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- Attachment 1. 2014 fluvial geomorphology model development, technical memorandum.
- Attachment 1, Appendix A. 1-D bed evolution model of the middle and lower Susitna River: model development and calibration.
- Attachment 1, Appendix B. FA-128 2-dimensional sediment-transport model development and calibration.

Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Fluvial Geomorphology Modeling below Watana Dam
Study Plan Section 6.6

2014-2015 Study Implementation Report

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

Tetra Tech

November 2015

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LIST OF ACRONYMS

Abbreviation	Definition
ADCP	acoustic *doppler* current profiler
AEA	Alaska Energy Authority
AGL	Above Ground Level
ASPRS	American Society for Photogrammetry and Remote Sensing
BEI	Bank Energy Index
BEM	Bed Evolution Model
FERC	Federal Energy Regulatory Commission
FVA	Fundamental Vertical Accuracy
ILP	Integrated Licensing Process
IMU	Inertial Measurement Unit
ISR	Initial Study Report (AEA 2014)
LAS	file format for LiDAR
Mat-Su	Matanuska-Susitna Borough
PDO	Pacific Decadal Oscillation
PRM	Project River Mile
RSP	Revised Study Report
SPD	Study Plan Determination
SVA	Supplemental Vertical Accuracy
TIN	triangulated irregular network
TM	technical memorandum

1. INTRODUCTION

The Fluvial Geomorphology Modeling below Watana Dam Study, Section 6.6 of the Revised Study Plan (RSP) approved by the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project, FERC Project No. 142241, focuses on modeling the potential effects of the proposed Project on fluvial geomorphology of the Susitna River and to assist in predicting the magnitude of geomorphic response in support of the license application for the proposed Project.

A summary of the development of this study, together with the Alaska Energy Authority's (AEA) implementation of it through the 2013 study season, appears in Part A, Section 1 of the Initial Study Report (ISR) filed with FERC in June 2014. As required under FERC's regulations for the Integrated Licensing Process (ILP), the ISR describes AEA's "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)).

Since filing the ISR in June 2014, AEA has continued to implement the FERC-approved plan for the Fluvial Geomorphology Modeling below Watana Dam Study. As described in detail below, AEA has continued data collection in support of Study 6.6 modeling efforts, continued development of initial 1-D and 2-D bed evolution models for Existing and with-Project conditions, and filed technical memoranda describing data collection and modeling efforts. For example:

- In 2014, AEA collected data in the Upper, Middle, and Lower Susitna River Segments including high density LiDAR, tributary cross sections, Upper River cross sections, main channel and tributary bed material surface and sub-surface samples, bank material samples, water surface elevation surveys, and discharge measurements.
- On May 25, 2014, AEA filed the *Updated Fluvial Geomorphology Modeling Approach Technical Memorandm* (Tetra Tech 2014a), which included "Attachment A: FA-128 (Slough 8A) Hydraulic Modeling Proof of Concept."
- On June 3, 2014, AEA filed Part A of the Initial Study Report for Study 6.6, which included "Appendix E: Evaluation of 50-Year Simulation Period, Pacific Decadal Oscillation, and Selection of Representative Annual Hydrographs." (Tetra Tech 2014b).
- On September 26, 2014, AEA filed the *Winter Sampling of Main Channel Bed Material Technical Memorandum* (Tetra Tech 2014c).
- On September 26, 2014, AEA filed the *Decision Point on Fluvial Geomorphology Modeling of the Susitna River below PRM 29.9 Technical Memorandum* (Tetra Tech 2014d).
- On October 16, 2014, AEA held an ISR meeting for the Fluvial Geomorphology Modeling below Watana Dam Study.

In furtherance of the next round of ISR meetings and FERC's Study Plan Determination (SPD) expected in 2016, this report describes AEA's overall progress in implementing the Fluvial Geomorphology Modeling below Watana Dam Study during calendar year 2014 and into 2015. Rather than a comprehensive reporting of all field work, data collection, and data analysis since the beginning of AEA's study program, this report is intended to supplement and update the information presented in Part A of the ISR for the Fluvial Geomorphology Modeling below

Watana Dam Study through the end of calendar year 2014 and into 2015. It describes the methods and results of the 2014-2015 effort, and includes a discussion of the results achieved.

This Study Implementation Report also includes Attachment 1, *2014 Fluvial Geomorphology Modeling Development Technical Memorandum*. The technical memorandum (TM) includes the development of the initial 1-D bed evolution model of the Middle and Lower Susitna River Segments from Watana Dam (PRM 187.1) to Susitna Station (PRM 29.9), development of the initial 2-D bed evolution model of FA-128 (Slough 8A), and initial results from the Existing and Max LF OS-1b conditions models.

2. STUDY OBJECTIVES

The overall goal of the Fluvial Geomorphology Modeling below Watana Dam Study is to model the effects of the proposed Project on the fluvial geomorphology of the Susitna River to assist in predicting the trend and magnitude of geomorphic response. More specifically, the purpose of the modeling study, along with the Geomorphology Study (Study 6.5), is to assess the potential impact of the Project on the behavior of the river downstream of the proposed dam, with particular focus on potential changes in instream and riparian habitat. Whether the existing channel morphology will remain the same or at least be in "dynamic equilibrium" under post-Project conditions is a significant question in any instream flow study (i.e., is the channel morphology in a state of dynamic equilibrium such that the distribution of habitat conditions will be reflected by existing channel morphology, or will changes in morphology occur that will influence the relative distribution or characteristics of aquatic habitat over the term of the license? [Bovee 1982]). This key issue prompts four overall questions that must be addressed by the two geomorphology studies:

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

The methods and results from the Geomorphology Study and the Fluvial Geomorphology Modeling below Watana Dam Study address these questions.

Specific objectives of the Fluvial Geomorphology Modeling below Watana Dam Study are as follows:

- Develop calibrated models to predict the magnitude and trend of geomorphic response to the Project.
- Apply the developed models to estimate the potential for channel change for with-Project operations compared to existing conditions.
- Coordinate with the Geomorphology Study to integrate model results with the understanding of geomorphic processes and controls to identify potential Project effects that require interpretation of model results.

- Support the evaluation of Project effects by other studies in their resource areas providing channel output data and assessment of potential changes in the geomorphic features that help comprise the aquatic and riparian habitats of the Susitna River.

3. STUDY AREA

RSP Section 6.6.3 initially established the study area for this study. Section 3 of the June, 2014 Study 6.6 ISR includes a detailed description of the study area. The current study area for the 1-D bed evolution modeling is the portion of the Susitna River from Watana Dam (PRM 187.1) to Susitna Station (PRM 29.9) excluding Devils Canyon, and includes the lower 18.1 miles of the Chulitna River and lower 4.7 miles of the Talkeetna River. The potential need to extend the downstream limit below PRM 29.9 was further evaluated in 2014 in the technical memorandum, *Decision Point on Fluvial Geomorphology Modeling of the Susitna River below PRM 29.9* (Tetra Tech 2014d). Based on evaluation of four metrics, the technical memorandum concluded that the downstream limit of fluvial geomorphology modeling did not need to extend below PRM 29.9.

While the bed evolution modeling approach includes the application of a 1-D Bed Evolution Model to predict the geomorphic response of the Susitna River to the Project for the entire study area (PRM 187.1 to PRM 29.9 excluding Devils Canyon), the 2-D hydraulic and 2-D bed evolution models are being used to evaluate the detailed hydraulic and sediment transport characteristics on smaller, more local scales where it is necessary to consider the more complex flow patterns to understand and quantify Project effects. The study area for the 2-D models is the ten selected Focus Areas (refer to R2 2013a and R2 2013b for more details on Focus Area selection) within the Middle River Segment.

4. METHODS AND VARIANCES

The implementation of the three Fluvial Geomorphology Modeling Study components and variances in 2014 are presented in this section. No variances are noted in the Study 6.6 ISR Part A. All proposed study modifications in ISR Part C are discussed below as variances and other new variances are also identified.

4.1. Study Component: Bed Evolution Model Development, Coordination, and Calibration

This study component has progressed in accordance with Study 6.6 ISR, Part A, Section 4.1 and RSP Section 6.6.4.1. It is comprised of 9 subtasks as listed:

1. Development of Bed Evolution Model Approach and Model Selection (RSP Study 6.6.4.1.2.1),
2. Coordination with Other Studies (RSP Study 6.6.4.1.2.2),
3. Model Resolution and Mesh Size Considerations (RSP Study 6.6.4.1.2.3),
4. Focus Area Selection (RSP Study 6.6.4.1.2.4),
5. Model Calibration and Validation (RSP Study 6.6.4.1.2.5),
6. Tributary Delta Modeling (RSP Study 6.6.4.1.2.6),
7. Large Woody Debris Modeling (RSP Study 6.6.4.1.2.7),
8. Wintertime Modeling and Load-Following Operations (RSP Study 6.6.4.1.2.8), and

9. Field Data Collection Efforts (RSP Study 6.6.4.1.2.9).

2014 – 2015 activities for subtasks 1, 5, and 6 are ongoing and compiled in the *2014 Fluvial Geomorphology Modeling (FGM) Model Development Technical Memorandum* (Attachment 1), which includes model development, hydraulic and sediment transport calibration of the initial 1-D bed evolution model, and sediment calibration of the initial 2-D bed evolution model for FA-128 (Slough 8A). Activities for subtask 2 are ongoing as needed using methods described in Study 6.6 ISR Part A, Section 4.1.2.2. Activities for subtasks 3 and 4 are complete and described in Study 6.6 ISR Part A. No work has been performed for subtasks 7 and 8 in 2014. These subtasks are intended to address specific conditions and the modeling for these subtasks will be performed when finalized 1-D and 2-D bed evolution models are available and sufficient coordination has occurred with the other studies.

Subtask 9, Field Data Collection Efforts is presented within the main body of this report. The subtask is broken into 5 further categories: (1) 1-D Bed Evolution Model, (2) Focus Areas, (3) Tributary Deltas, (4) Field Data From Other Studies, and (5) LiDAR Verification and Acquisition. The field data collection conducted in 2014 was a continuation of the 2013 efforts and followed methods described in Study 6.6 ISR Part A, Section 4.1.2.9.

4.1.1. Variance from Study Plan

There were no variances as part of this study component at the time of submitting the ISR Part A. ISR Part C, Section 7.1.2.1 describes a proposed Study Plan modification to include groundwater sources into the 2-D hydraulic models at Focus Areas to more accurately maintain wetted areas in some sloughs and other lateral features when they become disconnected from upstream river sources. This modification is currently considered a variance because it has not been approved, but has been implemented as discussed in the Proof of Concept (Tetra Tech 2014a). This variance increases AEA's ability to meet the objectives of this study component.

Subsequent to submittal of the ISR, one other variance was identified as part of the 1-D bed evolution model sediment calibration. This involved use of the Ackers White (Ackers 1993) sediment transport function rather than the planned use of the Wilcock Crowe (Wilcock and Crowe 2003) function. The Model Development TM (Attachment 1) describes the use of Ackers White and demonstrates its suitability. This variance does not affect AEA's ability to meet the objectives of this study component.

4.2. Study Component: Model Existing and with-Project Conditions

The goal of the Model Existing and with-Project Conditions study component is to provide a baseline and series of with-Project scenarios of future channel conditions for assessing channel change. This study component has progressed in accordance with Study 6.6 ISR, Part A, Section 4.2 and RSP Study 6.6.4.2. This study component consists of 4 subtasks listed as follows:

1. Existing Conditions – Base Case Modeling (RSP Study 6.6.4.2.2.1),
2. Future Conditions – with-Project Scenarios (RSP Study 6.6.4.2.2.2),
3. Uncertainty (RSP Study 6.6.4.2.2.3), and
4. Synthesis of Reach-Scale and Local-Scale Analyses (RSP Study 6.6.4.2.2.4).

The activities of this study component are compiled in the *2014 FGM Model Development Technical Memorandum* (Attachment 1). The technical memorandum includes application of the calibrated initial 1-D and 2-D bed evolution models for Existing conditions and one with-Project condition, Maximum Load Following OS-1b. The initial 1-D model was used to demonstrate the suitability of the selected model and approach to conditions on the Middle and Lower Susitna River Segments and was used to support the decision point on whether to extend fluvial geomorphology modeling below PRM 29.9 (Tetra Tech 2014d).

4.2.1. Variance from Study Plan

There were no variances as part of this study component at the time of submitting the ISR Part A. ISR Part C, Section 7.1.2.2 includes a Study Plan modification related to representative hydrology (affecting subtasks 1 and 2). The modification, which is currently a variance, is to not consider Pacific Decadal Oscillation (PDO) for open water conditions because it was determined that PDO is not a significant distinguishing factor affecting hydrologic characteristics. Because PDO has not been used to select representative hydrologic conditions used in subtasks 1 and 2 efforts, this is currently a variance from the Study Plan. The basis for this modification is described in Study 6.6 ISR Part A, Appendix E. The modification does not affect AEA's ability to meet the objectives of this study component.

4.3. Study Component: Coordination and Interpretation of Model Results

The goal of this study component is to ensure that the information from the Geomorphology Study is properly considered and incorporated into the modeling studies, that results of the modeling studies are used to update and refine the understanding of key processes identified in the Geomorphology Study, and to provide the necessary results to the other resource studies. This study component has progressed in accordance with Study 6.6 ISR Part A Section 4.3 and RSP Study 6.6.4.3. This study component consists of 2 subtasks:

1. Integration of Geomorphology and Fluvial Geomorphology Modeling Study Results (RSP Study 6.6.4.3.2.1) and
2. Coordination of Results with Other Resources Studies (RSP Study 6.6.4.3.2.2).

2014 activities for this study component include continued integration of the Fluvial Geomorphology Modeling below Watana Dam Study with the Geomorphology Study (Study 6.5) and coordination and feedback of the Geomorphology Studies (Study 6.5 and Study 6.6) with Other Resource Studies (Study 5.6, Study 7.5, Study 7.6, Study 8.5, Study 8.6, and Study 9.9) (Study 6.6 ISR, Part C, Section 7.2.1.3.1). Activities in 2014-2015 for this study component include reviewing the initial pre-Project and post-Project 1-D model run in the Middle River, interpreting results in terms of geomorphic response, and refining conceptual models describing the system, where necessary (ISR Study 6.5, Part C, Section 7.2.1.11).

4.3.1. Variance from Study Plan

There were no variances in 2014 or 2015 for this study component.

5. RESULTS

In 2014, activities for the study components for the Fluvial Geomorphology Modeling below Watana Dam Study are reported in this section. In many cases, the results are reported in technical memoranda filed in 2014 and Attachment 1 of the SIR. In these cases, reference is made to the technical memoranda presenting the results. A list of all data filed in association with the performance of the Fluvial Geomorphology Modeling Study (6.6) is provided in Table 5-1. This table is cumulative and includes data from 2013 and 2014. Each of the 9 columns of Table 5-1 are described below. The table is broken into two primary columns: (1) Active Data, and (2) Previously Submitted Data (now superseded). Each of these primary columns has sub-columns that further describe the data. To describe Table 5-1 below, the column headings are bolded and underlined, while the description of the contents of each column follow after the colon.

Column heading: description of contents

Active Data

Data: Title of data delivered

Data Type: The type of data delivered (i.e. ArcGIS Shapefile, ArcGIS MXD, JPEG, Excel Spreadsheet, MP4 Videos, PDF, GeoTIFF or modeling files)

File name: Submitted name of data file.

Location (URLs in footnotes): Alphabetical letter noted. Each letter corresponds to a URL of where to find the data. Locations of the data may be found at the following:

a: http://gis.suhydro.org/isr/06-Geomorphology/6.6-Geomorphology/

b: http://gis.suhydro.org/Post_ISR/06-Geomorphology/6.6-Geomorphology/

c: http://gis.suhydro.org/raster-data

d: http://gis.suhydro.org/SIR/06-Geomorphology/6.6-Fluvial_Geomorphology_Modeling/

Folder Nesting: The folder nesting sequence to locate the specified data at the corresponding URL.

Study 6.6 Study Component: Study component number associated with Study 6.6. The study component number corresponds to the number identified in the first decimal position of the RSP, ISR, or SIR section number (i.e. Section X.Y) where X identifies the section number (i.e. methods, results, or discussion) and Y identifies the study component associated with Study 6.6.

Data described in following report: Report where data is discussed. Using the indicated report, and study component number (where applicable), one can identify where in the specified report, data is further discussed.

Previously submitted Data (now superseded):

File Name: Submitted name of data file

Location: Alphabetical letter associated with URLs listed in footnotes.

5.1. Study Component: Bed Evolution Model Development, Coordination, and Calibration

Work performed on subtasks 1, 5, and 6 of this study component are compiled and discussed in the 2014 FGM Model Development TM (Attachment 1), which documents the development of the initial FGM models. This includes, development of the bed evolution model approach and model selection, model calibration and validation, and tributary delta modeling. Work performed on subtask 2 of this study component, coordination with other studies, is described in Study 6.6 ISR, Part A, Section 5.1.2. Work performed on subtask 3, model resolution and mesh size considerations, and subtask 4, Focus Area selection, are complete as described in Study 6.6 ISR, Part A, Sections 5.1.3 and 5.1.4. Large woody debris modeling (subtask 7) and winter conditions modeling (subtask 8) were not addressed in 2014.

The primary efforts associated with this study component and performed in 2014-2015 included development and calibration of the initial 1-D Bed Evolution Model (BEM), development and calibration of the 2-D BEM for FA-128 (Slough 8A), updating the initial 1-D model cross sections with 2014 bathymetry and LiDAR, and Field Data Collection Efforts (subtask 9). The initial 1-D BEM development and calibration for the Middle and Lower Susitna River Segments, and the initial 2-D BEM development and calibration for FA-128 (Slough 8A) are reported in Attachment 1. The initial 1-D bed evolution model was used to support the decision whether to extend FGM downstream of PRM 29.9 (Tetra Tech 2014d).

