PERIODIC REVIEW

South Wilbur Petroleum Contamination Site
Wilbur, WA

CSID 1949
FSID 7096

April 2012
Washington Department of Ecology
Toxics Cleanup Program
Eastern Regional Office
Spokane, WA

TABLE OF CONTENTS

FIGURES

TABLES

1.0 INTRODUCTION

This report presents the Washington State Department of Ecology's (Ecology) periodic review for the South Wilbur Petroleum Contamination Site (Site). This periodic review is required as part of the site cleanup process under the Model Toxics Control Act (MTCA), Ch. 70.105D RCW, implemented by Ecology. Periodic reviews evaluate post-cleanup site conditions and monitoring data to assure human health and the environment are being protected. They are required for sites where an institutional control is part of the cleanup action.

Cleanup actions were conducted at the Site by Lincoln County (County) in 2005. These actions addressed contaminated soils, but residual soil and groundwater contamination remains at the Site. Groundwater monitoring has been ongoing since completion of the cleanup action, and institutional controls are in place to ensure the remedy remains protective.

2.0 SUMMARY OF SITE CONDITIONS

2.1 SITE DESCRIPTION AND HISTORY

The Site is located approximately one block south of downtown Wilbur, WA in Lincoln County (figure 1). It is comprised of three separate properties: the former Washington State Department of Transportation (WSDOT) Maintenance Facility, the Lincoln County Maintenance Facility, and the former Lincoln Mutual No. 3 fueling station. It is bounded to the north by Goose Creek, to the west by the City Park, to the south by Front Avenue and a railroad yard, and to the east by Brace Street.

WSDOT operated its maintenance facility from the 1930s through the early 1970s, when major maintenance activities moved to Davenport. Major activities included vehicle maintenance, fueling, and storage of road maintenance supplies. Diesel and gasoline were stored in underground storage tanks (USTs). By 1996, all remaining equipment and personnel had been relocated to a different facility, and the Town of Wilbur leased the property for equipment storage. In 2001, the Site was purchased by Lincoln County.

The Lincoln County maintenance facility was in operation from the 1930s through the present. Site activities were similar to the WSDOT facility, including vehicle fueling and maintenance and supply storage. Four USTs were located on the Site storing diesel, gasoline, and waste oil. All of these tanks were decommissioned and removed between 1990 and 1992.

The former Lincoln Mutual No. 3 property was the location of a fueling station, and is estimated from aerial photographs to have operated from the 1950s through the 1980s. The property contained a fueling island, a 1,900 gallon diesel AST, and is inferred from photographs to have had two USTs near the fueling island. Fueling operations were discontinued prior to purchase by the present owners. Currently, the Site building is used as office space and the surrounding land is now paved and used for parking. Figure 2 shows the locations of all properties and approximate locations of petroleum discharges (in areas where tanks were formerly located, listed as "source areas" in the figure).

2.2 PHYSICAL SITE CHARACTERISTICS

The Site is at an elevation of approximately 2150 feet (ft) above sea level and is relatively flat, with little elevation change from the northern Site boundary to several blocks south of the Site. Goose Creek runs in a ravine about 10 feet below Site elevation.

The region is semi-arid, receiving between 10 and 15 inches of precipitation annually. The majority of the precipitation occurs in winter and early spring in the form of snow. The annual mean temperature is about 50˚F.

The geology in the vicinity of the Site consists of Wanapum Basalt, a subgroup of the Columbia River Basalt. It ranges from 200 to 400 feet in thickness and is Miocene in age (CH2MHill, 2002). In the vicinity of the Site, they are approximately 200 feet thick. These basalts are overlain by variable thicknesses of alluvium and/or loess.

The main groundwater producing unit is the Wanapum Basalt, where groundwater flows through joints, fractures, and interflows. Local water supply wells receive water from this unit, and flow is artesian in many places. Overlying the basalt in the vicinity of the Site is a unit of saturated silts and clays. These materials have a higher permeability than the basalt below, but still are relatively impermeable compared to other unconsolidated aquifer materials. The range of hydraulic conductivities is estimated to be $3x10^{-4}$ feet per second (ft/s) to $1.5x10^{-4}$ ft/s. These correspond roughly to that of a silty sand. Groundwater in the shallow aquifer is not considered a source of drinking water because of its low hydraulic conductivity and low water quality. Hydraulic gradient at the Site is fairly shallow, having been measured at approximately 0.004 ft/ft. Groundwater flows generally towards Goose Creek, with some slight variation in the angle depending on the season. In times of extremely high water in the creek, the flow can decrease significantly or even temporarily reverse such that water from Goose Creek recharges the groundwater system.

2.3 PREVIOUS SITE INVESTIGATIONS

A series of investigations have taken place to aid in determining the type, amount, extent, and source of the petroleum hydrocarbon contamination. Reports documenting these investigations can be found at Ecology's Eastern Regional Office in Spokane.

In 1990, three USTs on the Lincoln County maintenance facility property were decommissioned. It is not known if there were releases related to these tanks. In 1992, one more UST was removed. Soil samples collected from the excavation showed diesel and benzene, toluene, ethylbenzene, and xylene (BTEX) compounds were not present above cleanup levels.

The WSDOT property was first investigated in June 1991, when soil contamination was discovered during the removal of two USTs. It was also noted in a June 1992 WSDOT investigation that a sump in the shop building was full of oily water.

In 1995, the Lincoln County Highway Department completed a limited Phase II Investigation on four Lincoln County maintenance facility properties, including the one in Wilbur. Results for the Site showed no petroleum contamination adjacent to and just below the asphalt wash pads, to a depth of one foot below ground surface.

In February 1995, a Phase I and Phase II Environmental Site Assessment was completed for the WSDOT property to determine potential sources and possible extent of contamination at the Site. A drywell was excavated in October of 1996 and the majority of contaminated soil was removed; however, gasoline contamination was still present in the bottom and north wall of the excavation.

In July 1996, the WSDOT performed a soil and groundwater investigation. Four monitoring wells were installed on-site and soil and groundwater samples were collected. Results indicated soil was contaminated with gasoline to a depth of around 15 feet, and groundwater had concentrations of gasoline and BTEX exceeding cleanup levels.

WSDOT completed a second site characterization in May 1997 to investigate the extent of petroleum contamination beyond their property. Three additional wells were installed on the Lincoln County property, and soil and groundwater samples were again collected. Results showed soil exceedances for gasoline, benzene, and xylene; groundwater showed levels of gasoline, BTEX, and diesel exceeding cleanup levels. A third investigation was undertaken by WSDOT because the plume appeared to be larger than originally thought. A direct-push sampling rig was used to investigate areas upgradient of both properties. Groundwater and soil results again showed soil contaminated with gasoline and xylene, and groundwater contaminated with gasoline, benzene, toluene, and xylene. Impacted areas were located to the southeast and east of the Site.

In 1999, Ecology completed a limited site investigation of the WSDOT property, the Lincoln County property, and the former Lincoln Mutual #3 property which lies upgradient of the two maintenance facilities. Soil samples were collected upgradient of both maintenance facilities to help characterize other potential sources. Soil sampling showed gasoline contamination and groundwater samples had concentrations of gasoline, diesel, and BTEX exceeding cleanup levels on all three properties.

2.4 Remedial Investigation/Feasibility Study

A Remedial Investigation/Feasibility Study (RI/FS) was completed in 2001 by Lincoln County. The RI/FS further evaluated the nature and extent of soil and groundwater contamination at all three properties comprising the Site. Samples were taken primarily from the three properties and areas immediately adjacent to the properties. Eight soil borings were installed, and soil samples were taken from several depths in these borings. Five of the eight borings were completed as temporary monitoring wells, and representative groundwater samples were taken. In addition, three surface water samples were collected from Goose Creek at locations bordering the Site.

Results showed soil and groundwater contamination with gasoline, diesel, and BTEX at concentrations exceeding cleanup levels. Surface water and sediment samples did not show contamination by any of the petroleum-related compounds. Results indicated potential source areas located near former USTs. These areas are shown in gray on figure 2.

2.5 REMEDIAL ACTIONS

Remedial actions were completed under the Cleanup Action Plan for the Site, and under Consent Decree #05-2-00143-8 between Ecology and Lincoln County. The selected remedy involved the removal of approximately 2,182 tons of petroleum-contaminated soil from three source areas in 2005. The first area was to the north and west of the Lincoln County Garage building, the second was in the area of former fuel dispensers on the Lincoln Mutual #3 property, and the third was to the east of the fuel dispensers (shown in Figures 1 and 3). This represents all accessible contaminated soil at the Site. Once contaminated soil was removed, a slurry of oxygen-releasing compound was mixed with clean backfill and emplaced into each excavation. The oxygen-releasing compound was placed at depths designed to interact with the upper surface of groundwater where residual petroleum was present. A barrier trench filled with the oxygen-releasing compound slurry was also emplaced at the downgradient edge of the three contaminated properties. This barrier was intended to interact with and help remediate residual contaminated groundwater that had already moved past the excavation treatment zones and prevent it from leaving the Site.

A phytoremediation barrier consisting of willow trees was also installed at the downgradient boundary of the three contaminated properties. The trees were intended to provide additional protection of downgradient groundwater and surface water by intercepting contaminated groundwater before it left the Site. Figure 3 shows the locations of all remedial actions.

Institutional controls were also placed on all three properties to minimize the potential for exposure to remaining contamination. Controls included fencing to limit Site access, and deed restrictions to restrict activities that may interfere with the integrity of the cleanup action or cause an exposure to contamination.

The cleanup action required quarterly monitoring of all twelve monitoring wells at the Site. Samples were collected for all Site indicators, which included gasoline, diesel, and BTEX. Additionally, parameters designed to track the biological breakdown of contaminants were measured, including dissolved oxygen, nitrate, ferrous iron, and sulfate.

