GOLDSBOROUGH CREEK SECTION 206 RESTORATION PROJECT
Mason County, Washington

ECOSYSTEM RESTORATION REPORT AND ENVIRONMENTAL ASSESSMENT

JULY 1999

U.S. Army Corps of Engineers
Seattle District

EXECUTIVE SUMMARY

S.1 AUTHORITY AND JURISDICTION

This Ecosystem Restoration Report and Environmental Assessment was prepared pursuant to Section 206 of the Water Resources Development Act of 1996 (Public Law 104-303), as amended, and is in accordance with EC 1105-2-214, Project Modifications for Improvement of the Environment and Aquatic Ecosystem Restoration (dated November 1997). The Washington Department of Fish and Wildlife (WDFW), by letter dated December 1997, requested federal assistance in planning, designing and conducting a dam removal and stream restoration project along Goldsborough Creek. Although the project is a partnership between a variety of stakeholders, WDFW is the non-federal sponsor.

S.2 PROJECT BACKGROUND

This report addresses the need and justification for implementing a restoration project along Goldsborough Creek located in the southern Olympic Mountains in western Washington. An existing dam structure located at river mile 2.3 on Goldsborough Creek and associated channel degradation and instability has created a bottleneck in the system that hinders upstream and downstream passage of fish. The dam actually consists of four separate structures or steps with the largest drop at 14 feet and the total vertical drop over the dam of 35 feet. Under the existing conditions access to 14 miles of high value habitat area is severely restricted. Five species of anadromous salmonids (coho, chinook and chum salmon, steelhead and sea-run cutthroat trout) inhabit the lower reach of the creek. Only two of these species, coho and steelhead, can sometimes ascend the existing project reach. Chum salmon are unable to jump high enough to use the present passage facility, and cutthroat trout are too small to manage this passage, these species stand to gain the most significant benefit from restoration. Though chinook have been seen below the dam, they have not been observed above. Each of the species would have significantly higher reliability of accessing the upper watershed with the project in place and would benefit from more stable channel and habitat conditions. However, greater fish numbers tell only part of the story envisioned by the group of tribal, state and federal government and industry officials working together to remove the dam on Goldsborough Creek. With spawning and rearing habitat being continually lost to development throughout the Puget Sound area, the importance of a healthy, useable watershed takes on increasing significance. The Goldsborough Creek watershed is largely undeveloped, most of the watershed is designated long-term forestland in the Mason County Growth Management Plan, and the remainder is designated as rural. What makes this project so appealing is that the dam is the bottleneck to the entire Goldsborough Creek watershed system, and the environmental return in terms of habitat available is so much greater than just what will be accomplished in the project area.

S.3 PROPOSED PLAN

The proposed restoration plan consists of removing a portion of the existing timber pile and concrete structure, excavating material upstream of the dam, placing fill material downstream of the dam and constructing groups of one-foot high steel and vinyl sheet pile weirs to allow for fish passage. These weirs, in combination with fill and excavation of material, will provide necessary grade control. This stepped approach will establish and maintain the necessary gradient for hydraulic continuity, and provide significant improvement in fish passage through the project reach to 14 miles of high value habitat upstream. Habitat features including woody debris, plantings, spawning gravels and boulders have also been incorporated in the project design to support ecosystem functions. The total estimated fully funded Section 206 implementation cost, including planning, engineering, design, construction, construction management and five years of monitoring is $4,277,000. The non-federal sponsor's contribution is estimated at $1,497,000. Simpson Timber Company will be responsible for costs associated with dam removal; these are estimated at $148,000. The total fully funded implementation cost, including dam removal is estimated at $4,320,000. Project construction costs in October 1999 prices are $3,064,000 The recommended plan is incrementally justified, has a reasonable construction cost, minimizes maintenance concerns and has strong local support.

Substantial efforts have been made to reduce any possibility of impacts outside of the project area. The use of sheet pile weirs helps guard against any catastrophic impacts by reducing channel instability and head cutting. As further assurance, retaining a portion of the existing structure to provide further stability has been incorporated into the project design. Bank protection in certain locations has been incorporated to reduce erosion and potential unraveling of project grade control features, and specifying a 40 feet wide channel cross-section to effectively convey flood flows. Additionally, any potential sedimentation impacts that could occur as a result of the implementing the recommended plan have been minimized by setting the upstream channel invert above the railroad trestle at the level of the existing bed. Finally, the potential for any increased erosion, through changes in channel depth or velocity outside the project reach has been minimized in the project design. Increased velocities are expected through the project reach, however the hydraulic model indicates that the water surface profile of the preferred plan matches the existing condition profile downstream of the last weir group, indicating that the weir groups are able to dissipate sufficient energy so that the existing channel controls flow conditions. In other words, implementing the preferred plan should not alter hydraulic conditions below the last element of the project. As such it is not expected that the project as designed will exacerbate existing instabilities downstream of the project reach.

The cornerstone of ecosystem and fishery restoration for Goldsborough Creek is the expected recovery of native anadromous fish runs. Dam removal would result in unobstructed juvenile and adult fish passage and recovery of natural physical processes (i.e., sediment and nutrient transport, hydrology, and temperature regimens) in the lower river. The proposed plan (Weir Group Alternative) is the most effective and efficient alternative, as well as the alternative with the greatest likelihood of success. The recommended plan of using groups of sheet pile weirs with free flowing reaches best meets the Corps planning criteria, the technical design team criteria and has strong local support.

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MASON COUNTY, WASHINGTON

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1. BACKGROUND

1.1. PROJECT AUTHORITY

This Ecosystem Restoration Report and Environmental Assessment (ERR/EA) is submitted under Section 206 authority of the Water Resources Development Act of 1996, P.L. 104-303. This authority authorizes the Secretary of the Army to carry out aquatic ecosystem restoration and protection projects if the Secretary determines that the project will improve the quality of the environment, is in the public interest, and is cost-effective. This ERR/EA is in accordance with EC 1105-2-214, Project Modifications for Improvement of the Environment and Aquatic Ecosystem Restoration. The Washington Department of Fish and Wildlife (WDFW), by letter dated December 1997, requested federal assistance in planning, designing and conducting a dam removal and stream restoration project along Goldsborough Creek.

1.2. STUDY PURPOSE, SCOPE & PARTNERSHIP

1.2.1. Purpose

This report addresses the need and justification for implementing a restoration project along Goldsborough Creek. The project would consist of removing an existing dam structure, which is a hindrance to both upstream and downstream fish passage, and restoring the stream to a more natural gradient. If implemented, the project would allow dwindling salmonid populations to return to one of the last largely unspoiled watersheds in south Puget Sound.

1.2.2. Scope

The scope of the current study and project area is focused on the dam and adjacent areas, including 1,000 feet upstream of the dam and roughly 1,000 feet downstream. Beyond the direct project area, connectivity to the upstream and downstream areas has also been addressed. Flow conveyance considerations have been considered downstream through the City of Shelton to Oakland Bay. The production potential of the watershed upstream of the existing dam has also been considered to assess project benefits.

1.2.3. Corps Involvement & Partnership with Other Entities

The Goldsborough Creek Restoration Project was born of a motivated team of private, governmental and tribal interests, and continues to benefit from this broad base of support. The project stakeholders and partners include WDFW, Simpson Timber Company (Simpson), The Squaxin Island Tribe (Squaxins), and the US Fish and Wildlife Service (USFWS). The Corps of Engineers, at the request of the WDFW, requested funding under Section 206 of WRDA 1996 to conduct a reconnaissance evaluation for the proposed project. The Corps received funding in January 1998 to prepare the Preliminary Restoration Plan, which is the vehicle used to determine whether there is federal interest to continue to the more detailed feasibility phase. The Preliminary Restoration Plan was submitted to Corps Headquarters in April 1998. The District received approval and funding to begin the feasibility phase in August 1998 with a scheduled completion of the feasibility phase in September 1999. The feasibility phase culminates in the approval of the ERR/EA, and funding to initiate plans and specifications.

1.3. PROJECT LOCATION AND HISTORY

The project is located in Southwest Washington, just west of the City of Shelton in Mason County (approximately 20 miles northwest of Olympia, Washington). Reference figure 1 for a vicinity map. The existing dam is located at river mile 2.3 on Goldsborough Creek. Downstream of the project area, the creek runs through the City of Shelton and empties into Oakland Bay. Oakland Bay is a saltwater body that connects with Puget Sound. Upstream of the project the creek flows freely through forested areas, draining approximately 51.4 square miles of high quality habitat. Figure 2, a site map, shows the Goldsborough Creek drainage area.

The existing Goldsborough Creek Dam actually consists of four structures or steps. Figure 3 is a recent photo of the structure looking upstream. The primary structure is a fourteen-foot timber wall dam constructed in 1921. The structure was built to provide hydroelectric power to the City of Shelton, which operated the project in this capacity for several years. Rainier Pulp and Paper Company purchased and modified the dam in the 1930's, adding a 30-inch-diameter wood-stave pipeline to use the structure as an intake and diversion facility to provide water for cooling, fire protection, and for use in boilers at the mill site. Sometime during the 1930's, the structure was also widened to approximately 100 feet. It is likely that this widening contributed to extensive erosion downstream. The dam has a horizontal timber and plywood spillway supported by timber piles. The spillway discharges onto a shallow, concrete rimmed pool and rock step approximately 15 feet high and then into a pool. A steel sheet pile weir controls the pool elevation, from which the water flows downstream. Apparently the original dam structure had a fishway on the left bank, however because of severe erosion downstream this fishway became impassable. When the dam was modified in the 1930's a new fishway was also constructed. But erosion continued downstream again making the fishway impassable. This erosion also led to the construction of the additional structures that are now part of the four "step" dam. The three smaller "steps" range in height from 3 feet to 6 feet and consist of various materials. The concrete falls, rock face and sheet pile weirs were installed over time to arrest severe degradation of the channel below the dam. Although the existing fish ladder is operational, most species continue to be either partially or completely blocked from passage upstream. The streambed drops a total 35 feet over a distance of 100 feet at the dam.

Simpson Timber Company (the current owner) purchased full title to the site and structure and water rights in the early 1950's. After 1985, the water appropriated from the Creek was used primarily for fire protection. Sediment has accumulated over the years in the head pond of the dam, leaving no storage capacity to moderate high creek flows. Although this was not the intended use of the reservoir, the pool capacity likely helped reduce flood impacts around the reservoir. Severe flooding in 1996 destroyed the wood stave pipeline that carried the water to the mill, and since then, the dam has served no useful purpose. Although Simpson has maintained the structure over the years, including rehabilitation in 1997, the present dam serves no useful purpose and blocks fish passage. The condition of the existing structure is poor: the pilings that support a portion of the dam have significantly deteriorated, and there are large seeps on the downstream side of the wall and erosion of the soil that buttresses the timber.

1.4. RESOURCE PROBLEMS

The degraded project area is really only a small part of an otherwise healthy watershed. But under the existing without project condition the dam is a bottleneck that prevents use of the watershed by some of the Northwest’s most important species (see Figure 4 for an overview of the project reach). Five species of anadromous salmonids (coho, chinook and chum salmon, steelhead, and cutthroat trout) inhabit the lower part of the creek. Only two species can sometimes ascend the existing steep, eroded fish passage facilities. Past surveys have estimated that a few hundred coho per year have ascended the existing fish ladder, and it is assumed that steelhead can also jump high enough to pass the dam. Chum salmon are unable to jump high enough to use the present facility, and cutthroat trout are too small to manage this passage. Chinook have been seen below the dam, but not above it. Although they have the physical ability to ascend the present ladder, they apparently avoid it at least at times due to behavioral characteristics.

No detailed studies of juvenile salmon and trout downstream migration have been completed to date; though the Squaxin Tribe began a pilot study for assessing outmigrant studies in April 1999. Most likely, juvenile salmonids experience mortalities as a result of physical abrasion as they carry over the falls immediately below the concrete basin. Additional mortalities probably also occur as fish smash into the large rocks and concrete debris at the base of the falls.

Downstream of the dam, streambed degradation has noticeably extended many hundreds of feet and channelized the stream. Salmon and trout spawning habitat has been severely degraded in the channelized reach because of the loss of quantity and quality of spawning gravel.

Upstream of the dam wetlands and other habitat features have high value for biological use. Special habitat features including snags, down logs, and open water contribute to high habitat values. The backwater channels associated with many of the wetlands provide winter rearing habitat for juvenile fish and refuge from seasonal high flows following large storm events. The plentiful amount of instream large woody debris recruited from floodplain wetland areas also provides excellent habitat. Without the proposed restoration the high value habitat areas would continue to be under-utilized by key anadromous fish species.

The habitat features throughout much of the downstream 1,000 feet project area stream reach have been seriously degraded primarily due to erosion. The stream bank through much of this reach is very steep and void of vegetation. Habitat features such as pools and off-channel rearing areas are also lacking.

1.5. RESOURCE SIGNIFICANCE

Northwest salmonid stocks have been declining for decades, and many are now reaching critically low levels. Puget Sound Chinook salmon have been listed as threatened under the Endangered Species Act and coho and coastal cutthroat trout are candidate species for listing. Goldsborough Creek, with its extensive wetlands and marshy areas, is especially suitable spawning and rearing habitat for coho. It is one of the few streams in south Puget Sound that is still in relatively good shape: the watershed is primarily managed for timber harvest, with no towns or cities above Shelton, and the Simpson Timber Company is presently preparing a Habitat Conservation Plan (HCP) to help insure that stream habitat will be preserved for the next 50 years. The stream is a lowland stream fed mostly by groundwater, so it has a unique capability to maintain both high and low flows and is less vulnerable than many streams to flashy floods or devastating droughts.

Providing upstream passage of spawning anadromous fish also provides a critical link in aquatic food webs in the Pacific Northwest. Pacific salmon are considered a “keystone” species upon which producers and consumers from the bottom to the top of the food chain depend on (Wilson and Halupka 1995). Rearing in the rich-ocean environment, adult salmon return to nutrient poor streams with a wealth of ocean nutrients, enriching the food web from primary producers to top carnivores. At the top, at least 22 species of wildlife, including black bear, mink, river otter, and bald eagle, feed on salmon carcasses (Cederholm *et al*. 1989). At the base of the food web, salmon carcasses provide a significant, if not major amount of nitrogen to streamside vegetation as well as large amounts of carbon and nitrogen to aquatic insects and other macroinvertebrates

(Bilby et al. 1996). Juvenile salmon also utilize spawned-out salmon carcasses directly as a food source. Bilby et al. (1998) witnessed increased densities, increased body weight, and improved condition factor of juvenile coho and steelhead in stream reaches supplemented by the addition of salmon carcasses from a nearby hatchery. Sixty to 96 percent of the food material in the stomachs of juvenile steelhead and coho consisted of carcass flesh and eggs.

1.6. PRIOR STUDIES AND REPORTS

Prior to Corps involvement, a number of engineering studies and reports had been completed in the area related to dam removal. These studies are summarized below.

- Parametrix, Inc. (October 1997, August 1998), *Goldsborough Creek Restoration Project.* Prepared for Simpson Timber Company. The report outlines various alternatives and summarizes previous reports. The preferred plan in the Corps' Preliminary Restoration Plan was based on the conceptual design and cost estimate developed by Parametrix.

- Dames & Moore (1991), *Report of Geotechnical Consultation-Earth and Timber Dam, Shelton, Washington.* For Simpson Timber Company. The report provides recommendations concerning rehabilitation of the existing dam structure and includes subsurface geotechnical investigations to determine soil profiles and engineering properties in depositional material behind the existing dam structure, and examines a variety of structural rehabilitation concepts. A sheet pile wall was recommended for dam rehabilitation.

- Fraser, Jim (1993), *Evaluation of the Goldsborough Creek Simpson Dam and Fish Passage,* Washington Department of Fisheries, Habitat Management Division. The report provides dam construction and ownership history, qualitative history of erosion downstream of the dam, describes provisions for fish passage at the dam site, reports on recent field surveys on anadromous fish migration at the dam site, and comments on dam removal and dam maintenance. On behalf of WDFW, Fraser recommends dam removal and fishway replacement.

- Summit Technology (1996), *Goldsborough Creek Dam Investigation Report.* For Simpson Timber Company. Summit Technology (1996) expanded on the work of Dames & Moore in evaluating dam stabilization rehabilitation/removal and also addressed fish passage alternatives at the site.

- Golder Associates (1996), *Goldsborough Dam Preliminary Geomorphological and Geological Evaluation.* For Summit Technology, incorporated in Appendix 1 of Summit Technology (1996).

In addition to the above studies, the Seattle District Corps of Engineers has an authorized flood control project in the vicinity of the study area along Shelton Creek. Shelton Creek empties into Goldsborough Creek about 1.5 miles upstream of Oakland Bay. The principal features of the project include: a debris basin, intake diversion structure which diverts Shelton Creek flows in excess of 55 cubic feet per second (cfs), a buried pressure pipeline along 7th Street which transports diverted floodflows to Goldsborough Creek, and an outfall structure on Goldsborough Creek. The project provides flood protection against the 200-year flood event and was constructed in 1978.

1.7. EXPECTED SUCCESS OF RESTORATION

Guided by a committed team of professionals from all stakeholders, this project enjoys high levels of support because of the potential for successful restoration. Restoration issues on Goldsborough Creek are not terribly complex: the present fish blockage is a major limiting factor for migratory fish use of this stream. Because the available upstream habitat is largely pristine, additional factors limiting restoration success are minimal.

(1) Specifically, the project as proposed has great potential for successful restoration for the following two main reasons: migrating salmon and resident fish will have a significantly higher probability of ascending and descending through the project reach; and

(2) The proposed project is designed to restore hydraulic continuity that is necessary to support key ecosystem functions in the stream.

Figure 1. Vicinity Map.

Figure 2. Site Map.

Figure 3. Goldsborough Dam, Photo Courtesy of the Shelton-Mason County Journal

Figure 4. Existing Conditions.

2. PLANNING OBJECTIVES

Planning objectives have been addressed through two different perspectives: (1) Corps of Engineers project planning objectives and criteria and, more specifically, (2) project purpose and criteria developed by an interdisciplinary and interagency design team as part of the feasibility evaluation.

2.1. GENERAL PLANNING CRITERIA

The Corps of Engineers Water Resources Principles and Guidelines (P&G) establish a planning framework for federal water resource projects. This framework, in addition to planning considerations identified in EC 1105-2-214 and ER 1165-2-501 (Section 206 and General Ecosystem Restoration Planning Guidance), has been used to develop general planning objectives and criteria in order to develop and evaluate alternatives. The Federal objective in water resources planning is to contribute to National Economic Development (NED) in order to alleviate problems and/or realize opportunities related to water and related land resources, consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. The P&G states that the NED plan is to be selected unless the Secretary of the Army grants an exception to selecting the NED plan when there are overriding reasons for selecting another plan. Such overriding reasons include Federal, state, tribal, local and international concerns, as well as the provision of significant environmental outputs such as ecosystem restoration. The Corps' Civil Works budget guidance assigns priority to the restoration of ecosystems and associated ecological resources. Therefore, consistent with the analytical framework establish by the P&G, plans to address ecosystem restoration should be formulated, and measures for restoring ecological resources may be recommended, based on their monetary and non-monetary benefits.

Pursuant to the Corps' Ecosystem Restoration Guidance, the objective of ecosystem restoration projects is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. From this perspective, the objective of the proposed project is to restore Goldsborough Creek to a more natural gradient which will provide improved fish passage and access to approximately 14 miles of mainstem and tributary stream --over 10 times that presently available--for anadromous fish spawning and rearing. In addition to blocking fish passage, the dam structure has contributed to severe downstream scouring and headcutting and has impacted the natural flow of sediment and spawning gravels. Restoring and preserving other habitat features such as wetlands and backwater spawning/rearing areas will enhance an ecosystem approach to restoring the degraded area to support critical habitat functions and process. The general planning criteria used for evaluation of potential alternatives are included below. Project specific planning considerations are also discussed where appropriate.

(1) Outputs. Restoration projects must be justified on the basis of their contribution to restoring a degraded system when considering the cost of the proposal. Ecosystem restoration projects are justified through a determination that the combined monetary and non-monetary benefits of the project are greater than its monetary and non-monetary costs. Outputs for this proposed restoration project have been quantified in terms of two different components. The first is fish passage and reliability of providing access to the 14 miles of spawning and rearing habitat. The second component is the impacts to the 2,000-foot project reach. The outputs are discussed in detail in section 4.5.

(2) Cost effectiveness and Incremental Cost Analyses (CE/ICA). Cost effectiveness analysis is performed to identify least cost plans for producing alternative levels of environmental outputs. Incremental cost analysis identifies changes in costs for increasing levels of environmental output. These evaluations are used as a tool to help assess whether proposed alternatives are justified. Section 4.7 addresses the cost-effectiveness and incremental evaluation for the final array of alternatives.

(3) **Significance**. The resource significance is an important consideration. Significant environmental resources are those that are institutionally, publicly, or technically recognized as important. The restoration plan must make a significant contribution to addressing the restoration problems or opportunities.

(4) **Acceptability**. The workability and viability of the alternative plan with respect to acceptance by state, tribal and local entities as well as compatibility with existing laws, regulations, and public policies. In addition to providing fish passage, the primary concern related to an alternative plan's acceptability is avoidance of any adverse impacts downstream and through the City of Shelton. The primary areas of potential concern are increased flooding, erosion or other impacts over the current condition. In the framework of this evaluation, alternatives that might have such impacts were not considered.

(5) **Completeness**. The extent to which a given plan provides and accounts for all necessary investments or actions to ensure the environmental outputs are realized. The existing dam structure serves no useful purpose. Therefore removal of the structure to prevent any long-term potential negative consequences to either human safety or resource protection must be addressed to have a complete solution.

(6) **Effectiveness**. The extent to which a plan addresses resource needs and opportunities. In the context of Goldsborough Creek, effectiveness is a primary consideration in terms of how successful any restoration alternative will be over the long-term.

(7) **Partnership Context**. Cooperation between the Corps and non-federal sponsor, and collaboration with state, tribal and Federal resource agencies or non-governmental entities is also used in making decisions.

(8) **Reasonableness of Costs**. All costs associated with a plan should be considered including initial investment costs and costs which may be incurred through out the life of the project. The reasonableness of a plan's cost should be considered in addition to the cost-effectiveness and incremental evaluation. Maintenance and rehabilitation costs over the life of the project are a critical concern to the project sponsor and other stakeholders. Minimizing these costs without compromising environmental outputs is a key consideration for the Goldsborough project.

2.2. CORPS-STAKEHOLDER DESIGN TEAM TECHNICAL CRITERIA

As part of the planning process an inter-disciplinary and interagency feasibility design team was established. The purpose of the design team was to develop a project purpose; evaluation criteria (technical criteria), develop alternative project designs, assess alternatives, and finally propose a recommended plan. The members of the Design Team Included:

Ken Bates	State Department of Fish & Wildlife
Jim Fraser	State Department of Fish & Wildlife
Jim Stow	U.S. Fish and Wildlife Service
Dennis Mekkers	Corps Hydraulics
Brad Brandt	Corps Civil Design

Jerry Ficklin	Simpson Timber Company
Jeff Dickison	Squaxin Island Tribe
Lauran Cole Warner	Corps Biologist/Environmental Coordinator
Patty Cardinal	Corps Economist/Project Manager
Phil Hilgert	Fisheries Biologist R2 Resource Consultants
Richard Garrison	Corps Geologist

Members of the design team held four workshops in which the alternative designs were developed. The first task of the team was to develop a project purpose. The established project purpose was designated as:

To provide for unhindered upstream and downstream passage of resident and migratory fish.

