REMEDIATION SYSTEM EVALUATION

REILLY TAR & CHEMICAL CORP. (INDIANAPOLIS PLANT) SITE
A.K.A. "REILLY INDUSTRIES" SITE
INDIANAPOLIS, INDIANA

Report of the Remediation System Evaluation,
Site Visit Conducted at the "Reilly Industries" Superfund Site
October 28, 2003

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Remediation System Evaluation
Reilly Tar & Chemical Corp. (Indianapolis Plant) Site
A.K.A. "Reilly Industries" Site
Indianapolis, Indiana

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NOTICE

Work described herein was performed by GeoTrans, Inc. (GeoTrans) for the U.S. Environmental Protection Agency (U.S. EPA). Work conducted by GeoTrans, including preparation of this report, was performed under Dynamac Corporation Prime Contract No. 68-C-02-092, Work Service Request No. ST-1-15. 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, may be needed prior to implementation of the recommendation. The recommendations are based on an independent evaluation by the RSE team, and represent the opinions of the RSE team. The RSE described herein was performed at the "Reilly Industries site" in Indianapolis, Indiana. This is a "Responsible-Party (RP)" site and not a "Fund-lead" site. This site was selected as a test case to help determine if the RSE process might provide benefits if applied at RP sites.

The Reilly Industries site is an active chemical manufacturing facility surrounded by a mix of residential, industrial and commercial properties. All residences in the area of contaminated ground water have been connected to the municipal water supply. This RSE report is focused on the operating pump-and-discharge (P&D) system, and the related monitored natural attenuation (MNA) of off-site ground water. A two-well perimeter ground water extraction system began operation in October 1994. Extraction wells have been added/replaced in several increments since that time. The current P&D system contains five extraction wells, operating at a combined rate of approximately 220 gpm. There is also an SVE system located near one of the source areas that consists of 10 wells that are rotated (5 passive and 5 active at any point in time).

Three chemicals in the ground water are of primary concern: benzene, pyridine/pyridine derivatives, and ammonia. Concentrations have decreased substantially at many wells since the P&D remedy was first implemented in 1994, but there are wells located on-site and off-site where concentrations remain elevated at concentrations more than 100 times the cleanup levels. High concentrations are generally found in shallow wells on-site, but higher concentrations are found off-site to the east at the intermediate or deep wells (such as at RI-19D) . This may be the result of natural downward hydraulic gradients, or may be the result of downward hydraulic gradients caused by off-site industrial pumping.

There is no treatment plant at the site, so this RSE does not pertain to optimization of on-site treatment processes. Rather, this RSE focuses on hydrogeologic issues, such as the effectiveness of ground water capture, the progress of MNA, etc. and cost-effective approaches to evaluate and/or enhance the performance of the remedy. The RSE team noted a good working relationship between the responsible party and the EPA RPM. The observations provided in this report 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.

Recommendations to improve effectiveness in protecting human health and the environment include adding a cluster of piezometers and a cluster of monitoring wells, and performing a detailed capture zone evaluation (including the construction/update and calibration of a three-dimensional numerical flow model to then be used in conjunction with particle tracking) that will indicate if modifications to the extraction system are appropriate. The one recommendation to reduce cost is to potentially use the extracted water for process or cooling water. The RSE team acknowledges that Reilly has previously considered and rejected that idea, but a future increase in the discharge costs may make it appropriate to reconsider this option. Minor additions to routine O&M reports are suggested for technical improvement. For site closeout, the RSE team recommends that an alternate approach that includes discontinuing the P&D system be considered. The RSE team is not recommending this alternative approach per se, but is recommending that it be considered by the site team and the regulators. There is a potential to decrease remedy costs dramatically if all parties (including the regulators) agree that protectiveness is not negatively impacted by such an approach.

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 Superfund Remediation and Technology Innovation (OSRTI). The objective of this project is to conduct Remediation System Evaluations (RSEs) at selected pump and treat (P&T) systems that are jointly funded by EPA and the associated State agency. The project contacts are as follows:

Organization	Key Contact	Contact Information
USEPA Office of Superfund Remediation and Technology Innovation (OSRTI)	Jennifer Griesert	1235 Jefferson Davis Hwy, 12th floor Arlington, VA 22202 Mail Code 5201G phone: 703-603-8888 griesert.jennifer@epa.gov
GeoTrans, Inc. (Contractor to USEPA)	Doug Sutton	GeoTrans, Inc. 2 Paragon Way Freehold, NJ 07728 (732) 409-0344 Fax: (732) 409-3020 dsutton@geotransinc.com

The RSE described herein was performed at the Reilly Industries site. This is a “Responsible-Party (RP)” site and not a “Fund-lead” site. This site was selected as a test case to help determine if the RSE process might provide benefits if applied at RP sites.

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1.0 INTRODUCTION

1.1 PURPOSE

During fiscal years 2000, 2001, and 2002 Remediation System Evaluations (RSEs) were conducted at 24 Fund-lead pump and treat (P&T) sites (i.e., those sites with pump and treat systems funded and managed by Superfund and the States). Due to the opportunities for system optimization that arose from those RSEs, EPA OSRTI has incorporated RSEs into a larger post-construction complete strategy for Fund-lead remedies. During fiscal year 2003, RSEs were planned at up to six Fund-lead sites in an effort to improve or optimize the sites. Some of these (including the Reilly Industries RSE presented herein) were delayed into fiscal year 2004. Furthermore, OSRTI decided to conduct at least one of the six RSEs at a "Responsible Party (RP)" site rather than a Fund-lead site as a test case for applying the RSE process at RP sites. The Reilly Industries RSE presented herein pertains to an RP site. GeoTrans, Inc., an EPA contractor, is conducting these evaluations, and representatives from EPA OSRTI are attending the RSEs as observers.

The Remediation System Evaluation (RSE) process was developed by the US Army Corps of Engineers (USACE) and is documented on the following website:

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

An 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 1 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:

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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, might be needed prior to implementation of the recommendation. Note that the recommendations are based on an independent evaluation by the RSE team, and represent the opinions of the RSE team.

The Reilly Tar site was selected by EPA OSRTI based on a recommendation from the associated EPA Region. It was also selected as a test case to help determine if the RSE process might provide benefits if applied at RP sites. 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:

Rob Greenwald, Hydrogeologist, GeoTrans, Inc.
Peter Rich, Civil and Environmental Engineer, GeoTrans, Inc.

Doug Sutton at GeoTrans also provided logistical support and report review. The RSE team was accompanied by the following observer:

Jennifer Griesert from EPA OSRTI

1.3 DOCUMENTS REVIEWED

Author	Date	Title
US EPA	6/30/92	Record of Decision, OU1
US EPA	9/30/03	Record of Decision, OU2
US EPA	9/27/96	Record of Decision, OU3, OU4
US EPA	6/30/97	Record of Decision, OU5
US EPA	10/6/97	ESD, OU2
US EPA	12/16/99	Superfund Preliminary Site Closeout Report
US EPA	4/6/00	Five Year Review Report
Reilly Industries	11/18/02	December 2001 SMR Reports for ground water wells
Env. and Geol. Consultants	4/3/03	Annual Linear Regression Analysis
Env. and Geol. Consultants	9/17/03	Addendum #1 to Annual Linear Regression Analysis
Env. and Geol. Consultants	9/24/03	Water Table Maps (Shallow and Deep), Third Quarter FY03
Env. and Geol. Consultants	??	Cross Section Locations, and Cross Sections Based on Soil Boring Logs and Gamma Logging
Varies	Varies	Well logs and/or construction information for extraction wells
Reilly Industries	10/28/03	September 2003 SMR Reports for ground water wells and for bypasses
Env. and Geol. Consultants ??	10/03 ??	Quarterly Report, Third Quarter 2003
Todd Stark	11/3/03	Email to Tamra Kress with Oct 2003 PW flows

1.4 PERSONS CONTACTED

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

Dion Novak, RPM, EPA Region 5
Kevin Herron, IDEM (State)
Tamra Kress, Reilly Industries
Phil Smith, CH2M Hill (consultant to USEPA)
Keith Might, Environmental and Geological Consultants (consultant to Reilly Industries)

1.5 SITE LOCATION, HISTORY, AND CHARACTERISTICS

1.5.1 LOCATION AND HISTORY

The site is located at 1500 South Tibbs Avenue in the southwest quadrant of Indianapolis, Indiana. The general site vicinity is illustrated on Figure 1. Minnesota Street divides the 120 acre site into two parcels. The Oak Park property, which occupies approximately 40 acres, is located north of Minnesota Street. The Maywood property, which occupies approximately 80 acres, is located south of Minnesota Street.

The facility is an active chemical manufacturing facility. The majority of the operating facility buildings are located north of Minnesota Street, on the Oak Park property. Approximately 75% of the Oak Park property is covered by buildings, pavement, and above-ground tank farms. Chemical manufacturing also occurs on the northern portion of the Maywood Property.

The site is surrounded by a mix of residential, industrial, and commercial properties. Residential neighborhoods are located immediately adjacent to the eastern boundary (on the east side of Tibbs Avenue) of the Oak Park property. Two residences are also located abutting the northern property boundary near the Lime Pond in the northwest corner of the site. Commercial and industrial properties are located south and west of the site. All residences in the area of contaminated ground water have been connected to the municipal water supply.

