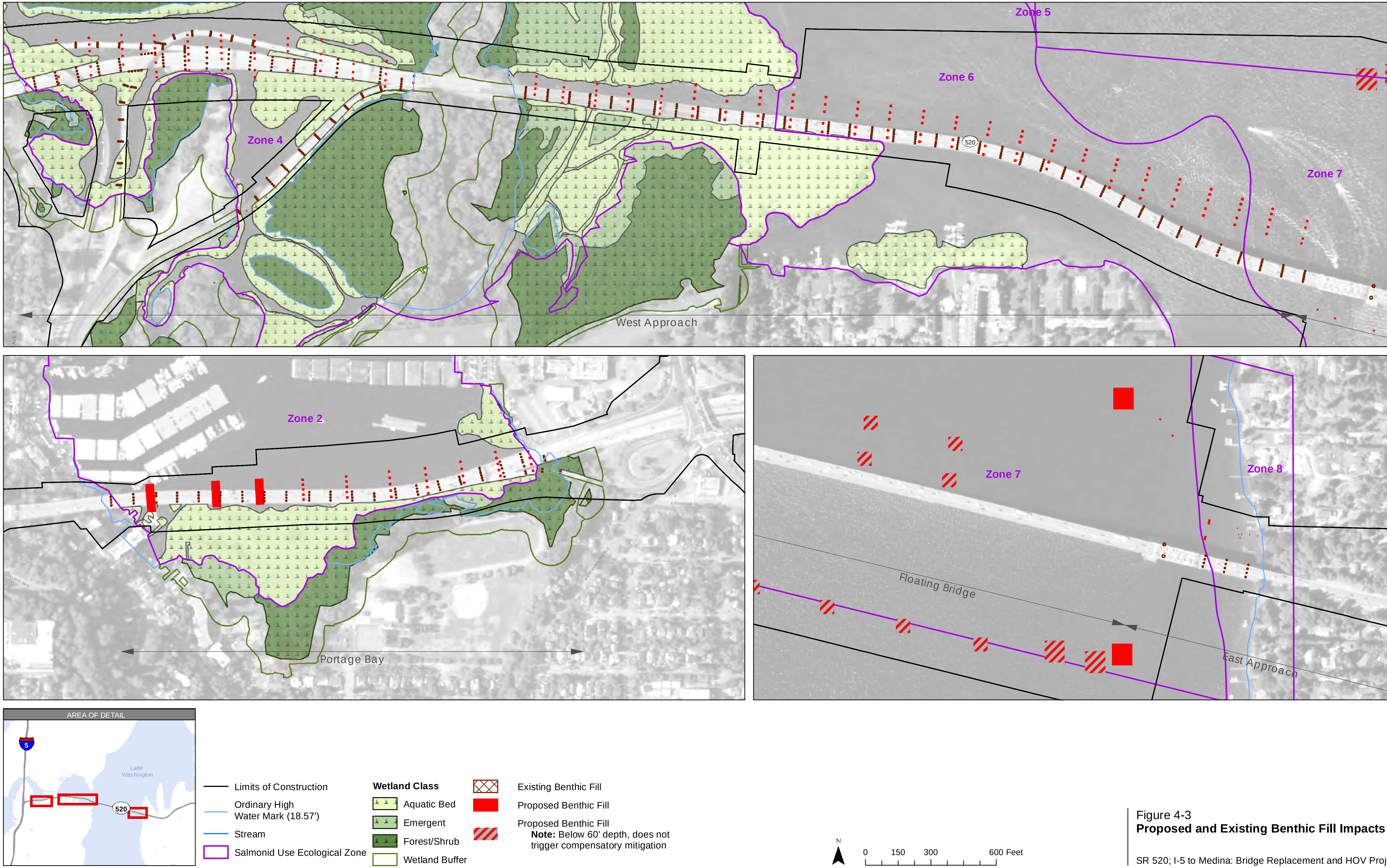

Figure 4-3
Proposed and Existing Benthic Fill Impacts

SR 520; I-5 to Medina: Bridge Replacement and HOV Project

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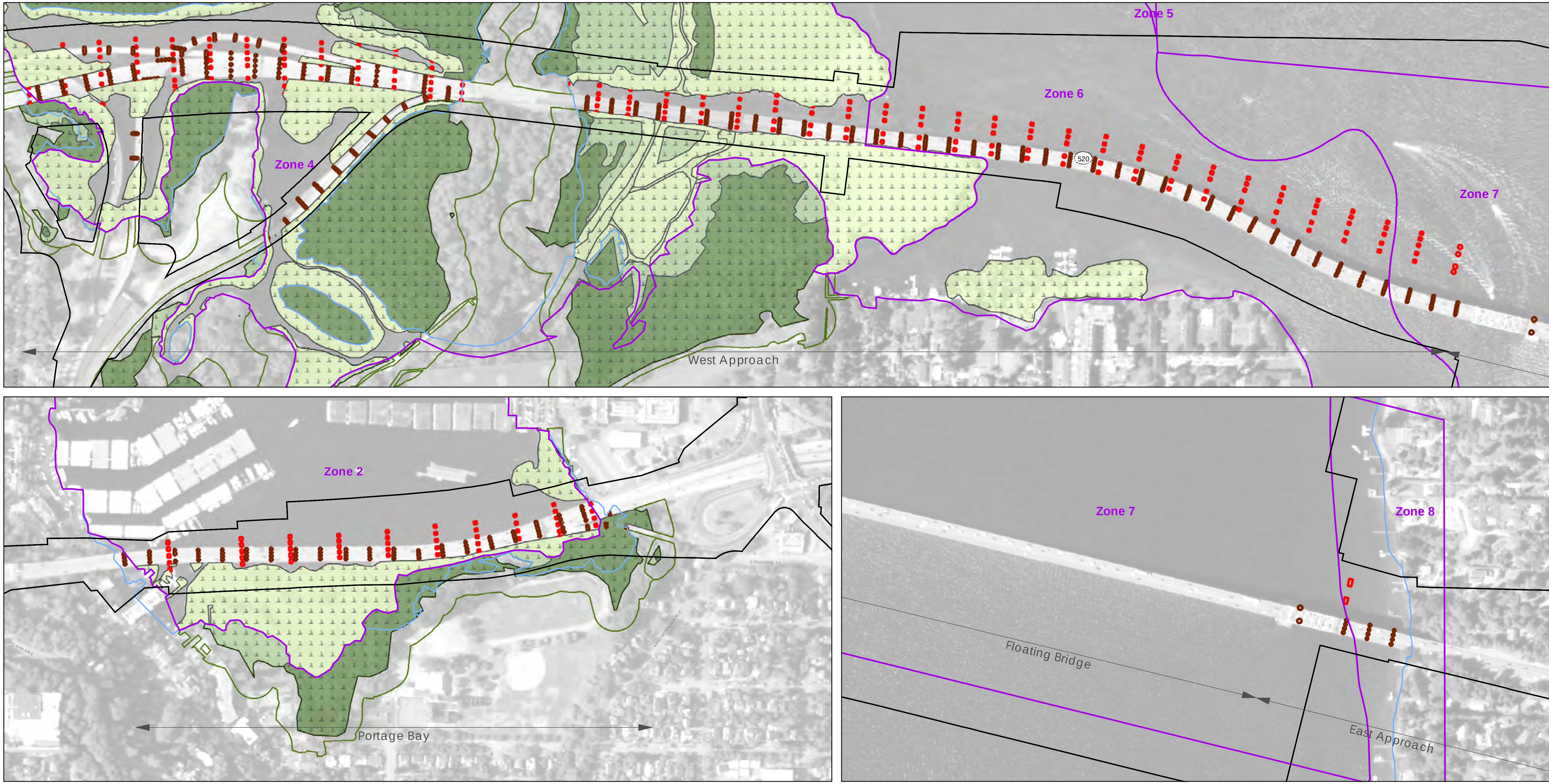

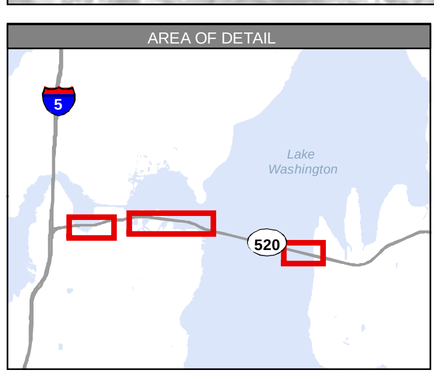

Limits of Construction
Ordinary High Water Mark (18.57')
Stream
Salmonid Use Ecological Zone

Wetland Class
Aquatic Bed
Emergent
Forest/Shrub
Wetland Buffer

Potential Predator Habitat (Existing)
Potential Predator Habitat (Proposed)

N
0 150 300 600 Feet

Figure 4-4
Proposed and Existing Predator Habitat Impacts

SR 520; I-5 to Medina: Bridge Replacement and HOV Project

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4.3.4. Impact Summary

To determine overall project mitigation needs, the mitigation team summed the impact calculations for shading, benthic fill, and structural complexity (see Tables 4-2 and 4-3). Using the methods discussed above, permanent project impacts are 7.43 acres, while temporary project impacts equate to 16.73 acre-years. The impact numbers were derived using the habitat function and life history stage model presented in Section 3 (see Figure 3-2).

Conservative Impact Analysis Assumptions

The mitigation team believes these methods are appropriate to describe the primary impact mechanisms, and that the methodology uses generally conservative assumptions and rules, which tend to err on the side of overstating the potential impacts to fishery resources. Some of the conservative assumptions used in impacts analysis are listed below.

Over-water and structural complexity: Under the methodology, over-water and structural complexity impacts from temporary and permanent structures are effectively treated as affecting 100% of both the available habitat and the associated habitat functions (for the time frame they are physically present). That is, they are treated as if the affected habitat was being removed or filled. In reality, although aquatic habitat functions will be affected, the habitat will generally be available for use and will support salmonid life histories, albeit at a somewhat reduced level. For example, juvenile salmonids will still migrate under the permanent bridge and temporary work bridges, with many of these fish experiencing no negative effects to survival or fitness. Also, although some increase in predation rate may occur in the vicinity of the temporary and permanent structures compared to existing conditions, the vast majority of rearing and migrating juveniles will not likely become prey due to these structures.

Benthic impacts: Permanent impact calculations for benthic impacts were also conservative because they included the area of column footings. Although the footings will initially displace benthic habitat, over time the mudline will form over the footings as sediment is redistributed. Final design may include the burial of mudline footings immediately following construction, thereby immediately providing available substrate. Although the footing area will provide at least some important benthic habitat functions over time, these areas were counted in the total impact area.

Shading impacts: Under the methodology, permanent shading impacts are assessed using a metric of net increase of over-water structure. This does not account for the net increase of height, and therefore of light intensity, under the new bridge structure compared to the existing structure. In addition, the gap between the north and south superstructures will also allow a greater amount of light under the bridge. Although the exact change in light intensity over the project area cannot be accurately calculated (and thus was not used for analysis purposes), it is likely that under future conditions, the intensity of shading will be less than under existing conditions, at least in key areas such as the west approach (Zone 6) or Portage Bay (Zone 3).

At all permanent structures and temporary work bridges in the west approach area (Zone 6), shading and structural complexity impacts were double-counted in cases where they overlapped (each impact type was counted separately and summed). This approach is conservative because an individual fish cannot be affected on multiple endpoints (e.g., both survival and growth).

Temporary work bridges: Preliminary engineering on the configuration and extent of the temporary work bridges was based on relatively conservative assumptions. Once final engineering on the work bridges is complete and a contractor is chosen, there is a likelihood that the extent (length) of the work bridges, and the associated over-water and in-water structures associated with the work bridges will substantially decrease for reasons including potential materials cost savings, schedule savings, and/or the use of different construction methods.

Fish Function Modifier: Furthermore, in several cases the methodology took a conservative approach to the assignment of Fish Function Modifiers by defaulting to the highest level of salmonid use documented for any given area. For example, in Zone 2 (Portage Bay), the entire zone was assigned a modifier of “moderate”, even though most studies have shown only minor use of the zone’s shallower southern portion by juvenile and adult salmonids (City of Seattle and USACE 2008).

5. Mitigation Framework

The overall goal of WSDOT mitigation measures is to achieve no net loss of habitat functions and values. Mitigation for impacts to aquatic functions and values from the proposed project activities will be considered and implemented, where feasible, in the following sequential order:

1. Avoiding the impact altogether by not taking a certain action or parts of an action.
2. Minimizing impacts by limiting the degree or magnitude of the action, and restoring temporary impacts.
3. Compensating for the impact by replacing or providing substitute resources or environments.

5.1 Avoidance of Aquatic Impacts – Design Features

The structures included in this project have been designed to avoid and minimize aquatic impacts whenever practicable. Specific design features to avoid and minimize effects on aquatic habitat are listed in the Ecosystems Discipline Report Addendum and Errata (WSDOT 2011f) and described in the following sections.

5.1.1. In-water Structures

An increased span length has reduced the number of in-water structures, relative to the existing condition. The use of precast girders will eliminate the need for falsework in most locations. Columns will be spaced farther apart, relative to the existing condition. Piers that require footers will be avoided, when possible. When structure foundations require footings, mudline footings or spread footings will be installed. Mudline footings will result in a reduction of in-water structure and shading compared to waterline footings. The footings will be installed below the mudline, allowing for natural deposition on top of the footing. Finally, the length and over-water coverage of the maintenance dock was designed with the minimum dimensions necessary to provide its required function. The size and number of pilings have been minimized to the most practicable extent. A detailed description of in-water structures in each project area is included in Section 2.1 and in the biological assessment (WSDOT 2010a).

5.1.2. Shading

Shading from over-water structures can delay juvenile salmonid migration by invoking a behavioral response such as milling, paralleling, or holding, and because a shade edge provides a foraging opportunity (see Section 4.2.2 for a discussion). Piscivorous fishes also use this shade edge to forage, thereby increasing the risk of predation on juvenile salmonids.

The shading intensity and sharpness of the shade edge is attenuated by increasing bridge height and reducing bridge width (see Section 4.2.2 for discussion).

The Portage Bay, west approach, and east approach bridges will be wider, but significantly higher than the existing structures (see Table 5-1, and Figures 2-2, 2-3, and 2-4). Increasing bridge width can increase shading intensity. The proposed widths of the Portage Bay, west approach, and east approach bridge structures are greater than the existing widths, even though the number of lanes and shoulder widths have been minimized. The west approach bridge will have a gap between eastbound and westbound lanes, further minimizing shading intensity. A detailed description of bridge height and width for each project area is included in Section 2.1 and in the biological assessment (WSDOT 2010a).

Table 5-1. Proposed Changes to Bridge Height Over Water (feet)

Statistic	Portage Bay		West Approach		East Approach	
	Existing	Proposed	Existing	Proposed	Existing	Proposed
Minimum	6	16	4	12	52	66
25th Percentile	8	19	5	21	NA[a]	NA[a]
75th Percentile	37	35	21	42	NA[a]	NA[a]
Maximum	63	63	45	49	64	78

[a] Percentiles were based on bridge height at pier locations. The proposed East Approach structure only has one pier. Therefore, no percentiles were calculated.

5.1.3. Stormwater Discharge

The proposed stormwater management condition will be substantially improved over the existing condition. All new pollutant-generating impervious surfaces (PGIS) will receive stormwater quality treatment. Enhanced stormwater treatment will occur where possible. Stormwater treatment includes the combined sewer system, conventional treatment BMPs, and—in the case of the floating bridge portion of the project—an innovative stormwater treatment approach identified in an "all known, available, and reasonable technology" (AKART) study (WSDOT 2010c).

Existing areas that will not receive post-construction treatment are primarily areas associated with restriping activities in the I-5 interchange. Project-related stormwater will be treated by facilities designed on the basis of the requirements in the 2008 WSDOT *Highway Runoff Manual* (HRM) and the WSDOT *Hydraulics Manual*. New and replaced PGIS requires stormwater treatment to a basic level of treatment for Lake Union and Lake Washington. The project will also be providing enhanced treatment for stormwater discharge from SR 520 into Lake Washington to further minimize any effects on the lake due to dissolved metals.

Stormwater discharge impacts will be minimized because of outfall location and design. New outfalls will be located at or near existing outfalls. Outfall discharge and energy dissipation will occur above the OHWM. Discharged stormwater will be conveyed to the lake. Revegetation will occur between outfalls and water bodies.

A detailed description of operational stormwater treatment and management is in section 2.3.1 and the biological assessment (WSDOT 2010a).

5.1.4. Lighting

The proposed lighting plan has minimized the number of luminaires to occur in areas of potential traffic conflicts such as merge lanes and transit stops. The number of luminaires will be decreased from 124 under existing conditions to 79 for the proposed condition. A photometric analysis has concluded that light spillage from proposed luminaires will be limited to areas of lesser importance to juvenile salmonids, and none will occur in Zone 6 along the west approach. Where proposed, cut-off light fixtures with shielding will be used when fixtures are adjacent to water. Cut-off lights focus on the target area, reducing the amount of light that shines outside the bridge roadway onto the water surface. Lights will be placed on the center median whenever possible to limit light spillage. During bridge operation, nighttime lighting on water surfaces will be avoided or minimized where feasible, and the net effect of light spillage will be an improvement over the baseline condition. A detailed description of proposed roadway lighting is included in Section 2.32 and in the biological assessment (WSDOT 2010a).

5.2 Avoidance of Aquatic Impacts – Construction Timing

WSDOT has been collaborating in research that improves our understanding of juvenile Chinook distribution, movement, and transit time through the project area (Tabor et al. 2010a; Celedonia et al. 2008a; 2008b). Juvenile Chinook are the most vulnerable to the presence of in-water structures and construction impacts because of their small size during migration. These tracking studies confirmed the benefit of previously published work periods, and also contributed to the basis of the project impact assessment (see Section 4).

The construction schedule has been optimized to limit the number of construction years. Seasonal restrictions (i.e., work windows) will be applied to the project to avoid or minimize potential impacts to fish species based on the Hydraulic Project Approval (HPA) issued by WDFW. The in-water work windows vary between water bodies (Table 5-2). The in-water work window is timed to protect peak abundances of juvenile and adult salmonids.

In-water construction will adhere to the proposed in-water construction timing shown in Table 5-2. The proposed dates were developed through a series of in-water construction Technical Work Group meetings attended by representatives from WSDOT, the United States Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), the Washington Department of Fish and Wildlife (WDFW), the Muckleshoot Indian Tribe, and local fish experts. Each in-water construction period is predicated on the nature of the construction activity, the habitat function zones described in Section 3.5.2, and the expected timing of fish use in the habitat function zone.

Table 5-2. Proposed In-Water Construction Periods for the Various Project Elements

Project Element	Proposed In-Water Construction Timing
Portage Bay [a]	
Work bridge/falsework pile installation	September 1 to April 30
Work bridge deck	N/A
Cofferdam – vibratory	August 16 to April 30
Mudline footings in cofferdam	N/A
Drilled shaft – vibratory	August 16 to April 30
Bridge superstructure	N/A
Materials transport	N/A
Column demolition	N/A
Pile removal	August 16 to April 30
Cofferdam removal	August 16 to April 30
Union Bay and West Approach – Salmonid Habitat Zone 4 [b]	
Work bridge pile installation	September 1 to April 30
Work bridge deck	N/A
Drilled shaft – vibratory	N/A
Bridge superstructure	N/A
Materials transport	N/A
Column demolition	N/A
Pile removal	N/A
West Approach – Salmonid Habitat Zone 6 [b]	
Work bridge pile installation	October 1 to April 15
Work bridge deck	N/A
Drilled shaft -–vibratory	August 1 to March 31
Bridge superstructure	N/A
Materials transport	N/A
Column demolition	N/A
Pile removal	August 1 to March 31
West Approach Connection Bridge [b]	
Work bridge deck	N/A
Drilled shaft – vibratory	August 1 to March 31
Bridge superstructure	N/A
Materials transport	N/A
Column demolition	N/A

Project Element	Proposed In-Water Construction Timing
Floating Bridge [b]	
Temporary pile anchors – vibratory	July 16 to March 15
Gravity or shaft anchor installation – west end	July 16 to March 15
Gravity or shaft anchor installation – east end	July 16 to June 15
Fluke anchor installation	N/A
Pontoon assembly	N/A
Bridge outfitting/superstructure	N/A
Materials transport	N/A
Pile removal	July 16 to March 15
East Approach [c]	
Work bridge/falsework/ maintenance dock pile installation	August 16 to March 15
Work bridge deck	N/A
Cofferdam – vibratory	September 1 to May 15
Mudline footings in cofferdam	N/A
Drilled shaft – vibratory	September 1 to May 15
Bridge superstructure	N/A
Materials transport	N/A
Column demolition	N/A
Pile removal	July 1 to March 15
Cofferdam removal	July 1 to March 15

[a] Published In-Water Construction Timing October 1 to April 15
[b] Timing July 16 to March 15 north of bridge and July 16 to April 30 south of existing bridge
[c] Published In-Water Construction Timing July 16 to March 15
N/A = not applicable

Note: In-water construction windows are not proposed for the Ship Canal because all construction related to the Montlake Bascule Bridge will occur above water or from a barge.

5.3 Minimization of Impacts during Construction

BMPs will be used during all construction activities to eliminate or minimize potential environmental effects. Many of these BMPs are standard and will apply universally too many project construction activities, including upland staging areas. The following section discusses provisional BMPs that WSDOT anticipates will be included as construction commitments for the project. A detailed description of construction methods that avoid or minimize aquatic impacts is described in the project biological assessment (WSDOT 2010a).

Monitoring will occur during construction to measure BMP efficacy. Activities will be adjusted as necessary, depending on monitoring results. Environmental performance (e.g., turbidity, underwater noise, water quality) will be reviewed during initial construction activities. Turbidity and noise will be monitored before and during construction. If environmental results are unsatisfactory during construction, subsequent similar activities will be implemented in a more conservative fashion to minimize these impacts.

5.3.1. Temporary Stormwater Management Strategy

The project's temporary stormwater management strategy is to reduce the risk of potential pollutants being discharged to a watercourse that may cause or contribute to the exceedances of water quality standards during construction and demolition activities. The strategy is to use BMPs and adhere to regulatory requirements to manage construction-related stormwater runoff and thereby minimize environmental impacts. The plan will include planning system design and water quality monitoring and sampling. The components of the temporary stormwater management strategy are listed below.

Stormwater Pollution Prevention Plan

A Stormwater Pollution Prevention Plan (SWPPP) is prepared to meet National Pollutant Discharge Elimination System (NPDES) permit requirements for stormwater discharges at construction sites. The SWPPP will address the following elements:

- Planning and organization
- Formation of a pollution prevention team
- Building on pre-existing plans
- Assessment
- Development of a site plan
- Material inventory
- Record of past spills and leaks
- Non-stormwater discharges
- Site evaluation summary
- BMP identification

- Preventive maintenance
- Spill prevention and response
- Sediment and erosion control
- Management of runoff
- Implementation
- Implementation of appropriate controls
- Employee training
- Evaluation and monitoring
- Annual site compliance evaluation
- Recordkeeping and internal reporting
- Plan revisions

Temporary Erosion and Sediment Control Plan

A Temporary Erosion and Sediment Control (TESC) Plan will be prepared and implemented to minimize and control pollution and erosion from stormwater runoff. Temporary erosion and sediment control is required to prevent erosive forces from damaging project sites, adjacent properties, and the environment. The TESC plan will address the following elements:

- Marking clearing limits
- Establishing construction access
- Controlling flow rates
- Installing sediment controls
- Stabilizing soils
- Protecting slopes
- Protecting drain inlets

- Stabilizing channels and outlets
- Controlling pollutants
- Controlling dewatering
- Maintaining BMPs
- Managing the project

Spill Prevention Control and Countermeasures Plan

WSDOT requires the implementation of a Spill Prevention Control and Countermeasures (SPCC) Plan on all projects to prevent and minimize spills that may contaminate soil or nearby waters. The plan is prepared by the contractor as a contract requirement and is submitted to the project engineer prior to commencement of any on-site construction activities.

