# REMEDIATION SYSTEM EVALUATION

## GROVELAND WELLS SUPERFUND SITE
## GROVELAND, MASSACHUSETTS


Report of the Remediation System Evaluation,
Site Visit Conducted at the Groveland Wells Superfund Site
April 30 - May 1, 2002

US Army
Corps of Engineers

US Environmental
Protection Agency

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# Groveland Wells Superfund Site
# Groveland, Massachusetts

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# NOTICE

Work described herein was performed by GeoTrans, Inc. (GeoTrans) and the United States Army Corps of Engineers (USACE) for the U.S. Environmental Protection Agency (U.S. EPA). Work conducted by GeoTrans, including preparation of this report, was performed under Dynamac Contract No. 68-C-99-256, Subcontract No. 91517. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

# EXECUTIVE SUMMARY

A Remediation System Evaluation (RSE) involves a team of expert hydrogeologists and engineers, independent of the site, conducting a third-party evaluation of site operations. It is a broad evaluation that considers the goals of the remedy, site conceptual model, above-ground and subsurface performance, and site exit strategy. The evaluation includes reviewing site documents, visiting the site for up to 1.5 days, and compiling a report that includes recommendations to improve the system. Recommendations with cost and cost savings estimates are provided in the following four categories:

- improvements in remedy effectiveness
- reductions in operation and maintenance costs
- technical improvements
- gaining site closeout

The recommendations are intended to help the site team identify opportunities for improvements. In many cases, further analysis of a recommendation, beyond that provided in this report, is required prior to implementation of the recommendation.

The Groveland Wells Superfund site is located in Groveland, Essex County, Massachusetts and has soil and ground water contaminated with trichloroethylene (TCE) and its degradation products. Soil and ground water impacts result from operations and disposal practices associated with screw machine manufacturing at the Valley Manufactured Products facility, which is located at the southern part of the site. An estimated volume of 3,000 gallons of TCE was released into the subsurface. Persistent and elevated concentrations of TCE (as high as 150,000 ug/L) on the Valley Manufactured Products property indicate the presence of a continuing source of ground water contamination. This continuing source likely consists of soil contamination in the vadose zone and perhaps dense non-aqueous phase liquid (DNAPL) below the water table. The current pump and treat system began operation in May 2000. It consists of 10 extraction wells distributed among three primary locations: the source area (3 wells); south and southwest of Mill Pond (2 wells); and north of Mill Pond (5 wells). The extracted ground water (approximately 90 gpm) is pumped to a treatment plant that removes total solids and destroys site-related contaminants on-site with UV/oxidation (UV/OX). Treated water is discharged to Mill Pond.

In general, the RSE team found a well operating system. Of the 23 Fund-lead pump and treat systems visited nationwide by the RSE team to date, this system is among the cleanest and best maintained in the country. The monthly reports provided by the operations contractor and data evaluation reports provided by the oversight contractor are detailed and thorough. The site team is commended for its efforts. The observations and recommendations contained in this report are not intended to imply a deficiency in the work of either the system designers or operators but are offered as constructive suggestions in the best interest of the EPA and the public. These recommendations have the obvious benefit of being formulated based upon operational data unavailable to the original designers.

The RSE team found no major issues regarding the effectiveness of the system to protect human health and the environment but does recommend that the institutional controls be implemented. The RSE team also recommends that extraction be discontinued at several wells.

The RSE team suggests that the site managers evaluate the costs for the current ground water monitoring provided by the oversight contractor. Based on RSE estimates, savings of up to $75,000 may be realized depending on the details of the monitoring program scope and quality assurance requirements.

The RSE team also suggests that substantial cost savings and energy savings can occur by switching from UV/OX to air stripping for treatment of VOCs. Although a capital investment of approximately $300,000 would be required, annual savings of up to $370,000 per year might result due to lower energy usage, substantially reduced labor required to operate the plant, and savings in materials. Savings might be closer to $270,000 per year if continued metals treatment is required; however, the RSE team feels that site managers can successfully negotiate a higher discharge level for arsenic, which would remove the need for metals treatment for a modified system using air stripping.

With respect to improving the potential for site closeout, the RSE teams recommends additional source area characterization to be followed by a limited feasibility study regarding more aggressive source removal options. However, site managers must recognize that complete removal of DNAPL may not be possible if DNAPL is located in the bedrock, and that a permanent pump and treat system may therefore be necessary.

A table summarizing the recommendations, including estimated costs and/or savings associated with those recommendations, is presented in Section 7.0 of this report.

# PREFACE

This report was prepared as part of a project conducted by the United States Environmental Protection Agency (USEPA) Office of Emergency and Remedial Response (OERR) and Technology Innovation Office (TIO). The objective of this project is to conduct Remediation System Evaluations (RSEs) of pump and treat systems at Superfund sites that are "Fund-lead" (i.e., financed by USEPA). The following organizations are implementing this project.

| Organization | Key Contact | Contact Information |
|---|---|---|
| USEPA Office of Emergency and Remedial Response<br>(OERR) | Jennifer Griesert | 1235 Jefferson Davis Hwy, 12th floor<br>Arlington, VA 22202<br>Mail Code 5201G<br>phone: 703-603-8888<br>griesert.jennifer@epa.gov |
| USEPA Technology Innovation Office<br>(USEPA TIO) | Kathy Yager | 11 Technology Drive (ECA/OEME)<br>North Chelmsford, MA 01863<br>phone: 617-918-8362<br>fax: 617-918-8427<br>yager.kathleen@epa.gov |
| GeoTrans, Inc.<br>(Contractor to USEPA TIO) | Doug Sutton | GeoTrans, Inc.<br>2 Paragon Way<br>Freehold, NJ 07728<br>(732) 409-0344<br>Fax: (732) 409-3020<br>dsutton@geotransinc.com |
| Army Corp of Engineers:<br>Hazardous, Toxic, and Radioactive Waste Center of Expertise<br>(USACE HTRW CX) | Dave Becker | 12565 W. Center Road<br>Omaha, NE 68144-3869<br>(402) 697-2655<br>Fax: (402) 691-2673<br>dave.j.becker@nwd02.usace.army.mil |

The project team is grateful for the help provided by the following EPA Project Liaisons.

| | | | |
|---|---|---|---|
| **Region 1** | Darryl Luce and Larry Brill | **Region 6** | Vincent Malott |
| **Region 2** | Diana Cutt and Rob Alvey | **Region 7** | Mary Peterson |
| **Region 3** | Kathy Davies | **Region 8** | Richard Muza |
| **Region 4** | Kay Wischkaemper | **Region 9** | Herb Levine |
| **Region 5** | Dion Novak | **Region 10** | Bernie Zavala |

They were vital in selecting the Fund-lead pump and treat systems to be evaluated and facilitating communication between the project team and the Remedial Project Managers (RPMs).

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# 1.0 INTRODUCTION

## 1.1 PURPOSE

In the *OSWER Directive No. 9200.0-33, Transmittal of Final FY00 - FY01 Superfund Reforms Strategy, dated July 7, 2000*, the Office of Solid Waste and Emergency Response outlined a commitment to optimize Fund-lead pump and treat systems. To fulfill this commitment, the US Environmental Protection Agency (USEPA) Office of Emergency and Remedial Response (OERR) and Technology Innovation Office (TIO), through a nationwide project, is assisting the ten EPA Regions in evaluating their Fund-lead operating pump and treat systems. This nationwide project is a continuation of a demonstration project in which the Fund-lead pump and treat systems in Regions 4 and 5 were screened and two sites from each of the two Regions were evaluated.

In fiscal year (FY) 2001, the nationwide effort identified all Fund-lead pump-and-treat systems in the EPA Regions, collected and reported baseline cost and performance data, and evaluated a total of 20 systems. The site evaluations are conducted by EPA-TIO contractors, GeoTrans, Inc. and the United States Army Corps of Engineers (USACE), using a process called a Remediation System Evaluation (RSE), which was developed by USACE and is documented on the following website:

http://www.environmental.usace.army.mil/library/guide/rsechk/rsechk.html

A RSE involves a team of expert hydrogeologists and engineers, independent of the site, conducting a third-party evaluation of site operations. It is a broad evaluation that considers the goals of the remedy, site conceptual model, above-ground and subsurface performance, and site exit strategy. The evaluation includes reviewing site documents, visiting the site for up to 1.5 days, and compiling a report that includes recommendations to improve the system. Recommendations with cost and cost savings estimates are provided in the following four categories:

- improvements in remedy effectiveness
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The recommendations are intended to help the site team identify opportunities for improvements. In many cases, further analysis of a recommendation, beyond that provided in this report, is required prior to implementation of the recommendation.

In FY 2002, additional RSEs have been commissioned to address sites either recommended by a Region or selected by OERR. The Groveland Wells Superfund Site was cooperatively selected by OERR and EPA Region 1. This site has high operation costs relative to the cost of an RSE and a long projected operating life. This report provides a brief background on the site and current operations, a summary of the observations made during a site visit, and recommendations for changes and additional studies. The cost impacts of the recommendations are also discussed.

## 1.2 TEAM COMPOSITION

The team conducting the RSE consisted of the following individuals:

Dave Becker, Geologist, USACE HTRW CX
Rob Greenwald, Hydrogeologist, GeoTrans, Inc.
Peter Rich, Civil and Environmental Engineer, GeoTrans, Inc.
Doug Sutton, Water Resources Engineer, GeoTrans, Inc.

The RSE team was also accompanied by Kathy Yager from EPA TIO and Peter Soyka from GeoTrans, Inc. Kathy Yager is the principal investigator for the Nationwide Fund-lead Pump and Treat Optimization Project. Peter Soyka is tasked by EPA TIO with leading an energy efficiency analysis effort at long-term Fund-lead Superfund sites.

## 1.3 DOCUMENTS REVIEWED

| Author | Date | Title |
|---|---|---|
| M. Anthony Lally Associates | 4/89 | Draft Final Report, Soil Vapor Vacuum Extraction System Treatability Study, Valley Manufactured Products |
| EPA | 11/15/96 | Final Explanation of Significant Differences, Groveland Wells |
| Metcalf & Eddy | 2/99 | Report of Field Investigations In Support of Ground water Extraction Well Placement, Groveland Wells |
| EPA | 6/28/00 | Preliminary Close Out Report for the Groveland Wells Superfund Site |
| Metcalf & Eddy | 3/01 | Operational and Functional Completion Report, Groveland Wells |
| Metcalf & Eddy | 6/01 | Interim Remedial Action Report, Groveland Wells |
| Falcone Environmental | 6/8/01 | SVE Systems Operations Report, April 2001, Valley Manufactured Products |
| Roy F. Weston | 7/01 | Operations and Maintenance Manual, Groveland Wells |
| Falcone Environmental | 8/6/01 | SVE Systems Operations Report, May 2001, Valley Manufactured Products |
| Falcone Environmental | 8/7/01 | SVE Systems Operations Report, June 2001, Valley Manufactured Products |
| Falcone Environmental | 9/17/01 | SVE Systems Operations Report, July 2001, Valley Manufactured Products |

| Author | Date | Title |
|---|---|---|
| Falcone Environmental | 9/18/01 | SVE Systems Operations Report, August 2001, Valley Manufactured Products |
| Metcalf & Eddy | 9/25/01 | Letter to Nobis including Flow Rate and Run-Time Tables |
| EPA | 9/30/91 | Record of Decision, Groveland Wells |
| EPA | 9/01 | Energy Consumption Report, 9/00 - 9/01 (faxed 2-page document) |
| Metcalf & Eddy | 9/01 | Data Evaluation Report, Groveland Wells, April 2001 Monitoring Round |
| Falcone Environmental | 11/2/01 | SVE Systems Operations Report, September 2001, Valley Manufactured Products |
| Metcalf & Eddy | 12/10/01 - 4/1/02 | Memo's describing routine site visits |
| Falcone Environmental | 1/8/02 | SVE Systems Operations Report, November 2001, Valley Manufactured Products |
| Roy F. Weston | 1/25/02 | November 2001 Monthly Operations Report, Groundwater Extraction and Treatment System, Groveland Wells |
| Roy F. Weston | 4/30/02 | Spreadsheet containing "Table III-1: Process Influent and Effluent Analytical Results, Groundwater Extraction and Treatment System, Groveland Wells", also includes some data from extraction wells |
| Metcalf & Eddy | 4/02 | Data Evaluation Report, Groveland Wells, October 2001 Monitoring Round |

## 1.4 PERSONS CONTACTED

The following individuals associated with the site were present for the site visit:

Warren Diesl, Technical Specialist, Metcalf and Eddy
Derrick Golden, Remedial Project Manager, EPA Region 1
Darryl Luce, Regional Project Liaison, EPA Region 1
Cinthia McLane, Project Manager, Metcalf and Eddy
Rich Mechaber, Project Manager, Nobis
John Moskal, EPA Region 1
Robert Ricard, Plant Operator, Roy F. Weston
Fred Symmes, Project Manager, Roy F. Weston
Janet Waldron, Site Manager, Massachusetts Department of Environmental Protection (MADEP)

## 1.5 SITE LOCATION, HISTORY, AND CHARACTERISTICS

### 1.5.1 LOCATION

The Groveland Wells Superfund site is located in Groveland, Essex County, Massachusetts and has soil and ground water contaminated with trichloroethylene (TCE) and its degradation products. The site encompasses approximately 850 acres and is bounded to the west by Washington Street and the former Haverhill Municipal Landfill, to the north by the Merrimack River, to the south by Salem Street. The site contains a number residential, commercial, and industrial properties including an active sand and gravel operation (Figure 1-1).

