Susitna-Watana Hydroelectric Project (FERC No. 14241)

Baseline Water Quality Study
Study Plan Section 5.5

Study Completion Report

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

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Abbreviation	Definition
AWQS	Alaska Water Quality Standards
ADEC	Alaska Department of Environmental Conservation
AEA	Alaska Energy Authority
Al	Aluminum
AOI	area of interest
ARI	Aquatic Research Inc. laboratory conducting water quality analysis
As	Arsenic
Ba	Barium
BTEX	Benzene, Ethylbenzene, Toluene, and Xylenes
°C	degrees Celsius
Ca	Calcium
$CaCO^3$	Calcium carbonate
Cd	Cadmium
Chl-a	Chlorophyll-a
CFR	Code of Federal Regulations
cm	centimeter
Cu	Copper
DL	detection limit
DO	dissolved oxygen
DOC	dissolved organic carbon
EPA	Environmental Protection Agency
°F	degrees Fahrenheit
FA	Focus Area
Fe	Iron
FERC	Federal Energy Regulatory Commission
ft.	feet
GPS	global positioning system
Hg	mercury
ILP	Integrated Licensing Process
ISR	Initial Study Report
J	The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample.
m	meter
MDL	Method Detection Limit
MeHg	Methyl mercury
Mg	Magnesium
µg	microgram

Abbreviation	Definition
µm	micrometer
µg/L	micrograms per liter
µmhos/cm	micromhos per centimeter
mg/L	milligrams per liter
Mn	Manganese
mV	millivolt
m/s	meters per second
MET	Meteorological
Mg	Manganese
Mo	Molybdinum
MQO	Measurement Quality Objective
NELAP	National Environmental Laboratory Accreditation Program
Ni	Nickel
NOAA	National Oceanographic and Atmospheric Association
NTU	Nephelometric Turbidity Unit
PAHs	polynuclear aromatic hydrocarbons
Pb	Lead
pH	potential hydrogen
PRM	Project River Mile
Project	Susitna-Watana Hydroelectric Project No. 14241
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
R	Data observation rejected based on failure to meet acceptance limits outlined in the QAPP
RF	radio frequency
RSP	Revised Study Plan
SCR	Study Completion Report
Se	Selenium
SGS	SGS Environmental Services Laboratory
SNTEMP	Stream Network Temperature
SQuiRT	Screening Quick Reference Tables
SWE	Snow Water Equivalent
TDS	total dissolved solids
THg	total mercury
TIR	thermal infrared remote
TKN	total Kjeldahl nitrogen
Tl	Thallium
TOC	total organic carbon
TP	total phosphorus

Abbreviation	Definition
TSS	total suspended solids
USGS	United States Geological Survey
Vn	Vanadium
WQ	water quality
Zn	Zinc

1. INTRODUCTION

This Baseline Water Quality Study, Section 5.5 of the Revised Study Plan (RSP, AEA 2012) approved by the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241, focuses on the methods for assessing the effects of the proposed Project and its operations on water quality in the Susitna River basin.

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 Baseline Water Quality Study. For example:

- Completion of sampling for temperature, sediment, pore water, and water quality (Baseline Monitoring and Focus Area Monitoring).
- On September 30, 2014, AEA filed with FERC the *Water Quality and Lower River Modeling Technical Memorandum* (AEA 2014a), which provided results of the analysis and recommendation of extending the Water Quality Model below Project River Mile (PRM 29.9) and an evaluation of the adequacy of the water temperature and meteorological data collected through 2014.
- On October 16, 2014, AEA held an ISR meeting about the Baseline Water Quality Monitoring Study (Study 5.5), Water Quality Modeling Study (Study 5.6), and Mercury Assessment and Potential for Bioaccumulation Study (Study 5.7).
- The 2014 water quality data was reviewed and the quality controlled data and DVRs per the Quality Assurance Project Plan were submitted to FERC and posted at http://gis.suhydro.org/isr_mtg on December 17, 2014.

In furtherance of the next round of ISR meetings and FERC's future Study Plan Determination, this report contains a comprehensive discussion of results of the Baseline Water Quality Study from the beginning of AEA's study program in 2012 through the end of calendar year 2014. It describes the methods and results of the Baseline Water Quality Study, and explains how all Study Objectives set forth in the Study Plan have been met. The Quality Assurance issues encountered during this study are summarized in a supplemental table as described in the Quality Assurance Project Plan (QAPP) for this study (AEA 2014b). Accordingly, with this report, AEA has now completed all field work, data collection, data analysis, and reporting for this study.

2. STUDY OBJECTIVES

The objectives for this study are established by RSP Section 5.5.1. The goal of the overall water quality study efforts is to assess the effects of the proposed Project and its operations on water quality in the Susitna River basin, which informs development of any appropriate conditions for inclusion in the Project license. The Project is expected to change some of the water quality characteristics of the drainage as well as the inundated area that will become the reservoir.

The objectives of the Baseline Water Quality Study are as follows:

- Document historical water quality data and combine with data generated from this study. The combined dataset will be used in the Water Quality Modeling Study to predict Project impacts under various operations.
- Collect stream temperature and meteorological data to supplement the existing data.
- Develop a monitoring program to adequately characterize surface water physical, chemical, and bacterial conditions in the Susitna River within and downstream of the proposed Project area.
- Measure baseline metals concentrations in sediment and fish tissue for comparison to state criteria. (a summary of metals results is included in this Study Completion Report and mercury results are reported in the Study 5.7 Mercury Assessment Report).
- Perform thermal infrared imaging (TIR) assessment of a portion (between Talkeetna and Devils Canyon) of the Susitna River and use this data to map the groundwater discharge and possible extent of thermal refugia. (Groundwater was mapped for Middle River Focus Areas and sloughs and most of the Lower River in 2013; methods and results are presented in ISR Part A Sections 4 and 5 and Appendix J).

3. STUDY AREA

As established by RSP Section 5.5.3, the study area for water quality monitoring includes the Susitna River from PRM 29.9 to PRM 235.2 (Oshetna River), and selected tributaries within the proposed transmission line and access corridors. Water temperature monitoring initiated in 2012 extended as far downstream as PRM 19.9.

4. METHODS AND VARIANCES

4.1. Water Temperature Monitoring

The methods employed correspond to Section 5.5.4.1 of the RSP. The water temperature monitoring sites were selected using the rationale described in Study 5.5 ISR Section 4.1.1. A detailed description of the thermistor systems and deployment can be found in Study 5.5 ISR Sections 4.1.2 and 4.1.3.

Baseline temperature monitoring sites were spaced at approximately 5-mile intervals so that the various factors that influence water temperature conditions were captured and support the development (and calibration) of the water quality model. The sensors were situated in the river to record water temperatures representative of the mainstem or slough being monitored, avoiding areas of groundwater upwelling, unmixed tributary flow, direct sun exposure, and isolated pools that would have affected representativeness of the data.

In 2012, field reconnaissance of the 1980s monitoring sites was conducted and 37 sites were selected for monitoring (Table 4.1-1 and Figure 4.1-1). Of these sites, 32 were replicates of sites with available water quality and temperature data from the 1980s, 7 of the sites were used for developing the SNTEMP model from the 1980s studies, and the remainder represented new or relocated sites from the 1980s dataset used to collect water quality or temperature data. Collection of water temperature data began in July 2012, and continued through the winter of 2013/2014 and summer 2014. Due to changes in the river channel and safety concerns, temperature monitoring stations were established at 30 of the 37 selected sites in the summer of 2012 and an additional 3 sites were established during the winter 2012-2013 deployment.

In September of 2012, 19 thermistors were redeployed as overwintering systems (Table 4.1-1). The locations were selected based on locations where ice forces might allow for their survival over the winter. Of the 19 deployed overwinter systems, 11 thermistors were found following ice breakup and six of those could be downloaded during the June 2013 site visits. Access restriction between PRM 145.6 and PRM 209.2 prevented recovery and download of thermistors in 2013. In this reach, thermistors had been deployed at 4 locations of which 2 were intact and could have data retrieved in 2014 (PRM152.2 and PRM 152.7). Data was retrieved from these two loggers for the period July 2012 through April 2013, at which time the internal storage capacity had been reached.

Additional systems were installed during the 2013 field season, and some equipment was lost and replaced during routine site visits conducted during the ice free period (June through October). The overwinter setups, outside of the restricted access reach, were removed from the river and replaced with anchor and buoy systems in June 2013, and replaced again with overwinter systems in September 2013. A total of 28 sites were monitored in 2013 (these include the two sites within the restricted access reach with partial data sets through April 2013). A summary of each site complete with photos, global positioning system (GPS) coordinates, aerial images, and installation/maintenance field notes are included in Appendix A of the Study 5.5 ISR (AEA 2014c).

During the winter of 2013/2014, 19 thermistor systems were left in place to characterize winter temperature conditions and all 19 were recovered and data successfully retrieved in summer 2014 (Table 4.1-1). In the Study 5.5 ISR Part C, Section 7.1.2, it was proposed to modify the logging interval from 15 minutes to 30 minutes to expand internal data storage capacity. However, this was not implemented and the logging interval remained as 15 minutes throughout 2014. A total of 36 thermistor systems were deployed in June 2014, including all eight of the monitoring sites that could not be accessed in 2013 (this included the 4 sites that were deployed in 2012 and 4 additional sites which could not be deployed in 2013 due to access limitations). All 36 thermistors were removed from the river in September 2014 and data retrieved.

4.1.1. Variances from the Study Plan

AEA implemented the methods as described in the Study Plan with the exception of variances noted in ISR, Part A, Section 4.1.4 (2013) as well as those explained below.

Thirty-seven sites were identified for continuous temperature monitoring in the Study 5.5 RSP. Continuous data were collected a total of 36 sites have varying periods of record monitored since 2012. The 37^{th} site, the Susitna River near Cantwell (PRM 225.5), had no continuous data collected. This site was consistently not accessible by helicopter during each visit. Single temperature observations were collected at this site during winter 2013/2014, when ice cover provided a solid helicopter landing site. Temperature data collected downstream of this site at PRM 209.2 and upstream at PRM 235.2 bracket this site and provide sufficient information to calibrate the temperature component of the EFDC model.

Continuous water temperature loggers between PRM 145.6 and the Oshetna River confluence (PRM 235.2) had different periods of record due to the following: late start for deployment in 2012, loss of logging equipment due to ice break-up (winter 2012/2013 and 2013/2014), and site access issues in 2013. The portion of the record available between 2012 and 2014 are summarized below and location are also provided in Table 4.1-1 (stations with complete records from summer 2012 through summer 2014 are in bold):

- PRM 152.2 Susitna below Portage Cr: Available summer 2012, winter 2012/2013 and summer 2014
- Portage Cr.: Available summer 2012 and summer 2014
- PRM 152.7 Susitna above Portage Cr.: Available summer 2012, winter 2012/2013 and summer 2014
- PRM 168.1 Susitna River: Available summer 2014
- PRM 183.1 Susitna River below Tsusena Cr.: Available summer 2012 and summer 2014
- Tsusena Cr.: Available summer 2014
- PRM 187.2 Susitna River at Watana Dam Site: Available summer 2014
- PRM 196.8 Susitna River above Watana Cr.: Available summer 2014
- **PRM 209.2 Susitna River at mouth of Kosina Cr.: Available summer 2012 through summer 2014**
- **Oshetna River: Available summer 2012 through summer 2014**

The purpose for including many monitoring sites throughout the river and multiple years of temperature monitoring was to acquire as complete a data record as possible for each of the sites, while acknowledging that an incomplete data set was likely to occur for some sites due to the three issues noted above, but collectively would be representative of the river. The volume of data and period of record among all sites are sufficient to construct a temperature profile with the EFDC model where records are missing. The study results are not impacted by the missing record and the data collected are sufficient to meet study plan objectives.

4.2. Meteorological Data Collection

As indicated in the RSP (Section 5.5.4.2 and 5.5.4.3), three MET stations (Figure 4.1-1) were installed in 2012 to collect data for constructing the (2D and 3D) Reservoir and River Water

Quality Models. The stations are spatially distributed on the Susitna River to represent a range of distinct physical settings throughout the study area (Figure 4.1-1 in the ISR). This data will be used for calibrating the temperature model for the reservoir and river and for calibrating the ice model in the reservoir.