Spill avoidance and containment BMPs will include the following:

- Maintain all construction equipment to minimize the risk of fuel and fluid leaks or spills.
- Implement spill control and emergency response plans for fueling and concrete activity areas. All spill-control materials will be present on the site prior to and during construction.
- If a leak or spill should occur, cease all work until the source of the leak is identified and corrected and the contaminants have been removed from the site.
- Clean all equipment that is used for in-water work prior to operations waterward of the OHWM. Remove external oil and grease as well as dirt and mud. Prohibit the discharge of untreated wash and rinse water into local waters. Ensure that all construction equipment working in the water, particularly pile-driving machines use vegetable-based hydraulic fluid.
- Conduct refueling activities within a designated refueling area away from the shoreline, streams, or any designated wetland areas.
- Minimize refueling activities on work bridges whenever feasible, and ensure that appropriate spill containment and cleanup equipment is on hand and in use as needed during any refueling of equipment on work bridges.

- Inspect daily all vehicles operating within 150 feet of any water body for fluid leaks before vehicles leave the staging area. Repair any leaks detected before the vehicle resumes operation. When vehicles are not in use, store them in the vehicle staging area.

- Modify off-pavement construction entrances according to WSDOT standard plans to reduce the spread of dirt from the project site.

Concrete Containment and Disposal Plan

A Concrete Containment and Disposal Plan will be developed to maintain water quality when handling and managing concrete. The plan will be used during construction of bridge columns and their footings, and also during demolition of the existing bridge.

Water Quality Sampling, Recording, and Reporting Procedures

All projects with greater than 1 acre of soil disturbance, except federal and tribal land, that may discharge construction stormwater to Waters of the State are required to seek coverage under the NPDES Construction Stormwater General Permit. Sampling guidance for meeting permit requirements is listed in WSDOT's HRM (2008), Section 6-8.

5.3.2. Land-Based Construction – Best Management Practices

The following BMPs and procedures are to be implemented for the proper use, storage, and disposal of materials and equipment on land-based construction limits, staging areas, or similar locations that minimize or eliminate the discharge of potential pollutants to a watercourse or Waters of the State. These procedures will be implemented for construction materials and wastes (solid and liquid), soil or dredging materials, or any other materials that may cause or contribute to exceedance of water quality standards.

Upland construction BMPs will involve the following:

- Clearly define construction limits with stakes and a high visibility fence before beginning ground-disturbing activities. No disturbance will occur beyond these limits.

- Minimize vegetation and soil disturbance to the extent possible.

- Avoid or reduce adverse impacts to critical areas during project construction, including shoreline buffers. These measures will include clearing, grading, and stormwater management.

- Protect designated sensitive areas, including the shoreline, with silt fencing. All silt fencing will be removed when construction is completed.

- Control all stormwater discharges from construction sites and ensure that NPDES permit requirements are met.

- Use construction BMPs to control dust and limit impacts to air quality; these BMPs include the following:

- Wet-down fill material and dust on-site.

- Ensure adequate freeboard to prevent soil particles from blowing away during transport.

- Remove dirt, dust, and debris from the roadway on a regularly scheduled basis in accordance with final permitting requirements.

- Minimize potential erosion from areas of disturbed soil by stabilizing and/or revegetating cleared areas in accordance with the TESC Plan.

- Wet-down concrete structures during demolition activities.

5.3.3. Over-Water Work – Best Management Practices

The following BMPs and procedures are expected to be implemented at a minimum for the proper use, storage, and disposal of materials and equipment on barges, boats, temporary construction pads (e.g., work bridges), or at similar locations that minimize or eliminate the discharge of potential pollutants to a watercourse or to Waters of the State. These procedures will be implemented for construction materials and wastes (solid and liquid), soil or dredging materials, or any other materials that may cause or contribute to exceedance of water quality standards.

Barge Moorage

During the primary juvenile outmigration period of April 15 to September 1, a 100-foot wide unobstructed corridor will be maintained between moored barges or between barges and work bridges in the primary outmigration corridor through the west approach and east approach areas. Moorage of barges in the Montlake Cut of the Ship Canal will be avoided from April 1 through September 15.

Construction Lighting

Construction lighting will be limited to areas of active work and directed at work surfaces. To the extent practicable, construction lighting will be shielded to minimize spillage onto adjacent waters.

Watertight Curbs, Bull Rails, or Toe Boards

Watertight curbs, bull rails, or toe boards will be installed around the perimeter of a work bridge, platform, or barge to contain potential spills and prevent materials, tools, and debris from leaving the over-water structure. These applications will be installed with a minimum vertical height of 10 inches.

Oil Containment Boom

An oil containment boom is a floating barrier that can be used to contain oil, and aids in preventing the spread of an oil spill by confining the oil to the area in which it has been discharged. The purpose of containment is not only to localize the spill and thus minimize pollution, but to assist in the removal of the oil.

Floating Sediment Curtain

These barriers can aid in controlling the settling of suspended solids (silt) in water by providing a controlled area of containment. This condition of suspension (turbidity) is usually created by disrupting natural conditions through construction or dredging in the aquatic environment. The containment of settleable solids is desirable to reduce the impact area.

Tie-Downs

Tie-downs can be used to secure all materials, which can aid in preventing discharges to receiving waters via wind.

Absorbent Materials

Absorbent materials will be placed under all vehicles and equipment on docks, barges, or other over-water structures. Absorbent materials will be applied immediately on small spills, and promptly removed and disposed of properly. An adequate supply of spill cleanup materials, such as absorbent materials, will be maintained and available on-site.

Equipment Maintenance and Inspection

- Vehicle and construction equipment inspection will occur daily. Vehicles will be inspected prior to entering any over-water work zone. Vehicles and equipment will be kept clean of excessive build-up of oil and grease.

- Land-based fueling stations will be used to the extent practicable.

- Off-site repair shops will also be used to the extent practicable. These businesses are better equipped to properly handle vehicle fluids and spills. Performing this work off-site can also be economical by eliminating the need for a separate maintenance area. If a leaking line cannot be repaired, the equipment will be removed from over-water areas.

- If maintenance must take place on-site, only designated areas away from drainage courses will be used. Dedicated maintenance areas will be protected from stormwater run-on and runoff.

Cover and Catchment Measures

Portable tents, drop cloths, tarps, blankets, sheeting, netting, and plywood panels will be used to cover work areas, temporary stockpile materials, or demolition debris. Nets, tarps, platforms, scaffolds, blankets, barges, and/or floats will be used to contain and control debris beneath structures being constructed or demolished. Vacuums, diverters, squeegees, absorption materials, holding tanks, and existing drainage systems will be used to control and contain concrete-laden water. These BMPs will also facilitate the suppression and dispersal of fugitive dust generated from the demolition process.

Construction Water Treatment Systems

These systems generally consist of temporary settling storage tanks, filtration systems, transfer pumps, and an outlet. The temporary settling storage tank provides residence time for the large solids to settle out. The filtration system will be provided to remove additional suspended solids below an acceptable size (typically 25 microns). The pumps provide the pressure needed to move the water through the filter and then to an acceptable discharge location. Once the solid contaminants are filtered out, the clean effluent is then suitable for discharge to a municipal storm drain or an acceptable discharge location. These systems will be located on work bridges and barges.

Spill Containment Kits and Containment Products

These pre-manufactured products will aid in spill containment and cleanup. These kits and products will be kept on-site and within construction vehicles for easy deployment.

Alternative Lubricants and Fuels

Eco-friendly lubricants and fuel sources (e.g., vegetable-based) will be used for in-water and over-water construction where practicable.

Barges and Floats

Barges and floats can be used to store stockpiled materials, store construction equipment, stage construction activities, transport demolition debris, and store water containment systems and water storage tanks. The barges and floats can also be used as a catchment for demolition debris if located below a proposed demolition activity.

Protection will be required to prevent debris or water from entering adjacent live traffic lanes and prevent the spread of such material over a larger area. The prevention of such occurrences can be accomplished by using temporary barriers and protective panels, and containing or vacuuming water from concrete saw usage.

5.3.4. In-Water Work – Best Management Practices

In addition to applicable BMPs described above for over-water work, the following BMPs apply where demolition or construction activity will occur in Waters of the State. These procedures will be implemented to contain construction materials and wastes (solid and liquid), soil or dredging materials, or any other materials that may cause or contribute to the exceedances of water quality standards. Equipment that enters waterways will be maintained such that no visible sheen from petroleum products appears within waterways. If a sheen appears around equipment in the water, the equipment will be contained within an oil boom and shall be removed from the water, cleaned, and/or maintained appropriately.

Construction Work Bridges, Over-water Staging Areas, and Barges

Work over open water will be accomplished from work bridges, barges, or over-water staging areas. Construction will be done from barges where feasible, because of their relatively small impact. The impacts are relatively small because they will result in only limited disturbance of the substrate; and they are likely to remain in any one place for a shorter time than the work bridges. The extent of work bridges has been estimated with an assumption that construction barges cannot travel into waters less than 10 feet deep. However, contractors will be allowed to use barges at shallower depths if they have equipment capable of safely navigating and operating in shallow waters (WSDOT 2010d). Where the lake depth is too shallow for barges to operate, temporary work bridges will be constructed. Portage Bay, Union Bay, west approach, and the east approach areas all have shallow waters that are inaccessible by barge and will require work bridges. In addition, a work bridge across Foster Island will be constructed instead of temporary work roads, thereby reducing temporary clearing. The quantity of work bridges in the east approach has been largely replaced with an over-water staging area (see section 2.1.6). The over-water height of the work bridges has been maximized to the furthest extent practicable, thereby minimizing shading impacts. Piles will be installed with a vibratory hammer, but proofed with an impact hammer. These structures will be removed at the earliest possible date, even if removal occurs outside of the in-water work window. The piles will be removed with a vibratory hammer and simultaneous lifting of the pile (WSDOT 2010d).

Underwater Containment System/Temporary Cofferdam

These systems will be implemented to prevent sediment, concrete, and steel debris from mixing with Waters of the State. Examples include a temporary cofferdam, an oversized steel casing, or another type of approved underwater containment system. This application will allow demolition work to be completed on and around an underwater structure, and will allow the work zone to be isolated. The system will also allow work to be completed at or below the mudline as determined by the state or contractor's removal requirements. Construction water and slurry within the containment system will be removed, treated, and pumped to an acceptable discharge location when demolition is complete. Fresh concrete will be prevented from coming in contact with Waters of the State.

Noise Attenuation

The Fisheries Hydroacoustic Working Group (FHWG) defined interim criteria for injury to fish from pile driving activities. The criteria identify sound pressure levels (SPLs) of 206 decibels (dB) peak and 187 dB accumulated sound exposure level (SEL) for all listed fish except those that are less than 2 grams. For the fish less than 2 grams, the criteria for the accumulated SEL is 183 dB.

To compare these criteria with the proposed pile driving activities, WSDOT initiated a Pile Installation Test Program (WSDOT 2010e). During this program, a vibratory hammer and an impact hammer were used on test piles, and WSDOT measured the peak and attenuated noise. Three minimization measures were employed and measured for effectiveness. Bubble curtains were very effective at reducing noise down to acceptable levels and will be installed during in-water impact pile driving for the SR 520, I-5 to Medina Project. The use of a bubble curtain is expected to substantially minimize the area affected by above-threshold sound levels. In-water pile driving in the Union Bay area will occur during the in-water work window to further avoid noise disturbance to fish.

Several factors suggest that the project's noise will have a relatively low impact to fish:

- Few juvenile or adult Chinook salmon are likely to occur in the project area during this construction period. The in-water work period is outside of the peak of Chinook outmigration from the Cedar River into Lake Washington (begins in January, but most fry enter the lake in mid-May), and is also outside of the adult migration period.

- Adult Chinook salmon are believed to migrate through deeper waters, away from behavioral and injury disturbance areas.

- WSDOT will deploy a bubble curtain matching the specifications of that used in the Pile Installation Test Program during impact pile driving. The use of a bubble curtain is expected to substantially minimize the area affected by above-threshold sound levels.

The underwater SPLs from in-water impact pile driving will be monitored by the contractor, per a forthcoming and agreed-upon monitoring plan. If the recorded SPLs exceed the thresholds agreed upon by the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA Fisheries), the U.S. Fish and Wildlife Service (USFWS), FHWA, and WSDOT, appropriate energy reduction measures shall be deployed by the contractor to attenuate the SPLs.

If a fish kill occurs or fish are observed in distress from pile driving, the contractor will immediately cease the activity and WSDOT will be notified. WSDOT will notify the WDFW Habitat Program immediately. The contractor will ensure that a project inspector/biologist is on-site during all in-water pile driving operations to monitor for distressed fish. The contractor will ensure that this inspector has full authority to stop work in the event that dead or distressed fish are observed.

5.3.5. Water Quality Monitoring

Discharges from construction and operation activities will be monitored per the contractor's Construction Water Quality Protection and Monitoring Plan (WQPMP) approved by Ecology. The contractor will submit the WQPMP to WSDOT for submittal to Ecology at least 30 calendar days prior to beginning construction. The purpose of the WQPMP is to assess compliance with water quality standards during the project's construction and operation activities. The WQPMP will identify all the construction and operation activities at the site that may have a discharge (e.g., dewatering water, construction stormwater, channel dredging, operational stormwater, etc.) to surface water or groundwater. Specific locations of proposed discharge points to be monitored and their water quality parameters will be defined in the WQPMP. If any of the monitoring parameters exceed the water quality standards, the contractor will cease construction activities in the vicinity and notify WSDOT until appropriate measures are taken to bring the project back into compliance. In the event that a violation of the state water quality standards occurs or if a revision from the permitted work is needed, WSDOT will immediately notify Ecology.

5.4 Compensatory Mitigation

Given the measures described in Sections 5.1–5.3, many potential impacts to the aquatic environment will be effectively avoided or minimized. However, some project elements and activities will require compensatory mitigation for impacts to aquatic habitat, or habitat functions will still be degraded after avoidance and minimization measures have been applied (see Section 4.1).

Many of the construction-related impacts will not result in a long-term impact to aquatic habitats or functions because the effect ceases almost immediately upon cessation of the activity (see Table 5-3). Furthermore, potential construction impacts, including in-water noise, temporary lighting, in-water turbidity/contaminants, stormwater discharge, and barge operation and moorage, will be effectively avoided and/or minimized (see Sections 5.1–5.3) to the extent that compensatory mitigation is not required. On an operational basis, the bridge lighting and stormwater impacts will be minimized through the implementation of design elements and BMPs.

Three types of activities will cause habitat function degradation (see Table 5-3). These functional effects will occur on both a temporary and a permanent basis. The bridge superstructure and temporary work bridges will alter the quality of migratory habitat for juvenile salmonid by projecting a shade edge onto the water. The bridge columns and temporary work bridge piles will result in permanent and temporary displacements of benthic habitat. The columns and temporary work bridge piles will also increase vertical habitat complexity, thereby attracting smallmouth bass, a juvenile salmonid predator. These impacts have the greatest potential to affect aquatic habitat functions, particularly in terms of salmonid life history stages and populations. A detailed discussion of these impact mechanisms is provided in Sections 4.1–4.2.

Table 5-3. Potential Impacts and Compensatory Mitigation Requirements

	Potential Impact	Avoided/ Minimized	Compensatory Mitigation
Temporary	In-water noise	X	
	Lighting	X	
	Turbidity	X	
	Construction stormwater	X	
	In-water work	X	
	Barge Operation	X	
	Barge Moorage	X	
	Over-water Shading (work bridges)		X
	Benthic fill (piles)		X
	Habitat complexity (piles)		X
Permanent	Lighting	X	
	Stormwater	X	
	Over-water Shading		X
	Benthic fill		X
	Habitat complexity		X

5.5 Compensatory Mitigation Framework

The following agencies have authority to require compensatory mitigation for aquatic (i.e., non-wetland) impacts that were not sufficiently avoided or minimized:

- USACE
- WDFW
- Ecology
- City of Seattle

The aquatic mitigation framework for the SR 520, I-5 to Medina Project is commensurate with the mitigation policies of these agencies. The WDFW policy "Requiring or Recommending Mitigation", POL-M5002, has stated goals to "…achieve no loss of habitat functions and values" and "to maintain the functions and values of fish and wildlife habitat in the state."

The following WDFW policy language applies to infrastructure projects:

"WDFW may not limit mitigation to on-site, in-kind mitigation when making decisions on hydraulic project approvals for infrastructure development projects. The State Legislature has declared that it is the policy of the state to authorize innovative mitigation measures by requiring state regulatory agencies to consider mitigation proposals for infrastructure projects that are timed, designed, and located in a manner to provide equal or better biological functions and values compared to traditional on-site, in-kind mitigation proposals. For these types of projects, WDFW may not limit the scope of options in a mitigation plan to areas on or near the project site, or to habitat types of the same type as contained on a project site. When making a permit decision, WDFW shall consider whether the mitigation plan provides equal or better biological functions and values, compared to the existing conditions, for the target resources or species identified in the mitigation plan…"

The City of Seattle has a similar policy goal on maintaining habitat functions and values. Policy SMC 25.09.200, Section B.3.b pertains to over-water structures and states that the "Mitigation is provided for all impacts to the ecological functions of fish habitat on the parcel resulting from any permitted increase in or alteration of existing over-water coverage."

Unlike the regulatory process for wetland mitigation, federal and state regulations and guidance do not prescribe calculation of metrics or mitigation formulas for the majority of the effects to aquatic habitat. In addition, many of the potential impacts to fish and other aquatic species will be indirect. For example, partial shading impacts from the new bridge structures could alter juvenile salmon migration patterns or timing, or influence the distribution of salmonid predators in the project area. These potential impacts could reduce the number of juvenile salmon completing successful outmigration to marine waters. Impacts on individual fish or populations of fish, resulting from habitat alterations are generally mitigated by increasing the quality and quantity of habitat for the species of interest.

Since on-site, in-kind opportunities were not feasible, WSDOT sought off-site mitigation opportunities that addressed the same functions and values that could be affected by the project. Aquatic functions and values were defined in terms of the following fish species and their life history requirements:

- Fall Chinook
- Sockeye
- Coho
- Steelhead

The spatial locations of project impacts and mitigation sites were classified in terms of their importance to these species, and assigned a score commensurate to their value to the focal fish. These Fish Function Modifier scores were assigned to impact and mitigation sites, in the form of a 0-1 weighting factor. Section 4.1 describes criteria and rationale for the Fish Function Modifier scoring. The acreage of a given mitigation action is multiplied by the applicable Fish Function Modifier score (Figure 5-1). Next, the mitigation acreage (adjusted by Fish Function Modifier score) is weighted in terms of the "Project Type" score (Figure 5-1).

Using this framework, all in-water mitigation activities (riprap removal, shoreline grading, levee removal, dredging) were assigned a Project Type score of 1.0. A score of 1.0 is indicative of the direct and immediate aquatic benefits that these projects produce. Riparian and floodplain restoration projects received a score of 0.2, to recognize the delay in achieving full function/and or the indirect nature of these projects to functioning aquatic habitat. While riparian function along the shoreline may directly benefit fish (e.g., fish cover), the functional value becomes indirect farther from the shoreline (e.g., pollutant filtration, shading, etc.). Floodplains provide indirect fish benefits by attenuating flood flows, performing water quality functions, maintaining riverine wetlands, providing off-channel salmonid habitat, and providing the opportunity for dynamic channel creation over time. Mitigation areas that improve both riparian and floodplain functions received a Project Type score of 0.4 to reflect the additive value of riparian and floodplain functions. After adjusting the mitigation acreages by Fish Function Modifier and Project Type scores, the adjusted acreage can be applied to permanent impacts (see Section 4.1).

If the adjusted mitigation acreage is applied to temporary impacts instead of permanent impacts, an additional step is required. Temporary impacts are calculated in terms of service-acre-years (see Section 4.1), i.e., the total area of impact summed for all years the impact is present. Restoration actions that are intended to mitigate for these temporary impacts must also be valued in terms of their temporal contribution to aquatic functions and values. The acreage of each mitigation action (adjusted by Fish Function Modifier and Project Type scores) is multiplied by the percent aquatic function that the project provides on an annual basis for the first 18 years after project completion. For example, if a mitigation project was completed in 2012, the service-acre mitigation credits will be counted until 2030 (18 years). A total of 18 years was selected as a suitable timeframe in which ecological functions could be realized and become established to fully offset the temporal loss of functions at the impact site, yet credits would not be overstated by extending the timeframe out into perpetuity. It should be noted, however, that ecological functions at the mitigation sites will continue beyond the first 18 years.

Mitigation actions that have full and immediate benefits are multiplied by 1.0 (i.e., 100% function) for all 18 years. Projects that take time to realize full function are multiplied by an increasing proportion (i.e., percent function) over time. Riparian restoration projects are assumed to realize 10% function during years 1 through 5, 50% function during years 6 through 10, and 100% function thereafter. The acre-years for all 18 years are summed to yield a total mitigation value that can be credited toward temporary impacts. In conclusion, the service acre-years provided by proposed mitigation actions will exceed the sum of temporary impact acre-years (Figure 5-2).

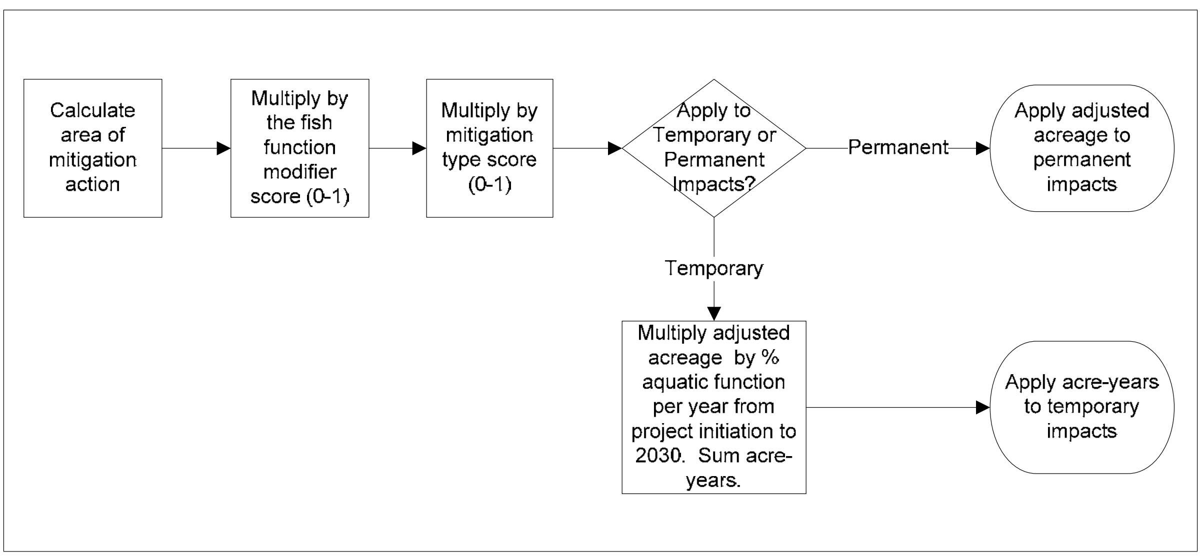

Figure 5-1. Process for Determining Value of Mitigation Actions

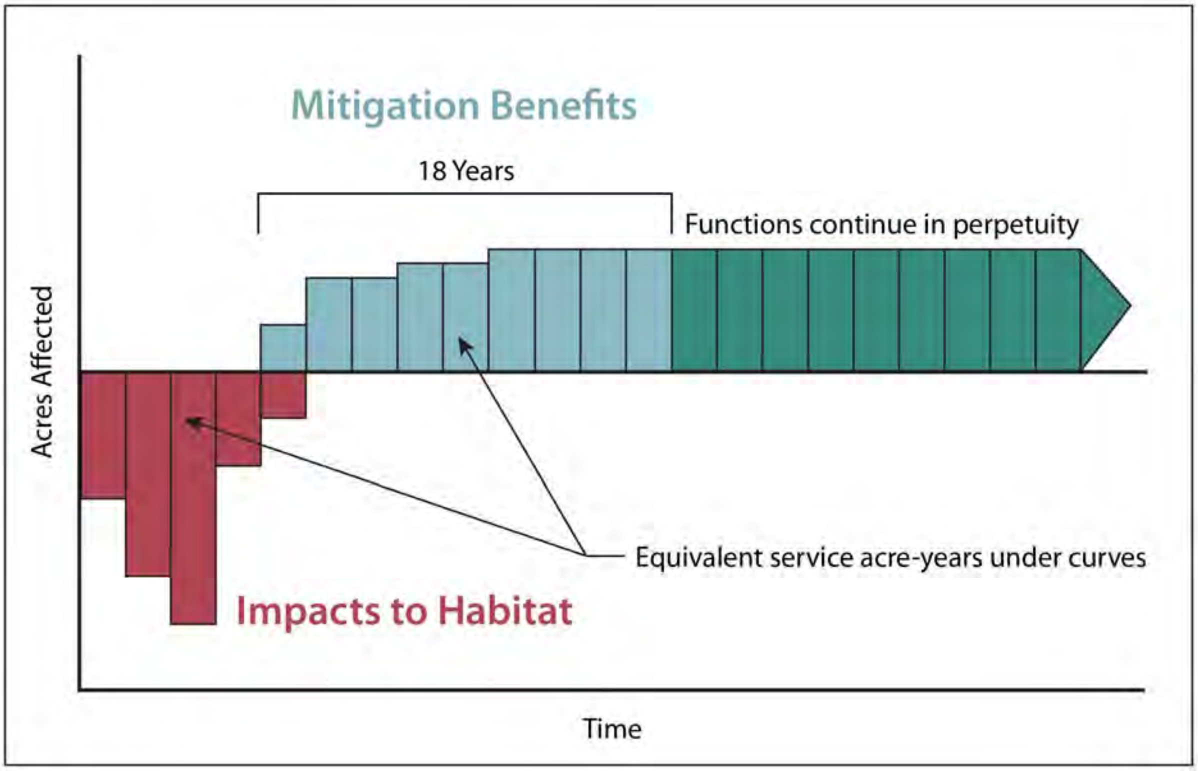

Figure 5-2. Conceptual Basis of Service-Acre-Years

6. Aquatic Mitigation Sites

6.1 Rationale for Site Selection

The goal of the mitigation screening and ranking process was to select a suite of habitat restoration projects that increase aquatic functions and values enough to offset the SR 520, I-5 to Medina Project's effects on similar functions and values. Chinook salmon, sockeye salmon, coho salmon, and winter steelhead were chosen as key indicator species because they are the most studied species in the watershed and a comprehensive data set is available linking salmonids to habitat variables in the watershed (City of Seattle and USACE 2008; King County 2005).

