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SUSITNA-WATANA HYDRO

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Geomorphology Resources Study Plan Section 6 Introduction

Final Study Plan

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

July 2013

6 GEOMORPHOLOGY

6.1 Introduction

The overall goal of the geomorphology studies below Watana Dam is to assess the potential effects of the proposed Project on the fluvial geomorphology of the Susitna River, with particular focus on providing information to assist in predicting Project impacts to aquatic and terrestrial habitat. In general, the geomorphology studies will focus on the likely trends and magnitudes of responses of a suite of geomorphic characteristics that make up and control the quantity, quality and distribution of riverine habitat downstream from the proposed dam.

Natural river channels tend toward a state of dynamic equilibrium with the upstream water and sediment supply by adjusting their physical characteristics to the imposed conditions (Chorley et al. 1984; Lane 1955). These physical characteristics, that include gradient, channel geometry, planform and boundary materials, form the habitat that is used by the aquatic and riparian organisms, and they occur and adjust at a variety of spatial and temporal scales. An understanding of whether and how they will change under Project conditions is critical to understanding potential Project impacts to the habitat. An understanding of the equilibrium status of the existing channel morphology provides a significant part of the basis for determining the distribution and characteristics of the existing habitat, and it also provides the baseline against which potential Project-induced impacts will be compared. A key question that must be answered in this regard is whether changes in morphology will occur in response to the Project that will influence the relative distribution or characteristics of the habitat over the term of the license (Bovee 1982). This key issue prompts four overall questions that must be addressed by the two geomorphology studies:

- Is the system currently in a state of dynamic equilibrium?
- If the system is not currently in a state of dynamic equilibrium, what is the expected evolution over the term of the license in the absence of the project?
- Will and in what ways will the Project alter the equilibrium status of the downstream river (i.e., what is the expected morphologic evolution over the term of the license under with-Project conditions)?
- What will be the expected effect of the Project-induced changes on the quantity, distribution and quality of the habitat?

A suite of key indicators have been identified by the instream flow and riparian habitat specialists for assessing potential Project effects. These indicators are part of the Instream Flow Study (IFS) analytical framework (Section 8.5.4.1) developed to identify Project effects on aquatic and riparian resources. The framework is provided in Figure 6.1-1. These indicators in the IFS analytical framework include the following:

- Weighted-Useable-Area (WUA) versus flow relationships.
- Magnitude and frequency of breaching flows that provide connectivity between the main channels, secondary channels, and side sloughs.

- Hydraulic and geomorphic conditions that affect fish passage, particularly into tributaries along the study reach where changes in hydraulic energy in the mainstem associated with the Project could potentially impact the characteristics of tributary mouth bars.
- Changes in the magnitude and timing of flows under Project conditions that could affect other yet-to-be identified, ecologically important attributes, as quantified using Indicators of Hydrologic Alteration- (IHA) or Ecosystem Flow Component (EFC)-type analyses.
- Characteristics of spawning/incubation areas, particularly as they relate to mobilization and cleaning of fines from the spawning substrate, replenishment of suitably-sized spawning gravels, hydraulic conditions that provide aeration and prevent smothering of the redds due to fine sediment deposition during incubation, and the potential for dewatering due to lower stages during incubation.
- Characteristics of winter rearing habitat, including groundwater upwelling that affects water temperature, changes in stage that could affect connectivity with off channel habitat, and the potential for changes in aggradation/degradation patterns in key habitat areas.
- Characteristics of the varial zone, including the frequency and duration of wetting and dewatering, the timing and rate of downramping, and the associated potential for stranding and trapping of fish and benthic macroinvertebrates.

Construction and operation of the Project has the potential to alter a suite of geomorphologically significant factors that are directly related to the above habitat indicators, including river flow, sediment gradations, transport and delivery, bank erosion rates, rates of bar, island and floodplain formation and large woody debris (LWD) recruitment and transport in the Susitna River. Changes to these processes may affect channel and floodplain geomorphic units and their interactions and, therefore, aquatic and terrestrial habitat for an as yet undefined distance downstream of the Watana Dam site. Since in-channel and channel-margin habitats are formed and maintained by the interaction of a range of flows with the boundary materials, it is necessary to develop a full understanding of the dynamics of the existing system, including the equilibrium status to provide a supportable basis for predicting Project impacts on channel, island/bar and floodplain morphology and dependent habitats downstream of the Watana Dam. Specific conditions that must be understood include how hydraulic conditions, bed mobility, bank erosion, LWD recruitment and aquatic habitat change over the range of river flows, and the relative stability (i.e., rate of change) of the river with respect to lateral erosion, aggradation/degradation, and island and bar formation in the identified geomorphic reaches over recent decades. Operation of the reservoir also has the potential to change the morphology and dynamics of streams and hillsides around the reservoir, as deltas form at the stream/reservoir interface, and the sides of the reservoir are exposed to erosion and beach formation. An understanding of existing (i.e., baseline) geomorphic conditions is needed for predicting the likely extent and nature of potential changes to river, hillside, and delta morphology that would occur due to Project operations.

