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March 1, 2013

Ms. Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: Susitna-Watana Hydroelectric Project, FERC Project No. 14241-000; Filing of 2012 Baseline Environmental and Resources Study Reports

Dear Secretary Bose:

As explained in its Pre-Application Document and Revised Study Plan (RSP) for the proposed Susitna-Watana Hydroelectric Project, FERC Project No. 14241 (Project), the Alaska Energy Authority (AEA) carried out numerous baseline environmental and resources studies related to the proposed Project during the 2012 field season. Because the 2012 studies occurred prior to the commencement of the study phase of the licensing effort under the Federal Energy Regulatory Commission's (Commission) Integrated Licensing Process, AEA was not required to complete these baseline studies. However, AEA voluntarily undertook these studies for purposes of taking advantage of the 2012 field season to gather environmental data related to the proposed Project, and to help inform the scope and methods of the licensing studies during 2013-14, as set forth in AEA's RSP.

As AEA has completed the study reports associated with these 2012 baseline environmental and resources studies, it has made the study reports publicly available by uploading them to the "Documents" page of its licensing website, http://www.susitna-watanahydro.org/type/documents/. The purpose of this filing is to submit these study reports to the Commission's record for the above-referenced Project.

In particular, the following study reports are attached, all of which are relevant to the Commission's study plan determination scheduled for April 1, 2013:

- Attachment A: *Adult Salmon Distribution and Habitat Utilization Study* (January 2013)
- Attachment B: *Synthesis of Existing Fish Population Data* (February 2013)
- Attachment C: *Mercury Assessment and Potential for Bioaccumulation* (February 2013)

- Attachment D: *Technical Memorandum, Susitna River Large Woody Debris Reconnaissance* (March 2013)

- Attachment E: *Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam* (February 2013)

- Attachment F: *Technical Memorandum, Reconnaissance Level Assessment of Potential Channel Change in the Lower Susitna River Segment* (February 2013)

- Attachment G: *Stream Flow Assessment* (February 2013)

- Attachment H: *Development of Sediment-Transport Relationships and an Initial Sediment Balance for the Middle and Lower Susitna River Segments* (February 2013)

- Attachment I: *Technical Memorandum, Initial Geomorphic Reach Delineation and Characterization, Middle and Lower Susitna River Segments* (February 2013)

As the remaining 2012 study reports are finalized, AEA will continue to update its website and submit them to the record.

If you have questions concerning this submission, please contact me at wdyok@aidea.org or (907) 771-3955.

Sincerely,

Wayne M Dyok

Wayne Dyok
Project Manager
Alaska Energy Authority

Attachments

cc: Distribution List (w/o Attachments)

Attachment D

Technical Memorandum, Susitna River Large Woody Debris Reconnaissance (March 2013)

Technical Memorandum
Susitna River Large Woody Debris Reconnaissance

Susitna- Watana Hydroelectric Project

FERC No. 14241

Alaska Energy Authority

March 1, 2013

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Term	Definition
Active floodplain	The flat valley floor constructed by river during lateral channel migration and deposition of sediment under current climate conditions.
Aggradation	1. Geologic process in which inorganic materials carried downstream are deposited in streambeds, floodplains, and other water bodies resulting in a rise in elevation in the bottom of the water body. 2. A state of channel disequilibrium, whereby the supply of sediment exceeds the transport capacity of the stream, resulting in deposition and storage of sediment in the active channel.
Alluvial	Relating to, composed of, or found in alluvium.
Bank	The sloping land bordering a stream channel that forms the usual boundaries of a channel. The bank has a steeper slope than the bottom of the channel and is usually steeper than the land surrounding the channel.
Braid	Pattern of two or more interconnected channels typical of alluvial streams.
Channel	A natural or artificial watercourse that continuously or intermittently contains water, with definite bed and banks that confine all but overbank streamflows.
Confinement	Ratio of valley width (VW) to channel width (CW). Confined channel VW:CW <2; Moderately confined channel VW:CW 2-4; Unconfined channel VW:CW >4.
Confluence	The junction of two or more streams.
Cubic feet per second (cfs)	A standard measure of the total amount of water passing by a particular location of a river, canal, pipe or tunnel during a one second interval. One cfs is equal to 7.4805 gallons per second, 28.31369 liters per second, 0.028 cubic meters per second, or 0.6463145 million gallons per day (mgd). Also called second-feet.
Deposition	The settlement or accumulation of material out of the water column and onto the streambed.
Disturbance regime	Floodplain vegetation disturbance types found within the Susitna River Study Area corridor include: channel migration (erosion and depositional processes), ice processes (shearing impacts, flooding and freezing), herbivory (beaver, moose, and hare), wind, and, to an infrequent extent, fire. Floodplain soil disturbance is primarily ice shearing and sediment deposition.
Drainage area	The total land area draining to any point in a stream. Also called catchment area, watershed, and basin.
Embeddedness	The degree that larger particles (boulders, large wood, rubble, or gravel) are surrounded or covered by fine sediment. Usually measured in classes according to percent of coverage.
Floodplain	1. The area along waterways that is subject to periodic inundation by out-of-bank flows. 2. The area adjoining a water body that becomes inundated during periods of over-bank flooding and that is given rigorous legal definition in regulatory programs. 3. Land beyond a stream channel that forms the perimeter for the maximum probability flood. 4. A relatively flat strip of land bordering a stream that is formed by sediment deposition. 5. A deposit of alluvium that covers a valley flat from lateral erosion of meandering streams and rivers.
Geomorphic mapping	A map design technique that defines, delimits and locates landforms. It combines a description of surface relief and its origin, relative age, and the environmental conditions in which it formed. This type of mapping is used to locate and differentiate among relief forms related to geologic structure, internal dynamics of the lithosphere, and landforms shaped by external processes governed by the bio-climate environment.

