6.0 HABITAT CONSIDERATIONS AND MITIGATION/RESTORATION PLAN

This section summarizes the ecological consequences of, and provides the ecological basis for final design of the remediation of Thea Foss and Wheeler-Osgood Waterways, the Upland Disposal Option, the St. Paul Waterway confined disposal facility (CDF) alternative, and associated mitigation and restoration actions. Detailed Plans and Specifications for mitigation and restoration components of the project accompany this report and are based on the project refinements described in this report, the Habitat Plan and Design Report (Round 3 DER, Appendix Z [City of Tacoma 1999a]), Appendix V, the Commencement Bay Nearshore/Tideflats Superfund Site ESD (EPA 2000) and companion documents, and agency and public comments on these documents.

6.1 Overall Project Habitat Objectives

The overall habitat objectives of the Thea Foss and Wheeler-Osgood Waterways Remediation Project and the possible use of the St. Paul Confined Disposal Facility are to:

- Actively remediate nearly 60 acres of contaminated benthic sediments in Thea Foss and Wheeler-Osgood Waterways (Table 6-1);
- Increase and enhance littoral habitat conditions in Thea Foss and Wheeler-Osgood Waterways resulting in improved shallow nearshore conditions for migration of juvenile salmonids;
- Fully mitigate for losses of all shallow subtidal and intertidal (littoral) habitat acreage resulting from remediation and from the possible use of St. Paul Waterway as a CDF; this will be accomplished by restoring or enhancing critical intertidal and other estuarine habitats adjacent to the neodelta;
- Fully mitigate for temporal loss of ecological functions that result from project implementation;
- Establish a monitoring and adaptive management program to help ensure that the waterways and mitigation/restoration actions are managed to optimize habitat functions provided; and
- Meet the performance criteria in the ESD including actions that contribute to the recovery of federally listed threatened species from a Commencement Bay ecosystem perspective.

The Commencement Bay Ecosystem Assessment (Simenstad 2000) identifies the naturally developing "neodelta" at the mouth of the Puyallup River as a key location in the current watershed. This assessment notes that one of the strategies that will "offer the greatest contribution to the estuarine life history of chinook and other salmon in the Commencement Bay watershed," from a landscape perspective, is to build upon and expand shallow water mudflat and vegetated intertidal habitats contiguous with this naturally developed neodelta.

Another top habitat restoration priority identified by Simenstad (2000) is to restore off-channel, or blind-slough, habitat types in the lower river and estuary. If the CDF Disposal Option is selected, the mitigation/restoration actions that are planned to offset the loss of 11.05 acres of marine habitat (approximately 10.0 acres of littoral habitat) from the filling of St. Paul Waterway have been carefully designed over a period of several years to support these priorities.

The specific salmonid habitat goals of the mitigation/restoration plan under the Upland Disposal Option are to:

- Increase both the quality and quantity of critical intertidal and shallow subtidal habitats and associated riparian areas in the Thea Foss Waterway including reintroduction of saltmarsh habitats;

- Compensate for the temporal loss of function resulting from Thea Foss and Wheeler-Osgood Waterways remediation through provision of improved shoreline habitat functions within the waterways and round the head of the Middle/St. Paul peninsula;

- Create new littoral habitat by bank layback in the Middle Corridor and by excavation of the northwest tip of the Middle/St. Paul peninsula uplands (Figure 6-1);

- Enhance littoral habitat at the Middle Corridor site, north and south of the proposed pier location;

- Enhance the Middle/St. Paul peninsula by removal of about 1,700 creosote-treated piles and removal of surface debris and enhance beach in front of the northwest tip by excavation; and

- Improve the shallow water migration corridor between the Puyallup River mouth and the Ruston shoreline.

The post-remediation Thea Foss Waterway and the constructed mitigation/ restoration habitats within the waterway and at the end of the Middle/St. Paul peninsula will provide both higher quality habitat than currently exists and a much improved migration corridor for fish moving from the Puyallup River delta to the Ruston Way tideflats. Thus, this option would provide affirmative restoration of littoral habitat area and function.

The additional specific salmonid habitat goals of the mitigation/restoration plan under the CDF Disposal Option are to:

- Expand critical habitats adjacent to the neodelta, including the reintroduction of side channel habitat, and achieve a near continuous corridor of enhanced, restored, reconstructed, and expanded littoral habitat from the rebuilding delta, across the outer St. Paul Waterway, around the St. Paul/Middle Waterway peninsula, and along most of the eastern shoreline of Middle Waterway;

- Protect and enhance the integrity of the relatively large, relict original mudflat in Middle Waterway by enlarging a part of its eastern shoreline with more complex and vegetated habitats;

- Increase both the quality and quantity of critical intertidal and shallow subtidal habitats and associated riparian areas in the waterways west of the Puyallup River mouth, including reintroduction of estuarine marsh habitats;

- Improve shallow water connectivity between these important estuarine habitat areas, leading to improved function of each;

- Compensate for the temporal loss of function resulting from Thea Foss and Wheeler-Osgood Waterways remediation to more than replace the existing habitat values lost to construction of the CDF in St. Paul Waterway. The post-remediation Thea Foss Waterway and the constructed mitigation/ restoration habitats will provide both higher quality habitat than currently exists and a more contiguous corridor from the Puyallup River delta to the Ruston Way tideflats; and

- Provide Puyallup River off-channel brackish marsh, intertidal and shallow subtidal mudflat, and shallow open water habitat.

The proposed CDF mitigation/restoration habitat package has been designed to include more littoral area and more functional value than the areas affected by the action. By providing a more diverse edge and habitat than currently exists in

the neodelta, along with an adaptive management plan to ensure that the planned functions are attained, the design will provide a margin of safety in the event that some intended functions are not fully realized and will provide affirmative restoration of littoral habitat area and function.

6.2 Habitat Changes Resulting from Remediation and Disposal

6.2.1 Thea Foss and Wheeler-Osgood Waterways

Remediating contaminated sediments in the Thea Foss and Wheeler-Osgood Waterways will alter the physical nature of benthic habitats to varying degrees; at the same time, existing chemical concentrations of sediment contaminants will be reduced. Discussions in this section are applicable to either the Upland or CDF Disposal Options. Dredging and capping, combined with natural recovery processes, will result in a much less contaminated bottom over the majority of the waterway (Figure 1-1). Sediments exposed by dredging or placed as subtidal capping material will consist predominantly of native silty sands, rather than the existing organically enriched fine mud. The bottom sediments exposed by dredging or created by filling are expected to be quickly recolonized by infauna and epibiota (McCauley et al. 1977, Richardson et al. 1977). Since the remediated bottom sediments may be lower in fines and organic material than sediments currently present in much of the waterways, initial productivity of infauna may be below current levels for one or more years. Based on information on recolonization of the Simpson Cap in St. Paul Waterway (Parametrix 1993 and 1998) and other studies (CH2M Hill 1995, Romberg et al. 1995), new sandy sediments are expected to provide epibenthic prey quality and quantity for salmonids exceeding those now provided within 1 to 2 years of placement. Longer periods (e.g., 3 or more years) may be required before the benthic assemblages reach levels of stability, productivity, and community structure fully comparable to those in similar habitats and at similar depths in Commencement Bay.

Substantial areas (over 60 acres) of the waterway that do not require remediation or will be remediated by natural recovery will provide local larval sources for recolonization. However, because of the prolonged period of planktonic larval development (several days to weeks) for most benthic species, it is expected that most larval recruitment will be derived from current transport into the waterway of plankton derived from spawning outside the waterway.

During the time required for development of a robust infauna and epibiota in these areas, food availability for use by evaluation species may be reduced. However, this reduction in benthos will only be a negative impact until prey

availability and quality surpasses that present before remediation; this condition is expected to occur within about 1 to 2 years. Because of their greater mobility and because they exploit organic material falling to the sediment surface from the plankton, epibenthic crustaceans are expected to recolonize more rapidly than infauna.

In some areas of the inner waterway, the existing sediments and prey base may contain chemical constituent concentrations that are harmful to benthic feeders and to animals that have direct contact with sediments. In these areas, removal of sediments exceeding SQOs and benthos will have an immediate positive effect; species not finding adequate prey for feeding in these areas may be forced to move to other areas where they may face increased competition for food, but they will be consuming uncontaminated prey and will be in contact with uncontaminated sediments.

Littoral slopes requiring capping will be protected with riprap for slope stabilization and riprap will be covered with habitat mix (minus 2-inch sand and gravel mix) to fill interstices, aid in water retention, and foster the development of epibenthic prey for juvenile salmonids. Habitat mix will be most effective at these functions below about elevation 4 feet MLLW and where the slope is protected from wave action. Above about elevation 9 feet MLLW, these materials may support growth of saltmarsh vegetation.

Over time (1 to 2 years), exposed riprap (i.e., that not covered by fine-grained habitat mix) below about elevation 8 feet MLLW will be colonized by an abundance of epibiota. Intertidally, this biota will resemble the assemblage now present on riprap and pilings throughout the waterway. Dominant species will be barnacles and mussels; attached macroalgae will also be abundant in unshaded areas. Deeper riprap and pilings will support a community dominated by anemones, hydroids, tube worms, and tunicates. These substrata (riprap and pilings), although not occurring naturally in this area, are highly productive and provide habitat and feeding areas for a variety of fish (e.g., pile perch, shiner perch, Embiotocidae), shellfish (crab and shrimp), and some species of marine birds (e.g., goldeneye ducks).

Since the City's November 2002 design submittal, progress has been made in defining the actual habitat changes that will result from the Utilities' 30 percent remedial design for the head of the Thea Foss Waterway. Also, the design for the banks within the Wheeler-Osgood Waterway has been modified to reduce adverse habitat effects as a result of a site walk by the City and agency representatives in October 2002. These changes are reflected in Table 6-1. More recent (December 4, 5, and 19, 2002) site walks along Thea Foss

Waterway resulted in additional design changes that will further reduce impacts and increase the quality of nearshore habitats along the waterway. Refinements included shoreline designs for the area in front of the Esplanade, the cove south of Johnny's Dock, and on either side of the Colonial Fruit Warehouse on the west side of the waterway. These changes are *not* reflected in the tables attached to this memo but will reflect additional positive conservation measures provided by the remediation.

The net effect of remediation on most species present in the waterways will be positive. Remediation, especially in the southern portion of Thea Foss Waterway, will result in an increase of 1.95 acres of littoral habitat (area between mean higher high water (MHHW) and elevation –10 feet MLLW; Table 6-1). This depth range is considered to be important habitat for migration, feeding, and refuge of juvenile salmonids, including chinook salmon that are listed as threatened under the Endangered Species Act (ESA). In addition to reduced concentrations of chemical constituents, other habitat improvements will include removal of shoreline debris, removal of derelict overwater structures and pilings, reduced intertidal slopes, and provision of finer sediments in the interstices of necessary riprap and quarry spalls. Thus, remediation will result in a significant increase in both quality and area of habitat for juvenile salmonids. Over time, these improvements will more than offset the temporal loss of habitat function that could result from the lag in benthic recolonization and production that may occur during the first spring or two following remediation of specific segments of shoreline.

The net increase in littoral habitat will come at the expense of deeper water (sublittoral) habitat (i.e., deeper than elevation –10 feet MLLW), which will be reduced by 2.55 acres (Table 6-1). Although this deeper habitat has been artificially created by dredging of waterways in Commencement Bay (Simenstad 2000), it is used by a variety of fish and invertebrates including crabs *(Cancer* spp.) and flatfish. These same species will benefit to a high degree from the improved habitat quality resulting from remediation. Eaton (1994 and 1998) has shown that the demersal assemblage in Thea Foss Waterway is typical of those in contaminated and organically enriched waterways with low species diversity and dominance by pollution-tolerant species. This assemblage is expected to change following remediation to one more representative of uncontaminated sheltered marine waters in central and southern Puget Sound.

Given the nature of the testing conducted for establishing the SQOs (chemistry and bioassays based on the apparent effects threshold [AET] approach) and the results of sampling and analysis conducted during Round 2, benthic habitats failing to meet the SQOs are considered to be degraded. SQO and benthic

failures imply at least a 50 percent reduction in numbers of one or more important groups of benthic organisms relative to an uncontaminated control. Thus, it can be assumed that cleaning up the sediments to below SQOs will increase the quality of the habitat for flatfish and Dungeness crab feeding because of the greater abundance and quality of prey; not only is prey expected to be more abundant and diverse, but the prey also will not contain chemical constituents that could adversely affect flatfish or crabs. Since a flatfish or crab seeking refuge by burial in the sediment will no longer be in direct contact with toxic levels of chemical constituents, it also can be assumed that the quality of the remediated habitat for refuge will be similarly improved. Thus, habitat quality improvement will result in a substantial increase of ecological functions and a small increase in habitat area for these evaluation resources.

Capping of the mudflat and shallow subtidal area at the head of the Thea Foss Waterway (by others) will result in an overall improvement of habitat quality at this special aquatic site. The coarser materials used in the cap surface will provide sand and gravel habitat for clams that would more than offset the small reduction in area of mixed fines and gravel habitat lost. Shallower depths and the clean sandy surficial material will improve habitat for juvenile salmon and for waterfowl and shorebird feeding. Presence of the SR 509 Bridge and marina floats will continue to limit local benthic primary productivity and to limit the quality of the area for bird refuge.

The remedy will result in a net loss of approximately 0.60 acre of marine habitat area in Thea Foss Waterway because of capping along shorelines (1.95-acre gain in littoral habitat; 2.55-acre loss in sub-littoral habitat; Table 6-1). This small net loss of marine habitat area is considered to be significant by EPA and the Trustees, given the large historical losses of marine and estuarine habitat in Commencement Bay. However, the net loss is minor relative to the scope of the remediation, the offsetting mitigation/restoration provided, and the associated positive effects:

- Improvements in sediment quality (enhancement) over nearly 60 acres of habitat that are actively remediated (Table 6-1), and the associated improvement in the overall health of the marine environment;

- Cleanup of shoreline and benthic debris and improvements in the habitat quality of the nearshore migration corridor (restoration); and

- Net gain of 1.95 acres of littoral habitat in the Thea Foss Waterway (Table 6-1).

These effects include all long-term effects under either disposal alternative. These effects have been incorporated into the overall project mitigation/ restoration balance that is provided for each alternative in Section 6.5.

6.2.2 Upland Disposal Option – Middle Waterway Impacts

In addition to the effects of remediation in Thea Foss Waterway (e.g., net loss of 0.60 acre of tidal habitat), if the Upland Disposal Option were selected, the Contractor would construct a barge offloading facility in Middle Waterway. This sediment transloading facility, as described in Appendix V, Section 2.0, is expected to require placement of approximately 132 new pilings (90 structural; 30 fender; 12 for mooring dolphins). These pilings will be 24 inches or smaller in diameter, and concrete, except that the mooring dolphin piles, which may be steel. The cumulative footprint of these pilings will be approximately 0.01 acre. The facility will be on the order of 140 by 204 feet in overall size (not including mooring dolphins; Figure 6-2) but will minimize shading of littoral habitat by accessing the berth via two, relatively narrow, pier access trestles. The structure will shade approximately 0.42 acre of total water surface below OHW; of this, 0.23 acre of overwater coverage will be over the littoral zone between elevation 13 and –10 feet MLLW and 0.19 acre will be over waters deeper than –10 feet MLLW. Of the littoral shading, 0.14 acre will shade the Middle Corridor habitat area (which extends only to elevation –2 feet MLLW in the area of the pier (see Figure 6-1). As explained below, this area of the Corridor Habitat area is not credited as mitigation, even though the existing substrate will be improved.

To offset these losses, and provide the affirmative conservation measures required by the ESD, the project will excavate 0.63 acre of new intertidal habitat from uplands (see Figure 6-1) and will restore or enhance an additional 4.31 acres of littoral habitat on the St. Paul/Middle Waterway peninsula and along Middle Waterway (Table 6-2).