The group then developed technical criteria to assess potential alternatives. The following criteria are more specific, but in some cases there may be some overlap with the "general criteria". This is considered acceptable as the general criteria are used primarily to eliminate alternatives, where as the technical criteria are used as a guide to develop and assess alternatives which meet each of the general criteria. The technical criteria include:

(1) The project must provide passage for all adults and, to the maximum extent practicable, juvenile resident salmonid and migratory fish (coho, chum, chinook, steelhead, sea-run cutthroat).

(2) The project must mitigate impacts to wetlands, riparian and stream habitat. The definitions for "mitigate," in order of priority, includes first avoiding impacts, second minimizing impacts and third, if necessary, mitigating impacts. Outside the immediate vicinity of the dam, the riparian and stream habitat is high quality, and thus minimizing disturbance to these areas is important.

(3) Any constructed channel and riparian areas should mimic natural stream conditions and processes.

(4) The fish passage standards must be complied with 90% of the time for adults of each salmonid species (coho, chum, chinook, steelhead, sea-run cutthroat). The State of Washington uses this criterion for designing any new fish passage facilities. In the case of the Goldsborough project, low and high flows were identified to generate the range of flows, which the project would provide the necessary hydraulic conditions to allow fish passage.

(5) The project structures must be safeguarded from catastrophic failure for something greater than 100-year event, corresponding to life safety criteria.

(6) The project surface structures must be capable of functioning for fish passage after a reasonable flood event. The intent of this criterion is to convey that some rehabilitation may be required after flood events to maintain fish passage, but this should not occur on a frequent basis. Initially a twenty-year flood event was identified as a reasonable event, but the group felt that specifying a specific frequency was unrealistic.

(7) The project cannot result in any adverse increase in downstream flooding, erosion damage, or sediment deposition. Any impacts or changes downstream of the project must be documented. The impetus behind this criteria is to address the fact that there are or may be existing erosion, deposition and flood issues in the area. Imparting any additional downstream flood, sedimentation or erosion impacts which currently do not exist would be an unacceptable outcome.

(8) The project must be in compliance with all Federal, State, and local legislation, policies and guidance, including funding restrictions.

(9) The project must provide successful, safe downstream passage to resident and migratory fish. Under the existing condition there is a high likelihood of injury or mortality for downstream passage, the effectiveness of the project cannot be assured unless a safe downstream passage is provided.

Other criteria that were considered but ultimately eliminated included:

(1) The project fish passage must consist of in-stream structures. All agreed that in-stream passage structures would function better for a wider variety of species, but using this as criteria may unnecessarily restrict the alternatives considered. If, because of design or cost considerations, an in-stream fish passage structure proved infeasible, alternatives might be considered.

(2) Any in-water construction must take place during the established fish window (June 15-September 15). The group felt that this was covered in criteria 8, and further it was not a project defining criteria, in that all alternatives would need to take the construction window into account. The group decided that should construction extend into the upstream migration window, arrangements could be made to pass fish upstream of the project area (e.g. trap and haul).

(3) Operation and Maintenance should be minimized. This was eliminated as a criterion because it was not project defining. The team recognized the importance of minimizing maintenance costs, and this was an integral component of any alternative.

3. EXISTING CONDITIONS

Figure 4 provides an overview of existing conditions in the project reach. The figure identifies current bank erosion, wetlands and other features pertinent to any proposed restoration actions.

3.1. GEOLOGY/SOILS/SEDIMENT

Goldsborough Creek lies in a heavily forested region of moderate relief formed by glacial sculpting and deposition during the last glacial advance (late Pleistocene). Elevations range from 90 feet at the dam to over 900 feet along the highest ridgeline overlooking the creek. The creek meanders through a narrow valley with occasional, broad marshlands and oxbows before draining into Oakland Bay in the town of Shelton. For about 500 feet downstream of the dam the creek is moderately straight and narrow with a steep gradient. Appendix E provides additional geotechnical information on the dam and surrounding area.

3.1.1. Geology

The fluvial sediments (river transported and deposited) are composed of silt and sand with gravels. Soil borings generally encountered lenses of silty sand with gravels, and well-graded sand. The gravels are sub-angular and probably derived from the Skokomish Gravel unit as well as the Vashon Till.

The fluvial sediments are underlain by the Kitsap Formation; a resistant clay and silt unit deposited during the Pleistocene epoch and subsequently over-consolidated by glacial ice sheets. This sedimentary unit is generally well-graded, but also includes some sand and gravel. There are surface exposures immediately downstream of the dam along the north bank and upstream near the 90-degree turn in the creek, between the dam and the railroad trestle (station 119+00). The Kitsap Formation has weak bedding planes gently dipping (14 degree) to the northeast. Along the south bank of the project site these planes dip into the canyon and contribute to small slope failures when combined with stream flow deflecting off the bank at station 119+00. At station 114+50, a small embayment may have resulted from slope failure possibly aggravated by flows from the outlet works. A contour map (Appendix E, Figure 2) was developed to show what the top of the Kitsap Formation may look like, based on information from geophysical surveys, soil borings and geological reconnaissance. The contours indicate this resistant unit preserved a channel path less contorted than the current stream flow.

Along the banks and nearby slopes, the soils are Vashon till, a mixture of clay, silt, sand, gravel and boulders deposited by glacial ice (Logan, 1987). Landforms and drainage patterns surrounding the project site suggest numerous landslides have helped shape the topography. However, there are no bare scarps or other indications of recent activity.

Channel geometry upstream and downstream of the dam is distinctly different. For about 500 feet downstream of the dam, the creek is confined in a canyon-like channel that narrows to about 20 to 30 feet wide, with canyon walls about 20 to 25 feet high. Further downstream of the canyon, the creek widens to about 30 to 40 feet and is flanked by a low stream bank on the north side and a 15-foot-high near vertical bank on the south.

3.1.2. Sediments

The forebay immediately upstream of the dam has trapped sediment over the years. Total weight of the sediment has been estimated to be between approximately 28,000 to 53,000 tons

(Golder Associates 1996). This volume represents several times the annual sediment yield for the drainage basin based on sediment yield calculations.

Sediment in the Goldsborough Creek basin is produced by mass wasting, soil surface erosion and stream erosion. Finer-grained sediment is carried downstream most of the year, while coarser sediment is moved only during higher flows. The coarser sediment accumulates in the bed of the stream and in point and side-channel bars at times of lower flow. In general, because of the types of soils in the basin are not highly erodable, the sources of sediment for this stream are not extensive.

About 800 feet below the dam, the channel abruptly widens, and there is net deposition and erosion of the banks. The channel is littered with large woody debris. This area, where unprotected by riprap, is the largest source of sediment in the lower part of Goldsborough Creek. It is presently unstable, but does not appear to have always been so; as recently as 1971, the channel in this area had a well defined meandering pattern. It is possible re-alignment and channelization during the construction of the SR 101 bridge introduced instability in this reach, but it is also likely that bank erosion during high flow events and deposition of large woody debris in the channel upstream have also contributed to instability.

Sediment samples analyzed for the standard Puget Sound Dredge Disposal Analysis (PSDDA) chemicals of concern showed that none of the tested parameters exceeded the State of Washington Sediment Quality Standards (Parametrix 1996).

3.2. WATER/WATER QUALITY

3.2.1. General

Goldsborough Creek is one of the larger creeks in the Puget Sound Watershed, with stream flows from a winter high of about 400 cfs to summer lows of about 20 cfs. Mean flow is 117 cfs. It is a relatively stable creek, with flows apparently controlled by favorable ground water conditions in the shallow valleys and marshy areas of the upper watershed (Williams et al. 1975). The 50-year flood discharge is approximately 1,750 cfs, and the 100-year discharge is approximately 2,240 cfs. The stream is unique in that it can sustain both high and low flows, suggesting that the terrain and soil types together act like a big sponge, storing large amounts of water and releasing them slowly.

Flooding in Shelton is caused by major floods on Goldsborough Creek or by extreme tides in Oakland Bay, or a combination of both. The most recent major flood was recorded was in 1996, caused by a major rain-on-snow event. Prior to the 1996 flood, no major flood has been recorded since 1972. The stream is capable of transporting fine sediment throughout its length and through Shelton into Oakland Bay.

Water quality in the basin is generally good. The ability of the basin to hold water, combined with the extensive canopy cover of the creek, moderate water temperatures. Water quality in the lower stream has been influenced by storm drainage and effluents from the homes and businesses that line the stream watershed (Williams et al. 1975).

3.2.2. Land Use and Potential Pollution Sources

According to Mason County's Growth Management Plan, some 68 percent of the land base within the entire Oakland Bay watershed is designated for forestry or long term commercial forest. The remainder of the land base is, for the most part, designated for rural use. Within the

Goldsborough subwatershed, 57.7 percent of the land base is owned by Simpson Timber Company and is proposed to be included in a Habitat Conservation Plan based on protection of aquatic species.

The Washington State Correction Center is located within the watershed, and operates on a septic system. The system was upgraded in the summer of 1997 to produce the equivalent of Class A reclaimed water with nitrogen reduction. Disposal is to a spray field with groundwater monitoring required.

The Mason County landfill is an unlined, covered facility closed in 1993. The landfill is situated in an abandoned sand and gravel mine pit. The aquifer is highly transmissive and volatile organic compounds (VOCs) have been detected at this site. VOC detection has occurred in the monitoring wells adjacent to the landfill, but have not been detected at the downgradient property boundary or in downgradient drinking water wells.

3.3. HYDRAULICS AND HYDROLOGY

The existing condition hydraulics and hydrology are addressed extensively in Appendix C. The focus of the hydraulic evaluation consisted of characterizing the existing condition and contrasting this condition to any changes in hydraulic or sediment transport parameters. The areas of consideration include (1) potential impacts outside of the project reach, (2) hydraulic evaluation of potential solutions to address high and low fish passage criteria, and, finally (3) performance of the preferred plan.

The identification of design flows to help assure reasonable passage conditions for fish was central to developing alternatives. This included the identification of both high and low flows when the various fish species would be migrating up and downstream. One of the design team's criteria was to ensure fish passage conditions 90% of the time.

Design discharges were selected based on the design criteria. The design team determined that criterion 4 could be reasonably well translated to discrete discharge values by selecting the 5% and 95% exceedence daily average discharge, by month, during months of fish migration. Chinook, coho, and chum salmon migrate upstream during the months of August through January. Their progeny migrate downstream during the months of February through July. The selected 5% and 95% exceedence daily discharges by month are near 475 cfs and 22 cfs, respectively. These quantities are also referred to as *high fish flow* (475 cfs) and *low fish flow* (22 cfs). Note that on an annual basis, these discharges actually span more the 90% of the daily average discharges recorded during the 20 years of record at USGS gage #12076500.
A range of discharge rates up to the 100-year discharge of 2240 cfs were also used in hydraulic models to evaluate project performance and downstream impacts. Hydraulic modeling studies are discussed in the hydraulics section of appendix C. Additionally, maintaining channel capacity to continue to convey flood flows was important to incorporate into any design considered. The 100-year peak discharge event is 2,240 cfs. A summary of discharges is provided below.

Table 1. Discharge Summary

Exceedence or Recurrence Interval	Discharge (ft^3/sec)
5% daily avg., by month (high fish flow)	475
95% daily avg., by month (low fish flow)	22
2-year peak flood	905
10-year peak flood	1500
50-year peak flood	2015
100-year peak flood	2240

NOTE: Discharges were determined from daily data at USGS gage 12076500 and scaled to dam site by proportional drainage area, i.e. gage discharge times the quantity (44/39.3).

3.4. VEGETATION

Vegetation in the project area is generally comprised of a mixed coniferous forest on the valley slopes and mixed deciduous forest in the valley floor. Douglas fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*) and bigleaf maple (*Acer macrophyllum*) dominate the overstory, while Indian plum (*Oemleria cerasiformis*), salal (*Gaultheria shallon*), hazelnut (*Corylus cornuta*), brackenfern (*Pteridium aquilinum*), and twin flower (*Linnaea borealis*) are common understory species. The vegetation is not particularly dense close to the stream channel other than in the forebay. It appears that high stream flows at times keep the vegetation from becoming dense in the riparian area.

3.5. WETLANDS

A field investigation was performed in May 1997 by Parametrix, Inc., to delineate jurisdictional wetlands in the dam vicinity. Wetlands were evaluated and delineated using the methods outlined in the Corps of Engineers Wetlands Delineation Manual (Corps manual) (Environmental laboratory 1987) and the Washington State Wetlands Identification and delineation Manual (Washington Department of Ecology 1997). In the project area, this survey found riparian and flood plain wetlands and a beaver marsh wetland (Figure 4). Wetlands are hydrologically supported by a high groundwater table and seasonal flooding by the stream. Subsurface drainage appears to convey only small amounts of groundwater discharge to these wetlands.

Directly downstream of the dam, riparian wetlands are generally absent because of the steep valley walls that have been downcut by the force of the creek. However, a small (<0.1 acre) riparian wetland (Wetland 1) exists on the north side of the creek, approximately 900 feet downstream of the dam and within the project area. This floodplain wetland meets the criteria for a Category 1 wetland according to Ecology’s rating system (Ecology 1993).

A 1.33-acre forested riparian wetland (Wetland 2) is present on the north side of the creek, in the forebay area of the dam. This is a flood plain wetland confined between the railroad tracks and the northeast valley slope. This wetland is classified as palustrine forested (Cowardin 1979) and meets criteria established for Category I wetlands according to Ecology’s rating system (Ecology 1993).

Wetland 3, a 2.50-acre palustrine shrub, emergent, and open water wetland occurs on the south side of the creek, about 400 feet upstream of the dam. This wetland is a beaver marsh located between the dam and the railroad bridge, within a backwater area. The wetland is a possible Category I, palustrine scrub/shrub, emergent and open-water wetland (Cowardin et al. 1979) and contains an active beaver dam located at the mouth of a small tributary to Goldsborough Creek.

It is hydrologically supported by a small stream, high groundwater, and seasonal flooding from Goldsborough Creek.

Wetland 4 is a 1.27 acre floodplain wetland supported by a high groundwater table and seasonal flooding by the stream. Soils within the floodplain wetlands (2 and 4) reflect the alluvial processes of deposition and scour common in floodplains. Organic material does not have the opportunity to accumulate because it is scoured during seasonal high flows that flood the wetlands. This floodplain wetland, like #1 and like additional floodplain wetlands upstream, meets the criteria for a Category 1 wetland according to Ecology's rating system (Ecology 1993).

3.6. FISH AND WILDLIFE

Anadromous fish found in Goldsborough Creek include chinook, coho, and chum salmon, steelhead and sea-run cutthroat trout. Of these, only a small percentage of coho have been documented ascending to the upper watershed using the existing fish ladder. It is also presumed that some steelhead and probably at least a few chinook can pass as well. Resident fish in the creek have not been well documented, but apparently include typical species that inhabit lower elevation streams in the lower Puget Sound Watershed. Further information is described below.

3.6.1. Stream Habitat

Despite the past efforts to mitigate any habitat damage created as a result of the construction of the dam, the stream has been severely degraded, and approximately 17 to 18 vertical feet of streambed has been lost due to erosion. Today the area immediately downstream from the dam is a series of steep drops in the hard clay bottom. This series of drops does not provide habitat of value to any resident species. The dam and inadequate fish ladder prevent the passage of smaller anadromous fish species, and the degraded fish habitat has caused the loss of quantity and quality of spawning grounds and rearing habitat, both upstream and downstream of the dam.

3.6.1.1. Habitat Surveys

Cook-Tabor and Moore (1999) conducted an instream habitat survey from RM 0 to 3, the reach most likely to be affected by the dam removal (about 2.1 miles below the dam and 1 mile above) using methods developed for the Timber Fish and Wildlife Ambient Monitoring Program (Schuett-Hames *et al.* 1994). The surveys, completed during the low flow period (September and October) in 1998, were conducted to determine the current habitat quality and to establish a pre-project baseline for future monitoring.

A total of 392 habitat units of five distinct habitat types were found during the survey totaling 13.1 acres. Habitat types are distinct water depth and velocity variations in the stream caused by different hydraulic conditions. They range from the deep, slowing moving water in pools to the shallow, faster moving water in riffles. Habitat types used in the survey included pools, riffles, cascades, glides, and tailouts. Expanding for the sample rate, a total of 152 pools (5 acres), 97 riffles (4.1 acres), 56 cascades (1.2 acres), 48 glides (2.3 acres), and 39 tailouts (0.5 acres) were recorded in the survey. Below the dam, riffles were more prevalent (36% of the total wetted surface area) than above the dam (22%). Above the dam, pools were the most abundant habitat type and comprised 57% of the total surface area.

Woody debris, most in the form of small-diameter logs, was prevalent in the stream. An estimated 44 log jams exist, with 86% occurring downstream of the dam. The total estimated number of woody debris pieces was 2,100. Fifty-four percent were small logs (4-7.9 inch-diameter), 34% were medium logs (8-20 inch-diameter), 5% were large logs (>20 inch-diameter), and 7% were rootwads.

Cook-Tabor and Moore (1999), using the Washington Forest Practices Board (1995) qualitative method for evaluating salmonid habitat quality, indicate that the stream reach below the dam was poor to fair fish habitat whereas the reach above the dam provided fair to good habitat (Table 2). Schuett-Hames *et al*. (1996) surveyed segments of Goldsborough in 1993 and 1994 using the same methodology. The Goldsborough Creek study was completed between RM 4.5 to 5.8 on the mainstem and RM 10.8 to 11.2 on the South Fork Goldsborough Creek. Results were very similar to the Cook-Tabor and Moore (1999) study as they concluded that; 1) the canopy closure may not be sufficient to meet the Class A water quality temperature standards, 2) the LWD total abundance was good, 3) the LWD key piece abundance was poor on the mainstem and fair on the south fork, 4) the pool frequency was fair, 5) the pool surface area was good on the mainstem and fair on the south fork, and 6) the quality of the spawning gravels was fine (Table 2).

Table 2. Habitat quality indices for Goldsborough Creek (adapted from Seavey 1999).

Habitat Parameter	**Downstream of Dam**	**Upstream of Dam**		
River Mile	**0 - 2.1**	**2.1 - 3.1**	**4.5 - 5.8**	**10.8 - 11.2**
Percent Pools	Poor	Good	Good	Fair
Pool Frequency	Poor	Fair	Fair	Fair
LWD Abundance	Good	Good	Good	Good
LWD Key Pieces	Poor	Poor	Poor	Fair
Substrate	Fair	Fair	-	-
Off-channel Habitat	Poor	Good	-	-
Holding Pools	Fair	Good	-	-
Access to Spawning Areas	Good	Poor		-
Gravel Quality - Spawning Area	Fair	Good	-	-
Fines in Gravel	-	-	Fair	Fair
Gravel Quality (Sand Dominance)	Fair	Fair	-	-
Adequacy of Canopy for Water Quality Goals	No	No	No	No

3.6.1.2. Biota

The USFWS (1999) performed a Benthic Index of Biotic Integrity (BIBI) in 1998. This index evaluates general stream health in comparison to similar lowland streams in Puget Sound. Two sites were selected to represent the current state of the creek above and below the dam in areas not to be directly affected by project. Two other sites were chosen within the proposed restored reach, one above the dam and one below, to provide comparisons of current health of this reach after project construction. The two sample sites outside of the project area were rated “Good” in the index, and the two within the project area rated “Fair.” The “fair” sites were within the dam area, one directly upstream and one directly downstream. The downstream “good” site was located about 300 feet upstream of the Hwy 101 bridge. The upstream “good” site was located several hundred feet above the Shelton/Matlock Road bridge. Poor sediment transport in the dam area was cited by the USFWS as the likely cause of the lower ratings.

3.6.2. Anadromous Fish

3.6.2.1. Chinook Salmon

Chinook salmon are the largest of all Pacific salmon, and can weigh over 100 pounds, though the average weight is closer to 22 pounds. Chinook salmon, the least abundant of the five Pacific salmon species, were historically found from the Ventura River, California to Point Hope, Alaska (Meyers et al. 1998). Presently, spawning populations of chinook exist from the San Joaquin River, California to the Kotzebue Sound, Alaska (Healey 1991). Chinook salmon are differentiated into two primary juvenile behavioral forms, ocean-type and stream-type, based on their pattern of fresh water rearing. Juvenile ocean-type chinook salmon migrate to the marine environment during the first year of life, generally within three to four months of emergence (Lister and Genoe 1970). Juvenile stream-type chinook salmon rear in fresh water for a year or more before outmigrating to the ocean. The population of chinook salmon in a single river system may exhibit variations in these freshwater rearing strategies depending on annual variations in food supply, water temperature and other environmental factors. Differences between these life history patterns are accompanied by differences in morphological and genetic attributes (Myers et al. 1998). Chinook salmon classification is further divided by the timing of upstream migration (e.g., spring or fall/summer runs).

The principal stock of chinook salmon present in Goldsborough Creek is summer/fall ocean-type chinook. Adult summer/fall chinook migrate upstream from late June to mid-November. Spawning takes place from mid-September through mid-November. The juveniles may migrate to the ocean in the first three months of life. Ocean-type chinook depend heavily on estuaries for juvenile rearing to achieve a larger size before moving offshore.

The Washington Department of Fish and Wildlife (WDFW) currently monitors three spawning index reaches in the Goldsborough Creek watershed; one upstream of the dam for coho salmon, and two downstream for chum salmon. Missildine et al. (1999) established three additional index reaches in 1998 to provide a more distributed survey to determine spawning distribution and abundance above and below the dam. The downstream reaches were surveyed for chum, coho, and chinook salmon, while the upstream reaches were surveyed for coho and chinook salmon. An estimated ten spawning chinook salmon were observed below the dam, of which seven were in the project area. Spawning chinook salmon were not found upstream of the dam.

3.6.2.2. Coho Salmon

Coho salmon are one of the most popular and widespread sport fishes found in Pacific Northwest waters. Coho populations exist as far south as the San Lorenzo River, California and north to Norton Sound Alaska (Sandercock 1991). Goldsborough Creek coho appear to be typical of Puget Sound stocks with regard to their life histories; eighteen months in fresh water followed by eighteen months in salt water (or up to three years) (Weitkamp et al. 1995). Juvenile coho salmon may extend their freshwater rearing period for up to two years or more (Sandercock 1991). Adult coho return and migrate upstream from early August through late January. Spawning occurs from mid-November through late January. All accessible reaches are used for spawning, with mainstem spawning typically heaviest in the braided channel reaches.

There have been substantial releases of hatchery-origin coho salmon fry and use of remote site incubators upstream of the Goldsborough Creek dam starting in 1955 (Weitkamp et al. 1995). Over the years, seven different stocks were used with the majority of the planted coho salmon originating from the George Adams (3.3 million) and Minter Creek (3.2 million) hatcheries. The total number of fish planted between 1955 and 1993 was 6.9 million fish. Between 1993 and 1998 about 100,000 coho salmon fry were stocked annually from Minter Creek and a remote site incubator with 30,000 eggs annually has operated since 1995 (Baranski 1999). However, WDFW and the Squaxin Island Tribe have agreed to stop all supplementation activities in Goldsborough Creek during the 8-10 year post-dam removal monitoring period. Baranski (1999) provided adult coho spawner count data from 1978 to 1999 for the index reach upstream of the dam. These data show an average of 419 fish per year (expressed as "fish-days") with a range from 0 to 1,259 coho, averaging 115 coho for the last 10 years.

