PORTfolio

PORTfolio Restoration Plan: Lower Duwamish River

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PORTfolio

Executive Summary

This PORTfolio Restoration Plan details the Port of Seattle's plan to restore or enhance approximately 66 acres of habitat among 16 sites throughout the Lower Duwamish River (LDR), including the Lower Duwamish Waterway and the East and West Waterways.

The Port proposes to implement selected PORTfolio projects in part to settle federal, state, and tribal Natural Resource Trustees' (Trustees) claims for natural resource damages (NRD) resulting from historical contamination of sediments at the Lower Duwamish River, Lockheed West, and Harbor Island Superfund sites. Where restoration outcomes exceed the Port's negotiated liabilities, the Port expects to sell restoration credits to other Potentially Responsible Parties (PRPs) without access to restoration sites..

Selection of the PORTfolio projects was based on the Port's habitat restoration planning framework (AHBL 2009) as well as guidance from the Trustees (NOAA 2013), and resulted in selection of the following 16 project sites:

- Terminal 117
- Terminal 25 South
- South Park
- Turning Basin 3
- Terminal 5 North
- Terminal 18
- Terminal 5 Southeast
- Terminal 104
- Terminal 105
- Terminal 108
- Terminal 107
- Terminal 115
- Terminal 10
- Slip 27
- Terminal 102
- Terminal 106

The 16 PORTfolio project sites combine a variety of past and future restoration actions. All of the projects feature some combination of riparian, estuarine marsh, intertidal, and shallow and deep subtidal habitat. Post-restoration conditions were designed to maximize ecological value using the Habitat Equivalency Analysis model developed by the Trustees for the LDR NRD Assessment. In estimating the ecological value of each project using this model, the Port considered the collective results of both past and future restoration actions.

Together, the 16 PORTfolio projects would restore approximately 66 acres of habitat to the LDR. In order to account for the contributions of outside parties to these projects, the Port completed an inventory and analysis of resources committed, including direct costs and property values. According to this analysis, approximately 97% of the total ecological value of these projects are attributed to Port contributions.

Proposed post-restoration conditions for each project will be achieved through application of one or more restoration treatments developed by experts with extensive experience conducting

successful, self-sustaining habitat restoration in the LDR. Two PORTfolio projects are proposed to be implemented within the next three (3) years: Terminal 117 and Terminal 25 South. .

Project-specific performance monitoring, maintenance, and long-term stewardship will be conducted to ensure that all constructed projects meet their stated objectives.

Table of Contents

Appendices

List of Tables

List of Figures

PART I

PART III

Acronyms and Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
dSAY	Discounted service acre year
EAA	Early Action Area
EPA	Environmental Protection Agency
GPS	Global positioning system
HEA	Habitat equivalency analysis
LDR	Lower Duwamish River
LDW	Lower Duwamish Waterway
LWD	Large woody debris
MHHW	Mean higher high water
MLLW	Mean lower low water
NOAA	National Oceanic and Atmospheric Administration
NRD	Natural Resource Damages
NRDA	Natural Resource Damage Assessment
Port	Port of Seattle
PRP	Potentially responsible party
SDOT	City of Seattle Department of Transportation
Trustees	Lower Duwamish River Natural Resource Damage Assessment Trustee Council
USACE	U.S. Army Corps of Engineers
WSDOT	Washington State Department of Transportation

PORTfolio

PART I: INTRODUCTION

1 Overview of PORTfolio Restoration Plan

This PORTfolio Restoration Plan details 66 acres of potential habitat restoration on 16 sites throughout the Lower Duwamish River (LDR), including the Lower Duwamish Waterway (LDW) and the East and West Waterways.

The Port proposes to implement one or more selected projects within the PORTfolio to settle the Lower Duwamish River Natural Resource Damage Assessment Trustee Council's (Trustees) claims against the Port for natural resource damages (NRD) resulting from historical contamination of sediments at the Lower Duwamish River, Lockheed West, and Harbor Island Superfund sites. As a component of its settlement, the Port has proposed to implement additional projects to create NRD restoration credits for other Potentially Responsible Parties (PRPs) in the LDR. This will facilitate rapid and effective restoration well in advance of future settlements. ,

The Port draws on over three decades of experience implementing and adaptively managing restoration projects in the LDR. In addition, as a primary landowner in the LDR, the Port is uniquely positioned to implement strategic restoration throughout the LDR to create a corridor of habitat refugia.

1.1 Background

1.1.1 Lower Duwamish River

The Duwamish River, now a channelized urban industrial waterway, was once a sinuous channel that meandered through a large tidal estuary. The river and its floodplain supported a large and complex network of riparian forests, freshwater wetlands, and tidal marshes. The river's estuary also consisted of multiple habitat types, supporting thousands of acres of forested tidal swamp, intertidal sandflats and mudflats, and intertidal marsh (AHBL 2009). Native American tribes, including the Muckleshoot and Suquamish Tribes, hunted, fished, gathered, and farmed within the Duwamish River ecosystem.

Beginning in the 1850s, European settlers developed the region for logging and agriculture, clearing the river's shorelines and draining its wetlands. Over the next 150 years, the reclamation and filling of its wetlands, marshes, and floodplains and the channelization of the LDR developed the estuary and the adjacent land into an active commercial and industrial area. Throughout the 1900s and 2000s, the land was used for numerous and varied purposes, including shipbuilding, airplane manufacturing, concrete production, food processing and cold storage, cargo storage and transportation, the production of metals, cars, and trucks; wastewater treatment/discharge; and materials salvage. These industrial activities led to the

chemical contamination of the LDR and ultimately to the listing of 5.5 miles of the LDR as a federal Superfund site in 2000.

1.1.2 Natural Resource Damage Assessment and Restoration

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, PRPs are required to compensate the public for the loss of natural resources and their services due to contamination. State, federal and tribal trustees of these natural resources work with the PRPs to quantify these losses through Natural Resource Damage Assessment (NRDA) and design compensatory restoration projects that will protect and restore the injured resources.

In the case of the LDR, the Trustees hold the Port and other PRPs responsible for damages to marine and aquatic natural resources. This damage is primarily the result of historical contamination of the waterway, and under CERCLA the Trustees can bring a claim for restoration to compensate for injury calculated as far back as 1980. The Port proposes to implement the PORTfolio projects in part to provide compensation for its contribution to LDR natural resource injury.

1.2 PORTfolio Goals

The overall goal of the PORTfolio project is to create resilient, self-sustaining habitat that will provide ecosystem functions that were once abundant but are now rare due to dredging and fill necessary for construction of the Duwamish Waterway and more than eight decades of industrial use. These functions will promote forage and refuge opportunities for migratory and resident fish and wildlife.

To achieve this goal, the PORTfolio projects will restore and/or create high-functioning habitat in the LDR. Specifically, the PORTfolio projects will increase the area and functional value of habitat for salmonids and other migratory and resident fish and wildlife through the restoration, enhancement, and/or creation of riparian, estuarine marsh, mudflat, intertidal, and subtidal environments. Together, these habitat types provide natural resource benefits to key species using the site as well as benefits relating to organic materials and invertebrate species exported from the site. The PORTfolio projects will be designed to maximize these benefits using dimensions, locations, elevations, and slope contours critical to each habitat type, as identified by the Trustees (NOAA 2013) and as modified according to the hydrodynamic and physical constraints of each site.

1.3 PORTfolio Projects

1.3.1 Project Selection

The projects presented in this document have been selected for their capacity to contribute to the overall goals and objectives of the PORTfolio, as described above. Past restoration actions

selected for inclusion were non-compensatory and voluntary, and were completed after 1980. They were completed primarily using Port resources, including direct funds, property, labor, or some combination thereof. Selection of sites for future restoration was informed by the habitat restoration planning framework developed by the Port as part of its Lower Duwamish River Restoration Plan (AHBL 2009). The Plan evaluated estuarine restoration opportunities in the river and laid out a framework for shoreline and aquatic area restoration coincident with continuing marine commerce and industrial use in the LDR. The Plan provides an inventory of potential habitat restoration opportunities on Port-owned property, including the ribbons of property in the commercial waterway (those portions of the river between the navigation channel and the shoreline in the LDR), and guidance for future implementation efforts. PORTfolio projects with future restoration include sites identified in the Plan, as well as opportunities that have arisen since the Plan was developed to enhance and expand past restoration actions. Selected projects are on Port property that is available for habitat restoration and will not interfere with adjacent marine industrial uses of the LDR or access to treaty-reserved fisheries.

Selection of the PORTfolio projects was also informed by guidance in the LDR NRDA Restoration Plan (NOAA 2013). Developed by the Trustees using an ecosystem approach, the NRDA Restoration Plan established Habitat Focus Areas (HFAs) that fulfill CERCLA requirements (by having a strong nexus to the injured resources) and prioritize restoration where habitat is scarce and essential for fish and wildlife in the LDR. The highest priority HFA comprises the LDR, extending from the northern tip of Harbor Island upstream to North Winds Weir in Tukwila. With the exception of Terminal 5 North, which lies within the Inner Elliott Bay HFA, all PORTfolio projects lie within this highest priority area. All projects have the capacity to support the types of habitat identified by the Trustees as most valuable to the LDR, and all can be protected as habitat in perpetuity through the application of a conservation easement.

1.3.2 Overview of Projects

The above selection process resulted in the inclusion of the following 16 PORTfolio projects (see Figure I-1):

- Terminal 117
- Terminal 25 South
- South Park
- Turning Basin 3
- Terminal 5 North
- Terminal 18
- Terminal 5 Southeast
- Terminal 104
- Terminal 105
- Terminal 108
- Terminal 107

- Terminal 115
- Terminal 10
- Slip 27
- Terminal 102
- Terminal 106

These projects involve a range of past and future restoration actions, including the removal of structures to daylight shaded aquatic and intertidal habitat; cleanup of historical industrial debris and removal of fill material; restoration of intertidal marsh, mudflat, and sandflat habitat; and creation of shoreline enhancements through riparian plantings. Part III of this document summarizes the past and planned future restoration actions for each project. Together, these 16 projects contribute approximately 66 acres of restored habitat that provides critical ecological services to the LDR.

1.4 Implementation

As currently planned, the Terminal 117 and Terminal 25 South projects would be the basis of the Port's NRD settlement proposal to the Trustees. Credits from Terminal 25 South would be applied against the Port's negotiated liability while Terminal 117 credits would be intended to supply the NRD liability market. If approved by the Trustees, both projects would be constructed by 2020. The additional PORTfolio projects would be constructed over time as determined by NRD credit demand and other factors. over time in response to market demand for NRD credits, 404 mitigation, or as voluntary initiatives.

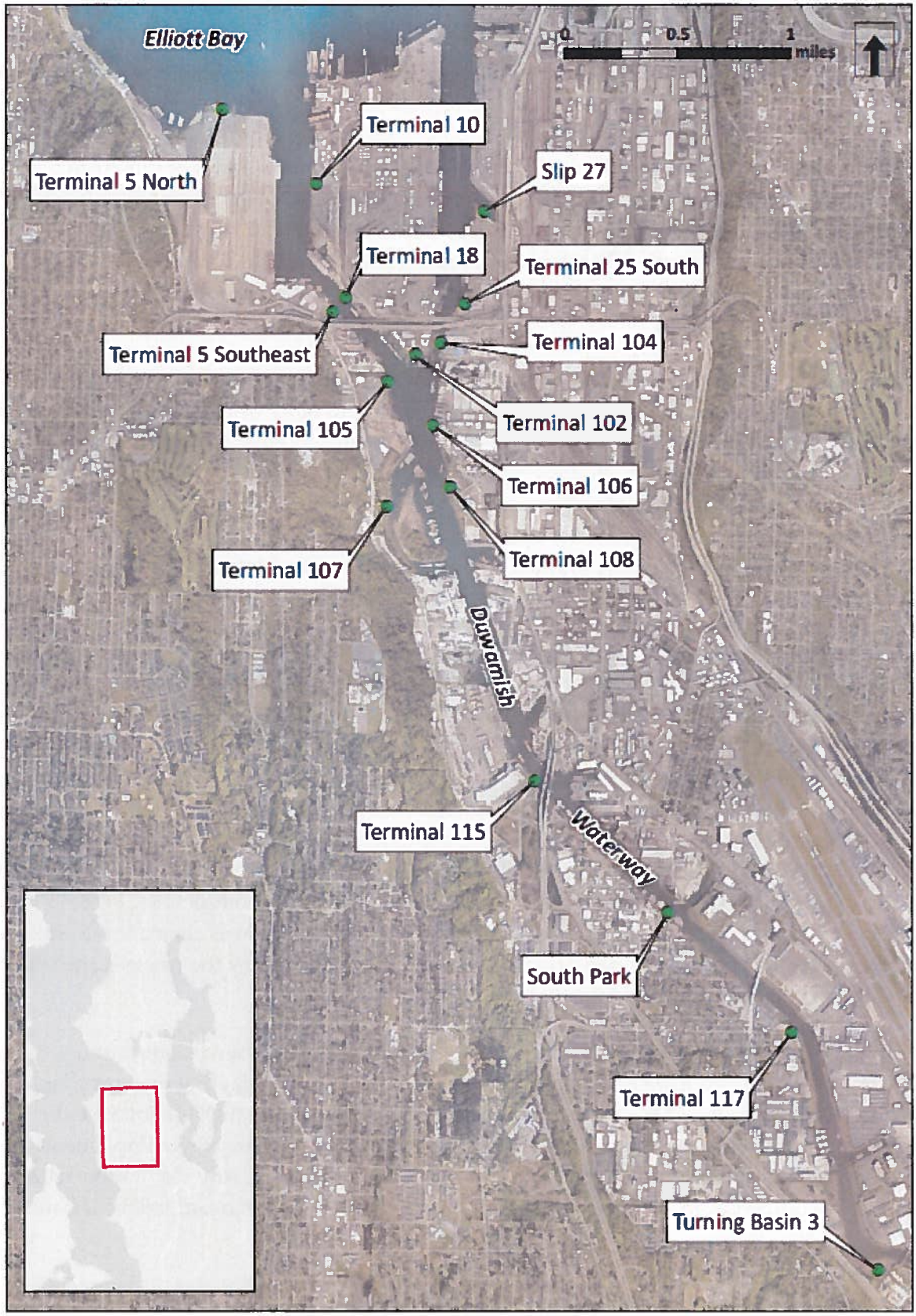

Figure I-1. Map of PORTfolio projects

2 Restoration Approach

2.1 Overview

As a whole, the PORTfolio is intended to maximize the quality and amount of self-sustaining habitat in the LDR. As described above, the projects described in this document have been selected and designed for their capacity to contribute to that goal. The 16 projects, located throughout the river and south Elliott Bay, combine a variety of past and future restoration actions. This chapter summarizes the Port's general approach to restoration design and valuation for these 16 projects.

The Port has a long history of habitat restoration in the LDR. Many of thePort's restoration actions were carried out as compensation for the development of its waterfront properties, and are therefore inappropriate for inclusion in a NRD settlement agreement or habitat bank. However, the Port has also conducted several voluntary habitat restoration actions. In 2010, with the help of Windward Environmental LLC, the Port began collecting information about these voluntary habitat projects in order to evaluate the ecological services they provided (Windward 2014). This work was continued and expanded by The Watershed Company beginning in 2014, combining past and future restoration actions into the 16-project PORTfolio.

Although NRD regulations do not specifically address the role of past habitat projects in NRD settlements, the 2007 DuPont Newport, Delaware, NRD settlement (*United States and State of Delaware v. E.I. Du Pont De Nemours and Co. and CIBA Specialty Chemicals Corp.*, Case No. 1:06-cv-612 (D. Del., Feb. 20, 2007)) provides an example of a case in which natural resource trustees evaluated "up front" restoration[1] implemented along with remediation (Stahl et al. 2008). Based on the trustees' recommendation, DuPont completed an onsite tidal wetland restoration project. The project greatly improved the habitat value of a low-lying area on DuPont's property but was completed without a legal agreement that habitat credits generated by the project would be considered in any future NRD settlement. Nearly five years after the completion of the restoration, during settlement discussions, DuPont asked that the trustees consider the wetland restoration project as partial compensation. The project was accepted by the trustees and offset a significant portion of DuPont's total restoration requirement.

The Port has taken a similar approach to accounting for its natural resource contributions to the LDR. These contributions have helped to offset historical damage, mitigating the overall injury to natural resources in the LDR. The past actions are additionally valuable as habitats have matured and ecological functions have increased over the time since they were implemented. The past restoration actions included in this accounting are voluntary. Any restoration actions completed as compensatory mitigation are excluded from the PORTfolio and will be left intact

[1] Up-front restoration is habitat restoration conducted prior to an NRD settlement.

by future restoration actions planned as part of the PORTfolio. The past restoration actions included in this accounting were also completed by the Port, using Port resources.

With the exception of the Turning Basin 3 and South Park projects, all PORTfolio projects include future restoration actions. In many cases, these planned actions will build off of past restoration actions. In all cases, they are designed to maximize the ecological value provided by the project, using best practices from the Port's experience with restoration in the LDR, as well as guidance from the Trustees. For all sites, the Port considered the collective results of both past and future restoration actions when estimating the ecological value of the project.

2.2 Restoration Design

All of the PORTfolio project concepts feature some combination of riparian, estuarine marsh, intertidal, and shallow and deep subtidal habitat. However, the existing conditions at each project site vary widely, and will determine how specific restoration actions would be implemented at the site to achieve final habitat types. As a means to organize and describe how restoration will be conducted at each PORTfolio site, the Port developed seven distinct restoration treatments. These treatments were developed using the Port's experience conducting successful, self-sustaining habitat restoration in the LDR. The seven restoration treatments are listed below:

- Riparian Top of Slope
- Sloped Riparian
- Sloped Riparian and Emergent Marsh
- Sloped Riparian and Intertidal Bench
- Fill Removal—Off-Channel Riparian, Marsh, and Mudflat
- Typical Berm—Riparian and Emergent Marsh
- Structure Removal

Each of the PORTfolio projects planned for future restoration would receive one or more of these seven restoration treatments. The treatment or treatments applied at each site have been selected and incorporated into the conceptual design for the project based on the objectives of the project, the existing conditions at the project site, and any other site-specific constraints. Restoration designs would be refined for each project prior to implementation.

Part II of this document describes the features of each restoration treatment and identifies sites to which each treatment will be applied. Appendix A contains detailed section and plan-view drawings, or "typicals," intended to accompany these descriptions and illustrate the features of restoration treatments 1 through 6.

2.3 Ecological Valuation

Ecological value, or "lift," provided by each of the PORTfolio sites will be determined using the Habitat Equivalency Analysis (HEA) model developed by the Trustees for the LDR NRDA

(NOAA 2013). The HEA model is an analytical tool designed to estimate the value of a restoration project in terms of its ecological services and is often used to evaluate compensation requirements as part of many NRD settlements. Inputs into the HEA model include the type and quantity of habitat restored, the duration of the restoration effort, and the overall expected life span of the restored habitat. The unit of measure used in the model is a discounted service acre year (dSAY), which quantifies the ecological service provided by an area (in acres) over a specific length of time (in years). Discounting incorporates the standard economic assumption that people place a greater value on having resources available in the present than on delaying availability until the future. The ecological value of a project (i.e., the amount of the restoration credit) also depends on the individual values afforded to different habitat types. In the case of the LDR, the Trustees developed habitat values for intertidal, shallow subtidal, deep subtidal, and riparian habitats for use in NRDAs (NOAA 2013).

As described above, many PORTfolio projects include both past and future restoration actions. For the purpose of ecological valuation using the HEA model, the Port defined baseline conditions as those conditions on the site prior to *all* restoration actions at the site, both past and future. Similarly, the Port defined post-restoration conditions as those conditions following *all* restoration actions at the site. In this way, the Port considered the collective results of all restoration actions on a given site when preparing baseline and post-project shapefiles for each site.

Field surveys were completed for all PORTfolio sites by Windward Environmental LLC and Port staff between May and July of 2013, with supplemental site visits in July of 2016 by The Watershed Company and Port staff. A high-resolution global positioning system (GPS) was used to delineate the boundaries of different habitat types and measure their elevation ranges. Field observations were also made to characterize the current condition and ecological function of each habitat type. Information from the field surveys was combined with information from high-resolution aerial imagery, archived Port engineering drawings, and *a priori* institutional knowledge to delineate baseline habitat types for each PORTfolio project (and post-restoration habitat types, for those projects comprising past restoration actions only). For those projects with future restoration actions, post-restoration habitat types were delineated using site elevations, property boundaries, and any other site constraint information.

The PORTfolio projects incorporate restoration actions completed as far back as 1989. Those past actions have been generating ecological value for the LDR in the years since their completion.

Final restoration design for each of the PORTfolio projects will be developed through coordination with the Trustees in order to maximize ecological value according to the project's location in the river.

Maps of the baseline and post-restoration HEA polygons for all PORTfolio projects are in Appendix B.

2.4 Estimation of Resources Committed

The overall approach to the financial valuation of each project was to estimate resources committed as both direct project costs and property value. The percentage of the total resources committed by the Port, rather than by outside parties, was then used to calculate the Port's portion of the total value of the project.

Direct project costs include costs associated with design, permitting, construction, project management, maintenance and monitoring, and long-term stewardship. For past restoration actions, direct cost information was gleaned from Port budget records to the extent possible. Permit documents and archived Port documents provided a second source of cost information, particularly for projects completed prior to 1995, and for projects completed with grant or other outside funding sources. When documentation was lacking, project costs were estimated using a combination of regional restoration planning tools (King County 2015), detailed engineering drawings, and statements of work, as well as comparisons with other Port habitat restoration projects. For future restoration actions, direct project costs were estimated based on individual project size, complexity, and design, and comparison to past expenditures for similar actions.