Term	Definition
Geomorphology	The scientific study of landforms and the processes that shape them.
Gradient	The rate of change of any characteristic, expressed per unit of length (see Slope). May also apply to longitudinal succession of biological communities.
Gravel	Substrate particles between 0.1 and 3.0 inches in size, larger than sand and smaller than cobble.
Groundwater	In general, all subsurface water that is distinct from surface water; specifically, that part which is in the saturated zone of a defined aquifer.
Habitat	The environment in which the fish live, including everything that surrounds and affects its life, e.g. water quality, bottom, vegetation, associated species (including food supplies). The locality, site and particular type of local environment occupied by an organism.
Ice dam	A stationary accumulation of fragmented ice or frazil that restricts or blocks a stream channel.
Large woody debris (LWD)	Pieces of wood larger than 10 feet long and 6 inches in diameter, in a stream channel. Minimum sizes vary according to stream size and region.
Instream flow	The rate of flow in a river or stream channel at any time of year.
Pool	Part of a stream with reduced velocity, often with water deeper than the surrounding areas, which is usable by fish for resting and cover.
Riparian	Pertaining to anything connected with or adjacent to the bank of a stream or other body of water.
Riparian vegetation	Vegetation that is dependent upon an excess of moisture during a portion of the growing season on a site that is perceptively more moist than the surrounding area.
River	A large stream that serves as the natural drainage channel for a relatively large catchment or drainage basin.
River mile	The distance of a point on a river measured in miles from the river's mouth along the low-water channel.
Scour	The localized removal of material from the streambed by flowing water. This is the opposite of fill.
Sediment	Solid material, both mineral and organic, that is in suspension in the current or deposited on the streambed.
Three Rivers Confluence	The confluence of the Susitna, Chulitna, and Talkeetna rivers at Susitna River Mile (RM) 98.5 represents the downstream end of the Middle River and the upstream end of the Upper River.
Wood recruitment	Process by which large woody debris is transferred from upland or riparian communities to the river system.

1. INTRODUCTION

The Alaska Energy Authority (AEA) is preparing a license application that will be submitted to the FERC for the Susitna-Watana Hydroelectric Project (Project) using the Integrated Licensing Process. The Project is located at RM 184 on the Susitna River, an approximately 300-mile long river in the South central region of Alaska (Figure 1). As currently envisioned, the Project would include a large dam with an approximately 35,000-acre, 41-mile long reservoir. Project construction and operation would have an effect on the flows downstream of the dam site, the degree of which will ultimately depend on final Project design and operations. Key flow changes will likely occur in the form of load following during the critical winter months of November through April each year. Seasonal variation will result in flows higher during the winter months and lower during summer reservoir refill. The alteration in flows would influence downstream resources and processes, including fish and aquatic biota, and their habitats and riparian and wildlife communities. Alterations to channel form and function would include sediment transport, large woody debris recruitment and transport, water quality, groundwater/surface water interactions, and ice dynamics.

Potential impacts of Project operations on large woody debris recruitment, transport and function, and subsequent effects upon geomorphologic processes include: (1) operations alterations of the extent and area of winter river ice and spring river ice break-up associated large woody debris transport, (2) changes in the deposition pattern of large woody debris down river from the Project dam site, (3) changes in the pattern of in-channel habitat associated with large woody debris resulting from recruitment and transport changes, (4) changes in pattern of wood generated patchwork floodplain development below the Three Rivers confluence, (5) changes in floodplain forest large woody debris source area and volume of wood down river of the Project dam site, and (7) changes in large woody debris generated side channel formation.

