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Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Study of Fish Passage Feasibility at Watana Dam
Study Plan Section 9.11

Final Study Plan

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

July 2013

9.11. Study of Fish Passage Feasibility at Watana Dam

On December 14, 2012, Alaska Energy Authority (AEA) filed with the Federal Energy Regulatory Commission (FERC or Commission) its Revised Study Plan (RSP), which included 58 individual study plans (AEA 2012). Section 9.11 of the RSP described the Study of Fish Passage Feasibility at Watana Dam. This section focuses on conducting a study to develop, to the feasibility level, a fish passage strategy in support of the license application for the proposed project. RSP 9.11 provided goals, objectives, and proposed methods for assessing the feasibility of fish passage at Watana Dam.

On February 1, 2013, FERC staff issued its study determination (February 1 SPD) for 44 of the 58 studies, approving 31 studies as filed and 13 with modifications. RSP Section 9.11 was one of the 31studies approved with no modifications.

On February 21, 2013, the National Marine Fisheries Service (NMFS) filed a notice of study dispute pursuant to section 5.14(a) of the Commission's regulations. This dispute included four elements of RSP Study 9.11.

On April 3, 2013, a dispute resolution panel held the technical conference, which was attended by representatives from NMFS, AEA, the Commission, and other licensing participants. On April 12, 2013, the panel filed its findings with the Commission, and recommended the following modification to RSP Section 9.11:

AEA is required to review existing literature relevant to glacial retreat and summarize the understanding of potential future changes in runoff associated with glacier wastage and retreat, as described in RSP section 7.7.4.1. RSP section 9.11.1, General Description of the Proposed Study, is modified to delete the text that reads: "(2) Can the fish passage alternative be constructed and operated while maintaining the original purpose of the project?" The deleted text shall be replaced with the following: "(2) Can the fish passage alternative be constructed and operated while allowing an economically feasible Project?"

On April 26, 2013, the Commission issued a formal study dispute determination and adopted the recommended changes.

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 the 2013–2014 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: (1) Can a fish passage alternative be identified that will effectively and safely collect and pass migratory fish? (2) Can the fish passage alternative be constructed and operated while allowing an economically feasible Project?

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 on the results of other study plans and other available information along with input from federal and state agencies and other licensing participants.

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 Project. This study plan outlines the process that will be 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: (1) proposed Project without fish passage, (2) integration of upstream and downstream passage features into the current 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 proposed reservoir during Alaska Department of Fish and Game (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 past Devils Canyon at relatively low numbers (Thompson et al. 1986). 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 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 surveys, 19 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 the proposed dam site during the 2012 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). 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 1985). 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 1984). Some Chinook salmon juveniles move into the Susitna mainstem and have been 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. 1981). 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 (Figure 9.11-1) 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 six tasks needed to determine fish passage technical feasibility for the Project. This study will generally follow the guidance provided in the National Marine Fisheries Service (NMFS) *Anadromous Salmonid Passage Facility Design* document (NMFS 2011). These tasks are summarized below.

1. Establish a Fish Passage Technical Workgroup (TWG) 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. Develop refined passage strategy(ies).

Task 1: Establish the Fish Passage Technical Workgroup 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 TWG with representatives from state and federal agencies, FERC, and other interested licensing participants. This workgroup 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. Four workshops will be scheduled at study milestones addressing the following topics: (1) review of dam design and operational concepts, biological, physical and site specific information, (2) conceptual alternatives brainstorming, (3) critique and refinement of concepts and packaging of conceptual components into alternatives, and (4) alternatives selection, refinement, and costs. The first Fish Passage TWG meeting will be convened to identify goals, set schedules, establish process, and refine and obtain input on list of information needed for Task 2.

Task 2: Prepare for feasibility study.

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

Existing data will be obtained from the 1980s Susitna studies, ADF&G surveys conducted 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 compiled as part of Task 2.