3.0 PERIODIC REVIEW

3.1 REGULATION

Under WAC 173-340-420, a periodic review of the cleanup action takes place at least every five years after the initiation of the cleanup action. A periodic review is required at sites where any of the following occur:

- The department conducts a cleanup action.
- The department approves a cleanup action under an order, agreed order, or consent decree.
- As resources permit, whenever the department issues a no further action opinion.

AND one of the following conditions exists:

- An institutional control and/or financial assurance is required as part of the cleanup action.
- Cleanup level is based on a practical quantitation limit as provided for in WAC 173-340-707.
- Modifications to the default equations or assumptions using site-specific information would significantly increase the concentration of hazardous substances remaining at the site after cleanup or the uncertainty in the ecological evaluation or the reliability of the cleanup action is such that additional review is necessary to assure long-term protection of human health and the environment.

Because the cleanup action was performed under a consent decree and institutional controls are required, the site is subject to periodic reviews at a frequency of no less than every five years.

3.2 BASIS

This review is based on documents describing the actions listed in Section 2.5. These include periodic groundwater compliance monitoring reports submitted quarterly and annually from 2006 through 2012.

3.3 EFFECTIVENESS OF COMPLETED CLEANUP ACTIONS

All accessible contaminated soils were removed from the Site. Due to the low permeability of Site soils, limited options to remediate contaminated groundwater were available at the time of the remedial action. The phytoremediation barrier and application of oxygen-releasing compound were intended to provide some level of groundwater remediation, by helping create an environment conducive to natural biodegradation of petroleum contaminants.

Since the sources of petroleum contamination were near buildings, it was expected that some amount of contamination remains under the buildings. This soil was not able to be excavated, yet remains as a potential ongoing source of contamination to groundwater.

Oxygen-releasing compound immediately begins degrading and providing oxygen to the subsurface. However, over time the material becomes depleted and loses its impact. It is likely it has lost its ability to provide oxygen, and is no longer effective.

The performance of the phytoremediation barrier is questionable. Due to semi-arid conditions, it has been difficult to establish the trees. Many have died and have needed replacement. Of those that survived, growth has been limited to less than 5 feet. It is likely they have not had a significant impact on controlling the movement of or affecting the cleanup of groundwater.

Institutional controls at the Site include access restrictions and a restrictive covenant. Fencing is regularly checked and maintained. Restrictive covenants for all three properties, which limit the uses of the Site, were recorded with the County Assessor's office and are in place. These limitations include limitations on groundwater withdrawal and use, restrictions on subsurface work in contaminated soil, and restrictions on activities which would interfere with the performance of the remedy. These institutional controls have proven effective in reducing exposure and protecting the integrity of the remedy.

Groundwater contaminant concentrations have been monitored quarterly since September 2006 at all eleven Site monitoring wells as shown in Figure 2 (well MW-5 was removed during the cleanup action). Monitoring wells MW-7, MW-8, MW-9, MW-11, and MW-12 have shown no exceedance of cleanup levels for gasoline, benzene, ethylbenzene, or xylene. Diesel has only had two exceedances at those wells; one very early at MW-7 with no exceedances since, and one only slightly above cleanup levels at MW-11. Toluene has remained below cleanup levels at all the wells on-site. Therefore, an analysis of contaminant trends will only be performed on wells MW-1 through MW-6 and MW-10, and for all contaminants except toluene. Table 1 shows the concentration data, and figures 4 through 9 show concentration trends at all monitoring wells. Table 2 shows the cleanup levels for groundwater at the Site. These cleanup levels are based on Method A for unrestricted use.

Mann-Kendall statistical tests were performed on wells MW-1, MW-2, MW-3, MW-4, MW-6, and MW-10 for the contaminants exceeding cleanup levels. Table 3 shows the results of the analysis. Positive Kendall tau values indicate increasing trends, and negative Kendall tau values indicate decreasing trends. The greater the positive or negative value is, the stronger the trend is.

MW-2 and MW-6 have the highest contaminant concentrations. MW-2 shows strongly decreasing trends for every contaminant, likely due to this well's location immediately downgradient of the excavation areas. MW-6 shows primarily increasing trends, with only diesel showing a significant decreasing trend. This well is likely still being impacted from contaminated soil that remains below the building, and doesn't show effects from the excavations because it is upgradient of them. MW-1 didn't have high concentrations before the cleanup action, but trends are decreasing. MW-10 shows decreasing trends for all contaminants; however, concentrations of gasoline and diesel still exceed cleanup levels. Trends at MW-3 are mixed; diesel is the only contaminant with a decreasing trend. MW-12 shows no contamination, and MW-1 shows limited to no contamination. Since these two wells are at the downgradient edge of the property, contaminants do not appear to be leaving the Site at the north and northwest Site boundaries. However, trends at MW-4 do not appear to be changing and concentrations of gasoline, diesel, and benzene exceed cleanup levels. Its location at the western boundary may indicate off-property exceedances of cleanup levels.

The groundwater remedy relies on the biodegradation of contaminants. Levels of terminal electron acceptors are measured to show biodegradation is occurring at the Site. At contaminated wells, lower levels of oxygen, nitrate, and sulfate and higher levels of ferrous iron indicate the microbial degradation of contaminants. Table 4 presents concentrations of electron acceptors. Changes can be observed by comparing contaminated wells to MW-9, the clean background well. At MW-9, the changes in electron acceptors are not present. Biodegradation is occurring at this Site, but slow groundwater movement limits access to the electron acceptors needed to break down contaminants.

The selected cleanup action was estimated to have a reasonable restoration time frame of 3 years. Improvements in groundwater quality have occurred, but since groundwater still exceeds cleanup levels, that time frame has not been achieved. This indicates that the cleanup action as originally designed has not been entirely successful, and additional actions should be taken at the Site.

3.4 New scientific information for individual hazardous substances or mixtures present at the Site

No new scientific information is available for gasoline, diesel, or BTEX.

3.5 New applicable state and federal laws for hazardous substances present at the Site

MTCA has been amended since the CAP was written. In 2007, updates were made to the way cleanup levels were calculated for certain mixtures of chemicals. However, no changes impacted the chemicals at this Site. No new federal or state laws would affect any contaminants at the Site.

3.6 Current and projected Site and resource uses

Lincoln County still owns both the County Maintenance facility and the former WSDOT maintenance facility. Both are used for the storage, maintenance, and repair of county vehicles. The use has not changed since the remedy, and is not expected to change. Upgrades have been made to the facility such as paving maintenance areas and adding connections to storm sewers.

The former Lincoln Mutual #3 property use also has not changed since the remedy. The building is currently used for storage, and is not expected to change.

Groundwater under the Site is not currently used as a drinking water supply, and is not expected to change.

3.7 Availability and practicability of more permanent remedies

A “permanent” cleanup action is defined in MTCA as a cleanup action in which cleanup standards can be met without further action being required. Soil removal was performed as a part of the remedy because it was determined to be a permanent cleanup action.

No permanent remedies were available for groundwater due to the low permeability of the soil. However, some remedies are considered more permanent than others. At the time of the remedial action, oxygen releasing compound was the most appropriate technology to encourage bioremediation of chemicals in groundwater. Monitoring indicates the oxygen releasing compound is no longer effective. Additional technologies may now be available to provide an ongoing source of electron acceptors to increase the biodegradation of contaminants. These technologies should be evaluated to determine their suitability in a low permeability environment.

3.8 AVAILABILITY OF IMPROVED ANALYTICAL TECHNIQUES

No improved analytical techniques are available.

4.0 CONCLUSIONS

Ecology has determined the remedy at the South Wilbur Petroleum Contamination Site is generally protective of human health and the environment. However, due to the very slow rate of biodegradation and the inability to meet the restoration time frame, additional technologies should be evaluated to increase that rate. Lincoln County will be required to submit a report that researches additional groundwater treatment technologies. After evaluating them, if an option is determined to be feasible, a plan to pilot test that option should be included. Additionally, the replacement of dead trees in the phytoremediation barrier will be discontinued, due to their limited success and effectiveness. Continued groundwater monitoring will measure groundwater impacts and trends, and will determine if additional technologies can increase the biodegradation rate. Despite increases in contaminant concentrations and exceedances of cleanup levels, institutional controls in the form of deed restrictions remain effective in preventing exposure to contamination. Further periodic reviews will be required as long as institutional controls are in place at the Site, in accordance with WAC 173-340-420(7).

