

Susitna-Watana Hydroelectric Project Document

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1.1. River Productivity Study

1.2. Requester of Proposed Study

AEA anticipates resource agencies will request this study.

1.3. Responses to Study Request Criteria (18 CFR 5.9(b))

The following sections provide the necessary context and justification for the proposed study.

1.3.1. Describe the goals and objectives of each study proposal and the information to be obtained.

The overarching goal of this study is to evaluate the effects of Project-induced changes in flow and the interrelated environmental factors (temperature, substrate, water quality) upon the benthic macroinvertebrate and algal communities in the middle and upper Susitna River. Individual objectives that will accomplish this are listed below.

1. Develop a white paper on the impacts of hydropower development and operations (including temperature and turbidity) on benthic macroinvertebrate and algal communities.
2. Characterize the pre-Project benthic macroinvertebrate and algal communities with regard to species composition and abundance in the middle and upper Susitna River.
3. Estimate drift of benthic macroinvertebrates in selected habitats within the middle and upper Susitna River to assess food availability to juvenile and resident fishes.
4. Conduct a literature/data search to identify existing river systems that could act as controls in evaluating future changes to productivity in the Susitna River.
5. Conduct a trophic analysis to describe potential changes in the primary and secondary productivity of the riverine community following post-project construction and operation.
6. Generate habitat suitability criteria for Susitna benthic macroinvertebrate and algal habitats to predict potential change in these habitats downstream of proposed dam site.
7. Characterize the benthic macroinvertebrate compositions in the diets of representative fish species in relationship to their source (benthic or drift component).
8. Conduct a pilot study in 2013 to evaluate the feasibility of reference sites on the Talkeetna and Chilitna Rivers to monitor baseline productivity, pre- and post-construction.

1.3.2. If applicable, explain the relevant resource management goals of the agencies and/or Alaska Native entities with jurisdiction over the resource to be studied. [Please include any regulatory citations and references that will assist in understanding the management goals.]

Aquatic resources including fish and their habitats are generally protected by a variety of state and federal mandates. In addition, various land management agencies, local jurisdictions, and non-governmental interest groups have specific goals related to their land management responsibilities or special interests. These goals are expressed in various statutes, plans, and directives:

- Alaska Statute 41.14.170 provides the authority for state regulations to protect the spawning, rearing, or migration of anadromous fish. Alaska Statute 41.14.840 regulates the construction of fishways and dams. State regulations relating to fish resources are

generally administered by ADF&G. ADF&G is responsible for the management, protection, maintenance, and improvement of Alaska's fish and game resources in the interest of the economy and general well-being of the state (AS 16.05.020). ADF&G monitors fish populations and manages subsistence, sport and commercial uses of fish through regulations set by the Board of Fisheries (AS 16.05.221). ADF&G's authority for protection of fish resources and habitat is further established through the Anadromous Fish Act (AS 16.05.871 – 901) and the Fishway Act (AS 16.05.841). In addition to the state statutes, the following resource management plans and directives provide guidance and direction for protection of fish resources and aquatic habitats on lands within or adjacent to the Project area:

- The Federal Subsistence Board, which comprises representatives of the U.S. Fish and Wildlife Service, National Park Service, Bureau of Land Management, Bureau of Indian Affairs, and U.S. Forest Service, oversees the Federal Subsistence Management Program (57 FR 22940; 36 CFR Parts 242.1–28; 50 CFR Parts 100.1–28), with responsibility for managing subsistence resources on Federal public lands for rural residents.
- Magnuson-Stevens Fishery Conservation and Management Act (PL 104-267) provides federal protection for Essential Fish Habitat (EFH) defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” NOAA's National Marine Fishery Service (NOAA Fisheries) is responsible for designating EFH. In the case of anadromous fish streams (principally salmon), NOAA Fisheries has designated the AWC prepared by ADF&G (Johnson and Klein 2009) as the definition of EFH within freshwater habitats.
- Aquatic Resources Implementation Plan for Alaska's Comprehensive Wildlife Conservation Strategy, September 2006. Prepared by ADF&G, Division of Sport Fish.
- Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources. Prepared by ADF&G, Juneau, Alaska. xviii+824 pp.

