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SUSITNA-WATANA HYDRO

Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam

Study Plan Section 11.6

Initial Study Report

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

ABR, Inc.—Environmental Research & Services

February 2014 Draft

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LIST OF ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

Abbreviation	Definition
ABR	ABR, Inc.—Environmental Research & Services
ArcGIS	Esri's geographic information system for mapping and analysis
AEA	Alaska Energy Authority
AVC	Alaska Vegetation Classification
CIR	color infrared
cm	Centimeter
DBH	diameter breast height
ELS	Ecological Land Survey
FA	Focus Area
FERC	Federal Energy Regulatory Commission
ft	feet
GIS	geographic information system
GPS	global positioning system
GW/SW	Riparian Groundwater/Surface Water
ha	hectare
IFS	Instream Flow Study
ILP	Integrated Licensing Process
in	Inch
ISR	Initial Study Report
ITU	Integrated Terrain Unit
LiDAR	Light Detection and Ranging
m	Meter
Mat-Su	Matanuska Susitna
NRCS	USDA Natural Resources Conservation Service

Abbreviation	Definition
NWI	National Wetlands Inventory
PM&E	protection, mitigation and enhancement
PRM	Project River Mile
Project	Susitna-Watana Hydroelectric Project No. 14241
Q1, Q2, Q3, Q4	first quarter, second quarter, third quarter, and fourth quarter of the annual year
Riparian IFS	Riparian Vegetation, Riparian Instream Flow
RSP	Revised Study Plan
RTK	Real time kinematic
SPD	study plan determination
TM	Thematic Mapper
TWG	Technical Workgroup
UAFAFES	University of Alaska Fairbanks Agricultural and Forestry Experiment Station
UK	United Kingdom
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USR	Updated Study Report

EXECUTIVE SUMMARY

Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam 11.6	
Purpose	The primary objectives are to (1) classify and map local-scale riparian ecosystems (riparian ecotypes), wetlands, and wildlife habitats in the Middle and Lower Susitna River downstream of the Watana Dam site, (2) characterize the roles of erosion and sediment deposition in the formation of floodplain surfaces in the same areas, and (3) model natural riparian vegetation succession pathways in the Susitna River floodplain. The data will be used to support the modeling of changes in riparian areas from alterations in river flows associated with development of the proposed Project.
Status	This is an ongoing, multi-year study that was initiated in 2012 and continued during 2013.
Study Components	The study is composed of the following components: Vegetation and soil sampling in the field; laboratory analyses for sediment aging; Integrated Terrain Unit (ITU) mapping of ecosystem components; and derivation of riparian ecotypes, wetlands, and wildlife habitats from the field and ITU mapping data.
2013 Variances	As agreed to through consultation with the Technical Workgroup, the allocation of Ecological Land Survey (ELS) plots in Focus Areas (FAs) was changed so that both the size of FAs and the number of ecotypes in each FA are incorporated into the stratified random plot-allocation process. Additionally, directed sampling in Satellite Areas was used to target those ecotypes under-represented in FAs (RSP Section 11.6.4.2). The effect of this variance will be more intensive sampling and a better understanding of riparian vegetation and soils in the study area. Other minor variances in field methods were implemented to improve the accuracy of the field data and facilitate possible long-term monitoring of riparian vegetation in the Susitna River floodplain.
Steps to Complete the Study	As explained in the cover letter to this draft ISR, AEA's plan for completing this study will be included in the final ISR filed with FERC on June 3, 2014.
Highlighted Results and Achievements	Substantial progress has been achieved in the classification and mapping of riparian ecotypes in the Middle River portion of the study area. Twenty-nine preliminary riparian ecotypes have been classified based on five ITU attributes (geomorphic unit, surface form, vegetation type, poplar size class [when applicable], and disturbance class). These ecotypes will be confirmed and expanded upon with further work in the next year of study, which will include field surveys and mapping upstream to the Project dam site and downstream in the Lower River to encompass the full study area. Soil

Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam 11.6	
	stratigraphy work was accomplished in the Middle River and soil cores for sediment aging were collected. With the additional work in the next study year, to include the derivation of wetland and wildlife habitats, sediment aging, and the modeling of riparian vegetation succession, the study is on track to meet its objectives.

1. INTRODUCTION

On December 14, 2012, Alaska Energy Authority (AEA) filed its Revised Study Plan (RSP) with the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project (FERC Project No. 14241), which included 58 individual study plans (AEA 2012). Included within the RSP was the Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam, Section 11.6. In the Riparian Vegetation Study, local-scale riparian ecosystems on the Susitna River downstream of the Project dam site will be characterized, and models describing the natural successional pathways for riparian vegetation along the Susitna River will be developed. This baseline information will be used to support the development of a spatially-explicit model to predict potential changes in riparian vegetation due to Project effects (to be developed in the Riparian Instream Flow Study [Riparian IFS]; see Initial Study Report [ISR] Study 8.6).

On February 1, 2013, FERC staff issued its study plan determination (February 1 SPD) for 44 of the 58 studies, approving 31 studies as filed and 13 with modifications. On April 1, 2013 FERC issued its study plan determination (April 1 SPD) for the remaining 14 studies; approving one study as filed and 13 with modifications. RSP Section 11.6 was one of the 13 approved with modifications in the April 1 SPD; FERC recommended the following:

Sampling Scheme

> *We recommend that AEA consult with TWG [Technical Working Group] on the sampling design for vegetation sampling within and outside the focus areas, and file no later than June 30, 2013, the following information:*
>
> *1) A detailed sampling design, including a schematic of the sampling scheme for each focus area, the stratification factors, and basis for the number of plots within and outside the focus areas.*
>
> *2) Documentation of consultation with the TWG, including how its comments were addressed.*

Consultation on the interrelated Riparian Vegetation, Riparian Instream Flow (Riparian IFS) and Riparian Groundwater/Surface Water (GW/SW) study plans was accomplished with TWG representatives in two meetings, held on April 23, 2013 and June 6, 2013. Licensing participants were provided the opportunity to address technical details and comments and concerns regarding the study's approaches and methods.

The Riparian Instream Flow, Groundwater, and Riparian Vegetation Studies FERC Determination Response Technical Memorandum (Riparian/GW TM) (R2/GW/ABR 2013) addresses FERC's April 1 SPD request concerning sampling design and intensity for vegetation sampling within and outside the Focus Areas (FAs). The Riparian/GW TM was filed with FERC on July 1, 2013.

Following the first study season, FERC's regulations for the Integrated Licensing Process (ILP) require AEA to "prepare and file with the Commission an initial study report describing its overall progress in implementing the study plan and schedule and the data collected, including an explanation of any variance from the study plan and schedule." (18 CFR 5.15(c)(1)). This Initial Study Report on the Riparian Vegetation Study Downstream of the Proposed Susitna-Watana Dam (Riparian Vegetation Study) has been prepared in accordance with FERC's ILP regulations and details AEA's status in implementing the study, as set forth in the FERC-approved RSP and as modified by FERC's April 1 SPD (collectively referred to herein as the "Study Plan").

2. STUDY OBJECTIVES

As established in the Study Plan, the overall goals of the Riparian Vegetation Study are to prepare maps of existing, local-scale riparian ecosystems (riparian ecotypes), wetlands, and wildlife habitat types in areas downstream from the proposed Project dam site; characterize sedimentation, vegetation succession, and vegetation-soil-landscape relationships; and coordinate with the Riparian IFS (Study 8.6) and other closely related studies to provide complimentary data products to support the development of a spatially-explicit model to predict potential changes to downstream riparian floodplain vegetation due to Project modifications of flow, sedimentation, groundwater, and ice processes (to be developed in the Riparian IFS; see Study 8.6). This multi-year study was initiated in 2012 and will be continued beyond 2013 through the next year of study. The mapping prepared in this study will be used, in the FERC License Application to assess the impacts to riparian ecotypes, wetlands, and wildlife habitats (see Study 10.19) in areas downstream from the Project dam site, and to develop possible protection, mitigation, and enhancement (PM&E) measures to address any identified effects.

The specific objectives of the Riparian Vegetation Study are to:

- Classify, delineate, and map riparian ecotypes, wetlands, and wildlife habitats downstream from the Watana Dam site;
- Characterize the role of erosion and sediment deposition in the formation of floodplain surfaces, soils, and vegetation using a combination of soil stratigraphic descriptions, sieve analysis, and several complimentary sediment dating techniques;
- Quantify and describe Susitna River riparian vegetation communities using a combination of basic statistical summaries (e.g., basal area, density, stand age) and multivariate statistical techniques (e.g., cluster analysis, ordination, sorted tables), which will be used to develop of a series of conceptual models of floodplain vegetation succession building from those developed by Helm and Collins (1997); and
- Coordinate closely in the implementation of the Riparian IFS (Study 8.6), Groundwater Study (Study 7.5), Ice Processes in the Susitna River Study (Study 7.6), and Fluvial Geomorphology Modeling below Watana Dam Study (Study 6.6) to provide necessary and complimentary data, including vegetation successional models and mapping in support of a spatially-explicit model (to be developed in the Riparian IFS; see Study 8.6) to predict potential impacts to downstream riparian floodplain vegetation due to Project alterations of existing conditions downstream of the Project dam site.

3. STUDY AREA

As established in the Study Plan, the Riparian Vegetation Study is being conducted in riparian areas along the Susitna River below the proposed Project dam site, with the downstream and lateral extents as described below.

The 2013 study area for the Riparian Vegetation Study is presented in Figure 3-1; this same study area is being used for the Riparian IFS (Study 8.6), Fluvial Geomorphology Modeling below Watana Dam Study (Study 6.6), and the Groundwater Study (Study 7.5). The study area includes those riparian areas downstream of the Project dam site to a point at which the effects of altered stage and flow effects expected in the Susitna River would not be ecologically significant (i.e., the expected hydraulic alterations would be overridden by the input from other rivers and/or the effects of tidal fluctuations from Cook Inlet). In RSP Section 11.6, the longitudinal extent of the Riparian Vegetation Study area extended to river mile (PRM) 75 because existing information at the time the RSP was prepared indicated that the hydraulic effects of the Project below the Three Rivers Confluence at the Sunshine Gage (PRM 84) showed substantial attenuation, although small hydraulic effects appeared to be detectable as far downstream as the Susitna Station Gage (PRM 26). The final determination of how far downstream Project operational effects would extend was not made until the results of the Open-water Flow Routing Model (see Study 8.5) were completed. Following the completion of the Open-water Flow Routing Model in Q1 2013, a TWG meeting was held to discuss the selection of (FAs) and study sites, which included discussion of the downstream extent of the study area for the riparian studies. During the TWG meeting, it was agreed that the downstream extent of the study areas for the riparian studies, including the Riparian Vegetation Study, would extend to Project River Mile (PRM) 29.5 (R2 2013). Figure 3-1 shows the study area boundary of the Riparian Vegetation Study extended downstream to PRM 29.5

For the 2013 work, the lateral extent of the Riparian Vegetation Study area was defined by the extent of the riverine physiographic region generated by the Susitna River. Riverine physiography includes (1) those areas of the valley bottom, including off-channel water bodies, that are directly influenced by regular (0–25 year) to irregular (25–100 year) overbank flooding; and (2) those areas of the valley bottom influenced indirectly by groundwater associated with the Susitna River. In 2012, riverine physiography was mapped by the Riparian Vegetation Study team from the Project dam site to PRM 29.5 (Figure 3-1) by interpretation of image-signatures on high-resolution aerial imagery for the Susitna River. The riverine physiographic map has undergone review and refinement by the principal investigators leading the Riparian Vegetation Study, the Riparian IFS (Study 8.6), and associated physical-processes studies (groundwater [Study 7.5], ice processes [Study 7.6], and fluvial geomorphology [Study 6.6]). After review by the agencies, a final riverine physiography layer will be prepared for use as the lateral boundary of the Riparian Vegetation Study in the next year of study.

4. METHODS AND VARIANCES IN 2013

This study involves the use of Integrated Terrain Unit (ITU) mapping, which is an integrated approach to mapping landscape elements. ITU mapping is a multivariate mapping process in which terrain unit map boundaries are adjusted by on-screen digitizing over high-resolution aerial photography or satellite imagery so that there is increased coincidence between the boundaries and occurrences of interdependent ITU variables, such as hydrography, geology, physiography, soils, and vegetation units (Jorgenson et al. 2003; 2009). The ITU approach being used to map riparian ecotypes, wetlands, and wildlife habitats is based on methods and concepts developed for Ecological Land Survey (ELS) studies conducted in tundra, boreal forest, and coastal regions in Alaska over the past 15 years (see Jorgenson et al. 2003 for an example study in Southcentral Alaska). The ITU mapping approach for the Riparian Vegetation Study involves mapping terrain units such as vegetation type, balsam poplar size class (e.g., pole, timber, large timber), fluvial geomorphology, and surface-form types. These map data are being combined into units with ecological importance (in this case riparian ecotypes, wetlands, and wildlife habitats). Also based on previous ELS studies in Alaska, a set of field plots are being sampled to collect detailed data on site characteristics, environmental variables, successional vegetation, and soils; a subset of the field plots also are designed for use as permanent, long-term monitoring plots (see Section 4.2.5, Sampling of ELS Plots, below).

For this study, a series of maps will be produced, including maps of the individual terrain units (i.e., geomorphology, surface form, vegetation type, poplar size class), and maps of the aggregated terrain units (i.e., riparian ecotype, wetlands, and wildlife habitat). The mapping of wildlife habitats in the Riparian Vegetation Study is being conducted in coordination with the vegetation and wildlife habitat mapping study (Study 11.5) to derive a seamless map of wildlife habitats that apply Project-wide. Similarly, the mapping of wetlands is being conducted in coordination with the wetland mapping study (Study 11.7) so that wetlands in the Riparian Vegetation Study area can be similarly classified and are compatible with the wetland types mapped in the Cook Inlet Basin wetlands classification system (Gracz 2011); this will result in a single Project-wide wetland map.

4.1. Develop Mapping Materials from Historical and Current Data

The methods for developing mapping materials were implemented as described in the Study Plan with no variances. Data sources being used for the mapping of riparian ecotypes and wildlife habitats include vegetation mapping and vegetation succession studies conducted in the Susitna River drainage by McKendrick et al. (1982), UAFAFES (1985), Collins and Helm (1997), Helm and Collins (1997). For wetlands, digital National Wetlands Inventory (NWI) data for the study area, which was developed in the 1980s, is available. Additional data include digital elevation data and the National Hydrography Dataset (USGS 1999). These data have been compiled and reviewed and are being used as map layers in a geographic information system (*ArcGIS*) to assist the mapping efforts.

The available, high- and moderate-resolution aerial imagery for the project area also has been acquired for use in the mapping effort. Additional recent and high-resolution aerial imagery, which is needed to complete the mapping in this multi-year study, is expected to be available in late 2013.

4.1.1. Variances

There were no variances from the protocols described in the Study Plan to develop mapping materials from historical and current data.

4.2. Field Surveys

The methods for the field surveys were implemented as described in the Study Plan with the exception of the variances explained below (see Sections 4.2.1.3 and 4.2.5.1). While land-access permits were not available for Cook Inlet Regional Working Group (CIRWG) lands for field surveys in 2013, this did not affect the study implementation and was not considered a variance because, as described in the Study Plan (Sections 11.6.1 and 11.6.6), the study design indicates that the entire study area will be surveyed and mapped sequentially over multiple years. In 2013, field surveys were conducted downstream of CIRWG lands, and in the final year of the study, assuming access is authorized, field surveys will be conducted upstream on CIRWG lands.

In 2013, field sampling was conducted during three periods, with sampling conducted in the Middle and Lower Susitna River (Figures 4.2-1 through 4.2-3). During the first period (May 19–22), the Riparian Vegetation Study and Riparian IFS (Study 8.6) study teams sampled sediment stratigraphy trenches at FA-104 (Whiskers Slough) (Figure 4.2-2) to refine the methodology for sampling soil stratigraphy and collecting soil cores for sieve analysis and sediment dating. Following that first field survey, it was concluded that the soil sampling methods for sediment dating required further review. During the months of June, July, and August, the Riparian Vegetation Study team worked collaboratively with the Riparian IFS (Study 8.6) team to revise and implement the field methods for sampling soils for sediment dating.

During the second and third field survey periods (June 17–July 10 and July 24–August 12, respectively), the sampling was focused on four study components: (1) ELS plots were sampled within the FAs in coordination with the study teams from the Riparian IFS (Study 8.6) and Groundwater Study (Study 7.5), (2) ITU mapping plots were surveyed along transects in the broader study area (i.e., outside FAs) to rapidly collect field-verification data to further refine the riparian ecotype classes and provide ground-reference data for verification of the ITU mapping in the Lower River (planned to commence in 2014), (3) ELS plots were sampled in the broader study area to supplement the data for rare vegetation types in the FAs and facilitate the scaling-up of the results from the FAs, and (4) rates of sedimentation across the Susitna River floodplain were quantified using field stratigraphic descriptions, sediment cores, and standard laboratory sediment dating methods. The sampling procedures and methods for each of the above components of the riparian vegetation surveys are provided below.

4.2.1. Plot Allocation Procedures

4.2.1.1. ELS Plots

The ELS plot allocation procedures were implemented as described in the Study Plan with the exception of the variances explained below (see Section 4.2.1.3). The preliminary ITU mapping of riparian ecotypes prepared in 2012was used to design a stratified random sampling procedure to preselect ELS study plots within the FAs.