The potential operational flow-induced effects of the Project will be evaluated as part of the licensing process, through studies spanning 2012 through 2014. The evaluation is important from both the impact minimization and operational optimization perspectives. In both cases, AEA desires to move from study results to decisions affecting flow releases in terms of (i) timing (seasonal, daily, diurnal), (ii) steady flow rates, and (iii) unsteady flow rates. These three aspects of flow regime influence physical habitat quantity and quality and geomorphic processes, which in turn influence carrying capacity and overall suitability for target fish species and riparian vegetation.

As part of the broader geomorphology study, *Study Component G-1.9: Large Woody Debris* will be conducted in 2013-2014 (see Section 6.5.4.9 of the Revised Study Plan (RSP) submitted to FERC December 14, 2012). The goal of the Large Woody Debris study is to assess the potential for project construction and operations to affect the recruitment, transport, storage and function of large woody debris in the Susitna River. The Susitna River Large Woody Debris Reconnaissance was identified as an original task of Riparian IFS 2012 work plan. This study was conducted to support development of the final 2013-2014 Large Woody Debris Study plan, *Study Component G-1.9: Large Woody Debris*. The Large Woody Debris Reconnaissance effort was implemented in coordination with, and conducted during, the 2012 Riparian Vegetation Study.

This technical memorandum reports preliminary observations of the role and function of Susitna River large woody debris made by the Riparian Vegetation Survey team over a 10-day period between June 23, 2012 and July 3, 2012. The 2012 large woody debris reconnaissance data will inform operations planning for the 2013-2014 Geomorphology Large Woody Debris Study by providing an on-the-ground and aerial overview of the types of large wood and wood debris accumulations throughout the Project Area (see RSP Section 6.5.4.9). In this technical memorandum we first define large wood terminology and then discuss the role of large wood in rivers. Second, we present study objectives. Third, we present photographic, and narrative, observations of Susitna River woody debris types, processes and functions.

1.1. Role and Function of Wood Debris

Large woody debris, hereafter referred to as "wood debris," is a fundamental geomorphic element in forested river networks (Collins et al. 2012; Montgomery et al. 2003). Wood debris has been identified to play a significant role in coastal Pacific rivers in the formation of fish habitat including pools and sediment sorting; channel planform type; generation of anastomozing/anabranching channel pattern; development of patchwork floodplains; and development of floodplain forests (Collins et al., 2012; Abbe and Montgomery 1996 and 2003; Montgomery et al. 2003). For consistency, wood debris nomenclature proposed by Abbe and Montgomery (2003) will be utilized throughout this technical memorandum and is provided in Tables 1 and 2.

1.2. Susitna River Floodplain Forests

The size of logs has been shown to be a principal factor controlling log stability in river channels (Abbe and Montgomery 2003). Log length, diameter, and root wad occurrence all contribute to log stability and geomorphic and habitat functions (Abbe and Montgomery 1996; Abbe and Montgomery 2003; Collins et al. 2012). Floodplain forests are the primary source of in-channel wood debris. Regionally specific floodplain forest tree composition and size contributes to regional variations in the types and degree of wood debris functions (Collins et al. 2012). For example, floodplain forests of the Olympic Mountains in coastal Washington State have very large diameter Sitka spruce (*Picea sitchensis*) that form frequent, large stable wood jams (Abbe and Montgomery 1996, 2003). Key member pieces in Olympic River channels have been measured at approximately 1.5 meters in diameter. By comparison, dominant trees of Susitna River floodplain forests−Balsam poplar (*Populus balsamifera*), White spruce (*Picea glauca*), paper birch (*Betula papyrifera*)−are much smaller in stature due, in part, to the shorter growing season in south central Alaska (Table 3; Helm and Collins 1997). Given that the size of logs controls log stability (Abbe and Montgomery 1996), it would be expected that Susitna floodplain balsam poplar (average DBH, 53 cm; DBH is tree diameter at breast height 1.4 above ground surface), white spruce (average DBH 26 cm), and paper birch (average DBH 28 cm) wood debris would produce smaller and less geomorphically functional wood jams than those found in coastal Pacific northwest rivers with larger stature trees. Furthermore, in contrast to coastal Pacific Northwest Rivers, the Susitna River is strongly influenced by the effects of river ice that effectively entrains unstable pieces of wood during annual spring river ice break-up mobilizing and transporting wood through the network.

