915063

CHERRY FARM/RIVER ROAD SITE
GROUNDWATER UPWELLING STUDY

December 2002 Sampling Event Data Report
Tonawanda, New York

SUBMITTED TO:

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NEW YORK STATE DEPARTMENT
OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS WASTE REMEDIATION

SUBMITTED BY:

CHERRY FARM/RIVER ROAD SITE
Potentially Responsible Parties

PREPARED BY:

PARSONS
180 Lawrence Bell Drive, Suite 104
Williamsville, New York 14221
(716) 633-7074 Fax (716) 633-7195

April 2003

Cherry Farm/River Road Site
Groundwater Upwelling Study
December 2002 Sampling Event Data Report

Prepared For:

Cherry Farm/River Road PRP Group

Prepared By:

PARSONS

180 Lawrence Bell Drive, Suite 104
Williamsville, New York 14221
Phone: (716) 633-7074
Fax: (716) 633-7195

REVIEWED AND APPROVED BY:

Project Manager: Mark A. Rayburn 4/15/03
Date

Technical Manager: Steph Rossetti /KRH 4/15/03
Date

April 2003

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DECEMBER 2002 SAMPLING EVENT DATA REPORT

INTRODUCTION

The primary objective of this groundwater upwelling study was to determine, through direct sampling and measurements in the Niagara River, whether the deep extraction system at the Cherry Farm/River Road Site can be permanently shut down. This report describes the methods used and presents results of the December 2002 sampling event. This was the second sampling event of the upwelling study. The first event was conducted prior to temporarily shutting down the extraction well system. The extraction system was shut-down on October 14, 2002. This second sampling event (first quarterly post-shutdown event) took place during the week of December 16, 2002.

The Cherry Farm/River Road Site in Tonawanda, New York (Figure 1) currently has an 11-well groundwater extraction system that was designed to prevent migration of impacted groundwater in the deeper aquifer from reaching the Niagara River. The extraction system has been in operation for more than five years, beginning in August 1997. Over this five-year period, the deeper aquifer has shown historical concentrations of organic chemicals of concern typically below or near groundwater quality standards. It is expected that natural attenuation occurring between the site and the river are reducing the observed concentrations prior to discharge to the river.

The specific goals of the field data collection are to quantify the concentration of chemical indicators in groundwater that is expected to be upwelling into the river, and to assess whether concentrations are acceptable to warrant shutdown of the extraction system. The scope of work includes measuring vertical hydraulic gradients and chemical constituent concentrations in upwelling groundwater at multiple locations.

The previous report (January, 2003) detailed the sampling installation methodology and summarized all measurements and analytical data collected prior to November 27th 2002. The results of the initial sampling event, prior to temporarily shutting down the extraction wells, indicated a lack of impact from the site on chemical concentrations in groundwater beneath the river.

METHODOLOGY

The methodology for piezometer installation and groundwater sampling was detailed in the first Cherry Farm Upwelling Report (Parsons, 2002). In accordance with the work plan, the approach proposed for measuring groundwater discharge and quality into and through the river-bottom sediment is as follows:

- Measurement of hydraulic pressures (water levels) with vibrating wire piezometers.
- Initiation sampling of water quality from the eight newly installed sampling stations below the river before shutting down the deep aquifer extraction system.

- Quarterly sampling of water quality from the eight sampling stations after shutting down the deep aquifer extraction system.

A summary of the planned sampling and analysis program from October 2002 through September 2003 is shown on Table 1. Three additional sampling/data collection events at approximately three-month intervals are planned to provide an entire year of groundwater monitoring data. The second quarterly sampling event following the shutdown of the extraction wells is planned for the week of March 31, 2003.

Sampling Station Locations

Groundwater sampling pumps and vibrating wire piezometers were installed in the Niagara River sediments downgradient (west) of monitoring wells MW-4 and MW-5 (see Figure 2). Downgradient from each well, two near shore stations approximately 15 feet from shore and five to seven feet deep (below the sediment surface), and two offshore stations, approximately 40 feet from shore and 10 to 12 feet below the sediment surface, were constructed. These locations were chosen to characterize groundwater concentrations directly downgradient of the areas containing the highest historical chemical constituent concentrations (MW-4 and MW-5).

Pumping Tests

Informal "pumping tests" were conducted in October and December 2002 during the sampling events, using the pumps installed in the sampling stations. The tests were conducted to evaluate the effectiveness of the sand/bentonite seals between the upper and lower piezometers. At each station, readings were recorded in both the shallow and deep piezometer before pumping and during pumping. These readings reflected changes in hydraulic head due to pumping.

Results from the pumping test indicated that the methods used to hydraulically isolate the piezometers and pumps were sufficient. Table 2 summarizes the pumping tests at each station. Pumping in the upper sand pack reduced the hydraulic head of the upper piezometers by a range of 2.6 ft to 0.15 ft. The lower piezometers only changed a negligible amount, ranging from a decline of 0.03 feet to a rise of 0.03 feet. These results indicated an effective seal between the upper and lower piezometers.

Sampling Methods

A round of samples was collected during the week of December 16, 2002. The event took place approximately two months after shutting down the extraction wells. Samples were collected from all eight sampling stations, and two monitoring wells (MW-4 and MW-5, collected by O'Brien and Gere during the routine semi-annual sampling event). These samples were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX), naphthalene, PCBs and anions/cations. One surface water sample was collected directly from the river and analyzed for anions/cations.

The river stations and monitoring wells were purged prior to sampling. Samples from the river stations were collected at low flow rates (less than 200 ml/ min). Monitoring wells were sampled with a stainless steel bailer.

Piezometer Readings

Weekly piezometer readings were used to quantify the vertical hydraulic gradient at each station. The river stage was also monitored weekly using the existing staff gauge. Pressure and temperature readings were recorded from switch boxes housed in the onsite sheds. A hand-held piezometer readout unit displayed the piezometer reading, which was recorded by hand onto field data sheets. The data were then entered into a spreadsheet that used a linear equation to correct for changes from initial conditions and to derive hydraulic head differences. Since the distance between the piezometers in each pair was known, the vertical gradient at each river station was calculated.

RESULTS

Major Anions and Cations

The results of the anion and cation analyses indicate a difference in water quality between the river stations and surface water from the river. Thus, it appears that the river station samples are not being influenced by river water, and that leakage from the surface to the zone in which the sampling pumps were installed does not appear to occurring. Details of the anion/cation analyses are provided below.

