U.S. Environmental Protection Agency
Region 10: Office of Environmental Assessment; Office of Air, Waste & Toxics
1200 –6th Ave, AWT-121 ♦ Seattle, Washington ♦ 98101

Rhone-Poulenc (Rhodia) sediment & porewater investigation Aug/Sept 2004

DATA REPORT:

VOLATILE ORGANIC COMPOUNDS, METALS, AND PESTICIDES/PCBS DETECTED IN SEDIMENT & POREWATER
DRAFT

September 13, 2005

Site ID No. WAD 009282302

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Acronyms

ACRONYM	Definition
DO	dissolved oxygen
EPA	US Environmental Protection Agency
GPS	Global positioning system
ICP	Inductive Coupled Plasma – analytical method used to lower Cu detection limits
LDW	Lower Duwamish Waterway
MHE	Mark Henry Enterprises? Mini-push probe piezometer
MLLW	mean lower low water
PCB	polychlorinated bi-phenyl
PPT	parts per thousand
QASP	quality assurance and sampling plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SVOC	semi-volatile organic compound
VOC	volatile organic compound

1.0 Introduction

The former Rhone-Poulenc facility is located on the Lower Duwamish Waterway (LDW) in Seattle, Washington. The facility is under a RCRA 3008(h) Order for cleanup of releases to the soil, ground water, and sediments. Sediments offshore of the facility are also part of the LDW Superfund site. Ground water monitoring conducted at the facility confirms that a number of organic and metals contaminants have discharged from the ground water to the Waterway. Metals migrating from the facility, for example copper and mercury, are present in some locations in the ground water immediately adjacent to the Waterway at levels three to five orders of magnitude in excess of the screening criteria. The RFI Report also documents metals in a bank seep at levels two to three orders of magnitude above the screening criteria. In addition, a removal action was conducted in 1995 due to PCBs in soils, process drains, and storm sewers at the facility. The PCB Remediation and Sewer Cleaning Report (April 1, 1998; site file) confirms that PCB-contaminated sediments were present in sewers which discharge to the Waterway.

A barrier wall was constructed in 2003 in an attempt to control contaminant migration to the Waterway, and work continues on the accompanying pump-and-treat system in order to provide hydraulic control of the contaminated ground water. A monitoring program is in place to determine the impacts of construction on the contaminants remaining in the riverbank outside of the barrier wall. The results of this monitoring indicate that, while copper contamination appears to be contained by the barrier wall at most locations, copper concentrations are increasing in some locations since the construction of the barrier wall.

The contaminants of interest for this sampling event were metals (i.e., including copper, lead, vanadium), total mercury, PCBs as total Aroclors, Semi-volatile Organic Compounds (SVOCs), and Volatile Organic Compounds (VOCs) (VOC analysis from water samples only).

The purpose of this sampling event was to determine whether there are contaminants of concern outside the barrier wall in either the transition zone ground water or the inter- or sub-tidal sediments adjacent to the facility. Sampling was done to obtain water samples for chemical analysis and for field parameters (measured at the time of sampling). The sampling was conducted with manual field equipment on the shoreline (mudflats during low tides), and with field kits. Sediment collection and transition zone sampling in the river and Slip 6 (along the south side of facility) was done with the EPA Region 10 dive team support. The dive report is attached as Appendix 5.4. The samples collected were analyzed at the EPA Region 10 Manchester

Environmental Laboratory except for Total Organic Carbon and percent moisture in sediment samples, which were analyzed at the EPA Region 7 Laboratory.

Purpose and Objectives

Purpose: The purpose of this investigation was to obtain representative ground water/surface water transition zone water samples and sediment samples, from locations that have the highest likelihood of containing the contaminants of interest to determine whether 1) human exposures are controlled, 2) unacceptable exposures to ecological receptors such as juvenile salmonids are occurring, and 3) whether a more detailed investigation to determine the full nature and extent of contaminants remaining outside the barrier wall, in the wedge between the wall and the river, is warranted.

Objectives: The primary objectives of this field investigation were to collect transition zone ground water and sediment data to:

- Assess the potential for water quality and sediment quality impacts to the Duwamish River, including Slip 6;
- Determine whether migration of contaminated ground water from the site has been controlled;
- Understand the nature of contamination outside the barrier wall on the shoreline mud flats along the Duwamish River and in the shallow sub-tidal zone of Slip 6;
- Provide data to develop a conceptual model of the contamination distribution; and,
- Determine whether further investigation of the ground water and sediments outside the barrier wall is warranted.

2.0 Sample Collection, Processing, & Laboratory Methods

This section describes in brief the collection of the sediment and transition zone ground water samples accessed from the shore and boat as well as sample processing methods. The following codes are used in this data report: SH = intertidal accessed from shore; SHB = intertidal accessed by boat; SB = subtidal accessed by boat. Sampling procedures are described in detail in the 8/5/2004 QASP. Sample locations are shown in Figure 1 and lat/lon coordinates in Table 2-1. Exact coordinates are not available for many of the subtidal stations because most subtidal stations in Slip 6 were located by placing a marked transect line on the bottom of the slip. Coordinates were recorded from the boat's GPS unit for (1) the beginning and end of the transect, (2) subtidal stations where the boat was on station, and (3) boat location in the vicinity of the station along with the bearing and distance from the boat GPS location to where the divers sampled. These data were used in ArcView to place station locations on an ortho photo and produce the best-estimated station locations as indicated on Figure 1. Intertidal station locations were obtained with hand-held GPS unit.