3.6.2.3. Chum Salmon

Chum salmon, known for the large teeth and calico-patterned body color of spawning males, have the widest geographic distribution of any Pacific salmonid (Johnson *et al.* 1997). In North America, chum range from the Sacramento River in Monterey, California to Arctic coast streams (Salo 1991). Chum salmon typically spawn in the lower reaches of rivers in from early December to early February (WDFW et al. 1994). Juvenile chum salmon, like ocean-type chinook, have a short freshwater residence and an extended period of estuarine residence, which is the most critical phase of their life history and often determines the size of subsequent adult, returns (Johnson et al. 1997).

Spawning surveys conducted in the mid-1970s found few fall chum salmon, however, recent returns to Goldsborough/Shelton Creek combined have totaled between 200 and 16,000 fish and appears to be stable (WDFW *et al.* 1994). Based on the index reach below the dam since 1987, the average spawner count (expressed as "fish-days") is 3,872, ranging from 405 to 14,479 fish per year. From 1995 to 1998 high flows resulted in poor estimates during those years. Shelton Creek chum are independent of Goldsborough Creek chum salmon, but the two stocks were combined by WDFW based on geographic proximity. Genetic stock identification (GSI) indicates that this stock is distinct from other South Puget Sound stocks.

Goldsborough Creek chum salmon are included in the Puget Sound/Strait of Georgia ESU. Commercial harvest of chum salmon has been increasing since the early 1970s throughout this ESU. This increased harvest, coupled with generally increasing trends in spawning escapement, provides compelling evidence that chum salmon are abundant and have been increasing in abundance in recent years within this ESU (Johnson *et al.* 1997). The National Marine Fisheries Service concluded that this ESU is not presently at risk of extinction, and is not likely to become endangered in the near future (63 Fed. Regist. 11778).

3.6.2.4. Steelhead

Steelhead, displaying perhaps the most diverse life history pattern of all Pacific salmonids, reside in most Puget Sound streams. Their historic native distribution extended from northern Mexico to the Alaska Peninsula. Presently, spawning steelhead are found as far south as Malibu Creek, California (Busby et al. 1996). Two different genetic groups (coastal and inland) of steelhead are recognized in North America (Busby *et al.* 1996). British Columbia, Washington, and Oregon, have both coastal and inland steelhead, while Idaho has only the inland form and California steelhead stocks are all of the coastal variety (Busby *et al.* 1996). Within these groups, steelhead trout are further divided based on the state of sexual maturity when they enter freshwater. Stream-maturing steelhead (also called summer steelhead) enter freshwater in an immature life stage, while ocean-maturing (or winter steelhead) enter freshwater with well developed sexual organs (Busby *et al.* 1996). Goldsborough Creek steelhead (both summer and winter stocks) have been placed into the Puget Sound ESU, along with 53 other steelhead stocks, by the National Marine Fisheries Service (Busby *et al.* 1996). Total run size for the major stocks of this ESU was estimated at 45,000, and natural escapement of approximately 22,000 steelhead (Busby *et al.* 1996).

The steelhead runs in Washington are differentiated by an arbitrary date of 31 October. Steelhead entering Goldsborough Creek from December through May are considered winter steelhead (WDFW *et al.* 1994). Winter steelhead are native to Hammersley Inlet tributaries and spawn from February through early-April (WDFW *et al.* 1994). Escapement of steelhead on Goldsborough Creek is not monitored by WDFW. Historically, Goldsborough Creek has received hatchery steelhead plants, however, WDFW considers any steelhead occurring in Goldsborough Creek a native stock sustained by natural production ((WDFW *et al.* 1994).

Goldsborough Creek steelhead have been classified as part of the Puget Sound ESU (1 of 15 west coast steelhead ESU's). National Marine Fisheries Service indicated that, in general, the entire Puget Sound ESU is not threatened at this time. However, future population declines may warrant changes in ESA status (Busby *et al.* 1996).

3.6.2.5. Coastal Cutthroat Trout

Coastal, or anadromous cutthroat trout, are distributed on the Pacific Coast from Prince William Sound in southern Alaska to the Eel River in northern California, rarely penetrating more than 100 miles inland (Johnston 1982; Behnke 1992). Considerable information exists for Puget Sound cutthroat trout, though little of that has been collected in a standardized manner and over a long enough time period to establish trends in populations (Leider 1997).

Coastal cutthroat trout exhibit early life history characteristics similar to coho and steelhead whereby juveniles spend time rearing in freshwater before outmigrating as smolts (Leider 1997). While little information exists on Goldsborough Creek cutthroat, Puget Sound cutthroat emigrate to estuaries at a younger age (age II) and smaller size (6 inches TL) than cutthroat that are exposed to rough coastal waters (age III to V, 8-10 inches TL) (Johnston 1982). Puget Sound cutthroat trout will feed and migrate along beaches, often in waters less than 10 feet deep (Johnston 1982). Many stocks are thought to stay within estuarine habitats for their entire marine life (Leider 1997). Most cutthroat return to freshwater the same year they migrate to sea.

Little information is available on the status of coastal cutthroat trout in Goldsborough Creek. The Squaxin Island Tribe captured juvenile cutthroat trout while conducting a study to determine smolt timing and abundance on several Puget Sound streams, including Goldsborough Creek (Seavey 1999).

3.6.3. Resident Fish

3.6.3.1. General

Little information about resident fish is available for Goldsborough Creek. Mongillo and Hallock (1997) examined the distribution and habitat of native nongame stream fishes on the Olympic Peninsula, including the Goldsborough Creek drainage. They concluded that eight nongame fish could potentially inhabit Goldsborough Creek. These fish include the speckled dace (*Rhinichthys osculus*), coastrange sculpin (*Cottus asper*), prickly sculpin (*Cottus perplexus*), reticulate sculpin (*Cottus gulosus*), riffle sculpin (*Cottus gulosus*), Pacific lamprey (*Lampetra tridentata*), three-spine stickleback (*Gasterosteus aculeatus*), and Olympic mudminnow (*Novumbra hubbsi*). Bernard (1999) also found that eulachon (*Thaleichthys pacificus*) were present in the watershed.

3.6.3.2. Bull Trout

Bull trout are native to Pacific Northwest waters, historically occurring from the McCloud River in Northern California to the Yukon River in Northwest Territories, Canada. The bull trout is now considered to be extinct in northern California, and shrinking in distribution throughout its former range. The taxonomic status of the bull trout has been confused with that of Dolly Varden. Bull trout were differentiated from Dolly Varden in 1978 (Cavender 1978) and recognized as a separate species by the American Fisheries Society in 1980. Both species are native salmonids and members of the Genus *Salvelinus*. The species are similar in coloration, morphology, and life history, making distinction between the two species difficult without the use of electrophoretic samples or measurements of morphometric characteristics (WDFW 1997). The state of Washington has established identical protective measures and management for the two species (WDFW 1997). Bull trout are distributed primarily inland as a resident species; however, several populations have been identified as anadromous. Spawning in most bull trout populations occurs during the fall, mainly in September and October. The eggs incubate and hatch in late winter or early spring. Juvenile bull trout may remain in fresh water two to three years (or longer) before migrating to the ocean. Little information exists on the presence or absence of bull trout in the Goldsborough Creek drainage.

3.6.4. Fish Passage

In the project reach, streambed degradation and instability has adversely affected fish habitat and production. Above the dam, there has been a severe loss of fish production as a result of poor upstream fish passage at the existing fish ladder, especially for chum salmon and sea-run cutthroat trout.

Though spawning coho salmon have been counted by WDFW upstream of the dam for the past 18 years, little is known about use of the stream by other anadromous species. All fish counting activities showed that coho are currently able to ascend the fishway, though studies made on fish passage attempts by large and small coho on the 3-foot high weir showed that only 6 to 10 percent of jumps to ascend the weir were successful. Though at least one chinook has been seen using the existing fish ladder at Goldsborough Dam, evidence suggests that it is at least a partial behavioral barrier for this species. In many systems, including the Ballard Locks and the Columbia River, chinook pool below older fish ladders not designed for their preferences (Fred Goetz, pers. comm.). In particular, they seem to avoid small openings and approaches (Eric Warner, pers. comm.). The fact that chinook were observed spawning directly below the dam, yet were not seen above, is consistent with observations at similar locations. However, no one can say for certain what percentage of chinook may be avoiding the fish ladder even if they are physically able to navigate it.

Steelhead trout should be able to ascend the fishway and metal sheet pile weir because of their known good jumping ability. But chum salmon have relatively poor jumping ability, and do not ascend the existing weir and fishway. Most sea-run cutthroat trout, because of their small size (1 to 4 pounds) would not be expected to have the ability to ascend the weir.

The sand and gravel deposition that occurs annually just upstream of the fishway has also produced a fish passage problem in some abnormally low flow years. This deposition results in insufficient water depth for adult fish exiting the fishway at the upstream end, and inadequate fishway flow, which hinders the hydraulic function of the fishway needed for successful fish passage.

3.6.5. Riparian Habitat

In 1998, the USFWS (1999) performed a habitat survey of the project area following the TFW Ambient Monitoring Protocol (Schuett-Hames et al. 1994). Their study found that the average bankfull width below the dam was 13.8 meters, and above the dam was 17.7 meters. Average canopy closure was similar above and below the dam at 61% and 60% respectively. The total number of habitat units (expanded for the sample rate) for the entire area was 392. There were 152 pools, 97 riffles, 56 cascades, 48 glides and 39 tailouts. They found 44 log jams in the study, the majority below the dam. The total expanded number of rootwads and logs for both upstream and downstream segments was 2,100.

Land use in the upper watershed is primarily conifer-deciduous mixed forest with occasional rural homes and small farms. Over the lower two miles, the stream flows through an urbanized area with the Simpson mill at the mouth.

Simpson Timber Company is currently negotiating, with NMFS and USFWS, a habitat conservation plan (HCP) which will cover 214,000 acres of company timberlands in Washington state. Essentially, the plan includes property east of Highway 101 and north of Highway 8, as this is the heart of Simpson's ownership. As stated above, approximately 57.7 percent of the Goldsborough watershed is owned by Simpson Timber Company and will be included in this plan.

Approximately three years of assessment and monitoring were conducted prior to creating the HCP strategy (Patti Case, pers. comm., 1999). The plan treats each watershed area specifically by looking at the basics of the stream channel and its landscape or geologic setting. The strategy divides Simpson's timberlands into five basic landscape types, called litho-topo units. Treatment of areas adjacent to streams will depend on which litho-topo unit the area is in and upon the characteristics of the stream reach as it moves through the area. The Goldsborough Creek drainage actually spans two of these litho-topo units.

Goldsborough Dam is not specifically included in the habitat conservation planning process. This was deliberate, in order to allow these two projects to go forward unencumbered; however, the Goldsborough Restoration Project certainly complements the goals of the Simpson aquatic strategy.

3.6.6. Wildlife

Wildlife observations in the area included over 20 species of birds, including kingfishers, hooded mergansers, and wood ducks. Also observed were coyote, deer and beaver sign, and numerous red legged frogs, garter snakes, and a Pacific giant salamander (Parametrix 1997).

3.7. THREATENED AND ENDANGERED SPECIES

Federal agencies must identify and evaluate any threatened and endangered species, and their critical habitat, that may be affected by an action proposed by that agency. The USFWS and NMFS have identified the following listed, proposed and candidate species under the Endangered Species Act that may occur in the project area:

Listed:	Puget Sound chinook (*Oncorhynchus tshawytscha*) - Threatened
Proposed:	Bull trout (*Salvelinus confluentus*)
Candidate:	Puget Sound coho (*Oncorhynchus kisutch*) Puget Sound coastal cutthroat trout (*Oncorhynchus clarki clarki*)

Profiles of these species, and their use of Goldsborough Creek, are discussed in sections 3.6. Additional information on the ESA status of these fish is presented here.

3.7.1.1. Chinook Salmon

Goldsborough Creek summer/fall chinook are part of the Puget Sound Evolutionary Significant Unit (ESU). Overall, abundance of chinook salmon in this ESU has declined substantially, and both long- and short-term abundance are predominantly downward. These factors have led to this ESU as being listed as threatened under the ESA (64 Fed. Regist. 11481:11520).

Though chinook have been observed spawning in Goldsborough Creek, below the existing dam, Goldsborough Creek is probably not preferred habitat for these fish, which prefer larger mainstem rivers for spawning. Most likely, the chinook seen are hatchery strays released from other south Puget Sound streams that did not return to their points of origin. The entire south Sound population is hatchery supported, and has been for years (SASSI 1994). In any case, evidence does not suggest that Goldsborough supports a self-sustaining run, however small (Dickison, pers. comm.). In addition, the present fish passage facility is probably at least a partial behavioral barrier for these fish (see section 3.6.4).

3.7.1.2. Coho Salmon

Goldsborough Creek coho stocks are considered part of the Puget Sound/Strait of Georgia ESU. Continued loss of habitat, extremely high harvest rates, and a severe recent decline in average spawner size are substantial threats to remaining native coho populations in this ESU. Currently, this ESU is not listed as threatened or endangered. Puget Sound coho presently use Goldsborough Creek and removal of Goldsborough Dam is intended to significantly increase spawning and rearing area for this species.

3.7.1.3. Coastal Cutthroat Trout

The Goldsborough Creek coastal cutthroat trout have been classified as part of the Puget Sound ESU by the National Marine Fisheries Service (64 Fed. Regist. 16397). This ESU includes populations of coastal cutthroat trout from streams in Puget Sound and the Strait of San Juan de Fuca west to, and including, the Elwha River. The southern boundaries extend to Nooksack River, while the northern boundaries include coastal cutthroat trout populations in Canada (64 Fed. Regist. 16397). The Puget Sound coastal cutthroat trout does not warrant listing under ESA, as populations have been relatively stable over the past 10-15 years (64 Fed. Regist. 16397).

3.7.1.4. Bull Trout

Bull trout within the Puget Sound ESU are proposed threatened under ESA (63 Fed. Regist. 31693:31709) due to several detrimental factors (including disease, predation, increased stream temperatures, and loss of habitat).

3.8. CULTURAL RESOURCES

3.8.1. Historical Significance of Dam

In accordance with federal regulations (36 CFR Part 800.4) a report was prepared as the first step on the Section 106 process. The report provides a basis for the Washington State Historic Preservation Officer (SHPA) to evaluate the historic significance of the property against the National Register Criteria.

The dam does not appear to meet the standards for inclusion on the National Register. While the dam is associated with both Rainier Pulp and Paper Company and Simpson Timber Company, there are a number of historic places associated with the timber companies that still survive in Shelton. Some of these remain in use by Simpson. Because of their greater visibility and familiarity, these resources serve to better illustrate the important role of the lumber industry in the history of the community. The dam is not directly associated with any one individual who was significant in history. Its structural design is not unusual, and, because of many efforts over the years to stabilize it, the design and the immediate setting lack historic integrity. Finally, because of these continual modifications, the property is unlikely to yield further information important to history.

3.8.2. Archaeological Resources

A review of environmental, historical, and ethnographic data by Larson Anthropological/Archaeological Services (LAAS) in 1997 indicated that the project area has a moderate probability for both historic and hunter-fisher-gatherer archaeological resources. The project area is on the banks of a major salmon-spawning stream and is within 1.6 miles of an ethnographically reported Sahehwamish village. In addition, historic logging has occurred since the 1880s, but most of the project area along the creek from Highway 101 to the dam is heavily disturbed by human and natural forces, leaving few intact sediments. The project area above the dam has been filled to the level of the spillway basin by sediment.

The project site is within the territory of the Sahehwamish people. The Sahehwamish primarily inhabited Hammersley Inlet, Totten Inlet, Eld Inlet, Budd Inlet, and Henderson Inlet in southwestern Puget Sound. The Sahehwamish were closely related to the Squaxin people who lived at the head of Case Inlet at North Bay. Descendants of the Sahehwamish and Squaxin people are now known as the Squaxin Islnad Tribe of the Squaxin Island Reservation.

No archaeological resources eligible for listing on the National Register of Historic Places were identified in the literature or during field reconnaissance. The heavily disturbed nature of the project area suggests that historic and hunter-fisher-gatherer resources do not occur within a 10-foot buffer on either side of Goldsborough Creek.

3.8.3. Treaty Tribe Rights

This project is within the Usual and Accustomed fishing grounds (U&A) of the Squaxin Tribe, which has long been a proponent of removing Goldsborough Dam

3.9. AIR QUALITY/NOISE/LIGHT

Air quality in the Puget Sound region has been in attainment with state and federal air quality regulations during the 1990s (PSAPCA 1996). The presence of a nearby gravel mine, a railroad, and the Highway 101 bridge contribute to local noise and light levels. Coordination with the Olympic Air Pollution Control Authority (OAPCA) is ongoing to ensure that the project and project construction meet with federal, state and local air pollution standards.

3.10. PUBLIC USE AND RECREATION

Goldsborough Creek is a popular fishing destination for steelhead and coho angling. Sportfishing groups are supportive of the dam removal project, in anticipation of healthier runs of target species. Currently, a public interpretive trail follows the right bank of the creek from the western end of Shelton to just below the dam.

3.11. SOCIAL AND ECONOMIC SETTING

The existing dam is located at river mile 2.3 on Goldsborough Creek. The area in the vicinity of the dam is undeveloped for the most part. A sand and gravel operation is located near the dam on the left bank. Some timber harvest occurs in the basin but not in the immediate vicinity of the dam. Simpson Timber operates a private railroad that traverses the creek just upstream of the dam. The railroad continues downstream of the dam on the left bank and through the City of Shelton. The City of Shelton has a population of nearly 8,000.

4. PLAN FORMULATION

4.1. PLAN FORMULATION METHODOLOGY

The Corps and other entities have considered a wide variety of dam removal and restoration strategies in the area since 1990. The full array of alternatives, including the without-project condition, are discussed below. Each of the alternatives went through a preliminary screening at which point it was determined whether or not further study was warranted. Following the description of each of these alternatives, a rationale is provided as to why it was not considered further. The rationale is based on the general planning criteria discussed in Section 2. With the exception of the dam removal/grade control alternative, the other alternatives had serious flaws that did not warrant further detailed evaluation during the feasibility phase. The feasibility phase focused detailed effort on the restoration strategy that included removing the dam and using grade control structures to stabilize the stream. Following hydraulic, design and environmental studies the Design team developed three alternatives that met the technical criteria to varying degrees. These alternatives are called "the final array of alternatives." Once these alternatives were identified, a 10% design and cost estimate was completed to assist in evaluation. The design team then scored each of the alternatives on how well they met the established technical criteria. This ranking was one tool used to help select a preferred plan. In addition to ranking by criteria, the Corps quantified outputs for each of the final alternatives. These outputs were used in combination with the 10% design costs to conduct cost-effectiveness and incremental cost analysis for the final alternatives, and served as a second tool to select a preferred plan.

4.2. PRELIMINARY ALTERNATIVES

4.2.1. No Action - Dam Failure

If the dam is left alone, it will fail. As there is little or no storage available behind the dam, the mode of failure is not expected to be catastrophic, at least not initially. Stored sediments would eventually be conveyed downstream. With the hard point in the river removed, head cutting would proceed, and would perhaps have some effect on the structure of the salmonid habitat upstream. Dam debris could also create a logjam below the dam, which could fail in time. Flooding around the left abutment, along the railroad grade, would continue at higher level events, exacerbating erosion around the structure. The no action option, which by its nature would result in dam failure, is a viable option because of the potentially serious impacts to downstream areas. Leaving the structure in place does not provide any restoration for fish passage. Once the dam fails under this alternative, the system would take years to stabilize the channel and result in negative socio-economic and environmental conditions. This alternative did not meet the completeness or acceptable general planning criteria and was eliminated from detailed consideration.

4.2.2. Continued Fish Blockage

4.2.2.1. Repair and Stabilize - Most Likely Without-Project Condition.

Simpson Timber has performed maintenance on the structure in the past and would be expected to continue to do so. The aim of the maintenance under the current condition is to prevent failure. This option would be expected to continue to increase in price as the structure continues to degrade. A variety of measures have been examined with respect to the repair and stabilization of the dam structure. Dames & Moore (1991) recommended construction of a sheet pile wall, but without provision for improved or alternative fish passage. Problems with this measure include inadequate knowledge of subsurface conditions and potential difficulties driving sheet piles in known soil formations; ongoing maintenance of the dam; and inadequate provision for fish passage. This measure does nothing to restore the stream; it only preserves a structure of questionable utilitarian value. Simpson Timber has estimated the cost of the alternative at approximately $50,000 per year or a present value of $679,000 over a 50-year evaluation period. This alternative is not complete, there are no improvements for fish passage, and maintenance expenditures would continue to be required to prevent any liability issues for the owner.

4.2.2.2. Remove Dam.

Dam removal would serve to eliminate uncertainty related to the effects of dam failure, however, in the absence of grade control, headcutting would proceed, and fish would not be able to pass the nickpoint. Thus the stream would continue to be a block to fish passage. The cost of removing the dam has been estimated at $145,000 in October 1999 prices. No costs have been estimated to address the eventual headcutting and other impacts associated with not stabilizing the channel. Due to the instability and uncertainty of the consequences of this alternative for fish passage and downstream impacts, it is not an acceptable restoration option and was eliminated from consideration.

4.2.2.3. Repair and Stabilize Dam Structure and Rehabilitate/ Modify Existing Fish Ladder.

This alternative would not only continue maintenance and rehabilitation on the dam structure but also incorporate improvements in the existing fish ladder. The existing fish ladder is impassable to many species largely because of the significant vertical drop across the structure. Under this option the ladder would likely have to be largely rebuilt over a much longer reach of the river to be passable to the targeted species. Even if this were to be accomplished, the majority of the creek would still present a blockage to both up and downstream migration. This option would not restore a natural gradient to the creek, maintenance of the structure would continue to be required, and the costs to rebuild a ladder that only passes a small portion of the flow does not appear to be a cost-effective solution. Costs have not been estimated for this alternative but would be expected to be substantially more than the $679,000 for the no action option. This alternative was eliminated from consideration because it is not a complete solution to addressing the problem or restoration needs.

4.2.3. Provide Fish Passage

4.2.3.1. Move Channel.

Golder Associates (1996) indicated that an old riverine channel may exist on the north side of the dam site, and that the stream has been directed into its present entrenched position by human activity. A detailed investigation during the feasibility phase was not conducted to determine whether or not such a north bank channel exists, whether it might be feasibly constructed, and whether a reasonable grade and natural geometry could be identified in order to bypass the existing dam site. The negative aspects of this alternative include the significant area and amount of disturbance involved initially. This plan would also not address removal of the deteriorating structure and would involve significant real estate costs. This option had questionable effectiveness, because of the many unknown factors. Unknown factors included engineering feasibility, especially related to geotechnical issues. The expected success of restoration would be lower than the other alternatives. If other options proved infeasible, the design team would have conducted further investigation on this option.

