Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

Appendix M
Other Analyses

Final Feasibility Study

Lower Duwamish Waterway
Seattle, Washington

FOR SUBMITTAL TO:

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

The Washington State Department of Ecology
Northwest Regional Office
Bellevue, WA

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Introduction

This appendix presents supporting information and memoranda for the Lower Duwamish Waterway Feasibility Study (LDW FS), which include other predicted model results, residual risk tables, and additional analyses for the remedial alternatives. Appendix M is organized as follows:

- **Part 1 (Remaining Bed Composition Model [BCM] Output, Residual Risks, and Bed Replacement Value Sensitivity Runs):** Predicted concentrations of the four human health risk drivers in surface sediment during and following construction and the associated excess cancer risks and non-cancer hazard quotients are presented in Part 1 of this Appendix. These include predicted surface sediment concentrations of the four human health risk drivers for three LDW reaches[1] (Table M-1) and surface sediment concentrations and associated risk for intertidal areas above minus 4 ft MLLW elevation (Table M-2). For these evaluations, the BCM was applied to natural processes only. No variation in bed composition prediction associated with anthropogenic activity was included. The effects of anthropogenic activity on predicted concentration of the human health risk drivers are discussed in Section 10. For each remedial alternative, Tables M-3 and M-4 present estimated total PCB risks for alternative human health seafood consumption scenarios (i.e., other than the reasonable maximum exposure [RME] scenarios presented in Section 9 of the FS). Table M-5 series presents estimated risks for human health direct contact scenarios for each risk driver (only cumulative excess cancer risks were shown in Table 9-8). Section 9 of the FS includes model-predicted surface sediment concentrations for the human health risk drivers and the associated risks predicted based on use of the mid-bed composition model (BCM) input parameters. BCM sensitivity around those values is presented in this appendix using the low and high input parameters for upstream, lateral, and post-bed sediment replacement values. Specifically, low and high sensitivity of spatially-weighted average concentrations (SWACs) of the human health risk drivers and corresponding excess cancer risks for human health direct contact RME scenarios are presented in the Table M-6 series and the Table M-7 series. Finally, sensitivity runs specific to the post-remedy bed sediment replacement values using total PCBs are presented in Table M-8 and Figures M-1 through M-24. Tables M-9a and M-9b provide the summary statistics for subsurface total PCB concentrations remaining within AOPC 1 and AOPC 2, outside of EAAs, and the dredge and cap footprints. Tables M-9c and M-9d provide the summary statistics for subsurface total PCB concentrations remaining within the cap and partial cap and dredge footprints. These tables and figures support remedial alternative analyses presented in Sections 9 and 10 of the FS.

[1] The three LDW reaches are River Mile [RM] 0 to 2.2, RM 2.2 to 4 and RM 4 to 5 based on the physical conceptual site model, hydrodynamic model, and sediment transport model developed for the LDW.

- **Part 2 (Memorandum – Estimate of PCB Export from the Lower Duwamish Waterway):** This memorandum presents estimated PCB exports resulting from losses during remedial dredging. It also presents estimated PCB exports from upstream- and lateral-source sediment, and those losses associated with resuspended bed-source sediments (resulting from natural erosion). PCB exports are also discussed in Section 9.1.2.3 (Short-Term Effectiveness) of the FS.
- **Part 3 (Memorandum – Change in Total PCB Mass in Surface Sediment for Remedial Alternatives Calculated Using the Bed Composition Model):** This memorandum discusses the mass of total PCBs remaining in the top 10 cm of surface sediment following remediation for each alternative, and the change in mass compared to baseline conditions. These mass estimates do not include the influence of anthropogenic activity on the mixing of sediments. Other estimates of residual risks remaining in surface sediments are also discussed in Section 9.1.2.1 (Long-term Effectiveness and Permanence) and Section 9.3.5 (uncertainty section).
- **Part 4 (Food Web Model Sensitivity):** This part of Appendix M presents the food web model output and associated predicted seafood consumption risks based on different assumptions of total PCB concentrations in water, as shown in Figure 1. Figure 2 presents the food web model output and associated predicted seafood consumption risks based on low, mid, and high BCM inputs for upstream, lateral, and post-bed sediment replacement values. These sensitivity runs are discussed in Section 9.3.2 (Changes in Tissue Concentrations for Total PCBs) of the FS.
- **Part 5 (Memorandum – Potential Increase in Surface Sediment Concentrations Due to Disturbance of Subsurface Sediments):** This memorandum was developed to address agency concerns regarding the potential for remaining subsurface sediment contamination to be exposed following active remediation. Methods are presented for estimating the potential effect of deep disturbance events on the long-term model-predicted surface weighted average sediment concentrations (SWAC) for total PCBs. These results are evaluated as one component of long-term effectiveness for the remedial alternatives in Section 9.1.2.1 (Long-term Effectiveness and Permanence).

Part 1: Bed Replacement Value Runs

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Table M-1 Effectiveness Evaluation – Predicted Post-Construction Arsenic, Total PCB, cPAH, and Dioxin/Furan SWACs by Reach

Arsenic (mg/kg dw) (RAO 2)

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Netfishing Direct Contact 10^{-6} RBTC = 3.7 PRG = Background = 7.0																													
			Reach 1 Baseline = 17										Reach 2 Baseline = 16										Reach 3 Baseline = 10									
			Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
			0 [a]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [a]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [a]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
EAA-Alternative 1	29	<5	17	13	11	9.9	9.5	9.4	9.3	9.3	9.2	9.2	16	12	11	11	12	11	11	10	10	11	10	9.4	9.2	9.1	9.1	9.1	9.1	9.1	9.1	9.0
Alternative 3C	58	3	17	11	9.9	9.5	9.3	9.2	9.2	9.2	9.2	9.1	16	9.5	9.3	9.2	9.2	9.2	9.2	9.1	9.1	9.1	10	9.3	9.2	9.1	9.1	9.1	9.1	9.1	9.1	9.0
Alternative 4C	107	6	17	10	9.8	9.5	9.3	9.2	9.2	9.2	9.2	9.1	16	9.6	9.3	9.2	9.2	9.2	9.2	9.1	9.1	9.1	10	9.3	9.2	9.1	9.1	9.1	9.1	9.1	9.1	9.0
Alternative 5C	157	7	17	10	9.8	9.4	9.3	9.2	9.2	9.2	9.2	9.1	16	9.6	9.3	9.2	9.2	9.2	9.2	9.1	9.1	9.1	10	9.3	9.2	9.1	9.1	9.1	9.1	9.1	9.1	9.0
Alternative 6C	302	16	17	10	9.8	9.4	9.1	9.1	9.1	9.1	9.1	9.1	16	9.6	9.3	9.2	9.2	9.2	9.2	9.1	9.1	9.1	10	9.3	9.2	9.1	9.1	9.1	9.1	9.1	9.1	9.0
Alternative 2R	32	4	17	11	10	9.6	9.4	9.3	9.2	9.2	9.2	9.1	16	9.5	9.3	9.2	9.2	9.2	9.2	9.1	9.1	9.1	10	9.3	9.2	9.1	9.1	9.1	9.1	9.1	9.1	9.0
Alternative 3R	58	6	17	11	9.9	9.5	9.3	9.2	9.2	9.2	9.2	9.1	16	9.5	9.3	9.2	9.2	9.2	9.2	9.1	9.1	9.1	10	9.3	9.2	9.1	9.1	9.1	9.1	9.1	9.1	9.0
Alternative 4R	107	11	17	11	9.9	9.5	9.3	9.2	9.2	9.2	9.2	9.1	16	9.5	9.4	9.2	9.2	9.2	9.2	9.1	9.1	9.1	10	9.3	9.2	9.1	9.1	9.1	9.1	9.1	9.1	9.0
Alternative 5R	157	17	17	11	9.9	9.5	9.4	9.3	9.3	9.2	9.2	9.1	16	9.5	9.4	9.2	9.3	9.2	9.2	9.2	9.1	9.1	10	9.3	9.2	9.1	9.2	9.1	9.1	9.1	9.1	9.0
Alternative 6R	302	42	17	11	9.9	9.5	9.4	9.3	9.2	9.2	9.1	9.1	16	9.5	9.4	9.2	9.3	9.2	9.2	9.1	9.1	9.1	10	9.3	9.2	9.1	9.2	9.1	9.1	9.1	9.1	9.0

Total PCBs (µg/kg dw) (RAOs 1, 2 and 4)

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Site-wide Netfishing Direct Contact: PRG = 10^{-6} RBTC = 1,300 Seafood Consumption - Human: PRG = Background = 2 Seafood Consumption - Ecological (otter): PRG = 128 - 159																															
			Reach 1 Baseline = 250										Reach 2 Baseline = 660										Reach 3 Baseline = 56									
			Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
			0 [a]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [a]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [a]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
EAA-Alternative 1	29	<5	190	120	84	60	51	48	48	46	45	43	220	98	67	57	61	55	52	47	47	46	56	40	40	38	38	38	39	38	38	37
Alternative 3C	58	3	190	99	73	55	48	45	45	44	44	42	220	83	61	54	57	53	50	45	45	44	56	41	40	38	38	38	38	38	38	37
Alternative 4C	107	6	190	83	64	51	46	44	44	44	43	42	220	76	57	51	54	50	48	44	44	43	56	41	40	38	38	38	38	38	38	37
Alternative 5C	157	7	190	83	58	49	45	44	44	44	43	42	220	76	57	50	53	50	48	44	44	43	56	41	40	38	38	38	38	38	38	37
Alternative 6C	302	16	190	83	58	47	36	39	41	42	42	41	220	76	57	36	41	41	42	41	41	40	56	41	40	35	38	38	38	38	38	37
Alternative 2R	32	4	190	106	77	58	50	47	47	46	45	43	220	85	63	55	58	54	51	46	46	45	56	40	40	38	38	38	39	38	38	37
Alternative 3R	58	6	190	99	73	55	48	45	45	44	44	42	220	83	61	54	57	53	50	45	45	44	56	41	40	38	38	38	38	38	38	37
Alternative 4R	107	11	190	99	73	53	47	45	45	44	44	42	220	83	59	51	54	50	48	44	44	43	56	41	41	38	38	38	38	38	38	37
Alternative 5R	157	17	190	99	73	53	48	45	45	44	44	42	220	83	59	51	54	50	48	44	44	43	56	41	41	38	39	38	38	38	38	37
Alternative 6R	302	42	190	99	73	53	48	45	43	41	38	39	220	83	59	51	54	39	38	40	41	40	56	41	41	38	39	35	38	38	38	37

Table M-1 Effectiveness Evaluation – Predicted Post-Construction Arsenic, Total PCB, cPAH, and Dioxin/Furan SWACs by Reach

cPAHs (µg TEQ/kg dw) (RAO 2)

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Netfishing Direct Contact 10^{-6} RBTC = 380 PRG = 380																													
			Reach 1 Baseline = 450										Reach 2 Baseline = 370										Reach 3 Baseline = 200									
			Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
			0 [a]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [a]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [a]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
EAA-Alternative 1	29	<5	430	280	200	140	120	110	110	110	110	102	280	150	130	120	130	120	120	107	108	104	200	107	97	87	90	86	92	85	87	81
Alternative 3C	58	3	430	230	170	130	110	109	110	110	109	101	280	130	120	106	110	108	108	100	101	96	200	100	94	86	90	86	88	84	87	81
Alternative 4C	107	6	430	200	150	120	109	107	110	110	109	101	280	130	110	104	110	106	106	100	101	95	200	100	94	86	90	86	88	84	86	81
Alternative 5C	157	7	430	200	150	120	108	106	110	110	108	101	280	130	110	104	110	106	106	100	101	95	200	100	95	86	90	86	88	84	86	81
Alternative 6C	302	16	430	200	150	120	105	104	108	108	107	100	280	130	110	104	104	102	103	98	100	94	200	100	95	85	89	86	88	84	86	81
Alternative 2R	32	4	430	250	180	130	120	110	110	110	110	102	280	140	120	110	120	110	110	103	104	99	200	103	96	86	90	86	90	85	87	81
Alternative 3R	58	6	430	230	170	130	110	109	110	110	109	101	280	130	120	106	110	108	108	100	101	96	200	100	94	86	90	86	88	84	87	81
Alternative 4R	107	11	430	230	170	120	110	108	110	110	109	101	280	130	120	103	110	106	106	100	101	95	200	100	96	86	90	86	88	84	86	81
Alternative 5R	157	17	430	230	170	120	120	110	110	110	109	101	280	130	120	103	110	106	106	100	101	95	200	100	96	86	91	86	88	84	86	81
Alternative 6R	302	42	430	230	170	120	120	110	110	110	108	100	280	130	120	103	110	107	104	98	100	94	200	100	96	86	91	85	88	84	86	81

Dioxin/Furan (ng TEQ/kg dw) (RAOs 1 and 2)

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Site-wide Netfishing Direct Contact: PRG = 10^{-6} RBTC = 37 Seafood Consumption - Human: PRG = Background = 2																													
			Reach 1 Baseline = 39										Reach 2 Baseline = 9.7										Reach 3 Baseline = 4.8									
			Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
			0 [a]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [a]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [a]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
EAA-Alternative 1	29	<5	36	18	10	6.2	5.2	4.8	4.7	4.6	4.5	4.4	8	5	4.7	4.4	4.6	4.5	4.5	4.4	4.4	4.3	5	4	4.3	4.1	4.2	4.2	4.2	4.2	4.2	4.1
Alternative 3C	58	3	36	6.8	5.7	4.9	4.6	4.5	4.5	4.5	4.5	4.4	8	4.7	4.5	4.3	4.5	4.4	4.4	4.3	4.3	4.2	5	4.2	4.2	4.1	4.2	4.2	4.2	4.2	4.2	4.1
Alternative 4C	107	6	36	6.0	5.3	4.7	4.5	4.5	4.5	4.5	4.5	4.4	8	4.4	4.3	4.3	4.4	4.4	4.4	4.3	4.3	4.2	5	4.2	4.2	4.1	4.2	4.2	4.2	4.2	4.2	4.1
Alternative 5C	157	7	36	6.0	4.9	4.5	4.4	4.4	4.5	4.5	4.5	4.4	8	4.4	4.3	4.3	4.4	4.4	4.4	4.3	4.3	4.2	5	4.2	4.2	4.1	4.2	4.2	4.2	4.2	4.2	4.1
Alternative 6C	302	16	36	6.0	4.9	4.5	4.3	4.3	4.4	4.4	4.4	4.3	8	4.4	4.3	4.1	4.3	4.3	4.3	4.3	4.3	4.2	5	4.2	4.2	4.0	4.1	4.2	4.2	4.1	4.2	4.1
Alternative 2R	32	4	36	7.2	5.9	5.0	4.7	4.6	4.6	4.5	4.5	4.4	8	4.8	4.5	4.4	4.5	4.5	4.5	4.3	4.3	4.3	5	4.2	4.3	4.1	4.2	4.2	4.2	4.2	4.2	4.1
Alternative 3R	58	6	36	6.8	5.7	4.9	4.6	4.5	4.5	4.5	4.5	4.4	8	4.7	4.5	4.3	4.5	4.4	4.4	4.3	4.3	4.2	5	4.2	4.2	4.1	4.2	4.2	4.2	4.2	4.2	4.1
Alternative 4R	107	11	36	6.8	5.7	4.7	4.5	4.5	4.5	4.5	4.5	4.4	8	4.7	4.3	4.3	4.4	4.4	4.4	4.3	4.3	4.2	5	4.2	4.2	4.1	4.2	4.2	4.2	4.2	4.2	4.1
Alternative 5R	157	17	36	6.8	5.7	4.7	4.4	4.4	4.5	4.5	4.5	4.4	8	4.7	4.3	4.3	4.4	4.4	4.4	4.3	4.3	4.2	5	4.2	4.2	4.1	4.2	4.2	4.2	4.2	4.2	4.1
Alternative 6R	302	42	36	6.8	5.7	4.7	4.4	4.4	4.4	4.4	4.4	4.3	8	4.7	4.3	4.3	4.4	4.3	4.3	4.3	4.3	4.2	5	4.2	4.2	4.1	4.2	4.1	4.2	4.1	4.2	4.1

Notes:

1. BCM predictions use base case STM outputs revised June 2010 (Appendix C).
2. Reach 1 = RM 0 to RM 2.2; Reach 2 = RM 2.2 to RM. 4.0; Reach 3 = RM 4.0 to RM 5.0 from STM report (QEA 2008).
3. BCM model area = 430 acres and FS study area = 441 acres

a. The 5-year model-predicted intervals associated with the BCM SWAC output are indexed to the start of construction for Alternatives 2 through 6. BCM SWAC output shown for Alternative 1 after EAA construction is completed.

BCM output used as approximation (estimate) of concentrations after construction.

BCM = bed composition model; C = combined technology; cPAH = carcinogenic polycyclic aromatic hydrocarbon; dw = dry weight; EAA = early action area; FS = feasibility study; kg = kilograms; µg = micrograms; mg = milligrams; ng = nanograms; PCB = polychlorinated biphenyl; PRG = preliminary remediation goal; R = removal emphasis; RAO = remedial action objective; RBTC = risk-based threshold concentration; RM = river mile; STM = sediment transport model; SWAC = spatially-weighted average concentration; TEQ = toxic equivalent; UCL95 = 95% upper confidence limit

Table M-2 Effectiveness Evaluation – Predicted Post-Construction Arsenic, Total PCB, cPAH, and Dioxin/Furan SWACs and Resulting Individual Chemical Risks in Intertidal Areas

Arsenic (mg/kg dw)

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Intertidal SWAC [a] Baseline = 15 — *Time from Beginning of Construction (years)*										Intertidal Risk [a] — *Time from Beginning of Construction (years)*									
			0 [b]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [b]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
EAA-Alternative 1	29	<5	15	12	11	11	10	10	10	10	10.2	10	1E-05	9E-06	9E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06
Alternative 3C	58	3	15	10	9.4	9.3	9.2	9.2	9.2	9.2	9.2	9.1	1E-05	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06
Alternative 4C	107	6	15	10	9.4	9.3	9.2	9.2	9.2	9.2	9.2	9.2	1E-05	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06
Alternative 5C	157	7	15	10	9.5	9.3	9.3	9.2	9.2	9.2	9.2	9.2	1E-05	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06
Alternative 6C	302	16	15	10	9.5	9.3	9.2	9.2	9.2	9.2	9.2	9.1	1E-05	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06
Alternative 2R	32	4	15	10	10	9.3	9.3	9.2	9.2	9.2	9.2	9.2	1E-05	8E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06
Alternative 3R	58	6	15	10	9.4	9.3	9.2	9.2	9.2	9.2	9.2	9.1	1E-05	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06
Alternative 4R	107	11	15	10	9.4	9.3	9.3	9.2	9.2	9.2	9.2	9.2	1E-05	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06
Alternative 5R	157	17	15	10	9.4	9.3	9.3	9.3	9.2	9.2	9.2	9.2	1E-05	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06
Alternative 6R	302	42	15	10	9.4	9.3	9.3	9.2	9.2	9.2	9.2	9.1	1E-05	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06	7E-06

Total PCBs (µg/kg dw)

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Intertidal SWAC [a] Baseline = 500 — *Time from Beginning of Construction (years)*										Intertidal Risk [a] — *Time from Beginning of Construction (years)*									
			0 [b]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [b]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
EAA-Alternative 1	29	<5	185	93	67	54	51	50	49	47	47	45	4E-07	2E-07	1E-07	1E-07	1E-07	1E-07	1E-07	9E-08	9E-08	9E-08
Alternative 3C	58	3	185	68	57	50	48	47	47	45	45	44	4E-07	1E-07	1E-07	1E-07	1E-07	9E-08	9E-08	9E-08	9E-08	9E-08
Alternative 4C	107	6	185	63	54	48	46	46	46	44	45	43	4E-07	1E-07	1E-07	1E-07	9E-08	9E-08	9E-08	9E-08	9E-08	9E-08
Alternative 5C	157	7	185	63	53	47	46	45	45	44	44	43	4E-07	1E-07	1E-07	9E-08	9E-08	9E-08	9E-08	9E-08	9E-08	9E-08
Alternative 6C	302	16	185	63	53	44	41	42	43	42	43	42	4E-07	1E-07	1E-07	9E-08	8E-08	8E-08	9E-08	8E-08	9E-08	8E-08
Alternative 2R	32	4	185	74	60	52	49	48	48	46	46	45	4E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	9E-08	9E-08	9E-08
Alternative 3R	58	6	185	68	57	50	48	47	47	45	45	44	4E-07	1E-07	1E-07	1E-07	1E-07	9E-08	9E-08	9E-08	9E-08	9E-08
Alternative 4R	107	11	185	68	56	49	47	46	46	44	45	43	4E-07	1E-07	1E-07	1E-07	9E-08	9E-08	9E-08	9E-08	9E-08	9E-08
Alternative 5R	157	17	185	68	56	49	48	46	46	45	45	43	4E-07	1E-07	1E-07	1E-07	1E-07	9E-08	9E-08	9E-08	9E-08	9E-08
Alternative 6R	302	42	185	68	56	49	48	44	44	42	41	41	4E-07	1E-07	1E-07	1E-07	1E-07	9E-08	9E-08	8E-08	8E-08	8E-08

Table M-2 Effectiveness Evaluation – Predicted Post-Construction Arsenic, Total PCB, cPAH, and Dioxin/Furan SWACs and Resulting Individual Chemical Risks in Intertidal Areas

cPAHs (µg TEQ/kg dw)

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Intertidal SWAC [a] Baseline = 410 — Time from Beginning of Construction (years)										Intertidal Risk [a] — Time from Beginning of Construction (years)									
			0 [b]	5	10	15	20	25	30	35	40	45	0 [b]	5	10	15	20	25	30	35	40	45
EAA-Alternative 1	29	<5	331	206	161	130	124	120	120	115	116	109	2E-06	1E-06	1E-06	9E-07	8E-07	8E-07	8E-07	8E-07	8E-07	7E-07
Alternative 3C	58	3	331	144	126	111	110	109	110	107	109	102	2E-06	1E-06	8E-07	7E-07	7E-07	7E-07	7E-07	7E-07	7E-07	7E-07
Alternative 4C	107	6	331	139	123	110	109	108	110	107	109	102	2E-06	9E-07	8E-07	7E-07	7E-07	7E-07	7E-07	7E-07	7E-07	7E-07
Alternative 5C	157	7	331	139	125	109	109	108	110	107	109	102	2E-06	9E-07	8E-07	7E-07	7E-07	7E-07	7E-07	7E-07	7E-07	7E-07
Alternative 6C	302	16	331	139	125	108	108	107	109	107	108	101	2E-06	9E-07	8E-07	7E-07	7E-07	7E-07	7E-07	7E-07	7E-07	7E-07
Alternative 2R	32	4	331	182	148	122	118	115	115	110	112	105	2E-06	1E-06	1E-06	8E-07	8E-07	8E-07	8E-07	7E-07	7E-07	7E-07
Alternative 3R	58	6	331	144	126	111	110	109	110	107	109	102	2E-06	1E-06	8E-07	7E-07	7E-07	7E-07	7E-07	7E-07	7E-07	7E-07
Alternative 4R	107	11	331	144	127	111	110	108	110	107	109	102	2E-06	1E-06	8E-07	7E-07	7E-07	7E-07	7E-07	7E-07	7E-07	7E-07
Alternative 5R	157	17	331	144	127	111	113	110	112	108	109	102	2E-06	1E-06	8E-07	7E-07	8E-07	7E-07	7E-07	7E-07	7E-07	7E-07
Alternative 6R	302	42	331	144	127	111	113	109	110	108	109	102	2E-06	1E-06	8E-07	7E-07	8E-07	7E-07	7E-07	7E-07	7E-07	7E-07

Dioxin/Furan (ng TEQ/kg dw)

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Intertidal SWAC [a] Baseline = 29 — Time from Beginning of Construction (years)										Intertidal Risk [a] — Time from Beginning of Construction (years)									
			0 [b]	5	10	15	20	25	30	35	40	45	0 [b]	5	10	15	20	25	30	35	40	45
EAA-Alternative 1	29	<5	27	13	8.1	5.5	4.9	4.7	4.6	4.5	4.5	4.4	2E-06	1E-06	6E-07	4E-07	4E-07	4E-07	4E-07	3E-07	3E-07	3E-07
Alternative 3C	58	3	27	5.3	5.0	4.6	4.5	4.4	4.4	4.4	4.4	4.3	2E-06	4E-07	4E-07	4E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Alternative 4C	107	6	27	5.2	4.9	4.5	4.5	4.4	4.4	4.4	4.4	4.3	2E-06	4E-07	4E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Alternative 5C	157	7	27	5.2	4.6	4.4	4.4	4.4	4.4	4.4	4.4	4.3	2E-06	4E-07	4E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Alternative 6C	302	16	27	5.2	4.6	4.4	4.3	4.3	4.4	4.4	4.4	4.3	2E-06	4E-07	4E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Alternative 2R	32	4	27	5.7	5.2	4.7	4.6	4.5	4.5	4.4	4.4	4.3	2E-06	4E-07	4E-07	4E-07	4E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Alternative 3R	58	6	27	5.3	5.0	4.6	4.5	4.4	4.4	4.4	4.4	4.3	2E-06	4E-07	4E-07	4E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Alternative 4R	107	11	27	5.3	4.9	4.5	4.5	4.4	4.4	4.4	4.4	4.3	2E-06	4E-07	4E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Alternative 5R	157	17	27	5.3	4.9	4.5	4.4	4.4	4.4	4.4	4.4	4.3	2E-06	4E-07	4E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Alternative 6R	302	42	27	5.3	4.9	4.5	4.4	4.3	4.4	4.4	4.4	4.3	2E-06	4E-07	4E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07

Notes:

1. BCM predictions use base case STM outputs revised June 2010 (Appendix C).
2. BCM model area = 430 acres and FS study area = 441 acres

a. Intertidal SWACs and individual contaminant risk information are provided for informational purposes. Excess cancer risks are calculated using tribal clamming exposure assumptions.

b. The 5-year model-predicted intervals associated with the BCM SWAC output are indexed to the start of construction for Alternatives 2 through 6. BCM SWAC output shown for Alternative 1 after EAA construction is completed.

BCM output used as approximation (estimate) of concentrations/risks after construction.

BCM = bed composition model; C = combined technology; cPAH = carcinogenic polycyclic aromatic hydrocarbon; dw = dry weight; EAA = early action area; FS = feasibility study; kg = kilogram; µg = micrograms; mg = milligrams; ng = nanograms; PCB = polychlorinated biphenyl; PRG = preliminary remediation goal; R = removal emphasis; RAO = remedial action objective; RBTC = risk-based threshold concentration; RM = river mile; STM = sediment transport model; SWAC = spatially-weighted average concentration; TEQ = toxic equivalent; UCL95 = 95% upper confidence limit

Table M-3 Excess Cancer Risks for non-RME Seafood Consumption Scenarios Associated with Alternative-Specific Residual Sediment Total PCB SWACs Over Time

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Adult Tribal CT (Tulalip data) — Time from Beginning of Construction (years) [a]									
			0	5	10	15	20	25	30	35	40	45
EAA-Alternative 1	29	<5	5×10^{-4}	4×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 3C	58	3	5×10^{-4}	3×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 4C	107	6	5×10^{-4}	3×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 5C	157	7	5×10^{-4}	3×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 6C	302	16	5×10^{-4}			2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 2R	32	4	5×10^{-4}	3×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 3R	58	6	5×10^{-4}	3×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 4R	107	11	5×10^{-4}		2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 5R	157	17	5×10^{-4}			2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 6R	302	42	5×10^{-4}								2×10^{-4}	2×10^{-4}

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Child Tribal CT (Tulalip data) — Time from Beginning of Construction (years) [a]									
			0	5	10	15	20	25	30	35	40	45
EAA-Alternative 1	29	<5	1×10^{-4}	7×10^{-5}	5×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 3C	58	3	1×10^{-4}	5×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 4C	107	6	1×10^{-4}	5×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 5C	157	7	1×10^{-4}	5×10^{-5}	4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 6C	302	16	1×10^{-4}			3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 2R	32	4	1×10^{-4}	5×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 3R	58	6	1×10^{-4}	5×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 4R	107	11	1×10^{-4}		4×10^{-5}	4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 5R	157	17	1×10^{-4}			4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 6R	302	42	1×10^{-4}								3×10^{-5}	3×10^{-5}

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Adult API CT — Time from Beginning of Construction (years) [a]									
			0	5	10	15	20	25	30	35	40	45
EAA-Alternative 1	29	<5	2×10^{-4}	1×10^{-4}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}
Alternative 3C	58	3	2×10^{-4}	8×10^{-5}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 4C	107	6	2×10^{-4}	8×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 5C	157	7	2×10^{-4}	8×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 6C	302	16	2×10^{-4}			5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 2R	32	4	2×10^{-4}	9×10^{-5}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 3R	58	6	2×10^{-4}	8×10^{-5}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 4R	107	11	2×10^{-4}		7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 5R	157	17	2×10^{-4}			6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 6R	302	42	2×10^{-4}								5×10^{-5}	5×10^{-5}

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Adult Tribal (Suquamish data) — Time from Beginning of Construction (years) [a]									
			0	5	10	15	20	25	30	35	40	45
EAA-Alternative 1	29	<5	2×10^{-4}	1×10^{-4}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}
Alternative 3C	58	3	2×10^{-4}	8×10^{-5}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 4C	107	6	2×10^{-4}	8×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 5C	157	7	2×10^{-4}	8×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 6C	302	16	2×10^{-4}			5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 2R	32	4	2×10^{-4}	9×10^{-5}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 3R	58	6	2×10^{-4}	8×10^{-5}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 4R	107	11	2×10^{-4}		7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 5R	157	17	2×10^{-4}			6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 6R	302	42	2×10^{-4}								5×10^{-5}	5×10^{-5}

One Meal Per Month

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Benthic Fish — Time from Beginning of Construction (years) [a]									
			0	5	10	15	20	25	30	35	40	45
EAA-Alternative 1	29	<5	5×10^{-4}	4×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 3C	58	3	5×10^{-4}	3×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 4C	107	6	5×10^{-4}	3×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 5C	157	7	5×10^{-4}	3×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 6C	302	16	5×10^{-4}			2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 2R	32	4	5×10^{-4}	3×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 3R	58	6	5×10^{-4}	3×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 4R	107	11	5×10^{-4}		2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 5R	157	17	5×10^{-4}			2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
Alternative 6R	302	42	5×10^{-4}								2×10^{-4}	2×10^{-4}

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Pelagic Fish — Time from Beginning of Construction (years) [a]									
			0	5	10	15	20	25	30	35	40	45
EAA-Alternative 1	29	<5	1×10^{-4}	7×10^{-5}	5×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 3C	58	3	1×10^{-4}	5×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 4C	107	6	1×10^{-4}	5×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 5C	157	7	1×10^{-4}	5×10^{-5}	4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 6C	302	16	1×10^{-4}			3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 2R	32	4	1×10^{-4}	5×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 3R	58	6	1×10^{-4}	5×10^{-5}	4×10^{-5}	4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 4R	107	11	1×10^{-4}		4×10^{-5}	4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 5R	157	17	1×10^{-4}			4×10^{-5}	4×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}
Alternative 6R	302	42	1×10^{-4}								3×10^{-5}	3×10^{-5}

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Crab — Time from Beginning of Construction (years) [a]									
			0	5	10	15	20	25	30	35	40	45
EAA-Alternative 1	29	<5	2×10^{-4}	1×10^{-4}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}
Alternative 3C	58	3	2×10^{-4}	8×10^{-5}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 4C	107	6	2×10^{-4}	8×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 5C	157	7	2×10^{-4}	8×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 6C	302	16	2×10^{-4}			5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 2R	32	4	2×10^{-4}	9×10^{-5}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 3R	58	6	2×10^{-4}	8×10^{-5}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 4R	107	11	2×10^{-4}		7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 5R	157	17	2×10^{-4}			6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 6R	302	42	2×10^{-4}								5×10^{-5}	5×10^{-5}

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Clam — Time from Beginning of Construction (years) [a]									
			0	5	10	15	20	25	30	35	40	45
EAA-Alternative 1	29	<5	2×10^{-4}	1×10^{-4}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}
Alternative 3C	58	3	2×10^{-4}	8×10^{-5}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 4C	107	6	2×10^{-4}	8×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 5C	157	7	2×10^{-4}	8×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 6C	302	16	2×10^{-4}			5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 2R	32	4	2×10^{-4}	9×10^{-5}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 3R	58	6	2×10^{-4}	8×10^{-5}	7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 4R	107	11	2×10^{-4}		7×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 5R	157	17	2×10^{-4}			6×10^{-5}	6×10^{-5}	6×10^{-5}	6×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Alternative 6R	302	42	2×10^{-4}								5×10^{-5}	5×10^{-5}

Notes:

1. Excess cancer risks were estimated using non-RME seafood consumption total PCB tissue concentrations in the food web model (Windward 2010), alternative-specific total PCB SWACs in surface sediment (Table 9-2a), and assumed surface water dissolved PCB concentrations of 0.6 ng/L, except 0.9 ng/L for Year 0 for all alternatives and Year 5 for Alternative 1.
2. Significant figures are displayed in accordance with the conventions established in the HHRA.
3. Risks were not estimated for construction period because of uncertainties in total PCB tissue concentrations during construction. Fish/shellfish tissue concentrations are expected to remain elevated in total PCBs for up to 2 years as a result of construction impacts (e.g., sediment resuspension).

a. The 5-year model-predicted intervals associated with the BCM SWAC output (for risk estimation) are indexed to the start of construction for Alternatives 2 through 6. Risk estimation for Alternative 1 uses the BCM SWAC output after EAA construction is completed.

10^{-3}
10^{-4}
10^{-5}

Colored cells indicate residual excess cancer risk rounded to the nearest order of magnitude.

5×10^{-4} Gray indicates alternative under construction. Red font indicates risk estimate based on the end of construction PCB SWAC.

API = Asian Pacific Islander; C = combined; CT = central tendency; BCM = bed composition model; EAA = early action area; HHRA = human health risk assessment; R = removal; RME = reasonable maximum exposure; SWAC = spatially-weighted average concentration

Table M-4 Non-Cancer Hazard Quotients for non-RME Seafood Consumption Scenarios Associated with Alternative-Specific Residual Sediment Total PCB SWACs Over Time

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Adult Tribal CT (Tulalip data)										Child Tribal CT (Tulalip data)										Adult API CT										Adult Tribal (Suquamish data)									
			Time from Beginning of Construction (years) [a]										Time from Beginning of Construction (years) [a]										Time from Beginning of Construction (years) [a]										Time from Beginning of Construction (years) [a]									
			0	5	10	15	20	25	30	35	40	45	0	5	10	15	20	25	30	35	40	45	0	5	10	15	20	25	30	35	40	45	0	5	10	15	20	25	30	35	40	45
EAA-Alternative 1	29	<5	13	9	6	5	5	5	5	5	5	5	29	19	13	11	11	10	10	10	10	10	9	6	4	4	3	3	3	3	3	3	9	6	4	4	3	3	3	3	3	3
Alternative 3C	58	3	13	7	6	5	5	5	5	5	5	4	29	15	12	11	10	10	10	10	10	10	9	5	4	3	3	3	3	3	3	3	9	5	4	3	3	3	3	3	3	3
Alternative 4C	107	6	13	6	5	5	5	5	5	5	5	4	29	14	12	10	10	10	10	10	10	9	9	4	4	3	3	3	3	3	3	3	9	4	4	3	3	3	3	3	3	3
Alternative 5C	157	7	13	6	5	5	5	5	5	5	5	4	29	14	11	10	10	10	10	10	10	9	9	4	4	3	3	3	3	3	3	3	9	4	4	3	3	3	3	3	3	3
Alternative 6C	302	16	13			4	4	4	4	4	4	4	29			10	9	9	9	9	9	9	9			3	3	3	3	3	3	3	9			3	3	3	3	3	3	3
Alternative 2R	32	4	13	7	6	5	5	5	5	5	5	5	29	16	13	11	11	10	10	10	10	10	9	5	4	4	3	3	3	3	3	3	9	5	4	4	3	3	3	3	3	3
Alternative 3R	58	6	13	7	6	5	5	5	5	5	5	4	29	15	12	11	10	10	10	10	10	10	9	5	4	3	3	3	3	3	3	3	9	5	4	3	3	3	3	3	3	3
Alternative 4R	107	11	13		6	5	5	5	5	5	5	4	29		12	11	10	10	10	10	10	9	9		4	3	3	3	3	3	3	3	9		4	3	3	3	3	3	3	3
Alternative 5R	157	17	13			5	5	5	5	5	5	4	29			11	10	10	10	10	10	9	9			3	3	3	3	3	3	3	9			3	3	3	3	3	3	3
Alternative 6R	302	42	13								4	4	29								9	9	9								3	3	9								3	3

Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	One Meal Per Month																																								
			Benthic Fish										Pelagic Fish										Crab										Clam									
			Time from Beginning of Construction (years) [a]										Time from Beginning of Construction (years) [a]										Time from Beginning of Construction (years) [a]										Time from Beginning of Construction (years) [a]									
			0	5	10	15	20	25	30	35	40	45	0	5	10	15	20	25	30	35	40	45	0	5	10	15	20	25	30	35	40	45	0	5	10	15	20	25	30	35	40	45
EAA-Alternative 1	29	<5	1.1	0.7	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3	0.9	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.4	1.1	0.7	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3	0.9	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.4
Alternative 3C	58	3	1.1	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	1.1	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4
Alternative 4C	107	6	1.1	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	1.1	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4
Alternative 5C	157	7	1.1	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	1.1	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4
Alternative 6C	302	16	1.1			0.4	0.3	0.4	0.4	0.4	0.4	0.4	1.3			0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.1			0.4	0.3	0.4	0.4	0.4	0.4	0.4	1.3			0.4	0.4	0.4	0.4	0.4	0.4	0.4
Alternative 2R	32	4	1.1	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3	0.7	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.4	1.1	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3	0.7	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.4
Alternative 3R	58	6	1.1	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	1.1	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4
Alternative 4R	107	11	1.1		0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3		0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	1.1		0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3		0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4
Alternative 5R	157	17	1.1			0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3			0.5	0.5	0.4	0.4	0.4	0.4	0.4	1.1			0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.3			0.5	0.5	0.4	0.4	0.4	0.4	0.4
Alternative 6R	302	42	1.1								0.4	0.4	1.3								0.4	0.4	1.1								0.4	0.4	1.3								0.4	0.4

Notes:

1. Non-cancer hazard quotients were estimated using non-RME seafood consumption total PCB tissue concentrations in the food web model (Windward 2010), alternative-specific total PCB SWACs in surface sediment (Table 9-2a), and assumed surface water dissolved total PCB concentrations of 0.6 ng/L, except 0.9 ng/L for Year 0 for all alternatives and Year 5 for Alternative 1.
2. All tabulated values are hazard quotients.
3. Hazard quotients were not estimated for construction period because of uncertainties in PCB tissue concentrations during construction. Fish/shellfish tissue concentrations are expected to remain elevated in total PCBs for up to 2 years as a result of construction impacts (e.g., sediment resuspension).

a. The 5-year model-predicted intervals associated with the BCM SWAC output (for risk estimation) are indexed to the start of construction for Alternatives 2 through 6. Risk estimation for Alternative 1 uses the BCM SWAC output after EAA construction is completed.

HQ >1
HQ ≤1
} Colored cells indicate residual non-cancer hazard quotient.

0.4 Gray indicates alternative under construction. Red font indicates hazard quotient estimate based on the end of construction PCB SWAC.

API = Asian Pacific Islander; BCM = bed composition model; C = combined; CT = central tendency; EAA = early action area; HQ = hazard quotient; R = removal; RME = reasonable maximum exposure; SWAC = spatially-weighted average concentration.

Table M-5a Total PCB Excess Cancer Risks for Direct Contact Based on Total PCB SWACs

Combined Alternatives

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		EAAs-Alternative 1									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-6}	1×10^{-7}	8×10^{-8}	6×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Tribal Clamming	8×10^{-6}	4×10^{-7}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	9×10^{-8}	9×10^{-8}	9×10^{-8}
Beach 1	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 2	1×10^{-7}	2×10^{-7}	1×10^{-7}	8×10^{-8}	5×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}
Beach 3	1×10^{-7}	6×10^{-8}	5×10^{-8}	5×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}
Beach 4[d]	6×10^{-4}	6×10^{-7}	2×10^{-7}	6×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}
Beach 5	1×10^{-7}	7×10^{-8}	4×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 6	5×10^{-7}	3×10^{-7}	7×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 7	5×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 8	6×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 3 Combined (3 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-6}	1×10^{-7}	7×10^{-8}	5×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Tribal Clamming	8×10^{-6}	4×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}
Beach 1	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 2	1×10^{-7}	2×10^{-7}	6×10^{-8}	5×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 3	1×10^{-7}	6×10^{-8}	5×10^{-8}	5×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}
Beach 4[d]	6×10^{-4}	6×10^{-7}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 5	1×10^{-7}	7×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 6	5×10^{-7}	3×10^{-7}	4×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 7	5×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 8	6×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 4 Combined (6 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-6}	1×10^{-7}	6×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Tribal Clamming	8×10^{-6}	4×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}
Beach 1	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 2	1×10^{-7}	2×10^{-7}	5×10^{-8}	4×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 3	1×10^{-7}	6×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}
Beach 4[d]	6×10^{-4}	6×10^{-7}	4×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}
Beach 5	1×10^{-7}	7×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 6	5×10^{-7}	3×10^{-7}	4×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 7	5×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 8	6×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 5 Combined (7 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-6}	1×10^{-7}	6×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Tribal Clamming	8×10^{-6}	4×10^{-7}	1×10^{-7}	1×10^{-7}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}
Beach 1	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 2	1×10^{-7}	2×10^{-7}	5×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 3	1×10^{-7}	6×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}
Beach 4[d]	6×10^{-4}	6×10^{-7}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}
Beach 5	1×10^{-7}	7×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 6	5×10^{-7}	3×10^{-7}	4×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 7	5×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 8	6×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 6 Combined (16 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-6}	1×10^{-7}	6×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Tribal Clamming	8×10^{-6}	4×10^{-7}	1×10^{-7}	1×10^{-7}	9×10^{-8}	8×10^{-8}	8×10^{-8}	8×10^{-8}	8×10^{-8}	8×10^{-8}	8×10^{-8}
Beach 1	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 2	1×10^{-7}	2×10^{-7}	5×10^{-8}	4×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 3	1×10^{-7}	6×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}
Beach 4[d]	6×10^{-4}	6×10^{-7}	4×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}
Beach 5	1×10^{-7}	7×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 6	5×10^{-7}	3×10^{-7}	4×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 7	5×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 8	6×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}

Table M-5a Total PCB Excess Cancer Risks for Direct Contact Based on Total PCB SWACs

Removal Alternatives

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 2 Removal (4 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-6}	1×10^{-7}	7×10^{-8}	5×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Tribal Clamming	8×10^{-6}	4×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}
Beach 1	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 2	1×10^{-7}	2×10^{-7}	8×10^{-8}	6×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 3	1×10^{-7}	6×10^{-8}	5×10^{-8}	5×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}
Beach 4[d]	6×10^{-4}	6×10^{-7}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}
Beach 5	1×10^{-7}	7×10^{-8}	4×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 6	5×10^{-7}	3×10^{-7}	7×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 7	5×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 8	6×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 3 Removal (6 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-6}	1×10^{-7}	7×10^{-8}	5×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Tribal Clamming	8×10^{-6}	4×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}
Beach 1	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 2	1×10^{-7}	2×10^{-7}	6×10^{-8}	5×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 3	1×10^{-7}	6×10^{-8}	5×10^{-8}	5×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}
Beach 4[d]	6×10^{-4}	6×10^{-7}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}
Beach 5	1×10^{-7}	7×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 6	5×10^{-7}	3×10^{-7}	4×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 7	5×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 8	6×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 4 Removal (11 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-6}	1×10^{-7}	7×10^{-8}	5×10^{-8}	4×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Tribal Clamming	8×10^{-6}	4×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}
Beach 1	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 2	1×10^{-7}	2×10^{-7}	6×10^{-8}	5×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 3	1×10^{-7}	6×10^{-8}	5×10^{-8}	5×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}
Beach 4[d]	6×10^{-4}	6×10^{-7}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}
Beach 5	1×10^{-7}	7×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 6	5×10^{-7}	3×10^{-7}	4×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 7	5×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 8	6×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 5 Removal (17 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-6}	1×10^{-7}	7×10^{-8}	5×10^{-8}	4×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Tribal Clamming	8×10^{-6}	4×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}	9×10^{-8}
Beach 1	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 2	1×10^{-7}	2×10^{-7}	6×10^{-8}	5×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 3	1×10^{-7}	6×10^{-8}	5×10^{-8}	5×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}
Beach 4[d]	6×10^{-4}	6×10^{-7}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}
Beach 5	1×10^{-7}	7×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 6	5×10^{-7}	3×10^{-7}	4×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 7	5×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 8	6×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 6 Removal (42 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-6}	1×10^{-7}	7×10^{-8}	5×10^{-8}	4×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Tribal Clamming	8×10^{-6}	4×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	9×10^{-8}	9×10^{-8}	8×10^{-8}	8×10^{-8}	8×10^{-8}
Beach 1	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 2	1×10^{-7}	2×10^{-7}	6×10^{-8}	5×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 3	1×10^{-7}	6×10^{-8}	5×10^{-8}	5×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}	4×10^{-8}
Beach 4[d]	6×10^{-4}	6×10^{-7}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}
Beach 5	1×10^{-7}	7×10^{-8}	4×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	2×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}	3×10^{-8}
Beach 6	5×10^{-7}	3×10^{-7}	4×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 7	5×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}
Beach 8	6×10^{-8}	3×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}	2×10^{-8}

$\leq 1 \times 10^{-6}$ Colored cells indicate residual excess cancer risk.

Notes:

1. Total PCB risk estimates are based on SWACs for netfishing, tribal clamming, and individual beaches predicted by the BCM and for each alternative.
2. The BCM total PCB input values used for the predicted future concentrations following start of construction are: 35 µg/kg dw (upstream), 300 µg/kg dw (lateral), and post-remedy bed sediment replacement values of 60 µg/kg dw for AOPC 1 and 20 µg/kg dw for AOPC 2.
3. Individual beach play areas are actively remediated in the first 5 years by Alternative 3.

a. Baseline risks using the RI baseline data for the direct contact scenarios as reported in Section 3 (Table 3-6a for netfishing, tribal clamming scenarios, and beach play scenarios).

b. Construction period.

c. The 5-year intervals for the BCM-predicted SWACs (and for risk estimation) are indexed to the start of construction for Alternatives 2 through 6. Risk estimates for time 0 (post-EAA/Alternative 1) use the BCM-predicted SWACs after construction of the EAAs. Differences in risks between the baseline risks presented in the HHRA and the risks at time 0 are attributable to: 1) the transition from the HHRA methodology (UCL95 or maximum values) to spatial interpolation methodology (SWACs); 2) the transition from the RI baseline dataset to the FS baseline dataset, which affects the SWACs in netfishing and clamming exposure areas; and 3) active remediation of the EAAs, which affects the SWACs in netfishing, clamming, and the Beach 3 exposure areas.

d. The large differences between the baseline risks and the SWAC-based risk estimates at Beach 4 result from removing the two highest PCB-concentration samples at Beach 4 from the FS dataset for interpolating PCB concentrations. After construction of Alternative 2, the locations with the highest PCB concentrations would have undergone active remediation.