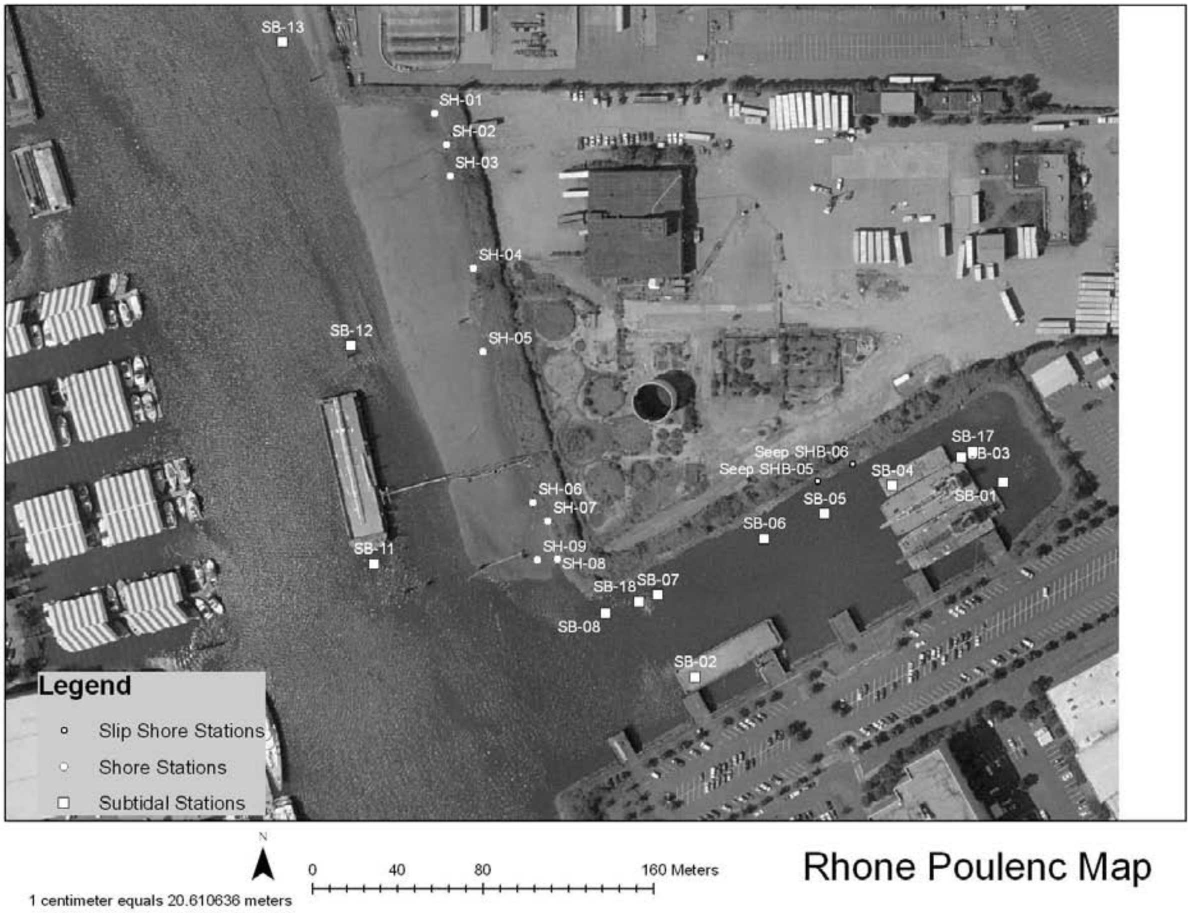

Figure 2-1. Sample locations

2.1 SAMPLE COLLECTION – GROUND WATER AND SEDIMENT SAMPLES

2.1.1. Ground water samples

Near-shore samples were collected using the "MHE Push-Point Sampling Tool" (QASP, Figure 2). This 70-cm sampling tool is stainless steel with a 4-cm, screened area near the tip, which was pushed 60 cm into the subsurface to access the ground water within the ground water/surface water transition zone. A peristaltic pump was used to draw a sample up to the surface for collection and analysis for field parameters. Collection of sub-tidal transition zone ground water samples was attempted using a push probe tool of larger diameter. The screened area consistently clogged with the sticky muds present in the slip sediments. Therefore, a field deviation from the QASP was required and transition zone ground water samples were collected using seepage meters. Using seepage meters to collect ground water samples is more labor intensive than using push probes and requires three sequential dives to: 1) place the seepage meter and let it purge the ambient water from the meter; 2) open the collection bag; and 3) to retrieve the collection bag. Therefore, subtidal sampling with seepage meters was conducted at relatively few stations. Seepage meters were based on the design by Lee and Cherry (1978) and were constructed from plastic buckets (26.6 cm diameter). Each seepage meter was pushed into the sediments until approximately 7.5 cm of space remained between the sediments and the top of the bucket. During installation, 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 a vent tube. Following installation and purging, the discharging water was diverted to the sampling bag by switching the position of the clamp. Sample collection information is in Table 2-2.

Table 2-1. Coordinates for intertidal sampling stations and subtidal transect

INTERTIDAL STATIONS	LATITUDE	LONGITUDE	SUBTIDAL STATIONS	LATITUDE	LONGITUDE
SH-01	47.520999	-122.305722	W end of Transect	47.51878	-122.30515
SH-02	47.520864	-122.305647	W end of transect	47.51875	-122.30519
SH-03	47.520732	-122.305628	E end of transect	47.51955	-122.30232
SH-13	*Same as SH-03 (field dup)*		SB-01	47.519420	-122.302199
SH-04	47.520342	-122.305487	SB-02	47.518610	-122.304129
SH-05	47.519991	-122.305431	SB-15	*Same as SB-02 (field dup)*	
SH-06	47.519351	-122.305129	SB-03	47.519527	-122.302458
SH-16	*Same as SH-06 (field dup)*		SB-04	47.519412	-122.302890
SH-07	47.519270	-122.305038	SB-05	47.519295	-122.303314
SH-08	47.519112	-122.304980	SB-06	47.519193	-122.303688
SH-09	47.519110	-122.305104	SB-07	47.518958	-122.304354
SHB-05	47.519431	-122.303356	SB-08	47.518883	-122.304679
SHB-06	47.519502	-122.303137	SB-11	47.519100	-122.306120
			SB-12	47.520023	-122.306254
			SB-13	47.521306	-122.306661
			SB-16	47.519552	-122.302387
			SB-17	*Same as SB-16 (field dup)*	
			SB-18	47.518929	-122.304472
SHB-05 & 06 are referred to as SB-05 & 06 in Appendix 5.1 Data Results. The H is added here and elsewhere in this data report to help distinguish them as intertidal (SHore) stations (they were shoreline seeps in Slip 6). SB18 = pore water sample only					

An additional deviation from the QASP was the collection of samples from two intertidal locations in Slip 6. These had not been targeted due to the difficulty of reaching locations in the intertidal riprap area, below the fence and blackberry vines in Slip 6. Because piezometer samples could not be acquired subtidally from Slip 6, these intertidal samples of opportunity from visible seep locations were obtained using the same sampling protocol as the other shoreline samples. The two Slip 6 shoreline samples are designated as SHB-05 and SHB-06 in this report and SB-05 and SB-06 in the Appendix data tables.

