FINAL

Appendix I
Recommended Recovery Category Modifications

1 Introduction

Recovery category areas are an important component of the remedial actions identified in the Lower Duwamish Waterway (LDW) Record of Decision (ROD) (EPA 2014) and are used to help identify the appropriate spatial application of remedial action levels (RALs) and remedial technologies. Recovery category areas were developed in the feasibility study (FS) (AECOM 2012) based on the criteria shown in ROD Table 23 and depicted in ROD Figure 17 (EPA 2014). Recovery category areas throughout the LDW were delineated in the ROD by using the following physical and chemical criteria to estimate areas of recovery and scour potential:

1. Identification of observed vessel-induced scour areas based on a visual review of a sun-illuminated bathymetric survey map produced from a comprehensive, site-wide bathymetric survey. The 2003 bathymetric survey conducted for the remedial investigation (RI)/FS was used to delineate the recovery category areas defined in the ROD.
2. Identification of berthing areas based on waterway configuration (i.e., location of docks), review of the 2002 U.S. Army Corps of Engineers Port Series report (USACE 2002), and review of the waterway user survey and its assessment of in-water structures (Integral et al. 2018).
3. Identification of sediment transport model (STM)-predicted 100-year high-flow event scour areas (> 10 cm) and STM-predicted net-scour and net-sedimentation areas as presented in the FS.
4. Evaluation of empirical contaminant trends over time, used on a case-by-case basis to adjust recovery categories based on physical criteria (1 through 3).

Modifications to the middle reach ROD recovery category areas were made in 2019 at three locations based on criteria 2 and 4 in the *Recovery Category Recommendations Report* (Integral et al. 2019). An additional nine modifications to the middle reach recovery category areas were made in Appendix C of the Pre-Design Investigation Work Plan (PDIWP) (Windward and Anchor QEA 2022) based on criterion 1, using the 2021 bathymetric survey. One additional modification was made based on the review of the Phase I and II PDI data (as described in this appendix).[1] Thus, Map I-1 shows the final recovery category designations for the middle reach based on all modifications.

The purpose of this appendix is to assess whether additional recovery category modifications in the middle reach are warranted based on: 1) review of the supplemental bathymetric surveys performed during the Phase I PDI effort (criterion 1), and 2) comparison of Phase I and Phase II PDI chemistry data with pre-PDI data (criterion 4).

[1] This change in the recovery category was made after the Phase I PDI sediment sampling effort. This change was incorporated prior to the Phase II PDI QAPP Addendum (i.e., the Phase II sample collection addressed this recovery category change).

2 Bathymetric Survey Analysis

As part of the Phase I PDI, Northwest Hydro, Inc. collected multi-beam bathymetry data over multiple events between January and June 2023 in areas of the middle reach that could not be accessed in 2021. These surveys provided new data to assess changes in waterway bathymetry and observed vessel-induced scour areas. Vessel-induced scour near and in berthing areas was evaluated by examining a sun-illumination bathymetry map (Map I-2), consistent with the analysis performed for the FS (FS Section 2.3.1.1) (AECOM 2012). Multi-beam bathymetric soundings were converted to a digital terrain model of the three-dimensional mudline elevations, and the digital terrain model was used to generate the sun-illumination map. The outlines of ROD Recovery Categories 1 and 2 are shown on Map I-2. Areas outside of Recovery Categories 1 and 2 are designated as Recovery Category 3.

The highlights and shading on the sun-illumination map emphasize fine-scale features and vertical relief, aiding in the visual identification of bedform features that may be a result of scour from vessel propeller wash (propwash), vessel grounding, or anchoring or spudding from vessel operations. The features can include ridges and furrows, depressions, and other disturbance features. However, it is the actual vertical elevation difference that is important. This difference can be exaggerated in sun-illumination maps, because the angle of illumination can create shading for even very small elevation differences (e.g., inches), implying greater bed disturbance than is actually present.

Consistent with the PDIWP recovery category assessment (Windward and Anchor QEA 2022), changes in bathymetric elevation of +/- 4 inches were functionally considered to indicate no change in elevation, because the results were within the accuracy limits of the evaluation.[2] For this analysis and as a general guide, bed vertical disturbances (i.e., depressions in the bed as seen on the sun-illumination map) of 6 inches or less were not considered sufficient to indicate scour. For example, in marina areas, shadowing could be seen on the sun-illumination map, but it was not deep enough to indicate vessel scour sufficient to trigger a change to Recovery Category 1.

In addition to the sun-illumination maps, empirical net-scour or deposition patterns were identified by evaluating changes in bathymetric elevation between the 2003 bathymetric survey and the 2021/2023 PDI bathymetric surveys depicted on an isopach map (Map I-3). Changes in bathymetry may have been caused by a number of factors: ongoing natural sedimentation processes; dredging, excavation, structure removal or construction, or material placement that occurred between the two surveys; bed erosion due to surface water flows; vessel-induced scour from vessel propwash; or bed disturbance from other vessel operations (e.g., spudding, anchoring, grounding). Analysis of the

[2] The vertical accuracy of individual real time kinematics-global positioning system multibeam surveys in shallow water is in the range of +/- 0.3 feet (USACE 2013).

isopach map can help identify areas of positive change (referred to as deposition), negative change (referred to as scour), or no net elevation change.

While used in the line of evidence evaluation, the empirical information depicted in the isopach map is not used to override the predicted STM results (criterion 3), because of the longer-term duration of the STM analysis (which analyzes the impacts of repetitive high-flow events, including a 100-year high-flow event). Hydrographic surveys generally have a vertical accuracy of +/- 0.3 feet (USACE 2013); this uncertainty is compounded when comparing two surveys. The accuracy of the comparison is reduced along slopes (e.g., adjacent to the Federal Navigation Channel [FNC] and along the shoreline), in areas of riprap or other armoring, and along the edges of the survey area. Therefore, for this analysis, net elevation changes of +/-6 inches or less on the isopach map (Map I-3) are considered non-significant with respect to net deposition or scour in flat areas. On slopes or within armored areas, net elevation changes of +/-12 inches or less are considered non-significant. These determinations are consistent with the PDIWP recovery category assessment.

