Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

USFWS Log# 13410-2007-F-0641

Interstate-405, State Route 520 to Interstate-5 Improvement Project

King and Snohomish Counties, Washington

Agency:

Federal Highway Administration
Olympia, Washington

Consultation Conducted By:

U.S. Fish and Wildlife Service
Western Washington Fish and Wildlife Office
Lacey, Washington

December 2008

Ken S. Berg, Manager Washington Fish and Wildlife Office	Date

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CONSULTATION HISTORY

The Washington State Department of Transportation (WSDOT) and Federal Highway Administration (FHWA) propose to construct safety and mobility improvements along approximately 15 miles of Interstate-405 (I-405), between the State Route 520 (SR 520)/I-405 Interchange in Bellevue (King County), Washington, and the I-405/Interstate-5 (I-5) Interchange in Lynnwood (Snohomish County), Washington. The project will require a Clean Water Act section 404 permit. Federal funding and issuance of a section 404 permit establish a nexus requiring consultation under section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.)(Act).

The U.S. Fish and Wildlife Service (Service) based this Biological Opinion (BO) on the following sources of information: the Biological Assessment (BA), dated August 2007 and received on September 7, 2007; WSDOT and FHWA responses to our requests for additional information (written correspondence received on December 11, 2007, March 4 and March 27, 2008); a field review of the project site; and, various scientific literature and personal communications cited and referenced herein. A complete record of this consultation is on file at the Western Washington Fish and Wildlife Office in Lacey, Washington.

The following timeline summarizes the history of this consultation:

September 7, 2007 – The WSDOT submits a BA and request for informal consultation with effect determinations of "may affect, not likely to adversely affect" for bull trout (*Salvelinus confluentus*) and "no effect" for designated bull trout critical habitat.

October 1, 2007 – The Service provides notice to the WSDOT and FHWA that it cannot concur, based on available information, with a "may affect, not likely to adversely affect" determination for bull trout. The Service requests additional information regarding stormwater design, drainage modifications and fish passage barrier corrections, compensatory mitigation for unavoidable impacts to wetland and instream functions and values, and related matters relevant to the effect determination for bull trout.

December 11, 2007 – The WSDOT and FHWA provide a partial response to the Service's requests for additional information via written correspondence (with attached, supplemental materials); the WSDOT and FHWA notify the Service of their intent to perform an audit of previous stormwater consultations affecting these same portions of I-405.

March 4, March 6, and March 27, 2008 – The WSDOT and FHWA provide a revised and expanded description of the environmental baseline, pre-project conditions, and proposed stormwater design via written correspondence (with attached, supplemental materials). The WSDOT, FHWA, and the Service meet to discuss the most current information. The Service reiterates that it cannot concur, based on available information, with a "may affect, not likely to adversely affect" determination for bull trout. The Service recommends that FHWA request formal consultation.

July 18, 2008 – The WSDOT and FHWA make a verbal request to initiate formal consultation.

BIOLOGICAL OPINION

Approach to the Jeopardy Analysis

To conduct a jeopardy analysis for the bull trout, we evaluate the following: (1) the *Status of the Species*, which evaluates the bull trout's rangewide condition, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of the bull trout in the action area, the factors responsible for that condition, and the conservation role of the action area; (3) the *Effects of the Action*, which determines the direct and indirect effects of the proposed Federal action and any interrelated or interdependent actions on the bull trout; and (4) the *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the bull trout.

Our analysis considers how the likelihood of survival and recovery of the bull trout in its coterminous United States (U.S.) range may change with implementation of the proposed Federal action. The analysis involves multiple spatial scales, and is predicated on the concept that the fate of individuals affected by the proposed action may influence the persistence of the affected local population(s), core area(s), Interim Recovery Unit(s), and the coterminous U.S. population of the bull trout. Our analysis begins by identifying the probable risks posed to individual bull trout by the proposed action, and then integrates those individual risks to identify consequences to the bull trout populations at the higher scales described above. Our jeopardy determination is based on whether bull trout are likely to experience a reduction in viability at the coterminous U.S. scale, and whether any reduction is likely to be appreciable.

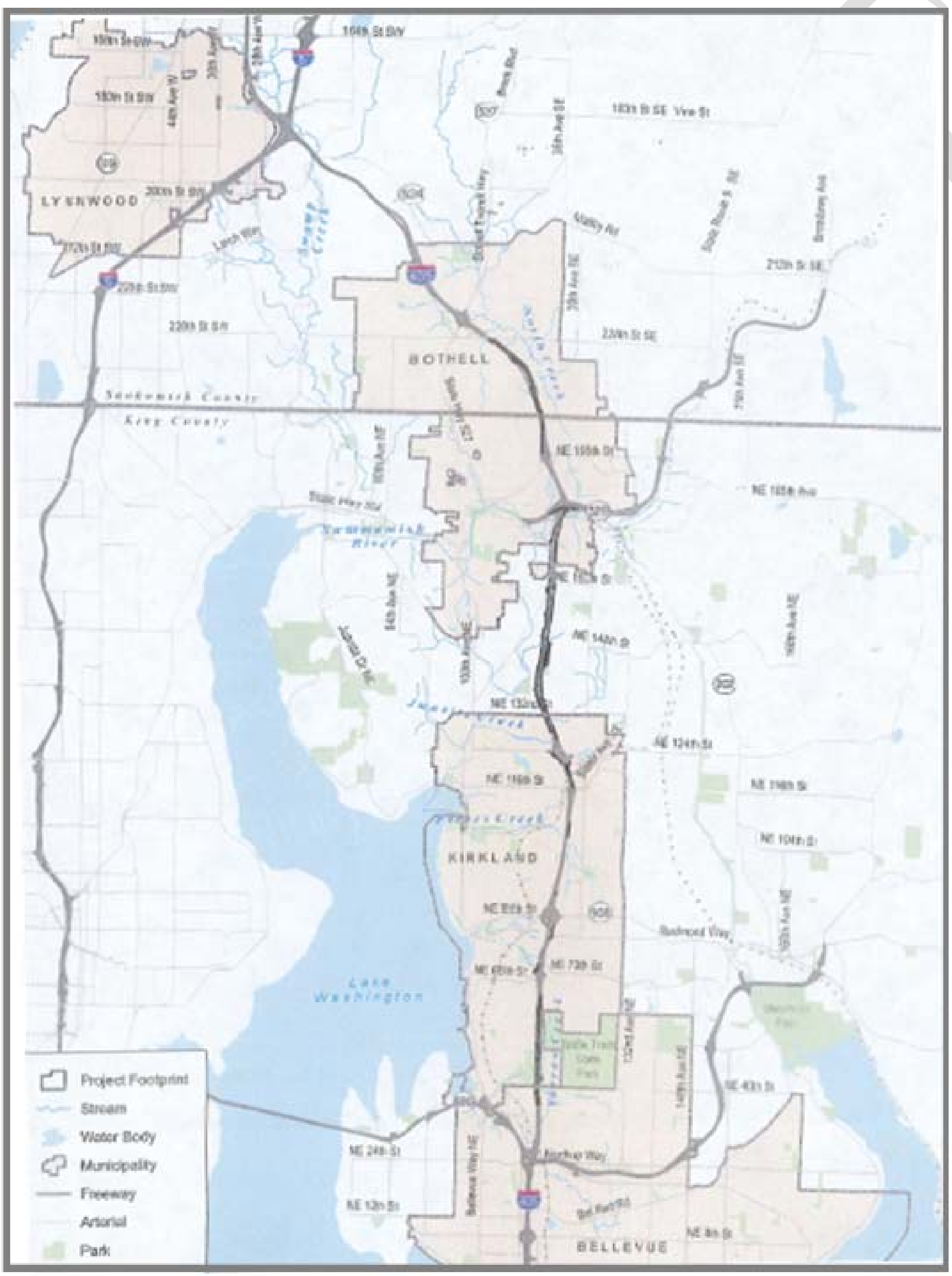
In other words, the effects of the proposed Federal action are evaluated with the aggregate effects of everything that has led to the bull trout's current status and, for non-Federal activities in the action area, those actions likely to affect the bull trout in the future. We then determine if, given the aggregate of all of these effects, implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the bull trout in the wild at the scale of the entire listed species.

DESCRIPTION OF THE PROPOSED ACTION

The proposed action would expand capacity along existing facilities with improvements to the I-405 corridor in the cities of Bellevue, Kirkland, Bothell, and Lynnwood, Washington, and in unincorporated King and Snohomish counties. The project is part of a comprehensive program to address congestion in the I-405 corridor ("Master Plan"). The Master Plan represents the selected alternative identified by the I-405 Corridor Program Environmental Impact Statement and 2002 Record of Decision (WSDOT 2007a). Currently, average daily traffic (ADT) along these portions of I-405 varies between 114,000 and 183,000 vehicles per day; design year ADTs (2014) are expected to vary between 139,000 and 213,000 vehicles per day.

The WSDOT and FHWA propose to construct safety and mobility improvements along approximately 15 miles of I-405, between the SR 520/I-405 Interchange in Bellevue (King County), Washington, and the I-405/I-5 Interchange in Lynnwood (Snohomish County), Washington (Figure 1). For topographical reference, the geographic location is: Township 27 North, Range 4 East, Section 24; Township 27 North, Range 5 East, Sections 30 and 32; Township 26 North, Range 5 East, Sections 4, 5, 8, 9, 17, 20, 28, 29, and 33; and, Township 25 North, Range 5 East, Sections 4, 8, 9, 16, 17, 20, and 21. The project is located in Water Resources Inventory Area (WRIA) 8 – Cedar-Sammamish, within hydraulic unit code 17110012 (Lake Washington).

Figure 1 Vicinity map.



The project will follow the "design-build" model, where the WSDOT will execute a single contract for final design and construction of a finished product. Building upon previous improvements to these same portions of I-405 (including the previously consulted upon "Kirkland Nickel Project"; Service Ref. No. 1-3-04-I-1116), and towards the eventual full Master Plan build-out of the corridor, the proposed project will improve safety, reduce traffic congestion, and enhance traveler and freight mobility with improved levels-of-service during peak travel periods.

The project's major design elements include, but are not limited to the following:

- *Mainline I-405 Improvements* – a) Design and construct one northbound (NB) general-purpose lane extending between NE 124th Street and State Route 522 (SR 522); and, b) design and construct one NB general-purpose lane extending between NE 195th Street and State Route 527 (SR 527).

- *Related Mainline Improvements* – a) Widen portions of NB and southbound I-405, between SR 520 and NE 70th Street, to provide Express Toll lane access and/or enhance safety with additional shoulder width and lane separation, b) widen the existing freight rail overpass structure and realign ramp connections between NE 116th Street and NE 124th Street, c) widen portions of NB and southbound I-405, between NE 124th Street and NE 132nd Street (including replacement of the bridges at NE 132nd Street), to enhance safety with additional shoulder width and lane separation, d) construct grade-separated ramps between the I-405 NB on-ramp from NE 160th Street and the NB I-405 off-ramp to SR 522 and, e) construct an additional NB auxiliary lane between NE 195th Street and SR 527.

- *Environmental Enhancements and Mitigation* – a) stabilize slide-prone slopes with retaining walls constructed between NE 160th Street and SR 522; b) provide compensatory mitigation for unavoidable impacts to wetlands and their buffers, regulated stream buffers (riparian functions), and instream habitat; and, c) design and construct enhanced stormwater runoff treatment and flow control facilities for new pollution-generating impervious surface (PGIS), replaced PGIS, and a portion of the pre-existing PGIS within the project limits. [Note: the project will meet a portion of its compensatory obligations by obtaining excess credits from the Kelsey Creek Wetland Mitigation Site; construction of that site was previously consulted upon ("Bellevue Nickel Project"; Service Ref. No. 1-3-06-I-0039); the balance of the project's compensatory obligations will be satisfied through wetland creation and enhancement at a second site (Crystal Creek; tributary to North Creek), and through instream and riparian enhancements constructed near the I-405 Sammamish River crossing and along an unnamed tributary to Juanita Creek ("C28")].

Minor items of work include, but are not limited to the following: on-site staging, relocation of utilities, bridge cleaning and washing (prior to or in conjunction with other bridge improvements), placement (or replacement) of guardrail runs and traffic barrier, paving and paint striping, and replacement of area lighting. Both the major design elements and these minor items of work are described more completely in the BA submitted by the WSDOT (WSDOT 2007a).

Those descriptions are incorporated here by reference, except where they have been revised or amended as agreed to during the course of consultation and documented in correspondence between the FHWA and the Service.

Construction of the proposed project will require approximately three years and is scheduled to begin during 2009. Work conducted below the Ordinary High-Water Mark (OHWM) will be completed during the approved in-water work window (June 15 to September 30), and will consist of the following (WSDOT 2007a): a) construction of two new stormwater outfalls, related bank stabilization, and instream habitat and riparian enhancements near the I-405 Sammamish River crossing; b) drainage/culvert modifications and related bank stabilization involving an unnamed tributary to the Sammamish River ("Stream 42"); c) drainage/culvert modifications, related bank stabilization, and instream habitat and riparian enhancements involving two unnamed tributaries to Juanita Creek ("C28" and "C29"; vicinity NE 140^{th} Street); d) drainage/culvert modifications and related bank stabilization involving two, unnamed tributaries to North Creek ("Stream 71-70" and "Stream 76-75"; vicinity Fitzgerald Road); and e) construction activities associated with compensatory mitigation completed at the "Crystal Creek" mitigation site (tributary to North Creek; vicinity SR 527 and I-405).

Construction Impacts and Summary of Quantities

The project will clear and grub or otherwise impact approximately 55 acres of native vegetation, including 1.7 acres of functioning riparian vegetation. Roughly a third of this area (21 acres, including 1.5 acres of riparian vegetation) will be permanently converted to intensively-managed uses associated with the I-405 corridor (i.e., travel lanes and shoulders, ramps, structures, utility corridors, stormwater and drainage facilities, etc.). Any areas disturbed on a temporary basis will be permanently stabilized in a manner consistent with the WSDOT's Roadside Classification Plan (WSDOT 1996).

The project will fill or otherwise permanently degrade approximately 0.5 acre of Category III and Category IV wetland, and approximately 3.5 acres of regulated wetland buffer. In addition, the proposed action will result in permanent impacts to approximately 1.6 acres of regulated stream buffer. The project will replace lost and/or degraded wetland/buffer and riparian functions and values according to approved ratios (WSDOT 2007a).

The project will replace, extend, or otherwise modify several drainage structures and cross-culverts in order to accommodate the expanded roadway width. These culvert modifications and/or replacements (and associated bank stabilization) will enclose, fill, or otherwise permanently degrade approximately 2,000 ft^2 below the OHWM of five minor tributaries (i.e., "Stream 42", "C28", "C29", "Stream 71-70", and "Stream 76-75"). The proposed action will also result in permanent impacts to approximately 500 ft^2 below the OHWM of the Sammamish River (i.e., two new stormwater outfalls and related bank stabilization). The project will not extend or otherwise modify any structure or conveyance identified as a partial or complete fish passage barrier (WSDOT 2007a). The project will provide compensatory mitigation for unavoidable impacts to instream habitat through instream and riparian enhancements constructed near the I-405 Sammamish River crossing, and along an unnamed tributary to Juanita Creek ("C28"). The proposed action will comply with all terms and conditions from the section 404 permit and Hydraulic Project Approval (HPA) issued for the project, and will satisfy requirements from critical area ordinances and regulations administered by those cities and counties with jurisdiction (WSDOT 2007a).

Staging locations have not been specifically identified. The project will mobilize and stage construction from locations which are outside of sensitive areas, such as closed portions of the travel lanes, shoulder, "clear-zone", and suitable adjacent properties. Measures will be taken to minimize impacts to wetlands, waterbodies, and native vegetation.

Stormwater Design

At completion, the proposed action would create approximately 13.9 acres of net-new PGIS across more than three dozen threshold discharge areas (WSDOT 2008a). After construction of the improvements included in the "Kirkland Nickel Project" (Service Ref. No. 1-3-04-I-1116), the pre-project baseline condition includes approximately 323 acres of existing PGIS, of which approximately 85 percent (273 acres) remain untreated. Table 1 summarizes pre- and post-project PGIS and identifies the receiving waterbody for six sub-areas along the project corridor.

Table 1 Pre-project and post-project PGIS (by sub-area).

Sub-Area	Pre-Project / Existing PGIS (Acres)[1]	Post-Project / New & Existing PGIS (Acres)	Receiving Waterbodies
Yarrow Creek	23	23.7	Yarrow Creek and tributaries.
North Bellevue	68	68.3	Everest Cr., Houghton Cr., other unnamed tributaries.
Forbes Creek	40	40	Forbes Creek and tributaries.
Juanita Creek	87	91.9	Juanita Creek and tributaries.
Sammamish River	53	58.6	Sammamish River and tributaries.
North Creek	52	54.4	North Creek and tributaries.
Corridor Total	323	336.9	See above.

[1] Quantities rounded to the nearest whole acre for convenience.

The project will design and construct permanent stormwater conveyance and treatment facilities to provide "enhanced" treatment for runoff from an area equivalent to the net-new PGIS in each sub-area (13.9 acres in total). [Note: runoff from PGIS associated with surface arterials may, depending upon traffic volume, receive "basic" rather than "enhanced" treatment.] In addition, the project proposes to retrofit approximately 4.7 acres of existing, untreated PGIS along the project corridor, principally within the North Bellevue (0.9 acre), Juanita Creek (1.5 acres), and North Creek (2.2) sub-areas (WSDOT 2008a). At project completion, approximately 268 acres of untreated PGIS will remain along these portions of I-405.

Site conditions are not conducive to infiltration and, owing to right-of-way and other constraints, most of the proposed stormwater facilities will consist of engineered ecology embankment. Where site conditions allow, the project proposes to construct four combined stormwater treatment wetland/detention ponds (with a combined area of approximately 0.5 acre).

The project will provide flow control for stormwater runoff from an area equivalent to the new and replaced PGIS, except for that new and replaced impervious which drains and discharges to the Sammamish River (approximately 5.6 acres). The project proposes little or no retrofit for flow control, but will either construct new flow control facilities (i.e., detention ponds, vaults, combined stormwater wetlands, etc.), or expand existing facilities in each of the six sub-areas. Nearly all of the runoff generated in the Sammamish River sub-area (treated and untreated) will discharge directly to the Sammamish River without detention; this portion of the Sammamish River is approved as a flow control-exempt waterbody (WSDOT 2008b). Existing outfalls to the Sammamish River are undersized. Therefore the project proposes to construct two new stormwater outfalls in the vicinity of the I-405 Sammamish River crossing (WSDOT 2007a).

Available right-of-way and other constraints limit the extent to which the proposed project is capable of providing retrofit for existing PGIS. The project proposes a modest amount of retrofit, equivalent in area to approximately 134 percent of the net-new PGIS. As a result, and with the large quantities of untreated PGIS that will remain in the post-project condition (i.e., approximately 268 acres), the proposed stormwater treatment is expected to achieve little or no measurable reduction in annual stormwater pollutant loadings. Table 2 summarizes anticipated pre-project and post-project pollutant loadings to the Sammamish River, to North Creek, and for the project corridor as a whole (WSDOT 2008a). [Note: the methods employed in determining these loadings are described in *Interim Guidance for Preparing the Stormwater Section of Biological Assessments* (WSDOT 2006a)].

Applying assumptions from the *Interim Guidance* (WSDOT 2006a), the proposed action is expected to achieve only very modest reductions in effluent/discharge concentration. Table 3 summarizes the range of pre-project and post-project effluent/discharge concentrations anticipated across the six sub-areas (WSDOT 2008a).

Table 2 Pre- and post-project pollutant loadings (Sammamish R.; North Cr.; Project Total).

	Total Suspended Solids	Total Zinc	Dissolved Zinc	Total Copper	Dissolved Copper
Sammamish River					
Pre-Project (lbs./yr.)	21,947	45.5	18.0	8.47	2.50
Post-Project (lbs./yr.)	21,959	45.7	18.1	8.52	2.53
Net Change (lbs./yr.)	+ 12	+ 0.2	+ 0.1	+ 0.05	+ 0.03
Percent Change	+ 0.1%	+ 0.4%	+ 0.8%	+ 0.6%	+ 1.2%
North Creek					
Pre-Project (lbs./yr.)	29,256	57.0	20.7	10.4	2.74
Post-Project (lbs./yr.)	28,108	55.1	20.2	10.0	2.69
Net Change (lbs./yr.)	-1,148	- 1.9	- 0.5	- 0.4	- 0.05
Percent Change	- 3.9%	- 3.3%	- 2.4%	- 3.8%	- 1.8%
Project / Corridor Total					
Pre-Project (lbs./yr.)	155,608	308.3	114.8	56.4	15.4
Post-Project (lbs./yr.)	153,301	305.2	114.5	56.0	15.5
Net Change (lbs./yr.)	- 2,307	- 3.1	- 0.3	- 0.4	+ 0.1
Percent Change	- 1.5%	- 1.0%	- 0.3%	- 0.7%	+ 0.6%

Table 3 Pre- and post-project effluent/ discharge concentrations.