Management and land use plans relevant to Aquatic Resources Study Components:

- The role of state land use plans, generally administered by Alaska Department of Natural Resources (DNR), was established by state statute (AS 38.04.005). The Susitna-Matanuska Area Plan (SMAP) and The Southeast Susitna Area Plan (SSAP) direct how the DNR will manage general state uplands and shorelands within the planning boundaries.
- The Susitna Basin Recreation Rivers Management Plan describes how the Department of Natural Resources (DNR) will manage state land and water along six rivers including: the Little Susitna River, Deshka River, Talkeetna River, Lake Creek, Talachulitna River, and Alexander Creek. The plan determines how these six rivers will be managed over the long term including providing management intent for each river segment, new regulations for recreation and commercial use, and guidelines for leases and permits on state land.
- The Susitna Flats Game Refuge Management Plan provides ADF&G guidance to manage the refuge to protect fish and wildlife populations, including salmon spawning and rearing habitats.

1.3.3. If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Fisheries and aquatic resources are owned by the State of Alaska, and the Project could potentially affect these public interest resources by affecting aquatic habitat.

1.3.4. Describe existing information concerning the subject of the study proposal, and the need for additional information.

A number of evaluations of the benthic macroinvertebrate community were conducted on the Susitna River in the 1970s and in 1980s for the original APA Susitna Hydroelectric Project (Friese 1975; Riis 1975, 1977; ADF&G 1983; Hansen and Richards 1985; Trihey and Associates 1986). ADF&G studies in the 1970s sampled macroinvertebrates using artificial substrates (rock baskets) deployed for a set period of time to colonize. Friese (1975) and Riis (1975) set a total of 8 rock baskets in Waterfall Creek, Indian River, and the mainstem middle Susitna River for 30 days during the summer period (July – September). Riis (1977) also deployed rock baskets in the Susitna River near the mouth of Gold Creek for a colonization period of 75 days; however, only 2 of 7 baskets were retrieved. Results were limited to low numbers of invertebrates per basket, identified to family-level only.

Studies conducted in the 1980s for the original Project focused on benthic macroinvertebrate communities in the sloughs, side channels, and tributaries of the middle reach of the Susitna River (RM 125 to 142) during the period from May through October. Efforts included direct benthic sampling with a Hess bottom sampler and drift sampling. ADF&G efforts in 1982 and 1984 also collected juvenile salmon in these side channels and sloughs, and conducted a gut analysis to compare with the drift and benthic sampling results (ADF&G 1983; Hansen and Richards 1985). In addition, Hansen and Richards (1985) collected water velocity, depth, and substrate-type data to develop habitat suitability criteria, which were used to estimate weighted usable areas for different invertebrate community guilds, based on their behavioral type (swimmers, burrowers, clingers) in slough and side channel habitats. Efforts in 1985 (Trihey and Associates 1986) expanded to sampling at nine sites in the middle reach of the Susitna: 3 side channels, 2 sloughs, 2 tributaries, and 2 mainstem sites.

Algal communities were sampled and analyzed for chlorophyll-a periodically at Susitna Station from 1978 to 1980; in the 1980s, algae was collected as part of the APA Project water quality studies, with sampling conducted at Denali, Cantwell (Vee Canyon), Gold Creek, Sunshine, and Susitna Station on the Susitna River, as well as on the Chulitna and Talkeetna rivers (Harza-Ebasco 1985 as cited in AEA 2011a). Analysis showed low productivity (less than 1.25 mg/m³ chlorophyll-a) and indicated algal abundance was most likely reduced by high concentrations of turbidity (AEA 2011a).

