Rhone Poulenc, Tukwila, WA Site

Evaluation of Ground Water Seeps Along Duwamish River Mudflats and Shallow Subtidal (April 2-3, 2002)

Summary

Ground-water field parameters from intertidal and subtidal samples collected by minipiezometer and seepage meter respectively, confirmed the hydraulic connection between ground water and surface water at the Rhone Poulenc site. Although variability in the field parameters was high, some patterns were observed and the seepage meter collection rates were influenced by tide height changes.

A. Overall Objectives

- Obtain shallow ground water samples from the mudflats and shallow subtidal zone adjacent to the Rhone-Poulenc facility in the Duwamish River and Slip 6 (see Figure C1).

- Measure and compare field parameters (conductivity, pH, etc.) in samples of mudflats ground water, river water, and the subtidal ground water, and use the resulting data to assist with understanding the hydraulic connection between the site and the Duwamish River/Slip 6.

B. Methods

See Sections E and F below for details on methods used intertidally and subtidally

C. Results and Discussion

See Sections E and F below for detailed tables of results. This section provides analysis of the integrated data and location maps.

The field parameter data were collected over space and time during tidal exchange and movement of the salt wedge in the Duwamish River. It is not surprising, therefore, that the results had high variability. For example, conductivity as a function of location varied from less than 500 to over 30,000 uS/cm (Figure C2). Although ground-water conductivity varied with location and time it seemed consistently lower than ambient conductivity in the east end of Slip 6 (there was insufficient sample volume to analyze the "day" samples from other locations). pH ranged from 5.9 to 8.8 (with 10.1 in the outfall sample), but did not show any pattern over time or space (Figure C3). Copper concentrations did not exceed the detection limit of the field sampling kit for any sample (0.05 mg/L). Although the results are highly variable, the mudflat ground water as well as the river surface water showed some increase in conductivity with respect to tide cycle (Figure C4).

In general, the subtidal sampling successfully demonstrated the hydraulic connection between ground water and surface water. For example, of 18 seepage collection bags successfully deployed and recovered, 14 had measurable volumes, ranging from 50 to 1490 mL; with larger volumes in bags collecting seepage water overnight. Seepage rates were fairly uniform for seepage meters left in overnight, ranging from 21 to 62 ml/h, with one meter collecting very little (Figure C5), over the span of about 23 hr (Table F3). Meters deployed on the falling tide only, had much higher collection rates, from about 1 to 4.7 L/h (Fig C6) over the span of about 1.75 to 4 hr (Table F3). These meters were deployed at slightly different times during the falling tide and some of their variability in collection rates appeared to be a function of the rate of tidal change (Fig C6). With tidal change expressed as how many feet the water level dropped over the time of deployment, and seepage rate in terms of ml/hr, the relationship does support the suspected predicted dynamic that increased head due to falling tide results in increased seepage collection rate.

D. Conclusions

- Subtidal seepage meter results demonstrated the hydraulic connection between ground water and surface water and seepage rates were significantly associated with change in tidal elevation.
- Although conductivity varied greatly with location and time, there was some indication of overall increasing conductivity with the falling tide, and ground-water conductivity did appear lower than ambient conductivity for the east end of Slip 6.

Figure C1. Sampling point locations showing the intertidal stations and the subtidal seepage meter stations in Slip 6 and along the Duwamish River.

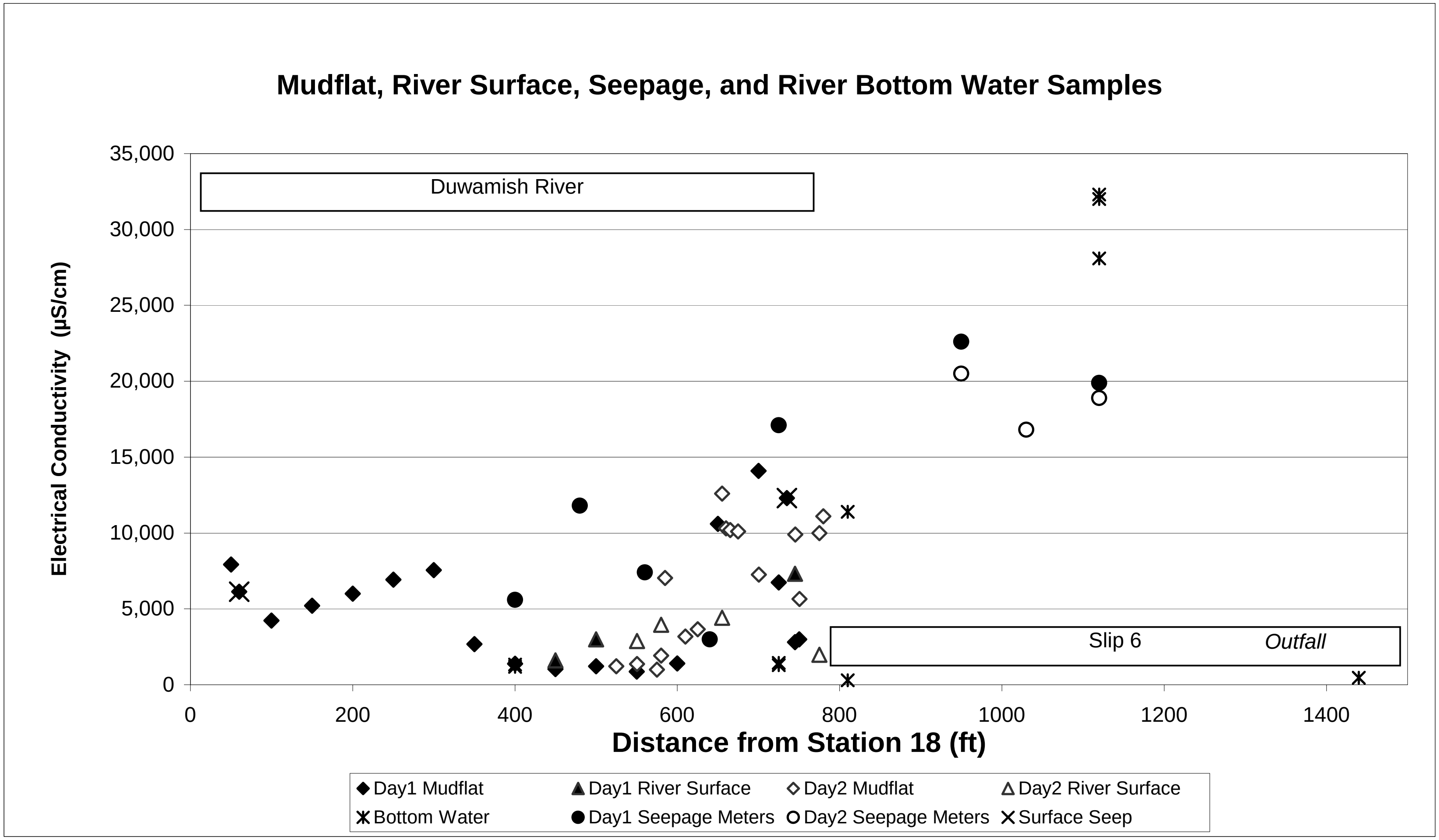

Figure C2. Conductivity from shoreline, subtidal seepage, and river surface and bottom water along the Duwamish River and in Slip 6. Distance in feet shown from Station 18 (see figure C1); distances from 0 to 800ft are N to S along the Duwamish River and distances from 800 to >1400 ft are W to E along Slip 6.