	Total Suspended Solids (mg/L)	Total Zinc (µg/L)	Dissolved Zinc (µg/L)	Total Copper (µg/L)	Dissolved Copper (µg/L)
Pre-Project	143 - 192	272 - 350	92 - 110	46 - 59	12 - 14
Post-Project	141 - 189	269 - 345	91 - 109	46 - 58	12 - 14
Percent Change	- 5% to + 2%	- 5% to + 1%	- 3% to + 1%	- 5% to +1%	- 2% to +1%

Conservation Measures

The proposed project would implement conservation measures, including but not limited to the following, to avoid and minimize impacts associated with construction:

- The project will implement an Engineer-approved Temporary Erosion and Sediment Control Plan and Stormwater Site Plan. The project will select, design, install, maintain, and adjust Temporary Erosion and Sediment Control Plan structural and operational best management practices according to WSDOT Standard Specifications. The project will take appropriate measures to stabilize construction entrances and protect temporary stockpiles.

- As one of the first orders of work, the project will install high-visibility construction fencing to avoid unintended impacts to sensitive areas.

- The project will implement an Engineer-approved Spill Prevention, Control, and Countermeasures (SPCC) Plan to guard against the release of any harmful pollutant or product. A current copy of the approved SPCC plan will be maintained on-site for the duration of the project and no work or staging in advance of work will commence prior to implementing the plan. The approved SPCC Plan will provide site- and project-specific details identifying potential sources of pollutants, exposure pathways, spill response protocols, protocols for routine inspection fueling and maintenance of equipment, preventative and protective equipment and materials, reporting protocols and other information according to WSDOT Standard Specifications.

- The project will fully comply with all terms and conditions from the Washington State Department of Ecology (WDOE) / WSDOT *Implementing Agreement for Compliance with State Surface Water Quality Standards* (WDOE / WSDOT 1998).

- Metalwork, preparation, and painting will follow applicable WSDOT Standard Specifications (WSDOT 2005; Standard Specification 6-07), and all terms and conditions from the HPA, or General HPA, issued for the project by the Washington State Department of Fish and Wildlife (WDFW). Concrete form and falsework, weather and temperature limits, curing procedures and other aspects of cast-in-place bridge deck and column construction will follow WSDOT Standard Specifications (WSDOT 2005; Standard Specification 6-02). The project will take measures to ensure all wet or curing concrete, concrete equipment washout, and wash water are prevented from entering waters of the State (including wetlands). [<u>Note</u>: WSDOT Standard Specifications and the WDOE / WSDOT *Implementing Agreement for Compliance with State Surface Water Quality Standards* do provide for the testing of waters in contact with uncured concrete and their proper handling and/or disposal, including discharge within allowable limits].

- The project will mobilize and stage construction from locations outside of sensitive areas and measures will be taken to prevent unintended impacts to wetlands, waterbodies, and native vegetation. [<u>Note</u>: some project elements cannot be constructed without unavoidably disturbing wetlands/ buffers and regulated stream buffers].

- All work below the OHWM will be completed during the approved in-water work window (June 15 – September 30), and will fully comply with the HPA(s) issued for the project by the WDFW.

- The project will not conduct pile driving below the OHWM.
- The project will not extend or otherwise modify any structure or conveyance identified as a partial or complete fish passage barrier. Any new (or modified) culverts conveying

fish-bearing waters shall be designed and built to meet all relevant and applicable Washington State Administrative Code (W.A.C.) criteria for fish passage (W.A.C. 220-110-070).

- The project will limit disturbance to the bed, banks, and native vegetation of adjacent waterbodies to the extent practicable. The project will stabilize and restore these areas (and associated buffer) with woody and herbaceous plantings, employing where feasible techniques endorsed by the Integrated Streambank Protection Guidelines (WDFW/WDOE/WSDOT 2003), such as bioengineered bank treatments with embedded large woody debris, in deference over heavy/angular rock armored treatments.

- Any new or modified stormwater outfalls (and associated bank protection) shall be designed and constructed so as to prevent bed and bank erosion/ scour under foreseeable flows.

- All materials placed below the OHWM will be clean and free of contaminants. The project will, to the extent practicable, remove excess dirt and sediment prior to placing large woody debris within any wetted channel.

- The project will contain, treat, and dispose of wash water and turbid dewater to prevent discharge of pollutants to waters of the State (including wetlands). Any sediment-laden wastewater produced by the project will be treated prior to discharge.

- Any areas disturbed on a temporary basis will be permanently stabilized in a manner consistent with the WSDOT's Roadside Classification Plan (WSDOT 1996). The project will remove any temporary fills, will till compacted soils, and restore woody and herbaceous vegetation according to an Engineer-approved restoration or planting plan.

- The project will replace lost and/or degraded wetland/ buffer, riparian, and instream functions and values according to ratios established by the U.S. Army Corps of Engineers, WDOE, King and Snohomish County, and the cities of Bellevue, Kirkland, Bothell, and Lynnwood, Washington (WSDOT 2007a). The project will satisfy critical area ordinance and other permitting requirements of these jurisdictions.

The proposed conservation measures are described more completely in the BA submitted by the WSDOT (WSDOT 2007a). Those descriptions are incorporated here by reference, except where they have been revised or amended as agreed to during the course of consultation and documented in correspondence between the FHWA and the Service.

STATUS OF THE SPECIES (Bull Trout)

Listing Status

The coterminous United States population of the bull trout (*Salvelinus confluentus*) was listed as threatened on November 1, 1999 (64 FR 58910). The threatened bull trout generally occurs in the Klamath River Basin of south-central Oregon; the Jarbidge River in Nevada; the Willamette River Basin in Oregon; Pacific Coast drainages of Washington, including Puget Sound; major rivers in Idaho, Oregon, Washington, and Montana, within the Columbia River Basin; and the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Cavender 1978; Bond 1992; Brewin and Brewin 1997; Leary and Allendorf 1997).

Throughout its range, the bull trout are threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and introduced non-native species (64 FR 58910). Although all salmonids are likely to be affected by climate change, bull trout are especially vulnerable given that spawning and rearing are constrained by their location in upper watersheds and the requirement for cold water temperatures (Battin et al. 2007)(Rieman et al. 2007). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

The bull trout was initially listed as three separate Distinct Population Segments (DPSs) (63 FR 31647; 64 FR 17110). The preamble to the final listing rule for the United States coterminous population of the bull trout discusses the consolidation of these DPSs with the Columbia and Klamath population segments into one listed taxon and the application of the jeopardy standard under section 7 of the Act relative to this species (64 FR 58910):

> Although this rule consolidates the five bull trout DPSs into one listed taxon, based on conformance with the DPS policy for purposes of consultation under section 7 of the Act, we intend to retain recognition of each DPS in light of available scientific information relating to their uniqueness and significance. Under this approach, these DPSs will be treated as interim recovery units with respect to application of the jeopardy standard until an approved recovery plan is developed. Formal establishment of bull trout recovery units will occur during the recovery planning process.

Current Status and Conservation Needs

In recognition of available scientific information relating to their uniqueness and significance, five segments of the coterminous United States population of the bull trout are considered essential to the survival and recovery of this species and are identified as interim recovery units: 1) Jarbidge River, 2) Klamath River, 3) Columbia River, 4) Coastal-Puget Sound, and 5) St. Mary-Belly River (USFWS 2002; 2004a; 2004b). Each of these interim recovery units is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

A summary of the current status and conservation needs of the bull trout within these interim recovery units is provided below and a comprehensive discussion is found in the Service's draft recovery plans for the bull trout (USFWS 2002; 2004a; 2004b).

The conservation needs of bull trout are often generally expressed as the four "Cs": cold, clean, complex, and connected habitat. Cold stream temperatures, clean water quality that is relatively free of sediment and contaminants, complex channel characteristics (including abundant large wood and undercut banks), and large patches of such habitat that are well connected by unobstructed migratory pathways are all needed to promote conservation of bull trout at multiple scales ranging from the coterminous to local populations (a local population is a group of bull trout that spawn within a particular stream or portion of a stream system). The recovery planning process for bull trout (USFWS 2002; 2004a; 2004b) has also identified the following conservation needs: 1) maintenance and restoration of multiple, interconnected populations in diverse habitats across the range of each interim recovery unit, 2) preservation of the diversity of life-history strategies, 3) maintenance of genetic and phenotypic diversity across the range of each interim recovery unit, and 4) establishment of a positive population trend. Recently, it has also been recognized that bull trout populations need to be protected from catastrophic fires across the range of each interim recovery unit (Rieman et al. 2003).

Central to the survival and recovery of bull trout is the maintenance of viable core areas (USFWS 2002; 2004a; 2004b). A core area is defined as a geographic area occupied by one or more local bull trout populations that overlap in their use of rearing, foraging, migratory, and overwintering habitat. Each of the interim recovery units listed above consists of one or more core areas. There are 121 core areas recognized across the coterminous range of the bull trout (USFWS 2002; 2004a; 2004b).

<u>Jarbidge River Interim Recovery Unit</u>

This interim recovery unit currently contains a single core area with six local populations. Less than 500 resident and migratory adult bull trout, representing about 50 to 125 spawning adults, are estimated to occur in the core area. The current condition of the bull trout in this interim recovery unit is attributed to the effects of livestock grazing, roads, incidental mortalities of released bull trout from recreational angling, historic angler harvest, timber harvest, and the introduction of non-native fishes (USFWS 2004b). The draft bull trout recovery plan (USFWS 2004b) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout within the core area, 2) maintain stable or increasing trends in abundance of both resident and migratory bull trout in the core area, 3) restore and maintain suitable habitat conditions for all life history stages and forms, and 4) conserve genetic diversity and increase natural opportunities for genetic exchange between resident and migratory forms of the bull trout. An estimated 270 to 1,000 spawning bull trout per year are needed to provide for the persistence and viability of the core area and to support both resident and migratory adult bull trout (USFWS 2004b).

<u>Klamath River Interim Recovery Unit</u>

This interim recovery unit currently contains three core areas and seven local populations. The current abundance, distribution, and range of the bull trout in the Klamath River Basin are greatly reduced from historical levels due to habitat loss and degradation caused by reduced water quality, timber harvest, livestock grazing, water diversions, roads, and the introduction of non-native fishes (USFWS 2002). Bull trout populations in this interim recovery unit face a high risk of extirpation (USFWS 2002). The draft Klamath River bull trout recovery plan (USFWS 2002) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and strategies, 4) conserve genetic diversity and provide the opportunity for genetic exchange among appropriate core area populations. Eight to 15 new local populations and an increase in population size from about 2,400 adults currently to 8,250 adults are needed to provide for the persistence and viability of the three core areas (USFWS 2002).

<u>Columbia River Interim Recovery Unit</u>

The Columbia River interim recovery unit includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60 percent of the Columbia River Basin, and presently occur in 45 percent of the estimated historical range (Quigley and Arbelbide 1997). This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in central Idaho and northwestern Montana. The Columbia River interim recovery unit has declined in overall range and numbers of fish (63 FR 31647). Although some strongholds still exist with migratory fish present, bull trout generally occur as isolated local populations in headwater lakes or tributaries where the migratory life history form has been lost. Though still widespread, there have been numerous local extirpations reported throughout the Columbia River basin. In Idaho, for example, bull trout have been extirpated from 119 reaches in 28 streams (Idaho Department of Fish and Game *in litt*., 1995). The draft Columbia River bull trout recovery plan (USFWS 2002) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of the bull trout within core areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies, and 4) conserve genetic diversity and provide opportunities for genetic exchange.

This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in Idaho and northwestern Montana. The condition of the bull trout within these core areas varies from poor to good. All core areas have been subject to the combined effects of habitat degradation and fragmentation caused by the following activities: dewatering; road construction and maintenance; mining; grazing; the blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment into diversion channels; and introduced non-native species. The Service completed a core area conservation assessment for the 5-year status review and determined that, of the 97 core areas in this interim recovery unit, 38 are at high risk of extirpation, 35 are at risk, 20 are at potential risk, 2 are at low risk, and 2 are at unknown risk (USFWS 2005).

Coastal-Puget Sound Interim Recovery Unit

Bull trout in the Coastal-Puget Sound interim recovery unit exhibit anadromous, adfluvial, fluvial, and resident life history patterns. The anadromous life history form is unique to this interim recovery unit. This interim recovery unit currently contains 14 core areas and 67 local populations (USFWS 2004a). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this interim recovery unit. Bull trout continue to be present in nearly all major watersheds where they likely occurred historically, although local extirpations have occurred throughout this interim recovery unit. Many remaining populations are isolated or fragmented and abundance has declined, especially in the southeastern portion of the interim recovery unit. The current condition of the bull trout in this interim recovery unit is attributed to the adverse effects of dams, forest management practices (e.g., timber harvest and associated road building activities), agricultural practices (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation), livestock grazing, roads, mining, urbanization, poaching, incidental mortality from other targeted fisheries, and the introduction of non-native species. The draft Coastal-Puget Sound bull trout recovery plan (USFWS 2004a) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of bull trout within existing core areas, 2) increase bull trout abundance to about 16,500 adults across all core areas, and 3) maintain or increase connectivity between local populations within each core area.

St. Mary-Belly River Interim Recovery Unit

This interim recovery unit currently contains six core areas and nine local populations (USFWS 2002). Currently, bull trout are widely distributed in the St. Mary-Belly River drainage and occur in nearly all of the waters that it inhabited historically. Bull trout are found only in a 1.2-mile reach of the North Fork Belly River within the United States. Redd count surveys of the North Fork Belly River documented an increase from 27 redds in 1995 to 119 redds in 1999. This increase was attributed primarily to protection from angler harvest (USFWS 2002). The current condition of the bull trout in this interim recovery unit is primarily attributed to the effects of dams, water diversions, roads, mining, and the introduction of non-native fishes (USFWS 2002). The draft St. Mary-Belly bull trout recovery plan (USFWS 2002) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and forms, 4) conserve genetic diversity and provide the opportunity for genetic exchange, and 5) establish good working relations with Canadian interests because local bull trout populations in this interim recovery unit are comprised mostly of migratory fish, whose habitat is mostly in Canada.

Life History

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Fraley and Shepard 1989; Goetz 1989). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989; Goetz 1989), or saltwater (anadromous form) to rear as subadults and to live as adults (Cavender 1978; McPhail and Baxter 1996; WDFW et al. 1997). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Leathe and Graham 1982; Fraley and Shepard 1989; Pratt 1992; Rieman and McIntyre 1996).

The iteroparous reproductive strategy of bull trout has important repercussions for the management of this species. Bull trout require passage both upstream and downstream, not only for repeat spawning but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous salmonids (fishes that spawn once and then die, and require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a downstream passage route. Additionally, in some core areas, bull trout that migrate to marine waters must pass both upstream and downstream through areas with net fisheries at river mouths. This can increase the likelihood of mortality to bull trout during these spawning and foraging migrations.

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length, and migratory adults commonly reach 24 inches or more (Pratt 1985; Goetz 1989). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982).

Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Howell and Buchanan 1992; Pratt 1992; Rieman and McIntyre 1993; 1995; Rich, Jr. 1996; Watson and Hillman 1997). Watson and Hillman (Watson and Hillman 1997) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993), bull trout should not be expected to simultaneously occupy all available habitats (Rieman et al.

1997).
Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993; Rieman et al. 1997; Mike Gilpin *in litt*., 1997). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic structuring of bull trout indicates there is limited gene flow among bull trout populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Rieman and McIntyre 1993; Spruell et al. 1999). Migration also allows bull trout to access more abundant or larger prey, which facilitates growth and reproduction. Additional benefits of migration and its relationship to foraging are discussed below under "Diet."

Cold water temperatures play an important role in determining bull trout habitat quality, as these fish are primarily found in colder streams (below 15 °C or 59 °F), and spawning habitats are generally characterized by temperatures that drop below 9 °C (48 °F) in the fall (Fraley and Shepard 1989; Pratt 1992; Rieman and McIntyre 1993).

Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992; Rieman and McIntyre 1993; Baxter et al. 1997; Rieman et al. 1997). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C (35 °F to 39 °F) whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (46 °F to 50 °F) (McPhail and Murray 1979; Goetz 1989; Buchanan and Gregory 1997). In Granite Creek, Idaho, Bonneau and Scarnecchia (Bonneau and Scarnecchia 1996) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 °C to 9 °C (46 °F to 48 °F), within a temperature gradient of 8 °C to 15 °C (4 °F to 60 °F). In a landscape study relating bull trout distribution to maximum water temperatures, (Dunham et al. 2003) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 11 °C to 12 °C (52 °F to 54 °F).

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Fraley and Shepard 1989; Rieman and McIntyre 1993; 1995; Rieman et al. 1997; Buchanan and Gregory 1997). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick et al. 2002). For example, in a study in the Little Lost River of Idaho where bull trout were found at temperatures ranging from 8 °C to 20 °C (46 °F to 68 °F), most sites that had high densities of bull trout were in areas where primary productivity in streams had increased following a fire (Bart L. Gamett, pers. comm. June 20, 2002).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Pratt 1992; Thomas 1992; Rich, Jr. 1996; Sexauer and James 1997; Watson and Hillman 1997). Maintaining bull trout habitat requires stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre

1993). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989; Pratt 1992; Pratt and Huston 1993). Pratt (Pratt 1992) indicated that increases in fine sediment reduce egg survival and emergence.

Bull trout typically spawn from August through November during periods of increasing flows and decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989; Pratt 1992; Rieman and McIntyre 1996). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992; Ratliff and Howell 1992).

Early life stages of fish, specifically the developing embryo, require the highest inter-gravel dissolved oxygen (IGDO) levels, and are the most sensitive life stage to reduced oxygen levels. The oxygen demand of embryos depends on temperature and on stage of development, with the greatest IGDO required just prior to hatching.

A literature review conducted by the Washington Department of Ecology (WDOE 2002) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). In a laboratory study conducted in Canada, researchers found that low oxygen levels retarded embryonic development in bull trout (Giles and Van der Zweep1996 *cited in* (Stewart et al. 2007)). Normal oxygen levels seen in rivers used by bull trout during spawning ranged from 8 to 12 mg/L (in the gravel), with corresponding instream levels of 10 to 11.5 mg/L (Stewart et al. 2007). In addition, IGDO concentrations, water velocities in the water column, and especially the intergravel flow rate, are interrelated variables that affect the survival of incubating embryos (ODEQ (Oregon Department of Environmental Quality) 1995). Due to a long incubation period of 220+ days, bull trout are particularly sensitive to adequate IGDO levels. An IGDO level below 8 mg/L is likely to result in mortality of eggs, embryos, and fry.

Migratory forms of bull trout may develop when habitat conditions allow movement between spawning and rearing streams and larger rivers, lakes or nearshore marine habitat where foraging opportunities may be enhanced (Frissell 1993; Goetz et al. 2004; Brenkman and Corbett 2005). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Rieman and McIntyre 1993; MBTSG 1998; Frissell 1999). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbances make local habitats temporarily unsuitable. Therefore, the range of the species is diminished, and the potential for a greater reproductive contribution from larger size fish with higher fecundity is lost (Rieman and McIntyre 1993).

Diet

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. A single optimal foraging strategy is not necessarily a consistent feature in the life of a fish, because this strategy can change as the fish progresses from one life stage to another (i.e., juvenile to subadult). Fish growth depends on the quantity and quality of food that is eaten (Gerking 1994), and as fish grow, their foraging strategy changes as their food changes, in quantity, size, or other characteristics. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987; Goetz 1989; Donald and Alger 1993). Subadult and adult migratory bull trout feed on various fish species (Leathe and Graham 1982; Fraley and Shepard 1989; Donald and Alger 1993; Brown 1994). Bull trout of all sizes other than fry have been found to eat fish half their length (Beauchamp and VanTassell 2001). In nearshore marine areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) (WDFW et al. 1997; Goetz et al. 2004).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. Optimal foraging theory can be used to describe strategies fish use to choose between alternative sources of food by weighing the benefits and costs of capturing one source of food over another. For example, prey often occur in concentrated patches of abundance ("patch model;" (Gerking 1994)). As the predator feeds in one patch, the prey population is reduced, and it becomes more profitable for the predator to seek a new patch rather than continue feeding on the original one. This can be explained in terms of balancing energy acquired versus energy expended. For example, in the Skagit River system, anadromous bull trout make migrations as long as 121 miles between marine foraging areas in Puget Sound and headwater spawning grounds, foraging on salmon eggs and juvenile salmon along their migration route (WDFW et al. 1997). Anadromous bull trout also use marine waters as migration corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Goetz et al. 2004; Brenkman and Corbett 2005).

<u>Changes in Status of the Coastal-Puget Sound Interim Recovery Unit</u>

Although the status of bull trout in Coastal-Puget Sound interim recovery unit has been improved by certain actions, it continues to be degraded by other actions, and it is likely that the overall status of the bull trout in this population segment has not improved since its listing on November 1, 1999. Improvement has occurred largely through changes in fishing regulations and habitat-restoration projects. Fishing regulations enacted in 1994 either eliminated harvest of bull trout or restricted the amount of harvest allowed, and this likely has had a positive influence on the abundance of bull trout. Improvement in habitat has occurred following restoration projects intended to benefit either bull trout or salmon, although monitoring the effectiveness of these projects seldom occurs. On the other hand, the status of this population segment has been adversely affected by a number of Federal and non-Federal actions, some of which were addressed under section 7 of the Act. Most of these actions degraded the environmental baseline; all of those addressed through formal consultation under section 7 of the Act permitted the incidental take of bull trout.

Section 10(a)(1)(B) permits have been issued for Habitat Conservation Plans (HCP) completed in the Coastal-Puget Sound population segment. These include: 1) the City of Seattle's Cedar River Watershed HCP, 2) Simpson Timber HCP, 3) Tacoma Public Utilities Green River HCP, 4) Plum Creek Cascades HCP, 5) Washington State Department of Natural Resources HCP, 6) West Fork Timber HCP (Nisqually River), and 7) Forest Practices HCP. These HCPs provide landscape-scale conservation for fish, including bull trout. Many of the covered activities associated with these HCPs will contribute to conserving bull trout over the long-term; however, some covered activities will result in short-term degradation of the baseline. All HCPs permit the incidental take of bull trout.