Anion/cation analytical results from the second quarter sampling event are provided in Table 3 and graphically displayed in Figure 3. Eleven analyses of major anions and cations were plotted on a Piper trilinear diagram. Two monitoring wells represented groundwater. Eight river station (RS) water analyses represented groundwater below the river. One surface water sample was collected directly from the river. The approximate total dissolved solids (TDS) content was included with cation/anion ratios on the table below the Piper diagram.

The river surface water and monitoring well samples were moderately low in magnesium, chloride, sodium and sulfate, and high in calcium and bicarbonate. River station samples (groundwater samples from below the river) were generally low in magnesium, chloride, and sulfate, had moderate percentages of calcium and sodium, and were high in bicarbonate. Groundwater samples collected from monitoring wells were generally low in chloride, sulfate, and magnesium, had moderate percentages of calcium and sodium, and were high in bicarbonate.

Two separate groupings of data were observed on the diamond portion of the Piper diagram. The river water sample and monitoring wells plot in the upper left side of the diamond. The river stations (RS samples) are grouped in the lower left side of the diamond. This water contained between 10 and 35 percent chloride plus sulfate and 40 to 80 percent sodium.

Anion/cation analytical results from the pre-shutdown (October 2002) and first post-shutdown (December 2002) quarterly sampling events are provided in Table 3 and graphically displayed in Figure 4. The two rounds of samples plot in similar sections of the plot. The river station samples in both events plot in the lower left section of the diamond. The river water samples in both events plot in upper left section of the diamond. Monitoring wells samples had a large variation between sampling events. The October 2002 monitoring well samples plotted

with the river station samples in the lower left side of the diamond. The December 2002 monitoring well samples plotted near the river water samples in the upper left section of the diamond.

The approximate TDS concentration also indicated a chemical differentiation between the river water and the groundwater below the river at each station. In the October 2002 sampling event, the average TDS of the groundwater samples was 688 mg/l. The average TDS of river water samples in October 2002 was 254 mg/l. In the December 2002, the average TDS of the groundwater samples was 744 mg/l and the river water sample was 211 mg/l.

As additional anion and cation data are collected during ensuing sampling events, it will be added to the Piper trilinear plots and evaluated.

Chemical Constituents of Concern

The laboratory analytical results from the first quarterly post-shut down sampling event in December 2002 are provided in Table 2. All eight river station samples were below detection limits for all compounds.

Monitoring well MW-5 contained 52 ug/L benzene and 17 ug/L total xylenes, and MW-4 had no detectable concentrations of any chemicals of concern.

These results indicate that chemical parameters detected at relatively low concentrations in onsite groundwater were not impacting groundwater beneath the river at near shore locations at the time of sampling, two months after shutting down the extraction wells.

Piezometer Readings

Weekly piezometer readings and river levels are summarized in Table 4. Gradients were calculated for hydraulic head by subtracting the shallower piezometer value (head or temperature) from the deeper piezometer value. Positive values represent an upward vertical hydraulic gradient, and negative values represent a downward vertical gradient. Although a range of gradients is shown, the most significant observation from the piezometer readings was the low hydraulic gradients at each station. Hydraulic gradients ranged from -0.079 to 0.097 feet per foot (ft/ft). Piezometers were typically separated by five feet, and head differences between the two piezometers did not exceed 0.39 feet. The low hydraulic gradients suggest low rates of either upward or downward movement of water between the aquifer and the river.

Temperatures, recorded from the river station piezometers, are shown on Table 5. The upper section of the table lists the temperature readings. The lower section of the table lists the difference between piezometers at each station. Positive values represent conditions where water adjacent to the deeper piezometer is colder than adjacent to the shallower piezometer; negative values represent conditions where water near the deeper piezometer is warmer than adjacent to the shallower piezometer. As expected, the temperature from the shallow piezometer in each pair was typically warmer than the deep piezometer in October 2002, as air and surface water temperatures tend to be warmer. In November 2002, the air and river temperatures cooled and the temperature differentials began to reverse. The deeper water was warmer. This trend

continued through March. Although not an integral part of the study, temperature differentials between the deep and shallow piezometers provide further indication of groundwater upwelling , and evidence that the sand/bentonite seals are functioning appropriately.

CONCLUSIONS/SCHEDULE

The results of the October and December 2002 sampling events indicated a lack of impacts from the site on chemical concentrations in groundwater beneath the river. Results from subsequent events will be evaluated and presented to the NYSDEC as the data are collected.

As shown on Table 1, the next event is scheduled for March 2003. The next quarterly report is expected to be submitted in May 2003.

RESPONSES TO NYSDEC COMMENTS ON THE OCTOBER 2002 SAMPLING EVENT REPORT

1. *Page 3,* ***Pre-Sampling Quality Assurance/Quality Control Tests*** *– Two analytical samples were collected but only one set of data can be located. It appears that the cation/anion data from the samples collected on 9/19/02 are missing.*

   Three samples taken on September 19, 2003 were missing from Table 2 (Laboratory Analytical Results). Samples RS-01P, RW-02P and RV-01P were incorporated into Table 2 and included in this report as Table 6 (Revised October 2002 Laboratory Analytical Results). In the Initial Report, the samples were included in the Piper analysis and Figure 4. Therefore, no further revisions were necessary regarding the Piper diagram.

2. *Page 4* ***Results, Major Cations and Anions****- This section indicates that seven extraction and monitoring well nine river station water and two surface water samples were collected. However, Table 1 indicates data for only six extraction and monitoring wells, eight river water stations and one surface water sample Again, it appears that the data from samples collected on 9/19/02 may be missing.*

   See response to Comment No. 1.

3. *There should be some discussion as to why the water in RW-02 and RS-03 plot in the location of river water in the Piper Diagram. Also, several of the samples have high cation-anion balance errors. This data therefore may be questionable.*

   As more data are collected, further analysis and discussions regarding the Piper analysis will be presented. Figure 4 (from both rounds of sampling) shows there may be heterogeneous anion/cation ratios beneath the landfill. RW-02 and RS-03 (October, 2002) plotted near the river water. MW-4 and MW-5 plotted near the river stations in October 2002, but near the River water in December 2002. The heterogeneity of anion/cation rations could be due to elevated metal concentrations in the deeper aquifer.