In 1979 TCE was detected in two municipal water supply wells (Station No. 1 and Station No. 2) at concentrations exceeding 100 ug/L, and the site was added to the NPL in 1982. An alternate water supply well (Station No. 3) was put into operation in 1979. Station No. 1, which previously pumped 600 gpm for 15-18 hrs per day, was provided with a wellhead treatment system in 1987, and it has operated at a rate of approximately 400 gpm on an as-needed basis since then (it no longer requires the wellhead treatment because VOC concentrations have declined). Station No. 2, which previously pumped 500 gpm in summer months only, is inoperable and there are no plans to restore operations.

Three potential sources of contamination were identified, including the Haverhill Municipal Landfill, the A.W. Chesterton Company, and the Valley Manufactured Products Company. Further investigations revealed that Valley Manufactured Products was the source of the TCE contamination. In 1986, through a Consent Order, DEQE (now DEP) required Valley Manufactured Products to install and operate a pump and treat system, and EPA ordered Valley Manufactured Products to install and operate a soil vapor extraction (SVE) system. The pump and treat system consisted of two wells and a treatment plant with an air stripper located to the north of Mill Pond. It was taken offline in 1999, and the two wells were added to the current Management of Migration (MOM) pump and treat system, which began its first year of operations and maintenance (O&M) in May 2000. The MOM system became officially operational and functional in August 2000. The SVE system installed and operated by Valley Manufactured Products was located at the southern (upgradient) edge of the their property. It pilot tested in 1987-1988, began operation in 1992, and was permanently discontinued in 2002 prior to the RSE site visit.

The RSE team visited the Groveland Wells Superfund Site on April 30 and May 1, 2002 with a primary focus on the MOM pump and treat system. Because the soil contamination is inextricably linked to ground water contamination, the RSE team has also reviewed documents associated with the previous SVE system operation at Valley Manufactured Products. This RSE report summarizes the findings made by the RSE team with respect to the MOM pump and treat system and provides recommendations for both the pump and treat system and potential remedial activity in the source area.

### 1.5.2 POTENTIAL SOURCES

Soil and ground water TCE contamination results from operations and disposal practices associated with screw machine manufacturing at the Valley Manufactured Products facility, which is located at the southern part of the site. Because that 1.5 acre property was previously owned by the Groveland Resources Company (GRC), it is referred to as the “Valley/GRC” property in many site documents and this RSE report. Operations at the facility began in 1963, and TCE was used as a vapor degreaser between 1963 and 1979. Methylene chloride replaced TCE as the degreaser from 1979 to 1983, and a detergent-type degreaser replaced the methylene chloride after 1983. An estimated volume of 3,000 gallons of TCE was released into the subsurface. Some of the TCE releases were associated with discharge of cutting oils onto ground surface, use of solvents as a defoliant, a release of at least 500 gallons of pure TCE from a from an underground tank, and releases to a floor drain that was not connected to a separator or a leachfield.

Persistent and elevated concentrations of TCE (as high as 150,000 ug/L) on the Valley/GRC property indicate the presence of a continuing source of ground water contamination. This continuing source likely consists of soil contamination in the vadose zone and perhaps dense non-aqueous phase liquid (DNAPL) below the water table. Minor dechlorination of TCE provides a source of cis-1,2-dichloroethylene (cis-1,2- DCE). However, the concentrations of cis-1,2-DCE are at least an order of magnitude lower in concentration than the TCE, and further dechlorination to vinyl chloride or ethene has not been observed from ground water sampling.

### 1.5.3 HYDROGEOLOGIC SETTING

Ground water flows north through the site and ultimately discharges to the Merrimack River approximately three quarters of a mile to the north. As depicted in Figure 1-1, Johnson Creek flows north through the site and discharges to the Merrimack River at the northern edge of the site. A portion of Johnson Creek is dammed, forming Mill Pond.

The site is underlain by glacially derived unconsolidated sediments that overlie fractured phyllite bedrock. A geological cross-section from north to south is provided in Figure 1-2. The surface elevation, bedrock elevation, and water table elevation all slope downward to the north. Land surface elevation near the source area is approximately 70 feet above mean sea level (MSL), decreases to approximately 30 feet MSL near Mill Pond, and decreases to below 20 feet MSL near the Merrimack River. The bedrock elevation is approximately 25 feet MSL near the source area and is as much as 50 feet lower beneath Mill Pond. Ground water is present in both the overburden and the bedrock throughout the site. Near the source area ground water is approximately 35 to 40 feet below ground surface, and south of Mill Pond it is approximately 10 feet below ground surface.

Ground water levels and TCE concentrations in October 1991 are illustrated in Figures 1-3 to 1-5 for the shallow overburden, deep overburden, and bedrock, respectively. The conceptual model (supported by water level data and ground water monitoring data) suggests that contamination in the source area flows through both the overburden and bedrock. In the source area, vertical gradients are likely downward under natural conditions, but pumping associated with the remedy (which occurs in both the bedrock and the overburden near the source area) may locally create upward gradients. Beneath Mill Pond, the contaminated water from the bedrock discharges to the overburden where the bedrock decreases in elevation. Some impacted water might enter Mill Pond from the overburden on the southern (upgradient) end. Water from Mill Pond discharges to both Johnson Creek and ground water at the northern end. Constituent concentrations in water in Mill Pond have been below the freshwater Ambient Water Quality Criteria since the remedial investigation. Just north of Mill Pond, remediation pumping occurs in the deep overburden, and there is a downward gradient within the overburden. Water level data taken in October 2001 from DEQE-13S and DEQE-13D, which are located immediately west of the pumping, also indicates potential for downward flow to the bedrock immediately north of Mill Pond. Far north of Mill Pond, however, ground water likely discharges from the bedrock to the overburden, and ultimately discharges to the Merrimack River.

Historically, pumping from the municipal water supply wells (Stations No. 1 and 2), which are located between Mill Pond and the Merrimack River, increased the rate of ground water flow to the north from the source area. Pumping at these wells was largely discontinued after contamination was discovered (only Station No. 1 has intermittently pumped since 1987), and the replacement well (Station No. 3) is located far to the north of these wells. Therefore, extraction from these municipal wells, which was partially responsible for expediting the transport of contamination from the source area, has substantially decreased, thereby reducing the magnitude of ground water flow and contaminant transport to the north from the site.

### 1.5.4 DESCRIPTION OF GROUND WATER PLUME

At the time of the ROD in 1991 the ground water plume extended from the source area to the north beyond Main Street and Municipal Supply Well 2. Originally, the pump and treat system was planned to extract 400 gpm, with a treatment plant to be built near Station No. 2 (far to the north of the present-day treatment plant). However, construction was delayed, and by 1996 sampling indicated that the plume extent had substantially diminished to the north. Therefore, the system was redesigned to extract only the more highly impacted ground water near Mill Pond and to the south. This resulted in a reduced extraction rate, and the treatment plant was ultimately located adjacent to the source area. An ESD associated with these changes was issued in September 1996.

A brief description of TCE contamination in three general site areas (source area, between source area and Mill Pond, and north of Mill Pond) is provided below.

Source Area

Both the overburden and bedrock are impacted by TCE in the source area. In October 2001, a maximum concentration of 150,000 ug/l was detected in well TW-17, an overburden monitoring well located near the source area. Concentrations have been consistently greater than 1,000 ug/l at that well since 1998. Extraction wells EW-S1 and EW-S2, which screen the overburden and bedrock and are also located near the source area, had TCE concentrations exceeding 10,000 ppb in June 2001. Extraction well EW-S3, which also screens the overburden and bedrock and is located adjacent to EW-S1 and EW-S2, has much lower TCE concentrations (approximately 100 ug/l), which suggests that it not only lies outside of the plume but is also not pulling contamination toward it.

Between Source Area and Mill Pond

Between the source area and Mill Pond, ground water in both the overburden and bedrock is contaminated. Downgradient of the source area, TCE concentrations between 10 ug/l and 100 ug/l are typical. However, at extraction wells EW-S4 and EW-S5, bedrock wells located just south of Mill Pond, TCE concentrations are higher (approximately 500 ug/l in June 2001).

North of Mill Pond

The October 2001 sampling event indicates that TCE samples taken north of Main Street are below the interim cleanup level of 5 ug/L. Therefore, the reduction of plume extent noted in 1996, relative to the original plume extent, has remained. In October 2001, the furthest downgradient sampled wells with TCE concentrations above drinking water standards were ERT-9 and ERT-13. These wells are located approximately 200 feet north (downgradient) of Mill Pond, and approximately 1,000 feet south (upgradient) of Main Street. ERT-9 screens the bedrock and had a TCE concentration of 17 ug/L. ERT-13 screens the deep overburden and had a TCE concentration of 30 ug/L. TCE concentrations are typically on the order of 5 to 100 ug/l north of Mill Pond. Concentrations above cleanup standards may exist further to the north, but site managers expect that contamination to attenuate before reaching receptors.

# 2.0 SYSTEM DESCRIPTION

## 2.1 SYSTEM OVERVIEW

The MOM pump and treat system began operation in May 2000. It consists of 10 extraction wells distributed among three primary locations: the source area (3 wells); south and southwest of Mill Pond (2 wells); and north of Mill Pond (5 wells). The extracted ground water is pumped to a treatment plant that removes total solids and destroys site-related contaminants on-site with UV/oxidation (UV/OX). A total of approximately 90 gpm is pumped from the 10 wells with recent influent concentration of less than 350 ppb (measured within the treatment plant) for TCE and cis-1,2-DCE. These parameters translate to the following approximate chemical loading rate due to TCE and cis-1,2-DCE:

$$\frac{90\ \text{gal.}}{\text{min.}} \times \frac{3.785\ \text{L}}{\text{gal.}} \times \frac{350\ \text{ug.}}{\text{L}} \times \frac{1440\ \text{min.}}{\text{day}} \times \frac{2.2\ \text{lbs.}}{1\times 10^{9}\ \text{ug}} = \frac{0.38\ \text{lbs.}}{\text{day}}$$

## 2.2 EXTRACTION SYSTEM

Locations and rates for the 10 extraction wells are presented in the following table along with calculations of “pounds per day” and “% of mass removed”. The extraction rates (June 2001) and TCE concentrations (October 2001) are from different points in time, so the calculated TCE influent concentration and “total pounds per day” deviate slightly from the values presented in Section 2.1.

| Extraction Well | Location | Formation Screened | Extraction Rate (gpm)[1] | TCE Conc. (ug/L)[2] | Pounds Per Day (lbs/day) | % of mass removed |
|---|---|---|---|---|---|---|
| EW-S1 | source area | OB & BR | 1.9 | 15,000 | 0.342 | 70.7% |
| EW-S2 | source area | OB & BR | 0.43 | 11,000 | 0.057 | 11.7% |
| EW-S3 | source area | OB & BR | 0.49 | 100 | 0.001 | 0.1% |
| EW-S4 | south of Mill Pond | BR | 5.3 | 490 | 0.031 | 6.4% |
| EW-S5[3] | south of Mill Pond | BR | 1.7 | 440 | 0.009 | 1.9% |
| EW-M1 | north of Mill Pond | OB | 30.3 | 110 | 0.040 | 8.3% |
| EW-M2 | north of Mill Pond | OB | 33.4 | 8 | 0.003 | 0.7% |
| EW-M3[3] | north of Mill Pond | BR | 1.5 | 39 | 0.001 | 0.1% |
| G-1 | north of Mill Pond | OB | 5.3[4] | 0.2U | 0 | 0.0% |
| G-2 | north of Mill Pond | OB | 8.9[4] | 4 | 0.0004 | 0.1% |
| | | **Plant Influent** | **~90** | **~450** | **0.48** | |

[1] Obtained from the October 2001 Data Evaluation Report
[2] Obtained from the June 2001 extraction and treatment system monitoring data
[3] Converted monitoring wells with extraction provided by pneumatic piston pumps
[4] Existing wells from the former Valley/GRC pump and treat system.

The majority of mass (more than 80%) is being removed by wells EW-S1 and EW-S2, located near the source area. At the time of the RSE, Well G-1 had been shutdown due to low concentrations and a failed pump. Pumping from G-1 will likely be discontinued indefinitely and pumping from G-2 may be discontinued in the near future.

Extracted ground water from each of the three locations is pumped from the extraction wells through a common double contained HDPE header to the treatment plant.

## 2.3 TREATMENT SYSTEM

The treatment plant was designed for a capacity of 150 gpm and a design influent TCE concentration of 12,300 ug/L. A table summarizing the design criteria, actual concentrations (which are much lower than design concentrations for TCE), and discharge limits is presented in Section 3.2 of this report.

The treatment plant consists of the following components for treatment of the extracted ground water:

- equalization/influent tank (hydrogen peroxide is added to oxidize the metals)
- rapid mix and flocculation tanks (polymer is no longer required)
- slant plate pack clarifier
- filter feed tank
- 3 parallel multimedia filters
- hydrogen peroxide addition
- 4 UV/OX units (only 2 are used)
- catalytic carbon unit
- effluent tank

In addition, a sludge thickening tank, sludge holding tank, and filter press (not used to date) are present for accommodating any sludge generated from the oxidation of metals in the plant influent. Two vapor phase granular activated carbon (GAC) units are arranged in series to treat the vapors from the process tanks.

## 2.4 MONITORING PROGRAM

Monitoring is separated into two components:

- monitoring of the ground water plume at monitoring wells

- monitoring of the extraction and treatment systems at the extraction wells and process points.

