Chehalis River Basin Flood Retention Structure
8-Year Project Planning Document

Final

October 30, 2012

Developed for the State of Washington and

Lewis County Public Utility District

Acknowledgements

This 8-year Project Planning Document is the result of a collaborative effort. The consulting team included EES Consulting, McMillen, LLC, Shannon & Wilson, Watershed Sciences & Engineering (WSE) and Anchor QEA, with project management provided by Jim Kramer for the Ruckelshaus Center. In addition valuable input was obtained from Washington State Department of Fish and Wildlife, Department of Ecology including the Dam Safety Office, and Department of Transportation.

Table of Contents

ACKNOWLEDGEMENTS **2**

TABLE OF CONTENTS **3**

INTRODUCTION **5**

PURPOSE 5
ORGANIZATION 5
COMMON TERMS 5
COST ESTIMATES 6

FUNCTIONAL OVERVIEW **8**

INTRODUCTION 8
ENGINEERING 8
GEOTECHNICAL 8
HYDROLOGY AND HYDRAULIC STUDIES 9
ENVIRONMENTAL 10
PERMITTING AND REGULATORY 11
ECONOMICS 12
PUBLIC INVOLVEMENT 12
PROJECT MANAGEMENT/PROGRAM MANAGER 12

STUDY PERIOD YEARS 1-2 ..... **13**

INTRODUCTION 13
ENGINEERING 13
Fish Passage Design Study *13*
Dam Design Study *14*
Evaluate and Compare Structure Alternatives *15*
GEOTECHNICAL 15
Conceptual Design Meetings and Support Tasks *15*
HYDROLOGY & HYDRAULICS 15
Development and Modeling of Preliminary Dam Operations Plan *16*
Peer Review Study of December 2007 peak and hydrograph at Doty gaging station *16*
Collect new channel cross-section data survey and update the hydraulic model *17*
Update and Extend Flood Depth Data for Economic Analysis *17*
Re-evaluate Statistical Hydrology (Optional) *18*
ENVIRONMENTAL 18
Collect Data on Fish Use in Reservoir Area and Mainstem Chehalis River *18*
Water Quality *20*
Sediment Transport and Geomorphology *21*
Habitat Mapping and Wildlife Studies *21*
PERMITTING & REGULATORY 22
Regulatory Review of Flood Control Only Permitting Alternative and FERC Licensing Alternative *22*
Cultural Resource Review *22*
Agency Pre-Consultation *23*
ECONOMICS 23
Methodology Selection *23*
Transportation Benefit Analysis *24*
Environmental Benefit and Cost Analysis (optional) *25*
Recreation Study (optional) *25*
Benefit/Cost Study *26*

Qualitative Research Study (optional)....28
SUMMARY OF STUDY YEARS 1-2....28

STUDY PLAN YEARS 3-5....30

INTRODUCTION....30
ENGINEERING....30
Dam Spillway and Tunnel Design Study....30
Fish Passage System Hydraulic Model....31
Fish Passage Preliminary Design....31
Dam Preliminary Design....31
GEOTECHNICAL....32
Preliminary Design....32
HYDROLOGY & HYDRAULICS....36
Refinement of Dam Operations Plan....36
Hydrologic Model Development....36
Hydrologic and Hydraulic Dam Safety Analyses (Washington DOE or FERC)....37
ENVIRONMENTAL....37
Fisheries Studies: Collect Data on Fish Use in Reservoir Area and Mainstem Chehalis River....38
Fisheries Impact and Mitigation Studies....39
Water Quality....39
Sediment Transport and Geomorphology....40
Downstream Wetland and Riparian Studies....40
PERMITTING & REGULATORY....41
Permitting related to Subsurface Explorations and Installing Scientific Measuring Devices....41
Permitting Process for Flood Control Only Dam Alternative....41
Permitting Process for Multipurpose Dam Alternative....42
ECONOMICS....43
Benefit/Cost Study....43
SUMMARY OF STUDY YEARS 3-5....43

STUDY PLAN YEARS 6-8....45

INTRODUCTION....45
ENGINEERING....45
Final Design....45
Services during Construction....45
GEOTECHNICAL....46
Final Design....46
HYDROLOGY & HYDRAULICS....47
ENVIRONMENTAL....47
Jurisdictional Wetland Delineation and OHWM Determination....47
Downstream Wetland and Riparian Studies and mitigation planning....48
PERMITTING & REGULATORY....48
Continue Permitting Process for Flood Control Only Dam Alternative....48
Continue Permitting Process for Multipurpose Dam Alternative Permitting....49
ECONOMICS....50
SUMMARY OF STUDY YEARS 6-8....50

SUMMARY OF 8-YEAR PLAN....51

COST ESTIMATE SUMMARY....51
SCHEDULE....52

Introduction

Purpose

This Project Planning Document was developed for Washington State and Lewis County Public Utility District (Lewis PUD) to help inform budgetary decision making for the Washington State 2013-2015 biennium. The studies identified in this document for the two-year biennium are needed to determine whether a water retention structure on the Upper Chehalis River should be pursued, and, if so, what type of structure is recommended. The two types of structures that would be analyzed over the next two years are a single-purpose structure used only for flood reduction and a multi-purpose structure with year-round water storage for downstream flow augmentation and hydropower.

Organization

This Project Planning Document provides study scopes and estimated budget ranges for three time periods over the next eight years or to the start of project construction. The first period, years 1-2, includes studies that would identify fatal flaws in either project design as well as refinements to the benefits, impacts, and costs for either alternative. This period begins July 2013 and needs to be completed by the end of December 2014[1]. At the end of the first study period, the interested parties in the Chehalis Basin and at the State of Washington will have the information needed to decide whether or not to move forward with one of the proposed structure configurations. The scope of studies suggested in years 3-5 and years 6-8 will ultimately depend on which structure is selected; therefore, cost estimates provided for these tasks should be interpreted only in terms of the order of magnitude.

Common Terms

The term "studies," as used in this report, is intended to collectively include field work related to the proposed project (such as mapping, fish sampling and habitat surveys, subsurface explorations, geophysical surveys, and field testing), testing performed in a geotechnical laboratory, and modeling, calculations, evaluations, and analyses completed in an office environment.

This document also makes use of the terms "Conceptual Design," "Preliminary Design," and "Final Design." While there is no hard-and-fast rule about what is to be included under these categories, we envision the following as general guidelines:

<u>Conceptual Design.</u> The objective of a conceptual design is to develop a workable concept about how the project is to be constructed and operated. For example, concepts include: the type of dam to be constructed (earthfill, earthfill-rockfill, roller-compacted concrete, etc.); the

[1] To collect sufficient data for the smolt trapping study, funding would have to start in early 2013 (January). This early start is needed to purchase or build the rotary screw trap, locate an appropriate deployment site and get access approval from the local landowner, obtain necessary sampling permits, and hire appropriate staff.

probable dam operation (how large of a conservation pool is anticipated during less flood-prone seasons of the year and what releases will be made from the dam during different times of the year); whether hydroelectric power generation will be included as part of the project, either from the beginning or added at some time in the future; a general estimate of operating life and manner of decommissioning, and the feasibility of installing facilities that will successfully pass adult and juvenile salmon for the type of dam to be constructed and the probable dam operation selected.

Preliminary Design. During preliminary design, the layout of the facility is developed. Stability, hydraulic, and other evaluations are conducted to determine the appropriate shape of the dam, and the size of pipes, etc. are established. Alternatives for various parts of the project are evaluated (such as where to locate the overflow spillway, outlet works, and other critical structures), and design criteria (such as the design flood and peak accelerations likely to result onsite from seismic events, including the Maximum Credible Earthquake) are quantified. In addition, preliminary design will include locating and designing adult and juvenile fish passage facilities as an integral component of the dam design. At the end of this phase, the plan for the project is well defined. The preliminary design phase is typically the phase where reviewers from regulatory agencies become more actively involved. By soliciting input during preliminary design, potential issues can be identified and addressed in a more timely and cost-effective manner. For example, significant modifications during the final design phase are not necessary because regulatory concerns were addressed early on.

Final Design. Final design refines and optimizes the preliminary design. The culmination of this phase is a project that is ready to be constructed.

Conceptual design elements may be defined during Study Years 1-2. Preliminary design studies will be completed during Study Years 3-5 given that the project moves forward. Final design elements will be completed in Study Years 6-8. A project timeline is included in the Summary section of the Project Planning Document.

Optional Studies. Some studies described in this document are labeled “optional.” An optional study, for the purposes of this document, means one or both of the following: the timeframe for which the study is suggested is flexible and the study can be completed during the suggested timeframe or in other periods as noted; or the study may not be desired by the project planners and is for informational purposes only. Details regarding why a study is deemed optional are described under each section.

Cost Estimates

The cost estimates in this document for services to be provided during the 8 year study period are in current (2012) dollars and are not adjusted for inflation. These cost estimates are for the primary work to be performed and do not include the cost of participation by key stakeholders and additional state employees. Each consultant developed costs ranges which incorporate the uncertainty of the level of effort required for each study. These estimates are based on currently available information. The cost estimate ranges are characterized by either uncertainty regarding scope or structure alternative or the number of tasks needed as outlined in this document. For example, the lower range of the cost estimates assume that not all of the

tasks described in the document will be performed, while the higher range assumes all tasks are performed. In some cases, a single cost estimate is provided; however, until a detailed scope is developed, and proposals received for each study, the actual cost will not be known. It is expected that proposal bids will fall within the range provided or be consistent with the magnitude of a single cost estimate.

In providing cost opinions, we have no control over the cost or availability of labor, equipment, or materials; changes in regulatory conditions; market conditions for this type of work; or the method of pricing that will be used by drilling and other contractors at the time investigation services are solicited. Our opinion is based on our knowledge of current cost conditions in the vicinity of the project for the type(s) of work described and our professional judgment and experience. We make no warranty, express or implied, that bids or negotiated prices for services will not vary from the opinions of probable cost contained herein.

Functional Overview

Introduction

This section of the report provides an overview of the work to be performed during the 8 year planning period for each of six functional areas. Each area describes the questions to be answered and timing of the required studies. Some of the functional areas overlap, and care has been taken to ensure study costs are not included in several functional areas.

Engineering

Engineering will examine and answer questions related to the actual design and feasibility of the dam and fish passage structure from an engineering perspective. From the engineering perspective the biggest questions are:

- What type of dam to build (flood control only or multipurpose)?
- Can a dam meeting dam safety office requirements be cost effectively constructed?
- How will the dam be operated?
- What are the fish passage requirements?

To examine these questions, the studies during years 1 and 2 will identify if there are fatal flaws in the dam concept (either flood control or multi-purpose), primarily regarding fish passage considerations. The operational criteria will also be identified during Study Years 1-2 to incorporate the information into the updated cost and benefit analysis. This task is discussed under the Fish Passage Design Study in Study Year 1.

Once a structure conceptual design and the operation criteria have been determined, the subsequent tasks include spillway and tunnel design studies to determine the optimal dam height, tunnel size and shape, and spillway configuration. The spillway and tunnel design will be completed once Probable Maximum Flood (PMF) and dam break studies to ascertain the Inflow Design Flood (IDF) are completed and concurrently with geotechnical studies identified in Years 3 to 5. Preliminary design work is completed in Study Years 3-5 and final design work will be completed in Study Years 6-8.

Geotechnical

Safety and integrity of the proposed dam are paramount in the dam feasibility assessment. Washington Department of Ecology Dam Safety Office (WDOE DSO) requirements will be incorporated in the assessment and consideration of risks and risk mitigation measures. Where power production is part of the proposed dam project, Federal Energy Regulatory Commission (FERC) requirements would also be considered and incorporated. WDOE DSO and FERC representatives are generally consulted during the dam feasibility assessment phase. They are relied upon to confirm regulatory requirements and expectations, and to verify that the approach and concepts being considered by the dam feasibility assessment team are in compliance with applicable regulations.

WDOE DSO classifies dams by a consequence rating system that includes embankment size (hydraulic height), reservoir operation, and downstream hazard conditions. The definition of a large dam is any structure greater than 50 feet high. Reservoir operation considers whether the dam operates with a permanent/seasonal pool or only impounds water temporarily/intermittently. Downstream conditions consider risk to human life, potential economic losses (including damage to structures and transportation corridors), as well as the environmental consequences that would be associated with dam failure.

Based on a vertical height of more than 200 feet, a permanent/seasonal pool, and the proximity of the Town of Pe Ell, Highway 6, and other urbanized areas downstream, the potential Chehalis River Retention Structure would need to be constructed to meet WDOE DSO requirements associated with the large, permanent pool, and high hazard classification criteria. As such, the structure will be subject to the most stringent design criteria and require the most detailed engineering analyses specified by WDOE DSO.