5.0 REFERENCES CITED

CH2MHill, 2002, Lincoln County Remedial Investigation/Feasibility Study Report, South Wilbur Petroleum Contamination Site

GeoEngineers, 2006, Cleanup Action Report, South Wilbur Petroleum Contamination Site

Washington State Department of Ecology, 2007, Model Toxics Cleanup Act Regulation Chapter 173-340 WAC

FIGURES

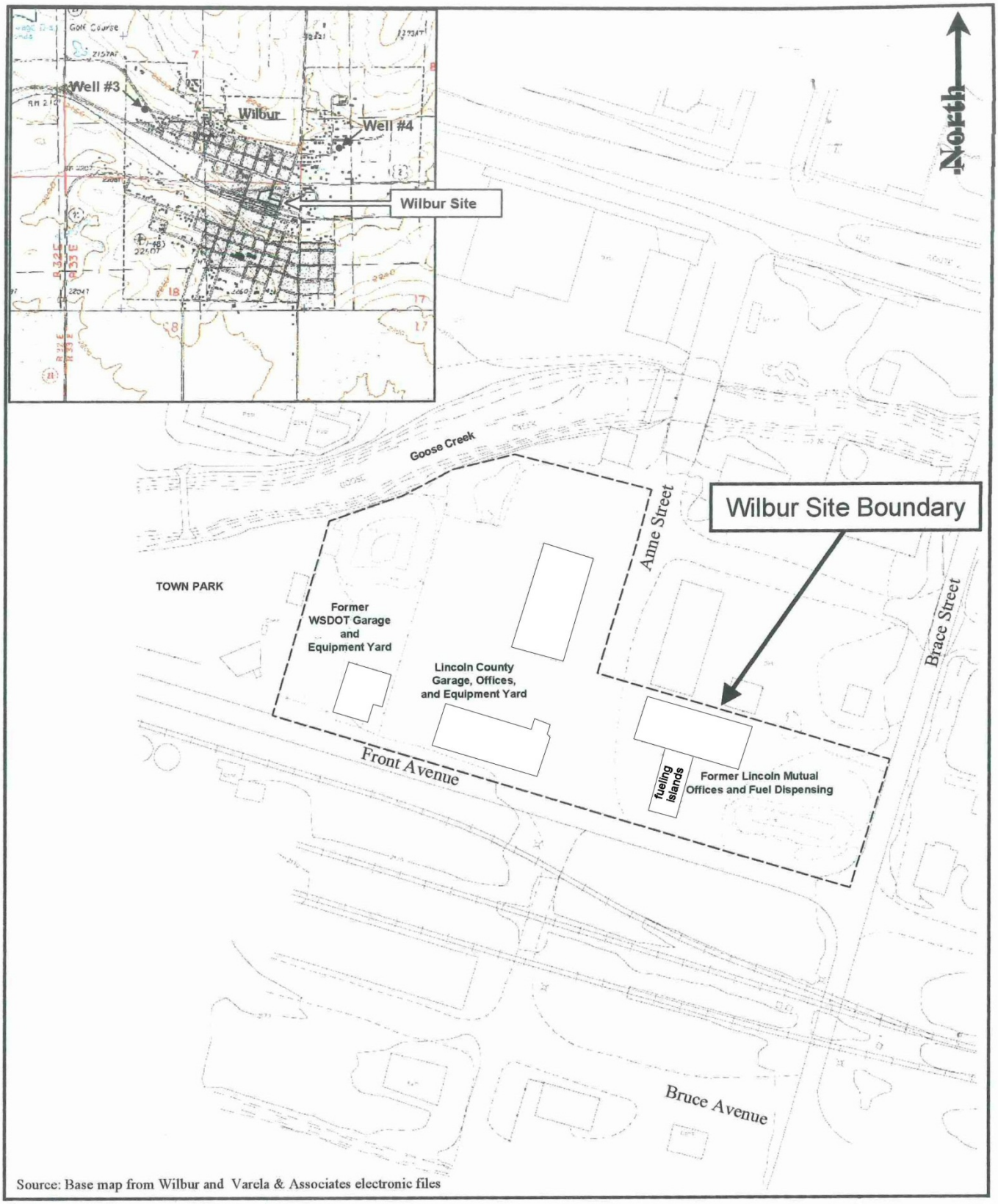

Figure 1. Site Location & Layout (modified from CH2MHill 2002)

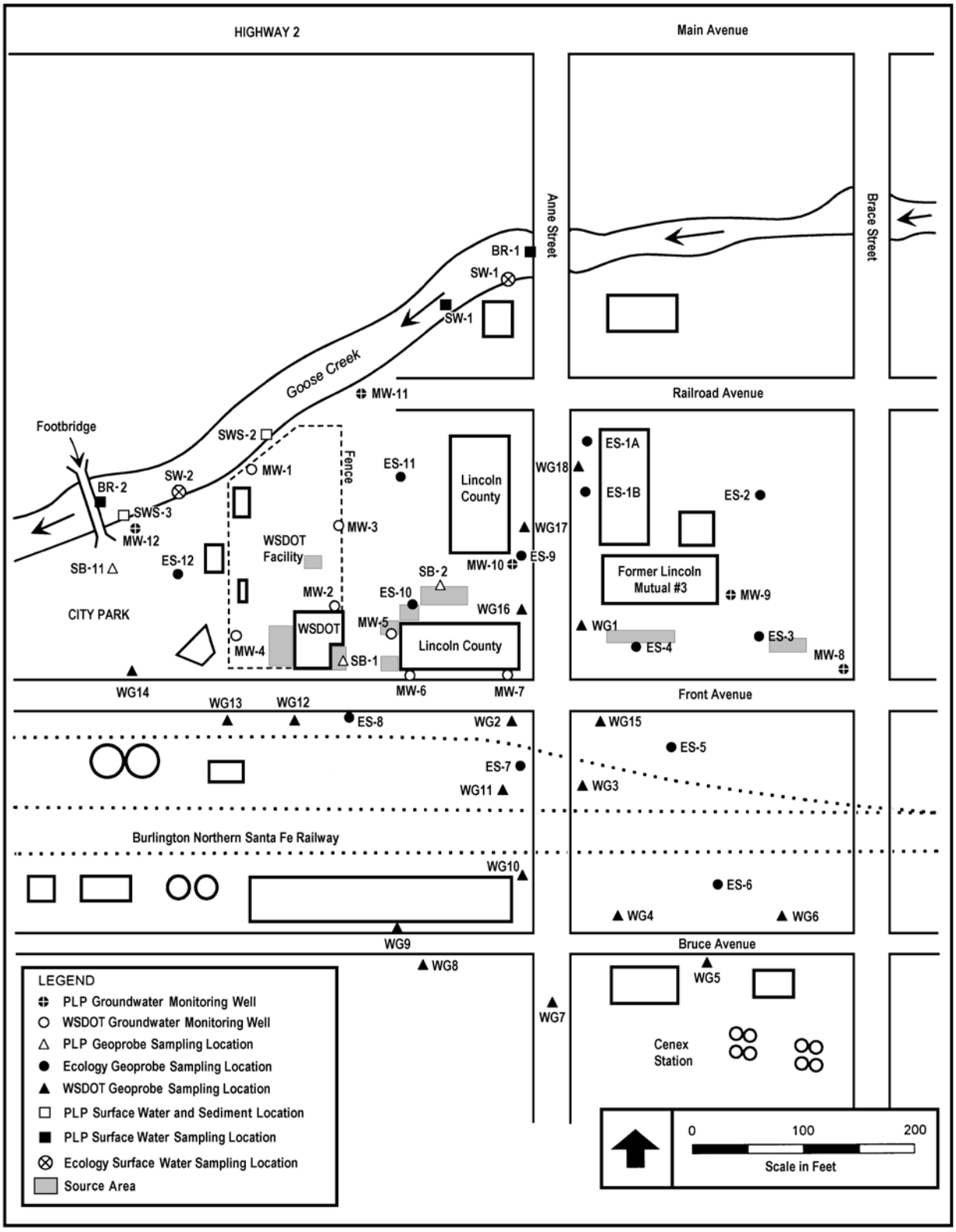

Figure 2. Investigation Locations & Source Areas (CH2MHill 2002)

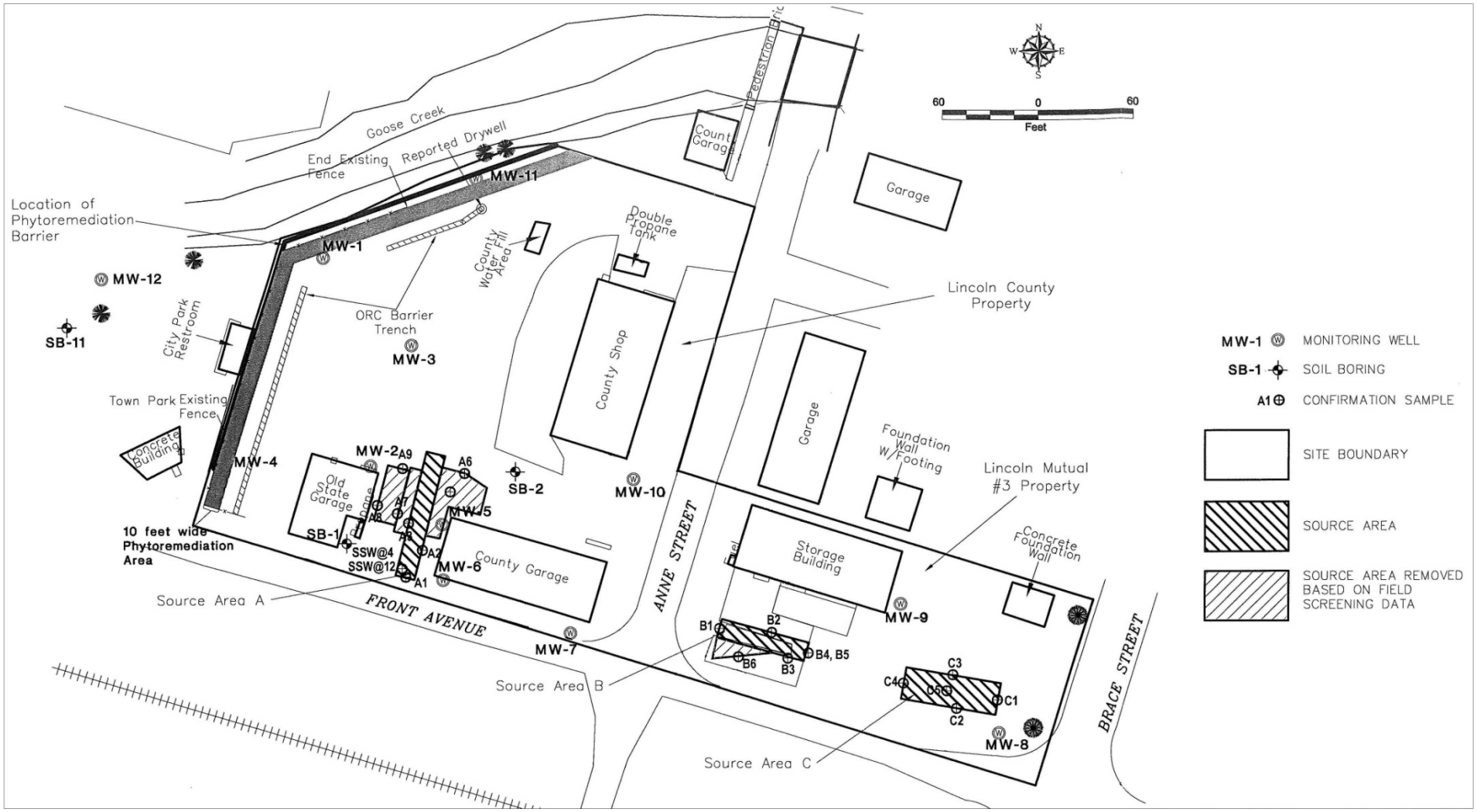

Figure 3. Locations of Remedial Actions (modified from GeoEngineers 2006)

