Terminal 108W Bank Stabilization and Rehabilitation Demonstration Project
Final As-Built and Performance Report

Inter-Agency Agreement No. C1400216

Port of Seattle®

Prepared by the Port of Seattle

For the Washington State Department of Ecology

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Figures

Appendices

1 Introduction

On April 9, 2014, the Port of Seattle (Port) and the State of Washington Department of Ecology (Ecology) entered into Inter-Agency Agreement (IAA) No. C1400216. In partial fulfillment of the requirements of the IAA, the Port completed stabilization and rehabilitation of approximately 345 linear feet of eroding shoreline at Terminal 108W (T-108W) in June 2015. This report summarizes the Terminal 108W bank stabilization and rehabilitation actions made possible by IAA No. C1400216.

Approximately 240 linear feet of bank at the project site was stabilized using alternative techniques, including anchored, large woody debris and native riparian vegetation. Existing riprap slopes were stabilized on an additional 105 feet of bank. The project is intended to provide proof-of-concept for innovative stabilization techniques, combining effective control of chronic bank erosion with rehabilitation of important riparian habitat. These methods may be appropriate for future, similar marine industrial shoreline locations throughout the Lower Duwamish Waterway (LDW).

Following city, state, and federal authorizations, bank construction began in late February (mobilization and site setup) and concluded the week of June 2 (demobilization and upland site sweeping). A follow-up inspection and evaluation of the bank was performed by Port staff four weeks after construction completion, confirming that the stabilized bank areas were constructed and performing as intended.

1.1 Background

The LDW Superfund Site consists of five miles of the Duwamish Waterway measured from the southern tip of Harbor Island to just south of the Norfolk Combined Sewer Overflow. The water area consists of approximately 441 acres and discharges to Elliott Bay, Seattle, Washington. The LDW Superfund Site was added to the EPA National Priorities List in September 2001 and to the Washington State Hazardous Sites List on February 2002 due to human health and ecological risk levels that warrant action under federal and state law. The Record of Decision (ROD, EPA 2014) for the cleanup of the in-waterway portion of the site (441 acres) was published in 2014.

As a component to the overall LDW cleanup, Ecology has implemented a source control strategy for the 32 square miles of combined sewer and stormwater drainage that serves the LDW Superfund site. The goal of source control is to prevent recontamination of the LDW to levels that exceed the Washington State Sediment Management Standards (Washington Administrative Code 173-204) and the LDW sediment cleanup goals (EPA, 2014). Bank erosion is an important contamination and recontamination pathway, with the potential for release of previously placed fill materials that make up the LDW shorelines.

Approximately 265 linear feet of unprotected bank at Terminal 108W on the east shore of the Duwamish Waterway (approximately river mile 0.5) had visual indications of erosion, mainly due to vessel-generated wakes and currents in the Duwamish Waterway (Figure 1). Erosion disrupts shoreline and aquatic areas, allows fill material and soils to enter the LDW, and reduces upland area available for marine industrial use.

1.2 Pre-construction Site Conditions

The Port's T-108W is approximately 8 acres and includes unoccupied marine industrial upland area and an adjacent Port of Seattle public shoreline access area (Figure 2). The shoreline at T-108W is approximately 1,200 feet (or 0.23 miles long). The marine industrial upland portion of the T-108W site includes concrete and asphalt pavement and compacted crushed rock surfaces. Shoreline conditions, prior to bank rehabilitation, included failed riprap armoring and an unstable, eroding bank, with slope angles ranging from vertical to 1:1 (horizontal:vertical). Shoreline vegetation between top-of-bank and Mean Higher High Water (MHHW equivalent to +11.3 feet MLLW) consisted of invasive plants and limited beach grass and emergent vegetation present below MHHW due to chronic erosion conditions. The public access portion of the site is maintained with landscaping consisting of turf, native trees and shrubs. An asphalt surface pathway extends to top-of-bank areas. As summarized in the Work Plan, five past bank samples collected in 2012 (AECOM, 2014) showed concentrations of PCBs in one sample (16 mg/kg OC or 89 µg/kg dry weight) slightly above the carbon normalized benthic Sediment Cleanup Objective (SCO) of 12 mg/kg OC. The OC normalized SCO is the same as the lowest LDW ROD Remedial Action Levels (RAL) in intertidal areas. No other analyte exceeded the SCO or the RALs.

