Technical Memorandum

Lincoln Avenue Water Company (LAWC) Treatment System
National Aeronautics and Space Administration, Jet Propulsion Laboratory, Pasadena, California

Final April 30, 2008

This technical memorandum documents the performance of the groundwater treatment system implemented at the Lincoln Avenue Water Company (LAWC) through March 2008. The treatment system was implemented as a removal action as part of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Program at the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL). The Action Memorandum for this removal action was signed on August 23, 2004[1]. Operation of the treatment system is now part of the remedial action for Operable Unit 3 (OU-3), documented in the Final Interim Record of Decision (ROD)[2]. Table 1 is an overview of the system operations to date, which began on July 28, 2004.

Table 1. LAWC System Operational Summary (August 2004 through March 2008)

Parameter	Units	LAWC #3	LAWC #5	Total
Total Volume of Groundwater Extracted	Acre-ft	4,902	3,705	8,607
Mass of Perchlorate Removed	lbs	296	81	377
Mass of Carbon Tetrachloride (CCl_4) Removed	lbs	33.3	9.0	42.3
Mass of Trichloroethene (TCE) Removed	lbs	37	37	74

BACKGROUND

Liquid wastes generated at JPL in the 1940s and 1950s (such as cleaning solvents, solid and liquid rocket propellants, cooling tower chemicals, and analytical laboratory chemicals) were disposed of in seepage pits, a then common and acceptable practice. Some of these wastes contained chemicals (e.g., perchlorate and chlorinated solvents containing volatile organic compounds [VOCs]) that have been found in groundwater beneath and adjacent to JPL, including groundwater extracted from two drinking water wells operated by LAWC (LAWC#3 and LAWC#5). Figure 1 is a location map showing JPL and the LAWC production wells.

In 1981, VOCs were first detected in LAWC#3 and LAWC#5. By 1984, VOC concentrations were increasing and both wells were shut down. With NASA funding, LAWC installed a VOC treatment facility for the wells in the early 1990s. NASA funded the ongoing operations of the plant as well. The existing VOC treatment facility consists of four 12-ft-diameter treatment vessels (Calgon Carbon Model 12 Adsorption Systems), each containing 20,000 lb of liquid-phase granular activated carbon (LGAC). The LGAC treatment facility was operated under an Operations Plan approved by the California Department of Public Health (DPH) (revised September 2002).

[1] NASA. 2004. *Action Memorandum for the Lincoln Avenue Water Company (LAWC), Altadena, California Associated with Groundwater Cleanup at the National Aeronautics and Space Administration, Jet Propulsion Laboratory, Pasadena, California.* August.
[2] NASA. 2007. *Final Interim Record of Decision for Operable Unit 3 Off-Facility Groundwater. National Aeronautics and Space Administration, Jet Propulsion Laboratory, Pasadena, California.* August.