Benthic macroinvertebrate information from the 1980s is focused on a limited number of side channel and slough habitats within a 17-mile reach of the Middle Susitna River. Additional information is needed on mainstem benthic communities, as well as those in side channel and slough habitats, within both the Middle and Upper Reaches. Benthic algae information needs to be collected in conjunction with the macroinvertebrates, in order to successfully define their relationship in the system's productivity. In order to assess the impact of future hydropower operation on the benthic communities with the Susitna River, additional information must be collected through an increased sampling effort, including more sampling sites along the river in relation to the distance both downstream from the proposed dam site and upstream from the dam and also the reservoir pool, and more collection periods to help define seasonal variability in the communities.

1.3.5. Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Benthic macroinvertebrates are an essential component in the processes of an aquatic ecosystem, due to their position as consumers at the intermediate trophic level of lotic food webs (Hynes 1970; Wallace and Webster 1996; Hershey and Lamberti 2001).

Macroinvertebrates are involved in the recycling of nutrients and the decomposition of organic materials, serving as a conduit for the energy flow from organic matter resources to vertebrate populations, such as fish (Hershey and Lamberti 2001; Hauer and Resh 1996; Reice and Wohlenberg 1993; Klemm et al. 1990). In turn, algae are an important base component in the lotic food web, being responsible for the majority of photosynthesis in a river or stream and serving as an important food source to many benthic macroinvertebrates.

These significant functional roles that macroinvertebrates and algae play in the freshwater ecosystem stress the importance of these communities in the study of a stream's ecology. The proposed hydropower operations for the Susitna-Watana Hydropower Project will likely affect one or more of the factors that can affect the abundance and distribution of benthic macroinvertebrate and benthic algae populations. The degree of impact on the benthic communities and fish resulting from hydropower operations will necessarily vary depending on the magnitude, frequency, duration, and timing of flows as well as potential Project-related changes in temperature and turbidity. By investigating the current populations in the Susitna River, and applying what is known regarding the impacts of river regulation and hydropower operations on benthic communities, this study and its objectives may be able to [inform decisions on the need for and content of mitigation measures, offer important options for P&A and PM&E measures](#)

1.3.6. Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The proposed methods are outlined, by objective, below.

Objective 1: Develop a white paper on the impacts of hydropower development and operations (including temperature and turbidity) on benthic macroinvertebrate and algal communities.

- Review and summarize relevant literature on macroinvertebrate and algal community information in Alaska, including 1980s Susitna River data
- Review and summarize literature on general influences of changes in flow, temperature, substrates, nutrients, turbidity, light penetration, and riparian habitat on benthic communities
- Review and summarize the potential effects of dams and hydropower operations, including flushing flows and load following, on benthic communities and their habitats

Objective 2: Characterize the pre-Project benthic macroinvertebrate and algal communities with regard to species composition and abundance in the Susitna River.

- Use 1980 data as a baseline to compare and contrast historic and current community structure

- Sampling sites will be located in multiple locations above and below the proposed dam site (RM 184).
- Sampling collections will be conducted in riffle habitats within mainstem, tributary confluences, side channels, and sloughs
- Sampling will be stratified by reach and mainstem habitat type defined in the project specific habitat classification scheme.
- Sampling will occur in both study years (2013-2014) during a period from April through October, in order to capture seasonal community structure and productivity. In addition, a period of winter sampling would be conducted in February/March, in order to collect information on winter productivity. However, winter sampling would be limited to a select number of accessible open-water sites.
- Efforts will be made to locate sampling sites at transects established by the instream flow team, in an attempt to correlate with additional environmental data (flow, substrates, temperature, water quality, riparian habitat, etc) for statistical analyses, and HSC development.
- Measurements of depth, mean water column velocity, and substrate composition will be taken concurrently with benthic macroinvertebrate sampling at the sample location for use in HSC development in the instream flow studies
- Sampling methods will collect replicate samples (n=6) to allow for statistical testing of results for short and long-term monitoring.
- Benthic macroinvertebrate sampling will be collected using a stream-type sampler (Hess, Surber, Surber-on-a-Stick) commonly used for other Alaskan benthic macroinvertebrate studies, to allow for comparable results. State and federal protocols will be considered.
- Benthic macroinvertebrate samples will be processed in a laboratory, using methods compatible with studies in other comparable streams/basin in Alaska. State and federal protocols will be considered. For example:
 - Subsampling.
 - Identifications to genus for most taxa (exceptions being non-insect taxa).
 - Chironomidae identification level to be determined (family vs. subfamily vs. genus).
- Benthic macroinvertebrate sampling and algal sampling will be collected concurrently, to ensure correlation.
- Benthic algae sampling will be collected using methods compatible with other Alaskan benthic algal studies, to allow for comparable results. State and federal protocols will be considered.
- Measurements of depth, mean water column velocity, turbidity, and substrate composition will be taken concurrently with algal sampling at the sample location for use in HSC development in the instream flow studies.
- Benthic algal samples will be processed in a laboratory, using methods compatible with studies in other comparable streams/basin in Alaska. State and federal protocols will be considered.
 - Dry weight and chlorophyll a are typically BOTH done.
 - Algal (diatom) samples will be identified to genus.
- Invasive benthic macroinvertebrates and algae identified in the sample collections will be identified and locations noted.