The project will affect four key life history functions of Lake Washington salmonids: juvenile rearing/ feeding, juvenile migration, adult migration, and lakeshore beach spawning. The mitigation screening approach looked at habitat features and ecological functions that supported these key life history phases in Lake Washington, and linked them with potential enhancements of such features.

Mitigation opportunities were sought from throughout WRIA 8, specifically in the marine nearshore, the Ship Canal, and throughout Lake Washington and its tributaries, and were organized through a screening plan (WSDOT 2009b). However, the results of this plan were substantially adjusted through agency input, coordination, and further field work.

6.1.1. Mitigation Opportunities in the Marine Nearshore and Ship Canal

Mitigation opportunities along the marine nearshore (and in proximity to the Ship Canal) are extremely limited. WSDOT has worked with the resource agencies and tribes in identifying mitigation measures that might be applied to the Lake Washington Ship Canal to benefit adult fish survival and migration into the Lake Washington system.

WSDOT evaluated the feasibility of options for reducing summer water temperatures in the Lake Washington Ship Canal to improve conditions for returning adult salmon. The two options evaluated (a dredging option and a pumping option) were determined to provide a slight improvement to temperature in the vicinity of the Montlake Cut and eastward; however, the benefits to adult salmon from this improvement would be insignificant, given the short duration which adults actually occupy this area during their return migration (minutes to hours). These options also presented a series of technical, regulatory, schedule, and cost issues, as well as risks that rendered them not feasible for implementation by WSDOT. A complete discussion of the evaluation and conclusions is available in the Draft Ship Canal Evaluation Report (WSDOT 2011d).

6.1.2. Mitigation Opportunities in Lake Washington

The objectives of the Lake Washington General Investigation (City of Seattle and USACE 2008) include habitat improvement for juvenile salmon in Lake Washington. The Lake Washington General Investigation prescribed management actions to support this objective, including the following:

- Continue to remove shoreline armoring and create shallow-water habitat with overhanging vegetation. These actions will improve rearing conditions for Chinook fry. Focus these activities in the southern portion of Lake Washington.

- Continue to improve habitat around over-water structures by removing structures, reducing their footprint, or by improving light penetration.

- Remove in-water solid waste debris (e.g., concrete, asphalt, and scrap metal) and riprap to reduce available predator habitat.

- Prioritize the restoration of tributaries and tributary mouths in south Lake Washington tributaries.

Some project opportunities in Lake Washington are located along juvenile salmonid migration routes; these opportunities were prioritized, because of the relatively high fish benefits. Juvenile Chinook (and sockeye to a lesser extent) use the lake shoreline for foraging, rearing, and refugia from predators (Tabor and Piaskowski 2002). They also slowly migrate along the shoreline toward the Ship Canal during this time. As noted above, once juvenile salmonids have migrated into the Ship Canal, holding and foraging is not desirable because of rapidly-degrading water quality in the late spring and the presence of warm-water predators. However, opportunities for habitat improvement along the more desirable Lake Washington migration corridors are extremely limited because the overwhelming majority of opportunities are on private residential land (WSDOT 2009b). These private residential lots were not pursued, because restoration of the narrow shoreline on a typical residential lot would not result in a large habitat gain. Projects on individual parcels would be surrounded by adjacent bulkheads, piers, and docks. Acquiring multiple contiguous residential properties was considered very unlikely.

WSDOT has investigated the possibility of conducting mitigation on privately-owned Boeing property and on City of Renton parcels near the mouth of the Cedar River to complement the South Lake Washington Restoration (see below), but has not been successful. Out of the limited public property with shoreline that has fisheries value, the following sites are proposed for restoration by the WSDOT 520 Program:

- Seward Park 1-4 (four spatially discrete actions are proposed)
- Magnuson Park 1 and 2 (two spatially discrete actions are proposed)
- Taylor Creek
- South Lake Washington Shoreline Restoration (DNR Parcel)
- East approach

These mitigation sites, and all of their attendant mitigation actions (e.g., Seward 1-4, Magnuson 1-2), are described in the subsequent sections of this section. The site locations are shown at the landscape scale in Figure 6-1. The known salmonid uses of each site, as well as their Fish Function Modifier scores, are shown in Table 6-1.

6.1.3. Mitigation Opportunities in Lake Washington Tributaries

Habitat improvement in the WRIA 8 Lake Washington tributaries is also an objective defined in the WRIA 8 watershed management plans. The WRIA 8 Chinook Salmon Conservation Plan (King County 2005) prioritizes the Lower Cedar River for restoration with a focus on actions that protect water quality, restore riparian zones, increase LWD and pools in the river (via installation and natural recruitment), and set back levees to increase floodplain function and off-channel habitat. The Chinook Salmon Conservation Plan also recommends restoration actions on Lower Bear Creek, Upper Bear Creek, and Cottage/Cold Creeks. However, the plan indicates that Lower Bear Creek has the poorest habitat function of these three water bodies, thereby representing the greatest improvement opportunity.

WSDOT will address these restoration priorities by implementing restoration projects at the following riverine locations:

- Cedar River/ Elliott Bridge reach
- Lower Bear Creek, near the mouth

The current and potential use of these mitigation sites by the focal fish species is discussed in detail in subsequent sections. Although none of the sites meet the “very high” fish function criteria (Table 6-1), they are all important locations in the watershed and will provide ecological functions that are priorities for fish recovery.

All of the proposed sites are publicly owned, and as such, WSDOT has engaged in partnerships with the public entities to use these sites for compensatory mitigation. Details regarding cost-sharing, construction, monitoring, and maintenance responsibility, and the long-term protection of the sites are provided in site description and summarized in Section 6.13.

These sites have undergone a basic screening for fatal flaws such as site access, landowner consent, hazardous materials, and cultural resources. However, if it becomes apparent during advanced design that a site is no longer feasible due to technical constraints, the site will be removed from this plan and replaced with another appropriate mitigation site. A mitigation site may also be replaced with another if WSDOT develops a new site concept that is of higher ecological value or has more ecological value per monetary cost for the State of Washington.

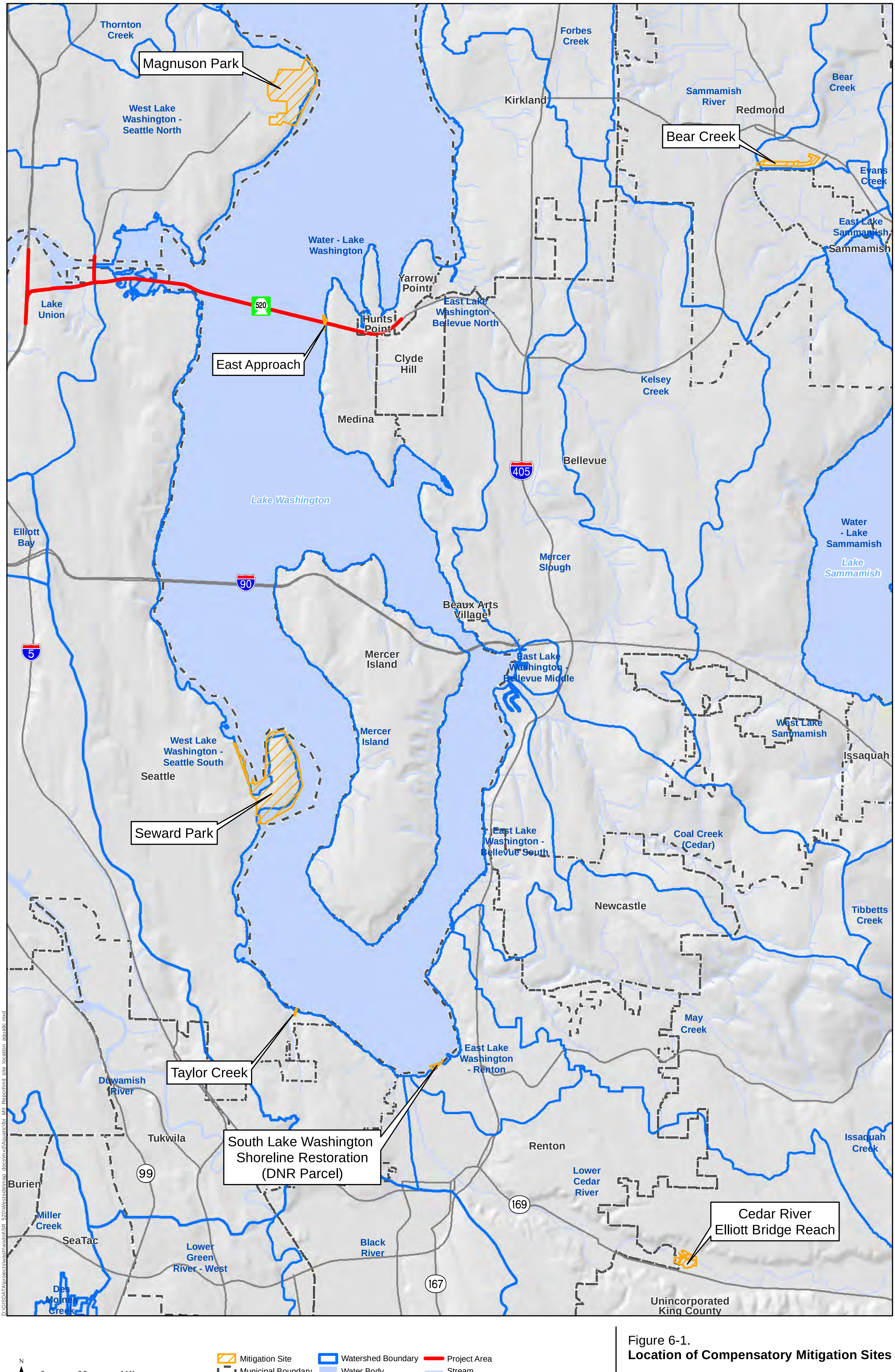

Figure 6-1.
Location of Compensatory Mitigation Sites

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Table 6-1. Mitigation Site Fish Use and Fish Function Modifier Scores

Fish Function Modifier Score	Proposed Mitigation Site Classification	Adult Salmonid Use	Juvenile Salmonid Use	Stocks Affected
0.8 – High	**Seward Park** 1 Shoreline Enhancements		Chinook (Rearing)	Taylor Creek Cedar River
0.8 – High	**Seward Park** 2 Shoreline Enhancements	Sockeye (Spawning)	Chinook (Rearing) Sockeye (Rearing/Feeding)	Taylor Creek Cedar River Lake Washington
0.6 – Medium	**Seward Park** 3 Shoreline Enhancements		Chinook (Rearing)	Taylor Creek Cedar River
0.8 – High	**Seward Park** 4 Shoreline Enhancements	Sockeye (Spawning)	Chinook (Rearing) Sockeye (Rearing/Feeding)	Taylor Creek Cedar River Lake Washington
0.6 – Medium	**Magnuson Park 1** Shoreline Enhancements		Chinook (Rearing)	North Lake Washington Issaquah
0.6 – Medium	**Magnuson Park 2** Shoreline Enhancements		Chinook (Rearing)	North Lake Washington Issaquah
0.8 – High	**Taylor Creek** Restoration	Coho (Spawning) Sockeye (Spawning)	Coho (Rearing) Chinook (Rearing) Sockeye (Rearing/Feeding)	Taylor Creek Cedar River

Fish Function Modifier Score	Proposed Mitigation Site Classification	Adult Salmonid Use	Juvenile Salmonid Use	Stocks Affected
0.8 – High	**South Lake Washington Shoreline Restoration (DNR Parcel)** Shoreline Enhancements		Chinook (Rearing/Feeding) Chinook (Migration) Sockeye (Rearing; Feeding)	Cedar River
0.8 – High	**Cedar River/ Elliott Bridge Reach** Enhancements	Coho (Spawning) Sockeye (Spawning) Chinook (Spawning) Steelhead (Spawning	Coho (Rearing/Feeding) Steelhead (Rearing/Feeding) Chinook (Rearing/Feeding	Cedar River
0.8 – High	**Bear Creek** Restoration		Sockeye (Rearing/Feeding) Chinook (Rearing/Feeding) Coho (Rearing/Feeding)	North Lake Washington
0.8 – High	**East Approach** Spawning Beach Enhancement	Sockeye (Spawning)	Sockeye (Rearing/Feeding)	Lake Washington

6.2 Seward Park Project 1

6.2.1. Site Location

Seward Park is in the City of Seattle, along the western shore of Lake Washington, as shown on Figure 6-1. Seward Project 1 is located on the southern portion of the peninsula (Figure 6-2).

6.2.2. Mitigation Site Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization of shoreline conditions is available in the SR 520 Final Aquatic Assessment Report (WSDOT 2011c).

Shoreline Conditions

This segment is approximately 550 feet long, has a vertical concrete bulkhead (2.5 feet high, 3 feet wide) along its length, and has very little riparian vegetation (Figure A-1). The vertical elevation gain between the uplands and the lake water level is approximately 6 to 7 feet (Appendix B).

The major shoreline feature at Seward 1 is a continuous 550-foot-long concrete bulkhead (Figure A-1). The bulkhead is 2.5 feet high and 3 feet wide. There is very little overhanging vegetation other than a few trees near the eastern half of the shoreline (Figure 6-2). One piece of large woody debris (LWD) was observed along the shoreline in 2011 (WSDOT 2011c). There are gradual slopes (4 to 13%) and a relatively shallow bathymetry along this shoreline. However, the bulkhead truncates this gradual transition to the uplands. The substrate along the shoreline is predominantly gravel. Riparian vegetation varies with distance from the shoreline. From the shoreline to the walking path, the riparian zone is primarily composed of grass, with lesser amounts of impervious surfaces (the walking path), invasive weeds, and a few scattered trees. The remainder of the riparian zone landward of the walking path transitions from grass to mature forest.

Ecological Condition of Adjacent Parcels

Immediately east of the project area, the Seward shoreline has been previously restored with bulkhead removal, bank re-grading, gravel placement, and riparian re-vegetation. Immediately to the west of the project area, the shoreline is steep and rip-rapped with a parking lot landward of the shoreline. In general, the Seward Park shoreline has discontinuous shoreline segments that vary by bank height, bank slope, bulkheads, native vegetation, or nuisance aquatic vegetation. Many of these shoreline segments were armored as early as 1916, and in many places the nearshore, creating a cobble substrate along the shoreline. In some locations, particularly hardened shoreline has altered wave-generated sediment processes, creating a cobble substrate along the shoreline. The cut-and-fill technique used to build the path along the shoreline has also resulted in modified bank shapes and slopes. Some segments of the park shoreline were restored in 2001 and 2006 by re-grading the bank to a lower slope, importing gravel to the re-sloped beaches, installing LWD for fish cover, and re-vegetating narrow riparian zone strips immediately adjacent to the shoreline. Parcels adjacent to Seward Park are residences with bulkheads and docks (to the south), and include a marina (to the north).

Fish Use

The Seward Park shoreline is used by juvenile Chinook for feeding, rearing, and migration from the Cedar River toward the Ship Canal, though Chinook abundance is lower here than along the South Lake Washington shoreline (Tabor and Piaskowski 2002). The southeast shoreline has shallow water and vegetative cover providing food resources (invertebrates) and protection from piscivorous fish and avian predators. The absence of piers, ramps, and floats along the park's natural shorelines allows unhindered migration along the area's littoral zone. Historical records document sockeye spawning along the Seward Park nearshore (Buchanan 2004). During a 1999 snorkel survey along the Seward Park shoreline, the presence of adult sockeye carcasses at various locations on the Seward Park shoreline throughout October, November, and December indicated that beach spawning was occurring (City of Seattle 2001).

Juvenile Chinook fish use along the southwest shoreline of Seward Park (a natural shoreline area adjacent to Seward 1) is documented in Tabor et al. (2006). During snorkel surveys in 2003 (April 7– May 6), a total of 76 Chinook salmon were observed, and their abundance was higher on each date than at any other site in Seward Park (Tabor et al. 2006). On two of these three surveys, more Chinook salmon were observed along this shoreline than at the other sites combined. Only six Chinook salmon were observed in this area during the last two surveys in 2003 (May 22 and June 10) and their abundance was similar to that at other sites in Seward Park. The high abundance of Chinook salmon at this site is likely due to better habitat conditions, specifically the sand substrate and gradual slope, and the site is closer to the Cedar River than other Seward Park sites. Given the high use by Chinook juveniles in this area of the park, Seward 1 fits the "high" FFM definition of "aquatic sites that serve as migration or rearing areas of considerable importance for one or more species of juvenile salmon". Therefore, Seward 1 has an FFM score of 0.8.

6.2.3. Rationale for Site Selection

Seward Park was selected for shoreline and riparian restoration because of documented use of this shoreline by Chinook salmon juveniles for foraging, rearing, and outmigration, and by sockeye salmon for beach spawning and early rearing. Shoreline restoration actions are proposed in areas where juvenile Chinook are known to rear and migrate, and where sockeye salmon are known to have spawned in the past. These restoration actions will increase habitat connectivity with adjacent high quality shoreline segments, including areas that were restored in 2001 and 2006. These past restoration projects created shallow water habitat and sediment that support both juvenile rearing and sockeye beach spawning. Recent effectiveness monitoring of these shoreline restoration projects concluded that the shallow habitat was functioning for juvenile Chinook refugia and migration. However, the gravel supplementation did not significantly increase epibenthic prey preferred by juvenile Chinook (Armbrust et al. 2009). This monitoring study recommended incorporating organic material into the gravel. The proposed restoration project will be very similar to these past projects, and will also cover eroded quarry spall along the shoreline with appropriate substrate. The size and amount of organic material in the new substrate will be determined by the erosive potential along the shoreline. Past gravel supplementation projects on adjacent shoreline segments have determined that wave exposure and lake currents will mobilize and erode pea gravel and finer sediments (Graves 2006). Covering the quarry spall with coarse gravel, however, will have multiple benefits, including reducing predator (e.g., sculpin) habitat and providing suitable substrate for sockeye spawning.

Seward Project 1 was defined as a project because of its southeastern location and documented high use by juvenile Chinook in adjacent natural areas.

6.2.4. Mitigation Site Design

Mitigation actions at this site will include bulkhead removal, bank regrading, gravel installation, LWD installation, and riparian revegetation (Figure 6-2). Grading plans will be developed that are consistent with cross-sections 1A and 1B (Figure 6-2, Appendix B). Approximately 630 cubic yards of clean and appropriately-sized gravel will be offloaded and distributed to a depth of 1 foot. Although the substrate size and distribution will be determined from an subsequent analysis of sediment transport from wind generated waves and currents, the substrate will be installed with the smallest size distribution possible, in order to maximize habitat function for rearing juvenile Chinook. Based on previous substrate enhancement projects, the substrate distribution will likely be similar to what is shown in Table 6-2. LWD will be anchored into the bank at the high lake level at a frequency of approximately 1 piece per 100 feet.

Table 6-2. Gravel Size Distribution for Recent Substrate Enhancement Projects in Lake Washington

Sieve Size (mm)	Percent Passing by Weight
127	100%
102	95 – 100%
76	90 – 95%
38	65 – 80%
32	45 – 60%

Revegetation will include a live stakes community near high lake level elevation and transition to a riparian upland community. Proposed planting zones, species lists, and densities for revegetation are included in Appendix C. Specific planting plans for site-specific conditions and constraints will be developed during the design phase. The implementation schedule is detailed in Section 6.13.

The following constraints will limit design elements of this project:

- Riparian restoration will not occur in public access areas or landward of the public walking trail.
- Riparian plantings will be grouped to provide access to the restored beach from the walking trail and picnic area.
- LWD will not be installed along the shoreline associated with public access areas.
- Construction schedule and access may be dependent on SPU's CSO reduction project planned for Seward Park parking areas.

The site design objectives and criteria are summarized below.

Engineering Objectives

- Provide a low-gradient shoreline between low and high lake levels.
- Provide gravel (round rock) and sand substrate along the shoreline that is appropriately sized to avoid erosion.

Habitat Objectives

- Provide shallow, low-gradient rearing and migratory habitat during juvenile Chinook and early juvenile sockeye rearing periods.
- Provide gravel and sand substrate along the shoreline that minimizes predator habitat.
- Provide LWD keyed into the shoreline for fish cover.
- Provide overhanging vegetation along the shoreline for juvenile salmonid refugia and forage base.
- Provide indirect riparian functions, including shading, pollutant filtration, and LWD recruitment to the shoreline.

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- Minimize construction impacts to existing habitat.
- Minimizes human impacts on areas of newly planted riparian habitat.

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

<u>Project Design Criteria</u>

- Bulkhead will be removed below sediment line.
- The slope of the enhanced shoreline habitat will be at or below 15% grade, as measured from low lake level to high lake level.
- Substrate will be installed along the shoreline according to an analysis of sediment transport from wind-generated waves and currents.

<u>Habitat Design Criteria</u>

- Create 0.39 acre of shallow aquatic habitat.
- Gravel substrate in the shallow littoral zone will be installed with the smallest size distribution possible in order to maximize habitat function for rearing juvenile Chinook.
- Provide 0.40 acre of enhanced riparian habitat adjacent to the shoreline.
- Include a vegetation plan to provide adequate shade and overhanging cover along the shoreline.
- The spatial and temporal extent of in-water work will be minimized.
- In-water work will occur during designated in-water work windows.
- Impacts to native vegetation will be minimized.
- Erosion will be minimized.

6.2.5. Ecological Functions and Benefits

The mitigation actions at Seward Project 1 will benefit Cedar River Chinook juveniles (Table 6-3). The juvenile Chinook will benefit from the conversion of shorelines with bulkheads to a gradual, sloping natural condition with functional riparian vegetation. These improved habitat features will provide an unobstructed migratory pathway, protection from piscivorous and avian predators, and enhanced food sources from the natural sediments and overhanging vegetation.