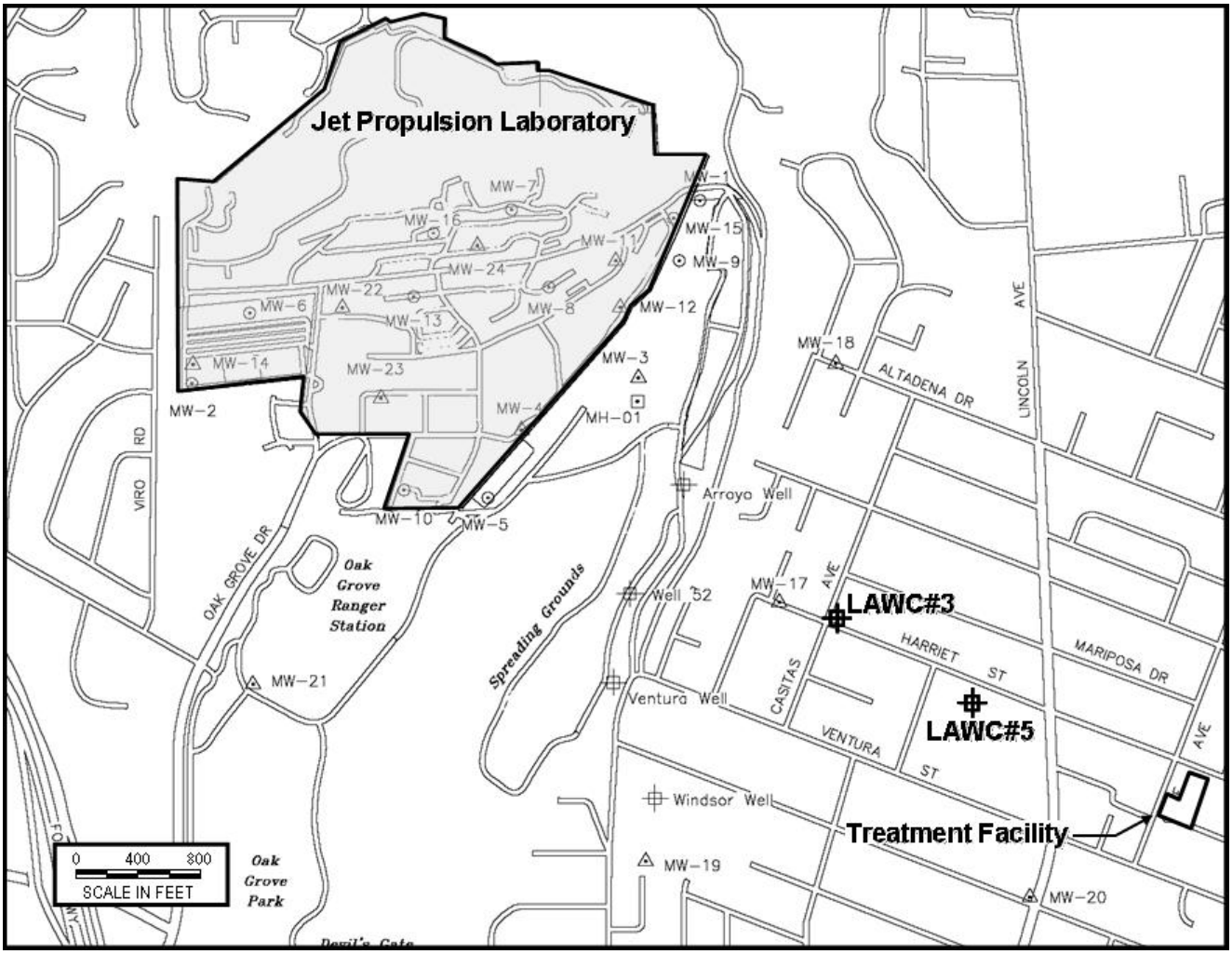

Figure 1. Location Map

Perchlorate concentrations were first detected in samples collected from the LAWC wells in 1997, when an improved analytical method, using ion chromatography, was developed to detect low levels of perchlorate. Since 1997, perchlorate concentrations in samples from the LAWC wells have ranged from less than 4 micrograms per liter (µg/L) to 46 µg/L. In July 2004, an ion exchange system was incorporated into the treatment train at LAWC, consisting of LGAC, chlorination, and blending with Foothill Municipal Water District (FMWD) water in the Olive Sump. Water in the Olive Sump is pumped into the distribution system for potable use by LAWC customers. A process flow diagram for this entire treatment system is provided as Figure 2.

Ion exchange (IX) treatment consists of a US Filter Model HP1220DS Hi-Flow System. The HP1220DS System has two 12-ft-diameter ion exchange vessels, with a nominal treatment capacity of 2,000 gpm. Each ion exchange unit contains 300 cubic feet of perchlorate-selective resin. DPH issued a permit amendment on July 26, 2004 for the LAWC system, a copy of which was provided in the Technical Memorandum submitted in 2005[3]. In late 2007, LAWC contracted Calgon Carbon for ion exchange resin replacement and management associated with the treatment system.

[3] NASA. 2005. *Technical Memorandum, Lincoln Avenue Water Company (LAWC) Treatment System, National Aeronautics and Space Administration, Jet Propulsion Laboratory, Pasadena, California*. May.

