Susitna-Watana Hydroelectric Project (FERC No. 14241)

Geomorphology Study (Study 6.5)

Updated Mapping of Aquatic Macrohabitat Types in the Middle Susitna River Segment from 1980s and Current Aerials Technical Memorandum

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

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LIST OF ACRONYMS AND SCIENTIFIC LABELS

Abbreviation	Definition
AEA	Alaska Energy Authority
AOI	Area of Interest
AOW	Additional open water
AT	Aerotriangulation
cfs	cubic feet per second
DEM	Digital Elevation Modern
DMC	Digital Mapping Camera
DTM	Digital Terrain Model
FERC	Federal Energy Regulatory Commission
FIPS	Federal Information Processing Standard
GIS	Geographic Information System
GPS	Global Positioning System. A system of radio-emitting and -receiving satellites used for determining positions on the earth.
Hz	Hertz
ILP	Integrated Licensing Process
IMU	Inertial measurement unit
LiDAR	Light Detection and Ranging
LR	Lower River
MR	Middle Susitna River Segment
NAD	North American Datum
NAVD	North American Vertical Datum
NEPA	National Environmental Policy Act
PRM	Project River Mile
QC	Quality control
RM	River Mile(s)
SC	side channel
USGS	U.S. Geological Survey

SUMMARY

The overall purpose of this technical memorandum is to update the Middle Susitna River Segment portion of the aquatic macrohabitat mapping results previously provided in the technical memorandum titled *Mapping of Aquatic Macrohabitat Types at Selected Sites in the Middle and Lower Susitna River Segments from 1980s and 2012 Aerials* (Tetra Tech 2013a). The present conditions mapping results in the 2013 technical memorandum were based on 2012 aerials and were performed at selected sites that represent about 50 percent of the total length of the Middle Susitna River Segment. The results in this technical memorandum add to the mapping results in the earlier technical memorandum by: (1) expanding the 2012/2013 mapping of aquatic macrohabitat types to 100 percent coverage of the Middle Susitna River Segment, (2) replace mapping previously developed from 2012 aerials with information from 2013 aerials in cases where the 2013 aerials are closer to the target flow and/or of higher quality than the 2012 aerials, and (3) digitize 100 percent of the available 1980s macrohabitat detailed in *Response of Aquatic Habitat Surface Areas to Mainstem Discharge in the Talkeetna-To-Devil Canyon Segment of the Susitna River, Alaska* (Trihey & Associates 1985). The aquatic habitat mapping results presented in this technical memorandum supersede the mapping results presented in the earlier technical memorandum (Tetra Tech 2013a).

The aquatic macrohabitat mapping was conducted using: (1) orthorectified digital aerial images of black and white aerial photographs collected in 1983 at a discharge of 12,500 cfs in the Middle River, and (2) aerial photographs collected in 2012 at flows of 12,900 and 17,000 cfs, and in 2013 at flows of 6,200 and 11,300 cfs. The aerial photographs were used to delineate and measure the wetted surface areas for the various aquatic macrohabitat types using Geographical Information Software (GIS). This information can be used by aquatic resource studies to support characterization of aquatic macrohabitat along the Middle Susitna River Segment.

As previously reported in Study 6.5 ISR Section 7.1.2.5, one variation from the study plan was implemented; the use of a single target discharge rather than multiple flows for developing the aquatic macrohabitat mapping. In the future, macrohabitat areas will be estimated using the combination of 2-D hydraulic modeling, bathymetry, and topography collected in the Focus Areas over the range of flows of interest, negating the need to develop aquatic macrohabitat versus flow relationships from aerial photography as was done in the 1980s studies.

1. INTRODUCTION

The Alaska Energy Authority (AEA) is preparing a license application that will be submitted to the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project (Project) using the Integrated Licensing Process (ILP). The Project is located on the Susitna River, an approximately 320-mile-long river in the Southcentral region of Alaska. The Project's dam site will be located at Project River Mile (PRM) 187.1[1]. The results of this study will provide information to support the FERC's National Environmental Policy Act (NEPA) analysis for the Project license.

This technical memorandum updates the aquatic macrohabitat mapping results previously provided in the technical memorandum titled *Mapping of Aquatic Macrohabitat Types at Selected Sites in the Middle and Lower Susitna River Segments from 1980s and 2012 Aerials* (Tetra Tech 2013a). **The aquatic habitat mapping results presented in this technical memorandum supersede the mapping results presented in the earlier technical memorandum (Tetra Tech 2013a).** The current conditions mapping results represented in the 2013 technical memorandum were based on 2012 aerials and were performed at selected sites that represent about 50 percent of the total length of the Middle Susitna River Segment. This mapping was extended to: (1) expand the current conditions mapping of aquatic macrohabitat types to 100 percent of the Middle Susitna River Segment ("current conditions" refers to mapping covering the entire Middle Susitna River Segment developed from 2012 and 2013 aerial photography), (2) replace mapping previously developed from 2012 aerials with information from 2013 aerials in cases where the 2013 aerials are closer to the target flow and/or of higher quality than the 2012 aerials, and (3) digitize 100 percent of the available 1980s macrohabitat detailed in *Response of Aquatic Habitat Surface Areas to Mainstem Discharge in the Talkeetna-To-Devil Canyon Segment of the Susitna River, Alaska* (Trihey & Associates 1985). The 1980s mapping is only available from PRM 102 to PRM 154, and therefore, does not extend upstream of the downstream limit of Devils Canyon.

