JV TASK 47 – DEMONSTRATION OF VACUUM-ENHANCED RECOVERY AND FEASIBILITY OF PERMEABLE TREATMENT BARRIERS FOR SITE REMEDIATION AT HAZEN

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ABSTRACT

The Energy & Environmental Research Center (EERC) conducted a demonstration of a vacuum-enhanced recovery and feasibility of permeable treatment barriers for soil and groundwater remediation at an Independent Oil (former Star Mart) site in Hazen, North Dakota. A total of 62,584 lb (28,388 kg) of contaminant was recovered from impacted soils and groundwater. The mass of recovered contaminant equals approximately 10,116 gallons of product. Groundwater quality monitoring confirmed the continuing contaminants of concern (COC) reduction trend in most monitoring wells and an average benzene reduction of 85% within the entire impacted area since remediation system start-up. A comparison of mass balance estimates for the extraction system with biodegradation stoichiometry using the assimilative capacity of the groundwater indicates that in situ natural attenuation processes became a dominant factor in reducing COCs and that improved site conditions justified termination of corrective action.

The unit cost of contaminant recovery was \$15.26/lb (\$33.65/kg). If in situ degradation resulting from oxygen delivery is considered, the cost would be \$12.62/lb (\$27.82/kg) of contaminant recovered or degraded.

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EXECUTIVE SUMMARY

At the request of North Dakota Department of Health (NDDH), the Energy & Environmental Research Center (EERC) conducted a demonstration of vacuum-enhanced recovery and investigated the feasibility of permeable treatment barriers for soil and groundwater remediation at an Independent Oil (former Star Mart) site in Hazen, North Dakota.

A total of 6,707,299 gallons (25,387 m^3) of groundwater and 110.8 million ft^3 (3.1 million m^3) of soil vapor have been extracted from well fields since extraction start-up, resulting in removal of over 62,584 lb (28,388 kg) of hydrocarbons prior to stripping and an additional 725 lb (329 kg) from the treated groundwater. The mass of recovered contaminant equals approximately 10,116 gal (38,290 l) of product, assuming specific gravity for gasoline of 0.75 g/cm^3.

Groundwater quality monitoring confirmed the continuing contaminants of concern (COC) reduction trend in most monitoring wells and an average benzene reduction of 85% within the entire impacted area since remediation system start-up. Comparison of mass balance estimates for the extraction system with biodegradation stoichiometry using the assimilative capacity of the groundwater indicates that in situ natural attenuation processes became a dominant factor in COC reduction. Improved site conditions and a steadily declining concentration of COCs justified termination of the corrective action.

The cost of contaminant recovery was $15.26/lb ($33.65/kg). If in situ degradation resulting from oxygen delivery is considered, the cost would be $12.62/lb ($27.82/kg) of contaminant recovered or degraded.

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1.0 INTRODUCTION

At the request of North Dakota Department of Health (NDDH), the Energy & Environmental Research Center (EERC) conducted a demonstration of vacuum-enhanced recovery and investigated the feasibility of permeable treatment barriers for soil and groundwater remediation at an Independent Oil (former Star Mart) site in Hazen, North Dakota.

The overall objective of the project activities was to design, implement, and operate a vacuum-enhanced recovery/multiphase extraction (MPE) system to reduce contaminant concentration levels in soils and groundwater at the subject site at Hazen, North Dakota, below acceptable regulatory limits or to levels that would allow for natural attenuation processes to complete in situ degradation of residual contaminants.

Characteristics of the target zone required the application of remediation technology capable of simultaneously removing contaminants in both the vapor and liquid phases. Based on favorable results from other sites in the state and after evaluation of alternative technologies, MPE was recommended as the technically most feasible option capable of achieving high contaminant removal rates from the target zone using a combination of extraction well fields while controlling the contaminant migration off-site. The project was initiated in April 2002. The MPE system was operated from July 12, 2002, to November 22, 2005. In addition to contaminants of concern (COC) recovery, plume interception using reinjection of the treated aerated water in the permeable treatment barrier was conducted from June to October 2004 and 2005 to accelerate the in situ biodegradation process.

This report presents a summary of results including a description of the technology applied. More detailed information, original data sets, and primary documentation are compiled in technical progress reports provided to the sponsors and regulatory agency on a quarterly basis. The project was sponsored by North Dakota Petroleum Tank Release and Compensation Fund (NDPTRCF) and the U.S. Department of Energy (DOE) and supervised by NDDH.

2.0 EXPERIMENTAL

EERC demonstration of the MPE system as one of the most efficient technologies for site remediation and reinjection of aerated treated water into a permeable treatment barrier marked the first application of a combination of these technologies in the state of North Dakota.

Definition of the contaminated target zone, contaminant properties, and the previous remediation effort indicated that remediation technology or a combination of technologies suitable for the subject site must be capable of:

- Efficiently removing contaminants from both the vadose and saturated zones in heterogeneous sediments with relatively low permeability.
- Creating a hydraulic impact that would reduce/control free product (FP) and contaminant migration off-site.

- Being flexible enough to address water table fluctuation across the contaminant smear zone.
- Providing for oxygen supply to stimulate biodegradation.
- Providing oxygen supply to permeable treatment barrier intercepting the plume to stimulate in situ contaminant degradation processes.

Additional objectives and requirements for this demonstration were:

- A simple design to minimize operational and maintenance costs.
- Well field design that would not be disruptive to daily operation of facilities at the site.
- Demonstration of an extraction and treatment system capable of successful continuous operation in the harsh conditions dominating winter weather in North Dakota.
- Real-time system monitoring using telemetric controls to allow for flexible evaluation of remediation system parameters and timely optimization.

3.0 RESULTS AND DOCUMENTATION

3.1 Site Characteristics

3.1.1 Location and Release History

The subject site is located at abandoned Independent Oil, Inc., formerly Star Mart, at 334 Antelope Drive, Hazen, North Dakota, T144N R86W Section 7, Mercer County, and covers an area of approximately 2.2 acres (Figure 1 and Appendix A).

The release of an estimated 36,000 gal of gasoline was documented in inventory records from October 1992 to August 1993; however, the reliability of the estimate could not be independently verified.

3.1.2 Hydrogeology and Contaminant Transport

The shallow groundwater flow and downgradient contaminant migration is bound to heterogeneous sandy silts, clayey silts, and clays of glaciofluvial origin, with construction fill in the center of the site. Abandoned channels of meandering Antelope Creek developed in discrete patterns throughout the site and likely provided preferential pathways for contaminant transport off-site and toward the current stream of Antelope Creek (Figure 1).

The unconfined water table at the subject site ranged from 2.44 ft (MW-6) to 10.54 ft (MW-7) below ground on July 10, 2002, with the mean depth to water at the center of the source area at about 9 ft. A declining trend and wide range of fluctuation in individual monitoring and extraction wells in response to operation of the extraction system were recorded during operation (Section 2.2.6). Groundwater flows across the site to the south–southeast, with an average gradient of about 0.006 (Appendix C).

Hydraulic properties reflect on geologic changes associated with a dynamic fluvial sedimentary environment, with more permeable sandy silts (hydraulic conductivity of 5.6×10^{-3} ft/min [3×10^{-5} m/s] and a sustained yield of over 5 gpm for well MW-3) in the western part of the site and an increasing presence of clayey silts accompanied by a declining share of sands toward its eastern portion (7.9×10^{-4} ft/min [4×10^{-6} m/s] and 1-gpm yield for well MW-2).

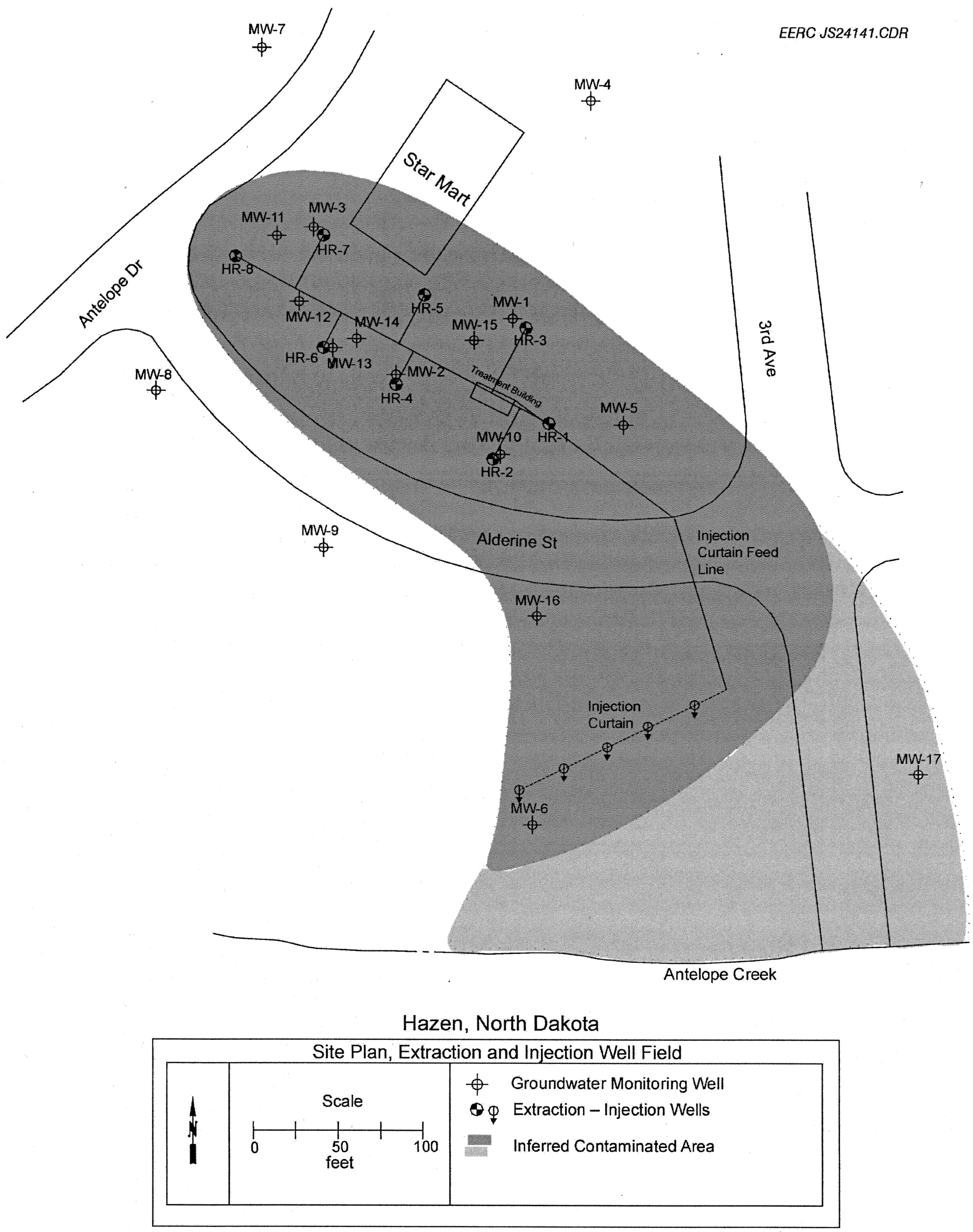


Figure 1. Site plan.

3.2 Remediation System

3.2.1 Extraction, Monitoring, and Injection Well Fields

Extraction and monitoring well field construction on June 24–27, 2002, included completion of eight (8) extraction wells and the addition of seven (7) new monitoring wells, as well as the retrofit of four (4) existing wells to allow for vacuum pressure and water level monitoring. Extraction well boreholes were advanced by a 6-in.-i.d. (10-in.-o.d.) hollowstem auger. Wells were completed with 4-in.-diameter flush-threaded Schedule 40 PVC with a 0.020-in. slot screen and No. 30 red flint pack. Extraction wells are equipped with pitless adaptors installed approximately 4 ft below the ground, with 1-in. PVC suction tubes extending 4 ft below the water table (at the time of construction). Seven monitoring wells were advanced using a 4-in.-i.d. by 8-in.-o.d. hollowstem auger and completed as 2-in.-diameter flush-threaded PVC, Schedule 40 PVC groundwater-monitoring wells. All extraction and selected monitoring wells were further equipped with pressure- and water-table-monitoring ports with a ¾-in. drop tube extending to <1 ft from the bottom of the well.

The 110-foot injection curtain completed July 7–10, 2004, consisted of 2-in. slotted (0.064 slot) Schedule 40 PVC pipe, with a manifold line above. Flow could be manipulated through a series of valves along the manifold line. The slotted pipe was contained within a 15-in. bed of ¾-in. washed rock; the total depth of the trench was 3 feet below ground surface. Highly oxygenated discharge water from the MPE system was injected into the curtain to intercept potential contaminant migration toward Antelope Creek. Treated discharged water from the extraction well fields met applicable criteria for benzene, toluene, ethylbenzene, and xylenes (BTEX) prior to reinjection. Figure 1 presents the site plan; the site layout is given in Appendix A.

Well completion technical data including geologic and survey logs are provided in Technical Progress Reports for April – July 2002 [1]. Following NDDH and EERC agreement on final activities at the site from June 13, 2006, all extraction and monitoring wells including piping and manifolds in ground were sealed June 19–22, 2006, in compliance with Article 33-18 North Dakota Administrative Code (NDAC) and NDDH guidelines for well abandonment.

3.2.2 Dual-Phase Extraction and Treatment System

The extraction and treatment system consists of a CoVac-500" 4-stage, 25-hp, oil-free regenerative blower with a maximum rating of 250 acfm @ 24 in. Hg. Recovered water and air pass through the 60-gal vapor–liquid separator (VLS) to the Hydro-Flo model TST-8 oil–water separator (OWS) with an integrated product storage tank. Water from the OWS is then pumped to a six-stage LP-2.6P air stripper (AS). Seasonally, with warm air temperatures, water from the AS is conveyed to an injection curtain which was installed on July 7–10, 2004 (Figure 1). The system layout and process flow design are provided in Appendix B.

The extraction and treatment system is equipped with a NEMA 4 controller, modem, and telemetry package, allowing for both on-site and telemetric control of the power circuits including monitoring of system performance parameters. Basic operational parameters are summarized in Table 1.

Table 1. Operational Parameters

Well Field	HR– 1, 2, 3, 4, 5, 6, 7, 8
Operated (date)	7/11/02 – 11/22/05
Groundwater Flow (gpm – average/range)	5.9 / 0.4–11.4
Combined Airflow (cfm – average/range)	90 / 50–153
Inlet Vacuum (in. Hg – average/range)	14.5 / 8-19
Extraction Wellhead Vacuum (in. H_2O – average/average range)	65 / 30-111
Total Operating Hours (runtime-h)	19,889
Operating efficiency1 7/11/02–11/22/05[1]	90.4%

[1] Downtime includes all maintenance shutdowns except for winter pauses.

3.2.3 System Performance Monitoring and Sampling

The MPE and treatment system started break-in operation on July 11, 2002. After system optimization, full-scale operation commenced October 2, 2002. System performance monitoring and effluent water and offgas sampling were conducted on a monthly basis; telemetric system control and data download was conducted daily throughout the operation. Alternating well fields were combined from up to six simultaneously operated wells integrated to maximize capture zone and contaminant removal efficiency while providing hydraulic control for off-site migration.

3.2.4 System Water Quality

Samples of extracted water and treated effluent were analyzed for COC (benzene, toluene, ethylbenzene, xylenes, phenols, and total petroleum hydrocarbons [TPH] as gasoline range organics [GRO]), total iron and manganese, and suspended solids. Field measured parameters included pH, electrical conductivity (EC), and temperature.

Values representing contaminant recovery from the respective well fields exhibited declining trends from TPH and BTEX values as high as 189.1 mg/l and 14.1 mg/l, respectively, to nondetect before system shutdown. A summary of extraction and treatment data is provided in Appendix G-1; complete analytical documentation is in the respective technical progress reports. A 100% water treatment system efficiency was achieved for BTEX removal.

3.2.5 Offgas Quality

Offgas quality from combined exhaust was monitored using charcoal tubes and real-time monitoring of hydrocarbons, CO_2, and O_2 using a photoionization detector (PID), a flame ionization detector (FID), and a Summit hydrocarbon analyzer.

Offgas-sampling results using charcoal tube desorption and analyzed by gas chromatography (GC)/FID are summarized in Appendix G-2. VOC concentration trends are provided in Figure 2. To overcome fluctuating airflow velocities, offgas was collected in a 1-l Tedlar bag at a rate of approximately 0.3 l/min. Charcoal tube samples were subsequently collected directly from the Tedlar bag using an SKC pump with flow regulated at 0.28 l/min. In addition, carbon dioxide and oxygen trends in extracted vapors were monitored using the Summit analyzer. The mass balance for recovered VOCs and average emission loads were calculated based on results of offgas analyses and average exhaust airflow corrected to standard conditions and reported to NDDH on a quarterly basis.

Extremely high volatile organic compounds (VOC) concentrations of 332,000 mg/m^3 (TPH) and 8950 mg/m^3 for BTEX recorded and analyzed during the first days of extraction indicated the presence of considerable amounts of residual free product trapped within the vadose and dewatered smear zone (Appendix G-2). VOCs in offgas typically sharply declined within several weeks of operation of a new well field and were mostly bellow detection limits for any combination of wells before system shutdown.

3.2.6 *Hydraulic and Pneumatic Response*

Groundwater table monitoring at the extraction and monitoring wells was conducted on a weekly basis from system start-up through October 16, 2002, and on a monthly basis from October 16, 2002, through November 22, 2005. Depth to water at the subject site ranged from near surface in well MW-6 during injection to 16.55 ft (MW-2) below ground, with the mean depth to water at the center of the source area at about 9.47 ft. Annual fluctuation of 2.63–3.68 ft was observed from July 10, 2002, to November 22, 2005, in hydraulically unimpacted wells MW-4, MW-7, and MW-17.

Drawdown measured at extraction wells ranged from 4.67 to 7.85 ft, with maximum values resulting in intermittent well dewatering. Average groundwater table decline within the source area during system operation was 13.58 ft below ground, yielding a 4.1-ft drawdown, i.e., meeting design criteria that required smear zone exposure and dewatering, allowing air to be a

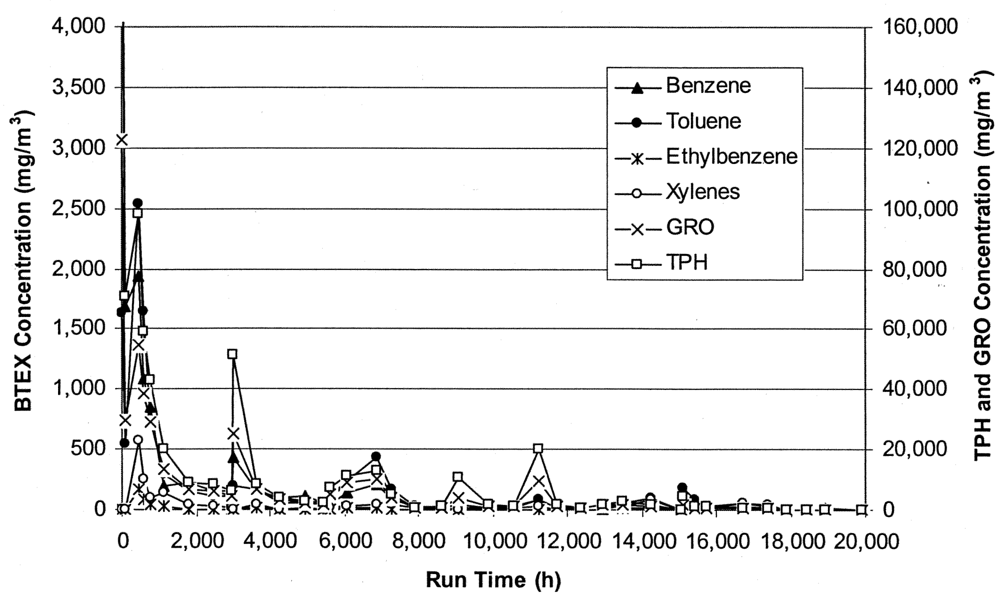


Figure 2. Hydrocarbon concentration trends in offgas since system start-up (initial data points exceed concentrations represented in figure).

primary contaminant carrier in the target zone. Considerable fluctuation of water levels and differences in hydraulic impact for each well are typically observed for single-pump vacuum-enhanced recovery wells as a result of fluctuating vacuum levels and variability in hydraulic conductivities specific to heterogeneous sediments within the extraction well field. Water level records and vacuum-monitoring data are summarized in Appendices C and D; detailed response maps are provided in quarterly technical progress reports.

