

Answer
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C-5
Preliminary Hydrologic Investigation
of the Equalization Basin Area
Geraghty & Miller
March 1987

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PRELIMINARY HYDROGEOLOGIC
INVESTIGATION OF THE EQUALIZATION
BASIN AREA
BTL SPECIALTY RESINS, INC.
ANDOVER, MASSACHUSETTS

March 1987

Geraghty & Miller, Inc.
Ground-Water Consultants
125 East Bethpage Road
Plainview, New York 11803

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1. Site Plan, Monitoring Wells and River Elevation Measurement Locations.
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FIGURES

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- C. Laboratory Report

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PRELIMINARY HYDROGEOLOGIC
INVESTIGATION OF THE EQUALIZATION
BASIN AREA
BTL SPECIALTY RESINS, INC.
ANDOVER, MASSACHUSETTS

INTRODUCTION

Geraghty & Miller, Inc. conducted a preliminary field investigation at the BTL Specialty Resins, Inc. plant in Andover, Massachusetts. The plant site was the location of a former Reichhold Chemicals, Inc. facility that specialized in the manufacturing of phenolic resins. The objective of this investigation was to evaluate the effects of a remedial program initiated by Reichhold Chemicals, Inc. on the property north of the Shawsheen River. The program goal was to improve ground-water quality by pumping phenol-contaminated ground water from the aquifer. This report is a separate part of the comprehensive plant-wide investigation conducted by Geraghty & Miller, Inc., which was designed to define the extent of ground-water contamination at the BTL facility and



March 6, 1987

Mr. Ron Carter
Manager Environmental Affairs
BTL, Inc.
621 Dundas Street East
Belleville, Ontario K8N 5C5

Mr. Richard Mahanna
Plant Manager
BTL, Inc.
77 Lowell Junction Road
Andover, Massachusetts 01810

Re: Project No. N1120BT1

Dear Messrs. Carter and Mahanna:

We have enclosed a copy of the Geraghty & Miller, Inc. draft report "Preliminary Hydrogeologic Investigation of the Equalization Basin Area, BTL Specialty Resins, Inc., Andover, Massachusetts.

If you have any questions or comments, please call us. At such time we can incorporate your comments and issue a final report. We look forward to our continued services to BTL, Inc.

Sincerely,

GERAGHTY & MILLER, INC.

Robert J. Mozer
Project Manager

Olin C. Braids, Ph.D.
Project Officer

RJM:OCB:sm

cc: Robert van Voorhees
Eric Rothenberg
Michael Kowalski
✓ Paul Brustofski

its potential migration pathways and possible ground-water discharge points.

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FIELD INVESTIGATION

The field work was conducted in September and October 1986 and consisted of locating and confirming the reliability of existing ground-water monitoring wells for the collection of ground-water samples and ground-water level data. Existing monitoring well construction logs of wells installed by Clarence Welti Associates, under contract by Donald Reed, consulting geologist, were reviewed in detail. Detailed measurements of well depth, size and type of well casing and depth to water were made in the field and compared with the published construction details in order to identify the existing wells. A total of 18 monitoring wells were identified and labeled in accordance with their original well designation. The well construction details are presented in Table 1. The well locations are illustrated in Figure 1.

Water-Level Measurements and Surveying

On October 29, 1986 water-level measurements were made in all monitoring wells and at selected locations along the

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Shawsheen River using a steel measuring tape and chalk. At the time of measurement, the production well was pumping at an estimated 70 gallons per minute (gpm). On December 29, 1986, the water-level measuring point elevations of the existing monitoring wells were surveyed by Dana Perkins and Associates of Reading, Massachusetts. Table 3 summarizes the water-level measurements collected by Geraghty & Miller, Inc. and the surveyors' report is included in Appendix A. Based on these measurements, the direction and gradient of ground-water flow under pumping conditions was established.

Figure 2 presents the ground-water contour map developed from these water level data. The zone of influence from the pumping well extends radially from the well and intersects the Shawsheen River to the south and to the east as far as Well OW-13. Under these conditions, most of the ground water within this zone is contained by the pumping well while it is in operation. Arrows indicating generalized ground-water flow have been included on Figure 2 to illustrate the effects of the production well on ground-water flow conditions.

Water Sampling and Results**DRAFT**

Between September 4 and 6, 1986, nine of the existing monitoring wells were sampled for total phenols. In addition, three of these wells were sampled and analyzed for volatile organic compounds (VOCs), total organic carbon (TOC), and total dissolved solids (TDS). Monitoring well OW-13 was also analyzed for the full range of USEPA priority pollutants. This well, is directly adjacent to the Shaw-sheen River and has had a history of high phenol concentrations.

Sampling and data collection were in accordance with the protocols developed and used extensively by Geraghty & Miller, Inc. for ground-water investigations. Prior to sampling, three to five times the calculated volume of standing water was evacuated from each well with a centrifugal pump or PVC bailer. Low-yielding wells were bailed dry during this process and allowed to recover before a sample was taken. All water samples were collected with a bottom-filling PVC bailer that was thoroughly decontaminated with a laboratory grade detergent (MicroTM) and rinsed with distilled water between samplings. Bailer cord was disposed of after use to avoid cross-contamination. Field measurements of pH and specific conductance were made and recorded on-site during sampling.

For quality assurance/quality control (QA/QC) a field blank, a blind replicate and a trip sample were also collected and analyzed. The field blank was analyzed to determine the effectiveness of the decontamination protocols used by Geraghty & Miller, Inc. The blind replicate was analyzed to determine the ability of the laboratory to reproduce results of two samples from one well. The trip blank sample was analyzed to determine whether the samples were contaminated during shipment. All samples were shipped overnight to Cambridge Analytical Associates (CAA) of Boston, Massachusetts, in an ice-filled cooler along with the appropriate chain-of-custody forms. Copies of the chain-of-custody forms are included in Appendix B.

Results of laboratory analyses for total phenols, priority pollutants, and other organic and inorganic compounds are summarized in Tables 3, 4, 5 and 6. Phenol concentrations ranged from 0.10 - 330 mg/L and are illustrated in Figure 3. Wells OW-13, OW-12, and OW-17 exhibited the highest concentrations of phenol; 330, 290 and 82 mg/l were found, respectively. Each of these wells is adjacent to the Shawsheen River. For comparison purposes, the results of total phenol analysis reported by Donald Reed, Consulting Geologist (1979), are included on Figure 3. The concentrations of phenol detected in this investigation are higher in most monitoring wells as compared to the concentrations reported

by Donald Reed in 1979. The increase in phenol concentrations in the ground water at these locations appears to indicate that a source of phenol still exists and that the pumping well has had little effect on lowering the overall concentrations in the aquifer.

VOCs were present in samples from two of the three wells tested. Concentrations of ethylbenzene (840 ug/L), toluene (220 ug/L), acetone (7,400 ug/L), total xylenes (11,000 ug/L), 4 methyl-2-pentanone (MIBK, 16,000 ug/L), 2-butanone (MEK, 230 ug/L) and vinyl acetate (40 ug/L) were detected in samples from Well OW-13. The sample collected from Well OW-5 contained trace concentrations of 1,1,1-trichloroethane (1 ug/L) and trichloroethylene (5 ug/L). Arsenic was detected at 0.11 mg/L in Well GM-13. This concentration exceeds the Federal Primary Drinking Water and Massachusetts Department of Environmental Quality Engineering (DEQE) Standard of 0.05 mg/L.

The QA/QC blind replicate samples from Well OW-13 were in agreement with each other, indicating good laboratory reproducibility. The field blank sample contained less than the quantifiable concentrations of VOCs and indicates that the decontamination protocols used by Geraghty & Miller, Inc. were acceptable.

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FINDINGS AND CONCLUSIONS

1. Fifteen of the existing monitoring wells on the property located north of the Shawsheen River are usable as ground-water monitoring wells.

2. The site is underlain by unconsolidated sediments including gravel, sand, and silt to a depth of at least 46.5 feet below land surface.

3. Ground water on the property north of the Shawsheen River flows generally towards the production well when the well is pumping at an estimated 70 gpm. Under these conditions, the Shawsheen River acts as a source of ground-water recharge beginning at a point near Well GM-6 and extending northwards along the river; south of this point, the river acts as a ground-water divide.

4. High concentrations of phenol (330,000 ug/L and 290,000 ug/L) were detected in monitoring wells OW-13 and OW-12. Both wells are located immediately adjacent to the Shawsheen River.

5. High concentrations (above 35,000 ug/L) of dissolved VOCs were detected in a ground-water sample from Well OW-13.

Geraghty & Miller, Inc.

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6. Arsenic was detected in the ground water at 0.11 ug/L which is in excess of the DEQE drinking water standard.

Respectfully submitted,
GERAGHTY & MILLER, INC.

Robert J. Mozer
Project Manager

Olin C. Braids
Project Officer

RJM:OCB:sm

Table 1. Summary of Construction Details for Monitoring Wells Installed for BTL (Reichhold Chemicals, Inc.) by Donald E. Reed.

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Well Number	Date Completed	Depth Drilled (feet below land surface)	Screen Setting (feet below land surface)	Measuring Point Elevation (feet above mean sea level)	Depth to Bedrock (feet below land surface)	Status
OW-1	12/7/78	36.0	15-35		36.0	Destroyed
OW-2	12/5/78	36.5	15-35		>36.5	Destroyed
OW-3	12/4/78	46.5	18.8-38.8		46.5	Destroyed
OW-4	12/15/78	21.5	10-20	85.33	>21.5	Operational
OW-5	12/8/78	31.5	10-30	87.72	>31.5	Operational
OW-6	12/5/78	36.5	15-35		>36.5	Destroyed
OW-7	12/6/78	21.5	3.5-13.5		>21.5	Destroyed
OW-8	12/5/78	29.0	0-13		29.0	Destroyed
OW-9	12/15/78	21.5	7-17	81.24	>21.5	Operational
OW-10	12/15/78	16.5	4-14	74.29	>16.5	Operational
OW-11	12/15/78	16.5	2-12	71.49	>16.5	Operational
OW-12	12/15/78	16.5	5-15	71.97	>16.5	Operational
OW-13	Not Reported	14.0	4-14	74.39	14.0	Operational
OW-14	2/27/79	15.2	2-12	73.96	>15.2	Operational
OW-15	2/27/79	21.5	9-19	89.22	>21.5	Operational
OW-16	10/18/79	16.5	5-10	77.20	>16.5	Silted in
OW-17	10/18/79	11.5	5-10	72.42	11.5	Operational
OW-18	10/18/79	10.7	3-8		10.7	Destroyed
OW-19	10/18/79	11.5	5-10		11.5	Destroyed
OW-20	10/18/79	14.0	3-8		>14.0	Destroyed
OW-21	10/18/79	14.5			14.5	Not a well
OW-22	10/18/79	16.0	10-15		>16.0	Destroyed
OW-23	4/27/81	42.5	10-25		>42.5	Destroyed
OW-24	4/28/81	36.5	15-30	79.01	>36.5	Operational
OW-25	4/28/81	40.3	15-30	86.56	>40.3	Operational
OW-26	4/28/81	37.3	17.5-32.5	80.62	37.3	Sealed off
OW-27	4/29/81	40.1	20-35		>40.1	Operational
OW-28	4/30/81	31.5	15-30	82.01	>31.5	Sealed off
OW-29	4/30/81	31.5	15-30	82.24	>31.5	Operational
OW-30	4/30/81	31.5	15-30	80.15	>31.5	Operational
OW-31	5/16/81	31.5	15-30		>31.5	Destroyed

Table 2. Water-Level Measurements in Wells North of the Shawsheen River at BTL Speciality Resins, Inc., Andover, MA, October 29, 1986.

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Well Number	Measuring Point Elevation (feet above mean sea level)	Depth to Water (feet below mean sea level)	Water Level Elevation (feet above mean sea level)
OW-4	85.33	18.19	67.14
OW-5	87.72	19.80	67.92
OW-9	81.24	13.59	67.65
OW-10	74.29	7.05	67.24
OW-11	71.49	4.29	67.20
OW-12	71.97	4.20	67.77
OW-13	74.39	6.47	67.92
OW-14	73.96	5.75	68.21
OW-15	89.22	20.71	68.51
OW-17	72.42	4.25	68.17
OW-24	79.01	11.39	67.62
OW-25	86.56	19.02	67.54
OW-29	82.24	14.81	67.43
OW-30	80.15	12.66	67.49
SS-1	69.18	1.79	67.39
SS-2	75.56	8.45	67.11
SS-3	88.81	21.78	67.03
Supply Well	78.02	16.30	61.72
GM-5	74.17	6.18	67.99
GM-6S	73.91	5.64	68.27

Table 3. Volatile Organic Compound Concentrations in Ground Water, BTL Speciality Resins, Andover, Massachusetts.

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Field
Blank

QA/QC Replicates

Well Number:	OW-5	OW-15	OW-2	OW-13	OW-1
Date Sampled:	9/5/86	9/5/86	9/5/86	9/5/86	9/5/86
Sampled By:	G&M	G&M	G&M	G&M	G&M

 Volatile Organic Compounds
 (micrograms per liter)

acrolein	--	--	--	--	--
acrylonitrile	--	--	--	--	--
benzene	--	--	--	--	--
bis (chloromethyl) ether	--	--	--	--	--
bromoform	--	--	--	--	--
carbon tetrachloride	--	--	--	--	--
chlorobenzene	--	--	--	--	--
chlorodibromomethane	--	--	--	--	--
chloroethane	--	--	--	--	--
2-chloroethylvinyl ether	--	--	--	--	--
chloroform	--	--	--	--	--
dichlorobromomethane	--	--	--	--	--
dichlorodifluoromethane	--	--	--	--	--
1,1-dichloroethane	--	--	--	--	--
1,2-dichloroethane	--	--	--	--	--
1,2-dichloroethylene	--	--	--	--	--
1,1-dichloroethylene	--	--	--	--	--
1,2-dichloropropane	--	--	--	--	--
1,3-dichloropropylene	--	--	--	--	--
ethylbenzene	--	--	--	840	--
methyl bromide	--	--	--	--	--
methyl chloride	--	--	--	--	--
methylene chloride	--	--	--	--	--
1,1,2,2-tetrachloroethane	--	--	--	--	--
tetrachloroethylene	--	--	--	--	--
toluene	--	--	--	220	--
1,2-trans-dichloroethylene	--	--	--	--	--
1,1,1-trichloroethane	1	--	--	--	--
1,1,2-trichloroethane	--	--	--	--	--
trichloroethylene	5	--	--	--	--
trichlorofluoromethane	--	--	--	--	--
vinyl chloride	--	--	--	--	--
acetone	--	--	--	7,400	--
total xylenes	--	--	--	11,000	--
4-methyl-2-pentanone	--	--	--	16,000	--
2-butanone	--	--	--	230	--
vinyl acetate	--	--	--	40	--
total volatile organics	6	<1	<1	35,730	<1
Detection Limit:	1	1	1	10	1

Note: -- means not detected.

Table 4. Organic and Inorganic Compound Concentrations in Ground Water, BTL Speciality Resins, Andover, Massachusetts.

	QA/QC Replicates											Field Blank
	Well Number:	OW-5	OW-10	OW-11	OW-12	OW-13	OW-15	OW-2	OW-17	OW-27	OW-29	OW-1
Date Sampled:	9/5/86	9/5/86	9/4/86	9/4/86	9/5/86	9/5/86	9/5/86	9/5/86	9/6/86	9/5/86	9/5/86	9/5/86
Sampled By:	G&M	G&M	G&M	G&M	G&M	G&M	G&M	G&M	G&M	G&M	G&M	G&M
Parameter reported in mg/L												
phenols	0.21	0.37	0.25	290	330	0.10	0.10	82	0.97	2.2	--	
TDS	365	NA	NA	NA	2730	168	NA	NA	NA	NA	NA	NA
TOC	16.9	NA	NA	NA	803	17.8	NA	NA	NA	NA	NA	NA
silver	NA	NA	NA	NA	0.07	NA						
arsenic	NA	NA	NA	NA	0.11	NA						
beryllium	NA	NA	NA	NA	<0.005	NA						
cadmium	NA	NA	NA	NA	<0.001	NA						
total cyanide	NA	NA	NA	NA	<0.01	NA						
chromium	NA	NA	NA	NA	<0.025	NA						
copper	NA	NA	NA	NA	0.013	NA						
mercury	NA	NA	NA	NA	<0.0002	NA						
nickel	NA	NA	NA	NA	0.06	NA						
lead	NA	NA	NA	NA	<0.01	NA						
antimony	NA	NA	NA	NA	<0.025	NA						
selenium	NA	NA	NA	NA	<0.004	NA						
thallium	NA	NA	NA	NA	<0.03	NA						
zinc	NA	NA	NA	NA	0.11	NA						
Field Parameters												
pH	7.0	6.5	8.0	7.0	6.4	7.0	7.0	7.7	7.6	8.5	--	
specific conductance (umhos/cm)	725	525	906	2,250	3,200	375	375	1,575	1,000	590	--	

NA - Not Analyzed
 -- Not Detected

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Table 5. Acid, Pesticide, and PCB Concentrations in Monitoring Well OW-13, BTL Speciality Resins, Andover, Massachusetts.

Date Sampled: 9/5/86

Sampled By: G&M

Acid Compounds
(reported in ug/L)

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phenol	120,000
2-chlorophenol	--
2-nitrophenol	--
2,4-dimethylphenol	--
2,4-dichlorophenol	--
4-chloro-3-methylphenol	--
2,4,6-trichlorophenol	--
2,4-dinitrophenol	--
4-nitrophenol	--
4,6-dinitro-2-methylphenol	--
pentachlorophenol	--
2-methylphenol	4,600
4-methylphenol	1,100
benzoic acid	1,500
2,4,5-trichlorophenol	--

Detection Limit: 400

Pesticide/PCBs
(reported in ug/L)

alpha-BHC	--
beta-BHC	--
delta-BHC	--
gamma-BHC	--
Heptachlor	--
Aldrin	--
Heptachlor Epoxide	--
alpha-Endosulfan	--
Dieldrin	--
4,4'-DDE	--
Endrin	--
beta-Endosulfan	--
4,4'-DDD	--
Endrin Aldehyde	--
Endosulfan Sulfate	--
4,4'-DDT	--
Methoxychlor	--
Chlordane	--
Toxaphene	--
Arochlor-1016	--
Arochlor-1221	--
Arochlor-1232	--
Arochlor-1242	--
Arochlor-1248	--
Arochlor-1254	--
Arochlor-1260	--

Detection Limit: 0.05

Note: -- means not detected.

Table 6. Base/Neutral Concentrations in Monitoring Well OW-13, BTL Speciality Resins, Andover, Massachusetts.

Date Sampled: 9/5/86
 Sampled By: G&M

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Base/Neutral Compounds
 (reported in ug/L)

bis (2-chloroethyl) ether	--
1,3-dichlorobenzene	--
1,4-dichlorobenzene	--
1,2-dichlorobenzene	--
bis (2-chloroisopropyl) ether	--
n-nitrosodi-n-propylamine	--
hexachloroethane	--
nitrobenzene	--
isophorone	--
bis (2-chloroethoxy) methane	--
1,2,4-trichlorobenzene	--
naphthalene	--
hexachlorobutadiene	--
hexachlorocyclopentadiene	--
2-chloronaphthalene	--
dimethyl phthalate	--
acenaphthylene	--
acenaphthene	--
2,4-dinitrotoluene	--
2,6-dinitrotoluene	--
diethyl phthalate	--
4-chlorophenyl phenyl ether	--
fluorene	--
n-nitrosodiphenylamine	--
4-bromophenyl phenyl ether	--
hexachlorobenzene	--
phenanthrene	--
anthracene	--
di-n-butyl phthalate	--
fluoranthene	--
pyrene	--
butyl benzyl phthalate	--
3,3-dichlorobenzidine	--
benzo (a) anthracene	--
bis (2-ethylhexyl) phthalate	--
chrysene	--
di-n-octyl phthalate	--
benzo (b) fluoroanthene	--
benzo (k) fluoranthene	--
benzo (a) pyrene	--
indeno (1,2,3-c,d) pyrene	--
dibenzo (a,h) anthracene	--
benzo (ghi) perylene	--
aniline	--
benzyl alcohol	--
4-chloroaniline	--
2-methylnaphthalene	--
2-nitroaniline	--
3-nitroaniline	--
dibenzofuran	--
4-nitroaniline	--

Detection Limit: 400



EXPLANATION

- OW9 ● LOCATION AND DESIGNATION OF GROUND-WATER MONITORING WELL
- SS-3 ■ LOCATION AND DESIGNATION OF RIVER ELEVATION MEASURING POINT

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SUBJECT: **SITE PLAN, MONITORING WELLS AND RIVER ELEVATION MEASUREMENT LOCATIONS**

FIGURE **1**

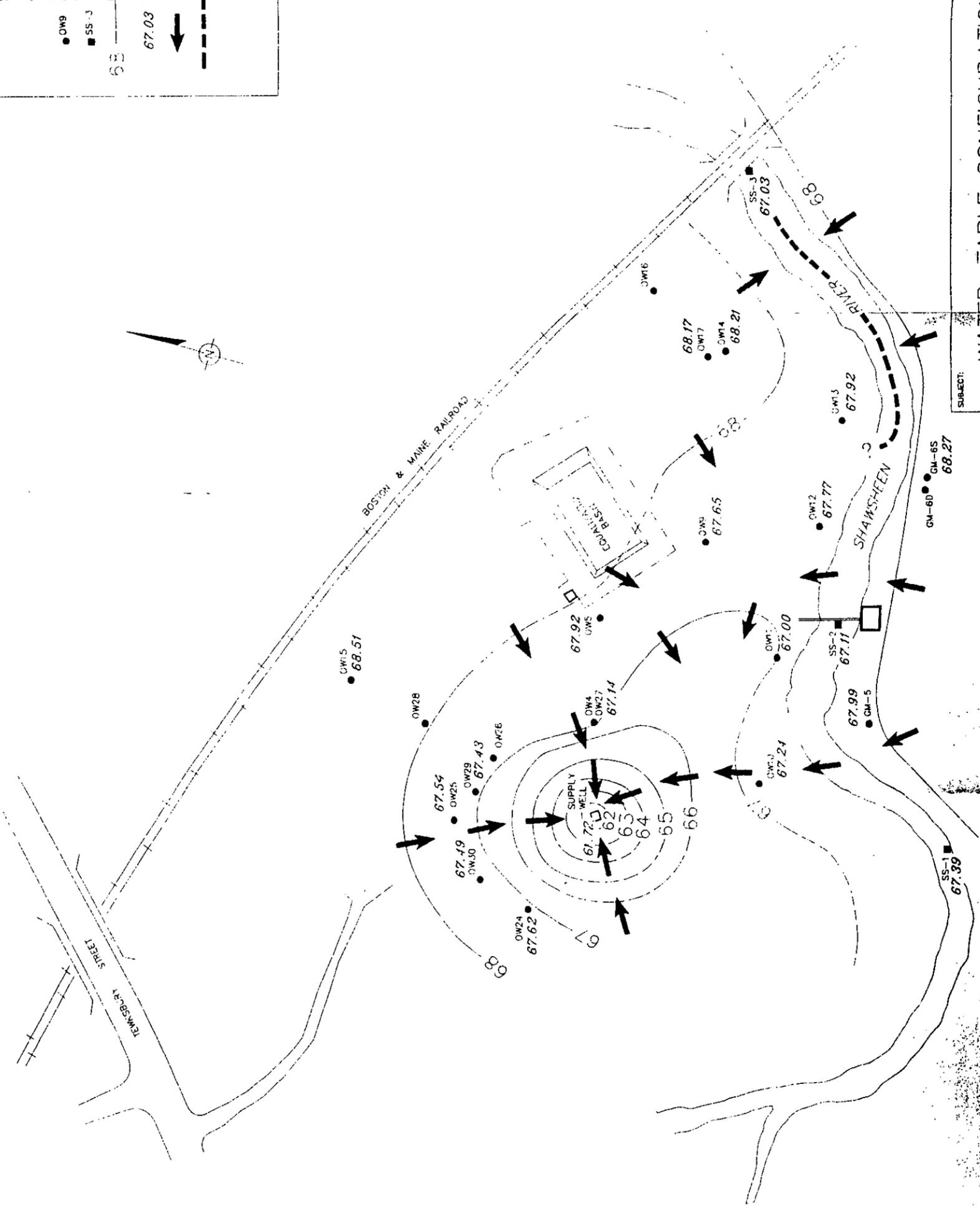


COMPILED BY: B.A. Blum
 PREPARED BY: W.H. Cicio
 PROJECT MGR.: R.J. Mozer

DATE: 2-87
 FILE NO.: N11208T1-

SCALE: shown

PREPARED FOR: BTL SPECIALTY RESINS, INC. Andover, Massachusetts



- EXPLANATION**
- OWB LOCATION AND DESIGNATION OF GROUND-WATER MONITORING WELL
 - SS-J LOCATION AND DESIGNATION OF RIVER ELEVATION MEASURING POINT
 - LINE OF EQUAL GROUND-WATER ELEVATION, IN FEET ABOVE MEAN SEA LEVEL (DASHED WHERE INFERRED)
 - 67.03 WATER-TABLE ELEVATION, IN FEET ABOVE MEAN SEA LEVEL
 - GENERALIZED DIRECTION OF THE HORIZONTAL COMPONENT OF GROUND-WATER FLOW
 - - - GROUND-WATER DIVIDE

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WATER-TABLE CONFIGURATION

OCTOBER 29, 1986

FIGURE 2

EXPLANATION

● OWS LOCATION AND DESIGNATION OF GROUND-WATER MONITORING WELL

■ SS-3 LOCATION AND DESIGNATION OF RIVER ELEVATION MEASURING POINT

— CONCENTRATION OF TOTAL PHENOL (MILLIGRAMS PER LITER)

0.10 0.10(B)

— QA/QC REPLICATE ANALYSIS

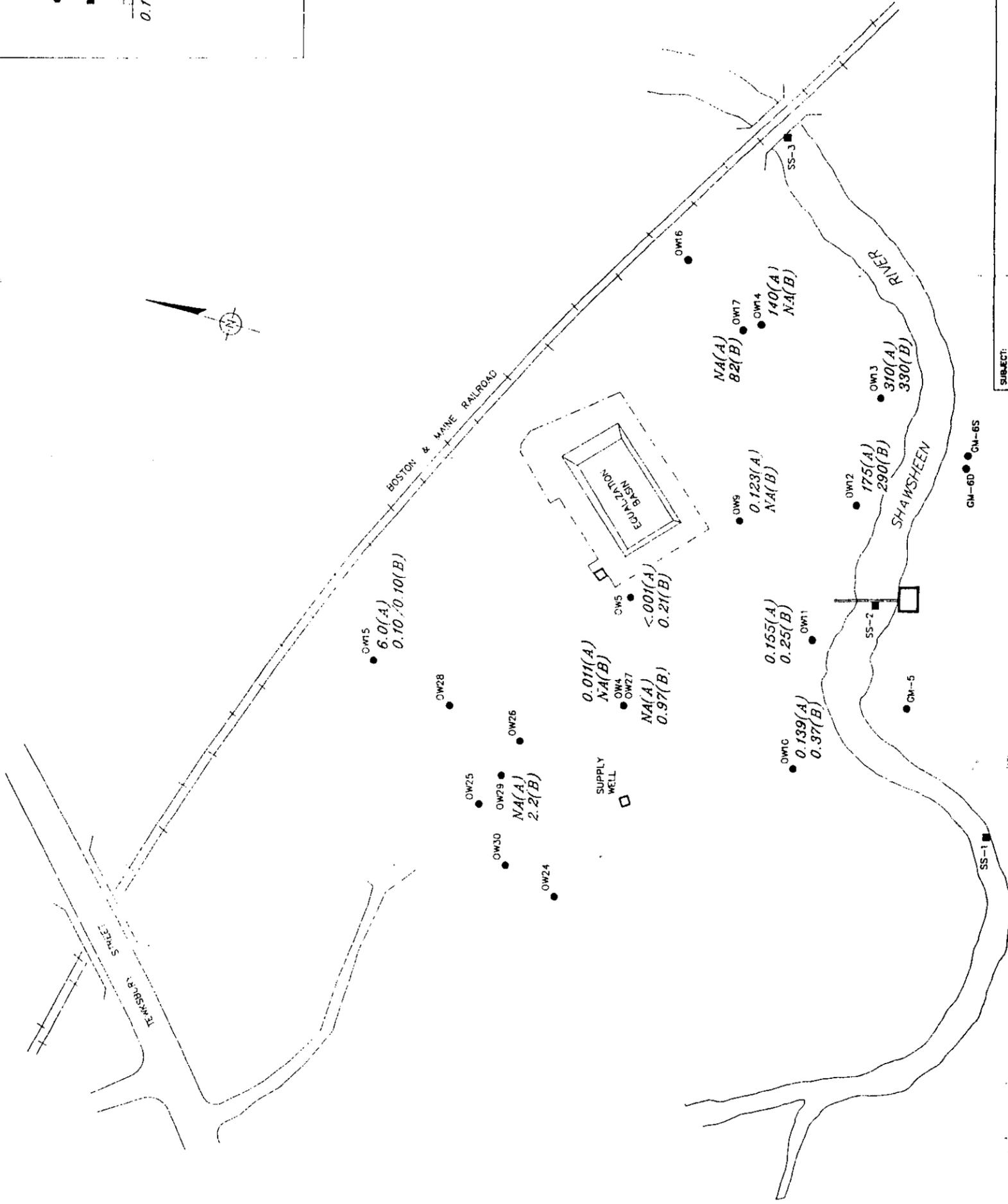
SOURCE

(A) - DONALD REED, CONSULTING GEOLOGIST, 1/79

(B) - GERAGHTY & MILLER, INC., 3/86

NA - NOT ANALYZED

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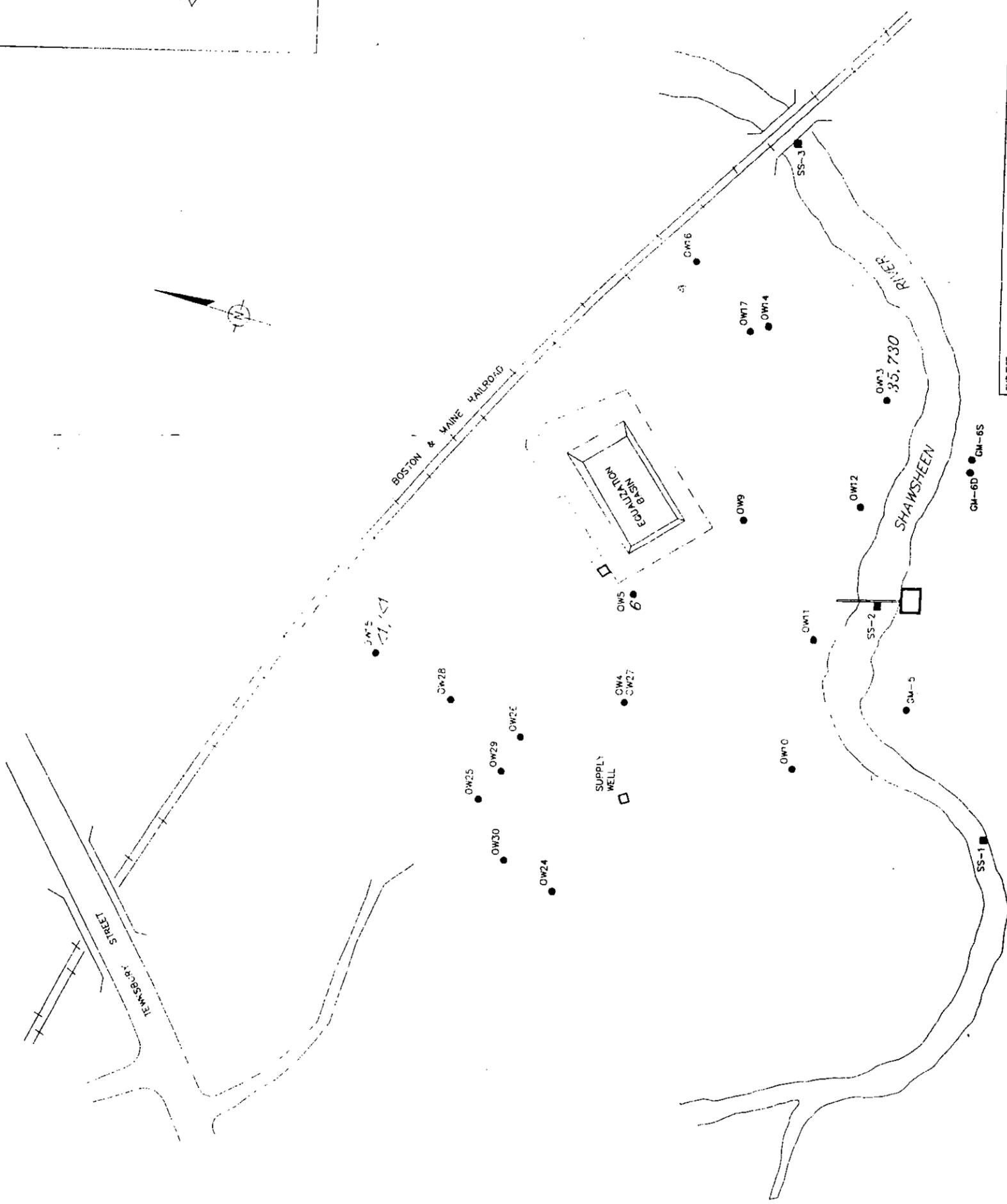


SUBJECT:

HISTORICAL DISTRIBUTION OF TOTAL PHENOL CONCENTRATIONS IN GROUND WATER

FIGURE

3



EXPLANATION

- OW9 LOCATION AND DESIGNATION OF GROUND-WATER MONITORING WELL
- SS-3 LOCATION AND DESIGNATION OF RIVER ELEVATION MEASURING POINT
- 35,730 CONCENTRATION OF TOTAL VOLATILE ORGANIC COMPOUNDS (PARTS PER BILLION)
- SA TOC REPLICATE

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SUBJECT: **DISTRIBUTION OF TOTAL VOLATILE ORGANIC COMPOUND CONCENTRATIONS IN GROUND WATER**

CLARENCE WELTI ASSOC., INC.
 986 NEW LONDON TURNPIKE
 GLASTONBURY, CONN. 06033

"BORING LOG"

PROJ. ANDOVER, MASS.
 CLIENT REICHOLD CHEMICAL

BORING NO. OW-3
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. 90.4

BORING NO. _____
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. _____

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
5.5	BR. FINE-CRS. SAND	6/6"	45.5
		22-38	
	BR. FINE-CRS. SAND & FINE-CRS. GRAVEL	25-45-40	
15.0		10-12-16	
	BR. FINE-MED. SAND		
2.0		6-10-12	
	BR. FINE-CRS. SAND	13-14-15	
		13-15-17	
		8-14-30	
39.0			
	REC/BR. FINE-MED. SAND, LITTLE FINE-CRS. GRAVEL	44-48-43	
15.0			

A	STRATUM DESCRIPTION	BLOWS PER	B
46.5	**	25-60-90	
	**DECOMPOSED ROCK, WEATHERED SCHIST		
	BOTTOM OF BORING 46.5 WATER AT 20.0 @ 0 HRS.		
	DATE: 12/4/78 DRILLER: GIGGEY		
	INSTALLED 20' WELL SCREEN + 20' 1 1/2" PVC PIPE TOTAL 40'		
	BOTTOM OF SCREEN: 38.8 PVC 1.2' ABOVE GROUND		

- COL. A STRATA DEPTH
- COL. B _____
- HAMMER = 140#; FALL 30"

AND - 40 to 50%
 SOME - 10 to 40%

"BORING LOG"

BORING NO. CW-7
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. 72.2

BORING NO. OW-8
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. 73.9

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
2.0	BLK. SILTY SAND		
5.0	BR. FINE-CRS. SAND		
	GR. FINE-CRS. SAND		
	SOME SILT, TR. FINE-CRS. GRAVEL	6-8-12	
5.0	GR. FINE-CRS. SAND, TR. FINE GRAVEL	6-10-12	
		7-10-12	
21.5		8-10-10	

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
	GR/BR. FINE-MED. SAND, SOME SILT		
4.0			
	GR/BR. FINE-CRS. SAND & FINE-CRS. GRAVEL, TR. SILT	40-32-35	
12.0		25-23-20	
	BR. FINE-CRS. SAND TR. FINE GRAVEL		
17.0		0-3-12	
	GR/BR. FINE-MED. SAND		
22.0		9-12-15	
	GR/RED FINE-CRS. SAND, TR. FINE GRAVEL	20-35-40	
29.0		100/1"	

BOTTOM OF BORING 21.5
 WATER AT 3.0 @ 0 HRS.

