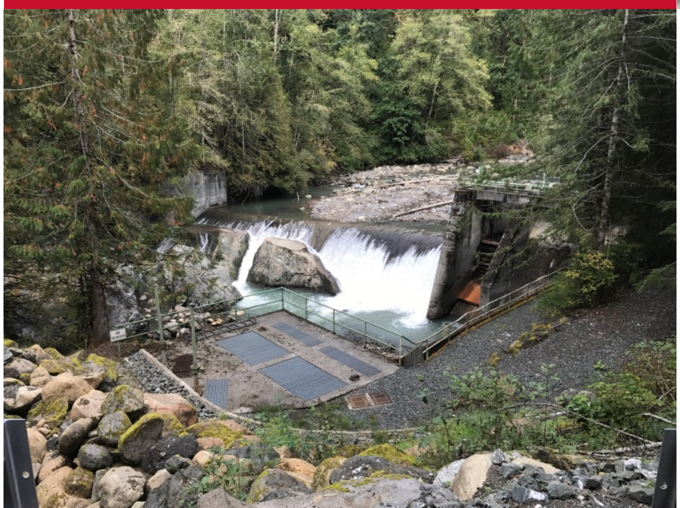

Alternatives Analysis and Conceptual Design Report

Middle Fork Nooksack Fish Passage

MF Nooksack River Mile 7.2
Lat: 48.77078, Long: -122.07334

Prepared for the City of Bellingham, WA
June 8, 2018

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Acronyms and Abbreviations

AR	American Rivers
APE	Area of Potential Effect
AACE	Association for the Advancement of Cost Engineering
AWS	Auxiliary water system
B&V	Black & Veatch
CFD	Computational fluid dynamics
cfs	Cubic feet per second
City	City of Bellingham
CLOMR	Conditional Letter of Map Revision
COB	City of Bellingham
County	Whatcom County
CWA	Clean Water Act
D/S	Downstream
DNR	Department of Natural Resources
DPS	Distinct population segment
DRT	Design Review Team
DAHP	Washington Department of Archaeology and Historic Preservation
EA	Environmental assessment
Ecology	Washington Department of Ecology
EDF	Energy dissipation factor
EFH	Essential Fish Habitat
EIS	Environmental impact statement
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
fps	Feet per second
ft	Foot/feet
GEI	GEI Consultants
H	Horizontal
HDPE	High density polyethylene
HDR	HDR Engineering, Inc.
HEC-RAS	Hydrologic Engineering Center River Analysis System
HPA	Hydraulic Project Approval
HSRG	Hatchery Scientific Review Group
IP	Individual Permit
JARPA	Joint Aquaculture Resource Permit Application
LiDAR	Light Detection and Ranging
MOA	Memorandum of agreement
MSA	Magnuson-Stevens Act
msl	Mean sea level
NHC	Northwest Hydraulic Consultants
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service (NOAA Fisheries)
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent

NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NWP	Nationwide Permit
O&M	Operations and maintenance
OHW	Ordinary high water
OHWM	Ordinary high water mark
OPCC	Opinion of probable construction cost
PAC	Partner Advisory Committee
pcf	Per cubic foot
PLC	programmable logic controller
psi	Pounds per square inch
RCP	Reinforced concrete pipe
RCW	Revised Code of Washington
RM	River mile
SEPA	State Environmental Policy Act
SP	Standard Permit
TBD	To be determined
TM	Technical Memorandum
U/S	Upstream
USACE	United States Army Corps of Engineers
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
V	Vertical
VFD	Variable frequency drive
WA	Washington
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington department of natural resources
WQC	Water Quality Certification
WRIA	Water Resource Inventory Area
WSDOT	Washington State Department of Transportation
WSEL	Water surface elevation
Wt	Weight

Executive Summary

The City of Bellingham (City) investigated several options to restore habitat connectivity and improve fish passage at the Middle Fork Nooksack diversion dam while ensuring that the City can continue to draw supplemental municipal water from the Middle Fork Nooksack River. Since 2002, the City's investigation has been and continues to be in partnership with the Nooksack Indian Tribe, Lummi Nation and the Washington Department of Fish and Wildlife. In 2017, American Rivers, with funding from the Paul G. Allen Family Foundation, also partnered with the City to achieve the project goal. Recently, the City retained HDR Engineering, Inc. (HDR) to review alternatives developed in previous studies and identify any new alternatives that incorporate lessons learned from decades of prior study to best meet the project goal and objectives. As part of this effort, HDR has prepared this report to summarize the history of alternative development, to present salient background data that characterizes the biological and physical aspects of the project, and to document the evaluation process used by the project partners to select a preferred alternative. Results of this report are intended to be used in establishing a common framework for final design.

The information presented in this document represents the results of Phase I of a multi-phase process formulated to achieve the following three objectives:

- Restore the channel through the dam site to a natural configuration to provide upstream fish passage to 16 miles of spawning and rearing mainstem and tributary habitat for three ESA-listed, threatened species (Puget Sound spring Chinook Salmon, Steelhead, and Bull Trout) by 2020;
- Construct a gravity-fed diversion intake on City property upstream of the existing location to eliminate the need for the dam while maintaining the City's existing ability to divert 116 cfs in supplemental municipal water supply;
- Protect fish from entrainment by complying with National Marine Fisheries Service (NMFS) and Washington Department of Fish and Wildlife (WDFW) fish screen criteria.

The project background is presented to establish the need for the project and to provide a thorough summary of the existing project facilities. Site-specific biological considerations are presented to establish the biological basis of design. Physical considerations are then provided to characterize key environmental and operational factors that significantly influence the formulation and relative feasibility of potential alternatives. The formulation of alternatives includes a discussion of options developed as part of previous efforts in addition to a new upstream intake option formulated by the project team. Each of the alternatives was initially evaluated based upon their ability to meet three fundamental feasibility thresholds:

- Does the alternative achieve the project goals and improve fish passage performance past the dam?
- Does the alternative meet safety and code requirements?

- Can the facility be operated successfully under the full range of environmental conditions without suffering long-term damage, significant impairment of fish passage performance, or catastrophic failure?

Of the alternatives evaluated in this document, only one of five was determined to be infeasible and this alternative, the "No-Action" alternative, was removed from further consideration. Four alternatives involving project action were deemed potentially feasible and were then subjected to further evaluation using a numerical rating and scoring methodology. The four alternatives included:

- Alternative A - Fish Ladder with Off-Stream Conventional Vertical Panel Fish Screen in Diversion Channel and No Dam Removal;
- Alternative B - Siphon Intake with Off-Stream Conventional Vertical Panel Fish Screen and Dam Removal;
- Alternative C - Upstream Intake with In-Stream Fish Screen and Self-Scouring Abutment Structures and Dam Removal; and
- Alternative D - New Upstream Intake with Conduit and Off-Channel Conventional Vertical Panel Fish Screen and Dam Removal

Evaluation factors were developed to provide a means of measuring an alternative's ability to achieve the project objectives. Relative weighting was assigned to the evaluation factors based on their relative contribution to achieving the overall project goal, with larger weighting of those with greater contribution. Each alternative was rated for its ability to meet the requirements of each evaluation factor, and scoring resulted from multiplication of the relative weighting of the various factors by the rating within that alternative for each factor, respectively. A higher computed score overall indicated that an alternative has a higher likelihood of achieving the project objectives over one with a lower score.

Results of the scoring methodology indicated that Alternative B and A (scores of 166 and 178, respectively) had a lower likelihood of meeting the project objectives while Alternatives C and D had a higher likelihood. Evaluation results were presented to the project partners and discussed at an Alternatives Selection Meeting on February 12, 2018. During the meeting, evaluation factors and comparison matrix were presented and discussed with the attendees in an effort to obtain feedback and reach a consensus among the participants. Prior to the conclusion of the meeting, there was general consensus among the attendees that Alternative D appeared to exhibit the greatest potential to achieve the project goal out of all alternatives considered and was identified as the preferred alternative.

Alternative D – Upstream Intake and Dam Removal is based on the evolution of the design concepts defined over the past decades of work, and utilizes knowledge learned from the prior studies to refine features that best fit the site-specific conditions and features, meet operational and diversion needs, and improve fish passage The alternative consists of an intake upstream of the dam on the left bank of the river, a fish screen between the intake and the existing dam, a buried conduit between the intake and the fish screens and between the fish screens and the existing dam, a bypass pipe to return fish to the river, sediment sluice pipes, replacing the existing trashrack with a solid wall, removal of the existing sluiceway and left portion of the dam, and recontouring of the river channel adjacent to the removed sluiceway and dam. The construction cost of Alternative D is anticipated to range from approximately $9.4M to $17.4M.

1 Introduction

The Middle Fork Nooksack River is a glacier-fed fork of the Nooksack River draining the flanks of Mount Baker in northwest Washington State. The river's cool water feeds a rich and diverse assemblage of aquatic habitats and supports a substantial run of native anadromous salmon and steelhead, the iconic symbols of much of the Native American indigenous culture of the northwest Washington State. For thousands of years, the area has depended on the waters generated by deep winter snow, tumbling glaciers, and generous rainfall to evolve a geologically young landscape still adjusting to the continuing retreat of the past continental glaciation that covered the entire Puget Sound region just 10,000 years ago. This young landscape is readily evident in the obvious signs of glacier-carved valleys, large moraine deposits, and scars borne by exposed bedrock in the upper reaches of the Middle Fork Nooksack River.

It is in this dynamic, high-energy land and waterscape that the City constructed its water supply diversion dam and associated facilities in the early 1960's. The diversion supplies water from the Middle Fork to Lake Whatcom through a tunnel, a pipeline, and a natural tributary stream channel over a distance of nearly 14 miles. Prior to the construction of the diversion facilities, the City's growing population and industrial base had depended entirely on the natural inflows to Lake Whatcom, which is its primary water supply. City leaders recognized the necessity of supplementing the natural inflow to Lake Whatcom, which, in spite of its relatively large size, is a remnant glacial scour lake with only a small contributing watershed area.

The 30 foot tall by 150 foot long concrete diversion dam was constructed near the upper end of a narrow, steep bedrock gorge through which the Middle Fork plunges to reach the broad glacial valley where it joins with the North Fork, and a few miles downstream, joins with the South Fork to form the mainstem Nooksack River (see Figure 1-1). The Nooksack River then flows into the Salish Sea via Bellingham Bay. The Middle Fork gradient is steep through the gorge and diversion dam reach, but flattens above and below. This hydraulic gradient bears significant influence on considerations for riverine process continuity and fish passage, as discussed in more detail in the body of this report.

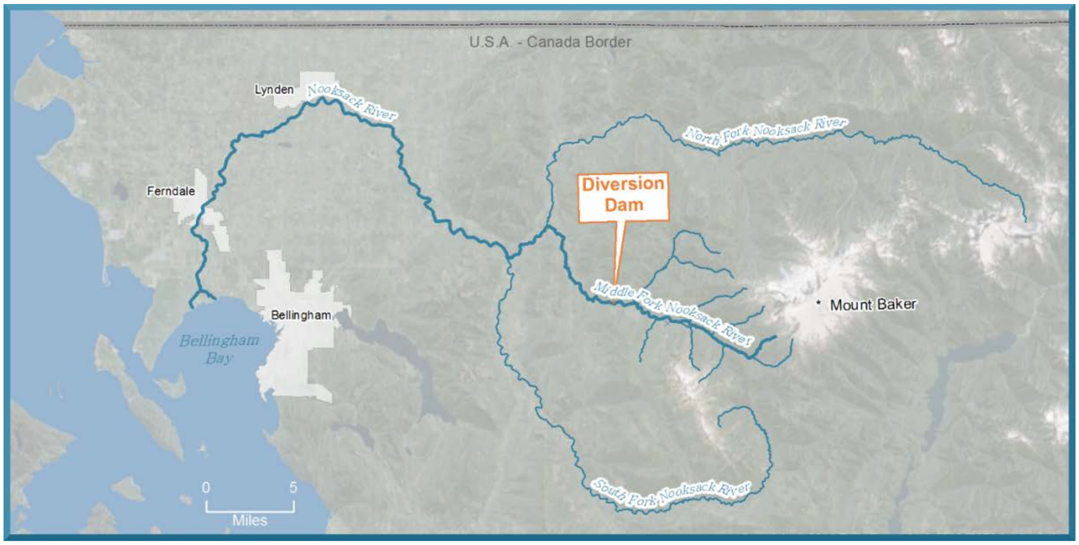


Figure 1-1. Map of the Nooksack River and Tributaries

1.1 Purpose and Scope of Document

Several studies conducted over the past two decades have sought a long-term solution for improving fish passage to the upper watershed. The intent of this report is to summarize the previously evaluated project alternatives. In addition, a new upstream intake alternative that includes off-channel fish screening and the removal of the dam structure is developed. Evaluation factors are used to compare all of the alternatives, which are then scored in terms of their feasibility and ability to meet project objectives, culminating in selection of a preferred alternative. The document also provides watershed and site ecological and physical information that establishes an initial basis of design. Questions asked in a collaborative Alternative Selection Meeting are documented, and answers provided or referenced in the report.

The purpose of this study report is to capture the important aspects of the previous and present studies conducted to improve fish passage and maintain the City's ability to divert supplemental municipal water supply from the Middle Fork Nooksack River in the vicinity of their existing diversion dam. This study is separated into two distinct Phases, with the first phase focusing on updating the costs and condensing the previous study results and incorporating the current study new alternative upstream intake configuration results. The first phase (Phase 1) is complete as of the end of February 2018, and culminated in a selected, preferred alternative that has been developed to a level sufficient to identify and rectify potential fatal flaws and to determine an associated reasonable opinion of probable construction cost. All alternatives reviewed do not necessarily need to be developed to the same equivalent level, as the feasibility of each had been previously determined in earlier studies. The capital investment costs of all the previous alternatives and the new upstream alternative have been escalated to current value pricing in this study to establish a common economic context between all alternatives. The second phase of this project will focus on developing the design and opinion of construction costs of the preferred alternative to the final design stage, and is anticipated to be completed by the end of February 2019.

The scope of this Phase 1 study report is to summarize the results as discussed above, and to provide justification and support for selection of the preferred new upstream intake alternative. The first phase is documented in the Conceptual Alternatives Analysis Report herein, while the second phase will be documented in the stamped and signed engineering drawings and specifications, as well as the Design Criteria Report. The Phase 1 tasks included the following:

- coordination with the City, American Rivers, and project partners
- review of previous work, including studies and alternatives developed since 2002
- development of a digital base map of the site and supplementing the base map with additional survey as necessary
- assessment of the need for additional geotechnical field exploration to be conducted in Phase 2
- identification of conceptual design criteria
- refinement of previous alternatives and development of one additional alternative
- evaluation of the alternatives based upon various selection factors, including an opinion of anticipated construction, implementation, and lifecycle costs
- assistance to the City, American Rivers, and the project partners in selection of one alternative for further development
- development of conceptual design drawings of the recommended alternative, and,
- assistance to the City in streamlining the permitting process and preparing permit applications for submission

A summary list of previous alternatives evaluated included, in chronological order of study, the following:

- Fish ladder – an investigation of several fish ladder configurations ascending the existing dam, coupled with a juvenile fish exclusion screen in the existing concrete intake channel to keep fish from being entrained into the diversion tunnel. The dam would be retained in this alternative.
- Upstream abutment intake – a series of evaluations of one or more new upstream screened intakes above the existing dam, coupled with removal of the existing dam
- Siphon intake – an evaluation of a large siphon system drawing flow from the scour pool below the existing dam through exclusion screens and up into the diversion tunnel, coupled with removal of the existing dam

The new upstream intake alternative builds on the previous knowledge gained about the river morphology, sediment transport, and fish passage characteristics, but considers off-channel screening systems instead of full exclusion screens at the intake as in the previous alternatives. The new upstream intake alternative considers the current status of National Marine Fisheries Service (NMFS) fish screening design criteria, in that off-channel screening may be acceptable if in-channel exclusion screening is not possible or practical. Previously evaluated intake alternatives were constrained by the previous NMFS screening criteria at that time, which did not include off-channel screening systems. Current standards permit consideration of off-channel screening where continuous bypass back into the river is proposed.

The next steps in Phase 2 of this project will include refinement and development of the final design of the new upstream intake alternative, as well as coordinating the permitting process through construction approval. This refinement will include additional field geotechnical exploration to provide a better understanding of possible foundation conditions at the new intake site and at points along the proposed alignment of the conduit. To document the design criteria and the design intent, a Design Criteria Report will be developed as part of the Phase 2 work.

1.2 Project Goals and Objectives

Project Goal: Restore habitat connectivity, fish passage, and increase species protection at the site of the Middle Fork diversion facilities while ensuring sustainability of the City's supplemental water supply from the Middle Fork Nooksack River.

Project Objectives:

- To restore the channel through the dam site to a natural configuration to provide upstream fish passage to 16 miles of spawning and rearing mainstem and tributary habitat for three ESA-listed, threatened species (Puget Sound spring Chinook Salmon, Steelhead, and Bull Trout) by 2020.
- To construct a gravity-fed diversion intake on City property upstream of the existing location to eliminate the need for the dam while maintaining the City's existing ability to divert 116 cfs in supplemental municipal water supply.
- To protect fish from entrainment by complying with National Marine Fisheries Service (NMFS) and Washington Department of Fish and Wildlife (WDFW) fish screen criteria.

Project goals and objectives basis: The goals and objectives represent the collective desired outcomes of the project partners (City, American Rivers, Nooksack Indian Tribe, Lummi Nation, and WDFW). Those expressed outcomes were refined into the project goal statement and objectives to guide project design after the first Partner Advisory Committee (PAC) meeting on December 7, 2018.

1.3 Background

The existing City of Bellingham diversion dam was constructed in the early 1960's at the upper end of a steep gradient bedrock gorge on the Middle Fork Nooksack River, above Deming, Washington. Below the dam, the river cuts through a near-vertical walled canyon of bedrock for a distance of about two miles. Above the diversion dam, a short reach of boulder stepped-pool steep gradient channel extends about a half mile up to a lesser gradient reach of at least 10 miles in length, with several contributing major tributaries.. Together, the upper watershed of the Middle Fork mainstem and tributaries contributed to runs of at least 4 of the 5 recognized species of Pacific salmon, as well as steelhead and bull trout.

1.3.1 Existing Facilities

The diversion dam was constructed at the apex of a narrow notch between a bedrock knob on the north bank and a steep bedrock exposure on the south bank. This site afforded the construction of an efficient intake and sedimentation channel just upstream of a mined rock tunnel through the ridge (Bowman Mountain) separating the Mosquito Lake basin from the upper Middle Fork Nooksack basin. Details showing the existing facility are illustrated on the overall project site plan in Appendix A on Plate P-1. The tunnel discharges into a pipeline that eventually feeds Lake Whatcom, Bellingham's municipal water supply reservoir. The narrow rock cleft upon which the dam was constructed allowed a relatively low dam (less than 20 feet hydraulic height) to divert up to 250 cfs into the tunnel without the need for moving large amounts of raw materials such as concrete and steel reinforcement up to the remote site. The dam is accessible by means of a steep access road leading down into the head of the canyon, crossing the river gorge over a bridge. The original wooden bridge was replaced with a precast concrete bridge on about the year 2000.

The existing dam was constructed across the narrow cleft in the rock gorge by first excavating the large rock knob on the right descending side of the channel down to a level shelf about 20 feet higher than the deepest portion of the natural channel thalweg through the rock formation. A low ogee crest was formed over the top of the rock shelf, and the narrow cleft was filled to form a level spillway crest approximately 128 feet in length. A center pier and a vertical left abutment frame a deep sluice opening approximately 16 feet wide and 10 feet deep. The sluice is controlled by a large, 10-foot-high vertical bulkhead-type gate over which flow passes when the gate is in the closed position. A single hoist lifts the sluice gate to the deck, which is approximately 28 feet above the sluice floor.

Just upstream of the sluice gate, two openings in the vertical left abutment wall, each about 10 feet wide and extending from 3 feet above the sluice floor to an intermediate deck elevation about 20 feet above the sluice floor. These two openings are fitted with slightly inclined trashracks and screens that exclude larger debris from entrainment. The sill into which the trashracks seat drops the same 3 feet back down to a collection chamber and approach section for the two 5 foot wide by 8 foot high closure gates feeding the downstream diversion/sedimentation channel. Downstream of the closure gates, a 10 feet wide and 10 feet deep sedimentation channel allows for most larger sediment to drop out of the flow. Excess flow into this sedimentation channel is discharged back to the river downstream of the dam over a side weir extending along the entire 70 feet of the channel at the same crest elevation as the main spillway.

At the downstream end of the 10 foot wide sedimentation channel, the channel splits into two channels about 9 feet wide separated by a center pier. Within this widened channel section , the floor drops 5 feet to form a depression about 5 feet long, where a 12 inch square side gate at the floor permits sediment to be sluiced back to the river. A culvert passes under the channel at this point to allow flow from a small tributary stream to pass under the channel below the floor. Downstream of the depression, the floor rises again to the gate sill at the upstream end of the tunnel entrances to an elevation 2.5 feet higher than the sedimentation channel (there are two side by side entrances about 6 feet high by 4 feet wide). Two 4 x 6 foot sluice gates provide for closure of the tunnel entrance openings.

Figure 1-2. Pre-Dam Photo, Taken Below Existing Dam Looking Upstream

Figure 1-3. Looking Upstream at the Middle Fork Diversion Dam

1.3.2 Problem Identification

The Nooksack watershed is home to important ecosystems, threatened NMFS- and USFWS-managed species, and provides essential ecosystem services and socio-economic benefits to the City and surrounding communities. The existing facilities decrease watershed ecosystem resiliency and are vulnerable to anticipated conditions under future climate change scenarios

In 1962 when the City constructed the diversion dam, fish passage to the upper reaches of the Middle Fork Nooksack River above the dam was not considered in the design. Presently, the dam blocks access to about 16 miles of habitat above the dam for three threatened Puget Sound anadromous fish populations (North/Middle Fork Nooksack spring Chinook Salmon, Puget Sound Steelhead, and Coastal-Puget Sound Bull Trout). Since construction, the dam has experienced abrasion and some minor damage to the dam foundation (Black and Veatch, 2014). Prior to the original dam construction, the Nooksack and Lummi Tribes and others, documented observations of anadromous salmon present above the dam site. Following dam construction, there have been no documented observations of anadromous fish above the dam site, though some have suggested that fish can, with great difficulty under certain hydraulic conditions, ascend the dam through the gullies and rivulets of flow at the ogee and rock foundation interface. However, no hard evidence has surfaced to date supporting these observations that we are aware of. More detailed discussion of fish passage issues, historical data and usage information, and contemporary observations are provided in Section 3.1. In 2002, the City and original project partners began investigating various options to provide upstream fish passage at the diversion dam, and also provide protection against entrainment of juvenile downstream migrant fish into the diversion tunnel. Section 1.3.3 below discusses the previous studies related to fish passage and the diversion replacement conducted to date.

The existing diversion dam has experienced some abrasion consistent with the very dynamic hydraulic environment of the site, but is otherwise functional. In addition, its location and the hydraulic characteristics of the diversion features leave it vulnerable to considerable sediment entrainment and debris fall, requiring ongoing maintenance and debris removal for diversion operations. Hence, several studies conducted over the past two decades have focused on the potential for restoring unimpeded fish passage to the upper watershed by either modifying or removing the existing dam and replacing the diversion intake to accommodate the restored channel. Restoration of the river channel processes are expected to benefit these anadromous fish populations and reduce risk to recreational users of the river.

The intent of this study is to summarize the previously evaluated alternatives for replacing the water diversion capability and modifying or removing the existing dam to permit fish passage through the affected reach. In addition, a new upstream intake alternative that includes off-channel fish screening and the removal of the dam structure is developed. Previous alternatives did not consider off-channel screening, as discussed in more detail in the report below.

1.3.3 Previous Studies

A full bibliography of the previous fish passage and diversion replacement alternatives was developed as part of a Black and Veatch study in 2011 (Black and Veatch, 2011). A partial and brief synopsis of those previous studies is presented here.

In 2001 and 2002, Northwest Hydraulic Consultants developed a number of concepts for upstream passage by means of a fish ladder around the diversion dam, coupled with a simple vertical panel exclusion screen within the existing sedimentation channel upstream of the tunnel entrance (NHC, 2002). In this study, it was assumed that the existing diversion dam would be rehabilitated to extend its useful life and maintain the existing diversion capacity of the intake and tunnel. Ladder alignments included a right (descending) ladder along the spillway cut retaining wall, a center alignment located to the immediate right of the center pier, adjacent to the highest section of the ogee spillway crest, and several left bank alternatives. The selected ladder alternative's entrance was located in the vicinity of the existing sediment sluice and tributary culvert that currently passes local runoff under the sedimentation channel and tunnel entrance. The ladder was to have been excavated in the bedrock immediately left of and adjacent to the existing sedimentation channel, and the ladder exit opening was to have been located just upstream of the existing retaining wall on the left bank above the existing debris boom. A limited program of geotechnical field investigation consisting of four borings along the alignment of the preferred fish ladder configuration provided foundation conditions and observed that bedrock is nearly at the surface at least up to the dam axis. The conclusions of this study were that the fish ladder and juvenile screening system would meet the objectives of fish passage, but the maintenance requirements and necessary rehabilitation of the dam for continued use would be significant. In addition, the reach impacted by the dam would continue to impede natural channel processes even though fish passage would be improved.

In 2003 through 2004, Northwest Hydraulic Consultants investigated additional fish passage alternatives that included demolition of most of the existing dam and replacement of the intake diversion function with a new intake or series of new intakes located upstream of the existing dam. Several of these alternatives consisted of multiple intake structures located with the 'boulder garden' reach of the river several hundred feet upstream of the existing dam. Each of the intakes was to have withdrawn a portion of the desired City water diversion needs, with the combined flow passed through the existing sedimentation channel and into the tunnel. At the time of the investigation, the National Marine Fisheries Service had recently developed new guidelines for fish exclusion screening systems for diversions (NMFS, 2000). These new guidelines discouraged off-channel screening in favor of direct screening at the intake structure, to prevent the diversion of fish from the main channel. In the environment posed by the Middle Fork Nooksack River above the existing diversion dam, on-channel screening systems would be subject to considerable damage from debris and sediment, and the limited available flow depth in the channel constrained by the very low permissible screen approach velocity made a single large screen possibly quite costly and intrusive to the river. Hence, smaller multiple screens drawing a portion of the total flow demand were considered to be a practical solution that might accommodate the necessary withdrawal rate without the addition of a major structure in the river.

These multiple intake structures relied on an artificial constriction in the channel formed by new concrete abutments to develop a deep natural scour pool at each intake through which the sediment would scour and refill in accordance with the variable sediment transport capacity through the constriction. Similar analogous constrictions were noted at other stream diversions, most particularly the Dungeness fish hatchery intake on the Dungeness River. The deep scour pool morphology permits the intake screen to draw flow from the upper portion of the water column, above the zone where most bed load sediment passes, and increase the available area for the screen, enabling the on-channel screen to meet the constraining approach velocity criteria. Though these alternatives met the exclusion screening criteria and accomplished the removal of the dam, the disturbance to the upstream reach to enable construction of the multiple intake structures was determined to be quite costly. An expanded geotechnical investigation program was accomplished in 2005 (PanGeo, 2005) to support the design of the new intake alternatives, which included additional borings collected along the proposed multiple conduit alignments, and near the proposed intake structures. In addition, a number of test pits were excavated along the old access roadway leading upstream above the present intake and within this overbank glacial deposit area to help determine depth to competent bedrock and characterize the substrate. The geotechnical investigations determined that these glacial deposits throughout the left descending overbank were quite deep, some as deep as 40 feet or more to bedrock. In addition, the investigations determined that these materials were quite porous and readily transmitted groundwater throughout the potential construction area, considerably complicating construction methods and increasing costs.

In 2005, the concept was tested in the physical modeling laboratory of NHC's Vancouver, B.C. office to refine the design, verify its efficacy, and document its performance in a mobile sediment environment (NHC, 2005). The modeling study determined that the stream channel though the 'boulder garden' reach was too steep to readily accommodate the construction of multiple artificial constriction-type intake structures needed to meet the on-channel screening requirement and still meet upstream fish passage objectives within the range of proposed design criteria. As part of the modeling investigation, an additional new alternative consisting of a single very large artificial constriction structure and a reconstructed and stabilized downstream channel reach, with boulder matrix grade control structures would effectively support the desired withdrawal rate and meet the fish passage objectives of both upstream and downstream migrating fish.

Following the modeling work in 2006 and culminating in 2006, a feasibility-level preliminary engineering design was accomplished for the single large artificial constriction alternative arising from the model study that incorporated on-channel screening, per the NMFS fish screening guidelines (NHC, 2006). The very large structures necessary to accommodate the required diversion rate and the difficult conduit construction across the deep, porous glacial deposits were found to be significant cost factors in the development of probably construction costs. Estimated construction methods included deep sheet pile caisson structures with extensive construction dewatering systems expected to enable construction of the deeply buried conduit. The very large structures, deep excavation, and expected high cost presented a formidable challenge, though the alternative was determined to be feasible and was verified with the physical modeling work.

Subsequent to the development of the preliminary engineering report for the single large on-channel screening intake alternative, a value engineering study was conducted by JGJ to try to determine if construction costs could be reduced or risk could be minimized (JGJ, LLC; 2009). The conclusions from the study determined that the difficult construction and the relatively difficult access to the site would likely make the cost of the project about $22.5 million (in 2008 dollars), even though approximately $8 million in VE savings were identified. The large cost of an on-channel screen intake system and naturalized grade control plateau utilizing large boulders was in excess of the funding that the City could obtain from their proposed sources, hence the project stalled. However, it was noted that if the on-channel screening requirement could be waived in favor of a much simpler and smaller conventional intake with an off-channel screening system that was well protected within a separate structure at some point along the conduit alignment, the cost could be reduced considerably, and the impacts to the project reach could be minimized. The final alternative included removal of most of the existing dam as well, similar to that proposed in earlier studies.

In 2011, Black and Veatch investigated an additional alternative (Black and Veatch, 2011) that consisted of a large screened siphon intake drawing flow from the existing scour pool immediately below the existing dam, removal of the dam to a configuration similar to that determined in the previous physical modeling studies to provide for upstream fish passage, and lining of the tunnel to permit a vacuum to be drawn and the siphon to function. The conclusions of the siphon study determined that the estimated construction cost of this alternative was in excess of $30 million, and its feasibility was not assured, given the difficulty in maintaining hydraulic prime in the siphon, and the variability in maintaining as adequate intake withdrawal pool depth at the base of the old dam. The study included another physical scale hydraulic model to refine the siphon intake configuration and verify the dam removal configuration with the siphon intake in place (NHC, 2011). Additionally, the physical model was used to document passage routes for upstream migrating fish through the resulting natural channel that would form once the dam was removed. Velocities and depths were mapped throughout as part of the results.

Several different configurations that included partial or complete removal of the low ogee spillway section in addition to the highest part of the dam spillway, center pier, and sluiceway removal were evaluated in the physical model. The model was used to simulate the effects of dam removal configurations on future channel morphology by simulating flood events of varying size while feeding sediment into the upstream boundary of the model. Additionally, the model refinements determined that retaining a portion of the low ogee crest on the right side of the dam would help to re-establish the original channel morphology through the dam removal reach, but would minimize the possibility of destabilizing the upstream ‘boulder garden’ reach. This conclusion was reached by comparing the historical photographs of the original large bedrock knob protruding well above the channel to the channel topography above the dam, the conveyance provided by the main channel through the portion formerly occupied by the existing main dam, and the channel morphology developed in the model after large flood events were simulated following dam removal. Complete removal of the entire low ogee appeared to permit more flow to pass over the right side of the channel, while retention of a portion of the low ogee only appeared to create a channel morphology most closely matching the original topography and morphology prior to dam construction. The model conclusions and recommendations did suggest that alternative passage routes might also be established by selective removal of narrower portions of the low ogee on the right side in addition to complete removal of the main dam, center pier, and sluiceway, while retaining the left abutment and sedimentation channel.

Black and Veatch conducted additional studies of the tunnel condition, the dam condition, and the pipeline downstream of the tunnel (Black and Veatch, 2010, 2014, and 2015, respectively). However, these studies did not include any additional investigation of dam removal or new intake design.

The conclusions of the previous studies identified several potentially feasible alternatives to provide for upstream fish passage and downstream fish entrainment exclusion screening. However, the feasible alternatives determined to be acceptable to agency review all incorporated on-channel fish exclusion screening, and one of the alternatives did not include removal of the dam and restoration of the natural geomorphic processes of the Middle Fork Nooksack River. Since the time those studies were concluded, the fisheries resource agencies have reconsidered the on-channel screening requirements, and determined that off-channel exclusion screening is acceptable, given new criteria (NMFS, 2011). This new criteria allows for consideration of much smaller and more compact, simpler, and less intrusive diversion structures for this project. In addition, the consideration of a much small intake structure also would permit moving the diversion intake location upstream to near the City property’s eastern boundary. This enables construction of the conduit across a much shallower section of glacial deposits and the majority of the alignment to be founded entirely on bedrock, as well as the screen structure. The off-channel screening system also permits the simplification of the exclusion screen cleaning system and design for smaller anticipated loads, and eliminates the need to protect the cleaning system from damage due to high river stages and flood-borne debris. Sediment handling and bypass is also simplified with an off-channel screening system. With the anticipated reduction in size and scale of the overall system arising from consideration of the off-channel screening system, the construction costs are expected to be reduced compared to the previous studies.

2 Collaboration with Project Partners, Additional Groups, and Outreach Efforts

The problems facing the existing facilities and the benefits of implementing an innovative solution affect a wide range of groups. Key partners, including the City of Bellingham (landowner and local agency), Lummi Nation, Nooksack Indian Tribe, and the Washington State Department of Fish and Wildlife (WDFW) signed a Memorandum of Agreement (MOA) in 2002 to find a solution to restore anadromous fish passage at the diversion dam. This collaborative effort resulted in completion of the previous studies described in Section 1.3.3, which provided essential information for the current effort. In 2017, American Rivers, with significant funding support from the Paul G. Allen Family Foundation, joined the cooperative effort to facilitate the near-term implementation (i.e., in less than three years) of the project and realize the fishery and community benefits. Several other groups have expressed or provided support for the project as well, including the United States Fish and Wildlife Service, American Whitewater, Long Live the Kings, Northwest Conservation, Whatcom Land Trust, and Northsound Trout Unlimited.

To ensure an efficient and effective collaborative planning process, a Partner Advisory Committee (PAC) and Design Review Team (DRT) were established. These groups play critical roles in ensuring project planning stays on track, permits are secured, and the project is funded, In addition to the PAC and DRT, U.S. Fish and Wildlife Service (USFWS) and Whatcom County have been engaged to provide guidance and advice throughout the current process. Together with the PAC, USFWS and Whatcom County participated in the Alternative Selection Meeting. See Table 2-1, Section 6.1, and Appendix B for more information regarding the Alternative Selection Meeting. Communication and outreach methods are being implemented to ensure interested parties receive timely information, and that project information is widely available.

2.1 Partners Advisory Committee

A Partner Advisory Committee (PAC) consisting of the original MOA partners (the City, the Lummi Nation, the Nooksack Tribe, and WDFW) and American Rivers was assembled to ensure key partner input and guidance in the renewed effort to complete the project. The PAC members have been involved in examining fish passage improvements at the Middle Fork Nooksack diversion dam over the past two decades. They are project partners and co-fishery managers that bring valuable background and experience to the development and selection of a preferred alternative. The PAC will also serve as a sounding board at key project milestones throughout the project planning phase. Primary PAC tasks include:

- Communicate each partner’s desired outcomes for the project.
- Assist in the selection of a “preferred alternative” for the project.
- Assist or lead efforts to secure the additional funding needed for the project.
- Assist or lead efforts to secure the permits needed for the project.
- Exchange information and ideas with other committee members and the project core team.
- Disseminate information and promote the project to their membership and peers.
- Provide a public voice to help guide the project toward implementation.

Table 2-1 provides a list of PAC meetings held to date.

Table 2-1. Middle Fork Nooksack Fish Passage Project Meetings

Date	Meeting Title	Attending Groups
December 7, 2017	PAC Meeting #1: Project Coordination and Update	City of Bellingham, American Rivers, Nooksack Tribe, Lummi Nation, WDFW
January 25, 2018	PAC Meeting #2: Permitting and Funding Approach	City of Bellingham, American Rivers, HDR, Nooksack Tribe, Lummi Nation, WDFW, USFWS
February 12, 2018	Alternative Selection Meeting	City of Bellingham, American Rivers, HDR, Nooksack Tribe, Lummi Nation, WDFW, Whatcom County

Note: Meeting Minutes are provided in Appendix C. A description of the Alternatives Selection Meeting is provided in Section 6.1. Questions and answers from the Alternative Selection Meeting are provided in Appendix B.

2.2 Design Review Team

The purpose of assembling the Middle Fork Nooksack River Fish Passage Project Design Review Team (DRT) is to ensure the desired project outcomes as identified by the PAC and established in the project goal are reflected in the design criteria and appropriately implemented throughout the design process. The Design Review Team will provide technical review as the selected alternative proceeds through preliminary and final design.

To date, the DRT consists of members from the City, American Rivers, HDR, the Lummi Nation, the Nooksack Tribe, WDFW, and USFWS. Additional groups and governmental agencies will join or engage with the DRT during preliminary and final design plan reviews as needed. Members of the DRT possess interdisciplinary technical expertise in the areas of fisheries/fish passage, geomorphology, permitting, engineering, hydraulics and facility maintenance/operations. Their input is critical to the development of design criteria and in the review of engineering plans. DRT input will be used to update engineering efforts and keep the design aligned with the project objectives and regulatory requirements. Primary DRT tasks include:

- Review of previous approved design criteria related to fish passage and other project components. Update as needed and coordinate approval with permitting contacts.
- Participation in final development of design criteria with engineering consultant.
- Review of engineering plans at the 30-, 60-, 90-percent levels.
- Alignment of permit requirements with site constraints and project objectives.

2.3 Outreach and Additional Engagement

Project information and outreach is provided through several methods. Project information is hosted on the City of Bellingham’s project webpage, which receives frequent updates and is available to the public at all times[1]. A project update is also sent to partners, other supporting groups, and individuals expressing interest in the project.

[1] https://www.cob.org/services/environment/restoration/middlefork/

The project update is distributed monthly for the purpose of soliciting feedback and input. The monthly updates are also available on the project webpage and thus available to the public.

3 Basis of Design

The following sections include existing, site-specific information that characterizes the biological and physical settings of the proposed project area and influences the applicability and selection of project alternatives.

3.1 Biological Basis of Design

The Middle Fork Nooksack River diversion dam is the only constructed barrier on the Middle Fork. At about River Mile 7.2, it disrupts habitat connectivity and greatly restricts anadromous fish to the section of river downstream from the dam. The dam presents a near-impassable barrier to upstream migration for most species under most hydrologic conditions. Downstream migrating fish are able to pass over the dam to the lower reaches of the river, although some may encounter the current screen system, which is not compliant with current fish protection standards. Knowledge of historical species utilization of the upper Middle Fork watershed mostly consists of anecdotal observations over the past century. Habitat assessments indicate spawning and rearing habitat are suitable for increasing populations of salmonids presently impacted by the dam (Currence, 2000; WRIA 1 2005; SSPS 2007).

3.1.1 Occurrence of Fish Species at Project Site

At least four and possibly all five species of Pacific salmon inhabit the lower Middle Fork Nooksack River (Williams et al. 1975). Steelhead and bull trout also inhabit the system (WRIA 1 2005).

3.1.1.1 Chinook Salmon (*Oncorhynchus tshawytscha*)

Chinook salmon exhibit two general races based on timing of river entry. Early timing (spring/summer) Chinook salmon spawn throughout the accessible reaches of the North, Middle, and South Forks, and portions of the mainstem downriver. The North/Middle Fork stock is considered distinct from the South Fork stock. There are historical accounts of Chinook salmon found upstream of the dam site prior to its construction. Late timing (fall) Chinook salmon also use the system, although the stock is considered to represent introduced genes; historic fall run fish are considered extinct in the basin (WRIA 1 2005; Ned Currence NIT, Pers. comm.). Critical habitat has been defined for Chinook Salmon to extend upstream of the dam to the confluence with Ridley Creek (Federal Register Vol 70, No. 170 Sept. 2, 2005).

3.1.1.2 Coho Salmon (*Oncorhynchus kisutch*)

All accessible streams and tributaries draining the Nooksack River are utilized by coho salmon. Tributary streams serve as the main coho salmon spawning grounds. Spawning also occurs in the mainstream and each of its forks, especially where channel splitting creates areas containing more suitable spawning conditions.

3.1.1.3 Chum Salmon (*Oncorhynchus keta*)

Chum salmon utilize the mainstream and each of the forks, and are found upstream as far as Cornell Creek on the North Fork, Porter Creek on the Middle Fork, and Hutchinson Creek on the South Fork. Chum salmon have not been noted in the vicinity of, or above, the diversion dam. Most spawning takes place in riffles and side channels of the three forks and in the mainstream downstream to within 1 mile of Bellingham Bay.

3.1.1.4 Pink Salmon (*Oncorhynchus gorbuscha*)

Pink salmon spawning occurs in nearly every accessible tributary in the Nooksack system, with the North Fork having the heaviest spawning concentrations. Pink salmon have been reported seen at the base of the dam, although it is unlikely that a substantial population would be maintained upstream. Adult pink salmon enter the river about mid-July, and spawning begins in late August and continues until mid-October.

3.1.1.5 Sockeye Salmon (*Oncorhynchus nerka*)

Sockeye salmon typically spawn in and upstream of lakes where their offspring rear before outmigrating to the ocean. However, river-type sockeye salmon also can be found in smaller numbers in many systems (Quinn 2005), including many rivers draining into the Puget Sound. Adults have been recorded spawning historically in the Nooksack River (Williams et al. 1975), although a more recent assessment of stock status did not note their presence (WDFW 1994).

3.1.1.6 Steelhead (*Oncorhynchus mykiss*)

Three distinct, native winter-run steelhead stocks and one summer-run stock have been identified in Nooksack River drainage (WDFW 1994). Winter steelhead utilize the mainstem and all three forks, and are thought to have spawned upstream of the dam site historically. Summer steelhead are found only in the South Fork. Steelhead can spawn more than once, migrating downstream to saltwater as ‘kelts‘ before returning again as upstream migrants. Critical habitat has been defined for steelhead to extend upstream to the dam (Federal Register Vol 81, No. 36 Feb. 24, 2016).

3.1.1.7 Bull Trout (*Salvelinus confluentus*)

Bull trout have been identified as utilizing the North Fork of the Nooksack below the falls, Canyon Creek, the upper and lower Middle Fork, and the South Fork. This species exhibits a range of life history strategies, with anadromous, (riverine) adfluvial, and (resident) fluvial adults found in the same system. Anadromous adults begin the downstream migration from late fall through the winter and enter the estuary in spring. They remain in the estuary until late spring or early summer when they again begin their upstream migration to spawn (WDFW 1998). Their relative char, Dolly Varden (*Salvelinus malma*), reside upstream of the dam site, but are likely too small-bodied as adults to pass upstream through the project reach historically (WRIA 1 2005). Critical habitat has been defined for Bull trout to extend upstream of the dam to the confluence with Ridley Creek (Federal Register Vol 75, No. 200 Oct. 18, 2010).

3.1.2 Selection of Target Fish Species for Design

This project will place greatest emphasis on affording upstream passage to those species/life stages that were most likely to have negotiated the project site in largest numbers prior to dam construction, rather than attempting to create conditions that are improved for all native species and life stages found below the dam site. Of the species listed above, pink and chum salmon are generally least able to negotiate high–gradient, upstream passage routes such as those that exist in the canyon section below the dam, and are, thus, not considered a target species for the design. Sockeye salmon are also not considered, given their limited historic presence in the broader basin and absence of a lake upstream of the dam site. Of life stages that may have used the upper river, it is plausible that juvenile and smaller resident adult fish may have experienced great difficulty moving upstream historically at lower flows, and may have been flushed through the gorge at higher flows. Hence, the primary target for design will be to restore conditions more suitable for upstream passage of adult Chinook and coho salmon, and Steelhead and Bull Trout to exceed passage conditions they encounter upstream and downstream. Other resident species are expected to benefit as well.

3.1.3 Summary of Fish Migration Timing

Upstream passage for the target species would be required at various times over the entire year, as shown in Figure 3-1. Information is less certain regarding downstream passage timing, but general periodicities elsewhere in the basin indicate most downstream passage occurs during the March-July snowmelt period.

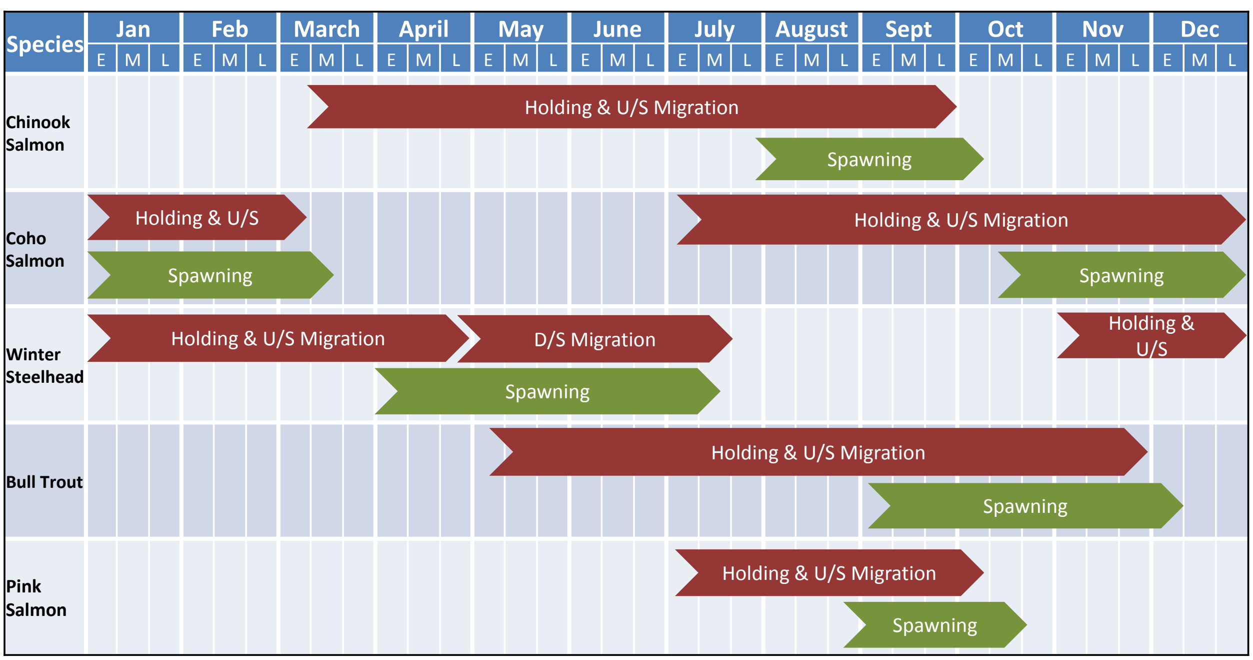


Figure 3-1. Timing of utilization of the Middle Fork Nooksack River by adult salmonid species most directly affected by the project

(Source: Williams et al. 1975; WDFW 1994, 1998; WRIA 1 Salmonid Recovery Plan 2005; Ned Currence NIT and Brett Barkdull WDFW, pers. comm. following PAC meeting on Jan. 25, 2018).

3.1.4 Fish Passage Objectives

3.1.4.1 Fish Passage Objectives

The passage objective of this project is to reestablish habitat connectivity and upstream passage to 16 miles of habitat in the upper watershed above the diversion dam site for three threatened Puget Sound anadromous fish species, and to provide for safe downstream passage of fish by eliminating potential for entrainment into the water supply tunnel. The physical setting and channel characteristics influence the selection of an appropriate design approach. The rugged relief and high-energy environment within the project reach effectively precludes developing a passage design relying on traditional fish passage and hydraulic assessment methods and design criteria for steep natural channels (e.g., Powers and Orsborn 1985; WDFW. 2013). Instead, the design philosophy for the project will be to develop a design that simulates hydraulic conditions in steep boulder, step-pool/cascade sections that are similar in slope and form to upstream and downstream of the dam site. The guiding principle is that passage conditions after dam removal should be no worse than, and to the extent possible, improved compared with conditions that likely existed before the dam was constructed.

Accordingly, typical biological criteria for fish passage have less influence on the design development for this project than in a fixed structure style fishway (e.g., a fish ladder), providing at best general guidance for most desirable upstream passage conditions for adults of target fish species. This aspect of designing for specific criteria has been recognized in the design of roughened channels, where certain criteria such as energy dissipation factors do not fit classical upstream passage goals established for fishway design (e.g., WDFW. 2013; Castro and Beavers 2016). Moreover, upstream passage conditions in a setting such as the project site may only be satisfied for a portion of the present fish population over a relatively narrow flow range compared to more controlled settings.

The water diversion facility will be upgraded to meet current NMFS and WDFW fish screen criteria to protect juvenile and adult salmonids from impingement or entrainment.

3.1.4.2 Review of Fish Swimming Capabilities

This section (3.1.4.2) focuses on identifying the relevant swimming capabilities for the species of interest, and the associated influence on upstream migration fish passage assessments and design. This stands in contrast to standard design of fishways, where criteria are intended to facilitate passage by weaker swimming individuals within a population.

Upstream passage designs are generally based on the physical capability of target fish species to negotiate their way through a specific reach. Upstream passage to the dam appears to be most difficult within the canyon reach where boulder drops are found. These drops have two general hydraulic attributes that affect how fish negotiate them: velocity through gaps and over falls, and head drop and fish trajectory distance along each constriction between leaping or resting locations. Each of these attributes is described below as applicable to the project site. In general, larger fish can swim faster and leap higher than smaller fish, which reflects the morphologic relation between body length and swim speed.

Velocity of flow will be a barrier to upstream if it exceeds a critical swimming speed. Critical swimming speeds depend on the level of physical effort the fish is capable of expending over a specified period before exhaustion or a behavioral fallback response occurs. USACE (1991) classified swimming speed into three categories:

1. Cruising – a speed that can be maintained for long periods (hours)
2. Sustained Swimming – a speed that can be maintained for minutes
3. Darting (burst) – a single effort, not sustainable for more than about 30 seconds

Of these, darting speeds will be most germane to the Middle Fork Nooksack Dam removal design, where upstream passage will be controlled in part by whether fish can negotiate higher velocities along boulder drops, over periods less than 30 seconds. However, it is also useful to evaluate sustained swimming speeds for a moderately conservative design. USACE (1991) reported sustained swimming speeds for adult steelhead, coho, and Chinook salmon were about 10 ft/s, and darting/burst speeds exceeded 20 ft/s.

Data are limited for evaluating bull trout passage criteria (Katopodis and Gervais 2016). Mesa et al. (2008) evaluated burst swimming speeds for bull trout at 10°C, and found they could reach maximum speeds ranging 4.3-7.5 ft/s over distances of 4.6-7.9 ft. Sustained swimming speeds were found to be less and reflected body size (Mesa et al. 2004). GEI (2009) calculated a burst speed as high as 14 ft/s in order to leap over a given obstacle. Some anecdotal information of bull trout behavior at fish facilities also provides insight into their swimming ability. For example, Montana Power and Light personnel observed bull trout traversing water at 10 ft/s while capturing fish at a dam on the Clark Fork River at Milltown, Montana. Brent Mabbott, a biologist at the same site, observed bull trout 16 to 22 inches in length traversing a 39–ft-long Denil fishway with average water velocity at 6.7 ft/s. These observations indicate that bull trout darting speed is at least 10 ft/s, and sustained swimming speed may be near 6 ft/s.

At locations where fish have to leap, physical factors controlling passage include height of obstacle, depth of pool at base of obstacle, and horizontal distance between the leaping origin and where the fish lands, and the suitability of the depth and velocity at and above the landing location. These factors can be analyzed in detail (e.g., Powers and Orsborn 1985), or more roughly by noting falls heights above which fish are not found (e.g., USFS 2001). For Chinook and coho salmon and steelhead, falls heights of around 11 ft have been assumed to be barriers by USFS (2001). Reiser and Peacock (1985) estimated maximum theoretical leaping heights of 7.9 ft and 7.3 ft for Chinook and coho salmon, respectively based on darting speed; the method of Powers and Orsborn (1985) results in slightly smaller estimated leaping capabilities. GEI (2009) relayed reports of bull trout successfully jumping over 4 to 6 ft high waterfall traps at Duncan and Round Butte Dams. It is assumed based on the collective information that if a drop of 6 ft or less is maintained at each boulder step, adults of the target species will be able to pass upstream; accordingly, the design should target smaller step heights.

Various environmental and physical factors influence the capability of fish to achieve their maximum burst speed and leaping height. Some environmental factors include the condition in which fish arrive at the barrier (sometimes correlating with the distance from the ocean), water temperature, and turbidity within the water. Further, higher flows can also be associated with greater levels of turbulence and air entrainment within the water. The air entrained in the water decreases the ability of fish to generate thrust. Therefore, as flow and turbidity increases in high gradient cascades, the ability for fish to reach their full darting velocity to negotiate such obstacles can diminish.

3.2 Physical Basis of Design

3.2.1 Location and Access

The Middle Fork Nooksack diversion dam and surrounding project area can be accessed via Washington State Highway 9 or 542, to Mosquito Lake Road, and then to Anacortes Veneer Road (also listed as Middle Fork Road) to the dam site. A gated access point is located 2.9 miles west of the turnoff from Mosquito Lake Road on Anacortes Veneer Road. Upon entering the COB's gate, a single-lane, gravel access road extends 0.6 mile to the dam site at about a 10-percent grade. The road crosses the Middle Fork Nooksack River via a bridge crossing and continues down to the diversion dam. The diversion channel and sluiceway are only accessible from this (left) abutment. The dam crest is inaccessible from the right bank. A small parking area is available at the dam. The access road continues upstream adjacent to the left bank for 300 feet. This portion of the access road is unimproved. There is no existing vehicle access to the river in the project area. See Appendix A, Plates P-3 and P-4 for an illustration of the existing access road and project area.

The bridge crossing the Middle Fork Nooksack River is load limited. It was constructed in the year 2000 and is about 150 feet long by 13.5 feet wide. The bridge has not been load rated after it was placed. Tran Tech Engineering provided a structural summary for the bridge as part of the study of the siphon alternative (B&V 2011). They determined that "for standard trucks that have maximum axle loads not exceeding the rating tonnage values associated with them, which are utilized for determining standard load ratings, the crossing of the trucks on the bridge is permitted with no further investigations" (B&V 2011, pg. 39). A specific post-installation load rating (e.g. – HS-20, HS-93, etc.) for the bridge has never been conducted. However, it is anticipated that the contractor may need to bring heavy equipment, such as cranes and concrete trucks, across the bridge that might exceed loading capacity provided in Tran Tech's report. It is recommended that a formal load rating of the in-place bridge be prepared prior to bidding so this constraint may be captured in the construction bid documents.

The current access road and proposed project area possesses limited space availability and will constrain construction activities. Due to site topography and environment, there are limited areas available for staging and laydown. Previous studies by COB located several potential laydown areas along the access road. These are shown in plate P-3 of Appendix A. A single potential staging and laydown area has been identified upstream of the dam at the end of the access road. However, the access road may need to be extended through the potential laydown area, limiting how much staging is able to occur near the dam for some alternatives. The laydown area near the dam is shown on sheet P-4 of Appendix A.

3.2.2 Hydrology

River flow conditions are responsive to basin runoff, and river stage can fluctuate rapidly within very brief periods. Heavy rain in the upper watershed can rapidly raise river flows within a few hours. The stream is generally very flashy and responds similarly (although to somewhat varying degree) to rainstorms in the upper watershed during any season, rain-on-snowmelt events during the winter, and heavy snowmelt events during hot weather in spring and early summer. The City owns, and the United States Geological Survey (USGS) operates, a gaging station on the Middle Fork Nooksack River about 3 miles downstream of the dam site (Gage No. 12208000, MF Nooksack River near Deming, Washington; https://waterdata.usgs.gov/nwis/dv/?site_no=12208000&PARAmeter_cd=00065). A flood frequency analysis was conducted using annual instantaneous peak flows for the 38-year period of record (1965-77; 1992-2016) to compute a flood frequency curve and peak flood discharges for a range of return intervals. Table 3-1 summarizes computed instantaneous peak flood frequency discharges and Figure 3-2 illustrates the computed flood frequency curve.

Table 3-1. Middle Fork Nooksack River Flood Frequency Discharges

Percent Chance Exceedance	Return Interval (year)	Discharge (cfs)
0.2	500	30,600
1	100	22,000
2	50	18,800
10	10	12,100
50	2	6,200

Source: USGS Gage 122088000 (1965-77; 1992-2017)

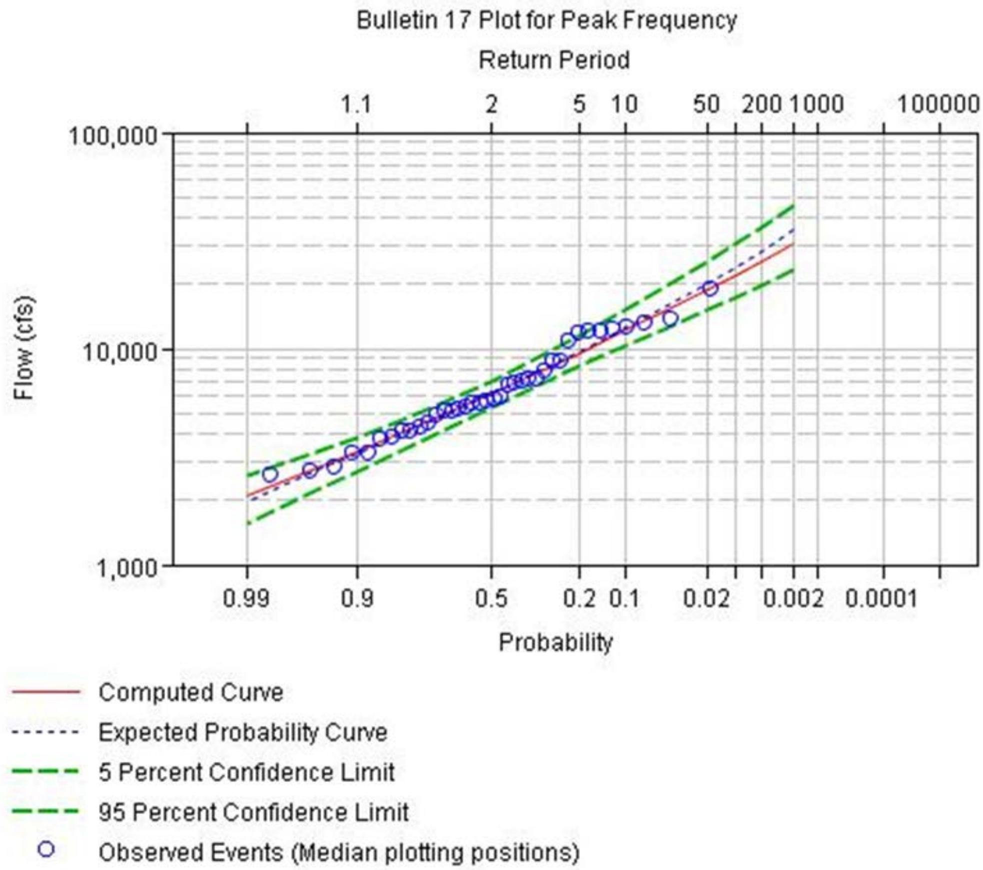


Figure 3-2. Computed Flood Frequency Curve for the Middle Fork Nooksack River

A flow duration analysis was conducted to evaluate seasonal flow variation and exceedance probability using daily mean discharges recorded from 1992 to 2017. Records extend sporadically back to 1920 and contain numerous discontinuities; thus, earlier values were disregarded. Figure 3-3 illustrates the annual flow duration curve and Figure 3-4 through Figure 3-7 below illustrate the monthly flow duration curves for the October – December, January – March, April – June, and July – September periods, respectively. Exceedance flows for annual and quarterly periods are given in Table 3-2.