Similarly to water table monitoring, the vacuum pressure at the extraction and monitoring wells was measured on a weekly basis until October 16, 2002, and on a monthly basis until November 22, 2005. Average operating vacuum for individual extraction wells ranged from 10.1 to 163.2 in. H_2O, with an overall average of 65 in. H_2O (Table 1). The highest vacuums resulted in temporary dewatering of extraction wells. Vacuum recorded at monitoring wells ranged from 0.1 to 80.4 in. H_2O (with vacuum pressure of 0.1 in. H_2O considered a cutoff value). Pneumatic impact was observed as far as 120–140 ft from the center of the extraction well field, with radii of influence for individual wells up to 60 ft. Vacuum-monitoring data are summarized in Appendix D, including an example map of pneumatic influence.

3.3 Contaminant Recovery Estimation

A total of 6,707,299 gallons (25,387 m^3) of groundwater and 110.8 million ft^3 (3.1 million m^3) of soil vapor have been extracted from well fields since extraction start-up, resulting in removal of over 62,584 lb (28,388 kg) of hydrocarbons prior to stripping and an additional 725 lb (329 kg) from the treated groundwater. The mass of recovered contaminant equals approximately 10,116 gal (38,290 l) of product, assuming specific gravity for gasoline of 0.75 g/cm^3. The average liquid flow rate since system start-up was approximately 5.90 gpm (22 l/s), ranging from 0.4 to 11.4 gpm. The average airflow rate was 90 scfm (2.5 m^3/min), ranging from 50 to 153 scfm, with an average temperature of 225°F (107°C). Data for mass removal calculation are provided in Appendix E; cumulative recovery is presented in Figures 3 and 4.

In addition to contaminant recovered by extraction and reduced by in situ biodegradation as a result of injection into a permeable treatment barrier, a total of 41,440 lb (18,800 kg) of oxygen was delivered to the contaminated zone during operation of the MPE system between July 11, 2002, and November 22, 2005, assuming 2% oxygen transfer efficiency [2] and 110.8 million ft^3 (3.13 million m^3) soil vapor exchanged/recovered.

Although quantification of in situ oxygen partitioning between soil- and groundwater-bound contaminants and their subsequent reduction is extremely difficult, by providing the necessary electron acceptor and assuming that a reduction of 1 mg/l of dissolved oxygen consumed by microbes results in biodegradation of 0.32 mg/l of benzene, the volume of oxygen delivered would translate into further in situ reduction of about 13,261 lb (6015 kg) ~ 2120 gallons (8000 l) of contaminant in the saturated zone.

3.4 Groundwater Quality Monitoring

3.4.1 Well Sampling

Selected monitoring and extraction wells were sampled for BTEX and biodegradation indicators on a semiannual basis to document overall remediation system impact on groundwater quality compared to original site data collected in June/July 2002 (prior to system start-up). The final sampling was conducted on May 9, 2006, 6 months after system shutdown.

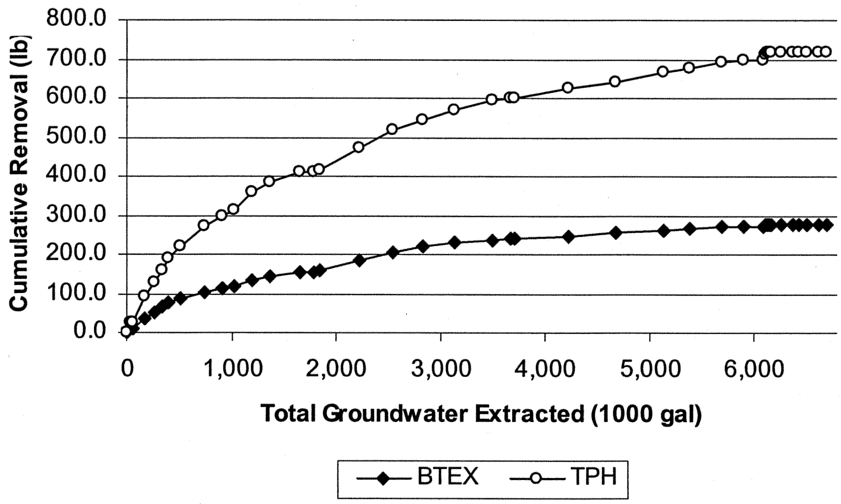


Figure 3. Cumulative TPH and BTEX removal – liquid phase.

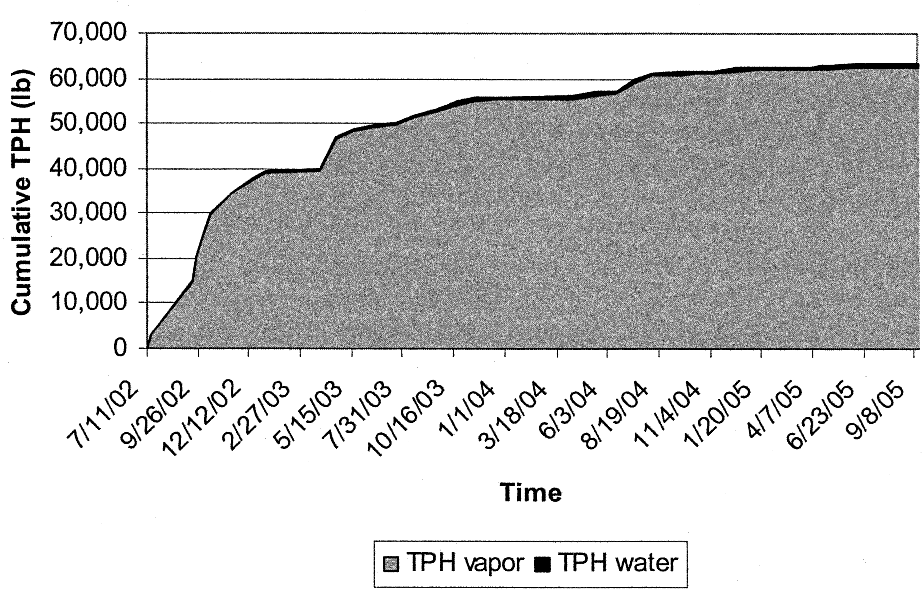


Figure 4. Total hydrocarbon removal.

Groundwater samples were collected using disposable PVC bailers, preserved on-site, and stored on ice prior to and during shipment. Samples for dissolved metals were filtered using 0.45-μm Geotech disposable filters. Analyses were conducted by MVTL in Bismarck, North Dakota, and New Ulm, Minnesota. Quality assurance/quality control samples included duplicates, equipment blanks, field blanks, and trip blanks for each sampling event. Field-monitored water quality parameters were measured in wells with an YSI-556 multiprobe.

3.4.2 Water Quality Trends

Asymptotic trends, declining VOC concentrations, and mass recovery efficiency in groundwater and soil vapor extracted between system start-up (July 2001) and November 2005 indicate that most of the residual FP trapped within the vadose and dewatered smear zone has been successfully removed, and further contaminant release is rate-limited (Figures 2 and 3, and mass balance worksheets in Appendix E).

Analytical results from the most recent sampling indicate that an overall 79% BTEX and 85% benzene reduction in groundwater was achieved since June 2002 (prior to system start-up) and that most of the contaminant plume is already amenable to natural biodegradation (Table 2). While concentrations of benzene and GRO remain above regulatory limits in several contaminated wells, concentrations of toluene, ethylbenzene, and xylene in most wells were successfully reduced to regulatorily acceptable limits of 1000 ppb, 700 ppb, and 10,000 ppb, respectively. BTEX was reduced to near- or nondetect levels in wells MW-2, 3, 11, 13, and 17. The summary of groundwater analyses before system start-up and 6 months after shutdown is provided in Table 3.

Declining trends and COC reduction of about 50% and 20% are documented for wells MW-10 and MW-16, respectively. Because of their location in a clayey sediment profile, both wells persistently exhibited relatively high concentrations of COC. A significant recent COC increase documented in well MW-12 since November 22, 2005, is in contrast to previous 98% COC reduction until May 4, 2005 (Appendix F-1). A comparison of the chromatographic signature of the groundwater samples from this well with other wells at the site is indicative of fresh gasoline and suggests recent incidental release directly to the well located in the middle of the frequented parking lot. Considerable COC reduction achieved as a result of corrective action and high risks associated with potential for secondary contamination prompted NDDH decision to proceed with abandonment of all wells at the site.

Table 2. Contaminant Reduction (average from all contaminated wells)

	COC Reduction (%)	
BTEX	79	85*
Benzene	85	94*
GRO	81	85*

*MW-12 data excluded.

Table 3. Groundwater Analyses – COC

Well ID	Date	Benzene ppb	Toluene ppb	Ethylbenzene ppb	Xylenes (total) ppb	GRO (TPH) mg/l	BTEX ppb	BTEX Trend
MW-1	04/08/02	34000	7790	2200	6440	133.0	50430	▼
MW-1	05/09/06	978	56.6	1284	1194	16.2	3513	
MW-2	04/09/02	4010	326	305	752	16.3	5393	▼
MW-2	05/09/06	12.5	<1	3.4	5.7	<0.2	22	
MW-3	04/09/02	777	1240	77.3	636	7.3	2730	▼
MW-3	05/09/06	<1	<1	<1	<3	<0.2	0	
MW-4	04/08/02	<1	<1	<1	<3	<0.2	0	-
MW-4	05/09/06	<1	<1	<1	<3	<0.2	0	
MW-5	04/08/02	30000	4000	584	977	101.0	35561	▼
MW-5	05/09/06	4754	1817	2417	2807	31.3	11795	
MW-6	04/08/02	11100	<100	213	<300	28.0	11313	▼
MW-6	05/09/06	209.5	1.6	58	3.6	1.5	269	
MW-7	04/08/02	<1	<1	<1	<3	<0.2	0	-
MW-7	05/09/06	<1	<1	<1	<3	<0.2	0	
MW-8	04/08/02	<1	<1	<1	<3	<0.2	0	-
MW-8	05/09/06	<1	<1	<1	<3	<0.2	0	
MW-9	04/08/02	<1	<1	<1	<3	<0.2	0	-
MW-9	11/22/05	<1	<1	<1	<3	<0.2	0	
MW-10	04/08/02	52800	16600	1470	4160	167.0	75030	▼
MW-10	05/09/06	5696	13940	2850	13360	71.9	35846	
MW-11	07/23/02	5310	14100	1920	12500	107.0	33830	▼
MW-11	05/09/06	<1	<1	<1	<3	<0.2	0	
MW-12	07/23/02	34700	29200	2180	9940	163.0	76020	▼
MW-12	05/09/06	36750	19340	1426	7937	100.8	65453	
MW-13	07/10/02	47900	21900	2590	9970	201.0	82360	▼
MW-13	05/09/06	37.7	<2	117.9	24.5	1.8	180	
MW-14	07/23/02	34400	36300	3260	17100	209.0	91060	▼
MW-14	05/09/06	2441	21.7	777.2	274.8	10.7	3515	
MW-15	07/23/02	31900	27700	2610	10700	174.0	72910	▼
MW-15	05/09/06	844	1692	1516	7963	29.6	12015	
MW-16	07/10/02	26400	<250	304	<750	52.1	26704	▼
MW-16	05/09/06	19130	133.6	1233	177.4	34.2	20674	
MW-17	07/10/02	11.9	3	<1	<3	<0.2	15	-
MW-17	05/09/06	<1	<1	<1	<3	<0.2	0	

Evaluation of natural attenuation conditions was carried out in order to determine the potential for further in situ reduction of COC levels in soil and groundwater. Although some biodegradation indicators exhibit trends typical for a contaminant plume with suppressed nitrate, dissolved oxygen (DO), and higher concentrations of manganese and ferrous iron, the plume exhibits marginal characteristics representative more of a transition between aerobic to anaerobic conditions.

In addition to trend analyses based on consistently declining COC concentrations in monitoring wells, evaluation of the aquifer's assimilative capacity was carried out to assess the aquifer's ability to complete BTEX degradation. The assimilative capacity assumes instantaneous degradation of BTEX once the contaminant is in contact with the primary electron acceptors (dissolved oxygen, nitrate, ferric iron, and sulfate). The assimilative capacity of the groundwater calculated at 18.2 mg/l (based on May 9, 2006, conditions) exceeds the concentrations of residual BTEX in most wells, with exception of wells MW-10, 12, and 16. Under current conditions, most of the aquifer is capable of completing the natural biodegradation process, but an excess of carbon (contaminants) in areas around the noted wells including a deficit of electron acceptors reduces biodegradation potential.

3.5 Technical and Economic Summary and Discussion

The MPE system was successfully operating 90% of the time, including monthly maintenance shutdowns, between July 11, 2001, and November 22, 2005. Excluded are winter pauses from January to March requested by the City of Hazen to reduce potential for effluent freezeup in a discharge ditch.

High contaminant removal efficiency of dual-phase (multiphase) extraction technology is a result of a combination of simultaneous extraction of water and vapor. It follows from contaminant recovery/degradation breakdown estimates (Table 4) that vapor extraction efficiency by far exceeds that for groundwater (in this case by a factor of 86) and, to a certain extent, draws a comparison between soil vapor extraction and pump-and-treat systems. Documented high contaminant recovery using vapor as a primary carrier could not, however, be achieved without simultaneous dewatering of the targeted smear zone.

Table 4. Contaminant recovery/degradation breakdown estimates

COC Recovered/Degraded	Total			
	(lb)	(kg)	(gal)	(%)
Vapor extraction	62,584	28,388	10,000	81.7
Groundwater extraction	725	329	116	1
Degradation by air exchange/O_2 delivery	13261	6015	2119	17.3
	76570	34732	12235	100

An additional advantage of dual-phase extraction is air exchange/oxygen delivery to the contaminated zone during operation of the MPE system. Because quantification of in situ oxygen partitioning between soil- and groundwater-bound contaminants and their subsequent reduction is extremely difficult, this means of degradation, albeit substantial, is often not considered by the environmental industry in mass balance estimates.

Based on project cost and total contaminant recovery of 63, 309 lb per unit, the cost for contaminant recovery was \$15.26/lb (\$33.65/kg). If in situ degradation resulting from oxygen delivery is considered, the cost would be \$12.62/lb (\$27.82/kg) of contaminant recovered/degraded.

4.0 CONCLUSIONS

A total of 6,707,299 gallons (25,387 m^3) of groundwater and 110.8 million ft^3 (3.1 million m^3) of soil vapor have been extracted from well fields since extraction start-up, resulting in removal of over 62,584 lb (28,388 kg) of hydrocarbons prior to stripping and an additional 725 lb (329 kg) from the treated groundwater. The mass of recovered contaminant equals approximately 10,116 gal (38,290 l) of product, assuming specific gravity for gasoline of 0.75 g/cm^3.

Analytical results from the most recent sampling indicate that about 83% average improvement in groundwater quality was achieved since June 2002 (prior to system start-up) and that most of the contaminant plume is already amenable to natural biodegradation. With exception of benzene, concentrations of toluene, ethylbenzene, and xylene in most wells were successfully reduced to regulatorily acceptable limits of 1000 ppb, 700 ppb, and 10,000 ppb, respectively.

Groundwater quality monitoring confirmed the continuing COC reduction trend in most monitoring wells and an average benzene reduction of 85% within the entire impacted area since remediation system start-up. Comparison of mass balance estimates for the extraction system with biodegradation stoichiometry using the assimilative capacity of the groundwater indicates that in situ natural attenuation processes became a dominant factor in COC reduction. Improved site conditions justified termination of corrective action.

The cost of contaminant recovery was $15.26/lb ($33.65/kg). If in situ degradation resulting from oxygen delivery is considered, the cost would be $12.62/lb ($27.82/kg) of contaminant recovered or degraded.

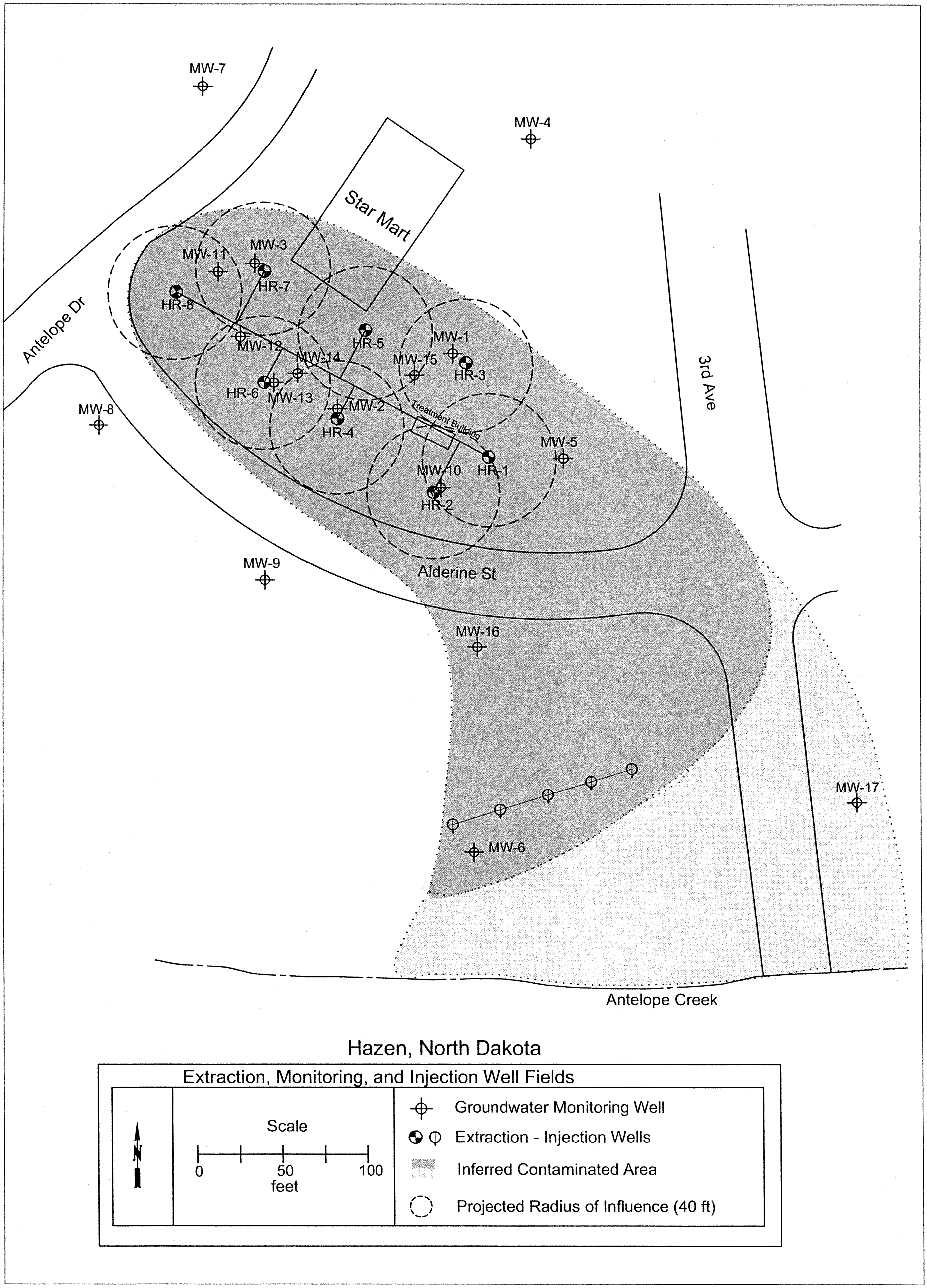
5.0 REFERENCES

1. Solc, J., 2002, Demonstration of vacuum-enhanced recovery and feasibility of permeable treatment barriers for site remediation at Hazen: Progress Report for April–July 2002.

