Lower Duwamish Waterway Group

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

Date	February 22, 2013
To	Allison Hiltner and Karen Keeley, EPA
CC	Andrew Smith and Ron Timm, Ecology
From	Lower Duwamish Waterway Group
Subject	**Development of the Final Technology Assignments and Modifications to Alternative 5C Plus Scenario 5a in Support of EPA's Preferred Alternative**

On November 11, 2012, EPA provided comments to LDWG on the Draft Technical Memorandum: Supplement to the Feasibility Study for the LDW Superfund Site, Approaches for Addressing Additional Concerns in Alternative 5C and Development of Alternative 5C Plus Scenarios dated September 17, 2012 (referred to as the "Supplemental Scenarios Memorandum"). The memorandum was finalized on December 20, 2012 (AECOM 2012a). EPA requested a version of Scenario 5a with two modifications plus the smoothing out of the GIS-based technology assignment areas, similar to what was done in the feasibility study (FS) (AECOM 2012b) to more realistically reflect implementable areas for active remedial technologies. This memorandum describes how the Scenario 5a footprint was modified and presents the revised areas, volumes, and costs based on these modifications. Also included in this memorandum are additional metrics from the FS related to both short- and long-term effectiveness, such as: long-term spatially-weighted average concentrations (SWACs), post-construction surface and subsurface sediment exceedances of Washington State Sediment Management Standards (SMS) criteria, air quality impacts during construction, and subsurface statistics for remaining PCB contamination in sediment. The modified version of Scenario 5a was requested to support EPA's development of the preferred alternative and will likely be called EPA's Preferred Alternative by EPA.[1] Modifications to Scenario 5a are based on changes specified by EPA direction and do not imply any position by LDWG.

Modifications to Scenario 5a

As described in the Supplemental Scenarios Memorandum, Scenario 5a had surface sediment remedial action levels (RALs) of 2 times sediment quality standards (2xSQS) for SMS contaminants that had been identified as contaminants of concern (COCs) in the remedial investigation (with the exclusion of PCBs and arsenic because they are also human health risk drivers) applied to Recovery Category 2 and 3 areas. For Modified Scenario 5a, EPA has specified that the surface sediment RAL be modified to 2xSQS or the cleanup screening level (CSL), whichever value is lower. As shown in Table 1, this change would reduce the RAL for 19 of 39 non-human health SMS COCs from 2xSQS to the CSL. This change in RALs is reflected in Table 2, which provides all the RALs and upper limits (ULs) for enhanced natural recovery

[1] Also referred to as Remedial Alternative 5C Plus.

(ENR) for Modified Scenario 5a. The surface sample locations above these RALs are shown in Figure 1.

The Supplemental Scenarios Memorandum (AECOM 2012a) and the FS (AECOM 2012b) refer to areas that are not actively remediated (and have surface sediment concentrations below the SQS) as: (a) the area of potential concern (AOPC) 2 outside of AOPC 1, and (b) the remaining study area; both of these are also labeled as "institutional controls, site-wide monitoring" in FS Alternative 5C tables and on figures. For the Proposed Plan, EPA is changing the name of these areas to "MNR[2] Below SQS." For this memorandum, Figure 2 represents Modified Scenario 5a using the same nomenclature as in the FS Supplemental Scenario Memorandum, and Figure 3 represents the data using the nomenclature preferred by EPA for the Proposed Plan. Other than labeling and coloring, there is no difference in how the various areas would be managed between the Supplemental Scenario Memorandum and the Proposed Plan (i.e., in terms of monitoring density, frequency, and contingency actions for sediment).

The Supplemental Scenarios Memorandum assigned technologies based strictly on mapping output from GIS. Best professional judgment (BPJ) was not used to smooth-out the small area and sliver artifacts that often occur during GIS mapping, as was done for all of the FS alternatives. In this memorandum, the Modified Scenario 5a footprint and its technology assignments from the GIS output were smoothed out using BPJ as was done for the alternatives in the FS. Small areas or slivers of technologies were lumped together with nearby technology assignments to make areas that are more realistic for remediation by dredging, capping, and ENR technologies and that would be large enough to remediate with normal equipment. The minimum size was generally set as 100 ft x 100 ft, but smaller technology assignment areas were used where appropriate, based on the waterway's physical features. For example, if a remedial area was based only on the exceedance of an intertidal RAL, the area was truncated at the end of the intertidal area even if the intertidal area was smaller than 100 ft wide. This mapping process has highlighted the uncertainty in the technology assignments for remedial areas that are driven by subsurface RALs and core polygons. Technology assignments for individual areas are likely to be modified as additional data become available during remedial design.

Estimated Areas, Volumes, and Costs

Estimated areas, volumes, and costs are presented in Table 3. The construction time for Modified Scenario 5a is 7 years, the same when rounded as for Scenario 5a in the Supplemental Scenarios Memorandum. The dredge acres increased and the MNR acres decreased in Modified Scenario 5a. This change in acreage occurred for two reasons: performing GIS smoothing[3] for mapping technologies, and decreasing the surface sediment RAL from 2xSQS to the CSL in Recovery Categories 2 and 3. If the smoothing function was applied to Scenarios 5a and 5b in the Supplemental Scenarios Memorandum, it would have the same net effect (more dredging/less MNR in areas currently assigned to MNR). The net difference between Scenario 5a and Modified Scenario 5a is estimated to be only a few acres (assuming the smoothing

[2] MNR is monitored natural recovery.

[3] GIS smoothing accounts for roughly 90% of the changes in acreages assigned to dredging, partial dredging and capping, capping, ENR, or MNR. The change in surface sediment RAL accounts for the remaining change in acreages. The RAL change may affect additional acres when new data are collected.

function was applied to both) based on the RAL change for non-human health SMS contaminants and using the FS baseline dataset (although the uncertainty in this estimate is noted above). The rounded total dredge volume for Modified Scenario 5a remains the same as for Scenario 5a (790,000 cy), because the increased volume resulting from an increase in dredging area was offset by decreased contingency volume due to a decrease in MNR area.

The costs for the Modified Scenario 5a, presented as net present value using a 2.3% discount rate (same as in the FS), are slightly higher than for Scenario 5a in the Supplemental Scenarios Memorandum. A detailed supporting cost estimate for Modified Scenario 5a (including capital costs, present value adjustment, contingencies, agency oversight, reporting, and monitoring costs) is presented in Table 4. In addition, Table 3 provides the estimated net present value costs developed for FS Alternative 5C, Scenario 5a, and the Modified Scenario 5a using 0% and 7% discount rates, consistent with the sensitivity analysis presented in the FS.

Comparative CERCLA Evaluation

Table 5 provides the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) threshold and balancing criteria for Modified Scenario 5a, in addition to the information already provided for the Supplemental Scenarios. Table 5 presents information in the same format as Table 10-1 in the Final FS and Table 11 in the Supplemental Scenarios Memorandum.

Like FS Alternative 5C and the other Supplemental Scenarios, Modified Scenario 5a is predicted to achieve the threshold criterion of overall protection of human health and the environment through varying combinations of engineering controls, natural recovery, and institutional controls. Modified Scenario 5a is not expected to fully comply with the Model Toxics Control Act (MTCA) requirement of natural background preliminary remediation goals (PRGs) (for the three risk-driver COCs with risk-based goals below natural background) or with applicable or relevant and appropriate requirements (ARARs) for water quality.

Modified Scenario 5a has only minor changes to total dredge volume and construction time compared to those for Scenario 5a (see Table 5)[4]; the bed composition model (BCM) predicts that this modified scenario achieves similar SWACs for the four human health risk drivers (PCBs, arsenic, cPAHs, and dioxins/furans) in the same time frames and with equivalent degrees of uncertainty as Scenario 5a (Table 6).

Modified Scenario 5a is predicted to achieve magnitudes of human health and ecological risks equivalent to those for Scenario 5a. Therefore, the predicted times to achieve the cleanup objectives (shown in Table 5) for this modified scenario remain unchanged from those for Scenario 5a in the Supplemental Scenarios Memorandum (AECOM 2012a). Tables 7a, 7b, and 7c present the risks associated with: total PCBs for human health seafood consumption (RAO 1), total PCBs for river otter (RAO 4), and all four risk drivers for human health direct contact (RAO 2).

[4] Modified Scenario 5a has incrementally larger volumes compared to Scenario 5a; however, the differences are not large enough to be evident after rounding to two significant figures (790,664 cy for Modified Scenario 5a compared to 785,216 cy for Scenario 5a).

Table 8 shows the predicted post-construction exceedances of SMS criteria for Modified Scenario 5a. As for Scenario 5a, this modified scenario is predicted to be at or below the SQS within 5 years after the start of cleanup, and has a few predicted point exceedances for phthalates located near outfalls. The BCM output, shown in 5-year increments, does not portray any difference between Scenario 5a and Modified Scenario 5a. However, Modified Scenario 5a reduces uncertainty in meeting the SQS within 10 years by addressing contamination that exceeds the CSL where 2xSQS is greater than the CSL.

Table 9 provides the magnitude of residual risks for Modified Scenario 5a presented as post-construction sediment conditions (long-term effectiveness and permanence criteria). The magnitude of risks is based on the amount of contamination remaining in the subsurface sediments after remediation and the potential for exposure of subsurface contamination. The metrics include: the number of cores remaining in the subsurface, the number of acres of remaining subsurface sediment contamination that could be disturbed, and PCB concentration statistics in the upper 2 ft of sediments, which all indicate only small differences compared to Scenario 5a. Compared to Alternative 5C (Table 10), Modified Scenario 5A reduces the subsurface concentrations in both Recovery Category 1 and Recovery Categories 2 and 3. In addition, Modified Scenario 5a has a low potential to expose remaining subsurface sediment contamination as a result of unanticipated disturbance effects, and has a low potential to affect long-term SWACs.

Modified Scenario 5a ranks similar to Scenario 5a for monitoring and maintenance, because it requires long-term monitoring of a large area, seafood consumption advisories, public outreach, and education programs (Table 5).

In terms of reductions in mobility, toxicity, and volume (Table 5), Modified Scenario 5a is equivalent to Scenario 5a because it does not include any *ex situ* treatment and the areas using *in situ* treatment as a component of ENR have not changed from Scenario 5a.

A summary of the short-term effectiveness metrics is presented in Table 11. Estimates of gas and particulate emissions, energy consumption, landfill capacity consumed, carbon footprint and depleted natural resources for Modified Scenario 5a vary slightly from those for Scenario 5a.

Modified Scenario 5a has a period of community exposure (including noise, traffic, air pollution), worker exposure, ecological disturbance, and elevated fish and shellfish tissue concentrations from resuspension of contaminated material equal to the estimated dredging duration of 7 years. For this modified scenario, active remediation would impact the benthic community within a similar area of intertidal and shallow habitat as Scenario 5a (Table 5).

Modified Scenario 5a takes 15 years to achieve the cleanup objectives, which is the same time frame as for Scenario 5a in the Supplemental Scenarios Memorandum[5] (AECOM 2012a), with a

[5] Note that the time to achieve cleanup objectives reported for all alternatives (15 years) is relative to the BCM output, which is generated in 5-year increments (see Table 6). However, in both the FS and in the Proposed Plan the values are adjusted based on time post-construction. For example, in the Proposed Plan, both FS Alternative 5C and Modified Scenario 5a are shown as requiring 17 years to achieve cleanup objectives versus 15 years in this memorandum. This is because the construction time frame of 7 years was rounded to the nearest 5-year

somewhat lower degree of uncertainty (due to the 16 acres of MNR) compared to Scenario 5a (27 acres of MNR).

Modified Scenario 5a is technically and administratively implementable during and after construction, because of its minor need for additional actions after dredging and capping as a result of its more stringent surface RALs (Table 5). This modified scenario has a lower potential to require contingency actions in the future than Scenario 5a because it has fewer acres of MNR.

The estimated net present value cost of Modified Scenario 5a is $305 million (Table 4), which is slightly higher than for Scenario 5a (Table 3). FS Alternative 5C, Supplemental Scenario 5a, and Modified Scenario 5a are predicted to achieve the total PCB excess cancer risk of 2×10^{-4} for the Adult Tribal RME seafood consumption scenario at the end of the construction period. Although the BCM predicts the same risk outcomes for Scenario 5a and Modified Scenario 5a, Modified Scenario 5a reduces uncertainty by addressing more contamination through active remediation rather than relying on natural recovery predictions.

References

AECOM 2012a. Technical Memorandum: Supplement to the Feasibility Study for the LDW Superfund Site, Approaches for Addressing Additional Concerns in Alternative 5C and Development of Alternative 5C Plus Scenarios. Prepared for the U.S. Environmental Protection Agency and Washington State Department of Ecology. Prepared by the Lower Duwamish Waterway Group. December 20, 2012.

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Windward Environmental, LLC 2007a. *Baseline Ecological Health Risk Assessment, Lower Duwamish Waterway.* Final. Prepared for Lower Duwamish Waterway Group for submittal to U.S. Environmental Protection Agency, Seattle, WA and Washington Department of Ecology, Bellevue, WA. July 31, 2007.

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increment for purposes of the BCM. The time to achieve cleanup objectives was predicted to be 15 years in the BCM, or 10 years post-construction. An actual construction time of 7 years plus 10 years post-construction equals 17 years following the beginning of construction.

