

**Hydrogeologic Investigation**  
**BP/Getty/Koch Fuel Terminals**  
**South Portland, Maine**

Submitted to:

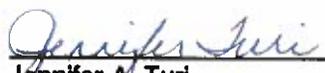
Maine Department of Environmental Protection  
Bureau of Oil and Hazardous Materials Control  
State House Station #17  
Augusta, Maine 04333

Submitted by:

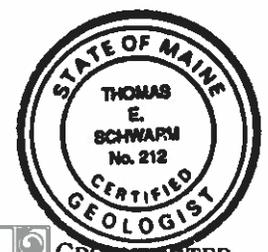
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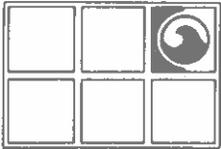
April 1992

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# GROUNDWATER TECHNOLOGY

Groundwater Technology, Inc.

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April 2, 1992

Mr. Rick Kaselis  
Maine Department of Environmental Protection  
State House Station #17  
Augusta, Maine 04333

Re: Hydrogeologic Investigation Report  
BP/Getty/Koch Fuel Terminals  
South Portland, Maine

Dear Rick:

On behalf of BP Oil Company (BP), Getty Petroleum Corporation (Getty), and Koch Materials Company (Koch), Groundwater Technology, Inc. prepared the attached report titled "Hydrogeologic Investigation, BP/Getty/Koch Fuel Terminals, South Portland, Maine". This report summarizes groundwater quality results collected from the terminals from December 1990 to December 1991.

The hydrogeologic investigation was conducted to determine the potential impact on the Fore River and to identify any free petroleum in the monitoring wells. The investigation consisted of installing 17 shallow monitoring wells, installing 2 deep monitoring wells, collecting and analyzing shallow and deep soil samples, collecting and analyzing groundwater samples quarterly for 1 year, conducting a tidal survey, measuring hydraulic conductivities in soil, collecting and analyzing groundwater discharge point samples, and collecting and analyzing surface water samples. The results from the investigation indicate that no free petroleum existed in any of the monitoring wells over the last year.

Even though no free petroleum has been found in any monitoring wells at these facilities, the terminals believe that extending the monitoring program for 1 additional year would be environmentally prudent.

Kaselis, DEP  
April 2, 1992  
Page 2

The monitoring will include collecting groundwater samples from the 19 monitoring wells and 6 groundwater discharge points semi-annually for 1 year beginning in April 1992. The samples will be analyzed for volatile petroleum compound concentrations and methyl tertiary butyl ether (MTBE) using modified EPA Method 602. In addition, the 19 monitoring wells will be gauged for depth to water quarterly for 1 year beginning in April 1992. The results will be summarized in semi-annual letter reports and submitted to the Maine Department of Environmental Protection.

Please review the attached report. If you have any questions or require additional information, please do not hesitate to call us, Rick Johnson at Koch at 316-832-7274, Rick Laubacher at BP at 216-271-8859, or Tom Dobbins at Getty at 207-799-8518. We would also be happy to meet with you at your earliest convenience.

Sincerely,

  
Jennifer A. Turi  
Geologist

  
Thomas E. Schwarm  
Hydrogeologist  
Maine Certified Geologist  
Territory Manager

Attachment

cc: John Beane, Maine DEP  
Rick Johnson, Koch Materials  
Tom Dobbins, Getty Petroleum  
Rick Laubacher, BP Oil  
Jim Parks, BP Oil  
Larry Hutchins, Koch Materials

Hydrogeologic Investigation  
BP/Getty/Koch Fuel Terminals

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Hydrogeologic Investigation  
BP/Getty/Koch Fuel Terminals, South Portland, Maine

**SUMMARY**

Groundwater Technology, Inc. was contracted by the Consortium of BP Oil Company (BP), Getty Petroleum Corporation (Getty), and Koch Materials Company (Koch) to perform a hydrogeologic investigation at their fuel storage terminals in South Portland, Maine. The purpose of the investigation was to determine the impact of the land use at the terminals to the Fore River water quality. The Maine Department of Environmental Protection (Department) is requiring all marine fuel storage facilities operating in Maine to perform a hydrogeologic investigation as a condition of facility relicensing. The purpose of this report is to present groundwater quality data collected from December 1990 to December 1991. This report is updated from the Hydrogeologic Investigation Report prepared by Groundwater Technology in April 1991. It contains all the technical information in the previous report.

The scope of work consisted of installing 17 shallow monitoring wells and 2 deep monitoring wells; developing and surveying the wells; collecting and analyzing soil and surface water samples; gauging each well monthly for 1 year; collecting groundwater samples from each well quarterly for 1 year; conducting a tidal survey; and performing soil permeability tests. All field activities were conducted between November 19, 1990, and December 9, 1991.

The soils encountered during the well installations consisted primarily of laminated sequences of silty sands and sandy silt. Soil samples were collected from each monitoring well boring (19 samples) and at 7 surface locations where known spills occurred. The samples were analyzed for volatile petroleum compounds using EPA Method 8020 and polynuclear aromatic hydrocarbons (PAHs) using EPA Method 8310. Nineteen samples showed total benzene, toluene, ethyl benzene, and xylenes (BTEX) concentrations at or below detection limits. Seven samples had total BTEX concentrations ranging from 1.4 parts per million (ppm) to 140 ppm. Twelve samples showed total hydrocarbon concentrations at or below detection limits. Fourteen samples had total hydrocarbon concentrations ranging from 7.4 ppm to 2,400 ppm. The PAH concentrations had a wide range of concentrations for each compound.

Between December 1990 and November 1991, the average low groundwater level was at a depth of 8.3 feet. The average high groundwater level was at a depth of 5.4 feet. The difference between the highest and lowest groundwater levels was 2.9 feet. Therefore, the groundwater levels fluctuated an average of approximately 3 feet across the facility during the last year. Groundwater contour maps at high and low tides during different seasons show the overall groundwater flow direction is toward the east. The soil permeability data conducted on 15 wells were used to calculate the groundwater velocity which is approximately 1 foot per day.

Groundwater samples were collected quarterly from the 19 wells and analyzed for volatile petroleum compounds and methyl tertiary butyl ether (MTBE) using modified EPA Method 602, PAHs using EPA Method 610, and dissolved metals including arsenic, cadmium, chromium, and lead using EPA Methods 206.2, 6010, and 239.2. The volatile petroleum compounds analyses showed that 10 wells had total BTEX concentrations at or below detection limits over the last year. Nine wells had BTEX concentrations ranging from 0.037 ppm to 45 ppm. Seven wells had total hydrocarbon concentrations at or below detection limits over the last year. Twelve wells had total hydrocarbon concentrations ranging from 0.092 parts per million (ppm) to 62 ppm. The PAH concentrations had a wide range of concentrations for each compound. Dissolved metals were detected in 4 samples. Lead concentrations ranged from 0.0052 ppm to 0.0088 ppm; arsenic concentrations ranged from 0.0062 ppm to 0.011 ppm.

Hydrogeologic Investigation  
BP/Getty/Koch Fuel Terminals, South Portland, Maine  
Summary Page 2

Six groundwater discharge points (seeps) located along the shoreline were sampled and analyzed for the same parameters as the groundwater samples. The average flow rate for the seeps was 0.5 gallons per minute. Only one sample, located near the dock area, showed elevated total hydrocarbon and total BTEX concentrations, which were 20 ppm and 9.5 ppm, respectively.

Four surface water samples were collected from the Fore River and Rolling Mills ponds and were analyzed for the same parameters as the groundwater samples. Results show concentrations of volatile petroleum compounds were at or below detection limits. No PAH compounds or metals were detected in any of the surface water samples.

No liquid petroleum was found in any monitoring well during the monthly gaugings or quarterly sampling. A 12-hour tidal survey was conducted using the 17 shallow wells and showed that the tide does not significantly impact groundwater elevations in monitoring wells or groundwater flow except adjacent to the shoreline.

The results of the hydrogeologic investigation conducted over the last year identified elevated concentrations of dissolved petroleum compounds in the common dock area. A substantial spill, by a former terminal, occurred in the common dock area several years ago. Residual petroleum from this spill is the likely source of the dissolved petroleum.

## 1.0 INTRODUCTION

### 1.1 Objectives

Groundwater Technology, Inc. was contracted by the Consortium of BP Oil Company (BP), Getty Petroleum Corporation (Getty), and Koch Materials Company (Koch) to perform a hydrogeologic investigation at their fuel storage terminals in South Portland, Maine. The Maine Department of Environmental Protection (Department) is requiring all marine fuel storage facilities operating in South Portland, Maine, to perform a hydrogeologic investigation as a condition of facility relicensing. The purpose of the investigation was to determine the impact of the land use at the terminals to the Fore River water quality. The site is the fuel storage terminals and common dock area operated separately by the members of the Consortium on the peninsula locally known as Rolling Mills. This investigation is in accordance with the document titled "Hydrogeologic Investigation Work Plan" that was prepared by Groundwater Technology in September 1990 and was reviewed by the Department.

### 1.2 Background

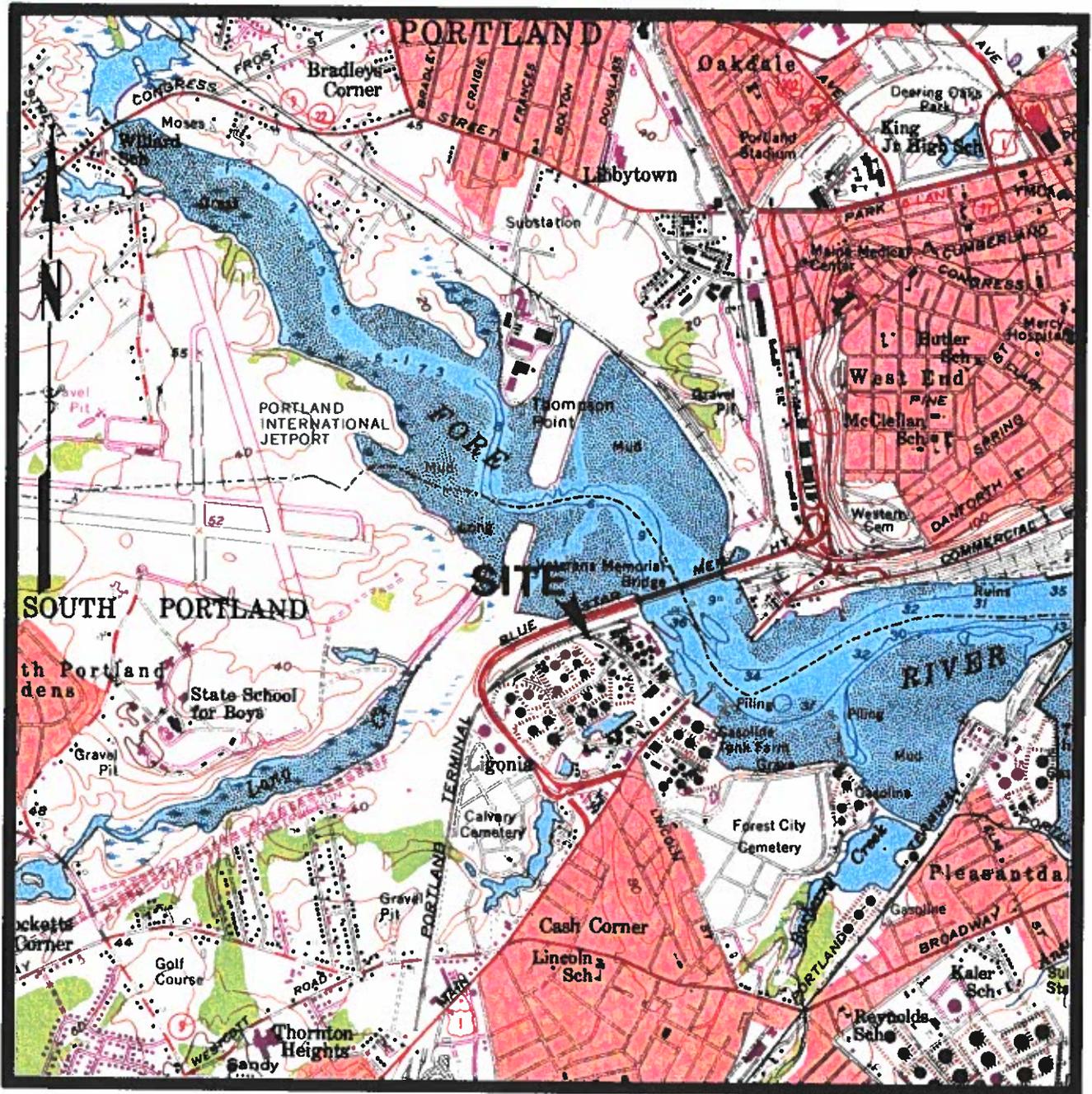
#### 1.2.1 Facility Location

The Rolling Mills peninsula is located in South Portland, Maine, east of U.S. Highway Route 1 (Figure 1). The site is bounded by the Fore River to the north, Main Street to the east, and Route 1 to the south and west.

#### 1.2.2 Facility Description

The peninsula has operated as a fuel storage facility for over 130 years. The first recorded storage of hydrocarbon fuel in the area occurred in 1859 with the construction of the Portland Kerosene Works. The peninsula is currently owned by Bancroft and Martin who acquired it during the early 1900's (Reed, 1986). The area covered under this investigation includes 3 terminals operated by BP, Getty, and Koch which occupy approximately 30 acres and contain 30 petroleum storage tanks (Figure 2). The total petroleum storage capacity of the terminals is 1,487,600 barrels. Two other terminals on the peninsula are operated by Clean Harbors, Inc. and Mobil Oil Company. Exxon previously operated a terminal on the peninsula, but the terminal is currently inactive and most of the tanks have been removed.

**FIGURE 1**  
**SITE LOCATION MAP**  
 BP/GETTY/KOCH/ROLLING MILL  
 SOUTH PORTLAND, MAINE



SOURCE: U.S.G.S. TOPO QUAD, PORTLAND WEST, ME 1956 (P.R.1970)

U.T.M. COORDINATES: 396,000E; 4,832,500N; 19N.

LAT.; LONG.: 43°38'15"N; 70°17'15"W.