A reconnaissance-level study completed in 2009 concluded that there are no fatal flaws related to geologic or geotechnical engineering issues at the proposed Chehalis River dam site. This conclusion does not mean that no geologic or construction challenges exist, nor does it mean that the proposed dam construction will meet project budgetary considerations. Rather, it means that, based on geologic and geotechnical engineering considerations, a dam meeting WDOE DSO and FERC requirements for dam safety and integrity can likely be constructed at the site.

Additional geologic, geotechnical engineering, and hydrogeologic studies are required to determine what issues, if any, will need to be addressed during the design phase. These studies will allow us to evaluate what type of engineered solutions will likely be required to safely construct and operate a dam that will meet the project objectives. The studies will be used to estimate the cost of the engineered solutions so that stakeholders can continue to evaluate the ratio of project benefit to project cost.

For simplicity, the remainder of this document will refer to the combination of geology, geotechnical engineering, and hydrogeology disciplines under the umbrella term "geotechnical." The following sections discuss our recommendations for the scope and timing of various geotechnical explorations and studies over the next 8 years, with the goal of completing final design of the dam and appurtenances at the end of Year 8, including development of construction documents (design drawings and specifications).

Hydrology and Hydraulic Studies

Hydrologic and hydraulic (H&H) investigations are necessary to support the other studies that will be undertaken to assess the feasibility of a water retention structure on the Upper Chehalis River. Hydrologic data is needed as input to define an optimal operation plan for the reservoir. Hydraulic analysis of the downstream river corridor will provide data for investigation of flood damage reduction benefits as part of the economic analysis. The hydraulic modeling will also support investigations of aquatic habitat conditions, water quality, geomorphology, sediment dynamics, and other issues relevant to the environmental assessment. Finally, H&H analyses

will provide the basis for engineering design of the dam's spillway, outlet works, and fish passage facilities.

A number of H&H studies have been conducted in the Chehalis River basin over the past decade as part of flood relief planning efforts. These previous studies have led to the development of hydrologic data and hydraulic models that can be used in the design of the water retention project. Relevant recent H&H studies include the following:

- Pre-2004: Twin Cities General Investigation (for U.S. Army Corps of Engineers, USACE)
    - Constructed UNET Hydraulic Model from Doty to Grand Mound (1989-1998 Channel and Floodplain Data)
    - Proposed Levees and Modifications to Skookumchuck Dam
- 2006 - 2011: Floodplain Mapping Study (for FEMA)
    - Built off of Corps Model (Doty to Grand Mound)
    - Calibrated Model to 1996, 2007, and 2009 events
    - Used to map 100-year floodplain and Floodway
- 2008 – 2010: Chehalis Flood Risk Reduction Alternatives (for Lewis County)
    - Identified concerns with USACE Twin Cities project
    - Evaluated several potential upstream storage alternatives
- 2010-2011: Upstream Storage Phase IIB Analyses (for Lewis County PUD)
    - Produced floodplain depth data for baseline and various alternatives
    - Presented information to Lewis County Commissioners and Flood Authority
- 2011-2012: Chehalis River Ecosystem General Investigation (for USACE)
    - Extend/Update 2010 Flood Insurance Study Model
    - Re-evaluate basin hydrology for flood and low flow conditions
    - Collect new channel survey data (Porter to Montesano, Doty to Pe Ell)
- 2011 – 2012: Chehalis Hydraulic Model Development (for Flood Authority)
    - Leverage/Extend USACE GI model (Pe Ell to Aberdeen plus tributaries)
    - Collect new channel survey data (Grand Mound to Porter, Montesano Aberdeen)
    - Used model to evaluate many flood relief alternatives

Tools and data developed for these studies will form the basis of H&H investigations of the dam. These tools will be refined in stages as necessary to support various levels of analysis and design. Limited additional analysis is anticipated during Study Years 1-2 (conceptual design phase) while significant new H&H studies would be required during the preliminary design of the dam in Study Years 3-5. Some additional investigations may be required to refine the design and support permitting efforts during final design in Study Years 6-8.

Environmental

The environmental studies will produce critical information that represents pre-project conditions and can be used to estimate the potential impact of the proposed structure. In addition, the studies will provide information on fish passage requirements.

An important need in the first two years is to conduct fish studies to fill in information gaps. The biological data is a critical element of the design process. It will be combined with engineering

information to develop a series of design alternatives. For example, information obtained from the fish studies is needed to define how the project must be operated and how dam components such as the tunnel and outlet structure will need to be designed to protect fish and provide effective passage. The studies will collect the following:

1. Information on salmon passage timing and abundance; this is needed to develop adult and juvenile fish passage facility design alternatives.
2. Information on the presence, distribution, abundance, and movement patterns of resident fish species and State-listed species of concern in the project area; this is needed to identify impacts and inform fish passage facility design alternatives.
3. Data on the amount of potential salmonid rearing and spawning habitat within the footprint of the proposed dam and reservoir that would no longer be available to support salmonid productivity; this is needed to identify impacts.
4. Data on salmonid and other anadromous species for which little-to-no information is currently available but the species may be impacted; if present, passing these species and life stages will need to be considered when assessing the feasibility of the proposed project; this includes but is not limited to summer steelhead, coastal cutthroat trout, brook and river lamprey, and white and green sturgeon; this is needed to identify impacts and inform fish passage facility design alternatives.

The cost of the fish passage facilities will be a significant component of the overall cost of the project and the scope for these cost estimates is included in the engineering section.

In addition to fish passage, water quality studies are needed during in the first two years of the study period to fill current data gaps. The water quality studies will benefit fisheries studies and future water quality studies regardless if a structure is built.

Wildlife studies are needed in the first two years to determine a baseline of species presence and abundance in and around the proposed reservoir area. These wildlife studies will be important information for developing a complete understanding of the direct impacts associated with the project. The direct impacts will need to be mitigated and mitigation could increase project costs significantly.

Lastly, sediment transport and geomorphology studies will provide information to the designers of the reservoir on the rate and timing of discharge from the dam that would minimize impacts to existing fish habitat in the Chehalis River downstream of the reservoir as well as address concerns of increased landslides and sediment accumulation within the reservoir area. These studies will affect the design of the outlet structures, identify potential risks and operating costs and will likely have project cost implications.

Permitting and Regulatory

Permitting and regulatory processes will vary depending on which of the two alternatives (flood control only or a multipurpose dam) is selected. In the first two years, permitting and regulatory work is limited to reviewing the permitting process for each alternative and a review of cultural resources to ensure no fatal permitting flaws exist. Beginning in year 3, the permitting and regulatory supporting studies will be conducted. The processes (USACE/EIS or

FERC Licensing) requiring these studies are different depending on which alternative is selected at the end of year 2. Each process would require studies, in addition to the work described under other functions, and agency/public consultation will be needed. It is anticipated the regulatory process would begin in the Year 3-5 timeframe and final permitting would be completed in the Year 6-8 period.

Economics

As the projects are further analyzed, and more information is known, it is important to continually update the benefit-cost analysis. It is suggested that a benefit-cost analysis be conducted for the first two of the three study periods over the next 8 years. The first benefit-cost analysis should be conducted by the end of Year 2. The second benefit-cost analysis should be conducted at some point in Study Years 4 or 5 depending on the timing of corollary studies such as Environmental or Engineering Design.

Public Involvement

Public involvement needs to be an early and continuing part of the project development process. It is essential that the community's values are understood in order mitigate potential impacts. The community also needs to understand the constraints and tradeoffs of the planning and project development process and to "buy-in" to the project needs and purpose. If involved early, the public can provide insight (directly or indirectly) into what their community would find acceptable in the way of mitigation. It is envisioned that the public involvement process includes the development of a website, information updates and facts about the project, facilitation of public meetings and handling of all communication to and from the public. While this function is not described in detail in the remainder of the document, the Public Involvement budget has been added to the cost tables in the remainder of the document.

Project Management/Program Manager

In order for the phases of this project to be completed in timely and cost effective manner, a dedicated project manager/program manager is needed. This person will be in charge of the overall scope development, schedule, financial plan and budget control, team organization, integration across the disciplines, quality control and project team communication. While this function is not described in detail in the remainder of the document, it is estimated that the project management task budget is approximately 10% of the overall budget. This additional cost has been added to the cost tables in the remainder of the document.

Study Period Years 1-2

Introduction

The objective of the first study period (July 2013 to December 2014) is to identify fatal flaws and to define the Preferred Alternative. To meet this objective, several main questions will have to be answered including:

- What type (flood control only or multi-purpose) dam will be built?
- How will the dam be operated?
- What environmental mitigation might be required?
- What type of fish passage facilities will be needed and what are the potential costs?
- What is the impact on water quality and sediments in terms of channel configurations?
- Is the benefit-cost ratio of the selected alternative positive?

At the end of this first study period, the interested parties in the Chehalis Basin and at the State of Washington should have the information needed to decide whether or not to move forward with one of the proposed structure configurations. The studies listed below for each functional area are intended to provide data and analysis necessary to answer the questions above.

Engineering

One of the main assumptions related to this project is that the dam will be an earthen dam. Other types of dams may be explored, but these other options may be cost prohibitive. The engineering function during this period will focus on the required design for fish passage and determining the type of structure (flood control only or multi-purpose) to build. The studies proposed during Study Years 1-2 for the engineering function are:

Fish Passage Design Study

This study is designed to address the question of what type of fish passage facilities may be required at the proposed flood control structures. The types of fish passage will likely vary depending on project purpose (flood control only or multipurpose). The fish passage study focuses on developing and evaluating alternatives for providing fish passage at the flood retention structures for both upstream and downstream migrants. It is anticipated that the study will consist of the following work tasks:

<u>Data collection and review of existing facilities</u>. The first step will be to collect information on existing fish passage facilities, which contain similar features to the proposed flood retention structures. Owners of the existing facilities will be contacted to determine the basic configurations and overall features, operational characteristics and limitations, and design pros and cons of the various passage facility alternatives. A standard questionnaire will be developed to ensure standardization of data collection and filing. For those facilities that appear to have merit for application at the proposed flood retention structures, site visits will be conducted to view the facilities and discuss operation with the site operators. The results of this task will be documented in a technical memorandum.

Develop design and operation criteria. To develop alternatives, an initial understanding of the proposed project operation will be required. Working with the project design team, a range of criteria will be developed which represents the anticipated operating scenarios. The fish passage will be designed for a new dam, thus innovative designs not currently in existence may be considered. These operating criteria will be combined with fish passage facility design criteria to form the design criteria framework upon which fish passage alternatives will be developed. The design and operation criteria will be summarized in a technical memorandum.

Brainstorming meeting to identify and pre-screen alternatives. Based on the review of existing facilities and data, the team will conduct a brainstorming session to identify potential fish passage alternatives. It is anticipated that the brainstorming session would be attended by the project team, other technical experts and key stakeholders. A list of potential alternatives would be developed, then pre-screened based on a set of pre-determined evaluation criteria to determine if any "fatal flaws" are associated with an alternative. A alternatives with fatal flaws will be removed from further considerations and the remaining alternatives will be advanced for development of feasibility level design details.

Develop feasibility level layouts for screened alternatives. Preliminary layouts and details for the fish passage alternatives will be developed to illustrate the arrangement and intended operation. The primary facility elements will be illustrated to ensure the intended operation is clearly illustrated.

Evaluate alternatives and select best alternative. For both upstream and downstream passage alternatives, a range of site specific evaluation criteria will be developed and used to evaluate each fish passage alternative being considered. These criteria will include biological effectiveness of the fish passage system, impact on the flood control operation, operation and maintenance complexity and cost, capital cost, and other criteria as identified. These criteria will be used to determine the best alternative for application at the flood retention structures.

Cost Estimates. Develop costs for construction, operation and maintenance of the proposed fish passage alternatives. These cost estimates will be used to update the benefit-cost analysis.

Prepare study report. The analysis and results of the fish passage study will be summarized in a study report. A draft report will be prepared for review by the team and stakeholders.

The engineering fish passage study would be conducted in concert with the biological studies proposed under the environmental studies portion of this report. The biological data provided from these studies will be required to determine fish species, timing, numbers, and general characteristics for upstream and downstream migrants.

Estimated Cost: $150,000 - $300,000

Dam Design Study

This task would occur during the end of the Year 1-2 planning period once it has been established what type of dam (flood control or multipurpose) is to be constructed and once fish passage needs are understood. It would also be helpful to understand the cost limitations based on the benefit-cost analysis before proceeding. This task would consist of developing a comprehensive survey of dam designs around the world and a discussion of the applicability to

the Chehalis site. Once the survey document has been completed, it is proposed that a focus group consisting of interested parties from State agencies and dam design engineers will explore possible options and new creative solutions to the Chehalis site. The cost of this task is highly dependent on the number of options explored, the number of meetings and how many participants would be included in the focus group. Another option would be to initiate an engineering contest for innovative, *feasible*, design for the site with a large price for the winner.