The results of the other efforts, which include development of cross sections for the next version of the 1-D BEM and field data collection efforts, are described in the following sections.

5.1.1. Cross Section Development for Version 2 of the 1-D Bed Evolution Model

The initial 1-D Bed Evolution Model is comprised of two main reaches: (1) Middle Susitna River (PRM 187.1 to PRM 107.1); (2) Lower Susitna River (PRM 107.1 to PRM 29.9); and the next version will include two additional reaches (3) the lower extent of the Chulitna River (PRM 18.1 to PRM 0.0); and, (4) the lower extent of the Talkeetna River (PRM 4.7 to PRM 0.0). Each reach is defined by cross sections perpendicular to the primary flow path and located to capture key hydraulic controls of each system.

Bathymetric data for the cross sections were surveyed by Geovera (Study 8.5 ISR, Part A, Section 5.3.1) in 2012, 2013 and 2014. Table 5.1-1 documents the bathymetric survey dates for each cross section. Between PRM 165.9 and PRM 154.6 (Devils Canyon), the Middle River is inaccessible for surveying, so no cross section surveys were conducted. Simplified trapezoidal geometry developed as part of ISR Study 7.6 Ice Processes in the Susitna River was used for bathymetry in this area. Table 5.1-1 also includes twelve cross section locations that were identified in Study 6.6 ISR, Part A, Figures 5.1-1 through 5.1-8 for which bathymetric surveys have not been completed. One of these was a field-relocated cross section moved 0.3 miles (PRM 166.6 to 166.3 for safety reasons) and 11 were cross sections in the Lower River that were considered unnecessary based on initial model results. Fourteen cross sections that were surveyed in the spring of 2012 were subsequently resurveyed in September and October of 2012. Preference was given to using the more recent survey data in developing the cross section geometry. Table 5.1-1 indicates all cross section locations.

Overbank topography for the Middle and Lower River was available from LiDAR mapping. LiDAR data were available for 2011, 2013 and 2014. Figure 5.1-1 shows the coverage for each LiDAR dataset. A composite LiDAR surface was created by merging the three coverages into a single coverage. For overlapping coverage, preference was given to the most recent data.

Cross sections were cut through the LiDAR surfaces using HEC-GeoRAS software. At each cross section location, the field surveyed bathymetry was merged into the cross section geometry derived from the LiDAR topography. This was accomplished using an Excel based Visual Basic utility.

Some manual editing of the merged cross section geometry was required for each cross section. For the most part, the required editing was necessary only to smooth the transitions between the bathymetric survey and the LiDAR based overbank survey. Preference was given to the field survey.

There were instances where more substantial manual editing of the merged cross section geometry was necessary. This was required for one of two reasons. The first reason was due to the fact that the bathymetric survey was not conducted perpendicular to the primary flow path. This was the case for seven of the cross sections, as indicated in Table 5.1-1. The second reason was that bank erosion had occurred between the date of the bathymetric survey and the date of the LiDAR survey. If the horizontal difference between the bathymetric survey and the LiDAR survey was greater than a nominal ten feet, then the merged cross section geometry was manually edited to replace the field survey with the more recent LiDAR topographic survey of the bank position. This was the case for twenty-one of the cross sections, as indicated in Table 5.1-1. If the horizontal difference between the bathymetric survey and the LiDAR survey was less than a nominal ten feet, then the merged cross section geometry was not manually edited beyond smoothing the transition between the bathymetric survey and the LiDAR based overbank survey.

5.1.2. Field Data Collection Efforts

Field data presented in this section were collected in 2014 to support both the Geomorphology Study and the Fluvial Geomorphology Modeling Study. Field data collected during this study year was in continuation with the methods identified for the 2013 field season presented in Study 6.6 ISR, Part A, Section 4.1.2.9. The types of data included:

1. Inputs to the 1-D Bed Evolution Model
    a. Hydraulic observations, and
    b. Bed material sampling
2. Characterization of Focus Areas
3. Characterization of tributary deltas
4. Data collected from other studies, and
5. LiDAR verification and acquisition

5.1.2.1. 1-D Bed Evolution Model

Data collection efforts for the 1-D Bed Evolution Model planned for 2014 (Study 6.6 ISR, Part C, Section 7.2.1.1.9.1) were performed and include channel roughness observations, water surface observations, and sediment sampling.

Sediment sampling is further categorized as bank sampling and surface/subsurface sampling. A summary of the number of 2014 bank and surface/subsurface samples along the Susitna River and tributaries is presented in Table 5.1-2. Gradation data for each 2014 collected bank sample is summarized in Table 5.1-3 (Lower River) and Table 5.1-4 (Middle River). Gradation data for each 2014 collected surface and subsurface sediment sample is compiled in Table 5.1-5 (Lower River), Table 5.1-6 (Middle River), Table 5.1-7 (Upper River), and Table 5.1-8 (Tributaries). Water surface measurements collected in 2014 are summarized in Table 5.1-9.

5.1.2.2. Focus Areas

Data collection efforts for Focus Areas planned for 2014 (Study 6.6 ISR, Part A, Section 7.2.1.1.9.2) were performed for three Focus Areas; FA-151 (Portage Creek), FA-173 (Stephan Lake Complex), and FA-184 (Watana Dam). This data included roughness observations, sediment sampling, geomorphic surface mapping, and LWD surveys. This data is summarized in several tables and figures. Gradation data for 2014 bank and surface/subsurface sampling in 2014 studied Focus Areas is summarized in Table 5.1-10 and Table 5.1-11. All 2014 Focus Area sediment sample locations (bank and surface/subsurface) are presented on 2014 geomorphic surface mapping in Figure 5.1-2 through Figure 5.1-4.

Further, the installation of pressure transducers at Focus Areas (as identified in Study 6.6 ISR, Part C, Section 7.2.1.1.9.2) was performed as part of Study 8.5 and the data are included in that study's Study Implementation Report.

LWD survey data is compiled in Study 6.5, Study Implementation Report, Section 5.9.

5.1.2.3. Tributary Deltas

Data collection efforts in 2014 for tributaries were performed as planned (Study 6.6 ISR, Part C, Section 7.2.1.1.9.3). The 12 surveyed tributaries in 2014 are summarized in Table 5.1-12. A summary of the sediment sampling at the tributary delta study sites is summarized in Table 5.1-13.

5.1.2.4. Field Data from Other Studies

This effort consisted of coordinating with other studies, to the extent possible, on 2014 field data corresponding to cross-section surveys, bathymetric surveys within Focus Areas, water-surface elevation measurements, substrate mapping, acoustic *doppler* current profiler (ADCP) measurements, sediment transport measurements, and characterization of groundwater inflows in the lateral habitats within Focus Areas (Study 6.6 ISR, Part C, Section 7.2.1.1.9.4).

Discharge measurements were collected in conjunction with the Fish and Aquatics IFS (Study 8.5) in September 2014. This consisted of data collected in 7 Focus Areas below Devils Canyon; FA-104 (Whiskers Slough), FA-113 (Oxbow I), FA-115 (Slough 6A), FA-128 (Slough 8A), FA-138 (Gold Creek), FA-141 (Indian River), and FA-144 (Slough 21). Table 5.1-14 presents discharge measurement locations and estimated discharge. A compilation of discharge data and discharge profile data is compiled in two excel spreadsheets and delivered with the electronic data (Table 5-1). Field Photos collected by the Fluvial Geomorphology team as part of this effort were delivered as part of the 2014 data delivery.

Sediment transport measurements were collected in 2014 by the USGS and are identified in Study 6.5, Study Implementation Report, Section 5.2.

5.1.2.5. LiDAR Verification and Acquisition

Two LiDAR data sets are available for various portions of the Susitna River. The Matanuska-Susitna Borough (Mat-Su) LiDAR was acquired in 2011 and AEA acquired higher density LiDAR in 2013 and 2014 (SuWa LiDAR). The original Mat-Su LiDAR was not indexed or verified using surveyed ground points. AEA decided to acquire the high-density LiDAR (Su-Wa LiDAR) to provide more accurate information, but unfavorable conditions limited the amount of LiDAR that was acquired in 2013. Therefore, in order to supplement the 2013 LiDAR data, the Mat-Su LiDAR was indexed and verified using 2013 ground survey data. This approach resulted in the best available LiDAR for use until additional LiDAR could be obtained in 2014. Additional LiDAR was then collected in the spring of 2014. The following sections describe the methods for acquiring and processing the 2014 Su-Wa LiDAR. The previous datasets were addressed in the Study 6.6 ISR, Part A (Section 5.1.9.5).

5.1.2.5.1. 2014 LiDAR Acquisition and Processing

Kodiak Mapping acquired LiDAR data with a Riegl VQ480i LiDAR sensor. The system includes an Inertial Measurement Unit (IMU), a 480kHz laser repetition rate, multi-pulse capability and four returns from each outgoing pulse. The data were collected to meet a minimum of 8 points per square meter density at 600 meters Above Ground Level (AGL) to support the Project requirements.

The 2014 LiDAR acquisition area was collected as two main block areas, the Middle River corridor and the reservoir area. The total 2014 LiDAR area was 223 square miles. Of that, 38 square miles were within the river corridor and 185 square miles were within the reservoir area. Priority areas were determined by the study teams and ranked in order of importance to schedule. Locations of 2014 Middle River LiDAR Acquisition are illustrated in Figure 5.1-5. Locations of 2014 Middle River ground survey points are illustrated in Figure 5.1-6. Locations of 2014 ground survey points in the reservoir area are illustrated in Figure 5.1-7.

The airborne LiDAR dataset was requested to meet the specifications shown in Table 5.1-15. Upon receipt of the collected data, LiDAR and GIS specialists reviewed the acquisition report and confirmed the results by performing an initial quality assurance and quality control assessment. This assessment verified LiDAR point cloud data coverage within the study area, point density, vertical accuracy, accurate matching between flight lines, compliance with the American Society for Photogrammetry and Remote Sensing (ASPRS) LAS v.1.2 technical specifications document, and other specifications requested for the 2014 Susitna-Watana project (Study 6.6 ISR, Part A, Section 4.1.2.9.5).

Once the initial quality assurance and quality control assessments were performed and the LiDAR data were validated, the unclassified LiDAR point cloud files (LAS) were prepared for an initial clean-up. All pulses were merged into the “Unclassified” or “Default” class (ASPRS Class 1) to be used by the ground classification routine. A rough minimum elevation threshold filter was applied to the entire dataset in order to eliminate the most extreme low/high point outliers. A second clean-up process was applied to search for isolated and low points using several algorithm iterations using Terrascan macros. The “Low Points” macro searches for possible error points that were clearly below the ground surface. The “Isolated Points” macro then searches for points that were without any neighbors within a specified radius. The “Low Points” as well as the “Isolated Points” were classified into the “Noise” class (ASPRS Class 7), which excludes them from subsequent steps.

A first classification process (unsupervised) was performed using all points in the previously cleaned “Unclassified”/”Default” class (ASPRS Class 1). Each laser return was assigned an “echo”: Only, First-of-Many, Last-of-Many, or Intermediate. To begin classification, the ”First-of-Many” and ”Intermediate” returns were removed from consideration as Bare-Earth points by assigning them to the Medium Vegetation class. The remaining points, the “Only” and “Last-of-Many” returns were placed in the “Unclassified”/”Default” class (ASPRS Class 1). The Bare-Earth class was developed from this set of returns by an iterative method. First, a rectangular filter was passed over the points in the “Unclassified”/”Default” class (ASPRS Class 1) , and a set of local low points was selected to seed the Bare-Earth class. Then the rest of the points in

"Unclassified"/"Default" class (ASPRS Class 1) were compared to the triangulated surface defined by the set of Bare-Earth points, and those that were found be close enough to fall within an acceptable angle and height of the surface were added to the Bare-Earth class (ASPRS Class 2). The process was repeated with the expanded Bare-Earth class until the number of points being added to the Bare-Earth class declined. Standard practice in the LiDAR industry acknowledges that no ground classification is perfect. Valid ground points on edges or sharp features are commonly misclassified by LiDAR point cloud processing software packages, leaving blank areas (gaps) in the ground surface. Using proprietary techniques, potential anomalies (artificial pits, "spikes" on the ground, etc.) were identified during the first classification process (unsupervised) to be corrected in further steps. The application of those techniques provides a semi-automated quality control of the first point cloud classifications and improves the efficiency of the next classification process.

After the unsupervised classification, a second classification process was applied (supervised), where the Bare-Earth model class (ASPRS class 2) were inspected on a tile-by-tile basis and edited as necessary. The Bare-Earth model was visualized as a triangulated irregular network surface (TIN) with contours and potential gap polygons overlaid. Irregularities or voids in the ground surface were subjected to special scrutiny, typically by generating and studying sectional views of the questionable area. Incorrectly classified points were reclassified as necessary, and the classification routine was re-run locally to correct nearby points. This careful review of each tile was central to making a consistently high-quality DEM.

The LiDAR point classification process was completed by performing a second vertical accuracy assessment using only points classified as Bare-Earth (ASPRS Class 2), and exporting the LiDAR-derived data to create the final deliverables.

5.1.2.5.2. 2014 Su-Wa LiDAR

LiDAR data acquisition for the Middle River occurred between May 21st, 2014 and June 3rd, 2014. A total of 3 flight days of acquisition were completed. The 2014 collected airborne LiDAR point cloud dataset covers 38 square miles along the river and is located north of the confluence area of Susitna, Chulitna, and Talkeetna rivers and south of the dam site as well as 185 square miles near the reservoir site as shown in Figure 5.1-1.

As shown in Tables 5.1-16 and 5.1-17, the Fundamental Vertical Accuracy (FVA) of the LiDAR meets the target accuracy of RMSEz < 9.25 cm (approximately 0.30 ft.). Including brush, low vegetation, and forested lands, SVA (RMSEz) ranges from approximately 0.25 to 0.56 ft. The vertical accuracy at the 95 percent confidence level is 1.96 times the RMSEz, which is approximately 0.3 ft (river corridor) and 0.56 ft (reservoir area) for open terrain and up to 1.1 ft. for other terrain types. These values indicate that the FVA is 1-ft contour interval equivalent and that the Supplemental Vertical Accuracy (SVA) is approximately 2-ft contour equivalent (presented in Table 5.1-18).

The verification process followed the ASPRS guidelines for vertical accuracy reporting for LiDAR data (ASPRS 2004) which recommends,

- *"A LiDAR dataset's required 'fundamental' vertical accuracy, which is the vertical accuracy in open terrain tested to 95% confidence (normally distributed error), shall be specified, tested and reported."*

- *"If information is required on the vertical accuracy achieved within other ground cover categories outside open terrain, either to meet the same specification as the fundamental vertical accuracy or a more relaxed specification, then "supplemental" vertical accuracies, that is vertical accuracy tested using the 95th percentile method (not necessarily normally distributed) shall be specified, tested and reported for each land cover class of interest."*

5.1.2.5.3. Su-Wa LiDAR Verification

The 2014 Su-Wa LiDAR meets 1-ft contour equivalence in open terrain (FVA) and 2-ft contour equivalence in brush and forested land areas (SVA). The RMSEz and 95% confidence levels of these data are approximately 0.25 and 0.5 ft for FVA, and 0.5 and 1.1 ft for SVA. These results indicate that the Su-Wa LiDAR meets project specifications for LiDAR acquisition.

5.1.3. Field Equipment

There was no field equipment installed in the field nor is there any field equipment remaining in the field.

5.2. Study Component: Model Existing and with-Project Conditions

The results of this effort are reported in the 2014 FGM Model Development Technical Memorandum (Attachment 1). The TM includes the development and results of the initial 1-D Bed Evolution Model (BEM) for the Middle and Lower Susitna River Segments, which was used for the decision whether to extend fluvial geomorphology modeling below PRM 29.9 (Tetra Tech 2014d), and the initial 2-D BEM for FA-128 (Slough 8A). The runs include Existing and the Max LF OS-1b with-Project conditions.

5.3. Study Component: Coordination and Interpretation of Model Results

This study component is part of the ongoing implementation of the Study Plan.

Subtask 1 - Integration of Geomorphology and Fluvial Geomorphology Modeling Study Results:

This task is part of an ongoing investigation. Initial results of this effort are presented in the Study 6.5 Study Implementation Report Section 5.11 as an initial framework to identify Project effects between studies. The framework is intended to be updated in future technical memoranda.

Subtask 2 - Coordination of Results with Other Resources Studies: Coordination with other studies has been ongoing in 2014 and is discussed in further detail in the Study 6.6 ISR, Part A, Section 5.3.2.

6. DISCUSSION

Significant progress has been made in achieving the objectives of the Fluvial Geomorphology Modeling below Watana Dam Study (6.6). Discussion of progress of the three study components is presented in this section. Much of the progress has been presented in technical memoranda filed in 2013 and 2014. The Study 6.6 ISR and its associated appendices also provide information related to this study.

6.1. Study Component: Bed Evolution Model Development, Coordination, and Calibration

Based on data available in 2013, the initial 1-D Bed Evolution Model (BEM), the initial 2-D hydraulic model of FA-128 (Slough 8A), and the initial 2-D BEM of FA-128 (Slough 8A) were developed and calibrated. The BEMs are described in Attachment 1 of this report and the 2-D hydraulic model is described in Appendix A of Tetra Tech (2014a). The 1-D BEM results were used as the basis of the decision whether to extend fluvial geomorphology modeling below PRM 29.9 (Tetra Tech 2014d).

