915063

INITIAL REPORT

CHERRY FARM/RIVER ROAD SITE
GROUNDWATER UPWELLING STUDY

Tonawanda, New York

SUBMITTED TO:

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
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January 2003

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Submitted To:

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Submitted By:

Cherry Farm/River Road Site PRP Group

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Date

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Date

January 2003

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INITIAL REPORT FOR THE CHERRY FARM/RIVER ROAD SITE GROUNDWATER UPWELLING STUDY

INTRODUCTION

The primary objective of this groundwater upwelling study is 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 initial data report describes the methods used and presents results of the first sampling event, conducted prior to temporarily shutting down the extraction well system. 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 concentrations of organic chemicals of concern in the deeper aquifer have typically been below or near groundwater quality standards. The groundwater upwelling study will identify whether natural attenuation processes are reducing concentrations in groundwater prior to discharge to the river.

The specific goals of the field data collection are to quantify the concentration of chemical indicators in groundwater upwelling into the river, and to assess whether concentrations are low enough 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, over a period of approximately one year.

METHODOLOGY

The piezometer installation and groundwater sampling were conducted in general accordance with the NYSDEC-approved July 2002 work plan. 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:

- Installation of eight sampling stations in the river consisting of two arrays of four stations. Each sampling/monitoring point consisted of a pair of vibrating-wire piezometers and a single dedicated dual-valve pneumatic sampling pump. The two arrays were constructed downgradient of onshore monitoring wells MW-4 and MW-5 as shown on Figure 2.
- Sampling of water quality from the eight newly-installed sampling stations below the river prior to shutting down the extraction system.
- Shut-down of the deep extraction system for a minimum of one year, followed by quarterly water quality sampling from the eight sample stations in the river, and analysis of the samples for site-specific compounds.
- Weekly measurement of hydraulic pressures (water levels) with continuously-emitting vibrating wire piezometers.

A summary of the planned sampling and analysis program from October 2002 through September 2003 is shown on Table 1. Details of the sample station installation and subsequent data collection efforts are provided below.

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). The depths and distances from shore were determined from known groundwater flow directions, chemical concentration distribution in the existing onsite monitoring wells, and groundwater flow modeling. The modeling was particularly useful in predicting groundwater flow paths and travel times from the shoreline to the sediments within the river.

Sample locations were marked with buoys, and a New York State licensed surveyor was utilized to locate positions on the shore. Measurements from the surveyed shoreline positions to the sample stations were then utilized to estimate the positions of the stations in the river. All survey results were tied into an existing site benchmark, and integrated into the existing coordinate system.

Installation of Piezometers and Sampling Pumps

The sampling stations were constructed utilizing a motorized cat-head on a tripod system, a drop hammer, and a high-pressure water pump secured to a 24-foot by 8-foot barge. The borings for sampling and piezometer installation were advanced using 4-inch diameter casing, which was jetted into place with water. Prior to casing advancement, continuous split-spoon samples were collected using the cat-head assisted hammer to characterize the sediments (Appendix A, Photograph 1).

Two vibrating wire piezometers were installed in each hole within the river sediments. One of the piezometers within each of the deeper holes was placed approximately five to seven feet below the sediment/water interface. The second piezometer was placed at a lower elevation, approximately 10-12 feet below the sediment/water interface (see Figure 3 – installation schematic). In each hole, a single dual-valve sampling pump was installed directly adjacent to the shallower piezometer (Appendix A, Photograph 3).

Each of the sampling and monitoring devices was installed inside of the casing. A sand filter pack was placed six inches below and one foot above the piezometer port or pump intake. The annular space between the two piezometers was filled with a bentonite/sand mixture. The annular space between the upper sand pack and the top of the sediment was filled with a thick bentonite slurry seal (Appendix A, Photograph 5). The temporary casing was removed as the

equipment was installed, leaving all equipment directly buried in the river sediments, with sand and filter packs as described above, and no casing remaining in the sediment.

Cables and tubing from the piezometers and sampling pumps were placed along the sediment surface to an onshore monitoring station. High pressure flexible hosing was wrapped around the wires and tubing for protection (Appendix A, Photograph 6). Concrete blocks were used to weight the tubing to the river bottom, allowing boat traffic to pass over the area of investigation without disturbing the piezometer and sampling setup.

Once onshore, cables and tubing were routed to an equipment shed at a designated, discrete location (total of two equipment sheds/one for each array). These locations were secured with padlocks.

Pre-Sampling Quality Assurance/Quality Control Tests

After the first river station (RS-1) was installed, two tests were conducted to evaluate the effectiveness of the sand/bentonite seals between the upper and lower piezometers, and between the sampling pump and the sediment/water interface: (1) An informal pumping test was conducted between the upper sampling pump/piezometer and the lower piezometer. Piezometer readings taken while the pump was on were compared to readings taken while the pump was off. (2) Analytical samples were collected from the station and from the river. The samples were analyzed for major anions and cations to compare water quality between the sampling station and the river.

Results from the pre-sampling pumping test indicated that the methods used to hydraulically isolate the piezometers and pumps were sufficient. Pumping from RS-1 reduced the hydraulic head of the upper piezometer by 2.6 ft, but the lower piezometer only changed a negligible amount of -0.01 ft, indicating a good seal.

Results of the anion/cation analysis indicated clear differences in water quality between the river station pump and the river water sample. Details of the analytical results are provided in the Results section.

Based on the results of these pre-sampling tests, the method of instrument installation was assumed to be sufficient to hydraulically isolate the instruments and was used for the remaining installations.

Sampling Methods

After installation of the river stations, a full round of samples was collected prior to shutting down the extraction wells. Samples were collected from all eight sampling stations, four groundwater extraction wells (RW-2 through RW-5) and two monitoring wells (MW-4 and MW-5). 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 major anions and 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 disposal bailers, and the extraction wells were sampled from sampling ports while the pumps were running.

Four additional sampling/data collection events at approximately three-month intervals are planned to provide an entire year of groundwater monitoring data. The first quarterly sampling event following the shut-down of the extraction wells was conducted the week of December 16, 2002. See Table 1 for a summary of the complete sampling and analysis program.

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. The data was 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.

Shutdown of Extraction System

On October 14, 2002, the 11 deep extraction wells were turned off. The wells will remain off until at least February 2004, at which time a decision will be made concerning the need to re-start the system or leave the wells off on a permanent basis. The decision will be made based on results of the ongoing groundwater upwelling study.

RESULTS

Major Anions and Cations

The results of the anion and cation analyses indicated a difference in water quality between the river stations and surface water from the river. Thus, it appears that the river station samples represent groundwater and are not being influenced by river water. Details of the anion/cation analyses are provided below.

Anion/cation analytical results are provided in Table 1 and graphically displayed in Figure 4. Eighteen analyses of major anions and cations were plotted on a Piper trilinear diagram. A total of seven extraction and monitoring wells were placed in one set representative of onsite groundwater. Nine river station (RS) water analyses were placed in a separate data set, representative of groundwater below the river. Additionally, two surface water samples were collected directly from the river, and plotted as a third data set.

The center portion of the Piper diagram indicated two separate groupings of data. The two river water samples and RW-02 (both the preliminary sample and first round sample), and river station piezometer RS-03 plotted in a small, circular area near the upper left side of the diamond. The other grouping, consisting of the river stations (RS samples) and the onsite extraction well

and monitoring well groundwater data, was more linear in shape. This water contained between 10 and 40 percent chloride plus sulfate and 30 to 75 percent sodium. In general, the well data plotted below and to the left of the river station sample data.

The river surface water samples were very low in sodium, moderately low in magnesium, chloride 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. Recovery and monitoring wells were generally low in chloride, sulfate, and magnesium, had moderate percentages of calcium and sodium, and were high in bicarbonate.

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 pre-shut down sampling event in October 2002 are provided in Table 2. All eight river station samples were below detection limits for all compounds, with the exception of benzene in RS-8. Benzene was detected at a concentration of 1 ug/L, exactly equal to the NYSDEC Class GA water quality standard.