A stratified random sample design was developed for riparian FA-104 (Whiskers Slough), FA-115 (Slough 6A), and FA-128 (Slough 8A) using riparian ecotype as the sampling stratum (Figure 4.2-2 and Figure 4.2-4). (Plot allocation and sampling of plots in areas upstream of FA-128 [Slough 8A] is planned for the next year of study.) In the stratification procedure, the 2012

ITU mapping first was clipped, using *ArcGIS*, to the boundary of each FA. The total number of ecotypes within a FA and the total area (acres) of each ecotype within a FA was then calculated. The total minimum number of random plots per FA was determined using the following formula as a guide:

FA plots=1 plot/ 20 acres + 1.5*the total # of terrestrial ecotypes in a FA

The above formula accounts for both total area of a FA and the total number of ecotypes, such that a smaller FA with a high number of ecotypes would be assigned a larger number plots than if it would be based on area alone. The total area of each ecotype was then divided by the total area of the respective FA to determine the percent area of each ecotype within each FA. Ecotypes encompassing ≥ 2% of the total area within a FA were assigned a minimum number of random plots using the following formula as a guide:

random plots per ecotype = % of total terrestrial ecotype area*# of FA plots

To ensure that the less common ecotypes would not be under-sampled, the results from the above formula were used to decrease (by 2–7 plots) the final number of plots per ecotype for the largest ecotypes in a FA and to increase slightly (by 1–3 plots) the final number of plots per ecotype for smaller ecotypes, particularly herbaceous ecotypes, in a FA. The number of ELS plots allocated by ecotype in each of the three FAs sampled in 2013 using this stratified random selection procedure is presented in Tables 4.2-1 through 4.2-3.

Once the number of plots per ecotype within a FA was determined, the GENERATE RANDOM POINTS TOOL from Hawth's Analysis Tools for *ArcGIS* (http://www.spatialecology.com/htools/rndpnts.php) was used to generate the locations of the random plots in the map polygons for each ecotype. Then once the random plot locations were generated, a 23-m (75-ft) buffer (plot radius) was created around each plot for review. The buffered points were reviewed by a GIS analyst over high-resolution aerial imagery mosaics in *ArcGIS* to ensure that each plot was located entirely within an ecotype. Plots where the 23-m (75-ft) radius circular plot was not located entirely within an ecotype were either (1) adjusted by hand slightly (< 25 m [82-ft]) to place the plot entirely within the target ecotype, or (2) were assigned an alternative plot shape of the same total area as the 23-m (75-ft) radius plot (e.g., long narrow riparian landforms required more elliptical-shaped plots). This plot reshaping was essential since riparian landforms are inherently narrow and often small and oddly shaped.

For those ecotypes that are uncommon or do not occur in FAs (to include herbaceous vegetation types), ELS plots were added in Satellite Areas outside of FAs to increase the total number of samples collected in those ecotypes that are under-represented in FAs (Table 4.2-4, Figure 4.2-1). For herbaceous vegetation types, a target of sampling at least 75% of the ecotype polygons of each of the herbaceous ecotypes was established. For all other ecotypes that are under-represented within FAs, 1 to 3 plots were added to increase the total sample size across the entire Middle River to at least 3 ELS plots per ecotype. To increase efficiency in the field, Satellite Area plots of different ecotypes were chosen such that they were clustered together spatially, typically within a 1-mi radius of other plots within that Satellite Area. Satellite Areas in 2013 were spaced such that they spanned the entire length of the Middle River from Gold Creek to the Three Rivers Confluence. ELS plot locations were selected in Satellite Areas to represent relatively homogeneous vegetation in selected ecotypes as determined from high-resolution imagery.

During the second and third field survey periods, a total of 28, 23, and 4 ELS plots were sampled, respectively, in FA-104 (Whiskers Slough), FA-115 (Slough 6A), and FA-128 (Slough 8A) (Figures 4.2-1 and 4.2-2). In Satellite Areas, a total of five ELS plots were sampled (Figure 4.2-1).The total number of ELS plots sampled by ecotype in each FA and within Satellite Areas in 2013 are presented in Tables 4.2-1 through 4.2-4. The remaining allocated plots will be surveyed during the field season of the next year of study.

4.2.1.2. ITU Mapping Plots

The methods for allocating ITU mapping plots in the study area were implemented as described in the Study Plan with no variances. During the 2013 field season, ITU mapping plots were sampled primarily in the Lower River (i.e., Three Rivers Confluence and areas downstream). ITU mapping plots were grouped spatially into transects and those transects were placed in areas that featured a diversity of different vegetation types and environments within a relatively short distance to one another. For the Lower River, which is not covered by the 2012 preliminary mapping, ITU plot locations were selected along transects to represent relatively homogeneous vegetation as determined from high-resolution imagery. Additional ancillary GIS data also were used to aid in selection ITU plot locations, including riparian process domains and LiDAR elevation data, and interpretation of image-signatures on aerial imagery for the Lower River.

In the Middle River in 2013, ITU mapping plots were used to (1) target areas on the 2012 ITU mapping that were identified during the mapping process as requiring more field data for verification, and (2) co-locate plots adjacent to groundwater well installations at FA-128 (Slough 8A).

In 2013, 191 ITU mapping plots were sampled in the Lower River (Figure 4.2-3), and 26 in the Middle River (Figures4.2-1 and 4.2-2).

4.2.1.3. Variances

The original plot-allocation procedure described in the Study Plan specified the sampling of ELS plots in FAs based on the size of the FAs alone (a sampling rate of 1 ELS plot per 10 acres for FAs up to 200 acres in size, and a maximum of 20 plots for FAs > 200 acres). This procedure had to be altered because the Study Plan was completed before the boundaries of the FAs were fully defined, and, upon finalization of the FA boundaries, it was determined that all FAs were > 250 acres. As agreed to in the TWG process, the plot-allocation procedure was modified to adjust for this and ELS plots were allocated based both upon the size of each FA and the number of ecotypes in each FA as described above. This revised procedure provided for a higher number of plots being assigned to each FA than would have occurred under the original sampling scheme (see R2 2013). Additionally, those ecotypes that were under sampled in FAs were sampled with additional ELS plots in Satellite Areas to increase the sampling of underrepresented ecotypes. The sampling of each FA (and the Satellite Areas) now is more intensive, which will result in more accurate information on vegetation structure and composition in each FA and throughout the study area. Additional field data also will be available to use to describe each ecotype in the study area. This increased sampling will serve to better meet the study objectives and no additional modifications are needed to the ELS plot-allocation process to complete the study.

4.2.2. Floodplain Sediment Stratigraphy Study

The field methods for the floodplain sediment stratigraphy study were implemented as described in the Study Plan with no variances. In support of the Riparian IFS (Study 8.6) floodplain-erosion and sediment-deposition analyses (see RSP Section 8.6.3.5), floodplain sediment stratigraphy was characterized using both soil trenches and sediment core techniques. The objective of the sediment stratigraphy study is to characterize the role of erosion and sediment deposition in the formation of floodplain surfaces, soils, and vegetation (see RSP Section 8.6.3.5). The collaborative field effort for this study was conducted by the study teams for the Riparian Vegetation Study and Riparian IFS (Study 8.6).

To quantify floodplain sediment deposition over the last century, two tasks were undertaken: (1) two exploratory soil trenches were excavated to characterize floodplain sediment stratigraphy and grain-size distribution, and (2) 13 sediment core samples were taken for analysis of ^{210}Pb and ^{137}Cs soil isotope geochronology (for direct dating of fluvial sediments).

Floodplain stratigraphy was assessed at two ELS plot at FA-104 (Whiskers Slough) (Figure 4.2-2). The trenches were placed in the 3-m (10-ft) trample zone at the plot center. Floodplain soil trenches were excavated from the floodplain surface to the gravel/cobble layer (historic channel bed). Soil materials extracted from the trenches were placed on tarps to protect the soil surface and increase efficiency in replacing the soil material when the sampling was complete. Soil profile and stratigraphy were measured and described using standard NRCS field techniques (Schoeneberger et al. 2012). Sediment samples were taken at all major horizons for sediment grain-size sieve analysis (USDA NRCS 2004).

Sediment cores were collected during 2013 at 13 locations in the Middle River, 5 at FA-104 (Whiskers Slough) and 8 at FA-115 (Slough 6A) (Figure 4.2-2). At both FA-104 (Whiskers Slough) and FA-115 (Slough 6A), sediment sample sites were located at ELS plot locations along transects perpendicular to the river (Figure 4.2-2). Topographic transects and plot locations were surveyed using real time kinematic (RTK) GPS survey instrumentation tied into the Project elevation datum (see Section 4.3.4, below). Sediment cores were collected with a 91-cm length x 2.5-cm diameter thin-walled soil probe (AMS Inc.). Recovery of sediment cores was generally excellent, and the longest cores (typically 60–130 cm depending on depth to the cobble/gravel refusal layer) were selected for ^{210}Pb and ^{137}Cs analysis.

The laboratory geochronology analyses for ^{210}Pb and ^{137}Cs will be conducted at the Department of Geography, University of Exeter, UK, using standard methods (Aalto 2003; Aalto et al. 2008). Selected sediment cores will be sectioned at 2-cm intervals for both particle-size and isotope analyses. Sediment isotope laboratory results from the 2013 soil cores will be used to evaluate the sediment geochronology methods and determine the appropriate design for the sediment stratigraphy study to be conducted during the next year of study (see RSP Section 8.6.3.5).

4.2.2.1. Variances

There were no variances from the methods described in the Study Plan for the floodplain sediment stratigraphy study.

4.2.3. Surface Elevation

The field methods for collecting surface elevation data were implemented as described in the Study Plan with no variances. Ground surface elevation was recorded at all ELS plot centers, including those in FAs and those in the broader study area in coordination with the Fish and Aquatics Instream Flow Study (Study 8.5) and Riparian IFS (Study 8.6) field teams. Elevation surveying was conducted in the following manner. Plot centers were surveyed in by Riparian IFS field teams using a transit (elevation) and GPS unit (latitude/longitude). Transit surveys were tied into an intermediate benchmark established at each FA and ELS transect (e.g., a nail in a tree near riverbank). The flow-routing field team then surveyed the intermediate benchmark using an RTK survey instrument to tie the riparian survey plot elevations into the Project elevation datum.

4.2.3.1. Variances

There were no variances from the methods for collecting surface elevation data as described in the Study Plan.

4.2.4. Sampling of ITU Mapping Plots

The field methods for the sampling of ITU mapping plots were implemented as described in the Study Plan with no variances. The ITU mapping plots are designed to facilitate the rapid collection of data for the variables used in the ecotype classification and ITU mapping process. The methods are designed for efficiency in the field in order to cover a large area in a relatively short amount of time (typically 5–8 ITU mapping plots/field team are completed in a day). Transects for the ITU plots were oriented more or less perpendicular to the Susitna River channel so as to cross various floodplain surfaces and patches of riparian vegetation in different successional stages. Five to 10 circular plots of 10-m (33-ft) radii were sampled along each transect, each on a distinct floodplain surface and in a distinct vegetation type. The shape of the ITU mapping plots varied depending on the shape of the vegetation stand being sampled (e.g., long narrow stands of willow required a more elliptical-shaped plot). However, the same absolute area was sampled on all plots. All field data were recorded digitally in the field using a standardized data entry form on an *Android* tablet computer designed to link directly to a relational database (Microsoft Access). The following variables were recorded at each ITU mapping plot:

- Geo-referenced plot location (< 3-m [10-ft] accuracy);
- Site variables, including physiography, geomorphic unit, surface form, elevation, aspect, and slope;
- Vegetation structure, plant community composition, and plant percent-cove data to classify vegetation types to Level IV of the Alaska Vegetation Classification (AVC) (Viereck et al. 1992);
- Shallow soil pits were dug to categorize drainage and soil moisture;

- Soil hydrologic variables, including depth of water above or below ground surface, depth to saturated soil, pH, and electrical conductivity (EC);
- Soil depositional profiles;
- Wildlife sign such as winter or summer browse marks, nests, dens, droppings, singing birds, carcasses, tracks, and burrows; and
- Locations of tree ice-scars, ice bull-dozing, or other evidence of disturbance by ice (e.g., ice rafted boulders) were recorded at each plot and along each transect, for use in the Ice Processes in the Susitna River Study (Study 7.6) and the Riparian IFS (Study 8.6).

4.2.4.1. Variances

There were no variances from the sampling methods for ITU mapping plots as described in the Study Plan.

4.2.5. Sampling of ELS Plots

The field methods for the sampling of ELS plots were implemented as described in the Study Plan with the exception of the variances explained below (see Section 4.2.5.1). The ELS plots, are being used to collect data on site and environmental variables (following Jorgenson et al. 2009); vegetation composition (abundance and richness) and structure (size class, density, age); as well as detailed soil characteristics (see Soil Sampling and Sediment Aging, below). The purpose of the ELS plots is two-fold. First, the ELS plots are designed to facilitate the collection of detailed data on existing conditions (site characteristics, environmental variables, vegetation, and soils) for use in floristic, ecotype, and habitat analyses; sediment stratigraphy, aging, and sieve analyses; and the development of vegetation successional models. Second, the ELS plots and methods are designed to provide baseline data for a possible long-term monitoring study, with emphasis on repeatability of methods and relocation of plots, for use in potential future studies of changes in riparian vegetation due to Project operations. Due to the dual purpose of ELS plots and the need for repeatability, the field sampling protocols for ELS plots are more intensive than ITU mapping plots, making the ELS plots more time consuming to sample than the ITU mapping plots (typically 1–2 ELS plots/day can be completed by a field team).

ELS plots were designed following a nested, variable-sized-plot approach as illustrated in Figure 4.2-4.The variable-sized-plot design included a plot center, 3 nested tree/shrub plots, and a larger point-intercept plot. The plot center (3-m [10 ft] radius) served as a trample zone in which no vegetation sampling occurred. A 5.56-m (18 ft) radius plot was used to record species and Diameter at Breast Height (DBH) of all trees and selected shrubs (*Alnus* spp., *Salix* spp.) with a DBH < 5 cm(2 in). For any shrubs with multi-stem clusters from a single individual, stems were counted and a note was made to indicate that stems were of a single individual. For saplings and shrubs < 5 cm (2 in) DBH, diameter was recorded in 5 size classes (< 1, 1–2, 2–3, 3–4, and 4–5 cm [< 0.4, 0.4-0.8, 0.8-1.2, 1.2-1.6, and 1.6-2 in, respectively]). An 11.28-m (37 ft) radius plot was used to record species and DBH to the nearest 0.1cm (0.04 in) for all trees with a DBH of ≥ 5 cm (2 in). Two trees of each species within this zone were aged using increment cores (2 per tree) extracted near the root collar. In plot locations where no trees with DBH ≥ 5 cm (2 in) were present, each shrub and/or sapling species was aged using increment cores (2 per species for trees > 4–5 cm [1.6-2.0 in] DBH) or cookies (2 per species For shrubs and trees < 4 cm [1.6 in] DBH); both increment cores and cookies were extracted near the root collar. The vertical distance from the root collar to the core/cookie location and the depth of sedimentation above the root collar to the floodplain surface was measured. A 16.25-m (53.3 ft) radius plot was used to record DBH and species (if recognizable) of dead standing snags. Snags were considered to be any dead tree or shrub with DBH ≥ 5 cm (2 in) and ≥ 1.5 m (4.9 ft) in height. A 23-m (75 ft) radius plot was used to collect data on vegetation structure, plant community composition, and plant cover using the line-intercept method. For those ELS plots along groundwater transects, the groundwater instrumentation was co-located with ELS plots whenever possible, and was placed just outside the 23-m (75 ft) outer boundary of each ELS plot.

Each 23-m (75 ft) radius ELS plot was divided into four quadrants using 50-m (164-ft) measuring tapes, which served as vegetation sampling lines for the point-intercept measurements of all herbaceous and shrub species, and densiometer measurements of tree species. The orientation of the lines was determined from a random initial compass bearing to orient the first line. The remaining lines were oriented at 90 degree intervals to each other. Along each line, point-intercept measurements were recorded at 1-m (3.3-ft) increments along the measuring tape, beginning at 4 m (13 ft) (i.e., 1 m [3.3 ft] past the boundary of the trample zone) and ending at 23 m (75 ft) for a total 20 points per line. An additional five points per plot quadrant were sampled randomly off the tape lines within each quadrant. Therefore, for each plot, 80 points were recorded on the sampling lines, and 20 points off-line for a total of 100 points. At each point, a laser point (*GreenBeam 50*) and densitometer (Geographic Resource Solutions™) mounted on an extendable painters pole were used to collect point-intercept data (species hits) from the ground surface to the tree canopy. All hits of each plant species by the laser were tallied in two height classes (0–1.5 and 1.5–3 m [0–4.9 ft and 4.9–9.8ft, respectively]). The laser was oriented upwards to detect hits in the 1.5–3.0 m (4.9–9.8 ft) class. The densitometer was used to record the presence of trees and shrubs taller than 3 m (10 ft) (i.e., forest canopy). In addition to vascular plant species, hits of several categories of mosses (feather moss, *Sphagnum* spp., and other mosses), lichens (foliose, fruticose, crustose), and bare ground (rock, bare soil, litter, water) were also recorded.

Once transect sampling was completed, a random wander through the plot area was conducted to record the presence of any vascular plant species not previously recorded on the point-intercept transects. The random wander continued until 10 minutes had passed since a new species had been recorded. Soil pits were located in a randomly selected quadrant at approximately 12 m (39 ft) from the plot center point and half way between the two adjacent vegetation sampling lines.

Landscape photographs were taken from the plot center looking out along each vegetation sampling line.

Additional sampling details and data recorded included:

- Plot center and sampling line end-point locations (latitude/longitude), were recorded using Trimble GeoXT GPS units (≤ 1-m [3.3 ft] accuracy);
- Permanent magnetic survey markers (SurvKap®) were buried at approximately 20 cm (8 in) depth at the plot center point to aid in relocating these plots in the future;
- Site variables, including physiography, geomorphic unit, surface form, elevation, aspect, and slope;
- Vegetation types, classified in the field, to Level IV of the AVC (Viereck et al. 1992);

- Wildlife sign such as winter or summer browse marks, nests, dens, droppings, singing birds, carcasses, tracks, and burrows;
- Locations of tree ice-scars, ice bull-dozing, or other evidence of disturbance by ice (e.g., ice rafted boulders) were recorded at each plot and while traversing to the next plot, for use in the Ice Processes in the Susitna River Study (Study 7.6) and the Riparian IFS (Study 8.6) studies.