- Biological
  - List of potential target fish species and life stages that will benefit from passage
  - Species and life stage-specific periodicity
  - Life stage-specific parameters: size, migratory behavior, swimming behavior, swimming ability, 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 existing ecological conditions (e.g. presence of predatory and/or invasive species, light, temperature and flow) and how they might be affected by passage facilities

- Physical
  - Topographic survey
  - Water quality and water temperature
  - Hydrologic and hydraulic information (e.g., 5 percent and 95 percent exceedance flows)
  - Ice processes
  - Sedimentation transport processes
  - Geomorphology

- Project Features
  - Project conceptual drawings
  - Project operations (e.g., reservoir storage, powerhouse, and spillway flows)
  - 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, particularly 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 the following: low survival success of downstream migrants through the reservoir, the potential for transporting adult Chinook salmon upstream that do not intend to go there, and 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; synthesized biological, physical, and site data listed above; 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 have been documented (i.e., Kosina Creek and Oshetna River).

Task 4: Develop concepts.

This task will utilize a facilitated two-day brainstorming workshop to identify fish passage concepts. Two days will be required to ensure that the brainstorming covers upstream and downstream passage for both the integrated with-dam design and retrofit strategies. The workshop environment will allow rapid and complete generation of fish passage concepts, based on the Fish Passage TWG'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 on studies, experience, and history of other fish passage facilities and specific criteria and guidelines published by NMFS. Concepts might be components of fish passage facilities, operational procedures, locations of facilities, or entire facilities.

Following the brainstorming workshop, AEA will organize the concepts, and, with input from the Fish Passage TWG, will perform an initial "fatal flaw analysis" to eliminate any concept that cannot 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 TWG and tested at the meeting to ensure that 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 ensure that all parameters and tool needs are included prior to more formal use of the tool in Task 5.

After the workshop, AEA will refine the fish passage concepts identified in this task into fish passage alternatives applicable to the proposed Watana Dam site to address site-specific applicability, hydraulic functional design, construction and operating cost estimates, and general layout, and to 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 the 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 TWG 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 alternative's 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 that reflect the relative success of achieving criteria, and will thus help rank or prioritize alternatives.

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 tool to help the Fish Passage TWG evaluate, repackage, and refine alternatives; the results of the matrix exercise are used to influence but not dictate decisions. Therefore, it is important to consider all relevant criteria with the potential to inform the feasibility of the alternatives. Through this process, 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 TWG 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 strategy(ies).

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 will be evaluated and compared under this task, including one each for (1) 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.

9.11.5. Consistency with Generally Accepted Scientific Practices

The study approach generally follows steps outlined in federal guidelines for anadromous fish passage design published by 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 will 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 as follows:

- Establishment of the Fish Passage TWG
- Preparation for the study with compilation, review, and summary of information

- Site reconnaissance
- Development of concepts
- Evaluation of conceptual alternative feasibility
- Refinement of passage strategies
- Completion of an Initial Study Report
- Completion of an Updated Study Report

The preliminary schedule for these tasks and workshops is shown in Table 9.11-1. In addition, Fish Passage TWG meetings will be held bimonthly, beginning the first quarter of 2013.

9.11.7. Relationship with Other Studies

The Study of Fish Passage Feasibility at Watana Dam will interrelate with other AEA Project studies (Figure 9.11-2). Along with a comprehensive literature review, the Study of Fish Distribution and Abundance in the Upper Susitna River (Section 9.5), the Study of Fish Distribution and Abundance in the Middle and Lower Susitna River (Section 9.6), the Salmon Escapement Study (Section 9.7), and the Study of Fish Passage Barriers in the Middle and Upper Susitna River and Susitna Tributaries (Section 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 (Section 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 and Soils (Section 4), Water Quality (Section 5), Ice Processes (Section 7.6), Geomorphology (Section 6.0), hydraulics, sediment transport, and others will provide input for the Study of Fish Passage Feasibility at Watana Dam.

The Study of Fish Passage Feasibility at Watana Dam will provide output information back to facility design and operations analyses and to the Future Watana Reservoir Fish Community and Risk of Entrainment Study (Section 9.10), the Analysis of Fish Harvest in and Downstream of the Susitna-Watana Hydroelectric Project Area (Section 9.15), and the Recreation Resources Study (Section 12.5).