Industrial development of the Reilly site began in 1921 when the Republic Creosoting Company (which later became Reilly Tar & Chemical, which in turn became Reilly Industries, Inc.) started a coal tar refinery and a creosote wood treatment operation on the Maywood property. On-site wood treatment operations occurred from 1921 until 1972. Beginning in 1941, several chemical plants were constructed and operated on the Oak Park property. Environmental problems at the site are related to the management and disposal of creosoting process wastes and to wastes associated with and substances used in the process of manufacturing custom synthesized specialty chemicals.

In 1984, Reilly Tar was listed on U.S. EPA's National Priorities List (NPL). In 1987, the potentially responsible party (Reilly) agreed to conduct an RI/FS. In 1989, Reilly Tar & Chemical changed their corporate name to Reilly Industries, Incorporated, under which they operate today.

Records of Decision have been issued for five Operable Units (OUs) at the site, as follows:

- OU1 ROD (June 1992) - calls for a ground water extraction/treatment/discharge system to contain the migration of ground water contaminated by the site at the site boundary.

- OU2 ROD (September 1993) - calls for the excavation and thermal desorption of soil at four on-site source areas and the solidification of sludge and placement of a soil cover

over a fifth on-site source area. An Explanation of Significant Differences (ESD) was issued in October 1997 to change from thermal desorption of some soil to off-site thermal treatment, primarily because of the high BTU content of the soil.

- OU3 and OU4 ROD (September 1996) - calls for the installation of a permeable cover over the OU3 "kickback" area, and also calls for soil vapor extraction and concrete/asphalt cover over portions of the OU4 area.

- OU5 ROD (June 1997) - calls for monitored natural attenuation for the off-site portion of contaminated ground water, and also calls for continued operation of OU1 Ground water Interim Remedial Measures system.

This RSE report is focused on the operating pump-and-discharge (P&D) system, and the related MNA of off-site ground water. A two-well perimeter ground water extraction system began operation in October 1994. Extraction wells have been added/replaced in several increments since that time.

1.5.2 POTENTIAL SOURCES

The RI indicated that there are at least five former waste disposal areas onsite that were potential source areas for both on-site and off-site contamination (see Figure 1):

- Lime Pond on the Oak Park property

- Abandoned Railway Trench on the northern portion of the Maywood property

- Former Sludge Treatment Pit on the northern portion of the Maywood property

- Drainage Ditch on the southern portion of the Maywood property

- South Landfill on the southern portion of the Maywood property

Each is briefly discussed below. Remedial measures associated with OU2, OU3, and OU4 were implemented in an attempt to eliminate or reduce the future impact to ground water from these sources.

In addition to the five areas listed above, 60,000 gallons of waste fuel, containing primarily pyridine and pyridine derivatives, benzene, xylene, and toluene, were accidentally spilled on the Oak Park property in 1987. Some, but not all, of the fuel oil was recovered and some, but not all, of the contaminated soil was excavated by Reilly.

<u>Lime Pond</u>

The Lime Pond was a lagoon constructed in 1953 to receive waste discharges from the first synthetic pyridine base processing unit constructed on the Oak Park property. Dimensions of the Lime Pond were approximately 350 feet by 350 feet. Until 1965, discharges from process areas on the Oak Park property went to the Lime Pond, which included solid material and sludge that had settled out of the waste water discharged to the Lime Pond area. Since 1965, when a connection to the city sewer was made, the Lime Pond received only water from the boiler operations on the Oak Park property. Buried drums were discovered at locations to the east and southeast of the lime pond. A total of 149 drums were removed during field activities in November 1992. The soils to the north and east of the Lime Pond, in the Drum Removal Area, were found to be contaminated with volatile organics up to levels of approximately 5,522,000 parts per billion (ppb) and semi-volatile organics up to levels of approximately 9,870,000 ppb.

Abandoned Railway Trench

The Abandoned Railway Trench was used as an unloading and loading area for incoming rail shipments. The railroad tracks were constructed below ground level to facilitate these operations. During the 1960s, the use of the railway trench for loading and unloading purposes decreased and it was gradually filled in with drums of off-specification coal tar enamel. Foundry sand obtained from a variety of local industry was also used to complete the filling of the trench. It is estimated that the trench was approximately 5 feet deep by 15 feet wide by 580 feet long. Soil contaminant concentrations from trench sampling for volatile organics ranged to 656,000 ppb and for semi-volatile organics 126,020,000 ppb.

Former Sludge Treatment Pit

From the early 1950s until 1979, waste water sludge from the coal tar refinery and synthetic chemicals operations was dried by placing it in the Former Sludge Treatment Pit, located in the center of the Maywood property. The sludge pit was used for thickening sludge by evaporation prior to off-site landfill disposal. The current RCRA-permitted sludge treatment area is located directly above the northern portion of this historical area. The dimensions of the original sludge pit were 110 feet long by 20 feet wide by 4 feet deep. Soil contaminant concentrations in the sludge pit sampling for volatile organics ranged to 202,900 ppb and for semi-volatiles 53,710,000 ppb.

Drainage Ditch

Prior to 1970, waste water and storm water were conveyed from the American Petroleum Institute (API) separator by the Former Drainage Ditch into the Raymond Street storm sewer, which then discharged directly to Eagle Creek. This water consisted of water separated from the raw tar, water decanted from the tar storage tanks, water separated from the oil-water separator, "wet-dry" in the refinery, blowdown water from the boiler operations, aqueous sodium sulfate from the extraction of tar acids and tar bases from the light and middle oils, and storm water entering the system due to natural drainage. Historically, the length of the ditch was 1,220 feet, the width was between 15 and 50 feet, and the depth was approximately 8 feet. Soil contaminant concentrations in the Former Drainage Ditch sampling for volatile organics ranged to 199,930 ppb and for semi-volatiles 117,120,000 ppb.

South Landfill

From the beginning of site operations in 1921 until the mid 1970s, the southern portion of the Maywood property was used as a landfil (the South Landfill) for construction debris and soil. In addition, various solid and semi-solid wastes (tars, sludges, still bottoms, tank cleanings) from the coal tar and the synthetic chemicals operations were also deposited in this area. Coal refinery wastes deposited in the area included off-specification pitches, creosoted timbers, coal, and tank car sludges and waste water sludge from the Maywood API separator. Wastes from the synthetic chemical operations were also deposited in the south landfill beginning in the 1960s. These wastes included waste water sludge from the API separator and distillation residues from various unit processes including vinylpyridine residue and 3-pyridine carbonitrile residue. Dimensions of the south landfill were approximately 1,000 feet by 200 feet. A dug well, or fire pond, was situated at the extreme southeast corner of the south landfill, but it dried up after a period of time, and was reportedly filled with tars, sludges, various chemical production residues, and foundry sand. Soil contaminant concentrations in the South Landfill sampling for volatile organics ranged to 197,300 ppb and for semi-volatiles 35,280,000 ppb. Field investigations in this area also identified both NAPLs (non-aqueous phase liquids) and DNAPLs (dense non-aqueous phase liquids) as present in the ground water in the form of oily sheen and distinct oil phases in ground water samples.

1.5.3 HYDROGEOLOGIC SETTING

The Reilly site lies within the White River drainage basin, located approximately three miles to the west of the White River. Eagle Creek is an attendant tributary and flows in a southeasterly direction approximately 4,000 feet to the east of the site. Topography in the site area is relatively flat with a gentle downward slope in an easterly direction. Other surface water bodies in the site area include Blue Lake (a former gravel pit) located approximately 2,000 feet northeast of the site, several small ponds or surface water impoundments located 2,000 to 4,000 feet east of the site, and one surface-water impoundment located immediately southwest of the Maywood property. The westernmost extension of Blue Lake has been filled in since 1979.

The sand and gravel deposits that underlie almost all of the White River drainage basin form the principal aquifer in the area. In the vicinity of the site, upper and lower zones have been identified within the sand and gravel outwash aquifer. At some locations, especially directly underneath the site, these zones are separated by one or more till units which, because of their silt content, are less permeable layers and may impede flow vertically. The upper and lower zones are referred to as the “shallow aquifer” and “deep aquifer” in site documents. Based on site cross-sections provided to the RSE team, “shallow” wells are typically screened approximately 20-40 ft below ground surface, and “deep” wells are generally screened in the range of 50-100 feet below ground surface. In the April 2003 “Annual Linear Regression Analysis” report it is suggested that an “intermediate aquifer” may also be present at some locations. The lack of a continuous fine grained unit and similar ground water levels in shallow and deep wells suggest that the upper and lower zones of the outwash sand and gravel deposits are hydraulically connected and that the till units do not act as a significant barrier to contaminant flow in ground water.

Bedrock underlies the sand and gravel deposits. To the east of the site, bedrock is approximately 100 feet below ground surface. However, bedrock is much shallower in portions of the on-site area (such as near RI-17, where bedrock is more like 50 feet below ground surface based on cross sections provided to the RSE team). It was reported during the RSE visit that the subsurface material on-site is more like a till and therefore less conductive compared to the off-site area to the east, and therefore less water is produced in on-site extraction wells than can be produced off-site to the east.

There are three industrial well fields located to the east of the site that, in the 1990s, had a reported combined pumping rate of 10 million gallons per day, or approximately 7,000 gpm. Regional hydrogeologic data indicate that ground water in the unconsolidated material in the area of the Reilly site flows east towards Eagle Creek with a southerly component. Water level data from the RI indicate that ground water flow is generally from the northwest to the southeast and that withdrawals from the neighboring industrial production wells significantly impact the flow of ground water east of the site, thus providing a barrier to further movement of ground water impacted by the site to the east. Hydraulic conductivities for wells tested during the RI range from 10^{-2} to 10^{-3} centimeters per second (it is not clear from documents provided to the RSE team which wells were tested). An average linear ground water velocity of 0.68 feet per day was calculated in the RI for the area that is not influenced by the industrial pumping to the east of the site, and an average linear ground water velocity of 2.0 feet per day was calculated in the RI for the area that is influenced by the industrial pumping.