DATE: 12/6/78
 DRILLER: GIGGEY

INSTALLED 10' WELL SCREEN
 + 3.5' 1 1/2" PVC PIPE
 TOTAL 13.5'
 PVC 3.5' ABOVE GROUND

NOTE: PUMPED WELL UNTIL
 CLEAR (20 MIN.)

AUGER REFUSAL AT: 29.0'
 WATER AT 5.0 @ 0 HRS.

DATE: 12/5/78
 DRILLER: GIGGEY

INSTALLED 13' WELL SCREEN
 + 3.5' 1 1/2" PVC PIPE
 TOTAL 16.5'

BOTTOM OF SCREEN: 13'
 PVC 3.5' ABOVE GROUND

NOTE: PUMPED WELL DRY - T

1. COL. A STRATA DEPTH
2. COL. B _____
3. HAMMER = 140#; FALL 30"
4. SAMPLER = _____ O.D. SPLIT SPOON

AND - 40 to 50%
 SOME - 10 to 40%
 TRACE - 0 to 10%

CLARENCE WELTI ASSOC., INC.
 358 NEW LONDON TURNPIKE
 GLASTONBURY, CONN. 06033

"BORING LOG"

PROJ. ANDOVER, MASS.
 CLIENT REICHOLD CHEMICAL

BORING NO. OW-9
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. 77.7

BORING NO. OW-10
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. 70.9

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
0.7	BR. FINE-CRS. SAND, TR. FINE-CRS. GRAVEL		
		5-6-8	
			3
		13-13-15	
		4-5-8	
1.5	**TOPSOIL	4-5-7	
BOTTOM OF BORING		21.5	
WATER AT 9.0 @ 0 HRS.			
DATE: 12/15/78			
DRILLER: MOODIE			
INSTALLED WELL POINT 17'			
10' WELL SCREEN			
10' RISER			
3' STICK UP			

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
1.0	TOPSOIL		
	BR/BLK. FINE-MED. SAND, TR. ROOTS (RIVER WASH)		
		3-5-6	
7.0	BR. FINE-CRS. SAND TR. FINE-CRS. GRAVEL		
		4-6-9	
16.5		6-7-9	
BOTTOM OF BORING		16.5	
WATER AT 2.7 @ 0 HRS.			
DATE: 12/15/78			
DRILLER: MOODIE			
INSTALLED WELL POINT 14'			
10' WELL SCREEN			
7' RISER			
3' STICK UP			

1. CCL. A STRATA DEPTH
2. CCL. B _____
3. HAMMER = 140#; FALL 30"
- O D SPLIT SPOON

AND - 40 to 50%
 SOME - 10 to 40%

AFINCE WELTI ASSOC., INC.
 100 LONDON TURNPIKE
 ASTONBURY, CONN. 06033

"BORING LOG"

PROJ. _____
 CLIENT REICHOLD CHEMICAL

BORING NO. OW-11
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. 69.6

BORING NO. OW-12
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. 69.3

Q	STRATUM DESCRIPTION	BLOWS PER 6"	B
	TOP SOIL		
	BR. FINE-CRS. SAND, TR. FINE-CRS GRAVEL		
		4-7-9	
		4-6-7	
5		6-7-9	

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
	BLK. ORGANIC PEAT & SILT		
		1-2-4	
7.0			
	GR. FINE-CRS. SAND, SOME SILT, TR. FINE-CRS. GRAVEL		
		13-19-23	
15.5		14-16-19	

BOTTOM OF BORING 16.5
 WATER AT 3.0 @ 0 HRS.

DATE: 12/15/78
 DRILLER: MCCOIS

INSTALLED WELL POINT 12'
 10' WELL SCREEN
 3' RISER
 3' STICK UP

BOTTOM OF BORING 16.5
 WATER AT 3.5 @ 0 HRS.

DATE: 12/15/78
 DRILLER: MOODIE

INSTALLED WELL POINT 15'
 10' WELL SCREEN
 8' RISER
 3' STICK UP

- COL. A STRATA DEPTH
- COL. B _____
- HAMMER = 140#; FALL 30"
 CAMBER = _____ O.D. SPLIT SPOON

AND - 40 to 50%
 SOME - 10 to 40%
 TRACE - 0 to 10%

"BORING LOG"

BORING NO. OW-16

LINE & STA. _____

OFFSET _____

GR. ELEV. _____

BORING NO. OW-17

LINE & STA. _____

OFFSET _____

GR. ELEV. _____

A	STRATUM DESCRIPTION	BLOWS PER	B
3.0	br. black org. peat & silt	auger	
		auger	
10.0	br. gr. silty fine sand & fine sand	7-9-11-11	
11.0	gr. silty fine sand	9-17	
		22	
16.5	gr. silty fine sand tr. of med. sand & fine-crs. gravel	8-16-24	
	Bottom of Boring at 16.5		
	1-W.P. 10' deep 3' S.U. 5' W.S. 8' riser		
	Date: 10/18/79 Driller: Moodie		

A	STRATUM DESCRIPTION	BLOWS PER
2.0	br. black org. peat & silt	auger
3.5	gr. br. silty f.-sand	auger
5.0	*	auger
10.0	gr. fine-med. sand, some silt, tr. fine-med. gravel	8-10-11-14 14-19-64
11.5	decomposed rock	16-19-31
	*br. gr. fine-crs. sand some fine-crs. grav. tr. of silt	
	Bottom of Boring at 11.5	
	1-W.P. 10' deep 3' S.U. 5' W.S. 8' riser	
	Date: 10/18/79 Driller: Moodie	

1. COL. A _____
2. COL. B _____
3. HAMMER = 140#; FALL 30"
4. SAMPLER = _____ O.D. SPLIT SPOON

AND - 40 to 50%
 SOME - 10 to 40%
 TRACE - 0 to 10%

"BORING LOG"

BORING NO. OW-18
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. _____

BORING NO. OW-19
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. _____

A	STRATUM DESCRIPTION	BLOWS PER _____	B
2.0	br.bl.org.silt,peat	auger	
4.5	br.gr.silty f. sand	auger	
6.0		9-13	
		19-17	
	gr.silty fine sand tr. of fine-crs.	9-12-10-13	
10.0	gravel	14-60/2"	
	*br.fine-med. sand some fine-crs.grav. tr. of silt		
10.7	**decomposed rock		
	Bottom of Boring at 10.7		
	1-W.P. 8' deep 3' S.U. 5' W.S. 6' riser		
	Date: 10/18/79 Driller: Moodie		

A	STRATUM DESCRIPTION	BLOWS PER _____
2.0	*	auger
4.5	gr.fine sand & silt & fine sand	auger
	br.fine sand & silt & fine-med. sand, tr.of fine-crs.	top of spoon
10.0	gravel	
11.5	decomposed rock	16-19-33
	*br.org.silt,tr. of peat & fine sand	
	Bottom of Boring at 11.5	
	1-W.P. 10' deep 3' S.U. 5' W.S. 8' riser	
	Date: 10/18/79 Driller: Moodie	

1. COL. A _____
2. COL. B _____
3. HAMMER = 140#; FALL 30"
4. SAMPLER = _____ O.D. SPLIT SPOON

AND - 40 to 50%
 SOME - 10 to 40%
 TRACE - 0 to 10%

"BORING LOG"

BORING NO. OW-20

LINE & STA. _____
 OFFSET _____
 GR. ELEV. _____

BORING NO. OW-21

LINE & STA. _____
 OFFSET _____
 GR. ELEV. _____

A	STRATUM DESCRIPTION	BLOWS PER	B
1.5	*	auger	
3.5	gr. silty fine sand	auger	
		auger	
	gr. br. fine sand & silt, tr. of fine-med. sand & fine-crs. gravel	9-16-22-27	
		16-29-24-38	
		16-19-21	
14.0			
	*br. org. silt tr. of black peat		
	Auger Refusal at 14'		
	1-W.P. 8' deep 3' S.U. 5' W.S. 6' riser		
	Date: 10/18/79 Driller: Moodie		

A	STRATUM DESCRIPTION	BLOWS PER	B
2.5	black org. peat	auger	
	black org. sandy peat	auger	
5.0			
6.5	gr. br. silty f. sand	2-2-2	
7.0	*	3	
	gr. fine sand, some peat	2-2-3-2	
10.0			
	gr. fine-med. sand & silt, tr. of fine-crs. grav. & c. sand	12-15-19	
14.0		auger	
	*br. fine-crs. sand		
14.5	**decomposed rock		
	Auger Refusal at 14.5 (no well point)	5	
	Date: 10/18/79 Driller: Moodie		

1. COL. A _____
2. COL. B _____
3. HAMMER = 140#; FALL 30"
4. SAMPLER = _____ O.D. SPLIT SPOON
5. _____

AND - 40 to 50%
 SOME - 10 to 40%

"BORING LOG"

Andover, Mass.

PROJ. _____

CLIENT Donald Reed

BORING NO. OW 23

LINE & STA. _____

OFFSET _____

GR. ELEV. _____

BORING NO. _____

LINE & STA. _____

OFFSET _____

GR. ELEV. _____

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
1.0	br f sand & silt		
	br./gr.fine sand, tr,silt		
7.0		5-6-7	
	gr./br.fine-med. sand	4-8-10	
		6-8-10	
19.0			
	gr./br.fine-crs. sand,some fine grav.	10-24-23	
26.0			
	gr.fine-med.sand	10-11-12	
32.0		4-6-8	
	gr.fine-med.sand occ.f.grav.		
35.0			
	gr.fine sand,tr. fine grav.,lit. med.crs.sand	10-35-15	
41.6			
42.5	***	17-19-48	
0.2	**blk.topsoil & roots		

A	STRATUM DESCRIPTION	BLOWS PER	B
	***gr.fine sand, tr.silt, tr. fine grav.,occ. pebbles "till"		
	Bottom of Boring at 42.5'		
	Water at 0 hrs: 5'		
	1 Well 25' deep		
	15' PVC Screen		
	12' PVC Riser		
	27' Total PVC		
	Pumped Well at 15-20 Min. took 1/2 Gal. Sample		
	S-1 No odor		
	S-2 Slight odor		
	S-3 Slight odor		
	S-4 Some odor		
	S-5 Slight odor		
	S-6 Slight odor		
	S-7 Slight odor		
	S-8 Some odor		
	Water tested o.k.		
	Date: 4/27/81		
	Driller: Ursin		

1. COL. A Strata Depth
2. COL. B _____
3. HAMMER = 140#; FALL 30"
4. SAMPLER = _____ O.D. SPLIT SPOON

AND - 40 to 50%
 SOME - 10 to 40%
 FACT - 0.00 100%

"BORING LOG"

PROJ. Andover, Mass.

CLIENT Donald Reed.

BORING NO. OW 24
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. _____

BORING NO. _____
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. _____

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
2.5	br. f. sand, tr. silt		
	gr. fine sand		
9.0		4-5-10	
3.0	br. gr. fine sand tr. f. grav., lit. med. sand	6-15-50	
	gr. fine sand, tr. silt, with layers of br. f.-med. sand, tr. f. grav.	4-8-9	
21.0		6-10-12	
	br./gr. fine-med. sand, some crs. sand, tr. f. grav.		
6.5		7-8-9	
	crs. sand with thin 1" layers gr. f. sand & silt		
12.0		8-8-8	
	gr. br. fine sand, some silt, tr. med. sand, tr. f. grav "till"	20-30-28	
1.5	**blk. topsoil		

A	STRATUM DESCRIPTION	BLOWS PER	B
	Bottom of Boring at 36.5' Water at 0 hrs. 10'		
	1 Well 30' deep 15' PVC Screen 17' PVC Riser 32' Total PVC		
	Pumped Well at 15-20 Min. 1/2 Gal. sample		
	S-1 No odor S-2 No odor S-3 Slight odor S-4 Slight odor S-5 Slight odor, S-6 Slight odor, S-7 No odor		brownish cc brownish cc
	Date: 4/28/81 Driller: Ursin		

1. COL. A Strata Depth
2. COL. B _____
3. HAMMER = 140#; FALL 30"
4. SAMPLER = _____ O.D. SPLIT SPOON

AND - 40 to 50%
 SOME - 10 to 40%
 TRACE - 0 to 10%

"BORING LOG"

BORING NO. OW 25
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. _____

BORING NO. _____
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. _____

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
4.0	br. f.-med. sand, tr. fine grav. "fill"		
10.0	br./blk. fine med. sand, leaves, roots	3-1-1	
16.0	gr./br. fine sand	3-9-10	
17.5	***	10-8-11	
27.0	br. fine-crs. sand, some f.-grav., tr. med. grav.	12-11-10	
	br./gr. fine-med. sand, tr. silt	14-8-9	
36.0		5-9-12	
37.5	gr. f. sand & silt	8-11-9	
40.3	gr. f. sand, s. silt tr. f. grav., occ. cobb., "till"	6 3/4"	
10.5	**drk. br. fine sand tr. silt		

A	STRATUM DESCRIPTION	BLOWS PER	B
17.5	*** br. fine-med. sand, tr. fine grav.		
	Bottom of Boring at 40.3'		
	1 Well 35' deep		
	15' PVC Screen		
	22' PVC Riser		
	37' Total PVC		
	Water at 0 hrs. 13' Pumped Well		
	1/2 Gall. of Water Sample		
	S-1 No odor		
	S-2 No odor		
	S-3 No odor		
	S-4 No odor, br. color iron		
	S-5 No odor, br. color iron		
	S-6 Slight odor		
	S-7 No odor		
	S-8 No odor		
	Water tested		
	Date: 4/28/81		
	Driller: Ursin		

1. COL. A Strata Depth.
2. COL. B _____
3. HAMMER = 140#; FALL 30"
4. SAMPLER = _____ O.D. SPLIT SPOON

AND - 40 to 50%
 SOME - 10 to 40%

CLARENCE WELTI ASSOC., INC.
 P.O. BOX 397
 GLASTONBURY, CONN. 06033

"BORING LOG"

Reichnoid Chemical Co
 PROJ. Andover, Mass.
 CLIENT Donald Reed

BORING NO. OW 27
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. _____

BORING NO. _____
 LINE & STA. _____
 OFFSET _____
 GR. ELEV. _____

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
2.5	drk.br.f.sand,s. silt		
	gr./br.fine sand, silt	5-5-6	
9.0			
	br.fine sand,tr. med-crs.sand & f.grav.in 2"lay.	8-9-10	
15.0			
	br.fine-med.sand, lit.crs.sand,tr. fine gravel	6-8-9	
20.5			
		9-14-10	
	gr.fine-med.sand, some crs.sand, little grav.tr. silt	12-8-7	
		7-13-16	
31.8			
	gr.fine sand & silt,tr,f.grav.	16-18-19	
40.1	***	60/1"	
47.2	**blk.topsoil,roots		

A	STRATUM DESCRIPTION	BLOWS PER	B
40.1	***gr.f.sand,s. silt,with mica frag. "till"		
	Bottom of Boring at 40.1' Water at 0 hrs. 18'		
	1 Well 35' deep 15' PVC Screen 22' PVC Riser 37' Total PVC		
	S-1 No odor S-2 No odor S-3 No odor S-4 No odor		
	S-5 Slight odor S-6 Slight odor (light red water sample)		
	S-7 No odor S-8 No odor		
	Date: 4/29/81 Driller: Ursin		

- COL. A Strata Depth
- COL. B _____
- HAMMER = 140#; FALL 30"
- SAMPLER = _____ O.D. SPLIT SPOON

AND - 40 to 50%
 SOME - 10 to 40%

"BORING LOG"

PROJ. Andover, Mass.

CLIENT Donald Reed

BORING NO. OW 29

LINE & STA. _____

OFFSET _____

GR. ELEV. _____

BORING NO. _____

LINE & STA. _____

OFFSET _____

GR. ELEV. _____

A	STRATUM DESCRIPTION	BLOWS PER 6"	B
2.5	drk.br.f.sand,silt		
.0	***		
9.0	br.fine sand,s. med.sand,tr.fine grav.,tr.silt	3-5-6	
11.0	br./red fine-crs. sand,some fine, grav.	6-9-10	
15.0	gr.fine-crs.sand, tr.fine grav.	3-6-8	
21.0	br.fine-med.sand, some silt in layers 6"	12-8-5	
27.5	gr.fine-med.sand, tr.fine grav.,lt.	3-3-4	
31.5	cr.sand in layers	9-15-14	
0.2	**blk. topsoil		
4.0	***red/br.fine- med.sand, strong odor		

A	STRATUM DESCRIPTION	BLOWS PER	B
	Bottom of Boring at 31.5'		
	Water at 0 hrs. 16'		
	1 Well 30' deep		
	15' Well Screen		
	17' Riser		
	32' Total 1/2" PVC		
	2.5'-4' strong odor, fine-med.sand		
	S-1 No odor		
	S-2 No odor, 10'-11' red color fine-crs.sand, in 3		
	S-3 Slight odor, lit.red,		
	S-4 No odor		
	S-5 Slight odor		
	S-6 Slight odor in coarser material also light red in color		
	Pumped Well 1/2 hr. 1/2 gal. of sample		
	Date: 4/30/81		
	Driller: Ursin		

1. COL. A Strata Depth
2. COL. B _____
3. HAMMER = 140#; FALL 30"
4. SAMPLER = _____ O.D. SPLIT SPOON

AND - 40 to 50%
 SOME - 10 to 40%
 TRACE - 0 to 10%

DANA F. PERKINS & ASSOC., INC.

Consulting Engineers

January 9, 1987

Mr. Robert Mozer
Geraghty & Miller Inc.
25 East Bethpage Road
Plainview, New York 11803

RE: BTL Resins
Lowell Junction Road
Andover, Massachusetts

Dear Mr. Mozer:

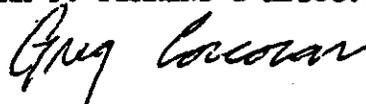
This letter is to inform you of the elevations of the monitoring wells at the above mentioned site. The elevations were established in the field on December 29, 1986. The elevations are based on U.S.C. & G.S. Datum.

<u>Well Number</u>	<u>Ground Elevation</u>	<u>PVC Elevation</u>	
OW-4	82.9	85.33	
OW-5	84.0	87.72	
OW-9	77.9	81.24	
OW-10	71.2	74.29	
OW-11	69.6	71.49	
OW-12	69.2	71.97	
OW-13	70.1	74.39	
OW-14	68.4	73.96	
OW-15	83.8	89.22	
OW-16	69.6	77.20	
OW-17	71.3	72.42	
OW-24	77.3	79.01	
OW-25	79.9	86.56	
OW-26	79.5	80.62	Top of Elbow
OW-28	81.0	82.01	Top of Elbow
OW-29	80.3	82.24	
OW-30	77.9	80.15	

If you have any questions regarding this information, please do not hesitate to call our office.

Very truly yours,

DANA F. PERKINS & ASSOC., INC.



Gregory Corcoran

GC/db

R E P O R T T O

**Geraghty & Miller, Inc.
125 East Bathpage Road
Plainview, NY 11803e**

Attn: Mr. Bob Mozer

**Work ID: BTL Resins NI120BT1
P.O. No.: NI120BT1
Work Order: 86-09-034**

**Cambridge Analytical Associates
Environmental Division
1106 Commonwealth Avenue
Boston MA 02215**



REPORT Geraghty & Miller, Inc.
TO 125 East Bethpage Road
Plainview, NY 11803e

ATTEN Brian Blum

CLIENT GER MIL NY SAMPLES 11
COMPANY Geraghty & Miller, Inc.
FACILITY 125 East Bethpage Road
Plainview, NY 11803

WORK ID N1120BT1
TAKEN By Brian Blum
TRANS By Federal Ex. #1667123371
TYPE Aqueous
P.O. # N1120BT1
INVOICE under separate cover

PREPARED Cambridge Analytical Assoc.
BY Environmental Division
1106 Commonwealth Avenue
Boston, MA 02215

ATTEN
PHONE 617-232-2207

CONTACT LAWLER

Edward P. Spiller
CERTIFIED BY

This report is approved for release by the following staff:
Laboratory Director: *John P. Spiller*
Inorganic Laboratory: *John P. Spiller*
Organic Laboratory: *John P. Spiller*

SAMPLE IDENTIFICATION

- 01 OW-12
- 02 OW-11
- 03 OW-10
- 04 OW-27
- 05 OW-5
- 06 OW-1
- 07 OW-2
- 08 OW-15
- 09 OW-13
- 10 OW-17
- 11 OW-29

TEST CODES and NAMES used on this report

- ABN A ABN(GC/MS)-aqueous-EPA 625
- AG I A Silver (Ag)-ICP
- AS GFA Arsenic (As)-furnace AAS
- BE I A Beryllium (Be)-ICP
- CD GFA Cadmium (Cd)-furnace AAS
- CNT A Total cyanide-EPA 335.3
- CR I A Chromium (Cr)-ICP
- CU I A Copper (Cu)-ICP
- DIG AQ Acid digestion-aqueous-EPA
- EXABNA A/B/N ext-aqueous-EPA 625
- EXPESA Ext-pest/PCBs-EPA 608
- HG CVA Mercury (Hg)-cold vapor
- NI I A Nickel (Ni)-ICP
- PB GFA Lead (Pb)-furnace AAS
- PEST A Pesticides/PCBs-ag-EPA 608
- PHEN A Phenols-EPA 420.2
- SB GFA Antimony (Sb)-furnace
- SE GFA Selenium (Se)-furnace
- TDS Dissolved solids-EPA 160.1
- TL GFA Thallium (Tl)-furnace

- TOC A Organic carbon-EPA 415.1
- V624 A VOC-aqueous-EPA 624
- ZN I A Zinc (Zn)-ICP



SAMPLE # 01 FRACTIONS: A
Date & Time Collected 09/04/86 Category _____

SAMPLE ID OW-12
PHEN_A 290
mg/l

SAMPLE # 02 FRACTIONS: A
Date & Time Collected 09/04/86 Category _____

SAMPLE ID OW-11
PHEN_A 0.25
mg/l

SAMPLE # 03 FRACTIONS: A
Date & Time Collected 09/05/86 Category _____

SAMPLE ID OW-10
PHEN_A 0.37
mg/l

SAMPLE # 04 FRACTIONS: A
Date & Time Collected 09/05/86 Category _____

SAMPLE ID OW-27
PHEN_A 0.97
mg/l

SAMPLE # 05 FRACTIONS: A,B,C
Date & Time Collected 09/05/86 Category _____

SAMPLE ID OW-5
PHEN_A 0.21 TDS _____
mg/l 365 TOC_A 16.9
mg/l mg/l

SAMPLE # 07 FRACTIONS: A,B
Date & Time Collected 09/05/86 Category _____

SAMPLE ID OW-2
PHEN_A 0.10
mg/l



Results by Sample

Received: 09/08/86

SAMPLE ID OW-15 FRACTIONS: A,B,C Category _____
 Date & Time Collected 09/05/86

PHEN_A 0.10 TDS 168 TOC_A 17.8
 mg/l mg/l mg/l

SAMPLE ID OW-13 FRACTIONS: A,B,C,D,E,F,G Category _____
 Date & Time Collected 09/05/86

AG_I_A 0.07 AS_GFA 0.11 BE_I_A <0.005 CD_GFA <0.001 CNT_A <0.01 CR_I_A <0.025
 mg/l mg/l mg/l mg/l mg/l mg/l

CU_I_A 0.013 DIG_AQ 09/24/86 EXABNA 09/09/86 EXPESA 09/10/86 HG_CVA <0.0002 NI_I_A 0.06
 mg/l date complete extraction date extraction date mg/l mg/l

PB_GFA <0.01 PHEN_A 330 SB_GFA <0.025 SE_GFA <0.004 TDS 2730 TL_GFA <0.03
 mg/l mg/l mg/l mg/l mg/l

TOC_A 803 ZN_I_A 0.11
 mg/l mg/l

SAMPLE ID OW-17 FRACTIONS: A Category _____
 Date & Time Collected 09/06/86

PHEN_A 82
 mg/l

SAMPLE ID OW-29 FRACTIONS: A Category _____
 Date & Time Collected 09/05/86

PHEN_A 2.2
 mg/l



SAMPLE ID QW-13

FRACTION Q2F TEST CODE ABN A

NAME ABN(GC/MS) -aqueous-EPA 525

Date & Time Collected 09/05/86

Category

Analysis

Completed: 09/30/86

BASE/NEUTRALS

COMPOUND	ug/L(a)	COMPOUND	ug/L(a)
bis(2-Chloroethyl) Ether		Di-n-butylphthalate	
1,3-Dichlorobenzene		Fluoranthene	
1,4-Dichlorobenzene		Pyrene	
1,2-Dichlorobenzene		Butylbenzylphthalate	
bis(2-Chloroisopropyl) Ether		3,3'-Dichlorobenzidine	
N-Nitroso-di-n-propylamine		Benzo(a)Anthracene	
Hexachloroethane		bis(2-Ethylhexyl)phthalate	
Nitrobenzene		Chrysene	
Isophorone		Di-n-octylphthalate	
bis(2-Chloroethoxy)Methane		Benzo(b)Fluoranthene	
1,2,4-Trichlorobenzene		Benzo(k)Fluoranthene	
Naphthalene		Benzo(a)Pyrene	
Hexachlorobutadiene		Indeno(1,2,3-cd)Pyrene	
Hexachlorocyclopentadiene		Dibenzo(a,h)Anthracene	
2-Chloronaphthalene		Benzo(g,h,i)Perylene	
Dimethylphthalate			
Acenaphthylene		The following are non-priority pollutant Hazardous Substance List compounds.	
Acenaphthene		Aniline	
2,4-Dinitrotoluene		Benzyl Alcohol	
2,6-Dinitrotoluene		4-Chloroaniline	
Diethylphthalate		2-Methylnaphthalene	
4-Chlorophenyl-phenylether		2-Nitroaniline	
Fluorene		3-Nitroaniline	
N-Nitrosodiphenylamine		Dibenzofuran	
4-Bromophenyl-phenylether		4-Nitroaniline	
Hexachlorobenzene			
Phenanthrene			
Anthracene			
		DETECTION LIMIT	400

(a) - Concentrations less than the detection limit are left blank. Concentrations between 1 and 10 times the detection limit are listed as trace levels 'TR'.



SAMPLE ID OW-13

FRACTION 09F TEST CODE ABN A NAME ABN(GC/MS)-aqueous-EPA 525
Date & Time Collected 09/05/86 Category _____

ACID COMPOUNDS

	ug/L(a)
Phenol.....	120,000
2-Chlorophenol.....	_____
2-Nitrophenol.....	_____
2,4-Dimethylphenol.....	_____
2,4-Dichlorophenol.....	_____
4-Chloro-3-methylphenol.....	_____
2,4,6-Trichlorophenol.....	_____
2,4-Dinitrophenol.....	_____
4-Nitrophenol.....	_____
4,6-Dinitro-2-methylphenol.....	_____
Pentachlorophenol.....	_____
2-Methylphenol.....	4,600
4-Methylphenol.....	11,000
Benzoic Acid.....	TR(1500)
2,4,5-Trichlorophenol.....	_____
DETECTION LIMIT.....	400

The following are non-priority pollutant
Hazardous Substance List compounds.

(a) - Concentrations less than the detection limit are left blank. Concentrations between 1 and 10 times the detection limit are listed as trace levels 'TR'.



SAMPLE ID OW-13

FRACTION 09G TEST CODE PEST A NAME Pesticides/PCBS-ag-EPA 608
Date & Time Collected 09/05/86

Category

Analysis

Completed: 9/12/86

Compound	ug/L(a)
alpha-BHC.....	_____
beta-BHC.....	_____
delta-BHC.....	_____
gamma-BHC (Lindane).....	_____
Heptachlor.....	_____
Aldrin.....	_____
Heptachlor Epoxide.....	_____
alpha-Endosulfan.....	_____
Dieldrin.....	_____
4,4'-DDE.....	_____
Endrin.....	_____
beta-Endosulfan.....	_____
4,4'-DDD.....	_____
Endrin Aldehyde.....	_____
Endosulfan Sulfate.....	_____
4,4'-DDT.....	_____
Methoxychlor.....	_____
Chlordane.....	_____
Toxaphene.....	_____
Aroclor 1016.....	_____
Aroclor 1221.....	_____
Aroclor 1232.....	_____
Aroclor 1242.....	_____
Aroclor 1248.....	_____
Aroclor 1254.....	_____
Aroclor 1260.....	_____

DETECTION LIMIT..... 0.05

(a) - Concentrations less than the detection limit are left blank.
Concentrations meeting identification criteria that are less than the method detection limit are listed as trace levels 'TR'. Detection limits for Aroclors are ten times the nominal detection limit.

SAMPLE ID OW-13

FRACTION Q9B TEST CODE V624 A NAME VOL-AQUEOUS-EPA 643

Date & Time Collected 02/05/86 Category

Analysis Completed: 9/15/86

COMPOUND

ug/L(ppb) (a)

COMPOUND

ug/L(ppb) (a)

Chloromethane.....
 Bromomethane.....
 Vinyl Chloride.....
 Chloroethane.....
 Methylene Chloride.....
 1,1-Dichloroethylene.....
 1,1-Dichloroethane.....
 trans-1,2-Dichloroethylene.....
 Chloroform.....
 1,2-Dichloroethane.....
 1,1,1-Trichloroethane.....
 Carbon Tetrachloride.....
 Bromodichloromethane.....
 1,2-Dichloropropane.....
 trans-1,3-Dichloropropene.....
 Trichloroethylene.....
 Chlorodibromomethane.....
 1,1,2-Trichloroethane.....
 Benzene.....
 cis-1,3-Dichloropropene.....

2-Chloroethylvinyl Ether.....
 Bromoform.....
 1,1,2,2-Tetrachloroethane.....
 Tetrachloroethylene.....
 Toluene.....
 Chlorobenzene.....
 Ethylbenzene.....
 total Xylenes.....

The following are non-priority pollutant
 Hazardous Substance List compounds.

Acetone.....
 Carbon Disulfide.....
 2-Butanone (MEK).....
 Vinyl Acetate.....
 2-Hexanone (MPK).....
 4-Methyl-2-pentanone (MIBK).....
 Styrene.....

DETECTION LIMIT.....

(a) - Concentrations less than the detection limit are left blank
 Concentrations between 1 and 10 times the detection limit
 are listed as trace levels 'TR'.



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Geraghty & Miller, Inc.

NOTES ON VOLATILE ANALYSIS:

The volatile fraction of sample 8609034-05 contains two non-priority pollutant compounds tentatively identified as 3-methyl-2-butanone with an estimated concentration of 20ppb, and 2-methyl-4-heptanone with an estimated concentration of 40ppb.



TEST CODE ABN A NAME ABN(GC/MS)-aqueous-EPA 625

Method Reference: U.S. EPA, 1984. Methods for Organic Analysis of Municipal and Industrial Wastewater. Appendix A. 40CFR Part 136. Federal Register, Vol. 49, No. 209. Method 625, test method for base/neutral and acid organic compounds.

Method Description: The analytes in an aqueous sample are isolated and concentrated by solvent extraction. The extract is injected into a gas chromatograph (GC) where the analytes are separated and detected with a mass spectrometric (MS) detector.

Quality Control Procedures: The GC/MS is tuned every twelve hours with decafluorotriphenylphosphine (DFTPP). Instrument response is calibrated every twelve hours using EPA traceable standard reference solutions. Analytes are quantified using the internal standard method. Surrogate standard compounds are added to every sample to monitor method performance. Additional quality control includes the analysis of replicates, duplicate matrix spikes, and blanks.

TEST CODE AG I A NAME Silver (Ag)-ICP

Method Reference: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 200.7-Inductively Coupled Plasma-Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes.

Method Description: Silver is determined by inductively coupled argon plasma emission spectroscopy on a Jarrell-Ash Model 2000 sequential plasma spectrometer.

Quality Control Procedures: The instrument is calibrated using a blank and a 10 ppm standard. Accuracy of the working standards is verified by analysis of an independent EPA or NBS reference standard, and calibraton is checked every 10 samples during the run. Procedural blanks are prepared with each batch of samples. Duplicates and matrix spikes are analyzed at a frequency of 10 %.

TEST CODE AS GFA NAME Arsenic (As)-furnace AAS

Method Reference: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 206.2-arsenic (atomic absorption, graphite furnace).

TEST CODE AS_GFA NAME Arsenic (As)-furnace AAS

Additional References: EPA. 1982. Test Methods for Evaluating Solid Waste-Physical/Chemical Methods. SW-846 (Second edition). EPA/Office of Solid Waste and Emergency Response, Washington, DC. Method 7060.

Method Description: Arsenic is determined by graphite furnace atomic absorption spectrophotometry on a Perkin-Elmer Model 5000 atomic absorption spectrophotometer using stabilized-temperature platforms, matrix modification, and Zeeman-effect background correction.

Quality Control Procedures: The instrument is calibrated using a blank and at least three working standards. Accuracy of the working standards is verified by analysis of an independent EPA or NBS reference standard, and calibration is checked every 10 samples during the run. Procedural blanks are performed with each batch of samples. Duplicates and matrix spikes are performed at a frequency of 10 %.

TEST CODE BE_I_A NAME Beryllium (Be)-ICP

Method Reference: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 200.7-Inductively Coupled Plasma-Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes.

Method Description: Beryllium is determined by inductively coupled argon plasma emission spectroscopy on a Jarrell-Ash Model 2000 sequential plasma spectrometer.

Quality Control Procedures: The instrument is calibrated using a blank and a 10 ppm standard. Accuracy of the working standards is verified by analysis of an independent EPA or NBS reference standard, and calibration is checked every 10 samples during the run. Procedural blanks are prepared with each batch of samples. Duplicates and matrix spikes are analyzed at a frequency of 10 %.

TEST CODE CD_GFA NAME Cadmium (Cd)-furnace AAS

Method Reference: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 213.2-cadmium (atomic absorption, graphite furnace).



Received: 09/08/86

REF ID: A66034

Work Order # 466-034
Continued From Above

Test Methodology

TEST CODE CD GFA NAME Cadmium (Cd)-furnace AAS

Additional References: EPA. 1982. Test Methods for Evaluating Solid Waste-Physical/Chemical Methods. SW-846 (Second edition). EPA/Office of Solid Waste and Emergency Response, Washington, DC. Method 7131.

Method Description: Cadmium is determined by graphite furnace atomic absorption spectrophotometry on a Perkin-Elmer Model 5000 atomic absorption spectrophotometer using stabilized-temperature platforms, matrix modification, and Zeeman-effect background correction, or a Perkin-Elmer Model 2380 atomic absorption spectrophotometer using stabilized temperature platforms, matrix modification, and deuterium arc background correction.

Quality Control Procedures: The instrument is calibrated using a blank and at least three working standards. Accuracy of the working standards is verified by analysis of an independent EPA or NBS reference standard, and calibration is checked every 10 samples during the run. Procedural blanks are performed with each batch of samples. Duplicates and matrix spikes are performed at a frequency of 10 %.

TEST CODE CNT A NAME Total cyanide-EPA 335.3

Method References: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 335.2-Cyanide, total (spectrophotometric). Method 335.3-cyanide, total (colorimetric, automated UV).

Method Description: Cyanide as hydrocyanic acid (HCN) is released from cyanide complexes by means of a reflux-distillation operation and absorbed in a scrubber containing sodium hydroxide solution. Cyanide ion in the absorbing solution is determined colorimetrically. Cyanide is converted to cyanogen chloride by reaction with chloramine-T at a pH less than 8 without hydrolyzing to cyanate. After the reaction is complete, color is formed by addition of pyridine-barbituric acid reagent. Absorbance is read at 578 nm. Colorimetric determinations are made using a Technicon AutoAnalyzer II.

QC Procedures: The spectrophotometer is calibrated using a blank and four working standards. Accuracy of the working standards is verified by analysis of an independent check standard. A procedural blank is run with each batch of samples, and duplicates and matrix spikes are run at a frequency of 10 %.

Received: 09/08/86

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Test Methodology

TEST CODE CR_I_A NAME Chromium (Cr)-ICP

Method References: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 200.7-Inductively Coupled Plasma-Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes.

Method Description: Chromium is determined by inductively coupled argon plasma emission spectroscopy on a Jarrell-Ash Model 2000 sequential plasma spectrometer.

Quality Control Procedures: The instrument is calibrated using a blank and a 10 ppm standard. Accuracy of the working standards is verified by analysis of an independent EPA or NBS reference standard, and calibrator is checked every 10 samples during the run. Procedural blanks are prepared with each batch of samples. Duplicates and matrix spikes are analyzed at a frequency of 10 %.

TEST CODE CU_I_A NAME COPPER (Cu)-ICP

Method Reference: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 200.7-Inductively Coupled Plasma-Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes.

Method Description: Copper is determined by inductively coupled argon plasma emission spectroscopy on a Jarrell-Ash Model 2000 sequential plasma spectrometer.