SCALE: 1" = 2,000'



 **GROUNDWATER  
 TECHNOLOGY, INC.**

FIGURE 2  
**SITE PLAN**

PROJECT: BP/GETTY/KOCH/ROLLING MILL  
 LOCATION: SOUTH PORTLAND, MAINE  
 PROJECT NO.: 01131-0158

ALL WELLS AND SAMPLING LOCATIONS  
 APPROXIMATELY LOCATED

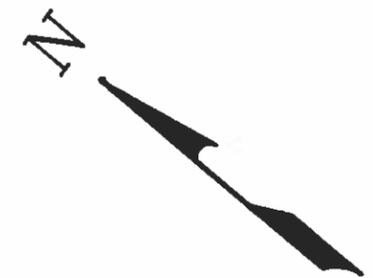
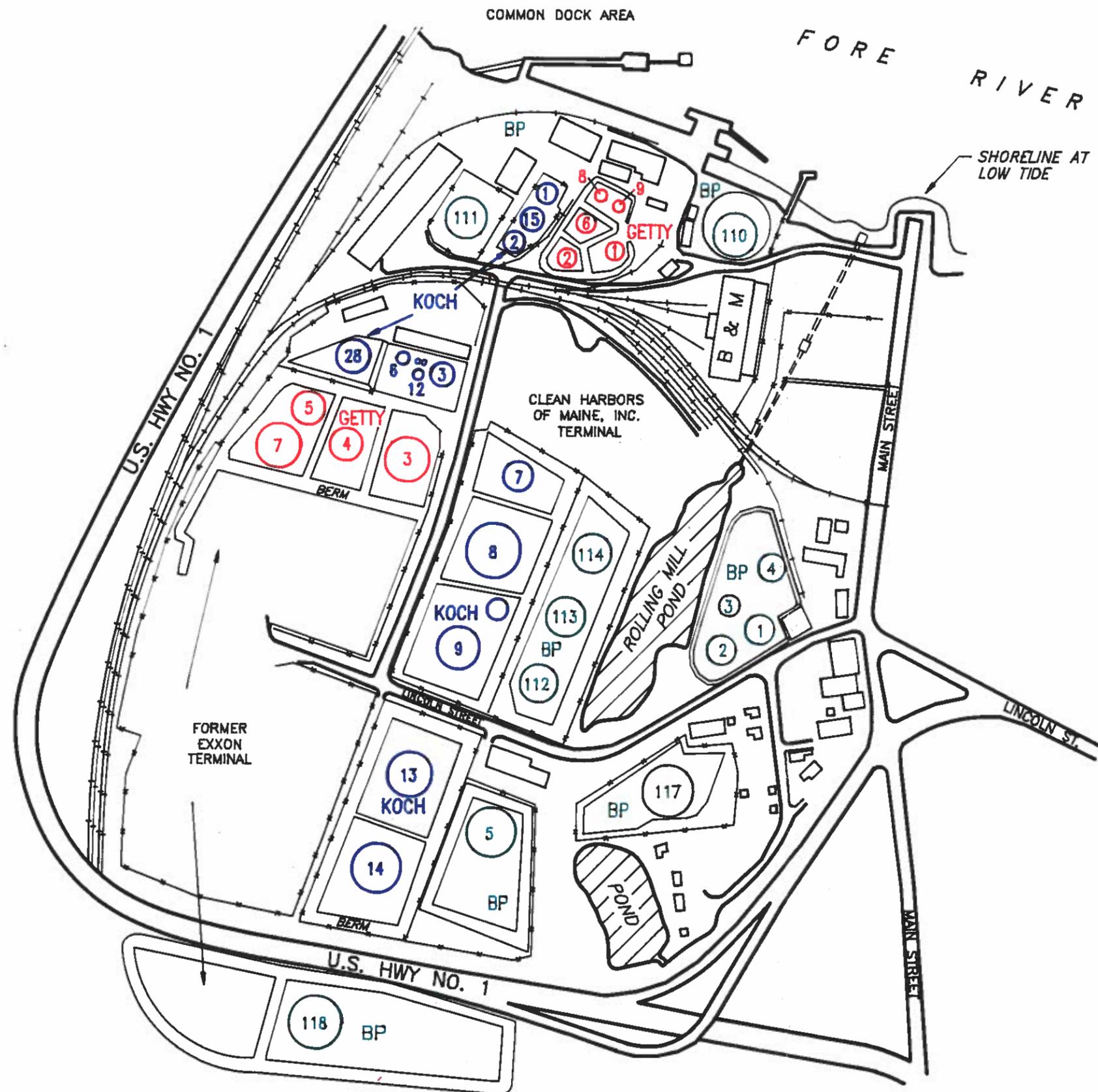
RAILWAY  
 FENCE

○ ABOVE GROUND FUEL OIL STORAGE TANK

BASE MAP SOURCE: "SITE MAP A -  
 ROLLING MILL INDUSTRIES GROUP, SOUTH  
 PORTLAND, MAINE", W.C. FINCH, 5/5/72

0 300  
 SCALE IN FEET

8/24/00  
 REV. 1/8/01  
 NO.: 002/DMC  
 FILE: ROLLML2



The following paragraphs regarding the Rolling Mills history were contained in a report titled "Study of Oil Port Facilities in Portland Harbor" by Beth Della Valle, 1982. The information presented in Tables 1, 2, and 3 was obtained from current terminal site maps.

In 1922, Little and Coffin Company was involved in oil bunkering for large and small vessels on the Bancroft and Martin Rolling Mills site. The facility was sold to Tidewater Oil Company who constructed its first oil storage tanks in 1926. Tidewater changed names to Getty Refining and Marketing Company (GRMC). GRMC sold the operation to Texaco in 1984 who then sold it to Power Test Corporation in 1986. Power Test Corporation changed names to Getty Petroleum Corporation. Getty leases a total of 5.7 acres from Bancroft and Martin. The Getty petroleum storage tank history is provided in Table 1.

Table 1  
Getty Tank History

<u>Tank Number</u>	<u>Year Tank Built</u>	<u>Capacity (barrels)</u>
1	1927	15,000
2	1928	10,500
3	1936	82,000
4	1936	35,000
5	1936	35,000
6	1927	14,500
7	1959	97,000
8	1926	5,050
9	1926	5,050

In June 1979, Koch purchased the current Koch assets from Shell Oil Company (Shell). Shell has been located within the Rolling Mills complex since 1929 when it purchased part of the facility from the Mayflower Corporation which also unloaded and handled petroleum products. Koch leases 11.4 acres of land from Bancroft and Martin. The Koch petroleum storage tank history is provided in Table 2.

Table 2  
Koch Tank History

<u>Tank Number</u>	<u>Year Tank Built</u>	<u>Capacity (barrels)</u>
3	1928	15,000
6	1929	5,000
7	1934	37,500
8	1955	110,000
9	1934	80,000
12	N/A	2,500
13	1929	80,000
14	1952	110,000
28	1970	42,000

N/A = Not Available

Currently, BP owns the former Astroline and Gulf terminals. Between 1920 and 1950, Valvoline constructed three storage tanks on this site. In the 1940's, Richfield Oil purchased the facility and constructed two additional tanks. The terminal was sold to Sinclair Refining in 1960, BP in 1968, and Astroline in 1975. Astroline owned tanks 1, 2, 3, 4, and 5 and owned 6.4 acres of property. Gulf constructed tanks on the South Portland property in the mid-1930's and later in the late 1950's. Gulf owned tanks 110, 111, 112, 113, 114, 117, and 118 and owned 7.0 acres of property. The BP petroleum storage tank history is provided in Table 3.

Table 3  
BP Oil Tank History

<u>Tank Number</u>	<u>Year Tank Built</u>	<u>Capacity (barrels)</u>
1	1936	32,000
2	1936	32,000
3	1936	13,000
4	1946	35,000
5	1946	90,000
110	1923	71,800
111	1937	53,000
112	1950	60,500
113	1950	60,500
114	1950	60,500
117	1959	79,000
118	1963	96,700

### 1.2.3 Facility Spill History

Several petroleum spills have occurred at the terminals in the past. Available spill report data from the Department files are summarized by facility in Table 4.

**Table 4  
Spill Incidents  
South Portland, Maine**

<u>Facility</u>	<u>Date</u>	<u>Type</u> <sup>1</sup>	<u>Amount</u> <sup>2</sup> <u>Spilled</u>	<u>Amount</u> <sup>2</sup> <u>Recovered</u>	<u>Location</u>
Gulf	1964	#2	1 mil	ND	Dikes of tanks 112, 113, 114
BP <sup>3</sup>	1975	#2	ND	ND	Tank 5
Gulf	10/14/81	gas	40,000	ND	Tank 110
BP Oil	12/18/81	kero	1,000	ND	Tank 3
BP Oil	04/82	gas	< 100	ND	Tank 2
BP Oil	02/10/86	gas	400	ND	Tank 112
BP Oil	04/04/86	#2	500-750	ND	Rolling Mill Pond/Fore River
BP Oil	11/02/87	gas	420	100+	Tank 1
BP Oil	04/27/90	gas	50-100	80	Truck loading rack
GRMC <sup>4</sup>	1975	#2	ND	ND	Tank 8
GRMC <sup>4</sup>	06/08/77	#2	ND	ND	Tank 1
Koch	05/05/85	gas	9,100	66	Tank 7
Koch	08/18/86	#2	ND	ND	Removal of 1,000- gallon tank

Notes: <sup>1</sup> #2 is #2 fuel oil, gas is gasoline, kero is kerosene  
<sup>2</sup> Amount spilled in gallons, Amount recovered in percent  
<sup>3</sup> BP/Sinclair  
<sup>4</sup> GRMC = Getty Refining and Marketing Company  
 ND=Not Documented

Reference: Maine Department of Environmental Protection

Two recovery wells were previously installed at the site by Exxon in response to a large petroleum spill. The wells are located in the northern portion of the site along the shoreline.

#### 1.2.4 Regional Geology

The regional bedrock geology of southeastern Maine is classified as the Casco Bay Group which consists of the Cushing Formation, Cape Elizabeth Formation, Spring Point Formation, Diamond Island Formation, Scarboro Formation, Spurwink Limestone, and Jewell Formation. The Group consists of a combination of metamorphosed pelites, subpelites, volcanic rocks, and immaturely re-worked volcanics (Hussey, 1968). The Rolling Mills peninsula is located in the Cape Elizabeth Formation. According to the Sand and Gravel Aquifer Map (Prescott, 1979), a boring near the western boundary of the peninsula (former Exxon terminal) reached bedrock at a depth of 70 feet. No bedrock exposures are visible at the surface.

The regional soils are characterized as glacial-marine deposits of the Presumpscot Formation. This Formation is composed mainly of clay and silt with minor amounts of sand and gravel. The thickness of this deposit varies regionally, but the average thickness is 40 feet. The upper limits of the marine silt layer have been reworked in some areas by fluvial and lacustrine processes which occurred during and after glacial retreat. This has produced localized deposits of sand, gravel, and silt. These deposits are often found as interbedded discontinuous units making any connection on a regional scale difficult.

The Coastal Marine Geologic Environments map indicates the entire peninsula is located in a supratidal environment indicating that the environment is just above the highest high water datum but under the partial influence of marine processes and forces (Timson, 1976). The area is characterized as man-made structures and fill in the near-shore environment (Timson, 1976). The shoreline at the terminals is classified as a mud flat environment which is a gently sloping or level environment composed primarily of fine sand, silt, and clay accumulated in relatively quiet water (Timson, 1976).

These flats are depositional areas controlled primarily by tidal currents and sediment settling from the water column which may be eroded temporarily by storm waves (Timson, 1976).

### 1.2.5 Regional Groundwater Characterization

Regional groundwater flow in the soil and bedrock appears to be toward the northeast in the direction of the Fore River located at the northern boundary of the site. The groundwater is not used as a source for drinking or industrial water. The groundwater quality has not been previously well documented. Considering the proximity of seawater and the long-term industrial use of the area, the groundwater is not likely to be developed as a resource for drinking water.

### 1.2.6 Surface Water Characterization

The Fore River is characterized by large mud-flat areas, unconsolidated benthic sediments, salt and fresh-brackish water marshes, and wetlands (Valle, 1982). Portland Harbor is located on the lower Fore River Estuary, a hydrologic area of high suspended solids with a large clay and silt sediment load (Valle, 1982). At the time of the Valle publication, 1982, water quality was classified as suitable for certain industrial uses but limited in terms of acceptability for water-contact recreation and shellfish harvesting (Valle, 1982).

During recent years, there has been a substantial improvement in water quality in the harbor area. This is due to the installation of sewage treatment plants and the improvement in industrial discharge water quality. The harbor is now a significant recreational boating area.

### 1.2.7 Potential Receptors and Sources

The nearest potential receptor to the entire peninsula is the Fore River which forms the Portland Harbor (see Figure 1). The closest sensitive wetlands are located 1.5 miles south of the terminals. These areas are classified as small forested wetlands. According to Maine Geological Survey Map of Significant Sand and Gravel Aquifers (Prescott, 1979), an aquifer with a yield of 10 to 50 gallons per minute is located under the northwestern part of the Rolling Mills area.

There is no apparent groundwater use in the area of the peninsula. Drinking water is supplied to the area by the Portland Water District. The source of water is Sebago Lake which is located approximately 20 miles northwest of the site. South Portland's wastewater treatment plant discharges to the Fore River

in Portland Harbor. The outfall point is located in the Fore River approximately 1 mile east and downstream of the terminals.

Potential off-site petroleum sources include the other nearby terminals in the area and untreated discharges from the storm drains and combined sewer overflows. There is evidence that spills have occurred at the other terminals. Other abutters include a cemetery, roads, railroads, former steel works, and the Fore River. The cemetery is not a likely source area, but the other abutters could contribute petroleum compounds to surface and groundwater as well as storm drains and the sewer system. The Fore River is potentially a source particularly of dissolved compounds. Tidal action may transport these compounds into the shoreline.

### 1.3 Scope of Work

The scope of work was developed from the terminal license requirements to members of the Consortium and other information supplied by the Consortium. The types, location, and number of monitoring wells and samples to be collected as well as the types of analyses were selected based on existing background data. Details of the work scope are discussed in Section 2.0, Methodology. This investigation was conducted under the supervision of a Maine Certified Geologist with experience in hydrogeology and environmental geology. The scope of work is outlined below.

- Monitoring Well Installation and Survey - 19 groundwater monitoring wells were installed and surveyed for top-of-casing elevations;
- Monitoring Well Development and Gauging - 19 wells were developed and gauged for depth to water;
- Groundwater Sample Collection - groundwater samples were collected from each of the 19 wells;
- Groundwater Discharge Point Sample Collection - groundwater samples were collected from 6 groundwater discharge points along the shoreline;
- Surface Water Sample Collection - 2 surface water samples were collected from the Fore River and 2 samples were collected from the 2 on-site Rolling Mills ponds;

- **Water Quality Analysis** - all first quarter water samples were analyzed for volatile petroleum compounds and methyl tertiary butyl ether (MTBE) using EPA Method 602; polynuclear aromatic hydrocarbons (PAHs) using EPA Method 610; and dissolved metals including arsenic, cadmium, chromium, and lead using EPA Method 200/7000;
- **Soil Sample Collection** - soil samples were collected during each monitoring well installation from split-spoon samplers at 5-foot intervals. Surface soil samples were collected from 7 areas within diked tank areas;
- **Soil Quality Analysis** - all soil samples were analyzed for volatile petroleum compounds using EPA Method 8020 and PAHs using EPA Method 8310;
- **Quality Assurance/Quality Control (QA/QC)** - Duplicate groundwater and soil samples and rinseate (equipment) blank samples were collected and analyzed;
- **Tidal Survey** - a 12-hour tidal survey was performed on the 17 shallow wells;
- **Soil Permeability Testing** - a soil permeability test (slug test) was performed on 15 wells;
- **Quarterly Groundwater Sampling** - groundwater samples were collected from each monitoring well quarterly for 1 year. The samples were analyzed for volatile petroleum compounds and MTBE using modified EPA Method 602; and
- **Preparation of Report** - this report summarizing all field work and analytical results over the last year was prepared.

## 2.0 METHODOLOGY

All field work was conducted between November 19, 1990, and December 9, 1991. The following sections provide the field work methods.

### 2.1 Monitoring Well Installation

Groundwater Technology, Inc. supervised the installation of 17 shallow groundwater monitoring wells (GT-1 through GT-17) between November 19 and 29, 1990. In addition, 2 deep groundwater monitoring wells were installed on May 20, 1991. Seventeen monitoring wells were installed using a truck-mounted hollow-stem auger drill rig. Two wells, GT-1 and GT-2, were installed using a mobile track-mounted bombardier drill rig because those wells are located on 8-foot- and 5-foot-high berms, respectively.

The shallow monitoring wells were installed in the uppermost water-bearing zone at each location to determine soil and groundwater quality in the shallow zones at the site. The deep wells were installed to identify any highly permeable zones and to evaluate potential vertical groundwater gradients.

