UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, Washington 98115

Refer to NMFS Tracking No.: 2010/05723

May 20, 2011

Daniel M Mathis
Federal Highway Administration
Suite 501, Evergreen Plaza
711 South Capitol Way
Olympia, Washington 98501-1284

Re: Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the SR 520 Bridge Replacement Project, (Cedar River, HUC 171100120302), King County, Washington

Dear Mr. Mathis: Dan

The enclosed document contains a Biological Opinion (Opinion) prepared by the National Marine Fisheries Service (NMFS) pursuant to section 7(a)(2) of the Endangered Species Act (ESA) on the effects of the project referenced above. In this Opinion, the NMFS concludes that the proposed action is not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon or PS steelhead and is not likely to destroy or adversely modify PS Chinook salmon critical habitat.

As required by section 7 of the ESA, the NMFS provides an incidental take statement with the Opinion. The incidental take statement describes a reasonable and prudent measure that is necessary to minimize incidental take. The take statement sets forth nondiscretionary terms and conditions. Incidental take from actions that meet these terms and conditions will be exempt from the ESA take prohibition.

This document also includes a description of the action's likely effects on Essential Fish Habitat pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and includes 11 conservation recommendations, which are a subset of the ESA Terms and Conditions. Federal agencies are required to provide a detailed written response to NMFS' EFH conservation recommendations within 30 days of receipt of these recommendations [50 CFR 600.920(j)(1)].

The response must include a description of measures proposed to avoid, mitigate, or offset the adverse affects that the activity has on EFH. If the response is inconsistent with the EFH conservation recommendations, the response must explain the reasons for not following the recommendations, including the scientific justification for any disagreements over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects.

If you have questions regarding this consultation, please contact Michael Grady of the Washington State Habitat Office at (206) 526-4645, or by electronic mail at Michael.Grady@noaa.gov.

Sincerely,

for William W. Stelle, Jr.
Regional Administrator

Enclosure

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F/NWR/2010/05723

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion, Section 7(a)(2) "Not Likely to Adversely Affect" Determination, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation

SR 520 Bridge Replacement Project

NMFS Consultation Number: 2010/05723

Action Agency: Federal Highway Administration

Affected Species and Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Puget Sound steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	N/A
Puget Sound Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
yelloweye rockfish (*Sebastes ruberrimus*)	Threatened	No	No	N/A
canary rockfish (*S. pinniger*)	Threatened	No	No	N/A
bocaccio (*S. paucispinis*)	Endangered	No	No	N/A
Southern Resident killer whales (*Orcinus orca*).	Endangered	No	No	No

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, Northwest Region

Issued By:

for William W. Stelle, Jr.
Regional Administrator

Date: May 20, 2011

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1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The biological opinion (opinion) and incidental take statement portions of this document were prepared by the National Marine Fisheries Service (NMFS) in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531, et seq.), and implementing regulations at 50 CFR 402. The NMFS also completed an Essential Fish Habitat (EFH) consultation. It was prepared in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801, et seq.) and implementing regulations at 50 CFR 600. The opinion and EFH conservation recommendations are both in compliance with section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-5444) ("Data Quality Act") and underwent pre-dissemination review.

1.2 Consultation History

Since May 2007, the Washington State Department of Transportation (WSDOT) and the Federal Highway Administration (FHWA), the U.S. Fish and Wildlife Service (USFWS) and NMFS, other regulatory agencies, and the Muckleshoot Indian Tribe Fisheries Division (MITFD) have been participating in a resource agency coordination process on the proposed action. The goal of the coordination was to facilitate collaboration with regulatory agencies and the MITFD as the project progresses through National Environmental Policy Act (NEPA) and State Environmental Policy Act (SEPA) documentation, ESA consultation, project design, and permitting.

In July 2007, WSDOT, FHWA, USFWS, and NMFS began participating in biweekly meetings of the ESA Steering Group. The intent of the Steering Group is to discuss and attempt to resolve technical issues related to the State Route (SR) 520 Bridge Replacement Project and its effects on listed species and designated critical habitats. On December 7, 2010, the FHWA submitted a biological assessment (BA) to the NMFS for the SR 520 Bridge Replacement Project and requested consultations under both the ESA and MSA. The proposed project will be carried out by the WSDOT and will be partially funded by the FHWA. This opinion is based on information provided in the December 7, 2010 BA and information WSDOT and FHWA provided to NMFS between May 2007 and April 2011. A complete record of this consultation is on file at Washington State Habitat Office in Lacey, Washington.

Table 1. FHWA ESA Determinations[1]

Species	Federal Status	Species Determination	Critical Habitat Determination	Listing/ Designation Date
Puget Sound Chinook salmon (*Oncorhynchus tshawytscha)*	Threatened	LAA[2]	LAA	Jun. 28, 2005 70 FR 37160/ Sept. 2, 2005 70 FR 52630
Puget Sound steelhead (*Oncorhynchus mykiss*)	Threatened	LAA	Not applicable	Jun. 11, 2007 72 FR 26722
Puget Sound/Georgia Basin DPS boccacio (*Sebastes paucispinis*)	Endangered	NLAA[3]	Not applicable	Apr. 28, 2010, 75 FR 22276
Puget Sound/Georgia Basin DPS canary rockfish (*S. pinniger*)	Threatened	NLAA	Not applicable	Apr. 28, 2010, 75 FR 22276
Puget Sound/Georgia Basin DPS yelloweye rockfish (*S. ruberrimus*)	Threatened	NLAA	Not applicable	Apr. 28, 2010, 75 FR 22276
southern resident killer whale (*Orcinus orca*)	Endangered	NLAA	NLAA	Nov. 18, 2005, 70 FR 69903/ Nov. 29, 2006 71 FR 69054

[1] The NMFS agreed with these determinations and initiated consultation accordingly.
[2] LAA = likely to adversely affect
[3] NLAA = not likely to adversely affect

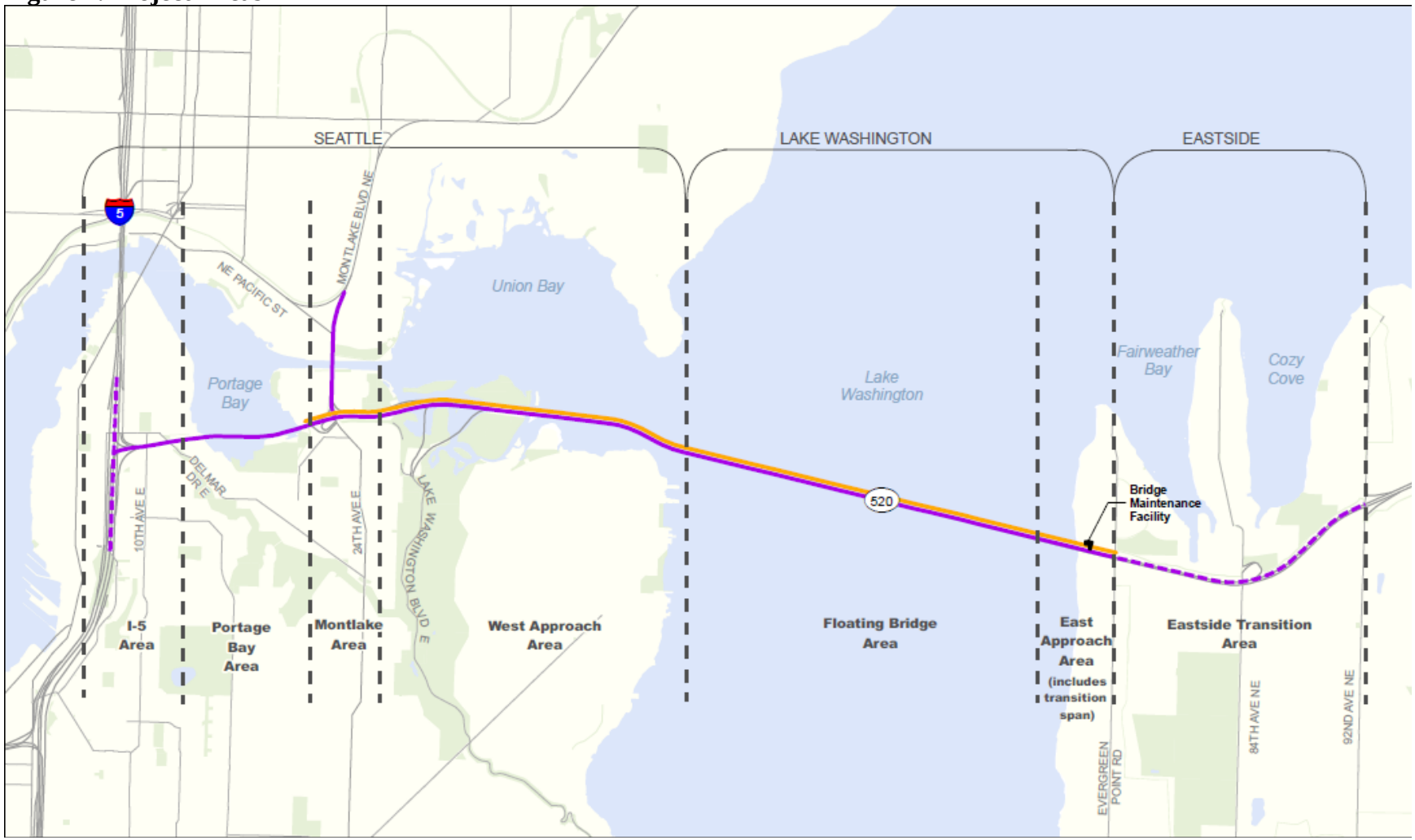
1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration.

The SR 520 Bridge Replacement Project will widen SR 520 from four lanes to six (two general purpose lanes and one high occupancy vehicle (HOV) lane in each direction) from Interstate 5 (I-5) in Seattle to Evergreen Point Road in the City of Medina (WSDOT 2010). The proposed action includes the construction of pontoons in Commencement Bay and the Port of Olympia, the transport of already-constructed pontoons from Grays Harbor and Puget Sound to Lake Washington, the outfitting of pontoons in Puget Sound, the widening of SR 520 between I-5 and

Medina (which includes the construction bridges across Portage Bay, Union Bay, and Lake Washington), and habitat improvement projects.

Figure 1. Project Areas



1.3.1 Pontoon Construction

The new floating bridge will have a total of 77 pontoons (21 longitudinal pontoons, two cross pontoons, and 54 supplemental stability pontoons (SSPs). WSDOT will construct the longitudinal and cross pontoons and 10 SSPs (33 total) as part of the separate Pontoon Construction Project (NMFS tracking number: 2010/0331) to replace the existing bridge in the event of an emergency. WSDOT will moor these pontoons in Grays Harbor, and, if the Evergreen Point Bridge does not fail, WSDOT will use those pontoons to construct the new, six-lane floating bridge.

The WSDOT will construct the other 44 supplemental stability pontoons at existing facilities in the Port of Tacoma (23 SSPs) and the Port of Olympia (21 SSPs) between August 2012 and February 2014. Fifty-eight precast gravity and fluke anchors for the floating bridge will also be fabricated at these facilities.

1.3.1.1 Port of Olympia Facility

The Port of Olympia site is on the West Bay of Budd Inlet in Thurston County, WA. WSDOT will construct the 21 SSPs on upland concrete slabs (casting beds). Piles will support the casting beds. Once a pontoon is cured, WSDOT will either move it to an upland storage facility or load it onto a barge. Onsite stormwater facilities and temporary construction stormwater best management practices (BMPs) will treat stormwater and construction process water to prevent any water quality degradation to Puget Sound.

1.3.1.2 Port of Tacoma

The Port of Tacoma site is on Blair Waterway, an inlet of Commencement Bay. The Concrete Technology Corporation (CTC) facility can build five SSPs at a time. WSDOT will cast SSPs on casting beds similar to those described for the Port of Olympia site and within the CTC casting basin. WSDOT will launch all of these SSPs through the CTC casting basin. After a cycle of pontoons is completed, the gate is removed, and the basin floods to allow the pontoons to float. After tug boats remove the pontoons, they will return the gates to their original position. Seawater is then allowed to drain with the ebbing tide through three ports. Pumps will then remove the remainder of the water. WSDOT will follow NMFS-approved, WSDOT fish handling protocols to remove any fish trapped to the maximum extent practical (WSDOT 2009a).

Before the first set of pontoons is constructed and after the construction of each cycle of pontoon is completed, the basin will be thoroughly cleaned (pressure washed) to prevent delivery of contaminants to the Blair Waterway. The constructed pontoons will also be pressure washed within the casting basin before transport. WSDOT estimates 10 CTC gate openings to launch the 23 SSPs between August 2012 and June 2014. WSDOT will not need to outfit the SSPs, so they will tow them directly to Lake Washington. Any anchors that WSDOT constructs at this site will not require any gate openings.

1.3.1.3 Pontoon Outfitting and Moorage

The WSDOT will outfit the longitudinal and cross pontoons at existing commercial shipping or mooring facilities in Puget Sound and in the SR 520 right-of-way in Lake Washington. Potential locations include the Ports of Bellingham, Everett, Seattle, Tacoma, Olympia, and Grays Harbor. Outfitting of pontoons could take up to 4 months in these port locations. At most, seven pontoons will be moored simultaneously. WSDOT will temporarily moor pontoons in Puget Sound at existing facilities used for mooring large vessels. Once outfitting construction is completed, WSDOT will tow the pontoons into Lake Washington.

The tow from Grays Harbor to Lake Washington is 250 nautical miles. The tug boats will travel at slow speeds, and each trip will take approximately 76 hours (including 27 hours in the open ocean). Pontoons towed from the CTC site or the Port of Olympia site will follow shipping lanes to Lake Washington. WSDOT will transport pontoons between August 2012 and August 2014.

1.3.2 Roadway and Bridge Construction

The roadway portion of the proposed action will reconstruct SR 520 from I-5 to the City of Medina. From west to east (Seattle to Medina) the project includes the following elements:

- I-5 interchange area
- Portage Bay Bridge (PBB)
- Montlake
- West approach
- Floating bridge
- East approach and maintenance facility

WSDOT will use drilled shafts for the foundations of all in-water columns and footings. To construct these shafts, WSDOT will lower a casing pipe to the substrate and vibrate it down leaving the top above the waterline. After the casing has been installed, a crane-mounted auger will drill the shaft. It may be necessary to fill the casings with a bentonite (clay) slurry to support the walls of the boring hole. WSDOT will contain the boring spoils, including any bentonite slurry, and transport it off site by barge or load it into dump trucks for hauling to a disposal site. After excavating the shaft, they will lower a reinforcing steel shaft cage and pump concrete into the casing, displacing the water or slurry. WSDOT will contain, collect, and treat the water or slurry prior to reuse or disposal. The casing pipe will remain and form the top of the shaft.

1.3.2.1 Interstate 5 Interchange

Activities in this area include roadway reconstruction, excavation and embankment grading, retaining wall and abutment construction, and paving. None of the work in this area will take place in-water. Existing PGIS measures 16.70 acres in this area. The project will add 0.05 acres

of PGIS for a total of 16.75 acres. WSDOT will construct a bioswale to treat stormwater from four acres of PGIS from this area. The bioswale will direct stormwater to Lake Union via the City of Seattle's East Allison Street outfall. This outfall also carries untreated stormwater from City of Seattle PGIS outside of the action area.

1.3.2.2 Portage Bay Bridge (PBB)

The WSDOT will replace the existing PBB with a wider structure for the two general purpose lanes and an HOV lane in each direction (six lanes total). The new bridge will have larger but fewer columns than the existing bridge. It will begin just east of Delmar Drive, extend across Portage Bay to Montlake Boulevard. To accommodate four lanes of traffic for the duration of the project, WSDOT will temporarily widen the existing PBB to the south.

The bridge will range between 105 and 143 feet wide compared to the 61- to 75-foot-wide existing bridge. The maximum over-water height of the western half of the new bridge will increase from 55 feet to approximately 62 feet, and the height of the eastern half will increase from 5 to 16 feet. Total over-water cover resulting from the Portage Bay Bridge will be approximately 4.5 acres. This is an increase of approximately 1.4 acres from the existing condition.

This portion of the action area contains 9.81 acres of existing PGIS. The project will add 2.19 acres of PGIS for a total of 12.00 acres. WSDOT will construct two stormwater treatment facilities, a bioswale and a constructed wetland, to treat stormwater from 11.64 acres of PGIS from this area. These BMPs will direct stormwater to two existing outfalls to Portage Bay, PB 1 and PB 2. The PB 1 outfall discharges near the west shore of Portage Bay and PB 2 near the east shore.

The WSDOT will construct mudline footings for three bents (a row of columns) on the west side of Portage Bay. Mudline footings are rectangular concrete blocks embedded into the lake bed and supported by 10 drilled shafts. The footings tie the multiple shafts together and distribute the load from the columns. These three footings will occupy approximately 12,500 square feet (0.3 acre) of substrate.

Fifty in-water columns (ranging in size from seven by seven feet to seven by 10 feet) will support the PBB. The columns will be either on top of a mudline footing or directly on top of a drilled shaft. Each of the three mudline footings will support five columns extending from the top of the footing to the bottom of the superstructure. The remaining 35 columns will be supported by individual drilled shafts. Eighty-two, seven-foot diameter drilled shafts will support the columns and footings of the new PBB. Sixty-five of these shafts will be in-water. To isolate the drilled shaft construction from the water, WSDOT will construct the drilled shafts within a casing pipe or within cofferdams.

The WSDOT will construct work bridges along the outer edge of the north and south sides of the proposed structure. The work bridges will not exceed 4.1 acres (1.9 acres over open water). Approximately 900, 24- to 30-inch steel piles will support the work bridges.

The WSDOT will temporarily widen the existing bridge to the south. Traffic will use this widened section during construction of the northern half of the new bridge. Following construction, traffic will be shifted to the newly constructed northern half of the new bridge to allow demolition of the existing and temporary south bridge lanes and the construction of the new southern half of the PBB.

Construction activities for the PBB will occur over a 5- to 6-year period. The following is an estimate of when, during this period, the various elements will be constructed. However, some activities may occur in different construction years than described below if construction progresses faster or slower than WSDOT's current estimates. All in-water work will occur within the windows described below. These windows are designed to minimize impacts to PS Chinook, PS steelhead, and other aquatic resources.

1.3.2.2.1 Portage Bay Bridge Construction Year 1 (2013-14). During the first construction year, WSDOT will construct work bridges along the south and north sides of the existing PBB. WSDOT will drive the 900 steel piles at a rate of approximately 16 piles per day to construct the work bridges. WSDOT will drive theses piles using both vibratory and impact hammers between September 1 and April 30. Vibratory driving will be used for the initial stages of pile driving, finishing with impact driving to achieve adequate load-bearing capacities. WSDOT will use a bubble curtain to attenuate underwater sound during all impact driving.

Once the work bridges are complete, WSDOT will build the temporary bridge south of the existing bridge. Approximately 42 temporary 8-foot-diameter drilled shafts will support the columns of the temporary bridge. The vibratory driving of the casing pipes will occur between August 16 and April 30. Work within the casings will take place throughout this construction year.

1.3.2.2.2 Portage Bay Bridge Construction Year 2 (2014-15). After traffic shifts to the temporary widening, WSDOT will demolish the northern portion of the existing PBB, beginning with the removal of the superstructure and the in-water vibratory removal (or cutting) of approximately 44 to 45 columns (roughly half the existing columns).

Construction of the new north substructure will follow the progression of demolition. WSDOT will construct three mudline footings supported by 18 drilled shafts for the three western most in-water bents. Three cofferdams will isolate the mudline footing construction from the water. The cofferdams will occupy approximately 8,200 square feet of substrate for the one year period they remain in place. WSDOT will construct the cofferdams by vibrating interlocking sheet piles 20 feet into the substrate. After completion of the cofferdam, they will remove any trapped fish using NMFS-approved, WSDOT fish handling protocols to the maximum extent practical (WSDOT 2009a). The area within the cofferdam will then be excavated below the existing mudline with a clamshell bucket, sealed with concrete, and dewatered. All excavated soils will be transferred into dump trucks on the work bridge or contained on work barges and hauled off site for disposal. The water coming out of the cofferdam will be treated before being discharged. Appropriate BMPs, such as containment tarps, will prevent excavated material from entering the water.

In addition to the mudline footings, WSDOT will construct 21 in-water drilled shafts within casing pipes to support individual columns for the northern half of the new bridge. The installation of the pipe casings and construction of the drilled shafts (within both the pipe casings and cofferdams) will follow the same construction procedures described for Construction Year 1. Installation of the cofferdams and pipe casings will take place between August 16 and April 30.

As elements of the substructure are completed, construction of the superstructure can begin. WSDOT will construct falsework from the work bridges to support concrete forms for the superstructure. Two hundred additional piles will support the falsework. WDSOT will drive these piles between September 1 and April 30. Once the falsework and concrete forms are completed, the cast-in-place girders and false arches will be poured.

1.3.2.2.3 Portage Bay Bridge Construction Year 3 (2015-16). In the third construction year, WSDOT will shift traffic to the new northern half of the bridge and will demolish the southern half of the existing bridge (including the temporary widening) using the same demolition methods described above.

1.3.2.2.4 Portage Bay Bridge Construction Year 4 (2016-17). Construction of the southern half of the substructure will begin in construction year 4. WSDOT will construct three mudline footings supported by 12 drilled shafts for the three western-most in-water bents. Three cofferdams will isolate the mudline footing construction from the water. The cofferdams will occupy approximately 5,500 square feet of substrate. In addition to the mudline footings, WSDOT will construct 14 in-water drilled shafts within casing pipes to support individual columns for the new bridge. Construction of the pipe casings, cofferdams, and drilled shafts will follow the same construction procedures described for Construction Years 1 and 2, and as in previous years, installation of the cofferdams and pipe casings will take place between August 16 and April 30.

When the arches are completed, the north work bridge and falsework will be removed. This work will consist of vibratory removal of 650 piles.

1.3.2.2.5 Portage Bay Bridge Construction Year 5 (2017-18). During construction year 5, as construction of the southern half of the substructure progresses, construction of the southern half of the superstructure will begin. This will require the installation of 200 additional falsework piles using the same methods described above.

1.3.2.2.6 Portage Bay Bridge Construction Year 6 (2018-19). During construction year 6 (the final construction year), WSDOT will complete the southern half of the superstructure and false arch. Construction year 6 will also include stormwater routing, bridge lighting, and roadway striping. The south work bridge and falsework will be dismantled, including the remaining 650 piles; and site cleanup and demobilization will conclude the construction activities.