Historically there have been elevated concentrations of metals in the background sample and beneath the landfill. Due to the non-uniform distribution of metals in the area, metal concentrations in groundwater may show spatial and temporal variability. Also, the Piper analysis did not include dissolved iron, which exhibited historically elevated concentrations. These factors may be causing an unpredicted variance in the anion/cation analysis program, as well as the high cation/anion balance error.

Difference in TDS further differentiates River water from groundwater. Future reports will graphically display the TDS variations that are tabulated on Figures 3 and 4. As more data are collected, the variability in data may decrease as effects from the initial conditions diminish.

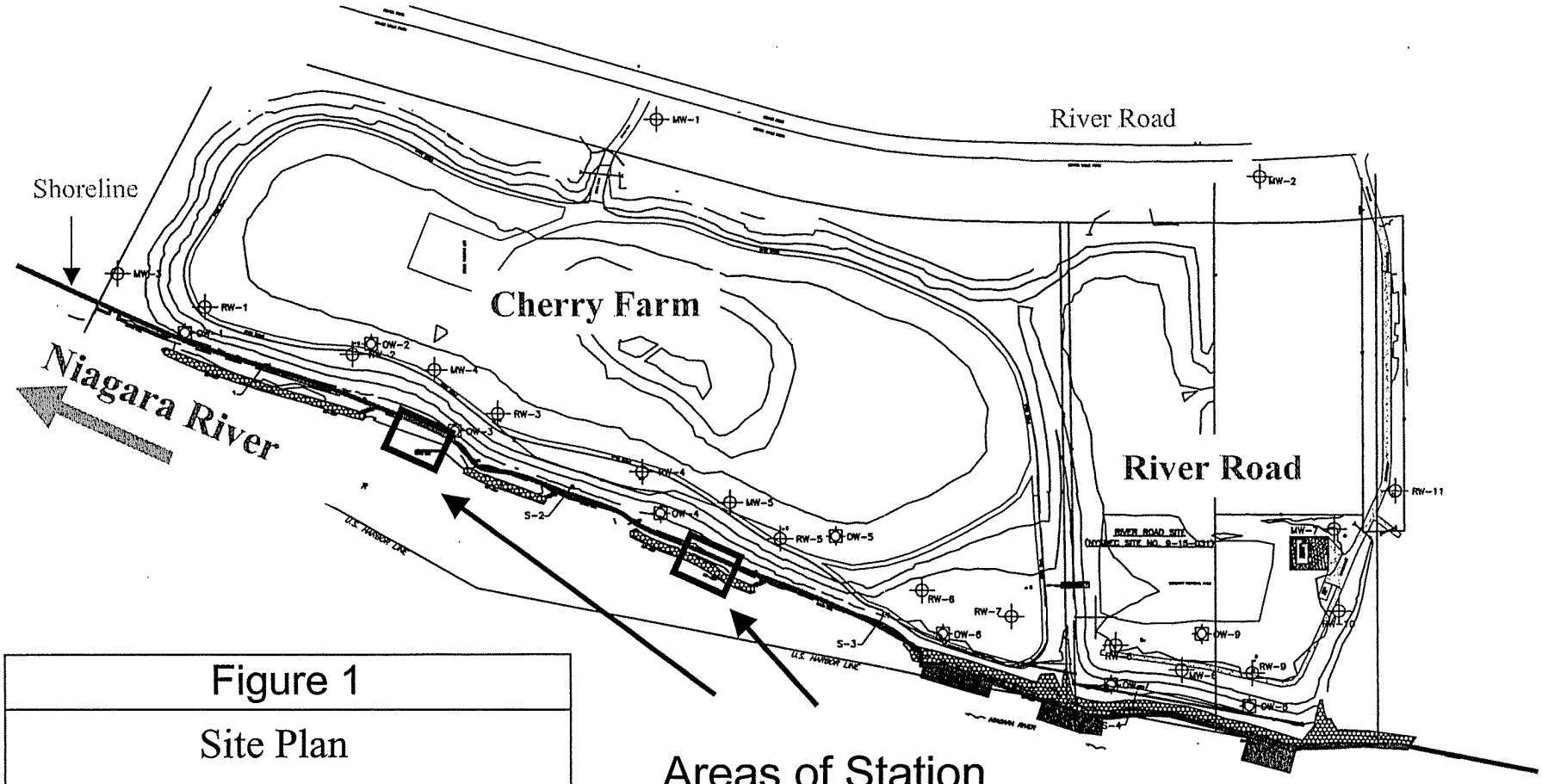

Figure 1
Site Plan
Cherry Farm/River Road Groundwater Upwelling Study
PARSONS 180 Lawrence Bell Drive, Suite 104, Williamsville, N.Y. 14221, Phone: (716) 633-7195