Table 3-2. Middle Fork Nooksack Seasonal Exceedance Flows

Exceedance (%)	Annual	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep
99	100	100	70	180	100
95	150	130	140	240	150
90	180	160	170	300	180
10	1,020	1,300	1,030	1,100	660
5	1,420	1,850	1,500	1,370	900
1	2,670	3,720	3,130	2,020	1,730

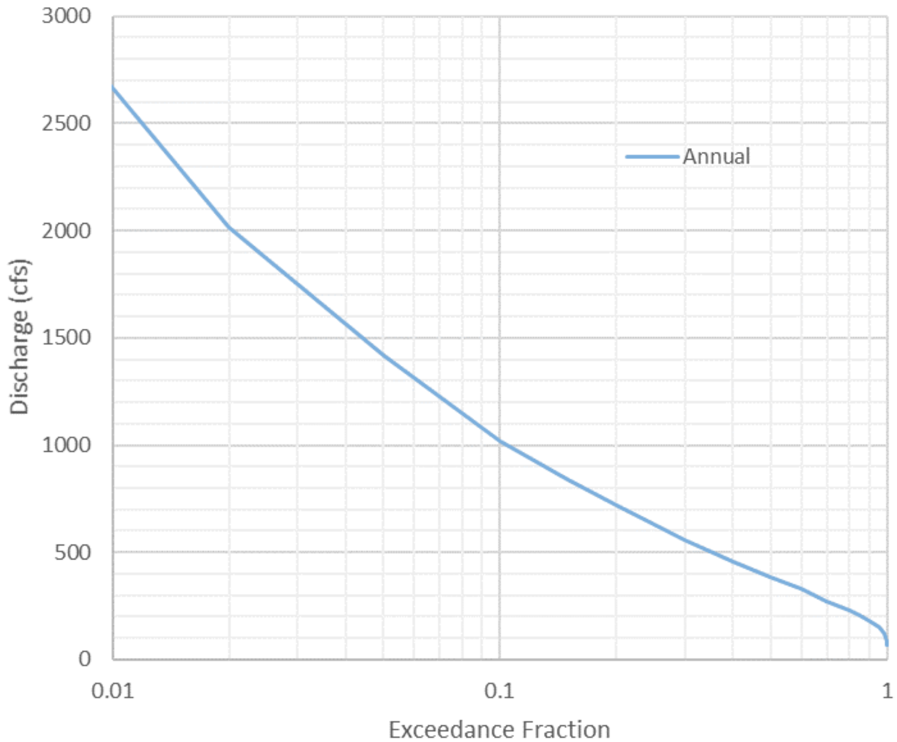


Figure 3-3. Annual Flow Duration

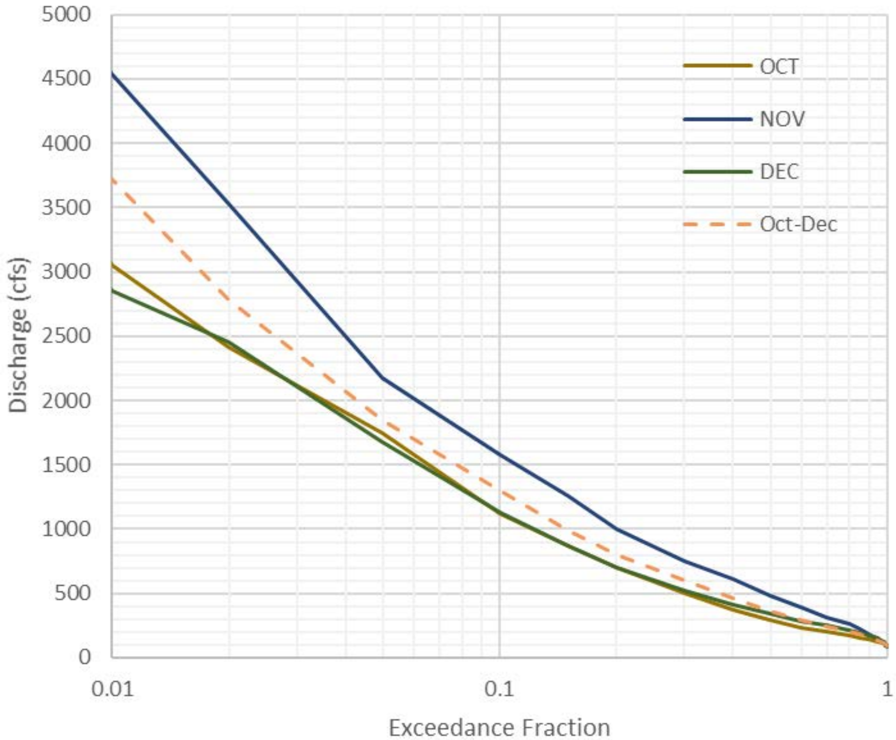


Figure 3-4. Monthly Flow Duration for October – December

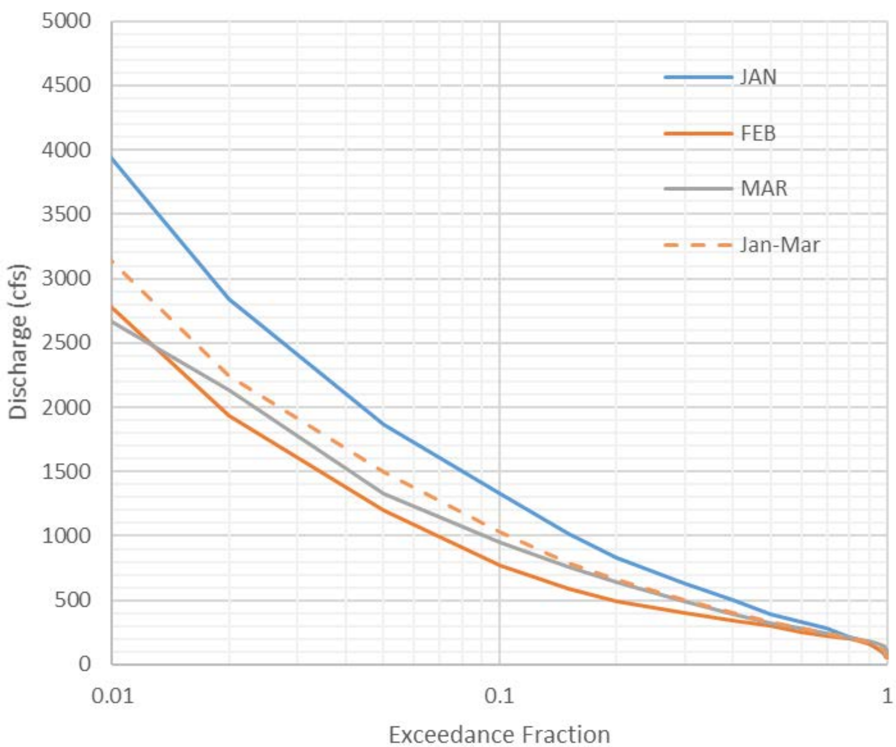


Figure 3-5. Monthly Flow Duration for January – March

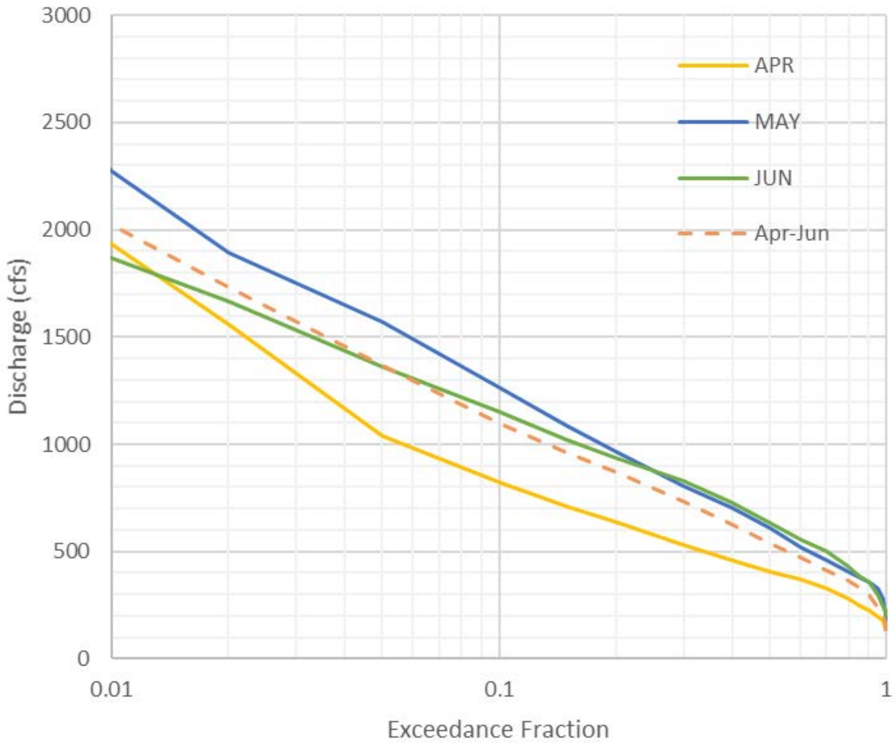


Figure 3-6. Monthly Flow Duration for April – June

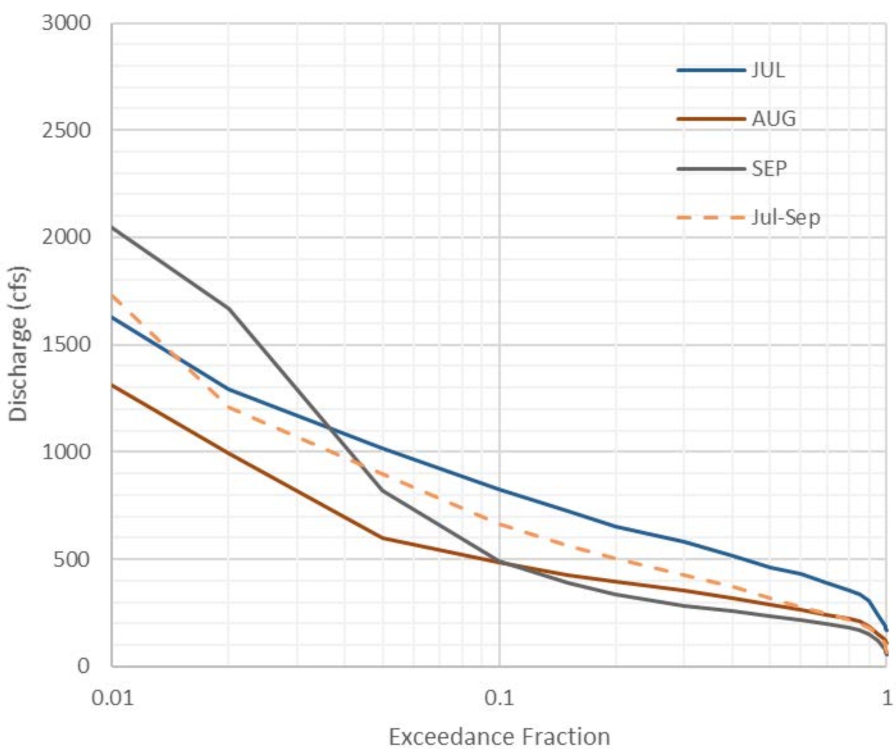


Figure 3-7. Monthly Flow Duration for July – September

3.2.3 Hydraulics

3.2.3.1 HEC-RAS Model

A previously developed HEC-RAS hydraulic model of the Middle Fork Nooksack River (NHC 2002; NHC 2005) was refined to evaluate water surface elevations and hydraulic characteristics along the project reach. Note that the existing dam is located at River Mile 7.88 in the HEC-RAS model, but the WRIA designates River Mile 7.2 as the location of the dam. This discrepancy is not important for the purpose of this analysis. Both existing (with dam) and proposed conditions (dam removed) were evaluated. Model refinements included incorporation of newly collected channel survey data to extend the detailed project reach 1,400 feet upstream of the existing dam as well as addition of large boulder features to cross-section geometry.

The model was recalibrated using surveyed water surface elevations and high-water marks observed during a site visit on January 28, 2018. Gage records indicate flow during the January 28 visit was approximately 3,000 cfs, while high-water marks were attributed to a high flow event that occurred on November 23, 2017, with a peak discharge of approximately 10,300 cfs. Model calibration was accomplished by adjusting Manning roughness coefficients (n) until computed water surface elevations matched surveyed values for the respective discharges. Previous models employed ‘high’ and ‘low’ roughness coefficient ranges of 0.08-0.40 and 0.15-0.50, to test sensitivity and variation with discharge (NHC, 2005). In the current model a single range of 0.05- 0.15 was implemented based on surveyed water levels and high-water marks. Figure 3-8 compares the computed water surface profiles to calibration points for existing conditions. Although deviations of up to two feet do occur in locations, agreement is generally good considering this is a one-dimensional, sub-critical approximation of true flow conditions which are likely highly turbulent and alternating between sub- and super-critical flow.

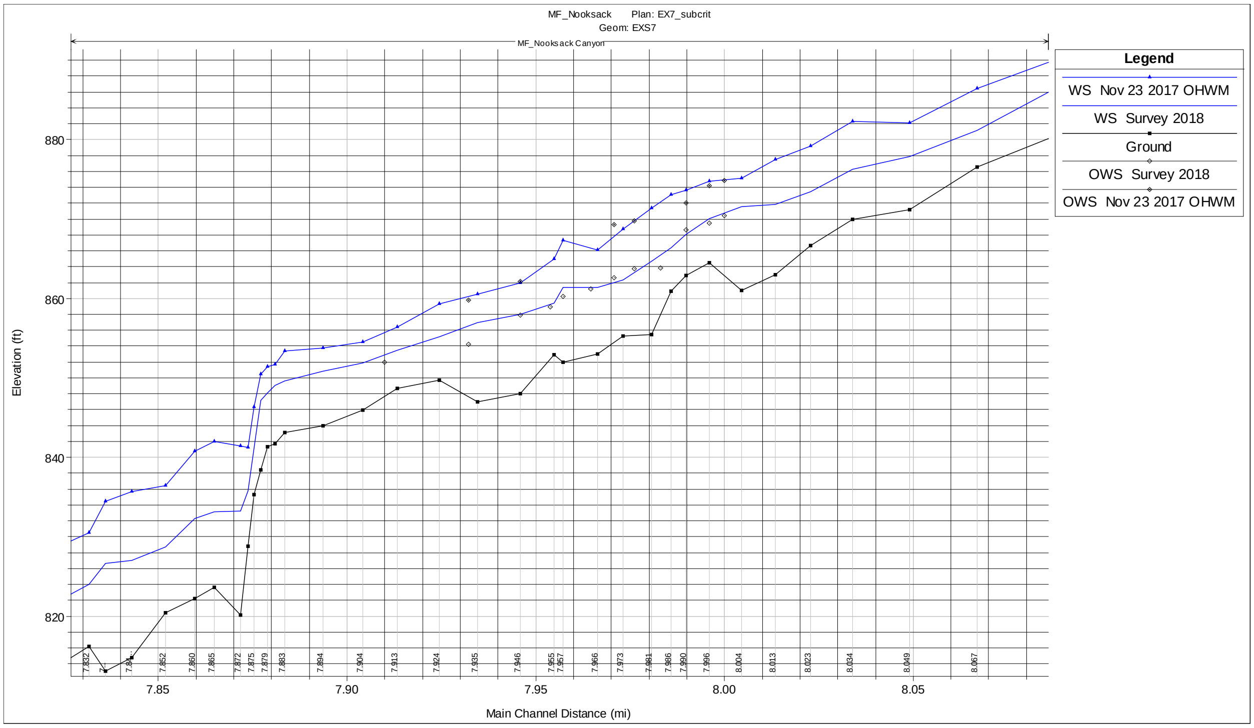


Figure 3-8. HEC-RAS Model Calibration Profiles (Existing Dam at RM 7.88 in model)

With the refined, recalibrated HEC-RAS model both dam removal and water surface elevations near the upstream intake location were evaluated. Figure 3-9 compares water surface profiles computed for existing (with dam) and proposed conditions (dam removed). Figure 3-10 shows a preliminary computed stage-discharge rating curve at the proposed upstream intake location (RM 7.996).

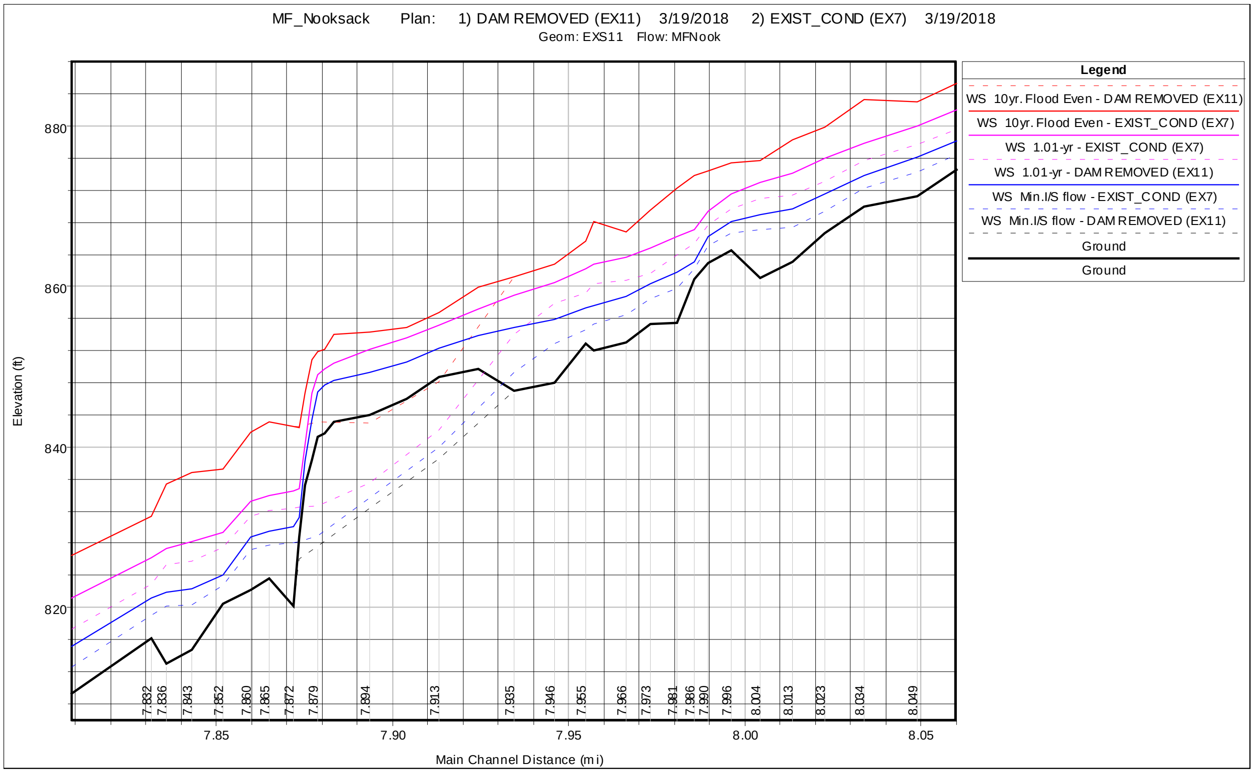


Figure 3-9. Computed Flood Profiles in the Project Reach for Existing (with Dam) and Proposed (Dam Removed) Conditions

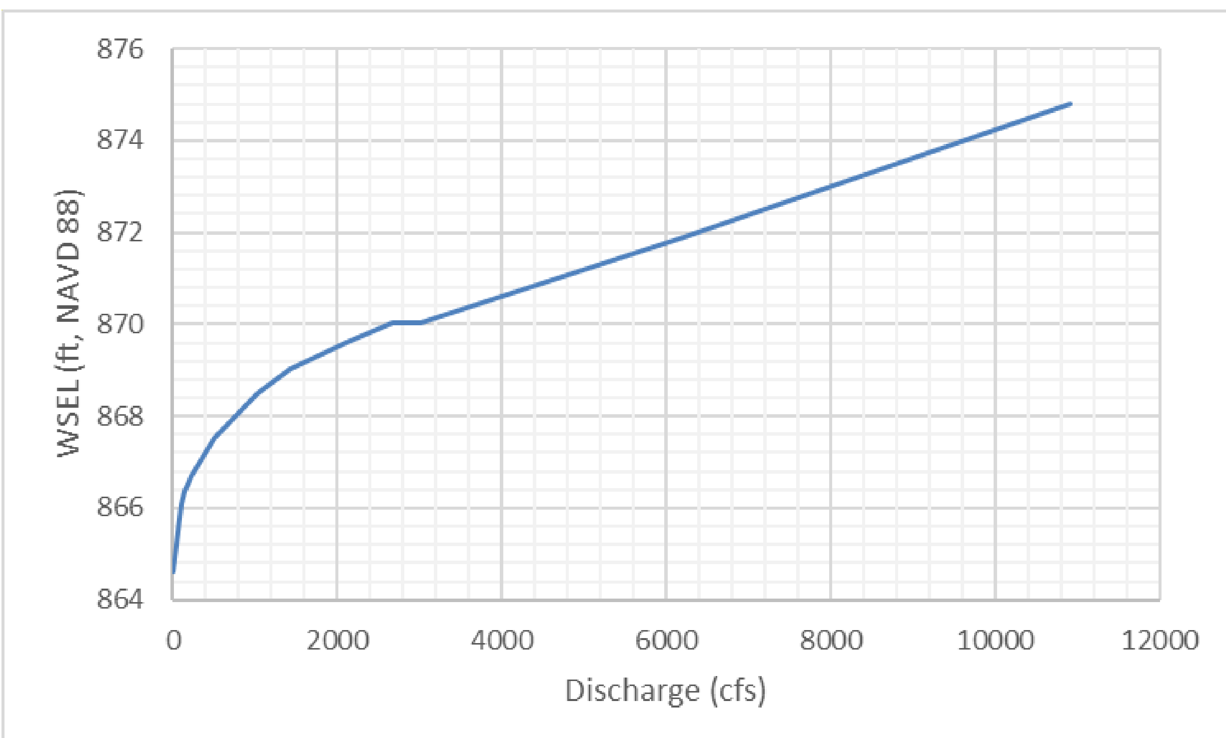


Figure 3-10. Preliminary Stage-Discharge Rating Curve at Proposed Upstream Intake Locations (RM 7.996)

3.2.3.2 Diversion Capacities and Minimum In-stream Flows

The criterion for maximum design diversion rate of 116 cfs at the intake has been established to meet the City's water supply needs. The diversion flow rates must also be designed to meet the current diversion flow protocols to accommodate the intake design flows. The City's diversion protocols intentionally and voluntarily comply with the instream flow provisions at the Middle Fork Nooksack River as defined in the current Chapter 173-501 of the Washington Administrative Code (WAC). Table 3-3 below summarizes the basis for the minimum in-stream flow amounts below the dam.

Table 3-3. Nooksack River (Middle Fork) Minimum Instream Flows

Month	Turn on CFS*	Shut Off CFS
January	335	275
February	440	380
March	440	380
April	440	380
May 1-14	440	380
May 15-31	510	450
June	585	525
July 1-14	585	525
July 15-31	460	400
August	330	275
September	335	275
October	335	275
November	335	275
December	335	275

* Note: The Shut off CFS corresponds to the Minimum Instantaneous Instream flows for the Nooksack River (Middle Fork) at Control Station 12-2080-00 (WAC 173-501-030).

The Turn On CFS includes the approximate 60-cfs typical diversion quantity removed from the river during operation.
Source: City of Bellingham

Under typical diversion conditions, approximately 60 cfs of river flow is passed into the diversion sluice and conveyance system. This 60 cfs value is used as a buffer to ensure that instream flow within the Middle Fork Nooksack remains above the minimum required instream flow values. Table 3-4 below provides a summary of the instream flows only, as established in the WAC.

Table 3-4. Nooksack River (Middle Fork) Minimum Instream Flows (WAC 173-501-030)

Period	Minimum River Flow Below Existing Dam Location(cfs)
August 1 – August 31	275
August 1 thru January 31	275
Feb 1 thru May 14	380
May 15 – May 31	450
June 1 – July 14	525
July 15 – July 31	400

3.2.4 Geology and Geotechnical

The soil and rock in the project area range in age from Quaternary to Permian (Brown and others, 1987). The Middle Fork Nooksack River valley was glaciated by the Cordilleran ice sheet and alpine glaciers (Kovanen and Easterbrook, 2001). Glacier deposits drape the Middle Fork Nooksack River and Mosquito Lake Valleys. Bedrock exposed in the Middle Fork Nooksack Valley bottom at the intake site is the Jurassic to Permian age Elbow Lake Formation greenstone and serpentinite. Other bedrock units are exposed in the ridgelines above the site, including Darrington Phyllite in the ridgeline to the south, the gorge downstream from the bridge, and in the conveyance tunnel. Slices of Yellow Aster Complex gneiss and Chilliwack Group metasedimentary rocks are present above the site. To the north of the site, Eocene Chuckanut Formation sandstone, conglomerate and mudstone underlie the higher ridges. The geologic map commonly shows the bedrock units in fault contact, suggesting that faulting and shearing are common in the area.

The geology in the intake area is characterized by bedrock overlain by glacial deposits and recent fill, alluvium and colluvium:

3.2.4.1 Fill

Spoils from mining the tunnel were deposited above the left bank of the river, and extend several hundred feet upstream from the dam. The fill is heterogeneous, ranging from clayey silt with angular rock fragments to angular gravel and cobbles and boulders. Much of the rock fragments in the tunnel mining spoils consist of Darrington Phyllite, which is a soft rock that weathers and mechanically degrades to clayey silt. Fill, other than the concrete dam structure and sediment impounded by the dam, is not generally present in the active channel.

The tunnels spoils were likely loose dumped or lightly compacted by tracking with construction equipment and fill soils within the spoils area are subject to settlement. Therefore, we do not recommend founding settlement-sensitive features, such as foundations or conveyance pipelines on fill. Unsupported excavations likely could be made in fill soils at slopes of 1.5 Horizontal to 1 Vertical (1.5H:1V) or flatter when above groundwater. We expect the fill was placed above river level; therefore, groundwater likely would be limited to seasonal and discontinuously perched groundwater. Dewatering with sumps should be feasible.

3.2.4.2 Alluvium and Colluvium

Recent deposits in the project area are alluvium and colluvium, including Middle Fork Nooksack River channel bars and bedload, debris torrent deposits, and hillside colluvium. The alluvium generally consists of interbedded silt, sand, gravel, cobbles, and boulders. Boulders include hard and dense dunite, some of which exceed 12 feet in diameter. Alluvium is present in the active channel of the Middle Fork Nooksack River, especially upstream from the dam, and in terraces next to the active channel. Terrace deposits extend about 1,000 feet along the right bank upstream from the dam to a 90-degree bend in the river.

Debris torrent deposits in the project area typically consist of poorly sorted silt, sand, gravel, cobbles, and boulders, with scattered logs and clasts of clay and silt (rip-up clasts) dislodged from the underlying glacial deposits. These deposits are present near the valley bottom below tributary creeks. The debris torrent deposits are commonly reworked by the Middle Fork Nooksack River and redeposited as alluvium. Hillside colluvium generally consists of a heterogeneous mixture of silt, sand, gravel, cobbles, and boulders. Colluvium forms along and near the base of the steep slopes above the proposed intake structures.

Alluvium is present in the river channel and along the left bank upstream from the dam. It is present in the right bank inside the 90-degree river bend that is about 1,000 feet upstream from the dam. Alluvium typically forms moderately steep banks above the ordinary high water on the right bank. Numerous large boulders are present below the ordinary high water on the left bank and in the active channel. Most boulders of 12-foot diameter or larger apparently do not move or move little during flooding events.

Alluvium is typically a loose deposit; therefore, we do not recommend founding settlement-sensitive structures on alluvium. Excavations in alluvium will encounter boulders that could be 10 feet in diameter or larger. Blasting is expected to be required to remove larger boulders. Open excavations not in bedrock below groundwater could require 2H:1V slopes or flatter.

Much alluvium at the site is below groundwater, and the unit is rapidly permeable. Typically, dewatering alluvium requires efficient, large diameter, dewatering wells. Discharge rates likely will be on the order of several thousands of gallons per minute. Where the bottom of a planned excavation is close in elevation to the contact of the alluvium with the underlying glacial soil or bedrock, well efficiency will be limited by the amount of drawdown that can occur in the well. For these cases, a groundwater cutoff wall, such as a slurry wall or secant pile wall could be needed. Sheet pile walls likely will not be practical because of the expected presence of boulders. Other types of cutoff walls, such as secant pile walls could be practical. However, it would require drilling equipment capable of penetrating 40,000 psi of unconfined compressive strength rock. Working in dry, dewatered conditions are ideal, but because of the cost associated with groundwater cutoff walls, we recommend considering construction methods that can accommodate work conducted in the wet, i.e., in a flooded excavation.

3.2.4.3 Glacial Deposits

The glacial history near the intersection of the Middle Fork Nooksack and the Mosquito Lake Valley is complex. The Mosquito Lake Valley is a dry tributary located south of the Middle Fork Nooksack River. According to Kovanen (1996), and Kovanen and Easterbrook (2001), the glacial deposits are from alpine glaciers that originated in the Middle Fork Nooksack River headwaters on Mount Baker and in the Twin Sisters Range. These glaciers deposited till and outwash in the Middle Fork Nooksack valley.

The glacial deposits encountered in borings at the site typically were classified as dense or hard, Sand and Silt, Clayey Sand and Silt, and Clayey Silt with varying amounts of gravel. Above the access road near the tunnel inlet, varved glaciolacustrine clay, silt, and sand (Qgl) are exposed in the banks of the debris torrent chute channel and up to about elevation 1,400 feet. Because of the dense or hard condition, we expect the glacial deposits should provide good foundation support. Excavations made in glacial deposits likely can be made with conventional earthwork equipment; however, excavations may be slow in very dense or hard soil. Contractors should be prepared to remove occasional large boulders. Temporary excavation slopes of 1.5H:1V should be practical. Because the glacial deposits contain substantial fines, we anticipate groundwater inflows should be relatively slow. Construction dewatering likely would be practical using sumps.

3.2.4.4 Bedrock Units

Greenstone and serpentinite of the Elbow Lake Formation outcrop near the intake diversion structures. The Elbow Lake Formation includes metamorphosed ribbon chert, basaltic flow rock, and volcaniclastic siltstone, sandstone, and rare conglomerate and limestone (Brown and others, 1987). The greenstone and serpentinite are relatively impermeable, very hard, and resistant to erosion. Serpentinite at the intake probably represents a fault zone and is sheared and contorted. It may have inclusions of other rock types that could range in size from 1 foot to many tens of feet. The geologic maps (Brown and others, 1987; Lapen, 2000) show a north-trending fault about 500 feet west of the access bridge to the dam site. Jurassic Darrington Phyllite is present west of the fault that is downstream from the bridge. It outcrops in the western half of the gorge downstream from the bridge.

Bedrock is present on both banks from the dam and downstream from the gorge. Softer, more erodible serpentinite is present near the dam and extending downstream towards the bridge. The presence of the more erodible serpentinite likely resulted in the wider channel near the intake. The differing erodibility of the serpentinite and harder greenstone likely caused the irregular topography that is present closely downstream from the dam. We have not mapped the bedrock units in the gorge, but anticipate they consist of greenstone and phyllite further downstream.

The bedrock should provide good bearing for foundations and to support the pipeline. We anticipate much of excavations made in hard greenstone will require drilling and blasting. Excavations made in serpentinite and metasedimentary rock might be possible by ripping; however, we recommend assuming drilling and blasting will be required for initial planning purposes. Excavation slopes could be made nearly vertical. Groundwater inflow through the bedrock should be limited mostly to fracture zones; therefore, we anticipate construction dewatering could be accomplished using sumps.

Locations of boreholes, test pits, and geophysical lines developed in previous studies and listed in this report are shown on in Appendix A on plate P-2.

3.2.5 Geomorphology

The Middle Fork Nooksack River drains off the Deming Glacier on the southwest side of Mount Baker stratovolcano. The glacier terminus, as of 2017, is located at approximately RM 20.6. Downstream, the river exhibits a concave longitudinal profile, with gradients gradually decreasing in the downstream direction from 10% to less than 1%; however, in the project reach vicinity, between RM 7 and 9, the river flows through an over-steepened segment (Figure 3-11). Here, the gradient is approximately 5% which contrasts with slopes of 1.5-2% observed immediately upstream and downstream. Within this reach the river exhibits cascade and step-pool morphology, dominated by large boulders and some bedrock exposure.

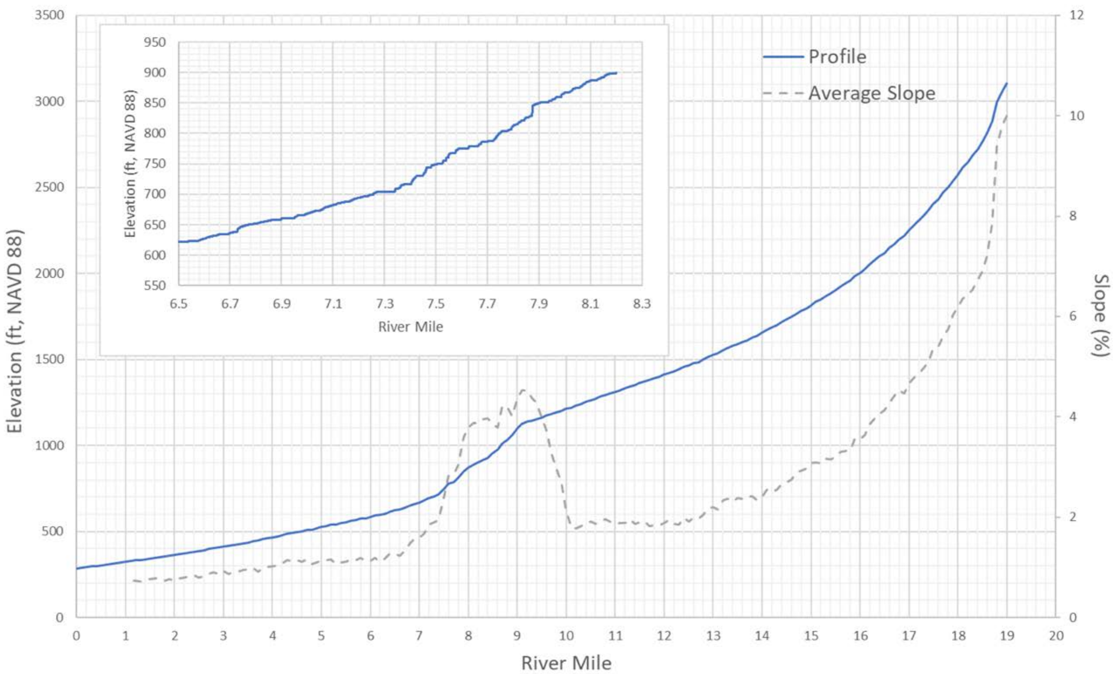


Figure 3-11. Longitudinal Profile of Middle Fork Nooksack River

Typical bankfull channel widths range from 50 to 60 feet but reduce to less than 20 feet at isolated locations within the canyon immediately downstream of the existing dam. These constrictions account for the exceedingly deep flood depths and backwater conditions computed downstream of the existing dam at high flows (>10-yr), shown in Figure 3-9, and likely have some influence on sediment transport capacity through the project reach. Along the 400-foot reach immediately upstream of the existing dam the channel is uncharacteristically wide, at approximately 130-140 feet. Historic photos suggest this sub-reach was over-widened prior to dam construction, possibly due to a combination of bedrock controls, river hydraulics, and hillslope processes. However, activities during dam construction, such as bedrock removal, likely contributed to further channel widening. It should be noted that the geophysical data suggests that bedrock is shallow along the right side of the channel through this reach.

As previously noted, bed material composition in the project reach is dominated by large boulders and isolated bedrock exposures; however, deposits of finer alluvial material, likely typical of the sediment load transported from upstream, can be observed on the bar immediately behind the dam as well as along channel fringes. Based on field observation, the largest boulders have estimated diameters of 8 to 10 feet, but the majority range in size from 2 to 6 feet. A bedrock bench is buried 8 to 16 feet along the right half of the channel immediately upstream of the existing dam. This feature is a remnant of a bedrock cliff face that was removed during construction of the dam. Exposed bedrock was also observed along the right descending bankline approximately 300 feet upstream of the existing dam, but geophysical testing indicates the bedrock is located 10 to 12 feet below the existing centerline channel grade. Approximately 150 feet further upstream, geophysical testing shows that the alluvial cover is only 2 to 4 feet thick over the underlying bedrock.

Alluvial deposits observed immediately upstream of the dam are primarily composed of cobble and gravel-sized material, but also includes 2 to 3-foot diameter boulders. These materials likely represent typical bedload transported through the project reach. More quantitative measures of grain size (e.g. pebble count sampling) could be not be conducted during the January 28 site visit due to high flows and limited accessibility. NHC (2005) does provide a single grain size distribution of ‘prototype’ sediment used in the physical model study, but it appears to represent a coarser framework material rather than what was observed upstream of the dam. Finer lag deposits of medium to coarse sand were also observed on top of elevated boulders downstream of the dam, within the dam sluiceway, and upstream along channel fringes. This material likely represents the coarser fraction of typical suspended load transported through the project reach.

Given the Middle Fork Nooksack River is high gradient, glacier-fed, and flanked by steep hillsides the sediment supply is unquestionably high. Furthermore, evidence of recent debris flows, in spring 2013, have been documented upstream of the project reach (Tucker et al, 2014). Although episodic, these events can deliver copious amounts of material to the river, which in turn, is rapidly eroded and transported downstream. Owing to the localized steep gradient and confined corridor, the project reach can be characterized as a transport segment (Montgomery and Buffington, 1997) with corresponding high sediment transport capacity. The only alluvial material present in any appreciable quantity along the project reach is impounded behind the existing dam. Historic photos indicate the impoundment was filled with sediment shortly after construction, either through natural deposition or post-construction grading. Preliminary estimates, based on channel and geophysical surveys, indicate as much as 5,000 to 10,000 cubic yards of sediment of alluvial and glacial origin may overlie the bedrock within the active channel immediately above the dam. A more refined estimate of this volume will be determined during design, as will the approximate amount that may be redistributed as a result of river processes once the dam is removed. Elsewhere, lesser amounts of alluvial material can be found in the channel effectively sheltered by larger clasts, as well as along channel fringes. Currently, it is evident that both suspended and bedload materials are transported past the project reach without significant deposition in the channel.

A first-order estimate of bedload transport capacity was conducted using the USFS’s Bedload Assessment in Gravel-bedded Streams software (Pitlick et al, 2009). Hydraulic conditions were obtained from the HEC-RAS model discussed in Section 3.2.3.1. Sediment transport capacity was computed using the Parker (1990) relation for bedload transport. As computation of sediment transport capacity requires a grain size distribution to quantify available bed material, two distributions were applied. First, the coarse distribution presented in NHC (2005) and second, a distribution visually estimated using professional judgment of the finer material observed upstream of the dam (Figure 3-12). Figure 3-13 plots computed bedload-discharge rating curves using the two different grain size distributions. The two curves represent the estimated 'high' and 'low' bounds of sediment transport capacity at the upstream end of the project reach. Given the lack of field data or direct measurement, these estimates of sediment transport capacity have a high uncertainty. Additional sampling during Phase 2 design will narrow this uncertainty. Still, the development of a high and low range provides a useful envelope to evaluate bedload transport.

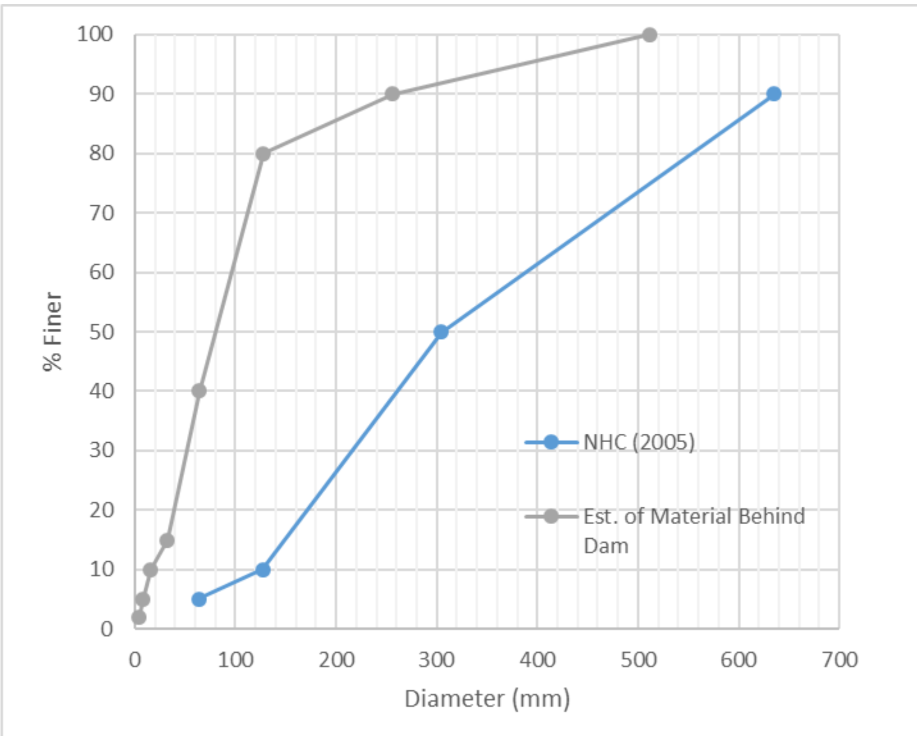


Figure 3-12. Middle Fork Nooksack River Grain Size Distributions

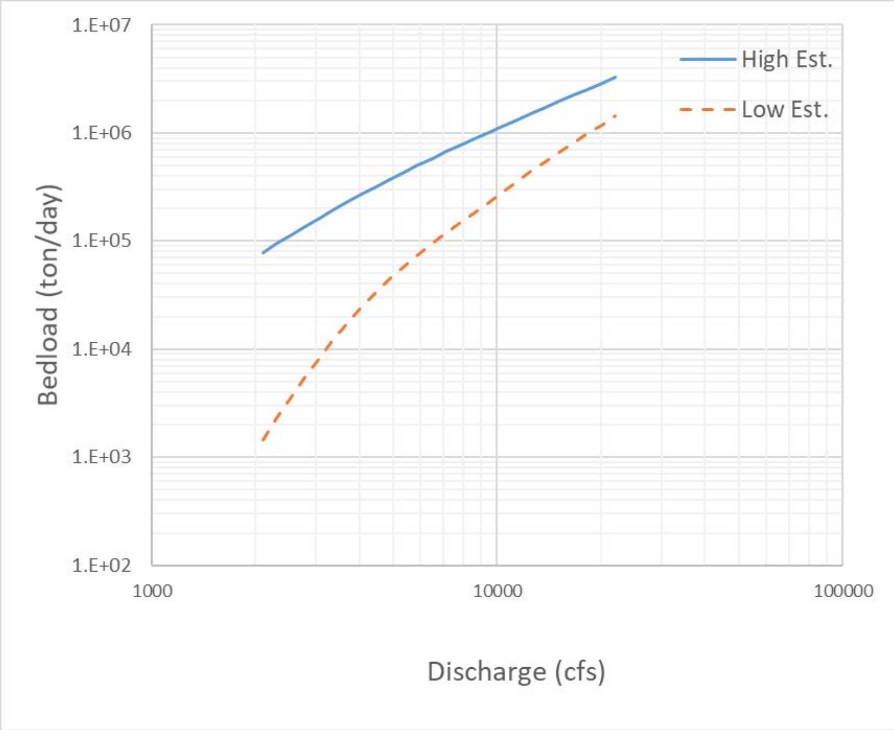


Figure 3-13. Computed Bedload Rating Curves

Suspended sediment transport was evaluated using concentration and turbidity data provided by the USGS at the Middle Nooksack River Gage (12208000). Eight suspended sediment concentration samples were collected between 2015 and 2016 three miles downstream of the project reach, during river flows ranging between approximately 100 and 9,100 cfs. Composition of the suspended material samples is quantified by the percentage of fines, i.e. silt and clays (D<0.064mm). Findings indicate that percent of fines sharply decreases as river discharge increases, suggesting a higher sand-size fraction for river flows greater than about 2,000 cfs (Figure 3-14). A rating curve of suspended sediment concentration (mg/L) was compared with contemporaneous turbidity (FMU) measurements and shows a good correlation (Figure 3-15). Having a reasonable estimate of suspended sediment load and caliber is useful for intake design.

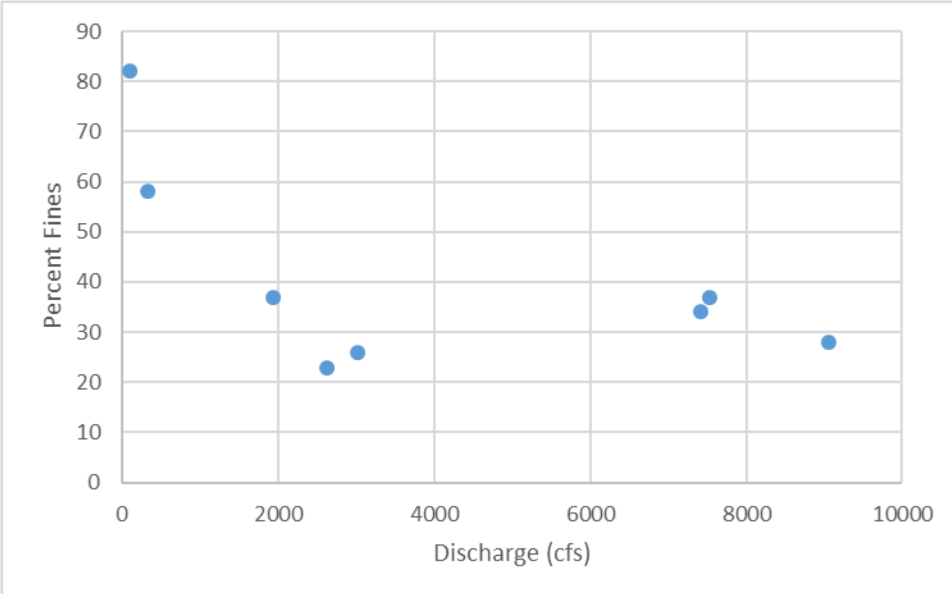


Figure 3-14. Percent Fines (D<0.064mm) in Suspended Sediment Samples (USGS)

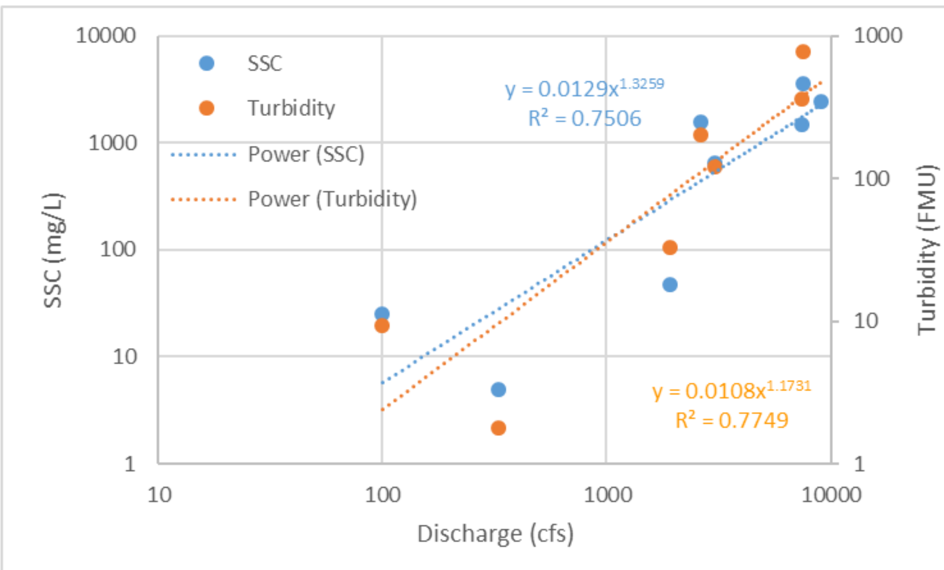


Figure 3-15. Comparison of Suspended Sediment Concentration (SSC) and Turbidity Rating Curves (USGS).

3.2.6 Climate Change

The impacts of climate change have been briefly considered in the evaluation of the alternatives. The most impactful potential effect to the project, as noted in the City of Bellingham's Climate Protection Action Plan (COB 2017), is the continued retreat of Deming Glacier due to melt. Opening the Middle Fork Nooksack River above the diversion dam to fish will provide cold-water refugia to salmon populations.

The impacts of climate change, such as glacial melt, higher peak flow events, lower river baseflow, and potentially higher sediment loads, are anticipated to affect all the alternatives nearly equally. As such, performance under climate change scenarios is not used as an evaluation factor, nor was the impact of climate change examined in additional detail at this level of design development. The potential impacts of climate change will be considered in more detail during final design of the selected alterative.

3.3 Design References

3.3.1 Technical Design Criteria

There are numerous guidelines and design criteria established by WDFW and NMFS, which provide a framework for fish passage design. Other literature sources are available which provide design guidance and biological criteria for the transport of fish. Although not explicitly referenced, applicable criteria are used in this report throughout the passage alternative formulation process. Such reference documentation includes the following:

- Fisheries Handbook of Engineering Requirements and Biological Criteria. U.S. Army Corps of Engineers (Milo Bell), 1991.
- Fish Screening Criteria for Anadromous Salmonids. NMFS Southwest Region, 1997.
- Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual. WDFW, 2000.
- Science Base and Tools for Evaluating Stream Engineering, Management, and Restoration Proposals. NOAA, 2011.
- Anadromous Salmonid Passage Facility Design. NMFS Northwest Region, 2011.
- Stream Habitat Restoration Guidelines. WDFW, 2012.
- Water Crossing Design Guidelines. WDFW, 2013.
- Sediment Management Guidelines in Dam Removal. USBOR, 2017.

Specific criteria applicable to fish passage related to the diversion intake system, such as fish screen approach velocity and fish bypass outfall impact velocity, are not listed in detail in this document, but will be documented and followed during alternative formulation and development.

3.3.2 Design Approach for Naturalized Fish Passage

Based on historic distribution and swimming capabilities of the species of concern, the fish passage design approach is intended to reflect natural river conditions present in the downstream gorge and the boulder-strewn reach above the diversion dam. Species periodicity as noted in the literature, various anecdotal observations, and other information suggest that the dam has either cut off or significantly restricted upstream passage to the predominantly moderate to high performance swimmers and leapers that could likely ascend the gorge, including Chinook and Coho Salmon, steelhead, and Bull Trout (WRIA 1, 2005). Previous indications are that weaker swimmers likely did not populate habitat upstream of the dam site sufficiently to contribute meaningfully to overall escapement and population level selection (WRIA 1, 2005). A post-dam channel morphology that resembles the hydraulic conditions upstream and downstream will therefore allow for upstream passage of adults of these species at minimum. This reference condition includes multiple upstream pathways over a range of various flows, around and adjacent to boulders, over and/or through small falls, and along the channel margins. Where possible, the design should capitalize on providing multiple potential passage routes when examined at different ranges of flow.

It is expected that the river will incise relatively quickly to its pre-dam grade within the dam and impacted upstream footprint (Grant and Lewis 2015; Tullos et al. 2016). The base topographic map suggests that the post-dam average gradient within the naturally re-graded reach will be between 5%-6% (Figure 3-17). This will depend on the extent to which bedrock was cut down during dam construction. Model studies conducted by NHC indicated the river channel will regrade itself via natural geomorphic processes to produce conditions favorable for fish passage (NHC 2011).

The approach for improving fish passage should accordingly be based on two components: defining a self-similar geomorphic template for boulder-bedrock step pool/cascade channels with a general longitudinal profile, and identifying the required stable size of key boulders maintaining the series of head drops along the profile that are within the range of existing upstream and downstream head drops at similarly restricted passage locations.

Researchers of bedrock and steep boulder channel morphology controls have inferred from field and flume observations and analysis that the step–pool morphology in steep channels reflects a geometry that provides maximum flow resistance and maximum bed stability. This geometry can be generally described in terms of a ratio of step height and length to channel slope, which falls within an empirically determined range (Lenzi 2002; Chin and Wohl 2005; Church and Zimmerman 2007; Weichert et al. 2008; Wohl and Merritt 2008). One expression of this range is $[1 < (H/L)/S < 2]$, where H = vertical step height, L = distance between steps, estimated in a parallel direction to the stream slope = S (Lenzi 2002). For an approximate 5% slope, (cf. Figure 3-18), this equates to $[0.05 < (H/L) < 0.10]$. Review of a longitudinal profile derived from LiDAR data and extending upstream and downstream of the dam and impounded sediment deposit indicates that the existing step height in sections where the gradient is in the range of 3-6% is generally less than 5 feet (Figure 3-18). This range appears to satisfy the leaping height criterion (see Section 3.1.4), thus these geomorphic parameters appear to be appropriate for assessing a naturally re-graded channel that will afford upstream passage. The corresponding expected post-incision step length range is 20 feet $< L <$ 80 feet, which should be sufficient to provide resting opportunities.

Stability of boulders can be evaluated using a variety of approaches, and reflects a balance between boulder size/weight/shape, friction, and interlocking geometry vs. forces inducing motion including drag and lift (Rathburn 1993; Carling and Tinkler 1998; D'Aoust and Millar 2000; Fischenisch and Seal 2000; Lenzi 2002; Carling et al. 2002; Mooney et al. 2007; Turowski et al. 2009; Recking and Pitlick 2012; Prancevic and Lamb 2015). The stability of the riverbed reflects two general discharges, one that moves material frequently within the step pool framework, and infrequent, extreme events that rearrange the long profile controls (Chin and Wohl 2005; Lenzi et al. 2006; Turowski et al. 2009). An evaluation of the stability of boulders in the project reach and general sizes that can be expected to remain stable over potentially a 50-100 year period is the first step in this assessment. An initial evaluation using these references suggests that a stable characteristic boulder size in the re-graded section will be designed to be between

6 ft and 10 ft. In comparison, Kieffer (1987) noted stable boulder sizes in Colorado River rapids to be generally greater than about 7 ft. This compares well to the larger size of several boulders that appear to have remained stable within the section above the dam deposit leading up to the proposed intake location.

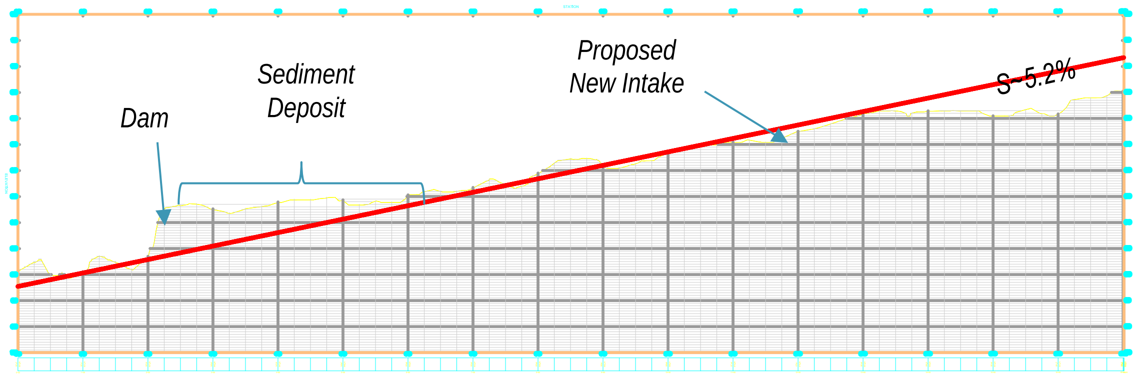


Figure 3-16. Longitudinal profile of thalweg through surveyed project reach, and approximate grade (red line) of steeper boulder step pool/cascade section above the dam deposit, extended downstream and upstream.

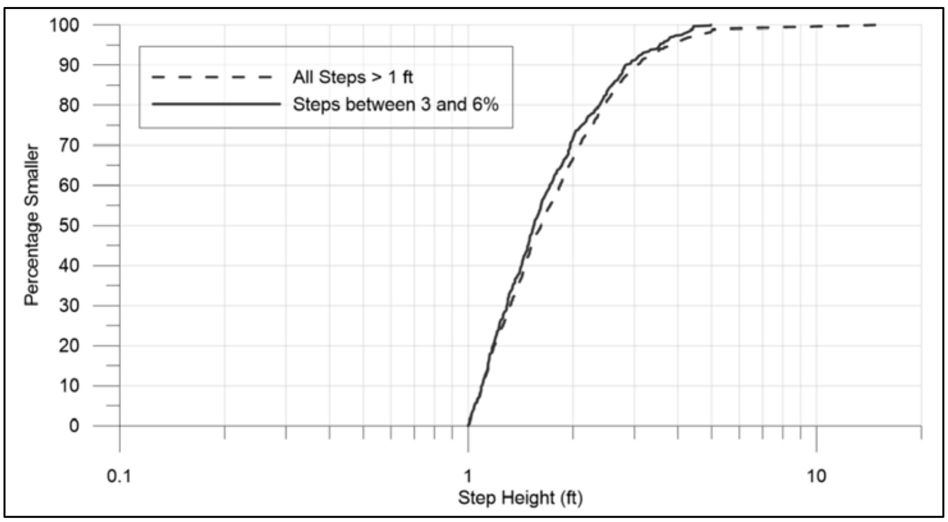


Figure 3-17. Cumulative distribution of estimated boulder drop/cascade step heights and lengths in the Middle Fork Nooksack River upstream and downstream of the dam site (computed for stream segments within RM 7-9 with slopes between 3-6%, derived from the 2013 LiDAR data).

4 Description of Alternatives

The formulation of alternatives to improve fish passage at this site began in 2001 and continued through the date of this report. Alternatives A, B, and C were developed in a series of independent studies prior to this report.

A study of a potential fish ladder to provide upstream passage occurred first and culminated in 30% design level report (NHC 2001). This fish ladder is designated for the purposes of this report as Alternative A.

Another study followed which examined several new abutment intake alternatives upstream of the existing dam that delivered water to the existing diversion structure via a conduit (NHC 2004). This study also included partial removal of the existing dam to improve fish passage, and culminated in a report that developed the selected upstream intake alternative to a 30% design level (NHC 2006). The 30% design level abutment intake is Alternative C.

Following development of the abutment intake alternative, another study examined a potential siphon at the existing intake to provide water to the City (B&V 2011). The siphon intake alternative, defined here as Alternative B, also incorporated partial removal of the dam to improve fish passage.

Finally, this report builds upon the work of these previous reports in the development of an additional upstream intake alternative, Alternative D. This section provides descriptions of the three previously developed alternatives and the new alternative developed as part of this report, as well as the No Action alternative. The section also contains the results of a brief feasibility analysis performed for each alternative.

4.1 Definition of Feasibility

For the purposes of this report, feasibility is defined by the ability to meet three requirements:

- Project Goal – Ability of the alternative to meet the project goal stated in Section 1.2 and improve fish passage performance past the dam.
- Constructability – Ability of the alternative to be constructed at the site given the environmental conditions present to meet safety and code requirements.
- Operability – Ability of the facility to be operated under the full range of environmental conditions without suffering long-term damage, significant impairment of fish passage performance, or catastrophic failure.

4.2 Previous Alternatives

4.2.1 No Action Alternative

One potential alternative to meet the project goal is to take no action. In this alternative, the dam and existing water intake and supply facilities would remain. As part of this alternative, no change would be made to the river channel other than those that currently occur naturally. The intake would continue to draw water from its current location without any changes to the existing trashrack or fish screen upgrades. The dam would continue to obstruct access to approximately 16 miles of river and tributary stream habitat for three anadromous Endangered Species Act-listed Puget Sound species: Chinook salmon, Steelhead and Bull Trout, as well as other native resident fish species. There is no capital cost associated with this alternative. The operation and maintenance cost would not change from that which is currently forecast by the City for continued operation.

4.2.1.1 Summary of Feasibility

- Project Goal: This alternative makes no changes to the current intake and dam. It does not remove the dam, restore geomorphic processes, or improve fish passage performance through implementation of structural or natural fish passage or other means. As such, taking no action will not achieve the project goal.
- Constructability: Taking no action is considered constructible as no construction or engineering design is required.
- Operability: The no action alternative meets the requirements for operability because the City has a history of operating the dam and intake under the full range of environmental conditions.

Due to the no action alternative's failure to achieve the project goal, no action is determined to be infeasible. Due to the resulting infeasibility, this alternative is not considered further.

4.2.2 Alternative A – Fish Ladder (Previous Alternative)

In 2001, Northwest Hydraulic Consultants provided a report to the City detailing four different alternatives to provide fish passage around the existing Middle Fork Nooksack diversion dam via a fish ladder (NHC 2001). None of the four designs included removal of any portion of the dam or modification to the existing intake. Analysis of the designs and hydraulic models culminated in a single preferred fish ladder alternative (Alternative 4 in the NHC reports), which was moved forward to a 30% design level. This alternative is referred to as Alternative A in this report. All four fish ladder alternatives were summarized in NHC's report *Middle Fork Nooksack River: Water Supply Diversion Dam Conceptual Fish Ladder Design 30% Submittal*, September 2001. Plates depicting this most feasible fish ladder design are shown in Appendix A, plates P-5 and P-6.

4.2.2.1 Design Elements

This alternative consists of an Ice Harbor-type of vertical slot concrete fish ladder traversing the left riverbank, around the diversion structure. It is cut into hard rock along its entire length. Given the elevation difference between the tailwater and upstream of the dam, the fish ladder runs parallel to the Middle Fork Nooksack River, requiring a few minor turns to traverse the potential rise and go around the existing diversion structure. A transport tunnel connects the fish ladder entrance to the first fish ladder pool to allow the fish ladder to pass under the existing diversion tunnel. The design target hydraulic differential between pools in the ladder is between 0.8 and 1.2 feet. Since this design was developed, the design standard for pool-to-pool hydraulic drops have changed to a maximum of 1 foot (NMFS 2011), however, for the purposes of comparison with the other alternatives and at this level of development, adjustment of the fish ladder design was determined to be unnecessary. The pools are 11 feet wide by 11 feet long. The preliminary design shows an approximate fish ladder length of 300 feet composed of roughly 19 pools, including an entrance and an exit pool. Auxiliary water is supplied to the entrance pool to provide attraction water from a screened intake at the upstream end of the ladder.

This alternative does not remove any portion of the existing dam or sluiceway. While the NHC 2001 report does not include any improvements to the existing intake, the City intended at the time that a conventional vertical flat plate screen would be constructed within the diversion channel to bring the existing intake into compliance with juvenile passage criteria (Harding ESE, 2001). The water control and cleaning systems for the fish ladder and auxiliary water system were assumed to be manual. No electrical power was assumed to be brought into the site nor were any on-site generators assumed.

Table 4-1 summarizes the anticipated functional elements that could be the basis of major design features for Alternative A – Fish Ladder. Plates P-5 and P-6 in Appendix A show the potential layout of these functional elements and the system as a whole.

Table 4-1. Summary of anticipated function elements for Alternative A – Fish Ladder without Dam Removal

Project Element	Function and Intent
Integration of gravity Auxiliary Water Supply (AWS) and cross connections to fish ladder	Provides attraction water at the fish ladder entrance to improve attraction to the ladder entrance under all potential fish passage conditions.
Technical concrete fish ladder designed in compliance with NMFS design guidelines for adult salmonids	Provides step pools with 0.8-feet to 1.2-feet of hydraulic differential and Energy Dissipation Factor (EDF) of 4 ft-lbs/sec/ft^3, which is proven to accommodate the swimming and leaping capabilities of the target fish species for engineered fish ladders (NMFS 2011).
Conventional fish ladder exit	Provides continuous hydraulic connection to the upstream river and accommodates volitional exit from the fish ladder throughout the river fluctuation range.
Modification to the existing intake trashrack and fish screen	Provides the full design water supply to the City while meeting juvenile fish screening criteria.

Additional detail regarding the project elements for and design development of Alternative A – Fish Ladder without Dam Removal can be found in the *Middle Fork Nooksack River: Water Supply Diversion Dam Conceptual Fish Ladder Design 30% Submittal* by Northwest Hydraulic Consultants (NHC 2001).

4.2.2.2 Summary of Feasibility

- Project Goal: This alternative installs a fish ladder from the tailwater pool below the dam to the river upstream of the intake. It does not restore geomorphic processes. The alternative improves fish passage performance by providing an upstream path for migrating salmonids and resident fish. Although this alternative leaves the dam intact, it does have the potential to achieve the project goal.
- Constructability: This alternative requires dewatering of the river channel and deep construction in porous river material and partially in bedrock. Dewatering for construction will be challenging but can be achieved using techniques common to the industry. Nothing about the alternative appears to preclude design of the project elements to meet industry standards and codes.
- Operability: On-river facilities are subject to a range of natural events that have the potential to impair function and damage project elements. However, on-river facilities,

including fish ladders, are usually designed to accommodate these events without catastrophic failure. While the fish ladder may require significant regular maintenance to keep it clear of debris and bedload, it is still expected to improve fish passage performance. In addition, the difficult setting and configuration of the proposed fish ladder would likely require specialized training and necessitate complex equipment access considerations for City staff to maintain operation of such a ladder.

This alternative has the potential to meet the project goal and is constructible and can be reliably operated, therefore, this alternative is considered feasible. Therefore, it will be considered further and evaluated against the other feasible alternatives.

4.2.3 Alternative B – Siphon Intake and Dam Removal (Previous Alternative)

In 2011 Black & Veatch (B&V) provided a report to the City detailing an alternative to provide fish passage at existing Middle Fork Nooksack diversion dam by removing part of the dam and replacing the existing intake with a siphon intake (B&V 2011). Included in the original siphon alternative are modifications to the full length of the existing diversion tunnel to make it suitable for operating in a negative pressure (vacuum) condition. Alternative B in this report is the Black & Veatch's 2011 siphon alternative including improvements to the existing diversion tunnel. The full siphon alternative is summarized in B&V's report *City of Bellingham Middle Fork Tunnel Intake Feasibility Study Basis of Design Report, Volumes 1 and 2*, September 2011. A plate depicting the siphon alternative chosen for Alternative B is provided in Appendix A, plates P-7.

4.2.3.1 Design Elements

A description of the design elements for the siphon alternative is described by Black & Veatch (B&V 2011, pg. 37-38) as follows:

> The intake site work consists of: partial removal of the existing diversion dam and the sediments impounded behind the dam; removal of existing intake features including the existing sluiceway, diversion channel and gates; construction of a new intake including a new retaining wall, an inlet trash rack, sediment bypass culvert and control gate, six fish screens and respective control gates and a siphon inlet chamber with S-shaped, rectangular cross-section siphon inlet; and the Pump Priming Building including buried suction and discharge piping. The diversion dam and new intake facility site plan is shown on (plate P-7), (Appendix A).
>
> Other aspects of the intake site include: existing gravel access road with new turnouts on the North bank of the river, existing steel bridge crossing the river below the intake, existing gravel access road around the South side of the intake to the diversion dam and intake site, and a new debris torrent channel protective barrier located South of the new intake…

> The new siphon pipe through the existing diversion tunnel is (steel and 84-inches in diameter). The diversion tunnel is approximately 8,900 feet long and 7’-9” tall. The siphon pipe through the tunnel transitions from the siphon inlet manifold at the upstream portal (at the existing diversion dam) and continues to a buried siphon pipe of the same diameter at the downstream portal…
>
> The transition to buried pipe at the downstream tunnel portal, a vacuum pump system and the siphon control valve vault are located within the vicinity of the downstream tunnel portal. A new gravel access road connecting the downstream portal to the siphon control valve vault is planned within the existing City right-of-way along the pipeline route.

Unlike Alternative C, the siphon alternative does not include engineered regrading or stabilization of the river channel upstream of the dam. However, the siphon alternative does include either natural scour or mechanical removal of some of the sediment deposited upstream of the dam that would likely be mobilized when the dam is removed. This alternative relies on model studies conducted by NHC that indicate the river channel will regrade itself via natural geomorphic processes to produce conditions favorable for fish passage (NHC 2011).

Table 4-2. Summary of anticipated function elements for Alternative B – Siphon Intake with Dam Removal

Project Element	Function and Intent
Removal of the sluiceway and removal of the left side of the existing dam	Removes barrier to upstream fish passage. Prevents movement of thalweg away from the right bank by excluding the majority of the erosive flows from the softer rock downstream of the existing dam on the right bank.
Fish bypass and sediment sluiceway	Provides a path back to the river for fish that pass the trashrack. Provides a path for bedload, sediment, and debris to pass back to the river. Assists in preventing the vertical plate fish screens from being occluded by sediment, bedload, and debris.
Vertical fish screens behind trashrack	Provides the full design water supply to the City while meeting juvenile fish screening criteria.
Trash rake and fish screen cleaning systems	Provides mechanical assistance in keeping the trashrack and fish screens from becoming occluded by debris. Reduces the required amount of fish screens by providing an active cleaning system.
Priming pump and associated facilities	Facilitates priming of the siphon system to begin water supply to the City.
Improve the existing diversion tunnel to withstand vacuum pressure and install siphon pipeline	Provides a controlled path to move water from the intake to the existing outlet under pressure.
Replace the existing intake trashrack with a concrete wall	Removes the ability to draw water off the river at the existing diversion trashrack. Ensures all flow provided to the existing diversion channel enters via the new siphon. Removes the potential water diversion via non-compliant (with fish passage criteria) intake structure.

Project Element	Function and Intent
No restoration of the river channel upstream of the dam	Relies on natural river processes to regrade the river to enable upstream and downstream fish passage. Provides resting places for upstream migrating fish at constructed velocity baffles along the intake channel wall.
Programmable logic controller	Automates screen cleaning for the trashrack, fish screens, priming of the siphon, sediment and fish screen control gates, and flow control via control valves. Reduces trips to the site by maintenance personnel vs. manual screen cleaning and flow control.
Electrical service to the project location via water supply tunnel	Provides 480-V, 3-phase power to the site. Provides the ability to operate mechanical equipment associated with siphon operation, monitoring, screen and trashrack cleaning, and flow control.

Additional detail regarding the project elements for and design development of Alternative B – Siphon Intake with Dam Removal can be found in the *City of Bellingham Middle Fork Tunnel Intake Feasibility Study Basis of Design Report* by Black and Veatch (B&V 2011).