<u>Changes in Status of the Columbia River Interim Recovery Unit</u>

The overall status of the Columbia River interim recovery unit has not changed appreciably since its listing on June 10, 1998. Populations of bull trout and their habitat in this area have been affected by a number of actions addressed under section 7 of the Act. Most of these actions resulted in degradation of the environmental baseline of bull trout habitat, and all permitted or analyzed the potential for incidental take of bull trout. The Plum Creek Cascades HCP, Plum Creek Native Fish HCP, and Forest Practices HCP addressed portions of the Columbia River population segment of bull trout.

<u>Changes in Status of the Klamath River Interim Recovery Unit</u>

Improvements in the Threemile, Sun, and Long Creek local populations have occurred through efforts to remove or reduce competition and hybridization with non-native salmonids, changes in fishing regulations, and habitat-restoration projects. Population status in the remaining local populations (Boulder-Dixon, Deming, Brownsworth, and Leonard Creeks) remains relatively unchanged. Grazing within bull trout watersheds throughout the recovery unit has been curtailed. Efforts at removal of non-native species of salmonids appear to have stabilized the Threemile and positively influenced the Sun Creek local populations. The results of similar efforts in Long Creek are inconclusive. Mark and recapture studies of bull trout in Long Creek indicate a larger migratory component than previously expected.

Although the status of specific local populations has been slightly improved by recovery actions, the overall status of Klamath River bull trout continues to be depressed. Factors considered threats to bull trout in the Klamath Basin at the time of listing – habitat loss and degradation caused by reduced water quality, past and present land use management practices, water diversions, roads, and non-native fishes – continue to be threats today.

Changes in Status of the Saint Mary-Belly River Interim Recovery Unit

The overall status of bull trout in the Saint Mary-Belly River interim recovery unit has not changed appreciably since its listing on November 1, 1999. Extensive research efforts have been conducted since listing, to better quantify populations of bull trout and their movement patterns. Limited efforts in the way of active recovery actions have occurred. Habitat occurs mostly on Federal and Tribal lands (Glacier National Park and the Blackfeet Nation). Known problems due to instream flow depletion, entrainment, and fish passage barriers resulting from operations of the U.S. Bureau of Reclamation's Milk River Irrigation Project (which transfers Saint Mary-Belly River water to the Missouri River Basin) and similar projects downstream in Canada constitute the primary threats to bull trout and to date they have not been adequately addressed under section 7 of the Act. Plans to upgrade the aging irrigation delivery system are being pursued, which has potential to mitigate some of these concerns but also the potential to intensify dewatering. A major fire in August 2006 severely burned the forested habitat in Red Eagle and Divide Creeks, potentially affecting three of nine local populations and degrading the baseline.

STATUS OF CRITICAL HABITAT (Bull Trout; Coterminous Range)

No designated bull trout critical habitat is present within the action area. The nearest designated bull trout critical habitat is located in Lake Washington (Federal Register 50 CFR 17; September 26, 2005; 56212), and will not be affected by the proposed action.

ENVIRONMENTAL BASELINE (Bull Trout)

Regulations implementing the Act (50 CFR section 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress.

Description of the Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR section 402.02). As such, the action area includes the extent of the physical, biotic, and chemical effects of the action on the environment.

I-405 is a 30-mile loop route originating at the I-405/I-5 interchange in the city of Tukwila, Washington, and extending in a generally northward direction to the I-405/I-5 interchange in the city of Lynnwood, Washington. I-405 is an important freight and commuter route, as it bypasses that portion of I-5 which passes through Seattle, Washington, and serves all of the “eastside” metropolitan area (including the cities of Tukwila, Renton, Bellevue, Kirkland, Redmond, Bothell, and Lynnwood). I-405 intersects with several regionally important highways along its length, including State Routes 167, 900, 520, and 522, and Interstate-90.

The project corridor includes approximately fifteen miles of I-405, from the vicinity of the SR 520/I-405 Interchange in Bellevue, to the I-405/I-5 Interchange in Lynnwood. The surrounding action area (Figure 2), which lies east of and extends along the northern half of Lake Washington, is heavily developed and supports high-density residential, commercial, and industrial uses.

The project corridor is located in WRIA 8 – Cedar-Sammamish, within hydraulic unit code 17110012 (Lake Washington). The entire action area drains into Lake Washington, by way of the Sammamish River and several small- and moderate-sized eastside tributaries to the lake. Six sub-areas describe the project's receiving waters; these include (from south to north): Yarrow Creek (Yarrow Creek and its tributaries); the North Bellevue sub-area of the east Lake Washington basin (including Everest Creek, Houghton Creek, and several unnamed tributaries); Forbes Creek (Forbes Creek and its tributaries); Juanita Creek (Juanita Creek and its tributaries); the Sammamish River (Sammamish River and its tributaries, excluding North Creek); and, North Creek (North Creek and its tributaries).

Figure 2 Aerial photo depicting extent of the action area.

The terrestrial boundaries of the action area were defined based on where temporary increases in sound and visual disturbance resulting from construction will attenuate to baseline levels of disturbance. Temporary increases in sound associated with (upland) impact pile driving are expected to have the farthest reaching effects in the terrestrial environment. The terrestrial boundaries of the action area extend a distance of approximately one mile in all directions from where work activities will be conducted.

The aquatic boundaries of the action area were defined based on where, and how far, suspended sediments are expected to extend upstream and downstream of work activities. The aquatic boundaries of the action area also encompass that area where the project may directly and indirectly affect, or exert an influence upon, surface water and sediment quality and hydrology. The aquatic boundaries of the action area extend from points of stormwater discharge (i.e., outfalls) to the Sammamish River, North Creek, Juanita Creek, Forbes Creek, and Yarrow Creek, downstream to the locations where these waterbodies enter and discharge into Lake Washington.

The action area also includes those areas where the project will complete compensatory mitigation for unavoidable impacts to wetland/buffer, riparian, and instream functions and values. These areas are near the I-405 Sammamish River crossing, along an unnamed tributary to Juanita Creek ("C28") and along Crystal Creek (tributary to North Creek; vicinity SR 527/I-405).

The proposed project will reduce congestion and improve mobility for vehicles traveling this portion of I-405. The project will not construct new points of access along the project corridor and will not increase traffic capacity along surrounding local arterials. The submitted BA assesses the potential for indirect effects related to land use (i.e., changes in the rate or pattern of land use conversion and related effects) and finds that no new development is contingent or dependent upon the proposed project. The Service expects that no discernible changes in the rate or pattern of land use conversion will result, in whole or in part, from construction of the project.

Environmental Baseline in the Action Area

Throughout the action area the dominant land use types include medium- and high-density residential developments, commercial, and industrial uses. The largest tracts of undeveloped (or relatively undeveloped) land are associated with Bridle Trails State Park (located east of I-405 and north of SR 520) and several much smaller county and community parks. Along portions of some of the waterbodies within the action area (e.g., along portions of North Creek and its tributaries, unnamed tributaries to the Sammamish River, etc.) land use includes low-density residential development and/or narrow riparian zones which are relatively intact. However, throughout much of the action area existing developments encroach on heavily degraded riparian zones. Most of the action area is located within the city limits or designated Urban Growth Area boundaries of the Cities of Bellevue, Kirkland, and Bothell, Washington. Even outside these cities and Urban Growth Areas, these portions of unincorporated King and Snohomish County are moderately to heavily developed.

The action area drains to Lake Washington by way of the Sammamish River and several small- and moderate-sized eastside tributaries to the lake, including Yarrow Creek, Forbes Creek, and Juanita Creek. These waterbodies support coho (*Oncorhynchus kisutch*), Chinook (*O. tshawytscha*), sockeye/kokanee (*O. nerka*), and steelhead (*O. mykiss*) salmon. These waterbodies also support cutthroat trout (*O. clarki*) and lie within the range of anadromous bull trout (*S. confluentus*). Lake Washington is designated as critical habitat for bull trout (Unit 28 – Puget Sound)(Federal Register 50 CFR 17; September 26, 2005; 56212), and Lake Washington, the Sammamish River, and all accessible tributaries are identified by the draft Bull Trout Recovery Plan (USFWS 2004) as important foraging, migration, and overwintering (FMO) habitat (Lake Washington FMO). The North Lake Washington and Lake Washington/Sammamish populations of Chinook and sockeye/ kokanee salmon are considered “healthy”; the Lake Washington/Sammamish population of coho salmon is considered “depressed”; and the Lake Washington winter steelhead population is regarded as “critical” (WDFW 2002).

Factors that limit salmonid productivity in the action area include but are not limited to the following: access (blockages), floodplain modification and loss of hydrologic connectivity, high levels of impervious surface and associated changes to the natural hydrologic regime, fragmented and heavily degraded riparian conditions, reduced instream habitat complexity (including degraded substrate conditions and loss of pool, refuge, and off-channel habitat), impaired surface water quality, and degraded lake conditions (e.g., pervasive nearshore and shoreline alterations, invasive species, etc.). The Washington State Conservation Commission has provided a good summary of limiting factors in WRIA 8 (Kerwin 2001).

The current baseline instream habitat and watershed conditions may be assessed applying the *Matrix of Diagnostics / Pathways and Indicators* (USFWS 1998). The matrix provides a framework for considering the effects of individual or grouped actions on habitat elements and processes important to the complete life cycle of bull trout. The matrix is a useful tool for describing whether habitat is functioning adequately, functioning at risk, or functioning at unacceptable levels of risk. The BA submitted by the WSDOT accurately and appropriately applies the matrix in describing baseline environmental conditions at the scale of the action area (WSDOT 2007a). Those descriptions are incorporated here by reference, and what follows is only a very brief summary. [Note: the Service has used additional sources of information to characterize the Chemical Contamination indicator, and has also summarized information describing the stream macroinvertebrate community (prey base) within the action area; the sub-section that follows is not simply a summary of information appearing in the submitted BA.]

Temperature: The waters within the action area are *functioning at unacceptable levels of risk* for the temperature indicator. The Sammamish River, North Creek, Juanita Creek, and Forbes Creek are each identified on the Washington State 303(d) list of impaired waterbodies for exceedances of the temperature criteria (WDOE 2005).

Sediment: The waters within the action area are *functioning at unacceptable levels of risk* for the sediment indicator. Both sediment loads and the degree of substrate embeddedness are high. Pool frequency and quality are reduced as a result of filling.

Chemical Contamination / Nutrients: The waters within the action area are *functioning at unacceptable levels of risk* for the contamination indicator. The Sammamish River, Juanita Creek, and Forbes Creek are each identified on the Washington State 303(d) list of impaired waterbodies for failure to meet the dissolved oxygen criteria (WDOE 2005). However, the waters within the action area are not currently listed for exceedance of the State's acute or chronic aquatic life water quality criteria for any metal or organic compound.

For many years King County's Department of Natural Resources and Parks has administered an ambitious program of water and sediment quality monitoring and toxicity testing (King Co. 2008a). These programs have produced a summary of historical "small streams" sediment monitoring data (King Co. 2005a), an extensive assessment of Sammamish River water and sediment quality (King Co. 2005b), and a body of more recent unpublished data describing the most current trends in sediment quality and toxicity (King Co. 2008b).

Table 4 Select sediment contaminants of concern and associated screening level SQGs (King Co. 2005a; King Co. 2008b; Smith *et al*. 1996).

Contaminant of Concern	**Threshold Effect Level (TEL)** *	**Probable Effect Level (PEL)** *
Zinc	123 ppm	315 ppm
Copper	36 ppm	197 ppm
benzo(a)anthracene	32 ppb	385 ppb
benzo(a)pyrene	32 ppb	782 ppb
pyrene	53 ppb	875 ppb
phenanthrene	42 ppb	515 ppb
chrysene	57 ppb	862 ppb
fluoranthene	111 ppb	2355 ppb

* All units expressed as parts-per-million (mg/kg dry weight) or parts-per-billion (µg/kg dry weight), as indicated.

Freshwater sediment quality is recognized as an indicator of surface water quality integrated over time (King Co. 2005a, p. vi). Summarizing 15 years of sediment monitoring data collected at 27 freshwater stream sites in WRIAs 8 and 9, including sites at the mouths of Forbes, Juanita, and North Creek, King County found that five metals (including cadmium and zinc) were occasionally detected at levels that exceed interim freshwater sediment quality guidelines (SQGs). The frequency of these exceedances was relatively low, but was greatest for zinc (8.8 percent) (King Co. 2005a, p. 13). Among the 27 sites, four had statistically higher concentrations of metals typically associated with urban runoff. Forbes Creek exhibited the highest levels of metals contamination. Data collected at the mouth of Forbes Creek (Site 0456) indicate that maximum zinc concentrations in these sediments exceed the established clean-up screening level and the probable effects level (PEL) above which adverse biological effects are frequently expected to occur (King Co. 2005a, p. 13). The sediment monitoring data summarized here are much more limited for organic parameters, but do indicate that a dozen or more polycyclic aromatic hydrocarbons (PAHs) are found with some frequency among the sites; observed concentrations typically fall between the respective PELs and lower threshold effect levels (TELs)(King Co. 2005a, p. 23).

Between 2001 and 2003 King County sampled and analyzed water and sediment pollutant concentrations, bioavailability, and toxicity at ten stations along the entire length of the Sammamish River, between Lake Sammamish and Lake Washington (King Co. 2005b). The published report summarizing these data finds that measured metal and organic compound concentrations in water were consistently below both acute and chronic aquatic life water quality criteria. Water quality bioassays conducted using three protocols/test species found a low incidence of toxicity, but also found that samples with observed toxicity did not exceed the TEL for any individual metal or organic pollutant. In explaining these apparently inconsistent results, the report authors suggest that the presence of chemical pollutants not analyzed, or the synergistic effects of multiple chemicals, may be evident (King Co. 2005b, p. 71).

This same report finds that sediment nickel concentrations were consistent across all stations, only slightly exceeded the TEL, and may very well be attributable to background concentrations in native soils (King Co. 2005b, p. 48). While in apparent low concentrations, analytical results adjusted for organic-carbon content suggest that metals measured in Sammamish River sediments are bioavailable (King Co. 2005b, p. 55). Five PAHs, a class of organic pollutants formed during combustion of fuels (and found in creosote-treated wood), were detected in sediments (from seven stations) at concentrations that exceed respective TELs. Maximum observed concentrations were as follows: benzo(a)anthracene (87 ppb), benzo(a)pyrene (128 ppb), pyrene (227 ppb), phenanthrene (74 ppb), fluoranthene (237 ppb)(King Co. 2005b, p. 53). Interpreting these data, King County concludes that because maximum concentrations are relatively low (i.e., TEL ratios are low) and below PELs, the risk of adverse effects to aquatic life from sediment PAH concentrations is low (King Co. 2005b, p. 52), but must also be characterized as uncertain.

King County continues to monitor current trends in sediment quality and toxicity employing the best available and most widely accepted techniques and protocols, including the WDOE's interim freshwater sediment quality guidelines, "floating percentile method", and AVS/SEM (acid volatile sulfides/simultaneously extracted metals) ratio as an indicator of bioavailability (King Co. 2008b). Table 5, below, summarizes preliminary (unpublished) conclusions regarding sediment quality and toxicity based on year 2005 data collected from six stations located within the project action area. Data collected at four additional stations within the action area (not identified below) suggest sediment quality exerts no adverse effect on stream biota (Forbes Creek YY456; Juanita Creek NN446; North Creek 0474 and WW474). [Note: elsewhere in the Sammamish River basin, year 2005 data suggest that at more than a dozen additional stations sediment quality exerts a probable or uncertain adverse effect on stream biota; many of these stations are located along reaches of North Creek upstream of the action area and throughout Swamp Creek (tributary to Sammamish River)].

Table 5 Monitoring stations within the action area exhibiting impaired sediment quality

(King Co. 2008b).

Station Location / ID	Chemical Contaminants Exerting ***Probable*** Effects (Concentrations > PEL)	Chemical Contaminants Exerting ***Uncertain*** Effects (PEL > Concentrations > TEL)
Forbes Creek 0456	bis(2-ethylhexyl)phthalate[1]	arsenic, cadmium, chromium, nickel, zinc, three pesticides and breakdown products [DDE, DDD, dieldrin]
Forbes Creek XX456	zinc	bis(2-ethylhexyl)phthalate[1], arsenic, nickel
Juanita Creek 0046		bis(2-ethylhexyl)phthalate[1], benzo(a)anthracene (PAH), benzo(a)pyrene (PAH)
Juanita Creek 0446	bis(2-ethylhexyl)phthalate[1]	five PAHs [chrysene, benzo (a)anthracene, benzo(a)pyrene, phenanthrene, pyrene], nickel, two pesticides and breakdown products [chlordane, DDE]
Juanita Creek LL446 Juanita Creek MM446		benzo(a)pyrene (PAH), pyrene (PAH), nickel

[1] There are some indications that laboratory tests may provide "false-positives" for phthalates.

It is instructive to consider with care how King County has characterized or interpreted data collected at some of these small stream sediment quality monitoring stations. Data collected at Forbes Creek Station XX456 indicate concentrations of zinc "above levels likely to cause adverse effects in sediment-dwelling animals" (King Co. 2008c). AVS/SEM ratios indicate these metal concentrations "are bioavailable and may cause adverse effects". Particle size distribution at Station XX456 suggests, the "site is very dynamic", "chemicals [(i.e., concentrations of zinc)] have not been there very long", and there is an apparent "on-going upstream source of these contaminants" (King Co. 2008c). Data collected at Juanita Creek Station 0446 indicate concentrations of five PAHs falling between their respective TELs and PELs. Whether these concentrations could, individually or in unison, result in adverse effects to sediment-dwelling animals is "uncertain" (King Co. 2008d). Again, at Station 0446, AVS/SEM ratios indicate metal concentrations are bioavailable, and particle size distribution suggests a dynamic system where sediment contaminants are still in transportable forms (King Co. 2008d).

Moshenberg (2004, p. 27) reports the findings of a study investigating sediment and benthic community impairment in Lake Union, Lake Washington, and Lake Sammamish (King County, Washington). The study found widespread impairment of sediment quality. The State of Washington's interim SQGs (King Co. 2008b; Smith *et al.* 1996) were frequently exceeded for polychlorinated biphenyls (70 percent of stations), metals (50 percent), phthalates (46 percent), and PAHs (23 percent); Zn and Cu were found to exceed their respective SQGs more frequently than any pollutant except Aroclor 1254 (Moshenberg 2004, p. 54).

The sediment quality findings summarized above indicate a pattern of widespread low to moderate contamination, and identify locations within the action area where metal concentrations are both bioavailable and a source of potential adverse effects to stream biota. Within the action area, sediment quality is degraded.

Access Barriers: The waters within the action area are *functioning at risk* for the access indicator. While these portions of the Sammamish River and North Creek function adequately (i.e., present no significant barriers to fish passage), Yarrow Creek, the minor (i.e., unnamed) east Lake Washington tributaries, Forbes Creek, and Juanita Creek are all functioning at risk (or at unacceptable levels of risk). Contrary to the summary appearing in the submitted BA, current information identifies several significant barriers to fish passage in the Forbes Creek sub-basin (Parametrix 2004, p. 3-3).

Substrate Embeddedness: The waters within the action area are *functioning at unacceptable levels of risk* for the substrate embeddedness indicator. Both sediment loads and the degree of substrate embeddedness are high.

Large Woody Debris: The waters within the action area are *functioning at risk* for the large woody debris indicator. The Sammamish River, North Creek, and Juanita Creek are all functioning at unacceptable levels of risk; the other waterbodies within the action area are either functioning at risk (Yarrow Creek, Forbes Creek) or functioning adequately.

Pool Frequency and Quality; *Large Pools*: The waters within the action area are *functioning at unacceptable levels of risk* for these indicators. Pool frequency and quality are reduced, and large pools are relatively few in number, as a result of heavy sediment loads, channel incision, and lack of large woody debris.

Off-Channel Habitat; *Refugia*: The waters within the action area are *functioning at unacceptable levels of risk* for these indicators. Channel complexity, floodplain connectivity, and riparian condition and function are all greatly reduced. Portions of these waterbodies are heavily degraded as a result of bank hardening and/or channelization.

Width-Depth Ratio: The waters within the action area are *functioning at unacceptable levels of risk* for this indicator. Pool frequency and quality are reduced, and large pools are relatively few in number. Some portions of these waterbodies exhibit moderate to severe channel incision.

Streambank Condition: The waters within the action area are *functioning at risk* for the streambank condition indicator. Portions of these waterbodies are heavily degraded as a result of bank hardening and/or channelization. The I-405 Forbes Creek crossing has been characterized as highly erosive.
Floodplain Connectivity: The waters within the action area are *functioning at risk* for the floodplain connectivity indicator. Floodplains and local patterns of hydrology are moderately to extensively modified.

Change in Peak / Base Flows: The waters within the action area are *functioning at unacceptable levels of risk* for this indicator. Yarrow Creek, Forbes Creek, and Juanita Creek all exhibit elevated peak flows and pronounced "flashiness". The Sammamish River, North Creek, Juanita Creek, and Forbes Creek are each identified on the Washington State 303(d) list of impaired waterbodies for exceedances of the temperature criteria and/or low levels of dissolved oxygen (WDOE 2005); these water quality impairments suggest seasonally-reduced base flows.