1.5.4 RECEPTORS

In May 1984, the Marion County Health Department (MCHD) declared the industrial area in the vicinity of Reilly to be a threat to the safety of ground water for use by humans for drinking and ordered all of the private water well users identified in the area to connect to the city water main and to properly abandon and seal their private wells. The MCHD declared that the use of well water in this area was a violation of the Code of the Health and Hospital Corporation of Marion County, Chapter 18, Section 18-803. At the direction of U.S. EPA, the MCHD recanvassed the survey area in August 1996. The survey results indicated that all properties in the survey area were connected to city water and that no existing wells were confirmed.

Institutional controls allow Reilly to use the ground water under the site for industrial purposes (non-contact cooling water) only after obtaining the express written approval of U.S. EPA, or any successor federal governmental department or agency. Industrial ground water production continues at neighboring properties east of the site. This water is only used for industrial purposes. When pumping at rates observed in the 1990's, these off-site wells provide a hydraulic barrier to further eastern migration of impacted ground water.

During the RI, it was determined that there was no significant risk to the environment from site contamination, primarily due to an absence of a suitable habitat for wildlife and the absence of any significant onsite surface water accumulations.

1.5.5 DESCRIPTION OF GROUND WATER PLUME

The risk assessment determined that three chemicals in the ground water are of primary concern: benzene, pyridine/pyridine derivatives, and ammonia. Other chemicals that were detected in the ground water are also of concern but were not found at the same frequency or amounts. Concentrations have decreased substantially at many wells since the P&D remedy was first implemented in 1994, but there are wells located on-site and off-site where concentrations remain elevated at concentrations more than 100 times the cleanup levels (discussed in more detail in Section 4.2.3). High concentrations are generally found in shallow wells on-site, but higher concentrations are found off-site to the east at the intermediate or deep wells (such as at RI-19D) . This may be the result of natural downward hydraulic gradients, or may be the result of downward hydraulic gradients caused by off-site industrial pumping.

2.0 SYSTEM DESCRIPTION

2.1 SYSTEM OVERVIEW

A “pump-and-discharge” (P&D) system operates at the site in an attempt to contain ground water at the site boundary. There is no ground water treatment prior to discharge to the POTW. The P&D system originated in 1994, and has been modified several times (detailed in Section 2.2). The current P&D system contains five extraction wells, operating at a combined rate of approximately 220 gpm. MNA is the selected ground water remedy for the off-site ground water.

There is also an SVE system located on the Oak Park property associated with OU4, in the vicinity of monitoring well location RI-18. The RSE did not focus on the performance or operation of the SVE system. However, it is noted that the SVE system started operation in 1999 and consists of 10 wells that are rotated (5 passive and 5 active at any point in time).

2.2 EXTRACTION SYSTEM

The current extraction system includes the following wells (see Figure 1):

Extraction Well	Other Name For Well	Well Depth (ft)	Screen Depth (ft)	Screen Length (ft)	Typical Rate (gpm)
PW-1 (S)	Maywood Well (S)	32	27-31	4	17*
PW-1 (D)	Maywood Well (D)	58.5	53-58	5	132*
PW-2R	Oak Park Well	28.5	23-25	2	15
PW-3	Orchard Well	53	12-52	40	35
PW-4	PW-4	69.5	25.5-65.5	40	20

* Combined flow for PW-1(S) and PW-1(D) is typically reported, the separate flow estimates were provided during the RSE site tour

The original two wells put in operation in 1994 were in the locations of PW-1 and PW-2 (see Figure 1). PW-3 and PW-4 were added in 1997 based in part on numerical modeling that suggested those locations for improved plume capture. PW-3 is located on the northern Oak Park property, and PW-4 is located approximately 1,200 feet south of PW-1. PW-1 (D) replaced original well PW-1 (located a few feet from the current well) in 2002. The original PW-1 began producing sand following a jet-washing procedure. Well PW-2R was installed in 2002 as a replacement to original well PW-2 (located a few feet from the current well). The original PW-2 was broken and separated at the top of the screen. PW-1 (S) was installed in 2003 to increase overall production rate near PW-1, and induce more drawdown in the shallow aquifer.

Based on extraction well sampling in September 2003, benzene was <5 ug/l at all the extraction wells except PW-2R, where it was 231 ug/l. The total mass of benzene removed is therefore mostly from PW-2R, and can be approximated as follows:

PW-2R (~15 gpm, ~231 ug/l benzene)

$$\frac{15\ \text{gal.}}{\text{min.}} \times \frac{231\ \text{ug}}{\text{L}} \times \frac{3.785\ \text{L}}{\text{gal.}} \times \frac{1440\ \text{min.}}{\text{day}} \times \frac{2.2\ \text{lbs}}{10^9\ \text{ug}} = \frac{0.04\ \text{lbs}}{\text{day}}$$

Other wells (~200 gpm, ~5 ug/l benzene)

$$\frac{15\ \text{gal.}}{\text{min.}} \times \frac{231\ \text{ug}}{\text{L}} \times \frac{3.785\ \text{L}}{\text{gal.}} \times \frac{1440\ \text{min.}}{\text{day}} \times \frac{2.2\ \text{lbs}}{10^9\ \text{ug}} = \frac{0.01\ \text{lbs}}{\text{day}}$$

Therefore, approximately 0.05 pounds per day of benzene is currently being removed by the extraction wells. This is extremely low. Pyridines are no longer monitored at these wells, but mass removal is likely to be similarly low

2.3 TREATMENT SYSTEM

There is no on-site treatment system for extracted ground water, which is discharged to two POTWs operated by the City of Indianapolis:

- Southport Wastewater Treatment Plant
- Belmont Wastewater Treatment Plant

In addition to approximately 225 gpm of extracted ground water sent to these POTW's, approximately 350 gpm of plant process water is also sent to the POTWs. The northern wells (PW-2, PW-3) discharge to the Southport plant, and the remaining wells plus the process water discharge to the Belmont plant.

2.4 MONITORING PROGRAM

For ground water monitoring some wells are monitored quarterly while others are monitored semi-annually or annually. This schedule is detailed below:

Monitoring Frequency	List of Wells
Quarterly	RI-4S, RI-4D, RI-5S, RI-5D, RI-6S, RI-6D, RI-8S*,RI-16S*, RI-16D*, RI-17S, RI-17D, RI-18S, RI-18D, RI-19S, RI-19D,
Semi-Annual	RI-11S, RI-11M, RI-11D, RI-15S, RI-15M, RI-15D, PW3, PW8
Annual	RI-2S, RI-9S, RI-9D, RI-23S, RI-25S, RI-28S, RI-29S, RI-30S, RI-31S, RI-32S,RI-33S, RI-34S, RI-35S, RI-36S

**RI-8S, RI-16S, and RI-16D are listed as "annual" in site database, but sampling has historically been quarterly.*

In a meeting in June 2002, it was decided that "MNA data" would also be collected at selected wells. For wells on the quarterly list, the following parameters are measured: DO, ORP, temperature, and conductivity. At selected wells (RI-16S/D, RI-11M, RI-18 S/D, RI-19 S/D) additional parameters measured are sulfate, methane, Fe^{+2}, and Fe^{+3}.

Water levels are measured quarterly, and potentiometric surface maps are produced quarterly. A Trend Analysis Report is prepared annually, to evaluate concentration trends over time for benzene, total pyridine, and ammonia. The purpose is to track effectiveness of the perimeter containment system and to track progress of MNA in OU5 (off-site ground water). The ground water wells for which trend analysis is conducted are grouped as follows:

Well Grouping	List of Wells
Background Wells (3)	RI-16S, RI-16D, RI-23S
On-site Wells (3)	RI-2S, RI-18S, RI-18D
Perimeter Wells (9)	RI-5S, RI-5D, RI-6S, RI-6D, RI-8S, RI-9S, RI-9D, RI-17S, RI-17D
Off-site Wells (10)	PW3, PW8, RI-11S, RI-11M, RI-11D, RI-15S, RI-15M, RI-15D, RI-19S, RI-19D

For ground water discharged to the POTW, some parameters (TSS, ammonia, flow) are measured monthly, and remaining parameters are measured semi-annually.

3.0 SYSTEM OBJECTIVES, PERFORMANCE AND CLOSURE CRITERIA

3.1 CURRENT SYSTEM OBJECTIVES AND CLOSURE CRITERIA

The remedial objectives for the five operable units are summarized below:

- OU1 - According to the OU5 ROD, which finalized the interim action for OU1, "the first operable unit action was selected by EPA to stop further off-site migration of contaminated ground water by installing a ground water extraction system/treatment system. This action provided adequate time to study and remediate on-site source areas as well as to prevent the further contamination of area ground water resources by contaminants migrating from the Reilly site." According to the ROD for OU5, the "the perimeter ground water extraction system, selected as an interim remedy for OU1, is an integral component of the final ground water cleanup for the site" and that "the GWIRM [Ground Water Interim Remedial Measures] system will be in operation until the cleanup and performance standards listed in Table 2 [of the OU5 ROD] are met at the facility boundary". The ground water criteria, as confirmed by Reilly, are those listed in Table 5 of the OU1 ROD.

