TABLES

Table 1-1. Duwamish River—8th Avenue South Tidal Datums.

	Relationship Between Various Datum Planes (ft)				
Tidal Stage	MLLW	NGVD	NAVD88	USACE	City
Highest Observed Tide	14.8	8.7	12.3	15.7	2.6
Mean Higher High Water	11.10	5.03	8.59	11.98	-1.13
Mean (Half) Tide Level	6.40	0.33	3.89	7.28	-5.83
Mean Lower Low Water	0.00	-6.07	-2.51	0.88	-12.23
Lowest Estimated Tide	-4.5 +/- 0.5	-10.6 +/- 0.5	-7.0 +/- 0.5	-3.6 +/- 0.5	-16.7 +/- 0.5

Source: USACE 2002; Nelson 1978

Notes: MLLW = mean lower low water
NAVD88 = North American Vertical Datum 1988
NGVD = National Geodetic Vertical Datum
USACE = U.S. Army Corps of Engineers

Table 1-2. Summary of Outfall Characteristics within the Removal Action Area.

Outfall	Diameter (in.)	Invert Elevation (ft, MLLW)	Drainage Area (acres)	Estimated Peak Flow Velocity (ft/s)	Estimated Peak Flow (CFS)	Notes
King County Airport SD#3/PS44 EOF	60	5.62	290 (SD) 75 (EOF)	9.6	130	Outfall to be protected during construction
North Boeing Field SD	24	5.19	3	3.0	1.4	Outfall to be protected during construction
I-5 SD	72	5.22	140	7.6	55.6	Outfall to be protected during construction
Georgetown Flume	72 x 44	1.06	Unknown	3.8	4.9	Outfall to be modified prior to Removal Action Construction
East Marginal Way EOF	36	Unknown	318	n/a	n/a	Outfall to be protected during construction. Location to be verified by contractor

Notes: SD = storm drain
EOF = emergency sewer overflow

Table 5-1. Soil and Sediment Properties Used for Slope Stability Analyses.

Sediment Code[a]	Saturated Density (pcf)	Friction Angle (degrees)	Description
SOIL1	130	34	Slope cap and armor—medium dense sand and gravel with riprap armoring. (These cap components were conservatively treated as a single layer to simplify stability analysis.)
SOIL2	122	32	In-water cap—medium dense silty sand
SOIL3	125	32	Loose to dense sand and gravel fill
SOIL4	95	27	Silt, stiffens with depth
SOIL5	120	30	Silty sand, very stiff to hard
SOIL6	125	34	Sand, loose to moderately loose
SOIL7	125	33	Silty sand interbeds

Notes:
[a]Refer to geotechnical cross-sections presented in Appendix E to identify location of respective sediment layers.

Table 5-2. Summary of Slope Stability Analysis Results.

Cross-Section	Factor of Safety for Existing Slope (Static Loading)	Factor of Safety for Capped Slope (Static Loading)	Factor of Safety for Capped Slope (Seismic Loading)
2+80	1.5	1.4	1.2
6+00	1.2	1.6	1.2

Notes: The Modified Bishop Method was used to calculate factors of safety.
A horizontal acceleration of 0.075 g was used for pseudo static analysis, consistent with a 100-year return period seismic event.
All analyses assume low tide conditions (elevation = 0 ft MLLW).

Table 5-3. Estimated Sediment Consolidation Due to Capping.

Condition	Silt layer Thickness (ft)	Settlement (in.)	Time for 90% settlement (days)
1. No dredging SC-21	8.0	9.0	34
2. With dredging SC-21	5.0	2.4	13
3. No dredging SC-20	6.0	2.5	19
4. With dredging SC-20	3.0	0.6	5