The mapping was coordinated with Study 9.9 (*Characterization and Mapping of Aquatic Habitats*) and Study 8.5 (*Fish and Aquatics Instream Flow Study*).

This technical memorandum update results from tasks that are part of the following studies:

- 2012 Study Plan G-S2: *Aquatic Habitat and Geomorphic Mapping of the Middle River using Aerial Photography.*
- RSP Study 6.5 Section 6.5.4.5.2.2 study component "*Riverine Habitat versus Flow Relationship Middle Susitna River Segment*" task "*Digitize Riverine Habitat Types*".

The effort to update the current aquatic macrohabitat mapping is identified in ISR Study 6.5 Section 7.2.1.5. Study Component: *Riverine Habitat versus Flow Relationship Middle Susitna River Segment*.

[1] Note: Project River Miles (PRMs) are the river mile system used for the current Susitna-Watana Project. River Miles (RMs) were the river mile system used in the 1980s project. The PRM delineation starts about 3 miles farther into Cook Inlet than the RMs and has a slightly different thalweg than that of the 1980s. Thus, PRM values are generally 3 to 4 miles higher than the RM values. Because this analysis is a temporal comparison, both systems are referenced.

2. STUDY OBJECTIVES

The objectives of the effort covered by this technical memorandum were:

- Update the current conditions aquatic macrohabitat mapping using the 2013 aerials in cases where the 2013 aerials were collected closer to the target flow of 12,500 cfs and/or of higher quality than the 2012 aerials.
- Expand the 1980s aquatic macrohabitat mapping to cover 100 percent of the area of available mapping (PRM 102 to PRM 154) from the approximately 50 percent presented in the earlier technical memorandum (Tetra Tech 2013a).
- Expand the current (2012/2013) aquatic macrohabitat mapping to cover 100 percent of the Middle Susitna River Segment (PRM 102 to PRM 187) from the approximately 50 percent presented in the earlier technical memorandum (Tetra Tech 2013a).
- Coordinate with the Characterization and Mapping of Aquatic Habitats (Study 9.9) and Fish and Aquatics Instream Flow Study (Study 8.5) to ensure consistency between different aquatic macrohabitat mapping efforts. The Characterization and Mapping of Aquatic Habitats (Study 9.9) has also produced aquatic macrohabitat mapping (HDR 2013).

The delineated macrohabitats are one of five levels of nested and tiered habitat classification being applied to the Middle Susitna River Segment. The system is presented in Table 1.1-1 of the Study 9.9 ISR Section 4.1. The classification levels include river segment, geomorphic reach, macrohabitats, mesohabitat, and edge habitat. The Geomorphology Study (Study 6.5) defined the Susitna River segments and geomorphic reaches in the updated technical memorandum *Geomorphic Reach Delineation and Characterization, Upper, Middle and Lower Susitna River Segments* (Tetra Tech 2014a).

3. STUDY AREA

3.1. General

The Susitna River located in Southcentral Alaska drains an area of approximately 20,010 square miles and flows about 320 miles from its headwaters at the Susitna, West Fork Susitna, and East Fork Susitna glaciers to Cook Inlet (U.S. Geological Survey [USGS] 2012). The Susitna River Basin is bounded on the west and north by the Alaska Range, on the east by the Talkeetna Mountains and Copper River Lowlands, and on the south by Cook Inlet. The highest elevation in the basin is Mt. McKinley at 20,320 feet while its lowest elevation is at sea level where the river discharges into Cook Inlet. Major tributaries to the Susitna River between the headwaters and Cook Inlet include the Chulitna, Talkeetna, and Yentna Rivers, which are also glacially fed in their respective headwaters. The basin receives, on average, 35 inches of precipitation annually with average annual air temperature of approximately 29^{o} F.

3.2. Middle Susitna River Segment

The study effort for the work presented in this technical memorandum covers the Middle Susitna River Segment from the Watana Dam site (PRM 187.1) to the Three Rivers Confluence (PRM 102.4). The Lower and Upper Susitna River Segments are not part of the 2014 study effort documented in this technical memorandum.

4. METHODS

4.1. Variations from Study Plan

One variance was identified for this study component in 2013 that carries over as a modification in 2014 and 2015 (ISR Study 6.5 Section 7.1.2.5) and affects some of the work described in this technical memorandum. The modification involves the collection of aerial photography in the Middle and Lower Susitna River Segments. In 2012 and 2013, aerial photography was acquired at a single target flow rather than the three flows identified in Study 6.5 RSP Section 6.5.4.5.2.1. The Study Plan detailed the acquisition of three sets of aerial photography in 2012 approximately corresponding to the following discharges: 23,000, 12,500, and 5,100 cfs. Due to a combination of weather and flow conditions, only one of the 3 datasets was collected. The 2012 aerial photography was collected for approximately 50 percent of the Middle River at 12,900 cfs and 50 percent of the Middle River at 17,000 cfs (Table 4.1-1).