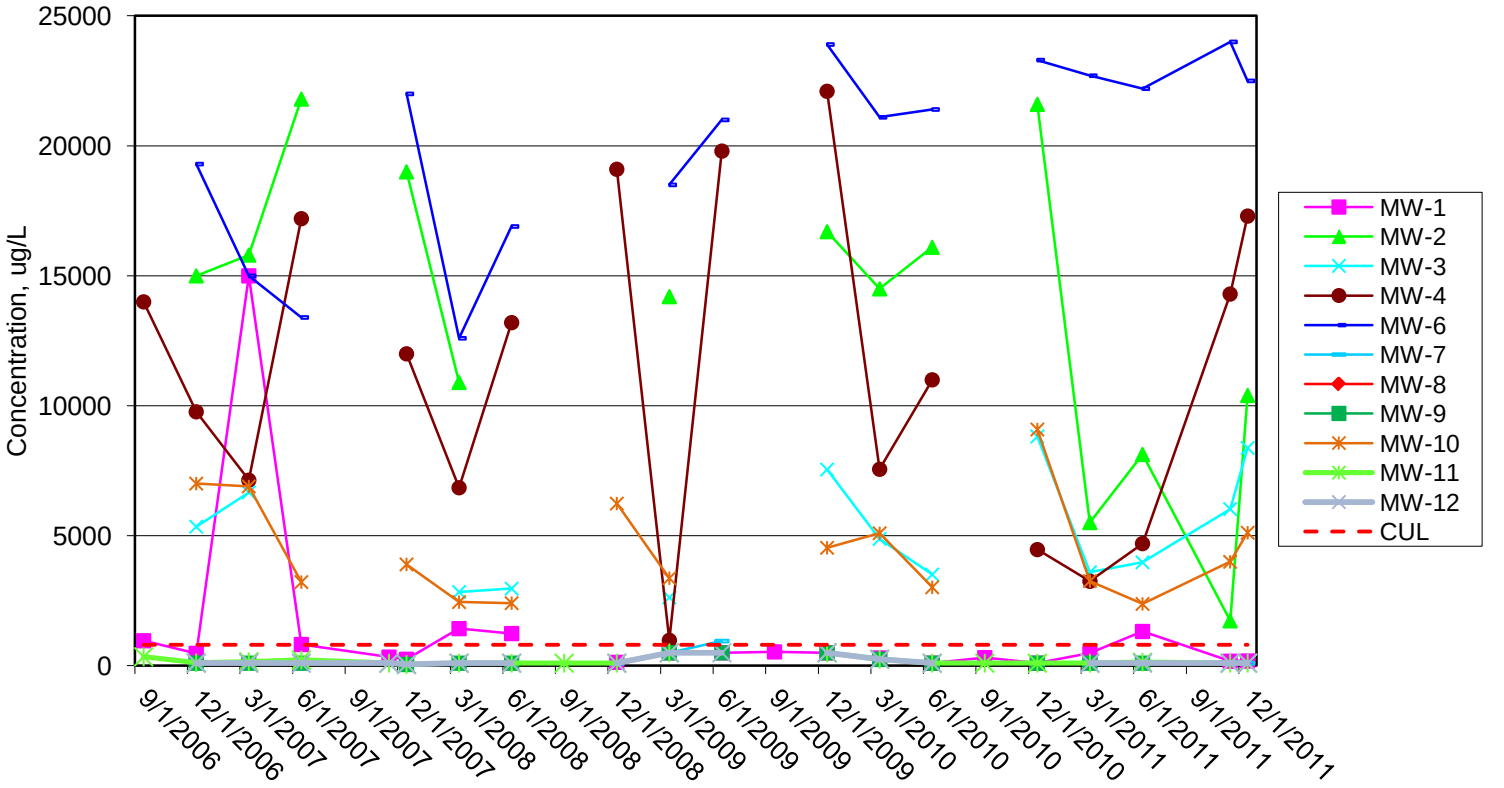

Figure 4. Gasoline Concentrations

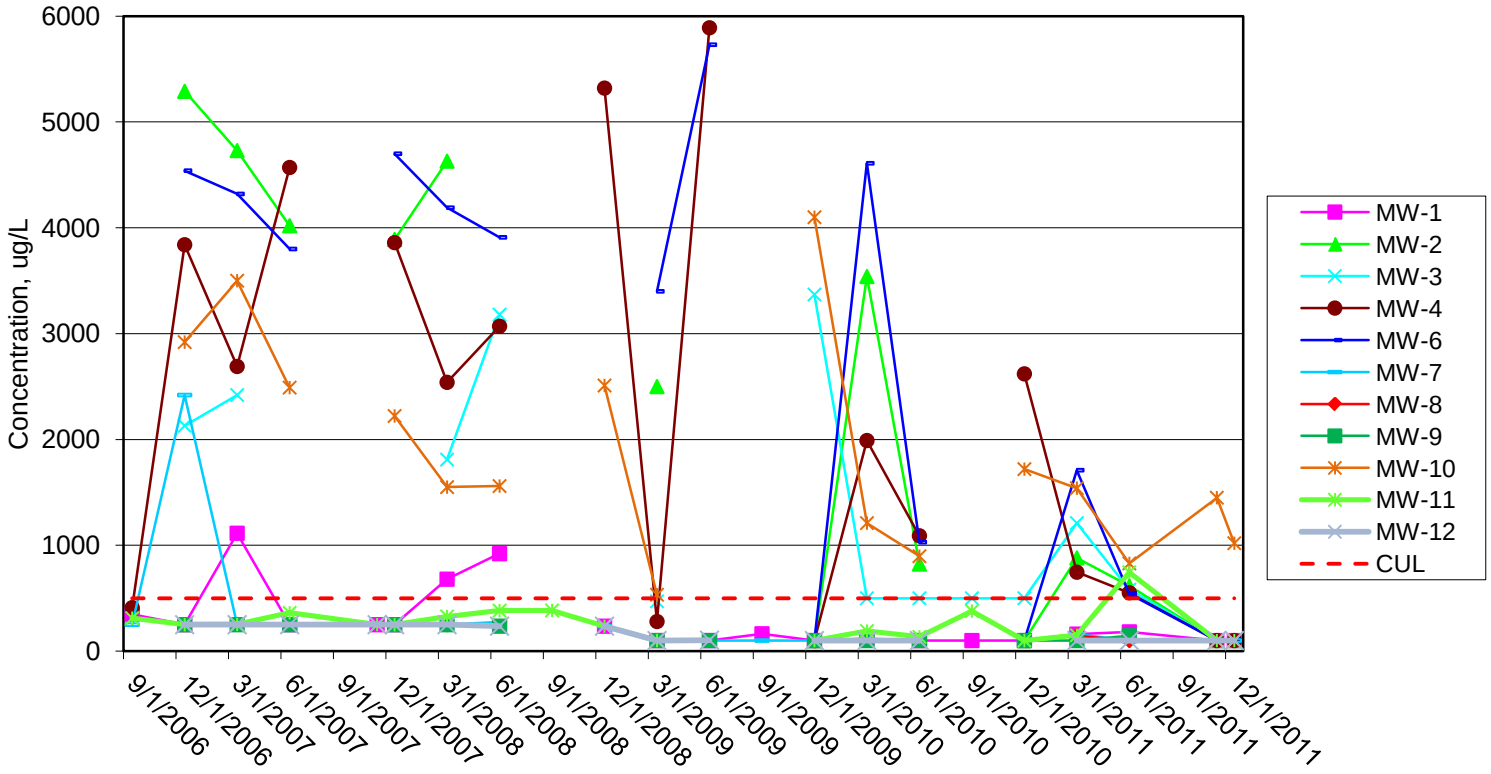

Figure 5. Diesel Concentrations

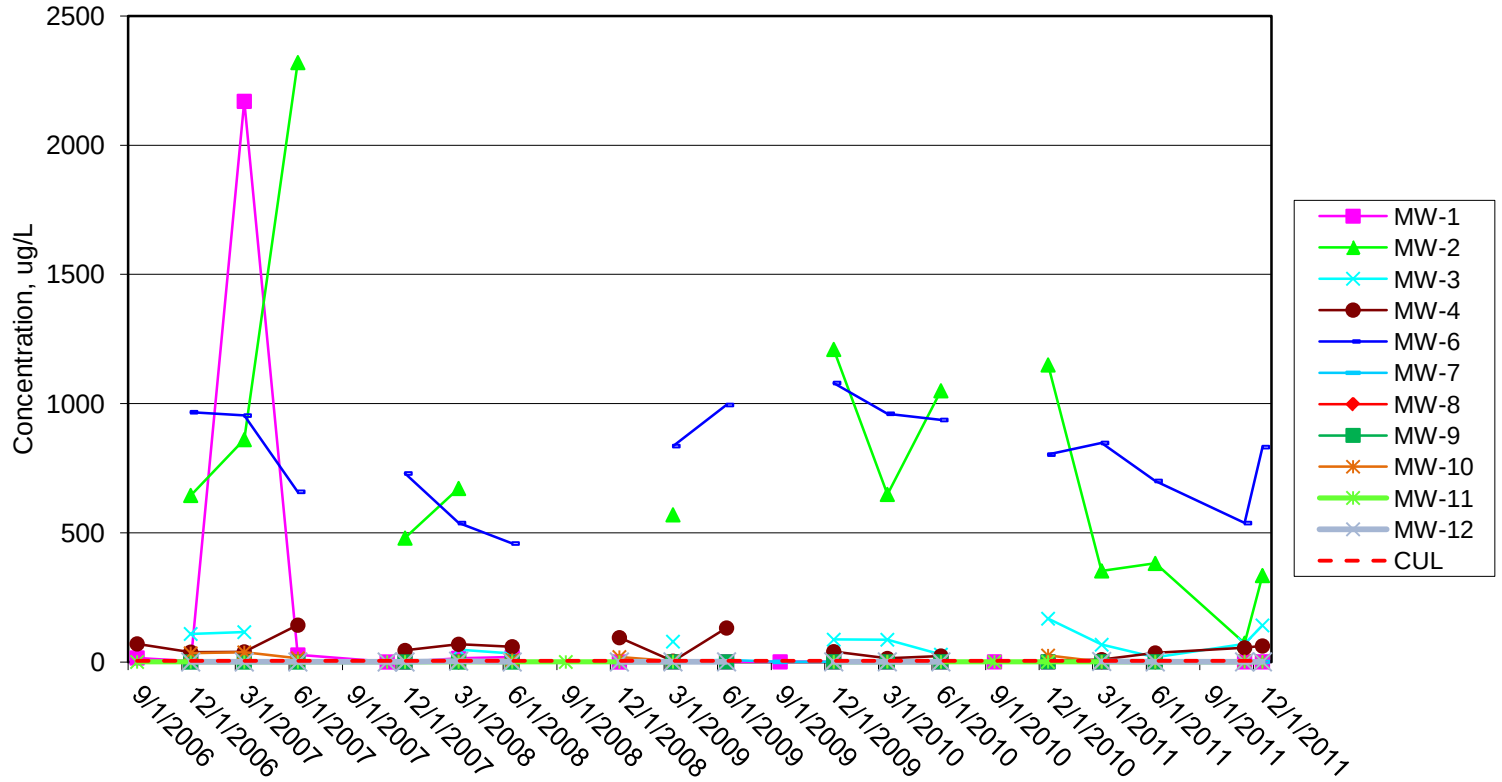

Figure 6. Benzene Concentrations

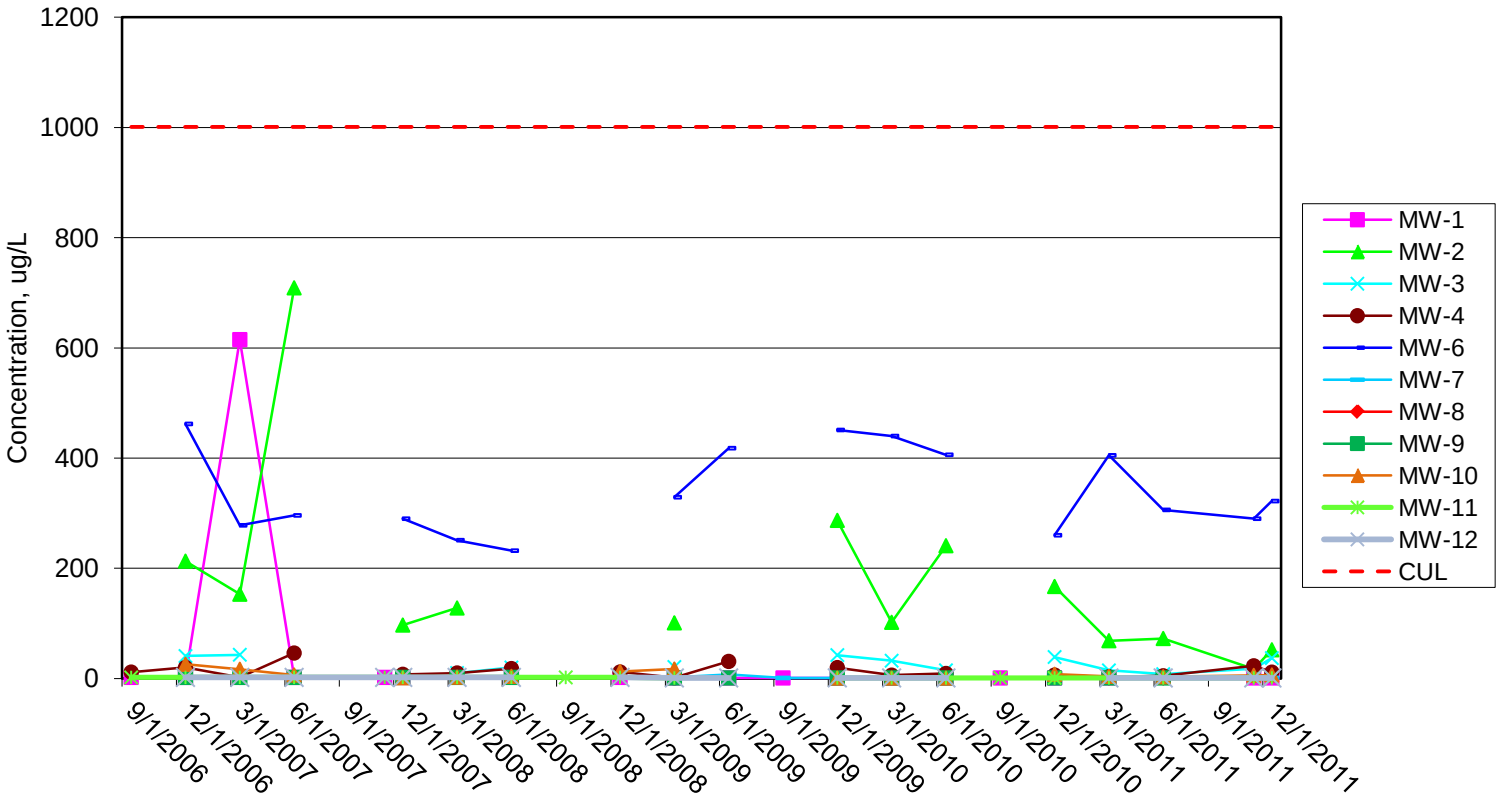

Figure 7. Toluene Concentrations

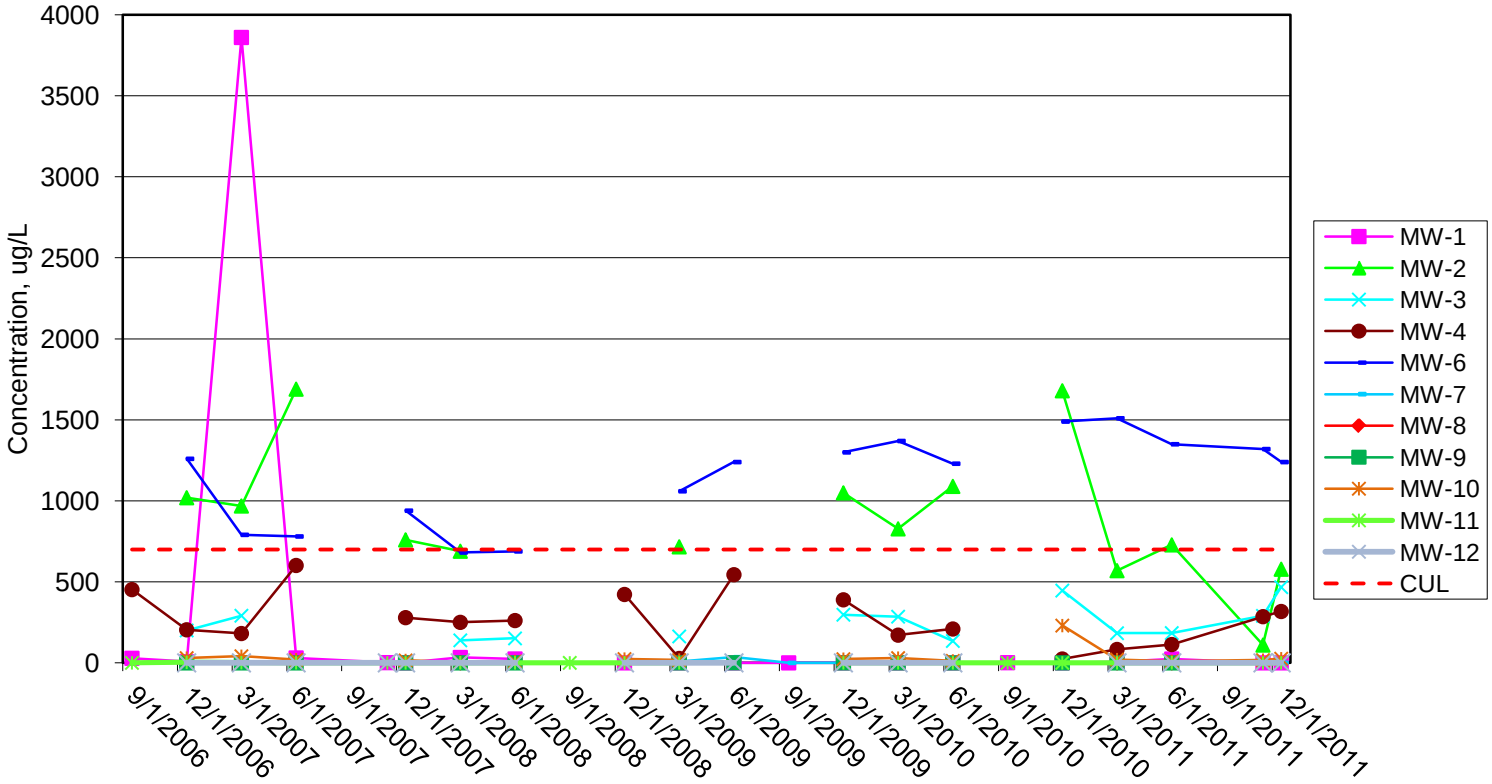

Figure 8. Ethylbenzene Concentrations

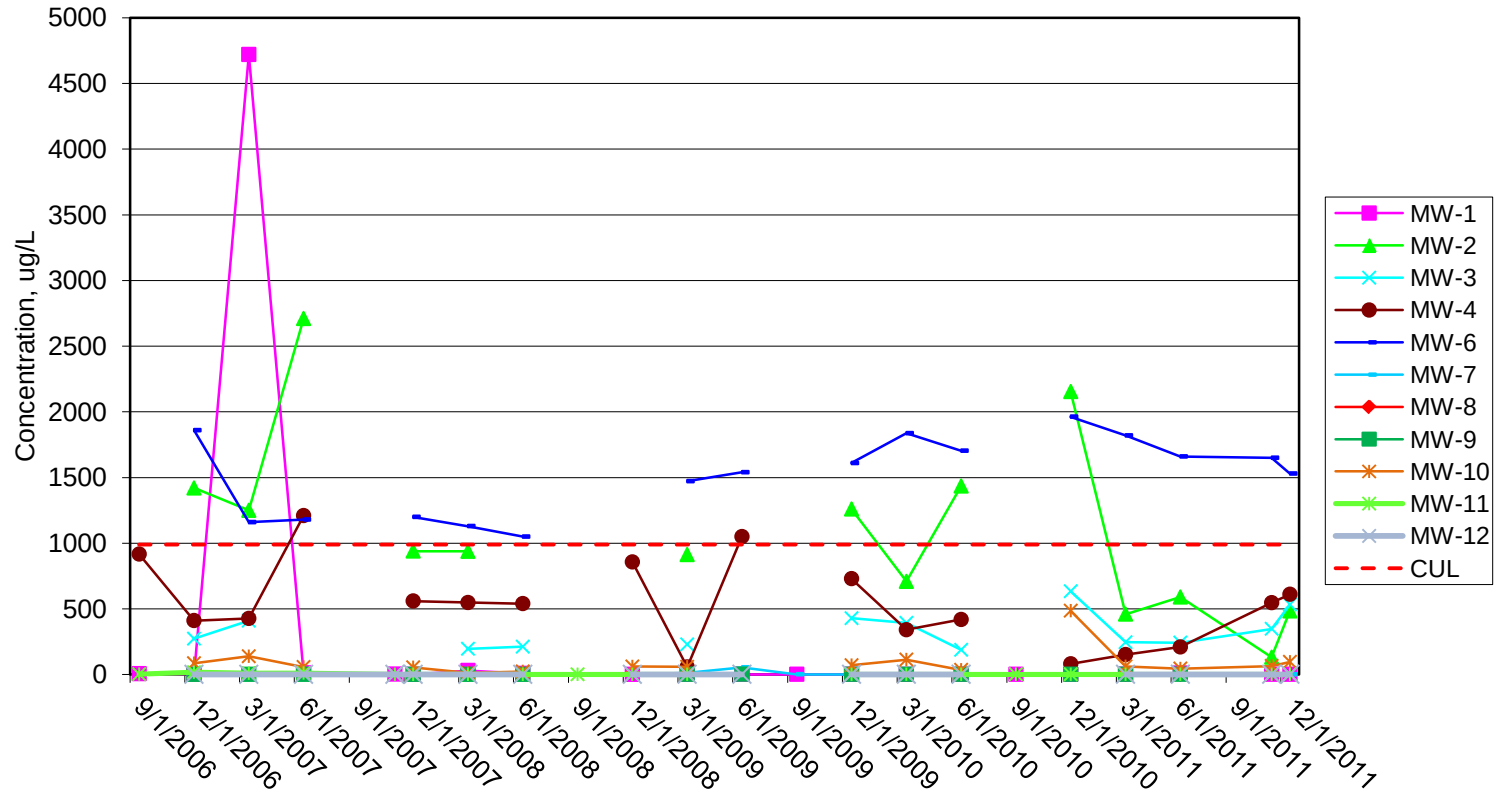

Figure 9. Xylene Concentrations

TABLES

	Date	MW-1	MW-2	MW-3	MW-4	MW-6	MW-7	MW-8	MW-9	MW-10	MW-11	MW-12
Gasoline	9/29/06	***963***	--	--	***14,000***	--	--	--	--	--	347	--
(µg/L)	12/19/06	478	***15,000***	***5350***	***9770***	***19,300***	ND	--	ND	***7010***	117	ND
	3/19/07	***15,000***	***15,800***	***6670***	***7140***	***15,000***	ND	--	ND	***6900***	155	ND
	6/26/07	***819***	***21,800***	--	***17,200***	***13,400***	ND	--	ND	***3220***	223	ND
	11/2/07	333	--	--	--	--	--	--	--	--	ND	ND
	12/12/07	ND	***19,000***	--	***12,000***	***22,000***	ND	--	ND	***3900***	51	ND
	3/27/08	***1430***	***10,900***	***2840***	***6850***	***12,600***	ND	ND	ND	***2450***	ND	ND
	6/4/08	***1240***	--	***2970***	***13,200***	***16,900***	ND	--	ND	***2410***	ND	ND
	9/12/08	--	--	--	--	--	--	--	--	--	ND	--
	12/3/08	132	--	--	***19,100***	--	ND	--	--	***6240***	ND	ND