Table 2-2. Sampling Information (see Figure 2-1 for location)

INTERTIDAL STATIONS	SEDIMENT COLLECTION DATE	START TIME	QA	GROUND WATER COLLECTION DATE	START TIME	QA
River						
SH-1	8/24/2004	7:58		8/31/2004	10:04	
SH-2	8/24/2004	8:25		8/31/2004	10:40	
SH-3 & 13	8/24/2004	8:50	DUPLICATES	8/31/2004	11:45	
SH-4	8/24/2004	9:31		8/31/2004	12:45	
SH-5	8/25/2004	9:45		8/30/2004	9:57	
SH-6 & 16	8/25/2004	9:05	DUPLICATES	8/30/2004	8:45	
SH-7	8/25/2004	8:26		8/30/2004	9:33	
SH-8	8/25/2004	7:35		8/30/2004	11:00	
SH-9	8/25/2004	8:56		8/30/2004	11:32	
Slip 6						
SHB-05				9/1/2004	13:33	
SHB-06				9/1/2004	12:45	
SUBTIDAL STATIONS	SEDIMENT COLLECTION DATE	START TIME	QA	SEEPAGE COLLECTION DATE	START TIME	QA
River						
SB-11	8/25/2004	11:57				
SB-12	8/25/2004	12:55				
SB-13	8/25/2004	17:23				
Slip 6						
SB-01	8/25/2004	14:44				
SB-02 & 15	8/25/2004	13:54	DUPLICATES			
SB-03*	8/24/2004	13:25		9/1/2004	12:32	
SB-04	8/24/2004	14:25				
SB-05	8/24/2004	15:30				
SB-06	8/24/2004	16:12				
SB-07	8/26/2004	12:08		9/1/2004	11:58	
SB-08	8/26/2004	11:23		9/1/2004	10:07	
SB-17 & 16	8/25/2004	15:49	DUPLICATES			
SB-18**				9/1/2004	10:07	

*Large diameter seepage meter placed at SB-03, recording field parameters from 8/24-30/2005
**Halfway between SB-07 and SB-08

2.1.2. Sediment Samples

Samples were taken with cores (subtidal = 30 cm by 5 cm diameter; intertidal = "clam guns," 1 m by 10 cm diameter) that were pushed into the sediment, capped (subtidal) and then pulled out with the sediment inside. Samples were split into an upper surface sample (upper 10 cm) and a lower deeper sample (rest of the core below 10 cm; the interval thickness of the lower samples ranged from 5 to 17 cm for subtidal (SB) stations and from 5 to 26 cm for intertidal (SH, SHB) stations, see Appendix 5.3). Separate cores were taken for metals (cores/clam guns made of plastic) and for organics (cores/clam guns made of aluminum). Multiple cores were needed to obtain sufficient sediment for analyses. Both upper and lower layers were analysed for metals to determine whether any concentration differences were present between the deeper zone and the zone near oxygenated surface water. SVOCs and PCBs were analyzed from lower layers to avoid recent deposition. Pesticides and PCBs were analyzed from upper layers at selected locations to compare with previous investigations.

2.1.3. Sampling method limitations

The sampling methods have some inherent limitations due to the materials used in their construction and to the method of acquiring the samples. These are discussed in detail in the QASP with major points reiterated here:

- Peristaltic pumps may have degassed some of the samples. This may have resulted in a low bias for VOCs.
- Contact with sampler materials was not expected to alter concentrations significantly due to short contact times. Blank samples were taken to account for this.

2.2 SAMPLE PROCESSING

Samples were processed in the field according to the QASP. Field parameters were recorded at many locations (Table 2-2)

2.3 LABORATORY METHODS

Laboratory methods followed the QASP (summarized in Table 2-3)

Table 2-3. Analytical methods for water and sediment analyses

ANALYTICAL GROUP	MATRIX	EPA METHODS
	Water	
Metals		6020/200.8
Mercury		1631E
SVOCs		8270
VOCs		8260
	Sediment	
Metals		6010/200.7
Mercury		245.5
SVOCs		8270
PCBs		8082
Pesticides		8081
TOC		PSEP/9060
Grain Size[a]		per MEL

[a] Grain size analyses not done due to lack of capacity at MEL

Deviations from the QASP were:

- The seepage meter samples were reanalyzed for Cu and Zn utilizing lower detection limits
- The samples selected for TOC and percent moisture were analyzed by EPA Region 7 Laboratory
- Grain size analyses were not done (lack of capacity at MEL)

3.0 Results

Analytical results of the ground water transition zone samples (piezometer and seepage meter samples) and sediment core samples (upper 10cm and below 10cm) are summarized in this section. Data presented in this section are the detected contaminants only. Complete data tables are attached in the Appendices and should be consulted for information on detection limits and qualifiers. Quality assurance was conducted in accordance with the QASP.

3.1 Ground Water Transition Zone Samples

Tables 3-1 and 3-2 present ground water data

Table 3-1. Detected metals in piezometer and seepage meter samples

Station	Mercury (ng/L)	Copper (ug/L)	Copper [ICP Low Det Limit] (ug/L)	Zinc (ug/L)
Piezometers				
SH-1	**37.3**			
SH-2	**48.8**			
SH-3	**2.25**			
SH-13	**1.37**			
SH-4	**23.7**			
SH-4 Dup	**26.8**			
SH-5	**2.99**			
SH-6	**2.52**			
SH-7	**2.06**			
SH-8	**1.6**			
SH-9	**2.7**			
SHB-06			**32**	
SHB-05		**259**	**264**	
Seepage meters				
SB-18A Bag4	**408**	**71**	**76.8**	**1560**
SB-07			**5.4**	**263**

Table 3-2. Detected organics in piezometer samples

Station	1,1'-Biphenyl (ug/L)	Benzo(a) pyrene (ug/L)	Benzo[b] fluoranthene (ug/L)	Benzo[k] fluoranthene (ug/L)	Bis(2-ethylhexyl) phthalate (ug/L)	Caprolactam (ug/L)	Diethyl phthalate (ug/L)	Fluoranthene (ug/L)	Pyrene (ug/L)
SH-1						**7.5**			
SH-2		**0.032**	**0.039**	**0.039**	**390**			**0.26**	**0.32**
SH-3					**5.7**	**3.4**			
SH-4	**0.032**				**2**	**4.8**			
SH-5					**4.3**	**6.8**			
SH-6	**0.026**					**3.1**			
SH-7						**2.2**			
SH-8					**3**	**2.4**			
SH-9						**1.5**			
SH-13					**6.7**	**5.3**			
Blank							**1.2**		
Insufficient ground water collected by seepage meters to analyze for organics									

