East Waterway, Harbor Island Superfund Site

SLIP 27 SEDIMENT SAMPLING RESULTS

For submittal to

The U.S. Environmental Protection Agency
Region 10
Seattle, WA

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1 Project Overview

This memorandum presents the results of the sediment sampling conducted in Slip 27 in accordance with Slip 27 Sampling Plan (Windward 2007). The Port is constructing a cargo connection bridge on the east end of Slip 27 and removing approximately 400 dilapidated creosote pilings from the southwest margin of Slip 27. This sediment investigation was conducted independently by the Port of Seattle (Port) with review and input from the US Environmental Protection Agency (EPA). To address EPA concerns at the site, the Port agreed to obtain samples from the footprint of the cargo connection bridge prior to installation of the bridge deck, since the bridge deck would likely impede any future sediment sampling efforts. The Port also sampled the sediment around the pilings in order to characterize the material that was re-suspending during the removal process.

2 Sampling and Results

Sediment sampling occurred on January 10 and 12, 2007. Six surface sediment grabs and three 4-ft cores that were analyzed in 1-ft sample intervals were collected and analyzed for the full suite Washington State Sediment Management Standards (SMS) chemicals, organochlorine pesticides, and bulk tributyltin (TBT).

2.1 SAMPLING LOCATIONS AND ACTIVITIES

All field activities were performed under the direction of the field coordinator. Sampling was accomplished by a joint operation of Windward and Research Support Services and Bio Marine Enterprises. Sediment cores were collected with a 4-in diameter barrel vibracorer and surface grabs were collected with a 0.1m^2 van Veen grab sampler.

Grab samples were processed on the boat immediately after collection. Core samples were processed at Analytical Resources, Inc within 24 hrs of collection. The core samples were to be collected to the maximum depth possible with 5.5 ft being the maximum depth possible with the coring device under ideal conditions (Blomberg et al. 2007). The final core depths were 4.2 ft (S27-1C) and 3.5 ft (S27-2C and S27-3C) which represent the maximum sediment penetration achieved at these locations. Sediment collection and processing followed standardized procedures for the Puget Sound area that have been developed by Puget Sound Estuary Program (PSEP 1997). The location and descriptions of the samples are presented in Table 1 and shown on Figure 1a and 1b.

Table 1. Slip 27 location descriptions

Location ID	Map ID	Location Type	Date	Actual Coordinates[a]		Target Coordinates[a]	
				X	Y	X	Y
EW-S27-1G	1G	Grab	1/10/07	1267842	214883	1267918	214815
EW-S27-2G[b]	2G	Grab	1/10/07	1267923	214966	1267881	214918
EW-S27-3G	3G	Grab	1/10/07	1267819	214973	1267977	214867
EW-S27-4G	4G	Grab	1/10/07	1268456	214495	1268456	214459
EW-S27-5G	5G	Grab	1/12/07	1268453	214579	1268458	214575
EW-S27-9G	9G	Grab	1/12/07	1268428	214502	1268426	214501
EW-S27-1C	1C	Core	1/12/07	1268459	214511	1268457	214511
EW-S27-2C	2C	Core	1/12/07	1268442	214583	1268457	214511
EW-S27-3C	3C	Core	1/12/07	1268394	214546	1268383	214547

[a] Washington State Plane North, NAD83, US survey ft.

[b] field duplicate EW-S27-101G was collected from this location

2.2 LABORATORY METHODS

The methods used to chemically analyze sediment samples are summarized in Table 2 and described in detail the Slip 27 Sampling Plan (Windward 2007).

Table 2. Summary laboratory methods

Parameter	Units	Method
Semivolatile organic compounds (SVOC)	µg/kg dw	GC/MS (EPA 8270D)
Selected SVOC[a]	µg//kg dw	GC/MS (EPA 8270D-SIM)
Polychlorinated biphenyls (PCBs)	µg/kg dw	GC/ECD (EPA 8082)
Organochlorine pesticides[b]	µg/kg dw	GC/ECD (EPA 8081A)
Butyltins	µg/kg dw	GC/MS (EPA 8270-SIM)
Mercury	mg/kg dw	CVAA (EPA 7471)
Other metals[c]	mg/kg dw	ICP-AES or ICP-MS (EPA 6010B or 6020)
TOC	percent dw	Combustion (Plumb 1981)
Grain size	percent dw	Sieve/ hydrometer (PSEP 1986)
Total solids	percent dw	Combustion (EPA 160.1)

[a] Selected SVOCs for SIM include: 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 2,4-dimethylphenol, 2-methylphenol, benzoic acid, benzyl alcohol, butyl benzyl phthalate, hexachlorobenzene, hexachlorobutadiene, n-nitrosodimethylamine, n-nitrosodiphenylamine, n-nitrosodi-n-propylamine, and pentachlorophenol. Dibenzo(a,h)anthracene and dimethyl phthalate were added to the SIM analyte list for the analysis of archived samples, and benzoic acid was moved to the full-scan analyte list for reasons discussed in Section 3.3. Chemicals analyzed using SIM were not included in the EPA Method 8270D analyte list

[b] Target pesticides include 4,4'-DDT, 4,4'-DDE, 4,4'-DDD, 2,4'-DDT, 2,4'-DDE, 2,4'-DDD, aldrin, alpha-benzene hexachloride (BHC), beta-BHC, delta-BHC, gamma-BHC, oxychlordane, alpha- and gamma-chlordane, cis- and trans-nonachlor, dieldrin, endosulfan, endosulfan sulfate, endrin, heptachlor, heptachlor epoxide, hexachlorobenzene, methoxychlor, mirex, and toxaphene.

[c] Other metals include arsenic, cadmium, chromium, copper, lead, silver, antimony, nickel, and zinc

dw – dry weight
AES – atomic emission spectrometry
CVAA – Cold vapor atomic absorption
ECD – electron capture detection
GC – gas chromatography
MS – mass spectroscopy
PCB – polychlorinated biphenyl
PSEP – Puget Sound Estuary Program
na – not applicable
SIM – selected ion monitoring
TOC - total organic carbon

2.3 FIELD AND LABORATORY DEVIATIONS

Sediment samples could not be obtained from the head of Slip 27 just east of the bridge location. Several attempts were made to collect surface sediment samples in this area, but large cobbles made it impossible for the sampler to penetrate to the sediment surface. The target sediment locations for 4C, 6G, 7G, and 8G are shown on Figure 1. Samples 1G, 2G, and 3G were collected from locations with deeper depths than the target locations due to the vessel's inability to access the target locations due to the presence of the dilapidated pier and pilings. The samples were collected from locations as close to the pier and surrounding pilings as possible and were still within the removal area. The sediment coring device was not able to achieve maximum penetration at any of the coring locations. The core samples were collected to the maximum achievable depths (3.5 ft and 4.2 ft) which were less than the maximum possible depth of 5.5 ft for the coring device under ideal conditions.

The laboratory followed all methods and procedures outlined in the Slip 27 Sampling Plan (Windward 2007); there were no laboratory deviations.

2.4 ANALYTICAL RESULTS

Sediment and chemistry results were compared to the SMS sediment standards. The criteria values and analytical results are presented in Tables 3 and 4. When SMS standards were not available, Dredge Material Management Program (DMMP) guidelines, screening level (SL) and maximum level (ML) values were used. For those chemicals whose standards are based on organic-carbon normalized concentrations [i.e. polycyclic aromatic hydrocarbons(PAHs), polychlorinated biphenyls (PCBs), and phthalates], four samples with organic carbon contents greater than 4% were not organic carbon normalized (S27-1G,S27-4G, S27-1C [0-1 ft], S27-3C [0-1 ft and 3-4 ft]). The concentrations associated with these samples were compared to the two lowest available Apparent Effects Threshold (AET) values on a dry weight basis. In the Tables 3 and 4 and Figures 2, 4 and 5, exceedance of the lowest AET (LAET) value is presented as a Sediment Quality Standard (SQS) exceedance and exceedance of the 2nd lowest AET (2LAET) value is presented as a Cleanup Screening Level (CSL) exceedance.

Table 3a. East Waterway - Slip 27 grab sample data comparison to SMS and DMMP values

Analyte	Unit	SQS/SL	CSL/ML	EW-S27-1G-010[a]	EW-S27-2G-010	EW-S27-101G-010[b]	EW-S27-3G-010	EW-S27-4G-010[a]	EW-S27-5G-010	EW-S27-9G-010
				0 – 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm
Metals and trace elements										
Antimony	mg/kg dw	150	200	*8 UJ*	9 UJ	9 UJ	8 UJ	8 UJ	7 UJ	8 UJ
Arsenic	mg/kg dw	57	93	*16.2 J*	10.6 J	9.7 J	9.0 J	3.5 J	4.5 J	5.6 J
Cadmium	mg/kg dw	5.1	6.7	*2.6*	1.4	1.3	1.5	0.4	1.2	1.2
Chromium	mg/kg dw	260	270	*30.4*	34.0	32.0	28.8	16.0	20.7	22.6
Copper	mg/kg dw	390	390	*93.5*	78.8	75.5	68.1	44.6	40.3	53.3
Lead	mg/kg dw	450	530	*109*	69	60	55	57	31	47
Mercury	mg/kg dw	0.41	0.59	***0.53 J***	0.37 J	0.36 J	0.31 J	0.10 J	0.13 J	0.13 J
Nickel	mg/kg dw	140	370	*18*	21	20	17	11	14	14
Selenium	mg/kg dw	nv	nv	*0.8 U*	0.9 U	0.9 U	0.9 U	0.8 U	0.7 U	0.8 U
Silver	mg/kg dw	6.1	6.1	*1.4*	1.3	1.1	1.1	0.5 U	0.5	0.5 U
Zinc	mg/kg dw	410	960	***500***	222	192	230	109	203	180
Organometals										
Monobutyltin as ion	µg/kg dw	nv	nv	5.3	5.7	7.1	5.1	3.6 U	8.4	8.4
Dibutyltin as ion	µg/kg dw	nv	nv	15	20	22	21	11	13	22
Tributyltin as ion	µg/kg dw	nv	nv	67	130	150	120	70	48	60
PAHs										
1-Methylnaphthalene	µg/kg dw	nv	nv	37	31 U	31 U	31 U	180	31 U	31 U
2-Chloronaphthalene	µg/kg dw	nv	nv	31 U	31 U	31 U	31 U	31 U	31 U	31 U
2-Methylnaphthalene	mg/kg OC	38	64	AET	1.2 U	1.5	1.5	AET	1.2 U	1.8
Acenaphthene	mg/kg OC	16	57	AET	2.1	2.6	4.0	AET	1.4	3.2
Acenaphthylene	mg/kg OC	66	66	AET	1.7	2.9	1.9	AET	1.2 U	5.0
Anthracene	mg/kg OC	220	1,200	AET	9.8	14	12	AET	5.2	35
Benzo(a)anthracene	mg/kg OC	110	270	AET	20	33	26	AET	10	**150**
Benzo(a)pyrene	mg/kg OC	99	210	AET	19	31	24	AET	10	73
Benzo(b)fluoranthene	µg/kg dw	nv	nv	930	1,100	1,600	1,000	1,600	560	2,500
Benzo(g,h,i)perylene	mg/kg OC	31	78	AET	6.0	9.1	5.9	AET	3.2	12
Benzo(k)fluoranthene	µg/kg dw	nv	nv	940	380	530	390	510	200	900
Benzofluoranthenes (total-calc'd)	mg/kg OC	230	450	AET	56	100	64	AET	30	180

Table 3a, cont.