- OU2, OU3, OU4 - The remedies selected in the RODs for OU 2, 3, and 4, were intended to remediate sources of ground water contamination located on the Reilly site, and/or mitigate the contributions of these areas to the ground water contamination problem.

- OU5 - the cleanup objective for the OU5 area is to restore ground water to drinking water quality for future use and the remediation levels are MCLs. The point of compliance is the property boundary, and ground water at the point of compliance must meet the cleanup criteria mentioned above.

The cleanup standards for the primary contaminants of concern in ground water are summarized in the following table.

Contaminant Exceeding Standard	Cleanup Standard
Benzene	5 ppb
Pyridine (individual compounds)	35 ppb
Ammonia	30 ppm*

**errantly listed as 10 ppm in the OU1 ROD text*

The OU1 ROD lists cleanup standards for several other VOC and SVOC compounds, as follows: trichloroethene - 5 ppb; ethylbenzene - 700 ppb; toluene - 1000 ppb; total xylenes - 10,000 ppb; benz(a) anthracene - 100 parts per trillion (ppt); benzo (a) pyrene - 200 ppt; benzo (b) fluoranthene - 200 ppt; benzo(k) fluoranthene - 200 ppt; chrysene - 200 ppt; dibenz(a,h) anthracene - 300 ppt; indeno (1,2,3 -c,d) pyrene - 400 ppt.

In the FFS for OU5, it was estimated that ground water in the OU5 area would achieve cleanup standards in 1.5 to 16 years, depending on the contaminant. The OU5 ROD stated that the remedy will be monitored on a continual basis over time to ensure that the selected remedy continues to be protective. U.S. EPA will immediately reevalute the remedy to determine if it continues to provide the levels of protection to human health and the environment outlined in the ROD if either of the following occurs:

- off-site industrial water users modify their extraction rates significantly or discontinue ground water extraction at any point in the future

- long term ground water monitoring shows that contaminant decay is not occurring at the rates predicted in the ground water modeling results presented in the FFS

If it is determined by U.S. EPA that the remedy is no longer protective, then U.S. EPA will take the appropriate steps necessary to provide protection of human health and the environment. The item pertaining to contaminant decay is the basis for preparing an annual "Trend Analysis Report".

The site team indicated that they plan to operate the current perimeter pumping system for a long time, but also indicated they might at some point seek to discontinue pumping before cleanup standards are met based on risk arguments, but it is unclear what levels at the site boundary or off-site would allow the pumping to be discontinued.

3.2 TREATMENT PLANT OPERATION STANDARDS

There is no on-site treatment, and extracted ground water is discharged directly to POTWs. The RSE team was provided with several "Self Monitoring Reports" (SMR's) for individual extraction wells, and they indicate the following "daily maximum levels" that are measured monthly:

- ammonia - 20 mg/l
- pH - range of 5 to 12
- TSS - 300

According to an email from Reilly subsequent to the RSE site visit, the ground water discharge permit no longer requires sampling for pyridine. As discussed earlier, water from some of the extraction wells is mixed with plant effluent, and the plant effluent is sampled under a different permit (unrelated to ground water).

4.0 FINDINGS AND OBSERVATIONS FROM THE RSE SITE VISIT

4.1 FINDINGS

The RSE team observed a site where ground water concentrations have decreased substantially at many wells, indicating the initial success of the remedies. However, elevated concentrations persist at some wells on-site and off-site. There is no treatment plant at the site, so this RSE does not pertain to optimization of on-site treatment processes. Rather, this RSE focuses on hydrogeologic issues, such as the effectiveness of ground water capture, the progress of MNA, etc. and cost-effective approaches to evaluate and/or enhance the performance of the remedy The RSE team also noted a good working relationship between the responsible party and the EPA RPM. 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

Water levels are measured quarterly, and potentiometric surface maps are produced quarterly. Figure 2 and Figure 3 illustrate water levels for the shallow and deep aquifers, respectively (the contours were interpreted by Environmental and Geological Consultants, Inc.). Ground water flow in both aquifers is generally to the east, and is influenced by on-site extraction (PW-1 to PW-4) and significant off-site extraction to the east. Note that the contours interpreted on those figures are based on water levels measured at the extraction wells, which are likely much lower than the surrounding aquifer material as a result of well losses. Without piezometers located near the extraction wells, the interpretation of water levels near the extraction wells is subject to considerable uncertainty, and extent of capture interpreted using such water levels may overestimated.

4.2.2 CAPTURE ZONES

The chosen Alternative 3 in the OU1 ROD indicated that 8 to 12 wells pumping a total of 1,200 gpm to 1,450 gpm would be needed to meet the containment objectives. The current extraction rate is about 220 gpm. The discrepancy in the flow rates from the ROD was due to the installed wells not producing as much water as expected, due to the relatively low conductivity of the aquifer materials on-site (relative to more productive aquifer materials to the east). The five year review conducted by EPA in 2000 concludes that "after the addition of the two extraction wells [PW-3 and PW-4] to the system, the entire system has been evaluated and is currently meeting the ROD performance goal of containment at the eastern property boundary". During the RSE site visit this conclusion was said to be based on the volume pumped and looking at contour maps. As discussed above, however, it is difficult to assess capture at the site boundary using the contour maps because the contour maps rely on water levels measured at operating extraction wells due to lack of piezometers near those extraction wells. Furthermore, a significant capture zone in the shallow aquifer (where the majority of on-site contamination is observed) is not apparent on Figure 2. The EPA RPM indicates that previous flow modeling performed in the 1997 timeframe supports that plume capture would be achieved with the current system (that modeling resulted in the installation of PW-3 and PW-4).

The portion of the eastern site boundary between extraction wells PW-1 and PW-4 is an area of particular concern with respect to capture effectiveness. These extraction locations are approximately 1,200 feet apart. Monitoring well RI-5S, located between these two extraction wells, had concentrations exceeding 500 ug/l for both benzene and total pyrdines in the last sample of 2002, and off-site well RI-19D (located downgradient of RI-5S) had concentrations exceeding 1,000 ug/l for both benzene and total pyridines in the last sample of 2002. The deep water levels at RI-4D (north of PW-1) and RI-5S (south of PW-1) are lower than surrounding wells, and indicate some potential for successful capture in the deep aquifer. However, the same cannot be said based on the water level map for the shallow aquifer, which is where most of the on-site contamination is found. Also, in both the shallow and the deep aquifer, there are not enough water level measurements immediately downgradient of the extraction wells to clearly delineate an actual capture zone.

A significant issue at this site regarding capture is that the extraction wells produce water with relatively low concentrations of site contaminants. As discussed in Section 2.2, PW-2 is the only extraction well that removes ground water with detectable benzene (pyridines are no longer monitored in the extraction wells). PW-2 is a relatively shallow well. For well clusters on-site, the contamination is generally in the shallow wells (e.g., RI-17S, RI-4S, RI-18S, RI-5S), and for well clusters off-site, the contamination is generally greater at depth (e.g., RI-15M and RI-15D, RI-11M, RI-19D). Although most of the on-site contamination is in the shallow wells, most of the water pumped from the on-site extraction wells is from the deep aquifer (e.g., approximately 60% of the extracted water is from deep well PW-1, and nearly 25% of the extracted water is from PW-3 and PW-4, which have 40-foot screens). It is possible that the majority of water captured by the current on-site extraction system is from the deep, less contaminated aquifer, and that shallow ground water is not effectively captured (particularly between PW-1 and PW-4) and subsequently migrates off-site, where it is then transported downward due to the influence of the off-site pumping wells.

Simple capture zone analyses (such as analytical calculations of capture zone width) are complicated at this site for several reasons. First, such calculations assume uniform hydraulic conductivity, but it was stated during the RSE site visit that hydraulic conductivity varies considerably at this site, and in particular increases to the east. Second, such calculations assume uniform aquifer thickness, but at this site the shallow, intermediate, and deep aquifers are hydraulically connected to a some degree, making specification of aquifer thickness difficult. In addition, aquifer thickness appears to also vary considerably by location. Third, the wells pump at vastly different pumping rates (ranging from less than 20 gpm to more than 100 gpm), complicating any such analysis. Finally, background conditions are likely impacted by the significant off-site pumping to the east. Due to the heterogeneity and three-dimensionality of the site flow conditions, a thorough capture evaluation will likely require water level measurements at additional locations, or the use of a calibrated three-dimensional numerical ground water flow model in conjunction with particle tracking.

The OU5 ROD defines the “compliance point” as the eastern property boundary. It states that “the GWIRM system will be in operation until the cleanup and performance standards...are met at the facility boundary”. The OU5 ROD further states that “in determining the point of compliance for this final action, U.S. EPA considered the following factors: there are multiple sources of contamination on the Reilly site, and through previous actions, U.S. EPA has left waste in place...” This compliance point appears reasonable for determining whether or not pumping should continue at the facility boundary if the goal is to prevent water impacted above cleanup levels from migrating offsite beyond the capture zone that is created by such pumping (i.e., in conjunction with MNA for OU5). However, the RSE team notes that the extraction wells are located close to the eastern site boundary, and that the stagnation point (the downgradient edge of the capture zone) associated with the on-site extraction may extend several hundred feet east of the site boundary. Thus, under current pumping conditions it should be expected that ground water above cleanup levels will persist at some distance (perhaps several hundred feet) beyond the eastern property boundary. This impacted ground water would be within the capture zone and therefore could remain above cleanup levels for a longer period of time than other wells in OU5.