Road Density & Location; *Disturbance Regime & History*: The waters within the action area are *functioning at unacceptable levels of risk* for these indicators. All of these waterbodies have been extensively modified (i.e., channelized, culverted, etc.) to accommodate developed land uses and an extensive surface street network.

Riparian Reserves: The waters within the action area are *functioning at unacceptable levels of risk* for the riparian reserves indicator. Fragmented and heavily degraded riparian conditions prevail throughout much of the action area. Recruitment and conveyance of large woody debris, shading, and other riparian functions are impaired.

Prey Base: The waters within the action area exhibit invertebrate community composition indicative of disturbed or degraded conditions. King County has reported findings from a 2002-2003 field survey of the benthic invertebrate communities in portions of Forbes Creek and North Creek. Conditions in Forbes Creek are rated as "very poor", based on benthic invertebrate index scores (King Co. 2008c); greater than 75 percent of the sampled invertebrates represent taxa tolerant of degraded conditions, and the surveys documented few species sensitive to degraded conditions. Conditions in North Creek are rated as "poor", based on benthic invertebrate index scores (King Co. 2008e); on a site-by-site basis, between 55 percent and 85 percent of the sampled invertebrates represent taxa tolerant of degraded conditions, and the surveys documented very few species sensitive to degraded conditions.

Status of the Species in the Action Area

The waters within the action area are FMO habitat for bull trout. Migratory bull trout use nonnatal watersheds (habitat located outside of their spawning and early rearing habitat) to forage, migrate, and overwinter (Brenkman and Corbett 2003a,b *in* USFWS 2004). Adult and subadult bull trout may occupy these waters at any time of year, but information is not available to reliably estimate the number of bull trout that forage, migrate, and overwinter in the action area. Bull trout using Lake Washington FMO habitat most likely originate from the Snohomish-Skykomish and Puyallup core areas (and local populations).

Because the action area is located outside of the eight bull trout core areas identified within the Puget Sound Management Unit, and the potential for spawning in the Lake Washington basin is believed to be low, we expect that only anadromous adult and subadult bull trout occur within the action area. Suitable spawning and rearing habitats are not present, and available information indicates that juvenile bull trout do not occur in the action area. Anadromous adult and subadult bull trout using Lake Washington FMO habitat originate from core areas located at a considerable distance from the action area. Current information suggests that adult and subadult bull trout use the waters within the action area infrequently and in relatively low numbers.

The action area exhibits heavily degraded watershed, riparian, and instream habitat conditions. These conditions, including poor habitat connectivity (i.e., access barriers) and degraded surface water quality (temperature and dissolved oxygen), limit suitability for bull trout within the action area. Adult and subadult bull trout are more likely to occur within the action area during winter months and/or when prey availability is greatest. Bull trout may enter Lake Washington tributaries in response to foraging opportunities, when juvenile or spawning salmonids are present in higher numbers or densities.

Juanita Creek, North Creek, and the Sammamish River are more likely to support adult and subadult bull trout than other portions of the action area. These sub-basins are comparatively larger, and currently offer better habitat connectivity and prey availability than the Yarrow Creek, North Bellevue, and Forbes Creek sub-basins.

Lake Washington FMO

The draft Bull Trout Recovery Plan has identified the Lake Washington system as important FMO habitat (USFWS 2004). Foraging, migration, and overwintering habitats are believed to be critical to the persistence of the anadromous bull trout life history form. Anadromous adult and subadult bull trout from nearby core areas may migrate through the marine environment into the Lake Washington FMO habitat. The Lake Washington FMO habitat is located within foraging and migratory distances of the Snohomish-Skykomish and the Puyallup River core populations. Their use of the Lake Washington FMO habitat is presumed to be related to the abundance of these core populations as well as the distance from the core area to the action area. More robust core populations such as the Snohomish-Skykomish are expected to utilize the marine environment in greater proportion than core populations that are extremely low in number (J. Chan, pers. comm. 2004).

The Lake Washington FMO habitat consists of the lower Cedar River (below Cedar Falls), Sammamish River, Lake Washington, Lake Sammamish, Lake Union, the Lake Washington Ship Canal, and all accessible tributaries. Population status information and extent of use of this area is currently unknown. Adult and subadult size individuals have been observed infrequently in the lower Cedar River (below Cedar Falls), Carey Creek (a tributary to Upper Issaquah Creek), Lake Washington, and at the locks. No spawning activity or juvenile rearing has been observed and no distinct spawning populations are known to exist in Lake Washington outside of the upper Cedar River above Lake Chester Morse (not accessible to bull trout within Lake Washington).

The potential for spawning in the Lake Washington basin is believed to be low as a majority of accessible habitat is low elevation, below 152 meters (500 ft), and thus not expected to have the proper thermal regime to sustain successful spawning. There are, however, some coldwater springs and tributaries that may come close to suitable spawning temperatures and that may provide thermal refuge for rearing or foraging during warm summer periods. These include Rock Creek (tributary to the Cedar River below Landsburg Diversion) and Coldwater Creek, a tributary to Cottage Lake Creek immediately below Cottage Lake. Coldwater Creek is a major temperature modifier for both Cottage Lake and Big Bear Creeks. Cottage Lake Creek below Coldwater Creek exhibits a much lower temperature profile than any other tributary to Big Bear Creek. High temperatures in Big Bear Creek are moderated by this flow to its confluence with the Sammamish River. Both Coldwater and Rock Creeks are relatively short, 1.6 to 3.2 kilometers (1 to 2 miles) in length, have high quality riparian forest cover and are formed by springs emanating from glacial outwash deposits.

Upper reaches of Holder and Carey Creeks, the two main branches of Issaquah Creek, have good to excellent habitat conditions and may hold potential for bull trout spawning due to their elevation and aspect. However, despite survey efforts by King County (Berge and Mavros 2001; KCDNRP 2002) no evidence of bull trout spawning or rearing has been found. Holder Creek drains the eastern slopes of Tiger Mountain, elevation of 914 meters (3,000 ft), and the southwestern slopes of South Taylor Mountain. Coho are found in Holder Creek up to an elevation of about 360 meters (1,200 ft) and cutthroat trout occur up to 427 meters (1,400 ft) in elevation.

Carey Creek originates at an elevation of roughly 700 meters (2,300 ft) in a broad saddle on the southeastern slopes of South Taylor Mountain. It is the only stream in the north Lake Washington/Sammamish drainage with a relatively recent (within past ten years) char sighting. The single observation of a pair of native char in the fall of 1993 (WDFW 1998) was about 0.8 kilometer (0.5 mile) downstream from an impassable, approximately 12-meter (40-foot) high falls, which is at an elevation of approximately 256 meters (840 ft). Thus habitat in which the pair of char was observed was potentially too low for successful spawning.

Aside from spawning, the Lake Washington drainage has potential benefits and challenges to adult and subadult bull trout. Two large lakes with high forage fish availability are dominant parts of the lower watershed, and provide significant foraging habitat. A number of observations of subadult and adult bull trout have been made in Lake Washington (KCDNR 2000; Shepard and Dykeman 1977; H. Berge, pers. comm. 2003). Connection with the Chester Morse Lake core area (population located in the upper Cedar River) is one-way only, and currently the level of connectivity with other core areas is unknown. Observations of bull trout in the locks suggest migration from other watersheds is likely occurring.

Bull trout were caught in Shilshole Bay and the locks during late spring and early summer in both 2000 and 2001. In 2000, up to eight adult and subadult fish (mean size 370 millimeters; 14.5 inches) were caught between May and July in Shilshole Bay below the locks. These fish were found preying upon juvenile salmon (40 percent of diet) and marine forage fish (60 percent of diet) (Footen 2000, 2003). In 2001, five adult bull trout were captured from areas within the locks and immediately below the locks. One bull trout was captured in the large locks during June, and one adult was captured during May at the head of the ladder in the adult steelhead trap while migrating upstream through the fish ladder. Three adult bull trout were also captured below the tailrace during the peak of juvenile salmon migration on June 18 (F. Goetz, pers. comm. 2003).

The Washington State Conservation Commission has provided a good summary of limiting factors for salmonids in the Cedar-Sammamish basin (Kerwin 2001).

Snohomish-Skykomish River Core Area

The Snohomish-Skykomish core area (Puget Sound Management Unit) includes the Snohomish, Skykomish, and Snoqualmie Rivers and their tributaries. Bull trout are distributed throughout these waters, generally downstream of anadromous barriers (USFWS 2004). Fluvial, resident, and anadromous life histories are all found within the core area. The Snohomish-Skykomish core area plays a critical role in the conservation and recovery of bull trout, since each core area is vital to maintaining the overall distribution and genetic diversity of bull trout within the Unit (USFWS 2004).

The Snohomish-Skykomish core area supports four known, identified local populations (North Fork and South Fork Skykomish, Salmon Creek, and Troublesome Creek). Troublesome Creek, a tributary to the North Fork Skykomish River, supports a largely resident population (USFWS 2004). With only four local populations, bull trout in this core area are considered at increased risk of extirpation and adverse effects from random, naturally occurring events. The lack of connectivity with the Troublesome Creek local population is a natural condition. Connectivity between the other three local populations diminishes the risk of extirpation in the core area from habitat isolation and fragmentation.

Current information suggests the core area's spawning and early rearing habitats are found only within the Skykomish River basin, generally at elevations ranging from 1,000 to 1,500 ft above mean sea level (USFWS 2004). The amount of spawning and early rearing habitat is more limited, in comparison with many other core areas, because of the topography of the basin. Upper portions of the North Fork Skykomish River, including Salmon Creek and Troublesome Creek, appear to be major areas of production. Rearing bull trout can be found throughout the anadromous portions of the Snohomish, Skykomish, North Fork and South Fork Skykomish Rivers (USFWS 2004).

Migratory bull trout use nonnatal watersheds (habitat located outside of their spawning and early rearing habitat) to forage, migrate, and overwinter (Brenkman and Corbett 2003a,b *in* USFWS 2004). Current information suggests many bull trout of the Snohomish-Skykomish core area are anadromous and therefore rely on middle portions of the Snohomish basin (including tributaries to the mainstem Snohomish River), the lower estuary, and nearshore marine areas for migrating, overwintering, extended rearing, and growth to maturity (USFWS 2004).

Juvenile, subadult, and adult bull trout may be found throughout the mainstem Snohomish and Skykomish Rivers. Fluvial subadult and adult bull trout are believed to typically forage and overwinter in large pools along middle portions of the mainstem Skykomish River (USFWS 2004). The mainstem Snohomish River provides important overwintering habitat for anadromous bull trout, including subadult bull trout from populations outside of the Snohomish-Skykomish core area (USFWS 2004).

Habitat conditions in the North Fork Skykomish basin, including water quality, are generally good to excellent (WDFW 2004). There has been some loss of side-channel habitat due to diking and construction of bank protection measures. Habitats throughout parts of the South Fork Skykomish basin have been substantially degraded by logging and road construction, especially in the Beckler and Tye watersheds (WDFW 2004). Where habitats along the mainstem Snohomish and Skykomish Rivers have been degraded as a result of diking, maintenance of inadequate riparian buffers, or other land use practices (e.g., draining of floodplain wetlands for agricultural purposes) this has reduced the amount of FMO habitat historically available to bull trout. Limiting factors have been discussed in great detail elsewhere (Haring 2002).

Threats and reasons for decline in the Snohomish-Skykomish core area include the following (USFWS 2004):

- Past timber harvest and harvest-related activities have degraded habitat conditions in the upper watershed.
- Agricultural and livestock practices have altered stream morphology and floodplain habitat, and degraded water quality in the middle and lower watershed.
- Municipal and industrial effluent discharges and development contribute to degraded surface water quality.
- Nearshore foraging habitat has been, and continues to be, affected by development activities.
- Illegal harvest or incidental hooking mortality may occur at several campgrounds where recreational fishing is allowed.
- Hybridization with introduced brook trout is considered a potential threat to the persistence of bull trout. Brook trout have been introduced into many lakes throughout the Skykomish subbasin and are known to occur in the South Fork Skykomish River above Sunset Falls.

Current information regarding adult abundance and productivity suggests bull trout of the Snohomish-Skykomish core area have relatively stable but low numbers (J. Chan, pers. comm. 2007). Trap-and-haul facilities continue to pass returning adults into the South Fork Skykomish River above Sunset Falls, where it appears new spawning and rearing areas are being colonized (USFWS 2004). Since 1988, redd counts conducted annually along the North Fork Skykomish River have documented a trend toward increasing numbers, with a peak of approximately 530 redds documented in 2002 (USFWS 2004). Counts along the North Fork Skykomish River declined to approximately 240 redds in 2005 and 2006 (WDFW 2007). The decline may be attributable to low flows, followed by scouring flows, during and following those spawning seasons (J. Chan, pers. comm. 2007). The WDFW considers the Snohomish-Skykomish bull trout population “healthy” (WDFW 2004).

The State of Washington allows a two-fish daily bag limit (20-inch minimum size limit) for native char (bull trout and Dolly Varden) caught by anglers in either the mainstem Snohomish River or the Skykomish River below the forks. All other areas in the basin are closed to fishing for native char (WDFW 2004). Poaching of adult native char has been identified as an ongoing problem in the upper North Fork Skykomish River.

Puyallup River Core Area

The Puyallup core area contains the southernmost population of bull trout in the Puget Sound Management Unit. This core area is critical to maintaining the overall distribution of migratory bull trout within the Unit, since it supports the only anadromous bull trout population in south Puget Sound. The anadromous life history form is believed to use Commencement Bay and likely other marine nearshore habitats along Puget Sound. Both anadromous and fluvial/resident bull trout local populations have been identified in the White River and Puyallup River systems, which converge in the lower basin at river mile 10.4 of the Puyallup River. Limited information is available regarding the distribution and abundance of bull trout in this core area. Observations of bull trout have generally been incidental to other fish survey work.

Five local populations have been identified. These are the upper Puyallup and Mowich Rivers, Carbon River, upper White River, West Fork White River, and Greenwater River. In addition, one potential local population, Clearwater River, has also been identified; although part of the current bull trout distribution, there is insufficient information to determine if reproduction is occurring here (USFWS 2004).

The status of each of the local populations within the Puyallup-White River system is currently unknown. Based on trap counts at Mud Mountain Dam, the number of adult migratory bull trout transferred upstream into the White River system is extremely low, especially relative to the size of other anadromous core populations within the Puget Sound Management Unit. It is uncertain whether these are primarily anadromous or fluvial migrants; however, a number of the bull trout scale and length samples collected at the trap (Hunter 2001) are comparable to that of anadromous forms sampled in the Lower Skagit River core area (Kraemer 2003).

Status of Critical Habitat in the Action Area

No designated bull trout critical habitat is present within the action area. The nearest designated bull trout critical habitat is located in Lake Washington (Federal Register 50 CFR 17; September 26, 2005; 56212).

Effects of Past & Contemporaneous Actions

Lake Washington FMO

The Lake Washington Basin has been dramatically altered from its pre-settlement conditions, resulting in possibly the most modified estuary on the West Coast of North America. Historically, Lake Washington flowed into the Black River and the Cedar River joined the Black River approximately one half-mile downstream from Lake Washington. The combined flow of these two Rivers joined the Duwamish River and emptied into Elliott Bay. A significant re-routing of the system occurred when the Cedar River was diverted to create a shipping channel into Lake Washington. This diversion was completed by a private entity just prior to the U.S. Army Corps of Engineer's construction of the Lake Washington Ship Canal (LWSC). Construction of the LWSC dropped the water level of Lake Washington approximately 9 ft, which also dewatered the Black River. The locks then became the outlet from Lake Washington (Williams 2000).

The Cedar River is now the major source of freshwater to the lake, providing about 50 percent (663 cubic feet per second) of the mean annual flow entering the lake. The Cedar River drainage area is approximately 184 square miles (476 square kilometers), which represents about 30 percent of the watershed area of the Lake Washington Basin. The Sammamish River provides about 25 percent (307 cubic feet per second) of the mean freshwater flow into Lake Washington. The Sammamish River has a drainage area of about 240 square miles (622 square kilometers) and represents about 40 percent of the Lake Washington Basin. The remainder of freshwater inflow into Lake Washington originates from a variety of small creeks located primarily along the northern and eastern shores.

Within Lake Washington, the natural hydrologic cycle has been temporally shifted. Historically, lake elevations peaked in winter and declined in summer. Today, lake elevation peaks in spring and begins to decline in summer during the drawdown period, reaching the lowest levels by winter (when the minimum elevation of 20 ft is maintained). Changes to the Lake Washington Basin have substantially altered the frequency and magnitude of flood events in Lake Washington and its tributary rivers and streams. In the past, Lake Washington's surface elevation was nearly 9 ft (2.7 meters) higher than it is today and the seasonal fluctuations further increased that elevation by as much as 7 ft (2.1 meters) annually (Williams 2000). In 1903, the average lake elevation was recorded at approximately 32 ft (9.8 meters).

Development and urbanization have also decreased base flow in many of the tributary systems (Horner and May 1998). Increases in impervious and semi-impervious surfaces (e.g., lawns) reduce infiltration, and thereby reduce groundwater discharge into streams and rivers. A substantial amount of surface water and groundwater also infiltrate into the City of Seattle and King County wastewater treatment systems and are eventually discharged to Puget Sound. The frequency and magnitude of flooding in tributary rivers and streams (with the exception of the dam-controlled Cedar River) have increased largely because of the extensive development that has occurred within the basin over the last several decades (Moscrip and Montgomery 1997).

The shoreline riparian and littoral zones of Lake Washington have undergone considerable change since pre-settlement times. The lowering of Lake Washington exposed 1,334 acres (540 hectares) of shallow water habitat, reducing the lake surface area by seven percent, and decreasing the shoreline by 10.5 miles (16.9 kilometers)(Chrzastowski 1981). The most extensive changes occurred in the sloughs, delta areas, and shallows of the lake.

Water and sediment quality in the Lake Washington Basin has been, and continues to be, degraded from a variety of point and non-point sources of pollutants. Historically, Lake Washington, Lake Union, and the LWSC were the receiving water bodies for municipal sewage. Outfalls were located at numerous locations along the shorelines and limited treatment or no treatment of sewage occurred prior to discharge. Efforts in the 1960s and 1970s to clean up Lake Washington and other Seattle area waterways led to the expansion of wastewater treatment and the elimination of discharges of untreated effluent into Lake Washington. Although raw sewage can no longer be discharged directly into Lake Washington, Lake Union, and the LWSC, untreated discharges occasionally still enter these waterways during periods of high precipitation through discharge from combined sewer overflows. Historical discharges and past dumping practices continue to impact the Lake Washington system. In historical industrial areas such as Lake Union and southern Lake Washington, sediments have been contaminated by persistent toxins, such as PAHs, polychlorinated biphenyls, and heavy metals (King County 1995).

In addition to point sources of pollutants, a variety of non-point sources contribute to the degradation of water and sediment quality. Non-point sources include stormwater and subsurface runoff containing pollutants from road runoff, failing septic systems, underground storage tanks containing fluids such as gasoline and diesel oil, gravel pits/quarries, landfills and solid waste management facilities, sites with improper hazardous waste storage, and commercial and residential sites treated with fertilizers and pesticides. As urbanization has occurred in the area, sediment input into the Lake Washington system has increased.

The ecology of Lake Washington has undergone substantial changes over the last 75 years. Several non-native fish and plant species have been introduced into Lake Washington and years of sewage discharge into the lake increased phosphorus concentration and subsequently led to eutrophication. Bluegreen algae dominated the phytoplankton community, and production of some species of zooplankton was suppressed. In the mid 1960s, water quality improved dramatically as sewage was diverted from Lake Washington to Puget Sound. Dominance by blue-green algae subsided and zooplankton populations rebounded. However, around this same time period (1970s), Eurasian water-milfoil was introduced into Lake Washington.

Milfoil can cause localized water quality problems when it grows in dense clumps and/or when it forms dense floating mats that can contain other plant material. Within the clumps, the DO can be reduced below five parts per million. In the lower layers of the mats the plants die and decompose, increasing biological oxygen demand reducing DO and pH. On occasion, conditions in the clumps and mats can become anoxic. Furthermore, substrates rapidly change from sand or gravel to mud because of the large amount of organic deposition and decomposition that occurs. Milfoil has established itself in much of the shallow shoreline habitat of Lake Washington, Lake Sammamish, Lake Union, Portage Bay, and the LWSC.

Operation of the locks allows saltwater to intrude into Lake Union during the summer when seasonal freshwater flow decreases and boat use of the locks increases. This intrusion creates a seasonally fluctuating saltwater layer in Salmon Bay, the Fremont Cut, and Lake Union. This system is dramatically different from the typical saltwater/freshwater interface seen in most estuarine systems of the Pacific Northwest because there is no natural tidal mixing of these layers east of the locks.

The sediments of Lake Union are very soft, relatively deep, and contain a large amount of organic material contributed from milfoil and other macrophytes. As microorganisms in the sediment break down this material, they consume much of the oxygen in the lower part of the lake. By the end of summer, concentrations of DO in the hypolimnion of Lake Union are near zero (WDNR 1999).

Water temperature changes dramatically above and below the locks. Summertime differences can be as high as 16° F (-8.8° C). The thermal stratification of Lake Union results in surface temperatures regularly exceeding 68° F (20° C) for extended periods during the summer. The average temperature of Puget Sound (below the locks) is 52 to 57° F (11 to 14° C) during this period. Because of the minimal mixing of freshwater and saltwater through the locks the large temperature gradient is maintained.