1.3.2.3 Montlake Interchange

The WSDOT will widen the Montlake interchange to the north to accommodate a shift in the alignment of the highway and ramps. They will also demolish the Montlake Boulevard and 24th

Avenue East overpasses and replace them with a lid, and construct a new bascule bridge over the Montlake Cut. Construction will occur over about a 4-year period and will include roadway reconstruction, excavation, retaining wall and abutment construction, and paving. Most of these construction activities will occur in upland areas and will not affect aquatic habitats. Staging areas include portions of a parking lot on the University of Washington campus, the unused R.H. Thomson Expressway ramps, the closed Lake Washington Boulevard ramps, and WSDOT right-of-way adjacent to SR 520.

This part of the action area has 0.21 acre of existing PGIS. The project will add 0.20 acre of PGIS for a total of 0.41 acre. WSDOT will route stormwater from this area to the combined sewer system. The West Point Wastewater Treatment Plant treats water from the combined sewer system and discharges it to Puget Sound. The existing Montlake Cut Bascule Bridge does not currently collect any water for treatment because the deck is steel grating. The proposed second bascule bridge will also have a steel-grated deck and will not collect stormwater.

The WSDOT will construct a new bascule bridge over the Montlake Cut, east of the existing bascule bridge. The bottom of the arched bridge will be approximately 35 feet above the water near the piers and approximately 46 feet above the water at mid-span. The new bridge will be approximately 60 feet wide and 150 feet long. Total over-water cover will be approximately 0.2 acre.

The construction will be staged from the shoreline. Except for the temporary use of barges to install the bridge leaves, no in-water construction will be necessary. Upland cofferdams will isolate pier construction from the water. After completing the upland pier supports, the bridge leaves will be attached to the piers. A barge-mounted derrick will lift the leaves into position. The barge work will require closing the Montlake Cut to boat traffic periodically over a 3- to 4-week period for less than 48 hours at a time.

1.3.2.4 West Approach

The existing west approach will be replaced by two new bridges, eastbound and westbound, with a gap between them. The west approach will begin in Montlake and extend through Union Bay, across Foster Island, and out into Lake Washington, terminating at the beginning of the floating bridge.

This part of the action area contains 12.60 acres of existing PGIS (SR 520). The project will add 8.71 acres of PGIS for a total of 21.31 acres. WSDOT will direct stormwater from this area to a constructed wetland on the site currently occupied by the Museum of History and Industry (MOHAI). The constructed wetland will provide enhanced treatment which targets dissolved metals. Stormwater from this facility will discharge into Union Bay south of the Montlake cut.

The supports for the west approach bridges will be concrete columns on individual drilled shafts (no mudline footings). The superstructure will consist of precast-concrete girders (which will not require falsework) and the roadway deck. The spans of the new bridges will be longer than those of the existing bridge (i.e., the piers will be farther apart). The increase in span length will result in fewer in-water columns. Overall, the width of the new west approach will range

between 252 feet near Montlake to 112 feet at the west transition span, with a gap width ranging between 7 and 40 feet. The width of the existing west approach varies between 57 and 104 feet. The height of the bridge over water will increase from a minimum of less than 3 feet to about 12 feet near Montlake and from 45 to 48 feet near the west transition span. Total over-water cover resulting from the west approach structure will be approximately 19 acres: 8.4 acres in Union Bay and 10.6 acres in Lake Washington. This represents an increase of 2.5 acres of over-water cover in Union Bay and 5.8 acres in Lake Washington.

Forty-two bents, 39 in-water and three bents on Foster Island will support the west approach. Most span lengths will be 150 feet. Of the 254, 10-foot-diameter shafts supporting the west approach, 233 will occur in the water. The Union Bay section (Arboretum and Foster Island) will consist of 104 in-water shafts, and the Lake Washington section (east of Foster Island) will consist of 129 in-water shafts. Construction will include a temporary work bridges and construction barges.

Like the PBB, the west approach will require work bridges. The northern portion of the new west approach will be constructed first, with traffic diverted to this structure, while the existing west approach bridge is demolished and construction of the southern half of the new west approach begins. Construction activities in this area will occur over a 5- to 6-year period. As with the PBB, some activities may occur in different construction years than described below, and all in-water work will occur within the windows described below to minimize impacts to PS Chinook, PS steelhead, and other aquatic resources.

1.3.2.4.1 West Approach Construction Year 1 (2013-14). In the first construction year, WSDOT will construct work bridges and finger piers along the north side of the existing bridges. The work bridges will require driving 500 steel 24- to 30-inch piles in Union Bay (Arboretum and Foster Island) and 450 in Lake Washington (east of Foster Island). WSDOT will drive theses piles using the same methods described above between October 1 and April 30. WSDOT will use a bubble curtain to attenuate under water sound during all impact driving. The north work bridges will cover approximately seven acres. They will span from Montlake to Foster Island, and extend approximately 1,700 feet out into Lake Washington, to roughly the 10-foot depth.

Construction on the northern half of the bridge substructure will then begin in Union Bay (Arboretum and Foster Island) and Lake Washington (east of Foster Island). To maintain traffic flow, an interim connection between the new floating span (see the following discussion of construction year 2) and the existing west approach span will then be completed in Lake Washington. WSDOT will construct 84 drilled shafts, 60 in Union Bay and 24 in Lake Washington between, August 1 and March 31. The construction methods will be the same as those described for the PBB drilled shafts. WSDOT will construct the 24 shafts in Lake Washington from barges.

1.3.2.4.2 West Approach Construction Year 2 (2014-15). The WSDOT will continue the construction of the west approach north substructure in Lake Washington in the second construction year, including constructing another 72 drilled shafts. After WSDOT completes the substructure elements, they will begin construction of the northern half of the west approach

superstructure. The superstructure will be constructed from both the north work bridges and barges. The superstructure completed in this year will measure 5.1 acres in Union Bay and 7.5 in Lake Washington. WSDOT will drive 400 piles in Union Bay (with the same pile type and driving methods describe previously) to construct the south work bridge in Union Bay. The south work bridge will add an additional 4.3 acres of over-water cover.

1.3.2.4.3 West Approach Construction Year 3 (2015-16). After traffic switches to the interim connection, WSDOT will begin demolishing the east end of the existing west approach bridge from barges. The demolition will include removing the superstructure and 80 columns in Lake Washington and 89 columns in Union Bay. Construction will also include the southern work bridge, which will involve the driving of 1,100 steel piles and the addition of 7.6 acres of additional overwater shade (500 piles and 3.3 acres of shade in Lake Washington and 600 piles and 4.3 acres of shade in Union Bay). As work bridge construction advances in Union Bay, WSDOT will demolish the existing Lake Washington Boulevard ramps, including the removal or cutting of 89 in-water columns.

As the south work bridges are completed, WSDOT will begin the construction of the drilled shafts for the south half of the substructure (44 drilled shafts in Union Bay and 42 in Lake Washington). WSDOT will build the shafts and columns (10 piers) east of the work bridge (water depths greater than 10 feet) from barges.

1.3.2.4.4 West Approach Construction Year 4 (2016-17). In the fourth construction year, traffic will shift to the northern portion of the bridge and WSDOT will complete the demolition of the existing Union Bay Bridge, west-approach bridge, and the interim west approach connection. The demolition will include the removal of 170 columns. WSDOT will also dismantle the north work bridges in this year (including removing the 500 steel piles) and begin construction of the southern half of the superstructure.

1.3.2.4.5 West Approach Construction Year 5 (2017-18). The WSDOT will continue construction of the southern half of the superstructure this construction year and dismantle a portion of the north work bridge including removing 450 piles.

1.3.2.4.6 West Approach Construction Year 6 (2018-19). The WSDOT will complete construction of the southern half of the superstructure this construction year and dismantle the rest of the north work bridge, including removing 500 piles. The final stage of construction will be site cleanup and equipment demobilization.

1.3.2.5 Floating Bridge

The new floating span will be between 190 and 160 feet north of the existing bridge. The new six-lane floating bridge will consist of a single row of 21 longitudinal pontoons, 2 cross pontoons (one at each end of the floating bridge), and 54 supplemental stability pontoons. The new pontoons will have a deeper draft than the existing pontoons. New longitudinal pontoons will extend between 22 and 28 feet below the surface of the water, compared to the existing pontoons, which extend 7 to 14.5 feet below the water surface. The two cross pontoons will extend deeper (about 34 feet below the surface). The new, larger longitudinal pontoons and the

supplemental stability pontoons will accommodate the wider highway. The over-water area from the pontoons will increase from 10.8 acres to 19.9 acres. The roadway will extend beyond the width of the pontoons and will add an additional 0.9 acre of over-water cover for a total of 20.8 acres.

The existing floating bridge contains 17.28 acres of existing PGIS. The new bridge will have 20.56 acres of PGIS, an increase of 3.28 acres. The existing bridge does not have any stormwater treatment. WSDOT will treat stormwater on the new bridge using monthly high-efficiency sweeping, modified catch basins, and spill control lagoons. High-efficiency sweeping will be a broom sweeper followed by a regenerative air sweeper. The modified catch basins are larger than standard catch basin structures. The catch basins will direct stormwater to spill control lagoons built into the supplemental stability pontoons. Forty-four of the 54 supplemental stability pontoons will have 19- by 29-foot spill control lagoons in the center of the pontoons. Stormwater will mix with water in the spill control lagoons and dilute prior to flowing into Lake Washington.

As with the existing floating bridge, the pontoons for the new bridge will be anchored to the lake bottom. The new bridge will have 58 anchors, 45 fluke anchors and 13 gravity anchors. WSDOT will install the pontoons over a 3-year period, beginning in 2012 and ending in early 2015. Once traffic shifts to the new floating bridge, the existing floating bridge will be dismantled and the pontoon sections towed away. The old pontoon sections could be sold for other purposes or hauled to an existing facility for demolition and recycling.

1.3.2.6 East Approach and Bridge Maintenance Facility

The WSDOT will replace the existing east approach span with a higher and wider structure spanning from the east end of the floating bridge to the bluff on the Medina shoreline. Like the PBB, the east approach substructure will consist of drilled shafts, mudline footings, and concrete support columns. The superstructure will consist of cast-in-place concrete girders and the roadway deck. The combined width of the north and south structures will range from 134 to 152 feet, from west to east. The structure will be approximately 660 feet long.

The east approach will have five columns per bent. Bent one will be in-water, approximately 350 feet from the shoreline, and Pier two will be onshore. Each bent foundation will consist of ten 10-foot-diameter drilled shafts supporting two mudline footings. The in-water mudline footings for bent one will be 90 by 60 feet for the north bridge and 60 by 50 feet for the south bridge and together will occupy approximately 8,300 square feet of substrate. The two in-water footings will support a total of five rectangular bridge columns.

Existing PGIS measures 1.75 acres. The project will remove 0.05 acres of PGIS leaving a total of 1.70 acres. A bioswale will treat stormwater from this area and discharge it below the east approach bridge. NMFS previously consulted on the construction of the bioswale and the effects of the stormwater discharge for the SR 520 Eastside Transit and High Occupancy Vehicle Project (NMFS tracking number: 2009/03446).

The WSDOT will use falsework to support the concrete forms for the box girders. The new bridges will be 83 and 51 feet wide (north and south bridges, respectively) at the west end and 91 and 61 feet at the east end. The bottom of the bridge deck will range from 66 feet to 78 feet above the water. The over-water cover of the east approach will be 1.3 acres. This is an increase of one acre from existing conditions. WSDOT will construct the new east approach span between 2012 and 2015. Construction will take place from work bridges, barges, and land.

The WSDOT will construct a bridge maintenance facility underneath the east approach. The facility will include a maintenance building and a T-shaped dock for two work boats. The dock will extend 100 feet offshore and cover 1,500 square feet. WSDOT will remove two existing docks with a total area of 900 square feet resulting in a net increase of 600 square feet of over-water shading. Five drilled shafts and columns will support the dock. WSDOT will use a vibratory hammer to install 20 temporary piles to support the shaft drilling rig. As describe above, some activities may occur in different construction years than described below, and all in-water work will occur within the windows described below to minimize impacts to PS Chinook, PS steelhead, and other aquatic resources.

1.3.2.6.1 East Approach Construction Year 1 (2012-13). In the first construction year, WSDOT will construct the work bridges, finger piers, and falsework. WSDOT will drive 125, 24- to 30-inch steel piles to support these structures between August 16 and March 15. Construction methods for the work bridges will be the same as those for the PBB and west approach. The work bridges will cover 0.8 acre and extend 380 feet out into Lake Washington to a depth of 20 feet.

The WSDOT will construct the first bent by constructing 10 drilled shafts, then containing them within a cofferdam between September 1 and May 15. The cofferdam will cover 9,550 square feet of substrate. WSDOT will construct the two mudline footings for bent one within this cofferdam. After completing the mudline footings, WSDOT will construct the concrete support columns. WSDOT will also begin upland construction of the maintenance facility and the second bent during this construction year.

1.3.2.6.2 East Approach Construction Year 2 (2013-14). As the substructure construction continues, WSDOT will begin construction of the superstructure. Forty 24- to 30-inch steel piles will support the falsework for superstructure. WSDOT will drive these piles using vibratory and impact hammers between July 16 and March 15. WSDOT will complete the maintenance facility in this construction year.

1.3.2.6.3 East Approach Construction Year 3 (2014-15). In the third construction year, traffic will shift to the new east approach allowing WSDOT to demolish the existing east approach structure. The demolition will include removing 14 in-water columns. With the completion of the new superstructure and demolition of the existing structure, the work bridges and falsework will be dismantled and the 165 piles removed. The third construction year marks the final year for construction in the east approach area. The final stage of construction will consist of site cleanup and demobilization.

1.3.2.7 Lighting

Currently, SR 520 has lighting across the entire bridge. The new bridge will reduce the amount of light spillage to Lake Washington. Similar to the current roadway, the new SR 520 will have continuous lighting from I-5 to Foster Island and on both bridges crossing the Montlake Cut. Except for the interim west approach connection, no roadway lighting is proposed for the fixed portions of the bridge east of Foster Island. The east approach will have six lights to illuminate a transit merge point. Recessed lighting will illuminate the proposed bicycle and pedestrian path along the west approach and the new floating bridge. This will prevent walkway lighting from reaching the lake surface. WSDOT will shield the lights from I-5 to Foster Island and the east approach to minimize light spillage to aquatic habitat. WSDOT will also use construction lighting during construction activities. To the maximum extent practical, WSDOT will shield construction lights and direct them away from the water.

1.3.2.8 Habitat Projects

1.3.2.8.1 Washington Department of Natural Resources Site (mouth of the Cedar River). This three-acre Washington Department of Natural Resources (WDNR) site is on the Lake Washington shoreline just east of the mouth of the Cedar River in the City of Renton. There is a sheet metal flume about 650 feet long between upland areas and the Lake. The flume provides habitat for predators, such as smallmouth bass. The primary habitat enhancement goal is to increase growth and survival of emigrating Chinook salmon fry from the Cedar River by improving nearshore habitat.

The WSDOT proposes to remove most of the existing flume and restore 630 feet of shoreline. The flume will be removed in pieces, likely with a barged crane or a vibratory pile rig. Once the flume has been disassembled and removed from the site, the shoreline grade will be adjusted to a constant, gentle slope. WSDOT will place fine-grained substrate and gravel on the shoreline, place large woody debris (LWD), remove nonnative plant species by physical means, and plant the site with native trees and shrubs.

1.3.2.8.2 Cedar River Site (King County). The purpose of this habitat project is to create side channels and restore floodplain function in order to improve spawn and rearing habitat for PS Chinook salmon, PS steelhead, and other anadromous fish. The 17-acre site is on the lower Cedar River at river mile (RM) 5.3 in unincorporated King County. There are levees along the north and south banks at this site, disconnecting it from the floodplain. The site includes 23 separate parcels, distributed on both sides of the river. King County has acquired most of the parcels at the mitigation site and has removed some of the buildings from these parcels.

The WSDOT proposes to purchase the remaining private properties, setback the levees, and restore the floodplain. They will remove all structures and impervious surfaces from the site. WSDOT will setback the levees by removing the existing levees (about 500 linear feet of levee on the right bank and about 400 linear feet on the left bank), then constructing new levees away from the river to protect adjacent properties. WSDOT will grade the area to mimic a natural floodplain and replant with native vegetation.

1.3.2.8.3 Taylor Creek (Seattle Public Utilities). Taylor Creek is in southeast Seattle. It enters Lake Washington 1.7 miles from the mouth of the Cedar River. WSDOT will restore the portion of the Creek between Rainier Avenue and Lake Washington. The goal of this habitat project is to improve rearing conditions for juvenile Chinook salmon both within the lower reach of Taylor Creek and its mouth in Lake Washington. Currently, the Creek flows through residential properties in a confined channel. Seattle Public Utilities has purchased these parcels. WSDOT will remove all the structures, utilities, underground storage tanks, a residential dock, channel armoring, and floodplain fill. WSDOT will reconstruct the channel with a meanders and LWD to create pool riffle morphology. They will also remove large cobble from the delta and plant native riparian vegetation throughout the site.

1.3.2.8.4 Seward Park (City of Seattle). Seward Park is on the western shore of Lake Washington, between the Cedar River and I-90, in the City of Seattle. The goal of this habitat project is to increase growth and survival of emigrating Chinook salmon from the Cedar River by improving nearshore habitat. There are three habitat sites in Seward Park. Site 1 is in the southern portion of the peninsula east of the parking lot. This segment is approximately 250 feet long and has a concrete bulkhead (2.5 feet high and 3 feet wide). WSDOT will remove the bulkhead, grade the bank, place gravel, and plant riparian vegetation.

Site 2 is in the northeastern portion of the peninsula. WSDOT proposes to remove approximately 250 feet of a riprap bulkhead, grade the shoreline, place gravel, and plant riparian vegetation. Site 3 is located in the northwestern portion of the peninsula. The sum of the two lengths of this segment is approximately 400 feet, and it has very little riparian vegetation. A previous restoration project at this site graded the shoreline and placed LWD. WSDOT proposes to plant a five- to 10-foot strip of riparian vegetation at this site.

1.3.2.8.5 Magnuson Park. The goal of this habitat project is to improve migrating and rearing conditions for juvenile Chinook salmon primarily from the north Lake Washington population. Magnuson Park is on the west shore of Lake Washington north of Union Bay. There are four habitat sites in Magnuson Park. Site 1 is a 50-foot wide and 200-foot long area of shoreline south of the boat launch. WSDOT will remove concrete/asphalt rubble, grade the bank, place gravel and LWD, and plant riparian vegetation. Site 2 is located north of the boat launch. WSDOT will remove a 250-foot section of bulkhead at this site.

Site 3 is a 450-foot section of shoreline north of the designated swimming area. Mitigation actions at this site will include shoreline vegetation planting and installation of LWD to increase fish cover. Magnuson Park project 4 is located at the north end of the Magnuson Park shoreline. This segment is 350 feet long with very little riparian vegetation. Actions at this site include bank sloping along the 100 feet of low bank, shoreline vegetation planting, and installation of LWD along the entire segment to increase fish cover.

1.3.2.8.6 Bear Creek. The NMFS consulted with the USACE on this City of Redmond project in 2009 (NMFS tracking number: 2009/04429; USACE permit number NWS-2009-242). WSDOT's SR 520 Program funded eighty percent of the restoration at this site. The project will realign Bear Creek from its confluence with the Sammamish River to 3,000 feet upstream and

will include 1,440 feet of off-channel habitat, 1,300 feet of pool habitat, and 3,000 pieces of LWD. The restoration will improve rearing habitat for PS Chinook salmon and PS steelhead.

1.3.2.9 High Efficiency Sweeping Study

The WSDOT will work with stormwater experts (including those at NMFS and the NOAA Northwest Fisheries Science Center) to develop a study that evaluates the potential benefits of using high efficiency sweepers in addition to traditional stormwater treatment. The purpose of the study is to determine if high efficiency sweeping (a broom sweeper followed by a regenerative air sweeper) reduces effluent loadings and concentrations of pollutants (total suspended solids and total and dissolved copper and zinc) beyond the reductions from traditional stormwater treatment methods.

The study will occur within the project limits of the SR 520 Bridge Replacement Project after construction is complete. FHWA may abandon the study if, after negotiations between WSDOT, FHWA and NOAA Fisheries, the agencies agree:

1. The actions of the study significantly damage the noise walls or barriers on SR 520; or
2. An experimental design cannot be developed for the Montlake Interchange; or
3. WSDOT's contribution to the study would exceed $100,000.

The final design for the study will be developed jointly with FHWA, WSDOT, and NOAA Fisheries (including the Northwest Fisheries Science Center) and will be completed by December 31, 2011.

1.4 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). Table 2 describes the action area for this project.

Table 2. Action Area

Area	Extent	Basis
Blair Waterway of Commencement Bay	CTC casting basin, approximately 1.8 acres	extent of fish handling
southern Portage Bay	within 150 feet of the existing and new bridges	extent of elevated suspended sediment
southern Union Bay	within 150 feet of the existing and new bridges	extent of elevated suspended sediment
Lake Washington	within 70 feet of the new floating bridge	extent of injurious levels of dissolved zinc from stormwater discharges
Lake Washington (eastern shore)	within 1,775 feet of the temporary work bridges and falsework for the east approach	extent of injurious levels of underwater sound
DNR Parcel (Lake Washington)	within 150 feet of the 630 linear feet of shoreline enhancement	extent of elevated suspended sediment
Cedar River (RM) 5.3	900 feet of shoreline and 300 feet downstream of the levee removal	extent of elevated suspended sediment
Taylor Creek	750 linear feet of Taylor Creek and Lake Washington within 150 feet of the confluence	extent of elevated suspended sediment
Seward Park (Lake Washington)	within 150 feet of the 900 linear feet of shoreline enhancement	extent of elevated suspended sediment
Magnuson Park (Lake Washington)	within 150 feet of the 1,250 linear feet of shoreline enhancement	extent of elevated suspended sediment

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat on which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with the United States Fish and Wildlife Service, NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Section 7(b)(3) requires that at the conclusion of consultation, the Service provide an opinion stating how the agencies' actions will affect listed species or their critical habitat. If incidental take is expected, Section 7(b)(4) requires the provision of an incidental take statement (ITS) specifying

the impact of any incidental taking, and including reasonable and prudent measures to minimize such impacts.