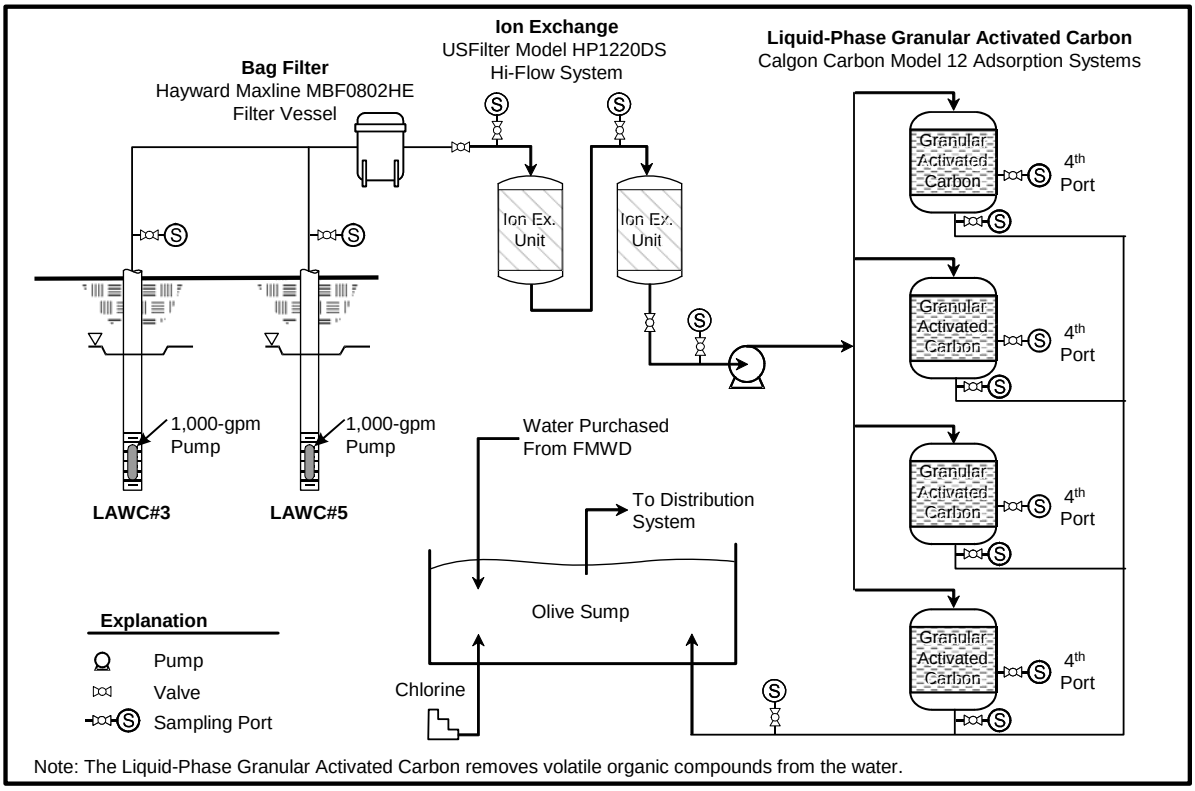

Figure 2. Process Flow Diagram

LAWC#3, LAWC#5, AND MW-17

Table 2 summarizes minimum and maximum carbon tetrachloride (CCl_4), trichloroethene (TCE), and perchlorate concentrations detected in LAWC#3 and LAWC#5. Figures 3 and 4 are graphs of historical concentrations in extracted groundwater samples collected from LAWC#3 and LAWC#5. Trends in LAWC#3 indicate that perchlorate concentrations were stable to decreasing and concentrations of CCL_4 and TCE were generally stable throughout 2007. As shown in Figure 4, trends in LAWC#5 indicate notable increases in perchlorate concentrations during 2007. Conversely, concentrations of TCE have decreased steadily and concentrations of CCl_4 have remained stable in 2007.

NASA-JPL has a multiport monitoring well, MW-17, located less than 500 ft upgradient of LAWC#3 (see Figure 1). Table 2 presents a summary of CCl_4, TCE, and perchlorate detections in samples collected from the five sampling screens (discrete sampling intervals) of MW-17. This monitoring well serves as the best available indicator of near-future (1-2 years) concentrations that may be observed in LAWC wells. Figures 5, 6, and 7 provide the historical concentrations of CCl_4, TCE, and perchlorate in MW-17. Sampling of MW-17 (Screen 3) indicate that the decreasing perchlorate concentration trend continued through 2007. The highest perchlorate concentration detected in MW-17 (Screen 3) was 209 µg/L in July/August 2003 compared to 33 µg/L in November 2007.

Table 2. Summary of Highest Chemical Concentrations Historically Detected

Analyte	Units	LAWC#3		LAWC#5		MW-17 (Maximum Levels)					Regulatory Level
		Min	Max	Min	Max	S1	S2	S3	S4	S5	
CCl_4	µg/L	<0.5	4	<0.5	1.9	<0.5	1.6	14.9	0.8	<0.5	0.5
TCE	µg/L	<0.5	20.8	<0.5	57.4	2	6.2	23	15.5	16	5
Perchlorate	µg/L	<4.0	46	<4.0	15	<4.0	17	209	17	22	6

Note: MW-17 is a multiport monitoring well containing five separate sampling screens, denoted S1 through S5