The initial 1-D BEM was developed and calibrated based on the procedures described in detail in the *Updated Fluvial Geomorphology Modeling Approach* technical memorandum (Tetra Tech 2014a). The hydraulic calibration of the 1-D BEM included comparisons of stage and flow measurements at three USGS gaging stations (Susitna River at Gold Creek, #15292000, Susitna River at Sunshine, #15292780, and Susitna River at Susitna Station, #15294350), stage records at Project ESS stations along the Susitna River, and water surface elevations surveyed at cross section locations. The sediment transport component of the 1-D BEM was calibrated primarily based on comparisons of USGS measured and 1-D BEM modeled sediment loads and gradations. The locations of the USGS measurements include the three stations listed above, but also include measurements at the Susitna River near Talkeetna (#15292100), which was the primary location for sediment transport measurements on the Middle Susitna River segment.

Although the initial 1-D BEM did not include subsequent cross section surveys, surface and subsurface bed material samples, or complete Su-Wa 2013-2014 LiDAR, the calibrated model is an excellent representation of the reach-scale Susitna River hydraulics and sediment transport conditions. The model results are also very consistent with observations and analyses conducted by Study 6.5 (Geomorphology Study). These results indicate that the very coarse bed of the Middle Susitna River is rarely mobilized during open water flow periods. In the Middle Susitna River, both sand and gravel size material appear to be transported primarily as throughput over a coarser armor and lag deposits. The Lower Susitna River, however, has an active alluvial bed due primarily to the significant sediment input from the Chulitna River, but also from sediment supplied from the Talkeetna River. The 1-D BEM indicates that the Lower Susitna River is aggrading very slowly for existing conditions, which is consistent with the highly dynamic, braided form.

Based on the results of the initial 1-D BEM development and calibration, AEA anticipates that the next version of the model will provide the information to assess potential Project effects. The next version of the model will include additional surveyed cross sections, more complete bed material information, more complete flow and sediment inputs from ungaged tributaries, and both the Chulitna and Talkeetna Rivers as tributary reaches rather than as direct flow and sediment inputs.

The initial 2-D models (hydraulic and BEM) of FA-128 (Slough 8A) were developed based on detailed bathymetric survey and 2011 Mat-Su LiDAR available in 2013 and 2014. These models calibrated very well compared to ADCP velocity and water surface elevation measurements, as well as flow distributions of the main channels, side channels, and other lateral features. The 2-D BEM included bed material information collected as part of this Study (6.6) and substrate information collected by Study 8.5, and used flow and sediment boundary condition from the 1-

D BEM. Based on available information, the results of the 2-D BEM are consistent with observed trends throughout the focus area, especially the continued growth of Skull Creek fan.

Considerable coordination with other studies occurred as part of this study component this will continue throughout the Project study period. The success of this coordination was demonstrated in the Proof of Concept exercise as described in Appendix A of Tetra Tech (2014a). The 1-D and 2-D BEMs were developed based on data and information shared between Studies 6.5 (Geomorphology), 7.5 (Groundwater), 7.6 (Ice Processes), 8.5 (Fish and Aquatics Instream Flow), and 8.6 (Riparian Instream Flow).

6.2. Study Component: Model Existing and with-Project Conditions

The initial models developed as part of Study Component 1 were run for Existing and with-Project flow and sediment conditions. The with-Project condition that was simulated was Max LF OS-1b. The results of these simulations for the 1-D and 2-D BEMs are presented in Attachment 1 of this report. The results of the initial 1-D BEM were used as the basis of the decision whether to extend fluvial geomorphology modeling below PRM 29.9 (Tetra Teach 2014d).

The with-Project conditions runs were identical to the Existing conditions runs with the exception that Max LF OS-1b release flows from Watana Dam were substituted for the hydrology and no sand or coarser sediment was included in the releases. Even though sediment from ungaged tributaries was not included in these runs, the Middle Susitna River showed very little bed response due to open water flows. The next version of the model will include these sediment sources, which are expected to be primarily gravel sizes, to provide a more complete picture of Middle Susitna River bed evolution. The Existing conditions model results of the Lower Susitna River show gradual aggradation over the 50-year simulation period, which is consistent with the active braided planform of the Lower River. The Max LF OS-1b simulation indicates that aggradation will continue under with-Project conditions, though at a slightly slower rate. This is a very reasonable result considering the dominant sediment input from the Chulitna River.

The results of the 2-D BEM model of FA-128 (Slough 8A) are presented in Attachment 1. The models indicate that the Skull Creek fan will extend further into the side channel for Max LF OS-1B conditions, but will not block the side channel. Floodplain areas will also be inundated less frequently under with-Project conditions, which is expected to significantly reduce floodplain sediment accretion rates. The frequency of inundation will also be reduced for unvegetated gravel bars. These areas may become vegetated for with-Project conditions and this possibility will be evaluated in coordination with Study 8.6 (Riparian Instream Flow) and Study 7.6 (Ice Processes).

This study component will continue when the next version of the models are developed and calibrated. At that point the other subtasks will also be addressed, which include uncertainty analysis and synthesis of reach-scale and local-scale analyses.

6.3. Study Component: Coordination and Interpretation of Model Results

This effort is described in Study 6.6 ISR, Part A, Section 6.3. The dam effects technical memorandum (R2 Resources and Tetra Tech 2014) identifies information on the orders of effects that can occur with a hydropower project. Initial First- and Second-order effects for the Susitna-Watana Project have been developed as described in the Geomorphology Study (6.5) study component 11 (Integration of the Fluvial Geomorphology Modeling below Watana Dam Study with Geomorphology Study) in the Study 6.5 SIR Sections 4.11, 5.11, and 6.11). This has provided a basis for integrating the results of the two studies.

7. CONCLUSIONS

In summary, significant progress has been made in 2014-2015. The initial 1-D BEM of the Middle and Lower Susitna River segments from Watana Dam (PRM 187.1) to Susitna Station (PRM 29.9) calibrated very well and is a useful tool to evaluate potential Project effects. The initial 2-D hydraulic model of FA-128 (Slough 8A) calibrated very well and was shown to provide the necessary hydraulic and sediment mobilization information needed by Study 8.5 (Fish and Aquatics Instream Flow) to perform habitat characterization (Appendix A of Tetra Tech 2014a). The initial 2-D BEM of FA-128 (Slough 8A) also calibrated well and provides results that are consistent with recent trends. This model was run for existing and with-Project conditions to provide information on future conditions within the Focus Area.

In addition to updating these models with data collected in 2014, 2-D hydraulic and BEMs will need to be developed for additional Focus Areas. The procedures that were developed and applied in 2014 to the initial models are sufficient for the updates to existing models and development of additional models. The models will also need to be run for the range of operational scenarios that have been selected.

7.1. Decision Points from the Study Plan

As described in Study 6.6 ISR Part C Section 7.1.1.1.2, AEA recommends not extending the 1-D Bed Evolution Model below PRM 29.9. This recommendation is based on the analysis presented in Tetra Tech (2014d).

As described in Study 6.6 ISR Part C Section 7.1.1.2.1, AEA recommends not including Pacific Decadal Oscillation in the range of representative wet, average, and dry hydrologic conditions as part of the 2-D BEMs. This recommendation is based on the analyses presented in Appendix E of Study 6.6 ISR Part A.

One future decision point cannot be evaluated until additional 2-D BEMs are developed and run for a range of operational scenarios. The decision point is described in Study 6.6 ISR, Part C, Section 7.1.1.2.2. This decision would potentially reduce the number of 2-D hydraulic and 2-D BEM runs, and would be based on the differences in bed evolution between operational scenarios, or if there are only minor differences between year 25 and year 50 conditions. The differences would be evaluated based on either 1-D or 2-D BEM simulations.

7.2. Modifications to the Study Plan

As described in Study 6.6 ISR Part C Section 7.1.2.1, AEA recommends including groundwater flows as point source inputs to the 2-D hydraulic models at lateral features that are identified as having persistent groundwater sources. This modification was identified during the Proof of Concept exercise (Appendix A of Tetra Tech 2014a) to more accurately represent wetted areas for subsequent habitat analyses. This led to the efforts by Studies 6.6 and 8.5 (Fish and Aquatics

Instream Flow) to measure and estimate flows in lateral features as described in Section 5.1.2.4 resulting in the data reported in Table 5.1-14. This modification will enhance AEA's ability to meet the objectives of the Study Plan.

As described in Study 6.6 ISR Part C Section 7.1.2.2, AEA proposes to exclude dimensionless critical shear as a parameter to evaluate model sensitivity and uncertainty depending on the selected sediment transport function. Other suitable variables will be included in the sensitivity analysis based on the formulation of the function. This proposed modification does not affect AEA's ability to meet the objectives of this study component.

Subsequent to the submittal of the ISR, a modification was identified as part of the 2-D model application of the Bank Energy Index (BEI) in Study Component 2, Model Existing and with-Project Conditions and is described in Attachment 1 of this report in Section 6.2.4. The BEI analysis was planned as an approach to address bank erosion and production of large woody debris. As described in Attachment 1, Section 5.2.4, the results indicate that open water flows do not contribute appreciably to bank erosion at FA-128 (Slough 8A) and that bank erosion is more likely related to ice processes. The proposed modification is to perform the BEI at one other Focus Area, and if the results are similar, not continue BEI analyses for open water conditions at the remaining Focus Areas. Because the evaluation of ice processes on channel geomorphology (ISR Part A Section 4.1.2.8) will still be conducted, this modification does not affect AEA's ability to meet the objectives of this study component.

Also subsequent to the submittal of the ISR, a modification was identified as part of the 2-D bed evolution modeling of existing and future conditions (ISR Part A Sections 4.4.2.1 and 4.4.2.2). As described in Attachment 1, Section 5.2.1, in addition to simulating the Wet, Average and Dry open water period hydrographs at FA-128 (Slough 8A), a sequence of 8 annual flow periods was simulated to effectively project conditions out to years 25 and 50. This was due to the continued accretion of the Skull Creek fan. Therefore, at other Focus Areas, additional years may be run in addition to the Wet, Average and Dry representative hydrographs. The number of years will be selected for each Focus Area based primarily on tributary fan development. This proposed modification increases AEA's ability to meet the objectives of this study component.

8. LITERATURE CITED

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9. TABLES

Table 5-1: Summary of cumulative data collected as part of the Fluvial Geomorphology Modeling Study (Study 6.6) with URLs to access datasets, notes to find description of data in associated report, and identification if data has previously been submitted and superseded.

Active Data				Folder Nesting	Study 6.6 Study Component	Data described in following report	Previously submitted Data (now superseded)	
Data	Data Type	File name (s)	Location				File name	Location
Cumulative (2013 & 2014) Subsurface bed-material sample locations	ArcGIS shapefile	SIR_6_6_FGM_All_FieldData_Sediment.shp	d	SHAPEFILES	1	Study Implementation Report	ISR_6_6_FGM_BedSamp_Subsurface.shp	a
Cumulative (2013 & 2014) Surface bed-material sample locations	ArcGIS shapefile	SIR_6_6_FGM_All_FieldData_Sediment.shp	d	SHAPEFILES	1	Study Implementation Report	ISR_6_6_FGM_BedSamp_Surface.shp	a
Cumulative (2013 & 2014) Bank Material Sample Locations within the Middle Susitna River Segment	ArcGIS shapefile	SIR_6_6_FGM_All_FieldData_Sediment.shp	d	SHAPEFILES	1	Study Implementation Report	ISR_6_6_FGM_Bank_Samples.shp	a
Cumulative (2013 & 2014) Cross-section Observations, Surveys and Level Loops Locations	ArcGIS shapefile	SIR_6_6_FGM_All_FieldData_XC_Pin.shp	d	SHAPEFILES	1	Study Implementation Report	ISR_6_6_FGM_XSec_Obs_Survey.shp	a
Cumulative (2013 & 2014) Geomorphic Surface Mapping	ArcGIS shapefile	SIR_6_6_FGM_All_GeomSurface_Mapping.shp	d	SHAPEFILES	1	Study Implementation Report	ISR_6_6_FGM_Surface_Mapping.shp	a
Upper Susitna River Segment Cross-Sections	ArcGIS shapefile	SIR_6_6_FGM_FieldData_UR_xsecs.shp	d	SHAPEFILES	1	Study Implementation Report	n/a	
Focus Area Discharge measurement Locations	ArcGIS shapefile	SIR_6_6_FGM_FieldData_Qmeas.shp	d	SHAPEFILES	1	Study Implementation Report	n/a	
Sediment Sample Distribution Spreadsheet - 2013 Summary	Excel Spreadsheet	SIR_6_6_FGM_SuWa TtFGM 2013 Sediment Distribution Summary QC3 20140120 LWZ.xlsx	d	DATA AND SPREADSHEETS > SEDIMENT > SUMMARY	1	Initial Study Report	n/a	
Sediment Sample Distribution Spreadsheet - 2014 Summary	Excel Spreadsheet	SIR_6_6_FGM_SuWa TtFGM 2014 Sediment Sample Distribution Summary QC3 20141230 RAV	d	DATA AND SPREADSHEETS > SEDIMENT > SUMMARY	1	Study Implementation Report	n/a	
Subsurface (SubS) bed-material field and lab data [surface (Sur) samples at same river location are included in combined spreadsheet]	Excel Spreadsheets	**ISR file name prefix:** "ISR_6.6_FGM_SuWa TtGeo" **SIR file name prefix:** "SIR_6_6_FGM_SuWa TtFGM" **File name format:** Sur SubS + *date collected* + PRM + *location* + S# (*where applicable*) +DistChart QC3 + *initials of QC performer* + *date of QC* **File name example**: ISR_6.6_FGM_SuWa TtGeo Sur SubS 20130714 PRM 103.9 DistChart QC3 LWZ 20140115	d	DATASHEETS AND SPREADSHEETS > SEDIMENT DATA	1	Initial Study Report + Study Implementation Report	ISR data previously submitted. Unchanged in SIR submittal. Reposted in SIR data location for cumulative dataset.	a

<table>
<tr><th colspan="4">Active Data</th><th rowspan="2">Folder Nesting</th><th rowspan="2">Study 6.6 Study Component</th><th rowspan="2">Data described in following report</th><th colspan="2">Previously submitted Data (now superseded)</th></tr>
<tr><th>Data</th><th>Data Type</th><th>File name (s)</th><th>Location</th><th>File name</th><th>Location</th></tr>
<tr><td>Surface bed-material field and lab data</td><td>Excel Spreadsheets</td><td>ISR file name prefix: "ISR_6.6_FGM_SuWa TtGeo"
SIR file name prefix: "SIR_6_6_FGM_SuWa TtFGM"

File name format: Sur + date collected + PRM + location + S# (where applicable) + DistChart QC3 + initials of QC performer + date of QC
File name example: ISR_6.6_FGM_SuWa TtGeo Sur 20130817 PRM 144.9A-FA144 DistChart QC3 MRM 20140115</td><td>d</td><td>DATASHEETS AND SPREADSHEETS > SEDIMENT DATA</td><td>1</td><td>Initial Study Report + Study Implementation Report</td><td>ISR data previously submitted. Unchanged in SIR submittal. Reposted in SIR data location for cumulative dataset.</td><td>a</td></tr>
<tr><td>Bank Material field and lab data</td><td>Excel Spreadsheets</td><td>ISR file name prefix: "ISR_6.6_FGM_SuWa TtGeo"
SIR file name prefix: "SIR_6_6_FGM_SuWa TtFGM"
File name format: Bank + sample number + date collected + PRM location + LabResults QC3 + initials of QC perfomer + date of QC3
File name example: ISR_6.6_FGM_SuWa TtGeo Bank1 20130907 PRM 145.7 LabResults QC3 LabResults QC3 ALS 20140114</td><td>d</td><td>DATASHEETS AND SPREADSHEETS > SEDIMENT DATA</td><td>1</td><td>Initial Study Report + Study Implementation Report</td><td>ISR data previously submitted. Unchanged in SIR submittal. Reposted in SIR data location for cumulative dataset.</td><td>a</td></tr>
<tr><td>Tributary Survey Data - 2013 & 2014

Each tributary may contain the following data:
1. Electronic version of survey data
2. Field form of survey data
3. Field form of tributary channel profile</td><td>Excel Spreadsheets and PDFs</td><td>ISR file name prefix: "ISR_6.6_FGM_SuWa TtGeo"
SIR file name prefix: "SIR_6_6_FGM_SuWa TtFGM"

Tributary Survey Data nested under folder by Tributary:
> 4th of July Creek
> 5th of July Creek
> Caswell Creek
> Chinook Creek
> Deadhorse Creek
> Fog Creek
> Gash Creek
> Gold Creek
> Indian River
> Lane Creek
> Little Tsusena Creek
> Sheep Creek
> Sherman Creek
> Skull Creek
> Slash Creek
> Trappers Creek
> Tsusena Creek
> UNT 113.7
> UNT 144.6
> UNT 173.6
>Whiskers Creek</td><td>d</td><td>DATASHEETS AND SPREADSHEETS > CROSS-SECTION DATA > TRIBUTARIES</td><td>1</td><td>Initial Study Report + Study Implementation Report</td><td>ISR data previously submitted. Unchanged in SIR submittal. Reposted in SIR data location for cumulative dataset.</td><td>a</td></tr>
</table>