4.2.3.2. Remove Dam and Replace with Grade Control Structures

Removing the existing dam and replacing with Grade Control Structures was the preferred alternative for the Preliminary Restoration Plan. Under this type of restoration strategy the dam and associated maintenance costs would be eliminated, but most importantly, removing the dam provides the best opportunity to provide for fish passage through controlling the grade in the project reach. As mentioned above, in the absence of grade control, head cutting would proceed, and fish would not be able to pass the nickpoint. Grade control measures could be accomplished through a variety of measures. The alternative that was presented in the PRP included removing the dam, using cut and fill sections above and below the dam respectively and placement of steel sheet pile weirs. This type of restoration strategy best met the general planning criteria of completeness, effectiveness, and acceptability. Different alternatives utilizing this concept were evaluated in detail during the feasibility phase.

Table 3. Preliminary alternatives.

	Acceptability	**Completeness**	**Effectiveness**
ALTERNATIVE			
No Action **Dam Failure**	No	No	
Continued Fish Blockage			
Repair & Stabilize		No	
Remove Dam	No	No	
Provide Fish Passage			
Move Channel			No
Upgrade Fish Ladder		No	
Remove Dam & Grade Control	Yes	Yes	Yes

4.3. SELECTION OF GRADE CONTROL ALTERNATIVES

4.3.1. Background

A full dam removal with grade control/sediment retaining weir alternative was first proposed by Summit Technology (1996). Their proposal consisted of removing the dam and constructing 37 weirs along the reach to control the grade. Parametrix (October 1997) refined this approach, and their design was the recommended plan for the reconnaissance report (PRP). This plan consisted of two weir groups above and below the existing dam structure. The four weirs upstream were placed at 20-foot intervals, while the five weirs downstream were to be at 10-foot intervals. Channel improvements would affect a 3,000-foot reach of the creek. Below the existing dam site, the channel would have a 1% gradient. Above the dam site, channel improvements would extend upstream to the existing railroad bridge structure, providing a 1.25% channel gradient. The amount of excavation was estimated at 20,000 c.y. and the amount of fill required was 62,000 c.y. The potential drawbacks to this proposal as presented by Parametrix were the high costs ($3.6 million dollars) and degree of in-channel disturbance required for construction. None the less, the Parametrix plan showed much merit and this type of approach became the focus of the Corps feasibility study.

The design team focused their effort on developing different configurations under the general dam removal with grade control alternative that better met the technical criteria established by the group. Several key design considerations for this type of restoration approach are presented below. The Hydraulic appendix (Appendix C) covers many of these considerations in more detail.
The design team concluded it would be most efficient and effective to leave a portion of the existing structure in place. This would not only reduce the amount of fill and cut quantities, but leaving the concrete base of the existing structure in place could serve as an added check point to reduce any potential headcutting or erosions.

- **Fixed channel bed**. The channel bed must be fixed for dam removal to be a success in terms of restoring channel geometry, arresting head cutting, and providing reliable fish passage. The primary purpose of fixing the bed is to insure safety of the project and to reduce impacts outside the project area. Preventing the channel from headcutting and creating long-term sediment releases, channel instability, flood capacity reductions downstream, and habitat degradation upstream and downstream was an important consideration through the project planning. A steppened channel created by dam removal would not be a stable alluvial channel. It would continue to headcut upstream for a considerable distance. Likewise, it cannot be stabilized solely by debris without substantial risk over time because a debris stabilized channel requires the continual recruitment of new, but mature, woody debris which cannot be guaranteed at this site. Stored material can be utilized as backfill. Depending on the type of bed material used, an impervious channel lining might be required.

- **The project start and end points**. Establishing the upstream invert of project restoration is important in reducing the risk of undesirable sedimentation impacts. The potential of increased sedimentation could arise if water surface profiles were to change substantially above the rail road trestle, which is at roughly station 124+00 (refer to Figure 4 for channel stationing). Each alternative would involve fixing the upstream grade to the existing invert at station 126+00 in order to prevent alteration in the sediment transport load entering the project reach. Alteration could result in headcutting and a greater sediment load in the stream than under existing conditions, thus increasing the likelihood of downstream impacts. The stream gradient currently flattens out above this point. All the alternatives have a weir or grade control element upstream of the railroad trestle in the vicinity of 126+00. The primary consideration at the downstream end was to avoid unnecessary impacts to existing habitat. Further the channel naturally widens out at approximately station 108+00. Based on field investigations, the team identified station 106+00 as a natural end point.

- **Total project footprint**. Based on the above considerations the total project footprint totals 2000 feet in length, a substantial reduction from the 3000 feet impact area of the reconnaissance level alternative.

- **The overall channel gradient**. Balancing sections of free flowing sections at a more natural gradient (.5%) with steeper reaches that would be stable. Provided that the weirs are constructed properly with minimum disturbance to the clay banks and appropriate bank protection elsewhere, the restored channel reach should stabilize in a short period of time. This may be up to five years depending on the alternative.

- **Material of grade control structures**. Grade control structures could be constructed from steel or vinyl sheet-pile weirs, boulders or logs. Sheet-pile weirs provided the greatest flexibility in designing the channel to optimize passage conditions over a broad range of flows. Boulder weirs were also considered a viable option that would result in a more natural looking stream. Log weirs were initially considered, but were thought to have less flexibility in design over a variety of flows. The expected physical life of log weirs was also thought to be substantially lower than for steel, vinyl or boulders. Further, the required armoring to stabilize log structures reduced their attractiveness. For these reasons, log weirs were not considered in the three final alternatives.

- **Channel cross-sections**. A trapezoidal cross-section with a 40 feet bottom width, 3H:1V side slopes to nine feet horizontal on each side, with 10H:1V side slopes to the intersection of existing topography. Channel geometry is based on interpretation of existing channel properties in the vicinity of the project reach and iterative gradually varied flow modeling.

4.3.2. Final Array of Alternatives

Three different options were developed, each meeting the established criteria to differing degrees and incorporating the above design considerations. Each of these options includes removing the timber wall portion, the spillway, and fish ladder of the existing dam and using cut and fill above and below the dam respectively to arrive at a stable grade. A natural grade for this type of stream is between 0.3% and 0.7%. To arrive at this grade without grade control structures, the overall project length would need to be on the order of 6,000 feet. This was considered unacceptable not only because of the large quantities of fill required, but also because of the tremendous impact to the existing relatively pristine habitat conditions outside the immediate vicinity of the dam. Further, and more importantly, this type of approach would introduce flooding problems in the project area that would need to be addressed. In order to reduce these impacts, and to meet the 90% fish passage reliability criterion, steeper sections were incorporated into the design at various intervals generally not exceeding 3.75%. The steeper reaches need to have drops small enough to provide for fish passage, but stable enough to withstand high flows without significant stream degradation or impacts downstream. In between the steeper sections, the gradient would be reduced to the more natural gradient of 0.5%.

Conceptual Designs were developed for the final three alternatives, as shown in Figures 5, 6 and 7. Further design considerations are addressed in the hydraulic and geotechnical appendices.

CONCENTRATED WEIRS. The sheet pile weir design is essentially a fish way, which uses the entire width of the stream as steps for the ascent and descent of fish. The sheet pile weir design also serves the grade control function, which is required in order to provide a passageway to the basin above the dam site. A concentrated weir alternative was considered as a means of reducing the project impact area. Figure 5 depicts this alternative. The spacing between the steel sheetpile grade control weirs is 20 feet for a total of approximately 45 weirs. The gradient through the steep reach would be 3.75%. This gradient was considered an upper limit to provide for structural safety in channel design. Upstream and downstream of the concentrated weirs the grade would be between .5% and .7%. Each of the weirs would have an approximate 40 feet bottom width, and 3H:1V side slopes to contain high flows, followed by 10H:1V slopes to tie into high ground. In addition to the two-stage channel, each weir will have a 6'wide low flow notch. The low flow notch will provide a water depth of 1' during low flow periods. The low flow period was defined as the 95% daily average discharge exceedence, by month, during the time of upstream migration. The project length of the concentrated weirs is approximately 800 feet. A buried stone grade control element would be placed at section 126+00 and 107+00 to ensure stability.

Achieving successful upstream fish passage through the Goldsborough project site requires that hydraulic conditions cannot exceed the physical abilities of the target species. Although a variety of anadromous fish are found in Goldsborough Creek, chum salmon are the weakest swimmers among the salmonid species. Chum salmon have an estimated upper limit of darting or burst speed of 10.6 fps (Orsborn and Powers 1985), and are generally considered to be poor leapers (Salo 1991). A fish moving at burst speed can only maintain that high rate of activity for 1-20 seconds before becoming fatigued. If when attempting to negotiate a barrier a fish becomes fatigued, the fish will fall back and rest for up to 3.2 hours before re-challenging the barrier. The most significant uncertainty regarding successful fish passage of concentrated weirs is whether the fish would make the effort to make the sustained ascent. If a fish becomes fatigued, it may fallback downstream until it reaches an acceptable holding area. Chum salmon may successfully pass individual weirs, but the concentrated series of up to 45 weirs lowers the likelihood that fish can successfully pass through the steepened reach.

BOULDER CASCADE. Rather than using exposed weirs to control the grade through the stream reach, incorporating boulder drop structures at spaced intervals was considered. Conceptually, the boulder channel alternative is designed to emulate natural step-pool morphology as described by Grant (1990). The boulder channel would basically look and function like a series of cascades or rapids. Boulders would be aligned across the channel in rib-like fashion, with a riprap bed to resist displacement of the boulders. Design elements consist of rapid slope, free flowing reach slope, rapid spacing, bed armor size, boulder size, and longitudinal and transverse spacing. A plan and profile drawings of the boulder channel alternative are shown in Figure 6.

A buried weir would be placed at the upstream end of each boulder cascade. The buried weir is required to prevent failure of the entire system. If one cascade were to fail by unraveling, the next cascades upstream would also likely fail in series. Each boulder group is approximately 100 feet in length and in a trapezoidal shape with a 40 feet bottom width and 3H: 1V side slopes and 10H: 1V side sloped thereafter to the intersection with the existing bank. In between the boulder groups the gradient would be roughly 0.5% to allow natural stream process to take place, and would provide for resting areas for migrating fish. Over time the boulder drop structures would disperse somewhat, while the buried weir would ensure against unraveling of the channel slope. The overall project length of this alternative is 2000 feet. This type of design has been used where smaller elevation drops were required.

There is a high level of uncertainty of successful fish passage when incorporating a series (11) of boulder cascade structures. Cascades can present fish with high velocities, high turbulence, and orientation difficulties that may prevent a fish from effectively using all of its swimming power (Powers and Orsborn 1985). Under low flow conditions, large bodied fish such as chinook or chum salmon may require a near-continuous thread of deep water to assure passage within a cascade group. Over time, and after repeated exposure to high winter flows, boulders will move around within a cascade group. Changes in the channel thalweg or the depth or shape of local scour pools within a cascade may present additional passage difficulties. An additional fish passage risk is that the boulders would disperse leaving the weir at the top of the cascade as a barrier with no opportunity for a scour pool to develop in the middle of the cascade. Because of uncertainty on how the project would function, maintenance and rehabilitation costs would also be higher.

WEIR GROUPS. Rather than concentrating the drop in one reach of the river, the concept of using groups (4-5) of weirs with free flowing sections in between the groups was the basis for the third alternative. The space between weir groups acts as an energy dissipating reach and provides a flexibility in the design in case extreme flows, debris jams or other perturbations exceed the design criteria. This alternative would have a somewhat larger impact area than the concentrated weir but as a trade-off would provide a higher likelihood of providing fish passage during a greater variety of fish flows. Grouping the weirs provides a more stable alternative compared to concentrated weirs. The space between weir groups acts as an energy dissipating reach and provides a flexibility in the design in case extreme flows, debris jams or other perturbations exceed the design criteria. The space between the weir groups also provides a variety of resting habitats to allow fish to recover after passing through the downstream group of weirs.

Design elements consist of determining the elevation drop between individual weirs, the number of weirs per weir group, longitudinal spacing between individual weirs, longitudinal spacing between weir groups, cross-sectional properties, low-flow notch geometry, and armor size. The maximum allowable elevation drop between individual weirs was specified to be 1 foot by the design team. Each of the weirs will provide for a two-stage channel in addition to a 6 foot-wide low flow notch. The low flow notch will provide a water depth of one foot during low flow periods. The provision of the low flow notch will increase the likelihood that chum salmon can swim through the notch rather than having to leap to ascend the weir. The design team also agreed to the suggestion by the fisheries experts that no more than 5 weirs be used in any one weir group.

These guidelines, in conjunction with site constraints and with emphasis on maintaining a slope of 0.5% in free flowing reaches between weir groups, helped to establish the alternative layout as follows: weir groups will consist of 4 to 5 sheet pile weirs in series, with 35-foot spacing between individual weirs at a maximum one foot elevation drop. Free flowing sections are a minimum of 100 feet in length at 0.5% channel bottom slope. The length of the free-flowing sections is up to 275 feet above the existing dam. Trapezoidal channel section as prescribed previously is retained for this section. The resultant 33-weir alternative, in seven groups, has an average channel slope of 2.3%, and the overall project length is less than 2,000 feet. As in the Concentrated Weir alternative, the individual weirs have a 'dog-leg' pattern.

4.4. DESIGN TEAM EVALUATION AND RECOMMENDATION

4.4.1. Design Team Evaluation

Following the conceptual development of each of the three grade control alternatives, the design team evaluated the alternatives. The evaluation included assessing each of the alternatives against the technical criteria developed by the team. A rating scale between one and ten was used, with 10 indicating that the criteria was entirely met, or had a 100% reliability of being met. The lower the rating the lower the reliability. Each member of the design team rated the alternatives individually; these were then averaged to arrive at the groups' final score for each criteria. Table 4 presents the results of the alternative evaluation. A total score for each alternative was not developed, in part because this would require assigning a weight to each criterion. Assuming each criteria was of equal weight was not necessarily appropriate since the primary project purpose is fish passage. Each criteria is critical to project success, but each does not relate to fish passage. The intent of the criteria is to assess how well each of the alternatives met the design criteria. The scores for each alternative are used as a tool to help compare the alternatives to one another

Table 4. Evaluation of Final Array of Alternatives.

Criteria	Alternative Weir Groups (Dog-leg Weirs with low flow fish passage notch)	Alternative Boulder Cascade with Buried Weir	Alternative Concentrated Drop Minimum Footprint
1. Provide Passage for adult and Max. Ext. prac. Juvenile resident and migratory fish	9	6.2	7.5
2. Mitigate Impacts to wetlands, riparian and stream habitat	7.4	6.6	7.6
3. Any Constructed Channel and Riparian Area Should Mimic Natural Conditions	7.0	8.6	5.4
4. Fish Passage Standards must be complied with 90% of the time for Each Species.	8.7	6.1	6.9
5. Surface Structures Must Safeguard against Catastrophic Failure	9.6	8.3	9.1
6. Project Surface Structures must be Capable of Functioning for fish Passage After a Reasonable Flood Event.	9.1	6.3	8.7
7. Project Cannot Result in any Significant Adverse increase in downstream Flooding, Erosion Damage, or Sediment Deposition.	9.1	8.1	8.9
8. Project Must be in Compliance with all Federal, State, and local legislation, policies and Guidance, Including Funding Restrictions	9.1	9.1	9.1
9. Project Must Provide Successful, Safe Downstream Passage to Resident and Migratory Fish.	9.2	8.6	9

4.4.2. Design Team Recommendation.

The score for each criterion among the alternatives conveys the strengths and weaknesses of the alternatives. The following summarizes the assessment of each of the alternatives.

4.4.2.1. Boulder Channel

The merits of the Boulder Cascade alternative are that it best mimics natural channel conditions, as evidenced by the scores under criterion 3. One of the weaknesses of Boulder Channel is the substantially lower reliability in assuring fish passage under criteria 1 and 4. There was also concern among the design team in how the alternative would function following a flood event in terms of rehabilitation costs and structural integrity as reflected in criterion 6. The ability of this alternative to adequately dissipate energy in the project reach was viewed as less reliable. The score for criterion 7 reflects this concern, which would be reflected in adverse impacts outside the project reach.

4.4.2.2. Concentrated Weir

One of the merits of the Concentrated Weir alternative is that it minimizes the project reach that would be impacted by construction. This consideration is perhaps best reflected in criterion 2. This alternative was thought to have the least effect on the wetlands upstream of the dam and the channel downstream. However, in minimizing the project footprint, the alternative raised significant concerns on whether fish would be able ascend such a large number of jumps without adequate resting areas, this is reflected in the score for criteria 1 and 4. The alternative somewhat surprisingly scored higher on fish passage than the Boulder Cascade. The reason for this is likely because of the shape of the weirs, especially the low flow notch. Of the three alternatives considered, the concentrated weir scored the lowest in terms of mimicking natural conditions. The gradient through the weir section, at 3.75%, was a concern for some members of the design team in terms of structural stability. However, based on the expected velocities through the project reach, it appears reasonable that this alternative could be designed to accommodate these flows.

4.4.2.3. Weir Groups

The Weir Group alternative scored lower than the Boulder Cascade alternative in its ability to mimic natural conditions. Incorporating adequate spacing between the weir groups resulted in a higher score in mimicking natural conditions than the concentrated weirs. The spacing between the weir groups also helped increase this alternatives ability to ensure fish passage when compared to the concentrated weirs. This alternatives ability to mitigate (avoid, minimize, mitigate) wetland and other impacts) was slightly lower than the concentrated weir alternative. Overall, the Weir Group alternative scored higher than the other alternatives on 6 out of the 9 criteria. There was strong concurrence among the design team that this alternative provided the most optimal design to:

- Provide passage for adult and juvenile resident and migratory fish (criterion 1)
- Ensure fish passage standards would be complied with 90% of the time
- Ensure surface structures would safeguard against catastrophic failure
- Provide for fish passage following a reasonable flood event.
- Minimize the potential for impacts downstream of the project
- Provide successful and safe downstream passage to resident and migratory fish.

4.4.2.4. Design Team Recommendation

Based on this evaluation technique the Weir Group Alternative is the recommended plan as it best meets all of the technical criteria. As discussed in the plan formulation methodology section (section 4.1) the design team scoring was used as one tool to select a recommended plan. The other tool is a cost-effectiveness analysis and incremental cost analysis (CEA/ICA). This evaluation more explicitly considers alternative costs in relation to expected outputs, and is requirement for all Corps of Engineers restoration projects. This evaluation is presented in the following sections.

Figure 5. Concentrated Weirs.

Figure 6. Boulder Cascade.

Figure 7. Weir Groups.

4.5. RESOURCE BENEFITS

4.5.1. Restoration Outputs.

Benefit-Cost evaluation is an integral part of all Corps of Engineers projects. For traditional Corps project purposes such as navigation and flood control, benefits and costs are quantified in monetary terms. Because both costs and benefits are monetized an easy comparison can be made to determine the optimal project. The economic rule used to determine the optimal project, is that alternative that has the greatest net (of costs) benefits. Quantifying environmental benefits in monetary terms is much more difficult for environmental restoration projects. Recognizing this difficulty, the Corps does not require a strict benefit cost evaluation. However because costs and benefits are an important consideration in determining whether a particular restoration project merits investment and to identify the optimal level of investment an alternative tool is used in place of the traditional benefit-cost evaluation. This tool is cost-effectiveness analysis and incremental cost evaluation (CEA/ICA). Although this approach does not result in a strict decision criteria, it is useful to assess project alternatives. Under this approach, potential project benefits are quantified, but not typically in monetary terms. The quantified benefit measure is different depending on the type of restoration project being considered. Examples might include habitat units or a habitat index. It is important to recognize that the selected measure typically can't include all components of ecosystem restoration and should be viewed as a proxy for the project benefits. Under the CEA/ICA the benefits or project outputs are quantified for each of the alternatives and then compared to the project cost. The relationship between changes in costs and outputs are then evaluated. This evaluation procedure should be viewed as a tool to help identify the most effective and efficient project alternative.

Quantifying outputs for the Goldsborough restoration project is difficult. The primary difference between the final array of alternatives in effect is how reliable the alternative is in meeting the primary project goal. Benefits from this restoration project are primarily from fish passage: the removal of a significant barrier to upstream fish passage and a hazard to downstream passage. In addition, the more natural gradient resulting from this project will restore the natural distribution of sediment and woody debris along the length of the stream. Another important component of the project, is the impact to the existing project reach. Although the project length of each of the alternatives has been minimized from the reconnaissance report from 3000 feet, each will have a significant construction impact in the project reach.

For this project, two components of resource benefits, or "outputs" were selected and analyzed in order to compare the relative benefits and merits of the proposed alternatives. These two components were:

- ♦ fish passage, and the resulting estimated use of the watershed by target species, and
- ♦ habitat value or condition in the in the project reach.

4.5.2. Fish Passage Output

Target species for this project are coho, chum, chinook and steelhead salmon and cutthroat trout. Information on historical stream use and abundance of these species is spotty at best. Spawning surveys have been done in one index reach above the dam by WDFW in recent years and have documented some coho spawning. Spawning of all other species has been observed downstream of the dam and in Coffee Creek, a tributary emptying into Goldsborough below the dam. But without reliable data on which to base resource benefits, a simple formula relying on the professional expertise of the design team was developed. An "Index of Reliability" (Table 5) was developed by choosing the design criteria related to fish passage, and averaging the design team ratings for all alternatives. This method implicitly assumes that each of the four selected criteria is of equal importance. This is a reasonable assumption, since the primary project purpose is fish passage.

Table 5. Index of Fish Passage Reliability.

CRITERIA		ALTERNATIVES			
#	**Description**	**Existing Condition**	**Boulder Cascade**	**Weir Groups**	**Concentrated Weirs**
1	Provide upstream passage	3.0	6.2	9.0	7.5
4	Fish passage standards 90% reached	2.5	6.1	8.7	6.9
6	Structures able to withstand flood event	3.0	6.3	9.1	8.7
9	Provide downstream passage	7.5	8.6	9.2	9.0
	MEAN = INDEX OF RELIABILITY	**4.0**	**6.8**	**9.0**	**8.0**

The potential benefit area of the project alternatives is the upstream habitat that could be accessible for spawning and rearing. This has been estimated at 14 miles of stream. To obtain a fish habitat score for each of the alternatives and the existing condition, the index of reliability was multiplied by the 14 miles of available upstream habitat. The resulting fish passage outputs are shown in Table 6.

Table 6. Fish Passage Output.

	ALTERNATIVES			
FISH PASSAGE OUPUT	**Existing Condition**	**Boulder Cascade**	**Weir Groups**	**Concentrated Weirs**
	56.0	**95.2**	**126.0**	**112.4**

4.5.3. Habitat Output

An important consideration in the project design is how each of the alternatives would affect the project reach, or construction area. The project reach includes approximately 1000' upstream of the existing dam and 1000' feet downstream. "Habitat output" was a method of relating the ultimate habitat value of the project reach (not upstream habitat) from the different alternatives and the existing condition. For this output (Table 7), design criteria referring to habitat values in the project area were chosen for rating. Criterion 2 was broken down into subcategories, as it included several different important considerations. Two fisheries biologists (Phil Hilgert, R2 and Lauran Warner, Corps) independently rated the project reach for the given criteria, and the score for a given alternative on a given criterion was a mean of the two independent ratings. The mean of these ratings was then used as a Habitat Impact Index score for each alternative and the existing condition. The existing condition scored higher than any of the alternatives. The reason for this is that with the exception of the roughly 200-foot channel reach where the dam is located, the habitat value is fairly high.