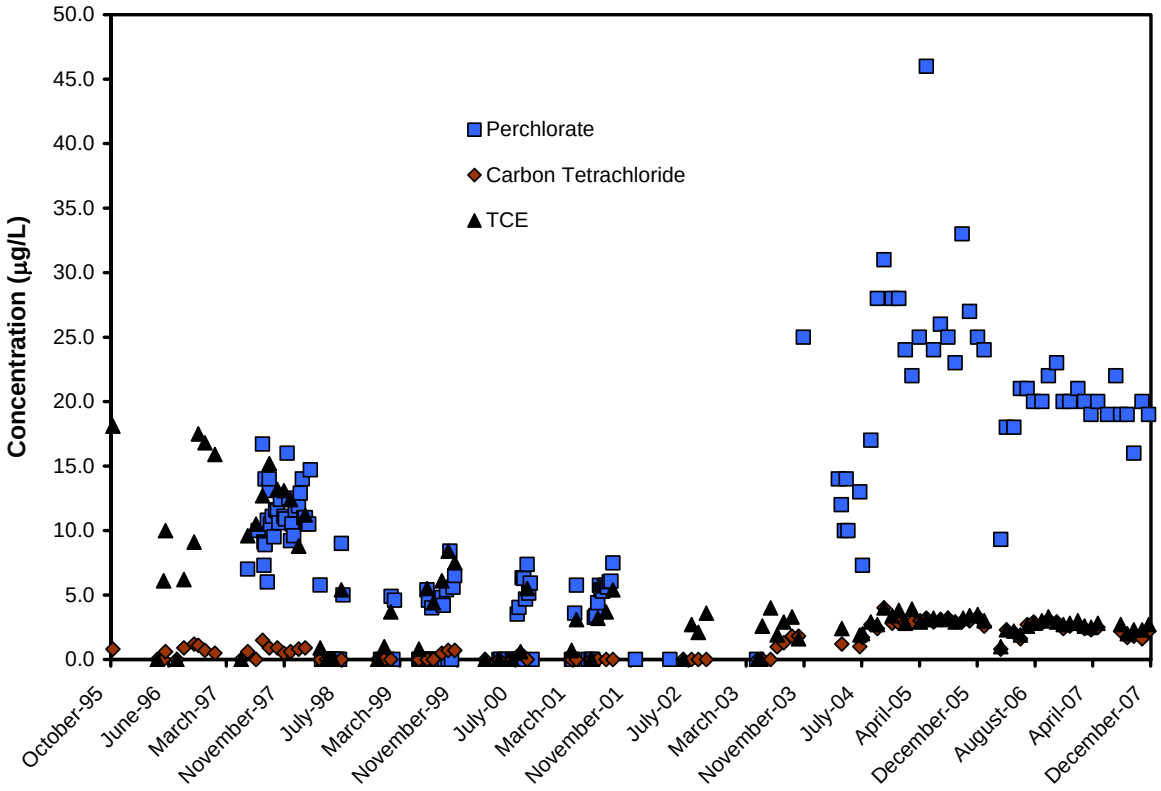

Figure 3. Historical Concentrations of CCl_4, TCE, and Perchlorate in LAWC#3

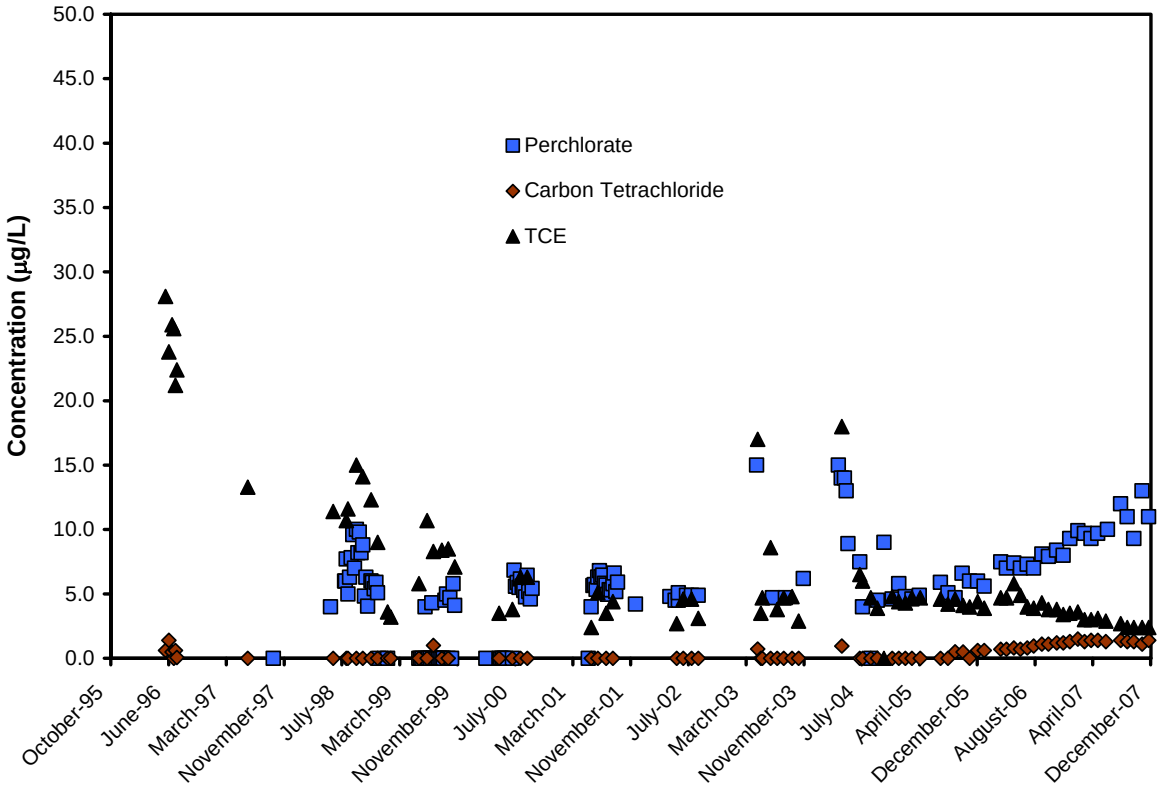

Figure 4. Historical Concentrations of CCl_4, TCE, and Perchlorate in LAWC#5

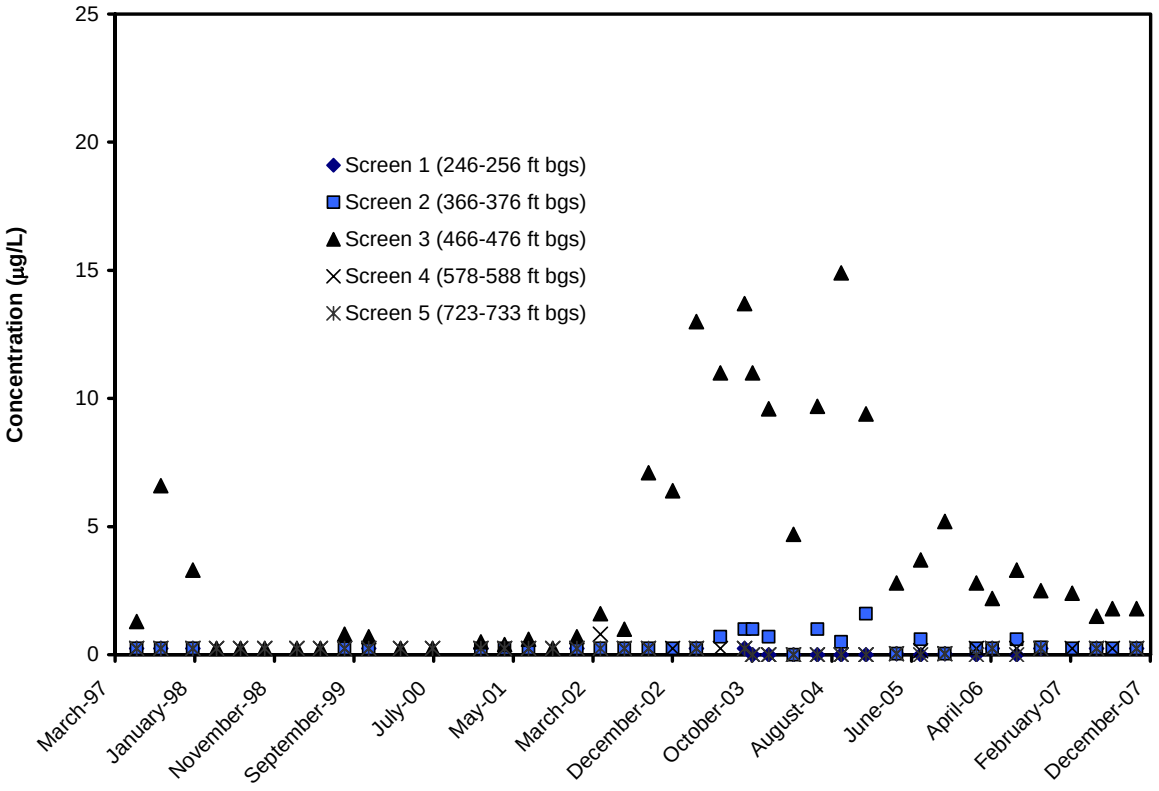

Figure 5. Historical Concentrations of CCl_4 in MW-17

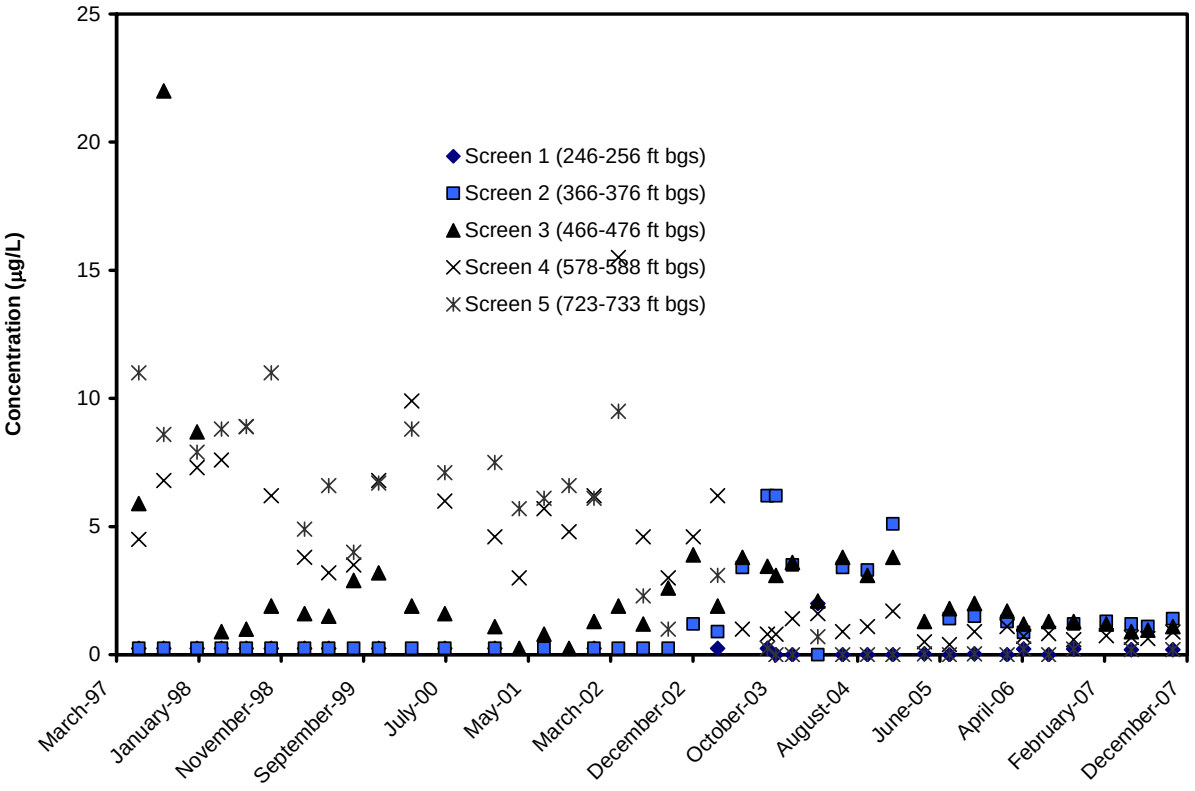

Figure 6. Historical Concentrations of TCE in MW-17