One MET station was established near the Watana Dam site (ESM-1), at an elevation of approximately 2,300 feet on the north side of the river. This station is above the projected elevation of the reservoir and proposed dam height. The second station was installed slightly upriver of the proposed reservoir footprint, at an elevation of approximately 2,100 feet near the confluence of Oshetna River and the Susitna River (ESM-2). The third station was installed 40 miles downriver of the proposed dam near the confluence with Indian River and the Susitna River at an elevation of approximately 720 feet (ESM-3). All three stations were equipped with instrumentation to measure wind speed and direction (at 3 meters), air temperature, relative humidity, barometric pressure, and incident solar radiation. Beginning in September 2013, precipitation was measured at ESM-2 and ESM-3 and then at ESM-1 beginning October 2014. A snow water equivalency sensor was installed at ESM-1 the same time as the precipitation gage in October 2014.

MET station installation and monitoring protocols are detailed in Study 5.5 ISR, Part A, Sections 4.2.1 and 4.2.2. The data recorded by the stations installed in 2012 was uploaded every hour via radio frequency (RF) telemetry and stored on a digital server in Talkeetna, Alaska. Data collection was monitored to ensure equipment was operating correctly.

ESM-2 and ESM-3 were dismantled in August 2015. ESM-1 continues to collect data for purposes other than water quality modeling.

MET data is also available from the National Oceanographic and Atmospheric Association (NOAA) station located at the Talkeetna Airport (Table 4.2-1 in Study 5.5 ISR Part A). Existing information from the Willow Creek and Susitna River near the Sunshine gage station also provide data on some of the parameters used for calibrating the water quality model (Study 5.6).

4.2.1. Variances from the Study Plan

AEA implemented the methods as described in the Study Plan with the exception of variances noted in Study 5.5 ISR, Part A, Section 4.2.3 and the two variances described below.

RSP Section 5.5.4.3 indicated rain gauges would be installed at all MET stations to collect data over a couple of years. One year of data is adequate to calibrate the EFDC model. However, AEA opted to collected additional years of data to ensure a complete record was available for all meteorological parameters. MET stations were installed in 2012, and rain gauges were installed at ESM-2 (Oshetna River) and ESM-3 (Indian River) in September 2013, as described in the ISR Part A, and in October 2014 at ESM-1 (Watana Dam). While the installations occurred later than intended, the same amount of data was collected at ESM-2 and ESM-3 because the stations were operated until August 2015, instead of August 2014. ESM-1 is currently installed and data collection is anticipated to occur through the next year. Precipitation records were collected for two years at each of the sites with additional years planned for ESM-1 (Watana Dam site). The data record from the MET Stations is adequate for calibrating the EFDC model.

As described as a Study Plan modification in ISR, Part C, Section 7.1.2, AEA proposed to install a CS725 snow water equivalency (SWE) sensor at MET station ESM-1 (Watana Dam site), which was not required in the Study Plan. The SWE sensor was installed October 2014. The SWE sensor is a new technology, developed in part by Hydro Quebec for the purpose of collecting higher accuracy and time variant SWE data in remote areas for reservoir modeling (Section 4.2.3 of ISR Part A). This variance will enhance AEA's ability to meet study objectives.

4.3. Baseline Water Quality Monitoring

There were two types of monitoring programs used to characterize surface water conditions: Baseline Water Quality Monitoring (Section 5.5.4.4 of the RSP) and Focus Area Monitoring (Section 5.5.4.5 of the RSP). The Focus Area Monitoring method is described below in Section 4.4. A detailed description of the baseline water quality monitoring methods (parameters monitored, sampling protocol, sample handling and QA/QC) can be found in Study 5.5 ISR, Part A, Section 4.3. Sampling technique was consistent with methods prescribed by the Alaska Department of Environmental Conservation (ADEC) and U.S. Environmental Protection Agency (EPA).

Water quality was monitored at a total of 17 sites in 2013 and 2014 distributed in the basin as follows: Susitna River mainstem (10 sites), Susitna River off-channel (1 site), and tributary (6) locations (Table 4.1-1, Table 4.3-1, and Figure 4.1-1). There were seven mainstem monitoring sites surveyed in the 1980s for temperature data below the dam and incorporated into the 1980s Stream Network Temperature (SNTEMP) modeling (Table 4.1-1). Four of these 1980s sites were included in the water quality sampling that was conducted in both 2013 and 2014. All water quality monitoring sites were co-located at continuous water temperature monitoring sites representing locations in the Lower, Middle, and Upper River segments.

In 2013, fifteen mainstem water quality monitoring sites were located below the proposed dam site and two were located above the dam site (Figure 4.1-1). During winter 2014, five mainstem sites were monitored, four below the dam site and one above. During summer 2014, 15 mainstem water quality monitoring sites were located below the proposed dam site, one at the dam site, and one above the dam site (Figure 4.1-1). In both summers, five sloughs were monitored, representing a combination of physical settings in the drainage and presence of important fish-rearing habitat. Tributaries below the proposed dam site contributing large portions of the Lower River flow to the Susitna River were also monitored during summer 2013 and 2014 as part of the baseline study, and include the Yentna, Deshka, Talkeetna, and Chulitna rivers. Middle River tributaries sampled for water quality included Gold Creek (summer sample collection) and Tsusena Creek (visited in winter 2014 only). Portage Creek was not sampled for water quality, but was sampled for continuous temperature. Instead, the Susitna River was sampled at Portage Creek in 2013 as well as upstream (PRM 152.7) and downstream (PRM 152.2) of its confluence. This additional effort met intended objectives of the Study Plan which was to calibrate the EFDC model with mainstem upstream and downstream conditions of Portage Creek and account for influence of this tributary. Two Upper River tributaries, Watana Creek and Oshetna River, were monitored for temperature only (Table 4.1-1).

The measured water quality parameters are listed in Table 4.3-2. Samples were analyzed for organics, metals, nutrients, and conventional/other substances (Table 4.3-2). The frequency of sample collection varied by: parameter being tested; potential for mobilization; and other supporting data that would enable an assessment for potential bioavailability to aquatic life. Most of the general water quality parameters and select metals were sampled on a monthly basis because each parameter had been demonstrated to be present in one or both of surface water and sediment samples (URS 2011).

During June to September 2013, sampling to characterize variability in water quality conditions was conducted along transects at the 17 locations described in Table 5.5-1 of the RSP. A summary of the water quality monitoring locations and collection dates for 2013 and 2014 are provided in Table 4.1-1, Table 4.3-1, and Figure 4.1-1. Five locations were monitored during winter 2014, and 17 during June to September 2014 (Table 4.3-1). The same Susitna River sites were visited in summer 2013 and summer 2014, with two differences. The summer 2013 sample collection characterized cross-section variation and the summer 2014 sample collection characterized condition in the thalweg with one sample from the surface. The second difference was that less water quality parameters were measured and analyzed in 2014.

The RSP indicated that water quality sampling would be completed in the first year of study, 2013. Water quality sampling was extended into 2014 to fill data gaps for select parameters that did not meet acceptance limits. All seventeen transects were re-visited for water sampling in 2014, but only one sample near the surface was collected along the original transect at each site in the main flow of the river. Previous sampling in 2013 had greater intensity and included three locations along a transect and samples collected at depth, the number depending on depth of the location on the transect (see Section 5.5.4.4.2 of the RSP). Replacement data collected in 2014 was collected at only one location on a transect at each baseline water quality site and the decision to implement this strategy based on evaluation of lateral and depth profiles for water quality parameters collected during 2013. Variation of measurements for water quality parameters tended to be very small both laterally and at depth along baseline water quality transects (see Section 6; Figure 6.4-1, Figure 6.4-2, and Figure 6.4-5 as examples). In 2014, data collection at baseline water quality sites occurred at the same frequency as for 2013 sampling (monthly beginning June 2014- September 2014). The alternative selected for generating valid data for those 2013 observations failing to meet acceptance limits was to re-sample all sites for the select water quality parameters as stated in Study 5.5 ISR, Part A, Section 5.4.

Baseline water quality collection was divided into two components: in situ and general water quality sampling. In situ water quality sampling consisted of on-site measurements of physical parameters at monitoring locations using field equipment. General water quality sampling consisted of monthly grab samples that were sent to an off-site laboratory for analysis.

The laboratory, SGS Environmental Services Laboratory (SGS) in Anchorage, was used in 2013 and included as one of two laboratories for split sample analysis (a requirement in the QAPP) with winter 2014 samples. SGS is ADEC and EPA certified. As part of the Data Quality Objectives described in Section B.5.2 of the QAPP, laboratory split samples from two sites (PRM 87.8 and Chulitna River) were also sent to Aquatic Research, Inc. (ARI) in Seattle, WA during summer 2013 and in winter 2014. Results from split sample analysis of the full set of water quality parameters were checked for precision. Where substantial differences occurred between laboratory results, the analytical methods were further investigated. In cases where split sample results exceeded acceptance limits during 2013, specific water quality parameters were identified where this occurred and a strategy developed for investigating potential causes, such as interference elements in the water (e.g., high turbidity), sample handling technique in the laboratory, or preservation techniques (e.g., acid fixing). A second set of samples was collected during summer 2014 and samples for water quality parameters that did not meet acceptance limits from the previous year were collected and re-analyzed at a sub-set of the sites visited in

2013 using the two different laboratories (SGS and ARI). Results from the two laboratories were used to develop a method to estimate concentrations by elimination of interfering elements.

4.3.1. General Water Quality Sampling

A detailed description of sampling methods can be found in ISR, Part A, Section 4.3.2.2. In 2013, one-time sampling occurred for a limited number of analytes (benzene, ethylbenzene, toluene, xylenes [BETX], polynuclear aromatic hydrocarbons [PAHs], radionuclides, aluminum (Al), chromium (Cr), selenium (Se), fecal coliform, and total organic carbon [TOC]). Samples collected for analysis of these parameters were intended to characterize existing conditions with the understanding that concentrations of these substances do not change appreciably over time, but can vary over space.

Variation of water quality at multiple points along river cross-sections can be significant and likely to occur from incomplete mixing of upstream tributary inflows, point-source discharges, or variations in velocity and channel geometry. Water quality field measurements were located in a manner to represent the extent of vertical and lateral mixing. In the summer of 2013, samples were collected at three equi-distant locations along each transect at each monitoring location (i.e., 25 percent from left bank, 50 percent from left bank, and 75 percent from left bank). Samples were collected from a depth of 1.5 ft. below the surface as well as 1.5 ft. above the bottom of the river if total water depth was 5 ft. or greater. This ensured that any variation in concentrations, especially metals, were detected and adequately characterized throughout the study area. Samples collected at 25 percent from left bank were referred to as the left bank sample, samples collected at 50 percent from left bank were referred to as the middle sample, and samples collected at 75 percent the distance from the left bank were referred to as the right bank sample.

During winter sampling in 2012/2013 and 2013/2014, only one bank (typically the left) was sampled due to ice conditions on the river and limited by helicopter access.

As described in ISR Part C Section 7.1.2, water quality samples were collected in 2014 at selected sites for parameters where 2013 samples were either qualified as “rejected” or “estimated.” Analysis of the 2013 data showed no spatial variation of water quality conditions at a transect, either laterally across the transect or vertically with depth. Therefore sampling at each transect during the summer of 2014 consisted of a single grab sample and field parameters determined from a point at the middle of the river site and at a depth of 1.5 ft. The objective for water quality sampling during 2014 was focused on a laboratory comparison of analytical results (see Section 6.4) and not on measurement of cross-sectional variation in water quality conditions.

4.3.2. Variances from the Study Plan

AEA implemented the methods as described in the Study Plan with the exception of variances described in Study 5.5 ISR, Part A, Section 4.3.4 and those explained below.

The Study Plan (RSP Section 5.5.4.4) indicated that water quality monitoring would occur at the Susitna River near Cantwell (PRM 225.5). Due to limited access to the area via helicopter during summer 2013 and 2014, sampling occurred instead just upstream of the Oshetna River confluence at PRM 235.2 During the winter of 2014, the Susitna River near Cantwell (PRM 225.5) was accessible with a helicopter and sampling occurred at that site. Collection of some water quality samples at PRM 235.2 rather than PRM 225.5 does not impact objectives of the study plan, because data show there is very little difference in physical and chemical water quality conditions between PRM 235.2 and PRM 187.2 (see Section 5.4).