One goal of acquiring three sets of 2012 aerials was to compare the macrohabitat versus flow relationships from current conditions to the 1980s information and determine if there is a difference in the habitat areas for current conditions from those mapped in the 1980s at similar flows. A summary of discharges corresponding to the 1980s aerial flight dates is shown in Table 4.1-2. This goal was met by collection of the single set of aerial photography in 2012 since, based on analysis of the 2012 aerial photography data, AEA concluded that the macrohabitat areas at specific locations were appreciably different from those mapped in 1983 (Tetra Tech 2013a). Subsequently, AEA also concluded that collection of aerial photography at 3 discharges to develop macrohabitat versus flow relationships was not necessary for meeting the overall objectives of the Study Plan. Instead, AEA supports the use of a combination of the 2-D hydraulic modeling and bathymetry and topography collected in the Focus Areas to provide direct determination of the area of the various macrohabitat types over the range of flows. Therefore, development of macrohabitat area versus flow relationships from aerial photographs collected at specified discharges as identified as a goal of this study component are not needed. This variance and the alternative approach were presented at the September 25 and December 2, 2013 Technical Work Group meetings. The objectives of the study will be met without collecting additional aerials at three flows as specified in RSP Study 6.5 Section 6.5.4.5.2.1.

4.2. Middle River 2013 Aerial Photo Acquisition

In 2013, a decision was made to acquire additional aerial photographs for the 12,500-cfs target discharge in the Middle River. Due to a combination of weather and flows conditions, aerials were obtained for about 60 percent of the Middle River at 11,300 cfs and 40 percent at 6,200 cfs. The 2013 aerial photographs were collected on four flights on September 16, 20, 24, and November 6, 2013 (Table 4.2-1). A total of 38 flight lines were flown. The 2013 area of interest (AOI) and the image center coordinates for all four flights are shown in Figure 4.2-1.

The aerial photos collected on November 6, 2013, showed ice formations along the channel margins and frazil ice within the Susitna River channel from PRM 185.0 to PRM 153.6. The Susitna River was completely ice-covered in a short portion of Devils Canyon from PRM 164.1 to PRM 163.4. It was determined that the ice observed in the photos was minor and would not

have an appreciable effect on aquatic macrohabitat delineations. Two examples of the typical amount of ice seen in the photos are shown in Figure 4.2-2 and Figure 4.2-3.

The 2013 aerial photographs were used to replace the 2012 mapping for the current conditions from approximately PRM 143.6 to PRM 153.6. The 2013 aerials were collected at 11,300 cfs, very close to the 12,500-cfs target flow. In this portion of the Middle River, the 2012 mapping was based on aerial photography collected at 17,000 cfs. A summary of the flows used to delineate the current conditions macrohabitat areas is presented in Table 4.2-2.

From PRM 153.6 to PRM 184.9, aquatic macrohabitat mapping was developed based on the 2013 6,200-cfs aerials; however, it was not used to replace the 2012 mapping in the current conditions for this portion of the Middle River developed from the 17,000-cfs aerials. Instead, the 2013 aerial photography collected at 6,200 cfs was used to develop a second set of macrohabitat maps that is referred to as the "2013 conditions". The 2013 conditions mapping along with the mapping from 2012 aerial photography available in the current conditions at 17,000 cfs bracket the 12,500-cfs target flow for this portion of the Middle Susitna River Segment.

4.3. Processing of 2013 Aerial Photography

The aerial photography was processed into orthoimagery (aka orthorectified aerial imagery). Orthoimagery is aerial imagery that has been rectified to a map projection by removing displacement caused by terrain undulation and camera geometry. The orthoimagery has a ground resolution of 1 foot. The datum and projection is Alaska State Plane, Zone 4, North American Datum of 1983 coordinate system. The four band imagery consisted of the natural color bands red, green, blue, and with near infrared. The processing of both the 2012 and 2013 the aerial photography followed the methods presented in ISR Study 6.5 Section 4.5.2.1.1.2.

4.4. Digitization Procedure

Within the area of geomorphic delineation (see Tetra Tech 2014b), polygons were delineated for wetted habitat types (see Section 4.5 for definitions of the habitat types). Wetted areas were mapped as one of the aquatic habitat types only if the area had a connection to the Susitna River. This connection did not have to be direct, but could be through one or more additional wetted habitat types. For example, an upland slough could connect to a side slough, which connects to a side channel and ultimately the main channel. If the water body was isolated and there was not a connection to the Susitna River, then the wetted area was mapped as background.

The habitat areas were delineated using ArcGIS 10.0 (a Geographic Information Systems [GIS] software package) at a scale of 1:3000. The 2011 Mat Su LiDAR (Matanuska-Susitna Borough 2011) was used to determine elevation differences to better define the boundary between channel areas and floodplain or island areas. The LiDAR was used to determine bank and water-surface elevations in areas of shadows and under vegetation cover in the upper ends of sloughs. The LiDAR dataset is referenced to the following coordinate system: North American Datum (NAD) 1983 State Plane Alaska 4 Federal Information Processing Standard (FIPS) 5,004 Feet.

The delineated habitat areas are reported to the sixth decimal point and tabulated to an accuracy of 1,000 square feet. Each habitat type within the habitat sites as well as the total area of the habitat site (control area) was measured and cross checked with the area of geomorphic delineation to ensure all the habitat areas were measured.