The middle reach areas surveyed in 2023 were evaluated and delineated into nine areas for detailed analysis; the early action areas were excluded (Maps I-4a to I-4i). Within the nine evaluation areas, the areas surveyed during the 2023 PDI surveys have either maintained stable bottom elevations or increased in elevation in comparison to the results of the 2003 survey (Map I3 and Table I2-1). The one exception is the area along the eastern shoreline between river mile (RM) 2.2 and RM 2.35. As shown in Map I-4f, one location (the eastern shoreline between RM 2.2 and RM 2.35) within nine analysis areas was identified for recovery category area modification or refinement based on this evaluation.

Table I2-1
Middle Reach Recovery Category Evaluation Summary

Evaluation Area	RM or Slip	Description of Location	Recovery Category Designation in PDIWP	Recovery Category Criterion 1	Supplemental Lines of Evidence	Recommendation and Rationale
				Vessel-induced Scour (Analysis of Bed Sediment Disturbance Using Sun-illumination Map) [1]	Analysis of Changes in Bathymetry from 2003 to PDI Using Isopach Map[2]	
1	1.6 to 1.85 (west)	Adjacent to Northland Services North Wharf and South Pier (Terminal 115)	North Wharf – Recovery Category 2 South Pier – Recovery Category 1	Undulations on the waterway bed due to vessel disturbance are visible; however, on average, they do not meet the 6-inch thickness criterion to signify significant vessel-induced scour.	North Wharf: Area is highly depositional (>6 feet accumulated). South Pier: Area is mostly depositional with portions with no elevation change.	**No changes to recovery categories**. Area is depositional and visible potential vessel impacts are likely due to shallowing of area.
2	1.7 (east)	South of Certainteed Pier	Recovery Category 1	Undulations on the waterway bed due to vessel disturbance are visible; however, on average, they do not meet the 6-inch thickness criterion to signify significant vessel-induced scour.	Area is highly depositional (>6 feet accumulated).	**No changes to recovery categories**. Area is depositional and visible potential vessel impacts are likely due to shallowing of area.
3	1.85 to 1.9 (west)	Adjacent to Seafreeze Pier (Terminal 115)	Recovery Category 2	No significant vessel-induced scour features observed.	Area is depositional.	**No changes to recovery categories**. Area is depositional and no significant potential vessel impacts observed.
4	Slip 3	Adjacent to Muckleshoot Tribe Marina and head of Slip 3	Recovery Category 2	No significant vessel-induced scour features observed.	Area is depositional.	**No changes to recovery categories**. Area is depositional and no significant potential vessel impacts observed.
5	2.1 to 2.25 (west)	Adjacent to Alaska Marine Lines Yard No. 2	Recovery Category 2	Undulations on the waterway bed due to vessel disturbance are visible; however, most are less than the 6-inch thickness criterion to signify significant vessel-induced scour. The few deeper undulations (about 1.5 feet thick) are limited to an area experiencing bed shallowing between the berth and 1st Ave South Bridge.	Area is depositional.	**No changes to recovery categories**. Area is depositional and visible potential vessel impacts are likely due to shallowing of area.
6	2.1 to 2.35 (east)	Adjacent to SeaTac Marine Wharf and moorage area immediately upstream	Recovery Category 2	SeaTac Marine Wharf: Undulations on the waterway bed due to vessel disturbance are visible; however, on average, they do not meet the 6-inch thickness criterion to signify significant vessel-induced scour. Moorage area: Undulations greater than 6 inches deep are present between the locations where vessels moor (Map I-4i).	SeaTac Marine Wharf: Area is depositional. Moorage area: Area generally exhibits no net change, except for an approximately 13,000-sf area where net erosion was observed.	SeaTac Marine Wharf: **No changes to recovery categories**. Area is depositional and visible potential vessel impacts are likely due to shallowing of area. Moorage area: **Change** 13,000-sf area that shows net erosion and sun illumination-observed scour **from Recovery Category 2 to Recovery Category 1**.
7	2.4 to 2.5 (west)	Boyer Alaska Barge Line Seattle Main Wharf	Recovery Category 1 and Recovery Category 2	Recovery Category 1 area: Undulations deeper than 6 inches are present in the Recovery Category 1 area. Recovery Category 2 area: Undulations on the waterway bed due to vessel disturbance are visible; however, on average, they do not meet the 6-inch thickness criterion to signify significant vessel-induced scour.	Area is mostly depositional with portions with no elevation change.	**No changes to recovery categories**. Area is depositional and visible potential vessel impacts are likely due to shallowing of area.
8	2.6 to 2.85 (west)	Pacific Pile and Marine Mooring and Wharf	Recovery Category 2	Undulations on the waterway bed due to vessel disturbance are visible; however, on average, they do not meet the 6-inch thickness criterion to signify significant vessel-induced scour.	Area is mostly depositional with portions with no elevation change.	**No changes to recovery categories**. Area is depositional and visible potential vessel impacts are likely due to shallowing of area.
9	2.85 to 2.95 (west)	Silver Bay Logging Wharf	Recovery Category 1	No significant vessel-induced scour features observed.	Area is mostly depositional with portions with no elevation change.	**No changes to recovery categories**. Area is depositional and no significant potential vessel impacts observed.

