Table 2-1. Slip 4 Outfalls (Tetra Tech 1988a,b; Schmoyer 2003, 2006a,b pers. comm.; Ecology 2005).

Name	**Outfall Diameter (inches)**	**Drainage Area (acres)**	**Location**
I-5 Storm Drain	72	~140	Located at head of Slip 4.
Georgetown Flume	60[a]	Unknown	Located at head of Slip 4.
North Boeing Field SD[b]	24	3 (SD)	Located at head of Slip 4.
King County Airport SD #3/PS44 EOF	60	290 (SD) 75 (EOF)[c]	Located at head of Slip 4.
East Marginal Way PS EOF[d]	36	318	Located at head of Slip 4.
Private SD	8	Unknown	Located at Crowley Marine property.
Private SD	8	Unknown	Located at Crowley Marine property.
Private SD	8	Unknown	Located at Crowley Marine property.
Private SD	8	Unknown	Located at Crowley Marine property.
Private SD	8	Unknown	Located at Crowley Marine property.
Private SD	8	Unknown	Located at Crowley Marine property.
Private SD	6	Unknown	Located at First South Properties.
Private SD	6	Unknown	Located at First South Properties.
Private SD	4	Unknown	Located at First South Properties.
Private SD	6	Unknown	Located at First South Properties.
Private SD	6	Unknown	Located at First South Properties.
Private SD	24	Unknown	Located at Boeing Plant 2.
Private SD	24	Unknown	Located at Boeing Plant 2.

[a] Drawings and survey notes indicate a 60" pipe in a 72" box culvert.
[b] The emergency overflow (EOF) from this drain has been rerouted to the King County Airport SD #3/PS44 EOF.
[c] SPU records indicate that there have been no overflows from this pump station in the last five years (Schmoyer 2004, pers. comm.).
[d] There has not been a recorded overflow to Slip 4 from the East Marginal Way PS since recordkeeping began in the 1970s.

Table 2-2. Endangered, Threatened, or Candidate Species in the LDW (SEA 2004, Windward et al. 2005, WDFW 2004).

	Federal			State		
	Threatened	Candidate	Species of Concern	Threatened	Candidate	Sensitive Species
Chinook salmon	X				X	
Coho salmon		X				
Bull trout	X				X	
Pacific cod					X	
River lamprey			X		X	
Pacific herring					X	
Walleye pollack					X	
Rockfish					X	
Bald eagle	X			X		
Peregrine falcon			X			X
Purple martin					X	
Merlin					X	
Common murre					X	
Common loon					X	
Western grebe					X	

Table 2-3. Washington State Sediment Management Standards Numerical Criteria (WAC 173-204).

	SQS	CSL/MCUL
Metals	***(mg/kg, dry weight)***	
Antimony	---	---
Arsenic	57	93
Cadmium	5.1	6.7
Chromium	260	270
Copper	390	390
Lead	450	530
Mercury	0.41	0.59
Nickel	---	---
Silver	6.1	6.1
Zinc	410	960
Organics	***(mg/kg organic carbon)***	
LPAHs	370	780
Naphthalene	99	170
Acenaphthylene	66	66
Acenaphthene	16	57
Fluorene	23	79
Phenanthrene	100	480
Anthracene	220	1,200
2-Methylnaphthalene	38	64
HPAHs	960	5,300
Fluoranthene	160	1,200
Pyrene	1,000	1,400
Benz[a]anthracene	110	270
Chrysene	110	460
Benzofluoranthenes	230	450
Benzo[a]pyrene	99	210
Indeno(1,2,3-c,d)pyrene	34	88
Dibenzo[a,h]anthracene	12	33
Benzo[ghi]perylene	31	78
Chlorinated Hydrocarbons		
1,3-Dichlorobenzene	---	---
1,4-Dichlorobenzene	3.1	9
1,2-Dichlorobenzene	2.3	2.3
1,2,4-Trichlorobenzene	0.81	1.8
Hexachlorobenzene	0.38	2.3
Phthalates		
Dimethylphthalate	53	53
Diethylphthalate	61	110
Di-n-buylphthalate	220	1,700
Butylbenzylphthalate	4.9	64
Bis(2-ethylhexyl)phthalate	47	78
Di-n-octylphthalate	58	4,500

Table 2-3. Washington State Sediment Management Standards Numerical Criteria (WAC 173-204).

	SQS	CSL/MCUL
Miscellaneous		
Dibenzofuran	15	58
Hexachlorobutadiene	3.9	6.2
Hexachloroethane	---	---
N-nitrosodiphenylamine	11	11
Total PCBs	12	65
Chlorinated Pesticides		
Total DDT	---	---
Aldrin	---	---
Chlordane	---	---
Dieldrin	---	---
Heptachlor	---	---
Lindane	---	---
Volatile Organic Compounds		
Ethylbenzene	---	---
Tetrachloroethene	---	---
Total xylene	---	---
Trichloroethene	---	---
Ionizable Organic Compounds	***(µg/kg, dry weight)***	
Phenol	420	1,200
2-Methylphenol	63	63
4-Methylphenol	670	670
2,4-Dimethylphenol	29	29
Pentachlorophenol	360	690
Benzyl Alcohol	57	73
Benzoic Acid	650	650

Table 2-4. Known and Potential Chemicals of Concern in Slip 4 Surface Sediments.[a]

	1990 - 1998			2004		
SMS Chemicals	**No. of Samples Analyzed**	**No. of Samples Exceeding SQS**	**No. of Samples Exceeding CSL**	**No. of Samples Analyzed**[e]	**No. of Samples Exceeding SQS**	**No. of Samples Exceeding CSL**
PCBs (total)	39	35[f]	24	30	10	4
Bis(2-ethylhexyl)phthalate	22	14	10	9	2	1
Dibenzo[a,h]anthracene	22	6	0	9	0	0
Indeno(1,2,3-cd)pyrene	22	6	0	9	1	0
Chrysene	22	5	0	9	0	0
Mercury	23	4	1	30	0	0
Fluoranthene	22	4	0	9	0	0
Butyl benzyl phthalate	22	3	0	9	0	0
Total HPAH	22	3	0	9	0	0
Zinc	23	3	0	5	0	0
Lead	23	2	1	5	0	0
Benz[a]anthracene	22	2	0	9	0	0
Benzofluoranthenes (total)	22	2	0	9	0	0
Di-n-octyl phthalate	22	2	0	9	0	0
Phenanthrene	22	2	0	9	0	0
Cadmium	23	1	1	5	0	0
N-Nitrosodiphenylamine	22	1	1	9	0	0
Benzo[a]pyrene	22	1	0	9	0	0
Benzo[ghi]perylene	22	1	0	9	0	0
Phenol	22	0	0	9	1	0
Non-SMS Chemicals						
DDT (total)	10	1[b]	1[c]	0	---	---
Dieldrin	10	1[b]	---[d]	0	---	---
alpha-Chlordane	10	1[b]	---[d]	0	---	---

[a]Known and potential chemicals of concern defined as detected chemicals exceeding the SQS in one or more surface sediment samples, or for chemicals without SMS numerical criteria, exceeding the PSDDA SL.

[b]Exceeds PSDDA SL.

[c]Exceeds PSDDA ML.

[d]No PSDDA ML for this chemical.

[e]Including intertidal composite sample; does not include field replicates or bank samples.