4.5. Riverine Habitat Classification Definitions

Two sets of aquatic macrohabitat classification definitions were used: one for the sites in the Lower Susitna River Segment and one for the sites in the Middle Susitna River Segment. This technical memorandum only addresses the Middle Susitna River Segment. The riverine aquatic macrohabitat classifications apply to the wetted area of a feature. The aquatic macrohabitat along with the exposed substrate contained within the banks of perennial vegetation comprise geomorphic features that are bounded at their mouths and inlets. Geomorphic feature mapping was performed for all areas within the geomorphic boundary of the Middle and Lower Susitna River Segments. This is in contrast to aquatic macrohabitat mapping which was also performed for the Middle Susitna River Segment, but only five habitat sites in the Lower Susitna River Segment. Further, while many habitat types are classified similarly, or the same as geomorphic types (i.e., main channel, side channel), there were distinctions made pertaining to the wetted connectivity of the area. For example, while a wetted area in a side slough with regions of exposed substrate isolating it from the main wetted slough region would be classified as part of the side slough in the geomorphic classification system, the isolated wetted region would be classified as background in the habitat classification system. This distinction is due to the lack of a wetted connection through which aquatic organisms can pass. This reflects a change in the definition of background in this technical memorandum compared to the earlier definition (Tetra Tech 2013a). Previously, the isolated wetted regions which were classified as: additional open water (AOW), vegetated islands (VI), and exposed substrate was classified as background to eliminate variance with the geomorphic feature mapping. The results of the geomorphic feature mapping are presented in a separate technical memorandum (Tetra Tech 2013b [initial technical memorandum] and Tetra Tech 2014b [updated technical memorandum]).

The aquatic macrohabitat in the Middle Susitna River Segment was classified using categories as defined in Trihey & Associates (1985). The Middle River macrohabitat types were classified into the following categories: main channel, side channel, side sloughs, upland sloughs, and tributary mouths. As previously mentioned, isolated wetted areas (mapped as AOWs in Tetra Tech (2013a) were mapped as background and were not considered part of the riverine habitat. With the inclusion of tributaries, the classifications were defined in 2014 as follows:

- **Main Channel** habitat types are those channels of the river that normally convey streamflow throughout the entire year. They are visually recognizable by their turbid glacial water and high velocities. In general, they convey more than 10 percent (approximate) of the total flow passing a given location.
- **Side Channel** habitat types are also characterized by turbid glacial water. Velocities often appear lower than in mainstem sites. In general, they convey less than 10 percent (approximate) of the total flow passing a given location. Side-channel habitat may exist in well-defined channels or in areas possessing numerous islands and submerged gravel bars. When the upstream berms of side channels are dewatered and the channels contain clear water, they are classified as side sloughs.
- **Side Slough** habitat types contain clear water. Small tributaries, upwelling groundwater, and local surface runoff are the primary sources of clear water for these areas. Side sloughs have non-vegetated upper thalwegs that are overtopped during periods of moderate to high

mainstem discharge. When these areas are overtopped they convey turbid water and are then classified as side channels.

- **Upland Slough** habitat types also contain clear water and depend on small streams, upwelling, and local surface runoff for their water supply. Upland sloughs possess vegetated upper thalwegs that are rarely overtopped by mainstem discharge.
- **Tributary** habitat is the portion of a tributary channel flowing across the floodplain. Tributaries are typically clear water channels.
- **Tributary Mouth** habitat types are clear water areas that exist where clear water tributaries flow into main channel or side channel habitats. This habitat type is located in the area of the clear-water plume that extends from the tributary into the turbid receiving water. Tributary mouth habitat also extends upstream into the tributary to the upper extent of any backwater influence that might exist. The surface area of tributary mouth habitat is affected both by tributary and mainstem discharges.
- **Background** was defined as any area within the defined boundary that did not provide connected aquatic macrohabitat. This included floodplain, vegetated islands, exposed substrate, and additional open water.

4.5.1. Quality Control

The Geomorphology Program Lead and the Geomorphology Task Lead provided training to the senior hydraulic engineers/geomorphologist and GIS analysts to ensure appropriate and consistent identification and delineation of the habitat categories. Senior hydraulic engineers/ geomorphologists reviewed the macrohabitat delineations for completeness, adherence to the classifications and scale criteria. The senior hydraulic engineers/geomorphologists frequently consulted with the Geomorphology Program Lead and the Geomorphology Task Lead on application of the definitions and for advice when differentiation between macrohabitat types was challenging.

Markups were provided to the staff performing the delineation in comments on the GIS files, marked up Adobe Acrobat PDFs and written instructions. Comments were provided for specific items such as changing the classification of a feature or general concerns such as the quality of the digitization and proper interpretation of the definitions. After the revisions were made, the mapping was re-checked by the reviewers, and if necessary, the process was repeated. Throughout the process, the senior hydraulics engineers/geomorphologists consulted with the Geomorphology Program Lead or the Geomorphology Task Lead to refine the application of definitions and help make decisions for unique situations encountered. The files were then reviewed for topology errors such as gaps between delineations (slivers) and overlaps. A final check was run on the tabulated areas for the reaches. The measured areas of the features and habitats were compared to their outer boundary to ensure complete and non-overlapping coverage. Comparisons between summed individual areas and the total reach area were considered acceptable if the difference was less than 0.5 percent.

Coordination with Fish and Aquatics Instream Flow Study (Study 8.5) and the Characterization and Mapping of Fish Habitat Study (Study 9.9) leads was conducted to ensure that delineated macrohabitat types were consistently identified in each of the three studies. Differences in the aquatic macrohabitat classification of features between the studies that were not related to the

discharge associated with the datasets being used to perform the delineation were updated, along with the mapping and analysis results. The emphasis of the comparison was on the classification rather than the variations in the upstream/downstream or lateral extents of the delineated habitat areas that may be due to differences in approaches (line mapping versus area mapping) or discharge. The emphasis for the coordination between studies was looking for macrohabitat call overlap where there was a difference in habitat classification that was not related to flow used in the specific studies. Also, side channel versus main channel differences were not addressed. The call between side channel and main channel is subjective without accurately knowing the actual volume of flow in the channels as the definition is based on conveyance of 10 percent or less of the flow (if greater than 10 percent then the feature is considered a main channel). However, there was consistency with the Study 6.5 area mapping and Study 9.9 2012 line mapping. Side-channel classification was not consistent between the studies due to the flow differences, but future application of aquatic macrohabitat mapping will use the Study 9.9 2012 line mapping as the official reference moving forward.