During winter 2013/2014 baseline monitoring, samples were collected in January instead of December as indicated in RSP Section 5.5.4.4.1. Sampling occurred during the ice cover period and water quality conditions are expected to be the same during this time of year. This change does not impact the results of this study. In winter 2013/2014, helicopter access to PRM 187.2 (Susitna at the Watana Dam site) was limited, and monitoring occurred a couple of miles downriver at PRM 185, above the confluence with Tsusena Creek, instead. This change does not impact study objectives as there are no substantial tributary influences expected to appreciably change sample results.

As described in ISR Part C, Section 7.1.2, additional water quality sampling occurred in 2014 at select locations and for parameters for which the 2013 samples were qualified as either “rejected” or “estimated.” Sample results from 2013 showed little horizontal or vertical variability at sample locations, suggesting the river is well mixed. Given the lack of variability as discussed in Section 4.2.1, only a single grab sample was collected at each site transect in 2014 to replace rejected sample water quality parameters collected in 2013. This variance has no impact on meeting study objectives.

The RSP specified a TP detection limit (DL) of 3.1 micrograms per liter (µg/L) (Table B1-3; Attachment 5-1). This DL was used for samples collected during 2013. TP concentrations below the specified DL in 2013 were reported as non-detected. In 2014, a DL of 2.0 µg/L was achieved by one of the two split sample laboratories used for sample analysis. Study objectives remain unaffected. Results from 2014 were generated from a laboratory meeting the lower DL for TP. The lower detection limit resulted in a greater number of samples with detectable concentrations of TP data that could be used for calibrating the water quality model (Study 5.6). Use of the lower DL improved the input data set for the water quality model as it extends the range of concentrations that can be predicted by the model.

4.4. Focus Area Water Quality Monitoring

As described in Section 5.5.4.5 of the RSP, water quality monitoring in the Focus Areas is distinguished from the Baseline Water Quality Program by a higher sampling density within a pre-defined, shorter reach length and a higher sample collection frequency (every two weeks; 3 sets of samples). The purpose for the intensive water quality monitoring in select Focus Areas was to evaluate potential effects from Project operations on resident and anadromous fisheries. A detailed description of the sampling protocol and the parameters measured can be found in RSP Section 5.5.4.5 and Study 5.5 ISR, Part A, Section 4.4. Specific analytical methods are detailed in the QAPP. Similar to baseline water quality monitoring, Focus Area samples were analyzed for organics, metals, nutrients, and conventional/other analytes (Table 4.3-2).

Surface water samples were collected at seven Focus Areas at the same locations during summer of 2013 and 2014: 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) (Figure 4.4-1 through Figure 4.4-7, respectively). Locations of Focus Areas sampled for water quality along the Middle River are shown in Figure 4.4-8. Frequency of sampling FAs during 2013 was every two weeks from July 22nd to August 26th for a total of three sample sets. Focus Areas sampled during 2014 were visited from July 15th to September 17th for a total of two sample sets. Sampling during winter 2013/2014 included FA-104 (Whiskers Slough), FA-128 (Slough 8A), and FA-138 (Gold Creek). The list of water quality parameters measured within these Focus Areas is found in Table 4.3-2.

Water quality sampling was extended into 2014 for select parameters for which 2013 samples did not meet acceptance limits. Samples were collected from all seven Focus Areas in 2014 (Figure 4.4-1 through Figure 4.4-7). Samples were collected from near the surface at locations along each transect; one from the main channel and the other from a side-channel, where these occurred. Other samples collected in each Focus Area were at side sloughs and at upland sloughs where surface water point samples had been identified and sampled in 2013. Variation of measurements for water quality parameters tended to be very small both laterally and at depth along Focus Area transects in 2013 (see Section 6; Figure 6.4-1, Figure 6.4-2, and Figure 6.4-5 as examples). Sample collection in 2014 that replaced select water quality parameters from the 2013 collection effort represented conditions in nearly all locations of each Focus Area.

Groundwater monitoring in the Focus Areas during 2013 occurred in three Focus Areas and at four locations (FA-104 (Whiskers Slough), 1 site; FA-113 (Oxbow I), 1 site; and FA-128 (Slough 8A), 2 sites. Locations for surface water quality monitoring within each Focus Area is found Figure 4.4-1 through Figure 4.4-7. Water quality laboratory parameters reported from summer 2013 groundwater samples are as follows: nitrate/nitrite, total Kjeldahl nitrogen (TKN), TP, orthophosphate, hardness as calcium carbonate ($CaCO_3$), turbidity, chlorophyll-*a* (chl-a), total and dissolved Al, total and dissolved iron (Fe), total mercury (THg) and dissolved mercury (Hg), TOC, and Dissolved Organic Carbon (DOC). Samples were not collected from groundwater sites in 2014.

Winter sampling of surface water in 2014 occurred at FA-104 (Whiskers Slough), FA-128 (Slough 8A), and FA-138 (Gold Creek) (Figure 4.4-8) during February, March, and April in support of Study 8.5. Water quality laboratory parameters reported are as follows: nitrate/nitrite, ammonia-nitrogen (NH^3-N), TKN, TP, orthophosphate, hardness, turbidity, total and dissolved Al, calcium (Ca), Fe, magnesium (Mg), dissolved Hg, THg, methyl mercury (MeHg), TOC, and DOC.

4.4.1. Variances from the Study Plan

AEA implemented the methods as described in the Study Plan with the exception of variances described in Study 5.5 ISR, Part A, Section 4.4.3 and the addition of 2014 sampling. As described in ISR Part C, Section 7.1.2, additional water quality sampling occurred in 2014 at select locations and for parameters for which the 2013 samples were qualified as either “rejected” or “estimated.” Sample results from 2013 showed little horizontal or vertical variability at sample locations, suggesting the river is well mixed. Given the lack of variability, only a single grab sample was collected at each site in 2014, once in July and again in August/September, to replace rejected sample water quality parameters collected in 2013 (Study 5.5 SCR Section 4.2.1). Additional 2014 sampling occurred in order to determine why select water quality parameters had estimated concentrations much higher than expected ranges described in Table A4-1 in Attachment 5-1 of the RSP. The combination of data satisfies requirements for use in calibrating the reservoir and riverine models from Study 5.6 (Water Quality Modeling) (Study 5.5 SCR Section 4.4.1).

4.5. TP Correction Factor

The unexpectedly high total phosphorous (TP) concentrations in the 2013 samples prompted the collection of additional water quality samples in 2014 and analysis of samples using two laboratories (split sample analysis) (Section 7.1.2 of the ISR Part C). The intent was to use results from the split sample analysis to determine a correction factor to adjust the analytical results for TP in 2013, if possible. Since a subset of sites from the baseline monitoring and Focus Areas were visited in 2014 for split sample analysis, a TP correction factor would be applied to remaining 2014 results collected by the same lab used in 2013. The second laboratory analyzing split samples produced results using several combinations of sample handling and analysis methods to identify the most accurate TP concentration in samples collected during 2014.

Laboratory samples from eight sites (10 samples including duplicates) were used to determine the amount of effect the fine total suspended solids (TSS) had on TP analytical results. Split samples were collected mostly from sites in the Middle River segment and one in the Lower River segment (Table 1; refer to Project Sample ID). The second laboratory reported all experimental sample handling and sample analysis. A four-step procedure (Step A through Step D below) was used to quantify the effects of the TSS on TP concentrations, as follows:

Step A: Determine TP in the sample by EPA 365.1 and EPA 200.8 methods.

The values in Table 4.5-1 are referred to as "whole sample" results because they include the TP in the water sample, as well as the interference effect from the TSS.

Table 4.5-1. Step A

Sample #	Case File Number	Project Sample ID	$TP_{Whole\ (365.1)}$ TP: EPA 365.1 *(mg/L)*	$TP_{Whole\ (200.8)}$ TP: EPA 200.8 *(mg/L)*
1	URS00524A2	WQSWB140.1	0.303	0.480
2	URS00524A3	WQSWB152.7	0.378	0.315
3	URS00524A4	WQSWB142.2	0.346	0.330
4	URS00524A5	WQSWBD	0.370	0.326
5	URS00524A6	WQSWB142.3	0.432	0.683
6	URS00525A1	WQSWB87.8M	0.836	0.761
7	URS00525A3	WQSWB107M	0.323	0.225
8	URS00525A4	WQSWB118.6M	0.963	0.877
9	URS00525A5	WQSWB124.2M	0.364	0.459
10	URS00525A6	WQSWBD	0.832	0.764

Step B: Determine TP resulting from suspended solids alone.

Table 4.5-2. Step B

Sample #	TSS in sample (mg/L)	Volume of original sample filtered (V_O) (L)	Filter wt. (mg)	Dry weight of Filter + Solids (mg)	Weight of Solids (mg)	TP in 0.05 L solution of re-suspended solids (TP_{RSS}) (mg/L)	Mass of Phosphorus in solution of suspended solids ($M_{P\ in\ SS} = TP_{RSS} * 0.05L$) (mg)	TP resulting from suspended solids alone $\left(TP_{SS} = \frac{M_{P\ in\ SS}}{V_O}\right)$ (mg/L)
1	193	0.03	23.9	29.7	5.8	0.154	0.0077	0.257
2	227	0.03	23.5	30.3	6.8	0.168	0.0084	0.280
3	190	0.03	23.4	29.1	5.7	0.146	0.0073	0.243
4	170	0.03	23.4	28.5	5.1	0.143	0.0071	0.238
5	197	0.03	23.2	29.1	5.9	0.160	0.0080	0.266
6	600	0.015	23.4	32.4	9	0.198	0.0099	0.660
7	187	0.03	23.8	29.4	5.6	0.174	0.0087	0.290
8	750	0.01	23.2	30.7	7.5	0.175	0.0088	0.876
9	220	0.03	23.3	29.9	6.6	0.178	0.0089	0.296
10	620	0.015	23.7	33	9.3	0.219	0.0109	0.729

Step C: Correct the 10 whole sample estimates of TP for effect of TSS.

Table 4.5-3. Step C

Sample #	*From Step A*		*From Step B*	*Step C*	
	TP_{Whole} TP: EPA 365.1	TP_{Whole} TP: EPA 200.8	TP_{SS} TP resulting from suspended solids alone	$TP_C = TP_{Whole} - TP_{SS}$ Corrected TP	
				EPA 365.1	EPA 200.8
	(mg/L)	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*
1	0.303	0.480	0.257	0.046	0.223
2	0.378	0.315	0.280	0.098	0.035
3	0.346	0.330	0.243	0.103	0.087
4	0.370	0.326	0.238	0.133	0.088
5	0.432	0.683	0.266	0.166	0.417
6	0.836	0.761	0.660	0.176	0.101
7	0.323	0.225	0.290	0.033	-0.065
8	0.963	0.877	0.876	0.087	0.001
9	0.364	0.459	0.296	0.068	0.163
10	0.832	0.764	0.729	0.102	0.035

Step D: Estimate the percent of TP in the whole sample that was due to TSS interference.

Table 4.5-4. Step D

Sample #	*From Step B*	*From Step A*		*Step D*
	TP_{SS}	$TP_{Whole\ (365.1)}$	$TP_{Whole\ (200.8)}$	$\% = \left(\frac{TP_{SS}}{TP_{Whole}}\right) * 100$

	TP resulting from suspended solids alone	TP: EPA 365.1	TP: EPA 200.8	% of TP that is due to TSS	
				EPA 365.1	EPA 200.8
	(mg/L)	*(mg/L)*	*(mg/L)*	*%*	*%*
1	0.257	0.303	0.480	84.9	53.5
2	0.280	0.378	0.315	74.0	88.9
3	0.243	0.346	0.330	70.1	73.6
4	0.238	0.370	0.326	64.1	72.9
5	0.266	0.432	0.683	61.6	39.0
6	0.660	0.836	0.761	79.0	86.7
7	0.290	0.323	0.225	89.8	128.8
8	0.876	0.963	0.877	91.0	99.9
9	0.296	0.364	0.459	81.4	64.6
10	0.729	0.832	0.764	87.7	95.4
			AVERAGE:	**78.3**	**80.3**

Step E: Develop Correction Factor.

The last step was to develop a correction factor for converting the remaining 2014 TP site data analyzed by the same laboratory used in 2013. An average of the two EPA analytical methods was used as the TP correction factor. This is reported in the results (Section 5.4.1.4).