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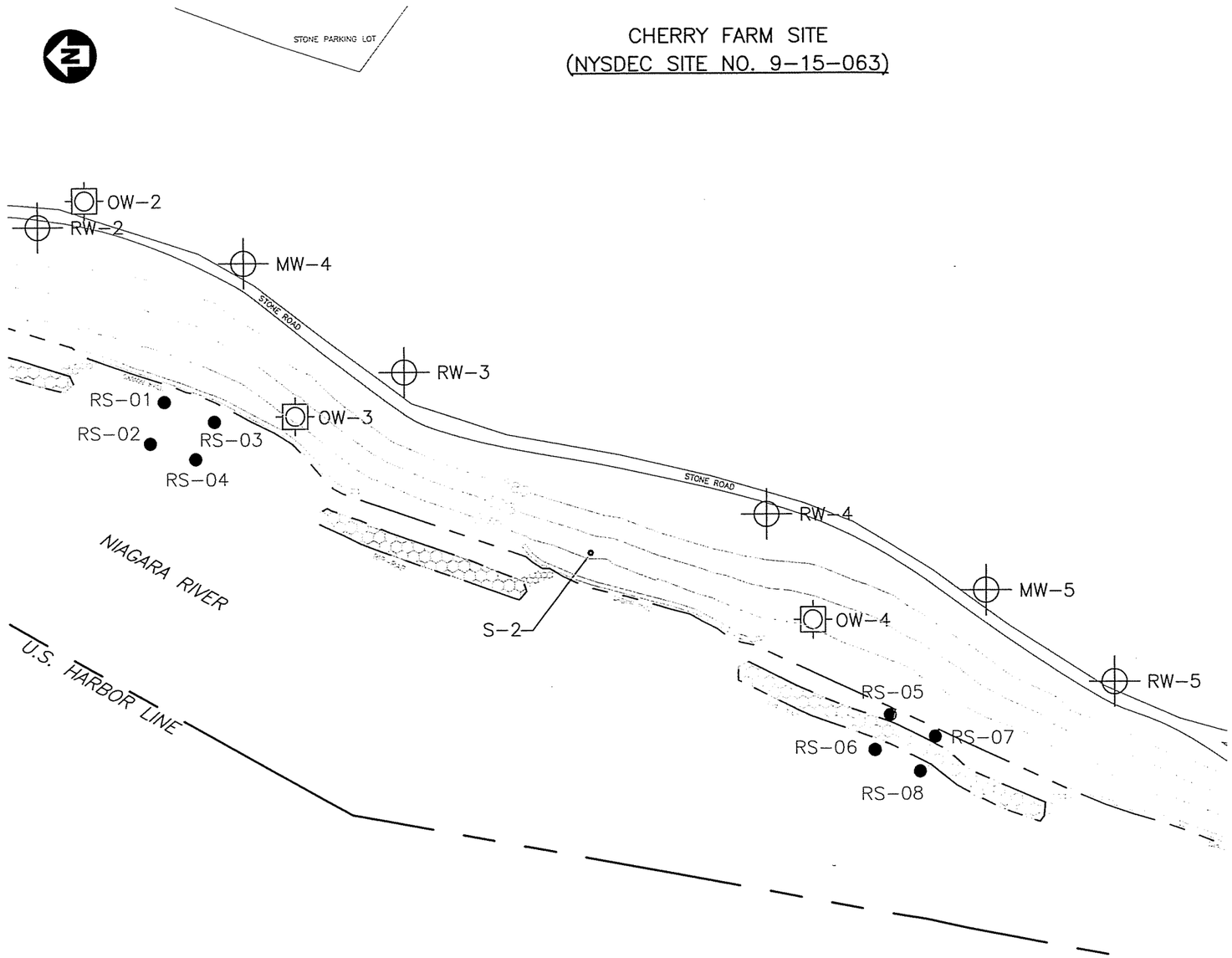
CHERRY FARM SITE
(NYSDEC SITE NO. 9-15-063)



LEGEND

OW-5	OBSERVATION WELL
MW-1	MONITORING WELL
RW-1	RECOVERY WELL AND VAULT
	PROPOSED FINAL GRADE INDEX CONTOUR
	RIP-RAP

120 60 0 120 240

SCALE: 1"=120'

FIGURE 2

CHERRY FARM/RIVER ROAD SITE
ANNUAL GROUNDWATER MONITORING REPORT

SAMPLE LOCATION MAP

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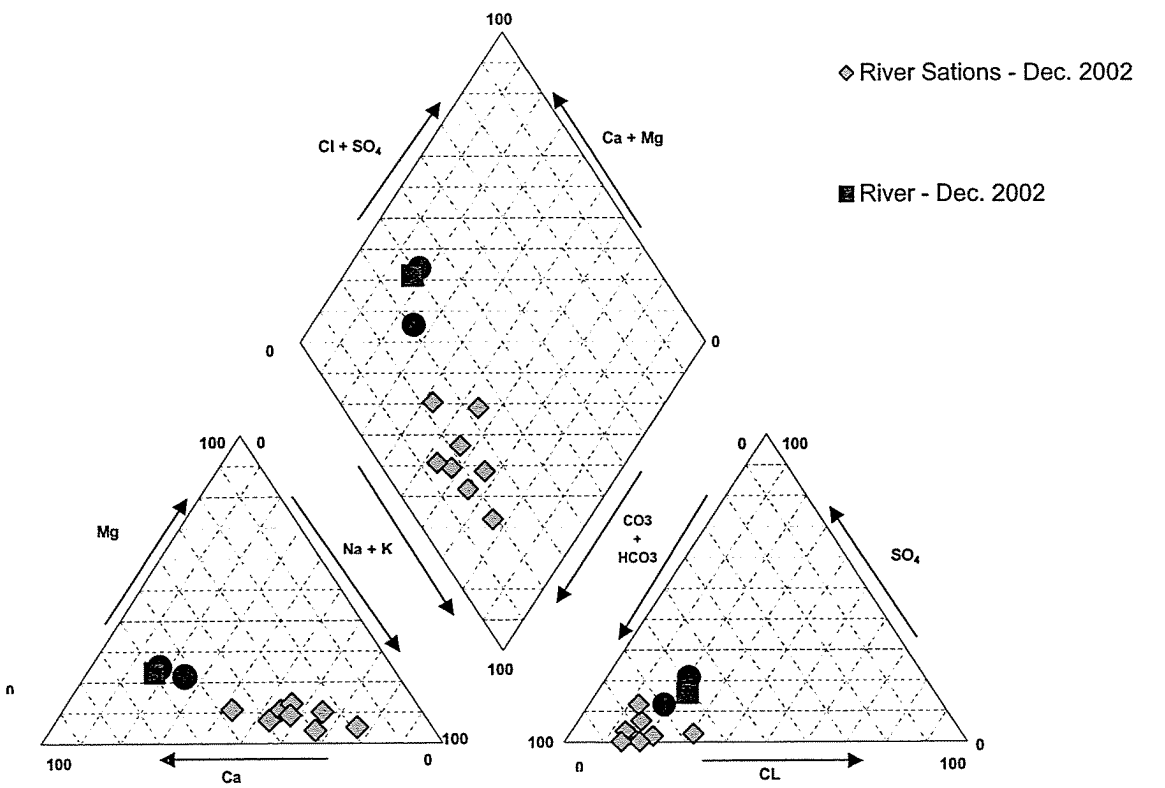

WELL	CATIONS				ANIONS				CATION-ANION	TDS (approx)
	Ca	Mg	Ca+Mg	Na+K	Cl	SO_4	Cl+SO_4	HCO_3+CO_3	Balance Error	MG/L
MW-04-2	58%	25%	82%	18%	20%	21%	41%	59%	15%	718
MW-05-2	53%	22%	75%	25%	19%	12%	31%	69%	18%	666
RS-01-2	35%	11%	45%	55%	31%	3%	33%	67%	3%	1023
RS-02-2	25%	10%	35%	65%	15%	2%	18%	82%	13%	903
RS-03-2	47%	11%	57%	43%	21%	2%	23%	77%	6%	900
RS-04-2	31%	13%	44%	56%	16%	7%	23%	77%	0%	826
RS-05-2	33%	9%	42%	58%	13%	4%	17%	83%	12%	515
RS-06-2	18%	5%	24%	76%	19%	0%	19%	81%	1%	616
RS-07-2	29%	4%	33%	67%	12%	12%	25%	75%	14%	733
RS-08-2	39%	7%	47%	53%	14%	0%	14%	86%	52%	539
RV-01-2	60%	23%	83%	17%	23%	16%	39%	61%	29%	211