1.3. Study Objectives

The objectives of the Susitna River Large Woody Debris study are as follows:

(1) provide the Geomorphology team with on-the-ground preliminary observations of the role and function of wood debris in the Susitna River;
(2) document and photograph occurrence and distribution of wood debris and wood debris accumulations both in-channel and on the floodplain; and
(3) provide observations concerning wood debris recruitment, transport, types of accumulations, and function.

1.4. Study Area

The 2012 riparian vegetation survey included the middle and lower Susitna River from the Project dam site (River mile 184) to the town of Willow (Figures 1 and 2). The vegetation survey study area, on-the-ground surveys, extended laterally from active channel edge approximately 200 meters across the floodplain to adjacent hillslopes (Figure 2). Large woody debris was observed and documented from both aerial surveys of the study area as well as on-the-ground observations during the riparian vegetation survey.

2. METHODS

Wood debris reconnaissance was conducted during the riparian vegetation survey over a 10-day period between June 23 2012 and July 3 2012. The entire study area was flown by helicopter and aerial photographic surveys of wood debris were conducted (Figure 2). On-the ground photographs and observations were made of wood debris encountered during the riparian vegetation survey. Photo-documentation focused on characterizing the following woody debris processes and elements: (1) wood recruitment, (2) wood transport, (3) wood debris and channel formation, including channel splitting and island development, (4) wood debris and channel bank stabilization, (5) stable wood jams and associated scour pools, and (6) unstable wood debris. Additionally, field measurements were made of select stable large wood piece diameters and length at a number of locations.

3. RESULTS AND DISCUSSION

3.1. Wood Recruitment Processes

Trees are recruited to river channels through a number of physical disturbance processes including: wind throw, wind snap, fire, bank erosion, beavers, and debris flows. Based upon summer 2012 observations, and review of previous studies of Middle Susitna River channel and floodplain stability (Labelle et al. 1985), it appears that most wood within the Middle Susitna River is recruited through wind throw, wind snap, and bank erosion (channel migration and ice process driven). Analysis of geomorphic change within the Middle Susitna River indicates that channel planform is relatively stable, at least since 1949 (Labelle et al. 1985). Therefore, current wood debris input in the Middle Susitna River does not appear to result from major channel migration and bank erosion, although significant episodic floodplain erosion and large wood recruitment may occur on the Susitna River.

Incremental wind throw and wind snap of large trees, primarily Balsam poplar, along floodplain margins, and incremental bank erosion were the primary recruitment processes observed in summer 2012 (Photographs 1-3). Many mid-channel trees observed being transported below the Three Rivers confluence have attached root wads, evidence of a recent bank erosion recruitment (Photographs 4-8). Although details were not documented for this report, the 78,000 cfs flood event of September 22, 2012 (Gold Creek gage) was observed in early October, 2012 to have caused large scale recruitment of trees to the river as a result of bank erosion.

3.2. Wood Transport

Wood transport, in June and July 2012, was observed to be predominantly occurring at and below the Three Rivers Confluence (Photographs 4, 5, 6, 9, 10). The Chulitna River appears to be a major source of the wood transported into the Lower Susitna River (Photographs 4-6) as large amounts of wood were observed in the main stem Chulitna River at Three Rivers Confluence. The braided reach below Three Rivers Confluence is a transport limited segment of the Susitna River as evidenced by both channel braiding and the large amount of deposited racked and unstable wood debris (Photographs 9 and 10). Wood transport was observed in the Middle Susitna; however, it was limited to single trees with root wads attached, evidence of incremental bank erosion recruitment (Photographs 7 and 8).

Ice processes, ice break-up and ice damming, likely have dramatic effects on initiating transport of wood debris through the channel network. The shear forces of moving ice would easily entrain wood during ice break-up causing large scale transport of unstable wood debris. Therefore, annual ice break-up likely initiates mass transport of wood debris. Furthermore, ice damming and associated backwater increases in flood stage is also likely to mobilize and transport any unstable wood.

3.3. Wood Debris: Channel Formation, Channel Splitting, and Island Development

Wood debris has been documented to influence channel form and development, floodplain formation, and island development influencing the formation of valley wide channel and floodplain planform and associated aquatic and riparian habitat (Collins et al. 2012). Wood debris was observed in 2012 to be associated with islands (Photographs 13, 14, 15, 16, 19, 20, 21, 23, 25, 26), channel splits (Photographs 15, 16, 18, 19) and side channel confluences (Photographs 22 and 24). The role that wood debris plays in Susitna River channel, floodplain and island formation needs to be further documented in terms of occurrence of key member size and function. This will occur in the geomorphology study, *Study Component G-1.9: Large Woody Debris* to be conducted in 2013-2014 (see Section 6.5.4.9 of the Revised Study Plan (RSP) submitted to FERC December 14, 2012).