AOPC = area of potential concern; BCM = bed composition model; dw = dry weight; EAA = early action area; FS = feasibility study; HHRA = human health risk assessment; kg = kilograms; µg = micrograms; PCB = polychlorinated biphenyl; RI = remedial investigation; SWAC = spatially-weighted average concentration; TEQ = toxic equivalent; UCL95 = 95% upper confidence limit

Table M-5b Arsenic Excess Cancer Risks for Direct Contact Based on Arsenic SWACs

Combined Alternatives

Risk for Each Alternative — EAAs-Alternative 1

Exposure Area	Baseline Risk[a]	*Time from Beginning of Construction (years)*: *0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	6×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Tribal Clamming	2×10^{-5}	1×10^{-5}	8×10^{-6}	8×10^{-6}	8×10^{-6}	8×10^{-6}	8×10^{-6}	8×10^{-6}	8×10^{-6}	8×10^{-6}	8×10^{-6}
Beach 1	5×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 2	6×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 3	4×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 4	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 5	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 6	3×10^{-5}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 7	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 8	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}

Risk for Each Alternative — Alternative 3 Combined (3 years[b])

Exposure Area	*Time from Beginning of Construction (years)*: *0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}
Tribal Clamming	1×10^{-5}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}
Beach 1	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 2	5×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 3	5×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 4	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 5	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 6	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 7	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 8	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}

Risk for Each Alternative — Alternative 4 Combined (6 years[b])

Exposure Area	*Time from Beginning of Construction (years)*: *0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}
Tribal Clamming	1×10^{-5}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}
Beach 1	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 2	5×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 3	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 4	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 5	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 6	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 7	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 8	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}

Risk for Each Alternative — Alternative 5 Combined (7 years[b])

Exposure Area	Baseline Risk[a]	*Time from Beginning of Construction (years)*: *0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	6×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}
Tribal Clamming	2×10^{-5}	1×10^{-5}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}
Beach 1	5×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 2	6×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 3	4×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 4	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 5	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 6	3×10^{-5}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 7	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 8	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}

Risk for Each Alternative — Alternative 6 Combined (16 years[b])

Exposure Area	*Time from Beginning of Construction (years)*: *0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}
Tribal Clamming	1×10^{-5}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}
Beach 1	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 2	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 3	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 4	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 5	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 6	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 7	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 8	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}

Table M-5b Arsenic Excess Cancer Risks for Direct Contact Based on Arsenic SWACs

Removal Alternatives

Risk for Each Alternative — Alternative 2 Removal (4 years[b])

Exposure Area	Baseline Risk[a]	Time from Beginning of Construction (years): 0[c]	5	10	15	20	25	30	35	40	45
Site-wide Netfishing	6×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}
Tribal Clamming	2×10^{-5}	1×10^{-5}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}
Beach 1	5×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 2	6×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 3	4×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 4	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 5	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 6	3×10^{-5}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 7	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 8	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}

Risk for Each Alternative — Alternative 3 Removal (6 years[b])

Exposure Area	Time from Beginning of Construction (years): 0[c]	5	10	15	20	25	30	35	40	45
Site-wide Netfishing	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}
Tribal Clamming	1×10^{-5}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}
Beach 1	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 2	5×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 3	5×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 4	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 5	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 6	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 7	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 8	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}

Risk for Each Alternative — Alternative 4 Removal (11 years[b])

Exposure Area	Time from Beginning of Construction (years): 0[c]	5	10	15	20	25	30	35	40	45
Site-wide Netfishing	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}
Tribal Clamming	1×10^{-5}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}
Beach 1	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 2	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 3	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 4	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 5	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 6	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 7	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 8	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}

Risk for Each Alternative — Alternative 5 Removal (17 years[b])

Exposure Area	Baseline Risk[a]	Time from Beginning of Construction (years): 0[c]	5	10	15	20	25	30	35	40	45
Site-wide Netfishing	6×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}
Tribal Clamming	2×10^{-5}	1×10^{-5}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}
Beach 1	5×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 2	6×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 3	4×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 4	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 5	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 6	3×10^{-5}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 7	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 8	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}

Risk for Each Alternative — Alternative 6 Removal (42 years[b])

Exposure Area	Time from Beginning of Construction (years): 0[c]	5	10	15	20	25	30	35	40	45
Site-wide Netfishing	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}
Tribal Clamming	1×10^{-5}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}	7×10^{-6}
Beach 1	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 2	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 3	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 4	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 5	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 6	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 7	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Beach 8	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}

$>1 \times 10^{-6}$ Colored cells indicate predicted residual risk

Notes:

1. Arsenic risk estimates are based on SWACs for netfishing, tribal clamming, and individual beaches predicted by the BCM and for each alternative.
2. The BCM arsenic input values used for the predicted future concentrations following start of construction are: 9 mg/kg dw (upstream), 13 mg/kg dw (lateral), and post-remedy bed sediment replacement values of 10 mg/kg dw for AOPC 1 and 9 mg/kg dw for AOPC 2.
3. Direct contact excess cancer risk at 1×10^{-6} cannot be achieved because 1) risk threshold is below natural background, and 2) the concentration of the upstream sediment input is assumed to be 9 mg/kg dw, which corresponds to a risk of 3×10^{-6}.
4. Individual beach play areas are actively remediated in the first 5 years by Alternative 3.

a. Baseline risks for the direct contact scenarios as reported in Section 3 (Table 3-6a for netfishing and tribal clamming scenarios, and Table 3-6b for beach play scenarios).

b. Construction period.

c. The 5-year intervals for the BCM-predicted SWACs (and for risk estimation) are indexed to the start of construction for Alternatives 2 through 6. Risk estimates for time 0 (post-EAA/Alternative 1) use the BCM-predicted SWACs after construction of the EAAs. Differences in risks between the baseline risks presented in the HHRA and the risks at time 0 are attributable to: 1) the transition from the HHRA methodology (UCL95 or maximum values) to spatial interpolation methodology (SWACs); 2) the transition from the RI baseline dataset to the FS baseline dataset, which affects the SWACs in netfishing and clamming exposure areas; and 3) active remediation of the EAAs, which affects the SWACs in netfishing, clamming, and the Beach 3 exposure areas.

AOPC = area of potential concern; BCM = bed composition model; dw = dry weight; EAA = early action area; FS = feasibility study; HHRA = human health risk assessment; kg = kilograms; mg = milligrams; RI = remedial investigation; SWAC = spatially-weighted average concentration; TEQ = toxic equivalent; UCL95 = 95% upper confidence limit

Table M-5c cPAH Excess Cancer Risks for Direct Contact Based on cPAH SWACs

Combined Alternatives

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		EAAs-Alternative 1									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	9×10^{-7}	6×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Tribal Clamming	5×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	9×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}
Beach 1	4×10^{-6}	4×10^{-6}	3×10^{-6}	2×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 2	8×10^{-5}	8×10^{-6}	5×10^{-6}	4×10^{-6}	2×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 3	1×10^{-5}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}
Beach 4	1×10^{-5}	4×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 5	3×10^{-5}	4×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 6	8×10^{-5}	6×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 7	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 8	3×10^{-6}	2×10^{-6}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 3 Combined (3 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	9×10^{-7}	5×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Tribal Clamming	5×10^{-6}	2×10^{-6}	9×10^{-7}	8×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}
Beach 1	4×10^{-6}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 2	8×10^{-5}	8×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	9×10^{-7}
Beach 3	1×10^{-5}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}
Beach 4	1×10^{-5}	4×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 5	3×10^{-5}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 6	8×10^{-5}	6×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	9×10^{-7}	9×10^{-7}	9×10^{-7}
Beach 7	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 8	3×10^{-6}	2×10^{-6}	9×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 4 Combined (6 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	9×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Tribal Clamming	5×10^{-6}	2×10^{-6}	9×10^{-7}	8×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}
Beach 1	4×10^{-6}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 2	8×10^{-5}	8×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	9×10^{-7}
Beach 3	1×10^{-5}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}
Beach 4	1×10^{-5}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 5	3×10^{-5}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 6	8×10^{-5}	6×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	9×10^{-7}	9×10^{-7}	9×10^{-7}
Beach 7	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 8	3×10^{-6}	2×10^{-6}	9×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 5 Combined (7 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	9×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Tribal Clamming	5×10^{-6}	2×10^{-6}	9×10^{-7}	8×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}
Beach 1	4×10^{-6}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 2	8×10^{-5}	8×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	9×10^{-7}
Beach 3	1×10^{-5}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}
Beach 4	1×10^{-5}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 5	3×10^{-5}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 6	8×10^{-5}	6×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	9×10^{-7}	9×10^{-7}	9×10^{-7}
Beach 7	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 8	3×10^{-6}	2×10^{-6}	9×10^{-7}	9×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 6 Combined (16 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	9×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Tribal Clamming	5×10^{-6}	2×10^{-6}	9×10^{-7}	8×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}
Beach 1	4×10^{-6}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 2	8×10^{-5}	8×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	9×10^{-7}
Beach 3	1×10^{-5}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}
Beach 4	1×10^{-5}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 5	3×10^{-5}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 6	8×10^{-5}	6×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	9×10^{-7}	9×10^{-7}	9×10^{-7}
Beach 7	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 8	3×10^{-6}	2×10^{-6}	9×10^{-7}	9×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}

Table M-5c cPAH Excess Cancer Risks for Direct Contact Based on cPAH SWACs

Removal Alternatives

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 2 Removal (4 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	9×10^{-7}	5×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Tribal Clamming	5×10^{-6}	2×10^{-6}	1×10^{-6}	9×10^{-7}	8×10^{-7}	8×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}
Beach 1	4×10^{-6}	4×10^{-6}	3×10^{-6}	2×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 2	8×10^{-5}	8×10^{-6}	3×10^{-6}	2×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	9×10^{-7}
Beach 3	1×10^{-5}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}
Beach 4	1×10^{-5}	4×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 5	3×10^{-5}	4×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 6	8×10^{-5}	6×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 7	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 8	3×10^{-6}	2×10^{-6}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 3 Removal (6 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	9×10^{-7}	5×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Tribal Clamming	5×10^{-6}	2×10^{-6}	9×10^{-7}	8×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}
Beach 1	4×10^{-6}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 2	8×10^{-5}	8×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 3	1×10^{-5}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}
Beach 4	1×10^{-5}	4×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 5	3×10^{-5}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 6	8×10^{-5}	6×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 7	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 8	3×10^{-6}	2×10^{-6}	9×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 4 Removal (11 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	9×10^{-7}	5×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Tribal Clamming	5×10^{-6}	2×10^{-6}	9×10^{-7}	8×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}
Beach 1	4×10^{-6}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 2	8×10^{-5}	8×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 3	1×10^{-5}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}
Beach 4	1×10^{-5}	4×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 5	3×10^{-5}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 6	8×10^{-5}	6×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 7	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 8	3×10^{-6}	2×10^{-6}	9×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 5 Removal (17 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	9×10^{-7}	5×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Tribal Clamming	5×10^{-6}	2×10^{-6}	9×10^{-7}	8×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}
Beach 1	4×10^{-6}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 2	8×10^{-5}	8×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 3	1×10^{-5}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}
Beach 4	1×10^{-5}	4×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 5	3×10^{-5}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 6	8×10^{-5}	6×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	9×10^{-7}	9×10^{-7}	9×10^{-7}	9×10^{-7}
Beach 7	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 8	3×10^{-6}	2×10^{-6}	9×10^{-7}	8×10^{-7}	8×10^{-7}	9×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 6 Removal (42 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	9×10^{-7}	5×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Tribal Clamming	5×10^{-6}	2×10^{-6}	9×10^{-7}	8×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}	7×10^{-7}
Beach 1	4×10^{-6}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 2	8×10^{-5}	8×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 3	1×10^{-5}	4×10^{-6}	4×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	2×10^{-6}
Beach 4	1×10^{-5}	4×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 5	3×10^{-5}	4×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 6	8×10^{-5}	6×10^{-6}	2×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	9×10^{-7}	9×10^{-7}	9×10^{-7}	9×10^{-7}
Beach 7	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Beach 8	3×10^{-6}	2×10^{-6}	9×10^{-7}	8×10^{-7}	8×10^{-7}	9×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}	8×10^{-7}

$> 1 \times 10^{-6}$	Colored cells indicate residual excess cancer risk.
$\leq 1 \times 10^{-6}$	

Notes:

1. cPAH risk estimates are based on SWACs for netfishing, tribal clamming, and individual beaches predicted by the BCM and for each alternative.
2. The BCM cPAH input values used for the predicted future concentrations following start of construction are: 70 µg TEQ/kg dw (upstream), 1400 µg TEQ/kg dw (lateral), and post-remedy bed sediment replacement value of 140 µg TEQ/kg dw for AOPC 1 and 100 µg TEQ/kg dw for AOPC 2.
3. All hot spots in beaches are actively remediated to achieve RAO 2 at the end of construction. Some beaches are shown to have excess cancer risks that slightly exceed the 1×10^{-6} threshold at the end of construction. This is an artifact of using a post-remedy bed sediment replacement value of 140 µg TEQ/kg. Given the uncertainty in this value and the fact that the beaches are actively remediated, it is assumed that risk from cPAHs at these beaches will be 1×10^{-6} following construction.

a. Baseline risks using the RI baseline data for the direct contact scenarios as reported in Section 3 (Table 3-6a for netfishing, tribal clamming scenarios, and beach play scenarios).
b. Construction period.
c. The 5-year intervals for the BCM-predicted SWACs (and for risk estimation) are indexed to the start of construction for Alternatives 2 through 6. Risk estimates for time 0 (post-EAA/Alternative 1) use the BCM-predicted SWACs after construction of the EAAs. Differences in risks between the baseline risks presented in the HHRA and the risks at time 0 are attributable to: 1) the transition from the HHRA methodology (UCL95 or maximum values) to spatial interpolation methodology (SWACs); 2) the transition from the RI baseline dataset to the FS baseline dataset, which affects the SWACs in netfishing and clamming exposure areas; and 3) active remediation of the EAAs, which affects the SWACs in netfishing, clamming, and the Beach 3 exposure areas.

AOPC = area of potential concern; BCM = bed composition model; dw = dry weight; EAA = early action area; FS = feasibility study; HHRA = human health risk assessment; kg = kilograms; µg = micrograms; PCB = polychlorinated biphenyl; RI = remedial investigation; SWAC = spatially-weighted average concentration; TEQ = toxic equivalent; UCL95 = 95% upper confidence limit

Table M-5d Dioxin/Furan Excess Cancer Risks for Direct Contact Based on Dioxin/Furan SWACs

Combined Alternatives

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		EAAs-Alternative 1									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	6×10^{-7}	4×10^{-7}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Tribal Clamming	1×10^{-4}	2×10^{-6}	1×10^{-6}	7×10^{-7}	4×10^{-7}	4×10^{-7}	4×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Beach 1	1×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 2	3×10^{-6}	8×10^{-7}	6×10^{-7}	4×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 3	1×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 4	1×10^{-5}	2×10^{-6}	5×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 5	1×10^{-6}	2×10^{-7}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Beach 6	3×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 7	1×10^{-7}	9×10^{-8}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 8	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 3 Combined (3 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	6×10^{-7}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Tribal Clamming	1×10^{-4}	2×10^{-6}	4×10^{-7}	4×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Beach 1	1×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 2	3×10^{-6}	8×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 3	1×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 4	1×10^{-5}	2×10^{-6}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 5	1×10^{-6}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Beach 6	3×10^{-7}	3×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}	1×10^{-7}
Beach 7	1×10^{-7}	9×10^{-8}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 8	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 4 Combined (6 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	6×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Tribal Clamming	1×10^{-4}	2×10^{-6}	4×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Beach 1	1×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 2	3×10^{-6}	8×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 3	1×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 4	1×10^{-5}	2×10^{-6}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 5	1×10^{-6}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Beach 6	3×10^{-7}	3×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}
Beach 7	1×10^{-7}	9×10^{-8}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 8	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 5 Combined (7 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	6×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Tribal Clamming	1×10^{-4}	2×10^{-6}	4×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Beach 1	1×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 2	3×10^{-6}	8×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 3	1×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 4	1×10^{-5}	2×10^{-6}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 5	1×10^{-6}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Beach 6	3×10^{-7}	3×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}	1×10^{-7}
Beach 7	1×10^{-7}	9×10^{-8}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 8	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}

Exposure Area	Baseline Risk[a]	Risk for Each Alternative									
		Alternative 6 Combined (16 years[b])									
		Time from Beginning of Construction (years)									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	6×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Tribal Clamming	1×10^{-4}	2×10^{-6}	4×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Beach 1	1×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 2	3×10^{-6}	8×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	2×10^{-7}	2×10^{-7}	1×10^{-7}
Beach 3	1×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 4	1×10^{-5}	2×10^{-6}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 5	1×10^{-6}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Beach 6	3×10^{-7}	3×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}	1×10^{-7}
Beach 7	1×10^{-7}	9×10^{-8}	2×10^{-7}	2×10^{-7}	1×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 8	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}

Table M-5d Dioxin/Furan Excess Cancer Risks for Direct Contact Based on Dioxin/Furan SWACs

Removal Alternatives

Risk for Each Alternative — Alternative 2 Removal (4 years[b]) — *Time from Beginning of Construction (years)*

Exposure Area	Baseline Risk[a]	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	6×10^{-7}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Tribal Clamming	1×10^{-4}	2×10^{-6}	4×10^{-7}	4×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Beach 1	1×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 2	3×10^{-6}	8×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 3	1×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 4	1×10^{-5}	2×10^{-6}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 5	1×10^{-6}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Beach 6	3×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 7	1×10^{-7}	9×10^{-8}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 8	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}

Risk for Each Alternative — Alternative 3 Removal (6 years[b]) — *Time from Beginning of Construction (years)*

Exposure Area	Baseline Risk[a]	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	6×10^{-7}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Tribal Clamming	1×10^{-4}	2×10^{-6}	4×10^{-7}	4×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Beach 1	1×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 2	3×10^{-6}	8×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 3	1×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 4	1×10^{-5}	2×10^{-6}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 5	1×10^{-6}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Beach 6	3×10^{-7}	3×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}
Beach 7	1×10^{-7}	9×10^{-8}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 8	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}

Risk for Each Alternative — Alternative 4 Removal (11 years[b]) — *Time from Beginning of Construction (years)*

Exposure Area	Baseline Risk[a]	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	6×10^{-7}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Tribal Clamming	1×10^{-4}	2×10^{-6}	4×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Beach 1	1×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 2	3×10^{-6}	8×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 3	1×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 4	1×10^{-5}	2×10^{-6}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 5	1×10^{-6}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Beach 6	3×10^{-7}	3×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}
Beach 7	1×10^{-7}	9×10^{-8}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 8	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}

Risk for Each Alternative — Alternative 5 Removal (17 years[b]) — *Time from Beginning of Construction (years)*

Exposure Area	Baseline Risk[a]	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	6×10^{-7}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Tribal Clamming	1×10^{-4}	2×10^{-6}	4×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Beach 1	1×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 2	3×10^{-6}	8×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 3	1×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 4	1×10^{-5}	2×10^{-6}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 5	1×10^{-6}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Beach 6	3×10^{-7}	3×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}
Beach 7	1×10^{-7}	9×10^{-8}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 8	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}

Risk for Each Alternative — Alternative 6 Removal (42 years[b]) — *Time from Beginning of Construction (years)*

Exposure Area	Baseline Risk[a]	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	6×10^{-7}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Tribal Clamming	1×10^{-4}	2×10^{-6}	4×10^{-7}	4×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}	3×10^{-7}
Beach 1	1×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 2	3×10^{-6}	8×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	1×10^{-7}	1×10^{-7}
Beach 3	1×10^{-7}	3×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 4	1×10^{-5}	2×10^{-6}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 5	1×10^{-6}	2×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}
Beach 6	3×10^{-7}	3×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}	2×10^{-7}	1×10^{-7}
Beach 7	1×10^{-7}	9×10^{-8}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}	2×10^{-7}
Beach 8	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}	1×10^{-7}

$> 1 \times 10^{-6}$	Colored cells indicate residual excess cancer risk.
$\leq 1 \times 10^{-6}$	

Notes:

1. Dioxin/furan risk estimates are based on SWACs for netfishing, tribal clamming, and individual beaches predicted by the BCM and for each alternative.
2. The BCM dioxin/furan input values used for the predicted future concentrations following start of construction are: 4 ng TEQ/kg dw (upstream), 20 ng TEQ/kg dw (lateral), and 4 ng TEQ/kg dw (post-remedy bed sediment replacement value).
3. Individual beach play areas are actively remediated in the first 5 years by Alternative 3.

a. Baseline risks using the RI baseline data for the direct contact scenarios as reported in Section 3 (Table 3-6a for netfishing, tribal clamming scenarios, and beach play scenarios).

b. Construction period.

c. The 5-year intervals for the BCM-predicted SWACs (and for risk estimation) are indexed to the start of construction for Alternatives 2 through 6. Risk estimates for time 0 (post-EAA/Alternative 1) use the BCM-predicted SWACs after construction of the EAAs. Differences in risks between the baseline risks presented in the HHRA and the risks at time 0 are attributable to: 1) the transition from the HHRA methodology (UCL95 or maximum values) to spatial interpolation methodology (SWACs); 2) the transition from the RI baseline dataset to the FS baseline dataset, which affects the SWACs in netfishing and clamming exposure areas; and 3) active remediation of the EAAs, which affects the SWACs in netfishing, clamming, and the Beach 3 exposure areas.

AOPC = area of potential concern; BCM = bed composition model; EAA = early action area; FS = feasibility study; HHRA = human health risk assessment; ng TEQ/kg dw = nangrams toxic equivalent per kilogram; RI = remedial investigation; SWAC = spatially-weighted average concentration; UCL95 = 95% upper confidence limit

Table M-6a Low Sensitivity of LDW Total PCB SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Total PCB SWACs

Combined Alternatives

	SWAC for Each Alternative																											
	EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	176	83	46	27	22	17	16	13	12	11	176	64	37	23	18	15	13	11	10	9	176	51	30	19	16	13	12	10	10	9
Tribal Clamming	191	73	40	26	22	19	18	15	14	14	191	42	28	21	17	16	15	13	13	13	191	36	24	19	15	14	14	12	12	12
Beach 1	51	35	24	15	11	9	9	9	9	8	51	28	20	14	10	9	9	9	9	8	51	28	20	14	10	9	9	9	9	8
Beach 2	278	178	113	62	36	25	20	15	12	9	278	95	64	40	25	18	15	12	10	8	278	66	45	30	19	14	12	10	9	7
Beach 3	99	63	42	26	22	21	21	19	19	17	99	58	39	25	22	21	21	19	19	17	99	37	28	23	21	20	21	19	19	17
Beach 4[d]	1099	265	77	21	22	16	12	9	8	7	1099	41	17	10	10	9	7	8	8	7	1099	32	14	10	9	8	7	8	8	7
Beach 5	123	52	39	39	38	37	36	31	32	34	123	45	37	37	36	35	35	30	31	33	123	38	30	30	29	29	28	24	25	26
Beach 6	448	95	38	25	27	24	15	10	9	9	448	30	12	10	8	8	7	6	6	6	448	30	12	10	8	8	7	6	6	6
Beach 7	46	10	9	8	8	8	9	7	7	7	46	10	9	8	8	8	9	7	7	7	46	10	9	8	8	8	9	7	7	7
Beach 8	49	6	6	6	6	5	5	5	5	5	49	8	6	5	6	5	5	5	5	5	49	8	6	5	6	5	5	5	5	5

		Risk for Each Alternative																												
		EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
	Baseline	*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-6}	1E-07	6E-08	4E-08	2E-08	2E-08	1E-08	1E-08	1E-08	9E-09	8E-09	1E-07	5E-08	3E-08	2E-08	1E-08	1E-08	1E-08	8E-09	8E-09	7E-09	1E-07	4E-08	2E-08	1E-08	1E-08	1E-08	9E-09	8E-09	7E-09	7E-09
Tribal Clamming	8×10^{-6}	4E-07	1E-07	8E-08	5E-08	4E-08	4E-08	4E-08	3E-08	3E-08	3E-08	4E-07	8E-08	6E-08	4E-08	3E-08	3E-08	3E-08	3E-08	3E-08	3E-08	4E-07	7E-08	5E-08	4E-08	3E-08	3E-08	3E-08	2E-08	2E-08	2E-08
Beach 1	3×10^{-8}	3E-08	2E-08	1E-08	9E-09	6E-09	6E-09	5E-09	5E-09	5E-09	5E-09	3E-08	2E-08	1E-08	8E-09	6E-09	5E-09	5E-09	5E-09	5E-09	5E-09	3E-08	2E-08	1E-08	8E-09	6E-09	5E-09	5E-09	5E-09	5E-09	5E-09
Beach 2	1×10^{-7}	2E-07	1E-07	7E-08	4E-08	2E-08	1E-08	1E-08	9E-09	7E-09	5E-09	2E-07	6E-08	4E-08	2E-08	1E-08	1E-08	9E-09	7E-09	6E-09	5E-09	2E-07	4E-08	3E-08	2E-08	1E-08	8E-09	7E-09	6E-09	5E-09	4E-09
Beach 3	1×10^{-7}	6E-08	4E-08	2E-08	2E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08	6E-08	3E-08	2E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08	6E-08	2E-08	2E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08
Beach 4[d]	6×10^{-4}	6E-07	2E-07	5E-08	1E-08	1E-08	1E-08	7E-09	5E-09	5E-09	4E-09	6E-07	2E-08	1E-08	6E-09	6E-09	5E-09	4E-09	5E-09	5E-09	4E-09	6E-07	2E-08	8E-09	6E-09	5E-09	5E-09	4E-09	4E-09	5E-09	4E-09
Beach 5	1×10^{-7}	7E-08	3E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08	7E-08	3E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08	7E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08	1E-08	1E-08	2E-08
Beach 6	5×10^{-7}	3E-07	6E-08	2E-08	1E-08	2E-08	1E-08	9E-09	6E-09	5E-09	6E-09	3E-07	2E-08	7E-09	6E-09	5E-09	5E-09	4E-09	4E-09	4E-09	4E-09	3E-07	2E-08	7E-09	6E-09	5E-09	5E-09	4E-09	4E-09	4E-09	4E-09
Beach 7	5×10^{-8}	3E-08	6E-09	5E-09	4E-09	5E-09	4E-09	6E-09	4E-09	4E-09	4E-09	3E-08	6E-09	5E-09	4E-09	5E-09	4E-09	6E-09	4E-09	4E-09	4E-09	3E-08	6E-09	5E-09	4E-09	5E-09	4E-09	6E-09	4E-09	4E-09	4E-09
Beach 8	6×10^{-8}	3E-08	4E-09	3E-09	3E-09	4E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-08	5E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-08	5E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09

Table M-6a Low Sensitivity of LDW Total PCB SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Total PCB SWACs

Combined Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	176	51	26	17	15	13	12	10	9	9	176	51	26	15	10	9	9	8	8	8
Tribal Clamming	191	36	24	17	15	14	13	11	11	11	191	36	24	16	12	11	11	10	10	10
Beach 1	51	28	24	15	11	10	9	9	9	8	51	28	24	15	10	9	9	9	9	8
Beach 2	278	66	43	28	18	14	12	10	9	7	278	66	43	28	11	9	8	8	7	6
Beach 3	99	37	29	22	21	20	21	19	19	17	99	37	29	22	21	20	21	19	19	17
Beach 4[d]	1099	32	16	10	9	8	7	8	8	7	1099	32	16	10	9	8	8	8	8	7
Beach 5	123	38	31	29	28	28	27	24	24	26	123	38	31	22	21	20	20	17	18	19
Beach 6	448	30	12	10	8	8	7	6	6	6	448	30	12	10	8	8	7	6	6	6
Beach 7	46	10	9	8	8	8	9	7	7	7	46	10	9	7	8	7	8	7	7	7
Beach 8	49	8	8	5	6	5	5	5	5	5	49	8	8	5	6	5	5	5	5	5

		Risk for Each Alternative																			
		Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
	Baseline	*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-6}	1E-07	4E-08	2E-08	1E-08	1E-08	1E-08	9E-09	8E-09	7E-09	7E-09	1E-07	4E-08	2E-08	1E-08	8E-09	7E-09	7E-09	6E-09	6E-09	6E-09
Tribal Clamming	8×10^{-6}	4E-07	7E-08	5E-08	3E-08	3E-08	3E-08	3E-08	2E-08	2E-08	2E-08	4E-07	7E-08	5E-08	3E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08
Beach 1	3×10^{-8}	3E-08	2E-08	1E-08	9E-09	6E-09	6E-09	5E-09	5E-09	5E-09	5E-09	3E-08	2E-08	1E-08	9E-09	6E-09	5E-09	5E-09	5E-09	5E-09	5E-09
Beach 2	1×10^{-7}	2E-07	4E-08	3E-08	2E-08	1E-08	8E-09	7E-09	6E-09	5E-09	4E-09	2E-07	4E-08	3E-08	2E-08	6E-09	5E-09	5E-09	4E-09	4E-09	4E-09
Beach 3	1×10^{-7}	6E-08	2E-08	2E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08	6E-08	2E-08	2E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08
Beach 4[d]	6×10^{-4}	6E-07	2E-08	9E-09	6E-09	5E-09	5E-09	4E-09	5E-09	5E-09	4E-09	6E-07	2E-08	9E-09	6E-09	5E-09	5E-09	5E-09	5E-09	5E-09	4E-09
Beach 5	1×10^{-7}	7E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08	1E-08	1E-08	2E-08	7E-08	2E-08	2E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08
Beach 6	5×10^{-7}	3E-07	2E-08	7E-09	6E-09	5E-09	5E-09	4E-09	4E-09	4E-09	4E-09	3E-07	2E-08	7E-09	6E-09	5E-09	5E-09	4E-09	4E-09	4E-09	4E-09
Beach 7	5×10^{-8}	3E-08	6E-09	5E-09	4E-09	5E-09	4E-09	6E-09	4E-09	4E-09	4E-09	3E-08	6E-09	5E-09	4E-09	5E-09	4E-09	5E-09	4E-09	4E-09	4E-09
Beach 8	6×10^{-8}	3E-08	5E-09	5E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-08	5E-09	5E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09

Table M-6a Low Sensitivity of LDW Total PCB SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Total PCB SWACs

Removal Alternatives

	SWAC for Each Alternative																											
	Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	176	70	41	25	20	16	15	12	11	10	176	64	37	23	18	15	13	11	10	9	176	64	36	20	16	13	12	10	10	9
Tribal Clamming	191	49	32	23	19	17	16	14	13	13	191	42	28	21	17	16	15	13	13	13	191	42	27	19	16	14	14	12	12	12
Beach 1	51	35	24	15	11	9	9	9	9	8	51	28	20	14	10	9	9	9	9	8	51	28	20	14	10	9	9	9	9	8
Beach 2	278	127	83	49	30	21	17	13	11	9	278	95	64	40	25	18	15	12	10	8	278	95	64	31	20	15	13	11	9	8
Beach 3	99	58	39	25	22	21	21	19	19	17	99	58	39	25	22	21	21	19	19	17	99	58	39	27	23	21	21	19	19	17
Beach 4[d]	1099	42	17	10	10	9	7	8	8	7	1099	41	17	10	10	9	7	8	8	7	1099	41	17	9	9	8	7	8	8	7
Beach 5	123	51	39	39	38	37	36	31	32	34	123	45	37	37	36	35	35	30	31	33	123	45	31	30	29	29	28	24	25	26
Beach 6	448	95	38	25	27	24	15	10	9	9	448	30	12	10	8	8	7	6	6	6	448	30	12	10	8	8	7	6	6	6
Beach 7	46	10	9	8	8	8	9	7	7	7	46	10	9	8	8	8	9	7	7	7	46	10	9	8	8	8	9	7	7	7
Beach 8	49	6	6	6	6	5	5	5	5	5	49	8	6	5	6	5	5	5	5	5	49	8	6	5	6	5	5	5	5	5

		Risk for Each Alternative																												
		Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
	Baseline	*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-6}	1E-07	5E-08	3E-08	2E-08	2E-08	1E-08	1E-08	9E-09	9E-09	8E-09	1E-07	5E-08	3E-08	2E-08	1E-08	1E-08	1E-08	8E-09	8E-09	7E-09	1E-07	5E-08	3E-08	2E-08	1E-08	1E-08	9E-09	8E-09	7E-09	7E-09
Tribal Clamming	8×10^{-6}	4E-07	1E-07	6E-08	5E-08	4E-08	3E-08	3E-08	3E-08	3E-08	3E-08	4E-07	8E-08	6E-08	4E-08	3E-08	3E-08	3E-08	3E-08	3E-08	3E-08	4E-07	8E-08	5E-08	4E-08	3E-08	3E-08	3E-08	2E-08	2E-08	2E-08
Beach 1	3×10^{-8}	3E-08	2E-08	1E-08	9E-09	6E-09	6E-09	5E-09	5E-09	5E-09	5E-09	3E-08	2E-08	1E-08	8E-09	6E-09	5E-09	5E-09	5E-09	5E-09	5E-09	3E-08	2E-08	1E-08	8E-09	6E-09	5E-09	5E-09	5E-09	5E-09	5E-09
Beach 2	1×10^{-7}	2E-07	7E-08	5E-08	3E-08	2E-08	1E-08	1E-08	8E-09	6E-09	5E-09	2E-07	6E-08	4E-08	2E-08	1E-08	1E-08	9E-09	7E-09	6E-09	5E-09	2E-07	6E-08	4E-08	2E-08	1E-08	9E-09	8E-09	6E-09	5E-09	4E-09
Beach 3	1×10^{-7}	6E-08	3E-08	2E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08	6E-08	3E-08	2E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08	6E-08	3E-08	2E-08	2E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08
Beach 4[d]	6×10^{-4}	6E-07	2E-08	1E-08	6E-09	6E-09	5E-09	4E-09	5E-09	5E-09	4E-09	6E-07	2E-08	1E-08	6E-09	6E-09	5E-09	4E-09	5E-09	5E-09	4E-09	6E-07	2E-08	1E-08	5E-09	5E-09	5E-09	4E-09	4E-09	5E-09	4E-09
Beach 5	1×10^{-7}	7E-08	3E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08	7E-08	3E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08	2E-08	7E-08	3E-08	2E-08	2E-08	2E-08	2E-08	2E-08	1E-08	1E-08	2E-08
Beach 6	5×10^{-7}	3E-07	6E-08	2E-08	1E-08	2E-08	1E-08	9E-09	6E-09	5E-09	6E-09	3E-07	2E-08	7E-09	6E-09	5E-09	5E-09	4E-09	4E-09	4E-09	4E-09	3E-07	2E-08	7E-09	6E-09	5E-09	5E-09	4E-09	4E-09	4E-09	4E-09
Beach 7	5×10^{-8}	3E-08	6E-09	5E-09	4E-09	5E-09	4E-09	6E-09	4E-09	4E-09	4E-09	3E-08	6E-09	5E-09	4E-09	5E-09	4E-09	6E-09	4E-09	4E-09	4E-09	3E-08	6E-09	5E-09	4E-09	5E-09	4E-09	6E-09	4E-09	4E-09	4E-09
Beach 8	6×10^{-8}	3E-08	4E-09	3E-09	3E-09	4E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-08	5E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-08	5E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-09

Table M-6a Low Sensitivity of LDW Total PCB SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Total PCB SWACs

Removal Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	176	64	36	20	17	14	12	10	10	9	176	64	36	20	17	12	11	10	9	8
Tribal Clamming	191	42	27	19	17	15	14	12	12	11	191	42	27	19	17	13	12	11	10	10
Beach 1	51	28	20	14	16	12	11	10	9	8	51	28	20	14	16	12	11	10	9	8
Beach 2	278	95	64	31	21	16	13	11	9	8	278	95	64	31	21	16	13	10	9	7
Beach 3	99	58	39	27	26	23	22	20	19	17	99	58	39	27	26	23	22	20	19	17
Beach 4[d]	1099	41	17	9	11	9	8	8	8	7	1099	41	17	9	11	9	8	8	8	7
Beach 5	123	45	31	30	31	28	28	24	24	26	123	45	31	30	31	21	20	17	18	19
Beach 6	448	30	12	10	8	8	7	6	6	6	448	30	12	10	8	8	7	6	6	6
Beach 7	46	10	9	8	8	8	9	7	7	7	46	10	9	8	8	7	8	7	7	7
Beach 8	49	8	6	5	8	5	5	5	5	5	49	8	6	5	8	5	5	5	5	5

		Risk for Each Alternative																			
		Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-6}	1E-07	5E-08	3E-08	2E-08	1E-08	1E-08	9E-09	8E-09	7E-09	7E-09	1E-07	5E-08	3E-08	2E-08	1E-08	9E-09	8E-09	7E-09	7E-09	6E-09
Tribal Clamming	8×10^{-6}	4E-07	8E-08	5E-08	4E-08	3E-08	3E-08	3E-08	2E-08	2E-08	2E-08	4E-07	8E-08	5E-08	4E-08	3E-08	3E-08	2E-08	2E-08	2E-08	2E-08
Beach 1	3×10^{-8}	3E-08	2E-08	1E-08	8E-09	9E-09	7E-09	6E-09	6E-09	6E-09	5E-09	3E-08	2E-08	1E-08	8E-09	9E-09	7E-09	6E-09	6E-09	6E-09	5E-09
Beach 2	1×10^{-7}	2E-07	6E-08	4E-08	2E-08	1E-08	9E-09	8E-09	6E-09	5E-09	5E-09	2E-07	6E-08	4E-08	2E-08	1E-08	9E-09	8E-09	6E-09	5E-09	4E-09
Beach 3	1×10^{-7}	6E-08	3E-08	2E-08	2E-08	2E-08	1E-08	1E-08	1E-08	1E-08	1E-08	6E-08	3E-08	2E-08	2E-08	2E-08	1E-08	1E-08	1E-08	1E-08	1E-08
Beach 4[d]	6×10^{-4}	6E-07	2E-08	1E-08	5E-09	7E-09	5E-09	5E-09	5E-09	5E-09	4E-09	6E-07	2E-08	1E-08	5E-09	7E-09	5E-09	5E-09	5E-09	5E-09	4E-09
Beach 5	1×10^{-7}	7E-08	3E-08	2E-08	2E-08	2E-08	2E-08	2E-08	1E-08	1E-08	2E-08	7E-08	3E-08	2E-08	2E-08	2E-08	1E-08	1E-08	1E-08	1E-08	1E-08
Beach 6	5×10^{-7}	3E-07	2E-08	7E-09	6E-09	5E-09	5E-09	4E-09	4E-09	4E-09	4E-09	3E-07	2E-08	7E-09	6E-09	5E-09	5E-09	4E-09	4E-09	4E-09	4E-09
Beach 7	5×10^{-8}	3E-08	6E-09	5E-09	4E-09	5E-09	4E-09	6E-09	4E-09	4E-09	4E-09	3E-08	6E-09	5E-09	4E-09	5E-09	4E-09	5E-09	4E-09	4E-09	4E-09
Beach 8	6×10^{-8}	3E-08	5E-09	3E-09	3E-09	5E-09	3E-09	3E-09	3E-09	3E-09	3E-09	3E-08	5E-09	3E-09	3E-09	5E-09	3E-09	3E-09	3E-09	3E-09	3E-09

Notes:

1. Low BCM input parameters (µg/kg dw total PCBs): upstream = 5; lateral = 100; post-remedy bed sediment replacement value = 30 (AOPC 1), 10 (AOPC 2).
2. BCM predictions use base case STM outputs revised June 2010 (Appendix C).
3. BCM area = 430 acres and FS study area = 441 acres
4. Significant figures are displayed in accordance with the conventions established in the HHRA.

$\leq 1 \times 10^{-6}$ Colored cells indicate residual excess cancer risk.

a. Construction period.

b. Baseline risks using the RI baseline data for the direct contact scenarios as reported in Section 3 (Table 3-6a for netfishing, tribal clamming scenarios, and beach play scenarios).

c. The 5-year intervals for the BCM-predicted SWACs (and for risk estimation) are indexed to the start of construction for Alternatives 2 through 6. Risk estimates for time 0 (post-EAA/Alternative 1) use the BCM-predicted SWACs after construction of the EAAs. Differences in risks between the baseline risks presented in the HHRA and the risks at time 0 are attributable to: 1) the transition from the HHRA methodology (UCL95 or maximum values) to spatial interpolation methodology (SWACs); 2) the transition from the RI baseline dataset to the FS baseline dataset, which affects the SWACs in netfishing and clamming exposure areas; and 3) active remediation of the EAAs, which affects the SWACs in netfishing, clamming, and the Beach 3 exposure areas.

d. The large differences between the baseline risks and the SWAC-based risk estimates at Beach 4 result from removing the two highest PCB-concentration samples at Beach 4 from the FS dataset for interpolating PCB concentrations. After construction of Alternative 2, the locations with the highest PCB concentrations would have undergone active remediation.

AOPC = area of potential concern; BCM = bed composition model; dw = dry weight; EAA = early action area; FS = feasibility study; HHRA = human health risk assessment; kg = kilograms; LDW = Lower Duwamish Waterway; µg = micrograms; PCB = polychlorinated biphenyl; RI = remedial investigation; STM = sediment transport model; SWAC = spatially-weighted average concentration; 95UCL = 95% upper confidence limit

Table M-6b Low Sensitivity of LDW Arsenic SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Arsenic SWACs

Combined Alternatives

	SWAC for Each Alternative																													
	EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	16	11	9	8	8	8	8	8	8	8	16	9	8	8	7	7	7	7	7	7	16	9	8	8	7	7	7	7	7	7
Tribal Clamming	13	10	9	9	9	9	9	8	8	8	13	8	8	8	7	7	7	7	7	7	13	8	8	8	7	7	7	7	7	7
Beach 1	8	8	8	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7
Beach 2	13	11	9	8	8	7	7	7	7	7	13	10	9	8	8	7	7	7	7	7	13	10	9	8	8	7	7	7	7	7
Beach 3	10	9	8	8	8	8	8	8	8	8	10	9	8	8	8	8	8	8	8	8	10	9	8	8	8	8	8	8	8	8
Beach 4	7	7	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7
Beach 5	9	8	7	7	7	7	7	7	7	7	9	8	7	7	7	7	7	7	7	7	9	8	8	8	8	8	8	7	7	7
Beach 6	12	8	7	7	7	7	7	7	7	7	12	9	7	7	7	7	7	7	7	7	12	9	7	7	7	7	7	7	7	7
Beach 7	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7
Beach 8	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7

		Risk for Each Alternative																													
		EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	6×10^{-6}	4E-06	3E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	4E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	4E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06
Tribal Clamming	2×10^{-5}	1E-05	8E-06	7E-06	7E-06	7E-06	7E-06	7E-06	6E-06	6E-06	7E-06	1E-05	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	1E-05	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06
Beach 1	5×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 2	6×10^{-6}	5E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	5E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	5E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 3	4×10^{-6}	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 4	4×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 5	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 6	3×10^{-5}	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 7	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 8	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06

Table M-6b Low Sensitivity of LDW Arsenic SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Arsenic SWACs

Combined Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	16	9	8	8	7	7	7	7	7	7	16	9	8	8	7	7	7	7	7	7
Tribal Clamming	13	8	8	8	7	7	7	7	7	7	13	8	8	8	7	7	7	7	7	7
Beach 1	8	7	8	7	7	7	7	7	7	7	8	7	8	7	7	7	7	7	7	7
Beach 2	13	10	9	8	8	7	7	7	7	7	13	10	9	8	8	7	7	7	7	7
Beach 3	10	9	8	8	8	8	8	8	8	8	10	9	8	8	8	8	8	8	8	8
Beach 4	7	8	8	7	7	7	7	7	7	7	7	8	8	7	7	7	7	7	7	7
Beach 5	9	8	8	8	8	8	8	7	7	7	9	8	8	8	8	8	7	7	7	7
Beach 6	12	9	7	7	7	7	7	7	7	7	12	9	7	7	7	7	7	7	7	7
Beach 7	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7
Beach 8	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7

		Risk for Each Alternative																			
		Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	6×10^{-6}	4E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	4E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06
Tribal Clamming	2×10^{-5}	1E-05	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	1E-05	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06
Beach 1	5×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 2	6×10^{-6}	5E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	5E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 3	4×10^{-6}	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 4	4×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 5	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 6	3×10^{-5}	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 7	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 8	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06

Table M-6b Low Sensitivity of LDW Arsenic SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Arsenic SWACs

Removal Alternatives

Exposure Area	SWAC for Each Alternative																													
	Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
	0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	16	9	8	8	7	7	7	7	7	7	16	9	8	8	7	7	7	7	7	7	16	9	8	8	7	7	7	7	7	7
Tribal Clamming	13	8	8	8	7	7	7	7	7	7	13	8	8	8	7	7	7	7	7	7	13	8	8	8	7	7	7	7	7	7
Beach 1	8	8	8	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7
Beach 2	13	10	9	8	8	7	7	7	7	7	13	10	9	8	8	7	7	7	7	7	13	10	9	8	8	7	7	7	7	7
Beach 3	10	9	8	8	8	8	8	8	8	8	10	9	8	8	8	8	8	8	8	8	10	9	8	8	8	8	8	8	8	8
Beach 4	7	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7	8	8	7	7	7	7	7	7	7
Beach 5	9	8	7	7	7	7	7	7	7	7	9	8	7	7	7	7	7	7	7	7	9	8	8	8	8	8	8	7	7	7
Beach 6	12	8	7	7	7	7	7	7	7	7	12	9	7	7	7	7	7	7	7	7	12	9	7	7	7	7	7	7	7	7
Beach 7	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7
Beach 8	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7

Exposure Area	Baseline Risk[b]	Risk for Each Alternative																													
		Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	6×10^{-6}	4E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	4E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	4E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06
Tribal Clamming	2×10^{-5}	1E-05	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	1E-05	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	1E-05	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06
Beach 1	5×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 2	6×10^{-6}	5E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	5E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	5E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 3	4×10^{-6}	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 4	4×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 5	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 6	3×10^{-5}	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 7	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 8	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06

Table M-6b Low Sensitivity of LDW Arsenic SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Arsenic SWACs

Removal Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	16	9	8	8	8	7	7	7	7	7	16	9	8	8	8	7	7	7	7	7
Tribal Clamming	13	8	8	8	8	7	7	7	7	7	13	8	8	8	8	7	7	7	7	7
Beach 1	8	7	7	7	8	7	7	7	7	7	8	7	7	7	8	7	7	7	7	7
Beach 2	13	10	9	8	8	8	8	7	7	7	13	10	9	8	8	8	8	7	7	7
Beach 3	10	9	8	8	8	8	8	8	8	8	10	9	8	8	8	8	8	8	8	8
Beach 4	7	8	8	7	7	7	7	7	7	7	7	8	8	7	7	7	7	7	7	7
Beach 5	9	8	8	8	8	8	8	7	7	7	9	8	8	8	8	8	8	7	7	7
Beach 6	12	9	7	7	7	7	7	7	7	7	12	9	7	7	7	7	7	7	7	7
Beach 7	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7
Beach 8	8	7	7	7	7	7	7	7	7	7	8	7	7	7	7	7	7	7	7	7

		Risk for Each Alternative																			
		Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	6×10^{-6}	4E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	4E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06
Tribal Clamming	2×10^{-5}	1E-05	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	1E-05	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06	6E-06
Beach 1	5×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 2	6×10^{-6}	5E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	5E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 3	4×10^{-6}	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 4	4×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 5	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 6	3×10^{-5}	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 7	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach 8	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06

Notes:

1. Low BCM input parameters (mg/kg dw arsenic): upstream = 7; lateral = 9; post-remedy bed sediment replacement value = 9 (AOPC 1), 8 (AOPC 2).
2. BCM predictions use base case STM outputs revised June 2010 (Appendix C).
3. BCM area = 430 acres and FS study area = 441 acres.
4. Significant figures are displayed in accordance with the conventions established in the HHRA.
5. Direct contact excess cancer risk at 1×10^{-6} cannot be achieved because 1) risk threshold is below natural background, and 2) the concentration of the upstream sediment input is estimated to be 7 mg/kg dw, which corresponds to a risk of 3×10^{-6}.

$> 1 \times 10^{-6}$ and $\leq 1 \times 10^{-5}$ Colored cells indicate residual excess cancer risk.

a. Construction period.
b. Baseline risks using the RI baseline data for the direct contact scenarios as reported in Section 3 (Table 3-6a for netfishing, tribal clamming scenarios, and beach play scenarios).
c. The 5-year intervals for the BCM-predicted SWACs (and for risk estimation) are indexed to the start of construction for Alternatives 2 through 6. Risk estimates for time 0 (post-EAA/Alternative 1) use the BCM-predicted SWACs after construction of the EAAs. Differences in risks between the baseline risks presented in the HHRA and the risks at time 0 are attributable to: 1) the transition from the HHRA methodology (UCL95 or maximum values) to -spatial interpolation methodology (SWACs); 2) the transition from the RI baseline dataset to the FS baseline dataset, which affects the SWACs in netfishing and clamming exposure areas; and 3) active remediation of the EAAs, which affects the SWACs in netfishing, clamming, and the Beach 3 exposure areas.