2.1 Introduction to the Biological Opinion

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species. The adverse modification analysis considers the impacts to the conservation value of the designated critical habitat.

"To jeopardize the continued existence of a listed species" means to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02). This biological opinion does not rely on the regulatory definition of 'destruction or adverse modification' of critical habitat at 50 C.F.R. 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[1]

We will use the following approach to determine whether the proposed action described in Section 1.3 is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- *Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action*. This section describes the current status of each listed species and its critical habitat relative to the conditions needed for recovery. For listed salmon and steelhead, NMFS has developed specific guidance for analyzing the status of the listed species' component populations in a "viable salmonid populations" (VSP) paper (McElhany et al. 2000). The VSP approach considers the abundance, productivity, spatial structure, and diversity of each population as part of the overall review of a species' status. For listed salmon and steelhead, the VSP criteria therefore encompass the species' "reproduction, numbers, or distribution" (50 CFR 402.02). In describing the range-wide status of listed species, we rely on viability assessments and criteria in technical recovery team documents and recovery plans, where available, that describe how VSP criteria are applied to specific populations, major population groups, and species. We determine the rangewide status of critical habitat by examining the condition of its physical or biological features (also called "primary constituent elements" or PCEs in some designations) - which were identified when the critical habitat was designated. Species and critical habitat status are discussed in Section 2.2.

- *Describe the environmental baseline for the proposed action*. The environmental baseline includes the past and present impacts of Federal, state, or private actions and other human activities *in the action area*. It includes the anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation and

[1] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

the impacts of state or private actions that are contemporaneous with the consultation in process. The environmental baseline is discussed in Section 2.3 of this opinion.

- *Analyze the effects of the proposed actions*. In this step, NMFS considers how the proposed action would affect the species' reproduction, numbers, and distribution or, in the case of salmon and steelhead, their VSP characteristics. NMFS also evaluates the proposed action's effects on critical habitat features. The effects of the action are described in Section 2.4 of this opinion.

- *Describe any cumulative effects.* Cumulative effects, as defined in NMFS' implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation. Cumulative effects are considered in Section 2.5 of this opinion.

- *Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.* In this step, NMFS adds the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5) to assess whether the action could reasonably be expected to: (1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 2.2). Integration and synthesis occurs in Section 2.6 of this opinion.

- *Reach jeopardy and adverse modification conclusions*. Conclusions regarding jeopardy and the destruction or adverse modification of critical habitat are presented in Section 2.7. These conclusions flow from the logic and rationale presented in the Integration and Synthesis section (2.6).

2.2 Rangewide Status of the Species and Critical Habitat

2.2.1 Relevance of Climate to Status

Salmon throughout Washington are likely affected by climate change. Several studies have revealed that climate change has the potential to affect ecosystems in nearly all tributaries throughout the state (Battin et al. 2007; ISAB 2007). While the intensity of effects will vary by region (ISAB 2007), climate change is generally expected to alter aquatic habitat (water yield, peak flows, and stream temperature). As climate change alters the structure and distribution of rainfall, snowpack, and glaciations, each factor will in turn alter riverine hydrographs. Given the increasing certainty that climate change is occurring and is accelerating (Battin et al. 2007), NMFS anticipates salmonid habitats will be affected. Climate and hydrology models project significant reductions in both total snow pack and low-elevation snow pack in the Pacific Northwest over the next 50 years (Mote and Salathe 2009). These changes will shrink the extent of the snowmelt-dominated habitat available to salmon. Such changes may restrict our ability to

conserve diverse salmon life histories, especially spring-run Chinook salmon.

In Washington State, most models project warmer air temperatures, increases in winter precipitation, and decreases in summer precipitation. Average temperatures in Washington State are likely to increase 0.1-0.6ºC per decade (Mote and Salathe 2009). Warmer air temperatures will lead to more precipitation falling as rain rather than snow. As the snow pack diminishes, seasonal hydrology will shift to more frequent and severe early large storms, changing stream flow timing and increasing peak river flows, which may limit salmon survival (Mantua et al. 2009). The largest driver of climate-induced decline in salmon populations is projected to be the impact of increased winter peak flows, which scour the streambed and destroy salmon eggs (Battin et al. 2007).

Higher water temperatures and lower spawning flows, together with increased magnitude of winter peak flows are all likely to increase salmon mortality. Higher ambient air temperatures will likely cause water temperatures to rise (ISAB 2007). Salmon and steelhead require cold water for spawning and incubation. As climate change progresses and stream temperatures warm, thermal refugia will be essential to persistence of many salmonid populations. Thermal refugia are important for providing salmon and steelhead with patches of suitable habitat while allowing them to undertake migrations through or to make foraging forays into areas with greater than optimal temperatures. To avoid waters above summer maximum temperatures, juvenile rearing may be increasingly found only in the confluence of colder tributaries or other areas of cold water refugia (Mantua et al. 2009).

Climate change is expected to make recovery targets for these salmon populations more difficult to achieve. Habitat action can address the adverse impacts of climate change on salmon. Examples include restoring connections to historical floodplains and freshwater and estuarine habitats to provide fish refugia and areas to store excess floodwaters, protecting and restoring riparian vegetation to ameliorate stream temperature increases, and purchasing or applying easements to lands that provide important cold water or refuge habitat (Battin et al. 2007; ISAB 2007).

2.2.2 Status of Species

2.2.2.1 Status of Puget Sound Chinook salmon

2.2.2.1.1 Listing, Spatial Structure, and Diversity. The PS Chinook salmon ESU encompasses all runs of Chinook salmon from the Elwha River in the Strait of Juan de Fuca eastward, including rivers and streams flowing into Hood Canal, Puget Sound, and the Strait of Georgia in Washington. Of an estimated 31 original populations, there are 22 extant geographically distinct populations (Good et al. 2005).

Long-term trends in abundance and median population growth rates for naturally spawning populations of PS Chinook salmon indicate that approximately half of the populations are declining and the other half are increasing in abundance. Eight of the 22 populations are declining over the short term, and 11 or 12 populations are experiencing long-term declines (Good et al. 2005). Factors contributing to the downward trends are widespread blockages of

streams, degraded freshwater and marine habitat, poor forest practices in upper river tributaries, and urbanization and agriculture in lower tributaries and main stem rivers. Hatchery production and release of PS Chinook salmon are widespread, and more than half of the recent total escapement returned to hatcheries.

2.2.2.1.2 Life History. Generally, PS Chinook salmon adults spawn in freshwater rivers and large streams at elevations above the floodplain. The eggs are deposited in gravel that has well oxygenated water percolating through it (Healey 1991). The eggs over-winter and hatch in the gravel to become juveniles with a yolk-sac. At about the time the yolk sac is absorbed, the juveniles emerge from the gravel and begin to forage on their own. The juveniles forage and move downstream into estuaries where they continue to forage before moving into the North Pacific Ocean where they reside for one to six years (Healey 1991).

There are two typical life history strategies known as stream type and ocean type (Healey 1991; Myers et al. 1998). Timing of adult returns is dependent on the life history type. Stream type individuals are commonly called spring-run Chinook salmon since adults with this life history migrate into near shore waters and return to natal streams in spring to early summer. The ocean type life history is commonly called the fall-run PS Chinook salmon since most of the adults move to their natal streams in late summer and early fall. Fall-run PS Chinook salmon spawn in late September through October (Healey 1991). Most PS Chinook salmon are ocean type.

2.2.2.1.3 Abundance and Productivity. Using peak recorded harvest landings in Puget Sound in 1908, Bledsoe et al. (1989) estimated that the historical run size of the ESU was 670,000. During a recent five-year period, the geometric mean of natural spawners in populations of PS Chinook salmon ranged from 222 to just over 9,489 fish. Most populations had natural spawners numbering in the hundreds (median recent natural escapement is 766), and, of the six populations with greater than 1,000 natural spawners, only two have a low fraction of hatchery fish. Estimates of the historical equilibrium abundance, based on pre-European settlement habitat conditions, range from 1,700 to 51,000 potential PS Chinook salmon spawners per population (Good et al. 2005).

The artificial propagation of fall-run PS Chinook salmon is widespread throughout the ESU. Transfers between watersheds within and outside the ESU have been commonplace throughout the last century. Nearly two billion Chinook salmon have been released into Puget Sound tributaries since the 1950s. The vast majority of these were from local returning fall-run adults. Returns to hatcheries have accounted for 57 percent of the total spawning escapement, although the hatchery contribution to spawner escapement is probably much higher in some populations due to hatchery derived strays on the spawning grounds. The electrophoretic similarity between Green and Duwamish River fall-run PS Chinook salmon and several other fall-run stocks in Puget Sound suggests that there may have been a significant and lasting effect from Green River hatchery transplants (Good et al. 2005).

The NMFS Biological Review Team (BRT) identified the following risks to the PS Chinook salmon ESU: (1) the concentration of the majority of natural production in just two basins; (2) high levels of hatchery production in many areas of the ESU; and (3) widespread loss of estuary and lower floodplain habitat diversity (Good et al. 2005).

2.2.2.1.4 Affected Populations of Puget Sound Chinook Salmon. Puyallup River Chinook salmon. The Puyallup River historically supported 42,000 Chinook salmon. Recently, natural spawning escapement has ranged from 1,500 to 5,000 (Shared Strategy 2007). From 2005-2010, adult returns averaged 2,007. Late returning fall-run Puyallup Chinook salmon natural spawning occurs in South Prairie Creek up to RM 15, the Puyallup mainstem up to the Electron Dam, the lower Carbon River, Voights Creek and Kapowsin Creek. Some spawning is now believed to occur in the upper Puyallup since passage has recently been established at the Electron diversion dam (Shared Strategy 2007). Approximately 99 percent of Puyallup River fall-run Chinook salmon are ocean-type fish, with the remaining one percent being stream-type fish (Beechie et al. 2006).

Hylebos Creek Chinook salmon are considered to be a subpopulation of the Puyallup River fall run population (Kerwin 1999). No data quantifying current escapement levels are available, but adult abundance is at a fraction of historical levels (Kerwin 1999).

White River Chinook salmon. The White River early-run Chinook salmon population is the most genetically distinctive stock in central and south Puget Sound. It is the last spring-run population in southern Puget Sound (Shared Strategy 2007). The earliest return records for White River spring-run Chinook salmon are from the Buckley fish trap in 1941 (Kerwin 1999 citing Miyamoto 1986). Adult returns from 1942 to 1950 averaged 2,953. Returns were lowest in the 1970's when approximately 50 fish returned in 1977. The recent escapement trend has been increasing primarily because of hatchery intervention programs initiated in the late 1970's. The mean number of natural Chinook salmon spawners in the White River between 1998 and 2002 was 1,039, with a range of 316 to 2,002 (Good et al. 2005). From 2005-2010, adult returns averaged 1,468.

Lake Washington Chinook salmon. The Lake Washington Basin PS Chinook salmon are fall-run stocks. The adults first appear at the lock complex in mid-June. In general, peak returns occur in mid- to late-August and the adult run is completed by early October.

Lake Washington PS Chinook salmon have declined since peak returns during the mid-1980s (Weitkamp and Ruggerone 2000). Adult returns have declined more than eight percent per year for each run, with the PS Chinook salmon Cedar River run declining at 10.1 percent per year, the Issaquah Creek run at 8 percent per year, and the North Lake Washington run at 16.6 percent per year. Of the 22 populations of PS Chinook salmon in Puget Sound, the Lake Washington populations were among the five populations showing the steepest declines (Myers et al. 1998).

Two populations of the PS Chinook salmon ESU are present in the Lake Washington Basin, the north Lake Washington Tributaries population, including Issaquah Creek, and the Cedar River population. Most natural production of juvenile Chinook salmon in Lake Washington originates in the Cedar River. For the north Lake Washington Tributaries population, most natural production is from Bear Creek. Escapement of naturally spawning PS Chinook salmon into the Lake Washington basin between 1994 and 2007 has averaged 243 for the north Lake Washington tributaries population and 581 for the Cedar River population. Small numbers of Chinook salmon also spawn in other tributaries to Lake Washington and Lake Sammamish, but no

information is available for the production from these streams (Celedonia et al. 2008a) Hatchery production in the basin occurs at the Issaquah Creek State Hatchery. Chinook salmon from this hatchery are part of the ESU. The University of Washington (UW) ended its hatchery program in 2010, how even, adults from past smolt releases will still return over the next several years. These Chinook salmon are not included in the ESU.

Most juvenile Lake Washington Chinook salmon migrate to the ocean in their first year. DeVries et al. (2005; 2007) documented juvenile outmigration through the Lake Washington Ship Canal (Ship Canal) from May to August with peak out-migration from late May to early June. Less than one percent of Chinook salmon spend a year or more in the lake prior to emigrating, however there are no data on their actual numbers or densities within Lake Washington or the Ship canal. (Devries et al. 2005). In Lake Washington, juvenile Chinook salmon use lentic habitat as a migratory corridor from late May through July and for rearing from January-June (Celedonia et al. 2008a). Chinook salmon juveniles either enter Lake Washington shortly after emergence (mid-January to March) and rear in the Lake for three to five months, or they rear in their natal tributaries and enter Lake Washington between April and late June (Celedonia et al. 2008a; Seiler et al. 2005).

Juvenile Chinook salmon from the Cedar River enter Lake Washington and rear in the south end of the Lake from January to May (Tabor and Piaskowski 2002; Tabor et al. 2006). During this time, they inhabit shallow areas (0.1 to 1.3 m deep) with a sandy substrate and gentle sloping gradient. Juvenile Chinook salmon will also rear in non-natal tributaries (Tabor et al. 2006). Overwater structures can provide cover for small juvenile Chinook salmon in February and March but, as they grow larger and predators such as smallmouth bass move inshore, Chinook salmon avoid structures. Fresh (2000) found juvenile Chinook salmon in Lake Washington are primarily restricted to the littoral zone until mid-May when they are large enough to move offshore. From May to July, juvenile Chinook salmon are located throughout the Lake (Celedonia et al. 2008a).

Juvenile Chinook salmon from the Cedar River migrate north along the western shoreline of the lake during the day in shallow water three to eight feet deep. Migrating smolts do not avoid milfoil (Tabor and Piaskowski 2002; Tabor et al. 2006; Celedonia et al. 2008), but rather the milgoil serves as a false-bottom which juvenile Chinook salmon migrate above. Celedonia et al. (2008; 2009) observed juvenile Chinook salmon in deeper water (up to 16 feet deep) in areas of dense milfoil. Migrating Chinook salmon smolts avoid overwater structures (Tabor and Piaskowski 2002; Tabor et al. 2006). They either move into deeper water to pass beneath the structure or move around the perimeter of the structure (Celedonia et al. 2008a).

2.2.2.2 Puget Sound Steelhead

2.2.2.2.1 Listing, Spatial Structure, and Diversity. The National Marine Fisheries Service designated PS steelhead as threatened under the Endangered Species Act (ESA) on June 11, 2007 (72 FR 26722). PS steelhead are found in all accessible large tributaries to Puget Sound and the eastern Strait of Juan de Fuca (WDFG 1932). Nehlsen et al. (1991) identified nine PS steelhead stocks at some degree of risk or concern. The WDF et al. (1993) identified 53 stocks within the DPS, of which 31 were considered to be of native origin and predominantly natural

production. Of the 31 stocks, they rated 11 as healthy, three as depressed, one as critical, and 16 as unknown.

Since 1992 there has been a general downward trend in steelhead populations in this DPS. Busby et al. (1996) reviewed the 21 populations in the Puget Sound DPS and found that 17 had declining trends and four had increasing trends. Marked declines in natural run size are evident in all areas of the DPS. Even sharper declines are observed in southern Puget Sound and in Hood Canal. Throughout the DPS, natural steelhead production has shown a weak response to reduced harvest since the mid 1990s. Median population growth rates were estimated for several populations in the DPS, using the 4-year running sums method (Holmes 2001; Holmes and Fagan 2002). They estimated that the growth rate was less than 1 for most populations in the DPS, meaing the populations are declining.

2.2.2.2.2 Life History. Steelhead are the anadromous form of *O. mykiss*. PS steelhead typically spend two to three years in freshwater before migrating downstream into marine waters. Once the juveniles emigrate, they move rapidly through Puget Sound into the North Pacific Ocean where they reside for several years before returning to spawn in their natal streams. Unlike other species of *Oncorhynchus*, *O. mykiss* are capable of repeat spawning. Averaged across all West Coast steelhead populations, eight percent of spawning adults have spawned previously. Coastal populations have a higher incidence of repeat spawning than inland populations (Busby et al. 1996). There are two types of steelhead, winter steelhead and summer steelhead. Winter steelhead become sexually mature during their ocean phase and spawn soon after arriving at their spawning grounds. Adult summer steelhead enter their natal streams and spend several months holding and maturing in freshwater before spawning.

2.2.2.2.3 Abundance and Productivity. The PS steelhead DPS is composed primarily of winter-run populations. No abundance estimates exist for most of the summer-run populations; all appear to be small, most averaging less than 200 spawners annually. Summer-run populations are concentrated in northern Puget Sound and Hood Canal; only the Elwha River and Canyon Creek support summer-run steelhead in the rest of the DPS. Steelhead are most abundant in northern Puget Sound, with winter-run steelhead in the Skagit and Snohomish rivers supporting the two largest populations (approximately 3,000 and 5,000 respectively). Most populations have declined in the last five years. Widespread declines in abundance and productivity in most natural populations have been caused by the following factors:

(1) Steelhead habitat has been dramatically affected by a number of large dams in the Puget Sound Basin that eliminated access to habitat or degraded habitat by changing river hydrology, temperature profiles, downstream gravel recruitment, and movement of large woody debris.

(2) In the lower reaches of rivers and their tributaries, urban development has converted natural areas (e.g. forests, wetlands, and riparian habitat) into impervious surfaces (buildings, roads, parking lots, etc.). This has changed the hydrology of urban streams causing increases in flood frequency, peak flow, and stormwater pollutants. The hydrologic changes have resulted in gravel scour, bank erosion, sediment deposition during storm events, and reduced summer flows (Moscrip and Montgomery 1997; Booth et al. 2002; May et al. 2003).

(3) Agricultural development has reduced river braiding, sinuosity, and side channels through the construction of dikes and the hardening of banks with riprap. Constriction of rivers, especially during high flow events, increases gravel scour and the dislocation of rearing juveniles. Much of the habitat that existed before European immigration has been lost due to these land use changes (Beechie et al. 2001; Collins and Montgomery 2002; Pess et al. 2002).

(4) In the mid 1990s, WDFW banned commercial harvest of wild steelhead. Previous harvest management practices contributed to the decline of PS steelhead (Busby et al. 1996). Predation by marine mammals (principally seals and sea lions) and birds may be of concern in some local areas experiencing dwindling steelhead run sizes (Kerwin 2001).

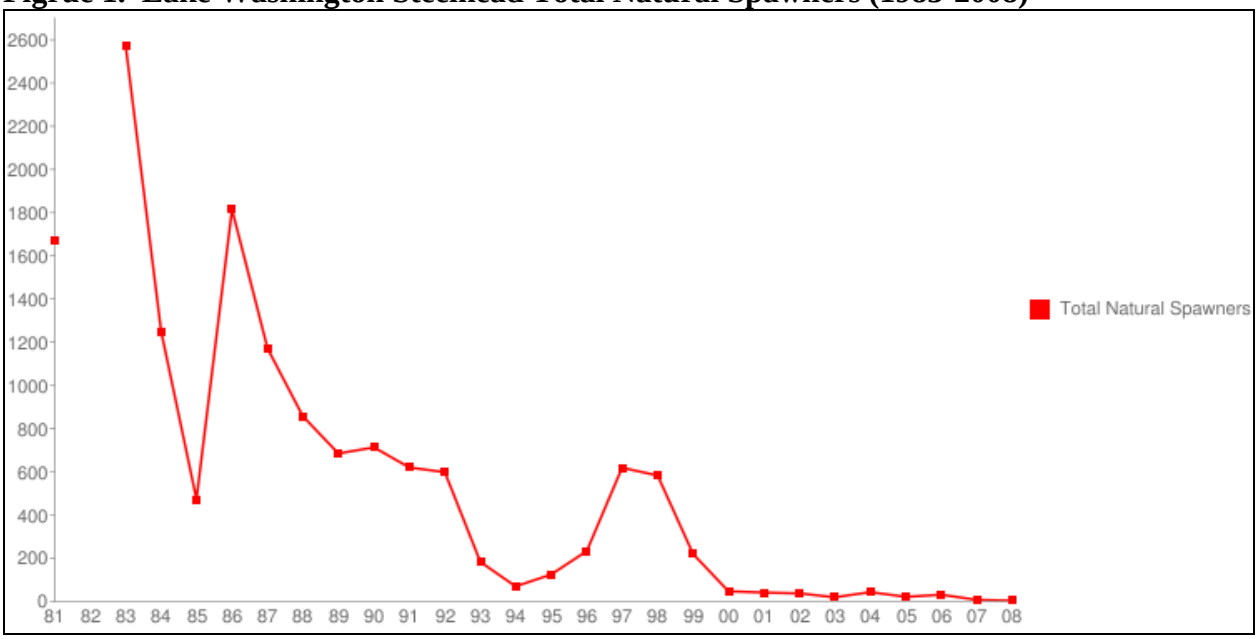
(5) Ocean and climate conditions can have profound impacts on steelhead populations. Changing weather patterns affect their natal streams. As snow pack decreases, in-stream flow is expected to decline during summer and early fall (Battin et al. 2007).

(6) The extensive propagation of the Chambers Creek winter steelhead and the Skamania Hatchery summer steelhead stocks have contributed to the observed decline in abundance of native PS steelhead populations (Hard et al. 2007). Approximately 95 percent of the hatchery production in the PS DPS originates from these two stocks. The Chambers Creek stock has undergone extensive breeding to provide an earlier and more uniform spawn timing. This has resulted in a large degree of reproductive divergence between hatchery and wild winter-run fish. The Skamania Hatchery stock is derived from summer steelhead in the Washougal and Klickitat rivers and is genetically distinct from the Puget Sound populations of steelhead. For these reasons, Hard et al. (2007) concluded that all hatchery summer- and winter-run steelhead populations in Puget Sound derived from the Chambers Creek and Skamania Hatchery stocks should be excluded from the DPS. NMFS included two hatchery populations that were derived from native steelhead, the Green River winter-run and the Hamma Hamma winter-run, as part of the DPS (72 FR 26722).