4.6. Sediment Samples for Mercury/Metals in the Reservoir Area

As described in Section 5.5.4.6 of the RSP, this task is designed to gather specific information on the distribution of metals within potential source areas along the Susitna River. In general, all sediment samples were taken from sheltered backwater areas, downstream of islands, and in similar riverine locations in which water currents are slowed, favoring accumulation of finer sediment along the channel bottom. Samples were analyzed for total metals, including arsenic (As), cadmium (Cd), copper (Cu), Fe, lead (Pb), Hg, nickel (Ni), Se, and zinc (Zn). Such base data of existing river sediment will be useful to establish sedimentation rates of constituents in sediment cores decades after dam construction.

In addition, sediment size and TOC was included to evaluate whether these parameters are predictors for elevated metal concentrations. Samples were collected near the mouths of tributaries near the proposed dam site, including Goose, Jay, and Kosina Creeks, and the Oshetna River (Figure 4.5-1 through Figure 4.5-4 in the ISR). The purpose of this sampling was to determine where metals, if found in the water or sediment, originate in the drainage. Toxics modeling will be conducted in Study 5.6 to address the potential for bioavailability in resident aquatic life. Comparison of bioaccumulation of metals in tissue analysis with results from sediment samples will indicate the potential for transfer mechanisms between source and fate.

A description of modeling analysis and sampling procedures are detailed in the ISR, Part A, Section 4.5. In 2013, all but six sites were sampled due to limited land access. In 2014, the remaining six sites were sampled: Fog Creek (Figure 4.6-1), Tsusena Creek (Figure 4.6-4), Deadman Creek (Figure 4.6-2), Watana Creek (Figure 4.6-3), Susitna River below the dam site (Figure 4.6-5), and Susitna River above the dam site (Figure 4.6-6). Collection of the samples in

2013 and 2014 combined occurred at all of the sites indicated in the RSP, providing adequate representation of sediment constituent conditions in and around the dam site.

4.6.1. Variances from the Study Plan

AEA implemented the methods as described in the Study Plan with the exception of variances noted in Study 5.5 ISR, Part A, Section 4.5.1, one of which was repeated during the 2014 sampling. Use of an Ekman Dredge or a modified Van Veen grab sampler was proposed in RSP Section 5.5. However, due to sampling site conditions and access via helicopter instead of boat, all sediment samples were collected using either a hand auger or stainless steel spoon by wading into shallow nearshore areas. This change will not impact meeting study objectives.

4.7. Baseline Metals Levels in Fish Tissue

The methods for fish tissue sampling were first described in Section 5.5.4.7 and Section 5.5.4.8 of the RSP and were further detailed in the Mercury Assessment and Potential for Bioaccumulation Study (Study 5.7) ISR Part A Section 4.2.6. The Mercury Study Plan (RSP Section 5.7.4.6.1) proposed to collect seven to ten fish of each target species. These goals were met or exceeded in 2013 (Arctic grayling = 16; round whitefish = 12), and this study component has been completed. No additional specimens of these fish were captured and analyzed in 2014.

4.8. Thermal Infrared Remote Sensing

TIR sensing was conducted in 2012 as a pilot study (AEA 2013) and at a larger scale in 2013, as summarized in the ISR Part A Section 4.7; the TIR images are included in ISR Part A, Appendix J. All of the Focus Areas in the Middle River and approximately 73 percent of the Lower River were surveyed in 2013. Collecting the data in the Middle River met the original objectives of this study component identified in RSP Section 5.5.1. The ISR (Part C Section 7.1.2) indicated that the remainder of the Lower River would be surveyed in 2014. However, the data was reviewed further and it was determined that no additional TIR data would be collected.

4.8.1. Variances from the Study Plan

In Study 5.5 ISR Part A Section 4.7.1 collection of less than 100 percent of the TIR in the Lower River (73 percent was actually collected) was identified as a variance. It was proposed as a modification in Study 5.5 ISR Part C, Section 7.2.1 to complete the collection of the TIR in the Lower River. After review of the collected TIR in the Lower River by the studies that would utilize the TIR data to determine locations of groundwater upwelling, the Groundwater Study (7.5) and the Fish and Aquatics Instream Flow (8.5), the data collected in 2013 was determined to be sufficient and no further collection of TIR data will be conducted. Since the data already collected fulfills the needs of the studies that the TIR data is intended to support, collection of less than 100 percent of the TIR in the Lower River will not interfere with AEA’s ability to meet study objectives.

4.9. Groundwater Quality in Selected Habitats

As described in Section 5.5.4.12 of the RSP and the Study 5.5 ISR, Part A, Section 4.8, basic water quality or physical/chemical information (water temperature, DO, specific conductance, pH, turbidity, redox potential) was collected at selected instream flow, fish population, and riparian study sites (Figure 4.4-1, Figure 4.4-2, and Figure 4.4-4.). These data were used to characterize groundwater and surface water interactions. Groundwater monitoring is detailed in the Groundwater Study (Study 7.5) ISR and Study Implementation Report. No groundwater sample collection occurred in 2014 as part of Study 5.5 Baseline Water Quality Monitoring.

5. RESULTS

This section summarizes the water quality data from the 2013 study season and supplemental data from the 2014 study season collected pursuant to this Study Plan (Baseline Water Quality). Water quality monitoring over the two-year period produced a complete data set that can be used to calibrate the EFDC water quality model. The 2014 water quality data collection was completed at a limited number of locations within each baseline monitoring site and within Focus Areas. These 2014 data results were used to replace those rejected from the 2013 monitoring effort. The 2013 water quality data was presented in Study 5.5 ISR, Part A, Section 5 and included field parameters (data collected during grab sampling using the Hydrolab® water quality instrument) and chlorophyll a.

Water quality data are presented in graphs for all parameters that had met acceptance limits following the quality assurance review process. These graphical presentations are located in two folders on the Project website, which can be accessed using the web addresses in Table 5.1.

5.1. Data Validation/Verification

5.1.1. 2013

AEA collected samples for analyses from June 2013 through the end of October 2013. Laboratory results have been reviewed for verification and validation according to ADECs Analytical Data Validation Checklist (Attachment 5-1 of the RSP) in preparation of an Analytical Data Validation Memorandum. Through validation and review of the 2013 data it was determined that select water quality parameters were outside of acceptance limits. The parameters affected were total metals (except for Ca and Mg), THg, TP, TKN, total nitrate/nitrite, and dissolved Al. These parameters were qualified as “rejected” or “estimated” throughout the 2013 study and were resampled in 2014.

Three types of quality assurance issues were identified among 2013 samples during the data review process:

- High concentrations of fine TSS that resulted in biased high results for some parameters during laboratory analysis.
- Holding time exceedance of samples transported to the laboratory.
- Temperature exceedance of samples in coolers while in transport to the laboratory.

Potential overestimations of the concentrations of select analytes due to the effects of high TSS can be identified when a parameter concentration has exceeded historical or known ranges of concentrations from water samples collected at or near the study area. Holding time exceedance can effect a sample concentration when parameters like nutrients or bacteriological content are influenced by complexation, consumption, or die-off.

Because a portion of the 2013 data were rejected, additional water sampling occurred at both the baseline water quality sites and the Focus Area sites during 2014. Table 5.1-1 summarizes the rejected sample results. The Measurement Quality Objectives (MQO's) require that the completeness of a data set be determined. For individual parameters, the data set is expected to be 95% or more complete (see Section A.7.2 in Attachment 5-1 of the RSP). Data for the above list of parameters did not meet the MQO goal, as nine percent of baseline monitoring sample results were rejected and thirty-three percent of Focus Area sample results were rejected. Failure to meet this MQO prompted continued monitoring in 2014 to use a split lab comparison for each of the water quality parameters.

The remaining quality assurance issues (e.g., holding time exceedances and temperature exceedances during sample transport) met the MQO's as described in Section A.7.2 in Attachment 5-1 of the RSP. Remaining, unqualified data for each of the parameters were considered to be adequate in characterizing water quality conditions. Data points qualified for holding time of temperature exceedance during transport can be used, but should be evaluated on a case-by-case basis.

5.1.2. 2014

Laboratory results have been reviewed for verification and validation according to ADECs Analytical Data Validation Checklist (Attachment 5-1 of the RSP). While subsets of reviewed data are provided in figures and tables in this document, a complete set of data collected during 2013 and 2014 has been posted to the Project website and can be accessed using web links listed in Table 5.1.

The majority of samples that were rejected during the quality assurance review process were rejected due to the TP results (Table 5.1-2). This was the same quality assurance issue encountered during collection of water quality samples in 2013. The difference is that laboratory split samples were collected during 2014 and a correction factor was developed to make these data useable for water quality model calibration.

All water quality parameter results met the completeness goal of 95 percent in 2014 except for the TP results. This outcome for analytical results was expected because primary sample results (those analyzed by the same laboratory as in 2013) were generated using the same method as the previous year. The secondary laboratory was tasked with analyzing the samples using several sampling handling techniques and analytical methods in order to compare results with the primary data set (see Section 4.3.1).

Given that the TP data were corrected, all data collected in 2014 have been validated and verified and will be used for calibration of the EFDC water quality model in both the river and reservoir.

In 2014, thermistors for some sites in the Middle and Upper River reach experienced technical difficulties. The most likely cause was synchronization between computer date and time and logger date and time during the calibration step. About one-third of the summer data logged at Middle River sites (part of August and all of September) were affected. This portion of the temperature data was qualified as rejected during the Data Validation/Verification (QA Review) process.

5.2. Continuous Water Temperature Monitoring

AEA collected continuous water temperature data from as early as June 2012 at some sites through September 2014. Thermistor temperature loggers were deployed at 36 different locations throughout the study area from PRM 19.9 on the Susitna River to PRM 235.2 on the Oshetna River (Table 4.1-1 and Figure 4.1-1).

ISR Study 5.5 Appendix A contains detailed maps of each continuous water temperature monitoring site, as well as site photos and logger information (deployment dates, logger numbers, depth, and maintenance notes). ISR Study 5.5 Appendix B contains average daily water temperature results for 2013 for all continuous monitoring locations. Table 5.1 provides the location of the data (2013 and 2014) posted to the Project website. The temperature data collected at several sites during the last month of data collection (late August-September) was rejected due to logger malfunction. The following sites in the Middle River and Upper River were affected by this issue: PRM 107, PRM 124.2, PRM 129.6, PRM 129.9, PRM 132.7, PRM 134.1, PRM 140.0, PRM 140.1, PRM 141.0, PRM 142.2, PRM 142.3, PRM 168.1, PRM 183.1, PRM 187.2, PRM 196.8, PRM 209.2, and PRM 235.2.

In the Project area, temporal patterns in water temperature were similar along the full length of the Susitna River (Figures 5.1-1 and 5.1-4 in the Study 5.5 ISR and Figures B-1 – B-12 in Appendix B of the Study 5.5 ISR). Similar temporal patterns in water temperatures were observed in many of the major tributaries, including in the Yentna River, Deshka River, Talkeetna River, Gold Creek, Indian River, Kosina Creek, and Oshetna River (Study 5.5 Figures 5.1-2, 5.1-5, and 5.1-6; Study 5.5 ISR Appendix B, Figures B-1, B-3, B-5, B-11, B-11, and B-14). A similar, but damped, pattern was observed in the Chulitna River (Study 5.5 Figure 5.1-3; Study 5.5 ISR Appendix B, Figure B-7). The synchronous temporal fluctuations in water temperature observed at the monitoring sites appeared to occur in response to fluctuations in ambient air temperature. With the onset of fall, temperatures declined noticeably towards the end of September at all locations. Continuous temperature monitoring over the winters of 2012 and 2013 indicated that at all over-winter monitoring sites temperatures fell to zero during mid-October to early November, and remained at zero until late spring, rising rapidly through late April and May (e.g., Figures 5.2-3 and 5.2-4).

During summer monitoring periods, there was very little vertical variation in water temperature within the water column at main stem sampling sites. For example, at PRM 29.9, one of the deeper sites (36 ft.) monitored on the Susitna River, water temperature was uniform at each of the monitored depths during the 2013 and 2014 data collection periods (Study 5.5 ISR Figure 5.1-1; Figure 5.2-1). Water temperature also did not vary with depth at the monitoring sites in the Yentna River, Talkeetna River, Chulitna River, Indian Rivers, Kosina Creek, and Oshetna River (Study 5.5 ISR Appendix B, Figures B-1, B-5, B-7, B-11, B-14). Greater vertical variability in water temperatures was observed in the Deshka River (Study 5.5 ISR Figure 5.1-2), in Gold Creek (Study 5.5 ISR Appendix B, Figure B-10), and in several of the monitored sloughs (e.g., PRM 129.6 and 143.6; Study 5.5 ISR Appendix B, Figures B-8 and B-13).