All field data were recorded digitally in the field using a standardized data entry form on an *Android* tablet computer designed to link directly to a relational database (*PostgreSQL*).

4.2.5.1. Variances

In 2013, two variances from the ELS sampling methods as described in the Study Plan were made and implemented. First, the original point-intercept sampling interval of 0.5 m (1.6 ft) described in the Study Plan for vegetation sampling on the ELS plots was changed to a 1.0-m (3.3 ft) interval; this change allowed for more accurate and representative data collection (less overlap in recording the same plants) in the dense, multi-canopied vegetation characteristic of the Susitna River floodplain. The larger sampling interval necessitated a larger sampling radius (23 m [75 ft]) for the ELS plots.

Second, for those ELS plots along groundwater transects, due to the large size of the groundwater installation hardware relative to the 3-m (10 ft) ELS plot center, and to reduce the risk of vegetation disturbance within the plot boundaries, the groundwater installation was not co-located with the ELS plot center as described in the Study Plan. Rather, the instrumentation was placed adjacent to the plot just outside the 23 m (75 ft) outer boundary of each ELS plot. The increased point-intercept sampling interval facilitated more accurate collection of field data, and the location of groundwater instrumentation outside of the ELS plots reduced vegetation disturbance on the ELS plots (preserving the plots utility for possible long-term monitoring studies). Both of these variances served to better fulfill the study objectives and there are no additional modifications needed for 2014 for the sampling of ELS plots.

4.3. ITU Classification and Mapping of Downstream Riparian Areas

4.3.1. ITU Classification

The methods for ITU classification were implemented as described in the Study Plan with no variances. Ecosystems in the study area were classified at two levels. First, individual ecosystem components (ITU variables) were classified and coded in the field using standard classification systems developed by ABR for Alaska (Table 4.3-1). Second, the ecosystem components were integrated to classify a set of preliminary riparian ecotypes (local-scale riparian ecosystems) that best partitioned the range of variation observed for all measured components.

Geomorphic units were classified according to a system based on landform and soil characteristics for Alaska; this system was developed originally by Kreig and Reger (1982) and ADGGS (1983) and was modified for previous work in Southcentral Alaska by Jorgenson et al., (2003). In classifying and mapping geomorphic units, materials near the surface (< 1 m deep) were emphasized because they have more influence on ecological processes than do materials deeper in the soil/substrate profile. For example, when mapping alluvial deposits, channel and overbank deposits were differentiated based on the differences in fluvial processes involved in creating and maintaining these surfaces. Similarly, three different types of overbank deposit (active, inactive, abandoned) were differentiated based on flooding frequency. Surface forms (macrotopography) were classified according to a system modified from that of Schoeneberger et al. (2012). Microtopography was classified according to the periglacial system of Washburn (1973). Vegetation was classified using Level IV types of the AVC developed by Viereck et al. (1992), with adjustments as needed for successional vegetation following Helm and Collins (1997).

The 2012 field data and the ITU mapping data were used to prepare a preliminary riparian ecotype classification for the Middle River portion of the Riparian Vegetation Study area. First, ecotypes were classified using contingency tables to establish common relationships among ecosystem components from the field data. Ecotype classes then were derived from a set of 215 unique ITU code combinations (from the full extent of the ITU mapping in the study area) by aggregating into a set of 20 ecotypes, and a crosswalk was created between the ecotype classes and the ITU combinations. The crosswalk was used to create a tabular join in *ArcGIS* and the ITU map data were then recoded to create an ecotype map class. In cross-walking the combined ecosystem components to ecotype classes, an attempt was made to use those ecological characteristics (primarily geomorphology, surface form, and vegetation structure) that could be readily interpreted from aerial imagery. The number of potential ecotype classes (215) was reduced by aggregating the field data for individual ecological characteristics (e.g., soil stratigraphy and vegetation composition) into more generalized classes. For geomorphology classes, soil profiles were generalized by aggregating soil horizons with similar textures and bed forms into geomorphic units using the approaches of Miall (1985). Geomorphic units were assigned to physiographic settings based on their erosional or depositional processes. Surface forms were aggregated into a reduced set of elements (primarily driven by ecological processes, including sedimentation, erosion, ice scour, and wind disturbance). For vegetation, the structural components of the AVC Level IV classes of Viereck et al. (1992) were emphasized, because vegetation structure is readily identifiable on aerial photographs.

In addition to the 20 ecotypes determined from the 2012 field data, map data from FA-104 (Whiskers Slough), FA-115 (Slough 6A), and FA-128 (Slough 8A) (see Section 5.1.6 below) also were used to develop another nine temporary ecotype classes, which will be assessed further in the next year of study with analyses of the 2013 field data. Ecotype names were based on the aggregated ecosystem components, including physiography, dominant soil texture, and vegetation composition and structure (e.g., Riverine Sandy Pole-sized Balsam Poplar Forest).

4.3.2. ITU Mapping

The methods for ITU mapping were implemented as described in the Study Plan with no variances. As noted above in Section 4.1, Overview, in this study riparian ecotypes, wetlands, and wildlife habitats are being mapped using an ITU approach. All the mapping of riparian areas is being conducted on-screen in *ArcGIS* and extensive use of the field ground-reference data is being made so that image-signatures are accurately interpreted. A minimum mapping size of 0.40 ha (1 acre) for terrestrial polygons and 0.10 ha (0.25 acres) for water bodies is being used. Individual ecosystem components or ITU variables were mapped concurrently and were identified by assigning a five-parameter, compound code to each polygon describing geomorphology (e.g., Braided Active Channel Deposit, Fbra); surface form (e.g., Mid-channel Bar, Fbm); vegetation class (e.g., Open Balsam Poplar Forest, Fbop), poplar size class (e.g., Pole, P), and disturbance class variables (e.g., Ice Bulldozing, Ngi) (Table 4.3-1). The five map components, when combined, represent unique ITUs (e.g., Fbra/Fbm/Fbop/P/Ngi). Following mapping, the compound ITU classes were aggregated to preliminary riparian ecotypes based on the combination of ITUs that best represents the local-scale riparian habitats in the mapped areas.

In 2012 and 2013, ITU mapping of riparian ecotypes in the Middle Susitna River was carried out by image-interpretation of the current aerial imagery available for the study area. Ground-reference data collected in summer 2012 and 2013 was used to verify the mapping. For this preliminary mapping effort, the mapping was limited to those areas delineated as riverine physiography (see Section 3, Study Area, above) and which are covered by the Matanuska-Susitna Borough (Mat-Su) true color and color infrared (CIR) orthophoto aerial imagery collected in mid- to late summer 2011 (upstream of PRM 121); this imagery provides the best color signatures for mapping since the imagery in these areas was collected at full vegetation green-up (Figure 4.3-1). Color signatures in areas of the Mat-Su aerial imagery collected in late spring/early summer are not consistent with the mid- to late summer imagery as the former areas were collected prior to full vegetation green-up, making consistent and accurate interpretation of image signatures across the entire study area difficult (Figure 4.3-2). Despite these shortcomings, the Mat-Su aerial imagery collected in late spring/early summer was the only high-resolution (≤ 1 m) imagery available in Q2 2013 that encompassed FA-104 (Whiskers Slough) and FA-115 (Slough 6A) (which are located downstream of river mile 121). This imagery was used as the base layer over which the mapping of riparian ecotypes in FA-104 (Whiskers Slough) and FA-115 (Slough 6A) was conducted (Figure 4.3-1). The resulting ecotype mapping was essential for use in developing the stratified random sampling design for those FAs, as described in Section 4.3.1, Plot Allocation Procedures, above.

In Q2 2013, the processing of the 2012 mid-summer Susitna High Flow CIR imagery was completed. Initially, the color signature was oversaturated, making it difficult to interpret color signatures between different vegetation types. In Q3 2013, the 2012 Susitna High Flow CIR imagery was rebalanced. The rebalanced imagery became available in early Q4 2013 and represents a significant improvement so that it now compares in quality to the 2011 mid-summer Mat-Su aerial imagery. However, the 2012 imagery only covers the riparian study area between PRM 63 to 119 (Figure 4.3-2). While the 2012 imagery fills a large and important gap in mid-summer, high-resolution imagery across the riparian study area, there are still two gaps in mid-summer, high-resolution imagery (PRM 119 to 121 and PRM 29.5 to 63). Notwithstanding the caveats noted above in using imagery collected outside of the mid-summer period, going forward the Riparian Vegetation Study team will rely on two sets of existing imagery that cover different portions of those two identified gaps in imagery (the high-resolution 2011 Mat-Su late spring/early summer and the coarser 2004 Mat-Su mid-summer imagery); in Q1 2014, the study team also will search the imagery archives for additional mid-summer imagery that may have been collected in recent years in those areas. Only after all sources of existing imagery are evaluated and, if they are found unsatisfactory, will discussions with AEA occur regarding the potential for collecting additional mid-summer imagery.

4.3.2.1. Variances

There were no variances from the protocol described in the Study Plan for ITU classification or ITU mapping.

5. RESULTS

The Results and Discussion sections are organized by the ecosystem components addressed in this study in both the field and mapping work. The preliminary mapping prepared for FA-104 (Whiskers Slough), FA-115 (Slough 6A), and FA-128 (Slough 8A) is presented for review because the mapping for the full study area will not be completed until the last year of study. In both the Results and Discussions sections, the number and area covered by each of the ecosystem component classes refers to the mapped classes occurring within the FA boundaries used in the stratification process for plot allocation (light grey bounding boxes in Figures 4.2-4, and 5-1 through 5-5) and not the component classes occurring within the broader study area (Figure 4.3-1). Tables 5-1 through 5-3 list the areal extent of each ecosystem component on the ITU map for each FA, and the definitions of each of the component classes are provided in Tables 5-4 through 5-8.

To illustrate the ITU classification and mapping methods, and the map products to be prepared in this study, the mapping presented in this report is limited to the three FAs noted above. In many cases, ecosystem components were described in the field in the broader study area but were not mapped in one of the three FAs (e.g., the vegetation class Subarctic Lowland Sedge-Moss Bog Meadow); in those cases the additional component classes do not appear in the map figures and area tables, but do occur in the description tables for each component. Similarly, ecosystem component classes may appear in the map figures but were not included in the area tables because they fell outside the FA boundaries for stratification. Tables 5-1 through 5-3 indicate which of the ecosystem component classes were mapped within the FA boundaries used in the stratification process for plot allocation. Hence, in the following section, the number of ecosystem component classes may differ between the area tables, description tables, and/or map legends for the reasons described above.

5.1. Ecosystem Components

The field ground-reference and ITU mapping data analyzed in this report are publicly available on-line at http://gis.suhydro.org/reports/isr. The field data are in the file: ISR_11_6_RIPR_Data_2012.accdb and the mapping data are in: ISR_11_6_RIPR_Data_ABR.gdb.

5.1.1. Geomorphic Units

Eleven terrestrial geomorphic units were mapped within the three FAs (Figure 5-1, Tables 5-1 through 5-4). The most common geomorphic units in FA-104 (Whiskers Slough) were Meander Inactive Overbank Deposit (18.3 percent of the mapped area), Meander Active Overbank Deposit (15.1 percent), and Old Alluvial Terrace (11.4 percent) (Table 5-1). In FA-115 (Slough 6A), the most common types were Meander Active Overbank Deposit (20.4 percent), Meander

Inactive Overbank Deposit (13.2 percent), and Meander Fine Active Channel Deposit (11.2 percent) (Table 5-2), and in FA-128 (Slough 8A) Meander Inactive Overbank Deposit (38.9 percent), Meander Active Overbank Deposit (14.5 percent), and Meander Fine Active Channel Deposit (10.1 percent) were most common (Table 5-3).

Of the aquatic geomorphic units, Upper Perennial Glacial River (i.e., the Susitna River) was the most common type in all three FAs, accounting for 20.3 percent, 33.5 percent, and 27.8 percent of the mapped areas in FA-104 (Whiskers Slough), FA-115 (Slough 6A), and FA-128 (Slough 8A), respectively (Tables 5-1 through 5-3).

5.1.2. Surface Form

Ten surface form classes were mapped within the three FAs (Figure 5-2, Tables 5-1 through 5-3, and 5-5). The most common surface form classes in all three FAs were Interfluv or Flat Bank, accounting for 50.1 percent, 37.3 percent, and 53.4 percent of the mapped areas in FA-104 (Whiskers Slough), FA-115 (Slough 6A), and FA-128 (Slough 8A), respectively; and River or Stream, which accounted for 21.0 percent, 33.5 percent, and 27.8 percent in of the mapped areas in those same FAs, respectively (Tables 5-1 through 5-3). Terrace was the third most common surface form in FA-104 (Whiskers Slough) (11.4 percent), while in FA-115 (Slough 6A) and FA-128 (Slough 8A) the third most common surface form was Mid-Channel Bar (14.5 percent and 10.8 percent, respectively).

5.1.3. Vegetation

Twenty vegetation classes were mapped within the three FAs (Figure 5-3, Tables 5-1 through 5-3, and 5-6). The most common vegetation types in FA-104 (Whiskers Slough) were Open Spruce-Paper Birch (47.4 percent of the mapped area), Fresh Water (22.2 percent), and Spruce-Paper Birch Woodland (5.5 percent) (Table 5-1). The most common vegetation types in FA-115 (Slough 6A) were Fresh Water (34.8 percent), Closed Balsam Poplar Forest (10.0 percent), and Ferns (7.9 percent) (Table 5-2).The most common vegetation types in FA-128 (Slough 8A) were Open Balsam Poplar Forest (30.6 percent), Fresh Water (27.8 percent), and Closed Tall Willow (14.3 percent) (Table 5-3).

5.1.4. Disturbance

Five disturbance classes were mapped within the three FAs (Figure 5-4, Tables 5-1 through 5-3, and 5-7). The most common disturbance class in all three FAs was Absent (no disturbance noted), which accounted for 44.8 percent, 53.6 percent, and 56.1 percent of the mapped areas in FA-104 (Whiskers Slough), FA-115 (Slough 6A), and FA-128 (Slough 8A), respectively. The next most common disturbance types were Wind (37.3 percent in FA-104 [Whiskers Slough]), and Ice-Bulldozing (33.8 percent and 32.9 percent, respectively, in FA-115 [Slough 6A], and FA-128 [Slough 8A]).

5.1.5. Poplar Size Class

Three balsam poplar size classes and one non-poplar class were mapped within the three FAs (Figure 5-5, Tables 5-1 through 5-3, and 5-8). In FA-104 (Whiskers Slough), 94.5 percent of the area was mapped as non-poplar vegetation types (Table 5-1); of the remaining area, 0.4 percent was Large Timber-sized poplar, 3.4 percent was Timber-sized poplar, and 1.6 percent was Pole-sized poplar. In FA-115 (Slough 6A), 79.3 percent of the area was mapped as non-poplar vegetation types (Table 5-2); of the remaining area, 6.5 percent was Large Timber-sized poplar, 11.3 percent was Timber sized poplar, and 2.9 percent was Pole sized poplar. In FA-128 (Slough 8A), 62.2 percent of the area was mapped as non-poplar vegetation types (Table 5-4); of the remaining area 25.7 percent was Large Timber-sized poplar, 4.8 percent was Timber-sized poplar, and 7.3 percent was Pole-sized poplar.

5.1.6. Ecotypes

Using the 2012 field data and map data from the three FAs, 29 preliminary ecotypes (25 terrestrial, 4 aquatic) were classified within the Middle River portion of the study area; this, included 20 classified from the 2012 field data, and nine ecotypes that were mapped but not sampled in the field in 2012 (Table 5.1-1). Twenty-three of the 29 preliminary ecotypes (19 terrestrial, 4 aquatic) were mapped within the three FAs (Figure 4.2-4, Tables 5-1 through 5-3, and 5.1-2).

In FA-104 (Whiskers Slough), 12 terrestrial and 4 aquatic ecotypes were mapped (Table 5-1); the most common terrestrial ecotypes were Riverine Loamy Spruce-Birch Forest (28.3 percent), Upland Loamy Spruce-Birch Forest (24.6 percent), and Riverine Sandy Balsam Poplar Sapling-Alder-Willow Tall Shrub (5.9 percent). In FA-115 (Slough 6A), 18 terrestrial and 2 aquatic ecotypes were mapped (Table 5-2); the most common terrestrial ecotype were Riverine Sandy Timber-sized Balsam Poplar Forest (11.3 percent), Riverine Loamy Spruce-Birch Forest (9.6 percent), and Riverine Sandy-Loamy Spruce-Balsam Poplar Forest (9.3 percent). In FA-128 (Slough 8A), 9 terrestrial and 1 aquatic ecotype were mapped (Table 5-3); the most common terrestrial ecotypes were Riverine Sandy-Loamy Balsam Poplar Large Tree Forest (25.7 percent), Riverine Sandy Alder-Willow Tall Shrub (15.0 percent), and Riverine Sandy Pole-sized Balsam Poplar Forest (7.3 percent). Of the aquatic ecotypes, Riverine Circumneutral Glacial River was the most common in all three FAs, accounting for 20.3 percent, 33.5 percent, and 27.8 percent in FA-104 (Whiskers Slough), FA-115 (Slough 6A), and FA-128 (Slough 8A), respectively.

6. DISCUSSION

The field data collection efforts and the mapping prepared in 2013 were conducted as planned and described in the Study Plan. Substantial progress has been made in using the ITU field data and mapping processes to characterize the local-scale riparian ecosystems occurring in the Middle River portion of the study area; in the next study year, those efforts will be extended upstream to the Project dam site and downstream into the Lower River portion of the study area. The progress of the study to date is sufficient to meet the study objectives with an additional year of field data collection, ITU mapping, and finally, the modeling of natural successional pathways for riparian vegetation in the Susitna River floodplain downstream of the proposed Project dam site.