6.2.3 CDF Disposal Option - St. Paul Waterway Impacts

Use of the St. Paul Waterway as a CDF for contaminated sediments removed from Thea Foss and Wheeler-Osgood Waterways was initially calculated as a loss of approximately 13.6 acres of existing intertidal and subtidal habitat that is considered to provide low quality ecological functions (Round 3 DER, Appendix Z). As the result of a lengthy planning and negotiation between the City, Simpson, the Trustee agencies, and EPA, a habitat plan was developed to compensate for this loss and to restore and improve critical intertidal habitat in the Puyallup River delta area.

Subsequent developments have reduced the required size of the CDF and allowed the footprint of the CDF to be reduced by 2.5 acres to 11.05 acres in area (Figure 6-3). Moving the berm southward allows creation of a larger littoral area at the St. Paul Beach location but reduces the area that can be enhanced along the St. Paul/Middle Waterway peninsula (hereinafter, the Peninsula). Collectively, these two areas (St. Paul Beach and Peninsula) are referred to as the North Beach. In summary, these design changes reduce the habitat loss to the CDF fill by about 2.5 acres; allow the area of created and enhanced littoral habitat at North Beach to be increased from about 6.1 acres based on the original plan, to about 6.8 acres; and allow area for development of a fringing saltmarsh along the front of the CDF berm. However, a portion of these area gains is no longer counted in the Middle Corridor habitat area (see detailed discussion below).

In total, project remediation and sediment disposal in the CDF will result in a loss of 11.65 acres of existing waters of the U.S. (0.60 acre in Thea Foss Waterway and 11.05 acres in St. Paul Waterway; Table 6-4). No significant areas of saltmarsh or brackish marsh will be impacted by these actions and the general quality of habitats impacted by the remediation and sediment disposal is poor to mediocre (Round 3 DER, Section 7; [City of Tacoma 1999a]). A summary of changes in habitat area and ecological functions is provided in Section 6.5.

To offset these losses, the project will provide, through excavation of uplands (creation 9.15 acres), removal of flow restrictions (enhancement 1.92 acres), or filling of deeper water (enhancement 3.60 acres), 14.67 acres of new littoral habitat. Enhancement of an additional 8.93 acres of existing littoral habitat will provide a total habitat package of 23.60 acres (Table 6-3). Mitigation and affirmative conservation measures associated with the CDF Disposal Option are described in the following sections.

6.3 Mitigation/Restoration Objectives

The overall project goals included several specific habitat objectives to meet the ESD mitigation/restoration performance criteria, as follows:

- Improve habitat conditions in Thea Foss and Wheeler-Osgood Waterways and improve the shallow nearshore conditions for migrating juvenile salmonids;

- Mitigate for habitat degradation that would result from construction of the sediment transfer facility under the Upland Disposal Option; or

- Mitigate for losses of littoral habitat acreage that would result from the filling of St. Paul Waterway under the CDF Disposal Option; and

- Mitigate, in part through avoidance of inwater construction during periods of major salmonid use, for temporal loss of ecological functions that result from project construction. (Not a specific requirement of the ESD.)

- Provide a net increase in habitat function that will serve as an affirmative conservation measure, contributing to the recovery of salmonid populations.

The basic goal of the habitat plan under either disposal option is to increase the amount and quality of critical estuarine habitat available at strategic locations in the landscape in and/or near the mouth of the Puyallup River, while simultaneously providing a facility (the sediment transfer facility or the CDF) for disposal of contaminated sediments from remediation of the Thea Foss and Wheeler-Osgood Waterways. Because the mitigation/restoration actions proposed are in tidal waters, risk of complete failure is very low; only the freshwater component and the marsh development objectives in the CDF mitigation package have some risk associated with full achievement of success and these risks are dealt with in the OMMP.

Simenstad (2000) states that restoration of off-channel tidal and freshwater habitats above the mouth of the Puyallup River is of utmost priority to salmon habitat restoration in the terms of probable contribution to salmon recovery. A primary habitat goal under the CDF Disposal Option is to construct the Puyallup River Side Channel (Figure 6-4) to provide 4.7 acres of new, high quality off-channel habitat for juvenile salmonids in that portion of the estuary that is critical to osmoregulatory adaptation and transition to the Commencement Bay.

The location and nature of the proposed CDF offer an opportunity to expand the intertidal functions at the developing Puyallup River "neodelta." This limited habitat type is extremely important to juvenile salmonids and other organisms and has been identified as a particularly high priority by Simenstad (2000).

Another primary mitigation/restoration goal is to increase connectivity with a littoral access corridor between the Puyallup River neodelta and the Middle Waterway. This corridor around the St. Paul/Middle Waterway Peninsula provides intertidal habitat for juvenile salmonid feeding and improves the quality of the habitats they experience while moving away from the river mouth and would be significantly enhanced and expanded under either disposal option.

The basic elements of this habitat mitigation and restoration program are described below for each disposal option. Although the design of these habitat features has been tailored to maximize habitat benefits to juvenile salmonids, this has been achieved largely by seeking to maximize characteristics of the natural river delta. As such, the habitats provided will also provide high ecological functions for many other estuarine species including demersal and pelagic fish, invertebrates, birds, and mammals.

6.4 Mitigation/Restoration Components

6.4.1 Thea Foss Waterway

Remediation of the Thea Foss Waterway will include two primary elements: sediment removal/capping and bank/slope improvements that will enhance long-term marine habitat quality and the nearshore migration corridor for juvenile salmonids. These actions also will offset the short-term impacts of construction and the delay in provision of ecological function while newly created habitat is colonized by marine organisms.

6.4.1.1 Capping Materials

The surficial material used over the low gradient portions of capped areas of the waterways (Figure 1-1) will be a clean sand. Where steeper subtidal or intertidal slopes must be capped, a riprap may be required to provide necessary cap stability. In the littoral zone (between elevation –10 and 13 feet MLLW), these areas will receive a 2-inch minus pit run sand and gravel habitat mixture. Either of these cap materials are expected to have very low levels of total organic carbon (TOC; i.e., 0.1 to 0.5 percent).

It is expected that the organic content of these sediments will increase gradually over the years as has been observed in a sand cap placed over wood debris in Port Angeles (Pentec 2001). Two processes are believed to be acting to increase TOC. First, organic matter ranging from phytoplankton to zooplankton to larger species defecate and/or die and settle out of the water column. Second, the sediment grains will be colonized by assemblages of diatoms and bacteria. These organisms are grazed by infauna and epibenthos that defecate on or within the sediment column, providing a substrate for further bacterial colonization. At Port Angeles, the TOC went from 0.0 to 0.7 percent in 3 years. In Thea Foss Waterway, these processes are expected to act more rapidly because of the higher rate of primary productivity in Commencement Bay compared to those in the Strait of Juan de Fuca. In addition, the storm drains entering the waterway will provide additional sources of organic material.

6.4.1.2 Bank/Slope Improvements

Several different bank and slope treatments will be applied to various sections of the shorelines of the waterways to accomplish the remediation objectives and to improve habitat conditions. Where possible, intertidal slopes will be reduced and finer sized materials will be used.

- **Placement of Riprap and Quarry Spalls.** This may be applied after removal of bank sediment, riprap, or debris and placement of fine-grained cap materials. Riprap or quarry spalls will be sized to the minimum standard necessary to adequately protect shoreline and cap integrity. Two-inch minus gravelly sand habitat mix will be used to fill interstices of riprap that is placed at slopes of 2H:1V or flatter to increase moisture and silt retention and improve habitat characteristics. Habitat mix will be applied between elevations of –10 and 13 feet MLLW. Below about elevation –5 feet MLLW, the low energy environment will allow accumulation of the fine sediments that will enhance the function of the habitat mix.

Two areas in the waterway will require replacement or installation of a vertical bulkhead. The existing bulkhead at Johnny's Dock on the east side of the waterway is in poor condition and dredging in the marina is likely to undermine the existing structure. A replacement bulkhead would be installed in front of the existing wall. In addition, a bulkhead will be installed on the northern edge of the property. On the east side of the waterway, a bulkhead would be installed along the bank of Johnny's Seafood to provide sufficient water depths at the float plane dock.

6.4.2 Wheeler-Osgood Waterway

Remediation of the Wheeler-Osgood Waterway will include two elements (hot spot dredging and sediment capping/backfilling) that will benefit long-term marine habitat quality and offset the short-term impacts of construction and the delay in provision of ecological function while newly created habitat is colonized by marine organisms.

6.4.2.1 Capping Materials

Materials used for capping/backfilling in the Wheeler-Osgood Waterway (fine to medium sand) will be similar to those described for the Thea Foss Waterway (Section 6.4.1.1). Coarser materials (2-inch minus pit run sand and gravel mixture) are unlikely to be used in Wheeler-Osgood Waterway except along the

upper beach where the central mudflat of the waterway transitions into the steeper upper bank.

6.4.2.2 Bank/Slope Improvements

The bank restoration in the Wheeler-Osgood Waterway, constructed as part of the 2002 Construction Project, will stabilize roughly 10 percent of the 2,900 linear feet of the existing banks. Many of the individual bank restoration activities will be 25 linear feet or less and may employ a riprap key, usually in the elevation 4 to 6 feet MLLW range with quarry spall backfill to slopes of approximately 2H:1V or flatter and faced with habitat mix. Where riprap already exists on stable slopes, usually in the elevation 4 to 10 feet MLLW range, it will be faced with habitat mix to just cover the riprap. Banks with stable slopes having suitable fine-grained substrates will be enhanced by removal of anthropogenic debris; if depressions occur in the banks following removal of large pieces of debris, the depressions will be filled to grade with quarry spalls and/or fish mix. Extensive bank restoration of less than 200 linear feet following removal of the large creosote-treated timber pier in the southeastern corner of the waterway will require an engineered slope using a combination of riprap base key, filter material, and quarry spalls, with the surface faced with habitat mix. Existing anthropogenic debris, including timber piles, concrete and asphalt (greater than 12 inches), boat hulls, metal, and bricks, will be removed from the littoral zone.

6.4.3 Mitigation/Restoration under the Upland Disposal Option

Under the Upland Disposal Option, the relatively minor impacts of construction of the sediment transloading pier (pile installation and shading) will be more than offset by improvements made to littoral habitat between the St. Paul/Middle Waterway peninsula and along the inner east side of Middle Waterway. Thus, the actions described below provide both compensatory mitigation (those actions necessary to offset habitat losses due to remediation and sediment disposal) and restoration (those additional habitat improvements that will meet ESD requirements for affirmative contributions to salmonid recovery).

6.4.3.1 Middle Waterway Pier

The location and orientation of the Middle Waterway pier has been selected to avoid or minimize adverse impacts to the nearshore migration corridor available for juvenile salmonids. Exercise of this option will avoid the impact of filling 11.05 acres of habitat, including 10 acres of littoral habitat in St. Paul Waterway.

The following conservation measures are incorporated into the pier design:

- The size of the pier has been significantly reduced from that originally contemplated, which would have had an overwater coverage of nearly 1 acre.

- The pier is located as far offshore as possible (at the harbor line).

- The current design minimizes the impact of shading overall by using a north-south alignment and by placing the decking well above the high tide elevation.

- The current design minimizes the impact on the nearshore migration corridor by mandating a one-way traffic pattern that will access the berth via two relatively narrow (30-foot) pier access trestles (Figure 6-2) whereas the original design would have had a single 80-foot-wide access (see Appendix V).

- To the extent practicable, all materials will be steel or concrete to avoid leaching of potentially toxic materials into the marine environment.

- Use of concrete or steel pilings will reduce the overall number of pilings required, thus, minimizing impacts to juvenile salmonids moving along the shoreline. The underside of the concrete pile bents and decking panels will be a light color to maximize under pier light levels.

- All stormwater and water from sediment handling actions will be directed landward into Simpson's stormwater treatment system or other EPA-approved treatment pathway prior to release.

Additional pier design details and operational BMPs are described in Appendix V.

Following its use for the Thea Foss Waterway remediation, the pier will be left in place for use as a marine cargo handling pier by the property owner. Leaving the pier in place will avoid the disruption to the Middle Waterway Corridor habitat area and to the Middle Waterway CERCLA cleanup that would result from pier demolition and pile extraction. Use of the pier for log handling from barges to the shore will result in less disturbance to littoral habitat in St. Paul Waterway where logs are now moved from water to land.

6.4.3.2 St. Paul/Middle Waterway Peninsula

The Peninsula habitat area is common to both disposal options but will be smaller under the Upland Disposal Option. Under this option, the City will remove over 1,700 creosote-treated pilings from the outer portion of the peninsula between Middle and St. Paul Waterways. This will add approximately 0.03 acre of new soft-bottom benthic habitat (where pilings are removed), will enhance approximately 2.86 acres (Table 6-2) of littoral habitat, and therefore, will improve the nearshore migration corridor of juvenile salmonids leaving the Puyallup River neodelta to the southwest.

The shoreline at the tip of the peninsula will be further enhanced by removal of the large concrete blocks that currently armor the tip and replacement with large riprap placed on a 2:1 slope. Habitat mix will be added to fill the interstices in the riprap below elevation 14 feet MLLW. West of the present location of the concrete blocks, in the area of a former log transfer facility (LTF), 0.75 acre of existing littoral habitat (Figure 6-1) will be expanded and enhanced as follows. The existing remnants of the asphalt LTF ramp will be removed. The shoreline and adjacent uplands above about elevation 8 feet MLLW will be excavated and sloped gradually to expand the existing pocket beach by approximately 0.55 acre. This area and the existing beach habitat (0.75 acre) will be stabilized as necessary with rounded river cobble that will be covered with a 0.5-foot layer of relatively fine-grained habitat mix. These materials are expected to be sorted by wave action into sediment bands that are stable for a beach with this slope and exposure. Four pieces of large woody debris (LWD) will be anchored into the upper beach between elevations 10 and 12 feet MLLW to increase habitat complexity. At and above OHW, the embankment leading to the uplands will be armored with large riprap. Overall, these actions will create 0.55 acre of new intertidal habitat and enhance 0.75 acre of existing habitat (Table 6-2).

Limited riparian plantings will be placed in soil among the riprap protecting the slope along the face of the CDF above OHW. Target species will include willows *(Salix* spp.), ocean spray *(Holodiscus discolor),* black cottonwood *(Populus trichocarpa),* red currant *(Ribes sanguineum),* and Douglas fir *(Pseudotsuga menziesii).*

6.4.3.3 Middle Waterway Corridor

The Middle Waterway Corridor habitat area is common to both disposal options but, because the Middle Waterway Marsh and Mudflat habitat area will not be constructed under the Upland Disposal Option, the Corridor habitat area size can be increased. The Corridor habitat area is a narrow strip of shoreline just

north of the proposed Middle Waterway pier location that connects the Peninsula habitat area to the broad mudflats and restored marshes in the southern portion of Middle Waterway. Under the Upland Disposal Option, this habitat area will extend to the south of the Transloading pier and will occupy 1.01 acres (Figure 6-1).

This corridor will be an intertidal beach with a moderate slope in the 0- to 6-foot MLLW tidal range. Smaller juvenile salmonids generally prefer such a corridor as a relatively safe migration route (compared with deeper water where more salmonid predators may reside). The intent of this corridor is to provide shallow water shoreline access to and from Middle Waterway habitat during most tidal conditions. The function of this shoreline as a migration corridor will be enhanced by replacing the existing concrete rubble intertidal with a more gradually sloping gravel-cobble beach and by adding LWD (tree boles with root wads) to increase habitat complexity and cover. Eight LWD pieces will be anchored between 6 and 12 feet MLLW. Boles will have attached rootwads and will be a minimum of 18 inches in diameter and 20 feet in length. Boles will be anchored in the bank so that the rootwads are exposed and in contact with the beach surface.

A portion of this habitat area (0.14 acre) will be shaded by the Middle Waterway pier; this area is not included as a credit in the habitat area calculations provided below (Section 6.5) and shown on Table 6-2. Thus, the Middle Corridor habitat area will provide 0.08 acre of new intertidal habitat from excavation of uplands and is conservatively considered to enhance an additional 0.70 acre of existing littoral habitat.

6.4.4 Mitigation under the CDF Disposal Option

A major project habitat objective under the CDF Disposal Option is to create a nearly continuous habitat corridor from the mouth of the Puyallup River across the rebuilding delta to the head of Middle Waterway. This objective includes construction of habitat access that is expected to improve juvenile salmonids utilization of the tideflats at the head of Middle Waterway (Figure 6-5). Other objectives include construction of higher quality habitat than currently exists along this corridor, and development of greater habitat complexity than currently exists.