5. RESULTS

The Middle Susitna River Segment habitat site analysis provides the area of the various aquatic macrohabitat types for the entire Middle Susitna River Segments for 1983 and current conditions (2012/2013). Tabulated areas for each aquatic macrohabitat type are provided in Table 5.1-1 for 1980s conditions, Table 5.1-2 for the current conditions, and Table 5.1-3 for 2013 conditions at 6,200-cfs discharge from PRM 184.9 to PRM 153.6. Aerial photographs with the aquatic habitat types mapped for the Middle River are provided in Appendix A for 1980s conditions and Appendix B for the current conditions. The habitat mapping for the 2013 conditions 6,200-cfs discharge from PRM 184.9 to PRM 153.6 is provided in Appendix C.

6. SUMMARY

This technical memorandum describes the aquatic macrohabitat mapping conducted for portions of the Middle Susitna River Segment in which 1983 mapping was available (PRM 102.4 to PRM 154) from the 1980s studies (Trihey & Associates 1985) along with mapping for the entire Middle Susitna River Segment for current conditions.

Current conditions macrohabitat areas were developed based on 2012 and 2013 aerial photography collected at flows closest to the target flow of 12,500 cfs. A third mapping set, referred to as the 2013 conditions, was developed from aerial photographs collected from PRM 153.6 to PRM 184.9 on November 6, 2013 when the flow was approximately 6,200 cfs. This additional mapping was conducted to bracket the target flow of 12,500 cfs with the 6,200-cfs 2013 condition and the 17,000-cfs current condition. This will allow for interpolation of habitat area at 12,500 cfs, if necessary in the future. The current mapping was reviewed in coordination with the Characterization and Mapping of Aquatic Habitats (Study 9.9) and Fish and Aquatics Instream Flow Study (Study 8.5) to ensure consistency between studies. The Characterization and Mapping of Aquatic Habitats (Study 9.9) has also produced aquatic macrohabitat quantification in the form of line mapping rather than the area-based mapping in this document (HDR 2013).

The aquatic habitat mapping results presented in this technical memorandum supersede the mapping results presented in the earlier technical memorandum (Tetra Tech 2013a).

This effort represents the completion of the study component identified in RSP Study 6.5 Section 6.5.4.5 and ISR Study 6.5 Section 7.2.1.5 "Riverine Habitat versus Flow Relationship Middle Susitna River Segment."

As previously identified and presented in ISR Study 6.5 Section 7.1.2.5 and in Section 4.1 of this document, one modification was made to the effort that involved the use of a single-target discharge rather than multiple flows for developing the aquatic macrohabitat mapping.

7. REFERENCES

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8. TABLES

Table 4.1-1. Summary of 2012 aerial photography.

Aerial Coverage (PRM)		Date	Discharge (cfs)	
From	To		Gold Creek	Sunshine Station
Upper Susitna River Segment				
266.5	231.5	10/20/2012	7,410	---
231.5	187	9/30/2012	17,000	---
Middle Susitna River Segment				
187	143.6	9/30/2012	17,000	---
143.6	102	9/10/2012	12,900	---
119	102	07/27/2012	22,200	---
Lower Susitna River Segment				
102	63	07/27/2012	---	53,000
102	78	09/10/2012		38,200
78	69	09/30/2012	---	48,000
69	33.5	10/10/2012	---	55,000
33.5	22.5	09/30/2012		48,000
22.5	0	10/10/2012	---	55,000

Table 4.1-2. Summary of 1980s aerials, discharges, and project river mile extents.

Aerial Coverage (PRM)		Date	Discharge (cfs)	
From	To		Gold Creek	Sunshine Station
Upper Susitna River Segment				
251	187	07/19-20/1980	35,800 & 31,600	---
Middle Susitna River Segment				
187	152	07/19-07/20/1980	35,800 & 31,600	---
158	102	09/11/1983	12,500 (12,200 published)	---
Lower Susitna River Segment				
102	0	09/6/1983	---	36,600

Table 4.2-1. Summary of 2013 aerial photography.

Aerial Coverage (PRM)		Date	Discharge (cfs)	
From	To		Gold Creek	Sunshine
Upper Susitna River Segment				
265.2	247.2	09/16/2013	19,200	---
247.2	214.8	09/20/2013	15,300	---
214.8	187.1	09/16/2013	19,200	---
Middle Susitna River Segment				
187.1	184.9	09/16/2013	19,200	---
184.9	153.6	11/6/2013	6,200[1]	---
153.6	106.8	09/24/2013	11,300	---
106.8	102.4	09/20/2013	15,300	
Lower Susitna River Segment				
102.4	0	09/20/2013	---	35,500

Notes:

1 USGS Gold Creek gage was not in operation on November 6, 2013, due to ice cover, the average daily flow on November 6, 2013, was extrapolated from the preceding week's daily discharges.

Table 4.2-2. Summary of aerial photography used to define the Middle River "Current Conditions" [1].