The geomorphology effort consists of two studies. The Geomorphology Study (Section 6.5) will investigate historical and current geomorphology and geomorphic/geologic controls of the Susitna River by geomorphic reach using available information and additional information collected as part of the licensing effort. This study will identify existing morphology, historic

changes in morphology over time along the Susitna River, and key physical processes governing the behavior of the river. This study will also provide an initial identification of potential Project effects within identified subreaches. In-channel (e.g., side channels, bars, islands) and channel margin (e.g. floodplain, side sloughs) geomorphic subunits are the foundations for the range of available habitats in the Susitna River, and thus, an analysis of river and floodplain morphology and morphologic change over time and space also provides a measure of the distribution and changes of habitats . The Fluvial Geomorphology Modeling Study (Section 6.6) will apply 1-D and 2-D hydraulic and bed evolution models to further quantify geomorphic processes in the existing river, equilibrium status of identified reaches and associated, potential Project effects on river geomorphology, and thus, habitats. An extensive data collection effort will be conducted as part of the Fluvial Geomorphology Modeling study. The understanding of the morphology and sedimentology of the system, and its governing physical processes gained from the integrated Geomorphology and Fluvial Geomorphology Modeling Studies will provide a rational basis for predicting and quantifying potential Project effects on habitat within the identified reaches of the Susitna River downstream of the Watana Dam site Studies in other resource areas, such as the instream flow studies (Section 8), will use this information to aid in quantifying Project effects for their resource areas. A key aspect of the integration between the various physical and biological studies will be the common use of the Focus Areas to jointly carry out integrated resource analysis.

The majority of the on-the-ground field data collection effort supporting both studies is encompassed in the Fluvial Geomorphology Modeling Study because the resulting data provides the information necessary to perform the 1-D and 2-D hydraulic and bed evolution modeling. The extensive field effort is described in the Bed Evolution Model Development, Coordination and Calibration Study component (Section 6.6.4.2). The exceptions are field data collection efforts described for the Bedload and Suspended Load Data Collection at Tsusena Creek, Gold Creek, and Sunshine Station on the Susitna River and the Chulitna River near Talkeetna (Section 6.5.4.2 to be performed by the USGS), Reservoir Geomorphology (Section 6.5.4.8), Large Woody Debris (Section 6.5.4.9), Geomorphology of Stream Crossings Along Transmission Line and Access Alignments (Section 6.5.4.10) study components of the Geomorphology Study. The coordination, integration, and interpretation of results between the Geomorphology Study and the Fluvial Geomorphology Modeling Study are described in Integration of Fluvial Geomorphology Modeling with the Geomorphology Study (Section 6.6.5.11) and Coordination and Interpretation of Model Results (Section 6.6.4.3). The collection of aerial photography supporting both studies is being conducted as part of the Geomorphology Study under the Riverine Habitat versus Flow Relationship Middle Susitna River Segment (Section 6.5.4.5) and Riverine Habitat versus Flow Relationship Lower Susitna River Segment (Section 6.5.4.7) study components.

The geomorphology studies will be subject to revision and refinements in consultation with licensing participants as part of the continuing study program identified in the ILP. The impact assessments will inform development of any necessary protection, mitigation, and enhancement measures to be presented in the draft and final License Applications.

6.2 Nexus Between Project Construction / Existence / Operations and Effects on Resources to be Studied

Construction and operation of the Project have the potential to alter river flow, sediment transport and delivery, and large woody debris (LWD) recruitment and transport in the Susitna River. Changes to these processes may affect channel morphology and aquatic habitat downstream of the Watana Dam site. Operation of the reservoir also has the potential to change the geomorphology of streams and hillsides around the reservoir as deltas form at the stream/reservoir interface and the sides of the reservoir are exposed to erosion and beach formation. Understanding existing, baseline geomorphic conditions, how geomorphic conditions and thus, aquatic habitat change over a range of stream flows, and how stable/unstable the geomorphic conditions have been over recent decades provides baseline information needed for predicting the likely extent and nature of potential changes to the fluvial geomorphology and associated habitats that would occur due to Project operations.