4.2.3.2 Summary of Feasibility

- Project Goal: This alternative removes the existing sluiceway and part of the existing dam. It allows the channel to naturally scour upstream of the dam to a slope approximately the same as that of the river prior to the existing dam. It restores natural geomorphic processes. The alternative improves fish passage performance via the removal of impeding structures and natural modification to the river channel. As such, this alternative has the potential to achieve the project goal.
- Constructability: This alternative requires dewatering of the river channel, rock excavation, and modification of existing concrete structures. Dewatering the river channel for dam removal will be challenging but can be achieved using techniques common to the industry. Rock excavation and modification of concrete structures are common industry tasks. Project features and elements would be designed to meet industry standards and codes.
- Operability: On-river facilities are subject to a range of natural events that have the potential to impair function and damage project elements. However, on-river facilities would be designed to accommodate these events without experiencing catastrophic failure. This alternative is expected to improve fish passage performance.

This alternative has the potential to meet the project goal and is constructible and could be operated successfully (though with some difficulty), therefore this alternative is considered feasible and is evaluated against the other feasible alternatives.

4.2.4 Alternative C – Abutment Intake at Constructed Scour Pool and Dam Removal (Previous Alternative)

A number of upstream intake alternatives were developed by Northwest Hydraulic Consultants (NHC) from 2002 – 2006. Each of these alternatives consisted of one or more intakes upstream of the dam on the left bank of the river, each with constructed abutments on each bank forming a constriction, resulting in natural scour of a deep pool from which water could be withdrawn through on-channel screens . Each also included partial or full removal of the dam to restore fish passage and a conduit to carry flow from the proposed intake to the existing intake channel at the dam. To support the development of the design of these alternatives and determine a preferred configuration, NHC constructed and tested physical scale hydraulic models to confirm performance and evaluate the effects on the river channel. The intake alternatives were summarized in NHC's report *Middle Fork Nooksack River: Water Supply Diversion Dam Intake Replacement Alternatives*, June 2004*.* Analysis of the designs and hydraulic models culminated in a single intake alternative that was moved forward to a 30% design level, which has been identified as Alternative C in this report.

4.2.4.1 Design Elements

Alternative C – Abutment Intake at Constructed Scour Pool and Dam Removal would improve fish passage by removing part of the dam and making changes to the river while providing water supply to the City. The proposed intake would be located about 170 feet upstream of the existing dam. Abutments located on each side of the river at the intake would constrict river flow up to a 5-year flood to a 28-foot wide channel in order to create an artificial scour pool about 30 feet wide and 70 feet long at the intake. A 480 square-foot trashrack would prevent large woody debris and boulders from entering the intake. Behind the trashrack would be a 32-foot-long, 96-inch diameter tee screen, compliant with juvenile screening criteria, and through which the City water demand would be withdrawn into a buried penstock conduit. The 78-inch-diameter, steel conduit runs about 130 feet to a 35-foot, deep-water control vault. Level sensors inside the vault inform a programmable logic controller (PLC) which automatically controls the weir to maintain the appropriate amount flow into the conduit. The PLC also controls the air-burst cleaning system on the tee screen. The water passes from the control vault to the existing diversion channel adjacent to the existing dam via a 380-foot-long, 78-inch-diameter steel conduit. In addition to the new intake, the existing sluiceway and left portion of the dam would be removed back to existing rock. The river channel between the existing dam and the new intake would be mechanically regraded by the construction contractor according to the engineer's design to approximately match the natural channel grade. Three grouted boulder grade control sills in the river were assumed to be required to stabilize the river grade. Anchored boulders were assumed necessary to provide this stability and enable fish passage routes and "resting" locations.

Table 4-3 summarizes the anticipated functional elements that are the basis of major design features of Alternative C – Abutment Intake at Constructed Scour Pool with Dam Removal. Plates P-8 thru P-11 show the potential layout of project elements.

Additional detail regarding the project elements for and design development of Alternative C – Abutment Intake at Constructed Scour Pool with Dam Removal can be found in the *Middle Fork Nooksack River: Water Supply Diversion Dam New Intake Preliminary Design Final Submittal* by Northwest Hydraulic Consultants (NHC 2006).

Table 4-3. Summary of anticipated function elements for Alternative C – Abutment Intake at Constructed Scour Pool with Dam Removal

Project Element	Function and Intent
Removal of the sluiceway and removal of the left side of the existing dam	Removes barrier to upstream fish passage. Prevents movement of thalweg away from the right bank by excluding the majority of the erosive flows from the softer rock downstream of the existing dam on the right bank.
Grouted boulder sills between the existing dam and new intake	Re-establishes the natural grade of the river between the tailwater and the new scour pool to improve fish passage performance. Creates hard points across the river channel to reduce the potential for future scour in the channel that may over-steepen the reach, make it impassable to fish, and adversely impact intake function. Placed boulders provide resting areas for fish as they migrate upstream.
Scour pool at the intake created by left and right bank abutments	Increases flow velocity in the river channel during moderate to high river flows to induce scour in front of the intake. Induced scour maintains a deep pool in front of the intake, reducing the likelihood that sediment will damage or occlude the intake or be entrained into the conduit.
Tee screen intake behind trashrack	Provides the full design water supply to the City while meeting juvenile fish screening criteria.
Flow control vault adjacent to the river	Provides the ability to control the water supply flow to the City and to shut off flow to the conduit for maintenance or in emergency situations.
Conduit running from the tee screen to the existing diversion structure	Provides a controlled path to move water from the intake to the existing diversion structure. Can be used by the Contractor during construction to dewater the river between the dam and the new intake.
Replace the existing intake trashrack with a concrete wall	Removes the ability to draw water off the river at the existing diversion structure. Ensures all flow provided to the existing diversion channel enters via the new conduit. Removes the condition of water diversion via an intake with non-compliant fish screening.
Modification of the river channel between the dam and scour pool	Provides an upstream and downstream fish passage. Stabilizes the river gradient between the new intake structure and existing channel below the dam. Provides resting places for upstream migrating fish.
Programmable logic controller	Automates screen cleaning for the tee screens and flow control via the weir in the water control vault. Reduces trips to the site by maintenance personnel vs. manual screen cleaning and flow control.
Electrical service to the project location via water supply tunnel	Provides single-phase power to the site. Provides the ability to operate mechanical equipment associated with gate operation, monitoring, screen cleaning, and flow control.

4.2.4.2 Summary of Feasibility

- Project Goal: This alternative removes the existing sluiceway and part of the existing dam. It also mechanically regrades and modifies the channel between the tailwater and the new intake to a slope that is similar to that of the river prior to construction of the existing dam. The alternative improves fish passage performance via the removal of impeding structures and modification to the river channel. As such, this alternative has the potential to achieve the project goal.

- Constructability: This alternative requires dewatering of the river channel and deep construction in porous river material. Dewatering for construction will be challenging but can be achieved using techniques common to the industry. In addition, the proposed construction of large boulder grade controls to stabilize the channel was identified as a very high cost element of the design. Project elements would be designed to meet industry standards and codes.
- Operability: In-river facilities are subject to a range of natural events that have the potential to impair function and damage project elements. However, in-river facilities would be designed to accommodate these events without experiencing catastrophic failure. This alternative is expected to improve fish passage performance.

This alternative has the potential to meet the project goal and is constructible and could be operated successfully, therefore this alternative is considered feasible and is evaluated against the other feasible alternatives.

4.3 New Alternative

4.3.1 Alternative D – Upstream Intake and Dam Removal

The new alternative, Alternative D, developed for this report is an evolution of earlier design concepts as described in this report. Alternative D utilizes knowledge learned from the prior studies to refine features that best fit the site-specific conditions, meet operational and diversion needs, and improve fish passage. Importantly, this alternative incorporates off-channel fish exclusion screening, commensurate with more recent NMFS interpretation of screening criteria and guidance (NMFS, 2011). As discussed in Section 1.3.3 above and elsewhere in this report, the off-channel screening configuration allows the intake structure to be considerably smaller and less intrusive than the large intakes considered in previous studies.

The alternative consists of an intake upstream of the dam on the left bank of the river, a fish screen between the intake and the existing dam, a buried conduit between the intake and the fish screens and between the fish screen and the existing dam, a bypass pipe to return fish to the river, sediment sluice pipes, replacement of the existing trashrack with a permanent solid wall, and removal of the existing sluiceway and left portion of the spillway.

This alternative aims to meet the project objective to restore the channel through the dam site to a natural configuration to improve fish passage. The existing channel at the dam site was widened during dam construction by removing the large rock outcrop on the right (facing downstream) channel margin at the dam axis. The low concrete ogee sill was cast atop that rock excavation, but complete removal of the low ogee would allow the right side of the channel to pass more of the total flow than the original river channel section provided. Retaining a portion of the existing low sill on the right side will more closely mimic the original channel morphology, and may help to minimize excessive erosion of the rock below the sill beyond the natural progression that would have occurred had the dam not been constructed. Plates P-12 thru P-16 located in Appendix A provide an overview, enlarged plans, and sections of Alternative D.

4.3.1.1 Design Elements

The proposed new intake is located about 600 feet upstream of the existing dam, as measured along the channel thalweg. The intake would be located just upstream of a series of very large boulders between several large and stable boulder matrices that form a stepped-pool channel morphology. This location is also within an apparently very stable reach of the river well upstream of the dam, having shown no evidence of significant movement or destabilization for many decades, and it has not changed since well before the dam was built. The location and associated water surface elevations of the intake are considered highly feasible design at this preliminary stage, based on the latest survey information, past experience of design team members, site reconnaissance during initial meetings, and the hydraulic profile provided by the hydraulic modeling results developed to date. This alternative has been developed to a conceptual design level, which is less than Alternatives A and C which were developed to a 30% design level. Accordingly, the conceptual plan and profile shown on Plates P-14 and P-16 respectively are provided to communicate the key features and operational needs of the intake. The specific dimensions of the major design elements will refined during final design as the design is optimized.

At this stage of design, we anticipate that the intake will be about 50 feet long (measured along the river) and sloped at approximately 30 degrees from horizontal to match the existing riverbank profile. The structure will be embedded into the left descending bank line and it will be constructed to permit diversion at all river stages and in such as way as to protect the structure during flood flows. The riverside invert at the edge of the intake will be set at an appropriate hydraulic elevation, and control provided between there and the conduit to provide the required diversion capacity. The control will be designed to divert the full 116 cfs at minimum allowed river flows (see Section 3.2.3), and the associated 20 to 30 cfs fish bypass flow, for a minimum total diversion capacity of about 136 to 146 cfs at lower river flows when maximum diversion is allowed. Flow management Is expected to be controlled with a gate or other functional mechanical regulating device. Final sizing and configuration of the intake and flow control will be developed during final design, once the flow control system is finalized. A manual closure gate or bulkhead will also be provided in the intake to allow complete shut-off and isolation of the diversion system when the City is not diverting flow.

Sediment management will be a key design feature of the intake. The intake opening will be protected by a coarse trashrack sized to limit maximum approach velocities to less than 1 fps to allow for safe passage of smolts and steelhead kelts, provide redundant rack area for debris accumulation and partial blockage. The open spacing of the bars will be developed during final design in consultation with the PAC and regulatory agencies, to best protect the facility from debris and large bedload particles, and allow safe passage of juvenile migrants and steelhead kelts. Trashrack cleaning operations are anticipated to be initiated whenever remote sensors indicate excessive head losses across the rack are present, and would be accomplished manually. Automated trash cleaning systems are not proposed at this site, due to the high potential for significant damage resulting from flashy flows in the Middle Fork Nooksack and the significant volume of woody debris and large sediment that typically passes the intake location. A gravel surface access road leading from the dam to the intake will provide for operator access.

Sediment that is entrained into the intake may be managed in one or more of the following ways:

1. An adversely sloped floor at the intake entrance may help to limit the continued movement of larger grain size material up and over the flow regulation weir inside the intake. Sediment retained within the outer portion of the intake may be removed manually from within the intake or perhaps with a separate sluice gate at the downstream end of the intake structure;
2. Smaller sediment entrained into the intake and over the flow control weir will be flushed through the penstock and into the screen structure, where it would be bypassed through the fish return conduit back to the river;
3. An access hatch in the top of the intake structure will be provided for personnel access and for eductor truck access to remove sediment and debris that does not flush through the penstock or cannot otherwise be removed.

These details will be developed further during final design. Based on this location and the river gradient, there is adequate head to provide necessary sediment transport velocities and sediment sluicing capability.

A conveyance channel and/or buried conduit (currently shown as 9-foot-diameter conduit on Plates P-12, P-14, and P-16) will route flow from the intake to the fish screen. The final conduit configuration/diameter and profile will be developed during final design to best accommodate the desired flow capacity and flow velocity required for temporary construction diversion and permanent diversion capacity. The fish screen structure will be located between the dam and the intake, currently shown on Plate P-12 approximately 150-feet upstream of the dam.

The fish screen structure is anticipated to be of conventional design, with a vertical flat plate-type screen within a narrowing channel section to maintain uniform sweeping velocity. The fish screen will be fitted with an automated screen cleaner, thereby qualifying as an “active” screen under NMFS criteria (NMFS, 2011). An ‘active screen’ system may be designed for up to 0.4 fps average screen approach velocity. The flat plate screen will be constructed of durable, corrosion resistant stainless steel profile bar material with a maximum opening width of 1.75 mm, with at least 27% open area (NMFS, 2011). Adjustable baffles will be provided behind the screen material to permit adjustment of approach velocity and uniform flow distribution. The minimum effective surface area of the screen at the lowest river level at which the desired 116 cfs diversion capacity can be achieved will be approximately 320 square feet, providing about 10% additional redundant screen area. A bypass pipe of at least 18-inch diameter will provide for approximately 20 to 30 cfs bypass flow back to the river, designed for open channel flow and a minimum depth of about 8 inches. A flow control orifice/gate will be provided at the downstream end of the fish screen structure to control the water level in the fish screen structure and regulate bypass flow. This system can also regulate flushing flows to periodically clean sediment and debris from the screen channel. A ramp gate may also be added to the screen bypass to help control bypass flows if determined necessary during final design. The final screen length, depth, flow control orifice and/or gate, and screen chamber configuration will be optimized during final design.

The screen cleaner is currently envisioned as a traveling brush system that requires less power than comparable backwash or air-burst systems. As discussed above, sediment management will be accomplished with periodic flushing flows, manual removal, manual pressurized jet sweeping, or educator systems. Personnel access into the screen structure will be provided.

Screened flow will be conveyed through a drop structure and energy dissipation structure at the downstream end of the fish screen or at the junction with the existing diversion channel control gate vault at the left abutment of the existing dam. The existing intake trashrack will be removed, and a permanent wall will be constructed in its place to isolate the future screened flow from the river channel, as shown on Plates P-8 and P-11 and in Figure 4-1.

Figure 4-1. Alternative D - Existing Trashrack/Screen to be Removed and Replaced with a Concrete Wall.

Note: Photo taken on right sluiceway pier looking toward the existing intake trashrack on the right bank.

Power is anticipated to be required at the site for this Alternative. A storage battery system and power inverter with a diesel generator for recharge is expected to provide for electric power to operate the screen cleaner, control gates, maintenance lighting, and operation of controls. A programmable logic controller (PLC) will be installed to monitor water levels, and provide local control for the screen cleaner and flow management gates. Communications with City Operations staff may be provided with low-frequency radio repeaters operating on the same frequency as the existing City communications system. This remote communication system may be designed to accommodate remote operation of some system control features, which can be defined as this alternative is developed further. A pre-engineered concrete or concrete-masonry building will be provided to house the generator, fuel storage, and control systems to protect it from weather and vandalism. Site fencing is also assumed around the screen and intake area for securing and safety measures.

In addition to the new intake, the existing sluiceway and left portion of the dam will be removed up to the existing vertical intake wall along the left bank, as shown on Plate P-13 and in Figure 4-2. Part of the low ogee on the right side of the existing dam will be retained, as identified in the physical modeling studies conducted previously. Retention of part of the low ogee was shown to best restore the pre-dam morphology of the river, and reduce the potential for excessive erosion of the softer rock forming the existing right channel margin below the ogee crest. The river channel section from the dam to approximately 200 feet upstream will be allowed to regrade to approximately match the longer reach channel grade (~5%) as shown on Plate P-13 and Figure 3.2.7.1. Assessment of the natural channel beyond approximately 200 feet above the dam indicates that headcutting will not proceed above this point, given the observed bedrock channel grade controls evident in the channel now.

Figure 4-2. Alternative D - Portions of Existing Dam to Be Removed. Photo of existing dam taken below the dam looking upstream.

Table 4-4 summarizes the anticipated functional elements that are the basis of major design features of Alternative D – Upstream Intake and Dam Removal. Plates P-12 thru P-16 show the general layout of project elements. All features are shown schematically, and described to a sufficient level to confirm feasibility and allow for a conservative cost estimate. As noted above, the exact location, physical geometry, and design will be developed further during final design to optimize features and best fit the facilities into the existing site. For example, the fish screen location, depth and length will be optimized with consideration of updated bedrock information to minimize costs, accommodate temporary diversion and control of water during construction, accommodate potential wetland areas, and be arranged to best accommodate site features.

Table 4-4. Summary of anticipated function elements for Alternative D – Upstream Intake and Dam Removal

Project Element	Function and Intent
Removal of the sluiceway and removal of the left side of the existing dam	Removes barrier to upstream fish passage. Prevents movement of thalweg away from the right bank by excluding the majority of the erosive flows from the softer rock downstream of the existing dam on the right bank.
Intake structure	Provides diversion point for the full 116 cfs design water supply to the City, plus at least 20 to 30 cfs fish bypass flow. Protected with a steel trash rack that also functions as a louver. Allows for sediment passage and management with bypass sluice and design features. Provides manual closure gate to shut down entire system when flows are not being diverted.
Conduit connecting intake to the fish screen	Provides a controlled path to move water, fish, and sediment from the intake to the new screen and bypass pipe. Pipe or channel can be used by the Contractor during construction to dewater the river between the dam and the new intake.
Fish Screen	Provides the full design water supply to the City while meeting juvenile fish screening and bypass criteria. Has automated screen cleaning system and provisions to manage sediment. Designed to meet all current fish passage criteria with approach velocity less than 0.4 fps.
Fish bypass pipe and ramp gate	Returns bypass water with fish and fine sediment to the river via open channel flow in a suitable location to facilitate downstream passage without injury or disorientation.
Flow control orifice/gate, energy dissipater and conveyance conduit to existing diversion channel	Controls flow into the screen and intake, and conveys up to 116 cfs screened flow to the existing diversion structure. Provides hydraulic connection to the existing sluice.
Replace the existing intake trashrack with a concrete wall	Removes the ability to draw water off the river at the existing diversion structure. Ensures all flow provided to the existing diversion channel enters via the new conduit from fish screen. Removes the condition of water diversion via an intake with non-compliant fish screening.
Restoration of the river channel through the site influenced by the dam	Provides similar channel characteristics to adjacent upstream and downstream river reaches. Relies on natural river processes for long-term channel regrade and upstream and downstream fish passage.
Programmable logic controller	Monitors water surface elevations, automates screen cleaning for the flat plate screens and flow control if necessary via a ramp weir in the screen section. Can control orifice/gate that controls flow into the intake. Reduces trips to the site by maintenance personnel vs. manual screen cleaning and flow control. Can also be incorporated into SCADA system used for monitoring and remote communications.
Electrical service via local generator, with fuel tank and support building.	Provides single or 3-phase power to the site. Provides the ability to operate mechanical equipment associated with gate operation, monitoring, screen cleaning, and flow control.

4.3.1.2 Summary of Feasibility

- Project Goal: This alternative removes the existing sluiceway and part of the existing dam. It also would include either natural or mechanical regrading of the channel through the reach currently occupied by the dam to a slope that is similar to that of the river prior to the existing dam, and restores geomorphic processes. The alternative improves fish passage performance via the removal of impeding structures and restoration of the river channel, and prevents entrainment of downstream migrants. As such, this alternative has the potential to achieve the project objectives.
- Constructability: This alternative requires dewatering of the river channel and deep construction work in deep, porous river material. Dewatering for construction will be challenging but can be achieved using techniques common to the industry. Project elements would be designed to meet industry standards and codes.
- Operability: In-river facilities (intake) are subject to a range of natural events that have the potential to impair function and damage project elements. However, in-river facilities would be designed to accommodate these events without experiencing catastrophic failure. This alternative is expected to improve fish passage performance. Design of the intake structure, conveyance conduits, flow control, and sediment management features associated with the intake, screen, and bypass systems is critical and will be addressed during final design.

This alternative has the potential to meet the project goal and is constructible and could be operated successfully, therefore this alternative is considered feasible and is evaluated against the other feasible alternatives.

5 Alternative Evaluation

The alternatives presented in this report were evaluated using a numerical rating and scoring methodology. Evaluation factors were developed to provide a means of measuring an alternative's ability to achieve the project objectives. Weights were given to the evaluation factors based on their contribution to achieving the overall project goal. Each alternative was rated for its ability to meet the requirements of each evaluation factor. Ratings for each evaluation factor were multiplied by the evaluation factor's weight to produce a score for each evaluation factor for each alternative. Scores for each alternative were added together to produce a final score for each alternative. Final scores were the compared to one another.

5.1 Evaluation Factors

Evaluation factors are specific, quantitative and qualitative measures of performance or compatibility of an alternative with achieving the project objectives. Each evaluation factor is weighted in accordance with its overall importance in meeting the project goal. Each alternative is rated against the evaluation factors. The weights of the evaluation factors and the ratings of the alternatives are used in determining the alternatives' scores. The alternative scores are used to compare each alternative's relative potential in meeting the project objectives.

5.1.1 Development of Evaluation Factors

The evaluation factors were developed to provide a framework for determining how well each alternative met the project objectives. Input on the evaluation factors was provided by the project partners at the Alternative Selection Meeting (See Section 6.1) and incorporated. Factors that appeared to be commensurate between alternatives and those that were not anticipated to independently differentiate the alternatives from one another were not selected for further use, but were retained as important considerations in alternative development. For example, permitting for each of the alternatives appeared to be of roughly the same cost, schedule, and complexity. As such, permitting was not selected as an evaluation factor, but permitting is an important consideration overall.

The following sections describe the overall selection and refinement process used to develop the list of selected evaluation factors used in this report.

5.1.2 Description of Evaluation Factors

A brief summary of the Evaluation Factors is provided in Table 5-1. A more detailed description and definition of each evaluation factor is provided in paragraphs following the summary table.

Table 5-1. Evaluation Factors

Evaluation Factor	Corresponding Design Objective
Upstream Fish Passage Performance	Provide natural and safe fish passage for all target species in the adult life stage throughout the range of anticipated flows where fish may require upstream passage through the project site. Alternatives that remove the dam rate most favorably.
Downstream Fish Passage Performance	Provide natural and safe fish passage for all target species and juvenile and kelt life stages throughout the range of anticipated flows where fish may require downstream passage through the project site. Alternatives that remove the dam rate most favorably.
Surface Water Supply Reliability	Maintain reliable water delivery through a wide range of environmental conditions, maximizing the simplicity of components, and reducing the potential for mechanical failures.
Channel Stability and Geomorphology	Minimize the potential for induced channel instability through the project area, restore natural processes, and maximize potential for geomorphic-based passage and habitat continuity.
Debris and Sediment Management and Transport	Maintain sediment transport continuity in the Middle Fork Nooksack and minimize the need for sediment management activities related to the intake system.
Public Safety and Security	Improve public safety and security by complying with all State and Federal safety requirements. Restoration of the natural channel will remove an in-water hazard for recreation users at this location.
Operation and Maintenance	Minimize operational and maintenance level of effort and complexity.
Relative Capital Costs	Minimize construction cost of the project.

5.1.2.1 Upstream Fish Passage Performance

The intent of this evaluation factor is to measure how well each alternative is expected to provide safe and effective upstream fish passage for all target species in the adult life stage throughout their anticipated migration periods. Performance is evaluated against five items:

- Dam Removal – Extent to which the existing dam is removed and channel processes restored to improve fish passage.
- Degree to which the hydraulic and geomorphic characteristics of the river reach are anticipated to mimic adjacent upstream and downstream river reaches throughout the range of anticipated flows,
- Level of confidence that fish passage objectives (e.g. – minimum in-stream flow, stream simulation, etc.) can be met while providing the maximum water supply design flow to the City,
- Ability of fish passage pathways to remain free of failure, occlusion, or disruption due to debris and sediment, and
- Additional biomechanical aspects of a proposed fish passage technology such as compatibility with known species or life stage swimming and leaping behaviors.

Multiple fish passage technologies exist which could be integrated into project alternatives. Each technology is best suited for different environmental and hydraulic conditions and for different aquatic species and life stages. The performance of each technology is dependent on where it is used, what conditions it is subject to, and which species and life stages it serves. For this project, natural hydraulic and geomorphic processes mimicking reaches upstream and downstream are rated more favorably than technical fish ladders. Geomorphic-based fish passage provides a larger variety of hydraulic conditions within the river channel, creating multiple pathways for passage over a wide range of environmental conditions, while fish ladders provide a very specific pathway with relatively uniform hydraulic characteristics. Hydraulic and geomorphic mimicry allows multiple species to find pathways that are more conducive to their swimming abilities. It also provides alternate pathways for passage if one pathway is occluded, disrupted, or fails.

5.1.2.2 Downstream Fish Passage Performance

The intent of this evaluation factor is to measure how well each alternative is expected to provide safe and effective downstream fish passage for all target species and juvenile and steelhead kelt life stages throughout their anticipated migration periods. Performance is evaluated against six items:

- Dam Removal – Extent to which the existing dam is removed and channel is restored to improve fish passage.
- Degree to which the hydraulic and geomorphic characteristics of the river reach are anticipated to mimic adjacent upstream and downstream river reaches throughout the range of anticipated flows,
- Level of confidence that fish passage objectives (e.g. – minimum in-stream flow, stream simulation, etc.) can be met while providing the maximum water supply design flow to the City,

- Ability of fish passage pathways to remain free of failure, occlusion, or disruption due to debris and sediment, and
- Additional biomechanical aspects of a proposed fish passage technology such as compatibility with known species or life stage swimming behaviors.
- Juvenile Fish Screening – Extent to which NMFS juvenile fish screening criteria are met.

Multiple fish passage technologies exist which could be integrated into project alternatives. Each technology is best suited for different environmental and hydraulic conditions and for different aquatic species and life stages. The performance of each technology is dependent on where it is used, what conditions it is subject to, and which species and life stages it serves. For this project, it was perceived that natural hydraulic and geomorphic processes mimicking reaches upstream and downstream should be viewed more favorably than technical fish ladders. Naturalized fish passages provide a larger variety of hydraulic conditions within the river channel, creating multiple pathways for passage over a wide range of environmental conditions, while technical fish ladders provide a very specific pathway with relatively uniform hydraulic characteristics. Hydraulic and geomorphic mimicry allows multiple species and life stages to find pathways that are more conducive to their swimming abilities. It also provides alternate pathways for passage if one pathway is occluded, disrupted, or fails.

5.1.2.3 Surface Water Supply Reliability

The City of Bellingham requires water supplied from their intake on the Middle Fork Nooksack to supplement the primary drinking water source for Bellingham and the surrounding area. Therefore, each alternative is evaluated based on its ability to meet performance objectives despite sediment and debris loads by providing operational redundancy and flexibility of operations during extreme or emergency conditions. Water supply reliability is evaluated as part of this evaluation factor through consideration of the following metrics:

- Level of certainty that water delivery objectives will be met throughout the full range of design environmental conditions.
- Potential for uninterrupted operation, including:
    - Certainty that the thalweg will be maintained at the intake structure
- Simplicity of components, including:
    - Skill level required to operate and maintain system components, such as certifications, manufacturer training, etc.
    - Level of effort and frequency required for facility maintenance, such as screen cleaning.
    - Ability to maintain the facility without in-stream access.

5.1.2.4 Channel Stability and Geomorphology

Channel stability and restoring geomorphic processes are essential to ensuring successful long-term fish passage and long-term, reliable water withdrawal. Differences in the extent and location of dam removal and in-channel modifications will have implications on geomorphology of the river and long-term stability of the channel. Movement of boulders in the channel may block fish passage routes. Movement of the thalweg away from, or deposition in front of, the intake may reduce the flow that the City is able to withdraw and/or result in much higher maintenance due to greater sediment and bedload entering the intake system. Alternatives that restore geomorphic processes through the dam site will rate better than alternatives that do not, or do to a lesser degree.

5.1.2.5 Intake Sediment Management and Transport

The intent of this evaluation factor is to assess how effective each alternative is at maintaining sediment transport continuity and managing sediment that enters the intake system. Alternatives that minimize sediment entering the intake system are preferred. Reducing the amount of sediment that enters the intake system reduces wear on project features, maintenance requirements, and risk of occlusion in the system. For example, an intake trashrack resting directly on the intake channel floor will rate lower than an intake with a trashrack mounted on a concrete curb because the concrete curb reduces the bedload that moves into the intake.

5.1.2.6 Public Safety and Security

Public safety and facility security is a concern at this remote site and is another factor that is evaluated to differentiate the alternatives. The existing dam and new facilities are unmanned and visited infrequently by City personnel. While the site is not open to the public, it is still accessible. Moving equipment, slippery landings, and other project features common to industrial sites may pose hazards to the general public. Metal, equipment, and other project features may be attractive to vandals and thieves. Poachers may also attempt to catch fish where fish passage may be confined to a single location. Proposed alternatives that minimize public exposure to project features, reduce the amount and exposure of attractive items to thieves and vandals, and minimize access to fish passage locations are rated more favorably. Specific public safety and security considerations include but are not limited to the following:

- Provide structures and equipment that are buried or removed from view;
- Minimize exposed metal and equipment, such as gates, valves, and pumps;
- Minimize accessibility to fish passage corridors to non-City personnel;
- Limit the access to project features and structures;
- Remove in-water hazards, such as the existing dam, for recreation users.

5.1.2.7 Operation and Maintenance

The intent of this selection factor is to estimate the level of effort and complexity required to operate and maintain a proposed facility.

Alternatives were evaluated based upon the following considerations:

- Skill level required to operate and maintain system components

- Level of effort required for facility maintenance
- Frequency required for facility maintenance
- Ability to maintain the facility without working below ordinary high water
- Use of electrical power
- Overall mechanical complexity
- Need for computerized automation for operational purposes

5.1.2.8 Relative Capital Costs

Capital cost is the fixed, one-time expense, of construction of the proposed alternative. An Opinion of Probable Construction Cost (OPCC) developed for each alternative is used to evaluate each alternative. OPCCs developed in previous reports for Alternatives A, B, and C were escalated to 2018 market values and markups applied to the raw capital cost were adjusted to be uniform across all alternatives. For example, Alternatives A and C were originally developed with 8.8% and 8.2% tax rates, respectively. The OPCCs for Alternatives A and C were adjusted to reflect the current 2018 tax rate of 8.5%. The OPCCs for alternatives A and B used a 30% contingency. The original contingency for Alternative C was 20% but was escalated for this report to 30% to provide uniformity between the alternatives. Alternative D used a contingency of 50% to reflect the lesser level of design development. The estimated range of capital costs are provided in Section 5.2.1. They reflect an estimated accuracy for the OPCCs of ±30%. Detailed OPCCs for the alternatives are provided in Appendix D.

5.1.3 Weighting of Evaluation Factors

Weightings were assigned to the evaluation criteria to help compare the alternatives. Each member of the PAC was encouraged to review the initial weightings and provide their own suggestions for the individual weights the evaluation factors.

Reviewers weighted each evaluation factor on a scale of 0 to 10, to reflect its relative importance. A value of 10 indicated that the evaluation factor is very important and a value of 0 indicated that the factor is of very little to no importance. For example, upstream fish passage performance is weighted higher than sediment management and transport because management and transport of sediment has less of an impact in meeting the project goal than upstream fish passage performance.

The initial weights of each evaluation factor are shown in Table 5-2.

5.2 Comparison of Alternatives

In order to evaluate the selected alternatives outlined in the previous sections, a comparison matrix was developed. The comparison matrix is broken into categories for each evaluation factor. Each evaluation factor is weighted in accordance with its overall importance in meeting the project goal. Then each alternative was rated on how well it met each factor. The weights were applied to the rates to produce weighted scores for each alternative and evaluation factor. The individual scores for each alternative were summed, allowing for alternative comparison. Initial weighting and rating was presented to the project partners at the Alternative Selection Meeting (see Section 6.1). The project partners were encouraged to provide input on the weighting and rating following the meeting.

The following sections provide descriptions of the how the evaluation factors were weighted and the resulting scoring of the alternatives.

5.2.1 Rating of Alternatives

Reviewers rated each evaluation factor on a scale of 0 to 10, to reflect how well it met the requirements of the factor. A value of 10 indicated that the alternative fully met the requirements of the evaluation factor and a value of 0 indicated that the alternative did not or nearly did not meet the requirements for the evaluation factor. For example, an alternative that includes dam removal and provides geomorphic-based design for upstream fish passage is rated higher for the upstream fish passage evaluation factor than an alternative that does not remove the dam and provides upstream fish passage via a fish ladder because an unimpeded naturalized channel provides upstream fish passage over a wider range of hydraulic and environmental conditions and more closely matches hydraulic and geomorphic conditions of the natural river reach.

The initial rates of each evaluation factor for each alternative are shown in Table 5-2.

5.2.1.1 Rating: Alternative A – Fish Ladder (Previous Alternative)

The following provides brief background behind the selection of the rating for each evaluation factor for Alternative A that are found in Table 5-2:

- **Upstream Fish Passage Performance**: Fish ladders have a strong history of positive passage performance but are unable to perform as well as a naturalized channel over the full range of flows.
- **Downstream Fish Passage Performance**: Fish ladders are known to pass juveniles and steelhead kelts downstream but when the fish ladder is the only downstream fish passage route during low flows studies have shown that downstream passage performance is poor compared to that of a naturalized channel. It is important to note there are few studies that have examined the performance of downstream fish passage through fish ladders. Juvenile fish passage is slightly improved by the replacement of the existing fish screens at the intake with fish screens meeting NMFS juvenile screening criteria.
- **Surface Water Supply Reliability**: This alternative does not significantly change the operation or complexity from what is in place now.
- **Channel Stability and Geomorphology**: This alternative rates low as it does not restore geomorphic processes.
- **Sediment Management and Transport**: The fish ladder alternative does not change the current sediment management and transport system wherein large amounts of sediment are deposited in the diversion channel and carried into the diversion tunnel.
- **Public Safety and Security**: The addition of a fish ladder to the site without dam removal increases the potential for poaching and theft while not removing a potential

hazard to recreationalists. As such, this alternatives rates poorly compared to the other alternatives.

- **Operation and Maintenance**: The alternative does not reduce the amount of maintenance needed to operate the intake and adds considerable very difficult and costly additional manual operation and maintenance for the fish ladder in this very difficult and dangerous site.
- **Relative Capital Cost**: The probable capital cost of this alternative may range from $13.6M to $25.3M. Costs for this alternative are escalated from the original opinion of probable construction cost (OPCC) in the NHC 2001 fish ladder report. It was assumed that costs for modifications to the intake to meet juvenile fish screening criteria are included in the project contingency.

5.2.1.2 Rating: Alternative B – Siphon Intake and Dam Removal (Previous Alternative)

The following provides brief background behind the selection of the rates for each evaluation factor for Alternative B that are found in Table 5-2:

- **Upstream Fish Passage Performance**: Naturalized river channels more closely mimic natural river processes than technical fish passage structures.
- **Downstream Fish Passage Performance**: Naturalized river channels more closely mimic natural river processes than technical fish passage structures.
- **Surface Water Supply Reliability**: The dependence on a complex automated, mechanical system and the additional challenges in maintaining a vacuum in the system results in a low rate compared to the other alternatives.
- **Channel Stability and Geomorphology:** This alternative is rated higher than the fish ladder alternative (Alt A), as it removes the existing dam and re-establishes natural channel processes, but still requires stabilization of a scour pool below the removed dam from which to siphon the required diversion flows.
- **Sediment Management and Transport**: The siphon alternative improves the existing sediment management and transport system by allowing less sediment into the diversion tunnel via the finer mesh fish screens and sediment sluiceway.
- **Public Safety and Security**: The addition of fish screens and mechanical and electrical equipment to the site increases the potential for unauthorized access to the facilities and for theft. However, the alternative includes partial dam removal, reducing a potential hazard to recreationalists. As such, this alternatives rates well compared to the fish ladder alternative.
- **Operation and Maintenance**: This alternative greatly increases the operation cost and maintenance effort due to the large amount of automated mechanical equipment necessary to operate the siphon intake.
- **Relative Capital Cost**: The probable capital cost of this alternative may range from $20.2M to $37.5M.

5.2.1.3 Rating: Alternative C – Abutment Intake at Constructed Scour Pool and Dam Removal (Previous Alternative)

The following provides brief background behind the selection of the rates for each evaluation factor for Alternative C that are found in Table 5-2:

- **Upstream Fish Passage Performance**: Naturalized river channels more closely mimic natural river processes than technical fish passage structures.
- **Downstream Fish Passage Performance**: Naturalized river channels more closely mimic natural river processes than technical fish passage structures.
- **Surface Water Supply Reliability**: This alternative relies on gravity to supply water to the diversion structure rather than complex pumping systems like Alternative B. Gates, valves, and cleaning systems beyond what is used at the existing intake increase the required maintenance and potential for water supply interruptions but are outweighed by the reduction in the need for manual debris removal and associated water supply interruptions due to the new automated cleaning and control systems.
- **Channel Stability and Geomorphology:** This alternative is rated higher than the fish ladder alternative (Alt A), and also higher than the siphon alternative (Alt B), as it removes the existing dam and re-establishes natural channel processes. However, the large size and intrusion of the proposed large artificial constriction and scour pool will affect natural channel processes to some degree. In addition, the proposed construction of the boulder grade control structures is expected to be very costly and nearly infeasible due to the difficult site and dynamic conditions that places long-term stability of these structures under considerable risk.
- **Sediment Management and Transport**: The upstream intake with scour pool alternative improves the existing sediment management and transport system by allowing keeping all but fine sediment passing the criteria fish screens out of the diversion channel.
- **Public Safety and Security**: The addition of fish screens and mechanical and electrical equipment to the site increases the potential for unauthorized access to the facilities and for theft. However, the alternative includes partial dam removal, reducing a potential hazard to recreationalists. As such, this alternatives rates well compared to the fish ladder alternative.
- **Operation and Maintenance**: This alternative reduces the operation and maintenance effort due to the automated trashrack and fish screen cleaning systems and ability to remotely operate flow into the intake. Effort required to maintain the additional equipment is more than offset by the reduction in operation effort.
- **Relative Capital Cost**: The probable capital cost of this alternative may range from $15.0M to $27.8M.

5.2.1.4 Rating: Alternative D – Upstream Intake and Dam Removal

The following provides brief background behind the selection of the rates for each evaluation factor for Alternative D found in Table 5-2:

- **Upstream Fish Passage Performance**: Restoring the natural channel to allow ecological and physical processes to maintain fish passage is optimal for long term fish passage. This alternative also does not depend on maintenance of an artificial fishway to provide passage and thus collectively scores higher than Alternatives B or C.
- **Downstream Fish Passage Performance**: Restoring the natural channel to allow ecological and physical processes to maintain fish passage is optimal for long-term fish passage, both upstream and downstream.
- **Surface Water Supply Reliability**: This alternative relies on gravity to supply water to the diversion structure rather than complex pumping systems like Alternative B. Gates, valves, and cleaning systems beyond what is used at the existing intake increase the required maintenance and potential for water supply interruptions but are outweighed by the reduction in the need for manual debris removal and associated water supply interruptions due to the new automated cleaning and control systems.
- **Channel Stability and Geomorphology:** This alternative is rated higher than the fish ladder alternative (Alt A), higher than the siphon alternative (Alt B), and higher than the large upstream intake abutment alternative (Alt C), as it removes the existing dam and fully re-establishes natural channel processes. The much smaller and less intrusive intake structure poses a reduced impact to natural channel processes.
- **Sediment Management and Transport**: The upstream intake alternative improves the existing sediment management and transport system by allowing less sediment into the diversion channel via the finer mesh fish screens and sediment sluiceway.
- **Public Safety and Security**: This alternative has similar benefits and risks for this evaluation factor as Alternative C, however, it has less mechanical and electrical equipment. As such, this alternative has a better rate.
- **Operation and Maintenance**: This alternative reduces the overall operation and maintenance effort required to operate the intake and screening facilities similarly to Alternative C. However, this alternative requires less mechanical and electrical equipment than Alternative C so the effort required to maintain the equipment is expected to be lower.
- **Relative Capital Cost**: The probable capital cost of this alternative may range from $9.4M to $17.4M.

5.2.2 Results of Alternatives Comparison

The scores, rates multiplied by the associated evaluation factor weight, indicating the overall performance of each alternative to meet the project goal is provided in Table 5-2 below. The results indicate that Alternative D – Upstream Intake and Dam Removal would best achieve the project goal.

Table 5-2. Alternative Comparison Matrix

Alternative	Description	Year Alternative was Developed	Evaluation Factors																
			Upstream Fish Passage Performance		Downstream Fish Passage Performance		Surface Water Supply Reliability		Channel Stability and Geomorphologic Continuity		Sediment Mgmt and Transport		Public Safety and Security		Operation and Maintenance		Relative Capital Costs		Total Weighted Score
			Wt = 8		Wt = 8		Wt = 6		Wt = 4		Wt = 3		Wt = 2		Wt = 4		Wt = 4		(39)
			Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	
Alternative A	Fish Ladder with Off-Stream Conventional Vertical Panel Fish Screen in Diversion Channel and No Dam Removal	2007	6	48	4	32	6	36	3	12	4	12	3	6	3	12	5	20	178
Alternative B	Siphon Intake with Off-Stream Conventional Vertical Panel Fish Screen and Dam Removal	2011	7	56	5	40	2	12	5	20	6	18	6	12	1	4	1	4	166
Alternative C	Upstream Intake with In-Stream Fish Screen and Self-Scouring Abutment Structures and Dam Removal	2006	7	56	8	64	7	42	4	16	7	21	6	12	4	16	3	12	239
Alternative D	New Upstream Intake with Conduit and Off-Channel Conventional Vertical Panel Fish Screen and Dam Removal	2018	9	72	6	48	7	42	6	24	6	18	7	14	6	24	7	28	**270**

*Weight Guide: (1) Low, (10) High
*Raw Score: (1) Least favorable, (10) Most favorable

6 Preferred Alternative Selection

A preferred alternative was selected in collaboration with the City, American Rivers, and the Partner Advisory Committee (PAC). A preliminary evaluation of the alternatives was presented to the project partners and discussed at an Alternatives Selection Meeting. A preliminary version of the comparison matrix provided in Table 5-2 shared at that meeting was refined based on input from the City, American Rivers, the PAC, and the WRIA 1 Salmon Team. The results of the comparison matrix and subsequent discussions between the parties resulted in a preferred alternative.

6.1 Alternative Selection Meeting

A preliminary evaluation of the alternatives was presented to the project partners and discussed at an Alternatives Selection Meeting that took place on February 12, 2018. As part of the presentation, HDR presented the newly developed upstream intake alternative, Alternative D, (see Section 4.3.1). The four alternatives, evaluation factors, and comparison matrix were presented and discussed to try to come to consensus among the participants on a preliminary preferred alternative. The slides presented at this meeting are provided in Appendix C. In the meeting, multiple questions were brought up by the project partners as well as attending government agencies and participants of the WRIA 1 Salmon Team. Many of the answers to the questions raised at this meeting are addressed in this report. The questions and answers are provided in Appendix B. Prior to the conclusion of the meeting, there was general consensus among the attendees that Alternative D is the preferred alternative.

6.2 Preferred Alternative

As presented in Table 5-2, Alternative D – Upstream Intake and Dam Removal is the preferred alternative. It appears to have the greatest potential to achieve the project goal of the alternatives considered. The project partners and other attendees at the Alternative Selection Meeting indicated that Alternative D was the preferred option as well, although it was understood that the development and evaluation of the alternatives was still at a conceptual stage.

6.3 Permitting of the Preferred Alternative

A permitting matrix is provided in Appendix E, which discusses the environmental permits anticipated to be required for this preferred alternative. To support anticipated permitting requirements, HDR biologists conducted a habitat reconnaissance on January 10, 2018 to delineate the ordinary high water mark (OHWM) of the Middle Fork Nooksack River within the project study area (Figure 6-1). HDR biologists also surveyed areas proposed for potential land disturbance to determine the presence of wetlands. A Stream and Wetland Reconnaissance technical memorandum is included as Appendix F. If disturbance to wetlands or their buffers is proposed, HDR will conduct a formal delineation of identified wetlands to confirm the wetland boundary and provide more sample plots.

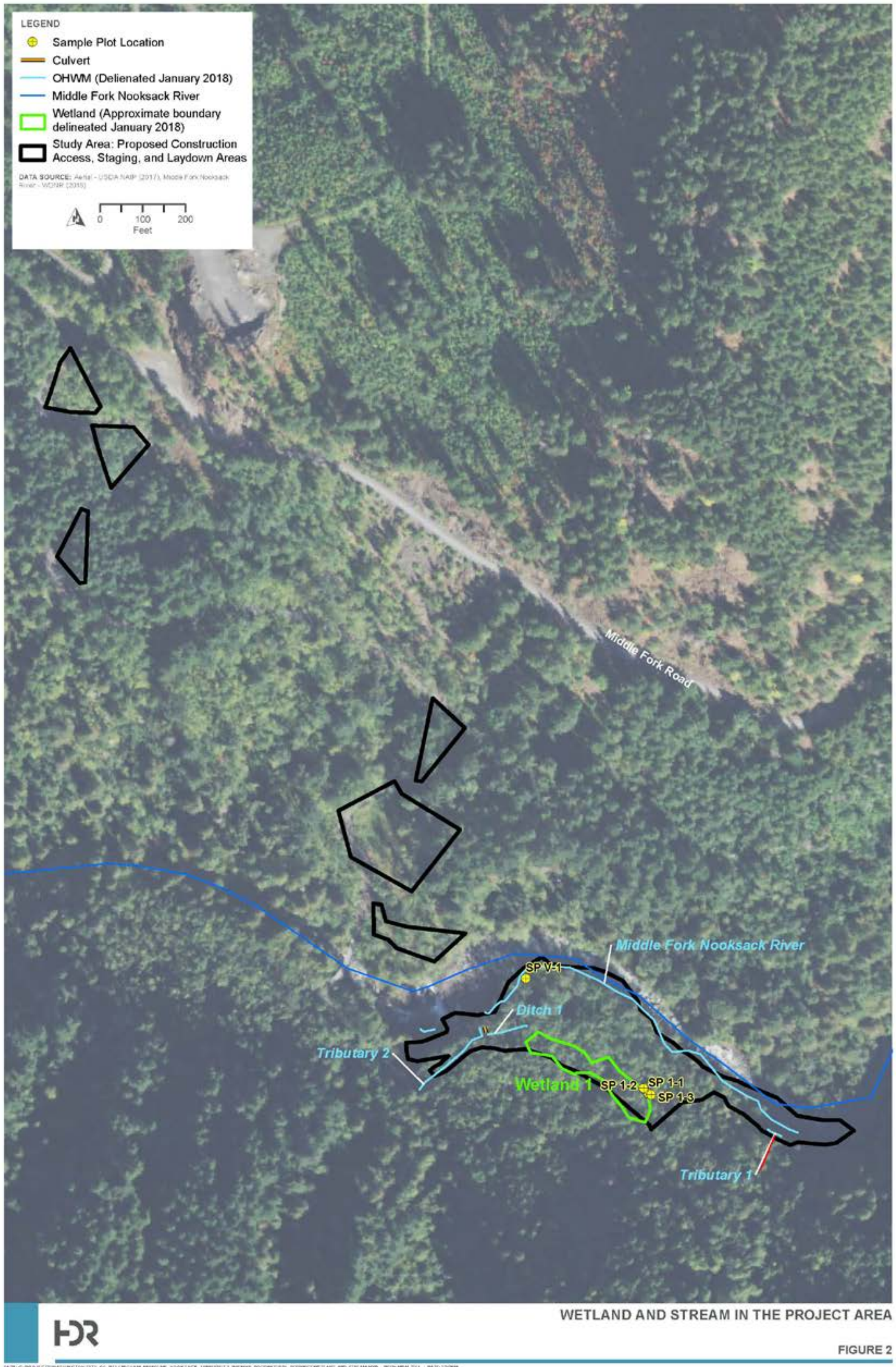


Figure 6-1. Wetlands and Streams in Project Study Area.

6.3.1 Summary of Anticipated Permits

Based upon existing conditions at the site and the need for in-water work and upland land disturbance and staging, the following permits or authorizations are likely to be required prior to project implementation:

- Federal
  - Clean Water Act Section 404 Discharge Authorization (administered by the U.S. Army Corps of Engineers)
  - Clean Water Act Section 401 Water Quality Certification (Ecology)
  - Clean Water Act Section 401 – Construction Stormwater NPDES permit (Ecology)
  - Section 7 or 4d Endangered Species Act and Magnuson-Stevens Act compliance (National Marine Fisheries Service)
  - Section 7 Endangered Species Act compliance (U.S. Fish and Wildlife Service)
  - National Historic Preservation Act Section 106 (Department of Archaeology and Historic Preservation)
  - Coastal Zone Management Consistency (Ecology)
- State
  - Hydraulic Project Approval (WDFW)
  - State Environmental Policy Act (City or Whatcom County)
  - State Owned Aquatic Lands - Aquatic Land Use Authorization (Department of Natural Resources [DNR])
  - Forest Practices Permit (DNR) - TBD
  - Demolition Approval (Northwest Clean Air Agency)
- Local (Whatcom County)
  - Growth Management Act – Critical Areas Ordinance
  - Shoreline Management Act (exemption or development permit)
  - Demolition Permit
  - Land Disturbance and Clearing Permit
  - Commercial Building Permit - TBD
  - Encroachment Permit

The permitting needs and approach assume that the City's new surface water intake structure would be relocated within the parcel owned by the City, and that the site would be accessed along an existing road that traverses lands managed by the Department of Natural Resources (DNR). No new roads would be required. Along the existing access road, laydown and construction staging would occur within upland (i.e., not wetland) areas. Additional laydown areas along the left bank riparian corridor of the Middle Fork Nooksack River have been identified, and portions of these areas contain wetlands. Use of wetland areas for laydown or temporary spoils disposal would require permits from federal, state, and local entities. Avoidance of wetland areas is recommended.

6.3.2 Approach and Schedule

The schedule for obtaining all permits is contingent upon the applicability of streamlined permitting pathways, as well as agency workload during processing and review. Permitting Option A assumes a streamlined approach for all authorizations that would allow for in-water construction in 2019, while Permitting Option B would require more traditional pathways whereby in-water work would commence in 2020. Under Permitting Option A, HDR assumes streamlining pathways are feasible for all federal permits and that agencies are able to process the applications in a timely manner. Under Permitting Option A, permits would be obtained in time to authorize work to begin during the 2019 summer in-water work window (potentially July 15 – September 30, or longer, TBD in coordination with WDFW, NMFS, USFWS, Corps of Engineers, and tribal biologists). Under Permitting Option B, HDR assumes that streamlining pathways under Section 404/401 of the CWA, Section 106 of the NHPA, or under Sections 4d or 7 of the ESA are not feasible. Under Permitting Option B, in-water work would not likely commence until 2020.

In-water work could be completed in one year if an extended window (i.e., up to four months) is granted by the agencies. Otherwise, in-water work would be required for two consecutive summers. In this case, the new intake would likely be constructed during the first summer of in-water work. The dam removal would occur during the second summer of in-water work. Under either scenario, the new intake and pipeline could be used as all or part of the river diversion and provide the City the opportunity to maintain its water supply if a second in-water work window is needed. This in-water work schedule is tentative and could be modified if an extended work window were granted to allow all in-water work to occur during one season. Site constraints for construction equipment access, laydown, and staging must also be considered in the schedule.

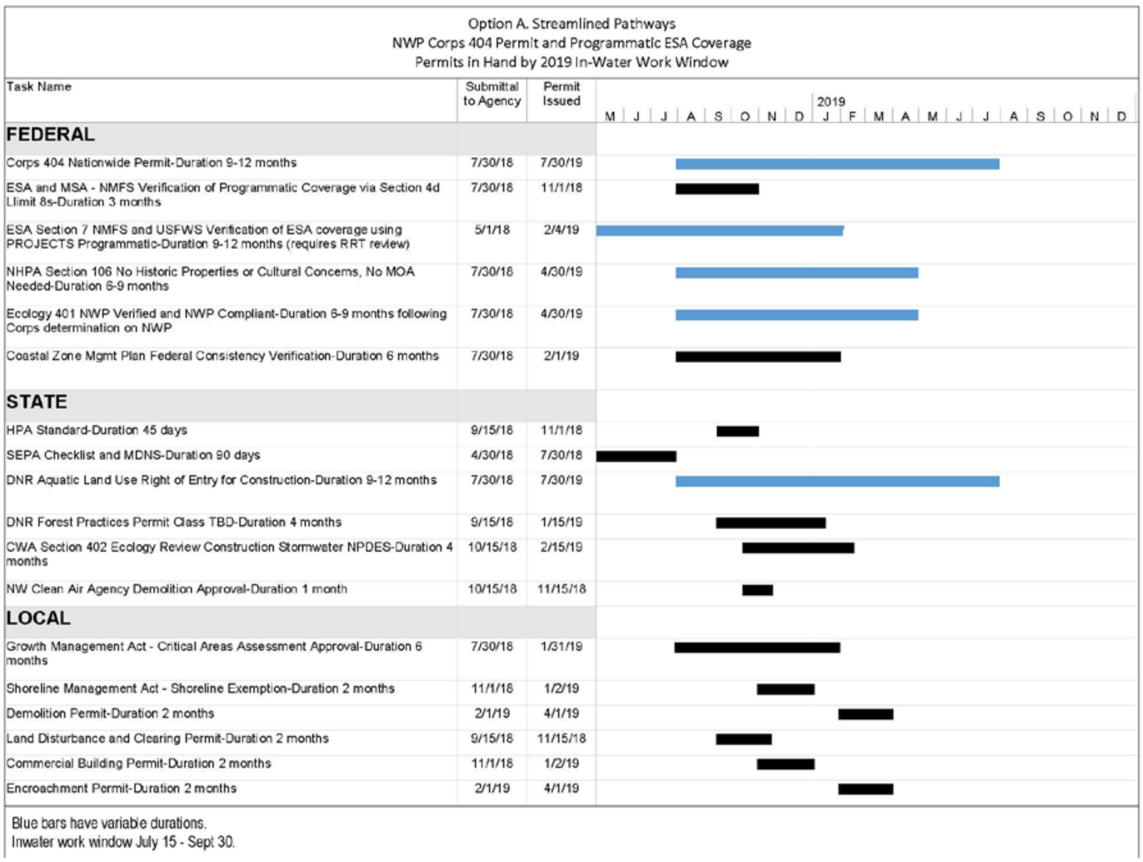
To expedite the permitting process, HDR recommends early and often coordination with agencies. This includes a pre-application site visit with resource agencies in spring 2018 to present the preferred alternative and solicit comments. HDR recommends submitting permit applications, including the JARPA and ESA consultation documents, no later than July 30, 2018. It should be noted that, upon submittal, HDR cannot control the length of time the agencies require to issue the authorizations or decisions made by the federal, state or local agencies.

The following sections discuss Permitting Option A (streamlined for in-water work in 2019) and Permitting Option B (standard permit processing for in-water work in 2020). Permitting pathways will be refined as the project progresses to determine which of the options represents the most likely scenario.

6.3.2.1 Permitting Option A

Under Permitting Option A, all federal permitting would be expedited using existing streamlining processes. CWA Section 404 permitting for discharge of fill into wetlands or waters below the OHWM would be authorized under the Nationwide Permit Program, and the project would comply with all regional water quality conditions such that an individual WQC would not be required under CWA Section 401, administered by Ecology. Under Permitting Option A, ESA consultation for both NMFS and USFWS species would be completed using existing programmatic consultations for both NMFS and USFWS species. Under this option, consultation under Section 106 of the NHPA would not require extensive multi-agency/tribal coordination, and an MOA would not be required. State and local permits would be issued within 6 months of application.

Under this option, it is anticipated that the environmental and development permitting processes would require approximately six to 12 months to complete once permitting documents are submitted to reviewing agencies (Figure 6-2).



Option A. Streamlined Pathways
NWP Corps 404 Permit and Programmatic ESA Coverage
Permits in Hand by 2019 In-Water Work Window

Task Name	Submittal to Agency	Permit Issued
FEDERAL		
Corps 404 Nationwide Permit-Duration 9-12 months	7/30/18	7/30/19
ESA and MSA - NMFS Verification of Programmatic Coverage via Section 4d Llimit 8s-Duration 3 months	7/30/18	11/1/18
ESA Section 7 NMFS and USFWS Verification of ESA coverage using PROJECTS Programmatic-Duration 9-12 months (requires RRT review)	5/1/18	2/4/19
NHPA Section 106 No Historic Properties or Cultural Concerns, No MOA Needed-Duration 6-9 months	7/30/18	4/30/19
Ecology 401 NWP Verified and NWP Compliant-Duration 6-9 months following Corps determination on NWP	7/30/18	4/30/19
Coastal Zone Mgmt Plan Federal Consistency Verification-Duration 6 months	7/30/18	2/1/19
STATE		
HPA Standard-Duration 45 days	9/15/18	11/1/18
SEPA Checklist and MDNS-Duration 90 days	4/30/18	7/30/18
DNR Aquatic Land Use Right of Entry for Construction-Duration 9-12 months	7/30/18	7/30/19
DNR Forest Practices Permit Class TBD-Duration 4 months	9/15/18	1/15/19
CWA Section 402 Ecology Review Construction Stormwater NPDES-Duration 4 months	10/15/18	2/15/19
NW Clean Air Agency Demolition Approval-Duration 1 month	10/15/18	11/15/18
LOCAL		
Growth Management Act - Critical Areas Assessment Approval-Duration 6 months	7/30/18	1/31/19
Shoreline Management Act - Shoreline Exemption-Duration 2 months	11/1/18	1/2/19
Demolition Permit-Duration 2 months	2/1/19	4/1/19
Land Disturbance and Clearing Permit-Duration 2 months	9/15/18	11/15/18
Commercial Building Permit-Duration 2 months	11/1/18	1/2/19
Encroachment Permit-Duration 2 months	2/1/19	4/1/19

Blue bars have variable durations.
Inwater work window July 15 - Sept 30.

Figure 6-2. Permitting Timeline – Permitting Option A

6.3.2.2 Permitting Option B

Under Permitting Option B, one or all of the federal permitting pathways would not be expedited using existing streamlining processes. For example, CWA Section 404 permitting would be authorized by an Individual Permit, and Ecology would require an individual Section 401 WQC. Both of these pathways require extensive processing times and mandatory public comment periods, and also require additional application materials. Under Option B, one or both ESA consultations would require individual Section 7 review for NMFS and USFWS species. In addition, a lengthier Section 106

NHPA review may be required if the dam is considered historic and removal requires an MOA. State and local permits would be issued within 6 months of application.

Under Permitting Option B, it is anticipated that the environmental and development permitting processes will require approximately 12 to 18 months to complete once permitting documents are submitted to the agencies (Figure 6-3). If an Individual Permit is required from the Corps of Engineers for in-water work, current agency workload may extend the permitting timeframe.

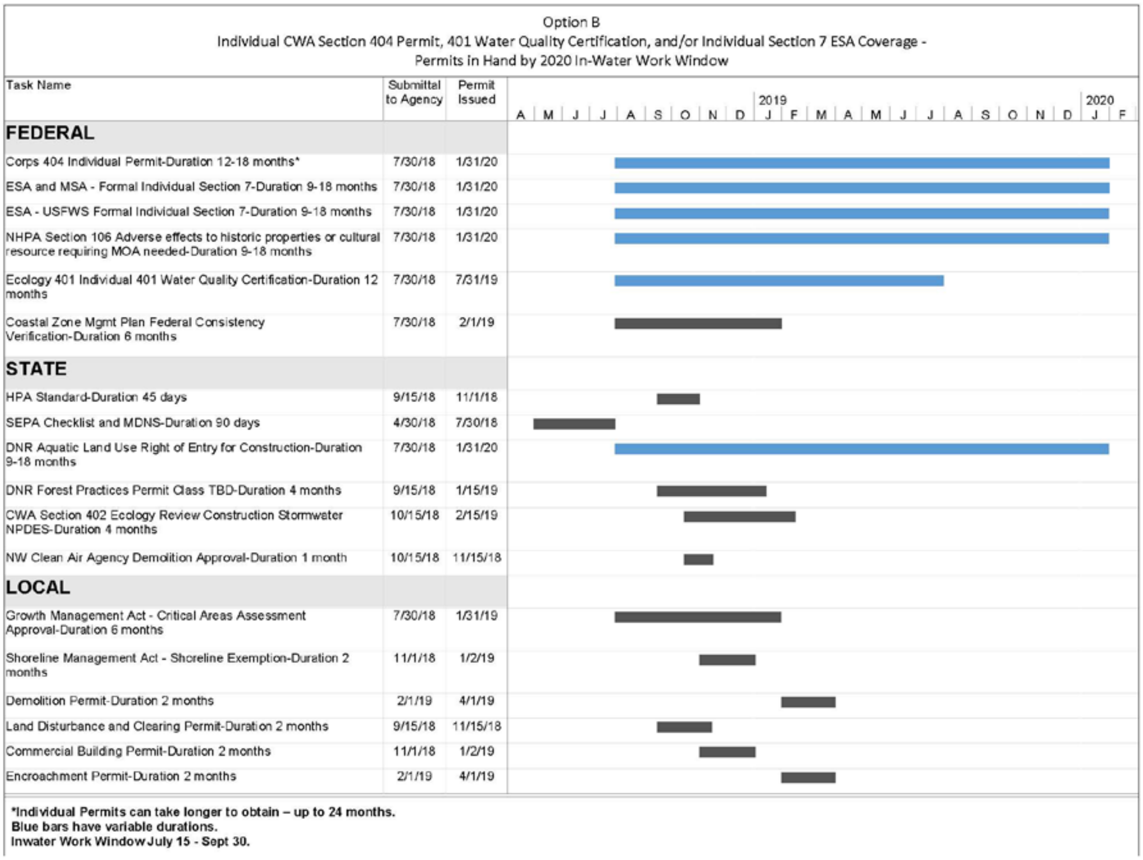


Figure 6-3. Permitting Timeline – Permitting Option B

6.3.3 Cultural Resources Assessment

In February 2018, Drayton Archaeology conducted a cultural and historical resources desktop analysis and an onsite survey of the estimated Area of Potential Effect (APE). The preliminary APE that was surveyed included all areas surrounding the dam and preferred intake and water conveyance location, along with staging and access areas along the existing access road and adjacent to the dam. The APE may be refined following the selection of a preferred alternative and upon submittal of the survey report to the USACE to support consultation under Section 106 of the NHPA. Drayton will submit a cultural and historical resources survey report to the City and evaluate archaeological and historic resources (e.g., dam) for potential eligibility on the National Register of Historic Places. Following completion of a cultural and historic properties survey, Drayton will prepare an assessment for submittal to the Corps of Engineers to support their Section 106 NHPA consultation with the state Department of Archaeology and Historic Preservation.

Following selection of a preferred alternative and submittal of a Joint Aquatic Resources Permit Application (JARPA) to the Corps of Engineers, Drayton will assist the City with on-going consultation under Section 106 of the National Historic Preservation Act.

7 Next Steps

Following this report, the project core team intends to continue to advance the project to construction. This report has been provided to the PAC and DRT for their review, consideration, and input. The PAC provided support for the preferred alternative at the Alternative Selection Meeting. The preferred alternative will be advanced to final design, culminating in a set of bid documents that can be provided to construction contractors for bidding. Concurrent with final design the permits necessary for construction of the preferred alternative will be pursued and obtained. At the same time, funding opportunities will be pursued. The DRT will review design refinements at the 30-, 60-, and 90-percent levels and will continue to provide input throughout the final design process. Final design, permitting, pursuit of funding, and ongoing collaboration with the PAC and DRT are expected to proceed immediately following this report.

