Biological Evaluation
Project: Diablo Powerhouse Tailwater Restoration
Applicant's Name: Seattle City Light (SCL)
Date: 26 June 2014

I. ***Location*****:** The proposed Diablo Powerhouse Tailrace Excavation project consists of an excavation site located immediately west of the mouth of Stetattle Creek along the northern shore of Gorge Reservoir (also known as Gorge Lake) in Whatcom County, Washington (lat. 48.71649N, long. 121.15000W); (Figure 1). The project also includes a disposal site (Copper Creek Quarry) for excavated materials (lat. 48.59011N, long. 121.23778W) in Skagit County that is located 5.4 miles northeast of the town of Marblemount, Washington and approximately 15.5 miles southwest of the excavation site (Figure 2). The excavation site is located just outside the town of Diablo, Washington and is within the boundary of Seattle City Light's (City Light) Skagit River Hydroelectric Project (No. 553) as licensed by the Federal Energy Regulatory Commission (FERC). The Skagit Hydroelectric Project consists of Gorge, Diablo, and Ross dams and their associated reservoirs, structures, and facilities. The disposal site is on property owned by City Light. Both the proposed excavation and disposal sites are located within the Ross Lake National Recreation Area (NRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex (NOCA).

II. ***Project Description*****:** The proposed project is the excavation of a cobble bar located adjacent to a free-flowing section of Gorge Lake immediately downstream of the confluence of Stetattle Creek (Figure 3). The project would restore hydraulic head and associated hydroelectric generating capacity at the Diablo Powerhouse which has been reduced due to the deposition of bed materials from Stetattle Creek. The cobble bar excavation would occur along the north shore of Gorge Lake within the Ordinary High Water Mark (OHWM) of the reservoir. The proposed disposal site for the excavated materials is an old quarry that is located beyond the OHWM of the Skagit River. The federal actions for this project include the issuance of an Individual Section 401 Water Quality Certification, an Individual Section 404 permit under the Clean Water Act by the Seattle District Army Corp of Engineers (COE), and the issuance of a Letter of Authorization from the NPS.

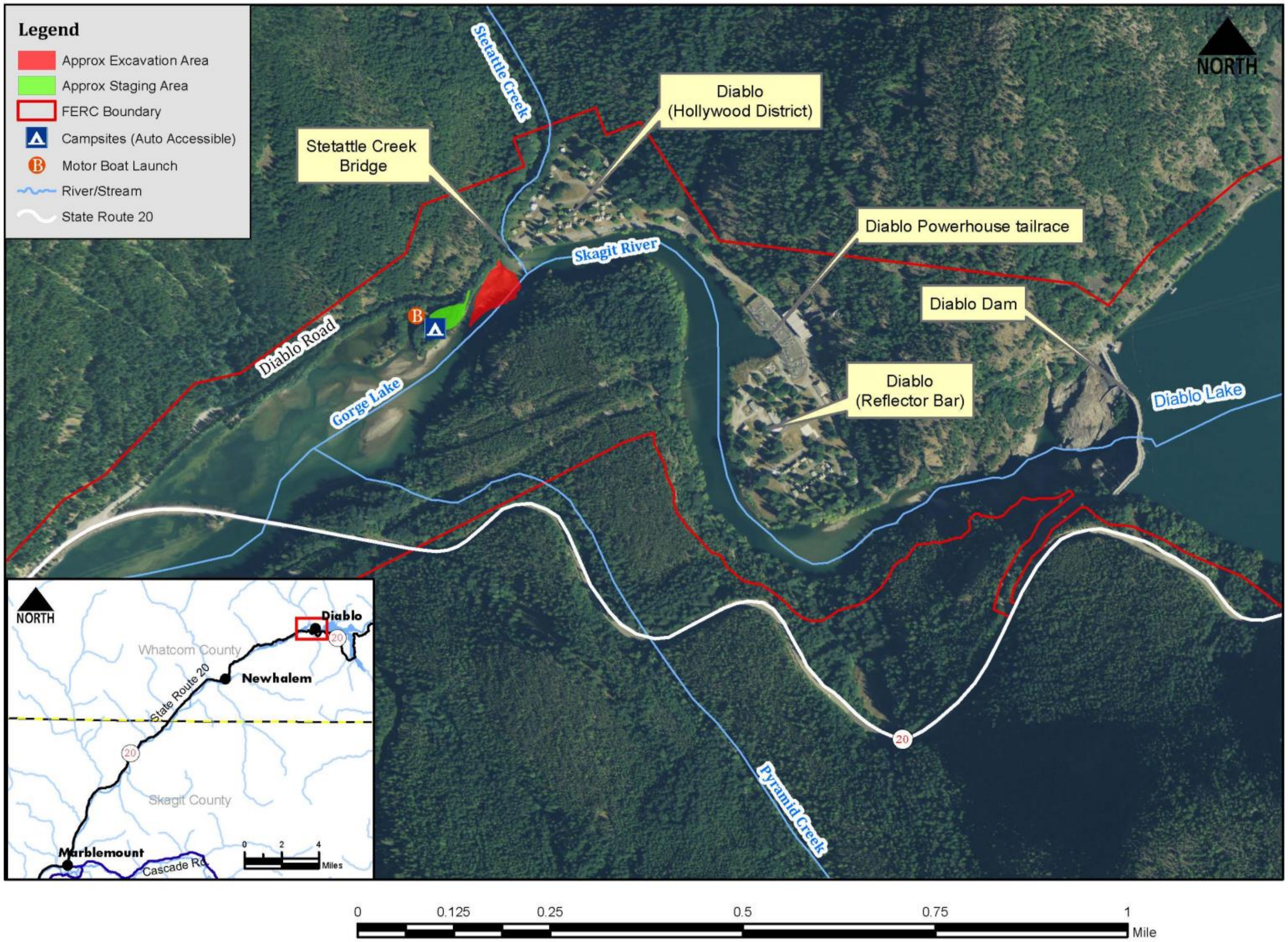

Figure 1. Map of excavation site at Gorge Lake, showing staging and excavation areas, and Stetattle Creek.

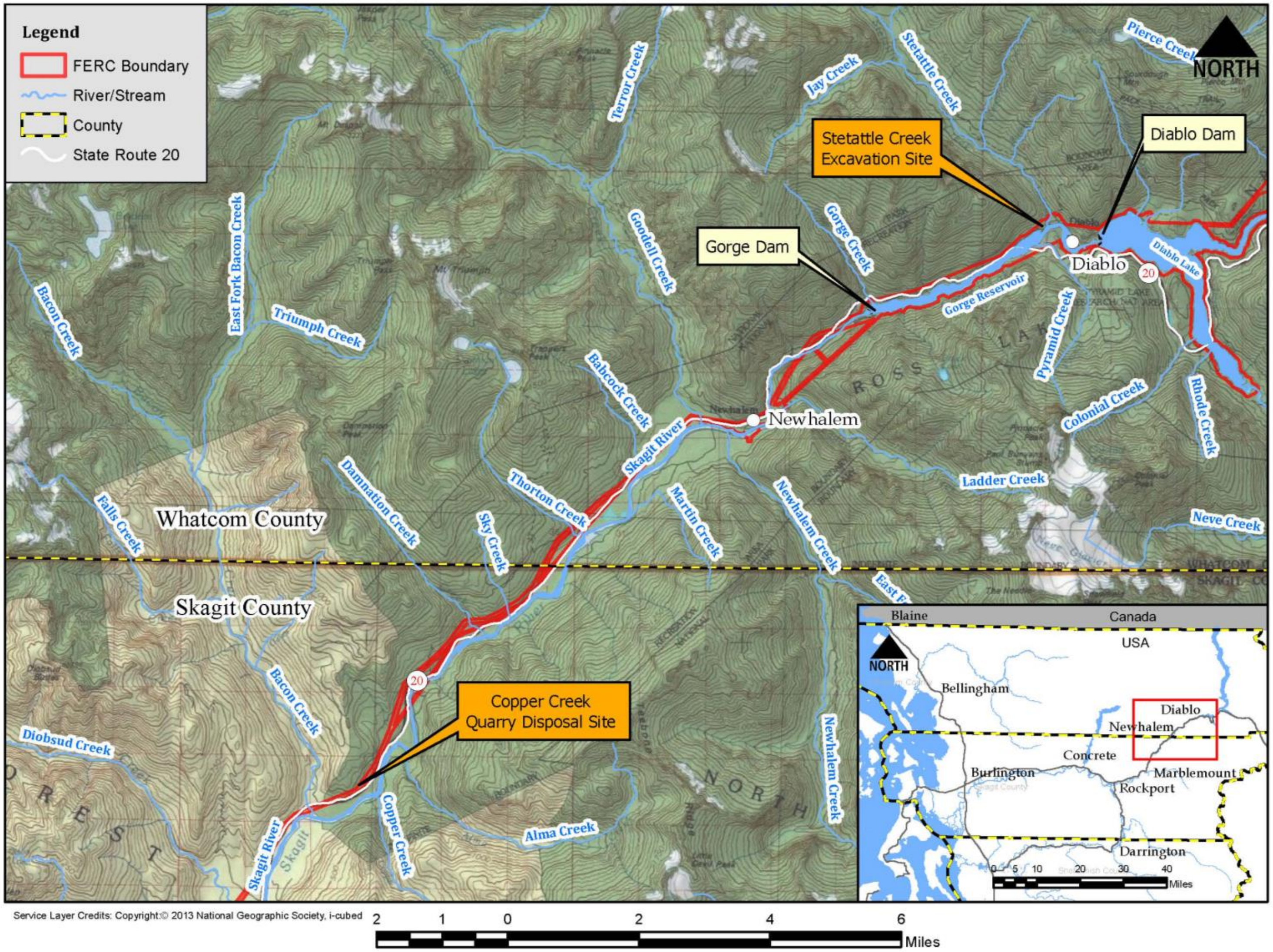

Figure 2. Map of project area, including excavation and disposal sites.

Figure 3. Aerial photo of cobble bar excavation site below outlet of Stetattle Creek. Image is dated 7/1/2013, and shows bar under project flow of 6,700 cfs at normal reservoir operating elevation (878.2 ft NAVD88).

A. Project Background. The excavation being proposed is to restore generating capacity at the Diablo Powerhouse that has been lost due to aggradation of bedload materials originating from Stetattle Creek. These bedload materials have been deposited onto a cobble bar at the mouth of the creek which has grown over time and elevated the tailrace pool of Diablo Powerhouse. The level of the tailrace pool has been increasing since the 1960s, although the observed increases in elevation were greatest during the 2000s, and most evident following a 50-year peak flow event in the Skagit River basin that occurred on October 23, 2003. This major flow event triggered a large landslide along the west bank of Stetattle Creek about 0.4 miles upstream of the mouth of the stream (Figure 4). Large amounts of landslide materials were deposited into the stream following the 2003 peak flow event, and were subsequently mobilized by streamflows to the mouth of Stetattle Creek and onto the upper end of the cobble bar in Gorge Lake.

The resulting deposition of gravel-sized substrates at the mouth of Stetattle Creek, and cobble and boulder-sized bed materials on the upper area of the cobble bar have directly resulted in the loss of hydraulic head and generating capacity and the Diablo Powerhouse (see Figure 5). The increasing elevation of the tailrace pool has reduced the hydraulic head of the Diablo Powerhouse by about 2.4 ft since 1998 (Figure 6; SCL data). The greatest increase in tailwater elevations occurred between 2002 and 2008, a period when two major flood events (October 2003 and November 2006) occurred in the Skagit River basin.

Figure 4. Landslide located on west bank of Stetattle Creek about 0.5 miles upstream from mouth.

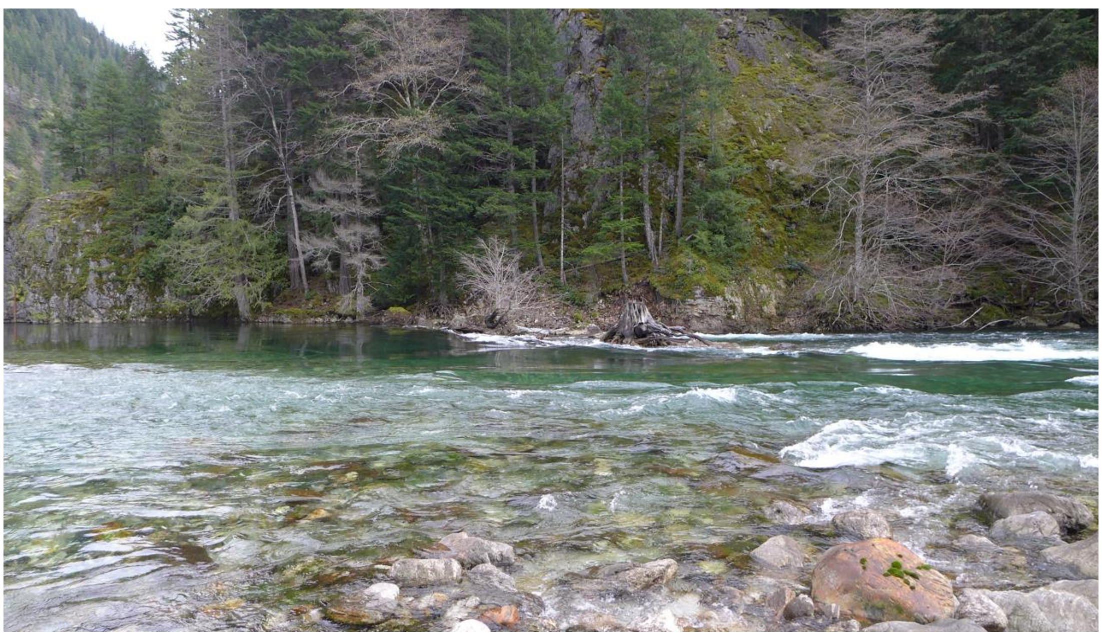

Figure 5. Hydraulic control for the Diablo Powerhouse tailrace pool at upper end of the cobble bar at outlet of Stetattle Creek. The tailwater of the Diablo tailrace pool has become elevated at this point by the deposition of bed materials from Stetattle Creek.

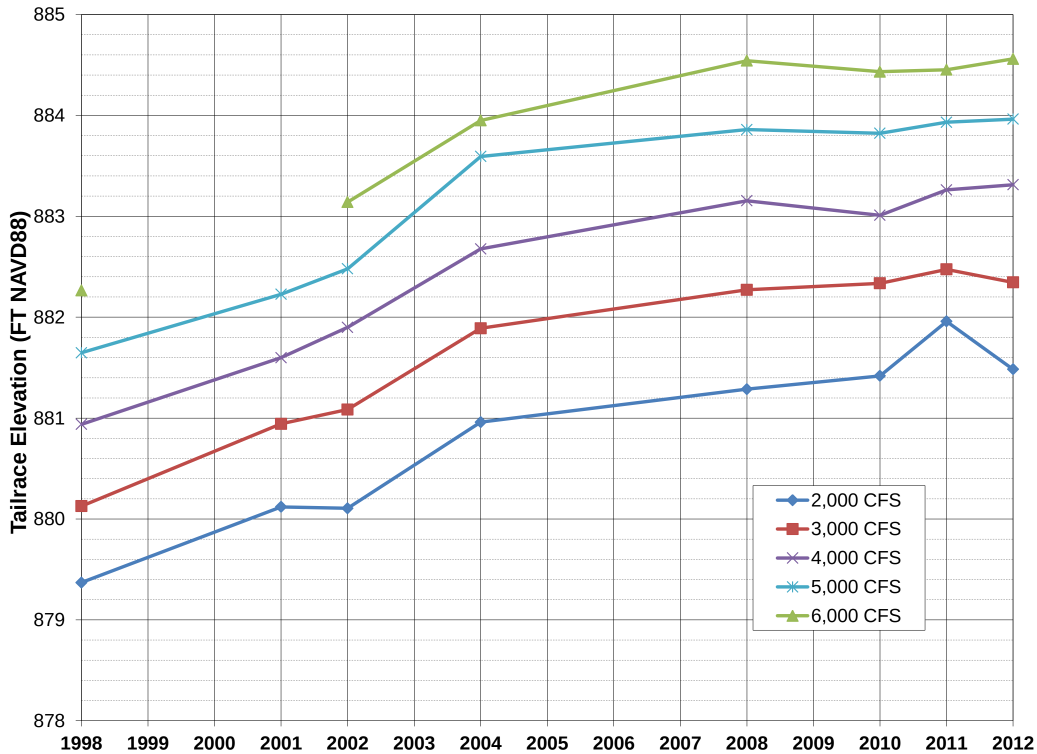

Figure 6. Increase in tailrace elevation of the Diablo Powerhouse from 1998 through 2012 for project flows ranging from 2,000 to 6,000 cfs.

Restoration of hydraulic head by the removal of the cobble bar would produce between \$4.8 million and \$9.6 million in additional power over the life of the project, depending on the price of power and based upon an estimated project design life between 49 and 98 years (R2 Resource Consultants 2013). The design life of the excavation project is dependent upon the delivery rate of bedload from Stetattle Creek into Gorge Reservoir, which has been estimated to vary between 200 and 400 CY annually. Bedload originating from Stetattle Creek is predicted to restore the cobble bar to its current size and elevation over a period of 49 years with a 400 CY annual bedload yield, and 98 years with a 200 CY bedload yield (R2 Resource Consultant 2013).

By using flushing flows periodically, it is expected that the design life of the excavation project could be extended. This would reduce the frequency and costs of future excavations needed to maintain hydraulic head and hydroelectric power generation capacity at the Diablo Powerhouse. Flows of 6,500 cfs, which are within the normal operating range of the project, were predicted to be effective in moving gravels up to 5-inches diameter downstream (R2 Resource Consultants 2012). Flows at the higher generating range of Diablo Powerhouse, as well as greater flushing flows created by controlled spilling at Diablo Dam, could be an effective way of preventing the accumulation of bed materials in the future. It is anticipated that the sheer velocities needed to move larger materials such as large cobbles and small boulders could be achieved by controlled releases of flows up to 30,000 cfs from Diablo Dam. These flushing flows would move bed materials that accumulate at the end of the tailrace pool and the mouth of Stetattle Creek further down the reservoir.

B. Proposed Construction. To restore the generating capacity of the Diablo Powerhouse to original levels occurring in the 1960s, SCL is proposing to excavate 18,300 CY of bed materials from a 1.5-acre cobble bar located at the north end of Gorge Lake that is situated immediately west of the mouth of Stetattle Creek. Excavation of the cobble bar would occur in four phases (Figure 7):

1. The construction equipment would be mobilized to the excavation project site, and the site would be prepared by installing erosion control and sediment prevention measures. Vegetation would be grubbed and several trees removed to construct an access ramp from the Gorge Lake Campground to the cobble bar. Initial excavation would then be completed on the highest areas of the cobble bar, with approximately 6,000 cubic yards of materials removed during this phase. The materials excavated from the cobble bar would be loaded into trucks, hauled 15.5 miles southwest on Washington State Route 20 (SR 20), and disposed at the Copper Creek Quarry disposal site.
2. Following site preparation and initial excavation, the elevation of Gorge Reservoir would be lowered and coffer dams installed along the northern edge of the cobble bar to isolate the excavation area from the mouth of Stetattle Creek, and along the eastern edge of the cobble bar to isolate the excavation area from the free-flowing section of Gorge Reservoir. After the coffer dams were installed, approximately 5,000 cubic yards of bed material would be excavated from the upper bench of the cobble bar.
3. Final excavation of the lower elevation sections of the cobble bar would be completed after determining that turbidity reduction measures were effective, and following the pumping of residual waters within the area isolated by the coffer dams. The final phase of excavation would result in the removal of approximately 8,500 cubic yards of bed material from the cobble bar**.**
4. Habitat mitigation structures, including large wood structures placed along the north bank of the reservoir and boulders placed at the outlet of Stetattle Creek, would be installed. The coffer dams and the access ramp to the excavation site would be removed. The northern bank of the reservoir (access ramp area) and existing eroding Gorge Campground bank would be re-vegetated with native hardwoods, conifers a and shrubs.

The four phases are described in more detail in Section IIIA.

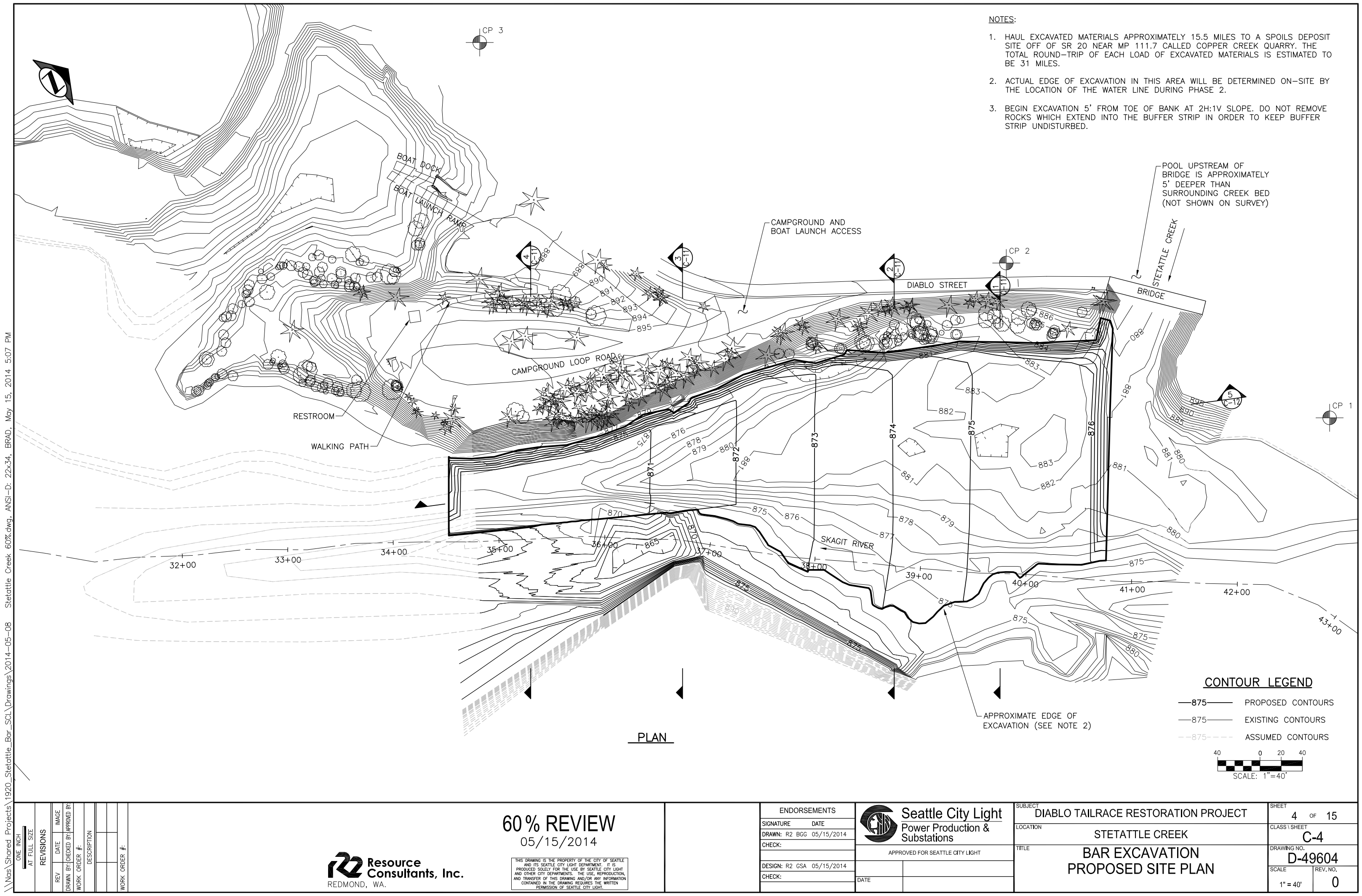

Figure 7. Drawing of proposed excavation plan for cobble bar.