	3/25/09	ND	***14,200***	***2630***	***981***	***18,500***	ND	--	ND	***3370***	ND	ND
	6/26/09	ND	--	--	***19,800***	***21,000***	***951***	--	ND	--	--	ND
	9/29/09	535	--	--	--	--	--	--	--	--	--	--
	12/10/09	ND	***16,700***	***7550***	***22,100***	***23,900***	ND	--	ND	***4540***	ND	ND
	3/24/10	301	***14,500***	***4880***	***7560***	***21,100***	ND	--	ND	***5100***	ND	ND
	6/17/10	ND	***16,100***	***3510***	***11,000***	***21,400***	ND	--	ND	***3020***	ND	ND
	9/14/10	314	--	--	--	--	--	--	--	--	ND	--
	12/7/10	ND	***21,600***	***8820***	***4470***	***23,300***	ND	--	ND	***9090***	ND	--
	3/24/11	483	***5510***	***3600***	***3250***	***22,700***	ND	ND	ND	***3260***	ND	ND
	6/21/11	1320	***8130***	***3980***	***4700***	***22,200***	ND	ND	ND	***2380***	139	ND
	11/22/11	176	***1730***	***6030***	***14,300***	***24,000***	ND	--	--	***4000***	ND	ND
	12/28/11	185	***10,400***	***8380***	***17,300***	***22,500***	ND	--	--	***5120***	ND	ND
Diesel	9/29/06	349	--	--	***411***	--	ND	--	--	--	312	--
(µg/L)	12/19/06	ND	***5290***	***2130***	***3840***	***4540***	***2420***	--	ND	***2920***	ND	ND
	3/19/07	***1114***	***4730***	***2420***	***2690***	***4320***	ND	--	ND	***3500***	253	ND
	6/26/07	ND	***4020***	--	***4570***	***3800***	ND	--	ND	***2490***	362	ND