AOPC = area of potential concern; BCM = bed composition model; dw = dry weight; EAA = early action area; FS = feasibility study; HHRA = human health risk assessment; kg = kilograms; LDW = Lower Duwamish Waterway; mg = milligrams; RI = remedial investigation; STM = sediment transport model; SWAC = spatially-weighted average concentration; 95UCL = 95% upper confidence limit

Table M-6c Low Sensitivity of LDW cPAH SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on cPAH SWACs

Combined Alternatives

	SWAC for Each Alternative																											
	EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	353	192	125	85	73	66	64	59	57	54	353	147	101	74	65	60	59	55	54	52	353	124	88	67	62	58	57	54	54	51
Tribal Clamming	286	154	111	85	76	72	69	64	64	62	286	89	73	63	61	59	59	56	56	55	286	85	71	62	60	58	58	55	56	54
Beach 1	397	274	184	114	79	68	63	61	59	55	397	72	66	59	54	54	54	55	56	53	397	72	66	59	54	54	54	55	56	53
Beach 2	752	476	301	169	106	81	71	61	55	49	752	99	81	66	56	52	51	49	47	46	752	95	78	65	55	52	50	49	47	46
Beach 3	370	253	187	140	135	131	130	117	116	111	370	232	177	136	134	131	130	117	116	111	370	207	164	133	132	130	130	117	116	111
Beach 4	382	130	75	54	57	56	47	52	54	50	382	89	64	53	55	54	48	52	54	50	382	73	60	52	53	54	48	52	54	50
Beach 5	385	142	90	79	79	75	72	65	65	65	385	89	74	71	71	70	69	63	64	65	385	81	70	69	69	68	68	63	64	64
Beach 6	531	164	97	81	81	78	61	54	54	54	531	70	50	48	47	46	46	45	45	44	531	70	50	48	47	46	46	45	45	44
Beach 7	74	52	53	49	52	50	60	50	51	48	74	52	53	49	52	50	60	50	51	48	74	52	53	49	52	50	60	50	51	48
Beach 8	184	47	43	42	44	43	42	40	41	40	184	49	43	42	43	43	42	40	41	40	184	49	43	42	43	43	42	40	41	40

		Risk for Each Alternative																												
		EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
Exposure Area	Baseline Risk[b]	*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	9E-07	5E-07	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	1E-07	9E-07	4E-07	3E-07	2E-07	2E-07	2E-07	2E-07	1E-07	1E-07	1E-07	9E-07	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	1E-07	1E-07	1E-07
Tribal Clamming	5×10^{-6}	2E-06	1E-06	7E-07	6E-07	5E-07	5E-07	5E-07	4E-07	4E-07	4E-07	2E-06	6E-07	5E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	2E-06	6E-07	5E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07
Beach 1	4×10^{-6}	4E-06	3E-06	2E-06	1E-06	9E-07	8E-07	7E-07	7E-07	7E-07	6E-07	4E-06	8E-07	7E-07	7E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	4E-06	8E-07	7E-07	7E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07
Beach 2	8×10^{-5}	8E-06	5E-06	3E-06	2E-06	1E-06	9E-07	8E-07	7E-07	6E-07	5E-07	8E-06	1E-06	9E-07	7E-07	6E-07	6E-07	6E-07	5E-07	5E-07	5E-07	8E-06	1E-06	9E-07	7E-07	6E-07	6E-07	6E-07	5E-07	5E-07	5E-07
Beach 3	1×10^{-5}	4E-06	3E-06	2E-06	2E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	4E-06	3E-06	2E-06	2E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	4E-06	2E-06	2E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06
Beach 4	1×10^{-5}	4E-06	1E-06	8E-07	6E-07	6E-07	6E-07	5E-07	6E-07	6E-07	6E-07	4E-06	1E-06	7E-07	6E-07	6E-07	6E-07	5E-07	6E-07	6E-07	6E-07	4E-06	8E-07	7E-07	6E-07	6E-07	6E-07	5E-07	6E-07	6E-07	6E-07
Beach 5	3×10^{-5}	4E-06	2E-06	1E-06	9E-07	9E-07	8E-07	8E-07	7E-07	7E-07	7E-07	4E-06	1E-06	8E-07	8E-07	8E-07	8E-07	8E-07	7E-07	7E-07	7E-07	4E-06	9E-07	8E-07	8E-07	8E-07	8E-07	8E-07	7E-07	7E-07	7E-07
Beach 6	8×10^{-5}	6E-06	2E-06	1E-06	9E-07	9E-07	9E-07	7E-07	6E-07	6E-07	6E-07	6E-06	8E-07	6E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	6E-06	8E-07	6E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07
Beach 7	1×10^{-6}	8E-07	6E-07	6E-07	5E-07	6E-07	6E-07	7E-07	6E-07	6E-07	5E-07	8E-07	6E-07	6E-07	5E-07	6E-07	6E-07	7E-07	6E-07	6E-07	5E-07	8E-07	6E-07	6E-07	5E-07	6E-07	6E-07	7E-07	6E-07	6E-07	5E-07
Beach 8	3×10^{-6}	2E-06	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	4E-07	5E-07	4E-07	2E-06	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	4E-07	5E-07	4E-07	2E-06	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	4E-07	5E-07	4E-07

Table M-6c Low Sensitivity of LDW cPAH SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on cPAH SWACs

Combined Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	353	124	81	64	60	57	57	54	53	51	353	124	81	61	54	53	54	52	52	50
Tribal Clamming	286	85	70	61	59	58	57	55	55	53	286	85	70	59	57	56	56	54	54	52
Beach 1	397	72	71	61	56	55	55	57	57	54	397	72	71	61	54	54	55	56	56	54
Beach 2	752	95	76	64	55	51	50	48	47	46	752	95	76	64	50	48	48	47	46	45
Beach 3	370	207	144	125	129	128	129	117	116	111	370	207	144	125	128	128	129	117	116	111
Beach 4	382	73	61	52	54	54	50	53	55	50	382	73	61	52	53	54	52	53	55	50
Beach 5	385	81	71	68	68	67	67	63	64	64	385	81	71	62	61	60	61	58	58	58
Beach 6	531	70	50	48	47	46	46	45	45	44	531	70	50	48	47	46	46	45	45	44
Beach 7	74	52	53	49	52	50	60	50	51	48	74	52	53	47	52	50	55	50	51	48
Beach 8	184	49	46	42	43	43	42	40	41	40	184	49	46	42	43	43	42	40	41	40

		Risk for Each Alternative																			
		Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	9E-07	3E-07	2E-07	2E-07	2E-07	1E-07	1E-07	1E-07	1E-07	1E-07	9E-07	3E-07	2E-07	2E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07
Tribal Clamming	5×10^{-6}	2E-06	6E-07	5E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	2E-06	6E-07	5E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	3E-07
Beach 1	4×10^{-6}	4E-06	8E-07	8E-07	7E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	4E-06	8E-07	8E-07	7E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07
Beach 2	8×10^{-5}	8E-06	1E-06	8E-07	7E-07	6E-07	6E-07	6E-07	5E-07	5E-07	5E-07	8E-06	1E-06	8E-07	7E-07	6E-07	5E-07	5E-07	5E-07	5E-07	5E-07
Beach 3	1×10^{-5}	4E-06	2E-06	2E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	4E-06	2E-06	2E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06
Beach 4	1×10^{-5}	4E-06	8E-07	7E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	4E-06	8E-07	7E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07
Beach 5	3×10^{-5}	4E-06	9E-07	8E-07	8E-07	8E-07	7E-07	7E-07	7E-07	7E-07	7E-07	4E-06	9E-07	8E-07	7E-07	7E-07	7E-07	7E-07	6E-07	6E-07	6E-07
Beach 6	8×10^{-5}	6E-06	8E-07	6E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	6E-06	8E-07	6E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07
Beach 7	1×10^{-6}	8E-07	6E-07	6E-07	5E-07	6E-07	6E-07	7E-07	6E-07	6E-07	5E-07	8E-07	6E-07	6E-07	5E-07	6E-07	6E-07	6E-07	6E-07	6E-07	5E-07
Beach 8	3×10^{-6}	2E-06	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	4E-07	5E-07	4E-07	2E-06	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	4E-07	5E-07	4E-07

Table M-6c Low Sensitivity of LDW cPAH SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on cPAH SWACs

Removal Alternatives

Exposure Area	SWAC for Each Alternative																													
	Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
	0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	353	168	113	79	69	63	61	57	56	53	353	147	101	74	65	60	59	55	54	52	353	147	100	68	62	58	57	54	54	51
Tribal Clamming	286	131	97	77	70	66	64	59	59	58	286	89	73	63	61	59	59	56	56	55	286	89	73	62	60	58	58	55	56	54
Beach 1	397	274	184	114	79	68	63	61	59	55	397	72	66	59	54	54	54	55	56	53	397	72	66	59	54	54	54	55	56	53
Beach 2	752	237	163	106	76	64	59	54	51	47	752	99	81	66	56	52	51	49	47	46	752	99	81	67	57	53	51	49	48	46
Beach 3	370	232	177	136	134	131	130	117	116	111	370	232	177	136	134	131	130	117	116	111	370	232	177	136	134	131	131	117	116	111
Beach 4	382	111	70	54	56	55	47	52	54	50	382	89	64	53	55	54	48	52	54	50	382	89	62	52	54	54	48	52	54	50
Beach 5	385	137	88	78	78	74	72	64	65	65	385	89	74	71	71	70	69	63	64	65	385	89	72	69	69	68	68	63	64	64
Beach 6	531	164	97	81	81	78	61	54	54	54	531	70	50	48	47	46	46	45	45	44	531	70	51	48	47	46	46	45	45	44
Beach 7	74	52	53	49	52	50	60	50	51	48	74	52	53	49	52	50	60	50	51	48	74	52	53	49	52	50	60	50	51	48
Beach 8	184	47	43	42	44	43	42	40	41	40	184	49	43	42	43	43	42	40	41	40	184	49	43	42	43	43	42	40	41	40

Exposure Area	Baseline Risk[b]	Risk for Each Alternative																													
		Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	9E-07	4E-07	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	1E-07	1E-07	9E-07	4E-07	3E-07	2E-07	2E-07	2E-07	2E-07	1E-07	1E-07	1E-07	9E-07	4E-07	3E-07	2E-07	2E-07	2E-07	2E-07	1E-07	1E-07	1E-07
Tribal Clamming	5×10^{-6}	2E-06	9E-07	6E-07	5E-07	5E-07	4E-07	4E-07	4E-07	4E-07	4E-07	2E-06	6E-07	5E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	2E-06	6E-07	5E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07
Beach 1	4×10^{-6}	4E-06	3E-06	2E-06	1E-06	9E-07	8E-07	7E-07	7E-07	7E-07	6E-07	4E-06	8E-07	7E-07	7E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	4E-06	8E-07	7E-07	7E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07
Beach 2	8×10^{-5}	8E-06	3E-06	2E-06	1E-06	8E-07	7E-07	7E-07	6E-07	6E-07	5E-07	8E-06	1E-06	9E-07	7E-07	6E-07	6E-07	6E-07	5E-07	5E-07	5E-07	8E-06	1E-06	9E-07	7E-07	6E-07	6E-07	6E-07	5E-07	5E-07	5E-07
Beach 3	1×10^{-5}	4E-06	3E-06	2E-06	2E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	4E-06	3E-06	2E-06	2E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	4E-06	3E-06	2E-06	2E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06
Beach 4	1×10^{-5}	4E-06	1E-06	8E-07	6E-07	6E-07	6E-07	5E-07	6E-07	6E-07	6E-07	4E-06	1E-06	7E-07	6E-07	6E-07	6E-07	5E-07	6E-07	6E-07	6E-07	4E-06	1E-06	7E-07	6E-07	6E-07	6E-07	5E-07	6E-07	6E-07	6E-07
Beach 5	3×10^{-5}	4E-06	2E-06	1E-06	9E-07	9E-07	8E-07	8E-07	7E-07	7E-07	7E-07	4E-06	1E-06	8E-07	8E-07	8E-07	8E-07	8E-07	7E-07	7E-07	7E-07	4E-06	1E-06	8E-07	8E-07	8E-07	8E-07	8E-07	7E-07	7E-07	7E-07
Beach 6	8×10^{-5}	6E-06	2E-06	1E-06	9E-07	9E-07	9E-07	7E-07	6E-07	6E-07	6E-07	6E-06	8E-07	6E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	6E-06	8E-07	6E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07
Beach 7	1×10^{-6}	8E-07	6E-07	6E-07	5E-07	6E-07	6E-07	7E-07	6E-07	6E-07	5E-07	8E-07	6E-07	6E-07	5E-07	6E-07	6E-07	7E-07	6E-07	6E-07	5E-07	8E-07	6E-07	6E-07	5E-07	6E-07	6E-07	7E-07	6E-07	6E-07	5E-07
Beach 8	3×10^{-6}	2E-06	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	4E-07	5E-07	4E-07	2E-06	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	4E-07	5E-07	4E-07	2E-06	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	4E-07	5E-07	4E-07

Table M-6c Low Sensitivity of LDW cPAH SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on cPAH SWACs

Removal Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	353	147	100	68	62	58	57	54	54	51	353	147	100	68	62	57	56	54	52	50
Tribal Clamming	286	89	73	62	61	59	58	55	56	54	286	89	73	62	61	57	57	54	55	53
Beach 1	397	72	66	59	59	57	57	57	57	54	397	72	66	59	59	57	57	57	56	54
Beach 2	752	99	81	67	59	54	52	50	48	46	752	99	81	67	59	54	52	50	48	46
Beach 3	370	232	177	136	133	131	131	117	116	111	370	232	177	136	133	131	131	117	116	111
Beach 4	382	89	62	52	55	54	51	53	55	50	382	89	62	52	55	54	51	53	55	50
Beach 5	385	89	72	69	70	67	67	63	64	64	385	89	72	69	70	62	61	58	58	58
Beach 6	531	70	51	48	47	46	46	45	45	44	531	70	51	48	47	46	46	45	45	44
Beach 7	74	52	53	49	52	50	60	50	51	48	74	52	53	49	52	48	55	50	51	48
Beach 8	184	49	43	42	46	43	42	40	41	40	184	49	43	42	46	43	42	40	41	40

		Risk for Each Alternative																			
		Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	9E-07	4E-07	3E-07	2E-07	2E-07	2E-07	2E-07	1E-07	1E-07	1E-07	9E-07	4E-07	3E-07	2E-07	2E-07	1E-07	1E-07	1E-07	1E-07	1E-07
Tribal Clamming	5×10^{-6}	2E-06	6E-07	5E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	2E-06	6E-07	5E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07
Beach 1	4×10^{-6}	4E-06	8E-07	7E-07	7E-07	7E-07	6E-07	6E-07	6E-07	6E-07	6E-07	4E-06	8E-07	7E-07	7E-07	7E-07	6E-07	6E-07	6E-07	6E-07	6E-07
Beach 2	8×10^{-5}	8E-06	1E-06	9E-07	7E-07	7E-07	6E-07	6E-07	6E-07	5E-07	5E-07	8E-06	1E-06	9E-07	7E-07	7E-07	6E-07	6E-07	6E-07	5E-07	5E-07
Beach 3	1×10^{-5}	4E-06	3E-06	2E-06	2E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	4E-06	3E-06	2E-06	2E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06
Beach 4	1×10^{-5}	4E-06	1E-06	7E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	4E-06	1E-06	7E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07
Beach 5	3×10^{-5}	4E-06	1E-06	8E-07	8E-07	8E-07	7E-07	7E-07	7E-07	7E-07	7E-07	4E-06	1E-06	8E-07	8E-07	8E-07	7E-07	7E-07	6E-07	6E-07	6E-07
Beach 6	8×10^{-5}	6E-06	8E-07	6E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	6E-06	8E-07	6E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07
Beach 7	1×10^{-6}	8E-07	6E-07	6E-07	5E-07	6E-07	6E-07	7E-07	6E-07	6E-07	5E-07	8E-07	6E-07	6E-07	5E-07	6E-07	5E-07	6E-07	6E-07	6E-07	5E-07
Beach 8	3×10^{-6}	2E-06	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	4E-07	5E-07	4E-07	2E-06	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	4E-07	5E-07	4E-07

Notes:

1. Low BCM input parameters (µg TEQ/kg dw cPAHs): upstream = 40; lateral = 500; post-remedy bed sediment replacement value = 70 (AOPC 1), 50 (AOPC 2).
2. BCM predictions use base case STM outputs revised June 2010 (Appendix C).
3. BCM area = 430 acres and FS study area = 441 acres.
4. Significant figures are displayed in accordance with the conventions established in the HHRA.

$> 1 \times 10^{-6}$ and $\leq 1 \times 10^{-5}$

$\leq 1 \times 10^{-6}$

Colored cells indicate residual excess cancer risk.

a. Construction period.

b. Baseline risks using the RI baseline data for the direct contact scenarios as reported in Section 3 (Table 3-6a for netfishing, tribal clamming scenarios, and beach play scenarios).

c. The 5-year intervals for the BCM-predicted SWACs (and for risk estimation) are indexed to the start of construction for Alternatives 2 through 6. Risk estimates for time 0 (post-EAA/Alternative 1) use the BCM-predicted SWACs after construction of the EAAs. Differences in risks between the baseline risks presented in the HHRA and the risks at time 0 are attributable to: 1) the transition from the HHRA methodology (UCL95 or maximum values) to -spatial interpolation methodology (SWACs); 2) the transition from the RI baseline dataset to the FS baseline dataset, which affects the SWACs in netfishing and clamming exposure areas; and 3) active remediation of the EAAs, which affects the SWACs in netfishing, clamming, and the Beach 3 exposure areas.

AOPC = area of potential concern; BCM = bed composition model; cPAH = carcinogenic polycyclic aromatic hydrocarbon; dw = dry weight; EAA = early action area; FS = feasibility study; HHRA = human health risk assessment; kg = kilograms; LDW = Lower Duwamish Waterway; µg = micrograms; RI = remedial investigation; STM = sediment transport model; SWAC = spatially-weighted average concentration; TEQ = toxic equivalent; UCL95 = 95% upper confidence limit

Table M-6d Low Sensitivity of LDW Dioxin/Furan SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Dioxin/Furan SWACs

Combined Alternatives

	SWAC for Each Alternative																											
	EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	24	11	6	4	3	3	3	2	2	2	24	4	3	3	3	2	2	2	2	2	24	4	3	3	2	2	2	2	2	2
Tribal Clamming	30	13	7	4	3	3	3	2	2	2	30	4	3	3	2	2	2	2	2	2	30	4	3	3	2	2	2	2	2	2
Beach 1	5	4	3	3	2	2	2	2	2	2	5	3	3	2	2	2	2	2	2	2	5	3	3	2	2	2	2	2	2	2
Beach 2	23	15	10	6	4	3	3	3	2	2	23	7	5	4	3	3	3	2	2	2	23	6	5	3	3	3	2	2	2	2
Beach 3	7	5	4	3	3	3	3	3	3	3	7	4	4	3	3	3	3	3	3	3	7	4	4	3	3	3	3	3	3	3
Beach 4	47	13	5	3	3	3	2	2	2	2	47	3	3	2	2	2	2	2	2	2	47	3	2	2	2	2	2	2	2	2
Beach 5	6	3	3	2	3	2	2	2	2	2	6	2	2	2	2	2	2	2	2	2	6	2	2	2	2	2	2	2	2	2
Beach 6	8	4	3	3	3	3	3	2	2	2	8	2	2	2	2	2	2	2	2	2	8	2	2	2	2	2	2	2	2	2
Beach 7	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Beach 8	4	2	2	2	2	2	2	2	2	2	4	2	2	2	2	2	2	2	2	2	4	2	2	2	2	2	2	2	2	2

		Risk for Each Alternative																												
		EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
Exposure Area	Baseline Risk[b]	*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	6E-07	3E-07	2E-07	1E-07	8E-08	7E-08	7E-08	6E-08	6E-08	6E-08	6E-07	1E-07	9E-08	7E-08	7E-08	7E-08	6E-08	6E-08	6E-08	6E-08	6E-07	1E-07	8E-08	7E-08	7E-08	6E-08	6E-08	6E-08	6E-08	6E-08
Tribal Clamming	1×10^{-4}	2E-06	1E-06	5E-07	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-06	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-06	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07
Beach 1	1×10^{-7}	2E-07	1E-07	1E-07	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-07	1E-07	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-07	1E-07	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 2	3×10^{-6}	8E-07	5E-07	4E-07	2E-07	1E-07	1E-07	1E-07	1E-07	9E-08	8E-08	8E-07	2E-07	2E-07	1E-07	1E-07	1E-07	9E-08	9E-08	8E-08	8E-08	8E-07	2E-07	2E-07	1E-07	1E-07	9E-08	9E-08	8E-08	8E-08	8E-08
Beach 3	1×10^{-7}	2E-07	2E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	2E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	2E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07
Beach 4	1×10^{-5}	2E-06	5E-07	2E-07	1E-07	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	2E-06	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-06	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 5	1×10^{-6}	2E-07	1E-07	9E-08	9E-08	9E-08	9E-08	9E-08	8E-08	9E-08	8E-08	2E-07	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-07	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 6	3×10^{-7}	3E-07	1E-07	1E-07	1E-07	1E-07	1E-07	9E-08	9E-08	9E-08	9E-08	3E-07	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	3E-07	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08
Beach 7	1×10^{-7}	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 8	1×10^{-7}	1E-07	8E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	1E-07	8E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	1E-07	8E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08

Table M-6d Low Sensitivity of LDW Dioxin/Furan SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Dioxin/Furan SWACs

Combined Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0* [c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	24	4	3	2	2	2	2	2	2	2	24	4	3	2	2	2	2	2	2	2
Tribal Clamming	30	4	3	2	2	2	2	2	2	2	30	4	3	2	2	2	2	2	2	2
Beach 1	5	3	3	2	2	2	2	2	2	2	5	3	3	2	2	2	2	2	2	2
Beach 2	23	6	4	3	3	2	2	2	2	2	23	6	4	3	2	2	2	2	2	2
Beach 3	7	4	3	3	3	3	3	3	3	3	7	4	3	3	3	3	3	3	3	3
Beach 4	47	3	2	2	2	2	2	2	2	2	47	3	2	2	2	2	2	2	2	2
Beach 5	6	2	2	2	2	2	2	2	2	2	6	2	2	2	2	2	2	2	2	2
Beach 6	8	2	2	2	2	2	2	2	2	2	8	2	2	2	2	2	2	2	2	2
Beach 7	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Beach 8	4	2	2	2	2	2	2	2	2	2	4	2	2	2	2	2	2	2	2	2

		Risk for Each Alternative																			
		Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
Exposure Area	Baseline Risk[b]	*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
		0 [c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	6E-07	1E-07	7E-08	7E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-07	1E-07	7E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08
Tribal Clamming	1×10^{-4}	2E-06	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-06	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07
Beach 1	1×10^{-7}	2E-07	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-07	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 2	3×10^{-6}	8E-07	2E-07	1E-07	1E-07	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-07	2E-07	1E-07	1E-07	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08
Beach 3	1×10^{-7}	2E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	2E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07
Beach 4	1×10^{-5}	2E-06	1E-07	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-06	1E-07	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 5	1×10^{-6}	2E-07	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-07	8E-08	8E-08	7E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 6	3×10^{-7}	3E-07	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	3E-07	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08
Beach 7	1×10^{-7}	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	9E-08	8E-08	8E-08	7E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 8	1×10^{-7}	1E-07	8E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	1E-07	8E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08

Table M-6d Low Sensitivity of LDW Dioxin/Furan SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Dioxin/Furan SWACs

Removal Alternatives

	SWAC for Each Alternative																													
	Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	*0* [c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	24	5	4	3	3	2	2	2	2	2	24	4	3	3	3	2	2	2	2	2	24	4	3	3	2	2	2	2	2	2
Tribal Clamming	30	4	3	3	3	2	2	2	2	2	30	4	3	3	2	2	2	2	2	2	30	4	3	3	2	2	2	2	2	2
Beach 1	5	4	3	3	2	2	2	2	2	2	5	3	3	2	2	2	2	2	2	2	5	3	3	2	2	2	2	2	2	2
Beach 2	23	8	6	4	3	3	3	2	2	2	23	7	5	4	3	3	3	2	2	2	23	7	5	3	3	3	2	2	2	2
Beach 3	7	4	4	3	3	3	3	3	3	3	7	4	4	3	3	3	3	3	3	3	7	4	4	3	3	3	3	3	3	3
Beach 4	47	3	3	2	2	2	2	2	2	2	47	3	3	2	2	2	2	2	2	2	47	3	2	2	2	2	2	2	2	2
Beach 5	6	3	3	2	2	2	2	2	2	2	6	2	2	2	2	2	2	2	2	2	6	2	2	2	2	2	2	2	2	2
Beach 6	8	4	3	3	3	3	3	2	2	2	8	2	2	2	2	2	2	2	2	2	8	2	2	2	2	2	2	2	2	2
Beach 7	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Beach 8	4	2	2	2	2	2	2	2	2	2	4	2	2	2	2	2	2	2	2	2	4	2	2	2	2	2	2	2	2	2

		Risk for Each Alternative																													
		Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0* [c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2 x 10^{-5}	6E-07	1E-07	1E-07	8E-08	7E-08	7E-08	7E-08	6E-08	6E-08	6E-08	6E-07	1E-07	9E-08	7E-08	7E-08	7E-08	6E-08	6E-08	6E-08	6E-08	6E-07	1E-07	9E-08	7E-08	7E-08	6E-08	6E-08	6E-08	6E-08	6E-08
Tribal Clamming	1 x 10^{-4}	2E-06	3E-07	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-06	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-06	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07
Beach 1	1 x 10^{-7}	2E-07	1E-07	1E-07	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-07	1E-07	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-07	1E-07	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 2	3 x 10^{-6}	8E-07	3E-07	2E-07	1E-07	1E-07	1E-07	9E-08	9E-08	8E-08	8E-08	8E-07	2E-07	2E-07	1E-07	1E-07	1E-07	9E-08	9E-08	8E-08	8E-08	8E-07	2E-07	2E-07	1E-07	1E-07	9E-08	9E-08	8E-08	8E-08	8E-08
Beach 3	1 x 10^{-7}	2E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	2E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	2E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07
Beach 4	1 x 10^{-5}	2E-06	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-06	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-06	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 5	1 x 10^{-6}	2E-07	1E-07	9E-08	9E-08	9E-08	9E-08	9E-08	8E-08	9E-08	8E-08	2E-07	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-07	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 6	3 x 10^{-7}	3E-07	1E-07	1E-07	1E-07	1E-07	1E-07	9E-08	9E-08	9E-08	9E-08	3E-07	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	3E-07	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08
Beach 7	1 x 10^{-7}	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 8	1 x 10^{-7}	1E-07	8E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	1E-07	8E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	1E-07	8E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08

Table M-6d Low Sensitivity of LDW Dioxin/Furan SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Dioxin/Furan SWACs

Removal Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0* [c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	24	4	3	3	2	2	2	2	2	2	24	4	3	3	2	2	2	2	2	2
Tribal Clamming	30	4	3	3	2	2	2	2	2	2	30	4	3	3	2	2	2	2	2	2
Beach 1	5	3	3	2	2	2	2	2	2	2	5	3	3	2	2	2	2	2	2	2
Beach 2	23	7	5	3	3	2	2	2	2	2	23	7	5	3	3	2	2	2	2	2
Beach 3	7	4	4	3	3	3	3	3	3	3	7	4	4	3	3	3	3	3	3	3
Beach 4	47	3	2	2	2	2	2	2	2	2	47	3	2	2	2	2	2	2	2	2
Beach 5	6	2	2	2	2	2	2	2	2	2	6	2	2	2	2	2	2	2	2	2
Beach 6	8	2	2	2	2	2	2	2	2	2	8	2	2	2	2	2	2	2	2	2
Beach 7	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Beach 8	4	2	2	2	2	2	2	2	2	2	4	2	2	2	2	2	2	2	2	2

		Risk for Each Alternative																			
		Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0* [c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	6E-07	1E-07	9E-08	7E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-07	1E-07	9E-08	7E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08
Tribal Clamming	1×10^{-4}	2E-06	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-06	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07
Beach 1	1×10^{-7}	2E-07	1E-07	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-07	1E-07	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 2	3×10^{-6}	8E-07	2E-07	2E-07	1E-07	9E-08	9E-08	8E-08	8E-08	8E-08	8E-08	8E-07	2E-07	2E-07	1E-07	9E-08	9E-08	8E-08	8E-08	7E-08	7E-08
Beach 3	1×10^{-7}	2E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	2E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07
Beach 4	1×10^{-5}	2E-06	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-06	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 5	1×10^{-6}	2E-07	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-07	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 6	3×10^{-7}	3E-07	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	3E-07	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08
Beach 7	1×10^{-7}	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08
Beach 8	1×10^{-7}	1E-07	8E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	1E-07	8E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08	7E-08

Notes:

1. Low BCM input parameters (ng TEQ/kg dw dioxins/furans): upstream = 2; lateral = 10; post-remedy bed sediment replacement value = 2.
2. BCM predictions use base case STM outputs revised June 2010 (Appendix C).
3. BCM area = 430 acres and FS study area = 441 acres
4. Significant figures are displayed in accordance with the conventions established in the HHRA.

$> 1 \times 10^{-6}$ and $\leq 1 \times 10^{-5}$

$\leq 1 \times 10^{-6}$

} Colored cells indicate residual excess cancer risk.

a. Construction period.

b. Baseline risks using the RI baseline data for the direct contact scenarios as reported in Section 3 (Table 3-6a for netfishing, tribal clamming scenarios, and beach play scenarios).

c. The 5-year intervals for the BCM-predicted SWACs (and for risk estimation) are indexed to the start of construction for Alternatives 2 through 6. Risk estimates for time 0 (post-EAA/Alternative 1) use the BCM-predicted SWACs after construction of the EAAs. Differences in risks between the baseline risks presented in the HHRA and the risks at time 0 are attributable to: 1) the transition from the HHRA methodology (UCL95 or maximum values) to -spatial interpolation methodology (SWACs); 2) the transition from the RI baseline dataset to the FS baseline dataset, which affects the SWACs in netfishing and clamming exposure areas; and 3) active remediation of the EAAs, which affects the SWACs in netfishing, clamming, and the Beach 3 exposure areas.

AOPC = area of potential concern; BCM = bed composition model; dw = dry weight; EAA = early action area; FS = feasibility study; HHRA = human health risk assessment; kg = kilogram; LDW = Lower Duwamish Waterway; ng = nanograms; RI = remedial investigation; STM = sediment transport model; SWAC = spatially-weighted average concentration; TEQ = toxic equivalent;95UCL = 95% upper confidence limit

Table M-7a High Sensitivity of LDW Total PCB SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Total PCB SWACs

Combined Alternatives

	SWAC for Each Alternative																											
	EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	180	138	120	106	104	103	104	103	103	98	180	121	112	101	101	100	102	101	102	97	180	109	105	98	99	99	101	101	101	97
Tribal Clamming	199	133	115	104	104	103	104	102	103	99	199	103	104	99	100	100	101	100	101	97	199	98	101	97	99	99	100	100	101	97
Beach 1	51	76	93	98	101	104	102	107	110	106	51	76	92	97	101	104	104	109	111	106	51	76	92	97	101	104	104	109	111	106
Beach 2	278	208	162	126	108	101	98	95	93	90	278	133	118	105	98	95	94	93	92	90	278	108	102	95	93	92	92	91	91	89
Beach 3	108	170	177	159	161	165	172	177	178	159	108	162	174	157	161	165	172	177	178	159	108	145	165	153	159	164	174	178	178	159
Beach 4[d]	1099	341	172	113	118	114	97	105	109	100	1099	114	112	101	106	107	95	104	109	100	1099	104	109	100	105	106	95	104	109	100
Beach 5	123	100	96	92	93	93	94	93	94	91	123	91	93	90	92	92	94	92	94	91	123	86	90	86	88	88	90	90	91	87
Beach 6	448	159	114	101	104	101	96	91	91	89	448	90	89	87	89	88	90	88	89	87	448	90	89	87	89	88	90	88	89	87
Beach 7	46	95	100	94	100	99	118	101	102	96	46	95	100	94	100	99	118	101	102	96	46	95	100	94	100	99	118	101	102	96
Beach 8	49	78	80	80	80	80	81	80	81	80	49	79	80	80	80	80	81	80	81	80	49	79	80	80	80	80	81	80	81	80

		Risk for Each Alternative																												
		EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
Exposure Area	Baseline Risk[b]	*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	1E-07	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	1E-07	9E-08	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	7E-08	1E-07	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	7E-08
Tribal Clamming	1×10^{-4}	4E-07	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	4E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	4E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07
Beach 1	1×10^{-7}	3E-08	4E-08	5E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	3E-08	4E-08	5E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	6E-08	3E-08	4E-08	5E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	6E-08
Beach 2	3×10^{-6}	2E-07	1E-07	1E-07	7E-08	6E-08	6E-08	6E-08	6E-08	5E-08	5E-08	2E-07	8E-08	7E-08	6E-08	6E-08	6E-08	6E-08	5E-08	5E-08	5E-08	2E-07	6E-08	6E-08	6E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08
Beach 3	1×10^{-7}	6E-08	1E-07	1E-07	9E-08	9E-08	1E-07	1E-07	1E-07	1E-07	9E-08	6E-08	1E-07	1E-07	9E-08	9E-08	1E-07	1E-07	1E-07	1E-07	9E-08	6E-08	9E-08	1E-07	9E-08	9E-08	1E-07	1E-07	1E-07	1E-07	9E-08
Beach 4[d]	1×10^{-5}	6E-07	2E-07	1E-07	7E-08	7E-08	7E-08	6E-08	6E-08	6E-08	6E-08	6E-07	7E-08	7E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-07	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08
Beach 5	1×10^{-6}	7E-08	6E-08	6E-08	5E-08	5E-08	5E-08	6E-08	5E-08	6E-08	5E-08	7E-08	5E-08	5E-08	5E-08	5E-08	5E-08	6E-08	5E-08	6E-08	5E-08	7E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08
Beach 6	3×10^{-7}	3E-07	9E-08	7E-08	6E-08	6E-08	6E-08	6E-08	5E-08	5E-08	5E-08	3E-07	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	3E-07	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08
Beach 7	1×10^{-7}	3E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	6E-08	6E-08	6E-08	3E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	6E-08	6E-08	6E-08	3E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	6E-08	6E-08	6E-08
Beach 8	1×10^{-7}	3E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	3E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	3E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08

Table M-7a High Sensitivity of LDW Total PCB SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Total PCB SWACs

Combined Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	180	109	101	96	98	99	101	101	101	97	180	109	101	86	84	91	96	98	99	95
Tribal Clamming	199	98	99	96	98	99	100	100	101	96	199	98	99	92	90	93	96	97	99	95
Beach 1	51	76	94	99	101	105	107	111	112	107	51	76	94	99	95	101	104	109	111	106
Beach 2	278	108	101	95	92	91	92	91	91	89	278	108	101	95	69	76	81	84	86	86
Beach 3	108	145	164	153	159	164	175	179	178	160	108	145	164	153	156	162	175	179	178	159
Beach 4[d]	1099	104	104	100	105	106	100	105	109	100	1099	104	104	91	103	106	102	106	109	100
Beach 5	123	86	89	86	88	88	90	90	91	87	123	86	89	74	82	82	85	85	86	82
Beach 6	448	90	89	87	89	88	90	88	89	87	448	90	89	87	89	88	90	88	89	87
Beach 7	46	95	100	94	100	99	118	101	102	96	46	95	100	84	99	98	109	100	102	96
Beach 8	49	79	81	80	80	80	81	80	81	80	49	79	81	80	80	80	81	80	81	80

		Risk for Each Alternative																			
		Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
Exposure Area	Baseline Risk[b]	*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	1E-07	8E-08	8E-08	7E-08	8E-08	8E-08	8E-08	8E-08	8E-08	7E-08	1E-07	8E-08	8E-08	7E-08	6E-08	7E-08	7E-08	8E-08	8E-08	7E-08
Tribal Clamming	1×10^{-4}	4E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	4E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07
Beach 1	1×10^{-7}	3E-08	4E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	7E-08	6E-08	3E-08	4E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	6E-08
Beach 2	3×10^{-6}	2E-07	6E-08	6E-08	6E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	2E-07	6E-08	6E-08	6E-08	4E-08	4E-08	5E-08	5E-08	5E-08	5E-08
Beach 3	1×10^{-7}	6E-08	9E-08	1E-07	9E-08	9E-08	1E-07	1E-07	1E-07	1E-07	9E-08	6E-08	9E-08	1E-07	9E-08	9E-08	1E-07	1E-07	1E-07	1E-07	9E-08
Beach 4[d]	1×10^{-5}	6E-07	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-07	6E-08	6E-08	5E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08
Beach 5	1×10^{-6}	7E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	7E-08	5E-08	5E-08	4E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08
Beach 6	3×10^{-7}	3E-07	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	3E-07	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08
Beach 7	1×10^{-7}	3E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	6E-08	6E-08	6E-08	3E-08	6E-08	6E-08	5E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08
Beach 8	1×10^{-7}	3E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	3E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08

Table M-7a High Sensitivity of LDW Total PCB SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Total PCB SWACs

Removal Alternatives

	SWAC for Each Alternative																											
	Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	180	125	115	103	103	102	103	102	102	98	180	121	112	101	101	100	102	101	102	97	180	121	110	98	99	99	101	101	101	97
Tribal Clamming	199	109	107	101	102	101	102	101	102	98	199	103	104	99	100	100	101	100	101	97	199	103	103	97	99	99	100	100	101	97
Beach 1	51	76	93	98	101	104	102	107	110	106	51	76	92	97	101	104	104	109	111	106	51	76	92	97	101	104	104	109	111	106
Beach 2	278	161	135	113	102	97	96	94	93	90	278	133	118	105	98	95	94	93	92	90	278	133	118	96	93	92	92	91	91	89
Beach 3	108	162	174	157	161	165	172	177	178	159	108	162	174	157	161	165	172	177	178	159	108	162	174	151	158	163	174	178	178	159
Beach 4[d]	1099	117	112	101	106	107	92	104	109	100	1099	114	112	101	106	107	95	104	109	100	1099	114	108	100	105	106	95	104	109	100
Beach 5	123	98	96	91	93	93	94	93	94	91	123	91	93	90	92	92	94	92	94	91	123	91	89	86	88	88	90	90	91	87
Beach 6	448	159	114	101	104	101	96	91	91	89	448	90	89	87	89	88	90	88	89	87	448	90	89	87	89	88	90	88	89	87
Beach 7	46	95	100	94	100	99	118	101	102	96	46	95	100	94	100	99	118	101	102	96	46	95	100	94	100	99	118	101	102	96
Beach 8	49	78	80	80	80	80	81	80	81	80	49	79	80	80	80	80	81	80	81	80	49	79	80	80	80	80	81	80	81	80

		Risk for Each Alternative																												
		Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
Exposure Area	Baseline Risk[b]	*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	1E-07	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	1E-07	9E-08	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	7E-08	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	7E-08
Tribal Clamming	1×10^{-4}	4E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	4E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	4E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07
Beach 1	1×10^{-7}	3E-08	4E-08	5E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	3E-08	4E-08	5E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	6E-08	3E-08	4E-08	5E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	6E-08
Beach 2	3×10^{-6}	2E-07	9E-08	8E-08	7E-08	6E-08	6E-08	6E-08	6E-08	5E-08	5E-08	2E-07	8E-08	7E-08	6E-08	6E-08	6E-08	6E-08	5E-08	5E-08	5E-08	2E-07	8E-08	7E-08	6E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08
Beach 3	1×10^{-7}	6E-08	1E-07	1E-07	9E-08	9E-08	1E-07	1E-07	1E-07	1E-07	9E-08	6E-08	1E-07	1E-07	9E-08	9E-08	1E-07	1E-07	1E-07	1E-07	9E-08	6E-08	1E-07	1E-07	9E-08	9E-08	1E-07	1E-07	1E-07	1E-07	9E-08
Beach 4[d]	1×10^{-5}	6E-07	7E-08	7E-08	6E-08	6E-08	6E-08	5E-08	6E-08	6E-08	6E-08	6E-07	7E-08	7E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-07	7E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08
Beach 5	1×10^{-6}	7E-08	6E-08	6E-08	5E-08	5E-08	5E-08	6E-08	5E-08	6E-08	5E-08	7E-08	5E-08	5E-08	5E-08	5E-08	5E-08	6E-08	5E-08	6E-08	5E-08	7E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08
Beach 6	3×10^{-7}	3E-07	9E-08	7E-08	6E-08	6E-08	6E-08	6E-08	5E-08	5E-08	5E-08	3E-07	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	3E-07	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08
Beach 7	1×10^{-7}	3E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	6E-08	6E-08	6E-08	3E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	6E-08	6E-08	6E-08	3E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	6E-08	6E-08	6E-08
Beach 8	1×10^{-7}	3E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	3E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	3E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08

Table M-7a High Sensitivity of LDW Total PCB SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Total PCB SWACs

Removal Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[b]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	180	121	110	98	98	99	101	101	101	97	180	121	110	98	98	93	94	93	93	92
Tribal Clamming	199	103	103	97	98	98	100	100	101	96	199	103	103	97	98	95	97	96	95	93
Beach 1	51	76	92	97	98	103	105	110	111	106	51	76	92	97	98	103	105	110	104	104
Beach 2	278	133	118	96	93	92	92	91	91	89	278	133	118	96	93	92	92	80	74	79
Beach 3	108	162	174	151	157	163	175	179	178	159	108	162	174	151	157	163	175	179	174	159
Beach 4[d]	1099	114	108	100	102	106	100	105	109	100	1099	114	108	100	102	106	92	104	109	100
Beach 5	123	91	89	86	88	88	90	90	91	87	123	91	89	86	88	76	83	85	86	83
Beach 6	448	90	89	87	89	88	90	88	89	87	448	90	89	87	89	88	90	88	89	87
Beach 7	46	95	100	94	100	99	118	101	102	96	46	95	100	94	100	87	107	100	102	95
Beach 8	49	79	80	80	81	80	81	80	81	80	49	79	80	80	81	80	81	80	81	80

		Risk for Each Alternative																			
		Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[b]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	1E-07	9E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	7E-08	1E-07	9E-08	8E-08	8E-08	8E-08	7E-08	7E-08	7E-08	7E-08	7E-08
Tribal Clamming	1×10^{-4}	4E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	4E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07
Beach 1	1×10^{-7}	3E-08	4E-08	5E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	6E-08	3E-08	4E-08	5E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08
Beach 2	3×10^{-6}	2E-07	8E-08	7E-08	6E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	2E-07	8E-08	7E-08	6E-08	5E-08	5E-08	5E-08	5E-08	4E-08	5E-08
Beach 3	1×10^{-7}	6E-08	1E-07	1E-07	9E-08	9E-08	1E-07	1E-07	1E-07	1E-07	9E-08	6E-08	1E-07	1E-07	9E-08	9E-08	1E-07	1E-07	1E-07	1E-07	9E-08
Beach 4[d]	1×10^{-5}	6E-07	7E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-08	6E-07	7E-08	6E-08	6E-08	6E-08	6E-08	5E-08	6E-08	6E-08	6E-08
Beach 5	1×10^{-6}	7E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	7E-08	5E-08	5E-08	5E-08	5E-08	4E-08	5E-08	5E-08	5E-08	5E-08
Beach 6	3×10^{-7}	3E-07	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	3E-07	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08
Beach 7	1×10^{-7}	3E-08	6E-08	6E-08	6E-08	6E-08	6E-08	7E-08	6E-08	6E-08	6E-08	3E-08	6E-08	6E-08	6E-08	6E-08	5E-08	6E-08	6E-08	6E-08	6E-08
Beach 8	1×10^{-7}	3E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	3E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08	5E-08

Notes:

1. High BCM input parameters (µg/kg dw total PCBs): upstream = 80; lateral = 1,000; post-remedy bed sediment replacement value = 90 (AOPC 1), 40 (AOPC 2).
2. BCM predictions use base case STM outputs revised June 2010 (Appendix C).
3. BCM area = 430 acres and FS study area = 441 acres
4. Significant figures are displayed in accordance with the conventions established in the HHRA.

≤ 1×10^{-6} Colored cells indicate residual excess cancer risk.

a. Construction period.

b. Baseline risks using the RI baseline data for the direct contact scenarios as reported in Section 3 (Table 3-6a for netfishing, tribal clamming scenarios, and beach play scenarios).

c. The 5-year intervals for the BCM-predicted SWACs (and for risk estimation) are indexed to the start of construction for Alternatives 2 through 6. Risk estimates for time 0 (post-EAA/Alternative 1) use the BCM-predicted SWACs after construction of the EAAs. Differences in risks between the baseline risks presented in the HHRA and the risks at time 0 are attributable to: 1) the transition from the HHRA methodology (UCL95 or maximum values) to spatial interpolation methodology (SWACs); 2) the transition from the RI baseline dataset to the FS baseline dataset, which affects the SWACs in netfishing and clamming exposure areas; and 3) active remediation of the EAAs, which affects the SWACs in netfishing, clamming, and the Beach 3 exposure areas.

d. The large differences between the baseline risks and the SWAC-based risk estimates at Beach 4 result from removing the two highest PCB-concentration samples at Beach 4 from the FS dataset for interpolating PCB concentrations. After construction of Alternative 2, the locations with the highest PCB concentrations would have undergone active remediation.

BCM = bed composition model; EAA = early action area; FS = feasibility study; HHRA = human health risk assessment; STM = sediment transport model; SWAC = spatially-weighted average concentration

Table M-7b High Sensitivity of LDW Arsenic SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Arsenic SWACs

Combined Alternatives

	SWAC for Each Alternative																													
	EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	16	13	12	11	11	11	11	11	11	11	16	11	11	10	10	10	10	10	10	10	16	11	11	10	10	10	10	10	10	10
Tribal Clamming	13	12	12	12	12	12	12	12	12	12	13	10	10	10	10	10	10	10	10	10	13	10	10	10	10	10	10	10	10	10
Beach 1	8	9	10	10	10	11	10	11	11	11	8	9	10	10	10	10	10	11	11	11	8	9	10	10	10	10	10	11	11	11
Beach 2	13	12	11	11	10	10	10	10	10	10	13	11	11	11	10	10	10	10	10	10	13	11	11	11	10	10	10	10	10	10
Beach 3	11	12	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12
Beach 4	7	10	10	10	10	11	10	10	11	10	7	10	11	10	11	11	10	11	11	10	7	10	11	10	11	11	10	11	11	10
Beach 5	9	9	10	9	9	9	9	10	10	9	9	10	10	9	10	10	10	10	10	10	9	10	10	10	10	10	10	10	10	10
Beach 6	12	10	10	10	10	10	10	10	10	10	12	11	10	10	10	10	10	10	10	10	12	11	10	10	10	10	10	10	10	10
Beach 7	8	10	10	10	10	10	11	10	10	10	8	10	10	10	10	10	11	10	10	10	8	10	10	10	10	10	11	10	10	10
Beach 8	8	10	10	10	10	10	10	10	10	10	8	10	10	10	10	10	10	10	10	10	8	10	10	10	10	10	10	10	10	10

		Risk for Each Alternative																													
		EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	6×10^{-6}	4E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Tribal Clamming	2×10^{-5}	1E-05	9E-06	9E-06	9E-06	9E-06	9E-06	9E-06	9E-06	9E-06	9E-06	1E-05	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	1E-05	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06
Beach 1	5×10^{-6}	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 2	6×10^{-6}	5E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	5E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	5E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 3	4×10^{-6}	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 4	4×10^{-6}	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 5	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	4E-06	3E-06
Beach 6	3×10^{-5}	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 7	3×10^{-6}	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 8	3×10^{-6}	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06

Table M-7b High Sensitivity of LDW Arsenic SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Arsenic SWACs

Combined Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	16	11	11	10	10	10	10	10	10	10	16	11	11	10	10	10	10	10	10	10
Tribal Clamming	13	10	11	10	10	10	10	10	10	10	13	10	11	10	10	10	10	10	10	10
Beach 1	8	9	10	10	10	11	11	11	11	11	8	9	10	10	10	11	11	11	11	11
Beach 2	13	11	11	11	11	10	10	10	10	10	13	11	11	11	10	10	10	10	10	10
Beach 3	11	12	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12
Beach 4	7	10	11	10	11	11	10	11	11	10	7	10	11	10	11	11	10	11	11	10
Beach 5	9	10	10	10	10	10	10	10	10	10	9	10	10	10	10	10	10	10	10	10
Beach 6	12	11	10	10	10	10	10	10	10	10	12	11	10	10	10	10	10	10	10	10
Beach 7	8	10	10	10	10	10	11	10	10	10	8	10	10	10	10	10	11	10	10	10
Beach 8	8	10	10	10	10	10	10	10	10	10	8	10	10	10	10	10	10	10	10	10

		Risk for Each Alternative																			
		Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	6×10^{-6}	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Tribal Clamming	2×10^{-5}	1E-05	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	1E-05	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06
Beach 1	5×10^{-6}	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 2	6×10^{-6}	5E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	5E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 3	4×10^{-6}	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 4	4×10^{-6}	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 5	3×10^{-6}	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	4E-06	4E-06	4E-06	3E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 6	3×10^{-5}	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 7	3×10^{-6}	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 8	3×10^{-6}	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06

Table M-7b High Sensitivity of LDW Arsenic SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Arsenic SWACs

Removal Alternatives

	SWAC for Each Alternative																											
	Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	16	11	11	11	10	10	11	10	10	10	16	11	11	10	10	10	10	10	10	10	16	11	11	11	10	10	10	10	10	10
Tribal Clamming	13	10	10	10	10	10	10	10	10	10	13	10	10	10	10	10	10	10	10	10	13	10	10	10	10	10	10	10	10	10
Beach 1	8	9	10	10	10	11	10	11	11	11	8	9	10	10	10	10	10	11	11	11	8	9	10	10	10	10	10	11	11	11
Beach 2	13	11	11	11	10	10	10	10	10	10	13	11	11	11	10	10	10	10	10	10	13	11	11	11	10	10	10	10	10	10
Beach 3	11	12	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12
Beach 4	7	10	11	10	11	11	10	11	11	10	7	10	11	10	11	11	10	11	11	10	7	10	11	10	11	11	10	11	11	10
Beach 5	9	9	10	9	9	9	9	10	10	9	9	10	10	9	10	10	10	10	10	10	9	10	10	10	10	10	10	10	10	10
Beach 6	12	10	10	10	10	10	10	10	10	10	12	11	10	10	10	10	10	10	10	10	12	11	10	10	10	10	10	10	10	10
Beach 7	8	10	10	10	10	10	11	10	10	10	8	10	10	10	10	10	11	10	10	10	8	10	10	10	10	10	11	10	10	10
Beach 8	8	10	10	10	10	10	10	10	10	10	8	10	10	10	10	10	10	10	10	10	8	10	10	10	10	10	10	10	10	10

		Risk for Each Alternative																													
		Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	6×10^{-6}	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Tribal Clamming	2×10^{-5}	1E-05	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	1E-05	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	1E-05	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06
Beach 1	5×10^{-6}	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 2	6×10^{-6}	5E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	5E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	5E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 3	4×10^{-6}	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 4	4×10^{-6}	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 5	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	4E-06	4E-06	3E-06
Beach 6	3×10^{-5}	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 7	3×10^{-6}	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 8	3×10^{-6}	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06

Table M-7b High Sensitivity of LDW Arsenic SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Arsenic SWACs

Removal Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	16	11	11	11	11	10	11	10	10	10	16	11	11	11	11	10	10	10	10	10
Tribal Clamming	13	10	10	10	11	10	11	10	10	10	13	10	10	10	11	10	10	10	10	10
Beach 1	8	9	10	10	11	11	11	11	11	11	8	9	10	10	11	11	11	11	11	11
Beach 2	13	11	11	11	11	11	10	10	10	10	13	11	11	11	11	11	10	10	10	10
Beach 3	11	12	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12
Beach 4	7	10	11	10	11	11	10	11	11	10	7	10	11	10	11	11	10	11	11	10
Beach 5	9	10	10	10	10	10	10	10	10	10	9	10	10	10	10	10	10	10	10	10
Beach 6	12	11	10	10	10	10	10	10	10	10	12	11	10	10	10	10	10	10	10	10
Beach 7	8	10	10	10	10	10	11	10	10	10	8	10	10	10	10	10	11	10	10	10
Beach 8	8	10	10	10	10	10	10	10	10	10	8	10	10	10	10	10	10	10	10	10

		Risk for Each Alternative																			
		Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	6×10^{-6}	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Tribal Clamming	2×10^{-5}	1E-05	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	1E-05	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06	8E-06
Beach 1	5×10^{-6}	3E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 2	6×10^{-6}	5E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	5E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 3	4×10^{-6}	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 4	4×10^{-6}	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 5	3×10^{-6}	3E-06	3E-06	4E-06	3E-06	4E-06	3E-06	4E-06	4E-06	4E-06	3E-06	3E-06	3E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 6	3×10^{-5}	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 7	3×10^{-6}	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach 8	3×10^{-6}	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06

Notes:

1. High BCM input parameters (mg/kg dw arsenic): upstream = 10; lateral = 30; post-remedy bed sediment replacement value = 11 (AOPC 1), 10 (AOPC 2).
2. BCM predictions use base case STM outputs revised June 2010 (Appendix C).
3. BCM area = 430 acres and FS study area = 441 acres
4. Significant figures are displayed in accordance with the conventions established in the HHRA.
5. Direct contact excess cancer risk at 1×10^{-6} cannot be achieved because 1) risk threshold is below natural background, and 2) the concentration of the upstream sediment input is estimated to be 10 mg/kg dw, which corresponds to a risk of 4×10^{-6}.