Quality Control Procedures: The instrument is calibrated using a blank and a 10 ppm standard. Accuracy of the working standards is verified by analysis of an independent EPA or NBS reference standard, and calibrator is checked every 10 samples during the run. Procedural blanks are prepared with each batch of samples. Duplicates and matrix spikes are analyzed at a frequency of 10 %.

TEST CODE DIG_AQ NAME Acid digestion-aqueous-EPA

Method Description: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Section 4.1.3.

Additional references: EPA. 1982. Test Methods for Evaluating Solid Waste-Physical/Chemical Methods. SW-846. EPA/Office of Solid Waste,

TEST CODE DIG AQ NAME Acid digestion-aqueous-EPA

Washington, DC.

Method Description: A 100-ml aliquot of sample is transferred to an acid-washed beaker. Following addition of 3 ml of concentrated Instra-analyzed nitric acid, the sample is placed on a hot plate and evaporated to near-dryness without boiling. After cooling, another 3-ml portion of acid is added, followed by 2 ml of 30 % hydrogen peroxide, and the sample is relaxed until digestion is complete (generally indicated by a yellow color). Additional acid is added until no change in sample composition is observed. The sample is again taken to near-dryness. For furnace AAS determinations, the sample is diluted to 100 ml with distilled, deionized water so that the final acid concentrations is 0.5 %. For flame AAS and ICP determinations, and for furnace determinations of Sb and Sn, the final dilution is performed with 1:1 HCl (5 ml/100 ml of solution). Insoluble material is removed by filtering or settling.



Received: 09/08/86

REPORT

Test Methodology

WORK ORDER # H6-1034

TEST CODE HG_CVA NAME Mercury (Hg)-cold vapor

Method Reference: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 245.1-Mercury (Manual Cold Vapor Technique).
Additional References: EPA. 1982. Test Methods for Evaluating Solid Waste. SW-846-Second edition. (Update No. 1-April 1984). EPA/Office of Solid Waste, Washington, DC. Method 7470-Mercury (Manual Cold-Vapor Technique).

Method Description: Mercury is determined in drinking, surface and saline waters, as well as domestic and industrial wastes by digestion of sample in sulfuric and nitric acids, followed by oxidation with potassium permanganate and potassium persulfate. Mercury in the digested sample is then measured by cold vapor atomic absorption spectrophotometry on a SpectroProducts Hg-3 analyzer.

Quality Control Procedures: Instrumental calibration is performed by analyzing a blank and four or more working standards. Accuracy of the working standards is verified by analysis of an independent EPA or NBS reference standard, and calibration is checked every 10 samples during the run. Procedural blanks are prepared with each batch of samples. Matrix spikes and duplicates are analyzed at a frequency of 10 %.

TEST CODE NI_LA NAME Nickel (Ni)-ICP

Method Reference: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 200.7-Inductively Coupled Plasma-Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes.

Method Description: Nickel is determined by inductively coupled argon plasma emission spectroscopy on a Jarrell-Ash Model 2000 sequential plasma spectrometer.

Quality Control Procedures: The instrument is calibrated using a blank and a 10 ppm standard. Accuracy of the working standards is verified by analysis of an independent EPA or NBS reference standard, and calibration is checked every 10 samples during the run. Procedural blanks are prepared with each batch of samples. Duplicates and matrix spikes are analyzed at a frequency of 10 %.

TEST CODE PB_GFA NAME Lead (Pb)-furnace AAS

Method Reference: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 239.2-lead (atomic absorption, graphite furnace).

Additional References: EPA. 1982. Test Methods for Evaluating Solid Waste-Physical/Chemical Methods. SW-846 (Second edition). EPA/Office of Solid Waste and Emergency Response, Washington, DC. Method 7421.

Method Description: Lead is determined by graphite furnace atomic absorption spectrophotometry on a Perkin-Elmer Model 5000 atomic absorption spectrophotometer using stabilized-temperature platforms, matrix modification, and Zeeman-effect background correction, or a Perkin-Elmer Model 2380 atomic absorption spectrophotometer using stabilized temperature platforms, matrix modification, and deuterium arc background correction.

Quality Control Procedures: The instrument is calibrated using a blank and at least three working standards. Accuracy of the working standards is verified by analysis of an independent EPA or NBS reference standard, and calibration is checked every 10 samples during the run. Procedural blanks are performed with each batch of samples. Duplicates and matrix spikes are performed at a frequency of 10 %.



TEST CODE PEST_A NAME Pesticides/PCBS-ag-EPA 608

Method Reference: U.S. EPA, 1984. Methods for Organic Analysis of Municipal and Industrial Wastewater. Appendix A. 40CFR Part 136. Federal Register, Vol. 49, No.209. Method 608, test method for Organochlorine Pesticides and PCBs.

Method Description: The analytes in an aqueous sample are isolated and concentrated by solvent extraction. The extract is injected into a gas chromatograph (GC) where the analytes are separated and detected with an electron capture detector (ECD).

Quality Control Procedures: Instrument response is calibrated every twelve hours using EPA traceable standard reference solutions. Analytes are quantified using the external standard method. Surrogate standard compounds are added to every sample to monitor method performance. Additional quality control includes the analysis of replicates, matrix spikes, duplicate matrix spikes, and blanks.

Received: 09/08/80

REPORT

Test Methodology

Work Order # 86-034

TEST CODE PHEN A NAME Phenols-EPA 420.2

Method Reference: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 420.2-phenol, total recoverable, automated 4-AAP with distillation).

Method Description: A 500-ml sample is distilled to remove phenolic material and then reacted with 4-aminocantipyrine in the presence of potassium ferricyanide at pH 10 to form a red-colored complex. Absorbance is measured at 505 or 520 nm. The colorimetry is performed utilizing a Technicon AutoAnalyzer II.

QC Procedures: The Technicon AutoAnalyzer II is calibrated using a blank and four working standards. Accuracy of the working standards is verified by analysis of an independent check standard. A procedural blank is run with each batch of samples, and duplicates and matrix spikes are run at a frequency of 10 %.



TEST CODE SB_GFA NAME Antimony (Sb)-furnace

Method Reference: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 204.2-antimony (atomic absorption, graphite furnace).

Additional References: EPA. 1982. Test Methods for Evaluating Solid Waste-Physical/Chemical Methods. SW-846 (Second edition). EPA/Office of Solid Waste and Emergency Response, Washington, DC. Method 7041.

Method Description: Antimony is determined by graphite furnace atomic absorption spectrophotometry on a Perkin-Elmer Model 5000 atomic absorption spectrophotometer using stabilized-temperature platforms, matrix modification, and Zeeman-effect background correction.

Quality Control Procedures: The instrument is calibrated using a blank and at least three working standards. Accuracy of the working standards is verified by analysis of an independent EPA or NBS reference standard, and calibration is checked every 10 samples during the run. Procedural blanks are performed with each batch of samples. Duplicates and matrix spikes are performed at a frequency of 10 %.

TEST CODE SE_GFA NAME Selenium (Se)-furnace

Method Reference: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 270.2-selenium (atomic absorption, graphite furnace).

Additional References: EPA. 1982. Test Methods for Evaluating Solid Waste-Physical/Chemical Methods. SW-846 (Second edition). EPA/Office of Solid Waste and Emergency Response, Washington, DC. Method 7740.

Method Description: Selenium is determined by graphite furnace atomic absorption spectrophotometry on a Perkin-Elmer Model 5000 atomic absorption spectrophotometer using stabilized-temperature platforms, matrix modification, and Zeeman-effect background correction.

QC Procedures: The instrument is calibrated using a blank and at least three working standards. Accuracy of the working standards is verified by analysis of an independent EPA or NBS reference standard, and calibration is checked every 10 samples during the run. Procedural blanks are performed with each batch of



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TEST CODE SE_GFA NAME Selenium (Se)-furnace

samples. Duplicates and matrix spikes are performed at a frequency of 10 %.

TEST CODE TL_GFA NAME Thallium (Tl)-furnace

Method Reference: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 279.2-thallium (atomic absorption, graphite furnace).

Additional References: EPA. 1982. Test Methods for Evaluating Solid Waste-Physical/Chemical Methods. SW-846 (Second edition). EPA/Office of Solid Waste and Emergency Response, Washington, DC. Method 7840.

Method Description: Arsenic is determined by graphite furnace atomic absorption spectrophotometry on a Perkin-Elmer Model 5000 atomic absorption spectrophotometer using stabilized-temperature platforms, matrix modification, and Zeeman-effect background correction.

Quality Control Procedures: The instrument is calibrated using a blank and at least three working standards. Accuracy of the working standards is verified by analysis of an independent EPA or NBS reference standard, and calibration is checked every 10 samples during the run. Procedural blanks are performed with each batch of samples. Duplicates and matrix spikes are performed at a frequency of 10 %.



TEST CODE TOC A NAME Organic carbon-EPA 415.1

Method Reference: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 415.1-Total Organic Carbon (Combustion or Oxidation).

Method Description: Total organic carbon is determined by converting organic carbon to carbon dioxide by wet chemical oxidation and measured by an infrared detector.

Quality Control Procedures: A calibration curve is established by measuring a blank and at least 3 standards. Accuracy of the working standards is verified by analysis of an independent EPA reference standard, and calibration is checked every 10 samples during the run. Procedural blanks are prepared with each batch of samples. Duplicates are analyzed at a frequency of 10 %.

TEST CODE V624_A NAME VOC-aqueous-EPA 624

Method Reference: U.S. EPA, 1984. Methods for Organic Analysis of Municipal and Industrial Wastewater. Appendix A. 40CFR Part 136. Federal Register, Vol. 49, No. 209. Method 624, test method for volatile organic compounds.

Method Description: The analytes in an aqueous sample are isolated and concentrated by purging the sample with inert gas and trapping them on an absorbant. The absorbant is thermally desorbed into a gas chromatograph (GC) where the analytes are separated and detected with a mass spectrometric (MS) detector.

Quality Control Procedures: The GC/MS is tuned daily with bromofluorobenzene (BFB). Instrument response is calibrated daily using EPA traceable standard reference solutions. Analytes are quantified using the internal standard method. Surrogate standard compounds are added to every sample to monitor method performance. Additional quality control includes the analysis of matrix spikes, duplicate matrix spikes, and blanks.

TEST CODE ZN_I_A NAME ZINC (Zn)-ICP

Method Reference: EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600-4/79-020 (Revised March 1983). EPA/EMSL, Cincinnati, Ohio. Method 200.7-Inductively Coupled Plasma-Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes.

Method Description: Zinc is determined by inductively coupled argon plasma emission spectroscopy on a Jarrell-Ash Model 2000 sequential plasma spectrometer.

Quality Control Procedures: The instrument is calibrated using a blank and a 10 ppm standard. Accuracy of the working standards is verified by analysis of an independent EPA or NBS reference standard, and calibration is checked every 10 samples during the run. Procedural blanks are prepared with each batch of samples. Duplicates and matrix spikes are analyzed at a frequency of 10 %.



Shipping Container ID: _____

Sampler(s) Brian A. Blum

SAMPLE CONTAINER DESCRIPTION

SAMPLE IDENTITY	Date Sampled	SAMPLE CONTAINER DESCRIPTION						Total	Remarks
		Phenols	Volatile Organics	TDS	Gran. Sol.	Turb. Matter	NB/Res/PB		
OW-12	9-4-86	1						1	
OW-11	9-4-86	1						1	
OW-10	9-5-86	1						1	
OW-27	↓	1						1	
OW-29	↓	1						1	
OW-5	↓	1	2					1	* TOG
OW-1	↓	2	2					4	
OW-2	↓	2	2					4	* TOG
OW-15	↓	1	2					3	* TOG
OW-13	↓	1	2			1	2	4	* TOG
OW-17	9-6-86	1						1	
							Total No. of Containers	27	

FIGURE 1.

Relinquished by: Brian Blum Organization: Geography Miller Received by: _____ Organization: _____
 Date: 9-6-86 Time: _____ Date: _____ Time: _____
 Relinquished by: _____ Organization: _____ Received by: _____ Organization: _____
 Date: _____ Time: _____ Date: _____ Time: _____
 Relinquished by: _____ Organization: _____ Received by: Diana Schuman Organization: Cambridge Analyt
 Date: 9/16/86 Time: 10 AM Date: _____ Time: _____

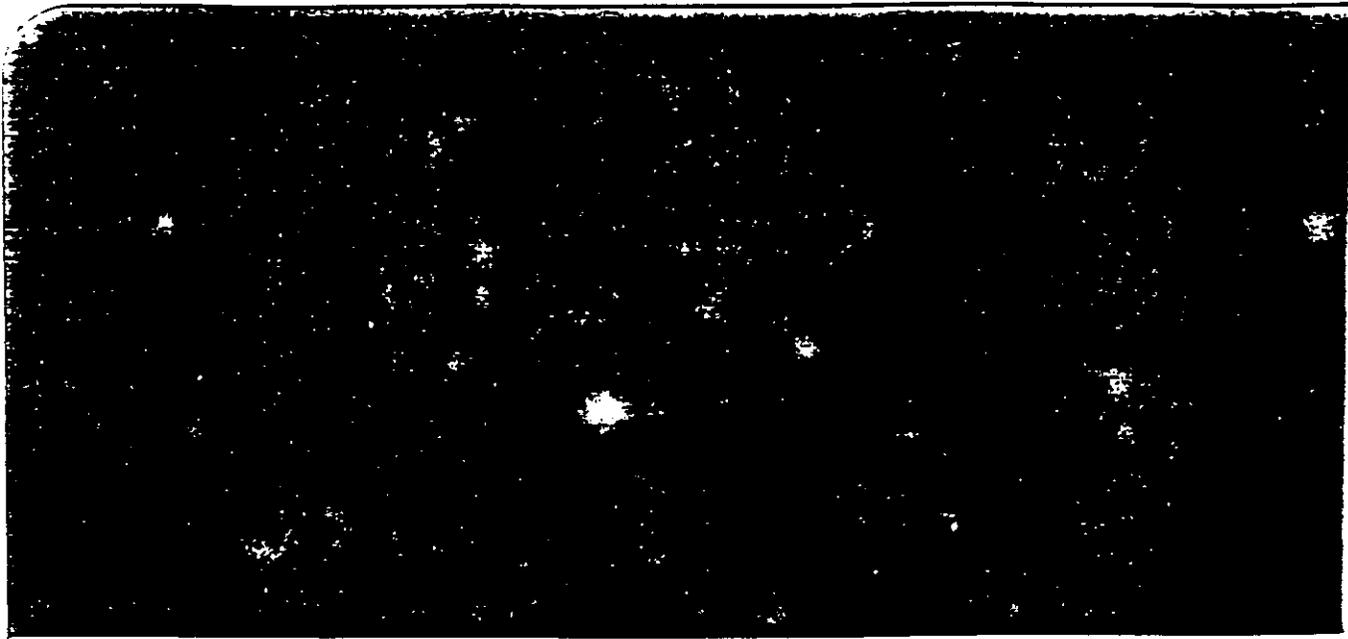


Method: FEDERAL EXPRESS

(attach shipping bill, if any)

(Use extra sheets, if necessary)

C-6
Site Investigation
O'Brien & Gere
September 1987



Site Investigation
77 Lowell Junction Road
North Andover, MA

Reichhold Chemicals, Inc.
White Plains, New York

September 1987



O'BRIEN & GERE

SITE INVESTIGATION REPORT

**77 Lowell Jct. Road
N. Andover, MA**

Prepared for:

**Reichhold Chemicals, Inc.
White Plains, NY**

September 1987

Prepared by:

**O'BRIEN & GERE ENGINEERS, INC.
Boston, MA**

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- 2.05 Ground Water Sampling

III. CONCLUSIONS AND RECOMMENDATIONS

- 3.01 Conclusions
- 3.02 Recommendations

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- 2 Ground Water Elevation Data
- 3 Volatile Organics & Phenol Data
- 4 Total Hydrocarbon Data

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- 2 Site Plan - Monitoring Well Locations
- 3 Ground Water Contour Map & Proposed Monitoring Well Locations
- 4 Concentration Map - Total Xylenes
- 5 Concentration Map - Ethylbenzene

APPENDICES

- A Boring Logs
- B Field GC Chromatographs
- C Analytical Data Sheets

SECTION 1 - INTRODUCTION

1.01 Background

The property at 77 Lowell Junction Road was sold by Reichhold Chemicals, Inc. to BTL, Inc. in the last quarter of 1986. We understand Reichhold has agreed to continue the investigation of an old landfill area on the eastern side of the plant shown on Figure 1.

An initial site investigation was completed in February 1987. A total of five (5) ground water monitoring wells (numbered GM-8 through GM-12) were installed within the landfill and in the immediate area around the landfill. The report concluded that ground water flows eastward from the landfill and analysis of the ground water at the landfill indicated the presence of volatile organics. The principal contaminants were benzene, toluene, xylenes and ethylbenzene.

Further investigation of ground water flow and definition of the lateral extent of contamination to the northeast of the landfill was recommended to gather information relative to evaluation of the appropriate course for remedial action.

1.02 Scope of Work

The following additional investigations were conducted to further characterize the site:

Monitoring Wells - Five (5) additional ground water monitoring wells were installed in the area surrounding the old landfill. Soil headspace samples were analyzed in the field for volatile organics using an portable gas chromatograph. Well locations were selected on the basis of site topography and the field screening of samples with the intent of identifying the direction and extent of migration of material from the landfill.

Ground Water Sampling - Ground water samples were collected from the five new monitoring wells (OBG1 - OBG5) and the five existing monitoring wells (GM-8 - GM-12) at the landfill. All samples were analyzed by the following methods: EPA Method 601 Volatile Halocarbons; EPA Method 602 Volatile Aromatics; and EPA 420.3 Phenols. Matrix spike, matrix spike duplicate, field blank samples were analyzed for QA/QC on the data.

SECTION 2 - FIELD INVESTIGATION

2.01 General

The monitoring well installation work was performed on July 30 and 31, 1987. Soil Exploration Corp. of Leominster, MA was the drilling subcontractor. Well sampling was performed on August 6, 1987. Access to the site was obtained through Reichhold Chemicals.

2.02 Soil Borings

Five (5) borings for monitoring well installations were progressed using a hollow-stem auger with split-spoon sampling using ASTM Method D-1586. Split-spoon sampling equipment was rinsed with water between samples. Boring locations are identified on Figure 2. Soil boring logs are attached in Appendix A.

Medium dense to very dense sand and gravel were characteristic of the site. A slightly confined water table condition was noted in a medium sand lense within boring OBG3. Perched water conditions were also noted at OBG3 and OBG4 where wet vegetation suggests the frequent accumulation of surface runoff.

Strong chemical odors were detected in OBG4; none were detected in other boring locations.

2.03 Soil Screening for Volatiles

Qualitative field analysis of soil sample headspace was performed using a Photvac Model 10S-50 Gas Chromatograph with the following setup:

Detector: PID
 Precolumn: 6-inch SE-30
 Analytical Column: 4-ft SE-30
 Column Temperature: Ambient
 Carrier Gas: Ultra-Zero Grade Air

WHY THESE AND NOT OTHERS?

Standards of benzene, toluene, and chlorobenzene were installed in the instrument calibration library for compound identification based on previous detection of those compounds in the landfill. Chromatograph printouts for unit calibration and analysis are shown in Appendix B. Unknown "ghost peaks" on the chromatograms were noted in the field. Subsequent laboratory analysis identified the presence of xylenes and dichlorobenzenes, which have very long retention times and would likely result in "ghost peaks".

Soil headspace analysis measures the presence of volatiles in air, and the analysis does not correlate directly to a soil concentration. Headspace analyses are summarized as follows:

Soil Headspace Field Analysis
(Concentration in Air)

Sample Location		OBG1	OBG2	OBG3	OBG4
Benzene	(ppm)	0.07	0.6	0.03	0.45
Toluene	(ppm)	0.60	0.4	0.49	0.56
Chlorobenzene	(ppm)	0.33	nd	0.14	0.23

*OTHERS
ADDED
- 3:5
AS HIGH
AS 3:54*

In addition to the calibrated peaks, there were several late eluting peaks for which there was a significant response in OBG4, but only slight response in OBG2. Samples for OBG1 and OBG3 were not run for long

enough times to detect the late eluting peaks. Laboratory analysis of ground water samples indicated that the late eluting peaks may have been xylenes.

Based on field GC analysis, the extent of contamination appeared limited to OBG4 which was closest to the landfill. A field survey of ground water elevations confirmed that wells OBG1 and OBG4 were downgradient of the landfill.

2.04 Monitoring Well Installation

Ground water monitoring wells were installed to obtain measurements of the ground water elevations and collect samples of ground water for chemical analysis.

Monitoring wells were installed using ten foot sections of 2-inch PVC well screen with 0.010 inch slots and solid 2-inch PVC riser. A well installation summary is listed on Table 1. Silica sand was placed around the well screen at least one foot above the apparent ground water table. A bentonite seal was placed over the sand and the well was completed with a 3-inch steel riser with locking cap set in concrete. Wells were developed after installation by bailing.

2.05 Ground Water Sampling

A. General

Ground water monitoring wells OBG1 through OBG 5 and GM8 through GM12 were sampled on August 6, 1987. Well sampling

protocols for purging the well prior to sampling, sample preservation, and chain of custody records were followed.

B. Ground Water Flow

Ground water elevations measured at the time of installation and on the sampling date are listed in Table 2. Water elevations measured on August 6 were used to construct the ground water contour map shown on Figure 3.

Ground water flow generally appears to be to the northeast from the landfill; however, there appears to be a component of flow in the due-east direction as indicated by the curvature in the contour lines around the landfill.

C. Ground Water Analysis

Ten (10) ground water samples were analyzed for volatile organics (EPA Methods 601/602) and phenols (EPA Method 420.3). Well locations are shown on Figure 2. Samples for wells OBG4 and GM11 were also analyzed for total hydrocarbons (EPA Method 503.1 and GC/FID) to determine whether the contamination showed a pattern resembling fuel oil or gas and whether the patterns were at all similar. A difference in the patterns would suggest either separate sources or differential migration of contaminants. Original laboratory report forms and QA/QC sample analysis report sheets are included in Appendix C.

1. Volatile Organics & Phenols

Test results for volatile organics and phenols are summarized on Table 3. Results for analysis from GM8 through GM11 agree well with earlier reports. Principal contaminants in the landfill include benzene, toluene, ethylbenzene and xylenes. East of the railroad tracks in down gradient well OBG4, benzene (15 ppb), ethylbenzene (160 ppb), xylenes (2300 ppb) and chlorobenzene (29 ppb) were the principal volatile organics detected. To the north and east (downgradient) of OBG4, only trace amounts of chlorobenzene (5 to 14 ppb) and xylenes (1-2 ppb) were detected in wells OBG1 through OBG3.

In summary, the extent of migration can be visualized by the preliminary ~~by the preliminary~~ concentration maps for total xylenes and ethylbenzene shown on Figure 3 and 4. Concentrations within the landfill are generally one or two orders of magnitude greater than in the downgradient area to the northwest.

Phenols were detected in the new downgradient monitoring wells (0.009 - 0.037 ppm) but the concentrations are orders of magnitude lower than those measured in the landfill (up to 14.5 ppm).

2. Total Hydrocarbon Analysis

Comparison of EPA Method 503.1 results for OBG4 and GM11 made on Table 4 indicates generally that the same

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compounds are present, but at much higher concentrations in GM11. Neither a fuel oil nor gasoline pattern was seen on either chromatograph.

SECTION 3 - CONCLUSIONS AND RECOMMENDATIONS

3.01 Conclusions

The following information and conclusions have been developed from the investigation program:

1. Ground water flow from the landfill appears to be to the northeast toward the Shawsheen river. There are currently no wells due east of the landfill to characterize whether the ground water table also flows to the east, although there appears to be some likelihood that it is occurring.
2. Analytical tests correlated well with data collected within the initial site investigation program for monitoring wells within the landfill.
3. Compounds identified within the landfill have been detected in monitoring well OBG4, east of the railroad tracks and about 150 feet north of the landfill area. The total concentration of volatile organics was 2,500 ppb, compared to the range of 8,700 to 39,400 ppb detected within the landfill. Principal constituents included benzene, toluene, ethylbenzene, xylenes and chlorobenzene.
4. Monitoring wells OBG1, OBG2 and OBG3 were placed further to the north and east of OBG4, sampled and analyzed; however,

only trace concentrations of xylenes and chlorobenzenes were detected in each well, and, in addition, a trace concentration of benzene was detected in OBG1.

5. Phenols were detected in the down gradient wells OBG1 through OBG4 at concentrations ranging from 0.009 to 0.037 ppm, compared with 0.025 to 14.8 ppm detected within the landfill.
6. The material detected within the landfill does not appear to be a fuel oil or gasoline product.
7. Testing of upgradient wells OBG5 and GM8 confirmed that there does not appear to be a source upgradient from the landfill.
8. Migration of dissolved constituents away from the landfill in the northeasterly direction is limited.
9. Based on the analysis of ground water in OBG1, the extent of migration of dissolved constituents to the east may also be limited, but this cannot be confirmed without conducting further investigations in the area due east of the landfill.

3.02 Recommendations

Based on the information and conclusions presented herein, we offer the following recommendations to Reichhold Chemicals for completing a full evaluation of the landfill area and developing a remedial action plan:

1. Install three (3) additional ground water monitoring wells due east of the landfill area in the proposed locations shown on Figure 3.
2. Survey the elevations of additional wells and measure ground water levels to characterize the ground water table and direction of ground water flow.
3. Sample the additional wells and re-sample existing wells OBG-1 through 4, and analyze the ground water by EPA Method 601/602 for volatile organics and EPA Method 420.3 for phenols.
4. Conduct in-situ permeability tests in each of the monitoring wells east of the railroad tracks to characterize the conductivity of the soils for a preliminary evaluation of ground water flow rates.
5. Following the determination of the extent of the contamination, the next step will be to conduct an analysis of remedial action alternatives for the site involving a review of appropriate technology, preliminary risk assessment and evaluation of the cost effectiveness of each alternative.

TABLE 1

Well Installation Summary

<u>Well</u>	<u>Diameter (in.)</u>	<u>Total Depth (ft)(1)</u>	<u>Screen Interval (ft)(1)</u>	<u>Ground Elevation FT(2)</u>	<u>Top of Casing Elevation FT(2)</u>
OBG1	2	18	8-18	76.17	78.09
OBG2	2	20	10-20	83.10	85.52
OBG3	2	18	8-18	73.21	76.08
OBG4	2	13.5	3.5-13.5	74.07	76.53
OBG5	2	13	3-13	81.54	84.84

(1) below ground surface

(2) above mean sea level

TABLE 2
Ground Water Elevations

<u>Well No.</u>	<u>GW Elevation (FT) (1)</u>
OBG-1	67.67
OBG-2	66.94
OBG-3	68.48
OBG-4	69.90
OBG-5	74.38
GM-8	73.38
GM-9	71.26
GM-10	71.86
GM-11	72.77
GM-12	73.38

(1) Measure on 8/6/87. Feet above mean sea level.

TABLE 3

3208.006
9/10/87

REICHOLD CHEMICALS
SITE EVALUATION
77 LOWELL JCT. ROAD
ANDOVER, MASS

GROUND WATER ANALYSIS
SAMPLE DATE: AUGUST 6, 1987

PARAMETER	UNITS	086-1	086-2	086-3	086-4	086-5	GM-8	GM-9	GM-10	GM-11	GM-12	FIELD BLANK
GSM: 624												
EPA Method 601/602: **												
CHLOROFORM	ppb	<1	<1	<1	<10	<1	<1	<100	9000	<100	<100	<1
BENZENE	ppb	3	<1	<1	15	<1	<1	<100	4000	2300	<100	<1
TOLUENE	ppb	<1	<1	<1	<10	<1	<1	100	1000	4300	50	<100
CHLOROBENZENE	ppb	5	6	14	29	<1	<1	<100	<1000	<1000	<100	<1
ETHYLBENZENE	ppb	<1	<1	<1	160	<1	<1	250	2600	2000	12000	900
XYLENES	ppb	2	2	1	2300	2	<1	9000	22000	64000	7000	<1
DICHLOROBENZENES	-	*	*	*	*	*	*	*	*	*	*	*
PHENOLS	ppm	0.009	0.012	0.026	0.037	<0.001	0.001	0.025	2.8	14.5	0.15	<0.001

NOTES: ** All other Method 601/602 compounds were below detection limits.
* Tentative identification of ortho- and para-dichlorobenzene; concentration not quantified



Packing Slip

2110 Hillsborough St.
Raleigh, NC 27607

(919) 832-1196
FAX 755-0173

Date: 2/20/95

To: RADIANT SYSTEMS

Attn: _____ Phone #: _____

Purchase Order Number: _____

Invoice attached? Yes No

Quantity	Description	Copies	Originals
	CAR WASH BOOKS W/O		
	COLOR COPIES —		
	10 BOOKS		
	14 BOOKS (10 BKS (P&R BOX))		

Delivered by: _____

Received by: _____

I hereby acknowledge that I have verified these items.



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Raleigh, NC 27607

(919) 832-1196
FAX 755-0173

Date: 2/20/95

To: RADIANT SYSTEMS

Attn: _____ Phone #: _____

Purchase Order Number: _____

Invoice attached? Yes No

Quantity	Description	Copies	Originals
	CAR WASH BDKS W/O		
	COLOR COPIES —		
	10 BDKS		
	14 BDKS (10 BKS / PK & BOX)		

Delivered by: _____

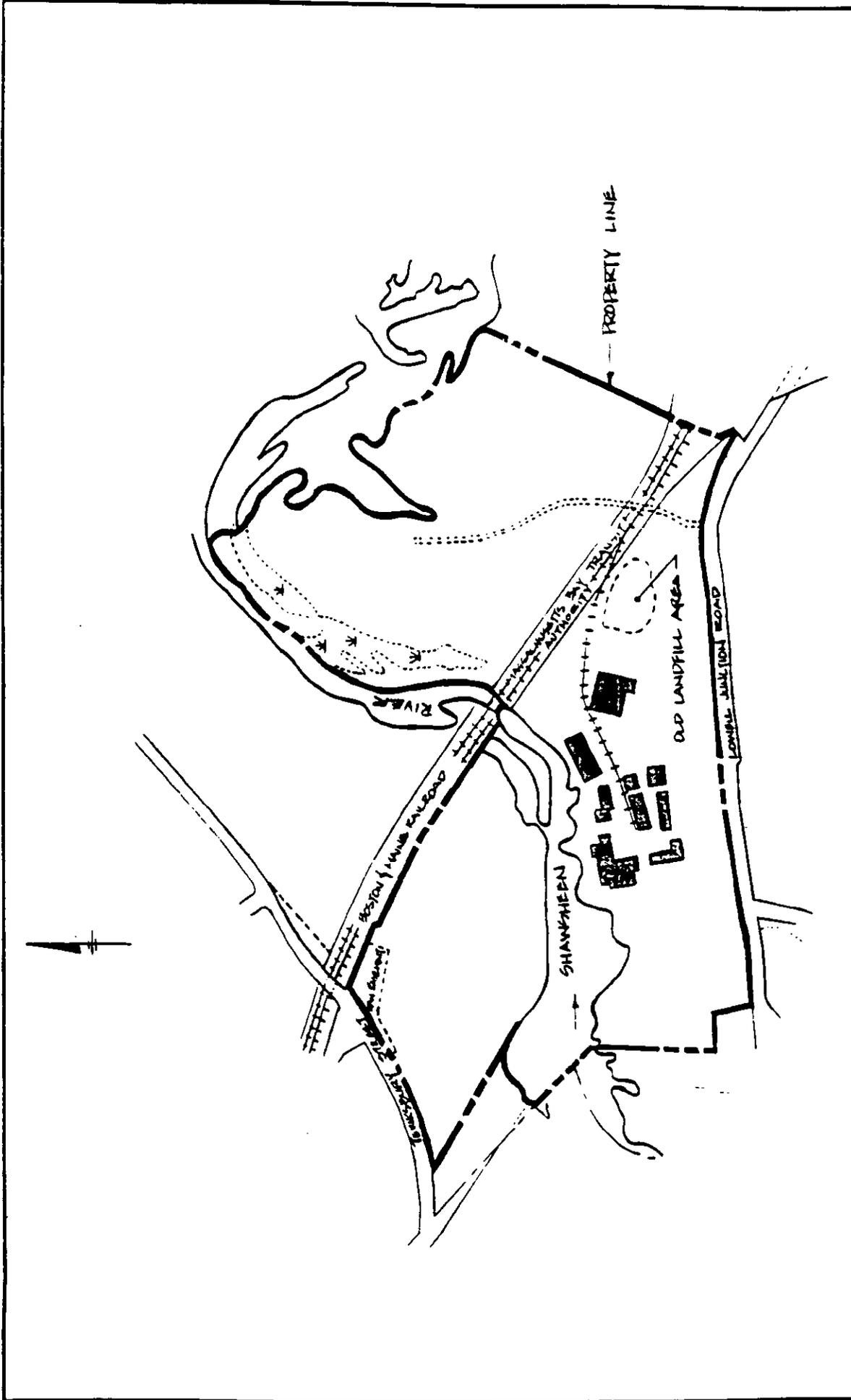
Received by: _____

I hereby acknowledge that I have verified these items.

TABLE 4

Total Hydrocarbon Data (ppb)

Description	OBG-4	GM-11
Sample #	D9485	D9493
Benzene	12.	2500.
A-Trifluorotoluene	< 10.	< 1000.
Toluene	< 10.	4400.
Ethylbenzene	13.	12000.
1-Chlorocyclohexene-1	< 10.	< 1000.
Xylenes	1900.	57000.
Chlorobenzene	14.	< 1000.
Isopropylbenzene	< 10.	< 1000.
Styrene	< 10.	< 1000.
p-Bromofluorobenzene	< 10.	< 1000.
n-Propylbenzene	< 10.	< 1000.
o-Chlorotoluene	< 10.	< 1000.
tert-Butylbenzene	< 10.	< 1000.
Bromobenzene	< 10.	< 1000.
sec-Butylbenzene	< 10.	< 1000.
1,2,5-Trimethylbenzene	< 10.	< 1000.
1,2,4-Trimethylbenzene	< 10.	< 1000.
p-Cymene	< 10.	< 1000.
p-Dichlorobenzene	20.	< 1000.
Cyclopropylbenzene	< 10.	< 1000.
n-Butylbenzene	< 10.	< 1000.
m-Dichlorobenzene	< 10.	< 1000.
2,3-Benzofuran	< 10.	< 1000.
o-Dichlorobenzene	< 10.	< 1000.
Hexachloro-1,3-butadiene	< 10.	< 1000.
1,2,4-Trichlorobenzene	< 10.	< 1000.
Naphthalene	< 10.	< 1000.
1,2,3-Trichlorobenzene	< 10.	< 1000.