These features are thus consistent with Simenstad (2000) and are designed to increase the capacity of the existing estuarine habitat in degraded areas of St. Paul and Middle Waterways. This increased capacity will promote juvenile salmon survival by increasing productivity and availability of selected

invertebrate prey and the conditions that maintain these prey communities. The structural characteristics of the proposed habitats are also designed to provide more complex side channel and mudflat habitats than currently exist in the wide, open dredged waterways with their "hard" shorelines.

These features are also designed to increase the opportunity for juvenile salmonids using the existing estuarine habitat near the mouth of the Puyallup River to access and benefit from the capacity of the restored and enhanced littoral habitat. The position of the habitat components in the delta estuary landscape is designed to increase opportunities compared with those now provided in the St. Paul Waterway, which is essentially unvegetated, is disturbed by industrial activity, and is relatively isolated. This approach includes connecting to the rebuilding delta islands and the Simpson Cap via the North Beach and the connecting Middle Waterway Corridor to restored and expanded habitats in Middle Waterway. Existing restored habitats along the east side of the waterway (Simpson/Trustee site) and around the southwest corner of the waterway (City of Tacoma NRDA site) will be enhanced by creation of additional mudflat and tidal channel habitat and the introduction of some freshwater input and brackish marsh.

In addition, the original and expanded tideflats of Middle Waterway, in combination with detrital input and other values of the riparian zone of the planned Middle Waterway tideflat habitat, will provide greater separation from upland industrial activities than now is provided at the existing head of St. Paul Waterway.

It is fully expected that the net cumulative effect of filling the St. Paul Waterway and constructing the habitats described below will result in a substantial improvement for most species over existing conditions in terms of residence time, foraging success, growth, and other relevant species-specific functions. Diverse species of juvenile salmon at various life stages are expected to utilize the planned habitat. Documenting this level of use will be a focus of the Mitigation Performance Monitoring and Adaptive Management Plan (MAMP).

Resource agency representatives have therefore asked that design criteria include riparian, saltmarsh, and corridor habitats as part of this plan. They have also asked that a freshwater supply be included to assist in the establishment of brackish marsh vegetation in a portion of the new marsh habitat in Middle Waterway and, potentially, to contribute to attracting juvenile salmon at earlier life stages to tidal side-channel habitat. EPA has asked that this freshwater source be sufficient to create a brackish plume that provides rearing and osmoregulatory habitat for pre-smolt salmon. The City has investigated the

feasibility of providing such a plume and found it to be poor (see Section 6.4.4.2.2 and Appendix R).

Specific objectives to meet these mitigation/restoration goals for the CDF Disposal Option are as follows:

- Provide higher quality intertidal habitat than currently exists from the edge of the previously constructed delta habitat to the existing habitat at the head of Middle Waterway;

- Increase the habitat function of intertidal and shallow subtidal habitat between the delta and inner Middle Waterway;

- Provide an improved juvenile salmonid migration corridor from the Puyallup River delta to habitats in the inner (southern) portion of Middle Waterway, and provide rearing habitat to support upstream restoration efforts;

- Add habitat complexity to the existing intertidal habitat by establishing conditions that will allow brackish marsh, saltmarsh, and riparian vegetation development in and adjacent to the habitats to be constructed; include a freshwater source to the Middle Waterway marsh/tidal channel;

- Construct additional side-channel habitat along the lower Puyallup River channel to provide off-channel refuge and rearing habitat and alleviate a portion of the artificial conditions produced by the diked river channel; to be accomplished by removing a tide gate and a portion of the dike separating the river from an existing 1.92 acre wetland and 2.25 acres of existing uplands, to be excavated to form 4.17 acres of continuous off-channel habitat;

- Increase the opportunity for additional future habitat actions such as the Olympic View Resource Area restoration to succeed by providing an environment that will improve juvenile salmonid migration conditions along the edge of Commencement Bay; and

- Provide adequate compensation for the temporal loss of function resulting from Thea Foss remediation and to replace the existing habitat values lost to construction of the CDF in St. Paul Waterway. The post-remediation Thea Foss Waterway and the constructed mitigation/restoration habitats will provide both higher quality habitat than currently exists and a more continuous corridor from the Puyallup River delta to the Ruston Way tideflats.

Despite the excellent track record of tidal restoration projects in Puget Sound, the City recognizes the uncertainties inherent in restoration science. Thus, the plan has been designed to include more littoral area and greater ecological function than the areas affected by the action. By providing a more diverse edge and higher functioning juvenile salmonid habitat than currently exist in the neodelta, and a MAMP to ensure that the planned functions are attained, the design of mitigation actions associated with the CDF Disposal Option will provide a margin of safety in the event that some intended functions are not fully realized and will also provide substantial affirmative conservation measures beyond the simple requirement to mitigation for lost area and functions.

6.4.4.1 North Beach (St. Paul Beach and Peninsula)

The North Beach habitat area is comprised of two contiguous areas between the mouth of St. Paul Waterway and the entrance to Middle Waterway (Figure 6-3). Under the CDF Disposal Option, the St. Paul Beach would be the 1.65-acre portion of the habitat plan that lies immediately north of the St. Paul berm; the 5.06-acre area north of the uplands of the peninsula between St. Paul and Middle Waterways is termed the Peninsula habitat area. Under the Upland Disposal Option, only the outer portion of the Peninsula habitat area would be enhanced by removal of pilings (Section 6.4.3.2).

Under the CDF Disposal Option, the existing fuel dock at the Simpson Tacoma Kraft Mill would be upgraded to move the fuel barge berthing area to the north (Figure 6-3). The dock modifications would add approximately 0.03 acre of additional over water coverage from the new facility. However, the net increase in overwater coverage would be over water deeper than –10 feet MLLW.

6.4.4.1.1 Objectives

Under the CDF Disposal Option, the objective of the North Beach habitat area is to create a productive shallow water migration corridor for juvenile salmonids migrating out from the Puyallup River. To meet this objective, North Beach has been designed to maximize the area of littoral habitat between elevation –4 feet MLLW and OHW (approximately elevation 13.5 feet MLLW).

6.4.4.1.2 Design

St. Paul Beach. The St. Paul Beach habitat area has been designed to be compatible with the CDF design and to maximize the area of low-gradient, fine-grained habitat in the area between the Tacoma Kraft Mill and the Peninsula habitat area. The primary constraint on this area is the need to maintain a berth

area at elevation –20 feet MLLW in front of the Tacoma Kraft Mill fuel dock and the need to provide a high probability that the mitigation/restoration contours will persist in the extant wave and propeller wash energies. Appendix M provides an analysis of the erosive forces that are likely to impact the St. Paul Beach area including wind waves, ship waves, and propeller scour from tugs operating near the fuel dock.

To accomplish the design objective and to accommodate these constraints, a sub-tidal berm will be constructed just south of the fuel dock berth area (Figure 6-3). The toe of the subtidal berm will be at approximately elevation –20 feet MLLW and the crest at –4 feet MLLW. The berm will be constructed of riprap and other suitable material as shown on the Plans and will be at a slope of 2H:1V.

From the top of the sub-tidal berm, the beach will slope upward at a low angle (10.8H:1V or flatter) to approximately elevation 8 feet MLLW. This portion of the beach will be a productive gravelly sand (habitat mix) flat that is expected to develop infaunal and epibenthic zooplankton assemblages that resemble those which have been documented on the Simpson Cap (Parametrix 1998). A steeper (3H:1V) transition will be constructed within the beach to raise the beach elevation from 8 to 10 feet MLLW. To ensure its stability, this transition will be engineered and surfaced with quarry spalls. Habitat mix will be applied to fill the interstices among the spalls. From there to the intersection with the existing Tacoma Kraft Mill fill to the east and the berm to the south, the beach will slope gradually upward, meeting the CDF berm at approximately elevation 13.5 feet MLLW. The 8-foot elevation will be continued into this flat as a bifurcated channel to allow juvenile salmonid to use the area during tides between 8 and 10 feet MLLW (Figure 6-3). The beach will be continuous with the new intertidal habitat of the Peninsula habitat area.

The area between elevation 10 feet and OHW (elevation 13.2 feet MLLW) will be of an elevation and substrate that will allow colonization and development of a halophytic saltmarsh. During the first year following construction, considerable movement and sorting of surficial sediments are expected. However, over time, this area is expected to be colonized by species such as *Salicornia virginica* and *Distichlis spicata* at lower elevations and by these species as well as *Atriplex patula*, *Plantago maritima*, *Deschampsia caespitosa*, and *Grindelia integrifolia* at higher elevations.

Surficial material on the St. Paul Beach habitat area will be a clean 2-inch minus gravelly sand habitat mix. Analysis of erosive forces in Appendix M indicate habitat mix materials (slightly gravelly sand) on the flat habitat beach from

elevation –4 to 8 feet MLLW are suitable for the anticipated wave climate. If excessive erosion should occur at the site, increasingly coarse materials may be added as directed in the adaptive management process described in the OMMP. Sediment eroded from the surfaces of the St. Paul Beach, Peninsula, and Simpson Cap habitat areas is expected to result in a need for periodic maintenance dredging of the slips at the fuel dock and chip dock.

Peninsula. The Peninsula habitat area (5.06 acres of littoral restored habitat under the CDF Disposal Option) will include a continuation of the shallow water habitat contours of the St. Paul Beach area (Figure 6-3). The majority of the approximately 1,900 creosote-treated piles in the Peninsula area will be removed, if possible, or, if inadvertently broken off, will be covered with a minimum of 3 feet of clean sand. Under the Upland Disposal Option, pilings would only be removed from the outer portion of the Peninsula habitat area.

Under the CDF Disposal Option, surface debris will be removed or covered with 0.5 to several feet of sand. The Peninsula habitat area will allow for development of an undulating band of marsh habitat at elevation 10 to 12 feet MLLW, above the steeper transition between 8 and 10 feet MLLW. The upper beach will slope to a relatively low pass across the central area of the Peninsula. This pass will allow juvenile salmonids moving across the face of the St. Paul Beach at tides above MLLW to continue their migration in relatively protected shallow water into the entrance to Middle Waterway.

North of the pass, the Peninsula habitat will rise to an offshore shoal or reef at elevation 12 feet MLLW (Figure 6-3). This shoal will shelter areas to the south and east from waves from the northwest. The outer surface of the offshore shoal will have rock protection to absorb the erosive forces of waves reaching the site. The sheltered upper beach on the south side of the shoal may support saltmarsh vegetation similar to that expected at the St. Paul Beach. To maximize habitat value, the remainder of the Peninsula will be constructed with a sandy material except where coarser materials are required to resist wave or propeller wash erosion.

The east side of the peninsula between elevation –15 and 0 feet MLLW will be subjected to propeller wash erosion during docking and undocking of the barges at the Simpson Tacoma Kraft Mill fuel pier (see Appendix M). This area will be protected with heavy riprap and habitat mix will be placed in the interstices. As energy from the propeller wash is dissipated, rounded river cobbles (6-inch minus) with habitat mix provide sufficient protection against erosive forces along the low pass between the St. Paul and Middle Waterways. In addition, the

rounded river cobbles provide suitable protection against wind waves from the northerly direction (see Appendix M).

6.4.4.1.3 Construction

St. Paul Beach. Site preparation at St. Paul Beach will require removal of existing pilings, especially along the western edge. The slope of the submerged habitat berm will be constructed during construction of the CDF berm using clamshell placement of berm materials. The 16-foot-high berm will be placed in lifts with clean fill placed in layers behind the berm face as it is built. Once the berm height has reached elevation –4 feet MLLW, the final surficial materials will be placed by clamshell. Above about MLLW, the final beach grade may be smoothed and compacted for stability by tracked equipment working at low tide. The steeper transition between elevation 8 and 10 feet MLLW will be constructed in the dry but the final beach grade above the transition may be placed either from a barge by clamshell or by land-based vehicles.

To accelerate colonization, during the first or second spring following construction, a minimum of two 16- by 16-foot (5- by 5-m) nodes of plantings will be made at each of two elevations. The nodes at about elevation 10.5 feet MLLW will consist of *Salicornia virginica* and *Distichlis spicata* interspersed and planted with approximately 12- to 15-inch (0.3- to 0.4-m) spacing. The nodes at elevation 12 feet will be planted with *Distichlis spicata* (lower half) and *Deschampsia caespitosa* (upper half) with similar spacings. All planted nodes will be provided with goose exclusion fencing, netting, or other deterrents that have proven effective in reducing or eliminating herbivory. Once vegetation has become well established in the nodes, goose exclosures will be relocated to an area adjacent to the node to promote colonization by marsh vegetation. The City will maintain the exclosures for 5 years from the time of planting; after 5 years, the exclosures will be removed or turned over to another party for maintenance. The marsh plantings will be monitored and undesirable non-native species removed as described in the OMMP Section 4.3.

Limited riparian plantings will be placed in soil among the riprap protecting the slope along the face of the CDF above OHW. Target species will include willows, ocean spray, black cottonwood, and red currant.

Peninsula. The Peninsula habitat area will require significant preparation; as noted above, the majority of the approximately 1,900 wooden pilings will be pulled, if possible, or if inadvertently broken off above the surface, will be cut so they are a minimum of 3 feet below the final surface after filling. Pilings that are inadvertently broken must be cut so that a minimum of 3 feet of clean sediment

covers the remainder of the piling once the beach is constructed. In the pass area, shallow excavation will be required to reach the final invert elevation of the pass. Locations of all pilings left in place will be plotted on as-built drawings.

Placement of the final beach surface materials, construction of the steep transition, and completion of the beach will be as described for the St. Paul Beach. Riprap, designed to protect the shoal at the end of the Peninsula (Figure 6-3), will be placed by barge and clam shell.

To accelerate colonization, during the first or second spring following construction, a minimum of one 16- by 16-foot (5- by 5-m) node of plantings will be made at each of two elevations. The lower and upper elevation nodes will be planted and protected as described above for the St. Paul Beach. All planted nodes will be provided with goose exclusion fencing, netting, or other deterrents that have proven effective in reducing or eliminating herbivory. Goose exclosures will be maintained/relocated for 5 years by the City as described above. The marsh plantings will be monitored and undesirable non-native species removed as described in the OMMP Section 4.3.

Riparian plantings will be placed in soil among the riprap protecting the slope above OHW and in areas along the top of the bank. Target species will include willows, ocean spray, black cottonwood, Douglas fir, and red currant.

6.4.4.2 Middle Waterway Corridor, Marsh/Mudflat/Channel, and Freshwater Source

6.4.4.2.1 Objectives

Three elements are included as mitigation for filling of the St. Paul Waterway under the CDF Disposal Option; these elements will expand habitat area and enhance long-term marine habitat quality along the east side of the Middle Waterway. These include the Middle Waterway Corridor, Middle Waterway Marsh/Mudflat/Channel, and the freshwater source (Figure 6-5).

Because the relocated log haul out lies between the Middle Waterway Corridor and the Marsh and Tidal Channel habitat areas, a series of BMPs has been established by Simpson to help protect the habitat values of both areas (Attachment 4 to Round 3 DER, Appendix Z) but connectivity between the two habitats will be impacted to some degree during operating activities at the log haul out. The OMMP describes a program for monitoring woody debris accumulations along shorelines in Middle Waterway. Adjustments may be made to log handling procedures to reduce adverse effects on habitat, if determined to

be necessary in the adaptive management process (Section 6.6 and OMMP Section 4.3.4).

6.4.4.2.2 Design

Middle Waterway Corridor. The Middle Waterway Corridor habitat area (0.85 acre) is a narrow shoreline that connects the North Beach habitat to the broad mudflats and restored marshes in the southern portion of Middle Waterway (Figure 6-5). This corridor will be an intertidal beach with a moderate slope in the 0- to 6-foot MLLW tidal range. Smaller juvenile salmonids generally prefer such a corridor as a relatively safe migration route (compared with deeper water where more salmonid predators may reside). The intent of this corridor is to provide shallow water shoreline access to and from the Middle Waterway habitat during most tidal conditions. The function of this shoreline as a migration corridor will be enhanced by replacing the existing concrete rubble intertidal with a more gradually sloping gravel-cobble beach and by adding tree boles with root wads (LWD) to increase habitat complexity and cover.