$> 1 \times 10^{-6}$ and $\leq 1 \times 10^{-5}$ Colored cells indicate residual excess cancer risk.

a. Construction period.

b. Baseline risks using the RI baseline data for the direct contact scenarios as reported in Section 3 (Table 3-6a for netfishing, tribal clamming scenarios, and beach play scenarios).

c. The 5-year intervals for the BCM-predicted SWACs (and for risk estimation) are indexed to the start of construction for Alternatives 2 through 6. Risk estimates for time 0 (post-EAA/Alternative 1) use the BCM-predicted SWACs after construction of the EAAs. Differences in risks between the baseline risks presented in the HHRA and the risks at time 0 are attributable to: 1) the transition from the HHRA methodology (UCL95 or maximum values) to spatial interpolation methodology (SWACs); 2) the transition from the RI baseline dataset to the FS baseline dataset, which affects the SWACs in netfishing and clamming exposure areas; and 3) active remediation of the EAAs, which affects the SWACs in netfishing, clamming, and the Beach 3 exposure areas.

BCM = bed composition model; EAA = early action area; FS = feasibility study; HHRA = human health risk assessment; STM = sediment transport model; SWAC = spatially-weighted average concentration

Table M-7c High Sensitivity of LDW cPAH SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on cPAH SWACs

Combined Alternatives

	SWAC for Each Alternative																											
	EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	362	361	352	328	328	330	339	339	340	325	362	312	328	314	320	325	333	335	338	322	362	286	315	305	317	323	332	335	337	322
Tribal Clamming	303	335	340	323	328	329	333	332	336	321	303	264	302	299	313	317	322	324	329	314	303	258	300	297	313	317	323	325	329	314
Beach 1	397	403	398	373	360	363	351	368	375	359	397	205	282	308	335	349	349	367	374	359	397	205	282	308	335	349	349	367	374	359
Beach 2	752	567	452	364	327	315	312	308	306	300	752	199	237	256	278	287	294	297	300	297	752	201	238	254	279	287	294	298	300	297
Beach 3	390	588	616	560	573	585	608	617	618	559	390	559	603	551	571	584	609	618	618	559	390	528	587	535	569	583	616	621	620	560
Beach 4	382	366	371	339	356	360	307	349	367	338	382	298	354	331	353	358	317	352	368	339	382	269	347	328	352	358	321	352	368	339
Beach 5	385	289	265	242	250	247	249	256	258	242	385	221	248	233	243	243	249	257	259	243	385	212	250	236	248	248	255	262	265	249
Beach 6	531	361	329	313	319	316	309	303	306	299	531	200	276	273	290	291	300	297	299	291	531	200	276	273	290	291	300	297	299	291
Beach 7	74	314	336	318	336	332	398	340	345	323	74	314	336	318	336	332	398	340	345	323	74	314	336	318	336	332	398	340	345	323
Beach 8	284	267	272	270	270	272	273	271	273	271	284	262	272	270	270	272	273	271	273	271	284	262	272	270	270	272	273	271	273	271

		Risk for Each Alternative																												
		EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	1E-06	9E-07	9E-07	9E-07	9E-07	9E-07	9E-07	9E-07	9E-07	9E-07	1E-06	8E-07	9E-07	8E-07	8E-07	9E-07	9E-07	9E-07	9E-07	8E-07	1E-06	8E-07	8E-07	8E-07	8E-07	8E-07	9E-07	9E-07	9E-07	8E-07
Tribal Clamming	5×10^{-6}	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06
Beach1	4×10^{-6}	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	2E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	2E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach2	8×10^{-5}	8E-06	6E-06	5E-06	4E-06	4E-06	4E-06	3E-06	3E-06	3E-06	3E-06	8E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	8E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach3	1×10^{-5}	4E-06	7E-06	7E-06	6E-06	6E-06	7E-06	7E-06	7E-06	7E-06	6E-06	4E-06	6E-06	7E-06	6E-06	6E-06	6E-06	7E-06	7E-06	7E-06	6E-06	4E-06	6E-06	7E-06	6E-06	6E-06	6E-06	7E-06	7E-06	7E-06	6E-06
Beach4	1×10^{-5}	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach5	3×10^{-5}	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach6	8×10^{-5}	6E-06	4E-06	4E-06	3E-06	4E-06	4E-06	3E-06	3E-06	3E-06	3E-06	6E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	6E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach7	1×10^{-6}	8E-07	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	8E-07	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	8E-07	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach8	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06

Table M-7c High Sensitivity of LDW cPAH SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on cPAH SWACs

Combined Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	362	286	300	302	315	321	332	335	337	322	362	286	300	275	279	303	320	328	333	320
Tribal Clamming	303	258	290	296	312	316	324	325	329	314	303	258	290	287	293	305	315	321	327	313
Beach 1	397	205	263	309	331	347	356	371	376	360	397	205	263	309	310	335	349	367	374	359
Beach 2	752	201	233	254	277	286	294	298	300	297	752	201	233	254	222	249	268	280	288	290
Beach 3	390	528	553	526	563	580	618	622	620	560	390	528	553	526	551	575	615	621	620	560
Beach 4	382	269	322	327	351	358	336	356	369	339	382	269	322	299	346	356	344	358	369	339
Beach 5	385	212	238	237	248	248	257	263	266	250	385	212	238	216	246	248	257	264	267	251
Beach 6	531	200	276	273	290	291	300	297	299	291	531	200	276	273	290	291	300	297	299	291
Beach 7	74	314	336	318	336	332	398	340	345	323	74	314	336	284	334	332	367	338	344	323
Beach 8	284	262	265	270	270	272	273	271	273	271	284	262	265	270	270	272	273	271	273	271

		Risk for Each Alternative																			
		Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	1E-06	8E-07	8E-07	8E-07	8E-07	8E-07	9E-07	9E-07	9E-07	8E-07	1E-06	8E-07	8E-07	7E-07	7E-07	8E-07	8E-07	9E-07	9E-07	8E-07
Tribal Clamming	5×10^{-6}	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06
Beach1	4×10^{-6}	4E-06	2E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	2E-06	3E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach2	8×10^{-5}	8E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	8E-06	2E-06	3E-06	3E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach3	1×10^{-5}	4E-06	6E-06	6E-06	6E-06	6E-06	6E-06	7E-06	7E-06	7E-06	6E-06	4E-06	6E-06	6E-06	6E-06	6E-06	6E-06	7E-06	7E-06	7E-06	6E-06
Beach4	1×10^{-5}	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach5	3×10^{-5}	4E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	2E-06	3E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach6	8×10^{-5}	6E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	6E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach7	1×10^{-6}	8E-07	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	8E-07	3E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach8	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06

Table M-7c High Sensitivity of LDW cPAH SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on cPAH SWACs

Removal Alternatives

	SWAC for Each Alternative																													
	Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	362	334	339	321	324	327	335	337	339	323	362	312	328	314	320	325	333	335	338	322	362	312	320	302	315	321	331	334	337	322
Tribal Clamming	303	309	326	313	322	324	327	327	332	317	303	264	302	299	313	317	322	324	329	314	303	264	298	296	312	316	322	324	329	314
Beach 1	397	403	398	373	360	363	351	368	375	359	397	205	282	308	335	349	349	367	374	359	397	205	282	308	335	349	349	367	374	359
Beach 2	752	332	316	298	298	299	302	302	303	299	752	199	237	256	278	287	294	297	300	297	752	199	237	249	274	284	292	296	299	297
Beach 3	390	559	603	551	571	584	609	618	618	559	390	559	603	551	571	584	609	618	618	559	390	559	603	508	555	576	612	619	619	559
Beach 4	382	332	362	335	354	359	311	350	367	339	382	298	354	331	353	358	317	352	368	339	382	298	332	330	351	358	321	352	368	339
Beach 5	385	280	263	241	249	247	250	256	258	242	385	221	248	233	243	243	249	257	259	243	385	221	241	237	247	248	255	262	265	249
Beach 6	531	361	329	313	319	316	309	303	306	299	531	200	276	273	290	291	300	297	299	291	531	200	276	273	290	290	300	297	299	291
Beach 7	74	314	336	318	336	332	398	340	345	323	74	314	336	318	336	332	398	340	345	323	74	314	336	318	336	332	398	340	345	323
Beach 8	284	267	272	270	270	272	273	271	273	271	284	262	272	270	270	272	273	271	273	271	284	262	272	270	270	272	273	271	273	271

		Risk for Each Alternative																													
		Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	1E-06	9E-07	9E-07	8E-07	9E-07	9E-07	9E-07	9E-07	9E-07	9E-07	1E-06	8E-07	9E-07	8E-07	8E-07	9E-07	9E-07	9E-07	9E-07	8E-07	1E-06	8E-07	8E-07	8E-07	8E-07	8E-07	9E-07	9E-07	9E-07	8E-07
Tribal Clamming	5×10^{-6}	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06
Beach1	4×10^{-6}	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	2E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	2E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach2	8×10^{-5}	8E-06	4E-06	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	8E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	8E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach3	1×10^{-5}	4E-06	6E-06	7E-06	6E-06	6E-06	6E-06	7E-06	7E-06	7E-06	6E-06	4E-06	6E-06	7E-06	6E-06	6E-06	6E-06	7E-06	7E-06	7E-06	6E-06	4E-06	6E-06	7E-06	6E-06	6E-06	6E-06	7E-06	7E-06	7E-06	6E-06
Beach4	1×10^{-5}	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach5	3×10^{-5}	4E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach6	8×10^{-5}	6E-06	4E-06	4E-06	3E-06	4E-06	4E-06	3E-06	3E-06	3E-06	3E-06	6E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	6E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach7	1×10^{-6}	8E-07	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	8E-07	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	8E-07	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach8	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06

Table M-7c High Sensitivity of LDW cPAH SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on cPAH SWACs

Removal Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	362	312	320	302	302	315	328	332	336	321	362	312	320	302	302	302	309	311	310	310
Tribal Clamming	303	264	298	296	299	311	321	323	329	314	303	264	298	296	299	303	315	315	313	307
Beach 1	397	205	282	308	298	329	343	364	372	358	397	205	282	308	298	329	343	364	348	351
Beach 2	752	199	237	249	263	277	287	293	297	296	752	199	237	249	263	277	287	259	245	264
Beach 3	390	559	603	508	534	566	609	618	618	559	390	559	603	508	534	566	609	618	605	557
Beach 4	382	298	332	330	327	352	334	355	369	339	382	298	332	330	327	352	309	350	367	338
Beach 5	385	221	241	237	236	246	255	263	266	250	385	221	241	237	236	225	252	263	267	252
Beach 6	531	200	276	273	290	290	300	297	299	291	531	200	276	273	290	290	300	297	299	291
Beach 7	74	314	336	318	336	332	398	340	345	323	74	314	336	318	336	294	364	338	344	323
Beach 8	284	262	272	270	263	272	273	271	273	271	284	262	272	270	263	272	273	271	273	271

		Risk for Each Alternative																			
		Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	1×10^{-6}	1E-06	8E-07	8E-07	8E-07	8E-07	8E-07	9E-07	9E-07	9E-07	8E-07	1E-06	8E-07	8E-07	8E-07	8E-07	8E-07	8E-07	8E-07	8E-07	8E-07
Tribal Clamming	5×10^{-6}	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06
Beach1	4×10^{-6}	4E-06	2E-06	3E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	2E-06	3E-06	3E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06
Beach2	8×10^{-5}	8E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	8E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach3	1×10^{-5}	4E-06	6E-06	7E-06	6E-06	6E-06	6E-06	7E-06	7E-06	7E-06	6E-06	4E-06	6E-06	7E-06	6E-06	6E-06	6E-06	7E-06	7E-06	7E-06	6E-06
Beach4	1×10^{-5}	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06
Beach5	3×10^{-5}	4E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	4E-06	2E-06	3E-06	3E-06	3E-06	2E-06	3E-06	3E-06	3E-06	3E-06
Beach6	8×10^{-5}	6E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	6E-06	2E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06
Beach7	1×10^{-6}	8E-07	3E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	8E-07	3E-06	4E-06	4E-06	4E-06	3E-06	4E-06	4E-06	4E-06	4E-06
Beach8	3×10^{-6}	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06

Notes:

1. High BCM input parameters (µg TEQ/kg dw cPAHs): upstream = 270; lateral = 3,400; post-remedy bed sediment replacement value = 200 (AOPC 1), 140 (AOPC 2).
2. BCM predictions use base case STM outputs revised June 2010 (Appendix C).
3. BCM area = 430 acres and FS study area = 441 acres
4. Significant figures are displayed in accordance with the conventions established in the HHRA.

$> 1 \times 10^{-6}$ and $\leq 1 \times 10^{-5}$
$\leq 1 \times 10^{-6}$

} Colored cells indicate residual excess cancer risk.

a. Construction period.
b. Baseline risks using the RI baseline data for the direct contact scenarios as reported in Section 3 (Table 3-6a for netfishing, tribal clamming scenarios, and beach play scenarios).

c. The 5-year intervals for the BCM-predicted SWACs (and for risk estimation) are indexed to the start of construction for Alternatives 2 through 6. Risk estimates for time 0 (post-EAA/Alternative 1) use the BCM-predicted SWACs after construction of the EAAs. Differences in risks between the baseline risks presented in the HHRA and the risks at time 0 are attributable to: 1) the transition from the HHRA methodology (UCL95 or maximum values) to spatial interpolation methodology (SWACs); 2) the transition from the RI baseline dataset to the FS baseline dataset, which affects the SWACs in netfishing and clamming exposure areas; and 3) active remediation of the EAAs, which affects the SWACs in netfishing, clamming, and the Beach 3 exposure areas.

BCM = bed composition model; cPAH = carcinogenic polycyclic aromatic hydrocarbon; dw = dry weight; EAA = early action area; FS = feasibility study; HHRA = human health risk assessment; kg = kilograms; µg = micrograms; STM = sediment transport model; SWAC = spatially-weighted average concentration; TEQ = toxic equivalent.

Table M-7d High Sensitivity of LDW Dioxin/Furan SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Dioxin/Furan SWACs

Combined Alternatives

	SWAC for Each Alternative																													
	EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	24	15	11	9	9	9	9	9	9	9	24	8	9	8	8	9	9	9	9	8	24	8	8	8	8	8	9	9	9	8
Tribal Clamming	30	17	12	9	9	9	9	8	9	8	30	8	8	8	8	8	8	8	8	8	30	8	8	8	8	8	8	8	8	8
Beach 1	5	7	8	8	9	9	9	9	9	9	5	7	8	8	9	9	9	9	9	9	5	7	8	8	9	9	9	9	9	9
Beach 2	23	17	14	11	10	9	9	9	9	8	23	9	9	9	9	8	8	8	8	8	23	9	9	8	8	8	8	8	8	8
Beach 3	8	10	11	10	11	11	11	11	11	11	8	9	10	10	11	11	11	11	11	11	8	9	10	10	11	11	11	11	11	11
Beach 4	47	18	11	9	9	9	9	9	9	9	47	8	9	9	9	9	8	9	9	9	47	8	9	8	9	9	9	9	9	9
Beach 5	6	7	7	6	7	7	7	7	7	7	6	6	6	6	6	6	6	7	7	6	6	6	6	6	6	6	7	7	7	7
Beach 6	8	9	9	9	9	9	9	9	9	9	8	6	8	8	8	8	8	8	8	8	8	6	8	8	8	8	8	8	8	8
Beach 7	2	8	9	8	9	9	9	9	9	9	2	8	9	8	9	9	9	9	9	9	2	8	9	8	9	9	9	9	9	9
Beach 8	4	8	8	8	8	8	8	8	8	8	4	8	8	8	8	8	8	8	8	8	4	8	8	8	8	8	8	8	8	8

		Risk for Each Alternative																													
		EAAs-Alternative 1										Alternative 3 Combined (3 years[a])										Alternative 4 Combined (6 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	7E-07	4E-07	3E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	7E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	7E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07
Tribal Clamming	1×10^{-4}	2E-06	1E-06	9E-07	7E-07	7E-07	7E-07	7E-07	7E-07	7E-07	6E-07	2E-06	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	7E-07	6E-07	2E-06	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	7E-07	6E-07
Beach 1	1×10^{-7}	2E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 2	3×10^{-6}	8E-07	6E-07	5E-07	4E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	8E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	8E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 3	1×10^{-7}	3E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	3E-07	3E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	3E-07	3E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07
Beach 4	1×10^{-5}	2E-06	6E-07	4E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-06	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-06	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 5	1×10^{-6}	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07
Beach 6	3×10^{-7}	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 7	1×10^{-7}	9E-08	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	9E-08	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	9E-08	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 8	1×10^{-7}	1E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	1E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	1E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07

Table M-7d High Sensitivity of LDW Dioxin/Furan SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Dioxin/Furan SWACs

Combined Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	24	8	8	8	8	8	9	9	9	8	24	8	8	8	8	8	8	9	9	8
Tribal Clamming	30	8	8	8	8	8	8	8	8	8	30	8	8	8	8	8	8	8	8	8
Beach 1	5	7	7	8	8	9	9	9	9	9	5	7	7	8	8	9	9	9	9	9
Beach 2	23	9	8	8	8	8	8	8	8	8	23	9	8	8	7	8	8	8	8	8
Beach 3	8	9	10	10	11	11	11	11	11	11	8	9	10	10	10	11	11	11	11	11
Beach 4	47	8	8	8	9	9	9	9	9	9	47	8	8	8	9	9	9	9	9	9
Beach 5	6	6	6	6	6	6	7	7	7	7	6	6	6	6	7	7	7	7	7	7
Beach 6	8	6	8	8	8	8	8	8	8	8	8	6	8	8	8	8	8	8	8	8
Beach 7	2	8	9	8	9	9	9	9	9	9	2	8	9	8	9	9	9	9	9	9
Beach 8	4	8	8	8	8	8	8	8	8	8	4	8	8	8	8	8	8	8	8	8

		Risk for Each Alternative																			
		Alternative 5 Combined (7 years[a])										Alternative 6 Combined (16 years[a])									
Exposure Area	Baseline Risk[b]	*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
		0[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	7E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	7E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07
Tribal Clamming	1×10^{-4}	2E-06	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	7E-07	6E-07	2E-06	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07
Beach 1	1×10^{-7}	2E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 2	3×10^{-6}	8E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	8E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 3	1×10^{-7}	3E-07	3E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	3E-07	3E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07
Beach 4	1×10^{-5}	2E-06	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-06	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 5	1×10^{-6}	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	3E-07	3E-07	2E-07
Beach 6	3×10^{-7}	3E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 7	1×10^{-7}	9E-08	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	9E-08	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 8	1×10^{-7}	1E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	1E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07

Table M-7d High Sensitivity of LDW Dioxin/Furan SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Dioxin/Furan SWACs

Removal Alternatives

	SWAC for Each Alternative																													
	Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	24	9	9	8	8	9	9	9	9	8	24	8	9	8	8	9	9	9	9	8	24	8	8	8	8	8	9	9	9	8
Tribal Clamming	30	8	9	8	8	8	8	8	8	8	30	8	8	8	8	8	8	8	8	8	30	8	8	8	8	8	8	8	8	8
Beach 1	5	7	8	8	9	9	9	9	9	9	5	7	8	8	9	9	9	9	9	9	5	7	8	8	9	9	9	9	9	9
Beach 2	23	10	9	9	9	9	9	8	8	8	23	9	9	9	9	8	8	8	8	8	23	9	9	8	8	8	8	8	8	8
Beach 3	8	9	10	10	11	11	11	11	11	11	8	9	10	10	11	11	11	11	11	11	8	9	10	10	10	11	11	11	11	11
Beach 4	47	8	9	9	9	9	8	9	9	9	47	8	9	9	9	9	8	9	9	9	47	8	8	9	9	9	9	9	9	9
Beach 5	6	6	7	6	7	7	7	7	7	7	6	6	6	6	6	6	6	7	7	6	6	6	6	6	6	6	7	7	7	7
Beach 6	8	9	9	9	9	9	9	9	9	9	8	6	8	8	8	8	8	8	8	8	8	6	8	8	8	8	8	8	8	8
Beach 7	2	8	9	8	9	9	9	9	9	9	2	8	9	8	9	9	9	9	9	9	2	8	9	8	9	9	9	9	9	9
Beach 8	4	8	8	8	8	8	8	8	8	8	4	8	8	8	8	8	8	8	8	8	4	8	8	8	8	8	8	8	8	8

		Risk for Each Alternative																													
		Alternative 2 Removal (4 years[a])										Alternative 3 Removal (6 years[a])										Alternative 4 Removal (11 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0*[c]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	7E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	7E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	7E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07
Tribal Clamming	1×10^{-4}	2E-06	6E-07	7E-07	6E-07	6E-07	6E-07	6E-07	6E-07	7E-07	6E-07	2E-06	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	7E-07	6E-07	2E-06	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	7E-07	6E-07
Beach 1	1×10^{-7}	2E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 2	3×10^{-6}	8E-07	4E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	8E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	8E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 3	1×10^{-7}	3E-07	3E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	3E-07	3E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	3E-07	3E-07	4E-07	3E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07
Beach 4	1×10^{-5}	2E-06	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-06	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-06	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 5	1×10^{-6}	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07
Beach 6	3×10^{-7}	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 7	1×10^{-7}	9E-08	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	9E-08	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	9E-08	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 8	1×10^{-7}	1E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	1E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	1E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07

Table M-7d High Sensitivity of LDW Dioxin/Furan SWACs to BCM Chemical Input Values and Excess Cancer Risks for Direct Contact Based on Dioxin/Furan SWACs

Removal Alternatives

	SWAC for Each Alternative																			
	Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
	Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	24	8	8	8	8	8	8	9	9	8	24	8	8	8	8	8	8	8	8	8
Tribal Clamming	30	8	8	8	8	8	8	8	8	8	30	8	8	8	8	8	8	8	8	8
Beach 1	5	7	8	8	8	8	9	9	9	9	5	7	8	8	8	8	9	9	9	9
Beach 2	23	9	9	8	8	8	8	8	8	8	23	9	9	8	8	8	8	8	7	8
Beach 3	8	9	10	10	10	11	11	11	11	11	8	9	10	10	10	11	11	11	11	11
Beach 4	47	8	8	9	8	9	9	9	9	9	47	8	8	9	8	9	8	9	9	9
Beach 5	6	6	6	6	6	6	7	7	7	7	6	6	6	6	6	6	7	7	7	7
Beach 6	8	6	8	8	8	8	8	8	8	8	8	6	8	8	8	8	8	8	8	8
Beach 7	2	8	9	8	9	9	9	9	9	9	2	8	9	8	9	8	9	9	9	9
Beach 8	4	8	8	8	8	8	8	8	8	8	4	8	8	8	8	8	8	8	8	8

		Risk for Each Alternative																			
		Alternative 5 Removal (17 years[a])										Alternative 6 Removal (42 years[a])									
		Time from Beginning of Construction (years)										*Time from Beginning of Construction (years)*									
Exposure Area	Baseline Risk[b]	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0[c]*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Site-wide Netfishing	2×10^{-5}	7E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	7E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07
Tribal Clamming	1×10^{-4}	2E-06	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	2E-06	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07	6E-07
Beach 1	1×10^{-7}	2E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 2	3×10^{-6}	8E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	8E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 3	1×10^{-7}	3E-07	3E-07	4E-07	3E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	3E-07	3E-07	4E-07	3E-07	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07
Beach 4	1×10^{-5}	2E-06	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-06	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 5	1×10^{-6}	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	3E-07	3E-07	2E-07
Beach 6	3×10^{-7}	3E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	2E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 7	1×10^{-7}	9E-08	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	9E-08	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07
Beach 8	1×10^{-7}	1E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	1E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07

Notes:

1. High BCM input parameters (ng TEQ/kg dw dioxins/furans): upstream = 8; lateral = 40; post-remedy bed sediment replacement value = 6.
2. BCM predictions use base case STM outputs revised June 2010 (Appendix C).
3. BCM area = 430 acres and FS study area = 441 acres
4. Significant figures are displayed in accordance with the conventions established in the HHRA.

$> 1 \times 10^{-6}$ and $\leq 1 \times 10^{-5}$
$\leq 1 \times 10^{-6}$

} Colored cells indicate residual excess cancer risk.

a. Construction period.

b. Baseline risks using the RI baseline data for the direct contact scenarios as reported in Section 3 (Table 3-6a for netfishing, tribal clamming scenarios, and beach play scenarios).

c. The 5-year intervals for the BCM-predicted SWACs (and for risk estimation) are indexed to the start of construction for Alternatives 2 through 6. Risk estimates for time 0 (post-EAA/Alternative 1) use the BCM-predicted SWACs after construction of the EAAs. Differences in risks between the baseline risks presented in the HHRA and the risks at time 0 are attributable to: 1) the transition from the HHRA methodology (UCL95 or maximum values) to spatial interpolation methodology (SWACs); 2) the transition from the RI baseline dataset to the FS baseline dataset, which affects the SWACs in netfishing and clamming exposure areas; and 3) active remediation of the EAAs, which affects the SWACs in netfishing, clamming, and the Beach 3 exposure areas.

d. Estimated risk at year 0 increased compared to the baseline risk because of the high post-remedy bed sediment replacement value.

BCM = bed composition model; dw = dry weight; EAA = early action area; FS = feasibility study; HHRA = human health risk assessment; kg = kilograms; ng = nanograms; STM = sediment transport model; SWAC = spatially-weighted average concentration; TEQ = toxic equivalent; UCL95 = 95% upper confindence limit on the mean

Table M-8 Sensitivity of Site-Wide Predicted Total PCB SWACs to BCM Post-Remedy Bed Sediment Replacement Values

Draft Final FS Remedial Alternative	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Sensitivity (Mid(Upst), Mid(Lat), 0(PRBSRV))									Sensitivity (Mid(Upst), Mid(Lat), Low(PRBSRV))									Sensitivity (Mid(Upst), Mid(Lat), Mid(PRBSRV))									Sensitivity (Mid(Upst), Mid(Lat), High(PRBSRV))								
			Time from Start of Construction (years)									*Time from Start of Construction (years)*									*Time from Start of Construction (years)*									*Time from Start of Construction (years)*								
			0	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*0*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*0*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*0*	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*
Alternative 3C	86	4	170	76	60	49	47	45	44	43	42	180	81	62	50	48	45	45	43	43	180	86	65	52	49	46	45	44	43	180	91	67	54	50	47	46	44	44
Alternative 5C	186	8	170	57	41	40	42	42	42	41	41	180	66	48	44	44	43	43	42	42	180	75	55	47	46	44	44	43	43	180	84	62	51	48	46	45	44	43
Alternative 6C	328	18	170	57	41	31	29	34	37	38	39	180	66	48	37	34	37	39	40	40	180	75	55	42	38	39	41	41	41	180	84	62	49	44	43	43	42	42
Alternative 3R	86	6	170	76	60	49	47	45	44	43	42	180	81	62	50	48	45	45	43	43	180	86	65	52	49	46	45	44	43	180	91	67	54	50	47	46	44	44
Alternative 5R	186	19	170	76	55	42	38	40	41	41	41	180	81	60	46	43	43	43	42	42	180	86	64	50	48	45	45	43	43	180	91	69	54	53	48	47	45	44
Alternative 6R	328	38	170	76	55	42	38	35	35	35	34	180	81	60	46	43	39	38	38	37	180	86	64	50	48	42	41	40	39	180	91	69	54	53	47	46	44	43

BCM input parameters (µg/kg dw total PCBs)
low: upstream = 5; lateral = 100; post-remedy bed sediment replacement value = 30 (AOPC 1), 10 (AOPC 2)
mid: upstream = 35; lateral = 300; post-remedy bed sediment replacement value = 60 (AOPC 1), 20 (AOPC 2)
high: upstream = 80; lateral = 1,000; post-remedy bed sediment replacement value = 90 (AOPC 1), 40 (AOPC 2)

Notes:

1. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.
2. Total PCB SWACs in µg/kg dw; baseline Total PCB SWAC = 346 µg/kg dw.
3. BCM predictions use base case STM outputs revised June 2010 (Appendix C).
4. BCM area = 430 acres and FS study area = 441 acres

BCM output used as approximation (estimate) of concentrations after construction.

AOPC = area of potential concern; BCM = bed composition model; dw = dry weight; FS = feasibility study; kg = kilograms; µg = micrograms; PRBSRV = post-remedy bed sediment replacement value; STM = sediment transport model; SWAC = spatially-weighted average concentration.

Table M-9a Summary Statistics for Subsurface Total PCB Concentrations Remaining within AOPC 1 and AOPC 2 but Outside of EAAs and the Dredge and Cap Footprints Specific to Each Alternative

Remedial Alternative	Recovery Category	Depth Interval (ft)	Total PCB Concentration (µg/kg dw)						
			n	Minimum	Maximum	Mean	Median	95% UCL	
2R / 2R-CAD	1	0 - 2	51	0.10	1100	192	138	95% Chebyshev (Mean, Sd) UCL	320
		2 - 4	46	0.10	5400	338	140	97.5% Chebyshev (Mean, Sd) UCL	1080
		> 4	16	2.0	2300	417	135	95% Approximate Gamma UCL	853
	2 and 3	0 - 2	98	1.9	3800	500	240	95% Chebyshev (Mean, Sd) UCL	823
		2 - 4	84	0.10	3400	511	220	95% Approximate Gamma UCL	662
		> 4	33	1.9	3300	529	237	95% Approximate Gamma UCL	792
	All	0 - 2	149	0.10	3800	395	170	95% Chebyshev (Mean, Sd) UCL	617
		2 - 4	130	0.10	5400	450	170	95% Chebyshev (Mean, Sd) UCL	742
		> 4	49	1.9	3300	492	227	95% Approximate Gamma UCL	688
3C	1	0 - 2	47	0.10	1100	190	137	95% Chebyshev (Mean, Sd) UCL	327
		2 - 4	44	0.10	5400	347	140	97.5% Chebyshev (Mean, Sd) UCL	1121
		> 4	16	2.0	2300	417	135	95% Approximate Gamma UCL	853
	2 and 3	0 - 2	91	1.9	3800	441	230	95% Chebyshev (Mean, Sd) UCL	754
		2 - 4	77	0.10	3400	486	216	95% Approximate Gamma UCL	641
		> 4	28	2.0	3300	593	275	95% Approximate Gamma UCL	914
	All	0 - 2	138	0.10	3800	356	150	95% Chebyshev (Mean, Sd) UCL	571
		2 - 4	121	0.10	5400	436	158	95% Chebyshev (Mean, Sd) UCL	734
		> 4	44	2.0	3300	529	234	95% Approximate Gamma UCL	753
3R	1	0 - 2	47	0.10	1100	190	137	95% Chebyshev (Mean, Sd) UCL	327
		2 - 4	44	0.10	5400	347	140	97.5% Chebyshev (Mean, Sd) UCL	1121
		> 4	16	2.0	2300	417	135	95% Approximate Gamma UCL	853
	2 and 3	0 - 2	78	1.9	3300	366	199	95% Chebyshev (Mean, Sd) UCL	638
		2 - 4	69	0.10	3400	470	200	95% Chebyshev (Mean, Sd) UCL	859
		> 4	22	9.7	3300	653	318	95% Approximate Gamma UCL	1055
	All	0 - 2	125	0.10	3300	300	150	95% Chebyshev (Mean, Sd) UCL	480
		2 - 4	113	0.10	5400	422	150	95% Chebyshev (Mean, Sd) UCL	739
		> 4	38	2.0	3300	553	234	95% Approximate Gamma UCL	811
4C	1	0 - 2	19	0.10	310	91	91	95% Approximate Gamma UCL	169
		2 - 4	17	0.10	920	136	96	99% Chebyshev (Mean, Sd) UCL	650
		> 4	7	10	230	97	103	95% Student's-t UCL	156
	2 and 3	0 - 2	79	13	3800	485	230	95% Chebyshev (Mean, Sd) UCL	845
		2 - 4	70	0.10	3400	494	199	95% Approximate Gamma UCL	668
		> 4	27	2.0	3300	567	260	95% Approximate Gamma UCL	885
	All	0 - 2	98	0.10	3800	409	153	95% Chebyshev (Mean, Sd) UCL	707
		2 - 4	87	0.10	3400	424	150	95% Chebyshev (Mean, Sd) UCL	748
		> 4	34	2.0	3300	470	227	95% Approximate Gamma UCL	708
4R	1	0 - 2	19	0.10	310	91	91	95% Approximate Gamma UCL	169
		2 - 4	17	0.10	920	136	96	99% Chebyshev (Mean, Sd) UCL	650
		> 4	7	10	230	97	103	95% Student's-t UCL	156
	2 and 3	0 - 2	59	16	3300	409	200	95% Chebyshev (Mean, Sd) UCL	759
		2 - 4	56	0.10	3400	481	184	95% Chebyshev (Mean, Sd) UCL	938
		> 4	19	9.7	3300	735	380	95% Approximate Gamma UCL	1212
	All	0 - 2	78	0.10	3300	332	150	95% Chebyshev (Mean, Sd) UCL	605
		2 - 4	73	0.10	3400	401	140	95% Chebyshev (Mean, Sd) UCL	762
		> 4	26	9.7	3300	563	247	95% Approximate Gamma UCL	900

Table M-9a Summary Statistics for Subsurface Total PCB Concentrations Remaining within AOPC 1 and AOPC 2 but Outside of EAAs and the Dredge and Cap Footprints Specific to Each Alternative

Remedial Alternative	Recovery Category	Depth Interval (ft)	Total PCB Concentration (µg/kg dw)						
			n	Minimum	Maximum	Mean	Median	95% UCL	
5C	1	0 - 2	16	0.10	300	80	75	95% Approximate Gamma UCL	166
		2 - 4	14	0.10	900	133	94	99% Chebyshev (Mean, Sd) UCL	750
		> 4	6	10	200	88	81	95% Student's-t UCL	158
	2 and 3	0 - 2	75	13	3300	399	214	95% Chebyshev (Mean, Sd) UCL	677
		2 - 4	66	0.10	3400	451	184	95% Chebyshev (Mean, Sd) UCL	847
		> 4	26	2	3300	623	318	95% Approximate Gamma UCL	987
	All	0 - 2	91	0.10	3300	343	150	95% Chebyshev (Mean, Sd) UCL	579
		2 - 4	80	0.10	3400	395	139	95% Chebyshev (Mean, Sd) UCL	730
		> 4	32	2	3300	523	236	95% Approximate Gamma UCL	806
5R/5R-T	1	0 - 2	16	0.10	300	80	75	95% Approximate Gamma UCL	166
		2 - 4	14	0.10	900	133	94	99% Chebyshev (Mean, Sd) UCL	750
		> 4	6	10	200	88	81	95% Student's-t UCL	158
	2 and 3	0 - 2	47	16	3300	313	150	95% Chebyshev (Mean, Sd) UCL	636
		2 - 4	43	0.10	3300	363	158	97.5% Chebyshev (Mean, Sd) UCL	908
		> 4	14	9.7	3300	585	275	95% Approximate Gamma UCL	1105
	All	0 - 2	63	0.10	3300	253	136	95% Chebyshev (Mean, Sd) UCL	501
		2 - 4	57	0.10	3300	306	136	95% Chebyshev (Mean, Sd) UCL	606
		> 4	20	9.7	3300	436	193	95% Approximate Gamma UCL	768
6C	1	0 - 2	0	-		-	-	-	-
		2 - 4	0	-		-	-	-	-
		> 4	0	-		-	-	-	-
	2 and 3	0 - 2	20	16	1400	352	254	95% Approximate Gamma UCL	558
		2 - 4	15	0.10	2900	573	45	95% Adjusted Gamma UCL	1904
		> 4	6	9.7	3300	973	558	95% Approximate Gamma UCL	3991
	All	0 - 2	20	16	1400	352	254	95% Approximate Gamma UCL	558
		2 - 4	15	0.10	2900	573	45	95% Adjusted Gamma UCL	1904
		> 4	6	9.7	3300	973	558	95% Approximate Gamma UCL	3991
6R	1	0 - 2	0	-	-	-	-	-	-
		2 - 4	0	-	-	-	-	-	-
		> 4	0	-	-	-	-	-	-
	2 and 3	0 - 2	0	-	-	-	-	-	-
		2 - 4	0	-	-	-	-	-	-
		> 4	0	-	-	-	-	-	-
	All	0 - 2	0	-	-	-	-	-	-
		2 - 4	0	-	-	-	-	-	-
		> 4	0	-	-	-	-	-	-

Notes:
1. Recovery Category 1, 2, and 3 designations were assigned to any area of the LDW, regardless of AOPC or RAL status, and based on a specific recovery assessment (see Section 6). Recovery in Category 1 areas is presumed to be limited. Recovery in Category 2 areas is less certain. Category 3 areas are predicted to recover.
2. Summary statistics for the 0- to 2-ft, 2- to 4-ft, and greater than 4-ft intervals are for the vertically averaged total PCB concentrations within each of those intervals at each remaining core station. Summary statistics were calculated with ProUCL 4.1 software; the ProUCL-recommended UCL was used as the UCL95 in all cases, with the exception of the H-Statistic UCL, use of which was avoided (per ProUCL warning) and overridden by a non-parametric 95% Chebyshev (Mean, Sd) UCL.

AOPC = area of potential concern; C = combined; CAD = contained aquatic disposal; dw = dry weight; EAA = early action area; kg = kilograms; LDW = Lower Duwamish Waterway; µg = micrograms; n = number of cores; R = removal; RAL = remedial action level; R-T = removal with treatment; UCL95 = 95 percent upper confidence limit on the mean

Table M-9b Summary Percentiles for Subsurface Total PCB Concentrations Remaining within AOPC 1 and AOPC 2 but Outside of EAAs and the Dredge and Cap Footprints Specific to Each Alternative

Remedial Alternative	Recovery Category	Depth Interval (ft)	Total PCB Concentration (µg/kg dw)										
			n	Percentile									
				5th	10th	20th	25th	50th	75th	80th	90th	95th	99th
2R / 2R-CAD	1	0 - 2	51	7.1	32	62	97	138	250	300	330	470	1055
		2 - 4	46	2.0	10	88	98	140	268	300	626	988	3465
		> 4	16	8.0	10	58	92	135	409	573	1201	1545	2127
	2 and 3	0 - 2	98	17	38	91	130	240	621	696	1256	2177	3314
		2 - 4	84	3.0	8.8	79	108	220	650	738	1141	2368	3317
		> 4	33	6.6	33	130	160	237	640	730	1072	2092	3294
	All	0 - 2	149	11	36	83	109	170	330	482	986	1374	3228
		2 - 4	130	2.0	10	82	101	170	525	642	992	1743	3371
		> 4	49	5.0	10	99	114	227	573	727	1140	1884	3290
3C	1	0 - 2	47	5.9	23	65	97	137	208	284	322	518	1059
		2 - 4	44	3.2	17	90	101	140	263	294	636	997	3551
		> 4	16	8.0	10	58	92	135	409	573	1201	1545	2127
	2 and 3	0 - 2	91	17	36	79	118	230	431	640	980	1553	3347
		2 - 4	77	2.6	8.2	64	100	216	640	728	1132	2010	3324
		> 4	28	13	71	130	158	275	724	757	1149	2587	3295
	All	0 - 2	138	10	35	74	104	150	316	362	762	1136	3245
		2 - 4	121	2.0	10	71	100	158	500	640	990	1550	3380
		> 4	44	9.7	12	99	114	234	660	750	1240	2127	3291
3R	1	0 - 2	47	5.9	23	65	97	137	208	284	322	518	1059
		2 - 4	44	3.2	17	90	101	140	263	294	636	997	3551
		> 4	16	8.0	10	58	92	135	409	573	1201	1545	2127
	2 and 3	0 - 2	78	15	36	77	117	199	344	548	762	1045	3185
		2 - 4	69	2.3	8.3	55	93	200	570	720	1022	2230	3332
		> 4	22	22	93	123	154	318	732	763	1078	3170	3296
	All	0 - 2	125	10	34	69	103	150	300	325	699	1004	2722
		2 - 4	113	2.0	10	66	96	150	320	596	968	1641	3388
		> 4	38	10	16	97	114	234	700	757	1161	2424	3293
4C	1	0 - 2	19	0.050	3.3	10	21	91	122	141	179	265	299
		2 - 4	17	0.050	6.0	14	32	96	114	143	199	392	814
		> 4	7	10	10	20	34	103	132	143	184	209	230
	2 and 3	0 - 2	79	33	39	83	118	230	540	672	1144	1816	3403
		2 - 4	70	2.3	8.0	44	87	199	639	771	1182	2203	3331
		> 4	27	12	63	123	155	260	680	733	1048	2621	3295
	All	0 - 2	98	12	33	59	81	153	323	548	997	1494	3314
		2 - 4	87	2.0	7.9	35	67	150	410	704	1042	1795	3314
		> 4	34	9.9	12	93	106	227	416	672	948	1853	3293
4R	1	0 - 2	19	0.050	3.3	10	21	91	122	141	179	265	299
		2 - 4	17	0.050	6.0	14	32	96	114	143	199	392	814
		> 4	7	10	10	20	34	103	132	143	184	209	230
	2 and 3	0 - 2	59	35	39	94	118	200	431	604	980	1122	3213
		2 - 4	56	2.0	9.0	62	98	184	518	720	1070	2563	3345
		> 4	19	85	93	146	193	380	753	871	1523	3282	3296
	All	0 - 2	78	10	33	53	68	150	303	376	762	1045	3185
		2 - 4	73	1.9	8.4	37	85	140	270	542	968	1861	3328
		> 4	26	10	34	93	106	247	700	736	1054	2731	3295

Table M-9b Summary Percentiles for Subsurface Total PCB Concentrations Remaining within AOPC 1 and AOPC 2 but Outside of EAAs and the Dredge and Cap Footprints Specific to Each Alternative

Remedial Alternative	Recovery Category	Depth Interval (ft)	Total PCB Concentration (µg/kg dw)										
				Percentile									
			n	5th	10th	20th	25th	50th	75th	80th	90th	95th	99th
5C	1	0 - 2	16	0.050	2.1	10	10	75	108	109	147	196	285
		2 - 4	14	0.050	3.0	10	22	94	110	112	146	425	821
		> 4	6	10	10	10	22	81	111	114	174	205	229
	2 and 3	0 - 2	75	33	39	77	113	214	431	636	980	1348	2708
		2 - 4	66	2.2	7.9	41	75	184	508	640	1055	2205	3335
		> 4	26	12	56	116	153	318	732	770	1192	2785	3295
	All	0 - 2	91	11	34	58	75	150	322	470	860	1217	2580
		2 - 4	80	1.9	7.5	33	61	139	304	583	981	1517	3321
		> 4	32	10	11	93	101	236	660	733	1078	2191	3294
5R/5R-T	1	0 - 2	16	0.050	2.1	10	10	75	108	109	147	196	285
		2 - 4	14	0.050	3.0	10	22	94	110	112	146	425	821
		> 4	6	10	10	10	22	81	111	114	174	205	229
	2 and 3	0 - 2	47	34	38	67	105	150	290	319	715	944	2233
		2 - 4	43	2.0	14	88	105	158	280	512	956	1134	2531
		> 4	14	64	93	107	129	275	700	740	990	1860	3012
	All	0 - 2	63	10	32	44	61	136	260	290	606	846	1862
		2 - 4	57	1.5	6.8	59	88	136	260	286	884	1022	2274
		> 4	20	10	10	86	93	193	481	656	801	1195	2879
6C	1	0 - 2	0	-	-	-	-	-	-	-	-	-	-
		2 - 4	0	-	-	-	-	-	-	-	-	-	-
		> 4	0	-	-	-	-	-	-	-	-	-	-
	2 and 3	0 - 2	20	18	36	57	75	254	511	640	744	1052	1302
		2 - 4	15	1.3	1.9	6.6	8.1	45	650	878	2057	2585	2837
		> 4	6	94	178	346	355	558	997	1084	2182	2731	3170
	All	0 - 2	20	18	36	57	75	254	511	640	744	1052	1302
		2 - 4	15	1.3	1.9	6.6	8.1	45	650	878	2057	2585	2837
		> 4	6	94	178	346	355	558	997	1084	2182	2731	3170
6R	1	0 - 2	0	-	-	-	-	-	-	-	-	-	-
		2 - 4	0	-	-	-	-	-	-	-	-	-	-
		> 4	0	-	-	-	-	-	-	-	-	-	-
	2 and 3	0 - 2	0	-	-	-	-	-	-	-	-	-	-
		2 - 4	0	-	-	-	-	-	-	-	-	-	-
		> 4	0	-	-	-	-	-	-	-	-	-	-
	All	0 - 2	0	-	-	-	-	-	-	-	-	-	-
		2 - 4	0	-	-	-	-	-	-	-	-	-	-
		> 4	0	-	-	-	-	-	-	-	-	-	-

Notes:
1. Recovery Category 1, 2, and 3 designations were assigned to any area of the LDW, regardless of AOPC or RAL status, and based on a specific recovery assessment (see Section 6). Recovery in Category 1 areas is presumed to be limited. Recovery in Category 2 areas is less certain. Category 3 areas are predicted to recover.
2. Summary percentiles for the 0- to 2-ft, 2- to 4-ft, and greater than 4-ft intervals are for the vertically averaged total PCB concentrations within each of those intervals at each remaining core station. Summary statistics were calculated with ProUCL 4.1 software.

AOPC = area of potential concern; C = combined; CAD = contained aquatic disposal; dw = dry weight; EAA = early action area; kg = kilograms; LDW = Lower Duwamish Waterway; µg = micrograms; n = number of cores; R = removal; RAL = remedial action level; R-T = removal with treatment

Table M-9c Summary Descriptive Statistics for Subsurface Total PCB Concentrations Remaining within Cap and Partial Dredge and Cap Footprints

Remedial Alternative	Depth Interval (ft)	Total PCB Concentration (µg/kg dw)													
		n	5th Percentile	10th Percentile	20th Percentile	25th Percentile	Median	Mean	75th Percentile	80th Percentile	90th Percentile	95th Percentile	99th Percentile	95% UCL	
2R / 2R-CAD	0 - 4	0	-	-	-	-	-	-	-	-	-	-	-	-	-
	> 4	0	-	-	-	-	-	-	-	-	-	-	-	-	-
3C	0 - 4	16	140	170	210	229	335	770	788	1020	1265	2317	4399	95% Chebyshev (Mean, Sd) UCL	830
	> 4	14	144	244	301	310	1359	629	1885	2203	3552	4467	5161	95% Approximate Gamma UCL	1444
3R	0 - 4	1	-	-	-	-	240	-	-	-	-	-	-	-	-
	> 4	1	-	-	-	-	2	-	-	-	-	-	-	-	-
4C	0 - 4	29	21	57	93	105	235	582	525	662	1154	2212	4304	95% Chebyshev (Mean, Sd) UCL	640
	> 4	24	127	142	201	279	1050	549	1213	1725	2437	3776	5028	95% Approximate Gamma UCL	1130
4R	0 - 4	1	-	-	-	-	240	-	-	-	-	-	-	-	-
	> 4	1	-	-	-	-	2	-	-	-	-	-	-	-	-
5C	0 - 4	31	21	66	95	135	315	610	670	795	1080	2085	4260	95% Chebyshev (Mean, Sd) UCL	665
	> 4	25	128	143	175	221	980	330	1010	1634	2413	3701	5014	95% Approximate Gamma UCL	1063
5R/5R-T	0 - 4	1	-	-	-	-	240	-	-	-	-	-	-	-	-
	> 4	1	-	-	-	-	2	-	-	-	-	-	-	-	-
6C	0 - 4	56	21	21	74	88	168	426	412	525	883	1505	3710	95% Chebyshev (Mean, Sd) UCL	479
	> 4	43	2	32	114	139	727	300	629	897	2127	3221	4774	95% Chebyshev (Mean, Sd) UCL	809
6R	0 - 4	4	41	46	57	63	80	109	127	149	195	217	235	95% Chebyshev (Mean, Sd) UCL	122
	> 4	2	7	12	22	27	52	52	78	83	93	98	102	95% Student's-t UCL	72

Note:

1. The PCB statistical concentrations for capped and partially dredged/capped areas in the 0- to 4-ft interval is the vertical average of the combination of clean capping material (0 to 2 ft) [with an assumed total PCB concentration of 40 µg/kg dw], and the native sediment (0 to 2 ft in areas to be capped, and 2 to 4 ft in areas to be partially dredged/capped [with the total PCB concentration from those intervals in the subsurface FS baseline dataset]. However, a sediment cap is designed to be 3 ft thick. Summary statistics were calculated with ProUCL 4.1 software.