Property constitutes a large percentage of the total resources contributed to these projects by the Port. Most of the PORTfolio projects are located on valuable urban industrial waterfront property owned by the Port. Property values were calculated through the application of a proposed conservation easement to protect the restored habitat in perpetuity. Located in an active industrial zone, these habitat project sites currently stand the risk of redevelopment. The application of an easement removes that risk, effectively stripping the land of its value as industrial property. The property resources committed for a given project represent that loss in value. This approach was used for Port-owned properties as well as for properties owned by other parties, such as City of Seattle street right-of-ways and aquatic lands owned by the Washington Department of Natural Resources. Where a PORTfolio project extends onto non-Port-owned property, it is assumed that the Port will enter into an agreement with the property owner to obtain a conservation easement for that portion of the property supporting PORTfolio habitat. The exception to this approach is for the Federal Waterway, which is regularly maintained for navigation and is therefore excluded from all proposed conservation easement boundaries. Also, while the Port may ultimately be required to purchase those portions of non-Port-owned property that support PORTfolio habitat, those future expenditures have not been included as part of the valuation. The proposed conservation easements used for this valuation will be presented as a proposal to the Port Commission in order to ensure protection in perpetuity of the PORTfolio projects.

The restoration cost summary, including direct costs and property values for both past and future restoration actions, are presented for each PORTfolio project in Part III. Maps of the proposed conservation easement boundaries are in Appendix C.

2.5 Assurances

Monitoring, maintenance, and long-term stewardship will be provided to ensure that projects meet their stated objectives and contribute to the overall goal of the PORTfolio. A project-specific monitoring and maintenance program will be developed as part of final project design for each project. This program will include performance standards and monitoring parameters specific to the project, which will be measured during a 10-year monitoring period following construction of each project. The program will identify contingency measures to apply in the event that monitoring parameters fall short of defined performance standards. The program will also identify maintenance activities, which will be conducted during the 10-year performance monitoring period by the Port's Marine Maintenance Division or bay a selected contractor with appropriate expertise.

After the initial 10-year monitoring period, the PORTfolio projects will be maintained according to a long-term stewardship plan to ensure the integrity of the restoration project in the long term (approximately 20 years). Projects will be protected in perpetuity by a conservation easement, funded by an endowment, and carried out by a third-party provider.

A Programmatic Monitoring, Maintenance, and Long-Term Stewardship Plan is included as Appendix D. Due to the advanced design stage of the two settlement projects at Terminal 117 and Terminal 25 South, more detailed and design-specific monitoring and maintenance plans are proposed and included as Appendix E-3 and F-3, respectively. The basic components of proposed monitoring, maintenance, and long-term stewardship for all PORTfolio projects are summarized in Part IV of this document.

PART II: RESTORATION DESIGN

1 Introduction

The PORTfolio habitat restoration program includes 16 sites along the LDR. Of these 16 sites, two are already constructed (Turning Basin #3 and South Park). Fourteen are planned for future restoration actions. Each of the 14 new sites will receive at least one of seven different restoration treatments. The seven general restoration treatments are listed below:

1. Riparian Top of Slope
2. Sloped Riparian
3. Sloped Riparian and Emergent Marsh
4. Sloped Riparian and Intertidal Bench
5. Fill Removal—Off-Channel Riparian, Marsh, and Mudflat
6. Typical Berm—Riparian and Emergent Marsh
7. Structure Removal

This document describes the features of each restoration treatment and identifies sites to which each treatment will be applied. Appendix A contains detailed section and plan-view drawings, or "typicals," intended to accompany these descriptions and illustrate these features for restoration treatments 1 through 6.

Restoration designs will be refined for each site prior to implementation based on site-specific characteristics and restrictions. Final designs for each site will be submitted to the Trustees for review and approval prior to implementation.

2 Restoration Treatments

2.1 Riparian Top of Slope

The Riparian Top of Slope treatment (Treatment #1) can be employed at sites with steep narrow slopes that cannot be modified due to site constraints. At sites where this treatment is employed, the existing slope is most commonly composed of angular rock armoring, commonly known as "riprap." The upland portion is typically narrow and cannot be widened due to existing property boundaries or adjacent land use constraints. The restoration treatment will involve a modification to the existing top of slope to establish a riparian buffer.

A trench at least 15 feet wide and 3 feet deep will be excavated parallel to the top of slope. The trench will be lined with biodegradable geotextile fabric and filled with three feet of clean imported topsoil. An additional one foot of woodchip mulch will be added on top of the imported soil. Dense native riparian plantings consisting primarily of trees and shrubs will be planted and a permanent irrigation system installed. A log edge will border both the landward and waterward margins of the riparian buffer to define and contain the riparian planting area. No modifications will be made to the existing riprap slope due to site constraints and slope stability issues.

Where existing degraded riparian habitats occur at the top of slope, a modified version of this treatment will be implemented to remove invasive species and install native infill vegetation.

2.2 Sloped Riparian

The Sloped Riparian treatment (Treatment #2) will be employed at sites where minimal slope excavation and regrading can occur, but where the site is otherwise constrained by site characteristics and property lines. The existing slope will be shaped to create a riparian area with a 2:1 to 4:1 slope.

The regraded slope will be lined with a geotextile fabric and topped with two feet of clean imported soil. Dense riparian vegetation consisting primarily of trees and shrubs will be planted in the imported soil and surrounded by 1 foot of woodchip mulch. A drip irrigation system will also be installed.

Due to the potential interaction between the plants and tidal waters at the waterward margin of the riparian buffer, it is important to include more transitional species at lower elevations. The riparian buffer will be defined by large woody debris on both the landward and waterward edge. A toe log will be installed at approximately +13 feet mean lower low water (MLLW) and anchored into a rock bolster. Another toe log – referred to as the "sacrificial log" – will be installed at approximately +11.3 feet MLLW and anchored into a rock bolster. The anchors will be checked and tightened if needed after the first and second year to ensure the logs remain secure. The area between the two parallel toe logs will be lined with coir fabric, covered in 2 feet

of fine grain sediments similar to that of the natural Duwamish River, and planted with transitional emergent marsh species. The purpose of the sacrificial log is to prevent erosion at the base of the riparian slope while the plant species develop. Once established, the emergent plants themselves will limit erosion. The slope beyond the sacrificial toe log will gradually transition into the existing conditions.

2.3 Sloped Riparian and Emergent Marsh

The Sloped Riparian and Emergent Marsh treatment (Treatment #3) will be employed at sites where the horizontal and vertical geometry allow for more excavation and grading than sites associated with Treatment #2.

The existing slope will be pulled back to create a riparian area with the same conditions and treatments as described in Treatment #2 to a waterward elevation of +14 feet MLLW. A toe log will be installed at +14 feet MLLW and anchored into a rock bolster. Waterward from the toe log at +14 feet MLLW, the riparian area will transition to a slope of 4:1 or flatter until it reaches the transition toe logs at +13 feet MLLW and +11.3 feet MLLW. The 4:1 or flatter slope will act as a gradual extension of the 2:1 riparian buffer and receive the same treatments described in Treatment #2. Riparian plantings in this area will consist of transitional species that can tolerate likely interaction with tidal waters.

Beyond the sacrificial log at +11.3 feet MLLW, the habitat will transition to emergent marsh at a slope of 5:1 to 10:1. The slope will be covered with a geotextile pillow encompassing 2 feet of well-mixed fine grain sediment with an organic fraction. High marsh species will be planted between +10 feet MLLW and +12 feet MLLW, while low marsh species will be planted between +8 feet MLLW and +10 feet MLLW. All vegetation plugs will be planted directly through the biodegradable geotextile fabric pillow. A log sill will be installed subsurface between +8 feet MLLW and +10 feet MLLW and anchored into a rock bolster. A veneer of fine grain sediments will extend past the log sill and gradually transition into the existing slope.

2.4 Sloped Riparian and Intertidal Bench

The Sloped Riparian and Intertidal Bench treatment (Treatment #4) will be employed at sites where intertidal habitats are limited or absent but a gradual transition from riparian to marsh to intertidal mudflat is not possible due to site constraints. In these situations, an intertidal bench will be installed to provide intertidal habitat functions.

Identical to Treatment #2, the existing slope will be shaped to create a 2:1 to 4:1 slope lined with geotextile fabric, clean imported soil, and mulch; the slope will then be planted with dense native trees and shrubs. The riparian slope will be bordered on the landward and waterward side by large wood. An intertidal bench will be excavated from the existing slope between +0 feet MLLW and +8 feet MLLW; the target elevation will be +5 feet MLLW. In order to provide intertidal habitat in areas with limited space, a 2:1 sloped vegetated log crib will be constructed. This will allow for a steeper drop to intertidal elevations without compromising slope stability

or habitat connectivity. The width of the bench will depend on site-specific characteristics. The intertidal bench will be lined with biodegradable geotextile fabric and covered with 2 feet of fine grain sediments similar to that of a natural low-gradient riverbank. At the waterward margin of the intertidal bench, a small raised reinforced lip will help to retain sediment within the intertidal bench. Additionally, transverse logs will be partially buried and anchored within the bench to retain and recruit sediment through longshore drift processes. These logs will be approximately flush with the surface sediment to minimize potential to snag on fishing nets. Beyond the raised lip, the slope will gradually transition into the existing conditions.

2.5 Fill Removal — Off-Channel Riparian, Marsh, and Mudflat

The Fill Removal — Off-Channel Riparian, Marsh, and Mudflat treatment (Treatment #5) will be employed at large sites where significant amounts of fill can be removed and extensive regrading can occur. This will include the construction of off-channel features including marsh and mud-flat. The existing slope will be pulled back as far as possible to expose previously filled sediment. The newly restored riparian slope will match the characteristics described in Treatment #2. Additionally, areas of emergent marsh will be nearly identical to Treatment #3, except that because of the reduced energy associated with off-channel environments, a geotextile fabric "pillow" will not be necessary for emergent marsh establishment, and similarly, large wood will be placed, but not anchored within the marsh. Beyond the submerged log sill defining the waterward margin of emergent marsh between +8 feet MLLW to +10 feet MLLW, the site will either extend into exposed unvegetated mudflat with a 20:1 or flatter slope or gradually transition to the existing slope.

2.6 Typical Berm — Riparian and Emergent Marsh

The Typical Berm — Riparian and Emergent Marsh treatment (Treatment #6) describes the interface between the Duwamish River habitat and off-channel habitat. This treatment will apply on the waterward side of Treatment #5. A low riparian berm is proposed to protect off-channel habitats from wake, wave, and longshore erosional forces and disturbance.

An anchored, buried log edge would mark the riverward extent of emergent marsh vegetation, which will be planted within a biodegradable geotextile pillow of fine grain sediment mix. Buried, anchored footer logs parallel to shore and partially buried cross-logs with exposed root-wads will provide complex shoreline habitat, while assuring long-term stability of the riparian berm.

The elevation of the riparian berm will range from +11.3 to +13 feet MLLW and the slope will be approximately 3:1. At elevation +11.3 feet MLLW, the off-channel side of the riparian berm will transition to emergent marsh at a 10:1 to 25:1 slope. Emergent vegetation will be planted within a 12-inch layer of fine-grain sediment mix. An anchored, buried toe log will define the lower edge of emergent marsh at the transition to intertidal mud flat habitat.

2.7 Structure Removal

The structure removal treatment (Treatment #7) will involve removal of derelict piles. These piles supported overwater structures and other marine infrastructure, such as a marine shipway. Most piles consist of creosote-soaked wood. The overwater structures that have been removed obstructed light penetration for emergent vegetation, discouraged salmonid occupation, and altered benthic invertebrate communities. On their own, piles create in-water structure that may favor predators to juvenile salmon. Finally, creosote exposure at certain concentrations results in chronic to acute effects in aquatic species ranging from invertebrates to fish, birds, and mammals.

The piles will either be entirely removed from the site or cut just at the surface, leaving a portion of the pile lodged in the sediments. The preferred method will depend on site characteristics such as pile condition and slope stability. In either case, an additional 1 to 2 feet of clean imported fine grain sediment will be placed over the historic pile footprint. This will adequately fill the void left over from the removed piling or behave as a cap to cover the remaining submerged pile and prevent release of residual creosote contamination. In most cases, structure removal will be combined with some other shoreline restoration treatment in order to increase the habitat connectivity between riparian, marsh, intertidal, and subtidal environments.

3 Restoration Treatments by Site

The application of restoration treatments that will apply to future work is summarized in Table II-1. Conceptual restoration plans for each site are described in Part III.

Table II-1. Restoration treatments for each PORTfolio project.

	Treatment						
	1. Riparian Top of Slope	2. Sloped Riparian	3. Sloped Riparian and Emergent Marsh	4. Sloped Riparian and Intertidal Bench	5. Fill removal-Off-channel	6. Typical Berm	7. Structure Removal
Terminal 117					X	X	X
Terminal 25					X	X	X
South Park	No new work						
Turning Basin 3	No new work						
Terminal 5 N	X	X	X*				X
Terminal 18		X	X				
Terminal 5 SE					X		
Terminal 104				X			
Terminal 105			X				
Terminal 108		X					
Terminal 107			X				
Terminal 115		X	X		X		
Terminal 10			X*				
Slip 27	X						
Terminal 102			X*				
Terminal 106		X		X			

Notes:
* Restoration action at these sites will involve modifications from the Treatment Type described in Part II Section 2. Details of proposed conceptual restoration actions are described in Part III.

PART III: PORTFOLIO PROJECT SITES

1 Overview

Part III contains detailed descriptions of each of the 16 PORTfolio project sites. Each project is presented in its own chapter. Terminal 117 and Terminal 25 South are the largest and most "shovel-ready" projects, and are presented first. The remaining projects are presented in the following order:

- Projects with past restoration actions only, in order from north to south;
- Projects with both past and future restoration actions, in order from north to south; and
- Projects with future restoration actions only, in order from north to south.

Each chapter contains a site overview, including location and site history. Each chapter then describes all restoration actions at the site, including baseline conditions, restoration activities performed or proposed, observations of function for completed activities, and proposed post-restoration conditions. Depending on whether a project includes past and/or future restoration actions, the description of restoration actions is structured slightly differently. To help the reader navigate this structure, the following provides a brief explanation of the subsections included:

Baseline Conditions. For the purpose of ecological valuation using the HEA model, baseline conditions are defined as conditions prior to *all* restoration actions at the site, both past and future. This subsection is included for all projects. For future restoration actions, baseline conditions may be the same as current, or existing, conditions at the site.

Restoration Activities. This subsection provides a summary of the specific restoration activities associated with the restoration action. Where the site includes both past and future restoration actions, past and future restoration actions are addressed in separate subsections.

Observation of Habitat Function. This subsection is included for those projects with past restoration actions, and it describes how the restored habitat has evolved over time. It summarizes any monitoring results or other indicators of habitat function.

Existing Conditions. This subsection is included only for those projects with both past and future restoration actions. It describes the current conditions at the site. These conditions may be different from the conditions following past restoration actions, which in many cases were completed several years earlier.

Post-Restoration Conditions. For the purpose of ecological valuation using the HEA model, post-restoration conditions are defined as those anticipated conditions following *all* restoration actions at the site, both past and future. This subsection is included for all projects, and is combined with **Observation of Habitat Function** for those projects with past restoration actions only.

Finally, each chapter contains a summary of the ecological value of the project (sections X.3), including the HEA results, restoration cost breakdown, and the portion of dSAYs attributable to Port contributions. For a description of the methods used to estimate ecological value, see Part I: Chapter 2.

2 Terminal 117

2.1 Site Overview and Background

2.1.1 Location and Project Overview

The Terminal 117 PORTfolio project site is located on the west bank of the LDW between River Miles 4.1 and 4.5 (see Figure III-1). The site is adjacent to the South Park Marina to the north; Dallas Avenue South to the northwest; the Boeing South Park facility to the southwest; and the LDW to the east.

Figure III-1. Terminal 117 PORTfolio project location

The Terminal 117 PORTfolio project includes upland and aquatic restoration with a combined area of approximately 13.5 acres and approximately 2,050 linear feet of existing LDW shoreline. Approximately six acres and 825 linear feet of shoreline is part of the Port's Terminal 117 property, east of the Dallas Avenue South and 17th Avenue South intersection in the South Park neighborhood of Seattle. An additional area of approximately 7.5 acres extends upstream along 1,225 linear feet of shoreline, east of the Boeing South Park facility. This area is also under Port ownership. The combined sites are described and evaluated as a single project at the Terminal 117 PORTfolio project site.

2.1.2 Site History

Terminal 117 was owned and operated by the Duwamish Manufacturing Company from 1937 to 1978. The Malarkey Asphalt Company bought the property in 1978 and operated an asphalt shingle plant at the site until 1993, when all manufacturing activities ended. Oils previously used at the facility led to significant PCB soil contamination in the surrounding upland and aquatic areas. Between 1996 and 1997 the former structures, including the asphalt plant, storage tanks, and some contaminated soils were removed. The Port acquired the property by 1999 and performed two Time Critical Removal Actions (TCRAs), the first in 1999 and the second in 2006, to remove sediments with the highest PCB concentrations. In 2003, Terminal 117 was identified as an Early Action Area (EAA) within the LDW Superfund Cleanup site.

The EAA encompasses 5.4 acres within the 13.5-acre Terminal 117 PORTfolio project site.. The Early Action cleanup removed contamination from 3.3 acres of uplands and 2.1 acres of aquatic area. The remaining buildings, shelters, loading docks, and foundations were demolished and removed. It should be noted that EAA cleanup and proposed habitat restoration are entirely separate actions.

2.2 Restoration Actions

2.2.1 Future Habitat Restoration

The future habitat restoration at the Terminal 117 PORTfolio project site will involve large-scale fill removal and bankline regrading. The project will create a large off-channel marsh with an on-channel riparian berm and enhance a continuous stretch of on-channel riparian slope with adjacent marsh. The project will restore approximately 2,050 linear feet of shoreline and will feature a public shoreline access site that will include environmental interpretation and community stewardship opportunities.

Baseline Conditions

The baseline conditions for the Terminal 117 PORTfolio project site are the existing, post-cleanup conditions. The Terminal 117 EAA cleanup was completed in 20144.The majority of the uplands portion of the Terminal 117 EAA was excavated, backfilled, and regraded. . Approximately 37,000 cubic yards of soil was excavated and replaced with 18,000 cubic yards of clean backfill material to a general elevation of +15 feet MLLW. Approximately 14,000 cubic yards of adjacent aquatic area sediments were excavated, and replaced with 10,000 cubic yards of clean backfill material, and re-contoured to reflect pre-project conditions.

A sheet pile wall, installed as a containment barrier during cleanup activities, remains at the site. The sheet pile wall runs parallel to the central shoreline for approximately 309 linear feet before tying into the bank on either end. The perpendicular sections of the sheet pile wall to the north and south are approximately 90 and 100 linear feet, respectively. Immediately landward of the sheet pile wall is a 2.5:1 riprap slope from +3 feet to +15 feet MLLW. Waterward of the sheet pile wall is a 5-foot-wide riprap slope that transitions into the existing slope.

The landward boundary of the Terminal 117 portion of the site has an unvegetated, east-facing 3:1 slope between +15 feet and +24 feet MLLW. The north bankline consists of a 2:1 riprap slope from -8 feet to +15 feet MLLW. The south bankline consists of a 2.5:1 riprap slope from +4 feet to +15 feet MLLW. The majority of the upland area is an extremely flat gravel surface with a 100:1 slope from the bottom of the landward riprap slope (+15 feet MLLW) to the top of the waterward riprap slope (+15 feet MLLW). A chain-link fence borders the project site boundary on all landward sides. Hydroseed was applied to the upland portion of the site after regrading activities but fail to become established due to the sterile and compact nature of the backfill material.

The existing 1,225 linear feet of bankline between the upland Boeing facility and aquatic area on the west margin of the LDW (south of the Terminal 117 portion of the site) extends up-slope from approximately +12 feet MLLW to top-of-bank elevations between approximately +23 feet and +28 feet MLLW. The filled bankline, 20 to 60 feet in width, is oversteepened and unstable. The intertidal areas along this bankline include coarse sands and limited amounts of rubble and debris, supporting little to no emergent vegetation. The surface layers of the existing substrate are believed to consist of eroded fill material. . Intertidal areas are oriented parallel to the LDW navigation channel with slopes ranging from 3:1 to 6:1. The level upland area includes a combination of introduced landscape trees and shrubs, non-native invasive species, open turf-planted areas, picnic tables, and cement walkway. Limited volunteer native trees are present in several locations along the abrupt bankline.

Restoration Activities

The Terminal 117 portion of the site will be restored using Restoration Treatments #5 and #6, involving large-scale fill removal to create off-channel marsh habitat and a riparian berm. The upper portions of the sheet pile wall will be cut off below grade at between -2 feet and +6 feet MLLW, leaving subgrade portions of the sheet pile in place for the purpose of deep, subsurface slope stability. Areas landward of the former sheet pile wall will be reduced in elevation, from approximately +15 feet MLLW to intertidal elevations between +8 feet and +12 feet MLLW, with slopes ranging from 6:1 to 30:1. Intertidal areas between approximately +7 feet and +12 feet MLLW will be graded and shaped to create stable exposed intertidal mud/sand substrate suitable for planting marsh vegetation.

Two low riparian berms will be constructed according to Restoration Treatment #6 and oriented parallel to the LDW. The berms will be approximately 520 feet long and approximately 15 feet wide with elevations between +12 feet and +14 feet MLLW. The berms will be constructed using subgrade rock bolsters with at-grade anchored large woody debris (LWD) placed parallel to the mean higher high water (MHHW) contour for the purpose of bank stabilization. The berms and the entire length of shoreline at the Terminal 117 portion of the site between +12 feet MLLW and top-of-bank-elevations will be planted with native riparian vegetation. Tidal exchange between the off-channel habitat and the LDW will be provided via a constructed, fish-passable channel.

Approximately 1,250 linear feet of bankline south of the Terminal 117 portion of the site will be regraded according to Restoration Treatment #3 to create intertidal marsh elevation and riparian habitat parallel to the LDW. The south portion of the Terminal 117 PORTfolio project site will be excavated, moving the top-of-bank landward 15 to 55 feet. A continuous 2:1 slope will extend from the relocated top-of-bank to approximately +14 feet MLLW, followed by a 4:1 slope between +14 feet and +12 feet MLLW. The riparian slope between +12 feet MLLW and top-of-bank will be approximately 20- to 25-feet-wide and densely planted with native riparian vegetation. The intertidal area, between +12 feet and +8 feet MLLW, will be approximately 20- to 35-feet-wide and planted with native emergent marsh vegetation.