C. Proposed Conservation Measures. Aquatic habitats within the project area that would be affected by the proposed project include:

1. The north end of Gorge Lake adjacent to the cobble bar, which would be directly impacted by the excavation, including an ephemeral side channel along the north side of the cobble bar, and the free-flowing section of the reservoir along the east side of the cobble bar**;**
2. The mouth of Stetattle Creek, between the bridge downstream to the confluence with Gorge Lake;
3. The section of Stetattle Creek above the bridge that may be impacted by head cutting of the stream following removal of the cobble bar;
4. The section of Gorge Lake immediately upstream of Stetattle Creek, which would be impacted by lower tailrace pool elevations and gravel bar mobilization following removal of the cobble bar; and
5. The area of Gorge Lake downstream of the excavation and disposal material loading site, which may be temporarily impacted by increased sediment deposition and turbidity caused by the project.

The proposed conservation measures are intended to achieve several objectives, including: 1) improve and maintain bull trout juvenile rearing habitats and adult foraging and migration habitats in the areas of Gorge Lake and the mouth of Stetattle Creek impacted by the excavation project; 2) on-site mitigation for temporary increases in sediment deposition and turbidity levels that may occur in the reservoir during the proposed excavation activities; and 3) on-site mitigation for potential head cutting that may occur in Stetattle Creek upstream of the bridge.

The proposed conservation measures include eight natural root wad structures along the north edge cobble bar site and large boulders placed at the centerline of the Stetattle Creek channel below the bridge (Figure 8). The conservation measures are described in detail as follows:

1. ***Install eight natural root-wad structures along the northern bank of Gorge Lake immediately west of Stetattle Creek***. The first of the root-wad structures would be placed in the transition zone between the Stetattle Creek and the backwater area of Gorge Reservoir, and would be situated immediately west of the bridge. The remaining seven structures would be equally spaced along the bank for a distance of 175 ft downstream of Stetattle Creek. The structures would be installed in the bank using the ballast and burial method (Craemer 2012). The log end of the structure would be placed at least 10 ft into a trench cut into the bank, and the root wad end would extend 10 ft out into the current and perpendicular to the bank (see Figure 9 for conceptual diagram of large wood structure). Large cobbles and boulders stockpiled during excavation of the cobble bar would be placed on top of the log in the trench for ballast up to the surface grade of the bank. These natural wood structures would create a low velocity

zone along the bank with highly complex habitat cover that is highly suitable for juvenile bull. The large wood structures would provide on-site mitigation for juvenile bull trout rearing habitat that would be impacted by the cobble bar excavation project, including rearing habitat located in the mouth of Stetattle Creek that would be replaced by riverine riffle habitat. The large wood structures would provide abundant habitat cover for juvenile rearing, adult foraging, and pre-spawning staging in the coldwater mixing zone that would occur downstream of Stetattle Creek following removal of the cobble bar.

2. ***Install a series of large boulders to form and maintain a relatively deep channel in the outflow area of Stetattle Creek downstream of bridge.*** These boulder structures would serve two purposes. First, they would be used to form a "training" channel and thalweg in the zone where the stream enters the reservoir backwater downstream. Once the cobble bar is removed, a gravel fan is expected to form immediately downstream of the bridge in the area where the mouth of Stetattle Creek meets the reservoir pool. The proposed boulder placement would provide the large roughness elements needed to maintain a channel and convey sediments from Stetattle Creek through this depositional fan zone. Second, the large boulders would improve juvenile rearing and spawning migration staging habitat at the mouth of the stream. The boulders would also produce deep "pocket" water through the gravel fan, which would provide highly suitable velocity cover and holding habitat for juvenile bull trout and migrating spawners.

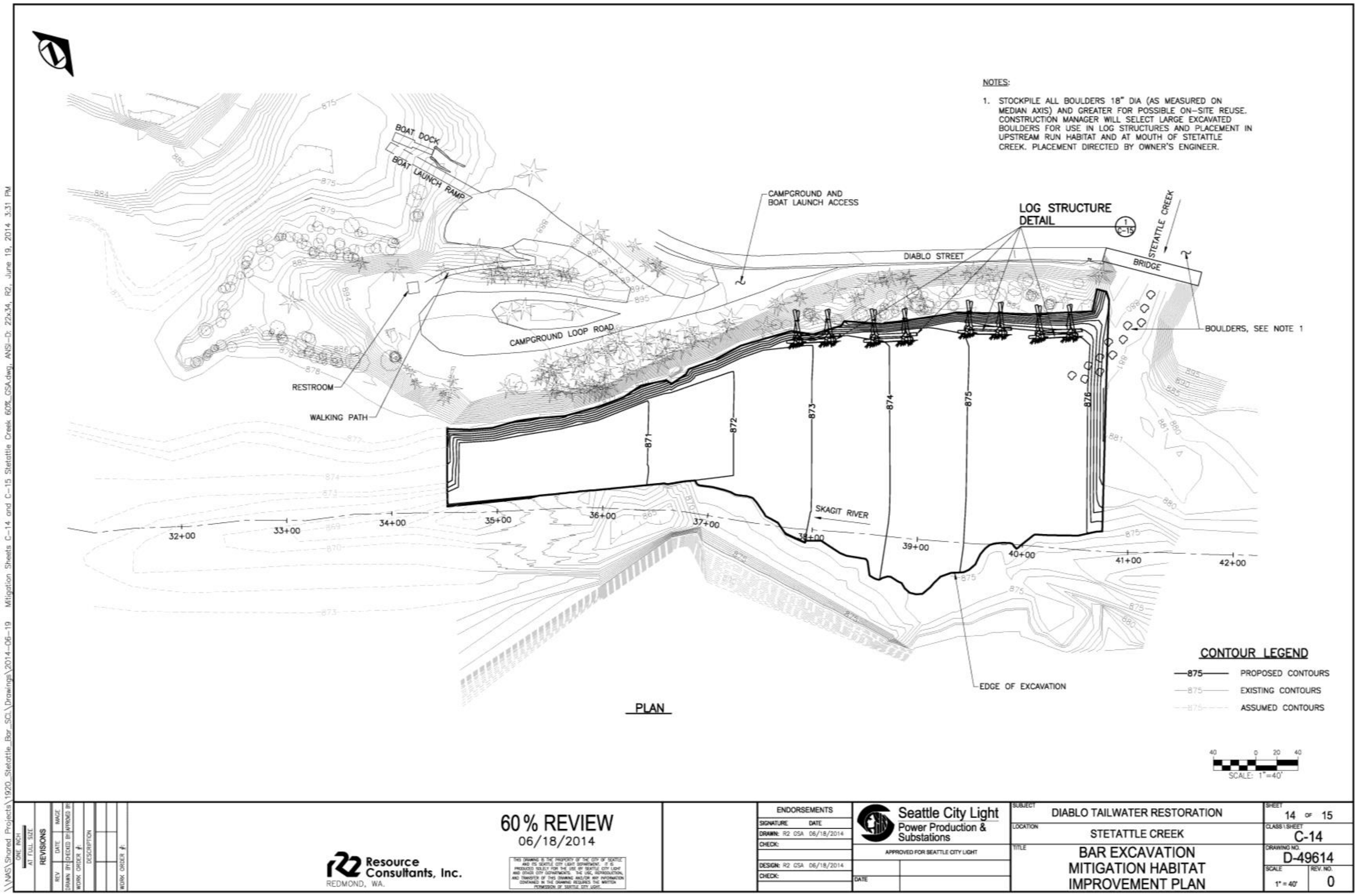

Figure 8. Drawing of post-project conditions at excavation site with proposed habitat mitigation measures.

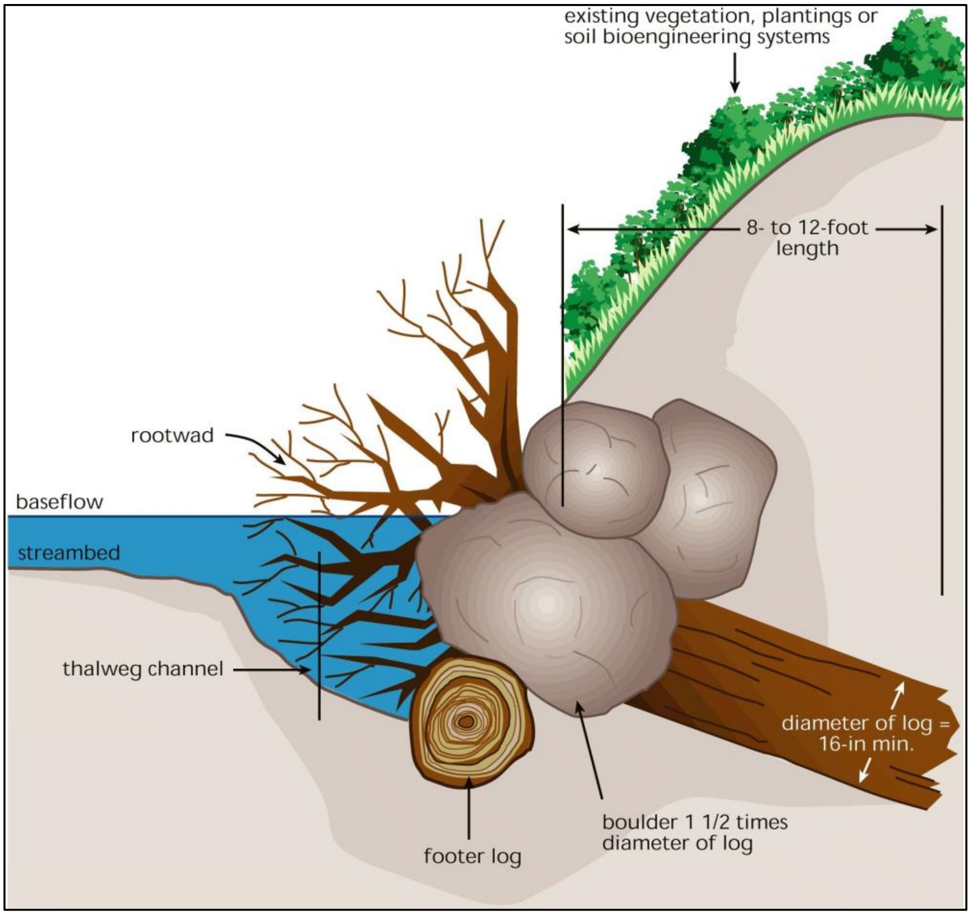

Figure 9. Conceptual diagram of large wood structure placed with large rock ballast (source: Federal Stream Restoration Interagency Work Group 1998).

III. Construction Methods and Materials: Construction methods are described below for each phase. Equipment and Best Management Practices (BMPs) for the entire project follow in Sections IV and V.

Isolation of the cobble bar excavation site is required for erosion and sediment control, and to protect equipment and personnel from river flow. Erosion and sediment control measures are required so turbidity levels do not exceed the limits established under project permitting. For river and stream construction projects, dewatering the site with bypassing flow, or creating a water tight coffer dam perimeter, is the ideal way to isolate a site and provide erosion and sediment control for construction. However, it is not feasible to completely dewater the excavation site during construction period due to inflows of water from Stetattle Creek, and inflows (albeit substantially reduced from normal operating conditions) from the Diablo Powerhouse. Bypassing the flows from Stetattle Creek and the Diablo Powerhouse is not feasible due the volume of water involved, and due to the presence of existing structures and facilities in the town of Diablo.

Because the site cannot feasibly be dewatered, a partial isolation coffer dam in combination with operational coordination is the site isolation method proposed. The excavation would be conducted in a stepwise sequence in close coordination with City Light operations at the Diablo and Gorge power facilities. Gorge Lake pool elevations would be kept low enough during the construction period to eliminate the backwater conditions normally present at the excavation site during the working period. In addition to drawing down Gorge Lake, flows released into Gorge Lake from the Diablo Powerhouse would be managed to maintain water surface elevations low enough to allow for coffer dam placement, and for excavation of the lower areas of the cobble bar.

The construction sequence would involve four phases, which are detailed as follows:

A. **Phase 1 – Mobilization, Site Preparation and Initial Excavation.** Phase I of the construction project would result in the excavation of approximately 6,000 cubic yards of bed materials from the cobble bar. This phase of the project would take approximately two weeks to complete. This phase includes the following steps:

1. Wait for Stetattle Creek flows to drop down to approximately 200 cfs for the summer season, typically the latter part of July.
2. Draw down Gorge Reservoir to elevation 871.15 ft. (NAVD88) and maintain this pool elevation for the duration of the proposed project.
3. Maintain flow from Diablo Powerhouse at an average daily flow of 2,500 cfs.
4. Remove vegetation, clear and grub bank at access ramp location. Six relatively small Douglas firs (<13 inches dbh) would be removed to construct the temporary access ramp.
5. Move an excavator down the bank to the cobble bar.
6. Build access ramp out of suitably-sized material to support use by heavy construction equipment.
7. Construction equipment, such as large excavators, a dozer, and compactor would be used to create a temporary access ramp to move to and from the bar. The method for bypassing Stetattle Creek flows and constructing coffer dams around the excavation area will be determined during the final design and permitting phase of the project. Fill super sacks with excavated materials and form a coffer dam to divert Stetattle Creek flow around the work area. Widths and heights of the coffer dam would vary from three-feet wide and three-feet wide (single tier) to nine-feet high and nine-feet wide (as shown below), depending on flows and velocities. Super sacks would be filled, moved, and placed with an excavator. Coffer dam construction and excavation would be phased as needed to maintain instream flows in the Skagit River below the Gorge Dam as required by SCLs FERC license and settlement agreements.

8. Appropriate erosion control and construction best management practices (BMPs) will be installed and maintained at the Gorge Campground Staging area to control dust and erosion.
9. Excavate about 6,000 CY of bar material working backward from the water level toward the interior portion of the bar to a level just above the water level and stockpile excavated materials near the access ramp.
10. Back dump trucks down the access ramp and use excavator(s) to load trucks.
11. Release sufficient flow to draw down Diablo Reservoir and Ross Lake levels as necessary to allow at least 20 hrs with no flow from the Diablo Powerhouse for Phase 2 coffer dam placement. Final coffer dam design will be developed during permitting phase of the project.

B. Phase 2 – Excavate Cobble Bar Bench and Place Coffer Dam to Isolate Site. The total volume of bed material to be excavated during Phase 2 of the construction project is estimated to be 5,000 cubic yards. This phase of the project would take approximately one week to complete. This phase of construction involves the following steps:

1. Shut down flows from the Diablo Powerhouse as necessary to allow for placement of remaining coffer dam needed to isolate the work area. Flows can be totally shut down for up to a maximum of about 36 hours for a wet year before they would need to be resumed.

2. Place two- and three-tiered coffer dams along the remainder of the excavation site as needed to isolate the work area from design flows. In addition to being chained together over the tops of the coffer dams as shown in Figure 10, steel plates would be overlapped a minimum of 1 foot with the upstream plate over the downstream plate, and chained together to prevent scour underneath the coffer dams.

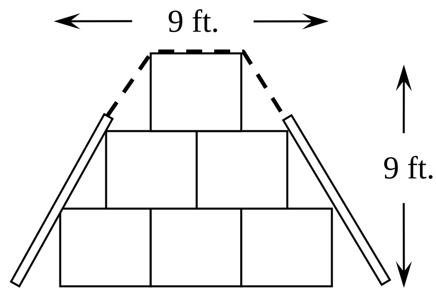

Figure 10. Typical cross section of a 3-tiered super sack coffer dam with 8-ft. x 10-ft. steel plates on sides that are chained together over the top.

3. Use multiple excavators with up to 3 CY buckets to excavate the bar working from the water's edge back towards the middle of the bar to minimize potential resuspension of fines and increases in turbidity.
4. Stockpile material towards the middle of the bar in the vicinity of the access ramp, load dump trucks and haul excavated materials about 15.5 miles to the Copper Creek Quarry disposal site. The approximately 31 mile round trip is expected to take a truck about 50 minutes.
5. Resume Diablo Powerhouse flow up to the flow calculated to be safe for installed coffer dams (assumed to be 2,700 cfs).

C. **Phase 3 – Remaining Excavation and Mitigation.** The third phase of construction would result in the removal of remaining bed materials on the cobble bar down to the target excavation elevation (873 ft NAVD88 at lower end of cobble bar to 876 ft NAVD88 at upper end of cobble bar). The estimated volume of bed materials to be removed during this phase is 8,500 cubic ft. This phase of the project would take approximately three weeks to complete.

1. Excavate remaining cobble bar material starting at downstream end of excavation area and working back upstream.
2. Continue work in the upstream direction up to the access ramp so equipment can always stay on dry ground.
3. Leave a pad at the end of the access ramp so trucks have a place to get loaded.
4. Continue working upstream of the access ramp by starting at the upstream end and working back down to the access ramp so that at the end the access ramp is the only remaining material to excavate.

5. Install eight large wood structures along the north bank of the reservoir between Stetattle Creek Bridge and Gorge Campground. Install large boulders along thalweg of recontoured Stetattle Creek outlet channel below the bridge. NPS to complete Gorge Campground bank restoration.
6. Remove the access ramp.

D. Phase 4 – Remove Coffer Dams. After the area within the coffer dams has been excavated, it would fill up with water. The final phase of the construction project would involve the following steps, and would require approximately one week to complete:

1. Remove coffer dams using either a land-based crane or a crane mounted on a small barge or boat.
2. Work from downstream to upstream.
3. Use land-based crane staged near the west end of the Stetattle Creek Bridge to remove the super sacks and steel plates from the barge and final super sacks. Equipment to be used and staging locations for this equipment will be determined during the final design and permitting phase.
4. Apply compost and topsoils as required to excavated bank of reservoir, and to former access ramp area, for re-establishment of native riparian vegetation. Replant these areas with hardwood and conifer seedlings.

IV. Equipment and Materials. The following or similar equipment would be used for the proposed excavation project:

1. Several 10 CY or larger Dump Trucks.
2. Several Cat 336EL Excavators.
3. 1 or more Cat D-6 Dozer
4. 1 or more Cat 938H Wheel Loader.

V. Best Management Practices (BMPs): A number of BMPs would be implemented to reduce project impacts on the environment. These BMPs are identified as follows for each phase of the construction project.

A. Phase 1 – Mobilization, Site Preparation and Initial Excavation. BMPs for the mobilization, site preparation, and initial excavation tasks are designed to reduce the risk of spills from heavy equipment, and minimize the noise and potential turbidity impacts from clearing and initial excavation.

1. Delineation of Staging Area and Excavation Area. Flagging and/or construction fencing would be used to clearly delineate the equipment staging and excavation areas. The purpose of delineating these areas is to protect vegetation in adjacent locations from being damaged by project activities. Trees that have been identified for removal would be flagged by an SCL ecologist and/or a NPS botanist.

3. Spills and Containment
   - A spill prevention and containment plan would be developed and implemented by the contractor. Spill clean-up kits would be kept onsite at all times.

4. Turbidity
   - A Temporary Erosion and Sedimentation Control (TESC) Plan or turbidity management plan would be developed and implemented to maintain turbidity levels in the reservoir 300 feet downstream of the excavation site below Ecology's water quality criteria for aquatic life in fresh water, which is 5 NTU above natural background levels for native char spawning and rearing areas (WDOE 2011).
   - Sediments, sediment-laden water, chemicals, or any other toxic or deleterious materials would be prevented from entering or leaching into the lake during equipment mobilization/demobilization, staging, and excavation.
   - Silt fencing or other appropriate erosion control and construction BMPs would be used to minimize potential sediment delivery from the equipment staging area located at the Gorge Lake Campground and tree removal areas along the right bank of the reservoir.
   - Coffer dams would be installed along the waterline of the cobble bar excavation area to minimize turbidity caused by excavation.
   - Turbidity would be monitored in accordance with the Department of Ecology Construction Stormwater General Permit required for the project. Other source control and/or conveyance and BMPs would be used as necessary to control turbidity levels in the reservoir and the Skagit River downstream of the excavation area.

B. BMPs for All Phases. BMPs that will apply to all phases include the following.

1. Trucks and Equipment Operating on the Shoreline
   - All equipment used for the project will be staged above full pool in the equipment staging area at the Gorge Lake Campground.

- Equipment and vehicles would be well inspected daily and maintained in good repair to prevent petroleum products or hydraulic fluid from entering the lake.
- Measures to reduce or control environmental health hazards would include compliance with regulations for handling fuels.
- Equipment would be kept free of external petroleum-based products.
- All diesel and gasoline-powered vehicles and equipment would be checked regularly to ensure they are in proper working condition and do not leak. Any necessary repairs would be made off-site.
- A Spill Prevention, Control, and Countermeasures Plan would be implemented as needed. Spill containment materials and cleanup kits would be present onsite at all times.
- Containment booms would be available for immediate response in case a spill occurs and the material enters the water.
- Equipment and vehicles would be refueled in designated upland staging areas or off-site and would not occur in areas below the OHWM.
- Vehicles and equipment used for construction activities would be cleaned and washed off-site; no washwater or deleterious material would be allowed to enter the reservoir.
- Vehicle engines would be turned off when not in use instead of allowing them to idle.
- If possible, antifreeze in radiators would be replaced with a non-toxic alternative.

2. Turbidity
   - TESC plans for all phases will be developed when final designs for these phases are complete and implemented during construction.

     Work below the OHWM would be done in the dry, when the reservoir is drawn down, Stetattle Creek flow is diverted around the excavation area and coffer dams are used to isolate the excavation area and minimize turbidity generation.

3. Weed Control
   - All construction equipment and all vehicles used on the site would be washed and free of imported soil and plant materials prior to their first use at the excavation site.

- Any imported topsoil, compost, or blended materials used in streambank or disposal area restoration activities shall be certified to be weed-free by the supplier.
- Existing weed infestations at the Cooper Creek Quarry disposal site would be either mechanically removed or chemically treated before placement of excavated materials begins to avoid transporting seeds and plant parts along the highway and to the dump truck loading area at the excavation site.

VI. ***Action Area*****:** For biological resources associated with the site, the area potentially affected directly and indirectly by the project is estimated as follows:

A. Aquatic species: The construction project would result in the removal of a 1.5- acre cobble bar that is located along the northern bank of Gorge Lake immediately downstream of the confluence of the reservoir with Stetattle Creek. Excavation of the cobble bar would directly affect aquatic habitats adjacent to the construction area, including the free-flowing section of the reservoir adjacent to the cobble bar, a side channel that flows on an intermittent basis on the north side of the cobble bar, and the mouth of Stetattle Creek from the Skagit River confluence upstream to Stetattle Creek Bridge. The action area also includes aquatic habitats in Gorge Lake upstream of the cobble bar, since water surface elevations of the tailrace pool and the upper reservoir would be lowered by up to 2.6 ft following the removal of the cobble bar (R2 Resource Consultants 2013). The reservoir downstream of excavation site to Gorge Dam is also included in the action area since aquatic habitats in this area would be potentially affected by turbidity during construction. Because of potential downcutting of the Stettatle Creek channel resulting from the proposed excavation, the action area also includes the stream from the bridge up to a deep pool located 1,470 ft. upstream of the bridge. This pool is located within a narrow bedrock canyon section of the stream, and it is unlikely that potential head cutting would occur upstream of this point (pers. comm., Mary Raines, geomorphologist, Nov. 2013).