[f]Surface sediment at one station had less than 0.2% TOC and so was not compared to SMS. PCBs (dry-weight) at this location were greater than the LAET but less than the 2LAET.

Table 2-5. PCB Concentrations in Slip 4 Sediments Sampled in 2004 and 2005.[a]

Location	Sample	Depth Interval (cm)		PCBs ug/kg		PCBs mg/kg, OC		SQS Exceedance Factor[c]		CSL Exceedance Factor[d]	
Surface Samples											
SG01	SG01	0	10	490	*J*	4.3	*J*	0.36	*J*	0.07	*J*
SG02	SG02	0	10	1620	*J*	**31.3**	***J***	2.61	*J*	0.48	*J*
SG03	SG03	0	10	5100		**201**		16.73		3.09	
SG04	SG04	0	10	4940	*J*	**103**	***J***	8.61	*J*	1.59	*J*
SG05	SG05	0	10	444	*J*	8.7	*J*	0.72	*J*	0.13	*J*
SG06	SG06	0	10	4730	*JM*	**148**	***JM***	12.40	*JM*	2.29	*JM*
SG06FR[b]	SG41	0	10	1130	*J*	**33.1**	***J***	2.76	*J*	0.51	*J*
SG07	SG07	0	10	470		**14.8**		1.23		0.23	
SG08	SG08	0	10	710	*J*	**23.4**	***J***	1.95	*J*	0.36	*J*
SG09	SG09	0	10	482	*J*	**13.4**	***J***	1.11	*J*	0.21	*J*
SG10	SG10	0	10	306		9.2		0.77		0.14	
SG11	SG11	0	10	242	*JM*	7.7	*JM*	0.61	*JM*	0.11	*JM*
SG11FR	SG43	0	10	239	*J*	7.1	*J*	0.59	*J*	0.11	*J*
SG12	SG12	0	10	529	*J*	**16.5**	***J***	1.38	*J*	0.25	*J*
SG13	SG13	0	10	368		10.5		0.88		0.16	
SG14	SG14	0	10	198	*J*	7.1	*J*	0.59	*J*	0.11	*J*
SG15	SG15	0	10	299	*J*	10.5	*J*	0.87	*J*	0.16	*J*
SG16	SG16	0	10	126	*J*	**15.4**	***J***	1.29	*J*	0.24	*J*
SG17	SG17	0	10	119		3.9		0.33		0.06	
SG18	SG18	0	10	130	*J*	4.1	*J*	0.34	*J*	0.06	*J*
SG19	SG19	0	10	154		5.4		0.45		0.08	
SG20	SG20	0	10	179	*J*	5.8	*J*	0.48	*J*	0.09	*J*
SG21	SG21	0	10	158	*J*	5.3	*J*	0.44	*J*	0.08	*J*
SG22	SG22	0	10	145	*J*	5.2	*J*	0.43	*J*	0.08	*J*
SG23	SG23	0	10	36		6.7		0.56		0.10	
SG24	SG24	0	10	99	*J*	3.4	*J*	0.29	*J*	0.05	*J*
SG25	SG25	0	10	116	*J*	4.5	*J*	0.38	*J*	0.07	*J*
SG26	SG26	0	10	129	*J*	2.9	*J*	0.24	*J*	0.04	*J*
SG27	SG27	0	10	77	*J*	2.5	*J*	0.20	*J*	0.04	*J*
SG28	SG28	0	10	72	*J*	4.3	*J*	0.36	*J*	0.07	*J*
SG29	SG29	0	10	210	*J*	7.2	*J*	0.60	*J*	0.11	*J*
IC01	IC01	0	10	1650		**154**		12.83		2.37	
Subsurface Cores											
SC01	SC01A	0	61	35000		**1549**		129.06		23.83	
SC01	SC01B	61	122	1390	*M*	**470**	***M***	39.10	*M*	7.22	*M*
SC01	SC01C	122	183	3.9	*J*	1.9	*J*	0.16	*J*	0.03	*J*
SC02	SC02A	0	61	1200	*J*	**35.2**	***J***	2.93	*J*	0.54	*J*
SC02	SC02B	61	122	8300	*MJ*	**276**	***MJ***	22.90	*MJ*	4.24	*MJ*
SC02	SC02C	122	183	10900		**333**		27.78		5.13	
SC02	SC02D	183	244	17400	*J*	**690**	***J***	57.54	*J*	10.62	*J*
SC02	SC02E	244	305	5400		**276**		22.96		4.24	
SC03	SC03A	0	61	560	*J*	**18.4**	***J***	1.53	*J*	0.28	*J*
SC03	SC03B	61	122	4820	*J*	**166**	***J***	13.85	*J*	2.56	*J*
SC03	SC03C	122	183	14700		**531**		44.22		8.16	
SC03	SC03D	183	244	2340		**198**		16.53		3.05	
SC03	SC03E	244	305	3.9	*U*	1.2	*U*	0.10	*U*	0.02	*U*
SC04	SC04A	0	61	14300	*J*	**475**	***J***	39.59	*J*	7.31	*J*

Table 2-5. PCB Concentrations in Slip 4 Sediments Sampled in 2004 and 2005.[a]

				PCBs		SQS	CSL
Location	**Sample**	**Depth Interval (cm)**		**ug/kg**	**mg/kg, OC**	**Exceedance Factor[c]**	**Exceedance Factor[d]**
SC04	SC04B	61	122	9700	**189**	15.76	2.91
SC04	SC04C	122	183	300	7.5	0.62	0.12
SC05	SC05A	0	61	1310	**49.4**	4.12	0.76
SC05	SC05B	61	122	26.6	1.2	0.10	0.02
SC05	SC05C	122	183	3.9 *U*	0.2 *U*	0.02 *U*	0.00 *U*
SC06	SC06A	0	61	354 *J*	**14.8 *J***	1.23 *J*	0.23 *J*
SC06	SC06B	61	122	990 *J*	**42.3 *J***	3.53 *J*	0.65 *J*
SC06	SC06C	122	183	770 *J*	**48.4 *J***	4.04 *J*	0.75 *J*
SC06	SC06D	183	244	3.9 *U*	na[e]	0.03[e]	0.01[e]
SC07	SC07A	0	61	6900 *J*	**288 *J***	24.10 *J*	4.43 *J*
SC07	SC07B	61	122	7300	**293**	24.42	4.51
SC07	SC07C	122	183	372	**27.2**	2.26	0.42
SC07	SC07D	183	244	3.9 *U*	na[e]	0.03[f]	0.01[f]
SC09[g]	SC-09-0-2	0	61	22.1	1.6	0.13	0.02
SC09[g]	SC-09-2-4	61	122	3.9 *U*	0.58 *U*	0.05 *U*	0.01 *U*
SC09[g]	SC-09-4-6	122	183	3.9 *U*	0.96 *U*	0.08 *U*	0.01 *U*
SC09[g]	SC-09-6-8	183	244	3.9 *U*	1.3 *U*	0.11 *U*	0.02 *U*
SC09[g]	SC-09-8-10	244	305	3.9 *U*	0.83 *U*	0.07 *U*	0.01 *U*
SC11[g]	SC11-0-2	0	61	1770	**77**	6.42	1.18
SC11[g]	SC11-2-4	61	122	600	**49**	4.08	0.75
SC11[g]	SC11-4-6	122	183	3.9 *U*	0.90 *U*	0.08 *U*	0.01 *U*
SC11[g]	SC11-6-8	183	244	3.9 *U*	0.72 *U*	0.06 *U*	0.01 *U*
SC11[g]	SC11-8-10	244	305	3.9 *U*	0.77 *U*	0.06 *U*	0.01 *U*
SC11[g]	SC11-10-12	305	366	3.8 *U*	0.70 *U*	0.06 *U*	0.01 *U*
Bank Samples 2004 (Integral 2004a)							
BK01	BK01	0	10	23	2.4	0.20	0.04
BK02	BK02	0	10	4700 *M*	**47 *M***	3.91 *M*	0.72 *M*
BK02FR	BK08	0	10	2710	**28.9**	2.40	0.44
BK03	BK03	0	10	850	**48.6**	4.05	0.75
BK04	BK04	0	10	790	**20.2**	1.68	0.31
BK05	BK05	0	10	1300	**26.3**	2.19	0.40
BK06	BK06	0	10	7800	**402**	33.51	6.19
Bank Samples 2005 (Paramatrix 2005; Bach 2005a)							
BK-06A	BK-06A	0	10	360	**16.7**	1.39	0.26
BK-06B	BK-06B	0	10	140	5.4	0.45	0.08
BK-06C	BK-06C	0	10	440	11.3	0.94	0.17
BS-01	BS-01	--	15	9640	**291.24**	24.27	4.48
BS-02	BS-02	--	15	617	**60.49**	5.04	0.93
BS-03	BS-03	--	15	215	**13.27**	1.11	0.20
BS-04	BS-04	--	15	365	**44.57**	3.71	0.69
BS-05	BS-05	--	15	1440	**68.25**	5.69	1.05
BS-06	BS-06	--	15	876	**53.41**	4.45	0.82
BB-01	BB-01	--	46	1800	**65.93**	5.49	1.01
BB-02	BB-02	--	46	9540	**829.57**	69.13	12.76
BB-03	BB-03	--	91	146	7.85	0.65	0.12
BB-04	BB-04	--	61	1594	**103.51**	8.63	1.59