Post-Restoration Conditions

The Terminal 117 PORTfolio project site will restore approximately 1.61 acres of riparian, 3.04 acres of emergent marsh, 3.32 acres of mudflat, 5.70 acres of shallow subtidal, and 0.04 acres of deep subtidal habitat, creating approximately 2,050 linear feet of significantly improved shoreline habitat (see Appendix E-1).

2.3 Ecological Value

The Terminal 117 PORTfolio project site is located in a key reach in the LDW, and is proposed restoration is configured to optimize critical off-channel marsh and important riparian and aquatic area habitat types. The Terminal 117 PORTfolio project site will include estuarine habitats extending from MHHW to shallow intertidal elevations and establish primary production by native riparian and emergent marsh vegetation in an area with minimal existing vegetation and associated alocthonous inputs. . Use of large woody debris and substrate habitat features will also produce important fish and wildlife resource values. In addition, the project site is located in close proximity to other significant habitat restoration projects, including the King County South Park Bridge Habitat Project and the Boeing Plant 2 Restoration Project.

2.3.1 Restoration Valuation

Using the HEA model, the Terminal 117 PORTfolio project will result in an ecological lift of approximately 521 dSAYs. Table III-1 shows the acres of each type of habitat converted from baseline to restored conditions. Note that dSAY estimates for each habitat type are not included in this table, as the total dSAY value of the Terminal 117 PORTfolio project has been verified by the Trustees.

Table III-1. dSAY summary for the Terminal 117 PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres
Baseline Adjusted Intertidal	Fully Functioning Estuarine Marsh	0.29
	Fully Functioning Intertidal	3.10
	Riparian	0.004
Baseline Adjusted Shallow Subtidal	Fully Functioning Intertidal	0.12
	Fully Functioning Shallow Subtidal	5.66
	Riprap	0.001
	Unvegetated Upland	0.01
Degraded Shallow Subtidal	Fully Functioning Shallow Subtidal	0.04
	Unvegetated Upland	0.01
Baseline Adjusted Deep Subtidal	Fully Functioning Deep Subtidal	0.04
Riprap	Fully Functioning Estuarine Marsh	0.51

Baseline Habitat Type	Restored Habitat Type	Acres
	Fully Functioning Intertidal	0.42
	Baseline Adjusted Intertidal	0.03
	Riparian	0.11
	Unvegetated Upland	0.01
	Riprap (no change)	0.09
Unvegetated Upland	Fully Functioning Estuarine Marsh	2.24
	Fully Functioning Intertidal	0.001
	Baseline Adjusted Intertidal	0.01
	Riparian	1.50
	Riprap	0.001
	Unvegetated Upland (no change)	0.14
	Total	**14.34**

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

3 Terminal 25 South

3.1 Site Overview and Background

3.1.1 Location and Project Overview

Terminal 25 South is located along the east shoreline of the East Waterway of the LDR. It is bordered by active container Terminal 25 to the north, an active storage yard and East Marginal Way to the east, the Southwest Spokane Street Bridge to the South, and the East Waterway to the west (see Figure III-2). The Terminal 25 South PORTfolio project site encompasses the westernmost portion of the Port's Terminal 25 South property. Both voluntary restoration and compensatory mitigation activities have taken place at the site in the past, although only voluntary actions are included in the PORTfolio project.

Figure III-2. Terminal 25 South PORTfolio project location

3.1.2 Site History

Terminal 25 South was initially constructed by dredging and filling activities in the early 1900s, when the Duwamish estuary was reconfigured to the current channel location. In addition to sediment fill placement, other upland fill materials (associated with the regrading of Beacon Hill and Denny Hill) were placed at the site. The project area at Terminal 25 South, historically, has been used as a log yard, saw mill, cold storage, and break-bulk cargo facility.

. In the early 1960s, the saw mill was removed from the project area to allow for lumber storage and automobile staging. . The Port acquired the property in the late 1970s. During the 1980s, the site continued to be used for cold storage, seafood processing, and break-bulk cargo operations. The warehouses on the Property were demolished by the Port in the 1990s.

In 1984, the Port enhanced approximately 0.11 acres of intertidal area along the south bankline of Terminal 25 South, approximately 125 feet south of the dock. The effort served as compensatory mitigation for the construction of the Terminal 30 apron and associated fill, and is not included in the PORTfolio project.

In 2004, all remaining seafood processing and cold storage facilities were removed by the Port, and the 16-acre-site was entirely cleared and partially paved. Since then, the project area has been used for concrete crushing and recycling, outdoor storage, and clean fill (crushed concrete from the King Dome demolition was placed on site and covered with hydroseed in the northeast portion of the project area.) .

3.2 Restoration Actions

3.2.1 Past Habitat Restoration

The Port performed two previous habitat restoration actions in 2000 and 2006. The actions involved the combined removal of approximately two acres of overwater cover at the historic dock site, once known as Pier 24 or the Spokane Street Terminal (Port of Seattle 2011).

Baseline Conditions

For the purposes of ecological valuation of the PORTfolio project, baseline conditions at Terminal 25 South are considered to be the existing site conditions. Past habitat restoration actions are not included. However, past actions are important to consider for context. .

Prior to the early 2000's, a derelict timber dock covered two acres of intertidal and shallow subtidal rip-rap. Pieces of the dock had fallen into the intertidal area. Other debris, including concrete, asphalt, and remnants of a concrete bulkhead, were present in the intertidal area beneath the dock. A 2:1 riprap slope exists between the intertidal area of the East Waterway and the former upland cargo area. Property landward of the derelict dock was vacant, consisting mostly of paved and unvegetated areas.

Restoration Activities

In 2000, the Port removed approximately 0.3 acres of overwater timber decking at the south end of the Terminal 25 South site due to seismic damage and stability concerns. In early 2006, the Port removed another approximately 1.6 acres of creosote timber decking at the north end of the Terminal 25 South site due to the failure of the aging under-dock sprinkler system. Hundreds of creosote timber piles, associated connecting timbers, concrete decking, rip-rap, and the previously mentioned intertidal debris were left in place.

Observation of Habitat Function

Biological monitoring was conducted at Terminal 25 South in 2007 by Taylor Associates, Inc. to document habitat conditions following the removal of the overwater cover. Both juvenile pink and chum salmon were observed and collected at the site and invertebrates were sampled. Salmon gut content analysis revealed that the fish were likely foraging upriver and using Terminal 25 South as a migratory corridor. When compared to a nearby control site under the active Terminal 25 wharf to the north, the Terminal 25 South overwater removal site had higher relative abundances of both epibenthic and terrestrial invertebrates (Jeltzell et al. 2007).

Additional observations by Windward Environmental LLC (Windward) in 2013 show that the overwater removal site provides foraging habitat for killdeer, based on observations of both adult and juvenile killdeer at the site (Love 2013).

3.2.2 Future Habitat Restoration

Proposed future actions at Terminal 25 South will include restoration of intertidal and shallow subtidal habitat within and around the footprint of the old dock structure, in addition to fill removal from over 5 acres of adjacent uplands, to create off-channel emergent marsh and riparian habitat. Bull kelp will be introduced to a portion of the restored shallow and deep subtidal area on the project site. In total the site will include over nine acres of productive estuarine habitat .

Existing Conditions

Except for one small piece of pier decking that remains in the middle of the western shoreline of the dock footprint, the intertidal and subtidal areas of the Terminal 25 South Property have been daylighted. Rubble and riprap is present within the intertidal zone; in some areas, the riprap is covered by rockweed or bladderwrack. Approximately 950 creosote timber piles, associated connecting timbers, concrete supports and pipes and other debris associated with the former pier remain in both the intertidal and shallow subtidal zones.

Landward of the remnants of the old dock, Terminal 25 South contains paved and unpaved unvegetated uplands, with no above-ground structures present. The property is generally flat, with a slight downward slope toward the center of the property from both the northern and southern edges. Upland elevations range from +12 feet to +16 feet MLLW (City of Seattle 2012).

The unpaved upland area is landward of the former dock footprint, and consists of sand, gravel, and concrete rubble, which has been sparsely colonized by weedy herbaceous species. Much of this area is within the preliminary 100-year floodplain (FEMA 2013). The concrete bulkhead from the old dock is still present approximately 50 feet landward from the former dock footprint.

South of the former dock footprint, the shoreline juts to the west. The area landward of the shoreline on this part of the site is paved and outside of the preliminary mapped floodplain (FEMA 2013). The shoreline is steep and heavily reinforced with rip-rap. A portion of the uplands are are currently leased to WSDOT for construction material storage . A separate lease area at the south boundary of the site is used for truck parking. These leases will obviously be terminated prior to construction of the restoration project. .

Restoration Activities

The remaining creosote timber piling, connecting timbers, concrete decking, and associated structures within the footprint of the former dock will be removed according to methods outlined in Restoration Treatment #7, structure removal. Additionally, approximately 250 cubic yards of in-water rubble, rip-rap, debris, and abandoned material will be removed from intertidal and shallow subtidal areas.

The Terminal 25 South PORTfolio project site will include large-scale soil excavation to a distance approximately 260 to 400 feet landward from MHHW to achieve off-channel emergent marsh elevations of between +8 feet MLLW to +12 feet MLLW. The Port anticipates removing up to 60,000 cubic yards of previously filled upland soil to create the off-channel marsh (Restoration Treatment #5). The inlet and outlet of the off-channel habitat will be graded to +5 feet MLLW, while the middle of the off-channel area will be graded to a minimum elevation of +8 feet MLLW to prevent water retention and fish isolation during extreme low tides. A riparian buffer will line the landward margin of the site and be densely planted with native trees and shrubs. Riparian slopes near the inlet and outlet will be constructed according to Restoration Treatment #3.

A riparian berm, constructed according to Restoration Treatment #6, will extend along the current waterward margin of the site with wide channel openings at the north and south boundary. The berm will extend between +12 feet and +14 feet MLLW with a 3:1 riparian slope on both the landward and waterward sides. Off-channel habitat will extend from the berm landward at a 10:1 to 25:1 slope throughout the off-channel area. The on-channel slope will not exceed 6:1 and will gradually transition to the existing slope conditions of the East Waterway.

Post-Restoration Conditions

The Terminal 25 South PORTfolio project, including past and future restoration actions, will restore approximately 1.89 acres of riparian, 3.21 acres of off-channel marsh, 0.65 acres of enhanced intertidal gravel, and 0.60 acres of shallow subtidal habitat (see Appendix F-1). An

additional 2.86 acres of deep subtidal habitat will be improved as a result of adjacent restored habitats.

3.3 Ecological Value

The ecological value of the Terminal 25 South PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. The value of the project is enhanced by the presence of multiple types of habitat: subtidal, intertidal, marsh, and riparian. The off-channel habitat makes it particularly valuable, as off-channel and side channel habitat are virtually absent from the East Waterway, and because off-channel habitats provide valuable ecological functions for juvenile salmon (NOAA 2013). The value of the project is further enhanced by its relatively large size, which can incorporate more types of habitats, support a more diverse assemblage of species, and be more resilient to stressors and climate change (NOAA 2013). Its location near the mouth of the river also means that the project provides valuable transitional marine habitat in an area currently devoid of such habitat.

The Terminal 25 South PORTfolio project has been designed to maximize ecological value using the HEA model, as described below. For example, the proposed off-channel habitat is defined as estuarine marsh, which yields the model's highest habitat values. However, the final design will be developed through conversations with the Trustees in order to maximize ecological value in recognition of the location in the river. Potential project features unique to the marine influence of the site that are not yet adequately captured using the HEA model include unvegetated mudflat (currently lower in value than estuarine marsh) and enhancement of the shallow subtidal area with kelp, Canopy kelp forests are known to be among the most productive ecosystems in the world, yet the existing HEA model significantly undervalues any sort of shallow subtidal habitat.

3.3.1 HEA Valuation

The Terminal 25 South PORTfolio project will result in significant ecological lift. Table III-3 shows the amount of restored habitat that will be evaluated using the HEA model.

Table III-3. Restoration summary for the Terminal 25 South PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres	
Baseline Adjusted Intertidal	Fully Functioning Estuarine Marsh	0.21	
	Fully Functioning Intertidal	0.14	
	Riparian	0.01	
Baseline Adjusted Shallow Subtidal	Fully Functioning Intertidal	0.04	
	Fully Functioning Shallow Subtidal	0.31	
Baseline Adjusted Deep Subtidal	Fully Functioning Deep Subtidal	2.54	

Baseline Habitat Type	Restored Habitat Type	Acres	
Riprap	Fully Functioning Estuarine Marsh	0.17	
	Fully Functioning Intertidal	0.44	
	Fully Functioning Shallow Subtidal	0.29	
	Fully Functioning Deep Subtidal	0.32	
	Riparian	0.58	
Unvegetated Upland	Fully Functioning Estuarine Marsh	2.83	
	Fully Functioning Intertidal	0.03	
	Riparian	1.30	
	Total	**9.21**	

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

4 South Park

4.1 Site Overview and Background

4.1.1 Location and Project Overview

The South Park PORTfolio project is located on the west shoreline of the LDW at approximately River Mile 3.3 (see Figure III-3). The site is bordered by the LDW to the northeast and by 8th Avenue South to the Southeast. Both voluntary restoration and compensatory mitigation actions have taken place at the site, although only voluntary actions are included in the South Park PORTfolio project. Voluntary restoration actions include two separate past Port efforts: one at South Portland Street in 2008 and another at South Riverside Drive in 2015. Other than monitoring and maintenance of existing restored areas, no future restoration actions are planned at this site.

Figure III-3. South Park PORTfolio project location

4.1.2 Site History

The South Park PORTfolio project area encompasses upland and aquatic area property owned by the Port of Seattle, as well as City of Seattle rights-of-way at South Portland Street and South Riverside Drive (Port of Seattle 2012a). Prior to construction of the project, the Port-owned portion was unimproved and the City-owned rights-of-way were used for the storage of construction materials and vehicle parking. Local residents also used the area for water access and related recreational activities. In 2008, the Port constructed a public shoreline access site at the intersection of South Portland Street and 8th Avenue South as compensatory mitigation for construction of a cargo bridge connection between Terminal 25 and Terminal 30, which vacated submerged public right-of-way at South Forest Street in Slip 27. The public access site improvements included a 180-foot gravel pathway and play area with picnic tables and benches. A concrete stair boat launch connects the upland area to the LDW.

4.2 Restoration Actions

4.2.1 Past Habitat Restoration

The South Park PORTfolio project was implemented as two separate phases that addressed one continuous stretch of shoreline. The first phase, completed in 2008, included bankline restoration along the South Portland Street street-end as part of the public access site construction described above. This restoration was not necessary as part of the compensatory mitigation for public access, and was implemented voluntarily by the Port. This phase restored approximately 345 linear feet of shoreline by removing debris and fill material, regrading and softening the shoreline, and establishing native riparian and marsh vegetation.

The second phase included restoration at the South Riverside Drive street-end. This phase, completed in 2015, was a joint effort between the Port and the City of Seattle. Restoration actions included the removal of a derelict barge, excavation of the intertidal area, and planting of native marsh and riparian vegetation.

Together, these two projects restored and enhanced approximately 2.7 acres of subtidal, intertidal, marsh, and riparian habitats.

Baseline Conditions

For the purposes of ecological valuation, baseline conditions are considered to be the site conditions prior to both phases of past habitat restoration. These conditions are described as follows.

Prior to restoration, the site featured unvegetated uplands and a steep, eroding bankline covered by debris, riprap, and other fill material. The bankline toe-of-slope was between +5 and +7 feet MLLW, with riprap and rubble between +6 and +11 feet MLLW. The shoreline slope throughout the site was nearly vertical. Mud and sand substrates were present in the adjacent intertidal area. A derelict wooden barge was located on the northwestern shoreline adjacent to South Riverside Drive and covered approximately 0.03 acres of intertidal habitat. Neglected creosote piles were located in the intertidal area near South Portland Street. Concrete and riprap were present in the intertidal area throughout the site.

Upland areas ranged from approximately +13 to +15 feet MLLW (Port of Seattle 2012a), with the exception of a six-foot-high landscape mound, approximately 25 feet in diameter, near South Portland Street. A portion of the upland area was used for parking and materials storage, and an area featured a public bench that overlooked the riprap bankline near South Portland Street. The upland area featured a few small stands of vegetation, including approximately 20 big leaf maple and poplar trees and approximately 15 native and non-native shrubs. Grasses, invasive ivy, and Himalayan blackberry vines were present throughout the site, and invasive Japanese knotweed, Scotch broom, and common tansy were present in the South Riverside Drive portion of the site.

Restoration Activities: South Portland Street (2008)

The shoreline was excavated to remove 550 cubic yards of fill and debris from an elevation of +11.3 feet MLLW to top-of-bank at +14 feet MLLW. A total of 45 cubic yards of concrete and riprap and 25 derelict creosote piles were removed from an elevation of +8 feet to +11.3 feet MLLW. The upland area was cleared of all existing vegetation, with the exception of a native western red-cedar tree. The shoreline was reshaped to have a more gradual slope, between 2:1 and 3:1, to support riparian vegetation.

Once the shoreline had been excavated and regraded, several measures were taken to provide stabilization. Approximately 2,700 square feet of coir fabric was installed along the riparian slope. Coir logs were installed at the toe-of-slope, and large woody debris was placed along the shoreline for stabilization and habitat enhancement. A minimal amount of riprap was installed on either side of the concrete stair boat launch to provide stabilization.

Approximately 225 cubic yards of topsoil was placed in the riparian area to a minimum depth of 6 inches in order to prepare the site for planting. New plantings were mulched after installation. Soil, mulch, and coir materials at the reshaped shoreline were held in position by 950 native willow plant stakes. The entire 345-foot shoreline was planted with native vegetation, including 20 large replacement trees, 900 native shrubs, and 3,500 native groundcover plants. Emergent low marsh vegetation was planted between +11.4 feet and +12.5 feet MLLW. Emergent high marsh vegetation was planted between +12.5 feet and +13.5 feet MLLW.

Native riparian trees and shrubs were planted between +13 feet MLLW to top-of bank elevations. Native grasses and groundcovers were planted at +15 feet MLLW and above. A 650-foot-long irrigation system was installed to establish and sustain the native planting areas. The site is regularly maintained as part of the Port's marine maintenance program.

Restoration Activities: South Riverside Drive (2015)

A derelict wooden barge and approximately 0.06 acres of concrete, metal, and industrial debris were removed from the intertidal area. The shoreline was regraded from approximately +16 feet MLLW to between +11 feet and +13 feet MLLW in order to address shoreline erosion (Port of Seattle 2012a). In addition, the MHHW elevation contour was shifted landward by 15 feet in order to provide approximately 0.09 acres of intertidal habitat that would support marsh vegetation. The shoreline was stabilized using rock-filled gabions and shaped with vegetation planting tubes and pockets to form a terraced, vegetated bank edge. Large woody debris was anchored at the toe of the terraced gabion slope for stabilization and habitat enhancement. The upland area was excavated to between +13 feet and +14.5 feet MLLW to create a surface water collection/retention swale. Riparian and upland vegetation were planted in imported topsoil and covered in mulch after installation.

Approximately 0.05 acres of native marsh vegetation was planted in a five-to-10-foot-wide strip at an elevation of +11 feet to +13 feet MLLW. Approximately 180 linear feet of gabions along the

shoreline were planted with native riparian plants at an elevation of +11 feet to +14 feet MLLW. Plantings in the riparian and upland areas, approximately 0.19 acres, included native trees, shrubs, and groundcover.

Post-Restoration Conditions and Observation of Habitat Function

The South Park PORTfolio project restored and enhanced approximately 0.92 acres of deep subtidal, 0.56 acres of shallow subtidal, 0.71 acres of intertidal, 0.04 acres of high marsh, and 0.28 acres of riparian habitat.

Since restoration was conducted at South Portland Street in 2008, the diverse native riparian community and adjacent native marsh vegetation have continued to develop and mature. The coir fabric is degrading as the vegetation is becoming more established.

During field surveys conducted in 2013, a great blue heron and sparrows were observed in the intertidal area (Love 2013). An osprey nest was also observed on a construction-crane north of the site (Love 2013). Monitoring at the South Portland Street area was conducted for five years post-restoration to ensure that at least 80 percent of the vegetation survived.

4.3 Ecological Value

The ecological value of the South Park PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. The value of the project is enhanced by the presence of multiple types of habitat: subtidal, intertidal, marsh, and riparian. The South Park PORTfolio project also benefits from proximity to several other habitat areas within and outside of the river corridor. Nearby habitat can provide many benefits, such as facilitating wildlife movement, serving as a source of native seeds, and buffering restored habitat areas from disturbance. Nearby habitat areas include:

- The City of Seattle's Duwamish Waterway Park, located approximately 0.2 miles upstream on the western shoreline of the LDW. The site features landscaped areas and a natural beach;
- Restored intertidal, shallow subtidal, and riparian habitat at Slip 4, located across the LDW from the South Park PORTfolio project;
- Boeing's Plant Two off-channel habitat restoration project, located immediately upstream of and adjacent to Slip 4;
- The West Duwamish Greenbelt, located approximately 0.75 miles west of the project; and
- A complex of engineered wetlands and intertidal habitat surrounding the First Avenue South Bridge, located just over 0.5 miles northwest of the South Park PORTfolio project.

This complex was constructed by WSDOT in the 1990s as habitat mitigation and for stormwater control (SAIC 2012b).

4.3.1 Restoration Valuation

The South Park PORTfolio project has resulted in moderate ecological lift. Table III-5 shows the areas restored within each HEA habitat category.