If capture at the site boundary is not sufficient, and continuing sources of dissolved contamination remain on site, then MNA may not remediate the offsite portion of the plume (such as at RI-19D) within the timeframe stated in the OU5 ROD. However, even if capture at the eastern site boundary is not sufficient, the Allison (Rolls Royce) production wells downgradient of the site likely capture any off-site plume that might persist in the aquifer at that distance from the site. In fact, site contaminants might not persist to a distance as far as the Allison wells. The RSE team noted during the site visit that, as ground water flows to the east, it is possible the ground water becomes more aerobic, which may promote natural remediation of the contaminants east of the site. Samples from Allison Well #3 have shown no detections of Reilly site contaminants since 1997, which may be due to natural attenuation with distance (as discussed above) and/or due to dilution with other water pumped by the Allison wells. Allison is aware of the potential Reilly impacts to the water quality in their wells.

All downgradient potable well use has been terminated and institutional controls are in place. The nearest environmental receptor is Eagle Creek about 4,000 feet east of the site. It is extremely unlikely that the site contamination could reach this creek, because the industrial pumping creates a hydraulic barrier (as long as such pumping continues) and aquifer conditions are likely more aerobic in the downgradient direction, which promotes natural degradation of the contaminants of concern.

4.2.3 CONTAMINANT LEVELS

Concentrations have decreased substantially at many wells since the P&D remedy was first implemented in 1994. Some examples are provided below:

Examples of Wells With Significant Concentration Decreases Since 1994

Location	Well	Max Conc 1994-1995	Max Conc 1999-2000	Max Conc. 2002
onsite, north property (near SVE system)	RI-18S	Ben: 16,000 Pyr: 65,900 Am: 51	Ben: 20,000 Pyr: 196,000 Am. 13	Ben: 60 Pyr: 166 Am: 14
onsite, north property (eastern site boundary)	RI-17S	Ben: 7,700 Pyr: 51,720 Am: 281	Ben: 250 Pyr: 333 Am: 170	Ben: 230 Pyr: 182 Am: 23
off-site: east of north property	RI-15D	Ben: 1,500 Pyr: 1,294 Am: 27	Ben: 260 Pyr: 327 Am: 11	Ben: 100 Pyr: 105 Am: 16
off-site: east of north property	RI-11M	Ben: 2,200 Pyr: 882 Am: 59	Ben: 950 Pyr: 294 Am: 100	Ben: 330 Pyr: 187 Am: 74
on-site, south property (near PW-4)	RI-6S	Ben: 1,800 Pyr: 2,651 Am: 12	Ben: ND Pyr: ND Am: 7	Ben: ND Pyr: ND Am: 2

Location	Well	Max Conc 1994-1995	Max Conc 1999-2000	Max Conc. 2002
off-site: east of south property	RI-19S	Ben: 2,200 Pyr: 841 Am: 16	Ben: 910 Pyr: 281 Am: 17	Ben: 30 Pyr: 96 Am: 3

Ben = Benzene (ug/l) Pyr = Total Pyridines (ug/l) Am = Ammonia (mg/l)

Despite impressive concentration reductions at these wells, concentrations remain above the cleanup levels at some of these wells. The cleanup criteria are 5 ug/l for benzene, 35 ug/l for individual pyridine compounds, and 30 mg/l for ammonia.

There are other wells located on-site and off-site where concentrations remain elevated at significantly higher concentrations than at the example wells listed above. Figure 4 illustrates wells where the latest sample in 2002 had benzene greater than 500 ug/l and/or total pyridines greater than 500 ug/l. These wells are summarized below:

Wells Where Last Sample in 2002 had Benzene and/or Total Pyridines Exceeding 500 ug/l

Location	Well	Last Conc.	Comments
on-site, north property (between PW-1 and PW-2)	RI-4S	Ben: 130 Pyr: 6,978 Am: 46	
on-site, south property (upgradient of PW-4)	RI-32S	Ben: 75 Pyr: 4,522 Am: 7	
on-site, south property (upgradient of PW-4)	RI-33S	Ben: 530 Pyr: 3,441 Am: 75	
on-site, south property (upgradient of RI-5S)	RI-30S	Ben: ND Pyr: 771 Am: 4	
on-site, south property (between PW-1 and PW-4)	RI-5S	Ben: 810 Pyr: 646 Am: 11	Concentrations relatively stable since 1996
off-site, south property (downgradient of RI-5S)	RI-19D	Ben: 1,300 Pyr: 1,522 Am: 11	Had much lower concentrations 1996 to 1998 which then increased to current values 1999-2002

Ben = Benzene (ug/l) Pyr = Total Pyridines (ug/l) Am = Ammonia (mg/l)

The declining concentrations at many wells suggest that the remedies to date (P&D, SVE, excavation, etc.) have been successful at reducing continuing impacts to ground water, while the high concentrations that persist at some wells indicate there continue to be some on-site areas where sources of ground water contamination may remain, especially on the south property but potentially on the north property as well (e.g., there are no ground water monitoring points immediately upgradient of PW-4S). Well RI-19D is of particular concern because it is located off-site and has relatively high concentrations of benzene and total pyridines that increased to current values after initially decreasing to much lower concentrations between 1996 and 1998. Well RI-19D is also located in a potential “capture zone gap” between extraction locations PW-1 and PW-4, as discussed in Section 4.2.2.

Also of note is that high concentrations are generally found in shallow wells on-site, but off-site to the east (such as at RI-19D) higher concentrations are found at the intermediate or deep wells. This may be the result of natural downward hydraulic gradients, or may be the result of downward hydraulic gradients caused by off-site industrial pumping.

4.3 COMPONENT PERFORMANCE

4.3.1 EXTRACTION SYSTEM WELLS, PUMPS, AND HEADER

Each Reilly extraction well has a well head building containing well controls including amperage shutoff and a flow meter, pressure indicator, check valve, throttling valve, sample port and air release valve on the carbon steel pipe within the structure. Above ground piping outside of the structure is heat traced and insulated. Grundfos pumps are used.

4.3.2 SYSTEM CONTROLS

System controls at the wellheads are summarized in Section 4.3.1. There are no centralized system controls.

4.4 COMPONENTS OR PROCESSES THAT ACCOUNT FOR MAJORITY OF O&M COSTS

During the RSE site visit, the annual costs for system O&M were estimated based on YTD costs (approximately 75% of the year completed), and are summarized in the table below. Annual costs are estimated to be approximately $392,000 per year for the P&D system and $55,000 per year for the SVE system.

P&D SYSTEM

Item Description	Estimated Cost
Labor: Consulting and GW Sampling	$40,000 per year
Well & Pump Maintenance, Electrical Repairs	$78,000 per year
Agency Oversight	$55,000 per year
Utilities: Electricity	$14,000 per year*
Disposal Fees (POTW)	$175,000 per year
Laboratory (GW Monitoring)	$30,000 per year
P&D Subtotal	**$392,000 per year**

** This cost is estimated by the RSE team based on total pump horsepower, see section 4.4.1*

SVE SYSTEM

Item Description	Estimated Cost
Labor: SVE	$20,000 per year
Utilities: Electricity	$5,000 per year*
Agency Oversight	$30,000 per year
SVE Subtotal	**$55,000 per year**

** This cost is estimated by the RSE team based on total pump horsepower, see section 4.4.1*

Thus, the total for the two systems is approximately $447,000 per year.

4.4.1 UTILITIES

Electrical costs are not tracked for the ground water remediation system versus the rest of the site operations. However, during the RSE site visit it was estimated that ground water pumps had a total of approximately 20 Hp and the five SVE blowers had a combined 7.5 Hp. Assuming an electricity rate of approximately $0.08/kWh, this would translate to an annual cost of approximately $14,000 per year for the P&D system and approximately $5,000 per year for the SVE system.

4.4.2 NON-UTILITY CONSUMABLES AND DISPOSAL COSTS

The pumped water is discharged to the POTW at a cost of $1.18 per 1,000 gallons, and total cost per year was reported at $150,000 to $200,000 per year. This is the largest annual cost item at the site. It was discussed during the RSE site visit that Indianapolis currently has one of the lowest POTW rates in the country. However, this is expected to rise in the future, perhaps up to 3 times higher, due to required system improvements.

4.4.3 LABOR AND MAINTENANCE COSTS

Labor cost is relatively low at this site, because there is no active ground water treatment system. Of the estimated $60,000 per year, approximately $20,000 is associated with operating the SVE system, and the reminder is primarily for ground water monitoring and reporting.

A contractor is used for well and pump maintenance, at cost of approximately $77,000 per year. This is a significant percentage of annual O&M costs and results because multiple wells need cleaning approximately two times per year and some wells (e.g., PW-2) as much four times per year. The site is hoping to reduce these costs in the future with new approaches. Additional costs for electrical repairs are estimated at $1,000 per year.

4.4.4 CHEMICAL ANALYSIS

At the RSE site visit it was estimated that annual cost for laboratory analysis was approximately $30,000 per year.

4.4.5 OVERSIGHT COSTS

At the RSE site visit, it was estimated that agency oversight costs (i.e., EPA and the State) charged to the site are typically on the order of $85,000 per year. Of that, perhaps $30,000 per year pertains to oversight costs for the SVE system, and the remainder is for ground water.

4.5 RECURRING PROBLEMS OR ISSUES

There have been issues regarding well fouling at the site for the extraction wells. In the Trend Analysis Report (April 2003) it states that, at PW-2, the original well had “water cascading down the interior of the well screen”, and that was thought to increase the onset and extent of well fouling. The replacement well at PW-2 was therefore constructed with a shorter (2 foot) screen. Similarly, the replacement well at PW-1(D) in 2002 was constructed with a short (5 foot) well screen.