SCALE 1" = 300'
NOT A PROPERTY SURVEY

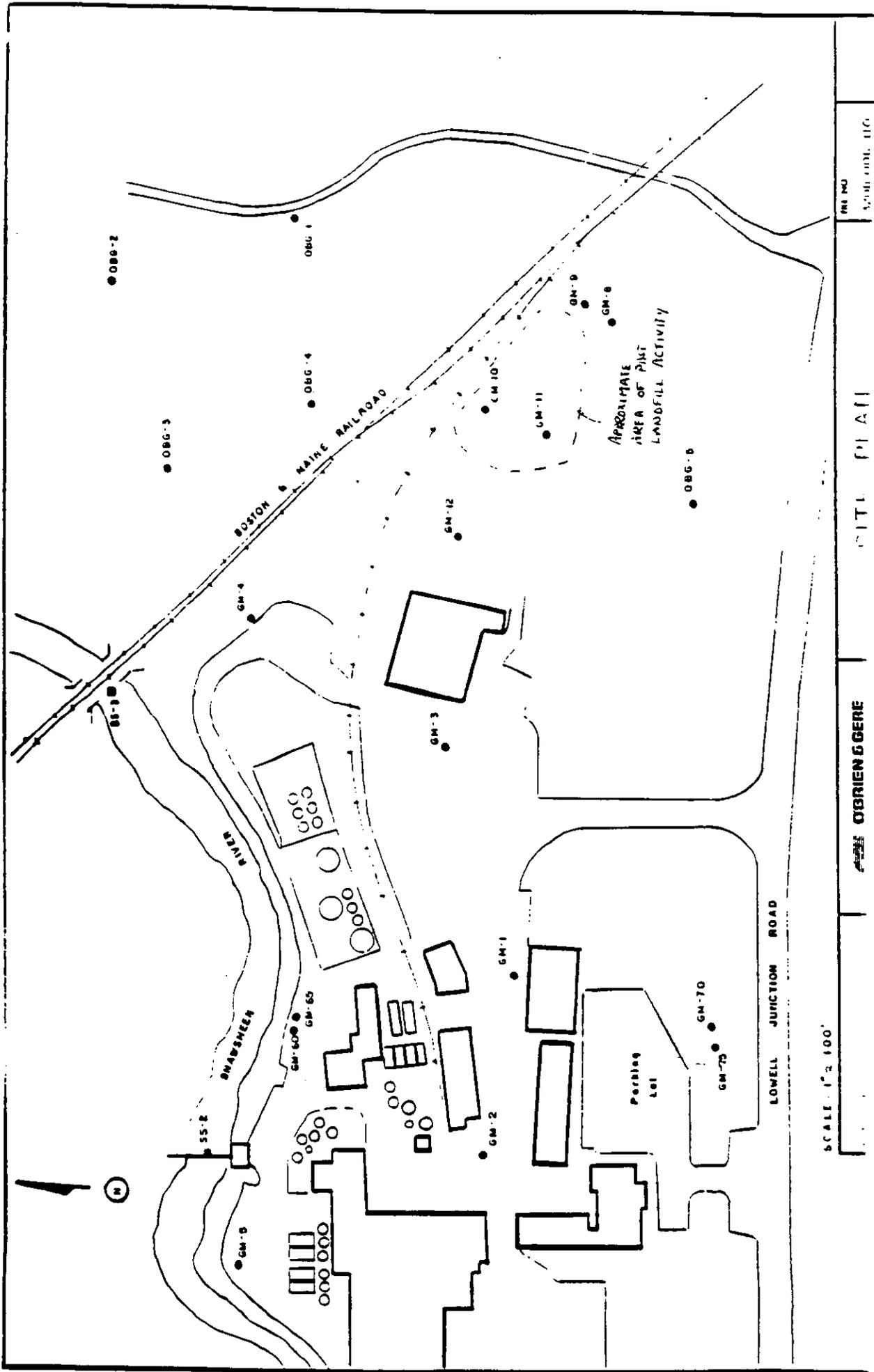
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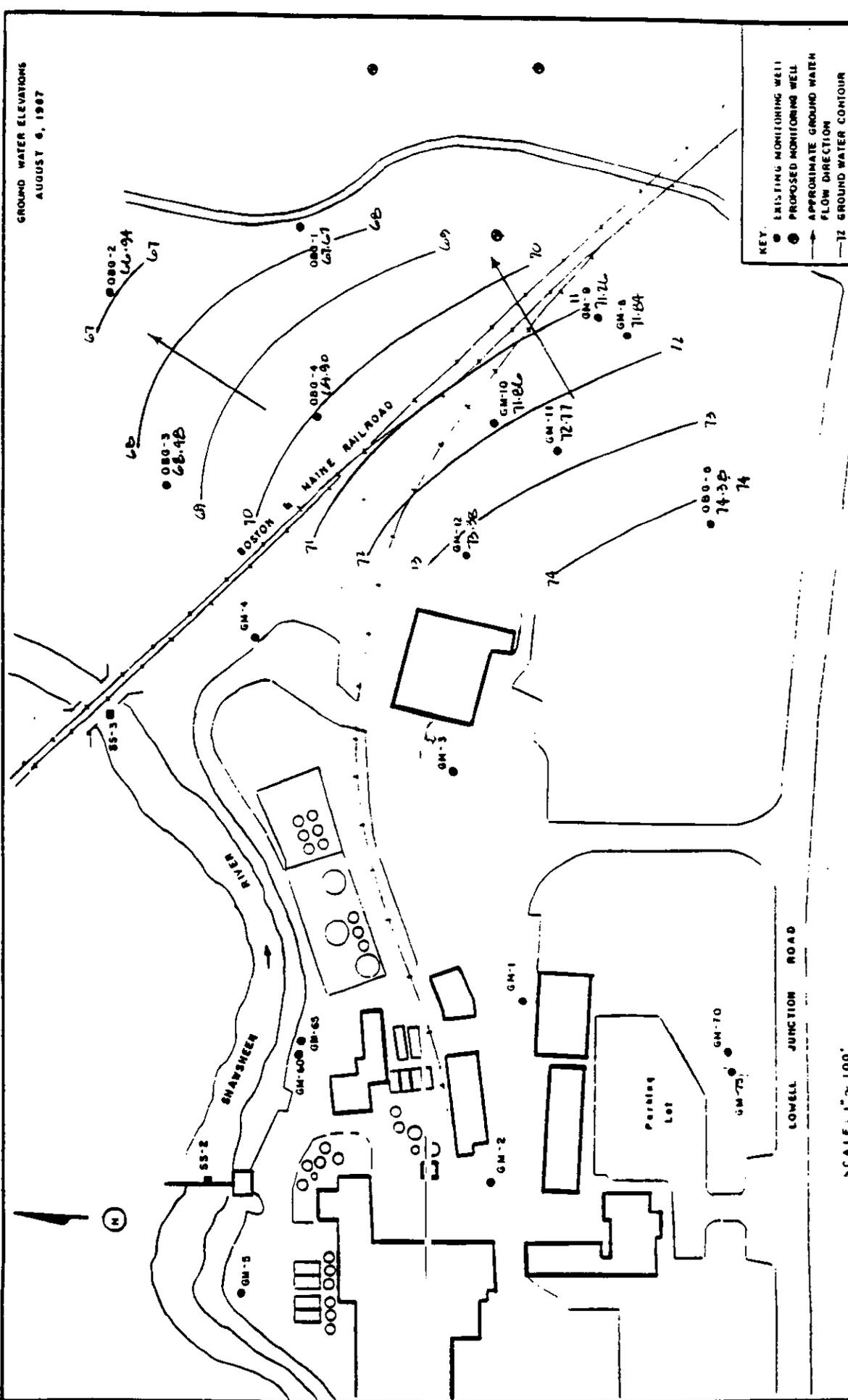
REICHOLD CHEMICALS, INC.

GENERAL

PL NO 3208 008

CIC 1





GROUND WATER ELEVATIONS
AUGUST 4, 1987

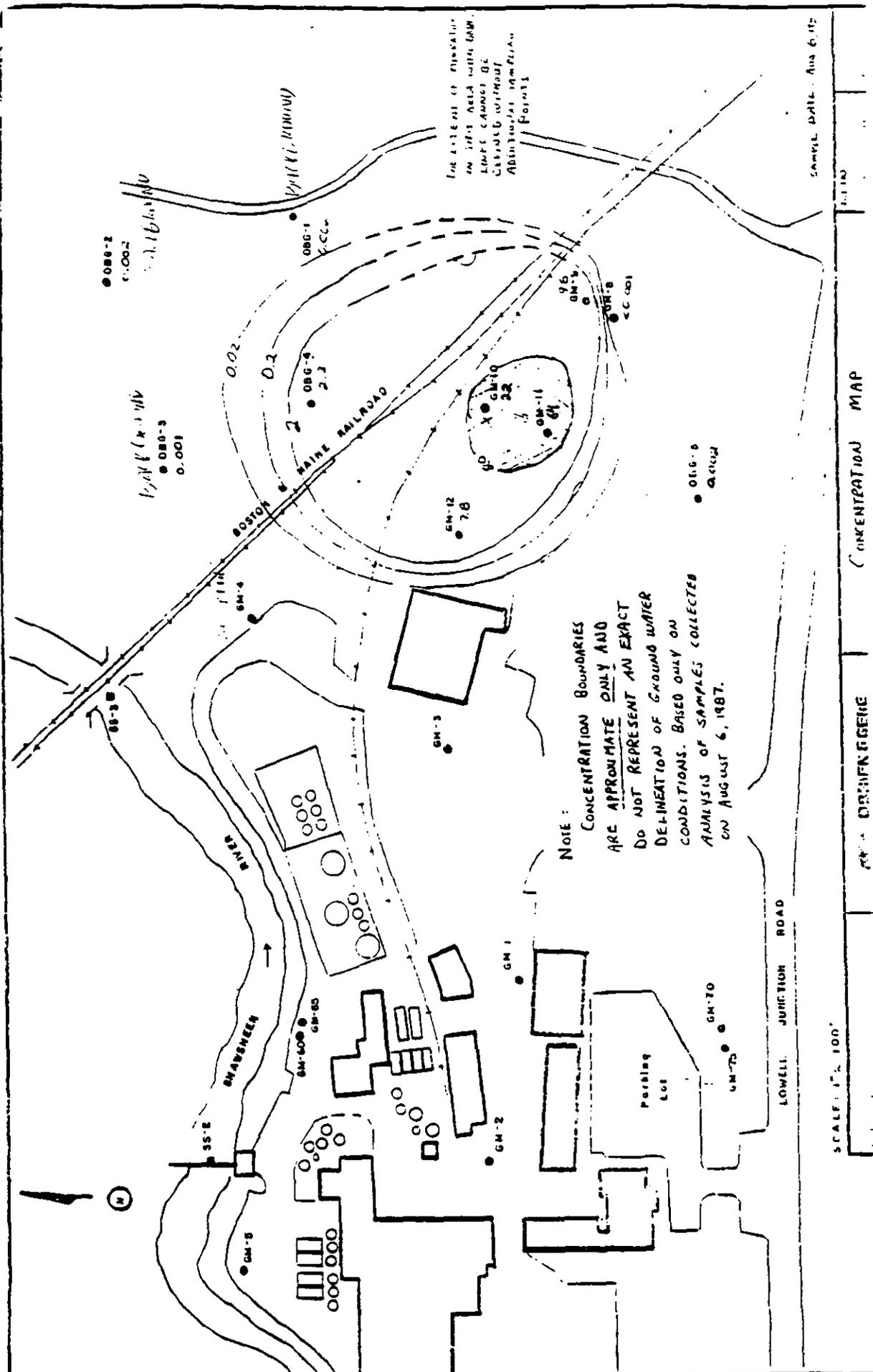
KEY:
 ● EXISTING MONITORING WELL
 ○ PROPOSED MONITORING WELL
 — APPROXIMATE GROUND WATER
 → FLOW DIRECTION
 - - - GROUND WATER CONTOUR

FIG. 3
 PRE NO. 3208 006-110
 DATE

GROUND WATER CONTOURS (8/6/87) &
 PROPOSED WELL LOCATIONS

O'BRIEN & GIERE
 ENGINEERS, INC.
 BOSTON, MASS.

SCALE: 1" = 100'
 In charge of _____
 Designed by _____
 Checked by _____



SCALE: 1" = 100'

DATE: 10/10/87

DESIGNER: GENE

CONCENTRATION MAP

LOWELL JUNCTION ROAD

Parking Lot

SHAWMUT RIVER

MAINE RAILROAD

BOSTON

0.001

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1

GM-1

GM-2

GM-3

GM-4

GM-5

GM-6

GM-7

GM-8

GM-9

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GM-11

GM-12

GM-100

GM-105

GM-110

GM-115

GM-120

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GM-130

GM-135

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GM-145

GM-150

GM-155

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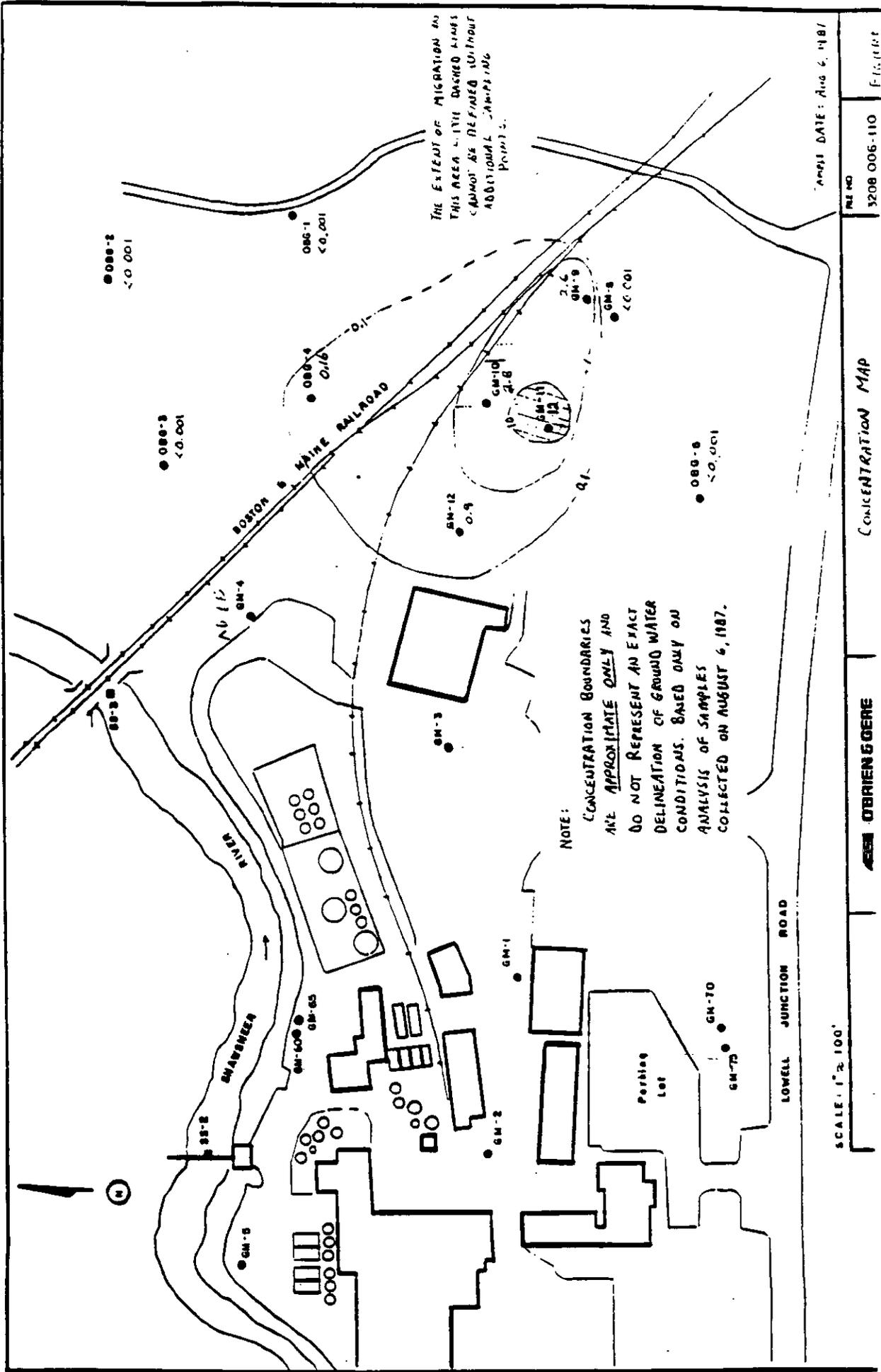
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THE EXTENT OF MIGRATION AS THIS AREA WITH DASHED LINES CANNOT BE DEFINED WITHOUT ADDITIONAL SAMPLING POINTS.

NOTE:
 CONCENTRATION BOUNDARIES ARE APPROXIMATE ONLY AND DO NOT REPRESENT AN EXACT DELINEATION OF GROUND WATER CONDITIONS. BASED ONLY ON ANALYSIS OF SAMPLES COLLECTED ON AUGUST 6, 1987.

PROJECT DATE: Aug 6, 1987
 FILE NO 3208 006-110
 PROJECT O'BRIEN & GERE

CONCENTRATION MAP

O'BRIEN & GERE

SCALE: 1" = 100'



148 Pioneer Dr.
Leominster, MA 01453
(617) 840-0391

SOIL EXPLORATION CORPORATION

Geotechnical Drilling and Groundwater Monitor Wells

23 Ingalls St.
Nashua, NH 03060
(603) 882-3601

Client **O'Brien and Gere** Date **8/3/87** Job No. **87-494**

Location **77 Lowell Junction Road, Andover, MA**

BORING NO. 086-1 **Ground Elev.** Surface **Date Start** 7/30/87 **Date Complete** 7/30/87 **Drilling Foreman** Camacho **Eng./Hydro. Geologist** A. I.

Depth ft.	Sample Data				Soil and/or bedrock strata descriptions		
	No.	Sample Depth (ft.)	Blows 6" Penetration	Rec. Inches	Casing Blows Per ft.	Strata Change Depth	Visual Identification of Soil and/or Rock Strata
	1	0'-1'6"	1-4-4			2'6"	Loose, dry very fine to fine sand, trace inorganic silt, trace fine gravel and root-matter.
5	2	4'-6'0"	16-27-21-20			6'0"	Dense, dry, very fine to fine sand, some fine to medium gravel, trace inorganic silt, cobbles.
	3	6'-7'6"	22-38-32				Very dense, moist to wet, fine to very fine sand, some inorganic silt, trace fine to medium gravel, trace cobbles.
	4	7'6"-9'6"	36-49-41-17				
10	5	9'-11'0"	10-15-21-23				
	6	11'-13'0"	34-36-38-44				
	7	13'-15'0"	41-50-95-90				
15						17'0"	
							Dense, wet, fine to coarse sand, some inorganic silt, trace fine gravel, cobbles.
20	8	19'-20'6"	11-17-16			20'0"	End of boring at 20'6'. set well point at 20'0". Water level at 13'0" upon completion.
25							WELL MATERIALS: 1 - 2" pvc end plug 1 - 10' x 2" pvc screen 1 - protective locking casing 4 - bags silica 1 - pail bentonite pellets
30							
35							
40							

Type of Boring **Casing Size:** Hollow Stem Auger Size: **3 1/2**

Proportion Percentages Trace 0 to 10% Some 10 to 40% And 40 to 50%	Granular Soils (blows per ft.) 0 to 4 Very Loose 30 to 50 Dense 4 to 10 Loose Over 50 Very Dense 10 to 30 Medium Dense	Cohesive Soils (blows per ft.) 0 to 2 Very Soft 8 to 15 Stiff 2 to 4 Soft 15 to 30 Very Stiff 4 to 8 Medium Stiff Over 30 Hard
--	--	---

Standard penetration test (SPT) = 140# hammer falling 30"
Blows are per 6" taken with an 18" long x 2" O.D. x 1 3/8" I.D. split spoon sampler unless otherwise noted.

The terms and percentages used to describe soil and or rock are based on visual identification of the retrieved samples. ■ Moisture content indicated may be affected by time of year and water added during the drilling process. ■ Water levels indicated may vary with seasonal fluctuation and the degree of soil saturation when the boring was taken. ■ The stratification lines represent the approximate boundaries between soil types, the actual transitions may be gradual. ■



148 Pioneer Dr.
Leominster, MA 01453
(617) 840-0391

SOIL EXPLORATION CORPORATION

Geotechnical Drilling and Groundwater Monitor Wells

23 Ingalls St.
Nashua, NH 03060
(603) 882-3601

Client **O'Brien and Gere** Date **8/3/87** Job No. **87-494**

Location **77 Lowell Junction Road, Andover, MA**

BORING NO. **086-2** Ground Elev. **Surface** Date Start **7/30/87** Date Complete **7/30/87** Drilling Foreman **Camacho** Eng./Hydro. Geologist **A.I.**

DEPTH	Sample Data				Soil and/or bedrock strata descriptions		
	No.	Depth (ft.)	Blows 6" Penetration	Rec. Inches	Casing Blows Per ft.	Strata Change Depth	Visual Identification of Soil and/or Rock Strata
	1	0'-1'6"	3-20-19			2'0"	Dense, dry, fine sand, some inorganic silt, trace fine gravel, root-matter.
5	2	4'-5'6"	8-8-1			7'0"	Medium dense, dry, very fine to fine sand, some inorganic silt, trace fine gravel.
10	3	9'-10'6"	7-8-7				Medium dense, dry, medium to coarse sand, trace inorganic silt.
15	4	14'-15'6"	8-8-7			15'0"	
						16'6"	***See below.
20	5	19'-20'6"	35-65-70				End of boring at 20'6". Set well point at 20'0". No water encountered upon completion. ***very dense, moist, very fine to medium sand, some inorganic silt, trace fine gravel and cobbles.
25							
30							WELL MATERIALS: 1 - 2" pvc end plug 1 - 10' x 2" pvc screen 1 - 10' x 2" pvc riser
35							
40							

Type of Boring **Casing Size:** **Hollow Stem Auger Size:** **3 1/2**

Proportion Percentages Trace 0 to 10% Some 10 to 40% And 40 to 50%	Granular Soils (blows per ft.) 0 to 4 Very Loose 30 to 50 Dense 4 to 10 Loose Over 50 Very Dense 10 to 30 Medium Dense	Cohesive Soils (blows per ft.) 0 to 2 Very Soft 8 to 15 Stiff 2 to 4 Soft 15 to 30 Very Stiff 4 to 8 Medium Stiff Over 30 Hard
--	--	---

Standard penetration test (SPT) = 140# hammer falling 30"
Blows are per 6" taken with an 18" long x 2" O.D. x 1 3/8" I.D. split spoon sampler unless otherwise noted.

The terms and percentages used to describe soil and or rock are based on visual identification of the retrieved samples. ■ Moisture content indicated may be affected by time of year and water added during the drilling process. ■ Water levels indicated may vary with seasonal fluctuation and the degree of soil saturation when the



148 Pioneer Dr.
Leominster, MA 01453
(617) 840-0391

SOIL EXPLORATION CORPORATION

Geotechnical Drilling and Groundwater Monitor Wells

23 Ingalls St.
Nashua, NH 03060
(603) 882-3601

Client **O'Brien and Gere** Date **8-24-87** Job No. **87-494**
Location **"BTL" 77 Lowell Junction Road, Andover, MA**

BORING NO. **OBG -3** Ground Elev. Date Start **7-31-87** Date Complete **7-31-87** Drilling Foreman **Wilkins** Eng./Hydrol. Geologist **Irwin**

DEPTH	Sample Data					Soil and/or bedrock strata descriptions	
	No.	Depth (ft.)	Blows 6" Penetration	Rec. Inches	Casing Blows Per ft.	Strata Change Depth	Visual Identification of Soil and/or Rock Strata
5	1	0'-1'6"	5-				Medium dense, dry, TOPSOIL.
	1A	0'6"-1'6"	8-22			0'6"	**SEE BELOW
10	2	4'0"-5'6"	18-27-34			2'0"	Very dense, moist, fine to medium SAND, some inorganic silt, trace fine gravel.
	3	5'6"-7'6"	13-32-49-47				
	4	9'6"-11'6"	13-56-35-46				
15	5	14'6"-15'6"	25-60			15'6"	Very dense, wet, fine to coarse SAND and INORGANIC SILT, trace fine to coarse gravel.
	5A	15'6"-16'6"	68-120				
20						19'6"	End of boring at 19'6" Set well point at 19'6" Water level at 19'0" upon completion
25							**Dense, dry, fine SAND and INORGANIC SILT, some medium to coarse sand and trace fine to medium gravel.
30							
35							
40							

Type of Boring **Casing Size:** **Hollow Stem Auger Size: 3 1/2"**

Proportion Percentages Trace 0 to 10% Some 10 to 40% And 40 to 50%	Granular Soils (blows per ft.) 0 to 4 Very Loose 30 to 50 Dense 4 to 10 Loose Over 50 Very Dense 10 to 30 Medium Dense	Cohesive Soils (blows per ft.) 0 to 2 Very Soft 8 to 15 Stiff 2 to 4 Soft 15 to 30 Very Stiff 4 to 8 Medium Stiff Over 30 Hard
Standard penetration test (SPT) = 140# hammer falling 30" Blows are per 6" taken with an 18" long x 2" O.D. x 1 3/8" I.D. split spoon sampler unless otherwise noted.		

The terms and percentages used to describe soil and or rock are based on visual identification of the retrieved samples. ■ Moisture content indicated may be affected by time of year and water added during the drilling process. ■ Water levels indicated may vary with seasonal fluctuation and the degree of soil saturation when the boring was taken. ■ The stratification lines represent the approximate boundaries between soil types, the actual transitions may be gradual. ■



166 Pioneer Dr.
Leominster, MA 01453
(617) 840-0391

SOIL EXPLORATION CORPORATION

Geotechnical Drilling and Groundwater Monitor Wells

23 Ingalls St.
Nashua, NH 03060
(603) 882-3601

Client: **O'Brien and Gere** Date: **8-24-87** Job No.: **87-494**
 Location: **"BTL" 77 Lowell Junction Road, Andover, MA**

BORING NO.: **OBG -4** Ground Elev.: Date Start: **7-31-87** Date Complete: **7-31-87** Drilling Foreman: **Wilkins** Eng./Hydro. Geologist: **Irwin**

DEPTH	Sample Data				Soil and/or bedrock strata descriptions		
	No.	Depth (ft.)	Blows 6" Penetration	Rec. Inches	Casing Blows Per ft.	Strata Change Depth	Visual Identification of Soil and/or Rock Strata
	1	0'-1'6"	1-1-1				Very soft, ORGANIC SILT and INORGANIC SILT.
5	2	4'6"-6'6"	2-1-3-5			3'0"	Soft to very dense, fine to coarse SAND and INORGANIC SILT.
10	3	9'6"-11'6"	13-22-31-35			13'6"	End of boring at 13'6" Set well point at 13'6"
15							Water level at 6'0" upon completion
20							
25							
30							
35							
40							

Type of Boring: **Casing Size: Hollow Stem Auger Size: 3 1/2"**

Proportion Percentages Trace 0 to 10% Some 10 to 40% And 40 to 50%	Granular Soils (blows per ft.) 0 to 4 Very Loose 30 to 50 Dense 4 to 10 Loose Over 50 Very Dense 10 to 30 Medium Dense	Cohesive Soils (blows per ft.) 0 to 2 Very Soft 8 to 15 Stiff 2 to 4 Soft 15 to 30 Very Stiff 4 to 8 Medium Stiff Over 30 Hard
Standard penetration test (SPT) = 140# hammer falling 30" Blows are per 6" taken with an 18" long x 2" O.D. x 1 3/8" I.D. split spoon sampler unless otherwise noted.		

The terms and percentages used to describe soil and/or rock are based on visual identification of the retrieved samples. ■ Moisture content indicated may be affected by time of year and water added during the drilling process. ■ Water levels indicated may vary with seasonal fluctuation and the degree of soil saturation when the boring was taken. ■ The stratification lines represent the approximate boundaries between soil types, the actual transitions may be gradual. ■



OBRIEN & GERE

SUBJECT

SAMPLE : OBG-1 20'

SHEET

BY

JAI

DATE

8/3/87

JOB NO

3208.006

FIELD GC ANALYSIS:

SAMPLE VOLUME: 300 ul

Calibration volume: 100 ul 10 ppm

Quantified Compounds: (Window ± 20s)

Benzene 0.07 ppm

Toluene 0.60 ppm

Chlorobenzene 0.33 ppm

Notes:

1. No odor from sample
2. No late peak ~ 1590 s found in OBG-4.

FF07065

START



STOP @ 1512.0
 SAMPLE RUN JUL 31 1987 14:10
 ANALYSIS # 5 OBG 6E2E
 TEMPERATURE 31 20 mL PER MIN
 GAIN 50 RCI ANODER

COMPONENT NAME	PEAK	A.T.	ANALYSIS
BENZENE	1	8.07	0.07 PPM
TOUENE	2	8.60	0.60 PPM
CHLOROBENZENE	3	8.33	0.33 PPM



SUBJECT

SAMPLE: OBG - 2 20'

SHEET

BY

DATE

JOB NO

FIELD GC ANALYSIS:

SAMPLE VOLUME = 300 ul

CALIBRATION VOLUME = 100 ul 10 ppm

Quantified Compounds: (Window ± 20 s)

Benzene 1.5 ppm ①

Toluene 0.38 ppm

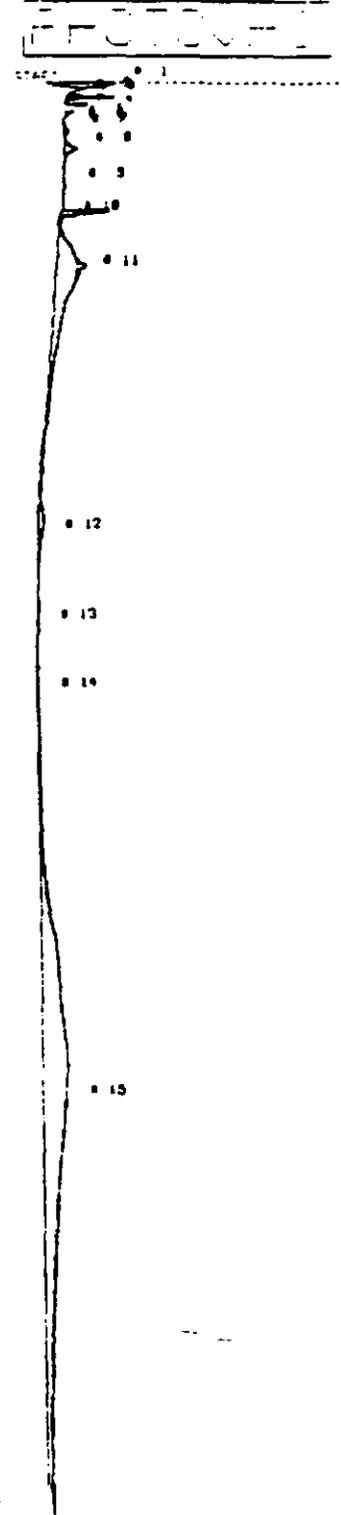
Notes:

① Benzene typically creates sharp peak. Peak #11 may be an interfering compound.

Small peak ~ 1 VS

$$\frac{1}{5.4} \times 10 \text{ ppm} \times \frac{1}{3} = 0.6 \text{ ppm}$$

② Peak #15 coincides roughly with RT of unknown peak at OBG-4.



4708 P 1025.6
SAMPLE RUN JUL 31 1984 10:14
ANALYSIS 0 OBG SC37
TEMPERATURE 31 20 ML PER MIN
GAIN 50 RCI MCOOPER

DATE: 7/31/84
TIME: 10:14
ANALYST: OBG
LAB: SC37
INSTR: RCI
METH: MCOOPER
PEAKS: 11, 12, 13, 14, 15
CONC: 1.5, 0.38, 0.6
UNIT: PPM



O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
SAMPLE: OBG-3 15'		JAI	8/3/87	3208.006

FIELD GC ANALYSIS:

SAMPLE VOLUME: 300 ul
 calibration Volume: 100 ul 10 ppm

Quantified Compounds: (Window ± 30s)

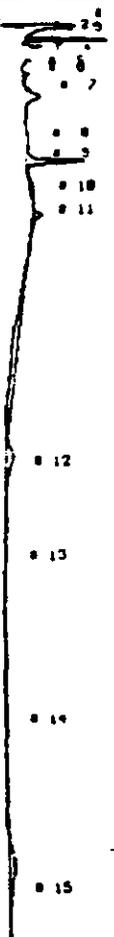
Benzene 0.03 PPM
 Toluene 0.49 PPM
 Chlorobenzene 0.14 PPM

Notes:

1. Recalibration based on retention time
 for PEAK #12 assumed toluene

1	COMPOUND	17.4	R.T.	11 PPM
	BENZENE	1	788.2	8.80P PPM
	CH. OROBENZENE	2	1388.2	8.80P PPM
	TOLUENE	3	783.2	8.80P PPM

PHOTOVAC



PHOTOVAC

CALIBRATED PEAK 12, TOLUENE
 SAMPLE RUN JUL 31 1987 13145
 ANALYSIS # 4 OBS SE3P
 TEMPERATURE 31 28 ML PER MIN
 GAIN 58 PCI ANODOUR

COMPONENT NAME	RET	R.T.	ANALYSIS
UNIDENT	1	788.2	8.80P PPM
UNIDENT	2	1388.2	8.80P PPM
UNIDENT	3	783.2	8.80P PPM
UNIDENT	4	783.2	8.80P PPM
UNIDENT	5	783.2	8.80P PPM
UNIDENT	6	783.2	8.80P PPM
UNIDENT	7	783.2	8.80P PPM
UNIDENT	8	783.2	8.80P PPM
UNIDENT	9	783.2	8.80P PPM
UNIDENT	10	783.2	8.80P PPM
UNIDENT	11	783.2	8.80P PPM
UNIDENT	12	783.2	8.80P PPM
UNIDENT	13	783.2	8.80P PPM
UNIDENT	14	783.2	8.80P PPM
UNIDENT	15	783.2	8.80P PPM

OFF # 1418.2
 SAMPLE RUN JUL 31 1987 13145
 ANALYSIS # 4 OBS SE3P
 TEMPERATURE 31 28 ML PER MIN
 GAIN 58 PCI ANODOUR

COMPONENT NAME	RET	R.T.	ANALYSIS
UNIDENT	1	788.2	8.80P PPM
UNIDENT	2	1388.2	8.80P PPM
UNIDENT	3	783.2	8.80P PPM
UNIDENT	4	783.2	8.80P PPM
UNIDENT	5	783.2	8.80P PPM
UNIDENT	6	783.2	8.80P PPM
UNIDENT	7	783.2	8.80P PPM
UNIDENT	8	783.2	8.80P PPM
UNIDENT	9	783.2	8.80P PPM
UNIDENT	10	783.2	8.80P PPM
UNIDENT	11	783.2	8.80P PPM
UNIDENT	12	783.2	8.80P PPM
UNIDENT	13	783.2	8.80P PPM
UNIDENT	14	783.2	8.80P PPM
UNIDENT	15	783.2	8.80P PPM



SUBJECT

SAMPLE : OBG-4 11'

SHEET

BY

JAI

DATE

8/3/87

JCB NO

7208.006

FIELD GC ANALYSIS :

SAMPLE VOLUME : 300 ul

CALIBRATION VOLUME : 100 ul ppm

QUANTIFIED COMPOUNDS : (Window ±20%)

Benzene 0.45 ppm

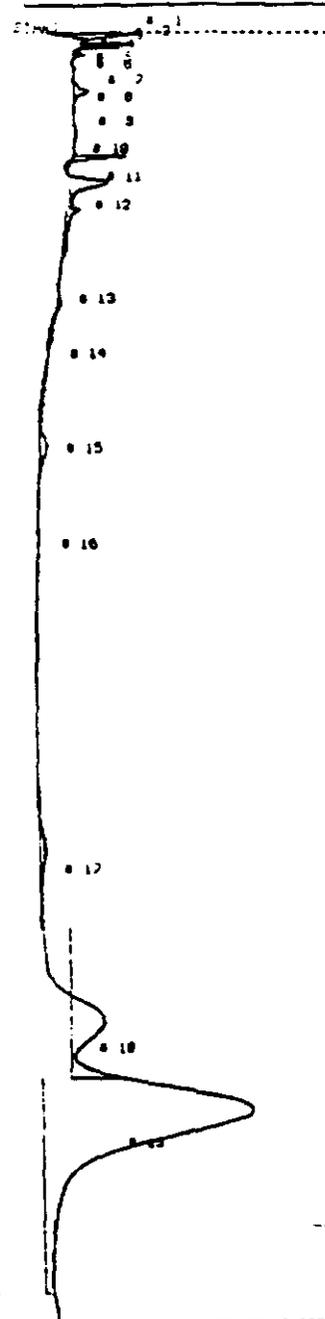
Toluene 0.56 ppm

Chlorobenzene 0.33 ppm

Notes :

- 1. Sample had moderate chemical odor
- 2. Tentative identification of late peaks as Xylenes

PHOTOGRAPH



STOP @ 7000.2
 SAMPLE RB. JUL 31 1987 14109
 ANALYSIS # 5 OBG SC3P
 TEMPERATURE 31 20 PL PER MIN
 GAIN 50 RCI ANOCUR

CONCENTRATION	FEAP	A.I.	IDENTIFY
UNKNOW	1	0.0	100
UNKNOW	2	10.0	100
UNKNOW	3	20.0	100
UNKNOW	4	30.0	100
UNKNOW	5	40.0	100
UNKNOW	6	50.0	100
UNKNOW	7	60.0	100
UNKNOW	8	70.0	100
UNKNOW	9	80.0	100
UNKNOW	10	90.0	100
UNKNOW	11	100.0	100
UNKNOW	12	110.0	100
UNKNOW	13	120.0	100
UNKNOW	14	130.0	100
UNKNOW	15	140.0	100
UNKNOW	16	150.0	100
UNKNOW	17	160.0	100
UNKNOW	18	170.0	100



O'BRIEN & GERE

SUBJECT

Field Recalibration of Library 7/31/87

SHEET

BY

DATE

JOB NO

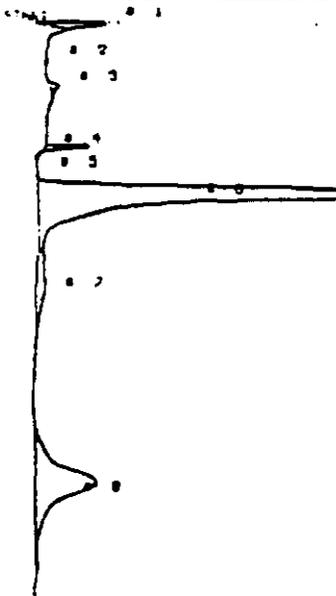
JAI

8/3/87

3208.006

100 ul 10 ppm
Toluene Standard

PHOTOVAC



STOP # 30.00
SAMPLE RUN JUL 31 1987 12:12
ANALYSIS # 1 OBS 5638
TEMPERATURE 31 20 ML PER MIN
GAIN 50 RCI ANDOVER

COMPONENT NAME PEAK # RT. AREA
BENZENE 1 278.5 8.898 PPM
O-CPHENYNE 2 1158.8 8.898 PPM
TOLUENE 3 587.5 8.898 PPM

LIBRARY #1 BEFORE CAL.