Cherry Farm/River Road Site, Tonawanda, New York

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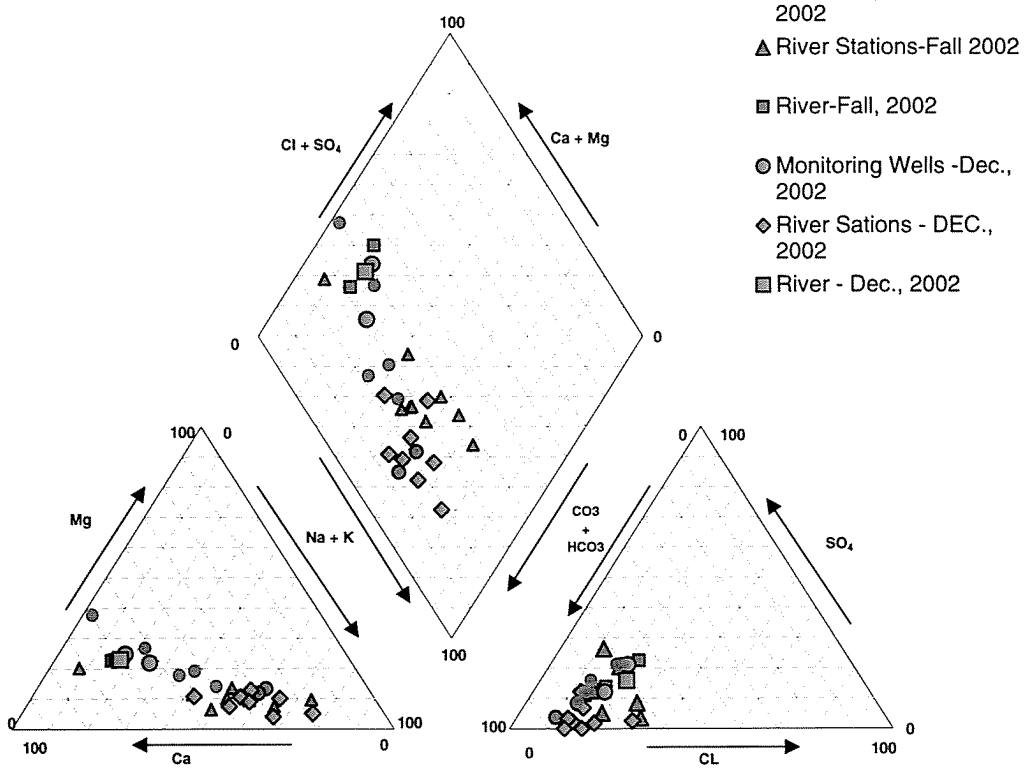
FIGURE 3
PIPER DIAGRAM
Monitoring Well, River Stations and River Water Data
December Sampling Event



WELL	CATIONS				ANIONS				CATION-ANION	TDS (approx)
	Ca	Mg	Ca+Mg	Na+K	Cl	SO_4	Cl+SO_4	HCO_3+CO_3	Balance Error	MG/L
RW-02-P	60%	38%	97%	3%	19%	21%	40%	60%	9%	899
MW-05-1	27%	13%	40%	60%	14%	8%	22%	78%	17%	589
MW-04-1	29%	12%	41%	59%	10%	4%	14%	86%	4%	881
RW-02-1	51%	27%	78%	22%	17%	21%	39%	61%	7%	1128
RW-03-1	47%	18%	65%	35%	13%	9%	22%	78%	33%	1117
RW-04-1	39%	14%	53%	47%	14%	12%	26%	74%	4%	475
RW-05-1	42%	19%	61%	39%	13%	16%	29%	71%	5%	688
RS-01-P	32%	11%	43%	57%	29%	9%	38%	62%	10%	816
RS-01-1	47%	12%	58%	42%	32%	4%	36%	64%	16%	946
RS-02-1	17%	10%	26%	74%	11%	27%	38%	62%	12%	570
RS-03-1	72%	20%	92%	8%	21%	5%	27%	73%	47%	737
RS-04-1	35%	14%	49%	51%	15%	13%	28%	72%	13%	474
RS-05-1	33%	10%	42%	58%	15%	15%	29%	71%	8%	413
RS-06-1	27%	7%	35%	65%	18%	21%	39%	61%	153%	264
RS-07-1	44%	7%	51%	49%	13%	12%	25%	75%	2%	604
RS-08-1	38%	10%	49%	51%	15%	13%	28%	72%	30%	417
RV-01-P	62%	23%	85%	15%	23%	23%	45%	55%	42%	178
RV-01-1	61%	23%	84%	16%	18%	14%	32%	68%	137%	416
MW-04-2	58%	25%	82%	18%	20%	21%	41%	59%	15%	718
MW-05-2	53%	22%	75%	25%	19%	12%	31%	69%	18%	666
RS-01-2	35%	11%	45%	55%	31%	3%	33%	67%	3%	1023
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Cherry Farm/River Road Site, Tonawanda, New York

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FIGURE 4
PIPER DIAGRAM
All Samples

Table 1

Cherry Farm/River Road Groundwater Upwelling Study
Sampling and Analysis Summary (Revised from Initial Report- Table 1)

Sampling Events						
Event	Date	BTEX	naphthalene	PCBs	cat/anion*	Comments
Pre-shutdown	Sept and Oct. 02	15	15	15	15	9 RSs, 5RWs, 2MWs, 1 dupe, 2 riv. Sample for cat/anions (no cat/anion dupe).
Quarter 1	Dec. 02	11	11	11	12	8 RSs, 2MWs, 1 dupe, MWs done by OBG, one riv. Samp. For cat/anions.
Quarter 2	Mar. 03	9	9	9	9	8 RSs, 1 dupe, one riv. sample for cat/ions, no cat/anion dupe.
Quarter 3	June 03	11	11	11	12	Same as Dec. 02
Quarter 4	Sept. 03	15	15	15	15	Same as Oct. 02
Total		**61**	**61**	**61**	**63**	

*Ca, Na, Mg, bicarbonate, Cl, Sulfate
MWs: MW-4, MW-5
RWs: RW-2, RW-3, RW-4, and RW-5

Samples will go to CES, with the exception of MW-4 and MW-5 samples in Dec. 02 and June 03, which are done by OBG.