Table 1 SMS Criteria and 2xSQS versus CSL Remedial Action Level Analysis for Surface Sediment

SMS Contaminant of Concern	SQS	2xSQS	CSL	Unit	2xSQS greater than CSL?
Metals					
Cadmium	5.1	10.2	6.7	mg/kg dw	Yes
Chromium	260	520	270	mg/kg dw	Yes
Copper	390	780	390	mg/kg dw	Yes
Lead	450	900	530	mg/kg dw	Yes
Mercury	0.41	0.82	0.59	mg/kg dw	Yes
Silver	6.1	12.2	6.1	mg/kg dw	Yes
Zinc	410	820	960	mg/kg dw	No
PAHs					
2-Methylnaphthalene	38	76	64	mg/kg oc	Yes
Acenaphthene	16	32	57	mg/kg oc	No
Anthracene	220	440	1,200	mg/kg oc	No
Benzo(a)anthracene	110	220	270	mg/kg oc	No
Benzo(a)pyrene	99	198	210	mg/kg oc	No
Benzo(g,h,i)perylene	31	62	78	mg/kg oc	No
Total benzofluoranthenes	230	460	450	mg/kg oc	Yes
Chrysene	110	220	460	mg/kg oc	No
Dibenzo(a,h)anthracene	12	24	33	mg/kg oc	No
Fluoranthene	160	320	1,200	mg/kg oc	No
Fluorene	23	46	79	mg/kg oc	No
Indeno(1,2,3-cd)pyrene	34	68	88	mg/kg oc	No
Naphthalene	99	198	170	mg/kg oc	Yes
Phenanthrene	100	200	480	mg/kg oc	No
Pyrene	1,000	2,000	1,400	mg/kg oc	Yes
Total HPAHs	960	1,920	5,300	mg/kg oc	No
Total LPAHs	370	740	780	mg/kg oc	No
Phthalates					
Bis(2-ethylhexyl)phthalate	47	94	78	mg/kg oc	Yes
Butyl benzyl phthalate	4.9	9.8	64	mg/kg oc	No
Dimethyl phthalate	53	106	53	mg/kg oc	Yes
Chlorobenzenes					
1,2,4-Trichlorobenzene	0.81	1.62	1.8	mg/kg oc	No
1,2-Dichlorobenzene	2.3	4.6	2.3	mg/kg oc	Yes
1,4-Dichlorobenzene	3.1	6.2	9	mg/kg oc	No
Hexachlorobenzene	0.38	0.76	2.3	mg/kg oc	No
Other SVOCs and COCs					
2,4-Dimethylphenol	29	58	29	µg/kg dw	Yes
4-Methylphenol	670	1,340	670	µg/kg dw	Yes
Benzoic acid	650	1,300	650	µg/kg dw	Yes
Benzyl alcohol	57	114	73	µg/kg dw	Yes
Dibenzofuran	15	30	58	mg/kg oc	No
n-Nitrosodiphenylamine	11	22	11	mg/kg oc	Yes
Pentachlorophenol	360	720	690	µg/kg dw	Yes
Phenol	420	840	1,200	µg/kg dw	No

Notes:

1. The SMS contaminants total PCBs and arsenic are not shown because they are also human health risk drivers. The site-wide surface sediment RALs for these contaminants are the SQS.
2. Five other SMS contaminants (diethyl phthalate, di-n-butyl phthalate, di-n-octyl phthalate, hexachlorobutadiene, and 2-methylphenol) are not listed because they were not identified as COCs during the remedial investigation.

COC = contaminant of concern; CSL = cleanup screening level; dw = dry weight; HPAH = high-molecular-weight polycyclic aromatic hydrocarbon; kg = kilogram; LPAH = low-molecular-weight polycyclic aromatic hydrocarbon; µg = micrograms; mg = milligrams; oc = organic carbon; PAH = polycyclic aromatic hydrocarbon; PCB = polychlorinated biphenyl; SMS = Sediment Management Standards; SQS = sediment quality standard; SVOC = semivolatile organic compound

Table 2 Remedial Action Levels (RALs) and Upper Limits (ULs) for ENR for Modified Scenario 5a

Risk Driver	Units	RAL or UL for ENR	Intertidal Sediments (+11.3 ft MLLW to -4 ft MLLW)				Subtidal Sediments (-4 ft MLLW and Deeper)			
			Recovery Category 1 Areas		Recovery Category 2 and 3 Areas		Recovery Category 1 Areas		Recovery Category 2 and 3 Areas	
			4 in (10 cm) depth interval	1.5 ft (45 cm) depth interval	4 in (10 cm) depth interval	1.5 ft (45 cm) depth interval	4 in (10 cm) depth interval	2 ft (60 cm) depth interval	4 in (10 cm) depth interval	2 ft (60 cm) depth interval (applied only at potential tug scour areas)[a]
PCBs (Total)	mg/kg oc	RAL	12	12	12	65	12	12	12	195
		UL for ENR[b]	--	--	65	97	--		65	195
cPAH	µg TEQ/kg dw	RAL	1,000	900	1,000	900	1,000	1,000	1,000	--
		UL for ENR[b]	--	--	3,000	1,350	--	--	3,000	--
Dioxins/Furans	ng TEQ/kg dw	RAL	25	28	25	28	25	25	25	--
		UL for ENR[b]	--	--	75	42	--	--	75	--
Arsenic (Total)	mg/kg dw	RAL	57	28	57	28	57	57	57	--
		UL for ENR[b]	--	--	171	42	--	--	171	--
39 SMS contaminants[c]	contaminant-specific	RAL	SQS	SQS	2xSQS not to exceed CSL[d]	--	SQS	SQS	2xSQS not to exceed CSL[b]	--
		UL for ENR[b]	--	--	3xRAL	--	--	--	3xRAL	--

Notes:

-- = no action level

1. The evaluation depth intervals for sediment are 10 cm, 45 cm, or 60 cm, depending on the location and recovery category.

a. Potential tug scour areas are defined as subtidal areas above -24 ft MLLW north of 1st Ave South Bridge, and above -18 ft MLLW south of 1st Ave South Bridge.

b. ENR is not an option in Recovery Category 1 areas. Upper limits for ENR are therefore shown only for Recovery Category 2 and 3 areas.

c. There are 41 SMS contaminants of concern, but PCBs and arsenic are addressed as human health risk drivers.

d. Surface sediment RAL in Recovery Category 2 and 3 areas is 2 times the SQS or the CSL, whichever is lower for non-human health risk drivers.

cm = centimeter; cPAH = carcinogenic polycyclic aromatic hydrocarbon; CSL = cleanup screening level; dw = dry weight; ENR = enhanced natural recovery; ft = feet; in = inch; kg = kilogram; µg = micrograms; mg = milligrams; MLLW = mean lower low water; ng = nanograms; oc = organic carbon; PCB = polychlorinated biphenyl; RAL = remedial action level; SMS = Sediment Management Standards; SQS = sediment quality standard; TEQ = toxic equivalent; UL = upper limit

Table 3 FS Alternative 5C, Supplemental Scenario 5a, and Modified Scenario 5a: Estimated Areas, Volumes, Construction Times, and Costs

Remedial Scenario	Remedial Technology and Areas											Dredge-cut Prism Volume (cy)[d]	Performance Contingency Volume (cy)[e]	Total Dredge Volume (cy)[f]	Total Placement Volume (Capping, ENR/*in situ*, Dredge Residuals, Habitat) (cy)	Construction Time Frame (years)[g]	Cost ($MM Net Present Value)[h]	High/Low Sensitivity Costs ($MM undiscounted/7% discount rate)
		Actively Remediated				Areas without Active Remediation												
	EAAs (acres)	Dredge (acres)	Partial Dredge and Cap (acres)	Cap (acres)	ENR/ *in situ* (acres)	MNR[a] (acres)	VM[b] (acres)	Institutional Controls, Site-wide Monitoring, & Natural Recovery (AOPC 2 and Rest of LDW)[c] (acres)	Total Active (acres)	Total not actively remediated (acres)	Total Study Area (acres)							
FS Alternative 5C	29	57	23	24	53	0	23	232	157	255	441	640,000	110,000	750,000	580,000	7	$290	$330 / $240
Scenario 5a[i,j,k,l] Subsurface RAL of CSL/ 3xCSL only for PCBs (intertidal/subtidal), and surface RAL of 2xSQS for non-HH risk drivers	29	62	16	23	48	27	17	220	148	264	441	650,000	130,000	790,000	560,000	7	$303	$345 / $245
EPA Preferred Alternative (Scenario 5a modified with technology assignment smoothing (BPJ) and surface sediment RAL adjusted to CSL when 2xSQS is greater for applicable non-human health risk driver SMS contaminants)	29	64	20	24	48	16	17	223	156	256	441	670,000	120,000	790,000	590,000	7	$305	$348 / 247

Notes:

1. Areas are rounded to the nearest acre. Acres for all remedial alternatives add up to the total study area of 441.3 acres; apparent discrepancies in total areas are due only to rounding. Volumes are rounded to two significant figures. Volumes are calculated in a spreadsheet prior to rounding; apparent discrepancies in total volumes are due only to rounding. Volumes and costs do not include the EAAs.

a. MNR is monitoring to achieve the SQS within 10 years following construction. This is referred to as MNR (Surface Sediment >SQS) in Figure 3.

b. VM areas are included as MNR (Surface Sediment >SQS) in Figure 3.

c. Institutional Controls, Site-wide Monitoring and Natural Recovery (AOPC 2 and the Rest of the LDW) are referred to as MNR (Surface Sediment <SQS) in Figure 3.

d. The dredge-cut prism volume estimate is the neat-line volume to the maximum depth of SQS exceedances plus an additional 50% to account for overdredging, additional sediment characterization, cleanup passes for residuals management, and additional volumes for constructability (e.g., stable side slopes).

e. Performance contingency volumes account for changes in technology assignment and performance-based contingency assumptions (e.g., 15% of ENR/*in situ*, MNR, and VM areas are assumed to require dredging based on long-term monitoring results)). There are no contingency actions assumed in the areas identified with institutional control and natural recovery.

f. Total dredge volume equals dredge-cut prism volume plus the performance contingency volume. Rounded values are shown in the table. Cost calculations are performed on unrounded values.

g. Construction time frame estimated based on open water dredge-cut prism volumes.

h. Net present value costs are calculated assuming a discount rate of 2.3% on both capital and monitoring costs starting at the beginning of construction. Best estimate cost assumptions are considered accurate to +50% and -30%.

i. Changes to FS Alternative 5C for the Supplemental Scenario 5a and Modified Scenario 5a include the three base elements: dredging of navigation channel shoaling areas exceeding Alt. 5C RALs, 1 sample/acre for monitoring in AOPC 2 and the Rest of LDW, and 4-ft cap thickness in intertidal areas. Additional remediation also added a 45-cm vertical point of compliance and an intertidal RAL of the SQS for PCBs. Volumes were estimated using the maximum concentrations in the upper 45 cm of cores, delimited horizontally using core polygons restricted to areas with surface sediment PCB concentrations >100 µg/kg dw (i.e., ~clipped to AOPC 2 boundary). The additional remediation due to subsurface concentrations in navigation channel shoaling areas was estimated using the maximum concentrations in the upper 2 ft of cores, delimited horizontally using core polygons restricted to areas where the existing bathymetric elevations were above the authorized navigation channel depth. Concentrations >Alternative 5C RALs were assigned to partial dredging/capping or dredging based on the technology assignment assumptions in the FS.

j. Scenario 5a and Modified Scenario 5a include an intertidal RAL of the CSL for PCBs to 45 cm depth, applied only to Recovery Category 2 and 3 areas (RALs for Recovery Category 1 areas remain the same as for FS Alternative 5C).

k. Subsurface RAL applies in potential tug scour water depths, defined as -24 ft MLLW to -4 ft MLLW in Reach 1 (i.e., north of 1st Ave Bridge), and -18 ft MLLW to -4 ft MLLW in Reaches 2 and 3 (i.e., south of 1st Ave Bridge).

l. Additional remediation from the subsurface RAL exceedances was estimated using the maximum concentrations in the upper 2 ft of cores, delimited horizontally using core polygons. Scenario 5a and Modified Scenario 5a restrict the core polygons to AOPC 1 (i.e., ~areas with surface sediment concentrations >Alt. 5C RALs).

AOPC = area of potential concern; BPJ = best professional judgment; C = combined technology; cm = centimeters; CSL = cleanup screening level; cy = cubic yards; EAA = early action area; ENR = enhanced natural recovery; FS = feasibility study; ft = foot; HH = human health; LDW = Lower Duwamish Waterway; MLLW = mean lower low water; MM = million; MNR = monitored natural recovery; n/a = not applicable; R = removal emphasis; RAL = remedial action level; SMS = Sediment Management Standards; SQS = sediment quality standard; UL = upper limit; VM = verification monitoring

Table 4 Cost Summary for Modified Scenario 5a (with 2.3% Discount Rate)