Snohomish-Skykomish River Core Area

Current and historical land use practices in the upper, middle, and lower portions of the Snohomish basin continue to have a lasting impact on floodplain and riparian functions, instream habitat diversity, and the availability of off-channel habitats and refugia. Habitats throughout parts of the South Fork Skykomish basin have been substantially degraded by logging and road construction, especially in the Beckler and Tye watersheds (WDFW 2004). Where habitats along the mainstem Snohomish and Skykomish Rivers have been degraded as a result of diking, maintenance of inadequate riparian buffers, or other land use practices (e.g., draining of floodplain wetlands for agriculture), the amount of FMO and rearing habitat has been reduced.

Between 1999 and 2007 the Service issued twelve BOs and approved at least two Habitat Conservation Plans (HCP) where incidental take of bull trout from the Snohomish-Skykomish core area was anticipated and exempted (Table 6). The authorizations granted for these actions exempt incidental take where in-water work was/is expected to result in temporary sediment increases, where instream habitat would be/will be permanently altered, and (less commonly) where fish handling related to salvage and relocation and/or in-water impact pile driving might cause direct harm to bull trout.

The Service has also issued take for Coastal-Puget Sound Bull Trout, including the Snohomish-Skykomish River core population, related to the Washington State Department of Natural Resources (WDNR) Forest Practices HCP and State Trust Lands HCP. Here take was estimated based on the amount of habitat likely to be effected over the 70-year HCP time frames. Take was not quantified at the subpopulation level.

Table 6 Previous BOs and HCPs exempting take of Snohomish-Skykomish bull trout.

Project	Extent of Incidental Take Authorized
Interstate 90 Land Exchange	None.
Stossel Creek Way - Harris Creek Culvert Replacement	Harm and harassment within 5.8 miles on Harris Creek and 2.0 miles on the Snoqualmie River.
Everett Bridges Seismic Retrofit	Harm and harassment within 0.92 mile of the Snohomish River.
SR 2, Snohomish River Bridge Replacement	Harm and harassment within 2.5 miles of the Snohomish River.
Anthracite Creek Bridge Scour Repair	Harassment within 600 ft from placement, removal, and dewatering of coffer dams; direct take of 1 individual (killed) and 2 individuals (captured) from fish capture/salvage operations.
Anacortes Ferry Terminal Tie-Up Slip and Dolphin Replacement Project	Harm and harassment within 398 meters and 4,642 meters, respectively, associated with impact pile driving.
SR 522, Paradise Lake Rd. to Cathcart Rd. (Widening & Interchange Improvements)	Harassment within 50 linear ft of in-water construction activities; 46 linear ft from placement of riprap; 600 ft from placement, removal, and dewatering of coffer dams; direct take of 1individual (killed) and 5 individuals (captured) from fish capture/salvage operations.
SR 522, Snohomish River Bridge (522/138) Scour Repair Project	Harassment within 600 linear ft of in-water construction activities; 800 linear ft from placement of riprap.
Seattle Aquarium	Harm and harassment within a 0.6 mile and 2.4 mile radius, respectively, associated with impact pile driving.
SR 522, Cathcart Rd. Vic. to US 2	Harm and harassment within a 0.3 mile and 2.6 mile radius, respectively, associated with impact pile driving. Harassment resulting from elevated turbidity, from 100 ft upstream to 300 ft downstream of in-water construction activities. Harassment resulting from elevated pollutant concentrations, from 100 ft upstream to 500 ft downstream of the new stormwater outfall from TDA 1.

The Service determined that each of these actions is not likely to jeopardize the continued existence of bull trout and will not destroy or adversely modify designated bull trout critical habitat. The combined effects of these past and contemporaneous Federal actions have resulted in short- and long-term adverse effects to bull trout of the Snohomish-Skykomish core area and incremental degradation of the environmental baseline.

State and local actions affecting Snohomish-Skykomish bull trout include the planning and implementation of various Total Maximum Daily Load (TMDL) clean-up plans for the Snohomish River estuary, the lower mainstem Snohomish River and its tributaries, and the Snoqualmie River. Since 1992 the State of Washington, local, and private partners have been implementing an approved TMDL clean-up plan for dioxin in the lower Snohomish River. Limited monitoring results from a handful of pulp and paper mills operating with allowable dioxin discharge permits in Washington suggest that effluent and sludge targets are generally being met and conditions in receiving waters are generally improving (Onwumere 2003).

The State of Washington is implementing a TMDL for fecal coliform bacteria and a related pollution prevention plan for dissolved oxygen in the lower Snohomish River tributaries, including French Creek and Woods Creek. The plan outlines State, local, and private actions directed at achieving loading reductions. Many of the actions relate to controlling point and non-point sources of pollution associated with agriculture (Svrjcek 2003). The State of Washington is also assessing the need for a temperature TMDL for a significant portion of the mainstem Snoqualmie River, extending from its mouth (within the action area) to a distance of more than 40 RM upstream (Kardouni and Cristea 2006). Over the long-term, implementation of these various clean-up plans may help achieve compliance with Washington's surface water quality criteria.

Managed public and private forest is the dominant land use throughout the Snohomish basin (Pentec 1999). Conditions that limit or reduce habitat productivity and function in the upper watersheds may improve over the long-term as a result of modern forest practices and implementation of the Forest Practices Act.

Puyallup River Core Area

Since the listing of bull trout in 1999, the Service has issued twelve BOs that exempt incidental take in the Puyallup River core area (Table 7). The authorizations granted for these actions exempt incidental take where in-water work was/is expected to result in temporary sediment increases, where instream habitat would be/will be permanently altered, and (less commonly) where fish handling related to salvage and relocation and/or in-water impact pile driving might cause direct harm to bull trout.

Table 7 Previous BOs exempting take of Puyallup bull trout.

Project	Extent of Incidental Take Authorized
White River Amphitheater	Harm and harassment within the lower 0.28 mile of Pussyfoot Creek (from the confluence with the White River).
Greenwater River Channel Relocation	Harm and harassment within 2.3 miles of the Greenwater River.
Puyallup Tribe-Electron Dam Fish Ladder	No more than two bull trout will be incidentally taken on river mile 41.7 of the Puyallup River.
Tacoma Public Utilities, Permit for Work in the White River	Harm and harassment extending 750 ft upstream and 900 ft downstream of river mile 23.3 on White River.
Asarco Smelter Superfund Site Shoreline Armoring	Harm and harassment in marine waters (within 200 ft of the mean lower low tide), along 3,464 ft of shoreline, along 780 ft in the breakwater peninsula, 703 ft by Sag Seawall, 875 ft along the South East. For a total of 15.9 surface area acres.
Hylebos Waterway Area 5106, Commencement Bay Superfund Site	Harassment of bull trout within 45.7 acres of the dredging/excavation activities and 8.3 acres of sediment capping activities in the Hylebos Waterway; 7.1 acres of habitat in Slip 5; ten percent exceedance of the dredged area (4.6 acres), sediment capping area (0.8) acres, and habitat construction area (0.7 acres). Harm to one bull trout in Slip 1.
SR 167, Sumner Interchange	Harassment from the site of the interchange and unnamed tributary, downstream to its confluence with the White River (totaling 2.2 miles along Soaton Creek). Harm to one bull trout within Soaton Creek. Harassment will occur between river miles 0.7 and 4.0, totaling 3.3 miles of the White River.

Project	Extent of Incidental Take Authorized
SR 167 Extension	Harassment resulting from loss or degradation of thermal refugia and reduction in prey base (lower Puyallup, RM 2.5 to 9). Harm and harassment resulting from exposure to elevated pollutant concentrations, to 300 ft downstream of new stormwater outfalls. Harm and harassment within a 44 meter and 341 meter radius, respectively, associated with impact pile driving. Harm of 3 bull trout resulting from fish handling. Harassment within 600 linear ft of in-water construction activities.
COE Programmatic	All bull trout associated with 5 miles of river from sediment impacts; between 35-40 fish (7-8 fish/year) resulting from stranding, capture and handling activities; bull trout associated with 7,500 square ft of permanent stream alteration; bull trout associated with 5,000 square ft of temporary stream alteration; bull trout associated with 0.5 acre of marine nearshore alteration; and, bull trout associated with five acres of scrub-shrub and forested riparian habitat impacts.
U.S. Forest Service Programmatic for Culvert Replacement	Harassment for all bull trout life stages within 600 ft downstream of the construction/dewatered stream reach. Harm to juvenile fish (aged 0+ and 1+), not to exceed 42 individuals.
Seattle Aquarium	Harm and harassment within a 0.6 mile and 2.4 mile radius, respectively, associated with pile driving.

The Service determined that each of these actions is not likely to jeopardize the continued existence of bull trout and will not destroy or adversely modify designated bull trout critical habitat. The combined effects of these past and contemporaneous Federal actions have resulted in short- and long-term adverse effects to bull trout of the Puyallup core area and incremental degradation of the environmental baseline.

EFFECTS OF THE ACTION (Bull Trout)

This section addresses the direct and indirect effects of the proposed action and its interrelated and interdependent activities. The regulations implementing the Act define “effects of the action” as “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 section 402.02).

Based on location and the limited amount of in-water work, and with full implementation of the proposed conservation measures (including work/ timing restrictions), the Service expects that bull trout will not be exposed to construction activities. Exposure of bull trout to construction activities is discountable, and no significant (i.e., measurable) temporary, construction-related effects to bull trout or their habitat are anticipated.

The Service expects that the proposed action will result in measurable, adverse indirect effects to bull trout, their habitat, and prey base, associated with long-term (operational) discharge of treated and untreated highway stormwater runoff. Resulting effects to surface water and sediment quality will last in perpetuity, but acute exposures of individuals are likely to be episodic. The Service expects that adult and subadult bull trout will be exposed to dissolved metal concentrations which, in the immediate vicinity of stormwater outfalls, are sufficient to cause adverse sub-lethal effects.

The Service also expects that long-term (operational) discharge of treated and untreated highway stormwater runoff originating from the project area will further impair surface water and sediment quality in the project’s receiving waters. Pollutant loadings associated with the post-project condition are likely to worsen the overall trajectory of water and sediment quality impairment in the action area. These pollutant loads may exert measurable adverse effects on bull trout, their habitat, and prey base.

The effects analysis that follows addresses these effects, as well as any potential effects associated with interrelated and interdependent actions.

Insignificant and Discountable Effects

Some of the proposed action’s potential effects to bull trout are/will be insignificant or discountable. The following direct and indirect effects are considered extremely unlikely to occur (discountable) or are not measurable or detectable (insignificant):

- Exposure to construction activities.
- Temporal losses of wetland/buffer, riparian, and instream habitat and function.
- Effects to local hydrology, hyporheic function, subsurface water exchange, and groundwater recharge.

- Indirect effects related to land use (i.e., changes in the rate or pattern of land use conversion and related effects).

Based on location and the limited amount of in-water work, and with full implementation of the proposed conservation measures (including work/timing restrictions), the Service expects that bull trout will not be exposed to construction activities. Accordingly, the Service expects any related, temporary effects to bull trout are extremely unlikely to occur and are therefore discountable.

Temporal losses of wetland/buffer, riparian, and instream habitat and function associated with the proposed action will not have a measurable or detectable effect on bull trout. The project will replace lost and/or degraded wetland/buffer, riparian, and instream habitat functions and values according to approved ratios, prior to or concurrent with construction of the larger project. Accordingly, the Service expects any related, temporary effects to bull trout or their habitat will be insignificant.

Conversion of land to impervious surface can alter the duration and frequency of runoff, can decrease both rates of infiltration and evapotranspiration, and can influence patterns of subsurface water exchange and baseflows (May *et al*. 1997; Beyerlein 1999; Angermeier *et al*. 2004). At completion, the proposed action would create approximately 13.9 acres of net-new impervious surface, an approximately four percent increase to the amount already present along the project corridor (323 acres) (WSDOT 2007a). The proposed stormwater design will provide flow control for stormwater runoff from an area equivalent to the new and replaced impervious, except for that new and replaced impervious which drains and discharges to the Sammamish River (approximately 5.6 acres). The Service expects that the proposed stormwater design will not cause or contribute to measurable increases in peak flows, measurable reductions in base flows or groundwater recharge, and will have no measurable effects to hyporheic function or subsurface water exchange. The Service expects the project will not have a measurable effect on surface water temperatures, and will not degrade thermal refugia within the action area. Related effects to bull trout, their habitat, and prey base will not be measurable in the short- or long-term and are therefore insignificant.

The proposed project will reduce congestion and improve mobility for vehicles traveling this portion of I-405. The project will not construct new points of access along the project corridor and will not increase traffic capacity along surrounding local arterials. The submitted BA assesses the potential for indirect effects related to land use (i.e., changes in the rate or pattern of land use conversion and related effects) and finds that no new development is contingent or dependent upon the proposed project. The Service does not expect discernible changes in the rate or pattern of land use conversion to result, in whole or in part, from construction of the project. Therefore, the Service does not expect the project will have any related indirect effects to wetlands, native vegetation, or the relative amount of pervious and impervious surface present within the action area.

Stormwater Effects to Surface Water Quality and Instream Habitat

The proposed action is expected to have adverse effects to bull trout, their habitat and their prey base resulting from the discharge of treated and untreated highway stormwater runoff. Resulting effects to surface water and sediment quality will last in perpetuity.

Stormwater Pollutants / Contaminants of Concern

Untreated highway runoff contains a variety of pollutants that impair water quality and pose a risk to aquatic organisms (Herrera 2007). Table 8 identifies the variety of pollutants typically found in untreated highway runoff. Sources of pollutants found in untreated highway runoff include atmospheric deposition, direct and indirect deposition and application, and vehicles and vehicular traffic (Herrera 2007).

Factors that influence the types and amounts of pollutants found in untreated highway runoff include rates of use (i.e., ADT) and traffic conditions, weather and precipitation patterns, road conditions and maintenance, and surrounding land uses. One particularly important factor is the buildup of solids and other pollutants on pavement and in stormwater conveyances between storm events (Herrera 2007).

Data obtained from a variety of sources indicate that pollutant concentrations in untreated highway runoff are highly variable (Herrera 2007). Table 9 reports mean pollutant concentrations obtained from studies examining highway runoff in western Washington and nationwide.

Highways can be significant contributors to overall pollutant loads in receiving waterbodies (Wheeler *et al*. 2005). Pollutants that are dissolved in, or mobilized by highway runoff, are easily transported to wetlands, streams, and rivers if the runoff is not intercepted and "passively" treated by vegetation, infiltrated, or conveyed to engineered treatment systems.

Some pollutants and contaminants of concern have a strong affinity for suspended solids and the particulate-phase (or fraction) of treated and untreated highway runoff (Grant *et al*. 2003; Wong *et al*. 2000). As a result, a large fraction of the toxic (inorganic and non-polar organic) contaminant load in treated and untreated stormwater is in particulate form, either sorbed onto, or complexed with solids (Fan *et al*. 2001, p. 1; Grant *et al*. 2003, pp. viii, x; Marsalek *et al*. 1999, p. 34; Muthukrishnan and Selvakumar 2006, pp. 2, 5; Wong *et al*. 2000, p. 11). The heavy metals, especially chromium (Cr), copper (Cu), lead (Pb), and nickel (Ni) are closely associated with the particulate fraction (Grant *et al*. 2003, p. 5-7; Wong *et al*. 2000, p. 32); and cadmium (Cd) and zinc (Zn) to a somewhat lesser extent. Polycyclic aromatic hydrocarbons, oils and petroleum hydrocarbons generally, and other non-polar organic contaminants (e.g., pesticides and their decomposition products) are also closely associated with the particulate-phase or fraction. Most of the PAH load in treated and untreated stormwater is bound to solids. Polycyclic aromatic hydrocarbons are often ubiquitous in urban and developed environments, but the dissolved-phase (or fraction) sometimes represents as little as 10 percent of the whole-water concentration, total burden or load (Grant *et al*. 2003, p. 5-6; Marsalek *et al*. 1997, p. ab; Wong *et al*. 2000, p. 11). For these and other reasons, some experts in the field have identified total suspended solids (TSS) as an appropriate indirect measure or indicator of toxic contaminant load (Grant *et al*. 2003, p. 1-4; Hallberg *et al*. 2007, p. ab). Where sampling and monitoring are concerned, TSS is a decidedly easier and cheaper parameter to sample and measure.

Table 8 Typical pollutants in highway runoff (Herrera 2007).

Pollutant Parameter Category	Parameter
Suspended Solids	Total suspended solids Volatile suspended solids
Metals	Arsenic Cadmium Chromium Copper Iron Lead Mercury Nickel Zinc
Nutrients	Ammonia nitrogen Nitrate nitrogen Total Nitrogen Total Kjeldahl nitrogen Total Phosphorus Orthophosphate phosphorus
Organic Compounds	Polycyclic aromatic hydrocarbons Oil and grease Total petroleum hydrocarbons Pesticides Herbicides
Bacteria	Total coliform bacteria Fecal coliform bacteria
Oxygen Demand	Biological oxygen demand (5-day) Chemical oxygen demand
Conventional Parameters	Sodium (if deicing performed) Chloride (if deicing performed) pH Turbidity Conductivity Hardness

Table 9 Constituents in untreated highway runoff (Herrera 2007): comparison of site mean concentrations.

Constituent	Western Washington Sites [a]	National Data [b]
Solids (mg/L)		
Total	No data	437 to 1,147
Dissolved	No data	356
Suspended	3 to 295 (27)	45 to 798
Volatile (dissolved)	No data	131
Volatile (suspended)	19 to 460 (5)	4.3 to 79
Volatile (total)	No data	57 to 242
Metals, total (µg/L)		
Antimony	1.2 to 8.7 (2)	Not reported
Arsenic	2.2 to 2.6 (2)	58
Barium	81 to 84 (2)	Not reported
Chromium	7.5 to 18 (2)	Not detected to 40
Cadmium	0.9 to 2.8 (2)	Not detected to 40
Cobalt	1.9 to 4.4 (2)	Not reported
Copper	4.6 to 72 (29)	22 to 7,033
Iron	No data	2,429 to 10,300
Lead	24 to 1,065 (10)	73 to 1,780
Lead[c]	24 to 61 (3)	73 to 1,780
Magnesium	No data	1,062
Mercury	0.02 (1)	3.22
Molybdenum	1.5 to 9.5 (2)	Not reported
Nickel	8.6 to 12.9 (2)	53
Vanadium	6.3 to 14.8 (2)	Not reported
Zinc	26 to 394 (29)	56 to 929
Metals, dissolved (µg/L)		
Copper	3.1 to 18.1 (21)	Not reported
Lead	1.0 to 3.2 (2)	Not reported
Lead[c]	3.2 (1)	Not reported
Zinc	13 to 134 (22)	Not reported
Nutrients (mg/L)		
Ammonia nitrogen	1.0 to 2.7 (2)	0.07 to 0.22
Nitrite nitrogen	No data	0.013 to 0.25
Nitrate nitrogen	No data	0.306 to 1.4
Nitrite+nitrate nitrogen	0.51 to 3.0 (6)	0.15 to 1.636
Organic nitrogen	No data	0.965 to 2.3
Total Kjeldahl nitrogen	0.38 to 3.4 (6)	0.335 to 55.0
Total nitrogen	0.78 to 21.7 (2)	4.1
Orthophosphate phosphorus	0.01 to 0.42 (9)	Not reported
Total phosphorus	0.03 to 0.57 (24)	0.113 to 0.998

Table 9 (continued). Constituents in untreated highway runoff (Herrera 2007).

Constituent	Western Washington Sites [a]	National Data [b]
Organic Compounds (mg/L)		
TPH-oil	0.42 to 7.9 (12)	Not reported
TPH-diesel	Not detected to 2.75 (8)	Not reported
Oil and grease	11.8 to 187 (4)	2.7 to 27
Bacteria		
Total coliform bacteria (CFU/100 mL)	9,350 (1)	570 to 6,200
Fecal coliform bacteria (CFU/100 mL)	35 to 11,775 (16)	50 to 590
E. coli bacteria (CFU/100 mL)	130 to 1,670 (3)	Not reported
Oxygen Demand (mg/L)		
Chemical oxygen demand	32 to 1377 (11)	14.7 to 272
Biological oxygen demand (5-day)	9.5 to 71 (2)	12.7 to 37
Conventionals		
pH	5.8 to 6.8 (5)	7.1 to 7.2
Specific conductivity (µS at 25 °C)	71.6 (1)	337 to 500
Total organic carbon (mg/L)	2.0 to 139.0 (8)	24 to 77
Turbidity (NTU)	16.3 to 86.7 (3)	19
Hardness (mg/L as $CaCO_3$)	11.1 to 86.1 (19)	Not reported
Alkalinity (mg/L as $CaCO_3$)	19.3 to 23.4 (2)	Not reported

Particle size distribution exerts a strong influence on contaminant-particulate dynamics and association. Heavy metals, PAHs, and other non-polar organic contaminants are generally bound in greatest concentration to the smallest of particles and colloids. For non-polar organic contaminants, particulate organic matter content also exerts a strong influence, but total (particulate) surface area is probably of greater significance. The smallest particles have the greatest "surface area to volume ratio", and therefore provide a comparatively larger total surface area to which contaminants may bind, sorb, and complex (Fan *et al*. 2001, p. 3; Herngren *et al*. 2005, p. 150; John and Leventhal 1995, p. 13; Pettersson 2002, p. 1).