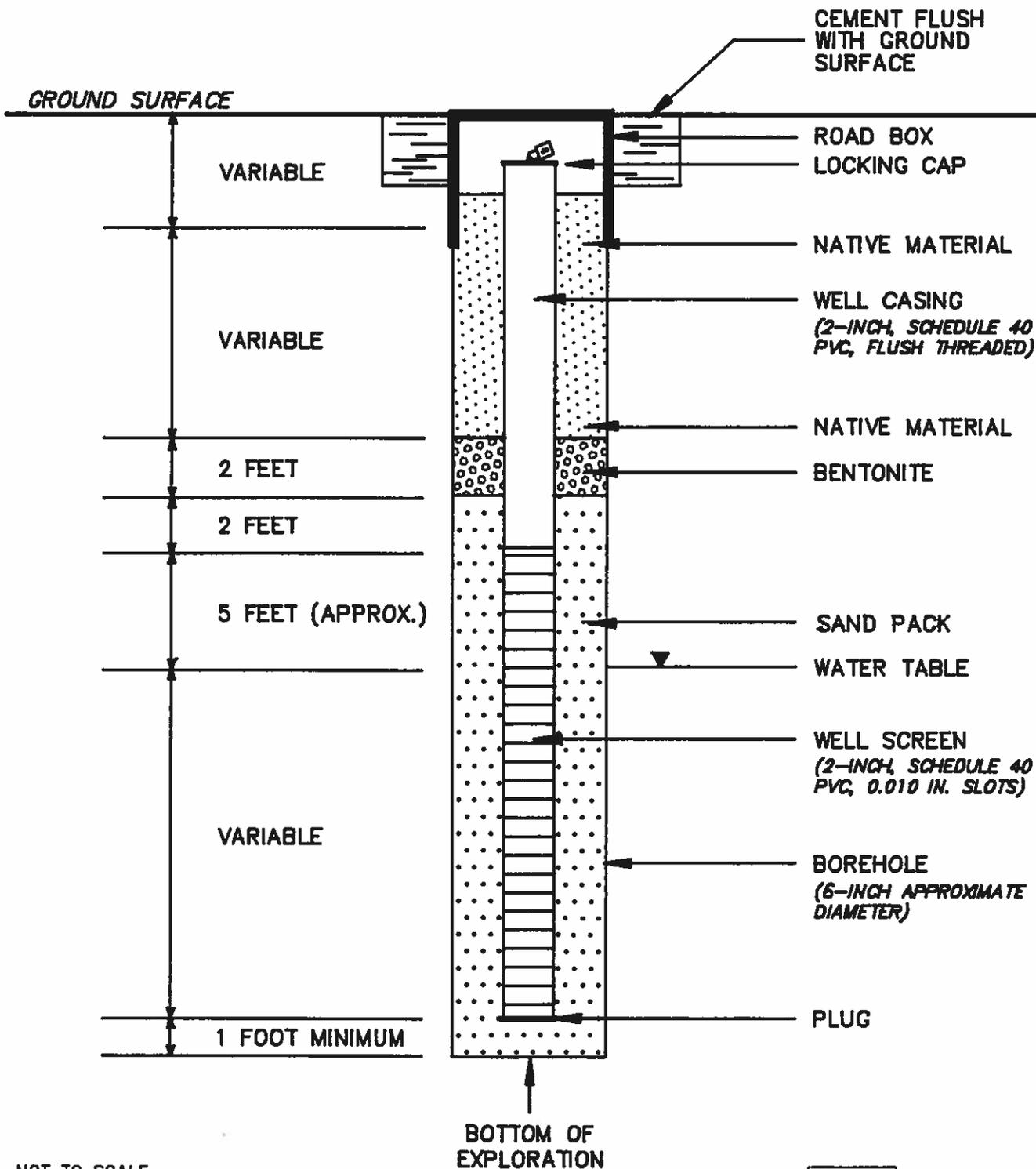
Each monitoring well was constructed of 2-inch-diameter, threaded, 0.010-inch slotted, PVC well screen and casing. Each well was backfilled with a sand pack (Figure 3). Well construction details are shown in the well logs (Appendix A). Eight of the 19 wells are flush-mounted to surface and constructed with cast-iron road boxes to protect them from vehicular traffic. The remaining 11 wells extend 2 to 3 feet above the surface and are constructed with cast-iron standpipes which are cemented in place for stability. The flush-mounted wells and standpipes are locked for protection from vandalism.

The locations of the wells were chosen to define the local hydrogeology, analyze concentrations of potential petroleum in soil and groundwater, and determine the extent of potential petroleum migration. The wells are located primarily along the outside perimeter of the 3 terminals to determine potential petroleum hydrocarbon impact at facility boundaries. The well placement forms several triangular patterns to more accurately determine groundwater flow. This placement also provides upgradient and downgradient information on water quality. Well locations are shown on Figure 4. (An additional copy of Figure 4 is provided as a detachable map at the end of this report.) A few well locations were slightly changed in the field from the work plan locations due to drill rig accessibility or utility clearances.

FIGURE 3

# MONITORING WELL SPECIFICATIONS

BP/GETTY/KOCH/ROLLING MILL  
SOUTH PORTLAND, MAINE



NOT TO SCALE  
8/24/90-DMC

**FIGURE 4**  
**SITE PLAN WITH**  
**WELL AND SAMPLE LOCATIONS**

PROJECT: BP/GETTY/KOCH/ROLLING MILL  
 LOCATION: SOUTH PORTLAND, MAINE  
 PROJECT NO.: 01131-0158

- DEEP WELL (2)
- ▲ RECOVERY WELL (2) (INSTALLED BY EXXON)
- MONITORING WELL (17)
- × SURFACE WATER SAMPLE LOCATION (4)
- \* SOIL SAMPLE LOCATION (7)
- WEIR SAMPLE LOCATION (7)

GT-5, GT-11, GT-12, GT-14, GT-16  
 AND GT-17 ARE FLUSH-MOUNTED WELLS

ALL WELLS AND SAMPLING LOCATIONS  
 APPROXIMATELY LOCATED

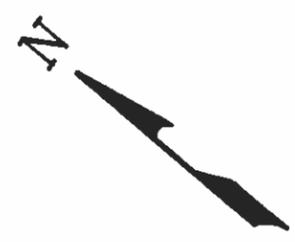
- RAILWAY
- FENCE

○ ABOVE GROUND FUEL OIL STORAGE TANK

BASE MAP SOURCE: "SITE MAP A -  
 ROLLING MILL INDUSTRIES GROUP, SOUTH  
 PORTLAND, MAINE", W.C. FINCH, 5/5/72



DRAWN: 8/24/80  
 REV: 6/25/81  
 NO: 003/DMC  
 FILE: ROLLML2



After installation, each monitoring well was developed to improve the hydraulic connection between the wells and adjacent soils.

Each well's top-of-casing elevation was surveyed by rod and level then gauged monthly for 1 year using an electronic interface probe to establish the elevation of the groundwater table, determine the direction of groundwater flow, and provide the necessary information for subsequent groundwater contour maps. Also, the well gauging data provides a long-term record of the seasonal groundwater fluctuations at the site. The interface probe is capable of detecting and measuring the thickness of liquid petroleum with an accuracy of 0.01 feet. The survey was conducted on all the wells during December 10 and 12, 1990. The elevations are relative to a known benchmark elevation of 12.86 mean low water located at the end of Main Street (Jordan, 1988).

## 2.2 Groundwater Sampling

Groundwater samples were collected from the monitoring wells in December 1990, and March, June, and October 1991. Prior to groundwater sample collection, each well was purged by bailing 3 to 5 times the wells' water volume. This provided assurance that the samples were representative of the groundwater. Groundwater samples were collected from each well using a teflon bailer. Each sample was poured directly from the bailer into the sample containers.

## 2.3 Groundwater Discharge Point Sampling

Groundwater samples were collected at 6 groundwater discharge points along the shoreline at low tide on December 13 and 14, 1990. Sample points are located on Figure 4 as WW-2 through WW-7. Groundwater samples were collected at these points by inserting trough-shaped weirs 4 to 6 inches into the shoreline. Groundwater flowed through the weir and into sample containers. The flow rate per minute was measured at each discharge point.

## 2.4 Surface Water Sampling

Four surface water samples were collected on November 28 and 30, 1990. Two of the 4 samples were collected from the Fore River (SW-1 and SW-2) and 2 samples were collected from the 2 on-site

Rolling Mills ponds (SW-3 and SW-4) (Figure 4). Samples were collected by submerging the capped sample containers in the water, opening the lids, and filling the containers with water.

## 2.5 Water Quality Analysis

During the first quarter sampling in December 1991, all groundwater and surface water samples were packaged and shipped to GTEL Environmental Laboratories (GTEL) of Milford, New Hampshire, and Tampa, Florida, for laboratory analysis. The samples were analyzed for volatile petroleum compounds and MTBE using EPA Method 602, PAHs using EPA Method 610, and the dissolved metals including arsenic, cadmium, chromium, and lead using EPA Methods 206.2, 6010, and 239.2. The samples collected for the second, third, and fourth quarters were analyzed for volatile petroleum compounds and MTBE only. Table 5 provides a list of compounds analyzed by each method. Appendix C contains the laboratory reports.

Table 5  
Compounds Analyzed by Each Method  
Water Samples

<u>VPC*</u> <u>Method 602</u>	<u>PAHs</u> <u>Method 610</u>	<u>Metals</u> <u>Methods 206.2/6010/239.2</u>
Benzene	Acenaphthene	Arsenic
Ethylbenzene	Acenaphthylene	Cadmium
Toluene	Anthracene	Chromium
Xylenes	Benzo(a) anthracene	Lead
Aliphatic Hydrocarbons	Benzo(a) pyrene	
Aromatic Hydrocarbons	Benzo(b) fluoranthene	
Total Hydrocarbons	Benzo(k) fluoranthene	
MTBE	Benzo(g,h,i) perylene	
	Chrysene	
	Dibenzo(a,h) anthracene	
	Fluoranthene	
	Fluorene	
	Indeno (1,2,3,c-d) pyrene	
	Naphthalene	
	Phenanthrene	
	Pyrene	
	1-Methylnaphthalene	
	2-Methylnaphthalene	

\* VPC = Volatile Petroleum Compounds

## 2.6 Soil Sampling

During monitoring well installation, soil samples were collected at 5-foot intervals using a 24-inch split-spoon sampler. Each soil sample was classified by the on-site Groundwater Technology geologist. Soil descriptions are noted in the well logs (Appendix A). Each split-spoon sample was collected, placed in a glass container, and analyzed on site for volatile organic vapors using a portable photoionization detector (PID). This instrument is calibrated relative to benzene and has a detection limit of 1 part per million (ppm). The sample indicating the highest concentration of volatile organic vapors by the PID was sent to GTEL for laboratory analysis. Appendix D contains the vapor monitoring forms which provide the PID results of all the split-spoon samples.

Seven surface soil samples (SS-1 through SS-7) were collected on November 28 and 30, 1990, in areas where documented petroleum spills occurred in the past (Figure 4). All samples were collected inside the tank berms. The 7 samples were collected using a hand auger at a maximum depth of 2 feet.

## 2.7 Soil Quality Analysis

All soil samples were packaged and shipped to GTEL for laboratory analysis. All samples were analyzed for volatile petroleum compounds using EPA Method 8020 and PAHs using EPA Method 8310. Table 6 provides a list of compounds analyzed for each method. Appendix C contains the laboratory reports.

**Table 6**  
**Compounds Analyzed by Each Method**  
**Soil Samples**

<u>VPC*</u> <u>Method 8020</u>	<u>PAHs</u> <u>Method 8310</u>
Benzene	Acenaphthene
Ethylbenzene	Acenaphthylene
Toluene	Anthracene
Xylenes	Benzo(a) anthracene
Aliphatic Hydrocarbons	Benzo(a) pyrene
Aromatic Hydrocarbons	Benzo(b) fluoranthene
MTBE	Benzo(k) fluoranthene
	Benzo(g,h,i) perylene
	Chrysene
	Dibenzo(a,h) anthracene
	Fluoranthene
	Fluorene
	Indeno (1,2,3,c-d) pyrene
	Naphthalene
	Phenanthrene
	Pyrene
	1-Methylnaphthalene
	2-Methylnaphthalene

\* VPC = Volatile Petroleum Compound

### 2.8 Quality Assurance/Quality Control

Approximately 10 percent of the samples were collected and analyzed as quality assurance/quality control (QA/QC) samples. Field QA/QC samples included rinseate (equipment) blanks and duplicate samples. Rinseate blanks were collected to ensure that groundwater sampling equipment (bailers) was thoroughly cleaned after every use. Distilled water was poured into the cleaned bailers then into sample containers for analysis. This sample was analyzed for the same parameters as the groundwater samples. Duplicate samples of groundwater and soil were collected from GT-1 and GT-2 for laboratory QA/QC. All duplicate samples were analyzed for the same parameters as the original samples.

Prior to shipment, all water samples to be analyzed for volatile petroleum compounds were preserved by adding hydrochloric acid to the sample to ensure the sample had a pH of less than 2. All water and soil samples were packaged in ice to ensure that the samples arrived at the laboratory with a temperature of 4 degrees Celsius or less. Water samples for metals analysis were filtered and acidified by the laboratory within 24 hours of collection.

## 2.9 Tidal Survey

A tidal survey was conducted on December 5, 1990. The tidal survey was conducted to evaluate the tidal effects on the groundwater elevations in monitoring wells and groundwater flow under the peninsula. These data were used to develop groundwater contour maps at high tide and low tide and to determine groundwater flow direction. The survey consisted of gauging the 17 shallow monitoring wells every hour for 12 hours using an electronic interface probe. The tidal survey graphs and data table are provided in Appendix E.

## 2.10 Soil Permeability and Groundwater Velocity

The soil permeability test evaluates the homogeneity of the aquifer and provides information for calculating groundwater flow velocities. The groundwater flow velocities were calculated from the permeabilities and the groundwater gradients which were measured from the groundwater contour map.

All monitoring wells except for GT-1 and GT-2 were tested for soil permeability by using a rising head analysis on December 19 and 20, 1990. GT-6 was tested for soil permeability on December 9, 1991. A slug of water was removed from each well by pumping. The rate at which the water level in each well returned to equilibrium was established by measuring the depth to water at specified time intervals using a Data Logger. This instrument permits continuous monitoring of groundwater elevations. The average hydraulic conductivity was calculated by a computer program using the Bouwer and Rice (1976) procedure for slug test analysis.

The soil permeability testing began by inserting an interface probe into a well and recording the depth to water. The probe was then placed at approximately 2 feet from the bottom of the well and secured by taping it to the standpipe or a wooden stake. The hose from a surface pump was placed inside the well alongside the probe at the same depth. The pump was then activated to remove the water from the well. Once the pump had lowered the groundwater table in the well to the probe depth (2 feet from the bottom), the Data Logger was started, and the pump was turned off. The test was complete when the groundwater recharge attained its initial reading. This procedure was repeated for all the wells.

In situations where recharge was slow, the time frame was limited to one hour for tracking groundwater recharge. The information from the Data Logger was then downloaded into a computer system. The computer program produced a table of hydraulic conductivities for each well.

Groundwater flow velocities were calculated for 2 flow paths through the site which included GT-2 to GT-14 and GT-13 to GT-6. The velocities were calculated using Darcy's Law.

## 3.0 RESULTS

### 3.1 Soils

The soils encountered during the shallow well installations consisted primarily of laminated sequences of silty sands and sandy silt. The layers within these deposits are discontinuous and have thicknesses ranging from 6 inches to 7 feet. A 6-inch fine gravel deposit was encountered in GT-8 which is underlain by 6 inches of silt. A 7-foot coarse to medium sand deposit was encountered in GT-15. These soils appeared to be fluvially reworked glacial-marine deposits of the Presumpscot Formation. The soils encountered during the deep well installations are similar to the soils from the shallow well installations (see well logs, Appendix A). The total thickness of soil investigated was 40 feet.

Geologic cross sections were prepared which show the general geologic stratigraphy from north to south and west to east (Figures 5 and 6). The general silty consistency of these soils is evident in these cross sections. Localized sand deposits are shown on the figures. These deposits appear to be discontinuous.

A 2-foot contour map of the area was prepared using several terminal site maps and presented as Figure 7. The topography as shown on this map is subdued. The top-of-casing elevations for each well and pond are provided in Figure 8.