Table 2-5. PCB Concentrations in Slip 4 Sediments Sampled in 2004 and 2005.[a]

Location	Sample	Depth Interval (cm)		PCBs ug/kg	PCBs mg/kg, OC	SQS Exceedance Factor[c]	CSL Exceedance Factor[d]
BB-05	BB-05	--	46	210	5.82	0.49	0.09
BB-06	BB-06	--	46	711	**67.71**	5.64	1.04

Notes:
U = Undetected.
J = Estimated. The result was qualified as estimated but met criteria for acceptance of data for use in site evaluation.
M = Mean of duplicate (i.e., field split) results.

[a]Boxes indicate concentrations exceeding SQS; shading indicates concentrations exceeding CSL.
[b]FR indicates field replicate sample. Field replicates are additional field samples collected at a station after obtaining the
[c]SQS Exceedance Factor = sample concentration/SQS (PCBs SQS = 12 mg/kg OC).
[d]CSL Exceedance Factor = sample concentration/CSL (PCBs CSL = 65 mg/kg OC).
[e]TOC is less than 0.2% so concentration is not TOC-normalized.
[f]Dry weight concentration compared to lowest apparent effects threshold (LAET) due to low TOC.
[g]Sample analyzed by The Boeing Company (Landau 1990).

Table 2-6. Concentrations of Detected Chemicals other than PCBs that Exceed SMS in Slip 4 Sediments.

Chemical	Station	Sample Depth (cm)	Concentration		SQS EF[a]	CSL EF[b]
Organics						
Bis(2-ethylhexyl) phthalate	SG06	0 - 10	102	mg/kg, OC	2.174	1.310
Bis(2-ethylhexyl) phthalate	SG06FR (SG41)[c]	0 - 10	132	mg/kg, OC	2.808	1.692
Bis(2-ethylhexyl) phthalate	SG16	0 - 10	51	mg/kg, OC	1.094	0.659
Indeno(1,2,3-cd)pyrene	SG06FR (SG41)	0 - 10	35	mg/kg, OC	1.035	0.400
Phenol	SG16	0 - 10	480	ug/kg	1.143	0.400
Metals						
Mercury	SC01	0 - 61	10.3	mg/kg	25.122	17.458
Mercury - reanalysis	SC01	0 - 61	0.99	mg/kg	2.415	1.678
Mercury	SC02	122 - 183	0.51	mg/kg	1.244	0.864
Mercury	SC02	183 - 244	0.82	mg/kg	2.000	1.390
Mercury	SC04	122 - 183	0.71	mg/kg	1.732	1.203
Mercury	SC04	183 - 244	0.49	mg/kg	1.195	0.831
Mercury	SC07	61 - 122	0.47	mg/kg	1.146	0.797
Silver	SC02	183 - 244	6.4	mg/kg	1.049	1.049

[a] SQS Exceedance Factor = sample concentration/SQS.

[b] CSL Exceedance Factor = sample concentration/CSL.

[c] FR indicates field replicate sample. Field replicates are additional field samples collected at a station after obtaining the primary or normal sample and repositioning the sampling vessel.

Table 2-7. Summary of Groundwater Investigations.

Facility	Investigation	Date	No. of Wells Sampled	Chemicals Analyzed					
				VOC	SVOC	PCBs	TPH	Metals	Other
First South Properties									
	Environmental Site Assessment, First Interstate Bank of Washington Property (Landau 1990)	June 1990	3	X	X	X	X	X	
	Underground Tank Removal and Groundwater/Soil Quality Report, Parcel E, Evergreen Marine Leasing Property (Hart Crowser 1991)	October 1990, January 1991, April 1991	4	X	X		X		
	Additional Independent Remedial Action Report, Former Evergreen Marine Leasing Property (Hart Crowser 1996)	1996 - ? (monitoring)	3				X		
Crowley									
	Assessment of Marine Power and Equipment Sites (Weston 1988, in Hart Crowser 1989a)	1988	2	X	X	X		X	pesticides
	Environmental Assessment - Parcel F Soil and Groundwater Conditions, Evergreen Marine Leasing Property (Hart Crowser 1989a)	November 1988 (phase 1)	2	X	X	X		X	pesticides
	Environmental Site Assessment, First Interstate Bank of Washington Property (Landau 1990)	June 1990	6	X	X	X	X	X	
	Environmental Assessment - Parcel D Soil and Groundwater Conditions, Evergreen Marine Leasing Property (Hart Crowser 1989b)	November 1988 (phase 1)	2	X	X	X		X	pesticides
		June 1989 (phase 2)	2					arsenic	
	Supplemental Site Characterization Report, Parcel D. Evergreen Marine Leasing Property (Hart Crowser 1990)	September 1990	7		PAHs			arsenic	

Table 2-7. Summary of Groundwater Investigations.

Facility	Investigation	Date	No. of Wells Sampled	Chemicals Analyzed					
				VOC	SVOC	PCBs	TPH	Metals	Other
	Site Investigation Crowley Marine Services 8th Avenue South Facility (SEACOR 1994)	July 1994	3	X			X	lead	
The Boeing Company									
	Phase II Subsurface Environmental Assessment, Proposed Integrated Aircraft Systems Laboratory Building (Weston 1990)	1990	6	X				X	oil & grease
	Release Assessment, Boeing-Plant 2 (Weston 1994)	1994	3		*unknown*			X	

Table 2-8. LDW Phase 1 Ecological Risk Assessment Summary (Windward 2003b).