Notes:
1. The term "significant" is used in the analysis to denote areas where natural recovery is presumed to be limited (consistent with the definition of Recovery Category 1) due to ongoing mixing from vessel scour. The term "on average" refers to situations wherein elevation differences greater than 6 inches in thickness were occasionally (less than 5 percent of observations) observed in a given evaluation area. The approach was consistent with the methods documented in Appendix C of the EPA-approved PDI Work Plan.
2. Gaps shown in the isopach map are due to an absence of bathymetry data in the 2003 survey. Trends from adjacent areas were used to estimate bathymetry within the 2003 survey gap areas.
EPA: U.S. Environmental Protection Agency
PDI: Pre-Design Investigation
PDIWP: Pre-Design Investigation Work Plan
RM: river mile

3 Contaminant Trend Evaluation

Criterion 4 was evaluated using the methodology outlined in the *Recovery Category Recommendations Report* (Integral et al. 2019) following a three-step process. First, surface and subsurface sediment locations within 10 feet of one another that had been resampled during the Phase I or Phase II of the PDI were identified. Second, concentration changes for polychlorinated biphenyls (PCBs), carcinogenic polycyclic aromatic (cPAHs), arsenic, and bis(2-ethylhexyl)phthalate (BEHP) in each location were calculated. Third, the data for each resampled location were interpreted in the context of potential recovery category modifications, consistent with the *Recovery Category Recommendations Report*, as follows:

- Areas with all increasing contaminant concentrations could be adjusted to Recovery Category 1.
- Areas with mixed results by contaminant of concern (COC) or concentration changes less than 50% could be adjusted to Recovery Category 2.
- Areas with more than 50% decreases or a mix of decreases and changes of less than 50% could be adjusted to Recovery Category 3.
- Areas with concentrations less than the benthic sediment cleanup objective (SCO) or RAL were also determined to be suitable for Recovery Category 3, because these areas had historically recovered or were not historically impacted by concentrations exceeding the benthic SCO or RAL.

As noted, contaminant trend data are considered a secondary line of evidence for evaluating recovery category designations. In other words, contaminant trend data alone are not sufficient to change a recovery category designation.

PCBs, arsenic, and cPAHs were selected for this assessment because they are human health risk drivers. BEHP was selected because it had the second-highest number of benthic SCO exceedances in the RI/FS dataset (following total PCBs). Only five locations (all surface sediment sampling locations) with existing dioxin/furan data were reoccupied.

The comparisons of point sample concentrations were interpreted in the context of surrounding data to account for uncertainties, such as spatial heterogeneity in LDW sediments, data from different sampling events separated in time, and analytical variance.

Table I3-1 summarizes the 57 resampled sediment locations (including 53 surface sediment and 4 subsurface sediment sampling locations) for the middle reach from Phase I and Phase II of the PDI. As shown, PCB concentrations generally decreased over time. PCB concentrations were similar to or

less than 130 µg/kg dry weight at 34 of 56 resampled locations (1 sample was analyzed for cPAHs only [i.e., not for PCBs]).

Table I3-1
Summary of Phase I and Phase II Reoccupations

Location Details								Pre-PDI Location and Results						PDI Location and Results						Percent Change[1]				
RM	Sample Type	Tidal Category	Recovery Category	In FNC?	Shoaling Area	Potential Vessel Scour Area	Current Mudline (ft MLLW)	Pre-PDI Sample ID	Year	PCBs (µg/kg)	Arsenic (mg/kg)	cPAH TEQ (µg/kg)	BEHP (µg/kg)	PDI QAPP Notes	PDI Sample ID	PCBs (µg/kg)	Arsenic (mg/kg)	cPAH TEQ (µg/kg)	BEHP (µg/kg)	Years Between Samples	PCBs	Arsenic	cPAH TEQ	BEHP	Are the Contaminant Trend Data Consistent with the Assigned Recovery Category?[2]
1.9	Surface (0–10 cm)	Subtidal	2	-	-	Yes	No data	LDW-SS2022-D	2011	370	10	200	170	Reoccupy LDW-SS2022-D (2011); total PCB EF of 1.4	LDW23-SS1056	144	15.1	-	-	11.9	**-61%**	**51%**	-	-	Yes – mixed trends (and increasing concentration of arsenic did not result in a RAL exceedance), consistent with Recovery Category 2
1.9	Surface (0–10 cm)	Subtidal	2	-	-	Yes	-11.8	LDW-SSPSF-U	2011	102	10	690	100	Reoccupy LDW-SSPSF-U (2011); PAH EFs up to 2.8	LDW23-SS1063	105	-	199	-	11.9	3%	-	**-71%**	-	Yes – mixed trends, consistent with Recovery Category 2
1.9	Surface (0–10 cm)	Subtidal	2	-	-	Yes	-10.7	LDW18-SS-088	2018	150[3]	17.7	272	-	None	LDW24-SS1371	235	-	-	-	6.3	**57%**	-	-	-	Yes – concentrations increased by > 50% (but no PCB RAL exceedance), consistent with Recovery Category 2
2.0	Surface (0–10 cm)	Intertidal	3	-	-	-	-3.1	LDW-SS2506-D	2011	40	16	93	4,900	Reoccupy 2011 sampling location (BEHP EF of 4.3) and potentially toxicity test.	LDW24-SS1379	130.5	7.61	27	130	13.3	**226%**	**-52%**	**-71%**	**-97%**	Yes – mixed trends (and increasing concentrations of PCBs did not result in a RAL exceedance), consistent with Recovery Category 3
2.0	Surface (0–10 cm)	Intertidal	3	-	-	-	-2.7	LDW-SS2506-A	2011	57	15	180	2,500	Reoccupy 2011 sampling location (BEHP EF of 1.4) and potentially toxicity test.	LDW24-SS1380	108.2	9.31	40	1,200	13.3	**90%**	-38%	**-78%**	**-52%**	Yes – mixed trends (and increasing concentrations of PCBs did not result in a RAL exceedance), consistent with Recovery Category 3
2.1	Surface (0–10 cm)	Subtidal	2	-	-	Yes	No data	LDW-SSBRSTSD-A	2011	115	20	250	160	Reoccupy LDW-SSBRSTSD-A (2011); HCB EF of 1.6	LDW23-SS1113	132	-	-	-	12.0	15%	-	-	-	Yes – concentrations changed by < 50%, consistent with Recovery Category 2
2.2	Surface (0–10 cm)	Subtidal	2	-	-	Yes	No data	LDW-SSBRSTSD-U	2011	104	20	1,200	590	Reoccupy LDW-SSBRSTSD-U (2011); sample with cPAH ROD RAL exceedance (and no other exceedances)	LDW23-SS1119	-	-	127	-	12.0	-	-	**-89%**	-	Yes – concentrations decreased by > 50% (but data for only a single chemical), consistent with Recovery Category 2
2.3	Surface (0–10 cm)	Subtidal	2	-	-	Yes	-7.9	LDW18-SS-098	2018	224[3]	11.8	172	-	Reoccupy LDW18-SS-098 (2018); total PCB EF of 0.98	LDW23-SS1129	205	12	149	182	4.9	-9%	2%	-13%	-	Yes – concentrations changed by < 50%, consistent with Recovery Category 2
2.4	Subsurface (0-60 cm)	Subtidal	1	-	-	Yes	-5.0	LDW-SC41	2006	310	20	180	270	Reoccupy 2006 subsurface sampling location (PCB EF of 1.1) in depositional area.	LDW24-SC1468A	162.9	10.8	-	-	18.4	-47%	-46%	**-**	-	No – concentrations decreased by nearly 50%, so could change from Recovery Category 1 to Recovery Category 2 or 3, but area is Recovery Category 1 based on evidence of propeller wash scour (Map I-3)
2.4	Surface (0–10 cm)	Intertidal	1	-	-	-	1.1	LDW-SSUNK-D	2011	120	6	13	18	Reoccupy LDW-SSUNK-D (2011); total PCB EF of 0.92	LDW23-SS1149	910	3.37	70.6	14.1	11.7	**658%**	-44%	**443%**	-22%	Yes – concentrations increased by > 50%, consistent with Recovery Category 1
2.4	Surface (0–10 cm)	Intertidal	3	-	-	-	-2.5	LDW-SS2030-U	2011	280	30	210	200	Reoccupy LDW-SS2030-U (2011); EFs > 1 for zinc, HCB, and benzoic acid and total PCB EF of 0.92	LDW23-SS1154	354	16.1	123	62.4	11.7	26%	-46%	-41%	**-69%**	Yes – mixed trends, consistent with Recovery Category 3