Stormwater Treatment Systems

There are a variety of engineered stormwater treatment systems and technologies. These systems and technologies vary with regard to which pollutants (or pollutant categories) they are best capable of treating, and the effectiveness with which they treat specific pollutants. Treatment efficiency and effectiveness depend both on the specific treatment systems and technologies employed, and on how well these systems are designed, operated, and maintained. Studies indicate significant variation among different treatment technologies and facilities (Schueler 1987; Young *et al*. 1996; WSDOT 2006b).

The WSDOT designs and constructs stormwater treatment and flow control facilities, and best management practices (BMPs), according to guidelines and criteria set forth in the *Highway Runoff Manual* (WSDOT 2008b). These guidelines are approved by the WDOE and meet State requirements for stormwater management. Facilities and BMPs designed, constructed, and managed according to the *Highway Runoff Manual* represent the controls deemed necessary by the State to reduce discharge of pollutants to the "maximum extent practicable" (WDOE 2008a).

Stormwater conveyance, treatment, and flow control facilities require routine maintenance to ensure proper function (WSDOT 2008b; WDOE 2008a, 2008b). Failure to adequately maintain facilities and structural BMPs almost inevitably leads to reduced performance and efficiency. Anderson *et al*. (2002, p. 280) have pointed to excessive sediment accumulation, and (related) shortened hydraulic residence time, as factors that reduce settling pond performance. In addition, long-neglected facilities and structural BMPs can become a source, rather than a sink, of some pollutants found in highway stormwater runoff. Resuspension and hydraulic flushing of accumulated sediments from facilities and BMPs has been implicated as a cause of failure and a significant maintenance concern (Anderson *et al*. 2002, p. 281; Fan *et al*. 2001, p. 2; Starzec *et al*. 2005, p. ab); this concern is heightened where accumulated sediments contain levels of metal or organic contamination sufficient to exert toxicological effects (Marsalek *et al*. 2002, pp. ab,9).

<u>Baseline Conditions and Performance of the Proposed Stormwater Design</u>

Available right-of-way and other constraints limit the extent to which the proposed project is capable of providing retrofit for existing PGIS. The project proposes a modest amount of retrofit, equivalent in area to approximately 134 percent of the net-new PGIS. As a result, and with the large quantities of untreated PGIS that will remain in the post-project condition (i.e., approximately 268 acres), the proposed stormwater treatment is expected to achieve little or no measurable reduction in annual stormwater pollutant loadings. Applying assumptions from the *Interim Guidance* (WSDOT 2006a), the proposed action is expected to achieve only modest reductions in effluent/discharge concentration.

The relationship between roadway ADT, or "usage", and pollutant loading potential is not entirely clear. However, some studies suggest that highways carrying heavy rates of traffic may produce higher pollutant loadings, effluent concentrations, and/or associated toxicities (Driscoll and Streker 1990, p. 28; EnviroVision Corp. *et al*. 2008, p. 5; Marsalek *et al*. 1999, p. ab). A 2008 report describing the contribution of highways and other land use categories to total toxic pollutant loadings in the Puget Sound found that highways are likely to produce comparatively low total loadings. However, the unit area loading rates for highways are comparable to those for commercial/industrial land uses, and exceed those of residential, agricultural, and "forest/field/other" land uses for more than 10 toxic metal and non-polar organic contaminants (EnviroVision Corp. *et al*. 2008, p. 2).

The concept of an ecological limit or threshold has appeal as a framework that permits comparison of real-world conditions with a theoretical or empirically-derived "tipping-point." Booth and Jackson (1997, p. 17) achieved something of this sort and argued that watersheds exhibiting greater than 10 percent effective impervious area begin to accumulate physical and biological effects leading to demonstrable loss of aquatic ecosystem function. Limits and thresholds are also central to regulatory protections for surface water quality and established beneficial uses. Criteria for the protection of freshwater life are based on the acute and chronic tolerances of the most sensitive biota, and Total Maximum Daily Loads (where developed) identify the maximum amount of a given pollutant that a waterbody can receive and still safely meet water quality standards (EPA 2008a).

The proposed project is located in urbanized watersheds and the project's receiving waters exhibit many signs of functional impairment (*See* Environmental Baseline in the Action Area). The waters within the action area exhibit what McCarthy *et al*. (2008, p. 6) have referred to as the "urban stream syndrome", a suite of commonly held characteristics including altered hydrology, elevated levels of contaminants, and low abundance and survival of sensitive aquatic species.

In the absence of quantitative information to describe the assimilative capacity of these waters, it is not possible to say definitively that pollutant loadings resulting from the proposed project will cause or contribute to an exceedance of one or another system limit or threshold. However, while we cannot quantify in exact terms the role or incremental contribution of these portions of I-405, it is plainly evident that existing sources of impairment, including inadequate treatment and flow control for highway stormwater runoff originating from the project area, will continue to degrade aquatic ecosystem function within the action area. These portions of I-405, and the treated and untreated stormwater discharges that originate within the project area, are not the only cause for observed water and sediment quality impairments. Nevertheless, pollutant loadings associated with the post-project condition will contribute to, and may exacerbate or worsen, some aspects of existing functional impairment. In particular, pollutant loadings associated with the post-project condition are likely to further degrade surface water and sediment quality in the action area.

The following sub-sections conclude: 1) existing functional impairments are a source of adverse effects to bull trout, their habitat, and their prey base, 2) functional impairments, including degraded surface water and sediment quality, will not measurably improve, and in some respects can be expected to worsen, as a result of the proposed project, and 3) while the Service cannot reliably quantify all of the anticipated adverse effects to bull trout, their habitat, and prey base, some effects can be quantified and are expected to result in adverse sub-lethal effects and/or significant disruption of normal bull trout behaviors (i.e., ability to feed, move, and/or shelter).

Acute Effects to Physiology and Behavior

Stormwater pollutants can affect the physiology and/or behavior of exposed salmonids in ways that disrupt normal behaviors (i.e., free movement, feeding, and sheltering), reduce growth, migratory success, and reproduction. In sufficient concentration, stormwater pollutants can also result in acute toxicity and death. Acute effects to aquatic life are influenced by the size and dilution capacity of the receiving waterbody, background water quality conditions, concurrent discharges and/or background levels of other contaminants, frequency and duration of exposure, concentration and relative toxicity of the pollutant(s), biological uptake and availability, and life stage.

Potential acute effects from exposures that may occur in and around points of highway stormwater discharge (i.e. outfalls) are of primary concern. On an event basis, pollutant concentrations contained in stormwater discharges may exceed the State's criteria for the protection of freshwater aquatic life and/or other criteria associated with adverse sub-lethal effects. Upon entering the receiving waterbody, stormwater discharges will typically mix with and be diluted by flow and the ambient water quality conditions. In order to assess the potential for adverse effects stemming from acute exposures, it is necessary to know something of the physical and temporal extents of the pollutant mixing-zone(s).

Highway runoff is a complex chemical mixture. Even during the course of a single discharge event, physical and chemical properties (including pollutant concentrations) can vary by orders of magnitude (Glenn *et al*. 2002, p. 3). Conditions in the receiving waterbody are also dynamic, and therefore estimates of the probable extent or duration of resulting mixing-zones must be understood as imprecise and subject to some amount of uncertainty. Additional sources of uncertainty include the effect of intermittent, episodic, or transient exposures (Burton *et al*. 2000, p. ab; Marsalek *et al*. 1999, p. 34); variations in tolerance among exposed individuals and/or populations (Ellis 2000, p. 89; Hodson 1988, p. ab; Lloyd 1987, p. 502); and, the potential for synergistic or additive effects among pollutants with similar or the same modes of toxic action (Burton *et al*. 2000, p. ab; Ellis 2000, p. 88; Lloyd 1987, p. 494). Burton *et al*. (2000, p. ab) warn that traditional toxicity tests may not lead to reliable predictions or conclusions if not tailored to reflect "real-world" patterns of exposure. Lloyd (1987, pp. 492, 501) has expressed concern that pollutants may have increased toxicity to salmonids under conditions of reduced dissolved oxygen, and has advised that aquatic life criteria (i.e. water quality standards) should apply to whole groups of contaminants with common modes of action, rather than individual contaminants.

The Service relies on toxicity data for other salmonids when specific information on toxicity to bull trout is not available. Due to taxonomic similarity, species in the Salmonidae family are expected to be better surrogates for bull trout than non-salmonids. However, Hansen *et al*. (2002) demonstrate that even among the members of Salmonidae specific sensitivities to chemical contaminants and mixtures of contaminants may differ. The Service has relied on toxicity data for species in the following preferential order: species (bull trout) > genus (Salvelinus) > family (Salmonidae). Rainbow trout are the primary freshwater fish species used by the Environmental Protection Agency (EPA) when developing toxicity data for regulatory purposes; therefore, the majority of data available in the literature have been generated from studies using rainbow trout as test subjects (family Salmonidae).

The most commonly reported end points in the toxicity literature are concentrations at which 50 percent of the test subjects/population died (LC50). Concentrations that result in the death of a smaller percentage of the test population (e.g., LC10) are likely to be somewhat lower. Bull trout and other salmonids would be adversely affected if exposed to lethal concentrations with the potential to result in acute toxicity and death, or if exposed to contaminant concentrations known to result in sub-lethal effects with consequences for normal behavior (i.e., effects that disrupt the ability to successfully feed, move, and/or shelter).

A variety of stormwater pollutants exhibit toxic mechanisms of action, including volatile organic compounds, organic herbicides and pesticides, and metals. Volatile organics and organic herbicides and pesticides may be present in untreated highway runoff at concentrations sufficient to cause adverse effects (Van Metre *et al*. 2000; Kayhanian *et al*. 2003). However, for the purpose of this consultation, it is assumed that metals originating from vehicular sources pose the greatest risk of acute lethal and sub-lethal effects to bull trout. Traffic residues contain several metals with toxic mechanisms of action, including Zn, Pb, Cd, Ni, Cu, and Cr (Wheeler *et al*. 2005). These metals originate from disintegrating tires, brake pads, and other vehicle parts and frequently accumulate in roadside dust and soil (Wheeler *et al*. 2005).

Acute (Lethal and Sub-Lethal) Effects – Dissolved Metals

There are three known physiological pathways by which salmonids may be directly exposed to and/or may uptake metals: 1) uptake of ionic metals at the gill surfaces (Niyogi *et al.* 2004), 2) dietary uptake, and 3) olfaction (sense of smell) involving receptor neurons (Baldwin *et al*. 2003). Of these three pathways, the mechanism of dietary uptake is least understood. For dissolved metals, the most direct pathway is through the gill surfaces.

Measurements of total recoverable metal concentration include a fraction that is bound to suspended solids and/or complexed with organic matter or other ligands; this fraction is not available to bind to gill receptor sites. As such, most metal toxicity studies have examined the dissolved metal fraction which is more bioavailable and therefore of greater significance for acute exposure and toxicity. However, metals bound to sediment remain biologically relevant. Sub-sections that follow examine the significance of the particulate bound (or complexed) fraction and total metal loadings (*See* Chronic Effects to Water / Sediment Quality and Ecosystem Function).

The relative toxicity of a metal (or metal species) can be altered by hardness, water temperature, pH, organic content, phosphate concentration, suspended solid concentration, the presence of other metals or contaminants (i.e., synergistic effects), and other factors. Eisler (1998) and Playle (2004) found that dissolved metal mixtures exhibit greater than additive toxicity. Water hardness affects the bio-available fraction of metals; as hardness increases, metals become less bio-available for uptake at the gill surfaces and therefore less toxic (Hansen *et al.* 2002; Niyogi *et al.* 2004). However, Baldwin *et al.* (2003) found water hardness did not influence the inhibiting effects of Cu on salmon olfactory functions.

Copper (Cu)

Even at low concentrations, Cu is acutely toxic to fish. Effects of Cu exposure include 1) weakened immune function and impaired disease resistance, 2) impaired respiration, 3) disruptions to osmoregulation, 4) impaired function of olfactory organs and brain, 5) altered blood chemistry, 6) altered enzyme activity and function, and 7) pathology of the kidneys, liver, and gills (Eisler 1998).

Sprague (1964) and Sprague and Ramsay (1965) reported Incipient Lethal Levels for dissolved Cu of 48 µg/L and 32 µg/L at water hardnesses of 20 and 14 mg/L, respectively. The Incipient Lethal Level is that concentration which is required to kill half of the fish tested within 1 week of exposure. Sprague and Ramsay (1965) found that higher concentrations of Cu killed juvenile salmon much more rapidly than did lower concentrations at 14 mg/L hardness.

Baldwin *et al.* (2003) found that short pulses of dissolved Cu, at concentrations as low as 2 µg/L, reduced olfactory sensory responsiveness by approximately 10 percent within 10 minutes, and by 25 percent within 30 minutes. At 10 µg/L responsiveness was reduced by 67 percent within 30 minutes. Baldwin *et al.* (2003) identified a Cu concentration neurotoxic threshold of an increase of 2.3 to 3.0 µg/L, when background levels are 3.0 µg/L or less. When exceeded, this threshold is associated with olfactory inhibition. The authors also reference three other studies examining long-duration Cu exposures (i.e., exceeding 4 hours); these studies found that long-duration exposures resulted in cell (olfactory receptor neuron) death in rainbow trout and Atlantic and Chinook salmon. Baldwin *et al.* (2003) found that water hardness did not influence the toxicity of Cu to coho salmon sensory neurons.

More recently, Sandahl *et al.* (2007) documented sensory physiological impairment, and related disruption to predator avoidance behaviors, in juvenile coho at concentrations as low as 2 µg/L dissolved Cu.

The effects of short-term Cu exposure may persist for hours and possibly longer. Although salmonids may actively avoid surface waters containing an excess of dissolved Cu, those individuals that are exposed may experience olfactory function inhibition within minutes of exposure. Furthermore, avoidance of a chemical plume may cause fish to leave refugia or preferred habitats in favor of less suitable or less productive habitats. This, in turn, can make fish more vulnerable to predation and can impair foraging success, feeding efficiency, and thereby growth.

Folmar (1976) observed avoidance responses in rainbow trout fry when exposed to a Lowest Observed Effect Concentration of 0.1 µg/L dissolved Cu (hardness of 90 mg/L). The EPA (1980) also documented avoidance by rainbow trout fry of dissolved Cu concentrations as low as 0.1 µg/L during a 1 hour exposure, as well as a LC10 for smolts exposed to 7.0 µg/L for 200 hours, and a LC10 for juveniles exposed to 9.0 µg/L for 200 hours.

Zinc (Zn)

Zn occurs naturally in the environment and is an essential trace element for most organisms. However, in sufficient concentrations and when bioavailable for uptake by aquatic organisms, excess Zn is toxic. Toxicity in the aquatic environment and for exposed aquatic organisms is influenced by water hardness, pH, organic matter content, levels of dissolved oxygen, phosphate, and suspended solids, the presence of mixtures (i.e., synergistic effects), trophic level, and exposure frequency and duration (Eisler 1993). Bioavailability of zinc increases under conditions of high dissolved oxygen, low salinity, low pH, and/or high levels of inorganic oxides and humic substances. Most of the Zn introduced into aquatic environments is eventually partitioned into sediments (Eisler 1993).

Effects of Zn exposure include 1) weakened immune function and impaired disease resistance (Ghanmi *et al.* 1989), 2) impaired respiration, including potentially lethal destruction of gill epithelium (Eisler 1993), 3) altered blood and serum chemistry, and enzyme activity and function (Hilmy *et al.* 1987a; Hilmy *et al.*1987b), 4) interference with gall bladder and gill metabolism (Eisler 1993), 5) hyperglycemia, and 6) jaw and branchial abnormalities (Eisler 1993).

Hansen *et al.* (2002) determined 120-day lethal concentrations of Zn for test subjects that included bull trout and rainbow trout fry. Multiple pairs of tests were performed with a nominal pH of 7.5, hardness of 30 mg/L, and at a temperature of 8 °C. Bull trout LC50 values measured under these conditions ranged from 35.6 to 80.0 µg/L, with an average of 56.1 µg/L. Hansen *et al.* (2002) found that rainbow trout fry are more sensitive to Zn (i.e., exhibit a lower LC50) than are bull trout fry. The authors also report that older, more active juvenile bull trout are more sensitive than younger, more docile juvenile bull trout based on observed changes in behavior at the juvenile life stage. The authors argue that the timing of Zn (and cadmium) exposure and the activity level of the exposed fish are germane to predicting toxicity in the field.

The mode of action for Zn toxicity relates to net loss of calcium. Studies suggest that Zn exposure inhibits calcium uptake, although it appears this effect is reversible once fish return to clean water. The apparent difference in sensitivity between rainbow trout and bull trout may be due to the lesser susceptibility of bull trout to calcium loss. Hansen *et al.* (2002) state that differences in sensitivity between these two salmonids may reflect different physiological strategies for regulating calcium uptake. These strategies may include gills that differ structurally, differences in the mechanisms for calcium uptake, and/or variation in resistance to or tolerance for calcium loss.

There are no known studies or data describing adult bull trout response to lethal (or near-lethal) concentrations of Zn. Active feeding and increased metabolic activity are apparently related to sensitivity. It is unknown whether sensitivity to Zn varies between adult, subadult, and juvenile bull trout. Activity level may be a better predictor of sensitivity than age.

In addition to the physiological effects of Zn exposure, studies have also documented a variety of behavioral responses. Among these, Eisler (1993) includes altered avoidance behavior, decreased swimming ability, and hyperactivity. The author also suggests Zn exposure has implications for growth, reproduction, and survival.

Sub-lethal endpoints have been evaluated with test subjects that include both juvenile and adult rainbow trout (Eisler 1993; EPA 1980; EPA 1987; Spear 1981). Some of these test results clearly indicate that juvenile rainbow trout are more sensitive than adult rainbow trout. Using juvenile rainbow trout as test subjects, studies have found that sub-lethal effects occur at concentrations approximately 75 percent lower (5.6 µg/L) than the concentrations that result in lethal effects (24 μg/L) (Eisler 1993; Hansen *et al.* 2002). Sprague (1968) found that at concentrations as low as 5.6 μg/L juvenile rainbow trout exhibit avoidance behavior.

Although salmonids may actively avoid surface waters containing an excess of dissolved Zn, it can generally be assumed that highway runoff contains a mixture of pollutants, including some known to affect the olfactory system (i.e., dissolved Cu). Bull trout exposed to these mixtures may not always be capable of detecting and avoiding elevated levels of dissolved Zn. Furthermore, avoidance of a chemical plume may cause fish to leave refugia or preferred habitats in favor of less suitable or less productive habitats. This can make fish more vulnerable to predation and can impair foraging success, feeding efficiency, and thereby growth.

Acute Pollutant Exposure and Effects Analysis

Bull trout may be exposed to pollutant concentrations contained in treated and untreated stormwater discharge originating from the project area. On an event basis, pollutant concentrations may exceed the effect levels associated with adverse sub-lethal effects. Acute exposures and effects are expected to occur in mixing-zones located in close proximity to points of discharge (outfalls).

Along much of the project corridor, both existing outfalls and the approximate location of planned (new) outfalls are positioned such that bull trout are not likely to be exposed to mixing-zones. Throughout the Yarrow Creek, North Bellevue, and Forbes Creek sub-areas, TDAs will drain and discharge to locations which, because of the presence of fish passage barriers and other heavily degraded instream conditions, are not likely to support bull trout. Acute exposures and effects are considered discountable in these sub-areas.

Acute exposures and effects to bull trout are not entirely discountable in the Juanita Creek, North Creek, and Sammamish River sub-areas. The TDAs located in the Juanita Creek and North Creek sub-areas will discharge to portions of these waterbodies that may support bull trout, particularly during winter months when surface water temperatures and dissolved oxygen concentrations are more favorable. However, the risk of acute exposures and resulting measurable effects to bull trout is probably greatest where TDAs will discharge directly to the Sammamish River. The Sammamish River is a major tributary within the Lake Washington FMO and is presumed to support foraging, migrating, and overwintering bull trout in low numbers.

Post-project effluent/discharge concentrations are expected to range between 91 and 109 μg/L dissolved Zn, and between 12 and 14 μg/L dissolved Cu at the points of discharge (WSDOT 2008a). Expected post-project dissolved Cu concentrations exceed the sub-lethal neurotoxic threshold of an increase of 2.0 μg/L over background (Sandahl *et al*. 2007). Therefore, reduced olfactory sensory responsiveness (i.e., olfactory inhibition) is likely to result where bull trout are exposed. Both Eisler (1998) and Playle (2004) found that dissolved metal mixtures exhibit greater than additive toxicity (i.e., synergistic effects). As such, we conclude that stormwater discharges to Juanita Creek, North Creek, and the Sammamish River are likely to result in acute adverse effects and will significantly disrupt normal bull trout behaviors (i.e., ability to feed, move, and/or shelter).

The WSDOT has estimated the size of anticipated outfall mixing-zones, with consideration for both seasonal highway runoff and receiving water conditions (i.e., effluent discharge rates, flows/ rates of discharge in the receiving waterbodies, ambient Zn and Cu concentrations, etc.)(WSDOT 2008a, 2008c). The best available scientific information suggests that dissolved Zn and dissolved Cu concentrations will intermittently exceed effect levels associated with adverse
sub-lethal effects throughout mixing-zones extending between 5 and 10 ft from points of discharge (outfalls).

In general, winter stormwater discharges (October – April) are likely to be more frequent, of longer duration, and greater in magnitude compared to summer stormwater discharges (May – September). In five of the six sub-areas, flow control facilities designed according to the *Highway Runoff Manual* (WSDOT 2008b) will service new and replaced PGIS. These flow control facilities can be expected to fully infiltrate runoff from most storm events, and will discharge on an infrequent basis (i.e., events exceeding the 6-month storm event). However, in the Sammamish River sub-area, where much of the treated and untreated highway stormwater runoff will discharge to the Sammamish River without flow control, acute exposures and potential adverse effects may occur at any time of year.