Middle Waterway Marsh/Mudflat/Channel. This portion of the site is currently primarily uplands (6.90 acres) along with a narrow, privately owned portion of the existing tideflat (3.02 acres). The 6.90-acre area of industrially zoned uplands adjacent to Middle Waterway will be excavated to construct new riparian, marsh, tide channel, and tideflat habitat (Figure 6-5). The riparian habitat will be relatively narrow (5 to 10 feet wide) along the northwestern end and broader (to 25 feet wide) along the southeastern end. Elevations that will support marsh vegetation will be of varying width (10 to 60 feet wide) between elevations 9 to 13 feet MLLW. Most of the area will be tideflat habitat in the elevation range of 0 to 10 feet MLLW.

Relatively steep transitions will be made between upland, marsh, and channel portions of the habitat to maximize the amount of area at the more desirable elevations by maximizing the amount of relatively flat area (tidal terraces) within specific tidal elevations (0 to 8 and 10 to 13 feet MLLW). The design also will maximize shoreline length at mean tide elevation (7 feet MLLW) by including sinuous contours.

This portion of the project will provide 9.92 acres of new and enhanced tideflat and marsh habitat that will substantially increase the quantity of functional habitat as well as enhance the function of existing intertidal habitat within Middle Waterway.

To the south, this habitat will be integrated with the existing elevations of the Simpson/Trustee Natural Resource Damage (NRD) Middle Waterway Shore Restoration Project. The proposed habitat area does not include acreage already in the adjacent NRD restoration project (Figure 6-5). The 0.85-acre Middle Corridor habitat described above is in addition to and is not included within these 9.92 acres.

A lower intertidal channel will be constructed to provide an access corridor from the subtidal portions of Middle Waterway deep into the new intertidal habitat. The lower intertidal channel (elevation –4 to 0 feet MLLW) will provide refuge for fish within the intertidal habitat except for brief periods during extremely low tides; nearly all of the current tideflat becomes completely dewatered at tide levels below about 6 feet MLLW.

Freshwater Supply. A freshwater supply will be provided for brackish marsh areas to be constructed within Middle Waterway. Water will be supplied from an existing source. The primary purpose of this freshwater supply is to aid in the establishment of desirable brackish marsh vegetation. A distribution system will be provided to release the freshwater just above expected marsh elevation (about 12 feet MLLW).

The objective is to provide sufficient freshwater flow to allow a marsh with brackish (rather than haline) characteristics and species to develop over an area of approximately 6,000 sf or more. The supply will be capable of providing 30 gpm of flow and will be valved to allow flow adjustment between 0.1 and 10 gpm to each of three 2,000 sf marsh areas. Initial calculations suggest that less than 1 gpm may be sufficient to allow a brackish marsh to persist over each area. Freshwater from the supply that is in excess of that needed to support the brackish marsh areas will be released to the beach surface at about elevation 13 feet MLLW and allowed to flow into one of the lateral branches of the excavated channel. Additional area may develop characteristics of the brackish marsh if supportable by the available flow but the City does not propose to plant any additional brackish marsh area, unless determined to be necessary under the OMMP. Target species include *Carex lyngbyei*, *Scirpus maritimus*, *Juncus balticus*, and other typical brackish marsh species.

A second objective for the freshwater inflow, to provide sufficient freshwater flow to create a brackish plume that might connect with the Puyallup River plume under north wind conditions, was added by EPA in the ESD and amplified in EPA's January 31, 2001, letter to the City. The ESD (page 30) required a freshwater source that "must provide enough volume to create a freshwater lens six inches deep under stratified conditions and extends [sic] at least two-thirds of

the waterway." In a letter to the City (dated January 31, 2001), EPA added a provision that the freshwater plume must "provide osmoregulatory support" for juvenile chinook salmon, or to provide sufficient freshwater flow to create a brackish plume that might connect with the Puyallup River plume under north wind conditions. In a subsequent meeting (May 3, 2001), EPA's consultant suggested that a plume consisting of a thin lens with water of less than 5 ppt would provide an opportunity for continued osmoregulatory adjustment by chinook fry migrants.

The City evaluated the feasibility of achieving this second EPA freshwater objective. Field data and empirical modeling (Appendix R) indicate that a substantial flow of water (e.g., more than 2 cfs; 900 gpm) would be required to reduce salinity in the surface waters of Middle Waterway by 1 to 2 ppt (e.g., from about 29.5 ppt down to 28 ppt). In excess of 25 cfs (11,200 gpm) would be required to produce a plume with salinity as low as 15 ppt. Such a reduction would not produce a brackish water area that would provide an improved osmoregulatory benefit to juvenile salmonids. Use of booms to constrain the freshwater could result in lowered surface salinities in smaller subareas of the waterway; however, such structures may well exclude the very fish that should benefit from the plume, would only be effective during a portion of the tidal cycle, and would ground at lower tides, impacting benthos. Therefore, the City proposes to provide only the freshwater flow to Middle Waterway that is required to maintain the three areas of brackish marsh.

6.4.4.2.3 Construction

Middle Waterway Corridor. Construction of the Middle Waterway Corridor will begin with removal of existing concrete and rubble material from the steep upper beach and from the lower angled lower beach. The upper beach, between elevations 6 and 13.2 feet MLLW will be laid back, where possible, to provide a final grade no steeper than 2H:1V. The final grade will be protected with riprap, sized as necessary for the site exposure and slope. A habitat mix of approximately minus 2-inch pit run sand and gravel will be added to the riprap to fill the interstices, increase moisture retention, and improve habitat characteristics.

The cleaned up lower beach, between elevations of approximately 0 and 6 feet MLLW, will be covered with a 1-foot layer of 6-inch minus rounded river cobbles to protect the beach slope and sediments; this layer will, in turn, be covered with a 1-foot surface layer of 2-inch minus pit run sand and gravel as the final habitat surface.

A minimum of six tree boles with attached root wads will be anchored along the Corridor area between elevations 0 and 12 feet MLLW to add to shoreline complexity. Boles will be anchored in the bank so that the rootwads are exposed and in contact with the beach surface.

Middle Waterway Marsh/Mudflat/Channel. Existing structures, vegetation, and debris piles will be removed from the site before site excavation begins. One of two clumps of cottonwood trees adjacent to the Simpson/Trustee NRD restoration site will be protected as part of the planned riparian zone (Figure 6-5). The other clump will be removed to accommodate creation of additional estuarine habitat. Site preparation and excavation of upland areas of the site above OHW can be accomplished during fish window closures when no work is allowed that could affect anadromous fish. If work is conducted during such periods, a temporary berm will be left in-place to isolate work areas from tidal waters. The riparian zone will include a multi-story canopy mix of overhanging, diverse native trees and shrubs, similar to that planted at the two other restoration sites in the waterway.

Steep transitions are included in the design to maximize the amount of area available to construct the desired habitat. A steep riparian slope (approximately 2H:1V) will connect the remaining uplands at about elevation 18 feet MLLW and the high marsh elevation (13 feet MLLW). Native trees and shrubs will be planted and maintained in this riparian habitat. A solid fence will visually separate the riparian and intertidal area from the industrial activities of the adjacent uplands.

Since lower elevation habitat features will be constructed by excavation from well-established soils, the transitions between tidal terrace areas will commonly not require structural support. A low saltmarsh terrace will be constructed from approximately elevation 10 to 12 feet MLLW and is expected to be colonized by vegetation such as diatoms, *Eleocharis* sp., *Salicornia virginica*, *Distichlis spicata*, and *Glaux maritima*. High saltmarsh will continue from elevation 12 to 13+ feet MLLW and is expected to support these species plus *Deschampsia, Plantago, Grindelia,* and *Atriplex* spp. The widths of these terraces will vary as shown on Figure 6-3. Below elevation 9 to 11 feet MLLW, the substrate will be remnant delta material uncovered by excavation of materials previously used to fill the historical tideflats to upland elevations. This remnant material is silty sand material that was previously dredged from the delta to construct the Middle and St. Paul Waterways. Except as noted below, these areas will not be planted; rather, they are expected to colonize naturally.

The tidal channel system will be the last contour to be constructed. The –4-foot elevation of the tidal channel will extend for at least two-thirds of the site length. To mimic natural tidal channels, the side slopes of the channel will be steep to near vertical. The invert elevation of side channels, and the head of the main channel will gradually slope up to meet the adjacent grade. The head of the main channel will connect to the existing Middle Waterway NRD project at south end of channel at about elevation 10 feet MLLW; the area of the NRD project where the connection would occur is not counted in the area of the Middle Waterway Marsh/Mudflat/Channel (Tables 6-3 and 6-4).

Simpson has committed to minimize lighting next to habitat where feasible and to direct adjacent upland lighting away from the habitat area.

The portions of the site that are intended to become brackish marsh, three, 100 by 20 feet sections along the east side, will be excavated 1 foot below final grade. The excavation will be lined with a geosynthetic clay liner (GCL), which will serve as an aquitard, backfilled with 12 inches of silty, fine sand to the final grade.

If available materials have a low organic content (e.g., <0.5 percent), organic matter amendments will be added and mixed with those materials to increase moisture retention, slow percolation of freshwater, and increase the rate with which marsh vegetation establishes and spreads.

At the upper margin of the brackish marsh areas at approximately elevation 11.5 to 12 feet MLLW, three linear freshwater distribution systems (e.g., subterranean diffusers) will be installed as shown on Figure 6-5 and the Plans. Irrigation water will be provided via 100-foot diffusers placed in an excavated trench at approximately elevation 12 feet MLLW. The diffuser pipes will be surrounded by filter gravel such that water flow percolates through the brackish marsh soil above the aquitard described above. Water will be piped to each diffuser from an existing source. A valve will be provided to allow flow control between 0.1 and 10 gallons per minute to each marsh area. Irrigation water will be provided, as needed, to maintain soil salinity less than 14 parts per thousand (ppt), with a target range of 5 to 10 ppt, from at least March through October; 14 ppt provides maximum cover of *Carex lyngbyei* in the nursery marsh in the Hylebos Waterway (Thom et al. 1999). A line will be constructed to release flow in excess of that needed for the marshes onto the beach at about elevation 13 feet MLLW. Flow will not be required during the rainy season (expected to be November to at least mid-February) when plants are dormant.

Planting from nursery stock will be the initial means to establish the three 2,000-sf plots of brackish marsh vegetation in those areas where freshwater can be supplied to initially maintain the plants. A combination of bare root plants and plugs will be considered for planting based on experience gained on other sites in the bay. Additional marsh is expected to establish from natural seed sources such as Gog-Li-Hi-Te and remnant and restored marsh areas in the Middle Waterway.

To accelerate colonization in other areas of the marsh, during the first or second spring following construction, a minimum of two 16- by 16-foot (5- by 5-m) nodes of plantings will be made at each of two elevations. The nodes at about elevation 10 feet MLLW will consist of *Salicornia virginica* and *Distichlis spicata* interspersed and planted with approximately 12- to 15-inch (0.3- to 0.4-m) spacings. The nodes at elevation 12 feet will be planted with *Distichlis spicata* (lower half) and *Deschampsia caespitosa* (upper half) with similar spacings. The brackish marsh area and all planted nodes will be provided with goose exclusion fencing, netting, or other deterrents that have proven effective in reducing or eliminating herbivory. Once vegetation has become well established in the nodes, goose exclosures will be relocated to an area adjacent to the node to promote colonization by marsh vegetation. The City will maintain the exclosures for 5 years from the time of planting; after 5 years the exclosures will be removed or turned over to another party for maintenance. The marsh plantings will be monitored and undesirable non-native species removed as described in the OMMP Section 4.3.

The riparian area above OHW will be hydroseeded with native grasses. Riparian shrub and tree plantings will be placed in soil above OHW, in areas along the top of the bank where space is available, and around the clump of existing cottonwoods at the south end of the habitat area. Target species will include willows, black cottonwood, ocean spray, Douglas fir, and red currant.

6.4.4.3 Puyallup River Side Channel

6.4.4.3.1 Objectives

As part of the compensation for the filling of the St. Paul Waterway for the CDF, the Puyallup River Side Channel (Figure 6-4) is intended to provide 4.17 acres of important off-channel habitat that is used for rearing and refuge from river currents by juvenile salmonids during their migration to the estuary. Low energy brackish marsh conditions may also be used by ocean-type chinook salmon to continue or complete physiological adaptation that will allow them to osmoregulate in more marine conditions. Simenstad (2000) pointed out that this

type of habitat is nearly absent along the lower Puyallup River and identified this type of project as of utmost importance to restoring salmonid habitat in the system. The proposed side channel habitat, including the adjacent riparian zone, will increase this important habitat type by 4.17 acres. This site is located just downstream and across from the Port of Tacoma's Gog-li-hi-te wetland and will complement the functions of that created off-channel habitat.

6.4.4.3.2 Design

The project will be designed to provide a wide (100-foot plus at the 12-foot elevation contour) connection between the existing 1.92 acre freshwater or low salinity marsh area and the adjacent 2.25 acres that will be excavated from existing uplands (Table 6-3; Figure 6-4). The breach entrance to the river will be armored with heavy riprap to minimize erosion of the remaining spur dikes. Interstices in the riprap will be filled with a 2-inch minus sand and gravel habitat mix below elevation 16 feet MLLW. The interior dike will be designed to be as narrow as practical to maximize habitat area below OHW (about elevation 13.2 feet MLLW). The site design includes a central channel that will contain water, allowing fish access, during most tides. A substantial area will be left between elevations of about 6 and 13 feet to allow development of a brackish marsh and riparian assemblages that will provide prey for juvenile salmonids and organic matter for export to the greater Commencement Bay ecosystem.

6.4.4.3.3 Construction

The project will be constructed by excavating approximately 2.25 acres of uplands adjacent to an existing wetland; tidal circulation and anadromous fish access will be restored by breaching the river dike (Figure 6-4). The approximately 1.92 acres of freshwater and brackish marsh habitat was constructed in 1989 and connects to the Puyallup River through a 12-inch pipe with a tide gate. Site excavation and contouring will be completed in isolation from the river (with the tide gate closed) and can occur anytime during the year provided that flow from the culvert meets applicable water quality criteria.

To prevent flooding of adjacent upland properties landward of the side channel habitat during extreme river flows and high tides, a dike will be constructed around the periphery of the site. This dike will form a flood containment wall with a top elevation of 22 feet MLLW. This inner dike will be formed by an earthen dike extending from elevation 22 feet MLLW, adjacent to the dike-top maintenance road, down at a 2H:1V slope to elevation 12 feet MLLW and at a flatter slope of 3H:1V into the habitat area. This design will maximize the area of usable fish habitat and will provide a stable dike structure. Below this elevation,

the riparian slope will be reduced progressively to mudflats adjacent to the central channel.

The river dike will be breached with an opening 100 feet wide at elevation 12 feet MLLW near the downstream end of the property where the pipe currently passes through the dike. If possible, breaching will be accomplished during an extreme spring tide series, preferably in June or July. This timing will allow the dike to be breached safely, working primarily in the dry, in the manner recently used to breach the dike for the Union Slough Restoration Project in Everett (J. Houghton, Pentec Environmental, personal observation). This timing also will allow the maximum time for development of site productivity before the following spring juvenile salmonid outmigration.

The inside slopes of the spurs of the original dike upstream and downstream of the breach will receive plantings of riparian vegetation to enhance habitat function within the side channel area. Species planted will include willows, cottonwoods, and red alder *(Alnus rubra)*.

6.4.5 Construction Timing Considerations

Several project activities can be accomplished outside the fish window, (i.e., during periods when in-water work may be restricted):

- The Middle Waterway Corridor (debris and vegetation removal above OHW);
- The Peninsula (upland debris removal and access road construction above OHW; pile pulling on upper beach may also be allowed during periods when the pile location is dry, provided that oily residue is removed and the hole backfilled before tidal inundation);
- The Middle Waterway Marsh/Mudflat/Channel (work above OHW);
- The Puyallup River Side Channel (internal dike construction; site excavation; site contouring); and
- All areas (riparian and marsh plantings).