Table III-5. Restoration summary for the South Park PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres	
Baseline Adjusted Intertidal	Baseline Adjusted Intertidal (no change)	0.24	
	Fully Functioning Intertidal	0.35	
Degraded Intertidal	Fully Functioning Intertidal	0.03	
Baseline Adjusted Shallow Subtidal	Baseline Adjusted Shallow Subtidal (no change)	0.27	
	Fully Functioning Shallow Subtidal	0.29	
Baseline Adjusted Deep Subtidal	Baseline Adjusted Deep Subtidal (no change)	0.45	
	Fully Functioning Deep Subtidal	0.47	
Riprap	Fully Functioning Estuarine Marsh	0.01	
	Baseline Adjusted Estuarine Marsh	0.01	
	Fully Functioning Intertidal	0.04	
	Baseline Adjusted Intertidal	0.05	
	Riparian	0.02	
	Riprap (no change)	0.01	
Unvegetated Upland	Fully Functioning Estuarine Marsh	0.01	
	Baseline Adjusted Estuarine Marsh	0.01	
	Riprap	0.01	
	Riparian	0.26	
	Unvegetated Upland (no change)	0.14	
	Total	**2.67**	

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

4.3.2 Restoration Cost Summary

Table III-6 shows an estimate of resources committed as part of the South Park PORTfolio project. All values have been converted to 2016 dollars using Consumer Price Index data from the US Department of Labor Bureau of Labor Statistics (2016). Based on the summary of resources committed, approximately 91% of the restoration value associated with the project should be attributed to the Port.

Table III-6. Summary of resources committed for the South Park PORTfolio project.

Project Component	Port Contribution	Non-Port Contribution
Direct costs, past	$627,827	$109,857
Direct costs, future	$50,000	--
Property value	$783,713	$112,361
Total	**$1,461,540**	**$222,218**

5 Turning Basin 3

5.1 Site Overview and Background

5.1.1 Location and Project Overview

The Turning Basin 3 PORTfolio project site is located along the west shoreline of the LDW at approximately River Mile 4.9. It is bordered by West Marginal Place South to the west, Dick's Towing Company and Shippers Transport Express to the south, and the LDW to the north and east (see Figure III-4). Both voluntary restoration and compensatory mitigation actions have taken place at the site, although only voluntary actions are included in the PORTfolio project. Other than monitoring and maintenance of existing restored areas, no future restoration actions are planned at this site.

Figure III-4. Turning Basin 3 PORTfolio project location.

5.1.2 Site History

Turning Basin 3 was historically used for the storage of construction equipment. In 1999, the Port constructed a 1.3-acre fish and wildlife habitat restoration site in the southern inlet and northern bay of the site. The action served as compensatory mitigation for aquatic area lost due to lengthening of the Terminal 5 container cargo pier, an element of the Terminal 5 Redevelopment Project. The compensatory mitigation included the removal of a derelict ferry in the southern inlet, daylighting approximately 0.28 acres of intertidal area. The bankline in the northern bay was excavated, regraded, and planted with native vegetation, restoring approximately 1.60 acres.

5.2 Restoration Actions

5.2.1 Past Habitat Restoration

Prior to the compensatory mitigation project at Turning Basin 3, the Port constructed a pilot habitat restoration effort in 1996 to test the success of various restoration techniques that were to be implemented in the compensatory mitigation effort. This pilot effort, described here as the

Turning Basin 3 PORTfolio project, was located between the two mitigation sites, encompassing the site's small peninsula. The action involved the removal of two derelict barges, intertidal debris, and fill material. Excavated and regraded areas were subsequently planted with native vegetation. The project restored approximately 0.57 acres of fish and wildlife habitat.

Baseline Conditions

For the purposes of ecological valuation of the PORTfolio project, baseline conditions are considered to be the site conditions prior the past habitat restoration. These conditions are described as follows.

Prior to voluntary restoration actions, the PORTfolio project area featured deep subtidal (0.1 acres), shallow subtidal (0.6 acres), intertidal (1.7 acres), low marsh (0.2 acres), and unvegetated upland (0.8 acres) habitat. Two derelict barges and a significant amount of fill material were also located in the intertidal zone. Located near the center of the site, the barges overlapped the waterward margin of emergent vegetation at an elevation of approximately +8.5 feet MLLW. A grounded wood and steel ferry boat hull and wreckage from the ferry were also present in the intertidal channel adjacent to and southeast border of the PORTfolio project area; this vessel was removed by the Port as part of a compensatory mitigation project.

The upland area in the southwest portion of the PORTfolio project area had been filled, and as a result of continuous disturbance from equipment storage, the shoreline and upland areas supported little vegetation other than herbaceous plants, invasive Himalayan blackberry, and Scotch broom. The substrate was composed of dredged fill material, overlaid with imported sandy fill material and a thin covering of upland soil.

Restoration Activities

Derelict barges (covering an area of 0.11 acres) and wreckage from the ferry (covering an area of 0.03 acres) were removed from the site. Of the 3,200 tons of fill material removed, approximately 2,100 cubic yards were landward of +11.3 feet MLLW (upland) and approximately 1,062 cubic yards were waterward of +11.3 feet MLLW (aquatic). The existing upland elevations of +12 feet to +15 feet MLLW were regraded to create intertidal elevations of +4 feet to +11 feet MLLW. The shoreline was lengthened by 105 feet (from approximately 205 to 310 feet), and a more complex and crenulated border was created. At the toe of the excavated slope, approximately 75 cubic yards of riprap were placed in a 1.5-foot-deep excavated trench, providing a foundation for the bankline landward of +10 feet MLLW. The riprap was covered with crushed rock flush to the surface of the excavated slope. At the landward edge of the PORTfolio project area, a drainage berm was installed, and a drainage pipe was buried below the berm.

The intertidal area was planted with existing native and emergent marsh vegetation that had been uprooted and stored during excavation. Excavated side slopes between +6 feet to +10 feet

MLLW were planted with native riparian shrubs and trees. Hydroseeding was also used to stabilize the slopes immediately following excavation.

The riparian area (+11 feet to +15 feet MLLW) was planted with native shrubs. Shrubs were planted three to five feet apart, with bearberry cotoneaster and rockspray cotoneaster groundcover planted between the shrubs. The upland area (landward of +16 feet MLLW) was planted with native trees and shrubs. The project area from an elevation of +11 feet MLLW to the landward edge of the construction was also seeded with a mixture of rye grass and clover. The seed mixtures were applied in the drainage berm area, as well as in the areas planted with trees, shrubs, and groundcover.

A floating boom attached to seven wooden piles was installed approximately 70 feet waterward of the site to protect the restored area from floating debris and to reduce interference from tribal fishing. Protective fences were also placed in the intertidal area to prevent initial grazing by Canada geese, allowing for the establishment of marsh vegetation. A gate, path, and fencing were installed to allow access by the Port for construction and maintenance purposes. Post-restoration maintenance included irrigation three times a week during the summer months from 1996 to 1999. The fencing, gate, and path were removed as part of the compensatory restoration effort in 1999.

Post-Restoration Conditions and Observation of Habitat Function

The Turning Basin 3 PORTfolio project restored and enhanced approximately 0.09 acres of deep subtidal, 0.52 acres of shallow subtidal, 1.92 acres of intertidal, 0.41 acres of marsh, and 0.64 acres of riparian habitat.

Since restoration was conducted in 1996, habitat has continued to develop and mature. The exposed mudflats extend from the marsh edge and are colonized in places by duckweed. The crushed rock placed over the installed riprap at the toe of the excavated slope is completely covered by sediment. The emergent marsh vegetation surrounding the intertidal mudflat habitat is dense. Scrub-shrub vegetation in the high marsh habitat consists of native shrubs and invasive Himalayan blackberry. The riparian area (adjacent to the marsh) is vegetated with trees and shrubs. During field surveys conducted in 2013, several observations of wildlife use were made at the habitat initiative site. These included a wren in marsh vegetation, shorebird prints, a heron in the mudflat habitat, and a beaver-gnawed sapling stump in the riparian habitat (Love 2013).

Habitat function and wildlife use in the vicinity of Turning Basin 3 have been documented in two biomonitoring studies (Cordell et al. 2001; Ruggerone et al. 2006). Both of these studies addressed improvements that resulted from the restoration, as well as adjacent habitat restoration efforts. Given the age of these monitoring studies and the fact that additional restoration has been conducted in the area, it is assumed that the sites have matured and the level of function provided has increased.

Between 1993 and 1999, biological monitoring was conducted at Duwamish River Coastal America restoration and reference sites (Cordell et al. 2001); this study included both the Project area and the adjacent Port compensatory mitigation sites. The purpose of the study was to evaluate salmonid habitat quality as determined by sediment grain size, vegetation, avifauna, the presence of benthic invertebrates and insects, and juvenile salmon diets.

Benthic invertebrate densities within the habitat initiative site trended upward from 1993 to 1999 (Cordell et al. 2001). Insect larvae, worms, and benthic crustaceans are an important part of the diets of juvenile salmon in the LDW. In the intertidal area, seven to nine benthic macroinvertebrate species were observed (including oligochaete worms, *Manayunkia aesturina* [a polychaete worm], the crustacean *Cumella vulgaris*, and chironomid larvae). Within vegetated areas, 13 to 15 macroinvertebrate species (depending on the month) were identified (including dipteran [fly] larvae, aphids, psyllids [jumping plant lice], and other hemipterans [true bugs]).

The stomach contents of juvenile chum collected near the restored area appeared to be more diverse over time. In 1996, the diets of the juvenile chum consisted primarily of harpacticoid copepods (Cordell et al. 2001). In spring and summer 1997, adult flies, amphipods, and aphids made up a large portion of the juvenile chum salmon diets. In late winter and early spring 1999, juvenile chum salmon had diets consisting primarily of adult insects, fly larvae, harpacticoid copepods, and plankton.

The Port restoration sites at Turning Basin 3 (both voluntary and compensatory) were also found to have the highest proportion of native bird species, as compared with other sites included in the study, and mean avian abundance increased slightly over the years of the study (Cordell et al. 2001). Birds were often observed foraging at both the habitat initiative and compensatory mitigation restoration sites.

In 2005, a study of juvenile Chinook salmon habitat use, abundance, diet, growth, and migration timing were conducted for LDW restoration sites, including Turning Basin 3 (Ruggerone et al. 2006). Juvenile Chinook salmon abundance was reported to be significantly higher at Turning Basin 3 (up to approximately 95 fish/acre), compared with an adjacent unrestored reference site. Chum salmon abundance at Turning Basin 3 was as high as approximately 300 fish/acre in March 2005, and coho abundance was approximately 30 fish/acre in May 2005. Other fish species captured at the site included shiner perch, sculpin, starry flounder and threespine stickleback. Fish taxa richness was higher at Turning Basin 3 than at the reference site. The consumption of prey by juvenile Chinook salmon was also greater at Turning Basin 3 than at the other two study sites evaluated (Hamm Creek and Herring's House restoration sites), suggesting greater prey availability and/or greater feeding activity at Turning Basin 3 (Ruggerone et al. 2006). Prey included oligochaete and polychaete worms, flies, chironomids (non-biting midges), and other species (Ruggerone et al. 2006).

Ruggerone et al. (2006) suggested that the location and layout of Turning Basin 3 might be one of the reasons for the presence of higher numbers of juvenile Chinook salmon. The relatively

large unobstructed opening between the off-channel habitat and the river makes the site more easily accessible as compared with other off-channel restoration sites in the LDW. In addition, because the turning basin is located in the "transition zone" of the Duwamish River (the area where marine and fresh water meet), it was suggested that juvenile salmon residence time may be greater in this location.

5.3 Ecological Value

The ecological value of the Turning Basin 3 PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. The project created a relatively flat, fine-grained intertidal area that provides habitat for emergent vegetation and invertebrates that are important to juvenile salmon, other fish, and birds. The ecological value of the project is enhanced by the presence of multiple habitat types, including subtidal, intertidal mudflat, high and low marsh, and riparian habitats.

5.3.1 Restoration Valuation

The Turning Basin 3 PORTfolio project resulted in significant ecological lift. Table III-7 shows the area restored in each HEA habitat category.

Table III-7. Restoration summary for the Turning Basin 3 PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres
Baseline Adjusted Estuarine Marsh	Fully Functioning Estuarine Marsh	0.03
	Fully Functioning Intertidal	0.08
	Riparian	0.04
Baseline Adjusted Intertidal	Fully Functioning Estuarine Marsh	0.16
	Fully Functioning Intertidal	1.56
	Fully Functioning Shallow Subtidal	0.01
	Riparian	0.02
Degraded Intertidal	Fully Functioning Estuarine Marsh	0.03
	Fully Functioning Intertidal	0.08
	Riparian	0.02
Baseline Adjusted Shallow Subtidal	Fully Functioning Intertidal	0.15
	Fully Functioning Shallow Subtidal	0.51
Baseline Adjusted Deep Subtidal	Fully Functioning Deep Subtidal	0.09
Unvegetated Upland	Fully Functioning Estuarine Marsh	0.19
	Fully Functioning Intertidal	0.05
	Riparian	0.56

Baseline Habitat Type	Restored Habitat Type	Acres
	Total	**3.58**

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

5.3.2 Restoration Cost Summary

Table III-8 shows an estimate of resources committed as part of the Turning Basin 3 PORTfolio project. All values have been converted to 2016 dollars using Consumer Price Index data from the US Department of Labor Bureau of Labor Statistics (2016). Based on the summary of resources committed, approximately 93% of the project's restoration value should be attributed to the Port.

Table III-8. Summary of resources committed for the Turning Basin 3 PORTfolio project.

Project Component	Port Contribution	Non-Port Contribution
Direct costs, past	$206,925	$251,508
Direct costs, future	$25,000	--
Property value	$3,679,680	--
Total	**$3,911,605**	**$251,508**

6 Terminal 5 North

6.1 Site Overview and Background

6.1.1 Location and Project Overview

The Terminal 5 North PORTfolio project area is located on the north shoreline of Terminal 5, adjacent to Elliott Bay (see Figure III-5). The western portion of the PORTfolio project area overlaps with a portion of the Jack Block Park, a 15-acre park that features a 45-foot-high observation tower, walking path along the shoreline, walkable pier, play area, and other public access amenities (Port of Seattle 2012b). To the south, the PORTfolio project area is bordered by Terminal 5, which is the Port's largest container terminal (approximately 330 acres) and features three berths with a combined total of 2,900 feet of dock (Port of Seattle 2012c). The Terminal 5 North PORTfolio project would include restoration of approximately 850 linear feet of shoreline.

Figure III-5. Terminal 5 North PORTfolio project location

6.1.2 Site History

The eastern portion of Terminal 5 was created through early dredge disposal activities. Prior to being filled, the eastern portion of Terminal 5 was flanked by water on both sides. The waterway on the west side received water from the West Seattle drainage creek and tidewater from Elliott Bay. The water on the east side was primarily Elliott Bay tidewater. The area to the west was later filled using dredge spoils to expand Terminal 5 to its present-day configuration (Port of Seattle 2012c). Prior to that, the north end of the site included the Wyckoff/PSR wood treatment (creosote) plant; Nettleton Lumber's sawmill; radio/television towers on property owned by KOMO; and Lockheed shipbuilding operations.

6.2 Restoration Actions

6.2.1 Past Habitat Restoration

Past habitat restoration actions at the north end of Terminal 5 include planting of riparian vegetation at the northeast corner . The two planted areas include the area immediately adjacent to the Lockheed pebble beach – the western portion of this riparian area extends into Jack Block Park; and the riprap shoreline at the eastern edge of the PORTfolio project area. In total, past habitat restoration actions, done completely as voluntary initiatives, restored approximately 1.2 acres of riparian habitat. Because the riparian work was not subject to maintenance and monitoring requirements, ruderal and invasive species have outcompeted the native vegetation.

Baseline Conditions

For the purposes of ecological valuation , baseline conditions at Terminal 5 North are considered to be the site conditions as they exist currently, i.e. the Port is not considering past habitat restoration actions. Current conditions are described as follows.

The PORTfolio project area currently features a combination of unvegetated upland, riprap, intertidal, shallow subtidal, and deep subtidal areas. Very little native vegetation i is present along the shoreline (Blomberg 2012a) or in the upland area.

East of the pebble beach, two piers (Piers 25 and 26) extend from the shoreline and cover a combined area of approximately 0.3 acres of degraded intertidal and subtidal habitat. An abandoned shipway lies between Piers 25 and 26, withing a very dense field of derelict creosote-treated piling. The shoreline from the east edge of the pebble beach all the way to the northeast corner of Terminal 5 is heavily armored by sections of concrete, steel and rip-rap bulkheads. .

Restoration Activities

Jack Block Park opened in 1998 as part of the Southwest Harbor Cleanup and Redevelopment Project. From 1999 to 2004, the riparian habitat in the portion of Jack Block Park within the PORTfolio project area was planted with native vegetation. Native trees, shrubs, and groundcover species were planted. A mix of native and ornamental plants were installed in areas outside of the PORTfolio project area.

Riparian planting at the eastern edge of the PORTfolio project area occurred from 1999 to 2004 following removal of approximately 3.3 acres of overwater cover removal (outside of the PORTfolio project area). Soil was imported from offsite in preparation for the planting of riparian vegetation. Native trees, shrubs, and groundcover species were planted. Geotextile fabric was installed for erosion control, and logs were used to stabilize the top of the waterward bank.

Observation of Habitat Function

Harbor seal pups and river otter have been observed using the pebble beach area immediately adjacent to the restored riparian area as a haul-out. Purple martin use nesting gourds placed on the remaining piers (Blomberg 2012a). Intertidal and subtidal habitats were not improved as part of past restoration actions, and remain degraded.

6.2.2 Future Habitat Restoration

Future habitat restoration at the PORTfolio project site is scalable. The site includes significant overwater cover, derelict piling, shoreline armoring and degraded riparian areas. The full-scale project would have the potential to restore approximately 850 linear feet of shoreline and several acres of intertidal, shallow subtidal and deep subtidal habitat.

Existing Conditions

Vegetation has become well established within Jack Block Park. This includes a diverse mix of native and non-native trees, shrubs, and groundcover. A few invasive species have also become established in these areas.

The vegetation in the riparian zone at the eastern edge of the PORTfolio project site consists of native trees, shrubs, and groundcover. Invasive species, such as Himalayan blackberry, Scotch broom, common tansy, and butterfly bush have become established and appear to be outcompeting native species.

Restoration Activities

A full-scale project at Terminal 5 North would remove all remaining in-water structures from Piers 25 and 26 and the abandoned shipway, including approximately 4,000 creosote piles and 0.3 acres of decking, according to Restoration Treatment #7. An 18-inch radius around each removed pile would be filled with a clean sand coverto enhance the intertidal substrate. The bulkhead present along the southeast corner of the pebble beach (adjacent to Pier 26 and the shipway) would be removed. A portion of the upland area behind the bulkhead would be excavated and regraded to intertidal elevations, and the pebble beach would be extended into the intertidal area currently occupied by the abandoned shipway. This area would be restored according to Restoration Treatment #2. The existing top-of-bank adjacent to the pebble beach would be planted with dense riparian vegetation according to Restoration Treatment #1, and invasive species removed. Additional planting would take place in the eastern portion of Jack Block Park that overlaps the project site, also according to Restoration Treatment #1.

Post-Restoration Conditions

The PORTfolio project, including past and future restoration actions, would create a connected riparian, intertidal and subtidal corridor in Southeast Elliott Bay

6.3 Ecological Value

The ecological value of the Terminal 5 North PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. The value of the project is enhanced by the presence of multiple types of habitat: subtidal, intertidal, and riparian. The site features one of the few natural beach areas on Elliott Bay that is restricted from public access (Blomberg 2012a); this provides unique value to wildlife species, including harbor seals. Additionally, as noted above, wave action has naturally sorted sediments at the existing pebble beach, such that the upper intertidal substrate consists of sand, small broken shells, and fine gravels, consistent with preferred spawning substrate for sand lance and surf smelt. Extension of the intertidal area to the east, combined with riparian enhancement to generate forest cover could substantially improve the site's potential to support forage fish spawning habitat..

6.3.1 Restoration Valuation

The Terminal 5 North PORTfolio project would result in significant ecological lift. Table III-9 shows the base number of dSAYs attributed to each type of habitat conversion in a sample small-scale project. Note that the project could be scaled up to include additional riparian, intertidal, and subtidal restoration,

Table III-9. dSAY summary for the Terminal 5 North PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres	
Baseline Adjusted Intertidal	Fully Functioning Intertidal	1.05	
Degraded Intertidal	Fully Functioning Intertidal	0.64	
	Riparian	0.06	
Baseline Adjusted Shallow Subtidal	Fully Functioning Shallow Subtidal	0.32	
Degraded Shallow Subtidal	Fully Functioning Intertidal	0.01	
	Fully Functioning Shallow Subtidal	0.14	
Baseline Adjusted Deep Subtidal	Fully Functioning Shallow Subtidal	0.001	
	Fully Functioning Deep Subtidal	0.32	
Degraded Deep Subtidal	Fully Functioning Shallow Subtidal	0.01	
	Fully Functioning Deep Subtidal	0.02	
Riprap	Fully Functioning Intertidal	0.05	
	Riparian	0.002	
Unvegetated Upland	Fully Functioning Intertidal	0.20	
	Riparian	1.09	
	Total	**3.91**	

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

7 Terminal 18

7.1 Site Overview and Background

7.1.1 Location and Project Overview

The Terminal 18 PORTfolio project is located on the southwest shoreline of Harbor Island at the mouth of the LDR, approximately 350 feet north of the Southwest Spokane Street Bridge (see Figure III-6). The site is bordered by 16th Avenue Southwest to the east and the LDW to the west. The PORTfolio project includes restoration of approximately 380 linear feet of shoreline.

Figure III-6. Terminal 18 Project location.

7.1.2 Site History

The Terminal 18 property includes three previously separate properties: Terminal 18, Pier 19, and Terminal 20. Prior to its purchase by the Port in the early 1940s, the southern portion of Terminal 18 was owned and operated by the East Waterway Dock & Warehouse Company. The Port initially used the land for warehousing and shipping offices, fishmeal manufacturing, ship fitting, barge transport, and oil storage. Pier 19 was operated by Shell Oil beginning around 1930. The Port purchased the property in the mid-1970s and filled the north end using the dredge spoils from the East and West Waterways to create the north end of the existing Terminal 18 facility. The Port acquired Terminal 20 in 1964. In 1982, Terminal 18, Pier 19, and Terminal 20 were combined to form the existing Terminal 18 property, which has handled both break-bulk and container cargo since the early 1980s. Terminal 18 encompasses 196 acres and has 4,400 feet of apron; until Terminal 5 was developed, Terminal 18 was the Port's largest container terminal.