Samples for VOCs and metals are sent to an offsite, independent lab with a limited number of split samples sent to the Contract Lab Program for quality assurance/control. Arsenic analysis must be conducted at selected laboratories with specialized equipment due to the extremely low detection limit required by the discharge limit (below 0.75 ug/L).

The ground water monitoring program has been optimized since its inception in 1998. At the time of the RSE, the ground water monitoring program consisted of collecting samples from 21 monitoring wells each October and a subset of 10 wells collected each April. Low-flow sampling is used for all of the wells except for a few that are too deep (where bailers are used). The samples are analyzed for VOCs. Synoptic ground water elevations are also collected during the sampling events. Data evaluation reports are generated for each sampling event and include updated plume maps and potentiometric surfaces.

The extraction and treatment system monitoring consists of samples taken quarterly from the extraction wells and analyzed for VOCs and metals. The acute toxicity of the effluent and VOC concentrations at three points along the vapor GAC units (influent, between the two units, and effluent) are also measured quarterly. The treatment plant influent and effluent are sampled monthly for VOCs and metals. On a weekly basis, turbidity, pH, iron, and hydrogen peroxide are measured at up to 13 points within the treatment process train. These measurements are obtained through the use of sensors or test kits. A VOC analyzer automatically samples and analyzes plant effluent hourly.

# 3.0 SYSTEM OBJECTIVES, PERFORMANCE AND CLOSURE CRITERIA

## 3.1 CURRENT SYSTEM OBJECTIVES AND CLOSURE CRITERIA

The goal of the MOM remedial action is to restore ground water to beneficial use, because the aquifer beneath the site is a source of drinking water for the town. For TCE the drinking water standard is 5 ug/L and for cis-1,2-DCE that standard is 70 ug/L. The 1991 ROD for the MOM remedy assumed that an additional pump and treat system would be designed, installed, and operated by Valley/GRC on the Valley/GRC property. Therefore, the 1991 ROD originally intended the MOM remedy to address the downgradient plume and not source area contamination. A 1996 Explanation of Significant Differences (ESD) specified that on-site pumping from the source area would occur and that the extracted water would be treated by the MOM treatment plant because building an additional treatment plant would not be warranted given the low yield expected from the source area wells.

## 3.2 TREATMENT PLANT OPERATION GOALS

Both the 1991 ROD and the 1996 ESD highlight on-site destruction of contaminants as a benefit of the UV/OX technology. Given that cost estimates in the ROD were similar for air stripping and UV/OX, the latter technology was selected for the remedy. Treated ground water is discharged to Mill Pond. The maximum design influent concentrations, actual influent concentrations, interim ground water cleanup levels, and surface water discharge limits for selected VOCs and metals are summarized in the following table.

| Parameter | Maximum Influent Design Basis (unfiltered/filtered) (ug/L) | August 2001 Plant Influent (ug/L) | ROD Interim Ground water Cleanup Level (ug/L) | Average Monthly Surface Water/Mill Pond Discharge Limits (ug/L) |
|---|---|---|---|---|
| **Volatile Organic Compounds (VOCs)** | | | | |
| Vinyl Chloride | ND | 0.2U | 2 | 2,816 |
| 1,2 DCE (cis & trans) | 2,800 | 18 | 70 | 172 |
| TCE | 12,300 | 260 | 5 | 434 |
| **Metals** | | | | |
| Arsenic | 22/ND | 4.8 | 50 | 0.75 |
| Barium | 17/14 | 13.4 | 1,000 | 5,400 |
| Cadmium | ND/ND | 0.095J | 5 | 2 |
| Iron | 7,400/1,390 | 2,030 | None | Not listed |
| Manganese | 2,700/2,770 | 895 | None | Not listed |
| Nickel | 10/12 | 8.6B | 100 | 100 |
| Zinc | ND/7.8 | 21.2J[2] | None | Not listed |

Based on the influent concentrations from August, which are representative of the influent concentrations in the latter half of 2001, the influent concentrations to the treatment plant meet all discharge criteria without treatment, except arsenic. However, the O&M contract requires 95% removal of contamination.

# 4.0 FINDINGS AND OBSERVATIONS FROM THE RSE SITE VISIT

## 4.1 FINDINGS

The RSE team found an extremely well-operated and maintained ground water extraction and treatment facility. Of the 23 Fund-lead pump and treat systems visited nationwide by the RSE team to date, this system is among the cleanest and best maintained in the country. The monthly reports provided by the operations contractor and data evaluation reports provided by the oversight contractor are detailed and thorough. The site team is commended for its efforts. The observations provided below are not intended to imply a deficiency in the work of the system designers, system operators, or site managers but are offered as constructive suggestions in the best interest of the EPA and the public. These observations obviously have the benefit of being formulated based upon operational data unavailable to the original designers. Furthermore, it is likely that site conditions and general knowledge of ground water remediation have changed over time.

## 4.2 SUBSURFACE PERFORMANCE AND RESPONSE

### 4.2.1 WATER LEVELS

The site team uses water levels for interpreting ground water flow as well as for determining the yield and influence of ground water extraction wells. The October 2001 Data Evaluation Report provides independent potentiometric surfaces for the shallow overburden, deep overburden, and bedrock. The water levels confirm a downward gradient in the source area and that ground water in the overburden and bedrock flows northeast from the source area toward Mill Pond where ground water then discharges from bedrock to the overburden. Ground water in both the overburden and bedrock flows to the north beneath Mill Pond and continues toward the Merrimack River. Ground water levels suggest discharge from the bedrock to the overburden between Mill Pond and the river.

### 4.2.2 CAPTURE ZONES

According to the Interim Remedial Action Report (Metcalf & Eddy, June 2001) the extraction wells in the source area and immediately south of Mill Pond were intended to remove highly contaminated ground water. According to the report complete capture at those locations was not a design goal. However, the wells downgradient of Mill Pond were designed to capture the plume to the greatest extent possible.

The October 2001 Data Evaluation Report states that the limited number and position of monitoring wells in the source area and the area south of Mill Pond do not allow for a capture zone analysis based on potentiometric surfaces. EW-S1, EW-S2, and EW-S3 are located adjacent to each other in the source area and screen a thin layer of overburden and fractured bedrock. The yield from EW-S1, which is located between the other two wells, is twice that of the combined extraction rate of the other two wells. Modification of the EW-S1 extraction rate has no effect on the other two wells, suggesting that the majority of extracted water from these wells comes from the bedrock and that the wells may intercept independent fractures.

Capture zone analyses based on potentiometric surfaces are, however, conducted downgradient of the pond in both the shallow and deep overburden. These analyses suggest that contamination traveling in the overburden from areas upgradient is captured by EW-M1, EW-M2, G-1, and G-2. Note that EW-M1 and EW-M2 each pump 30-35 gpm, whereas G1 and G2 (when operating) each pump less than 10 gpm. In the Interim Remedial Action Report it was concluded that discontinuation of pumping at G-1 did not adversely impact capture. EW-M3 is located in the bedrock to the west and has an extraction rate of approximately 1.5 gpm. It does not likely contribute to capture in the overburden. EW-M3 probably does not provide complete capture in the bedrock but does offer limited mass removal.

Monitoring wells ERT-11, ERT-13, and ERT-9 are located downgradient of the most downgradient extraction wells (EW-M1, EW-M2, EW-M3, G-1, and G-2), and sampling of these monitoring wells provides additional information about the extent of ground water plume capture. ERT-11 (shallow overburden) has contaminant concentrations well below cleanup standards, and in October 2001 ERT-13 (deep overburden) and ERT-9 (bedrock) show TCE concentrations of 30 ug/l and 17 ug/L, respectively. The TCE concentration in both ERT-13 and ERT-9 have decreased substantially since the beginning of monitoring in April 1998. The TCE 1998 concentration in ERT-13 was 170 ug/L and the 1998 TCE concentration in ERT-9 was estimated at 110 ug/L. These decreasing concentrations in concert with the evaluation of the potentiometric surfaces suggest adequate capture is achieved. Over time, the remaining downgradient TCE and DCE concentrations are expected to decline to levels below cleanup standards. Decreases in contaminant concentrations in monitoring wells upgradient of these downgradient monitoring wells also suggest that extraction wells EW-S4 and EW-S5, located south of Mill Pond, are providing some capture of contaminants south (upgradient) of Mill Pond.

### 4.2.3 CONTAMINANT LEVELS

Contaminant levels in the source area persist at concentrations over 10,000 ug/L TCE (and at times over 100,000 ug/L TCE), suggesting the presence of a continuing source of ground water contamination. This source might be DNAPL or contamination of soils in the vadose zone. Concentrations decrease substantially between the source area and the well cluster (EW-S4 and EW-S5) at the southern edge of Mill Pond. The transport of contaminants in this area also appears to be limited to the overburden and the upper reaches of the weathered bedrock, though this vertical limit of contamination is difficult to confirm without additional bedrock monitoring wells.

Contaminant levels at the southern (upgradient) edge of Mill Pond have decreased over time. For instance, overburden monitoring wells DEQE-7 and DEQE-8 showed declines in TCE concentrations of several orders of magnitude, to concentrations of less than 10 ug/l, from 1999 through 2001. TCE concentrations in extraction well EW-S4 have decreased from 3,100 ug/L in April 2000 to 490 ug/L in June 2001, and TCE concentrations in extraction well EW-S5 have decreased from 6,600 ug/L in April 2000 to 440 ug/L in June 2001. Similar decreases in TCE concentration have also been apparent in monitoring wells TW-12 and TW-24, bedrock monitoring wells located between these two extraction wells and the source area extraction wells. TCE concentrations in TW-12 and TW-24 have decreased from a maximum of 2,800 ug/L and an estimated 16,000 ug/L (during 1998/1999) to concentrations of 80 ug/L and 140 ug/L, respectively, in October 2001. These decreases in concentration suggest that the source area wells are significantly reducing the downgradient migration of TCE. The fact that the concentrations in EW-S4 and EW-S5 have remained higher than the upgradient monitoring wells (TW-12 and TW-24), however, suggests that significant TCE concentrations still reside downgradient of the source area. The extraction wells could be pulling contamination from the overburden or bedrock fractures that are not intercepted by TW-12 and TW-24.

To the north (downgradient) of Mill Pond, concentrations have been decreasing in both monitoring and extraction wells. The decreases in ERT-9 and ERT-13, discussed earlier, are likely due to upgradient plume capture provided by the extraction wells in this area. Concentrations in M&E-10D and M&E-20D, which are located upgradient of the extraction wells in this area and screen the deep overburden, have also decreased, suggesting that contaminant migration from upgradient has decreased.

Therefore, substantial progress has been made in reducing concentrations in the plume, and capture of contaminants is likely adequate. As cleanup progresses in the wells on the northern and southern edges of Mill Pond, these wells may eventually be shut down, reducing the amount of ground water extraction. Wells in these areas will need further monitoring to ensure cleanup levels are maintained and that rebounding does not occur. It is possible that cleanup levels in these areas could be reached prior to transferring the site to the State. However, the persistently high concentrations in the source area suggest that a continuing source of ground water contamination is present, which will likely require pump and treat to continue indefinitely if more aggressive source removal is not attempted.

## 4.3 COMPONENT PERFORMANCE

### 4.3.1 EXTRACTION SYSTEM WELLS, PUMPS, AND HEADER

The extraction system consists of 10 extraction wells distributed in three areas. The wells in each area are powered by remote above-ground panels. Control signals between the wells and the plant are transmitted via phone lines with a modem for wells north of Mill Pond; the other wells are directly connected to the plant by control wire. All wells except for EW-S5 and EW-M3 have Grundfos electric submersible pumps and the pumps are throttled to maintain a relatively constant flow rate and to minimize cycling. Extracted ground water is pumped through a common double-contained header to the treatment plant. The double-contained piping was required by the municipality because the piping would extend through uncontaminated areas. The leak detection system for the header functions as intended. The piping is cleaned three times per year to mitigate fouling, and some of the extraction well pumps are cleaned on a regular basis.

Extraction wells G-1 and G-2, which are located downgradient of Mill Pond in the shallow overburden, were part of an existing pump and treat system operated by Valley/GRC. That system was discontinued and these two wells were tied into the MOM pump and treat system. These wells have iron and arsenic concentrations that are generally higher than the iron and arsenic concentrations of the other extraction wells. These two wells also have extensive iron fouling of the pumps, and G-1 was recently shutdown due to pump failure. Pumping from this well will likely be discontinued permanently. Pumping from G-2 will also likely be discontinued in 2002. Concentrations in both wells are below cleanup levels and capture is likely provided by EW-M1 and EW-M2.

Extraction wells EW-S5 and EW-M3 are converted 2-inch monitoring wells that are operated with Blackhawk piston pumps. The wells are too small in diameter to use submersible pumps and too deep to use vacuum pumps. The piston pumps require frequent maintenance and are checked by the operator on a daily basis to drain condensate from the compressor for the pneumatic pumps. There is a weekly and monthly maintenance schedule for the 5 horsepower motor and air dryer required by each pump. Parts frequently need replacement.

Extraction wells EW-S1, EW-S2, EW-S3, EW-M1, and EW-M2 were all installed as part of the MOM remedy and the pumps have experienced limited problems with fouling. The wells are sampled for iron with Hach test kits and the pumps are cleaned regularly. The steel drop tubes in EW-S1, EW-S2, and

EW-S3 corroded and were replaced by polyethylene pipe. EW-S4 was shutdown at the time of the RSE due to pump failure. A higher flow rate could be achieved from this well if a larger pump were to be used, which the site team is considering.