Table 7. Construction Area Habitat Index.

CRITERIA		ALTERNATIVES			
#	**Description**	**Existing Condition**	**Boulder Cascade**	**Weir Groups**	**Concentrated Weirs**
2	Wetland, riparian, stream	9.5	6.6	7.4	7.6
2	Spawning habitat	7.5	7.0	8.3	6.8
2	Rearing habitat	7.5	8.5	8.0	7.0
2	Holding habitat	7.0	4.0	8.5	5.5
3	Mimic natural conditions	9.0	8.6	7.0	5.4
	HABITAT INDEX	**8.1**	**6.9**	**7.8**	**6.5**

The habitat reliability index for all alternatives and the existing condition as shown in Table 7 was then multiplied by the project length to obtain the habitat output score (see Table 8). The maximum project length for any alternative was used as the baseline project area*. For the Concentrated Weir alternative, which has a shorter project area, the score for the existing condition was used for that part of the baseline project area that would not be impacted. This procedure produced a habitat impact score that could then compare resulting habitat values between alternatives. That is, since the scores of the other two alternatives are measured over the entire project area of 2,000 feet, the concentrated weirs score needed to reflect a score over the same project area. The formula for determining the habitat output for the concentrated weirs is as follows: 6.5 x .15 + .23 (i.e. .38 - .15) x 8.1 = 2.8*

Table 8. Construction Area Habitat Impact.

	ALTERNATIVES			
PROJECT AREA HABITAT IMPACT	**Existing Condition**	**Boulder Cascade**	**Weir Groups**	**Concentrated Weirs**
Project length (mi)	**0.38**	**0.38**	**0.38**	**0.15**
Output score	**3.1**	**2.6**	**3.0**	**2.8**

Finally, both fish passage and habitat indices were summed together to create a resource benefit score for all alternatives and the existing condition (Table 9). Including the 'construction area habitat impact' clearly makes little difference in the overall project score, however it conveys an important point. Specifically that the overall benefits of restoring access to high quality habitat upstream of the dam outweighs the impacts to the project reach. The total output score for any of the final alternatives represents a substantial improvement over the existing conditions.

Table 9. Output Summary.

Description	Existing Condition	Boulder Cascade	Weir Groups	Concentrated Weirs
Fish Passage Output	56.00	95.20	126.00	112.4
Project Area Habitat	3.1	2.6	3.0	2.8
TOTAL	**59.1**	**97.8**	**129**	**115.2**
RELATIVE IMPROVEMENT	**0%**	**66%**	**118%**	**95%**

4.6. PRELIMINARY COSTS

Preliminary costs were developed for the three final alternatives. These costs are presented in Appendix D, and are summarized below. In addition to estimating construction costs, an estimate of expected maintenance is also included. The following figures do not include contingency, PED or other costs associated with project implementation and are based on a 10% level of design. They are used to compare and assess each of the alternatives. All costs are in October 1999 prices.

Boulder Cascade. Construction costs are estimated at $2,614,000. Operation, maintenance and rehabilitation is required every 20 years and is estimated to cost $326,000 per event.

Weir Group. Construction costs are estimated at $2,273,000. Operation, maintenance and rehabilitation is required every 20 years and is expected to cost $210,000 per event.

Concentrated Weirs. The construction costs for the third alternative are $2,119,000. Operation, maintenance and rehabilitation for this alternative is also required every 20 years and is estimated to cost $196,000.

4.7. COST EFFECTIVENESS AND INCREMENTAL EVALUATION

4.7.1. Final Restoration Measures

The evaluation of alternatives during plan formulation resulted in three viable alternatives remaining for further evaluation. The cost-effectiveness and incremental cost analysis evaluated these three remaining alternatives - none of which are dependent or combinable with another. The individual measures are:

Boulder Cascade – This measure consists of groups of boulder structures spaced at intervals in the creek to achieve a more natural looking stream. Each group is about 100 feet in length. A buried weir would be placed at the upstream end of each boulder group to ensure against unraveling of the channel slope. The overall project length is 2,000 feet. This alternative has an average annual cost of $194,000 and an output measured at 97.84.

Weir Groups – Consists of 7 groups of sheet pile weirs with spacing in between the groups to allow for free flowing areas. Each of the groups consists of three to five weirs spaced 35 feet apart. This alternative is approximately 2,000 feet in length. This measure has an average annual cost of $167,000 and an output of 128.98.

Concentrated Weirs – Is comprised of 45 weirs spaced 20 feet apart. Each weir would have a low flow notch, roughly a 40-foot bottom width and 3H: 1V side slopes to contain high flows. The project length is about 800 feet. This measure has an average annual cost of $156,000 and an output of 115.18.

4.7.2. Benefit Methodology

The evaluation of the remaining ecosystem restoration alternatives were evaluated in accordance with EC 1105-2-214, dated 30 November, 1997, "Project Modifications For Improvement of the Environmental and Aquatic Ecosystem Restoration". Since benefits (i.e. outputs) of restoration projects are not measured in monetary terms, a typical benefit-cost ratio is not used to determine project justification, and maximizing net benefits cannot be used to optimize project size. When benefits and costs are not measured in monetary terms, a cost effectiveness and incremental cost analysis offers the next best approach to evaluated plan alternatives. The cost-effective analysis filters out alternatives that produce the same output level as another plan but cost more; or cost the same or more than another plan but produce a lower output level. The incremental cost part of the analysis shows the incremental increases in cost as ecosystem outputs are increased. The results of the incremental analysis do not result in a discrete decision criterion but does provide a tool to facilitate selection of the federal plan. Total outputs associated with each of the alternative measures were quantified by summing an index number for fish passage with an index for the footprint area habitat. The indexes were weighted to reflect the fact that fish passage is considered to be a significantly more important restoration feature than habitat functions. See Section 4.5 "Resource Benefits" for detailed information on the quantification of project benefits.

4.7.3. Cost and Output Of Each Measure

The construction costs are based on a ten-percent level of design. Interest and amortization of the construction cost, at 6 7/8% are levelized over a 50-year economic life and include annual operation, maintenance and rehabilitation cost. Operation, maintenance and rehabilitation costs for each of the alternatives consists of (1) restoring earthwork, (2) grade control, (3) restoring bank protection and (4) restoring habitat features. Because of sponsor concerns related to maintenance and rehabilitation, the present worth of these expenditures have been taken over a 100-year period, and then amortized over the Corps maximum project life of 50 years to compute their average annual cost. These costs were computed based on the following:

Table 10. Operation, Maintenance and Rehabilitation Costs.

Cost Item	Year of Expenditure	Boulder Cascade	Weir Groups	Concentrated Weirs
* Restoring Earthworks	20, 40, 60, 80	$110,000	$113,000	$108,000
* Grade Control	20, 40, 60 ,80	125,000	10,000	11,000
* Restoring Bank Protection	20, 40, 60, 80	45,000	32,000	30,000
* Restoring Habitat Features	20, 40, 60, 80,	46,000	55,000	47,000
Total Cost	**N/A**	**$326,000**	**$210,000**	**$196,000**
Average Annual	**N/A**	**$8,000**	**$5,000**	**$5,000**

Total average annual costs as well as the annual output for each measure are presented in Table 11.

Table 11. Construction and average annual costs and outputs.

Measure	***Construction Cost***	***Interest and Amortization***	***Operation, Maintenance & Rehabilitation***	***Total Average Annual Cost***	***Annual Outputs***
(1) Boulder Cascade	$2,614,000	$186,000	$8,000	$194,000	97.8
(2) Weir Groups	$2,273,000	$162,000	$5,000	$167,000	129.0
(3) Concentrated Weirs	$2,119,000	$151,000	$5,000	$156,000	115.2

As shown in Table 11, the Boulder Cascade measure has a higher annual cost ($194,000) with less output (97.84) than the other two measures. Therefore, compared to the other two measures, Boulder Cascade is not cost efficient and was eliminated from further evaluation and consideration.

Table 12, below, shows the average annual cost and annual output of the two remaining measures as well as the incremental cost and incremental output plus the incremental cost per incremental output for these measures.

Table 12. Incremental Cost per Output.

Measure	*Average Annual Cost*	*Annual Output*[1]	*Incremental Cost*	*Incremental Output*	*Incremental Cost Per Incremental Output*
Concentrated Weirs	$156,000	115.2	$156,000	115.2	$1,354
Weir Groups	$167,000	129	$10,000	13.8	$725

PREFERRED PLAN. (Based on cost effectiveness) The above table shows that the "Concentrated Weirs" measure has a incremental cost per incremental output of $1,354 while "Weir Groups" measure has a incremental cost per incremental output of $725. This means the incremental increase in output versus the incremental increase in cost is less for Weir Groups than Concentrated Weirs. In addition, the cost per unit of output is less for Weir Groups ($1,295) than for Concentrated Weirs ($1,354). Based on this analysis, the preferred plan is construction of Weir Groups.

[1] Includes existing condition output of 59.08.

5. RECOMMENDED PLAN

Based on the results of the incremental analysis, and the evaluation conducted by the technical team and local sponsor support the recommended plan is the Weir Group Alternative. Following selection of the plan more detailed design work was completed on the Weir Group Alternative to provide for a 35% level feasibility design and cost estimate.

5.1. DESCRIPTION OF THE RECOMMENDED PLAN

5.1.1. Major Project Restoration Features of the Preferred Plan

The proposed restoration plan consists of removing a portion of the existing timber pile and concrete structure, excavating material above the dam, placing fill material below the dam and constructing groups of one-foot high weirs to allow for fish passage. These weirs, in combination with fill and excavation of material, will provide necessary grade control to prevent scour and erosion. This stepped approach will establish and maintain a gradient similar to other streams in the region.

5.1.1.1. __Removal of Existing Structure__.

Approximately 15' of the existing structure would be removed, taking the elevation from 90' to 74.5'. The demolition includes primarily treated timber piles that form the surface layer of the existing dam. Some concrete along the right bank would also be removed, as would the existing fish ladder.

5.1.1.2. __Earthwork (Excavation and Fill)__.

Excavation of material upstream of the dam extends 1000'. The total quantity to be excavated is 25,000 cubic yards. Immediately upstream of the dam the height of material to be excavated is approximately ten feet. Fill material would be placed downstream of the existing dam structure. Fill will come from material classified as satisfactory excavated upstream of the dam and from outside borrow sources. Immediately downstream of the structure the amount of fill required is about 14'. The amount of fill 350' downstream of the existing structure would be 5 feet. Similarly, 650' downstream of the structure the depth of fill material needed is diminished to approximately 2 feet. The final two feet of fill that will compose the channel bed will be a select mixture of cobbles, gravels, and sands.

5.1.1.3. __Grade Control & Fish Passage.__

Groups of sheet pile weirs will be used to control the grade through the project reach and provide for fish passage for various species. Seven groups of weirs will be used in the project footprint. Each of the weirs will have a 'dog-leg' pattern to help provide for fish passage in a variety of flow conditions. The spacing between individual weirs will be approximately 35'. The spacing between weir groups will vary between 189' to 275' above the existing dam. Downstream of the existing dam the spacing between the weir groups will be 100 feet. The average slope across each of the weir groups is 3.57%. The slope between the weir groups, in the free flowing area, is .5%. This results in an average gradient through the project reach of 2.3%. The drop over each weir is 12". Each of the weirs will provide for a two-stage channel in addition to a 6' wide low flow notch. The low flow notch will provide a water depth of 1' during low flow periods (20 c.f.s). The bottom width of the trapezoidal cross-section is 40'. Beyond this, a 3 horizontal on 1 vertical (3h: 1v) side slope will be used to contain winter flows. A 10h: 1v channel will be used beyond this and tied into high ground. The top width at intersection of 3:1 and 10:1 slope is 70 feet. The side-slope variation will be dependent on existing topography throughout the project reach. The first weir in each group will be steel sheet pile. The intermediate weirs will either be vinyl or steel sheet pile. Vinyl sheet piling is used for the intermediate weirs in the feasibility design due to cost considerations. Steel sheet pile could prove cost effective if a quantity of previously used sheet pile can be acquired during construction. Weir size and embedment depth is dependent on local site conditions. Weir size was estimated from a conservative value of scour depth potential. Each weir group will be sized based on the depth to the Kitsap Formation and relative strength of each material layer that it is being driven into. The upstream weir in each group will be designed to resist loading from a larger flood event to prevent catastrophic failure of the weir group. It will extend farther into both banks and be driven deeper than the intermediate weirs. The average size of the weirs to be used is estimated to be 150 feet wide by 20 feet deep for the first weir and 80 feet wide by 10 feet deep for the intermediate weirs of each group. Use of vinyl sheet pile weirs will require additional geotechnical information to determine if they can be driven to a sufficient depth. Each weir will have a concrete cap with exposed cobble finish to reduce the visual presence of the weir. Boulders will be placed at the base of the weirs at the upstream and downstream end of each weir group to help transition between the weirs to the free flow area.

5.1.1.4. Channel Design and Bank Protection.

Upstream of the dam in the excavated channel section the banks of the constructed channel will be composed of river sediments deposited since the dam was constructed. The Kitsap Formation is visible at the surface along the right bank near station 119+00. Additional geotechnical work is required to determine the long-term stability of this tall bank. The left bank directly across the channel will be excavated and a mound of riprap placed to prevent the flanking of weir group 2. The riprap will be placed with a 4h: 1v back slope and covered with soil and planted. The railroad abutments will be protected against channel scour with riprap. Weir group 3 will also require protection of its excavated banks. The increased velocity and turbulence of the water as it cascades over the weir necessitates that a hard bank protection design be incorporated. The existing bank material types will not withstand either channel average velocities (8.4 ft/second) nor maximum velocities (12 feet/second) manifested during the design 50-yr event. Due to the incised nature of the channel within the project reach, and the fact that all floods will be contained within the constructed channel, high bed and bank shear stresses will be present (in excess of 1.4 lb./ft^2) and riprap will be required. Bank protection details will vary depending on location (within weir groups or between weir groups) and bank material (Kitsap formation, sands and clays, raised berm). Seattle District riprap design guidance suggests that Class 2 riprap blanket (24” thick with a d_{100} of 500 lb., d_{50} of 200 lb., and $d_{10}$of 100 lb. will be sufficient to protect the banks. Downstream of the dam where the existing bank is currently experiencing erosion, additional bank protection will be required, specifically at weir groups 5 and 6 right bank, and weir group 7 both banks. Bank protection will extend from a toe placed below the edge of the 40-foot channel bottom to the top of the 3h:1v slope. Soil will be placed among the bank protection and plantings, such as willows, are included. The free flowing sections between weir groups do not require riprap bank protection. Woody debris and other habitat features involving the placement of large rocks, and logs have been incorporated into the design. Alternative or natural bank protection, such as fabric and vegetation, may be preferentially employed where suitable flow or soil conditions permit, but their use as the primary mechanism of bank protection should be very limited. Methods, materials, and locations will be refined during plans and specifications. Opportunities to incorporate 'softer' bank protection features will also be considered during plans and specifications. The use of softer features will be weighed against maintenance and rehabilitation costs over the project life.

5.1.1.5. <u>Habitat Features</u>.

A total of 4.5 acres has been estimated for planting in the project reach. A detailed planting scheme will be developed during plans and specifications. At this time a placeholder of $15,000 per acre has been used. In addition to planting, other habitat features including washed gravel, large woody debris, and large rocks are included in the feasibility design. Materials and locations will be refined in plans and specifications.

5.2. EXPECTED PERFORMANCE OF THE RECOMMENDED PLAN

5.2.1. General Considerations.

The recommended plan emphasizes maintaining conditions that are suitable for fish passage. These features include a slope of 0.5% in free flowing reaches between weir groups, having no more than 4 to 5 sheet pile weirs in series, with 35-foot spacing between individual weirs at a maximum one foot elevation drop. Additionally free flowing sections are a minimum of 100 feet in length at 0.5% channel bottom slope. The length of the free-flowing sections is up to 275 feet above the existing dam. Trapezoidal channel sections with a 'dog-leg' pattern help ensure fish passage over a variety of flows. The average gradient through the project reach is 2.3%, and the overall project length is less than 2,000 feet.

The following outlines expected performance and hydraulic considerations of the recommended plan. With-project water depths are expected to be lower than existing depths in the project reach, while velocities will be higher. The hydraulic models suggest that the existing water surface profile will prevail just downstream of the last weir, notwithstanding the existing instabilities there as discussed in the previous section. It is not expected that the project as designed will exacerbate existing instabilities downstream of the project reach. Further independent investigations will be conducted during the plans and specifications phase to verify this statement.

Flood flows will no longer become impinged upon the low chord of the railroad trestle upstream of the dam. This will eliminate maintenance associated with overbank flow due to impingement at and exceeding moderate flow.

While the preferred alternative channel has greater sediment transport capacity than the existing channel in the project reach, it is not expected that the available supply will be significantly increased, as the upstream end of the project will begin at the level of the existing stream bed. Because of this, additional bedload material should not be recruited, and only that portion of the existing in-flowing sediment load which is currently being deposited in the overbanks upstream of the dam between the vicinity of the railroad trestle and the dam, such as sand and silt and perhaps some pebbles, will be added to the existing sediment load passing over the dam and through the incised reach. This material should be readily mobilized by the stream and be passed through to Oakland Bay. That portion of sediment currently believed to represent a miniscule addition to the sand size portion of the existing sediment load, as that area over which deposition is currently occurring is on the order of four acres in size. While sensitivity runs conducted in HEC-RAS suggest that deltaic formations at the mouth of Goldsborough Creek can impact water surface elevations within the city limits, it is highly unlikely that this small addition of sand grain sized particles is of sufficient quantity, even accumulated over many years, to impart notable impacts, particularly when weighed against the sum total of existing annual riverine sediment transport (6,000 tons/year) and annual marine longshore sediment transport (3,300 tons/year (WADOE, 1980)) which supply sediments to the mouth of Goldsborough Creek at Oakland Bay.

Velocities in the project reach are important with respect to fish passage. If velocities exceed those at which fish can swim, the project purpose is defeated. Fish swimming speeds as presented in Bell (1986) suggest that the sustained swimming speed capabilities of coho and chinook are sufficient to overcome velocities on the order of 8 to 10 ft/second, which is greater than maximum velocities expected in the project reach during the high fish flow (475 cfs). The swimming prowess of the steelhead trout far exceeds that of chinook and coho salmon. Cutthroat trout, whose sustained swimming speeds are on the order of three to six feet per second, may be challenged to efficiently pass upstream at the high fish flow, as would chum, although both fish types exhibit darting speed bursts in excess of those believed necessary to pass over the weirs at 475 cfs. Regardless of fish type, most fish would probably rest at least once between individual weirs as they proceed through weir groups. Sufficient low velocity habitat within and between the weir groups, in the form of scour pools and areas close to the bed and banks, should be available for the resting purpose. Under ideal low flow passage conditions, the low flow notch should be backwatered by about a third of its depth to help assure that adult chum have the opportunity to swim through the notch rather than be forced to leap. It is unlikely that most fish would attempt upstream passage during flood events, although the most capable swimmers, such as steelhead, chinook, and coho, may be able to do so except during rare events.

Due to increased velocities in the project reach it is to be expected that sorting of the channel bed will occur with a d_{50} (mean diameter of which 50% by mass of near surface particles will not exceed) range of 3.0-3.5 inches (small cobbles) will predominate in the free flowing reaches between weir groups. An abundance of this size material, and larger, is present both upstream, within, and downstream of the project reach. Scour holes will form downstream of each weir notch, and a low flow thread channel should develop between individual weir notches within the weir groups, as well as between weir groups.

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Scour pools will form just downstream of each weir. Scour depth computations were performed based on Bureau of Reclamation design guidance (US Dept. of the Interior 1987) as well as more current literature (ASCE 1998). Assuming that small cobbles dominate in the reach, the scour prediction equations suggest that a conservative scour depths would be on the order of 7 feet below finished grade, or to a depth of 12 feet below the quiet water surface downstream of the weir. Scour pools will change in shape and depth over time.

While HEC-RAS cannot predict the length of the hydraulic jump, a phenomenon that is responsible for forming the scour pools, it can predict within a reasonable range where the jump will form. The hydraulic models suggest that the jump will form entirely between weirs and transition to more ‘normalized’ conditions as the next drop is approached. This implies that the pool will be contained between weirs and transition to a more standard bed configuration prior to reaching the next weir downstream.

5.2.2. Potential Hydraulic and Sedimentation Impacts

The use of sheet pile weirs helps guard against any catastrophic impacts by reducing channel instability and head cutting which could otherwise create long-term sediment releases that could reduce flood conveyance capacity and result in habitat degradation upstream and downstream.

Other than construction scars and channel disturbance during construction, significant hydraulic, riparian, and sedimentation impacts are not expected to occur. Overbank vegetation will be removed or damaged due to construction activity. Some local sloughing of the Kitsap formation banks is expected during moderate to high flows due to fracturing of the silty clay matrix from sheet pile weir installation.

5.2.3. Sedimentation Impacts

Significant sedimentation impacts are not expected upstream, within, nor downstream of the project reach. Sediments which will be conveyed downstream as a result of the proposed project, which are not currently being conveyed downstream will be of small grain size classes in very limited amounts and are not expected to exacerbate problems which are currently being manifested.

5.2.4. Downstream Flooding Impacts

Hydraulic impacts, in the form of higher velocities and decreased depths, are not expected to occur as a result of this project. Hydraulic impacts are, however, are occurring at present due to instabilities downstream of the project reach and are expected to continue for some time into the future. These impacts are relatively benign and should not extend past the SR 101 bridge. These impacts are a result of existing processes and are not likely to be exacerbated by this project. No hydraulic nor sedimentation impacts are expected through the city of Shelton.

Figure 8. Weir Group plan and profile.

Figure 9. Sheet Pile weir elevation

Figure 10. Cross Sections.

Figure 11. Low Flow Sketch.

Figure 12. High Flow Sketch.

Figure 13. Isometric Sketch.

5.3. CONSTRUCTION METHODS & PROCEDURES

5.3.1.1. Diversion

Construction of the creek restoration project would require that water be diverted around the project footprint. A temporary dam would be constructed at the upstream end of the project. A culvert pipe would be installed at the base of the dam and be routed under the railroad trestle and along the railroad tracks to below the location of the last weir. The pipe would be attached to piles or weighted to prevent any unwanted movement. The water would re-enter the existing creek channel into a constructed stilling basin to dissipate energy before flowing into the natural channel. The diversion pipe will be sized to handle 200 cfs; flows above 200 cfs would be routed through an emergency spillway on the diversion dam into the existing channel. After construction is complete the dam and the diversion pipe will be removed. Section 6.6.4 addresses construction schedule.

5.3.1.2. Dam Removal

Removing the existing dam will require excavating around the structure to remove and stabilize the channel bed and banks. The channel bed will be excavated to the foundation of the dam. The channel banks will have to be excavated to a stable slope so that the abutments can be removed safely. The dam will be most likely be removed with a large hydraulic excavator working from both banks and above and below the dam. All demolition debris will be removed from the site.

