9.11. Study of Fish Passage Feasibility at Watana Dam

9.11.1. General Description of the Proposed Study

The proposed Watana Dam would create a fish passage barrier on the Susitna River. Information regarding the fish passage feasibility and the engineering feasibility of passage at this location is important to the resource management decisions that pertain to the license application for construction and operation of the proposed Project. In implementing this study plan, AEA will compile the available biological information from the 1980s through 2013-14 studies and will develop new information regarding the feasibility of engineering alternatives to fish passage at the proposed dam site. AEA will assimilate this information and conduct a feasibility analysis of engineered passage solutions.

In this study plan, feasibility is defined in a technical sense and includes both engineering and fish passage feasibility. Engineering feasibility is governed by physical dam and reservoir characteristics, hydrology, primary water storage and release operations, and operating and construction cost. Fish passage feasibility is governed by fish behavioral responses to site conditions, including migration timing, and migratory pathways. The intent of this feasibility assessment is to address two basic questions. Can a fish passage alternative be identified that will effectively and safely collect and pass migratory fish? In addition, can the fish passage alternative be constructed and operated while maintaining the original purpose of the Susitna-Watana Dam?

This study plan is limited to analyzing the feasibility of fish passage and does not analyze the necessity of fish passage at the proposed Project. AEA has not made any decisions regarding whether to include fish passage as part of its proposed Project. In developing its license application for the proposed Project, AEA will assess whether to propose fish passage based upon the results of other study plans and other available information along with input from federal and state agencies and other stakeholders.

Study Goals and Objectives.

The goal of this study is to develop, to the feasibility level, a fish passage strategy in support of the license application for the proposed Susitna-Watana Hydroelectric Project. This study plan will outline the process that will used to achieve this goal. A variety of engineering, biological, sociological, and economic factors will be considered during this process. . The study will explore various alternatives in support of three basic strategies related to fish passage at Watana Dam: (1) the Watana dam without fish passage, (2) integration of upstream and downstream passage features into the dam design, and (3) the retrofit of upstream and downstream fish passage features to a dam designed without passage.

9.11.2. Existing Information and Need for Additional Information

The central feature of the proposed Project is the approximate 750 foot high Watana Dam (as measured from sound bedrock) at river mile (RM) 184 on the Susitna River. The dam would block the upstream passage of Chinook salmon, possibly other salmon species, and resident fish that migrate through and otherwise use the proposed Watana Dam site and upstream habitat in the Susitna River and tributaries. Chinook salmon were documented in two tributaries to the

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proposed reservoir during ADF&G sampling efforts in 2003 and 2011. Juvenile Chinook were found in Kosina Creek in 2003 and one adult was observed in 2011 at an approximate elevation of 2,800 feet; juveniles were also found in the Oshetna River near its confluence with the Susitna River, but none were observed in 2011 (ADF&G 2003a and b, 2011). Aside from these observations, other salmon species have not been documented above the dam site, but little else is known about migration patterns and habitat use upstream of the proposed dam site for other anadromous species in the Susitna River. In addition there are migratory resident fishes, including burbot, Dolly Varden and whitefish that have been documented both upstream and downstream of the proposed dam site.

There is currently no specific engineering information and little biological information to provide a basis for determining feasibility of passage at the proposed Watana Dam. Pacific salmon (all five species) were documented throughout the lower and middle Susitna River during the 1980s. The extent of their presence in the upper river has not been well documented. Coho, chum, sockeye, and pink salmon were found in the lower and middle Susitna River during the 1980s, but have not been observed upstream of Devils Canyon. Chinook salmon is the one anadromous species that migrates pass Devils Canyon at relatively low numbers (maximum peak count of 46 adult Chinook salmon during 1984; Thompson et al. 1986). More, recently ADF&G radio-telemetry studies using sockeye, coho, and chum salmon from the lower river have been conducted for several years and have not documented any tagged fish above Devils Canyon. In 2012, AEA expanded these studies in coordination with ADF&G to include additional species and add in a focused investigation of distribution of coho, Chinook, sockeye, chum, and pink salmon above Devils Canyon.