3.2 Ground Water/Surface Water Field Parameters

Table 3-3. Ground water & surface water field parameters

Location	Date	Depth	Temperature (degrees C)	pH (units)	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Salinity (%)	Turbidity (NTUs)
Ground water								
SH-01	8/31/2004		20.9	6.4	21.1	8.77	1.27	71
SH-02	8/31/2004		21.4	7.26	27.8	8.38	1.72	85
SH-03	8/31/2004		21.1	6.66	30.3	9.32	1.89	93
SH-04	8/31/2004		21.6	7	28.2	8.72	1.75	98
SH-05	8/30/2004		19	6.92	19.3	9.2	1.15	174
SH-06	8/30/2004		19.3	6.65	21.2	8.79	1.27	144
SH-07	8/30/2004		18.6	6.7	29.4	9.45	1.83	147
SH-08	8/30/2004		18.2	7.32	26.9	9.52	1.65	181
SH-09	8/30/2004		18.3	7.08	32.2	9.23	2.02	138
SHB-06	9/1/2004		20.1	7.14	7.32	9.0*	0.39	139
SHB-05	8/30/2004		20	6.55	8.23	8.84*	0.45	161
Surface water								
SH07	8/30/2004	surf	18.1	7.27	13.4	4.8	0.77	359
River	8/31/2004	surf	19.7	7.23	3.46	6.3	0.17	19
SLIP-6**	8/30/2004	bottom	18.9	6.95	44		28.5	30
SB-18	9/1/2004	1 ft	18.2	7.16	10	6.6	0.56	12
SB-18	9/1/2004	8.4 ft	17.5	7.16	27.5	8.69	1.7	69
SB-08	9/1/2004	1 ft	19.4	7.41	5.47	6.9	0.28	13
SB-08	9/1/2004	bottom	21.8	7.6	43	5.35	2.76	31 - 48
SB-08	9/1/2004	bottom (duplicate)	15.8	7.51	45	4.42	2.9	10 – 14
*air entrained in tubing by pump; **Redox potential was 281 mV								

Data on field parameters from the two data-sonde recorders at the large seepage meter at SB-03 are shown in Appendix 5.5 Dive Report.

3.3 SEDIMENT SAMPLES

Sediment sample results are presented in Tables 3-4 through 3-7.

Table 3-4. Detected metals in sediment samples

STATION	MERCURY (MG/KG)	ARSENIC (MG/KG)	CADMIUM (MG/KG)	CHROMIUM (MG/KG)	COPPER (MG/KG)	LEAD (MG/KG)	NICKEL (MG/KG)	VANADIUM (MG/KG)	ZINC (MG/KG)
Upper SH-01	**0.055**	**8.3**		**9.19**	**54.9**	**14.1**	**11**	**28.3**	**44.5**
Upper SH-01 Dup	**0.055**								
Lower SH-01	**0.134**	**9.3**		**15.6**	**132**	**29.2**	**9.94**	**41.2**	**55.3**
Upper SH-02	**0.201**	**11**	**0.77**	**20.1**	**89.9**	**38.1**	**14.9**	**49.6**	**156**
Lower SH-02	**0.288**	**10**	**0.68**	**21.2**	**175**	**43.9**	**17.8**	**36.6**	**212**
Upper SH-03	**0.057**	**10**		**13**	**22.6**	**6.3**	**10.5**	**43.3**	**43.7**
Lower SH-03		**4.7**		**12.1**	**14**		**8.81**	**43.6**	**29.5**
Upper SH-04	**0.108**	**8.8**	**0.58**	**16**	**70.3**	**30.6**	**12.8**	**37.9**	**73.7**
Lower SH-04	**0.302**	**8.3**	**0.65**	**14.7**	**114**	**40.7**	**10.8**	**24.4**	**79.9**
Upper SH-05	**0.067**	**4.5**		**11.6**	**29.4**	**17.7**	**8.06**	**32.6**	**45.8**
Lower SH-05	**0.068**	**5.6**		**12.1**	**35.7**	**16.8**	**9.52**	**32.4**	**49.1**
Upper SH-06	**0.158**	**6.3**		**14.5**	**47.3**	**17.6**	**7.66**	**27.9**	**35.6**
Lower SH-06	**0.058**			**6.67**	**16.6**	**4.9**	**4.8**	**18**	**18.6**
Lower SH-06 Dup	**0.05**								
Upper SH-07	**0.106**	**7.7**		**12.6**	**23.2**	**8.2**	**10.8**	**34.6**	**44.4**
Lower SH-07	**0.107**	**6.4**		**14.1**	**22.2**	**8.3**	**11.9**	**47.4**	**43**
Lower SH-07 Dup		**6.8**		**15.9**	**22.7**	**8.1**	**12.1**	**52.1**	**43.9**
Upper SH-08	**0.106**	**6.4**		**14.6**	**28.8**	**11**	**13.5**	**37.8**	**59.4**
Lower SH-08	**0.157**	**6.9**		**15.3**	**31**	**13.8**	**14.2**	**40.7**	**74.1**
Upper SH-09	**0.099**	**8**		**12.2**	**23.6**	**9.8**	**12.3**	**32.6**	**47.5**
Upper SH-09 Dup	**0.083**								
Lower SH-09	**0.054**	**7.2**		**8.94**	**17.7**	**12**	**8.3**	**30.2**	**33.8**
Lower SH-13				**7.6**	**10.9**		**6.81**	**24.9**	**21.8**
Upper SB-01	**0.277**	**22**	**0.97**	**28.2**	**70**	**30**	**21.5**	**73.8**	**130**
Lower SB-01	**0.272**	**17**	**0.84**	**27.4**	**65.2**	**28.9**	**21.7**	**72.2**	**122**
Upper SB-02	**0.251**	**14**	**0.78**	**23.3**	**49.1**	**20.9**	**19.1**	**61.7**	**104**
Lower SB-02	**0.246**	**16**	**0.75**	**25.1**	**55.1**	**23.5**	**20.3**	**68.5**	**111**
Upper SB-15 *(SB-02 field dup)*	**0.353**	**16**	**0.74**	**23.8**	**49.4**	**22.2**	**19.7**	**63.7**	**108**
Lower SB-15 *(SB-02 field dup)*	**0.226**	**14**	**0.71**	**24.2**	**53.7**	**22.1**	**20**	**66.4**	**107**
Upper SB-03	**0.253**	**22.6**	**1**	**27.5**	**68.9**	**29.8**	**21**	**72.4**	**140**
Lower SB-03	**0.328**	**19**	**0.87**	**26.2**	**66.6**	**27.1**	**20.6**	**70.2**	**128**
Lower SB-03 Dup	**0.253**								
Upper SB-04	**0.27**	**20**	**0.91**	**27.7**	**66.6**	**28.1**	**21.7**	**72.4**	**128**
Lower SB-04	**0.318**	**16**	**0.78**	**26.8**	**63.2**	**27.4**	**21.6**	**71.5**	**126**
Upper SB-05	**0.259**	**20**	**0.82**	**26.7**	**63.1**	**27.6**	**20.8**	**69.1**	**125**
Lower SB-05	**0.237**	**17**	**0.81**	**27.8**	**63.2**	**28.7**	**22.1**	**71.6**	**121**
Upper SB-06	**0.283**	**19**	**0.67**	**24.7**	**59.6**	**27**	**20.2**	**63.8**	**113**
Lower SB-06	**0.216**	**12**	**0.57**	**20.2**	**45.6**	**19.4**	**16.3**	**53.9**	**118**
Upper SB-07	**0.232**	**20**	**0.74**	**25**	**59.4**	**26.4**	**20**	**65.2**	**115**