PHOTOVAC

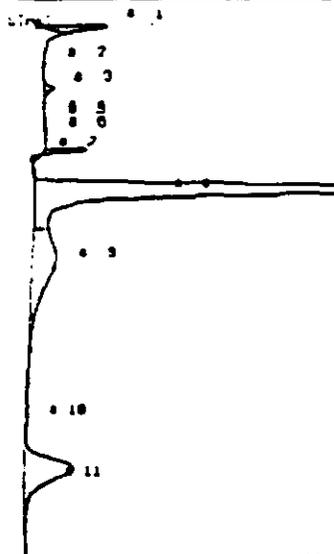
1 COPPOLAC 10 # R.T. LIPIT
BENZENE 1 278.5 8.898 PPM
O-CPHENYNE 2 1158.8 8.898 PPM
TOLUENE 3 587.5 8.898 PPM

Note:

1. Benzene (?) contamination of toluene standard?

100 ul 10 ppm
Toluene Standard

PHOTOVAC



STOP # 30.00
SAMPLE RUN JUL 31 1987 12:13
ANALYSIS # 2 OBS 5638
TEMPERATURE 31 20 ML PER MIN
GAIN 50 RCI ANDOVER

COMPONENT NAME PEAK # RT. AREA
BENZENE 1 278.5 8.898 PPM
O-CPHENYNE 2 1158.8 8.898 PPM
TOLUENE 3 587.5 8.898 PPM

PHOTOVAC

CALIBRATED PEAK 11, TOLUENE

SAMPLE RUN JUL 31 1987 12:14
ANALYSIS # 2 OBS 5638
TEMPERATURE 31 20 ML PER MIN
GAIN 50 RCI ANDOVER

COMPONENT NAME PEAK # RT. AREA
BENZENE 1 278.5 8.898 PPM
O-CPHENYNE 2 1158.8 8.898 PPM
TOLUENE 3 587.5 8.898 PPM



OBRIEN & GERE

SUBJECT	Calibration for Library 7/30/87	SHEET	BY	DATE	JHG 8/3/87	JOB NO	3208.006
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Benzene Std

10 ppm
100 ul

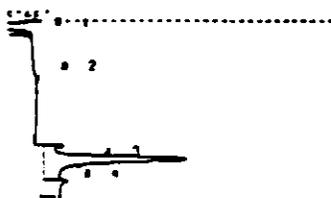
Toluene Std

10 ppm
100 ul

Chlorobenzene Std

10 ppm
100 ul

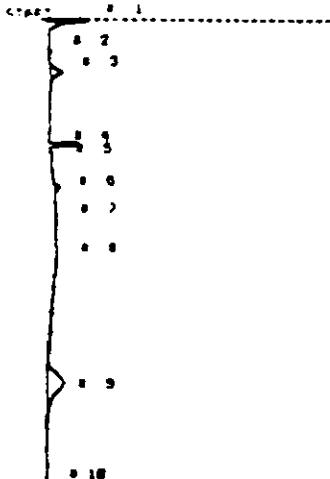
PHOTOLAC



STOP # 255.4
 SAMPLE RUN JUL 30 1987 19133
 ANALYSIS # 24 OBS SEC38
 TEMPERATURE 33 28 FL PER MIN
 GAIN 58 RCI MODDER

COMPONENT NAME	PEAK #	RET. TIME	AREA
BENZENE	1	10.2	100.0

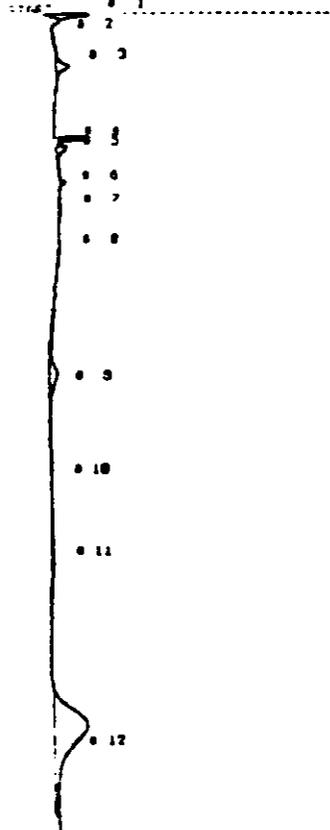
PHOTOLAC



STOP # 255.4
 SAMPLE RUN JUL 30 1987 20134
 ANALYSIS # 27 OBS SEC30
 TEMPERATURE 31 28 FL PER MIN
 GAIN 58 RCI MODDER

COMPONENT NAME	PEAK #	RET. TIME	AREA
TOLUENE	1	10.3	100.0

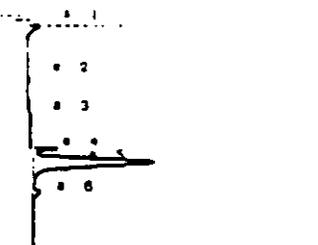
PHOTOLAC



STOP # 255.4
 SAMPLE RUN JUL 30 1987 21135
 ANALYSIS # 28 OBS SEC38
 TEMPERATURE 30 28 FL PER MIN
 GAIN 58 RCI MODDER

COMPONENT NAME	PEAK #	RET. TIME	AREA
CHLOROBENZENE	1	10.12	100.0

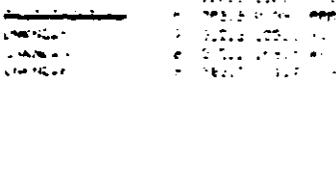
PHOTOLAC



STOP # 255.4
 SAMPLE RUN JUL 30 1987 28136
 ANALYSIS # 25 OBS SEC38
 TEMPERATURE 33 28 FL PER MIN
 GAIN 58 RCI MODDER

COMPONENT NAME	PEAK #	RET. TIME	AREA
BENZENE	1	10.2	100.0

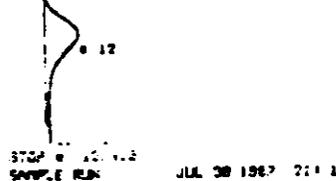
PHOTOLAC



STOP # 255.4
 SAMPLE RUN JUL 30 1987 28137
 ANALYSIS # 26 OBS SEC38
 TEMPERATURE 31 28 FL PER MIN
 GAIN 58 RCI MODDER

COMPONENT NAME	PEAK #	RET. TIME	AREA
TOLUENE	1	10.3	100.0

PHOTOLAC



STOP # 255.4
 SAMPLE RUN JUL 30 1987 28138
 ANALYSIS # 29 OBS SEC38
 TEMPERATURE 30 28 FL PER MIN
 GAIN 58 RCI MODDER

COMPONENT NAME	PEAK #	RET. TIME	AREA
CHLOROBENZENE	1	10.12	100.0

CALIBRATED LIBRARY #1

PHOTOLAC

COMPONENT	RET. TIME	AREA
BENZENE	10.2	100.0
CHLOROBENZENE	10.12	100.0
TOLUENE	10.3	100.0



Laboratory Report

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517

DESCRIPTION _____

DATE COLLECTED 8-6-87 DATE REC'D. 8-8-87 DATE ANALYZED _____

	Sample#	420.3 PHENOLS			
OBG - 4	D9485	0.037			
↓ - 3	D9486	0.026			
↓ - 2	D9487	0.012			
↓ - 1	D9488	0.009			
GM - 9	D9489	0.025			
↓ - 8	D9490	0.001			
OBG - 5	D9491	<0.001			
GM - 12	D9492	0.15			
↓ - 11	D9493	14.5			
↓ - 10	D9494	2.8			
Field Blanks	D9495	<.001			

Methodology: Federal Register — 40 CFR, Part 136, October 28, 1984 Units: mg/l (ppm) unless otherwise noted

Comments: _____

OBG Laboratories, Inc. Authorized: CAW
Box 4942 / 1304 Buckley Rd. / Syracuse, NY / 13221 / (315) 457-1494 Date: August 25, 1987



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517
 DESCRIPTION Field Blank

SAMPLE NO. D9495 DATE COLLECTED 8-6-87 DATE REC'D. 8-8-87 DATE ANALYZED 8-14-87

ppb		ppb	
Chloromethane	<1.	t-1,3-Dichloropropene	<1.
Bromomethane		Trichloroethene	
Vinyl chloride		Benzene	
Chloroethane		Dibromochloromethane	
Methylene chloride		1,1,2-Trichloroethane	
1,1-Dichloroethene		c-1,3-Dichloropropene	↓
1,1-Dichloroethane		2-Chloroethylvinyl ether	<10.
t-1,2-Dichloroethene		Bromoform	<10.
Chloroform		1,1,2,2-Tetrachloroethane	<1.
1,2-Dichloroethane		Tetrachloroethene	
1,1,1-Trichloroethane		Toluene	
Carbon tetrachloride		Chlorobenzene	
Bromodichloromethane		Ethylbenzene	
1,2-Dichloropropane	↓	Xylenes	↓

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 93%
 2-Bromo-1-chloropropane = 92%
 Trifluorotoluene = 79%

Authorized: _____

Date: August 25, 1987



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517
DESCRIPTION GM - 10

SAMPLE NO. D9494 DATE COLLECTED 8-6-87 DATE REC'D. 8-8-87 DATE ANALYZED 8-14-87

ppb		ppb	
Chloromethane	<1000.	t-1,3-Dichloropropene	<1000.
Bromomethane		Trichloroethene	<1000.
Vinyl chloride		Benzene	4800.
Chloroethane		Dibromochloromethane	<1000.
Methylene chloride		1,1,2-Trichloroethane	<1000.
1,1-Dichloroethene		c-1,3-Dichloropropene	<1000.
1,1-Dichloroethane		2-Chloroethylvinyl ether	<10,000.
t-1,2-Dichloroethene		Bromoform	<10,000.
Chloroform	9800.	1,1,2,2-Tetrachloroethane	<1000.
1,2-Dichloroethane	<1000.	Tetrachloroethene	<1000.
1,1,1-Trichloroethane		Toluene	<1000.
Carbon tetrachloride		Chlorobenzene	<1000.
Bromodichloromethane		Ethylbenzene	2800.
1,2-Dichloropropane		Xylenes	22000.

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 103%
2-Bromo-1-chloropropane = 106%
Trifluorotoluene = 88%



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517

DESCRIPTION GM - 11

SAMPLE NO. D9493 DATE COLLECTED 8-6-87 DATE REC'D. 8-8-87 DATE ANALYZED 8-14-87

ppb		ppb	
Chloromethane	<1000.	t-1,3-Dichloropropene	<1000.
Bromomethane		Trichloroethene	<1000.
Vinyl chloride		Benzene	2300.
Chloroethane		Dibromochloromethane	<1000.
Methylene chloride		1,1,2-Trichloroethane	<1000.
1,1-Dichloroethene		c-1,3-Dichloropropene	<1000.
1,1-Dichloroethane		2-Chloroethylvinyl ether	<10,000.
t-1,2-Dichloroethene		Bromoform	<10,000.
Chloroform		1,1,2,2-Tetrachloroethane	<1000.
1,2-Dichloroethane		Tetrachloroethene	<1000.
1,1,1-Trichloroethane		Toluene	4300.
Carbon tetrachloride		Chlorobenzene	<1000.
Bromodichloromethane		Ethylbenzene	12000.
1,2-Dichloropropane		Xylenes	64000.

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 103%
2-Bromo-1-chloropropane = 104%
Trifluorotoluene = 88%

Authorized: *AMT*

Date: August 25, 1987



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517
 DESCRIPTION GM - 12

SAMPLE NO. D9492 DATE COLLECTED 8-6-87 DATE REC'D. 8-8-87 DATE ANALYZED 8-14-87

ppb		ppb	
Chloromethane	<100.	t-1,3-Dichloropropene	<100.
Bromomethane		Trichloroethene	
Vinyl chloride		Benzene	
Chloroethane		Dibromochloromethane	
Methylene chloride		1,1,2-Trichloroethane	
1,1-Dichloroethene		c-1,3-Dichloropropene	
1,1-Dichloroethane		2-Chloroethylvinyl ether	<1000.
1,1,2-Dichloroethene		Bromoform	<1000.
Chloroform		1,1,2,2-Tetrachloroethane	<100.
1,2-Dichloroethane		Tetrachloroethene	
1,1,1-Trichloroethane		Toluene	
Carbon tetrachloride		Chlorobenzene	
Bromodichloromethane		Ethylbenzene	900.
1,2-Dichloropropane		Xylenes	7800.

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 113%
 2-Bromo-1-chloropropane = 108%
 Trifluorotoluene = 91%

Authorized: *CAWNT*
 Date: August 25, 1987



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517

DESCRIPTION RTI Resins OBG - 5

SAMPLE NO. D9491 DATE COLLECTED 8-6-87 DATE REC'D. 8-8-87 DATE ANALYZED 8-12-87

ppb		ppb	
Chloromethane	<1.	t-1,3-Dichloropropene	<1.
Bromomethane		Trichloroethene	
Vinyl chloride		Benzene	
Chloroethane		Dibromochloromethane	
Methylene chloride		1,1,2-Trichloroethane	
1,1-Dichloroethene		c-1,3-Dichloropropene	↓
1,1-Dichloroethane		2-Chloroethylvinyl ether	<10.
t-1,2-Dichloroethene		Bromoform	<10.
Chloroform		1,1,2,2-Tetrachloroethane	<1.
1,2-Dichloroethane		Tetrachloroethene	↓
1,1,1-Trichloroethane		Toluene	
Carbon tetrachloride		Chlorobenzene	
Bromodichloromethane		Ethylbenzene	↓
1,2-Dichloropropane	↓	Xylenes	2.

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 95%
 2-Bromo-1-chloropropane = 90%
 Trifluorotoluene = 91%

Authorized: *AMM*



LABORATORIES, INC.

Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517

DESCRIPTION BTL Resins GM - 8

SAMPLE NO. D9490 DATE COLLECTED 8-6-87 DATE REC'D. 8-8-87 DATE ANALYZED 8-12-87

ppb		ppb	
Chloromethane	<1.	t-1,3-Dichloropropene	<1.
Bromomethane		Trichloroethene	
Vinyl chloride		Benzene	
Chloroethane		Dibromochloromethane	
Methylene chloride		1,1,2-Trichloroethane	
1,1-Dichloroethene		c-1,3-Dichloropropene	
1,1-Dichloroethane		2-Chloroethylvinyl ether	<10.
t-1,2-Dichloroethene		Bromoform	<10.
Chloroform		1,1,2,2-Tetrachloroethane	<1.
1,2-Dichloroethane		Tetrachloroethene	<1.
1,1,1-Trichloroethane		Toluene	<1.
Carbon tetrachloride		Chlorobenzene	<1.
Bromodichloromethane		Ethylbenzene	<1.
1,2-Dichloropropane		Xylenes	<1.

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 87%
 2-Bromo-1-chloropropane = 76%
 Trifluorotoluene = 96%

Authorized: OMU

Date: August 25, 1987



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517

DESCRIPTION BTL Resins GM - 9

SAMPLE NO. D9489 DATE COLLECTED 8-6-87 DATE REC'D. 8-8-87 DATE ANALYZED 8-14-87

ppb		ppb	
Chloromethane	<100.	t-1,3-Dichloropropene	<100.
Bromomethane		Trichloroethene	
Vinyl chloride		Benzene	
Chloroethane		Dibromochloromethane	
Methylene chloride		1,1,2-Trichloroethane	
1,1-Dichloroethene		c-1,3-Dichloropropene	
1,1-Dichloroethane		2-Chloroethylvinyl ether	<1000.
t-1,2-Dichloroethene		Bromoform	<1000.
Chloroform		1,1,2,2-Tetrachloroethane	<100.
1,2-Dichloroethane		Tetrachloroethene	<100.
1,1,1-Trichloroethane		Toluene	100.
Carbon tetrachloride		Chlorobenzene	<100.
Bromodichloromethane		Ethylbenzene	2600.
1,2-Dichloropropane		Xylenes	9800.

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 102%
 2-Bromo-1-chloropropane = 86%
 Trifluorotoluene = 92%

Authorized: *OWM*



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517
DESCRIPTION BTL Resins OBG - 1

SAMPLE NO. D9488 DATE COLLECTED 8-6-87 DATE REC'D. 8-8-87 DATE ANALYZED 8-12-87

ppb		ppb	
Chloromethane	<1.	t-1,3-Dichloropropene	<1.
Bromomethane		Trichloroethene	<1.
Vinyl chloride		Benzene	3.
Chloroethane		Dibromochloromethane	<1.
Methylene chloride		1,1,2-Trichloroethane	<1.
1,1-Dichloroethene		c-1,3-Dichloropropene	<1.
1,1-Dichloroethane		2-Chloroethylvinyl ether	<10.
t-1,2-Dichloroethene		Bromoform	<10.
Chloroform		1,1,2,2-Tetrachloroethane	<1.
1,2-Dichloroethane		Tetrachloroethene	<1.
1,1,1-Trichloroethane		Toluene	<1.
Carbon tetrachloride		Chlorobenzene	5.
Bromodichloromethane		Ethylbenzene	<1.
1,2-Dichloropropane		Xylenes	2.

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 95%
 2-Bromo-1-chloropropane = 98%
 Trifluorotoluene = 93%

Authorized: CAWMA



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517
 DESCRIPTION BTL Resins OBG - 2

SAMPLE NO. D9487 DATE COLLECTED 8-6-87 DATE REC'D. 8-8-87 DATE ANALYZED 8-12-87

ppb		ppb	
Chloromethane	<1.	t-1,3-Dichloropropene	<1.
Bromomethane		Trichloroethene	
Vinyl chloride		Benzene	
Chloroethane		Dibromochloromethane	
Methylene chloride		1,1,2-Trichloroethane	
1,1-Dichloroethene		c-1,3-Dichloropropene	
1,1-Dichloroethane		2-Chloroethylvinyl ether	<10.
t-1,2-Dichloroethene		Bromoform	<10.
Chloroform		1,1,2,2-Tetrachloroethane	<1.
1,2-Dichloroethane		Tetrachloroethene	<1.
1,1,1-Trichloroethane		Toluene	<1.
Carbon tetrachloride		Chlorobenzene	6.
Bromodichloromethane		Ethylbenzene	<1.
1,2-Dichloropropane		Xylenes	2.

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 96%
 2-Bromo-1-chloropropane = 95%
 Trifluorotoluene = 96%

Authorized: *[Signature]*

Date: August 25, 1987



LABORATORIES, INC.

Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517

DESCRIPTION BTL Resins - OBG - 3

SAMPLE NO. D9486 DATE COLLECTED 8-6-87 DATE REC'D. 8-8-87 DATE ANALYZED 8-12-87

ppb		ppb	
Chloromethane	<1.	t-1,3-Dichloropropene	<1.
Bromomethane		Trichloroethene	
Vinyl chloride		Benzene	
Chloroethane		Dibromochloromethane	
Methylene chloride		1,1,2-Trichloroethane	
1,1-Dichloroethene		c-1,3-Dichloropropene	
1,1-Dichloroethane		2-Chloroethylvinyl ether	<10.
t-1,2-Dichloroethene		Bromoform	<10.
Chloroform		1,1,2,2-Tetrachloroethane	<1.
1,2-Dichloroethane		Tetrachloroethane	<1.
1,1,1-Trichloroethane		Toluene	<1.
Carbon tetrachloride		Chlorobenzene	14.
Bromodichloromethane		Ethylbenzene	<1.
1,2-Dichloropropane		Xylenes	1.

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 103%
 2-Bromo-1-chloropropane = 94%
 Trifluorotoluene = 102%

Authorized: *CRUM*

Date: August 25, 1987



LABORATORIES, INC.

Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517
DESCRIPTION BTL Resins - OBG - 4

SAMPLE NO. D9485 DATE COLLECTED 8-6-87 DATE REC'D. 8-8-87 DATE ANALYZED 8-12-87

ppb		ppb	
Chloromethane	<10.	t-1,3-Dichloropropene	<10.
Bromomethane		Trichloroethene	<10.
Vinyl chloride		Benzene	15.
Chloroethane		Dibromochloromethane	<10.
Methylene chloride		1,1,2-Trichloroethane	
1,1-Dichloroethene		c-1,3-Dichloropropene	
1,1-Dichloroethane		2-Chloroethylvinyl ether	<100.
t-1,2-Dichloroethene		Bromoform	<100.
Chloroform		1,1,2,2-Tetrachloroethane	<10.
1,2-Dichloroethane		Tetrachloroethene	<10.
1,1,1-Trichloroethane		Toluene	<10.
Carbon tetrachloride		Chlorobenzene	29.
Bromodichloromethane		Ethylbenzene	160.
1,2-Dichloropropane		Xylenes	2300.

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 100%
 2-Bromo-1-chloropropane = 99%
 Trifluorotoluene = 103%

Authorized: *CAWDA*
 Date: August 25, 1987



CHAIN OF CUSTODY RECORD

Page 1/2

SURVEY				SAMPLERS: (Signature)				
Reichhold Chemical				Russell P. Jaynes				
STATION NUMBER	STATION LOCATION	DATE	TIME	SAMPLE TYPE		SEQ. NO.	NO. OF CONTAINERS	ANALYSIS REQUIRED
				Water	Soil			
				Cont. Green				
08G-4	Andover MASS.	8/6/87	12:00	✓			2-40ml	601, 602, 503.1
08G-4		"	"	✓			1-qt.	420.3
08G-3		"	12:24	✓			2-40 ml	601, 602
08G-3		"	"	✓			2 qt	420.3
08G-2		"	12:40	✓			2-40ml	601, 602
08G-2		"	"	✓			1-qt.	420.3
5-1		"	1:00	✓			2-40ml	601, 602
6-1		"	1:00	✓			1-qt	420.3
7-9		"	1:35	✓			2-40ml	601, 602
7-9		"	"	✓			1-qt	420.3
8M-8		"	1:30	✓			2-40ml	601, 602
8M-8		"	"	✓			1-qt	420.3

Relinquished by: (Signature)	Received by: (Signature)	Date/Time
Relinquished by: (Signature)	Received by: (Signature)	Date/Time
Relinquished by: (Signature)	Received by: (Signature)	Date/Time
Relinquished by: (Signature)	Received by Mobile Laboratory for field analysis: (Signature)	Date/Time
Dispatched by: (Signature)	Date/Time	Received for Laboratory by: Wendy Smith
Method of Shipment:		Date/Time 8/8/87 15:10



CHAIN OF CUSTODY RECORD

SURVEY: Reichhold Chemicals SAMPLERS: (Signature) Russell P. Zagari

STATION NUMBER	STATION LOCATION	DATE	TIME	SAMPLE TYPE			SEQ. NO.	NO. OF CONTAINERS	ANALYSES REQUIRED
				Water	Air	Soil			
				Cont. Grav.					
ORG-5	Andover, Mass	9/6/97	1:55		✓		2-40 ml	ERA 601, 602	
ORG-5		"	"		✓		1-qt	420.3	
GM-12		"	2:40		✓		2-40 ml	601, 602	
GM-12		"	"		✓		1 qt	420.3	
M-11		"	2:42		✓		2-40 ml	601, 602, 503.1	
GM-11		"	2:42		✓		1 qt	420.3	
M-10		"	2:50		✓		2-40 ml	601, 602	
-10		"	"		✓		1 qt	420.3	

Relinquished by: (Signature)	Received by: (Signature)	Date/Time
Relinquished by: (Signature)	Received by: (Signature)	Date/Time
Relinquished by: (Signature)	Received by: (Signature)	Date/Time
Relinquished by: (Signature)	Received by Mobile Laboratory for field analysis: (Signature)	Date/Time
Dispatched by: (Signature)	Date/Time	Received for Laboratory by: <u>Wendy Smith</u> Date/Time <u>8/8/97 15:10</u>

Method of Shipment:

* Septum inverted on one of the 40 ml. vials.

C-7
Draft Preliminary Remedial Action Plan
O'Brien & Gere
February 1988

Report

DRAFT

**Preliminary Remedial
Action Plan**

**77 Lowell Junction Road
North Andover, MA.**

Reichhold Chemicals, Inc.
White Plains, New York

February 1988



O'BRIEN & GERE

PRELIMINARY REMEDIAL ACTION PLAN

77 Lowell Jct. Road
N. Andover, MA

Prepared for:

Reichhold Chemicals, Inc.
White Plains, NY

February 1988

Prepared by:

O'BRIEN & GERE ENGINEERS, INC.
100 SUMMER STREET, SUITE 2904
BOSTON, MASSACHUSETTS 02110

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SECTION 1 - INTRODUCTION

1.01 Background

The property at 77 Lowell Junction Road was sold by Reichhold Chemicals, Inc. to BTL, Inc. in the last quarter of 1986. Reichhold has agreed to continue the investigation of an old landfill area on the eastern side of the plant shown on Figure 1.

An initial site investigation was completed by Geraghty & Miller, Inc. in February 1987. A total of five (5) ground water monitoring wells (numbered GM-8 through GM-12) were installed in the water table at the landfill and in the immediate area around the landfill. The report concluded that ground water flows eastward from the landfill and analysis of the ground water at the landfill indicated the presence of volatile organics. The principal contaminants were benzene, toluene, xylenes and ethylbenzene.

Additional site investigations were completed by O'Brien & Gere in August, 1987. Five (5) ground water monitoring wells (numbered OBG-1 through OBG-5) were installed. Monitoring well OBG-5 was installed upgradient of the landfill and the other four monitoring wells were installed on the east side of the railroad tracks, and downgradient of the landfill, as shown on Figure 2. The headspace in soil samples were analyzed in the field for volatile organics using a portable gas chromatograph. Ground water samples were collected from monitoring wells GM-8 through GM-12 and at OBG-1 through OBG-5 and analyzed for volatile aromatics, volatile hydrocarbons and phenols.

Results of the August, 1987 investigation determined that compounds identified in the ground water beneath the landfill were detected in downgradient monitoring well OBG-4. The principal constituents beneath the landfill were benzene, toluene, ethylbenzene, and xylenes. Concentrations were 4,800, 4,300, 12,000 and 64,000 ppb, respectively. Concentrations for the same constituents, except toluene, at well OBG-4 were 15,160 and 2,300 ppb. Chlorobenzene was also found at 29 ppb. Trace concentrations of

xvlenes and chlorobenzenes were detected in wells OBG-1, OBG-2 and OBG-3 at 1 to 2 ppb and 5 to 14 ppb, respectively. A trace concentration of benzene was detected in OBG-1 at 3 ppb. Phenols were detected in wells OBG-1 through OBG-4 at concentrations of 9 to 37 ppb. The material detected within the landfill did not appear to be a fuel oil or gasoline products. Testing of upgradient wells OBG-5 and GM-8 confirmed that there does not appear to be a source upgradient of the landfill. The report also concluded that while the migration of dissolved constituents away from the landfill in the northeasterly direction is limited, there appeared to be a potential for migration of ground water and contaminants from the landfill in the easterly direction.

1.02 Scope of Work

Based on this effort, it was determined that additional investigations were required east of the landfill to provide the necessary information for the evaluation of remedial alternatives. The scope of work for this investigation consisted of the following tasks:

1. Install three (3) additional ground water monitoring wells to the east of the landfill area (OBG 6, 7, and 8).
2. Survey the elevations of the additional wells and measure ground water levels in the new wells and existing wells GM-8 to GM-12 and OBG-1 to OBG-4 to characterize the ground water table and direction of ground water flow.
3. Sample the new wells and the existing downgradient wells OBG-1 to OBG-4 and analyze the ground water by EPA Method 601/602 for volatile organics and EPA Method 420.3 for phenols. One matrix spike, one matrix spike duplicate and one trip blank was analyzed for quality assurance on the data.
4. Conduct in-situ hydraulic conductivity tests in all of the OBG monitoring wells east of the railroad tracks to characterize the

conductivity of the soils for input on preliminary evaluation of ground water collection alternatives.

5. Review regulatory standards and criteria for compounds detected in ground water at the site.
6. Inspect the existing permits and facilities at the plant for treatment and discharge of plant process water and pumped ground water from the lagoon area north of the Shawsheen River. On the basis of information collected at the plant, evaluate the potential for utilizing the existing systems for treatment of ground water from the landfill area and either using or amending the waste water discharge permit to the Greater Lawrence Sanitary District system.
7. Develop a preliminary remedial action plan encompassing an assessment of alternative methods for controlling contamination at the landfill area. The assessment was to consider the technical feasibility of implementing various remedial actions, relative to control of any environmental risk at the site. Technologies to be developed will include at least the following:
 - Ground water collection and treatment;
 - Containment;
 - Innovative treatment;
 - And no action.

Preliminary construction cost estimates were prepared for alternatives considered most technically feasible - from the engineering feasibility evaluation. The plan would also outline what work or testing would be necessary to develop a final design of the remediation systems.

SECTION 2 - ADDITIONAL INVESTIGATIONS AND SITE HYDROGEOLOGY

2.01 General

The monitoring well installation work for this investigation was performed on October 22 and 23, 1987 by Soil Exploration Corp. of Leominster, MA under the supervision of an O'Brien and Gere hydrogeologist. Well sampling was performed on October 30, 1987. Monitoring wells OBG-4 and OBG-8 were also resampled on December 2, 1987. Access to the site was obtained through Reichhold Chemicals.

2.02 Soil Borings

Three (3) borings for monitoring well installations were installed using hollow-stem augers with split-spoon sampling (ASTM Method D-1586). Split spoon samples were collected every two or three feet until a glacial till unit was encountered at about 18 to 23 feet, which represented a unit of lower permeability than the sand above. Split-spoon sampling equipment was revised with water between samples. Boring locations are identified on Figure 2. Soil Boring Logs are attached in Appendix A.

Soil samples were tested with a Photovac TIP 2 portable photoionization detector for organic vapor content to identify particular contaminant migration zones, if any. Photoionizer readings in borings OBG 6 and 7 were trace to non-detectable throughout the boring. Trace readings may have been due to moisture interferences. Photoionizer readings of 12 and 3 were found in the soil samples at the upper and lower portions of OBG-8. Odors were also present in a sand sample of top of till in OBG-8.

2.03 Monitoring well Installations

Ground water monitoring wells were installed within boreholes to obtain measurements of ground water elevations and collect samples of ground water for chemical analysis.

Monitoring wells were installed using ten foot sections of 2-inch PVC well screen with 0.010 inch slots and solid 2-inch PVC riser. Naturally occurring medium grained sand was allowed to collapse around the well screen. The wells screened the entire saturated thickness of the sand unit which is believed to be continuous between all wells. Well depths ranged from 20-23 feet deep, and the water table occurred about 4-6 feet below grade. A well installation summary is included as Table 1.

A. Well Development:

Following installation, all new wells were developed by a centrifugal pump until relatively sediment free water was observed at the discharge. Sustained discharge rates observed during development ranged from less than 1 GPM at OBG-7 to 1 GPM at OBG-6 and 4-5 GPM at OBG-8. Discharge water from OBG-8 contained no visually apparent free phase liquids.

B. Decontamination:

The pump and discharge hose was cleaned in between wells by flushing with a dilute mixture of trisodium phosphate (TSP) and control water and rinsing with water. Similarly, all soil and ground water sampling equipment was cleaned in the same manner between sampling events. Hollow stem augers and other associated drilling equipment was cleaned at the facility by use of a high pressure steam cleaner.

C. Surveying

Following installation of protective casings around the well risers, a land survey was conducted to establish the horizontal location and vertical elevation of the new wells relative to an existing well (OBG-1). Well casing elevations were calculated to be the following:

	<u>Ground Surface (ft)</u>	<u>Protective Casing (ft)</u>
OBG-6	78.18	79.48
OBG-7	74.18	75.48
OBG-8	78.14	79.44

D. Hydraulic Conductivity Testing

In-situ hydraulic conductivity tests were performed on the newly installed wells in a similar manner to those performed on OBG wells 1 through 5. The wells were pumped for a short period of time to create a difference in hydraulic head between the well and the aquifer. The response of the aquifer to this change was then measured over time with a ground water depth probe. The resultant in-situ hydraulic conductivity field logs are shown in Appendix B. The values of hydraulic conductivity (k) were found to be:

OBG-1	3.5×10^{-5} cm/sec
OBG-2	1.0×10^{-4} cm/sec
OBG-3	1.3×10^{-5} cm/sec
OBG-4	6.2×10^{-5} cm/sec
OBG-6	2.1×10^{-4} cm/sec
OBG-7	1.04×10^{-4} cm/sec
OBG-8	5.6×10^{-4} cm/sec

2.04 Ground Water Sampling

Ground water monitoring wells OBG-1 through OBG-4 and OBG-6 through OBG-8 were sampled on October 30, 1987. Ground water monitoring wells OBG-4 and OBG-8 were resampled on December 2, 1987. Well sampling protocols for purging the well prior to sampling, sample preservation, and chain of custody records were followed.

A. Ground Water Elevation Monitoring

Ground water elevations were collected from OBG wells prior to sampling to provide data for developing ground water flow maps in the overburden. Ground water elevations measured on October 30 are shown on Table 2. The ground water elevations previously measured on August 6, 1987 are also shown for reference. The ground water table for both of these dates is shown on Figure 3.

B. Ground Water Analysis

Seven (7) ground water samples taken on October 30 were analyzed for volatile organics (EPA Methods 601/602) and phenols (EPA Method 420.3). Monitoring wells OBG-4 and OBG-8 were also resampled on December 2, 1987 and analyzed for volatile organics to verify the October 30 results. Original laboratory report forms and chain of custody forms are included in Appendix C.

Test results for volatile organics and phenols are summarized in Table 3. Principal contaminants in the landfill (from August 6 samples of GM-9, GM-10 and GM-11) were benzene, toluene, ethylbenzene and xylenes. The concentrations of volatile organics in the October 30 samples from monitoring wells OB-1 through OBG-4 (north of the railroad tracks) were less than the concentrations noted on August 6 as shown on Figure 4. Most notably, the volatile organics were not detectable in well OBG-4 versus a total VOC concentration of 2504 ppb on August 6.

In the new monitoring wells further to the east, volatile organics were not detectable in wells OBG-6 and OBG-7. A total VOC concentration of 943 ppb was noted in well OBG-8, the principal contaminant being xylene at 850 ppb. The December 2 test results showed lower concentrations (total VOC of 316 ppb with xylene at 280 ppb). Concentrations within the landfill are generally one or two orders of magnitude greater than in the downgradient

area. The approximate boundary of the contaminant plume as designated by total VOC concentrations is shown in Figure 2.

Phenols concentrations detected in the downgradient wells ranged from 6 ppb to 100 ppb on October 30 versus 9 to 37 ppb on August 6. The concentrations are also orders of magnitude less than those measured in the landfill (up to 14,500 ppb).

C. Quality Assurance/Quality Control

Quality assurance/control analyses were performed along with ground water analyses to provide control of analytical results. Reports of QA/QC results including analyses of a field trip blank, and duplicate analyses are included in appendix C along with laboratory results.

2.05 Site Hydrogeologic Characterization

Information obtained from the supplemental well installation program enabled a fairly detailed evaluation of the geology, occurrence and movement of ground water in the area of investigation. The following subsections describe the types of soils encountered, their extent, and resultant movement of ground water and any associated contaminants. From this, a detailed evaluation of the technical feasibility of remedial options is presented in later sections.

A. Site Geology

Results of test borings indicate that an apparently continuous layer of coarse to medium sand with trace gravel and silt occurs across the site to a depth of 18 to 23 overlying a denser glacial till unit. The glacial till consists of coarse to fine sand dispersed in a matrix of silt with some gravel fragments. The test borings penetrated into the upper portion of this unit and in some instances, a refusal was obtained indicating the possibility of

bedrock occurring not too far below the top of the glacial till. The sand unit was found to be thicker to the east in borings OBG6-7 (19-23 feet) compared to 15-17 feet at OBG-1, 2, 3 and 13 feet at OBG-5. The sand unit also becomes more gravelly and cobbly toward the southwest (GM-12).

A deposit of fill was found to overlay the sand unit in the area of the landfill and railroad track, (see hydrogeologic cross section, Figure 3). Apparently, fill consisting of re-worked natural soils was placed in a formerly existing topographic swale located beneath the landfill and railroad track. The landfill material was then placed on this filled land.