The flow of information into and out of the Fish Passage Feasibility Study is anticipated to occur over the two-year study period through an iterative process. As relevant data (described above) is collected, it will be disseminated from the Fish Program to the Fish Passage TWG. In addition, three milestone deliveries of data that has been through a QA/QC procedure are anticipated: (1) data from the 2012 Upper River Fish and Escapement Studies will be incorporated into the Feasibility Study in Q1 2013; (2) data from the Salmon Escapement Study (Section 9.7) will be delivered by October 2013 and, if necessary, again in October 2014; and (3) data from Upper and Middle River radio telemetry studies will be delivered quarterly in 2013 and for the first two quarters of 2014 as necessary.

Information flowing out from this feasibility study regarding target species and passage alternatives will be communicated amongst study leads. Additional formal data sharing will also occur among studies after completion of QA/QC procedures and with delivery of the Initial Study Report (Q1 2014) and Updated Study Report (Q1 2015).

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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9.11.10. Tables

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

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

9.11.11. Figures

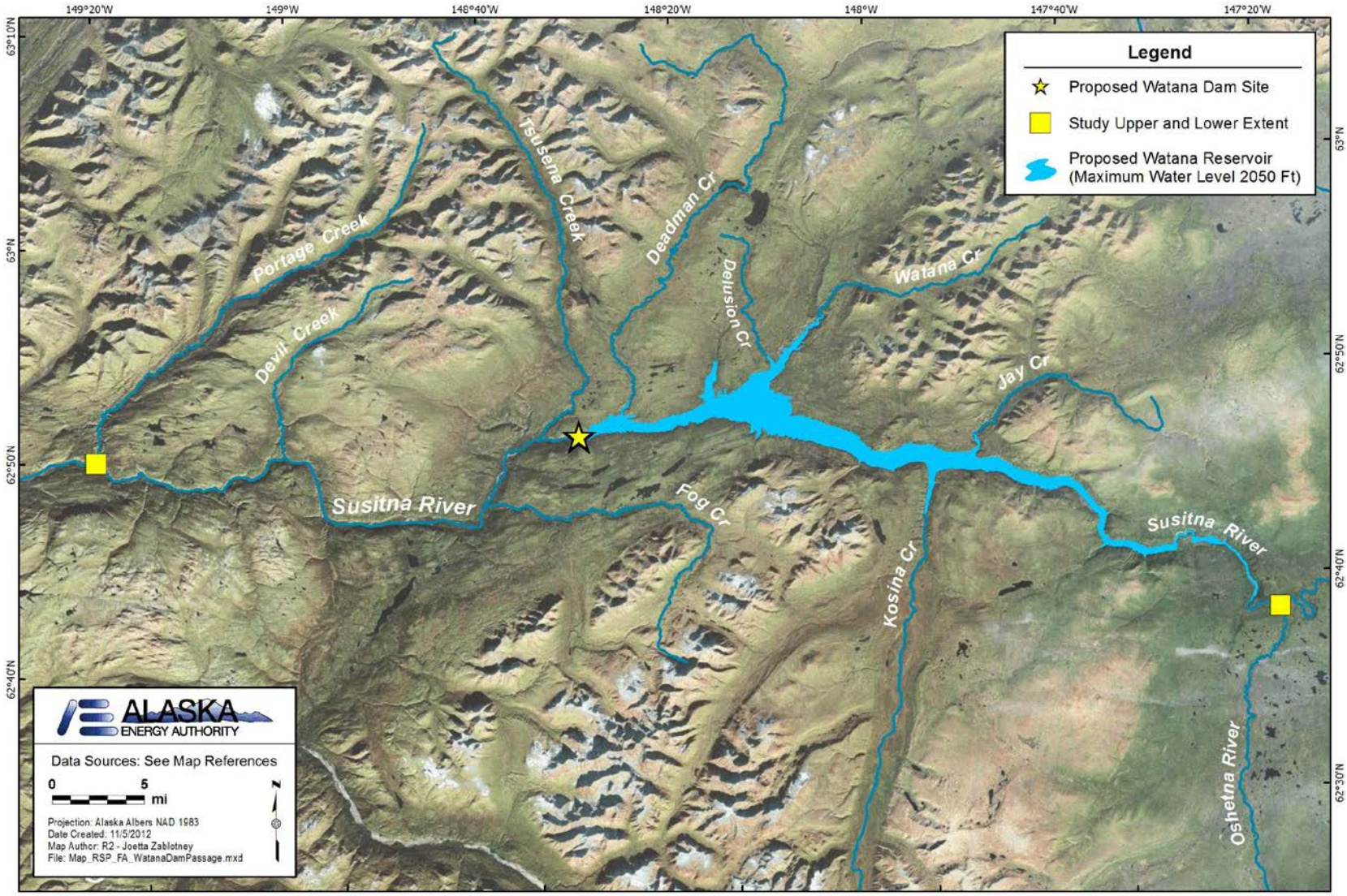

Figure 9.11-1 Study area for Fish Passage Feasibility, from the confluence with Portage Creek (RM 148) upstream to the Oshetna River (RM 233.4).

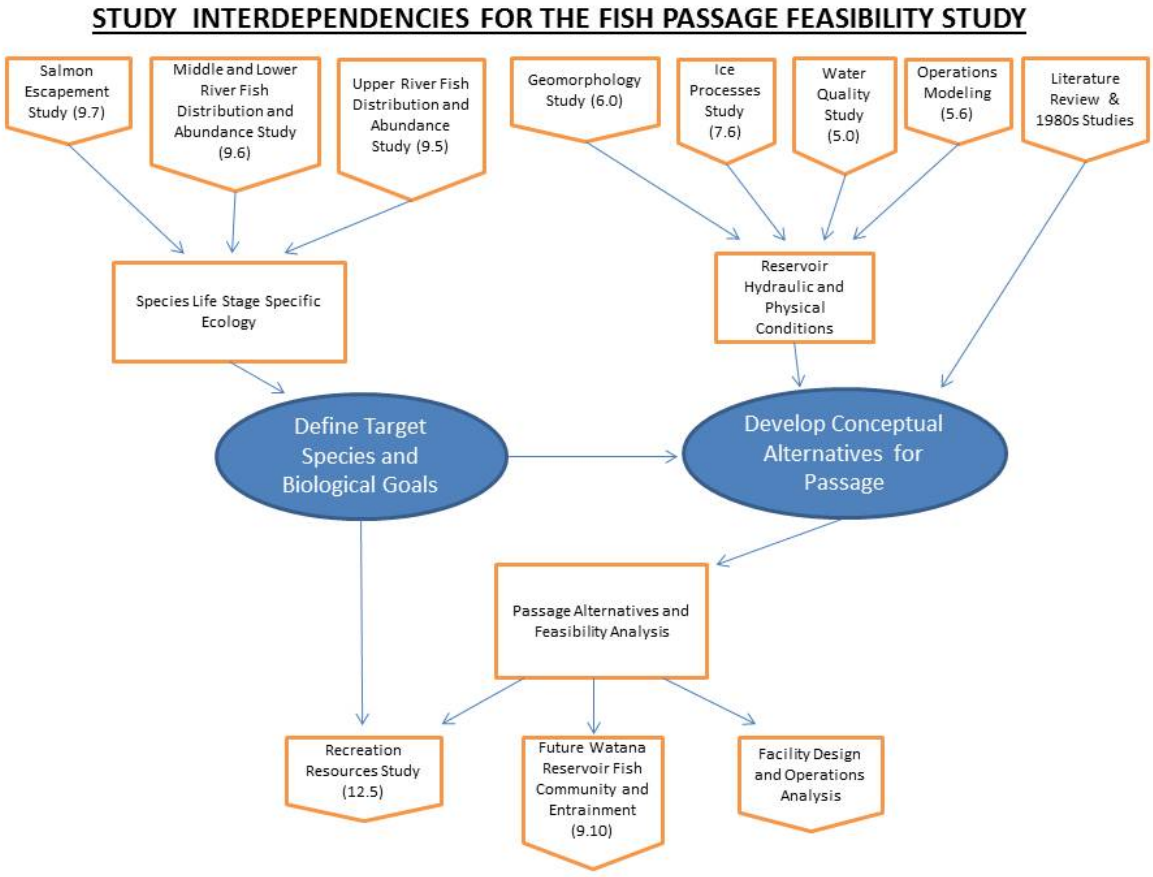

Figure 9.11-2. Fish passage feasibility interdependencies with other AEA studies.