Table 6-3. Seward Park Project 1 Mitigation Benefits

<table>
<tr><th>Mitigation Action</th><th>Acreage</th><th>Habitat Features Improved</th><th>Habitat Functions Improved</th><th>Species/Life Stage Addressed</th></tr>
<tr><td>Shoreline Enhancement + Hard Structure Removal</td><td>0.39</td><td>Gradual, sloped bank
Suitable sediment
Prey input</td><td>Protection from predators
Migratory corridor
Spawning habitat</td><td rowspan="2">Chinook
(Juvenile Rearing/Feeding)

Chinook
(Juvenile Migration)</td></tr>
<tr><td>Riparian Restoration</td><td>0.40</td><td>Vegetative cover
Prey input</td><td>Protection from predators
Food sources</td></tr>
</table>

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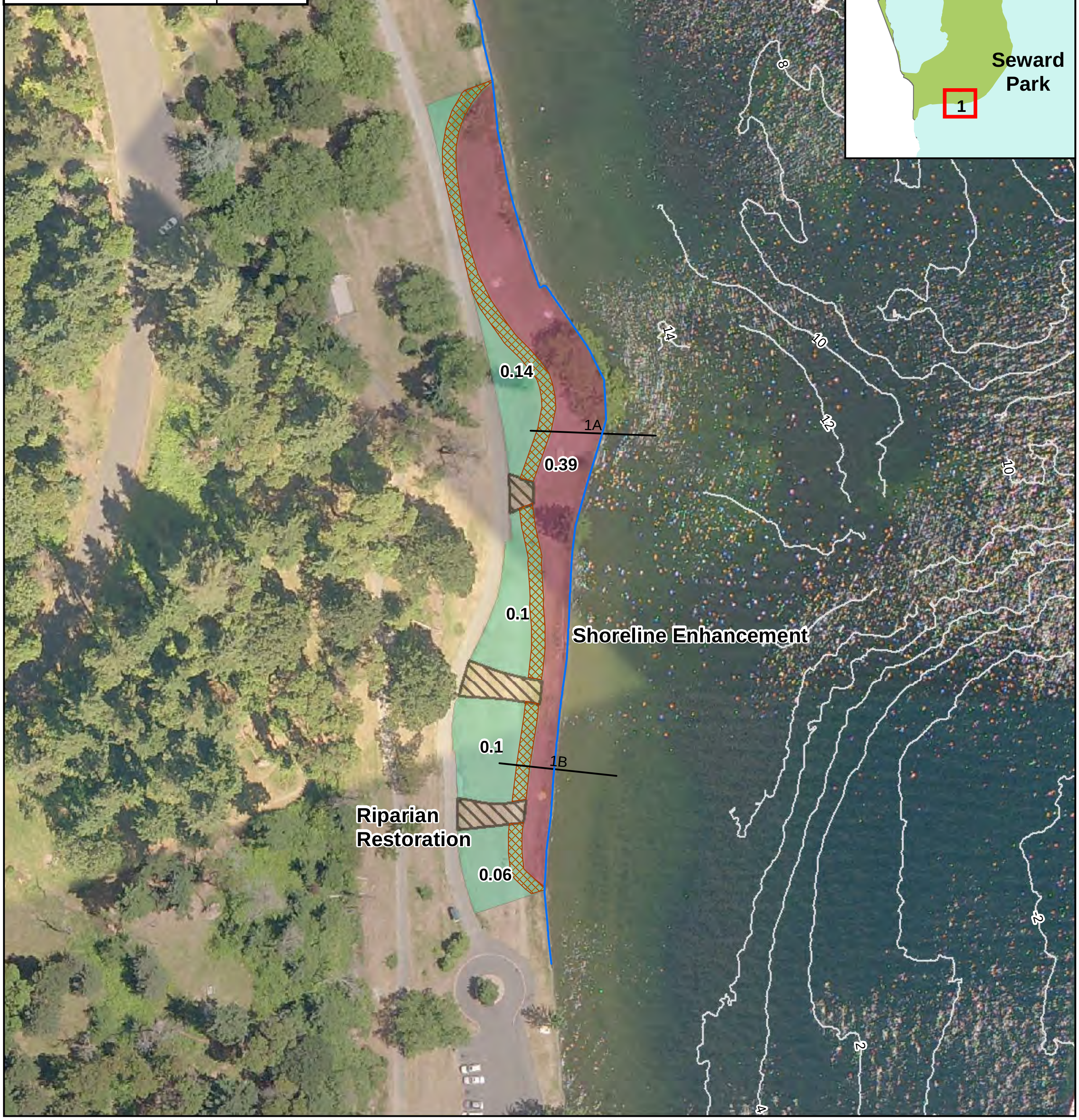
Mitigation Action	Acreage
Shoreline Enhancement	0.39
Riparian Restoration	0.40



N

0 50 100 Feet

Shoreline Enhancement
Riparian Restoration
Public Access
Shoreline Fringe Planting Zone
OHWM
Cross-Section
2-foot Contour

Figure 6-2.
Conceptual Restoration Plan at the Seward Park Mitigation Site, Project 1

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6.3 Seward Park Project 2

6.3.1. Site Location

Seward Park is in the City of Seattle, along the western shore of Lake Washington, as shown on Figure 6-1. Seward Project 2 is located on the eastern shore of the park (Figure 6-3).

6.3.2. Mitigation Site Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization of shoreline conditions is available in the SR 520 Final Aquatic Assessment Report (WSDOT 2011c).

Shoreline Conditions

At Seward Project 2, the shoreline has a narrow bench that extends about 50 feet from the shoreline where water is less than 10 feet deep during high lake level (Figure 6-3) before transitioning to a steep slope. The shallow bench has gravel substrate for approximately the first 30 feet and then quickly turns to predominantly sand. A 100-foot by 25-foot area is covered in cobble-sized angular basalt, very similar to the material found along the shoreline at Seward 3. Sand substrate is waterward of the angular basalt. The angular cobble area and the remainder of the shallow bench (waterward of the angular basalt) is the Seward 2 project area.

Ecological Condition of Adjacent Parcels

See Section 6.2.2 for a general description of the Seward Park shoreline. The adjacent shorelines to the north and south have bathymetry similar to that of the Seward 2 project area. Immediately to the north and south of the project area the substrate is gravel transitioning to sand.

Fish Use

See Section 6.2.2 for a general description of Seward Park fish use. The Seward 2 shoreline is used by migrating juvenile Chinook, primarily from the Cedar River. Although this segment of shoreline is along their primary migration path, the density of juvenile Chinook is not as high as at the southeastern extremity of the park (Tabor et al. 2006).

Historical records document sockeye spawning along this specific segment of the Seward Park nearshore (Buchanan 2004). During a 1999 snorkel survey along the Seward Park shoreline, the presence of adult sockeye carcasses at various locations on the Seward park shoreline throughout October, November, and December indicated that beach spawning was occurring (City of Seattle 2001). Therefore, this project area meets the 0.8 FFM criterion of being an “aquatic site that is known to support documented spawning of at least one salmonid species”, and is assigned an FFM of 0.8.

6.3.3. Rationale for Site Selection

The overall rationale for shoreline restoration at Seward Park is described in Section 6.2.3. Seward Project 2 will cover large, cobble-sized angular basalt with gravel suitable for sockeye spawning. Covering the angular cobble with coarse gravel will have multiple benefits, including reducing predator (e.g., sculpin) habitat for migrating and rearing juvenile Chinook as well as providing suitable substrate for sockeye spawning.

6.3.4. Mitigation Site Design

Seward Park Project 2 is located on the southeastern portion of the peninsula (Figure 6-3). In general, sockeye dig redds in gravel and small cobbles between 13 and 102 mm (Reiser and Bjornn 1979). Olsen (1968) indicated that sockeye may use either sand or gravel, depending upon which is available. If small amounts of silt, detritus, or fine sand are mixed with the coarser gravel, they are removed by the fish in the process of excavating the redd (Foerster 1968). Mathisen (1955) observed sockeye salmon egg concentrations 6 to 9 inches below the gravel surface. These observations on suitable habitat will govern the design requirements for Lake Washington spawning supplementation. Approximately 0.06 acre of lake nearshore will be supplemented with 97 cubic yards of clean and appropriately-sized gravel. The gravel will be offloaded and spread to a depth of 1 foot. Although the substrate size and distribution will be determined from a forthcoming analysis (design phase) of sediment transport from wind-generated waves and currents, the substrate will be installed with the smallest size distribution possible in order to maximize habitat function for rearing juvenile Chinook. Based on previous substrate enhancement projects, the substrate distribution will likely be similar to what is shown in Table 6-2. There are no apparent constraints to this project. The implementation schedule is detailed in Section 6.13.

The site design objectives and criteria are summarized below.

Engineering Objectives

- Provide gravel (round rock) and sand substrate along the shoreline that is appropriately sized to avoid erosion.

Habitat Objectives

- Provide gravel substrate along the shoreline that is suitable for sockeye beach spawning.

- Provide gravel and sand substrate along the shoreline that minimizes habitat for juvenile Chinook predators

- Minimize construction impacts to existing habitat.

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

Engineering Design Criteria

- Substrate installed along the shoreline according to an analysis of sediment transport from wind-generated waves and currents.

Habitat Design Criteria

- Create 0.06 acre of suitable sockeye spawning habitat.
- Gravel substrate in the shallow littoral zone will be installed with the smallest size distribution possible in order to maximize habitat function for rearing juvenile Chinook.
- The spatial and temporal extent of in-water work will be minimized.
- In-water work will occur during designated in-water work windows.

6.3.5. Ecological Functions and Benefits

The mitigation actions at Seward Park will benefit the Cedar River Chinook juveniles and lake spawning sockeye salmon (Table 6-4). The conversion of angular cobble to gravel will reduce predation and increase prey productivity for juvenile Chinook. Sockeye salmon will benefit from the coversion of angular cobble and sand to substate that is suitable for swawning. Sockeye salmon are known to spawn along the Seward Park shoreline, particularly where there is sufficient current to move water through the gravels.

Table 6-4. Seward Park Project 2 Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/Life Stage Addressed
Shoreline Enhancement	0.06	Suitable sediment	Protection from predators Migratory corridor Spawning habitat	Chinook (Juvenile Rearing/Feeding) Chinook (Juvenile Migration) Sockeye (Juvenile Rearing/Feeding) Sockeye (Spawning)

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Mitigation Action	Acreage
Spawning Gravel Supplementation	0.06

N

0 50 100 Feet

Spawning Gravel Supplementation

Shoreline

2-foot Bathymetry

Figure 6-3.
Conceptual Restoration Plan at the Seward Park Mitigation Site, Project 2

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6.4 Seward Park Project 3

6.4.1. Site Location

Seward Park is in the City of Seattle, along the western shore of Lake Washington, as shown on Figure 6-1. Seward Project 3 is located on the northeast end of the peninsula (Figure 6-4).

6.4.2. Mitigation Site Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization is available in the SR 520 Final Aquatic Assessment Report (WSDOT 2011c).

Shoreline Conditions

The Seward 3 shoreline has a steep bank above the high lake level (OHW) with vegetation growing through the riprap (Figure A-2). There are some native shrubs along the face of the shoreline intermingled with weedy forbs (Photograph A-2). Landward of the shoreline, the riparian cover is lawn, followed by the impervious walking path (Figure A-2). Landward of the path, the riparian vegetation consists of mature forest. A 20-foot segment of concrete bulkhead is present along the shoreline at the high lake level. One piece of large woody debris was observed on the southern end of the project. The shoreline bathymetry has a 16 to 18% slope near the shore. Substrate at the 1.3-foot depth interval is mostly gravel and sand, with scattered angular cobble (Figure A-3). Substrate at the 2.6-foot depth interval is mostly angular cobble.

Ecological Condition of Adjacent Parcels

See Section 6.2.2 for a general description of the Seward Park shoreline. A public access and heavily-used swimming area is located to the west of Project 3. Although this swimming area is heavily used during the summer, it has low (in-water) use by the public during the spring and has a gradually sloped beach. Immediately to the south is 100 feet of vegetated shoreline, followed by approximately 400 feet of shoreline without trees. The walking trail is close to the shoreline to the south of the Project 3 area.

Fish Use

See Section 6.2.2 for a general description of Seward Park fish use. The Seward 3 shoreline is used by migrating juvenile Chinook, primarily from the Cedar River. Although this segment of shoreline is along their primary migration path, the Chinook juveniles are not as dependent on shallow littoral areas as they are earlier in their life history. Therefore, this project area does not meet the 0.8 FFM criterion of being “migration or rearing areas of considerable importance for one or more species of juvenile salmon”, and is assigned an FFM of 0.6.

6.4.3. Rationale for Site Selection

The rationale for shoreline restoration along the Seward Park shoreline is described in Section 6.2.3. Seward Project 3 was selected because of the presence of angular cobble (quarry spall) along the shoreline and restoration potential along the adjacent riparian zone. Covering the angular cobble with gravel substrate will provide juvenile Chinook rearing opportunity. Previous restoration projects by USACE and Seattle Parks in the immediate vicinity have restored similar shorelines. This project extends and builds upon those previous efforts.

6.4.4. Mitigation Site Design

Mitigation actions at this site will include gravel substrate installation and riparian revegetation (Figure 6-4). Approximately 290 cubic yards of clean and appropriately-sized gravel will be offloaded and spread to a depth of 1 foot. Although the substrate size and distribution will be determined from subsequent analysis of sediment transport from wind-generated waves and currents, the substrate will be installed with the smallest size distribution possible in order to maximize habitat function for rearing juvenile Chinook. Based on previous substrate enhancement projects, the substrate distribution will likely be similar to what is shown in Table 6-2.

Because the riprap is largely above the managed lake levels and thinly applied, plants will be installed through the riprap matrix. Revegetation will include live stakes near high lake level elevation and transition to a riparian upland community. Riparian plantings will be installed along the riprap face and adjacent uplands. Proposed planting zones, species lists, and densities for revegetation are included in Appendix C. Specific planting plans for site-specific conditions and constraints will be developed during the design phase. The implementation schedule is detailed in Section 6.13.

The following constraints will limit design elements of this project:

- Riparian restoration may not occur landward of the public walking trail.

The site design objectives and criteria are summarized below.

Engineering Objectives

- Provide a low-gradient shoreline between low and high lake levels.
- Provide gravel (round rock) and sand substrate along the shoreline that is appropriately sized to avoid erosion.

Habitat Objectives:

- Provide shallow, low-gradient rearing and migratory habitat during juvenile Chinook and early juvenile sockeye rearing periods.
- Provide gravel and sand substrate along the shoreline that minimizes predator habitat.
- Provide overhanging vegetation along the shoreline for juvenile salmonid refugia and forage base.
- Provide indirect riparian functions, including shading, pollutant filtration, and LWD recruitment to the shoreline.
- Minimize construction impacts to existing habitat.
- Minimizes human impacts on areas of newly planted riparian habitat.

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

Project Design Criteria

- Substrate installed along the shoreline according to an analysis of sediment transport from wind-generated waves and currents.

Habitat Design Criteria

- Enhance substrate in 0.18 acre of shallow aquatic habitat.
- Gravel substrate in the shallow littoral zone will be installed with the smallest size distribution possible in order to maximize habitat function for rearing juvenile Chinook.
- Provide 0.23 acre of enhanced riparian habitat adjacent to the shoreline.
- Include a vegetation plan to provide adequate shade and overhanging cover along the shoreline.
- The spatial and temporal extent of in-water work will be minimized.
- In-water work will occur during designated in-water work windows.
- Impacts to native vegetation will be minimized
- Erosion will be minimized.

6.4.5. Ecological Functions and Benefits

The mitigation actions at Seward Park will benefit the Cedar River Chinook juveniles (Table 6-5). The conversion of angular cobble to gravel will reduce predation and increase prey productivity for juvenile Chinook. Riparian restoration will increase overhanging vegetation and woody debris cover.

Table 6-5. Seward Park Project 3 Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/Life Stage Addressed
Shoreline Enhancement (gravel supplementation)	0.18	Gradual, sloped bank Suitable sediment Prey input	Protection from predators Migratory corridor Spawning habitat	Chinook (Juvenile Rearing/Feeding) Chinook (Juvenile Migration)
Riparian Restoration	0.23	Vegetative cover Prey input	Protection from predators Food sources	

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Mitigation Action	Acreage
Shoreline Enhancement	0.18
Riparian Restoration	0.23

Figure 6-4.
Conceptual Restoration at the Seward Park Mitigation Site, Project 3

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6.5 Seward Park Project 4

6.5.1. Site Location

Seward Park is in the City of Seattle, along the western shore of Lake Washington, as shown on Figure 6-1. Seward Project 4 is located on the northern shore of the park (Figure 6-5).

6.5.2. Mitigation Site Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization of shoreline conditions is available in the SR 520 Final Aquatic Assessment Report (WSDOT 2011c).

Shoreline Conditions

At Seward Project 4, the shoreline has a shallow shelf that extends to the north (~200 feet) where the water is less than 20 feet deep during high lake level (Figure 6-5) before transitioning to a steep slope. For the first 75 feet, the substrate is mostly cobble, gravel, and sand. From there, the substrate quickly turns to predominantly sand. This shallow area is predominantly gravel with some sand, and exposed hardpan. The project area includes the shallow shelf that is predominantly sand.

Ecological Condition of Adjacent Parcels

See Section 6.2.2 for a general description of the Seward Park shoreline. The adjacent shoreline to the west has a narrowing shelf with similar substrate. Immediately to the south and west of the project area, the shelf is extremely narrow with gravel substrate. The adjacent shoreline, on both sides, has natural sloping shoreline with high public use in the summer, and minimal (in-water) use in the spring.

Fish Use

See Section 6.2.2 for a general description of Seward Park fish use. The Seward 4 shoreline is assumed to be used by migrating juvenile Chinook from the Cedar River, although this segment of shoreline has never been snorkeled for evidence of this fish use. Historical records document sockeye spawning along this specific segment of the Seward Park nearshore (Buchanan 2004). During a 1999 snorkel survey along the Seward Park shoreline, the presence of adult sockeye carcasses at various locations on the Seward park shoreline throughout October, November, and December indicated that beach spawning was occurring (City of Seattle 2001). Therefore, this project area meets the 0.8 FFM criterion of being an “aquatic site that is known to support documented spawning of at least one salmonid species”, and is assigned an FFM of 0.8.

6.5.3. Rationale for Site Selection

The overall rationale for shoreline restoration at Seward Park is described in Section 6.2.3. Seward Project 4 was selected because of the historical sockeye beach spawning records and the potential to create new spawning habitat by covering sand substrate with gravel suitable for sockeye spawning.

6.5.4. Project Objectives and Design Criteria

Seward Park Project 4 is located on the southeastern portion of the peninsula (Figure 6-5). In general, sockeye dig redds in gravel and small cobbles between 13 and 102 mm (Reiser and Bjornn 1979). Olsen (1968) indicated that sockeye may use either sand or gravel, depending upon which is available. If small amounts of silt, detritus, or fine sand are mixed with the coarser gravel, they are removed by the fish in the process of excavating the redd (Foerster 1968). Mathisen (1955) observed sockeye salmon egg concentrations 6 to 9 inches below the gravel surface. These observations on suitable habitat will govern the design requirements for Lake Washington spawning supplementation. Approximately 1.36 acres of lake nearshore will be supplemented with suitable gravel. Approximately 2,200 cubic yards of clean and appropriately-sized gravel will be offloaded and spread to a depth of 1 foot. Although the substrate size and distribution will be determined from subsequent analysis of sediment transport from wind-generated waves and currents, the substrate will be installed with a substrate size distribution that will be most suitable for sockeye spawning. Based on previous substrate enhancement projects, the substrate distribution will likely be similar to what is shown in Table 6-2. There are no apparent constraints to this project. The implementation schedule is detailed in Section 6.13.

The site design objectives and criteria are summarized below.

Engineering Objectives

- Provide gravel (round rock) and sand substrate along the shoreline that is appropriately sized to avoid erosion.

Habitat Objectives

- Provide gravel substrate along the shoreline that is suitable for sockeye beach spawning.

- Minimize construction impacts to existing habitat.

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

Engineering Design Criteria

- Substrate installed along the shoreline according to an analysis of sediment transport from wind-generated waves and currents.

Habitat Design Criteria

- Create 1.36 acres of suitable sockeye spawning habitat.
- Gravel substrate will be installed with the size distribution most suitable for sockeye beach spawning.
- The spatial and temporal extent of in-water work will be minimized.
- In-water work will occur during designated in-water work windows.

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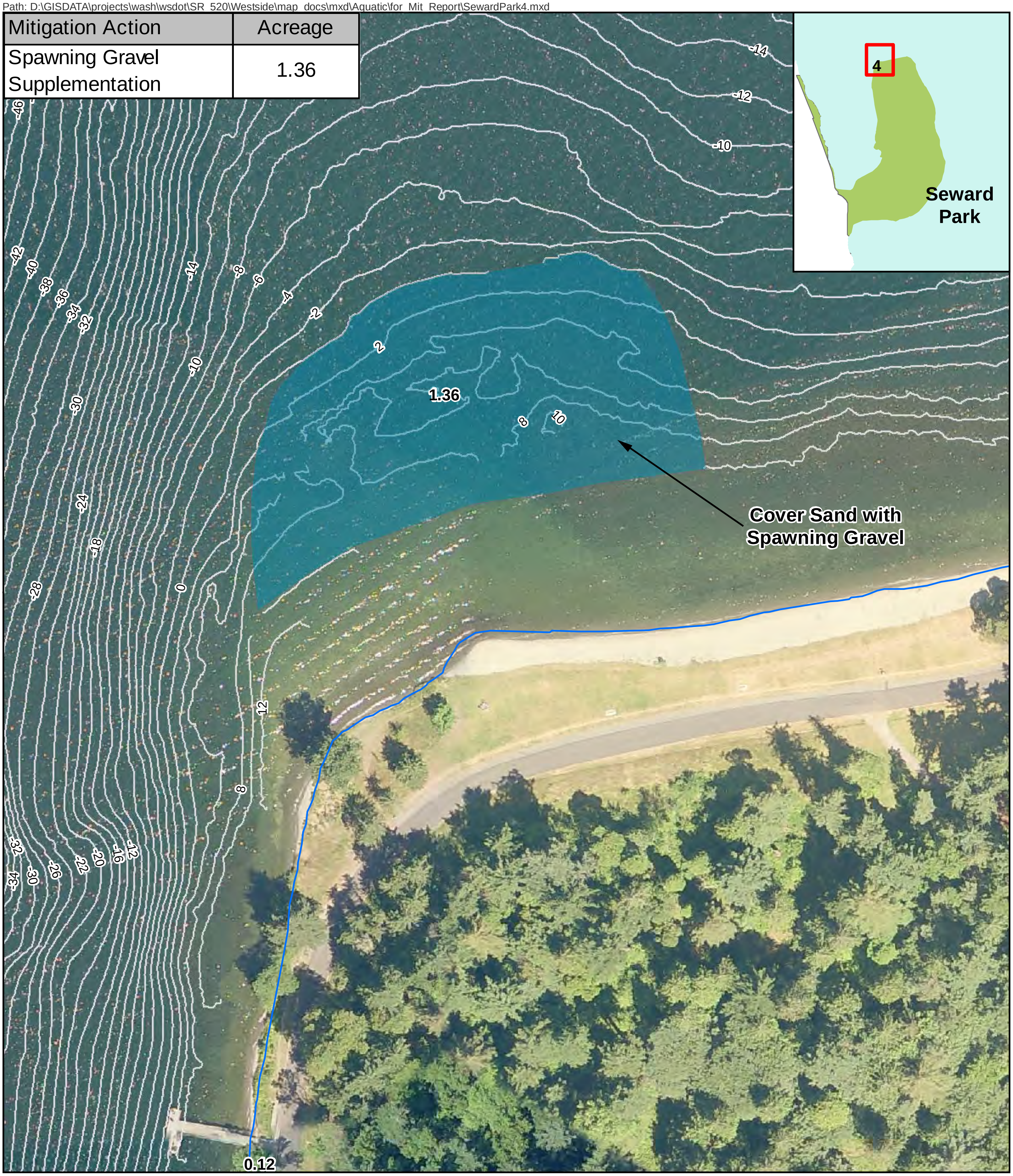
Mitigation Action	Acreage
Spawning Gravel Supplementation	1.36



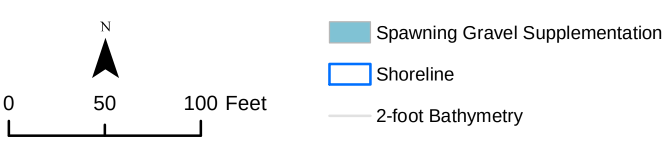


Figure 6-5.
Conceptual Restoration Plan at the Seward Park Mitigation Site, Project 4

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6.5.5. Ecological Functions and Benefits

The mitigation actions from Seward Project 4 will benefit lake spawning sockeye salmon (Table 6-6). The conversion of sand and cobble substrate to gravel will result in substrate that is suitable for sockeye spawning. Sockeye salmon are known to spawn along the Seward Park shoreline, particularly where there is sufficient current to move water through the gravels.

Table 6-6. Seward Park Project 4 Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/Life Stage Addressed
Shoreline Enhancement (Gravel Supplementation)	1.36	Suitable sediment	Spawning habitat	Sockeye (Spawning)

6.6 Magnuson Park Project 1

6.6.1. Site Location

The Magnuson Park mitigation site is located on the northwest shore of Lake Washington (Figure 6-1). Magnuson Project 1 is located south of the park boat launch (Figure 6-6).