4.6 REGULATORY COMPLIANCE

No problems were noted during the RSE site visit or document review.

4.7 TREATMENT PROCESS EXCURSIONS AND UPSETS, ACCIDENTAL CONTAMINANT/REAGENT RELEASES

No reagent releases or accidents were reported to the RSE team.

4.8 SAFETY RECORD

No problems were reported to the RSE team.

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

5.1 GROUND WATER

The current system removes little mass and possibly does not meet the ROD goal of containment at the site boundary (particularly between PW-1 and PW-4). In addition, some wells off-site (particularly RI-19D) have high VOC concentrations (e.g., benzene and total pyridines concentration in ground water exceeding 1,000 ug/l). However, all downgradient potable well use has been terminated and institutional controls are in place, so that protection of human health is likely provided.

5.2 SURFACE WATER

The nearest environmental receptor is Eagle Creek about 4,000 feet east of the site. It is extremely unlikely that the site contamination will reach this creek because the industrial pumping creates a hydraulic barrier (as long as such pumping continues) and aquifer conditions are likely more aerobic in the downgradient direction, which promotes natural degradation of the contaminants of concern.
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5.3 AIR

No issues regarding air were identified during the RSE site visit. Off-site the highest contaminant levels are at depth, while shallow ground water is relatively clean. As a result, volatilization will not likely cause impacts to off-site structures. On-site there are some areas where ground water has elevated VOC concentrations, and the RSE team is not aware if potential for impacts to indoor air quality have been evaluated to date.

5.4 SOILS

Soils have been addressed by OU2, OU3, and OU4 and were not a focus of this RSE.

5.5 WETLANDS AND SEDIMENTS

The nearest environmental receptor is Eagle Creek about 4,000 feet east of the site. It is extremely unlikely that the site contamination will reach this creek because the industrial pumping creates a hydraulic barrier (as long as such pumping continues) and aquifer conditions are likely more aerobic in the downgradient direction, which promotes natural degradation of the contaminants of concern.

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.

There is no treatment plant at the site, so this RSE does not pertain to optimization of on-site treatment processes. Rather, the focus of this RSE is on hydrogeologic issues and related site goals and site exit strategy. In developing the recommendations, the RSE team considers cost-effectiveness for the life-cycle of the remedy. The RSE team believes there are two "big-picture" approaches that could be considered at this site:

- Approach 1: Continue Current Approach. This approach seeks to achieve plume containment using on-site extraction, plus MNA for the area beyond the capture zone of on-site extraction, plus capture of any potentially impacted off-site ground water by off-site industrial wells to the east.

- Approach 2: Discontinue On-Site Extraction. This approach allows impacted ground water to migrate to the east towards the off-site industrial wells, and relies on a combination of institutional controls, natural remediation, and capture of any potentially impacted off-site ground water by off-site pumping wells to the east.

The recommendations provided below are based on Approach 1, since that is the basis of the current P&D system and is consistent with the latest OU5 ROD. The advantages and disadvantages of Approach 2 are discussed in Section 6.4.

6.1 RECOMMENDATIONS TO IMPROVE EFFECTIVENESS

6.1.1 INSTALL PIEZOMETERS AND MONITORING WELLS TO ALLOW FOR IMPROVED EVALUATION OF PLUME CAPTURE

The RSE team suggests the installation of one piezometer cluster (for measurement of water levels only) and one monitoring well cluster (for measurement of water levels and concentrations), to improve the evaluation of plume capture provided by on-site extraction wells. Suggested locations are as follows:

- Piezometer cluster (shallow and deep), downgradient of PW-1S/1D (on-site or immediately adjacent to Tibbs Road), for quarterly water level measurements

- Monitor well cluster (shallow and deep), north of RI-19S/19D near the intersection of Minnesota Street and Centennial Avenue, for quarterly water levels and concentration monitoring according to the same schedule as RI-19D.

The purpose of the piezometer cluster near PW-1S/1D is to better understand aquifer levels near the area of greatest site pumping. This will aid in the evaluation of potentiometric surfaces for both the shallow and deep aquifer, and will also help with calibration of a numerical flow model if one is created/updated. The purpose of the monitoring wells north of RI-19S/19D is to have an additional off-site monitoring well cluster (in addition to RI-19S/19D) to evaluate concentration trends over time. The RSE team notes that on-site monitoring well RI-4S has very high levels of total pyridines (nearly 7 ppm in the last sample of 2002). The suggested well cluster is located downgradient of RI-4S. If concentrations in this new well cluster decrease to below MCLs, then this result would provide substantial evidence that capture of the contamination near RI-4S is adequate.

Capital costs for installing these piezometers and monitoring wells might cost $40,000, including development of a work plan, oversight by a geologist, and documentation in a short report. Collection of water levels at additional points should not increase annual costs significantly. Additional monitoring of concentrations might add $5,000 per year.

6.1.2 PERFORM IMPROVED PLUME CAPTURE EVALUATION (INCLUDING USE OF A NUMERICAL MODEL)

After the monitoring points suggested in Section 6.1.1 are installed, and one round of water levels that includes the new points is available, an attempt should be made to interpret actual capture of the existing extraction system in three dimensions. This evaluation should include the following components:

- Draw a map that illustrates the "target capture zone" in three dimensions (i.e., for both the shallow and deep aquifers). This target capture zone should indicate the locations along the eastern site boundary where capture is desired (i.e., the spatial limits of target capture to the north and to the south), and should also indicate that conceptually the actual capture zone will extend off-site given the proximity of the extraction wells to the eastern site boundary.

- Interpret potentiometric surface maps relative to the target capture zone for both the shallow and deep aquifers without biasing the interpretation with water levels from operating extraction wells.

- Construct/update a three-dimensional numerical flow model that accounts for large-scale heterogeneities in hydraulic conductivity and stratigraphy, includes the off-site pumping stresses, and reasonably simulates water levels in both the shallow and deep aquifers under stressed (i.e., pumping) conditions associated with the extraction system. Observed upward and downward head differences should also be predicted reasonably by the numerical model. A short-term shutdown of the extraction system (or short-term change in pumping rates), and associated water levels, could then be used to verify the model predictions under a different set of conditions. Water levels at "PW" wells should not be used for the model calibration. The model, in conjunction with particle tracking, can then be used to evaluate capture zones of the on-site extraction wells in three dimensions. The best approach is to release particles throughout the model domain at several different depths (one depth at a time) and track the particles forward to determine where they are captured.

It is expected that this entire evaluation can be performed for approximately $40,000.

6.1.3 CONSIDER THE NEED FOR A MODIFIED EXTRACTION SYSTEM

The capture zone evaluation performed in recommendation 6.1.2 will indicate if modifications to the extraction system are appropriate. Such modifications could potentially take several forms:

- Potentially adding one or more extraction points (likely in the shallow aquifer), perhaps between PW-1 and PW-4

- Potentially discontinuing extraction of deep pumping at PW-1D, and/or potentially packing off the deep portions of PW-3 and PW-4, to focus on-site extraction in the shallow aquifer

- Potential consideration of shallow air sparging in place of (or in addition to) shallow ground water extraction, to augment biodegradation of site contaminants

The numerical model constructed (or updated) as part of the recommendation in 6.1.2 can be used to evaluate different alternatives. This evaluation task is estimated to cost approximately $10,000. Since it is not clear what (if any) modifications to the extraction system might result from this evaluation, no cost estimates are provided for any modifications. It is noted, however, that there could be capital costs if new extraction wells are required, and costs of discharging water could be increased or decreased depending on the total extraction rate of a modified system (if pumping was modified to focus only on the shallow aquifer, total pumping rate and thus the cost of discharging the water could potentially go down significantly).

6.2 RECOMMENDATIONS TO REDUCE COSTS

6.2.1 CONSIDER USING EXTRACTED WATER FOR PROCESS AND COOLING WATER

The site currently uses about 350 gpm of city water at an unknown cost for process and cooling uses. It is likely that with reasonable pretreatment, pumped ground water from the extraction wells could substitute for at least a portion of this potable water. This would save costs of purchasing and subsequently discharging that water. Based on current extraction rates, the cost of discharging to the POTW is approximately $150,000 to $200,000 per year, so it is likely that up to $200,000 per year could potentially be saved if no pre-treatment is required. If pre-treatment is required, some of the annual cost savings might be offset. During the RSE site visit, Reilly indicated this idea has been previously considered and rejected. The RSE team suggests this idea be re-considered periodically, especially if POTW fees increase significantly in future years.

6.3 MODIFICATIONS INTENDED FOR TECHNICAL IMPROVEMENT

6.3.1 MINOR SUGGESTION FOR IMPROVED O&M REPORTING

The RSE team did not review any routine O&M reports that included all of the following information in one document:

- pumping rates at extraction wells
- concentrations at extraction wells
- blended concentrations at points of discharge

Site information could be more easily reviewed and evaluated if such data were presented in one document that also included historical data, as is done with monitoring well concentrations in the “Annual Linear Regression Analysis”. This recommendation should cost approximately $1,000 per year to implement.

6.4 CONSIDERATIONS FOR GAINING SITE CLOSE OUT

Based on the current ROD, pumping will continue at the on-site extraction wells as long as ground water cleanup standards are exceeded at the site boundary. As mentioned in the OU5 ROD, EPA acknowledges that there are sources of contamination that remain on-site, and therefore the potential exists for contamination at the site boundary to be impacted above cleanup levels for decades (at significant cost to the responsible party due to P&D system operation). In addition, it is possible that cleanup levels off-site will not be obtained at all locations (via MNA) within the timeframe estimated in the OU5 ROD, despite the impressive concentration reductions observed to date at some wells. As discussed in Section 6.1 of this RSE report, additional efforts including new monitoring points and a detailed capture zone evaluation (including ground water flow modeling) are recommended to determine if capture provided by the on-site extraction wells is in fact adequate to help achieve those off-site cleanup levels.