Estimated cost: $100,000 - $300,000

Evaluate and Compare Structure Alternatives

Based on the fish passage alternatives reviewed and work completed under the other disciplines, the flood only and multipurpose projects will be compared and evaluated. The evaluation will consider cost and benefits, fish passage, flow augmentation, operational criteria, water use, permitting, potential for sediment accumulation, and other significant factors as deemed necessary to recommend which project should be pursued and advanced to final design. Work for subsequent study phases would be for only the recommended project. This task would be performed as part of the engineering studies in year 2 and may include presentations, stakeholder meetings, and correspondence with key staff at the state or governor's office.

Estimated Cost: $150,000-$200,000

Geotechnical

Conceptual Design Meetings and Support Tasks

No specific geotechnical exploration or analysis is proposed during the first two years of the Study. Geotechnical engineering services would be provided in a supporting role during this phase, with tasks to include:

- Attending meetings with stakeholders and other design personnel
- Providing geotechnical input to assist other disciplines
- Providing input into estimations of service life (sediment accumulation being one factor) and decommissioning costs
- Assisting with refinement and periodic reassessment of project economics

Estimated Cost: $50,000-$100,000

Hydrology & Hydraulics

During Study Years 1-2, hydrologic and hydraulic (H&H) studies will be undertaken to better define baseline conditions and to support other conceptual design efforts. Accurate hydrologic data is needed in order to quantify the impacts and benefits of the proposed project and to define an optimal operation plan for the reservoir. The hydrology data from the Doty gage will therefore be reviewed during this period. In addition the hydraulic model for the Chehalis basin will be updated to provide more accurate flood inundation information for use in the

economic benefit-cost study and environmental assessment. The studies proposed during Study Years 1-2 for the H&H function are:

Development and Modeling of Preliminary Dam Operations Plan

Conceptual design of reservoir structures (outlet works, bypass tunnel, sediment management facilities, fish passage facilities, spillway, powerhouse, energy dissipation, etc.) requires an improved understanding of reservoir operations i.e. flow releases. Likewise downstream environmental and flood damage reduction benefits and potential impacts of the reservoir will also be directly affected by the operation of the reservoir. In an earlier Fish Study (Anchor QEA, 2012), a reservoir operations model was developed and used to define a preliminary operation plan for the reservoir. Given the subsequent work done by WSE, Anchor, and others to evaluate downstream effects of the reservoir, it is necessary to revisit the earlier analysis and determine if a more beneficial operational plan can be developed. Project stakeholders including WDFW, the Chehalis Tribe, the Flood Authority, and downstream communities will be surveyed to gain insight into alternative flow conditions these stakeholders feel might reduce project impacts or increase project benefits. Using information collected from stakeholders, a range of alternative operation scenarios (i.e., discharge during small to large flood events, seasonal discharges, fish passage flows, discharge required to maintain geomorphic processes downstream of dam, etc.) will be defined.

The existing HEC-ResSIM operations model of the reservoir, prepared for the Fish Study, will be refined and used to review these alternative operational concepts to determine which conditions are feasible given the location and proposed size of the dam. A plan of proposed operations will be developed which will inform the design and cost estimate of outlet structures at the dam. The cost estimate shown below assumes that existing hydrologic data will be used with the existing reservoir operations model to evaluate the feasibility of operational alternatives. It is further assumed that downstream stakeholders already have adequate information to suggest operational alternatives and that no additional downstream benefit or cost analyses are required to define the operations plan.

Estimated Cost: $150,000

Peer Review Study of December 2007 peak and hydrograph at Doty gaging station

Pervious and future studies for the proposed retention structure alternatives have relied on information from the Doty gage. Several stakeholders in the basin have questioned the accuracy of the USGS estimate of the peak flow and flow hydrograph for the December 2007 flood event at the Doty gage station. A review of the flow estimate would improve stakeholder confidence in the data and (if the flow estimates change) allow a more accurate hydraulic model calibration. If there are significant issues found with the USGS peak flow or volume the statistical hydrologic analysis used for the basin scale hydraulic modeling would be updated to reflect the new data.

Estimated Cost: $50,000

Collect new channel cross-section data survey and update the hydraulic model

The hydraulic model is needed to provide river peak and flow information for engineering and environmental studies. The hydraulic model developed for the Chehalis River Basin Flood Authority in 2012 used all topographic data available at that time. Subsequent to the work in 2012, additional LiDAR based topographic data has been collected for much of the Chehalis River floodplain. In addition, the 2012 modeling did not include substantial updates (i.e., new cross sections) for the portion of the hydraulic model within Lewis County. Under this task the Flood Authority model would be updated using new channel surveys and recently collected topographic data.

New in-channel survey data will be collected for the reach between Doty and Grand Mound (approximately 50 miles). Surveys will be collected at either a nominal 2000-foot spacing (as in the current model) or at a tighter density such as 1000-foot average spacing. The range of costs shown below reflects differences in these two options. Previous (1998 or earlier) channel survey locations will be reoccupied to the extent possible. In-channel survey data will be merged with recently acquired LiDAR data for the overbanks to create composite cross sections for use in the hydraulic model.

The HEC-RAS model will be updated to reflect the new cross section data in the Grand Mound to Doty Reach and the model will be run for the 1 February 1996, December 2007, and January 2009 events. The model may also be updated to reflect new LiDAR based topographic data available for the floodplain between Grand Mound and Montesano. Other refinements to the model may be made if the new topographic data suggests these are appropriate. Additional model calibration will be performed as necessary. The budget range shown below reflects a range of assumptions about whether or not the lower basin LiDAR is used to update the model and the level of additional calibration required.

Following completion of model refinement and calibration the hydraulic model will be run for the 10-, 25-, 100-, and 500-year flood events. It is assumed that all hydrologic data needed for this analysis are available from the USACE GI study. If additional hydrologic data development is required the costs could be higher than those shown below.

Estimated Cost: $80,000-200,000

Update and Extend Flood Depth Data for Economic Analysis

The primary potential benefit of a dam on the Upper Chehalis River is flood damage reduction along the downstream river corridor. To determine the project benefit, the hydraulic model output (inundation area and water surface elevation) is processed into gridded depth data, which is then input to the FEMA HAZUS model to estimate avoided damages for floods with return intervals ranging from the 10- to the 500-year event. In earlier work in 2010, depth data were developed for the baseline and with-dam scenarios for the downstream reach between Doty and Grand Mound. Subsequent to that work the hydraulic model has been extended to cover the entire downstream floodplain from Pe Ell to Aberdeen and the model has been refined and recalibrated in the Twin Cities area. Updating the benefit cost analysis as described in the Economic Analysis section requires new depth data for input to the HAZUS analysis.

Flood event depth data will be developed for the entire floodplain from Pe Ell to Aberdeen for the baseline and with-project conditions. Data will be developed at a 30 x 30 foot grid. HEC-RAS model output will be post processed using GIS techniques to develop these data. Gridded ground elevation data developed from available LiDAR sources will be subtracted from water surface elevation grids for the 10-, 25-, 100-, and 500-year floods and the resultant depth grids will be provided digitally in GIS shape file format.

It should be noted that the most recent hydraulic analyses, conducted for the Chehalis River Basin Flood Authority, only evaluated the 100-year flood and the February 1996, December 2007, and January 2009 events. To develop the flood event data needed for the cost benefit analysis will require new modeling of the 10-, 25-, 100-, and 500-year events. The cost for this new hydraulic modeling is included in the estimate provided herein. However, it is assumed that any hydrologic data needed for this analysis is already available from the USACE General Investigations (GI) study. If additional hydrologic data development is required the costs could be higher than those shown below.

Estimated Cost: $75,000 - $125,000

Re-evaluate Statistical Hydrology (Optional)

The purpose of this task is to evaluate the historical record of flood events in greater detail to ensure that all significant flood patterns represented in the historical data are adequately captured by the simulation of the actual events of February 1996, December 2007, and January 2009, together with the theoretical design storms. In particular, this task will address the question of whether there is a reasonable possibility of extreme flood events that are focused in the Cascades and with only minor contributions from the Upper Chehalis basin. This evaluation will improve understanding of possible storm patterns (both spatially and temporally) over the basin and may lead to the development of additional hydraulic model inputs. The findings of this task might also be used in the development of the dam operations plan. This study is labeled optional as it is not required in Years 1-2 and may be completed in subsequent study years.

Estimated Cost: $25,000

Environmental

The environmental tasks for Study Years 1-2 focus on identifying the potential impact to fish and wildlife from the proposed structure. Also, additional information needs to be collected on water quality and sediment transport. The scope of the environmental studies was developed to collect the types of information needed during the early phase of the dam design process. The actual methods and study designs that will be used to gather the information will be refined upon future discussions with stakeholders. The work outlined below may be performed by WDFW or by contractors, depending on resources available within WDFW. The environmental studies proposed during the first study period are:

Collect Data on Fish Use in Reservoir Area and Mainstem Chehalis River

The work would include:

- Determine the composition, distribution, and abundance of fish and invertebrate species in the inundated reach and downstream. Monthly fish surveys will be conducted using various methods (netting, electrofishing, snorkeling, etc.). Invertebrate sampling would be less frequent and designed to identify community composition and species presence using various methods. In addition to sampling salmonids, the studies will also focus on collecting information on resident fish species and State-listed species of concern. The study objectives are to determine fish presence, distribution, abundance, and movement patterns to identify impacts and inform fish passage facility design alternatives using various methods. The species that will be targeted in the sampling will be determined after meetings with stakeholders. The non-salmonid species of interest could include northern pikeminnow, Olympic mud minnow, and brook and river lamprey, among others.
- Install a juvenile rotary screw trap on the mainstem Chehalis River at or above the location of the proposed dam to determine outmigrant age distribution, abundance and timing. This is needed to characterize smolt timing and abundance among years to: 1) capture how migration timing and magnitude varies with flow and environmental conditions, 2) gather information on species of interest to stakeholders, including species for which no data exists currently (summer steelhead, coastal cutthroat and lamprey), and 3) develop fish passage facility designs that will successfully pass adult and juvenile fish (location, type, and size of the facilities) and meet the mitigation requirements. To implement the smolt trapping study in 2013, the one year for which data will then be available to inform the dam feasibility discussions, the study would need to be funded no later than January 2013. This early start is needed to purchase components and build the rotary screw trap, locate an appropriate deployment site and obtain approval from the landowner to access the site, obtain necessary sampling permits, and hire appropriate staff. Starting in November 2012, the entity conducting the research should begin to survey potential deployment sites and initiate the permitting process. Long-lead time items for the trap will need to be ordered at this time as well. A large (8 foot diameter) trap cone and associated components (pontoons, clean-out doors, and cleaning drum) costs approximately $30,000 (personal communication between John Ferguson Anchor QEA and EG Solutions, Inc., Corvallis, Oregon, October 13, 2012). An additional $30,000 should be allocated to purchase or build additional trap components that will be needed (additional pontoons and trap structural reinforcements, a live box, and a custom trailer to transport the trap) and pay for labor costs associated with procuring the trap and trap components. The goal of this early start is to be able to place the trap in the river by late winter (February or March) to begin trap operations before the juvenile salmon outmigration begins, or as close to the beginning as is feasible.
- Determine adult salmon spawning timing, distribution and abundance through snorkel or boat surveys, spawner/redd/carcass surveys, including summer steelhead and coastal cutthroat trout.
- Design and conduct a juvenile fish telemetry study to investigate whether juvenile salmon move upstream during periods of warm water temperature to seek areas of cool-water refugia above the dam. If this is occurring and considered a key design

element, it will have to be incorporated into the design of the upstream passage facilities located below the flood control structure. This is a critical uncertainty of the design that needs to be informed, because providing upstream passage facilities for juvenile salmon has not been incorporated into the vast majority of upstream fish passage facilities at dams. Several telemetry technologies are available and could be used to gather this information, including passive integrated transponder (PIT) tags. PIT tags are the size of a grain of rice and are inexpensive (approximately $3/tag) compared to other telemetry tags that contain batteries and emit a coded signal. Radio tags for example cost approximately $250 to $300/tag. PIT tags are detected when the tagged fish swims near or over a specially designed array that emits a signal that activates the PIT tag, which then sends a coded signal to a receiver in the array, which is recorded.

- Determine the amount of off-channel habitat available for rearing along the mainstem Chehalis River, particularly overwinter rearing (which was not available in previous studies). The off-channel habitats are important rearing areas and information on the extent of off-channel habitats, the accessibility of the habitats, and the quality of the habitats would add certainty to the estimates of overwinter habitat availability that were used in the previous fish population model.
- Collect additional data in reservoir area to characterize existing habitat and for use in a Physical Habitat Simulation Model (PHABSIM) analysis.

Estimated Cost: $1,500,000 to $1,750,000.