### 3.2 Soil Quality

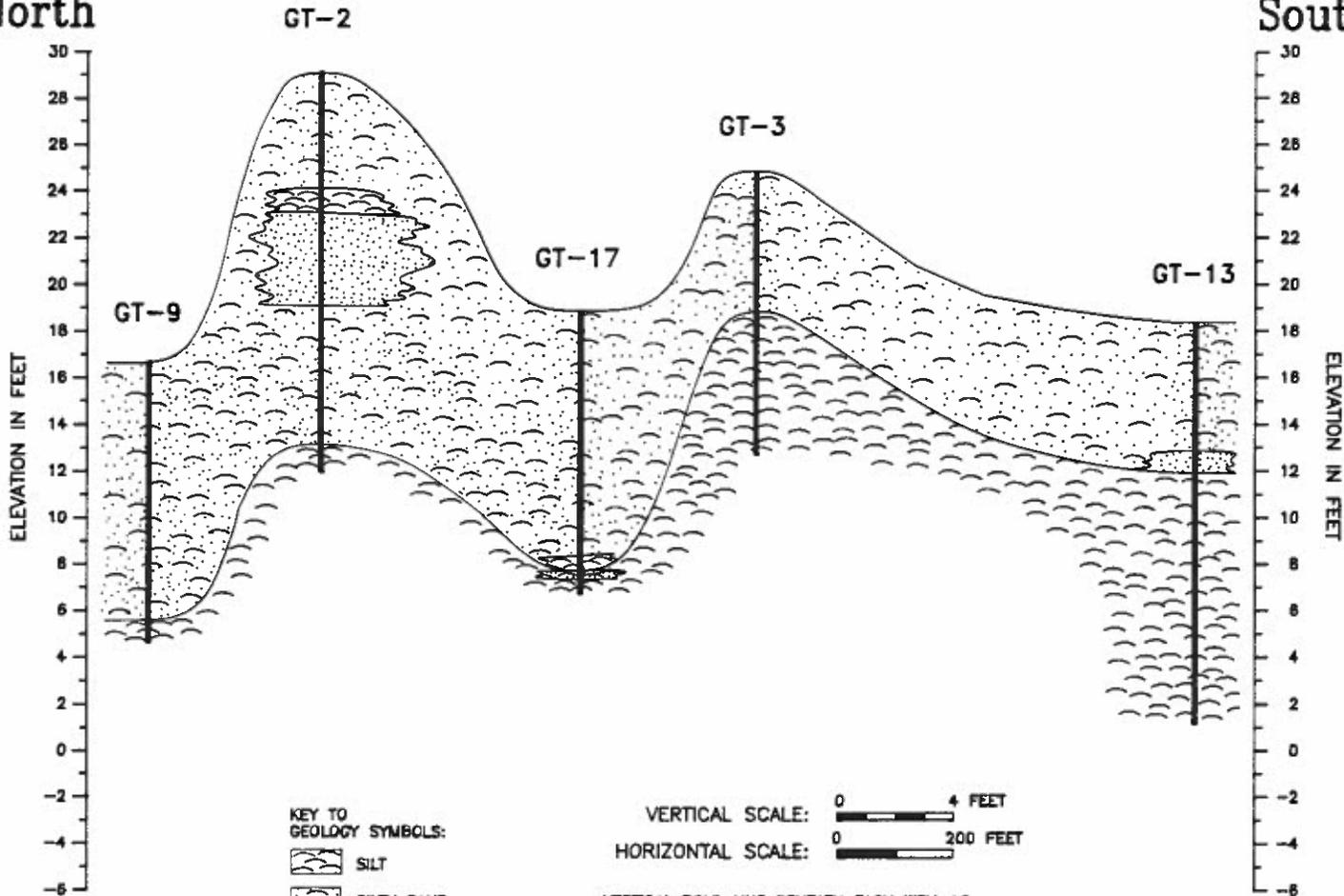
Results from the PID analysis of each split-spoon sample are summarized in Table 7. As shown in the table, the 5- to 7-foot-depth range shows the highest volatile organic concentrations. The split-spoon sample with the highest PID reading from each well was sent to the laboratory for analysis. The analytical results for volatile petroleum compounds and PAHs are summarized in Tables 8 and 9. Fifteen samples showed total BTEX concentrations at or below detection limits. Four samples had total BTEX concentrations ranging from 3 ppm to 140 ppm. Ten samples showed total hydrocarbon concentrations at or below detection limits. Five samples had total hydrocarbon concentrations ranging from 7.4 ppm to 2,400 ppm. The PAH concentrations had a wide range of concentrations for each compound.

# FIGURE 5 GEOLOGIC CROSS-SECTION

BP/GETTY/KOCH/ROLLING MILL  
SOUTH PORTLAND, ME

North

South



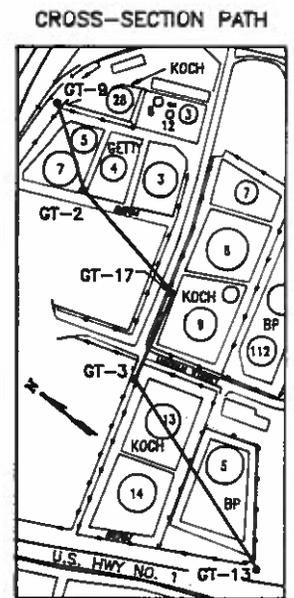
KEY TO  
GEOLOGY SYMBOLS:

- SILT
- SILTY SAND
- SAND

VERTICAL SCALE: 0 4 FEET  
 HORIZONTAL SCALE: 0 200 FEET

VERTICAL BOLD LINE BENEATH EACH WELL I.D.  
 REPRESENTS DEPTH OF EXPLORATION FROM GRADE

SOURCE: GROUNDWATER TECHNOLOGY, INC. WELL LOGS



2/18/91  
 NO.: 005/UMC  
 FILE: RANGEDNS



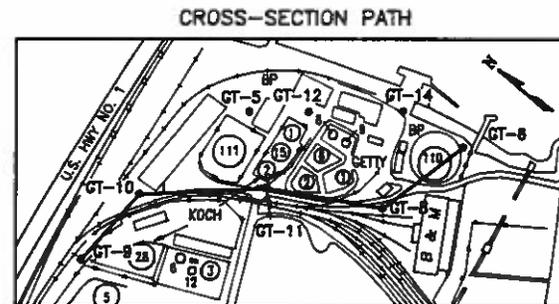
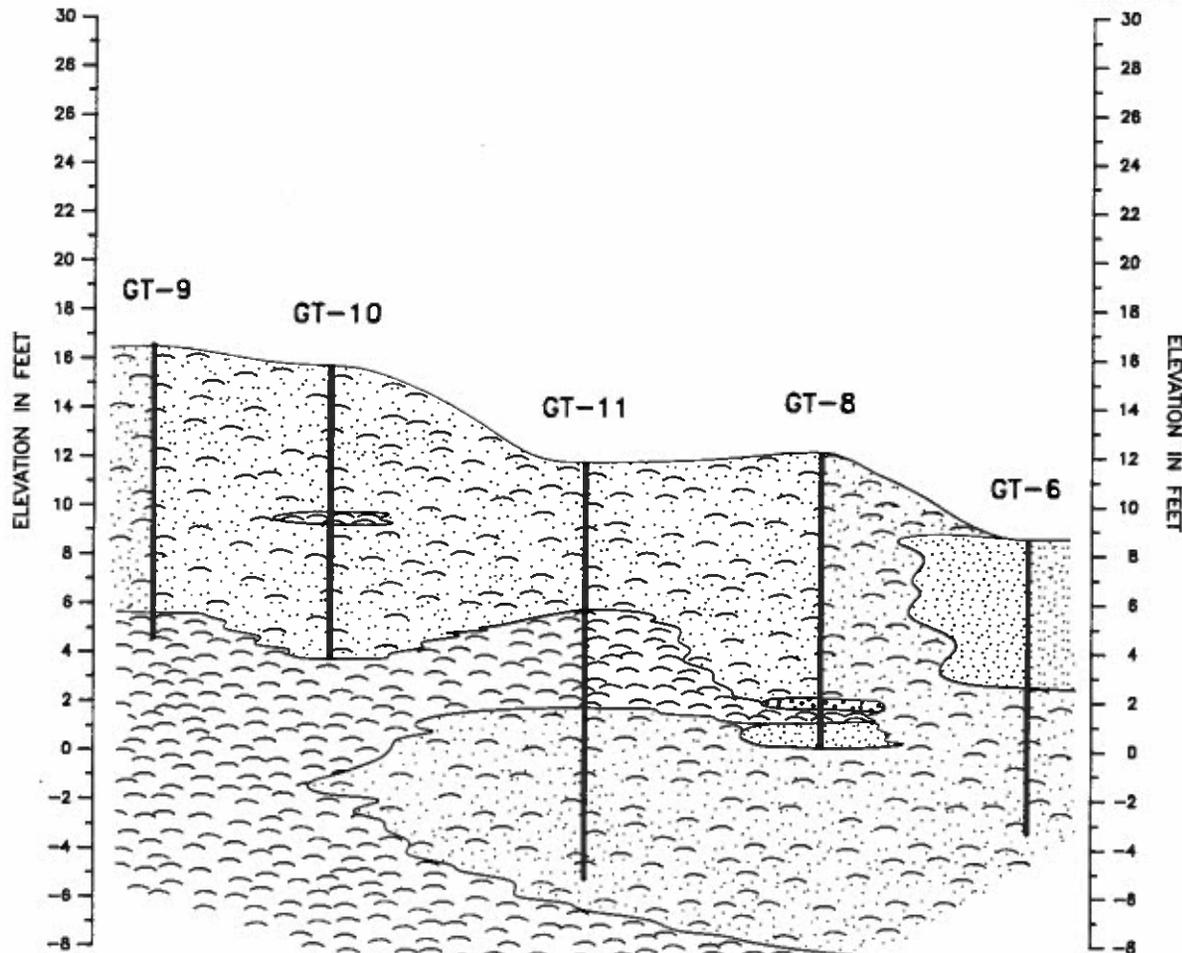
GROUNDWATER  
 TECHNOLOGY, INC.

FIGURE 6  
**GEOLOGIC CROSS-SECTION**

BP/GETTY/KOCH/ROLLING MILL  
 SOUTH PORTLAND, ME

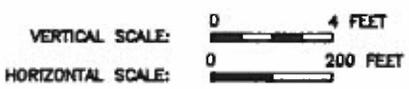
West

East



KEY TO GEOLOGY SYMBOLS:

- SILT
- SILTY SAND
- SAND
- FINE GRAVEL



VERTICAL BOLD LINE BENEATH EACH WELL L.D. REPRESENTS DEPTH OF EXPLORATION FROM GRADE

SOURCE: GROUNDWATER TECHNOLOGY, INC. WELL LOGS

2/19/91  
 NO.: 006/GMC  
 FILE: RMOEDAS



**GROUNDWATER TECHNOLOGY, INC.**

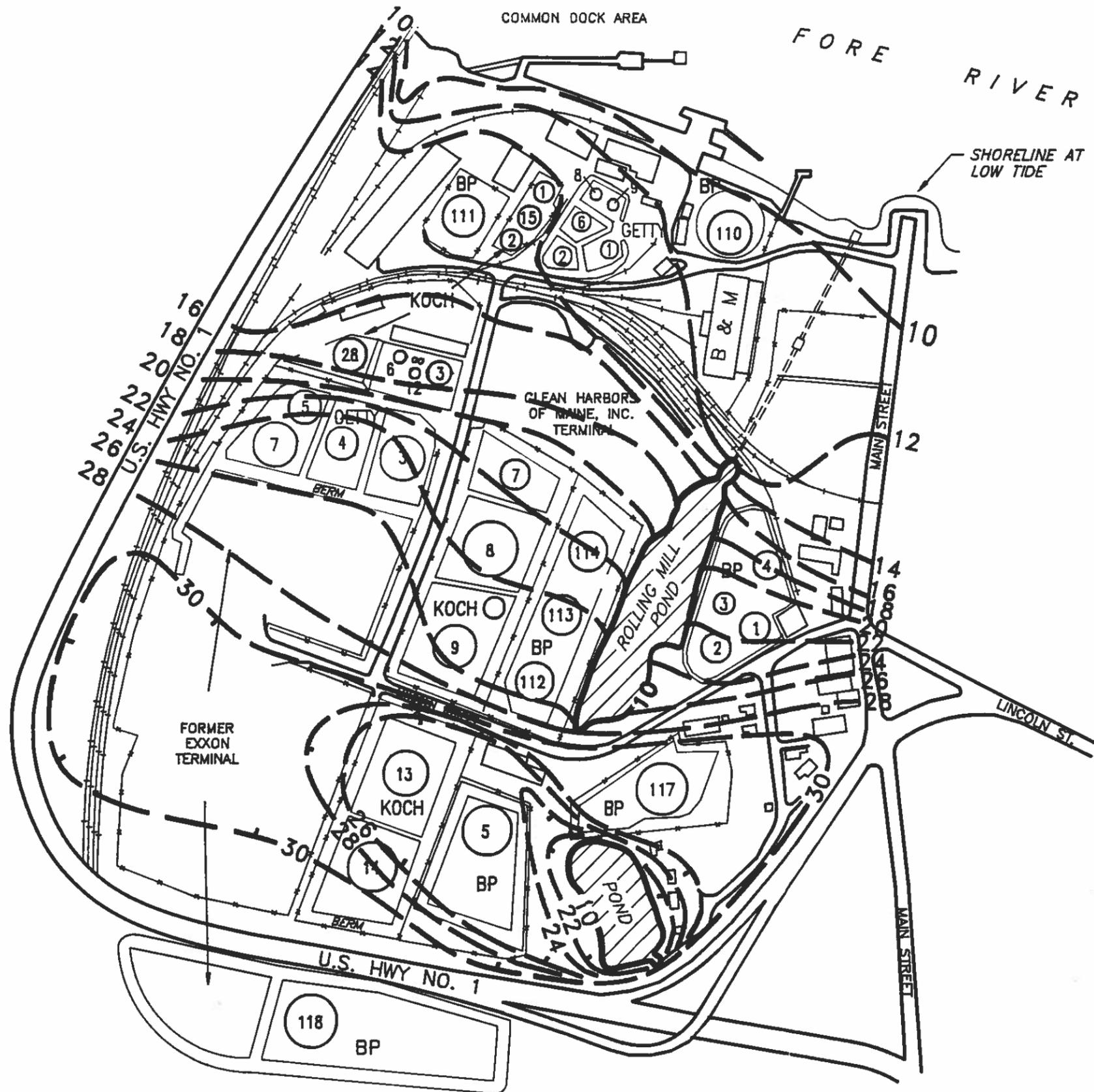


FIGURE 7  
**TWO FOOT SURFACE CONTOURS**

PROJECT: BP/GETTY/KOCH/ROLLING MILL  
 LOCATION: SOUTH PORTLAND, MAINE  
 PROJECT NO.: 01131-0158

THE SURFACE CONTOURS ON THIS PLAN HAVE BEEN REGIONALLY GENERALIZED (DISREGARDING LOCAL CHANGES IN BERMS, BUILDINGS, ETC.) FROM SPOT ELEVATIONS AND CONTOURS PROVIDED BY BP OIL

THE ELEVATIONS IMMEDIATELY SURROUNDING THE PONDS SLOPE STEEPLY DOWN TOWARD THE PONDS

U.S. HIGHWAY NO. 1 IS AT A HIGHER ELEVATION THAN THE TERMINALS AND RAILROAD

- +—+—+— RAILWAY
- +—+—+— FENCE
- ABOVE GROUND FUEL OIL STORAGE TANK

BASE MAP SOURCE: "SITE MAP A - ROLLING MILL INDUSTRIES GROUP, SOUTH PORTLAND, MAINE", W.C. FINCH, 5/5/72



4/09/91  
 NO: 008/CWC  
 FILE: ROLLML2

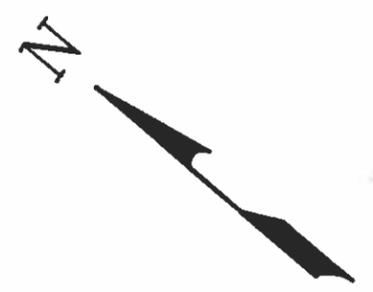


FIGURE 8

# WELL AND POND ELEVATIONS

PROJECT: BP/GETTY/KOCH/ROLLING MILL  
LOCATION: SOUTH PORTLAND, MAINE  
PROJECT NO.: 01131-0158

- DEEP WELL (2)
- MONITORING WELL (17)  
EX.: GT-1 - WELL IDENTIFICATION  
(20.54) - TOP OF CASING ELEVATION (FT)
- POND ELEVATION SURVEY LOCATION  
EX.: (8.88) - POND SURFACE ELEVATION (FT)

ELEVATIONS ARE RELATIVE TO MEAN LOW WATER DATUM:  
BENCHMARK (BM X) = 12.86'; SOURCE:  
E.C. JORDAN, INC. TERMINAL PLAN, 1988