Analyte	Unit	SQS/SL	CSL/ML	EW-S27-1G-010[a]	EW-S27-2G-010	EW-S27-101G-010[b]	EW-S27-3G-010	EW-S27-4G-010[a]	EW-S27-5G-010	EW-S27-9G-010
				0 – 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm
Chrysene	mg/kg OC	110	460	AET	32	67	37	AET	18	**160**
Dibenzo(a,h)anthracene	mg/kg OC	12	33	AET	2.9	5.3	4.0	AET	2.0	9.8
Dibenzofuran	mg/kg OC	15	58	AET	1.8	2.9	2.7	AET	1.2 U	2.4
Fluoranthene	mg/kg OC	160	1,200	AET	56	160	55	AET	25	140
Fluorene	mg/kg OC	23	79	AET	3.7	3.9	4.6	AET	1.3	4.6
Indeno(1,2,3-cd)pyrene	mg/kg OC	34	88	AET	7.9	11	7.3	AET	4.0	16
Naphthalene	mg/kg OC	99	170	AET	1.2 U	1.8	1.6	AET	1.2	2.4
Phenanthrene	mg/kg OC	100	480	AET	27	67	24	AET	8.8	30
Pyrene	mg/kg OC	1,000	1,400	AET	41	96	46	AET	21	160
Total HPAH (calc'd)	mg/kg OC	960	5,300	AET	240	517	260	AET	124	891
Total LPAH (calc'd)	mg/kg OC	370	780	AET	44	91	47.9	AET	18	79.8
Total PAH (calc'd)	µg/kg dw	nv	nv	7,900	7,600	12,700	6,900	13,500	3,540	18,800
Phthalates										
Bis(2-ethylhexyl) phthalate	mg/kg OC	47	78	AET	15	21	22	AET	11	40
Butyl benzyl phthalate	mg/kg OC	4.9	64	AET	2.7 J	1.3	1.3	AET	0.56 J	1.3
Diethyl phthalate	mg/kg OC	61	110	AET	1.2 U	1.5 U	1.4 U	AET	1.2 U	1.6 U
Dimethyl phthalate	mg/kg OC	53	53	AET	0.23 U	0.33 U	0.28 U	AET	0.24 U	0.45 U
Di-n-butyl phthalate	mg/kg OC	220	1,700	AET	1.2 U	3.3 U	1.7 U	AET	1.2 U	1.6 U
Di-n-octyl phthalate	mg/kg OC	58	4,500	AET	1.2 U	1.5 U	1.4 U	AET	1.2 U	1.6 U
Other SVOCs										
1,2,4-Trichlorobenzene	mg/kg OC	0.81	1.8	AET	0.23 U	0.30 U	0.28 U	AET	0.24 U	0.32 U
1,2-Dichlorobenzene	mg/kg OC	2.3	2.3	AET	0.23 U	0.30 U	0.28 U	AET	0.24 U	0.32 U
1,3-Dichlorobenzene	µg/kg dw	170	nv	31 U	31 U	31 U	31 U	31 U	31 U	31 U
1,4-Dichlorobenzene	mg/kg OC	3.1	9	AET	1.1	1.3	2.3	AET	0.29	0.32
2,4,5-Trichlorophenol	µg/kg dw	nv	nv	150 U	160 U	160 U	150 U	150 U	150 U	150 U
2,4,6-Trichlorophenol	µg/kg dw	nv	nv	150 U	160 U	160 U	150 U	150 U	150 U	150 U
2,4-Dichlorophenol	µg/kg dw	nv	nv	150 U	160 U	160 U	150 U	150 U	150 U	150 U
2,4-Dimethylphenol	µg/kg dw	29	29	**90 J**	6.2 U	6.2 U	6.2 U	6.2 U	6.1 U	6.8
2,4-Dinitrophenol	µg/kg dw	nv	nv	310 U	310 U	310 UJ	310 U	310 U	310 U	310 U

Table 3a, cont.

Analyte	Unit	SQS/SL	CSL/ML	EW-S27-1G-010[a]	EW-S27-2G-010	EW-S27-101G-010[b]	EW-S27-3G-010	EW-S27-4G-010[a]	EW-S27-5G-010	EW-S27-9G-010
				0 – 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm
2,4-Dinitrotoluene	µg/kg dw	nv	nv	150 U	160 U	160 U	150 U	340	150 U	150 U
2,6-Dinitrotoluene	µg/kg dw	nv	nv	150 U	160 U	160 U	150 U	150 U	150 U	150 U
2-Chlorophenol	µg/kg dw	nv	nv	31 U	31 U	31 U	31 U	31 U	31 U	31 U
2-Methylphenol	µg/kg dw	63	63	38 J	6.2 U	6.2 U	6.2 U	6.2 U	6.1 U	6.2 U
2-Nitroaniline	µg/kg dw	nv	nv	150 U	160 U	160 U	150 U	150 U	150 U	150 U
2-Nitrophenol	µg/kg dw	nv	nv	150 U	160 U	160 U	150 U	150 U	150 U	150 U
3,3'-Dichlorobenzidine	µg/kg dw	nv	nv	150 U	160 U	160 U	150 U	150 U	150 U	150 U
3-Nitroaniline	µg/kg dw	nv	nv	150 U	160 U	160 U	150 U	150 U	150 U	150 U
4,6-Dinitro-o-cresol	µg/kg dw	nv	nv	310 U	310 U	310 U	310 U	310 U	310 U	310 U
4-Bromophenyl phenyl ether	µg/kg dw	nv	nv	31 U	31 U	31 U	31 U	31 U	31 U	31 U
4-Chloro-3-methylphenol	µg/kg dw	nv	nv	150 U	160 U	160 U	150 U	150 U	150 U	150 U
4-Chloroaniline	µg/kg dw	nv	nv	150 U	160 U	160 U	150 U	150 U	150 U	150 U
4-Chlorophenyl phenyl ether	µg/kg dw	nv	nv	31 U	31 U	31 U	31 U	31 U	31 U	31 U
4-Methylphenol	µg/kg dw	670	670	120	31 U	31 U	38	31 U	31 U	31 U
4-Nitroaniline	µg/kg dw	nv	nv	150 U	160 U	160 U	150 U	150 U	150 U	150 U
4-Nitrophenol	µg/kg dw	nv	nv	150 U	160 U	160 U	150 U	150 UJ	150 U	150 UJ
Aniline	µg/kg dw	nv	nv	31 U	31 U	31 UJ	31 U	31 UJ	31 U	31 UJ
Benzoic acid	µg/kg dw	650	650	310 U	310 U	310 U	310 U	310 U	310 U	310 U
Benzyl alcohol	µg/kg dw	57	73	31 UJ	31 UJ	31 UJ	31 UJ	31 UJ	31 UJ	31 UJ
bis(2-chloroethoxy)methane	µg/kg dw	nv	nv	31 U	31 U	31 U	31 U	31 U	31 U	31 U
bis(2-chloroethyl)ether	µg/kg dw	nv	nv	31 U	31 U	31 U	31 U	31 U	31 U	31 U
bis(2-chloroisopropyl)ether	µg/kg dw	nv	nv	31 U	31 U	31 U	31 U	31 U	31 U	31 U
Hexachlorobenzene	mg/kg OC	0.38	2.3	AET	0.18 U	0.096 U	0.22 U	AET	0.038 U	0.10 U
Hexachlorobutadiene	mg/kg OC	3.9	6.2	AET	0.18 U	0.096 U	0.22 U	AET	0.038 U	0.10 U
Hexachlorocyclopentadiene	µg/kg dw	nv	nv	150 U	160 U	160 U	150 U	150 U	150 U	150 U
Hexachloroethane	µg/kg dw	1,400	14,000	31 U	31 U	31 U	31 U	31 U	31 U	31 U
Isophorone	µg/kg dw	nv	nv	31 U	31 U	31 U	31 U	31 U	31 U	31 U
Nitrobenzene	µg/kg dw	nv	nv	31 U	31 U	31 U	31 U	31 U	31 U	31 U
N-Nitrosodimethylamine	µg/kg dw	nv	nv	31 UJ	31 UJ	31 UJ	31 UJ	31 UJ	31 UJ	31 UJ

Table 3a, cont.

Analyte	Unit	SQS/SL	CSL/ML	EW-S27-1G-010[a]	EW-S27-2G-010	EW-S27-101G-010[b]	EW-S27-3G-010	EW-S27-4G-010[a]	EW-S27-5G-010	EW-S27-9G-010
				0 – 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm
N-Nitroso-di-n-propylamine	µg/kg dw	nv	nv	31 U	31 U	31 U	31 U	31 U	31 U	31 U
N-Nitrosodiphenylamine	mg/kg OC	11	11	AET	0.35 U	0.44 U	0.39 U	AET	0.24 U	0.62 U
Pentachlorophenol	µg/kg dw	360	690	110 J	67	66	63	71	58 U	65
Phenol	µg/kg dw	420	1,200	92	42	31	82	31 U	31 U	31 U
Polychlorinated biphenyls										
Aroclor-1016	µg/kg dw	nv	nv	160 U	170 U	58 U	100 U	59 U	57 U	95 U
Aroclor-1221	µg/kg dw	nv	nv	160 U	170 U	58 U	100 U	59 U	57 U	95 U
Aroclor-1232	µg/kg dw	nv	nv	160 U	170 U	120 U	100 U	59 U	57 U	95 U
Aroclor-1242	µg/kg dw	nv	nv	160 U	170 U	58 U	100 U	59 U	57 U	95 U
Aroclor-1248	µg/kg dw	nv	nv	240 U	170 U	120 U	160 U	59 U	57 U	95 U
Aroclor-1254	µg/kg dw	nv	nv	400	300	270	280	90	120	170
Aroclor-1260	µg/kg dw	nv	nv	610	420	420	450	200	200	310
Total PCBs	mg/kg OC	12	65	AET	**27**	**33**	**33**	AET	**13**	**25**
Pesticides										
2,4'-DDD	µg/kg dw	nv	nv	9.8 U	9.9 U	3.9 U	9.7 U	9.9 U	1.9 U	3.9 U
2,4'-DDE	µg/kg dw	nv	nv	9.8 U	9.9 U	21 U	9.7 U	9.9 U	10 U	3.9 U
2,4'-DDT	µg/kg dw	nv	nv	9.8 U	9.9 U	3.9 U	9.7 U	9.9 U	1.9 U	3.9 U
4,4'-DDD	µg/kg dw	nv	nv	9.8 U	9.9 U	3.9 U	9.7 U	9.9 U	7.2 U	3.9 U
4,4'-DDE	µg/kg dw	nv	nv	9.8 U	9.9 U	13 U	9.7 U	9.9 U	1.9 U	3.9 U
4,4'-DDT	µg/kg dw	nv	nv	82 UJ	52 UJ	3.9 UJ	9.7 UJ	35 UJ	1.9 U	3.9 UJ
Total DDTs	µg/kg dw	6.9	69	82 UJ	52 UJ	21 U	9.7 UJ	35 UJ	10 U	3.9 UJ
Aldrin	µg/kg dw	10	nv	4.9 U	4.9 U	2.0 U	4.9 U	5.0 U	0.95 U	2.0 U
Dieldrin	µg/kg dw	10	nv	22 U	9.9 U	16 U	18 U	9.9 U	6.3 U	11 U
Total aldrin/dieldrin (calc'd)	µg/kg dw	10	nv	22 U	9.9 U	16 U	18 U	9.9 U	6.3 U	11 U
alpha-BHC	µg/kg dw	nv	nv	4.9 U	4.9 U	2.0 U	4.9 U	5.0 U	0.95 U	2.0 U
beta-BHC	µg/kg dw	nv	nv	4.9 U	4.9 U	2.0 U	4.9 U	5.0 U	0.95 U	2.0 U
gamma-BHC	µg/kg dw	10	nv	4.9 U	4.9 U	2.0 U	4.9 U	5.0 U	0.95 U	2.0 U
delta-BHC	µg/kg dw	nv	nv	4.9 U	4.9 U	2.0 U	4.9 U	5.0 U	0.95 U	2.0 U
alpha-Chlordane	µg/kg dw	nv	nv	4.9 U	4.9 U	2.0 U	4.9 U	5.0 U	0.95 U	2.0 U

Table 3a, cont.