6.1. Ecosystem Components

6.1.1. Geomorphic Units

Geomorphic units in riparian areas are ecologically important because they represent areas with differing erosional and depositional characteristics and, as a result, they have different types of naturally occurring topography, disturbance regimes, and vegetation. For instance, channel deposits and overbank deposits were differentiated as separate geomorphic units because the former have more frequent flooding and are characterized by intense scouring and deposition of coarser sediments (sand and gravels), while the later are subject to lateral-flow overbank flooding and are characterized by the deposition of finer sediments (fine sand, silt, and clay). Channel deposits were further subdivided into two classes based on the dominate soil texture in the upper 40 cm (16 in): coarse soils (loamy fine sand and coarser, and/or > 15% rock fragments), and finer soils (finer than loamy fine sandy and < 15% rock fragments). Recognizing that floodplain surfaces located at different elevations above the active river channel are characterized by different flooding frequencies, three different types of overbank deposits (active, inactive, and abandoned) were differentiated. Active overbank deposits are flooded regularly (~1–15 years intervals) and may be flooded multiple times within a single year; inactive overbank deposits are flooded irregularly (~15–75 year intervals); and abandoned overbank deposits are rarely flooded (75–150 years). The disturbance regimes, soil textures, and flood frequencies characteristic of these different floodplain surfaces result in differences in vegetation. For instance, coarse active channel deposits are typically barren or partially vegetated, while fine active channel deposits are characterized by willow-alder-poplar sapling tall shrub. Active overbank deposits are characterized by balsam poplar and mixed balsam poplar-white spruce stands, and inactive overbank deposits are characterized by white spruce-paper birch forests.

6.1.2. Surface Form

Surface forms were characterized in this study because they are associated with local-scale ecological gradients and processes, and disturbances, each of which influences localized microtopography and vegetation establishment. For instance, tree mounds created by downed logs and upturned root balls are local-scale microtopographic features with exposed mineral soil, and these areas create microsites for seedling establishment.

In the ITU mapping process, researchers focused on those surface form classes that could be readily identified on aerial imagery, and especially on their topographic position in the floodplain. Topographic position determines the frequency and type of flooding, both of which influence patterns of disturbance and vegetation establishment. For example, mid-channel bars are frequently disturbed by ice flows during spring break-up, which can set back vegetation on these bars to an earlier successional state. Mid-channel and lateral bars are also characterized by abundant exposed sands and frequent flooding, a combination of factors which facilitates the establishment of poplar and willow seedlings.

6.1.3. Vegetation

The type and distribution of vegetation in an area reflects a combination of the available species pool, broad-scale climatic, and fine-scale topo-edaphic factors. For instance, the Riparian Vegetation Study area is located in Southcentral Alaska on the floodplain of the Susitna River, and in this area white spruce-paper birch forests, poplar forests, willow-alder scrub, fern and large umbel meadows are common. At a local scale, the distribution of vegetation in a given location is determined by fine-scale (1 to several m [3.3 to several ft]) topographic variability, flood frequency, and patterns of disturbance. Vegetation is important ecologically in riparian systems because it provides stability for fluvial soils, provides shade and cover for fish, contributes large woody debris to the river channel, and provides nutrient rich litter into aquatic systems. Riparian vegetation also provides food and cover for terrestrial wildlife, and serves as the essential structure for wildlife habitats. For instance, willows are essential winter browse for moose (Helm and Collins 1997), horsetails (*Equisetum* spp.) are an important spring food for grizzly bears (Helm and Mayer 1985), and black bears utilize cavities in large cottonwoods for winter den sites (Schwartz et al. 1987).

6.1.4. Disturbance

The focus in the ITU mapping was on recent (< 2–3 years) disturbances because recent disturbances were more reliably identified on the aerial imagery than older disturbances, and because the mapping is designed to represent contemporary floodplain conditions. Disturbance plays a pivotal role in riparian areas where local-scale vegetation and soil patterns strongly reflect patterns of disturbance. For instance, poplar sapling-alder-willow tall shrub is common in areas that experience regular ice scour. On higher, older floodplain surfaces where flooding is infrequent or rare, wind plays play a pivotal role in shaping forest structure. Large canopy gaps are created by wind, resulting in the formation of birch-spruce woodlands on these surfaces.

6.1.5. Poplar size class

Poplar size class (Pole, Timber, and Large Timber) was mapped for contiguous balsam poplar stands. The purpose of the poplar size classification was two-fold. First, it was designed to facilitate the mapping of various successional stages of poplar that were observed on the Susitna River floodplain. Second, it was designed to facilitate the mapping of wildlife habitat features, including black bear denning and raptor nest trees. The poplar size classes were designed so that the DBH range within each size class is ecologically important. For instance, the split between the pole- and timber-size classes(30 cm [12 in]) was determined based on the susceptibility to shearing by ice during spring break-up; trees smaller than this DBH are more prone to shearing than trees larger than this size, which are big enough to deflect ice. The lower end of the large timber size class (90 cm [35 in]) is the minimum diameter preferred by black bears for denning trees (Schwartz et al. 1987). The large timber class also encompasses a range of diameters typical of the dominant (often above-canopy) trees in a stand, which are commonly used as nesting platforms by Bald Eagles (Ritchie and Ambrose 2008).

6.1.6. Ecotypes

A hierarchical organization of physical and biological variables was used to classify the preliminary ecotypes in this study. In this hierarchical methodology, the combination of physiography (e.g., riverine, upland, lowland, which are strongly associated with geomorphic units); soil texture; and vegetation structure yields ecotype classes that effectively differentiate both soil characteristics and vegetation composition. This approach depends on characteristics that are readily identifiable from aerial imagery, including physiography (e.g., floodplains versus terraces); surface form (e.g., mid-channel bar vs. interfluv or flat bank); vegetation structure (e.g., woodland vs. open forest); and successional stage (e.g., poplar size classes). Understanding the associated variables is particularly important for differentiating ecotypes that (1) have different disturbance regimes and may respond differently to changes in river hydrology related to Project operational scenarios, and (2) are differentially important to wildlife for habitat. For example, the ecotype Riverine Sandy Balsam Poplar Sapling-Alder-Willow Tall Shrub is prone to disturbance by ice scour and shearing during spring break-up. Hence, this ecotype is likely to be more sensitive to changes in the ice regime that may occur under certain Project operational scenarios than Riverine Loamy Spruce-Birch Forest, which is more prone to wind disturbance and rarely, if ever, is affected directly by ice scour and shearing. Another example relates to wildlife habitat. The ecotype Riverine Sandy-Loamy Balsam Poplar Large Tree Forest is characterized by large diameter poplars. As discussed above, large poplar trees are commonly used by black bears as den sites, making this ecotype a favorable winter habitat for black bears. The vegetation in this ecotype is characterized by a woodland (10–25% tree cover) forest and features a thick cover of ferns (*Matteuccia struthiopteris*). Moose are unlikely to favor this habitat because the poplar branches are too high to browse and the ferns are unpalatable. Moose would, however, favor the ecotype Riverine Sandy Balsam Poplar Sapling-Alder-Willow Tall Shrub due to the high cover of tall willows (Collins and Helm 1997).

Because the descriptions of the ecotypes classified in this report are preliminary and presently are based on analysis of the 2012 field data only, nine ecotypes were mapped (in the Middle River FAs) but were not described in the field. These ecotypes represent placeholders for the purposes of the draft ecotype mapping and will be quantified and described during the next year of study.

6.2. Interrelated Studies

The Riparian Vegetation Study is integrally related to four other studies being conducted in riparian areas downstream of the proposed Project dam site. The set of five integrated riparian or riverine studies includes the Riparian Vegetation Study, the Fluvial Geomorphology Modeling below Watana Dam Study (Study 6.6), the Groundwater Study (Study 7.5), the Ice Processes in the Susitna River Study (Study 7.6), and the Riparian IFS (Study 8.6). Each of these studies was developed in detail, with extensive agency input, during the FERC Study Plan process in 2012 (see AEA 2012), and there was explicit recognition in the Study Plans for each study of the data that would be needed to be supplied to each of the related studies. Each study also was designed and scheduled so that those data would be available when needed. In 2013, the field work for the Riparian Vegetation Study, the Groundwater Study (Study 7.5), and the Riparian IFS (Study 8.6) were conducted in a collaborative fashion, with intensive data collected by all three studies in the same three Middle River FAs discussed above. Overall, these studies are designed to provide data and/or modeling results to the study team for the Riparian IFS to support the modeling of change in riparian areas that could result from construction and operation of the proposed Watana Dam. The study teams for each of the four interrelated riparian/riverine studies conducted extensive field work and data analysis in 2013, as was done in this study, and all studies are on track to provide the necessary data and modeling results to the Riparian IFS (Study 8.6) study team to facilitate the modeling of change in riparian areas (see ISR Studies 6.6, 7.5, 7.6, and 8.6).

7. COMPLETING THE STUDY

[As explained in the cover letter to this draft ISR, AEA's plan for completing this study will be included in the final ISR filed with FERC on June 3, 2014.]

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9. TABLES

Table 4.2-1. ELS Plots Allocated Randomly by Ecotype in Focus Area 104 (Whiskers Slough), Middle Susitna River, Riparian Vegetation Study Area, Susitna-Watana Hydroelectric Project, 2013.[1]

Terrestrial Ecotypes[2]	Area (acres)	% of Total Terrestrial Area	Proportion of Total Samples (N*% area) [3]	No. Plots Allocated	No. Sampled in 2013
Lowland Organic-rich Bluejoint-Herb Meadow	1.1	0.2%	0.1	0	0
Riverine Gravelly Wormwood-Horsetail Barrens and Partially Vegetated	7.8	1.6%	0.7	2	2
Riverine Loamy Ostrich Fern Meadow	23.8	4.8%	2.0	4	2
Riverine Loamy Spruce-Birch Forest	182.0	36.4%	15.7	7	5
Riverine Sandy Balsam Poplar Sapling-Alder-Willow Tall Shrub	37.7	7.5%	3.2	4	3
Riverine Sandy Bluejoint-Herb Meadow	15.5	3.1%	1.3	2	1
Riverine Sandy Pole-sized Balsam Poplar Forest	10.5	2.1%	0.9	4	3
Riverine Sandy Timber-sized Balsam Poplar Forest	22.1	4.4%	1.9	4	5
Riverine Sandy-Loamy Balsam Poplar Large Tree Forest	2.5	0.5%	0.2	0	0
Riverine Sandy-Loamy Spruce-Balsam Poplar Forest	33.7	6.7%	2.9	5	4
Riverine Wet Sedge-Forb Marsh	5.0	1.0%	0.4	0	0
Upland Loamy Spruce-Birch Forest	158.1	31.6%	13.6	6	3
FA-104 (Whisker Slough) Totals	499.8	100.0%	43.0	38	28

Notes:

1 Plots allocated by stratified random allocation procedures with ecotype as the stratum (see text).

2 Total number of ecotypes (ET) = 12.

3 Approximate total number of plots in FA-104 (Whiskers Slough) (N) (1 plot/20 acres + 1.5*ET) = 43.

Table 4.2-2. ELS Plots Allocated Randomly by Ecotype in Focus Area 115 (Slough 6A), Middle Susitna River, Riparian Vegetation Study Area, Susitna-Watana Hydroelectric Project, 2013.[1]

Terrestrial Ecotypes[2]	Area (acres)	% of Total Terrestrial Area	Proportion of Total Samples (N*% area)[3]	No. Plots Allocated	No. Sampled in 2013
Lowland Loamy Birch Forest	6.7	2.1%	0.9	2	0
Lowland Loamy Ostrich Fern Meadow	1.3	0.4%	0.2	0	0
Lowland Organic-rich Bluejoint-Herb Meadow	11.3	3.5%	1.5	2	1
Riverine Complex	5.1	1.6%	0.7	0	0
Riverine Gravelly Wormwood-Horsetail Barrens and Partially Vegetated	17.6	5.5%	2.4	2	1
Riverine Loamy Birch Forest	8.8	2.7%	1.2	2	0
Riverine Loamy Ostrich Fern Meadow	37.5	11.6%	5.0	2	1
Riverine Loamy Spruce-Birch Forest	47.7	14.8%	6.4	5	3
Riverine Sandy Alder-Willow Tall Shrub	4.4	1.4%	0.6	0	0
Riverine Sandy Balsam Poplar Sapling-Alder-Willow Tall Shrub	7.2	2.2%	1.0	2	1
Riverine Sandy Bluejoint-Herb Meadow	13.4	4.1%	1.8	5	3
Riverine Sandy Pole-sized Balsam Poplar Forest	14.1	4.4%	1.9	4	2
Riverine Sandy Timber-sized Balsam Poplar Forest	55.9	17.3%	7.4	4	3
Riverine Sandy-Loamy Balsam Poplar Large Tree Forest	32.3	10.0%	4.3	4	3
Riverine Sandy-Loamy Spruce-Balsam Poplar Forest	46.1	14.3%	6.1	5	2
Riverine Wet Sedge-Forb Marsh	6.2	1.9%	0.8	1	1
Upland Loamy Spruce-Birch Forest	6.6	2.1%	0.9	2	2
Upland, undifferentiated	0.2	0.1%	0.0	0	0
FA-115 (Slough 6A) Totals	322.5	100.0%	43.0	42	23

Notes:

1 Plots allocated by stratified random allocation procedures with ecotype as the stratum (see text).

2 Total number of ecotypes (ET) = 18.

3 Approximate total number of plots in FA-115 (Slough 6A) (N) (1 plot/ 20 acres + 1.5* ET) = 43.

Table 4.2-3. ELS Plots Allocated Randomly by Ecotype in Focus Area 128 (Slough 8A), Middle Susitna River, Riparian Vegetation Study Area, Susitna-Watana Hydroelectric Project, 2013.[1]

Terrestrial Ecotypes[2]	Area (acres) No. Water Bodies	% of Total Terrestrial Area	Proportion of Total Samples (N*% area) [3]	No. Plots Allocated	No. Sampled in 2013
Human Modified	0.5	0.1%	0.0	0	0
Riverine Gravelly Wormwood-Horsetail Barrens and Partially Vegetated	39.4	8.8%	3.2	5	0
Riverine Loamy Spruce-Birch Forest	7.7	1.7%	0.6	0	0
Riverine Sandy Alder-Willow Tall Shrub	92.9	20.7%	7.5	7	1
Riverine Sandy Balsam Poplar Sapling-Alder-Willow Tall Shrub	39.9	8.9%	3.2	5	0
Riverine Sandy Pole-sized Balsam Poplar Forest	45.2	10.1%	3.6	5	0
Riverine Sandy Timber-sized Balsam Poplar Forest	30.1	6.7%	2.4	4	0
Riverine Sandy-Loamy Balsam Poplar Large Tree Forest	159.6	35.6%	12.8	8	2
Riverine Sandy-Loamy Spruce-Balsam Poplar Forest	33.4	7.4%	2.7	4	1
FA-128 (Slough 8A) Totals	448.5	100.0%	36.0	38	4

Notes:

1 Plots allocated by stratified random allocation procedures with ecotype as the stratum (see text).

2 Total number of ecotypes (ET) = 9.

3 Approximate total number of plots in FA-128 (Slough 8A) (N) (1 plot/ 20 acres + 1.5* ET) = 36.

Table 4.2-4. ELS Plots Allocated By Ecotype in Focus Areas (FAs) and Satellite Areas (SAs), Middle Susitna River, Riparian Vegetation Study Area, Susitna-Watana Hydroelectric Project, 2013.

Terrestrial Ecotypes	Area (Acres)[1]	% of Terrestrial Ecotypes	No. Allocated Plots in FAs[2]	No. Allocated Plots in Satellite Areas	Total Allocated Plots in Middle River	No. Sampled in 2013 in FAs [SAs]
Human Modified	43.2	0.7%	0	0	0	0
Lowland Loamy Birch Forest	125.2	2.0%	2	0	2	0
Lowland Loamy Ostrich Fern Meadow	1.3	0.0%	0	0	0	0
Lowland Organic-rich Bluejoint-Herb Meadow	12.4	0.2%	2	0	2	1 [1]
Lowland Organic-rich Sedge Meadow	2.7	0.0%	0	0	0	0
Lowland Organic-Rich Wet Spruce Forest	6.4	0.1%	0	0	0	0
Riverine Complex	42.9	0.7%	0	0	0	0
Riverine Gravelly Wormwood-Horsetail Barrens and Partially Vegetated	722.7	11.5%	9	2	11	3 [1]
Riverine Loamy Birch Forest	45.2	0.7%	2	0	2	0
Riverine Loamy Large Umbel Meadow	29.8	0.5%	0	6	6	[1]
Riverine Loamy Ostrich Fern Meadow	127.8	2.0%	6	6	12	3
Riverine Loamy Spruce-Birch Forest	1068.0	17.0%	12	0	12	8
Riverine Sandy Alder-Willow Tall Shrub	421.8	6.7%	7	1	8	1
Riverine Sandy Balsam Poplar Sapling-Alder-Willow Tall Shrub	475.4	7.6%	11	2	13	4 [1]
Riverine Sandy Bluejoint-Herb Meadow	39.4	0.6%	7	4	11	4
Riverine Sandy Pole-sized Balsam Poplar Forest	332.5	5.3%	13	2	15	5
Riverine Sandy Spruce Forest	181.8	2.9%	0	4	4	0

Terrestrial Ecotypes	Area (Acres)[1]	% of Terrestrial Ecotypes	No. Allocated Plots in FAs[2]	No. Allocated Plots in Satellite Areas	Total Allocated Plots in Middle River	No. Sampled in 2013 in FAs [SAs]
Riverine Sandy Timber-sized Balsam Poplar Forest	652.4	10.4%	12	1	13	8
Riverine Sandy-Loamy Balsam Poplar Large Tree Forest	571.7	9.1%	12	2	14	5
Riverine Sandy-Loamy Spruce-Balsam Poplar Forest	667.9	10.6%	14	2	16	7
Riverine Wet Sedge-Forb Marsh	39.7	0.6%	1	5	6	1 [1]
Upland Barrens	1.9	0.0%	0	0	0	0
Upland Birch Forest	1.4	0.0%	0	0	0	0
Upland Loamy Spruce-Birch Forest	551.5	8.8%	8	0	8	5
Upland Poplar	32.4	0.5%	0	0	0	0
Upland Willow	4.6	0.1%	0	0	0	0
Upland, undifferentiated	88.1	1.4%	0	0	0	0
Total Terrestrial Ecotypes	6290.2	100.0%	118	37	155	60
Aquatic Ecotypes	Area (Acres)	% of Aquatic Ecotypes				
Lowland Headwater Stream	6.6	0.2%	0	0	0	0
Riverine Circumneutral Beaver Pond	37.5	1.2%	0	0	0	0
Riverine Circumneutral Glacial River	3143.2	98.5%	0	0	0	0
Riverine Slough	5.3	0.2%	0	0	0	0
Total Aquatic Ecotypes	3192.6	100.0%	0	0	0	0
Grand Total	9482.8					

Notes:

1 Areal Extent of ITU mapping completed to date includes : PRM 104.8-106.5 (FA-104 [Whiskers Slough]), 115.3-117.4 (FA-115 [Slough 6A]), 121.0-147.1 (includes FA-128 [Slough 8A and FA-138 [Gold Creek]), 173.0-175.4 (FA-173 [Stephan Lake Complex]).