Active Data				Folder Nesting	Study 6.6 Study Component	Data described in following report	Previously submitted Data (now superseded)	
Data	**Data Type**	**File name (s)**	**Location**				**File name**	**Location**
Cross-section Level Loop (water surface elevation) data - Set 1, 2013	Excel Spreadsheet	ISR_6.6_FGM_WSE_LevelLoops.xlsx	d	DATASHEETS AND SPREADSHEETS > CROSS-SECTION DATA > SUSITNA	1	Initial Study Report	ISR data previously submitted. Unchanged in SIR submittal. Reposted in SIR data location for cumulative dataset.	a
Cross-section Level Loop (water surface elevation) data - Set 2, 2014	Excel Spreadsheet	SIR_6_6_FGM_2014_TetraTech_WSE_level_loops QC3 LWZ 20141219.shp	d		1	Initial Study Report + Study Implementation Report	n/a	
Cross-section Observations data	Excel Spreadsheet	ISR_6.6_FGM_XSec_Obs_Summary.xlsx	d		1	Initial Study Report	ISR data previously submitted. Unchanged in SIR submittal. Reposted in SIR data location for cumulative dataset.	a
Upper River Cross-Section data	Excel Spreadsheet	SIR_6_6_FGM_2014_TetraTech_Upper River Cross-Sections QC3 LWZ 20141219.shp	d		1	Study Implementation Report - Study 6.5	n/a	
Focus Area Discharge Measurements	Excel Spreadsheets	SIR_6_6_FGM_SuWa_TtFGM_FAFeature_Q-DischargeData_QC3_LWZ_20150521.xlsx SIR_6_6_FGM_SuWa_TtFGM_FAFeature_Q-Discharge&ProfileData_QC3_PJH_20150130.xlsx	d	DATASHEETS AND SPREADSHEETS > DISCHARGE DATA	1	Study Implementation Report	n/a	
Fieldbooks	PDF	SIR_6_6_FGM_SuWa_TtFGM_*year collected* + *initials of field worker* + *location* + Field Book QC3 + *intials of reviewer* + *date of review*.pdf	d	DATASHEETS AND SPREADSHEETS > FIELD BOOKS	1	Study Implementation Report	n/a	
2013 Field Photo Log	Excel Spreadsheet	Photo Log Master.xlsx	d	PHOTOS > 2013 FIELD PHOTOS	1	Initial Study Report	n/a	
2013 Field Photos	JPEG	Nested under folder by Focus Area, Geomorphic Reach, or Tributary	d	PHOTOS > 2013 FIELD PHOTOS	1	Initial Study Report	n/a	
2014 Field Photo Logs	Excel Spreadsheet	SuWa TtFGM 2014 Other Field Photos Photo Log QC3 RAV 20141231.xlsx SuWa TtFGM 2014 Q meas in Focus Areas Photo Log QC3 RAV 20141231.xlsx SuWa TtFGM 2014 Sediment Photo Log QC3 RAV 20141231.xlsx SuWa TtFGM 2014 Tributary Photo Log QC3 RAV 20141231.xlsx SuWa TtFGM 2014 Upper River Recon Photo Log QC3 RAV 20141231.xlsx	d	PHOTOS > 2014 FIELD PHOTOS	1	Study Implementation Report	n/a	

Active Data				**Folder Nesting**	**Study 6.6 Study Component**	**Data described in following report**	**Previously submitted Data (now superseded)**	
Data	**Data Type**	**File name (s)**	**Location**				**File name**	**Location**
2014 Field Photos	JPEG	Nested under folders by data type: Other Field Photos, Q measurements in Focus Areas, Sediment Sampling, Tributary, or Upper River Reconnaissance	d	PHOTOS > 2014 FIELD PHOTOS	1	Study Implementation Report	n/a	
Winter Bed Material Sampling Videos	MP4 Video	**File Name:** ISR_MTG_6.6_WintBedMatSamp_*date of video collection*_GOPRO + *video number*.MP4 Video Data nested under folders by sample transect name: > CH_7_2 > CH_9_7 > PRM_21.8 > PRM_29.9 > PRM_39.2 > PRM_57 > PRM_75 > PRM_95.6 > PRM_104.1 > PRM_112 > PRM_113.9 > PRM_116 > PRM_129 > PRM_139.5 > PRM_142.7 > PRM_145.4 > PRM_152.1 > PRM_174.4 > PRM_184.3 > PRM_185.4 > PRM_195.6 > PRM_214 > PRM_230.1 > PRM_240 > PRM_253.6 > TK_2 > TK_4.1	b	ISR_MTG_6_6_FGM_Winter Bed Material Sampling TM - Video Data > *sample transect name* > Video_Extraction	1	Winter Bed Material Sampling TM (Tetra Tech 2014c)	n/a	
Winter Bed Material Sampling Video Log	Excel Spreadsheet	Video Log.xlsx	b	ISR_MTG_6_6_FGM_Winter Bed Material Sampling TM - Video Data	1	Winter Bed Material Sampling TM (Tetra Tech 2014c)	n/a	
Winter Bed Material Sampling Overall Metadata	Text File	ISR_MTG_6_6_FGM_Winter Bed Material Sampling TM - Data - OVERALL METADATA	b	ISR_MTG_6_6_FGM_Winter Bed Material Sampling TM - Data	1	Winter Bed Material Sampling TM (Tetra Tech 2014c)	n/a	
Winter Bed Material Sampling Sediment Gradation Summary	Excel Spreadsheet	ISR_MTG_6_6_FGM_Winter2014_BedMaterial_Gradations_Summary QC3 LWZ 20141009.xlsm	b	ISR_MTG_6_6_FGM_Winter Bed Material Sampling TM - Data	1	Winter Bed Material Sampling TM (Tetra Tech 2014c)	n/a	

Active Data				Folder Nesting	Study 6.6 Study Component	Data described in following report	Previously submitted Data (now superseded)	
Data	Data Type	File name (s)	Location				File name	Location
Winter Bed Material Sampling - Extracted Stills Photo Log	Excel Spreadsheet	ISR MTG 6.6 WintBedMatSamp Photo Log - Extracted Stills.xlsx	b	ISR_MTG_6_6_FGM_Winter Bed Material Sampling TM - Data	1	Winter Bed Material Sampling TM (Tetra Tech 2014c)	n/a	
Winter Bed Material Sampling - Ground Surface Photo Log	Excel Spreadsheet	ISR MTG 6.6 WintBedMatSamp Photo Log - Ground Surface.xlsx	b	ISR_MTG_6_6_FGM_Winter Bed Material Sampling TM - Data	1	Winter Bed Material Sampling TM (Tetra Tech 2014c)	n/a	
Winter Bed Material Sampling - Other Photos Photo Log	Excel Spreadsheet	ISR MTG 6.6 WintBedMatSamp Photo Log - Other Photos.xlsx	b	ISR_MTG_6_6_FGM_Winter Bed Material Sampling TM - Data	1	Winter Bed Material Sampling TM (Tetra Tech 2014c)	n/a	
Winter Bed Material Sampling - Rectified Stills Photo Log	Excel Spreadsheet	ISR MTG 6.6 WintBedMatSamp Photo Log - Rectified Stills.xlsx	b	ISR_MTG_6_6_FGM_Winter Bed Material Sampling TM - Data	1	Winter Bed Material Sampling TM (Tetra Tech 2014c)	n/a	
Winter Bed Material Sampling - Other Photos	JPEG	ISR_MTG_6.6_WintBedMatSamp_*date of photo*_P + *photo number*	b	ISR_MTG_6_6_FGM_Winter Bed Material Sampling TM - Data > Winter Bed Material Sampling - Other Photos	1	Winter Bed Material Sampling TM (Tetra Tech 2014c)	n/a	
Winter Bed Material Sample Locations	ArcGIS shapefile	ISR_MTG_6_6_FGM_Wint_Samp_Pts.shp	b	ISR_MTG_6_6_FGM_Winter Bed Material Sampling TM - Data > Winter Bed Material Sample Points - shapefile	1	Winter Bed Material Sampling TM (Tetra Tech 2014c)	n/a	

Active Data				Folder Nesting	Study 6.6 Study Component	Data described in following report	Previously submitted Data (now superseded)	
Data	Data Type	File name (s)	Location				File name	Location
Winter Bed Material Sample Data 1. Extracted Stillframes (JPEG) 2. Field photos from Transect (JPEG) 3. Rectified Stillframes (GeoTiff) 4. Field datasheet 5. Electronic version of field datasheet 6. Gradation data 7. ArcGIS MXD linked to rectifed still frame images and gridded sample point grid shapefile 8. Point grid shapefile for sampling	JPEG, GeoTiff, Excel Spreadsheet, PDF, ArcGIS MXD, and ArcGIS shapefile	Each sample location contains the following: 1. Extracted_Stillframes (folder) 2. Photos_of_Transect_from_Ground_Surface (folder) 3. Rectified Stillframes (folder) 4. ISR_MTG_6.6_WintBedMatSamp_[date of data collection]_[sample transect name] [QC level] [initials of QC personnel] [date of QC].pdf 5. ISR MTG 6.6 WintBedMatSamp [date performed] [sample transect name] [QC level] [initials of QC personnel] [date of QC].xlsx 6. ISR_MTG_6.6_WintBedMatSamp_[sample transect name]_gradation.xlsx 7. ISR_MTG_6_6_FGM_[sample transect name].mxd 8. ISR_MTG_6_6_FGM_[sample transect name]_pt_grid.shp Data nested under folders by sample transect name: > CH_7_2 > CH_9_7 > PRM_21.8 > PRM_29.9 > PRM_39.2 > PRM_57 > PRM_75 > PRM_95.6 > PRM_104.1 > PRM_112 > PRM_113.9 > PRM_116 > PRM_129 > PRM_139.5 > PRM_142.7 > PRM_145.4 > PRM_152.1 > PRM_174.4 > PRM_184.3 > PRM_185.4 > PRM_195.6 > PRM_214 > PRM_230.1 > PRM_240 > PRM_253.6 > TK_2 > TK_4.1	b	ISR_MTG_6_6_FGM_Winter Bed Material Sampling TM – Data > *sample transect name*	1	Winter Bed Material Sampling TM (Tetra Tech 2014c)	n/a	
LiDAR - 2011 Indexed	Unclassified las files, classified las files, DEM, tile index, and metadata	> PRM_29_to_188 (folder)	c	N/A	1	Initial Study Report	n/a	
LiDAR - 2013	Unclassified las files, classified las files, DEM, tile index, and metadata	> PA-01 South (folder) Data Extents: PRM 102 to PRM 107 > PA-07 (folder) Data Extents: PRM 65 to PRM 97 > PRM_97_to_102_confluence (folder) Data Extents: PRM 97 to Three Rivers Confluence at PRM 102	c	N/A	1	Initial Study Report	n/a	

Active Data				Folder Nesting	Study 6.6 Study Component	Data described in following report	Previously submitted Data (now superseded)	
Data	Data Type	File name (s)	Location				File name	Location
LiDAR - 2014	Unclassified las files, classified las files, DEM, tile index, and metadata	> Block 01 (folder): Data Extents: PRM 107 to PRM 146 > Block 02 (folder): Data Extents: PRM 146 to PRM 188 > Area_1 (folder): Data Extents: PRM 175 to PRM 195 > Area_2_3a (folder): Data Extents: PRM 185 to PRM 202	c	N/A	1	Study Implementation Report	n/a	
HEC-RAS Version 5 Beta version used for initial Bed Evolution Modeling	HEC-RAS installation of executable files	HEC-RAS_5.0_Beta_2014-06-06.exe[A]	d	Initial 1-D BEM > HEC-RAS	2	SIR Attachment 1	n/a	
Initial Middle Susitna River 1-D BEM of Existing conditions	HEC-RAS model	MRExisting.prj[B]	e	Initial 1-D BEM > MRExisting	2	SIR Attachment 1	n/a	
Initial Middle Susitna River 1-D BEM of Max LF OS-1b conditions	HEC-RAS Model	MRMAXLFOS1B.prj[B]	e	Initial 1-D BEM > MRMAXLFOS1B	2	SIR Attachment 1	n/a	
Initial Middle Susitna River 1-D BEM of Max LF OS-1b conditions with width change	HEC-RAS Model	MRMAXLFOS1BWC.prj[B]	e	Initial 1-D BEM > MRMAXLFOS1Bwidth	2	SIR Attachment 1	n/a	
Initial Lower Susitna River 1-D BEM of Existing conditions	HEC-RAS model	LRExisting.prj[B]	e	Initial 1-D BEM > LRExisting	2	SIR Attachment 1	n/a	
Initial Middle Susitna River 1-D BEM of Max LF OS-1b conditions	HEC-RAS Model	LRMAXLFOS1B.prj[B]	e	Initial 1-D BEM > LRMAXLFOS1B	2	SIR Attachment 1	n/a	
Initial Middle Susitna River 1-D BEM of Max LF OS-1b conditions with width change	HEC-RAS Model	LRMAXLFOS1BWC.prj[B]	e	Initial 1-D BEM > LRMAXLFOS1Bwidth	2	SIR Attachment 1	n/a	
SRH-2D version used for initial hydraulic and Bed Evolution Modeling	SRH-2D executable files	SRH2D.zip[C]	e	Initial 2-D BEM > SHR2D	2	SIR Attachment 1	n/a	
Initial FA-128 2-D hydraulic model	SRH-2D hydraulic model	Name_sif.dat[D]	e	Initial 2-D BEM > FA-128 > Hydraulic	2	Updated FGM Approach, Attachment A, Tetra Tech 2014a	n/a	
Initial FA-128 2-D BEM Model	SRH-2D sediment model	Name_sif.dat[E]	e	Initial 2-D BEM > FA-128 > Sediment > Existing / MaxLFOS1B > Average_Year_1985 / Dry_Year_1976 / Wet_Year_1981	2	SIR Attachment 1	n/a	

Notes:

* Further information about data can be found within referenced report and corresponds to study component listed herein. The study component number corresponds to sections identified in the first decimal position. (i.e. Section X.Y) where X identifies the initial section number and Y identifies the study component.

A	Includes HEC-RAS installation and computational engines.
B	Includes associated input files (geometry, sediment, flow, etc.).
C	Includes computational engines.
D	One name_sif.dat "sif" file that contains parameters, boundary conditions, and run control for each flow. Folder also contains associated geometry and initial conditions files.
E	One name_suf.dat "sif" file that contains parameters, boundary conditions, and run control for each year. Folder also contains associated geometry, bed material and rating curve files.
Location, a:	http://gis.suhydro.org/isr/06-Geomorphology/6.6-Geomorphology/
Location, b:	http://gis.suhydro.org/Post_ISR/06-Geomorphology/6.6-Geomorphology/
Location, c:	http://gis.suhydro.org/raster-data
Location, d:	http://gis.suhydro.org/SIR/06-Geomorphology/6.6-Fluvial_Geomorphology_Modeling/

Table 5.1-1. Bathymetric and LiDAR Survey Dates for 1-D Bed Evolution Model Cross Sections

Cross Section ID (PRM)	Bathymetric Survey		LiDAR Survey		Manual Editing of Merged Cross Section Geometry?
	Year	Month - Day	Year	Data Set	
187.2	2012	June 17	2014	SuWa 2014	
186.7	2014	June 17	2014	SuWa 2014	
186.2	2012	June 18	2014	SuWa 2014	
185.5	2012	June 18	2014	SuWa 2014	
185.2	2012	June 19	2014	SuWa 2014	
184.9	2012	June 19	2014	SuWa 2014	
184.7	2014	June 18	2014	SuWa 2014	
184.4	2012	June 19	2014	SuWa 2014	
183.8	2014	June 18	2014	SuWa 2014	
183.3	2012	June 20	2014	SuWa 2014	
182.9	2012	June 20	2014	SuWa 2014	
182.2	2014	June 18	2014	SuWa 2014	
181.6	2012	June 20	2014	SuWa 2014	
180.7	2014	June 18	2014	SuWa 2014	
180.1	2014	June 19	2014	SuWa 2014	
179.5	2012	June 21	2014	SuWa 2014	
179	2014	June 19	2014	SuWa 2014	
178.5	2012	June 16	2014	SuWa 2014	
177.8	2014	June 19	2014	SuWa 2014	
177.3	2014	June 19	2014	SuWa 2014	
176.5	2012	June 21	2014	SuWa 2014	
175.9	2014	June 19	2014	SuWa 2014	
174.9	2012	June 21	2014	SuWa 2014	
173.6	2014	June 20	2014	SuWa 2014	
173.3	2014	June 20	2014	SuWa 2014	
173.1	2012	June 21	2014	SuWa 2014	
172.2	2014	June 20	2014	SuWa 2014	
171.7	2014	June 20	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
170.8	2014	June 20	2014	SuWa 2014	
170.1	2012	June 22	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
169.7	2014	June 21	2014	SuWa 2014	
168.8	2014	June 21	2014	SuWa 2014	
168.1	2012	June 22	2014	SuWa 2014	
167.4	2014	June 21	2014	SuWa 2014	
166.6	n/a	field relocated to 166.3	2014	SuWa 2014	
166.3	2014	June 21	2014	SuWa 2014	
165.9	n/a	n/a	2014	SuWa 2014	Devils Canyon
165.5	n/a	n/a	2014	SuWa 2014	Devils Canyon
165.2	n/a	n/a	2014	SuWa 2014	Devils Canyon
164.9	n/a	n/a	2014	SuWa 2014	Devils Canyon
164.7	n/a	n/a	2014	SuWa 2014	Devils Canyon
164.4	n/a	n/a	2014	SuWa 2014	Devils Canyon
164.3	n/a	n/a	2014	SuWa 2014	Devils Canyon
164.1	n/a	n/a	2014	SuWa 2014	Devils Canyon
163.9	n/a	n/a	2014	SuWa 2014	Devils Canyon
163.6	n/a	n/a	2014	SuWa 2014	Devils Canyon
163.4	n/a	n/a	2014	SuWa 2014	Devils Canyon
162.8	n/a	n/a	2014	SuWa 2014	Devils Canyon