TASK	UNIT COST	UNIT	QUANTITY / SUBTOTAL
PRECONSTRUCTION			
Mobilization, Demobilization and Site Restoration (project)	$800,000	LS	1
Mobilization, Demobilization and Site Restoration (seasonal)	$120,000	YEAR	8.6
Land Lease for Operations and Staging	$250,000	YEAR	8.6
Contractor Work Plan Submittals	$100,000	YEAR	8.6
Barge Protection	$80,000	LS	1
Subtotal:			$4,925,966
PROJECT MANAGEMENT (CONTRACTOR)			
Labor and Supervision	$62,000	MONTH	39.0
Construction Office and Operating Expense	$21,600	MONTH	39.0
Subtotal:			$3,262,484
DREDGING			
Shift Rate	$25,963	DAY	761.0
Gravity Dewatering (on the barge)	$10	CY	790,664
Subtotal:			$27,664,177
SEDIMENT HANDLING AND DISPOSAL			
Transloading Area Setup	$1,000,000	LS	1
Water Management	$10,000	DAY	761.0
Transload, Railcar Transport to and Tipping at Subtitle D Landfill	$60	TON	1,185,997
Subtotal:			$79,769,663
SEDIMENT CAPPING, DREDGE RESIDUALS, DREDGE BACKFILL			
Debris Sweep	$30,000	ACRE	2
Shift Rate (12 hours)	$12,500	DAY	501.6
Cap material procurement and delivery (sand)	$27	CY	534,103
Subtotal:			$20,790,501
ENHANCED NATURAL RECOVERY			
Debris Sweep	$30,000	ACRE	5
Shift Rate (12 hours)	$12,500	DAY	46
Material procurement and delivery (sand)	$27	CY	28,824
Material procurement and delivery (carbon amended sand)	$161	CY	28,824
Subtotal:			$6,151,246
CONSTRUCTION QA/QC			
Construction Monitoring	$7,925	DAY	761.0
Subtotal:			$6,030,995
POST-CONSTRUCTION PERFORMANCE MONITORING			
Compliance Testing (Dredging)	alt specific	PROJECT	$1,202,024
Compliance Testing (Capping)	alt specific	PROJECT	$1,112,168
Compliance Testing (ENR)	alt specific	PROJECT	$1,221,569
Subtotal:			$3,535,761
CAPITAL COST (base)			$152,130,792
CAPITAL COST (present value)			$139,743,581
Construction Contingency			$48,910,253
Sales Tax			$13,275,640
Project Management, Remedial Design and Baseline Monitoring			$41,923,074
Construction Management			$13,974,358
TOTAL CAPITAL COST (INCLUDING SUM OF ABOVE)			$257,826,907
AGENCY OVERSIGHT, REPORTING, O&M, & MONITORING COSTS (present value)			
Agency Review and Oversight	alt specific	PROJECT	$8,198,903
Reporting	alt specific	PROJECT	$1,396,551
Operations and Maintenance (Dredging)	alt specific	PROJECT	$1,115,935
Operations and Maintenance (Capping)	alt specific	PROJECT	$4,400,270
Operations and Maintenance (ENR)	alt specific	PROJECT	$4,760,987
Operations and Maintenance (MNR >SQS)	alt specific	PROJECT	$1,701,475
Operations and Maintenance (MNR <SQS)	alt specific	PROJECT	$6,786,441
Long-term Monitoring	alt specific	PROJECT	$4,327,982
Institutional Controls	alt specific	PROJECT	$14,825,511
Subtotal:			$47,514,054
TOTAL COST (Net Present Value)			$305,000,000

Notes:

1. All cost values are estimates, and should not be interpreted as final construction or project costs.
2. Operating season based on 138-day fish window requirements and net 88 days of in-water work per season.
3. Operations & Maintenance and Monitoring Costs also includes repair for capping and ENR.
4. Present value calculation applied to both capital costs and O&M and monitoring costs starting at the beginning of construction.

CY = cubic yard; ENR = enhanced natural recovery; LS = lump sum; MNR = monitored natural recovery; O&M = operation and maintenance; QA/QC = quality assurance/quality control; SQS = sediment quality standard

Table 5 Comparative Evaluation and Relative Ranking of FS Alternative 5C, Supplemental 5C Plus Scenarios, and Modified Scenario 5a

Evaluation Criteria			Remedial Scenario								
			FS Alternative 5C	5C Plus Base (and PCB Intertidal RAL)	Scenario 1:	Scenario 2:	Scenario 3:	Scenario 4:	Scenario 5a:	Scenario 5b:	Modified Scenario 5a:
Overall Protection of Human Health and the Environment	*Summary of Overall Protection of Human Health and the Environment*		Alternative 5C, the Supplemental 5C Plus scenarios, and Modified Scenario 5a achieve overall protection of human health and the environment: in varying time frames and with varying degrees of certainty. All these remedial scenarios require institutional controls to fully achieve protectiveness. Longer construction periods result in proportionately greater short-term impacts. Dredging or capping a larger surface area has a lower potential for subsurface contamination to be exposed by natural or mechanical disturbances (e.g., scour, earthquakes). The potential for subsurface contaminated sediment to be exposed diminishes as more contaminated sediment is dredged.								
Comply with ARARs	*Summary of ARARs*		Alternative 5C, the Supplemental 5C Plus scenarios, and Modified Scenario 5a are not expected to comply with all surface water quality standards, or with all natural background sediment standards required under MTCA (for risk-based RBTCs below background). Surface water quality and MTCA ARAR waivers, the need for which varies among the remedial scenarios, will be required at or before completion of the remedial action.								
Achieve Threshold Requirements			Scenarios likely require one or more ARAR waivers to meet threshold criteria.								
Long-term Effectiveness and Permanence	Magnitude of Residual Risk (Contaminated sediment remaining in the subsurface)	Total dredge area outside of EAAs (acres)	57	72	80	82	73	66	62	55	64
		Total cap, partial dredge/cap	47	49	69	69	53	51	39	38	44
		Total ENR/*in situ* area (in Category 1/Categories 2 & 3 combined; acres)[a, b]	0/53	0/51	0/45	0/44	0/48	0/50	0/48	0/47	0/48
		MNR area (in Category 1/Categories 2 & 3 combined; acres)[b]	0/0	0/0	0/0	0/0	0/0	0/0	0/27	0/28	0/16
		Total VM and AOPC 2 area (in Category 1/Categories 2 & 3 combined; acres)[b]	23/122	23/110	19/100	19/100	23/108	23/115	23/108[c]	23/115	23/110
		Post-construction number of core stations remaining >CSL at any depth in the FS dataset (under caps/ all other locations)[d]	20/22	21/17	25/13	27/11	22/16	22/19	19/22	19/22	19/23
		Potential for Exposing Remaining Subsurface Contamination	Alternative 5C and all the scenarios have a low potential for exposure due to unanticipated disturbance effects. Modeling results range from 22 acres disturbed (FS Alternative 5C) up to 49 acres disturbed (Scenario 1) needed to produce a 25% increase in the long-term SWAC.								
	Adequacy and Reliability of Controls[e]	Relative amount of monitoring and maintenance required (based on total cap, partial dredge/cap, ENR/*in situ*, and MNR areas; acres)	Large area (100)	Large area (100)	Large area (114)	Large area (113)	Large area (101)	Large area (101)	Large area (114)	Large area (113)	Large area (108)
		Magnitude and Duration of Institutional Controls: Monitoring and notification of waterway users (based on total cap, partial dredge/cap, ENR/*in situ*, and MNR areas)[f]	Similar requirements for monitoring and maintenance as Alternative 5C.								
		Magnitude and Duration of Institutional Controls: Seafood consumption advisories, public outreach, and education	Similar seafood consumption advisories, public outreach, and education are required for Alternative 5C and all the scenarios.								
	Summary		Scenarios 1 and 2 leave the least area with subsurface contaminated sediments and therefore rank higher in long-term effectiveness and permanence than Alternative 5C and Scenario 5b. All others leave an intermediate amount of sediments, including Modified Scenario 5a. For comparison purposes, Alternative 4R dredges 93 acres, Alternative 6C dredges 108 acres and Alternative 5R dredges 143 acres (AECOM 2012b). The scenarios also have similar monitoring and maintenance requirements to Alternative 5C.								

Table 5 Comparative Evaluation and Relative Ranking of Alternative 5C, Supplemental 5C Plus Scenarios, and Modified Scenario 5a (continued)

Evaluation Criteria			Remedial Scenario								
			Alternative 5C	5C Plus Base (and PCB Intertidal RAL)	Scenario 1:	Scenario 2:	Scenario 3:	Scenario 4:	Scenario 5a:	Scenario 5b:	Modified Scenario 5a:
Reduction of Toxicity, Mobility, or Volume through Treatment		*Ex situ* treatment of dredged material	None	None	None	None	None	None	None	None	None
Reduction of Toxicity, Mobility, or Volume through Treatment		*In situ* treatment (Area in acres potentially treated *in situ* is assumed to be 50% of total ENR and *in situ* treatment area)	26.5	25.5	22.5	22	24	25	24	23.5	24
Short-term Effectiveness	Protection during Construction	Period of community exposure (including noise), worker exposure, ecological disturbance and resuspension of contaminated material from dredging (years of construction)[g]	7	8	9	9	9	8	7	6	7
Short-term Effectiveness	Protection during Construction	Dredge-cut prism volume/ Performance contingency (cy)	640,000/ 750,000	780,000/ 880,000	860,000/ 950,000	870,000/ 960,000	790,000/ 890,000	740,000/ 840,000	650,000/ 790,000	600,000/ 740,000	670,000/ 790,000[h]
Short-term Effectiveness	Protection during Construction	Air quality impacts (normalized to Alt 5C [divided by Alt. 5C impacts for a relative score])	1	1.17	1.27	1.28	1.19	1.12	1.05	0.99	1.05
Short-term Effectiveness	Protection during Construction	Ecological – Habitat area shallower than -10 ft MLLW disturbed (dredging and capping)	39	48	56	58	50	42	41[c]	33	43
Short-term Effectiveness	Time to achieve RAOs or important risk reduction milestones (years)[i]	RAO 1: 10^{-4} magnitude PCB risk (Adult Tribal RME)[j]	7	8	9	9	9	8	7	6	7
Short-term Effectiveness	Time to achieve RAOs or important risk reduction milestones (years)[i]	RAO 1: Predicted time for total PCBs and dioxins/furans to reach long-term model-predicted concentration range in surface sediment[j]	15	15	15	15	15	15	15	15	15
Short-term Effectiveness	Time to achieve RAOs or important risk reduction milestones (years)[i]	RAO 2: Total risk $\leq 1 \times 10^{-5}$ (All exposure scenarios)[k]	3	3	3	3	3	3	3	3	3
Short-term Effectiveness	Time to achieve RAOs or important risk reduction milestones (years)[i]	RAO 2: Individual risk from cPAHs $\leq 1 \times 10^{-6}$ in all areas except Beach 3	3	3	3	3	3	3	3	3	3
Short-term Effectiveness	Time to achieve RAOs or important risk reduction milestones (years)[i]	RAO 3: Benthic invertebrates (SQS)[l]	6	6	6	6	6	6	6	6	6
Short-term Effectiveness	Time to achieve RAOs or important risk reduction milestones (years)[i]	RAO 4: Ecological – river otters (HQ<1)[l]	7	8	9	9	9	8	7	6	7
Short-term Effectiveness	*Summary of short-term effectiveness*		Impacts from construction similar to Alt 3R and higher than Alt 2, 3C, and 4C and lower than Alt 5R, 6C and 6R. Construction time of 7 yrs to reduce contaminant concentrations. Very low uncertainty (no MNR).	Impacts are 20% higher than Alt 5C. Construction time of 9 years. No MNR.	Impacts are 30% higher than Alt 5C. Construction time of 9 years. No MNR.	Impacts are 30% higher than Alt 5C. Construction time of 9 years. No MNR.	Impacts are 20% higher than Alt 5C. Construction time of 9 years. No MNR.	Impacts are 10% higher than Alt 5C. Construction time of 8 years. No MNR.	Impacts are similar to Alt 5C. Construction time of 7 years. 27 acres MNR.	Impacts are similar to Alt 5C. Construction time of 6 years. 28 acres MNR.	Impacts are similar to Alt 5C. Construction time of 7 years. 16 acres MNR.

Table 5 Comparative Evaluation and Relative Ranking of Alternative 5C, Supplemental 5C Plus Scenarios, and Modified Scenario 5a (continued)

Evaluation Criteria		Remedial Scenario								
		Alternative 5C	5C Plus Base (and PCB Intertidal RAL)	Scenario 1:	Scenario 2:	Scenario 3:	Scenario 4:	Scenario 5a:	Scenario 5b:	Modified Scenario 5a:
Implementability	Technical and administrative implementability during construction	Construction period longer than Alt 2, 3 and 4C, and shorter than Alt 4R, 5R and 6. Low potential for difficulties and delays.	Longer construction period than 5C. Greater potential for construction delays.	Longer construction period than 5C. Greater potential for construction delays.	Longer construction period than 5C. Greater potential for construction delays.	Longer construction period than 5C. Greater potential for construction delays.	Longer construction period than 5C. Greater potential for construction delays.	Same construction period as 5C.	Lower construction period than 5C.	Same construction period as 5C.
	Technical and administrative implementability after construction	Additional actions may be needed after dredging to meet low RALs. Low potential for additional actions in ENR areas.	Additional actions may be needed after dredging to meet low RALs. Low potential for additional actions in ENR areas.	Additional actions may be needed after dredging to meet low RALs. Low potential for additional actions in ENR areas.	Additional actions may be needed after dredging to meet low RALs. Low potential for additional actions in ENR areas.	Additional actions may be needed after dredging to meet low RALs. Low potential for additional actions in ENR areas.	Additional actions may be needed after dredging to meet low RALs. Low potential for additional actions in ENR areas.	Less need for additional actions after dredging because of higher surface RALs. Higher potential for additional actions than Alternative 5C due to MNR areas.	Less need for additional actions after dredging because of higher surface RALs. Higher potential for additional actions than Alternative 5C due to MNR areas.	Less need for additional actions after dredging because of higher surface RALs. Higher potential for additional actions than Alternative 5C due to MNR areas.
Costs	Total Net Present Value (MM$)[n]	290	331	357	358	333	319	303	289	305

Notes:

a. The proportion of ENR with or without *in situ* treatment is assumed to be 50%/50% for Alternative 5C and all the scenarios.

b. Recovery categories: Category 1 – recovery presumed to be limited; Category 2 – recovery less certain than Category 3; Category 3 – recovery predicted to occur. The acres shown in Recovery Category 1 are "verification monitoring" acres, which are predicted to be below the Alt 5C RALS when remedial design data are collected.

c. Two values have been revised from Table 11 in the Supplemental Scenarios Memo (AECOM 2012a) as a result of QC checks. For Scenario 5a, the area of VM and AOPC 2 in Recovery Categories 2 and 3 was revised from 114 to 108 acres. Also for Scenario 5a, the habitat area (shallower than -10 ft MLLW) disturbed by dredging or capping was revised from 36 to 41 acres.

d. Remaining cores grouped by those located under caps and those located anywhere else within the LDW after construction.

e. This analysis evaluates the reliability of controls after RAOs are achieved. The construction periods differ (see Short-term Effectiveness) and various controls will also be required during construction.

f. Increased sediment monitoring in areas not actively remediated (AOPC 2 and the rest of the LDW) was assumed for the Supplemental Scenarios. Monitoring frequency changed to 1 sample/acre in natural recovery areas and ICs, and long-term monitoring areas.