Terminal 18 underwent significant redevelopment between 1998 and 2001. Improvements included the expansion of the container cargo marshalling area, enhancements to the intermodal rail facilities, and improved rail and truck access that ultimately increased container shipping capacity and efficiency. As a result of the development, the Port and Fisher Mill's cooperatively constructed a public access site along the southwest shoreline of Harbor Island.

The 1.1-acre public access area featured shoreline access, paths, three picnic shelters, a hand-carried boat launch, native landscaping, and on-site parking. This public access site is the site of the Terminal 18 PORTfolio project.

7.2 Restoration Actions

7.2.1 Past Habitat Restoration

Past habitat restoration at the site was completed in 2002 and included the construction of a 0.2-acre riparian buffer along the shoreline. The restoration effort was part of the public access improvements and represented one of the first restored habitats along the West Waterway.

Baseline Conditions

For the purposes of ecological valuation of the PORTfolio project, baseline conditions at Terminal 18 are considered to be the site conditions prior to past habitat restoration actions. These conditions are described as follows.

Prior to the implementation of the 2002 restoration action, the upland areas surrounding the picnic shelters (west of the paved walkway) were covered by gravel and a small building. The existing man-made shoreline was rocky and had a low bank. The site had an urban industrial land use designation. The upland areas comprise four parcels, two of which are owned by the Port. The other two are owned by King County and the City of Seattle.

Restoration Activities

The 2002 restoration action involved clearing and grading the area and making drainage improvements. Public access improvements included the construction of 600 feet of concrete walkways, three picnic shelters, a drinking fountain, stairs to the shoreline, a boat launch ramp for hand-carried and car-top boats, and a parking lot for 12 vehicles. In addition, approximately 3,300 cubic yards of sand fill were imported to prepare the site for planting, and an irrigation system was installed.

Native grass (American dune grass) was planted close to the shoreline in the central portion of the PORTfolio project area. Native western red-cedars and shore pines were planted at the northern and southern ends of the site; two staghorn sumacs were also planted at the southern end of the site. Ornamental shrubs and native groundcover were planted around the trees at the northern and southern ends of the site. The area is regularly maintained as part of the Port's marine maintenance program for public access parks.

Observation of Habitat Function

No monitoring studies of the 2002 riparian restoration area have been conducted.

7.2.2 Future Habitat Restoration

Future habitat restoration at the PORTfolio project site would involve the relocation of three picnic shelters and excavation of the existing shoreline. The bankline would be drawn back and regraded to create a riparian slope with adjacent emergent marsh habitat. The project would also include modifications to the public access site as a result of the new shoreline and picnic shelter relocation.

Existing Conditions

Since restoration in 2002, the riparian habitat at Terminal 18 has continued to develop and mature, and the vegetation has become established and stable. While several native species are present, non-native invasive species such as Himalayan blackberry dominate most of the PORTfolio project site. Litter and other anthropogenic debris are also present throughout the uplands. The riparian area (elevation of between +11 feet and +16 feet MLLW) is continuous along the entire project shoreline, but it is separated from the intertidal area by a steep 2:1 riprap slope. The boat launch is steep and does not provide easy access to the water.

Restoration Activities

The T18 project concept includes that approximately 380 linear feet of existing bankline would be excavated, removing the riprap shoreline, and regraded according to Restoration Treatment #3. Prior to excavation, the three picnic shelters would be relocated landward approximately 50 feet and placed over the existing paved walkway. Due to the presence of upland parking and other paved areas, excavation along the southern 70 feet of shoreline may need to be limited. As a result, Restoration Treatment #2, sloped riparian, may be executed as it involves less excavation and does not include adjacent emergent marsh habitat. Riprap would be removed and the slope planted with dense riparian vegetation. The remaining 310 linear feet of shoreline would also be planted with dense riparian vegetation and emergent marsh species at appropriate elevations. Sections of paved walkway that currently overlap with the proposed excavation zone would be removed. The continuous northwest-southeast walkway would remain and connect all three picnic shelters to the upland parking area.

Post-Restoration Conditions

The PORTfolio project, including past and future restoration actions, would create a connected riparian and marsh corridor in the West Waterway comprising approximately 0.17 acres of riparian, 0.30 acres of marsh, 0.34 acres of intertidal, 0.26 acres of shallow subtidal, and 1.44 acres of deep subtidal habitat. Overall, the Terminal 18 PORTfolio project would restore approximately 380 linear feet of shoreline.

7.3 Ecological Value

The ecological value of the Terminal 18 PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. The ecological value is enhanced by the presence of multiple types of habitat:

subtidal, intertidal, marsh, and riparian. Its location near the mouth of the LDR means that the project provides valuable transitional marine habitat in an area currently devoid of such habitat. The project also benefits from its proximity to the Terminal 5 Southeast PORTfolio project (see Chapter 8), located across the waterway; and to the Bluefield Site #1 and Site #2 projects.

7.3.1 Restoration Valuation

The Terminal 18 PORTfolio project would result in significant ecological lift on and around the site. . Table III-11 shows the restoration areas by HEA habitat category.

Table III-11. Restoration summary for the Terminal 18 PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres	
Baseline Adjusted Intertidal	Fully Functioning Estuarine Marsh	0.002	
	Fully Functioning Intertidal	0.30	
	Riparian	0.03	
Baseline Adjusted Shallow Subtidal	Fully Functioning Shallow Subtidal	0.26	
Baseline Adjusted Deep Subtidal	Fully Functioning Deep Subtidal	1.44	
Riprap	Fully Functioning Estuarine Marsh	0.23	
	Fully Functioning Intertidal	0.04	
	Riparian	0.02	
Unvegetated Upland	Fully Functioning Estuarine Marsh	0.07	
	Riparian	0.12	
	Total	**2.51**	

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the Terminal 18 PORTfolio project.

8 Terminal 5 Southeast

8.1 Site Overview and Background

8.1.1 Location and Project Overview

The Terminal 5 Southeast PORTfolio project is located in the unnamed section of waterway between the West Waterway and the Lower Duwamish River, approximately 115 feet north of the Southwest Spokane Street Bridge (see Figure III-7). The PORTfolio project would restore approximately 140 linear feet of existing shoreline.

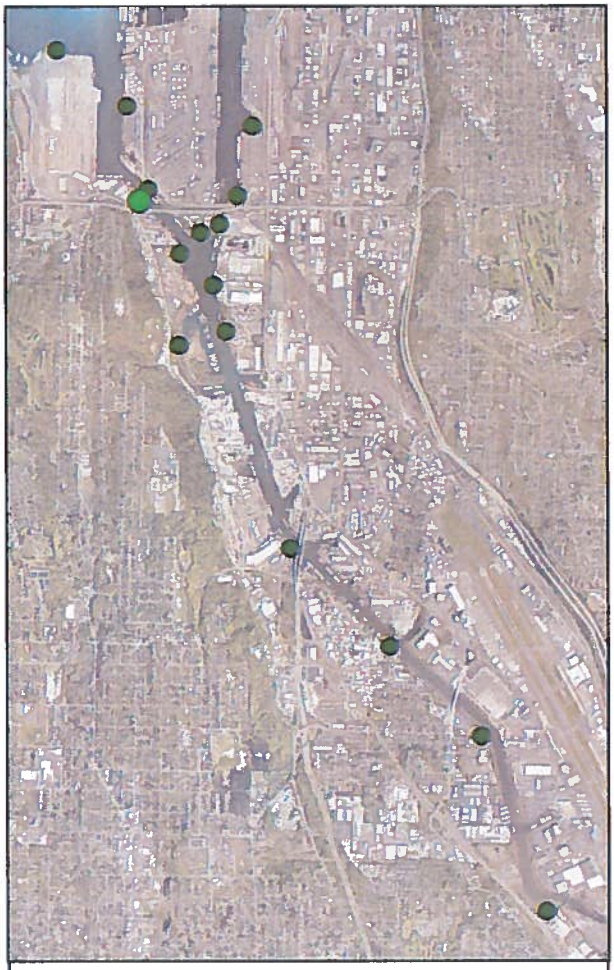

Figure III-7. Terminal 5 Southeast Project location

8.1.2 Site History

Prior to Port ownership, Terminal 5 Southeast was originally built and operated as a small marina. A two-story building with an approximately 0.07-acre footprint was constructed in 1976 and used as the marina office. The building is located in the southeast corner of the PORTfolio project area. The site also features 0.58 acres of asphalt paving and gravel used for parking, boat storage, and roadways. Quinn's Boat House, a boat house for lease, and an associated T-dock were built in 1985.

8.2 Restoration Actions

8.2.1 Past Habitat Restoration

Past habitat restoration actions at Terminal 5 Southeast include approximately 0.5 acres of overwater cover removal.

Baseline Conditions

For the purposes of ecological valuation of the Terminal 5 Southeast PORTfolio project, baseline conditions at Terminal 5 Southeast are considered to be the site conditions prior to past habitat restoration actions. These conditions are described as follows.

Prior to the overwater cover removal actions, approximately 402 linear feet of floating docks (covering an area of 0.06 acres), a travel lift or boat hoist, and a double gangway connection to moorage floats were present in the intertidal and subtidal areas of the PORTfolio project area. The floating docks and travel lift were held in place with 11 single creosote guide piles, one steel

guide pile, and two three-pile moorage dolphins. Marine vessels were tied off on all sides of the dock, sometimes two or three deep. The frequent presence of marine vessels tied to the dock increased the area shaded by the dock structure. By late 2005, storms had damaged the piles, moorage dolphins, gangways, and approximately half of the floating docks in the marina. The damaged structures were no longer safe for use and were a hazard to navigation.

Restoration Activities

The overwater cover removal at the PORTfolio project site was implemented in 2007. Approximately 0.06 acres of overwater structures were removed, including the floating T-dock, guide piles, moorage dolphins, travel lift, and gangway. A total of 17 piles were also removed, including seven single creosote guide piles, two three-pile moorage dolphins, and four piles northwest of gangway). The steel guide was not removed and remains in place. The EPA expressed concern that sand caps would interfere with future sediment sampling; consequently, sand caps were not used to cover pile holes following extraction. Approximately 0.05 acres of subtidal and intertidal habitat was daylighted by the removal of the wooden T-dock.

Observation of Habitat Function

No monitoring studies of the 2007 restoration area have been conducted. However, deep subtidal, shallow subtidal, and intertidal habitats areas adjacent to the PORTfolio project area are now unobstructed and exposed to daylight, presumably improving their overall habitat function.

8.2.2 Future Habitat Restoration

Future habitat restoration actions at Terminal 5 Southeast would include excavation of approximately 0.38 acres of uplands to create an off-channel marsh with a landward riparian buffer.

Existing Conditions

A bulkhead made of wooden piles and blocks of concrete spans the upper portion of the shoreline. The lower, intertidal portion of the shoreline features patches of riprap and other debris. Shoreline vegetation includes Pacific madrone, Himalayan blackberry, foxglove, various grasses, and other herbaceous species. An abandoned shipway to the north contains exposed mudflat scattered with riprap, concrete, and other debris. A stormwater outfall discharges at the central shoreline, just north of the building which extends over the water at the south end of the site.

A fence lines the top-of-bank, separating the shoreline from upland activities. Upland areas are mostly paved and used for parking, except a small area to the north (adjacent to the abandoned shipway) that is covered with grass and used as a picnic area.

Restoration Activities

All remaining structures within the PORTfolio project area would be demolished prior to restoration actions. Approximately 140 linear feet of existing shoreline would be excavated, drawing back the shoreline between approximately 50 and 80 feet to create a large off-channel marsh habitat according to Restoration Treatment #5. The marsh would be bordered by a landward sloped riparian buffer, vegetated with dense riparian plantings. Emergent marsh habitat would also be planted with emergent species. The off-channel marsh would extend to on-channel marsh and gradually transition to exposed unvegetated mudflat.

Post-Restoration Conditions

The Terminal 5 Southeast PORTfolio project, including past and future restoration actions, will create a connected riparian and marsh corridor in the West Waterway comprising approximately 0.13 acres of riparian, 0.25 acres of marsh, 0.32 acres of intertidal, 0.13 acres of shallow subtidal, and 0.75 acres of deep subtidal habitat. Overall, the PORTfolio project will restore approximately 310 linear feet of shoreline.

8.3 Ecological Value

The ecological value of the Terminal 5 Southeast PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. The ecological value is enhanced by the presence of multiple types of habitat: subtidal, intertidal, marsh, and riparian. The off-channel habitat makes it particularly valuable, as off-channel and side channel habitat are especially rare and significant in the LDR (NOAA 2013). Its location in the West Waterway near the mouth of the LDR will provide valuable transitional marine habitat in an area devoid of such habitat. The project also benefits from its proximity to the Terminal 18 PORTfolio project (see Chapter 6, above), located across the waterway; and to a habitat restoration project immediately south of the PORTfolio project, constructed by Bluefield Holdings.

8.3.1 Restoration Valuation

The Terminal 5 Southeast project would result in significant ecological lift. Table III-13 shows the restoration areas by HEA category

Table III-13. Restoration summary for the Terminal 5 Southeast PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres	
Baseline Adjusted Intertidal	Fully Functioning Estuarine Marsh	0.03	
	Fully Functioning Intertidal	0.21	
	Riparian	0.003	
Degraded Intertidal	Fully Functioning Intertidal	0.01	
Baseline Adjusted Shallow Subtidal	Fully Functioning Shallow Subtidal	0.09	

Baseline Habitat Type	Restored Habitat Type	Acres	
Degraded Shallow Subtidal	Fully Functioning Shallow Subtidal	0.04	
Baseline Adjusted Deep Subtidal	Fully Functioning Deep Subtidal	0.75	
Degraded Deep Subtidal	Fully Functioning Deep Subtidal	0.004	
Riprap	Fully Functioning Estuarine Marsh	0.03	
	Fully Functioning Intertidal	0.09	
	Riparian	0.01	
Unvegetated Upland	Fully Functioning Estuarine Marsh	0.19	
	Fully Functioning Intertidal	0.01	
	Riparian	0.12	
	Total	**1.59**	

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

9 Terminal 104

9.1 Site Overview and Background

9.1.1 Location and Project Overview

The Terminal 104 PORTfolio project is located on the east shoreline of the LDW, north of River Mile 0.0 (see Figure III-8). The site is bordered by the South Spokane Street Bridge to the north, Terminal 104 to the east, and the LDW to the west. The Terminal 104 PORTfolio project includes restoration on approximately 630 linear feet of shoreline.

Figure III-8. Terminal 104 Project location.

9.1.2 Site History

The Port acquired Terminal 104 in the late 1960s as part of the Lower Duwamish Industrial Development District and then developed a container freight station on the western portion of the terminal in the early 1970s. Terminal 104 was also used as transload facility and cement manufacturing plant, with a transload dock located on the southwest corner of the property. Terminal 104 served as the headquarters for the Port's overland common point and distribution services. A rail and vehicle corridor over the East Waterway was located adjacent to the site to the north.

9.2 Restoration Actions

9.2.1 Past Habitat Restoration

Past habitat restoration at Terminal 104 was completed in 1989 by the Port and the Muckleshoot Tribe as an intertidal fisheries enhancement project. Past restoration actions encompass approximately 0.1 acres of intertidal habitat and approximately 500 linear feet of shoreline.

Baseline Conditions

For the purposes of ecological valuation of the PORTfolio project, baseline conditions at Terminal 104 are considered to be the site conditions prior to past habitat restoration actions. These conditions are described as follows.

Prior to the implementation of the 1989 restoration action, the intertidal area featured a relatively steep 2:1 riprap-covered slope, with a substrate composed primarily of cobble and debris fill. The intertidal area included some sparse growth of small algae species. The shoreline immediately adjacent to and east of the PORTfolio project area at one time featured a marine cargo terminal.

Restoration Activities

Two flat-gradient intertidal mudflat benches were constructed by cutting into the shoreline bank above the intertidal area, placing structural barriers (approximately four feet in height and 20 to 30 feet in length and held in place with wooden piles) parallel to the existing slope contour, and filling the area shoreward of the barriers with select sediment. The southern bench was 97.5 feet in length and constructed at an elevation of +2 feet MLLW. The northern bench was 158 feet in length and constructed at an elevation of 0 feet MLLW. Geotextile fabric was used to protect the area from erosion.

During the project, approximately, 70 cubic yards of existing riprap and underlying sediment were excavated in order to prepare a foundation, or toe area, for the intertidal structures. The excavated material was later reused onsite as coarse fill behind the barriers. This fill also provides intertidal habitat important for food organisms used by juvenile salmon species. Fifteen intertidal enhancement structures were constructed to create approximately 4,200 to 4,500 square feet of minimum-slope, fine-grained intertidal area.

Past restoration actions also included the installation of riparian plants along the top-of-bank.

Observation of Habitat Function

In May 1995, the restored mudflat benches were surveyed for the presence of benthic invertebrates (Cordell et al. 2001) and identified as only one of two habitats surveyed where *Harpacticoid* copepods had been found. The other site was a sediment bench constructed at the U.S. General Services Administration site located approximately 1 mile south of Terminal 104. *Harpacticoid* copepods are important prey items for juvenile salmon when the fish out-migrate through marine habitats. At the time of the survey, the density of these benthic copepods was approximately 75,000 individuals per square meter at the Terminal 104 mudflat benches (Cordell et al. 2001). The density of all meiofaunal invertebrates observed at the Terminal 104 mudflat benches was approximately 7,000,000 individuals per square meter (Cordell et al. 2001).

Osprey have also been observed nesting at Terminal 104 (Blomberg 2007). During field surveys conducted in 2013, native bent-nose clam and other bivalves were observed in the substrate, indicating that the benches are deep enough for burrowing. The northern bench, which was installed at a lower elevation (0 feet MLLW), appeared to have more bivalves than the southern bench (elevation of +2 feet MLLW).

9.2.2 Future Habitat Restoration

Future habitat restoration at the PORTfolio project site would involve minimal excavation and regrading to establish a sloped riparian buffer and intertidal bench (where one does not already exists) along the entire length of shoreline. The PORTfolio project would create a continuous stretch of on-channel riparian slope with adjacent intertidal habitat, and restore approximately 630 linear feet of degraded shoreline.

Existing Conditions

The restored mudflat benches are stable and performing as designed. The benches are exposed at low tide but are covered by water during higher tides. The riprap located upslope from the mudflat benches is covered by rockweed or bladderwrack seaweed. Silt, mud, woody material, and other debris are continually deposited onto and washed from the mudflat benches. The riparian vegetation has not been adequately established and is dominated by invasive Himalayan blackberry interspersed with some willow, cottonwood, and chokecherry. Five catch basins run parallel to the north edge of the transload dock, providing drainage for Terminal 104. The mudflat benches do not alter the existing drainage from the adjacent upland area.

Restoration Activities

The existing bankline will be drawn back and regraded according to Restoration Treatment #4. The remaining riprap will be removed and replaced with dense riparian planting and slope-stabilizing large woody debris. Intertidal benches will be added in areas where a successful bench does not already occur.

Post-Restoration Conditions

The Terminal 104 PORTfolio project, including past and future restoration actions, will restore approximately 0.17 acres of riparian and 0.13 acres of enhanced intertidal mudflat habitat. Overall, the Terminal 104 PORTfolio project would restore approximately 630 linear feet of shoreline.

9.3 Ecological Value

The ecological value of the Terminal 104 PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. The project will create a relatively flat, fine-grained intertidal area that provides habitat for emergent vegetation and invertebrates that are important to juvenile salmon, other fish, and birds.

9.3.1 Restoration Valuation

The Terminal 104 PORTfolio project will result in an ecological lift of approximately five dSAYs. Table III-15 shows the base number of dSAYs attributed to each type of habitat conversion. A

multiplier for mudflat habitat was applied to this base number to estimate the total number of dSAYs.

Table III-15. Restoration summary for the Terminal 104 PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres	
Riprap	Baseline Adjusted Intertidal	0.13	
Unvegetated Upland	Riparian	0.17	
	Total	**0.30**	

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

10 Terminal 105

10.1 Site Overview and Background

10.1.1 Location and Project Overview

Terminal 105 is located on the west shoreline of the LDW at approximately River Mile 0.1 (see Figure III-9). The site is bordered by Terminal 103 to the north, the LDW to the east, Southwest Idaho Street to the south, and West Marginal Way Southwest to the west. The Terminal 105 PORTfolio project runs east-west across the north border of Terminal 105 and then south along the property's LDW shoreline, encompassing approximately 1,250 linear feet of off-channel habitat and 670 linear feet of on-channel shoreline.

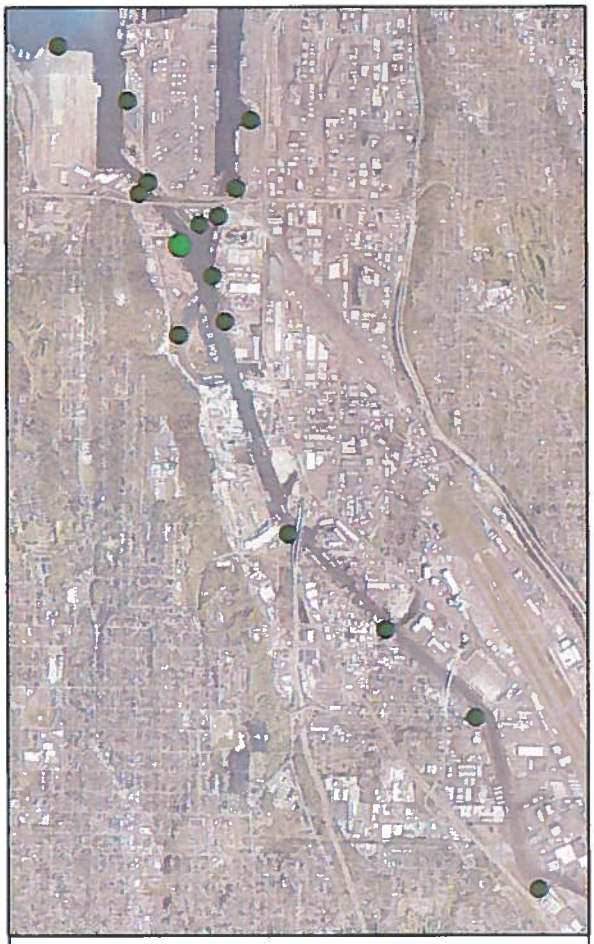

Figure III-9. Terminal 105 Project location.