Objective 3: Estimate drift of invertebrates in selected habitats within the Susitna River to assess food availability to juvenile and resident fishes.

- Use 1980 drift data as a baseline to compare and contrast historic and current invertebrate drift.
- Sampling sites will be located in multiple locations above and below the proposed dam site (RM 184).
- Sampling collections will be stratified by reach and conducted in riffle habitats within mainstem, tributary confluences, side channels, and sloughs.
- Twelve sampling sites should be located at sampling sites from the 1980s studies.
- Drift sampling will be conducted in conjunction with benthic macroinvertebrate sampling, to allow for comparison with the benthic community composition.
- Drift sampling will be conducted in daytime hours, as measure of constant (background) drift that is available to feeding fish.
- Sampling methods will collect duplicate samples to allow for statistical testing of results for short and long-term monitoring.
- Invertebrate drift sampling will be collected using a drift net sampler used for other Alaskan drift studies, to allow for comparable results. State and federal protocols will be considered.
- Invertebrate drift samples will be processed in a laboratory, using methods compatible with studies in other comparable streams/basin in Alaska. State and federal protocols will be considered. For example:
 - Subsampling.
 - Identifications to genus for most taxa (exceptions being non-insect taxa).
 - Chironomidae identification level to be determined (family vs. subfamily vs. genus).
 - Length measurements for individual specimens.

Objective 4: Conduct a literature search to identify existing river systems that could act as controls in evaluating future changes to productivity in the Susitna River. If feasible, collect data from these systems.

- Literature searches should focus on comparable river systems in Alaska and other cold climate regions.
- Information will be collected for turbid vs. non-turbid systems, especially those in glacial systems, with lakes.
- Compare and contrast benthic macroinvertebrate and algal communities from similar river systems with the with-Project Susitna River communities.
- Compare and contrast invertebrate drift results from similar river systems with the with-Project Susitna River invertebrate drift.
- Compare and contrast juvenile fish size at age and density from similar river systems with the with-Project Susitna River juvenile fish.

Objective 5: Develop a white paper and a modeling approach regarding a trophic analysis to describe potential changes in the primary and secondary productivity of the riverine community following post-project construction and operation.

- Review the abundant literature on the various existing approaches for trophic analyses, including methods, and levels of effort.

- Discuss the utility and feasibility of conducting a site-specific trophic analysis for the Susitna River.
- Investigate the ability of the river water quality model (Water Quality Modeling Study) to predict changes in primary productivity in the Susitna River with changes in turbidity and temperature.
- Conduct a trophic analysis based on the initial steps for this objective.

Objective 6: Generate HSC criteria for Susitna benthic macroinvertebrate and algal habitats to predict potential change in these habitats downstream of proposed dam site.

- Review the existing 1980s study (Hansen and Richards 1985) for applicable information and methodology.
- Coordinate data and transect information with F-S5 Instream Flow Planning Study.
- Review macroinvertebrate life histories, behavioral habits, and functional feeding groups to group taxa into guilds.
- Review literature for benthic macroinvertebrate and algae HSC criteria and their use for IFIM/PHABSIM/wetted perimeter analysis.
- Velocity, depth, and substrate data collected during benthic macroinvertebrate and benthic algae sampling (as stated in Objective 3) will be used to generate HSC criteria for Susitna benthic habitat use to predict potential change in benthic macroinvertebrate and algal habitats downstream of proposed dam site.
- Coordinate analysis and modeling efforts with the Instream Flow Team.