Table 5-4. Summary of Minimum Cap Thicknesses per EPA Guidance

	Minimum Cap Thicknesses per EPA Guidance (inches)					
Area	Bioturbation T_b	Erosion T_e	Consolidation T_c	Chemical Isolation T_i	Total Minimum Cap Thickness per EPA Guidance [a]	Overplacement Allowance T_o
RA1; RA2; RA3: Slope Caps [b]	0[c]	18	0	12	30	12
RA4: Outfall Area, Unarmored	36	12	0	12	60	12
RA4: Outfall Area, Armored	0[c]	18	0	12	30	12
RA5; Mid-Slip, Unarmored Subtidal	6	12	0	12	30	12
RA6: Mid-Slip, Unarmored Intertidal	36	12	0	12	60	12
RA7: Mid-Slip, Armored	0[c]	18	0	12	30	12

Notes:

[a] Thickness calculated according to USEPA guidance (USEPA 1998). Design requires greater thicknesses in some areas. See Table 5-5 for required thickness.

[b] The habitat area soil covers in RA1 and RA2 are not sediment caps and (USEPA 1998) guidance does not apply. See Table 5-5 for required thickness.

[c] For armored caps, the cap functions for bioturbation and erosion resistance are considered a combined component; Tb is accounted for in Te

Table 5-5. Summary of Required Cap Thicknesses (as Designed).

	Design Thickness (in inches)															
	Filter Material (h)		Waterway Cap Material		Cap Armor		Habitat Mix		Heavy Loose Riprap		Beach Sand		Total Required Cap Thickness	Total Overplacement	Constructed Thickness	Minimum Long-Term Cap
Area	Required	Overplacement	Required	Overplacement	Required	Overplacement	Required	Overplacement	Required	Overplacement	Required	Overplacement	(a)	Allowance	Range (g)	Thickness (d)
RA1; RA2; RA3: Slope Caps	12	6			18	6	(b)	(b)					30	12	30 - 42	30
RA1 and RA2: Habitat Area Soil Covers			12	3							12	3	24	6	24 - 30	(f)
RA4: Outfall Area, Unarmored	12	6	48 (c)	6									60 (c,e)	12	60 - 72	48
RA4: Outfall Area, Armored	12	6			18 (c)	6	(b)	(b)	(c)	12			30 (c)	12	30 - 42	30
RA5: Mid-Slip, Unarmored Subtidal			30	12									30	12	30 - 42	18
RA6: Mid-Slip, Unarmored Intertidal			60	12									60 (e)	12	60 - 72	48
RA7: Mid-Slip, Armored			12	6	18	6	(b)	(b)					30	12	30 - 42	30

Notes: (a) Required thickness is the minimum thickness the contractor must construct

(b) Habitat Mix is to be applied to all armored areas at a rate of 3 tons per 100 square ft.

(c) Outfall area cap to be constructed to design lines and grades.

(d) The minimum long-term cap thickness is the minimum cap thickness that must remain over time. It is equal to Ti + Tb for unarmored caps and Ti + Te for armored caps

(e) The 60-inch required thickness is based on protection of shellfishing treaty rights, as described in the text.

(f) The minimum long-term thickness of the habitat area soil cover will be determined in the Long-Term Monitoring and Reporting Plan, based on soil sample results.

(g) The actual thickness that is to be constructed is the range between the required thickness and the required thickness plus the overplacement allowance. As built surveys will document the actual thickness.

(h) Filter material is a mix of sands and gravels, as defined in the text.

Table 5-6. Cap Material Quantities.

Material	Quantity (tons)	Quantity (cy)
Habitat Mix	2,128	1,330
Cap Armor	9,344	5,840
Heavy Loose Riprap	154	96
Waterway Cap Material	28,422	17,763
Filter Material	5,475	3,422
Beach Sand	489	306
Total	**46,011**	**28,757**

Table 6-1. Habitat Acres by Elevation Range.

Habitat Elevation Range (ft MLLW)	Existing Conditions (Acres)	Post Construction (Acres)	Net Change (acres)
Upland (+12 to Top of Bank)			
Riparian (+12 to top of bank)	0.12	0.39	+0.28[a]
Aquatic (Below +12)			
Upper Intertidal (+12 to +4)	0.31	0.80	+0.49
Lower Intertidal (+4 to -4)	1.54	1.55	+0.01
Shallow Subtidal (-4 to -10)	0.80	1.08	+0.29
Sublittoral (Deeper than -10)	0.71	0.00	-0.71
Total Aquatic	**3.36**	**3.44**	**+0.08**
Project Total			
Total Acreage	3.48	3.83	+0.36

Notes:
[a] Includes 0.15 acre riparian habitat enhancement.