Water Quality

The purpose of the first two years of the water quality studies are to further characterize water temperatures, dissolved oxygen (DO) and water quality throughout the mainstem Chehalis River. In previous studies, 8 temperature data loggers were placed in the river and monitored for about 7 months. The ownership of those data loggers was turned over to Ecology and additional monitoring was performed in 2012 however only 5 data loggers were still present in 2012. Monitoring would be continued through this time period and beyond. Additional data loggers would be employed to further characterize temperature and DO along the mainstem Chehalis and key tributaries. The number and location of the additional data loggers would be determined through collaboration with Ecology and Stakeholders. To assist in evaluating the temperature data collected and calibrate future water quality models, a synoptic flow measuring program is proposed. This flow measuring program will measure Chehalis River and tributary inflows and temperature in a downstream direction to characterize flow and temperature inputs and temperature increases from upstream to downstream. A component of flow in the Chehalis River is provided by groundwater. At the same time the synoptic flow measurements are performed, groundwater temperatures will be measured in existing wells to help quantify the effect of groundwater inflow on temperature in the Chehalis River. Additional water quality sampling to characterize nutrients, BOD and suspended solids will also be performed in conjunction with the temperature and DO monitoring program. An analysis of riparian shading will be performed using aerial photography, LiDAR and field reviews to characterize the extent of shading along the Chehalis River. All of these analyses will provide additional input necessary to characterize solar heating along the mainstem Chehalis River,

supplement fish use data in the Chehalis River and provide a solid database for future water quality studies.

Estimated Cost: $100,000 to $150,000

Sediment Transport and Geomorphology

The purpose of the first two years of sediment transport studies is to refine estimates of bedload transport to help define the size of project facilities (outlet discharge) and operations in order to minimize impacts to Chehalis River fish habitat. The work will be performed by obtaining and reviewing recently surveyed cross-sections (between Pe Ell and Doty) and river cross-sections downstream of Doty proposed to be surveyed in the task described as "Collect new channel cross-section data survey and update the hydraulic model" in the Hydrology and Hydraulics Studies section. Additional sediment data will be collected and the estimates of sediment transport and sediment input from the previous Fish Study updated. Sediment sources and landslide areas in and above the reservoir area will be identified for more detailed engineering evaluations of stability and potential for reservoir infilling. Bedload sediment transport data will be collected at key locations if possible during a high flow event. A report summarizing the results of the studies will be prepared. The key result of that report will be an understanding of the potential impact to gravel transport (and fish habitat) through the Chehalis River with the potential reservoir and the way the reservoir can be designed to minimize those potential impacts. In addition, the results of this analysis will assist in reviewing potential sedimentation issues in the reservoir that could be caused by operating a reservoir with fluctuating water levels.

Estimated Cost: $100,000 to $150,000

Habitat Mapping and Wildlife Studies

The purpose of the first two years of habitat and wildlife studies is to determine a baseline of species presence and abundance in and around the reservoir area. The focus of the effort will be on species that are considered threatened, endangered or candidates for protection under state or federal law. This will be important information for developing a complete understanding of the direct impacts associated with the project in support of SEPA and NEPA and analysis. A report summarizing the results of the field studies will be prepared. The report would also contain scoping comments provided by agencies and contain an approach for completing further wildlife analyses.

Habitat Mapping would be accomplished through a combination of remote sensing analysis and field calibration and verification. One particular focus of the mapping would be on wetland habitats due to their ecological importance, and legal protection under various Federal, state and local regulations. A better, more quantitative assessment of wetland habitats is important in understanding requirements and costs associated with direct wetland impacts. Wetlands will be mapped based on remotely sensed data including a project specific orthophoto. This should be a high-resolution, low altitude, color plus infrared image shot with established ground control targets to facilitate accurate ortho-rectification and classification. Color infrared

imagery should be acquired during fall senescence for capturing the maximum variation between vegetation species targeted for differentiation.

Upland Habitats will be mapped simultaneously based on vegetation, soils, slopes and geology. The purpose of this effort is to quantify the direct impacts of the project alternatives on birds and wildlife that use the proposed reservoir site. Mitigation for these impacts will vary depending on the species and habitats impacted and the magnitude of those impacts.

Field verification of habitat mapping will occur in two phases and in both cases be combined with bird and wildlife observation points. The first phase should occur early in the habitat mapping process and will inform that process. The goal of the field verification will be to refine and calibrate the methods used in determining habitat boundaries and habitat quality based on the available data. The second field verification effort would be focused on ground truthing the habitat maps, clarifying any conflicts or uncertainties and correcting errors. This effort will also be used to stratify the wildlife observation points to represent the range of habitat conditions present.

Habitat observation points will be used to document all observations of species and species use (e.g. tracks and scat) as well as vocalizations. A standard protocol should be adopted and a subset of observation points in each habitat type should be monitored early and late in the day as well as throughout the year in order to account for temporal variations in species presence and activity. A report summarizing the results of the field studies will be prepared. The report would also contain scoping comments provided by agencies and contain an approach for completing further wetland analyses.

Estimated Cost: $250,000 to $375,000

Permitting & Regulatory

The permitting and regulatory tasks are fairly minimal in Study Years 1-2. The proposed tasks provide permitting support to ongoing studies and monitor the progress of the project from a permitting and regulatory perspective. The proposed tasks for Study Years 1-2 for the permitting and regulatory function are the following:

Regulatory Review of Flood Control Only Permitting Alternative and FERC Licensing Alternative

The proposed project for both alternatives will be analyzed against the regulations of anticipated permits to determine any issues that would prohibit or challenge development of the project. Land ownership will be reviewed. A permitting matrix will be developed that links the environmental studies to the anticipated permits.

Estimated Cost: $10,000 to $30,000

Cultural Resource Review

- Background/context research to identify previously recorded resources in the vicinity and to better understand tribal interests in the location.

- Participation in occasional meetings/calls to advise the project proponents on appropriate consultation processes and assist with review of information gathered that may be relevant to cultural resource issues.
- Review gathered information in the context of multiple alternatives and recommend a preferred alternative from the cultural resource perspective (if there is any distinction).

Estimated Cost: $40,000-50,000

Agency Pre-Consultation

Begin pre-consultation with permitting agencies to confirm or revise the detailed list of permits and other regulatory requirements and conceptual cost estimates projected for years 3 – 5 and 6 – 8. Could either be one-one-one meetings with each agency or one large meeting with everyone or a combination of both to review permits, process, issues, etc.

Estimated Cost: $20,000 to $50,000

Economics

The economic tasks for Study Years 1-2 will focus on updating the benefit/cost analysis to determine if the one or both of the project alternatives are cost effective. As part of this update, it is proposed that the benefit/cost analysis methodology be reviewed and agreed upon prior to updating the data. In addition, additional studies are proposed to improve input to the economic benefit/cost assessment. The proposed economic tasks are the following:

Methodology Selection

Previous benefit/cost analyses for the flood retentions structures in the Chehalis River Basin have employed different methodologies. The U.S. Army Corps methodology was recommended in the Phase IIB analysis. The Army Corps methodology follows the 1983 *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G). While this methodology is used by the Army Corps of Engineers (and would most likely be required for future funding), it is also limiting regarding the types of costs and benefits that can be included. For example, monetized costs and benefits for environmental or other qualitative analysis are not included in a P&G analysis. The P&G methodology is also specific about excluding costs and benefits for future development within a flood plain. Also, the P&G methodology relies on a benefit/cost analysis based on a national perspective; therefore, regional costs and benefits such as lost business income or unemployment are not included in the final benefit/cost ratio. Lastly, the P&G methodology evaluates flood damage reduction benefits on an expected value basis so that avoided damages for a 100-year flood are discounted by the probability of a 100-year flood. For these reasons, it may be important to develop, or decide upon, an alternative methodology for evaluating the costs and benefits of the proposed structures.

Secondly, the 2012 draft report from the Ruckelshaus Center[2] suggested that costs and benefits for proposed projects be summarized in terms of net benefit rather than in terms of benefit/cost ratios. A net benefit approach would reveal which project provides the greatest net benefit regardless of the magnitude of the costs and benefits.

Next, the methodology selection process may include a discussion of how uncertainty and risk should be evaluated in the benefit/cost analysis. Uncertainty can be modeled stochastically (such as Monte Carlo simulation) or deterministically (for example scenarios analysis) depending on the data available. Incorporating uncertainty into the cost effectiveness analysis will illustrate the level of sensitivity associated with the benefit and cost estimates. Benefit and cost estimation as well as discount rates or study periods could be included in the uncertainty analysis.

Finally, the benefit/cost analysis methodology definition should include a description of the baseline, or without project condition. For example, qualitative or quantitative costs and benefits associated with environmental costs and benefits could be defined assuming current conditions as the baseline, or the environmental conditions targeted through the Washington Department Fish and Wildlife's restoration efforts.

The selected methodology will dictate the emphasis that is placed on the cost and benefit studies shown below. It is recommended that at least two technical meetings or workgroups be held with stakeholders in order to determine the preferred methodology for future benefit/cost studies. The first meeting should include a detailed explanation of the P&G methodology followed by a discussion of the pros and cons of the P&G methodology. Once the P&G methodology is understood, the workgroup would then develop the preferred methodology. A second workgroup meeting would finalize the drafted preferred methodology.

Interested stakeholders may include the local tribes, Washington State staff or government officials, Lewis County PUD staff, groups from the state universities, the Chehalis River Basin Flood Authority members, or Lewis County residents.

Estimated Cost: $30,000 to $55,000

Transportation Benefit Analysis

Flood reduction on the Chehalis River is expected to reduce the instances of Interstate 5 closures. The benefits can be measured in two ways:

1) The avoided cost to travelers of using alternate routes during closure events
2) The reduced cost of repair and improvement to Interstate 5 (protecting I-5)

These two avoided costs can both be included in a benefit-cost analysis; however, they cannot both be included concurrently. In the past, the avoided costs associated with trips diverted from I-5 during a closure have been included up until the time Washington State Department of Transportation (WSDOT) would have begun a project that would protect Interstate 5.

[2] Washington State University. Chehalis Basin Flood Mitigation Alternatives Report – DRAFT. August 9, 2012.

Trip Diversion Cost Estimation. The cost to the traveling public of I-5 closures requires an understanding of the travel characteristics and behavior on the route. WSDOT will be commissioning a separate and concurrent study that will improve our understanding of I-5 travel, including origins, destinations, trip purpose, value of traveler time, and suitability and management of alternative routes. It is anticipated that the results of this study will be available for others to use in considering flood damage reduction project benefits.

Interstate 5 Improvements Cost Estimation. A major component of the benefits estimated in previous studies included the avoided cost to protect Interstate 5. As this benefit is over one-third of the current estimated project costs, the cost and schedule to protect I-5 should be evaluated closely.

Proposed Studies. WSDOT is including a proposal to the Governor's office to evaluate the transportation disruption on I-5 due to Chehalis River flooding. It is anticipated that the outcome of the WSDOT study will be incorporated into subsequent benefit-cost analyses.

Estimated Cost: $150,000 and is included in WSDOT proposal to Governor's office.

Environmental Benefit and Cost Analysis (optional)

The purpose of the Environmental Benefit and Cost Analysis would be to monetize the costs and benefits of the proposed projects based on the operation plan developed. The study would include estimated costs and benefits compared with:

a) The current state of the Chehalis River Basin environment; and
b) The projected state of the environment based on current enhancement efforts.

Each structure will have different effects on the environment through changes in water quality, ecosystem type, barriers, habitat, and specie use. The goal of the Environmental Benefit and Cost Analysis is to identify the major changes and monetize the net value of those changes. It is anticipated that an Environmental Benefit and Cost Analysis would be studied subsequent to the environmental studies conducted in the first two years of the plan period. The Environmental Benefit and Cost analysis could be conducted using the ARIES tool. ARIES can be used to generate scenarios to explore changes in ecosystem service provision and use based on changes in ecosystem service supply or demand. In the case of the Chehalis River Basin, the ARIES model could be used to monetize changes in ecosystem habitat due to the construction of the proposed structures. ARIES also has the capability to evaluate the "with project" scenario in terms of climate change. The cost range presented reflects the level of detail required or number of scenarios analyzed. This study is optional as project planners may not require the increased detail provided by this study or the inclusion of monetary costs and benefits may not be part of the selected evaluation criteria.

Estimated Cost: $200,000 to $500,000

Recreation Study (optional)

The proposed structures may affect recreation activities downstream such as activities at fishing. A recreation study could be implemented to determine if significant negative or positive effects are expected. A recreation study would require input from the fisheries studies

in terms of the increase or decrease in fish stocks. This study is listed as optional since the net effects are expected to be low in comparison to the flood damage reduction benefits. It is recommended that if the study is not undertaken in Study Years 1-2 that a study be completed during Years 3-5 for inclusion in the Principles and Guidelines benefit/cost analysis discussed later. Also, a recreation study could be completed in Study Years 3-5. The low end of the cost estimate would be a recreation study that employs currently available information from the literature together with input from the fisheries studies. The high estimated cost would account for original research or survey work. The timeframe for this study is optional as it can be completed in Years 1-2 or Years 3-5.