Changes in the channel morphology may alter the presence, physical characteristics, and function of important riverine aquatic habitat types such as side channels and sloughs. For example, reduction in sediment supply has the potential to cause channel downcutting and coarsening of bed material. In contrast, reduction in peak flow magnitude and changes in timing can result in sediment deposition both in the mainstream and at tributary mouths. The regulated hydrology may affect the rates and timing of sediment transport that ultimately govern formation and maintenance of dynamic aquatic habitats, as well as access to these habitats. Analysis of the complex interactions of water and sediment with the channel and floodplain boundaries to evaluate existing conditions and potential Project effects requires development and application of a sediment transport model.

AEA's Susitna Water Quality and Sediment Transport Data Gap Analysis Report (URS 2011) indicated that further quantification of the sediment supply and transport capacity would help identify the sensitivity of the channel morphology (and associated aquatic habitats) to the effects of the proposed Project. The report indicated that information on sediment continuity could provide a basis for evaluating whether the Susitna River below the Chulitna River confluence is currently aggradational and/or would be at risk of becoming more strongly aggradational to a sufficient degree to alter aquatic habitats and hydraulic connectivity to these habitats. The report also pointed out that side channels and sloughs are of particular importance to fish habitat, and changes to the relationships between flow and stage at which the habitats are accessible could affect habitat. These relationships can be affected by not only distribution of flows, but also changes in the bed elevations due to sediment transport processes. Other impacts to the sediment transport regime could affect cleaning and maintenance of spawning gravels, hyporheic flows through redds, groundwater inflows, and hydraulic connectivity for out-migration to the main channel.

6.3 Resource Management Goals and Objectives

Several natural resources agencies have jurisdiction over aquatic species and their habitats in the Project area. These agencies will be using in part, the results of the Geomorphology Study, Instream Flow Study, and other fish and aquatic studies to satisfy their respective mandates. The following federal and state agencies and Alaska Native entities have identified their resource

management goals, or provided comments in the context of FERC licensing, related to geomorphology, instream flow, and riparian resource issues.

6.3.1 National Marine Fisheries Service

The following text is an excerpt of the May 31, 2012, National Marine Fisheries Service (NMFS) letter and Geomorphology Study Request:

> *"NMFS is entrusted with federal jurisdiction over marine, estuarine, and anadromous fishery resources under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C.§ 1801 et seq, the Anadromous Fish Conservation Act (16 U.S.C. 757a-757g; Pub. L. 89-304, as amended), and the Pacific Salmon Treaty Act (16.U.S.C. §3631, et seq.). Section 305(b) of the MSA requires federal agencies to consult with NMFS on all actions that adversely affect Essential Fish Habitat (EFH). Where, in the judgment of NMFS, the proposed action would adversely affect EFH, NMFS is required to make EFH Conservation Recommendations, Section 10(j) of the Federal Power Act (FPA) authorized NMFS to recommend license terms and conditions necessary to protect, mitigate damage to, and enhance fish and wildlife habitat affected by the project. Section 18 of the FPA provides NMFS authority to issue mandatory fishway prescriptions. In addition, NMFS has the responsibilities related to FERC proceedings derived from the Fish and Wildlife Coordination Act, Endangered Species Act, and the Marine Mammal Protection Act.*
>
> *NMFS resource management objectives derived from these authorities include:*
>
> - *Maintaining native and natural aquatic communities for their intrinsic and ecological value ant their benefits to people. This includes habitat protection and maintenance to ensure the health and survival of all species and natural communities.*
> - *Maintaining stream flow regimes sufficient to sustain native riparian and aquatic habitats in the project-affected stream reaches.*
> - *Maintaining the diversified use of fish and wildlife including commercial, recreational, scientific and educational purposes.*
> - *Protecting, conserving and enhancing native fishes and their habitats by maintaining their access to suitable and fully functioning habitats.*
> - *Identifying and implementing measures to protect, mitigate, or minimize direct, indirect and cumulative impacts to native anadromous fish resources, including related spawning, rearing and migration habitats and adjoining riparian habitats.*
> - *Maintaining riparian resources, channel conditions, and aquatic habitats.*
> - *Maintaining stream flow regimes sufficient to sustain desired conditions of native riparian, aquatic, and wetland habitats.*
> - *Protecting aquatic systems to which species are uniquely adapted."*

6.3.2 U.S. Fish and Wildlife Service

The following text is an excerpt of the May 31, 2012, U.S. Fish and Wildlife Service (USFWS) Geomorphology Study Request:

"The overarching resource management goal of the USFWS is described in our mission:

> *to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people.*

The U.S. Fish and Wildlife Service (USFWS), is providing comments in accordance with provisions of the National Environmental Policy Act (NEPA) of 1969 (83 Stat. 852; 42 U.S.C. 4321 et seq.), Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), Bald and Golden Eagle Protection Act (BGEPA) (54 Stat. 250, as amended, 16 U.S.C. 668a-d), Migratory Bird Treaty Act (MBTA) (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), and Federal Power Act (16 U.S.C. § 791 et seq.). .).