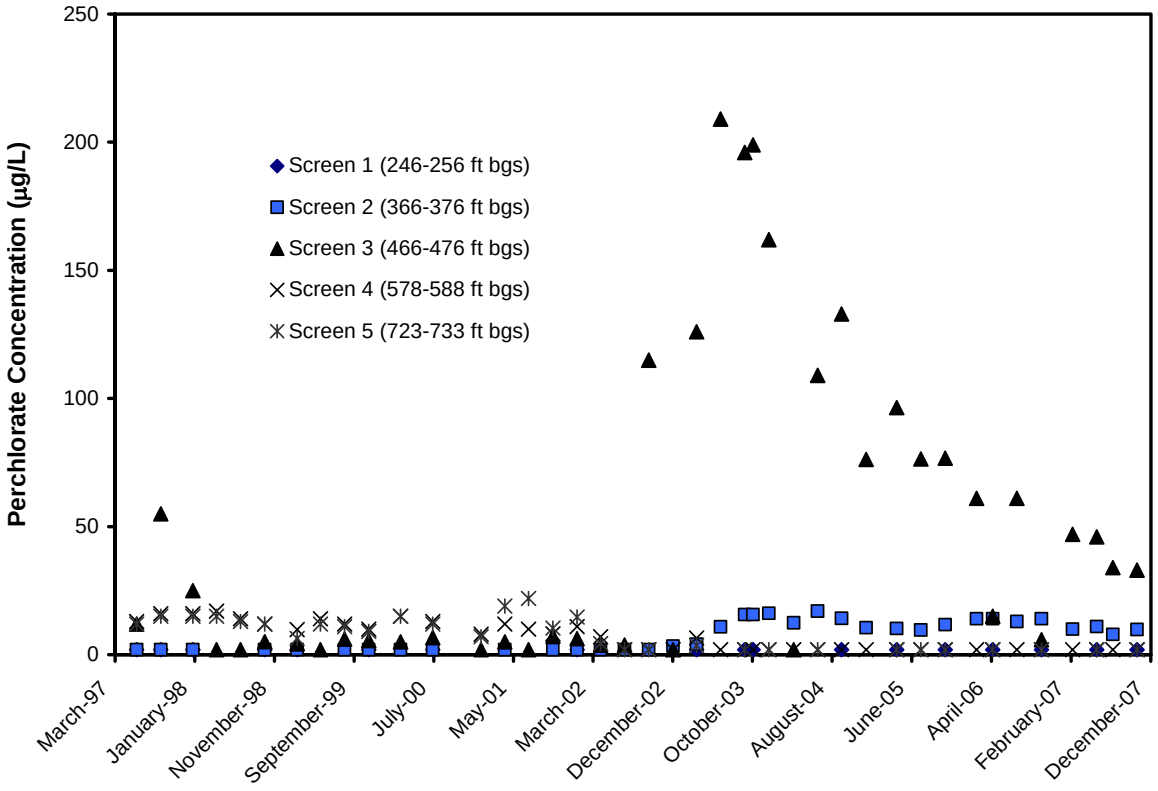

Figure 7. Historical Concentrations of Perchlorate in MW-17

ROUTINE MONITORING

Table 3 summarizes the routine monitoring schedule for the ion exchange and LGAC system. Analytical results from samples collected from LAWC#3 and LAWC#5 are presented in Figures 3 and 4, respectively.

Figure 8 shows perchlorate analytical results associated with the ion exchange system. Perchlorate break through in the lead IX vessel occurred twice during 2007, but never through the second ("lag") IX vessel. Table 4 summarizes the LGAC changeout dates and frequency based on the 4th port analytical results. Carbon tetrachloride consistently breaks through prior to other chemicals. In 2007, typical breakthrough occurred between 59 and 165 operating days, with an overall average of 117 days.