As expected, samples from the wells upgradient of the river stations had detectable concentrations of organic compounds. Monitoring well MW-5 contained 70 ug/L benzene, 10 ug/L toluene, 15 ug/L ethylbenzene and 59 ug/L total xylenes. Extraction well RW-04 contained 120 ug/L of benzene, and extraction well RW-05 showed concentrations of 42 ug/L benzene, 13 ug/L toluene, 5 ug/L ethylbenzene, and 22 ug/L total xylenes.

These results indicate that chemical parameters in onsite groundwater were not impacting groundwater beneath the river at near shore locations at the time of sampling, prior to shutting down the extraction wells.

Piezometer Readings

Weekly piezometer readings and river levels are summarized in Table 3. 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 -0.03 to 0.061 feet per foot (ft/ft). Piezometers were typically separated by five feet, and head differences between the two piezometers did not exceed 0.24 feet. The low hydraulic gradients suggest low rates of movement of water between the aquifer and the river.

Temperatures, recorded from the river station piezometers, are shown on Table 4. 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, as air and surface water temperatures tend to be warmer. In November, as air and river temperatures cooled substantially, the temperature differentials began to reverse, and the deeper water was warmer. Although not an integral part of the study, temperature differentials between the deep and shallow piezometers provide further indication of groundwater upwelling potential, and evidence that the sand/bentonite seals are functioning appropriately.

CONCLUSIONS/SCHEDULE

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. Results from subsequent events will be evaluated and presented in quarterly reports as the data are collected.

As shown on Table 1, the first post-shutdown quarterly sampling event was conducted in December 2002, and the next quarterly report is expected to be submitted in March 2003. The next quarterly sampling event is scheduled for March 2003.

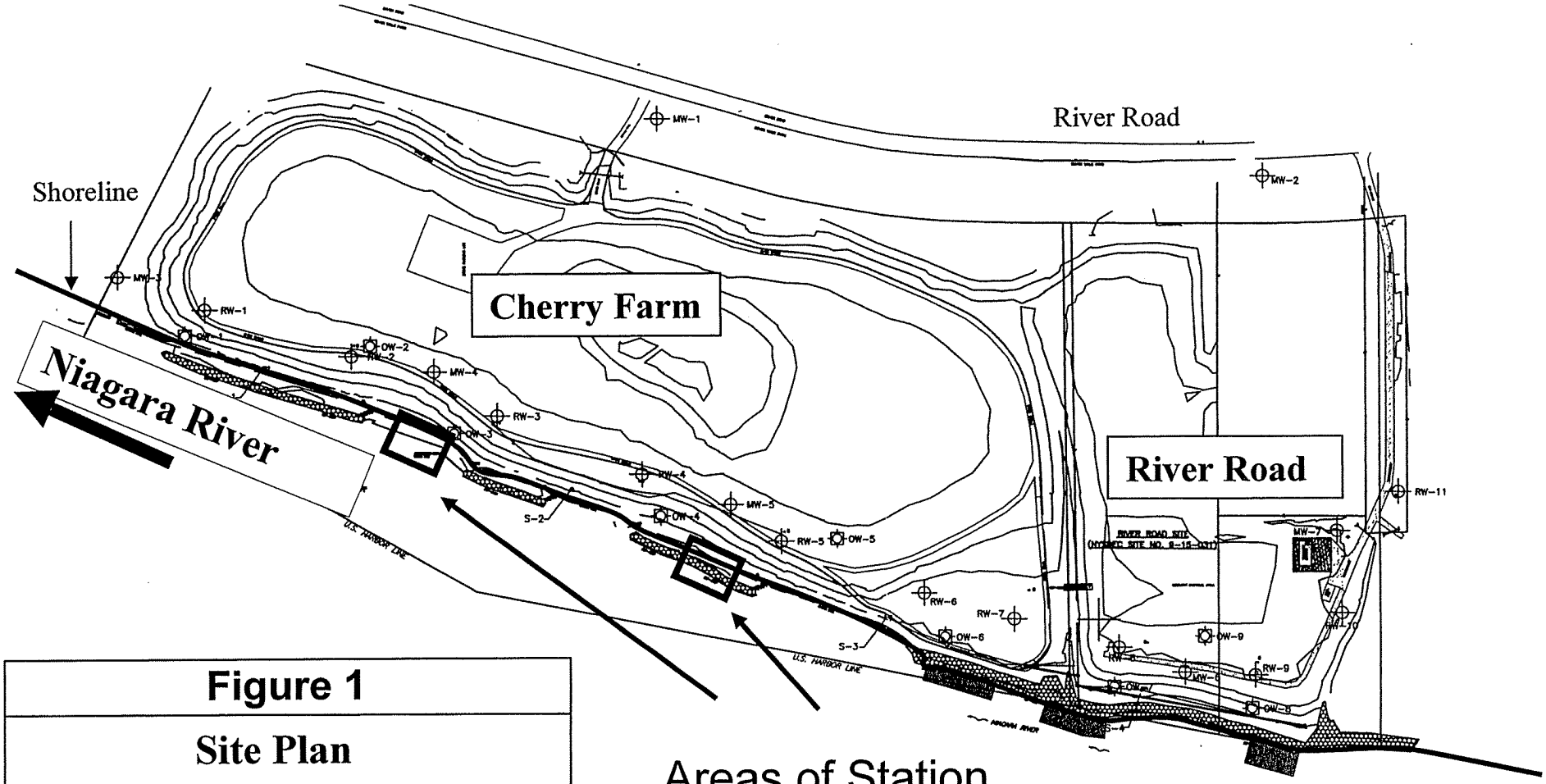

Figure 1

Site Plan

Cherry Farm/River Road
Groundwater Upwelling Study

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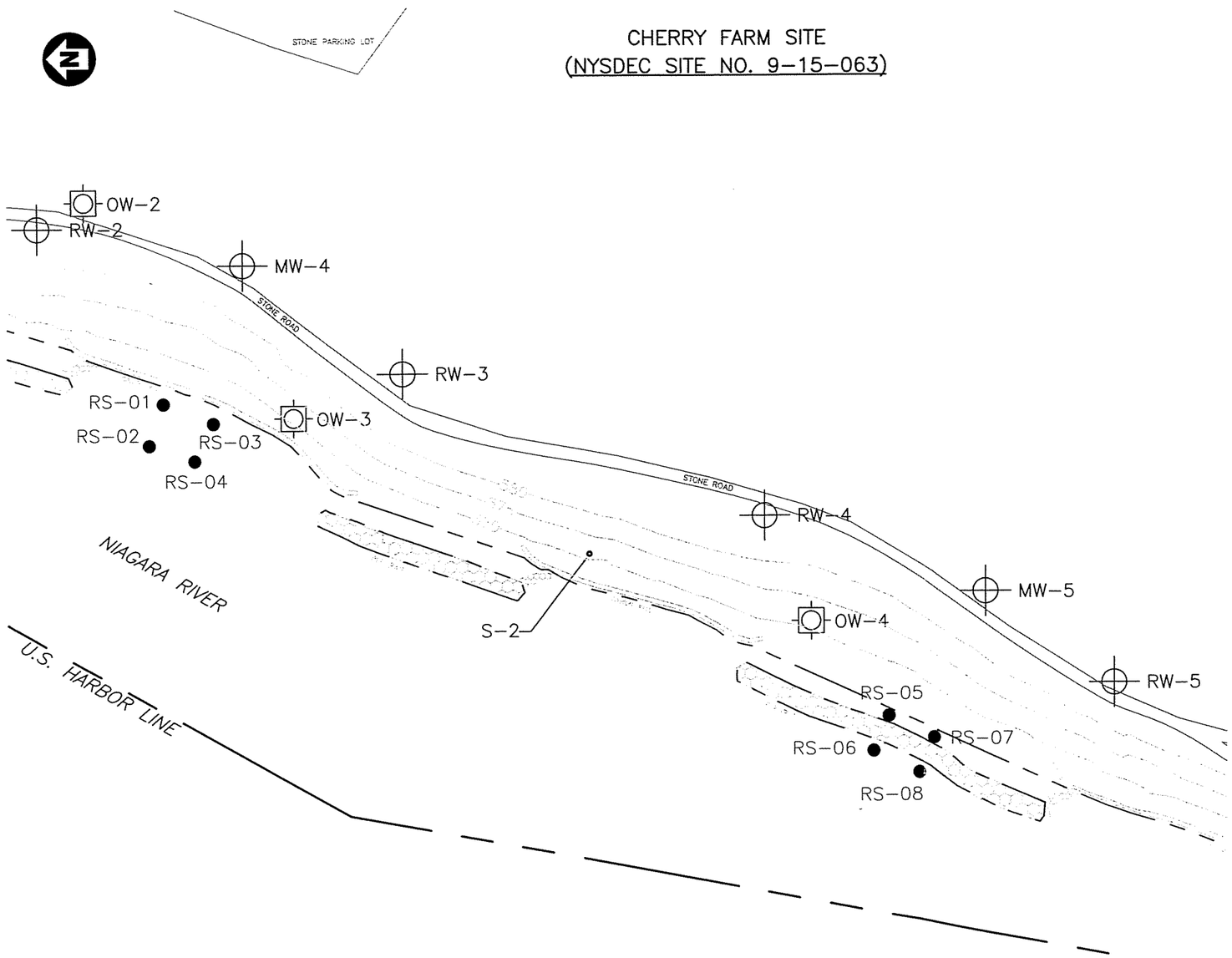
CHERRY FARM SITE
(NYSDEC SITE NO. 9-15-063)