The Service expects that adult and subadult bull trout will be exposed to dissolved Zn and Cu at concentrations that cause adverse sub-lethal effects and significant disruption to normal bull trout behaviors. These exposures will be episodic, occurring whenever bull trout are present near the outfalls to Juanita Creek, North Creek, and the Sammamish River coincident with discharge from storm events. Mixing-zones are expected to vary based on flow and discharge conditions, but are unlikely to exceed 15 ft under any foreseeable conditions. Exposures may be more frequent, and exposure durations somewhat longer, during winter months.

Adult and subadult bull trout will be exposed to concentrations of dissolved metals sufficient to result in adverse sub-lethal effects, including avoidance response and reduced olfactory sensory responsiveness. These exposures are expected to significantly disrupt normal bull trout behaviors. Bull trout may avoid the vicinity of outfalls to Juanita Creek, North Creek, and the Sammamish River when stormwater discharges are sufficient to result in elevated pollutant concentrations. However, bull trout exposed at sufficient concentrations, and for sufficient durations, are likely to experience olfactory inhibition. Avoidance behavior and olfactory inhibition will impair free movement through the action area, may temporarily displace individual bull trout from refugia or preferred habitats, and are likely to reduce foraging success and feeding efficiency. Reduced olfactory sensory responsiveness may cause individual bull trout to be more vulnerable to predation. Because suitable spawning habitat is not present in the action area, exposure to dissolved metal concentrations is not expected to interfere with bull trout reproductive behaviors. The Service expects that sub-lethal effects to individual bull trout will be episodic and of limited duration, but will still significantly disrupt normal bull trout behaviors. Some bull trout may be exposed repeatedly as a result of regular movements through the action area.

Pollutant Loadings and Chronic Sediment-Mediated Effects

Pollutant loads bound or complexed with the particulate-phase (or fraction) of highway stormwater runoff represent a persistent, long-term source of potential chronic exposures and effects (Chen *et al*. 1996, p. ab; Fan *et al*. 2001, pp. 2, 8; Glenn *et al*. 2002, p. 2; Grant *et al*. 2003, p. 4-3; Pettersson 2002, p. 1). Heavy metals do not degrade in the environment (Glenn *et al*. 2002, p. 2; Muthukrishnan and Selvakumar 2006, p. 2), and organic contaminants easily persist for durations that exceed the life spans of individual fish (or multiple generations of fish)(Heintz *et al*. 2000, p. 214). Chronic effects to individuals stem from repeated exposures over time, through multiple exposure pathways, and from multiple stressors and combinations of stressors (Burton *et al*. 2000, p. ab; Ellis 2000, p. 86; Heintz *et al*. 2000, p. 214). Ellis (2000, p. 89) has argued that sediment-mediated exposures and effects have not yet been given adequate attention, and furthermore that “procedures for the identification of chronic, sub-lethal no effects limits are still to be achieved”. Emphasizing the tendency for accumulation in sediments, both Hodson (1988, p. ab) and Pettersson (2002, p. 1) have argued that loads (and not simply water concentrations) should be a focus for management where discharges of metals and persistent organic pollutants are concerned.

Fate and Transport of Contaminants Present in Stormwater Runoff

As highway runoff moves from the “edge-of-pavement”, through drainage/conveyance structures, and treatment and flow control facilities and BMPs, it passes through a succession of varying physical and chemical environments. Treatment facilities and BMPs use controlled conditions to remove pollutants through adsorption, complexation, settling, and filtration. However, upon release to the receiving waterbody, stormwater discharges enter a more complex and dynamic environment. Contaminant fate and transport in the aquatic environment is influenced by a host of factors, including the unique chemical and physical properties of the pollutant/contaminant of concern, the chemical and physical properties of particulates/solids present in both runoff and the receiving waterbody, and changing ambient chemical, physical, and biological conditions in the receiving waterbody.

The factors influencing metal (and non-polar organic contaminant) fate and transport in the aquatic environment, including the important role of solids and the particulate fraction of stormwater runoff, are described thoroughly elsewhere (Glenn *et al*. 2002; Grant *et al*. 2003; John and Leventhal 1995; Lloyd 1987). However, to more fully appreciate the significance of pollutant loadings, and the nature of sediment-mediated exposures and effects, it is essential to understand a few fundamental premises: 1) partitioning of metals between the solid and aqueous phases has a strong influence on mobility, storage, export, and ultimate fate, 2) solids (whether particulates in discharge or sediments in the natural environment) can act as both “sinks” and “sources” for metals and non-polar organic contaminants, and 3) the ambient conditions which govern whether solids will act as sources or sinks are dynamic and can change over time.

Solid/liquid-phase dynamics and partitioning have a strong influence on the fate and transport of metal contaminants present in highway stormwater runoff. These processes begin when road solids are first brought into contact with precipitation. They continue as runoff passes through treatment and flow control facilities, and (after discharge) once highway stormwater runoff is released to the environment (Grant *et al*. 2003). Within stormwater conveyance and treatment systems, partitioning coefficients, residence time (i.e., how long road solids and runoff remain in contact), and the degree of mixing exert a strong influence on equilibrium concentrations in the particulate (solid) and dissolved (liquid) phases (Glenn *et al*. 2002, p. 3). Upon release to the environment, metal speciation, pH, redox potential, temperature, organic matter content, and other factors influence partitioning amongst six fractions present in suspended solids, soils, and sediment (John and Leventhal 1995, pp. 10, 11). These metal fractions exhibit widely-varying mobilities in the environment; exchangeable (dissolved) cations exhibit "high" mobility, while iron-manganese and organically-bound fractions exhibit "medium" mobilities; crystalline fractions are relatively immobile (John and Leventhal 1995, p. 10).

Solids can act as both "sinks" and "sources" for metals and non-polar organic contaminants. Contaminants are "reversibly bound to suspended particles", and these particles can act as a "source of water column toxicity or interstitial [pore] water toxicity" (Grant *et al*. 2003, p. 4-3). Adsorption and complexation are physiochemical processes that would tend to remove contaminants from the liquid-phase and sequester them in the solid-phase (Lloyd 1987, p. 491, 499). Redox potential (i.e., oxidizing or reducing conditions) and pH influence how contaminants are bound and, under varying conditions, can act to either keep contaminants bound in the solid-phase, or conversely, to release (or desorb) contaminants to the dissolved (liquid) phase (Bostick *et al*. 1998, p. 1; John and Leventhal 1995, p. 13). Some contaminated sediments constitute a persistent, continuing source of toxic contamination (Fan *et al*. 2001, p. 8).

There is considerable evidence to illustrate how urban stormwater and highway runoff can create accumulations of metals and non-polar organic contaminants in receiving waters. Carr *et al*. (2000, p. ab) and Rhoads and Cahill (1999, p. ab) both found that quality was degraded, and conditions potentially toxic, where sediments were located in close proximity to stormwater outfalls. Similarly, Maltby *et al*. (1995, p. ab) observed toxicity in sediments, attributable to metals and PAHs, downstream of highway runoff discharges. Chalmers *et al*. (2007, p. ab) found that urban lakes exhibited metal and PAH contaminant accumulation rates that were orders of magnitude greater than reference lakes, and concluded that sediment concentrations were attributable to local sources. Lester and Wilson (2002, p. ab) and Moshenberg (2004, p. 27), investigating sediment quality and toxic potential in urban lakes of the Seattle, Washington, metropolitan area, found that samples exceeded sediment quality guidelines (for metals and PAHs) at some sample locations, including the vicinity of stormwater discharges to Lake Sammamish. Because contaminated sediments are recognized as potential sources of toxic exposure and effects, the development of reliably predictive sediment quality guidelines is an area of continuing interest for researches and resource managers alike; a sub-section that follows describes sediment quality guidelines in greater detail (*See* Bioavailability and Toxicity of Contaminated Sediments).

Ambient conditions determine whether contaminated sediments will act as continuing sources or sinks for toxic metals and non-polar organic contaminants. Because ambient conditions are dynamic and can change over time and space, equilibrium levels of metals and organic contaminants in sediments, in interstitial/pore water, and the water column, are also variable. "Bioavailability is a complex function of many factors ... Many of these factors vary seasonally and temporally, and most factors are interrelated" (John and Leventhal 1995, p. 10).

Changes in ambient water and sediment chemistry (including redox state, dissolved oxygen concentration, pH, temperature, and buffering capacity/carbonate concentration/hardness) can release sequestered contamination to interstitial/pore water or the water column (Chen *et al*. 1996, p. ab; Marsalek *et al*. 2002, p. 7; Muthukrishnan and Selvakumar 2006, p. 10; Wong *et al*. 2000, p. 10). Bostick *et al*. (1998, pp. 2, 4), Chen *et al*. (1996, p. ab), and John and Leventhal (1995, pp. 14, 17) each describe changes in Zn partitioning and bioavailability in response to altered chemical environments. Bostick *et al*. (1998, pp. 2, 4) found that changes in redox state within a contaminated wetland influenced the size of fractions complexed to sorbents with varying properties. Chen *et al*. (1996, p. ab) found that 74 percent of Zn from bottom sediments of urban reservoirs was in easily remobilized fractions. John and Leventhal (1995, p. 14, 17) found that contaminated sediments can release significant amounts of Zn to the dissolved phase when oxidized or exposed to acidic conditions.

In fluvial environments, hydrology and fine and coarse sediment dynamics also exert a strong influence on patterns of sediment contamination. Rhoads and Cahill (1999, p. ab) describe variation in levels of sediment metal contamination reflecting distance from the source (outfalls), reach-scale variation in geomorphic conditions, and the degree of bed material sorting. Foster and Charlesworth (1995, p. ab) and Marsalek *et al*. (2002, pp. ab, 9) also emphasize the role of sediment deposition, accumulation, and remobilization. Baun *et al*. (2003, p. 4-4) and Chen *et al*. (1996, p. ab) suggest that hydraulic resuspension of contaminated sediments, and sporadic disturbance and release of contaminated interstitial/pore water, influences bioavailability. Ellis (2000, p. 86) has argued that understanding the "probability of biotic uptake and ecosystem response … requires incorporation of water quality effects with impacts on sediment and pore waters as well as habitat impairments resulting from flow hydraulics".

Bioavailability and Toxicity of Contaminated Sediments

Contaminated sediments are widely recognized as potential sources of toxic exposure and effects. This concern has created interest in the development of predictive (non-regulatory) sediment quality guidelines (SQGs) and of analytical tools for the assessment of bioavailability and toxicity (e.g., bioassays, AVS/SEM ratios, etc.). Grant *et al*. (2003, p. 4-12) have provided a concise summary and review of current methods for the measurement of sediment toxicity.

SQGs are "numerical limits recommended to support and maintain aquatic life", and generally reflect the sensitivities of sediment-dwelling organisms (Marsalek 2002, p. 6; MacDonald *et al*. 2000, p. 20). The U.S. Environmental Protection Agency has published guidance for the derivation of sediment benchmarks (EPA 2008b), and the WDOE implements several programs (e.g., Aquatic Lands Clean-Up, Water Quality, Environmental Assessment, etc.) engaged in the development and refinement of SQGs (WDOE 2008c). MacDonald *et al*. (2000) provide a good summary of published freshwater SQGs; SQGs derived using an "effects level approach" are in fairly wide use. [Note: as of the writing of this BO, the State of Washington has not formally adopted freshwater SQGs (King Co. 2008b); interim freshwater SQGs currently in use (and under evaluation) in King County and the State of Washington were derived using an "effects level approach" (King Co. 2008b; Smith *et al*. 1996)].

Marsalek *et al*. (1997b; 2002; 2006) have evaluated the toxic potential of accumulated bottom sediments and suspended particulates found in urban stormwater ponds through comparisons of measured sample concentrations with Canadian SQGs. Marsalek *et al*. (1997b, p. ab) report "marginal-to-significant" pollution for six heavy metals. More recent work has documented widespread "marginal-to-intermediate" pollution of heavy metals (80 to 100 percent of samples), and several instances of "severe" Zn pollution (including in sediments from oil and grit separators) (Marsalek *et al*. 2006, p. ab). Marsalek *et al*. (2002) found that sample concentrations for five metals, including Cu and Zn, frequently exceeded Threshold Effect Levels (TELs), and occasionally exceeded Probable Effect Levels (PELs). Applying the same TELs and PELs that are in use in the State of Washington (i.e., as interim SQGs), the authors found that the highest incidence of biological effects would result from concentrations of Cu and Zn. The incidence of adverse biological effects associated with Cu concentrations present in accumulated bottom sediments and suspended particulates may be as high as 38 percent, and does not account for potential additive or synergistic effects (Marsalek *et al*. 2002, p. 7). Marsalek *et al*. (2002, p. ab) have concluded that "suspended solids passing through stormwater ponds [are] polluted and could cause toxic effects in downstream waters". These findings suggest that the suspended solid fractions not settled and retained in stormwater treatment facilities (and therefore discharged to the receiving waterbody) sometimes contain metal concentrations sufficient to cause toxicological effects in exposed biota.

Lester and Wilson (2002, p. ab) report findings from an evaluation of sediment quality in Lake Sammamish, Washington. Using comparisons of measured sample concentrations with the State of Washington's interim SQGs, the authors report the following: both heavy metal and organic contaminant concentrations exceed guidelines; some observed concentrations indicate severe pollution (and a high probability of adverse effects to biota); and, "the highest levels of sediment associated contaminants were found in the vicinity of stormwater discharges". However, Lester and Wilson (2002, p. ab) also note that benthic community structure in the study area reflects the influence of nutrient enrichment, and it is difficult to separate effects associated with enrichment and sediment associated contaminants.

Baun *et al*. (2003) report findings from a study evaluating toxicity of interstitial/pore water and sediment suspensions collected from an urban stream receiving large inputs of untreated runoff. Undiluted pore water samples were toxic to an algal test subject, but no statistically significant correlations were found between individual metal or organic parameters and observed pore water toxicity. Prepared sediment suspensions exhibited toxicities approximately 50 times greater than pore waters from the same sediment samples. The authors conclude that contaminated "sediments may contribute significantly to toxic effects in receiving waters" as a result of "release of pore water and/or suspension of particles"(Baun *et al*. 2003, p. 4-5).

Maltby *et al*. (1995, p. ab) report findings from a study evaluating toxicity of ambient water and sediments collected from locations downstream of highway runoff discharges. Ambient water did not exhibit toxicity in the test subject (benthic amphipod), but a reduction in survival (over 14 days) was found to result from exposure to the same water spiked with sediment. Hydrocarbons, Cu, and Zn were identified as potential toxicants, with most of the observed toxicity attributable to PAHs.

AVS/SEM (acid volatile sulfides/simultaneously extracted metals) ratios probably provide the best, most reliable information with which to gauge sediment-mediated metal toxic potential. Where AVS fractions in sediment are greater than the total metal content, metals are bound in manner that generally renders them unavailable. King County, Washington, has compared sediment samples to interim SQGs, and has used AVS/SEM ratios to characterize sediment quality and toxicity in small streams from the action area (King Co. 2005a; King Co. 2008b) and the Sammamish River (King Co. 2005b). King County's findings, described in a previous section (*See* Environmental Baseline in the Action Area), indicate a pattern of widespread sediment contamination, and identify locations within the action area where metal concentrations are both bioavailable and a source of potential adverse effects to stream biota.

Chronic Effects to Aquatic Community Composition, Function, and Productivity

Sediments are an essential component of healthy, properly functioning aquatic ecosystems. Sediments function as both the physical growth medium and source of energy for benthic communities. Most of the organisms responsible for primary production in fluvial ecosystems, whether autotrophic (i.e., the green plants and algae) or heterotrophic (i.e., bacteria), rely crucially on sediments; in turn these organisms "represent the foundation of food webs upon which all other aquatic organisms depend" (MacDonald and Ingersoll 2002, p. 74).

Numerous studies have investigated aquatic community composition and structure in disturbed systems. These communities frequently exhibit a decline in species diversity and changes to the relative representation of various taxa; species that are tolerant of varying environmental conditions usually dominate communities subject to frequent disturbance. In urban settings conditions favor species tolerant of stormwater pollutants (Wong *et al*. 2000, p. 17), low-quality food sources and/or reduced organic matter inputs, and hydrological extremes of erosion and deposition (Ellis 2000, p. 86).

Maltby *et al*. (1995, p. ab) found that abundance of *Gammarus pulex* (a benthic amphipod) was greatly reduced downstream of highway runoff discharges. Carr *et al*. (2000, p. ab) conducted a "triad" study where chemical analyses, controlled toxicity tests, and field benthic indicators were used to assess impairment of sediment quality, and found that "four of the five most degraded [locations] were stormwater outfall sites". Scoggins *et al*. (2007, p. ab) characterized biological communities above and below stormwater discharges and found reduced invertebrate diversity and density, and a relative increase in tolerant taxa at downstream sites. Scoggins *et al*. also found that "increases in PAH sediment-toxicity units between upstream and downstream sites explained decreases in taxon richness [(diversity)] and density".

Moshenberg (2004, p. 27) reports the findings of a triad study investigating sediment and benthic community impairment in Lake Union, Lake Washington, and Lake Sammamish (King County, Washington). The study found widespread impairment of sediment quality. The State of Washington's interim SQGs (King Co. 2008b; Smith *et al*. 1996) were frequently exceeded for polychlorinated biphenyls (70 percent of stations), metals (50 percent), phthalates (46 percent), and PAHs (23 percent). Zn and Cu were found to exceed their respective SQGs more frequently than any pollutant except Aroclor 1254 (Moshenberg 2004, p. 54). The study found that observed toxicity more closely correlated with organic contaminant concentrations, than metal concentrations (Moshenberg 2004, p. 58), and there were only weak to moderate correlations between contaminant concentrations and most indicators of benthic community alteration. However, metal and PAH pollutant concentrations were a “significant predictor” of the Shannon-Weaver invertebrate diversity index (Moshenberg 2004, p. 56). In discussing potential sources of impairment, the author suggests that stormwater and transportation-related land uses are potential sources of Zn, Cu, and PAH contamination (Moshenberg 2004, pp. 58, 59).

Heintz *et al*. (2000) have reported findings that suggest a link between PAH exposure during egg incubation and subsequent rates of marine survival and growth for salmonids. The study found that statistically significant reductions in marine survival, or increases in delayed rates of mortality, resulted from exposure to concentrations as low as 5.4 ppb total PAH. The study also found that juvenile salmon surviving embryonic exposure exhibited reduced growth in response to doses as low as 18 ppb total PAH. The authors suggest that reductions in marine survival and growth are most likely attributable to biochemical impairment of gene and/or enzyme function, and that fish populations whose natal habitats are contaminated with PAHs “can be expected to experience the compound effects of mortality during exposure, reduced survivorship afterwards, and reduced reproductive output at maturity” (Heintz *et al*. 2000, pp. 213, 214).

McCarthy *et al*. (2008) have examined three case studies which provide an excellent summary of current research and our evolving understanding of potential stormwater effects on fish and fisheries of the Pacific Northwest. One of these case studies summarizes current investigations of coho salmon pre-spawn mortality in urban streams of the Seattle, Washington, metropolitan area. The authors argue that high temperature, low dissolved oxygen, overcrowding, disease, and accidental spills have all been “systematically ruled out” as causal mechanisms, and “the weight of evidence suggests that adult coho are acutely sensitive to … stormwater runoff from urban landscapes” (McCarthy *et al*. 2008, p. 6). The authors acknowledge uncertainty as to whether the observed pre-spawn mortalities result from exposure to a single contaminant, to a mixture of contaminants, and/or the additive effect of toxicological and other environmental stressors. The authors observe that while “pollution occasionally causes fish kills, most contaminant exposures are sublethal”, a fact that heightens our need to understand how toxic exposures influence “lifetime reproductive success” (McCarthy *et al*. 2008, p. 2).

Another of the case studies described by McCarthy *et al*. (2008) examines PAH developmental toxicity, modes of action, and consequences for exposed embryonic fish. The authors summarize work identifying effects to cardiac development, form, and function (McCarthy *et al*. 2008, p. 13). These effects to the embryonic heart may explain the common malformation syndrome and reduced growth and survival frequently documented where embryonic exposures to PAH contamination have been investigated. The authors observe that while we know the “developing fish heart is vulnerable … to multiple members of the PAH family”, “there are still a large number of PAH compounds whose individual toxicity is unknown, and PAH mixtures in stormwater are more complicated" (McCarthy *et al*. 2008, p. 13).

Taken as a whole, these findings and others reported in the literature, suggest urban/highway stormwater discharges, where they cause or contribute to sediment metal and PAH contamination, can exert an influence on aquatic community composition and structure. These findings do not address, and indeed there may be little current research that does address, whether observed shifts in aquatic community composition and structure have significance for primary production, or nutrient and organic cycling and dynamics. In this sense, it is difficult to know how completely or fundamentally aquatic food webs may be affected. However, these findings and others reported in the scientific literature do also suggest that toxic constituents found in highway stormwater runoff can exert a direct adverse effect on exposed fish with implications for growth, development, long-term survival, and reproductive fitness.

Chronic Exposures & Effects Analysis

Chronic effects stem from repeated exposures over time, through multiple exposure pathways, and from multiple stressors and combinations of stressors. The assessment of chronic effects, including "cumulative toxicity", requires consideration of exposure sequences, post-exposure stress, and their accumulative effects and significance for growth, reproductive fitness, and rates of mortality (Ellis 2000, pp. 86, 87; Grant *et al*. 2003, p. 4-2; McCarthy *et al*. 2008, p. 2).