Preliminary results from 2012 indicated that 12 Chinook salmon that were radio-tagged at Curry station passed upstream of the uppermost impediment within Devils Canyon. Four of these fish migrated to Kosina Creek and were last observed as mortalities. The rest of the tagged fish detected upstream of Devils Canyon were last detected in Cheechako Creek, Portage Creek, in Devils Canyon itself or in the mainstem river downstream of the canyon. Additionally information regarding Chinook salmon distribution comes from the 2012 spawner surveys. During these aerial surveys16 Chinook salmon were observed spawning in Kosina Creek, including the 4 radio-tagged fish mentioned earlier. No other adult Chinook salmon were observed upstream of Devils Canyon during the 2102 field observations.

Chinook salmon are the only anadromous species known to rear in the upper Susitna River and tributaries. Juvenile Chinook salmon have been documented in Fog Creek, Kosina Creek, and the Oshetna River (Buckwalter 2011). Very little is known about Upper Susitna Chinook salmon in terms of run size and inter-annual variability, locations of spawning, rearing, and over-wintering areas, and timing and duration of key life history events (e.g., upriver migration and spawning, period of freshwater residency, smolt out-migration). However historic data from the 1980s did document the life history of Chinook salmon in the Middle River. In summary these historic studies indicated that Susitna River Chinook salmon spawning is limited to tributary habitat. No Chinook salmon have ever been documented spawning in the mainstem river. These fish overwinter in the gravels and fry emerge in March or April (Harza-Ebasco 1985a). Chinook salmon fry remain near their natal areas in tributaries for a brief period, one or two months, before beginning a downstream movement into rearing and overwintering areas ((ADF&G 1984c). Some Chinook salmon juveniles move into the Susitna mainstem and have been

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collected throughout the basin during summer (Harza-Ebasco 1985). Other juveniles apparently remain in natal tributaries for early rearing and overwintering (ADF&G 1984).

In addition to the anadromous salmon, humpback whitefish and Dolly Varden also express anadromous life history patterns (Morrow 1980), but these life history patterns have not been documented for Susitna River populations. Both of these species have been documented in the Upper Susitna River (Delaney et al. 1981a). In 2012 otoliths were collected in order to evaluate the presence of anadromy for Susitna populations of Dolly Varden and humpback whitefish. Pacific lamprey exhibit an anadromous life history pattern and have been observed in nearby river systems (Chuit River, Nemeth et al. 2010), but do not have a documented presence in the Susitna River. Other resident fishes present in the Upper Susitna River that may have migratory components and may be affected by changes in connectivity between the upper and lower river include Arctic grayling, burbot, round whitefish, , and possibly rainbow trout.

9.11.3. Study Area

The study area extends from the confluence with Portage Creek (RM 148) upstream to the Oshetna River (RM 233.4. It is assumed that any potential upstream passage facilities to be considered (e.g., a trap and haul facility) would be located in the mainstem upstream of the confluence with Portage Creek.

9.11.4. Study Methods

This feasibility evaluation includes 6 tasks needed to determine fish passage technical feasibility for the Project. This study will generally follow the guidance provided in NMFS's Anadromous Salmonid Passage Facility Design document (NMFS 2011). These tasks are summarized below.

1. Establish a Fish Passage Technical Team to provide input on the feasibility assessment.
2. Prepare for Feasibility Study.
3. Conduct site reconnaissance.
4. Develop Concepts.
5. Evaluate Feasibility of Conceptual Alternatives.
6. As appropriate develop refined passage strategy (ies).

Task 1: Establish the Fish Passage Technical Team to provide input on the feasibility assessment.