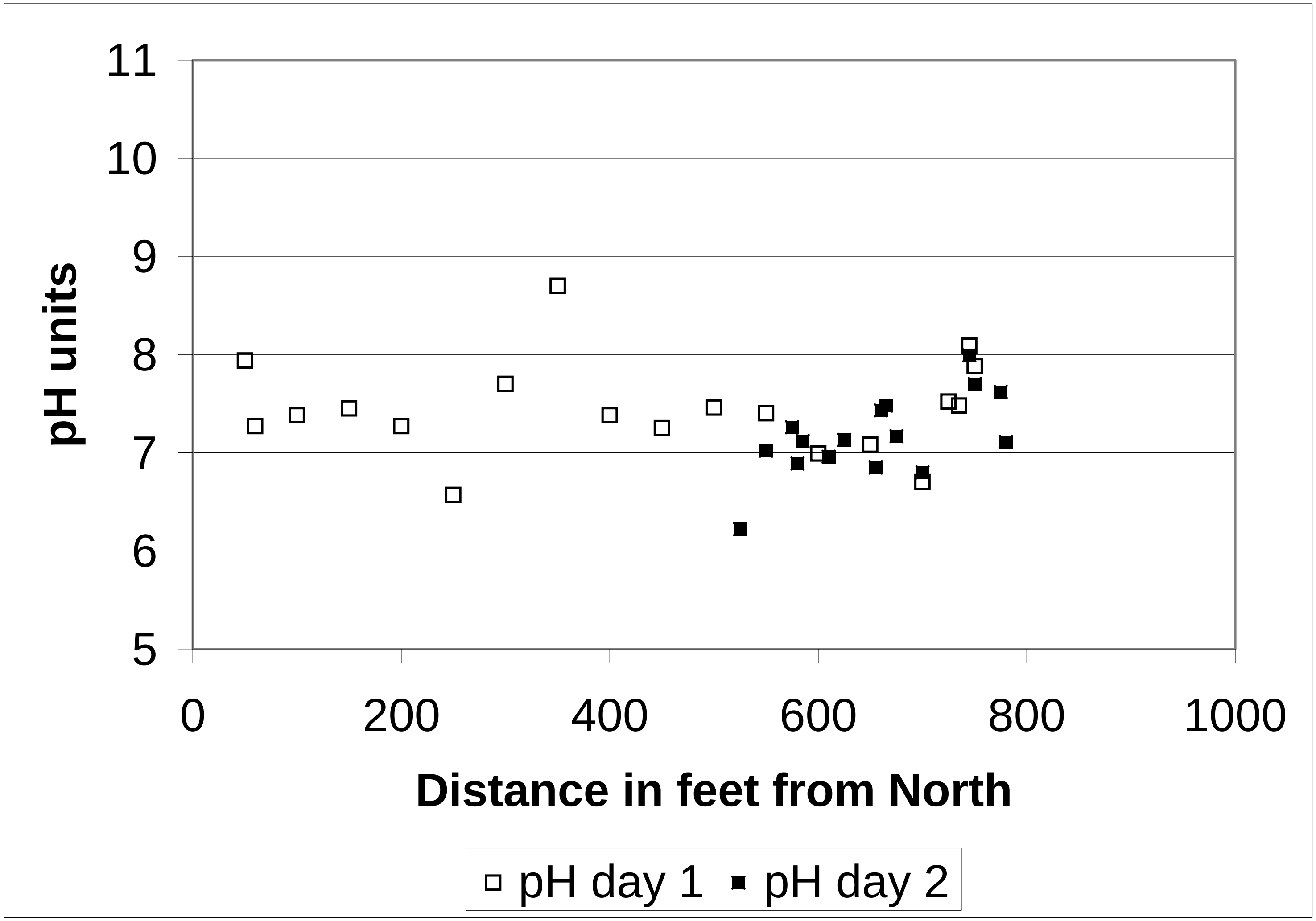

Figure C3. pH from intertidal stations.

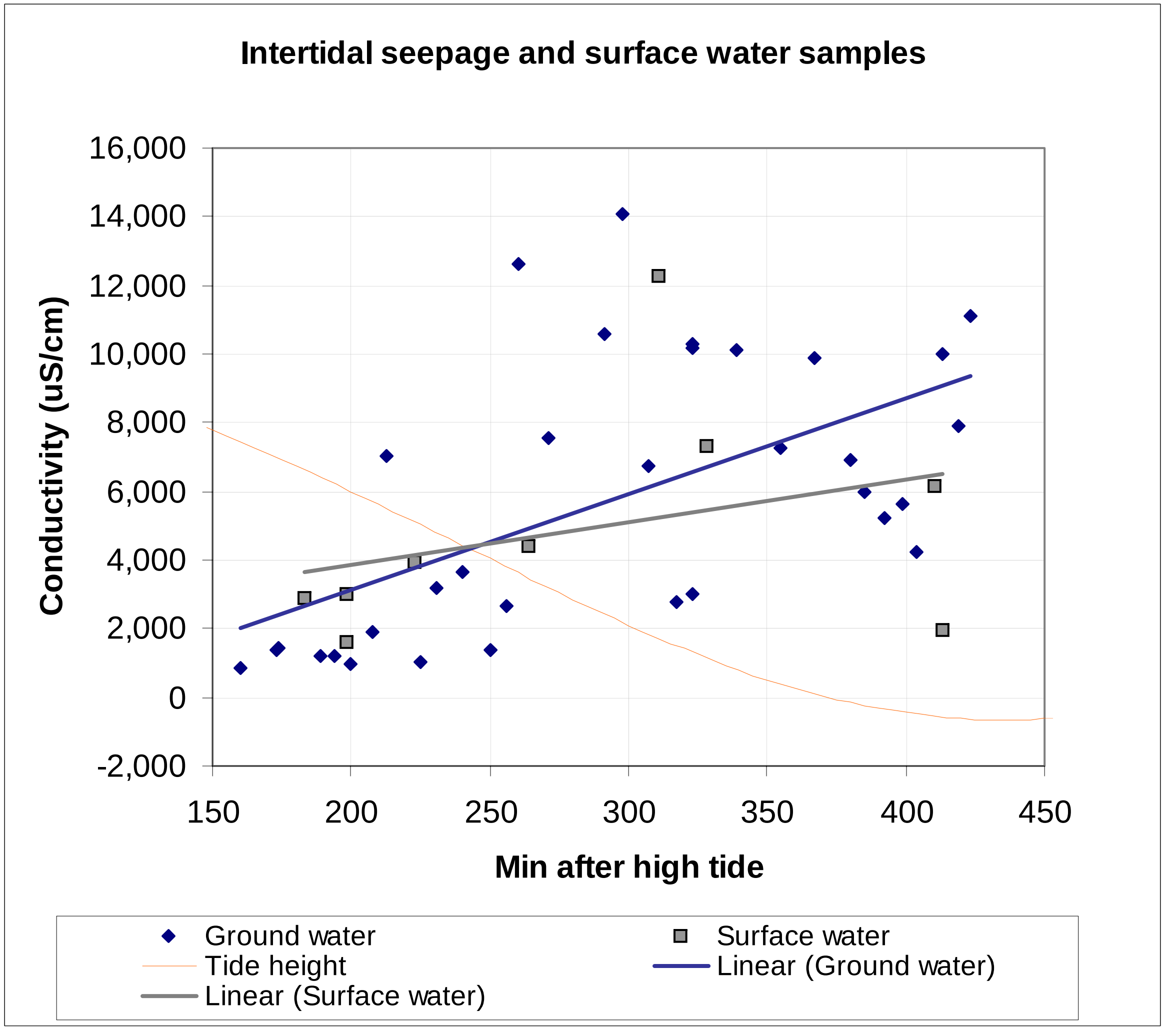

Figure C4. Conductivity in mudflat ground water samples and nearby surface water samples as a function of minutes after high tide, illustrating high variability and overlap, but the indication of increasing conductivity with the falling tide.