Table 5 summarizes the LGAC effluent and combined effluent sampling results. These effluent samples have not contained detectable CCl_4, TCE, PCE, or perchlorate at any time since startup in July 2004.

Table 3. Sampling Locations and Monitoring Schedule

Analyte	Method	LAWC#3	LAWC#5	IX Influent	Lead IX Effluent	Lag IX Effluent	LGAC- 4th Port [(a)]	LGAC-Effluent[(a)]	Combined Effluent
CCl_4	EPA 524.2	M	M	-	-	-	W	M	M
TCE	EPA 524.2	M	M	-	-	-	W	M	M
PCE	EPA 524.2	M	M	-	-	-	W	M	M
Perchlorate	EPA 314.0	M	M	W	W	W	-	-	M
Nitrate	EPA 300.0	-	-	M	M	M	-	-	-
Total Coliform	EPA 1604	M	M	-	-	-	-	M	W
Heterotrophic Plate Count	9215B	-	-	-	-	-	-	M	W

(a) Samples collected from each of the 4 LGAC vessels
M = Monthly; W = Weekly; EPA = Environmental Protection Agency
Note: Sampling locations are shown on Figure 2.

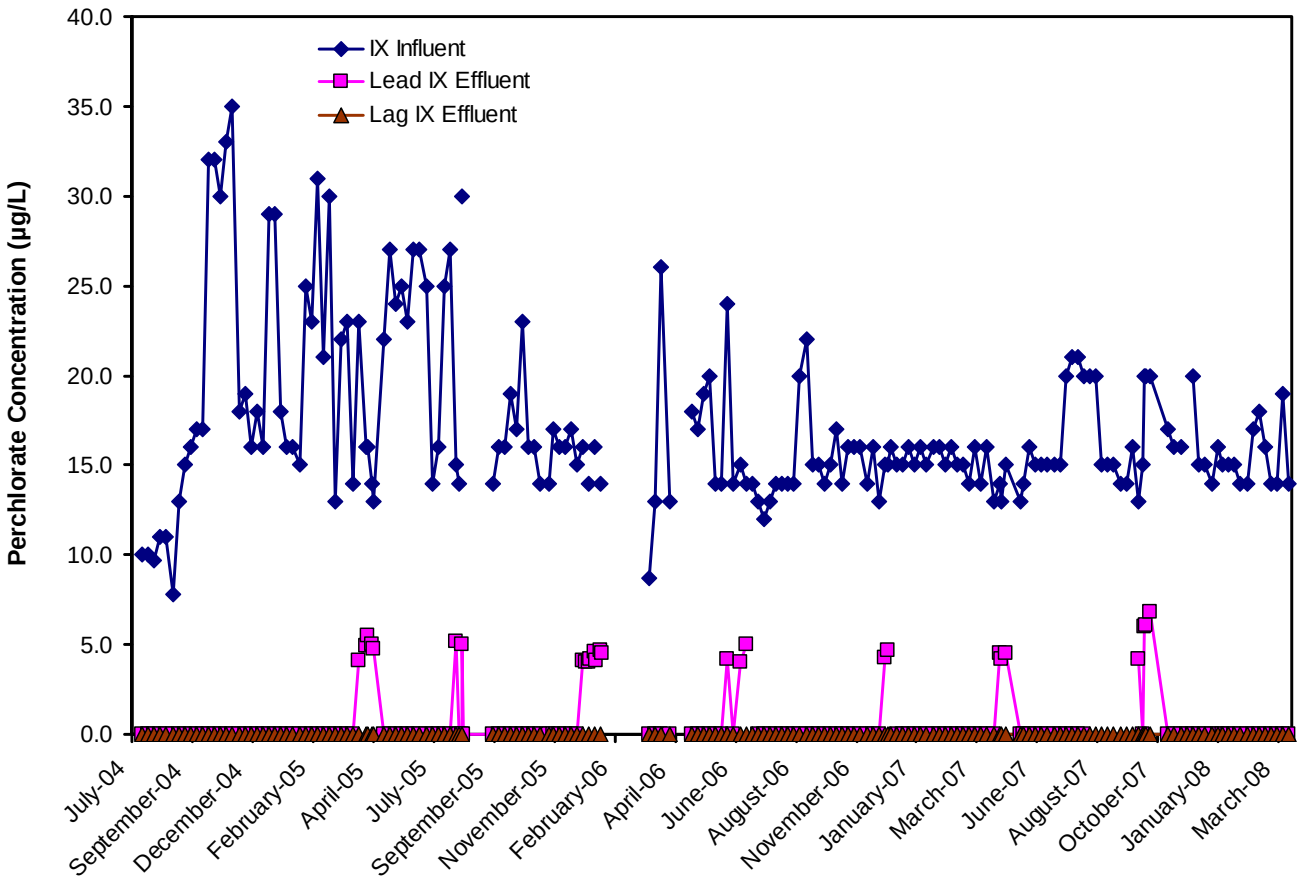

Figure 8. Ion Exchange System Performance

Table 4. Carbon Changeout Frequency Based on LGAC 4th Port VOC Sampling

Description	1st Vessel	2nd Vessel	3rd Vessel	4th Vessel
Date of 1st Changeout	12/14/2004	11/23/2004	3/22/2005	12/21/2004
Date of 2nd Changeout	7/19/2005	2/1/2005	7/26/2005	7/26/2005
Days between changeouts	217	70	126	217
Date of 3rd Changeout	11/22/2005	7/12/2005	11/15/2005	11/8/2005
Days between changeouts	126	161	112	105
Date of 4th Changeout	1/3/2006	11/1/2005	1/20/2006	1/20/2006
Days between changeouts	42	112	66	73
Date of 5th Changeout	5/31/2006	12/20/2005	3/9/2006	3/9/2006
Days between changeouts	148	49	48	48
Date of 6th Changeout	10/17/2006	3/9/2006	9/5/2006	8/29/2006
Days between changeouts	139	79	180	173
Date of 7th Changeout	3/2/2007	9/5/2006	1/16/2007	12/19/2006
Days between changeouts	136	180	133	112
Date of 8th Changeout	7/10/2007	12/26/2006	6/30/2007	4/1/2007
Days between changeouts	130	112	165	103
Date of 9th Changeout	12/7/2007	4/20/2007	10/24/2007	8/24/2007
Days between changeouts	150	115	116	145
Date of 10th Changeout	2/11/2008	9/6/2007	2/11/2008	11/13/2007
Days between changeouts	66	139	110	81
Date of 11th Changeout		12/19/2007		1/11/2008
Days between changeouts		104		59