Station	Mercury (mg/Kg)	Arsenic (mg/Kg)	Cadmium (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Nickel (mg/Kg)	Vanadium (mg/Kg)	Zinc (mg/Kg)
Lower SB-07	**0.243**	**16**	**0.85**	**24**	**58.9**	**25.7**	**20**	**63.5**	**118**
Lower SB-07 Dup		**16**	**0.83**	**25.9**	**59.6**	**24.4**	**20.6**	**70.6**	**118**
Upper SB-08	**0.214**	**14**	**0.71**	**23.3**	**49.6**	**21.4**	**18.5**	**61.5**	**103**
Lower SB-08	**0.232**	**12**	**0.64**	**23**	**48.6**	**19.8**	**19.2**	**61.8**	**106**
Upper SB-17	**0.282**	**22**	**0.85**	**26.4**	**67.2**	**31.1**	**20.3**	**67.3**	**141**
Lower SB-17	**0.249**	**19**	**0.88**	**25.4**	**64.1**	**27.7**	**20**	**68.2**	**131**
Lower SB-16 *(SB-17 field dup)*	**0.288**	**20**	**0.75**	**25**	**65.6**	**30.1**	**20**	**67.9**	**114**
Upper SB-11	**0.29**	**8.7**	0.5	**20.2**	**38.7**	**17.8**	**17.2**	**55.4**	**78.3**
Lower SB-11	**0.17**	**9.1**	0.5	**20.2**	**38.3**	**16.5**	**19**	**51.3**	**73.5**
Upper SB-12	**0.139**	**14**	0.5	**20.1**	**37.8**	**17.7**	**16.8**	**55.8**	**78**
Upper SB-12 Dup		**13**	0.5	**19.8**	**37.2**	**16.4**	**16.3**	**55.3**	**74.8**
Lower SB-12	**0.174**	**9.3**	0.5	**20.9**	**38.5**	**14.4**	**19.2**	**55.4**	**68.9**
Upper SB-13	**0.194**	**7.9**	0.5	**20.3**	**37.1**	**16.5**	**15.2**	**52.4**	**68.3**
Lower SB-13	**0.21**	**11**	**0.54**	**22.6**	**49.9**	**16.5**	**16.8**	**55.6**	**77**
Blank					**0.96**				

Note: Al, Ba, Be, Ca, Co, Fe, Mg, Mn, K, Na data not shown here, see Appendix 5.1 for these data
Upper = upper 10 cm; Lower = below 10 cm (*interval thickness* for Lower ranged from 5 to 17 cm for subtidal (SB) stations and from 5 to 26 cm for intertidal (SH, SHB) stations, see Appendix 5.3)

Table 3-5. Detected PCB Aroclors in sediment samples

STATION	% SOLID	TOC[1]	PCB-1242 (UG/KG)	PCB-1254/1260 (UG/KG)	PCB-1254 (UG/KG)	PCB-1260 (UG/KG)	SUM DETECTS (UG/KG)	SUM DETECTS NORMALIZED[2] (UG/KG-TOC)
Lower SH-01	**75.2%**	**0.66%**				**130**	**130**	**19,700**
Lower SH-02	**54.6%**	**1.45%**			**300**		**300**	**20,700**
Upper SH-03	**70.2%**	**0.37%**			**10**		**10**	**2,680**
Lower SH-04	**67.4%**	**0.61%**	**820**	**1700**			**2520**	**413,000**
Upper SH-05	**76.5%**	**0.28%**	**450**	**800**			**1250**	**448,000**
Upper SH-06	**68.2%**	**0.50%**				**94**	**94**	**18,700**
Lower SH-06	**82.2%**	**0.08%**				**44**	**44**	**54,600**
Lower SH-07	**72.1%**	**0.47%**		**34**			**34**	**7,190**
Lower SH-08	**60.1%**	**1.10%**	**18**	**63**			**81**	**7,360**
Upper SH-09	**69.5%**	**0.62%**		**37**			**37**	**5,930**
Lower SH-09	**72.6%**	**0.38%**	**11**	**51**			**62**	**16,400**
Upper SH-13	**70.2%**	**0.30%**			**16**		**16**	**5,390**
Upper SB-01	**38.9%**	**2.72%**	**36**	**130**			**166**	**6,100**
Lower SB-01	**45.8%**	**2.50%**	**42**	**130**			**172**	**6,880**
Lower SB-02	**46.6%**	**2.32%**	**27**	**98**			**125**	**5,390**
Lower SB-15 ***(SB-02 field dup)***	**45.5%**	**2.29%**	**36**	**110**			**146**	**6,380**
Upper SB-03	**41.1%**	**2.72%**	**42**	**140**			**182**	**6,690**
Lower SB-03	**42.7%**	**2.94%**	**35**	**130**			**165**	**5,610**
Upper SB-04	**41.1%**	**3.17%**	**42**	**130**			**172**	**5,430**
Lower SB-04	**43.5%**	**3.44%**	**36**	**130**			**166**	**4,830**
Upper SB-05			**37**	**110**			**147**	
Lower SB-05	**44.8%**	**2.90%**	**40**	**150**			**190**	**6,550**
Lower SB-06	**48.5%**	**2.98%**	**30**	**110**			**140**	**4,700**
Lower SB-07	**45.9%**	**2.92%**	**29**	**110**			**139**	**4,760**
Upper SB-08	**42.6%**	**2.87%**	**17**	**43**			**60**	**2,090**
Lower SB-08	**46.7%**	**2.48%**	**44**	**110**			**154**	**6,210**
Lower SB-17	**44.2%**	**3.32%**		**120**			**120**	**3,610**
Lower SB-11	**52.2%**	**2.26%**	**110**				**110**	**4,870**
Upper SB-12	**53.9%**	**1.61%**	**48**	**71**			**119**	**7,390**
Lower SB-12	**53.7%**	**1.79%**	**26**	**53**			**79**	**4,410**
Lower SB-13	**64.0%**	**1.50%**	**18**	**120**			**138**	**9,200**