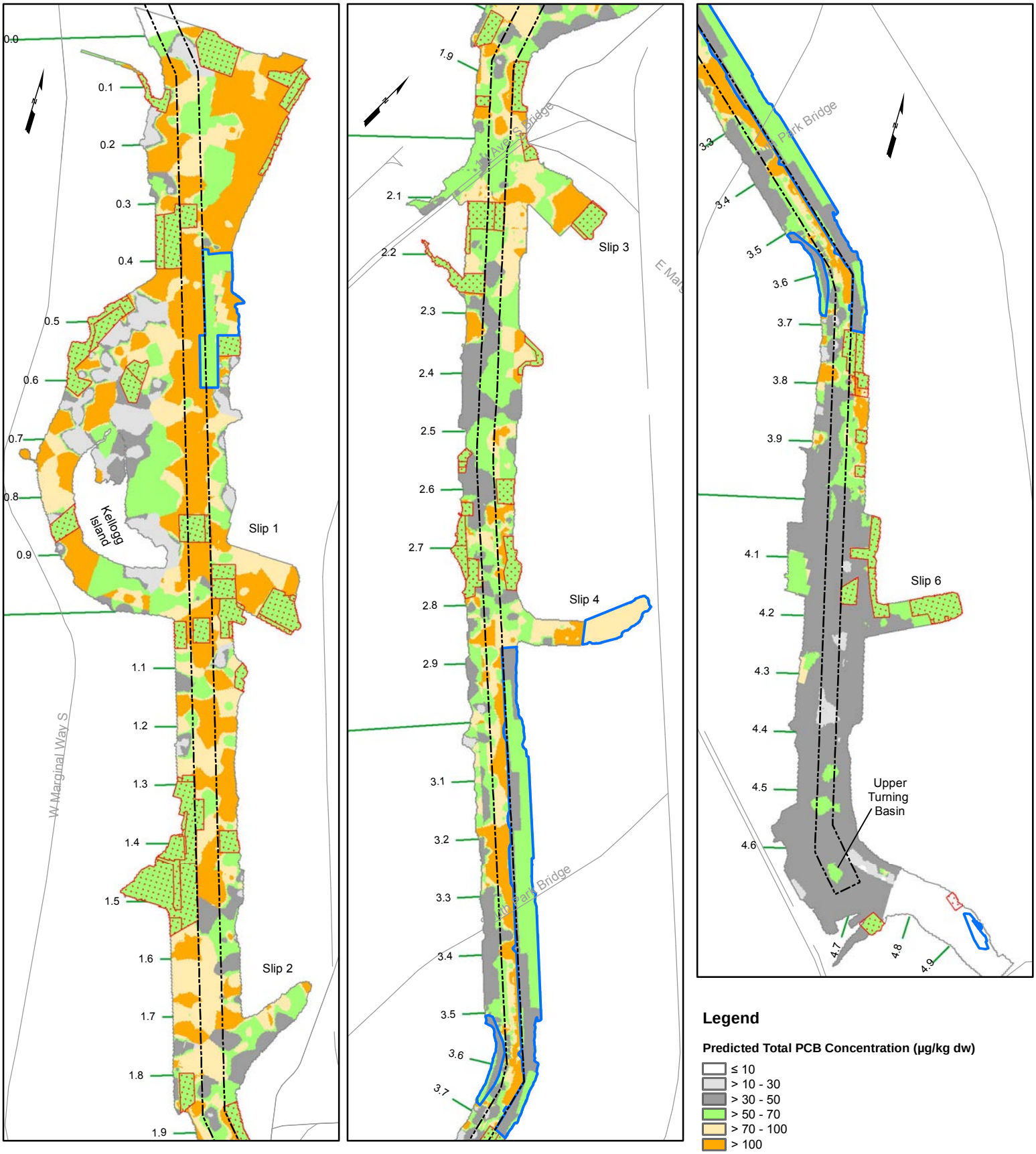
Table M-9d Summary Descriptive Statistics for Subsurface Total PCB Concentrations Outside of AOPCs 1 and 2 (Rest of LDW)

Rest of LDW	Depth Interval (ft)	Total PCB Concentration (µg/kg dw)													
		n	5th Percentile	10th Percentile	20th Percentile	25th Percentile	Median	Mean	75th Percentile	80th Percentile	90th Percentile	95th Percentile	99th Percentile	95% UCL	
	0 - 4	52	13	16	28	33	47	68	75	79	139	152	390	95% Chebyshev (Mean, Sd) UCL	120
	> 4	23	11	15	29	32	48	48	64	68	82	86	102	95% Student's-t UCL	58

Notes:

1. The area that comprises the rest of the LDW (outside of AOPCs 1 and 2) is approximately 110 acres and includes site-wide monitoring and natural recovery.
2. Summary statistics for the 0- to 4-ft, and greater than 4-ft intervals are for the vertically averaged total PCB concentrations within each of those intervals at each remaining core station. Summary statistics were calculated with ProUCL 4.1 software.

AOPC = area of potential concern; C = combined; CAD = contained aquatic disposal; dw = dry weight; EAA = early action area; FS = feasibility study; kg = kilograms; LDW = Lower Duwamish Waterway; µg = micrograms; n = number of cores; R = removal; R-T = removal with treatment; UCL95 = 95 percent upper confidence limit on the mean



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 3C Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

Notes:
1. STM GIS shapefile from 5-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 60 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

0 200 400 800 Feet

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Lower Duwamish Waterway Final Feasibility Study 60150279-8.4		**Predicted Total PCB Distribution in Surface Sediment, Alternative 3C Year 5, BRV = mid**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0
		FIGURE M-1

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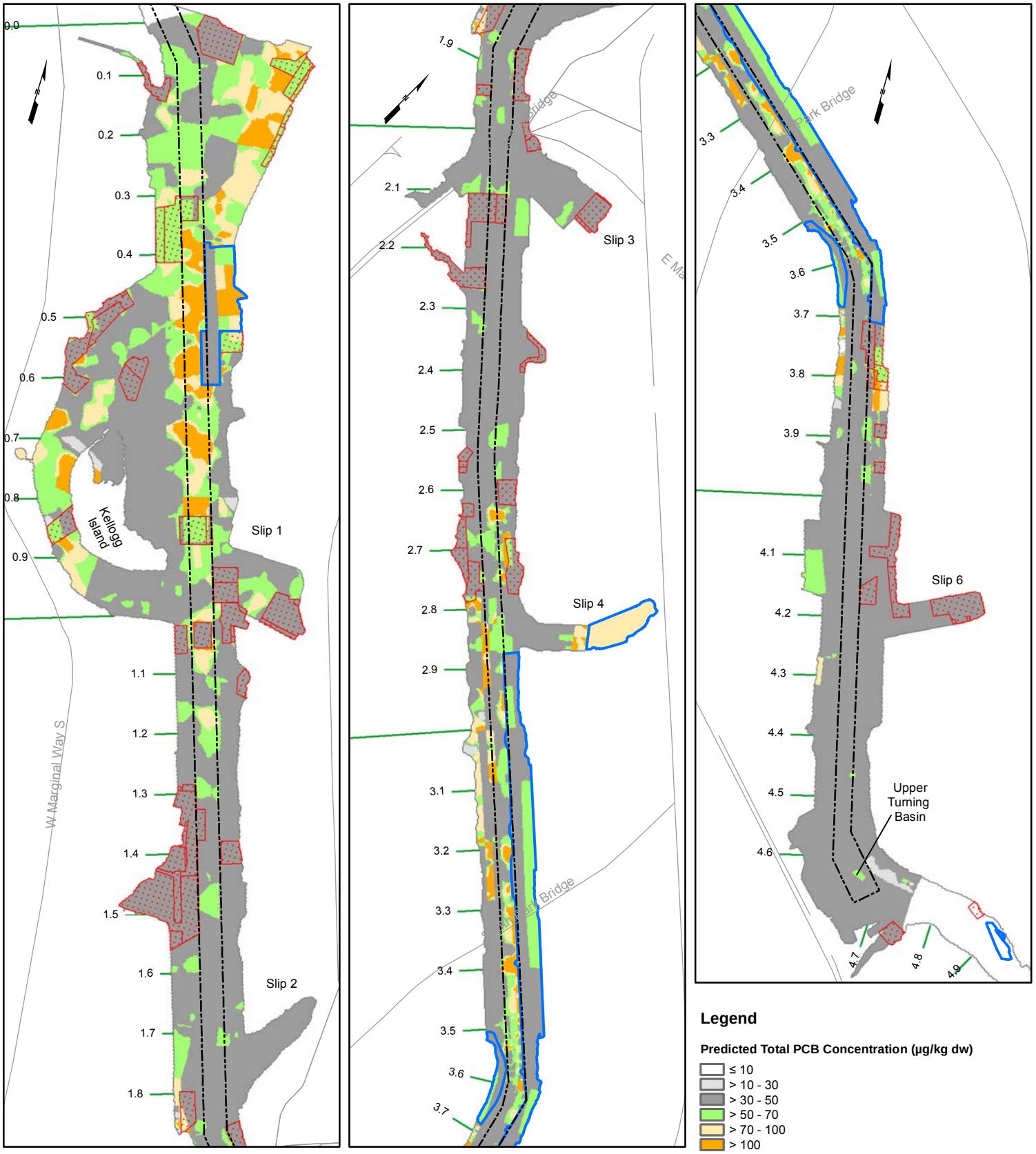

Notes:
1. STM GIS shapefile from 15-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 60 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

Feet
0 200 400 800

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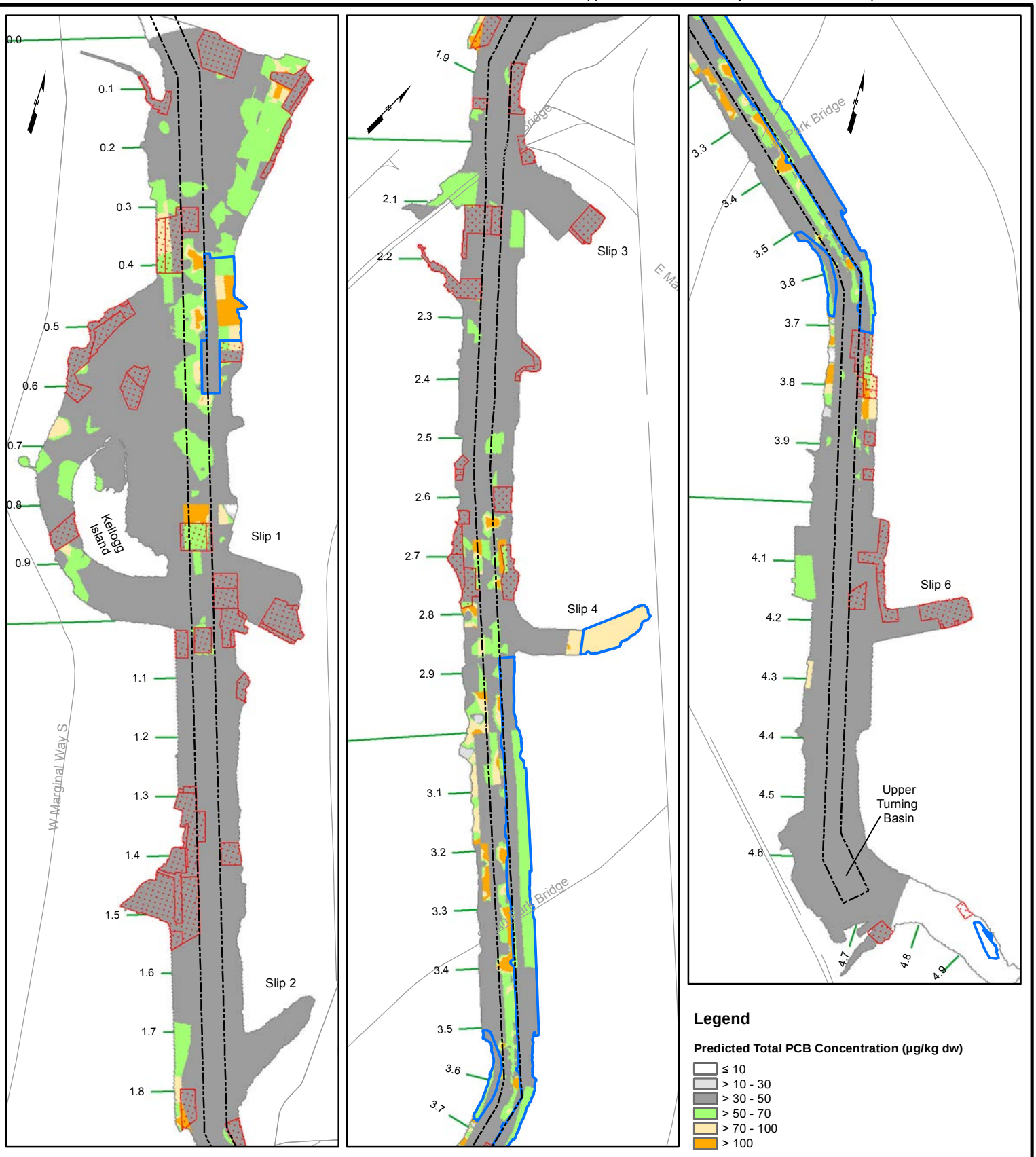
Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 3C Year 15, BRV = mid**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-2**

M1-54

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-2_Y5PCB_3C_BRVM.mxd



Notes:
1. STM GIS shapefile from 25-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 60 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

0 200 400 800 Feet

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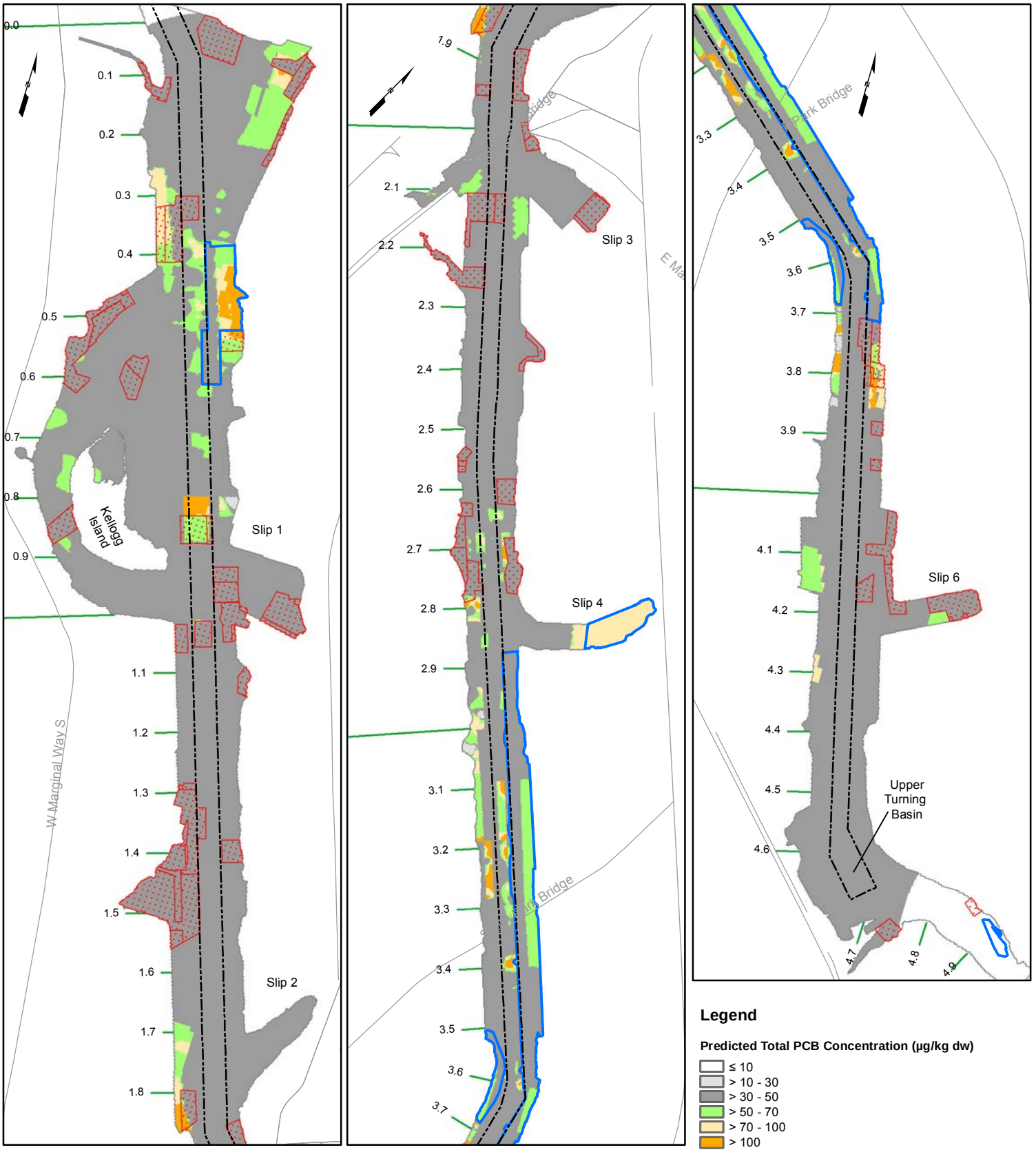
Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 3C Year 25, BRV = mid**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-3**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-3_Y25PCB_3C_BRVM.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 3C Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

Notes:
1. STM GIS shapefile from 35-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 60 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

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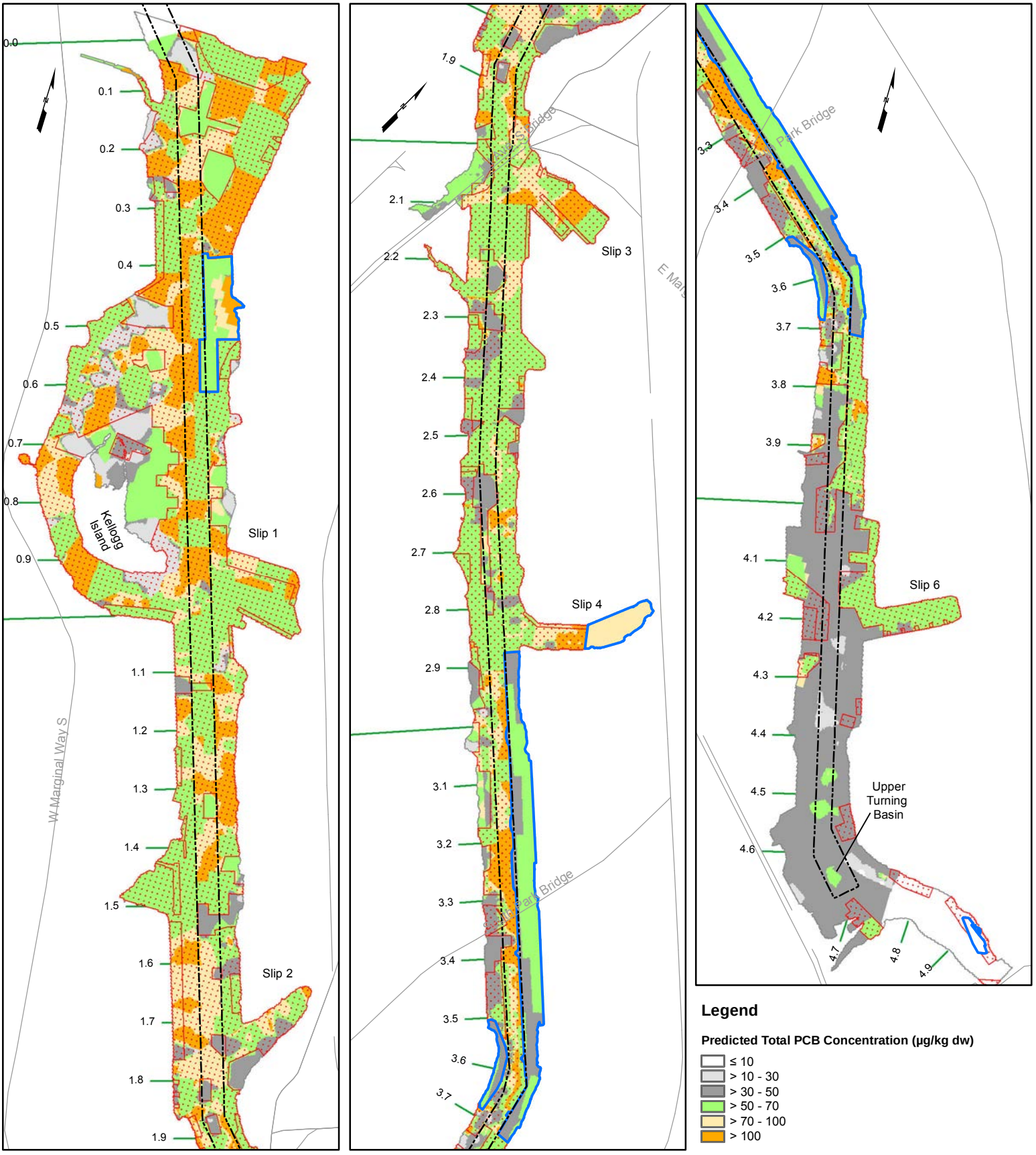
0 200 400 800 Feet

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4		**Predicted Total PCB Distribution in Surface Sediment, Alternative 3C Year 35, BRV = mid**
DATE: 10/31/12	DWRN:MVI/sea Revision: 0	**FIGURE M-4**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-4_Y35PCB_3C_BRVM.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 6C Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

Notes:
1. STM GIS shapefile from 5-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = (AOPC 1=60 µg/kg dw, AOPC 2=20 µg/kg dw)
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

0 200 400 800 Feet

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Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 6C Year 5, BRV = mid**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-5**

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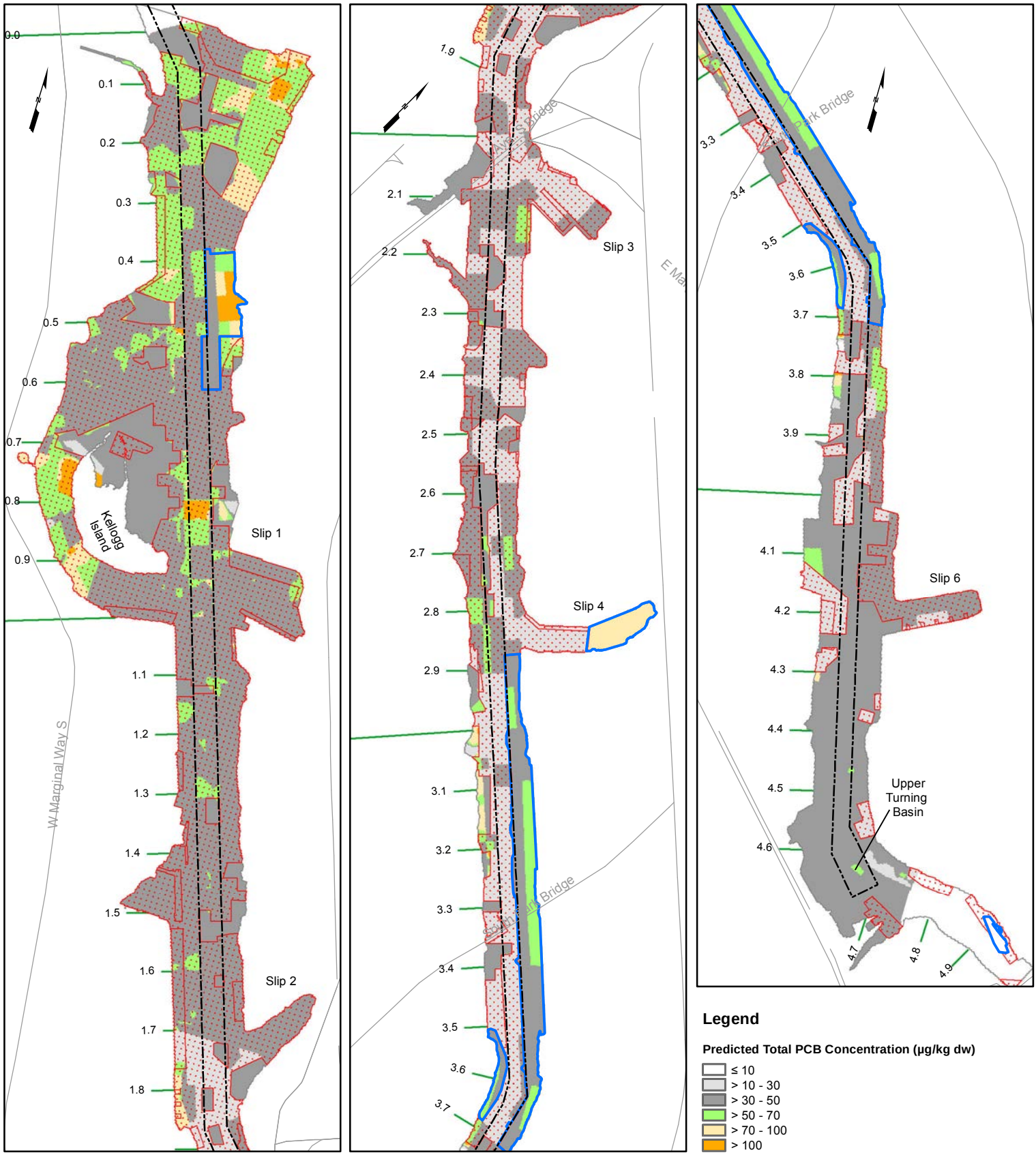

Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

Active Alternative 6C Footprint from Draft Final FS
Early Action Area
Road
Navigation Channel
River Mile Marker

Notes:
1. STM GIS shapefile from 15-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = (AOPC 1=60 µg/kg dw, AOPC 2=20 µg/kg dw)
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

0 200 400 800 Feet

AECOM

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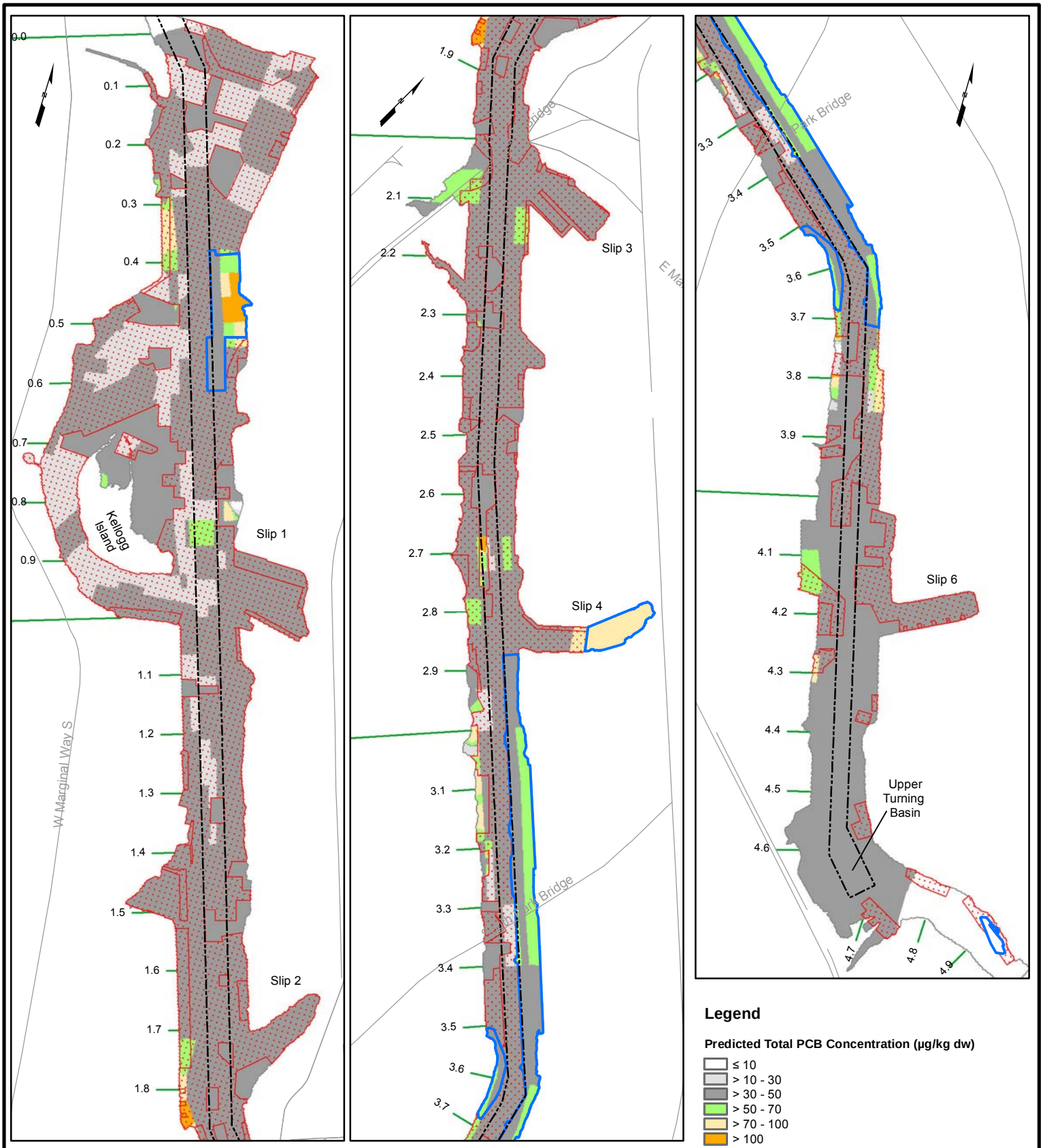
Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 6C Year 15, BRV = mid**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-6**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix MM-6_Y15PCB_6C_BRVM.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 6C Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

Notes:
1. STM GIS shapefile from 25-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = (AOPC 1=60 µg/kg dw, AOPC 2=20 µg/kg dw)
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

Feet
0 200 400 800

AECOM

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Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 6C Year 25, BRV = mid**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-7**

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Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

Active Alternative 6C Footprint from Draft Final FS
Early Action Area
Road
Navigation Channel
River Mile Marker

Notes:
1. STM GIS shapefile from 35-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = (AOPC 1=60 µg/kg dw, AOPC 2=20 µg/kg dw)
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

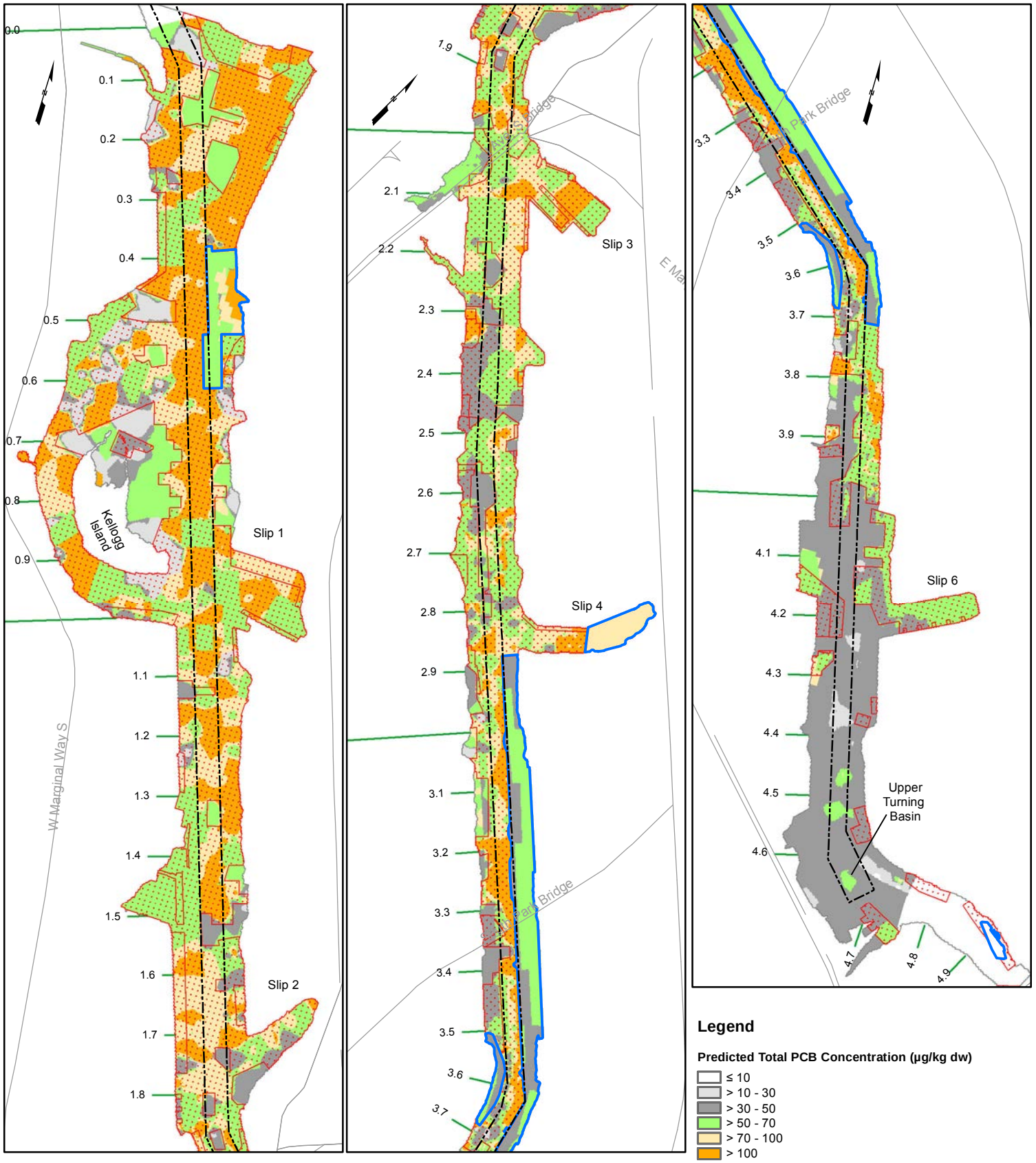
0 200 400 800 Feet

AECOM

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 6C Year 35, BRV = mid**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-8**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix MM-a_Y35PCB_6C_BRVM.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 6R Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

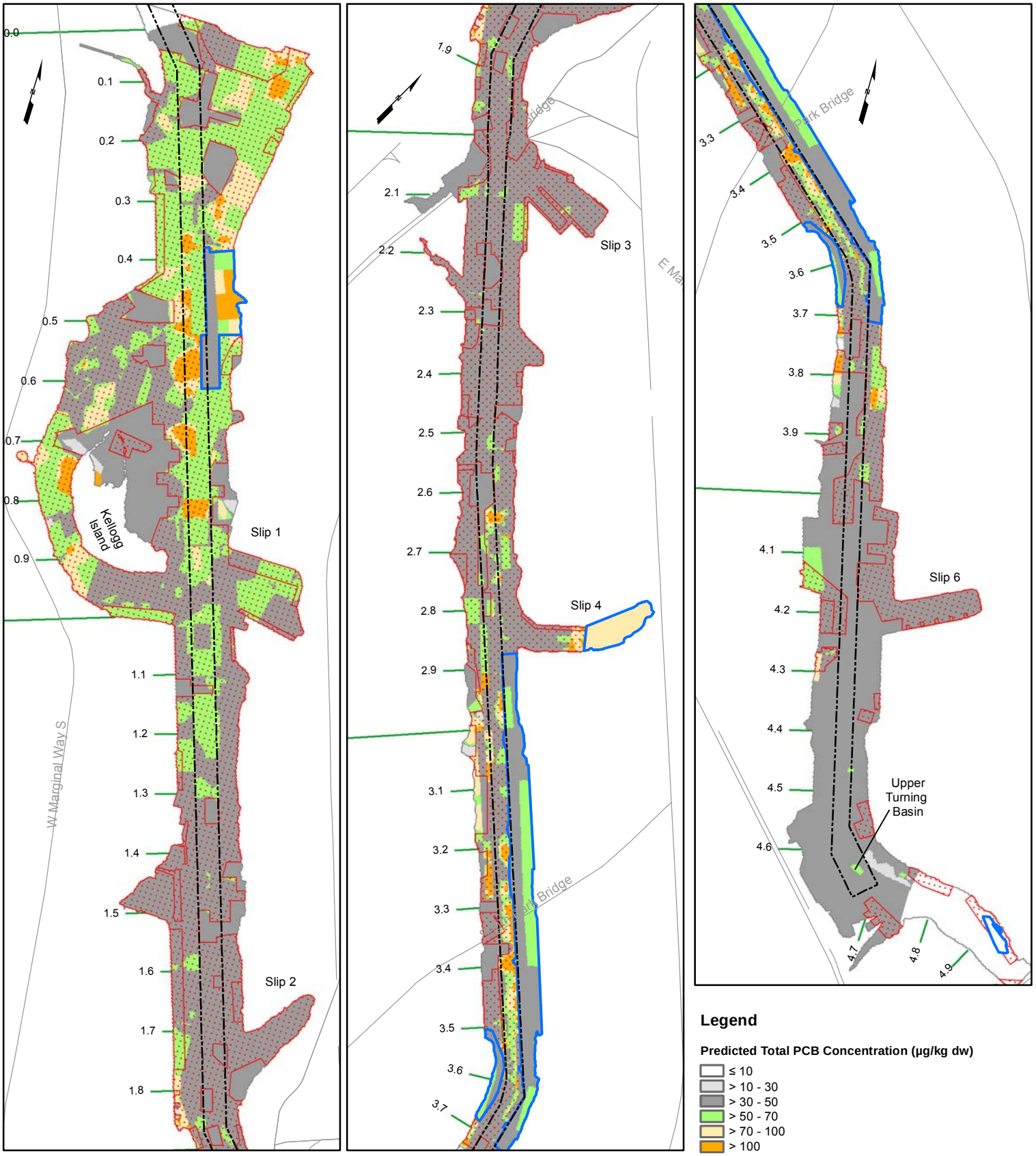
Notes:
1. STM GIS shapefile from 5-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = (AOPC 1=60 µg/kg dw, AOPC 2=20 µg/kg dw)
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

0 200 400 800 Feet

AECOM Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 6R Year 5, BRV = mid**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-9**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-9_YSPCB_6R_BRVM.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 6R Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

Notes:
1. STM GIS shapefile from 15-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = (AOPC 1=60 µg/kg dw, AOPC 2=20 µg/kg dw)
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

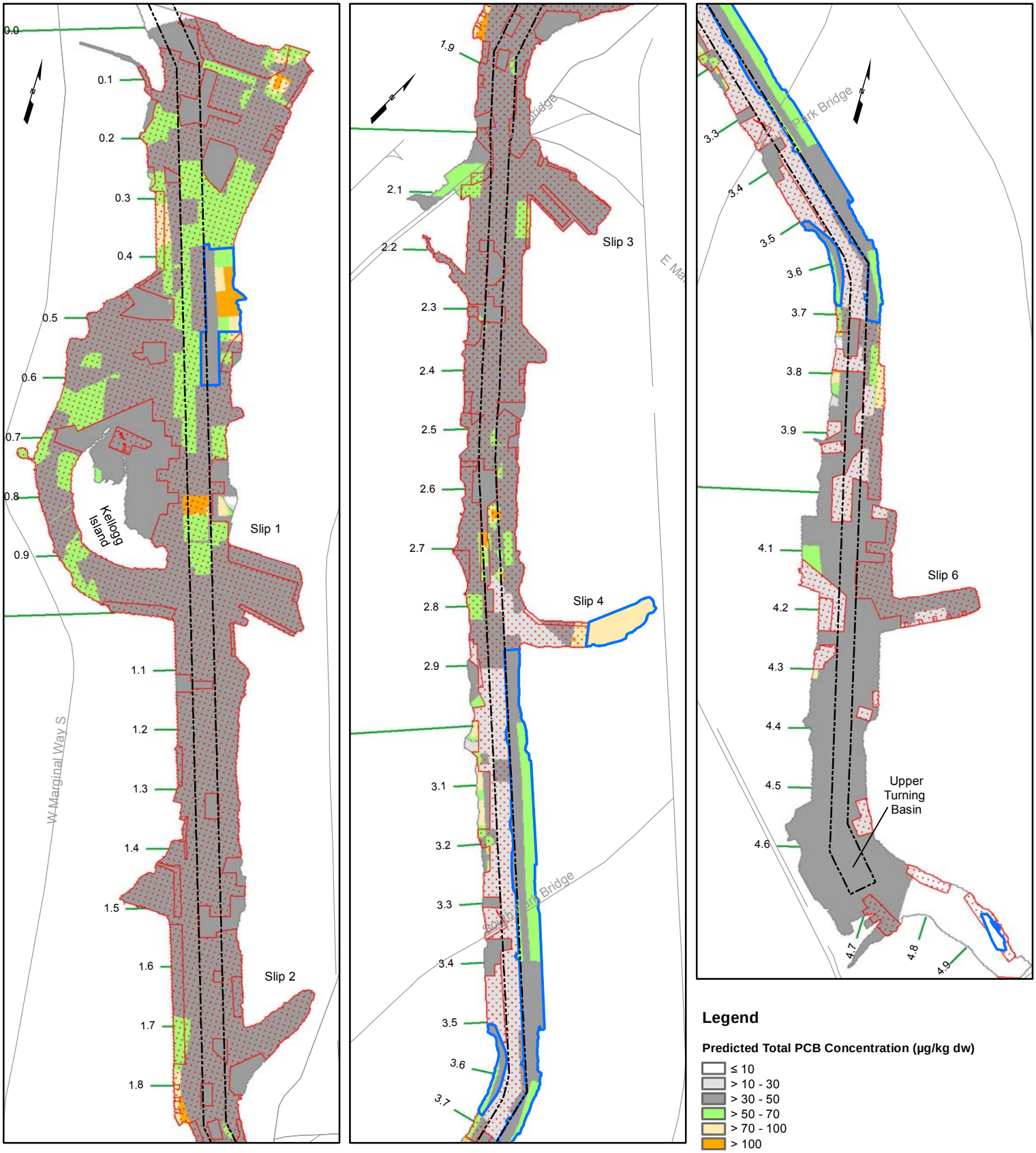
0 200 400 800 Feet

AECOM

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4		**Predicted Total PCB Distribution in Surface Sediment, Alternative 6R Year 15, BRV = mid**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0
		FIGURE M-10

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-10_Y15PCB_6R_BRVM.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 6R Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

Notes:
1. STM GIS shapefile from 25-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = (AOPC 1=60 µg/kg dw, AOPC 2=20 µg/kg dw)
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

M1-63

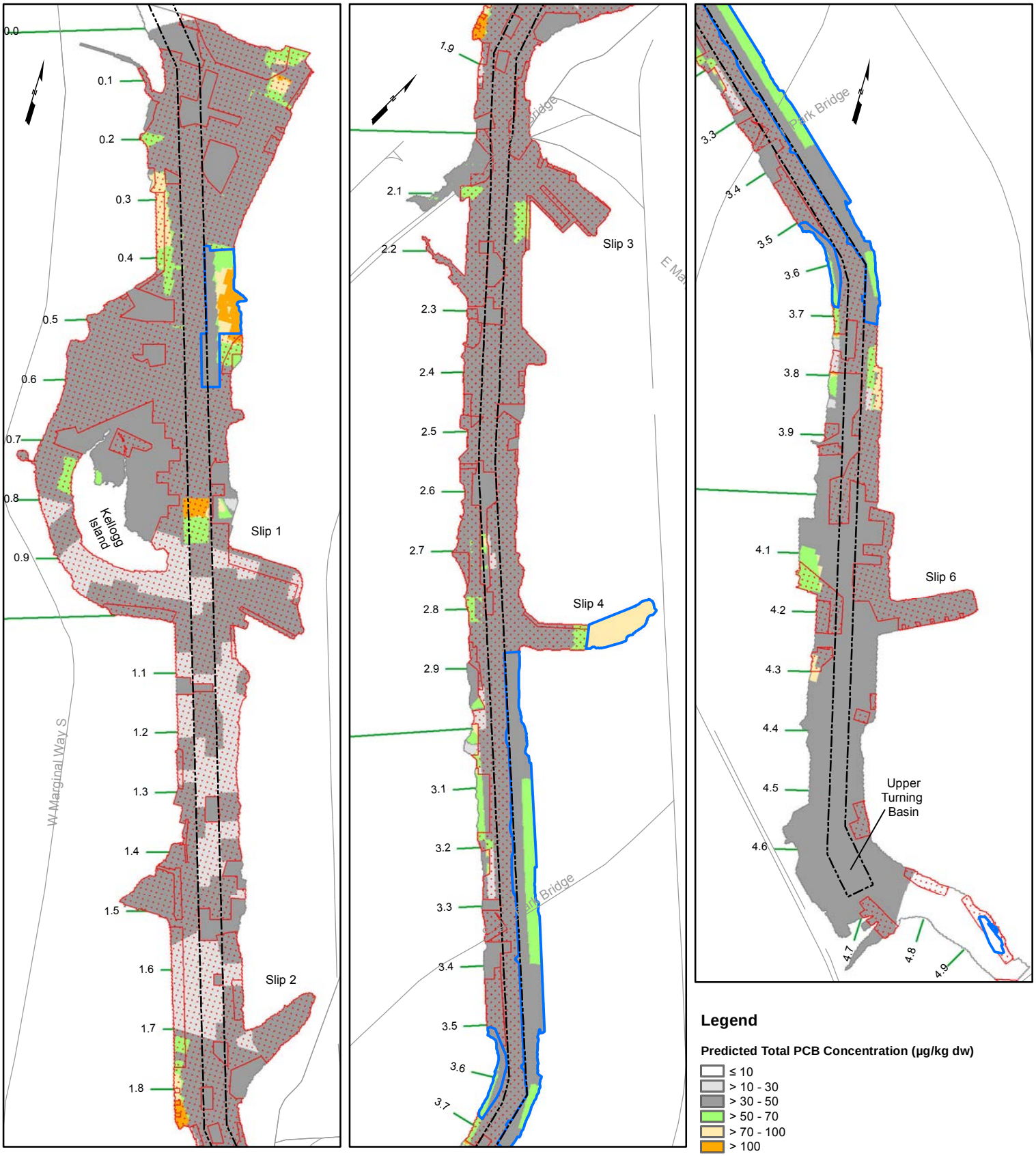
0 200 400 800 Feet

AECOM

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 6R Year 25, BRV = mid**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-11**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-11_Y25PCB_6R_BRV.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

Active Alternative 6R Footprint from Draft Final FS
Early Action Area
Road
Navigation Channel
River Mile Marker

Notes:
1. STM GIS shapefile from 35-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = (AOPC 1=60 µg/kg dw, AOPC 2=20 µg/kg dw)
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

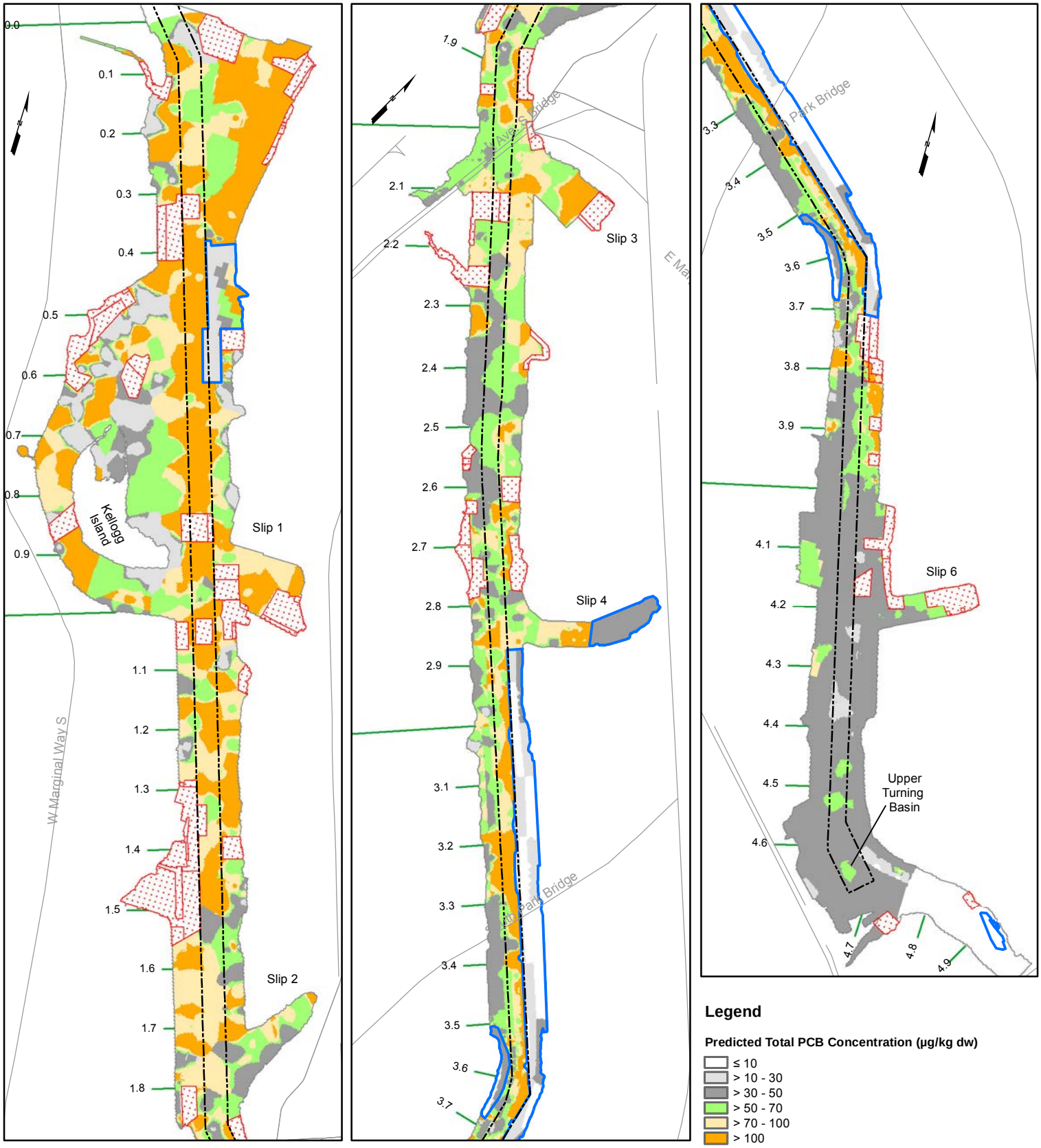
0 200 400 800 Feet

AECOM

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 6R Year 35, BRV = mid**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-12**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-12_Y35PCB_6R_BRV.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 3C Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

Notes:
1. STM GIS shapefile from 5-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 0 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