2. Kuo, J., 1999, Practical Design Calculations for Groundwater and Soil Remediation. CRC Press, LLC Lewis Publishers, Boca Raton, Florida.

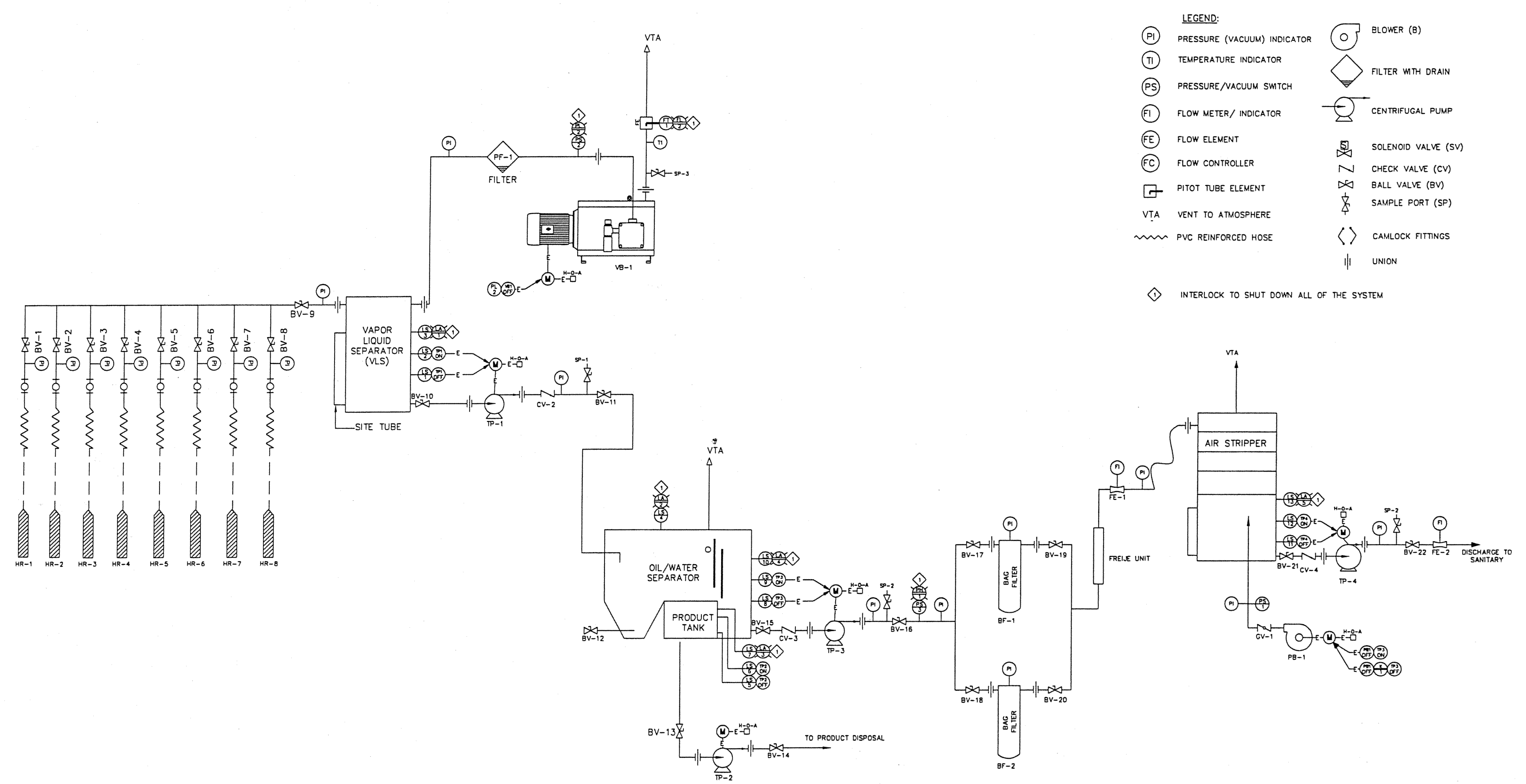
APPENDIX A

SITE PLAN AND EXTRACTION WELL FIELD


MW-7
MW-4
Star Mart
Antelope Dr
3rd Ave
MW-11
MW-3
HR-7
HR-8
HR-5
MW-1
MW-12
MW-14
MW-15
HR-3
HR-6
MW-13
MW-2
HR-4
Treatment Building
MW-8
MW-5
MW-10
HR-1
HR-2
MW-9
Alderine St
MW-16
MW-17
MW-6
Antelope Creek
Hazen, North Dakota
Extraction, Monitoring, and Injection Well Fields
N
Scale
0
50
100
feet
Groundwater Monitoring Well
Extraction - Injection Wells
Inferred Contaminated Area
Projected Radius of Influence (40 ft)

APPENDIX B

MPE AND TREATMENT SYSTEM

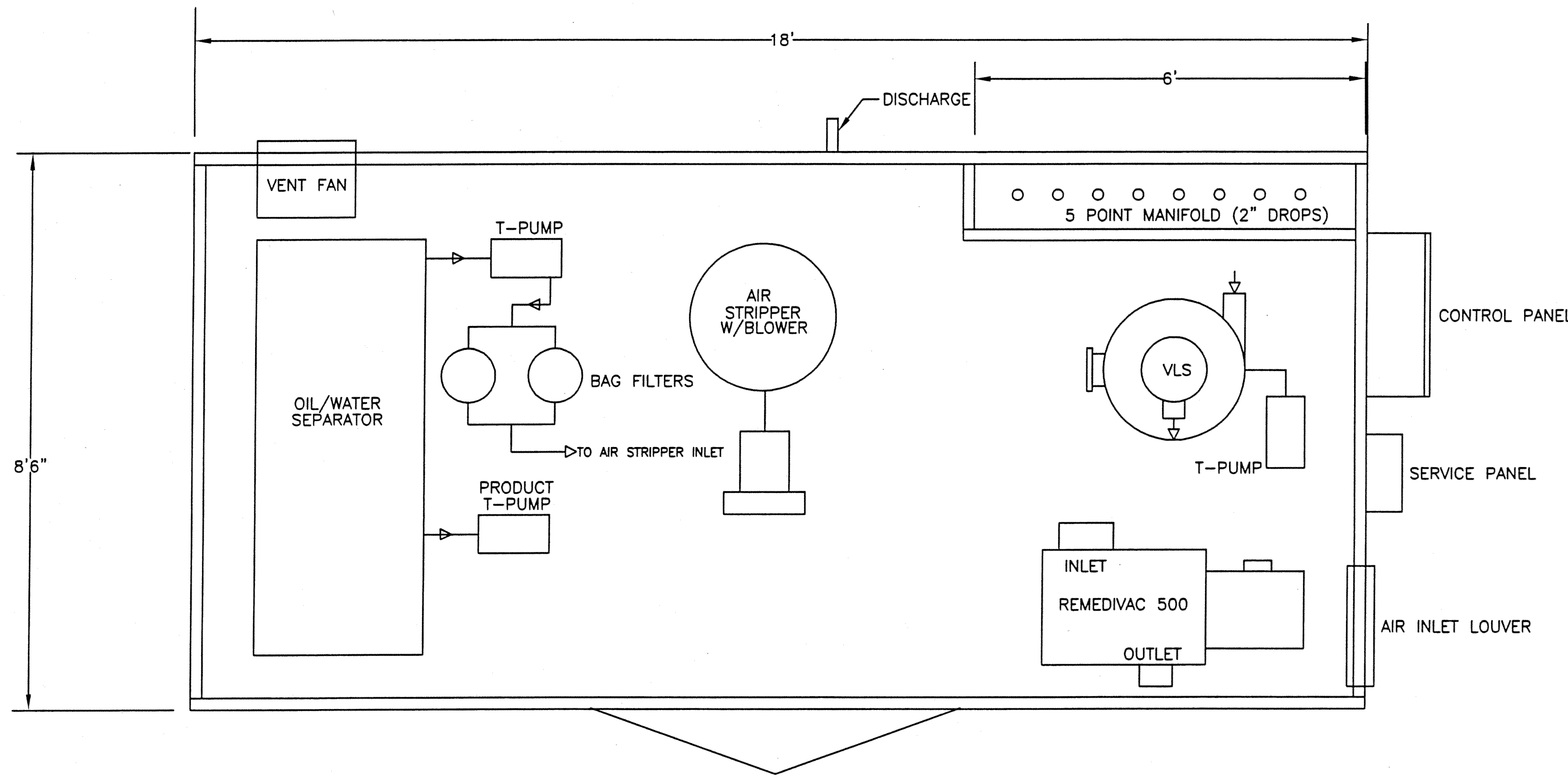


SPECIALTY SYSTEMS INTEGRATORS, INC
14150 23rd Avenue North
Plymouth, MN 55447
763-553-2661 Fax: 763-553-2656

TITLE:
PROCESS AND INSTRUMENTATION DIAGRAM

Hazen Facility
North Dakota

DWN: SB	DES.:	PROJECT NO.:
CHKD: SB	APPD: JS	FIGURE NO.: 012-PID
DATE: 05/03/02	REV.: 1	

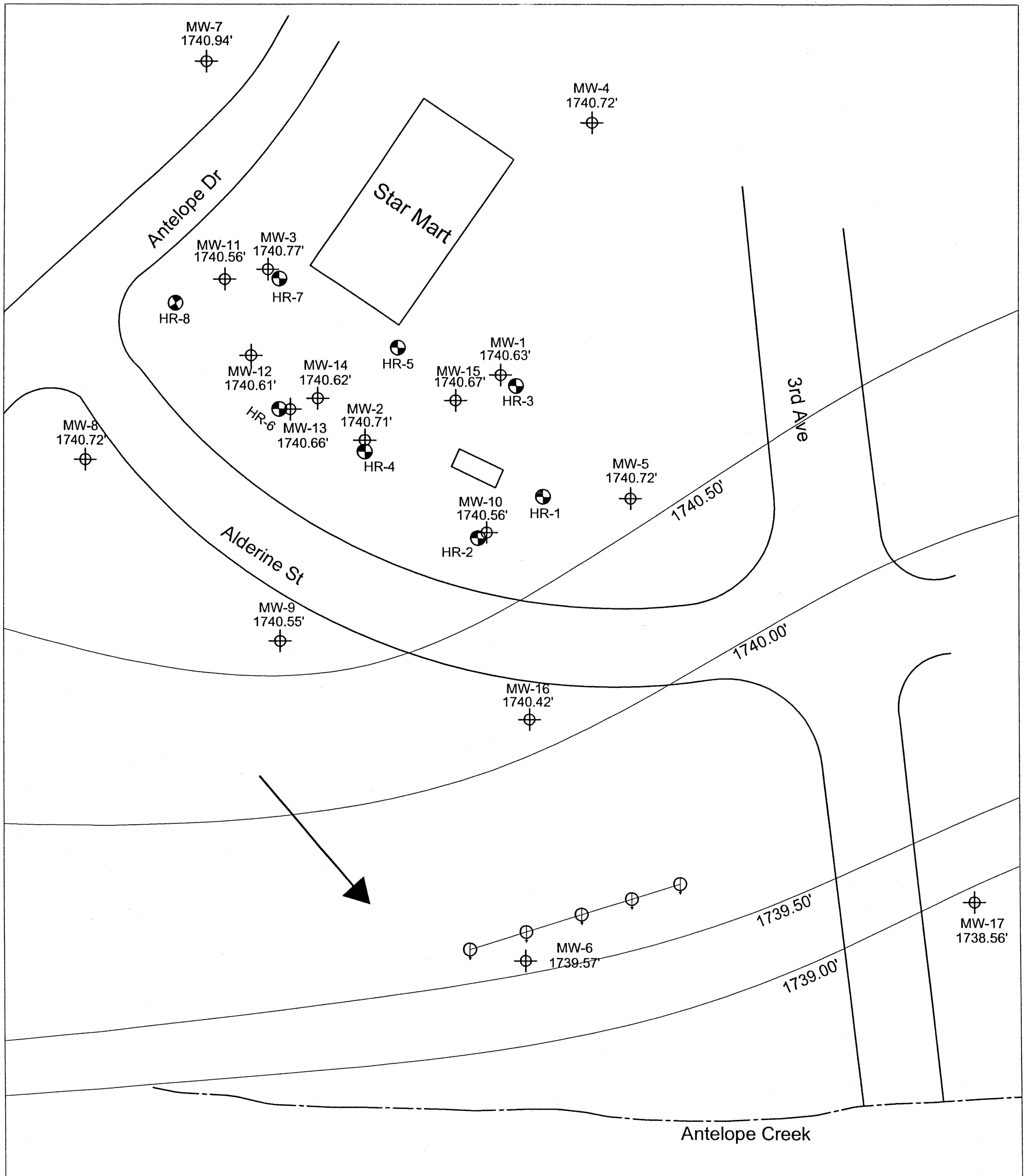


BUILDING LAYOUT

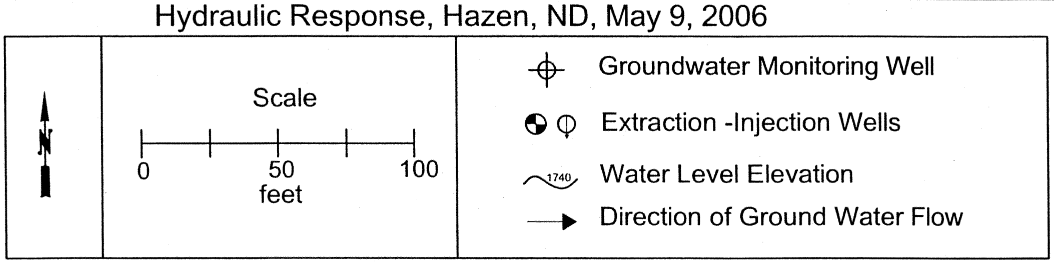
SPECIALTY SYSTEMS INTEGRATORS, INC 14150 23RD AVE N. PLYMOUTH, MN 55447 763-553-2661 FAX: 763-553-2656	TITLE: EERC HAZEN PROJECT BUILDING LAYOUOT	DWN: MV CHKD: MV DATE: 7-5-02	DES.: APPD: JS REV.: 1	PROJECT NO.: FIGURE NO.: 012-LAYOUT

APPENDIX C

HYDRAULIC RESPONSE – DATA SUMMARY AND GROUNDWATER TABLE CONFIGURATION



Hydraulic Response, Hazen, ND, May 9, 2006



Groundwater Table Monitoring

Elevations in feet

Well ID	Ground	TOC	MP1	07/10/02	07/12/02	07/16/02	07/23/02	07/31/02	08/07/02	08/15/02	08/23/02	09/05/02	09/18/02	09/23/02
HR-1	1749.70	1748.99	1749.20	1742.08	1741.29	1741.30	1741.57	1741.48	1741.43	1740.86	1740.58	1741.07	1740.90	1740.36
HR-2	1749.29	1748.79	1748.98	1742.14	1734.27	1734.26	1734.28	1734.28	1734.31	1734.14	1734.88	<1734.14	<1734.14	<1734.14
HR-3	1750.72	1750.17	1750.36	1742.12	1735.20	1735.11	1735.11	1735.12	1735.16	1741.31	1741.31	<1735.15	<1735.15	<1735.15
HR-4	1750.85	1750.25	1750.44	1742.17	1735.18	1735.17	1735.12	1735.14	1735.29	1735.10	1735.58	<1735.29	<1735.29	<1735.29
HR-5	1752.27	1751.62	1751.83	1742.28	1736.63	1736.62	1736.53	1736.54	1736.73	1736.54	1736.91	<1736.72	<1736.72	<1736.72
HR-6	1751.10	1750.47	1750.68	1742.18	1740.58	1741.93	1741.98	1741.99	1741.64	1741.53	1741.23	1741.36	1741.22	1741.13
HR-7	1752.26	1751.50	1751.71	1742.30	1742.00	1741.87	1741.81	1741.81	1741.86	1741.52	1741.85	1741.55	1741.04	1741.26
HR-8	1751.37	1750.71	1750.93	1742.22	1742.02	1741.88	1741.93	1741.94	1741.92	1741.54	1741.20	1741.60	1741.55	1741.31
MW-1	1751.06	1753.85	1753.90	1742.21	1740.08	1740.27	1740.57	1740.55	1740.78	1741.34	1741.03	1740.32	1740.63	1740.47
MW-2	1751.08	1750.47	1750.56	1742.18	1739.36	1740.03	1740.21	1740.17	1740.17	1740.20	1740.35	1739.78	1739.83	1739.88
MW-3	1752.35	1751.63	1751.70	1742.31	1742.10	1741.93	1741.90	1741.95	1741.91	1741.60	1741.47	1741.62	1741.58	1741.29
MW-4	1752.12	1754.50	1754.50	1742.66	1742.60	1742.61	1742.50	1742.60	1742.31	NM	NM	1742.10	1741.96	1741.74
MW-5	1749.03	1751.69	1751.69	1742.07	1741.88	1741.92	1741.92	1741.90	1741.53	1741.37	1741.22	1741.45	1741.32	1741.03
MW-6	1744.17	1746.46	1746.46	1741.73	1741.69	1742.19	1740.13	1740.25	1739.24	1739.91	1740.16	1739.88	1739.12	1739.07
MW-7	1753.22	1753.03	1753.03	1742.68	1742.70	1742.50	1742.55	1742.58	1742.46	1742.19	1743.19	1742.25	1742.10	1741.90
MW-8	1751.14	1753.39	1753.39	1742.19	1742.09	1741.97	1742.02	1742.00	1741.88	1741.66	1741.18	1741.66	1741.59	1741.36
MW-9	1749.78	1749.20	1749.20	1742.13	1742.14	1741.45	1741.58	1741.61	1741.25	1741.15	1741.08	1741.16	1740.94	1740.68
MW-10	1749.29	1750.59	1750.59	1742.10	1737.91	1738.74	1739.23	1739.24	1739.70	1737.18	1735.47	1737.56	1737.67	1737.85
MW-11	1751.79	1751.16	1751.25	1742.29	1742.10	1741.90	1742.00	1742.02	1741.92	1741.59	1741.60	1741.63	1741.58	1741.32
MW-12	1751.60	1751.08	1751.21	1742.22	1741.96	1741.81	1741.84	1741.86	1741.78	1741.50	1741.70	1741.52	1741.45	1741.25
MW-13	1751.18	1750.52	1750.59	1742.20	1741.63	1741.37	1741.39	1741.44	1741.45	1741.15	1742.36	1741.24	1741.09	1741.01
MW-14	1751.49	1750.78	1750.87	1742.18	1741.52	1741.28	1741.37	1741.43	1741.35	1741.05	1740.85	1741.12	1740.99	1740.94
MW-15	1751.11	1750.51	1750.64	1742.19	1741.17	1741.14	1741.29	1741.33	1741.28	1740.94	1741.24	1740.92	1740.94	1740.70
MW-16	1745.68	1745.48	1745.48	1743.21	1742.88	1741.35	1741.28	1741.32	1740.55	1740.97	1740.98	1740.79	1739.30	1740.08
MW-17	1745.01	1744.96	1744.96	1739.36	1738.31	1739.55	1739.72	1739.76	1738.73	1738.90	1739.11	1739.01	1738.53	1738.58