g. Construction period rounded to nearest year. Additional time beyond construction would be required for ecologically sensitive areas to recover. Also, fish and shellfish tissue contaminant concentrations may require additional time after construction to recover.

h. Modified Scenario 5a has incrementally larger volumes compared to Scenario 5a; however, the differences are not large enough to be evident after rounding to two significant figures (790,664 cy for Modified Scenario 5a compared to 785,216 cy for Scenario 5a).

i. The predicted time to achieve cleanup objectives is calculated from the start of construction.

j. No remedial scenario achieves RAO 1 PRGs. All remedial scenarios achieve protectiveness with some combination of active and passive remediation and ICs. Two time frames are provided for purposes of comparing the scenarios: 1) the point at which the remedial scenario reduces the Adult Tribal RME seafood consumption risk to 10^{-4}, and 2) the predicted time for risk-driver concentrations to achieve long-term model-predicted concentration ranges. The latter are based on achieving a site-wide total PCB SWAC within 25% (≤ 49 µg/kg dw)) of the 45-yr FS Alternative 6R total PCB SWAC of 39 µg/kg dw, and a site-wide dioxin/furan SWAC within 25% (≤ 5.4 ng TEQ/kg dw) of the 45-yr FS Alternative 6R dioxin/furan SWAC of 4.3 ng TEQ/kg dw. The time is from the beginning of construction (see Table 6). Fish and shellfish tissue concentrations are expected to remain elevated during construction as a result of resuspension and release of total PCBs into the water column. Note that the time to achieve cleanup objectives reported for all alternatives (15 years) is relative to the BCM output, which is generated in 5-year increments (see Table 6). However, in both the FS and in the Proposed Plan the values are adjusted based on time post-construction. For example, in the Proposed Plan, both FS Alternative 5C and Modified Scenario 5a are shown as requiring 17 years to achieve cleanup objectives versus 15 years in this memorandum. This is because the construction time frame of 7 years was rounded to the nearest 5-year increment for purposes of the BCM. The time to achieve cleanup objectives was predicted to be 15 years in the BCM, or 10 years post-construction. An actual construction time of 7 years plus 10 years post-construction equals 17 years following the beginning of construction.

k. Alternative 3C of the FS specifically addresses direct contact risks and achieves the total and individual direct contact risk metrics defined in FS Section 9.1.2.3 (AECOM 2012b) at the end of construction for all direct contact exposure scenarios. FS Alternative 5C, the Supplemental 5C Plus scenarios, and Modified Scenario 5a are expected to have similar risk results.

l. The FS assumes the time to achieve cleanup objectives for RAO 3 to be when at least 98% of FS surface sediment dataset stations are predicted to comply with the SMS and more than 98% of the LDW surface area is predicted to comply with the SMS. This is not intended as a compliance metric. EPA and Ecology will determine the appropriate metric for SMS compliance.

m. The time to achieve cleanup objectives for RAO 4 is when wildlife seafood consumption HQ <1 is achieved based on the site-wide total PCB SWAC at the end of construction.

n. Net present value costs are calculated using a discount rate of 2.3%. The costs for 5C Plus Base and Scenarios 1 through 3 have the highest uncertainties because of uncertainties in the volume of subsurface sediment above PCB intertidal RAL of the SQS (cost estimated at $16 MM but could be as high as $40 MM).

AOPC = area of potential concern; ARAR = applicable or relevant and appropriate requirement; C = combined-technology alternative; cPAH = carcinogenic polycyclic aromatic hydrocarbon; CSL = cleanup screening level; cy = cubic yards; dw = dry weight; ENR = enhanced natural recovery; FS = feasibility study; HQ = hazard quotient; IC = institutional control; kg = kilograms; µg = micrograms; mg = milligrams; MLLW = mean lower low water; MM = million; MNR = monitored natural recovery; n/a = not applicable; ng = nanograms; O&M = operation and monitoring; PCB = polychlorinated biphenyl; PRG = preliminary remediation goal; R = removal-emphasis alternative; RAL = remedial action level; RAO = remedial action objective; RME = reasonable maximum exposure; SMS = Sediment Management Standards; SQS = sediment quality standard; SWAC = spatially-weighted average concentration; TEQ = toxic equivalent; VM = verification monitoring

Table 6 Effectiveness Evaluation of Alternative 5C, Supplemental 5C Plus Scenarios, and Modified Scenario 5a – Predicted Post-Construction Arsenic, Total PCB, cPAH, and Dioxin/Furan Concentrations (SWACs)

Arsenic (mg/kg dw) (RAO 2)

Scenario	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Netfishing Direct Contact Baseline = 16 10^{-6} RBTC = 3.7 PRG = Background = 7.0										Tribal Clamming Direct Contact Baseline = 13 10^{-6} RBTC = 1.3 PRG = Background = 7.0										Beach Play Direct Contact Baseline = 9.1 10^{-6} RBTC = 2.8 PRG = Background = 7.0									
			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*
Alternative 5C	157	7	16	10	9.6	9	9	9	9	9	9	9	13	9.6	9.4	9.3	9.2	9.2	9.2	9.2	9.2	9.2	9.1	9.6	9.4	9.3	9.2	9.2	9.2	9.2	9.2	9.2
5C Plus Base[b]	172	8	16	10	9.5	9.3	9.2	9.2	9.2	9.1	9.1	9.1	13	9.6	9.3	9.3	9.2	9.2	9.2	9.2	9.2	9.1	9.1	9.6	9.4	9.3	9.2	9.2	9.2	9.2	9.2	9.2
Scenario 1	193	9	16	10	9.5	9.3	9.2	9.2	9.2	9.1	9.1	9.1	13	9.6	9.3	9.3	9.2	9.2	9.2	9.2	9.2	9.1	9.1	9.6	9.4	9.3	9.2	9.2	9.2	9.2	9.2	9.2
Scenario 2	195	9	16	10	9.5	9.3	9.2	9.2	9.2	9.1	9.1	9.1	13	9.6	9.3	9.3	9.2	9.2	9.2	9.2	9.2	9.1	9.1	9.6	9.4	9.3	9.2	9.2	9.2	9.2	9.2	9.2
Scenario 3	175	9	16	10	9.5	9.3	9.2	9.2	9.2	9.1	9.1	9.1	13	9.6	9.3	9.3	9.2	9.2	9.2	9.2	9.2	9.1	9.1	9.6	9.4	9.3	9.2	9.2	9.2	9.2	9.2	9.2
Scenario 4	167	8	16	10	9.6	9.4	9.2	9.2	9.2	9.1	9.1	9.1	13	9.6	9.4	9.3	9.2	9.2	9.2	9.2	9.2	9.2	9.1	9.6	9.4	9.3	9.2	9.2	9.2	9.2	9.2	9.2
Scenario 5a	148	7	16	10	9.6	9.4	9.2	9.2	9.2	9.1	9.1	9.1	13	9.5	9.3	9.3	9.2	9.2	9.2	9.2	9.2	9.1	9.1	9.5	9.3	9.3	9.2	9.2	9.2	9.2	9.2	9.2
Scenario 5b	139	6	16	10	9.6	9.4	9.2	9.2	9.2	9.1	9.1	9.1	13	9.5	9.4	9.3	9.2	9.2	9.2	9.2	9.2	9.2	9.1	9.5	9.3	9.3	9.2	9.2	9.2	9.2	9.2	9.2
Modified Scenario 5a	156	7	16	10	9.6	9.4	9.2	9.2	9.2	9.1	9.1	9.1	13	9.5	9.4	9.3	9.2	9.2	9.2	9.2	9.2	9.1	9.1	9.5	9.3	9.3	9.2	9.2	9.2	9.2	9.2	9.2

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

Scenario	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Site-wide Baseline = 346 Netfishing Direct Contact: PRG = 10^{-6} RBTC = 1,300 Seafood Consumption - Human: PRG = Background = 2 Seafood Consumption - Ecological (otter): PRG = 128 - 159										Tribal Clamming Direct Contact Baseline = 540 10^{-6} RBTC = 500 PRG = 500										Beach Play Direct Contact Baseline = 286 10^{-6} RBTC = 1,700 PRG = 1,700									
			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*
Alternative 5C	157	7	178	70	56	48	46	44	44	43	43	41	195	59	52	48	46	45	45	44	44	43	275	54	49	45	44	44	45	44	44	42
5C Plus Base[b]	172	8	178	70	53	47	45	44	44	43	42	41	195	59	48	46	44	44	44	43	43	42	275	54	47	45	44	44	45	44	44	42
Scenario 1	193	9	178	70	52	47	45	43	43	42	42	41	195	59	48	46	44	44	44	43	43	42	275	54	47	45	44	44	45	44	44	42
Scenario 2	195	9	178	70	51	47	45	44	43	42	42	41	195	59	48	46	44	44	44	43	43	42	275	54	47	45	44	44	45	44	44	42
Scenario 3	175	9	178	70	53	47	45	44	44	43	42	41	195	59	48	46	44	44	44	43	43	42	275	54	47	45	44	44	45	44	44	42
Scenario 4	167	8	178	70	54	48	46	44	44	43	43	41	195	59	51	48	46	45	45	44	44	43	275	54	49	45	44	44	45	44	44	42
Scenario 5a	148	7	178	70	55	48	46	44	44	43	42	41	195	59	49	46	45	44	44	43	43	42	275	54	48	45	44	44	45	44	44	42
Scenario 5b	139	6	178	70	55	48	46	44	44	43	43	41	195	59	52	48	46	45	45	44	44	43	275	54	49	45	44	44	45	44	44	42
Modified Scenario 5a	156	7	178	70	55	48	46	44	44	43	43	41	195	57	51	47	45	44	45	43	44	42	275	55	50	46	44	44	45	44	44	42

cPAHs (µg TEQ/kg dw) (RAO 2)

Scenario	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Netfishing Direct Contact Baseline = 390 10^{-6} RBTC = 380 PRG = 380										Tribal Clamming Direct Contact Baseline = 380 10^{-6} RBTC = 150 PRG = 150										Beach Play Direct Contact Baseline = 331 10^{-6} RBTC = 90 PRG = 90									
			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*
Alternative 5C	157	7	358	156	129	110	105	103	105	103	103	96	296	131	118	107	106	105	107	104	105	99	308	140	129	116	118	118	124	117	119	109
5C Plus Base[b]	172	8	358	156	127	109	104	102	105	103	103	96	296	131	116	106	106	105	107	103	105	99	308	140	128	116	118	118	124	117	119	109
Scenario 1	193	9	358	156	126	108	104	102	105	103	103	96	296	131	116	106	106	105	107	103	105	99	308	140	128	116	118	118	124	117	119	109
Scenario 2	195	9	358	156	126	108	104	102	105	103	103	96	296	131	116	106	106	105	107	103	105	99	308	140	128	116	118	118	124	117	119	109
Scenario 3	175	9	358	156	127	109	104	102	105	103	103	96	296	131	116	106	106	105	107	103	105	99	308	140	128	116	118	118	124	117	119	109
Scenario 4	167	8	358	156	128	109	105	103	105	103	103	96	296	131	117	107	106	105	107	104	105	99	308	140	128	116	118	118	124	117	119	109
Scenario 5a	148	7	358	158	130	110	105	103	105	103	103	96	296	130	117	107	106	105	106	103	105	99	308	139	129	116	118	118	124	117	119	109
Scenario 5b	139	6	358	160	131	111	105	103	105	103	103	96	296	130	118	107	106	105	106	103	105	99	308	139	129	116	118	118	123	117	119	109
Modified Scenario 5a	156	7	358	158	129	110	105	103	105	103	103	96	296	129	117	107	106	105	107	103	105	99	308	138	128	116	118	118	124	117	119	109

Table 6 Effectiveness Evaluation of Alternative 5C, Supplemental 5C Plus Scenarios, and Modified Scenario 5a – Predicted Post-Construction Arsenic, Total PCB, cPAH, and Dioxin/Furan Concentrations (SWACs)

Dioxins/Furans (ng TEQ/kg dw) (RAOs 1 and 2)

Scenario	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Site-wide Baseline = 26 Netfishing Direct Contact: PRG = 10^{-6} RBTC = 37 Seafood Consumption - Human: PRG = 2										Tribal Clamming Direct Contact Baseline = 32 10^{-6} RBTC = 13 PRG = 13										Beach Play Direct Contact Baseline = 18 10^{-6} RBTC = 28 PRG = 28									
			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*
Alternative 5C	157	7	24	4.9	4.7	4.4	4.4	4.4	4.4	4.4	4.4	4.3	30	4.9	4.7	4.4	4.4	4.4	4.4	4.3	4.4	4.3	14	4.7	4.7	4.5	4.5	4.5	4.6	4.6	4.6	4.5
5C Plus Base[b]	172	8	24	4.9	4.6	4.4	4.4	4.3	4.4	4.4	4.4	4.3	30	4.9	4.6	4.4	4.4	4.3	4.3	4.3	4.3	4.3	14	4.7	4.6	4.5	4.5	4.5	4.6	4.6	4.6	4.5
Scenario 1	193	9	24	4.9	4.5	4.3	4.3	4.3	4.4	4.4	4.4	4.3	30	4.9	4.6	4.4	4.3	4.3	4.3	4.3	4.3	4.3	14	4.7	4.6	4.5	4.5	4.5	4.6	4.6	4.6	4.5
Scenario 2	195	9	24	4.9	4.5	4.3	4.3	4.3	4.4	4.4	4.4	4.3	30	4.9	4.6	4.4	4.3	4.3	4.3	4.3	4.3	4.3	14	4.7	4.6	4.5	4.5	4.5	4.6	4.6	4.6	4.5
Scenario 3	175	9	24	4.9	4.6	4.4	4.4	4.3	4.4	4.4	4.4	4.3	30	4.9	4.6	4.4	4.4	4.3	4.3	4.3	4.3	4.3	14	4.7	4.6	4.5	4.5	4.5	4.6	4.6	4.6	4.5
Scenario 4	167	8	24	4.9	4.6	4.4	4.4	4.4	4.4	4.4	4.4	4.3	30	4.9	4.7	4.4	4.4	4.4	4.4	4.3	4.4	4.3	14	4.7	4.7	4.5	4.5	4.5	4.6	4.6	4.6	4.5
Scenario 5a	148	7	24	5.0	4.7	4.4	4.4	4.4	4.4	4.4	4.4	4.3	30	4.9	4.7	4.4	4.4	4.3	4.4	4.3	4.3	4.3	14	4.7	4.7	4.5	4.5	4.5	4.6	4.6	4.6	4.5
Scenario 5b	139	6	24	5.0	4.7	4.4	4.4	4.4	4.4	4.4	4.4	4.3	30	5.0	4.8	4.5	4.4	4.4	4.4	4.3	4.4	4.3	14	4.8	4.7	4.5	4.6	4.6	4.6	4.6	4.6	4.5
Modified Scenario 5a	156	7	24	4.9	4.7	4.4	4.4	4.4	4.4	4.4	4.4	4.3	30	4.9	4.6	4.4	4.4	4.3	4.4	4.3	4.3	4.3	14	4.7	4.6	4.5	4.5	4.5	4.6	4.6	4.6	4.5