2 Bank Stabilization Activities

The bank stabilization activities were performed by the Port's Port Construction Services (PCS) along approximately 345 linear feet of bank. Construction oversight, documentation, sampling and reporting was performed by Port staff. Other outside services included OnSite Laboratory for analytical services, Waste Management Inc. for soil disposal and Earth Corps for planting. Site as-builts and cross sections are presented on Figures 3 and 4.

The eroding bank was stabilized using two techniques: (1) approximately 240 linear feet in the south portion of the project area was regraded and rehabilitated using alternative engineering techniques using wood instead of riprap and (2) stabilization of approximately 105 linear feet at the north margin of the site was accomplished by reshaping and replenishing the riprap profile.

2.1 General Site and Erosion Control

Site Boundary and Shoreline/Bank Elevation Limits and Markings. Consistent with federal, state, and City permit authorizations, all work was conducted in bank areas landward of MHHW (+11.3 feet relative to MLLW). A pre-construction survey established and flagging marked the MHHW site contour. No soil disturbing activities were performed below MHHW. In addition, the plus nine feet MLLW contour was marked, in order to ensure appropriate separation between active work areas and tide levels. No Ecology Construction General Stormwater permit was required since less than one acre of soil was disturbed.

Exclusion Zone and Contamination Reduction Zone. PCS used the T-108 Site-Umbrella Health and Safety Plan (Port, 2013) to prepare several task-specific Job Hazard Analysis worksheets (concrete demo, bank excavation, stockpiling, etc.). As part of site setup, an exclusion zone (EZ) was established around the entire perimeter of the active work area. At the main ingress/egress of the EZ, PCS setup a Contamination Reduction Zone consisting of a boot wash and wheel wash for equipment. Outside the EZ

were located PCS's support trailer and vehicle parking areas. Throughout the project, PCS maintained tight control of the work site and minimized dust and track-out. Marine Maintenance swept the upland site with a vac truck on a weekly basis or more throughout the duration of site activities.

Erosion Control: Prior to beginning any site work, the Port prepared a site erosion and sediment control plan (POS, 2015a). Per the plan, all shoreline and bank construction activities were performed using measures to avoid release of sediments to adjacent aquatic area. At the end of each regrading/construction period, excavated and incomplete slopes were covered with fiber mats or plastic sheeting and secured with sand bags. In addition, all incomplete toe-of-slope areas were protected with 12 inch diameter, ten feet long coir material "logs", as a temporary erosion control measure.

Any potential adverse effects on water quality were minimized by the practices described above. At no time during the work did Port personnel see turbid water conditions in the river. No water quality monitoring was required since the work was done "in the dry".

Spill Prevention: All operating equipment at the site was subject to best management practices (BMPs) and Spill Prevention, Containment and Countermeasures (SPCC) implemented to avoid and minimize potential releases of fuel and petroleum products used by construction equipment. These measures included using diapers under all equipment engines and storing liquids and materials under cover (inside the support trailer or container box).

2.2 South Bank Regrading and Planting

Bank regrading: Approximately 240 feet of the south bank was regraded landward to establish a more gradual, stable bank profile, variable in slope between 3:1 to 4:1 (horizontal to vertical). In general, bank regrading moved the top-of-bank approximately six to ten feet landward.

PCS used a track-mounted excavator to accomplish shoreline regrading, operating from the landward margin of the project site. The bank work started by setting a row of large logs, as anchored large woody debris along the +11.3 elevation, followed by regrading up-slope.

Previously placed fill material and minor amounts of rubble and asphalt paving were removed from the slope and temporarily stockpiled at the site.

A total of approximately 725 tons of soil was excavated and disposed of at the Columbia Ridge Landfill, owned and operated by Waste Management. The graded soil consisted of gray to black medium sand, likely historic dredge material from the river. No visual signs of staining or discoloration were observed or any unusual odors. Prior to excavation, a soil sample of the planned new soil surface was collected from test pits (Section 2.3). A summary of removed and imported materials is provided below (Table 1 and 2).