5.3.1.3. Channel Excavation

The areas within the earthwork limits will be cleared of trees and vegetation. Excavated material from upstream of the dam site that is determined to be satisfactory for use as fill will be used to fill in the channel downstream of the dam. The excavated material will be placed in lifts and compacted. The channel will be excavated/filled to a depth of 2 feet below the profile grade shown on figure 4 to allow placement of select gravel and cobble material as the final bed surface. Approximately 25,000 cubic yards (cy) of material will need to be excavated. Import of fill material will be required for the gravel and cobble bed material and approximately 5,000 cubic yards of channel fill material. The channel fill material will consist of a pit run sand and gravel that can be obtained locally. Excavation methods will be the decision of the contractor, but may include using hydraulic excavators loading off-road dump trucks that will haul the material downstream where it will be dumped and rough graded with a dozer. A compactor would follow the dozer after each new lift is placed. Alternatively, scrapers may be used to excavate, haul, and place the material. This method would use a dozer for rough grading and a compactor. All excavating and hauling should stay within the project footprint. The haul roads would be kept within the 40-foot channel bottom width. Only short sections of new access roads will be required to allow ingress and egress from the channel, most likely near the upstream end. Existing access roads may require upgrading or widening.

5.3.1.4. Weir Placement

The sheet pile weirs will most likely be driven beginning at the downstream end and working upstream. A haul road over the weirs will need to be left in place to allow placement of the bed material and for placement of bank protection and habitat features like woody debris. The road will also be used to construct the concrete cap on each weir. The caps will be formed on site to conform to the channel cross section. An exposed cobble finish will be used to soften the appearance of the cap. Final grading of the bed material and placement of any bank protection and woody debris would follow cap construction. Plantings would follow into the fall.

5.3.1.5. Diversion Removal

Finally, the diversion dam would have to be removed allowing creek water back into the channel. This would be accomplished in stages. At first only small flows would be allowed to flush sediments gradually from the newly constructed channel. The flows would be stepped up until no water was flowing through the diversion. At this time the diversion dam and pipe would be removed. The downstream stilling basin would remain for a period after the diversion has been removed to serve as a sediment trap. It would be removed after sufficient time to allow for high flows to flush the majority of the sediments from the project reach. This would minimize the amount of sediments carried beyond the project footprint onto the spawning gravels immediately downstream.

5.3.1.6. Phased Construction.

The vast majority of the construction is to be completed during the summer months. However because the stream will naturally adjust following the first flood season, it is anticipated that some adjustment work will be required the following summer to ensure the project functions properly. This will include some earthwork, bank protection, and habitat features.

5.4. REAL ESTATE

5.4.1. Summary of Real Estate Requirements and Real Estate Cost Estimate

The Non-federal Sponsor needs to acquire easements for an estimated 19.19 acres of land to support construction and subsequent operation and maintenance of the proposed project. The lands are currently privately owned. Following execution of the project cooperation agreement the Non-federal Sponsor will complete its real estate activities and certify the lands available to the Corps before advertising for project construction. Following authorization for entry, the Non-federal Sponsor will provide the District Real Estate Division with all supporting lands, easements and rights-of-way crediting documentation. See Appendix B**,** Real Estate Plan, for additional real estate information. See Exhibit A of the Real Estate Plan for a map of the project area, and ownership information. See Exhibit B for an assessment of the Non-federal Sponsor's real estate acquisition capability.

Below is a baseline cost estimate in present dollars for the land value, non-Federal Sponsor incidental acquisition expenses, and Federal review and assistance costs.

Lands and Damages	$23,000
Non-Federal Sponsor Costs	$26,000
Federal Review and Assistance	$17,000
Subtotal	$66,000
Contingency 25%	$17,000
TOTAL	$83,000

5.5. MONITORING

According to recent thinking on restoration projects (Slaney & Zaldokas 1997; Spence *et al.* 1996), good monitoring plans are essential for determining whether a project has met stated objectives. A monitoring plan must address three general aspects of the project: compliance, validation, and effectiveness. Monitoring should address project objectives and determine project effectiveness.

For this project, the stated project objective is “to provide for unhindered upstream and downstream passage of resident and migratory fish.” But this project objective is also a means toward a broader objective: that of ecosystem restoration in Goldsborough Creek, including restoration of fluvial transport systems, of abiotic and biotic communities, and of the dwindling salmonid stocks that depend on them. This monitoring plan must first and foremost answer whether the objective of “unhindered upstream and downstream passage of resident and migratory fish” has been met. Secondary questions related to this objective ask how that restored fish passage has contributed toward ecosystem restoration objectives. The level of fish usage of the available habitat, and any related changes in stream ecology, is a question that all involved in this project would like to assess to the greatest degree possible. In addition, salmonid life cycles are such that increased usage of the basin will probably occur slowly, over several generations of fish that have life spans of two to five years. Thus, a five-year monitoring period will not be able to assess the full effects of creating fish passage on the ultimate use of the stream by target fish. For these reasons, the proposed monitoring plan takes into account a ten-year post-project monitoring period, and includes fish utilization and ecosystem restoration components. Although this time frame and all these components may not be funded under this project authority, additional funds will be sought to augment the monitoring plan. In the following table (Table 13), all monitoring components prioritized either “1” or “2” and occurring through the year 2005 would are recommended for funding under this authority.

Table 13 summarizes the entire monitoring plan envisioned for this project, based on baseline studies and an interagency coordination meeting held on 14 April 1999. Monitoring proposed as part of this project is shaded in the table. This monitoring is recommended for 5 years following project construction. Monitoring prior to and during project implementation is estimated at $25,000. Post-project monitoring is estimated for $50,000 for years one through five for a total of $250,000.

5.5.1. Compliance

This monitoring aspect pertains to assessing whether the project fulfilled design objectives and permit conditions. We must answer these two general questions: (1) did we do what we said we would, and (2) is the project functioning as designed? For this project, we would need to answer such things as:

- Were all areas replanted as specified, and did the plantings survive?
- Were all required habitat features placed?
- Did the structures meet specifications?
- Are spaces between weirs as specified?
- Is the project performing as designed with respect to hydraulic design parameters?

Studies proposed under compliance monitoring include:
1. quality control monitoring, to insure that design specs have been met
2. project performance during minimum/maximum flow events,
3. downstream water quality;

vegetation/riparian restoration of upstream wetlands.

5.5.2. Validation

This monitoring aspect pertains to validating assumptions used in model outputs. The assumptions used in the fish passage outputs were confidence levels that a given alternative could pass fish—a very difficult, and not necessarily useful, thing to validate. For fish passage, validation should equal effectiveness (next paragraph). Habitat outputs can be monitored with periodic habitat surveys of the project area and comparison with the pre-project survey, and habitat surveys (using accepted protocols) are the only recommended studies under this aspect.

5.5.3. Effectiveness

There are five targeted species in this project: coho, chum, chinook, steelhead and coastal cutthroat. Are all species able to make it? If they aren't, why not? Are those fish absent from the system, or all they holding/spawning below the project because they can't get beyond the dam? Are they getting only part way up?

The most direct method for assessing fish passage is to look for fish within the project area and directly above the dam. Unfortunately, a weir to catch and count all upstream migrants would likely be infeasible. Other methods are not as direct, and need to be used together to create a picture of project function. These methods, to support this information, snorkel surveys at both the bottom and top of the project area, as well as within the project, would establish whether a given species of fish is:

- present above and below the project (success)
- present below the project but not above (proceed to tiered problem solving to determine and fix problem)
- present below and partially up the project (proceed to tiered problem solving to determine and correct blockage)

Effectiveness of other project features would include:

- expected versus assumed performance of instream habitat features

Table 13. Monitoring plan.

		Pre-construction				Post-construction										
	Priority	98 Fall	98 Spr	99 Fall	00 Spr	00 Fall	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
COMPLIANCE	**Did project fulfill design objectives and permit conditions?**															
Quality control monitoring	2					x										
Instream habitat feature performance	2						x	x								
Project performance at all flows	2					x	x	x		x		x				x
Downstream WQ	2					x	x	x								
Revegetation success	2					x	x	x	x		x		x			x
VALIDATION	**Were valid assumptions used in outputs?**															
habitat survey	2	C				x		x		x		x		x		x
EFFECTIVENESS	**Are project criteria being met?**															
snorkel surveys	1					x	x	x	x	x	x	x	x	x	x	x
radio tagging	3					x										
downstream passage	2		x		x		x	x	x	x	x	x	x	x	x	x
B-IBI	3	C					x			x			x			x
spawning surveys	3	C		x		x	x	x	x	x	x	x	x	x	x	x

NOTES

- C = Completed; x = planned
- index species are early chum, early chinook and coho
- snorkeling may be best way to monitor presence/absence of chum and chinook
- Corps funding of monitoring program limited; additional funding will be sought by agency team
- Priorities identified by monitoring group:
    - 1 - fish passage effectiveness
      2 - direct construction impacts
      3 - ecosystem restoration effectiveness

5.6. SUPPORT OF SELECTED PLAN

The proposed restoration has a high level of support and commitment from many public entities including resource agencies. The proposed restoration presents a tremendous opportunity for a partnership approach including participation from the Simpson Timber Company. The plan has the support of the non-federal sponsor, Washington Department of Fish and Wildlife, and Simpson Timber Company who will also be contributing financially to the project. The plan best meets the objective to restore fish passage, while ensuring that OMRR&R expenditures over the life of the project are reasonable. The recommended plan also has the support of other project stakeholders including the Squaxin Island Tribe, US Fish and Wildlife Service, the City of Shelton and Mason County. Each of these entities has submitted a letter of support for the project. These are included in Appendix A.

Because the project is a "blockage" to fish passage, it is a high priority project for Statewide Salmon recovery efforts. As an indication of the high level of support for the project at the state level, the 1999-2000-state biennium budget includes a line item appropriation in the amount of $1.1 million dollars to support project implementation. Additionally, Simpson Timber Company has agreed to provide an additional $1.1 million to the state to support the project. The combined amounts are more than sufficient to meet the non-federal sponsor's obligation and to provide for maintenance and monitoring of the project.

6. ENVIRONMENTAL IMPACTS OF SELECTED PLAN

6.1. GEOLOGY/SOILS/SEDIMENT

After the dam is removed, sediment will not be catastrophically released. Rather, it will be released over a period of time when major storms pass through the area and erosion continues to remove sediment. A short-term burst of sediment that has already been in transport by the stream will not have long-term effects.

Downstream deposition of sediment will be a function of the amount and timing of the sediment release from behind the dam. The amount of sediment behind the dam that is released to the stream is limited by the size of the material and by the limits of mass wasting processes that bring sediment to the stream.

It is expected that the erosional area about 800 feet below the dam will continue to be unstable into the future with or without dam removal.

Section 5.2 and Appendix E provide more detailed considerations related to project design of the recommended plan.

6.2. WATER/WATER QUALITY

Water quality and flow in Goldsborough Creek are expected to change little. Because the project area is in a relatively small area in comparison to the remainder of the watershed, flow stability will not be altered. The stream will continue to transport fine sediment throughout its length, through Shelton into Oakland Bay.

Potential point and non-point sources of water pollution will not be affected by this project. Some canopy cover in the project area will be lost during project construction. Though replanting will occur, it may take several years for the canopy to return to pre-project conditions. This loss may contribute to slight temperature increases during warm temperature and low flow conditions within the project reach.

There will be some construction impacts on water quality at several stages during the construction process. Large pulses of sedimentation following diversion of the stream back into the restored stream bed will result in short term turbidity until the water slows sufficiently to allow settlement, potentially lowering dissolved oxygen concentrations for short durations. Localized shifting of sediments will continue sporadically as the new stream heals and adjusts. Floods during the winter and spring following construction will continue to mobilize sediments in the project area, potentially contributing to small increases in turbidity over that normally seen during flood events. Sedimentation impacts will be controlled through best management and conservation practices during construction. They should be temporary and of short duration. Water quality will be monitored in the project area and downstream during construction to detect any unacceptably high water quality impacts.

6.3. HYDRAULICS AND HYDROLOGY

The hydraulic impacts of any of the proposed alternatives were viewed from the perspective of changes from the existing condition. The intent of the hydraulic evaluation was to ascertain any changed conditions in water surface profiles. Appendix C addresses hydraulic, hydrologic and sedimentation performance of the recommended plan in detail. Section 5.2, also addresses the expected performance of the project.

There are three potential areas of concern related to the performance of the recommended plan; sedimentation, flood conveyance, and erosion. Substantial efforts have been made to reduce any possibility of impacts outside of the project area. The flood conveyance through the project reach is equal to the existing condition. Specifying a 40 foot wide channel cross-section, with appropriate side-slopes and tying into high ground ensures flood flows will be contained. Conveyance in the vicinity of the railroad trestle will be increased to prevent flood flows from diverting down the railroad grade and back into the stream in the vicinity of the fish ladder. Any potential sedimentation impacts that could occur as a result of implementing the recommended plan have been minimized by setting the upstream channel invert above the railroad trestle at the level of the existing bed. Finally, the potential for any increased erosion, through changes in channel depth or velocity, have been minimized in the project design. Increased velocities are expected through the project reach, however the hydraulic model indicates that the water surface profile of the preferred plan matches the existing condition profile downstream of the last weir groups, indicating that the weir groups are able to dissipate sufficient energy so that the existing channel controls flow conditions. In other words, implementing the preferred plan should not alter hydraulic conditions below the last element of the project. As such it is not expected that the project as designed will exacerbate existing instabilities downstream of the project reach. Also, due in part to the increases in velocity in the project reach, bank protection is required intermittently through the project footprint to reduce erosion potential. Bank protection is also required to ensure the integrity of the grade control features.

6.4. VEGETATION

Riparian impacts are not expected upstream of the project reach. However, between the upstream end of the project reach and the dam site, which requires that the existing channel be steepened, riparian areas will be impacted due to construction activities. Riparian impacts downstream of the project area will be non-existent in some areas and heavy in others, depending on construction access needs, siting, and practices. New vegetation will be planted along the disturbed riparian zone following construction. This new vegetation will take several years to replace the shading and detrital functions provided by existing vegetation within the construction area. Riparian and upland vegetation will also be removed for access roads and staging areas during construction. Following the completion of construction these areas will be revegetated.

6.5. WETLANDS

Impacts to wetland areas adjacent to the reach of Goldsborough Creek that may be affected by dam removal are varied (see Table 14). No impacts at all are expected in the small downstream wetland (Wetland 1).

The forested floodplain wetland that exists in the north side of the creek, in the forebay area of the dam (Wetland 2), was formed when the dam forebay filled with sediment, raising the water level. This wetland will be impacted when the streambed is lowered in the project area. Upstream of the dam, the reconstructed creek channel will be approximately 10 feet lower than the existing channel. Channel excavation to restore the natural stream gradient will eliminate portions of Wetland 2. There may be some loss of habitat used by waterfowl, kingfishers, or other water-dependent birds. Aquatic insect production and amphibian habitat may also be lost. But during the next phase of the project, the frequency of wetland inundation will be evaluated for both pre- and post-project conditions. If determined to be technically feasible, channel design features such as backwater channels or modification to cross-section (e.g. creation of a two-stage channel) may be added. Though part of this wetland may convert to an upland condition, that area will provide riparian forest habitat to terrestrial wildlife. Planting the restored stream channel with native trees and shrubs will generally replace any terrestrial habitat functions lost by dewatering portions of this wetland.

Wetland 3, the beaver marsh, occurs near the upstream end of the restoration area, where the creek channel will be lowered by dam removal. The water surface elevation in this wetland at the upstream end may be higher than the stream elevation. If this is the case, the elevation difference in existing water levels would indicate the wetland is controlled by factors other than the creek. It appears the wetland is maintained in part by a natural berm and beaver dam. The beaver dam and berm separating the wetland from Goldsborough Creek, a small influent stream, and potential groundwater inflow appears to maintain wetland water levels above the level of the creek. However, lowering of the streambed will significantly reduce the frequency of inundation by overbank flow. Further investigation of the existing wetland hydrologic balance and subsurface geology is required in order to more fully quantify impacts to the wetland. This will be determined by analyzing the direction of flow using survey data, and inferring flow direction from temperature data. These investigations will be continued during plans and specs. Based on this information, a plan for maintaining the hydrology of this wetland will be incorporated into the project design. This plan will most likely consist of one of the following:

- minimize impacts through plantings and possible backwater channels or other means to provide optimum wetland/riparian function based on new with-project hydrologic regime;

- lower wetland invert with stream profile and restore at new grade;

- maintain wetland at existing elevation by providing water using upstream diversions. Install steel sheetpile weir if necessary to retard sub-surface discharge of the wetland.

- allow small changes in hydrology and any adjustment to new hydrologic regime.

Wetland 4 is a 1.27-acre floodplain wetland supported by a high groundwater table and seasonal flooding by the stream. It will have limited construction impacts to approximately 0.3 acres of this wetland that will be restored with replanting.

The extensive wetlands upstream from the dam removal reach will not be altered by the project. These wetlands are beyond the area of construction, and water level changes in the creek adjacent to them will not occur.

Table 14. Summary of wetland impacts and restoration.

Wetland #	Location	Type	Dept. of Ecology Rating	Area (in acres)	Impacts	Restoration Plan
1	900 ft. below dam	riparian	Category 1	<0.1	none	not needed
2	forebay area of dam	floodplain/ forested	Category 1	1.33	construction; dewater	add backwater areas if feasible; replant
3	400 ft. upstream of dam	palustrine shrub, emergent, open water	Category 1	2.50	loss of some flood inundation	if warranted, restore hydrology
4	900 ft. upstream of dam	floodplain	Category 1	1.27	0.3 acre construction	replant

6.6. FISH AND WILDLIFE

6.6.1. Habitat

Channel reconstruction will include alternating pool and riffle sections at a more natural stream gradient. The incorporation of habitat enhancement features such as log jams, deflector logs, overhanging logs, and gravel bars, together with large woody debris included in the stream bands, will provide considerable improvements in the rearing and refuge habitat for young salmonids and resident fish.

Reconstruction of the stream channel will also provide stability to the channel habitat that does not currently exist. The source of erosion caused by the drop at the dam will be removed. Construction of a more natural stream gradient will also provide a more stable channel structure than the existing conditions. Reconstruction of the stream channel will also provide more natural migration and rearing habitat for outmigrating salmonids.

6.6.2. Anadromous Fish

Populations of salmon in the Pacific Northwest have declined precipitously over the past several decades (Nehlsen et al. 1991). Small streams like Goldsborough Creek have the capacity to buffer the declines in larger systems and support the efforts of the federal and state agencies to preserve and recover wild salmonid stocks.

Small streams like Goldsborough Creek are preferred by coho salmon for spawning, and typically exhibit low levels of primary production because of a combination of heavy shading, variable discharge, and low water temperatures (Bilby and Bisson 1992). In addition to the direct and indirect effects upon the aquatic biota, this project will restore natural stream processes to Goldsborough Creek. Natural fluvial processes will eventually restore the stream gradient and allow sediment to move downstream more efficiently. Over time, the downstream channel will benefit from the increased transport of sand and gravel and the substrate composition, channel meander, and riffle/pool sequence should approach the upstream condition. This will improve the currently poor salmonid habitat quality in this segment. Finally, the increased sediment transport should improve conditions in the estuary. Simpson Timber Company is no longer dredging the mouth of Goldsborough Creek, and an increase in the sediment supply will help restore the delta and increase the estuarine intertidal habitat available for rearing salmonids and migratory birds.

The Goldsborough Creek Dam is the primary bottleneck to salmonid upstream rearing and spawning habitats. Without a project to either remove the dam or significantly modify the fishway, the bottleneck would remain and continue to prevent most salmonids from accessing the upper watershed. This habitat is particularly limited in southern Puget Sound and the condition of Goldsborough Creek is better than most other streams in the area. Downstream passage for juvenile and resident fish will also improve through dam removal. The face of the dam, which includes a concrete basin, concrete and rock debris, metal sheetpile, and exposed clay banks, likely results in the mortality or decreased condition of juveniles migrating out of the system (Fraser 1993).

6.6.3. Resident Fish

Considering the currently degraded conditions of the project reach, there will be little impact to the resident fish population during construction. After diversion of the stream flow into the bypass pipe, as many fish as possible will be collected in the dewatered section. Fish could be trapped in numerous pools in this section. Resident fish will be placed upstream a minimum of one mile to avoid the project area and downstream sedimentation.

A significant increase in anadromous fish above the dam could affect the current population of resident trout. The upper watershed has always had some level of salmonid use, including natural spawning and extensive hatchery supplementation using coho fry. The proposed project would result in an incremental increase of primarily coho fry above the dam.

An increase in cutthroat trout smolt numbers in eastern Hood Canal streams coincided with declines in coho salmon abundance (Johnson *et al.* 1999). This suggests that the interactions between the two species may have reduced the abundance of cutthroat trout. There has also been some evidence that cutthroat trout are relegated to riffles by the more dominant coho salmon (Glova 1986), although other authors have found that cutthroat trout select the shallower and faster waters in riffles even though coho salmon are not present (Sabo and Pauley 1999). When coho salmon fry are present they can dominate cutthroat trout fry because juvenile coho salmon emerge from redds earlier and are larger in size (Laufle *et al.* 1986). Yet, adult cutthroat trout will readily prey on coho salmon fry or other small fish.

Anadromous salmonids historically occurred in the upper watershed. Additional nutrients and elevated primary productivity levels resulting from increased adult carcass densities will partially offset the detrimental effects to resident fisheries associated with the increased abundance of juvenile anadromous salmonids.

6.6.4. Fish Passage

In the long term, this project will restore natural river processes and improve fish passage. The plan would provide unobstructed fish passage, restore a healthy creek bed for fish use, and protect and enhance riparian and wetland habitat upstream and adjacent to the creek.

Removal of the dam will most likely improve downstream passage conditions for young anadromous salmon.

6.6.4.1. Short Term Impacts (Construction)

Removal of the dam and reconstruction of the stream will require approximately two to six months, depending upon the construction schedule, to complete. During this period, the creek will be diverted into a pipe for the length of the project area, and will provide little or no fish habitat along the length of the diversion.

The construction period will follow the spring high-flow period, so it will avoid impacts to the young salmon migrating downstream during the spring. Most of the construction (all in-water work) will occur prior to the adults arriving in the fall. There is some potential that upstream migrants, particularly early chinook and chum, will arrive in Goldsborough Creek prior to completion of the stream restoration.

6.6.4.2. Construction Mitigation Requirement (Stream Bypass)

6.6.4.2.1. Adult salmon Collection and Trucking Upstream

To avoid the most direct adverse construction impacts to salmonids, ideally the temporary stream bypass by pipe should only occur between June 15 and August 31, for a construction window of approximately 10 weeks. The downstream migration of smolts is completed by June 15 and the adult return of chinook and chum salmon for spawning can begin in early September. All reasonable effort will be made to require the contractor(s) to include a concentrated and intensive work schedule to complete instream work that requires flow bypass within this time frame.

After diversion of the stream flow into the bypass pipe, a concerted effort will be made to collect as many fish as possible in the dewatered section. Fish will be trapped in numerous pools in this section. Considering the size of this stream, numerous personnel and collection and transporting equipment will be required. Salmonid smolts will be placed downstream to allow them to continue their outmigration and resident fish will be placed at least a mile upstream to remove them from any effects of construction and sedimentation

If the project in-water work and temporary bypass by pipe cannot be completed in the preferred time frame, even with a concentrated and intensive work schedule, then it would preferable to initiate the work prior to June 15 rather than extend the work into September. However, based on the project schedule, it is extremely unlikely that in-water work could be initiated prior to 15 June 2000. During plans and specifications the project construction schedule will be revisited. If it appears likely that the in-water construction period required exceeds approximately 10 weeks, coordination will occur among all the project stakeholders to determine the best course of action. The options may include delaying construction one year so that the work could begin earlier the following spring, or continuing construction into September, in which case a trap and haul facility would be necessary.