<u>Lower vs. Middle vs. Upper Susitna</u>

In general, water temperatures during summer 2013 in the lower Susitna River (PRM 19.9, 29.9, 33.6, 59.9, 87.8 and 99.2) ranged from 6.5°C to 14°C. Water temperatures were slightly warmer above the confluence of the Susitna, Chulitna, and Talkeetna rivers in the middle portion of the

Susitna River during this same period, ranging from 7°C to 16°C just above the confluence (PRM 107, 116.7, 129.9, and 134.1) and 6.5°C – 15.5°C further upstream (PRM 140, 142.3, and 143.6; Study 5.5 ISR, Sections 4.1 and 5.2). No continuous temperature records exist for summer 2013 above this point.

In summer 2014, water temperatures were generally more consistent along the full length of the Susitna River, with occasional exceptions. Temperatures in the lower Susitna River (PRM 19.9, 29.9, 33.6, 59.9, 87.8 and 99.2) ranged from 6.5°C to 15°C (Study 5.5 SCR, Sections 4.1 and 5.2). In the middle portion (PRM 107, 116.7, 129.9, 134.1, 140, 142.3, and 143.6), temperatures ranged from 7.3°C to 14.8°C, except at PRM 143.6, where temperatures dropped as low as 6.3°C in September 2014 (Study 5.5 SCR, Sections 4.1 and 5.2). During this same period, temperatures in the upper portion of the Susitna River (PRM 152.2, 152.7, 168.1, 183.1, and 187.2) consistently ranged from 7°C to 14.5°C, except for at PRM 152.2, where temperatures were much cooler, ranging from 4°C to 11°C.

Influence of Yentna River

During summer 2013, water temperatures in the Yentna River, a major tributary to the Susitna at PRM 32.5, ranged from approximately 6.5°C to 12.5°C – slightly cooler than the observed range of water temperatures (~7 to 14.5°C) in the Susitna River just above the confluence of the Yentna and Susitna rivers (at PRM 33.6). However, water temperatures in the Susitna below the confluence with the Yentna River (at PRM 29.9) were the same or even slightly higher than above it, despite the cooler temperature of the inflowing water from the Yentna river, suggesting that the Yentna River had little to no influence on main stem water temperatures during summer 2013 (Study 5.5 ISR Appendix B, Figures B-1 and B-2).

The tributary also appear to have little effect on main stem water temperatures in summer 2014. During this period, water temperatures in the Yentna River (PRM 32.5) ranged from 6.4°C to 13.3°C. These temperatures were again cooler than temperatures observed above the confluence at PRM 33.6 (7.5°C – 14.8°C), but, as in summer 2013, water temperatures downstream of the confluence (at PRM 29.9), were similar to those above the confluence, ranging from 7.1°C to 14.9°C (Figure 5.2-1).

Influence of Deshka River

In summer 2013, the Deshka river (at PRM 45.1) was considerably warmer than adjacent segments of the Susitna main stem (at PRM 33.6 and 59.9), with water temperatures ranging from 9.5°C to 22.5°C from mid-June to mid-September. Above the confluence with the Deshka River, at PRM 59.9, water temperature in the Susitna mainstem ranged from just below 7°C to just over 13°C during that same period (Study 5.5 ISR Appendix B, Figure B-3). Below the confluence of the Deshka River, at PRM 33.6, Susitna River water temperatures were consistently 0.5°C to 1°C warmer than above the confluence – ranging from just over 7°C to just over 14°C (Study 5.5 ISR Appendix B, Figure B-2). This observed shift in main stem water temperatures suggests that during summer 2013, the inflow of the Deshka River may have influenced water temperatures in the main stem of the Susitna. In summer 2014, water temperatures in the Deshka River were again warm, ranging from 9.5°C to 21.5°C (Figure 5.2-2). Above the confluence (PRM 59.9), temperatures ranged from 6.5°C to 13.5°C, while below the confluence (PRM 33.6) temperatures ranged from 7.5°C to 14.8°C, suggesting that the Deshka River may have influenced main stem water temperatures in summer 2014 as well as summer 2013.

Influence of Talkeetna and Chulitna Rivers

The Talkeetna and Chulitna rivers meet the Susitna River at approximately the same river mile. During summer 2013, the trends in water temperature observed in the main stem and major tributaries (e.g., Study 5.5 ISR Appendix B, Figure B-2) were muted at the Chulitna River site (PRM 118.6), located slightly above its mouth (see thermistor location in Study 5.5 ISR Appendix A, Figure A-11a). The range of water temperatures in the Chulitna from mid-June to mid-September 2013 was 4°C to 8°C – a much smaller and less variable temperature range and considerably colder temperatures than were observed at other tributary or main stem sites (Study 5.5 ISR Appendix B, Figure B-7). In the Talkeetna River (PRM 102.8), temperatures ranged from 6°C to 14°C during this same period (Study 5.5 ISR Appendix B, Figure B-5). Just upstream of the confluence of the three rivers at PRM 107 on the Susitna River, water temperatures during summer 2013 ranged from approximately 7°C to 16.5°C (Study 5.5 ISR Appendix B, Figure B-6). After the confluence, at PRM 99.2, the observed summer temperatures were 0.5 to 2°C cooler (6 - 14°C; Study 5.5 ISR Appendix B, Figure B-5). This suggests that the inflow of the Chulitna and Talkeetna rivers influenced summertime water temperatures in the Susitna River during 2013.

The two rivers appeared to have a similar effect on main stem water temperatures in summer 2014. During this period, water temperatures in the Chulitna (PRM 118.6) ranged from 4°C to 9.3°C, while temperatures in the Talkeetna (PRM 102.8) ranged from 6°C to 13°C. Temperatures in the Susitna River above the confluence ranged from 7.8°C to 14.2°C, while temperatures below the confluence ranged from 7.1°C to 13.7°C, again suggesting that the inflow from the Chulitna and Talkeetna rivers lowered main stem temperatures. The Chulitna River likely has a greater impact on Susitna water temperatures than the Talkeetna, due to its larger discharge and colder temperature.

Influence of Gold Creek

Throughout summer 2013, water temperatures in the main stem of the Susitna River below the mouth of Gold Creek (PRM 140.0) ranged from 6 to 15.5°C (Study 5.5 ISR Appendix B, Figure B-10). Temperatures in Gold Creek itself (at PRM 140.1) were within the same range (6-15.5°C; Study 5.5 ISR Appendix B, Figure B-10). No thermistor was located in the main stem above the mouth of Gold Creek, but one was placed in a side channel of the Susitna above the confluence (PRM 141; Study 5.5 ISR Appendix A, Figure A-21a), and although water temperatures at this site may or may not be representative of water temperatures in the main channel, the observed water temperatures were very similar (6-15°C) to those at the lower site and in Gold Creek itself (Study 5.5 ISR Appendix B, Figure B-11). The close agreement between all three temperature records suggests that Gold Creek did not influence water temperatures in the main stem during summer 2013. In summer 2014, temperatures in the Susitna River side channel ranged from 6°C to 13°C. Water temperatures in the main stem Susitna River downstream of Gold Creek (PRM 140: 7.3- 14.4°C) were similar or slightly warmer than temperatures in Gold Creek (PRM 140.1: 6.9-14.2°C), again suggesting that the inflow of Gold Creek did not influence main stem water temperatures. In addition, the discharge from Gold Creek is likely too small to affect water temperatures in the main stem river.

Influence of Indian River

The summer 2013 water temperature record from the side channel at PRM 141 (for location see Study 5.5 ISR Appendix A, Figure A-21a), though not necessarily representative of the main channel, can also be compared to the main stem record upstream at PRM 142.3, just above the mouth of the Indian River. Water temperatures at the lower side channel site (6-15°C) were slightly cooler than water temperatures at the upper site (~6 to 15.5°C, at the bottom of the water column) over the course of summer 2013 (Study 5.5 ISR Appendix B, Figures B-11 and B-12). Temperatures in Indian River (PRM 142.2) were generally 0.5 to 2°C cooler than in the main stem Susitna River during this same period, and were never above 13°C. However, the discharge of the Indian River is small enough that it likely did not influence water temperatures within the main stem in summer 2013, or in summer 2014. In summer 2014, the side channel at PRM 141 was much cooler (6-13°C) than the main stem above the mouth of the Indian river at PRM 142.3 (7.6-14.7°C). In the Indian River, temperatures ranged from 5.2°C to 12.6°C during this same period. Again, however, the inflow from the Indian River was too small to influence main stem temperatures, and the cold temperatures observed in the side channel at PRM 141 may not have been representative of those in the main channel.

Influence of Portage Creek

During summer 2014, water temperatures in the main stem of the Susitna River at PRM 152.7, above the mouth of Portage Creek, ranged from 7.2°C to 14.5°C. Below the confluence, at PRM 152.2, water temperatures in the Susitna main stem ranged from 4.2°C to 11.2°C during this same period. Within Portage Creek (PRM 152.3), water temperatures ranged from 4.1°C to 10.7°C. This suggests that in summer 2014 the inflow of cool water from Portage Creek may have been enough to lower water temperatures within the main stem of the Susitna River.

5.3. Meteorological Characterization

The results of the low pass filtered, quality assurance reviewed meteorological observations recorded at the three stations over the period September 2012 to October 2013 are reported in the ISR Part A Section 5. The MET Station data collected at ESM-1 (Watana Dam), ESM-2 (Oshetna River), and ESM-3 (Indian River) from November 2013 through August 2015 will be used for calibrating the temperature model for the reservoir and river and for calibrating the ice model in the reservoir. This data is currently undergoing quality assurance review and will be reported in Study 5.6 (Water Quality Modeling) SCR.

5.4. Baseline Water Quality Monitoring

A list of the water quality parameters measured during this study is presented in Table 4.3-2. Parameters measured in 2013 are provided in two graphical forms in the ISR Part A: 1) by PRM and date to illustrate changes with depth across the river, and 2) using scatter plots for each site to illustrate horizontal changes across each transect. Complete in-situ baseline water quality parameters collected throughout the study area from June 2013 through September 2013 are reported in Appendix D of the ISR. The location of the baseline water quality field data on the Project website is provided in Table 5.1.

For the 2014 data, a subset of parameter results are provided in graphical form by PRM and date in order to illustrate water quality conditions between sites in the study area and over time. All 2014 baseline water quality field and laboratory data and summary graphs can also be found on the Project website (Table 5.1).

5.4.1. Water Temperature

This temperature monitoring is distinguished from the continuous water temperature monitoring in that the results are generated by collecting point samples in the field synchronous with other sampling.

In 2013, water temperature measurements tended to be the highest during the July sampling event with site averages around 14°C. The lowest temperatures were reported during the September 2013 sampling and averaged around 8°C. Appendix D of the ISR Part A contains figures of the water temperatures for each baseline monthly sampling site.

Summer 2014 water temperatures tended also to be the highest during July 2014 with site averages of around 11°C, which is 3ºC lower than the 2013 averages. The lowest temperatures were reported in September 2014 and averaged around 8°C. Figure 5.4-1 illustrates water temperatures for each baseline site during the August 2014 sampling event, which is a subset for all other figures showing field determined parameter data.

Water temperature during January and March 2014 was consistently 0ºC.

5.4.2. Dissolved Oxygen (DO)

DO concentrations were similar from July 2013 to September 2013 throughout the river and tributaries except for the Chulitna River. The Chulitna River had an average DO concentration of 13 mg/L while the mainstem Susitna sites averaged 11 mg/L. See ISR Part A Section 5.5 for figures of the 2013 data.

Summer 2014 DO concentrations were similar from July 2014 to September 2014 throughout the river and tributaries except for the Chulitna River in which the average concentration was around 12.5 mg/L, while the mainstem Susitna averaged 11.5 mg/L. Figure 5.4-2 provides an example of DO measurements by PRM for each site. All summer DO concentrations measured at mainstem and tributary sites were within the ADEC water quality criterion of >7.0 mg/L and <17.0 mg/L. Mainstem winter DO concentrations were a little higher averaging 13.4 mg/L in January 2014 and 11.7 mg/L in March 2014.