Table 1: Summary of total materials removed from site (includes all areas)

Material removed	Amount	Disposal Location
Vegetation	14 CY	ECI
Concrete Debris	22 CY	Renton Concrete Recyclers
Asphalt Debris	20 CY	Cedar Mountain Reclamation (Merlino)
Construction Debris	9.22 tons	Waste Management
Soil	751.76 tons	Waste Management

Table 2: Summary of total materials imported to site (includes all areas)

Material	Amount	Source
Logs	53 large diameter logs	Corps of Engineers
Quarry spalls/riprap	179.89 tons	CalPortland
Compost/topsoil	200 CY	Cedar Grove

Installation of large woody debris: Approximately 53 logs, installed as large woody debris, were provided by United States Army Corps Engineers (USACE) from their navigation hazard removal program. A first row of logs were placed at a new toe-of-slope at approximately +12 MLLW. These large logs are 20-25 feet in length and minimum of 1.5 feet diameter held in place with steel chain attached to subgrade "duck-bill" anchors. A second large woody debris installation was placed along the shoreline at approximately +13 feet MLLW and attached to the subgrade using the same anchors. The logs were lifted over the bank and placed using hydraulic arm excavation equipment operating at the top-of-bank. Logs were pressed into existing substrate, with approximately 70-75 percent of the log cross-section above grade. Anchors were driven into the substrate approximately 20 feet below grade using the hydraulic excavator and hand-operated equipment. In all instances, the logs were overlapped at their ends, with the outer end of the overlap between logs oriented downstream.

Installation of riparian vegetation: Approximately 200 cubic yards of imported topsoil was placed over the re-graded slope, approximately 1 to 1 ½ feet deep, and covered with a continuous layer of woven plant material fabric or fiber matting.

Plant fiber matting was staked at the top of slope and held in place at the toe-of-slope by the installed large, woody debris. During the week of May 18, native riparian vegetation was inserted through the plant fiber matting as a continuous band of native trees and shrubs, between approximately +12 feet MLLW to the top of the regraded bank, for a total of approximately 3,950 square feet coverage. Plantings included approximately 63 native riparian trees: black cottonwood, red alder, Hooker and Sitka willow, vine maple, shore pine, grand fir, Douglas fir, and Western red cedar. Native riparian shrubs (approximately 215) consisted of tall Oregon grape, snowberry, ninebark, Nootka rose, red osier dogwood, and red flowering currant. In addition, approximately 850 square feet was planted, between the single and double large woody debris logs, with native beach grass and hair-grass. Following planting, approximately six to ten inches of chipped/shredded wood and clean-green waste material (arborist chips) was applied to the re-shaped bank.

Ecology requested that the Port analyze a sample of placed material to verify topsoil quality was acceptable for the site. A three point composite was collected of the top soil material on July 20, 2015. The sample was submitted for laboratory analysis for arsenic, lead, copper, zinc, Semivolatile organics, and PCBs per Ecology request. A summary of detected results is provided below (Table 3) with copies of the laboratory reports presented in Appendix A.

Table 3: Topsoil Analytical Results

Analyte	LDW RALs or AET (1)	TOPSOIL
Detected Metals in mg/kg		
Arsenic	28	15 U
Copper	390	24
Lead	450	19
Zinc	410	100
Detected Semivolatiles in mg/kg		
Phenol	0.420	0.39
Flouranthene	1.7	0.021
Pyrene	2.6	0.023
Total PCBs in µg/kg	130	7.3 U

(1) Used the lowest RALs for intertidal areas listed on Table 28 of the ROD (EPA, 2014) or the Marine Sediment AET Sediment Cleanup Objective (SQO) for organics.

(2) U – not detected at indicated reporting limit

2.3 North Bank Stabilization

Riprap repair: Portions of the bank area on the north side of the existing pier (approximately 60 linear feet) were also repaired, where previously placed riprap had slumped or was missing. In addition, approximately 45 linear feet of riprap on the south side of the pier (e.g., dock bridge, see Figure 3) was also placed for erosion control. Starting at approximately +12 feet MLLW, the slope was excavated landward to a more stable 2:1 to 3:1 slope, and then stabilized with used and new riprap. Approximately 50 linear feet of slope north of the existing pier had a riprap bank to about +15 feet MLLW. Above this elevation, the existing bank was overgrown with shrubs and some riprap had sloughed. This area was stripped of vegetation and graded to a nearly flat slope, then covered with new riprap.