Information from auger refusals indicate that the top of the local bedrock appears to slope gently to the north toward the Shawsheen River with a small saddle located just north of the railroad tracks. The extent of the depression east and west currently is not known since most wells were not taken to rock.

B. Ground Water Flow Conditions

Ground water occurs in the sand unit about 2 to 14 feet below ground surface and is closest to the surface in the topographic swale located just north of the railroad tracks. The fluctuation of the water table from readings taken in August and October 1987 was about 1 to 2 feet. The water table in both periods was 1-3 feet below the base of the landfill.

During both periods, as is shown on the ground water flow map (Figure 2), the ground water flow direction is to the northeast and toward the Shawsheen River.

The hydraulic conductivity (K) of the sand unit as determined by in-situ tests ranged around 5.75×10^{-5} cm/sec in OBG wells northeast of the railroad tracks and about 4×10^{-3} cm/sec in GM

wells located southwest of the tracks. As mentioned, the higher K value southwest of the tracks corresponds to more gravely soils in this area.

The average linear velocity (V_s) was calculated for ground water flow rates both northeast and southwest of the tracks. A value of .013 ft/day was calculated northeast and .4 ft/day southwest of the tracks. Given that the ^{contaminant} ~~containment~~ front has migrated about 225 feet northeast of the landfill, the calculated time (t) for contaminant migration using the K value northeast of the tracks is about 30 years. This value assumes no contaminant retardation via adsorption, etc., but seems realistic for preliminary flow modeling discussed in Section 3.06.

SECTION 3 - PRELIMINARY REMEDIAL ACTION PLAN

3.01 General

This section of the report presents a preliminary assessment of alternative remedial action methods for controlling contamination at the landfill area. Regulatory standards and criteria for compounds detected in ground water at the site are presented. The existing treatment facilities and discharge permit at the plant is evaluated to formulate ground water treatment options. Finally, remedial action technologies are identified and screened; and feasible remedial action alternatives are identified and developed.

3.02 Review of Regulatory Standards and Criteria

Regulatory standards and criteria were reviewed to determine the criteria to be used as a basis for establishing the acceptability of an alternative relative to the control of environmental risk. Section 40.547 (a) (b) of the proposed Massachusetts Contingency Plan states that

"A permanent solution is sought for all disposal sites which, at a minimum, ensures attainment of a level of control of each identified substance of concern at the disposal site or in the surrounding environment such that no such substance of concern will present a significant or otherwise unacceptable risk of damage to health, safety, public welfare, or to the environment during any foreseeable period of time.

Where feasible, a permanent remedial action shall also reduce the level of oil or hazardous materials to a level that would exist in the absence of the disposal site."

Table 4 presents the compounds found in the ground water and the standard or criterion for each compound proposed to be used as the objective for clean-up of the site. The final maximum contaminant levels (MCL's) for

vinyl chloride, trichlorethane and benzene will become effective and part of the National Primary Drinking Water Standards on December 31, 1988. Proposed MCL's (Federal Register, November 13, 1985, pp 47021-2) are shown for 1,2 Dichloroethene, toluene and xylenes. The remaining compounds use EPA drinking water health advisory criteria as presented in the USEPA Superfund Public Health Evaluation Manual (EPA/540/1-86/060).

3.03 Ground Water Discharge Options

The current monitoring requirements and discharge limits for the BTL Specialty Resin plant wastewater discharge to the Greater Lawrence Sanitary District (GLSD) sewer was reviewed at the plant on December 4 to evaluate the possible discharge of ground water from the landfill area into the plant sewer system.

Current Waste Water Discharge

Plant wastewaters and stormwater runoff are currently collected in an equalization basin and discharged through a lift station to the GLSD system without further treatment. The effluent is monitored monthly for COD, Phenol, TS and TSS. In addition there is semi-annual testing for pH, Oil & Grease, and BOD5. For September 1987, the following values were noted:

Phenol - 82 mg/l
COD - 3605 mg/l
Flow - 6.7 Million Gallons

According to BTL, roughly 1.2 million gallons of the monthly discharge was ground water from the withdrawal system associated with the surface impoundments situated on the far side of the Shawsheen River. Phenol concentration in the ground water discharge was 0.1 ppm. A BOD5 value of 2,200 mg/l for the discharge was mentioned as typical.

The discharge permit allows an average monthly flow of 101,000 GPD. There is a surcharge of \$1,500/month for each million gallons of flow above the allowed average. A surcharge is also made for BOD in excess of the GLSD limit of 250 mg/l.

Impact of OCPSF Regulations

Final regulations (52FR52522) were promulgated for the Clean Water Act in the Organic Chemicals, Plastics and Synthetic Fibers Pretreatment Category in November, 1987. The products manufactured at the BTL facility fall into the SIC 2821 category which includes thermosetting and thermoplastic resins. Waste waters from plants in this SIC category are regulated under 40 CFR Part 414 Subparts D and E. All existing sources must meet pretreatment standards by November 5, 1990. The regulations include a mass discharge restriction based on the amount of "process wastewater flow."

Our analysis was limited to evaluation of the addition of ground water from the landfill area to the plant wastewater discharge; we are not evaluating the compliance status of the BTL operations. Regulated compounds under OCPSF found in ground water at the landfill included:

<u>Compound</u>	<u>Max. Detected near or within Landfill (ug/l)</u>	<u>OCPSF PSES Std. (ug/l)</u>	
		<u>Monthly Avg.</u>	<u>Max Day</u>
Vinyl Chloride	3	97	172
t-1,2 Dichloroethene	6	25	66
Chloroform	9800	111	225
t-1,2 Dichloroethane	1	180	574
1,2 Dichloropropane	16	196	794
Trichloroethene	5	26	69
Benzene	4800	57	134
Toluene	4300	28	74
Chlorobenzene	29	142	380
Ethylbenzene	12,000	142	380
Phenol	14,000	19	47

We contacted Mr. Elwood Forsht of the EPA regarding the consideration of ground water as a "process wastewater" regulated under the OCPSF

category. Mr. Forsht said that the pretreatment standards are for process wastewaters only and do not include contaminated ground water.

Based upon the information available at this time, the options for ground water discharge are as follows:

1. Separate pretreatment system (activated carbon or air stripping) and discharge to the GLSD sewer system. Costs would include the pretreatment system and a discharge line to the GLSD sewer. An additional sewer discharge permit would be required. Monitoring of the ground water discharge will be required to demonstrate compliance with the permit. The separate discharge of ground water would not be regulated under the pretreatment categorical standards.
2. Discharge to the existing plant process wastewater line to the equalization basin. The estimated ground water discharge is 5 to 40 gpm. It is anticipated that the contaminants in the ground water will not have a significant impact on the combined effluent waste stream due to the low flows (5 to 40 gpm vs. 155 gpm total effluent to the sewer) and the probable dilution of the static contaminant levels in the ground water by pumping. The GLSD sewer discharge permit should be modified to include the additional flow.

BTL will have to pretreat the process wastewater flow to comply with categorical pretreatment standards by November 5, 1990. The impact of the contaminated ground water flow should be evaluated at that time and a separate ground water treatment system implemented, if required.

3. Separate pretreatment system and discharge to the Shawsheen River. Costs would include the pretreatment system and a discharge line to the river. A SPDES permit would be required under Massachusetts regulation 314 CMR 3. Treatment would most

likely be required for a water quality based effluent limitation for a class B waterway. The implementation of this option would be more difficult and take longer due to the permit process.

It appears that Option 2, discharge to the plant process wastewater line, is the most feasible and least costly option; however, a final decision should not be made until the pumped ground water can be characterized. Analysis of ground water from a test recovery well is discussed in Section 4.02.

3.04 Identification of Potential Remedial Action Methods

The remedial action selection process presented in the EPA Handbook, Remedial Action at Waste Disposal Sites (EPA/625/6-85/006) was used in the identification, screening and evaluation of remedial action alternatives.

Site investigation data was used to identify site problems which were then compared to categories of remedial technologies to determine which technologies were applicable as follows:

<u>Site Problem</u>	<u>Remedial Technology Category(s)</u>
Leachate migrating vertically or horizontally	Ground water Controls, In-Situ Treatment
Precipitation infiltrating into site to form leachate	Surface Water Controls, Ground water Controls
Contaminated Ground water and Soils	Waste and Soil Excavation and Removal, In-Situ Treatment

3.05 Screening of Remedial Action Methods

The next step in the remedial action selection process is to identify and screen potentially applicable remedial action methods from the selected general remedial technology categories. Technologies were eliminated that may prove difficult to implement, rely on unproven or inapplicable technologies or may not achieve the remedial objectives within a reasonable time period. This screening process focuses on eliminating those technologies that have severe

limitations for the given set of waste and site-specific conditions. The remedial action methods, brief description of use and whether or not the remedial action is applicable are shown as follows:

1. Surface Water Control:

A. Capping

- To reduce the rainfall percolation through the landfill and effectively isolate (contain) the contaminants and eliminate a hydraulic mechanism for additional transport to the ground water.

B. Floating Covers

- Not applicable to site.

C. Grading

- Management of surface water infiltration.
- Used in conjunction with capping.

D. Revegetation

- Used with capping if a soil cap is used.

E. Surface Water Diversion and Collection

- Use in conjunction with capping.

2. Ground water Controls

A. Ground water pumping

- Used to contain and remove contaminant plume.

B. Subsurface drains (interceptor trench)

- Used to contain and remove contaminant plume

C. Subsurface barriers (slurry walls)

- Used to contain horizontal migration of ground water.
- Not applicable to the site since the existing data indicates that the landfill constituents remain 1 to 3 feet above the water table (August, October 1987)

3. Excavation and On-site or Off-site Disposal

A. Excavation and On-site Land Disposal

- Must construct secure on-site disposal facility and obtain license for hazardous waste disposal facility under RCRA (40 CFR Part 264).
- Ground water monitoring, leachate collection required.
- Eliminate from further consideration due to high cost and difficulty of implementation.

B. Excavation and Off-Site Disposal

- Permanent solution for source control.
- Contaminated ground water migration must still be addressed.
- Evaluate further for cost and implementation feasibility.

4. In-Situ Treatment (in place treatment of unsaturated soils).

A. Bioreclamation - use of micro-organisms in the soil to degrade contaminants by promoting favorable conditions through injection of nutrients into the soil.

- Three of the major contaminants found in the landfill (xylene, ethylbenzene and chloroform) are relatively undegradable by aerobic bacteria.
- Eliminate from further consideration.

B. Chemical Treatment - use of oxidizing/reducing agents to chemically degrade (detoxify) contaminants or the use of flushing agents to mobilize contaminants for extraction (soil flushing).

- Technology is in conceptual or development stage and has not been fully demonstrated for hazardous waste remediation.
- Unfavorable by-products may be formed.

C. Physical Methods

- In-situ heating, ground freezing, and vitrification methods are in the early stages of development and detailed information is not available.
- In-situ air stripping (soil venting) relies on the characteristics of the contaminant to volatilize into the air available in the void spaces within the subsurface soil matrix. This technology appears to be applicable to the site and will be developed further.

3.06 Development of Remedial Action Alternatives

Remedial action methods which have passed the initial screening process can now be combined to form overall remedial action alternatives. These alternatives represent a workable number of options that appear to adequately address the site problems and are as follows:

1. No Action - This alternative would allow the contaminants in the landfill to be transported to the ground water by percolation through the landfill. The contaminated ground water plume would continue to migrate to the east and eventually have a potential impact on the Shawsheen River and the parcels to the east which are undeveloped, but may be developed in the future. The No Action alternative is not likely to be acceptable to the DEQE if economically feasible remedial actions are available.
2. Excavation and removal and off-site disposal of contaminated soil off-site together with ground water collection and treatment.

3. Capping of landfill and ground water collection and treatment.
4. In-situ air stripping of soils and ground water collection and treatment.

Table 5 classifies the remedial action alternatives by the type of control (contaminant source vs. ground water migration) and type of solution (temporary vs. permanent). Alternatives 2, 3 and 4 all address ground water migration control since any viable alternative should address containment or treatment of the contaminant plume. Alternatives 2 and 4 would likely be considered permanent solutions since these alternatives include reduction or mitigation of the source. The following discussion further develops Alternatives 2, 3 and 4 so that a preliminary remedial action alternative can be recommended.

Alternative 2 - Excavation and Removal and Off-Site Disposal

This alternative would involve the excavation of the landfill contents and disposal of the contaminated soil at a secure landfill which is licensed under RCRA Part B. Ground water collection and treatment would also be included in Alternative 2.

It is estimated that the landfill (150 feet long by 100 feet wide by an average depth of 5 feet) contains about 75,000 cubic feet of contaminated soils (2,800 cubic yards). At the present time, there are no RCRA Part B licensed disposal facilities in the Commonwealth. The estimated cost for excavation and disposal is \$500 to \$600 per cubic yard or \$1.4 million to \$1.68 million for the landfill contents. Total costs for Alternative 2, including ground water collection and treatment is \$1.45 to 1.80 million as shown on Table 6.

The advantages of this alternative is that it would provide the shortest time frame for removal of the source and minimize future ground water monitoring, collection and treatment time. Besides the major disadvantage of cost, other disadvantages include possible release of

volatile halogenated organics (VHOs) into the air, the safety of workers involved in the excavation and the possible requirements for pretreatment of the soil which may be required for off-site transport (e.g., moisture content).

Alternative 3 - Capping of Landfill and Ground water Collection and Treatment

Landfill Capping

The capping of the existing landfill from a technical standpoint is considered to be a particularly effective component to on-site remediation. Existing data indicates that the landfill constituents remain 1 to 3 feet above the water table (August, October 1987) although this needs to be verified by additional data. Since the landfill is currently covered only by a thin veneer of native sandy soils, from a hydrogeologic standpoint, it is logical to assume that a certain portion of rainfall percolates through the cover into fill material. Contaminants identified in the landfill are most likely transported to the local water table by a percolating precipitation. Proper capping and grading of the landfill would reduce the potential for contaminants to impact the water table occurring beneath it and subsequent ground water collection and treatment time and costs would most likely be reduced.

A single-layered cap may be acceptable for a temporary measure; however, the use of a multi-layered RCRA type cap will be assumed for maximum cost impact. A multi-layered cap would consist of an upper vegetative layer (topsoil); a drainage layer of sand; and a low permeability layer (clay). The site may also have to be graded and drainage swales provided for surface water diversion and collection. Landfill capping costs are estimated at \$60,000 to \$75,000.

Two methods of ground water collection: interceptor trench and drain system, and recovery well system were evaluated as follows:

Ground Water Interception Trench

A technology available for capturing and treating contaminated ground water is through the placement of a collection trench. The trench would have to be excavated to the top of dense till or bedrock (25 - 30 feet deep) along a length of about 700 feet. The trench would also have to be located either immediately adjacent to the northeast of the landfill along the railroad or in a northwest-southeast alignment from OBG-3 toward OBG-6. This particular option of ground water withdrawal for treatment would be used in conjunction with landfill capping but it's effectiveness would be incomplete compared to a recovery well system for the following reasons:

- A trench on the southern side of the tracks along GM 9, 10 and 12 would collect only the most contaminated portion of ground water while letting the remaining portion of the plume north of the tracks escape.
- Cobbly subsoils, utilities, railroad track right-of-ways would also complicate trenching operations.
- It would be very difficult to excavate a trench to the required depth due to dewatering and sheeting requirements and proximity to the railroad.
- A trench on the northern site portion along OBG 3, 1 and 6 would require extended treatment time to allow contaminants from the landfill to migrate to the trench.
- The cost of trenching in either location (approximately 700 ft.) is prohibitively high due to the depths and construction difficulty.

Ground Water Recovery Well System

A recovery well system used in conjunction with capping of the landfill would simultaneously address remediation of contaminated ground water and reduce additional contaminant generation.

A couple of scenarios involving different recovery well placements were modeled for this evaluation. Since aquifer data available at this time is only preliminary, the resultant modeled data must also be considered preliminary. Further evaluations are recommended including an aquifer performance test prior to establishing design criteria for this option.

Hydraulic conductivity (k) data from the existing monitoring wells indicated a relatively uniform K for the areas north and south of the landfill and therefore was deemed sufficient to provide preliminary data for modeling of a recovery system. The configuration of the existing monitoring network should be sufficient to monitor the effects of an aquifer performance test and subsequent performance of a recovery system.

A preliminary ground water flow model (Theis well field) was run utilizing one recovery well 6 inch diameter, approximately 25 feet deep located near GM-10 adjacent to the landfill. Calculations using the Jacobs' equation indicated flow from the well will be about 1.5 gpm. The long term (180 days) cone of influence generated from this well however, was not sufficient to capture contaminated ground water occurring in wells GM 9, 12, and OBG wells 4 and 8 (Figure 5). The relatively low permeability of the formation restricted the shape of the resulting cone such that regional flow gradients in some areas of the plume were not reversed.

A system consisting of three recovery wells all designed alike was then modeled (Figure 6). The cumulative cone of influence was sufficient to capture ground water about 300 feet southeast and northwest of the landfill, and about 100-150 feet downgradient of wells OBG 4 and 8. This cone was sufficient to encompass the identified contaminant plume. Injection wells placed upgradient of OBG-5 to enhance flow gradients were considered but evaluated not to be effective since ground water flow northeast of the railroad may be controlled by lower permeable soils there. Excess ground water pumped into higher

permeable soils around the landfill may divert flow laterally northwest and southeast outside the capture zone.

Capture zones developed from the preliminary modeling provide an estimation of the amount of recovery wells which may be needed to remediate the contaminant plume. Prior to establishing the number of wells needed, it is imperative that a test recovery well be installed at the landfill and tested to verify or modify existing data.

A method for verifying the pumping scenario would be to install a recovery well to the top of bedrock just east of well GM-10. The well would consist of an 8-foot section of No. 20 slot stainless steel screen and 17 feet of riser with a No. 1 size gravel pack, and surface seal. A long term pump test (48-72 hours) should then be run while monitoring wells GM 7, 10, 11, 12 and OBG 4 and 8 to evaluate the cone of influence. The duration of the test is necessary to evaluate cone development in low permeable soils northeast of the tracks. The test well could be designed such that it could be used as a preliminary recovery well. It would seem practical, at this point, to simultaneously install a test well while developing a treatment alternative so that the well could be run over a long period of time to further evaluate the need for additional wells.

Table 6 indicates the range of estimated capital and operation and maintenance costs for a one to five recovery well ground water collection system. Costs are included for ground water treatment by activated carbon or air stripping or both to show potential cost impacts.

Alternative 4 - In-situ Air Stripping of Soils and Ground Water Collection and Treatment

The in-situ (in-place) treatment of VHO contaminated soil by air-stripping, also referred to as vacuum extraction and soil venting, is an innovative technology which has been given significant recent attention. The system consists of a minimum of one withdrawal or

injection well. The well is constructed similar to a ground water monitoring well, only the screened interval is located within the unsaturated soil zone. The well is connected to the intake or discharge of a blower. The blower develops a vacuum or pressure drop across the soil matrix, thus inducing an air flow through the soil. The VHOs are driven into the air phase due to the lower vapor pressure of the VHOs. Equilibrium drives the VHOs from the liquid phase which is adsorbed to the soil particles into the gas phase. As air moves from outside the contaminated zone through the contaminated zone, the air is enriched with VHOs prior to extraction and discharge. The sandy soils, occurrence of ground water relative to the landfill and volatile organic contaminants at the Reichhold/BTL site, are well suited to this technology and have been effective in past installations with similar hydrogeology and contaminants.

Cost of the in-situ air stripping system is determined by the number of extraction/injection wells, the size of the blower and length of interconnecting piping. The preliminary cost of the system shown on Table 6 is based on a cost of \$15 to \$35 per cubic yard. The major system operating cost is for sampling and analysis of the extracted soil gas to monitor system performance. A schematic of the in-situ air stripping system is included as Figure 7.

Although capital costs for Alternatives 3 and 4 are very close. Alternative 4 would reduce the time required for ground water treatment since the source of the contamination is being treated. At this stage, it is difficult to determine how long the ground water collection and treatment system will be required; however, a 10-year period is not unreasonable. To illustrate the potential for long-term cost savings with Alternate 4, a hypothetical case is presented below:

<u>Alternative</u>	<u>Capital Cost in thousands</u>	<u>Annual O&M Cost in thousands</u>	<u>No. of Years of operation</u>	<u>Present Worth Cost* (thousands)</u>
3	105-225	10.5-26.0	10	172 - 392
4	95-250	14.5-35.0	2-5	120 - 386

*at 9% interest rate.

SECTION 4 - CONCLUSIONS AND RECOMMENDATIONS

4.01 Conclusions

The following information and conclusions have been developed from the additional field investigations and preliminary remedial action alternative assessment:

1. Results of the test borings indicate a sandy unit occurs to a depth of 18-23 feet overlying a dense till, which is consistent with previous test borings. The landfill was placed on an apparent deposit of fill which extends to include the railroad bed (see Figure 3).
2. Monitoring wells OBG6-8 were placed further to the east of wells OBG1-4 and ground water levels were measured at wells OBG 1-4, 6-8 and GM 8-12. The water table in October 1987 was 1 to 2 feet higher than in August; however, the water table in both periods was 1 to 3 feet below the base of the landfill. Ground water flow from the landfill appears to be in the northeast direction towards well OBG-8.
3. In-situ permeability tests were performed on wells OBG1-4 and OBG 6-8 to characterize the conductivity of the soils. The hydraulic conductivity (K) of the sand unit consistently ranged around 5.75×10^{-5} cm/sec in OBG wells north of the railroad tracks and 4×10^{-3} cm/sec in GM wells south of the tracks; therefore, the controlling K is north of the railroad tracks.
4. Ground water monitoring wells OBG 1-4 and 6-8 were sampled on October 30 and analyzed for volatile organics and phenols and wells OBG 4 and 8 were resampled on December 2 and analyzed for volatile organics. The concentrations of VOCs in the October 30 samples from wells OBG1-4 were less than the concentrations detected on August 6 (Figure 4); most notably, VOCs were not

detectable in well OBG-4 versus a total VOC concentration of 2504 ppb on August 6. In the new monitoring wells, VOCs were not detectable in wells OBG 6 and 7; however, total VOC concentration of 943 ppb was noted in well OBG-8, the principal contaminant being xylene at 850 ppb. The December 2 samples showed lower concentrations of total VOCs and xylene (316 ppb and 280 ppb, respectively). The contaminant front (10 ppb) has migrated approximately 225 feet northeast of the landfill (Figure 2); however, the concentrations are generally one or two orders of magnitude less in the downgradient area than found in the landfill.

5. Current regulatory standards and criteria were reviewed to establish objectives for the site clean-up (Table 4). Although the concentrations found in the downgradient area are orders of magnitude less than those found at the landfill, concentrations of xylene, TCE and vinyl chloride at OBG-8 equal or exceed existing or proposed EPA maximum contaminant levels (MCLs).
6. Existing permits and plant facilities were inspected to evaluate the potential for utilizing the existing systems for treatment of ground water from the landfill area. It was determined that contaminated ground water would not be included under the EPA categorical pretreatment standards for the BTL plant SIC category. It appears that the discharge of pumped ground water to the existing plant process wastewater line to the equalization basin is the most feasible and least costly treatment option. However, additional data on the contaminants in the pumped ground water is needed so that the potential effect on the combined effluent waste stream can be evaluated.
7. General remedial technology categories were compared to site problems to determine applicable technologies. The identified remedial action methods were then screened to eliminate inappropriate methods. Four remedial action alternatives were then identified and are as follows:

1. No Action
 2. Excavation and removal and off-site disposal of contaminated soil and ground water collection and treatment.
 3. Capping of landfill and ground water collection and treatment.
 4. In-situ air stripping of soils and ground water collection and treatment.
8. The identified alternatives were then developed so that a preliminary recommendation of the remedial action method could be made. The No Action alternative was eliminated since it would most likely be unacceptable to DEQE. Excavation and removal was eliminated due to excessive cost. Alternatives 3 and 4 are both feasible alternatives and are similar in cost (Table 6). In-situ air stripping, however, has the potential for savings due to the reduced time required for ground water treatment. Additional data is required to determine the feasibility for in-situ air stripping.

4.02 Recommendations

Based on the information and conclusions presented herein, we offer the following recommendations to Reichhold Chemicals for developing a final remedial action plan:

1. Recovery Well Installation

Aquifer performance data is required to establish design criteria for the ground water collection system. A test recovery well should be installed to the top of bedrock just east of well GM-10 as shown on Figure 5. The test recovery well should be designed such that it can be used as a recovery well for the final ground water collection system.

The well should be constructed with an 8-foot section of 6-inch diameter stainless steel screen (0.020 slot) and 17-feet of low carbon steel riser. The screen would be packed with No. 2 silica sand and the annulus around the well riser backfilled with a cement bentonite mixture. Each well should be outfitted with a 3½-inch diameter, 1/2 horsepower, submersible well pump. A sample tap should be installed to collect samples during the test. The discharge would be run through a flexible hose to the nearest plant process-wastewater line to the equalization basin. A portable generator should be used to power the pump during the test.

2. Pump Test

A 48 to 72 hour pump test should be performed on the test recovery well to evaluate the long term yield of the well and to measure the radius of influence around the well. The long duration of the test is necessary to evaluate the cone development in the low permeable soils northeast of the railroad tracks. The radius of influence would be monitored by measuring water levels in existing wells GM, 7, 10, 11 and 12 and OBG4 and 8.

3. Sampling and Analytical Program

Soil samples, obtained during the drilling of the test recovery well, should be analyzed for VHOs (EPA Method 8010) and for oil and grease content to provide additional data to complete the evaluation of the in-situ air stripping method.

Water samples should be collected from the test recovery well during the test at 24 and 48 hours and at the end of the test. Water quality analysis parameters should include EPA Method 601/602 for volatile organics and EPA Method 420.3 for phenols to provide data to evaluate the need for treatment. The samples should also be analyzed for COD, total and suspended solids and pH to evaluate the impact on the effluent to the GLSD sewer.

Existing monitoring wells OBG1-4 and 6-8 should be sampled and analyzed by EPA Methods 601/602 and 420.3 to obtain additional data on the migration of the contaminant plume.

4. Final Remedial Action Plan

Using the data obtained from the pump test and soil and water analyses, the final remedial action plan should be developed. The following tasks should be completed and presented in the final plan:

- a. Complete the evaluation of the feasibility and costs of the in-situ air stripping method.
- b. Determine the required number of wells and estimated costs to capture the entire contaminant plume versus containment of the plume south of the railroad tracks only. Evaluate the additional costs for capturing the entire contaminant plume versus the cost of a risk assessment which would be required if containment was limited to the landfill side of the railroad tracks.
- c. Test data from the pump test, including flow quantities and analytical data, should be used to determine the most cost-effective treatment of pumped ground water. Options 1 and 2 presented in Section 3.03 should be evaluated.
- d. Finalize the selection of a remedial action alternative that will satisfy the remedial action objectives in the most cost-effective manner.

TABLE 1

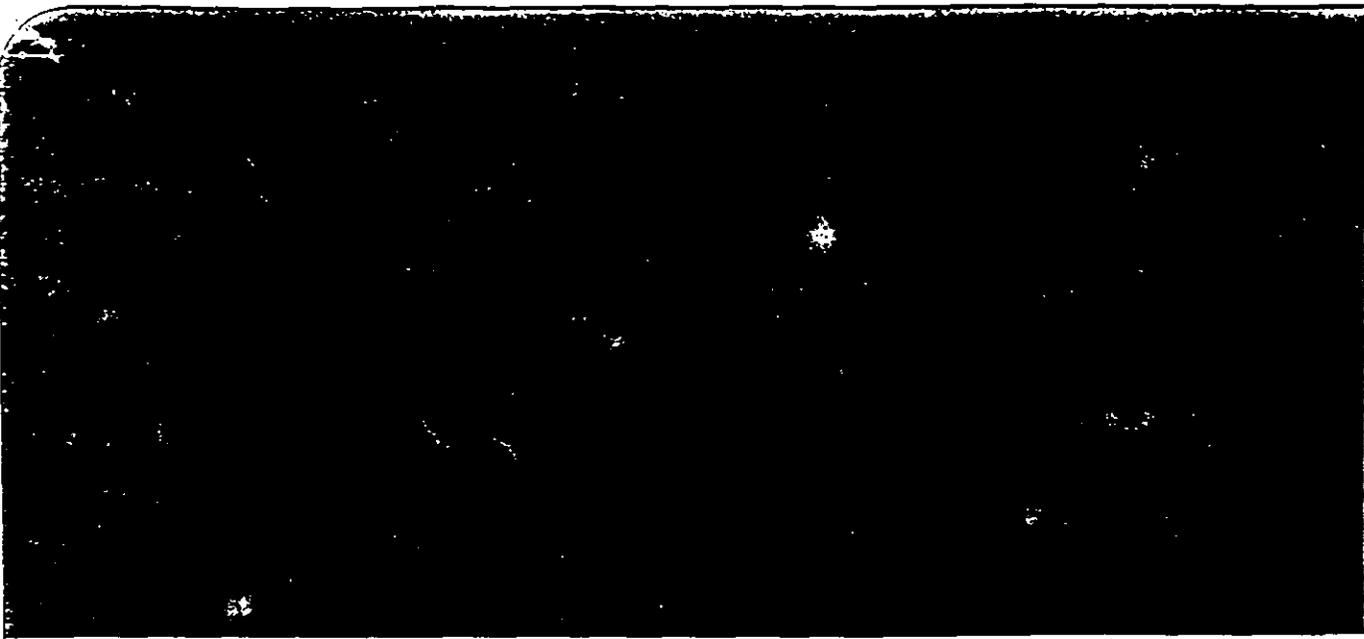
REICHHOLD CHEMICALS, INC.
77 Lowell Junction Road
Andover, MA

Well Installation Summary

<u>Well</u>	<u>Diameter (in.)</u>	<u>Total Depth (ft)(1)</u>	<u>Screen Interval (ft)(1)</u>	<u>Ground Elevation FT(2)</u>	<u>Top of Casing Elevation FT(2)</u>
OBG1	2	18	8-18	76.17	78.09
OBG2	2	20	10-20	83.10	85.52
OBG3	2	18	8-18	73.21	76.08
OBG4	2	13.5	3.5-13.5	74.07	76.53
OBG5	2	13	3-13	81.54	84.84
OBG6	2	23	3-23	78.18	79.48
OBG7	2	21	6-21	74.18	75.48
OBG8	2	20	5-20	78.14	79.44

- (1) below ground surface
(2) above mean sea level

C-8
Additional Site Investigation
and Preliminary Remedial Alternatives
O'Brien & Gere
June 1988



**Additional Site
Investigation and
Preliminary Remedial
Alternatives**

**77 Lowell Junction Road
Andover, MA**

Reichhold Chemicals, Inc.
White Plains, New York

June 1988



O'BRIEN & GERE

ADDITIONAL SITE INVESTIGATIONS
AND
PRELIMINARY REMEDIAL ALTERNATIVES

77 Lowell Junction Road
Andover, MA

Prepared for:
Reichhold Chemicals, Inc.
White Plains, NY

JUNE 1988

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SECTION 1 - INTRODUCTION

1.01 Background

The property at 77 Lowell Junction Road was sold by Reichhold Chemicals, Inc. to BTL Specialty Resins, Inc. in June of 1986. Reichhold and BTL have agreed to conduct a joint investigation of an old landfill area on the eastern side of the plant shown on Figure 1. The landfill is approximately 100 feet by 150 feet in area and averages five feet in depth.

Reichhold Chemicals purchased the property from Watson Park in 1953. Watson Park and Reichhold produced phenolic and urea formaldehyde resins for the textile industry. Miscellaneous fill material, solid filter cake and gelled resins were deposited in the landfill starting some time before 1963 and ending on or before 1972, when construction debris and clean soil from plant expansions and modernizations were deposited. Two test pits, dug within the landfill area by BTL in late 1986, indicated 4 to 6 feet of fill over a 6 to 8 foot layer of debris consisting of asphalt and concrete rubble, several chunks of solidified gelled resin, and a fiber drum containing solid resin.

An initial site investigation was completed by Geraghty & Miller, Inc. in February 1987. Five (5) ground water monitoring wells (numbered GM-8 through GM-12) were installed in the water table at the landfill and in the immediate area around the landfill as shown on Figure 2. Geraghty & Miller concluded that ground water flows northeastward from the landfill. The principal contaminants identified in the ground water at the landfill were benzene, toluene, xylene, ethylbenzene and phenolic compounds.

Additional site investigations were completed by O'Brien & Gere in August 1987, and reported in "Site Investigation", September 1987. Five (5) ground water monitoring wells (numbered OBG-1 through OBG-5) were installed as shown on Figure 2. Monitoring well OBG-5 was installed upgradient of the landfill and the other four monitoring wells were installed on the northeast side of the railroad tracks, and downgradient of the landfill. The headspace in soil samples collected during drilling was analyzed in the

field for volatile organics using a Photovac Model 10S-50 portable gas chromatograph. Ground water samples were collected from monitoring wells GM-8 through GM-12 and at OBG-1 through OBG-5 and analyzed for purgeable organics (EPA Method 601/602) and total phenols (EPA Method 420.3).

In the August 1987 investigation, materials identified in the ground water beneath the landfill were benzene, toluene, xylene, ethylbenzene, and phenolic compounds. Maximum concentrations of these constituents in wells GM-10 and GM-11, located in the landfill, were 4,800, 4,300, 64,000, 12,000, and 14,500 ppb, respectively. The concentrations dropped off significantly in downgradient wells OBG-1 through OBG-4. Concentrations in the ground water at downgradient well OBG-4 were 37 ppb of total phenols, 15 ppb of benzene, 160 ppb of ethylbenzene and 2,300 ppb of xylene. Chlorobenzene was found at 29 ppb in OBG-4. Trace concentrations of xylene were detected in wells OBG-1, OBG-2 and OBG-3 at 1 to 2 ppb. Trace concentrations of chlorobenzene were also detected in these wells at 5 to 14 ppb. A trace concentration of benzene was detected in OBG-1 at 3 ppb. Total phenols were detected in wells OBG-1 through OBG-3 at concentrations of 9 to 26 ppb.

Samples for wells OBG-4 and GM-11 were also analyzed for total hydrocarbons (EPA Method 503.1) to determine whether the organic compounds present showed a pattern resembling fuel oil or gasoline and whether the patterns were at all similar (a difference in the patterns would suggest either separate sources or differential migration of contaminants). The analysis indicated that, generally, the same compounds were present, but at much higher concentrations at GM-11 which is closer to the landfill than OBG-4. Neither a fuel oil nor gasoline pattern was indicated. Testing of upgradient wells OBG-5 and GM-8 confirmed that there does not appear to be a source of contamination upgradient of the landfill. It was concluded that while the migration of dissolved constituents away from the landfill in the northeasterly direction is limited, there appeared to be a potential for migration of ground water and contaminants from the landfill in the easterly direction.

1.02 Scope of Work

Based on the results of the August 1987 investigation, it was determined that additional investigations were required east of the landfill to provide the necessary information for the evaluation of remedial alternatives. The scope of work for this investigation consisted of the following tasks:

1. Install three (3) additional ground water monitoring wells to the east of the landfill area (OBG-6, 7, and 8).
2. Survey the elevations of the additional wells and measure ground water levels in the new wells and existing wells GM-8 to GM-12 and OBG-1 to OBG-4 to characterize the ground water table and direction of ground water flow.
3. Sample the new wells and the existing downgradient wells OBG-1 to OBG-4 and analyze the ground water by EPA Method 601/602 for volatile organics and EPA Method 420.3 for total phenols.
4. Conduct in-situ hydraulic conductivity tests in all of the OBG monitoring wells east of the railroad tracks to characterize the conductivity of the soils for preliminary evaluation of ground water collection alternatives.
5. Assess alternative methods for controlling contamination at the landfill area. Technologies to be developed were to include at least the following:
 - Excavation and removal of landfill contents;
 - Ground water collection and treatment;
 - Containment;
 - In-situ treatment; and
 - No action.

SECTION 2 - ADDITIONAL INVESTIGATIONS AND SITE HYDROGEOLOGY

2.01 General

The monitoring well installation work for the additional investigations northeast of the railroad tracks was performed on October 22 and 23, 1987 by Soil Exploration Corp. of Leominster, MA under the supervision of an O'Brien and Gere hydrogeologist. Well sampling was performed on October 30, 1987. Monitoring wells OBG-4 and OBG-8 were resampled on December 2, 1987. Access to the site was obtained through BTL.

2.02 Soil Borings

Three (3) borings (OBG-6, OBG-7 and OBG-8) for monitoring well installations were installed using hollow-stem augers with split-spoon sampling (ASTM Method D-1586). Split spoon samples were collected every two or three feet until a glacial till unit was encountered at 18 to 23 feet, which represented a unit of lower permeability than the sand above. Split-spoon sampling equipment was cleaned between sampling events by flushing with a dilute solution of tri-sodium phosphate (TSP) and rinsing with distilled water. Boring locations are identified on Figure 2. Soil Boring Logs are included in Appendix A.