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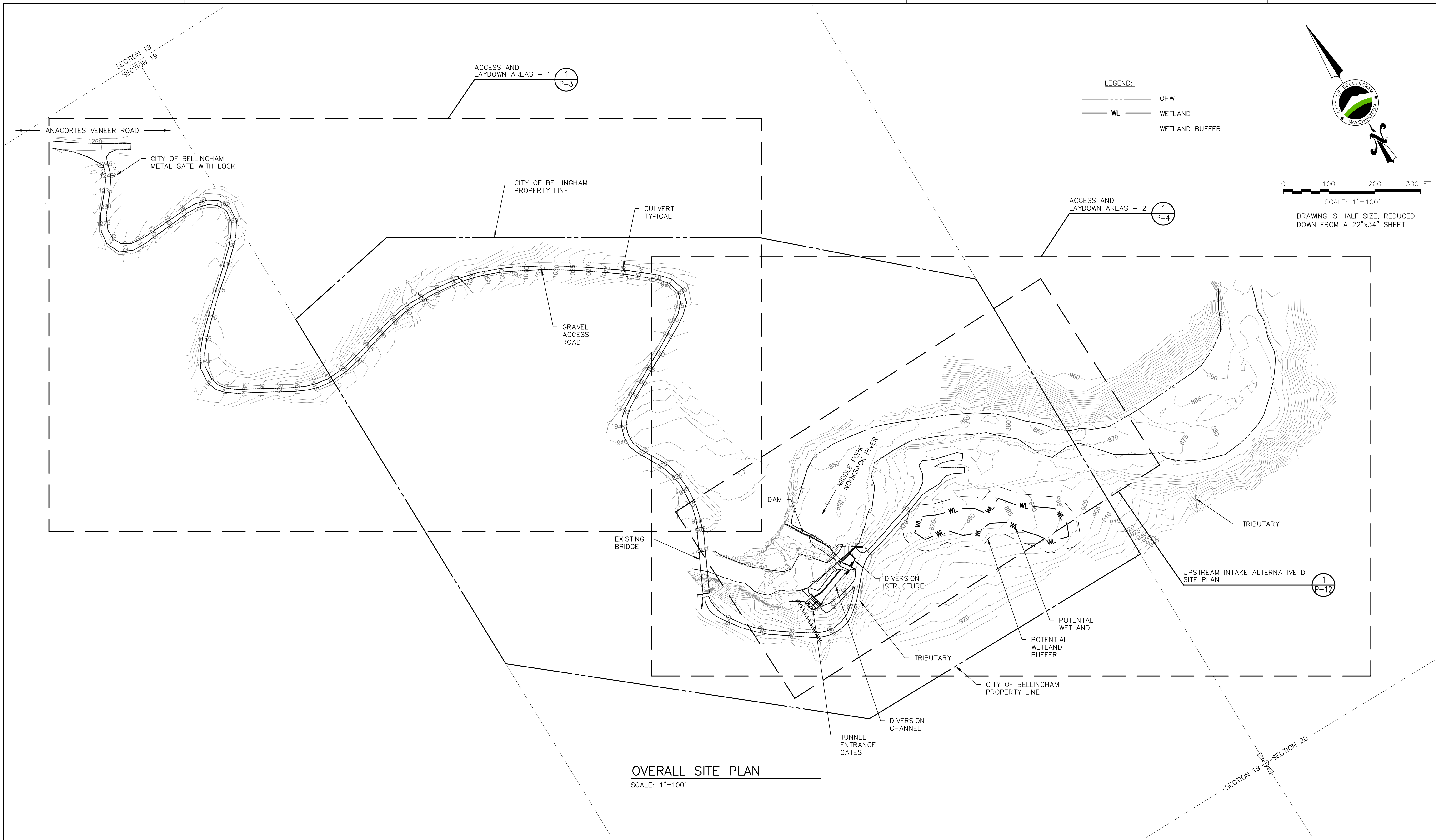
Appendix A. Alternatives Plates



OVERALL SITE PLAN

SCALE: 1"=100'

PROJECT MANAGER	ED ZAPEL, PE
DESIGNED BY	
CHECKED BY	
DRAWN BY	J CAMPBELL
PROJECT NUMBER	10090926

ISSUE	DATE	DESCRIPTION
-	-	-

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MIDDLE FORK NOOKSACK RIVER FISH PASSAGE PROJECT

PUBLIC WORK DEPARTMENT
ENGINEERING DIVISION

DIRECTOR PUBLIC WORKS TED CARLSON
CITY ENGINEER CHAD SCHULHAUSER PE
ASSISTANT DIRECTOR CHAD SCHULHAUSER PE

CONCEPT ALTERNATIVES REPORT

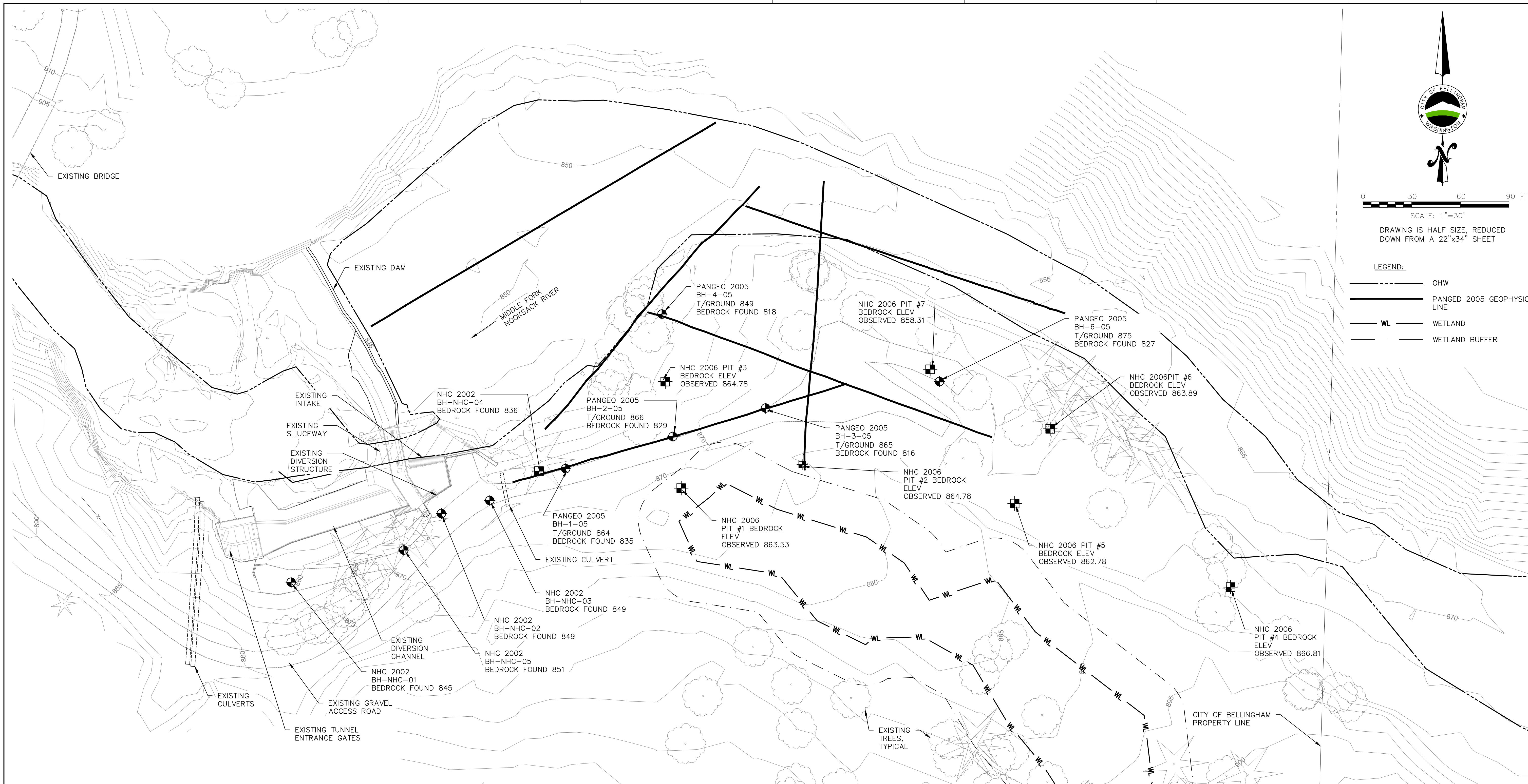
OVERALL EXISTING SITE PLAN

0 1" 2"

FILENAME P-01.dwg

SCALE -

PLATE P-1



SITE PLAN
SCALE: 1"=30'

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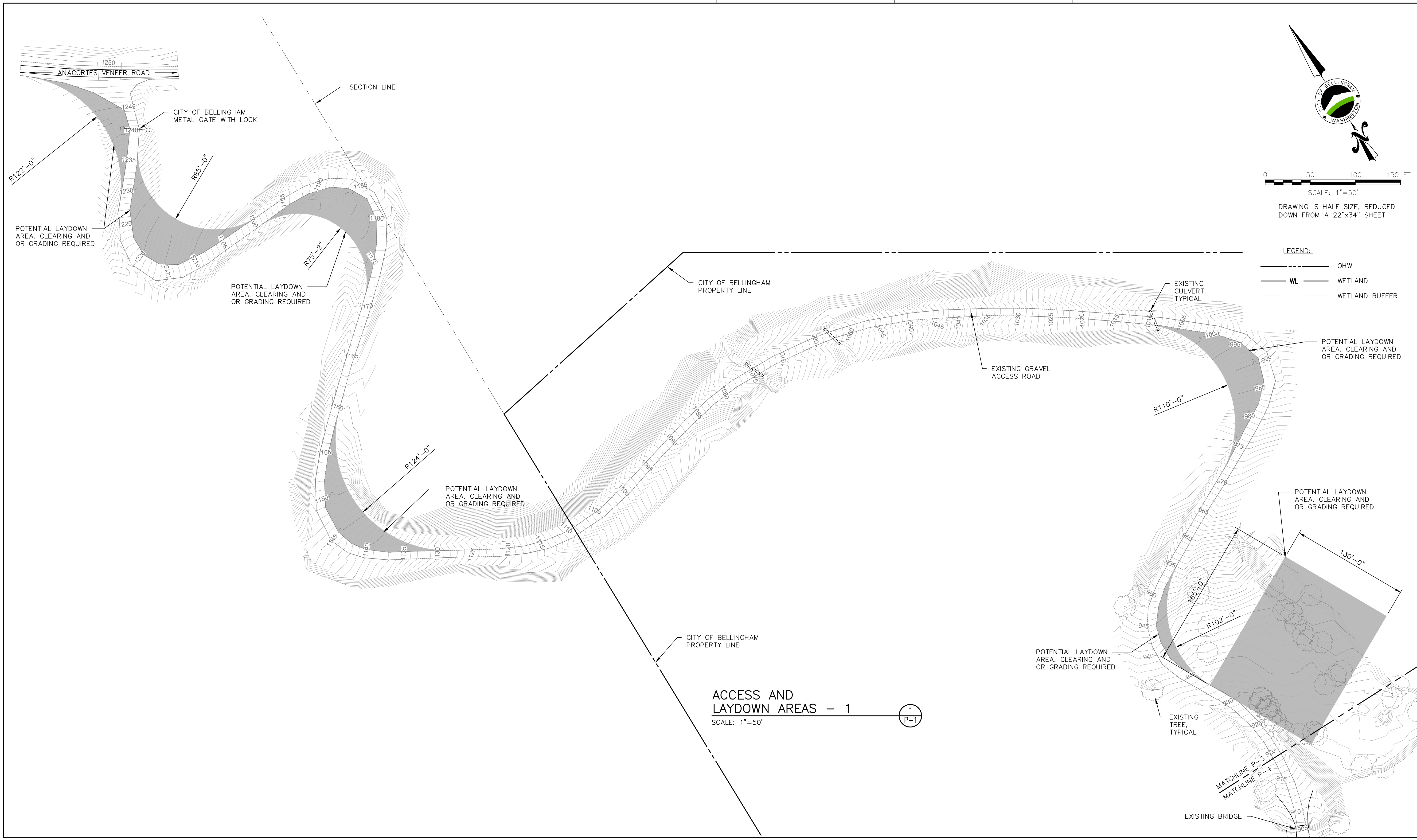
CONCEPT ALTERNATIVES REPORT GEOPHYSICAL LINES, BOREHOLES, AND TEST PITS DEVELOPED IN PREVIOUS REPORTS

FILENAME P-02.dwg
SCALE -
PLATE P-2



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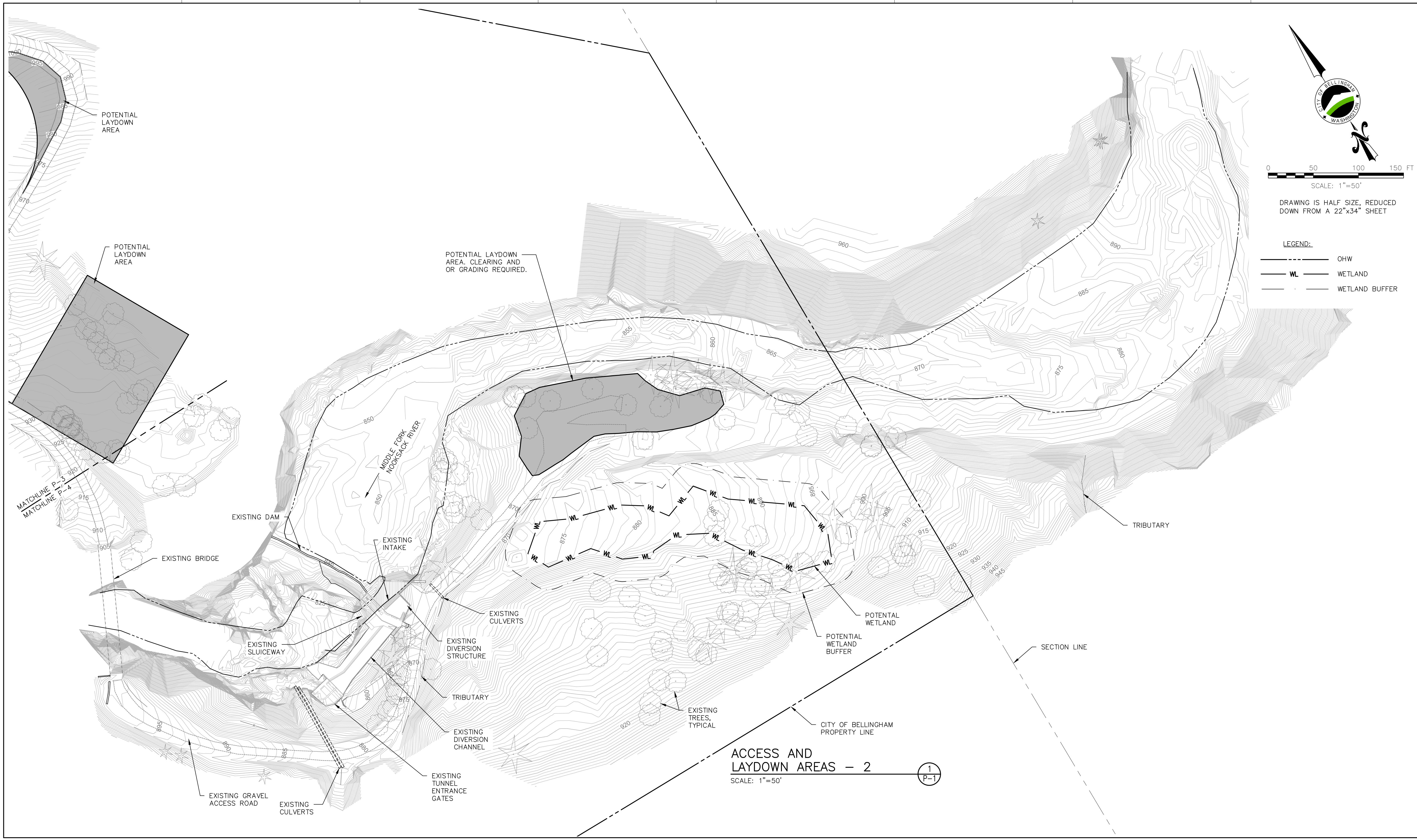
CONCEPT ALTERNATIVES REPORT

ACCESS AND LAYDOWN AREAS - 1

0 1" 2"

FILENAME P-03.dwg
SCALE -
PLATE P-3



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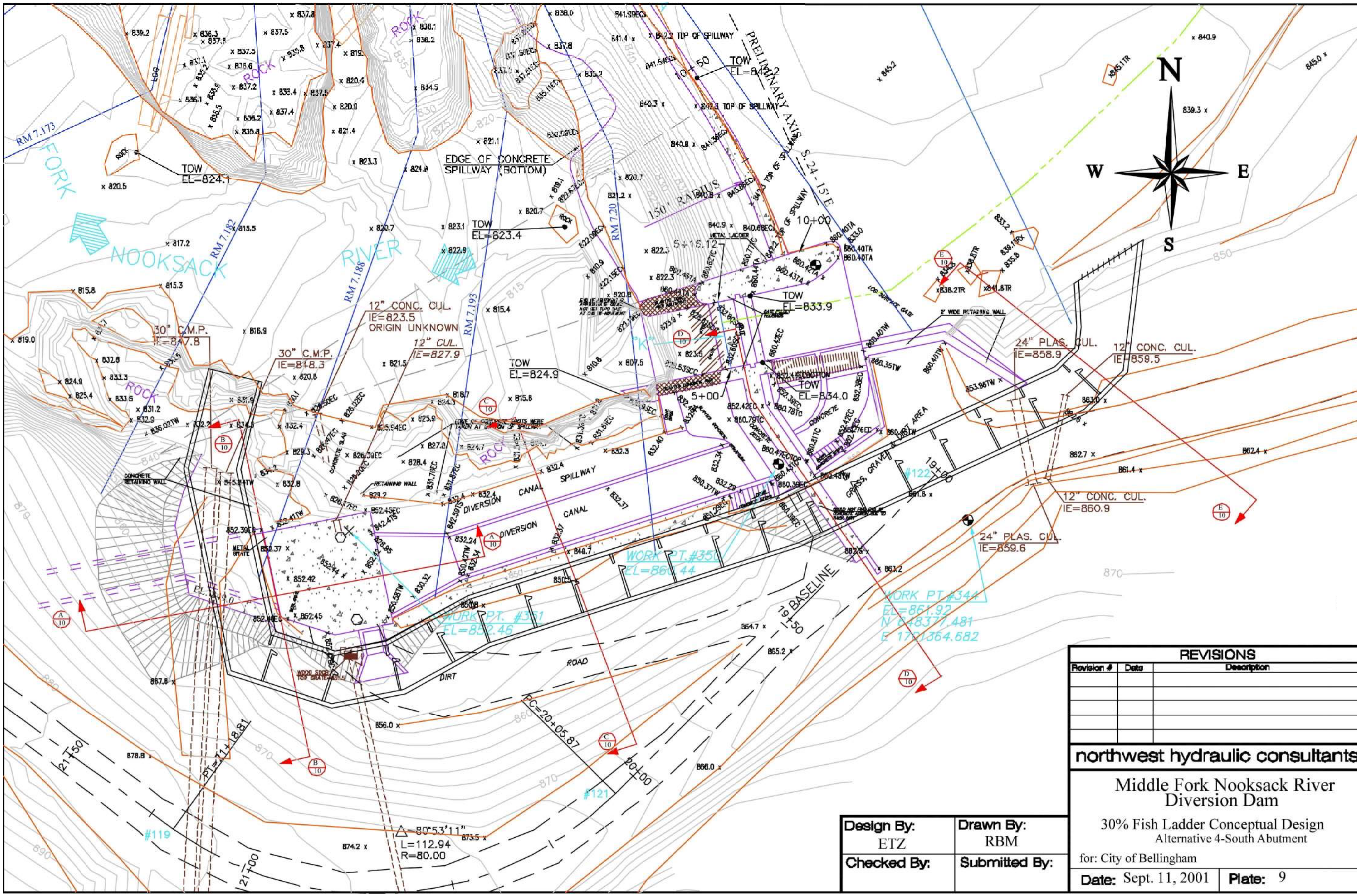
CONCEPT ALTERNATIVES REPORT

ACCESS AND LAYDOWN AREAS - 2

0 1" 2"

FILENAME P-04.dwg
SCALE -

PLATE
P-4



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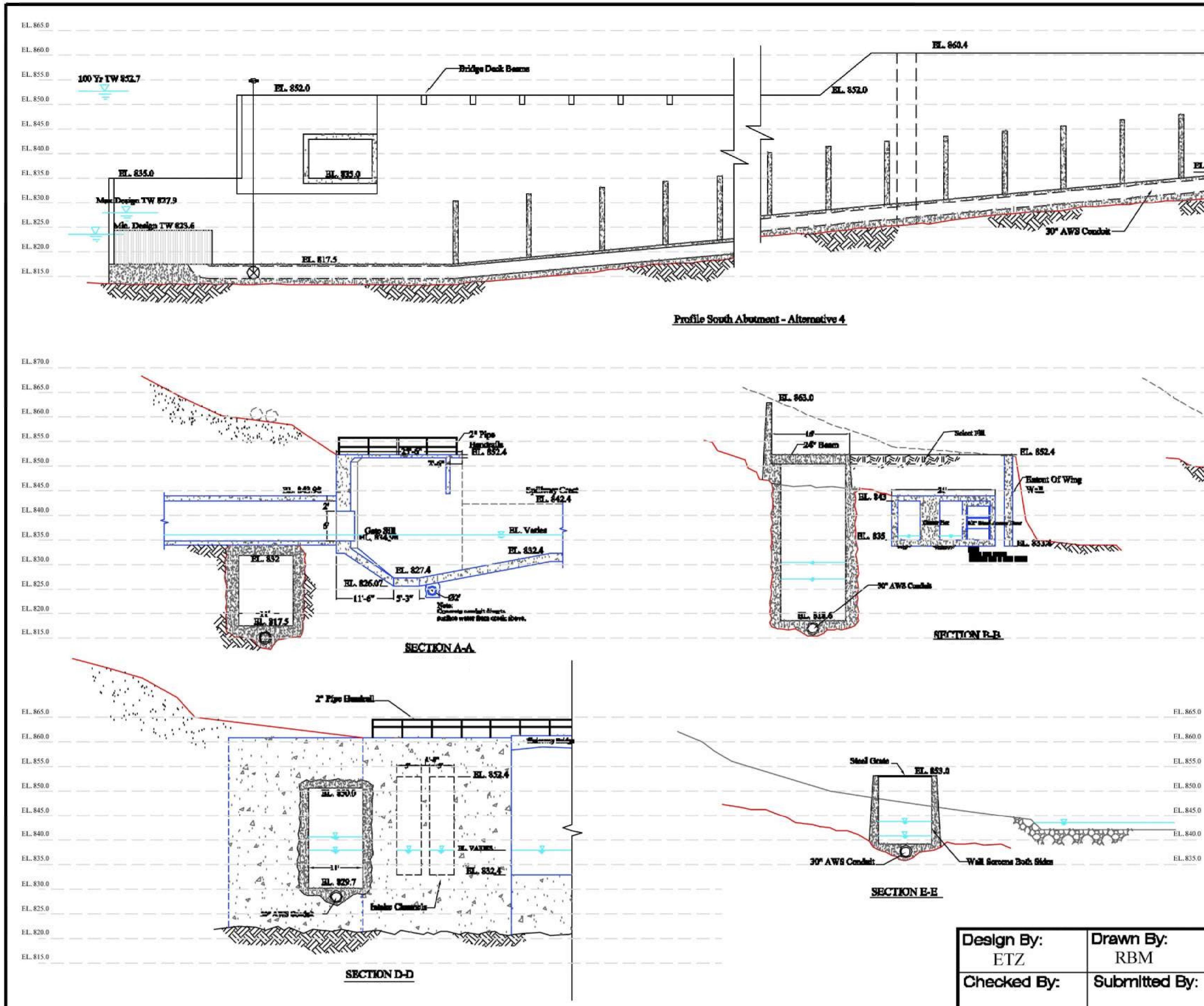
CONCEPT ALTERNATIVES REPORT

ALTERNATIVE A
FISH LADDER - PLAN

FILENAME P01-P07.dwg
SCALE NOT TO SCALE
PLATE P-5



REVISIONS

Revision #	Date	Description

northwest hydraulic consultants

Middle Fork Nooksack River Diversion Dam

30% Fish Ladder Conceptual Design
Alternative 4- South Abutment

for: City of Bellingham

Design By: ETZ	Drawn By: RBM
Checked By:	Submitted By:

Date: Sept. 11, 2001 — Plate: 10

HDR

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DESIGNED BY		
CHECKED BY		
DRAWN BY		
PROJECT NUMBER	10090926	

ISSUE — DATE — DESCRIPTION

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MIDDLE FORK NOOKSACK RIVER FISH PASSAGE PROJECT

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ENGINEERING DIVISION

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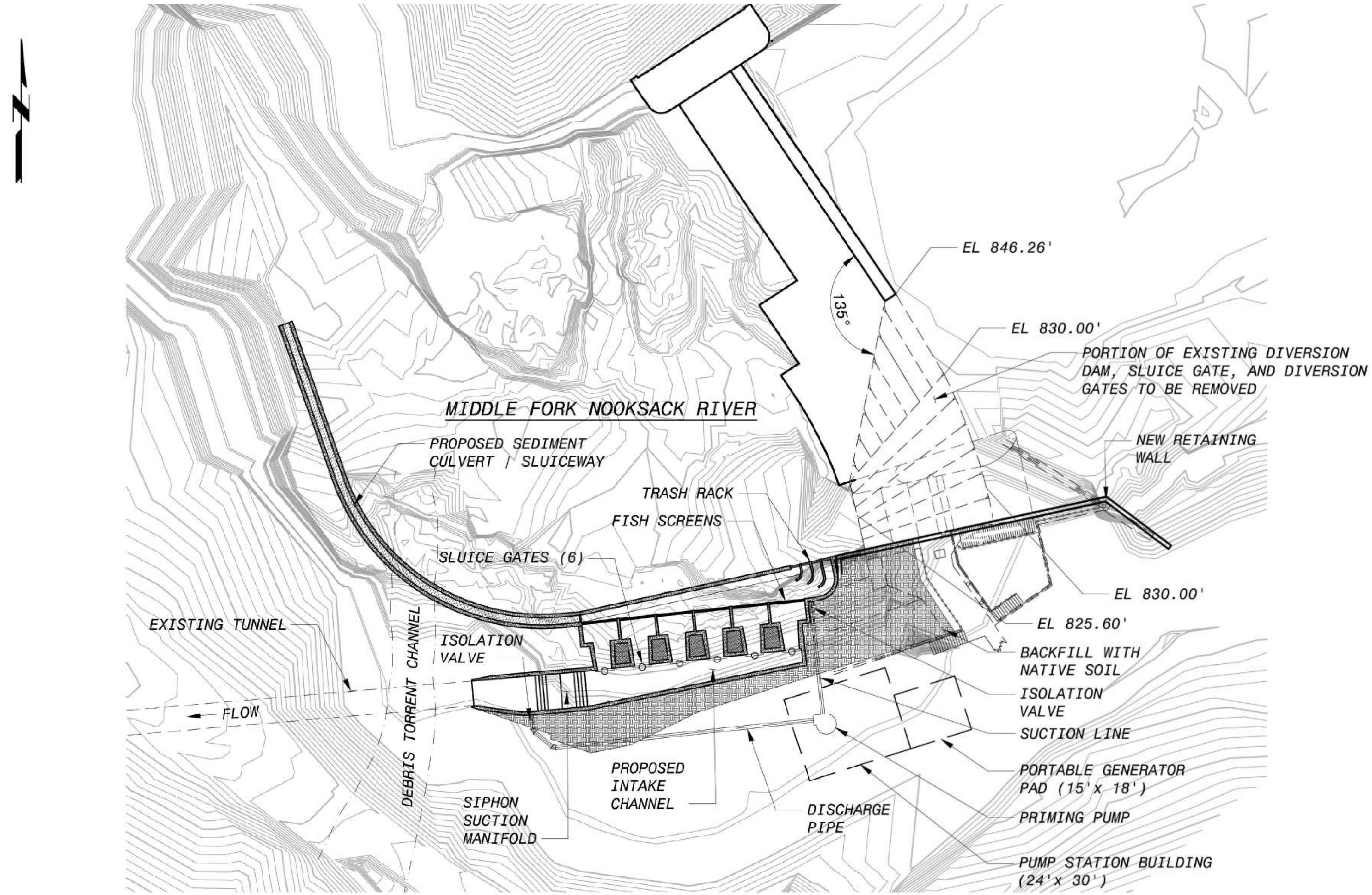
CITY ENGINEER CHAD SCHULHAUSER PE
ASSISTANT DIRECTOR CHAD SCHULHAUSER PE

CONCEPT ALTERNATIVES REPORT

ALTERNATIVE A
FISH LADDER - PROFILE & SECTIONS

FILENAME P01-P07.dwg
SCALE NOT TO SCALE
PLATE P-6



INTAKE - SITE PLAN

FIGURE 1

CITY OF BELLINGHAM
MIDDLE FORK TUNNEL INTAKE FEASIBILITY STUDY
INTAKE SITE PLAN - OPTION 1

BLACK & VEATCH
Black & Veatch Corporation
Portland, Oregon

HDR

ISSUE	DATE	DESCRIPTION
-	-	-

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PROJECT NUMBER	10090926

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MIDDLE FORK NOOKSACK RIVER
FISH PASSAGE PROJECT
PUBLIC WORK DEPARTMENT
ENGINEERING DIVISION
CITY OF BELLINGHAM WASHINGTON
DIRECTOR PUBLIC WORKS TED CARLSON
CITY ENGINEER CHAD SCHULHAUSER PE
ASSISTANT DIRECTOR CHAD SCHULHAUSER PE

CONCEPT ALTERNATIVES REPORT

ALTERNATIVE B
SIPHON WITH DAM REMOVAL - PLAN

0 1" 2"
FILENAME P01-P07.dwg
SCALE NOT TO SCALE
PLATE **P-7**

northwest hydraulic consultants (nhc)
16300 Christensen Rd Ste. 350
Seattle, WA 98188-3418
tel (206) 241-6000
fax (206) 439-2420
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HARBOR CONSULTING ENGINEERS
ENGINEERS · PLANNERS · SURVEYORS
3006 FUHRMAN AVENUE, EAST
SEATTLE, WA 98102
(206) 709-2387

PanGEO INCORPORATED

CLIENT
City of Bellingham
Final Submittal
CLIENT PROJECT NUMBER
2003-194

NOTES: Reduced to 50% of Full Size

Design By:	ETZ
Checked By:	
Drawn By:	RAB/CADDNW
Submitted By:	

NO.	DATE	REVISION	DWN.	CHK.	APPR.

Middle Fork Nooksack River
Water Intake Preliminary Engineering
Penstock Plan

SHEET SIZE:	D
SCALE:	
RELEASE DATE:	06/04/2006
PROJECT NUMBER:	21264
PLATE NUMBER	C3.0
SHT.No.	9 of 50
REV.	0

nhc-sea\21264-Nooksack\MFNooksack 01042006.dwg

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DESIGNED BY	
CHECKED BY	
DRAWN BY	
PROJECT NUMBER	10090926

ISSUE	DATE	DESCRIPTION
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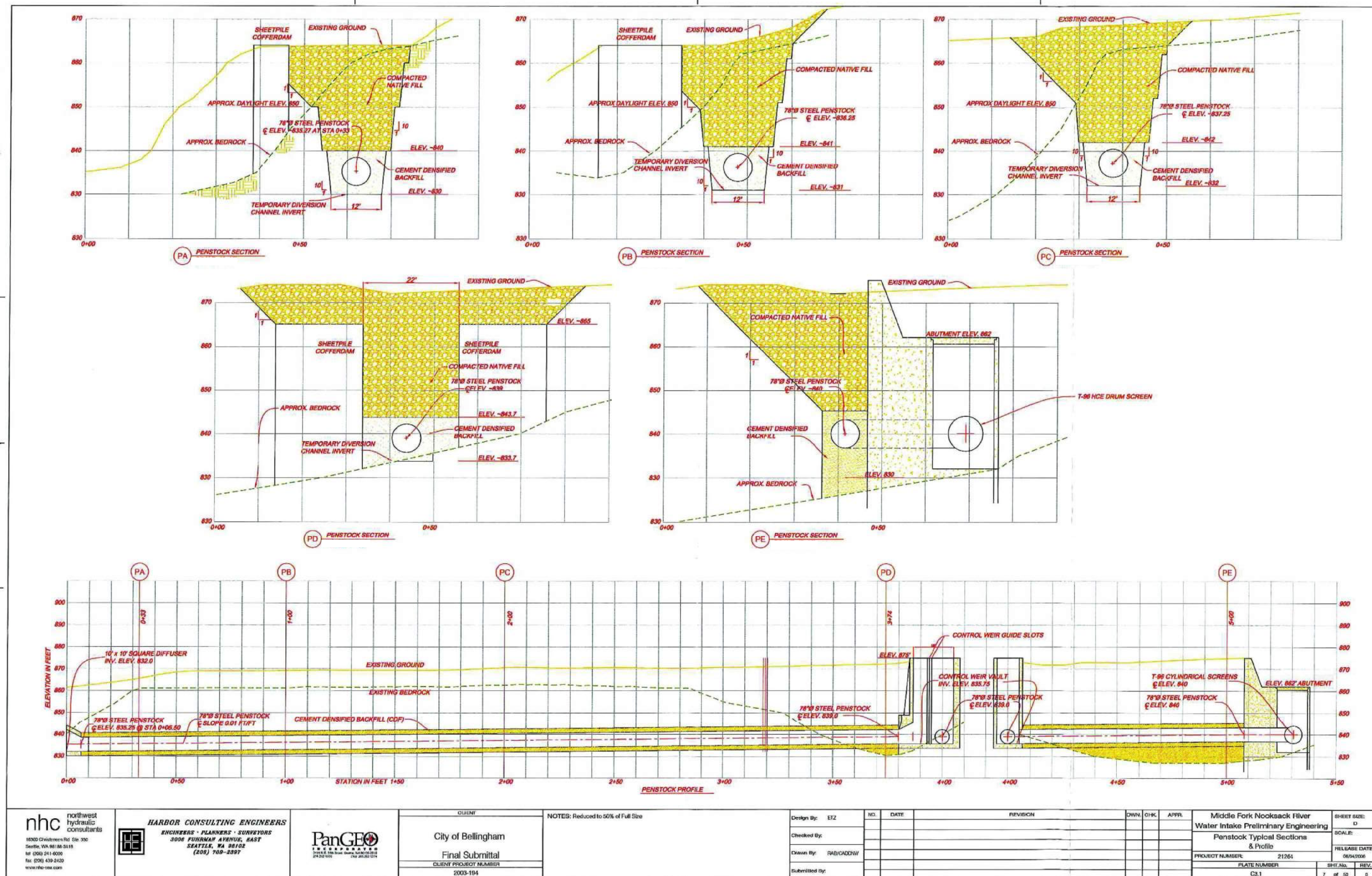
MIDDLE FORK NOOKSACK RIVER
FISH PASSAGE PROJECT

PUBLIC WORK DEPARTMENT
ENGINEERING DIVISION

DIRECTOR PUBLIC WORKS TED CARLSON
CITY ENGINEER CHAD SCHULHAUSER PE
ASSISTANT DIRECTOR CHAD SCHULHAUSER PE

CONCEPT ALTERNATIVES REPORT
ALTERNATIVE C
INTAKE AT CONSTRUCTED SCOUR POOL & DAM REMOVAL - PENSTOCK PLAN

FILENAME P01-P07.dwg
SCALE NOT TO SCALE
PLATE P-8



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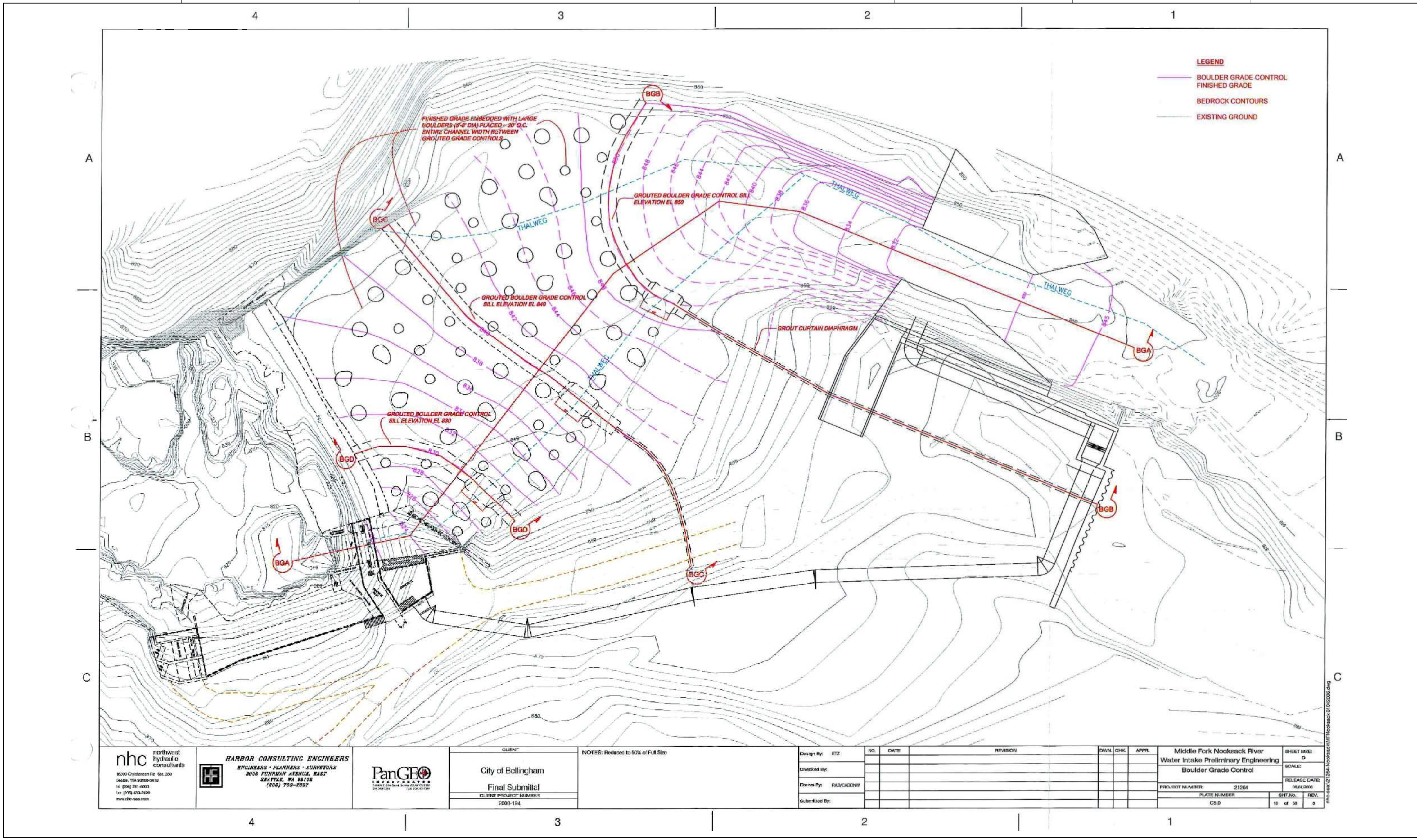
CITY ENGINEER CHAD SCHULHAUSER PE
ASSISTANT DIRECTOR CHAD SCHULHAUSER PE

CONCEPT ALTERNATIVES REPORT
ALTERNATIVE C
INTAKE AT CONSTRUCTED SCOUR POOL & DAM REMOVAL - PENSTOCK PROFILE & SECTIONS

FILENAME P01-P07.dwg
SCALE NOT TO SCALE

PLATE **P-9**



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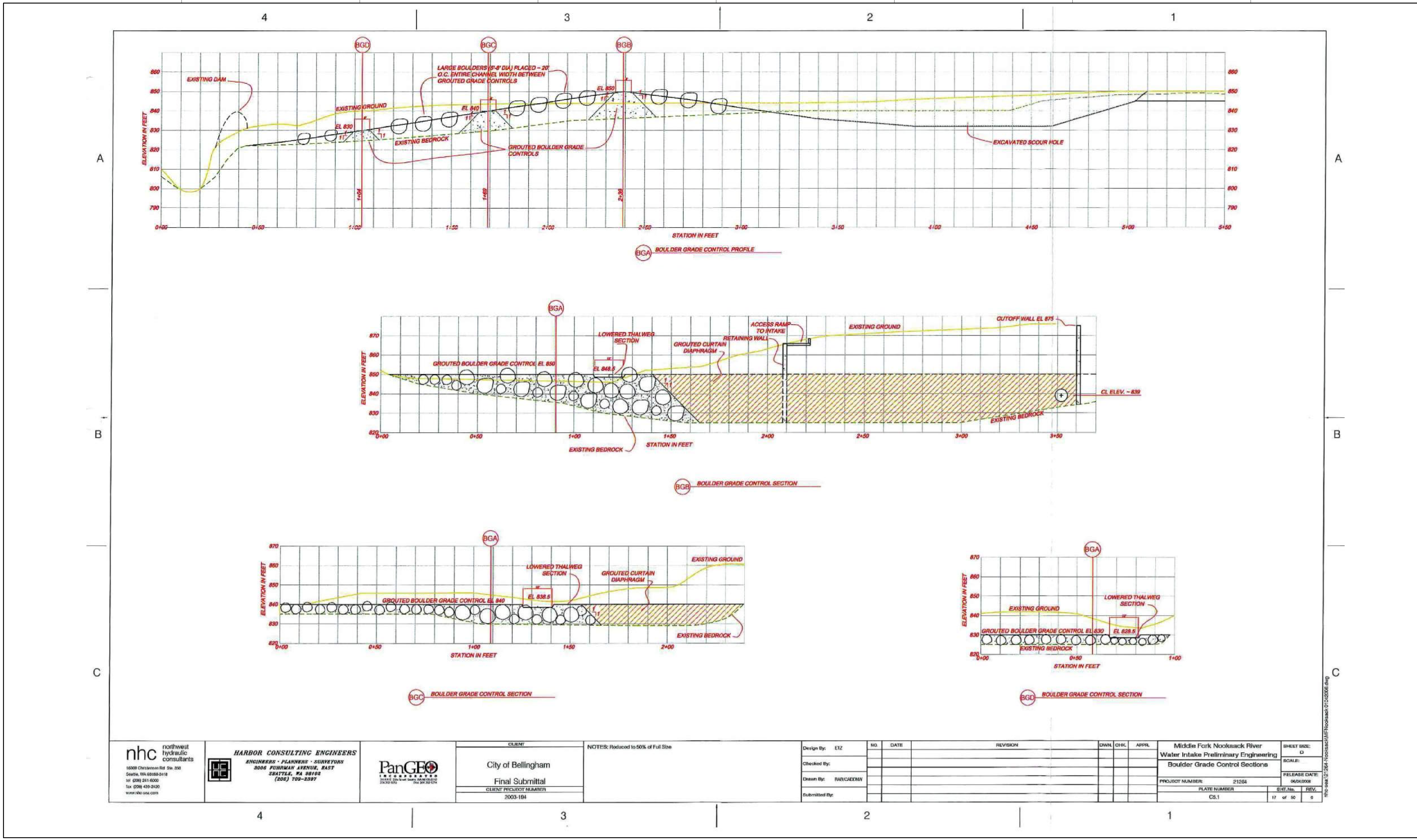
ENGINEERING DIVISION

DIRECTOR PUBLIC WORKS TED CARLSON
CITY ENGINEER CHAD SCHULHAUSER PE
ASSISTANT DIRECTOR CHAD SCHULHAUSER PE

CONCEPT ALTERNATIVES REPORT
ALTERNATIVE C
INTAKE AT CONSTRUCTED SCOUR POOL & DAM
DAM - CHANNEL MODIFICATION PLAN

FILENAME P01-P07.dwg
SCALE NOT TO SCALE
PLATE P-10



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PROJECT NUMBER	10090926

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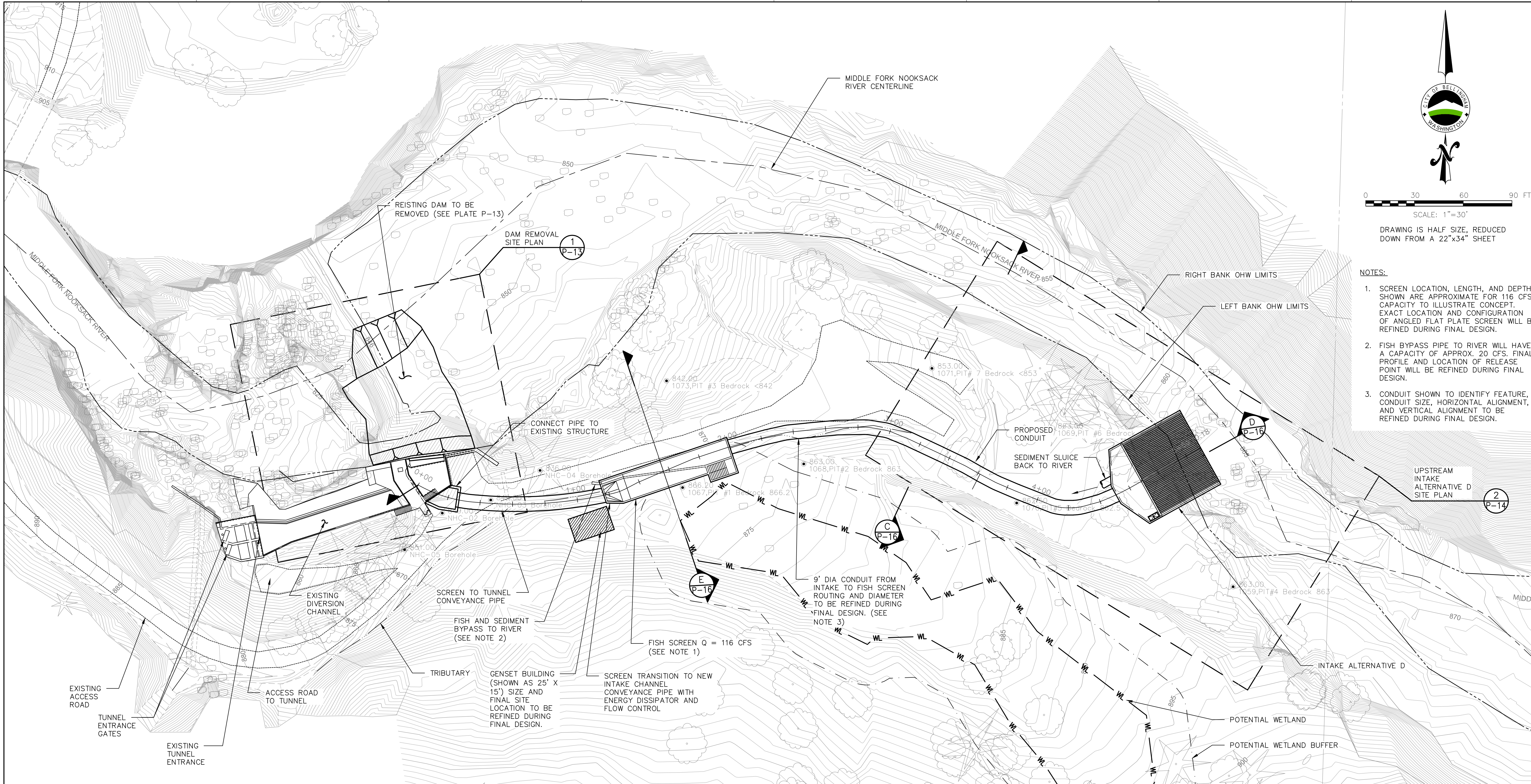
MIDDLE FORK NOOKSACK RIVER
FISH PASSAGE PROJECT
PUBLIC WORK DEPARTMENT
ENGINEERING DIVISION
DIRECTOR PUBLIC WORKS TED CARLSON
CITY ENGINEER CHAD SCHULHAUSER PE
ASSISTANT DIRECTOR CHAD SCHULHAUSER PE

CONCEPT ALTERNATIVES REPORT
ALTERNATIVE C
INTAKE AT CONSTRUCTED SCOUR POOL & DAM
DAM - CHANNEL MODIFICATION SECTIONS

FILENAME P01-P07.dwg
SCALE NOT TO SCALE
PLATE **P-11**



NOTES:

1. SCREEN LOCATION, LENGTH, AND DEPTH SHOWN ARE APPROXIMATE FOR 116 CFS CAPACITY TO ILLUSTRATE CONCEPT. EXACT LOCATION AND CONFIGURATION OF ANGLED FLAT PLATE SCREEN WILL BE REFINED DURING FINAL DESIGN.
2. FISH BYPASS PIPE TO RIVER WILL HAVE A CAPACITY OF APPROX. 20 CFS. FINAL PROFILE AND LOCATION OF RELEASE POINT WILL BE REFINED DURING FINAL DESIGN.
3. CONDUIT SHOWN TO IDENTIFY FEATURE, CONDUIT SIZE, HORIZONTAL ALIGNMENT, AND VERTICAL ALIGNMENT TO BE REFINED DURING FINAL DESIGN.

UPSTREAM INTAKE ALTERNATIVE D SITE PLAN (1 / P-1)

SCALE: 1"=30'

LEGEND:

- OHW
- WL — WETLAND
- WETLAND BUFFER

HDR

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT MANAGER	ED ZAPEL, PE
DESIGNED BY	
CHECKED BY	
DRAWN BY	J CAMPBELL
PROJECT NUMBER	10090926

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MIDDLE FORK NOOKSACK RIVER FISH PASSAGE PROJECT

PUBLIC WORK DEPARTMENT
ENGINEERING DIVISION

DIRECTOR PUBLIC WORKS TED CARLSON
CITY ENGINEER CHAD SCHULHAUSER PE
ASSISTANT DIRECTOR CHAD SCHULHAUSER PE

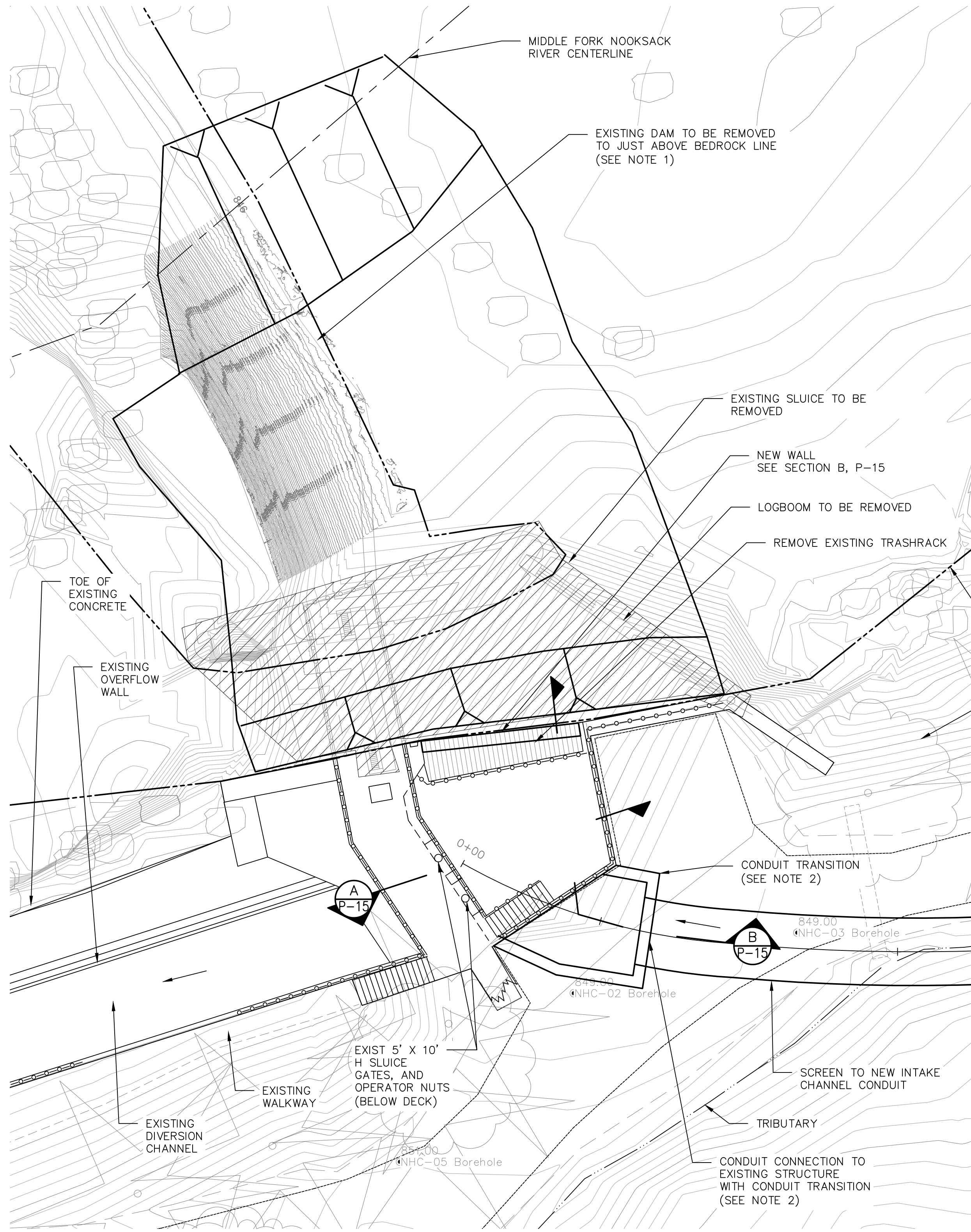
CONCEPT ALTERNATIVES REPORT

UPSTREAM INTAKE ALTERNATIVE D SITE PLAN

0 1" 2"

FILENAME P-12.dwg
SCALE -
PLATE P-12

1 2 3 4 5 6 7 8



DAM REMOVAL SITE PLAN (1 / P-12)
SCALE: 1"=10'

0 5 10 20 30 FT
SCALE: 1"=10'

DRAWING IS HALF SIZE, REDUCED DOWN FROM A 22"x34" SHEET

LEGEND:
- OHW
- WL — WETLAND
- WETLAND BUFFER

NOTES:

1. ADDITIONAL DETAIL ON GRADING WILL BE PROVIDED FOR FINAL DESIGN.
2. CONDUIT TRANSITION, PIPE DIAMETER, AND FLOW CONTROL TO BE DEVELOPED FURTHER DURING FINAL DESIGN, IMAGES SHOWN ARE ONLY TO IDENTIFY THESE FEATURES.

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT MANAGER	ED ZAPEL, PE
DESIGNED BY	
CHECKED BY	
DRAWN BY	J CAMPBELL
PROJECT NUMBER	10090926

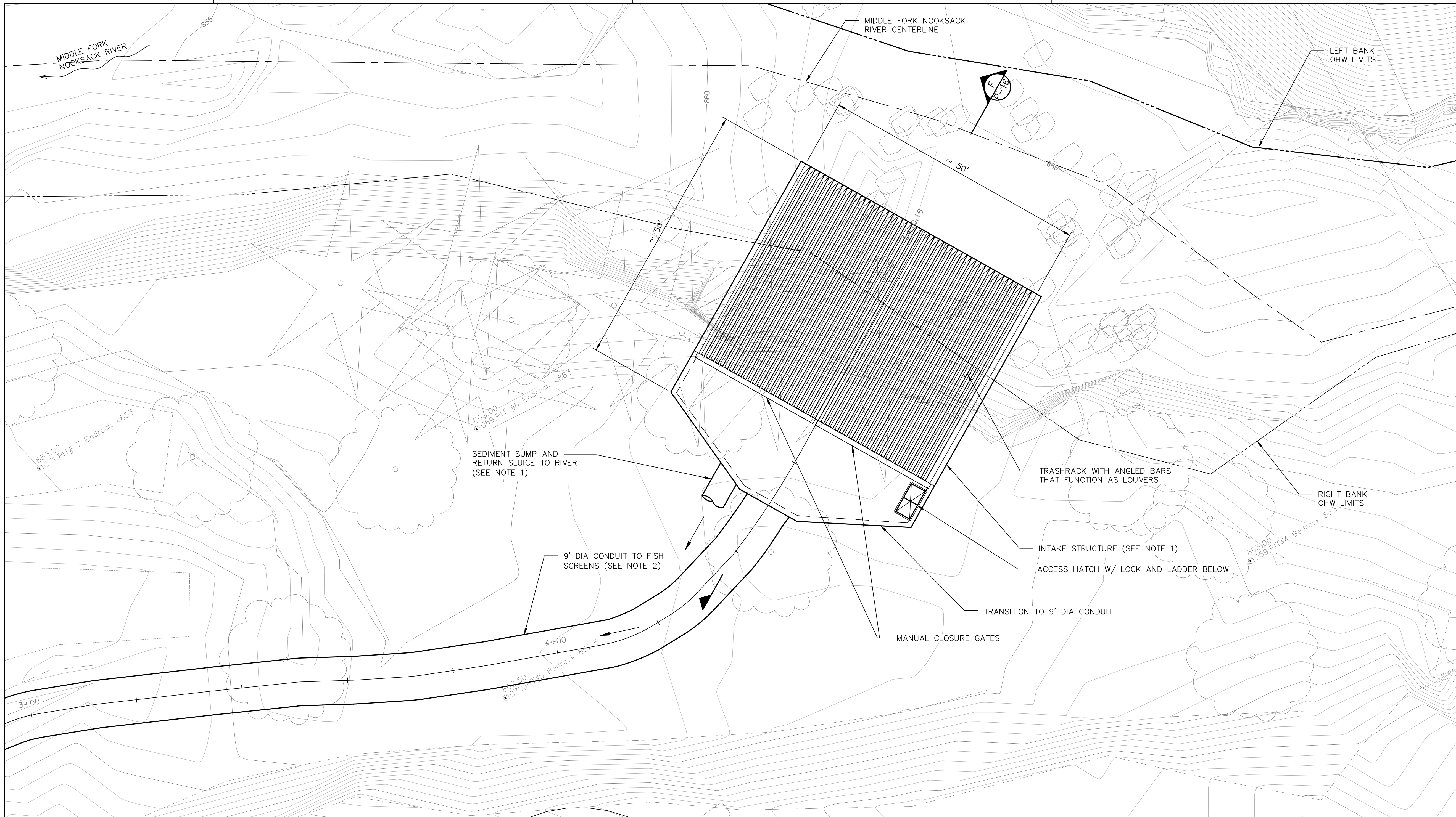
DRAFT

MIDDLE FORK NOOKSACK RIVER FISH PASSAGE PROJECT
PUBLIC WORK DEPARTMENT
ENGINEERING DIVISION
DIRECTOR PUBLIC WORKS TED CARLSON
CITY ENGINEER CHAD SCHULHAUSER PE
ASSISTANT DIRECTOR CHAD SCHULHAUSER PE

CONCEPT ALTERNATIVES REPORT

ALT D PROPOSED CONDUIT CONNECTION AND DAM REMOVAL

0 1" 2"
FILENAME P13.dwg
SCALE -
PLATE P-13



SCALE: 1"=10'

DRAWING IS HALF SIZE, REDUCED DOWN FROM A 22"x34" SHEET

LEGEND:

- OHW
- WL WETLAND
- WETLAND BUFFER

NOTES:

1. INTAKE LOCATION IS SHOWN FOR FINAL DESIGN. HOWEVER, INTAKE SIZE, SHAPE, SEDIMENT SUMP, AND SEDIMENT RETURN SLUICE FEATURES ARE SHOWN SCHEMATICALLY TO IDENTIFY KEY FEATURES AND GENERAL SIZE. ADDITIONAL DESIGN DEVELOPMENT WILL BE REQUIRED FOR FINAL DESIGN.
2. CONDUIT SHOWN TO IDENTIFY FEATURE, CONDUIT SIZE, HORIZONTAL ALIGNMENT, AND VERTICAL ALIGNMENT TO BE REFINED DURING FINAL DESIGN.

UPSTREAM INTAKE ALTERNATIVE D SITE PLAN (2 / P-12)

SCALE: 1"=10'

PROJECT MANAGER	ED ZAPEL, PE
DESIGNED BY	
CHECKED BY	
DRAWN BY	J CAMPBELL
PROJECT NUMBER	10090926

ISSUE	DATE	DESCRIPTION
-	-	-

DRAFT

MIDDLE FORK NOOKSACK RIVER FISH PASSAGE PROJECT

PUBLIC WORK DEPARTMENT
ENGINEERING DIVISION

DIRECTOR PUBLIC WORKS TED CARLSON
CITY ENGINEER CHAD SCHULHAUSER PE
ASSISTANT DIRECTOR CHAD SCHULHAUSER PE

CONCEPT ALTERNATIVES REPORT

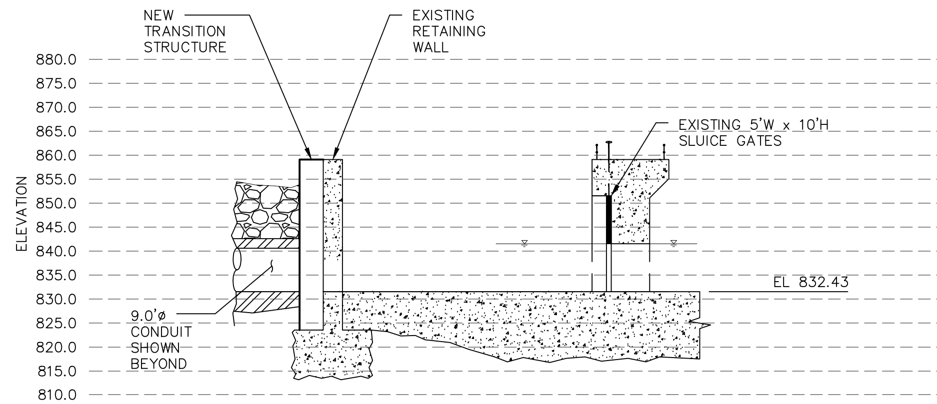
UPSTREAM INTAKE ALTERNATIVE D INTAKE PLAN

FILENAME P14.dwg

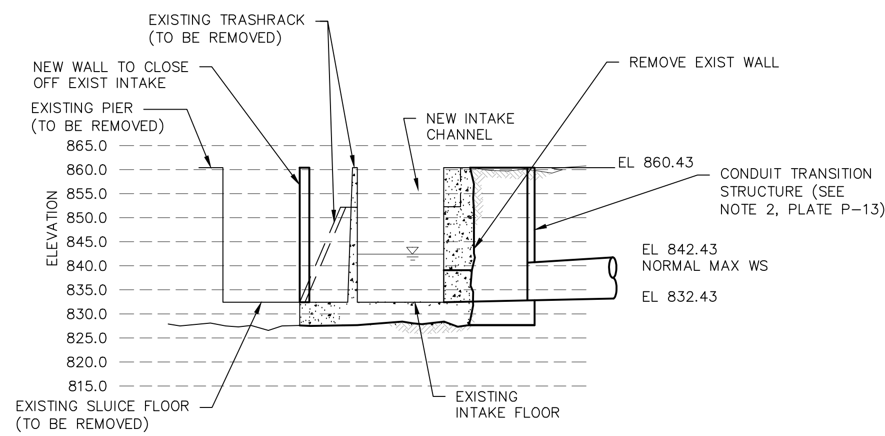
SCALE -

PLATE P-14

DRAWING IS HALF SIZE, REDUCED DOWN FROM A 22"x34" SHEET



SECTION A P-13
SCALE: 1"=20'



SECTION B P-13
SCALE: 1"=20'

PROJECT MANAGER	ED ZAPEL, PE
DESIGNED BY	
CHECKED BY	
DRAWN BY	J CAMPBELL
PROJECT NUMBER	10090926

ISSUE	DATE	DESCRIPTION
-	-	-

DRAFT

MIDDLE FORK NOOKSACK RIVER FISH PASSAGE PROJECT

PUBLIC WORK DEPARTMENT
ENGINEERING DIVISION

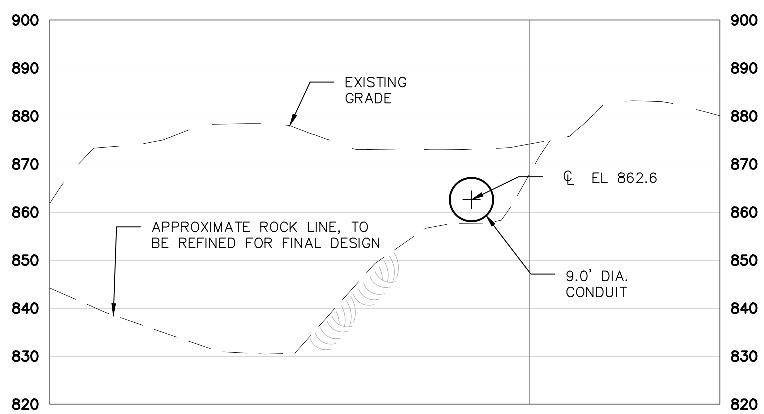
DIRECTOR PUBLIC WORKS TED CARLSON
CITY ENGINEER CHAD SCHULHAUSER PE
ASSISTANT DIRECTOR CHAD SCHULHAUSER PE

CONCEPT ALTERNATIVES REPORT

UPSTREAM INTAKE ALTERNATIVE D CONDUIT TRANSITIONS SECTIONS

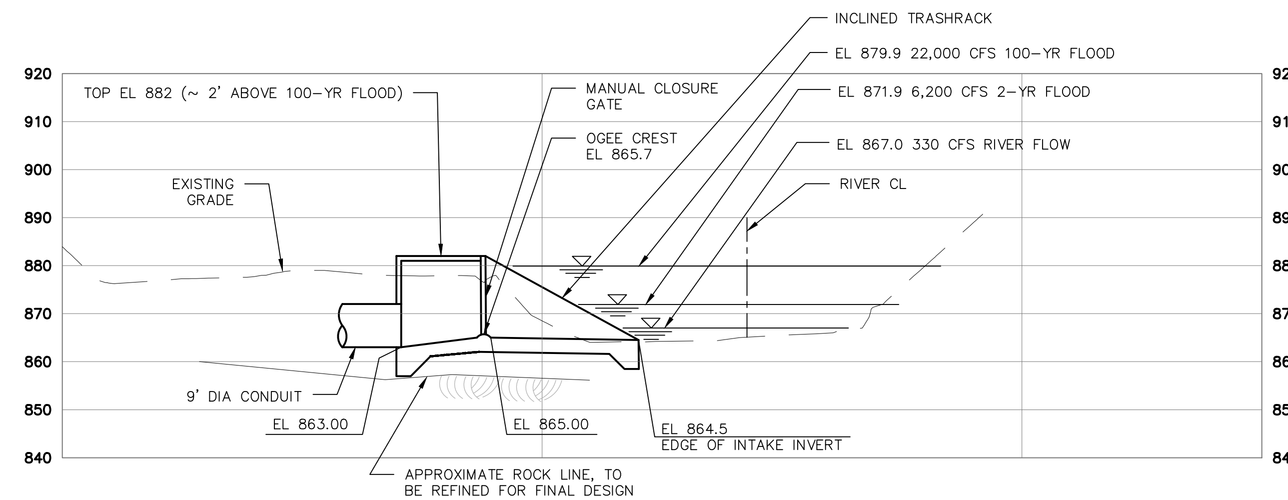
FILENAME P15.dwg
SCALE -
PLATE **P-15**

DRAWING IS HALF SIZE, REDUCED DOWN FROM A 22"x34" SHEET



SECTION C P-12

SCALE: 1"=20'



NOTE: CONCEPT AND ELEVATIONS SHOWN TO BE REFINED DURING FINAL DESIGN.