5.4.3. pH

Average pH values in 2013 ranged from pH 8 for the mainstem to lower values in tributaries (around pH 7), which were observed at the Deshka River. Summer 2014 average pH ranged from 7.7 for the mainstem, while tributary sites had lower pH values of around 7.45 (e.g., Deshka River). Winter 2014 pH averaged around 7.0. Water quality criteria established by ADEC for this basin is 6.5 to 8.5 unit pH range; all observations collected at mainstem Susitna River and tributary sites met this criterion.

5.4.4. Nutrients

Nutrients are defined as nitrate/nitrite, ammonia, TKN, TP, and orthophosphate (Table 4.3-2). All baseline water quality nutrient data can be found on the Project website (Table 5.1).

The orthophosphate concentrations in 2013 ranged from non-detectable to a maximum of 12 µg/L, while ammonia concentrations ranged from non-detectable to a maximum of 0.153 mg/L. Ammonia concentrations were highest in June, and largely undetectable by September.

The TP results from 2013 did not meet acceptance limits following a quality assurance review. These results were overestimates due to effects from high concentrations of fine TSS that affected laboratory analysis method results. Sample results for TKN and nitrate/nitrite were also suspect, and failed QA/QC review. The rejected data will not be used in calibrating the EFDC water quality model.

To replace these data, additional samples for TP, TKN, and nitrate/nitrite were collected in summer 2014. TKN and nitrate/nitrite samples were collected and analyzed normally, and passed QA/QC review. TP samples were collected using split sample analysis between two independent laboratories (see Section 4.3.1). Ten 2014 TP samples were also analyzed using two different analytical methods (one method used to verify results from the other) to estimate the interference from the TSS and generate a correction factor for the data (see Section 4.3.1).

As a result of the Steps A to D procedure described in Section 4.3.1, the average measured TP due to interference from TSS was approximately 78% for the EPA Method 365.1 and 80% for EPA Method 200.8. While the two methods produced similar results, EPA Method 200.8 produced slightly higher results compared with EPA Method 365.1. Overall, the direct correction of these ten samples produced TP values that are still unexpectedly high for a river draining a relatively pristine watershed. Corrected TP concentrations ranged from 4 to 197 µg/L and were generally the highest in June 2014 and July 2014.

Nitrate/nitrite concentrations were lowest in August 2014 and September 2014 and ranged from non-detect to 170 mg/L. TKN concentrations ranged from non-detectable concentrations to 579 µg/L.

Samples collected in winter (January and March 2014) were analyzed for nutrients. Nitrate/nitrite concentrations ranged from 0.1 to 0.3 mg/L, with concentrations increasing in the downstream direction. Orthophosphate concentrations ranged from non-detectable to 12 µg/L and increased with concentrations increasing in the downstream direction. TKN concentrations in January ranged from 0.25 to 0.45 mg/L (Figure 5.4-3). There was only one TKN detectable concentration that occurred during the March 2014 sampling event at PRM 185. Corrected TP concentrations from 2014 winter data ranged from 5 to 20 µg/L.

5.4.5. Chlorophyll-a

Water samples were collected for chl-a analysis at all baseline water quality monitoring locations in June 2013, July 2013, August 2013, and September 2013 as outlined in Section 5.5.4.4 of the RSP. Chl-a samples were filtered and frozen at the end of each day. Chl-a concentrations in the mainstem of the Susitna River ranged from 0 to 2.5 µg/L. Lower concentrations were measured in June 2013 and July 2013 with only a few locations having concentrations above 0 µg/L (see ISR Part A Section 5).

Chl-a in streams is usually low in fast-flowing streams with little plankton algae and algae that is suspended in the water column are eroded from surfaces of bottom substrata. Periphytic, or attached algae, are the main primary producers in fast-flowing streams and rivers and usually occur at densities of 50-100 mg/m^2 chl-a in oligotrophic waters to several 100 mg/m^2 in eutrophic waters. Dividing 100 mg/m^2 by a stream water column depth of 1 m gives an equivalent volumetric concentration of 100 mg/m^3 or µg/L. Small stream water measured concentrations of chl-a represent only the sloughing or erosion of attached periphytic algae, the principal stream producers.

Higher concentrations occurred in August 2013 and September 2013 (Figures 5.4-4 and 5.4-5). Chl-a concentrations were highest in the Deshka River, the Chulitna River, and at mainstem stations PRM 87.8 (Susitna at Parks Highway East) and PRM 59.9 (Susitna Station). Figure 5.4-6 and Figure 5.4-7 illustrate chl-a concentrations at Deshka River and PRM 124.2 (Curry Fishwheel Camp), respectively. Appendix E of the ISR contains chl-a data for all baseline monitoring locations. The location of the baseline water quality data on the Project website is also provided in Table 5.1.

Chl-a was sampled only during the winter in 2014. Chl-a concentrations were all non-detectable in the mainstem of the Susitna River.

5.4.6. Turbidity

In 2013, turbidity samples collected for lab analysis ranged from 95 NTUs (PRM 33.6; Susitna River above the Yentna River) in September 2013 to 950 NTUs below the Yentna River in July 2013. The Susitna River above the Yentna River had turbidity readings from 650 NTUs to 700 NTUs during the same month (July 2013). The Susitna River at the downstream PRM 29.9 site had a turbidity range of 750 NTUs to 950 NTUs during the month of July 2013 showing the influence the Yentna River has on the mainstem of the Susitna River downstream of the confluence.

Winter 2014 turbidity measurements ranged from 1-4.5 NTUs. These samples were analyzed in the laboratory only.

Samples were collected and analyzed for turbidity in summer 2014 using both the Hydrolab® water quality instrument and laboratory analyses. The results were consistent between the laboratory and field instruments.

Limited 2014 summer baseline sampling for turbidity was as low as 5.5 NTU in the Oshetna River. Maximum turbidity measurements were made on the mainstem of the Susitna River at PRM 59.9, with a high of 1,045 NTUs. The lowest turbidity measurement was recorded in August 2014 and the highest during June 2014. The mainstem turbidity conditions of the Susitna River are only affected by the largest tributaries. The turbidity in the Lower River mainstem is influenced by the three major tributaries: the Chulitna, Talkeetna, and Yentna rivers. All turbidity data collected during 2013 and 2014 can be found on the Project website (refer to Table 5.1 for web links to the data).

5.4.7. Metals

Specific metals analyzed as part of the baseline water quality program are listed in Table 4.3-2. After QA/QC review, 2013 total metals results except for Ca and Mg, as well as dissolved Al were rejected or estimated due to effects from fine TSS. Dissolved metals results that met acceptance limits were graphed and compared to Alaska Water Quality Standards (AWQS) (an example is provide in Figure 5.4-8.). Dissolved Fe concentrations in August 2013 exceeded water quality criteria at three Middle River sites (Figure 5.4-8). Total Mg concentrations were often around 10-15 mg/L throughout the river. Dissolved criteria were exceeded each month at the Deshka River site. Additional dissolved Mg exceedances occurred in August 2013 in the Lower to Middle River reach.

Water samples were collected again during summer 2014 for metals analyses. The samples were analyzed for total and dissolved Al, As, barium (Ba), Fe, THg and Mg. Exceedances of AWQS include total manganese (Mn) at nearly every site in July 2014 and August 2014 and minimal exceedances in September 2014. Exceptions without exceedances included clear water sites (e.g., Deshka River and Talkeetna River) in June 2014. In June 2014, total Fe concentrations also exceeded AWQS except in the Deshka River and Talkeetna River (Figure 5.4-9, PRM 45.1 and 102.8). As exceeded water quality criteria in July 2014 and August 2014. THg exceeded criteria (12 ng/L) in June 2014, July 2014, and August 2014 (e.g., the Susitna River at PRM 29.9 and PRM 87.8, and the Chulitna River) of 2014. There were total Al and dissolved Al concentration exceedances at nearly every site during all sampling events during 2014.

Water samples collected in winter 2014 were analyzed for metals by a primary laboratory (the lab used in 2013) and the second (split sample) laboratory (Table 4.3-2). The second (split sample) laboratory analyzed samples for total and dissolved Al, As, Ba, Ca, Fe, Mg, and Mn. SGS performed additional analysis for dissolved and total Cr, cobalt (Co), Cu, Pb, Hg, molybdenum (Mo), Ni, Se, thallium (Tl), vanadium (Vn), and Zn. The only exceedances of AWQS for total Al were at PRM 29.9 –analyzed by the primary and secondary laboratories – and PRM 87.8 – by AR (Figure 5.4-10).

All baseline metals data can be found on the Project website (see Table 5.1).

5.4.8. Total Dissolved Solids and Total Suspended Solids

Water samples were collected in the field for total dissolved solids (TDS) analysis in the laboratory. Concentrations often ranged from 120-160 mg/L throughout the river. In September 2013 concentrations dropped to around 100 mg/L. Mean TDS concentrations are shown for each PRM in Figure 5.4-11. September 2013 TDS concentrations in tributaries like the Yentna River, Deshka River, and Chulitna River did not appear to influence downstream mainstem Susitna River concentrations as shown in Figure 5.4-11.

TSS concentrations in the summer of 2013 were typically very high in most samples, ranging from 7.78 to 1,420 mg/L, with a mean of several hundred mg/L for individual sites. Concentrations were found to decline significantly throughout the summer, with the lowest concentrations in September 2013, and the highest in June 2013. The Chulitna River had a mean TSS concentration of 1,000 mg/L. The Talkeetna River had a mean TSS concentration during the same month of 326 mg/L. Combined, the TSS concentration from these tributaries resulted in an increased mean TSS concentration at PRM 87.8 (Susitna River at Parks Highway East) of 1,174 mg/L. This pattern of tributary influence on the mainstem of the Susitna River did not occur for remaining months of July, August, or September 2013.

Only ten samples were analyzed for TSS in 2014, for use in developing a TP correction factor (see Section 4.3.1) for 2014 data results. Concentrations of TSS ranged from 170 to 750 mg/L at mainstem sites sampled in 2014.

Winter 2014 samples (January and March) had much lower concentrations of TSS, ranging from 0.645 to 7.5 mg/L at mainstem Susitna River sites.

All baseline TSS and TDS data can be found on the Project website (see Table 5.1).

5.4.9. Specific Conductance

Specific conductance was determined using field measurements. Values were uniform throughout the sampling periods in 2013 and 2014, averaging 140 µmhos/cm. Tributaries tended to have lower specific conductance than the mainstem Susitna River sites. Examples of specific conductance scatter plots developed for each monitoring location in 2013 are shown in Section 5 of the ISR. An example figure showing summer 2014 specific conductance by PRM developed for each month is shown in Figure 5.4-12.

Conductivity in mainstem Susitna River samples ranged from 143.7 µmhos/cm to 193.3 µmhos/cm in September 2014 (Figure 5.4-13) with the highest conductivity recorded at PRM 235.2 above the Oshetna River. The lowest conductivity measured was at the Deshka River (PRM 45.1) which is not fed by glacial runoff with a range from between 44.5 µmhos/cm and 69.2 µmhos/cm. There is an order of magnitude difference contrasted between rivers supplied by glacial meltwater and those from snow meltwater and rain runoff.

Specific conductance was approximately 200 µmhos/cm in January 2014 and was approximately 250 µmhos/cm in March 2014.

All baseline water quality field data can be found on the Project website (Table 5.1).

5.4.10. Significant Ions

Ions analyzed as part of the baseline water quality program are outlined in Table 4.3-2. Significant ions analyzed include the cations: Ca, Mg, and Na, and the anions HCO^3, CO^3 and SO_4. Laboratory analyzed data are available and reported on the Project website (Table 5.1).

5.4.11. Total Hardness

Summer 2013 water samples were collected and analyzed for total hardness in a laboratory. Hardness concentrations were the lowest in the Deshka and Talkeetna Rivers (around 30 mg/L). Other sites exhibited higher but uniform hardness values at around 60 mg/L. Total hardness in winter 2014 and ranged from 60-120 µg/L. Hardness data can be found on the Project website (Table 5.1).

5.4.12. Total Alkalinity

Summer 2013 water samples were collected and analyzed for total alkalinity in a laboratory. Alkalinity concentrations were lowest at the Deshka and Talkeetna Rivers (around 35 mg/L). Other sites had higher but uniform concentrations at around 50 mg/L. Winter 2014 results (January and March) ranged from 40-95 mg/L. All baseline alkalinity data can be found on the Project website (see Table 5.1).