Because the Puyallup River Side Channel can be largely completed "in the dry" and the dike breached soon after the opening of the allowable period for in-water work, this 4.17-acre habitat area will be constructed and available for use

by juvenile salmonids before the loss of littoral habitat in St. Paul Waterway occurs with CDF berm closure.

6.5 Mitigation/Restoration Summary

6.5.1 Upland Disposal Option

6.5.1.1 Overall

Long-term project impacts of Thea Foss Waterway remediation under the Upland Disposal Option (Table 6-2) will include the following:

- Shading of 0.23 acre of littoral habitat and 0.19 acre of deeper subtidal habitat in Middle Waterway resulting from the construction of the Middle Waterway pier.

- A net loss of less than 0.60 acre of deeper, contaminated, subtidal habitat in Thea Foss Waterway.

Compensatory mitigation and affirmative conservation measures provided will include the following:

- Creation of 0.63 acre of new littoral habitat by bank layback in the Middle Corridor (0.08 acre) and by excavation of the northwest tip of the Middle/St. Paul peninsula uplands (0.55 acre; Figure 6-1 and Table 6-2);

- Enhancement of 0.70 acre of littoral habitat at the Middle Corridor site, north and south of the proposed pier location;

- Enhancement of 3.61 acres the Middle/St. Paul peninsula (2.86 acres by removal of about 1,700 creosote-treated piles and removal of surface debris and 0.75 acre by beach enhancement in front of the northwest tip excavation); and

- A net gain of 1.95 acres of clean littoral habitat in Thea Foss Waterway.

6.5.1.2 Area-Based Analysis

To assess whether the habitat provided under the Upland Disposal Option provides an affirmative contribution to recovery of ESA-listed species, the impacts and habitat offered (Table 6-2) were examined in light of compensatory mitigation typically required in Commencement Bay under in the course of

permitting waterfront development under Corps of Engineers Section 10/404 permits and State Hydraulic Project Approvals (HPAs).

Clearly there is a positive contribution to salmonid recovery:

- The net loss of 0.60 acre of deepwater, contaminated habitat in Thea Foss Waterway is more than offset by the net gain of 0.63 acre of clean, littoral habitat along the Middle Waterway (0.55 acre at the tip and 0.08 acre along the Corridor extension; Table 6-2).

- The shading of 0.23 acre of littoral habitat by the transloading pier would be compensated for (at the typical Section 10/404 ration of 0.5 to 1) by 0.11 acre of enhanced habitat in the Corridor habitat area. This leaves a net of 4.20 acres of enhanced littoral habitat (4.31 acres total enhanced area less 0.11 acre) as an affirmative conservation measure.

- The net gain in Thea Foss Waterway of 1.95 acres of littoral habitat is entirely an affirmative conservation measure. Coupled with the 0.63 acre of new littoral habitat created in Middle Waterway, there will be a net gain of 2.58 acres of productive littoral habitat. This will offset the net loss of 2.55 acres deepwater habitat in Thea Foss Waterway for a net gain of tidal waters of 0.03 acres (Table 6-2).

6.5.1.3 NOAA Habitat Equivalency Analysis

The mitigation/restoration actions provided to offset the impacts of Thea Foss Waterway remediation and Upland Disposal Option were analyzed using the NOAA Fisheries habitat equivalency analysis (HEA). HEA is widely used by NOAA and other trustee agencies in calculating natural resources damage claims, was used by NOAA in its preliminary assessment of the adequacy of the proposed mitigation provided for filling St. Paul Waterway, and has recently been used in the proposed Hylebos Waterway NRD claims settlement. This approach provides a more quantitative assessment of the relative ecological functions of habitats lost and gained. In this approach, the ecological function of marine habitat is rated against the functions provided by estuarine marsh, which is assigned a value of 1.0. Ratings are provided for three taxonomic groups: salmon, birds, and demersal fish, with salmon presumed to be twice as important as the other groups. Equivalency values are provided for three different habitat conditions: properly functioning, baseline adjusted, and degraded (Table 6-5).

Habitat equivalency values for habitats involved in the remediation and uplands disposal project and mitigation/restoration actions are shown on the left side of

Table 6-5. The center columns on the table provide an accounting of existing habitat areas that will be lost or altered. When multiplied by the corresponding equivalency values, the net loss in equivalent acres is calculated as 0.71 equivalent acre. Note that all habitats lost or altered were rated as degraded (because of contamination, debris, and/or lack of adjacent functioning habitat).

On the right hand side of Table 6-5 is an accounting of the post-construction habitat areas and qualities with their associated habitat equivalencies. Note that post-construction habitats are rated as baseline adjusted because sediments will be uncontaminated, and they will be connected with adjacent functioning habitats. When multiplied by the corresponding equivalency values, the total number of equivalent acres present after construction is calculated as 4.48 equivalent acres. The net gain is thus 3.77 equivalent acres, which represents the affirmative conservation measures provided by the Upland Disposal Option (Table 6-5) under this analytical approach.

6.5.1.4 EPA Mitigation Ratio Analysis

The changes resulting from remediation of Thea Foss Waterway and upland disposal also have been examined using the EPA suggested approach based on ratios of mitigation credit allowed for various types of mitigation actions (Table 6-6). This approach does not reflect a qualitative assessment of the actual ecological functions lost or gained; rather, the ratios reflect the probability that a given type of restoration will result in improved aquatic function at the site in question and are based largely on the history of poor success with freshwater wetlands mitigation. For example, creation of new littoral habitat by excavation of uplands is allowed as mitigation at a 1:1 ratio for lost marine habitat; restoration of existing low quality wetlands to higher quality tidal wetlands is valued at 0.5:1; while creation of new littoral habitat by filling of existing deep water is allowed at a 0.33:1 mitigation ratio since existing habitat values of deeper water would be lost. Riparian habitat (above OHW) is credited at a 0.1:1 ratio.

Using this approach (Table 6-6), the only project loss to be mitigated is the net loss of 0.60 acre of deep water marine habitat in Thea Foss Waterway (Table 6-1). It can be seen that mitigation/restoration provided for this loss of marine habitat (all elevations) due to remediation and upland disposal (equivalent acres) provides 2.10 equivalent habitat acres in excess of that which would be required to offset project impacts. This can be considered to be the sum of the affirmative conservation measures provided under this analytical approach.

6.5.2 CDF Disposal Option

6.5.2.1 General

A quantitative analysis has been conducted of the impacts of Thea Foss and Wheeler-Osgood Waterways remediation and the effects of the possible use of the St. Paul Waterway as a CDF on habitat area. This analysis includes impacts of associated mitigation/restoration actions and shows that the project (with mitigation/restoration actions described) would result in the following net changes in habitat quality under the CDF Disposal Option:

- Improvements in sediment quality over nearly 60 acres of habitat that are actively remediated in Thea Foss Waterway, with an associated improvement in the overall health of the marine environment;

- Cleanup of shoreline and benthic debris and improvements in the habitat quality of the nearshore migration corridor in Thea Foss and Wheeler-Osgood Waterways;

- Improvement and expansion of a shallow water migration corridor from the area of the Simpson fuel dock, across the face of the St. Paul CDF berm (St. Paul North Beach habitat area), around the Peninsula habitat area, and into Middle Waterway;

- Improvement and expansion of a shallow water migration corridor from the Peninsula habitat area into Middle Waterway via improvements to the Corridor habitat area and creation of the Middle Waterway Marsh/Mudflat/ Channel habitat area;

- Creation of deep (elevation –4 feet MLLW) channel habitat in Middle Waterway that will allow juvenile salmonids to remain in the waterway and adjacent to productive mudflat and marsh habitat during low tides;

- Addition of 4.17 acres of tidal off-channel habitat adjacent to the lower Puyallup River; and

- Creation of conditions that will allow development of several acres of saltmarsh and brackish marsh at locations in and adjacent to the mouth of the Puyallup River.

These actions will result in the creation, restoration, or enhancement of 23.6 acres of littoral habitat in a high priority restoration area near the mouth of the

Puyallup River. The sum of these positive changes in habitat area and quality will result in greatly improved ecological function for juvenile salmonids, marine fish, marine invertebrates, and shorebirds from that which currently exists.

6.5.2.2 Area-Based Analysis

Mitigation and conservation measures that will be implemented to offset the adverse effects of remediation under the CDF Disposal Option are described in detail in Section 6.4.4 and are summarized as follows (Thea Foss Waterway areas adjusted to reflect latest Utilities 30 percent design numbers (Table 6-1).

In total, project remediation and sediment disposal using the CDF Disposal Option would result in a loss of 11.65 acres of waters of the U.S. (0.60 acre in Thea Foss Waterway and 11.05 acres in St. Paul Waterway (Table 6-4). In addition 4.20 acres will be converted from deeper water to littoral depths (1.95 acres in Thea Foss Waterway and 1.65 acres at St. Paul Beach) and 1.92 acres of existing freshwater wetland will be converted to a fish-accessible tidal estuarine marsh (Puyallup River Side Channel). No significant areas of salt or brackish marsh will be impacted by these actions and the general quality of habitats impacted by the remediation and sediment disposal is poor to mediocre.

To offset these losses, the project will create 14.67 acres of new littoral habitat by excavation of uplands in Middle Waterway and the Puyallup River Side Channel (9.15 acres), filling of deeper water at St. Paul Beach and in Thea Foss Waterway (3.60 acres), and breaching of the dike on the Puyallup Side Channel (1.92 acres; Table 6-3). The project also will enhance 8.93 acres of existing littoral habitat (3.87 acres in Middle Waterway and 5.06 acres on the Peninsula; Table 6-3). Resulting net changes in various measures of habitat area include the following:

- A net loss of 0.58 acre in tidal habitat area (all depths; Table 6-4);
- A net gain of 4.67 acres in littoral habitat (Table 6-4);
- Improved sediment quality over nearly 60 acres of benthic habitat in Thea Foss and Wheeler-Osgood Waterways (Table 6-1);
- Enhanced littoral habitat quality over 8.93 acres of habitat on the Peninsula (5.06 acres) and in the Middle Waterway (3.87 acres); and
- In summary, the project will provide through creation, restoration, or enhancement, 23.6 acres (Table 6-3) of new or enhanced intertidal habitat in

a high priority restoration area (the rebuilding Puyallup River neodelta and adjacent waterways).

6.5.2.3 NOAA Habitat Equivalency Analysis

The mitigation/restoration actions provided to offset the impacts of Thea Foss Waterway remediation and CDF Disposal Option were analyzed using the NOAA HEA (see Section 6.5.1.3). Equivalency values are provided for three different habitat conditions: properly functioning, baseline adjusted, and degraded (Table 6-7).

Habitat equivalency values for habitats involved in the CDF Disposal Option and mitigation actions are shown on the left side of Table 6-7. The center columns on the table provide an accounting of existing habitat areas that will be lost; when multiplied by the corresponding equivalency values, the net loss in equivalent acres is calculated as 2.38 equivalent acres. Note that habitats lost were rated as degraded (because of contamination, debris, and/or lack of adjacent functioning habitat) except for the deep subtidal area lost in front of the CDF berm in the St. Paul Habitat area, which was rated as baseline adjusted.

On the right hand side of Table 6-7 is an accounting of the post-construction habitat areas and qualities with their associated habitat equivalencies. Note that post-construction habitats are rated as baseline adjusted or properly functioning because sediments will be uncontaminated, marsh fringes will be provided, and they will be connected with adjacent functioning habitats. When multiplied by the corresponding equivalency values, the total number of equivalent acres present after construction is calculated as 18.46 equivalent acres. The net gain is thus 16.08 equivalent acres (Table 6-7), which represents the sum of the affirmative conservation measures provided by the CDF Disposal Option under this analytical approach.

6.5.2.4 EPA Mitigation Ratio Analysis

The changes resulting from remediation of Thea Foss Waterway and CDF Disposal Option also have been examined using the EPA-suggested approach based on ratios of mitigation credit allowed for various types of mitigation actions (Table 6-8). This approach as described in Section 6.5.1.4 does not reflect a qualitative assessment of the actual ecological functions lost or gained; rather, the ratios reflect the probability that a given type of restoration will result in improved aquatic function at the site in question and are based largely on the history of poor success with freshwater wetlands mitigation.

Using this approach (Table 6-8), it can be seen that mitigation/restoration provided for the loss of 11.65 acres of marine habitat (all elevations) due to remediation and CDF Disposal Option (13.30 equivalent acres) provides 1.65 equivalent habitat acres in excess of that which would be required to offset project impacts. This can be considered to be the sum of the affirmative conservation measures provided under this analytical approach.

6.5.3 Comparison of Disposal Options and Associated Mitigation/ Restoration

A comparison of the significant habitat pluses and minuses associated with each of the sediment disposal options is provided in Table 6-9. This table shows less loss of existing habitat with the Upland Disposal Option since the CDF would require filling over 11 acres of St. Paul Waterway. Because of this loss, the City would provide a substantial (23.6-acre) mitigation package to offset the habitat impacts of the CDF Disposal Option.

With the associated mitigation/restoration offered, the Upland Disposal Option would result in a small net gain in tidal habitat (0.03 acre) while the CDF Disposal Option would have a small net loss in tidal habitat (0.58 acre) for a net difference of 0.61 acre between the two disposal options.

The affirmative conservation measures (ACM) provided by each disposal option are compared in the lower two sections of Table 6-9. When the options are compared using the EPA mitigation ratio approach, there is a small advantage to the Upland Disposal Option, which would provide 0.45 equivalent acres more of ACM than would the CDF option. However, when the NOAA Fisheries HEA approach, which takes into account that actual habitat functions lost and gained, is used, the advantage swings strongly to the CDF Disposal Option. This option would provide over 12 more equivalent acres than would the Upland Disposal Option.

6.6 Mitigation/Restoration Performance Monitoring and Adaptive Management Plan

6.6.1 Introduction

A Mitigation Performance Monitoring and Adaptive Management Plan (MAMP) has been developed to monitor and help ensure the ecological success of mitigation actions taken to compensate for loss of habitat in St. Paul Waterway under the CDF Disposal Option and for temporal loss of function during recolonization of remediated areas in the Thea Foss Waterway. The plan, which

is detailed in Section 4.3 of the OMMP, includes performance goals and qualitative and quantitative sampling methods that will be used to monitor the physical condition of habitats created or modified as mitigation/restoration for the project and to measure the long-term progress of restoration of ecological functions at the several sites, including epibenthos, anadromous fish, marsh, and riparian zone components. The MAMP also describes a contingency planning process for decision making in the event that project performance goals are not met.

Post-construction confirmation monitoring of site contours, soil, sediment, and plantings, described in Section 7.7 of the Construction Quality Assurance Plan (CQAP) and as Tier 1 monitoring in the MAMP, will establish the post-construction baseline for the long-term monitoring. Quantitative surveys of subtidal and intertidal benthos in the Thea Foss and Wheeler-Osgood Waterways also are described as part of the OMMP (Section 4.2). Since no adaptive management actions are tied to those monitoring efforts, they are not included in the MAMP.

6.6.2 Adaptive Management Plan

The adaptive management portion of the MAMP (OMMP Section 4.3.4 and Appendix E) is an interactive decision-making, feedback loop that specifies contingencies or corrective actions to be implemented in the event that monitoring data suggest such implementation would be appropriate to the long-term success of the mitigation/restoration. Contingencies to offset any failed mitigation/restoration action(s) may include modification of the physical configuration of the site, substrate amendments, additional mitigation/restoration such as supplemental plantings, and/or modification of project goals and objectives.

Adaptive management is an important component of restoration projects. It is recognized that restoration is a long-term process. Evaluation of the success of the restoration actions associated with this project will draw on site monitoring data and on the collective experience of two decades of restoration actions in Commencement Bay and Puget Sound. Each component of the mitigation/ restoration plan that is constructed will be monitored for results and confirmation of the technical concepts and approach. An adaptive management team (AMT) will be formed with representatives of resource and regulatory agencies, the City, and Simpson. Throughout the course of project implementation, a continuing review of the results by the AMT will offer the opportunity to reassess the conceptual model, management practices, and implementation schemes.