2.2.2.2.4 Affected Populations of Puget Sound Steelhead. Lake Washington Steelhead. The Lake Washington steelhead have undergone steep declines in abundance. Abundance trends over the most recent decade were strongly negative and alarmingly low. Estimates were computed from 10 years of data (1995-2004). Between 2000 and 2004, escapement averaged 38 fish (WDFW 2002). From 2005 to 2008, escapement continued to decline. The average escapement was 11 with a low of four in 2008 (Figure 1). Since 2008, returns have been less than 10 fish each year (Friends of the Ballard Locks in litt.)

WDFW operates smolt traps in Bear Creek and the Cedar River to estimate the production of juvenile Chinook salmon, coho salmon, and steelhead. Between 2007 and 2009, WDFW captured one smolt per year in the Cedar River. In Bear Creek, WDFW capture one smolt in 2007 and 2008 and none in 2009 (Kiyohara and Volkhardt 2008; Kiyohara and Zimmerman 2009; 2011). There has been a loss of connectivity between the Duwamish (Green) and Snohomish rivers due to the virtual extirpation of steelhead in the Lake Washington basin.

Figrue 1. Lake Washington Steelhead Total Natural Spawners (1983-2008)



WDFW data,
http://fortress.wa.gov/dfw/gispublic/apps/salmonscape/salmonscapeJSP/summaryStockReport.jsp?SasiStkNum=6154

In the Cedar River, wild steelhead are closely related to resident *O. mykiss*. Resident *O. mykiss* are abundant below Landsberg dam and are a native wild population. Marshall et al. (2004) found that resident Cedar River *O. mykiss* produce outmigrating smolts and speculated that steelhead could produce adult resident *O. mykiss*. They concluded that the conservation of resident *O. mykiss* is likely an important aspect of reducing extinction risk for steelhead.

2.2.3 Status of Critical Habitat

NMFS designated critical habitat for the PS Chinook salmon ESU on September 2, 2005. The following are the primary constituent elements (PCEs) NMFS identified for PS Chinook salmon critical habitat:

> PCE 1--Freshwater spawning sites with water quantity and quality conditions and substrate that support spawning, incubation, and larval development;
>
> PCE 2--Freshwater rearing sites with (1) water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility, (2) water quality and forage that support juvenile development, and (3) natural cover such as shade, submerged and overhanging large wood, logjams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks;
>
> PCE 3--Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and

overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks that support juvenile and adult mobility and survival;

PCE 4--Estuarine areas free of obstruction and excessive predation with (1) water quality, water quantity, and salinity conditions that support juvenile and adult physiological transitions between fresh water and salt water, (2) natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels, and (3) juvenile and adult foraging opportunities, including aquatic invertebrates and prey fish, supporting growth and maturation;

PCE 5--Nearshore marine areas free of obstruction and excessive predation with (1) water quality and quantity conditions and foraging opportunities, including aquatic invertebrates and fishes, supporting growth and maturation, and (2) natural cover including submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels;

PCE 6--Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The PS Chinook salmon ESU has 61 freshwater and 19 marine areas within its range. Of the freshwater watersheds, 41 are rated high conservation value, 12 low conservation values, and eight received a medium rating. Of the marine areas, all 19 are ranked with high conservation value. Watersheds within designated critical habitat, called Fifth Field Hydrologic Unit Codes (HUCs) have been ranked as to the conservation value they provide to each listed species they support14; conservation rankings are high, medium, or low. To determine the conservation value of each watershed to ESU viability, the Critical Habitat Analytical Review Team (CHART) evaluated the quantity and quality of habitat features, the relationship of the area compared to other areas within the ESU, and the significance to the ESU of the population occupying that area. Thus, even a location that has poor quality of habitat could be ranked at high conservation value if that location was essential due to factors such as limited availability, the unique contribution of the population it served, or other important role.

Critical habitat throughout the Puget Sound basin has been degraded by numerous activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large woody debris, intense urbanization, agriculture, alteration of floodplain and stream morphology, riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, timber harvest, and mining. Changes in habitat quantity, availability, diversity, stream flow, temperature, sediment load, and channel instability are common limiting factors of critical habitat.

2.3 Environmental Baseline

The “environmental baseline” includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the

consultation in process (50 CFR 402.02). Elements of the proposed action occur in several discrete locations, with effects limited to those locations. Therefore, this opinion presents environmental baseline by activity location, including the locations of the proposed habitat restoration projects.

The presence and operation of the Ship Canal, in addition to urban development in the area have dramatically altered the Lake Washington Basin. From the east end of the Ship Canal to Lake Union, there is little open shoreline (City of Seattle 1999). Portage Bay has numerous over-water structures ranging from small docks to large marinias with dozens of slips. Riparian vegetation within these areas is limited, except for the area south of SR 520 that contains the highest abundance of natural vegetation (Weitkamp and Ruggerone 2000). Portage Bay is lined by University of Washington facilities, commercial facilities, and houseboats. The southeastern portion of Portage Bay has an area of freshwater marsh habitat. Aside from the marsh, little natural vegetation remains in the riparian zone.

The Ship Canal has concrete bulkheads throughout the Montlake Cut. The Ship Canal extends eastward through Union Bay and terminates at Webster Point beyond which is the main body of Lake Washington. Union Bay has several areas of freshwater marsh and milfoil. The south side of the bay is bordered by the Arboretum and traversed by the SR 520 Bridge, creating a network of smaller embayments and canals. Numerous residences with landscaped waterfronts and docks dominate the remainder of the shoreline.

Water temperatures increase in the Ship Canal during the juvenile Chinook salmon out-migration season with temperatures reaching 66°F (19°C), a temperature that stresses salmonids. Water temperature and stratification in the Ship Canal has been documented to influence smolt distribution (water depth used) and behavior. The only portion of the Ship Canal that is stratified is just upstream of the locks where saltwater forms a cool, oxygen-rich lower layer. Fresh et al. (1999) observed adult salmon moving from the Locks immediately after near-surface temperatures dropped below 22°C, and there is a strong positive relationship between water temperatures above 19°C and increased delay at the Locks. Physiological causes of delay at the locks may include spawning readiness and readiness for freshwater.

A survey of 1991 aerial photographs estimated that 4 percent of the shallow water habitat within 100 feet of the shore was covered by residential piers (excluding coverage by commercial structures and vessels) (USFWS 2008). Later studies report that about 2,700 docks are present in Lake Washington and approximately 80 percent of the shoreline is armored (Warner and Fresh 1999; City of Seattle 2000; Toft 2001). The density of docks and shoreline modifications throughout the Ship Canal, Portage Bay, and Lake Union approaches 100 percent (City of Seattle 1999; Weitkamp and Ruggerone 2000).

2.3.1 Port of Tacoma (Blair Waterway, Commencement Bay)

The Blair Waterway is 2.6 miles long and is open to Commencement Bay. Freshwater enters the Blair Waterway through Wapato Creek and numerous stormwater outfalls. Water quality is impaired by high benzene concentrations, and the sediment has high concentrations of hexachlorobenzene. The CTC is approximately one mile from the mouth of the waterway.

There is no riparian vegetation at the CTC, and it is absent from most of the waterway. And almost all of the shoreline is developed with either armoring or over-water structures. Two small restoration sites, one of which is adjacent to CTC, are exceptions. These sites have gently-sloping shorelines, anchored LWD, and woody riparian vegetation. NMFS has designated most of Commencement Bay, including the action area, as critical habitat for PS Chinook salmon (PCE 4, estuarine areas). Critical habitat within the action area is degraded due to poor water quality, lack of natural cover, and limited foraging opportunities.

Juvenile Chinook salmon use the estuarine waters of the Blair Waterway in low numbers in March, peak in late May or early June and drop to low numbers again by July 1. They typically use areas near the mouths of the waterways more than near the heads (Kerwin 1999). Pacific International Engineering (2000; 2002) reported juvenile Chinook salmon densities from the Sitcum waterway which is adjacent to the Blair waterway. Prior to May 15, densities were averaged 0.001 fish per square foot. Between May 15 and June 15, densities were averaged 0.06 fish per square foot.

Available evidence shows that steelhead spend very little time in Commencement Bay. Adult steelhead spend little time staging in the marine areas prior to river entry, moving rapidly through nearshore habitats (Spence 1989), and steelhead smolts migrate rapidly to offshore marine habitats (Welch et al. 2004; Melnychuk et al. 2007; Pearcy 1992). Acoustic tagging studies of Puyallup River steelhead demonstrate similar behavior (Berger and Ladley 2006).

2.3.2 Portage Bay

Most of the Portage Bay shoreline, similar to the rest of the Ship Canal, is developed. There are several large marinas, houseboats, residential docks, and shoreline armoring. However, the area immediately south of the existing SR 520 bridge is mostly undeveloped with dense riparian and aquatic vegetation. Portage Bay also has a large population of salmonid predators. Tabor et al. (2004) estimated the population of small mouth bass in Portage Bay at 1,941with peak abundance in June. Other predators include largemouth bass and northern pikeminnow. The action area is in southern Portage Bay, approximately 0.25 mile south of the primary migratory corridor. Despite the less-than-ideal habitat conditions, this portion of the action area provides rearing and migration habitat for juvenile Chinook salmon (PCEs 2 and 3).

2.3.3 Montlake Cut

The Montlake Cut is a 30-foot deep channel connecting Union Bay and Portage Bay. All anadromous fish in the Lake Washington, including PS Chinook salmon and PS steelhead must migrate through the Cut (PCE 3, freshwater migration corridors). Due to poor habitat conditions (steep, armored shorelines, lack of riparian vegetation, and high water temperatures), NMFS does not expect any life history of PS Chinook salmon or PS steelhead to rear, hold, or mill within the Montlake Cut.

2.3.4 West Approach (Arboretum, Union Bay, and Lake Washington)

The west approach has two distinct habitat types. The area from the eastern shore of Montlake to the eastern shore of Foster Island has shallow, narrow waterways with dense aquatic vegetation. This area likely supports high populations of largemouth and smallmouth bass. PS Chinook salmon and PS steelhead are unlikely to use this habitat for any length of time. However, given this area's proximity to the only migratory corridor into and out of Lake Washington, NMFS cannot discount the possibility of adults and juveniles of both species moving through this area. Juvenile Chinook salmon in particular are likely to be present in small numbers in May and June during the peak of their out-migration.

The west approach area east of Foster Island is the primary migratory corridor for anadromous fish from the Cedar River (PCE 3). Juvenile Chinook salmon also rear within this area (Celdonia et al. 2008; 2009). These PCEs are degraded due to the high density of over-water structures, armored shoreline, aquatic macrophytes, and high summer temperatures. Given that Chinook salmon and steelhead do not necessarily migrate in the most direct path, fish from the north Lake Washington populations could also be present.

2.3.5 Floating Bridge (Lake Washington)

Puget Sound Chinook salmon and PS steelhead spend little time in the deeper portions of Lake Washington near the floating bridge. Fresh et al. (1999) found that adult Chinook salmon spend an average of 2.9 days in the Lake. Juvenile Chinook salmon, while predominately shoreline-oriented, have been observed near the existing floating bridge (P. Bloch pers. comm.). Very little information is available on adult and juvenile steelhead use in Lake Washington (SPU and USACE 2008). In other systems, steelhead typically migrate quickly from riverine habitats to saltwater and vice versa. NMFS expects that Lake Washington steelhead exhibit similar migratory behavior.

2.3.6 East Approach (Eastern shore of Lake Washington)

The east approach is on the eastern shore of Lake Washington near the City of Medina. This area provides habitat for rearing and migrating juvenile Chinook salmon (PCEs 2 and 3). These PCEs are degraded due to the high density of over-water structures and an armored shoreline. The shoreline has a very gradual slope. However, it is over four miles from any natal Chinook salmon or steelhead streams and over 1.5 miles from the western shore of the lake (Tabor et al. 2006). Therefore, NMFS expects juvenile Chinook salmon numbers to be lower than along the western shoreline and Union Bay. While the east approach is not within a direct line between the Ship Canal and any natal tributaries, NMFS cannot discount the possibility of adult Chinook salmon and juvenile and adult steelhead passing through the area during their migrations.

2.3.7 Habitat Project Locations

2.3.7.1 Washington Department of Natural Resources Renton/Cedar River Site

This three-acre Washington Department of Natural Resources (WDNR) site is on the Lake Washington shoreline just east of the mouth of the Cedar River in the City of Renton. This property was created in 1965 when Puget Sound Power and Light placed 150,000 cubic yards of fill into the lake. Tabor et al. (2004a; 2006) have documented high levels of juvenile Chinook salmon use on the site. The project area is most heavily used by Chinook salmon fry that migrate through the site from the Cedar River toward the Ship Canal (PCEs 2 and 3). These PCEs are degraded at this site. Approximately half of the shoreline consists of the 650-foot long flume on the northeastern half of the project area. 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, but with native vegetation cover. Three dolphins are located east of the shoreline. Each dolphin consists of seven creosote piles.

2.3.7.2 Cedar River

The lower Cedar River provided spawning, rearing, and migration habitat for PS Chinook salmon and PS steelhead (PCEs 1, 2, and 3). Floodplain development and levees have degraded these PCEs within the action area at RM 5.3. The river channel throughout most of this reach is confined and stabilized by levees and revetments which contribute to a loss of connectivity between the river and its floodplain leading 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.

On the upstream half of the left (south) 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). Several residences in the project area have been acquired by King County as part of a floodplain property acquisition program. These structures are vacant and slated for demolition as part of the restoration project. A levee with large riprap extends into the River; it is located about midway through the project area. The River is confined along this stretch, resulting in concentrated flow. The River has sufficient gradient and energy to produce a dynamic channel morphology if the artificial constraints confining the existing channel are removed. Just upstream of the levee and riprap, the river has eroded the bank.

A King County restoration area is located on the right bank, the most upstream and northeast corner of the project area; it is vegetated with an off-channel habitat feature. The second levee extends approximately 500 linear feet farther downstream. The levee has large boulder-size riprap below the OHWM that extends approximately five feet waterward and three to five feet below the waterline. The levee has cobble-sized riprap. Downstream of the levee, the floodplain is at a natural grade and is equal to or around two feet higher than the base flow river stage.

2.3.7.3 Taylor Creek

Taylor Creek, in southeast Seattle, enters Lake Washington 1.7 miles from the mouth of the Cedar River. Sockeye, coho, and Chinook salmon use Taylor Creek (Washington Trout 2000). Juvenile Chinook salmon use the Taylor Creek delta and convergence pool for feeding and rearing, but cannot access the upstream habitat because the gradient is too high (Tabor et al. 2004a). Tabor et al. (2010) surveyed Taylor Creek in the summer and found juvenile Chinook salmon and coho in Taylor Creek.

Juvenile Chinook salmon use this site for rearing and migration (PCEs 2 and 3). Taylor Creek's delta at Lake Washington consists of cobble in the prevailing flow paths and gravel and sand in the remainder of the delta. The delta transitions into a sandy beach with small pockets of marsh vegetation. Upstream from the delta, the Creek flows through residential properties for 560 feet before reaching Rainier Avenue South. The stream habitat in this reach is degraded because it has been confined by concrete walls, boulders, and pavers. The channel has been straightened to allow for historical industrial use and current residential use adjacent to the Creek. The riparian and floodplain areas have been modified with fill, residential homes, asphalt driveways, and a dock. 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.

2.3.7.4 Seward Park

Seward Park has an extensive shoreline with areas of bulkheads, native vegetation, invasive aquatic vegetation and a variety of bank heights and slopes. The Seward Park shoreline is used by juvenile Chinook salmon for feeding, rearing, and migration from the Cedar River toward the Ship Canal (PCEs 2 and 3), though Chinook salmon abundance is lower here than along the South Lake Washington shoreline (Tabor and Piaskowski 2002). These PCEs are degraded in some areas (e.g. those with bulkheads). Some segments of the park shoreline were restored in 2001 and 2006 by regrading 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. The shoreline segments with shallow water and vegetative cover provide 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.

2.3.7.5 Magnuson Park

Similar to Seward Park, Magnuson Park has an extensive shoreline with areas of bulkheads, native vegetation, invasive aquatic vegetation and a variety of bank heights and slopes. Similar to Seward Park, some segments of the Magnuson Park shoreline have been restored by grading the bank to a lower slope, placing gravel, and re-vegetating riparian areas. A boat launch on the southern end of the park has a heavily armored shoreline up to 50 feet on either side of the ramps.

The Magnuson Park shoreline is used by juvenile Chinook salmon from the North Lake Washington tributaries and the Sammamish/Issaquah Creek system as they migrate toward the Ship Canal (PCEs 2 and 3). The shoreline segments with shallow water and cover are used by the juvenile Chinook salmon for rearing, foraging, and refugia. North Lake Washington Chinook salmon juveniles have bimodal migration timing, with a some 0+ juveniles migrating out of their natal stream toward the lake as newly emerged fry in early spring and others as smolts in late May to June (Seiler et al. 2003). The early fry probably use the Magnuson Park shoreline and other nearshore areas in Lake Washington for rearing, foraging, and migration. The larger Chinook salmon juveniles reside in waters between three and 18 feet deep during the day, primarily over sand-gravel substrates.

2.4 Effects of the Action

"Effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. During consultation, neither NMFS nor the action agency identified any interrelated or interdependent actions.

2.4.1 Effects on Species

2.4.1.1 Lighting

The proposed lighting design will reduce the amount of artificial light cast onto adjacent waters. Along the west approach and floating bridge, the number of roadway light fixtures will be reduced by more than 50 percent (WSDOT 2010). The new bridge will not have roadway lighting from east of Foster Island to the east end of the floating span. The maintenance dock below the east approach will have on-demand overhead lighting. Only low-intensity path lighting would remain on at all times (WSDOT 2010). Similar to current conditions, the project will have continuous lighting from I-5 to Foster Island and on bridges crossing the Montlake Cut.

While WSDOT will minimize light spillage during construction, NMFS expects that artificial lighting during construction will be greater than current conditions. The behavioral responses of fish to natural and artificial lighting are complicated, with significant variation dependent on species, life history stage, feeding strategy, and environmental factors. Fish may be attracted by, or may avoid artificial sources of light, dependent upon a complex set of feeding, foraging, concealment, and predator avoidance strategies.

Tabor and Piaskowski (2002) investigated patterns of habitat use by outmigrating juvenile Chinook salmon and found that fish were inactive at night, residing at the bottom of shallow waters, even near sources of artificial light. Fish became active, moved off the bottom, and began schooling as light intensity increased at dawn. Mazur and Beauchamp (2003) investigated prey detection and reaction distance in piscivorous salmonids. Reaction distances for cutthroat and rainbow trout increased as light levels increased. However, Tabor et al. (1998) found that juvenile sockeye salmon's predator avoidance ability increased with increased light intensity.

Petersen and Gadomski (1994), in a similar finding, observed that the rate of capture of juvenile chinook salmon by northern squawfish was inversely related to light intensity.

Caledonia et al. (2009) found that juvenile Chinook salmon were attracted to areas of the existing SR 520 Bridge adjacent to roadway lights. The NMFS expects that artificial lighting will influence juvenile Chinook salmon behavior in the areas of the Lake adjacent to construction and permanent lights. Lighting will have the effect of extending the duration of twilight incident light conditions around dawn and dusk. These conditions are likely to allow juvenile Chinook salmon to visually detect prey and predators at night and also allow visual predators of juvenile Chinook salmon to forage. However, the studies cited above show that increased lighting favors juvenile salmonids more than their predators. Juvenile Chinook salmon in Lake Washington typically migrate during the day and are inactive at night (Celadonia et al. 2008a; Tabor and Piaskowski 2002), therefore, the attraction of the roadway and construction lighting at night is unlikely to delay their migration. Overall, NMFS does not anticipate adverse effects to juvenile Chinook from the permanent and construction lighting.

NMFS does not expect roadway and construction lighting to have any effect on adult Chinook salmon or juvenile or adult steelhead. Adult Chinook salmon and steelhead are too large to be preyed upon by piscivorous fish. Juvenile steelhead smolts are larger and better able to avoid predation, and are less likely than juvenile Chinook salmon to change their behavior due to artificial lighting (Newcomb and Coon 1997; McComas et al. 2008)

2.4.1.2 Suspended Sediment

Salmonids typically avoid areas of higher suspended sediment which can displace them from their preferred habitats. Fish unable to avoid suspended sediment can experience adverse effects. The severity of effect of suspended sediment increases as a function of the sediment concentration and exposure time, or dose (Newcombe and Jensen 1996; Bash et al. 2001). Suspended sediments can cause sublethal effects such as elevated blood sugars and cough rates (Servizi and Martens 1991), physiological stress, and reduced growth rates. Elevated turbidity levels can reduce the ability of salmonids to detect prey, cause gill damage (Sigler et al. 1984; Lloyd et al. 1987; Bash et al. 2001), and cause juvenile steelhead to leave rearing areas (Sigler et al. 1984). Additionally, short-term pulses of suspended sediment influence territorial, gill-flaring, and feeding behavior of salmon under laboratory conditions (Berg and Northcote 1985). Adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjornn and Reiser 1991). However, research indicates that chronic exposure can cause physiological stress responses that can increase maintenance energy and reduce feeding and growth (Lloyd et al. 1987; Servizi and Martens 1991).

Monitoring turbidity, a measurement of water clarity, is a surrogate for monitoring the concentration of suspended sediment in a water sample. A nephelometric turbidity unit (NTU) is a measurement of turbidity. For in-water project activities in Lake Washington and the Ship Canal, NMFS expects turbidity levels will not exceed five nephelometric turbidity units (NTUs) over background at 150 feet from the in-water activity. For the Cedar River habitat project, NMFS expects turbidity levels will not exceed five NTUs over background at 300 feet.

Below, NMFS describes physical and temporal extent of elevated suspended sediment and the life history stages of PS Chinook salmon and PS steelhead that will be exposed. However, NMFS cannot estimate the number of individuals that will experience adverse effects from suspended sediment. Pulses of elevated suspended sediment will occur episodically throughout the in-water work seasons. NMFS cannot predict the number or duration of each pulse nor the number of individual fish that will be exposed to each pulse. Furthermore, not all exposed individuals will experience adverse effects. Therefore, NMFS will use the physical and temporal extent of elevated suspended sediment to evaluate the effects to PS Chinook salmon and PS steelhead.