Upper = upper 10 cm; Lower = below 10 cm (*interval thickness* for Lower ranged from 5 to 17 cm for subtidal (SB) stations and from 5 to 26 cm for intertidal (SH, SHB) stations, see Appendix 5.3)

[1] TOC rounded to two decimal places (Calculations based on raw numbers)
[2] Normalized Sum rounded to three significant figures

Table 3-6. Detected Pesticides (ug/kg) in sediment samples

SEDIMENTS	UPPER SH-03	UPPER SH-06	UPPER SH-13	UPPER SH-16
% Solid	**70.2%**	**68.2%**	**70.2%**	
TOC	**0.37%**	**0.50%**	**0.30%**	
Aldrin				**0.014**
Alpha-BHC				**0.14**
Beta-BHC				**0.087**
cis-Chlordane				**0.2**
Delta-BHC				**0.081**
Dieldrin				**0.099**
EndosulfanI				**0.11**
Endosulfan II				**0.47**
Endosulfan Sulfate				**0.84**
Endrin				**9.1**
Endrin Aldehyde				**3.2**
Endrin Ketone				**3.7**
Gamma-chlordane				**2.4**
Heptachlor				**0.12**
Heptachlor Epoxide				**1**
Lindane				**0.05**
Methoxychlor				**2.8**
P,P'-DDD	**4.9**		**6.8**	**6.4**
Normalized to TOC	**1,314**		**2,290**	
P,P'-DDE	**5.4**		**7.3**	**3.1**
Normalized to TOC	**1,448**		**2,458**	
P,P'-DDT	**30**	**51**	**26**	**23**
Normalized to TOC	**8,043**	**10,159**	**8,754**	
P,P'-DDT (reanalysis 2/5/05)				**43**
Upper = upper 10 cm				

Table 3-7. Detected Organics (ug/kg) in sediment samples

Analyte	Lower SH-01	Lower SH-02	Upper SH-03	Lower SH-04	Upper SH-05	Upper SH-06	Lower SH-07	Lower SH-08	Upper SH-09	Lower SH-09
% Solid	**75.2%**	**54.6%**	**70.2%**	**67.4%**	**76.5%**	**68.2%**	**72.1%**	**60.1%**	**69.5%**	**72.6%**
TOC	**0.66%**	**1.45%**	**0.37%**	**0.61%**	**0.28%**	**0.50%**	**0.47%**	**1.10%**	**0.62%**	**0.38%**
1,2-Diphenylhydrazine							**100**			
normalized to TOC							**21,142**			
2-Chloronaphthalene										
normalized to TOC										
4-Methylphenol										
normalized to TOC										
9H-Carbazole										
normalized to TOC										
9H-Fluorene										
normalized to TOC										
Acenaphthene										
normalized to TOC										
Anthracene										
normalized to TOC										
Benzaldehyde										
normalized to TOC										
Benzo(a)anthracene		**390**		**150**				**150**		
normalized to TOC		**26,897**		**24,590**				**13,636**		
Benzo(a)pyrene		**490**						**140**		
normalized to TOC		**33,793**						**12,727**		
Benzo(g,h,i)perylene		**370**						**130**		
normalized to TOC		**25,517**						**11,818**		
Benzo[b]Fluoranthene	**250**	**880**	**290**	**310**	**260**	**220**	**290**	**420**	**250**	**200**
normalized to TOC	**37,879**	**60,690**	**77,748**	**50,820**	**93,190**	**43,825**	**61,311**	**38,182**	**40,064**	**53,050**
Benzo[k]fluoranthene		**490**		**92**				**210**		
normalized to TOC		**33,793**		**15,082**				**19,091**		
Benzoic acid			**940**			**840**	**930**			
normalized to TOC			**252,011**			**167,331**	**196,617**			
Bis(2-ethylhexyl)phthalate										

Analyte	Lower SH-01	Lower SH-02	Upper SH-03	Lower SH-04	Upper SH-05	Upper SH-06	Lower SH-07	Lower SH-08	Upper SH-09	Lower SH-09
normalized to TOC										
Caprolactam										
normalized to TOC										
Chrysene		**500**	**88**	**90**	**69**			**190**		
normalized to TOC			**23,592**	**14,754**	**24,731**			**17,273**		
Dibenzo[a,h]anthracene	**210**	**380**	**220**	**230**	**230**			**310**		
normalized to TOC	**31,818**	**26,207**	**58,981**	**37,705**	**82,437**			**28,182**		
Dibenzofuran										
normalized to TOC										
Diethyl phthalate	**2700**									
normalized to TOC	**409,091**									
Di-n-octylphthalate		**2000**								
normalized to TOC		**137,931**								
Fluoranthene		**1200**	**170**	**330**	**120**		**140**	**360**		**87**
normalized to TOC		**82,759**	**45,576**	**54,098**	**43,011**		**29,598**	**32,727**		**23,077**
Indeno(1,2,3-cd)pyrene	**150**	**470**	**180**	**170**	**180**	**150**	**190**	**270**	**160**	**130**
normalized to TOC	**22,727**	**32,414**	**48,257**	**27,869**	**64,516**	**29,880**	**40,169**	**24,545**	**25,641**	**34,483**
Isophorone						**430**				
normalized to TOC						**85,657**				
Pentachlorophenol	**840**			**930**						
normalized to TOC	**127,273**			**152,459**						
Phenanthrene		**190**						**120**		
normalized to TOC		**13,103**						**10,909**		
Phenol										
normalized to TOC										
Pyrene		**1100**	**130**	**590**	**100**		**110**	**330**		**69**
normalized to TOC		**75,862**	**34,853**	**96,721**	**35,842**		**23,256**	**30,000**		**18,302**
Retene		**130**		**300**	**99**			**230**	**100**	**120**
normalized to TOC		**8,966**		**49,180**	**35,484**			**20,909**	**16,026**	**31,830**