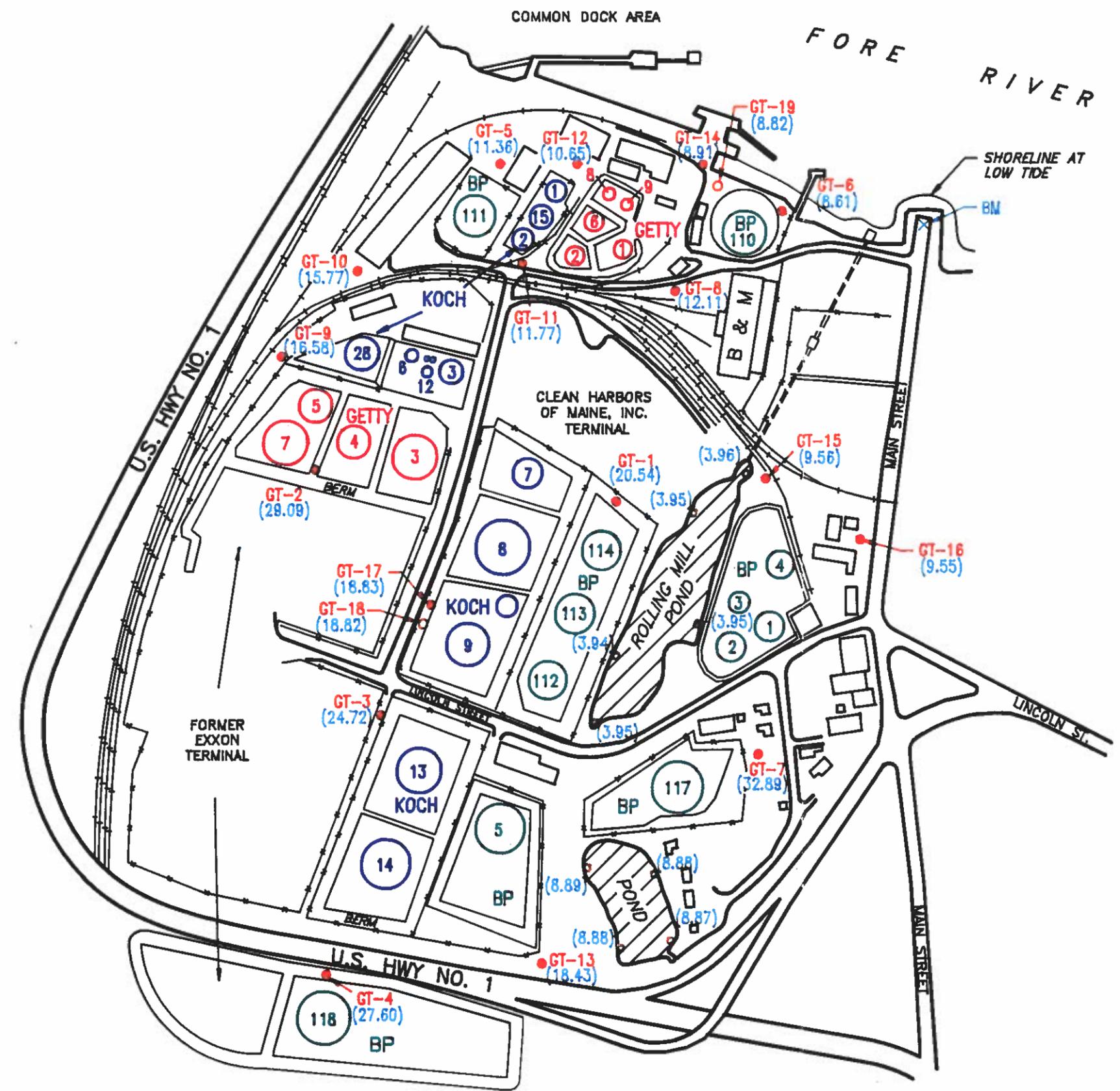
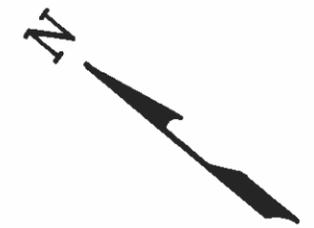
GT-5, GT-11, GT-12, GT-14, GT-16 AND GT-17 ARE  
FLUSH-MOUNTED WELLS  
ALL WELLS ARE APPROXIMATELY LOCATED

- +—+— RAILWAY
- +—+— FENCE
- ABOVE GROUND FUEL OIL STORAGE TANK

BASE MAP SOURCE: "SITE MAP A -  
ROLLING MILL INDUSTRIES GROUP, SOUTH  
PORTLAND, MAINE", W.C. FINCH, 5/5/72



DRAWN: 12/10/91  
NO.: 011/DWC  
FILE: ROLML11



**Table 7**  
**PID Analysis for Split-Spoon Soil Samples (feet)**  
**Concentrations in Parts per Million (ppm)**

<u>Boring</u>	<u>0-2</u>	<u>5-7</u>	<u>10-12</u>	<u>15-17</u>	<u>20-22</u>	<u>25-27</u>	<u>30-32</u>
GT-1*	130	90	92	84	96	--	--
GT-2	12	12	82	30	--	--	--
GT-3	9	10	10	--	--	--	--
GT-4	8	9	9	--	--	--	--
GT-5	8	10	90	--	--	--	--
GT-6	0	150	110	--	--	--	--
GT-7	0	0	1	1	--	--	--
GT-8	1	3	4	--	--	--	--
GT-9	0	4	8	--	--	--	--
GT-10	30	10	18	--	--	--	--
GT-11	105	400	150	165	--	--	--
GT-12	10	13	125	--	--	--	--
GT-13	9	10	9	9	--	--	--
GT-14	3	82	280	32	--	--	--
GT-15	0	280	0	--	--	--	--
GT-16	10	0	45	--	--	--	--
GT-17	9	22	22	--	--	--	--
GT-18**	1	10	120	4	3	6	ND
GT-19	1	100	210	210	45	ND	40

Notes: ND = None Detected  
 \* Monitoring well split-spoon samples  
 \*\* 35-37 feet = ND; 40-42 feet = ND

Table 8  
 Laboratory Analysis for Soil Samples  
 Volatile Petroleum Compounds  
 Method 8020  
 Concentrations in Parts per Million (ppm)

<u>Sample</u>	<u>Benzene</u>	<u>Toluene</u>	<u>Ethyl Benzene</u>	<u>Xylenes</u>	<u>Total BTEX</u>	<u>Total Hydrocarbons</u>
GT-1*	BDL	BDL	BDL	BDL	BDL	BDL
GT-2	BDL	BDL	BDL	BDL	BDL	BDL
GT-3	BDL	BDL	BDL	BDL	BDL	BDL
GT-4	BDL	BDL	BDL	BDL	BDL	BDL
GT-5	0.15	BDL	0.30	2.6	3.0	7.4
GT-6	13	6.0	BDL	20	39	2,400
GT-7	BDL	BDL	BDL	BDL	BDL	BDL
GT-8	0.24	0.21	BDL	BDL	0.45	0.45
GT-9	BDL	BDL	BDL	BDL	BDL	BDL
GT-10	BDL	BDL	BDL	BDL	BDL	BDL
GT-11	BDL	6.0	6.0	15	27	360
GT-12	BDL	BDL	0.57	BDL	0.57	430
GT-13	BDL	BDL	BDL	BDL	BDL	BDL
GT-14	BDL	BDL	BDL	BDL	BDL	140
GT-15	BDL	BDL	0.22	BDL	0.22	16
GT-16	BDL	BDL	BDL	BDL	BDL	73
GT-17	BDL	BDL	BDL	BDL	BDL	BDL
GT-18	BDL	BDL	BDL	BDL	BDL	150
GT-19	41	41	15	39	140	1,400
SS-1**	0.24	0.40	BDL	0.79	1.4	8.0
SS-2	0.19	0.48	BDL	1.6	2.3	76
SS-3	BDL	BDL	BDL	BDL	BDL	210
SS-4	BDL	BDL	0.59	2.9	3.5	320
SS-5	BDL	BDL	BDL	BDL	BDL	23
SS-6	BDL	BDL	BDL	BDL	BDL	BDL
SS-7	BDL	BDL	BDL	BDL	BDL	BDL

Notes: BDL = Below Detection Limits  
 \* Samples collected from split-spoons  
 \*\* Surface soil samples

**Table 9**  
**Laboratory Analysis for Soil Samples**  
**PAHs - Method 8310**  
**Concentrations in Parts per Million (ppm)**

<u>Compound</u>	<u>GT-1*</u>	<u>GT-2</u>	<u>GT-3</u>	<u>GT-4</u>	<u>GT-5</u>	<u>GT-6</u>
Naphthalene	100	BDL	BDL	BDL	BDL	570
Acenaphthylene	BDL	BDL	BDL	BDL	BDL	250
1-Methylnaphthalene	370	BDL	BDL	BDL	BDL	6,100
2-Methylnaphthalene	280	BDL	BDL	BDL	BDL	BDL
Acenaphthene	BDL	BDL	BDL	BDL	BDL	700
Fluorene	140	BDL	BDL	BDL	BDL	480
Phenanthrene	1,000	BDL	BDL	BDL	BDL	1,200
Anthracene	140	BDL	BDL	BDL	BDL	BDL
Fluoranthene	49	BDL	BDL	BDL	BDL	88
Pyrene	610	BDL	BDL	BDL	BDL	410
Benzo(a)anthracene	12	BDL	BDL	BDL	BDL	31
Chrysene	14	BDL	BDL	BDL	BDL	45
Benzo(b)fluoranthene	BDL	BDL	BDL	BDL	BDL	22
Benzo(k)fluoranthene	0.12	BDL	BDL	BDL	BDL	11
Benzo(a)pyrene	BDL	BDL	BDL	BDL	BDL	24
Indeno(1,2,3-cd)pyrene	BDL	BDL	BDL	BDL	BDL	BDL
Dibenzo(a,h)anthracene	BDL	BDL	BDL	BDL	BDL	2.3
Benzo(g,h,i)perylene	BDL	BDL	BDL	BDL	BDL	14

<u>Compound</u>	<u>GT-7</u>	<u>GT-8</u>	<u>GT-9</u>	<u>GT-10</u>	<u>GT-11</u>	<u>GT-12</u>
Naphthalene	BDL	BDL	BDL	BDL	14,000	5,700
Acenaphthylene	BDL	BDL	BDL	BDL	BDL	250
1-Methylnaphthalene	BDL	BDL	BDL	BDL	22,000	14,000
2-Methylnaphthalene	BDL	BDL	BDL	BDL	40,000	500
Acenaphthene	BDL	BDL	BDL	BDL	880	360
Fluorene	BDL	BDL	BDL	BDL	3,200	2,400
Phenanthrene	BDL	BDL	BDL	BDL	16,000	7,600
Anthracene	BDL	BDL	BDL	51	650	220
Fluoranthene	BDL	BDL	BDL	BDL	470	230
Pyrene	BDL	BDL	BDL	BDL	4,900	1,600
Benzo(a)anthracene	BDL	4.0	BDL	BDL	180	64
Chrysene	BDL	BDL	BDL	BDL	480	170
Benzo(b)fluoranthene	BDL	3.7	BDL	BDL	35	22
Benzo(k)fluoranthene	BDL	2.0	BDL	BDL	17	15
Benzo(a)pyrene	BDL	4.3	BDL	BDL	33	23
Indeno(1,2,3-cd)pyrene	BDL	BDL	BDL	BDL	BDL	16
Dibenzo(a,h)anthracene	BDL	BDL	BDL	BDL	5.6	13
Benzo(g,h,i)perylene	BDL	3.9	BDL	BDL	28	39

Table 9 (continued)  
 Laboratory Analysis for Soil Samples  
 PAHs - Method 8310  
 Concentrations in Parts per Million (ppm)

<u>Compound</u>	<u>GT-13</u>	<u>GT-14</u>	<u>GT-15</u>	<u>GT-16</u>	<u>GT-17</u>	<u>GT-18</u>	<u>GT-19</u>
Naphthalene	BDL	230	2,900	540	BDL	BDL	70
Acenaphthylene	BDL	< 130	150	150	BDL	BDL	BDL
1-Methylnaphthalene	BDL	570	3,000	1,800	BDL	BDL	600
2-Methylnaphthalene	BDL	250	4,800	2,900	BDL	BDL	210
Acenaphthene	BDL	83	470	180	BDL	BDL	140
Fluorene	BDL	420	250	430	BDL	BDL	220
Phenanthrene	BDL	1,200	940	2,500	BDL	BDL	780
Anthracene	BDL	6,600	1,500	930	BDL	2,100	BDL
Fluoranthene	BDL	960	200	300	BDL	1,300	110
Pyrene	BDL	5,300	1,000	2,000	BDL	5,300	410
Benzo(a)anthracene	BDL	390	80	110	BDL	570	36
Chrysene	BDL	1,400	110	100	BDL	1,500	200
Benzo(b)fluoranthene	BDL	BDL	46	49	BDL	890	43
Benzo(k)fluoranthene	BDL	BDL	27	28	BDL	410	14
Benzo(a)pyrene	BDL	BDL	63	71	BDL	870	34
Indeno(1,2,3-cd)pyrene	BDL	BDL	32	65	BDL	98	1.7
Dibenzo(a,h)anthracene	BDL	BDL	20	10	BDL	170	27
Benzo(g,h,i)perylene	BDL	BDL	67	70	BDL	300	15

<u>Compound</u>	<u>SS-1**</u>	<u>SS-2</u>	<u>SS-3</u>	<u>SS-4</u>	<u>SS-5</u>	<u>SS-6</u>	<u>SS-7</u>
Naphthalene	240	660	81	180	900	2,300	180
Acenaphthylene	360	910	120	BDL	BDL	2,400	BDL
1-Methylnaphthalene	95	1,500	BDL	580	BDL	BDL	BDL
2-Methylnaphthalene	310	BDL	100	300	BDL	BDL	BDL
Acenaphthene	340	BDL	64	300	370	BDL	BDL
Fluorene	52	BDL	BDL	BDL	BDL	1,200	BDL
Phenanthrene	1,100	300	320	1,600	1,900	7,900	BDL
Anthracene	2,400	3,400	85	840	5,000	16,000	BDL
Fluoranthene	1,300	28	93	260	2,200	7,900	BDL
Pyrene	3,600	700	900	1,600	5,800	18,000	BDL
Benzo(a)anthracene	570	34	130	120	980	3,600	BDL
Chrysene	1,200	44	180	330	490	1,200	BDL
Benzo(b)fluoranthene	490	27	24	32	1,200	3,000	0.72
Benzo(k)fluoranthene	250	9.4	7.6	14	630	1,600	BDL
Benzo(a)pyrene	480	1.9	3.8	33	1,400	3,800	BDL
Indeno(1,2,3-cd)pyrene	380	140	10	BDL	1,400	3,200	BDL
Dibenzo(a,h)anthracene	140	49	5.3	BDL	390	890	BDL
Benzo(g,h,i)perylene	560	99	12	25	1,400	3,200	BDL

Notes: \* Samples collected from split-spoon  
 \*\* SS-1 - SS-6, surface soil samples

Surface soil samples were collected from 7 areas within the diked tank areas and analyzed for volatile petroleum compound concentrations and PAHs. These results are also summarized in Tables 8 and 9.

QA/QC soil sample duplicates were collected from well borings GT-1 and GT-2 and analyzed for volatile petroleum compound concentrations and PAHs. The original GT-1 and GT-2 sample analytical results and duplicate analytical results are summarized in Table 10. Both samples and duplicates were below detection limits for volatile petroleum compounds.

Generally, the laboratory analysis detected very low to moderate concentrations of volatile petroleum compounds and PAHs in the soil samples collected during this investigation. The laboratory reports are presented in Appendix C.