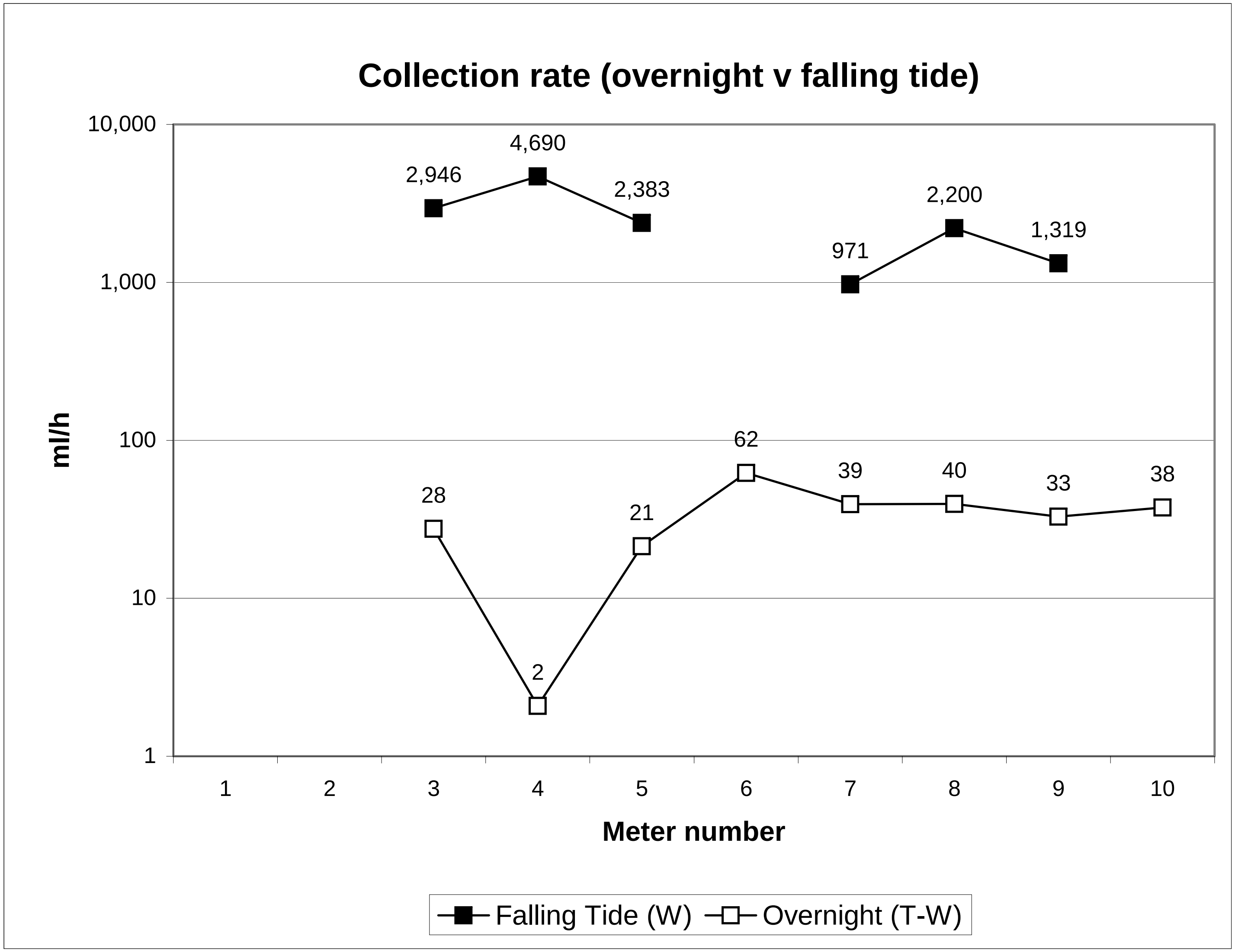

Figure C5. Seepage collection rate for overnight collections and for falling tide collections.

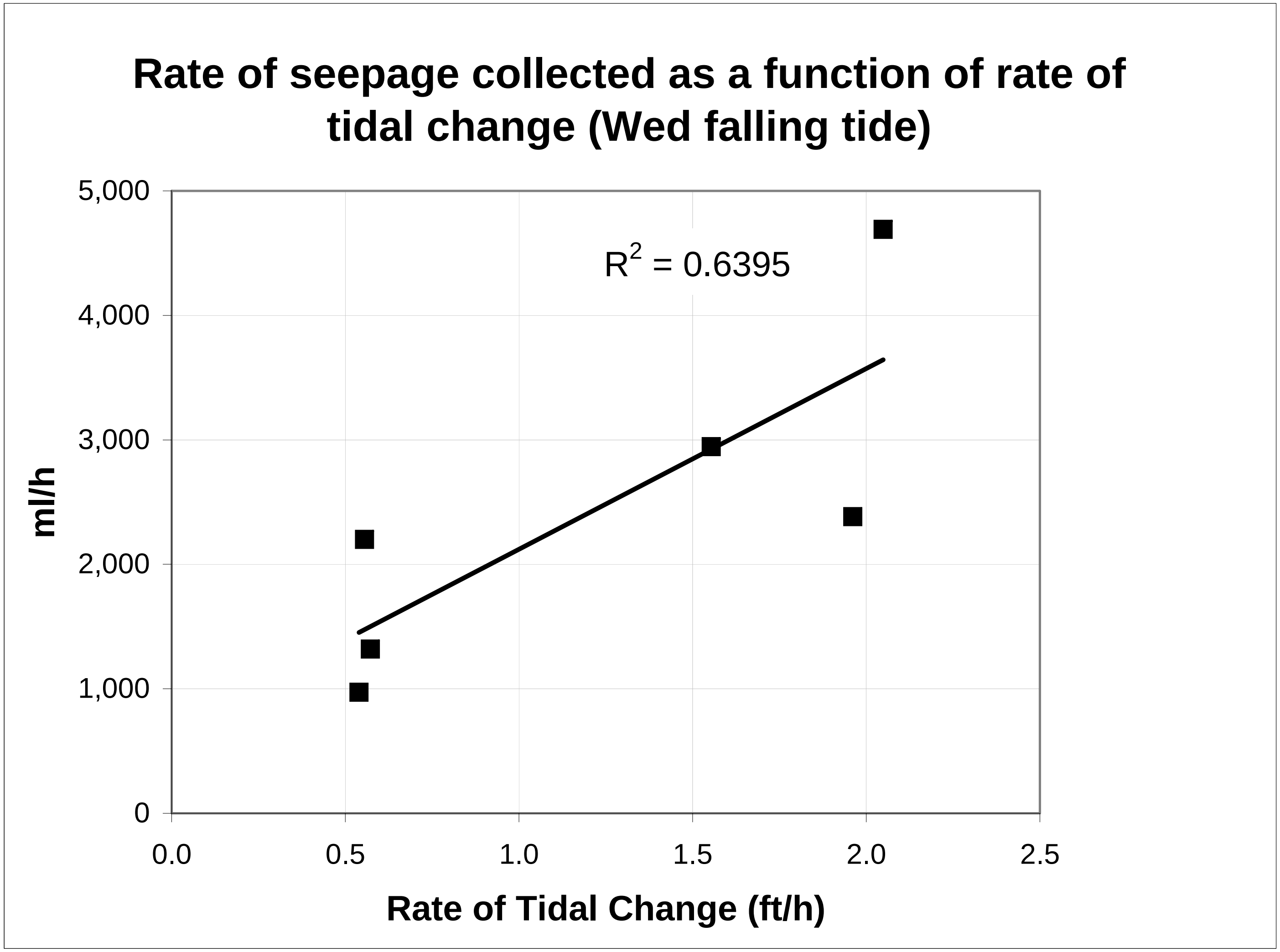

Figure C6. Seepage collection rate for falling tide as a function of the rate of tidal change.