Cross Section ID (PRM)	Bathymetric Survey		LiDAR Survey		Manual Editing of Merged Cross Section Geometry?
	Year	Month - Day	Year	Data Set	
162.2	n/a	n/a	2014	SuWa 2014	Devils Canyon
161.8	n/a	n/a	2014	SuWa 2014	Devils Canyon
161.6	n/a	n/a	2014	SuWa 2014	Devils Canyon
161.2	n/a	n/a	2014	SuWa 2014	Devils Canyon
161	n/a	n/a	2014	SuWa 2014	Devils Canyon
160.4	n/a	n/a	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	Devils Canyon
160.1	n/a	n/a	2014	SuWa 2014	Devils Canyon
159.3	n/a	n/a	2014	SuWa 2014	Devils Canyon
158.9	n/a	n/a	2014	SuWa 2014	Devils Canyon
158.4	n/a	n/a	2014	SuWa 2014	Devils Canyon
158.2	n/a	n/a	2014	SuWa 2014	Devils Canyon
158	n/a	n/a	2014	SuWa 2014	Devils Canyon
157.5	n/a	n/a	2014	SuWa 2014	Devils Canyon
157.3	n/a	n/a	2014	SuWa 2014	Devils Canyon
155.8	n/a	n/a	2014	SuWa 2014	Devils Canyon
155.1	n/a	n/a	2014	SuWa 2014	Devils Canyon
154.6	n/a	n/a	2014	SuWa 2014	Devils Canyon
153.7	2012	June 25	2014	SuWa 2014	
153.3	2014	June 27 & July 6	2014	SuWa 2014	
152.9	2012	June 26	2014	SuWa 2014	
152.1 [a]	2012	Sept 29	2014	SuWa 2014	
151.8	2014	June 27	2014	SuWa 2014	
151.5	2014	June 27	2014	SuWa 2014	
151.1	2012	June 25	2014	SuWa 2014	
150.6	2014	June 28	2014	SuWa 2014	
150.1	2014	June 28	2014	SuWa 2014	
149.3	2014	June 28	2014	SuWa 2014	
148.8	2014	June 28	2014	SuWa 2014	
148.3	2012	June 26	2014	SuWa 2014	
147.9	2014	June 28	2014	SuWa 2014	
147.5	2014	June 28	2014	SuWa 2014	
147	2014	June 29	2014	SuWa 2014	
146.6	2012	June 27	2014	SuWa 2014	
146.2	2013	Aug 4	2014	SuWa 2014	
145.7 [a]	2012	Sept 29	2014	SuWa 2014	
145.5	2012	June 27	2014	SuWa 2014	
144.9	2012	June 27	2014	SuWa 2014	
144.3	2012	June 27	2014	SuWa 2014	
143.9	2013	Aug 4	2014	SuWa 2014	
143.5	2012	June 28	2014	SuWa 2014	
143	2012	June 28	2014	SuWa 2014	
142.2 [a]	2012	Sept 29	2014	SuWa 2014	
141.9	2012	June 28	2014	SuWa 2014	
141.7	2012	June 28	2014	SuWa 2014	
141.5	2014	June 29	2014	SuWa 2014	
141.2	2013	Aug 4	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
140.8	2013	Aug 4	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
140.5	2013	Aug 5	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
140.2	2014	June 30	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
140 [a]	2012	Sep 30	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	

Cross Section ID (PRM)	Bathymetric Survey		LiDAR Survey		Manual Editing of Merged Cross Section Geometry?
	Year	Month - Day	Year	Data Set	
139.8	2012	June 29	2014	SuWa 2014	
139	2012	June 30	2014	SuWa 2014	
138.7	2012	June 30	2014	SuWa 2014	
138.4	2013	Aug 5	2014	SuWa 2014	
138.1	2012	June 30	2014	SuWa 2014	
137.7	2014	June 25	2014	SuWa 2014	
137.6 [a]	2012	Sep 30	2014	SuWa 2014	
137.2	2013	Aug 5	2014	SuWa 2014	
136.8	2014	June 25	2014	SuWa 2014	
136.7	2012	July 1	2014	SuWa 2014	
136.2	2012	July 1	2014	SuWa 2014	
135.7	2013	Aug 6	2014	SuWa 2014	
135.4	2014	June 30	2014	SuWa 2014	
135.2	2014	June 30	2014	SuWa 2014	
135	2012	July 1	2014	SuWa 2014	
134.7	2013	Aug 6	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
134.3 [a]	2012	Oct 1	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
134.1	2012	July 2	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
133.8	2012	July 2	2014	SuWa 2014	
133.3	2012	July 2	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
132.6	2012	July 2	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
132.1	2013	Aug 7	2014	SuWa 2014	
131.4	2012	July 3	2014	SuWa 2014	Yes - Skew
130.9	2013	Aug 8	2014	SuWa 2014	
130.5	2013	Aug 9	2014	SuWa 2014	
130.2	2014	July 1	2014	SuWa 2014	
129.7 [a]	2012	Oct 1	2014	SuWa 2014	
128.1	2012	July 4	2014	SuWa 2014	
127.8	2013	Aug 9	2014	SuWa 2014	
127.4	2014	Jul 1	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
126.8 [a]	2012	Oct 1	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
126.5	2013	Aug 10	2014	SuWa 2014	
126.1	2012	July 5	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
125.9	2014	July 2	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
125.8	2013	Aug 11	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
125.4	2012	July 5	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
125	2013	Aug 11	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	Yes - Skew
124.6	2014	June 30	2014	SuWa 2014	
124.5	2013	Aug 11	2014	SuWa 2014	
124.1 [a]	2012	Oct 1	2014	SuWa 2014	
124	2014	June 30	2014	SuWa 2014	
123.7	2012	July 6	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
123.2	2013	Aug 12	2014	SuWa 2014	
122.7	2012	July 6	2014	SuWa 2014	Yes - Skew
122.6	2012	July 6	2014	SuWa 2014	
122.1	2013	Aug 12	2014	SuWa 2014	
121.4	2013	Aug 12	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
120.7	2012	July 6	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	Yes - Erosion
120.3	2013	Aug 12	2014	SuWa 2014	
119.9 [a]	2012	Oct 3	2014	SuWa 2014	

Cross Section ID (PRM)	Bathymetric Survey		LiDAR Survey		Manual Editing of Merged Cross Section Geometry?
	Year	Month - Day	Year	Data Set	
119.5	2014	July 1	2014	SuWa 2014	
119	2013	Aug 14	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
118.4	2012	July 7	2014	SuWa 2014	Yes - Skew
118.2	2014	July 1	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
117.9	2013	Aug 14	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
117.4	2012	July 7	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
117.1	2013	Aug 14	2014	SuWa 2014	
116.8	2014	July 2	2014	SuWa 2014	
116.6	2012	July 7	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
116.3	2012	July 8	2014	SuWa 2014	
115.7	2012	July 8	2014	SuWa 2014	
115.4	2012	July 8	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
114.4	2012	July 8	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
113.6 [a]	2012	Oct 3	2014	SuWa 2014	
113.1	2013	Aug 15	2014	SuWa 2014	Yes - Skew
112.5	2013	Aug 15	2014	SuWa 2014	
111.9	2012	July 9	2014	SuWa 2014	
111.2	2014	July2	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
110.5 [a]	2012	Oct 3	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
109.7	2014	July 3	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
109	2013	Aug 15	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
108.3	2012	Aug 18	2011 / 2014	MatSu Indexed 2011 / SuWa 2014	
107.8	2013	Aug 15	2014	SuWa 2014	
107.4	2014	July 3	2014	SuWa 2014	
107.1	2012	July 9	2014	SuWa 2014	
106.9	2014	July 3	2014	SuWa 2014	
106.6	2013	Aug 15	2013 / 2014	SuWa 2013 / SuWa 2014	
106.1	2012	Aug 18	2013 / 2014	SuWa 2013 / SuWa 2014	
105.3	2012	Aug 18	2013	SuWa 2013	
104.7	2012	Aug 18	2013	SuWa 2013	Yes - Erosion
104.1	2012	Aug 19	2013	SuWa 2013	Yes - Erosion
103.5	2012	Oct 1	2013	SuWa 2013	Yes - Erosion
102.7	2012	July 10	2013	SuWa 2013	
102.1	2013	Aug 16	2013	SuWa 2013	
101.4 [a]	2012	July 10 & Oct 15	2013	SuWa 2013	
100.7	2013	June 10-11 & July 17	2013	SuWa 2013	
99.9	2013	June 11	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	Yes - Skew
99.1	n/a	n/a	2013	SuWa 2013	
98.4 [a]	2012	July 11 & Oct 5	2013	SuWa 2013	Yes - Erosion
97.9	n/a	n/a	2013	SuWa 2013	
97	2012	July 11	2013	SuWa 2013	
96.2	2013	June 12	2013	SuWa 2013	Yes - Erosion
95.3	2014	July 4-5	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	
94.8	2013	June 12	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	
94	2013	June 13	2013	SuWa 2013	Yes - Erosion
93.2	2013	June 13	2013	SuWa 2013	Yes - Erosion
92.3	2013	June 13	2013	SuWa 2013	
91.6	2012	Aug 21	2013	SuWa 2013	
91	2012	July 12	2013	SuWa 2013	
90.2	2013	June 14	2013	SuWa 2013	

Cross Section ID (PRM)	Bathymetric Survey		LiDAR Survey		Manual Editing of Merged Cross Section Geometry?
	Year	Month - Day	Year	Data Set	
89.5	2013	June 14	2013	SuWa 2013	
88.9	n/a	n/a	2013	SuWa 2013	
88.4	2012	Aug 22	2013	SuWa 2013	Yes - Erosion
88	2013	June 15	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	
87.6	2013	June 15	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	
87.1	2012	July 12	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	Yes - Erosion
86.3	2012	July 13	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	Yes - Erosion
85.4	2012	Aug 22	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	Yes - Erosion
84.4	2012	Aug 23	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	Yes - Erosion
83.5	n/a	n/a	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	
83	2012	July 13	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	Yes - Erosion
82.3	2012	Aug 23	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	Yes - Erosion
81.4	2013	June 16	2013	SuWa 2013	
80.7	2013	June 16	2013	SuWa 2013	Yes - Skew
80	2012	Aug 24	2013	SuWa 2013	Yes - Erosion
79	2013	June 17	2013	SuWa 2013	Yes - Erosion
78	2013	June 17	2013	SuWa 2013	
77	2013	June 18	2013	SuWa 2013	
75.9	2013	June 18	2013	SuWa 2013	
75	2013	June 19	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	Yes - Erosion
74.1	2013	June 19	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	
73.1	2013	June 20	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	
71	2013	June 20	2013	SuWa 2013	
70.1	n/a	n/a	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	
69.2	2013	June 23	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	
68.2	2013	June 23	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	
67.2	2013	June 23	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	
66.1	2013	June 24	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	
64.6	2013	June 26	2011 / 2013	MatSu Indexed 2011 / SuWa 2013	
63.6	n/a	n/a	2011	MatSu Indexed 2011	
62.7	2013	June 27	2011	MatSu Indexed 2011	
61.7	n/a	n/a	2011	MatSu Indexed 2011	
60.3	2013	June 26	2011	MatSu Indexed 2011	
59.1	2013	June 28	2011	MatSu Indexed 2011	
57.8	2013	June 28	2011	MatSu Indexed 2011	
56.8	n/a	n/a	2011	MatSu Indexed 2011	
55.4	2013	June 29	2011	MatSu Indexed 2011	
54.2	2013	June 30	2011	MatSu Indexed 2011	
52.1	2013	July 2	2011	MatSu Indexed 2011	
51.1	n/a	n/a	2011	MatSu Indexed 2011	
49	2013	July 4	2011	MatSu Indexed 2011	
47.9	2013	July 4	2011	MatSu Indexed 2011	
47.1	2013	July 5	2011	MatSu Indexed 2011	
46.3	2013	July 5	2011	MatSu Indexed 2011	Yes - Erosion
45.6	2013	July 7	2011	MatSu Indexed 2011	
44.5	2013	July 7	2011	MatSu Indexed 2011	
42.8	n/a	n/a	2011	MatSu Indexed 2011	
41.3	2013	July 8	2011	MatSu Indexed 2011	
40.4	2013	July 8-10	2011	MatSu Indexed 2011	
39.5	2013	July 10-11	2011	MatSu Indexed 2011	

Cross Section ID (PRM)	Bathymetric Survey		LiDAR Survey		Manual Editing of Merged Cross Section Geometry?
	Year	Month - Day	Year	Data Set	
38.3	2013	July 11-12	2011	MatSu Indexed 2011	
36.4	2013	July 11	2011	MatSu Indexed 2011	
34.8	2013	July 13	2011	MatSu Indexed 2011	
33.7	2013	July 14	2011	MatSu Indexed 2011	
33	n/a	n/a	2011	MatSu Indexed 2011	
32.4	2013	July 14	2011	MatSu Indexed 2011	
31.6	2013	July 15	2011	MatSu Indexed 2011	
30.8	2013	July 14	2011	MatSu Indexed 2011	
29.9	2013	July 15	2011	MatSu Indexed 2011	

Notes
a Two separate bathymetric surveys conducted at this location in 2012
n/a = bathymetric survey not conducted

Table 5.1-2 Summary of the number of sediment samples collected along the Susitna River, Focus Areas, and Tributaries in 2014

Location	Susitna River			
	Surface Samples	Surface / Subsurface Samples	Bulk Samples	Bank Samples
Lower River	3	0	0	52
Middle River	2	13	0	3
Upper River	7	3	1	0
FA-151 (Portage Creek)	1	0	0	0
FA-173 (Stephan Lake Complex)	8	3	0	5
FA-184 (Watana Dam)	2	2	0	3
Location	**Tributaries**			
	Surface Samples	**Surface / Subsurface Samples**	**Bulk Samples**	**Bank Samples**
Caswell Creek	4	0	4	0
Sheep Creek	3	1	0	0
Birch Creek	1	0	0	0
Deadhorse Creek	2	1	0	0
5th of July Creek	3	1	0	0
Sherman Creek	1	1	0	0
4th of July Creek	2	1	0	0
Portage Creek	3	2	0	0
Chinook Creek	3	1	0	0
UNT-173	2	2	0	0
Little Tsusena Creek	2	1	0	0
Tsusena Creek	1	1	0	0
Fog Creek	2	1	0	0
Oshetna Creek	1	0	0	0

Table 5.1-3 Summary of gradation for bank samples collected in the Lower River

PRM	Sample Name	Date Sampled	Bank Gradation (mm)			
			D_{16}	D_{50}	D_{84}	D_{90}
22.4	S5A	8/28/2014	0.08	0.15	0.23	0.24
22.4	S5B	8/28/2014	0.04	0.09	0.22	0.28
22.4	S5C	8/28/2014	0.26	0.35	0.47	0.50
23	S6A	8/28/2014	0.04	0.08	0.11	0.12
23	S6B	8/28/2014	0.03	0.07	0.11	0.12
23	S6C	8/28/2014	0.07	0.13	0.21	0.23
27.3	S8A	8/28/2014	0.02	0.05	0.10	0.11
27.3	S8B	8/28/2014	0.03	0.07	0.11	0.12
27.3	S8C	8/28/2014	0.28	0.39	0.66	0.81
29	S9A	8/28/2014	0.05	0.08	0.16	0.19
29	S9B	8/28/2014	0.04	0.08	0.13	0.16
29	S9C	8/28/2014	0.03	0.08	0.12	0.13
35.8	S10A	8/28/2014	0.06	0.11	0.19	0.21
35.8	S10B	8/28/2014	0.06	0.10	0.18	0.21
35.8	S10C	8/28/2014	0.03	0.07	0.12	0.13
37.3	S11A	8/28/2014	0.03	0.06	0.11	0.12
37.3	S11B	8/28/2014	0.13	0.20	0.35	0.40
37.3	S11C	8/28/2014	0.27	0.35	0.47	0.49
47.5	S3A	8/28/2014	0.05	0.10	0.20	0.23
47.5	S3B	8/28/2014	0.03	0.06	0.12	0.17
47.5	S3C	8/28/2014	0.25	0.34	0.46	0.48
51.2	S5A	8/27/2014	0.07	0.13	0.20	0.22
51.2	S5B	8/27/2014	0.02	0.04	0.10	0.11
51.2	S5C	8/27/2014	0.05	0.10	0.20	0.22
52	S1A	8/28/2014	0.08	0.15	0.23	0.25
52	S1B	8/28/2014	0.02	0.05	0.09	0.11
52	S1C	8/28/2014	0.05	0.08	0.12	0.14
55.6	S4A	8/27/2014	0.13	0.20	0.36	0.41
55.6	S4B	8/27/2014	0.07	0.12	0.20	0.22
55.6	S4C	8/27/2014	0.02	0.05	0.14	0.19
61.1	S3A	8/27/2014	0.08	0.15	0.22	0.23
61.1	S3B	8/27/2014	0.08	0.16	0.23	0.25
61.1	S3C	8/27/2014	0.03	0.08	0.15	0.21
68	S2A	8/27/2014	0.04	0.08	0.12	0.16
68	S2B	8/27/2014	0.06	0.11	0.20	0.22
68	S2C	8/27/2014	0.03	0.07	0.11	0.12
75	S1A	8/27/2014	0.01	0.04	0.10	0.11
75	S1B	8/27/2014	0.13	0.27	0.42	0.46
75	S1C	8/27/2014	0.07	0.12	0.20	0.22
80.8	S5A	8/26/2014	0.08	0.16	0.23	0.24
80.8	S5B	8/26/2014	0.01	0.03	0.10	0.12
80.8	S5C	8/26/2014	0.13	0.19	0.33	0.38
83	S4A	8/26/2014	0.03	0.08	0.13	0.16
83	S4B	8/26/2014	0.03	0.08	0.11	0.12
84.7	S3A	8/26/2014	0.08	0.16	0.22	0.24