**Table 10**  
**Laboratory Results**  
**Quality Assurance/Quality Control - Soil Samples**  
**Concentrations in Parts per Million (ppm)**

**Volatile Petroleum Compounds**

<u>Compound</u>	<u>GT-1</u>	<u>DP-1*</u>	<u>GT-2</u>	<u>DP-2*</u>
Benzene	BDL	BDL	BDL	BDL
Toluene	BDL	BDL	BDL	BDL
Ethylbenzene	BDL	BDL	BDL	BDL
Xylenes	BDL	BDL	BDL	BDL
Total BTEX	BDL	BDL	BDL	BDL
Total Hydrocarbons	BDL	BDL	BDL	BDL

**Polynuclear Aromatic Hydrocarbons**

<u>Compound</u>	<u>GT-1</u>	<u>DP-1*</u>	<u>GT-2</u>	<u>DP-2*</u>
Naphthalene	100	BDL	BDL	BDL
Acenaphthylene	BDL	BDL	BDL	BDL
1-Methylnaphthalene	370	BDL	BDL	BDL
2-Methylnaphthalene	280	BDL	BDL	BDL
Acenaphthene	BDL	BDL	BDL	BDL
Fluorene	140	BDL	BDL	BDL
Phenanthrene	1,000	60	BDL	BDL
Anthracene	140	BDL	BDL	BDL
Fluoranthene	49	BDL	BDL	BDL
Pyrene	610	39	BDL	BDL
Benzo(a)anthracene	12	1.1	BDL	BDL
Chrysene	14	BDL	BDL	BDL
Benzo(b)fluoranthene	BDL	BDL	BDL	BDL
Benzo(k)fluoranthene	0.12	BDL	BDL	BDL
Benzo(a)pyrene	BDL	BDL	BDL	BDL
Indeno(1,2,3-cd)pyrene	BDL	BDL	BDL	BDL
Dibenzo(a,h)anthracene	BDL	BDL	BDL	BDL
Benzo(g,h,i)perylene	BDL	BDL	BDL	BDL

Notes:           \* DP-1 and DP-2 = Duplicate sample of GT-1 and GT-2

### 3.3 Hydrogeology

Each monitoring well was gauged for depth to water monthly for 1 year. This information is contained on the well monitoring forms located in Appendix F. The highest groundwater level from the wells was recorded in April 1991 which is typical during the spring. The lowest groundwater level was recorded in July 1991 during low tide. The low groundwater level was due to below-average precipitation during the month of July. The greatest fluctuation in groundwater level was recorded in monitoring well GT-7. GT-7 is located approximately 18 feet higher than the average elevations of the other monitoring wells. The groundwater was gauged in April at 4.9 feet and 14.5 feet in July. The lowest fluctuation of the groundwater level was recorded in GT-15, located less than 50 feet from the Rolling Mills Pond and the terminals' oil and water separator. The groundwater was gauged in April at 5.6 feet and 6.6 feet in July.

Between December 1990 and November 1991, the average low groundwater level was 8.3 feet. The average high groundwater level was 5.4 feet. The difference between the highest and lowest groundwater levels was 2.9 feet. Therefore, the groundwater levels fluctuated an average of approximately 3 feet across the facility during the last year.

Groundwater contour maps have been prepared that show groundwater at high tide and low tide during different seasons. Figure 9 shows groundwater contours at high tide in December 1990 and June 1991. Although the groundwater depths are different, the overall flow direction toward the east remains relatively the same during the 2 seasons. Figure 10 shows groundwater contours at low tide in December 1990 and March 1991. Similarly, the groundwater depths are different but the groundwater flow direction is the same.

The soils at the site are of low permeability which restrict groundwater flow and can cause perched water tables during times of high recharge. Well GT-7 appears to exhibit a perched water table as shown by a much higher water elevation than the surrounding wells (Figures 9 and 10).

The groundwater elevations in the monitoring well pairs GT-17/GT-18 and GT-14/GT-19 were compared to evaluate potential vertical groundwater gradients. The first pair of wells is located near the center of the terminals; the second pair is near the shoreline. Monitoring wells GT-17 and GT-14 are 10 feet deep; GT-18 and GT-19 are 40 feet deep. At high tide, the groundwater elevations in GT-17/GT-18 showed a downward gradient of 0.45 feet in the 30-foot interval (elevations were 13.75 and 13.30 feet, respectively). Similar results were found at low tide with a downward gradient of 0.56 feet (elevations were 13.00 and 12.44 feet, respectively).

FIGURE 9  
**GROUNDWATER CONTOURS  
 AT HIGH TIDE**

PROJECT: BP/GETTY/KOCH/ROLLING MILL  
 LOCATION: SOUTH PORTLAND, MAINE  
 PROJECT NO.: 01131-0158

MONITORING DATE: 12/5/90

MONITORING DATE: 6/25/91

○ DEEP WELL (2)

● MONITORING WELL (17)

EX.: GT-1 - WELL IDENTIFICATION  
 6.04 - WATER TABLE ELEVATION (FT)  
 5.90 - WATER TABLE ELEVATION (FT)

ELEVATIONS ARE RELATIVE TO MEAN LOW WATER DATUM:  
 BENCHMARK (BM X) = 12.86'; SOURCE:  
 E.C. JORDAN, INC. TERMINAL PLAN, 1988

GT-7 WAS NOT USED IN CONTOURING DUE TO  
 PERCHED WATER TABLE

GT-5, GT-11, GT-12, GT-14, GT-16 AND GT-17 ARE  
 FLUSH-MOUNTED WELLS  
 ALL WELLS APPROXIMATELY LOCATED

— RAILWAY

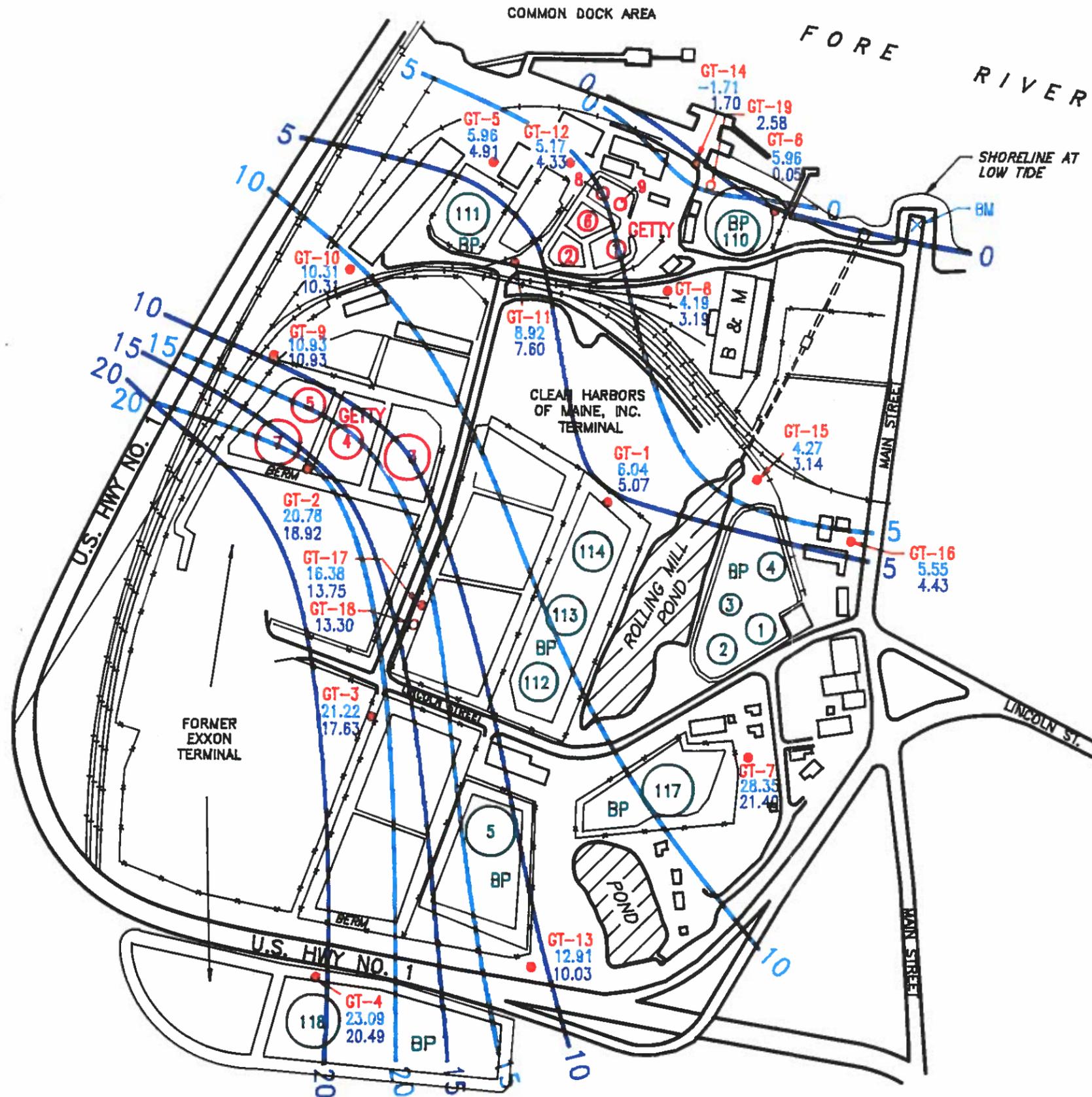
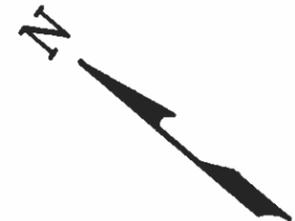
— FENCE

○ ABOVE GROUND FUEL OIL STORAGE TANK

BASE MAP SOURCE: "SITE MAP A -  
 ROLLING MILL INDUSTRIES GROUP, SOUTH  
 PORTLAND, MAINE", W.C. FINCH, 5/5/72

0 300  
 SCALE IN FEET

DRAWN: 12/10/91  
 NO: 012/DWC  
 FILE: ROLLMLB



THIS MAP WAS DESIGNED TO BE VIEWED IN COLOR

FIGURE 10

# GROUNDWATER CONTOURS AT LOW TIDE

PROJECT: BP/GETTY/KOCH/ROLLING MILL

LOCATION: SOUTH PORTLAND, MAINE

PROJECT NO.: 01131-0158

MONITORING DATE: 12/5/90

MONITORING DATE: 3/26/91

● **MONITORING WELL (17)**

- EX.: GT-1 - WELL IDENTIFICATION
- 6.00 - WATER TABLE ELEVATION (FT)
- 5.90 - WATER TABLE ELEVATION (FT)

ELEVATIONS ARE RELATIVE TO MEAN LOW WATER DATUM:  
 BENCHMARK (BM X) = 12.86'; SOURCE:  
 E.C. JORDAN, INC. TERMINAL PLAN, 1988

GT-7 WAS NOT USED IN CONTOURING DUE TO  
 PERCHED WATER TABLE

GT-5, GT-11, GT-12, GT-14, GT-16 AND GT-17 ARE  
 FLUSH-MOUNTED WELLS

ALL WELLS APPROXIMATELY LOCATED

— RAILWAY

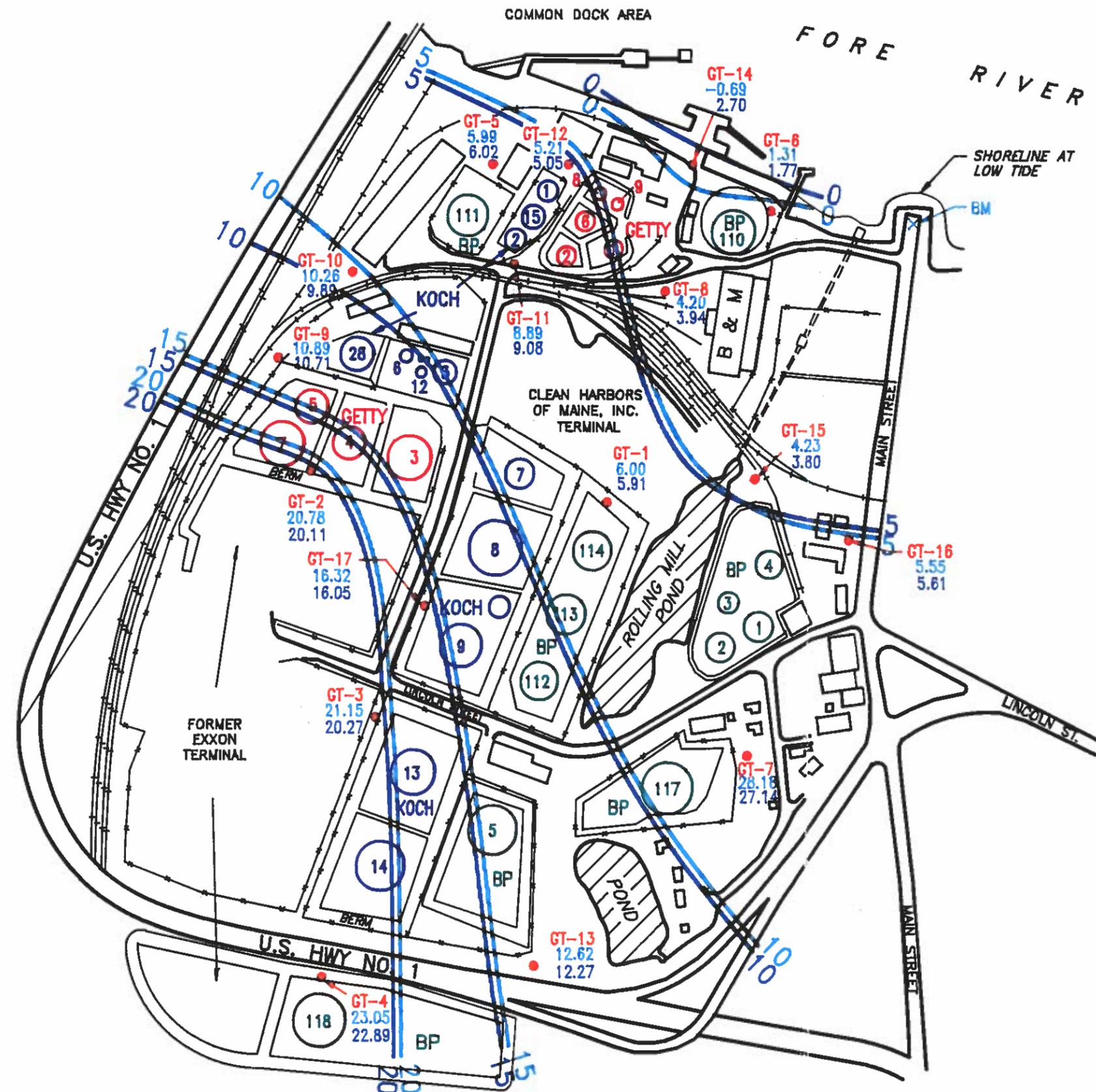
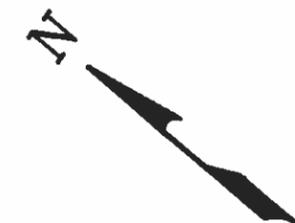
— FENCE

○ ABOVE GROUND FUEL OIL STORAGE TANK

BASE MAP SOURCE: "SITE MAP A -  
 ROLLING MILL INDUSTRIES GROUP, SOUTH  
 PORTLAND, MAINE", W.C. FINCH, 5/5/72

0 300  
 SCALE IN FEET

DRAWN: 12/10/91  
 NO.: 013/DMC  
 FILE: ROLLML12



Opposite results were observed at monitoring well pair GT-14/GT-19. At high tide there was an upward gradient of 0.88 feet (elevations were 1.70 and 2.58 feet, respectively), and at low tide the upward gradient was 1.93 feet (elevations were -0.49 and 2.42 feet, respectively).

In the wells along the shoreline, an upward gradient was evident which is typical in areas near major water bodies. The wells in the center of the terminals show a downward gradient. The likely cause of the downward gradient are low-permeability soils that create perched water tables. Perched water tables are common in silty soils like those found during drilling.

Further evidence of poor connection between shallow and deep groundwater is provided by the increased gradient measured during low tide. The gradient increases because groundwater in the zones is draining at different rates. The two zones are reacting relatively independently, which demonstrates that the upper zones are perched above the lower zones.