E. Mudflat Sampling and Results

1. Objectives

- Obtain shallow ground water field parameters from the mudflats adjacent to the Rhone-Poulenc facility in the Duwamish River.
- Measure field parameters in the mudflats ground water and in the river surface water and look for any apparent patterns in space or time.
- Compare the mudflats data with the results from the shallow subtidal investigation to assist in understanding ground water movement at the site.

2. Personnel

Mudflat Personnel and Seep Evaluation Tasks		
Group & Person	**Task**	**Date(s)**
On-Shore Team		
Rene Fuentes, EPA	Field Sampler	April 2, 3
Christy Brown, EPA	Field Sampler– Field Notes	April 2, 3
Bernie Zavala, EPA	Field Sampler	April 2
Howard Orlean, EPA	Field Sampler	April 3
Observers		
Pete Wold, and Chris (unknown), URS		

3. Mudflat Methods

Sampling Transect Layout

Transect of subsurface ground water samples using either an MHE Push-Point Sampling Tool and/or a Mini-piezometer sampler. Obtain transition zone ground water samples and obtain geochemical parameters to compare between locations sampled, and between the ground water and the Duwamish River. Obtained field parameter data (pH, electrical conductivity, salinity, turbidity and temperature). Attempted to get dissolved oxygen readings at a few locations but the readings did not provide reasonable results and decided not to continue attempting those measurements on this round. The transect was about 800 feet long along the Duwamish River, and along a much shorter transect along Slip 6 (estimated at 200 feet from shoreline bend into Slip 6) where additional attempts were made to get some opportunistic samples adjacent to the rip-rap. Figure C1 shows the locations of the mudflat sampling locations used.

MHE Push-Point Sampling Tool and Mini-piezometer Designs

Attachments to the sampling plan show the general design of the sampling tools. The MHE Tool is 27 inches long and the Mini-Piezometer is inserted into the sediment using a five (5) foot long pipe inserted to whatever depth it is possible to insert pipe (maximum of five feet, or less if desired). Also, actual field equipment photos are available.

Sample Collection

The samples were collected by inserting the MHE Tool or the Mini-piezometers into the mudflats, attaching tubing from a peristaltic pump to either of these subsurface samplers, and then evacuating water until the water cleared up the sediment and turbidity. In most cases the samples cleared up within less than a minute using a peristaltic pump at a relatively low speed. Water was collected for field parameters and samples after the flowing water purged the visual sediments and produced a steady flow of clear water. In the few cases where the water did not clear up the samples were taken after a stable state was reached.

Global Positioning System

The locations of the sampling points were measured with a graduated field tape from the wooden pier pilings, at 50 feet (and in some cases 25 feet) intervals, and flags were installed at those locations. In addition a Global Positioning System (GPS) was also used to record positions of sampling locations. The southern most sampling point (No. 9) is the last point for which GPS readings were taken. Additional sampling points near No. 9 were measured by tape or estimated due to their proximity, and no GPS readings were taken in the Slip 6 shoreline due to the inability to find sufficient sampling locations within the riprap.

Sample Analysis

Samples were collected directly from the sampling tube in the peristaltic pump into field jar and parameters measured using a Horiba U-10 multiparameter data logger. Additional sample volume was obtained from a few locations to analyze using a field kit for copper.

4. Mudflat Results

Transect layout

The transects followed the shoreline, 50 feet apart (based on field measurements using a tape, which correlated well with the independent GPS data).

Table E1. Lat/long for intertidal stations

Intertidal Station	LONGITUDE	LATITUDE
1	-122.30517	47.51954
2	-122.30512	47.51941
3	-122.30533	47.51966
4	-122.30533	47.51980
5	-122.30541	47.51992
6	-122.30543	47.52007
7	-122.30553	47.52020
8	-122.30506	47.51928
9	-122.30500	47.51917

13	-122.30550	47.52034
14	-122.30552	47.52044
15	-122.30559	47.52060
16	-122.30561	47.52073
16A	-122.30563	47.52084
17	-122.30566	47.52086
18	-122.30571	47.52101

Meter vertical placement

Most samples were taken with the shorter MHE Push-Point Sampling Tool, which is 27 inches long and seemed to reliably provide samples. The deeper samplers (about 5 feet depth) were only tried at a few locations mostly towards the southern end of the transect.

Analytical results

Field results are shown in Table E2. The samples that were taken for the copper screening were done at the EPA offices field room. All the six copper samples analyzed were below the detection levels of the field kit, at a detection level of 0.05 mg/L.

Graphical Analysis of Field Data

The pH, electrical conductivity, and temperature data were selected for graphical analysis. Only the electrical conductivity data appears to provide changes in patterns along the transects.

Observations during field activities

Overall the sampling systems worked very well. The MHE Push-Point Sampling Tool worked better because it seemed to get less plugged than the finer screened Mini-piezometers. Samples seemed to clear up from the turbidity relatively fast (less than a minute). The Horiba system gave very reliable results when compared to the calibrations and to duplicate and repeat measurements at the same locations on the next day. The dissolved oxygen did not seem to work because of potential air infiltration into the sampling system.

Some interesting observations along the shoreline include:

- On the north end near location No.16A there was a well-defined discharge channel in the mudflats that led back into the riprap but seemed to be more of a pipe feature discharge point. The mud in this small channel had a scum layer distinct from the rest of the adjacent mudflats.
- On location No.18 the probe came out with an oily coating, but no sample was taken due to the battery pack running out of power.
- On the southern end, near location No. 9 there were several interesting discharge features at low tide. One was a well-defined surface channel, after the tide had gone out, which discharged clear water towards Slip 6 long after the tide had gone out. Another was a well-defined discharge area (about 2 feet diameter) in the mudflats, which discharged a brown murky liquid. A third observation is that in this area there

was an upward gradient at a very shallow depth, which produced artesian flows from the MHE Push-Point Sampling Tool (at 27 inches below the mud line).

- The area along the riprap in Slip 6 requires sampling at a greater depth than can be easily done by wading due to the steep drop off. It may be doable from a small boat and using a variation of the minipiezometers, which can be installed from a boat into the softer sediments near the riprap.

Table E2. Rhone-Poulenc Mudflats - Measured Water-Quality field parameters
April 2, 2002

Location	Temperature (^{0}C)	pH	Specific Electrical Conductance (μS/cm)	Salinity (%)	Turbidity (NTUs)	Dissolved Oxygen[1] (mg/l)	Comments
#1	10.1	7.4	870	0.03		NT	T:1005
#2	9.9	6.99	1,410	0.06		8.1	Water purged to clear; T:1019
#3	10.5	7.46	1,220	0.05	999	NT	Water was muddy;T:1039
River sample @ #3	10.3	7.0	3,000	0.14	62	NT	clear; T:1043
Duplicate of #3	10	7.22	1,610	0.07	224	NT	Taken 1 to 2 feet from #3 T:1043
#4	9.9	7.25	1,040	0.04	9	NT	clear; T:1110
#5	11	7.38	1,390	0.06	51	NT	T:1135
#6	10.5	8.7	2,670	0.12	51	NT	T:1141
#7	12.5	7.7	7,550	0.40	NT	NT	flow rate low/ lot of sediment & black T:1156
#8	10.7	7.08	10,600	0.58	NT	NT	T:1216
#9	11.3	6.7*	14,100	0.80	NT	NT	piezometer was free flowing; T:1223
#10	9.6	7.52	6,740	0.35	51	NT	piezometer was free flowing; T:1232
SW sample collected by sampler (MHE)	12.4	7.48	12,300	0.69	48	NT	small stream of water flowing to the river; T:1236
#11	10	8.09	2,800	0.13	52	NT	water color has the appears of tea; T:1242
#12	9.9	7.88	3,000	0.14	52	NT	T:1248
River water sample from the slip area	10.8	7.6	7,310	0.38	4.98	NT	T:1253