2.4.1.2.1 Portage Bay. The project activities that will cause turbidity in the Portage Bay portion of the action area are the vibratory installation of sheet piles to construct cofferdams, the vibratory installation of drilled shaft casings, and the removal of temporary steel piles. All of these activities will occur between August 16 and April 30, starting August 16, 2013 and ending April 30, 2018. The in-water work window will avoid emigrating juvenile Chinook salmon and steelhead, but overlaps with the adult Chinook salmon and steelhead migration. As described above, adults from both species migrate quickly through the portion of the Ship Canal in northern Portage Bay. NMFS does not expect adults from either species to be exposed to turbidity in the action area in southern Portage Bay which is approximately 0.25 mile south of the migratory corridor through northern Portage Bay. While most juvenile Chinook salmon outmigrate as 0+ juveniles, a very small percentage rear in Lake Washington for a year or more (De Vries et al. 2007). Any residual Chinook salmon present in the action area of Portage Bay during the in-water work will be exposed to elevated levels of suspended sediment. NMFS expects these residual Chinook will experience sublethal effects from elevated suspended sediment including displacement from preferred habitats and physiological stress.

NMFS cannot estimate the number of residual Chinook salmon that will be exposed. Less than one percent of Chinook salmon residualize in Lake Washington, however there are no data on their actual numbers or densities within Lake Washington or the Ship Canal. Table 3 shows the total area that will be exposed to elevated turbidity during each construction year.

Table 3. Suspended Sediment Exposure

Total Area (Acres) Exposed to Elevated Suspended Sediment per Construction Year								
Project Area	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Total**
Portage Bay	N/A	23.3	11.9	17.1	20.9	15.3	17.4	105.9
West Approach (Arboretum/ Foster Island)	N/A	19.5	17.3	25.6	N/A	19.5	22.4	104.4
West Approach (east of Foster	N/A	25.8	31.6	39.7	N/A	25.8	23.2	146.1

Island)								
East Approach	6.5	4.5	N/A	7.1	N/A	N/A	N/A	18.1
Total	**6.5**	**73.1**	**60.8**	**89.5**	**20.9**	**60.6**	**63.0**	**374.5**

2.4.1.2.2 West Approach (Arboretum and Foster Island). The project activities that will cause turbidity in this area are the vibratory installation of drilled shaft casings, and the removal of temporary steel piles. Because of the limited listed species presence in this area, WSDOT is not proposing to limit the timing of these activities. While NMFS agrees that this area is not extensively used by PS Chinook salmon or PS steelhead, NMFS cannot discount the possibility of small numbers of fish being exposed to elevated levels of suspended sediment. NMFS expects any PS Chinook salmon or PS steelhead exposed will experience sublethal physiological stress.

2.4.1.2.3 West Approach (East of Foster Island). The project activities that will cause turbidity in the west approach east of Foster Island are the vibratory installation of drilled shaft casings, and the removal of temporary steel piles. All of these activities will occur between August 1 and March 31, starting August 1, 2013, and ending March 31, 2018. Construction activities outside the in-water work window will be either above water or fully contained with BMPs. This window overlaps with the tail end of juvenile Chinook salmon outmigration, the adult Chinook salmon migration, residual Chinook salmon rearing, and adult steelhead migration. NMFS expects these fish, with the exception of adult steelhead, will experience sublethal effects from elevated suspended sediment including displacement from preferred habitats and physiological stress. NMFS does not expect large fish such as adult steelhead to be harmed by brief exposure to elevated turbidity levels because larger fish can tolerate short term increases in suspended sediment (Bjornn and Reiser 1991).

Adult Chinook salmon are likely to be exposed to elevated turbidity levels. As described above, adult Chinook salmon, after holding in the cold saltwater just upstream of the Locks, migrate rapidly through the LWSC. Adult Chinook salmon may seek refuge from high water temperatures in water greater than 30 feet in depth (below the thermocline). However, they do not always avoid warm water once in Lake Washington. Adult Chinook salmon will hold at the mouths of natal tributaries in warm shallow water prior to migrating upstream (R. Tabor and F. Goetz pers comm). While adult Chinook salmon would not typically be harmed by brief exposure to elevated turbidity levels, adult Chinook salmon in the action area will be heat-stressed after migrating over six miles through the Ship Canal. Heat stress increases salmonids' sensitivity to other stressors, including turbidity (Materna 2001). NMFS expects that adult Chinook salmon exposed to elevated turbidity will alter their migration routes and experience sublethal physiological stress. These effects may lead to reduced spawning success.

2.4.1.2.4 East Approach. The project activities that will cause turbidity in the east approach portion of the action area are the vibratory installation of sheet piles to construct cofferdams, the vibratory installation of drilled shaft casings, and the removal of temporary steel piles. The vibratory installation of the drilled shaft casings and sheet piles will take place between September 1 and May 15. Removal of the temporary steel piles and sheet piles will take place between July 1 and March 15. NMFS does not expect adult Chinook salmon or adult or juvenile

steelhead to be present near the east approach during these windows. Residual Chinook salmon will be present year round and juvenile Chinook salmon will be present from February to July in small numbers. NMFS expects any exposed PS Chinook salmon will experience sublethal physiological stress.

2.4.1.2.5 Habitat Restoration Activities. With the exception of the Cedar River site (and the previously consulted upon Bear Creek project), all of the habitat projects are on, or adjacent to, the Lake Washington shoreline. For sites north of the existing SR 520 Bridge, the in-water work will take place between July 16 and March 15. For sites south of the bridge, the in-water work will take place between July 16 and April 30. These work windows will avoid emigrating juvenile Chinook salmon. NMFS does not expect adult or juvenile steelhead or adult Chinook salmon to be harmed by turbidity from these habitat projects. These fish are larger in size and are unlikely to be affected by short-term exposure to elevated turbidity. Furthermore, they are not shoreline-oriented and will not be displaced from their preferred habitat if they avoid areas of higher turbidity. Residual Chinook salmon exposed to elevated levels of turbidity from these habitat projects will experience displacement from preferred habitats and physiological stress. Table 4 show the total area of habitat that will experience elevated suspended sediment.

Table 4. Habitat Project Suspended Sediment Exposure

Habitat Project	Area of Elevated Suspended Sediment (acres)
DNR Parcel (Lake Washington)	2.2
Cedar River (RM 5.3)	2.1
Taylor Creek	0.8
Seward Park (Lake Washington)	3.1
Magnuson Park (Lake Washington)	4.3

At the Cedar River site (RM 5.3), all in-water work will take place between August 1 and August 31. This window overlaps with adult Chinook salmon migration, juvenile steelhead rearing, and steelhead egg incubation in the Cedar River. Because adult Chinook salmon are not heat stressed once they reach the Cedar River, NMFS does not expect adult Chinook salmon to be affected by the pulses of suspended sediment generated during the in-water work because adult salmonids can tolerate short-term increases in suspended sediment (Bjornn and Reiser 1991). Juvenile steelhead may be present during the in-water work in very low numbers. Any 0+ and 1+ juvenile steelhead exposed to elevated levels of turbidity from these habitat projects will experience displacement from preferred habitats and physiological stress. Larger juvenile steelhead (2+) are unlikely to respond adversely to their exposure.

Given the extremely low number of returning adult steelhead (e.g. four fish in 2008) and the miles of available spawning habitat in the Lake Washington Basin, NMFS considers the probability of steelhead redds being present within the action area to be discountable.

2.4.1.3 Impact Pile Driving

High levels of underwater sound can injure or kill fish and cause alterations in behavior (Turnpenny et al. 1994; Turnpenny and Nedwell 1994; Popper 2003; Hastings and Popper 2005).

Death from barotrauma can be instantaneous or delayed up to several days after exposure. Even in the absence of mortality, elevated noise levels can cause sublethal injuries. Fish suffering damage to hearing organs may suffer equilibrium problems, and may have a reduced ability to detect predators and prey (Turnpenny et al. 1994; Hastings et al. 1996). Hastings (2007) determined that a Sound Exposure Level (SEL) as low as 183 dB (re: 1 μPa^2-sec) [2] was sufficient to injure the non-auditory tissues of juvenile spot (*Leiostomus xanthurus*) and pinfish (*Lagodon rhomboides*) with an estimated mass of 0.5 grams.

Adverse effects on survival and fitness can occur even in the absence of overt injury. Exposure to elevated noise levels can cause a temporary shift in hearing sensitivity (referred to as a temporary threshold shift), decreasing sensory capability for periods lasting from hours to days (Turnpenny et al. 1994; Hastings et al. 1996). Popper et al. (2005) found temporary threshold shifts in hearing sensitivity after exposure to cumulative SELs as low as 184 dB. Temporary threshold shifts reduce the survival, growth, and reproduction of the affected fish by increasing the risk of predation and reducing foraging or spawning success.

Cumulative SEL is a measure of the risk of injury from exposure to multiple pile strikes. The Equal Energy Hypothesis, described by NMFS (2007), is used as a basis for calculating cumulative SEL. The number of pile strikes is estimated per continuous work period. This approach assumes that there will be a break of at least 12 hours between work periods. NMFS uses the practical spreading model to calculate transmission loss. The NMFS, USFWS, FHWA, and WSDOT agreed to interim criteria to minimize potential impacts to fishes (FHWG 2008). The interim criteria include peak sound pressure level (SPL) and SEL injury threshold limits of:

- Peak SPL: levels at or above 206 dB from a single hammer strike likely results in the onset of physical injury.
- SEL: cumulative levels at or above 187 dB for fish sizes of 2 grams or greater, or 183 dB for fish smaller than 2 grams. (All Chinook salmon and steelhead within the action area during impact pile driving will exceed 2 grams. Therefore, the injury threshold for cumulative SEL for this project is 187 dB.)
- The current criteria also include the disturbance threshold of 150 dB_{rms} for potentially altering fish behavior.

NMFS uses an SPL of 150 dB_{rms} as a guideline for when underwater sound may alter fish behavior. Whether these behavior alterations occur or result in actual injury is dependent on project specific factors. For the proposed action, NMFS does not expect underwater sound to alter the behavior of PS Chinook salmon or PS steelhead to the extent to cause actual injury because the timing of impact pile driving will avoid adult Chinook salmon and juveniles of both species. PS steelhead may avoid areas near pile driving; however, NMFS does not expect this to delay migration or significantly alter migration routes.

In analyzing the sound levels for impact pile driving, NMFS typically uses underwater sound data from previous projects with the same or similarly sized piles. Given the very soft substrates in Portage and Union bays, WSDOT and NMFS predicted that the actual underwater sound

[2] Throughout this document, the reference values for dB SEL is 1 μPa^2-sec.

levels from impact pile driving in these areas would be substantially lower than previous projects. In October 2009, WSDOT and FHWA conducted a test pile project to collect site specific data in Union and Portage Bays. The study measured underwater sound levels for impact pile driving and evaluated the effectiveness of three attenuation BMPs. Two of the BMPs, a confined bubble curtain and an unconfined bubble curtain, substantially attenuated underwater sound. The third BMP was not effective. For the analyses of impact pile driving for Portage Bay and the west approach, NMFS used the site-specific data from this study, including the bubble curtain performance (between 19dB and 30dB reduction).

The substrate at the east approach is more similar to previous pile driving projects than Portage and Union bays. Therefore, NMFS used data from past projects to analyze effects from impact pile driving at the east approach (Illingworth and Rodkin 2007; WSDOT unpublished data). Based on past data, NMFS predicts that the confined or unconfined bubble curtain will achieve a 10dB reduction at this location.

Below, NMFS describes the physical and temporal extent of injurious levels of underwater sound and the life history stages of PS Chinook salmon and PS steelhead that will be exposed. However, NMFS cannot estimate the number of individuals that will experience adverse effects from underwater sound. Impact pile driving will occur episodically throughout the in-water work seasons. NMFS cannot predict the number of individual fish that will be exposed. Furthermore, not all exposed individuals will experience adverse effects. Therefore, NMFS will use the physical and temporal extent of injurious levels of underwater sound to analyze the effects to PS Chinook salmon and PS steelhead.

For all of the work bridges and falsework in the work areas described below, WSDOT will use a vibratory hammer to drive the piles. However, in order to ensure that the pile will be able to support the weight of construction equipment, WSDOT will finish driving each pile with an impact hammer. WSDOT will use a confined or unconfined bubble curtain for all impact pile driving.

2.4.1.3.1 Portage Bay. To construct the temporary work bridges, WSDOT will drive 900, 24- to 30-inch steel piles between September 1, 2013 and April 30, 2014. In order to construct the falsework, WSDOT will drive 200, 24- to 30-inch steel piles between September 1, 2014 and April 30, 2015 and an additional 200 piles between September, 2016 and April 30, 2017. WSDOT estimates that the maximum piles and pile strikes per day for the work bridges will be 32 and 16,000 (500 strikes per pile), respectively. For the falsework piles, the maximum piles per day will be 16 with up to 8,000 impact pile strikes.

The NMFS estimates that the maximum sound levels for a single strike in Portage Bay will be 169 dB_{peak}, 155 dB_{rms}, and 139 dB SEL after attenuation based on data from the test pile project, (I&R, 2010). Using the above methodology and project information provided in the BA, NMFS calculated the distance from and the area that will be subjected to cumulative SELs greater than or equal to 187dB. The area within two meters of the pile driving (270 square feet per pile) will be affected. Table 5 gives the total area that will be subjected to cumulative SELs 187dB or higher per construction year. Table 6 gives the maximum area that will be affected in any single day.

Table 5.

Total Area (Acres) Exposed to Cumulative Sound Exposure Levels Greater than 187dB per Construction Year								
Project Area	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Total**
Portage Bay	N/A	1.9	0.8	N/A	0.8	N/A	N/A	**3.5**
West Approach (Arboretum/ Foster Island)	N/A	1.3	N/A	1.6	N/A	N/A	N/A	**2.9**
West Approach (east of Foster Island)	N/A	4.0	N/A	3.8	N/A	N/A	N/A	**7.8**
East Approach	150.2	134.1	N/A	N/A	N/A	N/A	N/A	**284.3**
Total	**150.2**	**141.3**	**0.8**	**5.4**	**0.8**	N/A	N/A	**298.5**

Table 6.

Maximum Daily Area (Acres) Exposed to Sound Exposure Levels Greater than 187dB								
Project Area	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Total**
Portage Bay	N/A	0.2	0.1	N/A	0.1	N/A	N/A	**0.4**
West Approach (Arboretum Foster Island)	N/A	0.1	N/A	0.1	N/A	N/A	N/A	**0.2**
West Approach (east of Foster Island)	N/A	0.8	N/A	0.8	N/A	N/A	N/A	**1.6**
East Approach	125.4	125.4	N/A	N/A	N/A	N/A	N/A	**250.8**
Total	**125.4**	**126.5**	**0.1**	**0.9**	**0.1**	N/A	N/A	**253.0**

The in-water work window of September 1 to April 30 will avoid emigrating juvenile Chinook salmon and steelhead, but overlaps with the adult Chinook salmon and steelhead migration. As described above, adults from both species migrate quickly through the ship canal. NMFS does not expect adults from either species to be exposed to injurious levels of underwater sound in the

action area in southern Portage Bay. Residual Chinook salmon present in the action area of Portage Bay during the in-water work will be exposed to injurious levels of underwater sound. NMFS expects that these individuals will be injured or killed.

2.4.1.3.2 West Approach (Arboretum and Foster Island). To construct the temporary work bridges for the west approach (Arboretum and Foster Island), WSDOT will drive 500, 24- to 30-inch steel piles between September 1, 2013 and April 30, 2014 and an additional 600 piles between September 1, 2015 and April 30, 2016. WSDOT estimates that the maximum piles and pile strikes per day for the work bridges will be 16 and 8,000 (500 strikes per pile), respectively.

The in-water work window (September 1 to April 30) for impact pile driving for this area will avoid out-migrating juvenile Chinook salmon and steelhead. While this window overlaps with the adult Chinook salmon and steelhead migrations, injurious levels of underwater sound from impact pile driving in this area will not extend into areas used by these fish for migration. Migrating adult fish may occasionally move through this area, but, due to the habitat conditions (shallow, narrow waterways with dense aquatic vegetation), they are unlikely reside for any length of time. NMFS estimates that the maximum sound levels for a single strike in this area will be 169 dB_{peak}, 155 dB_{rms}, and 139 dB_{SEL} after attenuation. These sound levels are not enough to cause injury for a single strike. In order in to sustain injury (cumulative SEL of 187dB), adult Chinook salmon and steelhead would have to remain within two meters of the pile for over 700 strikes. NMFS considers this scenario unlikely. Residual Chinook salmon could spend longer periods of time in this area, particularly in the winter months when water temperatures are lower and predators (largemouth and smallmouth bass) are less active. NMFS expects any residual Chinook salmon to be injured or killed.

2.4.1.3.3 West Approach (East of Foster Island). To construct the temporary work bridges for the west approach east of Foster Island, WSDOT will drive 450, 24- to 30-inch steel piles between October 1, 2013 and April 30, 2014 and an additional 500 piles between October 1, 2015 and April 30, 2016. WSDOT estimates that the maximum piles and pile strikes per day for the work bridges will be eight and 4,000 (500 strikes per pile), respectively.

Results from the test pile project demonstrated that attenuated underwater sound levels for the west approach near Foster Island were similar to Portage Bay and that the bubble curtains were less effective near western end of the west approach. NMFS estimates that the maximum sound levels for a single strike in the west approach near Foster Island will be 169 dB peak, 155 dB_{rms}, and 139 dB SEL after attenuation and 178 dB_{peak}, 167 dB_{rms}, and 155 dB SEL after attenuation for the western end of Foster Island (Illingworth and Rodkin 2010). For the west approach near Foster Island, the area within two meters of the pile driving (270 square feet per pile) will be affected. For the western end of the west approach, the area within 19 meters of the pile driving (0.1 acres per pile) will be affected. Table 5 gives the total area that will be subjected to cumulative SELs 187dB or higher per construction year. Table 6 gives the maximum area that will be affected in any single day.

The in-water work window for impact pile driving will avoid out-migrating juvenile Chinook salmon and steelhead and adult Chinook salmon. Residual Chinook salmon and adult steelhead will be exposed to injurious levels of underwater sound at the west approach. NMFS expects

residual Chinook salmon to be injured or killed. However, given their larger size, NMFS expects adult steelhead will experience sublethal effects including temporary threshold shifts.

2.4.1.3.4 East Approach. To construct the temporary work bridges, WSDOT will drive 125, 24- to 30-inch steel piles between August 16, 2012 and March 15, 2013. To construct the falsework, WSDOT will drive 40, 24- to 30-inch steel piles between August 16, 2013 and March 15, 2014. WSDOT estimates that the maximum piles and pile strikes per day will be eight and 4,000 (500 strikes per pile), respectively.

The test pile project did not cover the east approach area. Therefore, WSDOT will perform up to 500 unattenuated pile strikes to gather baseline data. This will allow them to ensure that the bubble curtain is working properly. NMFS used monitoring data from past projects to predict the levels of underwater sound in this area (Illingworth and Rodkin 2007; WSDOT unpublished data). Because the substrate at the east approach is harder than Portage Bay or the west approach, these values are substantially higher. NMFS estimates that the maximum sound levels for a single strike at the east approach will be 202 dB $_{peak}$, 185 dB $_{rms}$, and 176 dB SEL after attenuation. Using the above methodology and project information provided in the BA, NMFS calculated the distance from and the area that will be subjected to cumulative SELs greater than or equal to 187dB. The area within 541 meters of the pile driving (125.4 acres per pile) will be affected. Table 5 gives the total area that will be subjected to cumulative SELs 187dB or higher per construction year. Table 6 gives the maximum area that will be affected in any single day.

The in-water work window will avoid out-migrating juvenile Chinook salmon and steelhead, but overlaps with the adult Chinook salmon and steelhead migration. However, the east approach is not near any natal streams for Chinook salmon or steelhead, nor is the east approach between the Ship Canal and natal Chinook salmon and steelhead streams. While adult Chinook salmon will hold at tributary mouths prior to migrating up their natal tributaries, there is no evidence that adults of either species use other areas of Lake Washington for anything other than migration. However, given the much higher sound levels in this location, even actively migrating adult fish could be exposed to enough pile strikes to cause injury. NMFS expects adult Chinook salmon and adult steelhead will experience sublethal effects including temporary threshold shifts.

Residual Chinook salmon will be in the action area of the east approach during impact pile driving and will be exposed to injurious levels of underwater sound. NMFS expects that these individuals will be injured or killed.

2.4.1.4 Overwater Structure

Prior to 2001, most evidence for over-water structure effects on juvenile salmon migration was observational (Simenstad et al. 1999). The two primary concerns with overwater structures for juvenile Chinook salmon are migration delays and increased vulnerability to predators. In 2001, the USFWS began a series of studies to characterize the movement and habitat use of juvenile Chinook salmon and two of their predators in Lake Washington and the Ship Canal (Celadonia et al. 2008a). These studies included acoustic tracking of tagged juvenile Chinook salmon. Between 2003 and 2008, the USFWS studied the movement and habitat use of juvenile Chinook salmon, smallmouth bass, and northern pikeminnow in the Ship Canal and at the SR 520 bridge

west approach (east of Foster Island) using acoustic tracking (Celadonia et al. 2008a; 2008b; 2009). Below are summaries of the findings of these studies.

Celedonia et al. (2008a) reported findings from tracking studies performed in Lake Washington and the Ship Canal during May, June, and July of 2004 and 2005:

1. Juvenile Chinook salmon movement patterns varied within each site, from site to site, and from year to year. Each site was used differently by juvenile Chinook salmon, and the behavior of individual fish varied considerably.

2. Juvenile Chinook salmon showed two predominant migratory behaviors: active migration, where they swam rapidly toward Puget Sound; and holding, where they appeared paused in their migration.

3. At the one site studied in both years (Portage Bay), juvenile Chinook salmon movement patterns were different in the two sample years. In 2004, most fish spent several hours to several days at the site, whereas in 2005 most fish actively migrated spending less than one hour at the site. Differences in timing of moon apogee relative to tagged fish release appeared to be the primary contributing factor to these differences.

4. Distinct diel patterns were observed. In Lake Washington, juvenile Chinook salmon were close to shore in shallow water (1 to 5 m) during the day, and far offshore in limnetic areas at night.