Location Details								Pre-PDI Location and Results						PDI Location and Results						Percent Change[1]				
RM	Sample Type	Tidal Category	Recovery Category	In FNC?	Shoaling Area	Potential Vessel Scour Area	Current Mudline (ft MLLW)	Pre-PDI Sample ID	Year	PCBs (µg/kg)	Arsenic (mg/kg)	cPAH TEQ (µg/kg)	BEHP (µg/kg)	PDI QAPP Notes	PDI Sample ID	PCBs (µg/kg)	Arsenic (mg/kg)	cPAH TEQ (µg/kg)	BEHP (µg/kg)	Years Between Samples	PCBs	Arsenic	cPAH TEQ	BEHP	Are the Contaminant Trend Data Consistent with the Assigned Recovery Category?[2]
2.4	Surface (0–10 cm)	Subtidal	1	-	-	Yes	-6.5	LDW-SS2034-D	2011	250	61	-	-	Reoccupy LDW-SS2034-D (2011); total PCB and arsenic EFs of 1.1 in area with > 1.5 feet of deepening	LDW23-SS1166	172	41.8	340	152	11.8	-31%	-31%	-	-	No – concentrations decreased (but changed by < 50%), so location could change from Recovery Category 1 to Recovery Category 2, but area is Recovery Category 1 based on evidence of propeller wash scour (Map I-3)
2.5	Surface (0–10 cm)	Subtidal	1	-	-	Yes	-14.3	SD-PER101	2015	240	12.4	-	-	Reoccupy SD-PER101 (2015); total PCB EF of 1.3	LDW23-SS1172	182	12	164	144	7.8	-24%	-3%	-	-	No – concentrations decreased (but changed by < 50%), so location could change from Recovery Category 1 to Recovery Category 2, but area is Recovery Category 1 based on evidence of propeller wash scour (Map I-3)
2.5	Surface (0–10 cm)	Subtidal	1	-	-	Yes	-11.1	LDW-SS2035-U	2011	60	10	470	190	Reoccupy LDW-SS2035-U (2011); PAH EFs up to 1.3	LDW23-SS1174	202	13	265	321	11.8	**237%**	30%	-44%	**69%**	Yes – concentrations increased by > 50%, consistent with Recovery Category 1
2.6	Surface (0–10 cm)	Intertidal	3	-	-	-	1.3	LDW-PILOT8A-SS2	2014	151	-	-	-	Reoccupy LDW-PILOT8A-SS2 (2014); total PCB EF of 1.2.	LDW23-SS1196	80.7	7.12	531	-	8.2	-47%	-	-	**-**	Yes – concentrations decreased by nearly 50%, consistent with Recovery Category 3
2.6	Surface (0–10 cm)	Subtidal	1	-	-	Yes	-5.8	LDW-SS2037-D	2011	109	10	190	200	Reoccupy two 2011 sampling locations (benzoic acid EFs of 1.5 and 1.4) and potentially toxicity test	LDW24-SS1497	118.5	11	132	98	13.3	9%	10%	-31%	**-51%**	No – mixed trends, so location could change from Recovery Category 1 to Recovery Category 2, but area is Recovery Category 1 based on evidence of propeller wash scour (Map I-3) and nearby deepening
								LDW-SS2037-A	2011	100	10	140	130								19%	10%	-6%	-25%	
2.6	Subsurface (0-45 cm)	Intertidal	1	-	-	-	-3.0	LDW-PILOT8A-SC1	2014	590	-	-	-	Reoccupy 2014 sampling location (PCB EF of 5.8) in area with deepening.	LDW24-IT1508A	248	2.62	134	-	9.6	**-58%**	-	-	**-**	No – concentrations decreased by > 50%, so location could change from Recovery Category 1 to Recovery Category 3, but area is Recovery Category 1 based on deepening
2.6	Surface (0–10 cm)	Subtidal	1	-	-	Yes	-8.2	LDW-PILOT8A-SS1	2014	150	-	-	-	Reoccupy LDW-PILOT8A-SS1 (2014) in area with > 1.5 feet of deepening	LDW23-SS1193	36.4	5.33	42.6	49.9	8.2	**-76%**	-	-	-	No – concentrations decreased by > 50%, so location could change from Recovery Category 1 to Recovery Category 3, but area is Recovery Category 1 based on deepening
2.6	Surface (0–10 cm)	Intertidal	3	-	-	-	-1.2	LDW-SS2039-D	2011	230	23	85	87	Reoccupy LDW-SS2039-D (2011); total PCB EF of 1.1	LDW23-SS1195	83.7	7.97	-	-	11.9	**-64%**	**-65%**	-	-	Yes – concentrations decreased by > 50%, consistent with Recovery Category 3
2.7	Surface (0–10 cm)	Subtidal	1	-	-	Yes	-10.8	LDW-PILOT8B-SS4	2014	121	-	-	-	Reoccupy LDW-PILOT8B-SS4 (2014) in area with > 1.5 feet of deepening	LDW23-SS1207	13.2	3.57	18.1	49.9	8.2	**-89%**	-	-	-	No – concentrations decreased by > 50%, so location could change from Recovery Category 1 to Recovery Category 3, but area is Recovery Category 1 based on deepening