B. Terrestrial species: The action area for terrestrial species includes the 1.5-acre cobble bar in Gorge Lake that would be excavated; the adjacent bank of Gorge Lake which would be temporarily impacted by the project; the Gorge Lake Campground access road; the area bounding State Route 20 along which disposal materials would be hauled; and the Copper Creek Quarry disposal site.

The cobble bar is triangular in shape and is sparsely vegetated by early pioneer vegetation, including red alder and willow saplings and seedlings and forbs. Most of the vegetation cover occurs in the middle third of the bar. The bar is bounded by Gorge Lake to the south and west, and Stetattle Creek on the east side. The north side of the cobble bar is bordered by a side channel that flows on an intermittent basis along a steep bank of fill material and riprap that extends up to Diablo Road and

Gorge Lake Campground. This bank is dominated by Douglas-fir along the campground and by red alders along Diablo Road. Most of the deciduous trees along the bank are less than 10 inches dbh. The Copper Creek disposal site has an area of approximately 1.5 acres, and is situated 140 ft. away from the north bank of the Skagit River. This site has been scraped bare of vegetation in some places; other areas support a mixture of pioneer species, including red alder seedlings and saplings, native shrubs, and a mix of non-native and invasive forbs and grasses typical of disturbed sites.

The action area for terrestrial species also includes on the area affected by project-generated noise above ambient levels. The distance of noise attenuation to ambient levels was calculated using the following assumptions:

- NPS measured a background noise level of 46 decibels A-weighted (dBA) for Newhalem in the vicinity of Gorge Powerhouse. Like the project site, noise sources in this area include the nearby powerhouse, traffic from SR 20, and flowing water. 46 dBA is used as the ambient noise level for this analysis.

- Major work elements in the project area would include installation and removal of coffer dams, excavation of cobble bar material, hauling via dump trucks and grading activities at the disposal site; it would require a variety of construction equipment and vehicles (Table 1). The sound levels for individual equipment range from 76 to 82 dBA at 50 ft (Table 1). However, several pieces of equipment are likely to be in use at a single time, resulting in additive effects. 85 dBA would be the assumed noise level 50 ft from the work area at the excavation site, 81 dBA would be the combined noise level at the disposal site. Traffic noise is assumed to be 63 dBA.

- Topography and vegetation serve to dampen noise levels more than flat, hard surfaces such as concrete, rock, and water. While the project site itself consists of bare rock, the surface area of adjacent water is small and most of the surrounding area is forested and steeply sloped. These features are expected to provide a dampening effect of 7.5 dB per doubling distance from the noise source (WSDOT 2011). Using this dampening factor, noise at the excavation area would attenuate to the ambient level (46 dBA) at 4,456 ft from the excavation area; construction noise at the disposal site will be somewhat less and would attenuate at 2,812 ft while the highway noise created by the dump truck traffic would extend 2,339 ft from SR20 (Figure 11).

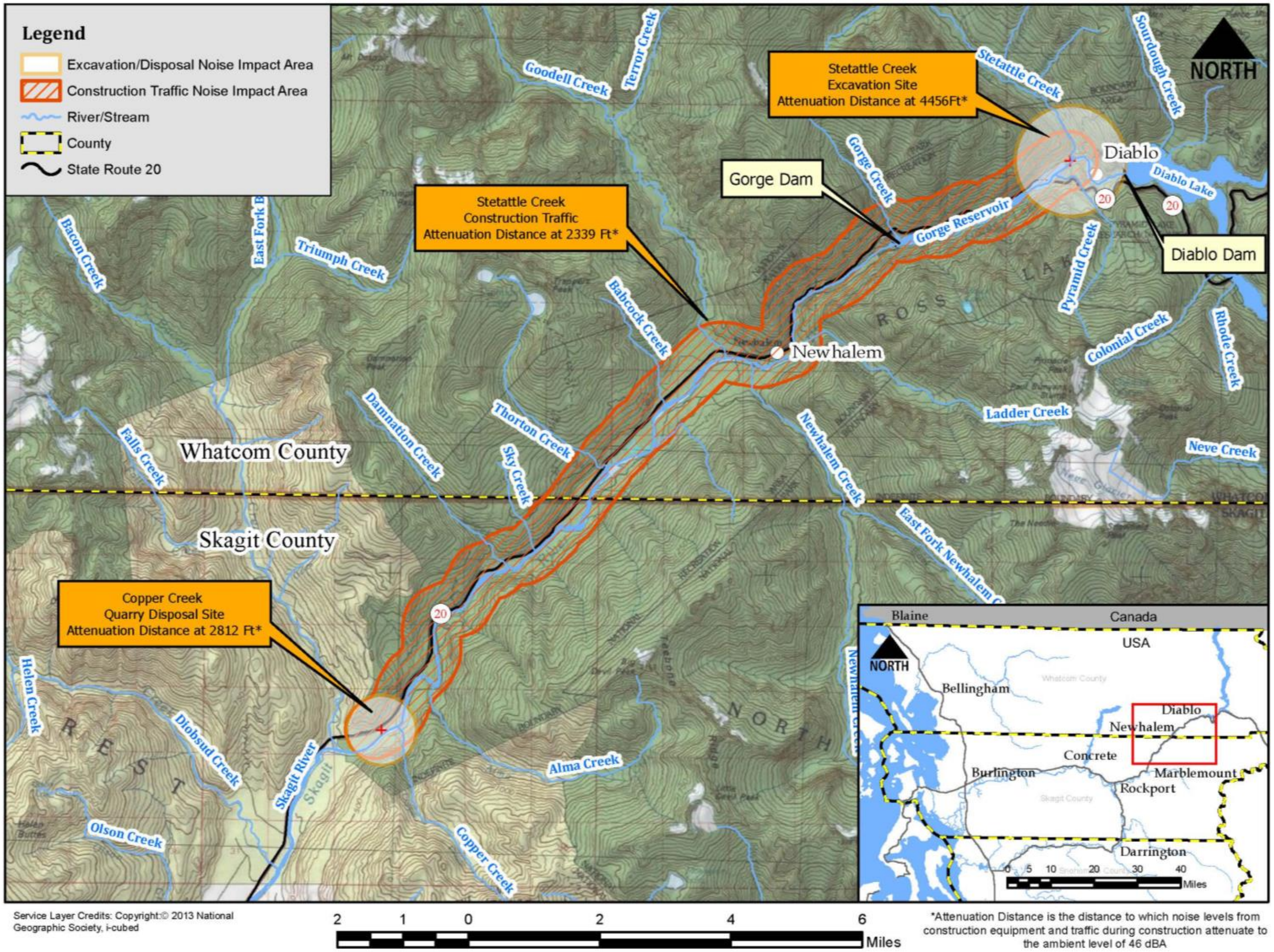

Figure 11. Action Area for terrestrial wildlife species based on noise attenuation.

Table 1. Project noise attenuation distances.

Construction Activity/Location	Equipment	Lmax (dBA) @ 50 ft[2] (specifications with actual measured levels in parentheses)	Total Lmax (dBA) at 50 ft[3]	Ambient Level (dBA)[5]	Attenuation Distance (in feet)[4]
Excavation Area	Cat 730 Articulating Dump Trucks[6]	76	85	46	4,456
	Cat 336EL Excavators	81			
	Cat D-6 Dozer	82			
	Cat 938H Wheel Loader	79			
Disposal Site	Dump Trucks	76	81	46	2,812
	Cat D-6 Dozer	82			
	Backhoe	78			
Construction Traffic[1]	N/A	63	63	46	2,339

Notes:

1. Construction traffic represents the traffic along SR-20 in Newhalem during the peak season (July) plus construction truck trips anticipated between Diablo and disposal site. The construction traffic noise levels represent the worst-hour noise level (i.e. the hour during which the noise level is anticipated to be highest).
2. Lmax (dBA) values for all pieces of equipment from Table 7-4 of WSDOT's Biological Assessment Preparation Advanced Training Manual
3. The total Lmax (dBA) represents the total noise level from the 3 loudest pieces of equipment, per WSDOT's BA Assessment Preparation Manual.
4. Attenuation Distance is the distance to which noise levels from construction equipment and traffic during construction attenuate to the ambient level of 46 dBA. The equation used to calculate the attenuation distance to ambient levels (pgs. 7.22-7.23 of WSDOT's BA Assessment Prep Manual):

   D=Do*10^((Construction Noise Level-Ambient Sound Level)/alpha), where D=distance from noise source (in feet)

   Do=reference measurement distance (50 feet) for source, alpha=20 for hard ground for point sources; 10 for hard ground for line sources (i.e. traffic along SR-20 hauling muck back and forth to disposal site
5. The ambient level was determined based on measurements conducted behind the Gorge Powerhouse by the NPS Natural Sounds Program. North Cascades National Park Service Complex Acoustic Monitoring Newhalem, 2009.
6. Articulating dump trucks were modeled and are larger and louder than those likely to be used for this project (e.g., 10 CY dump trucks). Articulating trucks cannot be used on the SR 20.

V. ***Endangered Species Act (ESA) Protected Species and Critical Habitat.*** Gorge Reservoir, also known as Gorge Lake, is part of the Skagit River Hydroelectric Project, which is operated under a license issued by the FERC in 1995. The Project is located in the upper Skagit River basin. The Skagit River, which originates in Canada, is the third largest in Washington and drains an area of 3,100 square miles. The Skagit River and its tributaries drain mountain areas from east to west, entering the United States from British Columbia at river mile (RM) 127 and flowing a total of 162 river miles from the headwaters in Canada to the Puget Sound near Mount Vernon, Washington. The basin is characterized by rugged mountain topography in the central and eastern parts, and by broad floodplains and rolling uplands in the western part. Gorge Lake has a drainage area of 1,125 square miles and is surrounded by very steep mountains over 6,000 ft elevation.

The license for the Skagit Hydroelectric Project was issued by FERC in 1995, which precedes the 1999 listing of bull trout (*Salvelinus confluentus*) as a threatened species under the federal Endangered Species Act (ESA). In 2012, Seattle City Light completed a Biological Evaluation that was trigged by a major amendment to the FERC license that included as actions the proposed construction of a second power tunnel for the Gorge Development and instream flow management improvements for salmon and steelhead in the Skagit River downstream of the Skagit Hydroelectric Project. This BE was completed under the authorization of FERC for a Section 7 Consultation with the U.S. Fish and Wildlife Service (USFWS) for this license amendment. Because this was the first Section 7 Consultation for the Skagit Hydroelectric Project since the listing of bull trout under the ESA in 1999, the Consultation covered all existing facilities and ongoing operations of the hydroelectric project. On February 3, 2013, the USFWS issued a Biological Opinion (BO) and Incidental Take Statement (ITS) that provide coverage for the proposed actions, and for the continuing operations of the Skagit Hydroelectric Project including the Gorge, Diablo, and Ross powerhouses and reservoirs. Much of the information on the status of federally listed bull trout, and the Critical Fish Habitat for this species in the project area is available in the Biological Evaluation (SCL 2011) and Biological Evaluation Supplement (SCL 2012), and in the BO and ITS (USFWS 2013) for the Skagit Hydroelectric Project.

There are no extant ESA-protected plant species known or suspected to occur at or near the project site. There are, however, eight ESA-listed fish and wildlife species known to occur in the North Cascades Ecosystem and potentially found within the Skagit Hydroelectric Project (Skagit Project) area. These include two bird, three mammal, and three fish species: marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis caurina*), gray wolf (*Canus lupus*), grizzly bear (*Ursus arctos horribilis*), Canada lynx (*Lynx canadensis*), and bull trout (*Salveninus confluentus*), Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), and steelhead (*O. mykiss*).

Puget Sound Chinook salmon and steelhead are found in the Skagit River downstream of the Gorge Powerhouse. Neither of these species occurs in Gorge Reservoir, as upstream migration was blocked by natural barriers located above the Gorge Powerhouse prior to the construction of the Skagit dams, as well as by Gorge and Diablo dams under current conditions. A recent baseline genetic analysis of *O. mykiss* populations in the Skagit River basin by WDFW's genetics lab (Kassler 2013) found that rainbow trout present in the Skagit Hydroelectric Project reservoirs (including Gorge Lake) are a native resident population, and are genetically distinct from Skagit River steelhead. Since Chinook and steelhead do not occur in the action area for aquatic species, they are not included in this biological evaluation.

Gorge Lake does not provide Critical Habitat for salmon or steelhead. For the Skagit River, the upstream limit for the Critical Habitat designation for Puget Sound Chinook salmon (70 FR 52630), and the proposed designation for Puget Sound steelhead (78 FR 2725), is 0.5 miles upstream of the town of Newhalem (i.e., 2 miles downstream of Gorge dam and reservoir), which is the upper historical limit for the distribution for salmon and steelhead (Smith and Anderson 1921) prior to the construction of the Skagit Hydroelectric Project.

Because Gorge Lake is above the upstream limit of salmon and steelhead migration, it is not designated as Essential Fish Habitat under the Magnuson-Stevens Act.

Habitat requirements for the six species addressed in this BA and project effect determinations are provided in the following sections.

A. Marbled Murrelet

Status: Federal Threatened, State Threatened

The marbled murrelet is a small seabird that nests in forest habitats and forages in coastal waters. The species was federally listed as threatened in 1992 due to loss of breeding habitat and mortality associated with gill net fishing and oil spills (57 FR 45328-45337). Critical habitat was designated in 1996 (61 FR 26255-26320) and the recovery plan was finalized in 1997 (USFWS 1997). The marbled murrelet ranges from Alaska to the central California coast and populations have declined throughout this area over the last 30 years (http://www.natureserve.org/explorer/servlet/NatureServe). At-sea breeding population estimates for marbled murrelets in Puget Sound and the Strait of San Juan de Fuca have fluctuated in the years 2000 through 2008, with no discernable increasing or decreasing trend; however, additional years of data are needed before a population change can be detected with high confidence (Lance et al. 2009). Recent data on nest success and adult:juvenile ratios at sea continue to confirm that murrelet reproduction in Washington, Oregon, and California is too low to sustain populations (USFWS 2009).

The distance inland that marbled murrelets breed is variable and is influenced by a number of factors, including the availability of suitable habitat, climate, and topography; predation rates; and maximum forage range (McShane et al. 2004). In

Washington the primary range is considered to extend 40 miles inland, but occupied habitat has been documented 52 miles from the coast (Hamer 1995; Madsen et al. 1999) and the species has been detected up to 70 miles inland. Marbled murrelets typically nest in old growth forests and select large, old trees with branches that support mats of epiphytes (McShane et al. 2004). The nesting in Washington occurs over an extended period from late April through late August (McShane et. al. 2004). Incubation lasts about 30 days and chick rearing takes another 28 days.

Determination of Effects

The excavation site near Stetattle Creek is about 60 miles straight-line distance from Puget Sound and is considerably outside of the primary marbled murrelet breeding range in Washington. However, the disposal site and a portion of the hauling route are within the breeding range. The disposal site lacks large conifers and thus does not represent potential murrelet nesting habitat. While no documented nesting has been recorded in the immediate area, marbled murrelets have been observed flying near potentially suitable nesting habitat in the Bacon Creek and Thornton Creek drainages more than 2 miles outside the Action Area, (Hamer Environmental, L.P. 2009). The nearest designated critical habitat is about 10 miles from the disposal site. Based on this information, the proposed project would have ***"no effect***" on marbled murrelets.

B. Northern Spotted Owl

Status: Federal Threatened, State Endangered

The northern spotted owl was federally listed as threatened in June 1990 (65 FR 5298-5300), with a final recovery plan for the species published in May 2008 (USFWS 2008a) and a revised recovery plan released in June 2011 (USFWS 2011). The four recovery criteria in the plan are: stable population trends throughout its range; adequate population distribution among defined recovery units; continued maintenance and recruitment of spotted owl habitat; and post-delisting monitoring (USFWS 2011). In Washington, populations of spotted owls are thought to have declined precipitously since 1990; however, the current number of occupied territories is unknown because not all areas have been or can be surveyed annually (USFWS 2011).

In the state of Washington, spotted owls typically nest in older, multi-layered forests at elevations from near sea level to 4,000 ft in the North Cascades. Spotted owl nesting and roosting habitat is characterized by a moderate to high canopy closure (60 to 90 percent); a multi-layered, multi-species canopy with large overstory trees (>30 inches dbh); a high incidence of large trees with large cavities, broken tops, mistletoe infections, and other evidence of decadence) large snags; large accumulations of downed trees and other woody debris; and sufficient open space below the canopy for flight (USFWS 2008a). Northern spotted owls typically lay eggs in late March or

April. After the incubation and brooding period, the young typically start flying nearby between May and June, and parental care continues into September (USFWS 2008a).

The northern spotted owl is considered an uncommon resident in the North Cascades National Park Complex (NOCA), which includes the action area. Most previously known territories west of the Cascade crest are now occupied by barred owls (*Strix varia*). Based on surveys conducted by the NPS, the nearest known spotted owl nest site is located in the Newhalem Creek drainage, more than 3 miles to the southwest of the excavation area. This site was active in 2009 but no spotted owls were detected in 2010, the most recent survey year (pers. comm., R. Kuntz, Wildlife Biologist, North Cascades National Park, 2011). There is one spotted owl activity area (2.7-mile radius circles around an activity site) that overlaps the excavation area. That activity center was located about 0.5 miles upstream along Stetattle Creek. There are two other activity areas that overlap portions of the haul route. There are no records in the last 15 years of spotted owl activity within the vicinity of the town of Diablo, (pers. comm., R. Kuntz, Wildlife Biologist, North Cascades National Park, 2011) which is adjacent to the proposed excavation area. The closest designated critical habitat areas are about 10 miles east of the excavation area in the upper portions of Ruby Creek and about 10 miles southwest of the disposal site.

Determination of Effects

No suitable spotted owl nesting, foraging, or dispersal habitat would be affected by the project. Approximately 70 trees located on the riverbank near the mouth of Stetattle Creek would be removed. As the project would occur during a 7-week period in July-September, it would overlap the latter portion of the March 1 - August 31 nesting and nestling development period. Previous studies have used thresholds of 57 dBA and 70 dBA as noise levels that potentially result in “alert” and “disturbance” behaviors of spotted owls, respectively (WSDOT 2011). Using these values, “alert” response could occur if owls are within 1,256 ft of the excavation site, while injury could occur if owls are within 281 ft. Due to the high level of development in Diablo and lack of mature conifer trees in the surrounding area, there is very low probability of spotted owls occurring within these distances during the project activities.

The dump truck traffic would cause increased noise along SR20 up to 2,339 ft on each side of the road. Because this highway is a commonly used route to eastern Washington and beyond and has regular loud truck and motorcycle traffic during the summer and fall, this noise would not likely affect spotted owls.

Due to the slight chance of owls being present in the Action Area, the project “***may affect, but is not likely to adversely affect”*** the northern spotted owl.

B. Gray Wolf

Status: Federal Endangered, State Endangered

The gray wolf was listed as an endangered species in all states except Minnesota and Alaska in 1978 (43 FR 9607-9615). No population recovery goals were developed for wolves in the North Cascades or Washington State in the recovery plan and no critical gray wolf habitat was designated in Washington (USFWS 1987). The species was delisted in the eastern one-third of Washington in March 2011 but remains federally protected in the western two-thirds of the state.

Wolves are carnivorous and typically prey on large ungulates; however, they will also feed on fish, carrion, small mammals, rabbits, and birds. Wolves may travel as far as 43 miles within a 24 hour period to hunt and range over greater distances during dispersal. Key components of wolf habitat are: 1) sufficient, year-round prey base of ungulates and alternative prey; 2) suitable denning and rendezvous sites; and 3) adequate space with minimal exposure to humans (USFWS 1987).

With the exception of the reservoirs and developed portions of the Skagit Hydroelectric Project, there is abundant habitat suitable for denning and rendezvous sites for the gray wolf in the North Cascades, as well as large areas that are isolated from humans. It is possible, however, that prey may be limited in this region since the area west of the Cascade crest does not currently support large ungulate populations (Wiles et al. 2011).

Wolves have been documented in the vicinity of the Skagit Project, both recently and in the past. Wolves were documented in the Hozomeen area of Ross Lake every year from 1990 to 1993 (Almack and Fitkin 1998). After many years with no reported observations, one potential wolf track was found in the Ross Lake drawdown zone near Hozomeen by a NPS biologist on May 27, 2009 (pers. comm., R. Christopherson, Wildlife Biologist, North Cascades National Park, 2009). In winter and early spring of 2010-2013, probable wolf tracks and scat have been found in the Hozomeen area during surveys by NPS and WDFW biologists (pers. comm. J. Bohannon, Wildlife Biologist, Washington Department of Fish and Wildlife, 2010; pers. comm., R. Christopherson, Wildlife Biologist, NPS, 2013). It is currently hypothesized that the wolves observed near Hozomeen likely have the majority of their home range in Canada. Hozomeen is about 29 miles from the project site.

<u>Determination of Effects</u>

Human activity associated with the operation of the Skagit River Hydroelectric Project, SR20 traffic and recreational activities are all deterrents to use of the immediate project vicinity by gray wolves. There is one old report of this species near Bacon Creek just north of the disposal site but there have not been any sightings in many years, suggesting that the area is not typically used as a travel corridor.

Although wolves could use habitats within the action area, the proposed project would have "no effect" on the gray wolf.

D. Grizzly Bear

Status: Federal Threatened, State Endangered

Grizzly bears were listed by the USFWS as threatened in 1970 (35 FR 16047-16048). Remnant populations are currently managed in Washington and three other states. The Grizzly Bear Recovery Plan (USFWS 1982) includes the North Cascades as one of the six ecosystems in which grizzly bears are known to have occurred within the decade prior to listing. Recovery goals for the North Cascades region are to 1) maintain current population, 2) provide protection under state and federal laws, and 3) collect baseline data on population status and habitat (USFWS 1982).

The NOCA and adjacent wilderness areas are believed to have suitable habitat to support grizzly bears (USFWS 1993). Suitable spring forage areas in the North Cascades include marshes, riparian areas, and low elevation shrubfields. Upper elevation shrubfields and grass sidehill parks and alpine ridges represent suitable summer foraging habitat. Densely forested areas with downfall are considered to be important for cover. No den sites have been identified in the North Cascades. However, suitable denning habitat – in excavated chambers or natural caves – is not considered a limiting factor in the North Cascades (Almack 1986).

The grizzly bear population in the North Cascades Ecosystem, which includes British Columbia and Washington, has been estimated at <50 bears on based on sighting data (Grizzly Bear Outreach Project web site http://www.washingtongrizzlies.org/; accessed July 2, 2010). Population estimates based on DNA hair sampling methods are lower, about 6 bears for the entire ecosystem or 0.39 bears/100 sq miles (0.15 bears/100 km) (Romain-Bondi et al. 2004). Natural recovery of grizzly bears in this region is considered unlikely due to the demographic and environmental stochastic events associated with small populations (Romain-Bondi et al. 2004).