LEGEND

OW-5	OBSERVATION WELL
MW-1	MONITORING WELL
RW-1	RECOVERY WELL AND VAULT
577	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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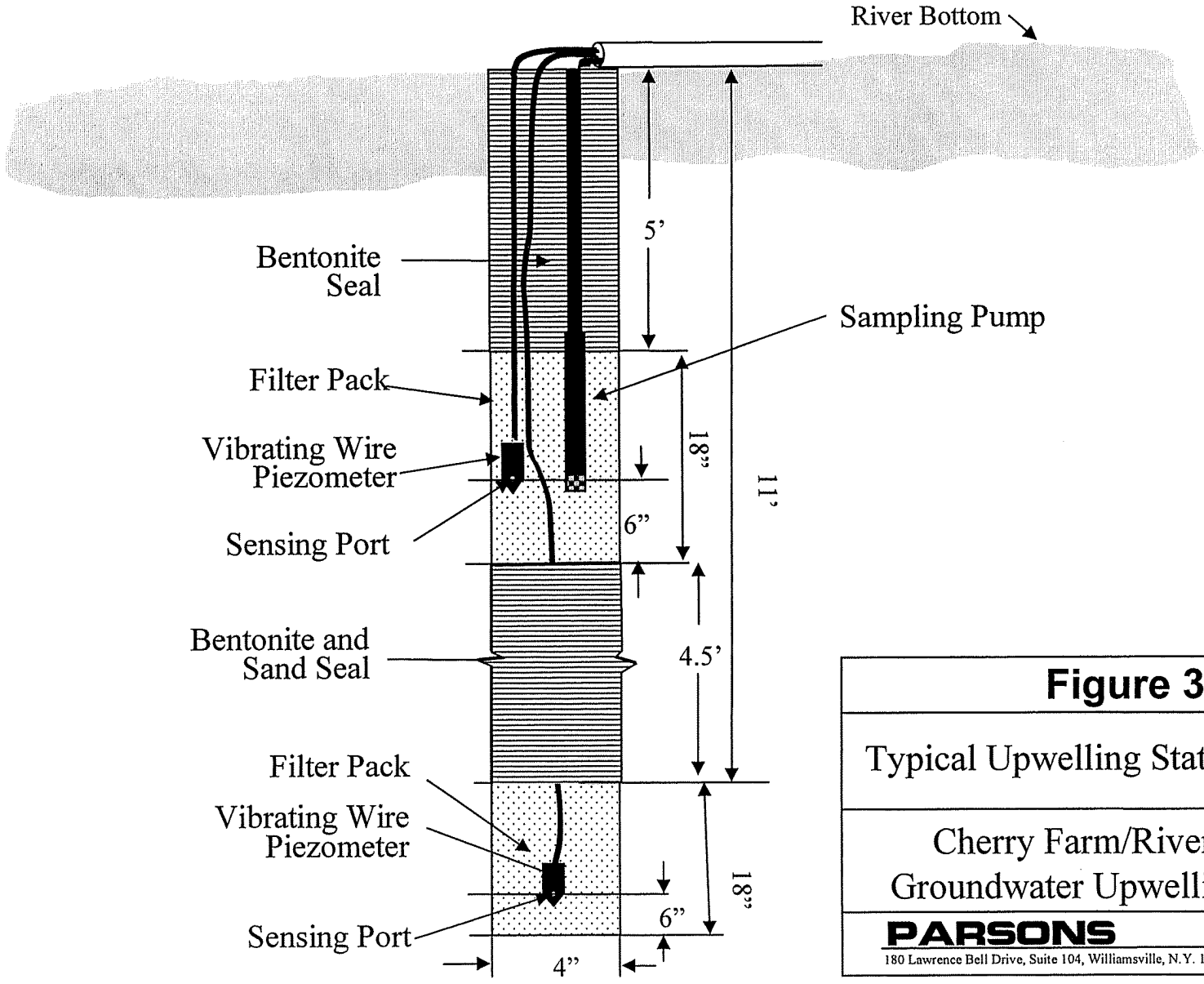

Figure 3

Typical Upwelling Station Design

Cherry Farm/River Road Groundwater Upwelling Study

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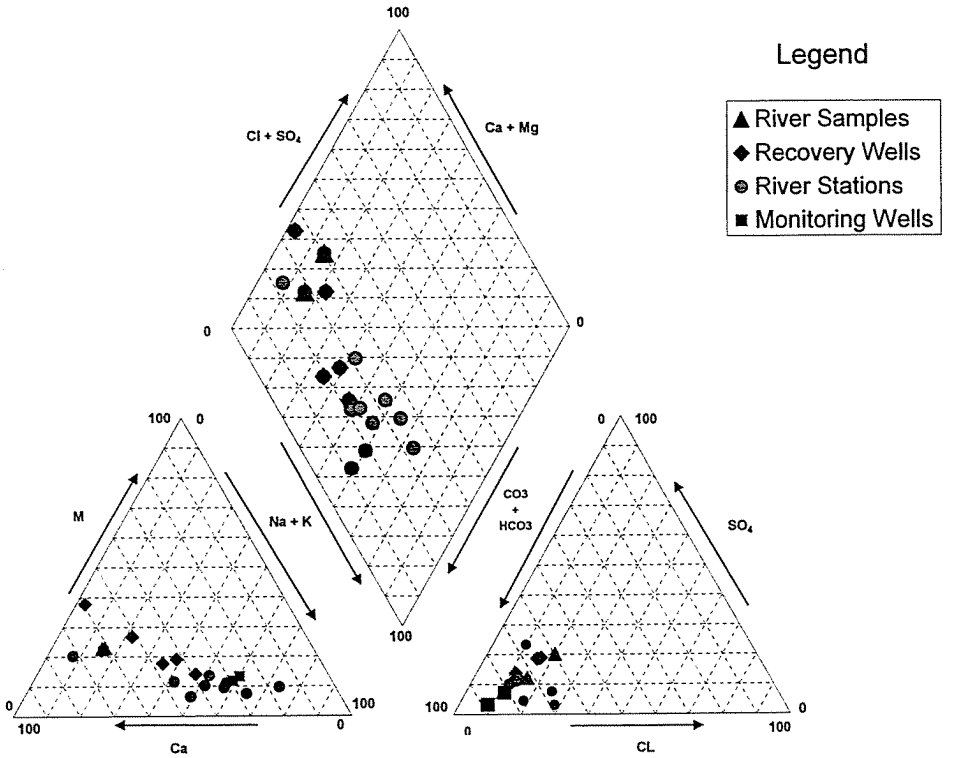