MP1 - measuring point after wellhead instrumentation

NM - not measured

Groundwater Table Monitoring

Elevations in feet

Well ID	10/02/02	10/16/02	11/18/02	12/16/02	01/07/03	02/18/03
HR-1	1740.18	1740.39	1740.28	1740.36	1740.46	NM
HR-2	<1734.14	<1734.14	<1734.14	<1734.14	<1734.14	1740.68
HR-3	<1735.15	<1735.15	<1735.15	<1735.15	<1735.15	NM
HR-4	<1735.29	<1735.29	<1735.29	<1735.29	<1735.29	1740.95
HR-5	<1736.72	<1736.72	<1736.72	<1736.72	<1736.72	1741.02
HR-6	1740.96	1741.04	1740.90	1740.88	1740.85	NM
HR-7	1741.06	1741.15	1740.89	1740.84	1740.81	1741.07
HR-8	1741.10	1741.18	1741.04	1740.99	1740.94	1741.10
MW-1	1740.28	1740.36	1740.23	1740.14	1740.08	1740.40
MW-2	1739.75	1739.43	1738.71	1738.33	1738.55	1740.82
MW-3	1741.09	1741.18	1741.02	1740.91	1740.88	1741.05
MW-4	1741.57	1741.59	1741.07	1741.26	1741.22	1741.20
MW-5	1740.91	1741.14	1740.72	1741.07	1741.35	1740.62
MW-6	1739.12	1739.46	1739.41	1739.34	1739.46	1739.01
MW-7	1741.69	1741.67	1741.50	1741.38	1741.31	NM
MW-8	1741.20	1741.25	1741.12	1741.05	1741.03	1741.12
MW-9	1740.52	1740.64	1740.57	1740.52	1740.53	NM
MW-10	1737.91	1738.17	1738.38	1738.47	1738.51	1740.52
MW-11	1741.12	1741.19	1741.03	1740.92	1740.88	1741.01
MW-12	1741.07	1741.23	1741.05	1740.96	1740.93	1741.03
MW-13	1740.87	1740.96	1740.82	1740.96	1740.74	1740.91
MW-14	1740.78	1740.86	1740.74	1740.69	1740.68	1740.94
MW-15	1740.51	1740.65	1740.50	1740.44	1740.42	1741.15
MW-16	1740.01	1740.26	1740.17	1740.18	1740.30	NM
MW-17	1738.71	1739.47	1739.01	1738.94	1739.39	1738.47

Groundwater Table Monitoring

Elevations in feet

Well ID	03/27/03	03/28/03	04/23/03	05/19/03	06/17/03	07/15/03	08/21/03	09/23/03	10/22/03	11/17/03	12/17/03
HR-1	1740.75	<1734.44	NM	1734.47	1740.79	1740.75	1737.57	1740.27	1739.13	1742.32	1739.79
HR-2	1740.79	<1734.14	NM	1734.35	1734.31	<1734.14	1735.54	1737.93	1739.41	1739.70	1734.50
HR-3	1736.11	<1735.15	NM	1735.61	<1735.15	<1735.15	1740.40	1740.36	1739.90	1740.54	NM
HR-4	1740.94	<1735.29	NM	1735.36	<1735.29	<1735.29	1735.29	1735.19	dry	dry	dry
HR-5	1741.05	<1736.72	NM	1736.75	<1736.72	<1736.72	1736.70	1736.63	dry	dry	dry
HR-6	Frozen	Frozen	NM	1741.31	1741.98	1741.16	1736.50	1736.48	1738.65	1737.11	1736.36
HR-7	1741.07	1740.83	NM	1741.36	1741.43	1741.37	1736.89	1737.04	1736.90	1736.89	1736.88
HR-8	1741.09	1740.90	NM	1741.42	1741.43	1741.38	1740.07	1740.06	1739.56	1739.55	1739.39
MW-1	1740.90	1739.46	1739.94	1739.99	1740.23	1740.01	1740.38	1740.33	1739.87	1740.30	1739.55
MW-2	1740.79	1738.21	1738.53	1737.86	1738.21	1738.23	1737.33	1734.01	1735.88	1735.95	1736.08
MW-3	1741.08	1740.85	1740.80	1741.34	1741.39	1741.30	1739.40	1739.35	1739.02	1738.98	1739.31
MW-4	1741.19	1741.10	1740.98	1741.87	1742.93	1741.84	1741.13	1740.90	1740.49	1740.22	1739.91
MW-5	1740.76	1740.45	1740.86	1741.38	1741.94	1741.45	1740.69	1740.67	1740.29	1741.87	1740.75
MW-6	1739.77	1739.77	1739.91	1742.24	1740.90	1739.58	1738.35	1739.27	1738.74	1739.03	1738.91
MW-7	1740.40	1740.36	1741.18	1741.74	1741.90	1741.88	1740.98	1740.98	1740.28	1740.15	NM
MW-8	1741.12	1740.98	1740.94	1741.28	1741.55	1741.41	1740.39	1740.29	1739.89	1739.82	1739.71
MW-9	1740.72	1740.65	1740.65	1739.37	1741.48	1737.22	1739.93	1740.20	1740.20	1739.86	1739.58
MW-10	1740.63	1737.39	1737.64	1736.96	1737.88	1738.29	1739.13	1739.22	1739.42	1741.69	1740.27
MW-11	1741.01	1740.82	1740.77	1741.26	1741.33	1741.26	1739.66	1739.68	1739.23	1739.21	1738.98
MW-12	1741.04	1740.79	1740.79	1741.33	1741.24	1741.28	1740.92	1739.86	1739.48	1739.45	1739.09
MW-13	1740.92	1740.52	1740.58	1741.22	1741.22	1741.06	1738.74	1738.22	1738.31	1738.35	1738.02
MW-14	1740.94	1740.44	1740.57	1741.24	1741.13	1740.97	1739.58	1739.32	1739.04	1739.07	1738.92
MW-15	1740.90	1740.06	1740.19	1740.58	1740.83	1740.76	1740.09	1739.85	1739.63	1740.24	1739.41
MW-16	1739.41	1739.40	1740.52	1743.28	1741.95	1740.92	1739.54	1740.13	1739.48	1740.28	1739.65
MW-17	1739.16	1739.11	1739.10	1740.38	1739.69	1739.18	1738.14	1738.46	1738.27	1738.65	1738.54

Groundwater Table Monitoring

Elevations in feet

Well ID	04/13/04	05/18/04	06/16/04	07/15/04	08/11/04	09/22/04	10/09/04	11/09/04	12/11/04	01/18/05
HR-1	1740.75	1740.22	1740.30	1740.20	1739.89	1739.91	1739.45	1739.89	1739.83	1739.79
HR-2	1741.07	1740.20	1740.38	1740.23	1739.84	1739.82	1739.18	1739.77	1734.21	-
HR-3	1741.05	1739.90	1739.96	1739.92	1739.74	1739.73	1739.28	1739.69	1739.52	1739.57
HR-4	1740.63	1739.68	1739.83	1740.03	1739.52	1739.55	1739.23	1739.81	1735.44	-
HR-5	1740.85	1739.51	1739.53	1739.81	1739.29	1739.32	1739.17	1739.34	1736.72	1736.74
HR-6	1736.43	1736.10	1736.33	1739.73	1736.16	1736.16	1736.16	1736.16	1739.97	1740.00
HR-7	1738.10	1737.60	1737.51	1737.91	1737.50	1737.52	1737.41	1737.69	1739.92	1739.88
HR-8	1737.73	1737.43	1736.78	1736.92	1737.35	1737.44	1738.68	1737.67	1739.98	1739.94
MW-1	1741.00	1739.82	1739.89	1739.92	1739.53	1739.45	1739.12	1739.33	1739.75	1739.74
MW-2	1740.59	1739.51	1739.47	1739.82	1739.17	1739.07	1739.10	1739.03	1737.79	1737.77
MW-3	1740.12	1738.89	1738.76	1738.92	1738.66	1738.60	1738.76	1738.19	1739.90	1739.85
MW-4	1741.36	1740.31	1740.47	1740.25	1739.99	1739.94	1739.56	1739.99	1739.97	1739.91
MW-5	1741.22	1740.72	1740.74	1740.59	1740.31	1740.30	1739.94	1740.72	1738.59	1738.59
MW-6	1739.83	1739.27	1742.72	1742.44	1742.00	1741.92	1738.06	1741.36	1738.54	1738.60
MW-7	1741.45	1740.19	1740.05	1740.02	1739.91	1739.88	1739.51	1739.76	1740.17	1740.10
MW-8	1740.76	1739.60	1739.53	1739.73	1739.43	1739.37	1739.18	1739.48	1740.00	1739.44
MW-9	1740.94	1739.78	1739.97	1739.96	1739.61	1739.57	1739.12	1739.62	1739.56	1739.54
MW-10	1740.90	1740.02	1740.18	1740.06	1739.68	1739.54	1739.50	1739.68	1737.74	1737.68
MW-11	1739.96	1738.72	1738.59	1738.95	NM	1751.25	1738.69	1751.25	1739.80	1739.76
MW-12	1740.20	1739.72	1739.19	1739.67	1739.83	1739.76	1739.05	1739.96	1739.88	1739.84
MW-13	1738.94	1740.06	1738.10	1739.99	1740.38	1740.34	1739.64	1740.23	1739.79	1739.59
MW-14	1739.84	1739.76	1738.94	1740.12	1739.42	1739.33	1739.24	1739.38	1739.71	1739.58
MW-15	1740.83	1739.72	1739.75	1739.87	1739.43	1739.35	1738.82	1739.22	1739.77	1739.65
MW-16	1740.83	1739.99	1741.15	1740.88	1740.19	1740.13	1739.09	1740.06	1739.17	1738.93
MW-17	1739.00	1738.82	1739.05	1738.46	1738.35	1738.17	1737.75	1738.13	1737.76	1737.75

measuring point after wellhead instrumentation

Groundwater Table Monitoring

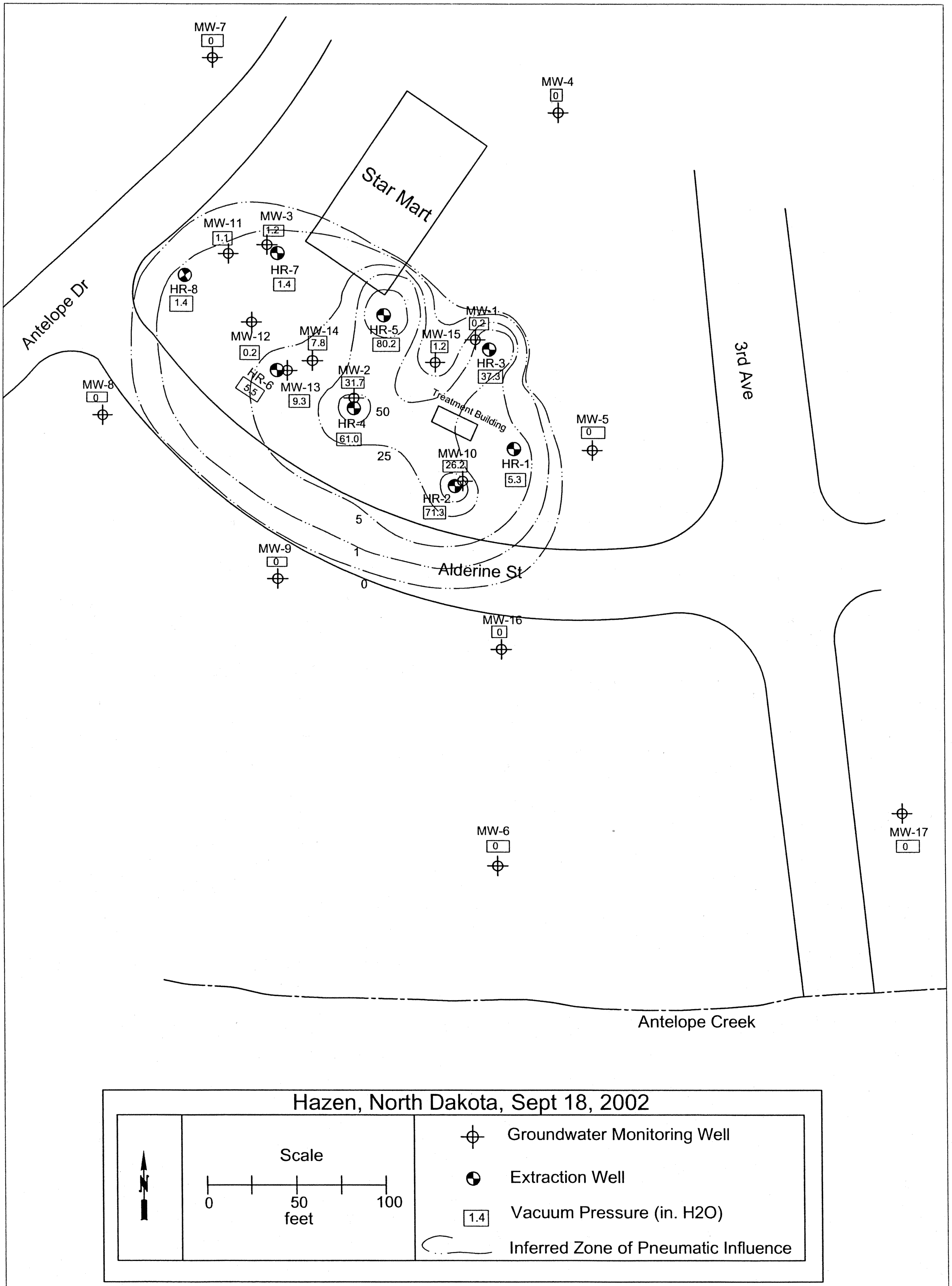
Elevations in feet

Well ID	04/05/05	04/19/05	05/02/05	06/13/05	07/11/05	08/02/05	08/25/05	09/13/05	11/22/05	05/09/06
HR-1	1739.79	1739.99	1740.10	1740.62	1740.58	1741.63	1740.55	1741.07	1740.02	1740.36
HR-2	1739.82	NM	1733.88	1734.28	1734.33	1741.52	1740.73	1740.61	1734.32	1740.45
HR-3	1740.27	NM	1735.16	1735.39	1735.47	1740.35	1740.65	1740.40	1740.34	1740.41
HR-4	1739.92	NM	1735.04	1735.24	1735.28	1741.08	1740.93	1740.41	1735.21	1740.20
HR-5	1739.95	1739.96	1740.02	1740.60	1740.54	1741.20	1740.86	1740.70	1740.70	1740.61
HR-6	1740.00	1740.55	1740.64	1741.09	1741.20	1736.08	1736.08	1736.08	1740.54	1740.64
HR-7	1736.96	1737.01	1737.36	1737.85	1737.82	1741.10	1741.00	1739.02	1740.55	1740.60
HR-8	1736.01	1736.04	1735.02	1735.50	1735.44	1738.15	1740.92	1738.94	1740.58	1740.60
MW-1	1739.79	1739.59	1739.61	1739.78	1739.89	1741.28	1740.65	1740.20	1740.37	1740.63
MW-2	1739.82	1738.22	1738.25	1738.55	1738.61	1741.09	1740.87	1740.27	1739.33	1740.71
MW-3	1738.11	1738.10	1738.01	1738.32	1738.41	1740.87	1741.11	1740.73	1740.53	1740.77
MW-4	1739.96	1739.95	1739.89	1741.08	1741.11	1741.55	1741.14	1741.04	1740.64	1740.72
MW-5	1739.84	1739.88	1739.59	1741.97	1742.07	1741.92	1740.78	1740.79	1740.48	1740.72
MW-6	1739.42	1739.40	1739.10	1739.85	1740.12	1739.87	1739.07	1740.45	1739.65	1739.57
MW-7	1740.12	1740.10	1740.12	1740.50	1740.82	1741.80	1741.00	1740.91	1740.81	1740.94
MW-8	1740.01	1739.99	1739.90	1740.27	1740.28	1741.00	1740.48	1740.36	1740.57	1740.72
MW-9	1739.87	1739.85	1739.83	1739.99	1740.02	1740.58	1740.39	1740.00	1740.30	1740.55
MW-10	1739.36	1738.24	1738.20	1738.41	1738.48	1741.09	1740.06	1740.24	1738.56	1740.60
MW-11	1737.88	1737.84	1737.86	1738.04	1738.06	1740.80	1740.76	1740.00	1740.42	1740.56
MW-12	1739.79	1739.81	1739.72	1740.04	1740.13	1740.85	1740.52	1740.02	1740.46	1740.61
MW-13	1739.87	1739.98	1739.86	1740.20	1740.44	1740.47	1740.23	1740.24	1740.41	1740.66
MW-14	1739.80	1738.77	1738.48	1738.70	1738.84	1740.73	1740.38	1740.09	1740.29	1740.62
MW-15	1739.78	1739.01	1738.17	1740.45	1740.58	1740.97	1740.53	1740.47	1740.43	1740.67
MW-16	1739.82	1739.89	1739.85	1740.12	1740.25	1740.79	1739.61	1740.19	1740.28	1740.42
MW-17	1738.14	1738.14	1738.01	1738.64	1738.78	1739.14	1738.07	1738.62	1738.50	1738.56

MP1 - meas

APPENDIX D

PNEUMATIC RESPONSE – DATA SUMMARY


MW-7
0
MW-4
0
Star Mart
MW-11
1.1
MW-3
1.2
HR-7
1.4
HR-8
1.4
Antelope Dr
MW-12
0.2
MW-14
7.8
HR-5
80.2
MW-15
1.2
MW-1
0.2
HR-3
37.3
3rd Ave
HR-6
5.5
MW-13
9.3
MW-2
31.7
HR-4
61.0
50
25
Treatment Building
MW-8
0
MW-5
0
MW-10
26.2
HR-1
5.3
HR-2
71.3
5
1
0
MW-9
0
Alderine St
MW-16
0
MW-6
0
MW-17
0
Antelope Creek
Hazen, North Dakota, Sept 18, 2002
N
Scale
0
50
100
feet
Groundwater Monitoring Well
Extraction Well
1.4
Vacuum Pressure (in. H2O)
Inferred Zone of Pneumatic Influence

VACUUM PRESSURE MONITORING

Operational extraction wells are shaded

Well ID	07/16/02 (in.H_2O)	07/23/02 (in.H_2O)	07/31/02 (in.H_2O)	08/07/02 (in.H_2O)	08/15/02 (in.H_2O)	09/05/02 (in.H_2O)	09/18/02 (in.H_2O)	09/23/02 (in.H_2O)	10/02/02 (in.H_2O)	10/16/02 (in.H_2O)	11/18/02 (in.H_2O)	12/16/02 (in.H_2O)	01/07/03 (in.H_2O)
HR-1	0.0	0.0	0.0	0.0	0	0.0	5.3	1.1	0.9	0.8	1.3	0.7	0.3
HR-2	34.0	33.0	28.0	26.5	72.1	81.2	71.3	54.2	49.9	45.8	37.9	42.8	28.3
HR-3	87.0	65.0	68.0	49.5	0	78.8	37.3	45.8	46.9	35.6	38.9	47.3	49.5
HR-4	83.0	81.0	80.0	70.0	67.5	69.8	61	61.2	61.6	61.5	57.8	60.3	63.2
HR-5	102.0	98.0	87.0	90.0	101.5	83.5	80.2	81.6	80.4	84.5	84.2	85.5	86.1
HR-6	0.0	5.8	4.7	4.5	7	9.6	5.5	7.7	7.7	8.1	7.4	5.9	5.4
HR-7	0.0	1.3	1.1	1.2	1.3	1.3	1.4	1.1	1.4	1.3	1.1	0.8	0.7
HR-8	0.0	1.7	1.2	1.4	1.5	1.5	1.4	1.1	1.2	1.3	1.1	0.7	0.7
MW-1	0.0	0.0	0.0	0.0	0	0.0	0.2	0	0	0.8	0.3	0.2	0.2
MW-2	20.0	24.2	23.8	26.8	26.8	32.1	31.7	31.3	30.4	34.4	29.2	29.6	29.2
MW-3	0.0	1.2	0.9	1.0	1.2	1.1	1.2	1	0.9	1.1	0.9	0.7	0.7
MW-10	12.8	11.0	11.1	8.5	24	22.1	26.2	16.4	16.4	11.9	7.8	16.1	11.8
MW-11	0.0	0.0	0.0	0.8	1.2	1.1	1.1	0.9	0.9	1.1	0.8	0.6	0.5
MW-12	0.0	0.0	0.0	1.3	1.7	0.3	0.2	3.1	3.1	2.6	4.7	0.8	0.9
MW-13	0.0	8.5	9.5	8.8	10.5	10.7	9.3	8.5	8.5	8.9	8.2	6.8	6.1
MW-14	0.0	5.7	2.5	2.2	5.9	4.6	7.8	7.8	7.8	9.2	10.2	8.7	7.5
MW-15	3.5	3.6	3.3	3.7	3.4	4.2	1.2	3.3	3.3	5.4	4.3	8	4.6