Location	Temperature (^{0}C)	pH	Specific Electrical Conductance (μS/cm)	Salinity (%)	Turbidity (NTUs)	Dissolved Oxygen[1] (mg/l)	Comments
13	10.7	6.57	6,930	0.36	6.57	NT	clear; T:1345
14	9.9	7.27	6,000	0.31	1	NT	T:1350
15	9.5	7.45	5,210	0.26	1	NT	clear: T:1357
16	10.3	7.38	4,230	0.21	2	NT	clear; T:1409
16A (outfall)	9.8	7.27	6,130	0.31	84	NT	T:1415
17	10.8	7.94	7,930	0.42	48	NT	T:1426

All ground water samples at 27 inches depth using MHE probe, mini-piezometer sampling depth variable, and listed individually.
NT - Samples not taken
* - Rubber cap was on pH probe
T- Time

Table E2. Rhone-Poulenc Mudflats- Measured Water-Quality field parameters (cont.)

April 3, 2002

Locations	Temperature (^{0}C)	pH	Specific Electrical Conductance (μS/cm)	Salinity (%)	Turbidity (NTUs)	Dissolved Oxygen[1] (mg/l)	Comments
1	11.2	7.02	1,370	0.06	9	14.8	T:1100
River sample @ #1	9.4	7.17	2,890	0.14	3	NT	T:11:10
Between 1 and 3	11	6.22	1,210	0.05	240	NT	T:11:16 cleaned up quickly
Between 1 and 2	10.3	7.26	1,000	0.03	523	NT	T:11:27 took Cu sample @ 27"
Between 1 and 2 A	10.1	6.89	1,920	0.08	12	NT	T:11:35 slightly artesian @ 27" took Cu sample
Between 1 and 2 B	11.0	7.12	7,030	0.40	39	NT	T:11:40 slightly artesian @ 27" took Cu sample
River sample between 1 and 2	10.7	7.4	3,960	0.21	23	NT	T:11:50

Locations	Temperature (^{0}C)	pH	Specific Electrical Conductance (μS/cm)	Salinity (%)	Turbidity (NTUs)	Dissolved Oxygen[1] (mg/l)	Comments
2 A	10.6	6.96	3,170	0.15	25	NT	T:11:58
Between 2 and 8	10.5	7.13	3,660	0.19	999 muddy	NT	T:12:07
8 A	11.2	6.85	12,600	0.69	2	NT	T:12:27 used 27" sampler
River sample @ 8A	10.4	7.37	4,410	0.23	9	NT	T:12:31
8A deep	11.3	7.43	10,300	0.56	456	NT	T:13:30 used longer sampler to 42"
Duplicate of 8A deep	10.5	7.48	10,200	0.56	139	NT	Duplicate used longer sampler to 42"
Between 8 and 9	12.2	7.17	10,100	0.55	344	NT	T:13:46 sampled at about 24"
9	12.6	6.8	7,250	0.42	56	NT	T:14:02 sampled with longer sampler at about 48"
11A	17.1	7.99	9,900	0.55	300	NT	T:14:14 Surface seep
12	14.9	7.7	5,650	0.31	13	NT	T:14:46 sampled at 27" for Cu
19	12.2	7.62	10,000	0.54	373	NT	T:15:00 on Slip 6 between rocks into sediment
River sample @ 19	11.7	7.92	1,970	0.09	49	NT	T:15:00
20	10.8	7.11	11,100	0.61	113	NT	T:15:10
Attempted, but could not get other samples in Slip 6 shoreline due to rocks							

All ground water samples at 27 inches depth using MHE probe, mini-piezometer sampling depth variable, and listed individually.
NT - Samples not taken
* - Rubber cap was on pH probe
T- Time

F. Subtidal Sampling and Results

1. Subtidal Objectives

- Collect seepage meter samples of discharging ground water in Slip 6 and Duwamish Waterway in the vicinity of the Facility.
- Begin to characterize ground water discharges to the river and slip from the Facility by estimating seepage rates and measuring field parameters.
- Measure field parameters in the subtidal ground water and in the river and slip bottom water and look for any apparent patterns in space or time.
- Compare the shallow subtidal data with the results from the mudflats investigation to assist in understanding ground water movement at the site.

2. Subtidal Personnel

Subtidal Personnel and Seep Evaluation Tasks		
Group & Person	**Task**	**Date(s)**
Dive Team		
Bruce Duncan	Divemaster, AquaMap	2 & 3
Burney Hill	Dive team, sample analysis	2 & 3
Chad Schulze	Dive team, decon	2
Joe Goulet	Dive team, camera/video prep	2
Rob Pedersen	Dive team	3
Sean Sheldrake	Dive team, video	3
Boat Operator		
Curt Black	Boat Operator, hydrogeologist	2 & 3
Other Boat Personnel		
Carla Fisher	Sample analyst, RCRA representative	2

3. Subtidal Methods

Transect and Seepage Meter Layout

Two 100 m transect lines were placed in approximately 15 - 20 ft deep water at about high tide on Tuesday, April 2, 2002, marked with floats at one or both ends and GPS coordinates were obtained. Marker floats were removed at the end of the day. The first transect line was placed approximately E-W in slip six, starting just south of the last dolphin that fronts the Duwamish River on the north bank of slip six. The second transect line was placed approximately N-S in the Duwamish, starting just west of the dolphin identified above. Figure C1 shows the locations of the transect and seepage meters along the transects. Before deployment, seepage meters (modified buckets) were clipped into both lines approximately every 25 m. Once the lines and meters were deployed, divers installed the meters and attached collection bags.

Table F1. Lat/Long for subtidal seepage meter (SM) stations and the two dolphins in the Duwamish River and the outfall with high pH in Slip 6.

Station	LONGITUDE (N)	LATITUDE (W)
SM 1	-122.30460	47.51889
SM 2	-122.30436	47.51899
SM 3	-122.30415	47.51909
SM 4	-122.30379	47.51921
SM 5	-122.30351	47.51930
SM 6	-122.30607	47.51902
SM 7	-122.30619	47.51922
SM 8	-122.30628	47.51943
SM 9	-122.30635	47.51964
SM 10	-122.30639	47.51986
S Dolphin	-122.30594	47.51897
N Dolphin	-122.30629	47.51998
Outfall	-122.30243	47.51973

<u>Seepage Meter Design</u>

The design of the seepage meters is described by (Lee and Cherry 1978) and was constructed from a plastic bucket (26.6 cm diameter). The seepage meter was pushed into the sediments until approximately 3 inches of space remained between the sediments and the top of the bucket. During installation the tubing connected to the sample collection bag (45 x 46 cm; low density polyethylene bag used in the food industry to hold milk) was clamped shut and the water trapped in the bucket escaped through the vent tube. Following installation, the discharging water was diverted to the sampling bag by switching the position of the clamp.