It is very unlikely that grizzly bears use the action area and there have been no documented observations of this species in or near the action area. Between 1959 and 1991, there were 21 confirmed grizzly bear observations in Washington's North Cascades; additional sightings are considered highly probable (Almack et al. 1993). Until recently, the only evidence of grizzly bears near the action area was a photograph of a grizzly bear track taken in 1991 in the Thunder Creek drainage, which is a tributary to Diablo Lake (North Cascades Grizzly Bear Outreach Project, accessed June 17, 2008; www.bearinfo.org). In October 2010, however, a possible grizzly bear was photographed in an alpine meadow in the upper Cascade River drainage, about 7 miles southwest of the project site (North Cascades Grizzly Bear Outreach Project, accessed July 29, 2011; www.bearinfo.org).

Determination of Effects

The project site and general vicinity do not represent suitable foraging or denning habitat for grizzly bears. In addition, the level of human activity in the area associated with the Skagit River Hydroelectric Project, SR20 traffic, and recreational development in the area, preclude the seclusion preferred by grizzly bears. There are no reports of this species at or near the project site, suggesting that the area is not typically used as a travel corridor. No grizzly bear critical habitat has been designated. For these reasons, the project would have ***"no effect"*** on grizzly bears.

E. Canada Lynx

Status: Federal Threatened, State Threatened

The Canada lynx was state listed as threatened in Washington in 1993 and federally listed as threatened in 2000. Primary threats to the species include habitat loss and over utilization (trapping) (FR 65 FR 16051-16086). Critical habitat was designated in 2006 (71 FR 53355-53361). A state recovery plan was published in 2001 (Stinson 2001) but there is no federal recovery plan to date for the lynx.

Lynx are closely associated with boreal forests because of their near-dependence on a single prey species—the snowshoes hare—which is mostly limited to this habitat type. In Washington, most records of lynx are from the northeastern and north central portions of the state, in the Selkirks, Kettle Range, and North Cascades east of the crest (Stinson 2001). Lynx typically occupy high elevation forests but can travel over 300 miles when dispersing during prey declines. Lynx populations in the northern boreal forest fluctuate on an approximate 10-year cycle in response to changes in snowshoe hare numbers. Cyclic variations in snowshoe hare-lynx populations are dramatic in Alaska and Canada but tend to be more moderate in Washington (Stinson 2001).

Determination of Effects

Critical habitat for lynx in Washington includes the North Cascades above 4,000 ft elevation and east of the crest (71 FR 53355-53361). The closest designated critical habitat is about 17 miles southeast of the project site. Most evidence suggests that lynx historically were rare west of the crest. The project site is under 1,000 ft elevation and considerably west of the Cascade crest. The action area encompasses a greater range of habitats and elevations but still lacks the boreal habitat and lodgepole pine (*Pinus contorta*) stands that provide a suitable prey base for the lynx. It is possible that the species may occasionally move through the action area during dispersal but would not be expected to occupy the area because of the lack of suitable habitat for snowshoe hares. The project would have ***"no effect"*** on the Canada lynx.

F. Bull trout

Status: Federal Threatened; State Candidate

The Skagit River system is part of the Puget Sound Management Unit (MU) of the Coastal-Puget Sound Distinct Population Segment (DPS) of bull trout (USFWS 2004), a native char species. All bull trout in the coterminous United States, including those in the Coastal-Puget Sound DPS, we listed as a threatened species under the ESA in 1999 (64 FR 58910). The Puget Sound MU includes eight core areas and 57 local populations. The Skagit River system accounts for two of the core areas (Lower Skagit and Upper Skagit) and 27 of the local populations. The two core areas are attributable to historic migration barriers in the Gorge and Diablo areas of the river and delineated by Diablo Dam (USFWS 2004).

Bull trout are present in all three reservoirs of the Skagit Hydroelectric Project, including Gorge Lake. Bull trout are also known to be present in Stetattle Creek (see Figure 12). The upper Skagit River basin, including Gorge Lake and Stetattle Creek, is also inhabited by another native char species: Dolly Varden (*Salvelinus malma*). Dolly Varden closely resemble bull trout, but are not designated on either the federal ESA list or the Washington State sensitive species list. The "similarity of appearance" clause of the ESA has not been applied to Dolly Varden.

<u>Population Status</u>

Bull trout in Gorge Lake were originally considered to be part of the Lower Skagit Core Area in the Puget Sound DPS by the USFWS Recovery Unit Technical Team (USFWS 2004). This designation was based upon the presence of a large natural fish barrier that was present in the Skagit River prior to the construction of Diablo Dam in 1932. This natural fish barrier was located just downstream of the site where Diablo Dam was constructed (Smith and Anderson 1921). However, recent genetic analysis of native char population in the Skagit River basin found that the Gorge Lake population is part of the Upper Skagit Core Area (Smith et. al 2010). Moreover, bull trout in Gorge Lake were found to be genetically indistinct from other bull trout populations in the Upper Skagit Core Area (Figure 13). In contrast, bull trout in the lower Skagit River basin downstream from Gorge Dam were found to be highly distinct from populations in the upper Skagit Reservoirs, including Gorge Lake. The analysis of mitochondrial DNA completed by the USFWS Abernathy Genetics Lab in 2013 found that bull trout in Gorge Lake, along with bull trout populations in Diablo and Ross Lake, originated from the Fraser River System and have been genetically isolated from bull trout populations in the lower Skagit River for over 10,000 years (pers. comm., Matt Smith, USFWS, July 2013).

Based upon these new genetics research findings, the recently-issued Biological Opinion for the ongoing operation of the Skagit Hydroelectric Project placed the Gorge Lake bull trout population in the Upper Skagit River Core Area (USFWS

2013). The Upper Skagit Core Area now includes the Skagit River and tributaries upstream of Gorge Dam, and Gorge, Diablo, and Ross Lakes. Local spawning populations in the Upper Skagit Core Area now include Stetattle Creek in the Gorge Lake drainage, Thunder Creek and Deer Creek in Diablo Lake drainage, seven populations in tributaries to Ross Lake, and six populations in the upper Skagit River drainage in Canada.

The USFWS designated the Upper Skagit Core Area in the "Low Risk" category (USFWS 2008), meaning that the population is considered to be healthy and diverse, and threats to the population are considered to be low. Only 4 out of 121 core areas in the United States received the "Low Threat" classification by the USFWS, including the Upper Skagit and Lower Skagit Core Areas.

The population of bull trout in the Gorge Lake drainage estimated to be less than 100 spawners (i.e., sexually mature fish), based upon population counts in the Ross Lake drainage and adjusting for the reservoir size and spawning area for the Gorge Lake drainage (SCL 2012). This estimate is collaborated by gill-netting surveys that have been conducted in the reservoir by Washington Department of Fish and Wildlife in 2006 (Downen 2011) and the National Park Service in 2010, by a creel census conducted by WDFW in the early 2000s (Downen 2011), and by catch-and-release sampling that has been conducted for acoustic tagging research (SCL 2012).

The abundance of bull trout in the Upper Skagit Core Area has been rapidly increasing over the past two decades (Figure 14), based upon snorkel surveys conducted in a 36-km bull trout population index area of the Skagit River upstream of Ross Lake (Anaka and Scott 2012). The abundance of bull trout almost doubled from 2009 to 2011. The abundance of bull trout in this index area has increased ten-fold since the initial snorkel survey was conducted in 1994. The abundance of adult bull trout was observed to peak in 2011, and has slightly declined from this level in 2012 (Anaka and Scott 2012). Over 90% of the bull trout counted during these surveys were over 400 mm total length (TL). So, most of these fish likely are adfluvial (lake-dwelling) adults (SCL 2012). The rapid population growth of redside shiners, a minnow species native to the lower Skagit River that was presumed introduced to Ross Lake in the early 2000s (Downen 2011), is thought to be a major factor contributing to the increasing abundance of bull trout in the Upper Skagit Core Area. Redside shiners have been found to be a major portion of the diet for bull trout in Ross Lake (pers. comm, Madeleine Eckmann, OSU, September 2013).

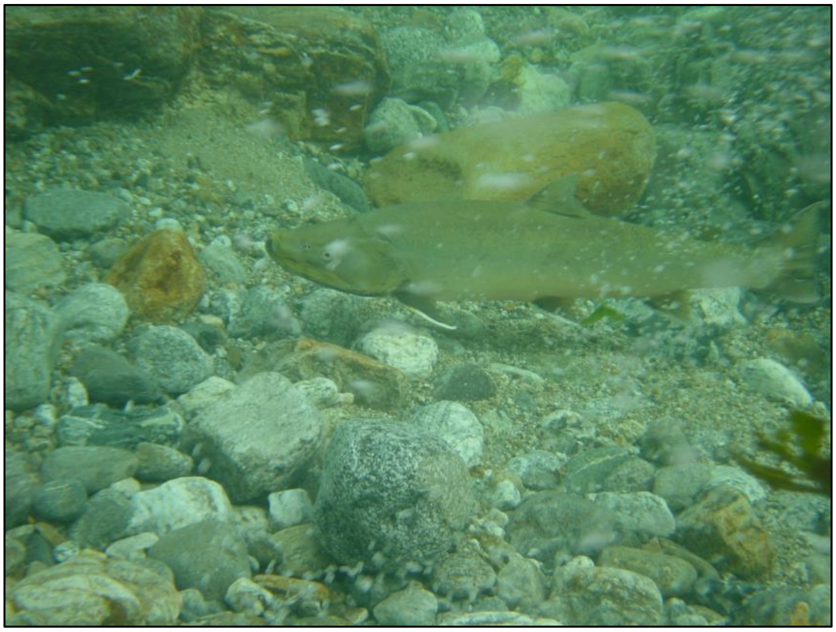

Figure 12. Large bull trout in Stetattle Creek during fall spawning period.

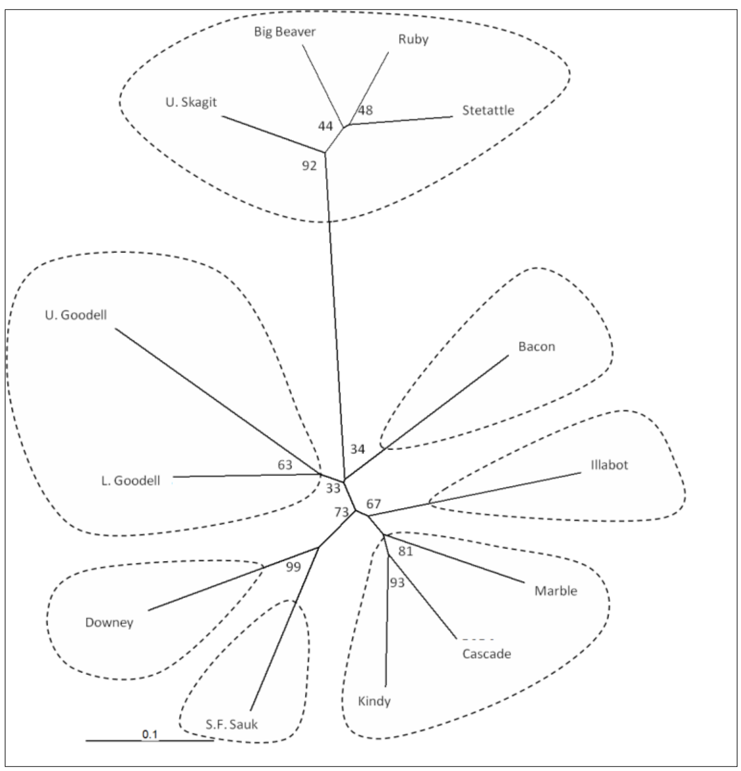

Figure 13. Unrooted neighbor-joining (NJ) dendrogram of bull trout collections from the Skagit River Basin using Cavalli-Sforza and Edwards (1967) chord distance to display genetic relationships among collections. Analysis shows that Stetattle Creek bull trout populations are members of Upper Skagit Core Area (source: Smith et al. 2010).

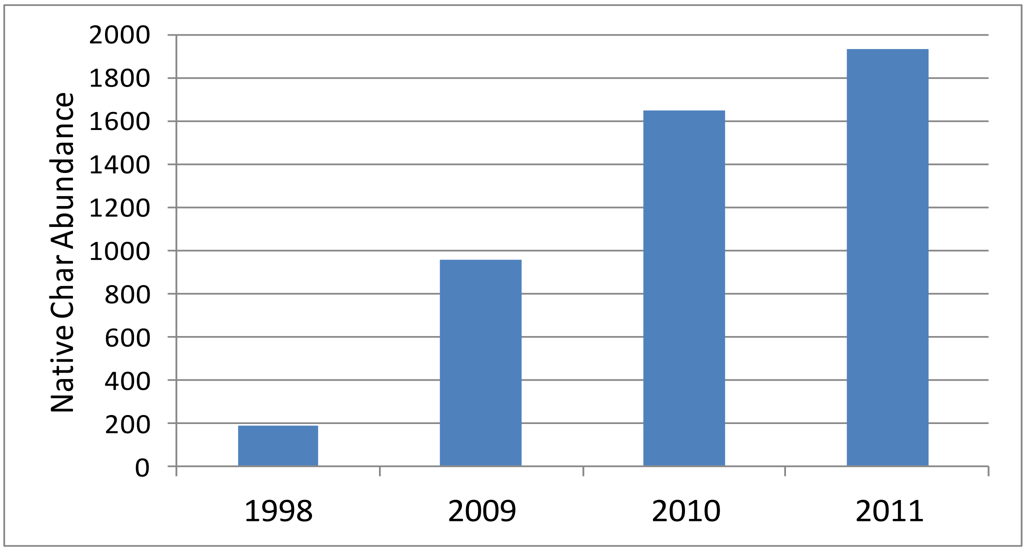

Figure 14. Abundance of native char in a 36-km index reach of the upper Skagit River above Ross Lake: 1998 through 2011 (source: Jesson and Scott 2012).

The total population of adult bull trout in the Upper Skagit Core Area, including the Ross Lake, Diablo Lake, and Gorge Lake drainages, was estimated to be over 7,000 adult fish based upon recent fish counts conducted in the upper Skagit River index area (SCL 2012). Most of these adult fish are located in the Ross Lake drainage, a consequence of the large size of the reservoir and the large amount of spawning and rearing habitat found in this drainage. Assuming a population of 100 adult bull trout, the Gorge Lake population would contribute 1.4% of the total population present in the Upper Skagit Core Area.

Based upon the results of genetics analysis completed for native char captured in Gorge Lake by WDFW in 2006, the majority of large native char that have been observed in Gorge Lake are bull trout (Small et al. 2010). All native char sampled in Gorge Reservoir during the 2006 census that were larger than 400 mm TL were found to be bull trout (Figure 15). The native char captured in the reservoir that were smaller than 300 mm were found to be predominately Dolly Varden. Of native char captured in a NPS gill-net fish census conducted by the NPS during the summer of 2010, 90 percent of the fish were found to be Dolly Varden based upon genetics testing (pers. comm., Hugh Anthony, NPS, December 2013). Most of the fish collected during the 2010 census in Gorge Lake were less than 350 mm TL.

Based upon the results to date, there are two native char populations present in Gorge Lake. The first is a population of bull trout that is comprised, based upon their large size, primarily of adfluvial fish that spend most of their adult life in the reservoir. The second and presumably more abundant population of native char in Gorge Lake is Dolly Varden. Fish from both populations have been confirmed to interbreed, based upon the presence of hybrid fish found in genetics studies of these fish (SCL

2012). The juveniles of both species have been found in Stetattle Creek (Smith et al. 2010). Consequently, both bull trout and Dolly Varden are presumed to spawn and rear as juveniles in this stream.

Based upon the information available to date, bull trout in Gorge Lake are assumed to have an adfluvial (lake-dwelling) life history. Adult reside much of the year in Gorge Lake to forage. These adults then migrate into Stetattle Creek from mid-September through late-October to spawn. Following spawning, the adults return to the reservoir. Bull trout likely reside as juveniles in Stetattle Creek for two to three years, and then migrate into Gorge Reservoir as subadults (SCL 2010; SCL 2012). Some of the adult bull trout observed in Gorge Reservoir could have originated from Diablo and Ross Lakes as juveniles, having passed through the turbines of the upstream dams (SCL 2013).

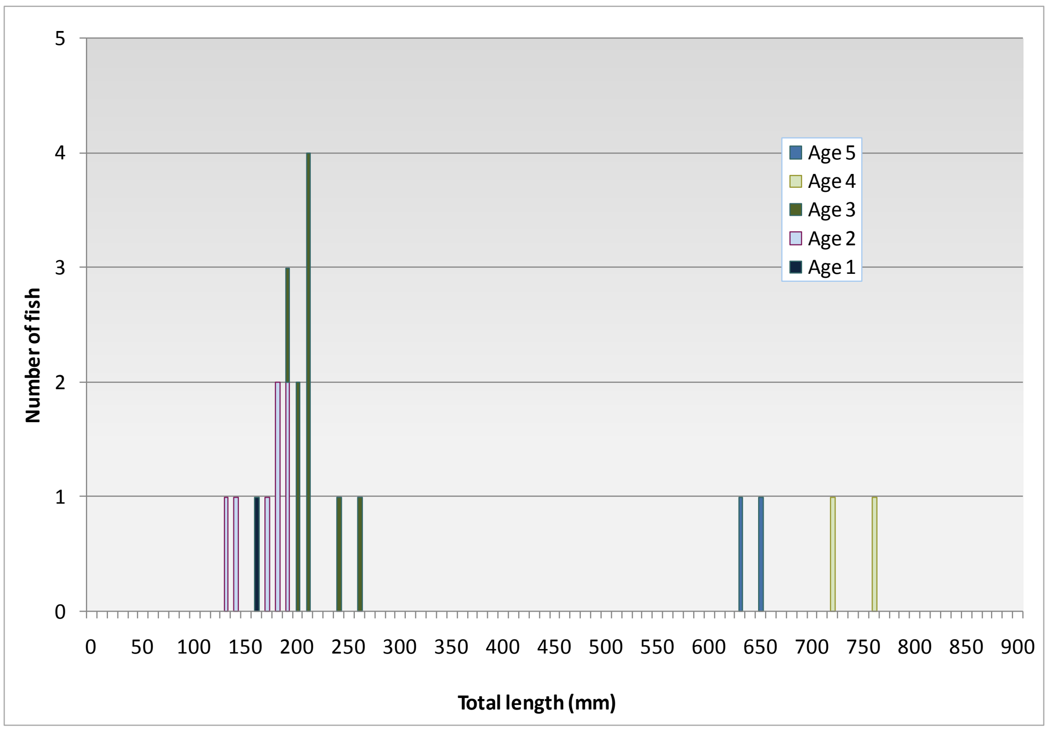

Figure 15. Length-frequency plot of native char sampled by gill nets in Gorge Lake during August 2006 (source: Downen 2011).

Current Habitat Conditions

Of the three Skagit Project reservoirs, Gorge Lake provides the least amount of lake and tributary habitat for bull trout. This is due primarily to the small size of Gorge Lake compared to Diablo and Ross lakes. Gorge Lake has a volume of 8,158 acre-ft and surface area of 240 acres under the normal operating elevation. In comparison, Ross Lake at full pool has a volume of 1,444,000 acre-ft and surface area of 11,700 acres. Diablo Lake has a volume of 90,400 acre-ft and surface area of 910 acres. This means that Gorge Lake provides only a small portion of the bull trout reservoir habitat present in the Upper Skagit Core Area. Based upon total reservoir area, Gorge Lake provides 1.9% of the reservoir habitat found in the upper Skagit River basin. Based upon reservoir volume, Gorge Lake contributes only 0.5% of the total reservoir habitat available in the upper Skagit River drainage.

Gorge Lake has a watershed drainage area of 34 sq-miles. Stettatle Creek is the only known fish-bearing tributary to Gorge Lake. The lower 1.1 miles of Stetattle Creek is accessible to upstream passage by fish from Gorge Lake. A natural falls barrier is located at stream mile 1.1 just below the mouth of Bucket Creek (SCL 2012). Stettatle Creek contains high quality habitat with cold water and clean gravels, albeit limited in quantity due to the short length of the stream that is accessible to fish from Gorge Lake. The total amount of spawning habitat accessible to trout in the Gorge Lake drainage is approximately 2,300 sq-ft (Tappel 1989). This represents only 0.7% of the total 325,300 sq-ft of potential bull spawning habitat found in the Upper Skagit Core Area, most of which is found in the Ross Lake drainage (SCL 2012).

There are several different distinct aquatic habitats that would be affected by the proposed excavation project. The quantity and quality of habitat in the majority of these areas is directly affected by the amount of flow released from Diablo Powerhouse, the operating level of Gorge Lake, and the amount of flow in Stetattle Creek.

Under normal operating conditions, flows released from the Diablo Powerhouse range from 1,400 to 6,900 cfs (95th and 5th percent exceedance values, respectively, for hourly discharges). The median hourly discharge released from the Diablo Powerhouse is 3,300 cfs. Generation at the Diablo Powerhouse typically follows a two-step cycle during the day. During high runoff periods (spring through mid-summer) and high electrical demand periods (mid-winter), Diablo Powerhouse typically releases a stable flow ranging between 5,000 and 6,900 cfs during periods of high demand that occur during the day and evening (example shown in Figure 16). The powerhouse then shifts to a low-flow regime that ranges between 2,500 and 4,000 cfs during periods of low power demand that typically occur during the night and early morning. During low runoff periods (late summer through late fall) and yearly low demand periods (early spring), flows released from the powerhouse typically consist of flows ranging from 1,400 to 4,000 cfs, which vary according to hourly changes in power demand (example shown in Figure 17). The flows released from Diablo Powerhouse are closely coordinated with flows at the Gorge Powerhouse to meet the instream flows required in the Skagit River for salmon and steelhead as set by the Fisheries Settlement Agreement for the Skagit Hydroelectric Project (SCL 1991).

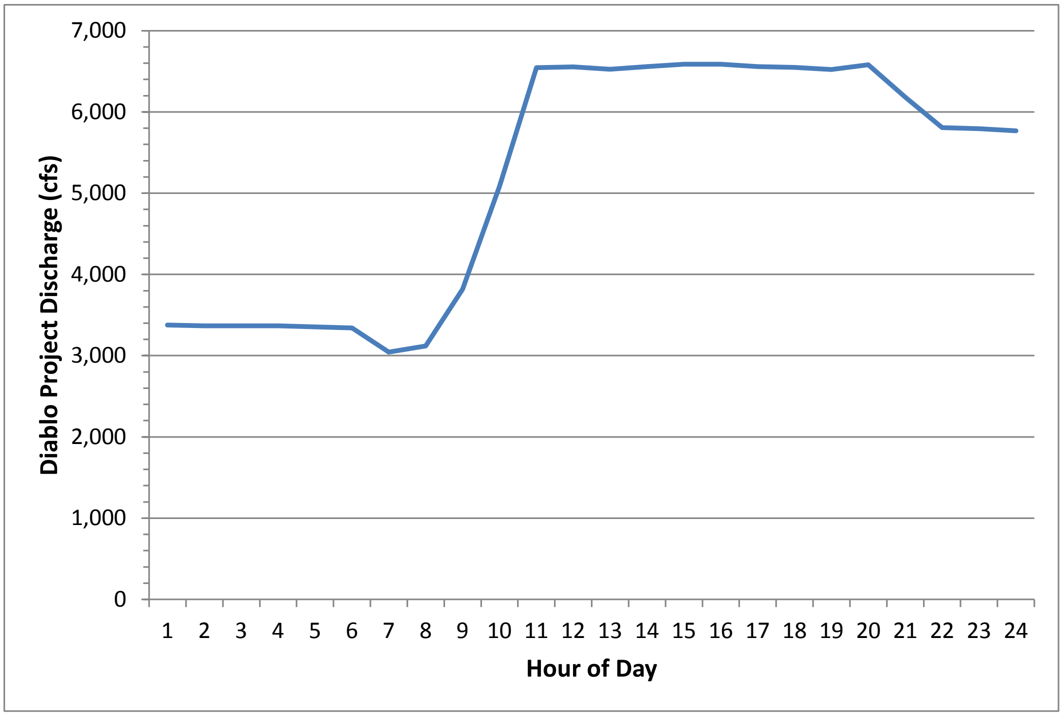

Figure 16. Hourly discharges at Diablo Powerhouse on June 14, 2009 (spring high-flow period).