Soil samples were placed in half filled containers with tin foil liners and allowed to sit for about two hours at room temperature. The ambient temperature headspace (ATH) was then measured with a Photovac TIP II portable photoionization unit. The purpose of this effort was to identify particular contaminant migration zones, if any. Photoionizer readings in borings OBG-6 and 7 were trace to non-detectable throughout the boring. Trace readings which were found may have been due to moisture interferences since similar readings were noted on control samples. At OBG-8, photoionizer readings of 12 and 3 ppm, calibrated to benzene, were found in the soil samples at the upper and lower portions, respectively. A solvent odor was detected in the soil sample from the bottom two feet of OBG-8.

2.03 Monitoring Well Installations

Ground water monitoring wells OBG-6, OBG-7, and OBG-8 were installed within boreholes to obtain measurements of ground water elevations and collect samples of ground water for chemical analysis.

Standard monitoring well procedures such as those referenced in Section 3.2.1 of the "Technical Enforcement Guidance Document" (TEGD), USEPA, September, 1986 were used to install ten foot sections of 2-inch PVC well screen with 0.010 inch slots and solid 2-inch PVC riser. Naturally occurring medium grained sand was allowed to collapse around the well screen. The wells screened the entire saturated thickness of the sand unit, which is believed to be continuous between all wells. Well depths ranged from 20-23 feet, and the water table occurred about 4-6 feet below grade. A well installation summary is included in Table 1.

A. Well Development:

Following installation, all new wells were developed by a centrifugal pump until relatively sediment free water was observed at the discharge. Sustained discharge rates observed during development were less than 1 GPM at OBG-7, 1 GPM at OBG-6 and 4-5 GPM at OBG-8. Discharge water from the three wells contained no visible free phase liquids and was discharged on the ground surface within 20 feet of each respective well.

B. Decontamination:

The pump and discharge hose was cleaned after each well development by flushing with a dilute mixture of trisodium phosphate and control water and rinsing with distilled water. All soil and ground water sampling equipment was cleaned in the same manner between sampling events. Hollow-stem augers and other associated drilling equipment were cleaned at the facility with a high pressure steam cleaner.

C. Surveying:

Following installation of protective casings around the well risers, a land survey was conducted to establish the horizontal location and vertical elevation of the new wells relative to an existing well (OBG-1). Well casing and ground surface elevations are shown in Table 1.

D. Hydraulic Conductivity Testing:

In-situ hydraulic conductivity (k) tests were performed on all of the OBG wells, except the upgradient well, OBG-5. The wells were pumped for a short period of time to create a difference in hydraulic head between the well and the aquifer. The response of the aquifer to this change was then measured over time with a ground water depth probe. The resultant in-situ hydraulic conductivity field logs are shown in Appendix B. The values of hydraulic conductivity were found to be:

<u>Well No.</u>	<u>k (cm/sec)</u>
OBG-1	3.5×10^{-5}
OBG-2	1.0×10^{-4}
OBG-3	1.3×10^{-5}
OBG-4	6.2×10^{-5}
OBG-6	2.1×10^{-4}
OBG-7	1.0×10^{-4}
OBG-8	5.6×10^{-4}

The range in k values for these wells north of the landfill was relatively narrow, indicating a relatively homogeneous overburden aquifer of moderate hydraulic conductivity. The use of this data to determine ground water flow conditions is discussed in Section 2.05.

2.04 Ground Water Sampling

Ground water monitoring wells OBG-1 through OBG-4 and OBG-6 through OBG-8 were sampled on October 30, 1987. Ground water monitoring wells OBG-4 and OBG-8 were resampled on December 2, 1987. Well sampling protocols for purging the well prior to sampling, sample preservation, and chain of custody records were followed.

A. Ground Water Elevation Monitoring

Ground water elevations were collected from OBG wells prior to sampling to provide data for developing ground water flow maps in the overburden. Ground water elevations were measured on October 30, 1987 and were also measured on May 10, 1988 to determine the groundwater level during the expected high groundwater period. These elevations are shown on Table 2. The ground water elevations previously measured on August 6, 1987 are also shown for reference. The ground water table contour map for the October 30, 1987 readings is shown in Figure 2. The groundwater table for the three dates is shown on the hydrogeologic cross section (Figure 3).

B. Ground Water Analysis

Seven (7) ground water samples taken on October 30, 1987 were analyzed for volatile organics (EPA Methods 601/602) and total phenols (EPA Method 420.3). Monitoring wells OBG-4 and OBG-8 were resampled on December 2, 1987 and analyzed for volatile organics to verify the October 30 results. Original laboratory report forms and chain of custody forms are included in Appendix C.

Test results for volatile organics and total phenols are shown in Table 3. Principal contaminants in the ground water beneath the landfill (from August 6, 1987 samples of GM-9, GM-10 and GM-11)

were benzene, toluene, xylene, ethylbenzene and phenolic compounds. A summary of all sampling events to date is shown on Table 4. Total volatile organic compound (VOC) concentrations and total phenols concentrations are shown in Figures 4 and 5, respectively. The concentrations of volatile organics in the October 30 samples from monitoring wells OBG-1 through OBG-4 (north of the railroad tracks) were less than the concentrations noted on August 6 as shown on Figure 4. Most notably, the volatile organics were not detectable in well OBG-4 versus a total VOC concentration of 2504 ppb on August 6, 1987.

In the new monitoring wells further to the east, volatile organics were not detectable in wells OBG-6 and OBG-7. A total VOC concentration of 943 ppb was noted in well OBG-8, the principal contaminant being xylene at 850 ppb. The December 2, 1987 test results showed lower concentrations (total VOC of 316 ppb with xylene at 280 ppb). Concentrations of VOCs in the downgradient wells are generally one or two orders of magnitude less than in the ground water beneath the landfill as shown on Figure 4.

The concentrations of total phenols detected in the downgradient wells ranged from 6 ppb to 100 ppb on October 30, 1987 versus 9 to 37 ppb on August 6, 1987. The concentrations are also orders of magnitude less than those measured in the landfill (maximum of 14,500 ppb at GM-11 on August 6, 1987) as shown on Figure 5.

C. Quality Assurance/Quality Control

Quality assurance/control analyses were performed along with ground water analyses to provide control of analytical results. Reports of QA/QC results including analyses of a field trip blank, and duplicate analyses are included in appendix C along with laboratory results. The QA/QC results demonstrate the validity of the data presented.

2.05 Site Hydrogeologic Characterization

Information obtained from the supplemental well installation program enabled a fairly detailed evaluation of the geology and the occurrence and movement of ground water in the area of investigation. The following subsections describe the types of soils encountered, their extent, the existing and potential movement of ground water and any associated contaminants. From this information, the evaluation of the technical feasibility for remedial options was developed and is presented in later sections.

A. Site Geology

Results of test borings indicate that an apparently continuous layer of coarse to medium sand with trace gravel and silt occurs across the site to a depth of 18 to 23 feet overlying a denser glacial till unit. The glacial till consists of coarse to fine sand dispersed in a matrix of silt with some gravel fragments. The test borings penetrated into the upper portion of this unit and in some instances, refusal was obtained, indicating the possibility of bedrock occurring not too far below the top of the glacial till. The sand unit was found to be thicker to the east in borings OBG-6 and 7 (19-23 feet) compared to 15-17 feet at OBG-1, 2, and 3 and 13 feet thick at OBG-5. The sand unit also becomes more gravelly and cobbly toward the southwest (GM-12).

A deposit of fill was found to overlay the sand unit in the area of the landfill and railroad track, (see hydrogeologic cross section, Figure 3). Apparently, fill consisting of re-worked natural soils was placed in a formerly existing topographic swale located beneath the landfill and railroad track. The landfill material was then placed on this filled land.

The nature of the auger refusals indicate that the top of the local bedrock may occur not far below the top of glacial till in some areas and appears to slope gently to the north toward the

Shawsheen River with a small depression located just north of the railroad tracks. The extent of the depression east and west currently is not known since most borings were not taken to rock.

The local bedrock, however, consists of intrusive Andover Granite that is very hard with typically low permeability. Due to this, it is most likely that the overall permeability of the bedrock is lower than the overburden.

B. Ground Water Flow Conditions

Ground water occurs in the sand unit about 2 to 14 feet below ground surface and is closest to the surface in the topographic swale located just north of the railroad tracks. Ground water levels varied by as much as 2 feet between August and October 1987. The water table in May 1988 was generally 1 to 1.5 feet higher than in October 1987. The high water table in May 1988 was 1-2.5 feet below the base of the landfill, which was defined from interpretation of soil borings in wells GM-10 and GM-11 (see Figure 3).

During both periods, as is shown on the ground water flow map (Figure 2), the ground water flow direction is to the northeast and toward the Shawsheen River, which is predictable for an unconfined aquifer near a local discharge source.

The hydraulic conductivity (k) of the sand unit as determined by in-situ tests ranged around 5.75×10^{-5} cm/sec in OBG wells northeast of the railroad tracks to about 4×10^{-3} cm/sec in GM wells located southwest of the tracks. As mentioned, the higher k value southwest of the tracks corresponds to more gravelly fill soils in this area.

The average linear velocity (V_s) was calculated for ground water flow rates both northeast and southwest of the tracks using the following calculation:

$$V_s = Ki/n$$

k = Hydraulic conductivity (ft/day)

i = Hydraulic gradient (ft/ft) = 0.015

n = Aquifer porosity (dimensionless = 0.25 from Freeze and Cherry, 1979).

Using average values of hydraulic conductivity of 6.6 ft/day for the wells near the landfill, south of the railroad tracks, and 0.21 ft/day for wells north of the railroad tracks, average linear velocities were calculated to be 0.4 ft/day and 0.013 ft/day, respectively.

Given that the contaminants have been detected about 225 feet northeast of the landfill, the calculated time for contaminant migration using the average k value and observed hydraulic gradient northeast of the tracks is about 30 years, which is consistent with the age of the landfill. This value assumes no contaminant dispersion or retardation via adsorption or biodegradation, but seems realistic for preliminary flow modeling discussed in Section 3.04. It appears that the ground water discharges to the Shawsheen River based on flow conditions in October and December 1987.

SECTION 3 - PRELIMINARY EVALUATION OF REMEDIAL ALTERNATIVES

3.01 General

This section of the report presents a preliminary evaluation of alternative remedial action methods for controlling contamination at the landfill area. Remedial technologies have been identified and screened; and feasible remedial action alternatives were identified and developed.

3.02 Identification of Potential Remedial Methods

The remedial action selection process presented in the EPA Handbook, "Remedial Action at Waste Disposal Sites" (EPA/625/6-85/006) was used in the identification, screening and evaluation of remedial action alternatives.

Site investigation data was used to identify site problems which were then compared to categories of remedial technologies to determine which technologies were applicable as follows:

<u>Site Problem</u>	<u>Remedial Technology Category(s)</u>
Leachate migrating vertically or horizontally	Ground water Controls, In-Situ Treatment
Precipitation infiltrating into site to form leachate	Surface Water Controls, Ground water Controls
Contaminated Ground water and Soils	Waste and Soil Excavation and Removal, In-Situ Treatment

3.03 Screening of Remedial Methods

The next step in the remedial action selection process is to identify and screen potentially applicable remedial methods from the selected general remedial technology categories. Technologies were eliminated that may prove difficult to implement, rely on unproven or inapplicable technologies, or may not achieve the remedial objectives within a reasonable time period. This screening process focuses on eliminating those technologies that have severe

limitations for the given set of waste and site-specific conditions. The remedial methods, brief description of use, and whether or not the remedial method is applicable are shown as follows:

1. Surface Water Controls:

A. Capping

- To reduce the rainfall percolation through the landfill and effectively isolate (contain) the contaminants and eliminate a hydraulic mechanism for additional transport to the ground water.
- Evaluate further.

B. Floating Covers

- Not applicable to site.

C. Grading

- Management of surface water infiltration.
- Used in conjunction with capping.

D. Revegetation

- Used with capping to reduce erosion of the cap.

E. Surface Water Diversion and Collection

- Used in conjunction with capping.

Note: Methods C, D and E are methods used to enhance the effectiveness of capping and will be considered part of the capping technology.

2. Ground Water Controls:

A. Ground water pumping

- Used to contain and remove contaminant plume.
- Evaluate further.

B. Subsurface drains (interceptor trench)

- A technology available for capturing contaminated ground water is through the placement of a collection trench. The trench would have to be excavated to the top of dense till or bedrock (25 - 30 feet deep) along a length of about 700 feet. The trench would also have to be located either immediately adjacent to the northeast portion of the landfill along the railroad or in a northwest-southeast alignment from OBG-3 toward OBG-6. This method of ground water withdrawal is less effective and less practical than a recovery well system for the following reasons:

1. A trench on the southern side of the tracks along GM 9, 10 and 12 would collect only the most contaminated portion of ground water while letting the remaining portion of the plume north of the tracks escape.
2. Cobbly subsoils, utilities, and railroad track right-of-ways would also complicate trenching operations.
3. It would be very difficult to excavate a trench to the required depth due to dewatering and sheeting requirements and proximity to the railroad.
4. A trench on the northern site portion along OBG 3, 1 and 6 would require extended service time to allow contaminants from the landfill to migrate to the trench.

For these reasons, the use of an interceptor trench will not be considered further.

C. Subsurface barriers (slurry walls)

- Used to contain horizontal migration of ground water.
- Evaluate further for applicability to site conditions.

3. Excavation and On-site or Off-site Disposal

A. Excavation and On-site Land Disposal

- Must construct secure on-site disposal facility and obtain license for hazardous waste disposal facility under RCRA (40 CFR Part 264).
- Ground water monitoring, leachate collection required.
- Eliminate from further consideration due to high cost and difficulty of implementation.

B. Excavation and Off-Site Disposal

- Permanent solution for source control.
- Contaminated ground water migration must still be addressed.
- Evaluate further.

4. In-Situ Treatment

A. Biodegradation - use of micro-organisms in the soil to degrade contaminants by promoting favorable conditions for degradation.

- Benzene, toluene, xylene, ethylbenzene and phenolic compounds are biodegradeable.
- Evaluate further for implementation feasibility.

B. Chemical Treatment

- use of oxidizing/reducing agents to chemically degrade (detoxify) contaminants or the use of flushing agents to mobilize contaminants for extraction (soil flushing). Technology is in conceptual or developmental stage and has not been fully demonstrated for hazardous waste remediation. Also, unfavorable by-products may be formed; therefore, eliminate from further consideration.

- Solidification and/or chemical fixation or stabilization is a remedial method whereby the waste material is either chemically "fixed", stabilized or bound within a solidification agent. These technologies have been developed for the remediation of oily wastes or sludges, with heavy metals and inorganic wastes. Although some manufacturers claim that silicate based processes can stabilize organic solvents, the application has not been fully demonstrated. Also, costs for a mobile unit to mix soils would be in the range of \$80 - \$100 per cubic yard. This technology will be eliminated from further consideration.

C. Physical Methods

- In-situ heating, ground freezing, and vitrification methods are in the early stages of development and detailed information is not available; therefore, eliminate from further consideration.
- In-situ air stripping (soil venting) relies on the characteristics of the contaminants to volatilize into the air available in the void spaces within the subsurface soil matrix. The solidified, gelled resins and asphalt construction debris deposited in the landfill may encapsulate the volatile organic compounds and severely limit the effectiveness of this in-situ method; therefore, eliminate this technology from further consideration.

3.04 Development of Remedial Alternatives

Feasible remedial methods which have been identified in the screening process can now be considered to form overall remedial alternatives. The No Action alternative will also be considered. These alternatives represent a workable number of options and are as follows:

1. No Action.
2. Source containment.
3. Ground water collection (and treatment, as required).
4. Biodegradation of contaminated soil.
5. Excavation, removal and off-site disposal of contaminated soil.

Alternative No. 1 - No Action

No action represents a viable alternative strategy in this case, and is supported by a number of observations:

1. Age of Landfill Deposits - Based on discussions with employees at the plant, this area has not been used for any type of landfilling since around 1975, when the last of construction debris and clean soil from plant construction projects was deposited.

Although the ground water analysis has indicated volatile organic compounds in the ground water beneath the landfill, it may be possible that a "continuing source" does not exist. As discussed in Section 1, the landfill contents were deposited 25 to 30 years ago and are known to contain solidified gelled resins. It is conceivable that the contaminants found in the ground water have leached out of the landfill contents years ago and that any remaining contaminants are encapsulated in the gelled resin material.

2. Limited Source of Contaminants - Two test trenches dug in 1986 indicate that chunks of resinous solids are scattered sparsely over a narrow range of depth within the landfill. The landfill consists of clean soil, cement and asphalt rubble, and old wood. Based on discussions with employees at the plant, this area was not a chronic dumping ground for wastes from plant operations.
3. Environmental Receptors - The nearest environmental receptor to the landfill is the Shawsheen River, which is approximately 1,000 feet downgradient. There are no public or private water supply wells in the area of concern. Ground water monitoring data show that contaminant levels present at the landfill drop off sharply outside the immediate landfill area. The sharp drop off in

contaminant levels may be due to natural processes which serve to prevent the spread of contaminants (e.g. biodegradation, adsorption onto soils, and volatilization). All of the contaminants detected in the landfill are amenable to one or more of these processes.

What is proposed under this alternative may be termed a passive remediation program consisting of the following elements:

1. Allow natural processes such as biodegradation and volatilization to destroy any contaminants that are not encapsulated.
2. Implement a sampling and analytical program to monitor ground water quality at selected wells.

Alternative No. 2 - Source Containment

Landfill Capping

This alternative would involve measures to effectively isolate or contain the source (landfill contents) from the environment. Since the landfill is covered by a thin layer of native sandy soils (approximately 3.5 feet of sand at well GM-11 and 2 feet of sand and bituminous macadam at well GM-10), it is logical to assume that rainfall percolates through the cover into the fill material. Contaminants identified in the landfill are most likely transported to the ground water table by the percolating precipitation. Proper capping and grading of the landfill would reduce the potential for infiltration from precipitation and surface runoff.

A multilayered cap system would perform the basic functions of minimizing infiltration, directing and transmitting percolated rainfall away from the landfill and providing a final cover and a growth medium for vegetation. A 12 to 18-inch layer of low permeability soil with a permeability of approximately 10^{-7} cm/sec would be placed on the existing landfill. Clay or a soil/bentonite admixture could be used. This would be followed with an 18-inch layer of sand or other porous material which would act as a drainage layer to allow runoff of percolated rainfall. Filter fabric would then be placed on top of the drainage layer to prevent the clogging of the pore spaces by fines from the topsoil layer. Finally, a 12-inch layer of topsoil would be placed to provide a cover for the drainage layer and to support a vegetative cover to prevent erosion of the cap. The site may also have to be graded and drainage swales provided for surface water diversion.

Subsurface Barrier

The May 1988 ground water level monitoring indicated that the bottom of the fill is approximately 1 to 2.5 feet above the water table, based on interpretation of borings for wells GM-10 and GM-11. A subsurface ground water barrier such as a slurry wall would isolate the landfill contents from the horizontal flow of ground water through the landfill during higher ground water periods. However, this remedial technique would be expensive (\$50,000 to \$75,000) and the need for a subsurface ground water barrier is questionable since the lower portion of the landfill most likely has been periodically exposed to the ground water during high ground water periods and any contaminants in the fill may have already leached out.

Alternative No. 3 - Ground Water Collection (and treatment, as required)

Alternative No. 3 consists of collection of the ground water (and treatment as required for discharge) to achieve an acceptable level of water quality. If the landfill contents do not constitute a continuing source, the collection of several pore volumes may be sufficient to achieve clean up objectives.

Two scenarios involving different recovery well placements were modeled for this evaluation. Since aquifer data available at this time is only preliminary, the resultant modeled data must also be considered preliminary. Further evaluations are recommended, including an aquifer performance test prior to establishing design criteria for this alternative.

Hydraulic conductivity (k) data from the existing monitoring wells indicated relatively uniform soils for the areas north and south of the landfill and therefore was deemed sufficient to provide preliminary data for modeling of a recovery system. The configuration of the existing monitoring network should be sufficient to monitor the effects of an aquifer performance test and subsequent performance of a recovery system.

The Theis Wellfield ground water flow model, which evaluates ground water flow hydraulics that are time dependent with Jacob's correction for unconfined conditions, was run utilizing one 6-inch diameter recovery well, approximately 25 feet deep located near GM-10 adjacent to the landfill (Figure 6). Calculations using Jacobs' modified Theis equation (Cooper and Jacob, 1946, Amer. Geophysical Union, Vol. 27, No. 4) indicated flow from the well will be about 1.5 gpm. The long term (180 days) cone of influence generated from this well however, was not sufficient to capture contaminants found in wells GM 9, 12, and OBG wells 4 and 8. The relatively low permeability of the formation restricted the shape of the resulting cone such that regional flow gradients in some areas of the plume were not reversed.

A system consisting of three recovery wells all designed alike was then modeled (Figure 7). The cumulative cone of influence was sufficient to capture ground water about 300 feet southeast and

northwest of the landfill, and about 100-150 feet downgradient of wells OBG 4 and 8. Injection wells placed upgradient of OBG-5 to enhance flow gradients were considered but determined not to be effective since ground water flow northeast of the railroad may be controlled by lower permeable soils there. Excess ground water pumped into higher permeable soils around the landfill may divert flow laterally northwest and southeast outside the capture zone.

Capture zones developed from the preliminary modeling provide an estimation of the amount of recovery wells which may be needed to remediate the contaminant plume. Prior to establishing the number of wells needed, a test recovery well should be installed at the landfill and tested to verify or modify existing data.

Alternate No. 4 - Biodegradation of Contaminated Soil

This innovative treatment technology consists of the use of indigenous bacteria and/or cultivated strains of bacteria to degrade the volatile organic and phenolic compounds in the landfill.

The optimum conditions for microbial activity include a balance of substrate ("food"), nutrients (nitrogen, phosphorous and trace elements), temperature, moisture, and pH in the range of 6 to 9. In-situ biodegradation is the in-place treatment of soils which is accomplished by injecting nutrients into the soil; however, the probable encapsulation of the contaminants by the solidified resin would severely limit the effectiveness of this method.

In this case, biodegradation would be accomplished by tilling of the soil with nutrient addition and moisture control. A one and a half foot layer of soil would be excavated with a backhoe and spread over a minimum one half acre area to a depth of one foot. Nutrients (fertilizer) and cultured bacteria would be pre-mixed in a tank and pumped onto the spread out soil. The soil would be tilled weekly with a tractor and chisel plow and watered with a sprinkler system as required to maintain a proper moisture content.

An estimated 16 weeks will be required for the contaminants to degrade to acceptable levels. The total time required for treatment will depend upon the area available for the tilling operation. If only a half-acre is available, four tilling operations and a total of 15 months will be required. A one acre area would reduce the operation to two tillings and an overall eight month time period since more soil could be treated at one time.

The advantages of this alternative are that the source is treated and it is much less expensive than excavation and removal. The disadvantages are that a pilot testing program should be performed which would delay implementation; the micro-organisms are sensitive to substrate conditions; the implementation period is much longer than excavation and removal and could be longer than a ground water pumping program; a minimum area of one-half acre is required for the tilling operation; and the excavation and tilling would expose the contaminants to workers and the ambient air.

Alternative No. 5 - Excavation, Removal and Off-Site Disposal of Soil

This alternative would involve the excavation of the landfill contents and disposal of the contaminated soil at a secure landfill which is licensed under RCRA Part B. It is estimated that the landfill (150 feet long by 100 feet wide by an average depth of 5 feet) contains about 75,000 cubic feet of contaminated soils (2,800 cubic yards).

The advantages of this alternative are that it would provide the shortest time frame for removal of the source and minimize future ground water monitoring, collection and treatment time. Disadvantages include possible release of volatile organic compounds into the air, the safety of

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workers involved in the excavation and the possible requirements for pretreatment of the soil which may be required for off-site transport (e.g., moisture content).

SECTION 4 - CONCLUSIONS

4.01 Conclusions

The following information and conclusions have been developed from the additional field investigations and preliminary evaluation of remedial alternatives:

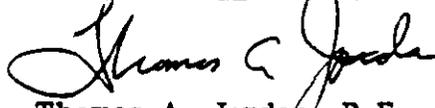
1. Results of the test borings indicate a sandy unit occurs to a depth of 18-23 feet overlaying a dense till, which is consistent with previous test borings. The landfill was placed on an apparent deposit of fill which extends to include the railroad bed.
2. The water table in May 1988 was 1 to 1.5 feet higher than in October 1987; however, the water table in May 1988 was 1 to 2.5 feet below the base of the landfill. Ground water flow from the landfill appears to be in the northeast direction towards well OBG-8.
3. Results of in-situ permeability tests indicate that the hydraulic conductivity (k) of the sand unit consistently ranged around 5.75×10^{-5} cm/sec in OBG wells north of the railroad tracks and 4×10^{-3} cm/sec in GM wells south of the tracks; therefore, the controlling k is north of the railroad tracks.
4. The concentrations of VOCs in the October 30 samples from wells OBG-1 through OBG-4 were less than the concentrations detected on August 6 (Figure 4); most notably, VOCs were not detectable in well OBG-4 versus a total VOC concentration of 2504 ppb on August 6. In the new monitoring wells, VOCs were not detectable in wells OBG-6 and OBG-7; however, total VOC concentration of 943 ppb was noted in well OBG-8, the principal contaminant being xylene at 850 ppb. The December 2, 1987 samples showed lower concentrations of total VOCs and xylene (316 ppb and 280 ppb, respectively). The concentrations of total phenols detected in the

downgradient wells ranged from 6 ppb to 100 ppb on October 30, 1987 versus 9 to 37 ppb on August 6, 1987. Although contaminants have been detected approximately 225 feet northeast of the landfill (Figures 4 and 5), the concentrations are generally one or two orders of magnitude less in the downgradient area than found in the ground water beneath the landfill.

5. Five remedial alternatives were identified and are as follows:
 1. No Action. (A "passive remediation" program consisting of sampling and analysis of ground water from selected wells).
 2. Source Containment (landfill capping).
 3. Ground water collection (and treatment, as required).
 4. Biodegradation of soils.
 5. Excavation and removal and off-site disposal of contaminated soil.
6. Additional site investigations will be required to further develop and evaluate final remedial action alternatives. The additional investigations might include the sampling and analysis of the landfill contents (required to further evaluate the feasibility of biodegradation and to conduct a qualitative risk assessment); the installation and pump testing of a ground water recovery well to refine the well model; and further sampling and analysis of the ground water monitoring wells.

Respectfully Submitted,

O'BRIEN & GERE ENGINEERS, INC.


Thomas A. Jordan, P.E.
Vice President

Prepared by:

Edward P. Zimmerman, P.E.
Sr. Project Engineer

Richard G. Stromberg
Project Hydrogeologist

TABLE 1

Well Installation Summary

<u>Well</u>	<u>Diameter (in.)</u>	<u>Total Depth (ft)(1)</u>	<u>Screen Interval (ft)(1)</u>	<u>Ground Elevation ft(2)</u>	<u>Top of Steel Casing Elevation ft(2)</u>
OBG-1	2	18	8-18	76.17	78.09
OBG-2	2	20	10-20	83.10	85.52
OBG-3	2	18	8-18	73.21	76.08
OBG-4	2	13.5	3.5-13.5	74.07	76.53
OBG-5	2	13	3-13	81.54	84.84
OBG-6	2	23	3-23	77.19	79.48
OBG-7	2	21	6-21	73.15	75.48
OBG-8	2	20	5-20	76.92	79.44

(1) below ground surface
(2) above mean sea level

TABLE 2

Ground Water Elevations

<u>Well No.</u>	<u>GW Elevation (ft) (1)</u>	<u>GW Elevation (ft) (2)</u>	<u>GW Elevation (ft) (3)</u>
OBG-1	67.67	68.60	69.71
OBG-2	66.94	67.44	68.23
OBG-3	68.48	69.81	70.81
OBG-4	69.90	72.01	72.63
OBG-5	74.38	-	76.53
OBG-6	-	69.99	71.53
OBG-7	-	68.02	69.33
OBG-8	-	70.14	71.16
GM-8	73.38	72.24	73.27
GM-9	71.26	71.49	73.04
GM-10	71.86	72.90	74.20
GM-11	72.77	74.56	75.74
GM-12	73.38	74.64	75.31

(1) Measured on 8/6/87 (above mean sea level.)

(2) Measured on 10/30/87 (above mean sea level.)

(3) Measured on 5/10/88 (above mean seal level.)

TABLE 3

VOLATILE ORGANICS AND TOTAL PHENOL DATA

Sample Location	Concentration											TRIP
	DBG-1	DBG-2	DBG-3	DBG-4	DBG-4	DBG-4	DBG-7	DBG-6	DBG-8	DBG-8	DBG-8	BLANK
Lab ID No.	62413	62414	62415	62416	62416	63455	62417	62418	62419	63456	62420	
Sample Date	10/30/87	10/30/87	10/30/87	10/30/87	10/30/87	12/02/87	10/30/87	10/30/87	10/30/87	12/02/87	10/30/87	
DUPLICATE												
PARAMETER	UNITS											
EPA METHOD 601/602:												
Vinyl Chloride	ppb	(1	(1	(1	(1	(1	(1	(1	(1	3	2	(1
t-1,2-Dichloroethene	ppb	(1	(1	(1	(1	(1	(1	(1	(1	6	2	(1
Chloroform	ppb	(1	(1	(1	(1	(1	(1	(1	(1	22	(1	(1
1,2-Dichloropropane	ppb	(1	(1	1	(1	(1	(1	(1	(1	12	16	(1
Trichloroethene	ppb	(1	(1	(1	(1	(1	(1	(1	(1	5	(1	(1
Benzene	ppb	(1	(1	(1	(1	(1	(1	(1	(1	2	4	(1
Toluene	ppb	(1	(1	(1	(1	(1	(1	(1	(1	6	2	(1
Chlorobenzene	ppb	(1	6	6	(1	(1	(1	(1	(1	22	10	(1
Ethylbenzene	ppb	(1	(1	(1	(1	(1	(1	(1	(1	15	(1	(1
Xylene	ppb	1	(1	(1	(1	(1	(1	(1	(1	850	280	(1
Total Volatiles	ppb	1	6	7	ND	ND	ND	ND	ND	943	316	ND
Surrogate Recoveries:												
Bromochloromethane	%	86	91	110	82	102	97	104	97	108	91	108
2-Bromo-1-chloropropane	%	93	91	109	82	112	101	105	97	103	98	109
Trifluorotoluene	%	93	76	82	87	97	107	98	84	82	100	106
TOTAL PHENOLS	ppm	-	0.009	0.02	0.012	-	-	0.006	0.006	0.1	-	(0.005

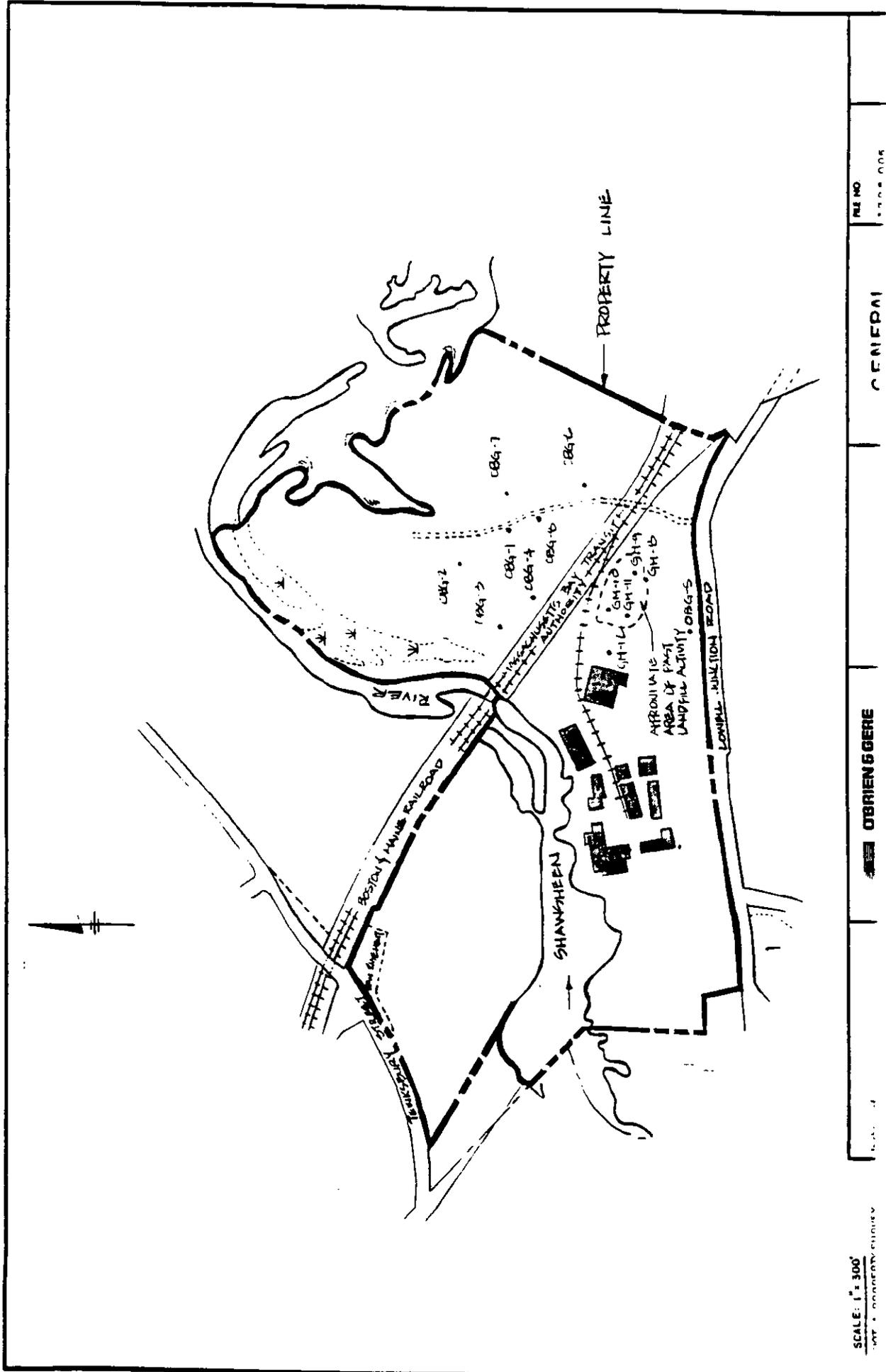
Notes: All other Method 601/602 compounds were below detection limits
 ND = None Detected

TABLE 4

Ground Water Analysis Summary

<u>Sample Location</u>	<u>Sample Date</u>	<u>Concentration (ppb)</u>				
		<u>Benzene</u>	<u>Toluene</u>	<u>Xylene</u>	<u>Ethyl-Benzene</u>	<u>Total Phenols</u>
GM-9	10/23/86*	< 100	300	11,000	2,500	350
	08/06/87	< 100	100	9,800	2,600	25
GM-10	10/23/86*	7,700	1,200	26,000	3,700	1,500
	08/06/87	4,800	< 1,000	22,000	2,800	2,800
GM-11	10/24/86*	2,000	6,000	66,000	14,000	6,700
	08/06/87	2,300	4,300	64,000	12,000	14,500
GM-12	10/24/86*	< 10	50	1,900	300	1,100
	08/06/87	< 100	< 100	7,800	900	150
OBG-1	08/06/87	3	< 1	2	< 1	9
	10/30/87	< 1	< 1	1	< 1	-
OBG-2	08/06/87	< 1	< 1	2	< 1	12
	10/30/87	< 1	< 1	< 1	< 1	9
OBG-3	08/06/87	< 1	< 1	1	< 1	26
	10/30/87	< 1	< 1	< 1	< 1	20
OBG-4	08/06/87	15	10	2,300	160	37
	10/30/87	< 1	< 1	< 1	< 1	12
	12/02/87	< 1	< 1	< 1	< 1	-
OBG-5	08/06/87	< 1	< 1	2	< 1	< 1
OBG-6	10/30/87	< 1	< 1	< 1	< 1	6
OBG-7	10/30/87	< 1	< 1	< 1	< 1	6
OBG-8	10/30/87	2	6	850	15	100
	12/02/87	4	2	280	< 1	-

* Data from "Preliminary Hydrogeologic Investigation of the Manufacturing and Landfill Areas, BTL Specialty Resins, Inc, Andover, Massachusetts" by Geraghty & Miller, Inc., February, 1987.