Group	Representative Species (receptor of concern)	COPCs	Risk Characterization
Benthic Invertebrates	Crab	PCBs, TBT, metals, other organic compounds	Low, except for arsenic[a]
Fish	English sole Bull trout[b] Wild juvenile chinook salmon[b]	PCBs, PAHs, TBT, DDT, arsenic, copper, mercury	Arsenic, copper, and PCB exposure concentration greater than concentrations associated with adverse effects for one or more of the representative fish species. PAHs, mercury, and tributyltin exposure estimates between the no-effects level and the adverse-effects level.
Birds and Mammals	Great blue heron Spotted sandpiper Bald eagle River otter Harbor seal	PCBs, BEHP, arsenic, copper, lead, mercury, and zinc	PCB exposure of great blue heron may be occurring at levels associated with adverse effects (eggs). PCB, mercury, lead, arsenic exposure estimates greater than no-effects levels for one or more wildlife species; no dietary exposures greater than doses associated with adverse effects to survival, growth, or reproduction.
Plants	Emergent aquatic plants	Lead, mercury, PCBs, and zinc	Exposure concentrations less than soil PCB concentrations associates with no effect, but within low end of the concentration range associates with effects for lead and zinc.

[a] Natural background levels of arsenic will be addressed in the Phase 2 ERA.
[b] Federally listed threatened or endangered species.

Table 2-9. Comparison of Maximum Chemical Concentrations in Slip 4 Surface Sediments to Human Health Risk-based Concentrations.

		NETFISHING EXPOSURE SCENARIO			BEACH PLAY EXPOSURE SCENARIO		
	Units	Maximum Reported Concentration[a]	Risk-Based Concentration[b]	Potential Human Health Concern?	Maximum Reported Concentration[c]	Risk-Based Concentration[b]	Potential Human Health Concern?
1,2,4-Trichlorobenzene	µg/kg dw	120 *U*	3,000,000	no	120 *U*	65,000	no
1,2-Dichlorobenzene	µg/kg dw	120 *U*	370,000	no	120 *U*	370,000	no
1,3-Dichlorobenzene	µg/kg dw	120 *U*	5,200	no	120 *U*	1,300	no
1,4-Dichlorobenzene	µg/kg dw	120 *U*	8,100	no	120 *U*	3,400	no
2,4-Dimethylphenol	µg/kg dw	120 *U*	1,800,000	no	120 *U*	120,000	no
2-Methylnaphthalene	µg/kg dw	120 *U*	na	no	120 *U*	na	no
2-Methylphenol	µg/kg dw	120 *U*	4,400,000	no	120 *U*	310,000	no
4-Methylphenol	µg/kg dw	220	440,000	no	120 *U*	31,000	no
Acenaphthene	µg/kg dw	120 *U*	3,800,000	no	120 *U*	370,000	no
Acenaphthylene	µg/kg dw	120 *U*	na	no	120 *U*	na	no
Anthracene	µg/kg dw	280	100,000,000	no	120 *U*	2,200,000	no
Antimony	mg/kg dw	10 *U*	82	no	6 *U*	3.1	undetected[e]
Arsenic	µg/kg dw	20	2.7	yes[d]	6 *U*	0.39	undetected
Benz[a]anthracene	µg/kg dw	1600	2,900	no	120	620	no
Benzo[a]pyrene	µg/kg dw	2500	290	no	150	620	no
Benzo[b+k]fluoranthene	µg/kg dw	7000 *J*	na[f]	no	340 *J*	na[g]	no
Benzo[ghi]perylene	µg/kg dw	930	na	no	120 *U*	na	no
Benzoic acid	µg/kg dw	1200 *U*	100,000,000	no	1200 *U*	100,000,000	no
Benzyl alcohol	µg/kg dw	120 *U*	100,000,000	no	120 *U*	1,800,000	no
Bis(2-ethylhexyl) phthalate	µg/kg dw	4500	180,000	no	160	35,000	no
Butylbenzyl phthalate	µg/kg dw	120	100,000,000	no	120 *U*	1,200,000	no
Cadmium	mg/kg dw	1.8	81	no	6 *U*	3.7	undetected
Chromium	mg/kg dw	53	448	no	24.4	210	no
Chrysene	µg/kg dw	2400	290,000	no	210	62,000	no
Copper	mg/kg dw	94.8	7,600	no	32.2	290	no
Dibenz[a,h]anthracene	µg/kg dw	280	290	no	120 *U*	62	undetected
Dibenzofuran	µg/kg dw	120 *U*	510,000	no	120 *U*	29,000	no
Dibutyl phthalate	µg/kg dw	120 *U*	8,800,000	no	120 *U*	610,000	no
Diethyl phthalate	µg/kg dw	120 *U*	100,000,000	no	120 *U*	4,900,000	no
Dimethyl phthalate	µg/kg dw	120 *U*	100,000,000	no	120 *U*	100,000,000	no
Di-n-octyl phthalate	µg/kg dw	220	10,000,000	no	120 *U*	120,000	no
Fluoranthene	µg/kg dw	3900	3,000,000	no	290	230,000	no
Fluorene	µg/kg dw	120 *U*	3,300,000	no	120 *U*	260,000	no

Table 2-9. Comparison of Maximum Chemical Concentrations in Slip 4 Surface Sediments to Human Health Risk-based Concentrations.

		NETFISHING EXPOSURE SCENARIO			BEACH PLAY EXPOSURE SCENARIO		
	Units	Maximum Reported Concentration[a]	Risk-Based Concentration[b]	Potential Human Health Concern?	Maximum Reported Concentration[c]	Risk-Based Concentration[b]	Potential Human Health Concern?
Hexachlorobenzene	µg/kg dw	120 *U*	1,500	no	120 *U*	300	no
Hexachlorobutadiene	µg/kg dw	120 *U*	32,000	no	120 *U*	6,200	no
Hexachloroethane	µg/kg dw	120 *U*	180,000	no	120 *U*	35,000	no
Indeno(1,2,3-cd)pyrene	µg/kg dw	1200	2,900	no	120 *U*	620	no
Lead	mg/kg dw	109	100	yes[h]	17	40	no
Mercury	mg/kg dw	0.4	8.8	no	0.06	0.61	no
Naphthalene	µg/kg dw	130	19,000	no	120 *U*	5,600	no
Nickel	mg/kg dw	29	4,100	no	27	160	no
N-Nitrosodiphenylamine	µg/kg dw	120 *U*	500,000	no	120 *U*	99,000	no
Pentachlorophenol	µg/kg dw	590 *U*	11,000	no	580 *U*	3,000	no
Phenanthrene	µg/kg dw	1200	na	no	120 *U*	na	no
Phenol	µg/kg dw	480	100,000,000	no	120 *U*	3,700,000	no
Polychlorinated biphenyls	µg/kg dw	5100	1,000	yes	1650 *J*	220	yes
Pyrene	µg/kg dw	4400	5,400,000	no	420	230,000	no
Silver	mg/kg dw	1	1,000	no	0.4 *U*	39	no
Zinc	mg/kg dw	256	100,000	no	67.4	2,300	no

Notes:

U = Undetected

J = Estimated

[a]Intertidal and subtidal surface sediment concentrations in 2004.

[b]Derived by Windward (2003c).

[c]Intertidal surface sediment composite sample in 2004.

[d]Arsenic concentration above Puget Sound background levels (5.03/10.4 mg/kg) at one location (SG-17).