Legend

- River Samples
- Recovery Wells
- River Stations
- Monitoring Wells

WELL	CATIONS				ANIONS				CATION-ANION
	Ca	Mg	Ca+Mg	Na+K	Cl	SO_4	Cl+SO_4	HCO_3+CO_3	Balance Error
RV-01-P	62%	23%	85%	15%	20%	20%	40%	60%	25%
RW-02-P	60%	38%	97%	3%	16%	19%	35%	65%	24%
RS-01-P	32%	11%	43%	57%	25%	8%	33%	67%	3%
RS-01-1	47%	12%	58%	42%	28%	3%	32%	68%	2%
RS-02-1	17%	10%	26%	74%	10%	23%	33%	67%	2%
RS-03-1	72%	20%	92%	8%	18%	5%	23%	77%	71%
RS-04-1	35%	14%	49%	51%	13%	11%	24%	76%	3%
RV-01-1	61%	23%	84%	16%	16%	12%	28%	72%	173%
RS-06-1	27%	7%	35%	65%	16%	18%	34%	66%	123%
RS-05-1	33%	10%	42%	58%	13%	13%	25%	75%	25%
MW-05-1	27%	13%	40%	60%	12%	7%	19%	81%	37%
MW-04-1	29%	12%	41%	59%	9%	3%	12%	88%	14%
RS-07-1	44%	7%	51%	49%	11%	10%	22%	78%	18%
RW-02-1	51%	27%	78%	22%	15%	19%	34%	66%	6%
RW-03-1	47%	18%	65%	35%	11%	8%	19%	81%	55%
RW-04-1	39%	14%	53%	47%	12%	11%	22%	78%	21%
RW-05-1	42%	19%	61%	39%	12%	14%	25%	75%	21%
RS-08-1	38%	10%	49%	51%	13%	11%	24%	76%	51%
0%									

Cherry Farm/River Road Site, Tonawanda, New York

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FIGURE 4
PIPER DIAGRAM

Table 1

Cherry Farm/River Road Groundwater Upwelling Study
Sampling and Analysis Summary

Sampling Events						
Event	Date	BTEX	naphthalene	PCBs	cat/anion*	Comments
Pre-shutdown	Oct. 02	15	15	15	15	8 RSs, 4RWs, 2MWs, 1 dupe, one 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 Data Study October 2002 Laboratory Analytical Results		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 2

Cherry Farm Upwelling Data Study October 2002 Laboratory Analytical Results		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		

Table 3
Vertical Hydraulic Gradients

Date (2002)	10/10		10/28		11/12		11/18		11/27	
	Head difference between pair (ft)	Upward Hydraulic Gradient	Head difference between pair (ft)	Upward Hydraulic Gradient	Head difference between pair (ft)	Upward Hydraulic Gradient	Head difference between pair (ft)	Upward Hydraulic Gradient	Head difference between pair (ft)	Upward Hydraulic Gradient
Piezometer Pair	(ft)	(ft/ft)	(ft)	(ft/ft)	(ft)	(ft/ft)	(ft)	(ft/ft)	(ft)	(ft/ft)
	10/10	10/10	28-Oct	28-Oct	12-Nov	12-Nov	18-Nov	18-Nov	27-Nov	27-Nov
RS-01	0.15	0.037	0.19	0.049	0.17	0.042	0.15	0.038	0.24	0.061
RS-02	0.10	0.026	0.07	0.018	-0.02	-0.006	0.01	0.003	0.19	0.050
RS-03	0.17	0.049	0.20	0.058	0.19	0.054	0.17	0.048	0.20	0.058
RS-04	0.11	0.021	-0.01	-0.003	-0.09	-0.017	-0.12	-0.022	-0.14	-0.026
RS-05	0.08	0.022	0.05	0.016	0.03	0.007	0.03	0.009	0.02	0.005
RS-06	0.03	0.008	0.00	-0.001	-0.02	-0.005	-0.04	-0.011	0.00	0.001
RS-07	0.23	0.057	0.17	0.042	0.22	0.055	0.12	0.030	0.18	0.045
RS-08	-0.02	-0.006	-0.04	-0.013	-0.10	-0.030	-0.09	-0.025	-0.04	-0.012
River Level (ft at staff gauge)		0.4		0.1		-1.0		0.4		-0.5

Table 4

Temperature Summary

Station ID	Piezometer ID	Temperature °F	Difference °F	Temperature °F	Difference °F	Temperature °F	Difference °F	Temperature °F	Difference °F	Temperature °F	Difference °F
		10-Oct-02		28-Oct-02		12-Nov-02		18-Nov-02		27-Nov-02	
RS-01D	2351	60.3	-4.3	59.9	-1.4	58.6	1.1	57.9	1.6	57.1	3.2
RS-01S	2352	64.6		61.3		57.5		56.3		53.9	
RS-02D	2353	67.8	1.8	57.9	-2.8	57.6	-1.5	57.5	-0.9	57.1	0.0
RS-02S	2354	66.0		60.7		59.1		58.4		57.1	
RS-03D	2355	63.8	-3.2	59.7	-1.6	58.4	0.6	57.8	1.0	56.7	2.1
RS-03S	2356	67.0		61.3		57.8		56.8		54.6	
RS-04D	2358	64.9	0.0	57.1	-4.8	56.8	-2.6	56.7	-1.7	56.2	-0.8
RS-04S	2357	64.9		61.9		59.4		58.4		57.0	
RS-05D	2359	57.5	-3.5	57.5	-2.5	57.1	-1.2	56.8	-0.7	56.2	0.2
RS-05S	2360	61.0		60.0		58.3		57.5		56.0	
RS-06D	2361	59.5	-1.9	58.9	-1.4	58.3	-0.3	57.9	0.3	57.1	0.6
RS-06S	2362	61.4		60.3		58.6		57.6		56.5	
RS-07D	2363	56.5	-3.8	56.8	-2.6	56.7	-1.1	56.5	-0.6	56.0	0.1
RS-07S	2364	60.3		59.4		57.8		57.1		55.9	
RS-08D	2366	59.5	-1.0	56.8	-2.9	58.3	-0.1	56.8	-1.0	56.0	-0.8
RS-08S	2365	60.5		59.7		58.4		57.8		56.8	
River water		63.32		53.42		50		46.76		40.3	
River in swale										39.7	