Average days between changeouts	**128**	**112**	**117**	**112**
Minimum days between changeouts	**42**	**49**	**48**	**48**
Maximum days between changeouts	**217**	**180**	**180**	**217**

Note: Changeout triggered after detection of VOCs, typically carbon tetrachloride, at the LGAC 4th Port

Table 5. Effluent Sampling Results

Date	LGAC Effluent VOCs[a]	Combined Effluent[b]
08/03/04	ND	ND
09/07/04	ND	ND
10/05/04	ND	ND
11/02/04	ND	ND
12/07/04	ND	ND
01/04/05	ND	ND
02/01/05	ND	ND
03/01/05	ND	ND
04/05/05	ND	ND
05/05/05	ND	ND
06/07/05	ND	ND
07/05/05	ND	ND
08/02/05	ND	ND
09/13/05	ND	ND
10/04/05	ND	ND
11/02/05	ND	ND
12/06/05	ND	ND
01/03/06	ND	ND
02/07/06	ND	ND
03/01/06	ND	ND
04/07/06	ND	ND
05/02/06	ND	ND

Date	LGAC Effluent VOCs[a]	Combined Effluent[b]
06/06/06	ND	ND
07/05/06	ND	ND
08/01/06	ND	ND
09/05/06	ND	ND
10/03/06	ND	ND
11/07/06	ND	ND
12/05/06	ND	ND
01/02/07	ND	ND
02/05/07	ND	ND
3/6/2007	ND	ND
4/6/2007	ND	ND
5/1/2007	ND	ND
6/5/2007	ND	ND
7/3/2007	ND	ND
8/7/2007	ND	ND
9/4/2007	ND	ND
10/2/2007	ND	ND
11/6/2007	ND	ND
12/4/2007	ND	ND
1/2/2008	ND	ND
2/5/2008	ND	ND
3/5/2008	ND	ND

(a) TCE, CCl_4, and PCE with detection limit of 0.5 µg/L from each of the 4 LGAC vessels effluent
(b) TCE, CCl_4, and PCE with detection limit of 0.5 µg/L and perchlorate with detection limit of 4.0 µg/L

COST SUMMARY

Table 6 summarizes the operational costs incurred between January and December 2007.

Table 6. Operational Costs: January through December 2007

Description	IX	GAC	Subtotal
Facility Inspections	$17,432.03	$17,915.10	$35,347.13
Sample Analysis	$18,777.50	$36,407.00	$55,184.50
Sample Collection	$4,844.50	$6,317.50	$11,162.00
Maintenance	$20,828.75	$22,990.00	$43,818.75
Carbon Change-Out	NA	$212,628.67	$212,628.67
IX Treatment Costs	$764,050.65	NA	$764,050.65
IX-GAC Associated Cost	Combined	Combined	$21,428.56
Chemical Cost	Combined	Combined	$12,727.90
Administration	$1,662.48	$1,662.48	$3,324.96
Energy Costs	Combined	Combined	$2,853.93
Auto Costs	Combined	Combined	$531.14
Incremental Costs	Combined	Combined	$221,685.95
DPH Fees	Combined	Combined	$15,681.68
		Grand Total	$1,400,425.82