The components of the adaptive management process will include:

- Annual site inspections;
- Collaborative review of monitoring data; and
- Review of monitoring plans for upcoming year.

Should statistically significant deviations from the pre-project mitigation and restoration goals be observed, contingency alternatives will be considered. Alternatives may include wait and see; active alteration of mitigation/restoration site physical structure; modifications to freshwater flow rates; additional plantings; and/or consideration of additional mitigation/restoration actions or sites. The MAMP is described in Section 4.3.4 and Appendix E of the OMMP.

If the Upland Disposal Option is selected, the AMT will meet and determine the appropriate monitoring goals and approaches to assure performance of the mitigation/restoration components associated with the design.

6.6.3 General Approach

A combination of qualitative and quantitative monitoring methods will be employed to measure the development of ecological functions at the mitigation/restoration sites that would be constructed. Qualitative monitoring measures that would be part of the MAMP under the CDF Disposal Option will include the following:

- Low altitude aerial photography of the several mitigation/restoration habitat areas to provide an overall systematic view of the habitats over time;

- Observations of the development of intertidal epibiota and wildlife use of the sites;

- Evaluation of the health and vigor of planted and naturally colonizing species;

- Establishment of, and periodic photodocumentation at permanent photo points; and

- Monitoring accumulations of debris in habitat areas and at the log haul out.

Quantitative monitoring measures under the CDF Disposal Option will include the following:

- Sediment erosion and accretion measurements and site topographic measurement to ensure that the desired elevations are maintained; this is particularly important for establishment of estuarine marsh;

- Sediment quality characteristics (grain size, TOC, TKN, soil salinity) in expected marsh areas;

- Long-term, stratified random sampling of vegetation along transects traversing the three different vegetation zones—low saltmarsh, high saltmarsh, and riparian and in grids encompassing planted vegetation nodes;

- Spring sampling of the juvenile salmonid outmigration in the Puyallup River Side Channel, Simpson Cap, St. Paul Beach, Peninsula, and Middle Waterway Marsh habitat areas; and

- Spring sampling of epibenthic zooplankton in the Simpson Cap, St. Paul Beach, and Middle Waterway Marsh habitat areas.

Monitoring data will be compared to established performance goals and objectives (e.g., for plant cover, species diversity, and substrate composition; see OMMP Section 4.3.4) to evaluate ecological functions provided at the site.

Proposed monitoring methods may be changed in the future as part of the adaptive management process (OMMP Section 4.3.4). Before implementing any proposed changes, such changes will be discussed with and agreed to by the EPA, Natural Resource Trustees, and the City. Adoption of any changes in monitoring methods will be documented in subsequent monitoring reports.

As noted above, details of the habitat monitoring that would be conducted under the Upland Disposal Option will be developed by the AMT, if that disposal option is selected. Monitoring is expected to include all components of the CDF monitoring listed above except for aerial photography, juvenile salmonid sampling and epibenthic zooplankton sampling. Geographic scope would be limited to the Peninsula and Corridor habitat areas.

6.7 Contribution Toward Recovery and ESD Performance Criteria

The ESD (pg. 14) states: "It is EPA's intent that remediation, including required compensatory mitigation, of the CB/NT site cumulatively contribute toward recovery of ESA listed species." The analyses of the mitigation/restoration balance described in Section 6.5 clearly demonstrate that the proposed remedy, with either the Upland or CDF Disposal Option, provides such a positive

contribution. Perhaps the best representation of those gains is provided by the HEA analyses (Tables 6-5, 6-7, and 6-9).

6.7.1 Upland Disposal Option

The proposed remedy, compensatory mitigation, and supplemental affirmative conservation actions associated with the upland disposal option meet the nine performance criteria provided in the ESD (pg. 14). The following paragraphs specifically summarize how the proposed actions meet those criteria:

1. The proposed actions are consistent with the criteria and findings of Simenstad (2000) in that they will remove or isolate contaminated sediments and create, enhance, and/or restore components of the estuarine ecosystem that have been degraded or lost. They will preserve and build on existing viable landscape elements such as the St. Paul/Middle peninsula and the mudflats in the Middle Waterway.

2. Preference is given to an implied suite of habitat function criteria derived from Simenstad (2000): All plans (remediation and mitigation/restoration) have sought to maximize littoral habitat area, to reduce slopes and sediment grain sizes, to add elevations where saltmarsh can become established, to add LWD to beaches, and to provide riparian vegetation zones where possible. All of these actions are intended to improve the shallow water migration corridor available to juvenile salmonids as they move through and between the waterways.

3. The acreages of each habitat type (Table 6-2) and functional analysis using the NOAA HEA (Tables 6-5, 6-9) are provided as measures of how the remediation and associated mitigation will contribute to recovery of listed species.

4. Mitigation/restoration actions are located, to the extent possible, in ways that improve habitat connectivity and the shallow water migration corridor available to juvenile salmonids. This is most evident in the upland disposal option in the improvements made from the St. Paul/Middle peninsula into the head of Middle Waterway. Also, in Thea Foss Waterway, the remediation of the banks will be linked, where possible, to existing habitat restoration completed with Esplanade construction along the inner west side of the waterway.

5. Mitigation/restoration actions for the upland disposal option are located in areas identified by Simenstad (2000) as of "particularly high priority"

(Peninsula and Corridor habitat areas). These actions, also will enhance a significant portion the nearshore migration corridor leading from the neodelta to restoration sites at the head of Middle Waterway and to the more natural and productive shoreline along Ruston Way.

6. Mitigation/restoration actions proposed are proven and low risk.

7. Measurable performance objectives, management, monitoring, and reporting requirements, responsibilities, and schedule will be provided in the MAMP.

8. Only native species will be used in plantings.

9. Detailed facility designs, site plans, and redevelopment plans are provided in the 100 percent design to the extent possible. Measures to minimize impacts to water quality and protect habitat during construction are provided in the CQAP.

6.7.2 CDF Disposal Option

The proposed remedy and compensatory mitigation actions associated with the CDF disposal option also meet the nine performance criteria provided in the ESD (pg. 14). The following paragraphs specifically summarize how the proposed actions meet those criteria:

1. The proposed actions are consistent with the criteria and findings of Simenstad (2000) in that they will remove or isolate contaminated sediments and create, enhance, and/or restore components of the estuarine ecosystem that have been degraded or lost. They will preserve and build on existing viable landscape elements such as the Simpson Cap and the mudflats in the Middle Waterway. The CDF habitat package will add two critical elements in the habitat continuum: the Puyallup Side Channel and the improved shoreline and fringing marsh from the entrance to St. Paul Waterway to the head of Middle Waterway.

2. Preference is given to an implied suite of habitat function criteria: All plans (remediation and mitigation) have sought to maximize littoral habitat area, to reduce slopes and sediment grain sizes, to add elevations where saltmarsh can become established, to add LWD to beaches, and to provide riparian vegetation zones where possible. All of these actions are intended to improve the shallow water migration corridor available to juvenile salmonids as they move through and between the waterways.

3. The acreages of each habitat type (Tables 6-3 and 6-4) and functional analysis using the NOAA HEA (Tables 6-7, 6-9) are provided as measures of how the remediation and associated mitigation will contribute to recovery of listed species.

4. Mitigation/restoration actions are located, to the extent possible, in ways that improve habitat connectivity and the shallow water migration corridor available to juvenile salmonids. This is evident in the CDF habitat improvements from the mouth of St. Paul Waterway into the head of Middle Waterway. Also, in Thea Foss Waterway, the remediation of the banks will be linked, where possible, to existing habitat restoration completed with Esplanade construction along the inner west side of the waterway. Other habitat improvement opportunities, while not directly linked to adjacent functioning habitat (e.g., the Puyallup River Side Channel), will provide important resting areas and food resources that may not be abundant in adjacent areas.

5. Mitigation/restoration actions for the CDF disposal option are located in areas identified by Simenstad as of "utmost importance" (the Puyallup River Side Channel), and of "particularly high priority" (North Beach habitat area including the Peninsula habitat area). These actions also will enhance a significant portion the nearshore migration corridor leading from the neodelta to restoration sites at the head of Middle Waterway and to the more natural and productive shoreline along Ruston Way.

6. Mitigation/restoration actions proposed are proven and low risk (with the exception of the experimental attempt to create a brackish marsh in Middle Waterway). Contingency plans are detailed in the MAMP (OMMP Section 4.3).

7. Measurable performance objectives, management, monitoring, and reporting requirements, responsibilities, and schedule are all provided in the MAMP (OMMP Section 4.3).

8. Only native species will be used in plantings.

9. Detailed facility designs, site plans, and redevelopment plans are provided in the 100 percent design to the extent possible. Measures to minimize impacts to water quality and protect habitat during construction are provided in the CQAP.

Table 6-1 - Net Habitat Area Change from Remedial Area in Thea Foss Waterway (by Remedial Area)

Remedial Area	Pre-Remediation Habitat Area in Square Feet			Post-Remediation Habitat Area in Square Feet			Habitat Area Change in Square Feet		Habitat Area Change in Acres	
	Below -10	-10 to +11.8	Total	Below -10	-10 to +11.8	Total	Below -10	-10 to +11.8	Below -10	-10 to +11.8
1A[1]	28,071	0	28,071	28,071	0	28,071	0	0	0.00	0.00
1B[1]	21,105	25,064	46,169	18,464	27,705	46,169	-2,641	2,641	-0.06	0.06
2	44,782	0	44,782	44,782	0	44,782	0	0	0.00	0.00
3[1]	14,194	16,431	30,625	10,758	17,826	28,584	-3,436	1,395	-0.08	0.03
4	20,700	0	20,700	20,700	0	20,700	0	0	0.00	0.00
5	163,683	2,294	165,977	165,977	0	165,977	2,294	-2,294	0.05	-0.05
6	565,888	21,507	587,395	587,395	0	587,395	21,507	-21,507	0.49	-0.49
7	137,159	2,155	139,314	136,370	2,944	139,314	-789	789	-0.02	0.02
8	3,477	68,286	71,763	12	61,356	61,368	-3,465	-6,930	-0.08	-0.16
9	0	50,000	50,000	0	50,000	50,000	0	0	0.00	0.00
10[1]	0	40,050	40,050	0	40,050	40,050	0	0	0.00	0.00
11[1]	0	22,434	22,434	0	21,600	21,600	0	-834	0.00	-0.02
12	0	34,693	34,693	0	34,693	34,693	0	0	0.00	0.00
13[1]	0	17,801	17,801	0	17,801	17,801	0	0	0.00	0.00
14	5,785	36,853	42,638	5,785	33,529	39,314	0	-3,324	0.00	-0.08
15	0	32,107	32,107	0	25,981	25,981	0	-6,126	0.00	-0.14
16	94,470	46,002	140,472	140,472	0	140,472	46,002	-46,002	1.06	-1.06
17	136,447	0	136,447	136,447	0	136,447	0	0	0.00	0.00
18	59,646	0	59,646	59,646	0	59,646	0	0	0.00	0.00
19A	97,103	128,641	225,744	71,493	154,251	225,744	-25,610	25,610	-0.59	0.59
19B	12,570	13,890	26,460	3,200	21,140	24,340	-9,370	7,250	-0.22	0.17
20	58,330	65,060	123,390	55,460	67,730	123,190	-2,870	2,670	-0.07	0.06
21	73,063	0	73,063	73,063	0	73,063	0	0	0.00	0.00
22	22,500	0	22,500	22,500	0	22,500	0	0	0.00	0.00
23/24[2]	165,975	216,975	382,950	33,278	348,590	381,868	-132,697	131,615	-3.05	3.02
Totals:	1,724,948	840,243	2,565,191	1,613,873	925,196	2,539,069	-111,075	84,953	-2.55	1.95
			Acres:	37.05	21.24	58.29	**Net Loss of Waters of the U. S:**			**-0.60**

Notes: 1. These RAs are part of the City's 2002 Construction Project.
2. These RAs are part of the Utilities work area and will be designed and constructed by others. The acreages presented in the Table were provided by the Utilities based on the 30% Preliminary Design.

Table 6-2 - Uplands Disposal Option - Mitigation/Restoration Balance

Habitat Component[1]	Marine Habitat Acreage					
	Littoral (-10 ft MLLW to MHHW[1])			Sublittoral (>-10 ft MLLW)		All Depths
	Habitat Excavated (Filled)	Enhanced Habitat	Total	Lost	Enhanced	Net Change
Thea Foss and Wheeler Osgood Remediation (filled)	1.95	21.24[2]	1.95	(2.55)	37.24[2]	(0.60)
Peninsula (pull piles, debris; enhance littoral function)		2.86	2.86			
Peninsula (excavate/restore historic function)	0.55	0.75	1.30			
Middle Waterway Corridor (cut back banks/reduce slopes)[3]	0.08	0.70	0.78			
Total	**2.58**	**4.31**	**6.89**	**(2.55)**		
Summary (Type of Action)						
New tidal waters (gained by excavation from uplands)	0.63		0.63			
New littoral habitat (gained by filling)	1.95		1.95			
Total new littoral habitat			2.58			
Net change in littoral habitat area			**2.58**			
Total tidal area (gained by excavation)			0.63			
Net change in tidal waters (all depths)						**0.03**

[1] Area of habitat impact or benefit extended from -10 ft MLLW to MHHW in Thea Foss, and to 13 ft in Middle Waterway. **Excavated** means excavated from existing uplands. **Enhanced** means restored to previous littoral depths by filling, or habitat quality and function markedly improved by removal or isolation of contamination and/or by removal of substantial quantities of anthropogenic debris such as concrete rubble or creosote-treated pilings.

[2] Enhanced area restored under CERCLA mandate (21.24 acres) - not included in mitigation/restoration totals except for 1.95 acres created by filling.

[3] Total Corridor Habitat area is 1.01 acres; 0.08 acre of this is created. Of the remaining 0.93 acre, 0.23 acres is shaded by the pier and not included as mitigation leaving 0.70 acre of enhanced area.

Table 6-3 - CDF Disposal Option - Littoral Habitat Acreage Impacts and Habitat Provided

Habitat Component[a]	Marine Littoral Habitat Acreage[a]			Comments
	New Habitat Excavated	Enhanced Habitat[b]	Total	
Thea Foss and Wheeler Osgood Remediation		21.24	1.95[b]	Sublittoral to littoral conversion; Table 6-1
St. Paul Beach (re-establish historic shallows)		1.65	1.65	Sublittoral to littoral conversion - marsh fringe above elevation 10 feet MLLW
Peninsula		5.06	5.06	Piling removal; substrate enhancement - marsh fringe above elevation 10 feet MLLW
Middle Waterway Corridor		0.85	0.85	Slope and substrate modifications; LWD addition
Middle Waterway Tideflat/Marsh	6.90	3.02	9.92	Creation of tidal channel, mudflat, marsh, new freshwater source, and riparian vegetation
Puyallup River Side Channel Habitat	2.25	1.92	4.17	Tidal side channel restoration; new marsh and riparian vegetation
Total Enhanced Littoral Habitat[b]		**14.45**		**Moderate to high quality**
Total New Littoral Habitat	**9.15**	**5.52**	**14.67**	From excavation (9.15 acres); filling (3.60 acres); dike breaching (1.92 acres)
Total Mitigation/Restoration Provided[b]	**9.15**	**14.45**	**23.60**	**Moderate to high quality**

[a] Area of habitat impact or benefit extended from elevation -10 feet MLLW to include all marsh and riparian vegetation. **Excavated** means excavated from existing uplands. **Enhanced** means restored to previous littoral depths by filling or restored to tidal function by removing dikes and reestablishing historic function or, habitat quality and function has been markedly improved by removal or isolation of contamination and/or by removal of substantial quantities of anthropogenic debris such as concrete rubble or creosoted pilings.

[b] Enhanced area restored under CERCLA mandate (21.24 acres) - not included in mitigation/restoration totals except for 1.95 acres created by filling.