Analyte	Unit	SQS/SL	CSL/ML	EW-S27-1G-010[a]	EW-S27-2G-010	EW-S27-101G-010[b]	EW-S27-3G-010	EW-S27-4G-010[a]	EW-S27-5G-010	EW-S27-9G-010
				0 – 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm
gamma-Chlordane	µg/kg dw	nv	nv	4.9 U	4.9 U	2.0 U	4.9 U	5.0 U	0.95 U	2.0 U
Total chlordane (calc'd)	µg/kg dw	10	nv	9.8 UJ	9.9 UJ	3.9 UJ	9.7 UJ	9.9 UJ	1.9 U	**16 UJ**
alpha-Endosulfan	µg/kg dw	nv	nv	4.9 U	4.9 U	2.0 U	4.9 U	5.0 U	0.95 U	2.0 U
beta-Endosulfan	µg/kg dw	nv	nv	9.8 U	9.9 U	3.9 U	9.7 U	9.9 U	1.9 U	3.9 U
Endosulfan sulfate	µg/kg dw	nv	nv	9.8 U	9.9 U	3.9 U	9.7 U	9.9 U	1.9 U	3.9 U
Endrin	µg/kg dw	nv	nv	9.8 U	9.9 U	7.7 U	9.7 U	9.9 U	1.9 U	3.9 U
Endrin aldehyde	µg/kg dw	nv	nv	25 U	21 U	16 U	20 U	9.9 U	8.0 U	12 U
Endrin ketone	µg/kg dw	nv	nv	47 U	9.9 U	26 U	26 U	41 U	1.9 U	3.9 U
Heptachlor	µg/kg dw	10	nv	4.9 U	4.9 U	2.0 U	4.9 U	5.0 U	0.95 U	2.0 U
Heptachlor epoxide	µg/kg dw	nv	nv	4.9 U	4.9 U	2.0 U	4.9 U	5.0 U	0.95 U	2.0 U
Methoxychlor	µg/kg dw	nv	nv	49 U	49 U	20 U	49 U	50 U	9.5 U	20 U
Mirex	µg/kg dw	nv	nv	9.8 U	9.9 U	3.9 U	9.7 U	68 U	1.9 U	3.9 U
Cis-Nonachlor	µg/kg dw	nv	nv	9.8 UJ	9.9 UJ	3.9 UJ	9.7 UJ	9.9 UJ	1.9 U	16 UJ
Oxychlordane	µg/kg dw	nv	nv	9.8 U	9.9 U	3.9 U	9.7 U	9.9 U	1.9 U	3.9 U
Toxaphene	µg/kg dw	nv	nv	490 U	490 U	200 U	490 U	500 U	95 U	200 U
Trans-Nonachlor	µg/kg dw	nv	nv	9.8 U	9.9 U	3.9 U	9.7 U	9.9 U	1.9 U	3.9 U
Grain size										
Fractional % phi >-1 (>2000 µm)	% dw	nv	nv	6.6	1.4	1.4	9.6	15.8	0.5	*7.9*
Fractional % phi -1-0 (1000-2000 µm)	% dw	nv	nv	2.7	1.5	1.2	4.9	6.7	2.5	*2.5*
Fractional % phi 0-1 (500-1000 µm)	% dw	nv	nv	6.8	2.0	2.3	2.9	11.4	11.7	*6.2*
Fractional % phi 1-2 (250-500 µm)	% dw	nv	nv	28.2	11.3	11.3	8.7	35.4	40.9	*32.9*
Fractional % phi 2-3 (125-250 µm)	% dw	nv	nv	16.3	14.7	14.5	15.3	17.6	18.5	*22.4*
Fractional % phi 3-4 (62.5-125 µm)	% dw	nv	nv	5.7	11.3	11.7	13.2	4.6	5.1	*6.9*
Fractional % phi 4-5 (31.2-62.5 µm)	% dw	nv	nv	3.1	9.4	8.9	6.6	3.2	3.6	*5.3*
Fractional % phi 5-6 (15.6-31.2 µm)	% dw	nv	nv	5.5	10.0	11.1	10.8	2.1	3.2	*4.9*
Fractional % phi 6-7 (7.8-15.6 µm)	% dw	nv	nv	6.5	9.7	10.0	9.0	0.4	3.1	*2.9*
Fractional % phi 7-8 (3.9-7.8 µm)	% dw	nv	nv	4.8	7.6	7.2	4.4	0.5	2.6	*1.5*
Fractional % phi 8-9 (1.95-3.9 µm)	% dw	nv	nv	2.9	4.7	4.3	3.0	0.1	1.6	*1*
Fractional % phi 9-10 (0.98-1.95 µm)	% dw	nv	nv	3.9	5.8	6.1	4.1	0.4	2.3	*1.8*

Table 3a, cont.

Analyte	Unit	SQS/SL	CSL/ML	EW-S27-1G-010[a]	EW-S27-2G-010	EW-S27-101G-010[b]	EW-S27-3G-010	EW-S27-4G-010[a]	EW-S27-5G-010	EW-S27-9G-010
				0 – 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm	0 - 10 cm
Fractional % phi 10+ (<0.98 µm)	% dw	nv	nv	7.0	10.5	10.1	7.6	1.8	4.5	*3.8*
Gravel (total calc'd)	% dw	nv	nv	6.6	1.4	1.4	9.6	15.8	0.5	*7.9*
Sand (total calc'd)	% dw	nv	nv	59.7	40.8	41.0	45.0	75.7	78.7	*70.9*
Silt (total calc'd)	% dw	nv	nv	19.9	36.7	37.2	30.8	6.2	12.5	*14.6*
Clay (total calc'd)	% dw	nv	nv	13.8	21.0	20.5	14.7	2.3	8.4	*7*
Fines (percent silt+clay)	% dw	nv	nv	33.7	57.7	57.7	45.5	8.5	20.9	*21*
Conventional parameters										
Total organic carbon (TOC)	% dw	nv	nv	*4.08*	2.66	2.09	2.19	10.1	2.50	1.93
Total solids	% ww	nv	nv	*61.08*	53.70	54.40	55.00	61.60	69.80	65.20

[a] Organic carbon normalization was not appropriate for this sample because TOC content >4.0%. Results are compared to LAET values in Table 3b.

[b] This sample is a field duplicate of the sample directly preceding it.

BHC – benzene hexachloride

dw – dry weight

HPAH – high-molecular-weight polycyclic aromatic hydrocarbon

LPAH – low-molecular-weight polycyclic aromatic hydrocarbon

nv – no value; there is no SQS/SL or CSL/ML for this chemical

OC – organic carbon

PAH – polycyclic aromatic hydrocarbon

SL and ML – screening level and maximum level (USACE et al. 2000)

SQS and CSL – sediment quality standard and cleanup screening level (WAC 173-204)

SVOC – semivolatile organic compound

Concentration in *italics* indicates that laboratory replicate was run for sample

Concentration in **bold** indicates SQS/SL exceedance.

Concentration in **bold underline** indicates CSL/ML exceedance.

Data qualifiers: J – estimated concentration
U – not detected at reporting limit shown
UJ –not detected at estimated reporting limit shown

Table 3b. East Waterway - Slip 27 grab sample data (comparison to LAET and 2LAET)

Analyte	Unit	LAET	2LAET	EW-S27-1G-010[a] 0 – 10 cm	EW-S27-4G-010[a] 0 - 10 cm
PAHs					
2-Methylnaphthalene	µg/kg dw	670	1,400	44	190
Acenaphthene	µg/kg dw	500	730	53	**1,500**
Acenaphthylene	µg/kg dw	1,300	1,300	48	62
Anthracene	µg/kg dw	960	4,400	210	600
Benzo(a)anthracene	µg/kg dw	1,300	1,600	450	770
Benzo(a)pyrene	µg/kg dw	1,600	3,000	630	560
Benzo(g,h,i)perylene	µg/kg dw	670	720	180	120
Benzofluoranthenes (total-calc'd)	µg/kg dw	3,200	3,600	1,870	2,100
Chrysene	µg/kg dw	1,400	2,800	760	1,400
Dibenzo(a,h)anthracene	µg/kg dw	230	540	84	94
Dibenzofuran	µg/kg dw	540	700	34	310
Fluoranthene	µg/kg dw	1,700	2,500	880	**2,800**
Fluorene	µg/kg dw	540	1,000	59	390
Indeno(1,2,3-cd)pyrene	µg/kg dw	600	690	220	160
Naphthalene	µg/kg dw	2,100	2,400	48	110
Phenanthrene	µg/kg dw	1,500	5,400	420	1,300
Pyrene	µg/kg dw	2,600	3,300	2,000	1,500
Total HPAH (calc'd)	µg/kg dw	12,000	17,000	7,100	9,500
Total LPAH (calc'd)	µg/kg dw	5,200	13,000	840	4,000
Phthalates					
Bis(2-ethylhexyl) phthalate	µg/kg dw	1,300	1,900	600	500
Butyl benzyl phthalate	µg/kg dw	63	900	14 J	35
Diethyl phthalate	µg/kg dw	200	1,200	31 U	31 U
Dimethyl phthalate	µg/kg dw	71	160	6.2 U	51 U
Di-n-butyl phthalate	µg/kg dw	1,400	5,100	47 U	31 U
Di-n-octyl phthalate	µg/kg dw	6,200	nv	31 U	31 U

ANALYTE	UNIT	LAET	2LAET	EW-S27-1G-010[a] 0 – 10 cm	EW-S27-4G-010[a] 0 - 10 cm
Other SVOCs					
1,2,4-Trichlorobenzene	µg/kg dw	31	51	6.2 U	6.2 U
1,2-Dichlorobenzene	µg/kg dw	35	50	6.2 U	6.2 U
1,4-Dichlorobenzene	µg/kg dw	110	120	26	6.8
Hexachlorobenzene	µg/kg dw	22	70	4.9 U	5.0 U
Hexachlorobutadiene	µg/kg dw	11	120	4.9 U	5.0 U
N-Nitrosodiphenylamine	µg/kg dw	28	40	9.3 U	**<u>180</u>**
Polychlorinated biphenyls					
Total PCBs	µg/kg dw	130	1,000	**<u>1,010</u>**	**290**
Total organic carbon (TOC)	% dw			*4.08*	10.1

dw – dry weight

nv – no value; there is no LAET or 2LAET for this chemical

HPAH – high-molecular-weight polycyclic aromatic hydrocarbon

LAET – lowest apparent effects threshold, 2LAET – second lowest apparent effects threshold

LPAH – low-molecular-weight polycyclic aromatic hydrocarbon

PAH – polycyclic aromatic hydrocarbon

SVOC – semivolatile organic compound

Concentration in *italics* indicates that laboratory replicate was run for sample

Concentration in **bold** indicates LAET exceedance.