Well ID	03/27/03 (in.H_2O)	03/28/03 (in.H_2O)	04/23/03 (in.H_2O)	05/19/03 (in.H_2O)	06/17/03 (in.H_2O)	07/15/03 (in.H_2O)	08/21/03 (in.H_2O)	09/23/03 (in.H_2O)	10/22/03 (in.H_2O)	11/17/03 (in.H_2O)	12/17/03 (in.H_2O)
HR-1	81.9	89.3	39.3	68.7	0.9	0	0	0	0	0	0
HR-2	51.4	49.5	36.4	68.4	69.2	68.5	2.6	0.2	0.3	0.7	10
HR-3	62.8	70.2	53.6	101.2	127.6	84.0	0	0	0	0	NM
HR-4	78.5	68.9	63.4	87.5	89.9	85.5	96.3	113.2	89.4	91.4	93.9
HR-5	71.3	67.3	70.4	98.4	104.2	92.8	115.4	140.0	115.8	121.6	119.8
HR-6	12.6	9.7	8.2	10.9	0	7	132.1	132.1	102.4	102.3	98
HR-7	1.3	1.2	0.7	0.9	0.9	0.9	27.2	28.5	28.5	24.6	24.9
HR-8	1.6	1.4	1.2	1.4	2.1	1.2	5.0	6.7	5.2	5.4	4.6
MW-1	1.1	1.2	0.8	1	0.7	0.1	0	0	0	0	0
MW-2	40.2	34.7	30.2	41	37.5	36.5	45.8	80.4	69.1	66.3	64.4
MW-3	1.2	1.1	0.7	1	0.8	0.9	9.3	10.3	9.1	9.3	9.1
MW-10	19.3	18.3	13.7	23.2	19	14.5	0.1	0	0	0	0.4
MW-11	0.9	1.1	0.8	1.1	0.9	0.9	5.5	6.8	5.4	5.6	3.8
MW-12	2.6	2.3	0.7	6.3	0	4.5	12.7	13.9	15.3	12.8	7.1
MW-13	12.4	10.4	9.2	10.9	0	9.9	41.7	49.5	46.3	46.2	36.5
MW-14	14.2	11.6	10.6	9.3	5	11.5	23.4	25.6	26.8	26.6	22.7
MW-15	9.1	7.9	5	10.2	7.4	6.1	5.0	3.9	4.6	4.7	4.5

VACUUM PRESSURE MONITORING (Continued)

Well ID	04/13/04 (in.H_2O)	05/18/04 (in.H_2O)	06/16/04 (in.H_2O)	07/15/04 (in.H_2O)	08/11/04 (in.H_2O)	09/22/04 (in.H_2O)	10/09/04 (in.H_2O)	11/09/04 (in.H_2O)	12/11/04 (in.H_2O)	01/18/05 (in.H_2O)
HR-1	0	0	0	0	0	0	0	0	0	0
HR-2	0	0	0	0	0	0	0	0	42.6	40.1
HR-3	0	0	0	0	0	0	0	0	0	0
HR-4	5.5	0	5.9	0	4.1	3.7	1.4	2.9	66.1	69.3
HR-5	3.7	0	4.3	0	2.9	2.6	1.3	1.7	88	67.7
HR-6	94.4	100.1	163.2	123.8	98.1	89.9	51.2	78.3	0	0
HR-7	10.1	20.6	18.3	15.8	22.3	20.4	19.3	19.3	0.7	0.5
HR-8	85.1	105.6	20.6	17.7	16.9	15.8	11.3	14.6	0.5	0.2
MW-1	0	0	0	0	0	0	0	0	0	0
MW-2	5.4	0	4.4	0	3.9	2.8	1.3	1.5	47	45.5
MW-3	6.1	8.4	17.7	6.9	7.3	6.9	6.1	3.6	0	0
MW-10	0	0	2.6	0	0	0	0	0	3	2.6
MW-11	7.6	9.5	19.4	6.1	7.3	6.3	6.3	5.7	0.5	0.3
MW-12	0.3	11.5	30.6	12.5	13.2	12.9	8.1	11.1	1.4	1.2
MW-13	33.3	36.1	58.7	0	38.2	37.1	15.7	28.2	3	2.1
MW-14	19.7	18.4	34.6	0	16	15.6	6.4	13.3	6.3	5.9
MW-15	0.3	0	72.4	0	1	0.5	0.5		2.8	2.2

Well ID	04/05/05 (in.H_2O)	04/20/05 (in.H_2O)	05/03/05 (in.H_2O)	06/13/05 (in.H_2O)	07/11/05 (in.H_2O)	08/02/05 (in.H_2O)	08/25/05 (in.H_2O)	09/13/05 (in.H_2O)	10/13/05 (in.H_2O)	11/22/05 (in.H_2O)
HR-1	0.5	0.3	0	0		0	0	0	0	0.2
HR-2	74.3	76.1	81.3	86.5	89.3	0	0	0	75	42.8
HR-3	80.9	82.3	89.2	121.2	125.4	0	0	0	0	0
HR-4	96.1	98.6	101.7	119.7	118.6	39.3	0	0	115.2	87.7
HR-5	3.6	3.6	4.9	6.3	5.9	0	0	0	78.5	57
HR-6	0.3	0	0	0	0	23.6	62.3	64.6	0.1	0
HR-7	1.1	1	0	0	0	13.2	3.1	51.9	2	0.5
HR-8	0.3	0	0	0	0	19.1	0.6	1.5	2.2	1.2
MW-1	0.3	0.1	0	0	0	0	0	0	0.1	0
MW-2	68.7	68.1	56.3	61.3	59.6	0	0	0	73.8	24.3
MW-3	1.2	0.8	0	0	0	16.1	0	0	1.8	0.4
MW-10	5.1	6.2	5.9	9.1	8.6	0	0	0	4.7	3.1
MW-11	1.5	1.1	0	0	0	11.4	2.5	0	1.9	1.4
MW-12	2.4	2	1.2	0	0	0	0	0	2	0.6
MW-13	12.6	13.1	4.3	12.9	13.1	0	8.3	0	14.9	3.8
MW-14	10.6	10.1	9.8	7.3	3.6	18.9	2.6	0	16.5	4.8
MW-15	4.6	5.1	6.2	3.2	2.9	0	0.9	0	5.9	1.8

APPENDIX E

MASS BALANCE WORKSHEETS

APPENDIX E-1

CONTAMINANT RECOVERY – LIQUID PHASE

Contaminant Recovery - Liquid Phase

Date	Totalizer (gal)	Flow (gpm)	TPH_{water} mg/l	BTEX mg/l	TPH Mass (lb)	BTEX Mass (lb)
	Well field HR-2, 3, 4, 5					
07/11/02	0		74.3	32.7		
07/16/02	45,100	10.5	57.0	22.2	24.7	10.3
07/23/02	49,908	9.9	51.5	20.3	2.2	0.9
08/15/02	177,277	9.9	68.8	28.5	63.9	25.9
09/18/02	267,961	10.5	35.2	15.1	39.3	16.5
09/24/02	340,139	8.0	67.7	22.6	31.0	11.4
10/02/02	403,460	5.6	44.1	16.6	29.5	10.4
10/16/02	509,217	5.2	30.7	11.1	33.0	12.2
11/18/02	750,129	6.0	20.7	6.0	51.7	17.2
12/16/02	909,574	4.0	15.3	5.7	23.9	7.8
01/07/03	1,027,069	3.7	12.6	4.93	13.8	5.2
	Well field HR-1, 2, 3, 4, 5					
03/28/03	1,034,482	5.7	53.4	16.48	2.9	0.9
04/23/03	1,196,925	4.3	16.2	7.34	47.2	16.1
05/19/03	1,378,891	4.8	14.8	6.05	23.5	10.2
	Well field HR-2, 3, 4, 5					
06/17/03	1,665,824	6.9	4.9	2.15	23.6	9.8
07/15/03	1,796,418	4.3	3.4	1.85	4.5	2.2
	Well field HR-4, 5, 6, 7					
07/22/03	1,847,512	5.2	15	8.80	1.4	0.8
08/21/03	2,230,972	10.4	20	8.80	56.0	28.2
09/23/03	2,551,793	10.4	15.1	7.83	47.0	22.3
10/22/03	2,829,793	8.4	9.7	3.97	28.8	13.7
11/17/03	3,144,793	8.5	10	2.90	25.9	9.0
12/17/03	3,503,086	8.5	4.9	1.96	22.3	7.3
01/05/04	3,682,286	7.1	4.9	1.96	7.9	3.2
	Well fields HR-4, 5, 6, 7 and HR-6, 7, 8					
04/13/04	3,711,086	10.0	6.2	1.85	0.7	0.2
05/18/04	4,235,969	11.4	5.1	1.82	24.7	8.0
06/16/04	4,694,156	11.0	4.3	1.69	18.0	6.7
07/15/04	5,133,582	10.7	8.0	3.10	22.6	8.8
08/10/04	5,396,932	8.9	4.7	1.55	14.0	5.1
09/22/04	5,702,666	8.2	4.0	0.93	11.2	3.2
10/16/04	5,896,606	5.8	2.0	0.45	4.9	1.1
11/09/04	6,086,103	5.8	2.0	0.03	3.2	0.4
	Well field 2, 4, 5					
11/09/04	6,086,103		189.0	40.10		
12/15/04	6,105,708	0.4	9.0	2.50	16.2	3.5
01/18/05	6,131,792	0.5	2.8	0.69	1.3	0.3
	Well field 2, 3, 4					
04/06/05	6,131,792	0.0	9.0	4.48	0.0	0.0
04/19/05	6,153,892	1.1	5.2	2.24	1.3	0.6
05/02/05	6,171,278	0.9	3.2	1.27	0.6	0.3
06/13/05	6,271,395	1.7	0.1	0.43	1.4	0.7
	Well field 6, 7, 8					
07/11/05	6,375,720	2.6	1.0	0.58	0.5	0.4
08/02/05	6,440,365	2.1	0.1	0.00	0.3	0.2
08/25/05	6,506,493	2.0	0.4	0.03	0.1	0.0
09/13/05	6,625,569	4.4	0.1	0.02	0.3	0.0
	Well field 2, 4, 5					
10/13/05	6631673	1.2	0.2	0.02	0.0	0.0
11/22/05	6707299	1.3	0.0	0.02	0.1	0.0
Total	**6,707,299**				**725.3**	**281.0**

APPENDIX E-2

CONTAMINANT RECOVERY – VAPOR PHASE

Contaminant Recovery TPH - Vapor Phase

Date	Runtime (hours)	Q_{air} (cfm)	Volume (1000 ft^3)	TPH_{air}[1] (mg/m^3)	$BTEX_{air}$[1] (mg/m^3)	TPH Mass (lb)	BTEX Mass (lb)
	Well field HR-2, 3, 4, 5						
07/11/02	4	80	19	218,000	6,440		
07/16/02	72	100	432	73,500	2,431	2953	92
09/18/02	367	100	2,202	98,300	5,213	11807	525
09/24/02	150	126	1,134	58,900	3,056	5566	293
10/02/02	189	124	1,406	43,050	1,712	4475	209
10/16/02	336	126	2,541	19,850	646	4990	187
11/18/02	666	127	5,074	9,125	419	4589	169
12/16/02	666	133	5,299	8,495	299	2914	119
01/07/03	529	126	3,998	6,325	284	1847	72
	Well field HR-1, 2, 3, 4, 5						
03/28/03	19	132	149	51,450	638	477	6
04/23/03	623	153	5,723	8,455	384	6861	160
05/19/03	629	122	4,603	4,155	155	1812	77
	Well field HR-2, 3, 4, 5						
06/17/03	695	83	3,463	2620	182	732	36
07/15/03	512	101	3,105	2160	114	463	29
07/22/03	164	50	995	2160	114	134	7
07/22/03	*Well field HR-4, 5, 6, 7*			6995	132		
08/21/03	616	74	2,736	11200	401	1734	57
09/23/03	513	58	1,786	13100	687	1354	61
10/22/03	550	81	2,672	5155	289	1522	81
11/17/03	616	123	4,550	508	56	804	49
12/17/03	702	95	4,001	1090	10	200	8
01/05/04	456	95	2,594	1090	0	176	1
	Well field 4, 5, 6, 7 and 6, 7, 8				0		0
04/13/04	24	73	105	10355	62	68	10
05/18/04	768	75	3,456	1680	30	830	8
06/16/04	696	78	3,257	1325	48	306	26
07/15/04	686	85	3,499	20200	191	2351	16
08/10/04	492	79	2,332	1645	25	1590	4
09/22/04	624	72	2,696	392	21	171	10
10/16/04	560	86	2,890	1760	86	194	7
11/09/04	542	83	2,699	0	1	148	0
	Well field 2, 4, 5						
11/09/04	0	83	0	2860	146	0	45
12/15/04	792	79	3,754	1720	240	537	31
01/18/05	808	82	3,975	0	6	213	1
	Well field 2, 3, 4						
04/06/05	19	95	105	4535	343	30	24
04/19/05	304	83	1,514	1345	160	278	11
05/02/05	312	84	1,572	845	61	107	32
06/13/05	1008	80	4,838	727	148	237	24
07/11/05	670	84	3,377	326	75	111	0
	Well field 6, 7, 8						
07/11/05		-	0	0	0	0	0
08/02/05	520	84	2,621	0	0	0	0
08/25/05	550	82	2,706	0	0	0	0
09/13/05	453	78	2,120	0	0	0	0
09/14/05	21	78	98	0	3	0	0
	Well field 2, 4, 5						
10/13/05	6	51	18	0	21	0	0.0
11/22/05	960	82	4,723	0	0	0	3.1
Total	**19,889**		**110,838**			**62,584**	**2,490**

APPENDIX F

SUMMARY OF ANALYTICAL DATA – GROUNDWATER QUALITY MONITORING

APPENDIX F-1

COC IN GROUNDWATER

Groundwater Quality Monitoring - MBTEX Scan

Well ID	Date	MTBE ppb	Benzene ppb	Toluene ppb	Ethylbenz. ppb	Xylenes (total) ppb	GRO (TPH) mg/l	BTEX ppb	BTEX Trend
MW-1	04/08/02	<250	34000	7790	2200	6440	133.0	50430	
MW-1	11/19/02	<200	19000	5030	1680	2650	89.4	28360	
MW-1	04/23/03	<200	15400	6250	1680	2920	65.2	26250	
MW-1	11/17/03	<250	9816	1505	1960	3246	63.1	16527	
MW-1	05/18/04	<100	5849	401.8	1409	1688	29.9	9348	▼
MW-1	10/09/04	<100	7817	4808	2113	6488	46.7	21226	
MW-1	05/04/05	364.2	4933	1088	1991	4361	37.1	12373	
MW-1	11/22/05	<50	1449	<50	1369	909.9	18.15	3728	
MW-1	05/09/06	<50	978	56.6	1284	1194	16.20	3513	
MW-2	04/09/02	<20	4010	326	305	752	16.3	5393	
MW-2	11/19/02	<5	343	<5	14.3	<15	2.2	357	
MW-2	04/23/03	<5	686	22.2	6.7	<15	2.4	715	
MW-2	11/17/03	<1	91	10.2	7.3	12.8	0.9	121	
MW-2	05/18/04	<5	996	19.1	18	17.8	2.2	1051	▼
MW-2	10/09/04	<5	1328	5.3	342.5	25.1	4.5	1701	
MW-2	05/04/05	<1	3.4	2.2	1.8	<3	0.3	7	
MW-2	11/22/05	<1	2.1	<1	<1	<3	<0.2	2	
MW-2	05/09/06	<1	12.5	<1	3.4	5.7	<0.2	22	
MW-3	04/09/02	<20	777	1240	77.3	636	7.3	2730	
MW-3	11/19/02	<10	214	969	46.9	648	4.9	1878	
MW-3	04/23/03	<10	236	1630	82.1	1900	8.0	3848	
MW-3	11/17/03	<1	1.6	<1	5.7	37.1	0.6	44	
MW-3	05/18/04	<1	<1	<1	<1	<3	0.2	0	▼
MW-3	10/09/04	<1	<1	<1	<1	<3	0.2	0	
MW-3	05/04/05	<1	<1	<1	<1	<3	0.2	0	
MW-3	11/22/05	<1	1.1	<1	<1	<3	<0.2	1	
MW-3	05/09/06	<1	<1	<1	<1	<3	<0.2	0	
MW-4	04/08/02	<1	<1	<1	<1	<3	<0.2	0	
MW-4	11/19/02	<1	<1	<1	<1	<3	<0.2	0	
MW-4	04/23/03	<1	<1	<1	<1	<3	<0.2	0	
MW-4	11/17/03	<1	<1	<1	<1	<3	<0.2	0	
MW-4	05/18/04	<1	<1	<1	<1	<3	<0.2	0	-
MW-4	10/09/04	<1	<1	<1	<1	<3	0.2	0	
MW-4	05/04/05	<1	<1	<1	<1	<3	0.2	0	
MW-4	11/22/05	<1	<1	<1	<1	<3	<0.2	0	
MW-4	05/09/06	<1	<1	<1	<1	<3	<0.2	0	
MW-5	04/08/02	<200	30000	4000	584	977	101.0	35561	
MW-5	11/19/02	<500	29000	15300	1070	2930	109.0	48300	
MW-5	04/23/03	<500	19800	20800	1620	4430	<100	46650	
MW-5	11/17/03	<500	13900	10930	2073	5122	76.2	32025	
MW-5	05/18/04	<50	3502	1439	709.5	1476	18.7	7127	▼
MW-5	10/09/04	<100	7706	10370	2730	6766	61.1	27572	
MW-5	05/04/05	89.7	497.3	274.6	248.1	587.5	5.3	1608	
MW-5	11/22/05	<10	1455	742	1804	2147	24.0	6148	
MW-5	05/09/06	<20	4754	1817	2417	2807	31.32	11795	
MW-6	04/08/02	<100	11100	<100	213	<300	28.0	11313	
MW-6	11/19/02	<50	5380	<50	119	<150	13.5	5499	
MW-6	04/23/03	<50	6150	<50	152	<150	13.9	6302	
MW-6	11/17/03	<100	10880	<100	392.5	<300	27.5	11273	
MW-6	05/18/04	54.6	7638	<50	269.4	<150	15.8	7907	▼
MW-6	10/09/04	<50	4460	<50	208.9	<150	11.2	4669	
MW-6	05/04/05	<50	793.9	<50	80.5	<150	3.0	874	
MW-6	11/22/05	<20	397.4	31.5	101.8	<60	2.440	531	
MW-6	05/09/06	<1	209.5	1.6	58	3,6	1.52	269	