Aerial Coverage (PRM)		Date	Discharge (cfs)
From	To		Gold Creek
187.1	153.6	09/30/2012	17,000
153.6	143.6	09/24/2013	11,300
143.6	102	09/10/2012	12,900

Notes:

1 From PRM 153.6 to PRM 184.9 aquatic macrohabitat mapping was also produced from the 2013 aerials obtained at 6,200 cfs. It is referred to as "2013 Conditions" and was developed to provide a set of flows, 17,000 and 6,200 cfs, which bracket the target flow of 12,500 cfs.

Table 5.1-1. Delineated habitat areas for the "1980s Condition" Middle Susitna River Segment, Geomorphic Reaches MR-5 through MR-8[1].

Reach	Aerial Date	PRM	Discharge	Main Channel (MC)	Side Channel (SC)	Side Slough (SS)	Upland Slough (US)	Tributary (TR)	Tributary Mouth (TM)	Background (BG)	Total Area
			cfs	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$
MR-5	09/11/1983	148.4 - 153.9	12,500	12,470	0	0	0	442	100	22,304	35,316
MR-6	09/11/1983	122.7 - 148.4	12,500	66,698	24,547	4,490	648	562	650	249,001	346,596
MR-7	09/11/1983	107.8 - 122.7	12,500	46,992	8,350	302	567	78	53	117,847	174,188
MR-8	09/11/1983	102.4 - 107.8	12,500	19,820	3,366	600	744	250	0	205,078	229,858
Total Area	09/11/1983	102.4 – 153.9	12,500	145,980	36,264	5,392	1,959	1,332	802	594,229	785,958

Notes:

1 Data to produce the 1980s aquatic macrohabitat mapping are not available upstream of Geomorphic Reach MR-5.

Table 5.1-2. Delineated habitat areas for the "Current Condition" Middle Susitna River Segment

Reach	Aerial Date	PRM	Discharge	Main Channel (MC)	Side Channel (SC)	Side Slough (SS)	Upland Slough (US)	Tributary (TR)	Tributary Mouth (TM)	Background (BG)	Total Area
			cfs	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$
MR-1	09/30/2012	184.6 - 187.1	17,000	5,964	222	0	0	0	0	6,530	12,715
MR-2	09/30/2012	169.6 - 184.6	17,000	41,764	247	667	77	1,014	40	122,716	166,525
MR-3	09/30/2012	166.1 - 169.6	17,000	8,801	6	30	0	10	0	11,508	20,356
MR-4	09/30/2012	153.9 - 166.1	17,000	18,175	0	0	0	90	0	24,651	42,916
MR-5	09/30/2012	153.6 - 153.9	17,000	579	0	0	0	2	0	640	1,221
MR-5	09/24/2013	148.4 - 153.6	11,300	12,084	0	5	0	429	119	21,457	34,094
MR-6	09/24/2013	143.6 - 148.4	11,300	16,060	622	517	82	51	78	30,616	48,025
MR-6	09/10/2012	122.7 - 143.6	12,900	66,812	10,932	1,850	559	479	358	217,585	298,575
MR-7	09/10/2012	107.8 - 122.7	12,900	52,807	2,057	393	353	115	52	118,411	174,189
MR-8	09/10/2012	102.4 - 107.8	12,900	23,175	1,485	203	1,016	285	57	202,409	228,631
Total Area	Varies	102.4 -187.1	Varies	246,221	15,571	3,697	2,056	2,474	706	756,523	1,027,248

Table 5.1-3. Delineated habitat areas for the "2013 Conditions" Middle Susitna River Segment from PRM 184.6 to PRM 153.9.

Reach	Aerial Date	PRM	Discharge	Main Channel (MC)	Side Channel (SC)	Side Slough (SS)	Upland Slough (US)	Tributary (TR)	Tributary Mouth (TM)	Background (BG)	Total Area
			cfs	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$	$ft^2 \times 10^3$
MR-1	11/06/2013	184.6 - 184.9[1]	6,200	NA	NA	NA	NA	NA	NA	NA	NA
MR-2[2]	11/06/2013	169.6 - 184.6	6,200	33,160	1,264	312	11	658	2,016	129,104	166,525
MR-3	110/6/2013	166.1 - 169.6	6,200	7,757	18	21	0	10	0	12,550	20,356
MR-4	11/06/2013	153.9 - 166.1	6,200	16,222	0	13	0	61	0	26,548	42,844
MR-5	11/06/2013	153.6 - 153.9[3]	6,200	NA	NA	NA	NA	NA	NA	NA	NA
Total Area	11/06/2013	153.9 - 184.6[4]	6,200	57,787	1,282	346	11	729	2,016	169,393	231,564

Notes:

1 The 11/06/2013 aerial photography covers the lower 0.3 miles of MR-1, PRM 184.6 to PRM 184.9. Since this is only 12 percent of the total geomorphic reach length, the results are not reported in the above table, but the aquatic macrohabitat mapping based on the 11/06/2013 aerial photography of the 0.3 miles of MR-1 is provided in Appendix C.

2 September 30, 2012, aerials were used to supplement the November 6, 2013, aerials to provide full coverage of background and tributaries within the area of geomorphic delineation.

3 The 11/06/2013 aerial photography covers the upper 0.3 miles of MR-5, PRM 153.6 to PRM 153.9. Since this is only 5 percent of the total geomorphic reach length, the results are not reported in the above table, but the aquatic macrohabitat mapping based on the 11/06/2013 aerial photography of the 0.3 miles of MR-5 is provided in Appendix C.