<u>Sample Collection</u>

Whenever new bags were attached to the seepage meters 1L plastic sample jars of ambient water adjacent to the collection bags on the first and last meters were also collected. Bags were attached on Transect 1 (E-W) at approximately 12:00 on April 2 and replaced approximately 11:15 on April 3, with final retrieval at approximately 15:00. A chart showing tidal information for the two days is in Section 6 - Attachment 1 (Dive Plan). Bags were attached on Transect 2 (N-S) at approximately 14:30 on April 2 and replaced approximately 14:00 on April 3, with final retrieval at approximately 15:45. Sample jars were initially filled with freshwater from the boat. At the appropriate seepage meter, jars were inverted under diver's exhaust bubbles, filled with air, moved to the desired sampling location and turned upright, releasing the trapped air and collecting the ambient sample. Sample bags were either clamped or tied. The most efficient retrieval method was to clamp the tubing using a clamp left loosely in place, remove the bag, and stow it in a mesh bag for conveyance to the surface. Replacement bags were "primed" with an inner rinse of deionized distilled water to remove any static cling and the tubing bent back on itself 180 degrees and held shut with a rubber band wrapped numerous times around the fold. The band came off easily underwater after the tube was attached to the meter and both ends of the tube pulled to straighten it out. Time of attachment and collection were estimated from the field dive tending forms by allotting 3 to 5 min at each end of the dive to descent/ascent, then dividing the remainder of the time equally among the 4 or 5 meters and then using the mid-point of those intervals (e.g., for a 28 min dive and 3 meters the assigned times would be 5min descent, 6 min meter 1, 6 min meter 2, 6 min meter 3, and 5 min ascent yields time of collection at 8 min, 14 min, 20 min).

A sample from an outfall on the north bank of slip 6 towards the NE corner, was collected into a 1 L plastic jar held under the discharge.

<u>AquaMap</u>
The regional underwater AquaMap system was used to record relative positions of seepage meters.

<u>Sample Analysis</u>
Jar and bag samples were analyzed according to the field sampling plan for volume using a graduated cylinder, for copper using a field analysis kit (Hach) and for pH, conductivity, turbidity, DO, temperature, and salinity, using a Horiba multiprobe.

4. <u>Subtidal Results</u>

<u>Transect and meter layout</u>
These are shown in Figures C1 and C3. As planned, stations meters were roughly 75 ft apart

<u>Meter vertical placement</u>
Limited visibility and time constraints precluded detailed measurements of the depth of insertion of the meters. However, upon cleaning the meters after the dive, it was clear that many of the meters had a stained ring, yellow-to-brown around the inner edge and these might give some indication of the head-space (top of the meter above the sediment surface). These data are shown in Table F2. Headspace (as estimated by this indicator) ranged from about 2 to 9 cm on average. The difference between maximum and minimum measures for each meter gives an indication of how parallel the meters were placed relative to the sediment surface (not necessarily an indication of how level the meters were). The range in the last column of Table F2 is from about 1 to 9 cm

<u>Analytical results</u>. Results from field parameters are shown in Table F3.

5. <u>References:</u>

Lee DR and Cherry JA. 1978. A field exercise on groundwater flow using seepage meters and mini-piezometers. J Geol Educ 27:6-10

Table F2. Subtidal results. Measurements of relative meter headspace estimated by the distance from stained ring (4 measurements equally spaced around the meter) to the top of the meter							
Meter ID	Comment on stained ring	4 equal-spaced measurements (cm) made counter-clockwise (view down on "installed" meter)				Average (cm)	Max-Min (cm)
1	Distinct; about 0.2 cm wide; one quadrant of meter smeared over 5 cm width	7.6	11.4	4.4	2.2	6.4	9.2
2	Distinct; about 0.2 cm wide; slight smear	10.8	10.2	7.0	7.0	8.7	3.8
3	Light ring; about 0.5 cm wide	8.9	6.4	6.4	7.0	7.1	2.5
4	No staining detected						
5	Distinct ring, about 0.5 cm wide	3.8	5.7	7.0	6.4	5.7	3.2
6*	Medium ring; 0.2-0.5 cm wide	4.8	2.5	2.5	4.4	3.6	2.2
7*	Medium ring; 0.2 cm wide; into "lid" of meter (5 cm toward center of meter)	1.3	5.7	2.5	0.0	2.4	5.7
8*	Distinct ring; 0.5 to 2 cm wide	4.1	2.2	2.2	1.0	2.4	3.2
9*	Medium ring; 0.2-1.3 cm wide	4.1	3.2	3.2	3.8	3.6	1.0
10*	Very light ring; 0.5 cm wide	7.6	9.5	3.2	2.5	5.7	7.0
* number assigned after project and do not indicate a sequential order. Meters 1-5 used on E-W Slip 6 transect; 6-10 used on the N-S Duwamish transect							

Table F3. Subtidal Results. Analytical results for jar, bag, and outfall samples (04/02-03/2002) - times based on dive logs (interpolating when necessary) and field analytical notebook records.

Sample ID/Depth	Time bag attached	Time collected	Time Analyzed[1]	Volume (ml)	pH	conductivity (uS/cm)	Salinity (%)	DO (mg/L)[2]	Temp (C)	Turbidity (NTU)	Cu[3] (mg/L)
Tuesday - 04/02/2002											
Jar 1-T (meter 1) Ambient/12 ft	--	11:55	12:25	1000	6.58	11.4	0.62	9.10	10.0	10	--
Jar 5-T (meter 5) Ambient/12 ft	--	12:25	12:32	"	6.94	28.1	1.69	8.52	9.9	10	--
Jar 6-T (meter 6) Ambient/5 ft	--		15:14	"	6.58	1.29	0.05	8.25	11.2	10	--
Jar 10-T (meter 10) Ambient/5 ft	--		15:21	"	7.97	1.18	0.05	7.58	10.9	10	--
Wednesday - 04/03/2002											
Jar 1-W (meter 1) Ambient/13 ft	--		11:12 16:52	1000	7.1	0.29	0.01	8.34	14.5	10	<0.05
Jar 5-W (meter 5) Ambient/16 ft	--		10:38 17:00	"	5.9	32.3	2.01	7.25	14.6	10	<0.05
Jar 5-W (meter 5) Ambient/7ft (water column)	--	15:01	15:51	"	7.1	32.0	1.98	6.6	13.2	10	<0.05
OUTFALL	--		12:45	"	10.1	0.46	0.01	6.8	14.6	10	<0.05
Jar 6-W (meter 6) Ambient/8 ft	--		13:37 17:09	"	7.9	1.44	0.06	7.42	12.8	10	<0.05
Jar 10-W (meter 10) Ambient/8 ft	--		14:17 17:18 est.	"	7.7	1.33	0.06	8.26	12.9	10	<0.05