If construction (in water work) is initiated prior to 15 June, the diversion structure would need to accommodate passage of outmigrating fish. No detailed evaluations have been completed as part of the feasibility phase to determine the design requirements that would need to be incorporated into the diversion structure to allow for safe passage of outmigrating fish.

It must be understood that even if the stream diversion is anticipated to be completed by August 31, unplanned delays may make this impossible. A contingency plan must be developed to mitigate this potential problem. Work progress will be carefully monitored throughout the construction period to determine if the schedule is being met. The decision to initiate collection and trucking procedures will be made by August 15 to allow sufficient time for implementation. The contractor will be required to demonstrate that it has the capability to accomplish this contingency plan before being allowed to begin work. Regardless of when construction occurs, a contingency plan will need to be in place prior to initiating construction.

If trapping and hauling (adult migration) is unavoidable, due to the construction schedule, the location and method should be selected well in advance of the need. The trap and haul may require that all adult salmonids be collected as close to the stream mouth as possible and trucked to upstream of the project. In this situation a net, louver, or other barrier would have to be placed across the stream upstream of the project to prevent the adults from entering the bypass pipe and spawning downstream of the project. The primary reason for this mitigation is the potential sedimentation to spawning chinook and early race of chum salmon. This sedimentation pulse could come from the new rebuilt channel section during the first flush when the flow is placed back into the new channel section and also from subsequent sediment release increases as fall stream flows increase.

However, potential problems with the trap and haul procedures will be avoided if a contingency plan is developed prior to construction. Requiring the contractor to demonstrate the capability to collect and haul adult salmon prior to beginning construction will also prevent problems with implementing the trap and haul process.

Further investigation into the potential effects of the first flush of sedimentation will continue during the permitting process. At this time WDFW has not fully evaluated from past experience and reasonable expectation if potential effects are understated or overstated. Mitigation of the potential first flush sedimentation will include gradually increasing the flow in the new channel over numerous days to use dilution to minimize downstream sedimentation. Nonetheless, upstream adult salmon collection and trucking upstream should be a required mitigation contingency and appropriately funded. Further investigations in 1999 should better qualify this mitigation requirement.

6.6.4.2.2. Fish Collection after Channel Dewatering

After diversion of the stream flow into the bypass pipe, a concentrated effort will be made to collect as may fish as possible in the dewatered stream. Fish will be trapped in numerous pools. The number of fish is likely to be high, based on the size of the stream and significant numbers of personnel and equipment will be required to accomplish this task. Salmonid smolts will be placed downstream to allow them to continue their out-migration.

6.6.4.3. Long Term Impacts

This project is proposed as a means to remove the existing adverse impact the dam has on anadromous fish passage and fish habitat within the dam reach of Goldsborough Creek. Removal of the dam will provide an opportunity to both restore natural and better upstream migration, and to restore a normal gradient to Goldsborough Creek in the area of the dam. Restoration of natural upstream migration for anadromous fish stocks is a primary objective of the proposed project.

Removal of the dam will eliminate the need for the existing fish ladder and its approach that has been an impediment to upstream passage of salmonids. The existing ladder and its approach conditions have apparently impeded the movement of chum salmon and anadromous cutthroat, and possibly coho salmon and steelhead, to the productive areas of Goldsborough Creek upstream from the dam. Since most of the potential spawning and rearing habitat (about 14 miles) of Goldsborough Creek exists upstream of the dam, eliminating this passage impediment has the potential to substantially increase the salmonid production from Goldsborough Creek.

Stream habitat in the dam reach will also be improved by removal of the dam. The dam dominates existing channel morphology. The dam has produced a sediment-filled forebay that provides a broad shallow channel section with relatively low stream velocities. It has also led to occasional out-of-channel flows during extreme storm events. During these periods the stream has overflowed its bank at the railroad bridge, flowing down the railroad tracks to return to the creek at the fish ladder. These events have adversely affected performance of the ladder until repairs are made.

Downstream of the dam the channel has been eroded by the plunge over the dam. This erosion has removed any potential spawning or rearing habitat in the area immediately downstream of the dam. This erosion has also produced a passage impediment due to the steep drops in the hard clay bottom of the eroded stream section. This passage impediment has been partially rectified by installation of sheet pile to form a shallow pool structure in the stream. However, additional erosion has produced a three-foot drop over the sheet pile again producing a passage impediment. This existing situation would be resolved by reconstruction of the stream channel as part of dam removal.

Channel reconstruction will include alternating pool and riffle sections at a more natural stream gradient. These features, together with large woody debris included in the stream bands, will provide considerable improvements in the rearing and refuge habitat for young salmonids and resident fish.

Removal of the dam will most likely improve downstream passage conditions for young anadromous salmon. Although it is unknown to what extent the existing drop at the dam produces injury or mortality in downstream migrants, any impacts that do occur will be eliminated by removal of the dam. Reconstruction of the stream channel will provide more natural migration and rearing habitat for these young salmon.

Reconstruction of the stream channel will also provide stability to the channel habitat that does not currently exist. The source of erosion caused by the drop at the dam will be removed. Construction of a more natural stream gradient will also provide a more stable channel structure than the existing conditions.

6.7. THREATENED AND ENDANGERED SPECIES

A draft Biological Assessment (BA) that assesses project impacts to chinook and bull trout is attached to this document (see Appendix F). The BA documents reasons that the project is not likely to adversely affect either of these listed species. ESA coordination is on going. Informal consultation is expected, as such the BA, when submitted to National Marine Fisheries Service and US Fish and Wildlife Service may be changed to a Biological Evaluation (BE).

Approximately 69% of chinook observed spawning in Goldsborough Creek in 1998 were within the project area. Though much of this spawning habitat will be lost with project construction, an equivalent or greater amount of similar habitat will be available upstream of the project area. Within the project reach, some substrate suitable for spawning will be available in the reaches between weir groups. However, during high flows there will likely be sediment transport and potential disruption of spawning redds within the project reach.

The BA further evaluates the effect of this project on chinook salmon. It concludes that, although some spawning habitat will be altered in the project reach, enough suitable habitat between weir groups and above the project area will replace any spawning habitat due to construction. Conservation measures during construction will insure that any juveniles remaining in the project reach will be moved downstream prior to construction, and any adults returning prior to project completion will be caught and trucked upstream of the project area into suitable spawning habitat.

Though some coho are able to use the existing fish passage structure in some flow conditions, 78% of the live adult coho salmon spawners observed during surveys in 1998 were below the dam. Improving fish passage should allow coho to use the extensive upstream spawning and rearing habitat available above the dam, and this species is the main target of this restoration.

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6.8. CULTURAL RESOURCES

6.8.1. Archeological & Historic Resources

Implementation of the preferred alternative will affect no known prehistoric or historic properties potentially eligible for the National Register. Larson Anthropological/Archaeological Service (LAAS) conducted a Cultural Resource Assessment in July 1997 and found that no other cultural resource studies have been previously conducted within or near the project area. In a letter dated May 26, 1999 to the Corps the State Historic Preservation Officer (SHPO) concur with the findings of LAAS that there are no cultural resource in the identified project area. If any inadvertent discoveries of archaeological materials are made during construction or testing, all activities in the immediate area of such a find will cease until it can be assessed, and the SHPO informed.

6.8.2. Treaty Tribe Rights

Providing this rare habitat to these species not only would benefit fish populations, but also provide an incidental increase for recreational and tribal fishing opportunities. The project would have significant positive impacts on fish available in the Usual and Accustomed (U&A) fishing areas of the Squaxin Tribe. The proposed restoration is consistent with and supports the Corps of Engineers Tribal Policy Principles (PGL #57) through;

- Self Reliance, Capacity Building, and Growth. The proposed restoration helps build economic capacity and fosters the Tribes ability to manage resources.
  Natural and Cultural Resources. The proposed restoration helps fulfill obligations to preserve and protect trust resources.
- Natural and Cultural Resources. The proposed restoration helps fulfill obligations to preserve and protect trust resources

6.9. AIR QUALITY/NOISE/LIGHT

During project construction, trucks and heavy equipment will contribute to increased noise and decreased air quality. Removal of canopy vegetation will allow additional light into the project area. Plantings in the area will not fully replace the shading function for several years after project completion.

6.10. PUBLIC USE AND RECREATION

Angling opportunities in Goldsborough Creek should increase with this project

6.11. ENVIRONMENTAL JUSTICE

This project is expected to comply with Executive Order 12989, Environmental Justice in Minority Populations and Low Income Populations. The project will not negatively affect low-income or minority populations. The work will most likely have a positive effect on Native American fishery resources as the populations of fishable salmon are expected to increase as result of this project. The project location is fairly remote and the residents of the area will have an opportunity to enjoy the natural amenities of this habitat restoration project.

6.12. CUMULATIVE IMPACTS

Cumulative impacts are assessed by evaluating the incremental effects of past, present, and future actions. The purpose of this project is to restore some of the biological productivity of Goldsborough Creek. The listing of Chinook salmon and the potential listing of several other migratory salmon indicate that impacts to the local environment (through loss of habitat) have already occurred. This project will not reverse all the those impacts but it will be a good localized response. Recently, as a result of the proposed salmon listing several local, state, and federal initiatives are underway that focus on restoring habitat (restoration is only one component of recovery under the Endangered Species Act).

Dam removal would result in unobstructed juvenile and adult fish passage, restoration of inundated habitat and recovery of natural physical processes (i.e., sediment and nutrient transport, hydrology, and temperature regimens) in the lower river. In contrast, dam removal and restoration of anadromous fish would result in increased returns of fish to the river, optimize use of all accessible portions of the watershed, produce much greater numbers of fish, and restore ecosystem processes. Wildlife prey would be provided by fish carcasses, juveniles and eggs.

More natural fluvial processes will be-introduced to the stream by restoring the stream gradient and allowing sediment and nutrients to move downstream more efficiently. Instream habitat features will be incorporated in the design to help facilitate upstream passage and recover the affected stream reach's habitat values more quickly. Over time, the downstream channel will benefit from increased transport of sand and gravel and the substrate composition, channel meander, and riffle/pool sequence should approach the upstream condition. This will improve the currently poor salmonid habitat quality in this segment. Finally, the increased sediment transport should improve conditions in the estuary.

There may be some wetlands in the project area that may be affected or altered by the project. However, the extensive wetlands upstream from the dam removal will not be altered by the project as these wetlands are beyond the area of construction and water level changes in the creek adjacent to them will not occur.

7. COST ESTIMATE AND SCHEDULE

7.1. ESTIMATED COST, COST SHARING AND SCHEDULE

7.1.1. Project Cost Estimate and Cost Sharing.

A detailed cost estimate, based on a 35% level of design, is included in the Cost Estimating Appendix D. The total estimated implementation cost, including construction cost, PED, construction management and monitoring, in October 1999 prices is $4,320,000. The average annual cost, at 6 7/8% interest rate over the 50-year economic analysis period in October 1999 prices, including operation and maintenance of $5,000 is $313,000.

As shown in Table 11, the estimated fully funded implementation cost, including the $550,000 feasibility study and $260,000 for plans and specifications, is $4,425,000. Included in this total is $148,000 for dam removal, which is solely the responsibility of Simpson Timber Company. The remaining cost sharing total is $4,277,000 ($4,425,000 - $148,000). Based on the cost sharing requirements as contained in Section 206 of the 1996 Water Resource Development Act (WRDA), the local sponsor is responsible for 35 percent of both the feasibility cost as well as the remaining total project cost or a total of $1,497,000 (implementation cost minus dam removal or $4,277,000 X 35%).

The total non-federal share is comprised of the sponsor's share totaling $1,497,000 plus Simpson Timber's cost to remove the dam estimated at $148,000 for a total estimated non-federal cost of $1,645,000. Included in the cost sharing total is a LERRD cost of $83,000 of which $66,000 is creditable against the sponsor's cost share. In addition, the sponsor has an in-kind estimated credit of $10,000. As a result, all non-federal funds due, except the LERRD credit of $66,000 and the in-kind credit of $10,000, are cash dollars – or $1,569,000. The estimated federal cost share is $2,780,000.

As shown in Table 15, the local sponsor (including the $148,000 from Simpson Timber Co.) is responsible for $1,422,000 during the first year of construction (year 2000) of which $1,351,000 are cash dollars and the remainder are the LERRD credit and in-kind work. In the second year of construction, the sponsor is responsible for an estimated $143,000, all in cash. This covers the local share of the Phase II construction and the local share of the first year monitoring. Over the third through sixth year, the sponsor is responsible for their share of monitoring costs or an estimated $80,000. Estimated federal funds total $2,780,000 of which $730,000 will be paid prior to construction (feasibility study and first year plans and specifications) 35 percent of which will be reimbursed by the project sponsor in year 2000. Federal funds needed in year 2000 are estimated at $1,637,000. The remaining federal funding requirements are spread over the years 2001 through 2005 as shown in the Table 16. The final cost sharing numbers will be determined via a final audit at the end of construction.

Table 15. Estimated full funded cost sharing computation.

	Total	Federal	Non-Federal
Lands & Damages			
Non-Creditable	17,000		
Creditable	66,000		
Construction Cost	2,983,000		
Feasibility	550,000		
Plans and Specs	260,000		
Construction Management	116,000		
Monitoring	285,000		
Sub-Total	$4,277,000	$2,780,000	$1,497,000
Dam Removal	148,000	0	148,000
Implementation Cost	**$4,425,000**	**$2,780,000**	**$1,645,000**

Table 16. Fully funded costs by year.

Entity	Paid Prior To Construction	2000	2001	2002-2005	Total
Federal	$730,000 [2]	$1,637,000	$265,000	$148,000	$2,780,000
Non-Federal					
**** Cash***					
Sponsor		$1,198,000	$143,000	$80,000	$1,421,000
Simpson		148,000	0	0	148,000
**** Non-Cash***					
Real Estate		66,000	0	0	66,000
In-Kind		10,000	0	0	10,000
Total	**$730550,000**	**$3,059,000**	**$408,000**	**$228,000**	**$4,425,000**

7.2. OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION (OMRR&R).

Operation and maintenance consists of various cost items expended periodically over the project life. The objective of the (OMRR&R) for the Goldsborough project has two purposes, to maintain fish passage and to protect the structural integrity of the project. Minor rehabilitation is expected to ensure fish passage occurs at each of the weir groups and bank protection is in place. More significant rehabilitation may occur following flood events might include replacing logs, riprap, gravel and large rocks. This type of rehabilitation may be necessary during the winter months.

2 Includes feasibility study cost of $550,000 plus $180,000 for first year plans and specifications.

Additionally, it is expected that the capping on the weir structures will require replacement every 20 years. Total rehabilitation costs over a 20-year period have been estimated at $210,000 which represents a percent of each of the cost items from the construction cost estimate. This figure was then amortized, at the federal discount rate of 6 7/8% over a 50-year project life to arrive at an expected annual amount of $5000. The following summarizes the breakdown of the rehabilitation costs.

Expected OMRR&R based on 20-year rehabilitation schedule.

Restore Earthwork	$113,000
Grade Control	$ 10,000
Restore Bank Protection	$ 32,000
Restore Habitat Features	$ 55,000
Total	$210,000

It is expected that maintenance costs will be higher during the first years of the project. Once the creek settles into the new configuration, between 3-5 years, maintenance costs are expected to drop substantially. As such the costs described above ($210,000) may be expected to drop after the initial interval, however until the project is in place for a number of years a reduction cannot be specified. These figures will be further addressed in plans and specifications. During construction, and OMRR&R manual will be prepared detailing specific items related to OMRR&R.

7.3. DESIGN AND CONSTRUCTION SCHEDULE

Schedule.

Submit PRP	6 April 1998
Initiate Feasibility	20 August 1998
Draft Feasibility Report	17 May - 25 June 1999
Submit for Agency and Technical Review	26 May 1999
Submit to Division, Review & Approval	6 August 1999
Advanced Feasibility Planning	6 August - 30 SeptemberInitiate
Plans & Specs	15 September
Initiate Construction (Contract Award)	12 April 2000
Initiate In-water work	15 June 2000
Complete In-water work	1 September 2000
Complete Phase I Construction	November 2000
Initiate Phase II Construction	1 July 2001
Complete Construction	1 November 2001

7.4. NON-FEDERAL RESPONSIBILITIES

The non-federal sponsor, WDFW, is responsible for the operation, maintenance, repair, replacement and rehabilitation requirements as described above and in the Project Cooperation Agreement. Additionally, WDFW will provide all necessary lands, easements and rights of way (LERRD) for construction and operation/maintenance of the project in perpetuity (including a disposal site for any waste material). All LERRD that the WDFW provides will be credited towards the overall 35% local share of the implementation costs

Based on a 22 June 1999 letter from the Washington Department of Fish and Wildlife, the non-federal sponsor has demonstrated their financial capability and willingness to support project implementation. The State of Washington has appropriated $1.1 million dollars in their biennium budget to support the non-federal share of the project implementation costs. In addition, Simpson Timber Company (May 19, 1999 letter) will provide up to $1.1 million dollars to the State to cover any additional project related costs including OMRR&R. The non-federal implementation costs (excluding OMRR&R) are estimated at $1,461. The financial resources identified by the sponsor are more than sufficient to cover non-federal implementation costs.

7.5. COORDINATION AND LOCAL SUPPORT

Coordination with interested parties has been accomplished throughout the reconnaissance and feasibility phases. Resource agencies, the local community, and the Squaxin Island Indian tribe have been involved through both direct contact with the Corps and the review of the draft designs and EA. In addition to conducting four interagency design team meetings during the feasibility study, several meetings were held with City of Shelton, Mason County representatives, and landowners that would be impacted by the project. An agency meeting was held April 29th 1999 and a public workshop was held on June 9th 1999. The project has a broad base of support.

7.6. LOCAL COORDINATION AND COMMENTS

A draft Ecosystem Restoration Report/Environmental Assessment was distributed on 26 May 1999 to all the above entities, as well as to other federal and local agencies and interested parties. This section summarizes agency and other stakeholder comments made on the draft report, and outlines how those comments were resolved and incorporated into this final ERR/EA.

AGENCY/STAKEHOLDER COMMENTS.

COMMENT: Determine the feasibility and biological benefits of a phased removal of the weirs.
RESPONSE: The Corps will be conducting additional investigations to refine and verify the hydraulic and sediment transport issues. This includes additional slope equilibrium and at-a-station transport capacity studies. As part of these refinements the Corps will be able to better assess the potential viability of removing weirs over time. However an adaptive management approach such as this presents several difficulties under the Corps Authority. Adaptive Management is not authorized under the Section 206 program. The Corps must recommend a project that is complete unto itself, in terms of function and expected outputs. Based on our guidance, the costs for removing weirs would be the local sponsor's responsibility, as would any required detailed study on aspect of the project.

COMMENT: Project construction schedule and contingency plan for if construction cannot be completed during the fish window.

- Avoid constructing the project during the period of adult salmonid migration (late summer into the fall). If summer chum salmon exists, then they may return to the stream as early as mid-September based on the timing in Oakland Bay's Johns Creek (Haymes 1999).
- The construction period should be started earlier in the summer or spring if more time is needed to construct the project. Providing for downstream passage will be easier than trapping and hauling adults upstream of the site.
- Initiating construction earlier will also minimize the pressure of completing prior to higher fall flows.
- If trapping and hauling (adult migration) is unavoidable, due to the construction schedule, the location and method should be selected well in advance of the need.
- Suggest the plans and specifications schedule be clearly defined and enforceable.
- We must maintain the capability of delaying the project for a year if the completion schedule appears not attainable.

RESONSE: The report has been revised to indicate agency preference for earlier construction. However, due to the extremely tight project schedule, it is extremely unlikely that in-water work could be initiated prior to 15 June 2000. During plans and specifications the project construction schedule will be revisited. If it appears likely that the in-water construction period required exceeds approximately 10 weeks, coordination will occur among all the project stakeholders to determine the best course of action. The Corps strongly supports the comment that capability to delay the project must be maintained. The Corps, with cooperation from the project stakeholders, is making and has made every effort to maintain the project schedule, and expedite where possible and reasonable. At this time the schedule to complete plans and specifications is January 2000 with a construction contract award in April 2000. The schedule for additional analysis, final plans and specifications, and executing the PCA is on an extremely tight project schedule which will require a high level of coordination and cooperation from all of the project stakeholders to ensure adequate technical review and for acquiring necessary permits.

COMMENT: Impacts to wetlands potentially affected by the project are not addressed, nor is any need for mitigation.
RESPONSE: A more detailed discussion of likely impacts to wetlands has been added to the report. Additional survey information and hydraulic studies is required to more fully assess impacts. Under Corps guidance for the 1135/206 program formal mitigation for restoration projects is not appropriate, however efforts to avoid and minimize impacts to wetlands will be incorporated into the preferred design. *The Corps will incorporate design features into the preferred plan to avoid and minimize impacts in order to preserve as much of the hydrology as possible.*

COMMENT: Simpson Timber will be relinquishing to the State of Washington (Washington Department of Ecology's Trust Water Rights program) most of its water rights (estimated at 50 c.f.s.) to the project. This relinquishment should be credited because it helps ensure that project design flows will be met (i.e., design flows for the project might not be met if Simpson continued to appropriate the water in Goldsborough Creek.
RESPONSE: The Corps has not investigated either the amount of water involved, timing of withdraws or whether Simpson continues to have an eligible water right for the amount stated (since the water has not been used for a number of years and ESA issues). However since the project benefits (fish passage) may be dependent on the assurance of adequate flows this issue will need to be resolved prior to implementing the project. Because of concerns on whether this would be eligible as a creditable item, Simpson Timber has agreed to resolve this issue outside of the Corps Section 206 project. The non-federal sponsor and Simpson Timber will have a separate agreement in which this issue is resolved. At this time it is unclear what type of assurances would be required by the Corps (to protect the federal investment). It is assumed that this agreement will be executed prior to executing the PCA between the Corps and the non-federal sponsor.

COMMENT: The use of Riprap should be minimized in the final phase of project design.
RESPONSE: Partially concur. Alternative bank protection measures will be considered in final project design, as will as criteria to determine bank protection requirements. However based on technical review comments and revisions to the H&H appendix, additional riprap may be required throughout the weir groups.

COMMENT: The draft report indicated slight increases in velocities downstream of the project. Although these were shown to dissipate prior to reaching the SR 101 bridge this raised concerns on the effect this might have on existing erosion concerns. Specifically, erosion of existing riprap near a gas line located in the vicinity of station 98+00 could potentially be worsened.
RESPONSE: Based on technical review comments, revisions to the HEC-RAS model were made. The revisions indicate that no increases in velocity are expected outside the project footprint (downstream of station 106+00). This will be re-verified during final design of the preferred alternative. No additional bank protection measures are anticipated from the downstream end of the project to the SR101 Bridge.

7.7. FISH AND WILDLIFE COORDINATION ACT

Under the Fish and Wildlife Coordination Act, a Draft Coordination Act Report (DCAR) was provided by Fred Seavey of the USFWS on June 24, 1999. A final CAR (FCAR) was provided on July 23, 1999 and is attached in Appendix F of this document. Recommendations in the DCAR are listed below, with Corps responses following in italics.