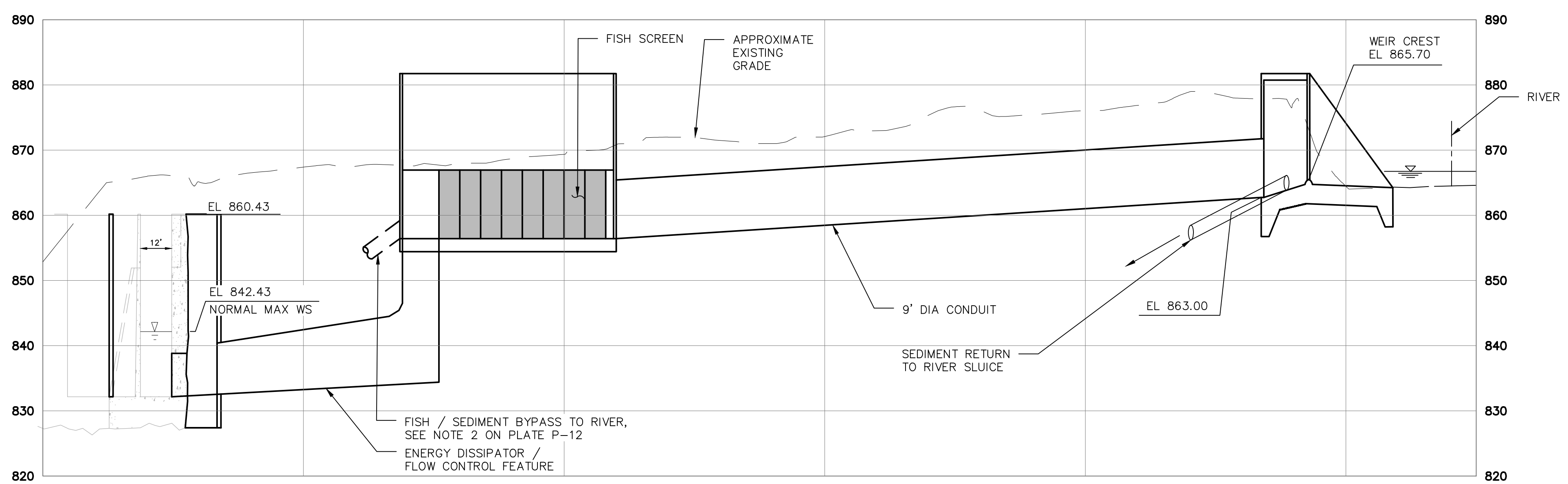
SECTION F P-14

SCALE: 1"=20'

DESIGN DEPTH AND FLOW DATA AT CENTERLINE OF INTAKE

EL FT	DEPTH FT	Q CFS	NOTES
864.5	0.0	0	CL THALWEG
866.4	1.9	160	95% ANNUAL EXCEEDANCE
866.7	2.2	225	REF
867.1	2.6	330	OK TO DIVERT
867.5	3.0	500	REF
869.0	4.5	1,420	5% ANNUAL EXCEEDANCE
869.6	5.1	2,100	REF
871.9	7.4	6,200	2 YR FLOOD
875.5	11.0	12,200	10 YR FLOOD
879.9	15.4	22,000	100 YR FLOOD

SOURCE: NHC HEC-RAS MODEL DATA, RS 7.996



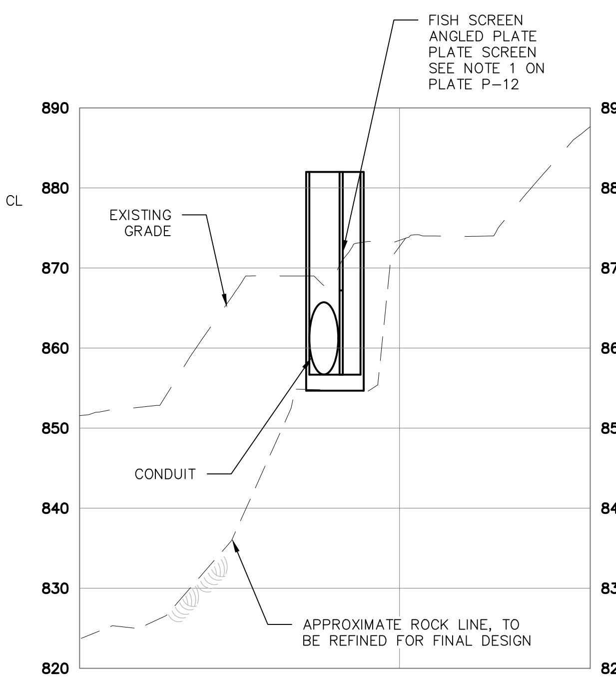
PROFILE D P-12

SCALE: HORIZONTAL 1"=30' VERTICAL 1"=12'

SCALE: 1"=30'

SCALE: 1"=12'

NOTE: INTAKE, SEDIMENT SLUICE, FLOW CONDUITS, SCREEN, AND SCREEN FLOW CONTROL TO BE REFINED DURING FINAL DESIGN.



SECTION E P-12

SCALE: HORIZONTAL 1"=30' VERTICAL 1"=12'

SCALE: 1"=30'

SCALE: 1"=12'

HDR

PROJECT MANAGER	ED ZAPEL, PE
DESIGNED BY	
CHECKED BY	
DRAWN BY	J CAMPBELL
PROJECT NUMBER	10090926

ISSUE	DATE	DESCRIPTION
-	-	-

DRAFT

MIDDLE FORK NOOKSACK RIVER FISH PASSAGE PROJECT

PUBLIC WORK DEPARTMENT
ENGINEERING DIVISION

DIRECTOR PUBLIC WORKS TED CARLSON
CITY ENGINEER CHAD SCHULHAUSER PE
ASSISTANT DIRECTOR CHAD SCHULHAUSER PE

CONCEPT ALTERNATIVES REPORT

UPSTREAM INTAKE ALTERNATIVE D CONDUIT PROFILE, SECTIONS AND DETAILS

FILENAME P16.dwg

SCALE -

PLATE **P-16**

Appendix B. Project Partner Questions from Alternative Selection Meeting & Emails

Alternative Selection Workshop:
Q&A Discussion and Report References

Alternative Selection Workshop Date: Feb 12, 2018

Attendees:

- John Thompson, Erika Douglas, George Boggs (Whatcom County Public Works – Natural Resources)
- Renee LaCroix, Stephen Day, Clare Fogelsong, Maric Schorr, Chad Schulhauser, Analiese Burns (City of Bellingham, Public Works, Natural Resources)
- Dave Beatty (Nooksack Salmon Enhancement Association)
- Joel Ingram (Washington Dept. of Fish and Wildlife)
- Ned Currence, Michael Maudlin, Treva Coe (Nooksack Tribe – Natural Resources)
- Lisa Wilson, Kara Kuhlman, Kelley Turner (Lummi Nation – Natural Resources)
- Ed Zapel, Matt Prociv, Becky Holloway (HDR)
- Paul DeVries (R2)
- April McEwen (American Rivers)

1. Initial set of questions related to Alternative D:
   Q: Could you explain how you're going to block the flow into the channel? Is that a gate of some sort?
   A: The intake structure will be provided with closure bulkheads to prevent diversion when not required. The volume of flow withdrawn from the river will be regulated by a weir in the intake structure, which will prevent diversion below minimum in stream river flows. The volume of diversion flow will be controlled by a gate at the screen channel, which will also regulate water depth on the screen system.
   See also:
   - ***Conceptual Alternatives Report - June 2018*, Section 4.3.1**
   - ***Conceptual Alternatives Report - June 2018*, Appendix A, plate P-14**

   Q: So there's no way to shut the pipe off [not have water in the pipe] when you're not diverting?
   A: As above, the closure bulkheads at the intake structure will provide positive closure of the diversion system.
   See also:
   - ***Conceptual Alternatives Report - June 2018*, Section 4.3.1**
   - ***Conceptual Alternatives Report - June 2018*, Appendix A, plate P-14**

   Q: Where will fish be returned to the river?
   A: We don't know exactly where fish will be returned to the river from the bypass channel. There are a lot of considerations that need to be made in refining the design to determine that. We will seek the best place to return fish from the bypass channel back to the river channel

based on all of the studies previously done. It could be a good idea at this stage to make that location somewhat flexible, in case we want to change it later in the design process. We want input on that…where is the best place to put fish back in the river? The design team definitely needs input from the fishery co-managers to determine the answer to that question.
See also:
- ***Conceptual Alternatives Report - June 2018*, Section 4.3.1**
- ***Conceptual Alternatives Report - June 2018*, Appendix A, plate P-12**

2. Q: Is the diversion gate the way you would be able to ramp flows?
A: At the end of the screen section, we could have a gate or ramp weir there to modulate amount of flow in the tunnel. The strategy here would be to ensure capacity for the City's 116 cfs to be diverted, and whatever bypass flow necessary to protect fish and get them out of the screen system and back to the river is all that is ever drawn from the river. We would use a control gate at the end to modulate that.
See also:
   - ***Conceptual Alternatives Report - June 2018*, Section 4.3.1**
   - ***Conceptual Alternatives Report - June 2018*, Appendix A, plate P-12**
3. Was the projected change in the seasonal flow patterns associated with climate change included in your evaluation of concepts?
A: It was, and is a consideration.
See also:
   - ***Conceptual Alternatives Report - June 2018*, Section 3.2.6**
4. Q: Another question that has come up is related to the diversion of water from the Middle Fork to Lake Whatcom, which has a pathogen-free water quality certification. There is nothing in your design that would eliminate that problem.
A: That is correct. WDFW has informed us this would not be an issue that restrains the project from moving forward, and thus we are considering Lake Whatcom's pathogen-free certification as a separate issue that is out of project scope. (Joel) WDFW and the other fishery co-manager project partners are discussing several solutions.
5. Q: When that part of the dam comes out, what will the slope be compared to prior to the dam?
A: The pre and post project profiles related to material relaxing downstream to fill in scour pool and geomorphic setting was discussed. Based on previous physical modeling studies, it is likely that the future channel will regrade to a similar combination of slopes that existed prior to dam construction. It will not likely be a straight slope, but rather a combination of boulder step pools.
See also:
   - ***Conceptual Alternatives Report - June 2018*, Section 3.2.5**
   - ***Conceptual Alternatives Report - June 2018*, Section 3.3.2**
   - ***Conceptual Alternatives Report - June 2018*, Section 4.3.1**
6. Q: There is going to be a need to monitor the results of this activity. Is going to take a fair amount of manpower, and fishery co-managers need to discuss.

A: Correct

7. Q: How is leaving in the remnant of the dam important to the channel stability of the reach between the dam and the new intake location?
   A: Ed referenced physical model study, historical photos of dam site, geological and geomorphological setting of the dam site. In the physical model study, when the river right side dam ogee crest was removed, the bankfull flow (channel shaping flow) occupied the entire width of the channel, and there was so much sediment transport on river right that the fear was it would continue to erode the softer greenstone and widen the channel further. Leaving in a portion of the dam on the side where there used to be a natural geomorphic control (large rock knob that was shaved off during dam construction), allows the channel to regrade into a natural channel, pre-dam configuration with more average channel width and slope and a natural boulder matrix as the material above the dam relaxes downstream to fill in the scour pool.
   See also:
   - ***Conceptual Alternatives Report - June 2018*, Section 1.3.3**
   - ***Conceptual Alternatives Report - June 2018*, Section 4.3.1**
   - ***Conceptual Alternatives Report - June 2018*, Appendix A, plate P-12**
8. Q: What do you anticipate in terms of the longevity of the remaining portion of the dam, considering the hard concrete dam crest has eroded down almost a foot over the years from sediment scour?
   A: Leaving a remnant of the dam on the river right side maintains grade elevation, and removing the dam on the left allows the channel thalweg to readjust to its historical position. This keeps the channel shaping (bankfull) flow, and associated sediment scour off the right side, protecting the remnant structure and reducing erosional influence on the soft greenstone. It may be necessary to conduct more detailed analysis of the effects of retaining portions of the remnant ogee crest that was constructed atop the excavated rock knob in the ensuing phase of the design.
   See also:
   - ***Conceptual Alternatives Report - June 2018*, Section 1.3.3**
   - ***Conceptual Alternatives Report - June 2018*, Section 4.3.1**
   - ***Conceptual Alternatives Report - June 2018*, Appendix A, plate P-12**

   Q: Will repairs be necessary regardless?
   A: We don't think so, but this will be looked at more. The concrete is very hard, much harder than the soft greenstone.
   Additional discussion – the slots through the greenstone on that side may be passable to steelhead. As an additional design consideration, we may explore ways to enhance the right side through those slots to open up additional pathways for migration. Velocity corridors/passage pathways were mapped in physical modeling under a dam removal scenario in previous efforts.
   See also:
   - ***Conceptual Alternatives Report - June 2018*, Section 4.3.1**
   - ***Conceptual Alternatives Report - June 2018*, Appendix A, plate P-12**
9. Q: Can you give us some idea of the difference of the $6 and $12M estimate?

A: ($6M) Everything goes as planned to ($12M) using all contingency with construction period being altered due to high flows, delays associated with working in a tight space and getting materials/equipment over the weight-limited bridge. The estimate will be updated at 60% design, on schedule to be completed by July 2018. At this time, the formal construction cost estimate is $12M.
See also:
- ***Conceptual Alternatives Report - June 2018*, Section 5.2.1**
- ***Conceptual Alternatives Report - June 2018*, Appendix D**

10. Q: Is the fish screen chamber open?
A: At this conceptual level, we are thinking it would probably have some sort of grating on it, because don't want people, birds, debris in there, and want to control access. We are thinking it will likely be a concrete box, 10-12 feet deep, 60-70 feet long, conventional vertical panel screen.
See also:
    - ***Conceptual Alternatives Report - June 2018*, Section 4.3.1**
    - ***Conceptual Alternatives Report - June 2018*, Appendix A, plate P-12**
11. Q: It is encouraging to see all the previous work was so helpful. This looks like a nice simple design, are you confident in it?
A: (Ed, HDR PM): I am confident in it knowing what I know about the channel characteristics, diversion characteristics, the manpower the City has, the alternative simplicity compared to the others, and how this alternative moves infrastructure out of the dynamic channel. This alternative lets the river do what it wants to do, doesn't force it, just nudges enough to allow the water diversion intake to be sustainable.
See also:
    - ***Conceptual Alternatives Report - June 2018*, Section 4.3.1**
12. Q: If you get a debris flow from glacier retreat, do you expect that to work its way through the system pretty quickly?
A: It has historically, and we figure it will probably continue to do so. There is evidence of those kinds of debris flows in that flatter upstream reach. There was a really large one in 2014, and the channel hasn't changed much.
See also:
    - ***Conceptual Alternatives Report - June 2018*, Section 3.2.5**
13. Q: How do you deal with a debris flow entering the intake and the penstock – how do you maintain it?
A: Those are major questions for consideration at the 30, 60, 90 levels, where does the sediment go, how do we get it out of there, and how do we keep the intake functioning? We think this approach is going to be more maintainable than the previous alternatives considered. Right now when the diversion occurs, the sluicegates close and pond any water behind it. So, all the fine silt and any other bedload transport either settles out behind the sluicegate, or goes through the screens and into the sedimentation channel. With the new alternative, the amount of sediment drawn into the diversion would be less, as the majority of bedload and silt would

generally pass on downstream instead of al being forced into the diversion as it is now. So, the new intake system will be designed to keep more debris and fine sediment out of the system than now.

See also:

- ***Conceptual Alternatives Report - June 2018*, Section 4.3.1**
- ***Conceptual Alternatives Report - June 2018*, Appendix A, plates P-12 & P-14**

14. Q: Can you discuss the geomorphic-based design approach to fish passage (post-dam removal) in more nimble terms?

    A: Geomorphic based passage design evaluates the relative stage and submergence or exposure of various head drops and chutes over a wide range of flow conditions. For example, some channel forms might appear to be a barrier at some flows but submergence at higher flows alter the apparent barrier to make it passable. We have a good understanding, both empirically and theoretically, of the swimming and jumping capabilities of anadromous salmonids, and geomorphic based design and evaluation considers these capabilities in light of the relative hydraulic characteristics of barriers. We certainly expect the channel to regrade and evolve through the dam site naturally, but we can help it along to be passable by placing boulders (note: there is a limit to what size boulders can be moved and adjusted due to equipment size limitations), etc. The guiding design principle is to make passage conditions be as good, or better, than pre-dam conditions, and the channel through the dam site to be no more of an impediment than typical channel conditions downstream and upstream.

    See also:

    - ***Conceptual Alternatives Report - June 2018*, Section 3.3.2**

15. Q: Wasn't there some evaluation of the flows through the downstream gorge that were optimal for fish passage?

    A: Previous studies evaluated these hydraulic characteristics, and this work is extended and expanded in the current evaluation. Both turbidity and hydraulic limitations were examined in prior studies, and these are included in the present studies. For example, the previous studies concluded that flows above 1200 cfs might limit passage through the downstream gorge.

    See also:

    - ***Conceptual Alternatives Report - June 2018*, Section 1.3.3**
    - ***Conceptual Alternatives Report - June 2018*, Section 4.3.1**

16. Q: Will the conceptual report provide a description of the expected physical configuration for a certain range of flows?

    A: We are assembling a fairly detailed hydraulic model that will help us characterize those kinds of hydraulic parameters, like jump heights, submergence, depths, velocities, through the entire reach from the Mosquito Lake Road bridge to above the dam-influenced reach. Additional data were obtained to help ground-truth the model from kayaker photos and data in the downstream gorge at various discharges to help characterize the typical cascades and drop heights. We also have LIDAR data. The hydraulic model includes these new data, and presents more detailed channel bathymetry and more accurate channel hydraulics below and above the dam.

See also:

- ***Conceptual Alternatives Report - June 2018*, Section 3.2.3.1**

Q: And will there be some monitoring to confirm that, or any follow-up to indicate those projections are confirmed?

A: There isn't a formal monitoring plan as of yet to document changes in physical parameters, but there is for species presence (passability at the site). Nooksack Tribe currently produces escapement estimates for steelhead and Chinook, and also document presence of additional species such as bull trout. Need to work out any details related to need to expand survey areas to request additional funding to support extra monitoring effort required. The Nooksack existing survey data can be used as baseline data, and annual estimates post dam removal can be used to verify passage as well.

17. From Michael Maudlin (Nooksack Tribe) email: "I recall from the physical modeling that passage at the dam site was improved across a wider range of flows with the full removal of the dam. I think I remember that the justification for leaving a portion in place was that passage was already restricted at higher flows downstream in the canyon and that the remaining dam was important for maintaining flow against the siphon. I understand that the designers are comparing the current site conditions with the pre-dam site conditions, when the bedrock constriction was present, but it seems like it would be more important to maximize the potential for fish passage at a wider range of flows if possible.

    If the remnant is having an impact on passage and is staying in place to address channel stability then I guess I'm still unclear about the channel instability issue that the designers are seeing in the reach and how it relates to the remnant piece of the dam. I gather the concerns are for the erosion of the deeper glacial material that is overlying the bedrock adjacent to the channel and the erosion of the greenstone under the dam. I understand that the expectation is that the channel will fairly quickly cut through the material stored behind the dam and regrade to ~5% through the reach, which is what I recall from the physical modeling, but I don't see how the transport of this stored material (under either a partial or full removal scenario) and the subsequent grade adjustment is tied to the other concerns about channel stability that were mentioned.

    Anyway, if the removal of the full dam would be expected to improve fish passage for a wider range of flows at the site then I think it's worth taking a closer look at the justification for leaving it there."

    See also:

    - ***Conceptual Alternatives Report - June 2018*, Section 1.3.3**
    - ***Conceptual Alternatives Report - June 2018*, Section 4.3.1**
    - ***Conceptual Alternatives Report - June 2018*, Appendix A, plate P-12**

Appendix C. Meeting Minutes

Partner Meeting Agenda and Minutes

Date/Time/Location:

- January 25, 2018, 3:30 - 5pm
- Bellingham City Hall, Mayor's Boardroom, 210 Lottie St, Bellingham, Washington

Attendees:

Representatives of the City of Bellingham, Lummi Nation, Nooksack Indian Tribe, USFWS, American Rivers, and HDR: Becky Holloway, April McEwen, Renee LaCroix, Matt Prociv, Chad Schulhauser, Joel Ingram, Brendan Brokes, Channing Syms, Ginger Phalen, Ned Currence, Ed Zapel, Kara Kuhlman, Clare Fogelsong

Purpose:

A. Provide an overview of existing project funding, potential funding sources, and budget.
B. Provide information on project permitting pathway to meet a 2019 construction window.
C. Discuss constraints and receive input/feedback on approaches to streamline permitting and secure funding.

Agenda:

1. Welcome and introductions (5 mins)

2. Design update (5 mins)

    - Ed gives an overview of the design team and their review previous work, development of a new upstream alternative, and bringing old alternatives up to same development level for comparison. He notes this should be done in about 3 weeks.
    - Becky notes that wetland delineation and identification of the ordinary high water mark has taken place.
    - Complex contracting process, but contracts are all signed w/ City and subs; work is underway
    - To date have explored 1 additional option to previously explored options.
    - HDR has been collecting data on site for permit applications together w/ habitat recon -

3. Funding overview (15 mins)

    - April presented ppt slides showing the project budget (secured funding and remaining need), discussed strategy related to potential funding sources, and challenges associated with the release of funding awards (i.e., how the award distribution date affects ability to reach 2019 construction target).
    - Need additional funding partners in design phase in order to have broad financial support to cover construction costs.

   i. Clare will draft support letter to be circulated for original partner (Lummi, Nooksack, WDFW) signatures.

- Design estimate cost $1.1M:
   i. 67% secured: $480k PAFF, $200k COB = $680k
   ii. 33% need: $330,000. Proposals submitted to RLF (private foundation) for $135k, and USFWS-NFPP for $50k
- Construction estimate cost ~~$16M – have 28%~~ (update: a new estimate was provided on 2/12/18 and is $12 million – which means we have secured 37% of the anticipated construction cost)
   i. 37% secured funding: $2.4M Paul Allen Family Fund (PAFF), $2M City of Bellingham (COB) = $4.4M
   ii. 63% needed: $7.6M
      - A funding strategy has been prepared targeting a range of funding sources, including private, state, and federal. All funding program timelines have been released, and we will be applying for all. This effort is led by the core team, with support from AR's extended funding team.
      - Ned – need to build support with NOAA. They are renegotiating Chinook sustainable fisheries agreement now; funding may be available via this avenue.
- Funding strategies identified for each funding source
   i. (Ned) NOAA negotiations are currently going on for hatchery supplementation, but there may be additional funding for mitigation for a project that can help boost production of salmon. April should look into this
   ii. Additional funding strategies related to permitting programmatic discussed in permitting notes (i.e., USFWS has programmatic, which if secured, means the Corps would be the only other consulting federal agency – could shorten up consultation period).
- (April) Aim for designs and permitting to be completed and project shovel-ready by early 2019, The targeted in-water construction window is summer 2019; actual construction date will depend on funding award distribution timeline
- (WDFW) may want to look into ECY's Centennial grants - some are for water supply
- (Ned) Some money could be possible through Tribal Wildlife Grants.

4. Permitting pathways (30 mins)

- Becky presented a streamlined permitting approach (Pathway A) that would enable 2019 project construction.
- Have started collecting data, populating permits with info - time is of the essence to meet construction timeline.
- Permitting Pathway A - assumes streamlining and programmatic coverage pathways
   i. Corps Section 404 permit - NWP 27, 33, 12

- Long lead time: 9-12 months - important for tribes to review these docs in a timely manner

ii. NMFS-SRFB funding & NMFS 4d Limit 8 coverage – Limit 8 exemption dependent on SRFB funding, which we won't know about until December 2017. Eliminates need for a Biological Assessment and potentially saves 6 months.
   - (Ned) Thinks it would be hard for a project of this size to get Limit 8 coverage. Limit 8 path eliminates NMFS review. The Nooksack rely on federal agencies to review projects to make sure they are done correctly. If NMFS doesn't review, the oversight burden falls to WDFW.

iii. April – a smaller amount of funding (~$100,000) will be requested from SRFB in 2018 for design. This is needed to demonstrate salmon recovery board support for the project, and would significantly reduce the remaining design $ need.

iv. USFWS – programmatic related to USFWS funding. If we qualify it may shorten USACE permit process.
   - Current proposal into the USFWS requests $50,000 from the National Fish Passage Program for design.
   - (Ginger) Potential challenges in getting USFWS funding associated with new Trump Administration requirements: All DOI grants $50,000 - $99,999 grants reviewed by Deputy Director of USFWS; more than $100,000 grants reviewed by Trump Admin appointee.

v. NHPA - no major cultural concerns, dam not considered historic (update: the dam may be considered historic as it is over 50 years old)

vi. Brendan and Ned – Support a longer in-water work window than the current window to accommodate construction. The current in-water window is the last week in July to the third week of August.
   - (WDFW) There is a broader window for work above the existing dam (i.e., construction of intake) because the dam is a fish barrier to listed anadromous species. As such, work above the dam just needs to address species and life stages currently in that area.
   - (April) A two month work window would likely be enough to complete in-water work phase (i.e., intake construction and dam removal), targeting the MF's lowest flow period (July-August?).

vii. Becky – If project qualifies for WDFW's Fish Habitat Enhancement Project exemption, no SEPA and local land use permits or fees are required.
   - (Joel) WDFW would support shoreline exemption, which would also be a significant time and cost savings.
   - (Ned) Suggest starting a discussion running through the salmon recovery board to facilitate exemptions.
   - (Becky) recommends city leading SEPA, not the county, especially considering shoreline exemption. Agreement from several others.

        - (Joel) To get shoreline exemption, need HPA in hand and letter from WDFW's Assistant Director supporting exemption.
    - (Brendan) WDFW is likely to consider this too large to go through the FHEP (SEPA exemption) because it is large, has public funding, and potential public safety implications. Joel notes this is not the same case for a shoreline exemption.
    - (April) the project removes a public safety hazard unlike other types of habitat restoration projects that are installing log jams, etc., and public meetings could be held, if that would address those concerns.
  viii. (Brendan and Ned) need FPA because DNR will consider this forested land and will be Section 4
  ix. April – The project is on City property. DNR has stated [the river bed through the project site] is likely state-owned aquatic land, requiring an authorization.
  x. (Becky) thinks it will take 9-12 months, but has seen it take up to 2 years to get DNR approval.
  xi. (April) DNR will provide their authorization/easement once all permits are in hand. As discussed at the DNR site visit with their leads, the plan is to frequently communicate project progress to DNR contacts, include in pre-permit application meeting with other agencies, and address concerns as they arise.
- Permitting Pathway B - no streamlining, no programmatic coverage pathways, unlikely to meet 2019 construction target
  i. 12-18 months due to Corps permits
  ii. Most others are relatively similar to Option A
- Only way to meet 2019 window is if we get coverage under Option A - the nationwide permit program - 6 to 12 month review process

5. Discussion: Permitting Interdependencies and Funding Support (30 mins)

- (Ned) small hydro projects have previously been proposed upstream of dam. By removing the dam, upstream Nooksack cultural sites will be better protected from potential hydro projects and there will be more streamflow required because the river will be open to anadromy. (April) This is great to identify as an additional project benefit.
- Partner Advisory Committee (PAC) and Design Review Team (DRT) sheets – representatives from each partner entity still need to be listed on the sheet, even if it is multiple people from each entity. Need that finalized - Nooksack (Ned) gave theirs, Kara will be technical for Lummi. Lummi doesn't have policy contact at this time.
- PAC/DRT Contacts:
  i. PAC
    - Nooksack - Mike Maudlin, Gary MacWilliams, & Ned Currence
    - Lummi – TBD

- WDFW – Joel Ingram

ii. DRT

- Nooksack – depending on topic: fisheries/habitat related - Ned Currence and Treva Coe; geomorphology – Michael Maudlin
- Lummi – Kara Kuhlman
- WDFW – Joel Ingram

- Alternative Selection Workshop – invite will be sent for February 12

6. Design Review Team (DRT) focus: Fish Passage design approach (30 mins)

- Ed – Describes the geomorphic-based design approach and reference reach methodology to restoring the channel through the dam. Geomorphic-based design approach simulating the natural channel is more applicable to high gradient, high sediment, flashy streams and rivers than NMFS passage criteria because NMFS passage criteria favors lower gradient rivers and concrete structures.
  i. The design approach is to understand the characteristics of the natural channel upstream and downstream so the restored channel can match or provide better passage conditions than the natural limitations created by typical channel characteristics.
- Ned – Likes the approach.
- Ned - proposes removing chum from passage list.
  i. Brendan struggles with pinks being on the passage list as well. Ned notes anecdotal evidence of historic pink passage.
- Channing – Said a geomorphic design approach is the standard preferred by WDFW.
- Ned and Brendan – Elizabeth Babcock at NMFS supports the project and would be good to have on the team. (update: Ned introduced Elizabeth to April through email, so she will be included in the monthly update)

7. Action Item Recap (10 mins)

- Any remaining items from Dec 7 meeting (PAC/DRT descriptions discussed above)
- Items from this meeting
- Alternative Selection Workshop – invite to be sent for February 12th

Action items/next steps

Responsible	Deadline	Description	Completed
April & Ned		Discuss potential funding via NOAA Chinook sustainable fisheries agreement	2/5/18
Kara		Check if Limit 8 (e.g. – not having a BA) is acceptable to the Lummi.	
Clare		See if there is a dollar definition to "partial funding" in the SRFB funding requirements.	

April & Ned		Meet to discuss Puget Sound Action goals	2/5/18
Becky		Determine FPA requirements. Discuss with Ned and Joel if needed.	
PAC		Provide comments on the fact sheet	Lummi - 2/2/18. Nooksack – 2/6/18 None received from WDFW
Clare	1/31/18	Send draft of support letter to PAC members	
PAC		Identify a contact person from each PAC member group	Still need Lummi policy rep identified.
Ed		Send species periodicity chart to the PAC for comment	completed
PAC		Provide comments on the species periodicity chart	Nooksack and WDFW have – 2/8/18 Need Lummi's.
Ed		Add bull trout to species periodicity chart	2/5/18

Middle Fork Nooksack Fish Passage Project: Preferred Alternative Selection Workshop

Monday, February 12, 2018

Agenda

- Project Goals
- Previous Alternatives
- New Upstream Intake Alternative
- Evaluation Matrix
- Discussion

Project Goals

Project Goals

Goal 1: **Restore fish passage and habitat connectivity at the City of Bellingham's diversion dam**:

- Feasibility and Design – Construction-ready documents by the end of 2018. Shovel-ready in early 2019.
- Downstream Migration –New fish screen meeting NOAA and Washington State.
- Upstream Migration – Remove diversion dam. Restore habitat connectivity and enable fish passage to 10-26 miles of upstream habitat.
- Instream Flow Protection –Reduce potential for downstream stranding.

Goal 2: **Maintain the City of Bellingham's municipal water supply** :

- Feasibility and Design – Construction-ready documents by the end of 2018. Shovel-ready in early in 2019.
- Intake – Gravity-fed diversion intake to maintain existing 116 cfs diversion capacity without dependency on the diversion dam.

Previously Considered Alternatives

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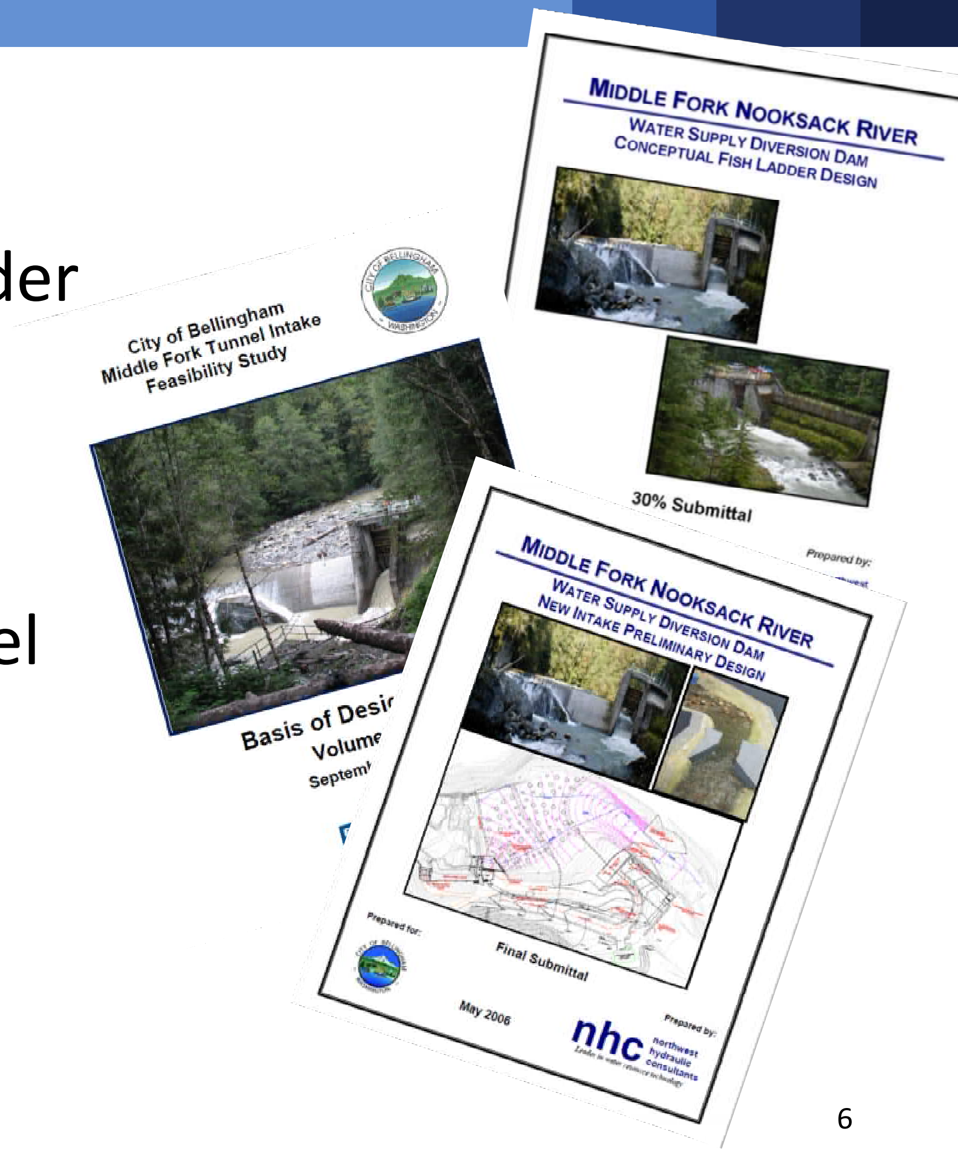
Previously Considered Alternatives

- No Action
- Alternative A – Fish Ladder
  - 2007
- Alternative B – Siphon
  - 2011
- Alternative C –In-Channel Screen Intake
  - 2006



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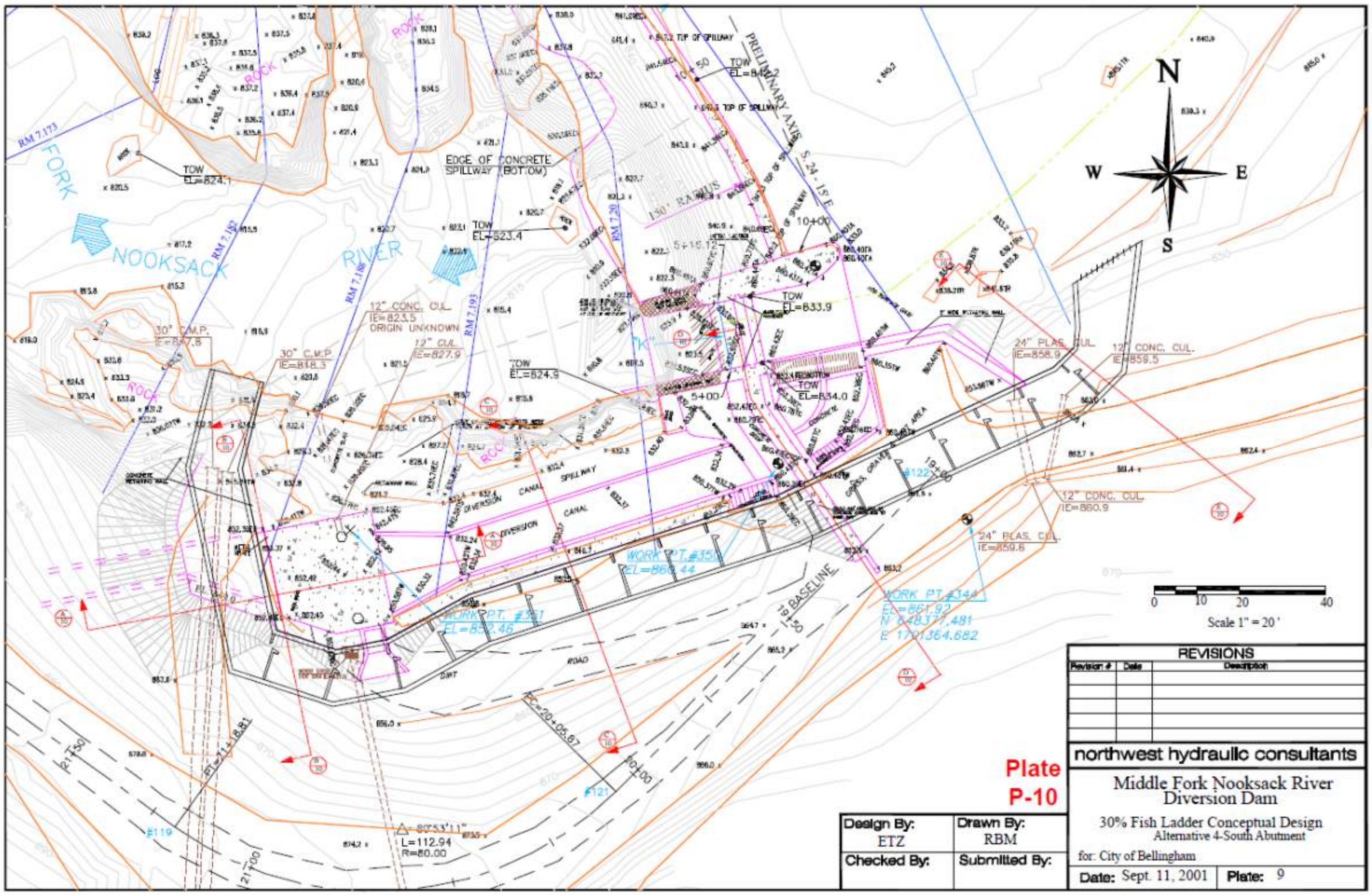
Alternative A – Fish Ladder



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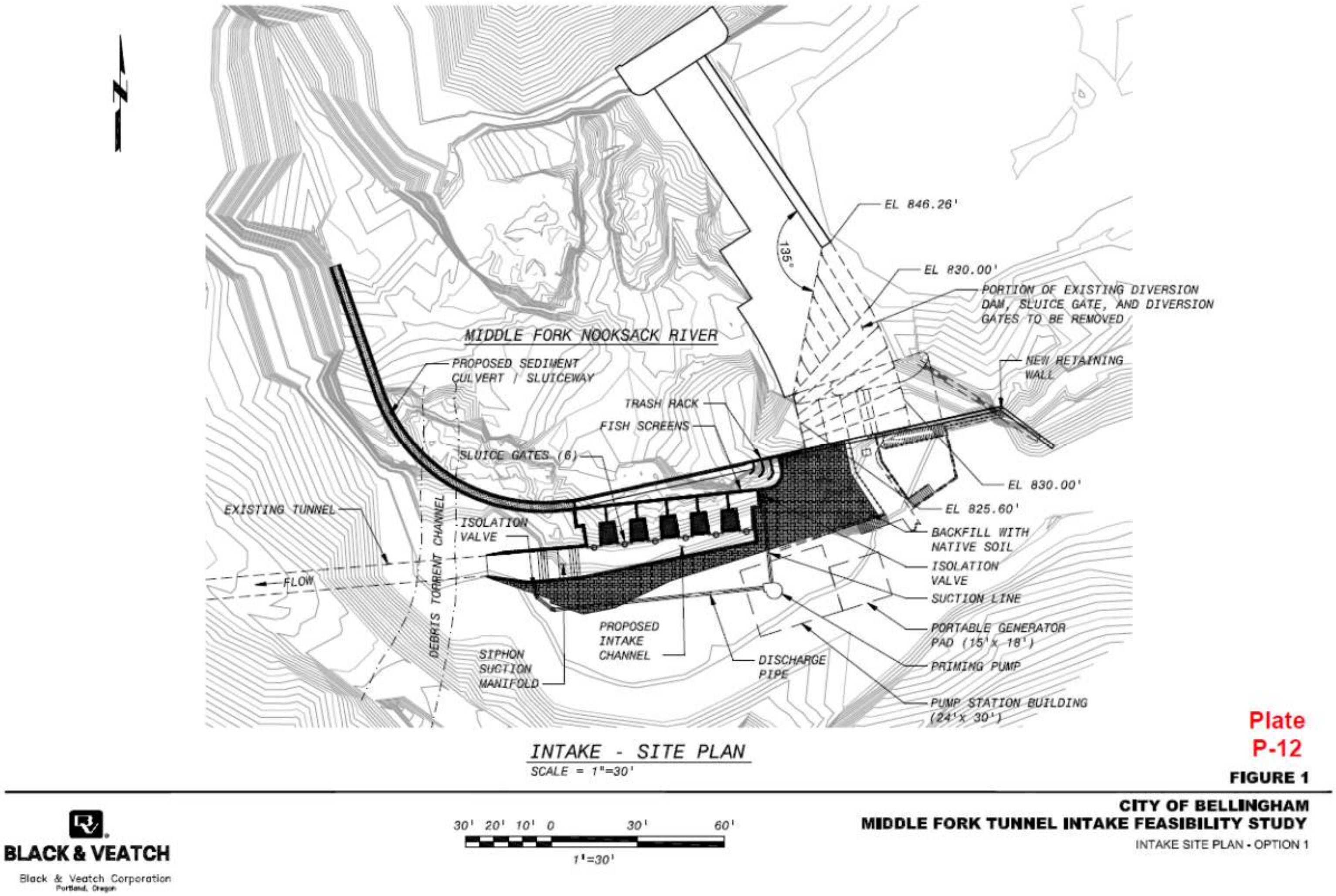
Alternative B – Siphon



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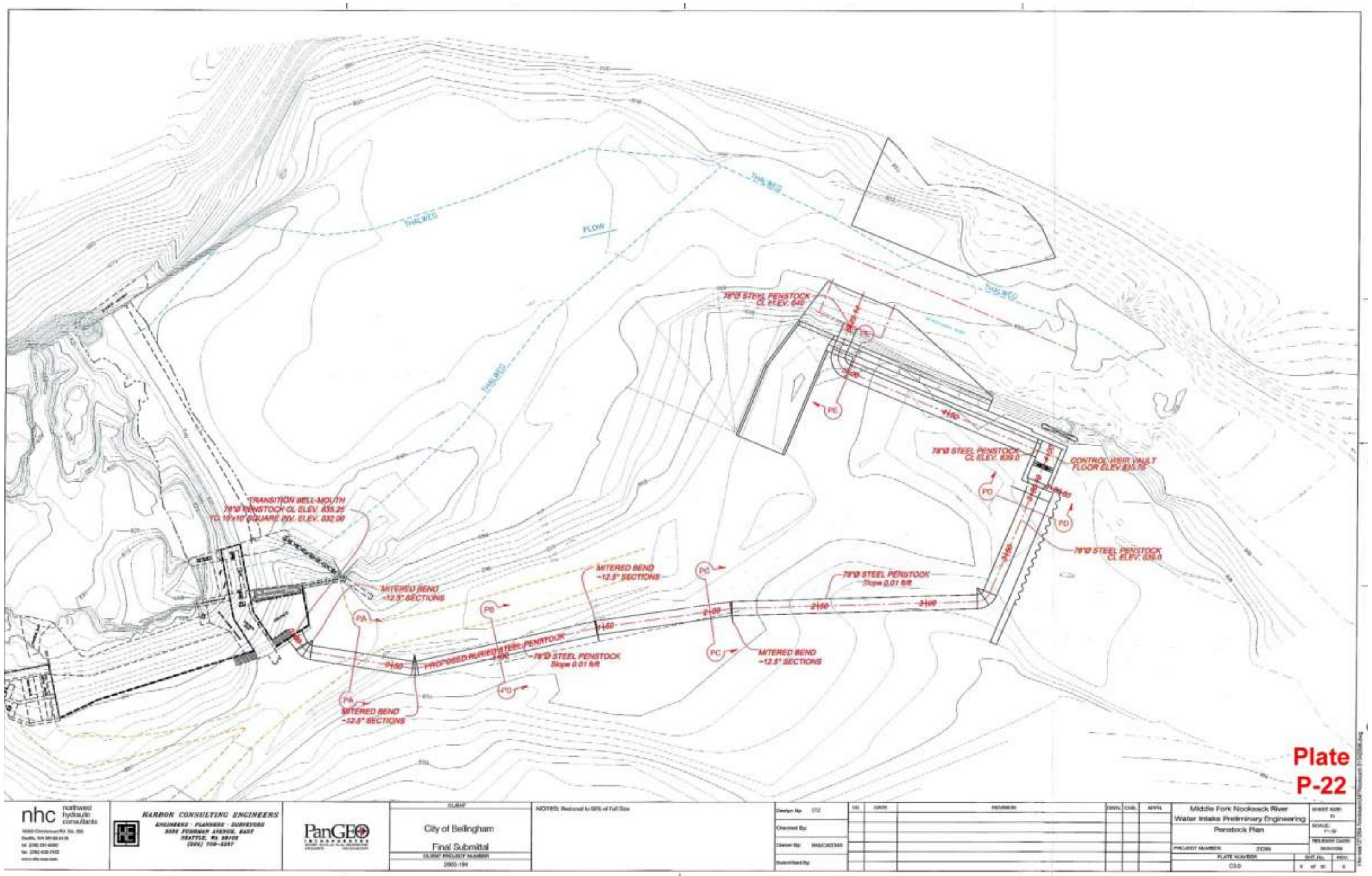
Alternative C – In-Channel Screen Intake



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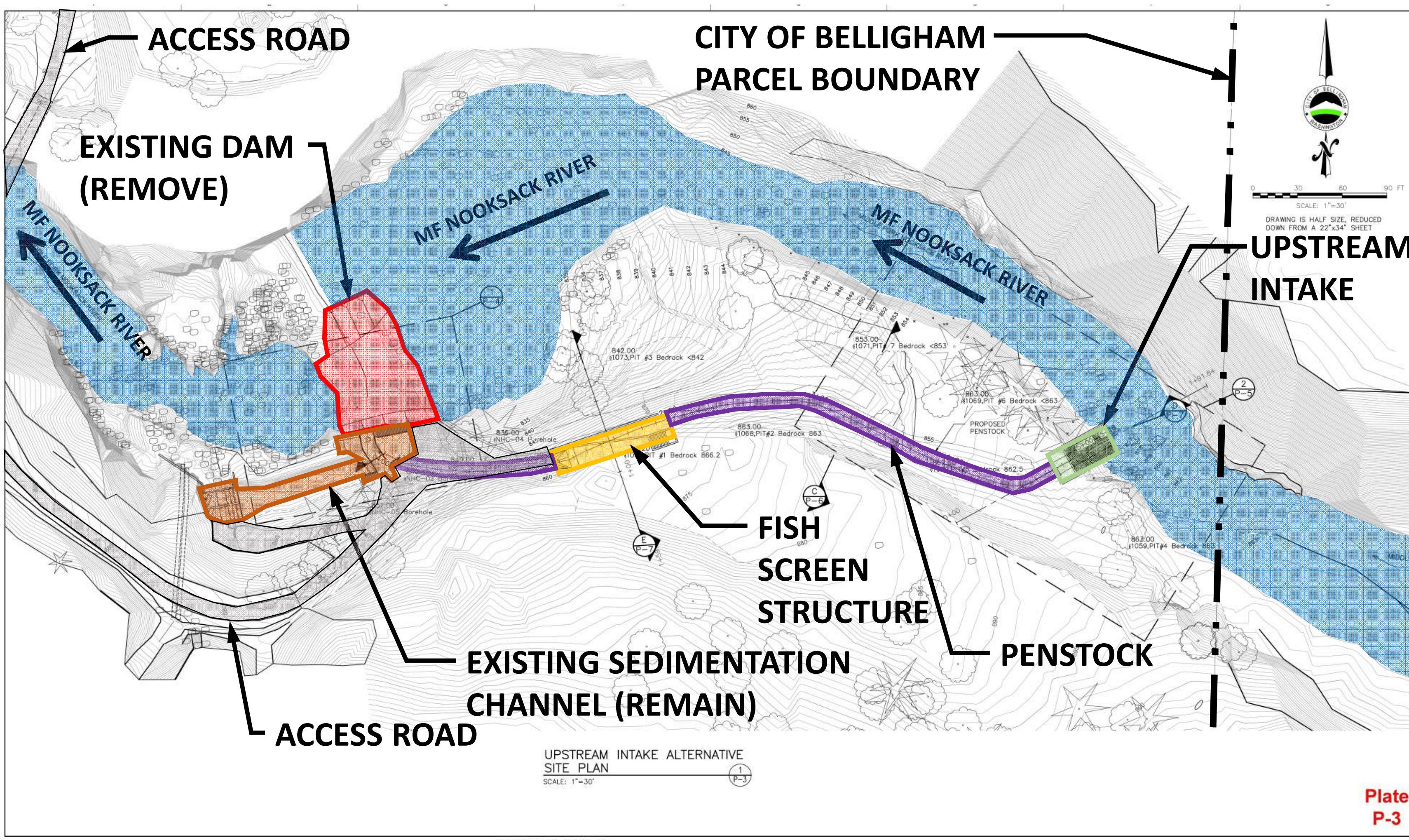
New Upstream Intake Alternative

New Alternative



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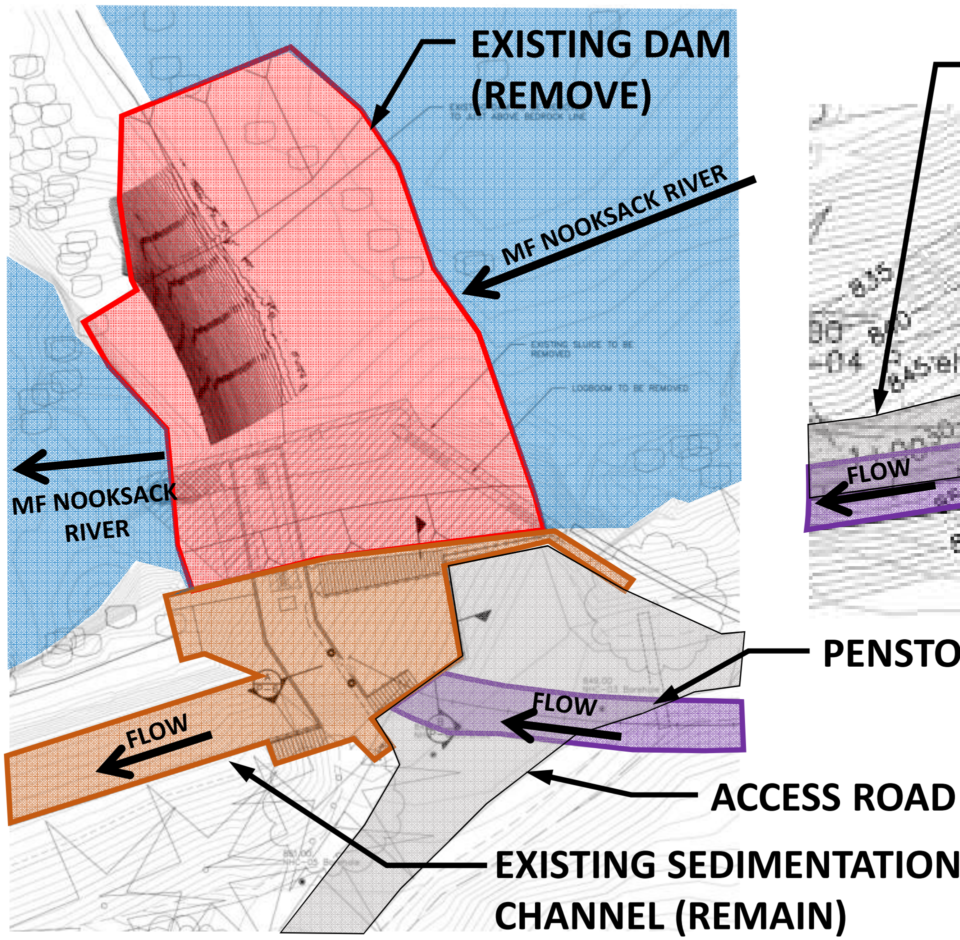
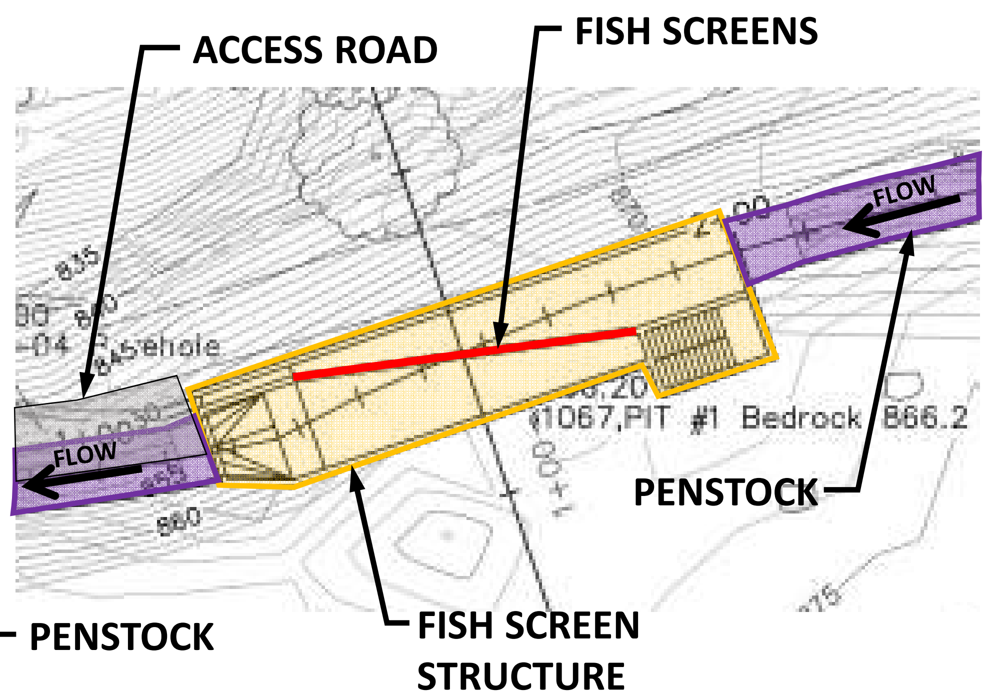
New Alternative

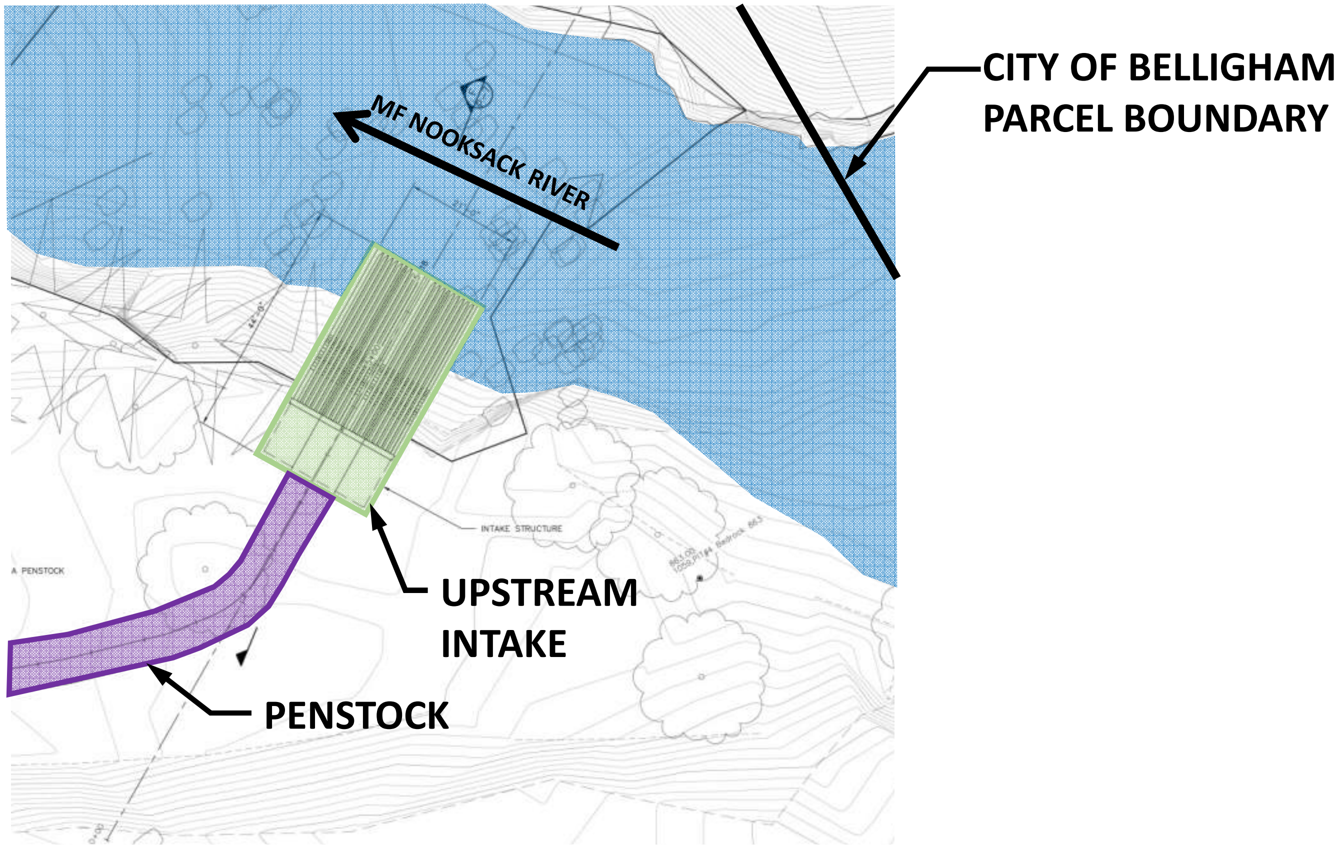


Existing Dam Removal & Penstock Connection Site Plan



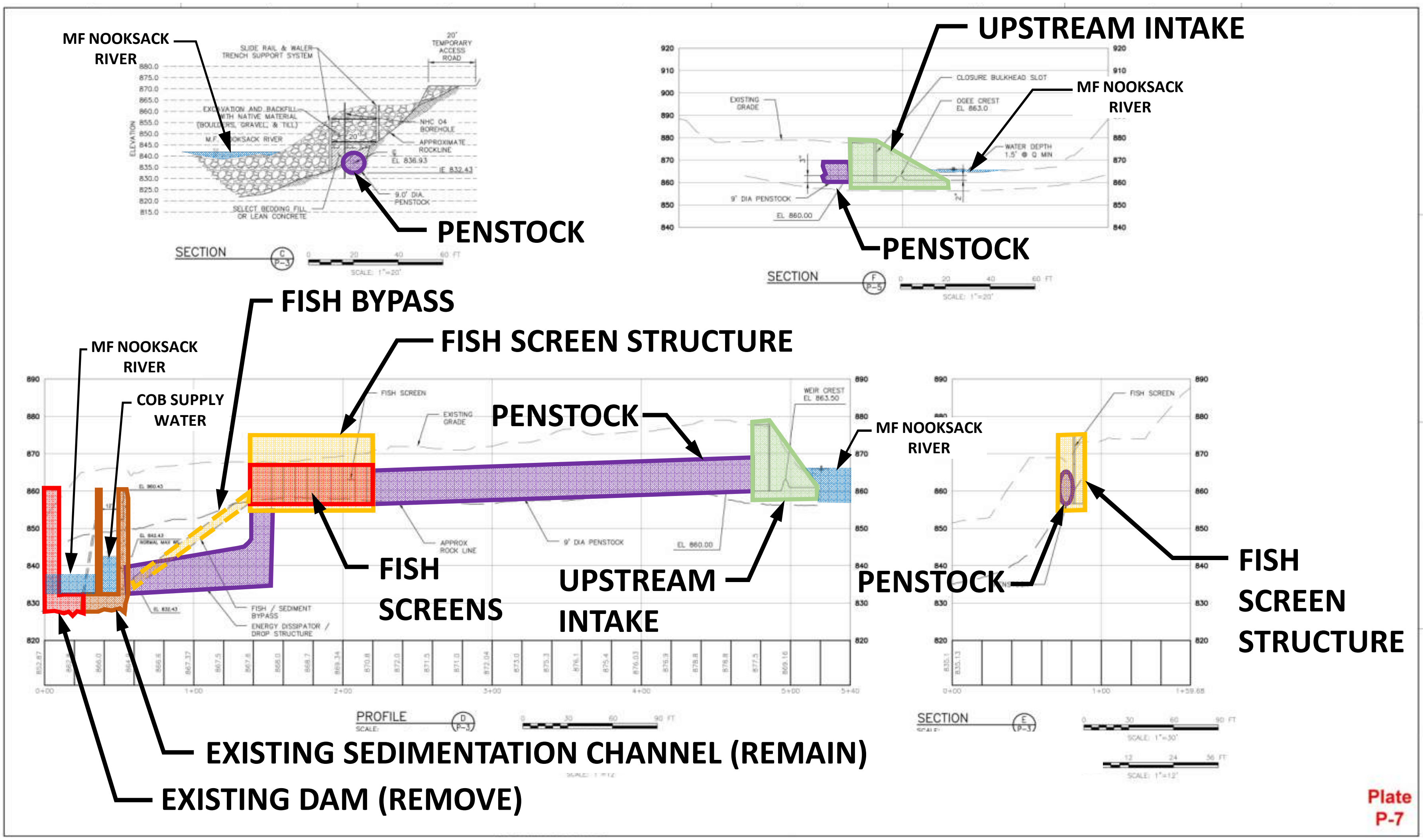
Fish Screens Site Plan

New Alternative



**Upstream Intake
Site Plan**

New Alternative



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Preliminary Opinion of Construction Cost

		Year	Present Day Cost	
			Low	High
Alternative A	Fish Ladder	2007	$13.6 M	$25.3 M
Alternative B	Siphon	2011	$20.2 M	$37.5 M
Alternative C	Previous Intake	2006	$15.0 M	$27.8 M
Alternative D	New Intake	2018	$6.5 M	$12.0 M

Evaluation Matrix

Evaluation Factors

Evaluation Factor	Corresponding Design Objective
Fish Passage Performance	Provide natural and safe fish passage for all target species and life stages throughout the range of anticipated flows where fish may require upstream or downstream passage through the project site. Alternatives that remove the dam score most favorably.
Surface Water Supply Reliability	Maintain reliable water delivery through a wide range of environmental conditions, maximizing the simplicity of components, and reducing the potential for mechanical failures.
Channel Stability and Geomorphic Continuity	Minimize anticipated movement of the thalweg away from the intake and fish passage channel, and minimize the potential for channel braiding through the project area.
Sediment Management and Transport	Maximize sediment transport continuity in the Middle Fork Nooksack and minimize the need for sediment management activities related to the intake system.
Public Safety and Security	Improve public safety and security by complying with all State and Federal safety requirements and minimizing public access to project features.
Operation and Maintenance	Minimize operational and maintenance level of effort and complexity
Relative Capital Costs	Minimize construction cost of the project.