In cooperation with State and Federal Agencies and other interested licensing participants, AEA will establish a Fish Passage Technical Team with representatives from state and federal agencies, FERC, and other interested licensing participants. This Team will be convened regularly (likely bi-monthly (once every other month)) throughout the study to provide input on assessing additional data needs, developing evaluation criteria, and developing conceptual design passage strategies. As part of this process, the regular meetings may be substituted with workshops that engage a broader group of participants. Approximately four workshops will be scheduled at study milestones addressing the following topics: 1) goals for passage feasibility and review dam design and operational concepts, 2) conceptual alternatives brainstorming, 3) critique and refinement of concepts, packaging of conceptual components into alternatives, and

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4) alternatives selection, refinement, and costs. The first workshop to identify goals, review conceptual dam design and operation will occur as part of this task. This workshop will engage engineers and hydrologists from AEA engineering team as well as the Fish Passage Technical Team.

Task 2: Prepare for Feasibility Study

Task 2 is focused on the technical preparation for the concept development brainstorm session described in Task 4. AEA will compile existing and salient background information listed below and the information will be disseminated to the Fish Passage Technical Team. Review of this information will facilitate preparation for a concept development brainstorming workshop. In addition, AEA will prepare workshop materials including further development of evaluation criteria and an evaluation process. The review will allow the Fish Passage Technical Team to become familiar with the operational, physical, hydrologic, and biological setting of the Susitna-Watana Dam. This information will assist Fish Passage Technical Team in providing input to alternatives identified by AEA that can reasonably and realistically fit within the construct of the proposed Project operations, and are compatible with hydrological and physical constraints.

Existing data will be obtained from the 1980s Susitna studies, ADF&G surveys between 2003 and 2011, AEA survey reports, and engineering documents prepared in 2012. Additional data will be developed during the licensing baseline study program in 2013 and these data will be used to inform development of alternatives and conceptual design. The following information will be complies as part of Task 2:

- Biological
  - Target fish species and life stages
  - Species and life stage-specific periodicity
  - Life-stage specific parameters: size, migratory behavior, swimming behavior, swimming capacity, and other physical passage constraints
  - Fish relative abundance and distribution upstream and downstream of the proposed Watana Dam site.
  - Locations of spawning and rearing habitats.
  - Migratory characteristics (seasonal timing, duration) by species and life-stage.
  - Identification of any predatory and/or invasive species that are present and how they might be affected by passage facilities
  - Genetics information on populations upstream and downstream of the proposed dam site.
- Physical
  - Topographic survey
  - Water quality and water temperature
  - Hydrologic and hydraulic information
  - Ice processes
  - Sedimentation transport processes
  - Geomorphology
- Project Features
  - Project conceptual drawings

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- Project operations
- Aerial photos
- Seasonal flows downstream of the Project (e.g., tailwater rating curves, flow duration curves)
- Seasonal pool elevation (e.g., forebay rating curves, fluctuations, etc.)
- Project design components (e.g., dam layout, cross sections, turbine type, draft tube velocity, sediment capacity, power availability, etc.)
- Project access or restrictions to access for operations and maintenance

Due to the nature of this project, in particular with respect to its location in the upper river and the uncertainty around the potential benefits and risks of passage to fish species, this task also involves development of a spreadsheet based biological performance tool. This tool will be used to qualitatively estimate potential passage success using concepts to be identified and refined in the feasibility study. Examples of challenging issues that can be addressed with this tool include: low survival success of downstream migrants through the reservoir, the potential for transporting adult Chinook salmon upstream that do not really intend to go there, the potential for spread of non-native fishes. The biological performance tool will present the positive and negative biological effects associated with the various passage concepts under consideration. In addition, compiling information on migratory behavior, preferably behavior specific to the Susitna River, will help identify the type, location, size, and timing of potential upstream and downstream fish passage facility components. Additional information needs may be defined during the compilation.

The deliverables for this task are a draft of the biological performance tool, base drawings, maps, and operational protocols necessary to conduct the study.