6.6.2. Mitigation Site Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization of shoreline conditions is available in the SR 520 Final Aquatic Assessment Report (WSDOT 2011c).

Shoreline Conditions

Magnuson Park has an extensive shoreline. The shoreline has discontinuous segments that vary by presence of bulkheads, presence of native vegetation, bank height, and bank slope. Similar to Seward Park, some segments of the Magnuson Park shoreline have been restored by regrading the bank to a lower slope, importing gravel to the re-sloped beaches, and revegetating narrow riparian zone strips immediately adjacent to the shoreline. A boat launch on the southern end of the park has a heavily armored shoreline at approximately 50 feet on either side of the ramps, and is incompatible with shoreline restoration. Two swimming areas are also incompatible with restoration.

The length of the Magnuson 1 shoreline is approximately 300 feet. A 2-foot-high vertical bank is actively eroding and has concrete/asphalt rubble along the shore (Figure A-4). Vertical profiles are provided in Appendix B. One piece of large woody debris was observed on the shoreline. The shoreline has a 9 to 14% slope (WSDOT 2011c; Appendix B). Substrate is predominantly cobble and gravel. Riparian vegetation is managed grass lawn, with one area of native vegetation along the shoreline. This area has been planted with native shrubs and a few trees and contributes about 500 sq. ft. of cover from overhanging vegetation. A wide impervious walking path runs through the riparian zone.

Ecological Condition of Adjacent Parcels

The adjacent parcels south of Magnuson Park are residences with bulkheads and docks. The adjacent parcels to the north and west belong to the National Oceanic and Atmospheric Administration (NOAA). The adjacent NOAA shoreline has a character similar to that of the Magnuson Park shoreline.

Directly adjacent to and south of Magnuson Project 1, the shoreline is vegetated with a thin and discontinuous row of deciduous trees. The shoreline is mostly vertical and varies in height above the water line. Bank protection associated with the boat launch is directly adjacent to and north of the project area. Park structures constrain riparian revegetation to the north.

Fish Use

The Magnuson Park shoreline is likely used by juvenile Chinook from the North Lake Washington tributaries and the Sammamish/Issaquah Creek system as they migrate toward the Ship Canal. The shoreline segments with shallow water and cover are used by the juvenile Chinook for rearing, foraging, and refugia. North Lake Washington Chinook juveniles have bimodal migration timing, with a some 0+ juveniles migrating out of their natal streams toward the lake as newly emerged fry (35–40 millimeter [mm] fork length) in early spring and others as smolts (85–95 mm fork length) in late May–June (Seiler et al. 2003). The early fry may use the Magnuson Park shoreline and other nearshore areas in Lake Washington for rearing, foraging, and migration. The larger Chinook juveniles reside in waters between 3 and 18 feet deep during the day, primarily over sand-gravel substrates. These larger juveniles will use the shoreline features for fish cover on an infrequent basis (King County 2005). Fish distribution data collected by (Fresh, NOAA Fisheries, NWFSC, unpublished data) are presented in Appendix D. These data indicate low densities of wild Chinook fry and other juvenile salmonids along the Magnuson Park shoreline during the early and late spring. Because the densities of juvenile Chinook are relatively low compared to that of other sites in the south lake, the Magnuson Project 1 scores a “Moderate” FFM score of 0.6 in terms of the juvenile rearing criterion (Table 4-1).

Mitigation Action	Acreage
Shoreline Enhancement + Hard Structure Removal	0.13
Riparian Restoration	0.37

Hard Structure Removal
Shoreline Enhancement
Riparian Restoration
Public Access
OHWM
Transect Line
2-foot Contour

N

0 50 100 Feet

Figure 6-6.
Conceptual Restoration Plan at the Magnuson Park Mitigation Site, Project 1

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Historical records document sockeye spawning along the Magnuson Park nearshore at Sand Point, to the north of Magnuson Projects 1 and 2 (Buchanan 2004). Sockeye fry originating from adults spawning on the Magnuson Park shoreline may use the littoral zone of Magnuson Park for very early rearing. Because sockeye spawning has not been documented in the specific project area, Magnuson Project 1 scores a "Moderate" FFM score of 0.6 in terms of the spawning criterion (Table 4-1).

6.6.3. Rationale for Site Selection

Magnuson Park was selected for shoreline and riparian restoration because of its predicted use by North Lake Washington and Sammamish/Issaquah Chinook salmon juveniles for foraging, rearing, and migration toward the Ship Canal (Seiler et al. 2003). Some shoreline segments in and adjacent to the park have already been restored. Magnuson Project 1 will build on these past efforts and provide a more continuous natural shoreline.

6.6.4. Mitigation Site Design

Mitigation actions at Magnuson Project 1 will include the creation of two cove beaches, separated by an existing vegetated point (Figure 6-6). In addition, targeted areas of the riparian zone will be restored in a configuration that will allow for public access to both cove beaches. Implementing this concept includes bank re-sloping, gravel augmentation, LWD installation, and revegetation. Grading plans will be developed that are consistent with Magnuson cross-sections A–C (Figure 6-6, Appendix B). Shoreline sediments may be comprised of rubble and anthropogenic backfill. Therefore, over-excavation and placement of clean material may be warranted. Approximately 323 cubic yards of clean and appropriately sized gravel will be offloaded and spread to a depth of 1 foot. Although the substrate size and distribution will be determined from a subsequent analysis of sediment transport from wind-generated waves and currents, the substrate will be installed with the smallest size distribution possible in order to maximize habitat function for rearing juvenile Chinook. Based on previous substrate enhancement projects, the substrate distribution will likely be similar to what is shown in Table 6-2. LWD will be installed at the bank at the high lake level at a frequency of approximately 1 piece per 100 feet. Revegetation will include live stakes installed near high lake level elevation and transition to a riparian upland community. Proposed planting zones, species lists, and densities for revegetation are included in Appendix C. Specific planting plans for site-specific conditions and constraints will be developed during the design phase. The implementation schedule is detailed in Section 6.13.

The following constraints will limit design elements of this project:

- Riparian restoration will not occur landward of the public walking trail.
- The extensive use of this area by the public will require existing uses to persist in a portion of the riparian zone (grass, paths, etc.).

The site design objectives and criteria are summarized below.

Engineering Objectives

- Provide two cove beaches with a low-gradient shoreline between low and high lake levels.
- Remove concrete and asphalt rubble along shoreline.
- Provide gravel (round rock) and sand substrate along the shoreline that is appropriately sized to avoid erosion.

Habitat Objectives

- Provides shallow, low-gradient rearing and migratory habitat during juvenile Chinook rearing periods.
- Provides overhanging vegetation along the shoreline for juvenile salmonid refugia and forage base.
- Provides gravel and sand substrate along the shoreline that minimizes predator habitat.
- Provides LWD keyed into the shoreline for fish cover.
- Provides indirect riparian functions, including shading, pollutant filtration, and LWD recruitment to the shoreline.
- Minimizes construction impacts to existing habitat.
- Minimizes human impacts on areas of newly planted riparian habitat.

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

Engineering Design Criteria

- The slope of the enhanced shoreline habitat will be at or below 15% grade, as measured from low lake level to high lake level.
- Excavate shoreline sediments until the extent of rubble and anthropogenic backfill is reached and replace with clean material.
- Substrate will be installed along the shoreline according to an analysis of sediment transport from wind-generated waves and currents.

Habitat Design Criteria

- Provide 0.13 acre of shallow aquatic habitat.
- Gravel substrate will be the smallest possible size distribution in order to provide maximum habitat benefits to rearing juvenile Chinook.
- Provide 0.37 acres of enhanced riparian habitat adjacent to the shoreline.
- Include a vegetation plan to provide adequate shade and overhanging cover along the shoreline.
- The spatial and temporal extent of in-water work will be minimized.
- In-water work will occur during designated in-water work windows.
- Impacts to native vegetation will be minimized.
- Erosion will be minimized.

6.6.5. Ecological Functions and Benefits

The mitigation actions at Magnuson Park will benefit a portion of the North Lake Washington and Sammamish/Issaquah Chinook juveniles that require shallow water rearing and foraging habitat (Table 6-7). The juvenile Chinook will benefit from the conversion of the eroding shoreline and bulkheads to a gradually-sloping natural condition with functional riparian vegetation. These improved habitat features will provide an unobstructed migratory pathway, protection from piscivorous and avian predators, and enhanced food sources from the natural sediments and overhanging vegetation. The larger juveniles spend most of their time in deeper water, between 3 and 18 feet deep, but the gravel supplementation proposed within this depth range will match their preferred substrate. The Magnuson Park shoreline is located along the migratory corridor for Sammamish/ Issaquah Creek juvenile Chinook; these juveniles are using the entire littoral zone (shallow and deeper) during migration.

The mitigation action benefits survival of juvenile Chinook by increasing habitat function along their migratory path toward the Ship Canal.

Table 6-7. Magnuson Project 1 Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/ Life Stage Addressed
Shoreline Enhancement + Hard Structure Removal	0.13	Gradual, sloped bank Suitable sediment Prey input	Protection from predators Migratory corridor	Chinook (Juvenile Rearing/Feeding) Chinook (Juvenile Migration)
Riparian Restoration	0.37	Vegetative cover Prey input	Protection from predators Food sources	

6.7 Magnuson Park Project 2

6.7.1. Site Location

The Magnuson Park mitigation site is located on the northwest shore of Lake Washington (Figure 6-1). Magnuson Project 2 is located adjacent to and north of the Magnuson Park boat launch (Figure 6-7). The length of this segment is approximately 450 feet.

6.7.2. Mitigation Site Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization of shoreline conditions is available in the SR 520 Final Aquatic Assessment Report (WSDOT 2011c).

Shoreline Conditions

See Section 6.6.2 for a discussion of the Magnuson Park shoreline. Riparian vegetation at Magnuson 2 is mostly grass, but a narrow band of deciduous trees along the shoreline provides a substantial amount of bank protection and cover. The trees have stabilized the banks and created cover from overhanging vegetation along the entire project area. Approximately the same area has either concrete rubble or a concrete bulkhead in the water. The 2-foot-wide concrete bulkhead is about 5 feet waterward of the shoreline and is a continuous barrier to fish accessing this functional shoreline (Figure A-5). The shoreline has a 14 to 38% slope. The bulkhead appears to cause sediment to accrue inside the bulkhead and erode waterward of the bulkhead. The natural substrate is predominantly gravel and cobble, but concrete rubble is widespread, extending 15- 20 feet from the shoreline.

Ecological Condition of Adjacent Parcels

See Section 6.2.2 for a description of parcels adjacent to Magnuson Park. Immediately adjacent to and south of the Magnuson Project 2 area is the public boat launch and riprap shoreline. Immediately adjacent to and north of the project area is a previously restored shoreline with gradually sloped banks and gravel substrate. Landward, and to the west, Seattle parks and WSDOT (2011a) are enhancing and creating interconnected wetland complexes that ultimately discharge to Lake Washington. Wetland water quality at the wetland outlet was within surface water quality standards, with the exception of dissolved oxygen (Otak 2010).

Fish Use

See Section 6.2.2 for a discussion of fish use in the Magnuson Park area. Since juvenile Chinook occur along Magnuson Park (See Section 6.6.2 and Appendix D), but the density is lower compared to that sites in the south lake, Magnuson Project 2 scores a “Moderate” FFM score of 0.6 in terms of the juvenile rearing criterion (Table 4-1).

Historical records document sockeye spawning along the Magnuson Park nearshore at Sand Point, to the north of Magnuson Projects 1 and 2 (Buchanan 2004). Sockeye fry originating from adults spawning on the Magnuson Park shoreline may use the littoral zone of Magnuson Park for very early rearing. Because sockeye spawning has not been documented in either specific project area, Magnuson Project 2 scores a “Moderate” FFM score of 0.6 in terms of the spawning criterion (Table 4-1).

6.7.3. Rationale for Site Selection

Magnuson Park was selected for shoreline and riparian restoration because of its predicted use by North Lake Washington and Sammamish/Issaquah Chinook salmon juveniles for foraging, rearing, and migration toward the Ship Canal (Seiler et al. 2003). Some shoreline segments in and adjacent to the park have already been restored. Magnuson Project 2 will build on these past efforts and provide a more continuous natural shoreline.

6.7.4. Mitigation Site Design

The primary mitigation actions at this site will include removal of the continuous bulkhead and rubble. The existing root structure of the bank vegetation will likely prevent shoreline erosion when the bulkhead and rubble are removed. However, if the existing root structure is insufficient to prevent shoreline erosion, re-grading and gravel placement will be considered. A surface water channel would also be constructed to convey flows from both WSDOT’s wetland mitigation site and Seattle Park’s planned habitat improvements. It is anticipated that the surface water outlet channel will typically carry 1 to 2 cfs of baseflow and will be accessible to fish for a distance (roughly 100 feet) to the point of the existing path. From this point, fish passage will be prevented by the installation of a weir, or similar impediment, to avoid the potential of fish access to unsuitable habitat or fish stranding. Water flowing from the wetlands will be aerated in the weir prior to entry into the lake. The implementation schedule is detailed in Section 6.13.

The site design objectives and criteria are summarized below.

Engineering Objectives

- Provide a surface water outlet channel downgradient of wetland complex.
- Prevent fish passage into the wetland complex.

Habitat Objectives

- Provide access to the existing shoreline to juvenile Chinook by removing bulkhead.
- Provide shallow aquatic habitat to juvenile Chinook by removing rubble.
- Provide shallow surface water outlet channel habitat downgradient of the Seattle Parks proposed wetland complex that is suitable for juvenile Chinook rearing.
- Prevent fish access between the proposed surface water outlet channel and the Seattle Parks wetland complex.
- Minimize construction impacts to existing habitat.
- Minimizes human impacts on areas of newly planted riparian habitat.

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

Engineering Design Criteria

- Surface water channel banks will not erode from wetland discharge or lake wave action.
- Surface water channel will not have angular cobble (riprap) below the OHWM.

Habitat Design Criteria

- Provide 0.04 acres of surface water outlet channel habitat with overhanging vegetation and substrate suitable for juvenile Chinook rearing.
- Enhance 0.14 acre of shallow aquatic habitat by removing bulkhead and rubble material.
- Restore 0.73 acre of riparian habitat and function.
- The spatial and temporal extent of in-water work will be minimized.
- In-water work will occur during designated in-water work windows.

6.7.5. Ecological Functions and Benefits

The ecological functions and benefits of Magnuson Project 2 will be the same as described in Section 6.6.5. The quantities of the benefits are shown in Table 6-8.

Table 6-8. Magnuson Park Project 2 Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/ Life Stage Addressed
Shoreline Enhancement + Hard Structure Removal	0.14	Gradual, sloped bank Suitable sediment Prey input	Protection from predators Migratory corridor	Chinook (Juvenile Rearing/Feeding) Chinook (Juvenile Migration)
Surface Water Outlet Channel Creation	0.04	Suitable sediment Prey input		
Riparian Restoration	0.73	Vegetative cover Prey input		

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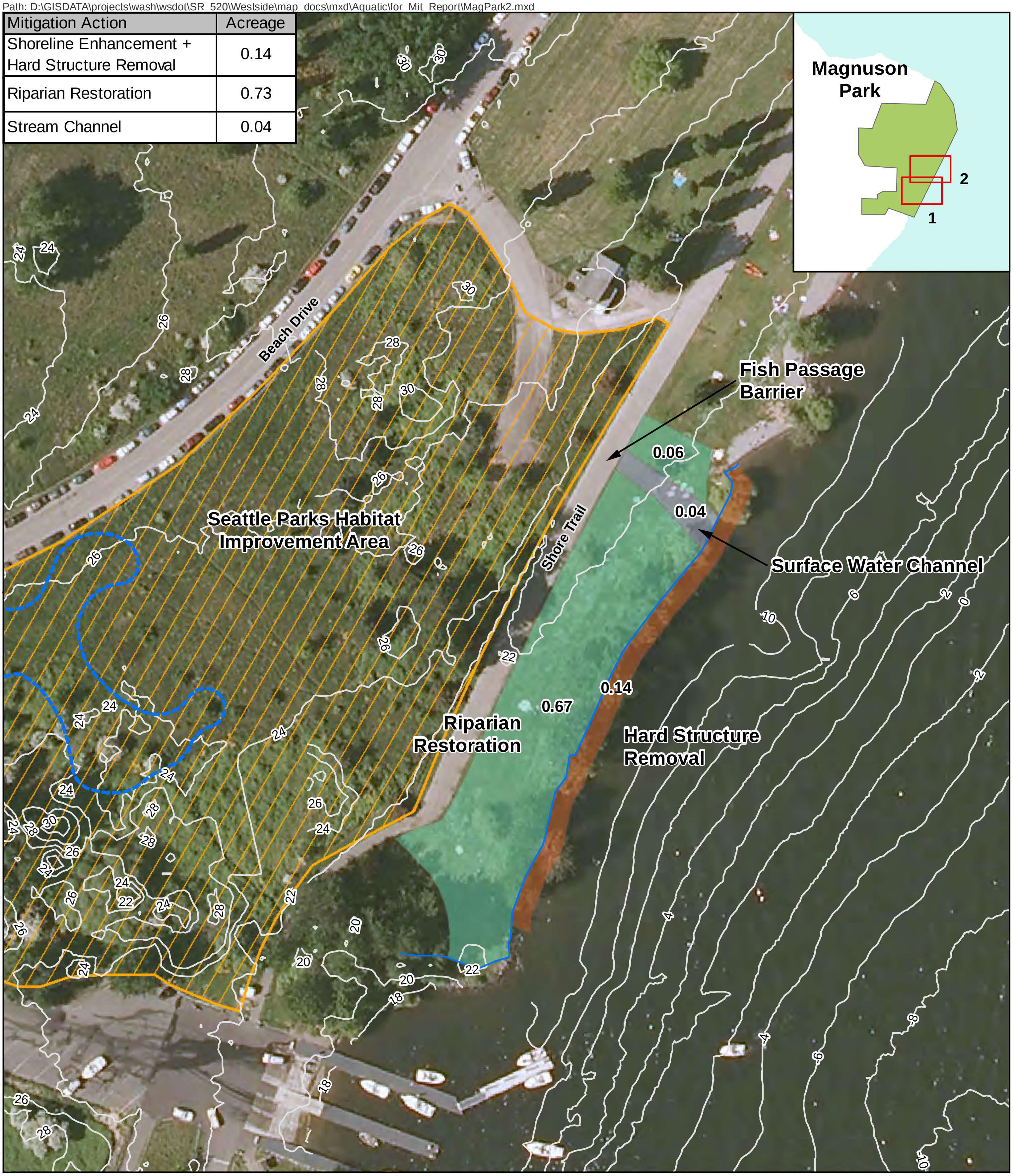
Mitigation Action	Acreage
Shoreline Enhancement + Hard Structure Removal	0.14
Riparian Restoration	0.73
Stream Channel	0.04



N

0 50 100 Feet

- Hard Structure Removal
- Riparian Restoration
- Stream Channel
- Public Access
- Seattle Parks Habitat Improvement Area
- Phase III Mitigation
- OHWM
- 2-foot Contour

Figure 6-7.
Conceptual Restoration Plan at the Magnuson Park Mitigation Site, Project 2

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6.8 Taylor Creek Site

6.8.1. Site Location

Taylor Creek is located in southeast Seattle (Figure 6-1). It is the fourth-largest creek in Seattle and drains a predominantly residential and park watershed. Its headwaters lie in King County and over two-thirds of the creek flows through relatively undisturbed wooded areas. Within the city limits, the creek flows through a large forested park before flowing into Lake Washington close to the southern city limits. The creek is unique in Seattle because of the length of contiguous forested buffers, low levels of development, and intact headwater wetlands. Taylor Creek enters the lake approximately 1.7 miles from the mouth of the Cedar River. The project area is the most downstream segment between Rainier Avenue South and Lake Washington (Figure 6-8).

6.8.2. Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization is available in the SR 520 Draft Aquatic Assessment Report (WSDOT 2011).

Shoreline Conditions

Taylor Creek has formed a delta along the Lake Washington shoreline (Figure A-6). The substrate is sorted by the preferential flowpaths through the delta. In the flowpaths, the substrate is composed of sand, with gravel and some cobble underneath the sand. Directly adjacent to this flowpath, the substrate composition of the delta changes to unembedded gravel and cobble and patches of sand (WSDOT 2011c). Due to accretion from sediment deposits consisting of large particle sizes, the delta can inhibit fish passage during periods of low lake levels. The delta transitions into a sandy beach with small pockets of marsh vegetation (i.e., rushes). This very narrow marsh fringe transitions into a residential lawn (Figure A-7). Upstream, the creek flows from Rainier Avenue South through residential properties for approximately 560 feet before reaching the delta. The stream habitat in this reach is degraded because it has been confined by modifications including concrete walls, boulders, and chunks of concrete (Figure A-8). The channel has been straightened to allow for the current residential use adjacent to the creek. The riparian/ floodplain area has been modified with fill, residential homes, asphalt driveways, and a patio/dock structure on the shoreline. The small amount of vegetation along the creek consists of a few mature trees and ornamental plants. The culvert under Rainier Avenue South is a total barrier to salmonids. No salmon have been found upstream of Rainier Avenue South for decades. The culvert was built in sections over time with different-sized pipes. Portions of the culvert are on private property.

Ecological Condition of Adjacent Parcels

Adjacent parcels along the shoreline and creek are high-density residential. The shoreline consists of bulkheads and docks. Upstream of the project area, Taylor Creek is likely to be realigned and enhanced. The WSDOT Taylor Creek project will be coordinated with this upstream restoration effort.

Mitigation Action	Acreage
Channel Restoration	0.15
Delta Re-sloping	0.08
Riparian + Floodplain Restoration	0.74

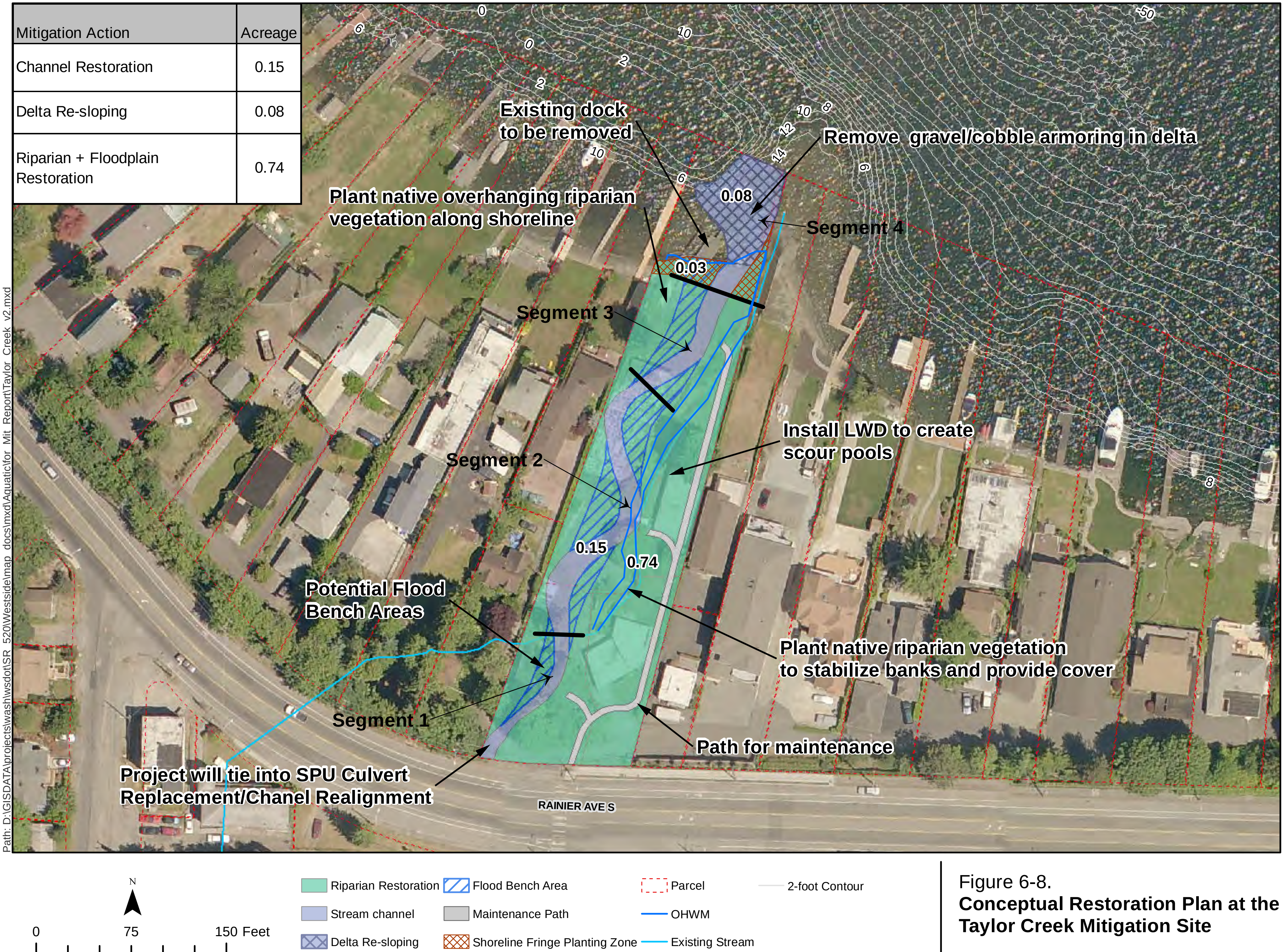

Figure 6-8.
Conceptual Restoration Plan at the Taylor Creek Mitigation Site

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Fish Use

Taylor Creek is used by sockeye, coho, and Chinook salmon, as indicated during surveys by Washington Trout (2000). These surveys are part of an annual program to document spawning salmon. Washington Trout inspects Seattle's major creeks weekly during the spawning season and documents the number of live and dead fish as well as the locations of redds (excavations dug by salmonids in gravel or other substrate for depositing eggs). Annual salmon spawning surveys have found coho and sockeye pooling just downstream of Rainier Avenue South. The results of these surveys are shown in Table 6-9. Juvenile Chinook use the Taylor Creek delta and convergence pool for feeding and rearing, but cannot typically access the upstream habitat because the gradient is too high (Tabor et al. 2004a) during low lake levels. Tabor et al. (2010b) surveyed Taylor Creek in the summer and found juvenile Chinook and coho in Taylor Creek.