Notes:

1. BCM predictions use base case STM outputs revised June 2010 (Appendix C) and FS dataset.
2. Arsenic BCM inputs (mg/kg dw): upstream 9, lateral 13, and post-remedy bed sediment replacement value 10 (AOPC 1) and 9 (AOPC 2).
3. Total PCB BCM inputs (µg/kg dw): upstream 35, lateral 300, and post-remedy bed sediment replacement value 60 (AOPC 1) and 20 (AOPC 2).
4. cPAH BCM inputs (µg TEQ/kg dw): upstream 70, lateral 1,400, and post-remedy bed sediment replacement value 140 (AOPC 1) and 100 (AOPC 2).
5. Dioxin/furan BCM inputs (ng TEQ/kg dw): upstream 4, lateral 20, and post-remedy bed sediment replacement value 4 (AOPC 1).
6. 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 Alternative 5C and all scenarios.
b. Alternative 5C Plus Base includes the common base elements and PCB intertidal RAL of the SQS.

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

AOPC = area of potential concern
BCM = bed composition model
cPAH = carcinogenic polycyclic aromatic hydrocarbon
dw = dry weight
EAA = early action area
FS = feasibility study
kg = kilogram
µg = microgram
mg = milligram
ng = nanogram
PCB = polychlorinated biphenyl
PRG = preliminary remediation goal
RAL = remedial action level
RAO = remedial action objective
RBTC = risk-based threshold concentration
SQS = sediment quality standard
STM = sediment transport model
SWAC = spatially-weighted average concentration
TEQ = toxic equivalent

Table 7a Excess Cancer Risks for RME Seafood Consumption Scenarios Associated with Residual Surface Sediment Total PCB SWACs Over Time

Remedial Scenario	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Adult Tribal RME (Tulalip data) Baseline HHRA Risk = 2×10^{-3}										Child Tribal RME (Tulalip data) Baseline HHRA = 3×10^{-4}										Adult API RME Baseline HHRA Risk = 5×10^{-4}									
			Time from Beginning of Construction (years)[a]										*Time from Beginning of Construction (years)*[a]										*Time from Beginning of Construction (years)*[a]									
			0 [b]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [b]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [b]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Alternative 5C	157	7	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}	2×10^{-4}	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}	3×10^{-5}	2×10^{-4}	7×10^{-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}
Scenario 5a	148	7	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}	2×10^{-4}	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}	3×10^{-5}	2×10^{-4}	7×10^{-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}
Modified Scenario 5a	156	7	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}	2×10^{-4}	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}	3×10^{-5}	2×10^{-4}	7×10^{-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}

Notes:
1. Excess cancer risks estimated using tissue concentrations predicted by the FWM (Windward 2010) with alternative-specific total PCB SWACs in surface sediment (Table 6) and assumed surface water dissolved total PCB concentrations of 0.6 ng/L except 0.9 ng/L for Year 0 for all remedial scenarios.
2. Significant figures are displayed in accordance with the conventions established in the HHRA (Windward 2007b)
3. Risks were not estimated for construction period because of uncertainties in total PCB tissue concentrations during construction. Fish/shellfish tissue total PCB concentrations are expected to remain elevated for up to 2 years as a result of construction impacts (e.g., sediment resuspension).

10^{-3}	Colored cells indicate residual excess cancer risk rounded to the nearest order of magnitude.
10^{-4}	
10^{-5}	

Table 7b Non-Cancer Hazard Quotients for RME Seafood Consumption Scenarios Associated with Residual Sediment Total PCB SWACs for Human Health and River Otter Over Time

Remedial Scenario	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Adult Tribal RME (Tulalip data) Baseline HHRA HQ = 40										Child Tribal RME (Tulalip data) Baseline HHRA HQ = 86										Adult API RME Baseline HHRA HQ = 29									
			Time from Beginning of Construction (years)[a]										*Time from Beginning of Construction (years)*[a]										*Time from Beginning of Construction (years)*[a]									
			0 [b]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [b]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [b]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
Alternative 5C	157	7	13	6	5	5	5	5	5	5	5	4	29	13	11	10	10	10	10	10	10	9	9	4	4	3	3	3	3	3	3	3
Scenario 5a	148	7	13	6	5	5	5	5	5	5	5	4	29	13	11	10	10	10	10	10	10	9	9	4	4	3	3	3	3	3	3	3
Modified Scenario 5a	156	7	13	6	5	5	5	5	5	5	5	4	29	13	11	10	10	10	10	10	10	9	9	4	4	3	3	3	3	3	3	3

Remedial Scenario	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Otter LOAEL-based HQ – with Juvenile Fish Baseline HHRA HQ = 2.9										Otter LOAEL-based HQ – without Juvenile Fish[c]									
			Time from Beginning of Construction (years)[a]										*Time from Beginning of Construction (years)*[a]									
			0 [b]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*0* [b]	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*
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
Scenario 5a	148	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
Modified Scenario 5a	156	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

Notes:
1. Non-cancer hazard quotients were estimated using tissue concentrations predicted by the FWM (Windward 2010) with alternative-specific total PCB SWACs in surface sediment (Table 6) and assumed surface water dissolved total PCBs concentrations of 0.6 ng/L, except 0.9 ng/L at Year 0 for all remedial scenarios.
2. All tabulated values are hazard quotients
3. Hazard quotients were not estimated for construction period because of uncertainties in total PCB tissue concentrations during construction. Fish/shellfish tissue total PCB concentrations are expected to remain elevated for up to 2 years as a result of construction impacts (e.g., sediment resuspension)

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

BCM Input Values (mid)			
Contaminant	Post-remedy Bed Sediment Replacement	Lateral	Upstream
PCB (µg/kg dw)	60 (AOPC 1) / 20 (AOPC 2)	300	35

Table 7c Total Excess Cancer Risks for Direct Contact Based on Predicted SWACs

Receptor Group	Baseline Risk[d]	Direct Contact Risk for Remedial Scenarios																													
		Alternative 5 Combined (7 years[e])										Scenario 5a (7 years[e])										Modified Scenario 5a (7 years[e])									
		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	3×10^{-5}	6×10^{-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}	6×10^{-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}	6×10^{-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^{-4}	1×10^{-5}	9×10^{-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}	1×10^{-5}	9×10^{-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}	8×10^{-6}	1×10^{-5}	9×10^{-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	9×10^{-6}	9×10^{-6}	4×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	9×10^{-6}	4×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	9×10^{-6}	4×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}
Beach 2	9×10^{-5}	9×10^{-5}	6×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	9×10^{-5}	6×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	9×10^{-5}	6×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}
Beach 3	1×10^{-5}	8×10^{-6}	7×10^{-6}	7×10^{-6}	6×10^{-6}	6×10^{-6}	6×10^{-6}	7×10^{-6}	6×10^{-6}	6×10^{-6}	6×10^{-6}	8×10^{-6}	7×10^{-6}	7×10^{-6}	6×10^{-6}	6×10^{-6}	6×10^{-6}	7×10^{-6}	6×10^{-6}	6×10^{-6}	6×10^{-6}	6×10^{-6}	8×10^{-6}	7×10^{-6}	7×10^{-6}	6×10^{-6}	6×10^{-6}	6×10^{-6}	7×10^{-6}	6×10^{-6}	6×10^{-6}	6×10^{-6}
Beach 4	6×10^{-4}	6×10^{-4}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	6×10^{-4}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	6×10^{-4}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}
Beach 5	3×10^{-5}	3×10^{-5}	5×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-5}	5×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	3×10^{-5}	5×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}
Beach 6	1×10^{-4}	1×10^{-4}	5×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	1×10^{-4}	5×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	1×10^{-4}	5×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}
Beach 7	4×10^{-6}	4×10^{-6}	4×10^{-6}	5×10^{-6}	4×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	5×10^{-6}	4×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	5×10^{-6}	4×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	5×10^{-6}	4×10^{-6}
Beach 8	6×10^{-6}	6×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	6×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	6×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}

Notes:

1. Total excess cancer risks include only the risk drivers (total PCBs, arsenic, cPAHs, and dioxins/furans).
2. Significant figures are displayed in accordance with the conventions established in the HHRA (windward 2007b).
3. The BCM input values used in the predicted future concentrations after start of construction are as follows:

Contaminant	Unit	Upstream	Lateral	Post-remedy Bed Sediment Replacement Value
Total PCBs	µg/kg dw	35	300	60 (AOPC 1), 20 (AOPC 2)
Arsenic	mg/kg dw	9	13	10 (AOPC 1), 9 (AOPC 2)
cPAHs	µg TEQ /kg dw	70	1,400	140 (AOPC 1), 100 (AOPC 2)
Dioxins/Furans	ng TEQ /kg dw	4	20	4

4. Baseline risks are used as the post-EAA risk at time 0 for the beaches (with the exception of beach 3).

Footnotes:

a. The 5-year model-predicted intervals associated with the BCM SWAC output (for risk estimation) are indexed to the start of construction for all remedial scenarios
b. Risk estimates for time 0 (post-EAA) use the BCM-predicted SWACs after constructions of the EAAs. While baseline HHRA seafood consumption risks were based on tissue data collected from the LDW, seafood consumption risks at time 0 (post-EAA construction) were estimated using tissue concentrations predicted by the FWM.
c. Otter LOAEL-based HQ without Juvenile Fish was not estimated in the ERA (Windward 2007a)
d. Baseline risks for the direct contact scenarios are reported in FS Section 3 (Table 3-6a for netfishing and tribal clamming scenarios, and Table 3-6b for beach play scenarios; AECOM 2012b)
e. Construction period.

AOPC = area of potential concern; API = Asian and Pacific Islander; BCM = bed composition model; C = combined; cPAH = carcinogenic polycyclic aromatic hydrocarbon; dw = dry weight; EAA = early action area; ERA = ecological risk assessment; FS = feasibility study; FWM = Food Web Model; HHRA = human health risk assessment; HQ = hazard quotient; kg = kilogram; L = liter; LDW = Lower Duwamish Waterway; LOAEL = lowest observed adverse effect level; ng = nanogram; µg = microgram; PCB = polychlorinated biphenyl; R = removal; RME = reasonable maximum exposure; SWAC = spatially-weighted average concentration.

Table 8 Effectiveness Evaluation of Alternative 5C, Supplemental 5C Plus Scenarios, and Modified Scenario 5a – Predicted Post-Construction Exceedances of SMS Criteria (CSL and SQS) (Addresses RAO 3)

Remaining CSL Chemistry Station Counts; Total Baseline Station Count = 1,395

			Time from Beginning of Construction																							
			0 yr [a]			5 yr			10 yr			15 yr			20 yr			25 yr			30 yr			10 Years Following End of Construction		
Scenario	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Number of Stations	% of Stations < CSL	% of Area < CSL	Number of Stations	% of Stations < CSL	% of Area < CSL	Number of Stations	% of Stations < CSL	% of Area < CSL	Number of Stations	% of Stations < CSL	% of Area < CSL	Number of Stations	% of Stations < CSL	% of Area < CSL	Number of Stations	% of Stations < CSL	% of Area < CSL	Number of Stations	% of Stations < CSL	% of Area < CSL	Number of Stations	% of Stations < CSL	% of Area < CSL
Alternative 5C	157	7	63	95%	96%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%
5C Plus Base[b]	172	8	63	95%	96%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%
Scenario 1	193	9	63	95%	96%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%
Scenario 2	195	9	63	95%	96%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%
Scenario 3	175	9	63	95%	96%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%
Scenario 4	167	8	63	95%	96%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%
Scenario 5a	148	7	63	95%	96%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%
Scenario 5b	139	6	63	95%	96%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%
Modified Scenario 5a	156	7	63	95%	96%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%	1	>99%	>99%

Remaining SQS Chemistry Station Counts; PRG = compliance with SQS; Total Baseline Station Count = 1,395