#### 4.3.2 EQUALIZATION/INFLUENT TANK

The extracted ground water flows from the header to an 8,000 gallon equalization tank. A 5 ppm solution of hydrogen peroxide is added and mixed in this tank to oxidize metals. One of two parallel 3 horsepower pumps with variable frequency drives transports water from the equalization tank to the metals removal system. Pumping is alternated between the two pumps on a weekly basis. The piping between these two components and throughout the plant are 304 stainless steel, which was substituted for the HDPE specified in the design for no increase in price.

#### 4.3.3 METALS REMOVAL SYSTEM

The metals removal system consists of a rapid-mix tank, a flocculation tank, and a clarifier. Polymer is no longer necessary and is not added. The polymer metering pump is run once a week to keep it operational. From the clarifier the process water drains by gravity to the filter feed tank. One of two parallel double diaphragm sludge pumps transports settled solids from the clarifier to the sludge thickening tank.

#### 4.3.4 MULTIMEDIA FILTERS

A 15 horsepower filter feed pump pushes water through three US Filter multimedia filters arranged in parallel. Each filter has a capacity of 75 gpm. The site operator manually backwashes the filters sequentially once a month with water from the effluent tank at a rate of 400 gpm. If the backwash frequency were to increase for any reason, or if operator labor was reduced, backwashing could be accomplished automatically.

The multimedia filters remove most of the iron. Typically the plant influent concentration for iron is 2.1 ppm, the effluent from the clarifier is 1.9 ppm, and the effluent from the filters is 0.02 ppm. The clarifier was taken offline prior to the RSE to be repainted, and while it is offline the filters are backwashed twice a month.

#### 4.3.5 UV/OXIDATION UNITS

The original operating conditions of the Rayox 30-4 UV/OX system included addition of a 50 ppm hydrogen peroxide solution and operation of four UV reactors, each with a 30 kilowatt lamp. However, due to lower than expected influent concentrations, these original conditions were modified in June 2000, approximately one month after the plant began operating. The modified conditions include addition of a 25 ppm hydrogen peroxide solution and operation of two UV reactors. This modification has therefore led to savings in both chemical and electricity usage. The modified system effectively destroys the organic contaminants, and a further reduction to one reactor might occur by the end of Fiscal Year 2002.

Maintenance of the UV/OX unit includes replacing a seal on a self-cleaning device for the lamps at a cost of $250 per seal and replacing the lamps after 3,000 hours of operation (i.e., once every four months) at a cost of $2,500 per lamp. Therefore, maintenance of the UV/OX unit alone requires approximately $15,500 per year in replacement parts (six lamps and two seals per year).

### 4.3.6 CATALYTIC CARBON UNIT

After the UV/OX system, the process water contains residual hydrogen peroxide at a concentration of approximately 15 ppm that is reduced to 2 ppm by a single catalytic carbon unit positioned between the UV/OX system and the effluent tank. The catalytic carbon unit contains 3,000 pounds of carbon and is rated for approximately 150 gpm. Over time the carbon in this unit solidifies due to mineral scaling, and channeling results. The O&M contract specifies that the carbon in this unit should be changed on an annual basis though the unit would remain effective with less frequent carbon replacement. The carbon will be replaced during Summer of 2002 for the first time since operation began in May 2000.

### 4.3.7 EFFLUENT TANK AND DISCHARGE

Process water from the catalytic carbon unit flows to a 5,600 gallon effluent tank. Water continuously discharges by gravity from the effluent tank to Mill Pond but is recycled to the head of the plant for further treatment if two consecutive hourly measurements from the VOC analyzer do not meet the discharge limits. The VOC analyzer is calibrated once a week to maintain accuracy, and the alarm is set for 75% of the discharge limit.

The effluent tank is kept full to provide water for backwashing the multimedia filters. Two 20 horsepower pumps provide a backwash flow of 400 to 425 gpm, and the backwash effluent is sent to a 10,600 gallon decant tank. Backwashing is conducted manually once per month though timers are installed to automate the process if more frequent backwashing is required.

### 4.3.8 SLUDGE HANDLING TANKS AND EQUIPMENT

Solids from backwashing and from the clarifier are sent to a 12,500 gallon sludge-thickening tank. The thickened sludge is then sent to a 4,000 gallon sludge holding tank. Approximately 2,000 gallons of thickened sludge have been produced since the beginning of operation. A filter press with a capacity of 34 cubic feet is present on site. If used, filtrate from press operations would be sent to a 4,000 gallon decant tank. However, in two years of operation the filter press had not been used. At the time of the RSE site visit, the site managers were beginning a cost-benefit analysis to determine if it would be more cost-effective to transport the thickened wet sludge off-site or to invest in the additional labor for sludge handling and cleanup associated with filter press operations.

### 4.3.9 VAPOR PHASE CARBON UNITS

Two 1,000 pound vapor phase carbon units are aligned in series to treat VOC-laden air from the head space of the influent, filter feed, and decant tanks as well as the clarifier. The influent, midpoint, and effluent of the vapor phase carbon units is monitored on a quarterly basis. The carbon in the lead vessel is changed out every quarter based a calculated time to breakthrough for TCE and DCE assuming a 25% volatilization estimate and usage calculations done during initial operation. Vinyl chloride discharge is not considered for carbon replacement. Contaminant loading has declined since initial operations.

### 4.3.10 VOC ANALYZER

A VOC analyzer that consists of a sampling/purge module, a gas chromatograph, and a dedicated laptop computer samples the process water in the effluent tank on an hourly basis. The unit is calibrated weekly and requires 20 minutes per calibration. If concentrations of PCE, TCE, 1,2 DCE, or 1,1,1 TCA exceed 75% of the discharge limit for two consecutive samples, then process water in the effluent tank is redirected to the head of the plant.

## 4.4 Components or Processes that Account for Majority of Monthly Costs

Approximately $3.8 million is allotted for oversight and site O&M for the current 5-year contract. If all of this money is spent, then this allotment translates to approximately $760,000 per year in costs. These costs are split between the oversight RAC oversight contractor (Metcalf and Eddy) and the O&M subcontractor (Nobis). Nobis then subcontracts O&M to a third contractor (Roy F. Weston). Of the $760,000 budgeted per year, approximately $473,000 per year goes to Nobis and their subcontractor for O&M of the extraction system and treatment plant. Additional funding is set aside for non-routine maintenance and waste disposal. The remaining funds are allocated for the oversight contractor that handles reporting, community relations, and annual evaluations. Because of the fixed-price nature of the contracts, specific breakdowns of all of the site costs were not available to the RSE team. The following table provides an approximate breakdown of the costs. Those costs that were provided by the site team are included in the table, and the remaining costs are estimated by the RSE team. Sections 4.4.1 through 4.4.4 explain the assumptions used in arriving at these estimates.

| Item Description | Estimated Cost |
|---|---|
| **Metcalf & Eddy** | |
| Labor: oversight, project management, reporting, and fee | $75,000 |
| Ground water sampling and chemical analysis | $142,000* |
| **Subtotal** | **$217,000** |
| **Nobis & Roy F. Weston** | |
| Project management, engineering, support staff, and fee | $70,000 |
| Labor: plant operators (60 hours/week, assumed rate of approximately $70/hour) | $220,000 |
| Utilities: Electricity | $67,000 |
| Utilities: Gas | $6,000 |
| Non-utility consumables (UV lamps, catalytic carbon, vapor phase GAC, hydrogen peroxide, miscellaneous parts) | $70,000 |
| Chemical Analysis | $40,000* |
| **Subtotal** | **$473,000*** |
| **Other Costs** | |
| Non-routine maintenance | $50,000* |
| Waste disposal | $20,000 |
| **Subtotal** | **$70,000** |
| **Total Allocation** | **$760,000*** |

*Notes: The total cost ($760,000) and the subcontractor subtotal cost ($473,000) were provided by the site managers. Those costs marked with an (*) were provided. All other costs are estimated by the RSE team.*

Correspondence from the RPM subsequent to the RSE site visit indicated that only $10,000 per year of the $50,000 per year for non-routine maintenance is typically used and that the waste disposal costs have not been used. Therefore, although $760,000 is allocated for O&M each year, approximately $60,000 per year is likely not spent. Approximately $700,000 per year is more accurate estimate of annual costs for site O&M.

### 4.4.1 UTILITIES

The utility costs are based on the actual costs provided during the RSE site visit. Electricity costs for Fiscal Year 2001 showed costs of approximately $54,000 per year (with no perceptible seasonal variation) for the treatment plant and approximately $13,000 per year for the downgradient extraction wells. The site managers estimated the natural gas costs of approximately $5,000 to $6,000 per year. The majority of the gas is used for the boiler that heats the building.

### 4.4.2 NON-UTILITY CONSUMABLES AND DISPOSAL COSTS

Non-utility consumables at the site are comprised of replacement UV lamps ($15,000 per year), seals for the UV/OX system self-cleaning system ($500 per year), catalytic carbon ($16,000 per year), vapor phase carbon ($7,150 per year), and hydrogen peroxide ($25,000 per year). These costs, with the exception of those for the hydrogen peroxide, were provided to the RSE team by the site managers. The hydrogen peroxide costs are based on a usage of approximately 4,800 gallons per year, as specified by the site managers, at an assumed cost of $3.50 to $4.00 per gallon. An additional $10,000 per year is included in the estimate provided in the table for miscellaneous chemicals, materials, or replacement parts.

The RSE team estimates that the site team likely allocated approximately $20,000 per year for waste disposal as non-hazardous material when the contract was setup. Waste disposal costs have not been incurred.

### 4.4.3 LABOR

The RSE team estimated the cost of oversight labor and fee by taking the total approximate annual cost of $760,000 and subtracting the provided costs for the ground water sampling and analysis (discussed in Section 4.4.4), the provided costs for the subcontractors ($473,000), and an estimate of other costs including waste disposal ($70,000).

Subcontractor labor is required for plant operations and maintenance, measurement of ground water levels from 51 wells, project management, monthly reporting, and engineering support. The site managers noted during the RSE visit that the plant operator spends approximately 50 hours per week at the site. Additional labor is available for other tasks such as cleaning the well lines and UV/OX system, and multiple operators are on call to respond to system alarms. The RSE team assumes an average of 60 hours per week with an approximate billing rate of $70 per hour. The costs associated with the other labor categories are blended together. This blended cost is the difference between $473,000 and the other cost estimates provided in the table.

### 4.4.4 CHEMICAL ANALYSIS

The RPM indicated that the ground water monitoring, reporting, and split sampling costs are approximately $142,000 per year. The RSE team estimates that the ground water sampling and the associated analysis (Metcalf & Eddy) is approximately $25,000 per year. This estimate assumes 6 days of labor, field materials, and rental equipment (as specified by the site managers) at an assumed rate of $2,000 per day and $125 per VOC analysis. The remaining estimated $117,000 per year are used for reporting, split sampling analysis, and data validation.

The $40,000 for process monitoring includes influent and effluent sampling for metals and VOCs. It also includes the toxicity testing, test kits used for weekly analysis of the iron and hydrogen peroxide, sampling of the air discharge from the vapor GAC, and specialty laboratory services required to analyze arsenic at low concentrations (i.e., equipment with a detection limit below the discharge standard).

## 4.5 ENERGY EFFICIENCY OBSERVATIONS

### 4.5.1 SITE ENERGY USE AND CONSERVATION PRACTICES

Energy sources employed at the site include electric power and natural gas. Electricity is reportedly supplied by a municipal power utility, while gas is delivered by KeySpan, a large, regional regulated gas utility.

Based upon the limited operating experience of the treatment facility, it appears that monthly electricity costs are on the order of $4,000 to $5,000. Average monthly electricity use during the period of September 2000 through September 2001 was 67,147 kWh, with a peak demand of 77,273 kWh in January 2001 and a low point in demand of 58,720 kWh in March 2001. Calculated unit costs were $0.093/kWh for the former and $0.0765/kWh for the latter. Data on natural gas consumption (for space heating) and costs are available for only a three month period, so generalizations are difficult to make. Weston representatives estimated that annual gas costs are on the order of $5,000 to $6,000.

The energy consumption of individual facilities and treatment system components is not measured, though treatment plant operations are metered separately from those of the lower extraction well cluster. By far, the largest energy user at the site is the UV/OX lamp array. With two lamps (2 X 30 kW) operating in continuous mode, the array generates about $3,000/month in electricity costs, or 60-80% of the total electricity cost of the facility.

Major energy using equipment at the site is listed in the table below.

| Device | Capacity/ Consumption Rate | Operating Mode |
|---|---|---|
| UV lamps | 2 X 30 kW | Continuous |
| Boiler | 2 million BTU | Seasonal, very intermittent |
| Compressors (2) | 25 hp | Intermittent, used to drive pumps in treatment plant |
| Blower | 25 hp | Seasonal, rarely used |
| Air conditioners (2) | | Seasonal, operated nearly full time in summer |
| Well heaters | 500 W | Intermittent, rarely used |
| Compressors (2, one for each well with a piston pump) | 5 hp | Intermittent, require frequent maintenance |
| Tank mixers (M1 & M2) | 1 hp | Continuous |
| Other mixers | 1 hp | 20 hours/month |
| Electric space heaters | 10 kW – peroxide room<br>3 kW – control room | Intermittent |

While energy conservation is not reportedly an area of specific focus within facility operations, energy consumption is, in essence, managed by limiting equipment use. Because the facility O&M contract has been awarded on a lump sum basis, the contractor has been provided with an incentive to minimize operating costs (including those for energy). No explicit energy conservation metrics, goals, or expectations have been established for the facility or its operation, nor are energy consumption/cost data regularly evaluated for trends.