3.4. Stable Wood Jams

Stable wood jams are accumulations of wood debris anchored by key members (Tables 1 and 2; Abbe and Montgomery 2003). Wood debris accumulations, or “jams,” may be classified as to whether wood debris has been fluvially transported some distance downstream, or not, and further typed based upon systematic ways in which jams form and affect alluvial terrain and habitat forming processes (Tables 1 and 2; Abbe and Montgomery 2003). It is beyond the scope of this memorandum to differentiate all of the 2012 reconnaissance observations by wood jam type. However, significantly, the vast majority of wood debris and wood debris accumulations observed during the 2012 reconnaissance survey appear to be unstable racked members and not stable wood jams anchored by large key member sized wood. Most of the wood debris observed appears to be transported long distances, multiple active channel widths, through the channel network. On-the-ground surveys are necessary to confirm this observation.

Also, observed stable wood jams were associated with scour pools, islands, channel embankments, and side channel complexes (Photographs 12-17, 19-30).

3.5. Wood Debris and Bank Stabilization

In large alluvial rivers, such as the Susitna, recruitment of floodplain streamside trees through bank erosion can result in wood debris structures composed of logs hydraulically aligned parallel to the channel bank that become embedded into the floodplain further stabilizing channel banks (Abbe and Montgomery 2003; Photographs 12, 17, 27, 28, 29, 30). Additionally, loose mobile wood debris was observed accumulating along river embankments forming unstable wood debris accumulations (Photographs 12, 17, 28, 29, 30).

3.6. Unstable Wood Debris

Bar top accumulations of unstable wood debris appear to be a defining characteristic of the Susitna River. Large quantities of unstable wood debris were observed throughout the Project study area with largest accumulations occurring in the Lower Susitna (Photographs 9, 10, 21) with apparently large contributions from the Chulitna River. However, unstable wood debris was observed throughout both Middle and Lower River segments during the 2012 aerial reconnaissance (Photographs 16, 21, 31, 32, 33, 34, 35, 36, 37). Loose, mobile wood was observed along river banks (Photographs 2, 3), mid channel islands (Photographs 18, 20), and throughout side channel complexes (Photographs 16, 17, 18, 21, 34).

4. REFERENCES

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5. TABLES

Table 1. Wood debris terminology.

Wood Debris Terminology[1]	
Key member	Large wood anchoring other woody debris
Racked member	Wood debris lodged against a channel obstruction (e.g., boulder, key member, or other debris)
Loose member	Wood debris filling wood jam interstitial space; add little physical integrity to the jam.
Wood jam	Stable accumulation of wood debris associated with key member.

Notes:

1. After Abbe and Montgomery (2003).

Table 2. Basic wood debris accumulation typology.

Basic Wood Debris Accumulation Typology[1]	
Types	**Distinguishing characteristics**
In-situ (autochthonous)	Key member has not moved down channel
Bank input	Some or all of key member in channel
Log steps	Key member forming log step in channel bed
Combination	In-situ key members with additional racked wood debris
Valley	Jam width exceeds channel width and influences valley bottom
Flow deflection	Key members may be rotated, jam deflects channel course
Transport (allochthonous)	Key members moved some distance downstream.
Debris flow/flood	Chaotic wood debris accumulation, key members uncommon or absent, catastrophically emplaced.
Bench	Key members along channel edge forming bench-like surface.
Bar apex	One or more distinct key members downstream of jam, often associated with development of bar and island.
Meander	Several key members buttressing large accumulation of racked wood debris upstream. Typically found along outside of meanders.
Raft	Large accumulation of wood debris capable of plugging even large channels and causing significant backwater.
Unstable	Unstable accumulations composed of racked wood debris upon bar tops or pre-existing banks.

Notes:

1. After Abbe and Montgomery (2003).

Table 3. Middle and Lower Susitna River dominant floodplain tree characteristics (from Helm and Collins 1997).