	11/2/07	ND	--	--	--	--	--	--	--	--	ND	ND
	12/12/07	ND	***3890***	--	***3860***	***4700***	ND	--	ND	***2222***	ND	ND
	3/27/08	***680***	***4630***	***1810***	***2540***	***4190***	ND	ND	ND	***1550***	328	ND
	6/4/08	***921***	--	***3180***	***3070***	***3910***	274	--	236	***1560***	383	236
	9/12/08	--	--	--	--	--	--	--	--	--	385	--
	12/3/08	236	--	--	***5320***	--	236	--	--	***2510***	236	236
	3/25/09	ND	***2500***	471	280	***3400***	ND	--	ND	***533***	ND	ND
	6/26/09	ND	--	--	***5890***	***5730***	ND	--	ND	--	--	104
	9/29/09	164	--	--	--	--	ND	--	--	--	--	--
	12/10/09	ND	ND	***3370***	ND	ND	ND	--	ND	***4100***	ND	ND
	3/24/10	119	***3540***	ND	***1990***	***4610***	ND	--	ND	***1210***	190	ND
	6/17/10	ND	***823***	ND	***1090***	***1030***	ND	--	ND	***897***	135	ND
	9/14/10	ND	--	ND	--	--	--	--	--	--	379	--
	12/7/10	ND	ND	ND	***2620***	ND	ND	--	ND	***1720***	ND	--
	3/24/11	161	***881***	***1210***	***746***	***1710***	160	144	ND	***1540***	150	ND
	6/21/11	182	***616***	***581***	***552***	***541***	ND	ND	145	***829***	***745***	ND
	11/22/11	ND	ND	ND	ND	ND	ND	--	--	***1450***	ND	ND
	12/28/11	ND	ND	ND	ND	ND	ND	--	--	***1020***	ND	ND
ND = not detected				-- = not sampled (no water or inaccessible)					***Bold italics*** = exceeds cleanup level			