PRM	Sample Name	Date Sampled	Bank Gradation (mm)			
			D_{16}	D_{50}	D_{84}	D_{90}
84.7	S3B	8/26/2014	0.16	0.30	0.43	0.46
84.7	S3C	8/26/2014	0.02	0.04	0.09	0.11
91.7	S2A	8/26/2014	0.08	0.15	0.23	0.25
91.7	S2B	8/26/2014	0.07	0.14	0.22	0.23
91.7	S2C	8/26/2014	0.02	0.04	0.09	0.11
97.9	S1A	8/26/2014	0.05	0.09	0.16	0.19
97.9	S1B	8/26/2014	0.01	0.03	0.08	0.09

Table 5.1-4 Summary of gradation for bank samples collected in the Middle River

PRM	Sample Name	Date Sampled	Bank Gradation (mm)			
			D_{16}	D_{50}	D_{84}	D_{90}
147.5	S1A & S1B[a]	7/25/2014	0.10	0.11	0.26	0.34
148.8	S2A & S2B[a]	7/25/2014	0.10	0.10	0.20	0.20
185.9	S4A & S4B[a]	7/20/2014	0.00	0.09	0.19	0.23

Notes:

a samples combined in lab by error

Table 5.1-5 Summary of gradation for surface and subsurface samples collected in the Lower River

PRM	Sample Name	Date Sampled	Surface Gradation (mm)				Subsurface Gradation (mm)			
			D_{16}	D_{50}	D_{84}	D_{90}	D_{16}	D_{50}	D_{84}	D_{90}
PRM 27.0	S7	08/28/2014	20.3	32.3	43.5	48.0	NA	NA	NA	NA
PRM 27.8	S4	08/28/2014	19.3	34.4	53.7	58.6	NA	NA	NA	NA
PRM 50.5	S2	08/28/2014	19.0	37.9	63.2	73.0	NA	NA	NA	NA

Notes:

NA = No sample collected

Table 5.1-6 Summary of gradation for surface and subsurface samples collected in the Middle River

PRM	Sample Name	Date Sampled	Surface Gradation (mm)				Subsurface Gradation (mm)			
			D_{16}	D_{50}	D_{84}	D_{90}	D_{16}	D_{50}	D_{84}	D_{90}
PRM 147.2	S2	06/24/2014	33.6	72.5	118.4	130.9	1.9	41.5	106.2	119.7
PRM 147.8	S1	06/24/2014	47.2	94.9	165.7	179.6	2.2	51.5	126.4	157.2
PRM 148.8	S4	06/20/2014	45.1	112.2	182.6	211.0	2.8	39.7	145.8	164.0
PRM 149.3	S3	06/20/2014	40.8	88.6	180.0	222.4	NA	NA	NA	NA
PRM 150.7	S2	06/20/2014	51.6	104.3	173.3	204.8	2.3	48.2	115.7	144.9
PRM 152.9	S1	06/20/2014	59.5	138.9	223.7	256.0	3.5	81.6	213.4	228.5
PRM 167.0	S3	07/09/2014	32.5	59.6	110.2	124.3	1.3	35.9	83.4	98.8
PRM 169.2	S1	07/16/2014	24.6	94.5	211.4	254.5	2.0	45.3	167.0	283.9
PRM 173.3	S2	07/09/2014	33.5	75.5	151.1	180.0	0.3	34.6	97.4	117.4
PRM 178.5	S1	07/11/2014	23.7	50.7	91.5	108.2	2.1	23.6	80.7	98.3
PRM 179.9	S2	07/10/2014	11.7	31.8	74.7	90.0	0.6	23.3	77.8	95.0
PRM 181.4	S2	07/11/2014	34.1	65.6	117.5	133.4	2.5	35.5	81.3	93.2
PRM 182.2	S1	07/12/2014	13.1	26.9	57.1	69.7	0.7	17.2	62.3	79.2
PRM 183.1	S5	07/21/2014	33.0	59.0	111.3	127.5	2.5	45.5	94.6	116.2
PRM 185.9	S5	07/20/2014	33.9	84.9	184.6	214.7	NA	NA	NA	NA

Notes:

NA = No sample collected

Table 5.1-7 Summary of gradation for surface and subsurface samples collected in the Upper River

PRM	Sample Name	Date Sampled	Surface Gradation (mm)				Subsurface Gradation (mm)			
			D_{16}	D_{50}	D_{84}	D_{90}	D_{16}	D_{50}	D_{84}	D_{90}
PRM 190.1	S4	08/16/2014	34.4	56.7	90.0	111.2	NA	NA	NA	NA
PRM 190.1	S5	08/16/2014	29.3	54.9	86.2	97.6	NA	NA	NA	NA
PRM 195.0	S3	08/16/2014	19.0	35.3	56.2	62.8	NA	NA	NA	NA
PRM 196.5	S2	08/16/2014	17.1	26.1	41.5	47.7	NA	NA	NA	NA
PRM 208.0	S1	08/15/2014	22.0	47.5	88.4	105.3	NA	NA	NA	NA
PRM 224.6	S1	08/14/2014	30.6	68.3	130.6	147.3	0.8	27.3	87.3	104.3
PRM 234.8	S1	08/13/2014	14.4	45.8	90.0	105.9	1.2	17.9	57.4	70.4
PRM 250.9	S2 & S3	08/11/2014	14.4	30.0	53.7	61.8	NA	NA	NA	NA
PRM 254.3	S1	08/11/2014	19.7	32.3	46.9	53.1	NA	NA	NA	NA
PRM 258.6	S2	08/10/2014	22.7	40.5	64.8	74.6	0.7	10.1	36.0	42.4
PRM 276.2	S1 (Grab)[1]	08/09/2014	0.6	4.2	13.4	16.0	NA	NA	NA	NA

Notes:

1. Sample represents both the surface and subsurface layer.
2. NA = No sample collected

Table 5.1-8 Summary of gradation for surface and subsurface samples collected in the tributaries studied in 2014

PRM	Sample Name	Date Sampled	Surface Gradation (mm)				Subsurface Gradation (mm)			
			D_{16}	D_{50}	D_{84}	D_{90}	D_{16}	D_{50}	D_{84}	D_{90}
Caswell Creek	CA-2 S-4 (Sur and Bulk)	08/15/2014	22.5	43.7	74.3	84.4	0.0	0.1	0.4	0.5
Caswell Creek	CA-10.5 S-2 (Sur and Bulk)	08/15/2014	17.3	40.2	59.9	64.0	4.0	23.7	39.0	41.1
Caswell Creek	CA-10 S-3 (Sur and Bulk)	08/15/2014	18.8	36.4	57.7	62.4	1.5	16.0	35.5	38.8
Caswell Creek	CA-13 S-1 (Sur and Bulk)	08/15/2014	14.7	34.1	59.2	64.0	1.3	16.5	37.0	39.8
Birch Creek	S1	08/09/2014	16.7	32.9	74.1	85.7	NA	NA	NA	NA
Sheep Creek	S2	08/12/2014	19.6	43.5	87.7	104.2	NA	NA	NA	NA
Sheep Creek	S1 (SH-1)	08/12/2014	18.8	35.2	61.8	77.5	1.7	26.1	59.3	77.5
Sheep Creek	S4	08/12/2014	10.4	17.9	31.3	38.7	NA	NA	NA	NA
Sheep Creek	S3	08/12/2014	20.1	41.6	75.3	83.0	NA	NA	NA	NA
Sherman	S2	06/21/2014	45.2	123.3	283.4	382.5	NA	NA	NA	NA
4th of July	S1	06/22/2014	20.3	68.5	153.3	172.9	NA	NA	NA	NA
4th of July	S3	06/22/2014	2.7	19.4	56.2	70.8	2.7	19.4	56.2	70.8
4th of July	S2	06/22/2014	26.1	83.3	177.8	229.3	NA	NA	NA	NA
Portage	S1	06/19/2014	21.3	50.1	101.4	115.2	2.1	23.3	73.1	92.5
Portage	Trib Fan	06/19/2014	53.7	136.2	412.1	462.7	NA	NA	NA	NA
Portage	S3	07/19/2014	58.6	132.0	245.0	293.4	NA	NA	NA	NA
Portage	S2	07/19/2014	387.5	463.3	554.0	571.8	NA	NA	NA	NA
Portage	S1	07/19/2014	21.0	56.2	88.9	107.3	1.7	25.1	78.2	93.6
Chinook Cr	S1	07/07/2014	23.7	113.8	244.0	330.6	NA	NA	NA	NA
Chinook Cr	S2	07/07/2014	73.8	180.0	414.5	512.0	NA	NA	NA	NA
Chinook Cr	S3	07/07/2014	26.8	62.9	157.9	188.1	NA	NA	NA	NA
Chinook Cr	S1	07/22/2014	41.4	94.5	174.1	202.2	1.8	32.3	97.7	122.2
UNT 173.8	S2 S3	06/25/2014	16.5	56.3	143.4	164.4	NA	NA	NA	NA
UNT 173.8	S1	07/09/2014	16.9	36.4	71.1	83.2	4.1	33.1	69.6	82.8
UNT 173.8	S1	06/25/2014	39.6	97.3	184.9	217.6	NA	NA	NA	NA
UNT 173.8	S4	07/18/2014	16.6	39.8	83.1	96.0	1.5	12.8	43.2	54.6
Little Tsusena	S2	07/21/2014	17.1	62.4	132.0	159.0	4.2	49.5	117.9	194.5
Little Tsusena	S3	07/21/2014	40.6	77.2	164.4	194.7	NA	NA	NA	NA
Little Tsusena	S4	07/21/2014	399.3	505.0	693.2	763.5	NA	NA	NA	NA
Tsusena Creek	S7	07/21/2014	NA	NA	NA	NA	1.1	12.1	39.0	45.8
Tsusena Creek	S6	07/20/2014	36.5	118.0	265.8	352.6	NA	NA	NA	NA
Fog Creek	S2, S3	07/22/2014	28.9	73.1	188.5	226.5	NA	NA	NA	NA
Fog Creek	S4	07/22/2014	17.9	31.1	58.6	70.5	NA	NA	NA	NA
Fog Creek	S3	07/11/2014	43.6	80.5	154.3	174.1	32.4	75.9	242.5	287.2
Oshetna	S1, S2, S3	08/12/2014	16.9	31.2	111.6	155.9	NA	NA	NA	NA

Notes:

NA = No sample collected

Table 5.1-9 Summary of water surface elevations surveyed along the Susitna River

PRM	Pin	Pin Northing (ft)	Pin Easting (ft)	WSE (NAVD88)	WSE Survey Date and Time	Discharge at Gold Creek (cfs)
147.9	RB_Pin	3223955.297	1722684.481	792.18	7/25/2014 @ 11:00	24,100
148.8	LB_Pin	3224665.432	1727247.657	802.31	7/25/2014 @ 11:45	24,400
149.3	LB_Pin	3225552.973	1729640.169	806.27	7/19/2014 @ 16:30	23,200
150.1	RB_Pin	3227447.47	1733351.005	817.11	7/25/2014 @ 12:30	24,700
150.6	LB_Pin	3227073.968	1735820.919	823.23	7/25/2014 @ 13:00	24,700
151.1	RB_Pin	3228551.031	1738634.158	830.36	7/25/2014 @ 14:00	25,000
151.5	RB_Pin	3227391.923	1740070.876	833.30	7/25/2014 @ 14:15	25,100
151.8	LB_Pin	3226659.377	1741530.949	837.65	7/19/2014 @ 15:50	23,000
152.1	RB_Pin	3227301.202	1743124.673	842.09	6/24/2014 @ 15:10	21,800
152.9	RB_Pin	3225596.583	1747115.94	851.32	6/24/2014 @ 16:40	21,600
152.9	RB_Pin	3225596.583	1747115.94	851.65	7/25/2014 @ 15:00	25,200
174.9	RB_Pin	3204853.977	1837600.1	1328.43	7/22/2014 @ 15:15	24,900

Table 5.1-10 Summary of gradations for bank samples collected in Focus Areas

PRM	Sample Name	Date Sampled	Bank Gradation (mm)			
			D_{16}	D_{50}	D_{84}	D_{90}
FA-173 Stephan Lake Complex						
173.6	S1A	7/18/2014	0.1	1.2	22.5	33.9
173.6	S1B	7/18/2014	0.2	2.3	13.8	20.1
174.1	S2	7/18/2014	0.2	0.3	0.4	0.5
174.8	S8A & S8B	7/22/2014	0.1	0.1	0.3	0.3
175.2	S7	7/22/2014	0.1	0.1	0.2	0.2
FA-184 Watana Dam						
184.7	S1A	7/21/2014	0.1	0.1	0.2	0.2
184.7	S1B	7/21/2014	0.1	0.1	0.2	0.2
185.4	S2A & S2B	7/20/2014	0.1	0.1	0.3	0.4

Table 5.1-11 Summary of gradations for surface and subsurface samples collected in Focus Areas

PRM	Sample Name	Date Sampled	Surface Gradation (mm)				Subsurface Gradation (mm)			
			D_{16}	D_{50}	D_{84}	D_{90}	D_{16}	D_{50}	D_{84}	D_{90}
FA-151 Portage Creek										
PRM 151.8	S4	07/19/2014	54.4	111.2	201.3	221.6	NA	NA	NA	NA
FA-173 Stephan Lake Complex										
PRM 173.8	S3	07/18/2014	276.3	337.5	445.5	471.0	NA	NA	NA	NA
PRM 174.1	S2	07/17/2014	29.3	65.0	114.8	129.8	1.4	38.9	133.2	149.1
PRM 174.3	S4	06/25/2014	69.2	135.0	217.6	256.0	NA	NA	NA	NA
PRM 174.3	S3, S4, S5	07/17/2014	15.4	43.8	114.8	137.8	NA	NA	NA	NA
PRM 174.4	S2	07/16/2014	26.7	65.7	116.5	132.4	0.8	27.0	82.0	110.9
PRM 174.5	S6	07/17/2014	27.8	96.6	180.0	218.1	NA	NA	NA	NA
PRM 174.5	S1	07/17/2014	59.3	117.8	188.7	217.2	NA	NA	NA	NA
PRM 174.6	S7	07/17/2018	38.5	95.8	228.9	251.3	NA	NA	NA	NA
PRM 175.0	S9	07/17/2014	29.8	93.4	171.0	195.2	NA	NA	NA	NA
PRM 175.0	S8	07/18/2014	26.6	57.1	106.7	123.4	0.5	21.8	90.2	117.8
PRM 175.1	S6	07/22/2014	32.7	94.6	190.0	223.6	NA	NA	NA	NA
FA-184 Watana Dam										
PRM 185.2	S3	07/20/2014	27.6	54.3	105.9	124.6	NA	NA	NA	NA
PRM 185.3	S8	07/20/2014	27.9	47.5	82.6	99.5	NA	NA	NA	NA
PRM 185.4	S1	07/20/2014	34.9	68.3	136.8	162.2	1.6	26.5	87.4	105.4
PRM 185.4	S2	07/12/2014	17.5	36.3	60.3	72.0	1.3	23.9	60.3	72.0

Table 5.1-12 Summary of tributaries surveyed in 2014

Tributary Name	PRM
Tsusena Creek	184.6
Little Tsusena Creek	184.0
Fog Creek	179.3
Un. Tributary	173.8
Chinook Creek	160.5
Portage Creek	152.3
Fourth of July Creek	134.3
Sherman Creek	134.1
Fifth of July Creek	127.3
Deadhorse Creek	124.4
Sheep Creek	71.7
Caswell Creek	67.2

Table 5.1-13 Sediment sampling conducted at the tributary delta study sites

Tributary	PRM	Surface Sample				Subsurface Sample			
		Size (mm)			Sand Cover[1] (%)	Size (mm)			Less Than 2 mm[2] (%)
		D_{16}	D_{50}	D_{84}		D_{16}	D_{50}	D_{84}	
Caswell	CA-2	22.5	43.7	74.3	0	0.0	0.1	0.4	81.1
Deadhorse	124.4	19.0	42.4	112.2	0	4.1	27.4	72	7.4
5th of July	127.4	1.9 [3]	26.1 [3]	69.4 [3]	16.2 [2,3]	NA	NA	NA	NA
Sherman	134.1	106.4	162.3	360	0	2.4	21.0	55.5	13.9
4th of July	134.4	9.1	30.7	72.7	0	2.7	19.4	56.2	11.0
Portage	152.2	21.3	50.1	101.4	2.7	2.1	23.3	73.1	15.1
Chinook	160.4	23.7	113.8	244.0	5	NA	NA	NA	NA
UNT 173.8	173.8	16.6	39.8	83.1	1.0	1.5	12.8	43.2	16.9
Fog	179.3	28.9	73.1	188.5	3.5	NA	NA	NA	NA
Little Tsusena	184.0	17.1	62.4	132.0	0.0	4.2	49.5	117.9	9.8
Oshetna	235.1	16.9	31.2	111.6	0.0	NA	NA	NA	NA

Notes:

1. Value is the percent of the surface that was covered with a layer of sand and finer material
2. Value represents the percent of the subsurface sample that was less than 2 mm which is the upper limit of sand.
3. Sample represents both surface and subsurface layer.
4. NA = No sample taken

Table 5.1-14: 2014 collected discharge measurements in Focus Areas.