5. Overwater structures and macrophyte beds appeared to influence movement patterns and depth selection. Actively migrating juvenile Chinook salmon appeared to change course as they approached and moved around structures. Fish appeared less hesitant to pass beneath narrow structures. Fish also sometimes moved into deeper water to travel beneath or around structures.

6. When macrophytes were present, juvenile Chinook salmon appeared to use deeper water, moving above the macrophyte canopy rather than avoiding macrophytes altogether. Macrophytes appear to function as a false bottom.

7. Smallmouth bass were generally close to shore in water that was less than four meters deep. Smallmouth bass were usually closely associated with overwater structure, steep sloping shoreline, and the offshore edge of aquatic macrophytes. Overlap in habitat between smallmouth bass and juvenile Chinook salmon appears to occur within each of these habitat types.

8. Prickly sculpin were primarily active at night, especially in shallow water. Nighttime patterns of prickly sculpin behavior may help explain the distribution of juvenile Chinook salmon (nighttime selection of offshore limnetic areas).

Celedonia et al. (2008b) reported findings from tracking studies performed in Lake Washington during May to August of 2007:

1. Behaviors of juvenile Chinook salmon were similar within release groups, but varied considerably between release groups. June 1 smolts exhibited an active migration pattern, rapidly migrating through the study site. June 14 and 28 smolts exhibited holding behaviors at or near the study site. Differences in migration cues (moon apogee), physiological status, water temperature and clarity, and prey availability may have contributed to the observed differences in behavior between release groups.

2. There was no evidence that the bridge at any time presented a complete barrier to juvenile Chinook salmon migration. Common behaviors included: 1) fish passing beneath the bridge with no apparent delay; 2) fish passing beneath the bridge after delays of a few seconds up to 46 minutes; and 3) fish passing beneath the bridge on multiple occasions.

3. Among actively migrating juvenile Chinook salmon, slightly more than one-third were delayed 3 to 46 minutes (median 15 minutes). Slightly less than one-third were delayed for less than one minute, and one-third appeared completely unhindered by the presence of the bridge.

4. Behavior may have been influenced by water depth, height of the bridge above the water surface, location of the bridge shadow at time of encounter, degree of contrast at the light-shadow edge, light intensity at time of crossing, and presence and variation in macrophyte density. Many of these factors varied together, and thus could not be isolated for their individual influence on behavior.

5. Holding juvenile Chinook salmon often crossed beneath the bridge to the north and were later observed returning to and holding in areas around the bridge. Holding smolts selected for areas near the bridge (5 to 20 meters from bridge edge), as well as areas of dense macrophytes away from the bridge. When near the bridge, smolts selected deeper water.

6. Holding behaviors may be triggered by an inhibition to enter the Montlake Cut arising from one or more ecological barriers, such as high water clarity, lack of directional flow, and/or elevated water temperatures. Inhibitions may also arise from a decrease in migration urge associated with desmoltification caused by prolonged exposure to elevated water temperatures.

7. Smallmouth bass previously captured in the Ship Canal were observed at the study site. Small bass overwhelmingly selected for nearshore overwater structures, and made no notable use of the bridge. Larger bass selected for both nearshore overwater structures and the bridge. Some bass were closely associated with bridge columns.

Celedonia et al. (2009) reported findings from tracking studies performed in Lake Washington during May to August of 2008:

1. Patterns in juvenile Chinook salmon behavior were similar to those observed in 2007, generally similar within release groups, but varied considerably between release groups. Three release groups primarily exhibited holding behaviors.

2. As in 2007, response to the bridge was at least partially dependent upon whether fish were actively migrating or holding. Behaviors of actively migrating fish were similar in both years, although few independent observations were obtained in 2008. Combining both years, 35 percent of actively migrating smolts showed minimal or no response to the bridge, 42 percent paralleled the bridge before passing underneath, and 23 percent paralleled the bridge and milled near the bridge before passing underneath. Median delay was 63 seconds (range 6 seconds to 19 minutes) for paralleling fish, and 22 minutes (range 3 to 46 minutes) for milling fish.

3. Holding juvenile Chinook salmon commonly selected for areas near the bridge (within 20 m) or condominium on the south side of the site. During the day, fish selected for deeper water when near the bridge or condominium than when they were not near either structure. Similar observations were made in 2007.

4. At night, juvenile Chinook salmon were attracted to areas where street lamps cast light into the water. A reevaluation of 2007 data found a similar pattern. Bridge lighting may be partially responsible for nighttime selection of the bridge area by juvenile Chinook salmon. However, neither smallmouth bass nor northern pikeminnow were attracted to the lights.

5. Results for northern pikeminnow and smallmouth bass were similar to 2007, and therefore data from both years were combined to provide more robust analyses. Northern pikeminnow concentrated in moderately dense vegetation, with no strong affinity for the bridge. Smallmouth bass did show a strong affinity for overwater structures, including the bridge. Smallmouth bass were also often closely associated with bridge columns.

6. Juvenile salmonids made up 35 percent of the northern pikeminnow diet. Approximately half of the smallmouth bass diet was composed of juvenile salmonids.

7. The authors suggest, with regard to holding behaviors and daytime attraction to the bridge, that the proposed bridge should lessen attraction. Consequences could include shorter area residence times. The proposed new bridge would reduce the quality of habitat for smallmouth bass.

Together these reports and findings suggest 1) some emigrating juvenile Chinook salmon experience a measurable delay in travel time in response to the existing bridge; 2) some juvenile Chinook salmon use the bridge as cover during day and/or night, typically occupying deeper portions of the lake than they might otherwise; 3) nighttime selection of the bridge may be a response to artificial light cast on to the adjacent waters, but may also reflect behavioral avoidance of littoral foraging sculpin (or other predators); and, 4) where holding or milling behaviors are exhibited, they may be in response to any number of factors and cannot be causally linked to the bridge's influence alone.

Based on the results of these studies, NMFS quantified the stressors from over-water as the total area shaded (behavior changes) and the area within five feet of piles or columns (predation zone). The predation zone area is based on data describing predator behavior and is defined as the plan view distance of the portion of the water body extending from the outside edge of a column or pier to a distance of five feet. The five-foot distance is based on field observations and scientific studies of the visual detection and reaction distances in picivorous fish. For example, Sweka and Hartman (2003) measured a maximum reactive distance for smallmouth bass of 2.1 feet in clear water. The reactive distance decreased exponentially with increasing turbidity. Similar reactive distances (between 0.8 and 6.6 feet) have been measured for largemouth bass (Howick and O'Brien 1983; Savino and Stein 1989), with the vast majority of strikes occurring within a distance of five feet. Based on these data, a predation zone of five feet was applied to each pile and column.

2.4.1.4.1 Portage Bay. Table 7 shows the area of over water cover for Portage Bay for the existing and new bridges, as well as for each year of construction. Celodonia et al. (2008a) described two primary behaviors for juvenile Chinook salmon tracked in northern Portage Bay, active migration and holding. Forty-seven percent of fish tracked were actively migrating. These fish were tracked only once moving quickly through the tracking area towards Puget Sound. Actively migrating Chinook salmon smolts are unlikely to enter the action area in southern Portage Bay. Shade from the existing, temporary, and new bridges in Portage Bay will not cross the migratory path of Chinook salmon smolts and will not cause migration delays.

Table 7.

Total Area of Overwater Coverage from Existing, New, and Temporary Structures (Acres)									
Project Area	**Existing**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Permanent**
Portage Bay	**3.1**	3.1	8.9	8.9	11.1	9.3	5.2	9.6	**7.6**
Montlake Cut	**0.2**	0.2	0.2	0.2	0.2	0.2	0.4	0.4	**0.4**
West Approach (Arboretum/ Foster Island)	**6.6**	6.6	9.2	12.3	16.6	16.0	12.7	12.7	**8.4**
West Approach (east of Foster Island)	**5.6**	5.6	8.3	15.8	19.1	17.4	13.9	13.9	**10.6**
East Approach	**0.7**	2.4	2.4	2.4	2.4	1.3	1.3	1.3	**1.3**
Total	**16.2**	17.9	29.0	38.3	47.2	44.2	33.5	37.9	**28.3**

Forty-three percent of the juvenile Chinook salmon tracked in northern Portage Bay exhibited holding behavior. These fish moved in and out of the tracking area repeatedly and resided in the

area for up to 74 hours. Celadoina et al. (2008a) concluded that the tracking area was part of a larger area the holding fish were using. An unknown portion of juvenile Chinook salmon exhibiting holding behavior within Portage Bay are likely enter the action area in southern Portage Bay. Celedonia et al. (2008b) found smallmouth bass closely associated with existing columns. While the project will reduce the total number of columns and piles in the long term, from 99 to 50, during construction there will be a dramatic increase in the number of piles and columns, with a peak of 1,173 in 2015 (Table 8). This will increase the amount of smallmouth bass habitat in southern Portage Bay during construction and lead to increased predation rates on holding juvenile Chinook salmon in this area (Table 9). NMFS cannot predict the number or proportion of holding juvenile Chinook salmon that will choose to venture into the action area in southern Portage Bay and be exposed to increased predation from smallmouth bass. NMFS also cannot predict what proportion of the exposed fish will actually be eaten. Therefore, NMFS will use the area within five feet of piles and columns to quantify the effects on holding juvenile Chinook salmon in this area.

Table 8

Total Number of Columns and Piles from Existing, New, and Temporary Structures									
Project Area	**Existing**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Permanent**
Portage Bay	**99**	99	1,031	1,017	1,173	500	700	700	**50**
Montlake Cut	**0**	0	0	0	0	0	0	0	**0**
West Approach (Arboretum/ Foster Island)	**186**	186	746	649	1,293	704	704	704	**104**
West Approach (east of Foster Island)	**228**	228	702	774	1,316	1,227	629	629	**129**
East Approach	**14**	148	188	188	188	9	9	9	**9**
Total	**527**	661	2,667	2,628	3,970	2,440	2,042	1,342	**292**

Table 9

Total Area Within Five Feet of Columns and Piles from Existing, New, and Temporary Structures (Acres)									
Project Area	**Existing**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Permanent**
Portage Bay	**0.37**	0.37	3.15	3.05	3.63	1.50	2.14	2.14	**0.25**
Montlake Cut	**0**	0	0	0	0	0	0	0	**0**
West Approach	**0.71**	0.71	2.16	1.97	3.81	2.01	2.01	2.01	**0.27**

(Arboretum/ Foster Island)									
West Approach (east of Foster Island)	**0.90**	0.90	2.21	2.56	4.28	3.97	2.07	2.07	**0.62**
East Approach	**0.06**	0.44	0.57	0.57	0.51	0.03	0.03	0.03	**0.03**
Total	**2.04**	2.42	8.09	8.15	12.23	7.51	6.25	6.25	**1.17**

2.4.1.4.2 Montlake Cut. Because of conflicts with boat traffic, the tracking studies have not examined juvenile Chinook salmon use within Montlake Cut itself. However, given the habitat conditions in the Cut, NMFS expects juvenile Chinook salmon to migrate rapidly through the Cut. NMFS does not expect the 0.4 acre of shade from the existing and new Montlake bridges to delay juvenile Chinook salmon migration. Furthermore, both the existing and new bridges will have a grated deck which will allow some light through and generate a less intense shadow. The existing and new bridges do not have any in-water piles or columns. Therefore, the action will not increase predation from smallmouth bass in the Montlake Cut.

2.4.1.4.3 West Approach (Arboretum and Foster Island). As described above, juvenile Chinook salmon rarely use this area. The existing, temporary, and new bridges in this area do not cross the migratory corridor, and NMFS does not expect actively migrating juvenile Chinook salmon to use this area. Therefore, shading from these bridges is not likely to cause migration delays. However, NMFS expects that small numbers of holding juvenile Chinook salmon explore this area for short periods of time. Similar to the Portage Bay area, the project will dramatically increase the number of in-water piles and columns during construction (a peak of 1,293 in 2015) and reduce the total number of columns and piles in the long term (from 186 to 104). The small number of holding juvenile Chinook salmon will be exposed to greater predation from smallmouth bass for short periods of time during the five years of construction (Table 9). Residual Chinook salmon will also be exposed to greater predation risk during construction.

2.4.1.4.4 West Approach (East of Foster Island). State Route 520 in this area crosses the primary migratory corridor for juvenile Chinook salmon from the Cedar River. The proposed action will expose migrating juvenile Chinook salmon to increased shading (from the existing, new, and temporary work bridges, and barges). As described above, Celadonia et al. (2009) found that 65 percent of actively migrating fish were delayed by the bridge with a maximum delay time of 46 minutes. Forty-five percent of these delayed fish (29 percent of the actively migrating fish) were delayed for less than three minutes. During construction, NMFS expects that both the percentage of actively migrating fish delayed and the length of the delay to increase due to the increased area of shading (from 5.6 acres from the existing bridge to greater than 20 acres in 2015), the greater light/dark contrast of the shadow produced by the work bridges and barges, and the increase in the number of light/dark transitions. Given the overall magnitude of the shading during construction, NMFS expects that, between 2014 and 2018, virtually all

actively migrating fish will experience some delay and the maximum delay time could increase to three hours.

The new bridge will permanently increase shading in this area from 5.6 acres to 10.6 acres and, because of a 50-foot gap between the eastbound and west bound bridges, double the number of light/dark transitions. These changes are likely to increase both the percentage of actively migrating fish that are delayed and the length of delay compared to the existing bridge. However, the new bridge will be higher than the existing, and will therefore produce a shadow with a less intense light/dark contrast. This may reduce the magnitude of the delay.

De Vries et al. (2008) released tagged juvenile Chinook salmon in Bear Creek and the Cedar River. Mean travel time ranged from 13 to 16 days. It is unlikely that delays of a few minutes to a few hours will cause reduced survivorship or fitness of juvenile Chinook salmon migrating through the action area.

Similar to the Portage Bay area, the project will dramatically increase the number of in-water piles and columns during construction (a peak of 1,316 in 2015) and reduce the total number of columns and piles in the long term (from 228 to 129). The majority of the in-water structures (950) are temporary piles to support the temporary work bridges. WSDOT will construct the work bridges in water 10-feet deep or shallower. Celadonia et al. (2009) found that both smallmouth bass and juvenile Chinook salmon selected water depths between 13 and 26 feet deep when near the existing west-approach bridge. The temporary piles are much less likely to be used as habitat by smallmouth bass and juvenile Chinook salmon are less likely to encounter any smallmouth bass in this area. The greatest increase in smallmouth bass habitat will occur between 2013 and 2016 when the existing and new columns will be present in the depths between 13 and 26 feet. This will increase the predation risk to juvenile Chinook from smallmouth bass during these years. Overall, the project will reduce the number of in-water columns and the risk of predation from smallmouth bass.

2.4.1.4.5 East Approach. While juvenile Chinook salmon do migrate along the eastern shore of Lake Washington, their numbers are much lower than the western shore due to the distance of the east approach from any natal streams and the Ship Canal (Tabor et al. 2006). Juvenile Chinook salmon exposed to the over-water structures and in-water piles and columns will experience similar effects as described for other the other portions of the project. The increase in piles and columns during the four years of construction (a peak of 188 from 2013 to 2015) will increase the availability of smallmouth bass habitat at the east approach and increase the risk of predation for juvenile Chinook salmon. The new bridge will have fewer piles than the existing bridge (from 14 to nine) (Table 8).

Shading from the 1,500 square-foot maintenance dock and the work bridges will be more pronounced than the shade of the new east approach bridge. The maintenance dock and work bridges will be less than three feet above the lake. Overwater structure this close to the water surface creates a shadow with a greater light/dark contrast. Juvenile Chinook salmon that encounter these types of structures typically migrate around the perimeter and return to shallower water (Tabor et al. 2006). Juvenile Chinook salmon in Lake Washington in May and June typically inhabit waters between 3 to 18 feet deep during the day to reduce predation risk. The

end of the dock is in water approximately 20 feet deep. Juvenile Chinook salmon moving around the dock will be forced into water deeper than they prefer and will briefly be exposed to greater predation risk.

Shade from the east approach bridge will function similarly to the west approach and have similar effects to juvenile Chinook salmon. Because fewer juvenile Chinook salmon migrate along the eastern shore, there will be substantially fewer individuals exposed to shading at the east approach. The new east approach bridges will be 66 to 78 feet above the water creating a shadow with less light/dark contrast.

2.4.1.4.6 Summary of Effects of Overwater Structure. The NMFS does not expect the over-water structures to affect the migration of adult Chinook salmon or adult and juvenile steelhead. These actively migrating fish do not show behavioral responses to over-water shade. NMFS also does not expect in-water piles and columns to increase predation on these life history stages. Adult Chinook salmon and steelhead are too large to be preyed upon by smallmouth bass. Juvenile steelhead smolts are too large (greater than 175mm) for most size classes of smallmouth bass, better able to avoid predation, and less likely than juvenile Chinook salmon to migrate through preferred smallmouth bass habitat.

2.4.1.5 Fish Handling

Handling stresses fish, increasing plasma levels of cortisol and glucose (Hemre and Krogdahl 1996; Frisch and Anderson 2000). Electrofishing can kill fish or cause physical injuries including internal hemorrhaging, spinal misalignment, or fractured vertebrae. Although potentially harmful to fish, electrofishing is intended to locate fish in the isolated work area for removal to avoid more certain injury. Ninety-five percent of fish captured and handled survive with no long-term effects, and up to five percent are expected to be injured or killed, including delayed mortality because of injury (NMFS 2003).

2.4.1.5.1 Fish Handling at Concrete Technology Corporation. WSDOT will construct 23 supplement stability pontoons (SSPs) at the CTC site in the Blair waterway of Commencement Bay. The WSDOT estimates 10 gate openings to launch the 23 SSPs between August 2012 and June 2014. The casting basin is approximately 77,500 square feet. When the gate is open and the basin flooded, fish can enter the casting basin. WSDOT will remove fish once the gate is closed and the basin has begun to drain. NMFS considers the potential for adult Chinook salmon and steelhead and emigrating steelhead smolts to enter the casting basin to be discountable. These fish migrate rapidly through Commencement Bay and do not use the Blair waterway. Juvenile Chinook salmon use the nearshore of Commencement Bay from March 1 to July 1, and their numbers peak between May 15 and June 15 (Kerwin 1999). Of the 10 scheduled openings, three will occur from March 1 and May 15, and four from May 15 and June 15. As described above, between March 1and May 15, juvenile Chinook salmon densities in Commencement Bay averaged 0.001 fish per square foot, and between May 15 and June 15, densities averaged 0.060 fish per square foot (Pacific International Engineering 2000; 2002). Using this data, NMFS expects that up to 78 juvenile Chinook salmon could be within the casting basin for each of the three launchings (a total of 234) between March 1 and May 15, and up to 4,650 fish for each of the four launchings (a total of 18,600) between May 15 and June 15. Five percent of these fish

could be injured or killed, a total of 942 fish. Using average smolt-to-adult survival rates from Quinn (2005) of 0.031 for Chinook salmon, this equates to 29 adult equivalents.

2.4.1.5.2 Portage Bay. To construct mudline footings, WSDOT will install cofferdams in Portage Bay between August 16, 2014 and April 30, 2015 and August 16, 2015 and April 30, 2016. The cofferdams will occupy approximately 14,000 square feet of substrate. After completion of the cofferdam, they will remove any trapped fish using NMFS-approved WSDOT fish handling protocols to the greatest extent practical (WSDOT 2009a). As described above, NMFS does not expect adult or juvenile Chinook salmon or adult or juvenile steelhead to be present in southern Portage Bay between August 16 and April 30. Residual Chinook salmon will be present and small numbers could be trapped within the cofferdams. The cofferdams will enclose 8,200 square feet in 2014 and 5,500 in 2016. NMFS does not have density data for residual Chinook salmon in Portage Bay or other parts of the Ship Canal or Lake Washington. However, Tabor et al. (2006) reported densities of juvenile Chinook salmon at 11 sites in Lake Washington from February to July. By July, densities of juvenile Chinook salmon had dropped to less than 0.02 fish per square foot. Using this density data, NMFS expects that up to 164 residual Chinook salmon could be within the cofferdams in 2014 and 110 in 2016. Five percent, or up to 14 fish, could be injured or killed.

2.4.1.5.3 East Approach. To construct mudline footings, WSDOT will install cofferdams at the east approach between September 1, 2012 and May 15, 2013. The cofferdams will occupy approximately 9,550 square feet of substrate. After completion of the cofferdam, they will remove any trapped fish using approved WSDOT fish handling protocols (WSDOT 2009a). As described above, NMFS does not expect adult Chinook salmon or steelhead to be present near the east approach during this window. Residual Chinook salmon will be present year round and juvenile Chinook salmon will be present from February to July in small numbers. These fish could be trapped within the cofferdams. Tabor et al. (2006) found juvenile Chinook salmon densities as high as 0.15 per square foot at site along the eastern shore of Lake Washington between February and May 15 (the end of the in-water work window). Using this density data, NMFS expects that up to 1,433 juvenile and residual Chinook salmon could be within the cofferdams in 2012. Five percent, or up to 72 fish, could be injured or killed. Using average smolt-to-adult survival rates from Quinn (2005) of 0.031 for Chinook salmon, this equates to two adult equivalents.

2.4.1.6 Stormwater

Widening SR 520 will increase PGIS and stormwater runoff in the action area. Exposure to stormwater pollutants causes reduced growth, impaired migratory ability, and impaired reproduction. The extent and severity of these effects varies depending on the extent, timing, and duration of the exposure, ambient water quality conditions, the species and life history stage exposed, pollutant toxicity, and synergistic effects with other contaminants (EPA 1980). The primary pollutants of concern in stormwater from road surfaces are total suspended solids (TSS), total zinc, dissolved zinc, total copper, and dissolved copper. Dissolved metals are particularly difficult to remove from stormwater. WSDOT is providing enhanced treatment where practicable to maximize the removal of dissolved metals.

The WSDOT used the Highway Runoff Dilution and Loading model (HI-RUN) model to predict the post-treatment annual pollutant loading, effluent concentration, and dilution zone dimensions (WSDOT 2009). The HI-RUN model uses a statistical procedure called Monte Carlo simulation. Monte Carlo simulation is a method that estimates possible outcomes from a set of random variables by simulating a process a large number of times and observing the outcomes. Using Monte Carlo simulation, the HI-RUN model calculates multiple model output scenarios by repeatedly sampling values for each input variable from computer-generated probability distributions. In this way, a probability distribution can be derived for the model output that indicates which predicted values have a higher probability of occurrence. The probability of exceeding a specific threshold for detrimental effects also can be determined using this procedure. WSDOT used the CORMIX dilution model for the Lake Washington discharges. WSDOT used a modified version of HI-RUN to calculate pollutant loadings and concentrations for the outfalls and fed that information into the CORMIX model.