Table 1. Contaminant Concentrations

	Date	MW-1	MW-2	MW-3	MW-4	MW-6	MW-7	MW-8	MW-9	MW-10	MW-11	MW-12
Benzene	9/29/06	***16.2***	--	--	***70.5***	--	--	--	--	--	ND	--
(µg/L)	12/19/06	2.81	***645***	***109***	***38.5***	***967***	ND	--	ND	***34.2***	ND	ND
	3/19/07	***2170***	***861***	***116***	***39.5***	***954***	ND	--	ND	***37.8***	ND	ND
	6/26/07	***27.6***	***2320***	--	***143***	***659***	ND	--	ND	***14.9***	ND	ND
	11/2/07	ND	--	--	--	--	--	--	--	--	ND	ND
	12/12/07	ND	***480***	--	***45***	***730***	ND	--	ND	1.9	ND	ND
	3/27/08	***14.8***	***672***	***47.9***	***69***	***538***	ND	ND	ND	***5.57***	ND	3.77
	6/4/08	***19.7***	--	***33***	***59.5***	***459***	ND	--	ND	***8.07***	ND	ND
	9/12/08	--	--	--	--	--	--	--	--	--	ND	--
	12/3/08	ND	--	--	***94.6***	--	ND	--	--	***19.6***	ND	ND
	3/25/09	ND	***570***	***79.2***	***3.5***	***836***	2.4	--	ND	3.6	ND	ND
	6/26/09	ND	--	--	***132***	***995***	***8.4***	--	ND	--	--	ND
	9/29/09	ND	--	--	--	--	ND	--	--	--	--	--
	12/10/09	ND	***1210***	***87***	***40.3***	***1080***	ND	--	ND	ND	ND	ND
	3/24/10	ND	***649***	***86.6***	***14***	***961***	ND	--	ND	2.87	ND	ND
	6/17/10	ND	***1050***	***29***	***23.5***	***937***	ND	--	ND	ND	ND	ND
	9/14/10	ND	--	--	--	--	--	--	--	--	ND	--
	12/7/10	ND	***1150***	***168***	5	***803***	ND	--	ND	***25.4***	ND	--
	3/24/11	ND	***353***	***67.3***	***9.48***	***848***	ND	ND	ND	ND	ND	2.51
	6/21/11	***8.23***	***382***	***18.6***	***35.4***	***701***	ND	ND	ND	ND	ND	ND
	11/22/11	ND	***73.2***	***69.7***	***55.3***	***538***	ND	--	--	4.35	ND	ND
	12/28/11	ND	***335***	***142***	***62.4***	***832***	ND	--	--	ND	ND	ND
Toluene	9/29/06	ND	--	--	11.6	--	--	--	--	--	ND	--
(µg/L)	12/19/06	ND	213	40.8	20.1	462	ND	--	ND	25.8	ND	ND
	3/19/07	615	153	43.1	2	278	ND	--	ND	16.8	ND	ND
	6/26/07	ND	709	--	46.2	296	ND	--	ND	6.39	ND	ND
	11/2/07	ND	--	--	--	--	--	--	--	--	ND	ND
	12/12/07	ND	97	--	7.6	290	ND	--	ND	1.4	ND	ND
	3/27/08	2.73	128	10	10	251	ND	ND	ND	2.48	ND	ND
	6/4/08	3.77	--	20	18	232	ND	--	ND	3.9	ND	ND
	9/12/08	--	--	--	--	--	--	--	--	--	ND	--
	12/3/08	ND	--	--	11.8	--	ND	--	--	12.6	ND	ND
	3/25/09	ND	101	20.9	1.4	329	1.9	--	ND	17.1	ND	ND
	6/26/09	ND	--	--	31	418	7.3	--	ND	--	--	ND
	9/29/09	ND	--	--	--	--	ND	--	--	--	--	--
	12/10/09	ND	287	42.5	19.8	451	ND	--	ND	ND	ND	1.1
	3/24/10	ND	102	32.3	6.05	440	ND	--	ND	ND	ND	ND
	6/17/10	ND	241	14.9	9.1	406	ND	--	ND	ND	ND	ND
	9/14/10	ND	--	--	--	--	--	--	--	--	ND	--
	12/7/10	ND	167	39	6.2	260	ND	--	ND	7.7	ND	--
	3/24/11	1.16	68.6	14.8	3.04	405	ND	ND	ND	3.99	ND	ND
	6/21/11	2.42	72.6	7.92	4.87	306	ND	ND	ND	3.27	ND	ND
	11/22/11	ND	17	17.6	23	290	ND	--	--	5.64	ND	ND
	12/28/11	ND	52.1	37.1	11.5	322	ND	--	--	6.4	ND	ND
ND = not detected				-- = not sampled (no water or inaccessible)					***Bold italics*** = exceeds cleanup level			

Table 1. Contaminant Concentrations (continued)

	Date	MW-1	MW-2	MW-3	MW-4	MW-6	MW-7	MW-8	MW-9	MW-10	MW-11	MW-12
Ethyl-	9/29/06	29.2	--	--	453	--	--	--	--	--	ND	--
benzene	12/19/06	8.02	***1020***	201	205	***1260***	ND	--	ND	30.3	3.9	ND
(µg/L)	3/19/07	***3860***	***969***	292	182	***791***	ND	--	ND	42	2.02	ND
	6/26/07	31.2	***1690***	--	602	***781***	ND	--	ND	20.2	1.3	ND
	11/2/07	2.44	--	--	--	--	--	--	--	--	ND	ND
	12/12/07	ND	***760***	--	280	***940***	ND	--	ND	16	ND	ND
	3/27/08	34.2	690	140	251	682	ND	ND	ND	4.29	ND	ND
	6/4/08	25	--	152	262	689	ND	--	ND	9.58	ND	ND
	9/12/08	--	--	--	--	--	--	--	--	--	ND	--
	12/3/08	ND	--	--	423	--	ND	--	--	24.5	ND	ND
	3/25/09	1.3	***717***	164	28.2	***1060***	9.3	--	ND	18.6	ND	ND
	6/26/09	ND	--	--	545	***1240***	36	--	1.6	--	--	ND
	9/29/09	ND	--	--	--	--	ND	--	--	--	--	--
	12/10/09	ND	***1050***	298	390	***1300***	ND	--	ND	23.8	ND	ND
	3/24/10	ND	***828***	286	172	***1370***	2.14	--	ND	30.4	ND	ND
	6/17/10	ND	***1090***	136	210	***1230***	ND	--	ND	13.1	ND	ND
	9/14/10	2.1	--	--	--	--	--	--	--	--	ND	--
	12/7/10	ND	***1680***	447	24.8	***1490***	ND	--	ND	231	ND	--
	3/24/11	6.2	570	184	83.7	***1510***	ND	ND	ND	21.3	ND	1.11
	6/21/11	24.8	***729***	185	114	***1350***	ND	ND	ND	10.8	1.42	ND
	11/22/11	ND	111	291	286	***1320***	ND	--	--	17.8	ND	ND
	12/28/11	ND	579	468	318	***1240***	ND	--	--	26.6	ND	ND
Xylene	9/29/06	6.56	--	--	917	--	--	--	--	--	3	--
(µg/L)	12/19/06	3.29	***1420***	273	411	***1860***	ND	--	ND	86.2	17.5	ND
	3/19/07	***4720***	***1250***	410	427	***1160***	ND	--	ND	139	9.8	ND
	6/26/07	13	***2710***	--	***1210***	***1180***	ND	--	ND	57.5	11.5	ND
	11/2/07	3.46	--	--	--	--	--	--	--	--	1.71	ND
	12/12/07	1.5	940	--	560	***1200***	ND	--	ND	55	ND	ND
	3/27/08	30.9	938	196	548	***1130***	ND	ND	ND	12	ND	ND
	6/4/08	8.63	--	212	540	***1050***	ND	--	ND	23.6	ND	ND
	9/12/08	--	--	--	--	--	--	--	--	--	ND	--
	12/3/08	1.5	--	--	857	--	ND	--	--	61.2	ND	ND
	3/25/09	ND	913	229.5	57.5	***1472***	14.3	--	ND	59.1	ND	ND
	6/26/09	ND	--	--	***1050***	***1540***	54.6	--	2.8	--	--	ND
	9/29/09	ND	--	--	--	--	ND	--	--	--	--	--
	12/10/09	ND	***1260***	428.8	730	***1610***	ND	--	ND	71.2	ND	ND
	3/24/10	1.25	709	393	341	***1837***	2.53	--	ND	114	ND	ND
	6/17/10	ND	***1435***	188	419	***1704***	ND	--	ND	35.8	ND	ND
	9/14/10	1.9	--	--	--	--	--	--	--	--	ND	--
	12/7/10	ND	***2154***	634	81.5	***1963***	ND	--	ND	486	ND	--
	3/24/11	3.18	460	246	152	***1820***	ND	ND	ND	62.6	ND	ND
	6/21/11	11.4	590	243	210	***1660***	ND	ND	ND	45.6	ND	ND
	11/22/11	ND	132	348	547	***1650***	ND	--	--	65.3	ND	ND
	12/28/11	ND	484	533	611	***1530***	ND	--	--	96.6	ND	ND

ND = not detected -- = not sampled (no water or inaccessible) ***Bold italics*** = exceeds cleanup level

Table 1. Contaminant Concentrations (continued)

Contaminant	Method A Cleanup Level, µg/L
TPH-gasoline	800
TPH-diesel	500
Benzene	5
Toluene	1000
Ethyl benzene	700
Xylene	1000
µg/L - micrograms per liter	