0 200 400 800 Feet

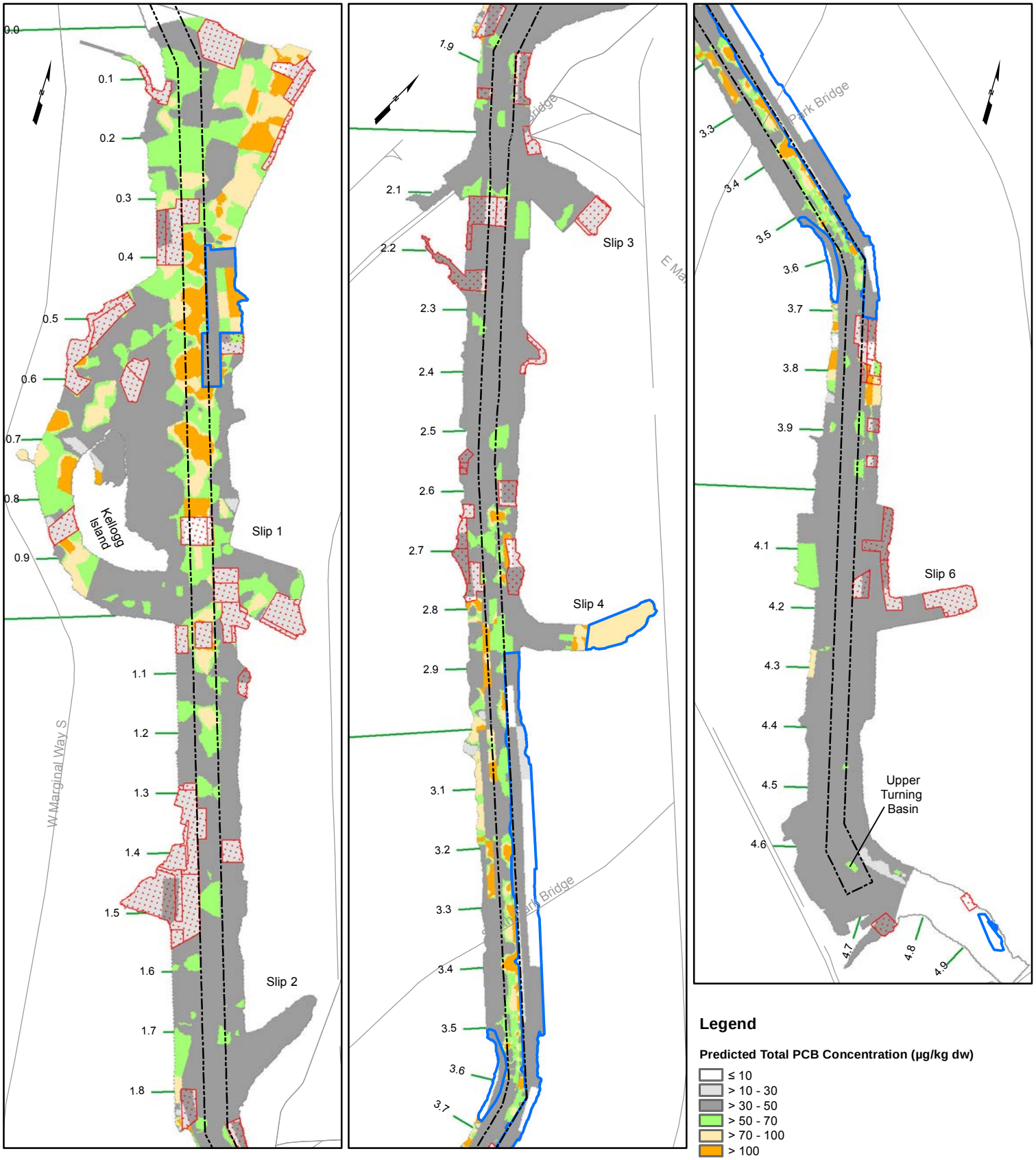
M1-65

AECOM

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 3C Year 5, BRV = 0**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-13**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-13_Y5PCB_3C_BRV0.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 3C Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

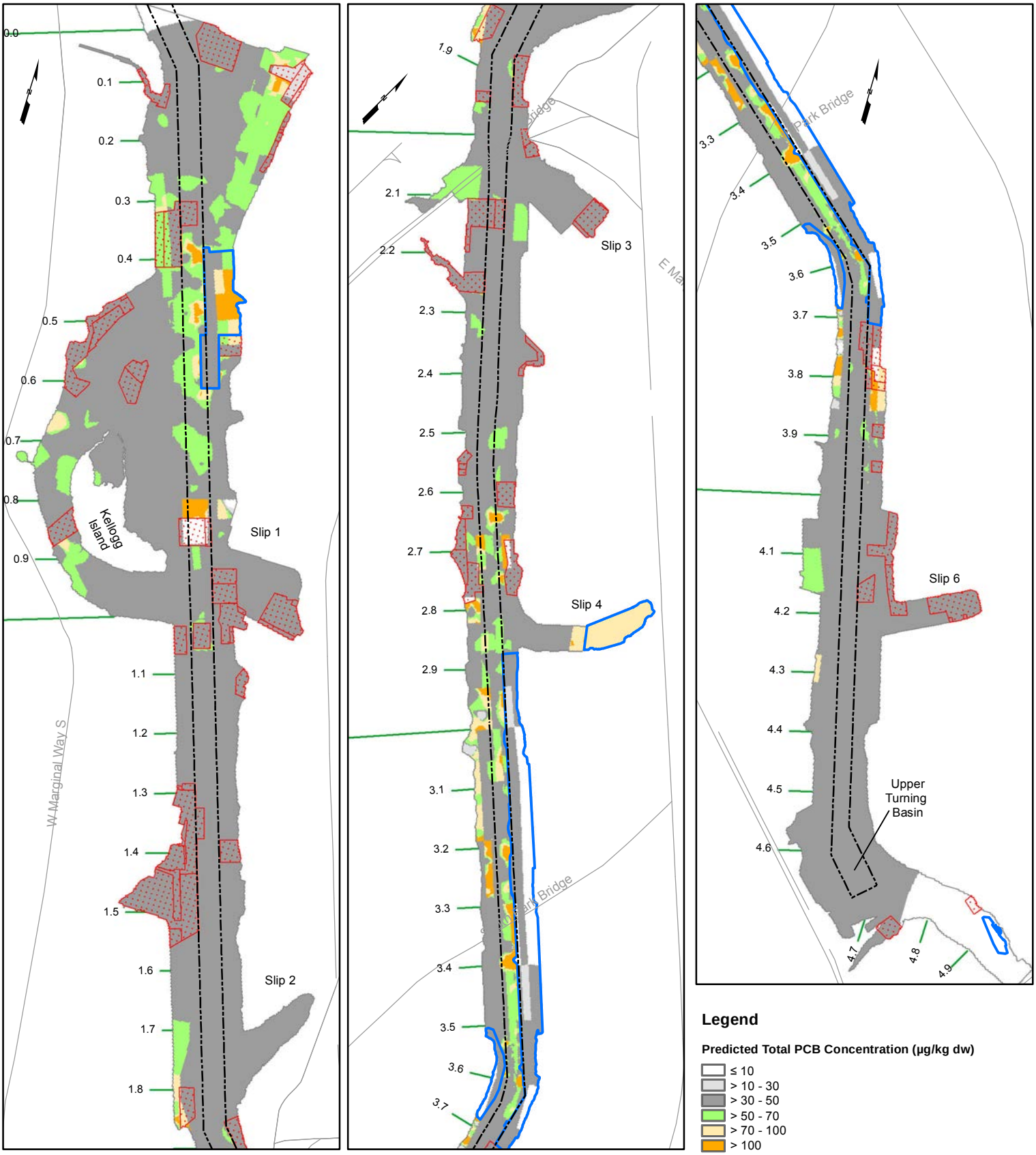
Notes:
1. STM GIS shapefile from 15-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 0 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

0 200 400 800 Feet

AECOM Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 3C Year 15, BRV = 0**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-14**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-14_YSPCB_3C_BRVM.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 3C Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

Notes:
1. STM GIS shapefile from 25-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 0 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

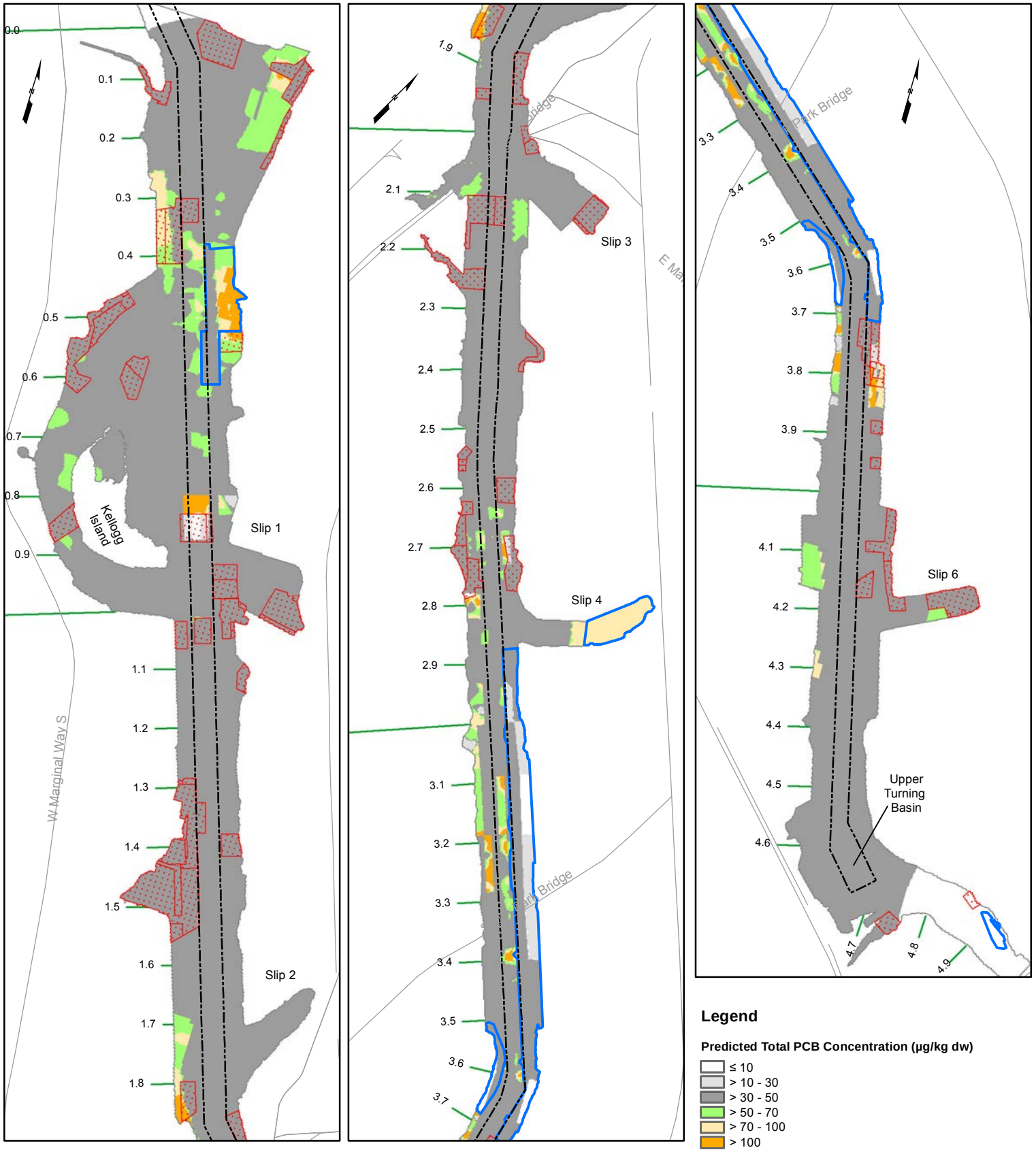
0 200 400 800 Feet

AECOM Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

M1-67

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4		**Predicted Total PCB Distribution in Surface Sediment, Alternative 3C Year 25, BRV = 0**
DATE: 10/31/12	DWRN:MVI/sea Revision: 0	**FIGURE M-15**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-15_Y25PCB_3C_BRV0.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 3C Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

Notes:
1. STM GIS shapefile from 35-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 0 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

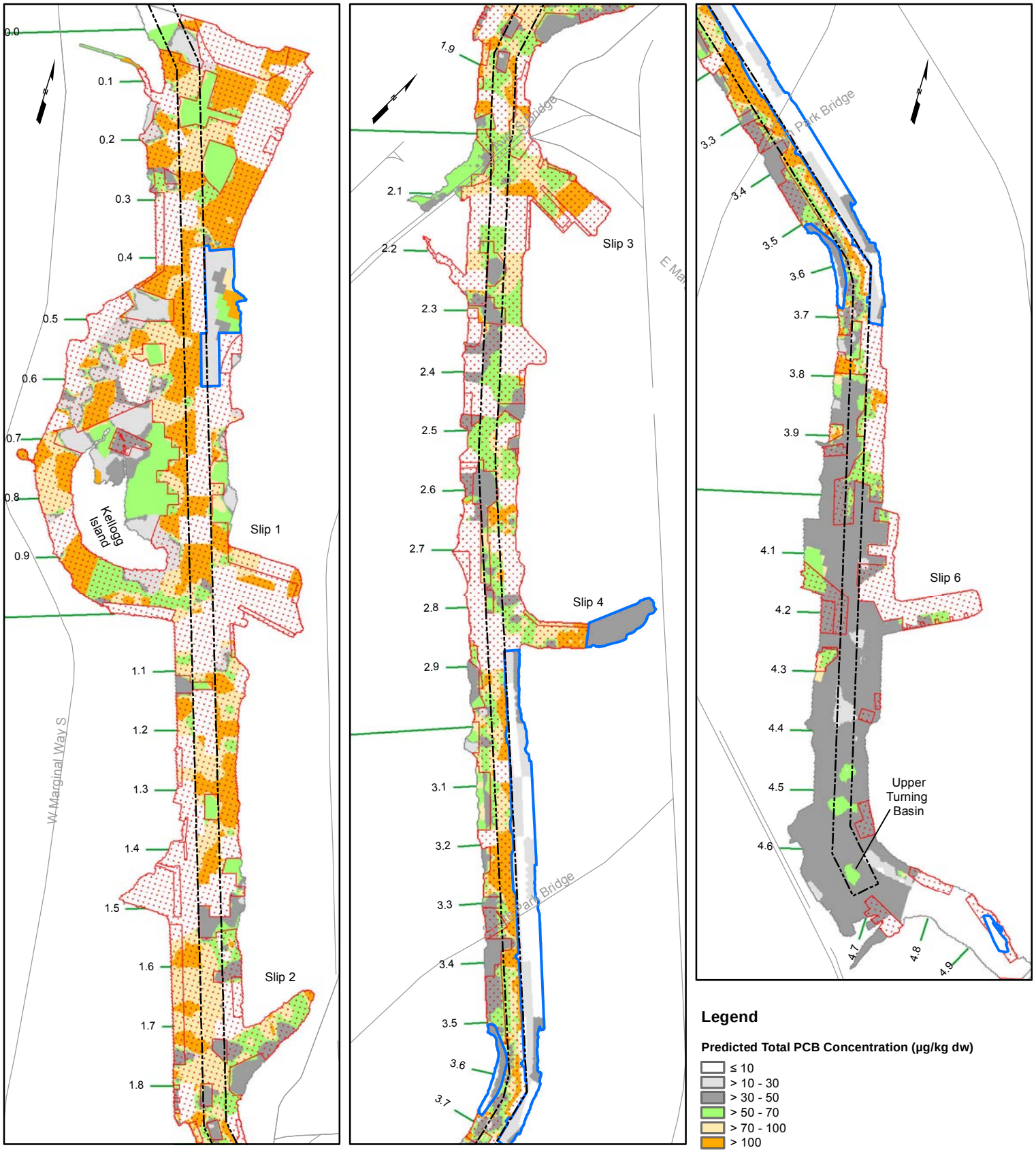
0 200 400 800 Feet

AECOM

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4		**Predicted Total PCB Distribution in Surface Sediment, Alternative 3C Year 35, BRV = 0**
DATE: 10/31/12	DWRN:MVI/sea Revision: 0	**FIGURE M-16**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-16_Y35PCB_3C_BRV0.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

Active Alternative 6C Footprint from Draft Final FS

Early Action Area

Road

Navigation Channel

River Mile Marker

Notes:
1. STM GIS shapefile from 5-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 0 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

0 200 400 800 Feet

AECOM

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 6C Year 5, BRV = 0**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-17**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-17_Y5PCB_6C_BRV0.mxd

Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 6C Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

Notes:
1. STM GIS shapefile from 15-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 0 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

0 200 400 800 Feet

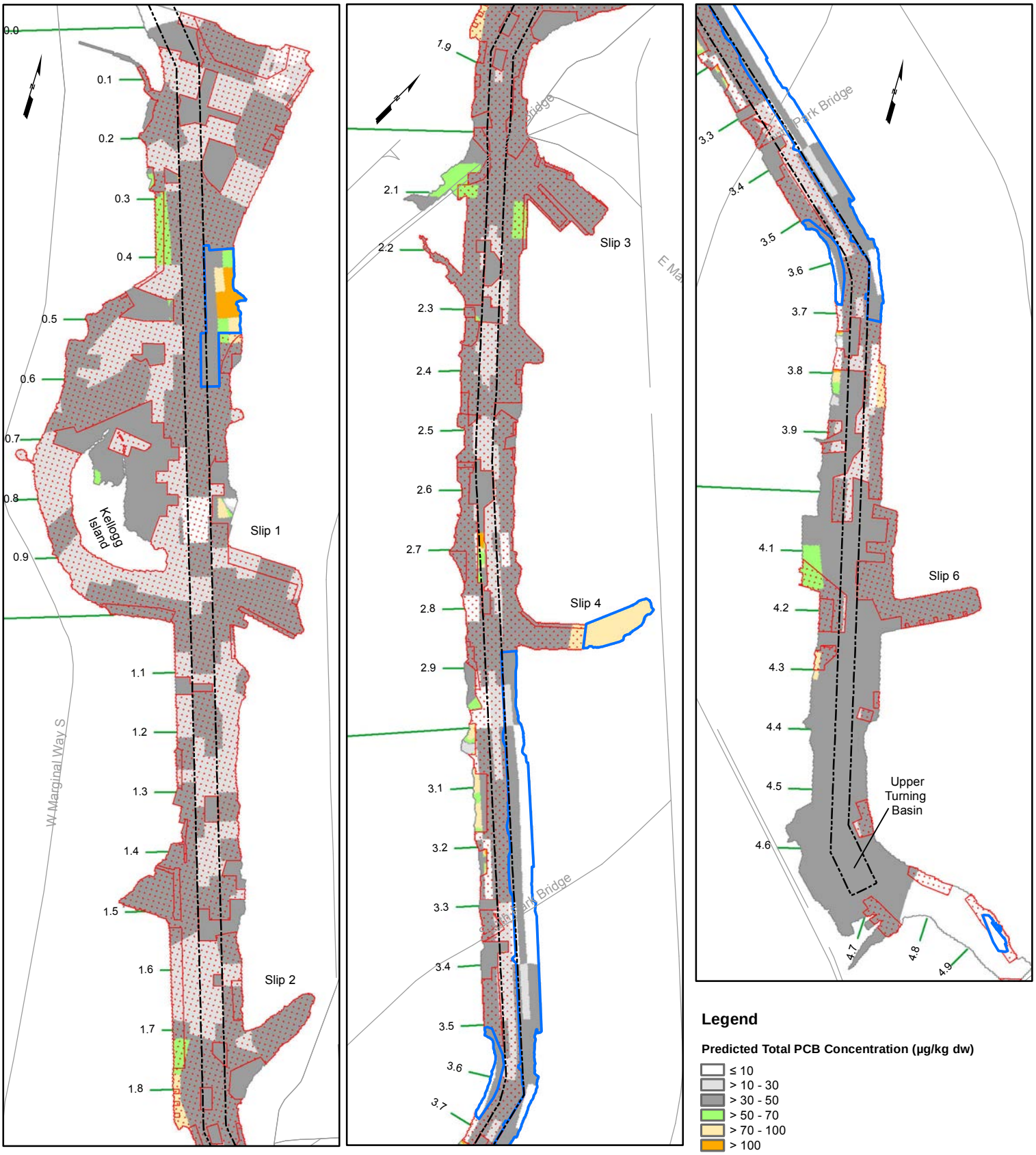
AECOM

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

M1-70

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 6C Year 15, BRV = 0**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-18**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix MM-18_YSPCB_3C_BRV.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

Active Alternative 6C Footprint from Draft Final FS
Early Action Area
Road
Navigation Channel
River Mile Marker

Notes:
1. STM GIS shapefile from 25-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 0 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

M1-71

0 200 400 800 Feet

AECOM

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 6C Year 25, BRV = 0**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-19**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-19_Y25PCB_6C_BRV0.mxd

Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 6C Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

Notes:
1. STM GIS shapefile from 35-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 0 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

0 200 400 800 Feet

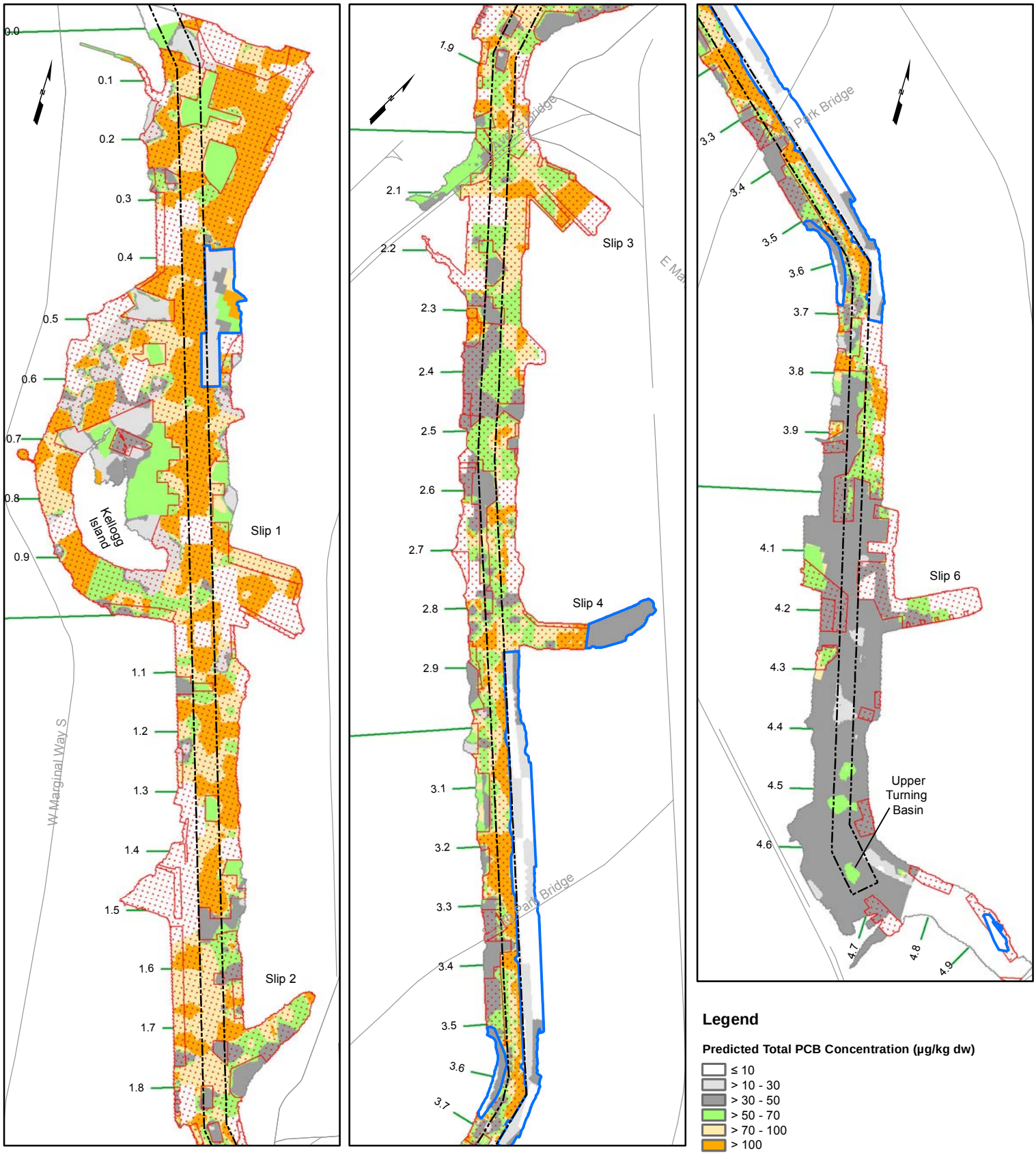
AECOM

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

M1-72

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4		**Predicted Total PCB Distribution in Surface Sediment, Alternative 6C Year 35, BRV = 0**
DATE: 10/31/12	DWRN:MVI/sea Revision: 0	**FIGURE M-20**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-20_Y35PCB_6C_BRV0.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 6R Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

Notes:
1. STM GIS shapefile from 5-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 0 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

0 200 400 800 Feet

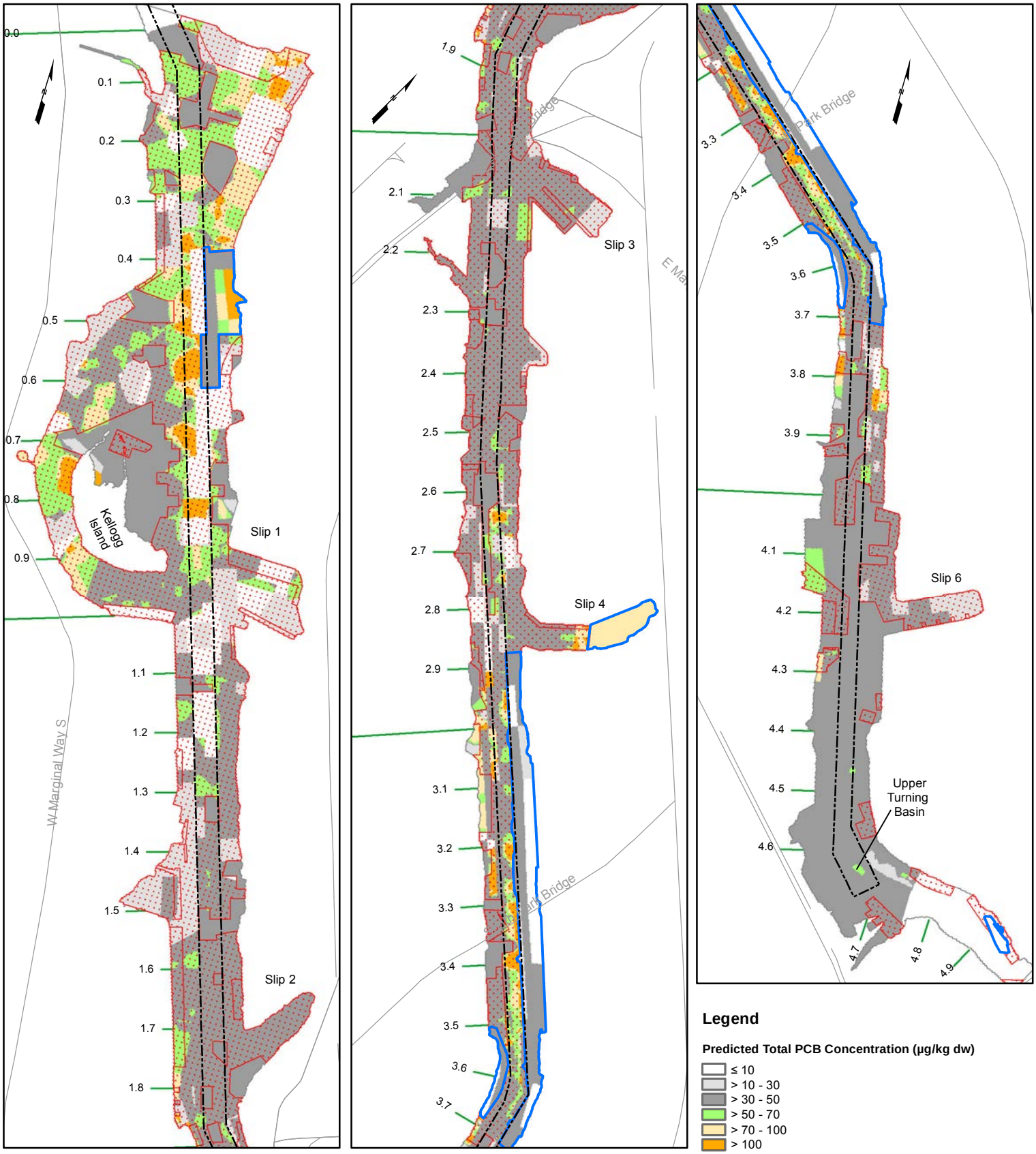
M1-73

AECOM

Lower Duwamish Waterway Group

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 6R Year 5, BRV = 0**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-21**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-21_YSPCB_6R_BRV0.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

Active Alternative 6R Footprint from Draft Final FS
Early Action Area
Road
Navigation Channel
River Mile Marker

Notes:
1. STM GIS shapefile from 15-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 0 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

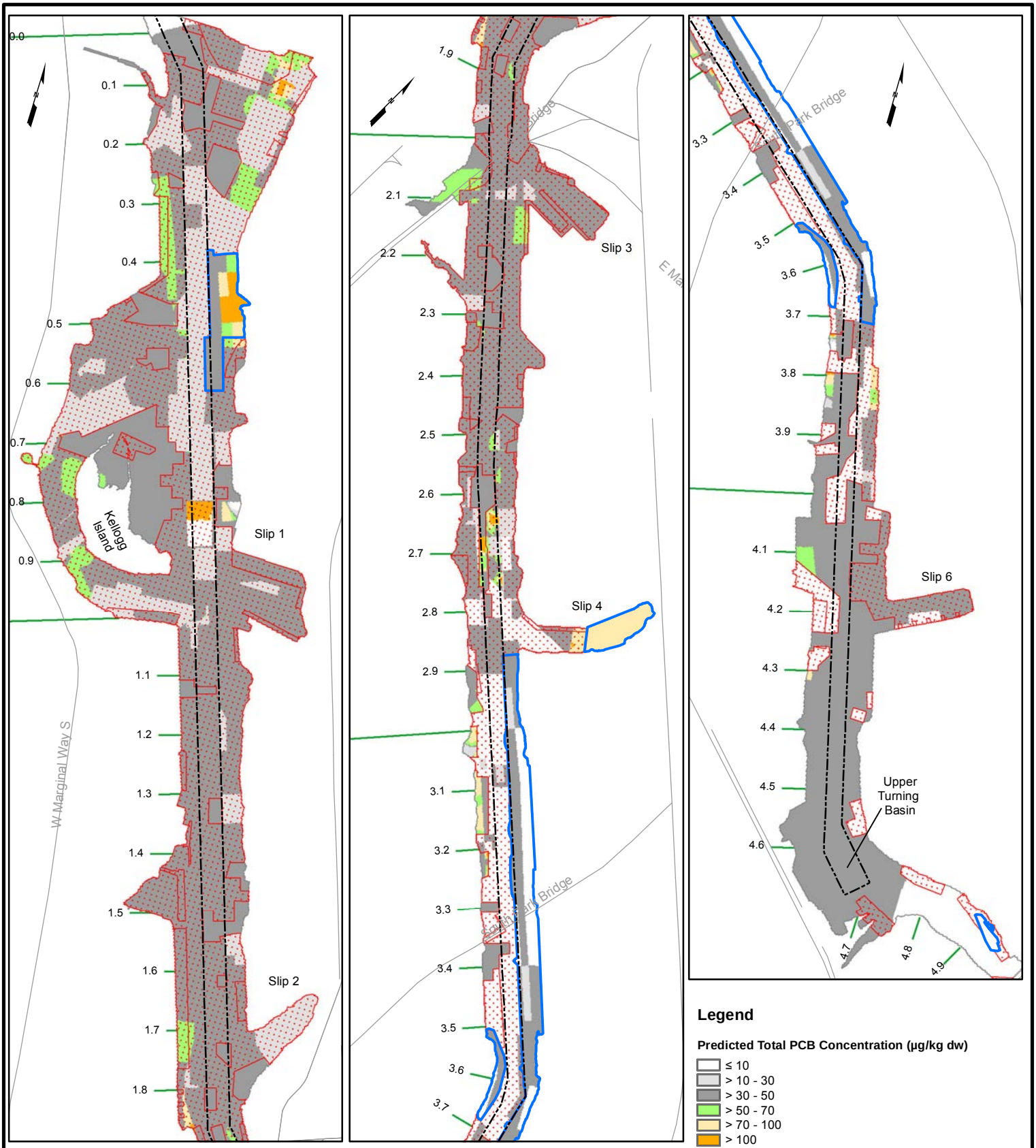
0 200 400 800 Feet

AECOM

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 6R Year 15, BRV = 0**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-22**

L:\Lower Duwamish FS\FS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-22_Y15PCB_6R_BRV0.mxd



Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 6R Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

Notes:
1. STM GIS shapefile from 25-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 0 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

0 200 400 800 Feet

AECOM

Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 6R Year 25, BRV = 0**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-23**

L:\Lower Duwamish F\SFS_Final_GIS\Oct2012\FS_GIS_MXDs_Oct12\Appendix M\M-23_Y25PCB_6R_BRV0.mxd

Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 10
- > 10 - 30
- > 30 - 50
- > 50 - 70
- > 70 - 100
- > 100

- Active Alternative 6R Footprint from Draft Final FS
- Early Action Area
- Road
- Navigation Channel
- River Mile Marker

Notes:
1. STM GIS shapefile from 35-year run (QEA Feb. 2009).
2. Total PCBs predicted using the following BCM input parameters:
   a. Mid upstream = 35 µg/kg dw
   b. Mid lateral = 300 µg/kg dw
   c. Bed replacement value (BRV) = 0 µg/kg dw
3. Remedial alternatives are from the Draft Final Feasibility Study (FS; October 2010). This analysis was conducted for FS comment resolution meetings (March 2011) prior to the Final FS remedial alternatives being finalized.

0 200 400 800 Feet

AECOM Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Final Feasibility Study 60150279-8.4			**Predicted Total PCB Distribution in Surface Sediment, Alternative 6R Year 35, BRV = 0**
DATE: 10/31/12	DWRN:MVI/sea	Revision: 0	**FIGURE M-24**

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Part 2: Memorandum – Estimate of PCB Export from the Lower Duwamish Waterway

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Memorandum

To: EPA and Ecology

From: AECOM

Subject: Estimate of PCB Export from the Lower Duwamish Waterway

Date: October 15, 2012

On behalf of the Lower Duwamish Waterway Group (LDWG), this memorandum addresses Comment 182 provided by the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) in response to the Lower Duwamish Waterway (LDW) Draft Feasibility Study (FS) submitted April 2009:

> ***Comment 182 Quantifying Output from LDW:*** *The FS must include an evaluation of chemical and physical export from the LDW to East and West Waterways and Elliott Bay. This evaluation must be conducted to provide information on the loading of LDW derived sediments to the other waterways. Evaluation of the reduction of this loading from each alternative should also be discussed.*

The Draft Final FS was submitted to EPA and Ecology on October 15, 2010; however, this comment was not specifically addressed in that submittal. This memorandum was first submitted to EPA and Ecology on January 19, 2011 to address Draft FS Comment 182. The contents of this memorandum were discussed with LDWG, EPA, Ecology, and the U.S. Army Corps of Engineers (USACE) in FS comment resolution meetings held on March 21, April 8, and April 26, 2011. The methodology presented herein was revised based on those discussions.

In the FS, sediment discharge from the LDW to the East and West Waterways and Elliott Bay was estimated using the sediment transport model (STM) and reported as a total discharge from the LDW. Separate sediment exports to the East and West Waterways were not computed from model output because data are not available to reliably calibrate the flow divide between the East and West Waterways. Consequently, the model is considered reliable for estimating total sediment discharge from the LDW, but the model cannot reliably quantify the distribution of sediment discharge between the waterways or the transport of those sediments within the East and West Waterways and Elliott Bay.

This memorandum estimates the export of polychlorinated biphenyls (PCBs) from the LDW associated with:

- Suspended solids from upstream of the LDW that pass through the LDW or that temporarily settle in the LDW bed and are later resuspended and exit the LDW,

calculated both for baseline conditions (as an initial point of reference) and for the construction periods of each alternative.

- Suspended solids from lateral sources discharging to the LDW (e.g., storm drains, combined sewer overflows, creeks) that pass through the LDW or that temporarily settle in the LDW bed and are later resuspended and exit the LDW, calculated both for baseline conditions (as an initial point of reference) and for the construction periods of each alternative.
- Sediment naturally eroded from the bed (i.e., the bed-source sediment), both for baseline conditions and after each remedial alternative.
- Surface and subsurface sediments that are resuspended by dredging and that exit the LDW, associated with each remedial alternative.

This memorandum focuses on export of bed-source sediments at baseline and changes in these natural erosion exports associated with the various remedial alternatives, as well as their comparison to the exports associated with upstream, lateral, and dredging sources. The upstream- and lateral-source sediments and PCB exports were calculated at baseline conditions as a point of reference to compare with the bed-source exports at baseline. Bed-source sediment export was estimated for each remedial alternative at various time points. To estimate the export, the spatially-weighted average concentrations (SWACs) of total PCBs predicted by the bed composition model (BCM) for each of the three LDW reaches were multiplied by an estimated annual export of bed-source sediment eroded from each reach. The annual export associated with dredging was calculated as an average total PCB concentration associated with sediment expected to be dredged for each remedial alternative, multiplied by an estimated annual dredging rate and an assumed suspended sediment loss. The total PCB export from upstream and lateral sources during construction of the remedial alternatives was calculated based on the annual average PCB export from those sources (assuming an annual average suspended solids load within the LDW and mid PCB input parameters) multiplied by each alternative's specific construction period. These exports were estimated using simplifying assumptions developed in collaboration with EPA, Ecology, and USACE.

Approach

Baseline PCB Export from Upstream- and Lateral-source Sediments

As a point of reference, the estimated sediment and PCB exports from each source (upstream, lateral, and bed) are provided for baseline conditions (Figures 1a and 1b). The sediment export for each sediment source in Figure 1a is the annual average from

the first 5 years of the STM hydrograph. The mid BCM input parameters were used to associate PCBs with the exports of upstream- and lateral-source suspended solids (error bars display estimated exports using low and high BCM input parameters; Figure 1b).

Export of PCBs Associated with Resuspended Bed-source Sediments

The estimated bed-source PCB export in Figure 1b uses the baseline surface sediment total PCB SWAC and the average solids export from the first 5 years of the STM hydrograph. Over time and with implementation of the remedial alternatives, sediment and PCB exports from resuspended bed-source sediments within the LDW change in two ways:

- In areas not subject to active remediation, total PCB concentrations in surface sediment generally decrease with time as upstream sediments settle in the LDW. The natural recovery processes associated with sediments originating from upstream are described in Section 5 of the FS and include deposition, mixing, and burial. These processes are modeled in the STM, and the resulting total PCB concentrations in surface sediments are predicted by the BCM.
- In areas that are actively remediated, the surface sediment PCB concentrations change at the time of remediation. Once an area is actively remediated, the total PCB concentration in that footprint is represented by the post-remedy bed sediment replacement value.

For this analysis, the export of resuspended bed-source sediment is assumed to be approximately constant over time because changes in the sediment composition (e.g., different grain sizes) attributable to capping and/or dredging were not incorporated into the STM. This provides a conservative overestimation of sediment export under post-remediation conditions, because capping material is generally coarser than existing bed material and sediments exposed by dredging in uncapped areas are more consolidated and have lower erosion potential than existing surficial sediments.

PCB exports at various times were calculated using the reach-wide PCB SWACs predicted by the BCM, multiplied by an assumed constant bed-source sediment export from each reach (annual export by reach from first 10 years of the STM; Table 1):[2]

- Reach 1 = 32 metric tons (MT)/year
- Reach 2 = 550 MT/year
- Reach 3 = 2 MT/year.

[2] Resuspension and export will vary annually with the hydrograph.

The baseline export rate for eroded bed-source sediments displayed in Figure 1a (732 MT/year) is greater than the annual bed-source sediment export averaged over the first 10 years of the hydrograph (584 MT/year; sum of bullets above) because the annual export of bed-source sediments decreases over time. This occurs as bed-source sediment is buried over time by depositing upstream- and lateral-source sediments, restricting scour and export of these original bed-source sediments.

Table M-1 (found in Part 1 of Appendix M of the Final FS) displays the reach-wide total PCB SWACs predicted by the BCM over time for each remedial alternative, using the mid BCM input parameters. Reach-wide SWACs were also calculated for each BCM period (5-year increments) using the low and high BCM input parameters, and those SWACs were used as inputs for each 5-year period. Reach-wide SWACs are provided for Year 10 in Tables 2a through 2c and for Year 30 in Tables 3a through 3c. The export of PCBs associated with naturally eroded bed-source sediments from each reach of the LDW was calculated as the sediment export rate in MT/year[3] multiplied by the reach-wide SWAC (µg/kg dw) (with unit conversions) to yield a total estimated PCB export rate in kg/year from each reach. The three reach-specific export rates were then summed to estimate the total annual export of PCBs from the LDW associated with erosion of bed-source sediments (Table 4 and Figures 2a and 2b).

Annual exports of PCBs were estimated for each 5-year BCM period, and thus a total export over each 5-year period was calculated (5 years × annual export). PCB export from erosion over the 45-year period for which the BCM was run is the sum of each 5-year export. PCB export rates for years 10 and 30 and the PCB export over the 45-year period are shown in Table 4.

Export of PCBs Associated with Resuspended Sediments Resulting from Remedial Dredging

The actively remediated footprints of the alternatives will be subject to physical disturbances during dredging and, to a lesser extent, from cap and ENR placement. These activities will suspend sediment into the water column during construction. The rate of sediment suspended into the water column and exported out of the LDW during dredging operations was estimated from the annual average dredging production rate (127,000 MT/year, which is equivalent to 140,000 tons/year) and the percent loss of dredged material assumed in the FS. In consultation with EPA and the USACE, it was estimated that the total release of PCBs from dredged sediments would be

[3] There are 1,000 kg in 1 MT. A bed-source sediment export rate of 584 MT/year (representing the 10-year annual average) was used in the analysis. The export rate was assumed to be constant, and the bed PCB concentrations (reach-wide PCB SWACs) used to assign the concentration of total PCBs to the exported material varied over time in 5-year time steps.

approximately 2% of the mass of PCBs originally in the dredged sediments. The total release includes:

- Dredge releases: particulate-bound and dissolved PCBs introduced into the water column that reach the end of the mixing zone approximately 100 meters downstream from the dredge.
- Dredge residuals: material containing PCBs that remains within or around the dredge excavation, but moves into the water column due to either desorption of PCBs into the water column or entrainment of the sediment because of the dredge residuals' low density and low critical shear stress for resuspension.
- Debris removal.

Of this 2% PCB release, half is estimated to be in the upper portion of the water column where it can be entrained in the freshwater surface layer and transported downstream. The other half is likely to be in the salt wedge (bottom of water column) and for the purposes of this evaluation is assumed to settle within the LDW. Material suspended in the upper water column is more likely to stay in suspension long enough to exit the LDW, relative to its grain size. Of the material in the upper water column, 50% is estimated to be greater than 100 micrometers (μm) in diameter and would mostly settle before exiting from the LDW. Based on the STM, the trapping efficiency of the finer sediment classes, Class 1A and Class 1B, is approximately 43%. Together, the overall effect of the total loss from the mixing zone, the effect of the salt wedge retaining suspended sediment, and the trapping efficiency of the LDW result in an estimation that 0.3% of the PCB mass in the dredged sediments will be exported from the LDW.

Annual exports of PCBs related to dredging were calculated as an average PCB concentration associated with the sediment to be dredged in each remedial alternative, multiplied by the annual average dredging rate of 127,000 MT/year, multiplied by the portion exported (0.3%; with unit conversions) to yield an estimated annual PCB export in kg/year. The expected concentration of PCBs associated with the dredged sediment was derived by identifying those sediment cores within the dredging and partial dredge and cap footprints for each remedial alternative. The footprints used to identify cores were incremental in that each alternative excluded the previous, smaller remedial alternative footprints (this assumes optimized sequencing of remediation under all alternatives). For example, the sediment cores included in the dredge footprint of Alternative 4R excluded cores in the Alternative 3R dredging footprint because they would have been previously removed during earlier dredging. This approach, which

assumes a specific sequencing of remediation, was used to estimate the annual PCB export associated with dredging as the remediation footprints change over time.[4]

For each remedial alternative's dredging (or partial dredge and cap) footprint, the subsurface sediment PCB samples, at depths shallower than the PCB sediment quality standard (SQS) isopach, were vertically averaged.[5] In other words, each sample was weighted by the thickness of the sample interval. The average PCB concentration from the cores was assumed to be the PCB concentration of all the dredged material exported from the LDW during dredging operations from the portion of each remedial alternative footprint beyond the smaller footprint of the previous alternative (used to estimate the PCB exports from dredging that incremental footprint). Cores from areas subject to other active remediation technologies (i.e., ENR/*in situ* or capping) were not included. PCB exports over the entire dredging duration of each remedial alternative were calculated incrementally by multiplying the annual average PCB export rate for each increment by the construction period for that increment. Table 5 lists the estimated in-water construction time frames for active remediation of each remedial alternative. Table 6 lists the incremental time period, the incremental PCB export, and the total PCB export from dredging of each remedial alternative. Table 7 presents an example calculation of PCB exports over the duration of dredging for each removal alternative.

Exports of PCBs from Upstream- and Lateral-source Sediments for Remedial Alternatives

The annual PCB load to the LDW for upstream sources was calculated for each year in the 30 year STM hydrograph. Parameters used to calculate the total PCB load included daily average upstream flow rate, weighted average suspended sediment concentration (as a function of flow rate), and assumed 35 µg/kg dw PCBs in upstream sediments (mid-range BCM upstream input value). PCB load varied for each day of the simulation period. Annual PCB loads calculated using this method ranged from 3.2 to 4.0 kg/yr for the 30 year hydrograph. Average annual PCB upstream load over the 30 year hydrograph was 3.7 kg/yr. The average annual lateral PCB export was estimated at 0.2 kg/yr using the same calculation method.

The exports associated with upstream and lateral sources over the construction periods of the remedial alternatives were calculated for comparison to the export associated

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[4] For example, remediation of Alternative 3R uses the PCB export rate for EAAs for the first 3 years (years -3 to 0), the Alternative 2R PCB export rate for the following 4 years (years 0 to 4), and the 3R PCB export rate for the following 2 years (years 5 and 6).

[5] This was a vertically-weighted average, with no horizontal weighting. Sample intervals with no analytical data were assumed to have the same PCB concentration as the next shallower sample interval. See Appendix E for a description of the SQS isopach layer, representing the estimated vertical extent of contamination.

with natural erosion of the sediment bed and dredging losses over the same time period.

Results

The bed-, lateral-, and upstream-source suspended sediments and PCB exports at baseline conditions are shown in Figures 1a and 1b, respectively, using average annual sediment exports from the first 5 years of the STM hydrograph. These figures illustrate how the majority of sediment and PCB mass export is associated with upstream-source sediments. The error bars on Figure 1b illustrate the uncertainty in the upstream- and lateral-source PCB exports related to the range of the BCM input parameters used in the analysis (5 to 80 µg/kg dw for upstream-source sediments and 100 to 1,000 µg/kg dw for lateral-source sediments). No error bars were estimated on the bed-source PCB export because this calculation used the baseline surface sediment SWAC.

Estimated PCB Export Rates from Natural Sediment Bed Erosion after Completion of Construction

Figures 2a and 2b present the estimated average annual PCB exports from natural erosion of bed-source sediments at model years 10 and 30, respectively, for each remedial alternative using the range of BCM input parameters (all low, all mid, and all high). Results are compared to the estimated PCB export from the sediment bed in the absence of remediation (baseline) of about 0.47 kg/year. Year 10 PCB export rates from bed-source sediments based on the mid BCM input parameters are about 6 to 9% of that for baseline conditions, while Year 30 PCB export rates from bed-source sediments are about 4 to 6% of that for baseline conditions (Table 4). This is largely because of the decrease (from both natural recovery and active remediation) in the PCB concentration of bed-source sediments estimated to be resuspended and transported out of the LDW by natural erosion events (i.e., high-flow scour). Figures 2a and 2b demonstrate that the bed-source PCB exports vary little among the remedial alternatives, because by Year 10, PCB surface sediment concentrations do not vary much among the alternatives. This is largely because PCB hot spots have been actively remediated and because of natural recovery processes in the rest of the LDW that do not vary among remedial alternatives.

The estimated export of PCBs associated with erosion of bed-source sediments for all alternatives ranges from 0.03 to 0.04 kg/year at model year 10 (Figure 2a and Table 4) and from 0.02 to 0.03 kg/year at year 30 (Figure 2b and Table 4). The baseline bed-source annual export is 0.47 kg/year. The estimated annual PCB exports at Year 10 decrease slightly as the actively remediated footprint increases (i.e., with increasing numbered alternatives). However, these incremental differences decrease over time, such that the PCB bed-source exports at Year 30 are similar for all remedial alternatives. This is because the reach-wide SWACs become similar over time, as a result of

remediation and BCM-predicted natural recovery processes. The total export of PCBs from naturally eroded bed-source sediments over the 45-year period for which BCM-predicted SWACs are presented is approximately 3 kg regardless of the remedial alternative (Table 4).

Accounting for Losses of PCBs Associated with Dredging

Table 6 presents the estimated PCB exports associated with dredging for each alternative. After the EAAs are remediated, estimated annual average PCB exports associated with dredging decrease from 1.3 kg/year to about 0.3 kg/year, but remain an order of magnitude greater than those for natural erosion of bed-source sediments (0.03 – 0.04 kg/year; Table 4). The estimated PCB exports associated with dredging range from approximately 4 kg for Alternative 1 [EAAs] up to 17.5 kg for Alternative 6R (Table 6 and Figure 3). Table 7 demonstrates the calculation of the cumulative PCB exports from dredging for the removal alternatives. These values represent the fraction of PCBs within the resuspended dredged sediments that are estimated to remain in the water column and leave the LDW. As described above, the remaining fraction of PCBs introduced into the water column from dredging is expected to resettle in the surface sediment bed. These resettled sediments may have elevated PCB concentrations relative to surrounding surface sediment concentrations. Although dredging is another form of disturbance that exposes subsurface contamination, this process was not factored into the STM and BCM calculations, nor was the potential for disturbance due to processes such as vessel scour, as discussed in Appendix M Part 5.