Evaluation Matrix

Alternative	Description	Year Alternative was Developed	Evaluation Factor																Total Weighted Score
			Upstream Fish Passage Performance (and Dam Removal) Wt = 8		Downstream Fish Passage Performance Wt = 8		Surface Water Supply Reliability Wt = 6		Channel Stability and Geomorphologic Continuity Wt = 4		Sediment Mgmt and Transport Wt = 3		Public Safety and Security Wt = 2		Operation and Maintenance Wt = 4		Relative Capital Costs Wt = 4		(39)
			Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	
Alternative A	Fish Ladder with Off-Stream Conventional Vertical Panel Fish Screen in Diversion Channel and No Dam Removal	2007	4	32	6	48	6	36	3	12	4	12	3	6	3	12	5	20	130
Alternative B	Siphon Intake with Off-Stream Conventional Vertical Panel Fish Screen and Dam Removal	2011	3	24	6	48	2	12	5	20	6	18	6	12	1	4	1	4	94
Alternative C	Upstream Intake with In-Stream Fish Screen and Self-Scouring Abutment Structures and Dam Removal	2006	6	48	8	64	7	42	4	16	7	21	6	12	4	16	3	12	167
Alternative D	New Upstream Intake with Penstock and Off-Channel Conventional Vertical Panel Fish Screen and Dam Remova	2018	8	64	6	48	7	42	6	24	6	18	7	14	6	24	7	28	214

*Weight Guide: (1) Low, (10) High

*Raw Score: (1) Least favorable, (10) Most favorable

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Discussion


NO TRESPASSING

Appendix D. Opinion of Probable Construction Cost

EXECUTIVE SUMMARY

		Year	Original Cost	Cost Escalated to Present Day	Escalation	Present Day Low	Present Day High	Items Influencing % Change Other Than Escalation
Alternative A	Fish Ladder	2007	**$ 13,217,307**	**$ 19,482,860**	**36%**	$13.7 M	$25.4 M	Lower tax rate, inc fish screen
Alternative B	Siphon	2011	**$ 16,469,830**	**$ 28,842,643**	**17%**	$20.2 M	$37.5 M	Inc Field O/H, Home Office, Profit, Bond, Insurance, & Taxes
Alternative C	Previous Intake	2006	**$ 13,611,465**	**$ 21,360,803**	**46%**	$15.0 M	$27.8 M	Inc 100% of taxes, higher tax rate, lower Field O/H, higher contingency
Alternative D	New Intake	2018	-	**$ 13,331,000**	-	$9.4 M	$17.4 M	-

*Note: The large escalation in Alt C is due to 1) orig estimate only included 12% of taxes in OPCC, and 2) orig estimate used 20% contingency whereas escalated used 30% contingency

*Note: Estimate range = 30%

DETAILED SUMMARY

	Direct Cost	Field O/H	Home Office	Profit	Bond	Insurance			Subtotal Cost	Sales Tax	Subtotal w/ Tax	Contingency	Total Cost
Uniform Markups	-	15%	5%	10%	1%	1%			-	8.5%	-	30%	-
Alternative A - Fish Ladder													
Original Markups	-	**15%**	**5%**	**10%**	**1%**	**1%**			-	**8.8%**	-	30%	-
Original	$ 6,940,594	$ 1,041,089	$ 347,030	$ 832,871	$ 91,616	$ 91,616			$ 9,344,816	$ 822,344	$ 10,167,159	$ 3,050,148	$ 13,217,307
Uniform Original	**$ 6,940,594**	$ 1,041,089	$ 347,030	$ 832,871	$ 91,616	$ 91,616			$ 9,344,816	$ 794,309	$ 10,139,125	$ 3,041,737	$ 13,180,862
2018 Escalated	$ 10,259,011	$ 1,538,852	$ 512,951	$ 1,231,081	$ 135,419	$ 135,419			$ 13,812,733	$ 1,174,082	$ 14,986,815	$ 4,496,045	$ 19,482,860
Alternative B - Siphon													
Original Markups	-	-	-	-	-	-			-	-	-	30%	-
Original	**$12,669,100**	-	-	-	-	-			-	-	-	$ 3,800,730	$ 16,469,830
Uniform Original	**$12,669,100**	$ 1,900,365	$ 633,455	$ 1,520,292	$ 167,232	$ 167,232			$ 17,057,676	$ 1,449,902	$ 18,507,579	$ 5,552,274	$ 24,059,852
2018 Escalated	**$15,187,555**	$ 2,278,133	$ 759,378	$ 1,822,507	$ 200,476	$ 200,476			$ 20,448,524	$ 1,738,125	$ 22,186,649	$ 6,655,995	$ 28,842,643
Alternative C - Previous Intake													
Original Markups	-	**25%**	**5%**	**10%**	**1%**	**1%**			-	**8.2%**	12%	20%	-
Original	$ 7,701,057	$ 1,925,264	$ 385,053	$ 1,001,137	$ 110,125	$ 110,125			$ 11,232,762	$ 921,087	$ 11,342,887	$ 2,268,577	$ 13,611,465
Uniform Original	**$ 7,701,057**	$ 1,155,159	$ 385,053	$ 924,127	$ 101,654	$ 101,654			$ 10,368,704	$ 881,340	$ 11,250,043	$ 3,375,013	$ 14,625,056
2018 Escalated	$ 11,247,872	$ 1,687,181	$ 562,394	$ 1,349,745	$ 148,472	$ 148,472			$ 15,144,136	$ 1,287,252	$ 16,431,387	$ 4,929,416	$ 21,360,803
Alternative D - New Intake												50%	
2018	$ 6,084,000	$ 913,000	$ 304,000	$ 730,000	$ 80,000	$ 80,000			$ 8,191,000	$ 696,000	$ 8,887,000	$ 4,444,000	$ 13,331,000

Alternative 4 - South Abutment Ladder
Pre-Construction Costs

Project Direct Cost

Feature	Quantity	Unit Of Measure	Labor Hrs / Unit	Labor Hrs	Mat. Rate	Material	Labor Rate	Labor	Equip. Rate	Equipment	Other	City Adjust.	Subtotal Cost	Equivalent Unit Cost	Modified Unit Cost/Subtotal	Modified Line Item Totals (2007)	Comments & Subtotals	2018 Costs (Dec. 2017)	Escalation Factor
1. Mobilization																			
Equipment, machinery, facilities	1	lump sum	0.000	0	$0.00	$0.00	$0.00	$0.00	$190,000.00	$190,000.00			$190,000.00	$190,000.00			8% of construction total		
Subtotal				**0.00**		**$0.00**		**$0.00**		**$190,000.00**			**$190,000.00**				**$728,051.92**	**728,052**	
2. Cofferdam																			
D/S Cofferdam - structural pile/waler	1080	ft^2	0.500	540	$18.00	$19,440.00	$13.32	$14,385.60	$7.92	$8,553.60			$42,379.20	$39.24	*$40*	$42,379.20	Slight increases	57,844	ENR CCI
Pumped grout seal	100	ft^3	0.350	35	$20.56	$2,056.00	$8.55	$855.00	$3.55	$355.00			$3,266.00	$32.66	*$40*	$4,000.00		5,460	ENR CCI
Membrane waterproofing above ground (urethane 1/16")	1080	ft^2	0.133	143.64	$0.58	$626.40	$3.43	$3,704.40	$0.00	$0.00			$4,330.80	$4.01	*$6*	$6,480.00		8,845	ENR CCI
U/S Cofferdam - structural pile/waler	2880	ft^2	0.500	1440	$18.00	$51,840.00	$13.32	$38,361.60	$7.92	$22,809.60			$113,011.20	$39.24	*$40*	$115,200.00		157,239	ENR CCI
Pumped grout seal	200	ft^3	0.350	70	$20.56	$4,112.00	$8.55	$1,710.00	$3.55	$710.00			$6,532.00	$32.66	*$40*	$8,000.00		10,919	ENR CCI
Membrane waterproofing above ground (urethane 1/16")	2880	ft^2	0.133	383.04	$0.58	$1,670.40	$3.43	$9,878.40	$0.00	$0.00			$11,548.80	$4.01	*$6*	$17,280.00		23,586	ENR CCI
Subtotal				**2611.68**		**$79,744.80**		**$68,895.00**		**$32,428.20**			**$181,068.00**				**$193,339.20**	**263,894**	
3. Dewatering / Drainage Diversion																			
Pumping, turbidity control	235	days	6.000	1410	$100.00	$23,500.00	$167.00	$39,245.00	$196.00	$46,060.00			$108,805.00	$463.00			Increase from 5 yrs ago		
Subtotal				**1,410.00**		**$23,500.00**		**$39,245.00**		**$46,060.00**			**$108,805.00**			**$200,000.00**	**$200,000.00**	**272,985**	**ENR CCI**
4. Excavation shoring/access/prep.																			
H-Piles Driven/Drilled (40 Piles x 15' Deep)	600	V.L.F	2.933	1759.8	$9.10	$5,460.00	$78.50	$47,100.00	$90.00	$54,000.00			$106,560.00	$177.60	*$200*	$120,000.00		163,791	ENR CCI
Shoring - 3" Wood Sheeting, 3 lines bracing, inc. removal	4875	ft^2	0.423	2062.125	$18.40	$89,700.00	$11.80	$57,525.00	$6.30	$30,712.50			$177,937.50	$36.50	*$40*	$195,000.00		266,161	ENR CCI
Drilled Pile Sockets 2' deep x 2' dia.(40 of them)	250	ft^3	0.933	233.25	$2.90	$725.00	$24.99	$6,247.50	$28.65	$7,162.50			$14,135.00	$56.54	*$112*	$28,000.00		38,218	ENR CCI
Tie Backs - 15 ft long	80	each	14.40	1152	$297.00	$23,760.00	$645.00	$51,600.00	$19.90	$1,592.00			$76,952.00	$961.90	*$1,200*	$96,000.00	geotech, approx $80/ft	131,033	ENR CCI
Access road improvements	1	lump sum	0.000	0	$0.00	$0.00	$0.00	$0.00	$25,000.00	$25,000.00			$25,000.00	$25,000.00		$250,000.00	New 4" - layer rock, truck turnouts, tree	341,231	ENR CCI
Bridge Strengthening																$250,000.00	Options: fiber wrap, ext post tensioning	341,231	ENR CCI
Subtotal				**5207.175**		**$119,645.00**		**$162,472.50**		**$118,467.00**			**$400,584.50**				**$939,000.00**	**1,281,665**	
5. Demolition of existing structures																			
Existing Concrete Removal	6250	ft^3	0.727	4543.75	$0.00	$0.00	$16.90	$105,625.00	$3.21	$20,062.50			$125,687.50	$20.11		$125,687.50		171,554	ENR CCI
Subtotal				**4,543.75**		**$0.00**		**$105,625.00**		**$20,062.50**			**$125,687.50**				**$125,687.50**	**171,554**	
6. Fish Ladder Construction																			
Rock Mechanical Splitting or Impact Hammer	5,808	yd^3	0.923	5360.784	$5.20	$30,201.60	$23.50	$136,488.00	$28.50	$165,528.00			$332,217.60	$57.20	*$100*	$580,800.00	Approx $100/cy mech split & exc	792,749	ENR CCI
Shot Rock Excavation	5,808	yd^3	0.200	1161.6	$0.00	$0.00	$5.70	$33,105.60	$5.15	$29,911.20			$63,016.80	$10.85	*Include in above (split & exc)*				
Boulders Drilling and Blasting w/mat (10% of sand & gravel exc.)	320.6	yd^3	2.560	820.736	$1.80	$577.08	$6.51	$2,087.11	$7.89	$2,529.53			$5,193.72	$16.20	*$200*	$64,120.00	Ties up resources, various diameters, hard	87,519	ENR CCI
Excavation Till (+ shot boulder remains)	3206	yd^3	0.160	512.96	$0.00	$0.00	$4.55	$14,587.30	$4.14	$13,272.84			$27,860.14	$8.69	*$25*	$80,150.00		109,399	ENR CCI
Gravel Drain & Pipe Installation	220	ft^2	0.15	33.00	$1.00	$220.00	$0.31	$68.20	$2.66	$585.20			$873.40	$3.97	*$8*	$1,760.00		2,402	ENR CCI
Backfill 3/4"(-) crushed rock	30	yd^3	0.16	4.8	$10.00	$300.00	$1.21	$36.30	$18.80	$564.00			$900.30	$30.01		$900.30		1,229	ENR CCI
Backfill select granular material	300	yd^3	0.218	65.4	$11.35	$3,405.00	$5.25	$1,575.00	$0.61	$183.00			$5,163.00	$17.21	*$30*	$9,000.00		12,284	ENR CCI
Concrete Cast in Place																			
Concrete Ready Mix 3500 psi (inc. delivery)	2413	yd^3	0.000	0	$75.00	$180,975.00	$45.00	$108,585.00	$50.00	$120,650.00			$410,210.00	$170.00	*$800*	$1,930,400.00	Approx $800/cy placed concrete with rebar	2,634,853	ENR CCI
Formwork (plywood, 2 uses)	34000	ft^2	0.166	5644	$1.29	$43,860.00	$4.71	$160,140.00	$0.00	$0.00			$204,000.00	$6.00	*(Include in above)*				
Placing Concrete - Crane & Bucket, includes vibrating	2413	yd^3	0.758	1829.054	$0.00	$0.00	$18.80	$45,364.40	$10.60	$25,577.80			$70,942.20	$29.40	*(Include in above)*				
Reinforcing in Place #3 to #7 bar	250	tons	10.667	2666.75	$525.00	$131,250.00	$350.00	$87,500.00	$0.00	$0.00			$218,750.00	$875.00	*(Include in above)*				
Rock Anchorage (Includes Drilling)	920	bolts	0.941	865.72	$20.00	$18,400.00	$42.50	$39,100.00	$10.50	$9,660.00			$67,160.00	$73.00	*$90*	$82,800.00		113,016	ENR CCI
Metals																			
Steel Grating Installation	4120	ft^2	0.038	156.56	$0.00	$0.00	$1.26	$5,191.20	$0.10	$412.00			$5,603.20	$1.36		$5,603.20	Steel generally double from 5 yrs ago	7,648	ENR CCI
Steel Grating Materials- (2-1/4" w/2" O.C. cross bars)	4120	ft^2	0.187	770.44	$4.30	$17,716.00	$15.90	$65,508.00	$5.95	$24,514.00			$107,738.00	$26.15	*$52*	$214,240.00		292,422	ENR CCI
Trashrack - Fabrication + installation	8360	lbs.	0.005	41.8	$3.00	$25,080.00	$1.26	$10,533.60	$5.95	$49,742.00			$85,355.60	$10.21	*$20*	$167,200.00		228,216	ENR CCI
Conduit 30" heavy smooth wall culvert	300	lineal ft	1.263	378.9	$56.00	$16,800.00	$13.50	$4,050.00	$93.50	$28,050.00			$48,900.00	$163.00	*$200*	$60,000.00		81,896	ENR CCI
Valve (Ball-type control valve)	2	each	8.000	16	$10,000.00	$20,000.00	$25.74	$51.48	$400.00	$800.00			$20,851.48	$10,425.74	*$80,000*	$160,000.00	Checked with estimators, Pratt	218,388	ENR CCI
Diffuser Sections 30" diameter	2	each	16.000	32	$1,500.00	$3,000.00	$25.74	$51.48	$400.00	$800.00			$3,851.48	$1,925.74	*$4,000*	$8,000.00		10,919	ENR CCI
Gate and Valve Operators	4	each	16.000	64	$1,000.00	$4,000.00	$25.74	$102.96	$400.00	$1,600.00			$5,702.96	$1,425.74	*$3,000*	$12,000.00		16,379	ENR CCI
Entrance Weirs & sediment sluice gates	1500	lbs.	0.010	15	$3.00	$4,500.00	$0.26	$386.10	$1.00	$1,500.00			$6,386.10	$4.26	*$8*	$12,000.00		16,379	ENR CCI
Emergency & Maintenance bulkheads -- U/S	10000	lbs.	0.000	0	$3.00	$30,000.00	$0.00	$0.00	$0.00	$0.00			$30,000.00	$3.00	*$6*	$60,000.00		81,896	ENR CCI
Maintenance bulkhead -- D/S	1250	lbs.	0.000	0	$3.00	$3,750.00	$0.00	$0.00	$0.00	$0.00			$3,750.00	$3.00	*$6*	$7,500.00		10,237	ENR CCI
Wall Intake & Discharge Screen	190	ft^2	0.225	42.75	$75.00	$14,250.00	$25.74	$4,890.60	$9.08	$1,724.25			$20,864.85	$109.82	*$200*	$38,000.00		51,867	ENR CCI
Embedded Steel																			
Floor Plates (21 Plates x 460 lbs. each)	9660	lbs.	0.000	0	$0.35	$3,381.00	$0.00	$0.00	$0.00	$0.00			$3,381.00	$0.35	*$1*	$9,660.00		13,185	ENR CCI
Anchor Bolts (J-Type 3/4" x 18" Long) - 16 bolts / plate	336	bolts	0.400	134.4	$2.40	$806.40	$11.65	$3,914.40	$0.00	$0.00			$4,720.80	$14.05	*$60*	$20,160.00		27,517	ENR CCI
Floor Plate installation (1 Welder, 1/2 Engineer)	798	ft^2	0.400	319.2	$10.50	$3,351.60	$2.68	$855.46	$49.00	$15,640.80			$19,847.86	$24.87	*$40*	$31,920.00		43,568	ENR CCI
Guide Slots 4" x 7.25 C LB/ft guides, 2 per Slot, 22 Slots	9860	lbs.	0.050	493	$0.35	$3,451.00	$3.00	$29,580.00	$0.10	$986.00			$34,017.00	$3.45	*$5*	$49,300.00		67,291	ENR CCI
Entrance Guides (875 lbs./ guide)	5250	lbs.	0.050	262.5	$0.35	$1,837.50	$3.00	$15,750.00	$0.10	$525.00			$18,112.50	$3.45	*$5*	$26,250.00		35,829	ENR CCI
Subtotal				**21691.354**		**$561,112.18**		**$769,502.18**		**$494,755.62**			**$1,825,369.99**				**3,631,764**	**4,957,088**	
7. Mechanical Systems																			
Johnson T-Screen																			
Prefabricated Johnson T-96 HCE Screen	1	Ea.	120.000	120	$105,000.00	$105,000.00	$6,933.30	$6,933.30	$2,391.30	$2,391.30			$114,324.60	$114,325		$114,325		156,045	ENR CCI
Hydroburst Compressor, Tank, Controls & Equip. (4,000 gal)	1	Ea.	128.000	128	$95,000.00	$95,000.00	$4,995.20	$4,995.20	$600.00	$600.00			$100,595.20	$100,595		$100,595		137,305	ENR CCI
~~Control Weir bulkhead panels (inc. guides)~~	~~0~~	~~Ea.~~	~~80.000~~	~~0~~	~~$70,000.00~~	~~$0.00~~	~~$6,933.30~~	~~$0.00~~	~~$1,594.20~~	~~$0.00~~			~~$0.00~~	~~#DIV/0!~~		~~$0~~	Already in Item 6	0	ENR CCI
Weir panel hoist (counterweighted cable hung)	1	Ea.	120.000	120	$15,000.00	$15,000.00	$6,933.30	$6,933.30	$2,391.30	$2,391.30			$24,324.60	$24,325		$24,325		33,201	ENR CCI
~~Vault Bulkhead Sluice Gate (inc. guides & operator)~~	~~0~~	~~Ea.~~	~~120.000~~	~~0~~	~~$150,000.00~~	~~$0.00~~	~~$6,933.30~~	~~$0.00~~	~~$2,391.30~~	~~$0.00~~			~~$0.00~~	~~#DIV/0!~~		~~$0~~	Already in Item 6	0	ENR CCI
Water Well																$0		0	ENR CCI
Drilling, casing, seal, screen, dist. piping & controls	1	Ea.	0.000	0	$7,700.00	$7,700.00	$1,900.00	$1,900.00	$0.00	$0.00			$9,600.00	$9,600		$9,600		13,103	ENR CCI
Septic System water & wastewater disposal																$0		0	ENR CCI
septic, toilet, water heater	1	Ea.	0.000	0	$11,000.00	$11,000.00	$0.00	$0.00	$0.00	$0.00			$11,000.00	$11,000	*$20,000*	$20,000	Cost increases	27,299	ENR CCI
Maintenance Building (includes HVAC)																$0		0	ENR CCI
toilet exhaust, genset exhaust/vent., gen htr, etc.	*1*	*Ea.*	*0.000*	*0*	*$13,000.00*	*$102,500.00*	*$7,500.00*	*$7,500.00*	*$0.00*	*$0.00*			*$110,000.00*	*$110,000*		*$110,000*	*Roll in Building costs with HVAC*	150,142	ENR CCI
Subtotal				**368**		**$336,200.00**		**$28,261.80**		**$5,382.60**			**$369,844.40**				**$378,844.40**	**517,095**	

8. Electrical Systems																			
PSE Power Supply to site	*1*	*l.s*											***Costs unknown***				*Need specific design to present to PSE to*		
15kV Power Supply Ductbank (2,100 l.f. 2-conduit)	1	l.s	0.000	0	$115,832.00	$115,832.00	$105,108.00	$105,108.00	$0.00	$0.00			~~$220,940.00~~	$220,940	*$110,470.00*	$110,470	Less distance from property to site	150,783	ENR CCI
480V & Communications Ductbank (700 l.f. 2-conduit)	1	l.s	0.000	0	$114,405.00	$114,405.00	$94,155.00	$94,155.00	$0.00	$0.00			~~$208,560.00~~	$208,560	*$69,450.48*	$69,450		94,795	ENR CCI
Miscellaneous Ductbank Elements (manholes, ground rod, wire, etc.)	1	l.s	0.000	0	$50,113.05	$50,113.05	$40,880.50	$40,880.50	$0.00	$0.00			$90,993.55	$90,994		$90,994	Generally same electrical work for both	124,199	ENR CCI
Metering Equipment	1	l.s	0.000	0	$6,000.00	$6,000.00	$2,500.00	$2,500.00	$0.00	$0.00			$8,500.00	$8,500		$8,500		11,602	ENR CCI
Pad Mounted Transformer	1	l.s	0.000	0	$6,500.00	$6,500.00	$1,750.00	$1,750.00	$0.00	$0.00			$8,250.00	$8,250		$8,250		11,261	ENR CCI
Generator Set (75 kW, 240/120V Diesel)	1	l.s	0.000	0	$25,700.00	$25,700.00	$2,810.00	$2,810.00	$0.00	$0.00			$28,510.00	$28,510		$28,510		38,914	ENR CCI
Power Distribution	1	l.s	0.000	0	$23,795.00	$23,795.00	$10,070.00	$10,070.00	$0.00	$0.00			$33,865.00	$33,865		$33,865		46,223	ENR CCI
Medium Voltage cable	1	l.s	0.000	0	$40,360.00	$40,360.00	$29,800.00	$29,800.00	$0.00	$0.00			$70,160.00	$70,160		$70,160		95,763	ENR CCI
Gate/Hoist Motors	*8*	*Ea.*			*$10,000.00*	*$80,000.00*							*$80,000.00*	*$10,000*		*$80,000*	*New item, need motor operators*	109,194	ENR CCI
Wire and Cable 600V and less	1	l.s	0.000	0	$6,445.00	$6,445.00	$5,130.00	$5,130.00	$0.00	$0.00			$11,575.00	$11,575		$11,575		15,799	ENR CCI
Control/Telemetry	1	l.s	0.000	0	$5,000.00	$1,500.00	$6,933.30	$6,933.30	$0.00	$0.00			$8,433.30	$8,433		$8,433		11,511	ENR CCI
Lighting	1	l.s	0.000	0	$13,200.00	$13,200.00	$10,500.00	$10,500.00	$0.00	$0.00			$23,700.00	$23,700		$23,700		32,349	ENR CCI
Subtotal				**0**		**$483,850.05**		**$309,636.80**		**$0.00**			**$793,486.85**				**$543,907.33**	**742,393**	
9. Gate Remove & Replace																	***$200,000***	272,985	ENR CCI
10. Dam Repair																	***$0.00***	0	
				Original %	***22.50%***	***4%***	***10%***	***1%***	***1%***										

2018 Escalated Project Indirect Cost

Feature	Modified Subtotal Cost	Original Subtotal Cost		Direct	Field O/H	Home Office	Profit	Bond	Insurance	Subtotal Cost	Sales Tax	Total Cost	Orig Total Cost	
					15.00%	5%	10%	1%	1%		8.80%			
1. Mobilization	$728,051.92	$190,000.00		$728,052	$109,208	$36,403	$87,366	$9,610	$9,610	$980,249	$86,262	$1,066,511	$1,066,511.00	
2. Cofferdam	$263,893.69	$181,068.00		$263,894	$39,584	$13,195	$31,667	$3,483	$3,483	$355,306	$31,267	$386,573	$283,219.00	
3. Dewatering	$272,985.19	$108,805.00		$272,985	$40,948	$13,649	$32,758	$3,603	$3,603	$367,547	$32,344	$399,891	$292,977.00	
4. Excavation shoring / access / preparation	$1,281,665.45	$400,584.50		$1,281,665	$192,250	$64,083	$153,800	$16,918	$16,918	$1,725,634	$151,856	$1,877,490	$1,375,525.00	
5. Demolition of existing structures	$171,554.13	$125,687.50		$171,554	$25,733	$8,578	$20,586	$2,265	$2,265	$230,980	$20,326	$251,307	$184,118.00	
6. Fish Ladder Construction	$4,957,088.19	$1,825,369.99		$4,957,088	$743,563	$247,854	$594,851	$65,434	$65,434	$6,674,224	$587,332	$7,261,555	$5,320,109.00	
7. Mechanical Systems	$517,094.55			$517,095	$77,564	$25,855	$62,051	$6,826	$6,826	$696,216	$61,267	$757,483	554963	
8. Electrical Systems	$742,393.22			$742,393	$111,359	$37,120	$89,087	$9,800	$9,800	$999,558	$87,961	$1,087,519	796761	
9. Gate Remove & Replace	$272,985.19			$272,985	$40,948	$13,649	$32,758	$3,603	$3,603	$367,547	$32,344	$399,891	292977	
10. Dam Repair	$ -			$0	$0	$0	$0	$0	$0	$0	$0	$0	0	
												$13,488,222	$4,372,513.33	

Project Total Cost

	2007	**2018**												
Total Construction Cost (+30% contingency)	*$13,217,307*	$17,534,688												
Total Engineering & Project Owner Cost	*$912,560*	$912,560												
Total	***$14,129,867***	**$18,447,248**	**31%**											

Feature	Quantity	Unit Of Measure	Aggr. Rate (2001 rates)	Overhead (2.0 mult.)	Profit (10%)	Subtotal Cost
1. Engineering - Feasibility level	1600	Hrs	$45	$90	$14	$237,600
Geotechnical Investigations	1	lump sum				$44,000
2. Engineering - Construction Plans and Specifications	2000	Hrs	$45	$90	$14	$297,000
3. Engineering - During Construction	1380	Hrs	$40	$80	$12	$182,160
4. Project Owner Costs	920	Hrs	$50	$100	$15	$151,800

ALTERNATIVE B - SIPHON INTAKE AND DAM REMOVAL

City of Bellingham
Middle Fork Tunnel Intake Feasibility Study
10% Design Level Cost Estimation

							2011	Dec. 2017		
Bid Item	**Description**			**Quantity**	**Unit of Measure**	**Cost Per Unit**	**Subtotal Cost**	**2018 Cost**	**Notes**	Escalation Factor
1	Mobilization			1	Lump Sum	$1,000,000	$1,000,000	1,198,787	Assumes approximately 8% of Total Construction Cost	ENR CCI
A - Intake Structure Related										
2	Cofferdam for the New Intake			1	Lump Sum	200,000	200,000	239,757	Placeholder - Design and implementation will be performed by Contractor	ENR CCI
3	Channel Diversion			1	Lump Sum	150,000	150,000	179,818	Placeholder - Design and implementation will be performed by Contractor	ENR CCI
4	Dewatering During Construction			1	Lump Sum	100,000	100,000	119,879	Placeholder - Design and implementation will be performed by Contractor	ENR CCI
5	Structure Excavation Class A Incl. Haul			3,600	Cubic Yard	100	360,000	431,563	Calculated quantities are per NHC details	ENR CCI
6	Structural Backfill			1,050	Cubic Yard	50	52,500	62,936	Calculated quantities are per NHC details	ENR CCI
7	Partial Demo of Existing Dam incl. Haul			1	Lump Sum	150,000	150,000	179,818	Placeholder - Design and implementation construction will be performed by Contractor	ENR CCI
8	Concrete Class 4000			2,100	Cubic Yard	850	1,785,000	2,139,835	Pricing per assumption that portable batch plant will be installed at the site	ENR CCI
9	Steel Reinforcement Bar			170,000	Lbs	2	255,000	305,691	Pricing per WSDOT Bridge design Manual - May 2010	ENR CCI
10	Equipment Housing			1,200	Sq. Feet	100	120,000	143,854	Pricing per past experience with similar mechanical housing facilities	ENR CCI
11	Site Improvements Complete			1	Lump Sum	250,000	250,000	299,697	Improvements envisioned are two turn-out pockets, fencing, drainage enhancement, etc Per Shannon & Wilson Preliminary Geotechnical Report	ENR CCI
12	Torrent Flow Deflector			1	Lump Sum	100,000	100,000	119,879	Placeholder - Implementation will be proposed by Contractor	ENR CCI
B - Tunnel Related										
12	Tunnel Improvements Complete			1	Lump Sum	1,000,000	1,000,000	1,198,787	Quote from NW Pipe and Casing regarding an	ENR CCI
13	84-inch Dia. (ID) Steel Liner Pipe Incl. Installation			1,617,000	Lbs	3	5,255,250	6,299,926	84-inch epoxy-lined 3/8-inch thick pipeline. Quote for material only: $450/ LF. Estimated length, 9,500 LF	ENR CCI
C - Equipment Related										
14	Sluice Gate			6	Each	30,000	180,000	215,782	Assumes 4'*6' stainless steel slide gate with a NEMA 6P actuator	ENR CCI
15	Knife Gate			2	Each	18,500	37,000	44,355	Assumes an 18-inch knife gate with electric actuator	ENR CCI
16	Priming Pump Discharge Control Valve			1	Each	10,000	10,000	11,988	Assumes 10-inch diameter control valve	ENR CCI
17	Air Release Valve			1	Each	10,000	10,000	11,988	Assumes 10-inch diameter Axial Flow Pump 2000gpm @20' TDH	ENR CCI
18	Priming Pump			1	Each	33,000	33,000	39,560	Per past cost data	ENR CCI
19	Priming Pump MCC			1	Each	10,000	10,000	11,988	Per past cost data	ENR CCI
20	HVAC Complete			1	Lump Sum	35,000	35,000	41,958	Per past cost data	ENR CCI
21	Flow Meter			1	Each	25,000	25,000	29,970	Based on 42-inch Mag meter	ENR CCI
22	Cable Driven Trolley/Brush Screen Cleaner			1	Each	200,000	200,000	239,757	Per past cost data	ENR CCI
23	Air Vacuum Extraction System			2	Lump Sum	20,000	40,000	47,951	Per past cost data	ENR CCI
24	Vertical Intake Fish Screens			360	Sq. Feet	275	99,000	118,680	Assumes 6 panels at 10' wide* 6' high	ENR CCI
25	Blank Panel Associated with Screens			900	Sq. Feet	75	67,500	80,918	Assumes 6 panels at 10' wide* 15' high	ENR CCI
26	Baffles Associated with Screens			360	Sq. Feet	150	54,000	64,735	Assumes 6 panels at 10' wide* 6' high	ENR CCI
27	Trash Racks			1	Lump Sum	20,000	20,000	23,976	Per past cost data	ENR CCI
28	Trash Rake			1	Each	180,000	180,000	215,782	Atlas Polar Upward Sweeping Rake	ENR CCI
D - Electrical Related										
29	Mech. Screen Cleaning System Control Panel			1	Each	30,000	30,000	35,964	Per past cost data	ENR CCI
30	Lighting Complete			1	Lump Sum	20,000	20,000	23,976	Per past cost data	ENR CCI
31	Security Equipment Complete			1	Lump Sum	50,000	50,000	59,939	Per past cost data	ENR CCI
32	PLC Panel Incl. Programming			1	Lump Sum	150,000	150,000	179,818	Per past cost data	ENR CCI
33	Transformer			2	Each	20,000	40,000	47,951	Per past cost data	ENR CCI
34	Electrical Transmission Cable			9,500	linear Feet	40	380,000	455,539	Assumes 1-inch diameter cable	ENR CCI
35	Manual Transfer Switch			1	Each	20,000	20,000	23,976	Per past cost data	ENR CCI
36	Electrical Distribution Complete			1	Lump Sum	100,000	100,000	119,879	Includes panels, raceways, grounding, etc	ENR CCI

E - Hydro Plant Bypass Related										
37	Structure Excavation Class A Incl. Haul			160	Cubic Yard	100	16,000	19,181	Calculated quantities per standard cut and cover for installation of a 40-inch diamter pipeline	ENR CCI
38	Structural Backfill			130	Cubic Yard	50	6,500	7,792	Calculated quantities per standard cut and cover for installation of a 40-inch diamter pipeline	ENR CCI
39	42-inch Resilient Seat Gate Valves			4	Each	16,000	64,000	76,722	Per past cost data	ENR CCI
40	40-inch Dia. (ID) Steel Pipe			8,200	Lbs	2	14,350	17,203	Pricing per WSDOT Bridge design Manual - May 2010. Estimated length 100 LF.	ENR CCI

Subtotal	$12,669,100	$15,187,555	
Contingency @ 30%	3,800,730	4,556,267	with the site access and complexity of the Project
Total Construction Cost	$16,469,830	$19,743,822	
Permitting Support	$50,000	$50,000	Assuming City will have the lead on permitting
Engineering @ 10%	1,646,983	1,974,382	
Construction Phase Engineering Support @ 5%	823,492	987,191	It includes responding to Contractor RFIs, review of shop drawings and engineer site visits for verification/ clarification purposes. It does not include construction management & construction field inspection services
Total Project Cost	$18,990,305	$22,755,395	
		19.83%	

Alternative 1 - Slot and Deep Pool Intake

Pre-Construction Costs

Feature	Quantity	Unit Of Measure	Aggr. Rate (2005 rates)	Overhead (2.0 mult.)	Profit (10%)	2005 Subtotal Cost	Dec. 2017 2018 Costs	Escalation Factor
1. Engineering - Feasibility level	2500	Hrs	$50	$100	$15	$412,500	602,352	ENR CCI
2. Engineering - During Construction	1200	Hrs	$45	$90	$14	$178,200	260,216	ENR CCI
3. Project Owner Costs	800	Hrs	$55	$110	$17	$145,200	212,028	ENR CCI
Subtotal						$735,900	$1,074,596	

Project Direct Cost

Feature	Quantity	Unit Of Measure	Labor Hrs / Unit	Crew (Means)	Labor Hrs	Mat. Rate	Material	Labor Rate	Labor	Equip. Rate	Equipment	Other	Materials City Adjust. (Everett)	Installation City Adjust. (Everett)	Subtotal Cost	Equivalent Unit Cost	2018 Costs	Escalation Factor
1. Mobilization																		
Equipment, machinery, facilities	1	lump sum	0.000		0	$0.00	$0.00	$0.00	$0.00	$20,000.00	$20,000.00		$1.00	$1.04	$20,800.00	$20,800.00	30,373	ENR CCI
Subtotal					$0.00		$0.00		$0.00		$20,000.00				$20,800.00		30,373	
2. Cofferdam Upstream (2 caisson cells + 8 cells excavate, separate boulders & replace)																		
8 sheet pile cell-type cofferdams 12-35'H x 20'L x 20-25'W	16210	ft2	0.116	B-40	1880.36	$15.40	$249,634.00	$3.91	$63,381.10	$4.14	$67,109.40		$0.94	$1.12	$380,927.87	$23.50	556,249	ENR CCI
U/s line of sheets left in place to provide form for cutoff wall	1930	ft2	0.064	B-40	123.52	$74.40	$143,592.00	$2.16	$4,168.80	$2.29	$4,419.70		$0.94	$1.12	$144,985.15	$75.12	211,714	ENR CCI
Waler beams for channel walls (W12x50, 3 rows, 100lf each s	15	tons	6.202	E-5	93.03	$3,500.00	$52,500.00	$233.00	$3,495.00	$109.00	$1,635.00		$1.05	$0.87	$59,813.49	$3,987.57	87,342	ENR CCI
Excavation Overburden (+ shot boulder remains)	11000	yd 3	0.013	B-12D	143	$0.00	$0.00	$0.39	$4,290.00	$1.58	$17,380.00		$0.94	$1.12	$24,166.38	$2.20	35,289	ENR CCI
Oversize boulders Drilling and Blasting (5% of overburden)	550	yd 3	0.240	B-47	132	$1.89	$1,039.50	$7.10	$3,905.00	$10.00	$5,500.00		$0.94	$1.12	$11,468.70	$20.85	16,747	ENR CCI
Excavate & load boulders for stockpile (30% of overburden)	3300	yd 3	0.120	B-10U	396	$0.00	$0.00	$3.84	$12,672.00	$7.00	$23,100.00		$0.94	$1.12	$39,892.93	$12.09	58,254	ENR CCI
Hauling boulders to temp. stockpile upstream bench	3300	yd 3	0.024	B-34E	79.2	$0.00	$0.00	$0.67	$2,211.00	$2.76	$9,108.00		$0.94	$1.12	$12,622.95	$3.83	18,433	ENR CCI
Dozing remaining overburden to stockpile 150' haul	3300	yd 3	0.024	B-10M	79.2	$0.00	$0.00	$0.77	$2,541.00	$2.39	$7,887.00		$0.94	$1.12	$11,629.31	$3.52	16,982	ENR CCI
Backfill native material	7150	yd 3	0.007	B-10M	50.05	$0.00	$0.00	$0.23	$1,644.50	$0.70	$5,005.00		$0.94	$1.12	$7,415.52	$1.04	10,828	ENR CCI
Pumped grout base seal (200 lf base x 5 ft 3/lf)	1000	ft 3	0.160	B-61	160	$18.20	$18,200.00	$4.54	$4,540.00	$1.00	$1,000.00		$0.94	$1.12	$23,340.81	$23.34	34,083	ENR CCI
Flexible grout joint waterproofing above ground (acrylic latex)	2500	vlf	0.073	Bric	182.5	$1.24	$3,100.00	$2.56	$6,400.00	$0.00	$0.00		$1.07	$0.99	$9,627.20	$3.85	14,058	ENR CCI
2 sheet pile caisson-type cofferdams 17-21'H x 20'L x 25'W	3050	ft2	0.116	B-40	353.8	$15.40	$46,970.00	$3.91	$11,925.50	$4.14	$12,627.00		$0.94	$1.12	$71,673.66	$23.50	104,661	ENR CCI
Excavation Till inside cells (+ shot boulder remains) w/ clamshel	750	yd 3	0.267	B-12H	200.25	$0.00	$0.00	$8.35	$6,262.50	$14.60	$10,950.00		$0.94	$1.12	$19,195.38	$25.59	28,030	ENR CCI
Boulders Drilling and Blasting (10% of till exc.)	75	yd 3	0.240	B-47	18	$1.89	$141.75	$7.10	$532.50	$10.00	$750.00		$0.94	$1.12	$1,563.91	$20.85	2,284	ENR CCI
Dozing remaining overburden to stockpile 150' haul	75	yd 3	0.024	B-10M	1.8	$0.00	$0.00	$0.77	$57.75	$2.39	$179.25		$0.94	$1.12	$264.30	$3.52	386	ENR CCI
Backfill native material w/clamshell inside cells	750	yd 3	0.100	B-12H	75	$0.00	$0.00	$3.13	$2,347.50	$5.50	$4,125.00		$0.94	$1.12	$7,218.13	$9.62	10,540	ENR CCI
Dozing remaining overburden to stockpile 150' haul	750	yd 3	0.024	B-10M	18	$0.00	$0.00	$0.77	$577.50	$2.39	$1,792.50		$0.94	$1.12	$2,643.02	$3.52	3,859	ENR CCI
Compaction (hand vibrating plate for gravel/sand)	750	yd 3	0.040	A-1D	30	$0.00	$0.00	$1.07	$802.50	$0.13	$97.50		$0.94	$1.12	$1,003.68	$1.34	1,466	ENR CCI
Subtotal					$4,016.00		$515,177.25		$131,754.15		$172,665.35				$829,452.41		1,211,205	
3. Cofferdam Downstream (2 cells excavate, separate boulders & replace)																		
2 sheet pile cell-type cofferdams 12-35'H x 20'L x 20-25'W	2400	ft2	0.116	B-40	278.4	$15.40	$36,960.00	$3.91	$9,384.00	$4.14	$9,936.00		$0.94	$1.12	$56,398.94	$23.50	82,356	ENR CCI
Waler beams for sides (W12x50, 2.5 rows ave, 30lf each side)	3.75	tons	6.202	E-5	23.2575	$3,500.00	$13,125.00	$233.00	$873.75	$109.00	$408.75		$1.05	$0.87	$14,953.37	$3,987.57	21,836	ENR CCI
Excavation Overburden (+ shot boulder remains)	750	yd 3	0.013	B-12D	9.75	$0.00	$0.00	$0.39	$292.50	$1.58	$1,185.00		$0.94	$1.12	$1,647.71	$2.20	2,406	ENR CCI
Oversize boulders Drilling and Blasting (5% of overburden)	37.5	yd 3	0.240	B-47	9	$1.89	$70.88	$7.10	$266.25	$10.00	$375.00		$0.94	$1.12	$781.96	$20.85	1,142	ENR CCI
Excavate & load boulders for stockpile (30% of overburden)	225	yd 3	0.120	B-10U	27	$0.00	$0.00	$3.84	$864.00	$7.00	$1,575.00		$0.94	$1.12	$2,719.97	$12.09	3,972	ENR CCI
Hauling boulders to temp. stockpile upstream bench	225	yd 3	0.024	B-34E	5.4	$0.00	$0.00	$0.67	$150.75	$2.76	$621.00		$0.94	$1.12	$860.66	$3.83	1,257	ENR CCI
Dozing remaining overburden to stockpile 150' haul	225	yd 3	0.024	B-10M	5.4	$0.00	$0.00	$0.77	$173.25	$2.39	$537.75		$0.94	$1.12	$792.91	$3.52	1,158	ENR CCI
Backfill native material	750	yd 3	0.007	B-10M	5.25	$0.00	$0.00	$0.23	$172.50	$0.70	$525.00		$0.94	$1.12	$777.85	$1.04	1,136	ENR CCI
Pumped grout base seal (30 lf base x 5 ft 3/lf)	150	ft 3	0.160	B-61	24	$18.20	$2,730.00	$4.54	$681.00	$1.00	$150.00		$0.94	$1.12	$3,501.12	$23.34	5,113	ENR CCI
Flexible grout joint waterproofing above ground (acrylic latex)	375	vlf	0.073	Bric	27.375	$1.24	$465.00	$2.56	$960.00	$0.00	$0.00		$1.07	$0.99	$1,444.08	$3.85	2,109	ENR CCI
Subtotal					$415.00		$53,350.88		$13,818.00		$15,313.50				$83,878.57		122,483	
4. Diversion Channel Stage 1 Excavation (inc re-excavate btwn u/s cofferdams)																		
Excavation Overburden (+ shot boulder remains)	7120	yd 3	0.013	B-12D	92.56	$0.00	$0.00	$0.39	$2,776.80	$1.58	$11,249.60		$0.94	$1.12	$15,642.24	$2.20	22,842	ENR CCI
Oversize boulders Drilling and Blasting (5% of overburden)	356	yd 3	0.240	B-47	85.44	$1.89	$672.84	$7.10	$2,527.60	$10.00	$3,560.00		$0.94	$1.12	$7,423.38	$20.85	10,840	ENR CCI
Excavate & load boulders for stockpile (30% of overburden)	2136	yd 3	0.120	B-10U	256.32	$0.00	$0.00	$3.84	$8,202.24	$7.00	$14,952.00		$0.94	$1.12	$25,821.61	$12.09	37,706	ENR CCI
Hauling boulders to temp. stockpile upstream bench	2136	yd 3	0.024	B-34E	51.264	$0.00	$0.00	$0.67	$1,431.12	$2.76	$5,895.36		$0.94	$1.12	$8,170.49	$3.83	11,931	ENR CCI
Dozing remaining overburden to stockpile 150' haul	2136	yd 3	0.02	B-10M	51.264	$0.00	$0.00	$0.77	$1,644.72	$2.39	$5,105.04		$0.94	$1.12	$7,527.33	$3.52	10,992	ENR CCI
Excavate bedrock (by drill and shoot method)	5410	yd 3	0.92	B-47	4993.43	$5.50	$29,755.00	$27.00	$146,070.00	$38.50	$208,285.00		$0.94	$1.12	$423,235.66	$78.23	618,029	ENR CCI
Remove shot material from trench	5410	yd 3	0.01	B-12D	70.33	$0.00	$0.00	$0.39	$2,109.90	$1.58	$8,547.80		$0.94	$1.12	$11,885.47	$2.20	17,356	ENR CCI
Dozing shot material to stockpile 150' haul	5410	yd 3	0.024	B-10M	129.84	$0.00	$0.00	$0.77	$4,165.70	$2.39	$12,929.90		$0.94	$1.12	$19,065.01	$3.52	27,840	ENR CCI
Subtotal					$5,730.00		$30,427.84		$168,928.08		$270,524.70				$518,771.19		757,534	
5. Dewatering during foundation construction																		
Pumping, turbidity control only for foundations prep and pour	60	days	12.000	B-10K	720	$0.00	$0.00	$385.00	$23,100.00	$248.00	$14,880.00		$0.94	$1.12	$42,355.30	$705.92	61,849	ENR CCI
Subtotal					720		$0.00		$23,100.00		$14,880.00				$42,355.30		61,849	

6. Downstream Penstock Connection Excavation																		
Excavation Overburden (+ shot boulder remains)	520	yd 3	0.013	B-12D	6.76	$0.00	$0.00	$0.39	$202.80	$1.58	$821.60		$0.94	$1.12	$1,142.41	$2.20	1,668	ENR CCI
Oversize boulders Drilling and Blasting (5% of overburden)	26	yd 3	0.240	B-47	6.24	$1.89	$49.14	$7.10	$184.60	$10.00	$260.00		$0.94	$1.12	$542.16	$20.85	792	ENR CCI
Excavate & load boulders for stockpile (30% of overburden)	156	yd 3	0.120	B-10U	18.72	$0.00	$0.00	$3.84	$599.04	$7.00	$1,092.00		$0.94	$1.12	$1,885.85	$12.09	2,754	ENR CCI
Hauling boulders to temp. stockpile upstream bench	156	yd 3	0.024	B-34E	3.74	$0.00	$0.00	$0.67	$104.52	$2.76	$430.56		0.943	1.1152	$596.72	$3.83	871	ENR CCI
Dozing remaining overburden to stockpile 150' haul	156	yd 3	0.024	B-10M	3.744	$0.00	$0.00	$0.77	$120.12	$2.39	$372.84		$0.94	$1.12	$549.75	$3.52	803	ENR CCI
Excavate bedrock (by drill and shoot method)	1425	yd 3	0.923	B-47	1315.275	$5.50	$7,837.50	$27.00	$38,475.00	$38.50	$54,862.50		$0.94	$1.12	$111,480.74	$78.23	162,789	ENR CCI
Remove shot material from trench	1425	yd 3	0.013	B-12D	18.525	$0.00	$0.00	$0.39	$555.75	$1.58	$2,251.50		$0.94	$1.12	$3,130.65	$2.20	4,572	ENR CCI
Dozing shot material to stockpile 150' haul	1425	yd 3	0.024	B-10M	34.2	$0.00	$0.00	$0.77	$1,097.25	$2.39	$3,405.75		$0.94	$1.12	$5,021.75	$3.52	7,333	ENR CCI
Subtotal					**1407**		**$7,886.64**		**$41,339.08**		**$63,496.75**				**$124,350.02**		**181,582**	
7. Right Abutment Excavation (reached by crane and clamshell from left bank)																		
Excavate bedrock (by drill and shoot method)	2100	yd 3	0.923	B-47	1938.3	$5.50	$11,550.00	$27.00	$56,700.00	$38.50	$80,850.00		$0.94	$1.12	$164,287.41	$78.23	239,900	ENR CCI
Remove shot mat'l w/ clamshell	2100	yd 3	0.267	B-12H	560.7	$0.00	$0.00	$8.35	$17,535.00	$14.60	$30,660.00		$0.94	$1.12	$53,747.06	$25.59	78,484	ENR CCI
Dozing shot material to stockpile 150' haul	2100	yd 3	0.024	B-10M	50.4	$0.00	$0.00	$0.77	$1,617.00	$2.39	$5,019.00		$0.94	$1.12	$7,400.47	$3.52	10,807	ENR CCI
Subtotal					**2549**		**$11,550.00**		**$75,852.00**		**$116,529.00**				**$225,434.94**		**329,191**	
8. Left Abutment (Intake) Excavation																		
Excavation Overburden (+ shot boulder remains)	2365	yd 3	0.013	B-12D	30.745	$0.00	$0.00	$0.39	$922.35	$1.58	$3,736.70		$0.94	$1.12	$5,195.77	$2.20	7,587	ENR CCI
Oversize boulders Drilling and Blasting (5% of overburden)	118	yd 3	0.240	B-47	28.38	$1.89	$223.49	$7.10	$839.58	$10.00	$1,182.50		$0.94	$1.12	$2,465.77	$20.85	3,601	ENR CCI
Excavate & load boulders for stockpile (30% of overburden)	709.5	yd 3	0.120	B-10U	85.14	$0.00	$0.00	$3.84	$2,724.48	$7.00	$4,966.50		$0.94	$1.12	$8,576.98	$12.09	12,525	ENR CCI
Hauling boulders to temp. stockpile upstream bench	709.5	yd 3	0.024	B-34E	17.028	$0.00	$0.00	$0.67	$475.37	$2.76	$1,958.22		$0.94	$1.12	$2,713.93	$3.83	3,963	ENR CCI
Dozing remaining overburden to stockpile 150' haul	710	yd 3	0.024	B-10M	17.028	$0.00	$0.00	$0.77	$546.32	$2.39	$1,695.71		$0.94	$1.12	$2,500.30	$3.52	3,651	ENR CCI
Excavate bedrock (by drill and shoot method)	530	yd 3	0.923	B-47	489.19	$5.50	$2,915.00	$27.00	$14,310.00	$38.50	$20,405.00		$0.94	$1.12	$41,463.01	$78.23	60,546	ENR CCI
Remove shot material from trench	530	yd 3	0.013	B-12D	6.89	$0.00	$0.00	$0.39	$206.70	$1.58	$837.40		$0.94	$1.12	$1,164.38	$2.20	1,700	ENR CCI
Dozing shot material to stockpile 150' haul	530	yd 3	0.024	B-10M	12.72	$0.00	$0.00	$0.77	$408.10	$2.39	$1,266.70		$0.94	$1.12	$1,867.74	$3.52	2,727	ENR CCI
Subtotal					**687**		**$3,138.49**		**$20,432.89**		**$36,048.73**				**$65,947.89**		**96,300**	
9. Scour Hole Excavation (shot rock excavation by crane and clamshell from left bank)																		
Excavation Overburden (+ shot boulder remains)	1,924	yd 3	0.013	B-12D	25.012	$0.00	$0.00	$0.39	$750.36	$1.58	$3,039.92		$0.94	$1.12	$4,226.92	$2.20	6,172	ENR CCI
Oversize boulders Drilling and Blasting (5% of overburden)	96	yd 3	0.240	B-47	23.088	$1.89	$181.82	$7.10	$683.02	$10.00	$962.00		$0.94	$1.12	$2,005.98	$20.85	2,929	ENR CCI
Excavate & load boulders for stockpile (30% of overburden)	577.2	yd 3	0.120	B-10U	69.264	$0.00	$0.00	$3.84	$2,216.45	$7.00	$4,040.40		$0.94	$1.12	$6,977.64	$12.09	10,189	ENR CCI
Hauling boulders to temp. stockpile upstream bench	577.2	yd 3	0.024	B-34E	13.8528	$0.00	$0.00	$0.67	$386.72	$2.76	$1,593.07		$0.94	$1.12	$2,207.87	$3.83	3,224	ENR CCI
Dozing remaining overburden to stockpile 150' haul	577.2	yd 3	0.024	B-10M	13.8528	$0.00	$0.00	$0.77	$444.44	$2.39	$1,379.51		$0.94	$1.12	$2,034.07	$3.52	2,970	ENR CCI
Excavate bedrock (by drill and shoot method)	1657	yd 3	0.923	B-47	1529.411	$5.50	$9,113.50	$27.00	$44,739.00	$38.50	$63,794.50		$0.94	$1.12	$129,630.59	$78.23	189,293	ENR CCI
Remove shot material from trench	1657	yd 3	0.013	B-12D	21.541	$0.00	$0.00	$0.39	$646.23	$1.58	$2,618.06		$0.94	$1.12	$3,640.34	$2.20	5,316	ENR CCI
Dozing shot material to stockpile 150' haul	1657	yd 3	0.024	B-10M	39.768	$0.00	$0.00	$0.77	$1,275.89	$2.39	$3,960.23		$0.94	$1.12	$5,839.32	$3.52	8,527	ENR CCI
Subtotal					**1736**		**$9,295.32**		**$51,142.12**		**$81,387.69**				**$156,562.72**		**228,620**	
10. Upstream Penstock Connection Excavation																		
Excavation Overburden (+ shot boulder remains)	10233	yd 3	0.013	B-12D	133.029	$0.00	$0.00	$0.39	$3,990.87	$1.58	$16,168.14		$0.94	$1.12	$22,481.33	$2.20	32,828	ENR CCI
Oversize boulders Drilling and Blasting (5% of overburden)	511.65	yd 3	0.240	B-47	122.796	$1.89	$967.02	$7.10	$3,632.72	$10.00	$5,116.50		$0.94	$1.12	$10,669.02	$20.85	15,579	ENR CCI
Excavate & load boulders for stockpile (30% of overburden)	3069.9	yd 3	0.120	B-10U	368.388	$0.00	$0.00	$3.84	$11,788.42	$7.00	$21,489.30		$0.94	$1.12	$37,111.31	$12.09	54,192	ENR CCI
Hauling boulders to temp. stockpile upstream bench	3069.9	yd 3	0.024	B-34E	73.6776	$0.00	$0.00	$0.67	$2,056.83	$2.76	$8,472.92		$0.94	$1.12	$11,742.79	$3.83	17,147	ENR CCI
Dozing remaining overburden to stockpile 150' haul	3069.9	yd 3	0.024	B-10M	73.6776	$0.00	$0.00	$0.77	$2,363.82	$2.39	$7,337.06		$0.94	$1.12	$10,818.43	$3.52	15,798	ENR CCI
Subtotal					**772**		**$967.02**		**$23,832.66**		**$58,583.93**				**$92,822.87**		**135,544**	
11. Access Roadway Excavation + Finish Grade & Maint Bldg Construction																		
Excavation Overburden (+ shot boulder remains)	1867	yd 3	0.024	B-10M	44.808	$0.00	$0.00	$0.77	$1,437.59	$2.39	$4,462.13		$0.94	$1.12	$6,579.37	$3.52	9,608	ENR CCI
Oversize boulders Drilling and Blasting (5% of overburden)	93.35	yd 3	0.240	B-47	22.404	$1.89	$176.43	$7.10	$662.79	$10.00	$933.50		$0.94	$1.12	$1,946.55	$20.85	2,842	ENR CCI
Excavate & load boulders for stockpile (30% of overburden)	560.1	yd 3	0.120	B-10U	67.212	$0.00	$0.00	$3.84	$2,150.78	$7.00	$3,920.70		$0.94	$1.12	$6,770.92	$12.09	9,887	ENR CCI
Hauling boulders to temp. stockpile upstream bench	560.1	yd 3	0.024	B-34E	13.4424	$0.00	$0.00	$0.67	$375.27	$2.76	$1,545.88		$0.94	$1.12	$2,142.46	$3.83	3,129	ENR CCI
Dozing remaining overburden to fill areas 150' haul	1213.55	yd 3	0.024	B-10M	29.1252	$0.00	$0.00	$0.77	$934.43	$2.39	$2,900.38		$0.94	$1.12	$4,276.59	$3.52	6,245	ENR CCI
Access roadway subgrade (gravel)	667	yd 3	0.029	B-36C	19.343	$17.80	$11,872.60	$0.92	$613.64	$1.83	$1,220.61		$0.94	$1.12	$13,241.42	$19.85	19,336	ENR CCI
Access roadway wear course (3/4" crushed, 3" thickness)	150	yd 3	0.092	B-36C	13.8	$27.50	$4,125.00	$2.95	$442.50	$5.85	$877.50		$0.94	$1.12	$5,361.94	$35.75	7,830	ENR CCI
Guardrail (450 l.f.)	450	l.f.	0.038	B-80	17.1	$15.20	$6,840.00	$1.08	$486.00	$0.63	$283.50		$0.94	$1.12	$7,308.27	$16.24	10,672	ENR CCI
Seeding entire site	43.5	m.s.f.	0.300	B-81	13.05	$24.00	$1,044.00	$8.90	$387.15	$5.05	$219.68		$0.94	$1.12	$1,661.22	$38.19	2,426	ENR CCI
Subtotal					**227**		**$23,014.03**		**$7,103.00**		**$16,144.20**				**$47,627.51**		**71,974**	
12. Boulder Grade Control Excavation and Construction (incl. moving boulders from stockpile to channel)																		
Excavation Overburden (+ shot boulder remains)	26894	yd 3	0.013	B-12D	349.622	$0.00	$0.00	$0.39	$10,488.66	$1.58	$42,492.52		$0.94	$1.12	$59,084.61	$2.20	86,278	ENR CCI
Oversize boulders Drilling and Blasting (5% of overburden)	1344.7	yd 3	0.240	B-47	322.728	$1.89	$2,541.48	$7.10	$9,547.37	$10.00	$13,447.00		$0.94	$1.12	$28,039.94	$20.85	40,945	ENR CCI
Excavate & load boulders for stockpile (30% of overburden)	8068.2	yd 3	0.120	B-10U	968.184	$0.00	$0.00	$3.84	$30,981.89	$7.00	$56,477.40		$0.94	$1.12	$97,534.60	$12.09	142,425	ENR CCI
Hauling boulders to temp. stockpile upstream bench	8068.2	yd 3	0.024	B-34E	193.6368	$0.00	$0.00	$0.67	$5,405.69	$2.76	$22,268.23		$0.94	$1.12	$30,861.96	$3.83	45,066	ENR CCI
Dozing remaining overburden to stockpile 150' haul	8068.2	yd 3	0.024	B-10M	193.6368	$0.00	$0.00	$0.77	$6,212.51	$2.39	$19,283.00		$0.94	$1.12	$28,432.59	$3.52	41,519	ENR CCI
RCC Concrete weirs and curtain walls (no forms)	4038	yd 3	0.009	B-10C	36.342	$60.50	$244,299.00	$0.30	$1,211.40	$1.18	$4,764.84		$0.98	$1.03	$245,103.85	$60.70	357,912	ENR CCI
Hauling RCC from batch plant to placement (loader, 12 min cy	4038	yd 3	0.075	B-10U	302.85	$0.00	$0.00	$2.40	$9,691.20	$4.38	$17,686.44		$0.98	$1.03	$28,308.48	$7.01	41,337	ENR CCI
Backfill native material (incl boulders)	22856	yd 3	0.007	B-10M	159.992	$0.00	$0.00	$0.23	$5,256.88	$0.70	$15,999.20		$0.94	$1.12	$23,704.78	$1.04	34,615	ENR CCI
Hauling boulders from temp. stockpile upstream bench	8068.2	yd 3	0.024	B-34E	193.6368	$0.00	$0.00	$0.67	$5,405.69	$2.76	$22,268.23		$0.94	$1.12	$30,861.96	$3.83	45,066	ENR CCI
Subtotal					**2721**		**$246,840.48**		**$84,201.30**		**$214,686.86**				**$571,932.78**		**835,163**	
13. Penstock Construction																		
Buried Penstock (excavation accounted for above)																		
6.5' Diameter Buried Steel Penstock 5/8" wall	480	l.f.	4.197	B-35A	2014.74	$477.75	$229,320.00	$134.06	$64,350.00	$93.44	$44,850.00		$0.94	$1.12	$338,028.60	$704.23	493,605	ENR CCI
5 bends, various angles	6	each	0.000	0.000	0	$5,000.00	$30,000.00	$166.00	$996.00	$127.00	$762.00		$0.94	$1.12	$30,250.52	$5,041.75	44,173	ENR CCI
Backfill cement densified material (incl compaction)	2773	yd 3	0.009	B-10C	24.957	$60.50	$167,766.50	$0.30	$831.90	$1.18	$3,272.14		$0.98	$1.03	$168,319.21	$60.70	245,788	ENR CCI
Backfill compacted native material for u/s section	600	yd 3	0.007	B-10M	4.2	$0.00	$0.00	$0.23	$138.00	$0.70	$420.00		$0.94	$1.12	$622.28	$1.04	909	ENR CCI
Hauling from stockpile upstream bench	600	yd 3	0.024	B-34E	14.4	$0.00	$0.00	$0.67	$402.00	$2.76	$1,656.00		$0.94	$1.12	$2,295.08	$3.83	3,351	ENR CCI
Compaction	600	yd 3	0.002	B-10Y	1.2	$0.00	$0.00	$0.07	$42.00	$0.07	$42.00		$0.94	$1.12	$93.68	$0.16	137	ENR CCI
Backfill native material all to restore final grade	14500	yd 3	0.007	B-10M	101.5	$0.00	$0.00	$0.23	$3,335.00	$0.70	$10,150.00		$0.94	$1.12	$15,038.47	$1.04	21,960	ENR CCI
Hauling from stockpile upstream bench	14500	yd 3	0.024	B-34E	348	$0.00	$0.00	$0.67	$9,715.00	$2.76	$40,020.00		$0.94	$1.12	$55,464.47	$3.83	80,992	ENR CCI
D/s connection concrete (inc. delivery, reinforcement, formwork)	32	yd 3	4.094	C-14D	131.008	$143.00	$4,576.00	$139.00	$4,448.00	$14.90	$476.80		$0.98	$1.03	$9,567.57	$298.99	13,971	ENR CCI
Rock Anchorage Tendons 60"x1" dia	6	Ea.	0.500	2 Skwk	3	$75.00	$450.00	$17.45	$104.70	$0.00	$0.00		$0.94	$1.12	$541.11	$90.19	790	ENR CCI
Rock Anchorage Drilling	6	Ea.	1.231	B-56	7.386	$0.00	$0.00	$37.00	$222.00	$75.50	$453.00		$0.94	$1.12	$752.76	$125.46	1,099	ENR CCI
Subtotal					**2650**		**$432,112.50**		**$84,584.60**		**$102,101.94**				**$620,973.76**		**906,775**	