APPENDIX A

PHOTO LOG

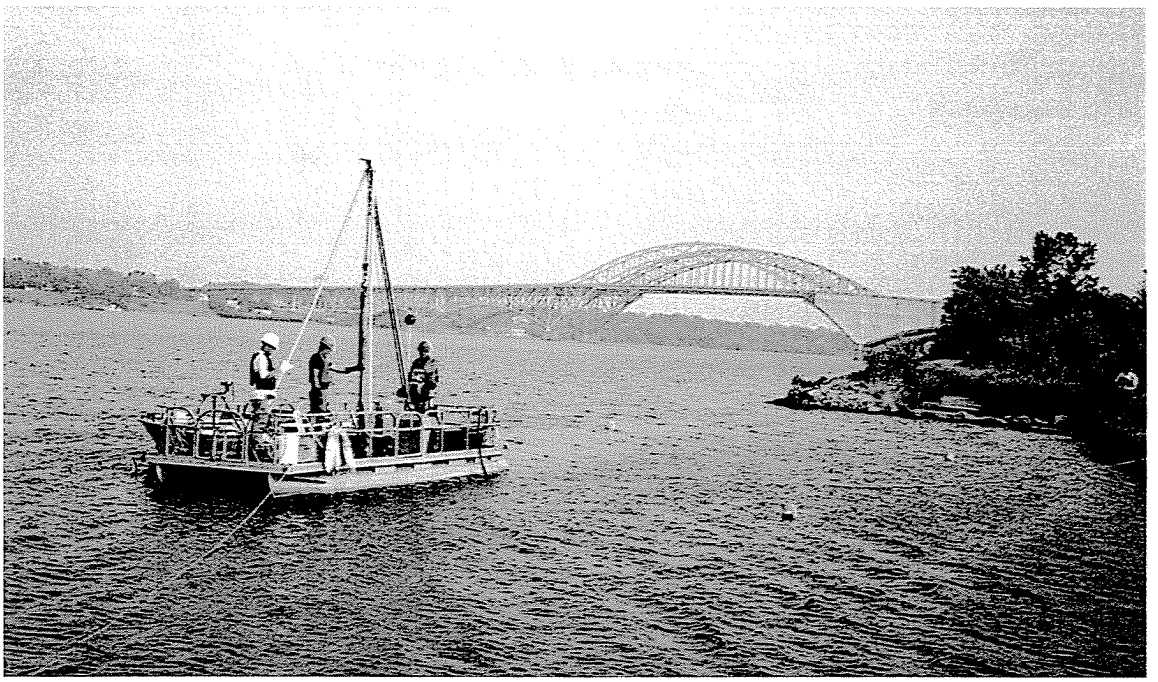


Photo No. 1. Split-spoon sampling at location RS-4. Orange buoys mark locations of RS-1 through RS-3.

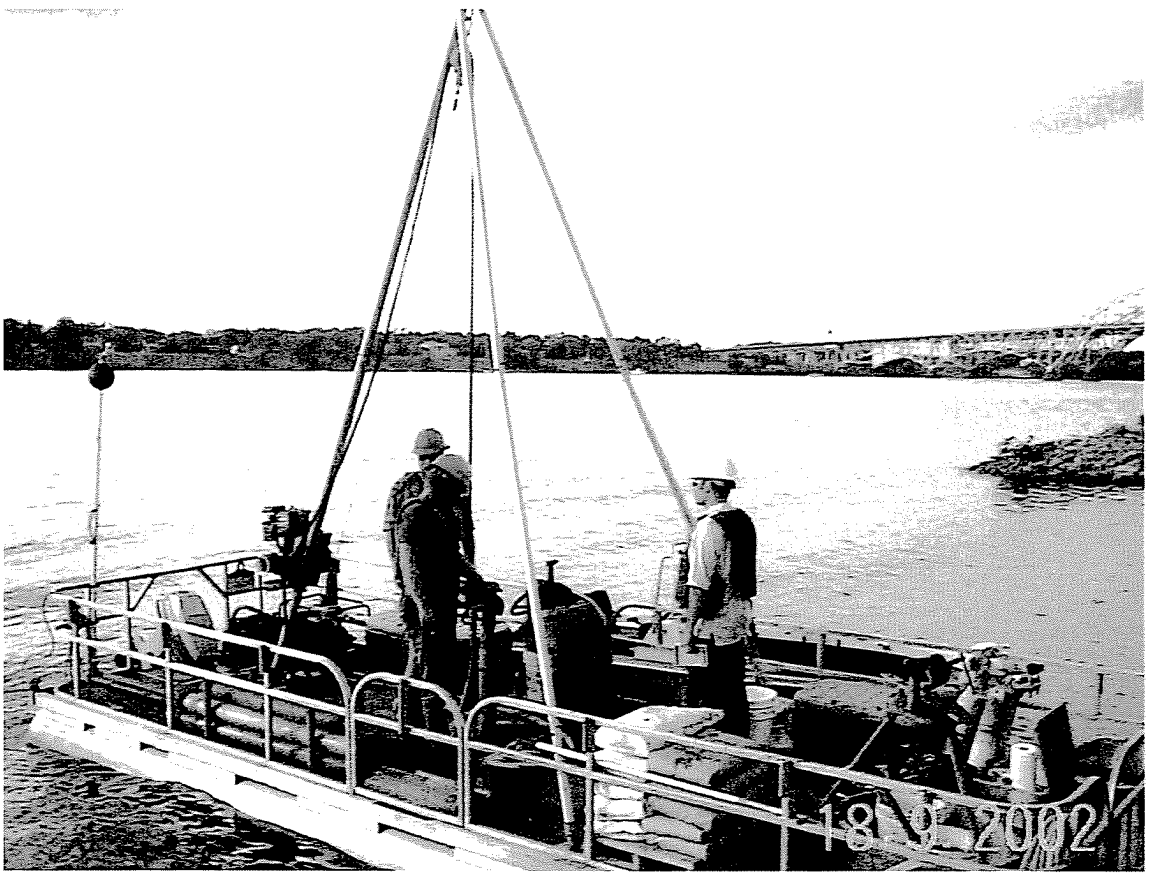


Photo No. 2. Four inch casing was jetted after sampling to known depth.

Photo No. 3. Vibrating wire piezometer and double valve pump were simultaneously lowered to depth.

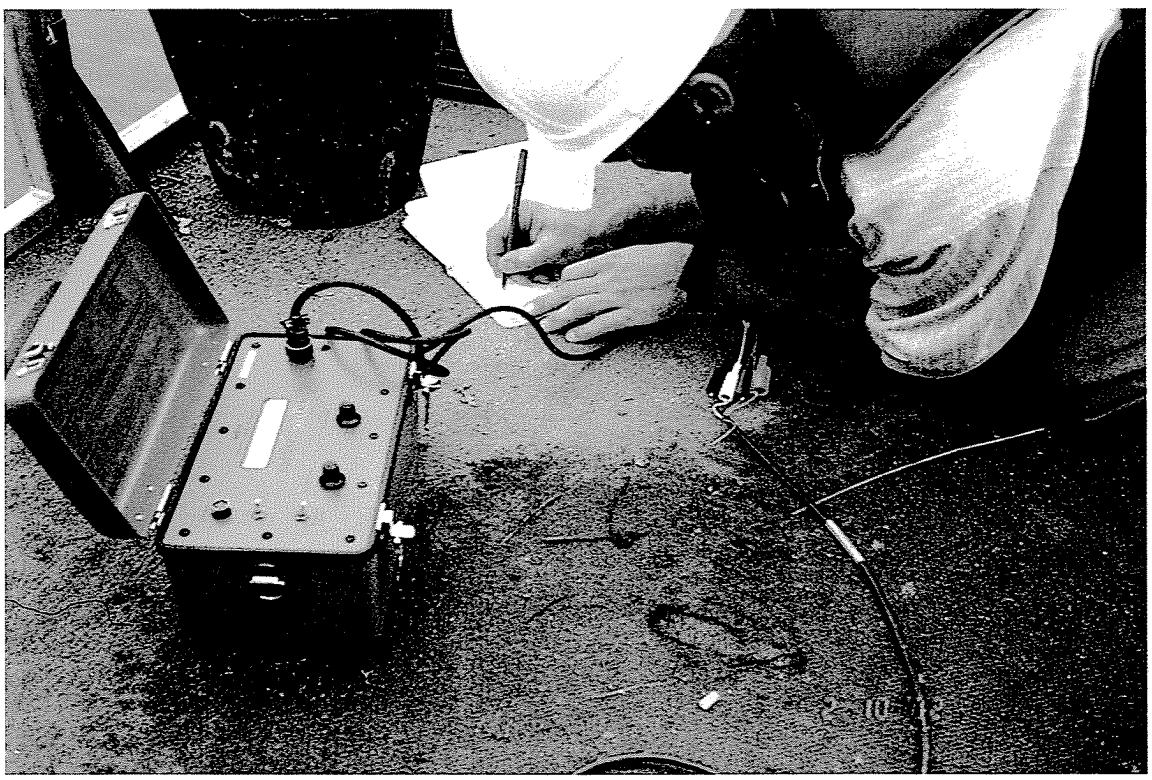


Photo No. 4. Initial pressure reading was read from the piezometer prior to installing the sand pack.