Table 6-4 - CDF Disposal Option - Project Habitat Acreage Impact and Mitigation/Restoration Balance

Habitat Component[a]	Marine Habitat Acreage					Wetland Conversion
	Littoral (-10 ft MLLW to MHHW[a])			Sublittoral (>-10 ft MLLW)		
	Habitat Excavated (Filled)	Enhanced Habitat	Total	Lost	Enhanced	
Thea Foss and Wheeler Osgood Remediation		21.24	1.95[b]	(2.55)	37.24[b]	
St. Paul CDF (loss to filling CDF)	(10.00)		(10.00)	(1.05)		
St. Paul Beach (re-establish historic shallows)		1.65	1.65	(1.65)		
Peninsula (rehabilitate/restore historic function)		5.06	5.06			
Middle Waterway Corridor		0.85	0.85			
Middle Waterway Tideflat/Marsh Complex	6.90	3.02	9.92			
Puyallup River Side Channel Habitat	2.25	1.92	4.17			(1.92)
Total	**(0.85)**	**14.45**	**13.60**	**(5.25)**		**(1.92)**
Existing tidal waters lost to filling (11.05 acres St. Paul; 0.60 acre in Thea Foss)				(11.65)		
New tidal waters gained by excavation from uplands			9.15			
New tidal waters gained (wetlands coverted to tidal by dike breaching)[c]			1.92			
New littoral habitat gained by filling			3.60			
Total new littoral habitat (from filling, excavation, dike breaching)			14.67			
Net change in littoral habitat area			**4.67**			
Total tidal area gained			11.07			
Net change in tidal waters (all depths)					**(0.58)**	

[a] Area of habitat impact or benefit extended from -10 ft MLLW to include all marsh and riparian vegetation. **Excavated** means excavated from existing uplands. **Enhanced** means restored to previous littoral depths by filling or restored to tidal function by removing dikes and reestablishing historic function or, habitat quality and function has been markedly improved by removal or isolation of contamination and/or by removal of substantial quantities of anthropogenic debris such as concrete rubble or creosoted pilings.

[b] Enhanced area restored under CERCLA mandate (21.24 acres) - not included in mitigation/restoration totals.

[c] 1.92 acres of conversion of existing non-fish accessible marsh to tidal marsh is included as restored littoral habitat.

Table 6-5 - Upland Disposal Option - Mitigation/Restoration Functional Equivalency Analysis

(NOAA Habitat Equivalency Analysis - weighted multispecies eqivalency for salmon, birds, flatfish)

	Eqivalency Value[1]			Existing			Post Construction		
Habitat type	Degraded	Baseline Adjusted	Properly Functioning	Acres	Equiv. Value	Equiv. Acres (Loss)	Acres	Equiv. Value	Equiv. Acres (Gain)
Mudflat (OHW to -4 feet)	**0.1**	**0.75**	**0.90**						
Thea Foss (net gain)							0.95	0.75	0.71
Peninsula (pile cleanup)				2.86	0.1	0.29	1.98	0.75	1.49
Peninsula (NW tip beach)				0.75	0.1	0.08	1.30	0.75	0.98
Corridor				0.93	0.1	0.09	1.01	0.75	0.76
Shallow subtidal (-4 to -10 ft MLLW)[2]	**0.1**	**0.55**	**0.70**						
Thea Foss (net gain)							1.00	0.55	0.55
Deep subtidal (> -10 ft MLLW)[2]	**0.1**	**0.30**	**0.30**						
Thea Foss (net loss)				2.55	0.1	0.26			
				Total Existing:		**0.71**	**Total Post Project:**		**4.48**
				Net Gain in Equivalent Acres:			**3.77**		

[1] NOAA HEA multi-resource equivalency values per Hylebos Waterway NRDA claims; weighted: salmon 50%; birds 25%; flatfish 25%.
Fully functional - based on premise that presence of adjacent desirable habitat results in a complex that enhances overall production
Baseline adjusted - minor physical degradation; no adjacent desirable habitat to enhance value.
Degraded - habitat value limited by physical or chemical conditions.

[2] NOAA defines intertidal (mudflat) as ranging from OHW to -4 ft MLLW; Shallow subtidal is defined as -4 ft to -14 ft MLLW. Note that in this analysis (and more commonly in Puget Sound), littoral habitat (intertidal and shallow subtidal habitat) is defined at elevation -10 ft MLLW.

Table 6-6 - Upland Disposal Option - Mitigation/Restoration Acreage Equivalency Analysis
(EPA Mitigation Ratio Approach)

Mitigation Type	Total Acreage		EPA Credit Ratio	Equivalent Acres
Creation (excavate from uplands)	0.63	[a]	1.00	0.63
Enhanced (by cleanup)	6.26	[b]	0.33	2.07
New riparian	0.05	[c]	0.10	0.01
Total New and Enhanced Habitat	**6.94**			**2.70**
Total Area Lost in Acres				**0.60**
Net Gain in Equivalent Acres				**2.10**

[a] Includes 0.55 acre at the head of Middle Waterway and 0.08 acre in the Corridor habitat area

[b] Includes 0.75 acre at the head of Middle Waterway; 0.70 acre in the Corridor habitat area, 2.86 acres on the St. Paul/Middle peninsula, and the 1.95 acres of littoral habitat created by capping in Thea Foss Waterway.

[c] Area adjacent to the head of Middle Waterway

Table 6-7 - CDF Disposal Option - Mitigation/Restoration Functional Equivalency Analysis

(NOAA Habitat Equivalency Analysis - weighted multispecies eqivalency for salmon, birds, flatfish)

	Eqivalency Value[a]			Existing (or Net Loss)			Post (or Net Gain)		
Habitat type	**Degraded**	**Baseline Adjusted**	**Properly Functioning**	**Acres**	**Equiv. Value**	**Equiv. Acres (Loss)**	**Acres**	**Equiv. Value**	**Equiv. Acres (Gain)**
Saltmarsh		**0.85**	**1.00**						
Puyallup River Side Channel[b]				1.92	0.2	0.38	1.00	1.00	1.00
Middle Wwy							0.40	0.85	0.34
Mudflat (OHW to -4 feet)	**0.1**	**0.75**	**0.90**						
Thea Foss							0.75	0.75	0.56
St. Paul Wwy				10	0.1	1.00			
Puyallup Side Channel							2.80	0.90	2.52
St. Paul beach							1.50	0.75	1.13
Peninsula				5.06	0.1	0.51	5.06	0.75	3.80
Corridor				0.85	0.1	0.09	0.85	0.75	0.64
Middle channel/marsh							5.82	0.90	5.24
Middle enhancement				3.02	0.1	0.30	3.02	0.75	2.27
Shallow subtidal (-4 to -10 ft MLLW)[c]	**0.1**	**0.55**	**0.70**						
Thea Foss							1.20	0.55	0.66
St. Paul beach							0.15	0.70	0.11
Deep subtidal (> -10 ft MLLW)[c]	**0.1**	**0.30**	**0.30**						
Thea Foss				2.55	0.1	0.26			
St. Paul beach				1.65	0.3	0.50			
St. Paul Wwy				1.05	0.1	0.11			
Vegetated buffer		**0.20**	**0.40**	0					
Middle channel/marsh[d]							0.68	0.20	0.14
Puyallup Side Channel[d]							0.37	0.20	0.07
				Total Loss/Gain:		**2.38**	**Total Post Project**		**9.05**
				Net Gain in Equivalent Acres:			**6.67**		

[a] NOAA HEA multi-resource equivalency values per Hylebos Waterway NRDA claims; weighted: salmon 50%; birds 25%; flatfish 25%.
Fully functional - based on premise that presence of adjacent desirable habitat results in a complex that enhances overall production.
Baseline adjusted - minor physical degradation; no adjacent desirable habitat to enhance value.
Degraded - habitat value limited by physical or chemical conditions.

[b] Isolated palustrine wetlands within the dikes assigned an equivalency value of 0.2 because only bird function currently provided.

[c] NOAA defines intertidal (mudflat) as ranging from OHW to -4 ft MLLW; Shallow subtidal is defined as -4 ft to -14 ft MLLW (note that in this analysis and more commonly in Puget Sound, littoral habitat (intertidal and shallow subtidal habitat is defined at elevation -10 ft MLLW.

[d] Baseline adjusted value assigned because of time required to reach full riparian function.

Table 6-8 - CDF Disposal Option - Mitigation/Restoration Acreage Equivalency Analysis
(EPA Mitigation Ratio Approach)

Mitigation Type	Total Acreage		EPA Credit Ratio	Equivalent Acres
Creation (excavate from uplands)	8.10	[a]	1.00	8.10
Restoration (breach dikes)	1.92	[b]	0.50	0.96
Enhanced (by filling or cleanup)	12.52	[c]	0.33	4.13
New riparian	1.05	[d]	0.10	0.11
Total New and Enhanced Habitat	**23.59**			**13.30**
Total Area Lost in Acres				**11.65**
Net Gain in Equivalent Acres				**1.65**

[a] Includes 6.9 acres in Middle Waterway and 2.25 acres in Puyallup River Side Channel, less 1.05 acres of riparian area above OHW.

[b] Restoration area in Puyallup River Side Channel.

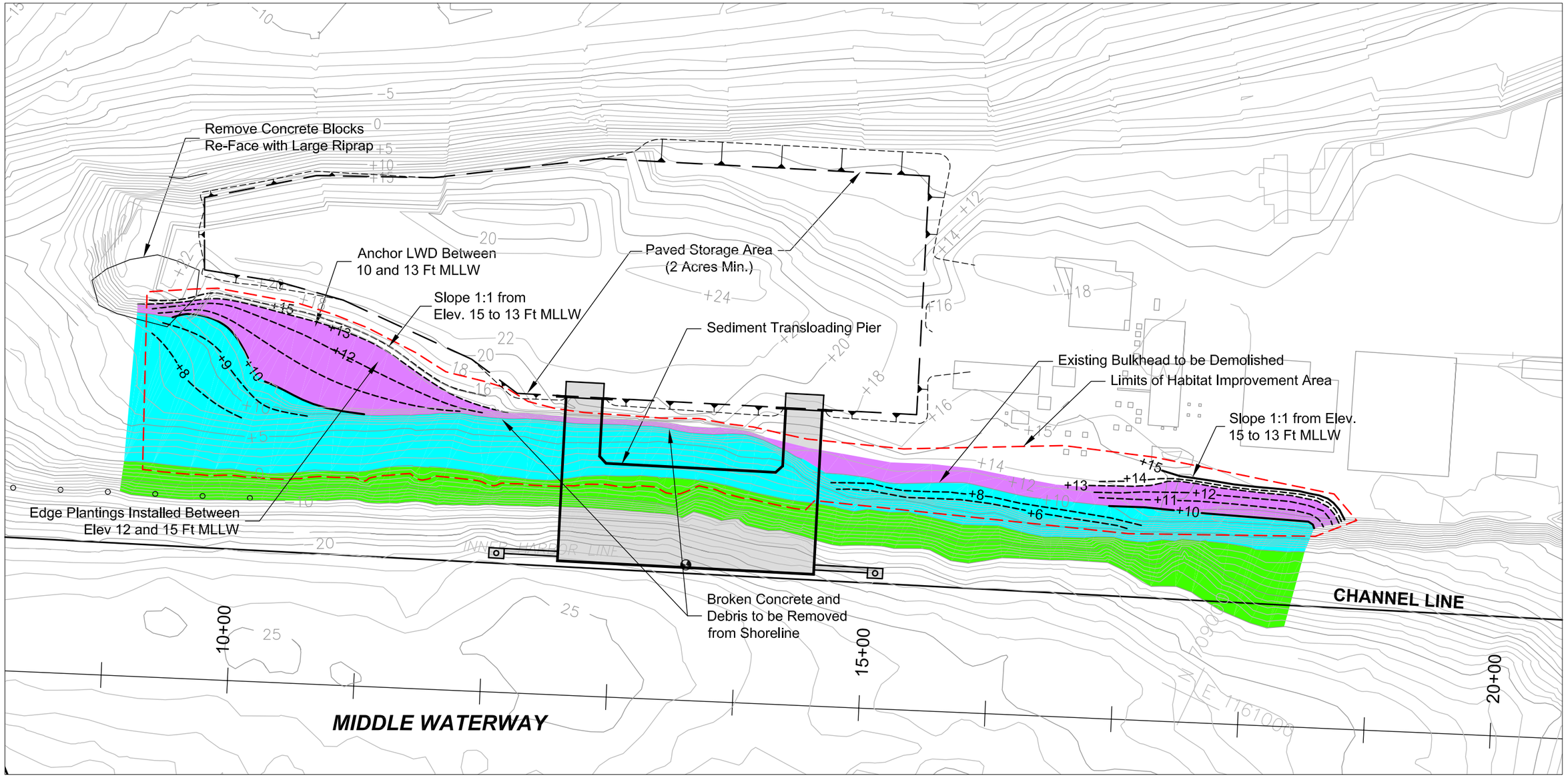
[c] Includes new littoral habitat in St. Paul habitat area (1.65 acres) and in TFWW (1.95 acres) as well as enhanced habitat in Peninsula (5.05 acres), Corridor (0.85 acre), and Middle Waterway (3.02 acres).

[d] Includes 0.68 acre in Middle Waterway and 0.37 acre in Puyallup River Side Channel.

Table 6-9 - Comparison of Sediment Disposal Alternatives

Measure Disposal Option	Habitat Acreage				Advantage in Acres	
	Upland		CDF		Upland	CDF
Thea Foss loss of subtidal habitat	-2.55	Table 6-1	-2.55	Table 6-1	- -	- -
Thea Foss loss of intertidal habitat	1.95	Table 6-1	1.95	Table 6-1	- -	- -
Thea Foss net change in tidal habitat	-0.60	Table 6-1	-0.60	Table 6-1	- -	- -
Habitat loss due to sediment disposal	0.00		-11.05	Table 6-4	11.05	
Total mitigation area provided (includes +1.95 acres from TFWW)	6.89	Table 6-2	23.60	Table 6-2		16.71
Net change in littoral habitat area	2.58	Table 6-2	4.67	Table 6-4		2.09
Net change in tidal waters (all depths)	0.03	Table 6-2	-0.58	Table 6-4	0.61	
HEA Analysis						
Pre-project equivalent acres	0.71	Table 6-5	2.38	Table 6-7	- -	- -
Post-project equivalent acres	4.48	Table 6-5	9.05	Table 6-7	- -	- -
Net Gain in Equivalent Acres (Equals Affirmative Conservation Measures)	**3.77**	Table 6-5	**6.67**	Table 6-7		**2.90**
EPA Ratio Analysis						
Total new and enhanced habitat	6.94	Table 6-6	23.59	Table 6-8	- -	- -
Equivalent acres	2.70	Table 6-6	13.30	Table 6-8	- -	- -
Acres lost	0.60	Table 6-6	11.65	Table 6-8	- -	- -
Net Gain in Equivalent Acres (Equals Affirmative Conservation Measures)	**2.10**	Table 6-6	**1.65**	Table 6-8	**0.45**	

St. Paul and Middle Waterway Peninsula Habitat Plan



Note: The vertical datum is US Corps of Engineers/Port of Tacoma based upon NGS benchmarks converted from NGVD 29 Datum by adding 6.78 feet.