### 3.3.1 Tidal Survey

Results from the tidal survey show that the tide does not significantly impact groundwater elevations in monitoring wells or groundwater flow except adjacent to the shoreline. Comparison of the groundwater contour maps for high tide and low tide indicates the tide slightly influences the monitoring wells along the shoreline (GT-5, GT-6, GT-12, and GT-14). The tidal influence measured in these wells ranged from 0.02 feet in GT-8 to 4.30 feet in GT-14. GT-13, which is located adjacent to upper Rolling Mills Pond, showed a steady decline in its water level during the survey. This decline was probably due to draining of perched water into the pond.

Weather conditions affecting the tidal survey included a rainfall of 3.5 inches on December 4, 1990, the previous day, due to a severe coastal storm. The normal high tide was anticipated at 11.60 feet; however, due to the storm, the actual high tide was recorded at 13.65 feet at 11:56 p.m. (Weather Service, 1990). Low tide was -0.20 feet which was recorded at 6:36 a.m.. Tidal survey graphs and data table are contained in Appendix E.

### 3.3.2 Soil Permeability and Groundwater Velocity

The results of the slug test analysis found hydraulic conductivity values on site varied from  $2.61 \times 10^{-2}$  centimeters per second (cm/sec) to  $6.81 \times 10^{-5}$  cm/sec with an average of  $5.92 \times 10^{-3}$  cm/sec. The observed values are similar to documented values for the identified soil types. The hydraulic conductivity values for each well are listed below in Table 11. Slug tests were not performed on GT-1 and GT-2 because they are located on high berms.

Table 11  
Hydraulic Conductivity Values (K)

<u>Well</u>	<u>Ft/Min</u>	<u>Ft/Day</u>	<u>Cm/Sec</u>	<u>GPD/Ft<sup>2</sup>*</u>
GT-3	0.0201	28.9	$1.02 \times 10^{-2}$	217
GT-4	0.0044	6.4	$2.25 \times 10^{-3}$	48
GT-5	0.0054	7.7	$2.72 \times 10^{-3}$	58
GT-6	0.0001	0.2	$7.06 \times 10^{-5}$	2
GT-7	0.0001	0.2	$6.81 \times 10^{-5}$	1
GT-8	0.0513	73.9	$2.61 \times 10^{-2}$	553
GT-9	0.0136	19.6	$6.91 \times 10^{-3}$	146
GT-10	0.0102	14.7	$5.18 \times 10^{-3}$	110
GT-11	0.0059	8.5	$3.00 \times 10^{-3}$	64
GT-12	0.0027	3.8	$1.36 \times 10^{-3}$	29
GT-13	0.0030	4.3	$1.53 \times 10^{-3}$	32
GT-14	0.0178	25.6	$9.04 \times 10^{-3}$	192
GT-15	0.0170	24.5	$8.64 \times 10^{-3}$	183
GT-16	0.0038	5.5	$1.93 \times 10^{-3}$	41
GT-17	0.0192	27.6	$9.75 \times 10^{-3}$	207
<b>Average</b>	<b>0.0157</b>	<b>16.8</b>	<b><math>5.92 \times 10^{-3}</math></b>	<b>126</b>

Notes: \* GPD/Ft<sup>2</sup> = Gallons per day per square foot

Groundwater discharge points flow rates are provided below in Table 12. These numbers show that the groundwater seeps have relatively low flow rates. Some of this flow is probably from bank storage that infiltrates the soils during high tide.

Table 12  
Groundwater Discharge Point Flow Rates  
Gallons Per Minute

<u>Sample Number</u>	<u>Flow Rate</u>
WW-2	0.5
WW-3	0.6
WW-5	0.3
WW-6	0.7
WW-7	0.5
<b>Average</b>	<b>0.5</b>

The flow rate for WW-4 was not recorded.

The average groundwater velocity for 2 flow paths were calculated from the hydraulic conductivities and the contour map gradients using slug test data, permeability data, and groundwater elevation gauging data. The average flow velocity from GT-2 to GT-12 is 1.3 feet per day based on the site's average hydraulic conductivity of  $5.92 \times 10^{-3}$ , an estimated porosity of 0.25, and a gradient measured from the groundwater contour map of 20 feet per 1,000 feet. The average flow velocity from GT-13 to GT-6 is 0.5 feet per day based on the same average hydraulic conductivity and estimated porosity but using a gradient of 15 feet per 2,000 feet. The velocities were calculated using the following formulas:

$$\text{Velocity} = \frac{K_i}{\phi}$$

Hydraulic Conductivity (K) =  $5.92 \times 10^{-3}$   
 Horizontal hydraulic gradient (i) = 20 feet/1,000 feet = 0.02  
 Assumed porosity ( $\phi$ ) = 0.25

$5.92 \times 10^{-3}$  centimeters/second = 6,126 feet/year

$$\begin{aligned} \text{GT-2 to GT-12} &= \frac{(6,126 \text{ feet/year})(0.02)}{0.25} \\ &= 490 \text{ feet/year} \\ &= 1.3 \text{ feet/day} \end{aligned}$$

$$\begin{aligned} \text{GT-13 to GT-6} &= \frac{(6,126 \text{ feet/year})(0.0075)}{0.25} \\ &= 184 \text{ feet/year} \\ &= 0.5 \text{ feet/day} \end{aligned}$$

The average groundwater velocity of the 2 flow paths is 1 foot per day based on the previous calculations.

### 3.4 Groundwater Quality

Analytical results from groundwater samples collected from the monitoring wells and groundwater discharge points are summarized in Tables 13, 14, and 15 which show volatile petroleum compounds and MTBE, PAHs, and metal concentrations, respectively. Table 13 shows the yearly analytical results for volatile petroleum compounds and MTBE from December 1990 through October 1991. The total BTEX concentrations decreased in 5 of the 19 wells from December to October. Ten wells remain at or below detection limits, and 4 of the 19 wells show slight increases in total BTEX concentrations. The total hydrocarbon concentrations decreased in 7 of the 19 wells from December to October. Seven wells remain at or below detection limits, and 5 wells show slight increases in total hydrocarbon concentrations.

Appendix B contains graphs for each well showing total BTEX and total hydrocarbon concentrations over the four quarterly samplings. The PAH concentrations had a wide range of concentrations for each compound which are summarized in the tables. Metal concentrations were found in 4 groundwater samples ranging from 0.005 ppm of lead to 0.011 ppm of arsenic. All groundwater laboratory reports are presented in Appendix B.

Table 13  
 Laboratory Analysis for Groundwater Samples  
 Volatile Petroleum Compounds and MTBE; Method 602  
 Concentrations in Parts per Million (ppm)

Sample	Benzene				Toluene			
	Dec.	March	June	Oct.	Dec.	March	June	Oct.
GT-1	1.8	0.8	0.0068	0.29	1.4	1.5	0.022	0.38
GT-2	0.40	0.59	2.2	0.27	0.055	0.15	0.56	0.026
GT-3	0.0002	BDL	BDL	BDL	0.0007	BDL	BDL	BDL
GT-4	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GT-5	0.77	0.48	1.0	1.0	5.5	4.5	5.6	8.8
GT-6	0.97	0.59	0.56	0.49	0.19	0.072	0.063	0.047
GT-7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GT-8	0.087	0.043	0.058	0.096	0.022	0.013	0.0035	0.024
GT-9	0.0063	0.0052	0.0065	0.0017	BDL	BDL	BDL	BDL
GT-10	0.084	0.10	0.0003	0.11	0.46	BDL	0.0084	0.38
GT-11	1.8	1.6	1.7	2.1	2.2	3.1	3.1	3.9
GT-12	0.001	0.14	0.14	0.17	0.03	0.28	0.020	BDL
GT-13	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GT-14	0.20	0.19	0.41	0.31	0.029	0.028	0.056	0.028
GT-15	0.15	1.5	0.017	0.34	0.099	3.1	0.035	BDL
GT-16	0.014	0.011	0.015	0.0092	0.0014	0.0011	0.0005	0.0005
GT-17	0.0016	BDL	0.0023	BDL	0.0006	BDL	0.0009	BDL
GT-18*	--	--	BDL	0.0003	--	--	BDL	BDL
GT-19*	--	--	0.51	1.1	--	--	0.078	0.14

Sample	Ethyl benzene				Xylenes			
	Dec.	March	June	Oct.	Dec.	March	June	Oct.
GT-1	0.045	0.047	0.0018	0.11	0.17	0.22	0.0066	0.37
GT-2	0.34	0.24	1.8	0.14	1.3	1.5	7.5	0.59
GT-3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GT-4	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GT-5	4.1	2.1	3.6	4.2	28	16	21	31
GT-6	0.47	0.27	0.29	0.28	0.59	0.27	0.22	0.24
GT-7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GT-8	0.075	0.11	0.0018	0.098	0.052	0.050	BDL	0.049
GT-9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GT-10	0.18	0.14	0.0037	0.18	1.8	1.6	0.033	1.7
GT-11	0.74	0.98	1.1	1.1	2.5	3.5	4.2	3.7
GT-12	0.37	BDL	0.0075	BDL	0.091	BDL	0.035	BDL
GT-13	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GT-14	0.037	0.050	0.15	0.13	0.029	BDL	0.10	0.061
GT-15	0.21	0.96	BDL	0.12	0.69	3.5	BDL	BDL
GT-16	0.0028	0.0029	0.0014	BDL	0.0031	0.0022	BDL	BDL
GT-17	BDL	BDL	0.0047	BDL	0.0018	BDL	0.012	BDL
GT-18*	--	--	BDL	BDL	--	--	BDL	BDL
GT-19*	--	--	0.23	0.45	--	--	0.23	0.56

Table 13 (continued)  
 Laboratory Analysis for Groundwater Samples  
 Volatile Petroleum Compounds and MTBE; Method 602  
 Concentrations in Parts per Million (ppm)

<u>Sample</u>	Total BTEX				TPH			
	<u>Dec.</u>	<u>March</u>	<u>June</u>	<u>Oct.</u>	<u>Dec.</u>	<u>March</u>	<u>June</u>	<u>Oct.</u>
GT-1	3.4	2.6	0.037	1.2	6.0	4.8	0.092	5.4
GT-2	2.1	2.5	12	1.0	7.4	5.9	36	3.8
GT-3	0.0009	BDL	BDL	BDL	0.043	BDL	BDL	BDL
GT-4	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GT-5	38	23	31	45	54	34	44	62
GT-6	2.2	1.2	1.1	1.1	46	13	13	16
GT-7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GT-8	0.24	0.22	0.063	0.27	2.1	1.9	1.4	2.3
GT-9	0.0063	0.0052	0.0065	0.0017	0.0063	0.83	0.76	1.0
GT-10	2.5	2.3	0.045	2.4	9.2	11	0.18	8.7
GT-11	7.2	9.2	10	11	31	28	32	43
GT-12	0.16	0.17	0.20	0.17	11	3.7	4.1	3.7
GT-13	BDL	BDL	BDL	BDL	0.024	BDL	BDL	BDL
GT-14	0.30	0.27	0.72	0.53	5.9	3.1	4.7	4.4
GT-15	1.1	9.1	0.052	0.46	9.0	26	10	4.1
GT-16	0.021	0.017	0.017	0.0097	0.55	0.47	0.43	0.41
GT-17	0.004	BDL	0.020	BDL	0.88	0.073	0.88	0.12
GT-18	--	--	BDL	0.0003	--	--	BDL	0.092
GT-19	--	--	1.0	2.2	--	--	4.1	11

<u>Sample</u>	MTBE***			
	<u>Dec.</u>	<u>March</u>	<u>June</u>	<u>Oct.</u>
GT-1	0.27	0.27	0.0056	0.14
GT-2	0.18	0.050	0.42	0.041
GT-3	BDL	BDL	BDL	BDL
GT-4	BDL	BDL	BDL	BDL
GT-5	0.083	BDL	0.19	BDL
GT-6	0.94	0.98	0.82	0.98
GT-7	BDL	BDL	BDL	BDL
GT-8	0.090	0.031	0.055	0.12
GT-9	3.8	0.81	1.1	1.4
GT-10	1.3	2.9	0.0096	0.13
GT-11	1.8	1.4	0.3	2.0
GT-12	0.12	0.093	0.11	0.16
GT-13	BDL	BDL	BDL	BDL
GT-14	0.28	0.29	0.49	0.22
GT-15	0.48	1.3	BDL	0.23
GT-16	0.0037	0.0017	0.0025	0.0034
GT-17	0.0044	BDL	0.0071	BDL
GT-18	--	--	0.30	BDL
GT-19	--	--	0.35	0.32

Table 13 (continued)  
 Laboratory Analysis for Groundwater Samples  
 Volatile Petroleum Compounds and MTBE; Method 602  
 Concentrations in Parts per Million (ppm)

<u>Sample</u>	<u>Benzene</u>	<u>Toluene</u>	<u>Ethyl Benzene</u>	<u>Xylenes</u>	<u>Total BTEX</u>	<u>TPH**</u>	<u>MTBE***</u>
WW-2	2.5	2.2	1.0	3.8	9.5	20	2.1
WW-3	0.0094	0.0024	0.0043	0.005	0.021	0.200	0.150
WW-4	0.16	0.0079	0.019	0.019	0.21	2.2	0.450
WW-5	BDL	BDL	BDL	BDL	BDL	BDL	BDL
WW-6	BDL	BDL	BDL	BDL	BDL	BDL	BDL
WW-7	0.39	0.024	0.042	0.042	0.6	6.3	0.700

- Notes: BDL = Below Detection Limits  
 \* GT-18 & GT-19 were installed in May 1991  
 \*\* TPH = Total Petroleum Hydrocarbons  
 \*\*\* MTBE = Methyl Tertiary Butyl Ether

Table 14  
 Laboratory Analysis for Groundwater Samples  
 Polynuclear Aromatic Hydrocarbons  
 Method 610  
 Concentrations in Parts per Million (ppm)

<u>Compound</u>	<u>GT-1</u>	<u>GT-2</u>	<u>GT-3</u>	<u>GT-4</u>	<u>GT-5</u>	<u>GT-6</u>
Naphthalene	0.18	0.27	BDL	BDL	0.76	0.07
Acenaphthylene	0.079	BDL	BDL	BDL	BDL	0.093
1-Methylnaphthalene	1.1	0.12	BDL	BDL	0.24	0.23
2-Methylnaphthalene	1.6	0.17	BDL	BDL	0.22	0.053
Acenaphthene	0.23	0.0091	BDL	BDL	BDL	0.020
Fluorene	0.014	0.0029	0.00004	BDL	BDL	0.018
Phenanthrene	1.2	0.014	0.0022	BDL	BDL	0.021
Anthracene	0.14	BDL	BDL	BDL	BDL	0.022
Fluoranthene	0.042	BDL	BDL	BDL	BDL	0.040
Pyrene	0.58	BDL	0.00006	BDL	BDL	0.012
Benzo(a)anthracene	0.0095	BDL	BDL	BDL	BDL	0.031
Chrysene	0.0088	BDL	BDL	BDL	BDL	0.0016
Benzo(b)fluoranthene	0.023	BDL	BDL	BDL	BDL	0.0072
Benzo(k)fluoranthene	BDL	BDL	BDL	BDL	BDL	0.016
Benzo(a)pyrene	BDL	BDL	BDL	BDL	BDL	0.0052
Indeno(1,2,3-cd)pyrene	0.0051	BDL	BDL	BDL	BDL	ND
Dibenzo(a,h)anthracene	0.0012	BDL	BDL	BDL	BDL	ND
Benzo(g,h,i)perylene	0.0036	BDL	BDL	BDL	BDL	0.0042