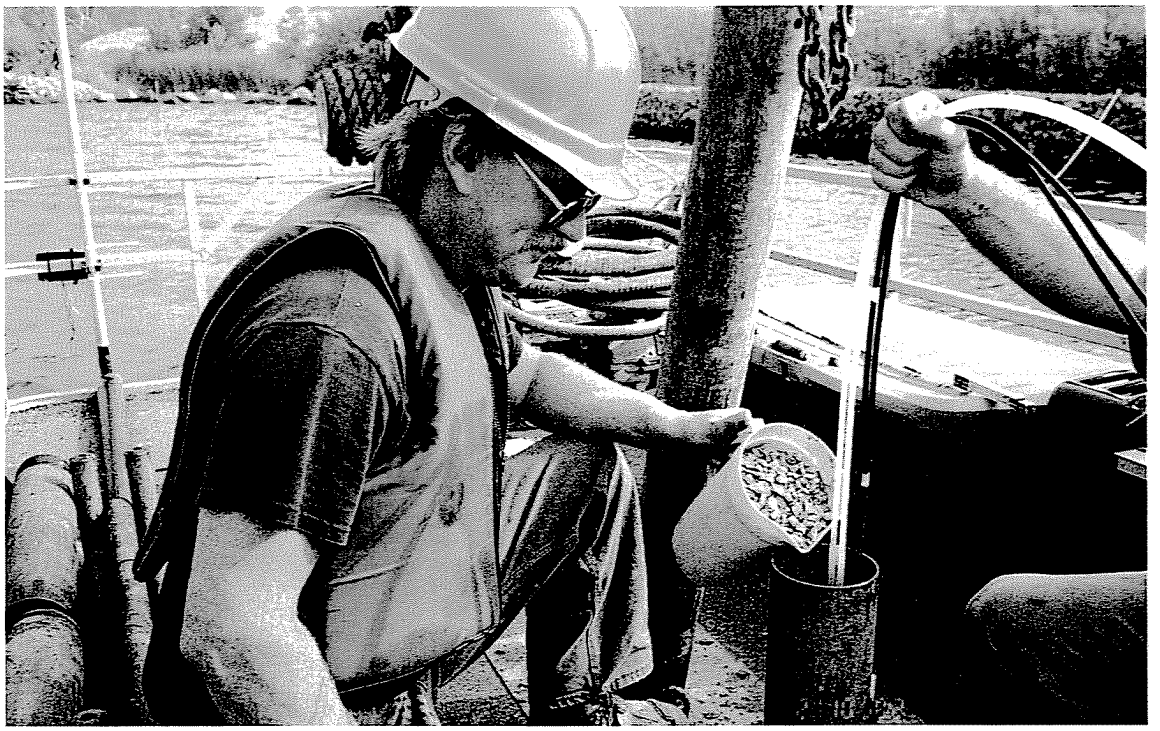


Photo No. 5. Bentonite chips were used to seal the boring.

Photo No. 6. High-pressure hose was used to protect the wire and sample lines from damage.

APPENDIX B

BORING LOGS

Contractor:	Northstar	**PARSONS DRILLING RECORD**	**BORING/ WELL NO.** RS-1 **Sheet** 1 **of** 1
Driller:	Jeff Thew		**Location Description:**
Geologist	Jim Schuetz	**PROJECT NAME:** Cherry Farm Upwelling	Downgradient from MW-04
Rig Type:	Barge tri-pod	**PROJECT NUMBER:** 742539	Northern most transect, 20 ft North of orthogonal from MW-04, 15 feet from Gabion wall.

GROUNDWATER OBSERVATIONS			
Water Level	NA		
Date			
Time			
Meas. From			

Weather: Sunny, 73-80 F

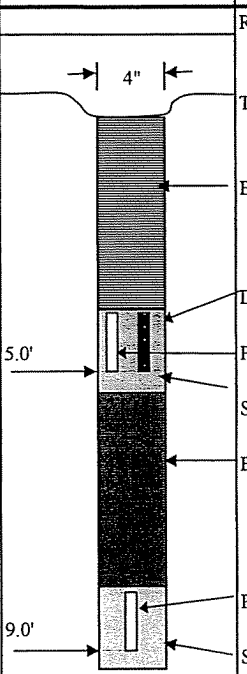
Date/Time Start: 9/18/02-1636

Date/Time Finish: 9/19/02-1025

Location Plan

SEE SITE PLAN

Sample Depth	Sample I.D.	SPT	in. Rec.	FIELD IDENTIFICATION OF MATERIAL
0-2		WOR/WOR	13	SILT, little Sand (fine), Gray, Dark Gray, wet, no odor, no sheen, no staining, some organics
		2/2		
2-4		1/2	13	Silt and Sand (fine), Gray, no odor, no stain, no sheen, some organic material: stems and root material.
		1/1		
4-6		2/2	24	Sand (fine) and Silt to Silt and Sand (fine) to SILT, trace Sand (course). No odor, or sheen .
		1/1		
6-8		2/3	24	SAND (fine) little Silt, gray, no odor or sheen.
		2/3		
8-9.5		3/3	18	SAND (fine) little Silt, gray, no odor or sheen,
		5		
				Terminated soil boring at 9.5' BTOS*.



SCHEMATIC	COMMENTS
	River level
	Top of Sediments (TOS)
	Bentonite Seal
	Double Valve Pump
5.0'	Piezometer # 2352
	Sand pack
	Bentonite/Sand Seal
	Piezometer # 2351
9.0'	Sand pack

SAMPLING METHOD
SS = SPLIT SPOON

COMMENTS:
BTOS: below top of sediments, in. Rec: inches recovered
SPT: 140# hammer with 30" drop using cathead.
WOR: Weight of Rods

Contractor:	Northstar	**PARSONS**	**BORING/** Sheet 1 of 1
Driller:	Jeff Thew	**DRILLING RECORD**	**WELL NO.** RS-2
Geologist	Jim Schuetz		**Location Description:**
Rig Type:	Barge tri-pod	**PROJECT NAME:** Cherry Farm Upwelling	Downgradient from MW-04
		PROJECT NUMBER: 742539	Northern most transect, 20 ft North of orthogonal
			from MW-04, 41 feet from Gabion wall.

GROUNDWATER OBSERVATIONS

Water Level	NA		
Date			
Time			
Meas. From			

Weather: 9/19/02: Cloudy, 73-80 F; 10/01/02: Partly Cloudy, Windy 67 F

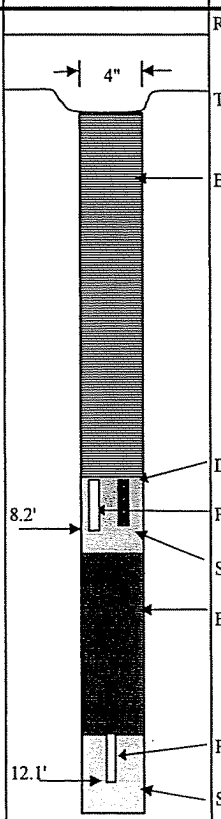
Date/Time Start: 9/19/02- 150, sampling

Date/Time Finish: 10/01/02-913, insturment installations

Location Plan

SEE SITE PLAN

Sample Depth	Sample I.D.	SPT	in. Rec.	FIELD IDENTIFICATION OF MATERIAL
0-2		WOR/WOR	7	Sand (fine) and Silt, trace Gravel, Gray Gray, wet, no odor, no sheen, no staining, some organics
		WOR/2		
2-4		1/1	18	SAND (fine) some Silt, trace gravel, gray, noodor, no staining.
		1/2		
4-6		6/10	24	SAND (fine) some Silt, gray, no staining, no odor.
		10/9		
6-8		7/11	24	SAND (fine) some Silt, gray, no odor or sheen.
		14/12		
8-10		3/4	24	Same as above
		4/3		
10-12		7/8	24	SAND (fine), little Silt, gray, no odor, no sheen.
		5/4		
12-13		8/10	12	SAND (fine), trace Silt, gray, no odor, no sheen. 2cm thick piece of tree or wood hoizontal to sediments, appears to be natural.
				Terminated soil boring at 13.0' BTOS*.