4 The total aquatic macrohabitat areas are reported for geomorphic reaches MR-2 through MR-4. The short, partial portions of MR-1 and MR-5 covered by the 11/06/2013 aerial photography are excluded from the totals.

9. FIGURES

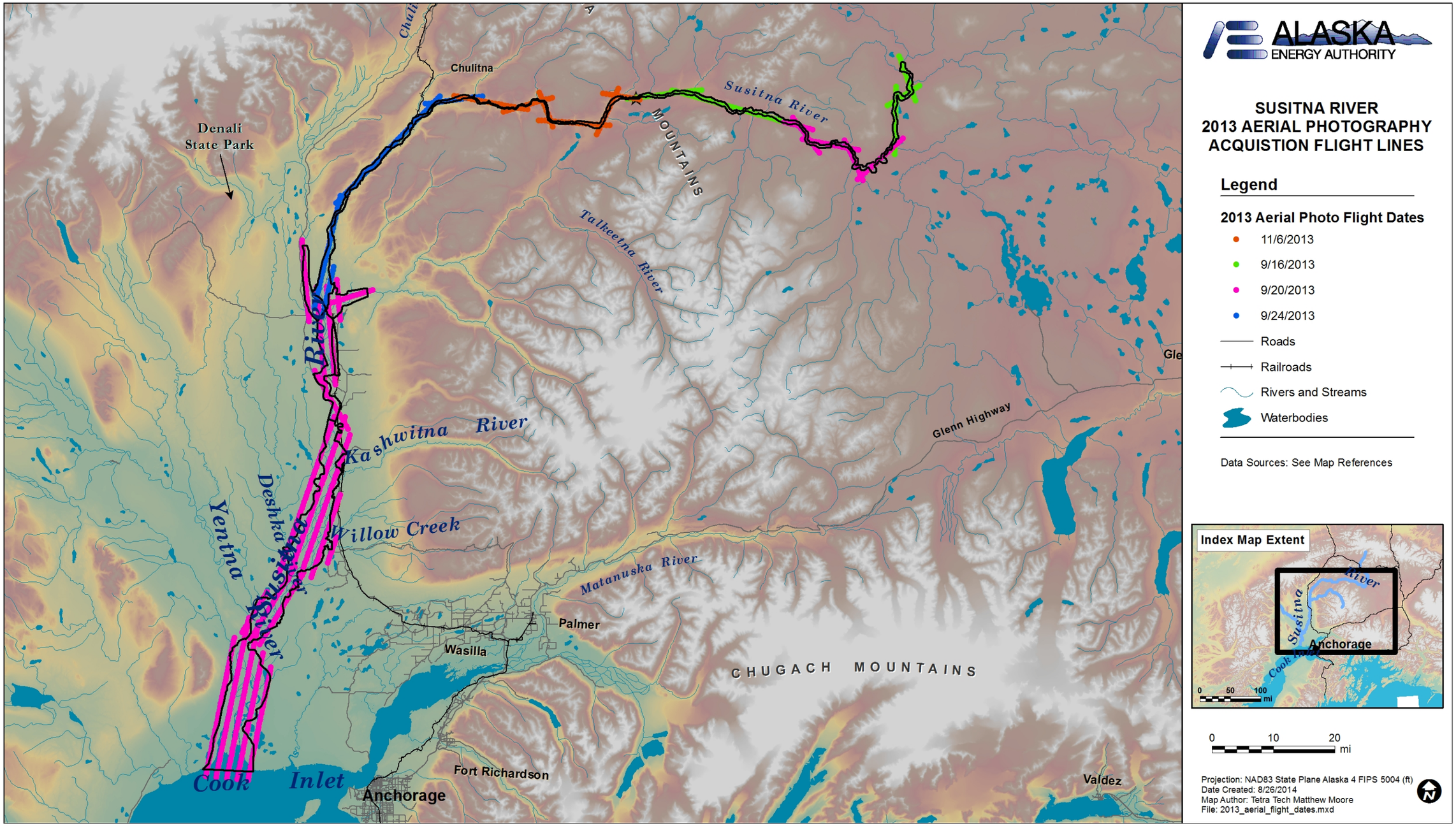

Figure 4.2-1. 2013 Area of Interest (AOI) and image center coordinates for the four aerial acquisition flights.