A total of approximately 25 tons of soil from the north bank regrading was excavated from both sides of the pier and disposed of. The regraded and exposed soil consisted of brown and gray silty sand with some gravel. The material appeared to be fill material. No visual signs of staining or discoloration were observed or any unusual odors detected. Prior to placement of riprap, a soil sample of the graded soil was collected (Section 2.3).

2.4 Soil Stockpile Handling, Profile Sampling and Disposal

In anticipation of direct-hauling bank soil (i.e., cut/grade bank soil and place directly into a haul truck), the Port, with Ecology's approval, chemically profiled soil along the south bank that was expected to be handled and eventually disposed of off site. Three shallow test pits, ranging from 1 to 3 feet deep into the side of the bank were excavated and a six-point composite sample was collected and shipped to OnSite Laboratory for analytical testing, including TPH-G, TPH-Dx, RCRA metals, PAHs, and PCBs per the Ecology approved Work Plan. A summary of the sample results of the soil is provided below (Table 4) with copies of the laboratory reports in Appendix A.

Table 4: Soil Stockpile Analytical Results

Analyte	T108-SP Result
TPH in mg/kg	
Gasoline Range	7.1 U
Diesel Range	27 U
Lube Oil Range	54 U
Detected Metals in mg/kg	
Barium	21
Chromium	11
Copper	10
Detected PAHs in mg/kg	
Fluoranthene	0.0097
Pyrene	0.0091
Chrysene	0.008
Benzo[b]fluoranthene	0.044
Benzo[g,h,i]perylene	0.0083
Total cPAHs in µg TEQ/kg	1.18
Total PCBs in µg/kg	54 U

U – not detected at indicated reporting limit

Results of testing confirmed the soil was appropriate for Subtitle D disposal. Waste Management accepted the profiled soil by issuing a Non-Hazardous WAM Approval (Profile #110010WA, Appendix B) on April 4, 2015 to PCS. A total of 751 tons of soil was hauled to Waste Management's Alaska Street transfer facility and ultimately disposed of at their Columbia Ridge landfill in Oregon (WM Bill of Lading, Appendix B). Graded/generated soil was either loaded into a truck and hauled directly to the WM facility or temporarily stockpiled on site. PCS constructed a temporary stockpile holding cell that was lined with plastic and bermed with Ecology blocks. No stormwater runoff was observed or recorded in weekly summaries, due to dry conditions. Soil stockpiles were also covered each night.

2.5 Bank-Soil Sampling and Analysis

The chemical quality of the exposed bank soil was determined by sampling and analyzing the final surface (top six inches) of the graded banks. Two locations – T108-B1 and T108-B2 – were generally co-located to previous bank soil sample locations BS-1 and BS-2 (AECOM 2012), except moved inland of +11.3 feet MLLW. South bank samples T108-B1 and T108-B2 were collected prior to bank grading

activities by excavating a shallow test pit down to the anticipated elevation of the final bank slope. North bank sample T108-B3 was collected once the bank was graded and immediately prior to placement of the riprap cover. As shown on Figure 2, north bank sample T108-B3 was located approximately 10 feet vertically east or upland of the 2012 BS-3 sample. Former sample BS-3 is located in an area of shoreline bank that has not experienced erosion (e.g., the riprap cover remains in place and structurally stable). Therefore sample T108-B3 was located just up-bank or land-ward of former sample BS-3 and in an area that was graded and stabilized during this project.

Bank soil samples were analyzed by OnSite Environmental Laboratory for PCBs, percent total Organic carbon, PAHs, and metals. The analytical results are summarized in Table 5 below. The table presents the samples that are not OC normalized since less than 0.5% organic carbon was present in samples. These results are compared to the LDW RALs or Ecology's Lowest Apparent Effects Observed Levels (LAETs) where there are OC normalized LDW RALs. Table 6 presents the sample that could be OC normalized and is compared to the LDW Remedial Action Levels (RALs); full laboratory reports are provided in Appendix A. This summary was revised to include an updated lower level detection limit for PCBs, per Ecology request.