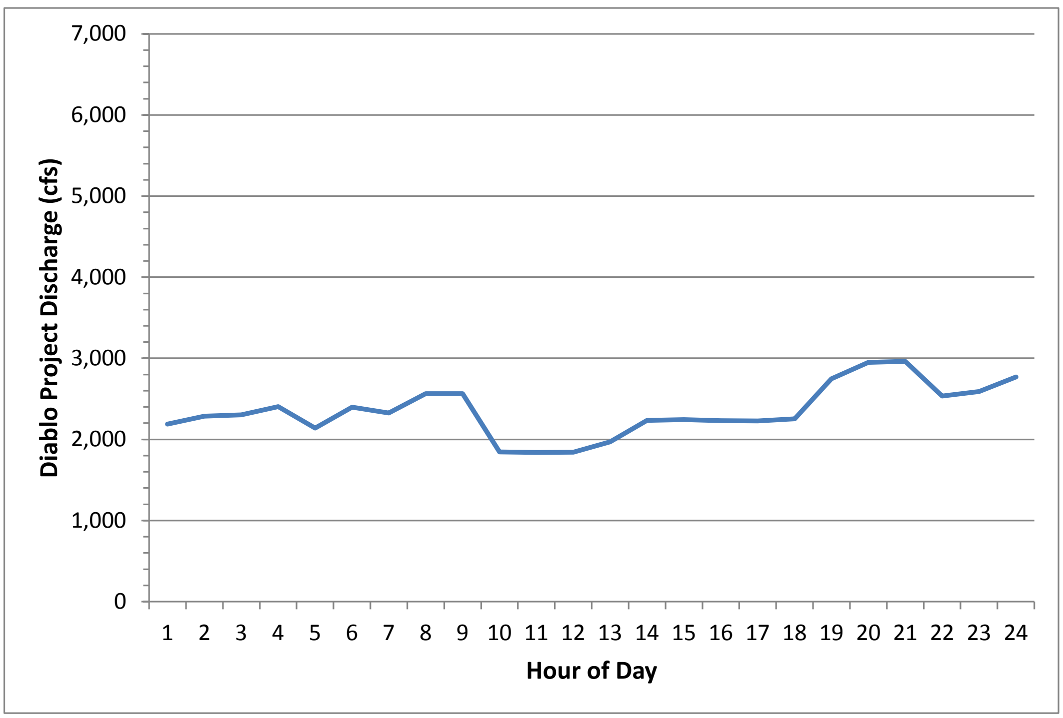

Figure 17. Hourly discharges at Diablo Powerhouse on September 15, 2009 (late summer – early fall low flow period).

Flows at the excavation project site below Stetattle Creek are the sum of Diablo Powerhouse discharges, Diablo Dam spills, and Stetattle Creek discharges. Inflows from small tributaries located between Diablo Dam and Stetattle Creek represent a small percentage (less than 1%) of the flow at the project site. Diablo Dam spills occur on average only six days per year, with most spills occurring during high runoff period during the spring and early summer when outflows from Thunder Creek (Diablo Lake basin) exceed project generation capacity. Mean monthly flows in Stetattle Creek range from 105 to 390 cfs, with the lowest flows occurring during the August through October baseflow period and January through March freezing period, and the highest flows occurring during the May through July snowmelt period (Figure 18).

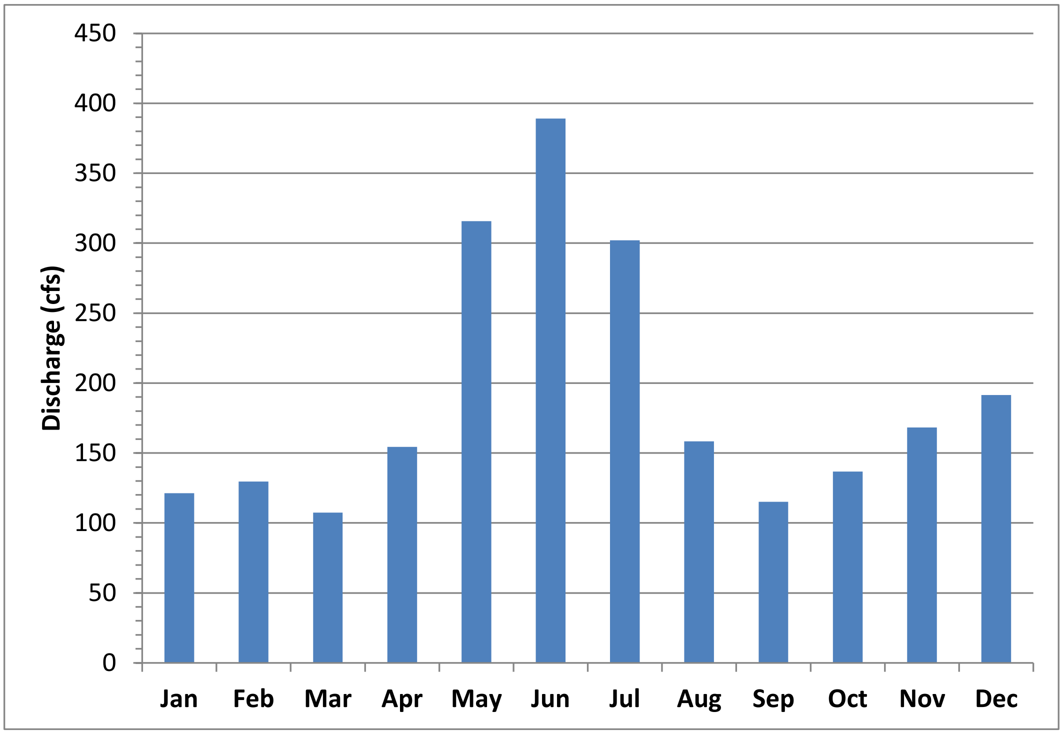

Figure 18. Mean monthly flows in Stetattle Creek (source: USGS gaging station records 1991-1983).

The highest flows at the cobble bar excavation site are observed during the months of January, February, March, June, July, November, and December (Figure 19). Flows during the high demand period of the day range from 4,200 to 5,800 cfs, while flows during the low demand period of the day range from 2,800 to 4,200 cfs. The daily flow amplitude (maximum – minimum flow) during these months ranges from 1,300 to 1,700 cfs.

The lowest flows at the excavation site are observed during the months of April, May, August, September, and October (Figure 19). For these months, flows during the high demand period of the day range from range from 3,200 to 4,000 cfs, while flows during the low demand period of the day range from 2,400 to 2,900 cfs. The daily flow amplitude for these months ranges from 750 to 1,500 cfs.

Because of the seasonal and daily variability in flows observed at the excavation project site, a range of flows will be required for assessing bull trout habitat under existing and post-project condition. Mean flows at the excavation project site range from 2,400 cfs which is the lowest monthly flow for low daily power demand, to 5,800 cfs which is the highest monthly flow for high daily power demand (Figure 19). The high range of daily flows during the low flow months is 4,000 cfs, while the low range of daily flows during high flow months is 4,200 cfs. Thus, a reasonable set of flows for assessing habitat conditions at the excavation project site for existing and post-project conditions would be 2,400 (low-low), 4,000 cfs (low-high and high-low mean flow), and 5,800 cfs (high-high flow).   The 4,000 cfs flow is also the median flow at the project site on an annual basis, so it is the best overall flow for comparing bull trout habitat under existing and post-project conditions.

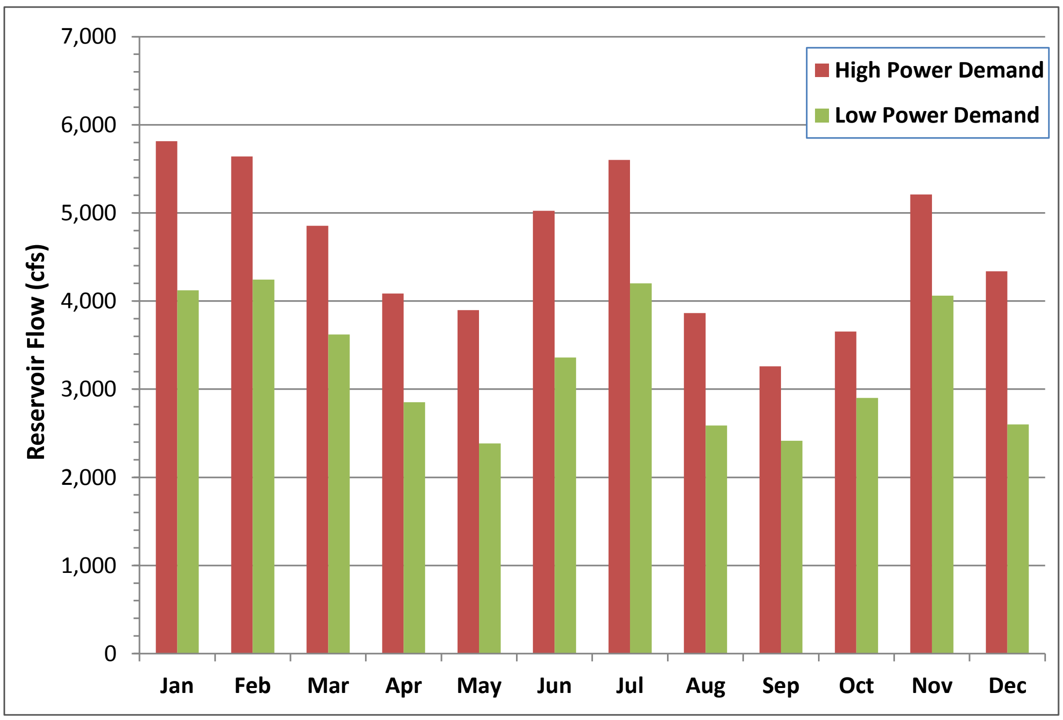

Figure 19. Monthly average values for flows in Gorge Lake during 24-hour generation cycle of Diablo powerplant. Flows include Diablo powerhouse discharge, Diablo Dam spill, and Stetattle Creek outflows (data source: hourly flows 1997-2009),

The normal operating pool elevation for Gorge Lake is 878.2 ft (NAVD88). From October 2000 through June 2013, the median daily operating level of Gorge Lake has been 877.9 ft. Reservoir pool elevations have been exceeded 876.4 ft (NAVD88) for 90% of the days in this 13-year period.

Seven distinct aquatic habitat zones were delineated in the vicinity of the cobble bar excavation site (Figure 20):

- Zone 1 - Mouth of Stetattle Creek
- Zone 2 – Ephemeral side channel located along right bank of cobble bar
- Zone 3 – Backwater side channel located along right bank of cobble bar
- Zone 4 – Exposed cobble bar proposed for excavation
- Zone 5 - Gravel bar in reservoir located immediately upstream of the Stetattle Creek confluence
- Zone 6 - Rapids located on the southeast side of the exposed cobble bar
- Zone 7 - Deep run habitat located below the Zone 6 rapids

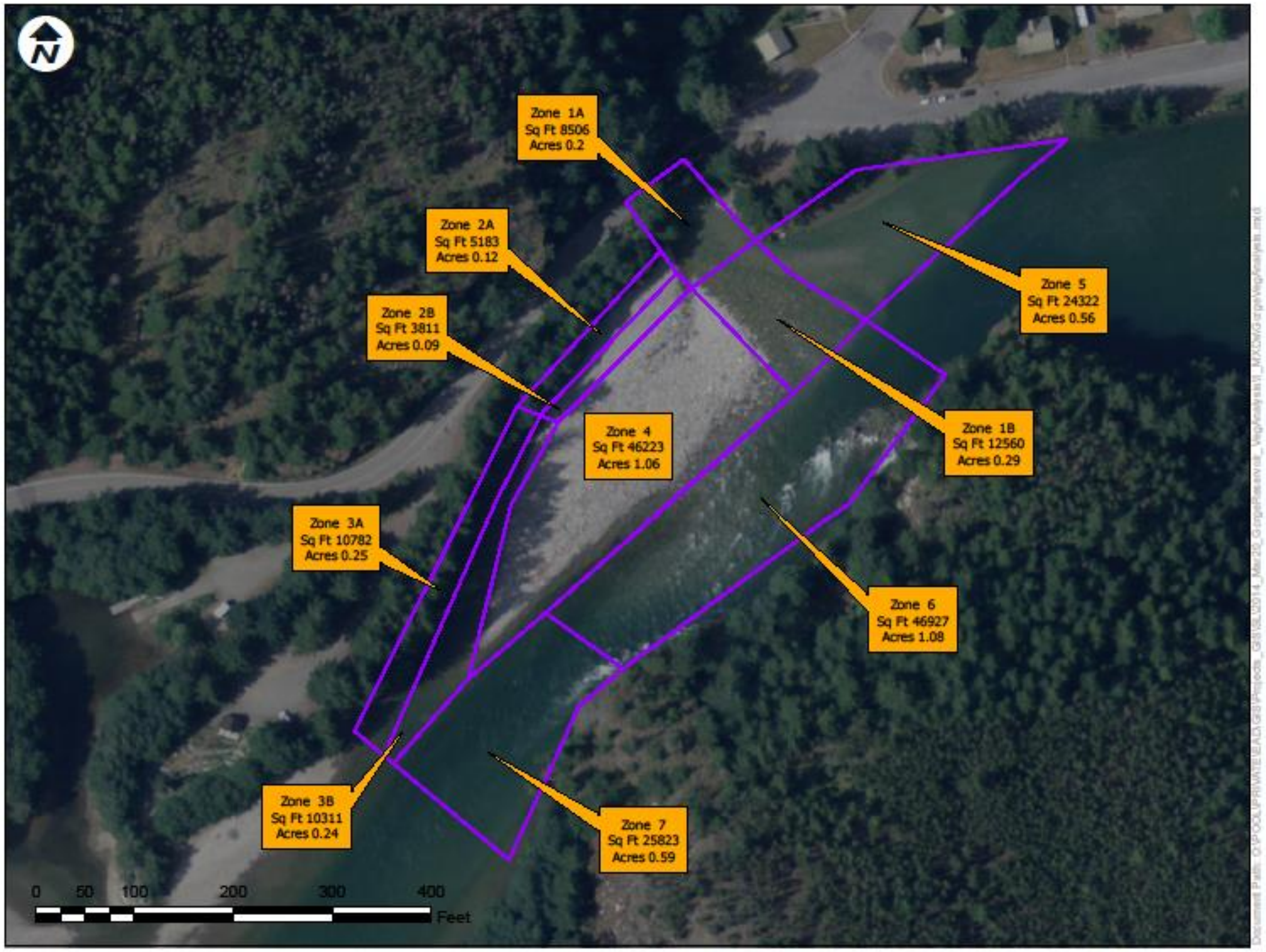

Figure 20. Map of habitat zones at cobble bar excavation site. Reservoir flow in photo is approximately 4,000 cfs. Zones 2 and 3 were divided into two subzones for the purpose of estimating habitat mitigation benefits under post-project conditions, but can be considered to be single habitat zones under existing conditions.

Zone 1 – Mouth of Stetattle Creek (Figure 21). The mouth of Stetattle Creek is about 220 ft in length under normal reservoir operating conditions, and has a total area of 0.49 acres, and a wetted channel area of 0.39 acres under fall low flow conditions. The substrate at the mouth of Stetattle Creek consists of an alluvial fan composed mainly of cobble and large gravel bed materials. The alluvial fan extends out to the fast waters of the free-flowing section at the upper end of Gorge Reservoir, and also extends upriver along the right bank of the reservoir where some of the flow from Stetattle Creek runs counter-current to flows in the reservoir. The alluvial fan of this stream also extends well onto the exposed cobble bar that is proposed for excavation (Zone 4). The mouth of the creek was surveyed with three habitat cross-sections during the spring and fall of 2013 by SCL. Velocities, depths, and substrate composition were measured across the stream channel during these surveys.

The upper section of the stream mouth zone (Zone 1a) is a plunge pool tail-out that transitions into run habitat, which extends about approximately 120 ft below the bridge. This section of the channel has a very gradual water surface slope, dropping less than 0.1 ft in elevation over 120 ft distance (slope = 0.07%). Under low flow conditions in the fall (75 cfs), this section of the Stetattle Creek mouth has a wetted width of 70 ft, a mean depth of 1.4 ft, and mean velocity of 0.7 ft/sec. Under higher flow conditions in the spring (250 cfs), this section of the channel is 80 ft wide, and has a mean depth of 2.1 ft and mean velocity of 1.5 ft/sec. Substrates in this run habitat area are dominated by small cobbles and large gravels.

The lower section of the Stetattle Creek mouth (Zone 1b) is a riffle that is approximately 100 ft in length. Water surface elevations drop 1.5 ft from the top of the riffle to the confluence with the free-flowing section of the reservoir (slope = 1.7%). Under fall low flow conditions (75 cfs), this lower section of the mouth has a wetted width of 77 ft, and has a mean depth of 1.3 ft and average velocity of 1.3 ft/sec. Under higher flow conditions in the spring (250 cfs), this section of the mouth is 87 ft wide, and has a mean depth of 1.5 ft and mean velocity of 2.0 ft/sec. Substrates in this riffle habitat are dominated by small and large cobbles.

Figure 21. Mouth of Stetattle Creek between Stetattle Creek Bridge and Gorge Reservoir. Flow of stream is approximately 80 cfs in this photo.

Zone 2 - Ephemeral side channel below confluence of Stetattle Creek (Figure 22). This habitat zone is a side channel located along the right bank of the reservoir adjacent to the cobble bar, and has surface flows only when discharge from Stetattle Creek exceeds 265 cfs. This is the 20% daily exceedance flow for Stettatle Creek, meaning that the side channel is dry 80% of the time. This side channel typically possesses flow only in the spring and early summer, and therefore provides limited habitat benefits to juvenile bull trout that reside in Stetattle Creek and the reservoir on a year-round basis. When flows are present in the channel, habitat cover for fish is provided by small boulders and overhanging alder branches. This habitat zone has a total area of 0.21 acres, though all of this area is dry when flows in Stetattle Creek are not high.

Zone 3 – Backwater side channel (Figure 22). This habitat area, which is located just downstream of Zone 2, is also side channel habitat, but is connected to the reservoir and is a zero-velocity backwater area except when Stetattle Creek is running high during the spring and early summer. This habitat zone has a total area of 0.49 acres, with a wetted channel area of 0.38 acres at normal reservoir operating elevations. The average depth of this backwater habitat is 1.9 ft (NPS 2013). Juvenile rainbow trout and bull trout were observed in Zone 3 during surveys conducted by the NPS in 2013.

Figure 22. Side channel located along right bank of cobble bar. The upper part of this channel (Zone 2) is ephemeral, while the lower part of this channel (Zone 3) is inundated by the reservoir. Stetattle Creek is flowing at approximately 500 cfs in this photo.

Zone 4 – Exposed cobble bar (Figure 23). This habitat area is currently a large expanse of cobble bar that is dry under typical flows from Diablo Powerhouse and Stetattle Creek. The dry portion of the cobble bar has an area of 1.06 acres, but provides zero acres of aquatic habitat under average flow and normal reservoir operating conditions.

Zone 5 – Reservoir gravel bar located upstream of Stetattle Creek (Figure 24). This gravel bar area of the reservoir that is located immediately upstream of the Stetattle Creek confluence that is relatively shallow under most flow conditions. Part of this gravel bar is dry during low generation flow conditions (2,400 cfs), but becomes completely submerged during high generation flows (5,800 cfs). The total area of this gravel bar is 0.56 acres, of which 0.45 acres are wetted under low flow (2,400 cfs) conditions. Depths are shallow within this habitat zone under low generation flow, having a mean depth of 0.7 ft and a mean velocity of 0.5 ft/sec. The gravel bar in Zone 5 has aggraded over the past two years, and an incised side channel that was formerly used by juvenile rainbow trout and bull trout is no longer present.

Figure 23. Photograph cobble bar located below mouth of Stetattle Creek. Removal of this cobble bar would result in the formation of 1.5 acres of reservoir backwater habitat.

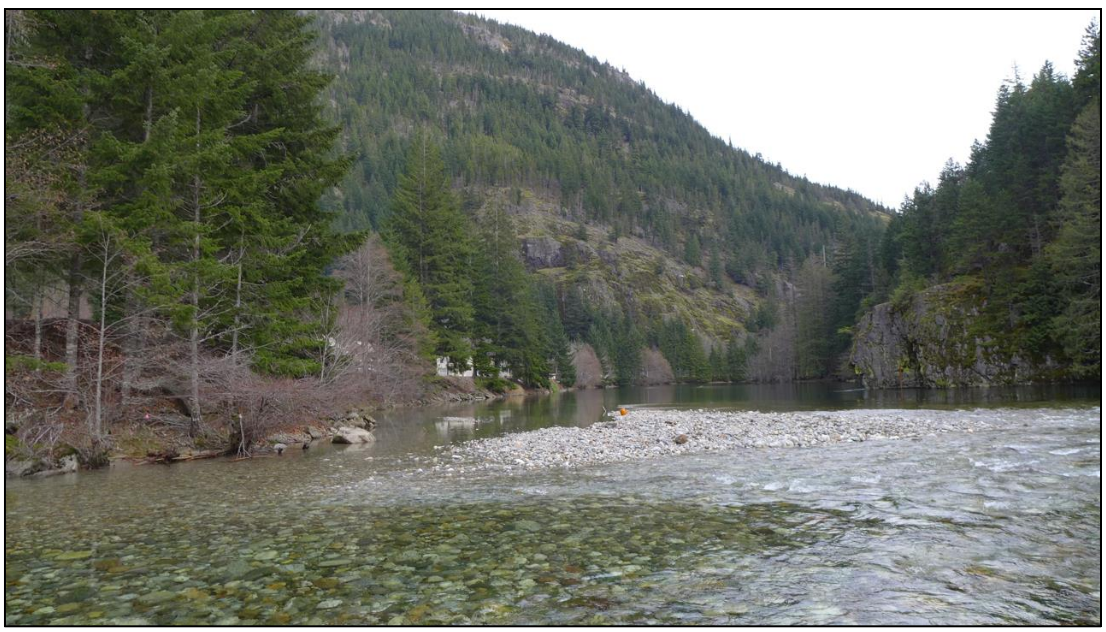

Figure 24. Gravel bar located in free-flowing section of reservoir immediately upstream of the mouth of Stetattle Creek. This photo was taken during the fall of 2013.