Table 6-9. Spawning Survey Results on Taylor Creek

Year	Coho	Sockeye
2000	0	28
2001	2	20
2002	4	29

Source: SPU and Washington Trout

A fish use and habitat evaluation of Taylor Creek concluded that the creek is capable of supporting coho and sockeye (Washington Trout 2000).

6.8.3. Rationale for Site Selection

The WRIA 8 Chinook Salmon Recovery Plan (King County 2005) prioritized the reduction of predation on juvenile migrants in Lake Washington by providing increased rearing and refuge opportunities. The Recovery Plan prescribes the restoration of shallow water habitats and creek mouths for juvenile rearing and migration. Chinook are known to make extensive use of tributary habitat in South Lake Washington (Tabor et al. 2006).

6.8.4. Mitigation Site Design

The stream, delta, and riparian restoration proposed by WSDOT will work in concert with separate restoration actions that will be implemented upstream by SPU. SPU is currently developing plans to replace the Taylor Creek culvert under Rainier Avenue South to the southeast at a new grade to restore fish passage. The City's work will accomplish the following objectives:

- Provide full fish passage for all life stages and species of native salmonids.
- Pass flows beyond the 25-year flood event to meet drainage service levels.
- Minimize any flow constrictions that affect flooding conditions.

SPU has already acquired the properties in the WSDOT project area, below Rainier Avenue South to Lake Washington (Figure 6-8) and is independently developing alternative restoration designs for the WSDOT project area. The WSDOT project will begin at the outlet of the SPU culvert replacement under Rainier Avenue South.

WSDOT proposes to develop a restoration design that both meets the objectives of SPU's restoration concept and satisfies the compensatory mitigation requirements of the project. Based on a functional assessment of the baseline conditions at the Taylor Creek site (WSDOT 2011) restoration actions in the WSDOT project area will focus on the following goals to address functional deficiencies of the site:

- The site presently has a high degree of hydromodification along the stream banks. WSDOT proposes to increase floodplain and stream capacity and natural floodplain and stream functions.
- WSDOT proposes to improve the channel configuration and gradient to allow for proper sediment transport and minimize large gravel and cobble depositing on the delta. The larger SPU project will need to address sediment management upstream to support this approach.
- WSDOT proposes to improve channel complexity with increased sinuosity and incorporation of woody debris.
- Riparian quality is very poor. WSDOT proposes to enhance the full extent of riparian habitat available at the site.

The entire project area, including out into the delta will undergo channel, floodplain, and riparian restoration. Floodplain restoration will include excavation of a floodway on the site to create a lower elevation zone along the channel throughout the site that can be accessed by higher flows. Berms will be created along the parcel boundaries to allow natural flooding in the project area, but protect adjacent private property. All structures, impervious surfaces, non-essential utilities, underground storage tanks, and the existing patio and dock will be removed. In addition, the existing channel armoring and floodplain fill will be removed, providing a natural floodplain grade.

The channel will be reconstructed with the primary objective of differential sediment size deposition to reduce the load of particles larger than 1 inch in diameter reaching the delta. Allowing only finer sediments to reach the delta would enable more effective erosive processes from wave and current action, thereby minimizing accretion. The mitigation site does not have sufficient capacity to completely manage the estimated sediment load delivered by the Taylor Creek system. The proposed sediment sorting approach will need to work in concert with the larger SPU project to address sediment management both upstream and on the site.

The channel design is predicated upon manipulating the competence of the stream's transport capacity. The competence refers to the largest particle size that will be moved by a given discharge, and in the case of this channel design is the 2-year discharge. The 2-year discharge was selected as the design flow for channel size and sediment dynamics because the proposed addition of a floodway and active floodplain on-site ensures that sediment transport does not increase significantly during flow events exceeding the bankfull discharge.

Using sediment data collected by SPU (2007), an analysis is being conducted to generally correlate the deposition of different sediment sizes to stream gradient. Based on the sediment load and grain size distribution data for the design flow, channel segments with a transport capacity specific to target size fractions of the load are proposed. The channel hydraulic radius and slope will be specified to result in an even and progressively coarse to fine distribution of sediment size fractions deposited under normal flows toward the delta. A schematic of the geomorphic analyses required to develop a channel design is shown in Figure 6-9.

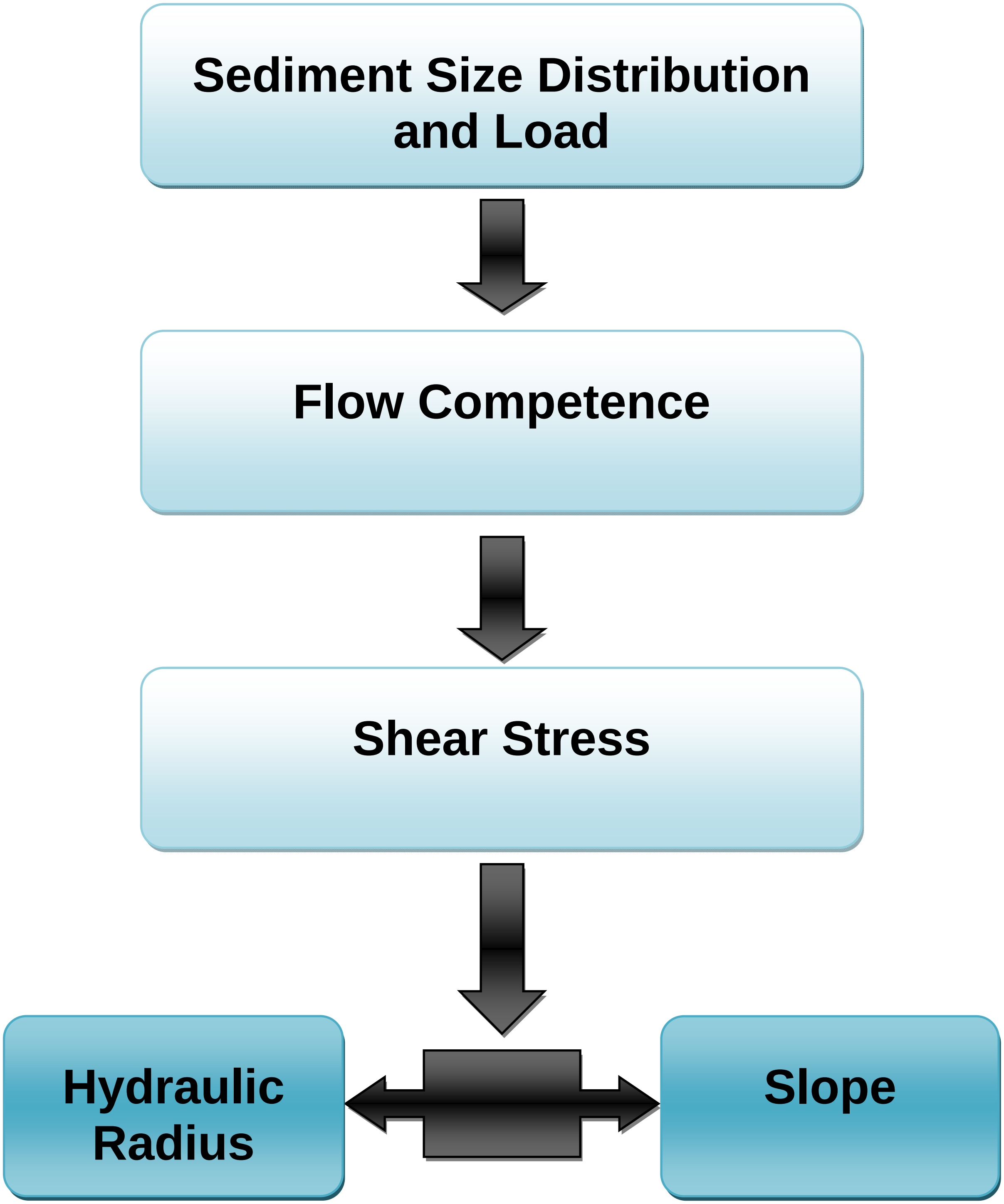

Figure 6-9. Taylor Creek Channel Design Schematic

The mouth and delta of Taylor Creek will be configured to minimize constraints on the natural evolution of the stream delta. The cobble substrate that is currently armoring the delta will be removed. This will expose the smaller sand and gravel that can be reworked by stream flows and waves to maintain an open channel across the delta at low lake levels. This change will result in a more complex delta that is passable by juvenile and adult salmon.

The full available width of the site will be planted with riparian vegetation and the lake shoreline plantings will focus on overhanging woody vegetation to promote juvenile rearing habitat. Once the riparian vegetation has become established, it will provide cover, bank stability, water quality filtration, and (long-term) LWD recruitment. Proposed planting palettes for revegetation are included in Appendix C. Specific planting plans will be based on site-specific conditions and constraints. The following site constraints limit restoration on the site:

- Riparian and floodplain restoration is limited by the width of the acquired parcels.
- Maintenance paths (Figure 6-8) will not be vegetated.
- Channel design is constrained by the available space in the acquired parcels.
- Channel design must be compatible with the SPU restoration work upstream of Rainier Avenue South, and the new realigned culvert under Rainier Avenue South.

The site design objectives and criteria are summarized below.

Engineering Objectives

- Provide a design that is supported by SPU and is forward-compatible with, or sequenced after, the planned restoration actions upstream of Rainier Avenue South.
- Support delta processes that promote fish passage at all flows and lake levels by inhibiting deposition of larger particles and general accretion of the delta.
- Provide a channel geometry that promotes the deposition of larger particle sizes in the upstream segments, and a progressive fining of sediment size deposition toward the lake.
- Provide a channel with lateral and vertical stability to maintain the target function of sediment deposition.
- Excavate accreted delta material and salvage for use in constructed channel.

- Do not adversely impact adjacent property owners.
- Do not adversely impact existing habitat within the littoral habitat of Lake Washington.
- Anticipate future changes in stream dynamics and develop appropriate contingency measures.
- Work closely with SPU to develop and implement an overall integrated sediment management plan that will facilitate manageable sediment dynamics in the constrained context of the site and ensure the success of the mitigation project downstream of Rainier Avenue South.

Habitat Objectives

- Improve upstream passability through delta re-sloping.
- Improve instream habitat complexity.
- Improve riparian conditions along the channel and at the mouth to promote allochthonous materials input to the channel and nearshore lake habitats.
- Improve spawning and rearing conditions for native salmonids, with an emphasis on juvenile Chinook rearing habitat along the lake shoreline and in the creek (Tabor et al. 2006).
- Minimize construction impacts to existing habitat.

The following criteria define the successful outcomes that would result if the above objectives are met. Criteria have been compiled for both engineering and habitat components.

Engineering Design Criteria

- Provide a laterally stable channel geometry within the project limits that transports only particles 1 inch or smaller to the confluence of Lake Washington for the 2-year design flow.
- Match transport capacity to sediment size distribution and load to create differential deposition zones or channel segments. Provide channel cross-section and platform (sinuosity) that correlate with transport capacity.

- Progressively sort coarse to fine sediment deposition from downstream; use competence and related shear stress to determine channel cross-section and profile.
    - Segment 1 – 4 inch particle size competence
    - Segment 2 – 3 inch particle size competence
    - Segment 3 – 2 inch particle size competence
    - Segment 4 – 1 inch particle size competence
- Size channel sub-grade material to maintain stability.
- Lower elevation of delta at a < 15% slope from mouth of constructed channel. Salvage excavated material for use as appropriate in reconstructed channel.
- The mitigation site alone does not have sufficient capacity to accept the entire estimated sediment load without overwhelming the proposed graded deposition zone. The proposed approach critically relies on establishing an overall sediment management plan as part of the larger SPU project that reduces the sediment load delivered to the site located downstream of Rainier Avenue South.

Habitat Design Criteria

- Provide approximately 600 linear feet of channel.
- Provide 0.74 acres of enhanced riparian habitat adjacent to channel.
- Include a vegetation plan to provide adequate shade and overhanging cover along channel.
- Incorporate LWD where feasible to provide cover and to promote pool formation.

6.8.5. Ecological Functions and Benefits

The proposed channel will be more complex, much less confined, and will attenuate sediment transport to the delta relative to the existing condition. This proposed condition will benefit multiple fish uses (Table 6-10). Coho and sockeye will have suitable spawning habitat in the riffle habitat and rearing habitat in the pools and margins. Pools associated with LWD will be particularly beneficial for coho and sockeye rearing. Chinook and sockeye fry will benefit from rearing and feeding in the delta, shoreline fringe, and the vegetated margins of the creek. Because the site is a migratory and rearing area of considerable importance for juvenile Chinook salmon, and coho and sockeye spawning occurs in the project area, the channel and riparian areas have a Fish Function Modifier score of 0.8 (Table 6-1). Because of the uncertainty regarding sediment delivery to the delta, WSDOT has made a conservative assumption that the improvements there are likely to be temporary unless an effective sediment management plan is implemented upstream.

Therefore, the mitigation value of the delta restoration area has been further discounted to reflect this uncertainty (i.e. a “mitigation type” modifier of 0.4 is applied to this area).

Table 6-10. Taylor Creek Mitigation Benefits

<table>
<tr><th>Mitigation Action</th><th>Acreage</th><th>Habitat Features Improved</th><th>Habitat Functions Improved</th><th>Species/Life Stage Addressed</th></tr>
<tr><td>Channel Restoration</td><td>0.15</td><td>LWD recruitment
Off-channel
Protection from predators</td><td>Food sources
Suitable spawning habitat</td><td rowspan="3">Chinook (Rearing/Feeding)
Sockeye (Spawning)
Sockeye (Rearing/Feeding)
Coho (Spawning)
Coho (Rearing/Feeding)</td></tr>
<tr><td>Delta Re-Sloping Restoration</td><td>0.08</td><td>Protection from predators
Prey input substrate size</td><td>Protection from predators
Fish passage potential
Food sources</td></tr>
<tr><td>Riparian + Floodplain Restoration</td><td>0.74</td><td>Vegetative cover
Prey input</td><td>Protection from predators
Food sources</td></tr>
</table>

6.9 South Lake Washington Shoreline Restoration (DNR Parcel)

6.9.1. Site Location

The Washington State Department of Natural Resources (DNR) manages approximately 3 acres of filled shoreline area in South Lake Washington. The property is located adjacent to the Boeing plant, approximately 1,300 feet east of the mouth of the Cedar River and 600 feet west of Gene Coulon Park (Figures 6-1, 6-10).

6.9.2. Mitigation Site Existing Conditions and Fish Use

Shoreline Conditions

This property was created in 1965 when Puget Sound Power and Light (PSPL) was permitted to place 150,000 cubic yards of fill into the lake (Figure A-9). The fill was placed alongside a flume made of two sheet-pile walls that PSPL used to release cooling waters from its Shuffleton Steam Plant. The flume is still located along the shoreline of this property.

Approximately half of the hardened shoreline consists of the 650-foot-long flume on the northeastern half of the project area (Figure A-10). Portions of the adjacent upland and a private dock require sections of the flume for stability. The remaining shoreline in the project area (600 feet) has a natural grade, but is hardened with riprap. The entire shoreline and riparian zone is in a degraded condition, with some native vegetation cover (Figure A-12). Three dolphins are located east of the shoreline. Dolphins are man-made structures extending above the water level and not connected to the shore. Each dolphin at this site consists of seven creosote piles.

Ecological Condition of Adjacent Parcels

The shoreline to the west is a vertical bulkhead shoreline and paved commercial yard associated with the Boeing plant. However, this degraded shoreline is only 1,200 feet long, and the mouth of the Cedar River is at the other end of this bulkhead. The shoreline to the east consists of additional lengths of the flume, a bulkhead, and a floating dock. Gene Coulon Park is located on the other side of these adjacent features, and offers additional rearing habitat for salmonids.

Fish Use

The project area is most heavily used by Chinook fry that migrate through the site from the Cedar River toward the Ship Canal. The Chinook fry primarily use the portions of shoreline that contain naturally-sloped beach, though this shoreline is degraded from the presence of riprap and lack of native vegetation. High levels of Chinook fry/smolt use have been documented on the site (Tabor et al. 2004a; Tabor et al. 2006). Sockeye fry are known to use the shallow littoral zone in South Lake Washington, especially during the early stages of rearing. Since this site is located adjacent to the mouth of the Cedar River, it is likely that sockeye fry are present in the project area during early rearing. Given the high use by Chinook juveniles in this area, The South Lake WA Shoreline Restoration Project fits the “high” FFM definition of “aquatic sites that serve as migration or rearing areas of considerable importance for one or more species of juvenile salmon”. Therefore, Seward 1 has an FFM score of 0.8.

6.9.3. Rationale for Site Selection

The WRIA 8 Chinook Salmon Recovery Plan (King County 2005) prioritized the reduction of predation on juvenile migrants in Lake Washington by providing increased rearing and refuge opportunities. The Recovery Plan prescribes the restoration of shallow water habitats and creek mouths for juvenile rearing and migration. The South Lake Washington DNR Shoreline Restoration Project is listed as project number C266 on the 3-year work plan under the WRIA 8 Chinook Salmon Conservation Plan. This project is a Tier 1 priority under the WRIA 8 Plan due to the project’s capacity to provide high-quality shallow water habitat, and location in a migratory and rearing corridor of Chinook salmon. Shorelines that are free of over-water structures, bulkheads, and other shoreline hardening structures are rare in Lake Washington.

6.9.4. Mitigation Site Design

The Washington State DNR has advanced this design to 95% (Appendix E). The objective of restoration at this parcel is to restore approximately 1.74 acres of shoreline/ aquatic habitat and approximately 1.92 acres of upland habitat. This is intended to improve water quality and restore migratory habitat for juvenile Chinook salmon. This project will be funded by WSDOT, but is being permitted separately by DNR. Following the restoration of this property, DNR proposes to withdraw the lands from leasing with a Commissioner's Order as well as maintain the property under a conservation easement. The following project elements are proposed for this project.

Shoreline Enhancement and Hard Structure Removal

The outer, waterward edge of the flume does not appear to provide structural support to the adjacent uplands and will therefore be removed (Figure 6-10). The inner, landward edge of the flume will be removed where it is not required to maintain the structural integrity of the Boeing parcel. Where the inner flume needs to be retained, the lakebed grade will be restored to the extent possible to match this shoreline elevation. This will include raising the grade of the adjacent lakebed and excavating portions of the uplands to create a gradual shoreline grade. The grade of the lakebed will be raised such that a shallow bench waterward of the shoreline will be created. The remainder of the shoreline will undergo minor regrading and enhancement for juvenile Chinook foraging and rearing habitat. Approximately 600 linear feet of riprap will need to be removed.

Additional in-water debris will be removed from the entire site to the extent that it will provide ecological benefit to do so. The entire shoreline will undergo placement of appropriately-sized sediment and to provide cover for juvenile salmonids at or near the 16- to 18-foot elevation range. Instead of placing logs along the shoreline, coir log will be used fronting the lacustrine wetland fringe to limit erosion of the low lying areas. LWD will not be placed along the shoreline due to the flat topography and the potential for it to not function properly. Three engineered log jams (ELJ) are being installed as part of the project, and will be secured in place.

Riparian Restoration

Approximately 1.92 acres of shoreline and riparian zone will be restored by removing non-native invasive plants and planting native trees and understory vegetation. The upland vegetation palette is largely open with the exception of limited easement adjacent to the Boeing property for wingtip clearance. Large, native plants will be installed where practicable to quickly provide overhanging vegetation fish cover along the shoreline. A portion of the shoreline will be planted with wetland vegetation. The Boeing Corporation has a wing-tip easement that precludes planting trees. This easement area, and an additional buffer area adjacent to the easement, will only be planted with shrubs. Detailed 95% plan sheets are provided in Attachment A.

Dolphin Removal

Three derelict dolphins, consisting of approximately 21 creosote-treated piles, will be removed from the lake. The dolphins are located along the eastern portion of the project area (Figure 6-10).

6.9.5. Ecological Functions and Benefits

Once this shoreline is restored, it will provide functional habitat features such as naturally sloped shoreline, native vegetation, LWD, and appropriately-sized substrate (Table 6-11). All these functions help meet the goals set in the WRIA 8 Chinook Salmon Conservation Plan. The plan states that the restoration of Lake Washington is a high priority for regional restoration efforts, and the remaining areas with sandy shallow water habitat, overhanging vegetation, and large woody debris should be protected and maintained. Restoration of sites close to the mouth of the Cedar River will have a significant benefit for fisheries because juvenile Chinook and sockeye salmon are very abundant near the mouth of the Cedar River (Tabor 2006). The mouth of the Cedar River does not have a functioning delta with estuarine marsh or freshwater emergent wetlands that Chinook typically depend on during early rearing (King County 2005). Therefore, Cedar River Chinook fry are dependent on suitable Lake Washington shoreline immediately adjacent to the mouth of the Cedar River during early rearing for feeding opportunities and refugia from predators. Sockeye salmon fry only use the Lake Washington shoreline early in their life history. The proximity of this site to the mouth of the Cedar River (where most sockeye enter the lake as young fry) make it one of the few areas relevant for this life history function. Since this project is a migratory and rearing area of considerable importance for juvenile Chinook and sockeye salmon, this site's mitigation areas have a Fish Function Modifier score of 0.8 for mitigation accounting purposes.

Table 6-11. South Lake Washington Shoreline Restoration (DNR Parcel) Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/ Life Stage Addressed
Shoreline Enhancement + Hard Structure Removal	1.74	Gradual, Sloped Bank; Suitable Sediment; Prey Input	Protection from Predators; Migratory Corridor	Chinook (Juvenile Rearing/ Feeding) Chinook (Juvenile Migration) Sockeye (Juvenile Rearing/Feeding)
Riparian Restoration	1.92	Vegetative Cover; Prey Input	Protection from Predators; Food Sources	
Riparian Restoration-Shrubs[a]	0.59	Vegetative Cover; Prey Input	Protection from Predators; Food Sources	

[a] 0.59 acres of the project area are within the Boeing wingtip-easement area and buffer. This area will only be planted with low-growing shrubs.