5.4.13. Organic Carbon

The sampling frequency for total and dissolved organic carbon (TOC and DOC, respectively) is presented in Table 4.3-2 and the data can be found on the Project website (see Table 5.1).. In summer of 2013, TOC was highest at the clear water Deshka River (4 mg/L) (Figure 5.4-14). All other sites exhibited lower but largely uniform concentrations of TOC at around 0.5 to 1.0 mg/L. Winter 2014 TOC ranged from 1.0 to 2.6 mg/L. An example figure with data from January 2014 is shown in Figure 5.4-15.

Summer 2013 DOC results for the same samples show DOC was also highest at the clear water Deshka River (12.9 mg/L in September). All other sites exhibited largely uniform concentrations of DOC at around 0.5 to 1.0 mg/L, except in September, when concentrations increased at all sites to approximately 2 mg/L. Winter 2014 DOC ranged from 0.43 to 2.46 mg/L.

5.4.14. Color

This parameter was collected during water quality baseline monitoring in 2013 only. Apparent color (i.e., not filtered) was determined in situ. Results were near or greater than 500 for all sites except for the Deshka River, which was around 25. Apparent color decreased in September 2013 and became varied from site to site. True color (i.e., filtered) values generally ranged from 0 to 50 for all sampling locations. Results are provided in Appendix D of the ISR Part A.

5.4.15. Redox Potential

Redox potential was determined in situ. Results averaged 350 mV in summer 2013, and were consistent throughout sampling sites and sampling events. Redox potential was also monitored in summer and winter 2014. Results averaged 400 mV in summer 2014, and were consistent throughout sampling sites and events. Winter results averaged 400 mV (January) to 440 mV (March) (Figure 5.4-16). All baseline water quality field data can be found on the Project website (Table 5.1).

5.4.16. Other Water Quality Parameters

One-time sampling occurred in 2013 for a limited number of analytes (BETX, PAHs, radionuclides, Al, Cr, Se, fecal coliform, and TOC). Samples were collected in September 2013 for analysis in a laboratory. Specific parameters analyzed are outlined in Table 4.3-2. Fecal coliform is the only parameter that exceeded AWQS and at only one site. The Deshka River had concentrations of fecal coliform around 30 cfu/100mL, which exceeded the criteria by 10 cfu/100 mL. Ethylbenzene was detected once at PRM 33.6. Xylene was detected once in Indian River while napthalene was detected in the Deshka River. The Susitna River at PRM 59.9 was the only site on the mainstem where naphthalene was found (Figure 5.4-17). All baseline water quality data are available on the Project website (Table 5.1).

Radionuclides were measured in water samples at all baseline water quality monitoring sites in September 2013. Uranium concentrations were detected at each of the sites, but at concentrations below the ADEC drinking water criterion of 30 µg/L (Figure 5.4-18). The highest concentration of uranium measured at baseline water quality sites was at the Chulitna River. The second highest uranium concentrations were measured one time in the Yentna River and in the Susitna River at Sunshine (PRM 29.9, below the Yentna River confluence).

5.5. Focus Area Water Quality

Analytical parameters for each Focus Area site sampled are summarized in Table 4.3-2. Focus Areas were re-sampled in 2014 for select water quality parameters for which the 2013 samples failed to meet quality assurance criteria. The water quality parameters that were rejected from the 2013 data validation/verification process for failing to meet quality assurance criteria are described above in Section 5.1.1. All in situ and laboratory determined parameters were assessed for QA/QC and summarized below. These data are available on the Project website (Table 5.1).

5.5.1. Water Temperature

Water temperature measurements were collected in situ. FAs were monitored in 2013 beginning July 22, 2013 through August 26, 2013. Water temperatures were higher at all FAs nearer the end of July 2013 with site averages around 14°C. The lowest temperatures occurred during the end of August 2013 and averaged around 9°C. Point sample temperatures differed from the mainflow areas of the FAs and were either higher or lower than at transects, depending on the date sampled (3 sampling events occurred at the FAs during 2013). A complete set of Focus Area field parameters are included in the ISR Part A Appendix G and temperature data figures are included in the ISR Part A Section 5.

In 2014, temperatures were highest in July, with site transect averages around 10.3°C. The lowest temperatures recorded were during September 2014 and averaged around 8.5°C. Point sample temperatures were generally lower than temperature recorded from transect samples. Figure 5.4-19, reports temperatures for FA-104 (Whiskers Slough) during the abbreviated site sampling of FAs in 2014. Similar figures are posted to the Project web site and accompany finalized data sets for 2013 and 2014.

5.5.2. Dissolved Oxygen

DO concentrations were determined in situ. On average, measurements in the main channel of each FA were around 11 to 12 mg/L. Sloughs, such as FA-144 (Slough 21) had lower concentrations with an average of 7 to 8 mg/L. The last sampling event at the end of August 2013 had the highest DO average concentrations at FAs near 12 mg/L.

5.5.3. pH

Measurements for pH were determined in situ. During all sampling events, pH values tended to be uniform around pH 7.5 to 8. Point samples in sloughs, e.g., FA-144 (Slough 21), were often slightly lower (average near pH 7), depending on location.

5.5.4. Nutrients

Nutrients are defined as nitrate/nitrite, ammonia, TKN, TP, and orthophosphate (Table 4.3-2).

The orthophosphate concentrations in 2013 ranged from non-detectable to a maximum of 60 µg/L in all Focus Areas, while ammonia concentrations ranged from non-detectable to a maximum of 0.153 mg/L. Ammonia concentrations were highest in June, and largely undetectable by September.

As previously described, the TP results from 2013 did not meet acceptance limits following a quality assurance review. To replace these data, additional samples for TKN and nitrate/nitrite were collected in summer 2014. TKN and nitrate/nitrite samples were collected and analyzed normally, and passed QA/QC review. Nitrate/nitrite concentrations were lowest in August 2014 and September 2014 and ranged from non-detectable to 1.8 mg/L. TKN concentrations ranged from non-detectable concentrations to 1.6 mg/L (example data from FA-141 shown in Figure 5.4-20).

5.5.5. Chlorophyll-a

Water samples were collected for chl-a samples in Focus Areas at all surface water transect locations as well as at point sample locations as reported in Section 5.5.4.5 of the RSP. Chl-a concentrations ranged from 0 to 3.5 µg/L in the Focus Areas for all three sampling events in 2013. The maximum chl-a concentration was observed at FA-144 (Slough 21) in the upstream transect of the mainstem on August 21, 2013. Chl-a concentrations varied in all Focus Areas among mainstem surface water transects and point samples with concentrations in sloughs, side channels, and side sloughs being generally higher than in the mainstem. Mean chl-a concentrations at the Focus Areas can be found in Appendix G of the ISR. All chl-a data can be found on the Project website (Table 5.1).

5.5.6. Turbidity

Water samples were collected for turbidity analysis and determined in a laboratory as well as in the field using a Hydrolab® water quality instrument. Quality assurance review of turbidity data using the Hydrolab® did not meet acceptance limits following quality assurance review. Turbidity measurements reported from the laboratory samples were valid with very few measurements that had qualifications and are cleared for further use. Turbidity measurements were determined again in 2014.

Turbidity measurements collected at Focus Areas were from the mainstem and from side-channel point locations. Mainstem Focus Area turbidity measurements were similar to conditions at the baseline monitoring sites where low turbidity measurements (1.4 NTU) were locations where clearwater tributaries (FA-144 (Slough 21)) entered the main channel and water separated from the more turbid mainstem Susitna River water. Other mainstem Susitna River locations had turbidity as high as 547 NTUs reflecting a well-mixed mainstem location (FA-113 (Oxbow I)).

5.5.7. Metals

Water samples were collected in the field for metals analysis in a laboratory. Specific metals analyzed as part of the Focus Area water quality program are outlined in Table 4.3-2. After QA/QC review, the 2013 samples for total metals, except for Ca and Mg, as well as dissolved Al, were reported as either not included or estimated, due to errors in laboratory analysis from matrix interference. Dissolved metals that passed data validation requirements were graphically compared to AWQS (e.g., Fe, Figure 5.4-21). Dissolved Fe concentrations exceeded water quality criteria at the following Focus Areas: FA-128 (Slough 8A), FA-138 (Gold Creek), FA-141 (Indian River), and FA-144 (Slough 21). All baseline water quality data can be found on the Project website (Table 5.1).

Water samples were collected again from the Focus Areas in 2014 and analyzed. AWQS for total and dissolved Al, Fe and Mn were exceeded at nearly every Focus Area sampling site during July. Concentrations were lower during September 2014 with few exceedances (see example Figure 5.4-22).

5.5.8. Specific Conductance

Specific conductance was collected in situ and averaged 150 µmhos/cm for most transect sites. Point samples were either lower or higher depending on location. For example, the side slough in FA-104 (Whiskers Slough) averaged 25 µmhos/cm in 2013.

5.5.9. Total Hardness

Water samples were collected for total hardness determined in a laboratory. Hardness concentrations were the highest at FA-138 (Slough 11) at around 140 mg/L. Other sites exhibited similar hardness values at around 500-100 mg/L.

5.5.10. Organic Carbon

Water samples were collected for organic carbon (TOC) analysis in a laboratory. The sampling frequency for TOC are presented in Table 4.3-2. TOC was highest overall at all sites during the end of August and highest at FA-104 (Whiskers Slough) at 10 mg/L. All other sites during the end of July through early August exhibited similar concentrations of TOC at around 0.5 to 1.0 mg/L (example data from FA-128 shown in Figure 5.4-23).

5.5.11. Redox Potential

Redox potential was measured in in situ. Values were uniform throughout the areas, with an average range of 300 to 350 mV in 2013, and 400 to 450 mV in 2014.

5.6. Sediment Samples for Mercury/Metals in the Reservoir Area

Sediment and porewater samples were collected from four locations in 2013: Mouth of Oshetna Creek, Mouth of Kosina Creek, Mouth of Goose Creek, and the Mouth of Jay Creek (Study 5.7 ISR Figures 4.2-14 and 4.2-15). Example results are shown for Zn in Figures 5.5-1 through 5.5-2. All sediment and porewater data are available on the Project website (see Table 5.1). In 2014, sediment and porewater samples were collected from ten locations including the six sites that were inaccessible in 2013. Laboratory results for these samples are presented in graphical form as examples shown in Figure 5.5-3 and Figure 5.5-4.

5.7. Baseline Metals in Fish Tissue

The results of this study component were reported in the ISR Part A. No additional work occurred in 2014.

5.8. Thermal Infrared Remote Sensing

The results of this study component were reported in the ISR Part A Section 5.7 and Appendix J. No additional work occurred in 2014.

5.9. Groundwater Quality in Selected Habitats

The results of the groundwater sampling can be found in the Groundwater Study (Study 5.7) ISR Part A and the Study Implementation Report.

6. DISCUSSION

The data collected as part of this study is intended to establish a baseline of information used for comparison with post-Project conditions. It will also be used to provide input data for models used to predict water quality conditions after construction of the dam. Several elements of the water quality are intended solely to support other studies, and are not discussed in this section:

- The TIR study was created to help identify sections of the river that may be under significant groundwater influence, as part of Study 8.5 (Fish and Aquatics Instream Flow Study Implementation Report or SIR). The complete dataset is provided in Study 5.5 ISR.
- Mercury sediment, surface water, and porewater sampling, while conducted in conjunction with the other water quality sampling, is discussed in the Study 5.7 Mercury Assessment and Potential for Bioaccumulation SIR.
- All fish, bird, and mammal tissue sampling is discussed in the Study 5.7 Mercury Assessment and Potential for Bioaccumulation SIR.
- Groundwater samples were collected in support of the Instream Flow Study (8.5) and the Groundwater Study (7.5). The results are discussed there.

The following sections summarize the adequacy of data collected in meeting Study objectives as listed in Section 5.5.1 of the RSP.

6.1. Historical Water Quality Data

Water quality monitoring information was examined from historical sources and compared with data collected in this study (Table 6.1-1 through Table 6.1-3). The current water quality data set is more comprehensive than the historic data set and fills in gaps of information that have been important for developing the EFDC model (Study 5.6). Based on a review of this data, it appears that the range of conditions in the Susitna Basin have not changed significantly since the 1980s. The available historical data is useful and appropriate for use in calibrating the models, but is not high enough resolution to serve as the primary source of information to support the modeling. Comparison with historical data shows that water quality conditions have not changed over the past approximately 30 years and is typical of water quality in glacial-fed Alaska streams.