Estimated Cost: $50,000 to $100,000

Benefit/Cost Study

The benefit/cost study will employ the selected methodology and results of the appropriate studies listed above. In addition, an updated estimate for flood damage reduction benefits will also be included. The methodology selected will dictate whether flood damage reduction benefits are calculated based on an expected value, or if another methodology is deemed more appropriate. For example, flood damage reduction benefits could be calculated using one event with 100 percent probability, or they can be calculated using several events according to the associated probabilities. The P&G methodology employs the latter methodology which can underemphasize the large costs associated with low-probability events.

The dam operation study will be an important factor in determining which costs and benefits should be included. For example, if the operation of the dam is designed so that minor flood events, or overbank flooding is allowed, then there may be little or no increased cost to agricultural production due to lack of nutrient deposits during flood events.

Flood Damage Reduction. In the Phase IIB study, flood damage reduction for building, contents, agricultural acreage, emergency costs, public assistance, and the amount of debris was estimated using FEMA's HAZUS model. The HAZUS model uses regional inputs such as census block data and hydrology input to estimate the level of flood damage for a particular event. The difference in flood damages between with and without project scenarios is the project benefit. The project benefits were calculated for several flood return intervals including 10, 50, 100, and 500 year events. The expected annual benefits were estimated based on the probability of each flood event and the flood reduction benefits calculated. This methodology was well-received, and; therefore, it is recommended that the HAZUS model be used for future flood damage reduction analyses.

Depth data will be needed from the hydraulic studies; costs to develop the depth data are included in the H&H studies in this section.

Power Supply. Under the multi-purpose project scenario, capacity and energy would be available. In the past, the energy value was monetized according to market prices with some renewable component under Washington State's Renewable Portfolio Standards. Based on the operation plan, the value of energy and or capacity should be updated according to appropriate methodology.

In addition to the power supply benefits, operation and maintenance costs for both structure types should be estimated and included in the benefit/cost analysis.

Benefit/Cost Analysis. The benefit/cost analysis refers to the specific modeling required to develop the cost-effectiveness metric (benefit/cost ratio, net benefit, or other). The preferred benefit/cost methodology selected will determine how flood damage reduction benefits are calculated in future studies. It is assumed that flood depth levels will be provided by the hydraulic engineers for use in HAZUS or similar model. The cost estimate for the benefit/cost analysis assumes relevant studies have been completed and includes only the addition of flood damage reduction benefits or other study benefits identified in the preferred benefit/cost methodology. The uncertainty in the cost estimate below is based on the uncertainty regarding which benefits and costs will be included under the preferred methodology, which has not yet been decided. Possible benefits and costs may include the following:

1. Property Values
2. Intrinsic or other non-use or cultural value
3. Economic Losses (direct or indirect)
4. Emotional hardship or public safety
5. Environmental benefit and costs

Other costs and benefits may be identified in the methodology study. The cost estimate has a wide range due to the uncertainty in methodology selection. Specifically, the following factors may affect the cost to conduct the benefit/cost study: the number of flood return intervals evaluated; type of uncertainty analysis (stochastic i.e. Monte Carlo or deterministic); inclusion/exclusion of benefits and costs such as environmental effects; meetings or stakeholder involvement; or other methodology components not described in this document.

The low cost estimate assumes the same methodology used in previous studies with updated data only. The high cost estimate assumes several other studies including environmental costs and benefits will be included in the analysis. The low end of the estimate assumes that the benefit-cost analysis will be a simple update to the Phase IIB analysis.

Estimated Cost: $65,000-$200,000

Qualitative Research Study (optional)

It may be beneficial to the State and local governments to evaluate how residents in the Chehalis River Basin view the proposed structures. Qualitative research professionals can assist in developing qualitative research insights, results, and facilitate communication about the project. A qualitative research study will help decision-makers understand resident's views regarding the cost of the project, environmental and social impacts, alternatives, and the estimated benefits. A comprehensive qualitative research program may include focus groups or surveys of members of the community.

The goal of qualitative analysis is an objective facilitation that combines guiding principles/beliefs, core values, and cultural and social influences into commonalities and differences. This study is optional and for informational purposes only.

Estimated Cost: $40,000 to $60,000

Summary of Study Years 1-2

The objective of this first study period is to identify fatal flaws and to define the Preferred Alternative. At the end of this first study period, the interested parties in the Chehalis Basin and at the State of Washington should have the information needed to decide whether or not to move forward with one of the proposed structure configurations. The studies would identify the preferred alternative, determine if it is cost effective and identify environmental mitigation needed going forward. As can be seen from Table 1, the estimated budget for Study Years 1-2 range from $3.7 million to $5.7 million.

Table 1 Study Period Years 1-2 Cost Summary			
Study	**Notes**	**Low Estimate**	**High Estimate**
Engineering			
Fish Passage Design		$150,000	$300,000
Dam Design Study		$100,000	$300,000
Evaluate & Compare Structure Alternatives		$150,000	$200,000
Geotechnical			
Conceptual Design Meetings and Support		$50,000	$100,000
Hydrology & Hydraulics			
Review Doty Gage Data		$50,000	$50,000
Channel Cross-Section Survey/Hydraulic Model		$80,000	$200,000
Reservoir Operations Plan		$150,000	$150,000
Update Flood Depth Data		$75,000	$125,000
Re-evaluate Statistical Hydrology	Optional	$25,000	$25,000
Environmental			
Collect Data on Fish Use		$1,500,000	$1,750,000
Water Quality		$100,000	$150,000
Sediment Transport & Geomorphology		$100,000	$150,000
Habitat and Wildlife Studies		$250,000	$375,000
Permitting & Regulatory			
Review Regulatory and FERC Licensing for Alternatives		$10,000	$30,000
Cultural Resource Review		$40,000	$50,000
Agency Pre-Consultation		$20,000	$50,000
Economics			
Methodology Selection		$30,000	$55,000
Transportation Benefits Analysis		$0	$0
Environmental Benefit and Cost Analysis	Optional	$200,000	$500,000
Recreation Study	Or Phase 2	$50,000	$100,000
Benefit/Cost Study		$65,000	$200,000
Qualitative Research Study	Optional	$40,000	$60,000
Subtotal Excluding Optional Tasks		*$2,920,000*	*$4,235,000*
Subtotal Including Optional Tasks		*$3,235,000*	*$4,920,000*
Public Involvement		$150,000	$350,000
Project Management[1]	10%	$292,000	$423,500
Grand Total Excluding Optional Tasks		**$3,362,000**	**$5,008,500**
Grand Total Including Optional Tasks		**$3,677,000**	**$5,693,500**

1. 10 percent of all costs excluding permit fees and services during construction.

Study Plan Years 3-5

Introduction

The second phase of the study period (January 2015 through December 2017) will include studies needed to develop the preliminary design of the selected structure purpose and will move the project concept toward a "preferred alternative" designation needed for the permitting process in the final design phase (Study Years 6-8). The questions answered in this phase depend on whether a flood control only or multipurpose structure is selected at the end of Year 2. Questions studied may include the following:

- What is the size and configuration of the spillway and tunnel?
- Depending on the fish passage alternative selected, how should the facilities be designed/modeled in order to optimize existing conditions and hydraulic characteristics both upstream and downstream of the dam?
- What materials are available for dam construction?
- Based on preliminary designs, what are the current refined best estimates for dam and fish passage costs?
- What flow conditions are expected at the dam site? And, what is the effect of flow augmentation downstream?
- If storage is available, how should the storage be used to best improve water quality downstream of the dam for fish?
- What is the current state of fish and wildlife habitat, water quality, and sediment transport on the Mainstem Chehalis River?
- What are the current uses near the dam site: recreational, cultural, archeological, rare plants?
- Given best available cost information, is the selected project expected to provide net benefits?

The studies below describe in greater detail what would be required to bring the selected project toward a final design phase.

Engineering

Once the structure alternative has been determined, the Engineering tasks will focus on designing the spillway, tunnel, fish passage components of the dam. Concurrently, the preliminary design of the main dam structure would be completed. The engineering tasks for Study Years 3-5 are the following:

Dam Spillway and Tunnel Design Study

Spillway. Study spillway alternatives to determine the best combination of storage capacity and spillway capacity based on estimates of the probable maximum flood (PMF) outflow. Determine the peak outflow by routing the PMF through the reservoir. Determine whether the spillway should be controlled by gates or uncontrolled. Evaluate and compare the benefits and

costs of the spillway alternatives. Determine height of dam required based on spillway capacity and flood elevations. Determine the spillway location, spillway structure configuration and requirements, and discharge channel requirements.

Tunnel. Develop facilities operational criteria and design criteria to recommend size and shape of bypass tunnel. Consider operations for dam construction, fish passage, sediment transport, normal and flooding conditions, hydropower, water quality, etc. Develop preliminary design layouts, data, and information for method of control and regulation of the tunnel. The size and shape of the tunnels will be known based on the outcome of this study.

Estimated Cost: $290,000-$375,000

Fish Passage System Hydraulic Model

Depending on the complexity of the selected fish passage facilities, advanced hydraulic modeling using Computational Fluid Dynamics (CFD) or physical modeling systems may be required. In general, these models would be used to optimize the hydraulic conditions approaching a fish passage facility, particularly for downstream passage facilities. For upstream passage where unique hydraulic conditions might occur such as fish barriers or passage through conduits, a hydraulic model study would be used to confirm the hydraulic conditions to ensure effective passage conditions are maintained throughout the facility. For the flood retention structures, this study would rely on the availability of a hydraulic model of the downstream passage facilities as well as the hydraulic conditions at the upstream passage facility.

Upstream Passage Estimated Cost: $250,000 - $350,000

Downstream Passage Estimated Cost: $350,000 - $600,000

Fish Passage Preliminary Design

With the completion of the hydraulic modeling and refined design layouts, the fish passage facility design would be advanced to approximately a preliminary level of completion. The design effort would be conducted in concert with the flood retention structure design to ensure effective integration between the two structures physically as well as operationally. The preliminary design package would then be used to support the environmental and permitting work efforts. Updated cost estimates, construction reviews, value engineering studies, and constructability review would be completed at this stage of the design completion.

Upstream Passage Estimated Cost: $250,000 - $400,000

Downstream Passage Estimated Cost: $400,000 - $700,000

Dam Preliminary Design

This task would use the information developed from geotechnical, fish passage, tunnel, and spillway studies to develop preliminary layouts and drawings of the principal structures. A project design criteria document would be developed to establish the basis of design of each project feature. This document would incorporate the results of the previous tasks.

Estimated Cost: $250,000-$500,000

Geotechnical

It has already been determined that a structure can be safely built at or near the proposed site. Geotechnical work during the second study phase will consist primarily of field investigations, laboratory testing, and analyses associated with developing the preliminary design. The studies will also allow for refinement of the construction cost estimates for various project alternatives. If geotechnical input to the cost estimates is a concern for decision-makers prior to Year 3, some of the geotechnical studies in Study Years 3-5 can be moved up to Study Years 1-2.

Preliminary Design

We anticipate that the majority of the geotechnical studies will occur in Study Years 3-5. These will include subsurface explorations, geophysical surveys, field testing, laboratory testing of specimens collected from the field investigations, and geological and engineering analysis.

The primary purpose of geotechnical studies during the Study Years 3-5 will be to support preliminary design of the dam, reservoir and project features. These studies will include furthering the understanding of subsurface conditions (soil, bedrock, and groundwater), address landslide potential above the dam, developing design alternatives, and performing preliminary engineering. Geotechnical studies would also be performed to aid in assessing soil erodibility and water loss due to infiltration, for water quality and water rights studies.

Questions to be answered include (but are not limited to):

- What is the total available volume of borrow material, how is the volume distributed (by material type), and how much processing will be required?
- Based on the engineering properties of the available borrow materials, what will be the geometry of the dam? This includes the slope of both the upstream and downstream face, and (for an earthfill or earthfill-rockfill dam), internal zonation, and internal seepage and drainage zones.
- How much excavation will be required within the dam footprint to remove existing landslide debris, and how will this affect the volume of material required construct the dam?
- How will seepage through foundation and abutments be controlled?
- What are the site-specific response characteristics for seismic events?
- How do geotechnical issues influence various design alternatives, such as siting of the spillway, design of the intake structure and outlet works, and fish passage facilities?
- What engineering and construction measures are necessary for the proposed dam and facilities?
- What is the potential for increased landslides and the potential volume of material that would be mobilized into the reservoir area?

The work would likely be completed in phases over the three-year period. Each phase would be performed to fill in information gaps to address questions or considerations identified during evolution of the dam design.

Field Studies. The purpose of field studies in Study Years 3-5 is to gather information necessary to develop the preliminary design. This information will also allow us to identify better quantify the geotechnical engineering challenges at the site and assess the impact of these challenges on the overall project cost. Specifically, field studies are intended to investigate the type, availability, and suitability of locally-sourced materials for dam construction and to characterize the dam foundation and abutments with regard to dam safety considerations such as dam stability, dam and foundation seepage, abutment stability, and foundation and abutment preparation requirements.

We envision the following scope of work:

Mapping of existing landslides and areas of potential slope instability in proximity to the proposed dam site. This will update the work completed in 2009 and include review of information collected during Sediment study in Years 1-2.