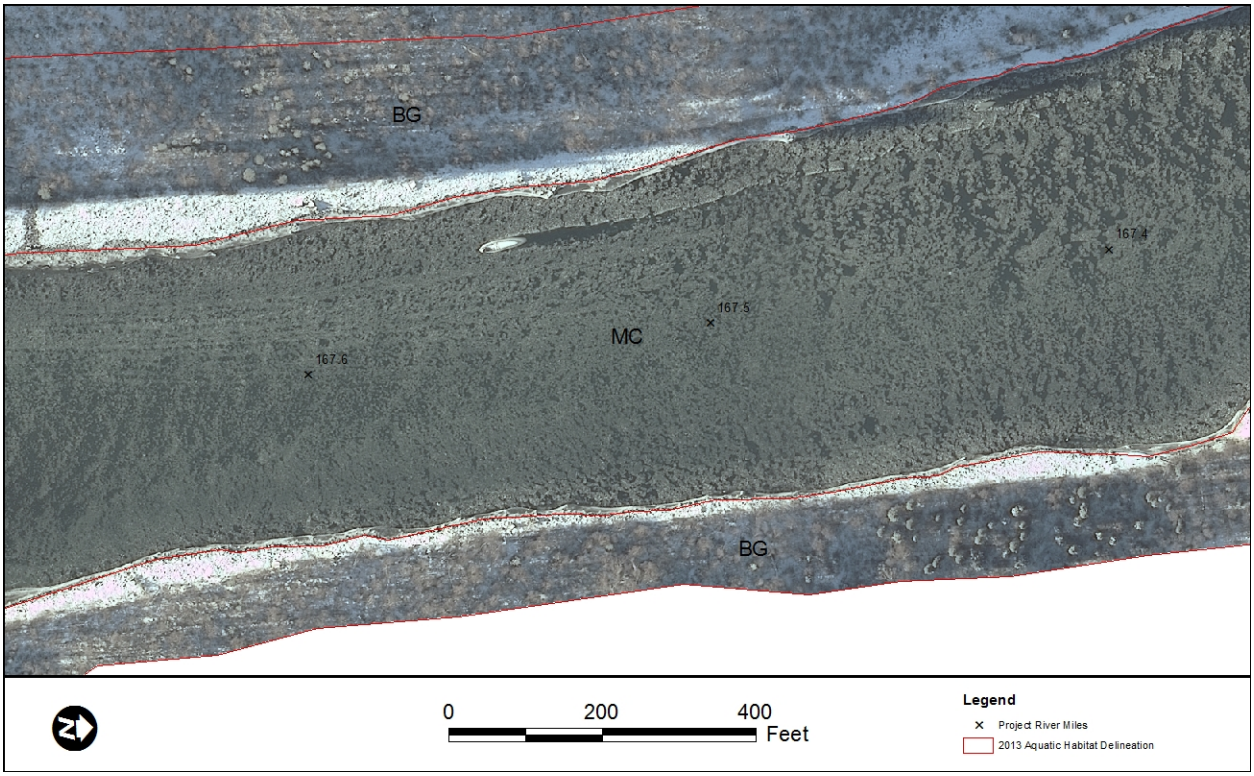

Figure 4.2-2. Example of typical ice on channel margins and within the Susitna River channel near PRM 167.5.

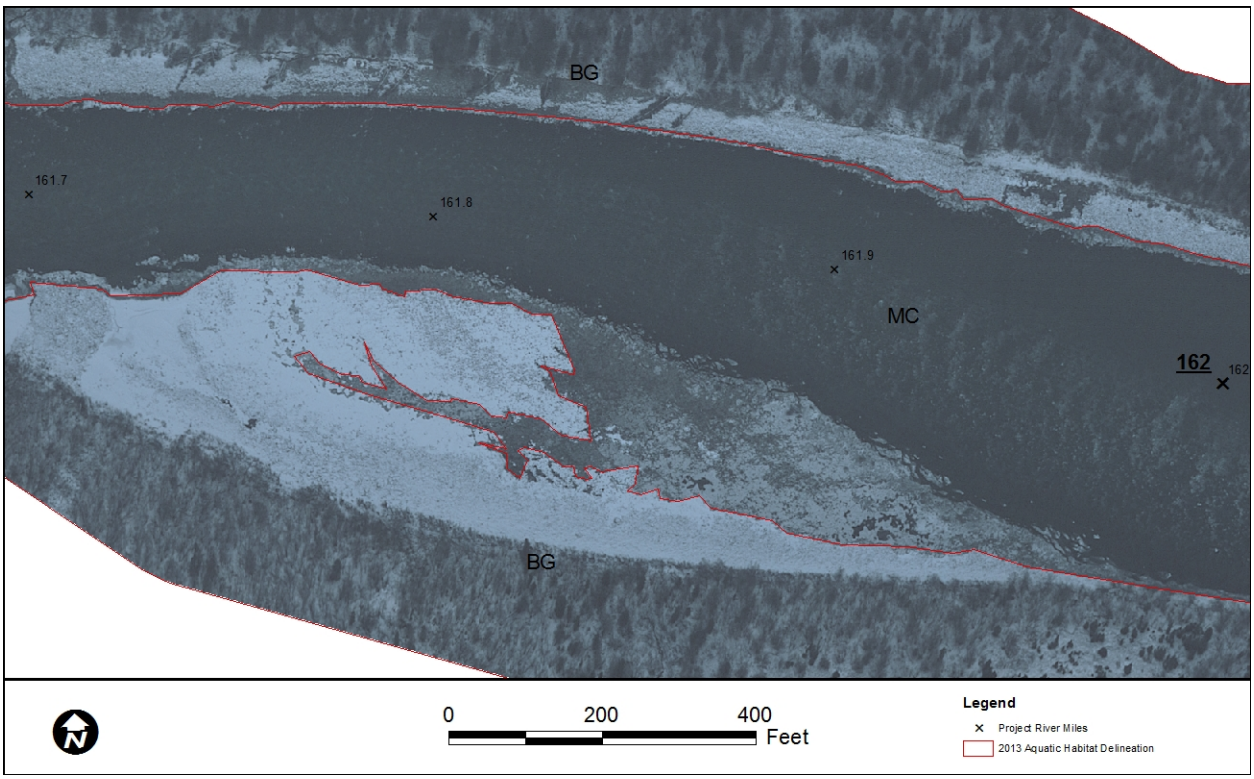

Figure 4.2-3. Example of typical ice on channel margins and within the Susitna River channel near PRM 162.