			Time from Beginning of Construction																							
			0 yr [a]			5 yr			10 yr			15 yr			20 yr			25 yr			30 yr			10 Years Following End of Construction		
Scenario	Active Area in FS Study Area (acres)	Construc-tion Period (years)	Number of Stations	% of Stations < SQS	% of Area < SQS	Number of Stations	% of Stations < SQS	% of Area < SQS	Number of Stations	% of Stations < SQS	% of Area < SQS	Number of Stations	% of Stations < SQS	% of Area < SQS	Number of Stations	% of Stations < SQS	% of Area < SQS	Number of Stations	% of Stations < SQS	% of Area < SQS	Number of Stations	% of Stations < SQS	% of Area < SQS	Number of Stations	% of Stations < SQS	% of Area < SQS
Alternative 5C	157	7	224	84%	82%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%
5C Plus Base[b]	172	8	224	84%	82%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%
Scenario 1	193	9	224	84%	82%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%
Scenario 2	195	9	224	84%	82%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%
Scenario 3	175	9	224	84%	82%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%
Scenario 4	167	8	224	84%	82%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%	0	>99%	>99%
Scenario 5a	148	7	224	84%	82%	2	>99%	>99%	3	>99%	>99%	3	>99%	>99%	3	>99%	>99%	3	>99%	>99%	3	>99%	>99%	3	>99%	>99%
Scenario 5b	139	6	224	84%	82%	2	>99%	>99%	3	>99%	>99%	3	>99%	>99%	3	>99%	>99%	3	>99%	>99%	3	>99%	>99%	3	>99%	>99%
Modified Scenario 5a	156	7	224	84%	82%	2	>99%	>99%	3	>99%	>99%	3	>99%	>99%	3	>99%	>99%	3	>99%	>99%	3	>99%	>99%	3	>99%	>99%

= Predicted percentage of baseline stations or LDW surface area below CSL or SQS is ≥ 98%

Notes:

1. FS study area = 441 acres. BCM model area = 430 acres.
2. Contaminant concentration predictions use BCM input parameters for SMS contaminants as described in Section 5 of the Final FS (AECOM 2012).
3. Stations falling within the actively remediated footprint of each remedial scenario are not counted after construction is completed for that scenario. However, recontamination potential analysis shows that 23 STM grid cells (out of >700) have the potential to recontaminate above the SQS for bis 2-ethylhexyl phthalate (BEHP) 10 years after remedy completion. These counts are not factored into the recontamination potential.
4. In some locations, the BCM predicts point concentrations above the SQS, but recent chemical data and trend analysis suggest sediment concentrations are below the SQS. Therefore, the assignment of remedial technologies may not be consistent with BCM point-counts. This apparent discrepancy will be resolved during remedy implementation through design sampling, monitoring, and adaptive management.
5. Many of the predicted remaining SQS exceedances are located on the edges of areas to be actively remediated and will likely be recharacterized during remedial design sampling. Other locations are in areas expected to recover (based on other factors used to define the recovery categories) and were assigned to MNR using best professional judgment.
6. The percent of LDW area below SMS criteria is calculated by dividing the polygon-derived areas associated with predicted exceedances by the total area of the LDW (441 acres).
7. The percent of stations below SMS criteria is calculated by dividing the predicted number of station exceedances by the number of FS baseline surface sediment stations (n = 1,395 points).
8. Station-specific TOC values were used to oc-normalize dry weight concentrations for non-polar organic compounds, with TOC values between 0.5 and 4%. For samples with a TOC outside this range, oc-normalization was not performed, and the dry weight concentration was compared to the LAET and 2LAET criteria.
9. The convention of 98% stations or LDW surface area below the SMS criteria is used in the FS for point count and area estimation purposes only. It does not represent a standard to be applied to compliance monitoring.

a. The 5-year model-predicted intervals associated with the BCM output are indexed to the start of construction for FS Alternative 5C and all the scenarios.
b. Alternative 5C Plus Base includes the common base elements and PCB intertidal RAL of the SQS.

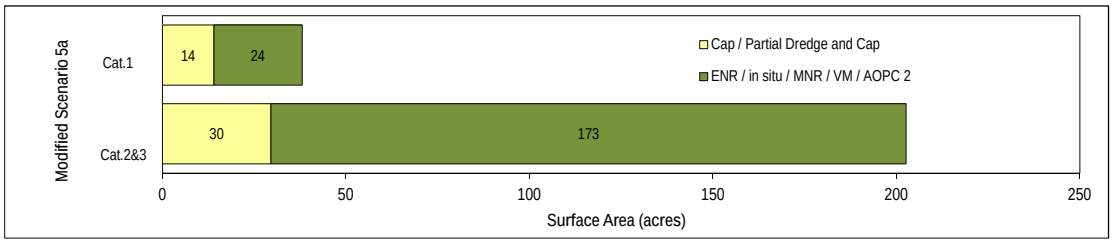
2LAET = second lowest apparent effects threshold
BCM = bed composition model
CSL = cleanup screening level
D/F = dioxins and furans
EAA = early action area
FS = feasibility study
LAET = lowest apparent effects threshold
LDW = Lower Duwamish Waterway
MNR = monitored natural recovery
oc = organic carbon
PRG = preliminary remediation goal
RAL = remedial action level
RAO = remedial action objective
SMS = Sediment Management Standards
SQS = sediment quality standard
STM = sediment transport model
TOC = total organic carbon
yr = year

Table 9 Post-construction Sediment Conditions for Modified Scenario 5a

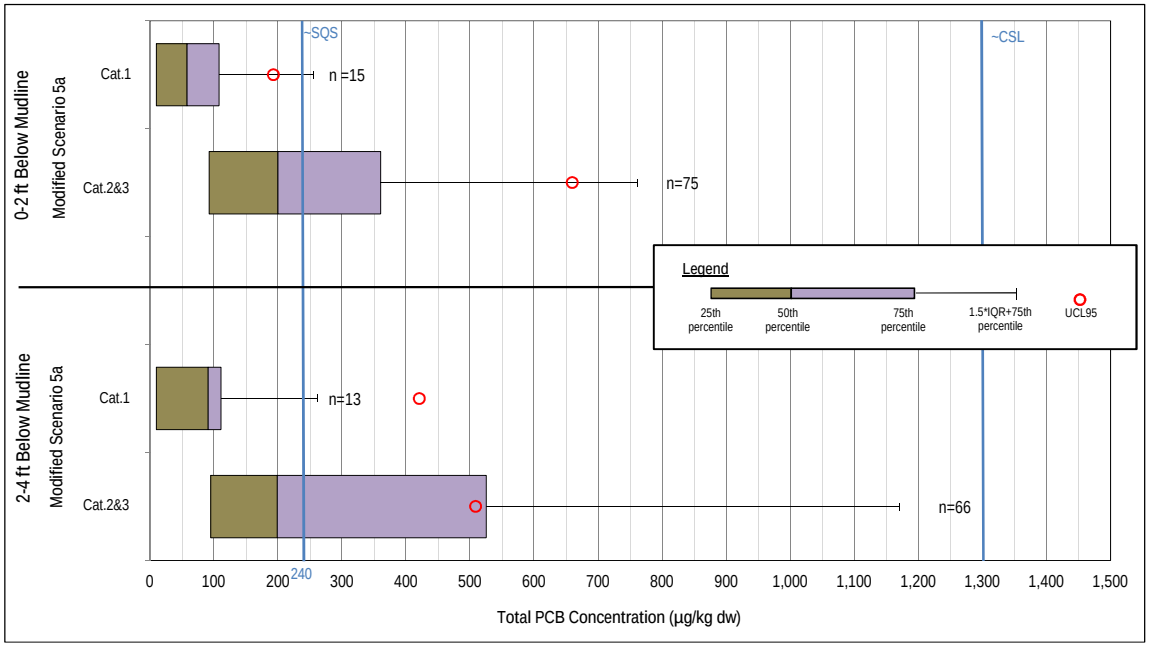
Number of Core Stations with SMS Chemistry Exceedances and Total PCB Concentrations in Areas Outside the EAA and Dredge Footprint for Modified Scenario 5a

Scenario	Recovery Category	Located within AOPC 1 and AOPC 2 Outside Dredge and Cap Footprint								Cap / Partial Dredge and Cap			
		Core Station Counts		Total PCB Concentration (µg/kg dw)						Core Station Counts		Total PCB Concentration (µg/kg dw)	
				0 to 2 ft depth			2 to 4 ft depth					0 to 4 ft depth	
		> CSL	< CSL, > SQS	n	Mean	UCL95	n	Mean	UCL95	> CSL	< CSL, > SQS	n	Mean
Modified Scenario 5a	1	0	3	15	79	193	13	136	420	19	4	27	639
	2 and 3	23	20	75	379	660	66	379	508				
	All	23	23	90	329	569	79	339	585				

Surface Areas Outside the EAA and Dredge Footprint Corresponding to Technology Assignment Groups for Modified Scenario 5a



Summary Statistics of Subsurface Total PCB Concentrations Remaining in AOPC 1 and AOPC 2 and Outside the EAA, Dredge and Cap Footprint for Modified Scenario 5a



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 FS 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. Core counts may be conservative because some of the material at these locations may have been previously dredged. In such cases, it is unconfirmed whether all contamination was removed and, in some instances, whether dredging actually occurred at these locations. Therefore, all remaining cores were included in the core counts.
3. Modified Scenario 5a includes 64 acres of dredged areas, not shown in center panel. The AOPC 1 and 2 footprints are approximately 180 and 122 acres, respectively.
4. Summary statistics for the 0- to 2-ft and 2- to 4-ft intervals (top table and lower panel) are for the vertically averaged total PCB concentrations in 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. No data greater than the 1.5*IQR+75th percentile are shown in the lower panel.
5. The mean PCB concentration for capped and partially dredged/capped areas in the 0- to 4-ft interval (shown in top table) 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, the sediment cap is designed to be 3 ft thick.
6. The mean and UCL95 total PCB concentrations in the 0- to 4-ft interval in the rest of the waterway (110 acres outside of AOPC 2; 52 cores) are 68 and 120 µg/kg dw, respectively.

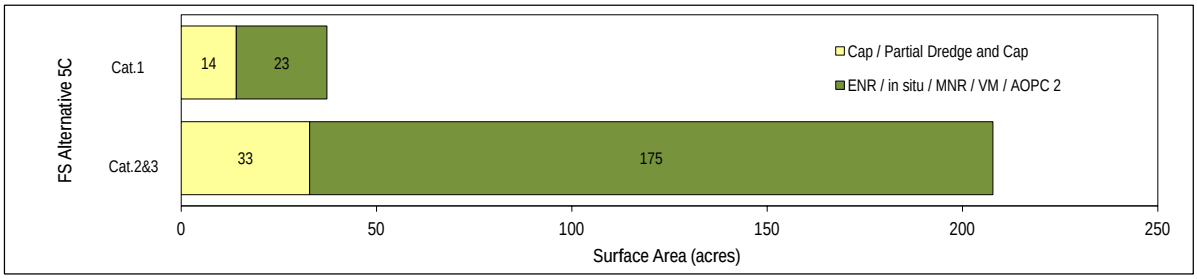
AOPC = area of potential concern; Cat. = recovery category; CSL = cleanup screening level; EAA = early action area; ENR = enhanced natural recovery; FS = feasibility study;
ft = foot; IQR = interquartile range; LDW = Lower Duwamish Waterway; µg/kg dw = microgram per kilogram dry weight; MNR = monitored natural recovery; n = number of cores; PCB = polychlorinated biphenyl;
RAL = remedial action level; SD = standard deviation; SMS = Sediment Management Standards; SQS = sediment quality standard; UCL95 = 95% upper confidence limit on the mean; VM = verification monitoring

Table 10 Post-Construction Sediment Conditions for FS Alternative 5C

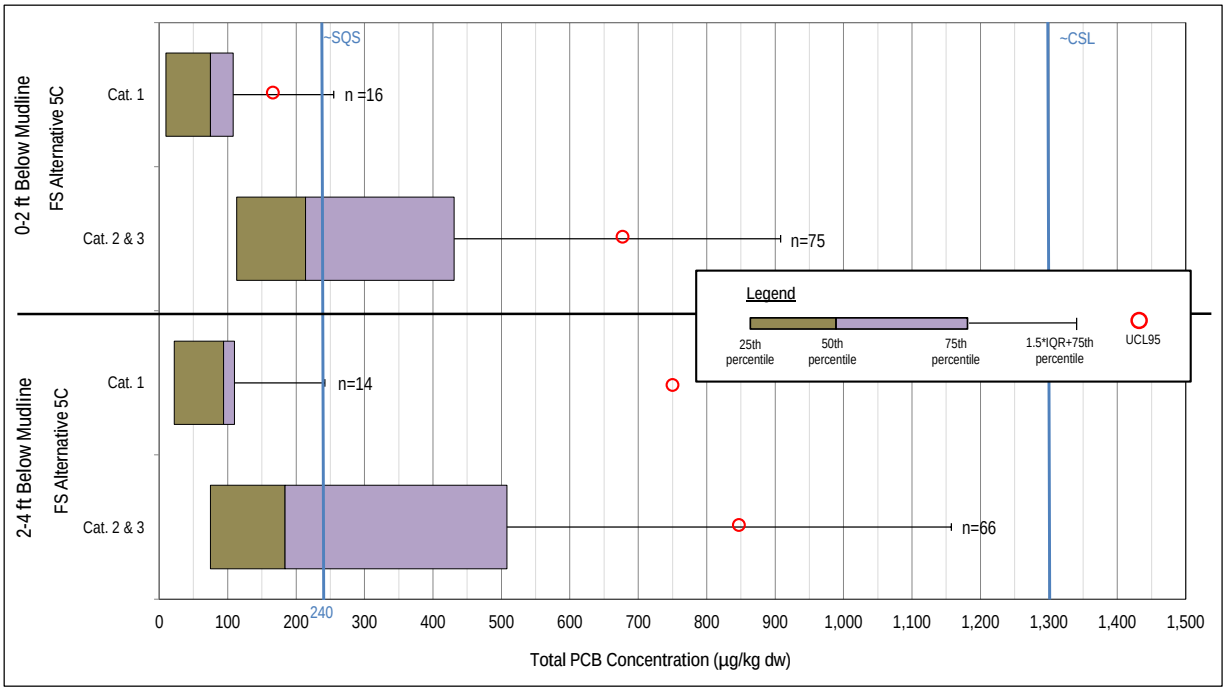
Number of Core Stations with SMS Exceedances and Total PCB Concentration in Areas Outside the EAA and Dredge Footprint for FS Alternative 5C