Table 9-1. Engineer's Construction Cost Estimate Summary.

Bid Item	Description of Direct Capital Costs	Quantity	Unit	Unit Cost	Cost
1	Mobilization	1	Lump sum	$462,920	$476,989
2	Maintenance & Protection of Traffic Control	1	Lump sum	$25,521	$26,008
3	Environmental Pollution Protection Control	1	Lump sum	$106,754	$108,787
4	Removal Action Work Plan	1	Lump sum	$65,625	$66,875
5	Demolition and Removals	1	Lump sum	$621,491	$633,329
6	Dredging, Excavation, and Disposal at Subtitle "D" Landfill	10,256	Cubic yards	$96.34	$1,006,828
7	Waterway Cap	28,422	Ton	$32.52	$941,796
8	Filter Material	5,475	Ton	$36.84	$205,567
9	Cap Armor	9,344	Ton	$40.43	$384,924
10	Habitat Mix	2,128	Ton	$41.61	$90,239
11	Heavy Loose Riprap	154	Ton	$75.08	$11,751
12	Beach Sand	489	Ton	$24.43	$12,173
13	Large Woody Debris	14	Each	$1,473	$21,009
14	Survey and Survey Control	1	Lump sum	$85,470	$87,098
15	Record Drawing and Closeout Documentation	1	Lump sum	$66,528	$67,795
16	Disposal at Subtitle "C" Landfill (0–30 tons)	30	Ton	$763	$23,317
17	Disposal at Subtitle "C" Landfill (31–90 tons)	60	Ton	$255	$15,572
18	Standby for Site Access (0–5 days)	5	Day	$10,106	$51,494
19	Thin-Layer Capping (0–830 tons)	830	Ton	$92.40	$78,118
	TOTAL ENGINEER'S ESTIMATE FOR BIDDING				**$4,310,000**
	Tax				**$409,000**
	TOTAL				**$4,719,000**

Notes:

Unit costs include contractor overhead and profit.

All quantities are estimates which may be refined.

All materials unit rates include costs for purchase, loading, and delivery of materials to the site, along with quality control sampling, O&P.

Items 16–19 are set up for contracting purposes. Maximum estimated quantities are shown as basis for bidding.

Table 9-2. Engineer's Overall Project Cost Estimate Summary.

Item	Estimated Cost
Engineering Design	$392,000
Land Acquisition and ICs (see Note 1)	$700,000
RA Construction Costs (Table 9-1)	$4,310,000
Owner Surveys (as a contingent action)	$42,800
CQA Contractor (see Note 2)	$488,990
Project Management (5% of RA Construction Costs)	$216,000
Construction Engineering and Management (6% of RA Construction Costs)	$259,000
Washington State Sales Tax (8.8% of RA Construction Costs)	$409,000
Contingency (15% of RA Construction Costs)	$647,000
Long-Term Operation & Maintenance (30-year present worth) (see Note 3)	$680,000
TOTAL	**$8,145,000**

Notes:

1. Estimated cost of land acquisition and implementation of ICs
2. Includes RAWP support, construction oversight including engineering, sampling, and analysis, and preparation of Removal Action Completion Report
3. Includes Long-Term Monitoring Plan preparation

CQA = construction quality assurance
IC = institutional control
RA = removal action
RAWP = remedial action work plan

Table 10-1. Institutional Controls Evaluation and Selection.