Concentration in **<u>bold underline</u>** indicates 2LAET exceedance.

Data qualifiers: J – estimated concentration
U – not detected at reporting limit shown
UJ –not detected at estimated reporting limit shown

Table 4a. East Waterway - Slip 27 core sample data (comparison to SMS and DMMP values)

Analyte	Unit	SQS/SL	CSL/ML	EW-S27-C1-1[a]	EW-S27-C1-2	EW-S27-C1-3	EW-S27-C1-4	EW-S27-C2-1	EW-S27-C2-2	EW-S27-C2-3	EW-S27-C2-4	EW-S27-C3-1[a]	EW-S27-C3-2	EW-S27-C3-3	EW-S27-C3-4[a]
				0 - 1 ft	1 - 2 ft	2 - 3 ft	3 - 4 ft	0 - 1 ft	1 - 2 ft	2 - 3 ft	3 - 4 ft	0 - 1 ft	1 - 2 ft	2 - 3 ft	3 - 4 ft
Metals and trace elements															
Antimony	mg/kg dw	150	200	*7 UJ*	6 UJ	6 UJ	6 UJ	7 UJ	8 UJ	9 UJ	9 UJ	8 UJ	9 UJ	9 UJ	9 UJ
Arsenic	mg/kg dw	57	93	*3.2*	1.8	2.2	1.5	7.0	17.9	13.4	8.8	10.9	15.7	18	35.8
Cadmium	mg/kg dw	5.1	6.7	*0.5*	0.3	0.2 U	0.2 U	1.6	**12.0**	4.3	5.0	2.1	**5.7**	**91.9**	**11.2**
Chromium	mg/kg dw	260	270	*18.4*	11.8	10.9	10.3	25.8	90.0	40.4	67.4	35.5	66.3	155	111
Copper	mg/kg dw	390	390	*53.3*	15.9	11.6	8.6	53.5	163	109	122	95.4	149	**655**	**406**
Lead	mg/kg dw	450	530	*64*	18	5	2 U	53	224	211	164	105	221	428	364
Mercury	mg/kg dw	0.41	0.59	*0.090*	0.10	0.060 U	0.050 U	0.17	**1.23**	**1.78**	**1.37**	**0.50**	**0.85**	**1.92**	**2.03**
Nickel	mg/kg dw	140	370	*12*	9	9	8	17	39	38	57	22	32	51	49
Selenium	mg/kg dw	nv	nv	*0.7 U*	0.6 U	0.6 U	0.6 U	0.7 U	0.8 U	0.9 U	0.9 U	0.9 U	0.9 U	4 U	1
Silver	mg/kg dw	6.1	6.1	*0.4 U*	0.4 U	0.4 U	0.4 U	0.5	4.1	1.8	1.8	0.8	2.8	**7.4**	**6.4**
Zinc	mg/kg dw	410	960	*132*	58.7	28.0	27.2	257	**1,680**	388	**623**	319	**567**	**16,100**	**1,610**
Organometals															
Monobutyltin as ion	µg/kg dw	nv	nv	7.3	4.4	3.6 U	3.6 U	4.0 U	3.9 U	4.0 U	3.7 U	3.9 U	4.6 U	12 U	12 U
Dibutyltin as ion	µg/kg dw	nv	nv	20	8.5	5.1 U	5.1 U	8.2	9.1	5.6 U	5.2 U	36	25	16 U	120
Tributyltin as ion	µg/kg dw	nv	nv	460	5.3	3.4 U	3.4 U	46	32	3.8 U	3.5 U	75	68	23	11 U
PAHs															
1-Methylnaphthalene	µg/kg dw	nv	nv	150	30 U	31 U	31 U	30 U	92 U	250	100	56	93 U	93 U	93 U
2-Chloronaphthalene	µg/kg dw	nv	nv	31 U	30 U	31 U	31 U	30 U	92 U	92 U	92 U	31 U	93 U	93 U	94 U
2-Methylnaphthalene	mg/kg OC	38	64	AET	1.1 U	4.9 U	5.9 U	1.7 U	3.2 U	6.3	4.8	AET	2.6 U	2.3 U	AET
Acenaphthene	mg/kg OC	16	57	AET	2.4	5.7	5.9 U	3.6	3.8	**55**	8.1	AET	7.8	14	AET
Acenaphthylene	mg/kg OC	66	66	AET	1.1 U	4.9 U	5.9 U	1.7 U	3.2 U	4.3	4.4	AET	4.2	3.3	AET
Anthracene	mg/kg OC	220	1,200	AET	6.0	14	6.7	6.7	19	92	24	AET	27	28	AET
Benzo(a)anthracene	mg/kg OC	110	270	AET	11	24	5.9 U	14	55	**130**	44	AET	97	100	AET
Benzo(a)pyrene	mg/kg OC	99	210	AET	4.5	17	5.9 U	17	29 J	66	37 J	AET	66	60	AET
Benzo(b)fluoranthene	µg/kg dw	nv	nv	2,500	310	200	43	720	2,300 J	5,200	2,400 J	2,300	4,300	3,100	11,000
Benzo(g,h,i)perylene	mg/kg OC	31	78	AET	1.1 U	4.9 U	5.9 U	3.7	8.9 J	14	9.3 J	AET	17	22	AET

Table 4a, cont.

Analyte	Unit	SQS/SL	CSL/ML	EW-S27-C1-1[a] 0 - 1 ft	EW-S27-C1-2 1 - 2 ft	EW-S27-C1-3 2 - 3 ft	EW-S27-C1-4 3 - 4 ft	EW-S27-C2-1 0 - 1 ft	EW-S27-C2-2 1 - 2 ft	EW-S27-C2-3 2 - 3 ft	EW-S27-C2-4 3 - 4 ft	EW-S27-C3-1[a] 0 - 1 ft	EW-S27-C3-2 1 - 2 ft	EW-S27-C3-3 2 - 3 ft	EW-S27-C3-4[a] 3 - 4 ft
Benzo(k)fluoranthene	µg/kg dw	nv	nv	820	91	74	31 U	260	780 J	1,400	760 J	750	4,900	3,600	4,000
Benzofluoranthenes (total-calc'd)	mg/kg OC	230	450	AET	15	43	8.2	55	110 J	190	120 J	AET	**250**	170	AET
Chrysene	mg/kg OC	110	460	AET	12	30	5.9 U	22	58	**120**	59	AET	110	110	AET
Dibenzo(a,h)anthracene	mg/kg OC	12	33	AET	0.83	2.7	1.7 U	3.0	2.6	4.0	7.0	AET	12	7.3	AET
Dibenzofuran	mg/kg OC	15	58	AET	1.9	5.6	5.9 U	2.5	3.2 U	**25 UJ**	6.7	AET	3.3	6.8	AET
Fluoranthene	mg/kg OC	160	1,200	AET	38	59	15	42	**170**	**460**	63	AET	**200**	**380**	AET
Fluorene	mg/kg OC	23	79	AET	2.1	6.7	5.9 U	2.5	5.5	**63**	8.9	AET	7.2	14	AET
Indeno(1,2,3-cd)pyrene	mg/kg OC	34	88	AET	1.1 U	5.2	5.9 U	4.6	10 J	18	11 J	AET	21	25	AET
Naphthalene	mg/kg OC	99	170	AET	1.2	5.1	5.9 U	2.5	10	9.8	20	AET	3.9	5.0	AET
Phenanthrene	mg/kg OC	100	480	AET	12	24	11	12	20	**180**	35	AET	33	55	AET
Pyrene	mg/kg OC	1,000	1,400	AET	25	64	14	56	180	630	230	AET	280	330	AET
Total HPAH (calc'd)	mg/kg OC	960	5,300	AET	110	245	37.3	220	623 J	**1,600**	581 J	AET	**1,100**	**1,200**	AET
Total LPAH (calc'd)	mg/kg OC	370	780	AET	24	56	18	27	58.6	**409**	101	AET	83	120	AET
Total PAH (calc'd)	µg/kg dw	nv	nv	19,200	3,400	1,890	291	4,400	19,900 J	71,000	18,400 J	11,500	41,000	52,000	102,000
Phthalates															
Bis(2-ethylhexyl)phthalate	mg/kg OC	47	78	AET	1.4	4.9 U	5.9 U	17	**110 J**	3.5	3.4 U	AET	**110**	**140**	AET
Butyl benzyl phthalate	mg/kg OC	4.9	64	AET	0.35 U	1.5 U	1.7 U	0.79	**6.5**	0.63	4.1	AET	4.2	**5.3**	AET
Diethyl phthalate	mg/kg OC	61	110	AET	1.1 U	4.9 U	5.9 U	1.7 U	3.2 U	2.7 U	3.4 U	AET	2.6 U	2.3 U	AET
Dimethyl phthalate	mg/kg OC	53	53	AET	0.35 U	1.5 U	1.7 U	0.62 U	1.5 U	0.35 U	1.1 U	AET	1.4 U	1.8 U	AET
Di-n-butyl phthalate	mg/kg OC	220	1,700	AET	1.1 U	4.9 U	5.9 U	1.7 U	3.2 U	2.7 U	3.4 U	AET	2.6 U	2.3 U	AET
Di-n-octyl phthalate	mg/kg OC	58	4,500	AET	1.1 U	4.9 U	5.9 U	1.7 U	R	2.7 U	3.4 U	AET	2.6 U	2.3 UJ	AET
Other SVOCs															
1,2,4-Trichlorobenzene	mg/kg OC	0.81	1.8	AET	0.35 U	**1.5 U**	**1.7 U**	0.51 U	**1.1 U**	0.27 U	**1.1 U**	AET	**0.86 U**	0.78 U	AET
1,2-Dichlorobenzene	mg/kg OC	2.3	2.3	AET	0.35 U	1.5 U	1.7 U	0.51 U	1.1 U	0.27 U	1.1 U	AET	0.86 U	0.78 U	AET
1,3-Dichlorobenzene	µg/kg dw	170	nv	31 U	30 U	31 U	31 U	30 U	92 U	92 U	92 U	31 U	93 U	93 U	93 U
1,4-Dichlorobenzene	mg/kg OC	3.1	9	AET	0.35 U	1.5 U	1.7 U	0.51 U	1.1 U	0.27 U	1.1 U	AET	0.86 U	0.78 U	AET
2,4,5-Trichlorophenol	µg/kg dw	nv	nv	160 U	150 U	160 U	150 U	150 U	460 U	460 U	460 U	150 U	460 U	460 U	460 U
2,4,6-Trichlorophenol	µg/kg dw	nv	nv	160 U	150 U	160 U	150 U	150 U	460 U	460 U	460 U	150 U	460 U	460 U	460 U

Table 4a, cont.