2 Plots allocated by stratified random allocation procedures with ecotype as the stratum (see text).

Table 4.3-1. Coding System for Classifying and Mapping Geomorphic Units, Surface Forms, Vegetation, Disturbance, and Poplar Size Classes, Riparian Vegetation Study, Susitna-Watana Hydroelectric Project, 2013.

Code	Class	FA Map Class
GEOMORPHIC UNIT		
Terrestrial		
Fboa	Braided Active Overbank Deposit	
Fbob	Braided Abandoned Overbank Deposit	
Fboi	Braided Inactive Overbank Deposit	
Fbra	Braided Active Channel Deposit	
Fbrac	Braided Coarse Active Channel Deposit	
Fbraf	Braided Fine Active Channel Deposit	
Fbri	Braided Inactive Channel Deposit	
Fbrif	Braided Fine Inactive Channel Deposit	
Fmoa	Meander Active Overbank Deposit	X
Fmob	Meander Abandoned Overbank Deposit	X
Fmoi	Meander Inactive Overbank Deposit	X
Fmra	Meander Active Channel Deposit	
Fmrac	Meander Coarse Active Channel Deposit	X
Fmraf	Meander Fine Active Channel Deposit	X
Fmrb	Meander Abandoned Channel Deposit	X
Fmrbf	Meander Fine Abandoned Channel Deposit	
Fmri	Meander Inactive Channel Deposit	
Fmrif	Meander Fine Inactive Channel Deposit	X
Fto	Old Alluvial Terrace	X
Ftr	Recent Alluvial Terrace	
Hfg	Gravel Fill	X
Ob	Bogs	
Of	Organic Fen	
Ofc	Channel Fen	X
U	Upland, undifferentiated	X
Code	Class	FA Map Class
Aquatic		
Wrhl	Lowland Headwater Stream	X
Wrug	Upper Perennial River, glacial	X
Wrsl	Riverine Slough	X
Wlscv	Shallow Connected Beaver Pond	X
SURFACE FORM		
B	Basins Or Depressions	
Dc	Riverbed Cobbles or Boulders	
Dr	Ripples	
Ds	Scour channels-ridges	
Fbl	Lateral Bar	X
Fbm	Mid-Channel Bar	X
Fbp	Point Bar	
Fc	Channel, Swale Or Gut	X
Ff	Flood Basin	X
Fi	Interfluv Or Flat Bank	X
Ft	Terrace	X
Hm	Human modified	X
Mid	Ice-rafted debris	
Mir	Ice-shoved ridge	
Ml	Tree mounds	
Mpm	Peat mounds	
Mu	Undifferentiated mounds	
N	Nonpatterned	
R	River Or Stream	X
U	Upland, undifferentiated	X
W	Waterbodies	X
Code	Class	FA Map Class
SURFACE FORM		
Xcb	Braided Channels And Interfluvs	
VEGETATION CLASS		
Bbg	Barren	
Bpv	Partially Vegetated	X
Dc	Disturbance complex	
Fbcb	Closed Paper Birch Forest	
Fbcp	Closed Balsam Poplar Forest	X
Fbob	Open Paper Birch Forest	X
Fbop	Open Balsam Poplar Forest	X

Fbwb	Paper Birch Woodland	X
Fbwp	Balsam Poplar Woodland	X
Fmcpws	Closed Balsam Poplar-White Spruce Forest	
Fmobps	Open Paper Birch-Balsam Poplar-Spruce Forest	
Fmosb	Open Spruce-Paper Birch Forest	X
Fmosp	Open Spruce-Balsam Poplar Forest	X
Fmwsb	Spruce-Paper Birch Woodland	X
Fmwsp	Spruce-Balsam Poplar Woodland	X
Fnobs	Open Black Spruce Forest	
Fnows	Open White Spruce Forest	
Fnwbs	Black Spruce Woodland	
Hfmc	Ferns	X
Hfmu	Large Umbel	
Hfw	Wet Forb Meadow	X
Hfwfh	Fresh Herb Marsh	
Hfwhb	Subarctic Lowland Herb Bog Meadow	
Hgmb	Bluejoint Meadow	X
Hgmbh	Bluejoint-Herb	

Code	Class	FA Map Class
Hgmbs	Bluejoint-Shrub	
Hgwfs	Fresh Sedge Marsh	
Hgwg	Subarctic Lowland Grass Wet Meadow	
Hgwgh	Subarctic Lowland Graminoid-Herb Wet Meadow	
Hgwsb	Subarctic Lowland Sedge Bog Meadow	
Hgwsl	Subarctic Lowland Sedge Wet Meadow	
Hgwsmb	Subarctic Lowland Sedge-Moss Bog Meadow	
Sddt	Dryas Dwarf Shrub Tundra	
Sfcpa	Closed Poplar Woodland-Alder Tall Shrub	X
Sfcpw	Closed Poplar Woodland-Willow Tall Shrub	
Sfopa	Open Poplar Woodland-Alder Tall Shrub	
Sfopaw	Open Poplar Woodland-Alder-Willow Tall Shrub	X
Sfopw	Open Poplar Woodland-Willow Tall Shrub	
Sfwbs	Dwarf Black Spruce Woodland	
Slcr	Closed Low Rose Shrub	
Sloaw	Open Low Alder-Willow Shrub	
Slobb	Open Low Shrub Birch-Ericaceous Shrub Bog	
Sloeb	Open Low Ericaceous Shrub Bog	
Slor	Open Low Rose Shrub	
Slow	Open Low Willow Shrub	X
Stca	Closed Tall Alder Shrub	
Stcaw	Closed Tall Alder-Willow Shrub	
Stcw	Closed Tall Willow Shrub	X
Stoa	Open Tall Alder Shrub	
Stoaw	Open Tall Alder-Willow Shrub	
Stow	Open Tall Willow Shrub	
U	Upland, undifferentiated	X

Code	Class	FA Map Class
VEGETATION CLASS		
Wf	Fresh Water	X
Xr	Riverine Complex	X
DISTURBANCE CLASS		
A	Absent, None (mature vegetation)	X
Ngf	Fluvial	
Ngfd	Fluvial Deposition	
Ngfe	Fluvial Erosion/channel migration	
Hc	Undifferentiated Clearing	
Hfg	Gravel Fill	X
Hdr	Residential Development	
Ng	Geomorphic Process	X
Ngi	Ice Bulldozing	X
Nwd	Wind	X
POPLAR SIZE CLASS		
P	Pole (5–30 cm DBH)	X
T	Timber (31–90 cm DBH)	X
L	Large Timber (> 90 cm DBH)	X

Table 5-1. Areal Extent of Individual Integrated Terrain Unit Classes and Aggregated Ecotype Classes in Focus Area 104 (Whiskers Slough), Middle Susitna River, Riparian Vegetation Study Area, Susitna-Watana Hydroelectric Project, 2013.[1]

	Acres	%
GEOMORPHIC UNIT		
Terrestrial		
Meander Inactive Overbank Deposit	117.5	18.3
Meander Active Overbank Deposit	97.2	15.1
Old Alluvial Terrace	73.4	11.4
Meander Fine Active Channel Deposit	56.3	8.8
Meander Fine Inactive Channel Deposit	55.9	8.7
Meander Abandoned Channel Deposit	43.5	6.8
Meander Abandoned Overbank Deposit	42.3	6.6
Meander Coarse Active Channel Deposit	8.6	1.3
Channel Fen	5.0	0.8
Aquatic		
Lowland Headwater Stream	5.0	0.8
Riverine Slough	2.9	0.5
Shallow Connected Beaver Pond	4.3	0.7
Upper Perennial Glacial River	130.6	20.3
TOTAL	642.7	100.0
AGGREGATED SUBTOTALS		
Terrestrial Geomorphic Units	499.8	77.8
Fresh Water	142.8	22.2
SURFACE FORM		
Interfluv or Flat Bank	322.0	50.1
River or Stream	134.7	21.0
Terrace	73.4	11.4
Mid-Channel Bar	52.8	8.2
Channel, Swale Or Gut	48.4	7.5
Lateral Bar	7.1	1.1
Water Bodies	4.3	0.7
TOTAL	642.7	100.0
	Acres	%
VEGETATION CLASS		
Open Spruce-Paper Birch Forest	304.8	47.4
Fresh Water	142.8	22.2
Spruce-Paper Birch Woodland	35.3	5.5
Ferns	23.8	3.7
Open Poplar Woodland-Alder-Willow Tall Shrub	21.7	3.4
Spruce–Balsam Poplar Woodland	21.0	3.3
Closed Balsam Poplar Forest	17.6	2.7
Bluejoint Meadow	16.6	2.6
Closed Poplar Woodland–Alder Tall Shrub	16.0	2.5
Open Spruce–Balsam Poplar Forest	12.7	2.0
Open Balsam Poplar Forest	10.6	1.6
Partially Vegetated	7.8	1.2
Balsam Poplar Woodland	6.9	1.1
Wet Forb Meadow	5.0	0.8
TOTAL	642.7	100.0
DISTURBANCE CLASS		
Absent, None	287.9	44.8
Ice Bulldozing	114.8	17.9
Wind	240.0	37.3
TOTAL	642.7	100.0
POPLAR SIZE CLASS		
Poplar vegetation types		
Large Timber (> 90 cm DBH)	2.5	0.4
Pole (5–30 cm DBH)	10.5	1.6
Timber (31–90 cm DBH)	22.1	3.4
Non Poplar Vegetation Types	607.6	94.5
TOTAL	642.7	100.0
	Acres	%
ECOTYPE		
Terrestrial		
Lowland Organic-rich Bluejoint-Herb Meadow	1.1	0.2
Riverine Gravelly Wormwood-Horsetail Barrens and Partially Vegetated	7.8	1.2
Riverine Loamy Ostrich Fern Meadow	23.8	3.7
Riverine Loamy Spruce-Birch Forest	182.0	28.3
Riverine Sandy Balsam Poplar Sapling-Alder-Willow Tall Shrub	37.7	5.9
Riverine Sandy Bluejoint-Herb Meadow	15.5	2.4
Riverine Sandy Pole-sized Balsam Poplar Forest	10.5	1.6
Riverine Sandy Timber-sized Balsam Poplar Forest	22.1	3.4

Riverine Sandy-Loamy Balsam Poplar Large Tree Forest	2.5	0.4
Riverine Sandy-Loamy Spruce-Balsam Poplar Forest	33.7	5.2
Riverine Wet Sedge-Forb Marsh	5.0	0.8
Upland Loamy Spruce-Birch Forest	158.1	24.6
Aquatic		
Lowland Headwater Stream	5.0	0.8
Riverine Circumneutral Beaver Pond	4.3	0.7
Riverine Circumneutral Glacial River	130.6	20.3
Riverine Slough	2.9	0.5
TOTAL	642.7	100.0
AGGREGATED SUBTOTALS		
Terrestrial Ecotypes	499.8	77.8
Aquatic Ecotypes	142.8	22.2

Note:

1 Area figures for each class represent the area mapped within the FA boundaries used for stratification in plot allocation (see text).

Table 5-2. Areal Extent of Individual Integrated Terrain Unit Classes and Aggregated Ecotype Classes in Focus Area 115 (Slough 6A), Middle Susitna River, Riparian Vegetation Study Area, Susitna-Watana Hydroelectric Project, 2013.[1]

	Acres	%
GEOMORPHIC UNIT		
Terrestrial		
Meander Active Overbank Deposit	100.9	20.4
Meander Inactive Overbank Deposit	65.4	13.2
Meander Fine Active Channel Deposit	55.3	11.2
Meander Fine Inactive Channel Deposit	48.1	9.7
Meander Abandoned Overbank Deposit	26.8	5.4
Meander Coarse Active Channel Deposit	22.2	4.5
Channel Fen	3.5	0.7
Upland, undifferentiated	0.2	0.0
Aquatic		
Shallow Connected Beaver Pond	6.6	1.3
Upper Perennial Glacial River	165.8	33.5
TOTAL	494.9	100.0
AGGREGATED SUBTOTALS		
Terrestrial Geomorphic Units	322.5	65.2
Fresh Water	172.4	34.8
SURFACE FORM		
Channel, Swale Or Gut	51.6	10.4
Flood Basin	8.4	1.7
Interfluv Or Flat Bank	184.8	37.3
Lateral Bar	6.0	1.2
Mid-Channel Bar	71.6	14.5
River Or Stream	165.8	33.5
Water bodies	6.6	1.3
Upland, undifferentiated	0.2	0.0
TOTAL	494.9	100.0
	Acres	%
VEGETATION CLASS		
Balsam Poplar Woodland	14.3	2.9
Bluejoint Meadow	24.7	5.0
Closed Balsam Poplar Forest	49.3	10.0
Closed Tall Willow Shrub	4.4	0.9
Ferns	38.9	7.9
Fresh Water	172.4	34.8
Open Balsam Poplar Forest	38.7	7.8
Open Paper Birch Forest	6.7	1.4
Open Poplar Woodland-Alder-Willow Tall Shrub	7.2	1.5
Open Spruce-Paper Birch Forest	26.4	5.3
Open Spruce-Paper Birch Forest	26.4	5.3
Open Spruce–Balsam Poplar Forest	18.1	3.7
Paper Birch Woodland	8.8	1.8
Partially Vegetated	17.6	3.6
Riverine Complex	5.1	1.0
Spruce-Balsam Poplar Woodland	28.0	5.7
Spruce-Paper Birch Woodland	27.9	5.6
Wet Forb Meadow	6.2	1.2
Upland, undifferentiated	0.2	0.0
TOTAL	494.9	100.0
DISTURBANCE CLASS		
Absent, None	265.4	53.6
Ice Bulldozing	167.5	33.8
Wind	62.0	12.5
TOTAL	494.9	100.0
	Acres	%
POPLAR SIZE CLASS		
Poplar vegetation types		
Large Timber (> 90 cm DBH)	32.3	6.5
Pole (5–30 cm DBH)	14.1	2.9
Timber (31–90 cm DBH)	55.9	11.3
Non Poplar Vegetation Types	392.6	79.3
TOTAL	494.9	100.0
ECOTYPE		
Terrestrial		
Lowland Loamy Birch Forest	6.7	1.4
Lowland Loamy Ostrich Fern Meadow	1.3	0.3
Lowland Organic-rich Bluejoint-Herb Meadow	11.3	2.3
Riverine Complex	5.1	1.0
Riverine Gravelly Wormwood-Horsetail Barrens and Partially Vegetated	17.6	3.6
Riverine Loamy Birch Forest	8.8	1.8
Riverine Loamy Ostrich Fern Meadow	37.5	7.6
Riverine Loamy Spruce-Birch Forest	47.7	9.6
Riverine Sandy Alder-Willow Tall Shrub	4.4	0.9

Riverine Sandy Balsam Poplar Sapling-Alder-Willow Tall Shrub	7.2	1.5
Riverine Sandy Bluejoint-Herb Meadow	13.4	2.7
Riverine Sandy Pole-sized Balsam Poplar Forest	14.1	2.9
Riverine Sandy-Loamy Balsam Poplar Large Tree Forest	32.3	6.5
Riverine Sandy-Loamy Spruce-Balsam Poplar Forest	46.1	9.3
Riverine Wet Sedge-Forb Marsh	6.2	1.2
Upland Loamy Spruce-Birch Forest	6.6	1.3
Upland, undifferentiated	0.2	0.0

	Acres	%
ECOTYPE		
Aquatic		
Riverine Circumneutral Beaver Pond	6.6	1.3
Riverine Circumneutral Glacial River	165.8	33.5
TOTAL	494.9	100.0
AGGREGATED SUBTOTALS		
Terrestrial Ecotypes	322.5	65.2
Aquatic Ecotypes	172.4	34.8

Note:

1 Area figures for each class represent the area mapped within the FA boundaries used for stratification in plot allocation (see text).