Institutional Control	Long-Term Effectiveness	Implementability	Enforceability	Cost	Selected for Slip 4?
Governmental Controls					
Local Permits	Very Good	Good	Very Good	Good	**Yes**
Zoning	Good	Very Good	Good	Good	No
Public Use Bans	Poor	Good	Poor	Good	No
Condemnation of Property	Good	Poor	Poor	Poor	No
Proprietary Controls					
Property Purchase	Very Good	Very Good	Very Good	Poor	**Yes**
Affirmative Easements	Very Good	Very Good	Very Good	Good	No
Negative Easements	Good	Good	Good	Very Good	No
Restrictive Covenants	Very Good	Good	Good	Good	**Yes**
Reversionary Interest	Very Good	Very Good	Good	Poor	No
State Use Restrictions	Good	Good	Good	Neutral	No
Conservation Easements	Very Good	Poor	Good	Poor	No
Enforcement and Permit Tools					
Administrative Orders	Very Good	Very Good	Very Good	Good	**Yes**
Consent Decrees	Very Good	Very Good	Very Good	Poor	No
Informational Devices					
Deed Notices	Poor	Very Good	Good	Very Good	**Yes**
State Registry	Neutral	Very Good	Good	Very Good	**Yes**
Advisories	Good	Good	Good	Good	**Yes**

Table 10-2. Implementation of Selected Institutional Controls.

IC	Objective	Site Portion	Mechanism	Timing	Monitoring	Enforcement	Responsibility	Termination
Governmental Controls								
Local Permits	Restrict construction and other intrusive actions	A, B, C	Permitting Procedures	Permit requirements under the CWA and WA State Shoreline Management Act are already in place.	Applies before, during and soon after the construction period of the proposed project.	Review of construction plans and inspecting the site during and after construction	Ecology, USACE	Indefinite life until legislative change made
Proprietary Controls								
Property Purchase	Allow control over all land uses and monitoring	A	Fee-Simple Purchase	Complete prior to remedial construction	Not required	None	City of Seattle - Seattle City Light	Indefinite
Restrictive Covenants	Restrict landowners from activities that might compromise the cap	A, B, C	Mutual agreement among parties	Establish following remedial construction	Ecology can monitor the covenants by confirming they are filed along with the publicly available property records	Landowners have a vested interest in enforcing the covenants upon themselves in order to avoid fines for breeching the covenant	Although Ecology has an interest in the covenants, the land owners bear responsibility for maintaining them	
Enforcement and Permit Tools								
Administrative Orders (AOs)	A government agency exercises authority by mandating a party to take action and/or restrict use	A, B, C	EPA or Ecology administers directive	The order is often the precipitating event for the remedial design.	EPA will review long-term monitoring results no less frequently than every five years	AOs are enforceable in a court of law	EPA is enforcing the Slip 4 ASAOC; The City of Seattle and King County are responsible for implementing all aspects of the Removal Action	Although an AO may be terminated at the completion of remediation, periodic reviews ensure the ICs for the site remains in place
Informational Devices								
Deed Notices	Provides public information	A	Land owner voluntarily files a notice with public land records	Deed notices should be filed soon after the City of Seattle completes the planned land acquisition	The deed notice is monitored by confirming it has been filed	Informational devices are not legally enforceable and primary serve to inform the public	The landowner is responsible for filing the notice	The notice remains on file indefinitely until a change in conditions warrants its removal
State Registry	Compiles a database of sites of concern for public viewing	A	Ecology has established the Site Register and the Hazardous Sites list	The LDW is already listed on the Hazardous Sites list, and public notices can be published in the Site Register as needed	Ecology monitors sites listed on the Hazardous Sites list		Ecology maintains the database	A site is removed from the Site Register upon reaching a No Further Action status
Advisories	Information is dispersed notifying the public of health risks	Addressed in the LDW sitewide remediation objectives	Signs, pamphlets, website, etc. (translated into regional languages)	Already in place for LDW Superfund Site	The WA Sate Dept. of Health will review data periodically to determine if the advisory should remain in place		Advisories are created by government agencies (i.e., Department of Health)	Advisories can be terminated when monitoring activities prove the risk has reach an acceptible level

Notes: Site Portions (see Figure 10-1)
A - City of Seattle
B - The Boeing Company
C - First South Properties