[e]Chemical is undetected but reporting limit is greater than risk-based concentration.

[f]Risk-based concentration (netfishing exposure) for benzo(k)fluoranthene = 29,000 µg/kg.

[g]Risk-based concentration (beach play exposure) for benzo(k)fluoranthene = 6,200 µg/kg.

[h]Exceeds risk-based concentration at one (SG-06) of six stations analyzed for lead in Slip 4; this station also exceeds risk-based concentration for PCBs.

Table 2-10. Chemicals Exceeding SMS[1] in Slip 4 Storm Drains.

Drain	Chemicals Exceeding SMS	Sample Type
King County Airport SD#3/PS44 EOF	Mercury, zinc, BEHP, PCBs	Sediment trap
	Mercury, zinc, acenaphthene, fluorene, benzo(b+k)fluoranthenes, phenanthrene, benzo(g,h,i)perylene, fluoranthene, indeno(1,2,3-cd)pyrene, BEHP, PCBs	Inline sediment samples
	Copper, lead, zinc, fluorene, phenanthrene, benzo(a)anthracene, benzo(a)pyrene, benzo(b+k)fluoranthenes, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, BEHP	Catch basin sediment
I-5 SD	Zinc, BEHP, PCBs	Sediment trap
Georgetown flume	Lead, mercury, zinc, phenanthrene, fluoranthene, BEHP, acenaphthene, fluorene, benzo(b+k)fluoranthenes, PCBs	Inline sediment samples
	Zinc, phenanthrene, benzo(b+k)fluoranthenes, benzo(g,h,i)perylene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, PCBs	Catch basin sediment
Private outfalls to Slip 4	Zinc, BEHP, butylbenzylphathalate, di-n-octylphthalate	Catch basin sediment

[1] Exceedances of SMS criteria are noted here for comparison purposes only, as the SMS do not apply to storm drain sediments.

Table 4-1. Advantages and Disadvantages of Using Treatment Technologies for Slip 4 Cleanup.

EE/CA Evaluation Criterion	Treatment Advantages	Treatment Disadvantages
Effectiveness	May destroy some or most of the organic contaminants such as PCBs. May reduce amount of PCBs being landfilled. May allow for beneficial use of the treated material. Incineration and high-temperature thermal desorption have proven effectiveness for PCBs.	Effectiveness of advanced soil washing is unproven for these site conditions. Each of the technologies produces waste streams (e.g., off gasses, wastewater) that may contain contaminants and may increase short-term risks. Waste streams from advanced soil washing require landfilling or discharge to water. Treated material may still have residual contamination. Beneficial use may create higher exposures and risks compared to landfilling without treatment. Beneficial use requires careful evaluation.
Implementability	Offsite incineration at established facilities is readily implementable.	Advanced soil washing would require treatability testing, delaying cleanup. Administratively difficult to assess and implement re-use options in a short time frame. Onsite treatment facility requires significant land and infrastructure. Administratively difficult to site a new PCB treatment facility.
Cost	No cost advantages.	Substantially higher costs than direct landfill disposal of untreated materials. Advanced soil washing costs are difficult to predict, and there is substantial potential for cost overruns. Costs may further increase if beneficial use cannot be implemented. Costs of each treatment technology is substantial and disproportionate to any benefits gained. Landfill disposal is a proven, lower-cost alternative.

Table 5-1. Summary of Estimated Quantities Associated with Slip 4 Removal Alternatives.

Action	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Removal Volumes (cy)[a]				
Bank Excavation [b,c]	7,300	9,700	3,200	4,300
Dredging [d]	700 [e]	4,300	24,000	36,000
Total Volume Removed	**8,100**	**14,000**	**27,000**	**40,000**
Fill Volumes (cy) [f]				
Capping	27,000	27,000	17,000	26,000
Enhanced Natural Recovery [g]	0	0	2,500	3,000
Total Fill Volume	**27,000**	**27,000**	**20,000**	**29,000**
Cap Areas (acres)				
Capping	3.6	3.6	2.5 [h]	0.73 [i]

Notes:

[a] All quantities are rounded to two significant figures; minor differences in the totals are due to rounding. All removal volume estimates include a 1-foot pay overdepth.

[b] Bank excavation quantities represent the volume of material expected to be removed by land-based equipment working from the upland. Actual equipment and methodology will be determined in the design and in the selected contractor's work plans. Bank excavation includes bank material from the top of bank down to elevations as low as -3 feet MLLW.

[c] Bank excavation includes material that could be defined as either "excavation material" or "dredged material." Using the criteria defined by the DMMP (2003), 100% of this material from Slip 4 may be considered to be "dredged material," as removal of this material has demonstrable ecological benefits at the project site. EPA tracks media as "soil" or "sediment." Approximately 70% of the bank excavation material is considered to be "sediment" and 30% is considered "soil."

[d] Dredge quantities represent the volume of sediment expected to be removed by floating equipment. Actual equipment and methodology will be determined in the design and in the selected contractor's work plans. Volumes for Alternatives 3 and 4 include allowance for contingency overdredging to address residuals.

[e] Sediment removal near the head of Slip 4 under Alternative 1 would likely be accomplished in-the-dry with land-based equipment, but may potentially be dredged with floating equipment.

[f] All fill volume estimates include a 1-foot overplacement pay allowance.

[g] Enhanced natural recovery represents placement of a thin layer of cap material, and is included as a contingency action for Alternatives 3 and 4.

[h] Cap area could range up to 3.6 acres if inner berth area requires capping.

[i] Cap area could range up to 3.6 acres if inner berth area requires capping and if backfilled areas are considered a "cap.

Table 5-2. Estimated Costs for Alternative 1.

Item		Estimated Cost
Land Acquisition and Institutional Control Implementation [a]	$	700,000
Mob/Demob/Site Prep	$	263,000
Bank Excavation and Disposal	$	558,000
Dredging and Disposal	$	98,000
Capping	$	1,235,000
Outfall Modifications	$	130,000
Debris Removal and Disposal	$	122,000
Construction Engineering, Management, and QA/QC [b]	$	710,000
Washington State Sales Tax	$	287,000
Design and Project Management [c]	$	681,000
Contingency [d]	$	770,000
Long-Term Operation & Maintenance (30-yr Present Worth) [e]	$	480,000
Total	**$**	**6,000,000**

Notes:

[a] Cost includes land acquisition and legal/administrative costs for institutional controls.

[b] Includes construction engineering and management (6% of direct capital costs); construction quality control activities (by contractor); and construction quality assurance activities such as surveys, confirmation sediment sampling, and water quality monitoring.

[c] Includes project management during design and construction (5% of direct capital costs) and estimated cost of removal design.

[d] Contingency based on 30% of subtotal direct capital costs.

[e] Long-term monitoring costs assume 7 monitoring events over 30 years. Maintenance costs based on one (1) cap repair event affecting up to 15% of the cap area. Present value analysis based on a 5% net discount rate.

Table 5-3. Estimated Costs for Alternative 2.

Item	Estimated Cost
Land Acquisition and Institutional Control Implementation [a]	$ 700,000
Mob/Demob/Site Prep	$ 263,000
Bank Excavation and Disposal	$ 740,000
Dredging and Disposal	$ 386,000
Capping	$ 1,240,000
Outfall Modifications	$ 130,000
Debris Removal and Disposal	$ 137,000
Construction Engineering, Management, and QA/QC [b]	$ 816,000
Washington State Sales Tax	$ 343,000
Design and Project Management [c]	$ 716,000
Contingency [d]	$ 920,000
Long-Term Operation & Maintenance (30-yr Present Worth) [e]	$ 480,000
Total	**$ 6,900,000**

Notes:

[a] Cost includes land acquisition and legal/administrative costs for institutional controls.