Zones 6 - Riverine rapids (Figure 25). This habitat zone is located within a free-flow section of Gorge Lake, and is located adjacent to the cobble bar (Zone 4). This habitat zone is a rapids, with standing waves visible during median and high generation flows. Average velocities in this rapids are 6.7 ft/sec under low flow conditions (2,400 cfs), 9.3 ft/sec under median flow conditions (4,000 cfs), and 12.4 ft/sec under high flow conditions (5,800 cfs). The average depth of this rapids ranges between 3.5 and 3.9 ft. This habitat area is unsuitable for adult and juvenile bull trout because of these high velocities. The dominant substrates in this zone are small boulders and large cobbles. This habitat zone has a wetted area of 1.08 under median flow conditions.

Zone 7 – Deep Riverine Run (Figure 25). This habitat zone is located immediately below Zone 6, but is much deeper and since it is a transition zone between the free-flowing section of the reservoir adjacent to the cobble bar and the impounded section of the reservoir backed up by Gorge Dam. Average velocities within Zone 7 are still high, with average velocities of 5.4 ft/sec for median flow conditions, and 7.7 ft/sec for high flow conditions. The average depth of this zone is 9.9 ft under median flows, and 10.1 ft under high flows. The dominant substrate in Zone 7 is large cobble. This habitat area was observed to be used by adult rainbow trout for foraging during snorkel surveys conducted by NPS biologists (NPS 2013). However, this is a low quality habitat zone for juvenile bull trout because of high velocities and unsuitable depths.

Figure 25. Free-flowing section of reservoir adjacent to cobble bar excavation area. The riverine rapids habitat area (Zone 6) is located in the foreground of this photo, and standing waves are visible. The deep run section (Zone 7) is located in the background. Flows in this photo are about 4,000 cfs.

Gorge Lake above the confluence of Stetattle Creek. The outlet of Stetattle Creek and the gravel bar forms the hydraulic control that determines the water surface elevation of the Diablo Powerhouse tailrace pool under normal operating conditions. The tailrace pool (Figure 26) extends well upstream of the tailrace outlet to the base of Diablo Dam. The tailrace pool is 5,812 ft in length, and has an area of 31.5 acres. The pool is very deep in most locations, with channel center depths ranging from 12.1 to 38.8 ft, and an average depth of 28.8 ft (Seattle University 2008). Habitat cover in this upper section of the reservoir is provided by deep water, large boulders, turbulent surface waters in the vicinity of the Diablo powerhouse tailrace, and by overhanging alder and willow branches.

Figure 26. Deep pool located between Diablo Dam and the mouth of Stetattle Creek. This photo was taken looking downstream from the tailrace of Diablo Powerhouse.

Gorge Lake downstream of the excavation site. Gorge Lake from the excavation site downstream to Gorge Dam would be potentially affected by sediment deposition and elevated turbidities during and shortly after cobble bar excavation. This section of the reservoir has an area of 206 acres, and is the operating pool of the reservoir. The section of the reservoir has lentic (lake) habitat conditions. The area of the reservoir immediately above the SR 20 causeway and bridge is relatively shallow with a depth of approximately 20 ft deep, and is a delta formed by the deposition of fine sediments in this upper backwater zone of the reservoir. Stumps and large boulders situated on either side of the SR 20, and along the north shore of the delta zone, provide the only habitat cover for fish in this area. The reservoir section between the SR 20 bridge and Gorge Dam provides progressively deeper habitat that ranges from 30 ft deep downstream of bridge to 100 ft deep at Gorge Dam. Habitat cover in this section is provided by large boulders and stumps located along both banks of the reservoir.

Stetattle Creek upstream of Stetattle Creek Bridge. Stetattle Creek immediately upstream of the bridge (Figure 27) is potentially vulnerable to head cutting following removal of the cobble bar. This section of stream has an average width of 51 ft, and wetted surface area of 1.7 acres. This section of the stream has a gradient of 1.78%, and is composed primarily of riffle, run, and cascade habitats. Substrates in this section of the stream are dominated by cobbles and small boulders. Gravels suitable for spawning are scarce in this section of the stream. Based upon a longitudinal (thalweg) survey of the Stetattle Creek channel, any headcutting commencing downstream at the excavation site would have to migrate upstream through a deep pool located under Stetattle Creek bridge (Figure 28). This deep pool is formed by large riprap that protects the foundation of the bridge from high scouring flows. Headcutting upstream through this deep pool is unlikely. Nevertheless, Seattle City Light plans to conduct a long-term monitoring program to monitor potential headcutting triggered by the excavation project. An engineered drop structure would be placed in the stream immediately above the bridge if monitoring demonstrates headcutting is beginning to occur in the future.

Figure 27. Stetattle Creek immediately upstream of Stetattle Creek Bridge. The discharge of the stream in this photo is approximately 80 cfs.

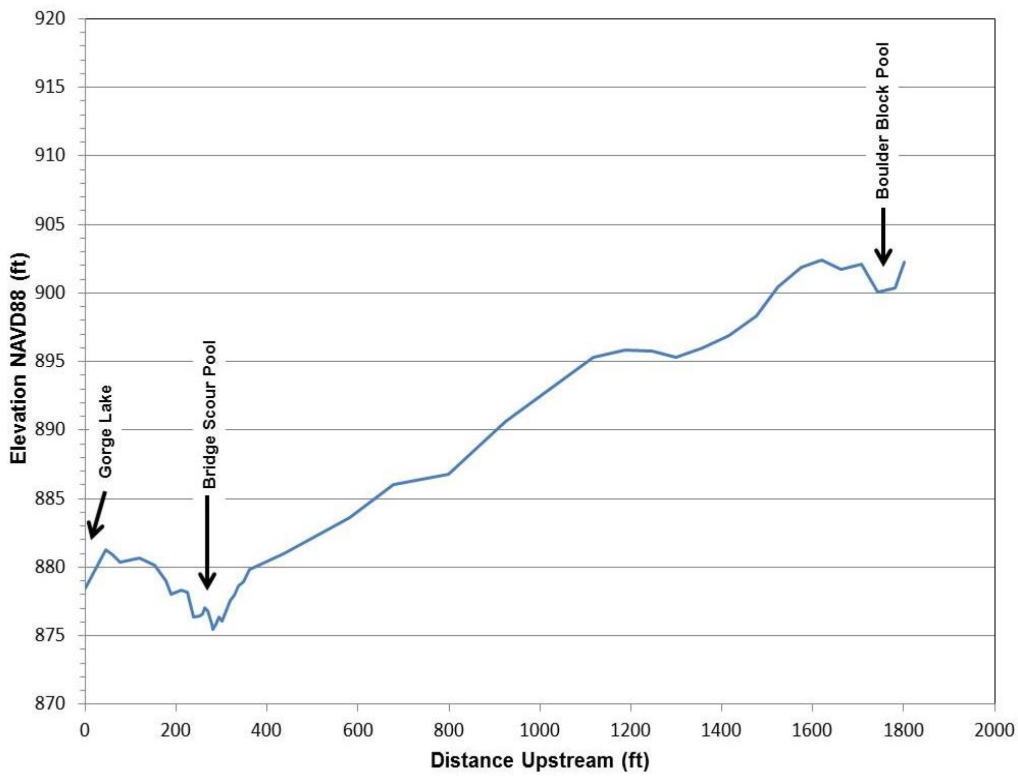

Figure 28. Thalweg profile of Stetattle Creek from confluence with Gorge Lake to the boulder block scour pool located just downstream of the landslide.

Construction Impacts of Proposed Project

The proposed excavation project is anticipated to require seven weeks to complete between July 15 and September 15, 2015. The excavation would occur prior to the bull trout spawning period, which typically starts in late September and continues through early November (SCL 2011). Juvenile and adult bull trout are expected to be present in the waters adjacent to the cobble bar, especially the mouth of Stetattle Creek, during the excavation period. Juvenile fish would be rearing in this area; adults would be foraging or migrating through. Adults would likely commence pre-spawning staging in the deep waters of the tailrace pool during the early September construction period. Fish holding or migrating in waters adjacent to the cobble bar excavation area are likely to be disturbed by construction activity visible from the water, and from noise and ground vibrations occurring from excavation and loading work. Bull trout would likely move into the deeper habitats of the tailrace pool or upstream into Stetattle Creek to avoid disturbance and to continue juvenile rearing or adult foraging activities. Behavioral avoidance by fish is most likely around the margins of the excavation area during the second and third phases of construction, especially during placement of the coffer dam, and during excavation at the margins of the cobble bar.

A coffer dam would be placed along the upper margin of the bar along Stetattle Creek, and along the lower edge of the cobble bar adjacent to the backwater area of the reservoir to isolate the excavation area, including any fine sediments, from surface waters. The coffer dam constructed along the west side of Stetattle Creek would be placed upon loosely packed large gravels and cobbles found along the margin of the stream mouth. These bed materials are expected to be highly permeable. The cobble bar adjacent to Stetattle Creek would be excavated down to 876 ft in elevation, while the water surface of Stetattle Creek would be approximately 883 ft in elevation during the construction period. This would produce up to 7 ft of hydraulic head between the surface of Stetattle Creek and the excavated area of the cobble bar. Due to the high permeability of the streambed materials and hydraulic head, infiltration rates of streamflows under the coffer dam and into the excavation site are likely to be appreciable. Assuming an infiltration rate of 5% of Stetattle Creek flow under the coffer dam, inflows of water into the excavation area under the coffer dam could range from 3 to 10 cfs during the construction period. Such flows would suspend any fine sediment exposed during excavation, and at least some of these suspended fine sediment particles would be expected to flow into the reservoir.

As described previously, a TESC or turbidity management plan would be developed and implemented to maintain turbidity levels in the reservoir 300 feet downstream of the excavation site below Ecology's water quality criteria for aquatic life in fresh water, which is 5 NTU above natural background levels for native char spawning and rearing areas (WDOE 2011). This plan could involve the collection of turbid water within the excavation area. This turbid water would then be pumped out of the excavation area and treated at a settling basin area, which would likely be located within the boat launch area of the Gorge Lake campground. Following treatment, the water would be released back into the reservoir. If there are substantial amounts of silt- and clay-sized particles, it may be necessary to use other BMPs, such as a pump and treat system using sand or chitosan filters. There is sufficient area near the boat launch area to accommodate a sufficient number of Baker tanks equipped with such filtration equipment.

If the TESC plan was not effective in containing runoff water from the construction site, excavation of the cobble bar would likely result in the flushing of some fine sediments from the cobble bar project area into the adjacent reservoir. Although the surface layer of the cobble bar is composed primarily of course bed materials ranging from large gravels to small boulders (R2 Resource Consultants 2013), recent accumulations of fine sediments (less than 1 mm diameter) are evident upon the surface of the bar. Deposits of fine sediment are likely to be present under the armored surface layer of the cobble bar, and these would be exposed during the excavation process. The amount of fine sediment stored in the bar is unknown.

Assuming that 1 percent of the cobble bar excavation area is composed of fine sediments on a volumetric basis, then a maximum of 446,000 pounds of sediment could enter the reservoir during the seven-week excavation period. Most of this sediment would enter the reservoir during Phase III of the project, a three-week period when the cobble bar would be excavated below the water level of Stetattle Creek. With flows in Gorge Reservoir managed at 2,700 cfs during this period (see Section III), the suspended sediment load would be expected to increase by 1.5 mg/l due to excavation. This suspended sediment load would result in increased turbidity levels that would average 0.7 NTU, which is under the 5 NTU maximum turbidity increase over background allowed under Ecology's water quality standards for native char spawning and rearing (WDOE 2012).

If 5 percent of the cobble bar excavation area is composed of fine sediments on a volumetric basis, then a maximum of 2,238,000 pounds of fine sediment could enter the reservoir during the excavation period. The suspended sediment load in the reservoir downstream of the excavation area would be expected to increase by 7 mg/l over background conditions during the three-week Phase III period. This would result in an estimated 4 NTU increase in turbidity levels, which would be slightly less than the maximum increase allowed by state water quality standards (5 NTU) for native char spawning and rearing waters.

Not all fine sediments within the cobble bar disturbed by excavation would move into the reservoir; a significant portion would be removed by the excavator and some (sand-sized particles) will drop out within the confines of the coffer dams or temporary settling pond in the boat launch area. Consequently, suspended sediment and turbidity levels in Gorge Lake would likely be substantially less than estimated for the scenarios described above during the excavation period. Assuming that 30 percent of the sediment was successfully captured by the excavator shovel and removed from the site, suspended sediment loads would not be expected to exceed 5 mg/l over background, and turbidity levels would not be expected to exceed 3 NTU over background, throughout most of the excavation period. Suspended sediments loads may occasionally exceed these values for periods of less than a day if a major fine sediment deposit is exposed during excavation.

Suspended sediment concentrations in the reservoir downstream of the excavation area would be far less than the values determined to cause injury or mortality salmonid fish including juvenile and adult bull trout. Based upon a literature review of suspended sediment impacts related to dredging, suspended sediment concentrations would have to exceed 1,000 mg/l to cause mortality levels of 25 percent or greater in juvenile and adult salmonids for a 30 day exposure period (Wilber and Clarke 2001). The estimated maximum of 7 mg/l suspended sediment concentration in the reservoir caused by excavation would not be expected to result in injuries or mortalities to juvenile and adult bull trout.

However, the suspended sediment concentrations and elevated turbidity levels caused by the excavation would likely result in minor behavior effects to juvenile and adult bull trout in the reservoir downstream of the excavation area. A literature review on the effects of suspended sediments related to dredging activities found that the lower threshold for behavior impacts to juvenile and adult salmonid fish was approximately 3 mg/l for exposures of one week or more (Wilber and Clarke 2001). Newcombe (2003) developed an impact assessment model on water clarity that predicted that turbidity levels of 3 NTU and greater would cause behavior impacts to salmonid fish for exposure durations ranging from 2 to 7 weeks. Under the range of suspended sediment and turbidity values expected to result from the proposed excavation juvenile and adult salmonid fish may exhibit behaviors such as alarm reaction, abandonment of habitat cover, and avoidance (Newcombe and Jensen 1996).

Elevated turbidity levels would affect a small percentage of adult bull trout in the reservoir, since recent acoustic tagging data suggest that most adult bull trout in Gorge Reservoir are found in the 31.5 acre tailrace pool located upstream of the excavation area throughout the entire year, including the July through September period for the proposed excavation (SCL unpublished data, Dec. 5, 2013). Any adult bull trout exposed to higher turbidity levels in the reservoir downstream of the excavation site would likely move quickly into less turbid areas of the reservoir, including the deep tailwater pool which appears to be their preferred reservoir habitat area. Elevated turbidity levels would likely impact juvenile bull trout rearing within the stumps and boulders located along the SR 20 causeway, and along the north shore of the reservoir in the delta zone upstream of the causeway. Fish in these areas would be impacted mainly by reduced foraging efficiency due to reduced visibility

(Berg and Northcoat 1985; Newcombe 2003). Reduced foraging efficiency over a short duration of time would not be expected to affect the growth or survival of these juvenile fish. Juvenile bull trout residing in Stetattle Creek would not be impacted by these elevated suspended sediment and turbidity levels.

In the unlikely event that the TESC plan or turbidity management plan fails to successfully control turbidity below the 5 NTU threshold, the proposed project would be expected result in suspended sediment concentrations that would be approximately 5 mg/l for a period of three weeks (i.e., the Phase III excavation period). The USFWS (Muck 2010) has developed a "severity of ill effects" (SAV) scoring system that can be used to evaluate the effects of elevated suspended sediment concentrations on bull trout based upon a model for salmonid fish developed by Newcombe and Jensen (1996). Using the USFWS's sediment impacts scoring system, the proposed excavation project would result in a SAV score of 5 for juvenile and adult bull trout. This SAV score would fall within the USFWS threshold for "harassment," but would not exceed the threshold for "harm." The most likely biological consequences of this "harassment" are described earlier, and would include the short-term displacement of individual fish from habitat cover, and reduced foraging efficiency of these fish due to turbid water conditions in the reservoir immediately downstream of the excavation area.

Water samples will be collected in the reservoir 300 feet downstream of the excavation site throughout the excavation period to verify turbidity values do not exceed 5 NTUs above background levels. If turbidity values exceed this maximum concentration, then suspended sediment concentrations would be determined from grab samples collected 300 feet downstream of the excavation site to verify that they did not exceed 20 mg/l for over 7 hours, which is the USFWS threshold for "adverse effects" to bull trout for a period of less than one day (Muck 2010). Due to logistical challenges in obtaining grab samples on an hourly basis for determining suspended sediment calculations, we propose to use measurements of turbidity as a surrogate for suspended sediment values. A site-specific regression equation would be used to predict suspended sediment from turbidity, with the data required for this regression collected in Gorge Reservoir downstream of Stetattle Creek over the range of turbidity conditions. Turbidity would be monitored on a continuous basis during the excavation period using an YSI Mode 6600 DataSonde outfitted with an optical turbidity probe that meets EPA turbidity monitoring standards.

The transportation of the excavation materials, and the deposition of these materials at the Copper Creek Quarry disposal site, is not expected to have any effects on bull trout. Both the SR 20 transportation route and the quarry site are located outside of the ordinary high water mark of the Skagit River.

Long-Term Impacts of Proposed Project

Zone 1. The mouth of Stetattle Creek would be moderately altered in terms of habitat conditions as a result of the cobble bar excavation. The upper end of the mouth below the bridge would transition from a stream pool tail-out to a stream run habitat after the excavation of the cobble bar. Substrates in this upper section of the mouth (Zone 1a) would continue to be dominated by cobbles and large gravels. Depth and velocities would be expected to be similar to those observed under existing conditions. The lower end of the stream mouth (Zone 1b) would become a riverine riffle, with most of the flows in this area originating from the Diablo Powerhouse tailrace. The mean depth of Zone 1b is predicted to be 3.2 ft under low flows (Table 2), 4.0 ft under median flows (Table 3), and 4.4 ft under high flows (Table 4). Mean velocities of 2.3 ft/sec are predicted under low flows, 3.4 ft/sec under median flows, and 4.3 ft/sec under high flows, respectively. Substrates would be expected to remain similar to those observed under existing conditions, consisting of primarily cobbles and large gravels. Hence, the lower section of the mouth of Stetattle Creek would remain riffle habitat but would have riverine rather than stream characteristics. The total area of aquatic habitat predicted in Zone 1 under post-project conditions would be 0.49 acres under median flow conditions.

Zone 2. Excavation of the cobble bar would convert the ephemeral side channel habitat found in Zone 2 to riverine riffle habitat. This area would become a mixing zone for water flowing out of Stetattle Creek with river water originating from the Diablo Powerhouse. For this reason, Zones 2 would be expected to possess both stream and riverine characteristics, resulting in heterogeneous aquatic habitats, a condition that is particularly valuable for fish and invertebrates. Zones 2 would become an aquatic habitat transition area that has ecological characteristics similar to those found at the confluence of Stetattle Creek and Gorge Lake under current conditions. Zone 2 would be expected to become riffle habitat. A total of 0.21 acres of aquatic habitat would be present in Zone 2 under post-project conditions.

Without habitat mitigation structures, velocities in Zone 2 would be expected to exceed 3.0 ft/sec under median and high flow conditions, which would be too fast for juvenile bull trout foraging and rearing. The habitat cover provided by small cobbles in this area would not provide an adequate refuge from velocities without the addition of habitat mitigation structures along the bank. In order to reduce velocities to suitable levels for juvenile bull trout, a total of eight natural root wad structures would installed in the bank along Zone 2 as habitat mitigation (see Figure 8 and 9). These root wad structures would extend 10 ft into the current from the bank, and would reduce velocities to the range preferred by juvenile bull trout. The root wads would provide complex habitat cover for that would protect these juvenile fish from predators including large bull trout. The root wads would also provide a complex surface area that would support a diverse assemblage of macroinvertebrates, thus improving the forage base for young bull trout in this zone. Juvenile bull trout residing in these root wad structures would also be able to forage on drifting invertebrates originating from Stetattle Creek.

For the purpose of estimating mean depth and velocity conditions provided by the large wood mitigation structures, we divided Zone 2 into a bank subzone (Zone 2a) and a non-bank subzone (Zone 2b); (see Figure 20). Mean depths in Zone 2a following installation of the eight large wood structures would be 2.6 ft under low flow conditions (Table 2), 2.8 ft under median flow conditions (Table 3), and 3.2 ft under high flow conditions (Table 4). Mean velocities in Zone 2a would be 0.3 ft/sec for low flows, 0.4 ft/sec for median flows, and 0.5 ft/sec for high flows. Juvenile bull trout in western Washington prefer depths between 1.2 ft and 2.9 ft, and velocities between 0.3 and 2.0 ft/sec (Beecher and Caldwell 2013). Consequently, the depths and velocities provided in Zone 2a by the root wad habitat mitigation structures would be nearly ideal for juvenile bull trout.

Mean depths in Zone 2b (non-bank side of zone) are predicted to be 3.4 ft under low flows (Table 2), 3.9 ft under median flows (Table 3, and 4.4 ft under high flows (Table 4). Mean velocities in Zone 2b would be 2.7 ft/sec for low flows, 3.8 ft/sec for median flows, and 4.9 ft/sec under high flows. This range of velocities would be unsuitable for juvenile bull trout rearing, though bull trout residing in Zone 2a could feed on drifting macroinvertebrates present in Zone 2b.

Zone 3. Excavation of the cobble bar would convert the backwater side channel habitat currently found in Zone 3 into riverine run habitat. The total amount of aquatic habitat predicted in this zone under post-project conditions would be 0.49 acres. Like Zone 2, this habitat area would be a mixing zone of water from Stetattle Creek and the free-flowing section of the reservoir. This zone was also split into two subzones in order to estimate depths and velocities along the bank (see Figure 20). For Zone 3a, which is located along the bank of the reservoir, mean depths would be 3.4 ft under low flow conditions (Table 2), 3.6 ft under median flow conditions (Table 3), and 3.8 ft under high flow conditions (Table 4). Mean velocities would be 1.2 ft/sec for low flows, 2.0 ft/sec for median flows, and 2.8 ft/sec for high flows. The range of depths and velocities predicted in this zone would be highly suitable for juvenile bull trout rearing. Good habitat cover for juvenile bull trout would be provided in Zone 3a by large cobbles and overhanging riparian vegetation.

Mean depths in Zone 3b (non-bank side of zone) would be 7.3 ft under low flows (Table 2), 7.5 ft under median flows (Table 3), and 7.8 ft under high flows (Table 4). Mean velocities in Zone 3b would be 1.7 ft/sec for low flows, 2.8 ft/sec for median flows, and 3.9 ft/sec under high flows. This zone would provide habitat conditions that were suitable for juvenile bull trout, though less so compared to conditions found in Zone 3a.