Location Details								Pre-PDI Location and Results						PDI QAPP Notes	PDI Location and Results					Years Between Samples	Percent Change[1]				Are the Contaminant Trend Data Consistent with the Assigned Recovery Category?[2]
RM	Sample Type	Tidal Category	Recovery Category	In FNC?	Shoaling Area	Potential Vessel Scour Area	Current Mudline (ft MLLW)	Pre-PDI Sample ID	Year	PCBs (µg/kg)	Arsenic (mg/kg)	cPAH TEQ (µg/kg)	BEHP (µg/kg)		PDI Sample ID	PCBs (µg/kg)	Arsenic (mg/kg)	cPAH TEQ (µg/kg)	BEHP (µg/kg)		PCBs	Arsenic	cPAH TEQ	BEHP	
2.6	Surface (0–10 cm)	Subtidal	1	-	-	Yes	-13.2	LDW-SS89	2005	3,500	-	-	-	Reoccupy LDW-SS89 (2005 RI/FS sample with PCB EF of 29) in area with > 1.5 feet of deepening	LDW23-SS1208	22.4	5.99	26.7	12.6	18.0	**-99%**	-	-	-	No – concentrations decreased by > 50%, so location could change from Recovery Category 1 to Recovery Category 3, but area is Recovery Category 1 based on deepening
2.7	Surface (0–10 cm)	Intertidal	3	-	-	-	no data	LDW-SS530	2009	860	-	-	-	Reoccupy LDW-SS530 (2009 RI/FS sample); total PCB EF of 4.6 and PAH EFs up to 2.4	LDW23-SS1211	416	13	178	54.8	13.1	**-52%**	-	-	-	Yes – concentrations decreased by > 50%, consistent with Recovery Category 3
2.7	Subsurface (0-60 cm)	Subtidal	1	-	-	Yes	-5.8	LDW-SC46	2006	200	15	1000	240	Reoccupy 2006 subsurface sampling location (PCB EF of 1.0 and PAH EF of 1.3) in depositional area.	LDW24-SC1532A	148.6	-	530	170	18.4	-26%	-	-47%	-29%	No – concentrations decreased (changed by < 50%), so location could change from Recovery Category 1 to Recovery Category 2, but area is Recovery Category 1 based on evidence of propeller wash scour (Map I-3)
2.7	Surface (0–10 cm)	Intertidal	3	-	-	-	2.2	PS Truck Lines-2	2011	3.9	75	39	33	Sample intended to characterize conditions at base of bank (within riprap) adjacent to 2011 Ecology bank sample location.	LDW24-SS1537	10.9	18	78	-	13.1	**179%**	**-76%**	**100%**		Yes – mixed trends (and increasing concentrations for PCBs and cPAHs did not result in RAL exceedances), so consistent with Recovery Category 3
2.8	Subsurface (0-60 cm)	Subtidal	1	-	-	Yes	-5.8	LDW-SC45	2006	250	14	210	170	Reoccupy 2006 subsurface sampling location (PCB EF of 1.4) in depositional area.	LDW24-SC1559A	132.4	11.1	230	-	18.3	-47%	-21%	10%	-	No – mixed trends and concentrations changed by < 50%, so location could change from Recovery Category 1 to Recovery Category 2, but area is Recovery Category 1 based on evidence of propeller wash scour (Map I-3)
2.8	Surface (0–10 cm)	Intertidal	3	-	-	-	-3.0	LDW-SS2106-A	2011	1,200	10	43	88	Reoccupy to address two 2011 samples (PCB EFs of 3.8 and 1.5).	LDW24-SS1570	130.2	-	-	-	13.4	**-89%**	-	-	-	Yes – mixed trends, consistent with Recovery Category 3
								LDW-SS2106-U	2011	200	20	72	120							13.3	-35%	-	-	-	
								LDW-SS2108-A	2011	100	10	75	120	None						13.3	30%	-	-	-	
2.8	Surface (0–10 cm)	Subtidal	1	-	-	Yes	-14.1	DENW6721-SSED-15A-2014	2014	360	-	-	-	Reoccupy DENW6721-SSED-15A-2014 (2014) in area with > 1.5 feet of deepening	LDW23-SS1228	168	7.28	8,300	67.9	8.1	**-53%**	-	-	-	No – concentrations decreased by > 50%, so location could change from Recovery Category 1 to Recovery Category 2, but area is Recovery Category 1 based on deepening
2.8	Surface (0–10 cm)	Subtidal	1	-	-	Yes	-5.1	DENW6721-SSED-13A-2014	2014	131	-	-	-	Reoccupy DENW6721-SSED-13A-2014 (2014) in area with > 1.5 feet of deepening	LDW23-SS1229	285	44.2	358	22.5	8.1	**118%**	-	-	-	Yes – concentrations increased by > 50%, consistent with Recovery Category 1
2.8	Surface (0–10 cm)	Subtidal	3	Yes	Yes	-	-18.6	DENW6721-SSED-18A-2014	2014	220	7.6	120	94	Reoccupy DENW6721-SSED-18A-2014 (2014)	LDW23-SS1230	189	-	145	-	8.1	-14%	-	21%	-	Yes – mixed trends, consistent with Recovery Category 3
2.8	Surface (0–10 cm)	Intertidal	2	-	-	-	-2.0	DENW6721-SSED-09-2014	2014	133	13.1	270	110	Reoccupy DENW6721-SSED-09-2014 (2014); total PCB EF of 1.0	LDW23-SS1232	57.5	30.4	565	25.3	8.1	**-57%**	**132%**	**109%**	**-77%**	Yes – mixed trends (increasing concentrations for arsenic and cPAHs did not result in RAL exceedances), consistent with Recovery Category 2