Table 5: Bank Soil Sample Analytical Results for T108-B1 and T108-B2 (dry weight only)

Analyte	LDW RALs or LAET (2)	T108-B1	T108-B2
Northing (1)	-	208298.329	208409.345
Easting	-	1267355.25	1267319.697
Elevation in feet	-	11.3	11.3
Total Organic Carbon in %	NA	0.042 U	0.042 U
Total Detected Metals in mg/kg			
Arsenic	28	11 U	11 U
Chromium	260	7.8	10
Copper	390	8.1	8.1
Zinc	410	34	29
PAHs in µg/kg	230-3200	7.2 U	7.2 U
Total PCBs in µg/kg	130	5.4 U	5.4 U

(1) Washington State Plane Coordinate System
(2) Used the lowest RALs for intertidal areas listed on Table 28 of the ROD (EPA, 2014) or Marine Sediment AET Sediment Cleanup Objective (SQO) for organics.
U – not detected at indicated reporting limit

Table 6: Bank Soil Sample Analytical Results for T108-B3 (organic normalized)

Analyte	LDW RALs (2)	T108-B3
Northing (1)	-	208495.44
Easting	-	1267304.86
Elevation	-	16.4
Total Organic Carbon in %	NA	0.84

Arsenic	28	11 U
Chromium	260	26
Copper	390	29
Zinc	410	74
Detected PAHs in mg/kg OC		
Naphthalene	99	1.67
2-Methylnaphthalene	NA	1.43
Phenanthrene	100	02.74
Anthracene	220	0.89
Fluoranthene	160	3.45
Pyrene	1000	3.57
Benzo[a]anthracene	110	2.74
Chrysene	110	3.45
Total Benzofluoranthenes	230	5.10
Benzo[a]pyrene	99	2.74
Benzo[g,h,i]perylene	31	2.26
Indeno(1,2,3-c,d)pyrene	34	1.55
Total cPAHs in µg TEQ/kg	900	31.17
Total PCBs in mg/kg OC	12	5.1

(1)Washington State Plane Coordinate System
(2) Used the lowest RALs for intertidal areas listed on Table 28 of the ROD (EPA, 2014).
U – not detected at indicated reporting limit NA – not applicable

In general, the new bank soil samples were either ND or below the LDW RALs. In addition, the result of this work stabilized the slope, so the direct bank-soil erosion pathway is unlikely. Combined, this indicates that remaining soils will not result in recontamination of the sediment remedy.

2.6 Construction Inspections and Reporting

Construction inspections were made continuously during excavation to determine the presence of any unanticipated contaminated soil based on visual and olfactory evidence. Both PCS personnel (daily) and Port environmental staff (weekly) were inspecting regraded soil and reporting their findings (or lack of findings) in weekly reports. During the work, Port staff also contacted Ecology on a regular basis to provide construction updates and observations. Copies of all weekly construction reports are provided as Appendix C and relevant project photos in Appendix D.

3 Post Construction Monitoring and Reporting

3.1 Post Construction Evaluation

The physical condition of the regraded and stabilized slope (overall slope stability, log and soil movement, new vegetation survival) was inspected approximately four weeks after completion of the bank work. A second inspection will be performed approximately 6 months (October 2015) after completion of the bank work; findings will be reported to Ecology in a letter report.

4-Week Post Construction Inspection. A 4-week follow up inspection was performed by Port staff. During this inspection, the bottom area of the leading (i.e., lowest) log line and the areas of topsoil filling and plantings were inspected . Finally, the 80-foot long north bank area with new riprap was inspected. During this inspection, no changes to the as-built conditions were observed, including no erosion or depositing near the logs. The new plantings were receiving daily watering from a temporary irrigation system; they all appeared healthy except for less than 5% of the plantings that were either brown or dead. Photos from the inspection are included in Appendix D.

6-Month Post Construction Inspection. (See addendum due in October 2015).

3.2 Reports

This Performance Report is submitted as a requirement of the project work plan and contract. The report includes a summary of field activities, validated sampling data, data review and analysis, performance observations and photographs, final as-built sections, and an evaluation of post construction performance. Further, the analytical data generated as part of this work has been submitted to Ecology's Environmental Information Management (EIM) data base.

4 References

AECOM, 2014. Terminal 108W, 108E, and 106W Source Control Data Evaluation Report.

EPA, 2014, Record of Decision Lower Duwamish Waterway Superfund Site

Port, 2013. Site Umbrella Health and Safety Plan (SUHASP), Terminal 108

Port, 2015. Terminal 108W Bank Stabilization and Rehabilitation Demonstration Final Work Plan.

Port, 2015a. Temporary Erosion and Sediment Control (TESC) Plan for T108 Bank Stabilization Project.