Analyte	Unit	SQS/SL	CSL/ML	EW-S27-C1-1[a] 0 - 1 ft	EW-S27-C1-2 1 - 2 ft	EW-S27-C1-3 2 - 3 ft	EW-S27-C1-4 3 - 4 ft	EW-S27-C2-1 0 - 1 ft	EW-S27-C2-2 1 - 2 ft	EW-S27-C2-3 2 - 3 ft	EW-S27-C2-4 3 - 4 ft	EW-S27-C3-1[a] 0 - 1 ft	EW-S27-C3-2 1 - 2 ft	EW-S27-C3-3 2 - 3 ft	EW-S27-C3-4[a] 3 - 4 ft
2,4-Dichlorophenol	µg/kg dw	nv	nv	160 U	150 U	160 U	150 U	150 U	460 U	460 U	460 U	150 U	460 U	460 U	460 U
2,4-Dimethylphenol	µg/kg dw	29	29	9.3 U	9.2 U	9.3 U	9.2 U	9.1 U	**31 U**	14	**31 U**	**31 U**	**31 U**	**31 U**	**31 U**
2,4-Dinitrophenol	µg/kg dw	nv	nv	310 U	300 U	310 U	310 U	300 U	920 U	920 U	920 U	310 U	930 U	930 U	930 U
2,4-Dinitrotoluene	µg/kg dw	nv	nv	160 U	150 U	160 U	150 U	150 U	460 U	460 U	460 U	150 U	460 U	460 U	460 U
2,6-Dinitrotoluene	µg/kg dw	nv	nv	160 U	150 U	160 U	150 U	150 U	460 U	460 U	460 U	150 U	460 U	460 U	460 U
2-Chlorophenol	µg/kg dw	nv	nv	31 U	30 U	31 U	31 U	30 U	92 U	92 U	92 U	31 U	93 U	93 U	93 U
2-Methylphenol	µg/kg dw	63	63	9.3 U	9.2 U	9.3 U	9.2 U	9.1 U	31 U	9.2 U	31 U	31 U	31 U	31 U	31 U
2-Nitroaniline	µg/kg dw	nv	nv	160 U	150 U	160 U	150 U	150 U	460 U	460 U	460 U	150 U	460 U	460 U	460 U
2-Nitrophenol	µg/kg dw	nv	nv	160 U	150 U	160 U	150 U	150 U	460 U	460 U	460 U	150 U	460 U	460 U	460 U
3,3'-Dichlorobenzidine	µg/kg dw	nv	nv	160 U	150 U	160 U	150 U	150 U	460 U	460 U	460 U	150 U	460 U	460 UJ	460 U
3-Nitroaniline	µg/kg dw	nv	nv	160 U	150 U	160 U	150 U	150 U	460 U	460 U	460 U	150 U	460 U	460 U	460 U
4,6-Dinitro-o-cresol	µg/kg dw	nv	nv	310 U	300 U	310 U	310 U	300 U	920 U	920 U	920 U	310 U	930 U	930 U	930 U
4-Bromophenyl phenyl ether	µg/kg dw	nv	nv	31 U	30 U	31 U	31 U	30 U	92 U	92 U	92 U	31 U	93 U	93 U	93 U
4-Chloro-3-methylphenol	µg/kg dw	nv	nv	160 U	150 U	160 U	150 U	150 U	460 U	460 U	460 U	150 U	460 U	460 U	460 U
4-Chloroaniline	µg/kg dw	nv	nv	160 U	150 U	160 U	150 U	150 U	460 U	460 U	460 U	150 U	460 U	460 U	460 U
4-Chlorophenyl phenyl ether	µg/kg dw	nv	nv	31 U	30 U	31 U	31 U	30 U	92 U	92 U	92 U	31 U	93 U	93 U	93 U
4-Methylphenol	µg/kg dw	670	670	31 U	30 U	31 U	31 U	30 U	92 U	92 U	92 U	31 U	93 U	93 U	93 U
4-Nitroaniline	µg/kg dw	nv	nv	160 U	150 U	160 U	150 U	150 U	460 U	460 U	460 U	150 U	460 U	460 U	460 U
4-Nitrophenol	µg/kg dw	nv	nv	160 U	150 U	160 U	150 U	150 U	460 UJ	460 U	460 UJ	150 U	460 UJ	460 UJ	460 U
Aniline	µg/kg dw	nv	nv	31 U	30 U	31 U	31 U	30 U	92 UJ	92 UJ	92 UJ	31 U	93 UJ	93 UJ	93 U
Benzoic acid	µg/kg dw	650	650	310 U	300 U	310 U	310 U	300 U	920 U	920 U	920 U	310 U	930 U	930 U	930 U
Benzyl alcohol	µg/kg dw	57	73	47 U	46 U	46 U	46 U	46 U	150 U	46 U	150 U	150 U	150 U	150 U	160 U
bis(2-chloroethoxy)methane	µg/kg dw	nv	nv	31 U	30 U	31 U	31 U	30 U	92 U	92 U	92 U	31 U	93 U	93 U	93 U
bis(2-chloroethyl)ether	µg/kg dw	nv	nv	31 U	30 U	31 U	31 U	30 U	92 U	92 U	92 U	31 U	93 U	93 U	93 U
bis(2-chloroisopropyl)ether	µg/kg dw	nv	nv	31 U	30 U	31 U	31 U	30 U	92 U	92 U	92 U	31 U	93 U	93 U	93 U
Hexachlorobenzene	mg/kg OC	0.38	2.3	AET	0.037 U	0.16 U	0.19 U	0.055 U	0.34 U	0.028 U	0.070 U	AET	0.27 U	0.25 U	AET
Hexachlorobutadiene	mg/kg OC	3.9	6.2	AET	0.037 U	0.16 U	0.19 U	0.055 U	0.34 U	0.028 U	0.070 U	AET	0.27 U	0.25 U	AET
Hexachlorocyclopentadiene	µg/kg dw	nv	nv	160 U	150 U	160 U	150 U	150 U	460 U	460 U	460 U	150 U	460 U	460 U	460 UJ

Table 4a, cont.

Analyte	Unit	SQS/SL	CSL/ML	EW-S27-C1-1[a] 0 - 1 ft	EW-S27-C1-2 1 - 2 ft	EW-S27-C1-3 2 - 3 ft	EW-S27-C1-4 3 - 4 ft	EW-S27-C2-1 0 - 1 ft	EW-S27-C2-2 1 - 2 ft	EW-S27-C2-3 2 - 3 ft	EW-S27-C2-4 3 - 4 ft	EW-S27-C3-1[a] 0 - 1 ft	EW-S27-C3-2 1 - 2 ft	EW-S27-C3-3 2 - 3 ft	EW-S27-C3-4[a] 3 - 4 ft
Hexachloroethane	µg/kg dw	1,400	14,000	31 U	30 U	31 U	31 U	30 U	92 U	92 U	92 U	31 U	93 U	93 U	93 U
Isophorone	µg/kg dw	nv	nv	31 U	30 U	31 U	31 U	30 U	92 U	92 U	92 U	31 U	93 U	93 U	93 U
Nitrobenzene	µg/kg dw	nv	nv	31 U	30 U	31 U	31 U	30 U	92 U	92 U	92 U	31 U	93 U	93 U	93 U
N-Nitrosodimethylamine	µg/kg dw	nv	nv	31 UJ	30 UJ	31 UJ	31 UJ	31 UJ	31 UJ	31 UJ	31 UJ	31 UJ	31 UJ	31 UJ	31 UJ
N-Nitroso-di-n-propylamine	µg/kg dw	nv	nv	47 U	46 U	46 U	46 U	46 U	150 U	46 U	150 U	150 U	150 U	150 U	160 U
N-Nitrosodiphenylamine	mg/kg OC	11	11	AET	0.64 U	1.5 U	1.7 U	0.67 U	1.1 U	0.27 U	1.1 U	AET	8.3 U	2.5 U	AET
Pentachlorophenol	µg/kg dw	360	690	120	46 U	86 U	85 U	120	150 U	92 U	320 U	290 U	310 U	150 U	160 U
Phenol	µg/kg dw	420	1,200	31 U	30 U	31 U	31 U	30 U	92 U	92 U	92 U	31 U	93 U	93 U	93 U
Polychlorinated biphenyls															
Aroclor-1016	µg/kg dw	nv	nv	20 U	20 U	20 U	20 U	20 U	510 U	58 U	20 U	99 U	1,300 U	410 U	390 U
Aroclor-1221	µg/kg dw	nv	nv	20 U	20 U	20 U	20 U	20 U	510 U	58 U	20 U	99 U	1,300 U	410 U	390 U
Aroclor-1232	µg/kg dw	nv	nv	20 U	20 U	20 U	20 U	20 U	510 U	58 U	20 U	99 U	1,300 U	410 U	390 U
Aroclor-1242	µg/kg dw	nv	nv	20 U	20 U	20 U	20 U	20 U	510 U	58 U	20 U	99 U	1,300 U	410 U	390 U
Aroclor-1248	µg/kg dw	nv	nv	20 U	20 U	20 U	20 U	74	1,000	58 U	20 U	99 U	1,400	1,800	990
Aroclor-1254	µg/kg dw	nv	nv	20 U	36	20 U	20 U	180	2,100	100	19 J	310	1,700	3,000	2,800
Aroclor-1260	µg/kg dw	nv	nv	3,400	81	20 U	20 U	300	2,700	170	29	600	2,000	4,000	5,100
PCBs (total calc'd)	mg/kg OC	12	65	AET	4.40	3.2 U	3.8 U	**31**	**200**	7.8	1.8 J	AET	**140**	**220**	AET
Pesticides															
2,4'-DDD	µg/kg dw	nv	nv	1.9 U	2.0 U	2.0 U	2.0 U	2.0 U	20 U	1.9 U	3.9 U	3.9 U	20 U	20 U	19 U
2,4'-DDE	µg/kg dw	nv	nv	1.9 U	2.0 U	2.0 U	2.0 U	14 U	20 U	1.9 U	3.9 U	3.9 U	20 U	20 U	19 U
2,4'-DDT	µg/kg dw	nv	nv	1.9 U	2.0 U	2.0 U	2.0 U	2.0 U	20 U	1.9 U	3.9 U	3.9 U	20 U	20 U	19 U
4,4'-DDD	µg/kg dw	nv	nv	1.9 U	6.2 U	2.0 U	2.0 U	2.0 U	20 U	4.2 U	3.9 U	3.9 U	20 U	20 U	19 U
4,4'-DDE	µg/kg dw	nv	nv	1.9 U	2.0 U	2.0 U	2.0 U	7.7 U	91 U	6.1 U	3.9 U	3.9 U	20 U	140 U	73 U
4,4'-DDT	µg/kg dw	nv	nv	22 U	9.0 U	2.0 U	2.0 U	2.0 UJ	20 UJ	11 UJ	8.4 UJ	3.9 UJ	210 UJ	20 UJ	19 UJ
DDTs (total-calc'd)	µg/kg dw	6.9	69	**22 U**	**9.0 U**	2.0 U	2.0 U	14 U	91 U	11 UJ	8.4 UJ	3.9 UJ	210 UJ	140 U	73 U
Aldrin	µg/kg dw	10	nv	0.97 U	0.99 U	0.99 U	1.0 U	0.98 U	9.8 U	0.97 U	1.9 U	2.0 U	9.8 U	9.9 U	9.7 U
Dieldrin	µg/kg dw	10	nv	5.9 U	4.7 U	2.0 U	2.0 U	7.9 U	**68 U**	1.9 U	3.9 U	**11 U**	**57 U**	**110 U**	**120 U**
Total aldrin/dieldrin	µg/kg dw	10	nv	5.9 U	4.7 U	2.0 U	2.0 U	7.9 U	**68** U	1.9 U	**3.9 U**	**11 U**	**57 U**	**110 U**	**120 U**

Table 4a, cont.