Well ID	Date	MTBE ppb	Benzene ppb	Toluene ppb	Ethylbenz. ppb	Xylenes (total) ppb	GRO (TPH) mg/l	BTEX ppb	BTEX Trend
MW-7	04/08/02	<1	<1	<1	<1	<3	<0.2	0	
MW-7	11/19/02	<1	<1	<1	<1	<3	<0.2	0	
MW-7	04/23/03	<1	<1	<1	<1	<3	<0.2	0	
MW-7	11/17/03	<1	<1	<1	<1	<3	<0.2	0	
MW-7	05/18/04	<1	<1	<1	<1	<3	<0.2	0	-
MW-7	10/09/04	<1	<1	<1	<1	<3	0.2	0	
MW-7	05/04/05	<1	<1	<1	<1	<3	0.2	0	
MW-7	11/22/05	<1	<1	<1	<1	<3	<0.2	0	
MW-7	05/09/06	<1	<1	<1	<1	<3	<0.2	0	
MW-8	04/08/02	<1	<1	<1	<1	<3	<0.2	0	
MW-8	11/19/02	<1	<1	1.2	<1	<3	<0.2	1	
MW-8	04/23/03	<1	6.8	5.2	<1	<3	<0.2	12	
MW-8	05/15/03	<1	<1	<1	<1	<3	<0.2	0	
MW-8	11/17/03	<1	<1	<1	<1	<3	<0.2	0	
MW-8	05/18/04	<1	<1	<1	<1	<3	<0.2	0	-
MW-8	10/09/04	<1	<1	<1	<1	<3	0.2	0	
MW-8	05/04/05	<1	<1	<1	<1	<3	0.2	0	
MW-8	11/22/05	<1	<1	<1	<1	<3	<0.2	0	
MW-8	05/09/06	<1	<1	<1	<1	<3	<0.2	0	
MW-9	04/08/02	<1	<1	<1	<1	<3	<0.2	0	
MW-9	11/19/02	<1	<1	1.5	<1	<3	<0.2	2	
MW-9	04/23/03	<1	1.3	1.8	<1	<3	<0.2	3	
MW-9	05/15/03	<1	<1	<1	<1	<3	<0.2	0	
MW-9	11/17/03	<1	<1	<1	<1	<3	<0.2	0	
MW-9	05/18/04	<1	<1	<1	<1	<3	<0.2	0	-
MW-9	10/09/04	<1	<1	<1	<1	<3	0.2	0	
MW-9	05/04/05	<1	<1	<1	<1	<3	0.2	0	
MW-9	11/22/05	<1	<1	1.1	<1	<3	<0.2	1	
MW-9	05/09/06	<1	<1	<1	<1	<3	<0.2	0	
MW-10	04/08/02	<500	52800	16600	1470	4160	167.0	75030	
MW-10	11/19/02	<200	20600	419	532	<600	40.1	21551	
MW-10	04/23/03	<200	19900	3480	1160	3790	59.2	28330	
MW-10	11/17/03	<500	6722	1032	1058	3476	29.3	12288	
MW-10	05/18/04	<50	5439	108.4	772.2	2598	24.4	8918	▼
MW-10	10/09/04	<100	24810	46110	5857	24800	209.1	101577	
MW-10	05/04/05	<200	6430	12290	2859	15570	100.8	37149	
MW-10	11/22/05	<200	5269	8342	1787	7124	54.76	22522	
MW-10	05/09/06	<200	5696	13940	2850	13360	71.91	35846	
MW-11	07/23/02	<200	5310	14100	1920	12500	107.0	33830	
MW-11	11/19/02	<500	8160	40200	3830	19800	170.0	71990	
MW-11	04/23/03	<100	1780	5110	662	6970	40.5	14522	
MW-11	11/17/03	<10	30.5	11.5	75.7	356	5.0	474	
MW-11	05/18/04	<5	11.2	<5	5.5	136.6	3.3	153	▼
MW-11	10/09/04	<1	<1	<1	<1	<3	0.2	0	
MW-11	05/04/05	<1	<1	<1	<1	<3	0.2	0	
MW-11	11/22/05	<1	<1	<1	<1	<3	<0.2	0	
MW-11	05/09/06	<1	<1	<1	<1	<3	<0.2	0	
MW-12	07/23/02	<100	34700	29200	2180	9940	163.0	76020	
MW-12	11/19/02	<200	40600	21000	2130	7370	159.0	71100	
MW-12	04/23/03	<200	37700	13000	2140	5370	123.0	58210	
MW-12	11/17/03	<500	35610	13150	1524	6506	148.6	56790	
MW-12	05/18/04	<20	1347	147.4	170.9	576.9	6.1	2242	-
MW-12	10/09/04	<20	3368	87.6	194.9	1361	13.8	5012	
MW-12	05/04/05	58.5	1384	174.9	70.8	209.9	5.2	1840	
MW-12	11/22/05	<50	15990	4005	519.3	1561	46.4	22075	
MW-12	05/09/06	<100	36750	19340	1426	7937	100.8	65453	

Well ID	Date	MTBE ppb	Benzene ppb	Toluene ppb	Ethylbenz. ppb	Xylenes (total) ppb	GRO (TPH) mg/l	BTEX ppb	BTEX Trend
MW-13	07/10/02	<1000	47900	21900	2590	9970	201.0	82360	
MW-13	11/19/02	<200	33600	15500	2130	7190	148.0	58420	
MW-13	04/23/03	<200	36400	18500	2290	8400	137.0	65590	
MW-13	11/17/03	<100	4020	1153	430.7	1530	20.9	7134	
MW-13	05/18/04	<50	2519	1126	278.4	827.8	10.3	4751	▼
MW-13	10/09/04	<5	308.6	<5	43.2	<15	1.4	352	
MW-13	05/04/05	29.4	211.9	7.6	118.9	37.2	2.82	376	
MW-13	11/22/05	<5	62.5	<5	85.8	17.9	1.552	166	
MW-13	05/09/06	<2	37.7	<2	117.9	24.5	1.824	180	
MW-14	07/23/02	<200	34400	36300	3260	17100	209.0	91060	
MW-14	11/19/02	<500	36300	24600	2340	9640	161.0	72880	
MW-14	04/23/03	<500	30400	24200	2480	10900	140.0	67980	
MW-14	11/17/03	<500	27990	15060	2187	7560	118.0	52797	
MW-14	05/18/04	<200	13800	3714	1502	6266	54.9	25282	▼
MW-14	10/09/04	<200	9230	2196	1184	2259	29.9	14869	
MW-14	05/04/05	<100	2153	<100	628.4	682.8	13.44	3464	
MW-14	11/22/05	<20	544.3	14.9	241.8	223	14.79	1024	
MW-14	05/09/06	<10	2441	21.7	777.2	274.8	10.68	3515	
MW-15	07/23/02	<500	31900	27700	2610	10700	174.0	72910	
MW-15	11/19/02	<200	22000	11700	1840	5490	95.8	41030	
MW-15	04/23/03	<200	26100	13000	2190	7200	97.6	48490	
MW-15	11/17/03	<500	10830	32560	7169	29440	177.0	79999	
MW-15	05/18/04	<200	14380	2759	2391	6573	62.1	26103	▼
MW-15	10/09/04	<200	10050	30250	13650	27630	208.5	81580	
MW-15	05/04/05	<200	7151	13810	2779	14610	90.4	38350	
MW-15	11/22/05	<200	841	1972	1397	9100	42.33	13310	
MW-15	05/09/06	<50	844	1692	1516	7963	29.55	12015	
MW-16	07/10/02	<250	26400	<250	304	<750	52.1	26704	
MW-16	11/19/02	<100	28300	<100	437	<300	61.1	28737	
MW-16	04/23/03	<100	23100	<100	199	<300	47.5	23299	
MW-16	11/17/03	<500	37290	<500	1378	<1500	104.0	38668	
MW-16	05/18/04	<100	31920	139.5	1006	<300	53.6	33066	▼
MW-16	10/09/04	<100	31000	<100	1773	<300	61.4	32773	
MW-16	05/04/05	<500	24070	<500	1315	<1500	48.23	25385	
MW-16	11/22/05	<250	22370	<250	1942	<750	56.02	24312	
MW-16	05/09/06	<50	19130	133.6	1233	177.4	34.16	20674	
MW-17	07/10/02	<1	11.9	3	<1	<3	<0.2	15	
MW-17	11/19/02	<1	<1	<1	<1	<3	<0.2	0	
MW-17	04/23/03	<1	<1	<1	<1	<3	<0.2	0	
MW-17	11/17/03	<1	<1	<1	<1	<3	<0.2	0	
MW-17	05/18/04	<1	<1	<1	<1	<3	<0.2	0	-
MW-17	10/09/04	<1	13	<1	<1	<3	0.2	13	
MW-17	05/04/05	<1	<1	<1	<1	<3	<0.2	0	
MW-17	11/22/05	<1	11.2	<1	<1	<3	<0.2	11	
MW-17	05/09/06	<1	<1	<1	<1	<3	<0.2	0	

APPENDIX F-2

BIODEGRADATION INDICATORS

Groundwater Quality Monitoring - Selected Biodegradation Parameters

	Units	MW-1 07/10/02	MW-1 11/19/02	MW-1 04/23/03	MW-1 11/17/03	MW-1 05/18/04	MW-1 10/9/04	MW-1 5/4/05	MW-1 11/22/05	MW-1 5/9/06
Sulfate	mg/l	12.6	6.4	37.9	33.6	288	66.2	42.4	56.9	47.7
Nitrate-Nitrite as N	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BOD	mg/l	0.11	106	103	79.8	56.2	126	32.6	16.3	<20
Fe (total)	mg/l	10.4	27.3	41.8	25.4	14.4	27.2	22.9	4.46	5.86
Fe (dissolved)	mg/l	4.5	2.21	3.58	2.04	2.24	1.14	0.57	3.03	3.16
Mn (total)	mg/l	1.95	2.41	2.99	2.12	2.95	2.3	2.34	1.57	1.38
Mn (dissolved)	mg/l	1.69	2.02	1.91	1.72	2	1.52	1.74	1.46	1.36
pH		7.01	7.10	7.13	6.98	7.08	8.45	7.78	8.85	7.35
ORP			-88	-80	-273	-143.3	-123.4	-136.3	-138.9	-212.4
EC	uS/cm	1034	1200	1120	1263	2181	1529	1269	1342	1072
T	^oC	11.0	12.6	8.9	15.3	9.86	14.36	9.2	13.97	8.88
DO	mg/l	0.62	0.17	0.12	0.16	0.27	0.93	1.19	0.40	3.91

	Units	MW-4 07/10/02	MW-4 11/19/02	MW-4 04/23/03	MW-4 11/17/03	MW-4 05/18/04	MW-4 10/9/04	MW-4 5/4/05	MW-4 11/22/05	MW-4 5/9/06
Sulfate	mg/l	165	137	160	128	136	86.5	99.9	64.5	89.3
Nitrate-Nitrite as N	mg/l	3.97	3.27	3.59	3.93	2.7	1.47	1.53	2.22	1.28
BOD	mg/l	0.86	<6	<2	<2	5.55	<2	<2	<2	<2
Fe (total)	mg/l	33.8	27.2	35.4	12.1	1.71	18.2	2.57	18.8	0.85
Fe (dissolved)	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mn (total)	mg/l	0.77	0.56	0.84	0.27	0.17	0.34	0.06	0.39	<0.05
Mn (dissolved)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.5	0.17	<0.05	<0.05	<0.05
pH		7.24	7.36	7.29	7.18	6.96	6.5	6.99	6.78	6.86
ORP			268	315	240	46.5	44.9	52.6	741	348.6
EC	uS/cm	652	840	870	1080	957	828	895	11.84	646
T	^oC	10.0	10.5	7.0	11.7	7.7	11.72	7.9	2.96	7.78
DO	mg/l	1.20	0.92	3.72	4.07	4.17	4.68	4.71	47.9	10.21

	Units	MW-5 07/10/02	MW-5 11/19/02	MW-5 04/23/03	MW-5 11/17/03	MW-5 05/18/04	MW-5 10/9/04	MW-5 5/4/05	MW-5 11/22/05	MW-5 5/9/06
Sulfate	mg/l	9.1	5.66	10.9	294	88.4	10.4	141	38.4	19.7
Nitrate-Nitrite as N	mg/l	<0.1	<0.1	<0.1	5.18	0.49	<0.1	<0.1	<0.1	<0.1
BOD	mg/l	0.82	107	114	89.3	21.3	66	21.7	21.8	32
Fe (total)	mg/l	30.7	23.6	37.1	38.7	15	99	20.5	8	7.15
Fe (dissolved)	mg/l	6	4.8	4.26	4.7	1.09	3.14	<0.1	4.57	6.27
Mn (total)	mg/l	1.96	1.56	1.83	1.41	2.87	3.73	0.92	1.06	1.11
Mn (dissolved)	mg/l	1.42	1.35	1.14	0.98	0.5	1.13	0.44	1.03	1.11
pH		6.96	7.15	7.29	6.86	7.13	7.43	7.37	8.43	6.86
ORP			-50	-90	-45	-45.3	-61.9	-73.2	-96.3	-219.6
EC	uS/cm	1137	1180	1120	1988	1281	1386	1295	1448	1248
T	^oC	9.9	11.4	6.2	12.6	7.63	12.79	7.6	13.18	7.81
DO	mg/l	0.02	0.02	0.03	2.26	3.53	3.45	3.59	0.14	3.04

Groundwater Quality Monitoring - Selected Biodegradation Parameters (continued)

	Units	MW-6 07/10/02	MW-6 11/19/02	MW-6 04/23/03	MW-6 11/17/03	MW-6 05/18/04	MW-6 10/9/04	MW-6 5/4/05	MW-6 11/22/05	MW-6 5/9/06
Sulfate	mg/l	191	201	181	165	126	132	142	138.00	133
Nitrate-Nitrite as N	mg/l	<0.1	0.11	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BOD	mg/l	0.36	18	15.2	13.6	7.4	7.35	5.07	2.8	2.54
Fe (total)	mg/l	12.9	15.1	8	70	2.79	20.7	5.21	1.99	1
Fe (dissolved)	mg/l	0.21	0.91	0.88	1.16	0.85	0.39	0.9	0.66	0.56
Mn (total)	mg/l	1.77	2.2	1.94	4.11	2.05	2.09	1.2	1.49	1.46
Mn (dissolved)	mg/l	1.55	2.06	1.93	1.82	1.85	1.27	1.24	1.52	1.45
pH		7.17	7.27	7.22	7.09	7.12	7.98	7.31	7.85	7.1
ORP			81	46	-116	-74	-102.2	-96.1	-8.3	23.3
EC	uS/cm	1447	1780	1910	2007	2239	1850	1846	1776	1539
T	°C	8.5	10.2	3.6	10.8	6.6	13.36	6.9	10.65	7.14
DO	mg/l	0.09	0.62	0.20	0.37	0.83	1.69	1.99	0.25	4.42

	Units	MW-7 07/10/02	MW-7 11/19/02	MW-7 04/23/03	MW-7 11/17/03	MW-7 05/18/04	MW-7 10/9/04	MW-7 5/4/05	MW-7 11/22/05	MW-7 5/9/06
Sulfate	mg/l	128	123	121	126	118	108	98.8	165	96.9
Nitrate-Nitrite as N	mg/l	7.12	7.11	7.33	8.48	8.61	5.65	7.44	8.05	5.4
BOD	mg/l	1.94	<6	<2	<2	<2	2.2	<2	<2	<2
Fe (total)	mg/l	31.2	38.8	119	71	2.71	20.6	6.82	14.8	1.82
Fe (dissolved)	mg/l	<0.1	0.16	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mn (total)	mg/l	1	0.81	2.98	1.81	0.19	0.35	0.13	0.29	0.05
Mn (dissolved)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	0.27	<0.05	<0.05	<0.05
pH		7.46	7.47	7.65	7.30	7.14	7.37	7.51	7.11	7.09
ORP			263	276	272	21.7	24.8	61.3	44.2	317.6
EC	uS/cm	807	1200	990	1032	1147	1213	1131	1290	921
T	°C	11.0	12.7	8.0	12.3	8.55	12.75	8.1	12.78	8.73
DO	mg/l	1.48	0.31	4.13	1.05	1.1	2.79	2.91	3.44	13.31

	Units	MW-14 07/10/02	MW-14 11/19/02	MW-14 04/23/03	MW-14 11/17/03	MW-14 05/18/04	MW-14 10/9/04	MW-14 5/4/05	MW-14 11/22/05	MW-14 5/9/06
Sulfate	mg/l	18.4	10.2	27.6	13.8	37.2	16.4	65.9	75.3	50.5
Nitrate-Nitrite as N	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BOD	mg/l	5.61	164	130	190		78	41.1	32.8	46.7
Fe (total)	mg/l	124	38	52	47	62	35.9	8.09	10.1	13.2
Fe (dissolved)	mg/l	<0.1	1.01	1.43	3.18	7	1.48	0.18	5.33	12.2
Mn (total)	mg/l	9.6	3.61	3.98	3.66	15.6	1.86	0.56	0.68	0.94
Mn (dissolved)	mg/l	0.36	1.81	1.51	1.13	0.92	0.66	0.48	0.56	0.94
pH		7.07	7.19	7.23	7.02	7.21	7.79	7.69	8.78	6.87
ORP			-40	-40	-186	-135	-91.1	-96.7	-132.2	-223.9
EC	uS/cm	1502	1880	1740	1758	1930	2421	2416	2267	18.53
T	°C	11.5	13.7	8.1	17.7	11.91	17.74	9.41	15.87	9.76
DO	mg/l	1.10	0.13	0.04	0.22	0.39	0.64	0.73	0.26	1.78

Groundwater Quality Monitoring - Selected Biodegradation Parameters (continued)

	Units	MW-16 07/10/02	MW-16 11/19/02	MW-16 04/23/03	MW-16 11/17/03	MW-16 05/18/04	MW-16 10/9/04	MW-16 5/4/05	MW-16 11/22/05	MW-16 5/9/06
Sulfate	mg/l	110	167	53.6	33.9	60.9	25.5	36.7	79.2	126
Nitrate-Nitrite as N	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BOD	mg/l	2.27	69	62.4	93.5	42	54	37.7	36	39
Fe (total)	mg/l	20.1	15.7	40.8	22.6	2.29	107	78.7	15.2	1.34
Fe (dissolved)	mg/l	<0.1	<0.1	0.18	0.18	0.4	<0.1	0.52	0.44	0.38
Mn (total)	mg/l	1.96	2.03	2.1	1.86	1.65	3.91	3.85	2.36	2.02
Mn (dissolved)	mg/l	0.59	1.66	1.38	1.67	1.63	1.81	1.97	2.05	1.9
pH		7.09	7.24	7.19	6.95	7.01	7.94	7.31	7.97	6.76
ORP			230	228	-62	-107.5	-69.9	-63.1	-18.1	-42.9
EC	uS/cm	1404	1760	1510	1795	2241	2030	2137	2134	1926
T	°C	10.8	11.6	5.2	11.7	7.27	12.93	7.36	11.15	7.32
DO	mg/l	0.18	0.33	0.02	0.38	0.55	1.06	1.29	0.21	3.35