Table F3 Continued - Results for Seepage Meter Bag samples

Sample ID & Collection Depth	Time bag attached	Time collected	Time Analyzed[1]	Collection Interval	Volume (ml)	pH	conductivity (uS/cm)	Salinity (ppt)	DO (mg/L)[2]	Temp (C)	Turbidity (NTU)	Cu[1,3] (mg/L)
Wednesday - 04/03/2002												
Meter 1: T-W 12 ft	12:21 (02/02)	11:48 (02/03)			Trace							
Meter1: W[4] 13 ft	11:48	14:55			--							
Meter 3: T-W 12 ft	12:09 (02/02)	11:43 (02/03)		21:34	660	6.5	22.6	1.35	6.3	13.0	10	
Meter 3: W 13 ft	11:43	14:57	17:46	3:14	395	7.3	20.5	1.20	8.5	11.6	10	<0.05
Meter 4: T-W 12 ft	12:03 (02/02)	11:05 (02/03)		21:02	50	7.0						<0.05
Meter 4: W 16 ft	11:05	14:59	18:00	3:54	763	8.8	16.8	0.97	7.2	11.4	117	
Meter 5: T-W 12 ft	11:57 (02/02)	10:53 (02/03)		22:56	512	6.1	19.9	1.18	5.9	15.7	307	<0.05
Meter5: W 16 ft	10:53	15:01	17:53	4:08	405	7.5	18.9	1.10	7.6	11.7	52	<0.05
Meter 6: T-W 5 ft	14:20 (02/02)	13:46 (02/03)		23:26	1490	6.6	17.1	1.00	5.8	14.8	203	<0.05 (15:51)
Meter 6: W[4]	13:46	15:40			--							
Meter 7: T-W 5 ft	14:32 (02/02)	13:52 (02/03)		23:20	945	7.9	3.0	0.14	6.8	13.7	5	<0.05 (14:16)
Meter 7: W	13:52	15:43	18:05	1:51	75							<0.05
Meter 8: T-W 5 ft	14:44 (02/02)	13:58 (02/03)		23:14	950	8.1	7.4	0.39	6.7	13.5	76	<0.05 (14:16)
Meter 8: W	13:58	15:46		1:48	165							
Meter 9: T-W 5 ft	14:56 (02/02)	14:04 (02/03)		23:08	790	6.8	11.8	0.66	6.9	15.2	10	<0.05 (15:41)
Meter 9: W	14:04	15:49	18:10	1:45	96							<0.05
Meter 10: T-W 5 ft	15:08 (02/02)	14:10 (02/03)		23:02	900	7.2	5.6	0.29	7.1	16.2	87	<0.05 (15:26)
Meter 10: W	14:10	15:52		--	--							

1. Cu analyzed later in day than other parameters
2. If DO would not stabilize - maximum reading recorded. This error is less than 5%. For e.g., Jar 6 - range was from 7.90 to 8.25; Jar 10 - read 7.58, then stabilized at 7.45
3. No Cu kit on 04/02
4. Meter came loose - no sample collected
5. 7 & 8 mixed up

G. Attachments

G-1. Field Sampling Plan
G-2. Dive Report

G-1. Field Sampling Plan

FIELD SAMPLING PLAN

FOR

Rhone-Poulenc Site
Duwamish River, Tukwila, WA

Prepared By US EPA Region 10
1200 Sixth Ave.
Seattle, WA 98101

Date: 04/01/02
Revision: 3

APPROVAL OF FIELD PLAN

Project Manager: Rene´ Fuentes //s// Date: 04/01/2002
USEPA, Office of Environmental Assessment

Field Sampling : Rene´ Fuentes, Bernie Zavala (OEA, Hydrogeologists)
Region 10 Dive Team
Christy Brown, RCRA Project Manager

TABLE OF CONTENTS

1 PROJECT MANAGEMENT

1.1 Distribution List

Rene´ Fuentes	Hydrogeologist
Bernie Zavala	Hydrogeologist
Christy Brown	RCRA Site Project Manager
Bruce Duncan	Ecologist/Dive Team coordinator

1.2 Project/Task organization

1.2.1 Small team will attempt to test the field equipment and obtain water samples for field analysis. Goal is to test the equipment and develop/alter the field work as needed to obtain useful field results, both in equipment deployment and in obtaining transition zone water samples from the subsurface of the mudflats and from the subsurface sediments in Slip 6.

1.3 Problem Definition/Background

1.3.1 Introduction.

The Rhone Poulenc facility in Tukwila, WA, is located along the Duwamish River, and has boundaries with both the Duwamish River and Slip 6. The site has documented contamination of the soils and ground water, and the purpose of this sampling is to determine whether available tools for sampling the ground water to surface water transition zone can be used to further delineate the migration of ground water contaminants to the river. Some of the main contaminants documented at the site include toluene, copper, and high pH (over 12 in some areas). The sampling will be conducted with manual field equipment on the shoreline (mudflats during low tides), and with geochemical parameter meters and field kits. In addition, the EPA Region 10 Dive Team will be using seepage meters placed on the bottom sediments, at a depth of about 20 feet of water depth during a falling tide.

1.3.2 Objective and Scope.

The objective of the EPA sampling is to provide EPA with field tests and data using these field tools at this facility and in the general Duwamish River environment.

1.4 Project/Task Description

Sampling along a transect on the mudflats between the Rhone-Poulenc site and the Duwamish River and in subtidal areas in Slip 6 and the Duwamish River. The general location of the proposed samples are shown in the attached map of the site (not in the electronic format).

ACTIVITY	DATE
Sample Collection	April 2 and 3, 2002.
Number of samples	Depends on site, but if proposed system works as planned, then will try at least one sampling location every 50 feet along the mudflats area. Subtidal seepage samples estimated as 25 per day
Completion of Sample Analysis	On the same field day.

1.5 Data Quality Objectives (DQOs) and Criteria for Measurement Data

Obtain transition zone ground water samples and obtain geochemical parameters to compare between locations sampled. Attempt to determine whether this type of field equipment will work at this site and whether it would be worth to do more sampling for laboratory analysis. The data will be field parameter data (pH, electrical conductivity, Dissolved Oxygen, Eh, and temperature), and each parameter will be within the accuracy of the instruments. The measured parameters will be compared to those at the other sampling sites along the mudflats transect and the subtidal seepage meter transect data (EPA Region 10 Dive Plan dated March 26, 2002). The dive team may also attempt to obtain differential hydraulic head from mini-piezometers, using a differential manometer, if time permits. One expectation is that using these field parameters the data obtained will allow interpretation of any discharges which have a different signature from others nearby, indicating a different quality discharge plume at those locations. One additional measurement that will be attempted is to do field tests for copper with a field kit. It is unknown whether the sampling systems will work to obtain water samples at this site, or if the copper concentrations in these samples will be within the detection range of the field kit.

1.6 Special Training Requirements/Certification

None required.

1.7 Documentation and Records

Field notes, photographs of area and tools, locations of sampling points with either a measuring tape to a permanent fixture (pier piling) or with a GPS (Global Positioning System), or, for the subtidal samples, with the dive team AquaMap systerm for future resampling of those locations.

2 MEASUREMENT/DATA ACQUISITION

2.1 Sampling Process Design (Experimental Design)

Nearshore samples will be taken using the “MHE Push-Point Sampling Tool” (see attached description and Figure 1). Tool is pushed into the subsurface to attempt to access the ground water within the ground water / surface water transition zone, pump it up to the surface and do field analysis for selected parameters which may indicate discharge of ground water and different water characteristics along the transect (pH, electrical conductivity, Dissolved Oxygen, Eh, and temperature). If possible to obtain enough water field tests for copper may be done using field kits as available. Subtidal samples will be collected using seepage meters and analyzed for the same parameters. Additional tests of the push-point sampler and field tests with minipiezometers may also be field-tested to attempt to obtain additional water samples at different depths and to determine vertical gradients.

2.2 Sampling Methods Requirements

Sampling will be adapted as necessary to obtain water for analysis. The basic method is as documented in the MHE Push-Point Sampling Device Operators Manual Ver. 1.02 dated 5/13/00 (see general description attached). The seepage meter techniques have been adapted from the original work of David Lee and John Cherry (A Field Exercise on Groundwater Flow Using Seepage Meters and Mini-Piezometers, Journal of Geological Education, 1978, v.27, pp. 6-10), and will be followed with the following adjustments: Bags will not be partially filled before deployment since net flow rates are not being measured (the goals are to detect the hydraulic connection and then to collect a ground water sample to compare the analytes described above with surrounding surface and transition zone water); smaller buckets to make them more maneuverable by the USEPA scuba divers; bags are from a differerent manufacturer.

2.3 Sample Handling and Custody Requirements

No field samples expected to be shipped to laboratory.

2.4 Analytical Method Requirements

Field tests for geochemistry indicator parameters and copper.

2.5 Quality Control Requirements

None other than following field tests calibration methods.