10.1.2 Site History

Terminal 105 is located entirely within an area that formerly consisted of tidal flats and marshes. Fill material used to create Terminal 105 likely includes fill imported from the Duwamish tidelands (1907 to 1912), soil sluiced in from the Beacon Hill regrade, and locally dredged materials. Historically, Terminal 105 was the site of boat and lumber yards, and the terminal was the Port's first major development south of Southwest Spokane Street in the Lower Duwamish Industrial Development District. The Port acquired a portion of the Terminal 105 property in 1967 and used it for log and container storage, handling, and berthing (SAIC 2012a).

A public access park was established by the Port in 1986 as a requirement for the redevelopment of the Terminal 5 property (Blomberg 2012b). The park featured a picnic shelter, parking lot, bike and pedestrian paths, fishing pier, and a riprap-covered shoreline. The park grounds included a seeded lawn and riparian area with a mix of native and non-native trees and shrubs. Between July 1994 and February 1995, the Port and Coastal America Grant program funded the construction of a habitat project at the site (AHBL 2009).

10.2 Restoration Actions

10.2.1 Past Habitat Restoration

Past habitat restoration at Terminal 105 created a 0.6-acre intertidal channel approximately 1,300 feet in length (AHBL 2009). The off-channel intertidal habitat included a drainage channel with intertidal marsh, mudflat habitat, and forested riparian buffers along both the intertidal channel and the main channel of the LDW. Approximately 210 linear feet of shoreline were restored (AHBL 2009).

Baseline Conditions

For the purposes of ecological valuation of the PORTfolio project, baseline conditions at Terminal 105 are considered to be the site conditions prior to past habitat restoration actions. These conditions are described as follows.

Prior to the construction of the off-channel intertidal habitat, the area featured a combination of unvegetated upland (2.7 acres), riprap (0.1 acres), intertidal (1.0 acre), shallow subtidal (1.0 acre), and deep subtidal (2.8 acres) habitat. The site was occupied by mid-sized manufacturing and industrial warehouse buildings, a container storage yard, assorted small office buildings, and an abandoned marina. The abandoned marina included an office and dock that provided overwater cover in the intertidal area at the southern end of the site. The southern portion of Terminal 105 featured a vacated street end (Southwest Idaho Street) that was used as a container storage yard and barge terminal by Northwest Container Services. A gravel road along the northern boundary of the site provided public access to the small shelter, picnic area, and viewing pier located in the northern portion of Terminal 105.

Prior to restoration, the PORTfolio project area was primarily unvegetated, with small patches of invasive Himalayan blackberry, Scotch broom, and non-native herbaceous plants and grasses. The shoreline was steeply sloped and consisted of riprap with a deteriorated log bulkhead in the northern portion of the intertidal area. The shoreline south of the riprap was unstable. A low-gradient intertidal area, which was created by the erosion of fill at the site, extended from the shoreline. Miscellaneous metal and glass debris, which was part of the original fine-grained fill material, was present at the southern end of the intertidal area.

Restoration Activities

The off-channel intertidal habitat project was constructed between July 1994 and February 1995 (AHBL 2009). All existing structures, including the over-water cover from the abandoned marina office and dock, were removed from the site. Approximately 12,500 cubic yards of fill material (11,000 cubic yards landward of +11.3 feet MLLW and 1,500 cubic yards waterward of +11.3 feet MLLW) were excavated to create an intertidal channel with mudflat, marsh, and riparian habitat (AHBL 2009). The existing riprap along the bank was pulled back, and the channel was excavated to an elevation of between +6 feet and +9.75 feet MLLW. During excavation activities, an underground fuel storage tank and a vault containing solvent wastes

and paint cans were unearthed and removed. An existing drainage ditch that ran along the southern edge of the project area was filled and rerouted to the head of the new intertidal channel. The new channel (approximately 110 feet wide by 700 feet long) was graded to create a bench configuration. The bottom of the channel was graded flat, and the side slopes ranged from 2:1 along upper bench to 4:1 on the lower bench. The steepest slope (1:1) was at the head of the channel. A continuous berm was also created around the perimeter of the excavation along the southern border.

Pieces of imported woody debris were buried in the entrance and bottom of the intertidal channel to provide protection from wave action and to focus sediment accretion. Log cribs were installed on the 1:1 slopes to provide temporary stabilization until the slopes could be naturally stabilized by vegetation. Riprap was installed along the steep slopes near the mouth of the channel for slope stabilization. A bulkhead of riprap and timber was also installed at the mouth of the channel, extending northward to the public park shoreline in order to establish the elevation necessary to create a shallow gradient for the mouth of the channel.

Following excavation, native riparian and emergent vegetation was planted by volunteers. Existing vegetation from the filled drainage ditch, including facultative and obligate wetland species, was transplanted at an elevation of +8 feet MLLW. Marsh vegetation was planted at lower elevations in the marsh habitat.

The berm along the southern border of the channel was planted with native trees and shrubs. The outside of the riparian berm was hydroseeded with grasses for erosion control. Native riparian vegetation was also planted adjacent to marsh habitat and in all areas that had an elevation of between +11 feet and +16 feet MLLW.

A temporary automatic irrigation system was installed, and the project area was irrigated three times a week during the summer months for the first three years post restoration. The off-channel intertidal restoration was constructed adjacent to a public access site, and both sites are regularly monitored and maintained as part of the Port's marine maintenance program.

In February 2016, most of the remaining piles were removed. Immediately landward of the pile removal site, approximately 285 feet of dense riparian vegetation was planted in July 2016 to enhance the shoreline.

Observation of Habitat Function

Biological monitoring was conducted between 1993 to 1999 in order to evaluate the effect of the restoration action on salmonid habitat (Cordell et al. 2001).

The off-channel intertidal restoration area was found to have abundant populations of invertebrates, including oligochaete and polychaete worms and amphipods. By 1999, a marked increase in the density of the polychaete worm *Manayunkia aesturina* was observed at the project area (*M. aesturina* is also a shorebird prey source). Collembolan arthropods (springtails) were

also relatively dense at the project area as compared with densities at other monitored restoration sites on the LDW. The highest taxa richness for benthic meiofauna (primarily harpacticoid copepods, nematode worms, and foraminifera) was found at the delta of the intertidal channel at the Terminal 105 restoration area and at one other restoration site (an intertidal bench at the General Services Administration restoration site). Overall, the study concluded that successful colonization of emergent and riparian vegetation at the Terminal 105 off-channel habitat restoration area had allowed the development of terrestrial and marsh insect assemblages.

Biological monitoring has also confirmed that the off-channel habitat created at the restoration area provides suitable habitat for salmonids and other fish. Species captured within the restored intertidal channel during monitoring included Pacific staghorn sculpin, chum salmon, Chinook salmon, and shiner perch (Cordell et al. 2001). On one day in the spring of 1999, over 500 chum salmon were captured in the channel.

The invertebrate taxa present at the project area are ecologically important because they make up a large portion of the juvenile salmonid diet. Of all of the sites included in the biological monitoring study, the Terminal 105 restoration area was the only site where a clear relationship between invertebrate prey production at the restoration site and the juvenile salmon diet was observed (Cordell et al. 2001). Sampling in 1997 showed that psyllids present in insect fallout traps at the Terminal 105 project area made up to 80% of the diet (by weight) of juvenile salmon captured at the site. Overall, the study concluded that the Duwamish River Coastal America restoration sites, including Terminal 105, had provided little to no habitat function prior to restoration and that restoration activities had resulted in a net gain of ecological function in the LDW.

Another study conducted in 2003 to monitor salmon use of restored off-channel habitats in the LDW (Ruggerone and Jeanes 2004) reported that 328 perch, 16 chum salmon fry, and two natural (non-hatchery) and one hatchery subyearling Chinook salmon were captured in the Terminal 105 intertidal channel in the spring. The highest recapture rates (54%) for natural subyearling Chinook salmon occurred at the Terminal 105 project area.

10.2.2 Future Habitat Restoration

Future habitat restoration project concept for Terminal 105 would involve excavation of approximately 350 linear feet of shoreline south of the previous habitat work, to create a riparian slope and emergent marsh habitat, described as a Restoration Treatment #3. Future restoration would also include the regrading of a riparian berm to marsh elevations. Shallow subtidal areas would receive secondary benefits from adjacent restored riparian and intertidal habitats.

Existing Conditions

Since restoration was completed in 1995, the restored off-channel habitat has continued to develop and mature. The intertidal channel is well established and surrounded by intertidal mudflats, marsh vegetation, and riparian vegetation. Marsh vegetation adjacent to the intertidal channel is dominated by Lyngbye's sedge and tufted hairgrass; non-native species, including sweet fennel, pepperweed, and bearded iris species, are also present. The riparian vegetation consists of a diverse mix of native vegetation, as well as non-native white poplar.

The flat-bottomed excavated channel has allowed the water to develop a natural meander pattern. Several pieces of large woody debris are located within the intertidal channel and along the LDW shoreline. The mudflat habitat is characterized by fine-grained sediment, and the intertidal area at the mouth of the channel is characterized by larger sediment and cobbles covered in bladderwrack or rockweed algae. Riprap slopes remain on the waterward margin of the riparian berm and the on-channel marsh opening. Some of the wood piles from the former Riverside Marina are still located in the intertidal area but most have been removed. Non-native European beachgrass is also present at the upper elevations of the intertidal habitat along the southern portion of the project area.

The intertidal channel receives stormwater runoff from West Marginal Way Southwest, which was rerouted from the original drainage ditch to the head of the intertidal channel during restoration. The quality of stormwater from West Marginal Way Southwest is typical of stormwater from a roadway surface. Two additional public storm drain outfalls that drain adjacent properties discharge to the intertidal channel at the middle and southern end of the channel. The intertidal channel is inundated, to an estimated minimum elevation of +9.3 feet MLLW, with water from the LDW at least once daily during each higher high tide. The uppermost aquifer underneath the site is hydraulically connected with the LDW and subject to tidal influence; however, groundwater seepage into the channel is minimal.

The shoreline south of the previous restoration action currently has an unobstructed low slope, approximately 8:1, that is unstabilized and experiencing erosion. The top-of-bank is at approximately +14 feet to +15 feet MLLW and vegetated primarily with Scotch broom and other non-native shrubs. Only a few deciduous trees remain at the north portion of the south shoreline. The north portion is also currently separated from intertidal elevations by a riprap slope whereas the south portion of the riparian buffer transitions to intertidal elevations with an approximately 8:1 slope, consisting of sand and mud substrates. Ledges of pre-development organic marsh are exposed in limited areas, and non-native beach grasses are also present in small amounts. Substantial creosote piling and rubble, including sandblast grit and slag, remain in the former small boat yard and shipway.

Restoration Activities

Previously restored areas would receive additional plantings where needed. The existing riparian berm south of the public access site would be regraded to high marsh elevations (+8

feet to +10 feet MLLW), connecting to the existing marsh habitat within the previous off-channel restoration area. The waterward boundary of the new marsh area would remain a stabilized riprap berm, backfilled with appropriate marsh substrate. This will protect the extended off-channel marsh from wave action and other eroding forces.

Approximately 350 linear feet of shoreline south of the off-channel restoration area, along the western extent of the PORTfolio project boundary, would receive riparian and intertidal restoration treatments (Restoration Treatment #3). The top-of-bank would be excavated between +10 feet and +12 feet MLLW to create a minimum 2:1 riparian slope at least 15 feet in depth. The riparian buffer would transition to high marsh and intertidal habitat, extending the existing intertidal areas approximately 50 to 80 feet west, across most of the south shoreline. A small section of riprap, approximately 100 feet, to the north currently divides riparian and intertidal habitat. This feature would be replaced with anchored large woody debris to a maximum elevation of +14 feet MLLW.

Post-Restoration Conditions

The PORTfolio project, including past and future restoration actions, would create a complex of off-channel marsh and riparian habitat comprising approximately 1.37 acres of riparian, 0.84 acres of marsh, 1.59 acres of intertidal, 0.99 acres of shallow subtidal, and 2.82 acres of deep subtidal habitat. Overall, the Terminal 105 PORTfolio project would restore approximately 1,920 linear feet of shoreline.

10.3 Ecological Value

The ecological value of the Terminal 105 PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. The ecological value is enhanced by the presence of multiple types of habitat: subtidal, intertidal, marsh, and riparian. The off-channel shape of the marsh habitat makes it particularly valuable, as off-channel and side channel habitat are especially needed in the LDW (NOAA 2013). The project will create a relatively flat, fine-grained intertidal area that provides habitat for emergent vegetation and invertebrates that are important to juvenile salmon, other fish, and birds. The Terminal 105 PORTfolio project also benefits from its proximity to several other habitat sites, including Herring's House, Terminal 107 PORTfolio project (see Chapter 11, below), and Kellogg Island to the south, and Terminal 102 PORTfolio project (see Chapter15, below) across the waterway.

10.3.1 Restoration Valuation

The Terminal 105 PORTfolio project will result in significant ecological lift. Table III-17 shows the restoration area by HEA catgegory.

Table III-17. Restoration summary for the Terminal 105 PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres	
Baseline Adjusted Intertidal	Fully Functioning Intertidal	0.96	
	Riprap	0.04	
Baseline Adjusted Shallow Subtidal	Fully Functioning Shallow Subtidal	0.99	
Baseline Adjusted Deep Subtidal	Fully Functioning Deep Subtidal	2.82	
Riprap	Fully Functioning Estuarine Marsh	0.01	
	Fully Functioning Intertidal	0.04	
	Riprap (no change)	0.09	
Unvegetated Upland	Fully Functioning Estuarine Marsh	0.83	
	Fully Functioning Intertidal	0.59	
	Riprap	0.04	
	Riparian	1.37	
	Total	**7.78**	

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

11 Terminal 108

11.1 Site Overview and Background

11.1.1 Location and Project Overview

The Terminal 108 PORTfolio project is located along the east shoreline of LDW between approximately River Mile 0.4 and 0.6 (see Figure III-10). The PORTfolio project area is bordered by Terminal 106 to the north, the Terminal 108 container storage facility to the east, Diagonal Avenue South to the south, and the LDW to the west. Both voluntary restoration and compensatory mitigation actions have taken place at the site, although only voluntary actions are included in the PORTfolio project.

Figure III-10. Terminal 108 PORTfolio project location

11.1.2 Site History

The northeast portion of Terminal 108 was at one time the site of the Diagonal Way Sewage Treatment Plant, which was operated by the City of Seattle from 1938 to 1962, at which time King County Metro assumed operation and made improvements to the plant (King County et al. 2005). Wastewater was treated in clarifiers and digesters, and the sludge was pumped into open ponds and drying beds, also located in the northeast portion of Terminal 108 (Dames & Moore 1988). Primary-treated effluent was discharged into the LDW through a 30-inch steel outfall located approximately mid-way along the Terminal 108 shoreline. King County Metro ceased operation of the plant in 1969, and the plant was closed by 1970.

In the mid-1970s, the Terminal 108 property was acquired by Chiyoda Corporation. In 1977, Chiyoda cut back and dredged the northern portion of the Terminal 108 shoreline to improve berthing, moving the shoreline approximately 100 feet farther inland (King County 2002). In 1980, Chiyoda sold the Terminal 108 property to the Port. The paved southeastern portion of the property and a small area in the central portion of the property were used by the Port for container storage. The Port subdivided the property into an east and west parcel.

In 1984, the Chevron USA Products Company (Chevron) purchased the eastern parcel (Windward 2009). From 1984 to 1992, Chevron used the property to stockpile soil and store equipment and, for a brief period of time in 1990, to treat soil contaminated with petroleum hydrocarbons using a technique called land-farming. The Port repurchased the parcel in the early 1990s, at which point it removed . approximately 5,000 cubic yards of soil and fill material were removed from the property to prepare the site as a container/chasis storage terminal. That use continues to the present. .

Between 1980 and 1985, the western portion of Terminal 108 remained vacant, with the exception of some container storage limited to the southern, paved portion of the parcel. In 1985, the Pioneer Construction Materials Company leased the site for storage of construction aggregate for a period of approximately 6 months (Taylor 1985). In 1989, Lafarge leased the the western parcel for use as a bulk cement transfer/shipping facility. The facility was constructed in the early 1990s and located on the southern half of the parcel. Lafarge used the facility to transport bulk cement from barges to trucks and rail cars for distribution until 1998.

In 1986, the Port conducted the Diagonal Avenue South intertidal mitigation excavation project at the southwestern corner of Terminal 108. Approximately 12,400 cubic yards of sediment and soil were removed from the existing shoreline to create 0.28 acres of intertidal habitat area immediately north of Diagonal Avenue South (Port of Seattle 1985b). An interim public access path was created at the end of the right-of-way along Diagonal Avenue South. Existing marsh plants were replanted along the new shoreline, as feasible, following intertidal excavation. The mitigation project was completed in 1987. Since that time, siltation has occurred, decreasing the lower tidal extremity from -2 feet to 0 feet MLLW.

11.2 Restoration Actions

11.2.1 Past Habitat Restoration

Past habitat restoration at the PORTfolio project site encompassed approximately 3.4 acres. Restoration completed in 1989 and 1993 involved the enhancement of off-channel intertidal habitat that had been previously created by the Diagonal Avenue South intertidal mitigation project (completed in 1987) through the planting of riparian vegetation. Additional riparian planting was conducted in conjunction with public access improvements to the park located in the southwest corner of the site. Shoreline enhancements were then conducted in 2015 just north of the mitigation site.

Baseline Conditions

For the purposes of ecological valuation of the PORTfolio project, baseline conditions at Terminal 108 are considered to be the site conditions prior to past habitat restoration actions. These conditions are described as follows.

Prior to previous restoration actions, the PORTfolio project area consisted of approximately 0.3 acres of unvegetated upland, 0.02 acres of riprap, 0.5 acres of mudflat, 1.0 acres of intertidal, 0.3 acres of shallow subtidal, and 1.3 acres of deep subtidal habitat. The project area also featured a 1.14-acre public access park with a 6-foot-wide public access path that extended from the north edge of the intertidal area to South Oregon Street. An intertidal area of approximately 0.28 acres with a 3:1 slope was created during the Diagonal Avenue South mitigation project at an elevation of -8 feet to +8 feet MLLW. Riprap was present on side slopes adjacent to the southern third of the intertidal area, and patchy marsh vegetation was present in two areas within the intertidal area. Some scrub-shrub vegetation was present on the northern portion of the intertidal and upland areas between +10 feet and 16 feet MLLW. The vegetation included deciduous trees, shrubs, and grasses, with a high percentage of the area being covered by invasive Himalayan blackberry and Scotch broom.

Restoration Activities

In 1989, invasive plants, including Himalayan blackberry and Scotch broom vegetation, were removed from the site. Any existing native vegetation was left undisturbed. Vegetation was installed to stabilize the slope surrounding the intertidal area. All cleared areas were seeded with rye and clover. A mixture of native and non-native trees, shrubs, and groundcover species were planted as a riparian buffer at an elevation of +10 feet to +16 feet MLLW.

The riparian vegetation was further enhanced in 1993 as part of a larger development project to pave the upland area and create a container storage area. The project was conducted by the Seattle Conservation Corps using Port funds. Native trees and shrubs were planted among and between existing plants, primarily along a new pedestrian access path.

Other improvements included the removal of one half of the existing asphalt parking area; the installation of picnic tables, a children's sand box, and additional interpretive signage; and the repair of a small eroded area along the existing shoreline path.

In 2015, approximately 200 linear feet of shoreline north of the Diagonal Avenue South compensatory mitigation site was excavated and regraded to a 2:1 riparian slope. Large woody debris was anchored into the bankline at +12 feet MLLW and dense riparian vegetation was planted between +12 feet MLLW and top-of-bank elevations. Emergent marsh species were planted between the large woody debris and an irrigation system was installed.

Observation of Habitat Function

Biological monitoring was conducted in 1989, two years after construction, and included epibenthic, fish, and sediment sampling (Invert-Aid 1989). Epibenthic invertebrate abundances were greater at the post-construction mitigation transects than at the control transects. Twenty-four invertebrate taxa were found in the control transects, and twenty were found in the mitigation transect.

A total of 81 Chinook salmon and one chum salmon were captured at the restored site (Invert-Aid 1989). The results of a fish stomach content analysis indicated that some juvenile salmon captured in the area had not recently eaten. The juvenile salmon that had eaten had selected gammarid amphipods, chironomids, and small sticks as primary food items, ignoring the more numerous harpactacoid copepod species.

As part of a Duwamish/Diagonal combined sewer overflow assessment, biologists observed existing habitat conditions in the northern portion and north of the PORTfolio project area (King County et al. 2005). In 1996, seven transects were established along the shoreline; two of the transects were located in the northern portion of the PORTfolio project area. At each transect, qualitative information was collected for substrate type, community dominance, macroinfauna, and slope and bank height. Algae and mussels were found in the intertidal area at the northern portion of the project area. Amphipods and isopods were also present under the rubble in the intertidal area. Evidence of shorebirds (e.g. probe holes) was also observed. In 2013, native bent-nose clams and sandpipers were observed at the PORTfolio project site.

11.2.2 Future Habitat Restoration

Future restoration at the PORTfolio project site would create a continuous strip of riparian vegetation along the shoreline north of the Diagonal Ave South mitigation site, transforming the compensatory mitigation site and previous shoreline restoration into one large habitat corridor.