Analyte	Upper SB-01	Lower SB-01	Lower SB-02	Lower SB-15 *SB-02* *Field Dup*	Upper SB-03	Lower SB-03	Upper SB-04	Lower SB-04	Upper SB-05	Lower SB-05	Lower SB-06
% Solid	**38.9%**	**45.8%**	**46.6%**	**45.5%**	**41.1%**	**42.7%**	**41.1%**	**43.5%**		**44.8%**	**48.5%**
TOC	**2.72%**	**2.50%**	**2.32%**	**2.29%**	**2.72%**	**2.94%**	**3.17%**	**3.44%**		**2.90%**	**2.98%**
1,2-Diphenylhydrazine											
normalized to TOC											
2-Chloronaphthalene											
normalized to TOC											
4-Methylphenol					**210**						
normalized to TOC					**7,721**						
9H-Carbazole	**340**	**240**			**250**	**170**					
normalized to TOC	**12,500**	**9,600**			**9,191**	**5,782**					
9H-Fluorene	**140**	**87**									
normalized to TOC	**5,147**	**3,480**									
Acenaphthene	**86**		**16**								
normalized to TOC	**3,162**		**690**								
Anthracene	**280**	**190**	**89**	**98**	**180**	**150**	**110**	**110**	**110**	**77**	**81**
normalized to TOC	**10,294**	**7,600**	**3,836**	**4,279**	**6,618**	**5,102**	**3,470**	**3,198**		**2,655**	**2,718**
Benzaldehyde	**210**	**280**	**180**	**190**	**200**	**210**	**380**	**290**	**250**	**260**	**250**
normalized to TOC	**7,721**	**11,200**	**7,759**	**8,297**	**7,353**	**7,143**	**11,987**	**8,430**		**8,966**	**8,389**
Benzo(a)anthracene	**1400**	**1000**	**460**	**450**	**990**	**730**	**460**	**500**	**550**	**340**	**310**
normalized to TOC	**51,471**	**40,000**	**19,828**	**19,651**	**36,397**	**24,830**	**14,511**	**14,535**		**11,724**	**10,403**
Benzo(a)pyrene	**1400**	**1200**	**350**	**390**	**1100**	**860**	**480**	**540**	**460**	**360**	**340**
normalized to TOC	**51,471**	**48,000**	**15,086**	**17,031**	**40,441**	**29,252**	**15,142**	**15,698**		**12,414**	**11,409**
Benzo(g,h,i)perylene	**1100**	**860**	**290**	**290**	**820**	**640**	**380**	**410**	**330**	**310**	**280**
normalized to TOC	**40,441**	**34,400**	**12,500**	**12,664**	**30,147**	**21,769**	**11,987**	**11,919**		**10,690**	**9,396**
Benzo[b]Fluoranthene	**2000**	**1800**	**770**	**870**	**1700**	**1600**	**990**	**1100**	**1200**	**900**	**760**
normalized to TOC	**73,529**	**72,000**	**33,190**	**37,991**	**62,500**	**54,422**	**31,230**	**31,977**		**31,034**	**25,503**
Benzo[k]fluoranthene	**1700**	**1400**	**470**	**410**	**1200**	**850**	**500**	**580**	**540**	**400**	**400**
normalized to TOC	**62,500**	**56,000**	**20,259**	**17,904**	**44,118**	**28,912**	**15,773**	**16,860**		**13,793**	**13,423**
Benzoic acid						**2000**	**1900**	**1700**		**1800**	**1800**
normalized to TOC						**68,027**	**59,937**	**49,419**		**62,069**	**60,403**
Bis(2-ethylhexyl)phthalate	**1600**	**1600**			**2100**	**2100**	**1900**	**1700**		**1600**	

Analyte	Upper SB-01	Lower SB-01	Lower SB-02	Lower SB-15 *SB-02 Field Dup*	Upper SB-03	Lower SB-03	Upper SB-04	Lower SB-04	Upper SB-05	Lower SB-05	Lower SB-06
normalized to TOC	**58,824**	**64,000**			**77,206**	**71,429**	**59,937**	**49,419**		**55,172**	
Caprolactam									**27**		
normalized to TOC											
Chrysene	**2100**	**1400**	**590**	**600**	**1400**	**1100**	**680**	**620**	**1100**	**430**	**410**
normalized to TOC	**77,206**	**56,000**	**25,431**	**26,201**	**51,471**	**37,415**	**21,451**	**18,023**		**14,828**	**13,758**
Dibenzo[a,h]anthracene	**700**	**630**	**380**	**410**	**630**	**540**	**460**	**490**	**460**	**420**	**420**
normalized to TOC	**25,735**	**25,200**	**16,379**	**17,904**	**23,162**	**18,367**	**14,511**	**14,244**		**14,483**	**14,094**
Dibenzofuran	**110**										
normalized to TOC	**4,044**										
Diethyl phthalate											
normalized to TOC											
Di-n-octylphthalate											
normalized to TOC											
Fluoranthene	**4800**	**3500**	**1100**	**1300**	**3200**	**2500**	**1300**	**1400**	**1500**	**950**	**900**
normalized to TOC	**176,471**	**140,000**	**47,414**	**56,769**	**117,647**	**85,034**	**41,009**	**40,698**		**32,759**	**30,201**
Indeno(1,2,3-cd)pyrene	**1200**	**970**	**420**	**440**	**950**	**800**	**540**	**580**	**520**	**470**	**440**
normalized to TOC	**44,118**	**38,800**	**18,103**	**19,214**	**34,926**	**27,211**	**17,035**	**16,860**		**16,207**	**14,765**
Isophorone											
normalized to TOC											
Pentachlorophenol											
normalized to TOC											
Phenanthrene	**1800**	**1300**	**350**	**340**	**1100**	**790**	**490**	**440**	**330**	**290**	**280**
normalized to TOC	**66,176**	**52,000**	**15,086**	**14,847**	**40,441**	**26,871**	**15,457**	**12,791**		**10,000**	**9,396**
Phenol	**160**				**1400**	**3100**	**1400**				
normalized to TOC	**5,882**				**51,471**	**105,442**	**44,164**				
Pyrene	**3600**	**2800**	**970**	**1000**	**2600**	**1800**	**1100**	**1200**	**1300**	**820**	**750**
normalized to TOC	**132,353**	**112,000**	**41,810**	**43,668**	**95,588**	**61,224**	**34,700**	**34,884**		**28,276**	**25,168**
Retene	**240**	**220**	**180**	**190**	**310**	**210**	**250**	**230**	**230**	**210**	**200**
normalized to TOC	**8,824**	**8,800**	**7,759**	**8,297**	**11,397**	**7,143**	**7,886**	**6,686**		**7,241**	**6,711**