Date	Flow (cfs)	Location	Reference PRM	Northing (feet)	Easting (feet)
FA-104 Whiskers Slough					
9/27/2014	10[a]	Near head of right bank side channel	105.8	3,063,308	1,615,080
9/27/2014	1[a]	Upstream connection into Slough 3B	105.4	3,062,647	1,613,263
9/27/2014	0.1[a]	Near head of left bank side channel	104.9	3,059,123	1,613,857
9/27/2014	0.14	Near head of left bank side channel	105.2	3,060,336	1,613,509
9/27/2014	0.3[a]	Near mouth of left bank side channel	104.9	3,058,879	1,613,582
9/27/2014	1.22[b]	Downstream of beaver dam in Slough 3B	105.4	3,062,266	1,612,578
9/27/2014	0.07	Near head of left bank side channel	105.2	3,060,134	1,613,640
FA-113 Oxbow					
9/23/2014	0.82	Mouth of Oxbow I	113.7	3,101,369	1,623,125
9/23/2014	6.20	Mouth of Gash Creek	115.1	3,107,391	1,622,840
9/23/2014	0.46	Mouth of Slash Creek	114.8	3,106,250	1,623,153
FA-115 Slough 6A					
9/23/2014	0.45[b]	Mouth of Unnamed Tributary 115.4	115.4	3,108,780	1,621,080
9/23/2014	0.15	Inflow from beaver dam at head of Slough 6A	116.1	3,112,010	1,619,438
9/23/2014	0.32	Groundwater inflow at head of Slough 6A	116.1	3,111,090	1,619,438
9/23/2014	1.04	Mouth of tributary into Slough 6A	116.0	3,111,431	1,619,417
9/23/2014	0.84[b]	Side channel in mid-channel island	115.9	3,111,547	1,620,764
FA-128 Slough 8A					
9/26/2014	1.01	Near head of Slough 8A	130.1	3,167,600	1,659,832
9/26/2014	1[a]	Unnamed Tributary to Slough 8 A	129.9	3,166,924	1,659,026
9/26/2014	1[a]	Unnamed Tributary to Slough 8A	130.0	3,167,209	1,659,443
9/26/2014	4.65	Downstream of beaver dam on Slough 8A	129.7	3,166,393	1,658,118
9/26/2014	10[a]	Channel across mid-channel island	128.3	3,165,013	1,650,820
9/26/2014	0.1[a]	Mouth of channel on south side of mid-channel island	128.6	3,164,469	1,652,751
9/26/2014	0.1[a]	Mouth of channel on north side of mid-channel island	128.8	3,166,472	1,652,610
9/25/2014	1[a]	Near head of channel into Slough 8A	129.5	3,166,780	1,656,565
9/25/2014	1.39	Near mouth of channel into Slough 8A	129.4	3,166,043	1,656,332
9/25/2014	9.22	Slough 8A above confluence with channel	129.4	3,165,724	1,656,500
9/25/2014	0.51	Near mouth of Slough A	128.1	3,163,824	1,650,824
9/25/2014	0.60	Head of channel across mid-channel island	128.7	3,166,031	1,652,420
9/25/2014	No flow	Near head of Half-Moon Slough	128.9	3,165,827	1,653,557
9/25/2014	1.96	Near mouth of channel across mid-channel island	128.4	3,164,548	1,651,705
FA-138 Gold Creek					
9/24/2014	1.69	Near head of Upper Side Channel 11	139.9	3,203,504	1,691,698
9/24/2014	2.13	Near mouth of Upper Side Channel 11	139.6	3,202,738	1,689,788
9/24/2014	60[a]	Near head of channel into mouth of Slough 12	138.7	3,199,419	1,688,668

Date	Flow (cfs)	Location	Reference PRM	Northing (feet)	Easting (feet)
9/24/2014	0.1[a]	Near mouth of Slough 12	138.8	3,199,475	1,689,142
9/24/2014	0.21	Near mouth of Slough 13	139.0	3,200,668	1,688,970
9/24/2014	1[a]	Outlet from beaver impounded pond along right bank	139.5	3,203,481	1,688,936
9/24/2014	0.25	Near head of Slough 11	139.4	3,202,434	1,690,710
9/24/2014	0.37	Left channel downstream of beaver dam in Slough 11	138.9	3,200,220	1,690,204
9/24/2014	1.16	Middle channel downstream of beaver dam in Slough 11	138.9	3,200,235	1,690,195
9/24/2014	0.62	Right channel downstream of beaver dam in Slough 11	138.9	3,200,249	1,690,182
9/24/2014	1.56	Left channel near mouth of Slough 11	138.7	3,199,033	1,689,404
9/24/2014	1.65	Right channel near mouth of Slough 11	138.7	3,198,943	1,689,382
FA-141 Indian River					
9/25/2014	0.1[a]	Mouth of Slough 17	142.3	3,211,169	1,698,990
FA-144 Slough 21					
9/24/2014	14.3	Mouth of Unnamed Tributary 144.6	144.5	3,217,382	1,708,369
9/24/2014	10.3	Side Channel 21 near mouth of Unnamed Tributary 144.6	144.6	3,217,686	1,708,391
9/24/2014	1.25	Mouth of channel across mid-channel island	144.9	3,218,990	1,709,017
9/24/2014	No flow	Mouth of channel across mid-channel island	145.0	3,219,661	1,709,360
9/23/2014	300[a]	Mouth of channel across mid-channel island	144.5	3,217,850	1,707,901
9/24/2014	1[a]	Near inlet berm into channel on mid-channel island	145.5	3,221,584	1,711,078
9/24/2014	0.01[a]	Near head of channel across mid-channel island	145.5	3,221,237	1,711,539
9/24/2014	0.23	Downstream of beaver dam in Slough 21	145.2	3,219,949	1,710,390
9/24/2014	0.90	Slough 21	145.1	3,219,801	1,710,244
9/24/2014	1.50[a]	Mouth of channel across mid-channel island	145.1	3,219,801	1,709,815

Notes:

a = estimated flow

b = flow measured with current meter

Table 5.1-15. 2014 Susitna-Watana airborne LiDAR data specifications.

Data Specification	Description
Point density	Minimum 8 points per square meter
Nominal point spacing	0.45 meter
Field of view	60° angle
Returns per pulse	4
Horizontal projection	NAD 1983 State Plane Alaska 4 FIPS 5004
Vertical projection	NAVD 88 – GEOID09
Horizontal accuracy (RMSEr)	≤ 17 cm (~0.56 ft)
Vertical accuracy (RMSEz)	≤ 9.25 cm (~0.30 ft)
LiDAR intensity values	0 to 255 (8 bits)
LiDAR files version	ASPRS LAS files version 1.2
Vertical and horizontal units	U.S. Survey Feet

Table 5.1-16. Middle river corridor vertical accuracy tests results for 2014 LiDAR.

LiDAR Vertical Accuracy Test	Cover type	# Survey points	Max (ft)	Min (ft)	Mean (ft)	STD (ft)	RMSEz (ft)	Vertical accuracy at 95% confidence level (ft)	# of Outliers
Fundamental Vertical Accuracy Test	Open terrain	86	0.474	-0.311	-0.004	0.158	0.159	0.311	0
Supplemental Vertical Accuracy Test	Brush land/Low vegetation	30	0.393	-0.42	-0.127	0.217	0.252	0.493	2
Consolidated Vertical Accuracy Test	All land cover types	116	0.474	-0.42	-0.036	0.184	0.187	0.367	2

Table 5.1-17. Reservoir areas vertical accuracy tests results for 2014 LiDAR.

LiDAR Vertical Accuracy Test	Cover type	# Survey points	Max (ft)	Min (ft)	Mean (ft)	STD (ft)	RMSEz (ft)	Vertical accuracy at 95% confidence level (ft)	# Outliers
Fundamental Vertical Accuracy Test	Open terrain	9	0.488	-0.535	0.012	0.288	0.288	0.564	0
Supplemental Vertical Accuracy Test	Brush land/Low vegetation	16	0.155	-0.891	-0.435	0.793	0.536	1.05	1
	Forest land	7	0.394	-1.137	-0.23	0.685	0.558	1.09	1
Consolidated Vertical Accuracy Test	All land cover types	32	0.488	-1.137	-0.264	0.407	0.485	0.95	2

Table 5.1-18. Comparison of NMAS/NSSDA Vertical Accuracy (ASPRS 2004).

NMAS Equivalent Contour Interval (ft)	NSSDA RMSEz (ft)	NSSDA Vertical Accuracy at 95% confidence level (ft)	Required Accuracy for Reference Data for "Tested to Meet" (ft)
0.5	0.15	0.30	0.10
1	0.30	0.60	0.20
2	0.61	1.19	0.40
3*	0.92*	1.79*	0.60*
4	1.22	2.38	0.79
5	1.52	2.98	0.99
10	3.04	5.96	1.98

Notes:

* Average of 2 and 4 ft equivalent contour interval rows in ASPRS 2004.

10. FIGURES

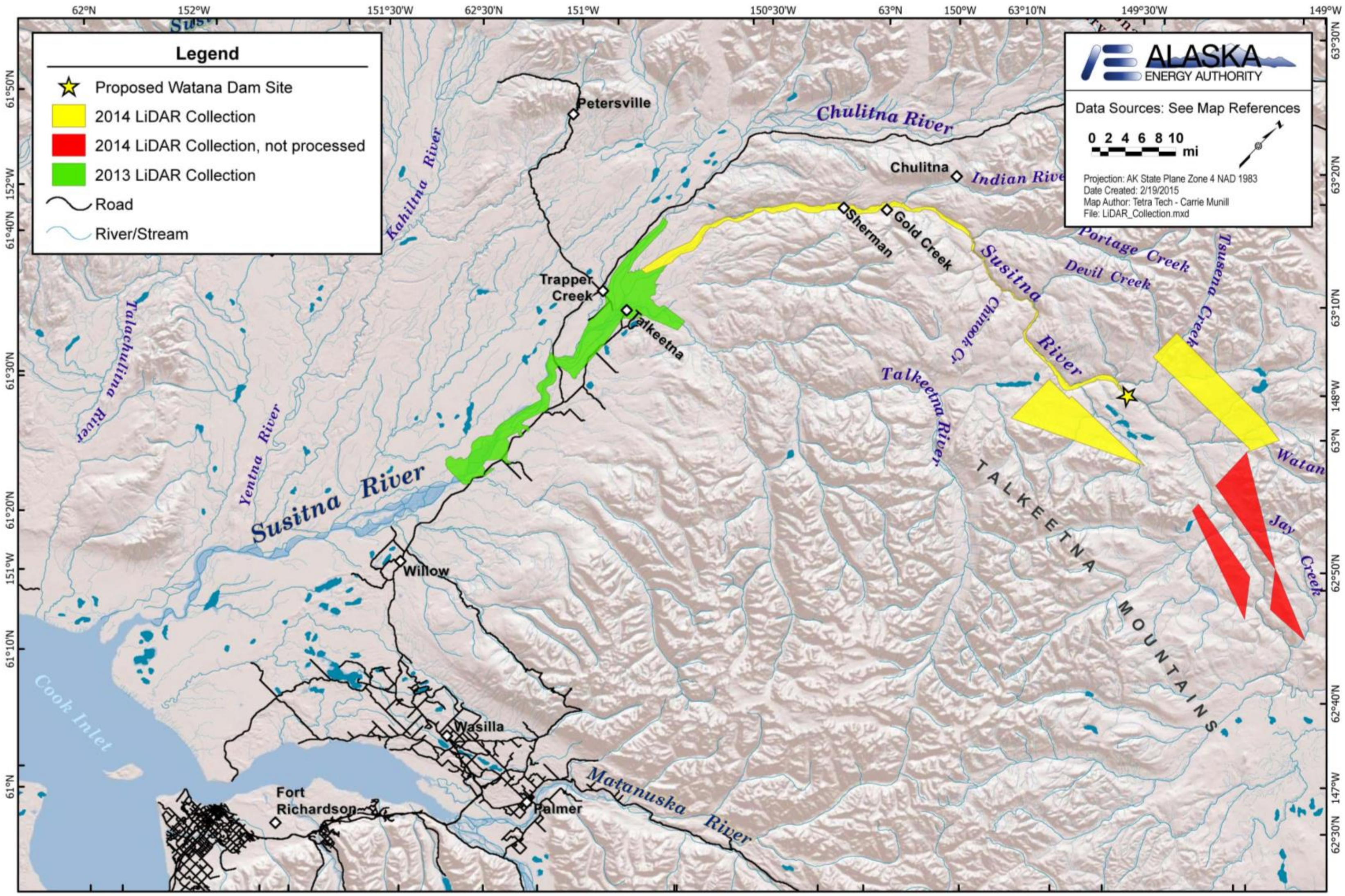

Figure 5.1-1: 2013 and 2014 LiDAR areas and collection.

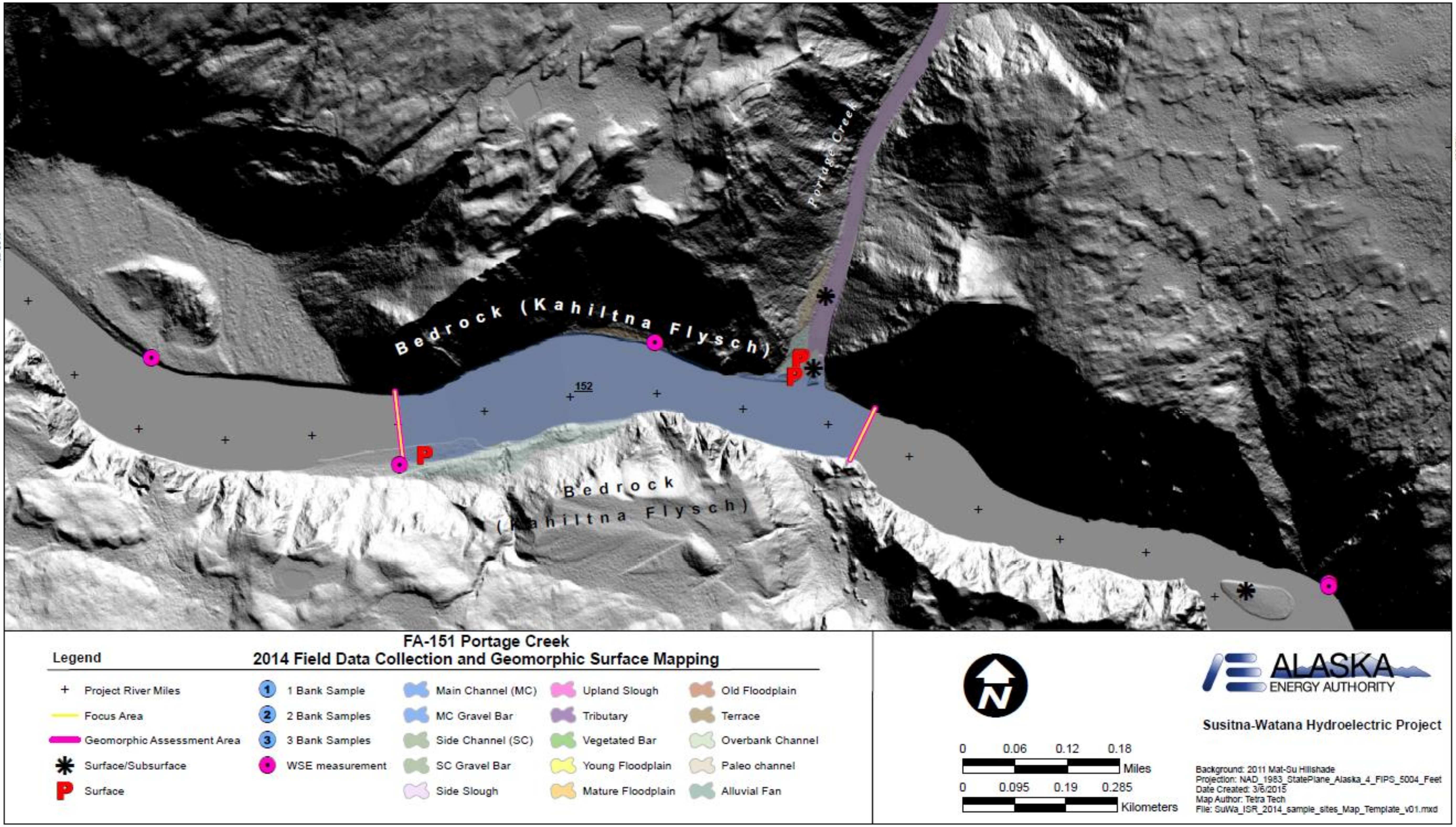

Figure 5.1-2 Field data collection and geomorphic surface mapping in Focus Area 151 Portage Creek