- Mapping and low-impact explorations (such as hand auger borings) within potential borrow areas for fine-grained material located downstream of the proposed dam site.

- Geophysical (seismic refraction) surveys at the locations of mapped landslides within and adjacent to the dam footprint.

- Geophysical (seismic refraction) surveys to investigate potential borrow areas within the reservoir area.

- Geophysical (seismic refraction) surveys of selected deep-seated mapped landslides around the reservoir perimeter. This work would be performed to partially address a comment by DSO regarding the potential for increased turbidity and sediment accumulation in the reservoir associated with localized instability around the reservoir rim.

- Borings to investigate the large landslide identified in the right abutment of the dam and the landslide identified along the downstream left groin area. This work will complement and build upon the geophysical surveys and help estimate volume of excavation required to prepare the dam foundation.

- Borings and test pits to investigate potential borrow areas within the reservoir. This work will complement the geophysical surveys. Laboratory testing of collected samples will allow for assessment of the suitability of potential borrow for the various materials that will be needed for dam construction. The explorations will also allow for estimation of the potential volume of suitable material available for comparison against the volume required to construct the dam.

- Borings in the valley bottom within the dam footprint to investigate the nature of the foundation bedrock. These borings will also be used to quantify the amount of material that will need to be excavated for the dam foundation. Packer testing, downhole geophysical testing, and video-logging in some of these borings will provide additional information, as discussed below.

- Borings in the dam abutments to characterize the nature of the abutment bedrock. Similar to the valley bottom borings, packer testing and downhole geophysical testing, and video logging will be performed in some holes to gather more information. Additionally, observation and laboratory testing of rock core recovered from the borings will help identify potential challenges associated with excavation of a spillway channel.

- Borings to investigate subsurface/foundation conditions for key appurtenant features, including planned locations for the intake structure, outlet tunnel/ conduit, diversion facilities, overflow spillway, fish passage facilities.
- Packer testing in selected borings in the dam foundation and abutments. Packer testing is used to characterize bedrock quality, fracturing, and to assess the potential for seepage through the rock mass.

- Downhole seismic shear wave velocity testing in selected borings. This information will be used for earthquake engineering and other geotechnical analyses.

- Video-logging of selected borings using a downhole optical or acoustic televiewer. This instrument creates an oriented “virtual core” that can aid rock characterization, rock mass stability assessment, and seepage evaluations.

- Installing vibrating wire piezometers and wells in selected borings to obtain groundwater data for use in assessing groundwater conditions. Groundwater information would be used for design, assessing construction challenges associated with groundwater, and to assess potential groundwater regime changes that may result from the dam and reservoir. Data loggers may be installed to automatically collect and record piezometeter data to allow assessment of seasonal variations in groundwater levels.

Laboratory Testing. Laboratory testing during the Study Years 3-5 preliminary design phase will be a combination of index testing and engineering properties tests to provide data for dam design and analysis. Testing for engineering properties may include triaxial and direct shear testing of soil under various conditions (drained, undrained, and cyclic loading); hydraulic conductivity, unconfined compressive strength of bedrock materials, abrasion and durability (for rock to be used an riprap or processed for aggregate), and soil susceptibility to dispersion (erosion), among others.

Analysis and Engineering. Significant engineering analysis will occur during the Study Years 3-5 preliminary design phase of the work. The analyses will include, but not be limited to:

- Evaluating soil samples, rock cores, video logs, and the results of downhole tests.
- Developing geologic profiles at the dam site based on the information gathered from the borings and geophysical surveys.
- Characterizing the volume and type(s) of available locally-sourced borrow materials for dam construction.
- Assessing the suitability of the available borrow materials (both soil and rock) for use in various parts of the dam, such as fill for the dam structure, filters and drains, riprap, concrete aggregate, etc.
- Reassessing the types of dam construction suitable for the site and construction challenges and considerations for each suitable dam type, e.g. zoned earth fill, rock fill, or roller compacted concrete.
- Identifying engineering solutions that are likely to be needed, including the volume of landslide and other material to be excavated from the dam foundation and abutments, measures required to stabilize slopes, outlet tunnel and conduit construction options, and foundation and abutment seepage control alternatives.
- Assessing seismotectonic hazards by completing a fault and ground acceleration study (more in-depth that what was included in the reconnaissance-level document).
- Completing a site-specific response spectra analysis to develop design parameters for resisting earthquake effects. Response spectra will be used in analysis required to design embankments, slopes, structures, and other project features.
- Evaluating stability of temporary abutment excavations, dam structure, dam foundation, dam abutments, and reservoir slopes.
- Evaluating seepage and feasible methods for seepage cutoff and abutment drainage.
- Developing foundation designs for various structures (such as the spillway).
- Designing underground elements of the project (such as an outlet works or diversion tunnel), if included in the design.
- Assisting with evaluation of alternatives for various elements of the project.
- Design of the temporary diversion structures.

- Design of features associated with fish bypass.
- Periodic re-evaluation of project costs.

Field and Laboratory Work Estimated Cost: $3,700,000-$5,200,000

Analysis & Engineering Estimated Cost: $1,700,000-$2,400,000

Hydrology & Hydraulics

During Study Years 3-5 H&H tasks will focus on continued support to the preliminary engineering design (sizing of outlet works, fish passage facilities, spillway design, etc) and hydrologic analysis related to dam safety. The two proposed H&H studies for Study Years 3-5 are as follows:

Refinement of Dam Operations Plan

This objective of this task is to review and refine the Operations Plan developed during the Conceptual Design phase. Information gained during years 1-2, including potential opportunities to reduce project impacts and increase project benefits will be used to update the dam operations plan. The existing HEC-ResSIM operations model will be updated and used to review these potential alternative operational concepts to determine which conditions would optimize benefits of the dam. Existing hydrologic data or data from the proposed hydrologic model will be used as input to the HEC-ResSIM model. Proposed operations will be will be summarized in an operations plan, which will inform the design and cost estimate of spillways, outlet structures, and fish passage facilities at the dam.

Estimated Cost: $50,000

Hydrologic Model Development

Preliminary sizing and cost estimates of the dam outlet works, spillways, and fish passage facilities can likely be prepared using currently available hydrologic data (through transposition and analysis of existing USGS gage data). However, refinement of the engineering design of these project elements will require more detailed and accurate hydrologic data. In particular, design of fish passage facilities will require accurate, site-specific flow data across a wide range of flows and sizing of the project spillway will require analysis of extreme flood events. These analyses necessitate hydrologic modeling of the watershed upstream of the dam. The probable model for this analysis is HEC-HMS, the US Army Corps software for hydrologic (rainfall/runoff) modeling, although this assumption will need to be confirmed in consultation with agencies and stakeholder groups.

A hydrologic model would be developed for the basin area tributary to the proposed retention dam. The model would be extended downstream as far as Doty to allow calibration to data from that gage. Additional data for model calibration may also be available for the Chehalis River below Thrash Creek from the current Flood Authority Early Flood Warning System project.

The hydrologic model would be calibrated to available flow data and then used to simulate long-term conditions (flood frequency events and seasonal flows) as necessary for design of the

project. At a minimum it is anticipated that the 2-, 10-, 25-, 100-, and 500-year floods would be simulated. In addition, the model would be used to re-evaluate estimates of low flow hydrology at the dam site and, if necessary, continuous hydrologic modeling would be conducted to improve low flow analyses. The lower end of the cost range below assumes event based modeling only while the upper end assumes continuous modeling as well.

In addition to the work described above the hydrologic model will be used to evaluate effects of projected climate change on future hydrologic conditions. This information can then be used in the development of a dam operations plan improving resiliency of the plan.

Estimated Cost: $75,000-100,000

Hydrologic and Hydraulic Dam Safety Analyses (Washington DOE or FERC)

Engineering design of the dam will require dam safety analyses. If the dam is to be a multipurpose facility with hydropower it will go through the FERC licensing process and will require a dam break routing study, a Probable Maximum Flood (PMF) Study, and development of an Emergency Action Plan (EAP). If the facility is to be a single purpose flood control project, it would require permitting under the Washington Department of Ecology (WDOE) Dam Safety Office (DSO). This would require WDOE Dam Safety Analyses including dam break routing, consequence rating, risk based inflow design flood (IDF) analysis, and an emergency action plan. Thus, although the permitting processes followed for the single and multi-purpose dam would be quite different the hydrologic and hydraulic studies required would be very similar.

Assuming the Flood Authority hydraulic model is refined as described in a separate study scope, and a hydrologic model of the upstream basin is developed and calibrated as described above, these tools would form an adequate basis for the dam safety studies. Dam break routing studies would be performed for the reach between the dam and the downstream location where the dam break flow would be fully contained within the 100-year floodplain. PMF or IDF modeling and analysis would be conducted as per the relevant FERC or WDOE technical guidance. Regular communication and coordination with the relevant agency would be conducted throughout the dam safety study.

An EAP would be prepared to identify agencies and landowners who would be notified in the event of issues at the dam. This would include all landowners in the potential dam break flood inundation area and relevant regulatory and emergency planning agencies. The EAP would conform to the relevant FERC or WDOE guidelines.

Note that the cost estimate provided below only covers the studies described herein. Additional dam safety analyses, for example geotechnical and seismic studies will also be necessary. Those studies are described elsewhere in this document.

Estimated Cost: $75,000-150,000

Environmental

The environmental tasks for Study Years 3-5 focus on continued data collection on fish use and refinement of the fisheries impact and mitigation. In addition, studies scoped by the agencies, such as additional water quality studies, sediment studies and wetland and riparian studies will

have to be completed. The proposed environmental studies for Study Years 3-5 are the following:

Fisheries Studies: Collect Data on Fish Use in Reservoir Area and Mainstem Chehalis River

For Study Years 3-5, the important task is to continue monitoring fish usage described in Study Plan Years 1-2 to incorporate variability among years in environmental conditions and fish population abundance. The first three years of data collected on fish presence, abundance, distribution and movement is needed to identify impacts and develop dam and fish passage design alternatives. The next two years of data collected on these objectives is needed to further refine the dam and fish facility designs, and develop the operational plans for the passage facilities. In addition, during Study Years 3-5, studies have been included that address whether potential levels of predation and disease issues associated with the multipurpose dam option (which incorporates a reservoir into the design) are a significant concern. The work would include:

- Determine the composition, distribution, and abundance of fish and invertebrate species in the inundated reach and downstream. Monthly fish surveys will be conducted using various methods (netting, electrofishing, snorkeling, etc.). Invertebrate sampling would be less frequent and designed to identify community composition and species presence using various methods. In addition to sampling salmonids, the studies will focus resident fish species and State-listed species of concern. The study objectives are to determine fish presence, distribution, abundance, and movement patterns to identify impacts and inform fish passage facility design alternatives using various methods. The species that will be targeted in the sampling will be determined after meetings with stakeholders, but could include northern pikeminnow, Olympic mud minnow, brook and river lamprey, among others.
- Continue operating a juvenile rotary screw trap on the mainstem Chehalis River at or above the location of proposed dam to characterize outmigrant age distribution, abundance and timing. This is needed to characterize smolt timing and abundance among years to: 1) capture how migration timing and magnitude varies with flow and environmental conditions, 2) gather information on species of interest to stakeholders, including specie for which no data exists currently (summer steelhead, coastal cutthroat and lamprey), and 3) develop fish passage facility designs that will successfully pass adult and juvenile fish (location, type, and size of the facilities) and meet the mitigation requirements.
- Determine adult salmon spawning timing, distribution and abundance through snorkel or boat surveys, spawner/redd/carcass surveys, including summer steelhead and coastal cutthroat trout,.
- Conduct additional juvenile fish telemetry studies to investigate whether juvenile fish move upstream during periods of warm water temperatures to seek area of cool-water refugia above the dam. If this is occurring and considered a key design element, it will have to be incorporated into the design of the upstream passage facilities located below the flood control structure.

- Assess the potential for predation in the reservoir that is a component of the multipurpose dam alternative to affect juvenile salmon abundance and population productivity. Predation by native or introduced resident fish species (bass and northern pikeminnow), piscivorous salmonids (bull and coastal cutthroat trout), and birds could be higher in the reservoir than the free flowing river alternative. The potential for this loss to occur will be estimated from studies conducted in similar-sized reservoirs in other river systems.
- Similarly, assess the potential for disease outbreaks to occur in juvenile salmon passing through or rearing in the reservoir that is a component of the multipurpose dam alternative. Warm water temperatures associated with the reservoir may result in outbreaks of infectious diseases. Estimate any effect on juvenile salmon abundance and population productivity. The potential for this loss to occur will be estimated from studies conducted in similar-sized reservoirs in other river systems where salmonid rearing is known to occur and has been studied. One such example is the River Mill Dam, Faraday Powerhouse and Dam, and North Fork Dam complex on the Clackamas River, Oregon owned by Portland General Electric.