### 4.5.2 Plant Design and Equipment Procurement Practices

Treatment System

According to representatives of the prime contractor and all subcontractors involved with design and operation of the site, no direct consideration of energy efficiency occurred during the evaluation of remedial alternatives, remedy selection, preparation of detailed design specifications and bid packages, or submission and evaluation of proposals. Equipment was not selected using energy efficiency ratings (e.g., Energy Star or equivalent), nor were available tools (e.g., DOE's Motor Master tool) employed to evaluate alternative brands/models. Variable speed drives have, however, been installed on most of the pumps in the treatment train. Heat recovery is not employed, nor, apparently, was it actively considered during facility design. With the exception of the filter press, all equipment in the plant was purchased new.

Site Buildings

The facility ground water treatment plant is housed in a large concrete building constructed on slab. The building is insulated with fiberglass (walls and roof), and is illuminated, in part, by a series of roof skylights. These skylights reportedly provide adequate illumination for plant operations under most conditions. The building also is equipped with twelve 400 W high pressure sodium vapor lights that are suspended near the ceiling. To control temperature and humidity inside the building, two large exhaust fans have been installed through the walls at the second-story level. These are rarely used, and the operator has covered their intakes with plastic to limit air infiltration. Air temperature, humidity, and the general indoor environment during the site visit were comfortable.

Energy Supply and Use

According to site contractor representatives, the possibility of generating energy at Groveland Wells was not considered during treatment facility design, nor was the possibility of outsourcing energy management to another entity (e.g., an “ESCO” or "Super ESCO"). There is no apparent use or consideration of load shedding or of interruptible power contracts at present.

Site Operating Practices

The treatment plant appeared to be very clean and well maintained. For reasons explained elsewhere in this report, some of the equipment in the treatment train is used infrequently or not at all. In these cases, the operator starts up and runs the equipment for a brief period once per week to maintain it in good operating condition.

## 4.6 Recurring Problems or Issues

Recurring problems or issues include air bubbles in the peroxide lines that result in the system shutting down, degradation of the galvanized pipe in the source area extraction well vaults, daily maintenance of the Blackhawk piston pumps at EW-5 and MW-3, and occasional scaling of the catalytic carbon. The galvanized piping in the source area wells has been replaced by polyethylene pipe. Maintenance of the Blackhawk pumps typically includes draining condensate from the air dryer and changing the oil in the air compressor motor.  Scaling of the catalytic carbon might continue, but the carbon is scheduled for replacement on an annual basis, and scaling should not adversely affect plant effectiveness.

## 4.7 REGULATORY COMPLIANCE

The plant regularly meets pertinent air and water discharge requirements.

## 4.8 TREATMENT PROCESS EXCURSIONS AND UPSETS, ACCIDENTAL CONTAMINANT/REAGENT RELEASES

No O&M excursions, upsets, or accidental releases were noted in the interviews during the RSE site visit.

## 4.9 SAFETY RECORD

No lost-time accidents were noted in the interviews conducted during the RSE site visit.

# 5.0 EFFECTIVENESS OF THE SYSTEM TO PROTECT HUMAN HEALTH AND THE ENVIRONMENT

## 5.1 GROUND WATER

Ground water continues to be impacted at the site and will likely remain impacted due to an apparent continuing source of ground water contamination beneath the Valley/GRC property. The pump and treat system, likely in concert with shutting down Municipal Supply Well 2, has reduced the migration of contaminants to the north toward the Merrimack River. The areal extent of contamination appears to have decreased. Prior to remedial action, ground water contamination extended to the north beyond Main Street, but ground water monitoring since October 1998 suggests that TCE and DCE concentrations above cleanup standards now only remain to the south (upgradient) of Main Street.

Ground water extraction occurs in three general areas at the site: the source area, south (upgradient) of Mill Pond, and north (downgradient) of Mill Pond. Decreasing concentrations in monitoring wells throughout the site, with the exception of those located in the source area, suggest the pump and treat system is containing the ground water contamination and restoring the aquifer. Though contaminant concentrations above cleanup standards remain in monitoring wells downgradient of the extraction wells located to the north of Mill Pond (ERT-9 and ERT-13), this contamination was likely in place prior to operation of the pump and treat system. Concentrations in these and other monitoring wells outside of the source area have decreased and will likely continue to decrease as long as contaminants in the source area are controlled or remediated. The site managers expect that these concentrations will decrease below the cleanup criteria (via dilution or degradation) prior to reaching receptors. The presence of TCE degradation products (cis-1,2-DCE and limited amounts of vinyl chloride) suggest that degradation of TCE to cis-1,2-DCE occurs at some level but that degradation to vinyl chloride and then to ethene is extremely limited.

Pumping from Municipal Supply Well 2 has been discontinued and the other municipal supply wells are located beyond the ground water contamination; therefore, site-related ground water contamination does not appear to threaten the public water supply. Institutional controls are part of the selected remedy and will prohibit the use of ground water from the impacted area once they have been implemented.

## 5.2 SURFACE WATER

Johnson Creek and Mill Pond represent the primary surface water bodies on site. Contamination was detected in these water bodies during the Remedial Investigation. However, since remedial action at the site began, contamination has not been detected within Mill Pond or Johnson Creek. Though discharge from the treatment plant to Mill Pond is permitted at concentrations up to 434 ug/L TCE, treatment plant effluent is routinely below MCLs. Therefore site-related contamination does not adversely affect Mill Pond. Toxicity testing is conducted on a quarterly basis to ensure that the hydrogen peroxide from the plant does not adversely affect the surface water, wetlands, or sediments near the treatment plant outfall.

The Merrimack River is located downgradient of the contaminant plume and the pump and treat system. Contaminant migration appears to be contained sufficiently such that contamination from the site is not expected to reach Merrimack River in detectable concentrations.

## 5.3 AIR

The majority of contaminants that enter the treatment system are destroyed by the UV/OX system and harmless by products result (water, carbon dioxide, and chloride). A small fraction of incoming contaminants are volatized from the head spaces of tanks or clarifier within the treatment plant. Air from these process components is vented through vapor phase GAC prior to discharge to the atmosphere. The vapor phase GAC is monitored regularly and is replaced on a conservative schedule to reduce or eliminate discharge of contaminants to the atmosphere.

Operation of the SVE system by the PRPs was discontinued two weeks prior to the RSE visit. The protectiveness of this decision has not yet been evaluated. The concentrations of TCE in soil gas around the Valley/GRC property and the neighboring residential properties are unknown.

## 5.4 SOILS

Contamination of the subsurface soils likely remains. The SVE system operated by the PRPs has been discontinued; therefore, further active remediation of the soils will likely require additional EPA involvement and funding at the site. The extent and magnitude of subsurface soil contamination remains unknown.

## 5.5 WETLANDS AND SEDIMENTS

The sediments and wetlands associated with Mill Pond were impacted at the time of the Remedial Investigation but are no longer impacted by site-related contamination. Toxicity testing is conducted on a quarterly basis to ensure that the hydrogen peroxide from the plant does not adversely affect the surface water, wetlands, or sediments near the treatment plant outfall.

# 6.0 RECOMMENDATIONS

Cost estimates provided herein have levels of certainty comparable to those done for CERCLA Feasibility Studies (-30/+50%), and these cost estimates have been prepared in a manner consistent with EPA 540-R-00-002, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, July 2000.

## 6.1 RECOMMENDATIONS TO IMPROVE EFFECTIVENESS

The RSE team has only one specific recommendation for improving the effectiveness of the pump and treat system: implement the institutional controls to prohibit the use of ground water and direct contact with impacted soils in the Valley Manufactured Products property. With respect to other effectiveness issues, routine monitoring suggests capture of contaminants is adequate and aquifer restoration downgradient of the source area is proceeding. As discussed in Section 6.4, the RSE team is recommending further characterization of the source area to increase the likelihood of site closeout. Such an investigation would also indicate if soils contamination (particularly soil gas contamination) extends towards neighboring residences, which would be an effectiveness concern.

## 6.2 RECOMMENDATIONS TO REDUCE COSTS

### 6.2.1 DISCONTINUE PUMPING AT EW-M3

EW-M3 is a bedrock extraction well located northeast of Mill Pond, due east of EW-M1 and EW-M2. It was retrofitted from a monitoring well. It pumps less than 2 gpm, and requires very frequent maintenance. TCE concentrations in the monitoring well were 530 ug/l in June 2000 and have declined since then (e.g., 18J ug/l in April 2001 and 39 ug/l in June 2001). In correspondence subsequent to the RSE site visit, the RPM indicated that the concentration had declined to 6.4 ug/L during the March 2002 sampling event.

When this well was retrofitted from the original monitoring well, a pneumatic piston pump was utilized, which required a different control scheme and pump enclosure from typical site wells (which utilize submersible pumps). It is these pneumatic piston pumps that require substantial maintenance.

Due to the low yield and relatively low concentrations at this well, the RSE team recommends discontinuing pumping at this well, and continuing to monitor contaminant concentrations over time. It is likely that concentration reductions are due to upgradient pumping and/or pumping at nearby EW-M1 and EW-M2, and that continued pumping at EW-M3 offers little or no benefit.

Maintenance time will be reduced, but under the current contract no net savings from labor reductions will result. However, if the system is modified in the future in a manner that does not require full-time staffing (see Section 6.2.2) this reduced maintenance will ultimately result in cost savings, perhaps on the order of $10,000 per year (8-10 hours/month x $70/hr x 12 months plus parts on the pneumatic pump). If monitoring indicates that concentrations substantially increase in EW-M3 after pumping is discontinued, then it should be replaced with a new well similar in construction to other site extraction wells.

### 6.2.2 EVALUATE COSTS FOR GROUND WATER SAMPLING AND ANALYSIS

In correspondence subsequent to the RSE site visit, the RPM indicated that the costs for ground water sampling and analysis, conducted by the oversight contractor, are approximately $142,000 per year. As discussed in Section 4.4.4 of this report, the RSE team estimates that the sampling labor, field materials, rental equipment, and laboratory analysis (metals and VOCs) totals approximately $25,000 per year. This leaves approximately $117,000 for reporting, split sampling analysis, and data validation. The fall and spring ground water reports are very well written and may require up to $10,000 each to compile. Assuming they actually cost $15,000 each, the RSE team estimates that the sampling, analysis, and reporting cost approximately $55,000 per year. This leaves approximately $87,000 per year for split sampling analysis and reporting, data validation, and other items associated with the sampling. The scope of the split sampling was not discussed during the RSE, but it is unlikely that the actual costs of it result in more than doubling the RSE cost estimates for collecting reliable ground water data. For a degree of quality assurance, results from new sampling rounds can be compared to this growing database of sampling results.

Given the large discrepancy between the RSE team estimates for ground water sampling and the actual costs reported by the RPM, the RSE team encourages the site managers to review the costs associated with the sampling program. There may be minor scope items that the RSE team is not accounting for in the provided cost estimates. Assuming the RSE cost estimates are accurate and quality assurance activities actually result in a 20% markup of the costs for ground water monitoring, savings of over $75,000 may be realized.

As suggested by the RPM, the use of diffusion bag sampling should be considered as an alternative to the current use of low-flow sampling. The use of diffusion bag sampling could reduce the labor costs associated with the sampling. This sampling approach has been tested at the Savage Municipal Water Supply Superfund Site in Region 1, and the site managers at the Groveland Wells site may benefit through discussions with site managers at the Savage site.

### 6.2.3 REPLACE UV/OXIDATION SYSTEM WITH AN AIR STRIPPER

The ROD highlighted on-site destruction of contaminants as a primary reason for selecting UV/OX for treatment of extracted ground water. However, the RSE team has evaluated 19 other Fund-lead pump and treat systems that address VOCs, and none of the RODs for these systems cited on-site destruction of contaminants as a criterion for selecting a component of the treatment process. Thermal oxidizers, which destroy contaminants on site, were used at 3 of the 19 sites, but the selection of that technology was primarily based on cost-effectiveness. The 30-year cost estimates provided in the ROD for the Groveland Wells site suggested that the cost to design, construct, and operate a UV/OX system (estimated net present worth estimate of $8,900,000 in the ROD) would be comparable to the cost to design, construct, and operate an air stripping system (net present worth estimate of $8,700,000 in the ROD). Therefore, cost was not a deciding factor between UV/OX and air stripping.

After two years of operation, cost and performance data of the UV/OX system suggest that air stripping would be a more cost-effective and energy-efficient treatment process. Air stripping is a proven technology to remove VOCs from extracted ground water. A form of air stripping is used at 12 of the 19 Fund-lead pump and treat systems mentioned in the preceding paragraph. Therefore, replacing UV/OX with air stripping would not sacrifice the protectiveness of the remedy.

Savings from replacing the UV/OX system with an air stripping system would realized for the following reasons:

Electricity usage - Eliminating the use of the UV/OX system and replacing it with an air stripper would result in an approximate savings of $35,000 per year in electricity.

Labor requirements - The air stripping system should only require approximately 16 hours of operator labor per week whereas the current system requires approximately 60 hours of operator labor per week. Assuming a billing rate of approximately $70 per hour (including overhead and fee), this translates to a savings of approximately $150,000 per year. This reduction in labor assumes current maintenance for retrofitted wells EW-M3 and EW-S5 will be eliminated as per recommendations in sections 6.2.1 and 6.3.1.