Legend:

- Saltmarsh (10 to 13 Ft MLLW)
- Intertidal Mudflat (0 to 10 Ft MLLW)
- Shallow Subtidal (-10 to 0 Ft MLLW)

PROJECT NORTH

0 80 160

Scale in Feet

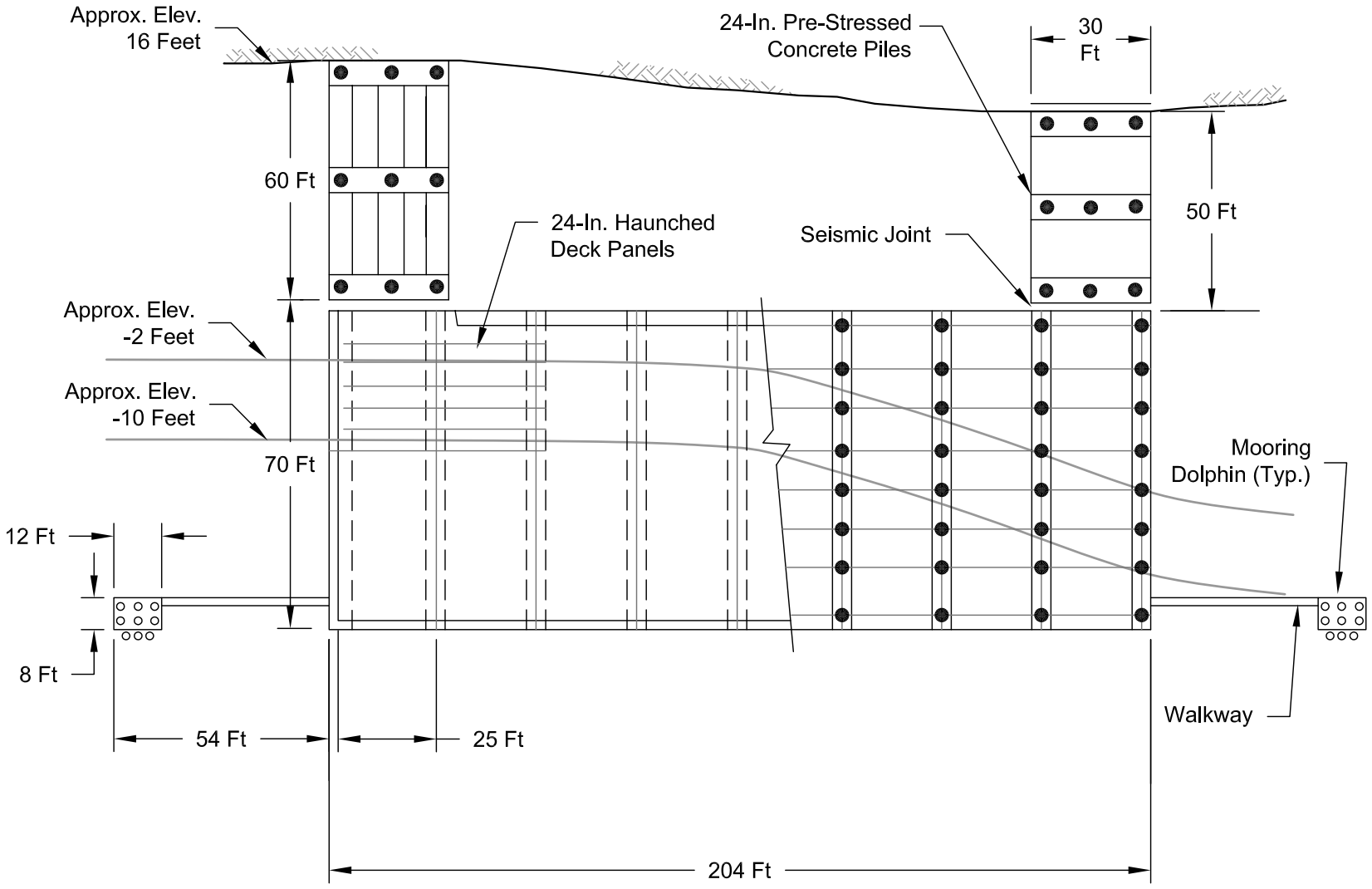
HARTCROWSER

4072-68 *1/03*

Figure 6-1

CAS 1/28/03 4072680A7.DWG

Middle Waterway Sediment Transloading Pier
Preliminary Plan View



Not to Scale

PILE LOADS

Dead Load 130 KIPS SERVICE
Live Load 150 KIPS SERVICE

BERGER/ABAM ENGINEERS INC.

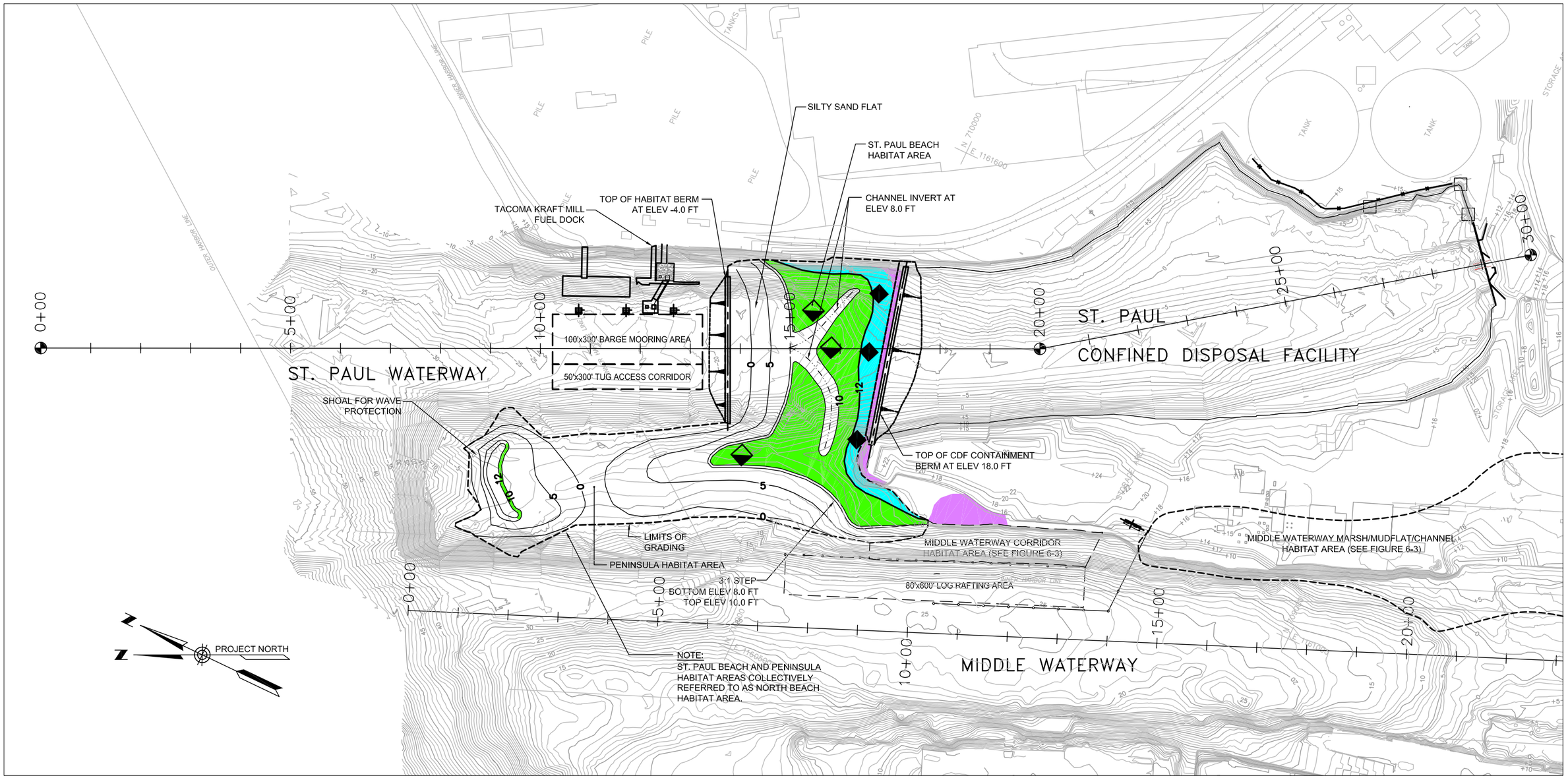
HARTCROWSER

4072-68 1/03

Figure 6-2

407268048.DWG CAS

Site Plan
North Beach Habitat Area



Note: The vertical datum is US Corps of Engineers/Port of Tacoma based upon NGS benchmarks converted from NGVD 29 Datum by adding 6.78 feet.

Legend:

- Riparian Zone (>13 Ft MLLW)
- High Saltmarsh (12 to 13 Ft MLLW)
- Low Saltmarsh (10 to 12 Ft MLLW)
- Low Saltmarsh Planted Node (16 Ft x 16 Ft)
- High Saltmarsh Planted Node (16 Ft x 16 Ft)

0 200 400
Scale in Feet

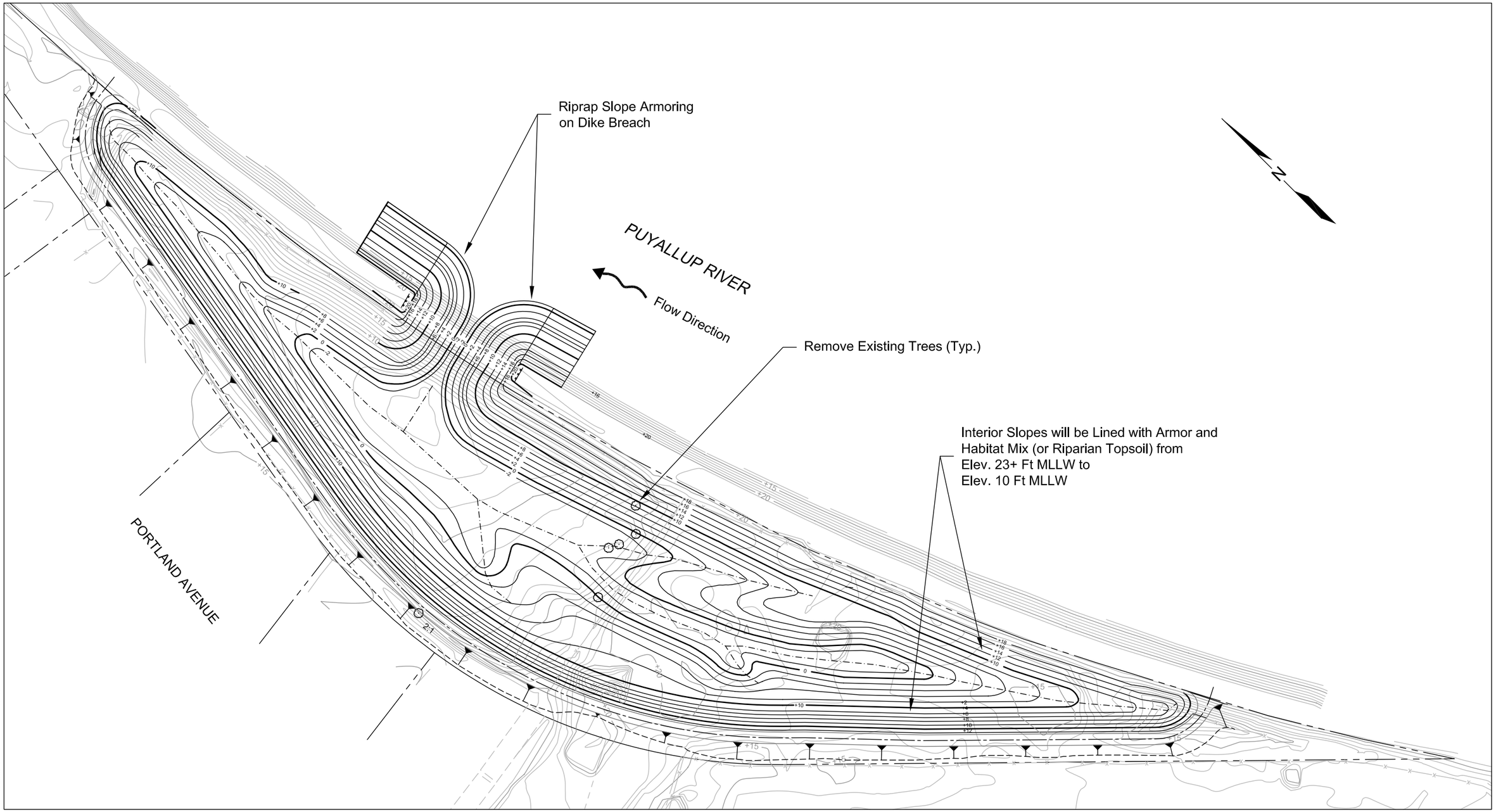
HARTCROWSER

4072-68 *1/03*

Figure 6-3

CAS 1/28/03 407268021.dwg

Site Plan
Puyallup River Side Channel



Legend:

+14 Proposed Elevation Contour in Feet

+15 Existing Elevation Contour in Feet

0 100 200

Scale in Feet

407268036.DWG 1:1 CAS

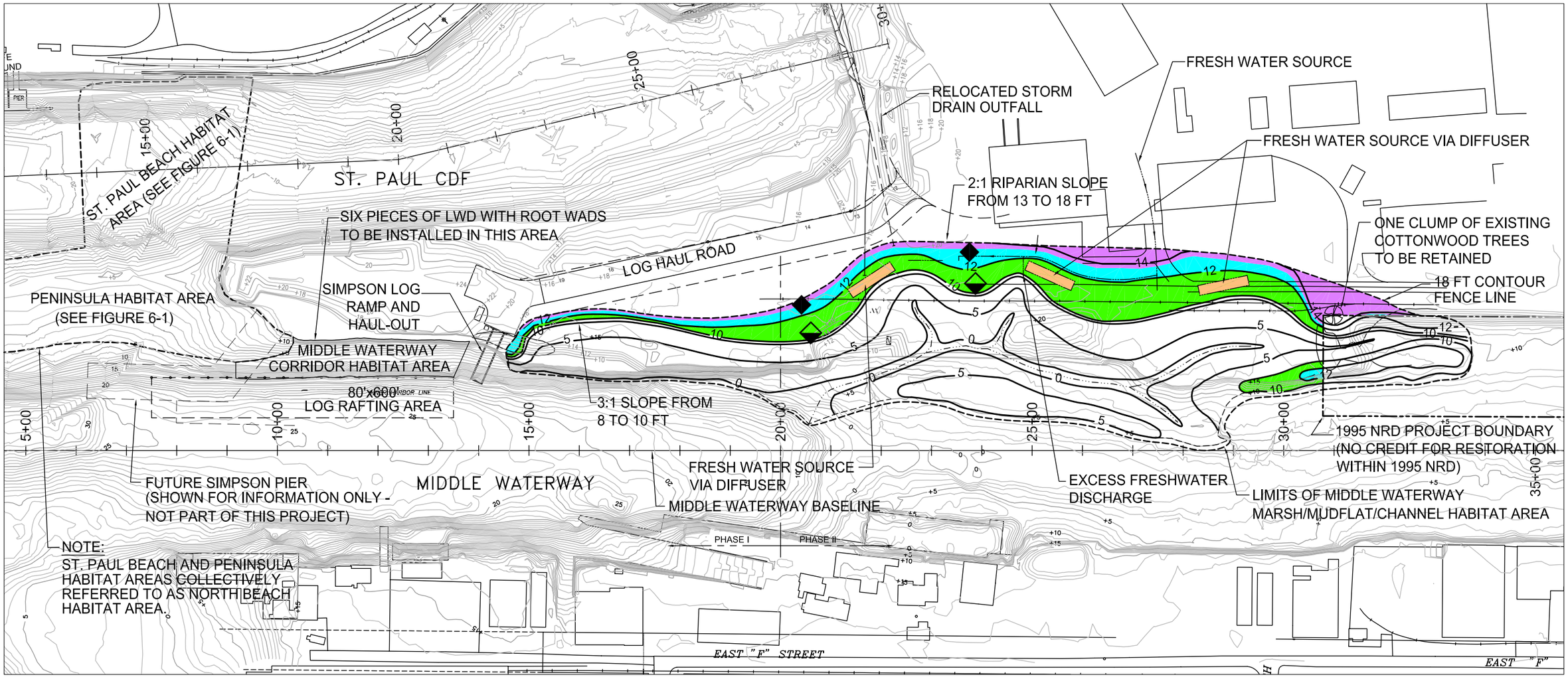
HARTCROWSER

4072-68 *1/03*

Figure 6-4

Site Plan

Middle Waterway Marsh/Mudflat/Channel Habitat Area



Note: The vertical datum is US Corps of Engineers/Port of Tacoma based upon NGS benchmarks converted from NGVD 29 Datum by adding 6.78 feet.

Legend:

- Riparian Zone (>13 Ft MLLW)
- High Saltmarsh (12 to 13 Ft MLLW)
- Low Saltmarsh (10 to 12 Ft MLLW)
- Brackish Marsh
- Low Saltmarsh Planted Node (16 Ft x 16 Ft)
- High Saltmarsh Planted Node (16 Ft x 16 Ft)

Project North

0 200 400

Scale in Feet

HARTCROWSER

4072-68 1/03

Figure 6-5

CAS 1/28/03 407268022