The proposed project is located in urbanized watersheds where existing functional impairments, including extensive hydrological alteration and pervasive water and sediment quality degradation, are a source of adverse effects to bull trout, their habitat, and their prey base. Available data suggest a pattern of low to moderate (metal and non-polar organic) sediment contamination in each sub-basin and the watershed as a whole. Some of these data indicate that metals are bioavailable, and that sediment concentrations (for metals and organics) pose a risk of adverse effects to stream biota. Surveys of the aquatic invertebrate community within the action area also indicate impairment. In conjunction with the many other forms of impairment evident at the scale of the sub-basins and watershed (*See* Environmental Baseline in the Action Area), these conditions present stressors and combinations of stressors that diminish habitat suitability and function. Baseline conditions in the action area expose adult and subadult bull trout to stressors, including diminished sources of prey, which are likely to result in measurable adverse effects (e.g., reduced growth, reduced reproductive fitness) with implications for long-term survival and productivity.

Stream function will not measurably improve, and in some respects is expected to worsen, as a result of the proposed project. The best available, scientific information suggests that pollutant loadings to the Sammamish River will increase because of the proposed project; this same information suggests that pollutant loadings will be reduced in some sub-areas, although not to levels that are likely to change the overall trajectory of water and sediment quality impairment. These portions of I-405, and the treated and untreated stormwater discharges that originate within the project area, are not the only cause for observed water and sediment quality impairments. Nevertheless, pollutant loadings associated with the post-project condition will contribute to, and may exacerbate or worsen, some aspects of existing stream functional impairment. Pollutant loadings associated with the post-project condition are likely to further degrade surface water and sediment quality in the action area.

It is difficult to accurately quantify the total toxic contaminant load present in highway stormwater runoff originating from the project area. We do know that across the project corridor these portions of I-405 will discharge to the environment (receiving waterbodies) approximately 50 lbs. of total Cu, 300 lbs. of total Zn, and 150,000 lbs. of suspended solids (TSS) annually. In the absence of quantitative information to describe the assimilative capacity of these waters, it is not possible to say definitively that these loadings will (or will not) cause or contribute to an exceedance of one or another system limit or threshold. However, because a large fraction of the toxic contaminant load found in highway stormwater runoff is sorbed onto or complexed with solids, and because these contaminants are persistent, mobile, prone to accumulation, and biologically active over time, the substantial suspended solid loadings expected from the project on an annual basis are of particular concern.

Suspended solid loadings resulting from the post-project condition are likely to worsen the trajectory of water and sediment quality impairment in the action area over time. Pollutant loads bound or complexed with the particulate-phase (or fraction) represent a persistent, long-term source of potential chronic exposures. Based on findings from the scientific literature (summarized in previous sub-sections), we expect that these pollutants may adversely affect bull trout, their habitat, and their prey base.

We assume that most bull trout foraging, migrating, and overwintering in the action area have been exposed to metal and non-polar organic contamination present at other locations, and/or during earlier stages of their development. Bull trout within the action area are likely to originate from the Puyallup or Snohomish-Skykomish core areas, and have therefore passed through contaminated portions of Lake Union, Lake Washington, and the nearshore marine waters of the Puget Sound. We expect that within the action area bull trout will be exposed to elevated water column (metal and non-polar organic contaminant) concentrations, resulting from episodic releases of contaminated pore water, suspension of contaminated sediment, and/or desorbtion under altered chemical conditions. However, because elevated water column concentrations are likely to be episodic, and because bull trout use of the action area is infrequent and/or transient, it is not possible to reliably quantify the frequency, duration, or intensity of chronic exposures within the action area. Furthermore, available information does not allow us to predict how exposures within the action area will or might add incrementally to the accumulative effect of multiple exposures over the lives of individual fish. These sub-lethal exposures are often coincident with other stressors (e.g., reduced dissolved oxygen availability), making evaluation of their ultimate significance for growth and reproductive fitness more difficult.

Based on findings from the scientific literature, we also conclude that sediments contaminated by highway stormwater runoff can measurably affect aquatic community composition and productivity. Within the action area, the dominant invertebrate taxa are those that are tolerant of degraded conditions, and there is some data to indicate metal and organic contaminants play a role (Moshenberg 2004, p. 56). Loadings associated with the post-project condition are likely to worsen the overall trajectory of water and sediment quality impairment in the action area over time, and therefore may also have an incremental effect on the aquatic community. Findings reported by Heintz *et al*. (2000) and McCarthy *et al*. (2008) suggest that toxic constituents found in highway stormwater runoff can exert a direct adverse effect on exposed fish with implications for growth, development, long-term survival, and reproductive fitness. Over time, the proposed project is likely to further diminish habitat suitability and function, including the productivity of prey (invertebrate and/or fish) populations.

The complexity of factors and interactions that combine in aquatic ecosystems to determine the ultimate significance of pollutant loadings cannot be resolved (at this time) with a singular, measurable outcome or indicator. Loadings themselves, however, do exert a functional influence at the community level and are a reasonable indirect measure with which to gauge potential effects. While the post-project condition is likely to worsen the overall trajectory of water and sediment quality impairment in the action area, and may also result in further degradation of the aquatic community, it is not possible at this time to ascertain and describe quantitatively the incremental effects of the proposed action. Adult and subadult bull trout in the action area will be exposed to chronic stressors that may have significance for growth and reproductive fitness, but it is not possible to describe quantitatively how the proposed action will incrementally change the pattern, frequency, or intensity of sediment-mediated toxic exposures. The Service cannot, at this time, describe how chronic exposures resulting incrementally from the proposed action will affect normal bull trout behaviors, growth, or reproductive fitness.

Summary of Effects (Matrix of Pathways and Indicators)

An earlier section applied the *Matrix of Diagnostics / Pathways and Indicators* (USFWS 1998) as a tool for describing whether habitat is functioning adequately, functioning at risk, or functioning at unacceptable levels of risk at the scale of the action area (Environmental Baseline in the Action Area). Table 10 summarizes the effects of the action using this same matrix. For a fuller description of the anticipated effects of the action see the preceding sections.

Table 10 Effects of the action (“Matrix of Pathways & Indicators”).

Pathway	Indicator	Baseline Conditions	Effect of the Action
Water Quality	Temperature	Unacceptable Risk	Maintain
	Sediment	Unacceptable Risk	**Degrade**
	Chemical Contamination & Nutrients	Unacceptable Risk	**Degrade**
Habitat Access	Physical Barriers	At Risk	Maintain
Habitat Elements	Substrate	Unacceptable Risk	Maintain
	Large Woody Debris	At Risk	Maintain
	Pool Frequency / Quality	Unacceptable Risk	Maintain
	Large Pools	Unacceptable Risk	Maintain
	Off-Channel Habitat	Unacceptable Risk	Maintain
	Refugia	Unacceptable Risk	Maintain
Channel Conditions & Dynamics	Width/Depth Ratio	Unacceptable Risk	Maintain
	Streambank Condition	At Risk	Maintain
	Floodplain Connectivity	At Risk	Maintain
Flow / Hydrology	Peak / Base Flows	Unacceptable Risk	Maintain
	Drainage Network	Unacceptable Risk	Maintain
Watershed Conditions	Road Density / Location	Unacceptable Risk	**Degrade**
	Disturbance History	Unacceptable Risk	Maintain
	Riparian Reserve	Unacceptable Risk	Maintain

Effects of Interrelated & Interdependent Actions

Interrelated actions are defined as actions “that are part of a larger action and depend on the larger action for their justification”; interdependent actions are defined as actions “that have no independent utility apart from the action under consideration” (50 CFR section 402.02). On-site and off-site compensatory mitigation to replace lost and/or degraded wetland/buffer, riparian, and instream habitat functions and values may be considered interrelated or interdependent actions related to the proposed action under consideration.

The project will meet a portion of its compensatory obligations by obtaining excess credits from the Kelsey Creek Wetland Mitigation Site; construction of that site was previously consulted upon (“Bellevue Nickel Project”; Service Ref. No. 1-3-06-I-0039). The balance of the project’s compensatory obligations will be satisfied through wetland creation and enhancement at a second site (Crystal Creek; tributary to North Creek), and through instream and riparian enhancements constructed near the I-405 Sammamish River crossing and along an unnamed tributary to Juanita Creek (“C28”). The proposed action will comply with all conditions from the section 404 permit and HPA issued for the project, and will satisfy requirements from critical area ordinances and regulations administered by those cities and counties with jurisdiction

(WSDOT 2007a).

Previous sub-sections of this BO, and the informal consultation identified above, have addressed all of the foreseeable direct and indirect effects that may result from these interrelated and interdependent actions. No additional effects to bull trout are expected to result from interrelated or interdependent actions.

CUMULATIVE EFFECTS (Bull Trout)

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this BO. 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.

State and local actions which may affect Lake Washington FMO habitat and conditions in the action area include implementation of TMDL clean-up plans for waterbodies (and portions of waterbodies) not meeting State surface water quality criteria. The State of Washington has begun planning and implementing TMDLs for fecal coliform, dissolved oxygen, and temperature in the Bear, Evans, and Cottage Creek sub-watersheds, and for fecal coliform in the Swamp Creek and North Creek sub-watersheds of the Sammamish River basin (WDOE 2008d). Over the long-term, implementation of these TMDL clean-up plans is expected to help achieve compliance with Washington's surface water quality criteria, an outcome that would benefit bull trout and other fish life.

Local actions that may affect bull trout and their habitat within the action area include planned growth consistent with the land use and growth management plans of King and Snohomish County, and the Cities of Bellevue, Kirkland, and Bothell, Washington. Additional residential, commercial, and industrial development (or redevelopment) is certain to occur in the action area. Planned growth consistent with the land use and growth management plans of these municipalities, will, over the long-term, result in additional effects to watershed functions, surface water quality, and instream habitat. However, with full implementation of the Comprehensive Plans, Shoreline Management Programs, and Critical Area Ordinances administered by these municipalities, and in conjunction with State and County environmental permit requirements (including those requirements established for the protection of wetlands and for the regulation of private and municipal stormwater discharges), effects to ecological functions may be reduced.

Taken as a whole, in the foreseeable future, State, Tribal, local and private actions will have effects to Lake Washington FMO habitat and conditions in the action area. Some of these actions (e.g., implementation of the TMDL clean-up plans) are likely to improve conditions in the action area for bull trout. Over time, other actions may further degrade conditions for bull trout in the action area.

CONCLUSION

The Service has reviewed the current status of bull trout in its coterminous range, the environmental baseline for the action area, the direct and indirect effects of the proposed I-405, SR 520 to I-5 Improvement Project, the effects of interrelated and interdependent actions, and the cumulative effects associated with future State, Tribal, local, and private actions that are reasonably certain to occur in the action area. It is the Service's Biological Opinion that the action, as proposed, is not likely to jeopardize the continued existence of the bull trout in its coterminous range.

The Service considers the waters within the action area to be FMO habitat for bull trout. FMO habitat is important to bull trout of the Puget Sound Management Unit for maintaining diversity of life history forms and for providing access to productive foraging areas (USFWS 2004). Adult and subadult bull trout may occupy these waters at any time of year, but information is not available to estimate reliably the number of bull trout that forage, migrate, and overwinter in the action area.

Current information suggests that adult and subadult bull trout use the waters within the action area infrequently and in relatively low numbers. Bull trout using Lake Washington FMO habitat most likely originate from the Snohomish-Skykomish and Puyallup core areas (and local populations). The potential for spawning in the Lake Washington basin is believed to be low. Suitable spawning and rearing habitats are not present, and juvenile bull trout do not occur in the action area.

The Service expects the proposed action will result in measurable, adverse effects to bull trout associated with long-term (operational) discharge of highway stormwater runoff. The proposed action does incorporate both permanent design elements and conservation measures which will reduce effects to habitat and avoid and minimize impacts during construction.

Foraging, migrating, and overwintering adult and subadult bull trout will be exposed to stormwater pollutants when near the outfalls to Juanita Creek, North Creek, and the Sammamish River coincident with discharge from storm events. Acute exposures will be episodic, but may be more frequent and of longer duration during winter months. Some bull trout may be exposed repeatedly as a result of regular movements through the action area.

The Service expects that acute exposure to dissolved metal concentrations contained in highway stormwater runoff will significantly disrupt normal bull trout behaviors (i.e., ability to feed, move, and/or shelter). Exposed adult and subadult bull trout are likely to suffer adverse sub-lethal effects, including reduced olfactory sensory responsiveness, foraging success, and feeding efficiency. Avoidance behavior may impair free movement and/or cause fish to leave refugia and preferred habitats. The Service does not expect that acute exposure to stormwater pollutants will cause lethal effects.

Long-term (operational) discharge of highway stormwater runoff originating from the project area will further impair surface water and sediment quality in the project's receiving waters. Pollutant loadings associated with the post-project condition are likely to worsen the overall trajectory of water and sediment quality impairment in the action area. Pollutant loadings may also further diminish habitat suitability and function, and/or result in reduced prey availability. However, the Service cannot evaluate or describe how chronic exposures resulting incrementally from the proposed action will affect normal bull trout behaviors, growth, or reproductive fitness.

The Service expects that pollutant loadings associated with the post-project condition, when added to the environmental baseline, will act as a persistent, long-term source of potential chronic exposures and effects throughout the action area. However, because these exposures are likely to be episodic and bull trout use of the action area is infrequent and/or transient, it is not possible to reliably quantify the frequency, duration, or intensity of chronic exposure for individual bull trout within the action area. Furthermore, available information does not allow us to predict how exposures within the action area will or might add incrementally to the cumulative effect of multiple exposures over the lives of individual bull trout.

Pollutant exposures and effects attributable to the proposed action will significantly disrupt normal bull trout behaviors (i.e., ability to feed, move, and/or shelter). However, the direct and indirect effects of the proposed action will not preclude bull trout from foraging, migrating, or overwintering within the action area. Furthermore, because bull trout are presumed to use the action area and Lake Washington FMO in low numbers and on an infrequent basis, the Service expects that the proposed action’s incremental effects to numbers (abundance) and reproduction (productivity) will not be measurable at the scales of the Snohomish-Skykomish core area, Puyallup core area, or Puget Sound interim recovery unit. The proposed action will not have a measurable effect on the relative size of the anadromous component contributing to either core area’s local populations, nor on distribution or connectivity at the scale of the Puget Sound interim recovery unit.

The action’s long-term effects will not measurably reduce the likelihood of persistence at the scales of the local populations, Snohomish-Skykomish core area, or Puyallup core area. The anticipated direct and indirect effects of the action, combined with the effects of interrelated and interdependent actions, and the cumulative effects associated with future State, Tribal, local, and private actions will not appreciably reduce the likelihood of survival and recovery of the species. The anticipated direct and indirect effects of the action (permanent and temporary) will not measurably reduce bull trout reproduction, numbers, or distribution at the scale of the Puget Sound interim recovery unit, and will not alter the status of bull trout at the scales of the Puget Sound interim recovery unit or coterminous range.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special 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 defined by the Service as an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the FHWA so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. The FHWA has a continuing duty to regulate the activity covered by this incidental take statement. If the FHWA (1) fails to assume and implement the terms and conditions or (2) fails to require the contractor or applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the FHWA must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR section 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

The Service anticipates that take in the form of harassment of bull trout from the Snohomish-Skykomish and Puyallup core areas is likely to result from the proposed action.

The Service anticipates that incidental take of individual bull trout will be difficult to detect or quantify for the following reasons: 1) the low likelihood of finding dead or injured adults or subadults; 2) delayed mortality; and, 3) the relationship between habitat conditions and the distribution and abundance of individuals is imprecise such that a specific number of affected individuals cannot be practically obtained. Using post project habitat conditions as a surrogate indicator of take, the Service anticipates that the following forms of take will occur as a result of activities associated with the project:

1. Incidental take of bull trout in the form of ***harassment*** resulting from degraded surface water quality and acute exposure to elevated stormwater pollutant concentrations. Effects will last in perpetuity, although acute exposures and effects to bull trout will be episodic. Harassment will result when dissolved Cu concentrations exceed the sub-lethal neurotoxic threshold of an increase of 2.0 μg/L over background (approximately 0.68 μg/L and 0.54 μg/L dissolved Cu, in the Sammamish River and other receiving waterbodies respectively), or when dissolved Zn concentrations exceed 5.6 μg/L over background (approximately 2.0 μg/L and 1.1 μg/L dissolved Zn, in the Sammamish River and other receiving waterbodies respectively).

- All adult and subadult bull trout migrating, sheltering, or foraging within the wetted perimeter of the Sammamish River, North Creek, or Juanita Creek, throughout mixing-zones extending a distance of approximately 15 ft from points of discharge (i.e., outfalls), in perpetuity and for the life of the proposed project.

EFFECT OF THE TAKE

In the accompanying BO, the Service has determined that the level of anticipated take is not likely to result in jeopardy to the bull trout.

The proposed action incorporates design elements and conservation measures which the Service expects will reduce permanent effects to habitat and avoid and minimize impacts during construction. The Service assumes the FHWA will fully implement these measures and therefore they have not been specifically identified as Reasonable and Prudent Measures or Terms and Conditions.

REASONABLE AND PRUDENT MEASURES

The Service believes that the following reasonable and prudent measures (RPM) are necessary and appropriate to minimize the impact of incidental take to bull trout:

1. Minimize and monitor incidental take caused by exposure to stormwater pollutant concentrations.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the FHWA must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

The following terms and conditions are required for the implementation of RPM 1:

1. The WSDOT and FHWA shall document and report the "as-built" stormwater facility configuration and outfall locations within the project limits.

2. The WSDOT and FHWA shall develop and implement a plan for monitoring and accurately characterizing ("end-of-pipe") post-project effluent/discharge concentrations (total and dissolved Cu, total and dissolved Zn, and TSS) at a minimum of one location within the project limits. Sampling, data collection, analysis, and reporting (including quality control/quality assurance procedures) shall follow requirements from the WSDOT's Municipal Stormwater NPDES (National Pollutant Discharge Elimination System) and State Waste Discharge General Permit. If the WSDOT and FHWA develop a more comprehensive, programmatic approach to monitoring stormwater

effluent/discharge concentrations, and if this programmatic approach includes a site or sites broadly representative of conditions within the action area, data and findings from that more comprehensive approach may be used to satisfy this term and condition. The WSDOT and FHWA shall submit to the Service for approval a description of the monitoring plan within one calendar year of project completion.

3. The WSDOT and FHWA shall report for a term of three years (beginning in calendar year 2009) the performance and effectiveness of ongoing routine maintenance operations within the project limits. The WSDOT shall report the outcome of any random condition surveys comparing conditions along these portions of I-405 with legislatively mandated target Levels of Service, and shall document any actions taken to correct deficiencies through routine maintenance (e.g., street sweeping; catch basin cleaning; ditch, channel, and culvert maintenance; removal of pond and vault sediments; etc.). The WSDOT and FHWA shall document and report this information for a term of three years and in the third year shall provide an assessment of the adequacy of currently mandated target Levels of Service, and the appropriateness and effectiveness of improved Levels of Service.

4. The WSDOT and FHWA shall submit all documentation in writing to the Service's consulting biologist (Ryan McReynolds; 360-753-6047) at the Western Washington Fish and Wildlife Office in Lacey, Washington.

The Service expects that the amount or extent of incidental take described above will not be exceeded as a result of the proposed action. The RPMs, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the RPMs provided. The FHWA must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the RPMs.

The Service is to be notified within three working days upon locating a dead, injured or sick endangered or threatened species specimen. Initial notification must be made to the nearest U.S. Fish and Wildlife Service Law Enforcement Office. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death, if that occurs. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. Contact the U.S. Fish and Wildlife Service Law Enforcement Office at (425) 883-8122, or the Service=s Western Washington Fish and Wildlife Office at (360) 753-9440.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service recommends the following to the FHWA:

1. Infiltrate and/or disperse treated highway stormwater runoff to the fullest extent practicable. Select, site, and design stormwater runoff treatment and flow control facilities so as to minimize direct discharges to fish bearing waterbodies.

2. When scoping/budgeting and designing future improvements to these same portions of I-405, pursue retrofit of untreated, existing impervious surface to the fullest extent possible. Projects demonstrating that they can reliably achieve a measurable reduction in annual stormwater pollutant loadings and discharge concentrations (for all priority pollutants, and in all threshold discharge areas) will avoid or reduce potential effects to listed species and may therefore require informal, rather than formal, consultation. Furthermore, the degraded baseline conditions that persist throughout the east Lake Washington basin require a concerted effort to address existing sources of impairment.

3. Work cooperatively with the WDOE, the Puget Sound Regional Council (and partners), the Puget Sound Partnership, local and county governments, and other interested parties to plan for an equitable and cost effective long-term strategy to reduce surface water and sediment quality degradation at the scale of Lake Washington and the Puget Sound.

4. Plan and commit resources to a strategy that will field validate models currently in use for the analytical description of annual stormwater pollutant loadings, "end-of-pipe" effluent/discharge concentrations, and resulting mixing-zones. Work cooperatively with the WDOE, WSDOT, and other operators of municipal separate storm sewer systems (i.e., local and county governments) to coordinate stormwater BMP effectiveness monitoring, to avoid redundancy, and obtain the highest possible quality of data for a wide range of BMPs and site conditions.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR section 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 that may affect listed species or 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 to 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. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

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