SCHEMATIC

COMMENTS

River level

Top of Sediments (TOS)

Bentonite Seal

Double Valve Pump

Piezometer # 2353

Sand pack

Bentonite/Sand Seal

Piezometer # 2354

Sand pack

SAMPLING METHOD
SS = SPLIT SPOON

COMMENTS:
BTOS: below top of sediments, in. Rec: inches recovered
SPT: 140# hammer with 30" drop using cathead.
WOR: Weight of Rods

Contractor:	Northstar	**PARSONS DRILLING RECORD**	**BORING/ WELL NO.** RS-3 **Sheet** 1 of 1
Driller:	Jeff Thew		**Location Description:**
Geologist	Jim Schuetz	**PROJECT NAME:** Cherry Farm Upwelling	Downgradient from MW-04
Rig Type:	Barge tri-pod	**PROJECT NUMBER:** 742539	40 ft South of orthogonal from MW-04, 16.5 feet from Gabion wall.

GROUNDWATER OBSERVATIONS			
Water Level	NA		
Date			
Time			
Meas. From			

Weather: Partly Cloudy, Windy ~ 20-22 knots, 67 F

Date/Time Start: 10/1/2002, 1115

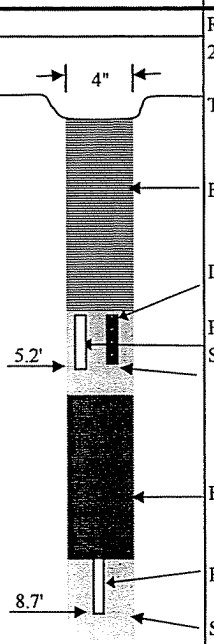
Date/Time Finish: 10/1/2002, 1640

Location Plan

SEE SITE PLAN

Sample Depth	Sample I.D.	SPT	in. Rec.	FIELD IDENTIFICATION OF MATERIAL
0-2		WOR/2	16	Organics, river vegetation, Clayey Silt, Silt, ray, no odor or sheen.
		2/2		
2-4		1/2	18	TOP: Clayey Silt, gray
		1/2		Bottom: SILT, little Sand (fine), gray, no odoror sheen.
4-6		1/2	20	SILT, trace Sand (fine), grades to SILT, trace Sand, soft, trace Clay. No odor or sheen.
		2/1		
6-8		3/3	18	SAND (fine) and Silt, gray, no odor or sheen.
		4/8		
8-10		5/7	24	SAND (fine) little Silt, no odor or sheen.
		8/10		
				Terminated soil boring at 13.0' BTOS*.

SCHEMATIC



COMMENTS

River level
2' above TOS
Top of Sediments (TOS)
Bentonite Seal
Double Valve Pump
Piezometer # 2356
Sand pack
Bentonite/Sand Seal
Piezometer # 2355
Sand pack

SAMPLING METHOD
SS = SPLIT SPOON

COMMENTS:
BTOS: below top of sediments, in. Rec: inches recovered
SPT: 140# hammer with 30" drop using cathead.
WOR: Weight of Rods

Contractor:	Northstar	**PARSONS DRILLING RECORD**	**BORING/ WELL NO.** RS-4 **Sheet** 1 of 1
Driller:	Jeff Thew		**Location Description:**
Geologist	Jim Schuetz	**PROJECT NAME:** Cherry Farm Upwelling	Downgradient from MW-04
Rig Type:	Barge tri-pod	**PROJECT NUMBER:** 742539	40 ft South of orthogonal
			from MW-04, 41 feet from Gabion wall.

GROUNDWATER OBSERVATIONS			
Water Level	NA		
Date			
Time			
Meas. From			

Weather: Cloudy, showers likely, 65 F, slight breeze

Date/Time Start: 10/02/02 840

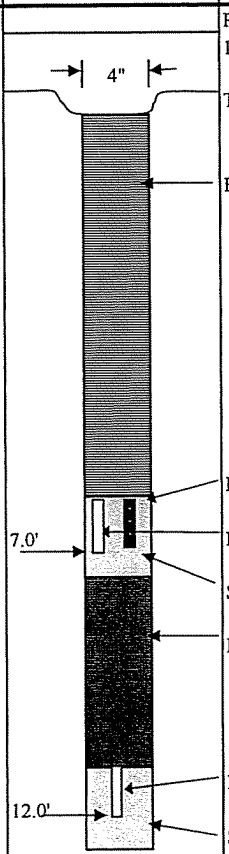
Date/Time Finish: 10/02/02, 1120

Location Plan

SEE SITE PLAN

Sample Depth	Sample I.D.	SPT	in. Rec.	FIELD IDENTIFICATION OF MATERIAL
0-2		WOR/1	8	Clayey Silt, trace Gravel (fine), organics, dark gray, no odor or sheen.
		1/1		
2-4		2/2	20	Clayey Silt to Silt and Sand (fine), organics, river vegetation, gray, no odor or sheen.
		1/1		
4-6		3/3	20	SAND (fine) and Silt, trace Gravel, Gray, organics, no odor or sheen.
		3/3		
6-8		3/5	18	SAND (fine) some Silt, gray, no odor or sheen.
		5/6		
8-10		6/5	18	Same as above
		5/5		
10-12		6/8	20	SAND (fine), trace Silt, gray, no odor, no sheen.
		7/7		
12-13		5/8	12	Same as above.
				Terminated soil boring at 13.0' BTOS*.

SCHEMATIC



COMMENTS

River level
1.8' water
Top of Sediments (TOS)
Bentonite Seal
Double Valve Pump
Piezometer # 2357
Sand pack
Bentonite/Sand Seal
Piezometer # 2358
Sand pack

SAMPLING METHOD
SS = SPLIT SPOON

COMMENTS:
BTOS: below top of sediments, in. Rec: inches recovered
SPT: 140# hammer with 30" drop using cathead.
WOR: Weight of Rods

Contractor: Northstar **Driller:** Jeff Thew **Geologist** Jim Schuetz **Rig Type:** Barge tri-pod	**PARSONS** **DRILLING RECORD** **PROJECT NAME:** Cherry Farm Upwelling **PROJECT NUMBER:** 742539	**BORING/** **Sheet** 1 of 1 **WELL NO.** RS-5 **Location Description:** Downgradient from MW-05, 13 feet from shore	

GROUNDWATER OBSERVATIONS			
Water Level	NA		
Date			
Time			
Meas. From			

Weather: Cloudy, Calm, 65 F

Date/Time Start: 10/4/2002, 815

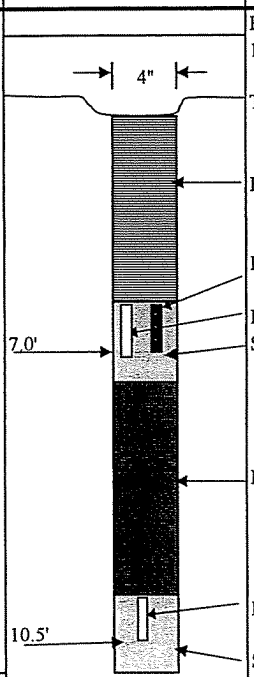
Date/Time Finish: 10/4/2002, 1100

Location Plan

SEE SITE PLAN

Sample Depth		SPT	in. Rec.	FIELD IDENTIFICATION OF MATERIAL
0-2		WOR/WOR	6	Mud, organics, soft, Silt, no ordor.
		WOR/WOR		
2-4		1/1	20	Clayey Silt, organics, no odor.
		2/1		
4-6		4/8	6	Silt and Sand, gray, no odor.
		6/6		
6-8		4/6	12	Silt and Sand (fine) to Sand (fine) some Silt gray no odor.
		8/12		
8-10		8/6	24	SAND (fine) little Silt, gray, no odor or sheen.
		10/5		
10-11		8/8	10	Same as above
				Terminated soil boring at 11.5' BTOS*.