Table 2
CHERRY FARM UPWELLING STUDY
SUMMARY: PIEZOMETER RESPONSE TO PUMPING

Date	Station ID	Piezometer ID	Drawdown (ft)
9/21/2002	RS-01D	2351	0.01
9/21/2002	RS-01S	2352	2.64
12/19/2002	RS-02D	2353	-0.03
12/19/2002	RS-02S	2354	0.22
12/18/2002	RS-03D	2355	0.02
12/18/2002	RS-03S	2356	1.78
12/18/2002	RS-04D	2358	0.02
12/18/2002	RS-04S	2357	0.15
12/19/2002	RS-05D	2359	-0.01
12/19/2002	RS-05S	2360	0.21
12/20/2002	RS-06D	2361	0.03
12/20/2002	RS-06S	2362	0.30
12/20/2002	RS-07D	2363	-0.03
12/20/2002	RS-07S	2364	0.63
12/20/2002	RS-08D	2366	-0.01
12/20/2002	RS-08S	2365	0.33

Table 3
Laboratory Analytical Results

Cherry Farm Upwelling Data Study December 2002 Laboratory Analytical Results		Sample ID: Lab Sample Id: Source: SDG: Matrix: Sampled: Validated:	MW-04 306944/Z7814 CES/OBG 4219 WATER 12/18/2002	MW-05 306946/Z7815 CES/OBG 4219 WATER 12/18/2002	RS-01 306923 CES 112462 WATER 12/16/2002	RS-02 306926 CES 112462 WATER 12/19/2002	RS-03 306924 CES 112462 WATER 12/18/2002	RS-04 309625 CES 112462 WATER 12/18/2002	RS-05 306928 CES 112462 WATER 12/19/2002	RS-06 307072 CES 112462 WATER 12/20/2002	RS-07 307082 CES 112462 WATER 12/20/2002	RS-08 307077 CES 112462 WATER 12/20/2002	RS-09 306927 CES 112462 WATER 12/19/2002	RV-01 306950 CES 112462 WATER 12/19/2002	TRIP BLANK 306929 CES 112462 WATER 12/19/2002	TRIP BLANK 307087 CES 112462 WATER 12/20/2002
CAS NO.	COMPOUND	UNITS:														
	VOLATILES															
71-43-2	Benzene	ug/L	10 U	52	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U		0.7 U	0.7 U
108-88-3	Toluene	ug/L	10 U	5 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U		1 U	1 U
100-41-4	Ethylbenzene	ug/L	10 U	4 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U		1 U	1 U
1330-20-7	Total Xylenes	ug/L	10 U	17	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U		3 U	3 U
	SEMIVOLATILES															
91-20-3	Naphthalene	ug/L	11 U	13	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U			
	PCBs															
11104-28-2	Aroclor 1221	ug/L	2 U	20	0.065 U	0.065 U	0.065 U	0.07 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U			
11141-16-5	Aroclor 1232	ug/L	1 U	1 U	0.065 U	0.065 U	0.065 U	0.07 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U			
53469-21-9/12674-11-2	Aroclor 1242/1016	ug/L	1 U	1 U	0.065 U	0.065 U	0.065 U	0.07 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U			
12672-29-6	Aroclor 1248	ug/L	1 U	1 U	0.065 U	0.065 U	0.065 U	0.07 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U			
11097-69-1	Aroclor 1254	ug/L	1 U	1 U	0.065 U	0.065 U	0.065 U	0.07 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U			
11096-82-5	Aroclor 1260	ug/L	1 U	1 U	0.065 U	0.065 U	0.065 U	0.07 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U			
	METALS															
7440-70-2	Calcium, Total	mg/L	104	84.4	98.3	62	106	66.3	40	28.9	60.7	39	59.6	28.9		
7439-95-4	Magnesium, Total	mg/L	27.2	21.2	18.3	15.6	15.1	16.8	6.71	4.96	5.2	4.53	15	6.76		
7440-23-5	Sodium, Total	mg/L	36.6	46.7	178	189	111	139	80.3	137	158	61.1	144	9.53		
	OTHER															
	Bicarbonate Alkalinity	mg/L	370	396	561	563	567	508	344	392	416	396	567	117		
(SULFA)	Sulfate	mg/L	105	54.9	17.7	13.3	11.1	36.1	11.5	0.5 U	53.1	0.5 U	13.3	24		
(CHLOR)	Chloride	mg/L	75	62.5	150	60	90	60	32.5	52.5	40	38	62.5	25		

Note: OBG analyzed VOCs, SVOCs, and PCBs for MW-04 and MW-05. CES analyzed metals and other parameters for MW-04 and MW-05.