Mitigation Action	Acreage
Shoreline Enhancement + Hard Structure Removal	1.74
Riparian Restoration	1.92
Riparian Restoration - Shrubs	0.59

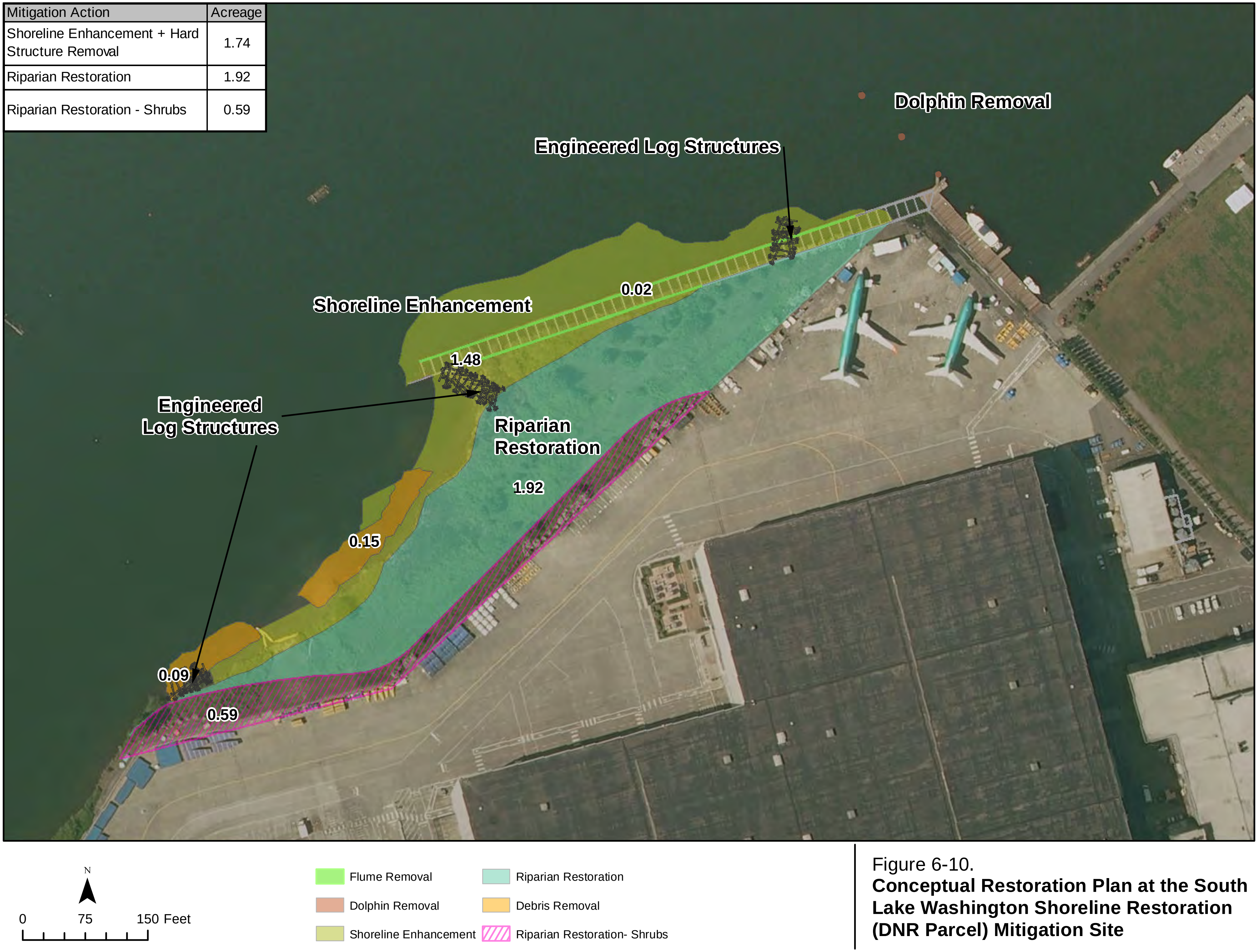

Figure 6-10.
Conceptual Restoration Plan at the South Lake Washington Shoreline Restoration (DNR Parcel) Mitigation Site

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6.10 Cedar River/ Elliott Bridge Site

6.10.1. Site Location

The Cedar River/Elliott Bridge site is located on the main stem Cedar River. The project area is on the right (north) bank of the Cedar River between the 154th Place SE Bridge and the 149th Avenue SE right-of-way, just east of the City of Renton Ron Regis Park (Figures 6-1, 6-11).

6.10.2. Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization is available in the SR 520 Final Aquatic Assessment Report (WSDOT 2011).

Shoreline Conditions

The river channel throughout most of this reach is confined and stabilized by levees and revetments, all of which contribute to a loss of connectivity between the river and its floodplain and to poor riparian conditions (King County 2005). The aquatic habitat has very little complexity, fish cover, or pool habitat for adult holding and juvenile rearing.

The downstream end of the project area is at the upstream boundary of the 149th Avenue right-of-way (ROW) where the bridge and approach have been removed and restored to a natural grade on the right bank. Immediately upstream of the 149th Avenue ROW, the right bank is unconfined with no hydromodifications for the first 226 ft (Figure A-12). This area is subject to flooding, although the OHWM (2-year flood) extends only 10–25 ft from the typical Cedar River shoreline during baseflow conditions (WSDOT 2011c). The ground surface elevation gradually increases to the north and moves upstream to the east. A wetland is present along the bank in this unconfined stretch. The next 200 feet upstream has a levee constructed with large, cobble-sized angular rock (Figures A-13, A-14). A floodplain bench has formed along the first 100 ft, with a gradual slope between the river's edge and the levee face. No large trees are present on the levee, although shrubs and willows were present.

A King County mitigation site for the 154th Avenue SE Bridge Project is located on the right bank just northeast of the 154th Avenue SE Bridge. The site is vegetated with a native riparian community and contains an off-channel habitat feature. Immediately downstream from the restoration area, a levee extends about 500 linear feet farther downstream. The levee has large boulder-size riprap below the OHWM that extends approximately 5 feet waterward and 3 to 5 feet below the observed waterline (Figure A-15). The upper portion of the levee consists of cobble-sized riprap. The elevation change from the observed waterline to the top of the levee is approximately 7 feet. Landward of the levee, there is an elevation drop of 2 to 3 feet. There are variable amounts of fill on each residential parcel. Downstream of the levee, the floodplain is at a natural grade and is equal to or around 2 feet higher than the base flow river stage.

Because of the constraints on channel migration, the river exhibits a simplified morphology through this reach. The reach could be characterized as having a riffle-pool morphology, though the lack of lateral movement diminishes the development of pronounced channel habitats. Generally, scour pools form along the toe of the revetments and riffles in the softer water margins of the channel. Large wood is notably absent throughout the project reach.

The riparian condition is generally poor due to past residential land use. The site is characterized predominantly with scattered native and ornamental trees and shrubs and a substantial amount of lawn that has now gone fallow. Bare ground is present in the footprints of the demolished homes. The downstream portion of the site contains a small amount of native riparian habitat comprised of predominantly deciduous species.

Ecological Condition of Adjacent Parcels

Several residences with associated structures are located adjacent to the project area. King County has acquired some of the properties opposite of the project area on the left bank of the river, as part of a floodplain property acquisition program.

On the upstream half of the left bank, the floodplain is unconfined. An upper terrace on the left bank floodplain is likely formed from fill (3 to 5 feet above the active floodplain. A levee with large riprap extends along the left bank of the river, across from the approximate midpoint of the project reach down to the remnant 149th Avenue SE bridge abutment. The river is confined along this stretch, resulting in concentrated flow with the potential to erode unprotected riverbanks. The 149th Street bridge abutment is still present on the left bank, with large boulders in the water around the abutment.

The upstream parcels along the left bank belong to King County for several thousand feet upstream. The upstream parcels along the right bank also belong to King County, but only for approximately 1,000 feet. These parcels have mature vegetation with functioning riverine and off-channel habitat. Shoreline restoration has occurred along both upstream banks on the King County property. Downstream parcels on both banks are privately owned and are typical of residential properties in the area that are primarily landscaped with scattered trees and shrubs. Avoiding risk to these properties forms a key constraint to the feasibility of restoration actions undertaken on the site. About 800 feet downstream of the site, a large tract of land owned by the City of Renton (Ron Regis Park) occupies the left bank for about 1,500 feet. These parcels also have mature vegetation with functioning riverine and off-channel habitat. The right bank across from Ron Regis Park is a steep forested slope.

Fish Use

This reach provides spawning habitat for all focal species: Chinook, sockeye, coho, and steelhead (WDFW and WWTIT 1994). Sockeye spawning is particularly heavy along the left (south) bank, upstream of the levee. This reach also functions as juvenile and adult migratory habitat for the four species listed above. Although side- and off-channel habitat does not currently exist in the project area because of past development, adjacent side- and off-channel habitat occurs naturally and is likely used by all four species.

6.10.3. Rationale for Site Selection

The WRIA 8 Chinook Salmon Recovery Plan (King County 2005) identified this portion of the Cedar River as lacking the habitat diversity needed for increased Chinook salmon productivity. The plan prescribes actions to increase Chinook salmon habitat diversity including protecting and restoring riparian habitat, removing or setting back levees and revetments to restore connections with off-channel habitat, and restoring sources of LWD and installing new LWD to restore pool habitat (King County 2005). The Cedar River/ Elliott Bridge project is listed as Project #C213 on the 3-year work plan under the WRIA 8 Chinook Salmon Conservation Plan. This project is a Tier 1 priority under the plan due to the project's capability to provide floodplain connectivity and riparian functions, and the heavy use of this reach by multiple salmonid species. This project will also increase floodplain capacity in the river, thereby attenuating downstream flooding and erosion problems in Ron Regis Park, directly downstream of the project area. The study of flooding and erosion in this downstream reach is listed as Project # C214 under the 3-year work plan under the WRIA 8 Chinook Salmon Conservation Plan (King County 2005). The Site is also part of the wetland mitigation plan (WSDOT 2011a), and will be designed to meet both aquatic and wetland mitigation needs. The selection of this site for wetland creation is consistent with the objectives of increasing floodplain capacity, connectivity, and fish habitat in the Cedar River.

6.10.4. Mitigation Site Design

At this site, WSDOT proposes to establish 0.70 acres of new river margin and aquatic off-channel habitat and to restore 3.47 acres of riparian and floodplain habitat along the Cedar River. Along the right bank, the levee will be lowered to the approximate 2-year flood elevation to restore connectivity to the floodplain. The riprap toe of the revetment will need to remain, however, because the site does not provide enough acreage to allow for active channel migration without significant risk to downstream properties. A setback levee will also be constructed along the north and east boundaries of the site (Jones Road SE and 149th Avenue SE, respectively). Should downstream properties be acquired, future phases of restoration at this site could undertake complete removal of the setback levee and all bank hardening to allow channel migration.

Approximately 3.47 acres of floodplain behind the levee will undergo significant excavation, reducing the overall elevation by 3 to 5 feet (Appendix B). Excavation to this elevation will make wetland and off-channel habitat creation feasible. A backwater side channel will be excavated into the floodplain, along the toe of the Jones Road and 149th Avenue SE road prisms, with the confluence near the old 149th Avenue SE bridge abutment. A shelf at the excavated floodplain elevation will be retained between road prism and off-channel feature. This shelf will be vegetated and will provide cover and riparian function along the off-channel aquatic habitat. The dimensions and configuration of the backwater channel mimic those of an abandoned former river channel of the Cedar River. This floodplain feature can be expected to evolve over time in the same way as a backwater slough formed by channel avulsion and abandonment.

The area between the primary channel and the backwater channel will function as a wetland and riparian mosaic. The backwater channel will emulate a valley wall channel because the Jones Road prism is at the toe of a steep slope (East Renton Highlands). It is anticipated that groundwater flow off the hillside and hyporheic flow from the river will provide sufficient year-round hydrology to the backwater channel. Piezometers will be installed prior to final design to determine hydrology and establish relative channel elevations. The channel and new river margin will result in 0.70 acres of new aquatic habitat.

LWD features will be installed along the right bank of the channel to provide fish cover and substrate for algae and macroinvertebrates. A large woody debris jam is proposed at the right bank mouth of the channel to provide cover and promote a scour pool suitable for adult holding.

From the approximate mid-point of the project reach downstream to the outlet of the backwater channel, the levee will be lowered to achieve an enlargement of the active channel. The formation of a gravel bar is anticipated in this location because the thalweg occurs along the left bank revetment. This would result in approximately 0.3 acre of additional main stem channel habitat below OHW and an increase in spawning habitat.

The design of this site has the following constraints:

- Riparian restoration is limited to the acquired parcels.
- The Cedar River cannot be allowed to move across the channel migration zone when the floodplain is restored, because of the limited area acquired to date and the potential detriment to adjacent private properties.

Engineering Objectives

- Provide a self-sustaining backwater channel with appropriate baseflow, depth, and other habitat features to provide quality habitat function for salmonids throughout the year.
- Reduce, to the maximum extent feasible, the elevation of the existing training levee to allow overbank flood flows, but avoid channel migration.
- Remove floodplain fill upstream of backwater channel to enlarge the active channel of the Cedar River.
- Reduce the floodplain grade throughout portions of the site to allow formation of wetland conditions.
- Provide stable LWD features.
- Do not adversely impact adjacent property owners; maintain the 149th Avenue SE road prism and right-of-way.
- Do not adversely impact existing habitat within the main stem of the Cedar River.
- Be forward-compatible with future phases of floodplain and/or channel migration restoration in this reach.

Habitat Objectives

- Provide off-channel rearing and high-flow refuge salmonid habitat for the target species and life stages.
- Provide habitat elements, cover types, and substrate appropriate to the target species, life stages, and side channel hydraulics imposed by site conditions.
- Provide ingress and egress for juvenile and adult salmonids for all flow conditions.
- Provide spawning habitat in the main stem of the Cedar River.
- Preserve existing natural vegetation to the extent practical; trees or other vegetation removed during construction will be incorporated in the backwater channel design.
- Enhance riparian vegetation to provide cover and allochthonous inputs.

- Minimize construction impacts to existing habitat.

Project Design Criteria

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components. Engineering design criteria may change, based on hydrologic and hydrolic modeling results, and the associated advancement in restoration design.

Engineering Design Criteria

- Backwater channel geometry: River margin and off-channel area = approximately 0.7 acre; Bankfull Depth = approximately 3feet. Create a channel profile to maintain positive drainage to the Cedar River – ≤ 1% slope.
- Size bed material to provide a suitable substrate for spawning. Size channel side-slope material to maintain stability.
- Lower the average elevation of floodplain wetland complex to an elevation of 96 feet.
- Provide an engineered log jam to withstand 100-year flow conditions. Provide a LWD roughened toe of the backwater channel. Wood should be exposed to the normal range of flows.

Habitat Design Criteria

- Provide a total of 0.70 acres of new channel margin and off-channel habitat.
- Incorporate LWD and channel dimensions to create preferred habitat elements through the backwater channel and main stem bar restoration.
- Include a vegetation plan to provide adequate shade and overhanging cover along the backwater channel. Provide 3.47 acres of riparian vegetation throughout the floodplain/wetland complex that promotes LWD recruitment to the Cedar River.
- Avoid the potential for fish stranding in the backwater channel.

6.10.5. Ecological Functions and Benefits

The Cedar River will be reconnected to its historic floodplain on the right bank through levee setbacks and excavation of historic fill. Reconnection of the floodplain will attenuate flood intensity downstream, thereby reducing channel incision and erosion in the main stem (Table 6-7). Increased connectivity to the floodplain will also increase maintenance of freshwater emergent wetlands, will import materials (LWD, etc.) into the main stem, and will function as fish habitat during high flows. Riparian restoration in the floodplain will provide fish cover, increase prey resources for fish, filter pollutants from nearby roads and development, provide bank stability, and contribute LWD to the river (Table 6-12). LWD recruitment is currently rated as poor along almost all of the Lower Cedar River, and land use practices generally preclude active recruitment. Also, large amounts of LWD are removed upstream at Landsburg Dam due to liability concerns (King County 2005).

The creation of off-channel rearing habitat will benefit all salmonid species. In the Cedar River, this habitat was historically used by juvenile Chinook for rearing, which in turn likely resulted in a larger and later timing of outmigration from the Cedar River. The loss of habitat has forced juvenile Chinook to migrate into Lake Washington as very young fry, a life history trajectory that may have reduced their survival (King County 2005). Coho rely on off-channel habitat for rearing and overwintering (Bustard and Narver 1975; Brown and Hartman 1988; Swales and Levings 1989). Therefore, the off-channel rearing habitat will also function as high-flow refugia.

The channel is positioned close to the valley wall to intercept groundwater flow coming off the hillside. Groundwater discharge wetlands are common along the valley slopes in this vicinity, suggesting that hydrology is persistent and sufficient to support subsurface groundwater flow into the off-channel area.

The installation of LWD along the right bank of the backwater channel will provide complex cover for juvenile salmonids and an organic substrate for prey items.

The proposed engineered logjam will be designed to provide scour pools suitable for use by adults of multiple salmonid species during upstream migration and for pre-spawn holding. This reach has very few pools and areas of fish cover. Juvenile coho often rear in pools associated with LWD and fish cover. Chinook salmon, in particular, will benefit from increased pools in the reach because they hold in pools prior to spawning, then spawn in riffle habitat adjacent to pools. The enlarged portion of the primary river channel upstream of the backwater should provide suitable spawning habitat in close proximity to the holding pool.

Lastly, the wetland/riparian mosaic of the restored floodplain will provide multiple indirect benefits to Cedar River salmonids. The capacity for overbank flow will alleviate stream velocities and erosive forces on the adjacent channel for anything larger than the 2-year flood event. The increased roughness of the floodplain will attenuate flows across it, allowing fine sediments to drop out of suspension. Connectivity to the floodplain will also restore energy transfer between the channel and riparian, allowing inputs of allochthonous materials to support the food web and large woody debris recruitment. It should be noted that the floodplain wetland mosaic is anticipated to be dynamic, with quantities of wetland area changing periodically in response to sediment deposition and scour. WSDOT will ensure that the site is protected long term through an appropriate legal protection mechanism.

Table 6-12. Cedar River/Elliott Bridge Mitigation Benefits

<table>
<tr><th>Mitigation Action</th><th>Acreage</th><th>Habitat Features Improved</th><th>Habitat Functions Improved</th><th>Species/Life Stage Addressed</th></tr>
<tr><td>River Margin and Aquatic Off-channel Creation</td><td>0.70</td><td>Vegetative cover
Pools
Off-channel</td><td>Protection from predators
Food sources
High-flow refugia</td><td rowspan="2">Sockeye (Spawning)
Sockeye (Rearing/Feeding)

Chinook (Spawning
Chinook Rearing/Feeding)

Coho (Spawning)
Coho (Rearing/Feeding)

Steelhead (Spawning)
Steelhead (Rearing/Feeding)</td></tr>
<tr><td>Riparian + Floodplain Restoration</td><td>3.47</td><td>Vegetative cover
Prey input
LWD recruitment
Bank stability</td><td>Protection from predators
Food sources
Water quality</td></tr>
</table>

Mitigation Action	Acreage
River Margin and Aquatic Off-channel Creation	0.70
Riparian + Floodplain Restoration	3.47

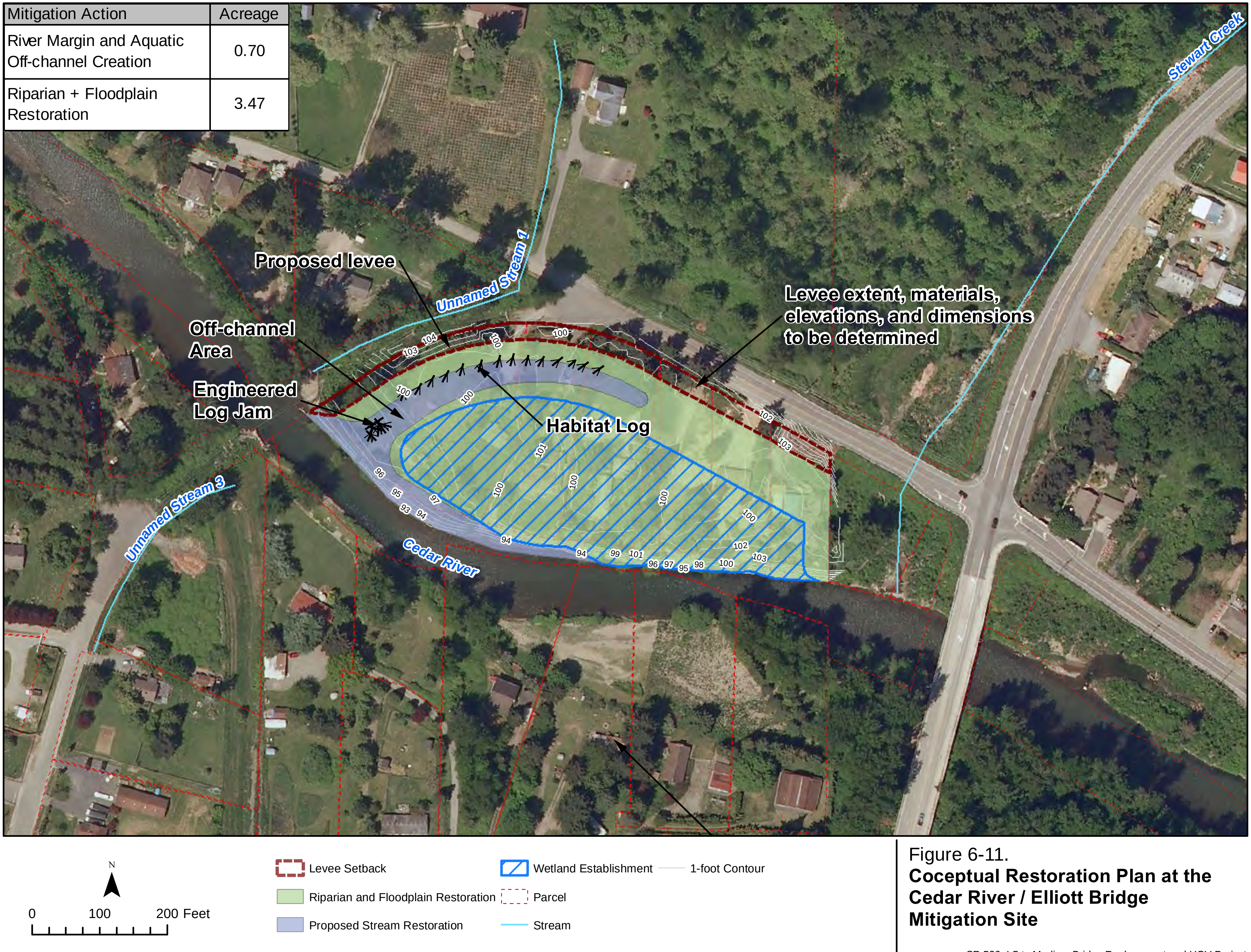

Figure 6-11.
Coceptual Restoration Plan at the Cedar River / Elliott Bridge Mitigation Site

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6.11 Bear Creek Site

6.11.1. Site Location

The project site is within the city of Redmond, in King County, adjacent to the Redmond Town Center. The site is located east of the Sammamish River, south of the Redmond Town Center, and north of SR 520 (Figures 6-1, 6-12).

6.11.2. Mitigation Site Existing Conditions and Fish Use

Shoreline Conditions

The project site is primarily an open space area managed by the City of Redmond and Redmond Town Center. A 10-foot-wide asphalt trail connects to the Sammamish River trail in the project area. Although the trail is near the creek, it provides limited viewing of the creek. The trail accommodates pedestrian and bicycle use.

Structures on the property include the trail and stormwater treatment facilities for Bear Creek Parkway. Existing environmental conditions are degraded. The Bear Creek stream channel is an artificial, straight, riprap-lined channel created to convey flood flows (Figure A-15). From the mouth up to 2,600 feet upstream, Oregon ash (*Fraxinus latifolia*) and black cottonwood (*Populus trichocarpa*) grow adjacent to the stream banks in a narrow (one tree-width) riparian corridor. The stream buffer on either side of this narrow riparian zone is primarily vegetated with reed canarygrass (*Phalaris arundinacea*), thistle (*Circium* sp.), and blackberries (Figure A-16). From 2,600 to 3,000 feet upstream, a riverine wetland exists with a buffer of black cottonwood and Oregon ash.

Ecological Condition of Adjacent Parcels

The project area is bounded by developed parcels. Redmond Town Center is to the north, consisting of commercial properties. SR 520 lies to the south, and Marymoor Park is on the south side of SR 520. The park consists of ball fields, roads, parking lots, and some small buildings. Upstream, and to the east, Bear Creek has been restored to a relatively higher degree of function. Downstream, in the Sammamish River Shoreline, the City of Redmond has been restoring floodplain benches and riparian function. The currently proposed restoration project would connect these restoration efforts.