<u>Compound</u>	<u>GT-7</u>	<u>GT-8</u>	<u>GT-9</u>	<u>GT-10</u>	<u>GT-11</u>	<u>GT-12</u>
Naphthalene	BDL	0.067	BDL	0.25	0.30	0.54
Acenaphthylene	BDL	0.063	BDL	0.0036	0.11	0.22
1-Methylnaphthalene	BDL	0.10	BDL	0.13	0.24	0.79
2-Methylnaphthalene	BDL	0.019	BDL	0.16	0.16	0.097
Acenaphthene	BDL	0.036	BDL	0.0053	0.09	0.049
Fluorene	BDL	0.0075	BDL	BDL	0.023	0.12
Phenanthrene	BDL	0.0049	0.00007	0.011	BDL	0.44
Anthracene	BDL	BDL	BDL	BDL	0.023	0.0084
Fluoranthene	BDL	0.0049	BDL	BDL	0.11	0.01
Pyrene	BDL	0.0026	BDL	0.00005	0.075	0.052
Benzo(a)anthracene	BDL	BDL	BDL	BDL	0.088	0.0029
Chrysene	BDL	0.00003	BDL	BDL	0.033	0.0076
Benzo(b)fluoranthene	BDL	BDL	BDL	BDL	0.033	0.00005
Benzo(k)fluoranthene	BDL	0.0011	BDL	BDL	0.022	0.00003
Benzo(a)pyrene	BDL	0.00004	BDL	BDL	BDL	0.00005
Indeno(1,2,3-cd)pyrene	BDL	BDL	BDL	BDL	BDL	0.00003
Dibenzo(a,h)anthracene	BDL	0.0024	BDL	BDL	0.017	0.00001
Benzo(g,h,i)perylene	BDL	BDL	BDL	BDL	0.0075	0.00004

Table 14 (continued)  
 Laboratory Analysis for Groundwater Samples  
 Polynuclear Aromatic Hydrocarbons  
 Method 610  
 Concentrations in Parts per Million (ppm)

<u>Compound</u>	<u>GT-13</u>	<u>GT-14</u>	<u>GT-15</u>	<u>GT-16</u>	<u>GT-17</u>
Naphthalene	BDL	BDL	0.14	0.013	BDL
Acenaphthylene	BDL	BDL	0.19	0.058	BDL
1-Methylnaphthalene	BDL	BDL	0.085	0.049	BDL
2-Methylnaphthalene	BDL	BDL	0.19	0.016	0.0022
Acenaphthene	BDL	BDL	0.065	0.037	BDL
Fluorene	BDL	0.055	0.031	0.011	0.00005
Phenanthrene	0.00007	0.009	0.018	0.0040	0.0024
Anthracene	BDL	0.008	0.014	0.0042	BDL
Fluoranthene	BDL	0.11	0.06	BDL	0.0003
Pyrene	BDL	0.16	0.038	0.0066	0.0011
Benzo(a)anthracene	BDL	0.13	0.030	0.00007	0.00001
Chrysene	BDL	0.03	0.018	0.001	0.00002
Benzo(b)fluoranthene	BDL	0.011	0.019	0.00003	0.00001
Benzo(k)fluoranthene	BDL	0.028	0.0095	0.00004	0.00006
Benzo(a)pyrene	BDL	BDL	BDL	0.00001	0.00001
Indeno(1,2,3-cd)pyrene	BDL	BDL	0.005	0.00002	0.00002
Dibenzo(a,h)anthracene	BDL	0.0026	0.027	0.00003	BDL
Benzo(g,h,i)perylene	BDL	0.018	0.018	0.00004	0.00001

<u>Compound</u>	<u>WW-2*</u>	<u>WW-3</u>	<u>WW-4</u>	<u>WW-5</u>	<u>WW-6</u>	<u>WW-7</u>
Naphthalene	0.13	BDL	0.018	BDL	BDL	0.081
Acenaphthylene	0.064	BDL	0.036	BDL	BDL	BDL
1-Methylnaphthalene	0.10	BDL	0.028	BDL	BDL	0.074
2-Methylnaphthalene	0.057	BDL	0.0034	BDL	BDL	BDL
Acenaphthene	0.011	BDL	0.019	BDL	BDL	0.054
Fluorene	0.0041	BDL	0.0050	BDL	BDL	0.013
Phenanthrene	0.0054	BDL	0.0013	BDL	BDL	0.0046
Anthracene	0.0050	BDL	BDL	BDL	BDL	BDL
Fluoranthene	0.0091	BDL	BDL	BDL	BDL	0.0028
Pyrene	0.0131	BDL	0.0012	BDL	BDL	BDL
Benzo(a)anthracene	0.0057	BDL	BDL	BDL	BDL	BDL
Chrysene	0.0035	BDL	BDL	BDL	BDL	BDL
Benzo(b)fluoranthene	0.0051	BDL	BDL	BDL	BDL	BDL
Benzo(k)fluoranthene	0.0031	BDL	BDL	BDL	BDL	BDL
Benzo(a)pyrene	0.0018	BDL	BDL	BDL	BDL	BDL
Indeno(1,2,3-cd)pyrene	0.00004	BDL	BDL	BDL	BDL	BDL
Dibenzo(a,h)anthracene	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(g,h,i)perylene	0.00005	BDL	BDL	BDL	BDL	BDL

Notes: \* Groundwater discharge point sample (WW-1 was not analyzed)

Table 15  
 Laboratory Analysis for Groundwater Samples  
 Metals  
 Concentrations in Parts per Million (ppm)

<u>Sample</u>	<u>Arsenic</u>	<u>Cadmium</u>	<u>Chromium</u>	<u>Lead</u>
GT-1	BDL	BDL	BDL	BDL
GT-2	BDL	BDL	BDL	BDL
GT-3	BDL	BDL	BDL	BDL
GT-4	BDL	BDL	BDL	BDL
GT-5	0.011	BDL	BDL	BDL
GT-6	BDL	BDL	BDL	0.0052
GT-7	BDL	BDL	BDL	BDL
GT-8	BDL	BDL	BDL	BDL
GT-9	BDL	BDL	BDL	BDL
GT-10	BDL	BDL	BDL	BDL
GT-11	0.0062	BDL	BDL	BDL
GT-12	BDL	BDL	BDL	BDL
GT-13	BDL	BDL	BDL	BDL
GT-14	BDL	BDL	BDL	BDL
GT-15	BDL	BDL	BDL	0.0088
GT-16	BDL	BDL	BDL	BDL
GT-17	BDL	BDL	BDL	BDL
WW-2*	BDL	BDL	BDL	BDL
WW-3	BDL	BDL	BDL	BDL
WW-4	BDL	BDL	BDL	BDL
WW-5	BDL	BDL	BDL	BDL
WW-6	BDL	BDL	BDL	BDL
WW-7	BDL	BDL	BDL	BDL

Notes: BDL = Below Detection Limits  
 \* Groundwater discharge point samples

Two of the upgradient wells (GT-4 and GT-13) show concentrations for all parameters below detection limits. However, GT-2 and GT-17, which are also located upgradient from Getty and Koch but are located downgradient from the former Exxon terminal, show total hydrocarbon concentrations of 7.4 ppm and 0.88 ppm, respectively. The wells with the highest concentrations of volatile petroleum compounds and PAHs are located less than 1,000 feet from the shoreline of the Fore River.

The analytical results for the groundwater discharge points (seeps) along the shoreline are in Tables 13, 14, and 15. The results show WW-2 (located near the dock area), WW-4, and WW-7 have total hydrocarbon concentrations at 20 ppm, 2.2 ppm, and 6.3 ppm, respectively. All results from WW-5 and WW-6 were below detection limits. Only 3 discharge points (WW-2, WW-4, and WW-7) had detected PAH concentrations, which were at very low concentrations. PAH concentrations in WW-3, WW-5, and WW-6 were all below detection limits. No dissolved metals were detected in any of the discharge point samples.

Results from the QA/QC sample duplicates and rinseate blank samples are summarized in Table 16. The duplicate sample results for all analyses were very similar. The rinseate blanks collected showed no concentrations above detection limits for any compounds, concluding that the bailers were thoroughly cleaned after every use.

The first groundwater discharge point sample collected (WW-1) was not analyzed because it was discovered that it was located adjacent to the oil and water separator discharge and may not show results indicative of the groundwater.

### 3.5 Surface Water Quality

Analytical results from surface water samples collected from the Fore River (SW-1 and SW-2) and Rolling Mills ponds (SW-3 and SW-4) are summarized in Table 17. Total hydrocarbon concentrations ranged from 0.0004 ppm to 0.11 ppm. The total BTEX concentrations ranged from BDL to 0.056 ppm. No metals or PAH compounds were found in any of the surface water samples.

Table 16  
 Laboratory Analysis  
 Quality Assurance/Quality Control - Water Samples  
 Concentrations in Parts per Million (ppm)  
 December 1990  
 Volatile Petroleum Compounds and MTBE

<u>Compound</u>	<u>GT-1</u>	<u>DP-1*</u>	<u>SB-1**</u>	<u>GT-2</u>	<u>DP-2*</u>	<u>SB-2**</u>
Benzene	1.8	1.8	BDL	0.40	0.37	BDL
Toluene	1.4	1.4	BDL	0.055	0.049	BDL
Ethylbenzene	0.045	0.045	BDL	0.34	0.33	BDL
Xylenes	0.17	0.18	BDL	1.3	1.2	BDL
Total BTEX	3.4	3.4	BDL	2.1	1.9	BDL
Total Hydrocarbons	6.0	6.1	BDL	7.4	6.4	BDL
MTBE***	0.27	0.27	BDL	0.18	0.077	BDL

Polynuclear Aromatic Hydrocarbons

<u>Compound</u>	<u>GT-1</u>	<u>DP-1</u>	<u>SB-1</u>	<u>GT-2</u>	<u>DP-2</u>	<u>SB-2</u>
Naphthalene	0.18	0.074	BDL	0.27	0.28	BDL
Acenaphthylene	0.079	0.015	BDL	BDL	BDL	BDL
1-Methylnaphthalene	1.1	0.50	BDL	0.120	0.13	BDL
2-Methylnaphthalene	1.6	0.72	BDL	0.170	0.17	BDL
Acenaphthene	0.23	0.11	BDL	0.0091	BDL	BDL
Fluorene	0.014	0.0063	BDL	0.0029	0.0031	BDL
Phenanthrene	1.2	0.58	BDL	0.014	0.015	BDL
Anthracene	0.14	0.065	BDL	BDL	0.00007	BDL
Fluoranthene	0.042	0.019	BDL	BDL	BDL	BDL
Pyrene	0.58	0.27	BDL	BDL	0.00005	BDL
Benzo(a)anthracene	0.0095	0.0057	BDL	BDL	BDL	BDL
Chrysene	0.0088	0.017	BDL	BDL	BDL	BDL
Benzo(b)fluoranthene	0.023	BDL	BDL	BDL	BDL	BDL
Benzo(k)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(a)pyrene	BDL	BDL	BDL	BDL	BDL	BDL
Indeno(1,2,3-cd)pyrene	0.0051	BDL	BDL	BDL	BDL	BDL
Dibenzo(a,h)anthracene	0.0012	BDL	BDL	BDL	BDL	BDL
Benzo(g,h,i)perylene	0.0036	BDL	BDL	BDL	BDL	BDL

Metals

<u>Compound</u>	<u>GT-1</u>	<u>DP-1</u>	<u>SB-1</u>	<u>GT-2</u>	<u>DP-2</u>	<u>SB-2</u>
Arsenic	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium	BDL	BDL	BDL	BDL	BDL	BDL
Chromium	BDL	BDL	BDL	BDL	BDL	BDL
Lead	BDL	BDL	BDL	BDL	BDL	BDL

Notes: \* DP-1 and DP-2 = Duplicate sample of GT-1 and GT-2  
 \*\* SB-1 and SB-2 = Site Blanks 1 and 2  
 \*\*\* MTBE = Methyl Tertiary Butyl Ether

Table 17  
 Laboratory Analysis for Surface Water Samples  
 Concentrations in Parts per Million (ppm)  
 December 1990

Volatile Petroleum Compounds and MTBE

<u>Compounds</u>	<u>SW-1</u>	<u>SW-2</u>	<u>SW-3</u>	<u>SW-4</u>
Benzene	BDL	0.0014	0.011	0.0004
Toluene	BDL	BDL	0.028	BDL
Ethylbenzene	BDL	BDL	BDL	BDL
Xylenes	BDL	BDL	0.017	BDL
Total BTEX	BDL	0.0014	0.056	0.0004
TPH*	0.014	0.0014	0.11	0.0004
MTBE**	0.0015	0.0050	0.013	BDL

Polynuclear Aromatic Hydrocarbons

<u>Compound</u>	<u>SW-1</u>	<u>SW-2</u>	<u>SW-3</u>	<u>SW-4</u>
Naphthalene	BDL	BDL	BDL	BDL
Acenaphthylene	BDL	BDL	BDL	BDL
1-Methylnaphthalene	BDL	BDL	BDL	BDL
2-Methylnaphthalene	BDL	BDL	BDL	BDL
Acenaphthene	BDL	BDL	BDL	BDL
Fluorene	BDL	BDL	BDL	BDL
Phenanthrene	BDL	BDL	BDL	BDL
Anthracene	BDL	BDL	BDL	BDL
Fluoranthene	BDL	BDL	BDL	BDL
Pyrene	BDL	BDL	BDL	BDL
Benzo(a)anthracene	BDL	BDL	BDL	BDL
Chrysene	BDL	BDL	BDL	BDL
Benzo(b)fluoranthene	BDL	BDL	BDL	BDL
Benzo(k)fluoranthene	BDL	BDL	BDL	BDL
Benzo(a)pyrene	BDL	BDL	BDL	BDL
Indeno(1,2,3-cd)pyrene	BDL	BDL	BDL	BDL
Dibenzo(a,h)anthracene	BDL	BDL	BDL	BDL
Benzo(g,h,i)perylene	BDL	BDL	BDL	BDL

Metals

<u>Compounds</u>	<u>SW-1</u>	<u>SW-2</u>	<u>SW-3</u>	<u>SW-4</u>
Arsenic	BDL	BDL	BDL	BDL
Cadmium	BDL	BDL	BDL	BDL
Chromium	BDL	BDL	BDL	BDL
Lead	BDL	BDL	BDL	BDL

Notes: \*      TPH   = Total Petroleum Hydrocarbons  
 \*\*        MTBE  = Methyl Tertiary Butyl Ether

## 4.0 CONCLUSIONS

The soils encountered during the well installations consisted primarily of laminated sequences of silty sands and sandy silt. The soil analytical results showed that nineteen samples had total BTEX concentrations at or below detection limits. Seven samples had total BTEX concentrations ranging from 1.4 ppm to 140 ppm. Twelve samples had total hydrocarbon concentrations at or below detection limits. Fourteen samples had total hydrocarbon concentrations ranging from 7.4 ppm to 2,400 ppm. The PAH concentrations had a wide range of concentrations for each compound.

Between December 1990 and November 1991, the average low groundwater level was at a depth of 8.3 feet. The average high groundwater level was at a depth of 5.4 feet. The difference between the highest and lowest groundwater levels was at a depth of 2.9 feet. Therefore, the groundwater level fluctuated an average of approximately 3 feet across the facility during the last year. Groundwater contour maps at high and low tides during different seasons show the overall groundwater flow direction is toward the east.

The analytical results from groundwater samples indicated that 10 wells had total BTEX concentrations at or below detection limits over the last year. Nine wells had total BTEX concentrations ranging from 0.037 ppm to 45 ppm. Seven wells had total hydrocarbon concentrations at or below detection limits over the last year. Twelve wells had total hydrocarbon concentrations ranging from 0.092 parts per million (ppm) to 62 ppm. The PAH concentrations had a wide range of concentrations for each compound. Dissolved metals were detected in 4 samples. Lead concentrations ranged from 0.0052 ppm to 0.0088 ppm; arsenic concentrations ranged from 0.0062 ppm to 0.011 ppm.

The average flow rate for the seeps along the shoreline was 0.5 gallons per minute. Only one sample, located near the dock area, showed elevated total hydrocarbon and total BTEX concentrations, which were 20 ppm and 9.5 ppm, respectively.

The surface water samples collected from the Fore River and Rolling Mills ponds showed volatile petroleum compound concentrations at or below detection limits. No PAH compounds or metals were detected in any of the surface water samples.

The tidal survey showed that the tide does not significantly impact groundwater elevations in the monitoring wells or groundwater flow except adjacent to the shoreline.

The results of the hydrogeologic investigation conducted over the last year identified elevated concentrations of dissolved petroleum compounds in the common dock area. A substantial spill, by a former terminal, occurred in the common dock area several years ago. Residual petroleum from this spill is the likely source of the dissolved petroleum.