Under Section 18 of the Federal Power Act (FPA), the National Marine Fisheries Service

(NMFS) and USFWS have authority to issue mandatory fishway prescriptions for safe, timely, and effective fish passage. Under Section 10(j) of the FPA, NMFS and USFWS are authorized to recommend license conditions necessary to adequately and equitably protect, mitigate damages to, and enhance, fish and wildlife (including related spawning grounds and habitat) affected by the development, operation, and management of hydropower projects. Section 10(a)(1) of the FPA requires the Federal Energy Regulatory Commission to condition hydropower licenses to best improve or develop a waterway or waterways for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat) based on NMFS and USFWS recommendations and plans for affected waterways. Specific management goals are the protection of anadromous, trust fish species and their habitats.

Consistent with our mission and with the legal authorities described above, our resource goal in this matter is to conserve existing fish and wildlife resources and their habitats in the Susitna River basin. With regard to fish passage, we will recommend scientifically-based and coordinated studies, collaborate with others, and ensure development of the best information possible to inform potential development of fishway prescriptions for this project pursuant to Section 18 of the Federal Power Act."

6.3.3 Alaska Department of Fish and Game

The following text is an excerpt of the May 30, 2012, Alaska Department of Fish and Game (ADF&G) letter and Instream Flow Study Request:

> *"The Fish and Game Act requires the Alaska Department of Fish and Game to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020)."*

6.3.4 Alaska Native Entities

6.3.4.1 Chickaloon Village Traditional Council

The Chickaloon Native Village provided comments on Project licensing activities in a May 31, 2012, letter to the FERC. Chickaloon Native Village is a federally recognized Alaska Native tribe. Chickaloon Village is an Ahtna Athabascan Indian Tribe governed by the nine-member Chickaloon Village Traditional Council. The Chickaloon Village Traditional Council strives to increase traditional Ahtna Dene' practices for the betterment of all residents in the area. Preserving and restoring the region's natural resources is one way of supporting Ahtna culture and the regional ecosystem. Concerning the potential effects of the Project on the geomorphology of the Susitna River, the Chickaloon Native Village wrote:

> *"The whole sediment transport system of the Susitna River will be changed by the proposed dam. Only the smaller sediment particles will pass downstream, as the dam will trap the larger particles. Since the substrate size for salmon redds varies by salmon species, studies must be conducted to ensure that the appropriate sediment particle sizes will be present for the salmon spawning habitats."*

6.4 Summary of Consultation with Agencies, Alaska Native Entities, and Other Licensing Participants Regarding Revised Study Plan Development

The geomorphology study plans have been modified in response to comments from various agency reviewers, including NMFS, the Alaska Department of Environmental Conservation (ADEC), and USFWS. Consultation on the Revised Study Plan (RSP) occurred during licensing participant meetings on April 6, 2012, and during the June 14, 2012 Water Resources Technical Workgroup (TWG) meeting. At the June 2012 TWG meeting, study requests and comments from the various licensing participants were presented and discussed, and refinements were determined and agreed-upon to address modifications to the draft study plans. The ILP formal study plan presentation meeting was held for the Geomorphology Study on August 17, 2012. On September 14, 2012 a TWG meeting was held to present and discuss the preliminary selection of Focus Areas. On October 2, 2012, a TWG meeting was held to discuss instream flow modeling and included a discussion of the integration with the geomorphology studies. This meeting was followed by a one-and-one-half day field reconnaissance conducted on October 3 and 4, 2012 with agency representatives to tour three of the proposed Focus Areas and discuss riparian, groundwater, geomorphology, fish habitat sampling and modeling. The field reconnaissance was followed by a two hour informal debrief meeting on the afternoon of October 4, 2012. On October 22, a TWG meeting was held to update the agencies on progress in the development of the RSP. As part of this meeting, comments received since the July filing of the Preliminary Study Plan (PSP) and associated responses and modifications being incorporated in the RSP were discussed.

Summary tables of comments and responses from formal comment letters filed with FERC through November 14, 2012, were provided in RSP Appendix 1 filed December 14, 2012. Copies of the formal FERC-filed comment letters were included in RSP Appendix 2. In addition, a single comprehensive summary table of comments and responses from consultation,

dated from PSP filing (July 16, 2012) through release of Interim Draft RSPs, was provided in RSP Appendix 3. Copies of relevant informal consultation documentation were included in RSP Appendix 4, grouped by resource area.

Consultation subsequent to the filing of the RSP is described within each Final Study Plan (FSP).