Table 2. Groundwater Cleanup Levels

Well	Analyte	Tau Value	Trend
MW-1	gasoline	-0.385	decreasing
MW-1	diesel	-0.541	decreasing
MW-1	benzene	-0.238	slightly decreasing
MW-2	gasoline	-0.41	decreasing
MW-2	diesel	-0.619	decreasing
MW-2	benzene	-0.429	decreasing
MW-2	ethylbenzene	-0.371	decreasing
MW-2	xylene	-0.505	decreasing
MW-3	gasoline	0.363	increasing
MW-3	diesel	-0.267	slightly decreasing
MW-3	benzene	0.077	no change
MW-3	ethylbenzene	0.385	increasing
MW-4	gasoline	0.076	no change
MW-4	diesel	-0.269	slightly decreasing
MW-4	benzene	-0.076	no change
MW-4	ethylbenzene	-0.064	no change
MW-4	xylene	-0.088	no change
MW-6	gasoline	0.574	increasing
MW-6	diesel	-0.456	decreasing
MW-6	benzene	-0.081	no change
MW-6	ethylbenzene	0.463	increasing
MW-6	xylene	0.324	increasing
MW-10	gasoline	-0.132	slightly decreasing
MW-10	diesel	-0.353	decreasing
MW-10	benzene	-0.529	decreasing
Tau value of <0.1 = no change			
Tau value between 0.1 and 0.3 = slight change			

Table 3. Mann-Kendall Tau Value Analysis

	Date	MW-1	MW-2	MW-3	MW-4	MW-6	MW-7	MW-8	MW-9	MW-10	MW-11	MW-12
Dissolved	12/1/04	1.96	1.93	1.59	1.87	2.86	1.82				2.32	3.01
Oxygen	4/29/05	0.41	0.53	0.66	0.82	0.56	5.6		4.9	0.4	1.5	0.57
(mg/L)	8/10/05						1.02				0.61	
	12/19/05	0.06	0.18	0.06	0.26		0.95		0.54	0.7	0.45	2.54
	4/27/06	0.31	0.29	0.29	0.32	0.45	4.75	2.2	6.4	0.37	0.47	0.53
	12/19/06	0.27	1.3	1.2	0.11	0.04	0.24		0	0	0	0.25
	3/19/07	0.51	2.08	0.14	0.14	0.63	3.17		3.29	0.19	0	0.15
	6/26/07	4.39	0.32	0.15	0.48	1.1	2.3		6.1	0.38	0.93	0.41
	12/12/07	3.06	2.52		2.33	2.4	7.48		7.78	2.12	3.78	3.48
	3/26/08	4.95	4.76	4.35	4.82	4.87	8.08	4.7	7.93	4.14	5.51	3.79
	6/4/08	0	0.2	0.02	0	0	1.43		5.08	0	0	0
	12/3/08	0			0		0			0	0	2.01
	3/25/09	5.03	10.43	6.36	6.91	9.93	12.55		6.47	4.49	10.65	4.6
	6/26/09	2.18			0.06	0.06	0.92		5.88			1.8
	9/29/09	0.03										
	12/10/09	0.06	0.1	0.05	0.08	0.16	1.27		4.56	0.05	0.14	0.04
	3/24/10	0.03	0.06	0.01	0.03	0.08	3.48		5.33	0.03	0.52	0.1
	6/17/10	0.01	0.09	0.03	0.04	0.06	5.5		4.37	0.09	0	0.08
	9/14/10	0.16									0.2	
	12/7/10	0.08	0.04	0.06	0.15	0.12	0.17		4.45	0.18	0.11	
	3/24/11	0.32	0.25	0.16	0.33	0.2	6	0.64	5.15	0.3	0.22	1.04
	6/21/11	0.53	0.69	0.46	0.59	0.51	6	2.29	7.18	0.59	0.51	1.19
	11/22/11	1.16	2.76	0.96	1.41	1.97	5.03			1.23	0.95	6.14
	12/28/11	1.13	1.06	0.77	1.45	1.47	2.92			0.86	1.38	4.48
Nitrate	12/1/04	2.68	5.42	5.37	5.36	4.88	4.88				4.93	4.03
(mg/L)	4/29/05	0.01	0.01	0.01	0.01	0.01	3.72		10	0.01	0.01	0.01
	8/10/05										5	
	12/19/05	5.7	5.2	5.2	5.2	5.8	5.7			5.2	5.2	6.9
	4/27/06	2.5	2.5	2.5	2.5	0.5	3.5	2.5	15.8	2.5	2.5	2.5
	9/29/06	5			5						5	
	12/19/06	5	5	5	5	5	2.42		11.1	5	5	0.7
	6/26/07	0.5	0.5		0.5	0.5	2.16		8.25	0.5	0.5	0.5
	11/2/07	0.5									0.5	0.53
	12/12/07	0.25	0.25		0.25	2.08	0.25		2.16	0.25	0.25	2.74
	3/26/08	0.5	0.5	0.5	0.5	0.5	2.5	0.5	8.1	0.95	0.5	0.5
	6/4/08	0.5		0.5	0.5	0.5	3.32		4.11	0.5	0.5	0.5
	12/3/08	0.5			0.5					0.5	0.5	2.84
	3/25/09	0.4	0.1	0.1	0.37	0.1	3.38		3.64	0.1	0.1	0.1
	6/26/09	0.1			0.1	0.1	2.2		2.92			0.1
	12/10/09	0.1	0.1	0.1	0.1	0.1	0.2		3.26	0.1	0.1	2.61
	3/24/10	0.1	0.1	0.1	0.1	0.1	2.33		4.87	0.14	0.1	0.1
	6/17/10	0.1	0.1	0.2	0.1	0.1	3.79		6.67	0.3	0.1	0.1
	9/14/10	0.1									0.15	
	12/7/10	0.1	0.1	0.1	0.1	0.1	0.1		5.25	0.1	0.1	
	3/24/11	0.373	0.1	0.283	0.1	0.1	2.54	0.1	13.8	2.02	0.1	0.227
	6/21/11	0.1	0.1	2.02	0.1	0.1	3.5	0.1	9.8	10.7	0.1	0.244
	11/22/11	0.1	0.1	0.1	0.1	0.1	0.196			0.1	0.1	3.02
	12/28/11	0.1	0.1	0.1	0.1	0.1	0.1			0.1	0.1	2.76

	Date	MW-1	MW-2	MW-3	MW-4	MW-6	MW-7	MW-8	MW-9	MW-10	MW-11	MW-12
Ferrous	12/1/04	0.5	25.1	20.7	28.2	16.1	0.5				10.5	0.5
Iron	4/29/05	9.24	13	12.9	31.2	7.28	0.5		0.5	11.4	64.8	0.5
(mg/L)	8/10/05										17.8	
	12/19/05	1.79	12.6	11.2	17.9	8.38	0.59			7.89	7.58	0.5
	9/29/06	1.56			13.4						5.5	
	12/19/06	3.2	3.2	2.4	3.2	3.6	3.2		0.5	2.6	3.4	0
	3/19/07	3.8	2.8	3	2.4	2.4	0		0	2.4	2.8	0
	6/26/07	3.5	3.4		4.8	3.2	0.8		0	2.8	3.2	0
	11/2/07	0.2									4	1.2
	12/12/07	1.1				3.6				2.4		0.1
	9/12/08										4	
	12/3/08	0.9			1.3		0			1	1.1	0
	3/25/09	2	30	15	0.1	2	0.1		0.1	10	3	0.1
	6/26/09	2			55	12	0.1		0.1			
	9/29/09	5.5										
	12/10/09	2	10	6.7	9	6	1.21		0.1	3.62	4	0.1
	3/24/10	2	10	6	7	8	0.1		0.1	4	4	0.1
	6/17/10	2	10	5	4	7	0.1		0.1	3	4	0.1
	9/14/10	4									3	
	12/7/10	4	10	8	3	7	0.1		0.1	8	0.8	
	3/24/11	2.0	6.0	12	0.8	7.0	<0.1	<0.1	<0.1	4.0	5.0	<0.1
	6/21/11	14	10.0	8.0	2.0	5.0	<0.1	<0.1	<0.1	0.1	20	<0.1
	11/22/11	4	10.0	9.0	10.0	7.0	<0.1			6.0	>10	<0.1
	12/28/11	4	>10	>10	>10	10.0	<0.1			5.0	2	<0.1
Sulfate	12/1/04	23.4	6.6	7.49	6.72	0.5	18.1					
(mg/L)	4/29/05	48.9	5.1	5	11.5	19.4	17.1		97.1	18.6		
	12/19/05	59.9	5	5	5	5	14			5	5	5
	4/27/06	9.3	15.8	15.8	19.8	0.5	11.2	152	98.4	10.4	76.5	84.1
	12/19/06	39.8	0.52	0.71	5		8.38		72.8	0.52	220	32
	3/19/07	12.1	105	6.07	9.15		8.93		101	3.36	117	59.1
	6/26/07	16.1				0.76	9.99		114	6.75	86.4	33.8
	11/2/07	93.2									39.9	83.1
	3/25/09	62.3	326	12.4	24.8	2.49	13		73.8	43.3	98.8	26.7
	6/26/09	74.1			3.57	0.81	18.7		81.3			113
	9/29/09	47.1										
	12/10/09	95.9	0.15	25.1	0.1	0.13	35.6		60	0.1	170	29.8
	3/24/10	69.7	261	13	22.2	1.22	11.2		45.6	8.64	164	29.6
	6/17/10	66	77.5	18.7	16.2	3.05	11.6		39.7	38.3	243	29.8
	9/14/10	56.9									116	
	12/7/10	97.1	0.23	0.1	14.6	0.26	27.8		47	0.1	117	
	3/24/11	60	60.1	17.7	12.7	14.4	9.57	134	32.8	30	114	58.3
	6/21/11	46.5	67.2	36.6	14.8	4.85	13.2	98.7	49.5	43.5	144	84.8
	11/22/11	110	0.355	0.512	5.9	0.301	35.7			0.242	77	38.1
	12/28/11	106	0.805	0.706	1.87	0.668	29.9			0.546	73	31.4

Blank cells = data not collected or well was dry

Table 4. Electron Acceptor Concentrations