	Units	MW-17 07/10/02	MW-17 11/19/02	MW-17 04/23/03	MW-17 11/17/03	MW-17 05/18/04	MW-17 10/9/04	MW-17 5/4/05	MW-17 11/22/05	MW-17 5/9/06
Sulfate	mg/l	55.4	76.8	43	38	39.1	37.6	49.6	87.3	56
Nitrate-Nitrite as N	mg/l	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BOD	mg/l	0.32	<6	<2	<2	10.2	<2	<2	4.26	<2
Fe (total)	mg/l	6.9	11	7.3	142	1.38	79	19.1	30.8	2.75
Fe (dissolved)	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mn (total)	mg/l	0.71	1.03	0.97	4.7	1.38	3.43	1.42	2.71	0.82
Mn (dissolved)	mg/l	0.48	0.78	0.44	0.71	0.69	0.6	<0.05	0.66	0.58
pH		7.27	7.38	7.31	7.14	7.14	7.41	7.39	7.54	6.86
ORP			279	264	19	7.9	23.2	27.9	43.2	118.1
EC	uS/cm	838	1150	1070	1203	1292	1417	1491	1351	1111
T	°C	10.0	10.2	5.4	10.9	6.33	12.65	7.49	11.03	6.74
DO	mg/l	1.20	1.27	0.12	0.29	0.43	1.51	1.69	0.62	5.65

Groundwater Quality Monitoring - Field-Measured Parameters

Well ID	Date	pH	EC	T	DO	ORP
			uS/cm	°C	mg/l	mV
MW-1	04/08/02	7.19	1278	6.2	0.05	-11.7
MW-1	11/19/02	7.10	1045	13.9	0.17	-88.0
MW-1	04/23/03	7.13	1218	8.9	0.12	-80.0
MW-1	11/17/03	6.98	1263	15.3	0.16	-272.6
MW-1	05/18/04	7.08	2181	9.9	0.27	-143.3
MW-1	10/09/04	8.45	1529	14.4	0.93	-123.4
MW-1	05/02/05	7.78	1269	9.2	1.19	-136.3
MW-1	11/22/05	8.85	1342	14.0	0.40	-138.9
MW-1	05/09/06	7.35	1072	8.9	3.91	-212.4
MW-2	04/09/02	7.18	1283	11.1	0.00	-16.4
MW-2	11/19/02	7.37	866	16.1	0.07	-150.0
MW-2	04/23/03	7.36	1078	12.4	0.03	-81.0
MW-2	11/17/03	7.15	9.15	12.9	0.12	-172.8
MW-2	05/18/04	7.32	1816	11.5	0.42	-33.0
MW-2	10/09/04	8.48	1753	17.4	0.56	-132.3
MW-2	05/02/05	7.93	1810	10.1	0.79	-129.1
MW-2	11/22/05	8.16	1077	14.2	0.34	-34.1
MW-2	05/09/06	7.13	1299	10.4	1.54	64.1
MW-3	04/09/02	7.28	950	11.6	0.07	-20.0
MW-3	11/19/02	7.18	826	14.2	0.33	110.0
MW-3	04/23/03	7.44	1021	9.4	0.64	141.0
MW-3	11/17/03	7.22	915	12.4	0.41	-76.0
MW-3	05/18/04	7.21	1013	9.0	0.52	6.3
MW-3	10/09/04	7.49	1010	12.3	0.65	4.1
MW-3	05/02/05	7.31	965	9.4	0.87	12.7
MW-3	11/22/05	7.71	1011	13.3	0.13	9.7
MW-3	05/09/06	6.8	822	9.1	2.36	51.7
MW-4	04/08/02	7.66	763	7.4	0.79	-38.5
MW-4	11/19/02	7.36	674	11.5	0.92	268.0
MW-4	04/23/03	7.29	874	7.0	3.72	315.0
MW-4	11/17/03	7.18	1080	11.7	4.07	239.5
MW-4	05/18/04	6.96	957	7.7	4.17	46.5
MW-4	10/09/04	6.5	828	11.7	4.68	44.9
MW-4	05/02/05	6.99	895	7.9	4.71	52.6
MW-4	11/22/05	6.78	741	11.8	2.96	47.9
MW-4	05/09/06	6.86	646	7.8	10.21	348.6
MW-5	04/08/02	7.28	1376	7.6	0.06	-16.8
MW-5	11/19/02	7.11	1123	12.0	0.02	-50.0
MW-5	04/23/03	7.29	1353	6.2	0.03	-90.0
MW-5	11/17/03	6.86	1988	12.6	2.26	-45.2
MW-5	05/18/04	7.13	1281	7.6	3.53	-45.3
MW-5	10/09/04	7.43	1386	12.8	3.45	-61.9
MW-5	05/02/05	7.37	1295	7.6	3.59	-73.2
MW-5	11/22/05	8.43	1448	13.2	0.14	-96.3
MW-5	05/09/06	6.86	1248	7.8	3.04	-219.6
MW-6	04/08/02	6.23	1889	6.7	0.03	-24.2
MW-6	11/19/02	7.27	1497	8.8	0.62	80.9
MW-6	04/23/03	7.22	2181	3.6	0.20	46.0
MW-6	11/17/03	7.09	2007	10.8	0.37	-115.8
MW-6	05/18/04	7.12	2239	6.6	0.83	-74.0
MW-6	10/09/04	7.98	1850	13.4	1.69	-102.2
MW-6	05/02/05	7.31	1846	6.9	1.99	-96.1
MW-6	11/22/05	7.85	1776	10.7	0.25	-8.3
MW-6	05/09/06	7.1	1539	7.1	4.42	23.3

Groundwater Quality Monitoring - Field-Measured Parameters

Well ID	Date	pH	EC	T	DO	ORP
			uS/cm	°C	mg/l	mV
MW-7	04/08/02	7.73	980	8.2	1.19	-43.5
MW-7	11/19/02	7.47	835	12.1	0.31	263.0
MW-7	04/23/03	7.65	1106	8.0	4.13	276.0
MW-7	11/17/03	7.30	1032	12.3	1.05	271.6
MW-7	05/18/04	7.14	1147	8.6	1.10	21.7
MW-7	10/09/04	7.37	1213	12.8	2.79	24.8
MW-7	05/02/05	7.51	1131	8.1	2.91	61.3
MW-7	11/22/05	7.11	1290	12.8	3.44	44.2
MW-7	05/09/06	7.09	921	8.7	13.31	317.6
MW-8	04/08/02	7.58	1873	7.3	1.38	-34.0
MW-8	11/19/02	7.39	1552	12.2	0.17	301.0
MW-8	04/23/03	7.66	1967	7.3	1.94	255.0
MW-8	11/17/03	7.40	1775	12.5	0.60	247.4
MW-8	05/18/04	7.44	1805	7.6	2.03	21.3
MW-8	10/09/04	7.44	1950	12.2	2.16	24.2
MW-8	05/02/05	7.58	1801	7.9	2.29	160.1
MW-8	11/22/05	7.45	1830	12.3	0.33	40.7
MW-8	05/09/06	7.28	1542	7.8	10.33	271.7
MW-9	04/08/02	7.64	1296	7.0	1.89	-37.7
MW-9	11/19/02	7.57	1059	11.6	1.56	290.0
MW-9	04/23/03	7.62	1362	6.5	3.09	275.0
MW-9	11/17/03	7.36	1263	11.4	1.73	155.0
MW-9	05/18/04	7.39	781	7.2	0.46	-13.2
MW-9	10/09/04	7.57	1134	11.9	1.37	18.5
MW-9	05/02/05	7.61	1197	7.2	2.41	36.9
MW-9	11/22/05	7.56	1385	11.5	0.42	41.8
MW-9	05/09/06	7.01	1180	7.3	8.46	254.0
MW-10	04/08/02	7.36	1583	7.7	0.02	-21.2
MW-10	11/19/02	7.25	1500	12.9	0.02	-109.0
MW-10	04/23/03	7.47	1684	8.7	0.05	125.0
MW-10	11/17/03	7.03	1456	13.1	0.18	-161.3
MW-10	05/18/04	7.27	1539	7.7	0.58	-94.6
MW-10	10/09/04	7.77	1668	12.7	1.36	-26.2
MW-10	05/02/05	7.13	1563	7.9	1.42	-19.1
MW-10	11/22/05	8.67	1616	12.4	0.38	-63.2
MW-10	05/09/06	7.07	1402	8.3	2	-239.8
MW-11	07/23/02	7.01	800	15.4	0.00	
MW-11	11/19/02	7.06	962	14.7	0.23	266.0
MW-11	04/23/03	7.07	1211	7.4	0.45	284.0
MW-11	11/17/03	7.13	951	14.7	0.27	-104.0
MW-11	05/18/04	7.01	1935	8.5	1.24	21.5
MW-11	10/09/04	7.7	1496	15.1	1.38	-41.9
MW-11	05/02/05	7.09	1595	8.8	1.49	-51.2
MW-11	11/22/05	7.67	2136	14.1	3.65	22.4
MW-11	05/09/06	6.85	1637	8.3	5.28	39.7
MW-12	07/23/02	7.06	1100	15.4	0.00	
MW-12	11/19/02	7.18	1000	13.6	0.02	-80.0
MW-12	04/23/03	7.26	1543	7.8	0.00	8.3
MW-12	11/17/03	7.00	1442	14.5	0.18	-185.0
MW-12	05/18/04	7.88	1339	8.9	0.81	-109.9
MW-12	10/09/04	8.02	1907	14.3	0.64	-85.2
MW-12	05/02/05	7.91	1714	9.2	0.97	-91.3
MW-12	11/22/05	8.33	2133	13.7	0.52	-82.4
MW-12	05/09/06	6.87	1772	8.8	2.25	-206.7

Groundwater Quality Monitoring - Field-Measured Parameters

Well ID	Date	pH	EC	T	DO	ORP
			uS/cm	°C	mg/l	mV
MW-13	07/10/02	7.00	1881	10.5	0.30	
MW-13	11/19/02	7.27	1930	14.4	0.11	-17.0
MW-13	04/23/03	7.17	2212	8.0	0.29	10.7
MW-13	11/17/03	7.16	1098	14.5	0.17	-149.8
MW-13	05/18/04	7.18	1229	11.3	0.94	-81.6
MW-13	10/09/04	8.22	1684	18.1	0.77	-88.8
MW-13	05/02/05	7.29	1615	10.0	0.99	-100.1
MW-13	11/22/05	8.29	1101	14.8	0.2	-33.4
MW-13	05/09/06	7.07	1039	9.2	2.01	-102.7
MW-14	07/23/02	7.30	1900	15.9	1.10	
MW-14	11/19/02	7.19	1703	14.3	0.13	-40.0
MW-14	04/23/03	7.23	1989	8.1	0.04	-40.0
MW-14	11/17/03	7.02	1758	17.7	0.22	-186.0
MW-14	05/18/04	7.21	1930	11.9	0.39	-135.0
MW-14	10/09/04	7.79	2421	17.7	0.64	-91.1
MW-14	05/02/05	7.69	2416	9.4	0.73	-96.7
MW-14	11/22/05	8.78	2267	15.9	0.26	-132.2
MW-14	05/09/06	6.87	2160	9.8	1.78	-223.9
MW-15	07/23/02	7.03	1100	15.5	0.09	
MW-15	11/19/02	7.27	930	15.1	0.05	-70.0
MW-15	04/23/03	7.28	1153	9.4	0.01	-73.0
MW-15	11/17/03	6.96	1394	18.3	0.18	-183.0
MW-15	05/18/04	7.34	1793	11.6	0.42	-147.2
MW-15	10/09/04	7.9	1986	17.8	0.87	-85.7
MW-15	05/02/05	7.67	1994	10.0	0.91	-81.3
MW-15	11/22/05	8.38	2350	15.3	0.3	-48.4
MW-15	05/09/06	7.24	2093	9.8	2.39	-24.5
MW-16	07/10/02	7.09	1404	10.8	0.18	
MW-16	11/19/02	7.24	1388	10.5	0.33	230.0
MW-16	04/23/03	7.19	1829	5.2	0.02	228.0
MW-16	11/17/03	6.95	1795	11.7	0.38	-62.3
MW-16	05/18/04	7.01	2241	7.3	0.55	-107.5
MW-16	10/09/04	7.94	2030	12.9	1.06	-69.9
MW-16	05/02/05	7.31	2137	7.4	1.29	-63.1
MW-16	11/22/05	7.97	2134	11.2	0.21	-18.1
MW-16	05/09/06	6.76	1926	7.3	3.35	-42.9
MW-17	07/10/02	7.27	838	10.0	1.20	
MW-17	11/19/02	7.38	882	10.5	1.27	279.0
MW-17	04/23/03	7.31	1218	5.4	0.12	264.0
MW-17	11/17/03	7.14	1203	10.9	0.29	19.2
MW-17	05/18/04	7.14	1292	6.3	0.43	7.9
MW-17	10/09/04	7.41	1417	12.7	1.51	23.2
MW-17	05/02/05	7.39	1491	7.5	1.69	27.9
MW-17	11/22/05	7.54	1351	11.0	0.62	43.2
MW-17	05/09/06	6.86	1111	6.7	5.65	118.1

APPENDIX G

SUMMARY OF ANALYTICAL DATA – SYSTEM MONITORING

APPENDIX G-1

WATER QUALITY

WATER QUALITY MONITORING

Extraction wellfield HR 2, 3, 4, and 5

VLS		VLS	VLS	VLS	VLS	VLS	VLS	VLS	VLS	VLS	VLS	VLS
		07/11/02	07/16/02	07/23/02	08/15/02	09/18/02	09/24/02	10/02/02	10/16/02	11/18/02	12/16/02	01/07/03
MBTE	ppb	<100	<200	<200	<200	<50	<100	<200	<100	<25	<20	<20
Benzene	ppb	14100	8030	6570	7730	4260	4620	3750	2530	1150	1235	1016
Toluene	ppb	12200	9390	8940	12100	6060	8630	6380	4060	1820	1917	1641
Ethylbenzene	ppb	1130	879	825	1340	621	1310	764	433	242	180.3	155
Xylenes (Total)	ppb	5300	3950	3940	7280	4110	8080	5740	4080	2820	2346	2109
Phenols (Total)	ppb	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GRO (TPH)	mg/l	74.3	57.0	51.5	68.8	35.2	67.7	44.1	30.7	20.7	15.1	12.6

OWS		OWS	OWS	OWS	OWS	OWS	OWS	OWS		OWS	OWS	OWS
		07/11/02	07/16/02	07/23/02	08/15/02	09/18/02	09/24/02	10/02/02		11/18/02	12/16/02	01/07/03
MBTE	ppb	<200	<200	<200	<200	<50	<50	<50		<20	<50	
Benzene	ppb	14700	8150	6660	7910	4370	3940	947		1160	1080	
Toluene	ppb	12600	9370	8850	12500	5860	8840	2180		1600	1540	
Ethylbenzene	ppb	1160	826	814	1720	604	1310	342		148	99.9	
Xylenes (Total)	ppb	5450	3770	3920	7820	4130	7850	2640		2100	1830	
Phenols (Total)	ppb	365	NA	NA	NA	NA	NA	NA		NA	NA	
GRO (TPH)	mg/l	73.9	59.1	50.7	68.2	35.6	52.3	19.6		15.7	15.1	

AS		AS	AS	AS	AS	AS	AS		AS	AS	AS	AS
Flow to stripper	gpm	15.4	16.3	14.8	15.5	29.1	29.2		10.6	11.9	12.3	12.2
		07/11/02	07/16/02	07/23/02	08/15/02	09/18/02	09/24/02		10/16/02	11/18/02	12/16/02	01/07/03
MBTE	ppb	<5	<1	<1	1.6	<1	<10		<1	<1	<1	
Benzene	ppb	63.6	13.2	5	5.9	49.7	209		4.6	7.5	3.1	
Toluene	ppb	75.1	16	7.3	9	70.3	466		7.6	5.6	2.7	
Ethylbenzene	ppb	14.1	2.2	2.1	2.7	6.7	97.8		3.3	4.7	4.3	
Xylenes (Total)	ppb	62.9	11.9	8.1	13.8	68.4	659		13.8	15.7	11.2	
Phenols (Total)	ppb	NA	NA	NA	NA	NA	NA		NA	NA	NA	
GRO (TPH)	mg/l	2.28	0.61	0.57	0.80	0.92	5.89		0.67	1.98	0.64	

Effluent		Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent
		07/11/02	07/16/02	07/23/02	08/15/02	09/18/02	09/24/02	10/02/02	10/16/02	11/18/02	12/16/02	01/07/03
MBTE	ppb	<5	<1	<1	2.4	<1	<10	<1	<1	<1	<1	<1
Benzene	ppb	66.1	10.4	3.2	11.6	36.8	198.0	7.1	3.7	4.1	2.3	2.2
Toluene	ppb	65.8	12.2	4.6	18.1	50.5	445.0	17.5	6.2	3.3	1.8	3.7
Ethylbenzene	ppb	9.2	1.9	<1	4.4	5.8	99.9	6.2	3.3	3.3	2.4	2.2
Xylenes (Total)	ppb	52.7	9.2	4.8	26.3	52.6	653.0	49.8	11.8	6.5	7.2	10.7
Phenols (Total)	ppb	335	355	NA	316	296	238	NA	207	207	160	152
GRO (TPH)	mg/l	1.91	0.60	0.43	1.08	0.81	5.98	0.61	0.61	1.20	0.52	0.48

Selected Parameters		Effluent	Effluent	Effluent		Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent
		07/11/02	07/16/02	08/15/02		09/18/02	09/24/02	10/02/02	10/16/02	11/18/02	12/16/02	01/07/03
Fe (total)	mg/l	13.7	9.0	<0.1		3.3	1.4		1.3	1.5	6.1	6.2
Mn (total)	mg/l	1.61	1.44	0.98		1.1	0.9		1.1	1.1	1.0	1.0
TSS	mg/l	426	340	506		103	27		35	17	267	203
pH		8.16	8.18	3.83		8.38	8.34	8.44	8.54	8.29	8.44	8.45
EC	uS/cm	1100	1000	1200		1100	1140	1130	1240	1140	1170	1170
T	°C	15.5	18.6	19.1		17.5	17.6	14.3	14.9	16.3	12.6	14.8

WATER QUALITY MONITORING

Extraction wellfield HR-1, 2, 3, 4, and 5 | **Extraction wellfield HR-2, 3, 4, and 5** | ***Extraction wellfield HR 4,5,6, and 7***

VLS		VLS	VLS	VLS	VLS	VLS	VLS	VLS	VLS	VLS	VLS	VLS
		03/28/03	04/23/03	05/19/03	06/17/03	07/15/03	07/22/03	08/21/03	09/23/03	10/22/03	11/17/03	12/17/03
MBTE	ppb	<200	<50	<50	<20	<10	<10	<100	<20	<5	<50	<20
Benzene	ppb	4120	1390	1350	503	458	655	843.8	877.7	265	290	137
Toluene	ppb	5260	2670	2320	747	632	3290	3538	3476	1093	555.4	285.8
Ethylbenzene	ppb	857	278	202	61.7	41.3	248	522.1	392	149.2	111.5	56.4
Xylenes (Total)	ppb	6240	3000	2180	836	720	3310	3897	3084	2468	1940	1485
Phenols (Total)	ppb	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GRO (TPH)	mg/l	53.4	16.2	14.8	4.9	3.4	15.0	<20	15.1	9.7	10.0	4.9

Effluent		Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent
		03/28/03	04/23/03	05/19/03	06/17/03	07/15/03	07/22/03	08/21/03	09/23/03	10/22/03	11/17/03	12/17/03
MBTE	ppb	<20	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Benzene	ppb	23	3.2	2.2	<1	<1	<1	1	2.3	<1	<1	1.0
Toluene	ppb	34.8	5	3.4	<1	<1	3	3.8	4.9	<1	1.4	1.4
Ethylbenzene	ppb	61.1	3.2	<1	<1	<1	<1	1.6	2.2	<1	<1	3.4
Xylenes (Total)	ppb	183.0	15.2	4.7	<3	<3	6.6	8.9	12.5	3.7	5.8	10.7
Phenols (Total)	ppb	181	394	236	140	130	52.2	149	114	70.3	58.8	43.9
GRO (TPH)	mg/l	15.00	0.90	0.23	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.3