Tree species	Common name	DBH (cm)	Height (m)
Populus balsamifera	Balsam poplar	53.2 ±2.4	24.7 ±0.5
Picea glauca	White spruce	26.3 ±1.8	13.8±1.0
Betula papyrifera	Paper birch	28.1±1.5	12.8±0.6

6. FIGURES

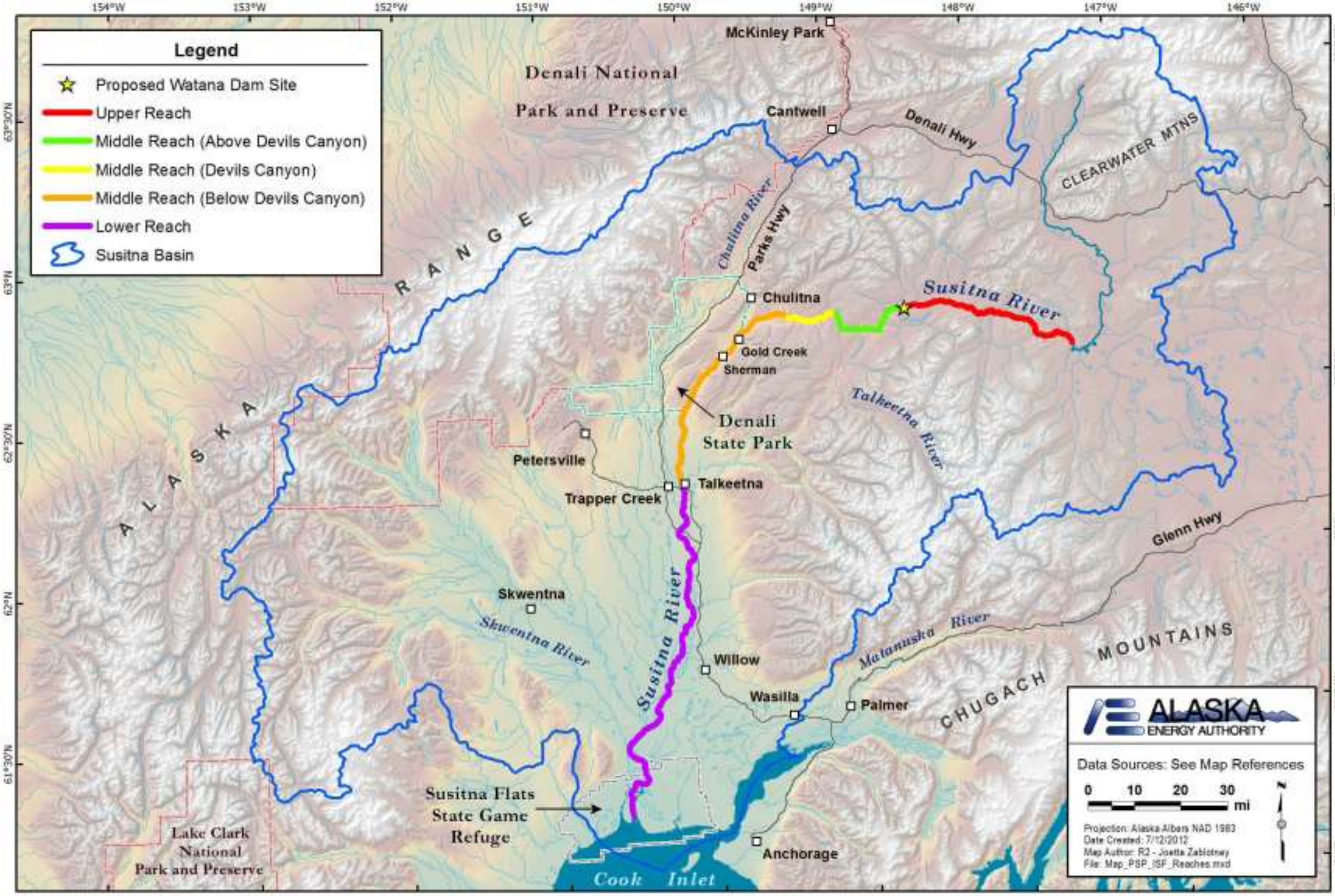

Figure 1. Susitna River Project Area.