Task 3: Conduct Site Reconnaissance

AEA will conduct a site reconnaissance to observe conditions and collect information as appropriate for concept development. At a minimum, the reconnaissance will consist of a helicopter fly-over of the study area from the mouth of Portage Creek to the proposed Watana Dam site at RM 184, as well as tributaries to the proposed reservoir where Chinook salmon are have been documented (i.e. Kosina Creek and Oshetna River).

Task 4: Develop Concepts

This task will utilize a facilitated 2-day brainstorm workshop to identify fish passage concepts. Two-days will be required to ensure that the brainstorm covers upstream and downstream passage for both the integrated with dam design and retrofit strategies. The workshop environment allows rapid and complete generation of fish passage concepts, based on Fish Passage Technical Team's diverse expertise and experience with related facilities. During the workshop, AEA will develop concepts based on the professional judgment of participants as well as studies, experience, and history of other fish passage facilities and specific criteria and

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guidelines published by NMFS. Concepts might be components of fish passage facilities, operational procedures, locations of facilities, or entire facilities.

Following the brainstorm workshop, AEA will be group and organize the concepts, and the AEA, with input from the Fish Passage Technical Team, will perform an initial "fatal flaw analysis" to eliminate any concept that cannon meet the basic criteria. Concepts at this early phase of development that are fatally flawed will be documented but will not be further developed. Fatal flaws might include dam or personnel safety issues, constructability concerns, or poor chance of satisfying fish passage objectives. Concepts without fatal flaws will be further analyzed and developed.

The biological performance tool developed in Task 2 will be reviewed by the Fish Passage Technical Team and tested at the meeting to assure all necessary parameters and data are provided to address the short list of passage concepts. The goal of this exercise is to obtain feedback and critique of the biological tool by all participants to assure all parameters and tool needs are included prior to more formal use of the tool in the Task 5.

After the workshop, AEA will refine the fish passage concepts identified in this task into fish passage alternatives applicable at the proposed Susitna-Watana dam site to address site-specific applicability, hydraulic functional design, construction and operating cost estimates, general layout, and identify any uncertainties for further examination. Performance of the alternatives will be identified using the biological performance tool (Task 2). Alternatives that are not technically feasible will be dropped from consideration and reasons for them being dropped, will be described. The alternatives will be combined into strategies consistent with an integrated dam design and a retrofit. The explanation of operation and biological performance of the alternatives will be presented to the Fish Passage Technical Team at the third workshop.

Task 5: Evaluate Feasibility of Conceptual Alternatives

Based on the alternatives developed through Task 4, an evaluation of the alternatives will be performed and documented in Task 5. An evaluation matrix will be used to prepare the first evaluation of the alternatives that will advance the existing state of each alternatives conceptual design for better performance, and will allow a relative comparison of the alternatives. The evaluation will be done by using a grid analysis technique, or Pugh Matrix, which breaks the alternatives down into discrete elements for comparison, evaluation, and optimization. Breaking the alternatives into discrete elements reduces the possibility of alternatives being selected based on general prejudiced opinions. The matrix will result in consolidated scores, which reflect the relative success of achieving criteria, and will thus help rank or prioritize alternatives.

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The results of the grid analysis can be used to further refine facility components, identify data gaps, and assess the potential influence of uncertainties. However, the grid analysis is only a decision tool; the results are used to influence but not dictate decisions. The characteristics and effectiveness of upstream and downstream fish passage facilities will be evaluated, and the results used to refine and optimize the location, size and timing of each type of passage facility.

Based on the results of this initial evaluation, AEA will work to update descriptions and drawings for the fish passage alternatives. The results will be presented to the Fish Passage Technical Team at the fifth and final workshop, with the goal of selecting a final list of alternatives for refinement in Task 6.