Remedial Alternative	Recovery Category	Located within AOPC 1 and AOPC 2 Outside Dredge and Cap Footprint								Cap / Partial Dredge and Cap			
		Core Station Counts		Total PCB Concentration (µg/kg dw)						Core Station Counts		Total PCB Concentration (µg/kg dw)	
				0 to 2 ft depth			2 to 4 ft depth					0 to 4 ft depth	
		> CSL	< CSL, > SQS	n	Mean	UCL95	n	Mean	UCL95	> CSL	< CSL, > SQS	n	Mean
5C	1	0	2	16	80	166	14	133	750	20	4	31	610
	2 and 3	22	22	75	399	677	66	451	847				
	All	22	24	91	343	579	80	395	730				

Surface Areas Outside the EAA and Dredge Footprint Corresponding to Technology Assignment Groups for FS Alternative 5C



Summary Statistics of Subsurface Total PCB Concentrations Remaining in AOPC 1 and AOPC 2 and Outside the EAA, Dredge and Cap Footprint for FS Alternative 5C



Notes:

1. Recovery Category 1, 2, and 3 designations were assigned to any area of the LDW (excluding EAAs), regardless of AOPC or RAL status, and based on a specific recovery assessment (see FS 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. Core counts may be conservative because some of the material at these locations may have been previously dredged. In such cases, it is unconfirmed whether all contamination was removed and, in some instances, whether dredging actually occurred at these locations. Therefore, all remaining cores were included in the core counts.
3. Areas in the center panel reflect designations made in developing the remedial alternatives and should not be assumed to contain subsurface contaminants at concentrations represented in the table.
4. FS Alternative 5C includes 57 acres of dredged areas, not shown in center panel. The AOPC 1 and 2 footprints are approximately 180 and 122 acres, respectively.
5. Summary statistics for the 0- to 2-ft and 2- to 4-ft intervals (top table and lower panel) are for the vertically averaged total PCB concentrations in 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. No data greater than the 1.5*IQR+75th percentile are shown in the lower panel.
6. The mean PCB concentration for capped and partially dredged/capped areas in the 0- to 4-ft interval (shown in top table) 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.
7. The mean and UCL95 total PCB concentrations in the 0- to 4-ft interval outside of AOPCs 1 and 2 (i.e., rest of the waterway–110 acres) are 68 and 120 µg/kg dw, respectively (52 cores).

AOPC = area of potential concern; C = combined; Cat. = recovery category; CSL = cleanup screening level; EAA = early action area; ENR = enhanced natural recovery; FS = feasibility study; ft = foot; IQR = interquartile range; LDW = Lower Duwamish Waterway; µg/kg dw = microgram per kilogram dry weight; MNR = monitored natural recovery; n = number of cores; PCB = polychlorinated biphenyl; R = removal; R-T = removal with treatment; RAL = remedial action level; SD = standard deviation; SMS = Sediment Management Standards; SQS = sediment quality standard; UCL95 = 95% upper confidence limit on the mean; VM = verification monitoring

Table 11 Summary of Short-term Effectiveness Metrics for FS Alternative 5C, Supplemental Scenario 5a, and Modified Scenario 5a

Metric		Remedial Scenario		
		FS Alternative 5C	Scenario 5a	Modified Scenario 5a
Period of community exposure, worker exposure and ecological disturbance (years of construction)[a]		7	7	7
Total PCB mass exported from site as a result of natural erosion; 45-yr model period (kg)		3.0	2.9	2.9
Total PCB mass exported from site as a result of dredging (kg)		6.3	6.3	6.3
Transportation (miles)[b]	Truck	480,000	500,000	510,000
	Train	130,000	130,000	130,000
Ecological – Habitat area above -10 ft MLLW disturbed (dredging/partial dredge and cap/capping; acres)		39	41	43
Gas / Particulate Emissions	Greenhouse gas emissions (CO_2; metric tons)	30,000	31,000	31,000
	Other air pollutants (NO_x/SO_x ; metric tons)	578 / 14	597 / 15	605 / 15
	Particulate matter emissions (PM_{10}; metric tons)	25	25	26
Energy Consumption (MJ)		4.2E+08	4.3E+08	4.3E+08
Landfill Capacity Consumed (1.2 x Dredge Volume)		900,000	940,000	950,000
Carbon Footprint (acre-years)[c]		7,094	7,290	7,412
Depleted natural resources (sand/gravel for in-water placement; cy)		580,000	560,000	590,000

Notes:

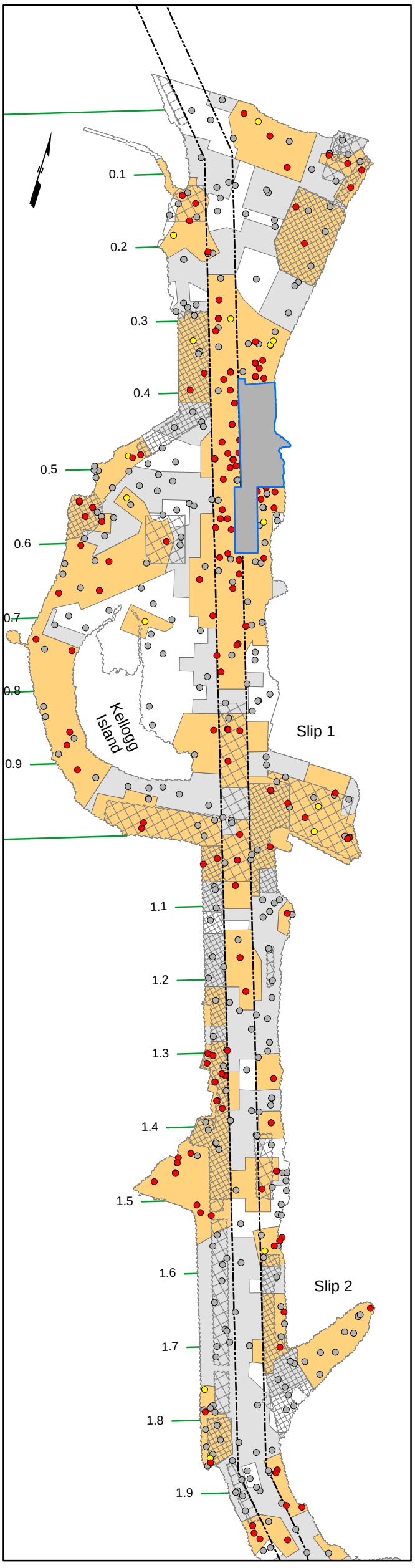
1. See FS Appendices L and M (AECOM 2012b) for details on basis and assumptions for short-term metric values.

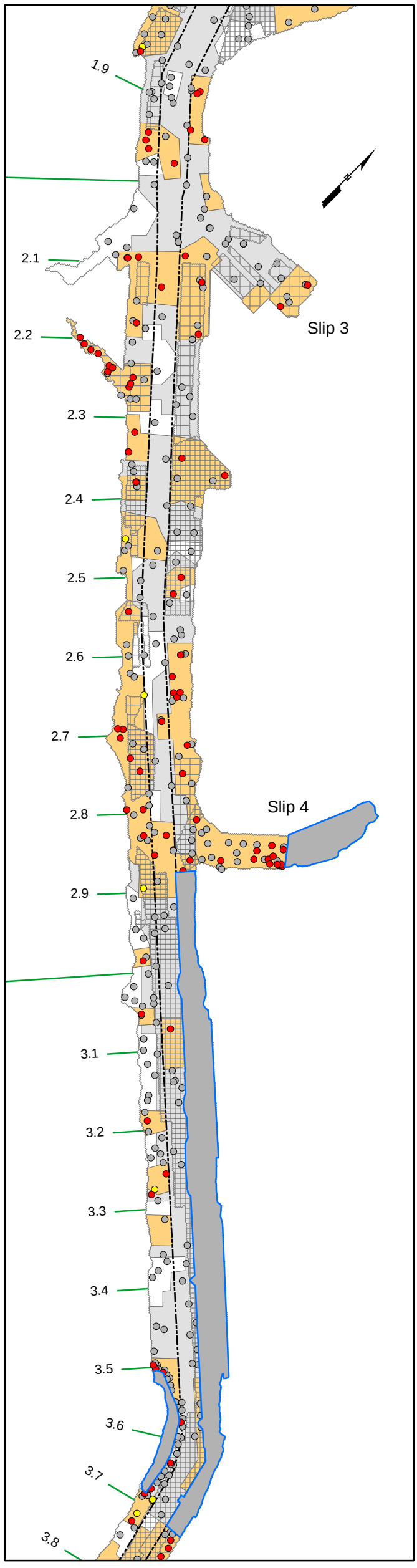
a. Construction period rounded to nearest year. Additional time beyond construction required for ecologically sensitive areas to recover. Also, fish and shellfish tissue contaminant concentrations may require additional time (1 to 2 years) after construction to recover.

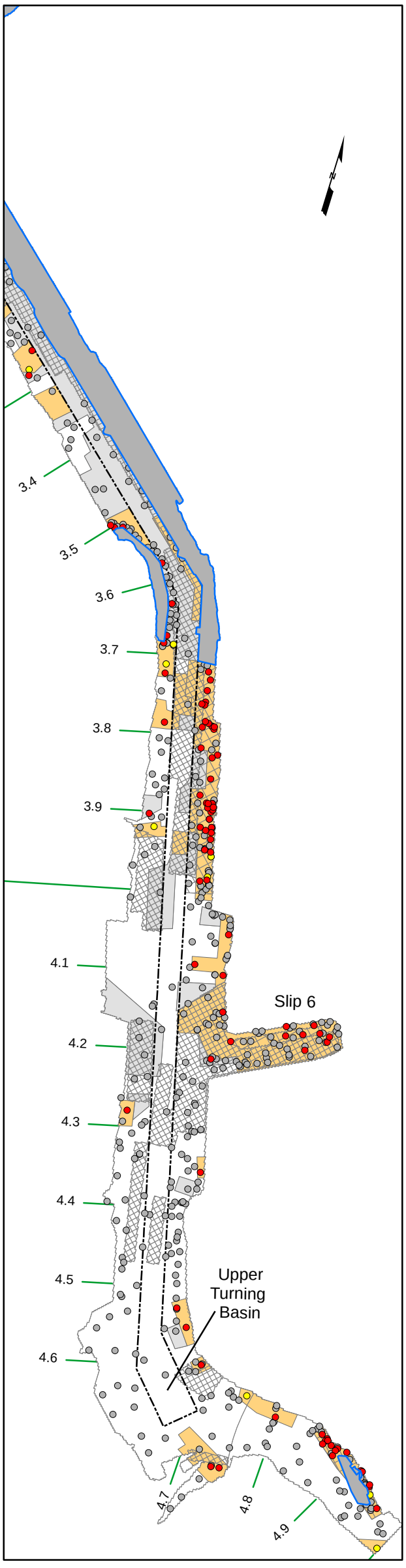
b. Sediment is assumed to be disposed of by trucking from a transloading area to an intermodal station, where it is loaded onto train cars for transport to a landfill in Eastern Washington or Eastern Oregon. Trucking miles are estimated using an average 28 tons/truck and 12 miles to the intermodal station. Train miles are estimated assuming 568 miles (round trip) to the landfill and assuming that each train can carry 5,000 tons of dredged material.

c. One acre-year represents the amount of CO_2 sequestered by one acre of Douglas fir forest for one year. Carbon footprint in units of acre-years is an appropriate way to account for the differences in construction periods among the alternatives.

C = combined; CAD = contained aquatic disposal; CO_2 = carbon dioxide; cy = cubic yards; kg = kilograms; MJ = megajoule; MLLW = mean low lower water; NO_x = nitrogen oxides; PM = particulate matter; R = removal; R-T = removal with treatment; SO_x = sulfur oxides







AOPC= area of potential concern; cPAH= carcinogenic polycyclic aromatic hydrocarbon; CSL= cleanup screening level; D/F= dioxins and furans; PCB= polychlorinated biphenyl; RAL= Remedial Action Level; SMS= Sediment Management Standards; SQS= sediment quality standard.

Note:
1. Locations DR290 and DR292 are not shown on the map because they have been dredged.