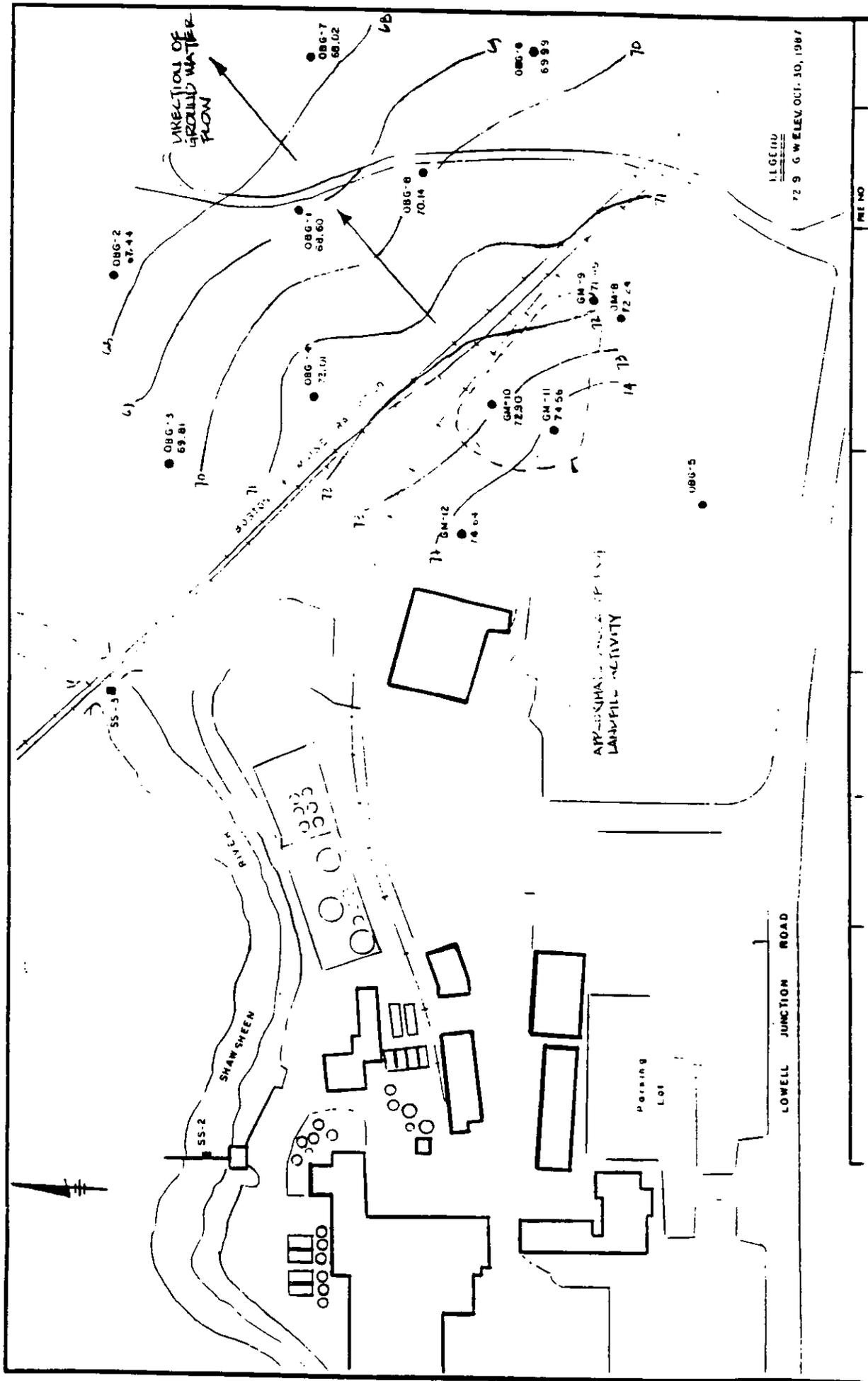


FILE NO. 100-1005

GENERAL

O'BRIEN & GIERE

SCALE: 1" = 300'
 NOT A PROPERTY PLAN

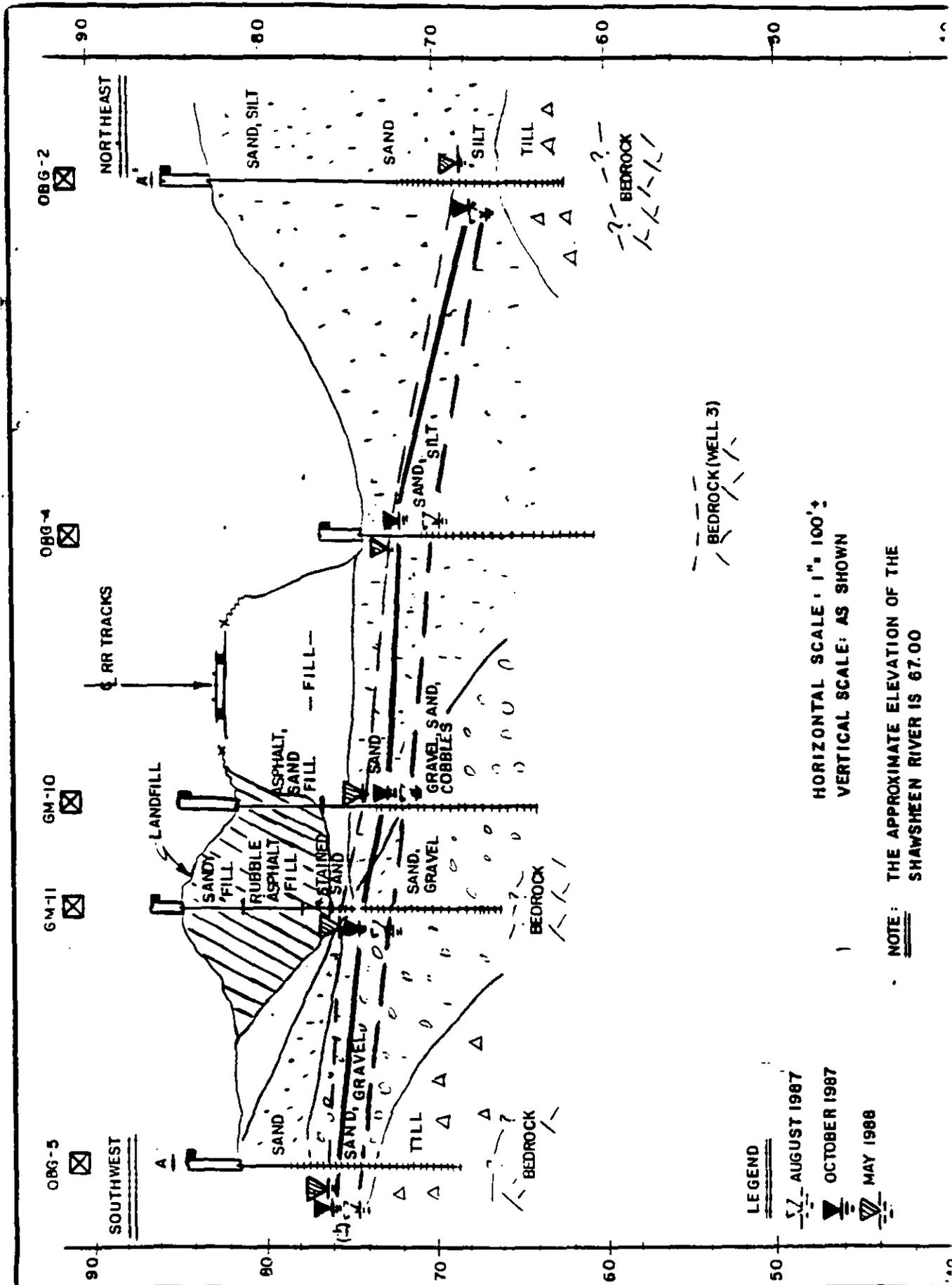


LEGEND

72 9 G W ELEV. OCT. 30, 1987

PRE NO

LOWELL JUNCTION ROAD



HORIZONTAL SCALE: 1" = 100'
 VERTICAL SCALE: AS SHOWN

NOTE: THE APPROXIMATE ELEVATION OF THE SHAWMSEEN RIVER IS 67.00

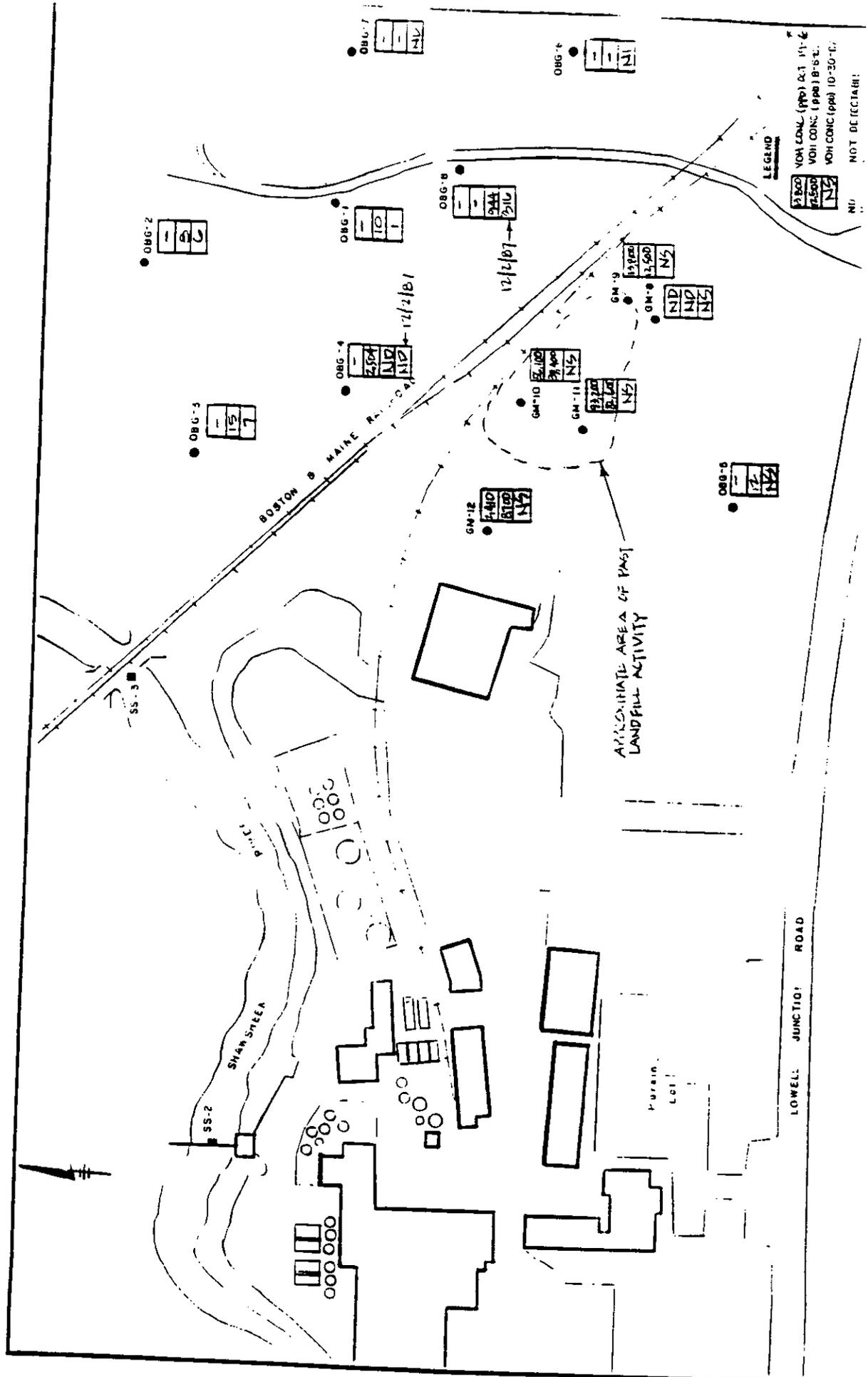
LEGEND

- AUGUST 1987
- OCTOBER 1987
- MAY 1988

O'BRIEN & GERE
 ENGINEERS, INC.
 BOSTON, MA

77 LOWELL JUNCTION RD.
 ANDOVER, MA
 HYDROGEOLOGIC

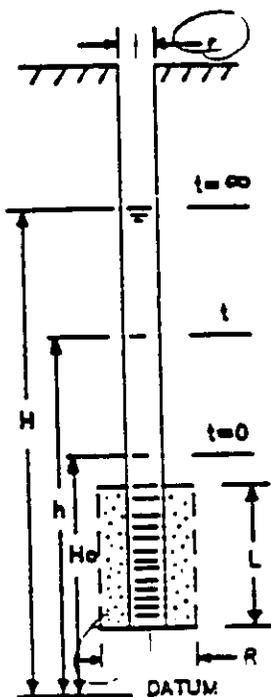
FILE NO.	3208.006
DATE	MAY 1988
DWG. NO.	



IN-SITU PERMEABILITY TEST FIELD LOG

PROJECT ANDOVER-REICHOID
 WELL NUMBER OBG-6
 DATE 10/30/87

LOCATION ANDOVER
 ELEVATION 79.48 TOP OF CASING



20
 minutes
 WATER DEPTH

STATIC HEAD (H) 10.5
 PIPE RADIUS (r) .07
 SCREEN RADIUS (R) .25
 SCREEN LENGTH (L) .12
 INITIAL HEAD (Ho) 6.54

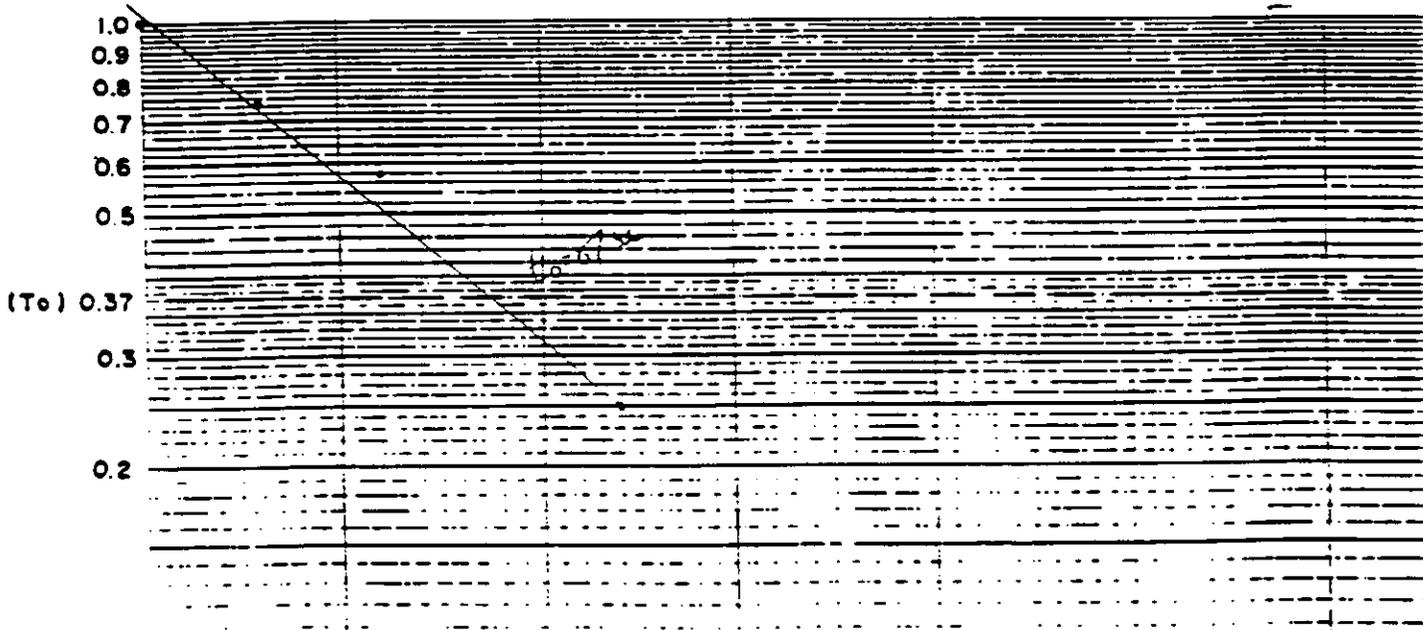
HYDRAULIC CONDUCTIVITY :

$$K = \frac{r^2 \ln(L/R)}{2LT_0}$$

$$K = \frac{.007^2 \ln(.12 / .25)}{(2)(.12)(6.54)} = 2.06 \times 10^{-2}$$

minutes	WATER DEPTH	t	h	H-h	H-Ho
0	13.46	6.54			1
.5m	12.45	7.55			10.5 - 7.55 = 2.95
1m	11.80	8.20			.58
1.5m	11.21	8.77			
2.0	10.86				
2.5	10.68				
3.0	10.50	9.5			.25
3.5	10.33	7			
4.0	10.12				
4.5	9.98	10.02			
5.0	9.81				
5.5	9.67				
6.0	9.50	10.5			
6.5	9.35				
7.0	9.22	10.78			

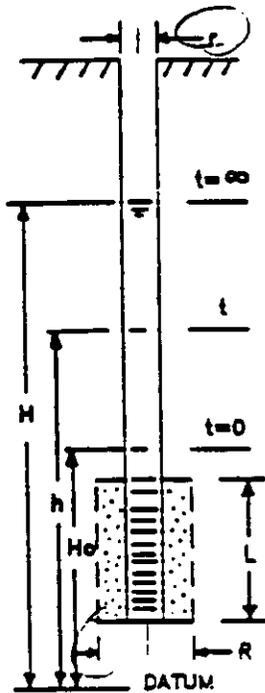
1.3
 add
 $1.274 \times 10^{-5} = 3.58 \times 10^{-4} \text{ cm/sec}$



IN-SITU PERMEABILITY TEST FIELD LOG

PROJECT ANDOVER - REICHOLOD
 WELL NUMBER OBG-7
 DATE 10/30/87

LOCATION ANDOVER
 ELEVATION 75.48 TOP OF C.



STATIC HEAD (H) 17.54
 PIPE RADIUS (r) .03
 SCREEN RADIUS (R) .25
 SCREEN LENGTH (L) .7
 INITIAL HEAD (Ho) 14.71

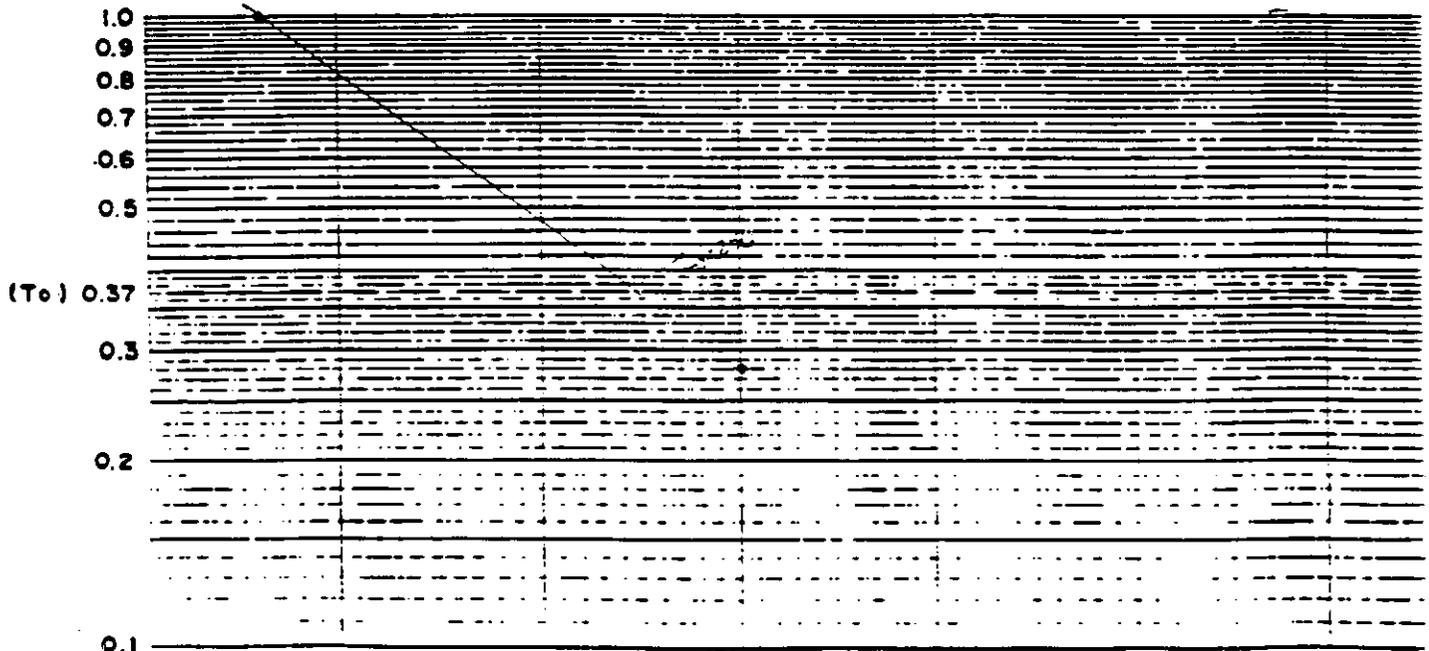
HYDRAULIC CONDUCTIVITY:

$$K = \frac{r^2 \ln(L/R)}{2L t_0}$$

$$K = \frac{0.03^2 \ln(.7/.25)}{2(.7)(250)} = \frac{3.91 \times 10^{-2}}{350} = 3.42 \times 10^{-6} \text{ m/sec}$$

 1.04 x 10⁻⁴ cm/sec
 41.00 x 10⁻⁵ m/sec (1.5)

MIN TIME	WATER DEPTH	t	h	H-h	H-h
0	10.29				
.5	10.29				
1.0	10.29	14.7			12.77
5.0	9.25	14.75			
5.5	8.05	16.95			
6.0	7.83	17.7			
6.5	7.73				
7.0	7.62				
7.5	7.52	17.46			
8.0	7.42				
8.5	7.35	17.65			
9.0	7.25				
9.5	7.17	17.83			



APPENDIX C

ANALYTICAL DATA



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517
 DESCRIPTION OBG-1

SAMPLE NO. G2413 DATE COLLECTED 10-30-87 DATE REC'D. 11-3-87 DATE ANALYZED 11-9-87

ppb		ppb	
Chloromethane	<1.	t-1,3-Dichloropropene	<1.
Bromomethane		Trichloroethene	
Vinyl chloride		Benzene	
Chloroethane		Dibromochloromethane	
Methylene chloride		1,1,2-Trichloroethane	
1,1-Dichloroethene		c-1,3-Dichloropropene	
1,1-Dichloroethane		2-Chloroethylvinyl ether	<10.
t-1,2-Dichloroethene		Bromoform	<10.
Chloroform		1,1,2,2-Tetrachloroethane	<1.
1,2-Dichloroethane		Tetrachloroethene	
1,1,1-Trichloroethane		Toluene	
Carbon tetrachloride		Chlorobenzene	
Bromodichloromethane		Ethylbenzene	
1,2-Dichloropropane		Xylenes	1.

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

- Bromochloromethane = 86%
- 2-Bromo-1-chloropropane = 93%
- Trifluorotoluene = 93%



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517
DESCRIPTION OBG-2

SAMPLE NO. G2414 DATE COLLECTED 10-30-87 DATE REC'D. 11-3-87 DATE ANALYZED 11-9-87

	ppb		ppb
		1-1,3-Dichloropropene	<1.
Bromomethane		Trichloroethane	
Vinyl chloride		Benzene	
Chloroethane		Dibromochloromethane	
Methylene chloride		1,1,2-Trichloroethane	
1,1-Dichloroethene		c-1,3-Dichloropropene	
1,1-Dichloroethane		2-Chloroethylvinyl ether	<10.
t-1,2-Dichloroethene		Bromoform	<10.
Chloroform		1,1,2,2-Tetrachloroethane	<1.
1,2-Dichloroethane		Tetrachloroethene	
1,1,1-Trichloroethane		Toluene	
Carbon tetrachloride		Chlorobenzene	6.
Bromodichloromethane		Ethylbenzene	<1.
1,2-Dichloropropane		Styrene	<1.

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 91%
2-Bromo-1-chloropropane = 91%
Trifluorotoluene = 76%



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517
DESCRIPTION OBG-3

SAMPLE NO. G2415 DATE COLLECTED 10-30-87 DATE REC'D. 11-3-87 DATE ANALYZED 11-9-87

ppb		ppb
Chloromethane		t-1,3-Dichloropropene <1.
Bromomethane		Trichloroethene
Vinyl chloride		Benzene
Chloroethane		Dibromochloromethane
Methylene chloride		1,1,2-Trichloroethane
1,1-Dichloroethene		c-1,3-Dichloropropene
1,1-Dichloroethane		2-Chloroethylvinyl ether <10.
t-1,2-Dichloroethene		Bromoform <10.
Chloroform		1,1,2,2-Tetrachloroethane <1.
1,2-Dichloroethane		Tetrachloroethene
1,1,1-Trichloroethane		Toluene
Carbon tetrachloride		Chlorobenzene 6.
Bromodichloromethane		Ethylbenzene <1.
1,2-Dichloropropane 1.		Xylenes <1.

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 110%
2-Bromo-1-chloropropane = 109%
Trifluorotoluene = 82%



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517

DESCRIPTION OBG-4

SAMPLE NO. G2416 DATE COLLECTED 10-30-87 DATE REC'D. 11-3-87 DATE ANALYZED 11-9-87

ppb		ppb	
Chloroethane		t-1,3-Dichloropropene	<1.
Bromomethane		Benzene	
Vinyl chloride		Dibromochloromethane	
Chloroethane		1,1,2-Trichloroethane	
Methylene chloride		c-1,3-Dichloropropene	
1,1-Dichloroethene		2-Chloroethylvinyl ether	<10.
1,1-Dichloroethane		Bromofom	<10.
t-1,2-Dichloroethene		1,1,2,2-Tetrachloroethane	<1.
Chloroform		Tetrachloroethane	
1,2-Dichloroethane		Toluene	
1,1,1-Trichloroethane		Chlorobenzene	
Carbon tetrachloride		Ethylbenzene	
Bromodichloromethane		Ayrene	
1,2-Dichloropropane			

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 82%
 2-Bromo-1-chloropropane = 82%
 Trifluorotoluene = 87%

Authorized: *ADUNA*



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517

DESCRIPTION OBG-4 (Duplicate)

SAMPLE NO. G2416 DATE COLLECTED 10-30-87 DATE REC'D. 11-3-87 DATE ANALYZED 11-16-87

	ppb		ppb
		t-1,3-Dichloropropene	<1.
Bromomethane			
Vinyl chloride		Benzene	
Chloroethane		Dibromochloromethane	
Methylene chloride		1,1,2-Trichloroethane	
1,1-Dichloroethene		p-1,3-Dichloropropene	↓
1,1-Dichloroethane		2-Chloroethylvinyl ether	<10.
t-1,2-Dichloroethene		Bromoform	<10.
Chloroform		1,1,2,2-Tetrachloroethane	<1.
1,2-Dichloroethane		Tetrachloroethene	↓
1,1,1-Trichloroethane		Toluene	
Carbon tetrachloride		Chlorobenzene	
Bromodichloromethane		Ethylbenzene	
1,2-Dichloropropane			

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

- Bromochloromethane = 102%
- 2-Bromo-1-chloropropane = 112%
- Trifluorotoluene = 97%



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517

DESCRIPTION OBG-6

SAMPLE NO. G2418 DATE COLLECTED 10-30-87 DATE REC'D. 11-3-87 DATE ANALYZED 11-9-87

ppb		ppb	
Bromomethane	<1.	t-1,3-Dichloropropene	<1.
Bromomethane		Trichloroethane	
Vinyl chloride		Benzene	
Chloroethane		Dibromochloromethane	
Methylene chloride		1,1,2-Trichloroethane	
1,1-Dichloroethene		c-1,3-Dichloropropene	
1,1-Dichloroethane		2-Chloroethylvinyl ether	<10.
t-1,2-Dichloroethene		Bromoform	<10.
Chloroform		1,1,2,2-Tetrachloroethane	<1.
1,2-Dichloroethane		Tetrachloroethene	
1,1,1-Trichloroethane		Toluene	
Carbon tetrachloride		Chlorobenzene	
Bromodichloromethane		Ethylbenzene	
1,2-Dichloropropane		Nyenes	

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 97%
 2-Bromo-1-chloropropane = 97%
 Trifluorotoluene = 84%



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517
 DESCRIPTION OBG-7

SAMPLE NO. G2417 DATE COLLECTED 10-30-87 DATE REC'D. 11-3-87 DATE ANALYZED 11-9-87

ppb	ppb
Chloroethane	t-1,3-Dichloropropene <1.
Bromomethane	Chloroethane
Vinyl chloride	Benzene
Chloroethane	Dibromochloromethane
Methylene chloride	1,1,2-Trichloroethane
1,1-Dichloroethene	o-1,3-Dichloropropene
1,1-Dichloroethane	2-Chloroethylvinyl ether <10.
t-1,2-Dichloroethene	Bromoform <10.
Chloroform	1,1,2,2-Tetrachloroethane <1.
1,2-Dichloroethane	Tetrachloroethene
1,1,1-Trichloroethane	Toluene
Carbon tetrachloride	Chlorobenzene
Bromodichloromethane	Ethylbenzene
1,2-Dichloropropane	Xylenes

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 104%
 2-Bromo-1-chloropropane = 105%
 Trifluorotoluene = 98%



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517

DESCRIPTION OBG-8

SAMPLE NO. G2419 DATE COLLECTED 10-30-87 DATE RECD. 11-3-87 DATE ANALYZED 11-9-87

ppb		ppb	
Chloroethane	3	t-1,3-Dichloropropene	<1.
Bromomethane	<1.	Chloroethane	3
Vinyl chloride	3	Benzene	2.
Chloroethane	<1.	Dibromochloromethane	<1.
Methylene chloride	↓	1,1,2-Trichloroethane	↓
1,1-Dichloroethene	↓	c-1,3-Dichloropropene	↓
1,1-Dichloroethane	↓	2-Chloroethylvinyl ether	<10.
t-1,2-Dichloroethene	6.	Bromoform	<10.
Chloroform	22.	1,1,2,2-Tetrachloroethane	<1.
1,2-Dichloroethane	1.	Tetrachloroethene	<1.
1,1,1-Trichloroethane	<1.	Toluene	6.
Carbon tetrachloride	↓	Chlorobenzene	22.
Bromodichloromethane	↓	Ethylbenzene	15.
1,2-Dichloropropane	12.	Xylenes	850.

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 108%
 2-Bromo-1-chloropropane = 103%
 Trifluorotoluene = 82%



Purgeable Priority Pollutants

CLIENT REICHOLD CHEMICAL JOB NO. 3208.001.517

DESCRIPTION Trip Blank

SAMPLE NO. G2420 DATE COLLECTED 10-30-87 DATE REC'D. 11-3-87 DATE ANALYZED 11-9-87

	ppb		ppb
Chloromethane		t-1,3-Dichloropropene	<1.
Bromomethane		Chloroethane	
Vinyl chloride		Benzene	
Chloroethane		Dibromochloromethane	
Methylene chloride		1,1,2-Trichloroethane	
1,1-Dichloroethene		c-1,3-Dichloropropene	
1,1-Dichloroethane		2-Chloroethylvinyl ether	<10.
t-1,2-Dichloroethene		Bromoform	<10.
Chloroform		1,1,2,2-Tetrachloroethane	<1.
1,2-Dichloroethane		Tetrachloroethene	
1,1,1-Trichloroethane		Toluene	
Carbon tetrachloride		Chlorobenzene	
Bromodichloromethane		Ethylbenzene	
1,2-Dichloropropane		Xylenes	

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

- Bromochloromethane = 108%
- 2-Bromo-1-chloropropane = 109%
- Trifluorotoluene = 106%



Laboratory Report

CLIENT: REICHOLO, CHEMICAL
 DESCRIPTION: Matrix Spikes and Matrix Spike Duplicates
 JOB NO: 3208, 001, 517

DATE COLLECTED: DATE REC'D: DATE ANALYZED:

UNITS	LAB # OF SPIKED SAMPLE	CONC. OF SPIKE	SAMPLE RESULT	CONC. MS	% RECOVERY	MSD	% RECOVERY	RPD (%)
ppb	G2417	22.	<1.	24.	109.	22.	100.	9.
		20.	<1.	21.	105.	20.	100.	5.
		20.	<1.	21.	105.	19.	95.	10.
		20.	<1.	20.	100.	18.	90.	11.
		20.	<1.	19.	95.	20.	100.	5.
PHENOLICS (ppm):								
matrix spike of G2414								
duplicate of G2417								
laboratory blank								
.019, .009, .010 = 100% Recovery								
0.006 vs. 0.005 RPD = 18%								
<0.005								

Methodology: Federal Register - 40 CFR, Part 136, October 26, 1984
 Comments:
 Units: mg/l (ppm) unless otherwise noted
 %S = Matrix Spike
 %SD = Matrix Spike Duplicate
 RPD = Relative Percent Difference
 Authorized: *C. M. P.*
 Date: December 3, 1987



OBG LABORATORIES, INC.

CHAIN OF CUSTODY RECORD

3208-006-517

SURVEY REICHLID - ANDOVER

SAMPLERS: (Signature)

David A. Chalander

STATION NUMBER	STATION LOCATION	DATE	TIME	SAMPLE TYPE		SEQ. NO.	NO. OF CONTAINERS	ANALYSIS REQUIRED
				Water				
				Cont.	Grab			
OBG 1	Monitoring Well	10/30/97	2:00	✓		③	2-40ml 1-GUAA	601 / 602 leads 42C-3 (P) FILTERED
OBG 2			3:00	✓		⑤		
OBG 3			4:30	✓		③		
OBG 4			4:00	✓		⑥		
OBG 6			2:15	✓		④		
OBG 7			12:30	✓		①		
OBG 8	▼	▼	1:30	✓		②	▼	▼

Relinquished by: (Signature) David A. Chalander	Received by: (Signature) Federal Express	Date/Time 11/2/97 5:15 PM
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Relinquished by: (Signature)	Received by: (Signature)	Date/Time
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Relinquished by: (Signature)	Received by: (Signature)	Date/Time
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Relinquished by: (Signature)	Received by Mobile Laboratory for field analysis: (Signature)	Date/Time
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Dispatched by: (Signature)	Date/Time	Received for Laboratory by: Wanda Smith	Date/Time 11/2/97 10am
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Method of Shipment: ✕ OBG-1 + OBG-6: one vial each site arrived

w/ Repturn inverted.



LABORATORIES, INC.

Purgeable Priority Pollutants

CLIENT REICHOLD - ANDOVER JOB NO. 3208.001.517

DESCRIPTION OBG - 8

SAMPLE NO. G3456 DATE COLLECTED 12-2-87 DATE REC'D. 12-8-87 DATE ANALYZED 12-15-87

ppb		ppb	
		t-1,3-Dichloropropene	<1.
Bromomethane			
		Benzene	4.
Chloroethane	<1.		
Methylene chloride		1,1,2-Trichloroethane	
1,1-Dichloroethene		1,3-Dichloropropene	
1,1-Dichloroethane		2-Chloroethylvinyl ether	<10.
t-1,2-Dichloroethene	2.	Bromoforn	<10.
Chloroform	<1.	1,1,2,2-Tetrachloroethane	<1.
1,2-Dichloroethane		Tetrachloroethane	
1,1,1-Trichloroethane		Toluene	2.
Carbon tetrachloride		Chlorobenzene	
Bromodichloromethane		Ethylbenzene	<1.
1,2-Dichloropropane	16.		

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

- Bromochloromethane = 91%
- 2-Bromo-1-chloropropane = 98%
- Trifluorotoluene = 100%



Purgeable Priority Pollutants

CLIENT REICHOLD - ANDOVER JOB NO. 3208.001.517

DESCRIPTION OBG - 4

SAMPLE NO. G3455 DATE COLLECTED 12-2-87 DATE REC'D. 12-8-87 DATE ANALYZED 12-15-87

ppb		ppb
		t-1,3-Dichloropropene <1.
Bromomethane		
vinyl chloride		Benzene
Chloroethane		Dibromochloromethane
Methylene chloride		1,1,2-Trichloroethane
1,1-Dichloroethene		t-1,3-Dichloropropene ↓
1,1-Dichloroethane		2-Chloroethylvinyl ether <10.
t-1,2-Dichloroethene		Bromoform <10.
Chloroform		1,1,2,2-Tetrachloroethane <1.
1,2-Dichloroethane		Tetrachloroethane
1,1,1-Trichloroethane		Toluene
Carbon tetrachloride		Chlorobenzene
Bromodichloromethane		Ethylbenzene
1,2-Dichloropropane		Styrenes ↓

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

SURROGATE RECOVERIES:

Bromochloromethane = 97%

2-Bromo-1-chloropropane = 101%

Trifluorotoluene = 107%