Analyte	Unit	SQS/SL	CSL/ML	EW-S27-C1-1[a] 0 - 1 ft	EW-S27-C1-2 1 - 2 ft	EW-S27-C1-3 2 - 3 ft	EW-S27-C1-4 3 - 4 ft	EW-S27-C2-1 0 - 1 ft	EW-S27-C2-2 1 - 2 ft	EW-S27-C2-3 2 - 3 ft	EW-S27-C2-4 3 - 4 ft	EW-S27-C3-1[a] 0 - 1 ft	EW-S27-C3-2 1 - 2 ft	EW-S27-C3-3 2 - 3 ft	EW-S27-C3-4[a] 3 - 4 ft
alpha-BHC	µg/kg dw	nv	nv	0.97 U	0.99 U	0.99 U	1.0 U	0.98 U	9.8 U	0.97 U	1.9 U	2.0 U	9.8 U	9.9 U	9.7 U
beta-BHC	µg/kg dw	nv	nv	5.6 U	0.99 U	0.99 U	1.0 U	0.98 U	9.8 U	10 U	1.9 U	2.0 U	11 U	9.9 U	9.7 U
gamma-BHC	µg/kg dw	10	nv	0.97 U	0.99 U	0.99 U	1.0 U	0.98 U	9.8 U	0.97 U	1.9 U	2.0 U	9.8 U	9.9 U	9.7 U
delta-BHC	µg/kg dw	nv	nv	0.97 U	0.99 U	0.99 U	1.0 U	0.98 U	9.8 U	0.97 U	1.9 U	2.0 U	9.8 U	9.9 U	9.7 U
alpha-Chlordane	µg/kg dw	nv	nv	0.97 U	0.99 U	0.99 U	1.0 U	0.98 U	9.8 U	0.97 U	1.9 U	2.0 U	9.8 U	9.9 U	9.7 U
gamma-Chlordane	µg/kg dw	nv	nv	3.5 U	0.99 U	0.99 U	1.0 U	0.98 U	9.8 U	0.97 U	1.9 U	2.0 U	9.8 U	9.9 U	9.7 U
alpha-Endosulfan	µg/kg dw	nv	nv	0.97 U	0.99 U	0.99 U	1.0 U	0.98 U	9.8 U	0.97 U	1.9 U	2.0 U	9.8 U	9.9 U	9.7 U
beta-Endosulfan	µg/kg dw	nv	nv	1.9 U	2.0 U	2.0 U	2.0 U	2.0 U	20 U	1.9 U	3.9 U	3.9 U	20 U	20 U	19 U
Endosulfan sulfate	µg/kg dw	nv	nv	1.9 U	2.0 U	2.0 U	2.0 U	2.0 U	20 U	8.7 U	3.9 U	3.9 U	20 U	20 U	19 U
Endrin	µg/kg dw	nv	nv	1.9 U	2.0 U	2.0 U	2.0 U	3.7 U	20 U	1.9 U	3.9 U	5.6 U	20 U	35 U	70 U
Endrin aldehyde	µg/kg dw	nv	nv	11 U	2.0 U	2.0 U	2.0 U	11 U	100 U	1.9 U	3.9 U	15 U	81 U	130 U	19 U
Endrin ketone	µg/kg dw	nv	nv	1.9 U	10 U	2.0 U	2.0 U	16 U	150 U	6.2 U	3.9 U	25 U	20 U	160 U	390 U
Heptachlor	µg/kg dw	10	nv	0.97 U	0.99 U	0.99 U	1.0 U	0.98 U	9.8 U	0.97 U	23 U	2.0 U	9.8 U	9.9 U	9.7 U
Heptachlor epoxide	µg/kg dw	nv	nv	0.97 U	0.99 U	0.99 U	1.0 U	0.98 U	9.8 U	0.97 U	1.9 U	2.0 U	9.8 U	9.9 U	9.7 U
Methoxychlor	µg/kg dw	nv	nv	9.7 U	9.9 U	9.9 U	10 U	9.8 U	98 U	9.7 U	19 U	20 U	98 U	99 U	97 U
Mirex	µg/kg dw	nv	nv	9.9 U	2.0 U	2.0 U	2.0 U	2.0 U	20 U	1.9 U	3.9 U	3.9 U	20 U	20 U	19 U
Cis-Nonachlor	µg/kg dw	nv	nv	7.6 U	2.0 U	2.0 U	2.0 U	10 U	87 UJ	1.9 UJ	3.9 UJ	17 UJ	74 UJ	130 UJ	200 UJ
Oxychlordane	µg/kg dw	nv	nv	1.9 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U	1.9 U	3.9 U	3.9 U	36 U	47 U	19 U
Toxaphene	µg/kg dw	nv	nv	97 U	99 U	99 U	100 U	98 U	980 U	97 U	190 U	200 U	980 U	990 U	970 U
Trans-Nonachlor	µg/kg dw	nv	nv	1.9 U	2.0 U	2.0 U	2.0 U	2.0 U	20 U	1.9 U	3.9 U	3.9 U	20 U	20 U	19 U
Total Chlordane (calc'd)	µg/kg dw	10	nv	7.6 U	2.0 U	2.0 U	2.0 U	10 U	87 UJ	1.9 UJ	3.9 UJ	17 UJ	74 UJ	130 UJ	200 UJ
Grain size															
Fractional % phi >-1 (>2000 µm)	% dw	nv	nv	13.1	1.3	0.4	0.9	3.6	1.2	0.7	0.4	18.0	2.2	2.8	2.8
Fractional % phi -1-0 (1000-2000 µm)	% dw	nv	nv	7.4	1.1	0.6	0.3	3.9	2.7	1.1	1.0	5.5	2.4	2.7	3.2
Fractional % phi 0-1 (500-1000 µm)	% dw	nv	nv	7.1	5.6	6.6	4.0	12.1	8.2	3.1	1.6	5.7	3.1	2.3	2.5
Fractional % phi 1-2 (250-500 µm)	% dw	nv	nv	28.5	45.0	45.0	39.1	41.4	17.6	15.8	4.4	22.7	14.6	7.7	7.0
Fractional % phi 2-3 (125-250 µm)	% dw	nv	nv	25.3	35.5	34.6	35.9	18.0	10.9	7.9	4.0	9.8	14.7	11.7	7.7
Fractional % phi 3-4 (62.5-125 µm)	% dw	nv	nv	9.2	5.4	7.2	10.6	3.7	4.9	4.2	3.6	3.4	6.3	5.5	4.2

Table 4a, cont.

Analyte	Unit	SQS/SL	CSL/ML	EW-S27-C1-1[a] 0 - 1 ft	EW-S27-C1-2 1 - 2 ft	EW-S27-C1-3 2 - 3 ft	EW-S27-C1-4 3 - 4 ft	EW-S27-C2-1 0 - 1 ft	EW-S27-C2-2 1 - 2 ft	EW-S27-C2-3 2 - 3 ft	EW-S27-C2-4 3 - 4 ft	EW-S27-C3-1[a] 0 - 1 ft	EW-S27-C3-2 1 - 2 ft	EW-S27-C3-3 2 - 3 ft	EW-S27-C3-4[a] 3 - 4 ft
Fractional % phi 4-5 (31.2-62.5 µm)	% dw	nv	nv	2.4	2.6	2.8	5.4	2.2	4.1	4.8	5.6	2.2	6.1	5.5	4.0
Fractional % phi 5-6 (15.6-31.2 µm)	% dw	nv	nv	1.5	0.7	0.8	1.4	2.1	5.8	7.5	7.5	6.0	7.5	7.4	6.7
Fractional % phi 6-7 (7.8-15.6 µm)	% dw	nv	nv	1.3	0.9	0.5	0.7	2.8	8.2	11.7	12.1	8.4	9.4	10.3	11.5
Fractional % phi 7-8 (3.9-7.8 µm)	% dw	nv	nv	1.6	0.7	0.5	0.6	2.7	9.7	11.2	16.4	4.6	9.2	11.7	12.9
Fractional % phi 8-9 (1.95-3.9 µm)	% dw	nv	nv	0.8	0.3	0.2	0.3	1.5	6.5	8.4	11.8	2.9	5.7	8.1	8.9
Fractional % phi 9-10 (0.98-1.95 µm)	% dw	nv	nv	1.0	0.5	0.3	0.3	2.5	7.9	9.7	13.3	4.2	7.7	10.0	12.2
Fractional % phi 10+ (<0.98 µm)	% dw	nv	nv	1.0	0.4	0.4	0.6	3.4	12.3	14.0	18.4	6.6	11.2	14.2	16.5
Gravel (total calc'd)	% dw	nv	nv	13.1	1.3	0.4	0.9	3.6	1.2	0.7	0.4	18.0	2.2	2.8	2.8
Sand (total calc'd)	% dw	nv	nv	77.5	92.6	94.0	89.9	79.1	44.3	32.1	14.6	47.1	41.1	29.9	24.6
Silt (total calc'd)	% dw	nv	nv	6.8	4.9	4.6	8.1	9.8	27.8	35.2	41.6	21.2	32.2	34.9	35.1
Clay (total calc'd)	% dw	nv	nv	2.8	1.2	0.9	1.2	7.4	26.7	32.1	43.5	13.7	24.6	32.3	37.6
Fines (percent silt+clay)	% dw	nv	nv	9.6	6.1	5.5	9.3	17.2	54.5	67.3	85.1	34.9	56.8	67.2	72.7
Conventional parameters															
Total organic carbon (TOC)	% dw	nv	nv	5.93	2.66	0.629	0.526	1.78	2.92	3.47	2.70	4.62	3.61	3.97	5.41
Total solids	% ww	nv	nv	73.30	85.10	75.50	81.80	73.60	57.90	55.50	56.00	57.90	58.20	50.40	49.10

[a] Organic carbon normalization was not appropriate for this sample because TOC content >4.0%. Results compared to LAET and 2LAET dry weight criteria in Table 4b..