Zone 4. The dry cobble bar in Zone 4 would be replaced by free-flowing reservoir habitat following completion of the excavation project. Given the 1.1% channel gradient of this habitat zone following excavation, this newly formed aquatic habitat area would be best classified as a deep riffle with an area of 1.06 acres. Mean depths in this zone are predicted to be 3.4 ft under low flows (Table 2), 4.0 ft under median flows (Table 3), and 4.4 ft under high flow (Table 4). Median velocities would be 2.6 ft/sec for low flows, 3.9 ft/sec for median flows, and 4.7 ft for high flow. The depth and velocities within this zone would be marginally suitable for juvenile bull trout under low flow conditions, but would be unsuitable for these fish under median and high flow conditions. Based upon substrates observed in similar habitat found at the lower end of the Stetattle Creek mouth, dominant substrates in the newly formed channel area would be cobbles and large gravels.

Zone 5. The gravel bar area located along the right bank of the river immediately upstream of the confluence of Stetattle Creek (Zone 5) would be expected to downcut following excavation, becoming a riverine riffle. Mean depths in this zone would be 3.0 ft under low flow conditions (Table 2), 4.0 ft under median flow conditions (Table 3), and 4.4 ft under high flow conditions (Table 4). Mean velocities would be 1.9 ft/sec for low flows, 2.9 ft/sec for median flows, and 3.9 ft/sec for high flows. The velocities in this zone would be suitable for juvenile bull trout under low flow conditions only. Substrates in this zone would continue to be dominated by small cobbles and large gravels following excavation of the cobble bar.

Zones 6 and 7. Flows from Diablo Powerhouse and Stetattle Creek are currently confined to a narrow channel (Zones 6 and 7) located between to the cobble bar and a bedrock wall located along the left bank of the reservoir. Under normal operating conditions, this channel has an average width of about 135 ft. Following completion of proposed cobble bar excavation, the flows will spread out over a much wider channel area. This new channel would average 250 ft in width. Velocities would be substantially lower in the rapids habitat adjacent to the cobble bar (Zone 6) and the deep run located immediately downstream of the rapids (Zone 7) under post-project conditions. This reduction in velocities would result from the expansion of this free-flowing section of the river from an average width of 135 ft under current conditions to 250 ft under post-project conditions. Mean depths in Zone 6 would be 4.4 ft for low flows (Table 2), 5.0 ft for median flows (Table 3), and 5.4 ft for high flows (Table 4). Mean velocities in Zone 6 would be 3.0 ft/sec under low flow conditions, 4.4 ft/sec under median flow conditions, and 5.3 ft/sec under high flow conditions. Rapids created by hydraulic jump (i.e., standing waves formed by supercritical velocities) would no longer be present in this zone following excavation of the cobble bar, since velocities throughout most of the Zone 6 would substantially lower than those occurring under existing conditions. These velocities would be marginally suitable for juvenile bull trout primarily at low flows. Substrates would be expected to remain dominated by small boulders and large cobbles. For this reason, Zone 6 would be best characterized as riverine run habitat under post-construction conditions.

Mean depths in Zone 7 would be 8.5 for low flows (Table 2), 8.7 ft for median flows (Table 3), and 9.1 ft for high flows (Table 4). Mean velocities in the deep run habitat zone (Zone 7) would be 2.1 ft/sec under low flow conditions, 3.3 ft/sec under median flow conditions, and 4.5 ft/sec under high flow conditions. Velocities would be suitable to juvenile bull trout only at low flows and marginally suitable at median flows. This zone would continue to provide deep run habitat under post-project conditions, but with velocities that were suitable for adult rainbow trout and not juvenile bull trout.

Gorge Lake above the confluence of Stetattle Creek. The water surface elevation of Gorge Lake tailrace pool would be reduced by up to 2.7 ft following removal of the cobble bar. This reduction in pool elevation would have a minor impact on adult habitat use, with average water depths changing from 28.5 to approximately 26 ft.

Gorge Lake downstream of the excavation site. This area of the reservoir would not be affected by removal of the cobble bar following completion of the excavation project.

Stetattle Creek upstream of Diablo Road bridge. Heading cutting is not expected to occur in Stetattle Creek following removal of the cobble bar. There are two reasons for this. First, there is a deep scour pool present in Stetattle Creek under the bridge that will be several feet deeper than the level of cobble bar area following excavation (Figure 29). This pool, which is formed where Stetattle Creek turns at an angle into riprap located under the bridge, has a maximum depth of 8.5 ft under late summer and fall (75 cfs) flow conditions. Head cutting would be initiated from this deep pool under existing conditions. However, none is evident in the stream channel upstream of the pool even though it has been present since the bridge was constructed in the 1940s. Second, the outlet area of Stetattle Creek will become a depositional area due to the backwater of the reservoir, which will extend under the bridge merging with the deep scour pool following cobble bar removal.

Table 2. Characteristics of major habitat zones at excavation site for existing and post-project conditions, low flow conditions (2,400 cfs). Habitat suitability and weighted usable area (WUA) values are for juvenile bull trout.

EXISTING CONDITIONS

Habitat Zone	Habitat Description	Total Area (acres)	Wetted Area (acres)	Substrate	Mean Depth (ft)	Mean Velocity (ft/sec)	Substrate Suitability	Depth Suitability	Velocity Suitability	Composite Suitability Index	Weighted Usable Area
1a	Stetattle Creek upper mouth	0.20	0.20	small cobble / large gravel	1.4	0.7	0.50	0.81	0.78	0.32	0.06
1b	Stetattle Creek lower mouth	0.29	0.19	small cobble / large gravel	1.3	1.3	0.50	0.74	0.59	0.22	0.04
2	Ephemeral side channel	0.21	0.00	small cobble / large cobble	dry	dry	0.50	0.00	0.00	0.00	0.00
3	Backwater side channel	0.49	0.38	small cobble / large cobble	1.9	0.0	0.50	0.99	0.25	0.12	0.05
4	Cobble bar	1.06	0.00	large cobble / small cobble	dry	dry	0.70	0.00	0.00	0.00	0.00
5	Upper Gravel bar	0.56	0.45	large gravel / small cobble	0.8	0.8	0.30	0.20	0.78	0.05	0.02
6	Rapids	1.08	1.08	large cobble / small boulder	3.5	6.7	0.70	0.55	0.00	0.00	0.00
7	Deep Run	0.59	0.59	large cobble / small boulder	9.8	3.3	0.70	0.02	0.14	0.00	0.00
Total		***4.48***	***2.89***								***0.17***

POST-PROJECT CONDITIONS

Habitat Zone	Habitat Description	Total Area (acres)	Wetted Area (acres)	Substrate	Mean Depth (ft)	Mean Velocity (ft/sec)	Substrate Suitability	Depth Suitability	Velocity Suitability	Composite Suitability Index	Weighted Usable Area
1a	Stetattle Creek upper mouth	0.20	0.20	large boulders / small cobble	1.4	0.7	1.00	0.81	0.78	0.63	0.13
1b	Riverine Riffle	0.29	0.29	small cobble / large gravel	3.2	2.3	0.50	0.55	0.42	0.12	0.03
2a	Riverine riffle (bank side with root wad habitat structures)	0.12	0.12	Rootwad/small cobble	2.6	0.3	1.00	0.85	0.64	0.54	0.07
2b	Riverine riffle (non-bank side)	0.09	0.09	large cobble/small cobble	3.4	2.5	0.70	0.55	0.39	0.15	0.01
3a	Riverine run (bank side with overhanging riparian vegetation)	0.25	0.25	large cobble / low vegetation	3.4	1.2	1.00	0.55	0.61	0.34	0.08
3b	Riverine run (non-bank side)	0.24	0.24	large cobble / small cobble	7.3	1.7	0.70	0.29	0.52	0.11	0.03
4	Riverine Riffle	1.06	1.06	large cobble / small cobble	3.4	2.6	0.70	0.55	0.37	0.14	0.15
5	Riverine Riffle	0.56	0.56	small cobble/large gravel	3.0	1.9	0.50	0.55	0.49	0.13	0.08
6	Riverine Run	1.08	1.08	large cobble / small boulder	4.4	3.0	0.70	0.55	0.31	0.12	0.13
7	Deep Run	0.59	0.59	large cobble / small boulder	8.5	2.1	0.70	0.16	0.46	0.05	0.03
Total		***4.48***	***4.48***								***0.73***

Table 3. Characteristics of major habitat zones at excavation site for existing and post-project conditions, median flow conditions (4,000 cfs). Habitat suitability and weighted usable area (WUA) values are for juvenile bull trout.

EXISTING CONDITIONS

Habitat Zone	Habitat Description	Total Area (acres)	Wetted Area (acres)	Substrate	Mean Depth (ft)	Mean Velocity (ft/sec)	Substrate Suitability	Depth Suitability	Velocity Suitability	Composite Suitability Index	Weighted Usable Area
1a	Stetattle Creek upper mouth	0.20	0.20	small cobble / large gravel	1.7	1.1	0.50	1.00	0.62	0.31	0.06
1b	Stetattle Creek lower mouth	0.29	0.24	small cobble / large gravel	1.4	1.6	0.50	0.81	0.54	0.22	0.05
2	Ephemeral side channel	0.21	0.00	small cobble / large cobble	dry	dry	0.50	0.00	0.00	0.00	0.00
3	Backwater side channel	0.49	0.38	small cobble / large cobble	1.9	0.0	0.50	0.99	0.25	0.12	0.05
4	Cobble bar	1.06	0.00	large cobble / small cobble	dry	dry	0.70	0.00	0.00	0.00	0.00
5	Upper Gravel bar	0.56	0.50	large gravel / small cobble	0.9	1.4	0.30	0.23	0.57	0.04	0.02
6	Rapids	1.08	1.08	large cobble / small boulder	3.7	9.3	0.70	0.55	0.00	0.00	0.00
7	Deep Run	0.59	0.59	large cobble / small boulder	9.9	5.4	0.70	0.01	0.00	0.00	0.00
Total		***4.48***	***2.99***								***0.18***

POST-PROJECT CONDITIONS

Habitat Zone	Habitat Description	Total Area (acres)	Wetted Area (acres)	Substrate	Mean Depth (ft)	Mean Velocity (ft/sec)	Substrate Suitability	Depth Suitability	Velocity Suitability	Composite Suitability Index	Weighted Usable Area
1a	Stetattle Creek upper mouth	0.20	0.20	large boulders / small cobble	1.7	1.1	1.00	1.00	0.62	0.62	0.12
1b	Riverine Riffle	0.29	0.29	small cobble / large gravel	4.0	3.4	0.50	0.55	0.05	0.01	0.00
2a	Riverine riffle (bank side with root wad habitat structures)	0.12	0.12	Rootwad/small cobble	2.8	0.4	1.00	0.81	0.85	0.69	0.08
2b	Riverine riffle (non-bank side)	0.09	0.09	large cobble/small cobble	3.9	3.8	0.70	0.55	0.00	0.00	0.00
3a	Riverine run (bank side with overhanging riparian vegetation)	0.25	0.25	large cobble / low vegetation	3.6	2.0	1.00	0.55	0.47	0.26	0.06
3b	Riverine run (non-bank side)	0.24	0.24	large cobble / small cobble	7.5	2.8	0.70	0.27	0.34	0.06	0.02
4	Riverine Riffle	1.06	1.06	large cobble / small cobble	4.0	3.9	0.70	0.55	0.00	0.00	0.00
5	Riverine Riffle	0.56	0.56	small cobble/large gravel	4.0	2.9	0.50	0.55	0.32	0.09	0.05
6	Riverine Run	1.08	1.08	large cobble / small boulder	5.0	4.4	0.70	0.54	0.00	0.00	0.00
7	Deep Run	0.59	0.59	large cobble / small boulder	8.7	3.3	0.70	0.14	0.14	0.01	0.01
Total		***4.48***	***4.48***								***0.35***

Table 4. Characteristics of major habitat zones at excavation site for existing and post-project conditions, high flow conditions (5,800 cfs). Habitat suitability and weighted usable area (WUA) values are for juvenile bull trout.

EXISTING CONDITIONS

Habitat Zone	Habitat Description	Total Area (acres)	Wetted Area (acres)	Substrate	Mean Depth (ft)	Mean Velocity (ft/sec)	Substrate Suitability	Depth Suitability	Velocity Suitability	Composite Suitability Index	Weighted Usable Area
1a	Stetattle Creek upper mouth	0.20	0.20	small cobble / large gravel	2.1	1.5	0.50	0.95	0.56	0.27	0.05
1b	Stetattle Creek lower mouth	0.29	0.29	small cobble / large gravel	1.5	2.0	0.50	0.56	0.47	0.13	0.04
2	Ephemeral side channel	0.21	0.00	small cobble / large cobble	dry	dry	0.50	0.00	0.00	0.00	0.00
3	Backwater side channel	0.49	0.38	small cobble / large cobble	1.9	0.0	0.50	0.99	0.25	0.12	0.05
4	Cobble bar	1.06	0.00	large cobble / small cobble	dry	dry	0.70	0.00	0.00	0.00	0.00
5	Upper Gravel bar	0.56	0.56	large gravel / small cobble	1.0	1.9	0.30	0.26	0.49	0.04	0.02
6	Rapids	1.08	1.08	large cobble / small boulder	3.9	12.4	0.70	0.55	0.00	0.00	0.00
7	Deep Run	0.59	0.59	large cobble / small boulder	10.1	7.7	0.70	0.00	0.00	0.00	0.00
Total		***4.48***	***3.10***								***0.16***

POST-PROJECT CONDITIONS

Habitat Zone	Habitat Description	Total Area (acres)	Wetted Area (acres)	Substrate	Mean Depth (ft)	Mean Velocity (ft/sec)	Substrate Suitability	Depth Suitability	Velocity Suitability	Composite Suitability Index	Weighted Usable Area
1a	Stetattle Creek upper mouth	0.20	0.20	large boulders / small cobble	2.1	1.5	1.00	0.95	0.56	0.53	0.11
1b	Riverine Riffle	0.29	0.29	small cobble / large gravel	4.4	4.3	0.50	0.55	0.00	0.00	0.00
2a	Riverine riffle (bank side with root wad habitat structures)	0.12	0.12	Rootwad/small cobble	3.2	0.5	1.00	0.55	1.00	0.55	0.07
2b	Riverine riffle (non-bank side)	0.09	0.09	large cobble/small cobble	4.4	4.9	0.70	0.55	0.00	0.00	0.00
3a	Riverine run (bank side with overhanging riparian vegetation)	0.25	0.25	large cobble / low vegetation	3.8	2.8	1.00	0.55	0.34	0.19	0.05
3b	Riverine run (non-bank side)	0.24	0.24	large cobble / small cobble	7.8	3.9	0.70	0.24	0.00	0.00	0.00
4	Riverine Riffle	1.06	1.06	large cobble / small cobble	4.4	4.7	0.70	0.55	0.00	0.00	0.00
5	Riverine Riffle	0.56	0.56	small cobble/large gravel	4.4	3.9	0.50	0.55	0.00	0.00	0.00
6	Riverine Run	1.08	1.08	large cobble / small boulder	5.4	5.3	0.70	0.50	0.00	0.00	0.00
7	Deep Run	0.59	0.59	large cobble / small boulder	9.1	4.5	0.70	0.10	0.00	0.00	0.00
Total		***4.48***	***4.48***								***0.22***

Figure 29. Photograph of scour pool located under Stetattle Creek bridge. This pool has a maximum depth of 8 ft under low flow conditions (75 cfs).

Aquatic habitat area. Under median flow, there will be a substantial gain in aquatic habitat area following completion of the cobble bar excavation project (Figure 30). The total area of aquatic habitat at the project site (i.e., seven habitat zones combined) would increase from 2.99 acres under existing conditions to 4.48 acre under post-project conditions. Therefore, there would be a net gain of 1.49 acres of aquatic habitat. The greatest gain in aquatic habitat would occur as a result of the inundation of the dry cobble bar (Zone 4) by the free-flowing section of the reservoir water following excavation. This would result in a 1.06 acre gain in riverine riffle habitat. An additional 0.21 acres of aquatic habitat would be created by the subsequent year-round inundation of the ephemeral side channel (Zone 2), which is dry most of the year under existing conditions. Additional riffle habitat would be created by downcutting and inundation of a dry gravel bar located in Gorge Lake immediately upstream of the confluence of Stetattle Creek. Downcutting of this cobble bar would increase riffle habitat in Zone 1 (lower section) by 0.05 acres and in Zone 5 by 0.06 acres. Finally, excavation of the backwater side channel (Zone 3) would increase aquatic habitat by 0.11 acres. Most of the habitat gained would be riverine riffle habitat, which would account for 2.37 of 4.48 acres (53%) of the total habitat that would be present following completion of the project. A total of 1.91 acres of riverine run habitat would be present following project completion, representing 42% of the post-project aquatic habitat at the excavation site. The remaining 0.20 acres of post-project habitat (5%) would be stream riffle habitat below Stetattle Creek bridge.

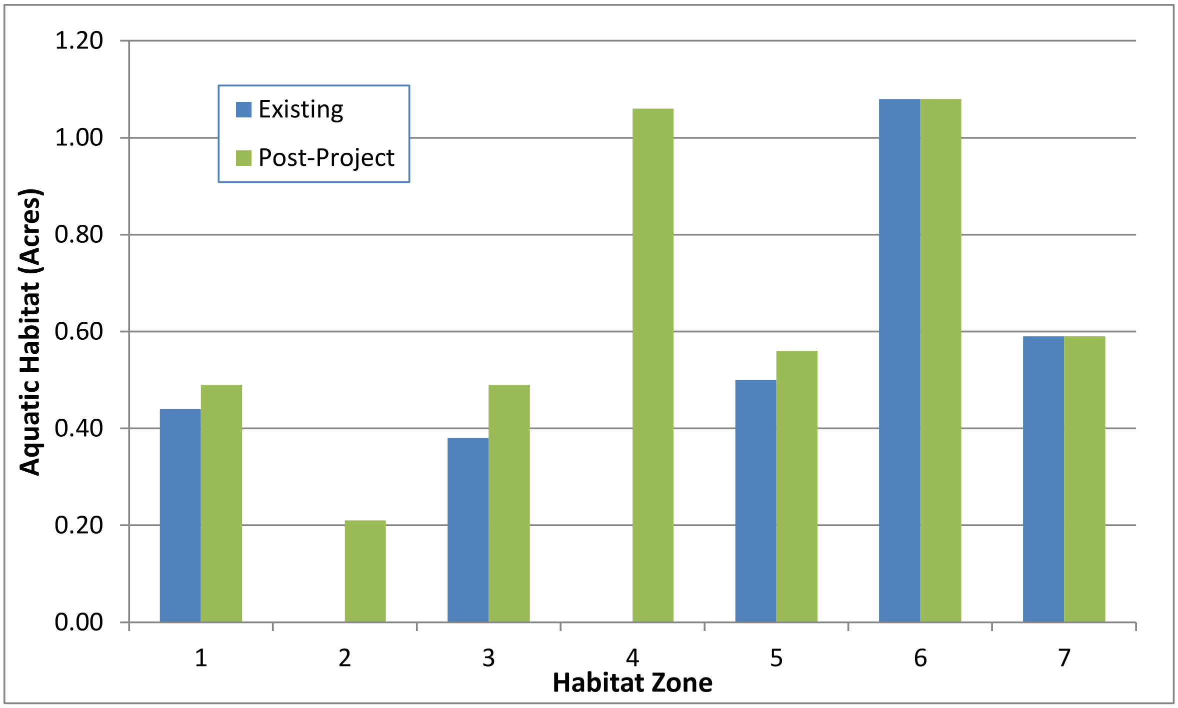

Figure 30. Comparison of aquatic habitat area among seven habitat zones under existing and post-project conditions (median flows).

Juvenile bull trout habitat. The long-term impacts of the excavation project on bull trout habitat were quantified using the Physical Habitat Simulation System (PHABSIM), a fish habitat model developed by the U.S. Fish and Wildlife Service. The weighted usable area (WUA) in each of the seven habitat zones was compared between existing and post-project conditions. WUA is a measure of habitat quantity and quality, and is equivalent to the area of optimal habitat for a given fish species and life stage at a specific flow. Mean depths and velocities within each habitat zone for existing and post-project conditions were estimated using the HEC-RAS hydraulic model developed at the project site by R2 Resource Consultants (2013). The depths and velocities predicted in each of the seven habitat zones is summarized in Table 2 for low flow conditions (2,400 cfs), in Table 3 for median flow conditions (4,000 cfs), and in Table 4 for high flow conditions (5,800 cfs).

Habitat suitability index (HSI) values for these depths and velocities were then calculated using regional preference curves for juvenile bull trout (Beecher and Caldwell 2013). Depths between 0.7 and 9.9 ft are considered suitable, while depths between 1.3 and 2.9 ft are considered optimal, for juvenile bull trout. Velocities ranging from 0.0 to 3.3 ft/sec are considered suitable for juvenile bull trout, while velocities between 0.4 and 0.9 ft/sec are considered optimal. HSI values were also determined for substrates present within each habitat zone under existing conditions, and under post-project conditions with habitat mitigation. A composite suitability index value was then calculated by multiplying the HSI values for velocity, depth, and substrate together. The composite suitability value for each habitat zone was then multiplied by the wetted area of the zone to calculate Weighted Usable Area (WUA) for that zone at a given flow. HSI, composite suitability index, and WUA values for the seven habitat zones are summarized in Tables 2, 3, and 4 for low, median, and high flows, respectively.

For low flow generating conditions (2,400 cfs), juvenile bull trout habitat (measured as weighted usable area) would increase from 0.17 acres under existing conditions to 0.73 acres under post-project conditions (Figure 31). This represents a 4.3 times increase in juvenile bull trout habitat from existing conditions. During low flow generation periods, velocities are sufficiently reduced to support bull trout foraging in all seven habitat zones (see Table 2). Low flow generation typically occurs during the evening and night, a period when juvenile bull trout actively forage for prey. Consequently, habitat conditions for juvenile bull trout foraging will substantially improve following completion of the excavation project.

For median generating flow conditions (4,000 cfs), juvenile bull trout habitat increases from 0.18 acres under existing conditions to 0.35 acres under post-project conditions (Figure 31). This represents a 1.9 times increase in juvenile bull trout habitat from existing conditions. Under median flows, velocities are suitable for juvenile bull trout foraging in Zone 1A (Stetattle Creek mouth with large boulder mitigation), Zone 2A (upper right bank with root wad mitigation structures), Zone 3A (lower right bank), Zone 3B (deep run adjacent to lower right bank), Zone 5 (gravel bar above Stetattle Creek), and Zone 7 (deep riverine run); (see Table 3).
For high generating flow conditions (5,800 cfs), juvenile bull trout habitat increases from 0.16 acres under existing conditions to 0.22 acres under post project conditions (Figure 31). This represents a 1.4 times increase in habitat area from existing conditions. During high generation flow periods, which occur 10% of the time, juvenile bull trout foraging would be supported in Zones 1a (Stetattle Creek mouth with large boulder mitigation), Zone 2A (upper right bank with root wad mitigation structures), and Zone 3A (lower right bank); (see Table 4). High generation flows typically occur during the day, a period when juvenile bull trout foraging is typically minimal. The mitigation structures (root wads and large boulders) provide important velocity refuge habitat during these high flow periods. These structures provide juvenile bull trout a suitable area to hold during daytime periods when flows can become high.