An alternate approach could be considered at this site that could ultimately save the responsible party the vast majority of future costs for operating the P&D system. The alternate approach would discontinue on-site pumping and allow impacted ground water to migrate to the east towards the off-site industrial wells. To maintain protection of human health and the environment, this approach would rely on a combination of institutional controls (that prevent the use of impacted ground water), natural remediation, and capture of any potentially impacted off-site ground water by off-site industrial wells to the east. The off-site wells would need to continue to operate for protectiveness to be maintained, but that is already a condition of the existing OU5 remedy. Obviously, this approach would require a ROD change.

Some arguments for such an alternate approach might include the following:

- Most of the contaminant reduction to date likely resulted from on-site remedial actions associated with OU2 to OU4 that have reduced the continuing source term, and more mass is likely removed currently due to natural remediation than from the P&D system. The current on-site extraction system is removing almost no contaminant mass, as discussed in Section 2.2 of this report. As a result, discontinuing extraction at these wells will likely not cause significant additional mass to migrate off-site than is currently occurring. Furthermore, if calculations were to be performed comparing the contaminant mass estimated to remain on-site to mass removed by the P&D system, it would likely be concluded that the current P&D system will not be the cause of significant on-site contaminant mass reduction in the future, and therefore extraction at these wells is not critical for on-site restoration (the current extraction wells were not in fact intended for that purpose).

- Because the on-site extraction wells are located near the eastern site boundary, the capture zone of those wells likely extends off-site to the east, perhaps several hundred feet. This off-site area within the capture zone of the extraction wells may continue to be impacted above cleanup levels for a long period of time. Therefore, some off-site impacts are expected to persist for a long period of time under the current extraction approach, and discontinuing the on-site extraction would only increase this "impacted off-site area" an incremental amount (the distance between the downgradient extent of the capture zone and the location of the Allison wells)

- If pumping is discontinued and off-site concentrations do not increase from current values, then there is no decrease in protectiveness relative to the current system (given the institutional controls that prevent water use). Therefore, an argument could be made to discontinue on-site pumping and to monitor off-site concentrations (including the new well cluster recommended in Section 6.1.1) at an appropriate frequency (perhaps quarterly) to determine concentration trends over time, with pre-set conditions that would trigger pumping to resume.

Some arguments against such an alternate approach include the following:

- It is not consistent with the current ROD, and a modified ROD would be required.
- It potentially relies more heavily on continued off-site pumping than the current remedy.
- It potentially increases the area between the site boundary and the off-site industrial wells that may remain above ground water cleanup levels for an extended period of time.

It is beyond the scope of the RSE to recommend this alternate approach in place of the existing approach. However, the RSE team suggests that this alternate approach be periodically considered by the site team and the regulators at this site because there is a potential to decrease remedy costs dramatically if all parties (including the regulators) agree that protectiveness is not negatively impacted by such an approach.

6.5 SUGGESTED APPROACH TO IMPLEMENTATION

The alternate approach suggested in Section 6.4, which includes discontinuing the P&D system, should be considered first. As stated, RSE team is not recommending that alternate approach per se, but is recommending the site team and regulators consider that alternative.

If the alternate approach is implemented, the additional monitoring well cluster in recommendations 6.1.1 should still be installed, but not the piezometer cluster. The other recommendations would no longer apply.

Assuming the on-site P&D system is to continue, recommendation 6.1.1 should be implemented as soon as feasible, followed by recommendation 6.1.2, and then 6.1.3. Recommendation 6.3.1 can be implemented with the next routine O&M report. Recommendation 6.2.1 is not a high priority, since the site team indicates it has previously been considered and rejected, and the RSE team simply recommends that it be periodically reconsidered.

7.0 SUMMARY

The RSE team observed a site where ground water concentrations have decreased substantially at many wells, indicating the initial success of the remedies. However, elevated concentrations persist at some wells on-site and off-site where . There is no treatment plant at the site, so this RSE does not pertain to optimization of on-site treatment processes. Rather, this RSE focuses on hydrogeologic issues, such as the effectiveness of ground water capture, the progress of MNA, etc. and cost-effective approaches to evaluate and/or enhance the remedy effectiveness. The RSE team also noted a good working relationship between the responsible party and the EPA RPM. 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.

Recommendations to improve effectiveness in protecting human health and the environment include adding a cluster of piezometers and a cluster of monitoring wells, and performing a detailed capture zone evaluation (including the construction (or update) and calibration of a three-dimensional numerical flow model to then be used in conjunction with particle tracking) that will indicate if modifications to the extraction system are appropriate. The one recommendation to reduce cost is to potentially use the extracted water for process or cooling water. The RSE team acknowledges that Reilly has previously considered and rejected that idea, but a future increase in the discharge costs may make it appropriate to reconsider this option. Minor additions to routine O&M reports are suggested for technical improvement. For site closeout, the RSE team recommends that an alternate approach that includes discontinuing the P&D system be considered. The RSE team is not recommending this alternate approach per se, but is recommending that it be considered by the site team and the regulators. There is a potential to decrease remedy costs dramatically if all parties (including the regulators) agree that protectiveness is not negatively impacted by such an approach.

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 ($) [1]	Estimated Change In Life-cycle Costs ($) [2]
6.1.1 Install Piezometers and Monitoring Wells To Allow For Improved evaluation of Plume Capture	Effectiveness	$40,000	$5,000	$190,000	$121,000
6.1.2 Perform Improved Plume Capture Evaluation (Including Use of a Numerical Model)	Effectiveness	$40,000	$0	$40,000	$40,000
6.1.3 Consider The Need for a Modified Extraction System	Effectiveness	$10,000	$0	$10,000	$10,000
6.2.1 Consider using Extracted Water For Process and Cooling Uses	Cost Reduction	$0	($200,000)	($6,000,000)	($3,228,000)
6.3.1 Minor Suggestion For Improved O&M Reporting	Technical Improvement	$0	$1,000	$30,000	($16,000)
6.4.1 Develop and Exit Strategy (Consider Alternate Approach)	Site Closeout	No costs estimated			

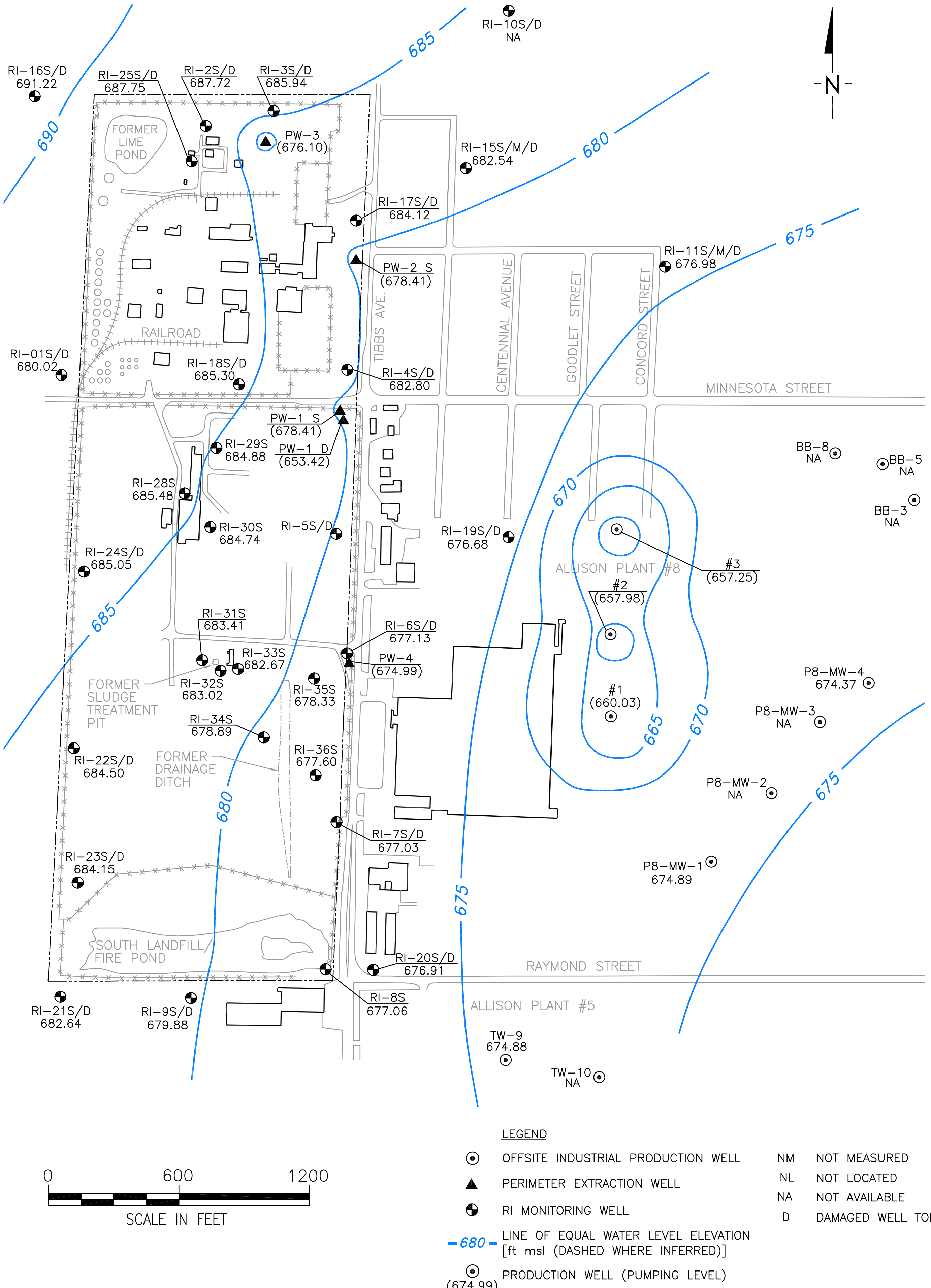
Costs in parentheses imply cost reductions.
[1] assumes 30 years of operation with a discount rate of 0% (i.e., no discounting)
[2] assumes 30 years of operation with a discount rate of 5% and no discounting in the first year

FIGURES

FIGURE 1. SITE LAYOUT AND SOURCES OF CONTAMINATION.