14. Abutments, Intake, and Concrete Construction Items																		
Right Abutment Concrete Cast in Place (excavation accounted for above)																		
Concrete Ready Mix 3500 psi (inc. delivery)	3022	yd 3	0.000	0.000	0	$82.00	$247,804.00	$0.00	$0.00	$0.00	$0.00		$0.98	$1.03	$242,352.31	$80.20	353,894	ENR CCI
Formwork (plywood, 4 uses)	3719	ft 2	0.145	C-2	539.255	$0.78	$2,900.82	$4.85	$18,037.15	$0.00	$0.00		$1.06	$1.01	$21,358.11	$5.74	31,188	ENR CCI
Placing Concrete - pumped, includes vibrating	3022	yd 3	0.427	C-20	1290.394	$0.00	$0.00	$12.25	$37,019.50	$5.00	$15,110.00		$0.98	$1.03	$53,901.90	$17.84	78,710	ENR CCI
Reinforcing in Place #3 to #8 bar (assume 150lbs/yd 3)	227	tons	12.064	4 Rodmn	2734.192275	$1,480.00	$335,442.00	$457.50	$103,692.38	$0.00	$0.00		$1.08	$0.94	$458,997.98	$2,025.14	670,250	ENR CCI
Rock Anchorage Tendons 60"x1" dia	128	Ea.	0.500	2 Skwk	64	$75.00	$9,600.00	$17.45	$2,233.60	$0.00	$0.00		$0.94	$1.12	$11,543.71	$90.19	16,857	ENR CCI
Rock Anchorage Drilling	128	Ea.	1.231	B-56	157.568	$0.00	$0.00	$37.00	$4,736.00	$75.50	$9,664.00		$0.94	$1.12	$16,058.88	$125.46	23,450	ENR CCI
Left Abutment Concrete Cast in Place (excavation accounted for above)																		
Concrete Ready Mix 3500 psi (inc. delivery)	2659	yd 3	0.000		0	$82.00	$218,038.00	$0.00	$0.00	$0.00	$0.00		$0.98	$1.03	$213,241.16	$80.20	311,385	ENR CCI
Formwork (plywood, 4 uses)	10975	ft 2	0.145	C-2	1591.375	$0.78	$8,560.50	$4.85	$53,228.75	$0.00	$0.00		$1.06	$1.01	$63,029.10	$5.74	92,038	ENR CCI
Placing Concrete - pumped, includes vibrating	2659	yd 3	0.427	C-20	1135.393	$0.00	$0.00	$12.25	$32,572.75	$5.00	$13,295.00		$0.98	$1.03	$47,427.25	$17.84	69,256	ENR CCI
Reinforcing in Place #3 to #8 bar (assume 200lbs/yd 3)	266	tons	12.064	4 Rodmn	3207.68465	$1,480.00	$393,532.00	$457.50	$121,649.25	$0.00	$0.00		$1.08	$0.94	$538,484.73	$2,025.14	786,321	ENR CCI
Rock Anchorage Tendons 60"x1" dia	82	Ea.	0.500	2 Skwk	41	$75.00	$6,150.00	$17.45	$1,430.90	$0.00	$0.00		$0.94	$1.12	$7,395.19	$90.19	10,799	ENR CCI
Rock Anchorage Drilling	82	Ea.	1.231	B-56	100.942	$0.00	$0.00	$37.00	$3,034.00	$75.50	$6,191.00		$0.94	$1.12	$10,287.72	$125.46	15,023	ENR CCI
Access Ramp Concrete Cast in Place (excavation accounted for above)																		
Concrete Paving (inc. delivery)	185	s.y	0.098	B-26	18.13	$74.00	$13,690.00	$2.92	$540.20	$2.62	$484.70		$0.94	$1.12	$14,052.64	$75.96	20,520	ENR CCI
Access Road retaining wall d/s side (excavation accounted for above)																		
Concrete Ready Mix 3500 psi (inc. delivery)	271	yd 3	0.000		0	$82.00	$22,222.00	$0.00	$0.00	$0.00	$0.00		$0.98	$1.03	$21,733.12	$80.20	31,736	ENR CCI
Formwork (plywood, 4 uses)	4880	ft 2	0.145	C-2	707.6	$0.78	$3,806.40	$4.85	$23,668.00	$0.00	$0.00		$1.06	$1.01	$28,025.69	$5.74	40,924	ENR CCI
Placing Concrete - pumped, includes vibrating	271	yd 3	0.427	C-20	115.717	$0.00	$0.00	$12.25	$3,319.75	$5.00	$1,355.00		$0.98	$1.03	$4,833.69	$17.84	7,058	ENR CCI
Reinforcing in Place #3 to #8 bar (assume 300lbs/yd 3)	41	tons	12.064	4 Rodmn	490.381275	$1,480.00	$60,162.00	$457.50	$18,597.38	$0.00	$0.00		$1.08	$0.94	$82,321.94	$2,025.14	120,210	ENR CCI
Rock Anchorage Tendons 60"x1" dia	12	Ea.	0.500	2 Skwk	6	$75.00	$900.00	$17.45	$209.40	$0.00	$0.00		$0.94	$1.12	$1,082.22	$90.19	1,580	ENR CCI
Rock Anchorage Drilling	12	Ea.	1.231	B-56	14.772	$0.00	$0.00	$37.00	$444.00	$75.50	$906.00		$0.94	$1.12	$1,505.52	$125.46	2,198	ENR CCI
Riprap slope protection (Class 5 rock, 10 ft blanket)																		
Riprap machine placed (inc. delivery)	1780	yd 3	0.258	B-12G	459.24	$37.50	$66,750.00	$8.10	$14,418.00	$8.75	$15,575.00		$0.94	$1.12	$96,393.44	$54.15	140,758	ENR CCI
Control Weir Vault (excavation accounted for above)																		
Concrete Ready Mix 3500 psi (inc. delivery)	550	yd 3	0.000		0	$82.00	$45,100.00	$0.00	$0.00	$0.00	$0.00		$0.98	$1.03	$44,107.80	$80.20	64,408	ENR CCI
Formwork (plywood, 4 uses)	6524	ft 2	0.145	C-2	945.98	$0.78	$5,088.72	$4.85	$31,641.40	$0.00	$0.00		$1.06	$1.01	$37,467.14	$5.74	54,711	ENR CCI
Placing Concrete - pumped, includes vibrating	550	yd 3	0.427	C-20	234.85	$0.00	$0.00	$12.25	$6,737.50	$5.00	$2,750.00		$0.98	$1.03	$9,810.08	$17.84	14,325	ENR CCI
Reinforcing in Place #3 to #8 bar (assume 300lbs/yd 3)	83	tons	12.064	4 Rodmn	995.23875	$1,480.00	$122,100.00	$457.50	$37,743.75	$0.00	$0.00		$1.08	$0.94	$167,074.05	$2,025.14	243,969	ENR CCI
Rock Anchorage Tendons 60"x1" dia	26	Ea.	0.500	2 Skwk	13	$75.00	$1,950.00	$17.45	$453.70	$0.00	$0.00		$0.94	$1.12	$2,344.82	$90.19	3,424	ENR CCI
Rock Anchorage Drilling	26	Ea.	1.231	B-56	32.006	$0.00	$0.00	$37.00	$962.00	$75.50	$1,963.00		$0.94	$1.12	$3,261.96	$125.46	4,763	ENR CCI
Cutoff Wall (excavation accounted for above)																		
Concrete Ready Mix 3500 psi (inc. delivery)	740	yd 3	0.000		0	$82.00	$60,680.00	$0.00	$0.00	$0.00	$0.00		$0.98	$1.03	$59,345.04	$80.20	86,658	ENR CCI
Formwork (plywood, 4 uses)	6705	ft 2	0.145	C-2	972.225	$0.78	$5,229.90	$4.85	$32,519.25	$0.00	$0.00		$1.06	$1.01	$38,506.61	$5.74	56,229	ENR CCI
Placing Concrete - pumped, includes vibrating	740	yd 3	0.427	C-20	315.98	$0.00	$0.00	$12.25	$9,065.00	$5.00	$3,700.00		$0.98	$1.03	$13,199.01	$17.84	19,274	ENR CCI
Reinforcing in Place #3 to #8 bar (assume 200lbs/yd 3)	74	tons	12.064	4 Rodmn	892.699	$1,480.00	$109,520.00	$457.50	$33,855.00	$0.00	$0.00		$1.08	$0.94	$149,860.36	$2,025.14	218,833	ENR CCI
Rock Anchorage Tendons 60"x1" dia	18	Ea.	0.500	2 Skwk	9	$75.00	$1,350.00	$17.45	$314.10	$0.00	$0.00		$0.94	$1.12	$1,623.33	$90.19	2,370	ENR CCI
Rock Anchorage Drilling	18	Ea.	1.231	B-56	22.158	$0.00	$0.00	$37.00	$666.00	$75.50	$1,359.00		$0.94	$1.12	$2,258.28	$125.46	3,298	ENR CCI
D/s closure wall across existing screen opening																		
Concrete closure wall (inc. delivery, reinforcement, formwork)	56	yd 3	4.094	C-14D	229.264	$143.00	$8,008.00	$139.00	$7,784.00	$14.90	$834.40		$0.98	$1.03	$16,743.25	$298.99	24,449	ENR CCI
Subtotal					**17336**		**$1,748,584.34**		**$600,572.70**		**$73,187.10**				**$2,479,628.03**		**3,620,870**	
15. Maintenance & Operations Building (24x40 CMU construction)																		
Maintenance Building (24' x 40')	960	s.f	0.000	0.000	0	$150.00	$144,000.00	$0.00	$0.00	$0.00	$0.00		$1.00	$1.00	$144,000.00	$150.00	210,276	ENR CCI
Subtotal					**0**		**$144,000.00**		**$0.00**		**$0.00**				**$144,000.00**		**210,276**	
16. Mechanical Systems																		
Johnson T-Screen																		
Prefabricated Johnson T-96 HCE Screen	1	Ea.	120.000	E-18	120	$105,000.00	$105,000.00	$6,933.30	$6,933.30	$2,391.30	$2,391.30		$1.00	$0.96	$113,923.64	$113,923.64	166,357	ENR CCI
Hydroburst Compressor, Tank, Controls & Equip. (4,000 gal)	1	Ea.	128.000	Q-7	128	$95,000.00	$95,000.00	$4,995.20	$4,995.20	$600.00	$600.00		$1.00	$0.96	$100,354.61	$100,354.61	146,543	ENR CCI
Control Weir bulkhead panels (inc. guides)	3	Ea.	80.000	E-18	240	$70,000.00	$210,000.00	$6,933.30	$20,799.90	$1,594.20	$4,782.60		$1.00	$0.96	$234,482.45	$78,160.82	342,402	ENR CCI
Weir panel hoist (counterweighted cable hung)	1	Ea.	120.000	E-18	120	$15,000.00	$15,000.00	$6,933.30	$6,933.30	$2,391.30	$2,391.30		$1.00	$0.96	$23,908.64	$23,908.64	34,913	ENR CCI
Vault Bulkhead Sluice Gate (inc. guides & operator)	1	Ea.	120.000	E-18	120	$150,000.00	$150,000.00	$6,933.30	$6,933.30	$2,391.30	$2,391.30		$1.00	$0.96	$158,923.64	$158,923.64	232,068	ENR CCI
Water Well																		
Drilling, casing, seal, screen, dist. piping & controls	1	Ea.	0.000		0	$7,700.00	$7,700.00	$1,900.00	$1,900.00	$0.00	$0.00		$1.00	$0.96	$9,510.60	$9,510.60	13,888	ENR CCI
Septic System water & wastewater disposal																		
septic, toilet, water heater	1	Ea.	0.000		0	$11,000.00	$11,000.00	$0.00	$0.00	$0.00	$0.00		$1.00	$0.96	$10,989.00	$10,989.00	16,047	ENR CCI
Maintenance Building HVAC																		
toilet exhaust, genset exhaust/vent., gen htr, etc.	1	Ea.	0.000		0	$13,000.00	$13,000.00	$7,500.00	$7,500.00	$0.00	$0.00		$1.00	$0.96	$20,164.50	$20,164.50	29,445	ENR CCI
Subtotal					**728**		**$606,700.00**		**$55,995.00**		**$12,556.50**				**$672,257.09**		**981,661**	
17. Electrical Systems																		
15kV Power Supply Ductbank (4,000 l.f. 2-conduit)	1	l.s	0.000		0	$115,832.00	$115,832.00	$105,108.00	$105,108.00	$0.00	$0.00		$1.04	$0.95	$221,096.53	$221,096.53	322,856	ENR CCI
480V & Communications Ductbank (2,500 l.f. 2-conduit)	1	l.s	0.000		0	$114,405.00	$114,405.00	$94,155.00	$94,155.00	$0.00	$0.00		$1.04	$0.95	$209,168.54	$209,168.54	305,438	ENR CCI
Miscellaneous Ductbank Elements (manholes, ground rod, wire, e	1	l.s	0.000		0	$50,113.05	$50,113.05	$40,880.50	$40,880.50	$0.00	$0.00		$1.04	$0.95	$91,277.14	$91,277.14	133,287	ENR CCI
Metering Equipment	1	l.s	0.000		0	$6,000.00	$6,000.00	$2,500.00	$2,500.00	$0.00	$0.00		$1.04	$0.95	$8,646.50	$8,646.50	12,626	ENR CCI
Pad Mounted Transformer	1	l.s	0.000		0	$6,500.00	$6,500.00	$1,750.00	$1,750.00	$0.00	$0.00		$1.04	$0.95	$8,453.75	$8,453.75	12,345	ENR CCI
Generator Set (75 kW, 240/120V Diesel)	1	l.s	0.000		0	$25,700.00	$25,700.00	$2,810.00	$2,810.00	$0.00	$0.00		$1.04	$0.95	$29,508.73	$29,508.73	43,090	ENR CCI
Power Distribution	1	l.s	0.000		0	$23,795.00	$23,795.00	$10,070.00	$10,070.00	$0.00	$0.00		$1.04	$0.95	$34,438.69	$34,438.69	50,289	ENR CCI
Medium Voltage cable	1	l.s	0.000		0	$40,360.00	$40,360.00	$29,800.00	$29,800.00	$0.00	$0.00		$1.04	$0.95	$70,535.24	$70,535.24	102,999	ENR CCI
Wire and Cable 600V and less	1	l.s	0.000		0	$6,445.00	$6,445.00	$5,130.00	$5,130.00	$0.00	$0.00		$1.04	$0.95	$11,617.47	$11,617.47	16,964	ENR CCI
Control/Telemetry	1	l.s	0.000		0	$5,000.00	$1,500.00	$6,933.30	$6,933.30	$0.00	$0.00		$1.04	$0.95	$8,173.43	$8,173.43	11,935	ENR CCI
Lighting	1	l.s	0.000		0	$13,200.00	$13,200.00	$10,500.00	$10,500.00	$0.00	$0.00		$1.04	$0.95	$23,787.30	$23,787.30	34,735	ENR CCI
Subtotal					**0**		**$403,850.05**		**$309,636.80**		**$0.00**				**$716,703.32**		**1,046,564**	
18. Miscellaneous Metals																		
Steel Grating over vault (2-1/4"x3/16" w/2" O.C. cross bars)	180	ft 2	0.187	E-2	33.66	$40.00	$7,200.00	$6.90	$1,242.00	$4.42	$795.60		$1.05	$0.87	$9,367.62	$52.04	13,679	ENR CCI
Labor Steel Grating over vault	180	ft 2	0.038	E-4	6.84	$0.00	$0.00	$1.46	$262.80	$0.10	$18.00		$1.05	$0.87	$245.14	$1.36	358	ENR CCI
Steel Grating over screen (2-1/4"x3/16" w/2" O.C. cross bars)	465	ft 2	0.124	E-2	57.66	$40.00	$18,600.00	$6.90	$3,208.50	$4.42	$2,055.30		$1.05	$0.87	$24,199.70	$52.04	35,338	ENR CCI
Labor Steel Grating over vault	465	ft 2	0.038	E-4	17.67	$0.00	$0.00	$1.46	$678.90	$0.10	$46.50		$1.05	$0.87	$633.27	$1.36	925	ENR CCI
Trashrack 20'x32' - Fabrication + installation	15	tons	14.222	E-6	213.33	$5,800.00	$87,000.00	$535.00	$8,025.00	$169.00	$2,535.00		$1.05	$0.87	$100,916.88	$6,727.79	147,364	ENR CCI
Embedded Steel																		
Trashrack Guides (750 lbs each side/guide)	1500	lbs.	0.050	E-4	75	$1.82	$2,730.00	$2.00	$3,000.00	$1.18	$1,770.00		$0.94	$1.12	$7,893.89	$5.26	11,527	ENR CCI
Subtotal					**404**		**$115,530.00**		**$16,417.20**		**$7,220.40**				**$143,256.51**		**209,190**	

19. Demolition of existing structures																		
Existing Spillway Removal	1150	yd 3	1.728		1987.2	$0.00	$0.00	$51.30	$58,995.00	$28.62	$32,913.00		$0.94	$1.12	$102,495.80	$89.13	149,669	ENR CCI
Existing Sluice Floor Removal & Retaining Wall Puncture	150	yd 3	1.728		$259.20	0	$0.00	51.3	$7,695.00	28.62	$4,293.00		0.943	1.1152	$13,369.02	89.13	19,522	ENR CCI
Existing Sluice Gate Equipment Removal	15	tons	1.212		18.18	0	0	500	7500	1200	18000		0.943	1.1152	$ 28,437.60	1895.84	41,526	ENR CCI
Subtotal					**2265**		**0**		**74190**		**55206**				**$ 144,302.42**		**210,717**	
															7,701,057		11,247,872	
															$ 10,011,375		$ 14,622,234	

Project Indirect Cost

Feature	Subtotal Cost	Direct	Field O/H	Home Office	Profit	Bond	Insurance	Subtotal Cost	Sales Tax	Total Cost
			25.00%	5%	10%	1%	1%		8.20%	
1. Mobilization	$30,373.14	$30,373.14	$7,593.28	$1,518.66	$3,948.51	$434.34	$434.34	$44,302.26	$3,632.79	$47,935.05
2. Cofferdam Upstream (2 caisson cells + 8 cells excavate, separate boulders & rep	$1,211,205.46	$1,211,205.46	$302,801.36	$60,560.27	$157,456.71	$17,320.24	$17,320.24	$1,766,664.28	$144,866.47	$1,911,530.75
3. Cofferdam Downstream (2 cells excavate, separate boulders & replace)	$122,483.44	$122,483.44	$30,620.86	$6,124.17	$15,922.85	$1,751.51	$1,751.51	$178,654.35	$14,649.66	$193,304.00
4. Diversion Channel Stage 1 Excavation (inc re-excavate btwn u/s cofferdams)	$757,534.13	$757,534.13	$189,383.53	$37,876.71	$98,479.44	$10,832.74	$10,832.74	$1,104,939.29	$90,605.02	$1,195,544.31
5. Dewatering during foundation construction	$61,849.20	$61,849.20	$15,462.30	$3,092.46	$8,040.40	$884.44	$884.44	$90,213.25	$7,397.49	$97,610.74
6. Downstream Penstock Connection Excavation	$181,581.77	$181,581.77	$45,395.44	$9,079.09	$23,605.63	$2,596.62	$2,596.62	$264,855.17	$21,718.12	$286,573.30
7. Right Abutment Excavation (reached by crane and clamshell from	$329,190.72	$329,190.72	$82,297.68	$16,459.54	$42,794.79	$4,707.43	$4,707.43	$480,157.58	$39,372.92	$519,530.51
8. Left Abutment (Intake) Excavation	$96,300.20	$96,300.20	$24,075.05	$4,815.01	$12,519.03	$1,377.09	$1,377.09	$140,463.47	$11,518.00	$151,981.48
9. Scour Hole Excavation (shot rock excavation by crane and clams	$228,620.27	$228,620.27	$57,155.07	$11,431.01	$29,720.64	$3,269.27	$3,269.27	$333,465.53	$27,344.17	$360,809.71
10. Upstream Penstock Connection Excavation	$135,544.34	$135,544.34	$33,886.09	$6,777.22	$17,620.76	$1,938.28	$1,938.28	$197,704.98	$16,211.81	$213,916.79
11. Access Roadway Excavation + Finish Grade & Maint Bldg Const	$71,973.74	$71,973.74	$17,993.44	$3,598.69	$9,356.59	$1,029.22	$1,029.22	$104,980.90	$8,608.43	$113,589.33
12. Boulder Grade Control Excavation and Construction (incl. movin	$835,163.18	$835,163.18	$208,790.79	$41,758.16	$108,571.21	$11,942.83	$11,942.83	$1,218,169.01	$99,889.86	$1,318,058.87
13. Penstock Construction	$906,775.13	$906,775.13	$226,693.78	$45,338.76	$117,880.77	$12,966.88	$12,966.88	$1,322,622.20	$108,455.02	$1,431,077.22
14. Abutments, Intake, and Concrete Construction Items	$3,620,869.67	$3,620,869.67	$905,217.42	$181,043.48	$470,713.06	$51,778.44	$51,778.44	$5,281,400.50	$433,074.84	$5,714,475.34
15. Maintenance & Operations Building (24x40 CMU construction)	$210,275.58	$210,275.58	$52,568.90	$10,513.78	$27,335.83	$3,006.94	$3,006.94	$306,707.97	$25,150.05	$331,858.02
16. Mechanical Systems	$981,661.46	$981,661.46	$245,415.36	$49,083.07	$127,615.99	$14,037.76	$14,037.76	$1,431,851.41	$117,411.82	$1,549,263.22
17. Electrical Systems	$1,046,563.95	$1,046,563.95	$261,640.99	$52,328.20	$136,053.31	$14,965.86	$14,965.86	$1,526,518.18	$125,174.49	$1,651,692.67
18. Miscellaneous Metals	$209,189.89	$209,189.89	$52,297.47	$10,459.49	$27,194.69	$2,991.42	$2,991.42	$305,124.37	$25,020.20	$330,144.57
19. Demolition of existing structures	$210,717.19	$210,717.19	$52,679.30	$10,535.86	$27,393.23	$3,013.26	$3,013.26	$307,352.10	$25,202.87	$332,554.97
Subtotal	$11,247,872.48							**$16,406,146.80**	**$1,345,304.04**	**$17,751,450.83**

Project Total Cost

	2005	2018	
Total Construction Cost (+30% contingency)	$13,611,465	$23,076,886	
Total Engineering & Project Owner Cost	$735,900	$1,074,596	
Total	**$14,349,370**	**$24,151,482**	**68%**

MF Nooksack Fish Passage Project
OPINION OF PROBABLE COST
Alternative D - Upstream Intake & Dam Removal

Line	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	**Contractor OH and Mobilization**				
1.01	Mobilization and General Requirements	5%	LS	$ 5,794,222	$ 289,711
2	**Construction Access and Site Prep**				
2.01	Clearing and Grubbing	2.2	AC	$ 15,000	$ 33,493
2.02	Erosion Controls/Spill Prevention	1	LS	$ 50,000	$ 50,000
2.03	Crew Access Ladder to Stilling Basin Area	1	LS	$ 15,000	$ 15,000
2.04	Crew H/S Allowance	1	LS	$ 7,500	$ 7,500
2.05	Working Platforms/Ladders Allowance	1	LS	$ 25,000	$ 25,000
2.06	Crane Mobe/Erect/Demobe	1	LS	$ 25,000	$ 25,000
2.07	Access Rd Improvements	1	LS	$ 15,000	$ 15,000
2.08	Bridge Improvements	1	LS	$ 15,000	$ 15,000
3	**Care of Water (Dewatering)**				
3.01	U/S Dewatering (In/Out) (assume $62,500/month fo	1	LS	$ 125,000	$ 125,000
3.02	Pumping/Treatment (10 well points @ 25ft deep, pu	10	EA	$ 2,500	$ 25,000
3.03	Cofferdam (assume sheeting 150 lf x 20 ft H)	3000	SF	$ 50	$ 150,000
4	**Intake**				
4.01	Excavation-Rock	0	CY	$ 50	$ -
4.02	Excavation-Common/Rubble	4150	CY	$ 35	$ 145,250
4.03	Backfill-Common	3100	CY	$ 40	$ 124,000
4.04	Foundation Prep (assume 10 days @ $5k/day)	10	DY	$ 5,000	$ 50,000
4.05	Concrete-slab	260	CY	$ 1,000	$ 260,000
4.06	Concrete-Walls	117	CY	$ 1,500	$ 175,500
4.07	Concrete-Elevated Slab	32	CY	$ 2,000	$ 64,000
4.08	Hatch	1	EA	$ 5,000	$ 5,000
4.09	Handrail	126	LF	$ 55	$ 6,930
4.10	Structural Steel	**24,925**	LBS	$ 3.50	$ 87,238
4.11	Misc Inbeds/Misc Metals	1	LS	$ 50,000	$ 50,000
4.12	Entrance Wier Bulkheads (low head only)	2	EA	$ 25,000	$ 50,000
4.13	Sluice Gate	1	EA	$ 15,000	$ 15,000
4.14	Trash Rack	1	EA	$ 25,000	$ 25,000
4.15	Hatch	1	LS	$ 8,000	$ 8,000
4.16	Access Ladder	22	FT	$ 300	$ 6,600
5	**Conduit**				
5.01	Excavation-Rock	2770	CY	**$ 50**	$ 138,500
5.02	Excavation-Common/Rubble	2190	CY	**$ 35**	$ 76,650
5.03	Backfill-Common	3980	CY	**$ 40**	$ 159,200
5.04	Backfill - Trench	800	CY	**$ 40**	$ 32,000
5.05	9-Foot Dia. Pipe or 8x8 box - concrete pressure	460	LF	$ 1,200	$ 552,000
6	**Bypass Pipe**				
6.01	Special Mobilization	0	LS	$ 15,000	$ -
6.02	Excavation-Rock	0	CY	**$ 50**	$ -
6.03	Excavation-Common/Rubble	2043	CY	**$ 35**	$ 71,505
6.04	Backfill-Common	2027	CY	**$ 40**	$ 81,066
6.02	Backfill - Trench	0	CY	**$ 40**	$ -
6.03	2.5-Foot Dia. Pipe	90	LF	$ 345	$ 31,050
7	**Sediment Sluice**				
7.01	Special Mobilization	0	LS	$ 15,000	$ -
7.02	Excavation-Rock	0	CY	**$ 50**	$ -
7.03	Excavation-Common/Rubble	0	CY	**$ 35**	$ -
7.04	Backfill-Common	0	CY	**$ 40**	$ -
7.02	Backfill - Trench	0	CY	**$ 40**	$ -
7.03	5-Foot Dia. Pipe	425	LF	$ 800	$ 340,000
8	**Fish Screen**				
8.01	Excavation-Rock	0	CY	**$ 50**	$ -
8.02	Excavation-Common	3243	CY	**$ 35**	$ 113,505
8.03	Foundation Prep	0	LS	$ -	$ -
8.04	Backfill-Common	2314	CY	**$ 40**	$ 92,572
8.05	Concrete-slab	160	CY	**$ 1,000**	$ 160,000
8.06	Concrete-Walls	440	CY	**$ 1,500**	$ 660,000
8.07	Concrete-Elevated Slab	0	CY	**$ 2,000**	$ -
8.08	Concete-Transition	5	CY	**$ 2,000**	$ 10,000
8.09	Fish Screens & Baffles	322	SF	$ 1,000	$ 322,222
8.10	Grating	1700	SF	$ 25	$ 42,500
8.11	Handrail	210	LF	$ 55	$ 11,550
8.12	Structural Steel	0	LBS	$ 3.50	$ -
8.13	Misc Inbeds/Misc Metals	1	LS	$ 50,000	$ 50,000
8.14	Exit Gate	1	EA	$ 35,000	$ 35,000
8.15	Screen Cleaner	1	EA	$ 250,000	$ 250,000
8.16	Stairs	1	EA	$ 40,000	$ 40,000
8.17	Access Ladder	82	FT	**$ 300**	$ 24,600

MF Nooksack Fish Passage Project
OPINION OF PROBABLE COST
Alternative D - Upstream Intake & Dam Removal

Line	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
9	**Dam Removal**				
9.01	Excavation-Rock	130	CY	$ 50	$ 6,500
9.02	Excavation-Common	0	CY	$ 35	$ -
9.03	Foundation Prep	1	LS	$ 50,000	$ 50,000
9.04	Backfill-Common	0	CY	$ 40	$ -
9.05	Spillway Concrete - demo	1150	CY	$ 100	$ 115,000
9.06	Sluice Floor Concrete - demo	150	CY	$ 100	$ 15,000
9.07	Sluice Gate Equip Removal	15	TONS	$ 2,800	$ 42,000
10	**Modification of Existing Diversion Structure**				
10.01	Excavation-Rock	175	CY	$ 50	$ 8,750
10.02	Excavation-Common	465	CY	$ 35	$ 16,275
10.03	Foundation Prep	1	LS	$ 20,000	$ 20,000
10.04	Backfill-Common	390	CY	$ 40	$ 15,600
10.05	Concrete-Wall-Trashrack wall	65	CY	$ 1,500	$ 97,500
10.06	Concrete-slab-conduit transition	13	CY	$ 1,000	$ 13,000
10.07	Concrete-Walls-conduit transition	100	CY	$ 1,500	$ 150,000
10.08	Concrete-Elevated Slab-conduit transition	13	CY	$ 2,000	$ 26,000
10.09	Demo existing trashrack	3171	LBS	$ 1	$ 3,171
10.10	Handrail	44	LF	$ 55	$ 2,420
10.11	Demo existing stairs and handrail	1	LS	$ 15,000	$ 15,000
10.12	Misc Inbeds/Misc Metals	0	LS	$ 50,000	$ -
10.13	Access Ladders	28	FT	$ 300	$ 8,400
11	**Electrical and Instrumentation**				
11.01	Diesel Storage Tank	1	LS	$ 200,000	$ 200,000
11.02	Diesel Gen Set	1	LS	$ -	$ -
11.03	Transformer	1	LS	$ -	$ -
11.04	Lighting	1	LS	$ 8,000	$ 8,000
11.05	Repeater Station	1	LS	$ 12,000	$ 12,000
11.06	Camera & Telemetry	1	LS	$ 10,000	$ 10,000
11.07	Pre-Fab Building	1	LS	$ 70,000	$ 70,000
11.08	Concrete - slab	14	CY	$ 1,000	$ 14,000
11.09	Excavation-Common	93	CY	$ 35	$ 3,263
11.10	Foundation Prep	0	LS	$ 25,000	$ -
11.11	Backfill-Common	73	CY	$ 40	$ 2,913
12	**Unlisted Items**				
12.01	Security Fencing	1	LS	$ 17,000	$ 17,000
	DIRECT COST (ROUNDED)				**$ 6,084,000**
13	**Field O/H**	**15%**			$ 913,000
14	**Home Office**	**5%**			$ 304,000
15	**Profit**	**10%**			$ 730,000
16	**Bond**	**1%**			$ 80,000
17	**Insurance**	**1%**			$ 80,000
	SUBTOTAL				**$ 8,191,000**
18	**Sales Tax**	**8.50%**			$ 696,000
	SUBTOTAL WITH TAX				**$ 8,887,000**
19	**Contingency**	**50%**			$ 4,444,000
20	**OPINION OF PROBABLE PROJECT COST (2018$)**				**$ 13,331,000**

Appendix E. Permitting Matrix

DRAFT Permitting Matrix

City of Bellingham

Middle Fork Nooksack Fish Passage

Whatcom County, Washington

February 9, 2018

Contents

Tables

Figures

Appendices

1 Introduction

This document summarizes the permits and authorizations that are likely to be required for the City of Bellingham's (City) proposal to remove the City's existing surface water diversion dam, or parts thereof, at river mile (RM) 7.2 of the Middle Fork Nooksack River in Whatcom County, near Deming (Figure 1). As part of the proposal, the City would relocate the surface water intake to an upstream left-bank location. The legal description of the project location is Township 38 North, Range 6 East, Section 19. The project is approximately 20 miles east of the City. The purpose of the proposed work is to restore pre-dam fish passage conditions in the upper reaches of the Middle Fork Nooksack River.

The document is organized into five sections, the first of which introduces and provides details for anticipated permits required by federal, state, and local regulatory entities. The second section of this document contains a matrix (Table 1) that briefly describes:

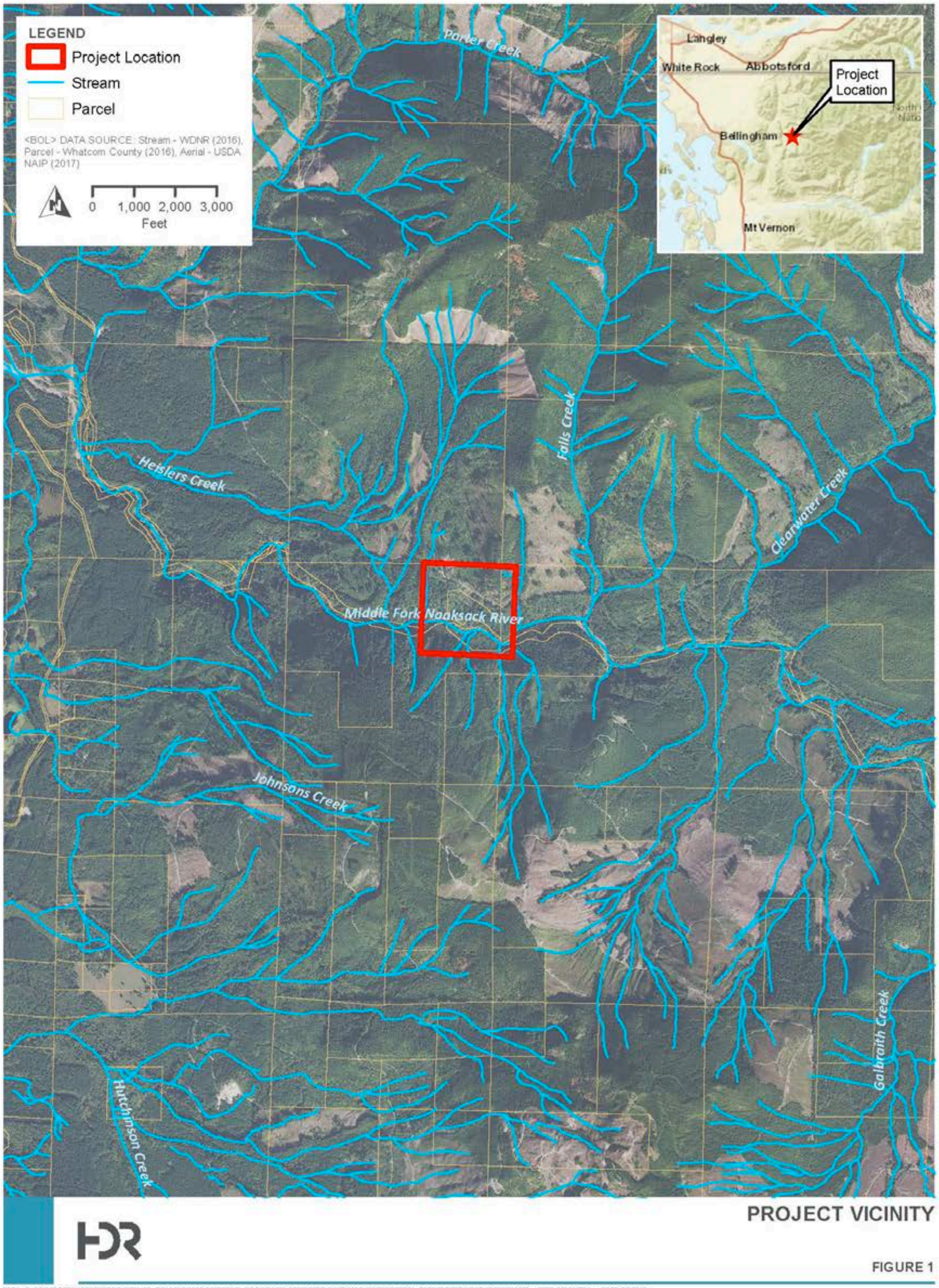
- The type of permit/authorization
- The permit trigger
- The authorizing agency
- Anticipated permit application development and processing timelines
- A summary of agency discussions to date
- A summary of required documentation to complete permit applications or other submittals

The third section provides a summary of future permitting needs and a schedule for application and document development. The fourth section provides a summary of anticipated permits and two options for a timeline of acquisition. The final section presents references cited.

This permitting memorandum assumes that the City's new surface water intake structure would be relocated within the parcel owned by the City, and that the site would be accessed along an existing road that traverses lands owned and managed by the Department of Natural Resources (DNR). No new roads would be required. Along the existing access road, laydown and construction staging would occur within upland (i.e., not wetland) areas. Additional laydown areas along the left bank riparian corridor of the Middle Fork Nooksack River have been identified, and portions of these areas contain wetlands. Use of wetland areas for laydown or temporary spoils disposal would require permits from federal, state, and local entities. Avoidance of wetland areas is advised.

This permitting summary should be considered an iterative document that will be refined and updated upon selection of a preferred alternative. The summary may also be updated if future design determines the need for additional development or authorizations not considered at the time of this writing. HDR has prepared this summary using existing information to date, and cannot guarantee any of the timelines provided herein. Agencies will make determinations of permitting pathways upon presentation of the selected alternative at pre-application meetings. Some agencies cannot make determinations until applications are submitted and preliminarily reviewed.

Figure 1. Location of Middle Fork Nooksack River Diversion Dam



2 Federal, State and Local Approvals

2.1 Federal Approvals

Dam removal would require excavation and fill within a water of the United States (U.S) (i.e., Middle Fork Nooksack River), and therefore would be reviewed for compliance with Section 404 of the Clean Water Act (CWA), administered by the U.S. Army Corps of Engineers (USACE). Any work, temporary or permanent, in jurisdictional wetlands would require USACE review and authorization. As the federal action agency authorizing the discharge of fill under Section 404 of the CWA, USACE must also ensure that the project complies with the Endangered Species Act (ESA) and the National Historic Preservation Act (NHPA). The project may have an additional federal nexus if the project is funded by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS).

Federal authorizations included in the matrix (Table 1) are described below.

2.1.1 Clean Water Act

2.1.1.1 Sections 404 and 401

For work requiring the discharge of dredged or fill materials into waters of U.S., including rivers, seeps, springs, tributaries, or jurisdictional wetlands, the activity must comply with Sections 404 and 401 of the CWA. In Washington, applicants must submit a Joint Aquatic Resources Permit Application (JARPA) to request permission in work in waters of the U.S. under sections 404 and 401 of the CWA.

Section 404

Section 404 of the CWA established a permitting program to regulate the discharge of dredged, excavated, or fill material in wetlands, streams, rivers, and other waters of the U.S. USACE is the federal agency authorized to issue Section 404 permits for certain activities conducted in waters of the U.S. The jurisdictional boundary for waters of the U.S., including the Middle Fork Nooksack River, is defined as the area waterward of the ordinary high water mark (OHWM). Therefore, the placement of any fill material below the OHWM, including temporary cofferdams, requires a permit from USACE. USACE may authorize discharge under Section 404 of the CWA via two pathways: 1) verification under the Nationwide Permit program, or, 2) Individual Permit[1].

Preliminary review of project alternatives and background information suggests that the project may qualify for coverage using several nationwide permits (Table 1, Item #1). Coordination with USACE is recommended as soon as an alternative is selected to determine eligibility under the Nationwide Permit program. If ineligible, an Individual Permit would be required. An Individual Permit requires longer processing times, additional application requirements, and mandatory public comment periods.

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[1] Note: A letter of permission (LOP) is a type of individual permit issued through a streamlined processing procedure compared to standard individual permits. The Seattle District issues LOPs in Section 10 Navigable Waters of the U.S. only; LOPs are not applicable for work subject to Section 404 of the Clean Water Act, and are therefore not applicable to this project.

Section 401

Projects reviewed under Section 404 of the CWA are also reviewed under Section 401 of the CWA, and are typically issued a Water Quality Certification (WQC) or, in the case of nationwide permits, verification that the project complies with state regional water quality conditions (Table 1, Item #2). Section 401 of the CWA is administered by the Environmental Protection Agency (EPA). In Washington, the EPA has delegated responsibility to administer Section 401 WQC to the Department of Ecology (Ecology). Issuance of a WQC or verification of compliance with regional conditions means that Ecology anticipates that the applicant's project will comply with state water quality standards and other aquatic resource protection requirements.

Based on the preliminary assessment of potential project eligibility for CWA Section 404 coverage under the Nationwide Permit program, Ecology would review the proposal for consistency with regional water quality conditions. If the proponent demonstrates compliance with these conditions, further review is not required under CWA Section 401. If a project does not comply with all of the regional conditions of specific nationwide permits to be authorized, an individual 401 WQC may be required. Individual 401 WQCs require more processing time, additional application requirements, and a public comment period.

2.1.1.2 Section 402: National Pollutant Discharge Elimination System (NPDES)

Ecology administers Section 402 of the CWA, which authorizes the discharge of stormwater into state waters for construction activities that disturb more than one acre of land (Table 1, Item #3). All project proponents requiring coverage under the NPDES permitting program must submit a Notice of Intent (NOI) to discharge construction-related stormwater prior to construction. A mandatory public comment period is required for all proposals, and the NOI is advertised in local newspapers to solicit comment.

2.1.2 Endangered Species Act

In the long term, removal of the City's diversion dam, or portions thereof, to restore natural fish passage would improve some of the factors limiting the recovery of anadromous salmonids in the Middle Fork Nooksack River. However, even actions that are ultimately beneficial may have short-term adverse effects. The actions likely to have the most significant short-term effects are those that will disturb the banks and channels of natural water bodies. These short-term effects from actions that have a Federal nexus (in this USACE-authorization under the CWA) trigger the requirement for consultation under the ESA (Table 1, Items #4a and #4b).

Three fish species listed as threatened under the ESA may occur in the Middle Fork Nooksack River both upstream and downstream of the dam: Puget Sound Chinook Salmon (*Oncorhynchus tshawytscha*), Puget Sound steelhead (*O. mykiss*), and Bull Trout (*Salvelinus confluentus*). The Washington Department of Fish and Wildlife (WDFW 2018b) indicates that both spring and fall Chinook salmon occupy habitat downstream of the dam, as well as a short reach upstream of the dam. Spring Chinook salmon may spawn downstream of the diversion dam at RM 7.2 (WRIA 1 Salmon Recovery Plan 2005). Anecdotal accounts from Nooksack tribal elders reported Chinook salmon in the upper Middle Fork in the 1930's and 1940's (STS Heislers Creek Hydro L.P. 1994, as cited in WRIA 1 Salmon Recovery Plan 2005). Small numbers of Chinook salmon have also occasionally been observed jumping at the diversion dam in recent years. Mainstem habitat upstream of the diversion dam is suitable for Chinook salmon use to RM 16.2, and several tributaries to the Middle Fork also provide suitable habitat (Nooksack Tribe, unpublished data as cited in WRIA 1 Salmon Recovery Plan 2005).

Summer-run steelhead may use habitat downstream of the dam for migration, and winter-run steelhead are indicated to spawn in the reach downstream of the dam (WDFW 2018b). Potential steelhead habitat has been estimated to extend to the confluence of the Middle Fork and Rankin Creek, nine miles above the diversion dam (STS Heislers Creek Hydro L.P. 1994, as cited in WRIA 1 Salmon Recovery Plan 2005). Spawner surveys in the Middle Fork between 2000 and 2003 documented several steelhead redds in the lower reaches of the Middle Fork (i.e., below RM 4.8) as early as mid-February. Redd creation peaked between mid-March and mid-June, and adult steelhead would be expected downstream of the dam during this timeframe (Anchor Environmental 2006).

Bull trout may occur both upstream and downstream of the dam, and may use upstream habitats for spawning. Anecdotal accounts report the observation of Bull Trout jumping at or over the diversion dam in the late 1980s and 1990s (STS Heislers Creek Hydro L.P. 1994; Currence 2000, both as cited in WRIA 1 Salmon Recovery Plan 2005). In the reach within a few hundred feet upstream and downstream of the dam, substrates are too large to support viable spawning for any salmonid species.

Critical habitat has been designated for each of the three listed fish species. For Puget Sound steelhead, critical habitat is designated from the mouth the Middle Fork Nooksack River to the diversion dam at RM 7.2. The entire mainstem Middle Fork Salmon River (both upstream and downstream of the dam) is designated as critical habitat for Puget Sound Chinook Salmon and Bull Trout.

In addition to these fish species, adjacent uplands may provide habitat for terrestrial species that are listed under the ESA. These may include marbled murrelet (*Brachyramphus marmoratus*), streaked horn lark (*Eremophila alpestris strigata*), Yellow-billed Cuckoo (*Coccyzus americanus*), Northern Spotted owl (*Strix occidentalis caurina*), Canada lynx (*Lynx canadensis*), Gray wolf (*Canis lupus*), and the North American Wolverine (*Gulo gulo luscus*) (USFWS 2018). No ESA-listed plants are documented onsite (USFWS 2018; WDFW 2018a).

Because USACE must review the project under Section 404 of the CWA, the project must comply with either Section 4d or 7 of the ESA. The ESA compliance pathway is contingent upon funding mechanisms and whether design can adhere to specific criteria and best management practices established in existing, applicable programmatic ESA consultations.

2.1.2.1 Section 4d, Limit 8 (Chinook Salmon and Steelhead)

ESA compliance may be streamlined for threatened species under NMFS jurisdiction pursuant to Limit 8 of Section 4d of the ESA. This pathway may be viable if a project meets all of the following requirements:

- Receives funding from the state's Salmon Recovery Funding Board (SRFB) via grant from the Recreation and Conservation Office

- Meets all requirements of the Self-Certification form (https://www.rco.wa.gov/documents/manuals&forms/Manual18Appendices/Limit-8-SelfCert.pdf)
- Meets specific design and implementation requirements

To determine if a project is eligible under Limit 8 of Section 4d, grant recipients must submit a one-page Self-certification for to the SRFB grant manager and to USACE, indicating that the project meets the eligibility requirements of the state's Habitat Restoration Program. Eligibility is typically confirmed in one week.

Removal of the City's Middle Fork Nooksack River dam is included in the WRIA 1 Salmon Recovery Plan (2005); however, the project has not yet obtained SRFB funding. Therefore, future applicability of ESA Section 4d Limit 8 coverage is currently unknown at this time. Further, coordination with both USACE (as federal nexus) and NMFS is recommended to ensure that this pathway is viable.

2.1.2.2 Section 7

Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services (PROJECTS)

If the project receives technical assistance or funding from the USFWS or National Oceanic and Atmospheric Administration Restoration Center, and can adhere to project design criteria for dam removal, it may qualify for programmatic ESA Section 7 coverage for both NMFS and USFWS species. Applicants can request coverage under the programmatic if the Services are involved in planning and review of the project.

Potential coverage under the PROJECTS programmatic must be confirmed with the Services for consistency with the following:

1. USFWS PROJECTS programmatic: FWS reference: O1EOFWOO-2014-F-0222: Dam and Legacy Structure Removal -Project Design Criteria 35
2. NMFS PROJECTS programmatic (NMFS Ref No.: NWR-2013-10221]: Dam Removal Projects (Project Design Criteria 35a)

Note that coverage under these programmatics may require a variance for use of the "geomorphic habitat-based" fish passage approach in lieu of NMFS fish passage criteria (NMFS 2011). Use of PROJECTS may also require a variance to include the new diversion structure in the consultation. Preliminary discussions with the USFWS indicate that this is likely possible. Any guidelines for the diversion would likely be similar to what is outlined for irrigation diversions under PROJECTS.

Dam removal must comply with the most recent version of the Contractor's handbook (NMFS and USFWS 2016), a supplement to PROJECTS, which outlines project activities, general conservation measures, Project Design Criteria and Species conservation measures. As a dam removal project, coverage under this consultation would require Restoration Review Team (RRT) review and approval to proceed. The City would provide the RRT with a 30 percent design plan set, and the RRT would provide comments and recommendations. It is recommended that RRT review start one year in advance of project implementation (Ginger Phalen, USFWS, pers comm, 2018a).

If PROJECTS is the selected pathway for ESA compliance, there will be more involvement in the project design process from USFWS and NMFS. Specifically, Paul Bakke (USFWS) would be the RRT reviewer from a geomorphology perspective, and Aaron Beavers (NMFS) would be the reviewer from a fish passage perspective. Use of PROJECTS involves more agency input on the design, and might require the development of a long term monitoring and adaptive management plan. However, this is the preferred ESA compliance pathway for the Services, and preliminary discussions indicate that this review would be faster, and may be given higher priority than an individual Section 7 consultation.

Fish Passage and Habitat Restoration Programmatic

This pathway applies to projects requiring a USACE permit (e.g., CWA Section 404), and that affect land (e.g., marbled murrelet) or freshwater species (e.g., Bull Trout) under USFWS jurisdiction. NMFS species are not covered by this programmatic. Projects are determined eligible for coverage under the Fish Passage and Habitat Restoration Programmatic if they fall into one of the nine habitat restoration categories listed in the Programmatic Biological Assessment for Restoration Actions in Washington State (USACE 2008a). Upon application and completion of a Special Project Information Form (SPIF), USACE determines eligibility in approximately 30 days.

The proposed dam removal, or portions thereof, does not appear to meet the eligibility requirements of this programmatic and is not likely applicable. However, the City is encouraged to review the programmatic biological assessment, identify the action categories that appear to cover the project, identify any project elements that may not be covered, and coordinate with USACE and USFWS to determine project eligibility.

Individual Section 7 Consultation

If the project were not eligible for ESA streamlining under existing habitat restoration programmatics or Section 4d (Limit 8), individual coverage under Section 7 of the ESA would be required. Individual consultation would require preparation of a Biological Assessment (BA) that would be submitted to USACE with the JARPA. The BA would describe the project in detail, including all in-water work, construction sequencing and duration, and measures proposed to minimize impacts on ESA-listed species and their habitat. Under this process, the proposed action would be reviewed by NMFS for fish passage issues, and the USFWS review to ensure long-term channel stability in bull trout habitat.

If the project were determined likely to adversely affect listed species or their critical habitat, formal consultation would be required. If the project is determined not likely to adversely affect listed species or their critical habitat, informal consultation would be required. Timelines for completing individual Section 7 consultations vary; however, with early coordination and agency communications, upon submittal of all required information, informal consultations typically can be completed in 6 months. Formal consultations may require 9-18 months, depending on project complexity and agency workload.

2.1.3 Magnuson-Stevens Fishery Conservation and Management Act (MSA)

The Middle Fork Nooksack River is designated as Essential Fish Habitat (EFH) for Chinook, Coho, and Pink Salmon (NMFS 2018) (Table 1, Item #5). EFH is defined by the Magnuson-Stevens Act (MSA) in 50 CFR 600.905-930 as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity,” and includes all waters currently and historically accessible to Pacific Salmon. Although the natural condition of the falls adjacent to the existing dam may have precluded passage for most individuals, anecdotal reports (WRIA 1 Salmon Recovery Plan 2005) and Salmonscape (WDFW 2018b) indicate Chinook salmon, at a minimum, have ascended the falls on occasion, even before the dam was constructed. Therefore, it is likely that EFH includes portions of the mainstem upstream of the existing dam. As such, an EFH assessment and MSA consultation would be required, concurrent with the ESA consultation. Programmatic ESA coverages discussed previously for NMFS species are assumed to also cover EFH.

2.1.4 Section 106 - National Historic Preservation Act

Section 106 of the NHPA requires the responsible federal agency (in this case, USACE) to determine whether any activity that it authorizes, funds, or sponsors has the potential to affect historic properties or cultural resources (Table 1, Item #6). The Washington Department of Archaeology and Historic Preservation (DAHP) must be consulted when projects are subject to review under Section 106 of the NHPA.

In compliance with the NHPA, Drayton Archaeology has been contracted to conduct a cultural resources assessment and archaeological review of all areas proposed for ground disturbance, including areas for access and staging. In addition, Drayton Archaeology will conduct a historic property inventory assessment to determine eligibility on the National Register of Historic Places (NRHP). If the dam is eligible, removing the dam could be considered an adverse effect and would require a Memorandum of Agreement (MOA) among stakeholders, including USACE and affected tribes (Lundquist, USACE, pers comm, September 18, 2017).

2.1.5 Coastal Zone Management Act

Ecology administers Washington's Coastal Zone Management (CZM) Program, which meets the broader national interests of protecting, restoring, and responsibly developing the coast (Table 1, Item #7). The program applies to all the lands and waters in the 15 coastal counties, including Whatcom County. During JARPA review, Ecology will determine if the proposed action is consistent with the CZM Program. Review is concurrent with CWA Section 401 water quality review, and the application for CZM consistency is a one-page attachment to the JARPA.

2.1.6 National Environmental Policy Act

Because USACE must authorize in-stream work, it is the project’s federal nexus via CWA permitting. Therefore, the project must comply with the National Environmental Policy Act (NEPA) (Table 1, Item #8). If USACE verifies that the project is eligible for coverage under the Nationwide Permit program, individual NEPA review is not required because NEPA has already been completed for the Nationwide Permit program. USACE fulfills the requirements of NEPA when it finalizes an environmental assessment in its national decision document for the issuance or reissuance of individual Nationwide Permits; decision documents have been finalized for all 2017 nationwide permits. Therefore, a Nationwide Permit verification issued by USACE does not require separate NEPA documentation. (See 53 FR 3126, USACE final rule for implementing the National Environmental Policy Act, which was published in the February 3, 1988, issue of the Federal Register.)

If the project is determined ineligible for CWA Section 404 coverage under the Nationwide Permit program, and requires an Individual Permit, USACE typically prepares a project-specific Environmental Assessment (EA) during permit processing.

If funding from USFWS or NMFS is used, the City is recommended to coordinate with both agencies on potential NEPA needs and compliance pathways. At the time of this writing, no federal funding has been confirmed. The USFWS has a NEPA Cat Ex memo that may apply to this restoration project (Ginger Phalen, USFWS, pers comm., 2018b).

2.1.7 Rivers and Harbors Act

Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403) prohibits the obstruction or alteration of navigable waters of the United States without a permit from USACE. USACE does not include the Middle Fork Nooksack Dam as a navigable water of the state (USACE 2008b). Therefore, authorization under Section10 is not required.

2.2 State Approvals

Refer to Table 1 for a complete list of all state permits likely to be required for this project.

2.2.1 Dam Safety Review

The Department of Ecology’s Dam Safety Office (DSO) regulates dams that store at least 10 acre-feet of water (3.26 million gallons) or more above ground level (RCW 90.03.350). This volume is measured from the toe to the crest of the impounding barrier. There is no minimum height for a dam to be under Ecology’s authority. A pond holding 10 acre-feet of water would be equivalent to a football field of water, eight feet deep.

The DSO oversees dams and dam construction or modification for the purpose of protecting public safety. Because the City’s diversion on the Middle Fork Nooksack River does not store water at least 10 acre-feet of water, removal would not appear to be regulated by the DSO. Further, the City’s diversion is not on DSO’s list of dams they regulate (https://fortress.wa.gov/ecy/publications/documents/94016.pdf).

Regardless, HDR recommends the City confirm with DSO that the dam is not subject to state dam safely regulations or review.

2.2.2 Surface Water Diversion Relocation

The City of Bellingham coordinated with the Department of Ecology to clarify whether moving the City's surface water intake upstream would necessitate any type of water right process. No process is required if the diversion is moved upstream to a location with boundaries of the City's parcel (Fogelsong, pers comm, January 31, 2018).

2.2.3 State Environmental Policy Act

Compliance with the State Environmental Policy Act (SEPA) is a prerequisite to obtain most state and local permits/approvals for the project (Table 1, Item #9). SEPA allows agencies to both consider and mitigate for environmental impacts of proposals as well as to provide opportunities for public participation prior to any final decision being made. The SEPA process must be coordinated with other agencies requiring SEPA, and factored into the project schedule (e.g. WDFW will not accept the application for a Hydraulic Project Approval [HPA] until SEPA compliance is achieved).

Pursuant to RCW 77.55.181, actions that remove man-made fish passage barriers may qualify as a Fish Habitat Enhancement Project (FHEP). FHEPs are exempt from SEPA (and all local permitting) if they meet specific sponsorship criteria, are approved by WDFW, and do not pose a substantial threat to public health and safety. However, WDFW has indicated that the size of the project warrants public review to address concerns regarding public health and safety (Brokes, WDFW, pers comm, January 25, 2018). Regardless of the FHEP designation, WDFW has indicated that they would support project streamlining and issue a letter of support for the project as a restoration activity per RCW 90.58.147, if approved by Whatcom County as a shoreline exemption. The City is advised to coordinate with Whatcom County upon selection of a preferred alternative and schedule a pre-application meeting to discuss permitting needs.

It is assumed that the City or Whatcom County would serve as the SEPA lead agency. Depending on the extent of public comments received, SEPA compliance using a checklist with a mitigated determination of non-significance (MDNS) can typically be completed within 3-4 months.

2.2.4 Hydraulic Project Approval

Washington State's "Hydraulic Code" (Chapter 77.5 RCW) requires that any entity proposing to conduct construction that will use, divert, obstruct, or change the bed or flow of state waters must do so under the terms of a permit called the Hydraulic Project Approval (HPA), issued by WDFW (Table 1, Item #10). The law's purpose is to ensure that needed construction is done in a manner to prevent damage to the state's fish and their aquatic habitat. WDFW (Joel Ingram, Area Habitat Biologist, pers comm, 1/24/18) indicated that WDFW's work window for the reach of the Middle Fork Nooksack River is July 15 – August 16. However, the USACE published work window for the reach of the Middle Fork Nooksack River upstream of the dam is July 1 – September 30. WDFW has acknowledged the need for an extended window and is open to negotiations that are biologically supported.

An HPA will be required for any project-related demolition or construction in or adjacent to the Middle Fork Nooksack River. Upon receipt of a completed application (online APPs form), HPAs are issued within 45 days.

2.2.5 WDNR Aquatic Use Authorization

Activities taking place on state-owned aquatic lands (i.e., those considered by the state to be navigable at the time of statehood) require a lease or other form of use authorization (easement or right-of-way) (Table 1, Item #11). Representatives from American Rivers and HDR met with the Washington Department of Natural Resources (DNR) Aquatic Land Use Manager for the Orca-Straits District, Joelene Boyd onsite on November 29, 2017. Following a search of DNR-navigable waters in the state, Ms. Boyd (pers comm with April McEwan, American Rivers, 1/10/18) determined that the reach of the Middle Fork Nooksack adjacent to the project site shows “evidence of navigability” and DNR would likely assert ownership of the reach. Therefore, an Aquatic Land Use Authorization would be required for this action. Depending on the type of authorization, processing can require 9-18 months. This authorization cannot be executed until all environmental permits are issued.

2.2.6 WDNR Forest Practices Permit/Notification

The Washington State Forest Practices Rules (Title 222 WAC) establish standards for forest practices such as timber harvest, pre-commercial thinning, and road construction, among other activities. Depending on the need for and location of tree removal for the project (including tree removal required for temporary construction staging and laydown areas), if the project requires the removal of more than 5,000 board feet of timber, a Forest Practices permit may be required (Table 1, Item #12). Further, activities taking place in habitat supporting state listed or threatened species is considered a special use, and will require additional review, including SEPA analysis.

The class of forest practice, if applicable, would be determined upon review of the site plan and identification of the limits of construction and tree removal. Following selection of a preferred alternative, DNR recommends a meeting to discuss limits of clearing required, and will determine if a Forest Practices permit is necessary. DNR will also determine the class of permit required (Ranten, pers comm, January 31, 2018).

2.2.7 Approval from Northwest Clean Air Agency

The Northwest Clean Air Agency regulates demolition of structures exceeding 120 square feet (Table 1, Item #13). An online application for demolition must be completed a minimum of 10 days prior to demolition activities. http://nwcleanairwa.gov/forms/nwcaa-asbestos-removal-or-demolition/

2.3 Local Approvals

Local permitting requirements cannot be verified until an alternative is selected. Upon selection of a preferred alternative, HDR recommends that the City requests a formal pre-application meeting to confirm permitting needs with the County. Application for pre-application is available at: https://www.whatcomcounty.us/DocumentCenter/View/2209.

2.3.1 Shoreline Exemption or Substantial Development Permit

As discussed under the Hydraulic Project Approval section, if WDFW cannot verify project eligibility as an FHEP, pending design review, they could provide a letter of support as a fish passage improvement project (Joel Ingram, WDFW, pers comm with A. McEwen, American Rivers, 1/8/18). Such a letter could provide the documentation the County requires to consider the project for exemption from permitting requirements under RCW 90.58.147 (Shoreline Substantial Development Permit – Exemption for projects to improve fish and wildlife habitat or fish passage) (Table 1, Item #14). This exemption is consistent with Whatcom County's Shoreline Management Program (i.e., a shoreline exemption would be issued; exempt from the shoreline substantial development permit requirement), pursuant to Section 23.60.02.2(P):

> A public or private project, the primary purpose of which is to improve fish or wildlife habitat or fish passage, when all of the following apply:
>
> 1. The project has been approved in writing by the Department of Fish and Wildlife as necessary for the improvement of the habitat or passage and appropriately designed and sited to accomplish the intended purpose
>
> 2. The project received hydraulic project approval by the Department of Fish and Wildlife pursuant to RCW 77.55
>
> 3. The Administrator has determined that the project is consistent with this Program. The Administrator shall make such determination in a timely manner and provide it by letter to the project proponent.

Whatcom County's Shoreline Management Program ordinance also states the following: *If any part of a proposed development is no eligible for exemption, then a substantial development permit is required for the entire project* (Whatcom County 2008, Section 23.60.02.1). Therefore, given that the project also includes relocation of the City's surface water intake in the shoreline, coordination with Whatcom County will be prudent to determine the applicability of overall project exemption. If a shoreline development permit is needed, a hearing may be required.

2.3.2 Critical Areas Ordinance

Pursuant to the State of Washington Growth Management Act (RCW 36.70A), Whatcom County has designated critical areas and adopted regulations for their protection (Table 1, Item #15). Pursuant to the county's Critical Areas Ordinance (WWC 16.16):

> Critical areas include geologically hazardous areas, frequently flooded areas, critical aquifer recharge areas, wetlands, and habitat conservation areas…No development shall be constructed, located, extended, modified, converted, or altered, or land subdivided without full compliance with this chapter.

The Whatcom County Critical Areas Ordinance applies to all sensitive areas. Specifically, per WCC 16.16.225, Regulated Activities, clearing, grading, excavating, discharging or filling activities are subject to the provisions of the Critical Areas Ordinance when they occur within critical areas or their buffers. Streams and wetlands, both of which occur on site, are classified as critical areas. Streams are defined as Habitat Conservation Areas; the Middle Fork Nooksack River has a minimum 150-foot buffer. A wetland was identified onsite during a site visit conducted by HDR on January 10, 2018. This wetland is likely jurisdictional, and was preliminarily rated as a Category IV wetland. Wetland buffers are determined both by the habitat rating score and the intensity of land use for adjacent activities. Assuming a low intensity land use designation, a Category IV wetland would require a 25-foot buffer. A moderate intensity land use designation would require a 40-foot buffer. Whatcom County must approve of the land use intensity designation; however, based upon review of Article 9 of WCC 16.16, a low to moderate score is anticipated (see HDR 2018 for details).

Unless the County determines that the project is exempt from critical areas ordinance permitting requirements[2], a critical areas report and assessment must be prepared and submitted to the county for approval prior to project implementation. The assessment must describe impacts on critical areas and their buffers pursuant to WCC 16.16, and describe measures to avoid, minimize or mitigate for temporary and permanent impacts to critical areas and their buffers. Anticipated processing time and project approval per WCC 16.16 is 4-6 months following submittal of a critical areas assessment to the county as part of land use permitting (e.g., land disturbance and clearing, shorelines).

2.4 Tribal Coordination

As discussed under the Federal Approvals section (see Section 106 NHPA), Drayton Archaeology has been contracted to conduct a cultural resources survey and coordinate with tribal entities to determine effects on cultural resources and identify potential mitigation strategies.

2.5 Other Development Permits

Additional permits and/or authorizations that may be required are described briefly in Table 1 and include:

- Land Disturbance and Clearing Permit
- Commercial Building Permit, which may require
    - Approved water verification form (proof of water right for new intake)
- Demolition Permit
- Encroachment permit (if any work occurs in County road right-of-way)

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[2]Whatcom County adopted a new CAO in December 2017. For permit applications submitted on or after December 27, 2017, the new Critical Area Ordinance will be used for review of these applications. Unlike the 2005 CAO, the 2017 CAO does not allow for streamlined CAO review of fish restoration projects. However, the new CAO only pertains to those areas of the County <u>not within</u> the Shoreline jurisdiction of the Shoreline Management Plan (200' inland of Waters of the State). For those areas within the Shoreline jurisdiction (i.e., this project), the existing (2005) CAO will still govern until the Department of Ecology approves a limited amendment to the Shoreline Management Plan updating the date of the referenced CAO. This is anticipated to take 3-6 months (from December 2017).

The 2005 CAO allows the following activity to occur without full CAO review (i.e., a 10-day review vs. extensive processing times and fees):

> 16.16.235 (Activities allowed with notification)
>
> H. Fish, wildlife, and/or wetland restoration or enhancement activities not required as project mitigation; provided, that the project is approved by the U.S. Fish and Wildlife Service, the Washington State Department of Ecology, Washington State Department Fish and Wildlife, or other appropriate local, state, federal, or tribal jurisdiction.