Existing Conditions

Since restoration was completed in 2015, the restored habitat at the PORTfolio project site has continued to develop and mature. Robust riparian vegetation surrounds the intertidal area in a contiguous strip, including on- and off-channel habitat. The upper intertidal area has a relatively low gradient and is thinly vegetated with plants, including dunegrass, forbs, and native willows. At the extreme high-water line, debris and other miscellaneous human refuse accumulate; some of these materials support a dense epibiota, including brown algae (Fucus spp.). Acorn barnacles (Balanus glandula) are also found on hard substrates throughout the intertidal area.

A sand and cobble substrate is present at higher elevations, and a sand and silt substrate is present in the lower tidal range. A narrow band of sand and cobbles slopes gradually down to a broad and relatively flat clay formation that extends out from under sand layer down to a scarp. The clay layer is densely perforated in some areas by decaying roots. Below this clay layer, a gradually sloping sandy mud beach extends into the water.

The Diagonal Avenue South storm drain outfall and the former Diagonal Avenue Wastewater Treatment Plant outfall are located along the northern edge of the riparian habitat. A catch basin is located in the middle of the public access area east of the compensatory mitigation site. The stormwater that flows into the catch basin is diverted around the restored intertidal area.

The northern shoreline is absent of previous restoration actions and reflects the pre-restoration conditions of the southern shoreline. The north shoreline is steep, consisting primarily of riprap with some exposed intertidal mudflat and outcroppings of relic sediments. Upland elevations are relatively flat and vegetated with grasses and sparse trees. The top-of-bank consists primarily of invasive Himalayan blackberry. A 0.23-acre derelict barge sits approximately 110 feet offshore, moored to a 350-foot-long derelict catwalk. Both the barge and catwalk create significant overwater cover in the intertidal areas of the PORTfolio project site. A decommissioned waste water treatment plant outfall acts as a beach groin, allowing sediment to build up on the north side and beach grass to develop.

Restoration Activities

The existing bankline would be excavated and restored according to Restoration Treatment #2. The slope would be drawn landward and regraded to create adjacent 2:1 and 4:1 riparian slopes, which would be densely planted with native trees and shrubs.

Post-Restoration Conditions

The PORTfolio project, including past and future restoration actions, would create a connected riparian corridor along the LDW with approximately 0.92 acres of riparian, 1.55 acres of intertidal, 0.31 acres of shallow subtidal, and 1.31 acres of deep subtidal habitat. Overall, the project would restore approximately 1,300 linear feet of shoreline.

11.3 Ecological Value

The ecological value of the Terminal 108 PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. The ecological value is enhanced by the presence of multiple types of habitat: subtidal, intertidal, and riparian. Riparian planting will enhance an adjacent, existing relatively flat, fine-grained intertidal area that provides habitat for emergent vegetation and invertebrates that are important to juvenile salmon, other fish, and birds. The PORTfolio project also benefits from its proximity to several other habitat sites, including Herring's House, Terminal 107 PORTfolio project (see Chapter 11, below), and Kellogg Island across the waterway.

11.3.1 Restoration Valuation

The Terminal 108 PORTfolio project will result in significant ecological lift. Table III-19 shows the restoration areas using HEA habitat categories.

Table III-19. Restoration summary for the Terminal 108 PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres	
Baseline Adjusted Intertidal	Fully Functioning Intertidal	1.55	
Baseline Adjusted Shallow Subtidal	Fully Functioning Shallow Subtidal	0.31	
Baseline Adjusted Deep Subtidal	Fully Functioning Deep Subtidal	1.31	

Baseline Habitat Type	Restored Habitat Type	Acres	
Unvegetated Upland	Riparian	0.92	
	Total	**4.09**	

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

12 Terminal 107

12.1 Site Overview and Background

12.1.1 Location and Project Overview

The Terminal 107 PORTfolio project is located on west shoreline of the LDW between approximately River Mile 0.6 and 1.0 (see Figure III-11). The site is bordered by Herring's House Park to the north, West Marginal Way Southwest to the west, and an intertidal channel of the LDW and Kellogg Island to the east. The west boundary of the PORTfolio project site overlaps with the Terminal 107 public access park. The eight-acre public access park features a 1,400-foot-long pedestrian pathway, a model boat keel, landscaping, and approximately 2,250 linear feet of shoreline.

Figure III-11. Terminal 107 PORTfolio project location

12.1.2 Site History

Historically, Terminal 107 was the site of a tribal village (SoundEarth Strategies 2011). The Port acquired the parcels that make up T107 between 1969 and 1976 from various landowners (Tanner and Williams 1990). Prior to Port ownership, the site supported residential, commercial and industrial uses common to the area.

In 1985, the Port designated a portion of Terminal 107, which included the northern half of Kellogg Island, as a public access preserve. The southern half of Kellogg Island was set aside to be free from future commercial or marine terminal development. In 1985, a public access path was created along the southern shoreline of Terminal 107. The access path included railroad crossings, a paved bike trail with public viewing turnouts, and wooden benches. New shrubs and a viewing area were added in 1992.

The Port designated and developed the Terminal 107 park in exchange for the loss of public access at Terminal 105 in 1995 under a two-phased public access improvement plan. Phase one was completed in 1996 and involved the cleanup of an impassible Himalayan blackberry thicket and removal of thousands of pounds of concrete rubble. Phase two of the improvement plan encompassed 5 acres of riparian, marsh, and upland restoration in 2000 and 2001. Portions of

this phase of the improvement plan are included in the PORTfolio project as past habitat restoration actions, as described below.

12.2 Restoration Actions

12.2.1 Past Habitat Restoration

Past habitat restoration at the Terminal 107 PORTfolio project site consisted of the removal of invasive species and debris and planting of native marsh, riparian, and upland vegetation; as well as the excavation of a pocket marsh at the southern end of the site. Restoration was primarily implemented in 1999, 2000, and 2001, although some marsh enhancements were conducted in 2007 and 2010 (AHBL 2009).

Baseline Conditions

For the purposes of ecological valuation of the PORTfolio project, baseline conditions at Terminal 107 are considered to be the site conditions prior to past habitat restoration actions. These conditions are described as follows.

Prior to the restoration activities initiated in 1999, the project area consisted of unvegetated upland, high marsh, intertidal, and shallow subtidal habitat. The area contained a significant amount of fill material generated from maintenance dredging of the LDW (Tanner and Williams 1990). Very little vegetation was present in the northern portion of the site, other than grass and various herbaceous species. Based on a habitat survey conducted in 1979 (Canning et al. 1979), most herbaceous species present at the site were non-native species, such as white clover, common tansy, and common chickweed. Himalayan blackberry, Scotch broom, and other invasive shrubs were scattered among the herbaceous species. There were few trees present at the site in 1979; those that did exist were generally located in the upland area on the southern portion of the property.

The site featured a pocket of brackish marsh habitat, dominated by cosmopolitan bulrush, Lyngbye's sedge, and common brass button. The intertidal area in the northern portion of the PORTfolio project area featured a steep bankline with sparsely vegetated mudflats that were covered with concrete, brick, and log debris. Bladderwrack or rockweed algae were attached to rocks and concrete debris. Mats of mountain rush (formerly known as Baltic rush) and small patches of salt grass were also present on the mudflat. A steep, armored bankline was present south of the PORTfolio project area.

Restoration Activities

In 1999, using federal funds, the Port conducted cooperative restoration actions at Terminal 107 with the Army Corps of Engineers (USACE). The brackish marsh area at the southern end of the PORTfolio project site was extended to approximately 0.5 acres through the excavation of 9,000 cubic yards of sediment (Blomberg 2012c). A bench was created at an elevation of +10 feet

MLLW, and a channel connecting the pocket marsh to the LDW was created at an elevation of +8 feet MLLW.

In 2000, remnants of commercial and residential structures were removed; most of these were located in the northern portion of the PORTfolio project area. Approximately 4,500 tons of concrete debris was removed. An 18-to-24-inch-thick topsoil berm was constructed near the central shoreline area, and the site was landscaped. A limited amount of regrading was performed in the upland area, and gravel swales were installed.

In 2001, approximately 2 acres of invasive plants were removed, and 3.5 acres of native trees, understory shrubs, and seeds were planted. Native trees and shrubs were installed along the shoreline to enhance riparian habitat. Native riparian species were planted along the perimeter of the pocket marsh habitat at the southern end of the habitat initiative project area.

Large woody debris was placed around the pocket marsh at the southern end of the site to reduce erosion.

In 2007, the Port added over 1,200 native marsh plants to the marsh habitat north of the boat launch. In addition, goose exclusion fences were installed until young plants could become established. In 2010, the Port planted native marsh plants south of the boat launch. A temporary irrigation system was installed in 2001, and the restoration area was irrigated three times a week during the summer months for the first 3 years after restoration. The Terminal 107 public access park is regularly maintained by the Port. Invasive plants are removed from the pocket marsh on a monthly basis by volunteers.

Observation of Habitat Function

From 2000 to 2008, various groups conducted post-restoration monitoring of the pocket marsh area (Armbrust et al. 2008). As part of the Volunteer Salmon Habitat Restoration and Monitoring Program, People for Puget Sound conducted annual vegetation monitoring from 1999 to 2003 and again from 2005 to 2009. Each July, volunteers identified plant species, counted shoots, and measured the diameter and height of the largest plant within each of four riparian and eight intertidal data collection areas. Monthly site visits to inspect for problems such as invasive weeds, goose grazing, and vandalism, were also conducted. After the first four years of monitoring, the estuarine area showed an increase in the number of native plant shoots and no invasive species. In the upland area, the number of natives also increased, and a sudden increase of invasive plants (mostly Robert's geranium) occurred in 2003.

The USACE conducted vegetation monitoring in the pocket marsh area from 2003 to 2004, and several invasive species were found (Armbrust et al. 2008). By 2004, plantings in both the intertidal and riparian zones were well established. Lyngbye's sedge and bulrush together comprised 100% of the cover in the intertidal marsh area. In 2004, native red alder had attained near 100% cover in most of the riparian planting zone, providing deep shade to the understory plants.

From March through July 2001, fish surveys were conducted once a month near the pocket marsh by USFWS (Armbrust et al. 2008). A fyke net was set across the mouth of the channel at high tide, timed to coincide with juvenile salmonid outmigration in the LDW. No fish were caught in March or April. Juvenile chum were captured in May (16 individuals) and June (11 individuals), as were Puget Sound sculpin. In 2002, consultants used a beach seine to sample fish in four two-to-three-day efforts between May and June (Armbrust et al. 2008). Two-hundred fish were collected; these included shiner perch, sculpin, threespine stickleback, and one juvenile Chinook salmon.

In the summer of 2008, the USACE conducted biological monitoring of the pocket marsh as well as other USACE-constructed sites (Armbrust et al. 2008). Invertebrate traps were deployed to estimate terrestrial invertebrate composition and the production of potential prey for juvenile salmonids. Several important prey taxa, including insects in the families *Chironomidae, Hemiptera, Ephydridae,* and *Dolichopodidae,* were found. Overall densities of invertebrates were within or near the ranges identified in other riparian restorations sites in the LDW, although the densities of some groups (e.g. *Diptera,* including *Chironomidae*) were below those in other riparian restoration sites in the LDW.

The USACE also recorded the presence of invasive plant species, progress of planted vegetation, obstacles to fish passage, and other performance issues specific to the pocket marsh site (Armbrust et al. 2008). A dense (~100%) riparian canopy of deciduous trees was present. Deep shade was created by a volunteer red alder, which might have been harmful to planted Douglas fir and Sitka spruce, which appeared small and stressed. The intertidal marsh area was entirely covered in emergent vegetation, including Lyngbye's Sedge (90%) and hardstem bulrush (10%). A large number of invasive species were found, but infestation was relatively light, except at the southern edge of the study area.

12.2.2 Future Habitat Restoration

The future habitat restoration concept at Terminal 107 would involve excavation of the existing shoreline to create a riparian slope and emergent marsh habitat. The project would restore approximately 1,200 linear feet of shoreline and enhance the Terminal 107 public access park.

Existing Conditions

Since the completion of previous restoration actions in 2010, the habitat at the PORTfolio project site has continued to develop and mature. The pocket marsh habitat at the southern end of the site supports hardstem bulrush and Lyngbye's sedge. The pocket marsh is surrounded by dense riparian vegetation, including Douglas fir, western red-cedar, Pacific dogwood, bigleaf maple, vine maple, swordfern, evergreen huckleberry, nettle, and thimbleberry. This dense vegetation hinders access and provides protection from disturbance by humans or domesticated animals.

Marsh vegetation along the northern shoreline has become well established. As a result, approximately four to six inches of sediment aggradation has occurred and significantly

reduced beach erosion in this area (Blomberg 2012c). Marsh species include mountain rush, hardstem bulrush, and Lyngbye's sedge. The riparian area adjacent to and south of the marsh is densely vegetated with a variety of native trees, shrubs, and groundcover. The upland greenbelt habitat adjacent to the riparian habitat also contains native species, including bigleaf maple, Douglas fir, Pacific dogwood, shore pine, Nootka rose, and vine maple.

Two grass and gravel swales at the site discharge to drain fields. The groundwater generally flows toward the north, away from Terminal 107, although a small amount of groundwater seeps to the surface and flows into the LDW. A storm drain that conveys runoff from West Marginal Way Southwest discharges into the LDW at Terminal 107. Another storm drain that drains the former delta of the original Puget Creek discharges to the LDW north of the PORTfolio project area. A catch basin is present in the gravel parking lot south of the PORTfolio project area. The stormwater conveyance exceeds the City of Seattle's runoff standards for the site and nature of the improvements.

The shoreline is steeply sloped, ranging from 1:1 to an almost vertical bank, particularly on the southern shoreline where a bulkhead is present. The vertical drop of the shoreline bank generally ranges from four to 12 feet. Upland areas are relatively flat.

Restoration Activities

The existing bankline would be excavated and regraded according to Restoration Treatment #3. Due to areas of cultural and archaeological significance at the site, approximately 472 linear feet of the north shoreline that overlaps with a historical tribal village (an area previously enhanced during past restoration efforts) would not be excavated. Minimal excavation would be done along the southern 800 linear feet of shoreline to achieve the desired slopes and grades (with archaeological assessment/monitoring). The riparian slope would be densely planted with native vegetation, and emergent marsh species would be planted between +8 feet and +12 feet MLLW.

Post-Restoration Conditions

The PORTfolio project, including past and future restoration actions, would create a complex of habitat comprising approximately 2.42 acres of riparian, 0.98 acres of marsh, 4.49 acres of intertidal, and 1.21 acres of shallow subtidal habitat. Overall, the PORTfolio project would restore approximately 1,200 linear feet of shoreline.

12.3 Ecological Value

The ecological value of the Terminal 107 PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. The ecological value is enhanced by the presence of multiple types of habitat: subtidal, intertidal, marsh, and riparian. The off-channel shape of the pocket marsh habitat makes it particularly valuable, as off-channel and side channel habitat are especially needed in the LDR (NOAA 2013). The PORTfolio project also benefits from its proximity to several other

habitat sites, including Herring's House to the north, Kellogg Island across the waterway, and the Terminal 105 PORTfolio project to the south.

12.3.1 Restoration Valuation

The Terminal 107 PORTfolio project concept would result in significant ecological lift. Table III-21 shows the restoration areas by HEA habitat category.

Table III-21. Restoration summary for the Terminal 107 PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres	
Baseline Adjusted Intertidal	Fully Functioning Estuarine Marsh	0.60	
	Fully Functioning Intertidal	4.48	
Baseline Adjusted Shallow Subtidal	Fully Functioning Shallow Subtidal	1.21	
Riprap	Fully Functioning Estuarine Marsh	0.21	
Unvegetated Upland	Fully Functioning Estuarine Marsh	0.17	
	Fully Functioning Intertidal	0.01	
	Riparian	2.42	
	Unvegetated Upland (no change)	0.06	
	Total	**9.16**	

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

13 Terminal 115

13.1 Site Overview and Background

13.1.1 Location and Project Overview

The Terminal 115 PORTfolio project is located on the west shoreline of the LDW at approximately River Mile 2.0 (see Figure III-12). It encompasses approximately 2.65 acres at the southeast corner of Terminal 115. The PORTfolio project area is bordered by upland portions of Terminal 115 to the west, First Avenue South Bridge to the south, and the LDR to the east.

Figure III-12. Terminal 115 PORTfolio project location

13.1.2 Site History

Present-day Terminal 115 was originally part of the main channel of the LDR, until extensive dredging and filling activities reshaped the shoreline. The Port purchased the property from The Boeing Company as part of the Lower Duwamish Industrial Development District in 1969. Development of the marine terminal began in 1969, and the facility was opened in 1971. Terminal 115 was initially used for the unloading of imported cars, Foss Alaska Line's barge service, and van storage. In 1978, Seapro/Seafreeze built a fish processing and cold storage facility at the south end of Terminal 115; the facility is currently operated by Icicle, Incorporated. The southeast corner of Terminal 115, which is the PORTfolio site, was previously leased by the Commercial Fence Corporation.

In 1971, the Port established a public access area at Terminal 115, immediately downstream of what later became a WSDOT habitat restoration area. The area was listed as a candidate for further habitat restoration in the Lower Duwamish River Habitat Restoration Plan: An Inventory of Port of Seattle Properties (AHBL 2009).

13.2 Restoration Actions

13.2.1 Past Habitat Restoration

Past habitat restoration at the Terminal 115 PORTfolio project site encompasses approximately 0.1 acres of overwater structure removal along the southern shoreline.

Baseline Conditions

For the purposes of ecological valuation of the PORTfolio project, baseline conditions at Terminal 115 are considered to be the site conditions prior to past habitat restoration actions. These conditions are described as follows.

The area was fenced and bordered to the south by a Port-owned vacant asphalt-paved parking lot. The bankline was heavily armored with concrete debris, riprap, and a bulkhead. Overwater structures included a derelict T-dock, gangway, and float system. The derelict dock was approximately 0.07 acres in area, in significant disrepair, and supported by approximately 60 piles. Surrounding the dock were remnants and debris that had become detached (covering an area of approximately 0.05 acres).

Two small vacant buildings were also within the PORTfolio project area. One structure was an aluminum pole-and-beam building located at the edge of the shoreline. A portion of this building was supported on fill contained by a bulkhead (with an area of 0.06 acres). The concrete slab on which the building was constructed had begun to fail between 2008-2010. The second structure, approximately 70 feet from the shoreline, was a one-story office building that had been constructed in the 1970s. This building was boarded up and unsuitable for use.

Restoration Activities

In 2011, all overwater cover associated with the derelict T-dock structure was removed, daylighting 0.03 acres of shallow subtidal and 0.06 acres of intertidal habitat. Both vacant buildings were demolished to ground level without breaking through the pavement or destabilizing the bulkhead and bankline. Non-embedded debris surrounding the dock structure was removed to the extent possible without destabilizing the bankline. No piles were removed from the site.

Observation of Habitat Function

No monitoring studies of the restoration area have been conducted. However, shallow subtidal and intertidal habitats areas were unobstructed and exposed to daylight, presumably improving their overall habitat function. A peregrine falcon nest box is located on a post in the upland portion of the site.

13.2.2 Future Habitat Restoration

Future habitat restoration at the PORTfolio project site would involve areas of large-scale fill removal and minimal bankline regrading. The project would create an off-channel marsh habitat surrounded by a landward riparian buffer and would enhance a continuous stretch of on-channel riparian slope with adjacent marsh. The PORTfolio project would restore approximately 720 linear feet of degraded shoreline.

Existing Conditions

The site includes minimal exposed intertidal substrate and no riparian or marsh vegetation. Piles from the historic dock remain at the site. Patches of muddy and sandy substrate are present in the intertidal zone at elevations below +5 feet MLLW. The shoreline is steep, between 3:1 and near vertical, and covered with riprap and debris. Upland areas between approximately +15 feet and +18 feet MLLW include paved equipment storage and approximately 1.2 acres of a demolished building foundation (AHBL 2009).

A large water main and transmission tower are present north of the building foundation at top-of-bank elevations. A T-dock defines the northern-most boundary of the restoration site and results in approximately 0.07 acres of overwater cover. The dock is used for seafood receiving and initial processing by the Icicle, Incorporated seafood processing warehouse. Shoreline surrounding the T-dock consists of riprap and almost no vegetation.

Restoration Activities

All remaining creosote piles would be removed from intertidal areas and intertidal substrate would be restored according to the methods outlined in Restoration Treatment #7. Restoration Treatment #5 would be applied to the southern portion of the site in the area of the former warehouse foundation. Approximately 0.63 acres would be excavated to create a large off-channel marsh surrounded by a densely vegetated riparian slope. The landward extent of the riparian slope would not interfere with or extend beyond the existing water main. The off-channel marsh would extend to on-channel marsh and gradually transition to exposed unvegetated mudflat.

The shoreline immediately north of the off-channel marsh would be restored according to Restoration Treatment #3. The existing slope would be regraded to create adjacent 2:1 and 4:1 riparian slopes with a 4:1 to 10:1 emergent marsh bench.

The bankline between the transmission tower and the T-dock would be restored according to Restoration Treatment #2. The existing slope would be drawn back with minimal excavation to achieve a 2:1 riparian slope with a small emergent marsh strip. The waterward extent of the restoration is limited by the presence of the T-dock and associated maritime uses. As such, restoration actions would not actively enhance the intertidal habitat in this area.

Post-Restoration Conditions

The PORTfolio project, including past and future restoration actions, will create a complex of habitat comprising approximately 0.28 acres of riparian, 0.53 acres of marsh, 0.45 acres of intertidal, 0.43 acres of shallow subtidal habitat, and 0.96 acres of deep subtidal habitat. Overall, the PORTfolio project will restore approximately 720 linear feet of shoreline.

13.3 Ecological Value

The ecological value of the Terminal 115 PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. The ecological value is enhanced by the presence of multiple types of habitat: subtidal, intertidal, marsh, and riparian. The off-channel shape marsh habitat makes it particularly valuable, as off-channel and side channel habitat are especially needed in the LDR (NOAA 2013). The PORTfolio project also benefits from its adjacency with a WSDOT off-channel wetland and intertidal habitat project to the south, surrounding the First Avenue South Bridge.

13.3.1 Restoration Valuation

The Terminal 115 PORTfolio project would result in significant ecological lift. Table III-23 shows the restoration areas by HEA habitat category.