Materials/Chemicals - Current materials and chemical usage is likely approximately $70,000 per year due to annual replacement of catalytic carbon, quarterly replacement of vapor phase carbon, hydrogen peroxide, parts for the UV/OX system, and miscellaneous parts. The new system might require extra vapor phase carbon, but catalytic carbon would no longer be required. Hydrogen peroxide and the lamps and seals for the UV/OX system would also no longer be required. The RSE team estimates that approximately $30,000 per year may be saved.

Other savings would be realized for items including reduced engineering support, sampling and analysis, and oversight. In the following tables, the RSE team provides approximate cost estimates for installation and O&M of an air stripping system. The air stripper could be incorporated into the existing plant with the UV/OX system and unnecessary treatment components dismantled or bypassed. Only a component of the treatment process would be modified, not the entire plant and building. The cost estimates below consider those cost savings discussed in 6.2.1 and 6.2.2 as well as other opportunities for cost reductions in project management and oversight.

**Approximate costs of installing an air stripper into the existing building**

| Item | Capital Cost |
|---|---|
| Tray aerator (100 gpm to 150 gpm capacity) | $75,000 |
| Controls, piping, and electrical | $100,000 |
| Engineering | $25,000 |
| Contingencies (~25%) | $50,000 |
| Startup/shakedown (including samples and analysis) | $50,000 |
| **Total** | **$300,000** |

**Approximate annual costs of operating an air stripping system**

| Item | Annual O&M Cost |
|---|---|
| Project management | $40,000/year |
| Reporting<br>(monthly O&M, fall and spring ground water reports) | $35,000/year |
| Operator labor (16 hours per week) | $60,000/year |
| Quarterly Engineering inspections and maintenance | $20,000/year |
| Chemical analysis for process sampling (VOCs and metals, monthly) | $10,000/year |
| Materials (monthly changeout of vapor phase GAC and miscellaneous parts) | $40,000/year |
| Utilities | $30,000/year |
| Ground water sampling and analysis (sampling and VOC analysis of 10 extraction wells quarterly, 21 monitoring wells in the fall, and 10 additional monitoring wells in the spring) | $35,000/year |
| Contingencies/non-routine maintenance (~25%) | $60,000/year |
| **Total** | **$330,000/year** |

Installing an air stripper and the associated piping would likely cost approximately $300,000, but operations and maintenance (including management, monitoring, analysis, and reporting) should be feasible for approximately $330,000 per year. Compared to the current cost of $700,000 per year for these items, a savings of approximately $370,000 per year could potentially be realized.

An air stripping system can easily meet effluent discharge requirements for VOCs. The metals removal system currently in place is primarily required to prevent fouling of the UV/OX system. Current influent concentrations of iron are approximately 2 ppm. Tray air strippers can function effectively at these levels of iron with monthly cleaning. Discontinued pumping at wells G1 and G2 (see recommendation in Section 6.3.2), which are historically high in iron, may further reduce influent iron levels.

A potential issue associated with replacing the UV/OX system with an air stripper is the ability to meet the arsenic discharge limit. Although the MCL for arsenic is 50 ug/L and might soon be 10 ug/L, the discharge criterion for arsenic into Mill Pond is 0.75 ug/L (which in the experience of the RSE team is far lower than at similar sites across the country). Arsenic is not a contaminant of concern at the site; rather, as stated in USGS Professional Paper 1270 (Shacklette and Boerngenm, 1984), it is a natural constituent of soils at an average concentration of 7.2 mg/kg. Due to exchange between soils and ground water, arsenic also naturally occurs in ground water. However, because it is present in plant influent above the discharge criterion of 0.75 ug/L (influent concentration for arsenic is typically less than 5 ug/l, but is sometimes between 5 and 10 ug/l), it must be removed prior to discharging treated water to Mill Pond. Removing wells G1 and G2 (See Section 6.3.2), which are historically high in arsenic, may mitigate the need to reduce arsenic concentrations. However, the RSE team assumes meeting the very low discharge requirement of 0.75 ug/l will not be achieved simply be removing wells G1 and G2 from the system.

The primary recommendation of the RSE team regarding arsenic is to negotiate the discharge limit from 0.75 ug/L to a more reasonable concentration that is still protective of human health and the environment.

A modified discharge limit of 10 ug/L might be reasonable. The current MCL for arsenic is 50 ug/L and may soon be 10 ug/L. The cost associated with this negotiation has not been quantified by the RSE team. However, the RSE team believes this is the most sensible approach, and the cost estimates provided above assume no metals precipitation for a modified system using air stripping.

However, if negotiations on the arsenic discharge limit are not successful, the RSE team envisions the following two alternate approaches.

- The first alternative is to continue the metals removal process through hydrogen peroxide addition. As it is now, the process could be automated. Because only a 5 ppm solution would be required, rather than the 25 ppm solution currently used for the UV/OX system, chemical usage would be substantially lower. Hydrogen peroxide solution of 30%, rather than the current 50%, could be used. Filtration would be required. The cost of this approach beyond the baseline cost to operate an air stripping system would primarily be due to chemical usage and additional labor. Hydrogen peroxide would likely be reduced to approximately one fifth of the current usage of 4,800 gallons per year (i.e., about 1,000 gallons per year). At a cost of $3.50 to $4.00 per gallon, this translates to approximately $4,000 per year. Other oxidants, such as potassium permanganate, may be considered for slightly lower costs. An additional three days of labor each week might be required. At an approximately billing rate of $70 per hour (including overhead and fee) this would amount to approximately $90,000 per year. Other analyses of process water might add another $5,000 per year. Rounding up, this approach to meeting applicable arsenic discharge criteria would add approximately $100,000 per year to the costs of the modified system estimated above.

- The second alternative is to pursue reinjection of treated water to the subsurface. The influent arsenic concentrations are below the MCL (the likely discharge criteria) and would therefore require no treatment. Capital costs for pursuing this option would include permitting, design and installation of the basins, and piping modifications. The RSE team estimates that permitting may cost $25,000, design and installation of the basins may cost $250,000, and piping modifications may cost $75,000. Annual costs would include periodic cleaning of the basins to address iron fouling. The RSE team estimates that this may cost approximately $40,000 per year.

With either scenario, the estimated costs compared to the actual costs for the existing system result in significant savings. With metals treatment the cost savings is approximately $270,000 per year, and with reinjection the cost savings is approximately $330,000 per year. Although the reinjection scenario provides the potential greater annual savings, it does require substantial capital costs for implementation. The site managers would need to carefully consider the two scenarios to determine which option would be more cost-effective. The life-cycle costs associated with each option are provided in Table 7-1 in Section 7.0 of this report.

## 6.3 MODIFICATIONS INTENDED FOR TECHNICAL IMPROVEMENT

### 6.3.1 REPLACE OR DISCONTINUE PUMPING AT EXTRACTION WELL EW-S5

EW-S5 is a bedrock extraction well located just south of Mill Pond, next to EW-S4. It was retrofitted from a monitoring well. It pumps less than 2 gpm, and requires very frequent maintenance. TCE concentrations in the monitoring well were 2,400 ug/l to 6,300 ug/l in 1998-1999. Since extraction started, concentrations have decreased (e.g., 410 ug/l in April 2001 and 440 ug/l in June 2001). In correspondence subsequent to the RSE site visit, the RPM indicated that the concentration had declined to 17 ug/L during the March 2002 sampling event.

When this well was retrofitted from the original monitoring well, a pneumatic piston pump was utilized, which required a different control scheme and pump enclosure from typical site wells (which utilize submersible pumps). It is these pneumatic piston pumps that require substantial maintenance.

If concentrations in EW-S5 continue to decrease the site managers should consider discontinue pumping from the well and using the well to monitor for rebound. However, the if TCE concentrations in extracted water do not continue to decrease and the 17 ug/L measured in March 2002 is an anomalously low concentration, pumping may need to continue. In such a case, the RSE team suggests that the site managers replace EW-S5 with a new well, in the same location, drilled in a manner similar to EW-S4. Estimated cost for drilling this well is approximately $40,000. Although maintenance time will be reduced, under the current contract no net savings from labor reductions will result. However, if the system is modified in the future in a manner that does not require full-time staffing (see Section 6.2.2) this reduced maintenance will ultimately result in cost savings, perhaps on the order of $10,000 per year (8-10 hours/month x $70/hr x 12 months plus parts on the pneumatic pump).

#### 6.3.2 DISCONTINUE EXTRACTION AT WELLS G1 AND G2

Extractions wells G1 and G2 are overburden wells located north of Mill Pond. They are older wells that were part of an original air stripping system operated by Valley Manufactured Products. G1 is located near overburden extraction well EW-M2, and G2 is located near overburden extraction well EW-M1. When operating, they pump on the order of approximately 10 gpm each.

TCE concentrations in these two wells are quite low (< 0.2 ug/l and 4 ug/l, respectively, in June 2001). These wells are also relatively high in iron, manganese and arsenic compared to wells in other parts of the site. According to data provided by the contractor, in June 2001, the iron concentrations in these two wells were 4,170 ug/L and 6,360 ug/L, the manganese concentrations were 378 ug/L and 713 ug/L, and the arsenic concentrations were 16.3 ug/L and 17.5 ug/L. As a comparison, the arsenic concentrations in the other extraction wells ranged from undetectable to 4.3 ug/L during the same time period. These wells require frequent pump maintenance (every month or two) due to clogging. Site contractors have questioned the need to keep G1 operating, because it extracts water with TCE concentrations less than the MCL. Based on a capture zone evaluation they performed while G1 was inactive, site contractors determined adequate capture would still be achieved without pumping from G1. During the RSE site visit, G1 was not operating, and site contractors indicated G2 might be shut down in the future.

The RSE team agrees that little benefit is likely derived from pumping G1 and G2, and recommends discontinuing extraction at both wells. If necessary, pumping at EW-M1 and/or EW-M2 can be increased to compensate for the reduced pumping, but the RSE team believes that will not likely be necessary to maintain system effectiveness. The RSE team has not quantified cost savings associated with this recommendation, though reduced maintenance time will be required. Although maintenance time will be reduced, under the current contract no net savings from labor reductions will result. However, in the case of a modified system that does not require full-time staffing (see Section 6.2.2), this recommendation will result in cost savings due to reduced maintenance. Removing these wells may also obviate the need to treat for arsenic.

### 6.3.3 MONITOR EXTRACTION WELLS FOR FOULING

The site managers report that the pumps and piping associated with the extraction system have required maintenance to mitigate fouling. The wells, however, have not been cleaned or redeveloped. The RSE team suggests that periodic cleaning of the wells should also be done to prevent fouling of the well screen and gravel pack. The status of the wells and the need for cleaning can be determined by tracking the specific capacity (flow rate divided by drawdown) in each operating well over time. Fouling blocks the well screen and provides resistance to water entering the well. As a result, the water level in the well decreases until there is a sufficient hydraulic gradient directing water from the formation into the well to balance the flow that is extracted from the pump. Fouling may therefore occur with no noticeable change in the extraction rate until the pump shuts down. When this occurs, however, fouling may be so severe that the well cannot be rehabilitated and a new well may be required.

A baseline specific capacity should be determined, and then determining the specific capacity should be done monthly or added to the quarterly sampling of the extraction wells. The increase in effort is minimal and should not require an increase in cost. If a decrease in specific capacity of more than 10% is noted, well rehabilitation is likely required. Products such as Aquaclear AE and MGA from Baroid can be used to address such fouling. The active ingredients are glycolic and sulfamic acid with a wetting/surfactant agent.

It is likely worthwhile to clean the wells at the same time the pumps and lines are cleaned.

## 6.4 CONSIDERATIONS FOR GAINING SITE CLOSE OUT

### 6.4.1 FURTHER CHARACTERIZATION OF THE SOURCE AREA

Three extraction wells from the pump and treat system are located in the source area and continue to remove mass, but operating these wells will not likely result in site close out in a reasonable time frame. This is particularly so with the SVE system no longer operating. Even when it was operating, it was no longer removing significant mass of contaminants, and it was not addressing some areas known or suspected of being impacted by free product or residual product (e.g., near TW-17, EW-S1, and EW-S2). The RSE team, therefore, recommends further characterization regarding the extent of the source area.

One approach would utilize a GeoProbe in conjunction with a membrane interface probe to delineate areas of free product horizontally and vertically (vendors include Columbia Technologies). A GeoProbe outfitted with a membrane interface probe can typically be applied for less than $5,000/day, and approximately 5 holes per day can be expected. Although this will allow thorough investigation of the overburden, it may not be possible to investigate the fractured bedrock. Nevertheless the RSE team recommends an overburden evaluation of this type (extending into bedrock if conditions allow), in conjunction with a soil gas analysis. Assuming a one-week field effort, the study and report should require less than $50,000.

### 6.4.2 POTENTIAL OPTIONS FOR MORE AGGRESSIVE REMEDIATION OF THE SOURCE AREA

The source area almost certainly has DNAPL. Some form of ground water remediation will continue indefinitely unless steps are taken to address the DNAPL. Once the source is better delineated (see Section 6.4.1), one approach for more aggressive remediation of the source area might involve a multi-phase extraction system. This would include the extraction of ground water and vapors from the same wells, which would enhance the removal of mass and NAPL. The vapor extraction would remove residual contaminants from the composite cone of depression, assuming the air-entry pressures are not too high. A pilot test would be necessary.