BHC – benzene hexachloride

dw – dry weight

HPAH – high-molecular-weight polycyclic aromatic hydrocarbon

LPAH – low-molecular-weight polycyclic aromatic hydrocarbon

nv – no value; there is no SQS/SL or CSL/ML for this chemical

PAH – polycyclic aromatic hydrocarbon

OC – organic carbon

SL and ML – screening level and maximum level (USACE et al. 2000)

SQS and CSL – sediment quality standard and cleanup screening level (WAC 173-204)

SVOC – semivolatile organic compound

Concentration in *italics* indicates that laboratory replicate was run for sample.

Concentration in **bold** indicates SQS/SL exceedance.

Concentration in **bold underline** indicates CSL/ML exceedance.

Data qualifiers: J – estimated concentration
R – rejected
U – not detected at reporting limit shown
UJ – not detected at estimated reporting limit shown

Table 4b. East Waterway - Slip 27 core sample data (comparison to LAET values)

Analyte	Unit	LAET	2LAET	EW-S27-C1-1[a] 0 - 1 ft	EW-S27-C3-1[a] 0 - 1 ft	EW-S27-C3-4[a] 3 - 4 ft
PAHs						
2-Methylnaphthalene	µg/kg dw	670	1,400	140	60	110
Acenaphthene	µg/kg dw	500	730	**1,600**	100	390
Acenaphthylene	µg/kg dw	1,300	1,300	56	150	260
Anthracene	µg/kg dw	960	4,400	650	330	**2,200**
Benzo(a)anthracene	µg/kg dw	1,300	1,600	**1,400**	680	**11,000**
Benzo(a)pyrene	µg/kg dw	1,600	3,000	980	1,100	**6,000**
Benzo(g,h,i)perylene	µg/kg dw	670	720	200	360	**2,300**
Benzofluoranthenes (total-calc'd)	µg/kg dw	3,200	3,600	**3,300**	3,100	**15,000**
Chrysene	µg/kg dw	1,400	2,800	**2,200**	1,200	**11,000**
Dibenzo(a,h)anthracene	µg/kg dw	230	540	160	200	**580**
Dibenzofuran	µg/kg dw	540	700	230	79	300
Fluoranthene	µg/kg dw	1,700	2,500	**5,200**	1,100	**21,000**
Fluorene	µg/kg dw	540	1,000	190	93	**760**
Indeno(1,2,3-cd)pyrene	µg/kg dw	600	690	250	420	**2,600**
Naphthalene	µg/kg dw	2,100	2,400	71	83	260
Phenanthrene	µg/kg dw	1,500	5,400	750	450	**3,000**
Pyrene	µg/kg dw	2,600	3,300	2,200	2,200	**26,000**
Total HPAH (calc'd)	µg/kg dw	12,000	17,000	**15,900**	10,300	**95,000**
Total LPAH (calc'd)	µg/kg dw	5,200	13,000	3,300	1,210	**6,900**
Phthalates						
Bis(2-ethylhexyl)phthalate	µg/kg dw	1,300	1,900	500	580	**2,600**
Butyl benzyl phthalate	µg/kg dw	63	900	22	37	**190**
Diethyl phthalate	µg/kg dw	200	1,200	31 U	31 U	93 U
Dimethyl phthalate	µg/kg dw	71	160	57 U	31 U	31 U
Di-n-butyl phthalate	µg/kg dw	1,400	5,100	57 U	39 U	130 U
Di-n-octyl phthalate	µg/kg dw	6,200	nv	31 U	31 U	93 U

Analyte	Unit	LAET	2LAET	EW-S27-C1-1[a] 0 - 1 ft	EW-S27-C3-1[a] 0 - 1 ft	EW-S27-C3-4[a] 3 - 4 ft
Other SVOCs						
1,2,4-Trichlorobenzene	µg/kg dw	31	51	9.3 U	31 U	31 U
1,2-Dichlorobenzene	µg/kg dw	35	50	9.3 U	31 U	31 U
1,4-Dichlorobenzene	µg/kg dw	110	120	9.3 U	31 U	31 U
Hexachlorobenzene	µg/kg dw	22	70	0.97 U	2.0 U	9.7 U
Hexachlorobutadiene	µg/kg dw	11	120	0.97 U	2.0 U	9.7 U
N-Nitrosodiphenylamine	µg/kg dw	28	40	**190 U**	31 U	40 U
Polychlorinated biphenyls						
PCBs (total calc'd)	µg/kg dw	130	1,000	**3,400**	**910**	**8,900**
Total organic carbon (TOC)	% dw	nv	nv	5.93	4.62	5.41

dw – dry weight

HPAH – high-molecular-weight polycyclic aromatic hydrocarbon

LAET – lowest apparent effects threshold, 2LAET – second lowest apparent effects threshold

LPAH – low-molecular-weight polycyclic aromatic hydrocarbon

nv – no value; there is no LAET or 2LAET for this chemical

PAH – polycyclic aromatic hydrocarbon

SVOC – semivolatile organic compound

Concentration in *italics* indicates that laboratory replicate was run for sample

Concentration in **bold** indicates LAET exceedance.

Concentration in **bold underline** indicates 2LAET exceedance.

Data qualifiers: J – estimated concentration
U – not detected at reporting limit shown
UJ –not detected at estimated reporting limit shown

Figures 2 through 9 show the grab and core locations of chemicals which exceeded the SQS or CSL in more than 1 sample. The results for total HPAH were presented rather than the results for each individual PAH (Figure 4). Figure 10 shows all other detected exceedances not shown in Figures 2-9. Figure 11 shows all the locations with reporting limits associated with non-detected results that exceeded SMS or DMMP values.

2.4.1 Surface sediment grab samples

The results for the surface sediment grab samples are presented in Table 3. The surface sediment samples exceeding SMS criteria are also indicated on Figures 2 through 9.

- One sample (S27-1G) exceeded the SQS criteria for mercury and zinc (Figures 3 and 9, respectively). Two samples exceeded SMS values for PAHs. Two PAH compounds (acenaphthene and fluoranthene) had concentrations above the corresponding 2 LAET values in S27-4G and two PAH compounds (benzo(a)anthracene and chrysene) were above the corresponding SQS in S27-9G.
- Two samples had semi-volatile organic compounds (SVOC) exceedances, N-nitrosodiphenylamine exceeded the CSL in S27-4G and 2,4-Dimethylphenol exceeded the CSL in S27-1G.
- All surface grab samples exceeded the SQS for PCBs (Figure 2), of which one sample also exceeded the 2LAET (CSL dry weight equivalent).
- No pesticides were detected any of the grabs samples, however total DDTs reporting limits associated with non-detected results exceeded the SL (5 samples) and ML (1 sample)\. The RL for dieldrin was above the SL in S27-1G. The RL for total chlordane exceeded the SL in S27-9G.
- There are no SMS values for sediment TBT concentrations. The maximum sediment TBT concentrations were reported in samples S27-2G, a field replicate of S27-2G and S27-3G (120, 150 and 130 mg/kg dw, respectively).

2.4.2 Sediment core samples

The results for the three sediment cores are presented in Table 4. The results of the core samples for selected analytes are also presented on Figures 2 through 9.

- At core locations S27-2C (1-2 ft) and S27-3C (2-3 ft, 3-4 ft) cadmium and zinc exceeded the CSL criteria (Figures 6 and 9, respectively).
- Copper and silver concentrations (Figures 7 and 8, respectively) were greater than the respective CSLs in S27-3C (2-3 ft and 3-4 ft).
- Mercury concentrations (Figure 3) exceeded the SQS in the 0-1-ft sample from S27-3C and the CSL in the three remaining samples from S27-3C as well as the 0-1 ft, 1-2 ft, 2-3 ft, and 3-4 ft samples from S27-2C.

- There is no SMS value for sediment TBT concentrations. The maximum sediment TBT concentration (460 mg/kg dw) was measured in S27-1C (0-1 ft).
- PAH concentrations exceeded the LAET [(benzo(a)anthracene, total benzofluoranthenes, chrysene and high molecular weight PAH (HPAH)] and 2LAET (acenaphthene, fluoranthene) in the 0-1ft interval of core location S27-C1. PAH concentrations also exceeded the SQS the 1-2 ft (fluoranthene) and 2-3 ft (acenaphthene, benzo(a)anthracene, chrysene, fluoranthene, phenanthrene, HPAH, LPAH) intervals from locations S27-2C. PAH concentrations above the SQS were reported for S27-C3 in the 1-2 ft sample (total benzofluoranthenes, fluoranthene, HPAH) and the 2-3 ft sample (fluoranthene and HPAH). In the 3-4 ft sample, concentrations of nine individual PAH and total HPAH concentrations (Figure 4) exceeded the 2LAET and concentrations of two individual PAH and total LPAH exceeded the LAET.
- Bis(2-ethylhexyl)phthalate (BEHP) exceeded the CSL in four core samples (Figure 5), S27-2C (1-2 ft) and S27-3C (1-2 ft, 2-3 ft, and 3-4 ft).
- Butylbenzyl phthalate concentrations exceeded the SQS in S27-2C (1-2 ft).
- N-nitrosodiphenylamine RL exceeded the SQS in S27-1C (0-1 ft).
- PCBs exceeded the CSL or 2LAET at least once in each core location (Figure 2). The 2LAET was exceeded in samples S27-1C (0-1 ft) and S27-3C (0-1 ft and 3-4 ft). The CSL was exceeded in samples S27-2C (1-2 ft) and S27-3C (1-2 ft and 2-3 ft), the SQS for PCBs was also exceeded at S27-2C (0-1 ft).
- No pesticides were detected any of the core samples, however RLs associated with non-detected values for total DDTs exceeded the SL (5 samples) and ML (4 samples). Reporting limits associated with non-detected values for dieldrin exceeded the SL(4 samples). Total chlordane reporting limits exceeded the same four samples. The four samples with total DDT RLs above the ML and dieldrin and total chlordane RLs above the SL were all samples with total PCB concentrations above the CSL.

2.5 DATA VALIDATION

The raw laboratory data and field sample documentation forms are available upon request. Rinsate blank (RB) and field duplicate samples were collected as part of the quality assurance procedure. The RB results were not detected indicating that no cross contamination between samples or introduction of contamination from sampling equipment occurred. A field duplicate was also collected and its results are presented next to its parent sample.

The sediment samples submitted to ARI were analyzed in two sample delivery groups: KL33 and KL34. EcoChem conducted a summary-level data validation on all results. The data validation included a review of calibration, internal standard, and

interference check sample summary forms. The majority of the data did not require qualification, or were qualified with a J, indicating an estimated value. Based on the information reviewed, the overall data quality was considered acceptable for use as qualified. The complete data validation report providing detailed information regarding every qualified sample is available upon request.