Location Details								Pre-PDI Location and Results						PDI Location and Results						Percent Change[1]				
RM	Sample Type	Tidal Category	Recovery Category	In FNC?	Shoaling Area	Potential Vessel Scour Area	Current Mudline (ft MLLW)	Pre-PDI Sample ID	Year	PCBs (µg/kg)	Arsenic (mg/kg)	cPAH TEQ (µg/kg)	BEHP (µg/kg)	PDI QAPP Notes	PDI Sample ID	PCBs (µg/kg)	Arsenic (mg/kg)	cPAH TEQ (µg/kg)	BEHP (µg/kg)	Years Between Samples	PCBs	Arsenic	cPAH TEQ	BEHP	Are the Contaminant Trend Data Consistent with the Assigned Recovery Category?[2]
2.8	Surface (0–10 cm)	Subtidal	3	-	-	Yes	-9.6	LDW-SS2106-D	2011	139	13	62	86	Reoccupy LDW-SS2106-D (2011);1,4-dichlorobenzene EF of 1.1	LDW23-SS1237	103	8.63	91.5	171	11.9	-26%	-34%	48%	**99%**	Yes – mixed trends (and increasing concentrations for BEHP did not result in a RAL exceedance), consistent with Recovery Category 3
2.8	Surface (0–10 cm)	Subtidal	3	Yes	-	Yes	-17.6	SD-PER201	2015	151	9.7	-	-	Reoccupy SD-PER201 (2015); total PCB EF of 1.4	LDW23-SS1238	82.7	10.7	160	118	7.9	-45%	10%	-	-	Yes – mixed trends, including concentrations that decreased by nearly 50%, consistent with Recovery Category 3
2.8	Surface (0–10 cm)	Subtidal	1	-	-	Yes	-14.6	DENW6721-SSED-17A-2014	2014	270	10.6	91	89	Reoccupy DENW6721-SSED-17A-2014 (2014); total PCB EF of 0.92	LDW23-SS1240	124	11.9	224	79.3	8.1	**-54%**	12%	**146%**	-11%	No – mixed trends (and increasing concentration for cPAHs did not result in a RAL exceedance), so location could change from Recovery Category 1 to Recovery Category 2, but area is Recovery Category 1 based on evidence of propeller wash scour (Map I-3)
2.8	Surface (0–10 cm)	Subtidal	1	-	-	Yes	-13.1	DENW6721-SSED-11-2014	2014	330	14	95	94	Reoccupy DENW6721-SSED-11-2014 (2014); total PCB EF of 1.3	LDW23-SS1242	114	8.73	111	121	8.1	**-65%**	-38%	17%	29%	No – mixed trends, so location could change from Recovery Category 1 to Recovery Category 2, but area is Recovery Category 1 based on evidence of propeller wash scour (Map I-3)
2.8	Surface (0–10 cm)	Subtidal	1	-	-	Yes	-9.6	DENW6721-SSED-10-2014	2014	300	14.8	190	79	Reoccupy DENW6721-SSED-10-2014 (2014); total PCB EF of 1.1	LDW23-SS1243	87.8	-	-	-	8.1	**-71%**	-	-	-	No – concentrations decreased by > 50%, so location could change from Recovery Category 1 to Recovery Category 2, but area is Recovery Category 1 based on evidence of propeller wash scour (Map I-3)
2.8	Surface (0–10 cm)	Subtidal	2	-	-	Yes	-9.6	SD-PER518	2015	240	13.1	-	-	Reoccupy SD-PER518 (2015) to evaluate PCB trends in Slip 4; total PCB EF of 1.8	LDW23-SS1245	88.2	16	101	85.9	7.7	**-63%**	22%	-	-	Yes – mixed trends, consistent with Recovery Category 2
2.8	Surface (0–10 cm)	Subtidal	1	-	-	Yes	-14.0	SD-PER507	2015	224	12.9	-	-	Reoccupy SD-PER507 (2015); total PCB EF of 1.7	LDW23-SS1251	156	12.7	103	80.1	7.8	-30%	-2%	-	-	No – concentrations changed by < 50%, so location could change from Recovery Category 1 to Recovery Category 2, but area is Recovery Category 1 based on evidence of propeller wash scour (Map I-3)
2.8	Surface (0–10 cm)	Subtidal	2	-	-	Yes	-12.1	SD-PER515	2015	310	13.1	-	-	Reoccupy SD-PER515 (2015) to evaluate PCB trends in Slip 4; total PCB EF of 0.92	LDW23-SS1253	141	0	0	0	7.7	**-55%**	-	-	-	No – concentration decreased by > 50% so location could change from Recovery Category 2 to Recovery Category 3, but location is in berthing area, so no change
2.8	Surface (0–10 cm)	Subtidal	2	-	-	Yes	-14.6	SD-PER516	2015	233	11	-	-	Reoccupy SD-PER516 (2015) to evaluate PCB trends in Slip 4; total PCB EF of 0.58	LDW23-SS1254	135	18	95.4	105	7.7	-42%	**64%**	-	-	Yes – mixed trends (and increasing concentration for arsenic did not result in a RAL exceedance), consistent with Recovery Category 2
2.8	Surface (0–10 cm)	Subtidal	2	-	-	Yes	-14.5	SD-PER517	2015	260	12.3	-	-	Reoccupy SD-PER517 (2015) to evaluate PCB trends in Slip 4; total PCB EF of 0.73	LDW23-SS1255	137	-	-	-	7.7	-47%	-	-	-	Yes – concentrations changed by < 50%, consistent with Recovery Category 2