Fish Use

Although stream and buffer habitat is degraded in the area planned for mitigation, Bear Creek is a major producer of salmon in WRIA 8. Chinook, coho, and sockeye all spawn in Bear Creek upstream of the mitigation area. In the mitigation area, Bear Creek is used by salmonids as a migration and rearing corridor, but not for spawning. Given the high use of the project area for rearing by Chinook, and by coho juveniles, Bear Creek fits the “high” FFM definition of “aquatic sites that serve as migration or rearing areas of considerable importance for one or more species of juvenile salmon". Therefore, Bear Creek has an FFM score of 0.8.

6.11.3. Rationale for Site Selection

The WRIA 8 Chinook Salmon Recovery Plan (King County 2005) identified this portion of Bear Creek as lacking the habitat diversity needed for increased Chinook salmon productivity. Actions prescribed by the Recovery Plan to increase habitat diversity include the restoration of meanders, in-stream complexity, off-channel habitat, and riparian vegetation in the lower 3,000 feet of Bear Creek. Because of its role in upstream staging and downstream migration and rearing, and as a refuge for salmonids escaping the warmer waters of the Sammamish River, the Lower Bear Creek sub-basin has been recognized as a Locally Significant Resource Area by King County. The Lower Bear Creek project is listed as Project #N201 on the 3-year work plan under the WRIA 8 Chinook Salmon Conservation Plan, and is a Tier 1 priority under the plan. This project was funded by WSDOT, but was permitted separately by the City of Redmond.

6.11.4. Mitigation Site Design

The Bear Creek project has advanced to 90% design (Appendix F). Restoration will include increased meandering, LWD, bank stabilization, stream gravel, and native riparian plantings (Figure 6-12). Created wetlands will be hydraulically connected to the stream to provide high-flow refuge habitat and floodplain functions. Adjacent uplands will also be excavated to create more floodplain storage and habitat associated with the new channel. New riparian/floodplain plantings will enhance in-stream and riparian functions such as cover, shading, LWD recruitment, bank stabilization, terrestrial insect food production, and leaf-litter organic debris in support of in-stream food sources. By making the stream channel more sinuous, the channel's length will be increased by 340 feet. The existing stream channel will be connected to the new channel in places to provide off-channel habitat. The remainder of the existing stream channel will be filled in with excavated gravels from the new channel. The new channel will include 1,300 linear feet of pool habitat with two different types of LWD bank stabilization methods. The outside of stream meanders will have a Type 3 configuration that will provide extra bank protection. A total of 3,000 pieces of LWD will be added to the stream channel within the bankfull width.

Three riparian planting zones will be located along elevational gradients across the site relative to flood stages of Bear Creek. The three riparian planting zones are listed in descending order of expected inundation:

1. Floodway Zone (1.71 acres): Tree layer consists of black cottonwood (12%) and Oregon ash (13%); shrub layer consists of Pacific ninebark (*Physocarpus capitatus*, 15%), Pacific willow *(Salix lucida*, 15%), red-osier dogwood (*Cornus sericea* 15%), salmonberry (*Rubus spectabilis*, 15%), and Sitka willow (*Salix sitchensis*, 15%).

2. Transition Slope Zone (4.35): Tree layer consists of black cottonwood (9%), Sitka spruce (*Picea sitchensis*, 8%), and western red cedar (*Thuja plicata*, 8%); shrub layer consists of black twinberry (*Lonicera involucrate*, 15%), Indian plum (*Oemleria cerasiformis*, 15%), peafruit rose (*Rosa pisocarpa*, 15%), salmonberry (15%), and Sitka willow (15%).

3. Upland Buffer Zone (5.22 acres): Tree layer consists of big leaf maple (*Acer macrophyllum*, 8%), Douglas fir (*Pseudotsuga menziesii*, 9%), and western hemlock (*Tsuga heterophylla*, 8%); shrub layer consists of bitter cherry (*Prunus emarginata*, 9%), cascara (*Rhamnus purshiana*, 9%), nootka rose (*Rosa nutkana*, 10%), oceanspray (*Holodiscus discolor*, 9%), red elderberry (*Sambucus racemosa*, 10%), tall Oregon grape (*Berberis aquifolium*, 10%), and vine maple (*Acer circinatum*, 9%).

Trees will be planted at an approximate spacing of 10 to 15 feet on center and shrubs at an approximate spacing of 5 feet on center, in randomly mixed groupings. In areas where the current vegetation will be retained, plant spacing will depend on the densities of the existing desirable native vegetation. Plants will be installed during specified planting windows. Native plants will be obtained from approved nurseries. A temporary irrigation system will be installed, if necessary, for watering during the plant establishment period. Emergent vegetation will not be planted for this project because of limiting factors such as depredation by waterfowl (e.g., Canadian geese) and reed canarygrass infestation. The intended vegetation types after restoration will be forested wetland and riparian plant communities, facultative or wetter, to withstand inundation. Scrub-shrub wetland plant communities may be included in final design. This will also lead to quicker establishment of woody vegetation close to the channel for habitat benefits, including in-stream cover and shading.

This site has the following design constraints:

- Riparian and floodplain restoration is constrained by the SR 520 on the left bank, and the Bear Creek Parkway on the right bank.
- Cultural and archeological resources have been found on the site, and will constrain the grading plan for the final design.

6.11.5. Ecological Functions and Benefits

The project will create significant habitat improvements to establish a compositionally and structurally complex ecosystem with attributes important for supporting fish and wildlife with an emphasis on anadromous fish such as Chinook, coho, and sockeye salmon (Table 6-13). As the riparian/floodplain vegetation matures, it will increase the continuous patch riparian corridor and contribute to channel and bank stabilization, riparian corridor habitat diversity, and cover and refuge for both juvenile and adult fish and wildlife.

Table 6-13. Bear Creek Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/Life Stage Addressed
Stream Enhancement	3.16	Off-Channel Pools LWD Fish Cover	Protection from Predators Food Sources	Sockeye Rearing/Feeding) Chinook (Rearing/Feeding) Coho (Rearing/Feeding)
Riparian Restoration	12.62	Fish Cover, LWD recruitment	Water Quality Protection from Predators Food Sources	

Mitigation Action	Acreage
Stream Enhancement	3.16
Riparian Restoration	12.62

Figure 6-12.
Conceptual Restoration Plan at the Bear Creek Mitigation Site

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6.12 East Approach

6.12.1. Site Location

Shoreline and nearshore enhancement is proposed near the existing and proposed SR 520 east approach (Figure 6-1 and Figure 6-13).

6.12.2. Mitigation Site Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization of shoreline conditions is available in the SR 520 Final Aquatic Assessment Report (WSDOT 2011c).

Shoreline Conditions

Portions of the shoreline in the project area are highly modified with bulkheads, docks, and landscaped riparian zones (WSDOT 2009c). Natural, undisturbed shoreline in the project area is limited to a stretch directly below the Evergreen Point Bridge. In addition, boat traffic here is concentrated relatively close to the shoreline, leading to considerable wave action. As a result, vegetation densities tend to be relatively low close to shore, and substrate material relatively large. In general, the lake bottom substrate is cobble and gravel near the shoreline and transitions to sand and finer material moving away from the shoreline.

The shoreline consists of a failing wood bulkhead, some large boulder-sized riprap, and two piers (Figure A-17). Both docks are fixed piers with treated wood piles, substructure, and decking. Both docks have solid decking with no functional grating. A deciduous tree recently fell into the lake, over the wood bulkhead, and is providing cover (Figure A-17). The East Approach shoreline has a 12 to 13% slope. Substrate is predominantly gravel near the shoreline. The riparian zone at the East Approach has mature deciduous and coniferous trees throughout the area, except for some bare ground near the shoreline. The understory is dominated by invasive plants.

The two piers will be removed and replaced with one pier that will be used for WSDOT maintenance activities (see Section 4.3.1). The non-native species Eurasian watermilfoil (*Myriophyllum spicatum*) and native species of pondweed (*Potamogeton* sp.) and American wild celery (*Vallisneria americana*) are the most abundant aquatic plants (WSDOT 2009c). Lake bottom substrate in the project area is dominated by cobble and sand. In general, substrate near the shore consists of cobble and transitions through gravel to sand and silt moving offshore (Figure A-18); patches of bare clay are also present (WSDOT 2009c).

Ecological Condition of Adjacent Parcels

Much of the shoreline is modified with bulkheads and boat docks, although the shoreline immediately under the existing bridge is relatively unmodified, with a natural slope. Parcels in the project vicinity consist of the SR 520 approach, bridge, and residential properties with piers, ramps, and floats.

Fish Use

The site has been identified in the past as a sockeye spawning area based on historical WDFW map records (Buchanan 2004). Estimated annual escapement of Lake Washington beach-spawning sockeye varied from 54 to 1,032 fish from 1976 through 1991 (WDFW 2004). These sockeye spawn wherever suitable gravel beaches and groundwater upwelling occur around the lake, particularly along the north shore of Mercer Island and the east shore of Lake Washington. These spawning areas occur over a wide range of water depths. The estimated total beach spawning population ranged between 200 and 1,500 fish between 1986 and 2003 (WDFW 2004). This sockeye spawning area is one of more than 85 shoreline spawning areas identified in Lake Washington on maps provided by WDFW (Buchanan 2004). Therefore, this project area meets the 0.8 FFM criterion of being an "aquatic site that is known to support documented spawning of at least one salmonid species", and is assigned an FFM of 0.8.

6.12.3. Rationale for Site Selection

This site was selected for sockeye spawning enhancement because of documented sockeye spawning and known groundwater upwelling. The colluviums/weathered till geologic strata probably result in a patchy distribution of upwelling areas from the underlying pressurized aquifer. In much of this area, the existing sediments do not currently appear suitable for sockeye spawning (WSDOT 2009c). Therefore, gravel supplementation is expected to maximize spawning habitat suitability where groundwater upwelling does occur.

Shoreline restoration is proposed because of the paucity of natural shoreline in this area of the lake and because of likely Chinook and sockeye use during early rearing. Chinook juveniles migrating along from the shoreline from the south lake and local beach spawning sockeye are the most likely to benefit from a natural shoreline feature.

6.12.4. Mitigation Site Design

Mitigation actions at this site will include sockeye gravel supplementation, bulkhead removal, nearshore substrate enhancement, and riparian restoration (Figure 6-13).

In general, sockeye spawn in areas of clean gravel substrate and groundwater upwelling. Sockeye dig redds in gravel and small cobbles between 13 and 102 mm (Reiser and Bjornn 1979). Olsen (1968) indicated that sockeye may use either sand or gravel, depending upon which is available. If small amounts of silt, detritus, or fine sand are mixed with the coarser gravel, they are removed by the fish in the process of excavating the redd (Foerster 1968). Mathisen (1955) observed sockeye salmon egg concentrations 6 to 9 inches below the gravel surface. The site has some areas of clean cobble and gravel that have the potential to support sockeye spawning (WSDOT 2009c). However, most of the nearshore substrate consists of cobble material and the offshore areas are dominated by sandy substrate. The site is generally less than 50 feet deep. This depth stratum is associated with the Colluvium/ Recessional geologic stratum (WSDOT 2011b). A confined and pressurized aquifer underneath the Colluvium/ Recessional stratum provides localized groundwater upwelling into the project area.

Approximately 1,210 cubic yards of clean and appropriately-sized gravel will be offloaded and spread to a depth of 1 foot. Although the substrate size and distribution will be determined from subsequent analysis of sediment transport from wind-generated waves and currents, the substrate will be installed within the suitable range for beach spawning sockeye, to the greatest extent practicable. Based on previous substrate enhancement projects, the substrate distribution will likely be similar to what is shown in Table 6-2.

The wood bulkhead and adjacent boulder-sized riprap will be removed. The shoreline behind the bulkhead will be re-graded to a gradually sloped shoreline and supplemented with approximately 130 yards of clean and appropriately-sized gravel. Grading plans will be developed that are consistent with cross-sections A and B (Figure 6-13, Appendix B). The grass upland immediately landward of the bulkhead will be revegetated. Revegetation will include a live stakes community near high lake level elevation and transition to a riparian upland community. Proposed planting zones, species lists, and densities for revegetation are included in Appendix C. Specific planting plans for site-specific conditions and constraints will be developed during the design phase. The implementation schedule is detailed in Section 6.13.

The following additional actions will be completed, per the associated SR 520, Medina to SR 202: Eastside Transit and HOV Project:

- All existing large rock (greater than 100 pounds) located underneath the existing eastside SR 520 Bridge on the shoreline and in the water will be removed. Area specified on sheet 3 of 47 plans entitled “Purpose: Reduce travel times and enhance reliability, mobility, access and safety for transit and HOV vehicles”, dated April 30, 2010.

- Fifty cubic yards of clean (washed), well-rounded gravel, 2-inch minus in gradation spawning gravel shall be placed extending from the bulkhead waterward 15 feet to fill in the created holes.

These actions may be completed concurrently with the larger bulkhead removal, re-grading, and gravel installation project.

This site has the following design constraints:

- Riparian restoration cannot occur in the footprint of the proposed maintenance facility or paths.
- Shoreline restoration must be compatible with the proposed maintenance dock.
- Spawning gravel supplementation cannot occur within the footprint of the maintenance dock, or where the maintenance boat ties up to the dock.

The site design objectives and criteria are summarized below.

Engineering Objectives

- Provide a low-gradient shoreline between low and high lake levels.
- Provide gravel (round rock) and sand substrate along the shoreline that is appropriately sized to avoid erosion.

Habitat Objectives

- Provides gravel substrate along the shoreline that is suitable for sockeye beach spawning.
- Provides shallow, low-gradient rearing and migratory habitat during juvenile Chinook and early juvenile sockeye rearing periods.
- Provides overhanging vegetation along the shoreline for juvenile salmonid refugia and forage base.
- Provides gravel and sand substrate along the shoreline that minimizes predator habitat.
- Provides indirect riparian functions, including shading, pollutant filtration, and LWD recruitment to the shoreline.
- Minimizes construction impacts to existing habitat.

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

Engineering Design Criteria

- Bulkhead will be removed below the sediment line.
- The slope of the enhanced shoreline habitat will be at or below 15% grade, as measured from low lake level to high lake level.
- Substrate installed along the shoreline according to an analysis of sediment transport from wind-generated waves and currents.

Habitat Design Criteria

- Create 0.75 acre of suitable beach spawning habitat for sockeye. Gravel substrate will be installed with the size distribution most suitable for sockeye beach spawning.
- Provide 0.08 acre of shallow rearing habitat for juvenile Chinook.
- Gravel substrate in the shallow littoral zone will be installed with the smallest size distribution possible in order to maximize habitat function for rearing juvenile Chinook.
- Provide 0.05 acre of enhanced riparian habitat adjacent to the shoreline.
- Include a vegetation plan to provide adequate shade and overhanging cover along the shoreline.
- The spatial and temporal extent of in-water work will be minimized.
- In-water work will occur during designated in-water work windows.
- Impacts to native vegetation will be minimized.
- Erosion will be minimized.

6.12.5. Ecological Functions and Benefits

This mitigation action will primarily benefit sockeye salmon spawning habitat (Table 6-14). Shoreline areas with upwelling and suitable sockeye spawning substrate are an important habitat feature in Lake Washington.

Table 6-14. East Approach Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/Life Stage Addressed
Spawning Gravel Supplementation	0.75	Suitable sediment	Suitable spawning habitat	Sockeye (Spawning)
Riparian Enhancement	0.08	Vegetative cover Prey input	Protection from predators Food sources	Chinook (Juvenile Rearing/Feeding) Chinook (Juvenile Migration) Sockeye (Juvenile Rearing/Feeding)
Shoreline Enhancement + Bulkhead Removal	0.05	Gradual, sloped bank Suitable sediment Prey input	Protection from predators Migratory corridor	

Mitigation Action	Acreage
Spawning Gravel Supplementation	0.75
Riparian Restoration	0.05
Shoreline Enhancement + Bulkhead Removal	0.05
Shoreline Enhancement + Boulder Removal	0.03

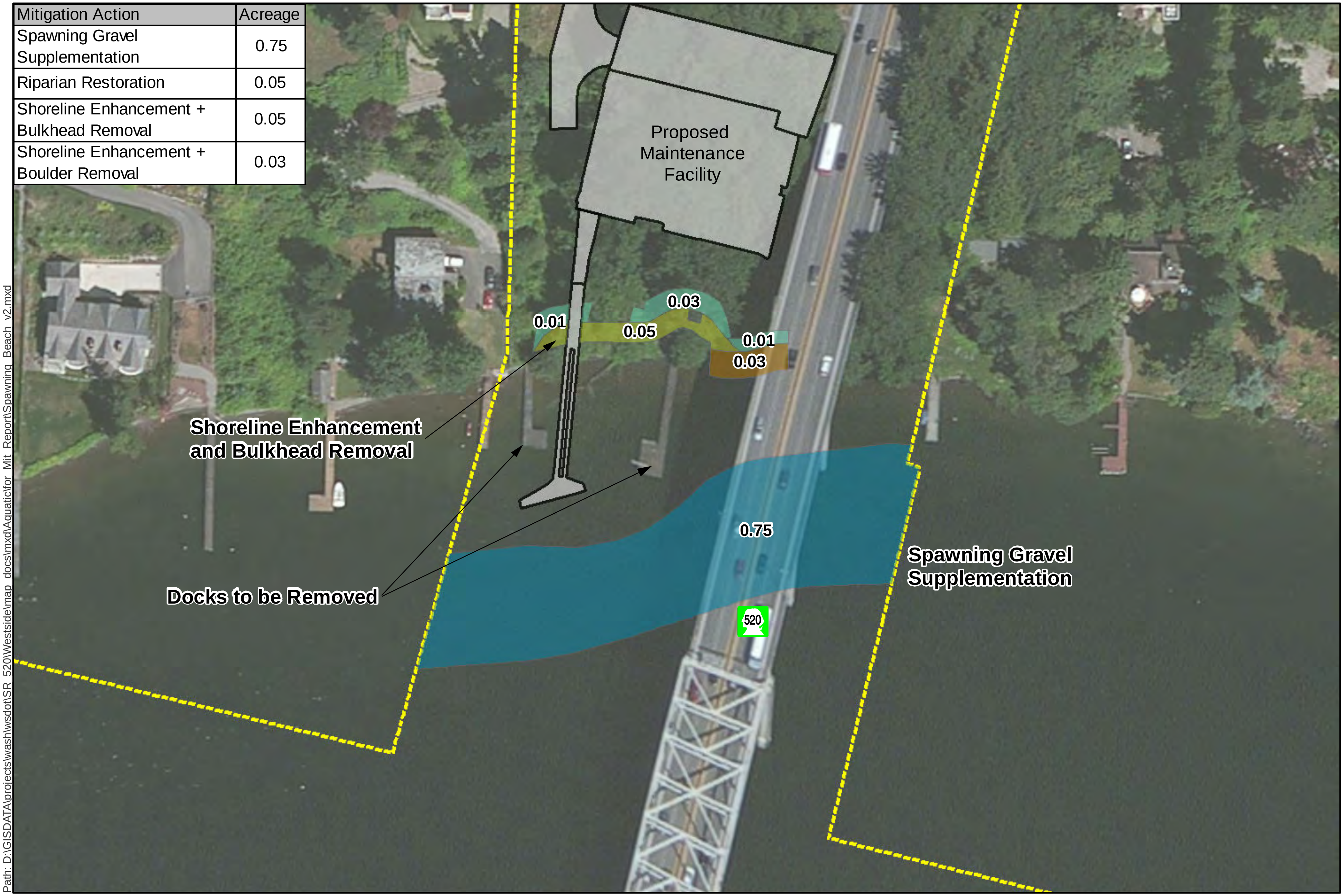

Figure 6-13.
Conceptual Restoration Plan at the East Approach Mitigation Site

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6.13 Implementation

All the proposed mitigation sites are on publicly-owned land, and WSDOT has engaged in several partnerships with the landowning entities, some of whom have initiated restoration design concepts for the sites independent of this process. Table 6-15 summarizes the roles and responsibilities shared between WSDOT and its partner agencies on the mitigation sites.

The following technical studies may be implemented for each project, as appropriate, prior to and as part of the design process:

- Shallow groundwater monitoring
- Identification of historic elevations, fill elevations, etc.
- Hydrologic and hydraulic modeling
- Topographic survey
- Geotechnical survey
- Hazardous materials site assessment (Phase I)
- Cultural and archeological investigation

A more comprehensive implementation schedule will be developed as each project design advances. The SR 520 Final EIS (WSDOT 2011f) describes the overall construction sequence for the project (see also Figure 2-5). The anticipated schedule for project elements and mitigation site construction is provided in Table 6-15 and 6-16. Concurrent mitigation will be provided that will equal or will be in excess of impacts. It is anticipated that the first compensatory mitigation sites to be constructed will be the 1) East Approach, 2) So Lake Washington Shoreline Restoration, 3) Bear Creek, and 4) Cedar River/ Elliott Reach. If impacts identified in this plan are not realized due to future design refinements, then the total area of aquatic mitigation constructed may be reduced.

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Table 6-15. Compensatory Mitigation Project Implementation Schedule[a]

Project Element	Mitigation Sites													
	Magnuson Park		Seward Park		Taylor Creek		S. Lake WA - DNR		Elliott Bridge Reach		Bear Creek		East Approach	
	Implementing Agency	Schedule	Implementing Agency	Schedule	Implementing Agency	Schedule	Implementing Agency	Schedule	Implementing Agency	Schedule	Implementing Agency	Schedule	Implementing Agency	Schedule
Pre-Design	WSDOT	2011-2012	WSDOT	2010-2011	WSDOT/SPU	2010-2011	DNR	2010-2011	WSDOT[d]	2011	City of Redmond	2010	WSDOT	2011
Technical Studies	Seattle Parks	2013-2014	WSDOT	2013-2014	SPU	2011	DNR	2010-2011	WSDOT[d]	2011-2012	City of Redmond	2010-2011	WSDOT	2011-2012
Design and Permitting	Seattle Parks	2014-2015	WSDOT	2014-2015	SPU	2012-2013	DNR	2011	WSDOT[d]	2011-2012	City of Redmond	2011-2012	WSDOT	2011-2012
Construction	Seattle Parks	2016-2017	WSDOT	2016-2017	SPU	2014-2015	DNR	2012-2013	WSDOT[d]	2014-2015	City of Redmond	2012-2014	WSDOT	2014
Monitoring and Maintenance	WSDOT	2017-2027	WSDOT	2017-2027	WSDOT	2015-2025	WSDOT	2013-2023	WSDOT[d]	2015-2025	WSDOT	2014-2024	WSDOT	2014-2019
Long-Term Management	Seattle Parks	NA	Seattle Parks	NA	SPU[a]	NA	DNR	NA	King County	NA	City of Redmond	NA	WSDOT	NA
Protection Mechanism	Conservation Easement[c]		Conservation Easement[c]		Conservation Easement[c]		Conservation Easement[c]		MOA		MOA		WSDOT Ownership	

[a] Implementation schedule and agency responsibilities are subject to change.
[b] Ownership will be transferred to the Seattle Parks Department in 2012.
[c] Conservation Easement or other suitable mechanism for legal protection.
[d] Implementation roles between WSDOT and King County to be determined.

Table 6-16. Project Element and Aquatic Mitigation Site Construction Schedule

Design Phase Schedule [a]		Permanent Impacts and Mitigation						Temporary Impacts and Mitigation				
				Mitigation Site Construction						Mitigation Site Construction		
Year	Phase Complete [b]	Cumulative Permanent Impacts (acres)	Cumulative Permanent Mitigation (acres)	S. Lake WA - DNR	Bear Creek	East Approach	Elliott Bridge Reach	Cumulative Temporary Impacts (acre-years)	Cumulative Temporary Mitigation (acre-years)	Taylor Creek	Magnuson Park	Seward Park
2012		N/A	0	x	x			N/A	0			
2013		N/A	1.75	x	x			N/A	0			
2014		N/A	6.90		x	x	x	N/A	0	x		
2015	FB&L	1.99	8.56				x	0.65	5.2	x		
2016		1.99	8.56					0.65	5.2		x	x
2017	WAB	4.85	8.56					12.31	38.68		x	x
2018 [c]	PBB/MBB	7.43	8.56					16.87	38.68			

[a] Design phase as shown in Figure 2-5, Project Delivery Shedule
[b] Expected completion of construction for the stated phase.
[c] Year denotes the scheduled completion of construction; does not correspond to impacts occurring in 2018.

Note: FB&L = Floating Bridge and Landings, WAB = West Approach, PBB = Portage Bay Bridge, MBB = Montlake Bascule Bridge