[b] Includes construction engineering and management (6% of direct capital costs); construction quality control activities (by contractor); and construction quality assurance activities such as surveys, confirmation sediment sampling, and water quality monitoring.

[c] Includes project management during design and construction (5% of direct capital costs) and estimated cost of removal design.

[d] Contingency based on 30% of subtotal direct capital costs.

[e] Long-term monitoring costs assume 7 monitoring events over 30 years. Maintenance costs based on one (1) cap repair event affecting up to 15% of the cap area. Present value analysis based on a 5% net discount rate.

Table 5-4. Estimated Costs for Alternative 3.

Item		Estimated Cost
Institutional Control Implementation [a]	$	100,000
Mob/Demob/Site Prep	$	328,000
Bank Excavation and Disposal	$	245,000
Dredging and Disposal	$	2,178,000
Capping	$	1,079,000
Outfall Modifications	$	130,000
Debris Removal and Disposal	$	163,000
Construction Engineering, Management, and QA/QC [b]	$	1,142,000
Washington State Sales Tax	$	484,000
Design and Project Management [c]	$	906,000
Contingency [d]	$	1,299,000
Long-Term Operation & Maintenance (30-yr Present Worth) [e]	$	660,000
Total	**$**	**8,700,000**

Notes:

[a] Cost includes land acquisition and legal/administrative costs for institutional controls.

[b] Includes construction engineering and management (6% of direct capital costs); construction quality control activities (by contractor); and construction quality assurance activities such as surveys, confirmation sediment sampling, and water quality monitoring.

[c] Includes project management during design and construction (5% of direct capital costs) and estimated cost of removal design.

[d] Contingency based on 30% of subtotal direct capital costs.

[e] Long-term monitoring costs assume 7 monitoring events over 30 years. Maintenance costs based on four (4) cap repair events affecting up to 15% of the cap area. Present value analysis based on a 5% net discount rate.

Table 5-5. Estimated Costs for Alternative 4.

Item		Estimated Cost
Institutional Control Implementation [a]	$	100,000
Mob/Demob/Site Prep	$	328,000
Bank Excavation and Disposal	$	327,000
Dredging and Disposal	$	3,140,000
Capping	$	1,489,000
Outfall Modifications	$	130,000
Debris Removal and Disposal	$	163,000
Construction Engineering, Management, and QA/QC [b]	$	1,429,000
Washington State Sales Tax	$	647,000
Design and Project Management [c]	$	1,008,000
Contingency [d]	$	1,735,000
Long-Term Operation & Maintenance (30-yr Present Worth) [e]	$	660,000
Total	**$**	**11,200,000**

Notes:

[a] Cost includes land acquisition and legal/administrative costs for institutional controls.

[b] Includes construction engineering and management (6% of direct capital costs); construction quality control activities (by contractor); and construction quality assurance activities such as surveys, confirmation sediment sampling, and water quality monitoring.

[c] Includes project management during design and construction (5% of direct capital costs) and estimated cost of removal design.

[d] Contingency based on 30% of subtotal direct capital costs.

[e] Long-term monitoring costs assume 7 monitoring events over 30 years. Maintenance costs based on four (4) cap repair events affecting up to 15% of the cap area. Present value analysis based on a 5% net discount rate.

Table 6-1. Applicable or Relevant and Appropriate Requirements.

Source	Requirement
Washington State Model Toxics Control Act (WAC 173-340-440)	These regulations are applicable to establishing institutional controls for capping. Each alternative would comply with these requirements by implementing appropriate institutional controls in capped areas.
Federal Water Pollution Control Act/ Clean Water Act (CWA) (33 USC 1251-1376; 33 CFR 320-330; 40 CFR 230-231)	These regulations establish the basic structure for regulating discharges of pollutants into the waters of the United States. Section 404 regulates the discharge of dredged material or fill into navigable waters. Section 401 requires water quality certification for such activities. The implementing regulations of these laws are applicable to sediment dredging and capping actions. Each alternative would comply with these regulations through design elements to avoid or minimize adverse effects, the implementation of best management practices, and a water quality monitoring program.
Washington State Water Quality Standards for Surface Waters (WAC 173-201A)	Standards for the protection of surface water quality have been established in Washington State. Acute marine criteria are anticipated to be relevant and appropriate requirements for discharge to marine surface water during sediment dredging and capping. Each alternative would comply with these regulations through the implementation of best management practices and a water quality monitoring program.
Washington State Sediment Management Standards (WAC 173-204)	Chemical concentration and biological effects standards are established for Puget Sound sediments and are applicable to each alternative. For each alternative, chemical concentrations in surface sediment within the removal boundary will be below the SQS following construction.
Construction in State Waters, Hydraulic Code Rules (RCW 77.55; WAC 220-110)	Hydraulic code rules for construction projects in state waters have been established for the protection of fish and shellfish, and are applicable to Slip 4 construction activities. Each alternative would comply with the substantive requirements of these regulations by implementing best management practices for the protection of fish and shellfish, as recommended by the Washington Department of Fish and Wildlife.
Federal Endangered Species Act of 1973 (16 USC 1531 et seq.; 50 CFR 216-226; 50 CFR 402)	These regulations are applicable to any actions performed at this site as this area is potential habitat for threatened and/or endangered species. A biological assessment will be conducted in conjunction with the removal design documents in consultation with NOAA Fisheries and USFWS. Each alternative is expected to comply with the substantive requirements of the Act through design elements to avoid or minimize adverse effects, and implementing best management practices and conservation measures as recommended by NOAA Fisheries and USFWS.
Resource Conservation and Recovery Act [40 CFR 260 - 268]	Dredged/excavated material may be subject to RCRA regulations if it contained a listed waste, or if it displays a hazardous waste characteristic, for example by the Toxicity Characteristic Leaching Procedure (TCLP). RCRA regulations may potentially be ARARs for the storage, treatment, and disposal of the dredged/excavated material unless an exemption applies. Based on site-specific information, it is likely that none of the sediments or soils meet the RCRA definition of hazardous waste.

Table 6-1 (continued). Applicable or Relevant and Appropriate Requirements.