In addition, coordination will be provided for EIS and other permitting assistance.

Estimated Cost: $2,250,000 to $2,625,000

Fisheries Impact and Mitigation Studies

For Study Years 3-5, the impacts of the reservoir and its operation should be better characterized and mitigation strategies developed and cost estimates prepared. The work would include:

- Conduct studies to refine estimates of impacts and the mitigation or enhancement required. Those studies may include the application of a fish population models that will be further calibrated to the Chehalis River using additional fisheries, water quality and geomorphology data collected in Study Years 1-2 and 3-5. The fish population model may also be extended to tributaries that would be the focus on enhancement to better estimate the potential benefits from mitigation or enhancement, and species other than those previously modeled once data is available for model parameterization.
- Develop a final mitigation/enhancement strategy for dam impacts and estimate cost.

Estimated cost: $300,000 - $500,000

Water Quality

For Study Years 3-5, temperature and DO monitoring would be continued and the temperature and DO model of the proposed reservoir will be updated and further calibrated using the additional information available. A new temperature and DO model of the Chehalis River will be prepared using CE-QUAL-W2 or similar software accepted by Ecology. The choice of model will be determined by the reservoir alternative selected and the extent of data collected in years 1-2. The models will be used in conjunction with the hydrologic models to help the design team optimize the operations of the reservoir. The temperature and DO models will be used to characterize the benefits and impacts of the selected reservoir alternative. The analyses will be

performed to meet Washington State Department of Ecology 401 certification requirements and will be used in the Environmental Impact Statement (EIS) and Federal Energy Regulatory Commission (FERC) licensing documents and permit applications for the project as needed. Assistance in permitting will be provided. In addition, climate change impacts will be analyzed for the reservoir using results of modeling performed by the Climate Impacts Group at the University of Washington.

The scoping comments may request additional water quality parameters such as nutrients or BOD be analyzed in Study Years 3-5 with the water quality models. The study plan for Study Years 1-2 provided for enough data collection to characterize existing conditions and calibrate an existing conditions water quality model for the Chehalis River. The model selected and used in Study Years 3-5 for the water quality analysis will need to have the capability to analyze additional water quality parameters such as nutrients and BOD. The results of this study will be used in support of the Section 401 certification request (discussed in permitting section). This task may be greatly reduced in scope and budget if the multi-purpose reservoir alternative is not selected as the recommended alternative.

Estimated Cost: $400,000 - $600,000

Sediment Transport and Geomorphology

For Study Years 3-5, additional studies scoped by agencies will be performed. This may include preparing a sediment transport model of the Chehalis River. The information collected and produced will be used in the fisheries analyses. Also, the analyses will be used in the EIS and FERC licensing documents and permit applications for the project as needed. Assistance in permitting will be provided.

Estimated Cost: $200,000 - $400,000

Downstream Wetland and Riparian Studies

The purpose of the year three study of wetland and riparian habitats is to inventory wetlands and establish a baseline of the extent and quality of these wetlands. The purpose of the year four analysis would be to predict the indirect impact to these wetlands resulting from anticipated flow changes. The study area would be from the reservoir downstream to approximately the City of Centralia, where the hydrologic effect of the proposed reservoir may diminish to the point of not having much potential effect on wetlands.

The work is proposed to be performed using aerial inventory with color infrared photography which can be combined with existing LiDAR and high-resolution aerial photos to identify wetlands in the study area (similar to the Year 1-2 study of the reservoir and dam site). The study area will need to be negotiated with agencies, and field verification would be performed to refine the wetland mapping. Wetland mapping would include vegetation and hydrogeomorphic classification of the wetland (Cowardin and HGM Class) of potentially affected wetlands. At key wetlands that may potentially be affected by the change in Chehalis River flow regime, monitoring will be performed. Piezometers will be installed and transects established through the wetland to document existing conditions. The piezometers will be

monitored for at least one year. Water levels recorded will be compared to river water surface elevations.

Estimated Cost: $325,000 - $400,000

Permitting & Regulatory

Once the preferred alternative is chosen, preparations will need to begin on coordinating the studies and consultations with the agencies. It should be noted that it is difficult to estimate permit requirements when the project design and operation have not been determined yet or what the agencies will require once an application is submitted. Below are descriptions of what would be anticipated for year 3-5 in terms of permitting based on our understanding of the proposed alternatives and current regulations.

Permitting related to Subsurface Explorations and Installing Scientific Measuring Devices

Any permitting activities required to implement studies from other resource areas.

Estimated Cost: $10,000 - $20,000

Permitting Process for Flood Control Only Dam Alternative

The permitting process for the flood control only alternative includes the following:

- Review activities that require a permit under Section 404 of Clean Water Act (CWA)
- Arrange pre-application meeting with US Army Corps of Engineers (USACE) and other permitting agencies. (More than one may be required.)
- Prepare and Submit JARPA and any other supplemental materials to USACE to begin Section 404 Permit process
- Conduct NEPA and SEPA processes (assumes EIS rather than EA) and additional resource studies:
- Prepare project description, maps, and alternatives description for public scoping
- Public scoping process: Prepare public notices and distribution list, publish and mail notices
- Coordinate additional environmental surveys/studies:
    - Cultural/archaeological ($225,000-$270,000)
    - Rare plants, noxious weeds ($75,000-$250,000)
    - Recreation use ($10,000-$100,000)
    - Additional studies that result from the scoping process ($10,000-$500,000)
- Coordinate tribal consultation process (e.g., by USACE)
- Prepare Draft EIS (one internal review and one final Draft EIS)
- Prepare public notices and distribution list, publish and mail Draft EIS for public review
- Review and catalog public comments, prepare draft responses to comments for internal review
- Prepare Final EIS (one internal review and one final Final EIS)
- Submit CWA 401 Water Quality Certification Request to Ecology
- Prepare Record of Decision (ROD), publish the notice and mail ROD to distribution list

- Ecology issues 401 Certification
- COE Issues Section 404 Permit

Estimated Cost: $1,000,000 - $2,500,000

Permitting Process for Multipurpose Dam Alternative

Permitting the multipurpose dam alternative assumes that the Federal Energy Regulatory Commission (FERC) Integrated Licensing Process (ILP) will be used as opposed to either the Traditional or Alternative Process. It is important that all parties understand the fast moving timeframe and consultation requirements from the Applicant, agencies and public prior to its start. The permitting process for the multipurpose alternative includes the following:

- Prepare and submit Water Right Application and Reservoir Permit Application to Ecology
- Apply for a Preliminary Permit from FERC
- FERC issues notice of application for preliminary permit, receives comments from public/agencies, issues preliminary permit with unique FERC project number. This usually takes 3-6 months, depending on comments received.
- Begin gathering existing information on the project to be used in the Pre-Application Document (PAD) and formulating study plans.
- Arrange pre-consultation meetings with USACE and other permitting agencies to help gather any existing information, identify issues, educate about the FERC process and proposed timeline.
- Begin FERC licensing process (ILP)
    - Prepare and Submit Notice of Intent to file an Application and PAD
    - FERC will begin NEPA Scoping Process (Scoping Document 1, Scoping Meetings/Site Visit, Scoping Document 2)
        - Provide comments to FERC on Scoping Document 1, attend meetings/site visit
    - Prepare and Submit Proposed Study Plans
- Once FERC approves Proposed Study Plans, conduct the studies and report results. Coordinate additional environmental surveys/studies:
    - Cultural/archaeological ($225,000-$270,000)
    - Rare plants, noxious weeds ($75,000-$250,000)
    - Recreation use ($10,000-$100,000)
    - Additional studies that result from the scoping process ($10,000-$500,000)
- Prepare Draft License Application or Preliminary Licensing Proposal
- Review and catalog public comments, prepare draft responses to comments for internal review

- Finalize, prepare and submit Final License Application
- Submit CWA 401 Water Quality Certification Request to Ecology
- FERC Completes NEPA Process as well as ESA, NHPA, CWA 401

Estimated Cost: $1,000,000 - $3,000,000

Economics

Benefit/Cost Study

The Benefit/Cost study in Study Years 3-5 will include any updates from the other study disciplines during that period including updated construction cost estimates, fish and wildlife mitigation, hydraulic modeling, and environmental effects (if appropriate). This benefit/cost study will follow the same methodology employed during the first two years of the 8 year study period. In addition, the Principles & Guidelines benefit/cost methodology will be conducted in order to determine if the project is cost effective from a national perspective and, therefore, eligible for federal funding. Costs and benefits will be updated as they are developed in preliminary design or identified with additional study such as improved hydraulic modeling.

Estimated Cost: $65,000-$100,000

Summary of Study Years 3-5

The studies described in this section provide significantly more certainty regarding cost and design criteria required to bring the selected project toward final design and ultimately construction. Given the work completed in this study period, final design elements can be completed in Study Years 6-8. Table 2 summarizes the cost estimates provided in this section. These costs range from $13.5 million to $20.8 million.

Table 2 Study Period Years 3-5 Cost Summary			
Study	**Notes**	**Low Estimate**	**High Estimate**
Engineering			
Dam Spillway & Tunnel Study		$290,000	$375,000
Fish Passage System Hydraulic Model		$600,000	$950,000
Fish Passage Preliminary Design		$650,000	$1,100,000
Dam Preliminary Design		$250,000	$500,000
Geotechnical			
Preliminary Design: Field and Laboratory Work		$3,700,000	$5,200,000
Preliminary Design: Analysis and Engineering		$1,700,000	$2,400,000
Hydrology & Hydraulics			
Refinement of Dam Operations Plan		$50,000	$50,000
Hydrologic Model Development		$75,000	$100,000
Hydrologic & Hydraulic Dam Safety Analysis		$75,000	$150,000
Environmental			
Collect Data on Fish Use		$2,250,000	$2,625,000
Fisheries Impact and Mitigation Studies		$300,000	$500,000
Water Quality		$400,000	$600,000
Sediment Transport & Geomorphology		$200,000	$400,000
Downstream Wetland & Riparian Studies		$325,000	$400,000
Permitting & Regulatory			
Either: Permitting Process Flood Control Option		$1,000,000	$2,500,000
or: Permitting Process Multipurpose Option		$1,000,000	$3,000,000
Permitting Geotechnical Field Work		$10,000	$20,000
Economics			
Recreation Study	Or Phase 1	$50,000	$100,000
Benefit/Cost Study		$65,000	$100,000
Subtotal		*$11,990,000*	*$18,570,000*
Public Involvement		$300,000	$400,000
Project Management[1]	10%	$1,199,000	$1,857,000
Grand Total Including Optional Tasks		**$13,489,000**	**$20,827,000**

1. 10 percent of all costs excluding permit fees and services during construction.

Study Plan Years 6-8

Introduction

The last study phase consists primarily of final design and permitting tasks. It is unknown at this time if additional work would be required from hydrology and hydraulic engineers or if additional economic analyses are needed. The cost estimates in this document assume no additional costs are required for these functions during this period. The primary questions answered in Study Years 6-8 include:

- What are the final design details for fish passage and final cost estimates?
- What are the final design details for the structure and final cost estimates?
- What wetland mitigation is required?
- What will be required to obtain final permits from FERC or other agencies?

Once the studies in this final phase are completed, and all permits are obtained, the project construction period may begin.

Engineering

For Study Years 6-8 the engineering tasks are focused on developing final design for the tunnel, dam structure, and fish passage. The engineering tasks for this period include the following:

Final Design

A contracting plan would be developed taking into consideration timing of the work and logical divisions in the work. The contracting plan could consist of separate contracts for the tunnel, dam, and mechanical supply such as spillway gates or hydromechanical equipment. Separating the work provides opportunities to attract specialty contractors, reduce overhead and markup, potentially saving money. Final design work includes engineering calculations, developing contract drawings, and writing technical specifications for each contract.

The plans and specifications for the upstream and downstream fish passage facilities would be prepared under this work element. Detailed submittals including the design drawings, specifications, and design report would be prepared and submitted for review at various levels of completion. The final drawing package would be used to obtain the final permits and site specific construction plans such as SWPPP.

Upstream Passage Estimated Cost: $1,000,000 - $2,000,000

Downstream Passage Estimated Cost: $1,500,000 - $4,000,000

Dam Final Design Estimated Cost: $3,900,000-$5,200,000

Services during Construction

This work involves bidding assistance, reviewing bids, and making recommendations for contract award; contractor submittal review; factory inspections of mechanical and electrical equipment; construction monitoring; field changes; startup assistance; and preparing O&M

manuals and final record drawings. The cost estimates below assume that services during construction would extend beyond the 8-year period.

Estimated Cost: $1,300,000-2,000,000

Geotechnical

For Study Years 6-8 the geotechnical tasks are focused on developing supporting information for final design.

Final Design

We anticipate that additional geotechnical field studies will be required in Study Years 6-8 as the design is refined and the final project selected. For example, the dam crest alignment or the site of an appurtenant structure may be shifted to a location where subsurface information is limited, necessitating supplemental investigation.