Table 4
Vertical Hydraulic Gradients

Date (2002)		10/10	10/28	11/12	11/18	11/27	12/4	12/13	12/16	12/23	1/15	2/6	3/13
RS-01	Head difference between pair (ft)	0.15	0.19	0.17	0.15	0.24	0.26	0.28	0.27	0.20	0.25	0.33	0.39
	Upward Hydraulic Gradient	0.037	0.049	0.042	0.038	0.061	0.065	0.071	0.067	0.049	0.062	0.083	0.097
RS-02	Head difference between pair (ft)	0.10	0.07	-0.02	0.01	0.17	0.02	0.07	0.04	0.00	0.08	0.04	0.04
	Upward Hydraulic Gradient	0.026	0.018	-0.006	0.003	0.044	0.004	0.017	0.010	-0.001	0.021	0.011	0.011
RS-03	Head difference between pair (ft)	0.17	0.20	0.19	0.17	0.20	0.20	0.20	0.19	0.18	0.15	0.17	0.18
	Upward Hydraulic Gradient	0.049	0.058	0.054	0.048	0.058	0.057	0.058	0.054	0.050	0.042	0.049	0.051
RS-04	Head difference between pair (ft)	0.11	-0.01	-0.09	-0.12	-0.14	-0.17	-0.21	-0.21	-0.26	-0.33	-0.35	-0.44
	Upward Hydraulic Gradient	0.021	-0.003	-0.017	-0.022	-0.026	-0.031	-0.038	-0.038	-0.047	-0.059	-0.064	-0.079
RS-05	Head difference between pair (ft)	0.08	0.05	0.03	0.03	0.02	0.01	0.00	-0.01	0.02	-0.07	-0.05	-0.09
	Upward Hydraulic Gradient	0.022	0.016	0.007	0.009	0.005	0.004	0.000	-0.002	0.005	-0.020	-0.014	-0.025
RS-06	Head difference between pair (ft)	0.03	0.00	-0.02	-0.04	0.00	-0.01	0.00	-0.04	-0.01	-0.02	-0.04	-0.02
	Upward Hydraulic Gradient	0.008	-0.001	-0.005	-0.011	0.001	-0.004	-0.001	-0.011	-0.002	-0.007	-0.011	-0.006
RS-07	Head difference between pair (ft)	0.23	0.17	0.22	0.12	0.18	0.15	0.09	0.13	0.13	0.09	0.08	0.03
	Upward Hydraulic Gradient	0.057	0.042	0.055	0.030	0.045	0.037	0.023	0.032	0.031	0.023	0.020	0.008
RS-08	Head difference between pair (ft)	-0.02	-0.04	-0.10	-0.09	-0.04	-0.07	-0.06	-0.03	-0.08	-0.07	-0.05	-0.03
	Upward Hydraulic Gradient	-0.006	-0.013	-0.030	-0.025	-0.012	-0.019	-0.018	-0.010	-0.023	-0.020	-0.013	-0.008
River Level (ft at staff gauge)		0.4	NS	NS	0.4	-0.5	NS	-0.80	-0.40	0.7	ICE	ICE	ICE

NS: No measurement

Table 5
Temperature Summary

Station ID	Piezometer ID	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F
		10-Oct-02	28-Oct-02	12-Nov-02	18-Nov-02	27-Nov-02	4-Dec-02	13-Dec-02	16-Dec-02	23-Dec-02	15-Jan-03	6-Feb-03	12-Mar-03
RS-01D	2351	60.3	59.9	58.6	57.9	57.1	56.2	55.0	54.4	53.4	50.9	49.2	46.1
RS-01S	2352	64.6	61.3	57.5	56.3	53.9	52.6	50.2	49.5	48.2	45.1	43.0	40.2
RS-02D	2353	67.8	57.9	57.6	57.5	57.0	56.7	56.0	55.7	55.4	53.4	52.1	49.5
RS-02S	2354	66.0	60.7	59.1	58.4	57.1	56.2	55.0	54.4	53.4	50.7	48.9	45.8
RS-03D	2355	63.8	59.7	58.4	57.8	56.7	55.9	54.4	54.1	53.1	50.4	48.5	45.7
RS-03S	2356	67.0	61.3	57.8	56.8	54.6	53.1	51.2	50.4	49.2	46.0	43.9	41.0
RS-04D	2358	64.9	57.1	56.8	56.7	56.2	55.9	55.2	55.0	54.4	52.8	51.7	49.0
RS-04S	2357	64.9	61.9	59.4	58.4	57.0	55.9	54.2	53.6	52.5	49.6	47.5	44.5
RS-05D	2359	57.5	57.5	57.1	56.8	56.2	55.9	55.0	54.4	54.1	52.1	50.9	48.2
RS-05S	2360	61.0	60.0	58.3	57.5	56.0	55.2	53.6	52.6	52.0	49.2	47.5	44.3
RS-06D	2361	59.5	58.9	58.3	57.9	57.1	56.7	56.7	54.7	56.7	53.7	52.6	50.6
RS-06S	2362	61.4	60.3	58.6	57.6	56.5	56.5	54.1	53.1	52.5	49.8	47.9	45.2
RS-07D	2363	56.5	56.8	56.7	56.5	56.0	55.5	55.0	54.6	54.2	52.5	51.3	48.9
RS-07S	2364	60.3	59.4	57.8	57.1	55.9	55.0	53.7	52.9	52.3	49.6	47.9	45.1
RS-08D	2366	59.5	56.8	58.3	56.8	56.0	56.7	56.7	54.7	56.7	53.7	52.6	51.3
RS-08S	2365	60.5	59.7	58.4	57.8	56.8	55.7	54.6	53.9	53.3	50.9	49.5	46.7
River water		63.32	53.42	50	46.76	40.3	NS	NS	33.9	36	32	32	32
River in swale						39.7				37	32	32	32
Station ID		Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F
RS-01		-4.3	-1.4	1.1	1.6	3.2	3.6	4.8	4.9	5.2	5.8	6.2	5.9
RS-02		1.8	-2.8	-1.5	-0.9	-0.1	0.5	1.0	1.3	2.0	2.7	3.2	3.7
RS-03		-3.2	-1.6	0.6	1.0	2.1	2.8	3.2	3.7	3.9	4.4	4.6	4.7
RS-04		0.0	-4.8	-2.6	-1.7	-0.8	0.0	1.0	1.4	1.9	3.2	4.2	4.5
RS-05		-3.5	-2.5	-1.2	-0.7	0.2	0.7	1.4	1.8	2.1	2.9	3.4	3.9
RS-06		-1.9	-1.4	-0.3	0.3	0.6	0.2	2.6	1.6	4.2	3.9	4.7	5.4
RS-07		-3.8	-2.6	-1.1	-0.6	0.1	0.5	1.3	1.7	1.9	2.9	3.4	3.8
RS-08		-1.0	-2.9	-0.1	-1.0	-0.8	1.0	2.1	0.8	3.4	2.8	3.1	4.6