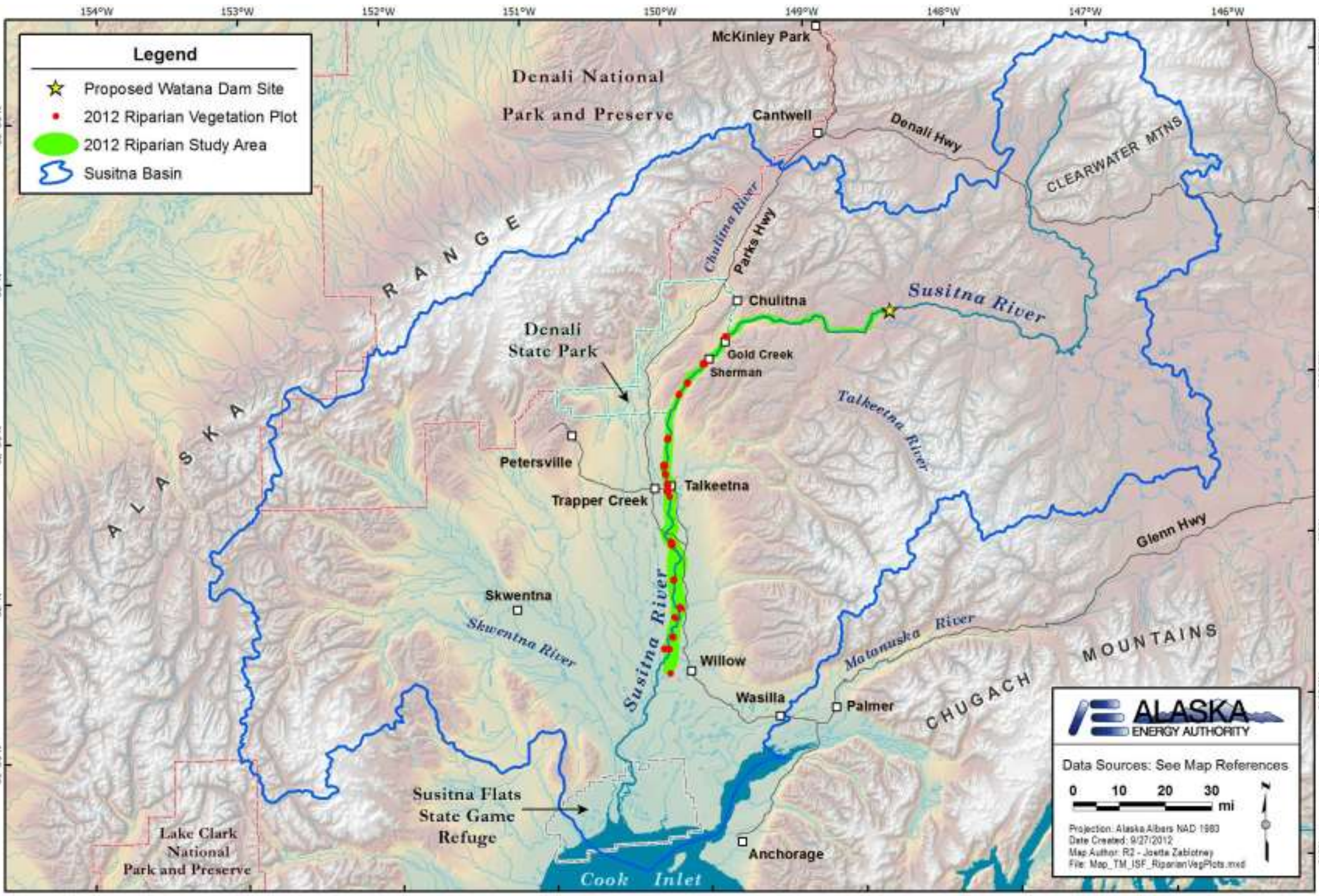

Figure 2. 2012 Riparian Vegetation Survey Study Area.

7. PHOTOGRAPHS

Photographic Documentation of Role and Function of Susitna River Wood Debris

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7.4 Wood Debris: Channel Splitting & Island Formation
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7.1. Wood Recruitment

Photograph 1. June 26, 2012 Susitna Middle River between Three Rivers Confluence and Gold Creek. Wind snapped and wind throw balsam poplar recruitment to channel.

Photograph 2. June 26, 2012 Middle Susitna River between Three Rivers Confluence and Gold Creek. Bank erosion and wind throw balsam poplar wood recruitment.

Photograph 3. June 26, 2012 Middle Susitna River between Three Rivers Confluence and Gold Creek. Wind snap balsam poplar recruitment.

7.2. Wood Debris: Transport

Photograph 4. June 26, 2012 Three Rivers (Susitna, Chulitna, and Talkeetna rivers) Confluence. Fresh recruited balsam poplar transport.

Photograph 5. June 26, 2012 Three Rivers (Susitna, Chulitna, and Talkeetna rivers) Confluence. Fresh recruited balsam poplar transport.

Photograph 6. June 26, 2012 Three Rivers (Susitna, Chulitna, and Talkeetna rivers) Confluence balsam poplar transport.

Photograph 7. June 26, 2012 Middle Susitna River immediately upstream of Three Rivers Confluence. Freshly recruited white spruce.

Photograph 8. June 26, 2012 Middle Susitna River wood transport. Paper birch deposited on a mid-channel island bar.