Dissolved copper and dissolved zinc are the constituents of greatest concern because they are prevalent in stormwater, they are biologically active at low concentrations, and they have adverse effects on salmonids (Sandahl et al. 2007; Sprague 1968). Increased copper and zinc loading presents two pathways for possible adverse effects: direct exposure to water column pollutant concentrations in excess of biological effects thresholds and indirect adverse effects resulting from the accumulation of pollutants in the environment over time, altered food web productivity, and possible dietary exposure.

Baldwin et al. (2003) found that 30 to 60 minute exposures to a dissolved copper concentration of 2.3 µg/L over background level caused olfactory inhibition in coho salmon juveniles. Sandahl et al. (2007) found that a three hour exposure to a dissolved copper concentration of 2.0 µg/L caused olfactory inhibition in coho salmon juveniles.

The toxicity of zinc is widely variable, dependent upon concurrent levels of calcium, magnesium, and sodium in the water column (De Schamphelaere and Janssen 2004). A review of zinc toxicity studies reveals effects including reduced growth, avoidance, reproduction impairment, increased respiration, decreased swimming ability, increased jaw and bronchial abnormalities, hyperactivity, hyperglycemia, and reduced survival in freshwater fish (Eisler 1993). Juveniles are more sensitive to elevated zinc concentrations than adults (EPA 1987). Sprague (1968) documented avoidance in juvenile rainbow trout exposed to dissolved zinc concentrations of 5.6 µg/L over background levels.

The results of CORMIX modeling are shown in Table 10. This table shows the distances from each outfall where the concentrations of dissolved zinc and dissolved copper will remain above the biological effects thresholds during stormwater discharge.

Table 10.

Outfall	Receiving Water body	Dilution Zone Dissolved Zinc (ft)	Dilution Zone Dissolved Copper (ft)
East Allison Street	Lake Union	7.9	4.4

Portage Bay 1	Portage Bay	10.3	2.2
Portage Bay 2	Portage Bay	13.2	4.9
MOHAI	Union Bay	11.1	6.7
Floating Bridge (44 outfalls)	Lake Washington	70.0	20.0

2.4.1.6.1 Interstate 5 Interchange. As described above, WSDOT will add 0.05 acres of PGIS and will construct a bioswale to treat stormwater from four acres of PGIS in this area. The bioswale will direct stormwater to Lake Union via the City of Seattle's East Allison Street outfall. This outfall also carries untreated stormwater from the City of Seattle PGIS outside of the action area. This section analyzes the effects of proposed action's contribution to the total stormwater discharged at this outfall. Table 10 shows the distances from the outfall where dissolved zinc and dissolved copper will dilute to below the biological effects thresholds. Because they are shoreline-oriented, individual juvenile and residual Chinook salmon will have the highest probability of exposure to stormwater pollutants from this outfall. However, because the project will discharge stormwater in perpetuity and the outfall is close to the migratory corridor, NMFS cannot discount the probability of adult and juvenile steelhead and adult Chinook salmon exposure.

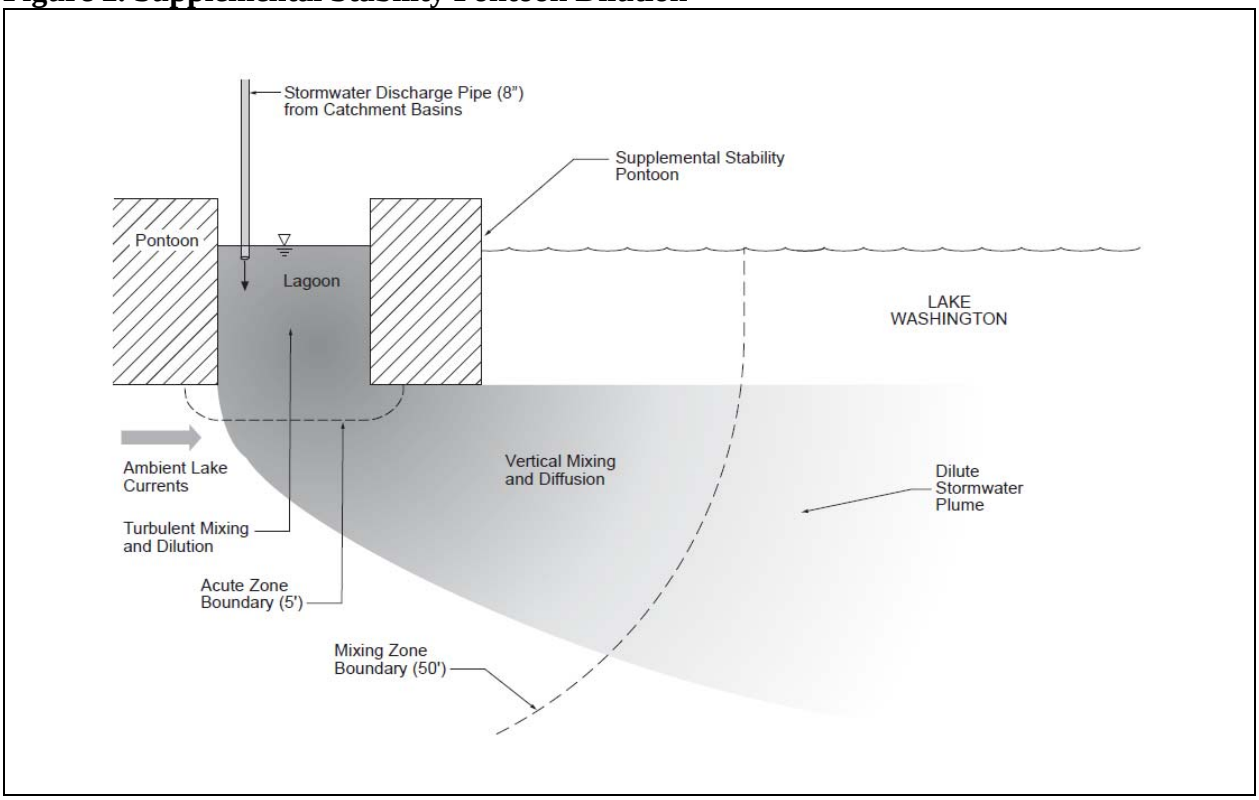
2.4.1.6.2 Portage Bay. This portion of the action area has 9.81 acres of existing PGIS. The project will add 2.19 acres of PGIS for a total of 12.00 acres. WSDOT will construct two stormwater treatment facilities, a bioswale and a constructed wetland, to treat stormwater from 11.64 acres of PGIS from this area. The bioswale will treat stormwater from 2.94 acres of PGIS and discharge at the southwest corner of Portage Bay via outfall PB 1. The constructed wetland will treat stormwater from 8.70 acres of PGIS and discharge at the southeast corner of Portage Bay via outfall PB 2. The various life history stages of Chinook salmon and steelhead exposed to stormwater pollutants will be similar to those seen at the East Allison outfall.

2.4.1.6.3 West Approach. Existing PGIS for SR 520 in this area measures 12.60 acres. The project will add 8.71 acres of PGIS for a total of 21.31 acres. WSDOT will direct stormwater from this area to a constructed wetland on the site currently occupied by the Museum of History and Industry (MOHAI). Stormwater from this facility will discharge into Union Bay south of the Montlake cut via the MOHAI outfall. The various life history stages of Chinook salmon and steelhead exposed to stormwater pollutants will be similar to those seen at the East Allison outfall.

2.4.1.6.4 Floating Bridge. The PGIS for the existing floating bridge measures 17.28 acres. The new bridge will have 20.56 acres of PGIS, an increase of 3.28 acres. The existing bridge does not have any stormwater treatment. WSDOT will treat stormwater on the new bridge using monthly high-efficiency sweeping, modified catch basins (cleaned twice a year), and spill control lagoons. High-efficiency sweeping will consist of a broom sweeper followed by a regenerative

air sweeper. The modified catch basins will be larger than standard catch basin structures. The catch basins will direct stormwater to spill control lagoons built into the SSPs (Figure 2). Forty-four of the 54 supplemental stability pontoons will have 19- by 29-foot spill control lagoons in the center of the pontoons. Stormwater will mix with water in the spill control lagoons prior to flowing into Lake Washington. Based on the dilution distances in Table 11, dissolved copper will dilute to below the biological effect threshold inside the spill control lagoons, while dissolved zinc will remain above the biological effect threshold for 40 to 50 feet beyond the lagoons.

Figure 2. Supplemental Stability Pontoon Dilution



The SSPs will be 28.5 feet deep. This will limit exposure of Chinook salmon and steelhead to stormwater in the lagoons. It is unlikely that any life history stage of either species will dive to a depth greater than 28.5 feet deep, and then resurface in the lagoons. Juveniles and adults of both species spend little time in the deeper portions of Lake Washington near the floating bridge. Fresh et al. (1999) found that adult Chinook salmon spend an average of 2.9 days in the lake. Juvenile Chinook salmon, while predominately shoreline-oriented, have been observed near the existing floating bridge (P. Bloch pers comm). Very little information is available on adult and juvenile steelhead use in Lake Washington (SPU and USACE 2008). In other systems, steelhead typically migrate quickly from riverine habitats to saltwater and vice versa. NMFS expects that Lake Washington steelhead exhibit similar behavior. Therefore, small numbers of juveniles and adults of both species are likely to experience short-term exposures to concentrations of dissolved zinc above the biological effects threshold.

2.4.1.6.5 Local Arterials (Combined Sewer System). Areas of PGIS from local streets (I-5 Interchange, Portage Bay, and the Montlake Interchange) the proposed action will modify drain

to the City of Seattle's combined sewer system (CSS). The CSS joins sewage from homes and businesses and stormwater together in a single conveyance system to the West Point Treatment Plant. Under typical operating conditions, the combined stormwater and sanitary sewage are treated and discharged to the marine waters of Puget Sound. During extreme wet weather, the CSS can exceed capacity resulting in untreated discharges at CSS outfalls. The CSS outfalls are relief points for the excess flow to prevent sewer backups, surface flooding, or operational issues at the West Point Treatment Plant. The proposed action will reduce CSS contributions from the action area and will not increase the frequency or size of CSS discharges.

2.4.1.6.4 Stormwater Summary. Because of they are shoreline-oriented and spend a greater amount of time within the action area, juvenile PS Chinook salmon will have the greatest exposure to stormwater discharges. While none of the dilution zones reach the primary migratory corridor, they will impact sub-optimal holding and rearing habitat. Juveniles using the dilution zones for rearing during stormwater discharges will likely experience increased physiological stress, reduced feeding, impaired ability to detect predators, and behavior alterations.

Because they migrate quickly through the action area, adult and juvenile steelhead and adult Chinook salmon will experience less exposure to dissolved copper and dissolved zinc than juvenile Chinook salmon. Juvenile steelhead will likely experience increased physiological stress, reduced feeding, impaired ability to detect predators, and behavior alterations. Adult Chinook salmon and adult steelhead exposed to stormwater discharges will experience increased physiological stress and behavior alterations (e.g. altered migration routes). As described above, heat stress can increase salmonids sensitivity to other stressors. Heat stressed adult Chinook salmon exposed to stormwater discharges will likely experience more severe effects which could lead to reduced spawning success.

NMFS cannot predict the number of Chinook salmon and steelhead that will exposed to the stormwater discharges into Lake Washington. Stormwater discharges will occur in perpetuity. The numbers of each species within Lake Washington varies year to year as does the number of rain events that produce stormwater effluent. NMFS also cannot estimate the proportion of fish each year that will enter the dilution zones. Therefore, NMFS will use the distance from the outfalls where dissolved copper and dissolved zinc are above the biological effects thresholds described above as a surrogate for the number of Chinook salmon and steelhead affected.

2.4.1.7 Beneficial Effects of Habitat Restoration Activities

2.3.1.7.1 Washington Department of Natural Resources Renton/ Cedar River Sites. Restoration of sites close to the mouth of the Cedar River will have a significant benefit for fisheries because juvenile Chinook 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 salmon typically depend on during early rearing (King County 2005). Therefore, Cedar River Chinook salmon 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. This restoration will remove 540 feet of flume and three dolphins (composed of 21 creosote piles), restore another

630 feet of rip rapped shoreline, increase native vegetation by removing invasive species and planting native riparian species,and place LWD and appropriately-sized substrate. These activities will increase the quantity and quality of rearing habitat for Chinook salmon fry. The removal of the flume and dolphins will reduce predator habitat. The shoreline restoration will increase the shallow near-shore habiat that Chinook salmon fry depend upon for predator avoidance and increase food resources through the placement of gravel and the riparian plantings.

2.3.1.7.2 Cedar River. The Cedar River will be reconnected to its historical floodplain on the left and right bank through 900 feet of levee setbacks. Reconnection of the floodplain will attenuate flood intensity downstream and reduce channel incision and erosion. Increased connectivity to the floodplain will also increase wetlands, import LWD, and provide refuge 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. LWD recruitment is currently rated as poor along almost all of the lower Cedar River, and land use practices generally preclude active recruitment.

This reach has very few pools and areas of fish cover. Scour pools will be used by adults of multiple salmonid species during upstream migration and for pre-spawn holding. 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. Juvenile coho often rear in pools associated with LWD and fish cover. The creation of off-channel rearing habitat will benefit all salmonid species. In the Cedar River, this habitat was historically used by juvenile Chinook salmon for rearing, which in turn likely resulted in a larger and later timing of outmigration from the Cedar River.

2.3.1.7.3 Taylor Creek. Because of Taylor Creek's location in southern Lake Washington, the Chinook salmon juveniles using the creek are smaller and more dependent upon shallow nearshore areas and natural cover. These fish will benefit from improved rearing and migration habitat and feeding in the delta and the 560 feet of creek. Because of Taylor Creek's proximity to the Cedar River, NMFS expects densities of juvenile Chinook between 0.2 and 0.6 per square meter from February to May.

2.3.1.7.4 Seward Park. The WSDOT will remove two bulkheads in Seward Park, a 250-foot long concrete bulkhead and a 250-foot long riprap bulkhead. Cedar River Chinook salmon juveniles will benefit from the conversion of these bulkheads to a gradual, sloping shore with riparian vegetation. These improved habitat features will provide an unobstructed migratory pathway, protection from predators, and enhanced food sources from the natural sediments and overhanging vegetation.

2.3.1.7.5 Magnuson Park. The WSDOT will remove a 250-foot long concrete bulkhead at Magnuson Park. The Magnuson Park shoreline is along the migratory corridor for the North Lake Washington tributaries juvenile Chinook salmon. These juveniles use the entire littoral zone during migration. Chinook salmon juveniles will benefit from the conversion of the bulkhead 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.

2.4.2 Effects on Critical Habitat

2.4.2.1 Freshwater Spawning Sites (PCE 1)

The only spawning habitat in the action area is at the Cedar River habitat restoratrion site (RM 5.3). The project will have short term impacts to water quality from elevated sediment. The project will substantially improve spawning habitat at this location in the long term by creating side channels and improving floodplain function.

2.4.2.2 Freshwater Rearing Sites and Freshwater Migration Corridors (PCE 2 and PCE 3)

The project will have significant temporary effects to rearing habitat over the seven years of construction. WSDOT will schedule all impact pile driving to avoid juvenile and adult Chinook salmon rearing and migration. Impact pile driving will not affect the ability of these PCEs to provide for the conservation of PS Chinook salmon.

The WSDOT will schedule activities causing elevated suspended sediment to avoid areas heavily used by juvenile Chinook salmon for rearing and migration. Some in-water activities will take place in areas with low levels of juvenile Chinook salmon use (e.g. the Arboretum and Foster Island areas) during rearing and migration. In-water work will also occur during the adult Chinook salmon migration. Elevated suspended sediment will temporary degraded water quality and impair PCEs 2 and 3. There will be no permanent impacts to these PCEs from the elevated turbidity.

Over-water structures and their supporting piles and columns will also impact PCEs 2 and 3. Lack of excessive predation is a component of PCE 3. The increase in in-water pile and columns during construction will increase the availability of smallmouth bass habitat in the action area and degrade PCE 3 (juvenile migration). The new bridge will result in a reduction in the number of piles. As described above, shading from the over-water structures will not affect migrating adults or rearing/holding juveniles. Shading will cause short term delays for a portion of actively migrating juveniles and degrade PCE 3 both during construction and for the life of the new bridge. Stormwater discharges will also affect these PCEs by intermittently degrading the water quality component in areas near the outfalls for the life of the new bridge (Table 10).

The Cedar River habitat restoration site will improve PCEs 2 and 3 for a 900-foot long reach of the lower Cedar River by restoring floodplain connectivity, improving physical habitat conditions, increasing available forage, and providing natural cover (including side channels and LWD). The DNR restoration site will improve PCEs 2 and 3 for a 1,170 feet of Lake Washington shoreline adjacent to the mouth of the Cedar River by improving physical habitat conditions, increasing available forage, reducing predation risk (by remove in-water structure that provides predator habitat), and providing natural cover. The Taylor Creek site will improve these PCEs by restoring 560 feet of a non-natal stream improving physical habitat conditions (restoring the delta and creating a meandering channel), increasing available forage (improved

substrate and riparian planting), and reducing predation risk. The Seward and Magnuson Park restoration sites will restore a combined 750 feet of shoreline by removing bulkheads and creating gently-sloping shore. This will improve the function of the essential elements of PCEs 2 and 3, improving physical habitat conditions, increasing available forage (improved substrate and riparian planting), and reducing predation risk.

2.5 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. NMFS conducted an online search of State and local agencies' websites with jurisdiction in the action area. These agencies included the City of Seattle (Department of Planning and Development, Department of Transportation, and Seattle Public Utilities), the City of Medina (Departments of Public Works and Development Services), the University of Washington, and the State of Washington (Departments of Transportation, Natural Resources, and Fish and Wildlife). NMFS did not find any future activities that were both within the action area and did not involve Federal activities. Furthermore, the action area is already fully developed with the exception of areas protected from development such as the Arboretum and Seattle Parks.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step of NMFS' assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 2.2).

2.6.1 Puget Sound Chinook Salmon ESU

2.6.1.1 Puyallup River Chinook Salmon Populations

Fish handling at the CTC site in Commencement Bay will affect juvenile Chinook salmon from two populations, the Puyallup River and the White River. Natural origin spawners average over 1,000 fish per year for both of these populations. The loss of the equivalent of 29 adults from these populations over two years will result in a short-term reduction in abundance. From 2005-2010, adult returns for the Puyallup River population averaged 2,007, and returns for the White River population averaged 1,468 spawners for a total of 3,475 per year. Twenty-nine adults would be 0.4 percent of the total number of spawners over two years and is less than the year-to-year fluctuations in returns.

Therefore, the loss of the equivalent of 29 adults from these populations over two years will not affect the productivity, spatial structure, diversity, long-term abundance, or the potential for recovery of these populations or the ESU as a whole.

2.6.1.2 Lake Washington Chinook Salmon Populations

A small portion of the Lake Washington populations Chinook salmon residualize. Residual Chinook salmon are present in Lake Washington year-round and are not protected by the in-water work windows. They will be exposed to the each of the stressors of the action occurring in Lake Washington. De Vries et al. (2007) found that juvenile Chinook salmon residualize in Lake Washington, with rates ranging between zero and 0.45 percent. Residual fish were tagged and released in 2003 and 2004 and detected leaving the Ship Canal in 2004 and 2005. None of the fish tagged in 2002 or 2007 migrated through the Ship Canal as 1+ or older fish. Anecdotal reports suggest that residual Chinook in Lake Washington are in poor condition (Tabor pers. comm.). These residual fish are unlikely to survive and return to spawn. Because these fish do not breed, the effects to them will not affect the VSP parameters of the Lake Washington populations or the ESU as a whole.

For most Chinook salmon in Lake Washington, prescribed timing for construction will help avoid exposure of juvenile Chinook salmon to project effects (e.g. impact pile driving). Other projects will occur in habitats Lake Washington Chinook salmon are unlikely to use (e.g. the Arboretum and Foster Island). Effects during construction will include sublethal effects from elevated suspended sediment at the east approach and the west approach (during August). While NMFS cannot predict the number of fish or the precise percentage of the population that will be affected by elevated suspended sediment, NMFS can conclude that it will be a very small proportion of the populations because: (1) the habitat at the west approach in the Arboretum and Foster Island is unsuitable for Chinook salmon and is unlikely to be used for any length of time; (2) in-water work at the west approach east of Foster Island will not start until August 1, when the vast majority of juvenile Chinook have already migrated out of lake Washington; (3) the area of elevated suspended sediment in-water work at the west approach east of Foster Island will take up a small percentage of the migratory corridor available to adult Chinook salmon; and (4) juvenile Chinook are present at the east approach only in low densities. These sublethal effects to a small proportion of the Lake Washington populations will not have an observable effect on the spatial structure, productivity, long-term abundance, or diversity of the PS ESU.

Fish handling at the east approach will injure or kill up to 72 juveniles (2 adult equivalents). The loss of the equivalent of two adults from these populations will result in a short-term reduction in abundance. From 2005-2010, adult returns for the Cedar River population averaged 850, and returns for the North Lake Washington population averaged 140 spawners for a total of 990 per year. Two adults would be 0.2 percent of the total number of spawners and is less than the year-to-year fluctuations in returns. Therefore, the loss of the equivalent of two adults from these populations will not affect the productivity, spatial structure, diversity, long-term abundance, or the potential for recovery of these populations or the ESU as a whole.

All juvenile Chinook salmon from the Cedar River and a small percentage of the North Lake Washington population will be exposed to increased shading during construction and for the life

of the bridge. Holding juvenile Chinook salmon will not be affect by the additional shading. For actively migrating fish, the response to the shading will range from no response to a delay in migration of up to a few hours. The vast majority of actively migrating juvenile Chinook salmon will experience delays of less than an hour (Celadonia et al. 2009). Migration times from the Sammamish and Cedar Rivers to the locks in the Ship Canal averages between 13 and 16 days. Delays up to a few hours are unlikely to have any lasting adverse effects on individual Chinook salmon. Therefore, shading will not affect the VSP parameters of the Lake Washington populations or the ESU as a whole.