Another alternative would be the use of in-situ thermal methods. Six-phase soil heating or thermal conduction heating may be useful. The low electrical resistance observed in the bedrock by the US Geological Survey in their geophysical evaluation may work against the use of six-phase heating. Vendors for this technology include Thermal Remediation Services and Current Environmental Solutions. The small size of the site and low permeability of the aquifer may work in favor of thermal conduction. A vendor for this is approach is TerraTherm (local to the Boston area). Steam injection may also be feasible, though the accumulation of the NAPL near the bedrock interface may make steam override a problem - the buoyancy of the steam causes it to ride up and over the targeted NAPL. A pilot study would ne necessary.

In-situ soil flushing using surfactants or solvents may allow substantial mass recoveries, but the heterogeneity of the soils and weathered rock in the source area will make it difficult to achieve good surfactant/contaminant contact. The same concern would apply to in-situ chemical oxidation.

The RSE team has not quantified potential costs for implementing any of these technologies, partially because the extent of the source area is not known. However, once the results of the additional source area characterization are determined, site contractors can perform a limited feasibility study on potential options, which would include contacting vendors of these and other technologies. Estimated cost for a limited feasibility study is $25,000. It should be noted that the ability to improve mass removal above the top of competent bedrock is excellent, but if there is substantial mass in fractures below the top of rock, there will be difficulties in remediating the source area adequately to achieve a real benefit for the ground water extraction system, and the focus perhaps would return to containment. Therefore, more aggressive mass removal in the source area may never completely remove the need for a pump and treat system, and that should be considered when evaluating possible alternatives and the associated life-cycle costs.

## 6.5 SUGGESTED APPROACH TO IMPLEMENTATION

Recommendations to discontinue pumping and/or replace specific extraction wells (Section 6.2.1, 6.3.1, 6.3.2) can be implemented immediately. Any outstanding issues discussed in Section 6.1 regarding institutional controls can also be considered immediately. Improved source characterization (Section 6.4.1) can be performed within 1 year. Consideration of more aggressive source removal (Section 6.4.2) should be deferred until results are determined from the improved source characterization.

The major cost savings opportunity is associated with switching from UV/OX to air stripping (Section 6.2.2). It is not clear that this will require an ESD. It may not, because it is essentially swapping technologies of similar effectiveness, and air stripping is such a commonly applied technology. However, due to the emphasis in the ROD regarding on-site destruction, an ESD might be required. Therefore, the first action should be to determine if an ESD is required. At the same time, inquiries should be made regarding the potential to modify the arsenic discharge standard to a more reasonable value (e.g., 10 ug/l), the results of which will determine the need for continued metals treatment in a modified system. Perhaps an increase in the arsenic discharge limit could be coupled with a decrease in the TCE discharge limit (which is 434 ug/l, which is higher than plant influent and far higher than that actually accomplished by the treatment plant). Replacing the UV/OX system with air stripping can be accomplished within a several month period once the change is directed.

# 7.0 SUMMARY

In general, the RSE team found a well operating system. Of the 23 Fund-lead pump and treat systems visited nationwide by the RSE team to date, this system is among the cleanest and best maintained in the country. The monthly reports provided by the operations contractor and data evaluation reports provided by the oversight contractor are detailed and thorough. The site team is commended for its efforts. The observations and recommendations contained in this report are not intended to imply a deficiency in the work of either the system designers or operators but are offered as constructive suggestions in the best interest of the EPA and the public. These recommendations have the obvious benefit of being formulated based upon operational data unavailable to the original designers.

The RSE team found no major issues regarding the effectiveness of the system to protect human health and the environment, but does recommend that the institutional controls be implemented. The RSE also recommends that extraction be discontinued at several wells.

The RSE team suggests that substantial cost savings and energy savings can occur by switching from UV/OX to air stripping for treatment of VOCs. Although a capital investment of approximately $300,000 would be required, annual savings of up to $370,000 per year might result due to lower energy usage, substantially reduced labor required to operate the plant, and savings in materials. Savings might be closer to $270,000 per year if continued metals treatment is required; however, the RSE team feels that site managers can successfully negotiate a higher discharge level for arsenic, which would likely remove the need for metals treatment for a modified system using air stripping.

With respect to improving the potential for site closeout, the RSE teams recommends additional source area characterization to be followed by a limited feasibility study regarding more aggressive source removal options. However, these efforts must recognize that complete removal of DNAPL may not be possible if DNAPL is located in bedrock fractures, and that a permanent pump and treat system may therefore be necessary.

Table 7-1 summarizes the costs and cost savings associated with each recommendation in Sections 6.1 through 6.3. Both capital and annual costs are presented. Also presented is the expected change in life-cycle costs over a 30-year period for each recommendation both with discounting (i.e., net present value) and without it.

**Table 7-1. Cost Summary Table**

| Recommendation | Reason | Additional Capital Costs ($) | Estimated Change in Annual Costs ($/yr) | Estimated Change In Life-cycle Costs ($) * | Estimated Change In Life-cycle Costs ($) ** |
|---|---|---|---|---|---|
| 6.2.1 Discontinue Pumping at EW-M3 | Cost Reduction | $0 | $0[(1)] | $0 | $0 |
| 6.2.2 Evaluate costs for ground water sampling and analysis | Cost Reduction | $0 | ($75,000) | ($2,250,000) | ($1,211,000) |
| 6.2.2 Switch from UV/OX to air stripping<br>• air stripping only<br>• w/ metals treatment<br>• w/ reinjection | Cost Reduction | $300,000<br>$300,000<br>$650,000 | $370,000[(2)]<br>$270,000[(2)(3)]<br>$330,000[(2)(3)] | ($11,400,000)<br>($8,100,000)<br>($9,550,000) | ($6,272,000)<br>($4,658,000)<br>($5,976,000) |
| 6.3.1 Replace well EW-S5 | Technical Improvement | $40,000 | $0[(1)] | $40,000 | $40,000 |
| 6.3.2 Discontinue Pumping at G1 and G2 | Technical Improvement | $0 | $0[(1)] | $0 | $0 |
| 6.3.3 Monitor extraction wells for fouling | Technical Improvement | $0 | $0 | $0 | $0 |
| 6.4.1 Improved Source Area Characterization | Site Closeout | $50,000 | $0 | $50,000 | $50,000 |
| 6.4.2 Limited Feasibility Study Regarding More Aggressive Source Area Remediation | Site Closeout | $25,000 | $0 | $25,000 | $25,000 |

Costs in parentheses imply cost reductions.
* assumes 30 years of operation with a discount rate of 0% (i.e., no discounting)
** assumes 30 years of operation with a discount rate of 5% and no discounting in the first year

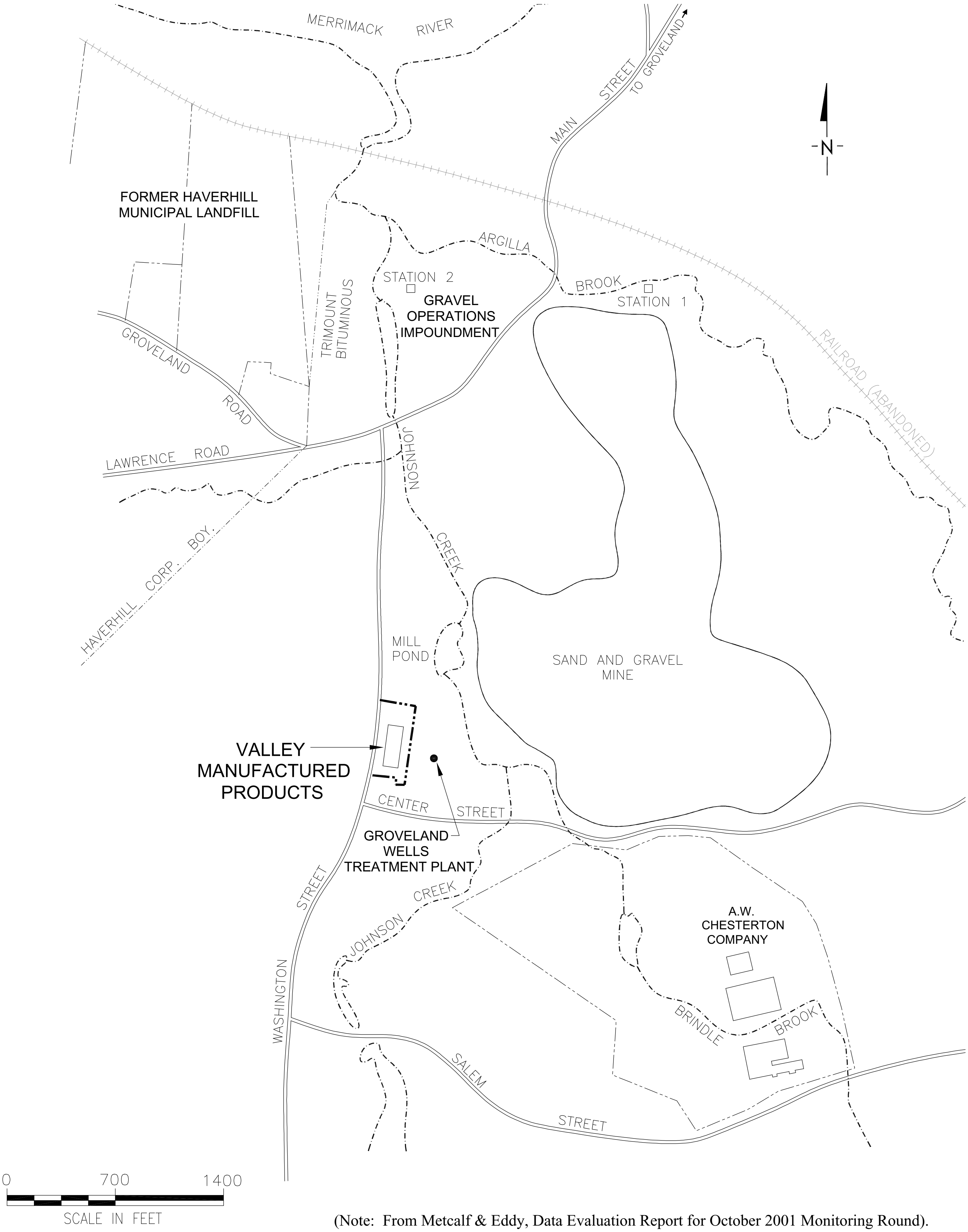
(1) This will not achieve substantial cost savings under current contract, but reduced maintenance requirements will achieve cost savings if system is modified in future, as per 6.2.2.

(2) The cost savings from evaluating ground water sampling and analysis costs have been included.

(3) These options would be required if the negotiations regarding the arsenic discharge level due not succeed. However, the RSE team feels a higher discharge level for arsenic that is still protective can be successfully negotiated, removing the need for metals treatment in a modified system

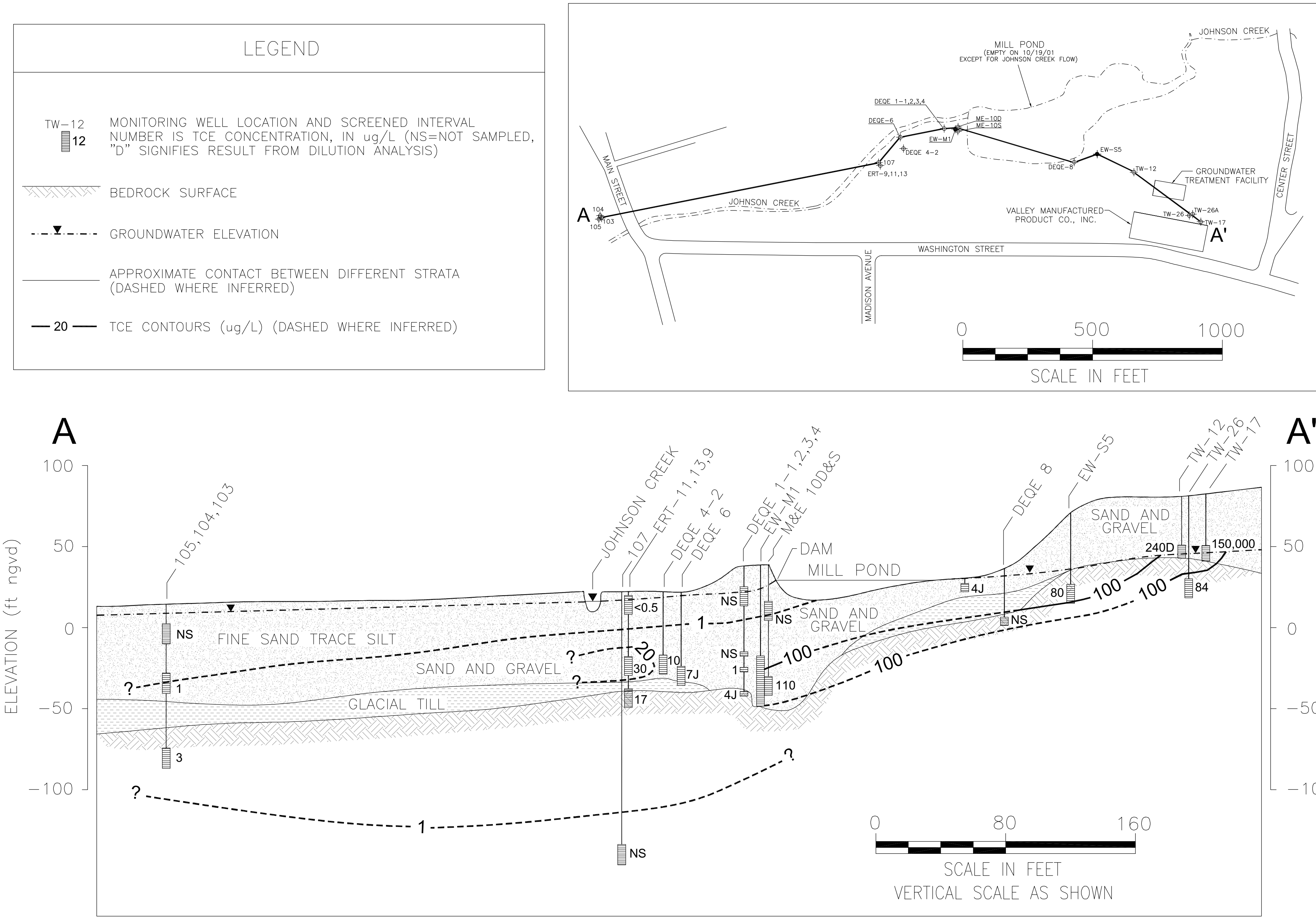
**FIGURES**

FIGURE 1-1. SITE LOCATION MAP.