NS: No measurement

Table 6
Revised October 2002 Laboratory Analytical Results

Cherry Farm Upwelling Data Study October 2002 Revised Laboratory Analytical Results from the Initial Report (Table 2)		Sample ID: Lab Sample Id: Source: SDG: Matrix: Sampled: Validated:	MW-04 301457/68/78/88/97 CES 301455 WATER 10/11/2002	MW-05 301456/67/77/87/96 CES 301455 WATER 10/11/2002	RS-01 301177/83/88/93/99 CES 301177 WATER 10/9/2002	RS-02 301178/84/94/200 CES 301177 WATER 10/9/2002	RS-03 301179/85/90/95/201 CES 301177 WATER 10/9/2002	RS-04 301180/86/91/96/202 CES 301177 WATER 10/9/2002	RS-05 301455/66/76/86/95 CES 301455 WATER 10/11/2002	RS-06 301181/87/92/98/204 CES 301177 WATER 10/9/2002	RS-07 301458/69/79/89/98 CES 301455 WATER 10/11/2002
CAS NO.	COMPOUND	UNITS:									
	VOLATILES										
71-43-2	Benzene	ug/L	0.7 U	70	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U
108-88-3	Toluene	ug/L	1 U	10	1 U	1 U	1 U	1 U	1 U	1 U	1 U
100-41-4	Ethylbenzene	ug/L	1 U	15	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1330-20-7	Total Xylenes	ug/L	3 U	59	3 U	3 U	3 U	3 U	3 U	3 U	3 U
	SEMIVOLATILES										
91-20-3	Naphthalene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
208-96-8	Acenaphthylene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
83-32-9	Acenaphthene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
86-73-7	Fluorene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
85-01-8	Phenanthrene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
120-12-7	Anthracene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
206-44-0	Fluoranthene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
129-00-0	Pyrene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
56-55-3	Benzo(a)anthracene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
218-01-9	Chrysene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
205-99-2	Benzo(b)fluoranthene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
207-08-9	Benzo(k)fluoranthene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
50-32-8	Benzo(a)pyrene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
193-39-5	Indeno(1,2,3-cd)pyrene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
53-70-3	Dibenzo(a,h)anthracene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
191-24-2	Benzo(ghi)perylene	ug/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
	PCBs										
11104-28-2	Aroclor 1221	ug/L	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U
11141-16-5	Aroclor 1232	ug/L	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U
53469-21-9/12674-11-2	Aroclor 1242/1016	ug/L	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U
12672-29-6	Aroclor 1248	ug/L	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U
11097-69-1	Aroclor 1254	ug/L	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U
11096-82-5	Aroclor 1260	ug/L	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U
	METALS										
7440-70-2	Calcium, Total	ug/L	67400	36100	135000	26800	107000	48000	33800	34000	68800
7439-95-4	Magnesium, Total	ug/L	16500	11000	20300	9530	18300	11200	5930	5610	6180
7440-23-5	Sodium, Total	ug/L	156000	93800	139000	137000	13300	79700	67800	92700	87700
	OTHER										
	Bicarbonate Alkalinity	ug/L	581000	378000	487000	275000	488000	266000	238000	91000	360000
(CHLOR)	Chloride	ug/L	40000	38000	143000	29000	83000	32000	29000	16000	37000
(SULFA)	Sulfate	ug/L	20000	32000	21400	92300	27500	36600	38700	24300	44800

Table 6
Revised October 2002 Laboratory Analytical Results

Cherry Farm Upwelling Data Study October 2002 Revised Laboratory Analytical Results from the Initial Report (Table 2)		Sample ID: Lab Sample Id: Source: SDG: Matrix: Sampled: Validated:	RS-08 301464/75/85/94/503 CES 301455 WATER 10/11/2002	RV-01 301197/203 CES 301177 WATER 10/9/2002	RW-00 301463/74/84 CES 301455 WATER 10/11/2002	RW-02 301459/70/80/90/99 CES 301455 WATER 10/11/2002	RW-03 301460/71/81/91/500 CES 301455 WATER 10/11/2002	RW-04 301461/72/82/92/501 CES 301455 WATER 10/11/2002	RW-05 301462/73/83/93/502 CES 301455 WATER 10/11/2002	TRIP BLANK 301182 CES 301177 WATER 10/9/2002	TRIP BLANK 301465 CES 301455 WATER 10/11/2002
CAS NO.	COMPOUND	UNITS:									
	VOLATILES										
71-43-2	Benzene	ug/L	1		49	0.7 U	0.7 U	120	42	0.7 U	0.7 U
108-88-3	Toluene	ug/L	1 U		21	1 U	1 U	5 U	13	1 U	1 U
100-41-4	Ethylbenzene	ug/L	1 U		7.5	1 U	1 U	5 U	5	1 U	1 U
1330-20-7	Total Xylenes	ug/L	3 U		31	3 U	3 U	15 U	22	3 U	3 U
	SEMIVOLATILES										
91-20-3	Naphthalene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
208-96-8	Acenaphthylene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
83-32-9	Acenaphthene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
86-73-7	Fluorene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
85-01-8	Phenanthrene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
120-12-7	Anthracene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
206-44-0	Fluoranthene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
129-00-0	Pyrene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
56-55-3	Benzo(a)anthracene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
218-01-9	Chrysene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
205-99-2	Benzo(b)fluoranthene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
207-08-9	Benzo(k)fluoranthene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
50-32-8	Benzo(a)pyrene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
193-39-5	Indeno(1,2,3-cd)pyrene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
53-70-3	Dibenzo(a,h)anthracene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
191-24-2	Benzo(ghi)perylene	ug/L	5 U		5 U	5 U	5 U	5 U	5 U		
	PCBs										
11104-28-2	Aroclor 1221	ug/L	0.065 U		0.065 U	0.065 U	0.065 U	0.065 U	0.065 U		
11141-16-5	Aroclor 1232	ug/L	0.065 U		0.065 U	0.065 U	0.065 U	0.065 U	0.065 U		
53469-21-9/12674-11-2	Aroclor 1242/1016	ug/L	0.065 U		0.065 U	0.065 U	0.065 U	0.065 U	0.065 U		
12672-29-6	Aroclor 1248	ug/L	0.065 U		0.065 U	0.065 U	0.065 U	0.065 U	0.065 U		
11097-69-1	Aroclor 1254	ug/L	0.065 U		0.065 U	0.065 U	0.065 U	0.065 U	0.065 U		
11096-82-5	Aroclor 1260	ug/L	0.065 U		0.065 U	0.065 U	0.065 U	0.065 U	0.065 U		
	METALS										
7440-70-2	Calcium, Total	ug/L	34500	34400		168000	111000	47300	74400		
7439-95-4	Magnesium, Total	ug/L	5570	7880		53100	25400	10300	20500		
7440-23-5	Sodium, Total	ug/L	53100	10200		82600	95900	65100	78600		
	OTHER										
	Bicarbonate Alkalinity	ug/L	256000	276000		573000	743000	284000	400000		
(CHLOR)	Chloride	ug/L	32000	43000		95000	74000	31000	44000		
(SULFA)	Sulfate	ug/L	35800	44600		156000	67200	37100	70900		