Table 1. Permits and Procedures Anticipated to be Required for the Middle Fork Nooksack River Fish Passage Project

Item #	Permit/ Consultation	Responsible Agency	Permit Trigger and Notes	Estimated Timeframe	Application Start Date	Anticipated Submittal Date	Needs for Completion
Federal							
#1	CWA Section 404	U.S. Army Corps of Engineers (USACE)	Impacts to regulated waters (including wetlands, if present) require a permit from USACE. If impacts to wetlands, mitigation plan will need to be developed prior to completion of the permit application. USACE may authorize multiple NWPs to permit this project, as long as maximum impact thresholds are not exceeded for any specific activity. If thresholds are exceeded and impact minimization and avoidance measures cannot reduce fill to NWP thresholds, an individual permit (IP) may be required. Applicable NWPs may include: • NWP 12 for (utility lines and associated intakes) water line and intake; NWP coverage includes temporary staging and laydown areas • NWP 27 (Aquatic Habitat Restoration, Enhancement, and Establishment Activities) dam removal • NWP 33 (temporary construction, access and dewatering necessary for construction activities) – in-water cofferdams and construction laydown (note laydown may also be covered by another NWP if it is directly associated with that work) If an IP is required, a 404b(1) alternatives analysis will be required that analyzes alternatives that should be considered that would result in less impacts to waters of the U.S. An IP also requires public comment period.	Submit complete JARPA to USACE at least 12 months prior to bid letting. If applying for an individual permit, may take up to 24 months depending on local workload. Pre-application: Upon selection of preferred alternative, schedule interagency pre-application meeting (including local, state, federal government representatives (regulatory staff) along with representatives from the tribes. USACE of Engineers conducts pre-application meetings each month at their Seattle office (typically second Wednesdays) or it could be held elsewhere.	30% design, once facility footprint determined and construction method selected; cut and fill quantities should be determined at 60%	At 60-70% or July 30, 2018	Design Information/Drawings required for JARPA 1. Populate cut and fill quantities table for all elements below ordinary high water mark (OHWM) of river, and for all elements adjacent to (i.e., intake and portions of pipeline) 2. Provide existing conditions plan – all drawings to use USACE block example (see end of this table – all drawings in 8.5 x 11") 3. Provide proposed site plan – • identify staging areas on site plan • Illustrate silt fencing BMPs for wetland and stream protection • Show dewatering settling ponds/basins, if applicable. • call out OHWM on plan • include scale • N arrow 4. Provide plan for dewatering, river bypass 5.Provide plan and section for all pipeline installation • show OHWM on drawings • BOTH PLAN and section must contain OHWM • Include N arrow, scale 6. Provide site plan overlain atop color aerial at a scale of 1:100' or greater 7. Provide a brief narrative that describes the following: • Equipment to be used on site, anticipated construction schedule and timing of work adjacent to and below OHWM, including in-stream work • Define trench width, depth for pipelines • Describe bedding materials, type of backfill, depth of overburden (how far beneath lakebed will pipelines be sited) • Location of excess dredged material – if off-site, provide details • Description of how existing intake will be removed, if applicable • Description of new intake, NMFS/WDFW screening compliance and/or off-channel bypass • Description of bank armoring for intake • Restoration plan for unavoidable temporary impacts (including wetland delineation report and conceptual restoration plan) • Provide list of standard BMPs for prevention of spills, etc. All JARPA drawings must meet basic requirements for USACE – see drawing Checklist: http://www.nws.usace.army.mil/Portals/27/docs/regulatory/forms/Drawing_Checklist_(4-17-12).pdf

Table 1. Permits and Procedures Anticipated to be Required for the Middle Fork Nooksack River Fish Passage Project

Item #	Permit/ Consultation	Responsible Agency	Permit Trigger and Notes	Estimated Timeframe	Application Start Date	Anticipated Submittal Date	Needs for Completion
#2	CWA Section 401, Water Quality Certification	Washington Department of Ecology for the EPA Federal Water Pollution Control Act Section 401; RCW 90.48.260 WAC 173-225	Ecology will review Section 404 permit to determine if the project would affect beneficial uses of wetlands/waters. Stormwater and erosion and sediment control plans generally required. If project qualifies for CWA 404 coverage under NWP, Ecology will review each NWP for consistency with regional conditions. If inconsistent with general regional conditions, Ecology may require individual CWA Section 401 water quality review.	Concurrent with CWA 404 permit process. 401 Water Quality Cert application is the JARPA. Ecology has 180 days from issuance of USACE permit for projects verified under NWP program. If individual review, Ecology has one year to issue WQC from date of USACE determination on NWP coverage.	30% design	12 months prior to construction.	In addition to the requirements listed for Item #1, above, provide methods, during construction, which will limit water quality degradation to waterbodies. JARPA submitted separately to Ecology.
#3	CWA Section 402 (NPDES Construction) Act 402 WAC 173-220 33 USC 1344 RCW 90.48.260	Ecology for the EPA	Required for construction (clearing, grading, and excavating) affecting 1 or more acres. Temporary Erosion and Sedimentation Control Plan (TESCP) to be developed during final design.	If under 1 acre, NA. If over 1 acre, submit Notice of Intent (NOI) to Ecology and prepare Erosion and Sedimentation Control Plan during final design (complete prior to final plans & specifications). Typically, a 90-day review process.	6 months before construction	4 months before construction	It is anticipated that City will place the burden of NPDES construction stormwater permit on contractor. Should initiate permitting process as soon as contractor is selected so that the permit processing can be completed prior to groundbreaking (typically 90-day review, once Notice of Intent is filed).
#4a	Endangered Species Act – NMFS	NMFS	USACE CWA Section 404 authorization for fill in waters of US is trigger. USACE must ensure their authorization for fill complies with ESA.	Programmatic Coverage Pathways: 1. 4d Limit 8s – 3 months 2. PROJECTs – 9-12 months Individual Section 7 Consultation Pathway: 9-18 months upon JARPA submittal.	30% design	July 30, 2018	NMFS: If funding is received from Salmon Recovery Funding Board, and project meets all other qualifications, coverage under an existing programmatic ESA consultation for NMFS species may be possible, if verified by Section 4d, Limit 8 certification. If SRFB funding is not available or timely, or if the federal action agency (USACE) determines that this pathway is not viable, individual Section 7 consultation may be required for Puget Sound Chinook, Puget Sound steelhead and their critical habitat. If USFWS or National Oceanic and Atmospheric Administration Restoration Center funding received, or if Services are actively involved in the project, potential coverage under PROJECTS programmatic (NMFS Ref No.: NWR-2013-10221]: Dam and Legacy Structure Removal (Project Design Criteria 35a) – may require variance for geomorphic habitat-based fish passage criteria If project does not qualify for programmatic coverage, individual Section 7 ESA consultation would be required for anadromous salmonids under NMFS jurisdiction (i.e., Puget Sound Chinook salmon and steelhead).
#4b	Section 7 Endangered Species Act – USFWS	USFWS	USACE CWA Section 404 authorization for fill in waters of US is trigger. USACE must ensure their authorization for fill complies with ESA.	Programmatic Coverage via PROJECTs – 9-12 months Individual Section 7 Consultation Pathway: 9-18 months upon JARPA submittal.	30% design	July 30, 2018	USFWS: Requires determination of applicability for project coverage under: 1. If USFWS or National Oceanic and Atmospheric Administration Restoration Center funding received, potential coverage under PROJECTS programmatic (FWS reference: O1EOFWOO-2014-F-0222]: Dam and Legacy Structure Removal (Project Design Criteria 35) – may require variance for geomorphic habitat-based fish passage 2. If project qualifies as one of the categories of the state programmatic for habitat restoration (http://www.nws.usace.army.mil/Portals/27/docs/regulatory/ESA%20forms%20and%20templates/2008%20Restoration%20BA.pdf). If project does not qualify for any programmatic coverage, individual Section 7 ESA consultation would be required for all freshwater and terrestrial ESA-listed (or proposed) species under USFWS jurisdiction (e.g., bull trout, spotted owl, marbled murrelet, Canada lynx, grizzly bear, wolverine).

Table 1. Permits and Procedures Anticipated to be Required for the Middle Fork Nooksack River Fish Passage Project

Item #	Permit/ Consultation	Responsible Agency	Permit Trigger and Notes	Estimated Timeframe	Application Start Date	Anticipated Submittal Date	Needs for Completion
#5	Magnuson Stevens Act	NMFS	The Magnuson-Stevens Act, as amended by the Sustainable Fisheries Act of 1996, requires federal agencies to consult with NMFS on activities that may adversely affect essential fish habitat (EFH). EFH for Pacific salmon is designated in project area (Chinook, Coho, pink salmon).	EFH assessment concurrent with ESA consultation	30% design	July 30, 2018	A search of NMFS's Essential Fish Habitat mapper indicates that Pacific Salmon EFH is designated in the Middle Fork Nooksack River, both upstream and downstream of the City of Bellingham diversion dam http://www.habitat.noaa.gov/protection/efh/habitatmapper.html). Accordingly, an EFH assessment would be required for dam removal as well as new intake construction and operation. An EFH assessment would be included as part of the project Biological Assessment; EFH consultation would be conducted concurrent with ESA consultation.
#6	National Historic Preservation Act (NHPA), Section 106	WA State Dept of Arch. And Historic Preservation (DAHP)	USACE CWA Section 404 permit issuance must comply with NHPA Section 106 to ensure no adverse effects to cultural resources or historic properties. City must conduct a survey to identify potential cultural sites at all areas subject to ground disturbance.	Concurrent with CWA 404 permit process – 3-9 months, typically.	30% design, when footprint and clearing/grading limits determined.	July 30, 2018	The project is in a sacred area for the Nooksack tribe. Consultation with Nooksack Tribe and Lummi Nation would be necessary to determine if removing the dam or relocating the surface water diversion would adversely affect the TCP. USACE requires a historic property inventory assessment and cultural assessment. If is the dam is NRHP-eligible, removing the dam would be an adverse effect and would require an MOA = takes time. Drayton Archaeology to complete historic and cultural survey of all sites proposed for staging and ground disturbance. Drayton to coordinate with George Swanaset, Nooksack Tribe, representatives from Lummi Nation, and Lance Lundquist, USACE. Upon review and approval of the APE and associated report, Drayton will submit the report to the Washington DAHP SHPO for formal review and concurrence of findings. Consultation pursuant to Section 106 of the NHPA will occur via USACE concurrent with CWA Section 404 review.
#7	Coastal Zone Management (CZM) Federal Consistency	Ecology	If project takes place in one of the 15 coastal counties in Washington, review is required for project consistency under Washington's Coastal Zone Management Program.	Ecology has six months from issuance of USACE permit to issue a decision. If Ecology does not act within the six months, the activity is presumed consistent and approved.	90% stage, following completion of SEPA, shoreline determination and JARPA submittal	September 2018	City of Bellingham prepares Determination of Consistency or statement form and develops a Federal Consistency Document: https://ecology.wa.gov/DOE/files/de/def7d5ed-ec89-43ea-a826-cff3c0ea2e9b.pdf Public involvement provisions for shoreline permits and some USACE permits are provided independently of the consistency process and are deemed adequate for purposes of consistency. For projects not required to provide a public involvement process through shoreline or USACE permits, or for large, complex and controversial projects, Ecology has developed a separate public involvement process. This involves public notice, a 21-day public comment period, and potentially a public meeting or hearing. Notification is sent to interested parties based on the development of general and project-specific mailing lists.
#8	NEPA	USACE* (*if federal funding is obtained, NEPA compliance pathway must be confirmed)	USACE issuance of CWA Section 404 triggers NEPA review. If project is permitted under NWP program, for which NEPA was already completed, no additional NEPA review required. If project cannot qualify under NWP program and requires an IP, USACE will complete additional NEPA review.	CWA Section 404 authorization via NWP program – NA CWA Section 404 authorization via IP – likely an EA, 3-6 months	NA – USACE completes internally		If CWA Section 404 authorization via NWP program – NA CWA Section 404 authorization via IP – likely an EA, 3-6 months. If IP pathway, NEPA and potential need for additional analysis should be a topic of discussion with USACE. USACE may elect to adopt or modify SEPA document for streamlining NEPA review. NOTE: If project receives federal funding, NEPA compliance pathway must be confirmed. The USFWS has a NEPA Cat Ex memo that may apply to this restoration project (Ginger Phalen, USFWS, pers comm., 2018b).
				State			
#9	SEPA	TBD (City of Bellingham or Whatcom County)	Various triggers (project cost and size) under State Environment Policy Act. SEPA checklist to be prepared for construction-related activities.	3-4 months	10% design	April 30, 2018	Unless the project qualifies for SEPA exemption as a Fish Habitat Enhancement Project (RCW 77.55.181), assumed SEPA compliance pathway is via Checklist and 30-day maximum public comment period. SEPA lead status would be City of Bellingham as property owner, or Whatcom County as local jurisdiction. Either entity is expected to issue a Determination of Non-Significance (DNS) or Mitigated DNS.

Table 1. Permits and Procedures Anticipated to be Required for the Middle Fork Nooksack River Fish Passage Project

Item #	Permit/ Consultation	Responsible Agency	Permit Trigger and Notes	Estimated Timeframe	Application Start Date	Anticipated Submittal Date	Needs for Completion
#10	Hydraulic Project Approval as required under WA Hydraulic Code (Chapter 77.55 RCW).	WDFW - Joel Ingram, Area Habitat Biologist	Permit trigger is any work that uses, diverts, obstructs or changes the natural flow or bed of state waters. Per RCW 77.55.011: "Waters of the state" and "state waters" means all salt and freshwaters waterward of the ordinary high water line and within the territorial boundary of the state. HPA will be required for any work in or adjacent to Middle Fork Nooksack River.	WDFW uses an online Aquatic Protection Permitting System (APPS) to manage permit applications. Typically, a 45 day review process upon receipt of complete APPs application and completion of SEPA.	30% design	July 30, 2018	Preliminary coordination with WDFW indicates that public safety concerns may preclude project qualification as Fish Habitat Enhancement Project per RCW 77.55.181. WDFW has indicated that the size of the project warrants public review to address concerns regarding public health and safety (Brokes, WDFW, pers comm, January 25, 2018). SEPA compliance is required before WDFW can issue HPA. Application for HPA requires fee and characterization and quantification of in-stream and streambank disturbance, in-stream work (means, methods, duration), and identification of stream bypass (in-water work isolation methods), and staging areas. On-going coordination with WDFW fish passage engineers and geomorphologists will be required (currently conducted through the PAC).
#11	Aquatic Land Use Authorization	Washington Department of Natural Resources (WDNR)	Aquatic lands director, Jolene Boyd, has determined the project reach is navigable. Therefore, as a state-owned aquatic land, City must apply for the Aquatic Use Authorization (lease, easement or license).	12-18 months	30% design	July 30, 2018	Following a site visit with WDNR on November 29, 2017, WDNR determined project reach was navigable, and confirmed state-owned aquatic lands via follow up email. Three options are available for aquatic use authorization: 1) lease, requiring an annual fee for continued use, 2) easement, a one-time fee for construction access, and 3) license or right of entry, requiring a fee for the first year and reduced in subsequent years, typically for up to 5 years. Per Mary Huff, WDNR, 11/29/17, possible pathway for authorization (to be determined during application review): • License or Right of Entry for construction; easement for intake operation (preliminary determination by Mary Huff, WDNR, 11/29/2017 Easement = 1 time fee • Right of Entry = fee for first year and reduced for subsequent years of construction access (WDNR determines fee amount) Applicant to submit JARPA Attachment E to WDNR to start the aquatic land use authorization process. WDNR cannot execute the authorization until all permits are in place. City will coordinate with WDNR upon selection of preferred alternative. Once WDNR has determined an easement or lease is required, and following construction of elements (e.g., intake) that require an easement, survey of State Owned Aquatic Lands (SOAL) also needs to be recorded with the permit. Applicant is responsible for: • All costs and work associated with creating, submitting, revising, and recording the survey with the County's auditor's office • Survey must be completed by licensed surveyor • Survey conditions can be found here: https://www.dnr.wa.gov/publications/psl_requirements_for_records_of_survey.pdf
#12	Forest Practices Permit	WDNR	Potential removal of greater than 5,000 board feet of trees from new waterline footprint as well as removal for construction access, spoils placement, and laydown. Removal from Riparian Management Zone (RMZ) along river will require increased level of analysis. RMZ widths vary based on site class and stream width, likely 200 feet.	1- 3 month review period if SEPA has been completed (and includes tree removal as part of proposed action)	30% design	July 30, 2018	"Forest land" means all land which is capable of supporting a merchantable stand of timber and is not being actively used for a use that is incompatible with timber growing. Upon selection of preferred alternative, coordination with WDNR is required to determine applicability (Ranten, pers comm, 1/30/18). A site plan showing all areas of tree removal, and characterization of tree quantity, size and type may be required. City may also need to estimate loss of shading habitat from tree removal along RMZ. A fee is required for submittal of FPA/N application; fees vary by Forest Practices class.
#13	Demolition approval	Northwest Clean Air Agency	Demolition of existing dam infrastructure may require approval from NWCAA. Triggered for demolition of structures >120 square feet.	10 days	2 months prior to construction (Contractor to procure)		Contractor must submit demolition permit and $53 fee to Northwest Clean Air Agency a minimum of 10 days prior to demolition of structures exceeding 120 square feet in size. http://nwcleanairwa.gov/forms/nwcaa-asbestos-removal-or-demolition/

Table 1. Permits and Procedures Anticipated to be Required for the Middle Fork Nooksack River Fish Passage Project

Item #	Permit/ Consultation	Responsible Agency	Permit Trigger and Notes	Estimated Timeframe	Application Start Date	Anticipated Submittal Date	Needs for Completion
				Local			
#14	Shoreline Exemption; Substantial Development Permit, Conditional Use, or Variance	Whatcom County	As a Shoreline of the State, activities conducted within and adjacent to the Middle Fork Nooksack River, a Type S water, are subject to review under Whatcom County's Shoreline Management Program.	4-6 months	30% design	July 30, 2018	If project does not qualify as FHEP, review under county Shoreline Management Program is required. However, the project may be eligible for a shoreline exemption (i.e., exempt from local permitting requirements under the program) if all portions of the project are determined to qualify as a fish passage project pursuant to RCW 90.58.147 and Section 23.60.02.2(P) of the Whatcom County Shoreline Management Program. If ineligible under any exemption mechanism, a Shoreline Substantial Development Permit would be required. Application and fees: http://wa-whatcomcounty.civicplus.com/DocumentCenter/View/2218 HDR strongly recommends a pre-application meeting with the County to discuss the project, and potential local permitting needs and exemption applicability.
#15	Whatcom County Critical Areas Review (WCC 16.16) and Natural Resource Assessment	Whatcom County	Required for proposed land use within any defined critical area including wetlands, habitat conservation areas (e.g., streams), geologically hazardous areas, floodplains, and critical aquifer recharge areas. Assessment of impacts on critical areas is required prior to development and issuance of County permits (e.g., Shorelines, building permit, land disturbance). The provisions of the CAO apply to any land use or development within an area that meets the definitions and criteria for critical areas as established in the ordinance. All land use and development permit applications submitted to Whatcom County PDS are reviewed for conformance with the provisions of the CAO.	Depends on extent and nature of impacts to sensitive areas, and mitigation requirements.	30% design	July 30, 2018	Upon 60% design, submit design with Natural Resource Assessment checklist, with fees: http://www.co.whatcom.wa.us/DocumentCenter/View/1745 Because the project will occur in a critical area (i.e., Middle Fork Nooksack River), City must prepare a Critical Areas Assessment Report for County approval. http://www.co.whatcom.wa.us/794/Development-Reviews CAO approval must be obtained before County will issue any land use or building permit. See the following for details on process: http://www.co.whatcom.wa.us/795/Natural-Resource-Assessment NOTE: In December 2017, Whatcom County adopted a new CAO. For permit applications submitted on or after December 27, 2017 the recent Whatcom County Council approved Critical Area Ordinance will be used for review of these applications. HOWEVER, the new CAO only pertains to those areas of the County not within the Shoreline jurisdiction of the Shoreline Management Plan (200' inland of Waters of the State). For those areas within the Shoreline jurisdiction, the existing (2005) CAO will still govern until the Department of Ecology approves a limited amendment to the Shoreline Management Plan updating the date of the referenced CAO. This is anticipated to take 3-6 months. The 2005 CAO allows the following activity to occur without full CAO review (i.e., a 10-day review vs. extensive processing times and fees), but this activity is NO LONGER allowed under the 2017 adopted regulations: 2005 CAO (allowance not part of 2017 CAO): 16.16.235 (Activities allowed with notification) H. Fish, wildlife, and/or wetland restoration or enhancement activities not required as project mitigation; provided, that the project is approved by the U.S. Fish and Wildlife Service, the Washington State Department of Ecology, Washington State Department Fish and Wildlife, or other appropriate local, state, federal, or tribal jurisdiction. The City is strongly advised to coordinate with Whatcom County as soon as possible to determine how the project can be reviewed under the 2005 code. A pre-application meeting is recommended upon selection of a preferred alternative and availability of conceptual design.
#16	Commercial Building Permit	Whatcom County	TBD. If any buildings are required for the intake or associated new infrastructure, prepare building permit application and site plans to comply with requirements per the Whatcom County Planning and Development Services. https://www.whatcomcounty.us/876/Commercial-Permit-Process Fees and 100% signed plan sheets required for permit issuance.	Depends on application load and critical areas review needs. County currently outsources to Int'l Code Council for initial review. Minimum 8-12 week review period with 1-2 rounds of revision required.	TBD – likely 9 months before construction	6 months prior to construction	Complete Whatcom County Commercial Building Permit Application and associated site plans (2 sets, 11x17") and fees (fees can be substantial for commercial building permits). Site plans, architectural plans, mechanical/plumbing plans, and electrical plans must be prepared pursuant to the requirements of the County, and include all applicable setbacks (including those for CAOs). Application: http://wa-whatcomcounty.civicplus.com/DocumentCenter/View/2036 County must approve stormwater management plan prior to building permit issuance: http://wa-whatcomcounty.civicplus.com/DocumentCenter/View/381

Table 1. Permits and Procedures Anticipated to be Required for the Middle Fork Nooksack River Fish Passage Project

Item #	Permit/ Consultation	Responsible Agency	Permit Trigger and Notes	Estimated Timeframe	Application Start Date	Anticipated Submittal Date	Needs for Completion
#17	Land Disturbance and Clearing Permit	Whatcom County	Various triggers for requiring land disturbance permit including: All building permits, any fill, grade, clearing within 300 feet of critical areas; any fill or grade in excess of 50 cubic yards (approx. 5 dump trucks); any movement of >50cy offsite requires a permit.	Concurrent with building permit review.			6-page application and grading plans with $600 fee. Application must include topography, showing proposed stormwater treatment during construction and operation. Clearing limits must be staked for county inspection prior to clearing activity: https://www.whatcomcounty.us/DocumentCenter/Home/View/1889 Timing restrictions apply to any activity that exposes more than 500 square feet of soil between October 1 and May 31 OR that exposes more than 5,000 square feet of soil between June 1 and September 30 within the Lake Whatcom, Lake Samish or Lake Padden watersheds.
#18	Demolition Permit	Whatcom County	Required for demolition of structures. City must contact the Northwest Clean Air Agency at 360-428-1617 or 800-622-4627 prior to the submittal of your demolition application for structures >200 square feet in size.	1-2 weeks	2 months prior to construction (TBD following pre-application with County)		City must submit application to County with fee: https://www.whatcomcounty.us/DocumentCenter/View/2194
#19	Encroachment Permit	Whatcom County	Any work that utilizes a new or existing access off of a public road right-of-way may require a Revocable Encroachment Permit, Trail Permit, and/or a possible drainage study from Whatcom County's Engineering Division.	Concurrent with building permit review.			TBD – Contact Whatcom County's engineering division: (360) 778-6220.
#20	Floodplain Development Permit -TBD	Whatcom County	In general, floodplain development permit required for all structures sited in 100-year floodplain. TBD depending on selected alternative and associated infrastructure in floodplain.	N/A	N/A	N/A	The City's diversion dam site is well upstream of mapped floodplain per FEMA FIRM map # 53073C1300D, Whatcom County. HDR assumes this permit is not required, but this should be confirmed with Whatcom County during the project's pre-application meeting.
			Tribal Coordination				
#21	Cultural Resource Coordination	Nooksack Tribe and Lummi Nation	Ground disturbance in traditional cultural property (TCP) requires tribal coordination.	Concurrent with SHPO review for Section 106 NHPA consultation.	Cultural resource assessment to be conducted in February 2018	Concurrent with JARPA submittal.	Refer to notes for Item #4, Section 106 NHPA consultation.

3 Required Documentation

A brief overview of the timeline required to develop and obtain necessary authorizations, as well as necessary documents required to complete project permitting is described below.

3.1 Additional Studies Anticipated to Support Permit Acquisition Efforts

The following environmental and engineering activities and studies would be required to facilitate development of permitting documents. Note that this list of studies assumes a streamlined USACE/Ecology permitting process. If you an Individual Permit under CWA Section 404, or Individual CWA 401 WQC is required, additional documentation will be required (e.g., alternatives analysis, water quality monitoring plan):

- Thirty percent and 60 percent engineering design set for proposed facility and all in-stream components, including plan and cross section to facilitate estimated cubic yards of cut and fill below the OHWM of Middle Fork Nooksack River
- Access road improvement plans
- Cultural and historical resources assessment of APE, including staging areas
- Geotechnical Report
- Hydraulic Assessment
- Critical Areas Report and Assessment and/or written notification to the Whatcom County technical administrator if project can be approved under 2005 CAO.
- Stream and Wetland Delineation
- Spill Prevention and Control Plan (contractor to prepare)
- Biological Assessment, Section 4d Limit-8 Self Certification, or PROJECTS programmatic consistency report
- SEPA Checklist
- JARPA
- Wetland and stream restoration plan

3.2 Anticipated Schedule for Development of Permit Documents

HDR will prepare draft permit support documents 5 months after the selection of the preferred alternative (10 percent design); final cut and fill quantities for the JARPA submittal will require 60 percent designs. At the end of the 5-month period, draft documents will be submitted to the City for review. Following a two-week review period, HDR will incorporate one consolidated set of comments into each document. At that point, the documents will become finalized and, either the City or HDR will submit the required documents to the respective agencies for review and approval.

4 Summary and Anticipated Schedule for Obtaining Permits

Based upon existing conditions at the site and the need for in-water work and upland construction and staging, the following permits or authorizations are likely to be required for project implementation:

- Federal
  - Clean Water Act Section 404 Discharge Authorization (USACE)
  - Clean Water Act Section 401 Water Quality Certification (Ecology)
  - Clean Water Act Section 402 NPDES Construction Authorization (Ecology)
  - Section 7 or 4d Endangered Species Act and Magnuson-Stevens Act compliance (NMFS)
  - Section 7 Endangered Species Act compliance (USFWS)
  - National Historic Preservation Act Section 106 (DAHP)
  - Coastal Zone Management Consistency (Ecology)
- State
  - Hydraulic Project Approval (WDFW)
  - State Environmental Policy Act (City or Whatcom County)
  - State Owned Aquatic Lands - Aquatic Land Use Authorization (WDNR)
  - Forest Practices Permit (WDNR) - TBD
  - Demolition Approval (Northwest Clean Air Agency)
- Local (Whatcom County)
  - Growth Management Act – Critical Areas Ordinance
  - Shoreline Management Act (exemption or development permit)
  - Demolition Permit
  - Land Disturbance and Clearing Permit
  - Commercial Building Permit - TBD
  - Encroachment Permit

At this time, it is assumed that in-water work would be required for two consecutive summers. Because the City’s water supply must remain on-line at all times, the new intake would be constructed during the first summer of in-water work. The dam removal would occur during the second summer of in-water work. This in-water work schedule is tentative and could be modified if an extended work window were granted to allow all in-water work to occur during one season. Site constraints for construction equipment access, laydown, and staging must also be considered in the schedule.

To expedite the permitting process, HDR recommends early and often coordination with agencies. This includes a pre-application site visit with resource agencies in spring 2018 to present the preferred alternative and solicit comments, and a formal pre-app meeting with Whatcom County to confirm County permitting requirements. HDR recommends submitting permit applications, including the JARPA and ESA consultation documents, no later than July 30, 2018. It should be noted that, upon submittal, HDR cannot control the length of time the agencies require to issue the authorizations or decisions made by the federal, state or local agencies.

The schedule for obtaining all permits is contingent upon the applicability of streamlined permitting pathways, as well as agency workload during processing and review. Under Option A, HDR assumes streamlining pathways are feasible for all federal permits and that agencies are able to process the applications in a timely manner. Under Option A, permits would be obtained in time to authorize work to begin during the 2019 summer in-water work window (likely July 15 – September 30, or longer, TBD in coordination with WDFW, NMFS, and USFWS). Under Option B, HDR assumes that streamlining pathways under Section 404/401 of the CWA, and under Sections 4d or 7 of the ESA are not feasible. Under Option B, in-water work would not commence until July 2020. The actual project permitting timeline could be a combination of elements from Options A and B. For instance, the project may be processed as a NWP, but individual Section7 consultation would be required, thus extending the permit authorization window from up to 12 months to up to 18 months.

4.1 Option A

Under Option A, all federal permitting would be expedited using existing streamlining processes. CWA Section 404 permitting for discharge of fill into wetlands or waters below the OHWM would be authorized under the Nationwide Permit Program, and the project would comply with all regional water quality conditions such that an individual WQC would not be required under CWA Section 401, administered by Ecology. Under Option A, ESA consultation for both NMFS and USFWS species would be completed using existing programmatic consultations for both NMFS and USFWS species. Under this option, consultation under Section 106 of the NHPA would not require extensive multi-agency/tribal coordination, and an MOA would not be required. State and local permits would be issued within 6 months of application.

Under this option, it is anticipated that the environmental and development permitting processes would require approximately 6 to 12 months to complete once permitting documents are submitted to the agencies (Figure 2).

Figure 2. Permitting Timeline – Option A

Option A. Streamlined Pathways
NWP Corps 404 Permit and Programmatic ESA Coverage
Permits in Hand by 2019 In-Water Work Window

Task Name	Submittal to Agency	Permit Issued
FEDERAL		
Corps 404 Nationwide Permit-Duration 9-12 months	7/30/18	7/30/19
ESA and MSA - NMFS Verification of Programmatic Coverage via Section 4d Llimit 8s-Duration 3 months	7/30/18	11/1/18
ESA Section 7 NMFS and USFWS Verification of ESA coverage using PROJECTS Programmatic-Duration 9-12 months (requires RRT review)	5/1/18	2/4/19
NHPA Section 106 No Historic Properties or Cultural Concerns, No MOA Needed-Duration 6-9 months	7/30/18	4/30/19
Ecology 401 NWP Verified and NWP Compliant-Duration 6-9 months following Corps determination on NWP	7/30/18	4/30/19
Coastal Zone Mgmt Plan Federal Consistency Verification-Duration 6 months	7/30/18	2/1/19
STATE		
HPA Standard-Duration 45 days	9/15/18	11/1/18
SEPA Checklist and MDNS-Duration 90 days	4/30/18	7/30/18
DNR Aquatic Land Use Right of Entry for Construction-Duration 9-12 months	7/30/18	7/30/19
DNR Forest Practices Permit Class TBD-Duration 4 months	9/15/18	1/15/19
CWA Section 402 Ecology Review Construction Stormwater NPDES-Duration 4 months	10/15/18	2/15/19
NW Clean Air Agency Demolition Approval-Duration 1 month	10/15/18	11/15/18
LOCAL		
Growth Management Act - Critical Areas Assessment Approval-Duration 6 months	7/30/18	1/31/19
Shoreline Management Act - Shoreline Exemption-Duration 2 months	11/1/18	1/2/19
Demolition Permit-Duration 2 months	2/1/19	4/1/19
Land Disturbance and Clearing Permit-Duration 2 months	9/15/18	11/15/18
Commercial Building Permit-Duration 2 months	11/1/18	1/2/19
Encroachment Permit-Duration 2 months	2/1/19	4/1/19

Blue bars have variable durations.
Inwater work window July 15 - Sept 30.

4.2 Option B

Under Option B, one or all of the federal permitting pathways would not be expedited using existing streamlining processes. For example, CWA Section 404 permitting would be authorized by an Individual Permit, and Ecology would require an individual Section 401 WQC. Both of these pathways require extensive processing times and mandatory public comment periods, and also require additional application materials. Under Option B, one or both ESA consultations would require individual Section 7 review for NMFS and USFWS species. In addition, a lengthier Section 106 NHPA review may be required if the dam is considered historic and removal requires an MOA. State and local permits would be issued within 6 months of application.

Under Option B, it is anticipated that the environmental and development permitting processes will require approximately 12 to 24 months to complete once permitting documents are submitted to the agencies (Figure 3). If an Individual Permit is required from USACE for in-water work, current agency workload may extend the permitting timeframe.

Figure 3. Permitting Timeline – Option B

Option B
Individual CWA Section 404 Permit, 401 Water Quality Certification, and/or Individual Section 7 ESA Coverage - Permits in Hand by 2020 In-Water Work Window

Task Name	Submittal to Agency	Permit Issued
FEDERAL		
Corps 404 Individual Permit-Duration 12-18 months*	7/30/18	1/31/20
ESA and MSA - Formal Individual Section 7-Duration 9-18 months	7/30/18	1/31/20
ESA - USFWS Formal Individual Section 7-Duration 9-18 months	7/30/18	1/31/20
NHPA Section 106 Adverse effects to historic properties or cultural resource requiring MOA needed-Duration 9-18 months	7/30/18	1/31/20
Ecology 401 Individual 401 Water Quality Certification-Duration 12 months	7/30/18	7/31/19
Coastal Zone Mgmt Plan Federal Consistency Verification-Duration 6 months	7/30/18	2/1/19
STATE		
HPA Standard-Duration 45 days	9/15/18	11/1/18
SEPA Checklist and MDNS-Duration 90 days	4/30/18	7/30/18
DNR Aquatic Land Use Right of Entry for Construction-Duration 9-18 months	7/30/18	1/31/20
DNR Forest Practices Permit Class TBD-Duration 4 months	9/15/18	1/15/19
CWA Section 402 Ecology Review Construction Stormwater NPDES-Duration 4 months	10/15/18	2/15/19
NW Clean Air Agency Demolition Approval-Duration 1 month	10/15/18	11/15/18
LOCAL		
Growth Management Act - Critical Areas Assessment Approval-Duration 6 months	7/30/18	1/31/19
Shoreline Management Act - Shoreline Exemption-Duration 2 months	11/1/18	1/2/19
Demolition Permit-Duration 2 months	2/1/19	4/1/19
Land Disturbance and Clearing Permit-Duration 2 months	9/15/18	11/15/18
Commercial Building Permit-Duration 2 months	11/1/18	1/2/19
Encroachment Permit-Duration 2 months	2/1/19	4/1/19

***Individual Permits can take longer to obtain – up to 24 months.**
Blue bars have variable durations.
Inwater Work Window July 15 - Sept 30.

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Appendix A. USFWS Species IPaC List for Project Area (Unofficial)

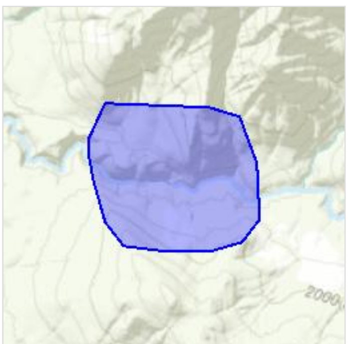
IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Whatcom County, Washington



Local office

Washington Fish And Wildlife Office

(360) 753-9440
(360) 753-9405

510 Desmond Drive Se, Suite 102
Lacey, WA 98503-1263

http://www.fws.gov/wafwo/

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Gray Wolf *Canis lupus* There is **final** critical habitat for this species. The location of the critical habitat is not available. https://ecos.fws.gov/ecp/species/4488	Endangered
North American Wolverine *Gulo gulo luscus* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5123	Proposed Threatened

Birds

NAME	STATUS
Marbled Murrelet *Brachyramphus marmoratus* There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/4467	Threatened
Streaked Horned Lark *Eremophila alpestris strigata* There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/7268	Threatened
Yellow-billed Cuckoo *Coccyzus americanus* There is **proposed** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/3911	Threatened

Fishes

NAME	STATUS
Bull Trout *Salvelinus confluentus* There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/8212	Threatened

Dolly Varden Salvelinus malma No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1008	PSAT

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
Bull Trout Salvelinus confluentus https://ecos.fws.gov/ecp/species/8212#crithab	Final

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see maps of where birders and the general public have sighted birds in and around your project area, visit E-bird tools such as the E-bird data mapping tool (search for the name of a bird on your list to see specific locations where that bird has been reported to occur within your project area over a certain timeframe) and the E-bird Explore Data Tool (perform a query to see a list of all birds sighted in your county or region and within a certain timeframe). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON (IF A BREEDING SEASON IS INDICATED FOR A BIRD ON YOUR LIST, THE BIRD MAY BREED IN YOUR PROJECT AREA SOMETIME WITHIN THE TIMEFRAME SPECIFIED, WHICH IS A VERY LIBERAL ESTIMATE OF THE DATES INSIDE WHICH THE BIRD BREEDS ACROSS ITS ENTIRE RANGE. "BREEDS ELSEWHERE" INDICATES THAT THE BIRD DOES NOT LIKELY BREED IN YOUR PROJECT AREA.)
Bald Eagle Haliaeetus leucocephalus This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Dec 1 to Aug 31
Black Swift Cypseloides niger This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8878	Breeds Jun 15 to Sep 10

Brewer's Sparrow Spizella breweri — Breeds May 15 to Aug 10
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/9291

Clark's Grebe Aechmophorus clarkii — Breeds Jan 1 to Dec 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Golden Eagle Aquila chrysaetos — Breeds Dec 1 to Aug 31
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/1680

Lesser Yellowlegs Tringa flavipes — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9679

Lewis's Woodpecker Melanerpes lewis — Breeds Apr 20 to Sep 30
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9408

Long-billed Curlew Numenius americanus — Breeds Apr 1 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/5511

Marbled Godwit Limosa fedoa — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9481

Olive-sided Flycatcher Contopus cooperi — Breeds May 20 to Aug 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3914

Willet Tringa semipalmata — Breeds Apr 20 to Aug 5
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Willow Flycatcher Empidonax traillii — Breeds May 20 to Aug 31
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/3482

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in your project's counties during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)

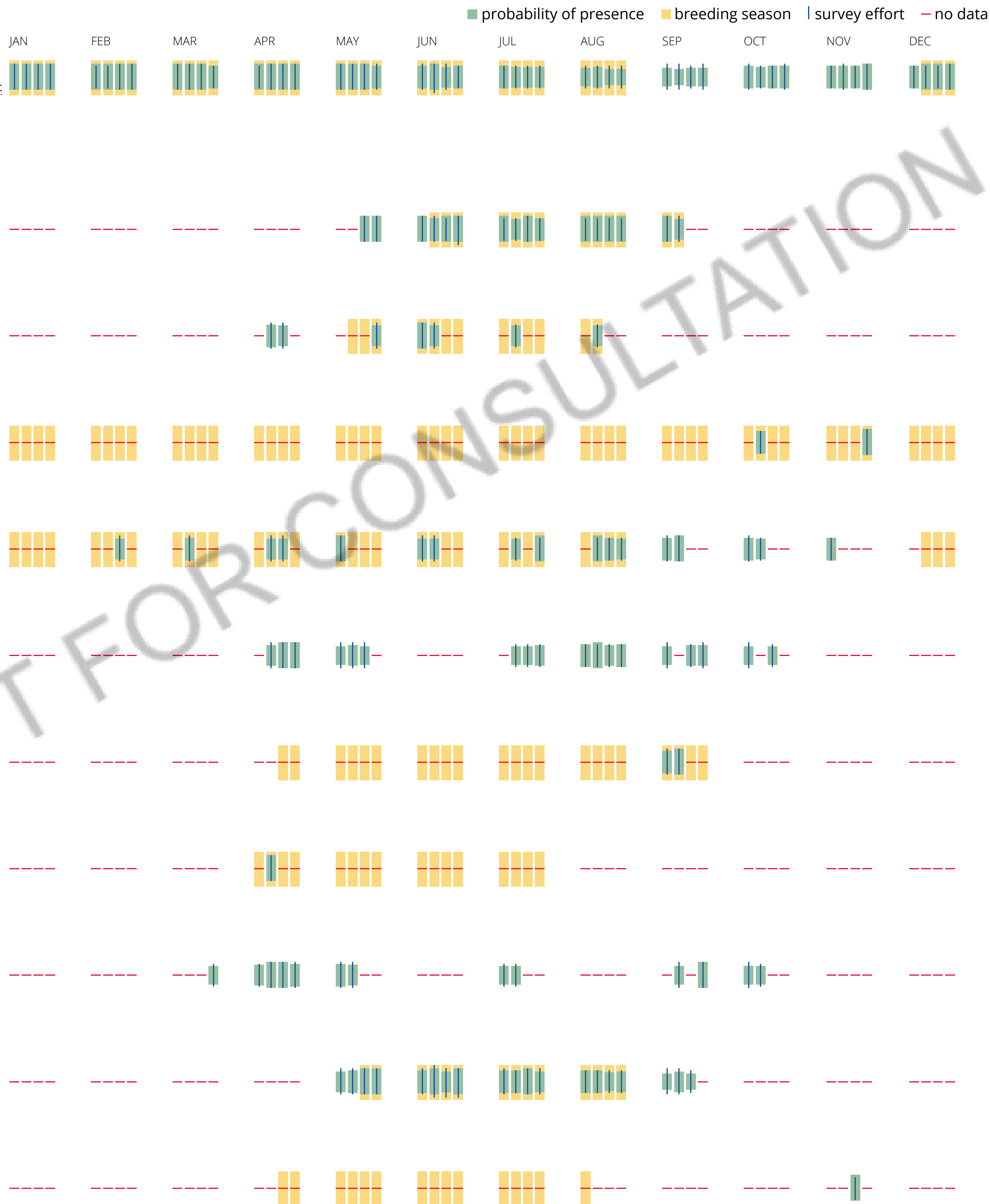
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the counties of your project area. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information.



SPECIES

Bald Eagle
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

Black Swift
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Brewer's Sparrow
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)

Clark's Grebe
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Golden Eagle
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)

Lesser Yellowlegs
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Lewis's Woodpecker
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Long-billed Curlew
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Marbled Godwit
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Olive-sided Flycatcher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Willet
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Willow Flycatcher
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the counties which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the E-bird Explore Data Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird entry on your migratory bird species list indicates a breeding season, it is probable that the bird breeds in your project's counties at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the BGEPA should such impacts occur.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

This location overlaps the following wetlands:

FRESHWATER POND
- PUBHh

RIVERINE
- R3UBH

A full description for each wetland code can be found at the National Wetlands Inventory website: https://ecos.fws.gov/ipac/wetlands/decoder

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Appendix B. WDFW Priority Habitat Species List

WASHINGTON DEPARTMENT OF FISH AND WILDLIFE
PRIORITY HABITATS AND SPECIES REPORT

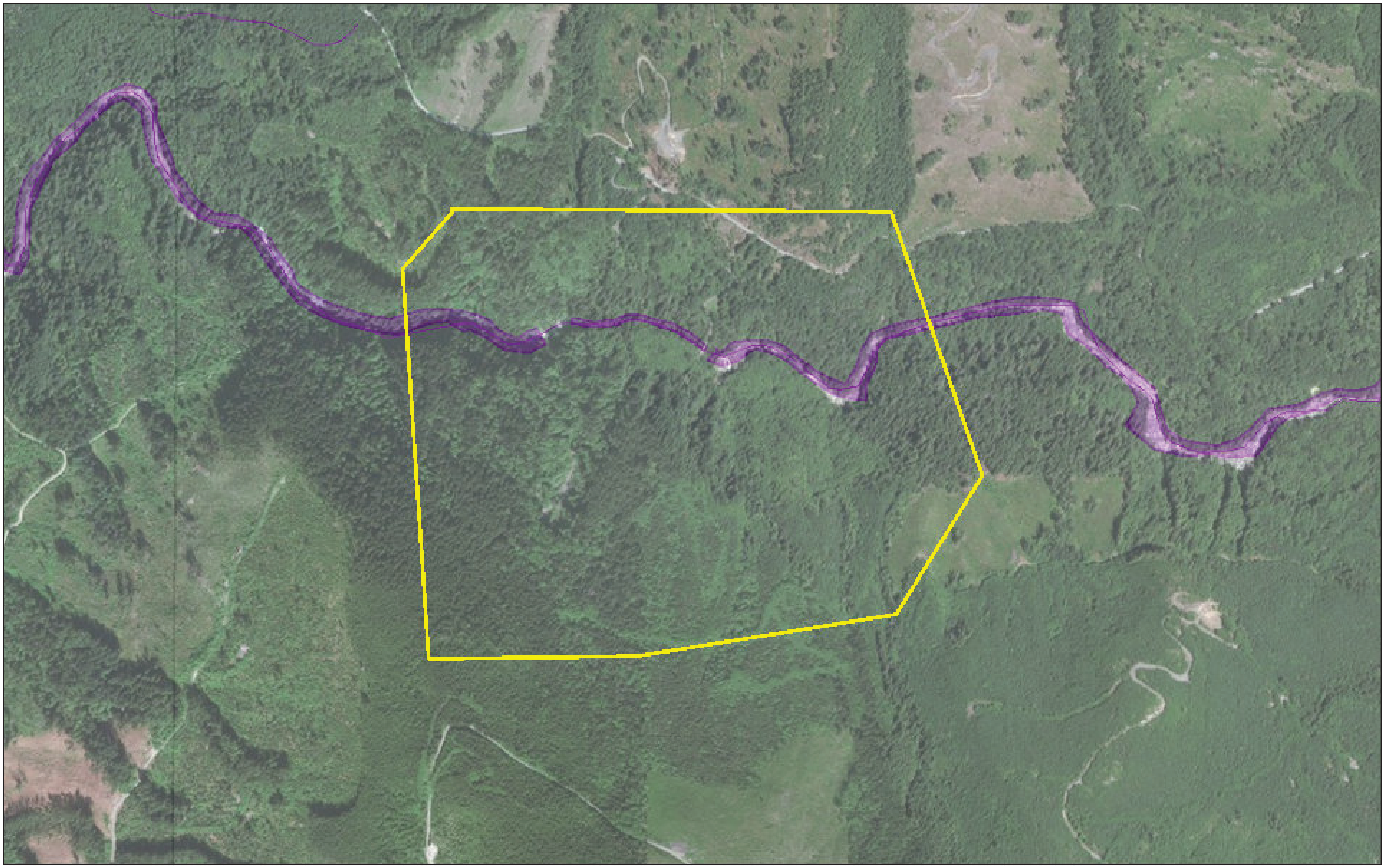
SOURCE DATASET: PHSPlusPublic　　Query ID: P180116103656
REPORT DATE: 01/16/2018 10.37

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Bull Trout Salvelinus malma	Middle Fork Nooksack River SASI 8024	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Bull Trout Salvelinus malma	Middle Fork Nooksack River SASI 8036	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chinook Oncorhynchus tshawytscha	Middle Fork Nooksack River SASI 1008	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Cliffs/bluffs	MIDDLE FORK NOOKSACK PHSREGION 913840	Habitat Feature N/A N/A	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Coho Oncorhynchus kisutch	Middle Fork Nooksack River SWIFD 33938	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Cutthroat Oncorhynchus clarki	Middle Fork Nooksack River SASI 7180	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Not Warranted N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Dolly Varden/ Bull Trout Salvelinus malma	Middle Fork Nooksack River SWIFD 33941	Breeding Area Breeding area http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Dolly Varden/ Bull Trout Salvelinus malma	Middle Fork Nooksack River SWIFD 33942	Breeding Area Breeding area http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Fall Chinook Oncorhynchus tshawytscha	Middle Fork Nooksack River SWIFD 33928	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Fall Chinook Oncorhynchus tshawytscha	Middle Fork Nooksack River SWIFD 33929	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Harlequin duck Histrionicus histrionicus	UPPER MIDDLE FORK PHSREGION 914033	Breeding Area Breeding occurrence http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Northern Spotted Owl Strix occidentalis	WS_OccurPoint 101824 March 30, 1994	Breeding Area Nest http://wdfw.wa.gov/publications/pub.php?	Map 1:100,000 <=	Threatened Endangered PHS LISTED	Y TOWNSHIP	WA Dept. of Fish and Wildlife Points
Northern Spotted Owl Strix occidentalis	WS_OwlStatus_Buf	Management Buffer Management buffer http://wdfw.wa.gov/publications/pub.php?	NA	Threatened Endangered PHS Listed	Y TOWNSHIP	WA Dept. of Fish and Wildlife Polygons
Northern Spotted Owl Strix occidentalis	WS_OwlStatus_Buf	Management Buffer Management buffer http://wdfw.wa.gov/publications/pub.php?	NA	Threatened Endangered PHS Listed	Y TOWNSHIP	WA Dept. of Fish and Wildlife Polygons
Pink Oncorhynchus gorbuscha	Middle Fork Nooksack River SASI 4140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Not Warranted N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Pink Salmon Odd Year Oncorhynchus gorbuscha	Middle Fork Nooksack River SWIFD 33945	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Rainbow Trout Oncorhynchus mykiss	Middle Fork Nooksack River SWIFD 33948	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Rainbow Trout Oncorhynchus mykiss	Middle Fork Nooksack River SWIFD 33949	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Resident Coastal Cutthroat Oncorhynchus clarki	Middle Fork Nooksack River SWIFD 33926	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Spring Chinook Oncorhynchus tshawytscha	Middle Fork Nooksack River SWIFD 33933	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Summer Steelhead Oncorhynchus mykiss	Middle Fork Nooksack River SWIFD 33952	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Winter Steelhead Oncorhynchus mykiss	Middle Fork Nooksack River SWIFD 33954	Breeding Area Breeding area http://wdfw.wa.gov/wlm/diversty/soc/soc.htm	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines

WDFW Test Map



January 16, 2018

PHS Report Clip Area

PT

LN

POLY

AS MAPPED

SECTION

QTR-TWP

TOWNSHIP

1:19,842

0 0.15 0.3 0.6 mi

0 0.275 0.55 1.1 km

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Appendix F. Stream Delineation and Wetland Reconnaissance

DRAFT Technical Memorandum

To: **City of Bellingham**

From: **Becky Holloway, Lisa Danielski, PWS (HDR)**

Date: **February 9, 2018**

Project: **City of Bellingham – Middle Fork Nooksack Fish Passage Project**

Subject: **Stream Delineation and Wetland Reconnaissance**

1.0 Introduction

The City of Bellingham (City) proposes to improve stream function and fish passage at the City's Middle Fork Nooksack River Diversion. The City proposes to maintain an important municipal water supply by carefully removing enough of the dam to accomplish fish passage and relocate the diversion while preserving channel stability and enabling upstream fish passage.

The project site is located on RM 7.2 of the Middle Fork (MF) Nooksack River in unincorporated Whatcom County. The project area encompasses a City of Bellingham parcel (Tax Parcel # 3806194544140000) and a Washington Department of Natural Resources (WDNR) parcel (3806193334380000) (Figure 1). The project is located in Section 19, Township 38 North, Range 6 East. This technical memorandum provides information on results of the MF Nooksack River ordinary high water mark (OHWM) delineation, tributary and ditch documentation, and wetland reconnaissance within the project area.

2.0 Methods

The study area for the OHWM delineation and wetland reconnaissance includes areas affected by proposed dam removal, staging, access, and laydown areas as shown on Figures 1 and 2.

The stream delineations and wetland reconnaissance included two steps. The first step was a review of existing documents such as federal, state, and local wetland and stream inventories, stream geomorphology reports prepared for the project, and other environmental documents. The second step was a field investigation of the site.

2.1 Document Review

The following existing documents were reviewed prior to beginning the field work:

- UC Davis Soil Lab (2015) SoilWeb Earth
- U.S. Fish and Wildlife Service (2017) National Wetland Inventory
- Whatcom County (2018) Critical Areas Geodatabase
- Washington Sate Department of Fish and Wildlife (WDFW 2018) Priority Habitats and Species web based map application
- Washington Department of Natural Resources (WDNR 2018) Forest Practices Application Mapping Tool

2.2 Field Methods

HDR biologists conducted a site visit on January 10, 2018, and delineated the OHWM of the left bank of MF Nooksack River within the study area. HDR did not delineate the right bank because it could not be accessed safely. The left-bank OHWM was identified using methods consistent with Washington State Department of Ecology (Ecology) guidelines (Ecology 2010). In particular, HDR biologists looked for the landward limit of drift, vegetation, and sediment deposition on the stream bank. The OHWM was marked with a handheld GPS Trimble unit capable of sub-meter accuracy. The resulting data were incorporated into project base maps. HDR biologists marked the centerline of tributaries and ditches in the study area with the Trimble unit.

HDR biologists also inspected the study area for the presence of potential wetlands. Representative wetland and upland sample plots were established in the study area using the three parameter methods described in the *Corps of Engineers Wetland Delineation Manual* (U.S. Army Corps of Engineers [USACE] 1987) and as updated in the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys and Coast Region* (USACE 2010). The sample plots and approximate boundary of wetlands were marked with the Trimble unit; however, formal wetland delineations were not conducted. HDR biologists provisionally rated wetlands in the study area using *Washington State Wetland Rating System for Western Washington- Revised,* Washington State Department of Ecology Publication #14-06-029 (Hruby 2014). Site photographs were taken to document existing site conditions (see attachment).

3.0 Existing Conditions

The majority of the study area consists of uplands comprised of second-growth mixed deciduous and coniferous forest. Dominant tree species include western redcedar (*Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), and red alder (*Alnus rubra*). Common understory species include salmonberry (*Rubus spectabilis*), sword fern (*Polystichum munitum*), and evergreen blackberry (*Rubus ursinus*). Staging and laydown areas north of the diversion dam mainly consist of young red alder trees, evergreen blackberry, and sword fern. HDR biologists delineated the OHWM of the left bank of MF Nooksack River, two tributaries and one ditch, and identified one wetland in the study area. These features are discussed below.

3.1 Streams and Ditches

Table 1 summarizes the regulatory designations of the MF Nooksack River and tributaries and ditches within the study area.

Table 1. Summary of Streams and Ditches in the Study Area

Stream/Ditch	Tributary to	Stream Type[a]	Stream Buffer Width[b]	Shoreline Jurisdiction Width
Middle Fork Nooksack River	Nooksack River	Type S	150 ft.	200 ft.
Tributary 1	Middle Fork Nooksack River	Type N	50 ft.	N/A
Tributary 2	Middle Fork Nooksack River	Type N	50 ft.	N/A
Ditch 1	Middle Fork Nooksack River	n/a	n/a	N/A

[a] Whatcom County Code (WCC) 16.16.700; Washington Administrative Code (WAC) 173-18-410. Whatcom County shall make final determination on known or potential fish use in streams that are not shorelines of the state.
[b] WCC 16.16.740

3.1.1 Middle Fork Nooksack River

The MF Nooksack River, a Shoreline of the State, generally flows east to west within the project area (Figure 2). Between Middle Fork RM 17.4 and 7.2 (existing diversion dam), several large tributaries enter the Middle Fork and the gradient is moderate. Upstream of the diversion dam, the stream gradients are variable, ranging from 1 to 8 percent and the channels are mostly confined (Smith 2002). Below the diversion dam, from RM 7.2 to 7.1, is a steep, narrow gorge with swift water, a steep gradient, and many large boulders. A habitat assessment between RM 7.2 and 8.9 identified 18.8 percent of the habitat as pools, 14.6 percent glides, and 6.3 percent runs (STS Heisler's Creek Hydro L.P. et al. 1994). Gravels, small cobbles, large cobbles, and boulders are the dominant substrates.

In the Middle Fork, the City's diversion dam is considered the upstream end of the current anadromous salmonid distribution, although some anadromous salmonids have reportedly been observed attempting to pass the dam (WRIA 1 Recovery Plan 2005). Anadromous fish species in the MF Nooksack below the City's diversion dam include all five Pacific salmon (*Oncorhynchus*) species,[1] as well as steelhead (*O. mykiss*), coastal cutthroat trout (*O. clarkii*), bull trout (*Salvelinus confluentus*), and Dolly Varden (*S. malma*) (Anchor Environmental LLC 2007). Upstream and downstream of the dam, the resident fish species include bull trout, Dolly Varden, coastal cutthroat trout, rainbow trout (*O. mykiss*), eastern brook trout (non-native) (*S. fontinalis*), mountain whitefish (*Prosopium williamsoni*), western brook lamprey (*L. richardsoni*), longnose dace (*Rhinichthys cataractae*), threespine stickleback (*Gasterosteus aculeatus*), and multiple sculpin species (*Cottus spp*.). The anadromous Pacific lamprey (*Lampetra tridentate*) and river lamprey (*L. ayresi*) may also occur in the Middle Fork downstream of the dam (Anchor Environmental LLC 2007).

[1] Few sockeye salmon (*O. nerka*) have been observed in the Middle Fork, but a small sockeye salmon population is established in the North Fork of the Nooksack River (Anchor Environmental LLC 2007). Chum salmon (*O. keta*) are unlikely to occur upstream of the Middle Fork gorge, downstream of the dam, due to their limited leaping ability (Ned Currence, Nooksack Tribe, personal communication with Ed Zapel, HDR, February 5, 2018).

Sparse quantities of vegetation overhang most of the left bank of the MF Nooksack. However, shading is provided by a riparian tree canopy consisting mainly of red alder and western redcedar.

3.1.2 Tributaries 1 and 2 and Ditch 1

Tributaries 1 and 2 are left bank tributaries to the MF Nooksack River (Figure 2). Tributary 1 generally corresponds to a Type N (seasonal, nonfish) stream and Tributary 2 corresponds to a Type U (untyped) stream mapped on the WDNR (2018) Forest Practices Application Mapping Tool. Tributary 1 and Tributary 2 originate from naturally formed channels in steep (over 30 percent gradient) ravines south of the MF Nooksack. Water from Tributary 1 dissipates onto a bench above the OHWM of MF Nooksack and enters the river as sheet flow. The stream channel of Tributary 2 has been realigned within the study area to flow east along the south side of the diversion dam access road. Tributary 2 then flows north through a 4-foot diameter culvert under the access road, discharging into a steep channel that drains to the MF Nooksack. Ditch 1 is an excavated feature that drains surface water from Wetland 1. It is not mapped as a stream feature on WDNR (2018). Ditch 1 flows west, discharging to the 4-foot culvert under the diversion dam access road.

3.2 Wetlands

HDR biologists identified one wetland, Wetland 1, located south and upslope of the MF Nooksack River (Figure 2). Representative sample plots in the wetland confirmed the presence of wetland hydrology, hydrophytic vegetation, and hydric soils. Wetland 1 is a slope wetland fed by groundwater perched on shallow subsurface bedrock. Surface water from Wetland 1 eventually drains to Ditch 1. Wetland 1 is a forested wetland dominated by red alder, salmonberry, and pig-a-back plant (*Tolmiea menziesii*). Table 2 summarizes the regulatory designations for Wetland 1. Based on review of historic aerial photos and undisturbed soil and vegetation conditions encountered in the study area, Wetland 1 does not appear to meet the definition of an artificial wetland as defined in Whatcom County Code 16.16.900 or Washington Administrative Code 173-22-030.

Table 2. Summary of Wetlands in the Study Area

Wetland Identifier	Total Size[a]	HGM Class[b]	Cowardin Classification[c]	Ecology Rating[d]	Habitat Function Score	Buffer Width[e]
1	0.38 ac	Slope	PFO1	IV	6	25 ft.

[a] Approximate size.

[b] Hydrogeomorphic classifications are based on A Hydrogeomorphic Classification of Wetlands (Brinson 1993).

[c] Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979). PFO1 = Palustrine, Forested, broad-leaved deciduous.

[d] State Wetland Rating System for Western Washington (Hruby 2014)

[e] WCC 16.16.630; wetland buffer width is based on a low intensity land use as defined in WCC 16.16.900.

4.0 References

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Hruby. 2014. Hruby, T. (2014). *Washington State Wetland Rating System for Western Washington: 2014 Update*. (Publication #14-06-029). Olympia, WA: Washington Department of Ecology.

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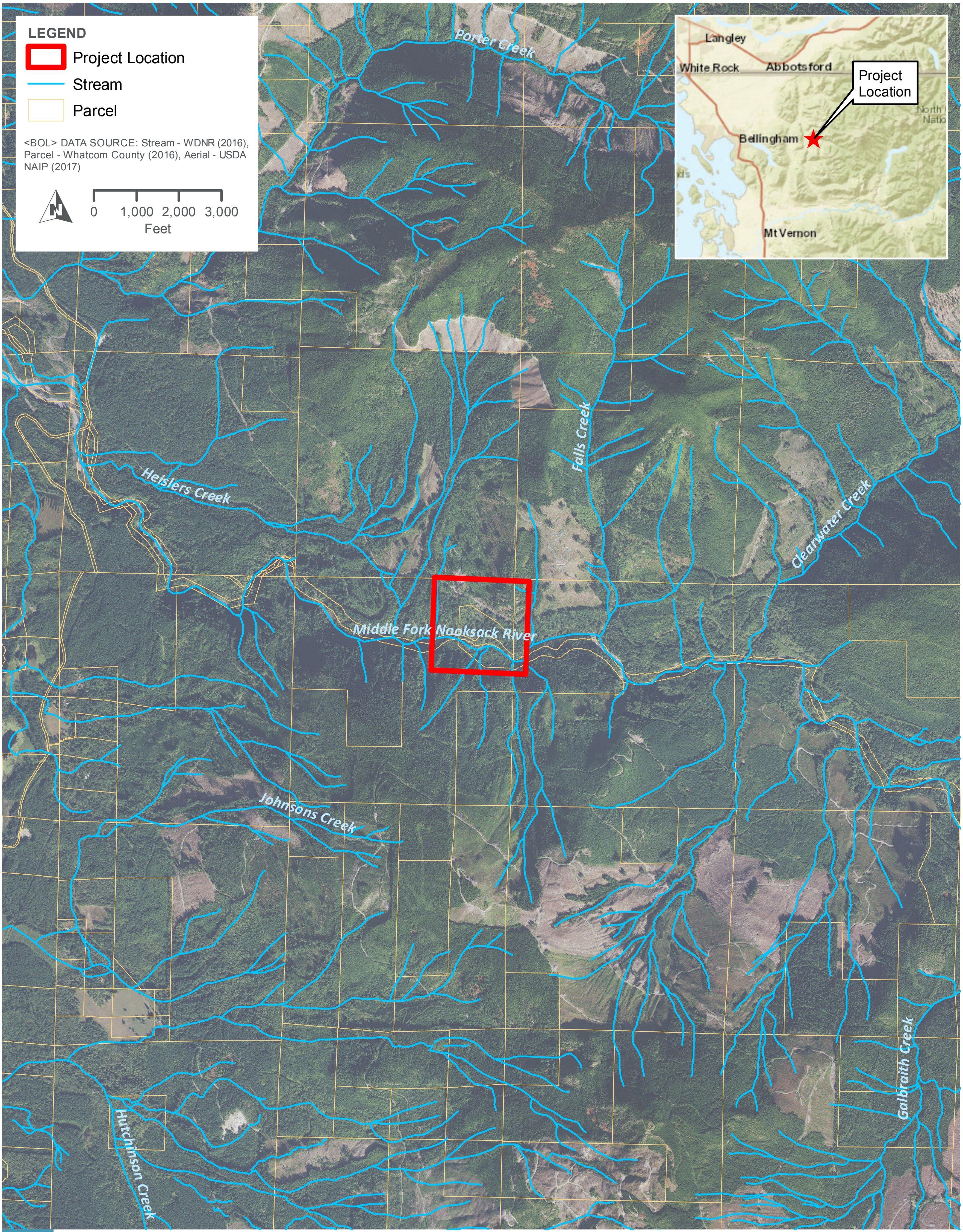
Figures



PROJECT VICINITY

FIGURE 1

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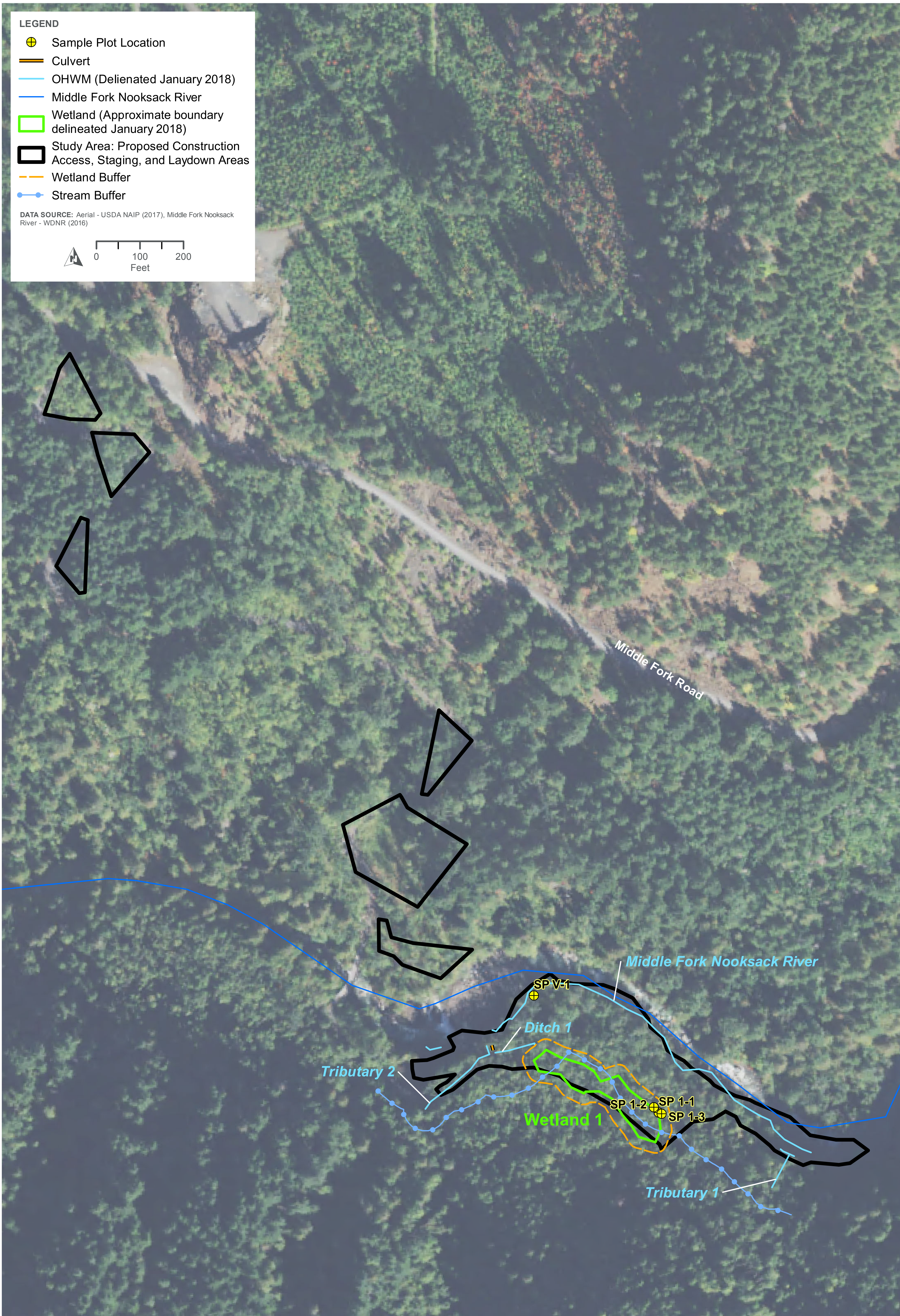

WETLAND AND STREAM IN THE PROJECT AREA

FIGURE 2

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Photographs

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Photo 1: MF Nooksack looking upstream from diversion dam.

Photo 2: MF Nooksack looking downstream near upstream end of study area.

Photo 3: Tributary 1 looking south/upslope from MF Nooksack

Photo 4: Tributary 2 along diversion dam access road, looking west

Photo 5: Ditch 1 looking west.

Photo 6: Wetland 1 looking east/southeast near wetland boundary.