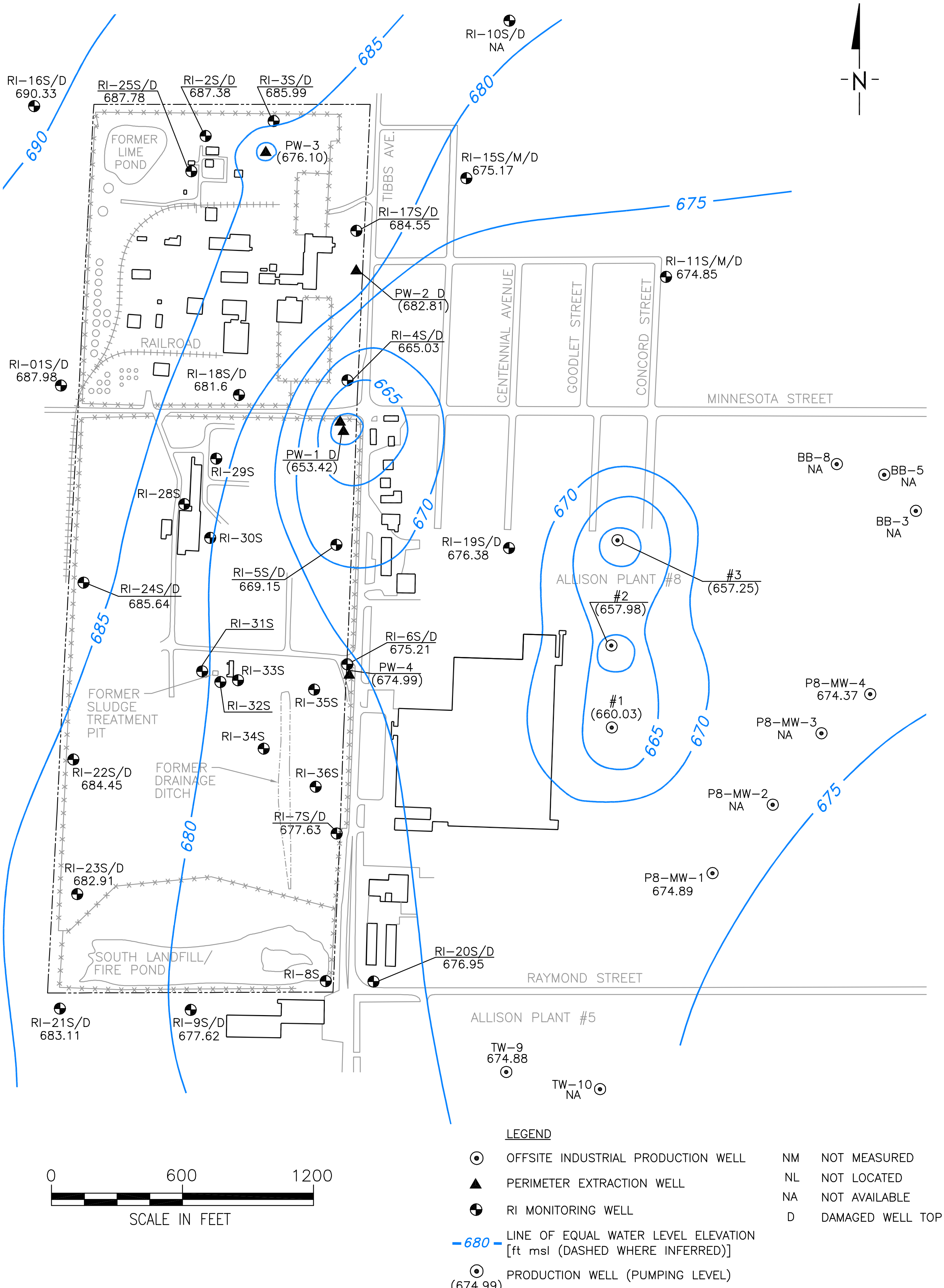
(Note: Basemap from this figure produced by ECG, Inc., potential sources from figure in Five Year Review Report.)

FIGURE 2. SHALLOW WATER LEVELS, 3RD QUARTER FY03.



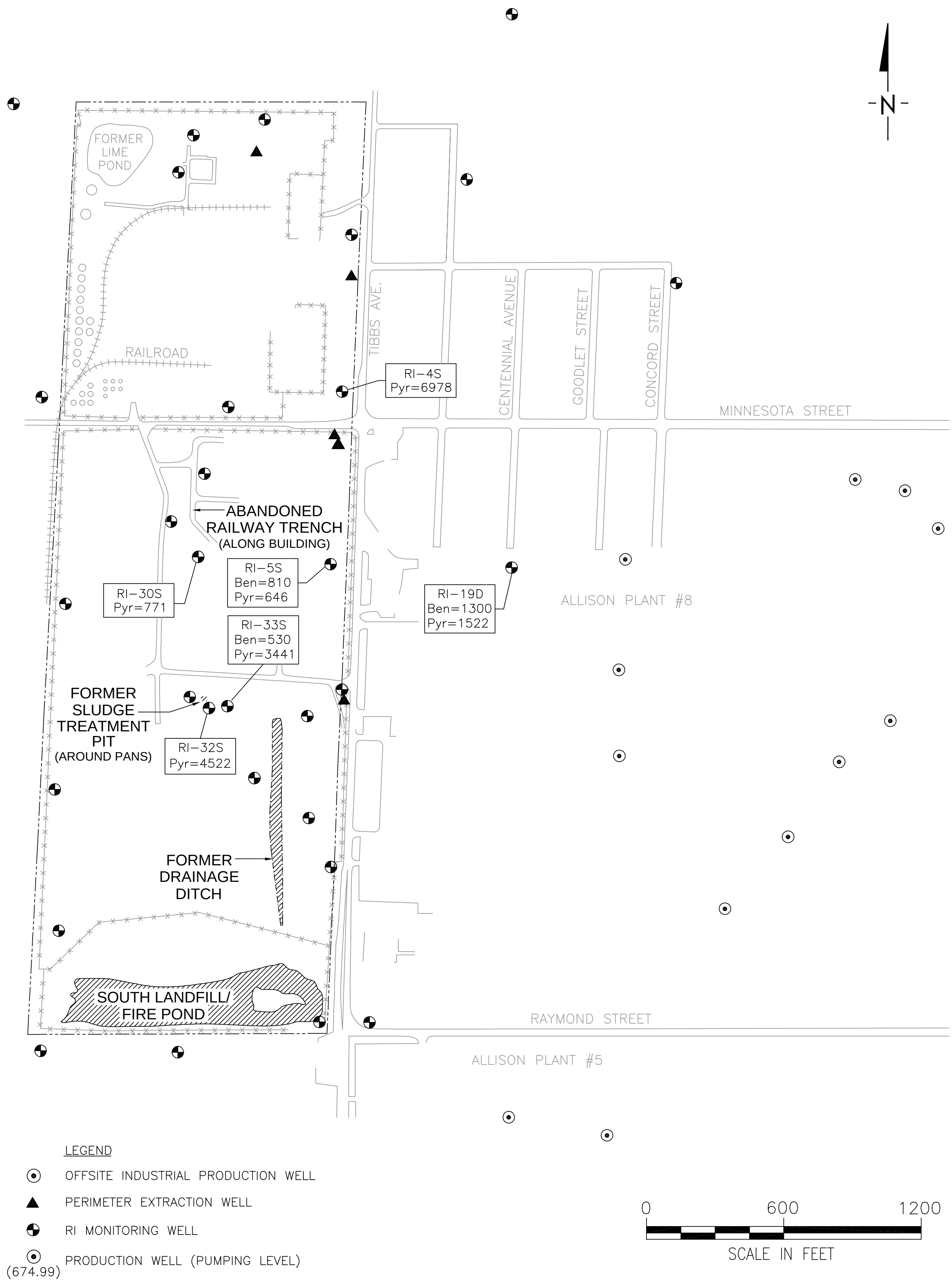
(Note: Based on figure produced by ECG, Inc.)

FIGURE 3. DEEP WATER LEVELS, 3RD QUARTER FY03.



(Note: Based on figure produced by ECG, Inc.)

FIGURE 4. WELLS WHERE LAST SAMPLE IN 2002 HAD MORE THAN 500 ug/L BENZENE AND/OR TOTAL PYRIDINES.



(Note: Basemap from this figure produced by ECG, Inc., potential sources from figure in Five Year Review Report.)