Task 6: Develop Refined Passage Strategies

Task 6 will focus on the refinement of the remaining fish passage alternatives that may be technically feasible. In addition to further development of the conceptual design drawings, AEA will prepare an opinion of probable construction and operating cost for each alternative, describe operational protocols and issues, address comments from Task 5, perform final runs of the biological performance tool, prepare a final quantitative evaluation of the alternatives using the final Pugh matrix and evaluation criteria, and address constructability issues and any remaining data needs or significant risks. A minimum of three distinct passage strategies including one each for: (1) Susitna-Watana dam without fish passage, (2) integration of upstream and downstream passage features into the dam design and (3) the retrofit of upstream and downstream fish passage features to a dam designed without passage will be evaluated and compared under this task.

9.11.5. Consistency with Generally Accepted Scientific Practices

The study approach generally follows steps outlined in federal guidelines for Anadromous Fish Passage Design published by the National Marine Fisheries Service (NMFS 2011).

9.11.6. Schedule

Upstream and downstream fish passage facilities can have a significant effect on the overall design and cost of the Project. Consequently, conceptual alternatives would be completed during 2013 so that further refinement of the top ranked conceptual design(s), if determined to be needed and technically feasible, can continue during 2014 (Table 9.11-1). Anticipated milestones are:

- Establishing the Fish Passage Techincal Team,
- Preparing for the study with compilation, review, and summary of information,
- Site reconnaissance,
- Development of concepts,
- Evaluation of conceptual alternative feasibility,

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- Refinement of passage strategies
- Completion of an Initial Study Report, and

Completion of an Updated Study Report. The preliminary schedule for these tasks and workshops is located in Table 9.11-1.

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Table 9.11-1. Schedule for implementation of the Fish Passage Feasibility Study.

Activity	2013				2014				2015
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q
T1. Establish Team and Define Process	W1								
T2. Prepare for Feasibility Study									
T3. Site Reconnaissance									
T4. Develop Concepts			W2						
T5. Evaluate Feasibility of Alternatives					W3				
T6. Develop Refined Passage Strategies							W4		
Initial Study Report					Δ				
Updated Study Report									▲

Legend:

—— Planned Activity
----- Follow up activity (as needed)

- W1: Workshop 1
Δ Initial Study Report
▲ Updated Study Report

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9.11.7. Interdependency with Other Studies

The Fish Passage Feasibility Study will interrelate with other AEA Project studies (Figure 9.x). Along with a comprehensive literature review, the Upper River Fish Distribution and Abundance Study (9.5), the Middle and Lower River Fish Distribution Study (9.6), the Salmon Escapement Study (9.7) and the Fish Passage Barriers Study (9.12) will provide baseline biological inputs on migratory timing and behavior as well as distribution over various life stages in the vicinity of the proposed dam site. The Future Watana Reservoir Fish Community and Risk of Entrainment Study (9.10) will interrelate by providing and receiving biological information on the anticipated reservoir fish assemblage and entrainment risk. Along with information on project design and operations, physical studies on (Geology 4.0), Water Quality (5.0), Ice Processes (7.6), Geomorphology (6.0), hydraulic information, sediment transport, and others will provide input information for the Fish Passage Feasibility Study.

The Fish Passage Feasibility Study will provide output information back to facility design and operations analysis and to the Future Watana Reservoir Fish Community and Risk of Entrainment Study (9.10), the Fish Harvest Study (9.15), the Recreation Resources Study (12.5).

9.11.8. Level of Effort and Cost

This study will not include any fieldwork other than the site reconnaissance. However, coordination with resource agency engineers and biologists is anticipated. In addition, engineering design work will be necessary to develop conceptual drawings. The anticipated cost for completing this study is $1,000,000.

9.11.9. Literature Cited

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Table 9.11-1. Schedule for implementation of the Fish Passage Feasibility Study.