Location Details								Pre-PDI Location and Results						PDI Location and Results						Percent Change[1]				
RM	Sample Type	Tidal Category	Recovery Category	In FNC?	Shoaling Area	Potential Vessel Scour Area	Current Mudline (ft MLLW)	Pre-PDI Sample ID	Year	PCBs (µg/kg)	Arsenic (mg/kg)	cPAH TEQ (µg/kg)	BEHP (µg/kg)	PDI QAPP Notes	PDI Sample ID	PCBs (µg/kg)	Arsenic (mg/kg)	cPAH TEQ (µg/kg)	BEHP (µg/kg)	Years Between Samples	PCBs	Arsenic	cPAH TEQ	BEHP	Are the Contaminant Trend Data Consistent with the Assigned Recovery Category?[2]
2.8	Surface (0–10 cm)	Subtidal	2	-	-	Yes	-11.5	SD-PER513	2015	550	11.5	-	-	Reoccupy SD-PER513 (2015) to evaluate PCB trends in Slip 4; total PCB EF of 4.2	LDW23-SS1257	156	23.7	28.7	24	7.8	**-72%**	**106%**	-	-	Yes – mixed trends (and increasing concentration for arsenic did not result in a RAL exceedance), so consistent with Recovery Category 2
2.8	Surface (0–10 cm)	Subtidal	2	-	-	Yes	-11.0	SD-PER510	2015	300	13.9	-	-	Reoccupy SD-PER510 (2015) to evaluate PCB trends in Slip 4; total PCB EF of 2.3	LDW23-SS1258	156	-	-	-	7.8	-48%	-	-	-	Yes – concentrations changed by < 50%, so consistent with Recovery Category 2
2.9	Surface (0–10 cm)	Subtidal	2	-	-	Yes	-10.8	SD-PER511	2015	240	9.6	-	-	Reoccupy SD-PER511 (2015) to evaluate PCB trends in Slip 4; total PCB EF of 1.3	LDW23-SS1259	138	-	-	-	7.7	-43%	-	-	-	Yes – concentrations changed by < 50%, so consistent with Recovery Category 2
2.9	Surface (0–10 cm)	Subtidal	2	-	-	Yes	-11.4	SD-PER514	2015	270	10.9	-	-	Reoccupy SD-PER514 (2015) to evaluate PCB trends in Slip 4; total PCB EF of 0.83	LDW23-SS1260	154	-	-	-	7.7	-43%	-	-	-	Yes – concentrations changed by < 50%, so consistent with Recovery Category 2
2.8	Surface (0–10 cm)	Subtidal	2	-	-	Yes	-10.3	SD-PER509	2015	300	14.2	-	-	Reoccupy SD-PER509 (2015) to evaluate PCB trends in Slip 4; total PCB EF of 2.3	LDW23-SS1262	150	20.2	98.3	164	7.7	-50%	42%	-	-	Yes – mixed trends, consistent with Recovery Category 2
2.8	Surface (0–10 cm)	Subtidal	2	-	-	Yes	-8.9	SD-PER508	2015	340	15.7	-	-	Reoccupy SD-PER508 (2015) to evaluate PCB trends in Slip 4; total PCB EF of 0.83	LDW23-SS1263	136	-	-	-	7.8	**-60%**	-	-	-	No – concentration decreased by > 50%, so could change from Recovery Category 2 to Recovery Category 3, but location is in berthing area, so no change
2.9	Surface (0–10 cm)	Subtidal	3	Yes	-	Yes	-16.8	SD-PER202	2015	260	12.4	-	-	Reoccupy SD-PER202 (2015); total PCB EF of 1.0	LDW23-SS1267	86.6	8.21	107	73.1	7.8	**-67%**	-34%	-	-	Yes – concentrations decreased (some by > 50%), consistent with Recovery Category 3
3	Surface (0–10 cm)	Intertidal	3	-	-	-	-3.0	SD-PER206	2015	93	6.4	-	-	Reoccupy SD-PER206 (2015); total PCB EF of 1.5	LDW23-SS1274	61.5	-	-	-	7.8	-34%	-	-	-	Yes – decreasing concentrations, consistent with Recovery Category 3
2.8	Surface (0–10 cm)	Intertidal	2	-	-	-	No data	DENW6721-IS-1	2013	350	28.6	260	2,000	Reoccupy 2013 under-structure sample (PCB EF of 2.7).	LDW24-SS1830	892	-	-	-	10.8	**155%**	-	-	-	No – concentrations increased by > 50%, so could change from Recovery Category 2 to Recovery Category 1 based on chemistry only, but no other lines of evidence support recovery category designation change for this location (e.g., no evidence of vessel scour or deepening), which is in a high-elevation intertidal area
2.8	Surface (0–10 cm)	Intertidal	3	-	-	-	No data	DENW6721-IS-2	2013	220	26.2	160	550	Reoccupy 2013 under-structure sample (dioxin/furan EF of 0.98).	LDW24-SS1831	120.4	-	-	-	10.8	-45%	-	-	-	Yes – concentrations decreased by nearly 50%, consistent with Recovery Category 3
2.8	Surface (0–10 cm)	Intertidal	3	-	-	-	No data	DENW6721-IS-3	2013	380	19	150	1,200	Reoccupy 2013 under-structure sample (PCB EF of 1.0).	LDW24-SS1832	54.9	-	-	-	10.8	**-86%**	-	-	-	Yes – concentrations decreased by > 50%, consistent with Recovery Category 3
2.8	Surface (0–10 cm)	Intertidal	3	-	-	-	No data	DENW6721-IS-4	2013	900	30	250	670	Reoccupy 2013 under-structure sample (PCB EF of 3.5 and dioxin/furan EF of 1.0).	LDW24-SS1833	112.8	-	-	-	10.8	**-87%**	-	-	-	Yes – concentrations decreased by > 50%, consistent with Recovery Category 3