All juvenile Chinook salmon from the Cedar River and a some percentage of the North Lake Washington population will be exposed to increased predation risk from smallmouth bass from the increase in in-water piles and columns during construction. However, given that there are over 2,700 docks in lake Washington and the Ship Canal, the increase in in-water piles and columns during construction does not represent a significant increase in in-water structures that migrating juvenile Chinook salmon encounter, and, therefore, will not significantly increase the rate of predation by smallmouth bass. The new project will reduce the number of in-water columns and reduce predation risk from smallmouth bass in the long-term. The increase in predation risk from smallmouth bass will not have an observable affect on the VSP parameters of the Lake Washington populations or the ESU as a whole.

PS Chinook salmon will be exposed to elevated pollutant levels from stormwater discharges. While none of the dilution zones reach the primary migratory corridor, they will impact sub-optimal holding and rearing habitat. Juveniles using the dilution zones for rearing during stormwater discharges will likely experience increased physiological stress, reduced feeding, impaired ability to detect predators, and behavior alterations. However, only a subset of the populations in any given year will migrate or rear within the dilution zone of the outfalls. Furthermore, migration of Chinook salmon through the action area occurs from late-spring to early-fall (peak migration for juveniles in June and July and July through September for adults) when rain events large enough to cause stormwater discharges are less frequent. Only individuals within the dilution zones during stormwater discharges will be affected. Given the low level of Chinook salmon use of the dilution zones, the infrequency of rain events during the Chinook salmon migration times, and the small area of the dilutions zones compared to the amount of habitat in the action area, the elevated pollutant levels from stormwater discharges will not have an observable affect on the VSP parameters of the Lake Washington populations or the ESU as a whole.

The proposed action will improve spawning, rearing, and migration habitat for Chinook salmon by restoring a 900-foot long reach of the lower Cedar River at RM 5.3 through levee removal and floodplain restoration. The proposed action will improve rearing and migration habitat for Chinook salmon by restoring 1,170 feet of Lake Washington shoreline adjacent to the mouth of the Cedar River through shoreline restoration, 560 feet of Taylor Creek through channel and delta restoration; and 750 feet of Lake Washington shoreline at Seward and Magnuson Parks through shoreline restoration. These activities are likely to improve the productivity of the Lake Washington populations, but will not have an observable affect on the VSP parameters of the ESU as a whole.

Because the viability of the Lake Washington Chinook salmon populations will not impaired by the proposed action, and there are no adverse cumulative effects, the project will not reduce the likelihood of survival or recovery of the PS Chinook salmon ESU.

2.6.2 Puget Sound Steelhead DPS

Lake Washington Basin steelhead are virtually extirpated (less than 10 adult fish per year). Populations of steelhead this small are not viable. However, steelhead (anadromous *O. mykiss*) interbreed with rainbow trout (resident *O. mykiss*) in the Cedar River (Marshall et al. 2004). NMFS's June 2007 status review found that, where resident and anadromous *O. mykiss* co-occur, rainbow trout had a close biological relationship to steelhead (Hard et al. 2007). Hard et al. (2007) also concluded that resident *O. mykiss* are likely to reduce imminent risk of extinction and that the resident *O. mykiss* can retain the genetic basis for anadromy for several decades. Negative effects from the loss of anadromy include lower productivity and increased extinction risk over the long-term (Hard et al. 2007).

For the most part, construction activities will be timed to avoid PS steelhead, will occur in habitats steelhead are unlikely to use, or generate stressors that do not typically harm larger salmonids such as adult and out-migrating juvenile steelhead. Impact pile driving will cause sublethal injury to small numbers of adult steelhead at the west approach (in 2013 and 2015) and at the east approach (2012 to 2013). At most, 30 fish could be exposed to impact pile driving during these three years of construction. It is unlikely that all adult steelhead will migrate through the action area during impact pile driving, and only a subset of those that do will remain near the pile driving activities long enough to sustain sublethal injury (i.e. be exposed to enough pile strikes so that the cumulative SEL reaches the injury threshold of 187dB or higher).

The restoration activities at the Cedar River will cause sublethal injury small numbers of 0+ and 1+ juvenile steelhead. Since 2007, WDFW has not been able to estimate the production of steelhead in the Cedar River because the number of steelhead smolts trapped is so low (zero to one per year) (Kiyohara and Zimmerman 2011). For 2006, the last year that WDFW trapped enough fish to estimate the production of steelhead, they estimated the total number of steelhead smolts in the Cedar River to be 267 fish. Only a very small percentage of juvenile steelhead within the Cedar River will be exposed to elevated suspended sediment at the restoration site, and these fish are unlikely to suffer permanent injury. Overall, the habitat restoration activities at this site will improve habitat for PS steelhead.

The resident *O. mykiss* in the Cedar River are native and abundant and they interbreed with steelhead (Marshall et al. 2004). It is likely that the resident population retains much of the genetic diversity and the genetic basis for anadromy of the population (Hard et al. 2007). The sublethal impacts to small numbers of individuals described above will not significantly change the percentage of the Cedar River *O. mykiss* population that expresses anadromy, and will therefore not affect the abundance, productivity, spatial structure, and diversity of the PS DPS as a whole.

Restoration of the anadromous form of Lake Washington *O. mykiss* is still possible. Restoration efforts have previously brought extirpated and nearly extirpated populations of anadromous

salmonids back to sustainable numbers (e.g. Redfish Lake sockeye salmon and Tahuya River summer-run chum salmon). If efforts are undertaken to restore steelhead in the Lake Washington Basin, the proposed action will not reduce the likelihood of success of those efforts.

2. 2.6.1 Puget Sound Chinook Salmon Critical Habitat

The CHART rated the conservation value of critical habitat in Lake Washington as "medium" and in the Cedar River as "high." The temporary effects of the proposed action on critical habitat include elevated suspended sediment, increased shading from over-water structures, and increased smallmouth bass habitat. These effects are likely to cause a reduction in the conservation value of PCEs 2 and 3 during construction within the action area, but will not result in lasting effects. Furthermore, most of the effects to PCEs 2 and 3 will be timed to avoid Chinook salmon or will occur in areas of low Chinook salmon use. Permanent impacts to critical habitat include increased shading from over-water structures and stormwater discharges. The proposed action will improve PCEs 1, 2, and 3 for a 900-foot reach of the lower Cedar River and at the Lake Washington restoration sites. Overall, critical habitat will remain functional and retain the current ability for PCEs to serve the intended conservation role for the species. Therefore, the proposed action will not significantly reduce the conservation value of critical habitat at the ESU scale.

7 Conclusion

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon or PS steelhead or destroy or adversely modify PS Chinook salmon designated critical habitat.

2.8. Incidental Take Statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a permit or exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Section 7(b)(4) and Section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA, if that action is performed in compliance with the terms and conditions of this incidental take statement.

2.8.1 Amount or Extent of Take

Effects of the action will coincide with the presence of PS Chinook salmon and PS steelhead such that the incidental take is reasonably certain to occur. Take from fish handling is reported as the number of fish. Take caused by elevated suspended sediment, impact pile driving, over-

water structures, increased smallmouth bass habitat, and stormwater discharges cannot be accurately quantified as a number of fish because NMFS cannot predict, using the best available science, the number of PS Chinook salmon and PS steelhead that will be exposed to these stressors. Furthermore, even if NMFS could estimate that number, the manner in which each exposed individual responds to that exposure cannot be predicted. In contrast, the number of fish affected by capture and handling can be estimated as provide below.

In circumstances where NMFS cannot estimate the amount of individual fish that would be injured or killed by the effects of the proposed action, NMFS assesses the extent of take as an amount of modified habitat and exempts take based only on that extent. This extent is readily observable and therefore suffices to trigger reinitiation of consultation, if exceeded and necessary (see H.R. Rep. No 97-567, 97th Cong., 2d Sess. 27 (1982).

Take from elevated suspended sediment is exempted for:

1. 105.9 acres in Portage Bay, with a maximum of 23.3 acres in any one construction year;
2. 104.4 acres at the West Approach (Arboretum and Foster Island), with a maximum of 26.5 acres in any one construction year;
3. 146.1 acres at the West Approach (east of Foster Island), with a maximum of 39.7 acres in any one construction year;
4. 18.1 acres at the east approach, with a maximum of 7.1 acres in any one construction year;
5. 2.2 acres at the DNR Parcel (south Lake Washington);
6. 2.1 acres at the Cedar River (RM 5.3);
7. 0.8 acre at Taylor Creek;
8. 3.1acres at Seward Park; and
9. 4.3 acres at Magnuson Park.

Take from impact pile driving (cumulative SEL greater than 187dB) is exempted for:

1. 3.5 acres in Portage Bay, with a maximum of 1.9 acres in any one construction year and a maximum of 0.2 acre in any one day;
2. 2.9 acres at the West Approach (Arboretum and Foster Island), with a maximum of 1.6 acres in any one construction year and a maximum of 0.1 acre in any one day
3. 7.8 acres at the West Approach (east of Foster Island), with a maximum of 4.0 acres in any one construction year and a maximum of 0.8 acre in any one day; and
4. 284.3 acres at the east approach, with a maximum of 150.2 acres in any one construction year and a maximum of 125.4 acres in any one day.

Take from increased shading from over-water structures is exempted for the areas shown in Table 7.

Take from increased smallmouth bass habitat from over-water structures is exempted for the areas shown in Table 9.

Take from fish handling is exempted for:

1. 18,834 juvenile Chinook salmon at the CTC site with 3,836 that will be injured or killed;
2. 274 residual Chinook salmon in Portage Bay with 14 that will be injured or killed; and
3. 1,433 juvenile and residual Chinook salmon at the east approach with 72 that will be injured or killed.

Take from stormwater discharges (dissolved zinc 5.6 mg/l over background concentrations and dissolved copper at 2.0 mg/l over background concentrations) is exempted for:

1. The area within 7.9 feet of the East Allison street outfall for dissolved zinc and within 4.4 feet for dissolved copper;
2. The area within 10.3 feet of the Portage Bay 1 outfall for dissolved zinc and within 2.2 feet for dissolved copper;
3. The area within 13.2 feet of the Portage Bay 2 outfall for dissolved zinc and within 4.9 feet for dissolved copper;
4. The area within 11.1 feet of the MOHAI outfall for dissolved zinc and within 6.7 feet for dissolved copper; and
5. The area within 70 feet of the 44 floating bridge outfalls for dissolved zinc and within 20 feet for dissolved copper.

2.8.2 Effect of the Take

The effect of take on PS Chinook salmon and PS steelhead is describe above in Section 2.4.

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" (RPMs) are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). "Terms and conditions" implement the reasonable and prudent measures (50 CFR 402.14). These must be carried out for the exemption in section 7(o)(2) to apply.

The FHWA shall minimize take of PS Chinook salmon and PS steelhead. These reasonable and prudent measures are necessary and appropriate to minimize the take of PS Chinook salmon and PS steelhead. The FHWA shall:

1. minimize incidental take from elevated suspended sediment;

2. minimize incidental take from underwater sound;

3. minimize incidental take from over-water structures;

4. minimize take from fish handling; and

5. minimize incidental take from stormwater discharges.

2.8.4 Terms and Conditions

1. To implement RPM 1, FHWA shall:

   a) monitor turbidity levels during in-water work to ensure that the turbidity does not exceed 5 NTUs above background at 150 feet from the source. The FHWA shall report the results of the turbidity monitoring to NMFS within 60 days of the completion of each in-water work season; and

   b) Preclude any turbidity generating in-water work at the west approach east of Foster Island between April 15 and September 1 in all construction years.

2. To implement RPM 2, FHWA shall:

   a) Use a vibratory hammer to drive piles to the maximum extent practicable;

   b) Use a confined or unconfined bubble curtain with the same specifications as the bubble curtains from the test pile project (Illingsworth and Rodkin 2009) for all impact pile driving except up to 500 strikes per day at the east approach (to establish baseline sound levels);

   c) Monitor at least 10 piles in Portage Bay, the west approach (Arboretum and Foster Island), and the east approach for each construction year. If the number of impact strikes required to reach bearing capacity increases by more than 50 percent from the average for four consecutive pilings, then additional five pilings will be monitored to confirm underwater noise levels.

   d) Monitor at least 20 piles in the west approach east of Foster Island for each construction year. At least 10 of these pile will be between the midpoint of the work bridge and its eastern terminus; and

   e) Preclude any impact pile driving at the west approach east of Foster Island between April 15 and October 8 in any construction year.

3. To implement RPM 3, FHWA shall:

   a) Between April 15 and September 1 of any construction year, within the area of the west approach (east of Foster Island) between 15 and 27 feet deep, maintain at least a 100-foot unobstructed corridor between barges and between barges and work bridges to allow juvenile salmonid outmigration. The 100-foot corridor can be relocated throughout the work window to accommodate construction sequencing;

   b) Move any barges delivering or removing construction materials, equipment, or debris out of the primary migratory corridor (the area of the west approach (east of

Foster Island) between 15 and 27 feet deep) as soon as possible after loading or off-loading;

c) For the east approach, moor any barges at least 15 feet away from the temporary work bridge and falsework. Moorage closer to the structure is allowed during inclement weather or when moving heavy loads onto or off of the barge;

d) Construct the maintenance dock with open grating for at least one third of its width (approximately 4.5 feet); and

e) Preclude mooring barges in the Montlake Cut between April 15 and September 1.

4. To implement RPM 4, FHWA shall:

a) Submit a fish removal plan for the CTC and the cofferdams at least 60 days prior to any gate openings. The fish removal plan will follow the NMFS-approved WSDOT Fish Exclusion Protocols and Standards as closely as possible;

b) Document all PS Chinook salmon encountered during work area isolation by submitting an In-water Construction Monitoring Report (Appendix I) or equivalent to NMFS within 30 days of work area isolation;

c) To the maximum extent practical, preclude gate openings at the CTC site between May 15 and June 15; and

d) Provide NMFS a schedule of CTC gate openings and a description of the necessity of any openings between May 15 and June 15. The description will include the date of the next suitable tide cycle to launch the pontoons.

5. To implement RPM 5, FHWA shall:

a) Upon project completion, monitor stormwater discharges from the floating bridge and the MOHAI outfall for two years in order to accurately characterize stormwater BMP effectiveness and "end-of-pipe" effluent concentrations for treated and untreated stormwater runoff (total and dissolve copper, total and dissolved zinc; total suspended solids);

b) Submit stormwater monitoring plans to NMFS for the floating bridge and the MOHAI outfall by October 31, 2011;

c) Submit annual monitoring reports to NMFS.

2.9. Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding

discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

In order to develop information regarding improving migratory habitat for Lake Washington PS Chinook salmon, NMFS recommends that FHWA, in cooperation with the USACE and other stakeholders, investigate methods to reduce summer water temperatures in the Ship Canal.

2.10 Reinitiation of Consultation

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action on listed species or designated critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat not considered in this opinion, or 4) a new species is listed or critical habitat designated that may be affected by the action.

2.11 "Not Likely to Adversely Affect" Determinations

2.11.1 Southern Resident Killer Whale and Southern Resident Killer Whale Critical Habitat

The proposed action will not have any direct effects on Southern Resident killer whales; the towing speeds for the pontoons from Grays Harbor to Lake Washington are too slow to strike whales. However, the project may indirectly affect the quantity of prey available to Southern Residents. Any salmonid take up to the aforementioned maximum extent and amount would result in an insignificant reduction in adult equivalent prey resources for Southern Resident killer whales that may intercept these species within their range. Therefore, NMFS concurs with FHWA's determination that the proposed action may affect, but is not likely to adversely affect Southern Resident killer whales.

2.11.2 Yelloweye Rockfish, Canary Rockfish, Bocaccio

Rockfish fertilize their eggs internally and the young are extruded as larvae. Rockfish larvae are pelagic, often found near the surface of open waters, under floating algae, detached seagrass, and kelp. Juvenile bocaccio and canary rockfish settle onto shallow nearshore water in rocky or cobble substrate that support kelp and other macroalgae at 3 to 6 months of age, and move to progressively deeper waters as they grow (Love et al. 2002). Juvenile yelloweye rockfish do not typically occupy shallow waters (Love et al. 1991) and are very unlikely to be within the project area. Adult yelloweye rockfish, canary rockfish, and bocaccio typically occupy waters deeper than 120 feet (Love et al. 2002).

The project will occur adjacent to waters that consist of sand and mud substrates of Commencement Bay and that are devoid of kelp. The action area are less than 120 feet deep. As such, adults of ESA-listed rockfish are not expected to occur within this area and will not be affected by project activities. Juvenile canary rockfish, yelloweye rockfish, and bocaccio are

unlikely to occupy the action area because of the characteristics of their substrates and lack of kelp.

Larval yelloweye rockfish, canary rockfish or bocaccio could occur within the project and action area, though they are readily dispersed by currents after they are born, making the concentration or probability of presence of larvae in any one location extremely small (NMFS 2003). The size of the project and action area where effects could occur to larval ESA-listed rockfish, combined with the short duration of project activities, make it extremely unlikely and therefore discountable that a larvae will be present and thus exposed to project activities.

Because all potential adverse effects are discountable, NMFS concurs with the FHWA determination of may affect, not likely to adversely affect for yelloweye rockfish, canary rockfish, and bocaccio.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

The consultation requirement of section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effects include the direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside EFH, and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the FHWA and descriptions of EFH for Pacific coast salmon (PFMC 1999) contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The proposed action and action area for this consultation are described in the Introduction to this document. The action area includes areas designated as EFH for various life-history stages of Chinook salmon (*O. tshawytscha*) and coho salmon (*O. kisutch*), but does not occur within a Habitat Area of Particular Concern.

3.2 Adverse Effects on Essential Fish Habitat

The NMFS determined that the proposed action will have adverse effects to EFH designated for Chinook salmon and coho salmon, based on information provided in the BA and the analysis of effects presented in the ESA portion of this document. The NMFS determined that the proposed action will adversely affect EFH by temporarily elevating suspended sediment levels, increasing over-water shading (both temporary and permanent), and discharging stormwater. EFH will also be improved by the habitat restoration activities.

The following is the amount of EFH that will be adversely affected by elevated suspended sediment for each portion of the action area:

1. 105.9 acres in Portage Bay;
2. 104.4 acres at the West Approach (Arboretum and Foster Island);
3. 146.1 acres at the West Approach (east of Foster Island);
4. 18.1 acres at the east approach, with a maximum of 7.1 acres in any one construction year;
5. 2.2 acres at the DNR Parcel (south Lake Washington);
6. 2.1 acres at the Cedar River (RM 5.3);
7. 0.8 acre at Taylor Creek;
8. 3.1acres at Seward Park; and
9. 4.3 acres at Magnuson Park.

The amount of EFH that will be adversely by shading from over-water structures in each portion of the action area is shown in Table 7.

The following is the amount of EFH that will be adversely affected by stormwater discharges:

1. The area within 7.9 feet of the East Allison street outfall;
2. The area within 10.3 feet of the Portage Bay 1 outfall;
3. The area within 13.2 feet of the Portage Bay 2 outfall;
4. The area within 11.1 feet of the MOHAI outfall; and
5. The area within 70 feet of the 44 floating bridge outfalls.

The following is the amount of EFH that will be improved by the restoration activities:

1. A 900-foot long reach of the lower Cedar River at RM 5.3 through levee removal and floodplain restoration;
2. 1,170 feet of Lake Washington shoreline adjacent to the mouth of the Cedar River through shoreline restoration;
3. 560 feet of Taylor Creek through channel and delta restoration; and
4. 750 feet of Lake Washington shoreline at Seward and Magnuson Parks through shoreline restoration.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS expects that full implementation of these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2 above, approximately 395 acres of designated EFH for Pacific coast salmon. These conservation recommendations are a subset of the ESA terms and conditions. NMFS recommends that FHWA:

1. Monitor turbidity levels during in-water work to ensure that the turbidity does not exceed 5 NTUs above background at 150 feet from the source.

2. Report the results of the turbidity monitoring to NMFS within 60 days of the completion of each in-water work season;

3. Preclude any turbidity generating in-water work at the west approach east of Foster Island between April 15 and September 1 in all construction years;

4. Between April 15 and September 1 of any construction year, within the area of the west approach (east of Foster Island) between 15 and 27 feet deep, maintain at least a 100-foot unobstructed corridor between barges and between barges and work bridges to allow juvenile salmonid outmigration. The 100-foot corridor can be relocated throughout the work window to accommodate construction sequencing;

5. Move any barges delivering or removing construction materials, equipment, or debris out of the primary migratory corridor (the area of the west approach (east of Foster Island) between 15 and 27 feet deep) as soon as possible after loading or off-loading;

6. For the east approach, moor any barges at least 15 feet away from the temporary work bridge and falsework;

7. Construct the maintenance dock with open grating for at least one third of its width (approximately 4.5 feet);

8. Preclude mooring barges in the Montlake Cut between April 15 and September 1;

9. Upon project completion, monitor stormwater discharges from the floating bridge and the MOHAI outfall for two years in order to accurately characterize stormwater BMP effectiveness and "end-of-pipe" effluent concentrations for treated and untreated stormwater runoff (total and dissolve copper, total and dissolved zinc; total suspended solids);

10. Submit stormwater monitoring plans to NMFS for the floating bridge and the MOHAI outfall by October 31, 2011; and

11. Submit annual monitoring reports to NMFS.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Federal agency must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation from NMFS. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations, unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NMFS Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects [50 CFR 600.920(k)(1)].

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The FHWA must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations [50 CFR 600.920(l)].

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) (Data Quality Act) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Biological Opinion addresses these Data Quality Act (DQA) components, documents compliance with the DQA, and certifies that this Opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. These users include four agencies of the Federal government (NMFS, FHWA, USACE, and the US Coast Guard), the WSDOT, the residents of the Cities of Seattle and Medina, King County, the State of Washington, and the general public.

Individual copies were provided to the above-listed entities. This consultation will be posted on the NMFS Northwest Region website (http://www.nwr.noaa.gov). The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

4.3.1 Information Product Category

Natural Resource Plan.

4.3.2 Standards

This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01, *et seq.,* and the MSA implementing regulations regarding EFH, 50 CFR 600.920(j).

4.3.3 Best Available Information

This consultation and supporting documents use the best available information, as referenced in the Literature Cited section. The analyses in this Opinion/EFH consultation contain more background on information sources and quality.

4.3.4 Referencing

All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

4.3.5 Review Process

This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with Northwest Region ESA quality control and assurance processes.

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