Photograph 9. June 30, 2012 Lower Susitna River between Talkeetna and Willow. Large wood transport and deposition. Root wads are facing upriver. Flow is from right to left.

Photograph 10. June 30, 2012 Lower Susitna River between Talkeetna and Willow. Large wood transport and deposition. Root wads are facing upriver. Flow is from left to right.

7.3. Wood Debris: Stable Log Jams and Scour Pools

Photograph 11. July 2, 2012 Lower Susitna River below Talkeetna. Large balsam poplar (79 cm diameter, DBH) with root wad (210 cm diameter) and adjacent scour pool formation (Sample Plot T19_04).

Photograph 12. July 2, 2012 Middle Susitna River near Talkeetna. Wood jam with key and racked members.

7.4. Wood Debris: Channel Splitting and Island Formation

Photograph 13. June 26, 2012 Middle Susitna River wood jam at head of mid channel island and adjacent side-channel.

Photograph 14. July 2, 2012 Lower Susitna River near Talkeetna. Partially buried key member with racked members and unstable wood. Young balsam poplar establishment in association with wood jam.

Photograph 15. June 26-27, 2012 Middle Susitna River above Three Rivers Confluence. Wood jam located at island apex and side channel entrance. Lower Photograph close up of wood jam with small diameter racked and loose members.

Photograph 16. June 30, 2012 Lower Susitna River below Talkeetna. Rafts of racked and unstable wood. Accumulations at island apex and main stem side-channels.

Photograph 17. July 2, 2012 Lower Susitna River side channel between Talkeetna and Willow. Rafts of wood debris in side channel and along floodplain embankment.

Photograph 18. July 2, 2012 Lower Susitna River between Talkeetna and Willow. Close-up of racked wood debris deposited on side channel gravel bar.

Photograph 19. July 2, 2012 Lower Susitna River between Talkeetna and Willow. Racked wood debris at island apex and side channel.

Photograph 20. June 30, 2012 Lower Susitna River between Talkeetna and Willow. Racked wood on mid channel islands.

Photograph 21. June 30, 2012 Lower Susitna River between Talkeetna and Willow. Unstable accumulations of racked wood debris upon bars and stable island bar apex jams with racked members.

Photograph 22. June 30, 2012 Lower Susitna River between Talkeetna and Willow. Bar apex wood jam with racked members at island apex and side channel entrance.

Photograph 23. June 30, 2012 Lower Susitna River between Talkeetna and Willow. Wood jams in side channel complex.

Photograph 24. June 30, 2012 Lower Susitna River between Talkeetna and Willow. Bar apex wood jam at side channel exit.

Photograph 25. June 30, 2012 Lower Susitna River between Talkeetna and Willow. Rafts of wood in side channel complex.

Photograph 26. July 2, 2012 Lower Susitna River below Talkeetna. Bar apex wood jam with buried key member and racked members. Young balsam poplar colonizing elevated wood jam surface.

7.5. Wood Debris: Bank Stabilization

Photograph 27. June 26, 2012 Middle Susitna River above Three Rivers Confluence. In-situ key member forming floodplain bench.

Photograph 28. June 26, 2012 Middle Susitna River above Three Rivers Confluence. Bench jam with racked members.

Photograph 29. July 1, 2012 Middle Susitna River immediately above Whiskers Slough. Bar apex jam with large accumulation of racked members upstream of jam.

Photograph 30. June 30, 2012 Lower Susitna River between Talkeetna and Willow. Long bench jam with large accumulations of racked wood. Flow is from right to left.

7.6. Unstable Wood Debris

Photograph 31. July 2, 2012 Middle Susitna River immediately above Three Rivers Confluence. Typical unstable wood debris. Note orange tape measure for scale.

Photograph 32. July 2, 2012 Lower Susitna River below Talkeetna. Typical loose, unstable wood debris.

Photograph 33. June 30, 2012 Lower Susitna River between Talkeetna and Willow. Mid channel rafts of wood debris. Flow is from right to left.

Photograph 34. June 30, 2012 Lower Susitna River between Talkeetna and Willow. Rafts of racked wood debris.

Photograph 35. June 30, 2012 Lower Susitna River between Talkeetna and Willow. Racked wood deposited at young balsam poplar/alder vegetation obstruction.

Photograph 36. June 30, 2012 Lower Susitna River between Talkeetna and Willow. Racked wood on mid channel gravel bar.

Photograph 37. June 30, 2012 Lower Susitna River at Talkeetna immediately below Three Rivers Confluence. Balsam poplar (85 cm diameter, DBH; 18 m length; Plot T19).