The majority of the questions to be answered during final design are related to the following:

- Are there ways to further refine or improve the design to modify the operational characteristics or reduce the construction cost?

- Do any of the modifications or refinements have a significant effect on the overall design, and are the design basis assumptions still valid?

Field Studies. Because final design subsurface explorations will be supplemental, it is difficult to predict exactly what will be required. For the purpose of this planning document, we have used our experience to estimate the total scope of geotechnical exploration necessary for complete design of a dam and reservoir facility of this size, including an allowance for modifications during the design process. We have assigned approximately 20 percent of that total to the final design phase. We envision that this work will include:

- Borings in the vicinity of the dam and appurtenances, including packer testing, optical televiewer video-logging, and piezometer installation.
- Borings and test pits in borrow areas.

For a project of this magnitude, field tests of certain construction techniques are often conducted during the design process to help confirm that required procedures to be described in the construction specifications will yield the desired results. We envision that construction field tests will include:

- One or more test fills using the planned borrow material(s) and specified construction techniques. Compaction of the fill will be tested for conformance to the design. Specifications would be modified to be suitable for the material to be used.
- A test blast (assuming the on-site rock will be quarried for use as riprap, or to produce aggregate).

- A trial grouting program to evaluate grout takes, develop grouting specifications, and assist in developing grout bid quantities.

Laboratory Testing. We anticipate additional laboratory testing commensurate with the supplemental subsurface explorations. Laboratory testing may also be performed on specimens collected from the test fill.

Analysis and Engineering. Office tasks in Study Years 6-8 can be divided into two categories: analysis and development of construction documents. Analysis will be similar to what was done under preliminary design, but updated to reflect new data and modifications to the project.

Development of construction documents will include:

- Preparing technical specifications related to geotechnical aspects of the work, such as earthwork, foundation and abutment grouting, tunneling, structure foundations, etc.
- Assisting with geotechnical-related portions of administrative specifications (such as measurement and payment).
- Preparing design drawings related to geotechnical aspects of the project, such as the dam zonation, grout curtain, excavations, instrumentation, etc.

We anticipate that we will provide assistance with development of an engineer's opinion of probable construction cost for the project based on the final design.

Field and Laboratory Work Estimated Cost: $1,250,000-$1,800,000

Analysis & Engineering Estimated Cost: $750,000-$1,000,000

Hydrology & Hydraulics

No hydrologic or hydraulic studies are currently scoped for Study Years 6-8. Additional studies may be identified during the course of the project and some studies described herein (i.e., the development of flood inundation depth data) may need to be reviewed and/or revised as additional information becomes available or to provide higher resolution data for final design and permitting. These studies will be scoped and estimated as they are requested.

Environmental

The final environmental studies proposed are related to wetlands. The proposed environmental studies for Study Years 6-8 are the following:

Jurisdictional Wetland Delineation and OHWM Determination

Relevant lines of jurisdiction will need to be determined for the development of permit documents. This included the boundaries and ratings of all wetlands directly impacted by the project. It would also include a determination the ordinary high water mark (OHWM) of the stream, and any tributaries directly impacted by the project. Direct impacts are assumed to be

those areas where dam, reservoir, or mitigation construction would permanently or temporarily disturb habitat conditions.

Wetland Delineations will be conducted according to the appropriate US Army Corps of Engineers and Washington State Department of Ecology Protocols. OHWM determination and wetland ratings will be conducted according to the appropriate Washington State Department of Ecology Protocols. Wetland boundaries and other pertinent lines of jurisdiction would be flagged in the field and then surveyed in order to develop permit drawings.

Wetland delineation, OHWM determination, wetland ratings, or wetland functional assessments may also be required in areas where indirect impacts are predicted as well. This would include riparian wetlands downstream of the dam site that would be affected by changes in hydrology related to reservoir operations. The extent of such an effort is unknown at this time and a very limited budget has been assigned to it in this scope of work.

Estimated Cost: $35,000-$70,000

Downstream Wetland and Riparian Studies and mitigation planning

Direct impacts to wetlands would require mitigation under Federal, State and Local regulations. Development of mitigation sites would likely occur in the vicinity of the dam and is anticipated to involve reconnection riverine hydrology to historic riparian wetlands currently cut-off from the river by levees or other structures. This mitigation could also be in the form of newly constructed off channel areas that provide high flow refugia for fish as well as wetland habitat functions.

A wetland mitigation plan will be prepared based on the policies and guidance of the US Army Corps of Engineers and Washington State Department of Ecology. Construction management of the mitigation sites, and monitoring costs (typically ten years) are not included in this scope of work

Estimated Cost: $70,000-$210,000

Permitting & Regulatory

The permitting process identified in the second study phase will be continued in Study Years 6-8. The permitting and regulatory tasks outlined for Study Years 6-8 are the following:

Continue Permitting Process for Flood Control Only Dam Alternative

The following work is anticipated:

<u>Comply with terms and conditions of Section 404 Permit-Cost undetermined at this time</u>

- Cultural Resource Follow-up
    - Complete surveys of the APE as determined necessary by the USACE.
    - Make recommendations of resource eligibility for inclusion on the National Register of Historic Places, effects assessments, and mitigation of effects options where applicable.
    - Conduct limited construction monitoring.

    - Participate in annual meetings of stakeholders to present on cultural resource issues and study progress.

Estimated Cost: $140,000

Permitting-Apply for Other Permits

Once the Engineers have the Final Design drawings completed, the permit applications for the Other Permits listed below may be prepared.

- Prepare and submit JARPA Applications to WDFW and Lewis County, for HPA and Shoreline Development Permit, respectively
    - Prepare and submit permit applications to
        - WDOE for Dam Construction Permit
        - WDOE for NPDES Construction Stormwater Permit
        - Lewis County for clearing/grading permit
        - Obtain right-of-way approvals from landowners
        - Agencies can adopt COE's NEPA document

Estimated Cost: $10,000 to $24,000 labor + permit fees

Continue Permitting Process for Multipurpose Dam Alternative Permitting

The following work is anticipated:

- FERC Issues License Order
- Comply with terms and conditions of FERC License Order - Cost undetermined at this time
- Cultural Resource Follow-up
        - Prepare a Historic Properties Management Plan (HPMP) in consultation with the Cultural Resource agencies/tribes. Three rounds of review before submittal to FERC.
        - Participate in biannual meetings of the Cultural Resource agencies/tribes.
        - Initiate implementation of the HPMP in Year 8 with a limited task list focused on surveying areas marked for development or other disturbances that were not considered in Years 3-5 surveys, and some limited construction monitoring.

Estimated Cost: $140,000

Permitting-Apply for Other Permits

Once the Engineers have the Final Design drawings completed, the permit applications for the Other Permits listed below may be prepared.

- Prepare and submit JARPA Applications to USACE, WDFW, and Lewis County for CWA Section 404, HPA and Shoreline Development Permits, respectively
- Prepare and submit permit applications to
    - WDOE for Dam Construction Permit

- WDOE for NPDES Construction Stormwater Permit
- Lewis County for clearing/grading permit
- Obtain right-of-way approvals from landowners
- Agencies can adopt FERC's NEPA document

Estimated Cost: $10,000 to $30,000 labor + permit fees

Economics

As noted previously, it is not anticipated that a benefit-cost analysis is needed after year 5. At this time, the decision of whether or not to build one of the structures has been made and the permitting process has begun.

Summary of Study Years 6-8

Table 3 summarizes the cost estimates provided in the final study phase. After this final study phase, and once all the appropriate permits are obtained (described above), the project can then move forward into the construction phase. For this phase, the cost estimate range from $11.0 million to $18.2 million.

Table 3
Study Period Years 6-8 Cost Summary

Study	Notes	Low Estimate	High Estimate
Engineering			
Final Design: Fish Passage		$2,500,000	$6,000,000
Final Design: Dam		$3,900,000	$5,200,000
Services During Construction (continues beyond year 8)		$1,300,000	$2,000,000
Geotechnical			
Preliminary Design: Field and Laboratory Work		$1,250,000	$1,800,000
Preliminary Design: Analysis and Engineering		$750,000	$1,000,000
Hydrology & Hydraulics			
None Identified		$0	$0
Environmental			
Jurisdictional Wetland Delineation and OHWM Determination		$35,000	$70,000
Downstream Wetland & Riparian Studies & Mitigation		$70,000	$210,000
Permitting & Regulatory			
Either: Permitting Process Flood Control Option	+ permit fees	$150,000	$164,000
or: Permitting Process Multipurpose Option	+ permit fees	$150,000	$170,000
Economics			
None Identified		$0	$0
Subtotal		*$9,955,000*	*$16,450,000*
Public Involvement		$50,000	$150,000
Project Management[1]	10%	$995,500	$1,645,000
Grand Total Including Optional Tasks		**$11,000,500**	**$18,245,000**

1. 10 percent of all costs excluding permit fees and services during construction.

Summary of 8-Year Plan

Cost Estimate Summary

Table 4 summarizes the total cost estimates for studies proposed in this Project Planning Document.

Table 4
8-year Plan Estimated Costs

Years 1-2	**Low Cost Estimate**[1]	**High Cost Estimate**
Engineering Studies	$400,000	$800,000
Geotechnical Studies	$50,000	$100,000
Hydrology and Hydraulic Studies	$355,000	$550,000
Environmental Studies	$1,950,000	$2,425,000
Permitting & Regulatory	$70,000	$130,000
Economic Studies	$95,000	$915,000
Public Involvement	$150,000	$350,000
Project Management	$282,000	$393,500
Subtotal	*$3,362,000*	*$5,693,500*
Years 3-5		
Engineering Studies	$1,790,000	$2,925,000
Geotechnical Studies	$5,400,000	$7,600,000
Hydrology and Hydraulic Studies	$200,000	$300,000
Environmental Studies	$3,475,000	$4,525,000
Permitting & Regulatory	$1,010,000	$3,020,000
Economic Studies	$115,000	$200,000
Public Involvement	$300,000	$400,000
Project Management	$1,199,000	$1,857,000
Subtotal	*$13,489,000*	*$20,827,000*
Years 6-8		
Engineering Studies[2]	$6,400,000	$11,200,000
Geotechnical Studies	$2,000,000	$2,800,000
Hydrology and Hydraulic Studies	$0	$0
Environmental Studies	$105,000	$280,000
Permitting & Regulatory	$150,000	$170,000
Economic Studies	$0	$0
Public Involvement	$50,000	$150,000
Project Management	$995,500	$1,645,000
Subtotal	*$9,700,500*	*$16,245,000*
Total	$26,551,500	$42,765,500

1. Excludes optional studies
2. Excludes services during construction

Schedule

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Engineering Studies								
Fish Passage Design Study & Cost Estimate								
Dam Design Study								
Evaluate & Compare Structure Purpose								
Dam & Spillway Design			PMF needed					
Fish Passage Hydraulic Model								
Fish Passage Preliminary Design								
Dam Preliminary Design								
Fish Passage Final Design								
Dam Final Design								
Services During Construction								
Geotechnical Studies								
Conceptual Design Meetings and Support Tasks								
Preliminary Design Field, Laboratory, Analysis & Engineering	Optional							
Final Design Field, Laboratory, Analysis & Engineering								
Hydrology & Hydraulics								
Review Doty Gage 2007 peak & Hydrograph								
Update Flood Depth Data (input to benefit/cost analysis)								
Collect channel cross section data								
Develop Hydrologic Model								
Reservoir Operations Plan								
Re-evaluate Statistical Hydrology		Optional						
Hydrologic and Hydraulic Dam Safety Analysis								
PMF Study			Needed for Engineering					
Other Identified Studies								
Environmental								
Fisheries Studies								
Collect Data on Fish Use (Reservoir + Mainstem)								
Fish Tracking Study								
Mitigation Strategies, EIS and other permitting assistance								
Water Quality								
Dissolved Oxygen & Temperature								
Sedement Transport & Geomorphology								
Estimate Bedload Transport (needed to size facility)			Sediment transport Model					
Habitat Mapping and Wildlife Studies								
Determine baseline species presence & abundance (reservoir)								
Downstream Wetland & Riparian Studies								
Inventory wetlands and establish baseline of quality								
Jursidictional Wetland Delineation								
Downstream Wetland & Riparian Mitigation Planning								

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Permitting Studies								
Review Permitting Process of each structure purpose								
Cultural Resource Review								
Agency Pre-Consultation								
Permitting Geotech Explorations			(as needed)					
Flood Control Only Structure								
JARPA Applications			preparation			submission		
NEPA/SEPA								
Permitting: WDOE, NPDES, ROW								
Multipurpose Structure								
Water Right Application								
FERC			preparation			submission		
Permitting: WDOE, NPDES, ROW								
Economic Studies								
Methodology Selection								
Transportation Benefit Analysis (WSDOT)								
Recreation Study	Phase 1 or 2							
Environmental Benefit-Cost Analysis	Optional							
Benefit Cost Study			Can be completed any time in years 3-5					
Qualitative Research Study	Optional							