2.6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

This section does not apply to this project. These requirements are met by the EPA OEA Manchester Lab facilities (per Andy Hess, provider of the instrumentation)

2.7 Calibration Procedures and Frequency

Calibration will be performed when appropriate prior to use of field instruments following the procedures found in equipment manuals.

2.8 Reports to Management

A draft report will be prepared to document the results of this investigation. A final report containing the data, calculations, and conclusions will be prepared. A separate dive report will be prepared that briefly summarizes the sampling results (but focuses more on the dive safety issues and the completion of objectives).

G-2. Dive Report

EPA REGION 10 DIVE REPORT

From: Bruce Duncan, Divemaster **Date of Report:** April 10, 2002

Thru: **Rob Pedersen**, UDO
To: **Jan Hastings**, Director, OEA
Keven McDermott, OEA

Project: Rhone Poulenc (RCRA) ground water discharge evaluation

Dates of Dive: April 2 and 3, 2002

Location: Lower Duwamish River, Seattle, WA

Scientific Objectives: Support RCRA Program by collecting information on the hydraulic connection between the facility and the Duwamish River/Slip 6.
The data confirm the hydraulic connection and suggest Copper levels may be below 0.05 mg/L and pH should be evaluated further

Scientific Observations/Data collection:
Day 1 - Tuesday, April 2
As planned, 10 seepage meters on two 100m transect lines (5 on each line, about 25m apart) were placed in approximately 20 ft water depth at beginning of a falling tide. Transects were deployed at right angles to each other into Slip 6 (~E-W) and along the Duwamish (~N-S). Placing the transects and diving to install the meters took from about 9:00 am to 3:00 pm.

09:00-11:00 Place the transect lines and the AquaMap system
11:45-12:30 Install the first 5 meters, collect 2 ambient samples, and attach collection bags
12:30-13:30 Place the second transect line
14:00-14:45 Install the second 5 meters, collect 2 samples, attach collection bags
14:45-15:15 Retrieve pelican floats

Originally we had hoped to change out sampling bags twice during the day. Due to lack of time, bags were left to collect the mix of seepage and ambient water (water left in the head space of the meter) overnight. The four jars were analyzed for pH, cond, T, S, turbidity, DO. The copper kit was not available for use on Tuesday.

Day 2 - Wednesday, April 3
As originally planned, we collected and replaced all 10 bags and analyzed seepage water for the parameters described above including copper. Due to lack

of time, we did not test other sampling devices (push probes; underwater manometer; mini-piezometers)

10:30-12:00 Collect and replace 5 bags on transect 1
13:30-14:15 Collect and replace 5 bags on transect 2
14:50-15:00 Collect 5 bags on transect 1
15:35-15:55 Collect 5 bags on transect 2 (and run AquaMap baseline survey)
Chemical analyses occurred throughout the day

In addition to the seepage samples, we collected a sample from an outfall discharging into slip 6 from the north bank. This had a pH of about 10.

We also documented meters on transect 1 with limited video (due to poor visibility). On transects 1 & 2 we also noted shrimp and mussels (around meter #4 and #8)

Both AquaMap (diver station only mode) and GPS were used to fix locations of the transect lines, nearby landmarks (dolphins), and approximate locations of the seepage meters. EPA hydrogeologists and RCRA personnel obtained push probe and other samples of GW in the intertidal zone.

Science Report: The report: "Rhone Poulenc, Tukwila, WA Site - Evaluation of Ground Water Seeps Along Duwamish River Mudflats and Shallow Subtidal (April 2-3, 2002)" should be consulted for details on the methods and results from this diving operation. In brief, the use of seepage meters clearly showed that under these conditions (falling tide) and with this kind of equipment, discharging water was collected (of 18 bags successfully deployed and recovered, 14 had measurable volumes, ranging from 50 to 1490 mL; with larger volumes in overnight bags). Copper concentrations did not exceed the detection limit of the field sampling kit for any sample (0.05 mg/L). pH ranged from 5.9 to 8.8 (with 10.1 in the outfall sample). Salinity varied with location and time and seemed lower than ambient salinity for the east end of Slip 6 (there was insufficient sample volume to analyze the "day" samples from other locations)

Pollution Sources: Divers only had minor amounts of sediment on them on arriving back at the boat (no free product such as creosote or any odors on equipment were noted, but note that the seepage meters had a brown ring on their interior that did not rinse off). A small outfall in Slip 6 had a relatively high pH (10.1). No copper samples of surface or ground water were above the detection limit of 0.05 mg/L.

Decontamination Procedures Followed: Rinse divers on swim step with clean boat water concentrating on Aga masks, gloves and removal of any visible sediment (e.g., under protective plastic covers of dive computers). Spray light coat of Betadine from all angles (while wearing gloves and goggles) again concentrating on masks, gloves, octopus regulator, BC hose, webbing, etc.. No obviously contaminated equipment (e.g., over-gloves, swim fins) was noted. After 10min, rinse divers with clean boat water. Follow-up standard soaking of equipment on board in cooler and later in dive locker sink, as needed.

Considerations needed for decontamination protocols:
When and how to decontaminate BCs
Equipment and SOP for controlling and isolating lines/weights/etc. and subsequent decontamination.

Hazards: Diver retrieval in current and wind in shallow water near pilings. Low visibility was a hindrance but not a large safety hazard although it did lead to diver separation (but shallow diving and transect lines helped with this aspect). Boat traffic and underwater hazards were not a problem. The river surface current was a minor hindrance to divers. The northerly winds actually overrode the surface current in terms of effects on the boat.

Water Depth: We planned on less than 30ft and ideally between 10 and 20 ft; dives were actually between 5 and 16ft.

Water Current: As expected, the current was low to moderate at our operational depths near the shoreline.

Diving Platform: EPA Monitor.

Divemaster: Bruce Duncan
Divers: Day 1 (Tues April 2): B Duncan, J Goulet, B Hill, C Schulze
Day 2 (Wed April 3): B Duncan, B Hill, R Pedersen, S Sheldrake
Cox'n: Curt Black
Tender: divers
Hydrogeologists (on shore): Rene Fuentes (shore team leader, may have RCRA personnel as well)
Others: Carla Fisher, RCRA (Tues April 2)

Equipment/Diver Issues:
New SOP was instituted - divers will have equipment stowed and clipped off so that their hands are free to stay in contact with dive buddy or dive line and to conduct ear equalization maneuvers.
One dive pencil crushed
Lost AquaMap magnetic wand on first dive - recovered next day - need backup
Divers frequently separated in low visibility - fairly easy to find one another in 5 ft water depth by standing up - new SOP should help prevent separations.
AquaMap down line caught in boat prop - pressure from the float (which miraculously remained intact) jammed into the prop caused the engine to die - we drifted into a dolphin and tied up while the line -which was moderately chafed was unwound from the prop shaft. This incident was likely a result from retrieving a nearby marker line (Pelican float and weight). When we pulled up on the

Pelican line, it probably raised the scope from the AquaMap line closer to the surface just as we slowly motored over to retrieve the Pelican line.
See other decontamination considerations

Diver Stats:

Divers	Max Depth (ft)	Bottom Time (min)	Task	Agas
Tuesday, April 2, 2002				
BD, CS	12	39	2 jars, install meters 1-5	#1, #4
BH, JG	5	71	2 jars, install meters 6-10; retrieve pelicans	#3, #2
Wednesday, April 3, 2002				
BD, SS	16	34	1 jar, bags 4, 5, video (SS)	#1, #5
BD, SS	13	14	1 jar, bags 1-3	
BH, RP	8	40	2 jars, bags 6-10	#3, #6
BD, SS	8	10	bags 1-5	
BD, SS	7	18	bags 6-10	