Objective 7: Characterize the benthic macroinvertebrate compositions in the diets of representative fish species in relationship to their source (benthic or drift component).

- Use 1980 data as a baseline to compare and contrast historic and current fish gut analyses
- Target fish species will be determined by consultation and coordination with fish distribution and abundance study teams (Fish Distribution and Abundance in the Middle and Lower Susitna River Study, Fish Distribution and Abundance in the Upper Susitna River Study, and/or Salmon Escapement Study teams)
- Coordinate with the appropriate fish study team for the collection and sampling of fish stomach contents
- Fish collection sites will correspond with benthic macroinvertebrate collection sites (both bottom and debris sampling) to allow for comparison with the benthic community composition.
- Fish gut content samples will be processed in a laboratory, using methods compatible with studies in other comparable streams/basin in Alaska. State and federal protocols will be considered.

Objective 8: Conduct a pilot study in 2013 to evaluate the feasibility of reference sites on the Talkeetna and Chilitna Rivers to monitor baseline productivity, pre- and post-construction.

- Sampling sites will be established on each of the two rivers in areas that are physically similar to those in the middle Susitna River, to assure comparability.
- Sampling collections will be conducted in riffle habitats within mainstem, side channels, and sloughs

- A minimum of six sample sites (two for each habitat type) would be established in each river, for a total of 12 sites.
- Sampling would occur approximately during the same periods as sampling in the Middle Susitna River (Objective 2), with seasonal sample collections during 2013.
- Benthic macroinvertebrate and benthic algal sampling methods and processing protocols would be identical to those used in sampling in the Middle Susitna River (Objective 2).
- Sampling results would be compared to results from similar sites in the Middle Susitna River to verify if the Talkeetna and/or Chulitna rivers would provide suitable reference sites.

Deliverable work products will include the following:

Draft Study Plan

Final Study Plan: The study plan for 2013-14 will be finalized in consultation with AEA, the Program Lead, resource agencies and other licensing participants.

Benthic Community Impact White Paper: The white paper summarizing the impacts of hydropower development and operations on benthic macroinvertebrate and algal communities will be prepared and presented to the Work Group as part of the Year 2012 studies.

Trophic Analysis White Paper: The white paper reviewing trophic analysis methodology, and its utility and feasibility for the Susitna River will be prepared and presented to the Work Group.

Summary of Interim Results: Interim reports will be prepared and presented to the Work Group to provide study progress. Reports will include up-to-date compilation and analysis of the data and ArcGIS spatial data products.

ArcGIS spatial products: Shape files of the sampling sites of river productivity studies will be created. All map and spatial data products will be delivered in the two-dimensional Alaska Albers Conical Equal Area projection, and North American Datum of 1983 (NAD 83) horizontal datum consistent with ADNR standards. Naming conventions of files and data fields, spatial resolution, and metadata descriptions must meet the ADNR standards established for the Susitna-Watana Hydroelectric Project.

Technical Memorandum: A technical memorandum summarizing the study results will be prepared and presented to resource agency personnel and other licensing participants, along with spatial data products.

1.3.7. Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

Initial cost estimates for completion of the eight study objectives above place the overall cost of this study at \$750,000. Efforts such as the white paper, literature review, trophic analysis, and HSC criteria development would be office-based studies. Collection of benthic macroinvertebrates and periphyton, with the addition of an analysis of fish feeding habits, would require at least four field efforts per year for the two study years. A majority of the work effort would be in the laboratory to subsample, sort, and identify the macroinvertebrate and periphyton specimens. The remainder of the study effort, after sample processing, would be office-based,

with data entry, analysis, and report synthesis. The schedule, staffing, and costs will be detailed as the 2013 - 2014 Study Plan develops

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