Table III-23. Restoration summary for the Terminal 115 PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres	
Baseline Adjusted Intertidal	Fully Functioning Estuarine Marsh	0.02	
	Fully Functioning Intertidal	0.27	
Degraded Intertidal	Fully Functioning Intertidal	0.06	
Baseline Adjusted Shallow Subtidal	Fully Functioning Shallow Subtidal	0.40	
Degraded Shallow Subtidal	Fully Functioning Shallow Subtidal	0.03	
Baseline Adjusted Deep Subtidal	Fully Functioning Deep Subtidal	0.96	
Riprap	Fully Functioning Estuarine Marsh	0.11	
	Fully Functioning Intertidal	0.04	
	Riparian	0.04	
Unvegetated Upland	Fully Functioning Estuarine Marsh	0.40	
	Fully Functioning Intertidal	0.08	
	Riparian	0.24	
	Total	**2.65**	

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

14 Terminal 10

14.1 Site Overview and Background

14.1.1 Location and Project Overview

The Terminal 10 PORTfolio project is located on the west side of Harbor Island, along the east shoreline of the West Waterway (see Figure III-13). The site is bordered by 16th Avenue Southwest to the east, Southwest Lander Street to the north, and the West Waterway to the west. The PORTfolio project will restore approximately 200 linear feet of shoreline.

Figure III-13. Terminal 10 PORTfolio project location

14.1.2 Site History

Upland, shoreline, and aquatic areas at Terminal 10 were used as a ship building and repair facility for approximately four decades. Use of the area as a shipyard ended in 1988. The site was purchased by the Port of Seattle in 1997 as part of the redevelopment and improvement of the Harbor Island container cargo transshipment facility. Redevelopment involved the removal of approximately 2.38 acres of former shipyard pier overwater coverage in 2003. Approximately 11 acres of upland area were leveled and paved to provide adequate container storage, construction staging, and parking. Upland and aquatic cleanup and remediation actions, managed by the EPA as an operable unit of the Harbor Island Superfund site, were completed in 2005.

14.2 Restoration Actions

14.2.1 Future Habitat Restoration

Future habitat restoration at the Terminal 10 PORTfolio project site involves the placement of clean imported fill on the existing shoreline and grading to create a sloped riparian buffer with adjacent emergent marsh habitat.

Baseline Conditions

For the purposes of ecological valuation of the PORTfolio project, baseline conditions at Terminal 10 are considered to be the existing conditions, described as follows.

The upland area consists of a paved impervious surface cap. Aquatic area conditions include a sediment cleanup cap, accomplished through removal of previous sediments and placement of a prescribed layer of clean imported cap materials (referred to as the Lockheed Shipyard Sediment Operable Unit sediment cap). No upland structures are present. The site includes a limited existing stormwater collection system and eight inch diameter stormwater outfall.

As a constructed fill site, no native or un-altered shoreline or adjacent intertidal or shallow subtidal aquatic area is present at the PORTfolio project site. Paved upland portions do not include substantial vegetation of any kind. However, a small area of native riparian vegetation at approximately +16 feet MLLW was installed as an element of a Harbor Island Superfund operable unit site cleanup and remediation action in 2005. The riparian area, approximately 110 feet long and 30 feet wide, is located outside and to the southwest of the Terminal 10 PORTfolio project area and includes willow, cottonwood, and shrubs. Northeast of the riparian area and within the PORTfolio project area is a 0.21-acre concrete slab formerly used as a boat launch prior to redevelopment. The concrete slab is considered an element of the sediment cap and will not be removed during restoration actions. The slab is partially exposed and approximately 3 feet thick, ranging between +11 feet and +16 feet MLLW. Intertidal areas at the site consist of a vertical bulkhead, steep riprap slopes, and sediment cap materials. Small amounts of surface algae growth are present in the intertidal sediment cap area. No emergent vegetation is present at the site.

Restoration Activities

As a result of the EPA sediment cap and location of the concrete boat launch, no excavation will take place at the PORTfolio project site. Instead, a layer of fine grain sediment will be placed over the concrete and surrounding areas. The slope will be graded according to Restoration Treatment #3 without excavation and utilizing the existing slope, post-fill. Large woody debris will be anchored directly into the concrete slab to provide increased stability. The new slope will be planted with dense riparian and emergent marsh vegetation.

Post-Restoration Conditions

The Terminal 10 PORTfolio project will create a complex of habitat comprising approximately 0.16 acres of riparian, 0.09 acres of marsh, 0.30 acres of intertidal, 0.17 acres of shallow subtidal habitat, and 1.30 acres of deep subtidal habitat. Overall, the PORTfolio project will restore approximately 100 linear feet of shoreline.

14.3 Ecological Value

The ecological value of the Terminal 10 PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. The ecological value is enhanced by the presence of multiple types of habitat: subtidal, intertidal, marsh, and riparian. Its location in the West Waterway provides valuable transitional marine habitat in an area currently devoid of such habitat.

14.3.1 Restoration Valuation

The Terminal 10 PORTfolio project would result in moderate ecological lift. Table III-25 shows the restoration areas by HEA habitat category.

Table III-25. Restoration summary for the Terminal 10 PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres	
Baseline Adjusted Intertidal	Fully Functioning Estuarine Marsh	0.001	
	Fully Functioning Intertidal	0.30	
Degraded Intertidal	Fully Functioning Estuarine Marsh	0.09	
	Fully Functioning Intertidal	0.02	
Baseline Adjusted Shallow Subtidal	Fully Functioning Shallow Subtidal	0.17	
Baseline Adjusted Deep Subtidal	Fully Functioning Deep Subtidal	1.30	
Unvegetated Upland	Riparian	0.14	
	Total	**2.02**	

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

15 Slip 27

15.1 Site Overview and Background

15.1.1 Location and Project Overview

Slip 27 is located on the east shoreline of the East Waterway (see Figure III-14). It is bordered by Terminal 25 to the south, Terminal 30 to the north, East Marginal Way South to the east, and the East Waterway to the west. The Slip 27 PORTfolio project will take place along the northern and southern shoreline of Slip 27 and the north shoreline of Terminal 25, approximately 940 linear feet.

Figure III-14. Slip 27 PORTfolio project location.

15.1.2 Site History

Slip 27 is part of the East Waterway Operable Unit of the Harbor Island Superfund Site. In 2007, a 300-foot concrete-piling-supported bridge was constructed between Terminal 30 and Terminal 25 at the head of Slip 27. Two actions were performed in 2006 to mitigate for the increased overwater cover from the new bridge. Approximately 0.33 acres of overwater cover, previously a rail-barge transfer span and piling-supported-dock, were removed from the southwest corner of Slip 27 and the southwest shoreline, respectively. Additionally, the entire southern shoreline of Slip 27 received 0.24 acres of riparian planting in 2006. The planting included native tree and shrub plantings at the top-of-bank, approximately +14 to +16 feet MLLW. The site is subject to restrictive conditions associated with a Port-Muckleshoot agreement which makes it unavailable for conventional development.

15.2 Restoration Actions

15.2.1 Future Habitat Restoration

Future habitat restoration would involve minimal bankline excavation to establish a sloped riparian buffer along the entire length of shoreline. The PORTfolio project would create a continuous stretch of on-channel riparian slope that would enhance adjacent intertidal and subtidal habitats.

Baseline Conditions

For the purposes of ecological valuation of the PORTfolio project, baseline conditions at Slip 27 are considered to be the existing conditions, described as follows.

Slip 27 is an active moorage site for container Terminal 30, operated by the Northwest Seaport Alliance. A wharf along the northern shoreline provides significant overwater cover; no natural shoreline is present. In addition to the wharf, a 300-foot bridge adds an additional 0.20 acres of overwater cover at the head of Slip 27. Past compensatory mitigation efforts to restore riparian vegetation at the top-of-bank of the southern shoreline were unsuccessful. Few shrubs remain, with the area largely exposed and occupied by gravel sediments. A 3:1 to 4:1 riprap slope separates the top-of-bank from the water. An intertidal bench is present along the middle of the southern shoreline and appears to consist of intertidal mud and riprap debris.

Restoration Activities

The small amount of remaining riparian vegetation would be replaced with a five-foot-wide top-of-bank riparian buffer according to Restoration Treatment #1. The slope would be stabilized with anchored large woody debris and planted with dense native riparian vegetation.

Post-Restoration Conditions

The Slip 27 PORTfolio project would create approximately 0.35 acres of riparian habitat. Overall, the PORTfolio project will restore approximately 940 linear feet of shoreline.

15.3 Ecological Value

The ecological value of the Slip 27 PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. Its location in the East Waterway provides valuable transitional marine habitat in an area currently devoid of such habitat.

15.3.1 dSAY Valuation

The Slip 27 PORTfolio project concept would result in moderate ecological lift. Table III-27 shows the restoration areas by HEA habitat category.

Table III-27. Restoration summary for the Slip 27 PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres	
Unvegetated Upland	Riparian	0.35	
	Total	**0.35**	

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

16 Terminal 102

16.1 Site Overview and Background

16.1.1 Location and Project Overview

The Terminal 102 PORTfolio project is located at the southernmost point of Harbor Island, where the East and West Waterways join at Turning Basin One in the LDR (see Figure III-15). The site includes approximately 1,750 linear feet of shoreline between River Mile 0.5 and 0.6. It is bordered by the Jim Clark Marina to the southwest, Harbor Island Marina to the south and east, and the Harbor Island Marina Corporate Center on Southwest Klickitat Way to the north.

Figure III-15. Terminal 102 PORTfolio project location

16.1.2 Site History

Terminal 102 was built on top of fill material used to construct Harbor Island, one of the largest man-made islands in the world. Prior property owners included D.R. Fisher, the Milwaukee Railroad Company, and the Lone Star Cement Corporation. The Port obtained the property in late 1960s and used it to store logs until eventually redeveloping it into a corporate center and marina.

16.2 Restoration Actions

16.2.1 Future Habitat Restoration

Future habitat restoration would involve minimal excavation and regrading of the shoreline to create a sloped riparian buffer with a small emergent marsh bench pressed into the existing riprap slope.

Baseline Conditions

For the purposes of ecological valuation of the PORTfolio project, baseline conditions at Terminal 102 are considered to be the existing conditions, described as follows.

Terminal 102 includes approximately 8.1 acres of existing upland area, 13.9 acres of aquatic area, and approximately 1,750 linear feet of shoreline. Upland areas of the site are relatively flat, with top-of-bank elevations between +17 feet and +20 feet MLLW. The Harbor Island Marina Corporate Center includes four separate buildings that cover much of the central uplands, approximately 3.17 acres. The buildings are surrounded by paved roads, parking areas, and minimal landscaping. A paved footpath lines the top-of-bank. The shoreline slopes rapidly (approximately 2:1 to 3:1) and is structurally stabilized with exposed riprap along the entire margin of the site. Some riparian vegetation exists immediately waterward of the paved footpath, but quickly diminishes as the slope decreases in elevation.

A single 10-foot by 584-foot dock (approximately 0.13 acres) runs parallel to the entire eastern shoreline. Additionally, four floating docks oriented perpendicular to the southern shoreline, each with four to five intersecting docks, encompass much of the aquatic area south of the PORTfolio project site. Together the eastern and southern docks make up the Harbor Island Marina, which provides monthly moorage to approximately 77 vessels ranging from 24 to 70 feet. The western shoreline is bordered by the Jim Park Marina which encompasses approximately four acres of aquatic area and consists of approximately 60 open and covered moorages. The entire shoreline at the PORTfolio project site is committed to water-dependent marine uses.

Restoration Activities

The existing shoreline would be drawn back and regraded according to Restoration Treatment #4. However, rather than installing an intertidal bench between +0 feet MLLW and +8 feet MLLW, an emergent marsh bench no deeper than +9 feet MLLW would be installed. This modification is due to space constraints resulting from adjacent marinas. This treatment would be applied to the entire shoreline. The riparian slope would be planted with dense native vegetation and the intertidal bench would be planted with emergent marsh species.

Post-Restoration Conditions

The Terminal 102 PORTfolio project concept would create approximately 0.80 acres of riparian, 0.33 acres of marsh, and approximately 0.67 acres of intertidal habitat. Due to the presence of the active marina waterward of the PORTfolio project area, habitat benefits are not extended to the adjacent subtidal habitats. Overall, the Terminal 102 PORTfolio project will restore approximately 1,750 linear feet of shoreline.

16.3 Ecological Value

The ecological value of the Terminal 102 PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. The ecological value is enhanced by the presence of multiple types of habitat: intertidal, marsh, and riparian. Its location near the mouth of the LDR provides valuable transitional marine habitat in an area currently devoid of such habitat.

16.3.1 Restoration Valuation

The Terminal 102 PORTfolio project concept wwould result in significant ecological lift. Table III-29 shows the restoration areas by HEA habitat category.

Table III-29. Restoration summary for the Terminal 102 PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres	
Baseline Adjusted Intertidal	Fully Functioning Estuarine Marsh	0.59	
Riprap	Fully Functioning Estuarine Marsh	0.33	
	Fully Functioning Intertidal	0.09	
Unvegetated Upland	Riparian	0.80	
	Unvegetated Upland (no change)	0.03	
	Total	**1.83**	

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

17 Terminal 106

17.1 Site Overview and Background

17.1.1 Location and Project Overview

The Terminal 106 PORTfolio project is located on the eastern shoreline of the LDW at approximately River Mile 0.1 to 0.4 (see Figure III-16). The site is bordered by Terminal 104 to the north, South Oregon Street to the south, East Marginal Way South to the east, and the LDW to the west. The PORTfolio project includes restoration along approximately 1,360 linear feet of shoreline.

Figure III-16. Terminal 106 PORTfolio project location

17.1.2 Site History

Prior to development, the western portion of present day Terminal 106 consisted of exposed intertidal flats and marshland. By 1984 the upland warehouse was demolished and the railway tracks were removed. Shoreline modifications began in the 1960s and by 1995 the shoreline was reclaimed for industrial development through the placement of hydraulic fill (GeoEngineers 1986). The source of fill was primarily contaminated dredge material from the LDW. The historic surface elevation was raised from between +17 feet and +19 feet MLLW to between +20 feet and +22 feet MLLW. The site was regraded and paved as a container storage yard.

For the past 25 years, upland areas have been used for various cargo container care and maintenance activities. There are currently no active marine related uses in the shoreline area.

17.2 Restoration Actions

17.2.1 Future Habitat Restoration

Future habitat restoration would involve minimal bankline excavation to establish a sloped riparian buffer along the entire length of shoreline. Depending on site-specific characteristics, intertidal areas adjacent to the riparian buffer may be suitable for an intertidal bench, in which

case more excavation would be necessary. The PORTfolio project would create a continuous stretch of on-channel riparian slope that would enhance adjacent intertidal habitats.

Baseline Conditions

For the purposes of ecological valuation of the Terminal 106 PORTfolio project, baseline conditions at Terminal 106 are considered to be the existing conditions, described as follows.

A fence separates the top-of-bank from current upland activities. Waterward of the fence, the top-of-bank width varies between 15 and 35 feet. A structurally stabilized 1.75:1 riprap slope extends from the top-of-bank (+18 feet MLLW) to intertidal elevations (-20 feet to -25 feet MLLW). The riparian slope is mostly unvegetated, except for the sparse presence of Himalayan blackberry. There is no marsh vegetation and little algal growth in the intertidal habitat. Currently this area does not have a fine grained, low slope intertidal area.

A small picnic area for employees is present approximately mid-way along the shoreline. The area is mostly overgrown by Himalayan blackberry and does not appear to be frequently utilized. No existing or former dock or other in-water structures are present.

Restoration Activities

The existing fence line would be relocated landward approximately 15 to 35 feet. The riprap shoreline would be excavated and regraded according to Restoration Treatment #2. The riparian slope would be densely planted with native vegetation and stabilized using anchored large woody debris. Transitional species would be planted between pieces of large woody debris to create a small but continuous strip of emergent marsh. Areas along the bankline (to be determined after a more detailed site characterization) may also receive the addition of an intertidal bench described in Restoration Treatment #4. The bench would be pressed into the existing slope between +0 feet and +8 feet MLLW and provide fine-grained substrate habitat that is otherwise absent from the site.

Post-Restoration Conditions

The Terminal 106 PORTfolio project would create approximately 0.39 acres of riparian habitat. Overall, the PORTfolio project would restore approximately 1,360 linear feet of shoreline.

17.3 Ecological Value

The ecological value of the Terminal 106 PORTfolio project is based on the types and quantity of habitat restored, as well as the duration of the restoration effort and the expected lifespan of the restored habitats. The Terminal 106 PORTfolio project also benefits from its proximity to the Terminal 108 PORTfolio project, immediately south of Terminal 106.

17.3.1 Restoration Valuation

The Terminal 106 PORTfolio project concept would result in moderate ecological lift. Table III-31 shows the restoration area by HEA habitat category.

Table III-31. Restoration summary for the Terminal 106 PORTfolio project.

Baseline Habitat Type	Restored Habitat Type	Acres	
Unvegetated Upland	Riparian	0.39	
	Total	**0.39**	

See Appendix B for maps of the HEA polygons (baseline and restored conditions) used to estimate the ecological value of the PORTfolio project.

18 Summary of PORTfolio Project Sites

The Port has identified seven restoration treatments that could be used to create ecological service flows on 16 PORTfolio project sites. Taken together, the 16 sites would restore, create or enhance ecological service flows in over 65 acres ofriparian, marsh, intertidal, and subtidal habitat.

In the context of Habitat Equivalency Analysis (HEA), the Port's preliminary assessment indicates that the combined value would be over 1,500 dSAYs, of which more than 97% could be attributed to the Port (i.e. not completed as compensatory mitigation or paid for by others.) .

PART IV: ASSURANCES

1 Introduction

Monitoring, maintenance, and long-term stewardship activities are proposed to ensure that PORTfolio projects meet their stated objectives. The Programmatic Monitoring, Maintenance, and Long-Term Stewardship Plan (Appendix D) addresses each type of proposed habitat restoration in the PORTfolio. Due to the advanced design stage of the proposed projects at Terminal 117 and Terminal 25 South, detailed and design-specific monitoring and maintenance plans are included for these two sites (Appendix E-3 and F-3, respectively). The basic components of proposed monitoring, maintenance, and long-term stewardship for all PORTfolio projects are described in the following sections.

2 Monitoring

Each component of the monitoring plan is briefly summarized below. Additional detail can be found in the programmatic and site-specific monitoring, maintenance, and long-term stewardship plans in the appendices.

2.1 Goals and Objectives

The overall goal of the PORTfolio is to create durable, self-sustaining habitat projects that will provide ecosystem functions that were once abundant but are now rare due to dredging and fill necessary for construction of the Duwamish Waterway (including the East and West Waterways) and more than eight decades of industrial use. Objectives are described for each habitat type in terms of dimensions, locations, elevations, and slope contours critical to each habitat type, as identified by the Trustees (NOAA 2013).

2.2 Performance Standards

Performance standards are derived from project objectives, and are designed to determine whether the restored habitat types are functioning as intended. They represent key structures, functions, or processes provided by the restored habitat, and are categorized as either physical characteristics or vegetation. In many cases, interim benchmarks are establish to ensure that restoration projects are on track to meet the final Year-10 performance standards. In addition to performance standards related to physical characteristics and vegetation, at the primary projects, Terminal 117 and Terminal 25 South, the Port has also established performance standards and monitoring parameters for fish and invertebrate communities.

2.3 Monitoring Parameters

For each performance standard, one or more monitoring parameters are measured and evaluated against the standard. The program specifies the monitoring tasks, methods, and schedule necessary to effectively measure each monitoring parameter against its designated performance standard. The monitoring period for each site is anticipated to be 10 years.

Sample quantities included in the monitoring methods are meant to be statistically representative of site conditions. The number of vegetation sampling replicates is generally based on the methodology described by WSDOT in its Wetland Mitigation Monitoring Methods report (2008).

2.4 Implementation

This section identifies a 10-year monitoring period for each project site. It also identifies reporting requirements and contingency measures. In the event that a monitoring parameter falls short of the performance standard, the program identifies potential corrective actions, or contingency measures, that may be necessary to ensure project success.

Where project restoration activities have been completed, at the initiation of the PORTfolio monitoring period, these projects will be evaluated to determine whether they meet the appropriate performance standard based on the time since project implementation. If they meet or exceed the performance standards for the appropriate monitoring year, monitoring, maintenance, and long-term stewardship activities will proceed forward from that monitoring year. If they do not meet performance standards for the appropriate monitoring year, then contingency measures will be implemented, which may include corrective measures, as well as extending the monitoring and maintenance period.

3 Maintenance

Maintenance activities will be required to ensure that the PORTfolio projects meet both short-term performance standards and long-term restoration goals. Primarily, maintenance will be required to ensure that newly-planted vegetation becomes established and is not out-competed by invasive species or destroyed by herbivores. Maintenance activities include watering, mulching, weeding, dead plant removal, and debris removal. Other design elements, such as large woody debris, may also require maintenance to ensure that elements are secured and functioning as intended. Anchored large woody debris is an essential slope-stabilizing structure in the restoration designs, and anchors may require regular assessment and adjustment to prevent buoyancy. The maintenance plan is a key factor to ensuring a successful restoration project.

Maintenance during the 10-year performance monitoring period will be conducted by the Port's Marine Maintenance Division. The Marine Maintenance Division maintains public access and

restoration sites owned by the Port, including several on the LDW. Following construction and the completion of Year 0 monitoring, the Project site will be added to the Division's roster of maintained sites. The site will be inspected regularly, with maintenance activities performed consistent with the appropriate maintenance plan.

4 Long-term Stewardship

The long-term stewardship component of the plan describes the maintenance activities that will be conducted after the initial 10-year monitoring to ensure the integrity of the restoration project in the long term (approximately 20 years). The plan includes a description of activities that will be conducted on an as-needed basis to maintain the ecological function of the sites. The long-term stewardship of the PORTfolio sites will be ensured by a conservation easement, funded by a non-wasting endowment, and carried out by a third-party provider.

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