Activity	2013				2014				2015
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q
T1. Establish Team and Define Process	W1								
T2. Prepare for Feasibility Study									
T3. Site Reconnaissance									
T4. Develop Concepts			W2						
T5. Evaluate Feasibility or Alternatives					W3				
T6. Develop Refined Passage Strategies							W4		
Initial Study Report					Δ				
Updated Study Report									▲

Legend:

—— Planned Activity
----- Follow up activity (as needed)
• W1: Workshop 1
Δ Initial Study Report
▲ Updated Study Report

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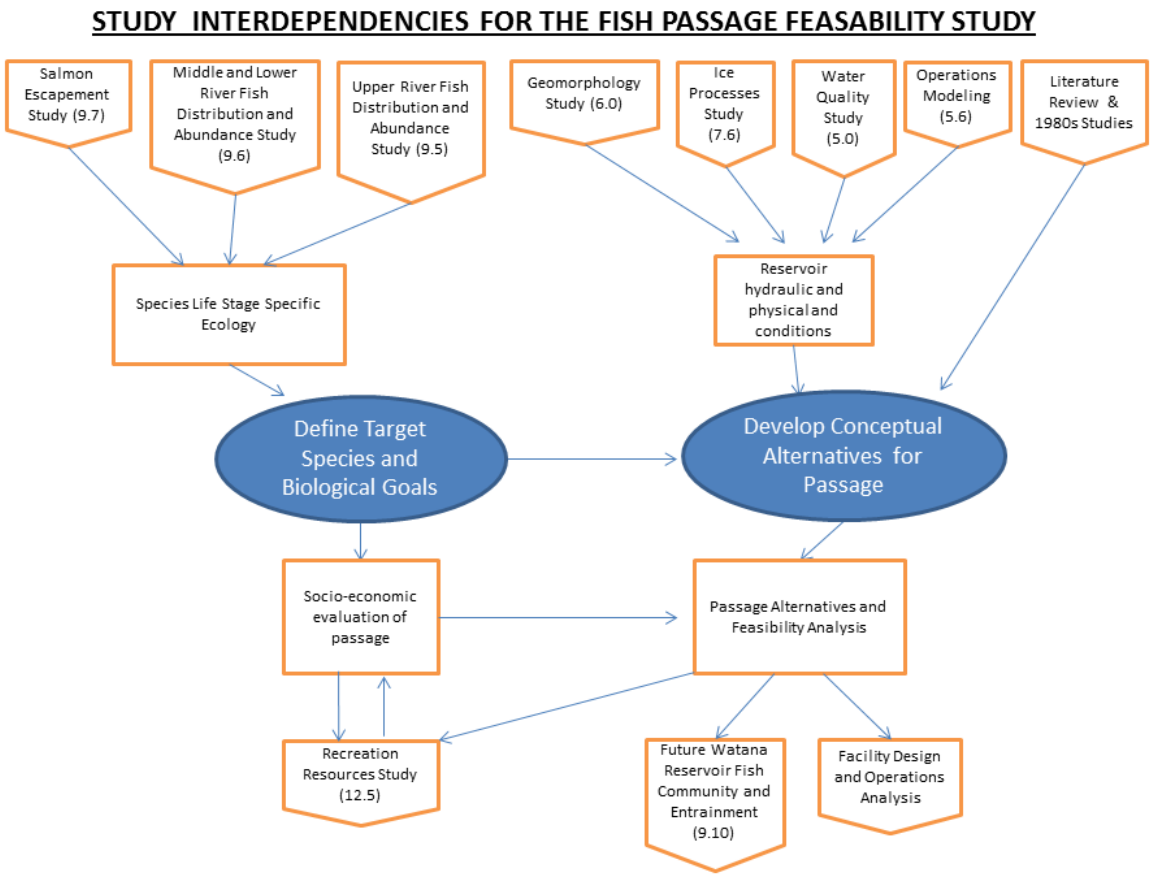

Figure 9.11-1. Fish passage feasibility interdependencies with other AEA studies.

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