Analyte	Lower SB-07	Upper SB-08	Lower SB-08	Lower SB-11	Upper SB-12	Lower SB-12	Lower SB-13	Lower SB-15	Lower SB-16 *SB-17 Field Dup*	Lower SB-17
% Solid	**45.9%**	**42.6%**	**46.7%**	**52.2%**	**53.9%**	**53.7%**	**64.0%**	**45.5%**	**45.1%**	**44.2%**
TOC	**2.92%**	**2.87%**	**2.48%**	**2.26%**	**1.61%**	**1.79%**	**1.50%**	**2.29%**	**3.71%**	**3.32%**
1,2-Diphenylhydrazine										
normalized to TOC										
2-Chloronaphthalene									**16**	
normalized to TOC									**431**	
4-Methylphenol										
normalized to TOC										
9H-Carbazole									**200**	**220**
normalized to TOC									**5,391**	**6,627**
9H-Fluorene										
normalized to TOC										
Acenaphthene										
normalized to TOC										
Anthracene	**70**				**220**	**140**		**98**	**180**	**210**
normalized to TOC	**2,397**				**13,665**	**7,821**		**4,279**	**4,852**	**6,325**
Benzaldehyde	**290**	**200**			**120**	**110**		**190**		**320**
normalized to TOC	**9,932**	**6,969**			**7,453**	**6,145**		**8,297**		**9,639**
Benzo(a)anthracene	**330**	**270**	**260**	**140**	**1400**	**620**	**180**	**450**	**830**	**1100**
normalized to TOC	**11,301**	**9,408**	**10,484**	**6,195**	**86,957**	**34,637**	**12,000**	**19,651**	**22,372**	**33,133**
Benzo(a)pyrene	**320**	**270**	**290**	**110**	**640**	**470**	**160**	**390**	**1000**	**1300**
normalized to TOC	**10,959**	**9,408**	**11,694**	**4,867**	**39,752**	**26,257**	**10,667**	**17,031**	**26,954**	**39,157**
Benzo(g,h,i)perylene	**260**	**250**	**270**	**130**	**260**	**240**	**120**	**290**	**730**	**910**
normalized to TOC	**8,904**	**8,711**	**10,887**	**5,752**	**16,149**	**13,408**	**8,000**	**12,664**	**19,677**	**27,410**
Benzo[b]Fluoranthene	**780**	**780**	**700**	**420**	**1100**	**850**	**400**	**870**	**1700**	**1800**
normalized to TOC	**26,712**	**27,178**	**28,226**	**18,584**	**68,323**	**47,486**	**26,667**	**37,991**	**45,822**	**54,217**
Benzo[k]fluoranthene	**310**	**300**	**320**	**130**	**830**	**640**	**170**	**410**	**990**	**1300**
normalized to TOC	**10,616**	**10,453**	**12,903**	**5,752**	**51,553**	**35,754**	**11,333**	**17,904**	**26,685**	**39,157**
Benzoic acid	**1700**	**1700**	**1500**	**1200**	**1300**	**1300**			**2000**	**1800**
normalized to TOC	**58,219**	**59,233**	**60,484**	**53,097**	**80,745**	**72,626**			**53,908**	**54,217**

Analyte	Lower SB-07	Upper SB-08	Lower SB-08	Lower SB-11	Upper SB-12	Lower SB-12	Lower SB-13	Lower SB-15	Lower SB-16 *SB-17 Field Dup*	Lower SB-17
Bis(2-ethylhexyl)phthalate	**1400**								**1800**	**1800**
normalized to TOC									**48,518**	**54,217**
Caprolactam										
normalized to TOC										
Chrysene	**420**	**350**	**340**	**160**	**1600**	**950**	**200**	**600**	**1300**	**1500**
normalized to TOC	**14,384**	**12,195**	**13,710**	**7,080**	**99,379**	**53,073**	**13,333**	**26,201**	**35,040**	**45,181**
Dibenzo[a,h]anthracene	**410**	**440**	**410**	**320**	**420**	**380**	**300**	**410**	**630**	**660**
normalized to TOC	**14,041**	**15,331**	**16,532**	**14,159**	**26,087**	**21,229**	**20,000**	**17,904**	**16,981**	**19,880**
Dibenzofuran										
normalized to TOC										
Diethyl phthalate										
normalized to TOC										
Di-n-octylphthalate										
normalized to TOC										
Fluoranthene	**760**	**720**	**700**	**270**	**5300**	**2700**	**440**	**1300**	**3100**	**3800**
normalized to TOC	**26,027**	**25,087**	**28,226**	**11,947**	**329,193**	**150,838**	**29,333**	**56,769**	**83,558**	**114,458**
Indeno(1,2,3-cd)pyrene	**420**	**410**	**410**	**250**	**430**	**370**	**250**	**440**	**860**	**1000**
normalized to TOC	**14,384**	**14,286**	**16,532**	**11,062**	**26,708**	**20,670**	**16,667**	**19,214**	**23,181**	**30,120**
Isophorone										
normalized to TOC										
Pentachlorophenol										
normalized to TOC										
Phenanthrene	**230**	**240**	**250**	**110**	**900**	**230**	**250**	**340**	**1100**	**1300**
normalized to TOC	**7,877**	**8,362**	**10,081**	**4,867**	**55,901**	**12,849**	**16,667**	**14,847**	**29,650**	**39,157**
Phenol	**380**								**480**	
normalized to TOC	**13,014**								**12,938**	
Pyrene	**680**	**580**	**610**	**290**	**4100**	**3900**	**360**	**1000**	**2100**	**2800**
normalized to TOC	**23,288**	**20,209**	**24,597**	**12,832**	**254,658**	**217,877**	**24,000**	**43,668**	**56,604**	**84,337**
Retene	**210**	**250**	**220**	**220**	**200**	**160**	**270**	**190**	**210**	**240**
normalized to TOC	**7,192**	**8,711**	**8,871**	**9,735**	**12,422**	**8,939**	**18,000**	**8,297**	**5,660**	**7,229**

Upper = upper 10 cm; Lower = below 10 cm (*interval thickness* for Lower ranged from 5 to 17 cm for subtidal (SB) stations and from 5 to 26 cm for intertidal (SH, SHB) stations, see Appendix 5.3)

4.0 References

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

5.0 Appendices

5.1 DATA RESULTS

5.2 QASP

5.3 FIELD NOTEBOOKS

5.4 SAMPLE DATA AND CHAIN OF CUSTODY FORMS

5.5 DIVE REPORT

5.6 PREVIOUS TRANSITION ZONE CHARACTERIZATION

5.1 DATA RESULTS

5.2 QASP

5.3 Field Notebooks

5.4 Sample Data and Chain of Custody Forms

5.5 Dive Report

5.6 Previous Transition Zone Characterization