Table 5-3. Areal Extent of Individual Integrated Terrain Unit Classes and Aggregated Ecotype Classes in Focus Area 128 (Slough 8A), Middle Susitna River, Riparian Vegetation Study Area, Susitna-Watana Hydroelectric Project, 2013.[1]

	Acres	%
GEOMORPHIC UNIT		
Terrestrial		
Gravel Fill	0.5	0.1
Meander Active Overbank Deposit	89.8	14.5
Meander Coarse Active Channel Deposit	39.4	6.3
Meander Fine Active Channel Deposit	62.9	10.1
Meander Fine Inactive Channel Deposit	14.4	2.3
Meander Inactive Overbank Deposit	241.5	38.9
Aquatic		
Upper Perennial Glacial River	172.5	27.8
TOTAL	621.0	100.0
AGGREGATED SUBTOTALS		
Terrestrial Geomorphic Units	448.5	72.2
Fresh Water	172.5	27.8
SURFACE FORM		
Channel, Swale Or Gut	8.2	1.3
Human Modified	0.5	0.1
Interfluv Or Flat Bank	331.3	53.4
Lateral Bar	41.6	6.7
Mid-Channel Bar	66.9	10.8
River Or Stream	172.5	27.8
TOTAL	621.0	100.0
VEGETATION CLASSES		
Balsam Poplar Woodland	17.2	2.8
Closed Balsam Poplar Forest	27.8	4.5
Closed Poplar Woodland-Alder Tall Shrub	11.7	1.9
Closed Tall Willow Shrub	88.9	14.3
Fresh Water	172.5	27.8
	Acres	%
VEGETATION CLASS		
Open Balsam Poplar Forest	189.8	30.6
Open Low Willow Shrub	4.0	0.6
Open Poplar Woodland-Alder-Willow Tall Shrub	28.2	4.5
Open Spruce-Balsam Poplar Forest	10.3	1.7
Partially Vegetated	39.9	6.4
Spruce-Balsam Poplar Woodland	23.1	3.7
Spruce-Paper Birch Woodland	7.7	1.2
TOTAL	621.0	100.0
DISTURBANCE CLASS		
Absent, None	348.3	56.1
Geomorphic Process	3.9	0.6
Gravel Fill	0.5	0.1
Ice Bulldozing	204.3	32.9
Wind	64.0	10.3
TOTAL	621.0	100.0
POPLAR SIZE CLASS		
Poplar vegetation types		
Large Timber (> 90 cm DBH)	159.6	25.7
Pole (5–30 cm DBH)	45.2	7.3
Timber (31–90 cm DBH)	30.1	4.8
Non Poplar Vegetation Types	386.2	62.2
TOTAL	621.0	100.0
ECOTYPE		
Terrestrial		
Human Modified	0.5	0.1
Riverine Gravelly Wormwood-Horsetail Barrens and Partially Vegetated	39.4	6.3
	Acres	%
ECOTYPE		
Terrestrial		
Riverine Loamy Spruce-Birch Forest	7.7	1.2
Riverine Sandy Alder-Willow Tall Shrub	92.9	15.0
Riverine Sandy Balsam Poplar Sapling-Alder-Willow Tall Shrub	39.9	6.4
Riverine Sandy Pole-sized Balsam Poplar Forest	45.2	7.3
Riverine Sandy Timber-sized Balsam Poplar Forest	30.1	4.8
Riverine Sandy-Loamy Balsam Poplar Large Tree Forest	159.6	25.7
Riverine Sandy-Loamy Spruce-Balsam Poplar Forest	33.4	5.4

Aquatic		
Riverine Circumneutral Glacial River	172.5	27.8
TOTAL	621.0	100.0
AGGREGATED SUBTOTALS		
Terrestrial Ecotypes	448.5	72.2
Aquatic Ecotypes	172.5	27.8

Note:

1 Area figures for each class represent the area mapped within the FA boundaries used for stratification in plot allocation (see text).

Table 5-4. Classification and Description of Geomorphic Units and Water Bodies in the Middle Susitna River Portion of the Riparian Vegetation Study Area, Susitna-Watana Hydroelectric Project, 2013.

Geomorphic Unit	Description
TERRESTRIAL	
Alluvial Fan (Ff)	Gently sloping cone-shaped deposit of alluvium formed where a stream extends onto a relatively level plain, such as where streams issue from mountains onto lowland. Alluvial fans are comprised predominantly of coarse-grained materials, but also have varying quantities of silt.
Bogs (Ob)	Ombrotrophic wetlands with thick (> 40 cm [16 in]) organic matter accumulations developed in basins with essentially closed drainage receiving their water from precipitation and immediate surroundings. Water chemistry is typically acidic (pH ≤ 5.5) and dissolved minerals are present at low concentration (electrical conductivity < 100 µS). The surface is flat and the water table is near the surface. Organic matter is dominated by fibric peat of *Sphagnum* mosses and ericaceous woody material, but may be underlain by sedge peat.
Braided Abandoned Overbank Deposit (Fbob)	Vertical accretion deposits of braided floodplains that no longer are associated with the present fluvial regime or where flooding is sufficiently infrequent that fluvial sediments form a negligible component of surface material. Surface materials often include a mixture of fluvial, eolian, and organic materials, but typically are highly organic. The deposits are > 40 cm (16 in) thick, and organic layers comprise > 40% of the top 40 cm (16 in).
Braided Active Channel Deposit (Fbra)	Lateral accretion deposits formed in braided channels that interweave as a result of repeated bifurcations and convergences of flow around inter-channel bars.[1] Riverbed material can range from gravels and cobbles to gravelly-cobbly sand. Surface organic materials are typically < 3 cm (1.2 in) thick, often not imbedded into the mineral soil surface, and are therefore regularly washed away by flood waters. This geomorphic unit is often flooded even during relatively minor increases in river stage.
Braided Active Overbank Deposit (Fboa)	Vertical accretion deposits on low portions of the overbank environment in close proximity to the braided river channels. The deposits are comprised of silts and fine sands that have a laminar, interbedded structure formed by changes in velocity and deposition during waxing and waning floods. Frequent flooding and sedimentation prevents organic matter accumulation. Fine-grained material must be > 40 cm (16 in) thick and organic layers comprise less than 10% of the thickness.
Braided Coarse Active Channel Deposit (Fbrac)	Braided Active Channel Deposit in which > 50% of the soil in the upper 40 cm (16 in) is loamy fine sand or coarser. These deposits also include all rocky soils, regardless of dominant texture, with > 15% coarse fragments, typically gravels. These deposits primarily occur on mid-channel and lateral bars.
Braided Fine Active Channel Deposit (Fbraf)	Braided Active Channel Deposit in which > 50% of mineral soil in the upper 40 cm (16 in) is dominated by textures that are loamy very fine sand or finer, and coarse fragments are either absent, present at < 15% abundance, or present at >15% abundance but at a thickness < 50% of the mineral soil in the upper 40 cm (16 in) . On mid-channel or lateral bars, these deposits can occur in the concave microtopography of scour channels and ridges. These deposits also occur in former meander channels, swales or guts.
Braided Fine Inactive Channel Deposit (Fbrif)	Braided Inactive Channel Deposits in which > 50% of mineral soil in the upper 40 cm (16 in) is dominated by textures that are loamy very fine sand or finer; coarse fragments are either absent, present at < 15% abundance, or present at >15% abundance but at a thickness < 50% of the mineral soil in the upper 40 cm (16 in). On mid-channel or lateral bars, these deposits can occur in the concave microtopography of scour channels and ridges. These deposits also occur in former river channels, swales or guts.
Braided Inactive Channel Deposit (Fbri)	Lateral accretion deposits in inactive (“high water” or “cut-off”) channels of braided rivers that are flooded only during high-water events. Riverbed material often has a thick layer (> 20 cm [8 in]) of fine-grained material over the coarse channel deposits and surface is usually vegetated.

Geomorphic Unit	Description
Braided Inactive Overbank Deposit (Fboi)	Vertical accretion deposits formed on higher portions of the overbank environment in close proximity to braided river channels. Areas are subject to infrequent flooding (approx. every 5–25 years). Comprised of interbedded organics, silts and fine sands. Deposits are > 40 cm (16 in) thick and organic layers comprise 10–40% of the top 40 cm (16 in).
Channel Fen (Ofc)	Similar to Organic Fen but specific to fens forming in abandoned river channels.
Gravel fill (Hfg)	Deposits of gravel and other fill primarily used for the creation of roads and pads.
Meander Abandoned Channel Deposit (Fmrb)	Lateral accretion deposits of a meander floodplain that no longer is associated with the present fluvial regime or where flooding is sufficiently infrequent that fluvial sediments form a negligible component of surface material. On flat interfluve areas, surface materials are dominated by gravel or sand and lack fine-grained overbank deposits. In concave areas, such as scour channels and former river channels, the deposits are dominated by very fine sands and silts. Abandoned channel deposits are > 40 cm (16 in) thick, and organic layers comprise > 40% of the top 40 cm (16 in).
Meander Abandoned Overbank Deposit (Fmob)	Vertical accretion deposits of meandering floodplains that no longer are associated with the present fluvial regime or where flooding is sufficiently infrequent that fluvial sediments form a negligible component of surface material. Surface materials often include a mixture of fluvial, eolian, and organic materials, but typically are highly organic. The deposits are > 40 cm (16 in) thick, and organic layers comprise > 40% of the top 40 cm (16 in).
Meander Active Channel Deposit (Fmra)	Lateral accretion deposits formed in meandering channels that wind freely in regular to irregular, well-developed, S-shaped curves. Channels range from highly sinuous to only slightly meandering. Riverbed material can range from gravels and cobbles to gravelly-cobbly sand, and lateral accretion deposits along point bars typically are sandier. Surface organic materials are absent, or if present are not imbedded into the mineral soil surface, and are therefore often washed away by flood waters. These deposits occur primarily on mid-channel and lateral bars.
Meander Active Overbank Deposit (Fmoa)	Vertical accretion deposits on low portions of the overbank environment in close proximity to the meandering river channels. The deposits are comprised of silts and fine sands that have a laminar, interbedded structure formed by changes in velocity and deposition during waxing and waning floods. Frequent flooding and sedimentation prevents organic matter accumulation. Fine-grained material must be > 40 cm (16 in) thick and organic layers comprise less than 10% of the thickness.
Meander Coarse Active Channel Deposit (Fmrac)	Meander Active Channel Deposits in which > 50% of the soil in the upper 40cm (16 in) is loamy fine sand or coarser. These deposits also include all rocky soils, regardless of dominant texture, with > 15% coarse fragments, typically gravels. These deposits primarily occur on mid-channel or lateral bars.
Meander Fine Abandoned Channel Deposit (Fmrbf)	Meander Abandoned Channel Deposits in which > 50% of mineral soil in the upper 40 cm (16 in) is dominated by textures that are loamy very fine sand or finer, and coarse fragments are either absent, present at < 15% abundance, or present at > 15% abundance but at a thickness <50% of the mineral soil in the upper 40 cm (16 in). On interfluves or flat banks, these deposits are located in scour channel and ridge microtopography; they also occur in former river channels, swales or guts.
Meander Fine Active Channel Deposit (Fmraf)	Meander Active Channel Deposits in which > 50% of mineral soil in the upper 40 cm (16 in) is dominated by textures that are loamy very fine sand or finer, and coarse fragments are either absent, present at < 15% abundance, or present at > 15% abundance but at a thickness < 50% of the mineral soil in the upper 40 cm (16 in). On mid-channel or lateral bars, these deposits can occur in the concave microtopography of scour channels and ridges. These deposits also occur in former river channels, swales or guts.
Meander Fine Inactive Channel Deposit (Fmrif)	Meander Inactive Channel Deposit in which > 50% of mineral soil in the upper 40 cm (16 in) is dominated by textures that are loamy very fine sand or finer, and coarse fragments are either absent, present at < 15% abundance, or present at > 15% abundance but at a thickness < 50% of the mineral soil in the upper 40 cm (16 in). On mid-channel or lateral bars, these deposits can occur in the concave microtopography of scour channels and ridges. These deposits also occur in former river channels, swales or guts.

Geomorphic Unit	Description
Meander Inactive Channel Deposit (Fmri)	Mixed lateral and vertical accretion deposits in inactive ("high water" or "cut-off") channels of meander rivers that are flooded only during high-water events. Riverbed material often has a thin layer of fine-grained material over the coarse channel deposits and surface is usually vegetated.
Meander Inactive Overbank Deposit (Fmoi)	Vertical accretion deposits formed on higher portions of the overbank environment in close proximity to meandering river channels. Areas are subject to infrequent flooding (approx. every 5–25 years). Comprised of interbedded organics, silts and fine sands. Deposits are > 40 cm (16 in) thick and organic layers comprise 10–40% of the top 40 cm (16 in).
Old Alluvial Terrace (Fto)	Relatively flat surfaces resulting from the dissection of former floodplain areas. Old terraces are typically higher in elevation than Recent Alluvial Terraces (relative to the present day river channel), are never subject to flooding under the current regime, and were formed previous to the end of the Little Ice Age (> 150 years). Deposits consist of gravelly sand, sand, silty sand, and peat. Deposits usually are overlain by eolian silt and sand and have moderately thick organic horizons. Lack of flooding is indicated by the presence of E- and/or Bs-horizons and the lack of stratified silts, sands, and organics in the upper 40 cm (16 in) of the soil profile.
Organic Fen (Of)	Minerotrophic wetlands with thick (> 40 cm [16 in]) organic matter accumulations developed in basins fed by mineral-rich surface water or groundwater. Water chemistry is typically circumneutral (pH 5.5–7.3) or alkaline (pH > 7.3), and dissolved minerals are present at moderate to high concentrations (electrical conductivity > 100 µS). The surface is flat and the water table is near the surface. Organic matter is dominated by fibric peat of sedges, horsetails, and willow leaves.
Recent Alluvial Terrace (Ftr)	Relatively flat surfaces resulting from the dissection of former floodplain areas. Recent terraces are typically lower in elevation than Old Alluvial Terraces (relative to the present day river channel), are never subject to flooding under the current regime, and were formed since the end of the Little Ice Age (< 150 years). Deposits consist of gravelly sand, sand, silty sand, and peat. Deposits usually are overlain by eolian silt and sand and have moderately thick organic horizons. Lack of flooding is indicated by the presence of E- and/or Bs-horizons and the lack of stratified silts, sands, and organics in the upper 40 cm (16 in) of the soil profile.
Upland, undifferentiated (U)	These include small areas of upland hillsides and mountain slopes directly adjacent to riverine areas that were not assigned a specific geomorphic unit in the Integrated Terrain Unit (ITU) mapping.
AQUATIC	
Upper Perennial Glacial River (Wrug)	Permanently flooded channels of freshwater rivers where the gradient is relatively steep; substrate consists of rock, cobble, gravel, and sand; and discharge and water quality are affected by glacial meltwater. River water may appear discolored from high concentrations of suspended sediments during mid-summer. Rivers experience peak flooding during mid-summer.
Lowland Headwater Stream (Wrhl)	Permanently flooded first order tributaries of higher order creeks and rivers, typically low gradient and meandering.
Riverine Slough (Wrsl)	A sluggish channel of water, such as a side channel of a river, in which water flows slowly through low, swampy ground, or a section of an abandoned river channel which may contain stagnant water and occurs in a flood plain.[1]
Shallow Connected Beaver Pond (Wlscv)	A shallow (< 1.5 m [5 ft]) pond on created by the impoundment of water behind a beaver dam that is connected to the main channel of a river by a small stream (i.e., fish may freely pass from the river into the pond, particularly during high-water events).

Notes

1 From Glossary of Landform and Geologic Terms (USDA NRCS 2013).

Table 5-5. Classification and Description of Surface Form Classes in the Middle Susitna River Portion of the Riparian Vegetation Study Area, Susitna-Watana Hydroelectric Project, 2013.

Surface Form Class	Description
Bar	A ridge-like accumulation of sand, gravel, or other alluvial material formed in the channel, along the banks, or at the mouth of a stream where a decrease in velocity induces deposition.[1]
Basins Or Depressions (B)	An area that is concave in all directions. Often collects water. This class includes kettle holes, formed by the melting of a glacial ice mass formed on the surface of glacial drift.
Braided Channels And Interfluvs (Xcb)	Complex surface form characteristic of active channel deposits along braided rivers in which narrow (3–10 m [10–33 ft]), shallow (0.1–0.5 m [0.3–1.6 ft]) braided channels are intermixed with narrow interfluvs or flat banks.
Channel, Swale Or Gut (Fc)	Low-lying concave portions of the floodplain developed from river scouring. Tend to be water gathering.
Flood Basin (Ff)	Flat, distal portion of a floodplain behind a levee. Surface tends to impound water.
Human Modified	Areas of the landscape affected by human activities.
Ice-rafted debris (Mid)	Mounds and otherwise undulating terrain created by materials, typically gravelly-cobbly sands and down wood, rafted into an area by ice during breakup.
Ice-shoved ridge (Mir)	Ridges of surficial materials, typically gravelly and cobbly sands, created by the “bull-dozing” effect of large chunks of ice forced downstream during breakup in the spring of the year. This surface form is often associated with deep pits in the ground surface from which the ridge material was excavated.
Interfluv Or Flat Bank (Fi)	Flat areas on floodplains that are slightly raised above adjacent lower active or paleo-channels.
Lateral Bar (Fbl)	Flat to gently sloping, oblong or linear shaped shoal forming immediately forming along the lateral margins of an active channel of a river. See also “Bar”.
Mid-Channel Bar (Fbm)	Flat to gently sloping, oblong or linear shaped shoal forming in the middle of a river (i.e., islands). Mid-channel bars are surrounded on all sides by perennially flowing river water, or are surrounded on at least three sides by active channel deposits, with the river on the fourth side. See also “Bar”.
Nonpatterned (N)	Flat areas of the landscape where surface form features are absent.
Peat mounds (Mpm)	Low (< 0.5 m [1.6 ft]), round or oblong mounds, 0.2 to 1.5 m (0.7 to 5 ft] in diameter, often composed of sedge and *Sphagnum* moss and formed by differential growth rates. Also referred to as turf hummocks.[2]
Point Bar (Fbp)	Flat to gently sloping, crescent shaped shoal forming immediately adjacent to a river, usually forming on the inside of a bend.
Ripples (Dr)	An undulating surface of alternating, subparallel, small-scale ridges and depressions, commonly composed of loose sand. It is produced on land by wind and under water by the agitation of water by currents or wave action, and generally tends at right angles or obliquely to the direction of flow of the moving fluid.[1]
River Or Stream (R)	General surface form characteristic assigned to rivers, a natural, freshwater waterbody of considerable volume and generally with a permanent base flow, moving in a defined channel; and streams, a body of running water of lower volume that moves under gravity to progressively lower levels, in a relatively narrow but clearly defined channel on the ground surface.[1]
Riverbed Cobbles or Boulders (Dc)	Undulating surface form of active channel deposits created by river cobbles, stones, and boulders.