SCHEMATIC



COMMENTS

River level
1.5' above TOS
Top of Sediments (TOS)
Bentonite Seal
Double Valve Pump
Piezometer # 2360
Sand pack
Bentonite/Sand Seal
Piezometer # 2359
Sand pack

SAMPLING METHOD
SS = SPLIT SPOON

COMMENTS:
BTOS: below top of sediments, in. Rec: inches recovered
SPT: 140# hammer with 30" drop using cathead.
WOR: Weight of Rods

Contractor:	Northstar	PARSONS DRILLING RECORD	BORING/ WELL NO. RS-6 Sheet 1 of 1
Driller:	Jeff Thew		Location Description:
Geologist	Jim Schuetz	PROJECT NAME: Cherry Farm Upwelling	Downgradient from MW-05, 10 feet from outer edge of
Rig Type:	Barge tri-pod	PROJECT NUMBER: 742539	Island.

GROUNDWATER OBSERVATIONS			
Water Level	NA		
Date			
Time			
Meas. From			

Weather: Intermittent rain, 65 F

Date/Time Start: 10/3/2002, 1415

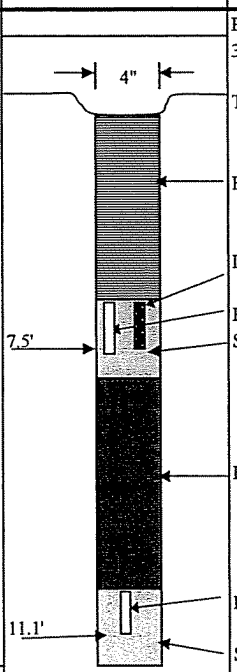
Date/Time Finish: 10/3/2002, 1655

Location Plan

SEE SITE PLAN

Sample Depth		SPT	in. Rec.	FIELD IDENTIFICATION OF MATERIAL
0-2		WOR/WOR	0	No recovery
		WOR/WOR		
2-4		WOR/WOR	22	Clay and Silt, gray, no odor.
		WOR/WOR		
4-6		WOR	8	SAND (fine), some Silt, gray, no odor.
		6/5		
6-8		2/4	14	Same as above
		5/7		
8-10		7/8	18	Same as above
		9/8		
10-11		7/7	10	Same as above
				Terminated soil boring at 11.0' BTOS*.

SCHEMATIC



COMMENTS

River level
3.5' above TOS
Top of Sediments (TOS)
Bentonite Seal
Double Valve Pump
Piezometer # 2362
Sand pack
Bentonite/Sand Seal
Piezometer # 2361
Sand pack

SAMPLING METHOD
SS = SPLIT SPOON

COMMENTS:
BTOS: below top of sediments, in. Rec: inches recovered
SPT: 140# hammer with 30" drop using cathead.
WOR: Weight of Rods

Contractor: Northstar	**PARSONS DRILLING RECORD**	**BORING/ WELL NO.** RS-7	**Sheet** 1 **of** 1
Driller: Jeff Thew		**Location Description:**	
Geologist Jim Schuetz	**PROJECT NAME:** Cherry Farm Upwelling	Downgradient from MW-05, 12 feet from shore.	
Rig Type: Barge tri-pod	**PROJECT NUMBER:** 742539		

GROUNDWATER OBSERVATIONS			
Water Level	NA		
Date			
Time			
Meas. From			

Weather: Cloudy, slight breeze, showers, 65 F

Date/Time Start: 10/2/2002, 1430

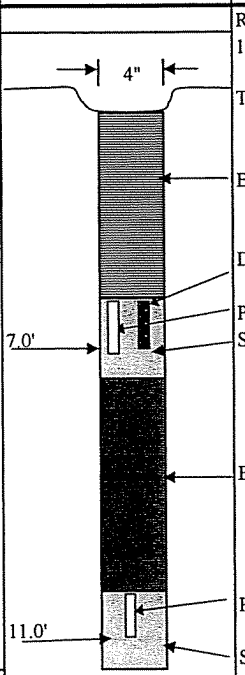
Date/Time Finish: 10/3/2002, 1655

Location Plan

SEE SITE PLAN

Sample Depth		SPT	in. Rec.	FIELD IDENTIFICATION OF MATERIAL
0-2		WOR/WOR	6	Organic mud, black, organic odor
		WOR/WOR		
2-4		WOR/WOR	12	Organic mud, no fill, Bottom 8" Clayey Silt, Dark gray, no sheen
		WOR/WOR		
4-6		WOR	8	SAND (fine), some Silt, gray, no odor or sheen
6-8		6/8	14	SAND (fine) little Silt, gray, no odor or sheen
		12/12		
8-10		5/9	16	Same as above
		13/12		
10-12		8/6	12	Same as above
		10/11		
				Terminated soil boring at 12.0' BTOS*.

SCHEMATIC



COMMENTS

River level
1.3' above TOS
Top of Sediments (TOS)
Bentonite Seal
Double Valve Pump
Piezometer # 2364
Sand pack
Bentonite/Sand Seal
Piezometer # 2363
Sand pack

SAMPLING METHOD
SS = SPLIT SPOON

COMMENTS:
BTOS: below top of sediments, in. Rec: inches recovered
SPT: 140# hammer with 30" drop using cathead.
WOR: Weight of Rods

Contractor: Northstar	**PARSONS**	**BORING/**	**Sheet** 1 **of** 1
Driller: Jeff Thew	**DRILLING RECORD**	**WELL NO.** RS-8	
Geologist Jim Schuetz		**Location Description:**	
Rig Type: Barge tri-pod	**PROJECT NAME:** Cherry Farm Upwelling	Downgradient from MW-05, 10.2 feet from outer edge of	
	PROJECT NUMBER: 742539	See diagram	

GROUNDWATER OBSERVATIONS			
Water Level	NA		
Date			
Time			
Meas. From			

Weather: Intermittent rain, 65 F

Date/Time Start: 10/3/2002, 1135

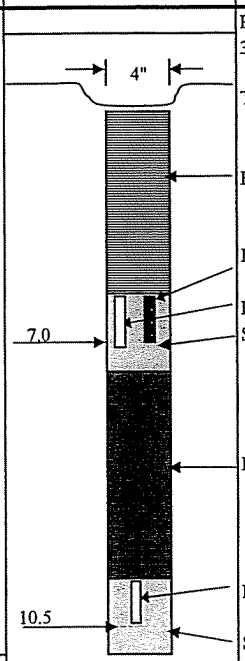
Date/Time Finish: 10/3/2002, 11400

Location Plan

SEE SITE PLAN

Sample Depth		SPT	in. Rec.	FIELD IDENTIFICATION OF MATERIAL
0-2		WOR/WOR	8	Organic mud, black.
		WOR/WOR		
2-4		WOR/WOR	18	Clayey-Silt, dark gray, no odor.
		WOR/WOR		
4-6		4/7	6	Same as above
		11/10		
6-8		5/6	6	SAND (fine) little Silt, gray, no odor.
		7/12		
8-10		5/6	15	SAND (fine) trace Silt, gray, no odor
		11/12		
10-11		5/7	12	Same as above
				Terminated soil boring at 11.0' BTOS*.

SCHEMATIC



COMMENTS

River level
3.5' above TOS
Top of Sediments (TOS)
Bentonite Seal
Double Valve Pump
Piezometer # 2365
Sand pack
Bentonite/Sand Seal
Piezometer # 2366
Sand pack

SAMPLING METHOD
SS = SPLIT SPOON

COMMENTS:
BTOS: below top of sediments, in. Rec: inches recovered
SPT: 140# hammer with 30" drop using cathead.
WOR: Weight of Rods