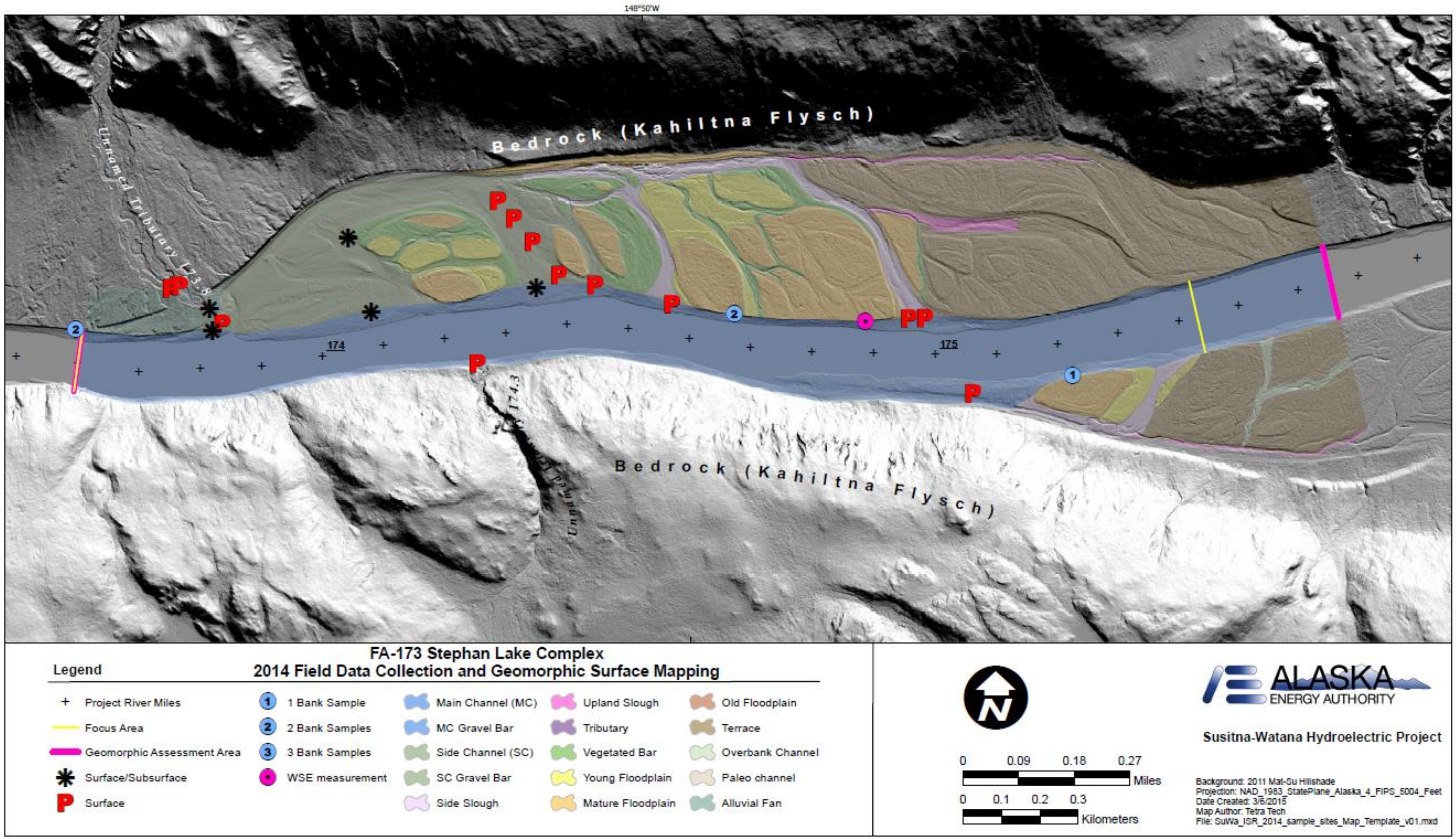

Figure 5.1-3 Field data collection and geomorphic surface mapping in Focus Area 173 Stephan lake Complex

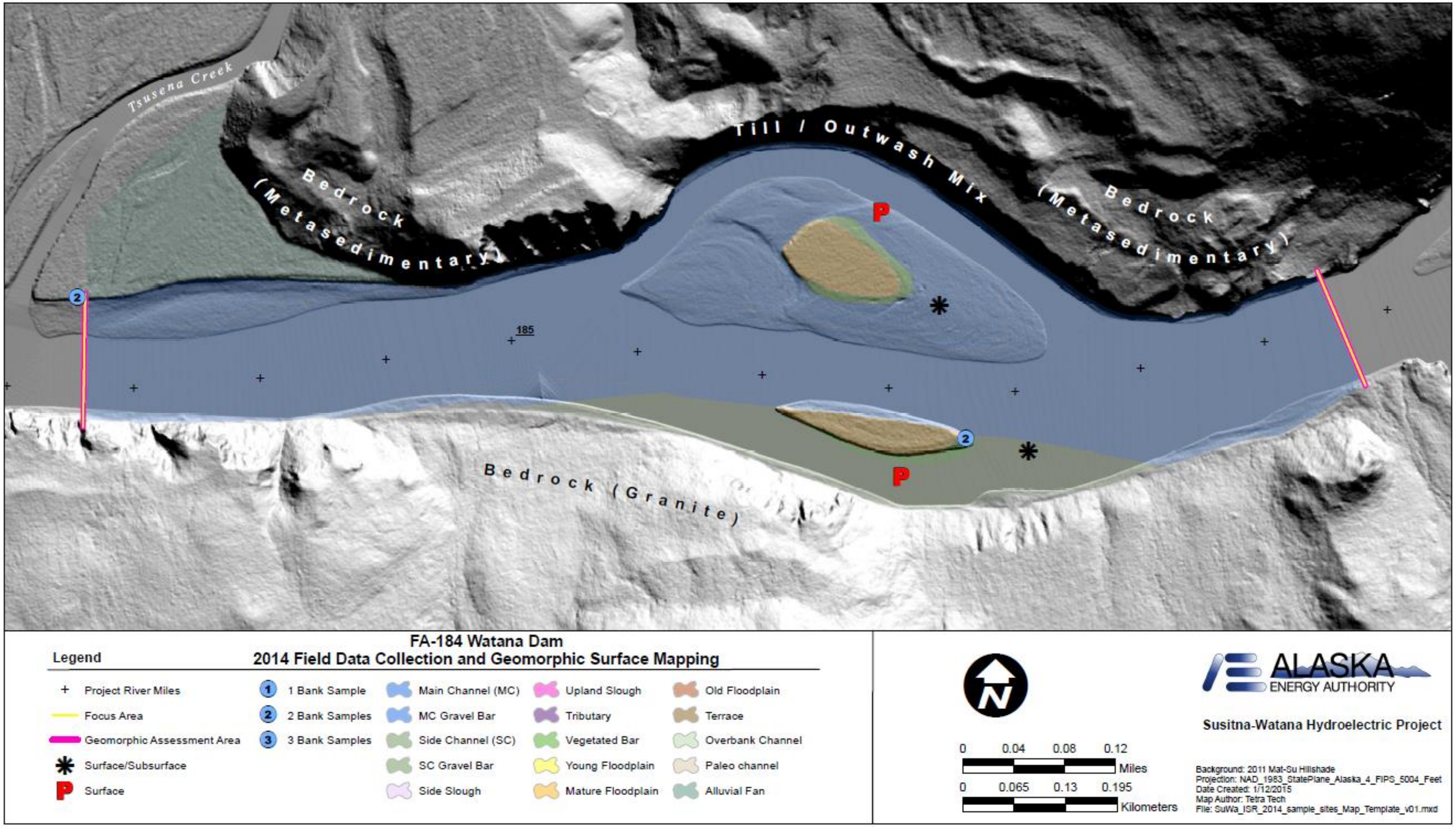

Figure 5.1-4 Field data collection and geomorphic surface mapping in Focus Area 184 Watana Dam

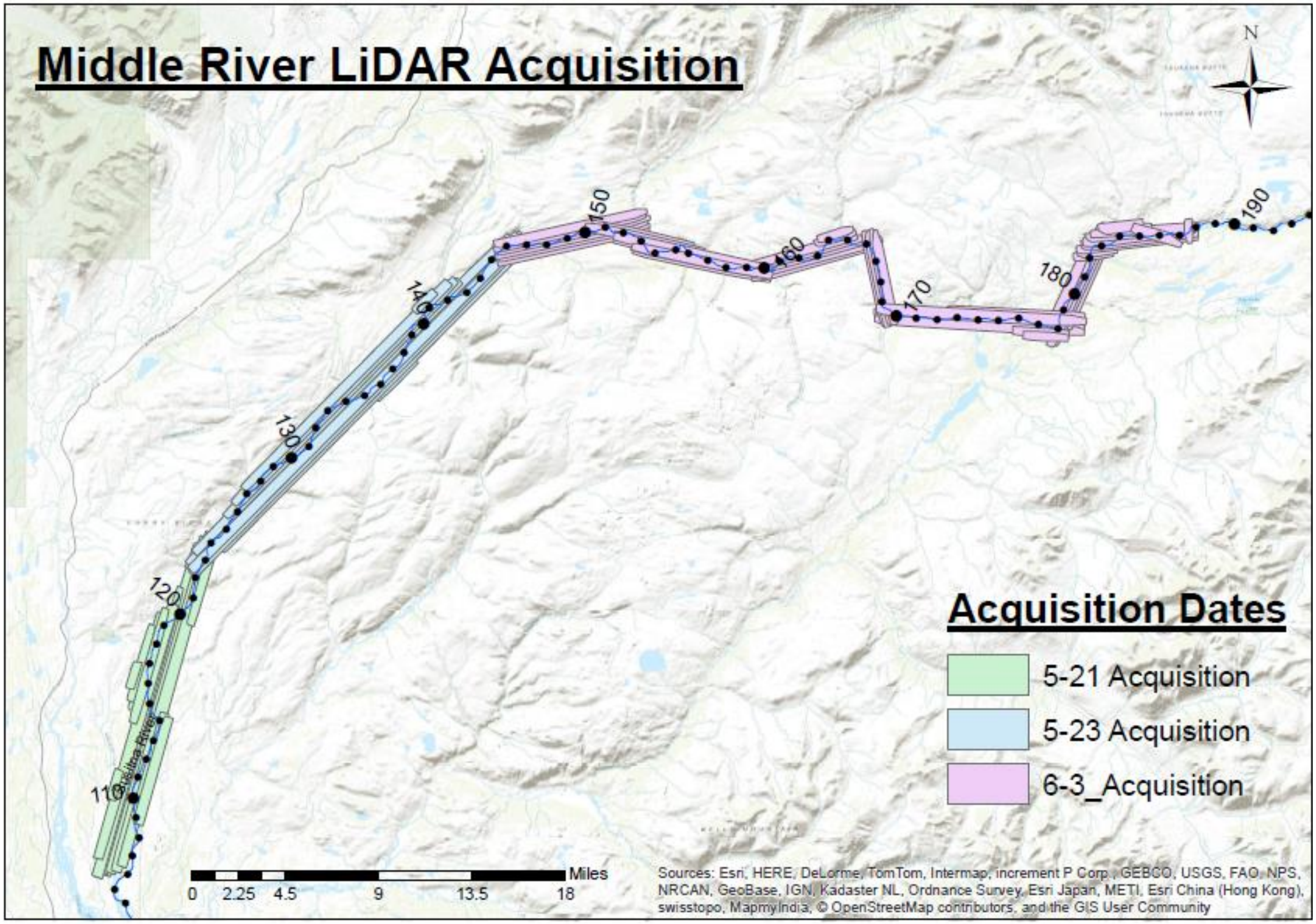

Figure 5.1-5: 2014 Middle River LiDAR Acquisition.

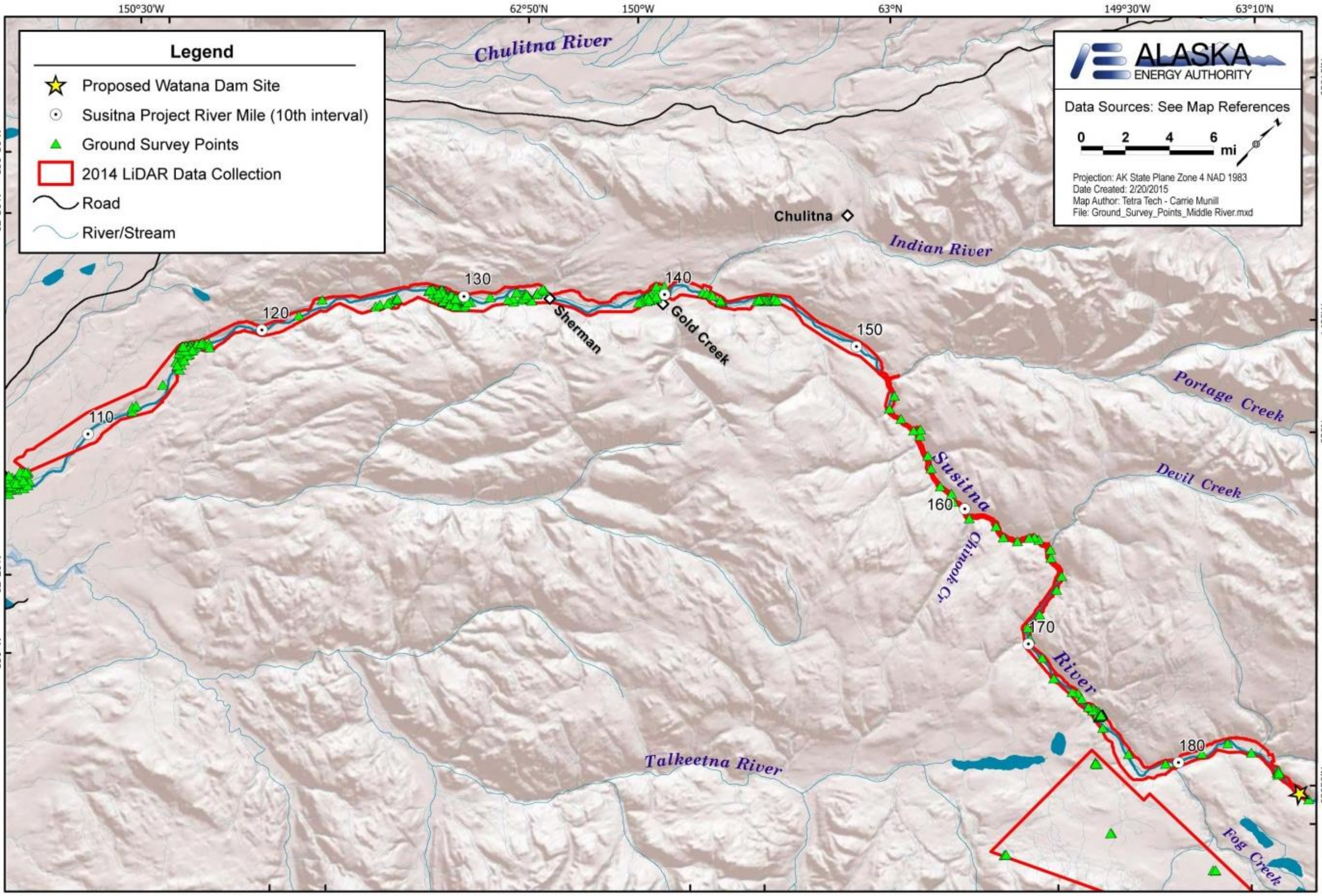

Figure 5.1-6: 2014 Middle River ground survey point locations.

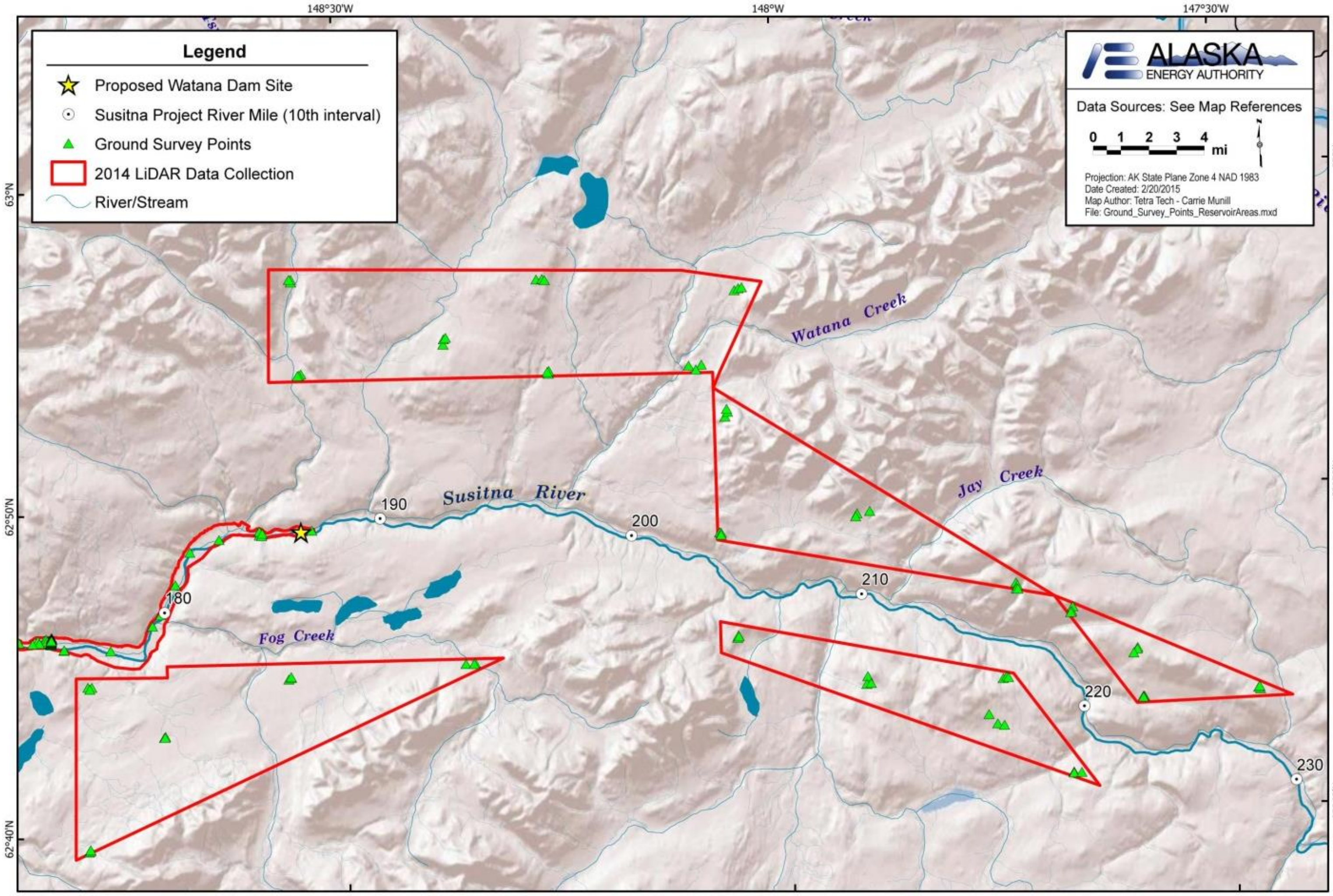

Figure 5.1-7: 2014 reservoir areas ground survey point locations.