Surface Form Class	Description
Scour channels-ridges (Ds)	Complex surface form characteristic of active channel deposits along braided rivers in which narrow (< 3 m [10 ft]), deeply incised (0.5–1.0 m [1.6–3.3 ft]) channels are intermixed with narrow, steep ridges formed from alluvial material.
Terrace (Ft)	Flat, bench-like landforms on inactive and abandoned floodplain surfaces. Terraces are associated with the Abandonded Overbank (both meander and braided) and Recent Alluvial Terrace geomorphic units. Terraces are differentiated from the surface form class Interfluv or Flat Bank by featuring a short (0.5–1.5 m [1.6–5 ft]), steep, distinct break in elevation ('riser') between the floodplain surface and the terrace 'bench'.
Tree mounds (Ml)	Mounds and on the forest floor created by downed logs and root balls.
Undifferentiated mounds (Mu)	Low (0.2–1.0 m [0.7–3.3 ft]) earthen mounds of unknown origin and composition.
Upland, undifferentiated (U)	These include small areas of upland hillsides and mountain slopes directly adjacent to riverine areas that were not assigned a specific surface form in the ITU mapping.
Water Bodies (W)	Freshwater bodies of water, including ponds, streams, and rivers.

Notes

1 From Glossary of Landform and Geologic Terms (USDA NRCS 2013)

2 From Permafrost – A guide to frozen ground in transition (Davis 2001)

Table 5-6. Classification and Description of Vegetation Classes in the Middle Susitna River Portion of the Riparian Vegetation Study Area, Susitna-Watana Hydroelectric Project, 2013.

Vegetation Class	Description
Balsam Poplar Woodland (Fbwp)	Riverine woodlands (10–25% tree cover) dominated by large (> 0.75 m [2.5 ft] DBH) *Populus balsamifera*. Commonly associated species include *Alnus tenuifolia*, *Equisetum arvense*, *Alnus crispa*, *Viburnum edule*, *Ribes triste*, *Galium triflorum*, and *Matteuccia struthiopteris*.
Barren (Bbg)	Barren sites (e.g., active cobble bars) where vegetation is absent or nearly so (< 5% cover).
Black Spruce Woodland (Fnwbs)	Lowland woodlands (10–25% tree cover) dominated by *Picea mariana*. Commonly associated species include *Chamaedaphne calyculata*, *Ledum decumbens*, *Rubus chamaemorus*, *Oxycoccus microcarpus*, *Vaccinium uliginosum*, *Empetrum nigrum*, *Drosera rotundifolia*, *Sphagnum fuscum*, and *S. angustifolium*
Bluejoint Meadow (Hgmb)	Graminoid meadows dominated by *Calamagrostis canadensis*. Other associated species occur at low abundance (~1–3%), including *Epilobium angustifolium, Rubus idaeus*, *Artemisia tilesii*, *Geum macrophyllum*, and *Galium boreale*.
Bluejoint-Herb (Hgmbh)	Graminoid meadows co-dominated by *Calamagrostis canadensis* and a diversity of associated forb species. Commonly associated species include *Heracleum lanatum*, *Polemonium acutiflorum*, *Mertensia paniculata*, *Thalictrum sparsiflorum*, and *Epilobium angustifolium*.
Bluejoint-Shrub (Hgmbs)	Graminoid meadows co-dominated by *Calamagrostis canadensis* and a diversity of associated shrub species. Total shrub cover is less than 25%. Commonly associated species include *Alnus tenuifolia*, *Rubus idaeus*, *Rosa acicularis*,*Viburnum edule*, *Ribes triste*, *Athyrium filix-femina*, *Gymnocarpium dryopteris*, and *Mertensia paniculata*.
Closed Balsam Poplar Forest (Fbcp)	Closed (> 60% tree cover) riverine forests dominated by *Populus balsamifera*. Commonly associated species include *Viburnum edule*, *Rosa acicularis*, *Alnus crispa*, *Alnus tenuifolia*, *Artemisia tilesii*, and *Aster sibiricus*.
Closed Balsam Poplar-White Spruce Forest (Fmcpws)	Closed (> 60% tree cover) riverine forests co-dominated by *Populus balsamifera* and *Picea glauca*. Commonly associated species include *Viburnum edule*, *Rosa acicularis*, *Ribes triste*, *Calamagrostis canadensis*, and *Pyrola asarifolia*.
Closed Low Rose Shrub (Slcr)	Similar to Open Low Rose Shrub, but with a closed (> 75% shrub cover) shrub canopy.
Closed Paper Birch Forest (Fbcb)	Closed (> 60% tree cover) riverine forests dominated by *Betula papyrifera*. Commonly associated species include *Viburnum edule*, *Rosa acicularis*, *Ribes triste*, *Calamagrostis aanadensis*, *Gymnocarpium dryopteris*, *Equisetum arvense*, and *E. pratense*
Closed Poplar Woodland-Alder Tall Shrub (Sfcpa)	Riverine closed (> 75% shrub cover) stands of *Populus balsamifera* saplings co-dominant with alder tall shrub (> 1.5 m [5 ft]) including *Alnus sinuata*, *A. tenuifolia*, and *A. crispa*. Commonly associated species include *Artemisia tilesii*, *Equisetum variegatum*, and *Agropyron boreale*.
Closed Poplar Woodland-Willow Tall Shrub (Sfcpw)	Riverine closed (> 75% shrub cover) stands of *Populus balsamifera* saplings co-dominant with willow tall shrub (> 1.5 m [5 ft]) including *Salix alaxensis*, *S. barclayi*, *S. lasi*andra, and *S. sitchensis*. Commonly associated species include *Artemisia tilesii*, *Equisetum variegatum*, and *Agropyron boreale*.
Closed Tall Alder Shrub (Stca)	Riverine closed (> 75% shrub cover) tall shrub (> 1.5 m [5 ft]) stands dominated or co-dominated by *Alnus tenuifolia*, *A. crispa*, and *A. sinuata*. Commonly associated species include *Equisetum variegatum*.
Closed Tall Alder-Willow Shrub (Stcaw)	Riverine closed (> 75% shrub cover) tall shrub (> 1.5 m [5 ft]) co-dominated by alders and willows, including *Alnus crispa*, *A. tenuifolia*, *Salix alaxensis*, and *S. barclayi*. Commonly associated species include *Cinna latifolia*, *Heracleum lanatum*, *Matteuccia struthiopteris*, *Mertensia paniculata*, and *Rosa acicularis*.

Vegetation Class	Description
Closed Tall Willow Shrub (Stcw)	Riverine closed (> 75% shrub cover) tall shrub (> 1.5 m [5 ft]) co-dominated by *Salix barclayi* and/or *S. alaxensis*. Commonly associated species include *S. lasi*andra, *Matteuccia struthiopteris*, *Alnus tenuifolia*, *Viburnum edule*, *Heracleum lanatum*, *Equisetum arvense*, *Gymnocarpium dryopteris*, *Epilobium angustifolium*, *Ribes triste*, *Streptopus amplexifolius*, *Calamagrostis canadensis*, and *Mertensia paniculata*
Disturbance Complex	Areas on the landscape with 3 or more vegetation types resulting from human disturbance.
Dryas Dwarf Shrub Tundra (Sddt)	Riverine dwarf shrub dominated by *Dryas drummondii*. Commonly associated species include *Shepherdia canadensis*, *Epilobium latifolium*, *Equisetum variegatum*, and *Stereocaulon sp*.
Dwarf Black Spruce Woodland (Sfwbs)	Lowland dwarf (< 10 m [33 ft] in height) needleleaf forests dominated by *Picea mariana*. The trees in these stands are dwarf due to harsh environmental conditions, including high water table or permafrost. Commonly associated species include *Rubus chamaemorus*, *Empetrum nigrum*, *Ledum decumbens*, *Betula nana*, *Oxycoccus microcarpus*, *Vaccinium uliginosum*, *Drosera rotundifolia*, *Andromeda polifolia*, *Sphagnum fuscum*, and *S. angustifolium*.
Ferns (Hfmc)	Riverine herbaceous meadows dominated (> 75% cover) by the fern *Matteuccia struthiopteris*, which forms nearly monotypic stands. Commonly associated species that occur in low abundance (< 3% cover) include *Alnus tenuifolia*, *Equisetum arvense*, *Mertensia paniculata*, *Trientalis europaea*, *Adoxa moschatellina*, *Delphinium glaucum*, *Galium boreale*, *G. triflorum*, and *Streptopus amplexifolius*.
Fresh Herb Marsh (Hfwfh)	Riverine and lowland marshes dominated by aquatic forbs, including *Equisetum fluviatile*, *Potentilla palustris*, and/or *Menyanthes trifoliata*. Commonly associated species include *Cicuta mackenzieana* and *Carex utriculata*.
Fresh Sedge Marsh (Hgwfs)	Riverine and lowland marshes dominated by sedges, namely *Carex utriculata*. Commonly associated species include *Glyceria pauciflora*.
Fresh Water (Wf)	Permanently flooded non-vegetated waterbodies, included in this class are non-vegetated Lower Perennial River, glacial; Lowland Headwater Stream; Riverine Slough, and Shallow Connected Beaver Pond. This class may include some waterbodies with submerged vegetation that was not mappable.
Large Umbel (Hfmu)	Lowland and riverine herbaceous meadows dominated by *Heracleum lanatum*. These meadows feature a rich-array of forbs, including *Epilobium angustifolium*, *Polemonium acutiflorum*, *Mertensia paniculata*, *Thalictrum sparsiflorum*, *Delphinium glaucum*, *Botrychium lunaria*, *B. virginianum*, *Geranium erianthum*, *Athyrium filix-femina*, *Adoxa moschatellina*, *Ranunculus abortivus*, and *Urtica gracilis*.
Open Balsam Poplar Forest (Fbop)	Open (25–60% tree cover) riverine forests dominated by *Populus balsamifera*. Commonly associated species include *Alnus tenuifolia*, *Viburnum edule*, *Mertensia paniculata*, *Equisetum arvense*, and *Calamagrostis canadensis*.
Open Black Spruce Forest (Fnobs)	Lowland forests with an open (25–60% tree cover) canopy dominated by *Picea mariana*. Commonly associated species include *Ledum groenl*andicum, *Vaccinium uliginosum*, *Empetrum nigrum*, *Vaccinium vitis-idaea*, *Rubus chamaemorus*, *Cornus Canadensis*, *Oxycoccus microcarpus*, and *Hylocomium splendens*.
Open Low Alder-Willow Shrub (Sloaw)	Riverine open (25–75% shrub cover) low shrub (< 1.5 m [5 ft]) co-dominated by *Salix alaxensis* and *S. barclayi*, with occasional occurrences of *S. lasi*andra. Commonly associated species include *Artemisia tilesii*, *Epilobium angustifolium*, *Equisetum variegatum*, and *E. arvense*.
Open Low Shrub Birch-Ericaceous Shrub Bog (Slobb)	Bogs co-dominated by *Sphagnum* mosses, *Betula nana*, and variety of ericaceous shrubs, including *Vaccinium uliginosum* and *Chamaedaphne calyculata*. Commonly associated species include *Oxycoccus microcarpus*, *Drosera rotundifolia*, *Carex chordorrhiza*, and *C. limosa*
Open Low Ericaceous Shrub Bog (Sloeb)	Bogs co-dominated by *Sphagnum* mosses, including *Sphagnum angustifolium*, *S. magellanicum*,and *S. warnstorfii*, and low (< 1.5 m [5 ft]) ericaceous shrubs, including *Chamaedaphne calyculata* and *Myrica gale*. Commonly associated species include *Oxycoccus microcarpus*, *Carex chordorrhiza*, *Equisetum fluviatile*, and *Drosera rotundifolia*

Vegetation Class	Description
Open Low Rose Shrub (Slor)	Riverine open (25–75% shrub cover) low shrub (< 1.5 m [5 ft]) dominated by *Rosa acicularis*. Commonly associated species include *Calamagrostis canadensis*, *Rubus idaeus*, *Viburnum edule*, *Mertensia paniculata*, *Equisetum arvense*, *Ribes triste*, *Epilobium angustifolium*, *Alnus tenuifolia*, and *Thalictrum sparsiflorum*,
Open Low Willow Shrub (Slow)	Riverine open (25–75% shrub cover) low shrub (< 1.5 m [5 ft]) co-dominated by *Salix barclayi* and *S. alaxensis*. Commonly associated species include *Calamagrostis Canadensis*, *Mertensia paniculata*, *Equisetum arvense*, *Rubus idaeus*, *Epilobium angustifolium*, *Galium triflorum*, and *Thalictrum sparsiflorum*.
Open Paper Birch Forest (Fbob)	Similar to Closed Paper Birch except forest canopy is open (25–60% tree cover).
Open Paper Birch-Balsam Poplar-Spruce Forest (Fmobps)	Open (25–60% tree cover) riverine forests co-dominated by *Populus balsamifera*, *Betula papyrifera*,and *Picea glauca*. Commonly associated species include *Rosa acicularis*, *Viburnum edule*, *Cornus Canadensis*, *Hylocomium splendens*, and *Pleurozium schreberi*.
Open Poplar Woodland-Alder Tall Shrub (Sfopa)	Riverine open (25–75% shrub cover) stands of *Populus balsamifera* saplings co-dominate with tall alder shrub (> 1.5 m [5 ft]) including *Alnus sinuata*, *A. tenuifolia*, and *A. crispa*. Commonly associated species include *Hedysarum alpinum,Calamagrostis Canadensis*, *Artemisia tilesii*, *Castilleja caudate*, *Platanthera hyperborean*, and *Ceratodon purpureus*.
Open Poplar Woodland-Alder-Willow Tall Shrub (Sfopaw)	Riverine open (25–75% shrub cover) stands of *Populus balsamifera* saplings co-dominate with tall alder and willow shrub (> 1.5 m [5 ft]) including *Alnus sinuata*, *A. tenuifolia*, *A. crispa*, *Salix alaxensis*, and *S. barclayi*. Commonly associated species include *Artemisia tilesii*, *Equisetum variegatum*, and *Agropyron boreale*.
Open Poplar Woodland-Willow Tall Shrub (Sfopw)	Riverine open (25–75% shrub cover) stands of *Populus balsamifera* saplings co-dominate with tall willow shrub (> 1.5 m [5 ft]) including *Salix alaxensis*, *S. barclayi*, and *S. sitchensis*. Commonly associated species include *Hedysarum alpinum*, *Astragalus alpinus*, *Equisetum variegatum*, and *Ceratodon purpureus*.
Open Spruce-Balsam Poplar Forest (Fmosp)	Similar to Closed Balsam Poplar-White Spruce except forest canopy is open (25–60% tree cover).
Open Spruce-Paper Birch Forest (Fmosb)	Upland, lowland, or riverine forests with an open (25–60% cover) canopy co-dominated by *Betula papyrifera* and *Picea glauca*. Commonly associated species include *Viburnum edule*, *Rosa acicularis*, *Ribes triste*, *Streptopus amplexifolius*, *Dryopteris dilatata americana*, *Trientalis europaea arctica*, *Epilobium angustifolium*, and *Lycopodium annotinum*.
Open Tall Alder Shrub (Stoa)	Riverine and lowland stands of open (25–75% shrub cover) tall shrub (> 1.5m [5 ft]) dominated or co-dominated by *Alnus sinuata*, *A. tenuifolia*, and/or *A. crispa*. Commonly associated species include *Salix alaxensis*, *Artemisia tilesii*, *Populus balsamifera*, *Salix barclayi*, and *Calamagrostis canadensis*.
Open Tall Alder-Willow Shrub (Stoaw)	Riverine open (25–75% shrub cover) tall shrub (> 1.5 m [5 ft]) co-dominated by alders and willows, including *Alnus crispa*, *A. tenuifolia*, *Salix alaxensis*, and *S. barclayi*. Commonly associated species include *Mertensia paniculata*, *Rubus idaeus*, *Epilobium angustifolium*, and *Equisetum arvense*. *Picea glauca* seedlings are commonly found in the understory of this vegetation type.
Open Tall Willow Shrub (Stow)	Riverine open (25–75% shrub cover) tall shrub (> 1.5 m [5 ft]) by willow, namely *Salix barclayi*. *Calamagrostis canadensis*, *Rosa acicularis*, *Gymnocarpium dryopteris*, *Rubus idaeus*, *Alnus tenuifolia*. *Athyrium filix-femina*, *Galium triflorum*, and *Heracleum lanatum*.
Open White Spruce Forest (Fnows)	Riverine forest with an open (25–60% tree cover) canopy dominated *Picea glauca*. Commonly associated species include *Viburnum edule*, *Mertensia paniculata*, *Calamagrostis canadensis*, *Alnus tenuifolia*, *Rosa acicularis*, and *Ptilium crista-castrensis*.
Paper Birch Woodland (Fbwb)	Riverine woodlands (10–25% tree cover) dominated by *Betula papyrifera*. Commonly associated species are similar to Closed Paper Birch.