Annual PCB Export under Removal and Combined Alternatives

Figure 4 compares estimates of PCB export from all four sources (upstream, lateral, natural bed erosion, dredging) over the construction periods of each alternative. This figure illustrates the relative contributions from each source; upstream contributes the most and depending on the alternative, either natural bed erosion or lateral contributes the least.

Figures 5a and 5b, respectively, present estimated annual and cumulative PCB exports for the removal alternatives. Figures 6a and 6b present the same type of estimated exports for the combined alternatives.

Figures 5b and 6b are line graphs showing the cumulative PCB export associated with dredging and natural bed erosion for each remedial alternative over the period of active remediation, and the incremental addition of PCBs above the export estimated by the previous (smaller-numbered) alternative. The estimated cumulative PCB export associated with dredging for Alternative 6C is about 9 kg compared to 17.5 kg for Alternative 6R. The removal alternatives have higher cumulative PCB exports associated with dredging compared to the combined alternatives because of longer

construction times and greater disturbance of sediments. Figure 4 presents the PCB exports from the LDW originating from natural erosion of bed sediments, lateral sources, dredging losses, and upstream over the construction period for each remedial alternative.

Assumptions

This analysis uses four simplifying assumptions that could influence the estimate of PCBs exported from the LDW. First, the analysis does not include resuspension and export of sediment from ship scour and propeller wash, which would increase the PCB export presented in this memorandum. Second, exports of bed-source sediments are estimated on a reach-wide basis. Reach-wide SWACs (predicted by the BCM) were used to associate PCB concentrations with reach-wide solids export (estimated by the STM). However, there is spatial variability in sediment PCB concentrations and in sediment resuspension and export within each reach of the LDW. More precision (and perhaps greater differences among the remedial alternatives) could be possible by tracking bed-source sediments and PCB exports on a grid-cell basis. The analysis indicates that PCB exports associated with natural erosion of bed-source sediments are similar (3.0 kg to 2.8 kg over 45 years) for Alternatives 2 through 6 as shown in Table 4. Third, the estimated PCB exports associated with dredging were calculated from the average of all subsurface sediment data within the incremental dredging footprints; the data were not spatially interpolated. The average PCB concentrations in the cores within each dredging footprint were based on limited subsurface data and therefore there is uncertainty in the estimated PCB exports associated with dredging. Fourth, the estimate of dredged sediment export to Elliott Bay is based on a simple estimated trapping efficiency (not on using the STM to model transport releases) and estimated dredge loss rates. Therefore, these are only screening level estimates and include a high degree of uncertainty.

Conclusions

In all cases, the estimated export of PCBs out of the LDW from natural erosion of bed-source sediments after completion of remediation under any remedial alternative is substantially less than the PCB export for the baseline condition, because less contamination remains in the sediment bed after remediation. The largest incremental change in PCB export from the baseline condition results from cleanup of the EAAs. Smaller incremental changes are associated with the remedial alternatives based only on natural bed erosion (not accounting for releases from dredging). However, the PCB export associated with the natural resuspension and export of bed-source sediments for any remedial alternative (after completion of the EAAs) is small compared to PCB exports associated with upstream-source sediments over time. The upstream source of

PCB export is also much greater than the exports associated with dredging, natural bed erosion, and lateral sources.

Dredging releases account for a greater proportion of PCB exports from the LDW than does natural erosion of the sediment bed under any of the remedial alternatives. The export estimates presented in this memorandum are based on sediment discharges estimated by the STM and dredged sediment export based on screening level estimated trapping efficiency of the LDW. Similar to lateral source and bed erosion quantities, the dredging operations result in a relatively small amount of PCBs exported from the LDW relative to upstream sources. Therefore, PCBs associated with upstream solids are the largest source of export of PCBs to Elliott Bay and will remain so under all remedial alternatives.

Table 1 STM Estimated Solids Export from Bed-Source Sediment in Each Reach of the LDW

LDW	Bed-Source Sediment Leaving the LDW in 10 Years (MT)	Average Annual Sediment Export Rate from Erosion of the Bed (MT/year)
Reach 1	320	32
Reach 2	5,500	550
Reach 3	20	2
Total Bed-Source Sediments Leaving the LDW	5,840	584

Source: Figure 5-9, Section 5 of the FS.

Notes:

1. The average annual bed-source sediment export in this table (584 MT/year) differs from that in Figure 1a because Figure 1a uses average annual exports over the first 5 years of the hydrograph to represent baseline conditions. The exports in Table 1 are averaged over the first 10 years of the hydrograph and are used to calculate exports of PCBs related to the remedial alternatives.

FS = feasibility study; LDW = Lower Duwamish Waterway; MT = metric ton; PCB = polychlorinated biphenyl; STM = sediment transport model

Table 2 Reach-Wide Year 10 Total PCB SWACs (µg/kg dw) for Each Remedial Alternative

Table 2a Using Low BCM Input Parameters

LDW	No Action – Baseline Reach-Wide SWACs (µg/kg dw)	Year 10 Reach-Wide Total PCB SWACs (µg/kg dw)					
		Alternative 1 (EAAs)	Alternative 2R	Alternative 3C/3R	Alternative 4C/4R	Alternative 5C/5R	Alternative 6C/6R
Reach 1	250	59	51	46/46	36/46	30/46	30/46
Reach 2	660	39	34	33/33	27/30	27/30	27/30
Reach 3	56	10	10	10/10	10/11	11/11	11/11

Table 2b Using Mid BCM Input Parameters

LDW	No Action – Baseline Reach-Wide SWACs (µg/kg dw)	Year 10 Reach-Wide Total PCB SWACs (µg/kg dw)					
		Alternative 1 (EAAs)	Alternative 2R	Alternative 3C/3R	Alternative 4C/4R	Alternative 5C/5R	Alternative 6C/6R
Reach 1	250	84	77	73/73	64/73	58/73	58/73
Reach 2	660	67	63	61/61	57/59	57/59	57/59
Reach 3	56	40	40	40/40	40/41	40/41	40/41

Table 2c Using High BCM Input Parameters

LDW	No Action – Baseline Reach-Wide SWACs (µg/kg dw)	Year 10 Reach-Wide Total PCB SWACs (µg/kg dw)					
		Alternative 1 (EAAs)	Alternative 2R	Alternative 3C/3R	Alternative 4C/4R	Alternative 5C/5R	Alternative 6C/ 6R
Reach 1	250	130	123	119/119	110/118	103/118	103/118
Reach 2	660	115	110	109/109	105/104	104/104	104/104
Reach 3	56	88	88	88/88	88/89	89/89	89/89

Notes:
1. There is no Alternative 2C.
2. Low, mid, and high BCM input parameters are as follows: upstream = 5, 25, and 80 µg/kg dw; lateral = 100, 300, and 1,000 µg/kg dw; RV in AOPC 1 = 30, 60, and 90 µg/kg dw; RV in AOPC 2 = 10, 20, and 40 µg/kg dw.

AOPC = area of potential concern; BCM = bed composition model; C = combined alternative; dw = dry weight; EAA = early action area; kg = kilogram; LDW = Lower Duwamish Waterway; µg = microgram; PCB = polychlorinated biphenyl; R = removal alternative; RV = post-remedy bed sediment replacement value; SWAC = spatially-weighted average concentration

Table 3 Reach-Wide Year 30 Total PCB SWACs (µg/kg dw) for Each Remedial Alternative

Table 3a Using Low BCM Input Parameters

LDW	No Action – Baseline Reach-Wide SWACs (µg/kg dw)	Year 30 Reach-Wide Total PCB SWACs (µg/kg dw)					
		Alternative 1 (EAAs)	Alternative 2R	Alternative 3C/3R	Alternative 4C/4R	Alternative 5C/5R	Alternative 6C/6R
Reach 1	250	15	14	12/12	11/11	10/12	9/12
Reach 2	660	22	20	19/19	17/17	17/17	11/11
Reach 3	56	8	8	7/7	7/7	7/7	7/7

Table 3b Using Mid BCM Input Parameters

LDW	No Action – Baseline Reach-Wide SWACs (µg/kg dw)	Year 30 Reach-Wide Total PCB SWACs (µg/kg dw)					
		Alternative 1 (EAAs)	Alternative 2R	Alternative 3C/3R	Alternative 4C/4R	Alternative 5C/5R	Alternative 6C/6R
Reach 1	250	48	47	45/45	44/45	44/45	41/43
Reach 2	660	52	51	50/50	48/48	48/48	42/38
Reach 3	56	39	39	38/38	38/38	38/38	38/38

Table 3c Using High BCM Input Parameters

LDW	No Action – Baseline Reach-Wide SWACs (µg/kg dw)	Year 30 Reach-Wide Total PCB SWACs (µg/kg dw)					
		Alternative 1 (EAAs)	Alternative 2R	Alternative 3C/3R	Alternative 4C/4R	Alternative 5C/5R	Alternative 6C/6R
Reach 1	250	108	107	105/105	105/105	105/104	98/100
Reach 2	660	104	102	102/102	100/100	100/100	94/84
Reach 3	56	92	90	89/89	89/89	89/89	89/88

Notes:
1. There is no Alternative 2C.
2. Low, mid, and high BCM input parameters are as follows: upstream = 5, 25, and 80 µg/kg dw; lateral = 100, 300, and 1,000 µg/kg dw; RV in AOPC 1 = 30, 60, and 90 µg/kg dw; RV in AOPC 2 = 10, 20, and 40 µg/kg dw.

AOPC = area of potential concern; BCM = bed composition model; C = combined alternative; dw = dry weight; EAA = early action area; kg = kilogram; LDW = Lower Duwamish Waterway; µg = microgram; PCB = polychlorinated biphenyl; R = removal alternative; RV = post-remedy bed sediment replacement value; SWAC = spatially-weighted average concentration

Table 4 Estimated Export of PCBs from Natural Erosion of Bed-Source Sediments for Each Remedial Alternative

PCB Export	No Action – Baseline Conditions (Year 0)	Alternative 1 (EAAs)	Alternative 2R	Alternative 3C/3R	Alternative 4C/4R	Alternative 5C/5R	Alternative 6C/6R
Annual Export of PCBs Using Year 10 BCM SWACs (kg/year)	0.47	0.04	0.04	0.04/0.04	0.03/0.03	0.03/0.03	0.02/0.03
Annual Export of PCBs Using Year 30 BCM SWACs (kg/year)		0.03	0.03	0.03/0.03	0.03/0.03	0.03/0.03	0.02/0.02
Total Export of PCBs (kg) Estimated from Natural Erosion of Bed-Source Sediment over 45 years	n/a	3.1	3.0	3.0/3.0	3.0/3.0	3.0/3.0	2.8/2.9

Notes:

BCM = bed composition model; C = combined alternative; EAA = early action area; kg = kilogram; LDW = Lower Duwamish Waterway; n/a = not applicable; PCB = polychlorinated biphenyl; R = removal alternative; SWAC = spatially-weighted average concentration

Table 5 Construction Time Frames for Each Remedial Alternative

	Alternative 1 (EAAs)	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Estimated In-water Construction Time (years); Not Including EAAs						
Combined Alternative ("C")	0	n/a	3	6	7	16
Removal Alternative ("R")		4	6	11	17	42
Estimated In-water Construction Time (years) Used to Calculate Export from Dredging; Including EAAs						
Combined Alternative ("C")	3	n/a	6	9	10	19
Removal Alternative ("R")		7	9	14	20	45

Notes:

a. For dredging export graphing, EAA construction is assumed to take three years and ends at Year 0. Alternative 2 construction and the BCM begin at Year 0.

BCM = bed composition model; EAA = early action area; LDW = Lower Duwamish Waterway; n/a = not applicable; PCB = polychlorinated biphenyls; SWAC = spatially-weighted average concentration

Table 6 Estimated Export of PCBs from the LDW Associated with Dredging Losses, Upstream-source, and Lateral-source Sediments

Source and Parameter		Remedial Alternative									
		1 (EAAs)	2R	3C	3R	4C	4R	5C	5R	6C	6R
Dredging Losses[a]	Average Total PCB Concentration (µg/kg dw) of Subsurface Sediment Samples in Incremental Dredged Footprint[b]	3,400	1,100	960	750	810	720	780	970	700	720
	PCB Export Rate (kg/year) from Dredging Losses During Dredging of Incremental Footprint	1.3	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.3	0.3
	Construction Time (Total Years including 3 years of EAAs)	3	7	6	9	9	14	10	20	19	45
	Incremental Construction Years from Previous Alternative (years)	n/a	4	3	2	3	5	1	6	9	25
	Incremental PCB Export from Previous Alternative (kg)	n/a	1.6	1.2	0.6	0.9	1.5	0.3	2.4	2.7	7.5
	Total Estimated PCB Export During Active Remediation (kg)[c]	3.9	5.5	5.1[d]	6.1	6.0	7.6	6.3	10.0	9.0	17.5
Upstream	Total Estimated PCB Export Over Construction Period (kg)[e]	11.1	14.8	11.1	22.2	22.2	40.7	25.9	62.9	59.2	155.4
Lateral	Total Estimated PCB Export Over Construction Period (kg)[e]	0.6	0.8	0.6	1.2	1.2	2.2	1.4	3.4	3.2	8.4

Notes:

a. Assuming a 127,000 MT/year dredging production rate and 0.3% of material exported from the LDW.

b. Incremental samples are the samples from dredging footprint of remedial alternative beyond the dredging footprint of the previous, smaller remedial alternative.

c. PCB export is calculated incrementally by multiplying the annual average PCB export rate by the duration of dredging for an incremental remediation footprint. Incremental exports are summed for a total export. For example, the Alternative 3R export is calculated as the Alternative 1 (EAAs) annual export rate multiplied by 3 years, plus the Alternative 2R annual export rate multiplied by 4 years, plus the Alternative 3R annual export rate multiplied by 2 years, for a total PCB export over a 9-year period of dredging.

d. Total export of PCBs for Alternative 3C is sum of Alternative 1 (EAAs) export plus Alternative 3C incremental export. There is no Alternative 2C.

e. PCB exports from upstream and lateral sources are calculated by multiplying the annual average PCB export rates of 3.7 kg/year and 0.2 kg/year, respectively, over the construction period for each alternative (excluding 3 years of EAAs except for Alternative 1).

BCM = bed composition model; C = combined alternative; dw = dry weight; EAA = early action area; kg = kilogram; LDW = Lower Duwamish Waterway; µg = microgram; MT = metric ton; n/a = not applicable; PCB = polychlorinated biphenyls; R = removal alternative

Table 7 Example Calculation of Total PCB Export Associated with Dredging for Each Removal Alternative

Remedial Alternative Dredged	PCB Export (kg) Associated with Dredging of Each Incremental Footprint						Total PCB Export Associated with Dredging (kg)[b]
	EAAs[a]	2R	3R	4R	5R	6R	
Alternative 1 (EAAs)	3.9					*no active remediation*	3.9
Alternative 2R	3.9	1.6				*no active remediation*	5.5
Alternative 3R	3.9	1.6	0.6			*no active remediation*	6.1
Alternative 4R	3.9	1.6	0.6	1.5		*no active remediation*	7.6
Alternative 5R	3.9	1.6	0.6	1.5	2.4	*no active remediation*	10.0
Alternative 6R	3.9	1.6	0.6	1.5	2.4	7.5	17.5

Notes:

a. Estimated exports from dredging of EAAs were included for completeness. Construction of EAAs is assumed to be completed prior to construction within the remedial alternative footprints.

b. Sum of values to the left.

EAA = early action area; kg = kilogram; LDW = Lower Duwamish Waterway; PCB = polychlorinated biphenyls; R = removal alternative

Figure 1a. Estimated Average Annual Sediment Export at Baseline Conditions

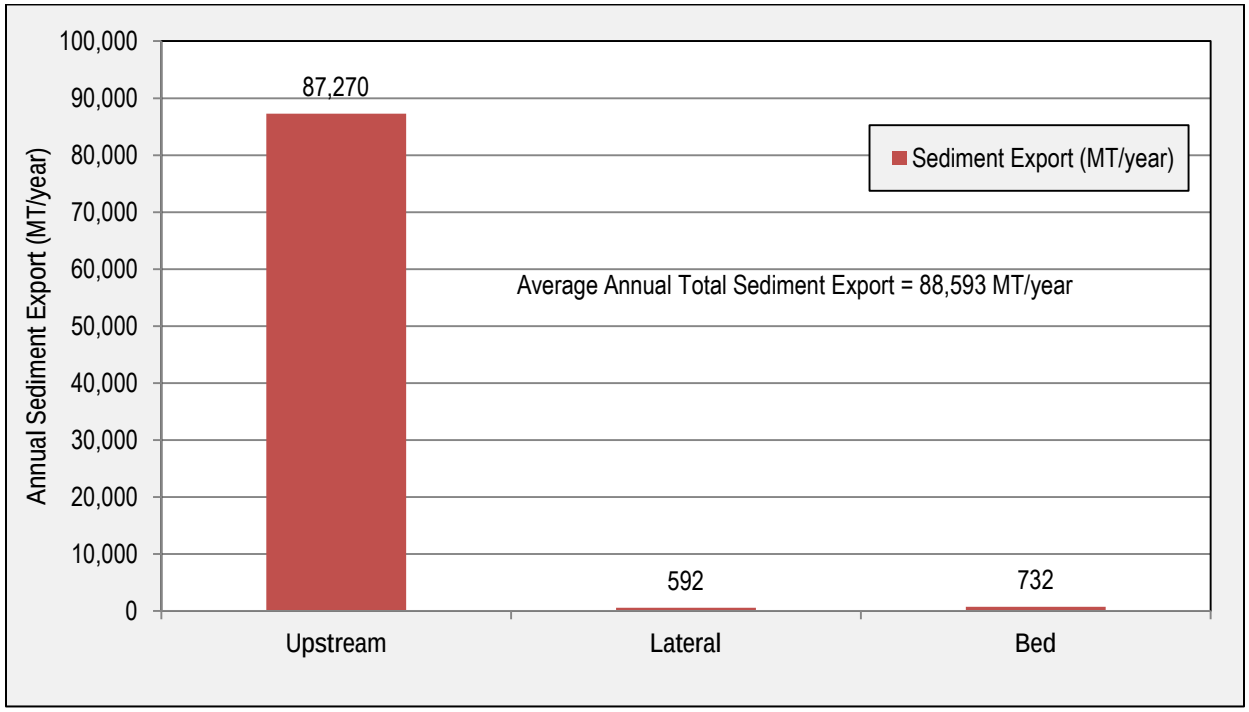


Figure 1b. Estimated Average Annual PCB Export at Baseline Conditions

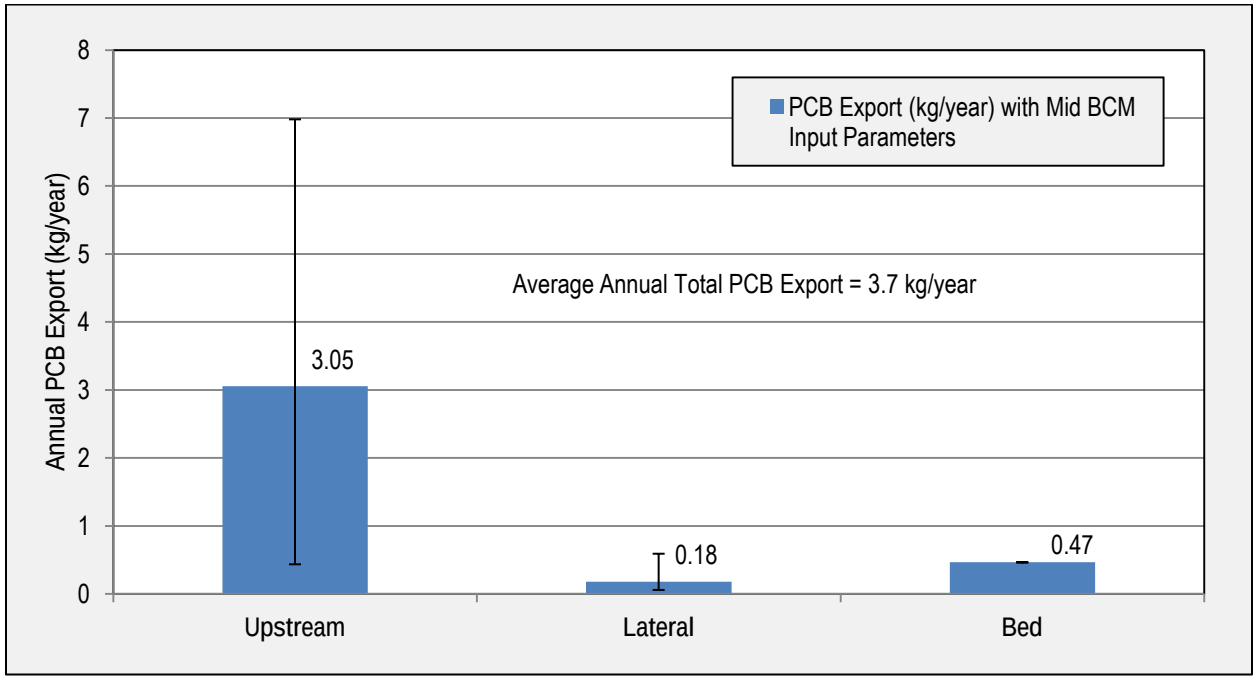


Figure 2a. Estimated Average Annual PCB Export From Year 0 to Year 10

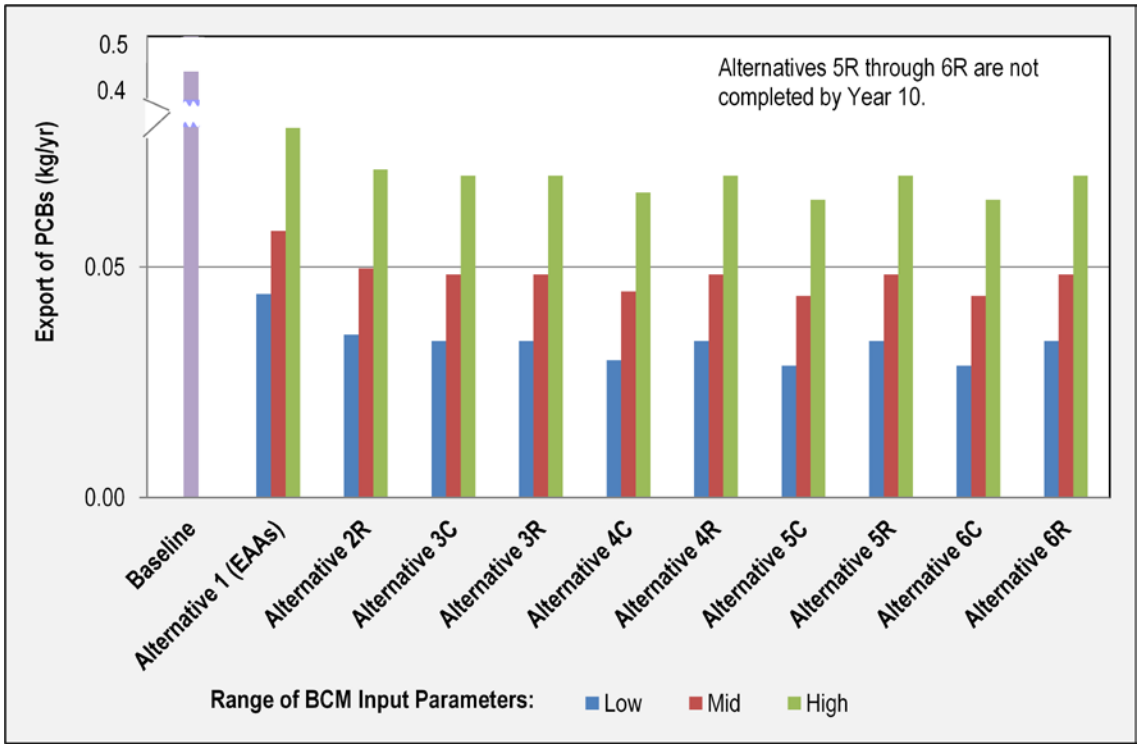
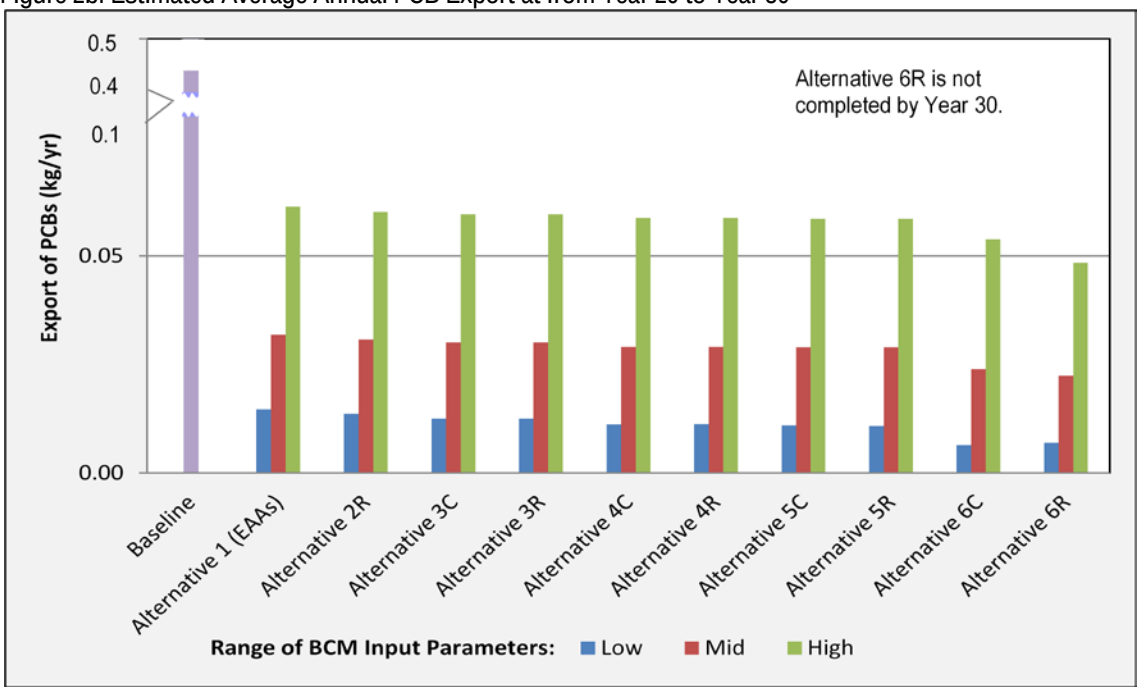


Figure 2b. Estimated Average Annual PCB Export at from Year 20 to Year 30



Notes:

1. Total PCB export is the sum of each reach-wide SWAC from the baseline dataset multiplied by each reach-specific annual average bed sediment export rate over the first 5 years of the STM hydrograph.
2 PCB exports presented in this figure are attributable only to natural erosion of the sediment bed. Additional losses will occur from dredging. Losses associated with dredging are presented in Figures 3 through 6.

Figure 3. Estimated Total Export of PCBs from Dredging Losses

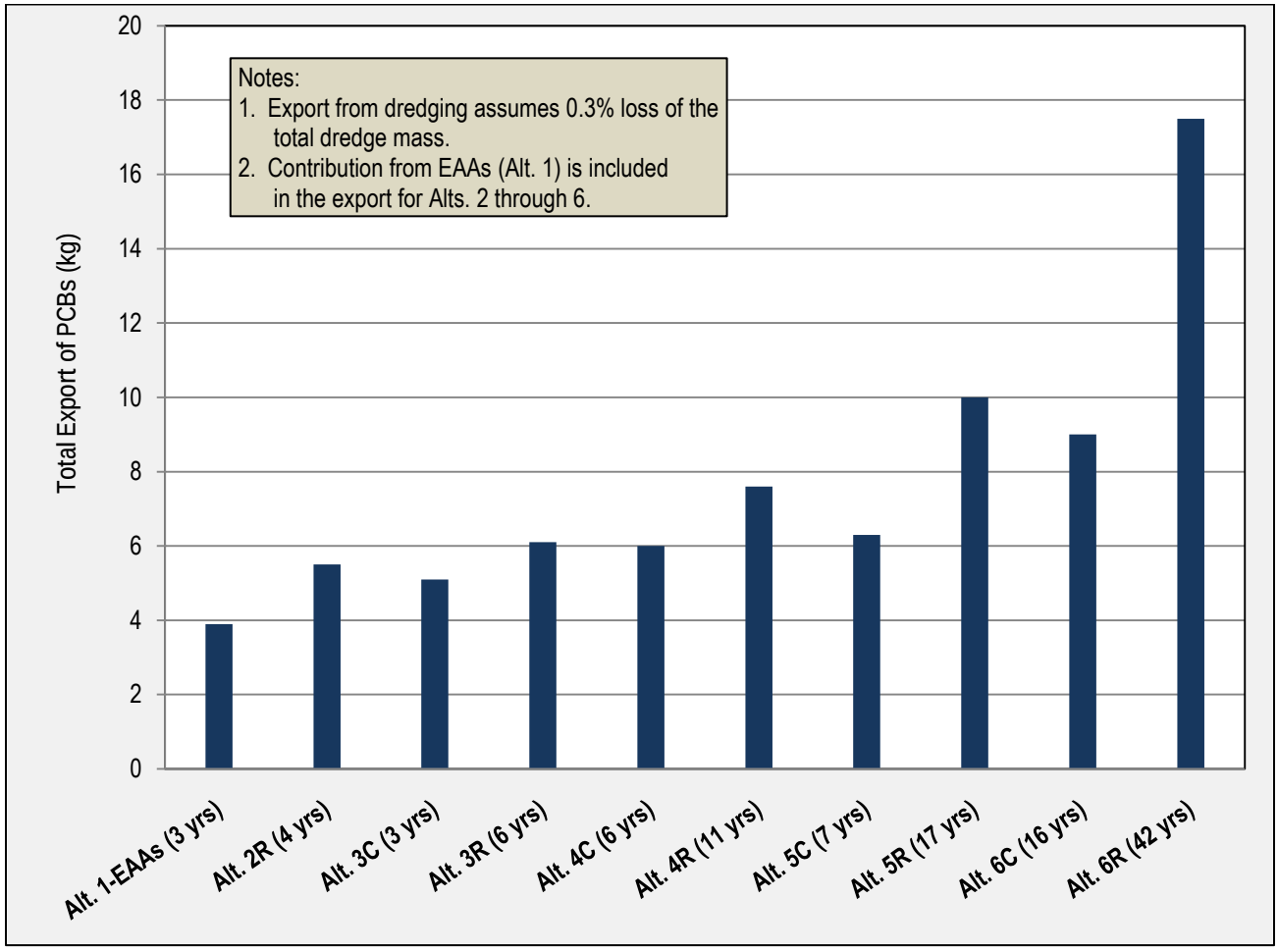
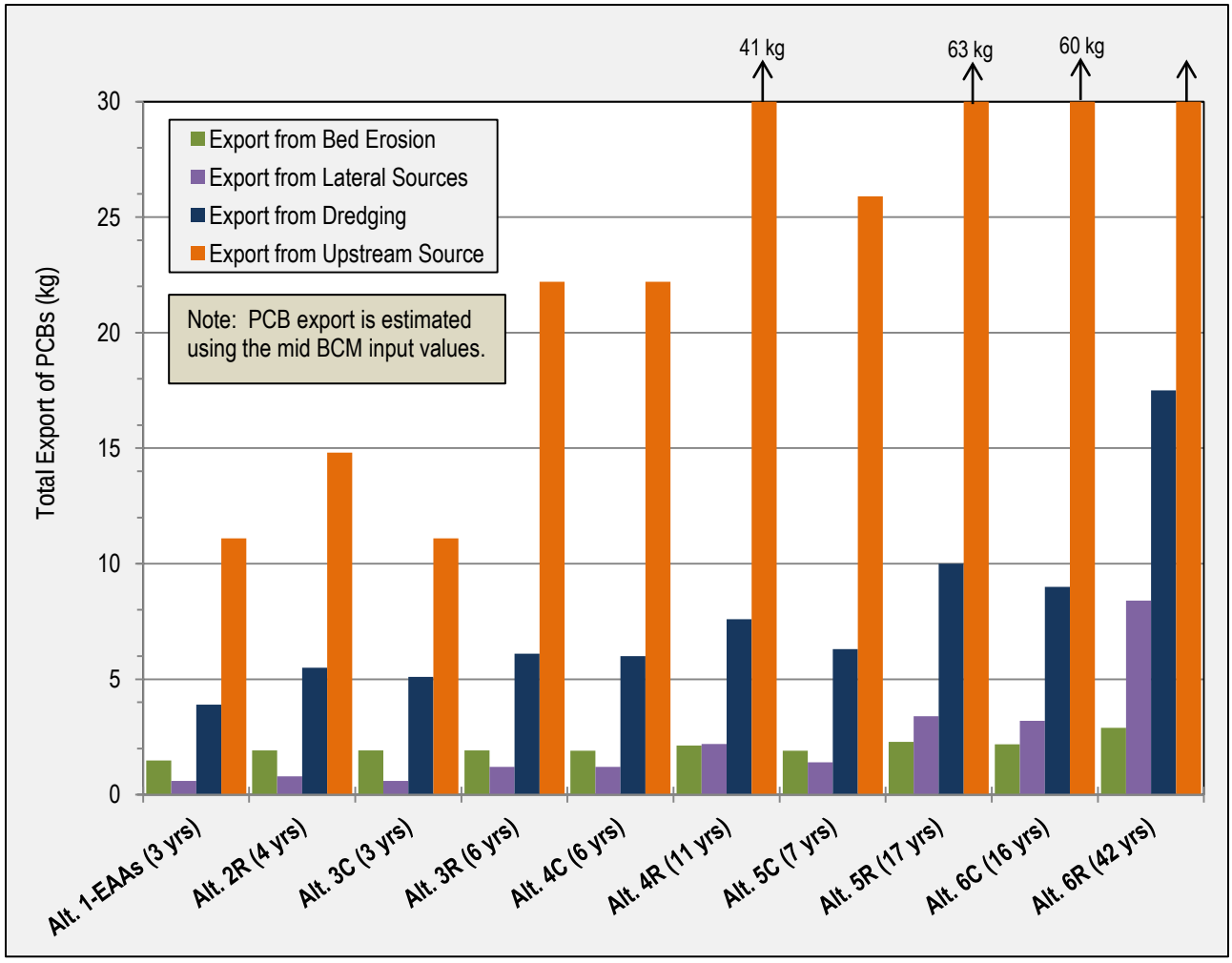


Figure 4. Estimated Total Exports of PCBs from Dredging Losses, Lateral Sources, Natural Bed Erosion, and Upstream Source over Construction Period



Notes:

1. Export from bed erosion was calculated as the sum of the BCM-predicted reach-wide SWACs in 5-year increments for each remedial alternative multiplied by an assumed constant annual bed sediment export rate from each reach.
2. The dredge export rate assumes a 0.3% export of material and an annual dredging production rate of 127,000 MT/year.
3. Contribution from EAAs (Alt. 1) is not included in the export from lateral sources and upstream sources for Alts. 2 through 6. Contribution from EAAs (Alt. 1) is included in the export from dredging and bed erosion for Alts. 2 through 6.
4. The range of PCB export from upstream using the low and high BCM input values ranges from about 2 to 25 kg (Alternative 1, 3 yrs) up to about 20 to 340 kg (Alternative 6R, 42 yrs).
5. The annual PCB export for upstream sources was calculated as a weighted average over a 30-year period from the STM, using 3.2 kg/yr from 0 to 10 years and 4.0 kg/yr from 10 to 30 years. There is year-to-year variability in the hydrograph, but the 10 to 30-year period includes a major storm event. The annual weighted average for the 30-yr period is 3.7 kg/yr for upstream, using the mid BCM input parameter. The same method was used for lateral and the annual PCB export is 0.2 kg/yr.
6. Upstream and lateral source exports for all alternatives were calculated using annual weighted average sediment exports for upstream (3.7 kg/year) and lateral (0.2 kg/year) multiplied by the construction period.

Figure 5a. Estimated Annual PCB Export from Natural Bed Erosion and Dredging Losses for the Removal Alternatives

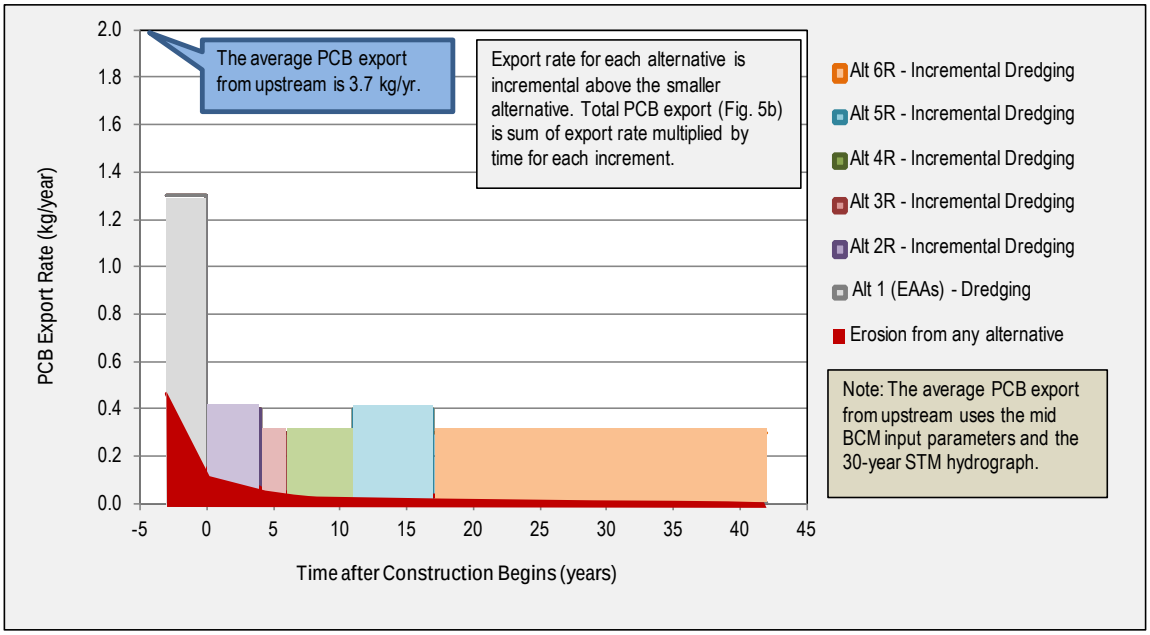
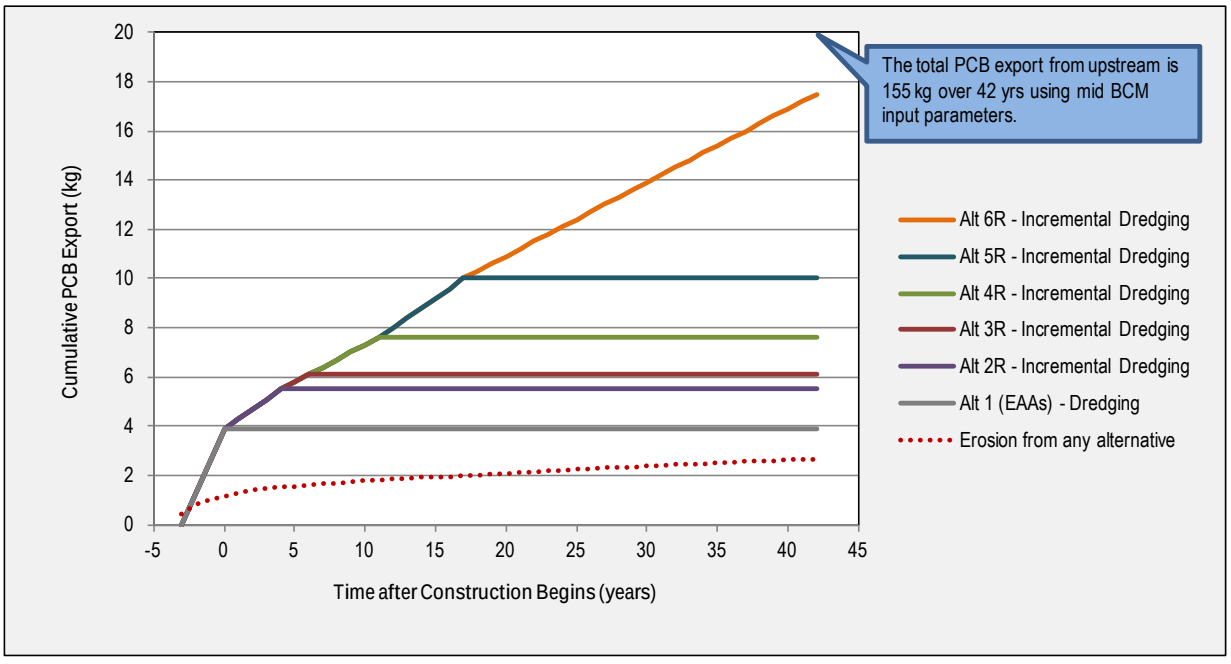


Figure 5b. Estimated Cumulative PCB Export from Natural Bed Erosion and Dredging Losses for the Removal Alternatives



Notes:
1. Dredging export rates were estimated from the average total PCB concentrations in cores (average of all core samples) in incremental dredged footprint beyond smaller alternative's dredged footprint, multiplied by an annual average dredging production rate of 127,000 MT/year, and assuming a 0.3% export of material.
2. Total dredging export is calculated incrementally. For example, total PCB export for Alternative 3R uses the Alternative 1 (EAAs) annual export rate for the first 3 years (years -3 to 0), the Alternative 2R annual export rate for years 0 through 4, and the Alternative 3R annual export rate for years 5 and 6. Construction year 0 is at the beginning of Remedial Alternative 2R.
3. On the scale of these charts, no difference in natural bed erosion is discernible among the alternatives. Therefore, only one line is displayed.
4. Dredging durations are equivalent to the construction periods in Table 5. Alternative 1 is assumed to occur between year -3 and year 0.
5. Average annual export from upstream (3.7 kg/yr shown in Figure 5a) was calculated using the 30-year STM hydrograph. This export does not match the export in Figure 1b (3.05 kg/yr), which was calculated using the first 5 years of the hydrograph.

Figure 6a. Estimated Annual PCB Export from Natural Bed Erosion and Dredging Losses for the Combined Alternatives

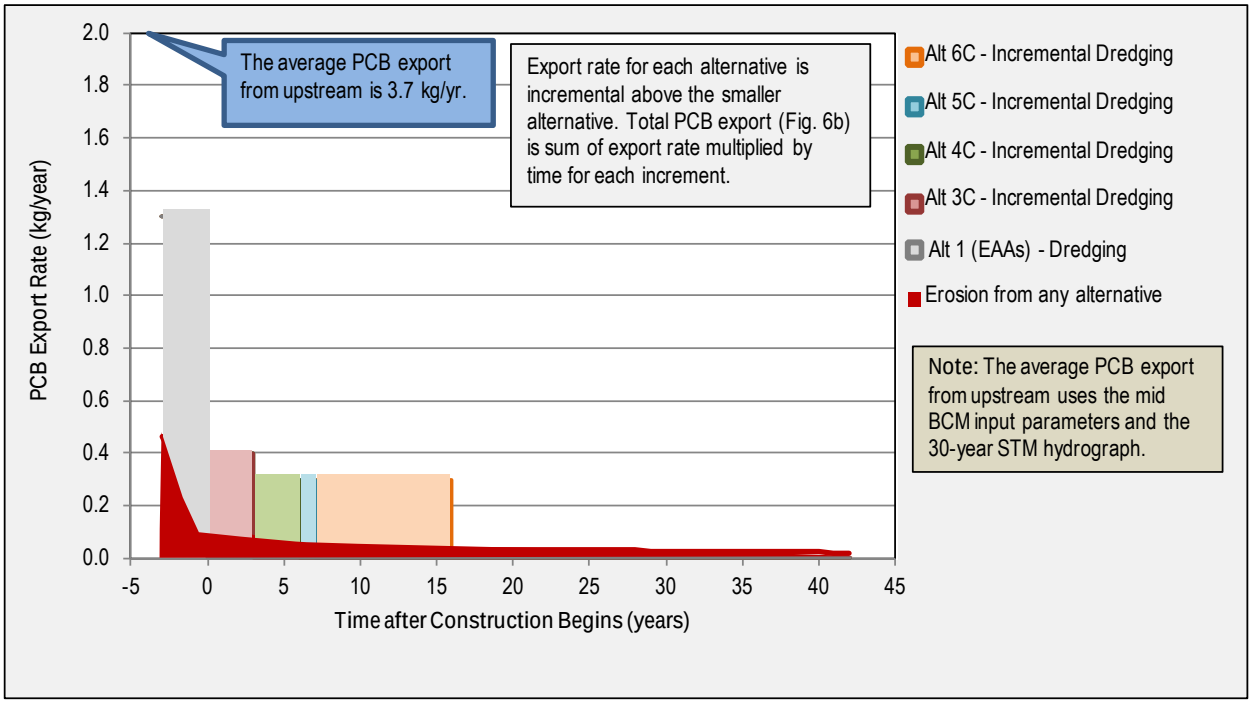


Figure 6b. Estimated Cumulative PCB Export from Natural Bed Erosion and Dredging Losses for the Combined Alternatives

Notes:

1. On the scale of these charts, no difference in natural bed erosion is discernible among the alternatives. Therefore, only one line is displayed.
2. Dredging durations are equivalent to the construction periods in Table 5. Alternative 1 is assumed to occur between year -3 and year 0.
3. Average annual export from upstream (3.7 kg/yr shown in Figure 6a) was calculated using the 30-year STM hydrograph. This export does not match the export in Figure 1b (3.05 kg/yr), which was calculated using the first 5 years of the hydrograph.

Part 3: Memorandum – Change in Total PCB Mass in Surface Sediment for Remedial Alternatives Calculated Using the Bed Composition Model

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Memorandum

To: EPA and Ecology

From: AECOM

Subject: Change in Total PCB Mass in Surface Sediment for Remedial Alternatives Calculated Using the Bed Composition Model

Date: October 15, 2012

On behalf of the Lower Duwamish Waterway Group (LDWG), this memorandum addresses U.S. Environmental Protection Agency (EPA) and Washington State Department of Ecology (Ecology) comments (General Comment 1 and Specific Comment 177)[1] on the Draft Final Feasibility Study (FS) and direction from the FS comment resolution meetings held on March 21, April 8, and April 26, 2011 among LDWG, EPA, and the U.S. Army Corps of Engineers (USACE). Calculations were performed in accordance with these discussions and are presented in this memorandum.

For each remedial alternative, this memorandum summarizes the changes in the mass of total polychlorinated biphenyls (PCBs) in surface sediments of the entire LDW both at the completion of construction and following the 45-year period over which natural recovery was modeled in the FS. Within the active footprint for each remedial alternative, the change in PCB mass occurs from dredging, as well as from non-removal actions (capping and enhanced natural recovery/*in situ treatment* [ENR/*in situ*]). The changes in PCB mass that occur as a result of natural recovery processes both within the active footprint after construction and outside of the active footprint are included in this memorandum.

The change in the mass of PCBs does not necessarily represent PCBs removed from the LDW. It represents the mass of PCBs that is predicted to no longer be present in the surface sediment (the primary exposure pathway) either through removal (dredging), burial (capping, ENR/*in situ*), or natural recovery via deposition of upstream-source sediments from the Green/Duwamish River. The change in PCB mass attributed to both the active remediation activities and natural recovery is calculated over the entire 441 acres of the LDW.

[1] EPA/Ecology comments received February 25, 2011 on the Draft Final Feasibility Study submitted October 15, 2010.

Methods

The change in PCB mass was based on two processes accounted for by the bed composition model (BCM):

- When a remedial alternative footprint is actively remediated, the total PCB concentration in that footprint was changed to an assumed post-remedy bed sediment replacement value (60 or 20 micrograms per kilogram dry weight [µg/kg dw] for grid cells in Areas of Potential Concern 1 and 2, respectively).
- Natural recovery decreases the mass of PCBs in the surface sediment as contaminated sediment is buried (below the biologically active zone) by cleaner upstream-source sediment.

As discussed below, the change in PCB mass was evaluated at two time periods for each remedial alternative: immediately after construction and at the end of the 45-year BCM period.

Immediately After Construction

For each remedial alternative, the change in PCB mass was calculated immediately after construction for:

- **The active footprint:** This represents the change in mass due to active remediation alone. This area includes the EAAs.
- **The entire LDW (441 acres):** This represents the change in mass due to both natural recovery and active remediation. It is assumed that natural recovery processes reduce the surface sediment concentrations of total PCBs in areas beyond the active remedial footprint. In the case of remedial alternatives that take more than 5 years to complete, natural recovery also occurs in the smaller, incremental footprints that are remediated prior to the end of construction for the entire remedial alternative. For example, construction of Alternative 6C takes 15 years, while Alternative 5C is completed by year 5.[2] Therefore, the footprint of Alternative 5C is subject to 10 years of natural recovery while remediation of the incremental footprint of Alternative 6C (the footprint beyond 5C) is under construction. By the same token, the early action areas (EAAs) would be subject to 15 years of natural recovery by the completion of construction of Alternative 6C.

The dry weight mass of surface sediments across the entire LDW was first calculated by multiplying the volume of the surface sediment (441 acres multiplied by a 10-cm depth)

[2] Construction years are rounded to the nearest 5-year interval in the BCM for this analysis.

by a uniform dry bulk density for LDW surface sediments (60.4 pcf)[3], with unit conversions. The mass of total PCBs in surface sediments (at baseline and immediately after construction) was then calculated by multiplying the dry weight mass of surface sediments by the BCM-predicted site-wide SWACs from Table 9-2a.