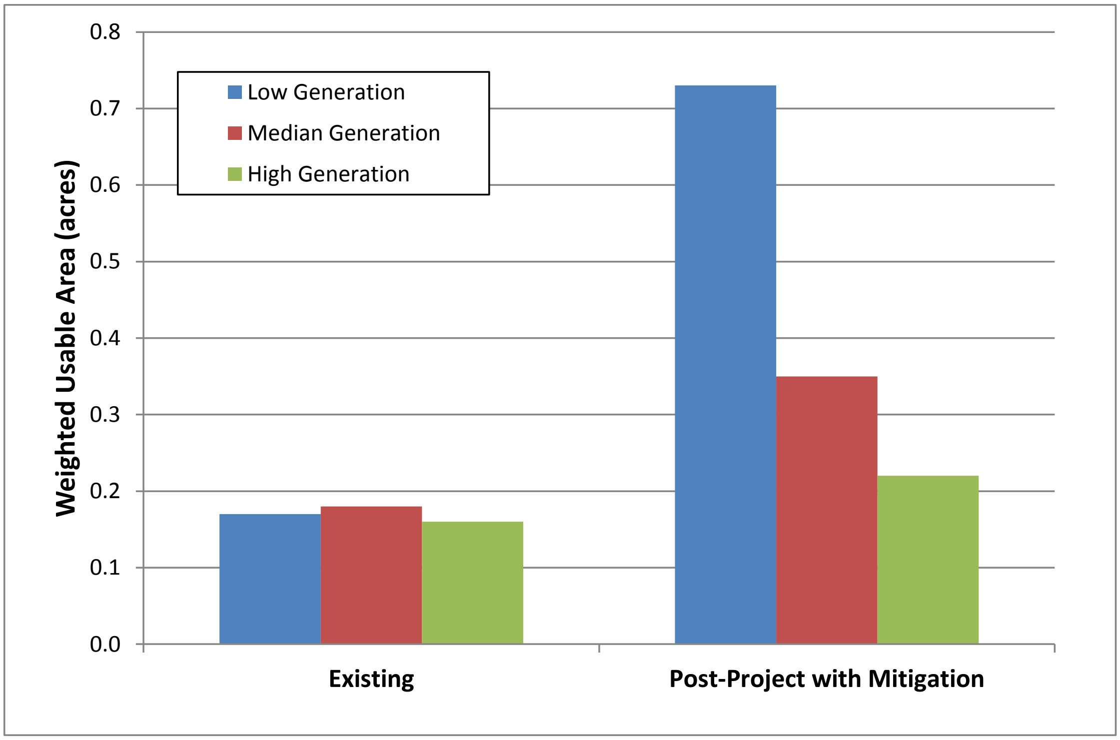

Figure 31. Comparison of juvenile bull trout weighted usable area values between existing and post-project conditions for low, median, and high generation flows.

Post-Project Monitoring

Monitoring of the thalweg profile of Stetattle Creek will be conducted annually for 5 years following excavation to insure that head cutting does not occur. After 5 years, monitoring would be only after a 5-year or greater magnitude flood event. If head cutting occurs following cobble bar removal, then appropriate engineering actions (e.g., installation of log and boulder structure) will be implemented to alleviate this problem. Stetattle Creek above the bridge is dominated by riffle, run, and cascade habitat having fast current velocities even under low flow conditions during the fall. Rainbow and adult bull trout have been observed holding in this section of the Skagit River, but no spawning has been observed in this area. Juvenile bull trout have been observed in Stetattle Creek in the section immediately above and below the bridge during night snorkel surveys conducted by SCL in 2010. Juvenile bull trout have also been captured by electrofishing in this section of the stream (Smith 2010).

Determination of Effects

The number of bull trout in Gorge Lake is relatively small compared to the total population found in the Upper Skagit Core Area. The proposed cobble bar removal, when combined with the proposed onsite mitigation measures, will result in a net increase in habitat suitable for juvenile and adult bull trout in the project area. The proposed project "***may affect, but is not likely to adversely affect"*** bull trout.

VI. *Critical Habitat*

Critical habitat is designated for areas containing the physical and biological habitat features, or primary constituent elements (PCEs) essential for the conservation of the species or that require special management consideration. PCEs include sites that are essential to supporting one or more life stages of the evolutionarily significant unit (ESU) and that contain physical or biological features essential to the conservation of the ESU. No critical habitat has been designated in or near the action area for the northern spotted owl, marbled murrelet, gray wolf, grizzly bear, or Canada lynx.

Critical habitat for bull trout in the Puget Sound DPS was designated by the USFWS (70 FR 56212) September 26, 2005. Under the 2005 designation, Gorge Lake was exempted as critical habitat. Stetattle Creek was designated as critical habitat at the time of this listing. More recently in January, 2010, the USFWS requested, and was granted, a voluntary remand of the 2005 final rule and reconsidered critical habitat designations for bull trout (75 FR 2270). Gorge Lake was designated as critical habitat for bull trout under revised rule finalized by the USFWS on October 18, 2010, which became effective on November 17, 2010 (USFWS 2010).

Seven of the nine PCEs for Coastal-Puget Sound bull trout critical habitat are present in the action area:

- *PCE #1: Permanent water of sufficient quantity and quality such that normal reproduction, growth and survival are not inhibited.*

  Bull trout have not been documented to spawn in Gorge Lake or within the mouth of Stetattle Creek. The most likely spawning for bull trout in the Gorge Lake drainage is Stetattle Creek. The growth and survival of juvenile and adult bull trout residing throughout Gorge Reservoir would be improved by the proposed construction activities with the proposed mitigation measures.

- *PCE #2 - Water temperatures that support bull trout use.*

  Bull trout have been documented in streams with temperatures from 32º to 72º F (0 to 22º C), but are found more frequently in temperatures ranging from 36º to 59º F (2 to 16º C). The temperature ranges used by bull trout may vary depending on their life-history stage and form, geography, elevation, diurnal and seasonal variation, shade (such as that provided by riparian habitat), and local groundwater influences.

Gorge Lake has water temperatures that are typically less than 13ºC throughout the year, which are highly suitable for adult bull trout holding and foraging. Stetattle Creek, including the mouth of this stream, process temperatures are than 10ºC throughout the year. These temperatures are highly suitable for spawning and juvenile rearing, and will remain unchanged following the proposed action.

- *PCE #3 - Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and instream structures.*

  The proposed mitigation measures will provide highly suitable complex stream features for bull trout, including deep water with appropriate velocities adjacent to instream structures that will include large woody debris and large boulders.

- *PCE#4: Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine substrate less than 0.63 cm (0.25 in) in diameter and minimal substrate embeddedness are characteristic of these conditions.*

  Bull trout spawning has not been observed within the proposed action area, except for Stetattle Creek upstream of the bridge. Incubation in Stetattle Creek is not expected to be affected by the proposed action. The proposed project will not introduce fine sediments or contribute to embedded conditions that would potentially adversely affect spawning, survival to emergence, or young-of-the year and juvenile bull trout survival.

- *PCE #5: A natural hydrograph, including peak, high, low, and base flows within historic ranges, or if regulated, currently operate under a biological opinion that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation.*

  This PCE is not applicable to this project, since proposed action will not result in any change to Diablo project flows and Gorge Lake operations, except as required for personnel and equipment safety during the two month construction period.

- *PCE #6: Springs, seeps, groundwater sources, and subsurface water connectivity to contribute to water quality and quantity.*

  The project will not result in any changes to springs, seeps, groundwater sources, or subsurface water connectivity in the area.

- *PCE #7: Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.*

  The proposed project would result in a migration barrier to the upstream passage of juvenile and adult bull trout at the outlet of Stetattle Creek for a short-term period of time following the completion of excavation. The excavation will result in a 2.5 ft drop in water elevation over a 30-ft section of the stream channel located between the deep plunge pool and the excavation area (see Figure 22). This short section of the stream would have an 8.3% water surface gradient, and would have velocities that would exceed 10 ft/sec at flows of 75 cfs and greater. The streambed immediately downstream of the plunge pool would be expected to erode rapidly during winter storm events, so the migration barrier would be expected to only be present for a few weeks to a few months following construction. Nevertheless, the barrier would be expected to block upstream migration during the first bull trout spawning season following construction. Consequently, engineering solutions will be developed as part of the final design to eliminate this upstream passage barrier. These would likely involve contouring the 30-ft section of the stream channel so that the water surface gradient in this section would be reduced to the level where velocities would not exceed 3.0 ft/sec.

- *PCE #8: An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.*

  Rainbow trout, Dolly Varden, bull trout are the predominant fish species in Gorge Lake. Adult bull trout are primarily piscivorous and feed on 1-3 year old rainbow trout throughout the reservoir. Juvenile bull trout residing are primarily insectivorous. The project would slightly reduce the amount of lotic invertebrate production by replacing the existing Stetattle Creek mouth with slower flowing, less productive reservoir habitat. However, the placement of large log and boulder structures at the outlet area of Stetattle Creek will provide an optimal foraging zone for juvenile bull trout that can feed an invertebrate drift originating from Stetattle Creek.

  As describe previously, riverine riffle and run habitats are expected to substantially increase in area following completion of the proposed project (see Figure 30). Riffle habitats are typically the most productive and diverse habitats for aquatic invertebrates in streams and rivers (Hynes 1970; Minshall 1984). Macroinvertebrates have been found to be most abundant and taxonomically diverse in gravel and cobble substrates which have moderate velocities and relatively shallow depths found in riffles and runs (Minshall 1984; Jowett 2003).

The highly productive stream-river mixing zone for aquatic macroinvertebrates found in Zone 1 under current conditions would occur in Zones 2 and 3 under post-project conditions. These areas would be converted to riffle and run habitat following completion of the proposed project with much of the flow in these two areas originating from Stetattle Creek. Thus, the most productive and diverse habitat area for aquatic macroinvertebrates within the project site (i.e., the tributary confluence where stream and reservoir waters mix) would shift from Zone 1 (Stetattle Creek mouth) under existing conditions to Zones 2 and 3 under post-project conditions. The productivity and diversity of the aquatic invertebrate assemblage in Zones 2 and 3 would be further improved by large wood structures and riparian vegetation placed along the banks of these habitat areas as mitigation measures. We are proposing to add large wood structures, including root wads, along the river bank in Zones 2 an 3 to provide complex cover habitat for juvenile bull trout, and to reduce velocities of the channel along the bank to those that suitable for these fish. These large wood structures would also provide a large surface area for aquatic invertebrates to inhabit.

Two aquatic habitat types – riverine rapids and reservoir backwater side channel habitat – will be greatly reduced in area by the cobble excavation project (Figure 2). The rapids habitat found in Zone 6 likely supports a less productive and diverse aquatic invertebrate assemblage than the run habitat that will occur in this area after the project is completed. Aquatic invertebrate abundance and diversity is negatively correlated to areas having high shear velocities and turbulence (Brooks et al. 2005), which are evident in Zone 6 from the presence of hydraulic standing waves in this area. The run habitat formed in Zone 3 following excavation of the cobble bar would provide heterogeneous habitat conditions for aquatic invertebrates because of the presence of cobble and gravel substrates, the presence of complex wood structures, and the mixing of stream and river water. This area would be expected to support a considerably higher diversity and abundance of benthic invertebrates than the zero-velocity backwater habitat that is found within this zone under existing conditions. Consequently, the loss of the rapids and backwater habitat types within the cobble excavation area would be offset by the formation of new habitat types that support a more abundant and diverse aquatic invertebrate assemblage. This would provide an improved forage base for juvenile bull trout.

Waters in the Diablo tailrace remain cold throughout the year, and would therefore be expected to maintain a cold water dominated invertebrate community under post-project conditions. Because of the greater volumes of water originating from the Diablo tailrace in Zones 4 and 5, the forage for invertebrates would be dominated by fine particulate organic matter (FPOM) originating from Diablo Reservoir (allochthonous inputs) and periphyton (autochthonous inputs) growing on riffle substrates, rather than course particulate organic matter (CPOM) originating from leaf matter transported in Stetattle Creek. Consequently, the riverine riffle habitat created by the project would be expected to be more dominated by filter feeders, collector, and grazing macroinvertebrate feeding guilds, with reduced abundance of leaf shredding insects when compared to the macroinvertebrate community found in Stetattle Creek. Additional CPOM trapped by the habitat mitigation wood structures in Zones 2 and 3 would support a greater diversity of aquatic invertebrates, including leaf shredders and wood gougers.

Invertebrate drift densities would be expected to increase in habitat zones adjacent to and downstream of Zone 4 due to the substantial increase in riffle and run habitat that would occur with the excavation project. These increased drift densities would favor rainbow trout (>150 mm length) that are found in relatively high abundance along the low-velocity margins of Zones 6 and 7, and juvenile native char currently observed in the backwater habitat of Zone 3 by NPS (2014). Invertebrate drift produced by the stream riffle habitat in the Zone 1, the riverine riffle habitat in Zones 1 and 5, and the deep riffle habitat in Zone 4 would provide increased forage for the juvenile bull trout that would be expected to reside in Zones 2 and 3 under post-project conditions.

- *PCE #9: Few or no predatory, interbreeding, or competitive and nonnative species present.*

  Bull trout, Dolly Varden, and rainbow trout are the primary fish species present in Gorge Lake, though non-native eastern brook trout are present in low numbers in this reservoir. Bull trout are known to hybridize with Dolly Varden, a native char species, and brook trout, a non-native char species, in Stetattle Creek. However, the proposed project will not increase the abundance of brook trout in the reservoir, or increase the likelihood that bull trout will interbreed with these species in Stetattle Creek. It is unlikely that the project will increase rates of predation, interbreeding or competition with nonnative species. This project will not impact the biological persistence or genetic integrity of bull trout in the Gorge Lake.

To avoid potential impacts on critical habitat for bull trout, a number of onsite mitigation measures including natural root wood structures and large boulder placements will be used to improve habitat conditions for juvenile and adult bull trout in the proposed action area. The proposed project "***may affect, but is not likely to adversely affect"*** critical habitat for bull trout.

VII. *References*

Almack, J.A. 1986. Grizzly bear habitat use, food habits, and movements in the Selkirk Mountains, northern Idaho. Pgs. 150-157 in: G. P. Contreras and K.E. Evans, editors. Proceedings: Grizzly bear symposium. General Technical Report INT 207. U.S. Forest Service.

Almack, J.A. and S.H. Fitkin. 1998. Grizzly bear and gray wolf investigations in Washington State, 1994-1995. Washington Department of Wildlife, Olympia, Washington.

Almack, J.A., W.L. Gaines, R.H. Naney, P.H. Morrison, J.R. Eby, G.P. Wooten, M.C. Snyder, S.H. Fitkin, and E.R. Garcia. 1993. North Cascades Grizzly Bear Ecosystem Evaluation: Final Report. Interagency Grizzly Bear Committee. Denver, Colorado. 156 pp.

Anaka, R.J., and K.J. Scott. 2012. Snorkel survey of trout and char in the Canadian Skagit River: 2011. Report prepared for Skagit Environmental Endowment Commission, North Vancouver, B.C.

Beecher, H., and B. Caldwell. 2013. Instream flow study guidelines: technical and habitat suitability issues including fish preference curves. Wash. State. Dept. of Fish and Wildlife and Wash. Dept. of Ecology. Olympia, Washington.

Berg, L., and T.G Northcote. 1985. Changes in the territorial, gill-flaring, and feeding behavior of juvenile coho salmon (Oncorhynchus kisutch) following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Sciences 42:1410-1417.

Brooks, A.J., T. Haeusler, I. Reinfelds, and S. Williams. 2005. Hydraulic microhabitats and the distribution of macroinvertebrate assemblages in riffles. Freshwater Biology 50: 331-344.

Cramer, Michelle L. (managing editor). 2012. Stream Habitat Restoration Guidelines. Co-published by the Washington Departments of Fish and Wildlife, Natural Resources, Transportation and Ecology, Washington State Recreation and Conservation Office, Puget Sound Partnership, and the U.S. Fish and Wildlife Service. Olympia, Washington.

Downen, M. 2005. Diablo Reservoir fish community baseline: 2005 survey and fish management plan. Wash. Dept. of Fish and Wildlife, La Conner, Washington.

Downen, M. 2012. Ross Lake rainbow brood stock program, upper Skagit reservoir fish community surveys, and upper Skagit Reservoir fish community surveys and management plan. Draft report prepared for Seattle City Light. Wash. Dept. of Fish and Wildlife, Olympia, Washington.

FISRWG. 1998. Stream corridor restoration: principles, processes, and practices. By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US gov't). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3.

Hamer Environmental, L.P. 2009. Use of audio-visual surveys to determine the presence/probable absence of marbled murrelets in North Cascades National Park, Washington. Final report prepared for North Cascades National Park. August 21, 2009.

Hamer, T. 1995. Inland habitat associations of marbled murrelets in western Washington. Pp 163-175 In.: Ecology and Conservation of the marbled murrelet (C.J. Ralph, G.L. Hunt, M.G. Raphael, J.F. Piatt, editors). USDA Forest Service, PSW-GTR 152, Albany, California.

Hynes, H.B.N. 1970. The ecology of running waters. Liverpool University Press. Liverpool, England. 555p.

Jowett, I.G. 2003. Hydraulic constraints on habitat suitability for benthic invertebrates in gravel-bed rivers. River Research and Applications 19: 495-507.

Lance, M.M., S.F. Pearson, M. G. Raphael, and T.D. Bloxton. 2009. 2008 At-sea marbled murrelet population monitoring. Research Progress Report. WDFW, Wildlife Science Division, Olympia, Washington. 147 pp.

Madsen, S., D. Evans, T. Hamer, P. Henson, S. Miller, K. Nelson, D. Roby, and N. Stapanian. 1999. Marbled murrelet effectiveness monitoring plan for the Northwest Forest Plan. USDA Forest Service, PNW-GTR 439, Portland, Oregon. 51 pp.

McShane, C., T. Hamer, H. Carter, G. Swartzman, V. Friesen, D. Ainley, R. Tressler, K. Nelson, A. Burger, L. Spear, T. Modhagen, R. Martin, L. Henkel, K. Prindle, C. Strong, and J. Keany. 2004. Evaluation report for the 5-year status review of the marbled murrelet in Washington, Oregon, and California. Unpublished Report, EDAW, Inc. Seattle, Washington. Prepared for the U.S. Fish and Wildlife Service, Region 1.

Minshall, G.W. 1984. Aquatic insect-substratum relationships. In: Resh, V.H., and D.M. Rosenberg (eds.). The ecology of aquatic insects. p. 358-400. Praeger, New York.

Muck, J. 2010. Biological effects of sediment on bull trout and their habitat – Guidance for evaluating effects. U.S. Fish and Wildlife Service, Lacey, Washington. 57 pp.

Newcombe, C.P. 2003. Impact assessment model for clear water fishes exposed to excessively cloudy water. Journal American Water Resources Association 39:529-544.

Newcombe, C.P., and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16(4):693-727.

National Park Service. 1999. National Park Service handbook for the storage, transportation, and use of explosives. Washington D.C. 224 pp.

National Park Service. 2014. Fish and habitat assessment of Stetattle Creek. Report to Seattle City Light. North Cascades National Park, Sedro Woolley, Washington. 50p.R2 Resource Consultants. 2013. Stetattle Creek Cobble Bar Project: preliminary engineering design report. Report prepared for Seattle City Light, Seattle, Washington.

Romain-Bondi, K.A., R.B. Weilgus, L. Waits, W.F. Kasworm, M. Austin, and W. Wakkinen. 2004. Density and population size estimates for the North Cascades grizzly bear using DNA hair-sampling techniques. Biological Conservation 117 (2004): 417-428.

Seattle City Light. 1991. Fisheries Settlement Agreement incorporating anadromous fish flow plan (Flow Plan) and anadromous and resident fish non-flow plan (Non-Flow Plan). Skagit Hydroelectric Project, FERC No. 553.

Seattle City Light. 2011. Biological Evaluation - Skagit River Hydroelectric License (FERC No. 533) Amendment: Addition of second power tunnel at the Gorge Development. Seattle City Light, Seattle, WA.

Seattle City Light. 2012. Biological Evaluation – Supplement: Impacts of entrainment on bull trout. Skagit River Hydroelectric License (FERC No. 533) Amendment: Addition of second power tunnel at the Gorge Development. Seattle City Light, Seattle, WA.

Small, M.P., C. Bowman, and D. Hawkins. 2007. Microsatellite DNA analysis of char population genetic structure in the Pacific Northwest. Wash. Dept. of Fish and Wildife, Science Division, Conservation Biology Unit, Genetics Lab. Olympia, Washington.

Smith, Matt. 2010. Population structure and genetic assignment of bull trout (*Salvelinus confluentus*) in the Skagit River Basin. Report prepared for Seattle City Light. Univ. of Washington, School of Fisheries and Aquatic Sciences, Seattle.

Stinson, D. 2001. Washington state recovery plan for the lynx. Washington Department of Wildlife, Olympia, WA. 78 pp.

Tappel, P. 1989. Ross Lake tributary stream catalog. Report prepared for Seattle City Light, Environmental Affairs Division, Seattle, Washington.

USFWS (United States Fish and Wildlife Service). 1982. Grizzly bear recovery plan. U.S. Fish and Wildlife Service, Denver, Colorado. 195 pp.

USFWS. 1987. Northern Rocky Mountain wolf recovery plan. U.S. Fish and Wildlife Service. Denver, Colorado. 119 pp.

U.S. Fish and Wildlife Service. 1997. Recovery plan for the threatened marbled murrelet (*Brachyramphus marmoratus)* in Washington, Oregon and California. Portland, Oregon. 203 pp.

USFWS. 2008a. Final recovery plan for the northern spotted owl. U.S. Fish and Wildlife Service, Portland, Oregon. 142 pp.

USFWS. 2008b. Bull trout (Salvelinus confluentus) 5-Year Status Review and Evaluation. U.S. Fish and Wildlife Service. Portland, Oregon.

USFWS. 2009. Marbled murrelet (Brachyramphus marmoratus) 5-year review. U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, Washington. June 12, 2009.

USFWS. 2010. Critical Habitat for Bull Trout Puget Sound Unit: 2. http://www.fws.gov/pacific/bulltrout/crithab/index.cfm?unit=2.

USFWS. 2011. Revised Recovery Plan for the Northern Spotted Owl (Strix occidentalis caurina). U.S. Fish and Wildlife Service, Portland, Oregon. xvi + 258 pp.

USFWS. 2004. Draft recovery plan for the Coastal-Puget Sound distinct population segment of bull trout (Salvelinus confluentus). U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS. 2013. Biological Opinion for the Seattle City Light Skagit River Hydroelectric Project, FERC Number 553-221 in Skagit and Whatcom Counties, Washington. U.S. Fish and Wildlife Service, Lacey, Wash. Reference Number 01EWFW00-2012-F-0302.

Wilber, D.H., and D.G. Clarke. 2001. Biological effects of suspended sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Management 21: 855-875.

Wiles, G., H. Allen, and G. Hayes. 2011. Draft wolf conservation and management plan for Washington. Washington Department of Fish and Wildlife. Wildlife Program. Olympia, Washington.

WDOE (Washington Department of Ecology). 2012. Water quality standards for Surface waters of the State of Washington: Amended May 9, 2011. Chapter 173-201A Washington Administrative Code. Washington Department of Ecology, Olympia. Publication no. 06-10-091.

WSDOT (Washington State Department of Transportation). 2011. Advanced training manual. Biological assessment preparation for transportation projects. WDOT Environmental Services, Olympia, Washington.