Location Details								Pre-PDI Location and Results						PDI Location and Results						Percent Change[1]				
RM	Sample Type	Tidal Category	Recovery Category	In FNC?	Shoaling Area	Potential Vessel Scour Area	Current Mudline (ft MLLW)	Pre-PDI Sample ID	Year	PCBs (µg/kg)	Arsenic (mg/kg)	cPAH TEQ (µg/kg)	BEHP (µg/kg)	PDI QAPP Notes	PDI Sample ID	PCBs (µg/kg)	Arsenic (mg/kg)	cPAH TEQ (µg/kg)	BEHP (µg/kg)	Years Between Samples	PCBs	Arsenic	cPAH TEQ	BEHP	Are the Contaminant Trend Data Consistent with the Assigned Recovery Category?[2]
2.8	Surface (0–10 cm)	Intertidal	3	-	-	-	0.7	DENW6721-IS-5	2013	490	17.9	280	400	Reoccupy 2013 under-structure sample (PCB EF of 1.3).	LDW24-SS1834	72.6	-	-	-	10.8	**-85%**	-	-	-	Yes – concentrations decreased by > 50%, consistent with Recovery Category 3
3	Surface (0–10 cm)	Subtidal	3	-	-	-	-8.3	LDW18-SS-118	2018	162[2]	8.04	277	-	Reoccupy 2018 sample (PCB EF of 1.0)	LDW23-SS1273	107	8.99	-	-	4.9	-34%	12%	-	-	Yes – mixed trends, consistent with Recovery Category 3

Notes:

1. Percent changes of greater than 50% or less than -50% are shown in bold.
2. As described in the text preceding Table I3-1, contaminant trend data are considered a secondary line of evidence for evaluating recovery category designations (i.e., contaminant trend data alone are not sufficient to change a recovery category designation). Consistent with the methodology outlined in the *Recovery Category Recommendations Report* (Integral et al. 2019), contaminant trend data are categorized as follows: 1) areas with increasing concentrations, 2) areas with mixed trends or concentration changes less than 50 percent, 3) areas with decreases greater than 50 percent or a mix of decreases and changes less than 50 percent, and 4) areas with concentrations less than the benthic SCO or RAL.
2. Total PCBs for these samples are equal to the sum of congeners.

BEHP: bis(2-ethylhexyl)phthalate
cPAH: carcinogenic polycyclic aromatic hydrocarbon
Ecology: Washington State Department of Ecology
EF: exceedance factor
FNC: Federal Navigation Channel
HCB: hexachlorobenzene
ID: identification
MLLW: mean lower low water
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
PDI: Pre-Design Investigation
QAPP: quality assurance project plan
SCO: sediment cleanup objective
RAL: remedial action level
RM: river mile
ROD: Record of Decision
TEQ: toxic equivalent

4 Recommendations

The recovery categories are based on multiple lines of evidence and have been evaluated in the FS (AECOM 2012), the *Recovery Category Recommendations Report* (Integral et al. 2019), and PDIWP (Windward and Anchor QEA 2022). The evaluation in this appendix considered surface sediment data, subsurface sediment data, and bathymetric survey data from the PDI in the context of previous evaluations.

Based on this evaluation, the 13,000-square-foot area at approximately RM 2.25E was recommended to be modified from Recovery Category 2 to Recovery Category 1 (Map I-4f) because of evidence of net erosion and sun illumination-observed scour (Table I2-1). After further discussion with the U.S. Environmental Protection Agency, the change from Recovery Category 2 to 1 was applied to a larger 72,000 square-foot area (approximately 1.66 acres) stretching from approximately RM 2.2E to RM 2.35E to include this entire moorage area (Map I-4f). No other modifications are recommended.

5 References

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