Vegetation Class	Description
Partially Vegetated (Bpv)	Sites where vegetation is poorly established and total cover of live plants is 5–30%. Commonly associated species include *Salix alaxensis*, *Populus balsamifera*, *Artemisia tilesii*, *Equisetum variegatum*, *Astragalus alpinus*, *Epilobium latifolium*, and *Dryas drummondii*.
Riverine Complex (Xr)	To be described.
Spruce-Balsam Poplar Woodland (Fmwsp)	Riverine woodlands (10–25% tree cover) co-dominated by *Populus balsamifera* and *Picea glauca*. Commonly associated species include *Calamagrostis canadensis*, *Viburnum edule*, *Alnus tenuifolia*, *Ribes triste*, and *Equisetum arvense*.
Spruce-Paper Birch Woodland (Fmwsb)	Upland, lowland, or riverine woodlands (10–25% tree cover) co-dominated by *Betula papyrifera* and *Picea glauca*. Commonly associated species are similar to Open Spruce-Paper Birch.
Subarctic Lowland Graminoid-Herb Wet Meadow (Hgwgh)	Lowland wet meadows and fens co-dominated by sedges and aquatic forbs, including *Carex utriculata*. *C. aquatilis*, *Potentilla palustris*,and *Menyanthes trifoliata*. Commonly associated species including *Equisetum fluviatile*, *Carex pluriflora*, *Carex canescens*, and *Calliergon* sp.
Subarctic Lowland Grass Wet Meadow (Hgwg)	Lowland wet meadows and fens dominated by *Calamagrostis canadensis*. Commonly associated species include *Equisetum fluviatile*, *Potentilla palustris*, *Alnus tnuifolia*, *Carex utriculata*, and *C. aquatilis*.
Subarctic Lowland Herb Bog Meadow (Hfwhb)	Bogs co-dominated by *Sphagnum* mosses and aquatic forbs, including *Potentilla palustris*, *Equisetum fluviatile*, and *Menyanthes trifoliata*. Commonly associated species include *Carex utriculata*, *Carex sitchensis*, *Chamaedaphne calyculata*, and *Salix fuscescens*.
Subarctic Lowland Sedge Bog Meadow (Hgwsb)	Bogs dominated by wet sedges, including *Trichophorum caespitosum*, *Carex chordorrhiza*, *C. rotundata*, *C. aquatilis*, *C. limosa*, and *C. pauciflora*. Common associated species include *Betula nana*, And*romeda polifolia*, *Myrica gale*, *Drosera rotundifolia*, *Chamaedaphne calyculata*, *Oxycoccus microcarpus*, *Sphagnum fuscum*, *S. magellanicum*, and *S. angustifolium*.
Subarctic Lowland Sedge Wet Meadow (Hgwsl)	Sedge dominated wet meadows in which *Carex aquatilis*, *C. canescens*, *C. utriculata*, *C. sitchensis* and/or *Scirpus microcarpus* are dominant. Commonly associated species include *Potentilla palustris*, *Equisetum fluviatile*, and *Cicuta mackenzieana*.
Subarctic Lowland Sedge-Moss Bog Meadow (Hgwsmb)	Bogs co-dominated by *Sphagnum* mosses, including *S. fuscum*, *S. magellanicum, S. angustifolium*, and wet sedges, *including Carex chordorrhiza*, *C. tenuiflora*,and *C. limosa*. Commonly associated species include *Betula nana*, *Drosera rotundifolia*, *Eriophorum angustifolium*, And*romeda polifolia*, and *Oxycoccus microcarpus*.
Upland, undifferentiated (U)	To be described.
Wet Forb Meadow (Hfw)	Lowland wet meadows and fens dominated by *Equisetum fluviatile* or *E. arvense*. Commonly associated species include *Carex utriculata*, *Poa palustris*, and *Potentilla palustris*.

Table 5-7. Classification and Description of Disturbance Classes in the Middle Susitna River Portion of the Riparian Vegetation Study Area, Susitna-Watana Hydroelectric Project, 2013.

Class	Description
Absent, None (A)	No recent (within 1–3 years) disturbance.
Fluvial (Ngf)	Recent (1–3 years old), undifferentiated disturbance related to deposition or erosion of sediments due to riverine processes.
Fluvial Deposition (Ngfd)	Recent (1–3 years old) deposition of sediment related to riverine flooding.
Fluvial Erosion/channel migration (Ngfe)	Recent (1–3 years old) erosion of sediment related to riverine flooding.
Geomorphic Process (Ng)	Recent disturbance (1–3 years old) caused by an unknown geomorphic process.
Gravel Fill (Hfg)	Areas on the landscape where covered by gravel fill (e.g., Alaska Railroad)
Ice Bulldozing (Ngi)	Recent (1–3 years) disturbance from ice during spring break up events, including shearing of trees and shrubs; tree ice-scars; gouging, mounding, and erosion of floodplain surfaces; and deposition of ice-rafted sediment and coarse fragments.
Residential Development (Hdr)	Areas of the landscape where human residences have been built.
Undifferentiated Clearing (Hc)	Areas of the landscape where vegetation has been cleared and which the intent of the clearing in unknown.
Wind (Nwd)	Recent (1–3 years old) wind thrown trees characterized by down logs and upturned root wads with exposed mineral soil.

Table 5-8. Classification and Description of Poplar Size Classes in the Middle Susitna River Portion of the Riparian Vegetation Study Area, Susitna-Watana Hydroelectric Project, 2013.

Class	Description
Pole (P)	Diameter at Breast Height (DBH) ranges between 5 and 30 cm (2 and 12 in). The upper DBH limit of this class was determined based on susceptibility to shearing by ice during spring breakup. Trees smaller than this diameter are more prone to shearing than larger trees.
Timber(T)	DBH ranges between 31 and 90 cm (12 and 35 in). The lower DBH limit of this class was determined based on susceptibility to shearing by ice during spring breakup. Trees larger than this diameter are less prone to shearing and are more likely to deflect ice than smaller trees.
Large Timber (L)	DBH > 90 cm (35 in). Trees larger than the minimum diameter of this class are preferred by black bears for den trees and by raptors for nest platforms.

Table 5.1-1. List of Preliminary Ecotypes Classified Using 2012 Field Data and Mapping Data for FA-104 (Whiskers Slough), FA-115 (Slough 6A), and FA-128 (Slough 8A), Middle Susitna River, Riparian Vegetation Study Area, Susitna-Watana Hydroelectric Project, 2013.

Ecotype	FA Map Class[1]	2012 Plot Data[2]
Terrestrial		
Human Modified	X	
Lowland Loamy Birch Forest	X	X
Lowland Loamy Ostrich Fern Meadow	X	
Lowland Organic-rich Bluejoint-Herb Meadow	X	
Lowland Organic-Rich Wet Spruce Forest		X
Lowland Peaty Wet Birch Low Shrub Bog		X
Riverine Complex	X	
Riverine Gravelly Wormwood-Horsetail Barrens and Partially Vegetated	X	X
Riverine Loamy Birch Forest	X	X
Riverine Loamy Large Umbel Meadow		X
Riverine Loamy Ostrich Fern Meadow	X	X
Riverine Loamy Spruce-Birch Forest	X	X
Riverine Sandy Alder-Willow Tall Shrub	X	X
Riverine Sandy Balsam Poplar Sapling-Alder-Willow Tall Shrub	X	X
Riverine Sandy Bluejoint-Herb Meadow	X	X
Riverine Sandy Pole-sized Balsam Poplar Forest	X	X
Riverine Sandy Raspberry-Rose Low Shrub		X
Riverine Sandy Spruce Forest		X
Riverine Sandy Timber-sized Balsam Poplar Forest	X	X
Riverine Sandy-Loamy Balsam Poplar Large Tree Forest	X	X
Riverine Sandy-Loamy Spruce-Balsam Poplar Forest	X	
Riverine Wet Sedge-Forb Marsh	X	X
Upland Loamy Spruce-Birch Forest	X	X
Upland Poplar Forest		
Upland, undifferentiated	X	
Aquatic		
Lowland Headwater Stream	X	
Riverine Circumneutral Beaver Pond	X	X
Riverine Circumneutral Glacial River	X	X
Riverine Slough	X	

Notes:

1 Indicates whether a given ecotype was mapped in FA-104 (Whiskers Slough), FA-115 (Slough 6A), or FA-128 (Slough 8A) (X) or not (blank).

2 Indicates whether an ecotype class was classified based on 2012 field plot data (X) or was developed as a temporary map class until 2013 data are incorporated into the ecotype analysis (blank).

Table 5.1-2. Classification and Description of Preliminary Ecotypes Identified in the Middle Susitna River, Riparian Vegetation Study Area, Susitna-Watana Hydroelectric Project, 2013.

Ecotype	Description
Human Modified	Areas of the landscape affected human activities, including gravel fill, excavations, vegetation clearing, and residential development.
Lowland Headwater Stream	Low-gradient, meandering tributary streams of the Susitna River, e.g., Whisker's Slough in Focus Area 104.
Lowland Loamy Birch Forest	This ecotype includes Open and Closed Paper Birch forests and occurs on Meander Abandoned Overbank Deposits. Soils are loamy and moist. Tree mounds are common microtopographic features associated with this ecotype. Floristic classes included in this ecotype include *Betula papyrifera/Ribes triste/Gymnocarpium dryopteris*.
Lowland Loamy Ostrich Fern Meadow	No plot data was collected for this ecotype in 2012. This ecotype was mapped in the Middle Susitna River on Meander Abandoned Overbank Deposits.
Lowland Organic-rich Bluejoint-Herb Meadow	No plot data was collected for this ecotype in 2012. This ecotype was mapped in the Middle Susitna River on Meander Abandoned Overbank Deposits and Meander Abandoned Channel Deposits.
Lowland Organic-Rich Wet Spruce Forest	This ecotype includes Open Spruce-Paper Birch Forest on wet, organic-rich soils on alluvial terraces. The hydrology of this ecotype along the middle Susitna River is strongly influenced by hillside seeps and springs. Floristic classes include *Picea glauca-Betula papyrifera/Alnus tenuifolia/Athyrium filix-femina*.
Lowland Peaty Wet Birch Low Shrub Bog	This ecotype includes Open Low Shrub Birch-Ericaceous Shrub Bog in bogs on alluvial terraces. Soils are wet and organic-rich. Peat mounds are common microtopographic features associated with this ecotype. Floristic classes include *Betula nana/Oxycoccus microcarpus/Sphagnum* sp.
Riverine Circumneutral Beaver Pond	This ecotype includes ponds formed due to impoundment of water by beaver dams which are often located at the downstream end of inactive and abandoned river channels. Vegetation typically is a complex of open water, aquatic bed, and forb and graminoid marshes.
Riverine Circumneutral Glacial River	This ecotype includes the Susitna River.
Riverine Complex	No plot data was collected in this ecotype in 2012 is a map class only. Riverine complex includes areas on the Susitna River floodplain where there were 3 or more geomorphic/vegetation classes that occurred adjacent to one another but none of the unique types were large enough in areal extent to separate given the scale of mapping.
Riverine Gravelly Wormwood-Horsetail Barrens and Partially Vegetated	This ecotype includes barrens and partially vegetated riverine areas and is associated with the geomorphic units Meander Active Channel Deposits and Braided Active Channel Deposits. Soils are sandy and gravelly. This ecotype occurs on river bars where scour channels and ridges are common microtopographic features. Floristic classes include *Artemisia tilesii-Equisetum variegatum*.
Riverine Loamy Birch Forest	This ecotype includes Open and Closed Paper Birch forests on Meander Inactive Overbank Deposits. Soils are typically loamy with thin interbedded organic horizons. Tree mounds are common microtopographic features associated with this ecotype. Floristic classes included in this ecotype include *Betula papyrifera/Ribes triste/Gymnocarpium dryopteris*.
Riverine Loamy Large Umbel Meadow	This ecotype includes Large Umbel Meadows on Meander Fine Inactive Channel Deposits and Meander Inactive Overbank Deposits. Soils are loamy and moist. Floristic classes include *Heracleum lanatum-Thalictrum sparsiflorum-Botrychium lunaria*.
Riverine Loamy Ostrich Fern Meadow	One plot was sampled in 2012 and occurred on a Meander Inactive Overbank Deposit. Soils were loamy with thin interbedded organic horizons. Given the low sample size in 2012 no floristic class was determined for this ecotype.

Ecotype	Description
Riverine Loamy Spruce-Birch Forest	This ecotype includes Open Spruce-Paper Birch Forest, Open White Spruce Forest, and Spruce-Paper Birch Woodland, and occurs on Meander Inactive Overbank Deposits. Soils in this ecotype are loamy with thin interbedded organic horizons. Tree mounds are common microtopographic features associated with this ecotype. Floristic classes include *Betula papyrifera-Picea glauca/Matteuccia struthiopteris* and *Picea glauca-Betula papyrifera/Alnus tenuifolia/Athyrium filix-femina*.
Riverine Sandy Alder-Willow Tall Shrub	This ecotype includes Closed Tall Willow Shrub, Open Low WillowShrub, Open Tall Alder Shrub, and Open Tall Alder-Willow Shrub, and occurs on Meander Fine Active Channel Deposits. Soils are dominated by sands with thin interbedded silt layers throughout the upper soil profile. Ice-rafted debris and Scour channels-ridges are common microtopographic features associated with this ecotype. Floristic classes include *Alnus tenuifolia-Salix barclayi-Salix alaxensis* and *Alnus tenuifolia/Matteuccia struthiopteris*.
Riverine Sandy Balsam Poplar Sapling-Alder-Willow Tall Shrub	This ecotype includes Closed Poplar Woodland-Alder Tall Shrub, Open Poplar Woodland-Alder Tall Shrub, and Open Poplar Woodland-Willow Tall Shrub on Meander Fine Active Channel Deposits and Braided Fine Active Channel Deposits. The vegetation in this ecotype is characterized by poplar saplings, and mixed alder-willow tall shrub. Soils are sandy and gravelly. This ecotype occurs on river bars where ice-rafted debris and scour channels-ridges are common microtopographic features. This ecotype is frequently disturbed by ice scour during spring break up. Floristic classes include *Populus balsamifera/Shepherdia canadensis*, *Populus balsamifera* (seedling)-*Salix alaxensis/Equisetum variegatum/Ceratodon purpureus*, and *Populus balsamifera* (sapling)/*Salix alaxensis/Hedysarum alpinum*.
Riverine Sandy Bluejoint-Herb Meadow	This ecotype includes Bluejoint Meadow and Bluejoint-Herb, and occurs on Meander Fine Inactive Channel Deposit and Braided Fine Inactive Channel Deposit. Soils are sandy with thin interbedded layers of silt. Floristic classes include *Calamagrostis canadensis-Epilobium angustifolium-Heracleum lanatum*.
Riverine Sandy Pole-sized Balsam Poplar Forest	This ecotype includes Closed Poplar Woodland-Alder Tall Shrub and Open Balsam Poplar Forest. Poplar in this ecotype are typically pole-sized (5–30 cm [2–12 in] DBH). This ecotype occurs on Braided Fine Active Channel Deposits and Meander Fine Inactive Channel Deposits. Soils are sandy and moist. This ecotype commonly occurs on river bars where Scour channels-ridges and Ice-shoved ridges are common microtopographic features. Floristic classes include *Populus balsamifera* (pole)/*Alnus* sp./*Platanthera hyperborea.*
Riverine Sandy Raspberry-Rose Low Shrub	This ecotype includes Closed Low Rose Shrub and Open Low Rose Shrub, and occurs on Braided Inactive Overbank Deposits in the lower Susitna River. Soils are sandy and moist. This ecotype commonly features abundant dead standing tall *Alnus tenuifolia*. Alder mortality is likely related to fungal stem canker disease (Nossov et al. 2011, Ruess et al. 2009). Floristic classes include *Rosa acicularis-Rubus idaeus/Thalictrum sparsiflorum*.
Riverine Sandy Spruce Forest	This ecotype includes Open White Spruce Forest, and occurs on Braided Inactive Overbank Deposits and Meander Inactive Overbank Deposits. Soils are sandy and moist. Tree mounds are common microtopographic features associated with this ecotype. Floristic classes include *Picea glauca/Alnus tenuifolia/Rhytidiadelphus triquetrus*.
Riverine Sandy Timber-sized Balsam Poplar Forest	This ecotype includes Closed Balsam Poplar Forest. Poplar in this ecotype are typically timber-sized (31–90 cm [12–35 in] DBH). This ecotype occurs on Braided Fine Inactive Channel Deposits, Braided Active Overbank Deposits, and Meander Active Overbank Deposits. Soils are sandy with thin interbedded layers of silt. On channel deposits, scour channels-ridges and ice-shoved ridges are common microtopographic features. Floristic classes include *Populus balsamifera (timber)/Viburnum edule/Pyrola asarifolia*.

Ecotype	Description
Riverine Sandy-Loamy Balsam Poplar Large Tree Forest	This ecotype includes Balsam Poplar Woodland and Open Balsam Poplar Forest. Poplar in this ecotype are typically large timber-sized (> 90 cm [35 in] DBH). This ecotype occurs on Meander Inactive Overbank Deposits and Braided Inactive Overbank Deposits. Soils are sandy and moist. Tree mounds are common microtopographic features associated with this ecotype. Floristic classes include *Populus balsamifera* (large timber)/*Alnus tenuifolia/Matteuccia struthiopteris* and *Populus balsamifera* (large timber)/*Oplopanax horridus*.
Riverine Sandy-Loamy Spruce-Balsam Poplar Forest	No plot data was collected in this ecotype in 2012. This ecotype was mapped in the middle Susitna River on Meander Active Overbank Deposits and Meander Inactive Overbank Deposits.
Riverine Slough	A sluggish channel of water, such as a side channel of a river, in which water flows slowly through low, swampy ground, or a section of an abandoned river channel, e.g., Whisker's Slough.
Riverine Wet Sedge-Forb Marsh	This ecotype includes Subarctic Lowland Herb Bog Meadow, and occurs on margins of beaver ponds, in abandoned channels, and fens. Floristic classes include *Carex utriculata-Equisetum fluviatile-Potentilla palustris*.
Upland Loamy Spruce-Birch Forest	This ecotype includes Open Spruce-Paper Birch Forest, and occurs on Meander Abandoned Overbank Deposit and Recent Alluvial Terraces. Soils are loamy and interbedded silt and organic layers are absent in the upper soil profile. Tree mounds are common microtopographic features associated with this ecotype. Floristic classes include *Picea glauca-Betula papyrifera/Linnaea borealis*.
Upland Poplar	No plot data was collected for this ecotype in 2012. This ecotype includes uplands, including hillsides and lower mountain slopes dominated by poplar forests.
Upland, undifferentiated	These include small areas of upland hillsides and mountain slopes directly adjacent to riverine areas that were not assigned a specific ecotype in the ITU mapping.

10. FIGURES

[See separate file for Figures.]