Source	Requirement
Toxic Substances Control Act (TSCA) (40 CFR 761)	This regulation is applicable to excavated or dredged materials containing PCBs. Each alternative would comply with TSCA by disposing all soils and sediments with total PCB concentrations greater than 50 mg/kg at a TSCA landfill. Disposal of soils and sediments with total PCB concentrations less than 50 mg/kg will follow the substantive requirements of 40 CFR 761.61, cleanup and disposal requirements for PCB remediation waste. Material meeting the definition of PCB remediation waste (761.3) would be disposed of using the three options under 761.61 (self-implementing option; performance-based option, and a risk-based option). The risk-based option under 761.61(c) would be expected to be selected at this site, and it may incorporate the requirements of the self-implementing option. If so, then PCB remediation wastes containing less than 50 mg/kg are allowed to be disposed of at non-TSCA municipal or solid waste landfills.
Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Act (50 CFR 600)	This act identifies and protects important habitats of federally managed marine and anadromous fish species. This act is relevant and appropriate to cleanup actions at Slip 4. EPA makes a determination about whether a proposed action may adversely affect EFH.
US Fish and Wildlife Coordination Act. (16 USC 661-667e)	This statute establishes criteria to protect fish and wildlife that could be affected by proposed or authorized federal projects involving “impounding, diverting, or controlling waters.” This act is relevant and appropriate to cleanup actions at Slip 4. EPA will consult with the U.S. Fish and Wildlife Service and the Washington Department of Fish and Wildlife regarding the potential effects of the project on fish and wildlife and identify measures that would mitigate those impacts. Also, the statute requires that adequate provision be made for the conservation, maintenance, and management of fish and wildlife resources and their habitats. The ESA consultation described above will also satisfy the substantive requirements of the Fish and Wildlife Coordination Act.
Migratory Bird Treaty Act (16 USC 703-712)	Governs the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts and nests. This act is applicable to cleanup actions at Slip 4. Actions will be taken as needed to protect habitat for migratory birds, and avoid disturbances of their nests and eggs.
Rivers and Harbors Appropriations Act (33 USC 403; 33 CFR 320 - 323)	Section 10 of this act establishes permit requirements for activities that may obstruct or alter a navigable waterway. Activities that could impede navigation and commerce are prohibited. These substantive permit requirements are anticipated to be applicable to dredging and capping actions that may affect the navigable portions of the waterway. EPA will evaluate compliance with these regulations concurrently with their CWA 404 evaluation.

Table 6-1 (continued). Applicable or Relevant and Appropriate Requirements.

Source	Requirement
Washington Solid Waste Management Act (RCW 70.95) Solid Waste Handling Standards (WAC 173-350)	These regulations are applicable to the disposal of non-hazardous waste generated during remedial activities. These standards set minimum functional performance standards for the proper handling and disposal of solid waste, identifies functions necessary to assure effective solid waste handling programs at both the state and local level, and follows priorities for the management of solid waste. Because the disposal of the dredged sediments and debris will take place in a permitted solid waste landfill that is outside the site boundaries, both substantive and administrative requirements of applicable regulations must be met for this activity. The offsite rule (40 CFR 302.440) of the NCP requires that solid and hazardous waste offsite landfills to which CERCLA hazardous substances are being sent must be acceptable to EPA. The project specifications will require the contractor to obtain EPA approval of the proposed disposal facility. In practical terms, the requirements for disposal of dredged sediments will be found in the permit of the landfill that agrees to accept the waste. For example, the Roosevelt Regional Landfill's permit allows it to accept sediments that, while dewatered, do not need to pass the paint filter test (to limit free-draining liquids) before disposal.
Washington Dangerous Waste Regulations (WAC 173-303)	These state rules regulate the generation, handling, storage, and disposal of dangerous waste. Dredged material and debris would be evaluated for dangerous waste designation in accordance with these regulations. Because the disposal of the dredged sediments and debris will take place in a permitted solid waste landfill that is outside the site boundaries, both substantive and administrative requirements of applicable regulations must be met for this activity.
Executive Order for Floodplain Management (Executive Order 11988; 40 CFR Part 6, App. A) FEMA National Flood Insurance Program Regulations (44CFR 60.3 (d)(3))	Executive Order 11988 requires measures to reduce the risks of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains. The NFIP regulations prohibit encroachments, including fill, within the adopted regulatory floodway unless engineering analyses demonstrate that the proposed encroachment would not increase flood levels. Each alternative meets the requirements of the Executive Order. EPA's sediment guidance document (USEPA 2005b) states that although not ARARs, the Agency normally follows executive orders as a matter of policy. The dredge and fill activities in Slip 4 are outside the floodway limits, and therefore the net filling under Alternatives 1 and 2 is allowable under the NFIP regulations.
Native American Graves Protection and Repatriation Act (NAGPRA) (25 USC 3001 et seq.; 43 CFR 10)	NAGPRA and implementing regulations are intended to protect Native American graves from desecration. These regulations are potentially applicable. Excavation or dredging must cease if Native American burials or cultural items are discovered.
American Indian Religious Freedom Act (42 USC 1996 et seq.)	These regulations are potentially applicable. Excavation or dredging must cease if Native American sacred religious sites, burials, or cultural items are discovered.

Table 6-1 (continued). Applicable or Relevant and Appropriate Requirements.

Source	Requirement
National Historic Preservation Act (16 USC 470f; 36 CFR 800)	These regulations are potentially applicable. If Native American or other cultural materials are discovered as part of the dredging or excavation, alternatives must be evaluated to avoid, minimize, or mitigate the impact.
Archaeological Resources Protection Act (16 USC 470 et seq.; 43 CFR 7)	These regulations are potentially applicable. Excavation or dredging must cease if archaeological resources are discovered.
Washington State Shoreline Management Act (RCW 90.58) Shoreline Management KCC Title 25	KCC Title 25 regulations implement the State Shoreline Management Act, and are applicable to all building, excavation, dredging, and filling within 200 feet of regulated shorelines. May require removal of illegal fill placed after 1972. Changes to the shoreline resulting from cleanup will be evaluated in design.
Critical Areas KCC Title 21A.24	State Law (the Growth Management Act) requires local governments to develop regulations to protect critical areas, but the content of these regulations is left to local government discretion – these ordinances are not subject to State approval. These will be addressed as To Be Considered for the Slip 4 CERCLA cleanup.

Table 6-2. Habitat Acres by Elevation Range.

Habitat Elevation Range (ft MLLW)	Existing Conditions (Acres)	Historically Permited Conditions [a] (Acres)	Alternative 1 (Acres)	Alternative 2 (Acres)	Alternative 3 (Acres)	Alternative 4 (Acres)
Upland (+12 to TOB)						
Riparian (+12 to top of bank)	0.21	0.21	0.23	0.21	0.20	0.20
Aquatic (Below +12)						
Upper Intertidal (+12 to +4)	0.33	0.32	1.15	0.81	0.63	0.57
Lower Intertidal (+4 to -4)	1.54	1.30	1.13	1.59	1.26	1.29
Shallow Subtidal (-4 to -10)	0.79	0.71	1.15	1.05	0.43	0.42
Sublittoral (Deeper than -10)	0.71	1.05	0.00	0.00	1.07	1.10
Total Aquatic	**3.38**	**3.38**	**3.43**	**3.46**	**3.38**	**3.38**
Project Total						
Total Acreage	3.59	3.59	3.66	3.67	3.58	3.58

[a] Historically permitted conditions inferred from permitted 1981 dredge prism, and existing topography outside of dredge prism.

Table 6-3. Net Changes in Habitat Acres by Elevation Range.

Habitat Elevation Range (ft MLLW)	Alternative 1 (Acres)	Alternative 2 (Acres)	Alternative 3 (Acres)	Alternative 4 (Acres)
Upland (+12 to Top of Bank)				
Riparian (+12 to top of bank)	0.01	0.00	-0.01	-0.01
Aquatic (Below +12)				
Upper Intertidal (+12 to +4)	0.82	0.49	0.30	0.24
Lower Intertidal (+4 to -4)	-0.41	0.05	-0.29	-0.26
Shallow Subtidal (-4 to -10)	0.35	0.26	-0.37	-0.37
Sublittoral (Deeper than -10)	-0.71	-0.71	0.36	0.39
Total Aquatic	0.06	0.08	0.00	0.00
Project Total				
Total Acreage	0.07	0.07	-0.01	-0.01

Notes:

Changes in acreages are relative to existing conditions.