AOPC 1 (189 acres)
AOPC 2 (116 acres)
Early Action Area (29 acres)

Feet
0 200 400 800

Legend

Surface Sediment Exceedance Location

- Surface Sediment Location >RALs for Human Health Risk Drivers, and/or >2xSQS or >CSL for SMS Contaminants
- Surface Sediment Location >SQS, but <2xSQS and <CSL and <RALs for Human Health Risk Drivers (PCBs, arsenic, cPAH, D/F)
- Surface Sediment Location <Alt 5C RALs (<SQS)

Recovery Category

- Category 1: Recovery Presumed to be Limited (77 acres)
- Category 2: Recovery Less Certain (45 acres)
- Category 3: Predicted to Recover (290 acres)

- Navigation Channel
- River Mile Marker

AECOM

Lower Duwamish Waterway Group
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Lower Duwamish Waterway
60150279-9.9

Surface Sediment RAL Exceedances for EPA's Preferred Alternative (Alternative 5C Plus)

DATE: 02/22/13 | DWRN:MVI/sea | Revision: 0

FIGURE 1

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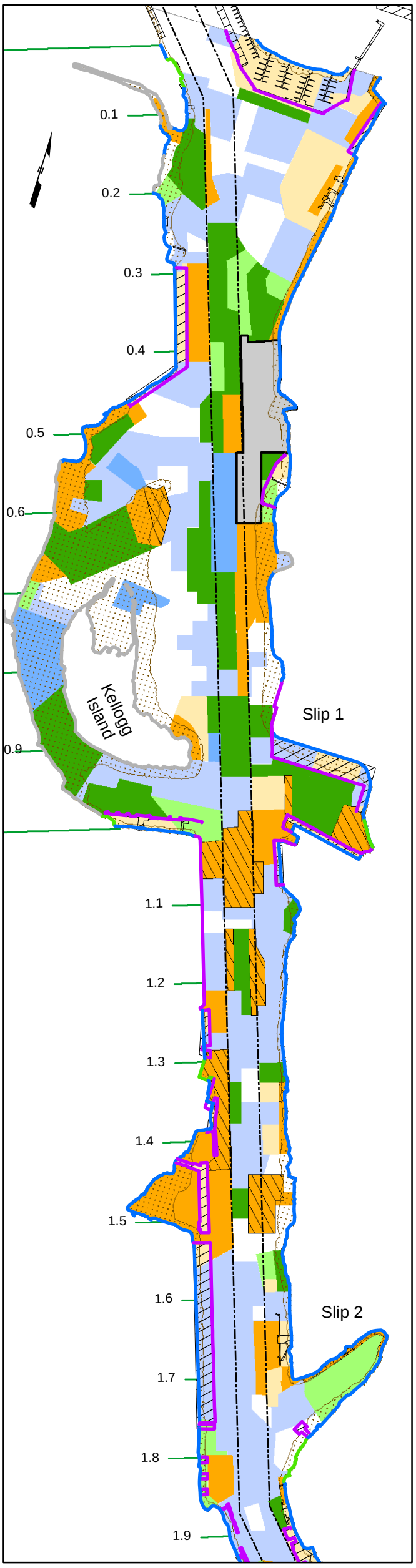

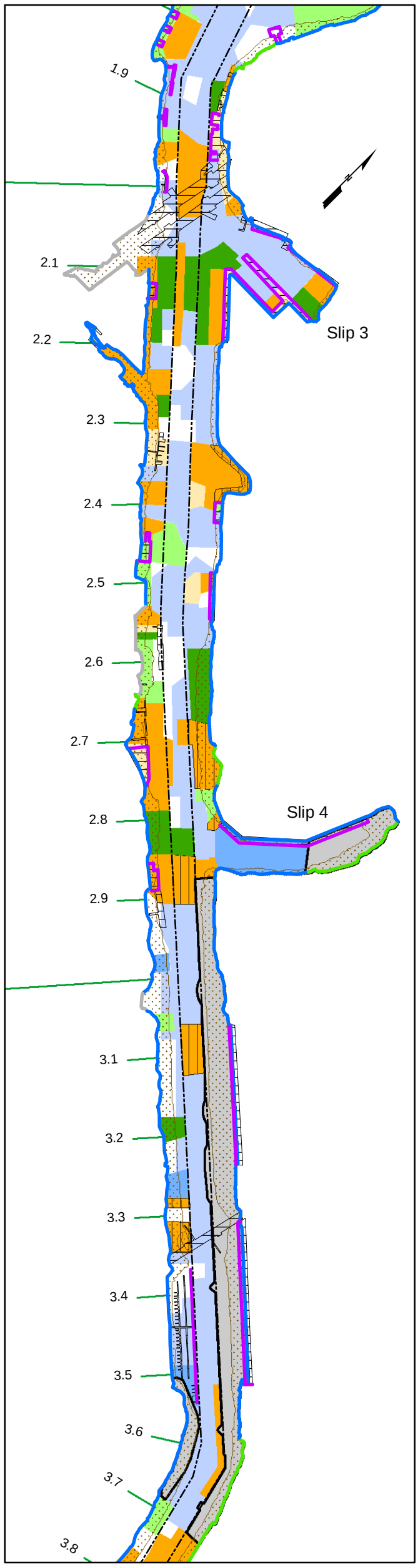

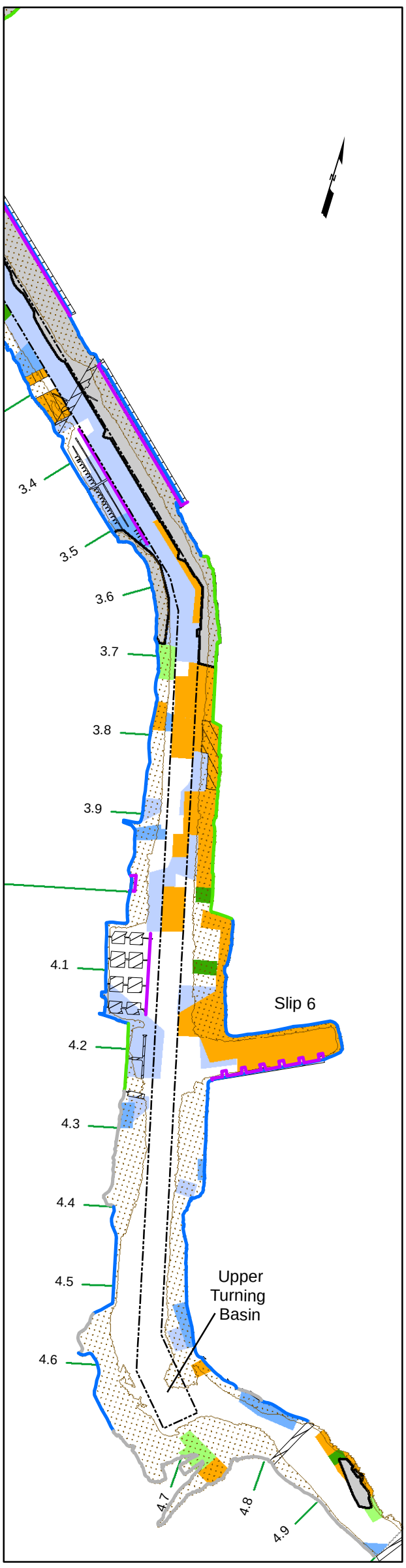

AOPC= area of potential concern; ENR= enhanced natural recovery;
MLLW= mean lower low water; SMS= Sediment Management Standards;
SQS= sediment quality standard.

Shoreline Condition

- Armored Slope (10.1 miles)
- Exposed Bank (3.7 miles)
- Dock Face (4.9 miles)
- Vertical Bulkhead (1.0 miles)
- Navigation Channel
- River Mile Marker

Feet
0 200 400 800

Legend

Technology Assignment

- Dredge (64 acres)
- Partial Dredge and Cap (20 acres)
- Cap (24 acres)
- ENR/*in situ* (48 acres)
- Monitored natural recovery (surface sediment >SQS)(16 acres)
- Verification Monitoring (17 acres)
- AOPC 2 Outside of AOPC 1 (Institutional Controls and Site-wide Monitoring) (116 Acres)
- Remaining Study Area (Institutional Controls and Site-wide Monitoring) (107 acres)
- Early Action Area (29 acres)
- Overwater Structures
- Intertidal Area > -4 ft MLLW

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Lower Duwamish Waterway
60150279-9.8

EPA's Preferred Alternative (Modified Scenario 5a) - Areas Labeled as in the Feasibility Study

DATE: 02/22/13 | DWRN:MVI/sea | Revision: 0

FIGURE 2

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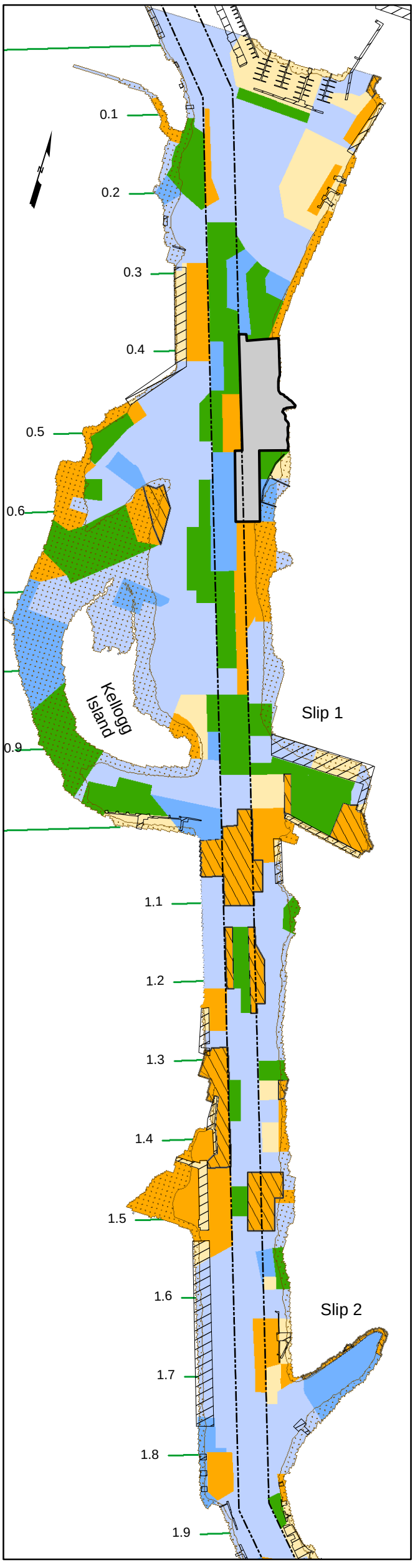

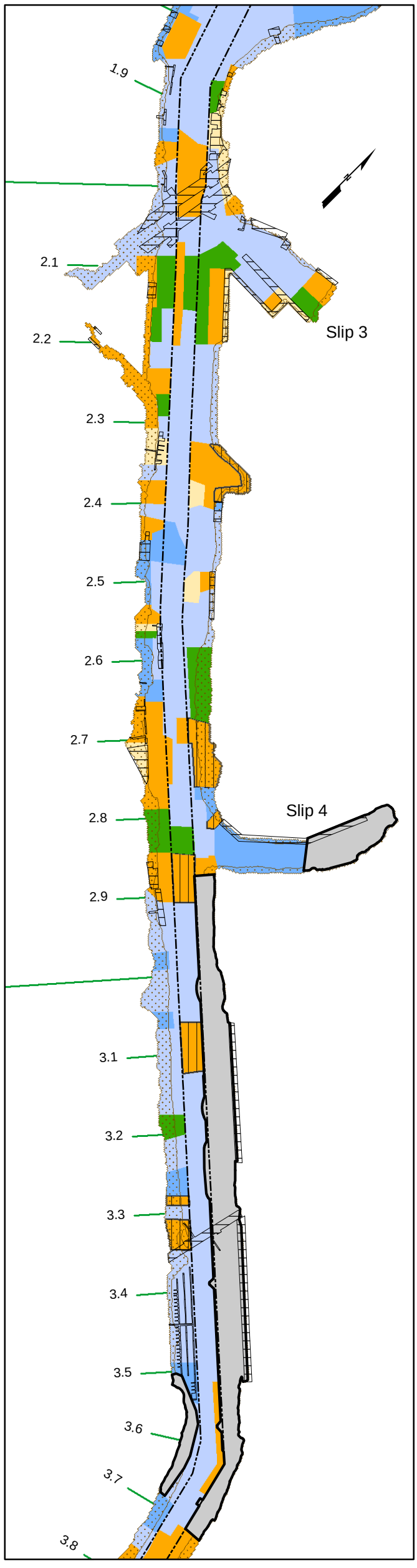

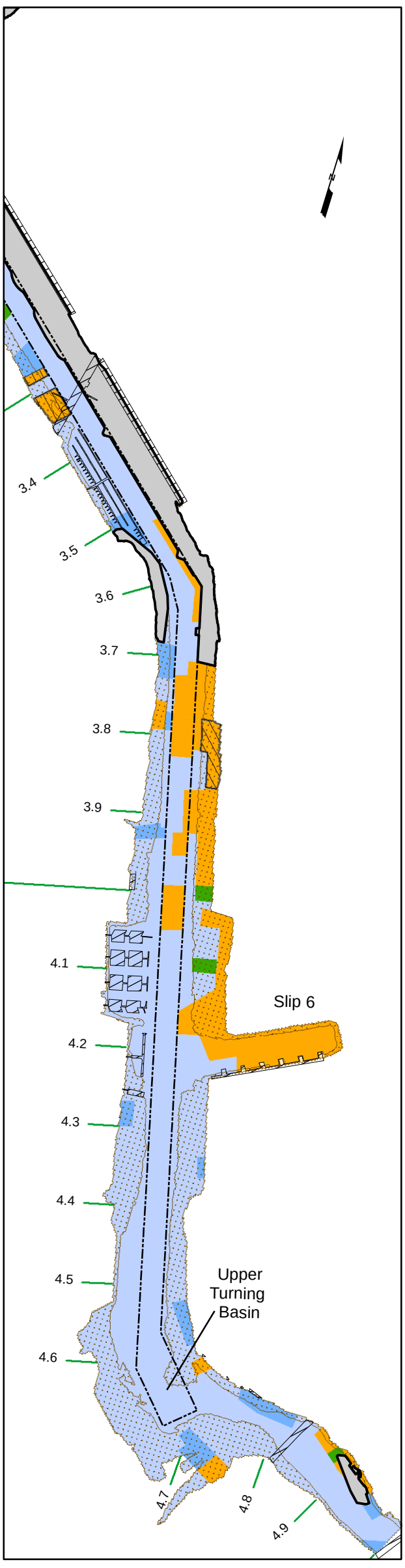

AOPC= area of potential concern; ENR= enhanced natural recovery;
MLLW= mean lower low water; SMS= Sediment Management Standards;
SQS= sediment quality standard.

Legend

Technology Assignment

- Dredge (64 acres)
- Partial Dredge and Cap (20 acres)
- Cap (24 acres)
- ENR/*in situ* (48 acres)
- Monitored Natural Recovery (Surface Sediment >SQS)(33 acres)
- Monitored Natural Recovery (Surface Sediment <SQS)(223 acres)
- Early Action Area (29 acres)
- Overwater Structures
- Intertidal Area > -4 ft MLLW
- Navigation Channel
- River Mile Marker

Feet
0 200 400 800

AECOM

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

Lower Duwamish Waterway
60150279-9.8

EPA's Preferred Alternative (Modified Scenario 5a) - Areas Labeled as in the Proposed Plan

DATE: 02/22/13 | DWRN:MVI/sea | Revision: 0

FIGURE 3

Path: Q:\GIS_ENV\Lower Duwamish FS\Prefered Alternative\MXDs\Suplemental Scenarios Post FS_112012\Memo Figures\Scenario5aBPJ Memo\Figure3-Alt5a BPJ GenerationBlue.mxd