The mass of total PCBs within each active footprint prior to construction (at baseline) was calculated by multiplying the dry weight mass of the sediments within each active footprint by the average baseline total PCB concentration within the active footprint (the SWAC of the active footprint). Following construction, the mass of total PCBs within each active footprint was calculated by multiplying the dry weight mass of the sediments within each active footprint by the applicable post-remedy bed sediment replacement value.

The equation used to calculate change in PCB mass is:

$$\Delta m_c = c_o m_s - c_f m_s \qquad \text{Equation 1}$$

Where:

- Δm_c is the reduction in mass of PCBs in the upper 10 cm for the given area
- c_o is the baseline PCB SWAC for the given area
- m_s is the dry weight mass of sediment in the upper 10 cm for the given area
- c_f is the final PCB SWAC for the given area (immediately after construction)

For the change in mass in the entire LDW, c_o is the site-wide baseline SWAC, and c_f is the site-wide SWAC at the end of construction (see Table 9-2a). For the change in mass attributable to active remediation, c_o is the baseline SWAC within the active footprint, and c_f is the post-remedy bed sediment replacement value. The reduction in the mass of PCBs attributable to natural recovery alone is the difference between the site-wide change in PCB mass and the change in PCB mass attributable to active remediation:

$$\Delta m_{c(NR)} = \Delta m_{c(site\text{-}wide)} - \Delta m_{c(active)} \qquad \text{Equation 2}$$

Where:

- $\Delta m_{c(NR)}$ is the change in site-wide mass of PCBs in the upper 10 cm attributable to natural recovery
- $\Delta m_{c(site\text{-}wide)}$ is the change in site-wide mass of PCBs (entire LDW) in the upper 10 cm, which is attributable to both active remediation and natural recovery
- $\Delta m_{c(active)}$ is the change in mass of PCBs in the upper 10 cm within the actively remediated footprint

[3] pcf = pounds per cubic foot. *Lower Duwamish Waterway Remedial Investigation, Remedial Investigation Report, Final*. Windward Environmental, LLC. July 9, 2010. p. 30.

Over 45-year Model Period

Additionally, the change in PCB mass for the entire LDW was calculated at the end of the 45-year BCM period by the same method as above, with the exception that c_f is the site-wide PCB SWAC at the end of the 45-year model period (see Table 9-2a). It is assumed that natural recovery processes continue to change the PCB mass in surface sediments from the completion of construction through the end of the 45-year period.

For the smaller remedial alternatives that take 5 or fewer years to complete, natural recovery processes occur over four decades following construction. For remedial alternatives that take more than 5 years to complete, natural recovery processes occur over varying lengths of time within the incremental active remediation footprints, depending on when each was completed.

Results

Table 1 presents the end-of-construction changes in the PCB mass in surface sediments for each remedial alternative. Changes in mass are presented within the active footprint of each remedial alternative (attributable only to active remediation), for the entire LDW (attributable to both construction and natural recovery), and attributable to natural recovery alone.

The "end of construction" varies widely among the remedial alternatives because of the range in construction years (3 to 42 years). Therefore, the predicted change in site-wide PCB mass was also calculated after the 45-year BCM period (Table 2). The change in PCB mass attributable to active remediation is also reported relative to the overall change in PCB mass at the end of the 45-year BCM period (which is due to both active remediation and natural recovery).

Active remediation of the EAAs, prior to the start of any remedial alternative, is estimated to result in the largest change in PCB mass. It accounts for approximately 50% of the overall change in PCB mass over the 45-year BCM period. The progressions from Alternatives 2R through 5R and from Alternatives 3C through 5C result in relatively small incremental reductions in the PCB mass attributable to active remediation (i.e., each step up through the progression removes only an additional 1 to 4 kg of PCBs). However, because Alternatives 6R and 6C actively remediate a fairly large surface area (145 acres beyond that actively remediated by Alternatives 5R and 5C), they achieve a larger incremental reduction in PCB mass (i.e., 12 kg), even though total PCB surface concentrations within the footprint of Alternative 6 are lower (< 240 µg/kg dw). After 45 years, all of the remedial alternatives achieve a nearly identical site-wide reduction in PCB mass (approximately 53 kg relative to a baseline PCB mass of 60 kg). As the remedial alternatives get larger, the PCB mass reduction attributable to active

remediation increases while the mass reduction attributable to natural recovery decreases.

Table 3 presents the same summary information as Table 1, but illustrates the incremental contribution from sequential active remediation from Alternative 1 through Alternative 6. In addition, this table helps explain the change in PCB mass calculation attributable to natural recovery over time.

Table 1 Change in PCB Mass in the Top 10 cm of Sediment at the End of Construction

Remedial Alternative	Construction Completion (BCM years)[a]	Site-wide PCB Mass (kg)			Cumulative Area Actively Remediated (acres with EAAs)	Cumulative Change in PCB Mass (kg) at the End of Construction	
		Baseline[b]	At End of Construction[c]	Change		Attributable to Active Remediation[d]	Attributable to Natural Recovery[e]
Alternative 1 (EAAs)	Before year 0	60	35	25	29	25	0
Alternative 3C	5	60	18	42	87	33	9
Alternative 4C	5	60	14	46	136	36	10
Alternative 5C	5	60	12	48	186	39	9
Alternative 6C	15	60	10	50	331	48	2
Alternative 2R	5	60	19	41	61	31	10
Alternative 3R	5	60	18	42	87	33	9
Alternative 4R	10	60	14	46	136	36	10
Alternative 5R	15	60	12	48	186	39	9
Alternative 6R	40	60	10	50	331	48	2

Notes:

a. Construction periods rounded to the nearest 5 years, corresponding to output of the BCM.

b. PCB mass was calculated from the site-wide SWAC at baseline (Year 0).

c. PCB mass was calculated from the site-wide SWAC predicted at the completion of construction, using mid BCM input parameters; see Table 9-2a.

d. See text for explanation of the calculation of these values.

e. Change in PCB mass attributable to natural recovery was calculated for each remedial alternative as the site-wide (entire LDW) change in PCB mass at the end of construction minus the change in PCB mass attributable to active remediation.

BCM = bed composition model; EAAs = early action areas; C = combined technology emphasis; alternative; cm = centimeters; kg = kilogram; PCB = polychlorinated biphenyl; R = removal emphasis; SWAC = spatially weighted average concentration.

Table 2 Change in PCB Mass in the Top 10 cm of Sediment at the End of 45-Year BCM Period

Remedial Alternative	Site-wide PCB Mass (kg)			Cumulative Change in PCB Mass (kg) at the End of 45-Year BCM Period	
	Baseline[a]	At End of 45-Year BCM Period[b]	Change	Change in PCB Mass (kg) Attributable to Active Remediation[c] (Percent of Total Change)	Change in PCB Mass (kg) Attributable to Natural Recovery[d] (Percent of Total Change)
Alternative 1 (EAAs)	60	7.4	52.6	25 (48%)	27.6 (52%)
Alternative 3C	60	7.2	52.8	33 (63%)	19.8 (37%)
Alternative 4C	60	7.1	52.9	36 (68%)	16.9 (32%)
Alternative 5C	60	7.1	52.9	39 (74%)	13.9 (26%)
Alternative 6C	60	6.9	53.1	48 (90%)	5.1 (10%)
Alternative 2R	60	7.4	52.6	31 (59%)	21.6 (41%)
Alternative 3R	60	7.2	52.8	33 (63%)	19.8 (37%)
Alternative 4R	60	7.1	52.9	36 (68%)	16.9 (32%)
Alternative 5R	60	7.1	52.9	39 (74%)	13.9 (26%)
Alternative 6R	60	6.7	53.3	48 (90%)	5.3 (10%)

Notes:

a. PCB mass was calculated from the site-wide SWAC at baseline (Year 0).

b. PCB mass was calculated from the site-wide SWAC predicted at the end of the 45-year BCM period, using mid BCM input parameters; see Table 9-2a.

c. Values from Table 1.

d. Change in PCB mass attributable to natural recovery was calculated for each remedial alternative as the site-wide (entire LDW) change in PCB mass at the end of the 45-year BCM period minus the change in PCB mass attributable to active remediation.

BCM = bed composition model; EAAs = early action areas; C = combined-technology emphasis; cm = centimeters; kg = kilogram; LDW = Lower Duwamish Waterway; PCB = polychlorinated biphenyl; R = removal-emphasis; SWAC = spatially-weighted average concentration.

Table 3 Example Calculation of Incremental Change in Mass Attributable to Active Remediation and Natural Recovery – at End of Construction

Remedial Alternative Dredged	Change in PCB Mass Associated with Active Remediation of Each Incremental Footprint (kg)							Cumulative Change in PCB Mass Attributable to Active Remediation (kg)[a]	Cumulative Change in PCB Mass Attributable to Active Remediation and Natural Recovery (kg)[b]
	EAAs	2R	3R	4R	5R	6R	Rest of LDW		
Alternative 1 (EAAs)	25	*No NR*						25	25
Alternative 2R	25	6	*5 years of NR in EAAs and rest of LDW*					31	41
Alternative 3R	25	6	2	*5 years of NR in EAAs and rest of LDW*				33	42
Alternative 4R	25	6	2	3	*5 years of NR in Alts 2R and 3R; 10 years of NR in EAAs and rest of LDW*			36	46
Alternative 5R	25	6	2	3	3	*5 years of NR in Alt 4R; 10 years of NR in Alts 2R and 3R; 15 years of NR in EAAs and rest of LDW*		39	48
Alternative 6R	25	6	2	3	3	9	*25 years of NR in Alt 5R; 30 years of NR in Alt 4R; 35 years of NR in Alts 2R and 3R; 40 years of NR in EAAs and rest of LDW*	48	50

Notes:
a. Sum of unshaded cells in row and values from Table 1.
b. Values from Table 1.

EAA = early action area; kg = kilogram; LDW = Lower Duwamish Waterway; NR = natural recovery; PCB = polychlorinated biphenyls; R = removal alternative

Part 4: Food Web Model Sensitivity

Prepared by Windward Environmental, LLC

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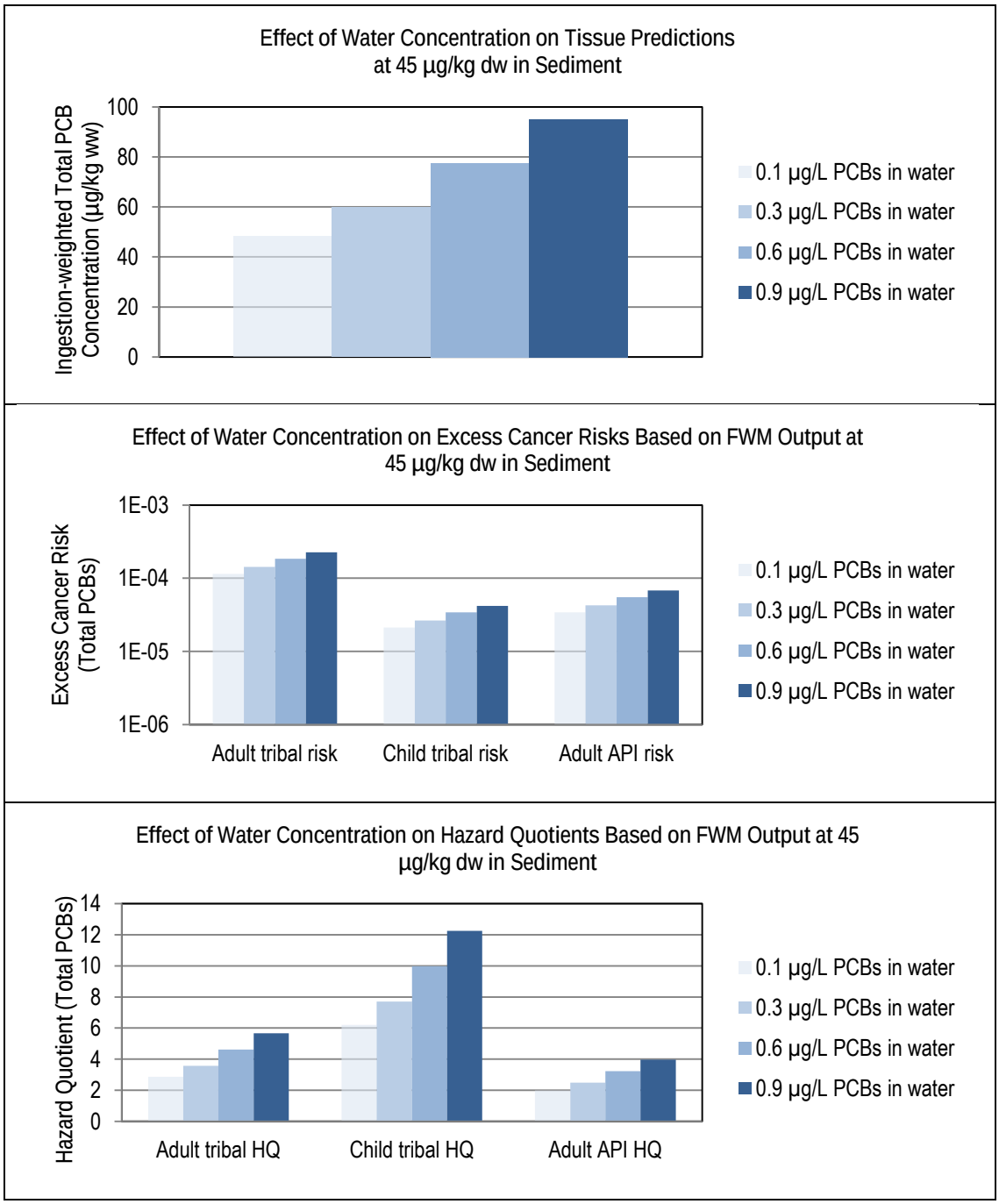
Figure 1 PCB FWM Output and Related Human Health Risk Based on Different Assumptions of Total PCB Concentrations in Water



Notes:

1. A total PCB concentration in sediment of 45 µg/kg dw was selected for the sensitivity analysis because this is the approximate long-term average sediment concentration for the various alternatives.
2. Although a total PCB concentration of 0.1 µg/L was evaluated for the sensitivity analysis, the existing data for the Green River upstream of the LDW suggest this concentration was be unrealistically low for the LDW.

API = Asian Pacific Islander; dw = dry weight; FWM = food web model; HQ = hazard quotient; kg = kilograms; L = liters; µg = micrograms; PCB = polychlorinated biphenyl; ww = wet weight

Figure 2 PCB FWM Output and Related Human Health Risk Based on Alternate BCM Scenarios

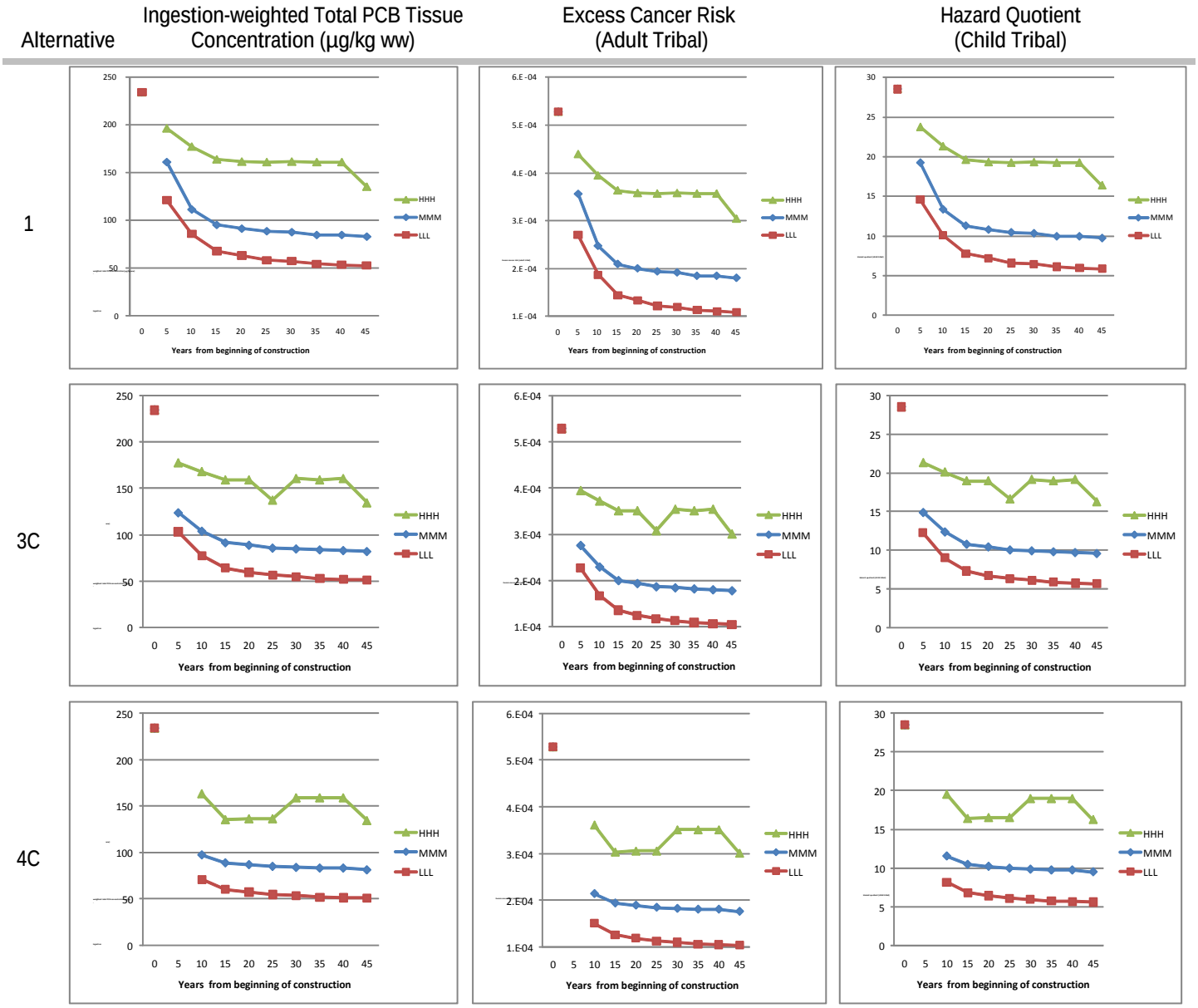


Figure 2 PCB FWM Output and Related Human Health Risk Based on Alternate BCM Scenarios (continued)

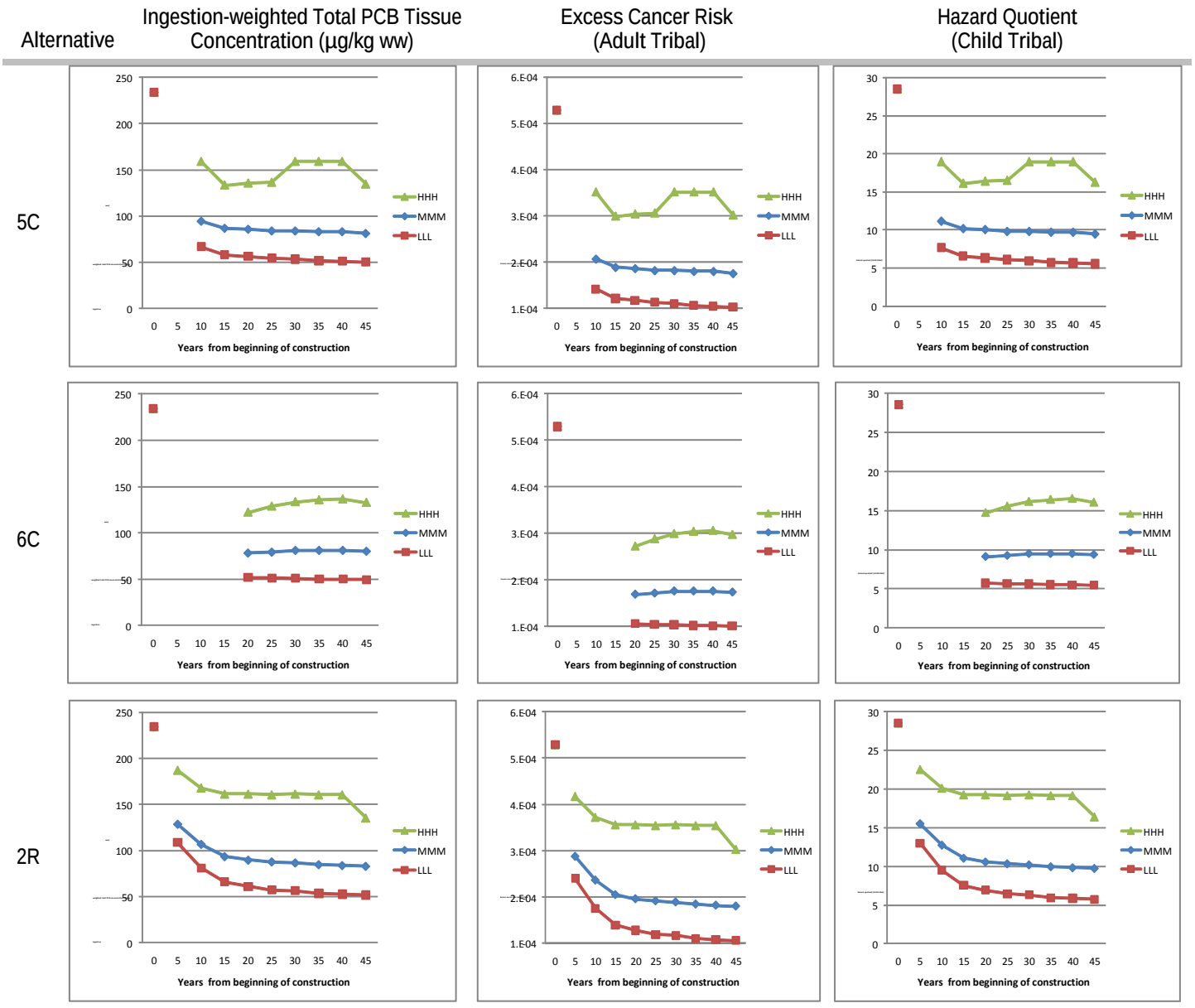


Figure 2 PCB FWM Output and Related Human Health Risk Based on Alternate BCM Scenarios (continued)

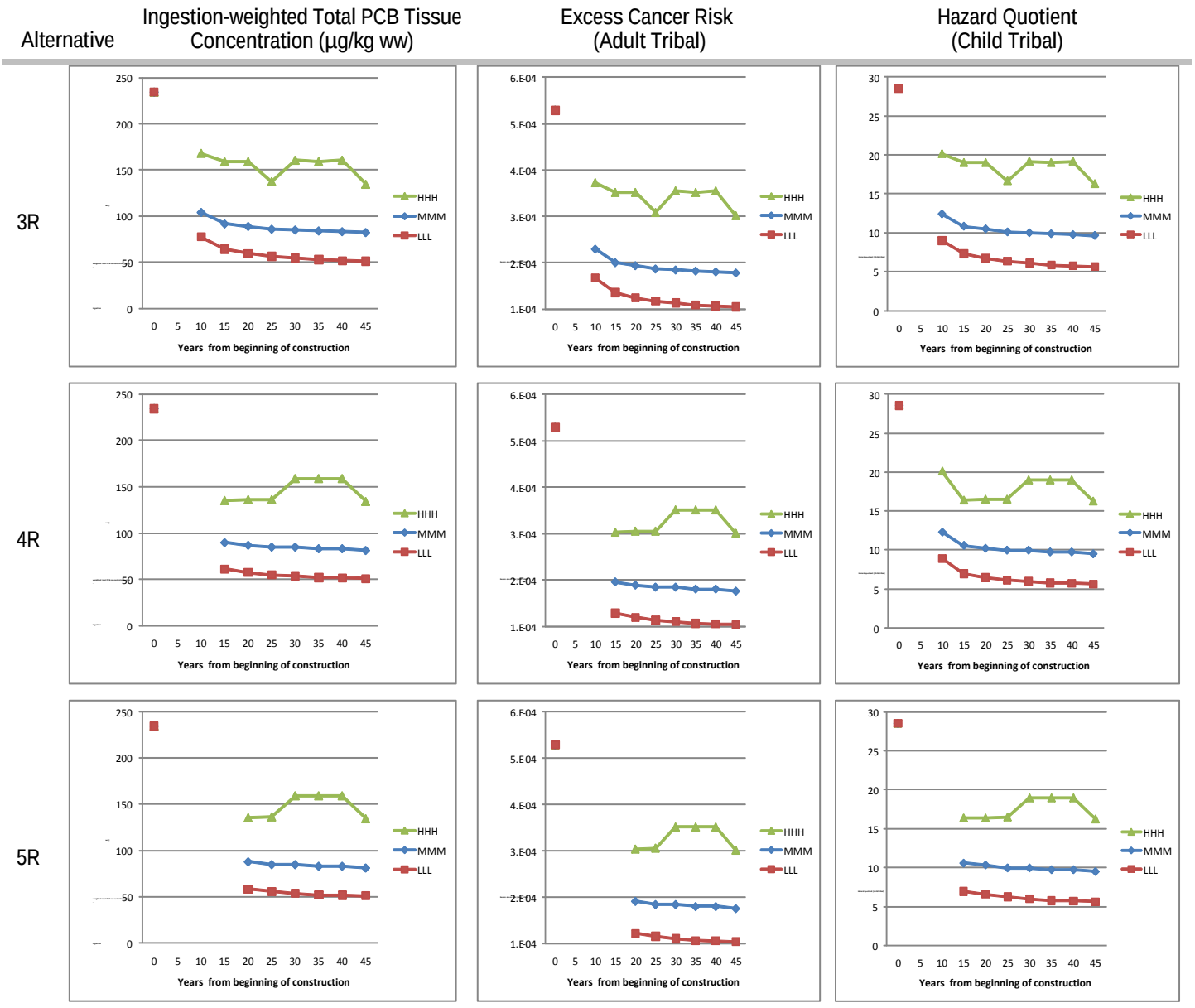
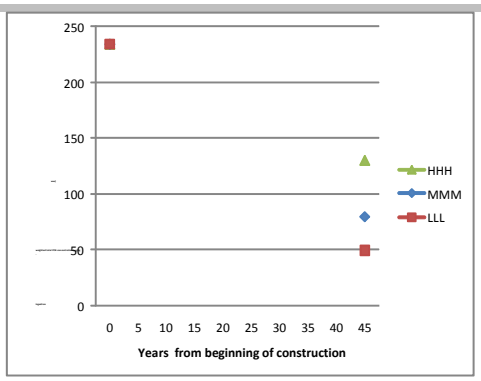
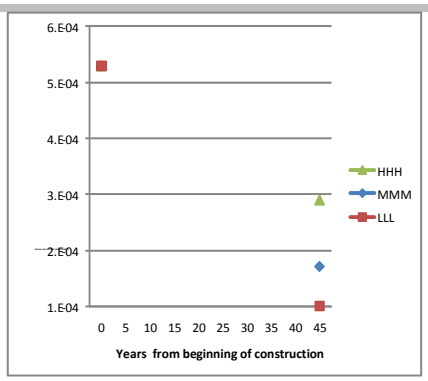
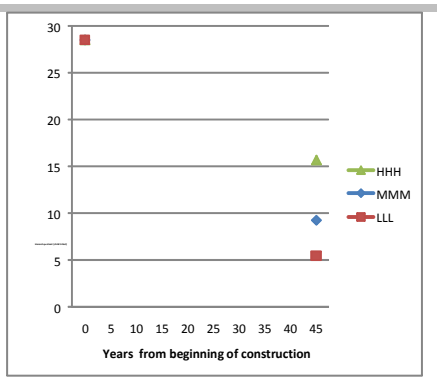


Figure 2 PCB FWM Output and Related Human Health Risk Based on Alternate BCM Scenarios (continued)

Alternative	Ingestion-weighted Total PCB Tissue Concentration (µg/kg ww)	Excess Cancer Risk (Adult Tribal)	Hazard Quotient (Child Tribal)
6R			

Notes:

1. Model output is not shown for construction years, given the high uncertainty of model predictions under those conditions.
2. The exposure scenarios shown for excess cancer risk and hazard quotient are the highest among the reasonable maximum exposure scenarios. The shape of the curves would be identical for the other exposure scenarios.
3. The BCM input parameters for total PCBs (in µg/kg dw) used in the three scenarios are: 1) Low-Low-Low (LLL): upstream = 5; lateral = 100; bed sediment replacement value = 30 (AOPC 1), 10 (AOPC 2); 2) Mid-Mid-Mid (MMM): upstream = 35; lateral = 300; bed sediment replacement value = 60 (AOPC 1), 20 (AOPC 2), and 3) High-High-High (HHH): upstream = 80; lateral = 1,000; bed sediment replacement value = 90 (AOPC 1), 40 (AOPC 2).
4. Excess cancer risks estimated using the FWM, alternative-specific total PCB SWACs in surface sediment (Section 9, Table 9-2a of the FS), and assumed surface water dissolved total PCB concentrations of 0.6 ng/L, except 0.9 ng/L for Year 0 for all alternatives and Year 5 for Alternative 1.

AOPC = area of potential concern; BCM = bed composition model; FWM = food web model; kg = kilograms; L = liters; µg = micrograms; ng = nanograms; PCB = polychlorinated biphenyl; ww = wet weight

Part 5: Potential Increase in Surface Sediment Concentrations Due to Disturbance of Subsurface Sediments

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Memorandum

To: EPA and Ecology

From: Lower Duwamish Waterway Group

Subject: **Potential Increase in Surface Sediment Concentrations Due to Disturbance of Subsurface Sediments**

Date: October 15, 2012

The potential for remaining subsurface sediment contamination to be exposed following active remediation of the Lower Duwamish Waterway (LDW) is evaluated as one component of long-term effectiveness of the remedial alternatives presented in this feasibility study (FS). This memorandum presents a method for estimating the potential effect of disturbance events on surface sediment concentrations along with results of the evaluation. The method was developed based on discussions among the Lower Duwamish Waterway Group (LDWG), the U.S. Environmental Protection Agency (EPA), the Washington State Department of Ecology (Ecology), and the U.S. Army Corps of Engineers (USACE) on October 25, 2011, March 6, 2012, and April 12, 2012 and comments received from EPA on April 23, 2012 and July 12, 2012. It provides a tool for evaluating the potential impact of these deep disturbance events, without attempting to determine the cause or estimate the spatial extent of these disturbances.

Introduction

The potential effects of vessel propeller wash from routine operations in the navigation channel and maneuvering in/out of berthing areas, and from high-flow scour on LDW sediment stability were identified in the FS by analyzing several lines of evidence, including bathymetric contours, vessel traffic patterns, and model predictions. Recently, concern has been raised by EPA and Ecology regarding the potential effect of other types of deep disturbance events, such as vessels traveling outside of frequent lanes of operation, vessels operating with excessive propeller power in berthing areas or elsewhere, barge groundings, emergency maneuverings, changes in the patterns of site use, maintenance of overwater structures, and earthquakes on predicted future surface sediment contaminant concentrations. There is some indication, based on contaminant profiles in some cores and geochronological data, that deep disturbance events may hinder recovery at localized areas. However, the frequency and magnitude of these events is unknown.

The STM and bed composition model (BCM), which were used to predict future surface sediment contaminant concentrations for the remedial alternatives (e.g., see FS Sections 5 and 9), did not incorporate these disturbance events into the long-term

model-predicted surface sediment contaminant concentrations in the LDW. Although the frequency, magnitude, and impact of individual disturbance events is not known, methods were sought to estimate bounds on their cumulative impacts.

This memorandum presents a method for estimating the potential effect of the disturbance events mentioned above. Such events could cause erosion or scour that would expose humans or organisms to contaminated subsurface sediments. The potential magnitude of these effects was estimated using the site-wide spatially-weighted average concentration (SWAC) for total polychlorinated biphenyls (PCBs). This method takes into account: 1) potential sediment disturbance in any area of the waterway, and 2) subsurface sediment contaminant concentrations. Results are presented for all remedial alternatives. [1]

Methods and Assumptions

An equation was developed to estimate the long-term site-wide SWAC based on a hypothetical area of disturbance, a fraction of the disturbance area that results in exposure, and a concentration in the exposure area:

$$C' = C_{lt} + \frac{A_d F_e (C_e - C_{lt})}{A_t}$$

Where:

C′ = site-wide total PCB SWAC

$\mathbf{C_{lt}}$ = long-term BCM-predicted total PCB SWAC (assumed to be 40 micrograms per kilogram dry weight [µg/kg dw] for all remedial alternatives)

$\mathbf{A_d}$ = total area (acres) disturbed in areas of potential concern (AOPCs) 1+2

$\mathbf{F_e}$ = fraction of the total disturbance area that has the potential to expose subsurface contaminants (assumed to equal the area of ENR+MNR+VM+AOPC 2[2] for each alternative divided by the total area of AOPCs 1+2; this is equivalent to the total area within AOPCs 1+2 that is outside the EAAs and capped or dredged areas)

[1] In addition, in FS Section 5.3.2.7, a first-order sensitivity evaluation was developed to estimate the potential impact of vessels operating under normal operations to create potential scour and alter the STM/BCM predictions. That evaluation assumed that areas of the LDW with evidence of vessel scour (i.e., Recovery Category 1 areas) do not undergo natural recovery because continual disturbance from normal vessel operations could reduce accumulation of layers of cleaner upstream sediments, thereby hindering recovery. Results were presented for Alternatives 3C and 3R.

[2] ENR = enhanced natural recovery, MNR = monitored natural recovery, VM = verification monitoring.

C_e = total PCB SWAC in the exposure area, assumed to be equal to the average sediment concentration in the 0- to 2-ft interval of cores outside of the EAAs and dredged and capped areas (i.e., cores inside of ENR+MNR+VM+AOPC 2 areas for each alternative)

A_t = total area of the site (441 acres)

Figure 1 presents a schematic of the variables, and Table 1 presents the input values. The equation shown above calculates a site-wide SWAC (C') for each alternative, assuming a sediment concentration (C_e) in exposure areas (A_dF_e) and the long-term BCM-predicted concentration of 40 µg/kg dw (C_{lt}) in non-exposure areas. The area calculated to have subsurface exposure (A_dF_e) is assumed to have a total PCB concentration equal to the average total PCB concentration (C_e) in the upper 2 ft of sediment cores. The disturbance is assumed to be limited to the upper 2 ft of the sediment core. The average total PCB concentration was determined for sediment cores located in ENR, MNR, VM, and AOPC 2 footprints after active remediation. The area that does not result in exposure includes all areas outside of the disturbance area, and areas within that disturbance area that would not result in exposure (i.e., areas that have been dredged or capped). In those areas, the surface sediment concentration is assumed to equal the long-term BCM-predicted concentration (C_{lt}).

This simplified model of disturbance effects on the SWAC is sufficient for the purpose of this analysis, but contains some simplifying assumptions:

- The long-term total PCB SWAC without disturbance effects (C_{lt}) is assumed to be 40 µg/kg dw for all remedial alternatives. BCM sensitivity runs indicate that the long-term SWAC is likely to fall within the range of 5 µg/kg dw to 80 µg/kg dw.
- The area of disturbance within AOPCs 1+2 (A_d) is expressed as a range from 0 to 45 acres, with 45 acres representing 10% of the total waterway. The most likely area that may be disturbed is not defined for this analysis, nor is the location-specific disturbance mechanism. Disturbance is assumed to have an equal chance of occurring anywhere in AOPCs 1+2 without accounting for factors such as proximity to berthing areas, bathymetric evidence of scour, water depth, or contaminant evidence of vessel scour.
- Areas with empirical evidence of disturbance were classified as Recovery Category 1 areas (not likely to recover) and were assigned technologies such as dredging or armored capping when concentrations of contaminants of concern (COC) in the top 2 ft of sediments exceeded the RALs. This mitigates the impacts of disturbance in all remedial alternatives to varying degrees, with more of the Category 1 areas addressed through dredging or capping in higher-numbered alternatives (see FS Section 8). However, the empirical evidence used to delineate Recovery Category 1 such as the sun-illuminated

interpretations of sediment elevation are unlikely to detect disturbed areas that have filled in. This memorandum addresses disturbances that could occur anywhere in the waterway.

- The recurring fraction of the area disturbed (i.e., that would be continuously exposed over time) that could result in exposure (F_e) is assumed to be equal to the total area remediated by ENR or passively remediated (MNR+VM+AOPC 2) divided by the total area of AOPCs 1+2. As discussed above, this calculation assumes that exposure of subsurface contamination has an equal chance of occurring anywhere in AOPCs 1+2, without considering location-specific conditions.
- The total PCB SWAC in the exposure area is assumed to be equal to the average subsurface total PCB concentration (C_e) in the upper 2 ft of cores in that area (ENR+MNR+VM+AOPC 2).[3,4] The estimation of C_e does not factor in: 1) new sedimentation over the long term, 2) the addition of sand material in ENR/*in situ* areas, 3) repeated disturbance events in localized areas, 4) adaptive management measures to mitigate these disturbances, and 5) that actual subsurface concentrations may differ from those used in this analysis because of the potentially unrepresentative distribution of cores. These conditions, which would effectively lower the average concentration in the 0- to 2-ft depth range, were not factored into the analysis. Factoring these conditions in might mitigate some of the increases in predicted SWACs in this analysis. In addition to change in the SWAC, time is also a factor because ongoing deep disturbances could result in longer recovery times needed to achieve the cleanup objectives.

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[3] The average concentration of core data in the upper 2 ft is considered reasonable for this analysis because sediment is resuspended/mixed after disturbance then homogenized into average concentrations from the disturbed interval. It represents the net effect of disturbance events. It also represents the average concentration exposed from a range of scour events between 0 and 2 feet deep. Upper bound values, such as the 95% upper confidence limit on the mean or maximum concentrations were not used because of the skewed distribution of core sampling locations and the preponderance of cores collected in hotspot areas.

[4] The vertically-weighted average total PCB concentration for each core was calculated following these steps: 1) identify all samples in a core overlapping the 0- to 2-ft depth interval; 2) calculate the thickness of overlap between the samples and the 0- to 2-ft interval (e.g., a sample collected from the 1- to 3-ft depth interval has a 1-ft thick overlap with the desired 0- to 2-ft interval); 3) multiply the sample concentration by the thickness of overlap for each sample (concentration*thickness); 4) sum all the concentration*thicknesses for samples that overlap the 0- to 2-ft interval; and 5) divide the result of step #4 by the sum of all the thicknesses for samples that overlap the 0- to 2-ft interval. This calculation effectively weights thicker intervals more than thinner intervals (within the 0- to 2-ft interval) and ignores intervals that do not have data (intervals that were not analyzed). After a vertically-weighted average concentration was calculated for each core, the average concentration of all cores of interest was calculated without weighting (i.e., each core in an area of interest was weighted equivalently).

- One factor that can influence the extent of scour effects from maneuvering vessels is water depth. The energy generated by a propeller decreases exponentially away from the source with water depth. Deeper water depths could limit the areas available for potential deep disturbance but were not factored into this analysis.

Results

The results are presented in Figure 2 for disturbance areas ranging from 0 acres to 45 acres, representing up to 10% of the total waterway, or 15% of AOPCs 1+2. This data range provides a first-order estimate on the bounds of reasonable minimum acreage (0 acres) to maximum acreage (45 acres) of continuously exposed subsurface contamination from repetitive disturbance events. These acreages are used to bound the possible effects on the predicted total PCB SWAC since the frequency and magnitude of these events is unknown. At 45 acres, the site-wide SWACs range from 40 µg/kg dw (Alternative 6R) (i.e., no change from the long-term model-predicted SWAC) to 80 µg/kg dw (Alternative 1), with the other alternatives in between, generally proportional to the acres of dredging and capping for each.

References

U.S. Environmental Protection Agency (EPA) 2012. *Memorandum: Agency Review of Evaluation of Disturbance Events* Provided on April 12, 2012. April 23, 2012.

Table 1 Input Parameters for Estimating Potential Change in the Site-wide SWAC Resulting from Disturbance of Subsurface Sediments

Parameter			Remedial Alternative									
Row #	Variable	Description	1	2R	3R	4R	5R	6R	3C	4C	5C	6C
Input - Areas of Interest (acres)												
1		Area that could have a disturbance (AOPCs 1+2)	302	302	302	302	302	302	302	302	302	302
2		Area that could result in an exposure due to disturbance (AOPC 1+2 excluding EAAs, dredged and capped areas; equivalent to the total ENR+MNR+VM+AOPC 2 area)	302	270	245	195	146	0	254	212	199	101
3	F_e	Fraction of potential disturbance area that could result in exposure of subsurface contamination (Row 2 divided by Row 1)	1.00	0.89	0.81	0.65	0.48	0.00	0.84	0.70	0.66	0.33
4	A_t	Total FS study area	441	441	441	441	441	441	441	441	441	441
Input - Total PCBs Concentrations of Interest (µg /kg dw)												
5	C_{lt}	Long-term SWAC in non-exposure areas	40	40	40	40	40	40	40	40	40	40
6	C_e	Long-term SWAC in exposure areas (assumed to equal the mean concentration in the upper 2 ft of cores in FS baseline dataset in areas that could result in exposure, i.e., areas in Row 2)[a]	431	394	300	332	253	n/a	356	409	343	352

Notes:

a. The long-term SWAC in exposure areas (C_e) is assumed to equal the mean concentration in the upper 2 ft of cores in the baseline dataset in potential exposure areas (i.e., the areas in Row 2). Therefore, the calculation does not account for natural recovery in shallow subsurface sediment, mixing with surface sediment, or mixing with ENR/*in situ* material. Note that some counter-intuitive trends occur in subsurface concentrations between alternatives (e.g., Alternatives 3C and Alternative 4C). These are not considered to be significant and are attributable to the small numbers of cores used to calculate averages for the larger alternatives.

AOPC = area of potential concern; C = combined; EAA = early action area; ENR = enhanced natural recovery; FS = feasibility study; MNR = monitored natural recovery; R = removal; SWAC = spatially-weighted average concentration; VM = verification monitoring

Figure 1 Representation of Site, Disturbance Area, and Exposure Area

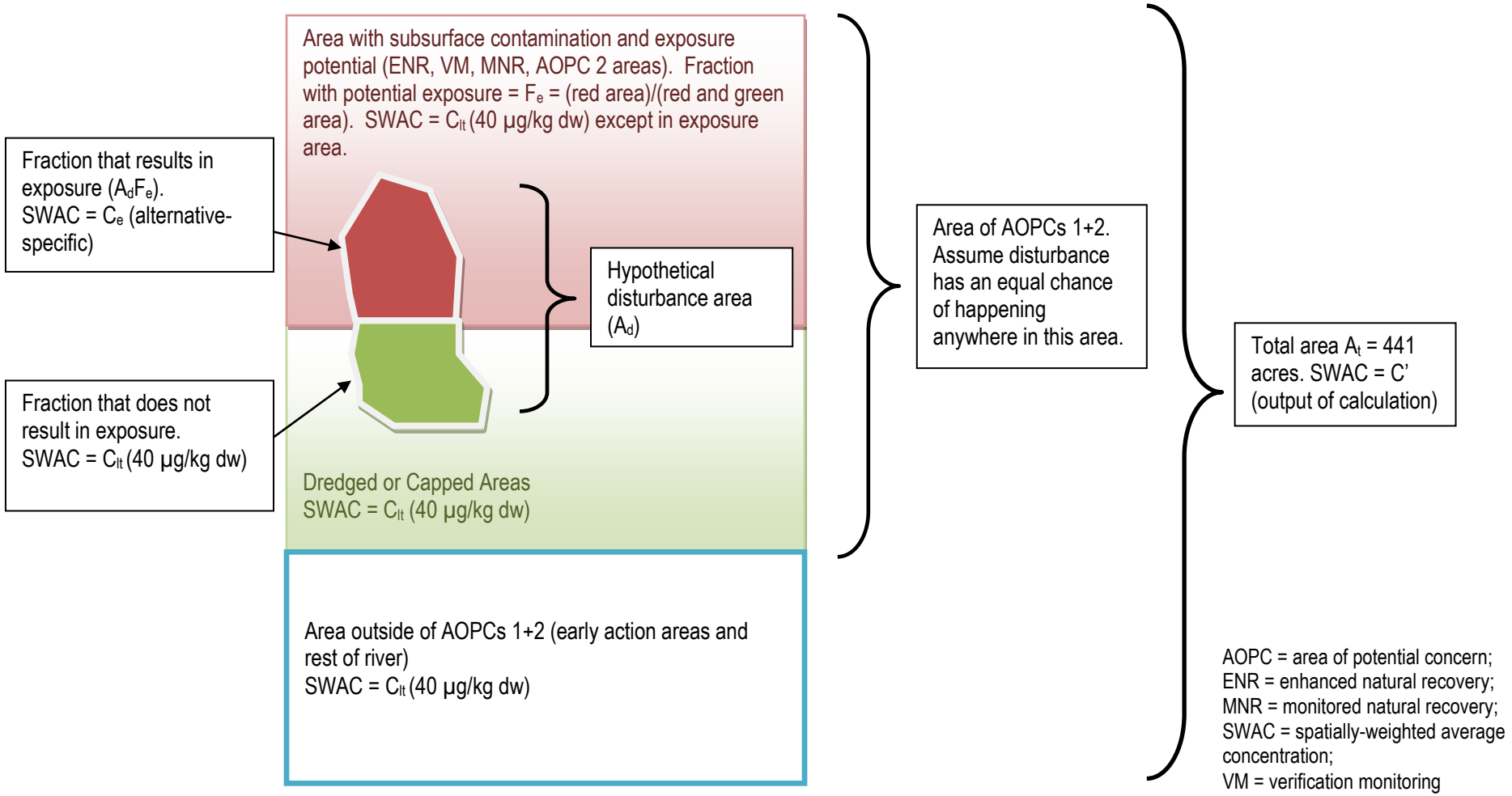
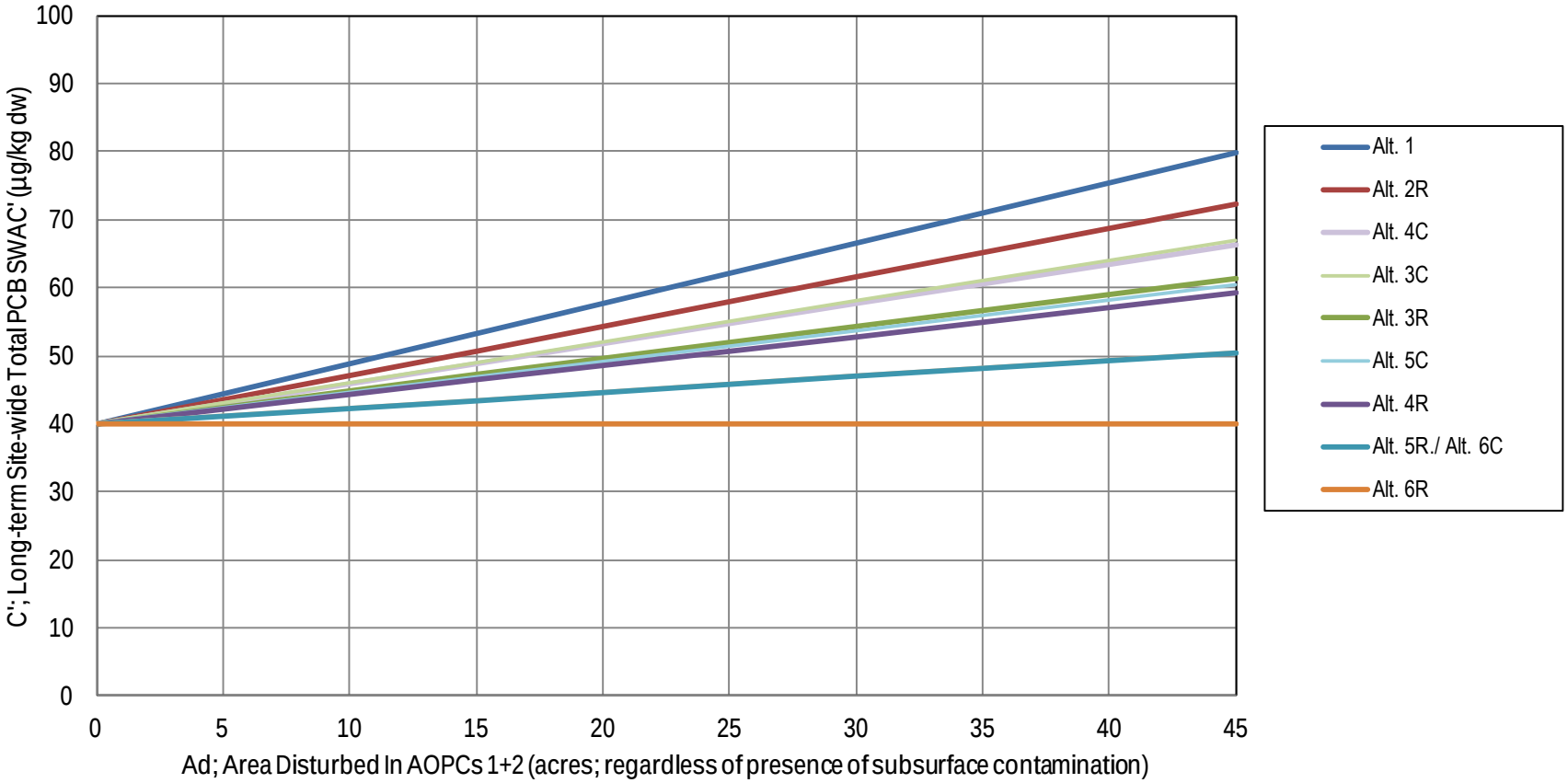


Figure 2 Estimates of Potential Change in the Site-wide SWAC Resulting from Disturbance of Subsurface Sediments



Notes:
1) For comparison, all alternatives are assumed to have the same long-term SWAC without any disturbance (40 µg/kg dw).

AOPC = area of potential concern; C = combined; PCB = polychlorinated biphenyl; R = removal; SWAC = spatially-weighted average concentration