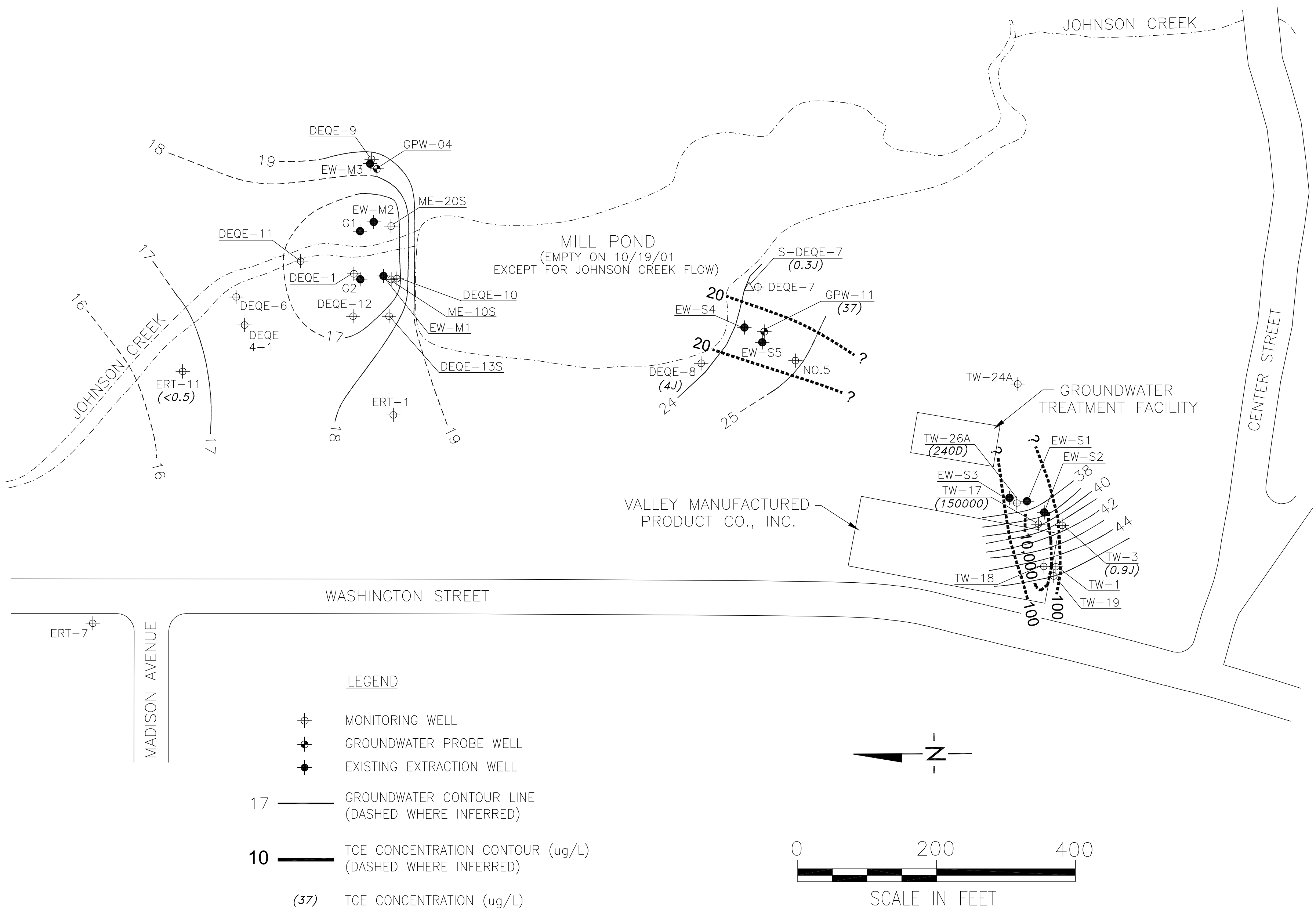

(Note: From Metcalf & Eddy, Data Evaluation Report for October 2001 Monitoring Round).

**FIGURE 1-2. CROSS SECTION AND CROSS SECTION LOCATION.**



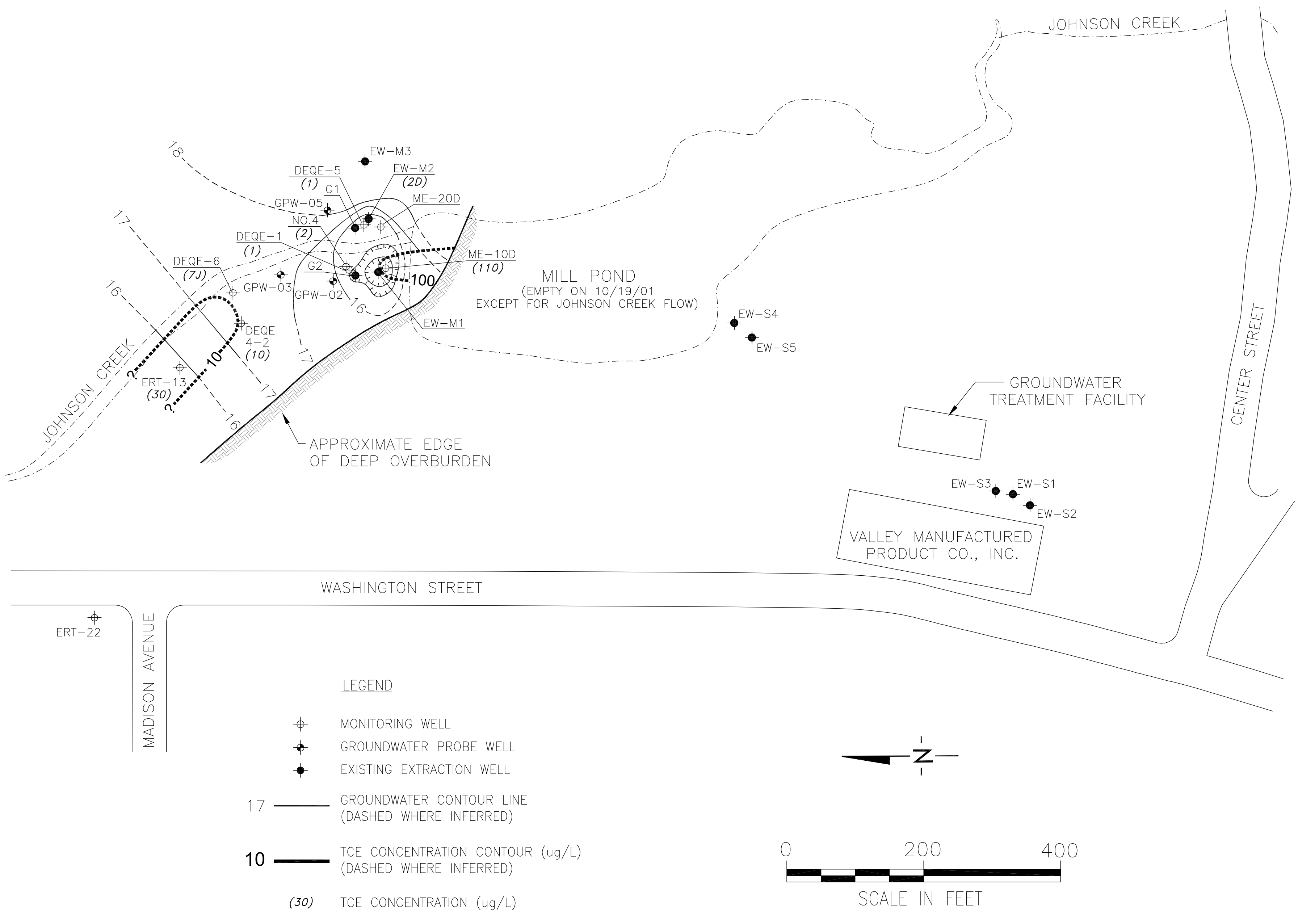

(Note: Based on Record of Decision).

**FIGURE 1-3. GROUNDWATER ELEVATIONS AND TCE CONCENTRATIONS IN SHALLOW OVERBURDEN GROUNDWATER, OCTOBER, 2001.**



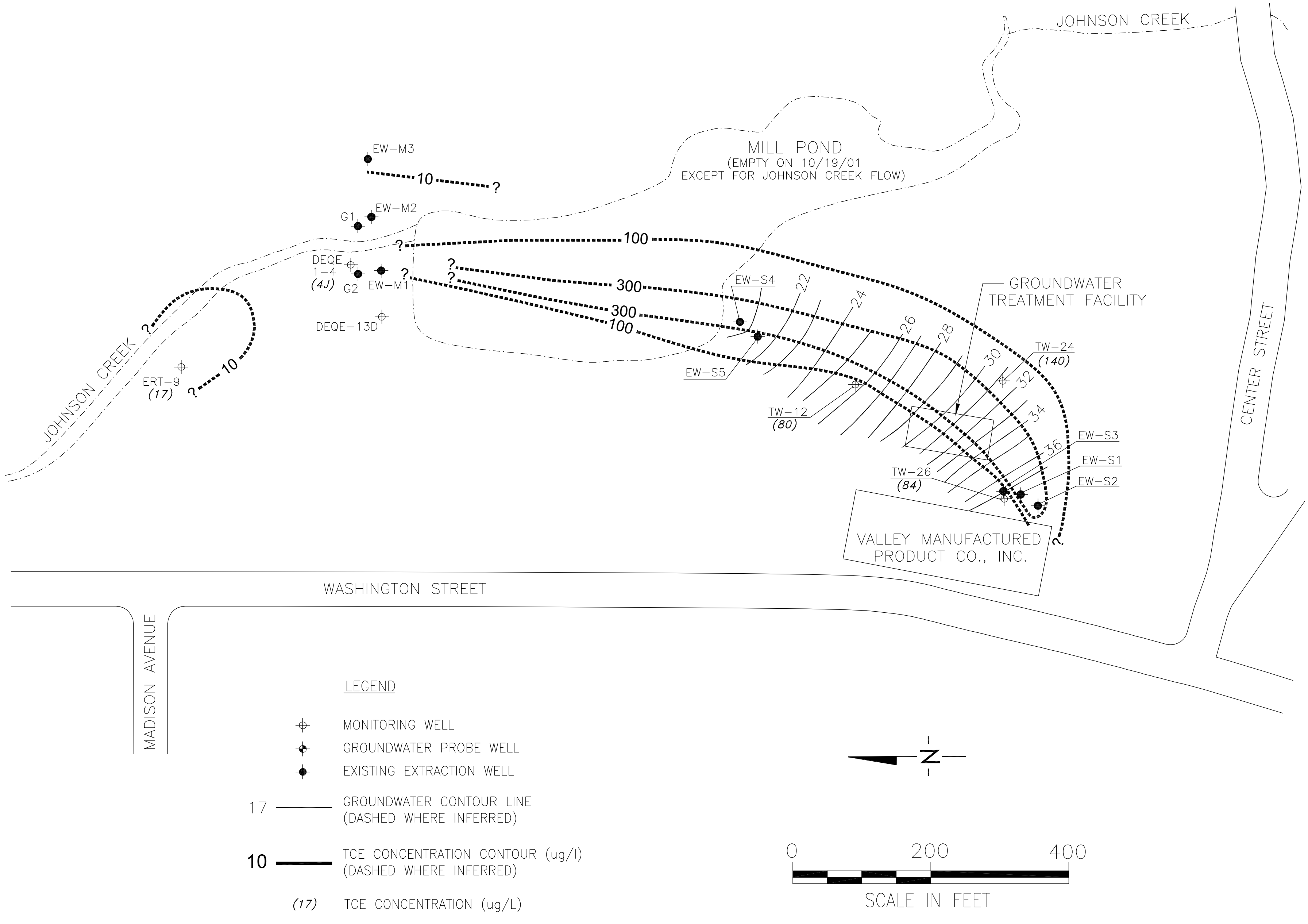

(Note: From Metcalf & Eddy, Data Evaluation Report for October 2001 Monitoring Round).

**FIGURE 1-4. GROUNDWATER ELEVATIONS AND TCE CONCENTRATIONS IN DEEP OVERBURDEN GROUNDWATER, OCTOBER, 2001.**




(Note: From Metcalf & Eddy, Data Evaluation Report for October 2001 Monitoring Round).

FIGURE 1-5. GROUNDWATER ELEVATIONS AND TCE CONCENTRATIONS IN BEDROCK GROUNDWATER, OCTOBER, 2001.




(Note: From Metcalf & Eddy, Data Evaluation Report for October 2001 Monitoring Round).