1. Avoid constructing the project during the period of adult salmonid migration (late summer into the fall). If summer chum salmon exists, then they may return to the stream as early as mid-September based on the timing in Oakland Bay's Johns Creek (Haymes 1999). The construction period should be started earlier in the summer or spring if more time is needed to construct the project. Providing mitigation for downstream passage will be easier than trapping and hauling adults upstream of the site.

   Concur. The report has been revised to indicate agency preference for earlier construction. However, due to the extremely tight project schedule, it is extremely unlikely that in-water work could be initiated prior to 15 June 2000. During plans and specifications the project construction schedule will be revisited. If it appears likely that the in-water construction period required exceeds approximately 10 weeks, coordination will occur among all the project stakeholders to determine the best course of action. . However, this project is on an extremely tight schedule, and initiating work earlier than presently scheduled may not be possible.

2. Preserve as much of the hydrology of the current wetlands as possible, especially Wetland 3. This may involve changing the current weir configuration or providing a water source for Wetland 3 as part of the project's design.

   Concur. The Corps will incorporate design features into the preferred plan to avoid and minimize impacts in order to preserve as much of the hydrology as possible. Mitigate for 1.1 acres of floodplain (net wetlands and floodplain loss based on the bankfull discharge) that will be directly lost from the project. This could include connecting the pond in Wetland 3 at an upstream site which would benefit rearing fish and increase flood plain function, providing a backwater area and/or offchannel pond near the bend at Wetland 2, a wider bankfull width in some locations, or the incorporation of backwater or side channel areas in the downstream portion of the project.

   Partially concur. Opportunities to incorporate floodplain features into the project design will be carefully evaluated during the plans and specifications phase of this project, and implemented were feasible. Under the 206 authority, no compensatory mitigation is allowed, and will not be included in this project. Also, as there are no continuous, well defined natural banks of generally consistent height in the project reach or in the near vicinity, "bankfull discharge" is difficult to apply. The discharge to overtop the existing banks varies by over an order of magnitude (if not two between the railroad bridge and the incised channel) in the project reach

3. Discuss the disposition of the 50-cfs water right with Simpson Timber Company, and if Simpson is agreeable, include the donation of the water right to the Washington Department of Ecology's Trust Water Rights program as a feature of the proposed project.

Concur, water rights need to be resolved. Disposition of the water rights are being negotiated outside the project. It is our understanding that Simpson Timber Company is agreeable to donation of eligible water rights to the Dept. of Ecology.

4. Determine the feasibility and biological benefits of a phased removal of the weirs in the first weir group so that the stream can re-establish its natural gradient upstream of the project. If feasible, modify the weir design to include a future phased removal apart from the Corps' project.

   Concur. Although specifics on exactly what fluvial processes are believed to be deficient by the proposed design, the reality of the design is that some fluvial processes are enhanced, such as through-transport of gravels and finer materials, while others are reduced, such as bank erosion and overbank sediment deposition. The Corps will be conducting additional investigations to refine and verify the hydraulic and sediment transport issues. This includes additional slope equilibrium and at-a-station transport capacity studies. As part of these refinements the Corps will be able to better assess the potential viability of removing weirs over time. However an adaptive management approach such as this presents several difficulties under the Corps Authority. The Corps must recommend a project that is complete unto itself, in terms of function and expected outputs. Based on our guidance, the costs for removing weirs would be the local sponsor's responsibility.

5. Broaden the project purpose to recognize all the ecosystem benefits of the project, not just fish passage. The monitoring plan should recognize these broader benefits by including elements to measure them.

   Concur. Monitoring plan includes elements to measure ecosystem benefits of the project. However, not all portions of the plan can be funded and cost-shared under the 206 authority. The cost-shared portion of the monitoring plan must be directly related to the primary project purpose of fish passage. Corps' guidance suggests using only 1% of project costs for monitoring, though this report supports a funding level of 10%. A broader based monitoring plan may be appropriate for other project stakeholders to consider.

6. Provide a construction contingency that will allow minor adjustments of the project to be made for at least five years after construction. This will ensure that project functions properly before the sponsor's operations and maintenance responsibility starts.

   Partially Concur. The District is proposing an 18-month construction period in which the majority of in-stream construction would be completed during the first summer, plantings in the September to October time frame, and final adjustments the following summer.

7. A 5-year monitoring plan is insufficient to measure the success of the project. The Corps should monitor the project for the 10-year post project period recommended in the feasibility report. This monitoring period was recommended by the resource agencies because of the desire to obtain information from at least three cycles of salmonid use (for coho) and to monitor longer term changes in habitat in the affected and downstream reaches.

Concur that a longer monitoring period is desirable to measure ecosystem changes. However, the recovery of the target fish in the watershed is a larger question than the adequacy of fish passage for those species. The core of the Corps' monitoring plan is to assure that the design is adequately passing fish.

8. Determine the feasibility of using bioengineering techniques for all or part of the project's bank protection. These techniques should replace the proposed riprap if they can meet the bank protection goals. Eliminate bank protection from the project's "free flowing" segments.

   Partially concur. Detailed studies in the next phase will evaluate designs to minimize the amount of bank protection and use alternative bank protection techniques where feasible. However, we cannot commit to elimination of all bank protection in the "free-flowing" areas until further studies are complete.

9. Provide more plan detail during the plans and specifications phase of the project. Address the eight items we described in the previous section. The Service should be given the opportunity to participate in the refinement of the project design, including the instream habitat design and revegetation, mitigation, monitoring and operations plans, during the plans and specification phase. It is also our expectation to participate in the post construction review of the project.

   Concur. Service personnel were members of the design and planning teams, and close coordination throughout the project will continue.

10. Replace or supplement the partial weir or snorkeling surveys proposed in the monitoring plan with downstream monitoring of juveniles at two locations, one above and one below the project area.

    Concur. Monitoring plan suggests using all the above techniques to evaluate fish use of the project area.

11. Invite the Service and other cooperating agencies to the preconstruction meeting to ensure that all mitigation features are understood and to work out any unanticipated problems.

    Concur that Service and all other cooperating agencies will be invited to preconstruction meeting. Please again note that this restoration project cannot include compensatory mitigation features. This recommendation is understood to refer to restoration features incorporated as part of the project design.

12. Ensure that the project design protects federally listed or proposed threatened or endangered species.

    Concur. ESA coordination is ongoing.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1. CONCLUSIONS

This study has included an examination of all practicable alternatives to address the restoration needs in the basin. In order to provide upstream and downstream fish passage, hydraulic continuity must be restored. The most effective and efficient alternative, as well as the alternative with the greatest likelihood of success is the weir group alternative which includes removing the existing structure and providing for grade control through the project reach. The recommended plan of using groups of sheet pile weirs with free flowing reaches best meets the Corps' planning criteria and the technical design team criteria. This alternative provides significant improvement in fish passage through the project reach and would allow access to 14 miles of the high value habitat upstream for five species of salmonids.

Substantial efforts have been made to reduce any possibility of impacts outside of the project area. This has included the use of steel and vinyl sheet pile weirs to prevent any type of catastrophic failure, bank protection in certain locations to reduce erosion and potential unraveling of project grade control features, and specifying a 40-foot wide channel cross-section to effectively convey flood flows. Additionally, any potential adverse sedimentation impacts that could occur as a result of the recommended plan have been minimized by setting the upstream channel invert above the railroad trestle at the level of the existing bed. Finally, the potential for any increased erosion, through changes in channel depth or velocity outside the project reach has been minimized in the project design. Increased velocities are expected through the project reach, however the hydraulic model indicates that the water surface profile of the preferred plan matches the existing condition profile downstream of the last weir groups, indicating that the weir groups are able to dissipate sufficient energy so that the existing channel controls flow conditions. In other words, implementing the preferred plan should not alter hydraulic conditions below the last element of the project. As such it is not expected that the project as designed will exacerbate existing instabilities downstream of the project reach.

Based on a 22 June 1999 letter from the Washington Department of Fish and Wildlife, the non-federal sponsor has demonstrated their financial capability and willingness to support project implementation. The State of Washington has appropriated $1.1 million dollars in their biennium budget to support the non-federal share of the project implementation costs. In addition, Simpson Timber Company (May 19, 1999 letter) will provide up to $1.1 million dollars to the State to cover any additional project related costs including OMRR&R. The non-federal implementation costs (excluding OMRR&R) are estimated at $1,461. The financial resources identified by the sponsor are more than sufficient to cover non-federal implementation costs.

The recommended plan provides substantial environmental restoration benefits, is incrementally justified, has a reasonable construction cost, minimizes maintenance concerns and has strong local support

8.2. RECOMMENDATIONS

I recommend the proposed work be authorized and funding allotment of $260,000 be made for plans and specifications and $1,904 be made available for the federal share of the construction costs. The proposed work would include fish passage improvements for the designated area of Goldsborough Creek in Mason County, Washington as generally described in this report, with such modifications by the Chief of Engineers as may be advisable to meet provisions of Section 206 of the 1996 Water Resources Development Act, as amended. Authorization is subject to cost sharing and financing arrangements with the local sponsor, WDFW, and is based on the cost sharing and financing requirements as contained in Public Law, 99-662, as amended. Prior to construction, and during Plans and Specification stage, the local sponsor will: provide all lands, easements, and rights of way necessary for the project; hold and save the United States free from damages due to the construction or operation and maintenance of the project; and operate and maintain the project after construction.

Colonel James M. Rigsby
Colonel, Corps of Engineers
District Engineer

Date

9. REFERENCES

ASCE 1998. "Siting, Monitoring, and Maintenance for the Design of Grade Control Structures," Draft Report. Evaluation and Design for Grade Control Task Committee. American Society of Civil Engineers

Behnke, R. J. 1992. Native trout of western North America. American Fisheries Society Monograph 6. Bethesda, Maryland.

Bell, Milo C. 1986. "Fisheries Handbook of Engineering Requirements and Biological Criteria." Fish Passage Development and Evaluation Program. US Army Corps of Engineers, North Pacific Division, Portland, Oregon.

Bilby, R.E., and P.A. Bisson. 1992. Allochthonous versus autochthonous organic matter contributions to the trophic support of fish populations in clear-cut and old growth forested watersheds. Canadian Journal of Fisheries and Aquatic Sciences 49:540-551.

Bilby, R.E., B.R. Fransen, and P.A. Bisson. 1996. Incorporation of nitrogen and carbon from spawning coho salmon into the trophic system of small streams: evidence from stable isotopes. Canadian Journal of Fisheries and Aquatic Sciences 53:164-173.

Bilby, R.E., B.R. Fransen, P.A. Bisson, and J.K. Walter. 1998. Response of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead (*Oncorhynchus mykiss*) to the addition of salmon carcasses to two streams in southwestern Washington, U.S.A. Canadian Journal of Fisheries and Aquatic Sciences 55:1909-1918.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Oregon, and California. National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum NMFS-NWFSC-27, Seattle, Washington.

Case, Patti, Simpson Timber Company Public Affairs, July 1999.

Cavender, T. M. 1978. Taxonomy and distribution of the bull trout, *Salvelinus confluentus*, (Suckley), from the American Northwest. California Fish and Game 64:139-174.

Cederholm, C.J., D.B. Houston, D.L. Cole, and W.J. Scarlett. 1989. Fate of coho salmon (*Oncorhynchus kisutch*) carcasses in spawning streams. Canadian Journal of Fisheries and Aquatic Sciences 46:1347-1355.

Cook-Tabor, C., and L. Moore. 1999. Ambient habitat monitoring of Lower Goldsborough Creek - 1998. U.S. Fish and Wildlife Service. Draft. Lacey, Washington. 32 pp.

Cowardin, L.M., Carter, V., Golet, F.C. and E.T. LaRoe. Classification of wetland and deepwater habitats of the United States. Government Printing Office, Washington, D.C.

Dames and Moore, 1991. Report of geotechnical consultation, earth and timber dam, Shelton, Washington: prepared for Simpson Timber Company, Shelton, Washington, October 2, 1991.

Environmental Laboratory. 1987. Wetland Delineation Manual. Corps of Engineers Environmental Laboratory, Vicksburg, Mississipi.

Fraser, J. 1993. Evaluation of the Goldsborough Creek Simpson Dam and fish passage. Prepared for Washington Department of Fish and Wildlife. 28 October 1993. 17 p.

Golder Associates, 1996. Goldsborough Dam preliminary geomorphological and geological evaluation. Letter report to Summit Technology. Ref. 963-1391. 9 pp.

Grant 1990. Grant, G. E., Swanson, F.J., Wolman M.G. (1990). "Pattern and Origin of Stepped Bed Morphology in High Gradient Streams, Western Cascades, Oregon." Geological Society of America Bulletin, V. 102, pp. 340-352.

Healey, M. C. 1991. Life history of chinook salmon (*Oncorhynchus tshawytscha*). Pages 311-393 *in* C. Groot and L. Margolis, editors. Life history of Pacific Salmon. University of British Columbia Press. Vancouver, British Columbia.

Johnson, O. W., W. S. Grant, R. G. Cope, K. Neely, R. W. Waknitz, and R. S. Waples. 1997. Status review of chum salmon from Washington, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-32.

Johnson, O.W., M.H. Ruckelshaus, W.S. Grant, F.W. Waknitz, A.M. Garret, G.J. Bryant, K. Neely, and J.J. Hard. 1999. Status review of coastal cutthroat trout from Washington, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-NWFSC-37. 292 p.

Johnston, J. M. 1982. Life histories of anadromous cutthroat trout with emphasis on migratory behavior. Pages 123-127 *in* E. L. Brannon and E. O. Salo, editors. Salmon and trout migratory behavior symposium. School of Fisheries, University of Washington, Seattle, Washington.

Larson 1997. Cultural Resource Assessment Goldsborough Creek Dam Removal Mason County, Washington. Prepared for Simpson Timber Company, July 25th 1997.

Laufle, J. C., G. B. Pauley, and M. F. Shepard. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) - coho salmon. U.S. Fish Wildlife Service Biological Report 82(11.48). U.S. Army Corps of Engineers, TR EL-82-4.

Leider, S. A. 1997. Status of sea-run cutthroat trout in Washington. Pages 68-76 *in* J. D. Hall, P. A. Bisson, and R. E. Gresswell, editors. Sea-run cutthroat trout biology, management, and future conservation. Oregon Chapter American Fisheries Society, Corvallis, Oregon.

Lister, D.B., and H.S. Genoe. 1970. Stream habitat utilization by cohabiting underyearlings of chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmonids. Journal of Fisheries Research Board of Canada 27:1215-1224.

Logan, R.L., 1987. Geologic map of the south half of the Shelton and south half of the Copalis Beach quadrangles, Washington: Washington Sate Division of Geology and Earth Resources Open-File Report 87-9.

Low, D. R.J. Peters and B.R. Missildine. 1999. Ecosystem health of Goldsborough Creek, Washington, based on a benthic index of biotic integrity. U.S. Fish and Wildlife Service. Draft. Lacey, Washington. 8 pp.

Missildine, B. R., R.J. Peters, and D.L. Low. 1999. Chinook, coho, and chum salmon spawner escapement estimates - 1998. Draft. U.S. Fish and Wildlife Service. Lacey, Washington. 8 p.

Mongillo, P.E. and M. Hallock. 1997. Distribution and habitat of native nongame stream fishes of the Olympic Peninsula. Washington Department of Fish and Wildlife. Technical Report No. FRD 97-05. Olympia, Washington. 44 p.

Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-NWFSC-35. 443 p.

Orsborn, J. F. and P. D. Powers. 1985. Fishways—An assessment of their development and design. Department of Civil and Environmental Engineering, Washington State University, Pullman, Washington. Prepared for Bonneville Power Administration, Portland, Oregon, Contract DE-A179-82BP36523. 159 p.

Parametrix, Inc. 1997. Goldsborough Creek wetlands delineation and assessment technical memorandum. Prepared for Simpson Timber Company, June 1997. 15 pp. plus appendices.

Powers, P. D. and J. F. Orsborn. 1985. An analysis of barriers to upstream fish migration – An investigation of the physical and biological conditions affecting fish passage success at culverts and waterfalls. Department of Civil and Environmental Engineering, Washington State University, Pullman, Washington. Prepared for Bonneville Power Administration, Portland, Oregon, Contract DE-A179-82BP36523. 120 p.

Sabo, J.L., and G.B. Pauley. 1997. Competition between stream-dwelling cutthroat trout (*Oncorhynchus clarki*) and coho salmon (*Oncorhynchus kisutch*): effects of relative size and population origin. Canadian Journal of Fisheries and Aquatic Sciences 54:2609-2617.

Salo, E. O. 1991. Life history of chum salmon (*Oncorhynchus keta*). Pages 233-309 *in* C. Groot and L. Margolis, editors. Life history of Pacific salmon, University of British Columbia Press, Vancouver, British Columbia.

Sandercock, F. K. 1991. Life history of coho salmon (*Oncorhynchus kisutch*) Pages 397-445 *in* C. Groot and L. Margolis, editors. Pacific salmon life histories. University of British Columbia Press, Vancouver, Canada.

Schuett-Hames, D.H. Flores, and I. Child. 1996. An assessment of salmonid habitat and water quality for streams in the Eld, Totten-Little Skookum and Hammersley Inlet-Oakland Bay Watersheds in Southern Puget Sound, Washington 1993-1994. Squaxin Island Tribe.

Schuett-Hames, D., A. Pleus, L. Bullchild, and S. Hall. 1994. Ambient monitoring program. Prepared for Timber-Fish-Wildlife Program and Northwest Indian Fisheries Commission. TFW-AM9-94-001. August 1994.

Seavey, F. 1999. Fish and wildlife coordination act report: Goldsborough Creek Restoration Project Mason County, Washington. Draft. Prepared for the U.S. Army Corps of Engineers, Seattle District. Seattle, Washington. June 1999.

Summit Technology 1996 "Goldsborough Creek Dam Investigation Report." For Simpson Timber Company, Shelton, WA

US Dept. of the Interior 1987.. "Design of Small Dams," Third Edition, US Bureau of Reclamation, US Government Printing Office, Denver, CO.

Washington Department of Ecology. 1997. Washington State wetlands identification and delineation manual. Ecology Publication #93-94. Olympia, Washington. 88 pp. plus appendices.

Washington Department of Fish and Wildlife (WDFW) and Western Washington Treaty Indian Tribes. 1994. 1992 Washington State salmon and steelhead stock inventory, Appendix 1 Puget Sound stocks. WDFW, Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 1997. Washington State salmonid stock inventory: bull trout/Dolly Varden. September 1997. Olympia, Washington. 437 p.

Weitkamp, L. A., T. C. Wainwright, G. J. Bryant, G. B. Milner, D. J. Teel, R. G. Kope, and R. S. Waples. 1995. Status review of coho salmon from Washington, Oregon and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-24.

APPENDICES

A – LOCAL AGENCY LETTERS

B – SPONSORSHIP LETTER, DRAFT PCA, REAL ESTATE PLAN

C – HYDRAULICS AND HYDROLOGY

D – COST ESTIMATING

E – GEOTECHNICAL

F – ENVIRONMENTAL COORDINATION

G – FINDING OF NO SIGNIFICANT IMPACT

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APPENDIX A

LOCAL AGENCY LETTERS

APPENDIX B

SPONSORSHIP LETTER, DRAFT PCA & REAL ESTATE PLAN

APPENDIX C

HYDRAULICS AND HYDROLOGY

APPENDIX D

COST ESTIMATING

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GEOTECHNICAL

APPENDIX F

ENVIRONMENTAL COORDINATION

Law/Regulation	Status of Compliance
NEPA	This document is final NEPA documentation.
SEPA	NEPA document will be prepared to allow sponsor to adopt NEPA documentation per SEPA.
Clean Water Act, Section 404	Public review under 404 and completion of review will occur during plans and specs. Project is designed to be consistent with 404.
Clean Water Act, Section 401	401 Certification will be obtained following the 404 public notice, all requirements of permit will be complie with.
Clean Water Act, Section 402	A stormwater pollution prevention plan will be prepared for the stormwater discharge permit during plans and specs.
Endangered Species Act	ESA coordination is on going. A draft Biological Assessment is attached; no adverse impact is expectec any listed or candidate species. Informal consultation is expected, as such the document may be a Biological Evaluation upon submittal to NMFS and USFWS
Fish and Wildlife Coordination Act	Coordination Act Report is attached and coordination is ongoing. USFWS supports this project.
National Historic Preservation Act	State Historic Preservation Officer has determined that no historic or cultural resources are likely to be in the project area.
Executive Order 11988, Floodplain Managemen	Project will not encourage further development in the floodplain.
Executive Order 11990, Protection of Wetlands	Project will provide for restoration of any wetland impacts.
Shoreline Management Act	Local sponsor will obtain a shoreline permit from Masor County. Project is designed to be consistent with these regulations.
Coastal Zone Management Act	State will determine consistency with CZMA and SMA during public notice period. Project is designed to be consistent with these regulations.
Clean Air Act	Coordination with local air pollution control agency (Olympic Air Pollution Control Authority) is ongoing. Project construction will have minor impact on air quality; no other impacts expected.
Washington Hydraulic Code	Local sponsor will obtain HPA, project is designed to enhance fish habitat. WDFW supports and sponsors this project.
Indian Treaty Rights	Coordination is ongoing, project is designed to enhance fish habitat. Squaxin Island tribe supports this project.

APPENDIX G

FINDING OF NO SIGNIFICANT IMPACT

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-2255

REPLY TO
ATTENTION OF

CENWS-PM-PL-ER

FINDING OF NO SIGNIFICANT IMPACT

GOLDSBOROUGH CREEK SECTION 206 RESTORATION PROJECT
MASON COUNTY, WASHINGTON

1. Background. The proposed action is described in the attached ecological restoration report/environmental assessment ERR/EA Feasibility Report and will restore fish and wildlife habitat to Goldsborough Creek, near the town of Shelton, Mason County, Washington. The project would consist of removing an existing dam structure, which is a hindrance to both upstream and downstream fish passage, and restoring the stream to a more natural gradient. If implemented, the project would allow dwindling salmonid populations to return to one of the last largely unspoiled watersheds in south Puget Sound.

2. Action. The proposed restoration plan consists of removing a portion of the existing timber pile and concrete structure, excavating material above the dam, placing fill material below the dam and constructing groups of one-foot high weirs to allow for fish passage. These weirs, in combination with fill and excavation of material will provide necessary grade control to prevent scour and erosion. Each of the weirs will have a 'dog-leg' pattern to help provide for fish passage in a variety of flow conditions. This stepped approach will establish and maintain a gradient similar to other streams in the region and allow fish passage throughout the watershed.

3. Evaluation. An environmental assessment has been prepared for the proposed work and was circulated to governmental agencies and other interested parties. The proposed project will not negatively impact the Goldsborough Creek area and its natural resources, and in fact, the project is expected to improve fish and wildlife habitat. The proposed action will comply with all applicable laws, regulations, and agency consultations.

4. Finding of No Significant Impact. It has been determined that performance of this work, in accordance with the conditions herein described or referenced, is a major federal action that will not significantly affect the quality of the human environment, and thus does not require preparation of an Environmental Impact Statement.

Date

James M. Rigsby
Colonel, Corps of Engineers
District Engineer

APPENDIX H

MATRIX FOR CONSISTENCY DETERMINATION