Matrix interferences were identified in the SVOC full-scan, SVOC-SIM, and the pesticide analyses. Extracts were submitted for silica gel clean up and re-analyzed following the cleanup. Two SVOCs, N-nitrosodiphenylamine (8 samples) and pentachlorophenol (3 samples) were initially M-qualified by the laboratory and subsequently JN qualified by EcoChem to indicate that analytical interferences resulted in uncertainty with regard to analyte identification and quantification. A single monobutyltin result was JN qualified for the same reason. The spectra for these twelve M-qualified results were evaluated by EPA, and it was concluded that these results should be reported as non-detected with RLs elevated to the level of the reported concentration. Several pesticide results were qualified as not detected with elevated reporting limits that reflect probable interference in the analysis due to the presence of PCBs in the samples. Additional matrix interferences resulted in elevated reporting limits for several SVOC results. One non-detected result for di-n-octyl-phthalate in sample EW-S27-C2-2 was rejected because of severely low internal standard recoveries. The detected results in this sample that were associated with low internal standard recoveries were J-qualified as estimated.

3 Data Interpretation

Elevated reporting limits associated with pesticide results are not indicative of the presence of pesticides in the sediment samples. Matrix interference in the analysis of pesticides due to the presence of PCBs has been observed historically in East Waterway, the lower Duwamish and many other sites.

The sediment concentrations were compared to results for two grab samples and a core sample collected in this area in 1991 by Battelle (Smolski et al. 1991) (Figure 1). The results for the historical samples are summarized in Table 5. There are important differences between the historical data and the 2007 data presented here. The core sample collected in 1991 was analyzed as two composites representing 0-5.7 ft and 5.7-11.2 ft. In 2007, sediment cores were collected representing 0-4 ft of sediment and analyzed in one foot intervals. In addition, the surface grabs analyzed by Battelle represent the top 2cm of sediment compared to the surface sediment results for this investigation which represent the top 10cm.

Table 5a. East Waterway Pier 27 (historical) grabs and core samples

Analyte	Unit	SQS/SL	CSL/ML	G01	G18	V01	
						V1-1	V1-2[a]
				0 – 2 cm	0 – 2 cm	0 – 5.66 ft	5.66 – 11.16 ft
Metals and trace elements							
Cadmium	mg/kg dw	5.1	6.7	2.9	**5.42**	**8.18**	0.47
Chromium	mg/kg dw	260	270	102	109	180	48
Copper	mg/kg dw	390	390	160.6	155.2	160.1	37.6
Mercury	mg/kg dw	0.41	0.59	**0.664**	**0.607**	**0.970**	0.16
Silver	mg/kg dw	6.1	6.1	1.82	1.68	3.89	0.3
Zinc	mg/kg dw	410	960	**799**	**946**	**840**	124.4
PAHs							
Acenaphthene	mg/kg OC	16	57	4.2 J	10	**34**	**AET**
Acenaphthylene	mg/kg OC	66	66	6.0 J	4.9 J	2.4	**AET**
Anthracene	mg/kg OC	220	1,200	34	45	3.7	**AET**
Benzo(a)anthracene	mg/kg OC	110	270	**180**	100	51	**AET**
Benzo(a)pyrene	mg/kg OC	99	210	**190**	**110**	23	**AET**
Benzo(b)fluoranthene	µg/kg dw	nv	nv	7,000	5,400	1,800	340
Benzo(g,h,i)perylene	mg/kg OC	31	78	**42**	23	10	**AET**
Benzo(k)fluoranthene	µg/kg dw	nv	nv	5,300	5,200	na	na
Total benzofluoranthenes	mg/kg OC	230	450	**464**	**344**	61	**AET**
Chrysene	mg/kg OC	110	460	**230**	**180**	51	**AET**
Dibenzo(a,h)anthracene	mg/kg OC	12	33	**31**	**23**	4.7	**AET**
Dibenzofuran	mg/kg OC	15	58	6.8 U	7.8	**18**	**AET**
Fluoranthene	mg/kg OC	160	1,200	**490**	**390**	100	**AET**
Fluorene	mg/kg OC	23	79	6.8 J	16	**27**	**AET**
Indeno(1,2,3-cd)pyrene	mg/kg OC	34	88	**110**	**75**	11	**AET**
Naphthalene	mg/kg OC	99	170	3.6 J	3.9 J	6.4	**AET**
Phenanthrene	mg/kg OC	100	480	68	**200**	64	**AET**

Analyte	Unit	SQS/SL	CSL/ML	G01	G18	V01	
						V1-1	V1-2[a]
				0 – 2 cm	0 – 2 cm	0 – 5.66 ft	5.66 – 11.16 ft
Pyrene	mg/kg OC	1,000	1,400	240	200	160 J	**AET**
Total HPAH	mg/kg OC	960	5,300	**2,000**	**1,400**	480 J	**AET**
Total LPAH	mg/kg OC	370	780	120 J	280 J	140	**AET**
Total PAH	µg/kg dw	nv	nv	56,000 J	53,000 J	18,200 J	5,400
Phthalates							
Bis(2-ethylhexyl)phthalate	mg/kg OC	47	78	20	32	**<u>150</u>**	**AET**
Polychlorinated biphenyls							
PCBs (total calc'd)	mg/kg OC	12	65	**35**	**46.4**	**<u>78.4</u>**	**AET**

[a] Organic carbon normalization was not appropriate for this sample because TOC content <0.5%. Results are compared to LAET and 2LAET dry weight criteria in Table 5b.

dw – dry weight

nv – no value; there is no SQS/SL or CSL/ML for this chemical

OC – organic carbon

HPAH – high-molecular-weight polycyclic aromatic hydrocarbon

LPAH – low-molecular-weight polycyclic aromatic hydrocarbon

PAH – polycyclic aromatic hydrocarbon

SQS and CSL – sediment quality standard and cleanup screening level (WAC 173-204)

SL and ML – screening level and maximum level (USACE et al. 2000)

Concentration in **bold** indicates SQS/SL exceedance.

Concentration in **<u>bold underline</u>** indicates CSL/ML exceedance.

Data qualifiers: J – estimated concentration

Table 5b. East Waterway Pier 27 (historical) core sample (comparison to LAET values)

Analyte	Unit	LAET	2LAET	V1-2 5.66 – 11.16 ft
PAHs				
Acenaphthene	µg/kg dw	500	730	**600**
Acenaphthylene	µg/kg dw	1,300	1,300	18
Anthracene	µg/kg dw	960	4,400	420
Benzo(a)anthracene	µg/kg dw	1,300	1,600	310
Benzo(a)pyrene	µg/kg dw	1,600	3,000	130
Benzo(g,h,i)perylene	µg/kg dw	670	720	48
Total benzofluoranthenes	µg/kg dw	3,200	3,600	340
Chrysene	µg/kg dw	1,400	2,800	370
Dibenzo(a,h)anthracene	µg/kg dw	230	540	17
Dibenzofuran	µg/kg dw	540	700	320
Fluoranthene	µg/kg dw	1,700	2,500	1,200
Fluorene	µg/kg dw	540	1,000	390
Indeno(1,2,3-cd)pyrene	µg/kg dw	600	690	67
Naphthalene	µg/kg dw	2,100	2,400	78
Phenanthrene	µg/kg dw	1,500	5,400	510
Pyrene	µg/kg dw	2,600	3,300	880
Total HPAH)	µg/kg dw	12,000	17,000	3,400
Total LPAH	µg/kg dw	5,200	13,000	2,020
Phthalates				
Bis(2-ethylhexyl)phthalate	µg/kg dw	47	78	140
Polychlorinated biphenyls				
PCBs (total calc'd)	µg/kg dw	12	65	**380**

dw – dry weight

PAH – polycyclic aromatic hydrocarbon

LAET – lowest apparent effects threshold, 2LAET – second lowest apparent effects threshold

Concentration in **bold** indicates LAET exceedance.

Concentration in **bold underline** indicates 2LAET exceedance.

The SMS exceedances for the historical data and the 2007 samples are summarized in Table 6. The historical data is presented in Table 3-1 and is presented on Maps 2-9 with the 2007 results. The non-detected results in the 1991 data were reported with detection limits which exceeded the SQS for 10 SVOCs. In 2007, reporting limits above the SL for organochlorine pesticides and one RL above the CSL was reported for 2,4-dimethyl phenol.

Table 6. Summary of SMS exceedances in 1991 and 2007

SUMMARY OF EXCEEDANCES IN 1991	SUMMARY OF EXCEEDANCES IN 2007
Surface sediment (0-2cm) (n =2)	**Surface sediment (0-10cm) (n = 7)**
Mercury above the CSL in both samples	Mercury above the SQS in one sample
Zinc concentrations above the SQS in both samples	Zinc above the SQS in one sample
Cadmium above the SQS in one sample	No exceedances for cadmium
Nine individual PAH compounds above the SQS	Two individual PAH above the CSL in one sample
HPAH above SQS in both samples	Two individual PAH above the SQS in one sample
	2,4-dimethyl phenol above the CSL in one sample
No exceedance for 2,4-dimethylphenol	Total PCBs above the LAET in one sample and 2LAET in one sample
Total PCBs above SQS for both samples]	
	Core Samples (three locations, four one foot intervals)(n=12)
	Cadmium above the CSL in three samples, SQS in one sample
Core samples (one location, two intervals -0-5.66 ft, 5.66-11.16 ft) (n=2)	Copper above the CSL in two samples
Cadmium above the CSL in one sample	Mercury above the CSL in six samples, above the SQS in one sample
No exceedances for copper	Silver above the CSL in two samples
Mercury above the CSL in one sample	Zinc above the CSL in three samples, SQS in one sample
No exceedances for silver	Thirteen individual PAH above the SMS and the LAET values
Zinc concentrations above the SQS in one sample	Total HPAH above the SQS in three samples, LAET in one sample and 2LAET in one sample
Three individual PAH compounds above the SQS	Total LPAH above the SQS in one sample, LAET in one sample
Bis(2-ethylhexyl)phthalate above CSL in one sample	Total PCBs above the CSL in three samples, above the LAET in one sample, above 2LAET in two samples
Total PCBs above CSL for one sample	

Results for the surface composite of the historical core sample, V01 (0-5.7 ft), are also presented on Figures 2 through 9 for comparison to the core sample results from this investigation. The total PCB concentration reported in the 1991 sample is consistent with the concentrations reported for the three cores collected in 2007 (Figure 2). Mercury concentrations are also comparable between the two studies with the exception of S27-1C which had much lower mercury concentrations than the other cores (Figure 3). HPAH concentrations are also comparable with the exception of

S27-3C which had HPAH concentrations higher than the historical core and the two other cores collected in 2007 (Figure 4). BEHP concentration in V01 is consistent with the concentrations reported for S27-3C. Both of these cores had consistently higher concentrations than the concentrations in S27-1C and S27-2C (Figure 5). Cadmium, copper, silver, and zinc concentrations in the V01 composite are higher than the concentrations reported for S27-1C and similar to the concentrations reported for S27-2C. The maximum concentrations of these four metals were measured in the 2-3 ft sample from S27-3C.

In conclusion, the chemicals present in the sediments at concentrations above SMS are similar in the 2007 data set and the 1991 data set. In both studies, metals (cadmium, mercury and zinc), PAHs and PCBs were found to be present at concentrations above SMS values.

4 References

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