Selected Parameters		Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent
		03/28/03	04/23/03	05/19/03	06/17/03	07/15/03	07/22/03	08/21/03	09/23/03	10/22/03	11/17/03	12/17/03
Fe (total)	mg/l	9.0	11.7	9.9	2.1	5.2	6.10	0.98	1.5	2.6	2.33	0.85
Mn (total)	mg/l	1.3	1.3	1.1	1.1	1.2	0.96	0.78	1.03	0.79	0.76	0.75
TSS	mg/l	260	432	423	110	186	354	185	29	14	87	32
pH		8.41	8.25	NM	8.32	8.11	8.1	8	7.86	NM	NM	NM
EC	uS/cm	1140	1200	NM	1180	1161	1125	1144	1101	NM	NM	NM
T	°C	10.5	14.9	NM	21.1	22.1	20.0	16.5	17.1	NM	NM	NM

VLS-Vaporl/liquid Separator Sample Port
OWS-Oil/Water Separator Sample Port
AS-Air Stripper Sample Port

WATER QUALITY MONITORING

		Extraction wellfield HR 6, 7, and 8 and HR 4, 5, 6								*Extraction wellfield HR 2, 4, and 5*		
VLS		**VLS** 04/13/04	**VLS** 05/18/04	**VLS** 06/16/04	**VLS** 07/15/04	**VLS** 08/10/04	**VLS** 09/22/04	**VLS** 10/16/04	**VLS** 11/09/04	**VLS** 11/09/04	**VLS** 12/15/04	**VLS** 01/18/05
MBTE	ppb	<10	<10	<10	<10	<10	<10	<10	<1	<250	<10	<10
Benzene	ppb	598	126	78.1	414.1	85.3	45.2	21.8	1.3	2552	253.5	99.9
Toluene	ppb	433	274	182.9	656.1	159.4	40.6	21.6	<1	10090	786	194.4
Ethylbenzene	ppb	49	38.3	39.4	103.2	19.7	<10	<10	<1	3371	163.8	33.6
Xylenes (Total)	ppb	772	1382	1386	1944	1289	836	408	26	24070	1175	382
Phenols (Total)	ppb	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GRO (TPH)	mg/l	6.2	5.1	4.3	8.0	4.7	4.0	2.0	<0.2	189.1	9.1	2.8

Effluent		**Effluent** 04/13/04	**Effluent** 05/18/04	**Effluent** 06/16/04	**Effluent** 07/15/04	**Effluent** 08/10/04	**Effluent** 09/22/04	**Effluent** 10/16/04	**Effluent** 11/09/04	**Effluent** 11/09/04	**Effluent** 12/15/04	**Effluent** 01/18/05
MBTE	ppb	<1	<1	<1	<1	<1	<1	<1	<1	2.2	<1	<1
Benzene	ppb	<1	<1	<1	<1	<1	<1	<1	<1	2.6	1.3	<1
Toluene	ppb	<1	<1	<1	<1	<1	<1	<1	<1	4.2	3.9	<1
Ethylbenzene	ppb	<1	<1	<1	<1	<1	<1	<1	<1	9.6	3.3	<1
Xylenes (Total)	ppb	<3	<3	<3	<3	<3	<3	<3	<3	28.2	11	<3
Phenols (Total)	ppb	27.2	23.6	22.1	22.2	21.6	15.7	<10	<10	71.7	175.0	98.6
GRO (TPH)	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	1.70	0.5	<0.2

Selected Parameters		**Effluent** 04/13/04	**Effluent** 05/18/04	**Effluent** 06/16/04	**Effluent** 07/15/04	**Effluent** 08/10/04	**Effluent** 09/22/04	**Effluent** 10/16/04	**Effluent** 11/09/04	**Effluent** 11/09/04	**Effluent** 12/15/04	**Effluent** 01/18/05
Fe (total)	mg/l	7.1	1	0.68	0.8	2.34	2.88	0.42	0.49	8.05	2.76	0.98
Mn (total)	mg/l	0.74	0.5	0.44	0.41	0.53	0.54	0.36	0.36	0.56	0.66	0.37
TSS	mg/l	76	105	11	17	122	126	2	3	125	80	40
pH		8.03	8.02	7.89	7.39	7.35	7.38	7.23	7.46	7.29	7.39	7.47
EC	uS/cm	1065	1059	1008	1123	1050	1036	1102	1023	1064	1050	1213
T	°C	9.9	12.8	16.42	16.91	16.32	16.30	13.73	11.1	11.3	10.2	10.6

WATER QUALITY MONITORING

		Extraction wellfield HR 2, 3, and 4									Extraction wellfield HR 2, 4, and 5	
VLS		**VLS**	**VLS**	**VLS**	**VLS**	**VLS**	**VLS**	**VLS**	**VLS**	**VLS**	**VLS**	**VLS**
		04/06/05	04/19/05	05/02/05	06/13/05	07/11/05	07/11/05	08/02/05	08/25/05	09/13/05	10/13/05	11/22/05
MBTE	ppb	<10	<10	<10	<10	<1	<1	<1	<1	<1	<5	<1
Benzene	ppb	1305	432.3	200.7	43.8	108.3	1.4	<1	8.5	6.7	102.8	<1
Toluene	ppb	2132	977.5	578.4	151.4	157.1	1.7	<1	<1	1.4	10.2	<1
Ethylbenzene	ppb	102	63.3	35.7	20.6	17.2	<1	<1	<1	<1	8.2	<1
Xylenes (Total)	ppb	953	769	446.5	215.6	330.8	<3	<3	16.3	7.2	28.6	<3
Phenols (Total)	ppb	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GRO (TPH)	mg/l	9.0	5.2	3.186	<0.2	1.0	<0.2	<0.2	0.4	<0.2	<0.2	<0.2

Effluent		**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**
		04/06/05	04/19/05	05/02/05	06/13/05	07/11/05	07/11/05	08/02/05	08/25/05	09/13/05	10/13/05	11/22/05
MBTE	ppb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Benzene	ppb	23.6	7.8	2.9	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	ppb	39.8	18.6	8	<1	<1	<1	<1	<1	<1	<1	<1
Ethylbenzene	ppb	1.9	1.5	<1	<1	<1	<1	<1	<1	<1	<1	<1
Xylenes (Total)	ppb	28.5	19.4	9.4	<3	<3	<3	<3	<3	<3	<3	<3
Phenols (Total)	ppb	215.0	204.0	151	112.0	62.5	<10	<10	11.7	<10	49.5	43.6
GRO (TPH)	mg/l	0.39	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

Selected Parameters		**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**
		04/06/05	04/19/05	05/02/05	06/13/05	07/11/05	07/11/05	08/02/05	08/25/05	09/13/05	10/13/05	11/22/05
Fe (total)	mg/l	6.27	4.38	2.17	2.67	2.66	3.95	0.46	0.3	0.41	26.1	8.55
Mn (total)	mg/l	1.14	0.81	0.81	0.82	0.49	0.49	0.14	0.4	0.42	1.51	0.66
TSS	mg/l	145	116	39	29	55	79	33	<1	<1	405	14
pH			7.99	7.97	7.79	7.82	7.79	7.83	7.62	7.91	7.48	7.66
EC	uS/cm		1242	1241	1397	1121	1492	1134	1321	1140	1133	1124
T	°C		8.49	8.5	8.9	8.9	8.4	10.6	11.4	9.4	10.5	9.1

APPENDIX G-2

OFFGAS QUALITY

OFFGAS QUALITY MONITORING

Organic Vapors By Charcoal Tube Desorption, Summit Analyzer, Flame Ionization Detector, and Photo Ionization Detector
Data represent combined VOC concentrations for specific extraction wellfield.

Date/Time	Collection Interval	Sampling Flow Rate (L/min)	GRO (mg/m^3)	TPH (mg/m^3)	MTBE (mg/m^3)	Benzene (mg/m^3)	Toluene (mg/m^3)	Ethyl benzene (mg/m^3)	Xylenes (mg/m^3)	Summit (ppm)	FID (ppm)	PID (ppm)
7/11/02 14:05	CT-30 s	0.20	99,600	218,000	ND	4,810	1,630	ND	ND	OL	OL	OL
7/11/02 14:07	CT-15 s	0.20	146,000	332,000	ND	7,320	1,630	ND	ND			
7/16/02 18:30	CT-30 s	0.20	30,800	73,500	ND	1,800	631	ND	ND	OL	OL	1,910
7/16/02 18:35	CT-15 s	0.20	28,100	68,400	ND	1,580	446	ND	ND			
9/18/02 9:45	CT-30 s	0.28	53,400	97,800	ND	1,890	2,310	150	493	OL	OL	OL
9/18/02 9:47	CT-30 s	0.28	56,100	98,800	ND	1,990	2,750	193	650			
9/24/02 15:40	CT-30 s	0.28	38,400	58,900	ND	1,090	1,640	79	247	OL	OL	2,355
10/2/02 14:05	CT-30 s	0.28	26,700	40,900	ND	767	571	ND	51	8,907	45,000	2,000
10/2/02 14:07	CT-30 s	0.28	31,000	45,200	ND	943	914	39	138			
10/16/02 12:15	CT-60 s	0.28	13,000	19,200	ND	233	318	21	143	5,800	15,000	800
10/16/02 12:17	CT-60 s	0.28	14,200	20,500	ND	157	261	21	138			
11/18/02 16:03	CT-30 s	0.28	2,240	4,390	ND	74	20	ND	ND	3,395	7,800	1,283
11/18/02 16:05	CT-60 s	0.28	6,710	9,070	ND	211	138	4.9	30			
11/18/02 16:07	CT-60 s	0.28	6,890	9,180	ND	224	174	7.3	48			
11/18/02 16:15	[1]CT-60 s	0.28	6,070	8,290	ND	175	111	3.5	24			
12/16/02 14:54	CT-60 s	0.28	6,440	8,620	ND	139	101	3.3	18	2,480	3,800	273
12/16/02 14:54	CT-60 s	0.28	6,000	8,370	ND	177	130	4.2	25			
1/7/03 12:47	CT-60 s	0.28	4,200	6,040	ND	135	86	ND	8.5	2,005	3,040	270
1/7/03 12:49	CT-60 s	0.28	4,850	6,610	ND	166	138	4.8	24			

[1]Charcoal tube sample collected from tedlar bag

GRO - Gasoline Range Organics
TPH - Total Purgeable Hydrocarbons
CT - Charcoal Tube
TB - Tedlar Bag
FID - Flame Ionization Detector
PID - Photoionization Detector
Summit - Summit HydrocarbonAnalyzer

ND - Not Detected
NM - Not Measured
OL=Overloaded
>10,000 ppmv for Summit (calibrated on hexane)
>10,000 ppmv for PID (calibrated on isobuthylene)
>50,000 ppmv for FID (calibrated on methane)

OFFGAS QUALITY MONITORING (Continued)

Date/Time	Collection Interval	Sampling Flow Rate (L/min)	GRO (mg/m^3)	TPH (mg/m^3)	MTBE (mg/m^3)	Benzene (mg/m^3)	Toluene (mg/m^3)	Ethyl benzene (mg/m^3)	Xylenes (mg/m^3)	Summit (ppm)	FID (ppm)	PID (ppm)
3/28/03 11:00	CT-30 s	0.28	32,400	65,200	ND	590	309	11	ND	12,755	OL	OL
3/28/03 11:02	CT-30 s	0.28	18,000	37,700	ND	276	90	ND	ND	12,755	OL	OL
3/28/03 11:05	[1]CT-30 s	0.28	74,100	144,000	ND	1,790	2,020	216	1100			
4/23/03 10:10	CT-60 s	0.28	6,230	8,220	ND	157	134	4.9	29	2,342	3,500	1,470
4/23/03 10:12	CT-60 s	0.28	6,670	8,690	ND	163	204	11	66			
5/19/03 13:58	CT-60 s	0.28	2,100	2,810	ND	63	17	ND	ND	1,515	2,264	1,470
5/19/03 14:00	CT-60 s	0.28	4,490	5,500	ND	146	81	2	ND			
6/17/03 15:10	CT-60 s	0.28	1,960	2,280	ND	90	36	ND	5.6	811	1,350	560
6/17/03 15:12	CT-60 s	0.28	2,650	2,960	ND	126	86	ND	20			
7/15/03 17:20	CT-60 s	0.28	1,680	2,170	ND	53	46	ND	4.5	783	901	507
7/15/03 17:22	CT-60 s	0.28	1,660	2,150	ND	64	53	ND	7.6			
7/22/03 13:28	[1]CT-60 s	0.28	4,540	6,240	ND	34	52	ND	4.6	710	3,870	1,200
7/22/0313:30	[1]CT-60 s	0.28	5,610	7,750	ND	48	101	3.3	18			
8/21/03 9:44	[1]CT-60 s	0.28	8,180	10,500	ND	115	175	4.2	11	5,620	10,000	1,540
8/21/03 9:45	[1]CT-60 s	0.28	9,500	11,900	ND	150	300	12	35			
9/23/03 17:50	[1]CT-60 s	0.28	9,480	12,300	ND	185	294	6.4	15	5,015	3,875	1,571
9/23/03 17:55	[1]CT-60 s	0.28	11,100	13,900	ND	221	568	20	65			
10/22/03 15:26	[1]CT-60 s	0.28	3,350	4,320	ND	33	48	ND	5.9	data set	3,330	1,599
10/22/03 15:32	[1]CT-60 s	0.28	4,720	5,990	ND	124	289	11	68	data set		
11/17/03 16:00	[1]CT-60 s	0.28	345	501	ND	22	20	ND	5.1	Malfuncti	1,140	920
11/17/03 16:05	[1]CT-60 s	0.28	358	515	ND	24	29	ND	11	Malfunction		
12/17/03 16:33	[1]CT-60 s	0.28	1,640	2,180	ND	19	ND	ND	ND	1513	1,720	777
12/17/03 16:36	[1]CT-60 s	0.28	ND	ND	ND	ND	ND	ND	ND			

OFFGAS QUALITY MONITORING (Continued)

Date/Time	Collection Interval	Sampling Flow Rate (L/min)	GRO (mg/m^3)	TPH (mg/m^3)	MTBE (mg/m^3)	Benzene (mg/m^3)	Toluene (mg/m^3)	Ethyl benzene (mg/m^3)	Xylenes (mg/m^3)	Summit (ppm)	FID (ppm)	PID (ppm)
4/23/04 12:07	[1]CT-60 s	0.28	3,770	11,000		49	13	ND	ND			
4/23/04 12:22	[1]CT-60 s	0.28	3,500	9,710		45	17	ND	ND			
5/18/04 9:59	[1]CT-60 s	0.28	1,160	1,470	ND	11	10	ND	ND	720	820	350
5/18/04 10:09	[1]CT-60 s	0.28	1,510	1,890	ND	15	18	ND	6			
06/16/04 14:40	[1]CT-60 s	0.28	1140	1260	ND	12	20	ND	5.3	539	195	452
06/16/04 14:42	[1]CT-60 s	0.28	1270	1390	ND	11	26	ND	21			
7/15/04 16:32	[1]CT-60 s	0.28	9420	21300	ND	72	70	4.6	24	9999	>50000	1657
7/15/04 16:34	[1]CT-60 s	0.28	9040	19100	ND	84	87	5.3	36			
8/10/04 15.40	[1]CT-60 s	0.28	1100	1590	ND	7.8	9.6	ND	4.5	1050	624	567
8/10/04 15:42	[1]CT-60 s	0.28	1190	1700	ND	9.6	11	ND	8.3			
9/22/04 14:15	[1]CT-60 s	0.28	265	340	ND	0.89	0.93	6.6	7.8	587	562	475
9/22/04 14:15	[1]CT-60 s	0.28	354	443	ND	1	1.4	11	13			
10/16/04 19:30	[1]CT-60 s	0.28	1350	1690	ND	4.2	ND	37	45	530	392	malf
10/16/04 19:30	[1]CT-60 s	0.28	1460	1830	ND	4	ND	37	45			
11/9/04 8:35	[1]CT-60 s	0.28	ND	ND	ND	ND	ND	0.94	0.72	2100	88	99.1
11/9/04 8:35	[1]CT-60 s	0.28	ND	ND	ND	ND	ND	0.84	ND			
11/9/04 16:05	[1]CT-60 s	0.28	1560	2750	ND	42	59	6.6	32	4920	10,073	1927
11/9/04 16:05	[1]CT-60 s	0.28	1720	2970	ND	45	65	7	34			
12/15/04 23:15	[1]CT-60 s	0.28	1390	1820	ND	35	100	20	92			
12/15/04 23:30	[1]CT-60 s	0.28	1220	1620	ND	32	95	18	85			
1/18/05 0:00	[1]CT-60 s	0.28	ND	ND	ND	ND	6.8	ND	4.8	96	189	251
1/18/05 0:00	[1]CT-60 s	0.28	ND	ND	ND	ND	ND	ND	ND			

OFFGAS QUALITY MONITORING (Continued)

Date/Time	Collection Interval	Sampling Flow Rate (L/min)	GRO (mg/m^3)	TPH (mg/m^3)	MTBE (mg/m^3)	Benzene (mg/m^3)	Toluene (mg/m^3)	Ethyl benzene (mg/m^3)	Xylenes (mg/m^3)	Summit (ppm)	FID (ppm)	PID (ppm)
4/6/05 8:00	[1]CT-60 s	0.28	389	1900	ND	39	74	3.1	24	3558	13342	3358
4/6/05 8:00	[1]CT-60 s	0.28	2880	7170	ND	146	281	16	99			
4/19/05 18:10	[1]CT-60 s	0.28	ND	ND	ND	ND	ND	ND	ND	2246	1252	932
4/19/05 18:10	[1]CT-60 s	0.28	1600	2690	ND	69	168	10	72			
5/2/05 14:40	[1]CT-60 s	0.28	1420	1690	ND	26	61	15	18	511	965	382
5/2/05 14:40	[1]CT-60 s	0.28	ND	ND	ND	ND	ND	ND	ND			
6/13/05 14:00	[1]CT-60 s	0.28	670	780	ND	20	63	9.3	55	211	425	279
	[1]CT-60 s	0.28	547	673	ND	22	59	9.3	59			
7/11/05 14:00	[1]CT-60 s	0.28	288	311	ND	18	30	3.8	34	96	275	99
	[1]CT-60 s	0.28	312	340	ND	20	33	4.4	44			
7/11/05 16:00	[1]CT-60 s	0.28	ND	ND	ND	ND	ND	0.59	4.5	57	131	74
	[1]CT-60 s	0.28	ND	ND	ND	ND	ND	ND	ND			
8/2/05 12:30	[1]CT-60 s	0.28	ND	ND	ND	ND	ND	ND	ND	18	71	15
	[1]CT-60 s	0.28	ND	ND	ND	ND	ND	ND	ND			
8/25/05 14:15	[1]CT-60 s	0.28	ND	ND	ND	ND	ND	ND	ND	9	12.7	36.1
	[1]CT-60 s	0.28	ND	ND	ND	ND	ND	ND	ND			
9/13/05 17:00	[1]CT-60 s	0.28	ND	ND	ND	2.2	ND	ND	ND	74	49	121
	[1]CT-60 s	0.28	ND	ND	ND	4.6	ND	ND	ND			
10/13/05 14:00	[1]CT-60 s	0.28	ND	ND	ND	ND	ND	ND	ND	1830	1172	NM
	[1]CT-60 s	0.28	ND	ND	ND	32	3.4	ND	6			
11/22/05 14:00	System shutdown		No samples collected with respect to ND in previous sampling events							NM	0	0