Table 6-4. Summary of Comparative Analysis.

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Effectiveness				
Overall protection of human health and environment	Protective.	Protective.	Protective.	Protective.
Achievement of RAOs	Achieves the RAO.	Achieves the RAO.	Achieves the RAO.	Achieves the RAO.
Compliance With ARARs	Complies with ARARs. Surface sediment PCB concentrations will be below the SQS following the removal action. Complies with CWA 404 and ESA requirements. Expands shallow subtidal, intertidal, and total aquatic habitat. Landfill disposal complies with federal and state regulations.	Complies with ARARs. Surface sediment PCB concentrations will be below the SQS following the removal action. Complies with CWA 404 and ESA requirements. Expands shallow subtidal, intertidal, and total aquatic habitat. Landfill disposal complies with federal and state regulations.	Complies with ARARs. Surface sediment PCB concentrations will be below the SQS following the removal action. Complies with CWA 404 and ESA requirements. No net loss of aquatic habitat. Decreases shallow subtidal and intertidal habitat to historically permitted conditions. Requires armoring in remaining intertidal areas, which may result in a less desirable substrate. Landfill disposal complies with federal and state regulations.	Complies with ARARs. Surface sediment PCB concentrations will be below the SQS following the removal action. Complies with CWA 404 and ESA requirements. No net loss of aquatic habitat. Decreases shallow subtidal and intertidal habitat to historically permitted conditions. Requires armoring in remaining intertidal areas, which may result in a less desirable substrate. Landfill disposal complies with federal and state regulations.
Reduction of toxicity, mobility, or volume through treatment	Does not include treatment.	Does not include treatment.	Does not include treatment.	Does not include treatment.

Table 6-4 (continued). Summary of Comparative Analysis.

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Long-term effectiveness and permanence	Effective and permanent. Most contaminated material would remain in place, effectively contained by engineered caps. Caps require long-term monitoring and potentially maintenance. Low erosion potential. However, consequences of cap erosion at head of slip could be greater than Alternatives 2, 3, or 4. Monitoring and periodic reviews would verify long-term effectiveness and permanence. Land use restrictions would minimize potential for cap disturbance.	Effective and permanent. Sediments with the highest concentrations of contaminants would be permanently removed. Remaining contaminated material would be effectively contained by engineered caps. Caps require long-term monitoring and potentially maintenance. Low erosion potential. Monitoring and periodic reviews would verify long-term effectiveness and permanence. Land use restrictions would minimize potential for cap disturbance.	Effective and permanent. Sediments with the highest concentrations of contaminants would be permanently removed. Additional contaminated sediments in the inner berth area would be removed. Remaining contaminated material would be effectively contained by engineered caps. Caps require long-term monitoring and potentially maintenance. Greater erosion potential and potentially greater cap maintenance requirements than Alternatives 1 and 2 due to navigation uses. Monitoring and periodic reviews would verify long-term effectiveness and permanence. Land use restrictions would minimize potential for cap disturbance.	Effective and permanent. Most contaminated material would be permanently removed from the slip. Remaining contaminated material would be effectively contained by engineered caps. Caps require long-term monitoring and potentially maintenance. Greater erosion potential than Alternatives 1 and 2 due to navigation uses. Potentially less cap maintenance requirements than Alternative 3, since backfill in many areas would not be considered a cap. Monitoring and periodic reviews would verify long-term effectiveness and permanence. Land use restrictions would minimize potential for cap disturbance.

Table 6-4 (continued). Summary of Comparative Analysis.

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Short-term effectiveness	Achieves RAOs immediately following construction. No significant risks to workers or the community. Limited excavation (8,100 cy). Most excavation would be completed in-the-dry, and surrounding areas would be capped. Low potential for water quality impacts or releases of material into surrounding areas. Short-term impacts to water quality would be managed through engineering controls and BMPs.	Achieves RAOs immediately following construction. No significant risks to workers or the community. Limited excavation and dredging (14,000 cy). Roughly two-thirds of the material would be excavated in-the-dry, and areas surrounding all excavation or dredging would be capped. Low potential for water quality impacts or releases of material into surrounding areas. Short-term impacts to water quality would be managed through engineering controls and BMPs.	Achieves RAOs immediately following construction. No significant risks to workers or the community. Substantial amount of excavation and dredging (27,000 cy). Dredging would extend to removal area boundaries. Potential releases of material into surrounding areas would be minimized through BMPs and managed with contingency actions. Some potential need for extension of in-water work period to complete in one construction season – this would be coordinated with agencies. Short-term impacts to water quality would be managed through engineering controls and BMPs. Short-term impacts to water quality would be of greater duration as compared to Alternatives 1 and 2.	Achieves RAOs immediately following construction. No significant risks to workers or the community. Greatest amount of excavation and dredging (40,000 cy). Dredging would extend to removal area boundaries. Potential releases of material into surrounding areas would be minimized through BMPs and managed with contingency actions. Some potential need for extension of in-water work period to complete in one construction season – this would be coordinated with agencies. Short-term impacts to water quality would be managed through engineering controls and BMPs. Short-term impacts to water quality would be of greatest duration.

Table 6-4 (continued). Summary of Comparative Analysis.

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Implementability				
Technical feasibility	Readily and reliably implemented.	Readily and reliably implemented.	Readily and reliably implemented. Actions in the inner berth area would require special consideration of design, monitoring, and construction elements to attain SQS in the inner berth, remove sediments under the pier, and cap under the pier. Similar care in design, monitoring, and construction would be needed to address potential fugitive dredging residuals affecting surrounding areas.	Readily and reliably implemented. Actions in the inner berth area would require special consideration of design, monitoring, and construction elements to attain SQS in the inner berth, remove sediments under the pier, and cap under the pier. Similar care in design, monitoring, and construction would be needed to address potential fugitive dredging residuals affecting surrounding areas.
Availability	Services, equipment, and materials readily available.	Services, equipment, and materials readily available.	Services, equipment, and materials readily available.	Services, equipment, and materials readily available.
Administrative feasibility	City purchase of land is feasible. The work will be completed on land owned by the City, First South Properties, and potentially The Boeing Company. Access agreements are anticipated to be required for the work. Institutional controls are required to protect the cap, including deed restrictions if the property is sold.	City purchase of land is feasible. The work will be completed on land owned by the City, First South Properties, and potentially The Boeing Company. Access agreements are anticipated to be required for the work. Institutional controls are required to protect the cap, including deed restrictions if the property is sold.	The work will be completed on land owned by Crowley Marine Services, First South Properties, and potentially The Boeing Company. Access agreements are anticipated to be required for the work. Institutional controls are required to protect the cap, including deed restrictions if the property is sold.	The work will be completed on land owned by Crowley Marine Services, First South Properties, and potentially The Boeing Company. Access agreements are anticipated to be required for the work. Institutional controls are required to protect the cap, including deed restrictions if the property is sold.
Total Cost[1]	**$6,000,000 [2]**	**$6,900,000 [2]**	**$8,700,000**	**$11,200,000**

Notes:
[1] Net Present Value analysis based on 2007 year 0, and 5% net discount rate. Long-term monitoring costs based on seven events over 30 years. Maintenance costs based on assumed cap repairs associated with erosion potential.
[2] Costs for Alternatives 1 and 2 include cost of land acquisition for implementation.