6.2. TP Corrected Results

TSS concentrations in the Susitna River affected results for analyses of TP in grab samples collected for baseline and Focus Area water quality monitoring. Analysis of redigested samples from 2014 by ARI demonstrated that TSS accounted for an average 80% overestimate of the TP reported using the two EPA methods. As a result, 2014 TP results for sites where split samples were not collected were corrected by subtracting the average overestimate (80%) accounted for by TSS [$TP_{Corrected} = TP_{Whole} - (TP_{Whole} * 0.8)$]. The correction factor provides an accurate estimate based on laboratory results demonstrating the influence of TSS in estimating TP.

Total phosphorus concentrations estimated from samples collected in 2013 did not meet acceptance limits established in the Quality Assurance Project Plan (QAPP). Specifically, the matrix spikes and matrix spike duplicates demonstrated an over-recovery of the known amount and this translated into overestimation of TP in the samples. Laboratory results for TP were further examined in 2014 by determining the source of the overestimate by testing effects from sample collection bottles, preservative used in the field, and by laboratory split sample analysis.

Initial indication of a problem with TP concentration estimates was from sites in the basin with high turbidity and concentrations of TP were two to three orders of magnitude higher than sites with little or no turbidity. Winter 2014 samples from mainstem sites had little to no turbidity and had TP concentrations that were low in comparison to TP concentrations at the same sites in summer 2013 where overestimates were identified. Other indicators confirming a problem with overestimation of TP concentrations included: no increase in Chl a, conductivity, SRP (soluble reactive phosphorus), or Nitrogen (TKN). Some TP concentrations were representative of levels that are measured from raw sewage samples and this is not reflective of the Susitna River basin or the geochemistry. It was also noted that in estimating TP concentrations from samples collected from glacial meltwater that “interference” by fine suspended solids is an issue with analytical methods. There is no historical TP data available from the 1980s studies that could be summarized in an initial data gaps report (URS 2011) and used for comparison with the current Study 5.5. Comparing ratios of total nitrogen (TN) to total phosphorus (TP) is a common way to evaluate the limiting nutrient for phytoplankton growth in freshwater ecosystems (commonly referred to as the Redfield Ratio; Redfield 1934). This N:P ratio is constant throughout nature (16:1) with little deviation among ecosystems. In evaluating the 2013 laboratory results using this established relationship for N:P, nitrogen was often one to two orders of magnitude lower than phosphorus and this does not occur in nature.

6.3. Comparison to Regulatory Standards

Protected water use classes and subclasses in Alaska are defined for freshwater and marine water resources in 18 AAC 70.020(a). Water quality standards for these protected uses are described in 18 AAC 70 (AWQS amended as of April 8, 2012), and the Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances as amended through December 12, 2008, and have been adopted by ADEC. The numeric criteria (Table 6.3-1 and Table 6.3-2) apply to uses such as drinking water, stock water and irrigation, freshwater aquatic life, marine aquatic life, wildlife, and human health for consumption of water and/or aquatic organisms.

The concentration of contaminants in the Susitna River can also be compared to the National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRTs) (Table 6.3-3).

In summary, the concentrations of several metals routinely exceeded both NOAA SQuiRT and AWQS. The metals that most commonly exceeded standards were:

2013

- Dissolved Fe concentrations in August 2013 exceeded water quality criteria at three Middle River sites.
- Total Mg concentrations were often around 10-15 mg/L throughout the river.
- Dissolved Mn criteria were exceeded each month at the Deshka River site. Additional dissolved Mn exceedances occurred in August 2013 in the Lower to Middle River reach.

2014

- Total Mn at nearly every site in July 2014 and August 2014 and minimal exceedances in September 2014. Exceptions without exceedances included clear water sites (e.g., Deshka River and Talkeetna River) in June 2014.
- In June 2014, total Fe concentrations exceeded ADEC water quality criteria except in the Deshka River and Talkeetna River (Figure 5.4-9). Total Fe concentrations also exceeded criteria later in the summer (summer 2014 total Fe at PRM 235.2 and PRM 29.9 shown in Figures 6.3-1 and 6.3-2).
- As exceeded water quality criteria in July 2014 and August 2014.
- THg exceeded criteria (12 ng/L) in June 2014, July 2014, and August 2014 (e.g., Susitna River at PRM 29.9 and PRM 87.8, and the Chulitna River) of 2014.
- There were total Al and dissolved Al concentration exceedances at nearly every site during all sampling events during 2014 (summer 2014 total Al at PRM 235.2 and PRM 29.9 shown in Figures 6.3-3 and 6.3-4).

Exceedances of surface water quality standards by natural surface water are not uncommon in Alaska, particularly by these metals. The cause is usually the result of naturally occurring minerals or the degradation of naturally-occurring organic compounds (USGS 2001). It should be also noted that the Susitna River basin is a productive and natural ecological environment, and these natural exceedances do not appear to be adversely impacting wildlife.

6.4. Variation in Analyte Concentration by Season

Significant changes in select water quality parameters were observed between summer and winter. This was especially the case where TSS reach a maximum of 780 mg/L at PRM 29.9 during July 2013 (Figure 6.4-1) and low of 0.65 mg/L in March 2014. A greater seasonal difference was for TSS was recorded at PRM 140.1 where the maximum concentration was 1,050 mg/L in June 2013 (Figure 6.4-2) and 1.55 mg/L in January 2014. The same pattern existed for turbidity at these two sites (Figure 6.4-3 and Figure 6.4-4). Water temperature varies on a daily basis, as well as on a monthly average, and displays a distinct seasonal pattern (Figure 5.2-5). Concentrations of metals, especially the total fractions (e.g., Zn, Figure 6.4-5), closely track TSS trends (Figure 6.4-1) whereas dissolved organic carbon (Figure 6.4-6) is closely associated with dissolved metals (e.g., Zn, Figure 6.4-7) fractions in water (Rember and Trefry 2003).

6.5. Adequacy of Data to Support Modeling

Water quality data rejected for failing to meet quality assurance performance thresholds from the 2013 monitoring effort in both the Baseline Monitoring and Focus Area Monitoring programs prompted additional sampling in 2014. Even though rejected data from 2013 resulted in an overestimate of concentrations for select water quality parameters, data generated at the same locations from baseline monitoring and from Focus Area monitoring in 2014 were validated and will be used for calibration of the water quality model (Study 5.6).

Water quality data was validated using the thresholds reported in Section A.7.2 in Attachment 5-1 of Section 5 in the RSP. During this validation process a number of data observations representing several parameters from 2013 sampling were rejected from further use.

Concentrations for these rejected water quality data are biased high and may exceed many of the water quality criteria if not flagged and re-evaluated for more accurate estimates by accounting for interference elements in the water (e.g., TSS and sample preservative). Water quality data collected in 2014 at all baseline monitoring locations and Focus Areas were corrected for elements interfering with accurate estimates for concentration. These data can be used without further qualification in calibration of the water quality model.

The data set collected for this study is very large, with thousands of measurements collected over three years from multiple locations between Susitna Station (PRM 29.9) and the Oshetna River (PRM 235.2). Combined with the historical data set from the 1980s, the entire data set is more than sufficient to generate and support the water quality model (Study 5.6), which is the primary goal of this study.

6.6. Stream Temperature Monitoring and Meteorological Data

Stream temperature data was collected from June 2012 until September 2014. This represented three years of monitoring data collection. Temperature data was not collected continuously at every planned baseline monitoring sites due to site access limitations in 2013 as described in Section 6 of Study 5.5 ISR Part A and loss of loggers. The lack of continuous temperature data at every site over the three year period will not impact the results of this study, given that relatively little variation in temperature was noted between monitoring sites on the river and many sites throughout the river were monitored at some time during the 3-year period. Table 6.1-1 compares historic temperature data ranges with current data ranges collected during 2013 and 2014. Based on similarity of temperature data collected at each of the sites from 2012 through 2014 and in comparison to historic temperature data, the current data set is considered adequate to finalize calibration of the temperature water quality model. The first two years of temperature data (2012 and 2013) are currently being used to calibrate the water quality model and the 2014 temperature data is being used as an independent data set for verification of model accuracy.

6.7. Extension of Water Quality Model

Extending the water quality model below PRM 29.9 was evaluated and results reported in a Technical Memorandum filed September 2014. Calibration temperature and dissolved oxygen data were used from a wet year (model runs over a three-year period ended in 1981) and a dry year (model runs over a three-year period ended in 1976) (Section 5.2, AEA 2014c). Findings from this study showed little or no change in water temperature patterns throughout the year. Similarly, dissolved oxygen concentrations are expected to show no difference between pre-Project and Post-project conditions below PRM 29.9. The model runs demonstrated that oxygen remained near saturated, especially in the lower 90 miles of the river. The primary factor that promotes near saturation of oxygen is surface water temperature. No further water quality sampling or modeling will be conducted below PRM 29.9 shows little or no change in temperature patterns over the year.

7. CONCLUSION

The Baseline Water Quality Study was completed to support development of water quality models. The field work, data collection, data analysis, and reporting for this Baseline Water Quality Study successfully met all study objectives in the FERC-approved Study Plan. A complete data set has been generated for both the baseline and Focus Area sites that meet study objectives.

8. LITERATURE CITED

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9. TABLES

Table 4.1-1. Susitna River Basin Temperature and Water Quality Monitoring Sites

PRM	Description	Latitude (WGS84)	Longitude (WGS84)	Water Temperature							Water Quality Monitoring					Location Rationale
				Historic		Current					Historic		Current			
				W	S	S	W	S	W	S	W	S	S	W	S	
						2012	2012-2013	2013	2013-2014	2014			2013	2013-2014	2014	
19.9	Susitna above Alexander Creek	61.43903	-150.48456			X	X	X		X						Outer Project area site (above the "Beluga Line")
29.9	Susitna Station	61.54428	-150.51556	X	X			X		X	X	X	X	X	X	Influence of upstream tributary
32.5[1]	Yentna River	61.587604	-150.48301	X	X	X	X	X	X	X	X	X	X		X	Major Tributary
33.6	Susitna above Yentna	61.57595	-150.42741			X	X	X	X	X			X		X	Above major tributary
45.1[1]	Deshka River	61.710142	-150.32470			X	X	X		X			X		X	Major Tributary
59.9	Susitna	61.86220	-150.18463			X	X	X	X	X			X		X	Above major tributary
87.8	Susitna at Parks Highway East	62.174531	-150.173677			X	X	X	X	X			X	X	X	Mainstem river site
88.3	Susitna at Parks Highway West	62.181096	-150.16787	X	X	X	X	X	X	X	X	X				Side channel habitat connected with the mainstem
99.2	LRX 1	62.306018	-150.108764			X	X	X	X	X						Below confluence of major tributary
102.4[1]	Chulitna River	62.567703	-150.23782	X	X	X	X	X	X	X	X	X	X		X	Major Tributary (Chulitna site is below the bridge crossing on Chulitna River at George Parks Highway)
102.8[1]	Talkeetna River	62.34243	-150.11266			X	X	X		X			X		X	Major Tributary
107	Susitna River at Talkeetna	62.39724	-150.13728		X	X		X		X			X		X	Downstream of existing townsite; Historic (1980s) monitoring site
116.7	LRX 18	62.526527	-150.114671			X		X	X	X						Upstream of existing townsite
124.2	Curry Fishwheel Camp	62.61783	-150.01373		X	X		X		X			X		X	Important side channel habitat
129.6	Slough 8A	62.670479	-149.903241			X		X	X	X						**Important side channel habitat**
129.9	LRX 29	62.673914	-149.899025			X		X		X						Historic (1980s) monitoring site
132.7	Slough 9	62.702358	-149.841895			X		X	X	X						**Important side channel habitat**
134.1	LRX 35	62.713854	-149.808926			X		X	X	X						**Historic (1980s) monitoring site**
140	Susitna near Gold Creek	62.767054	-149.693532			X		X	X	X				X		Below confluence of major tributary
140.1[1]	Gold Creek	62.767892	-149.68978	X	X	X		X	X	X	X	X	X		X	Major Tributary
141.0	Slough 16B	62.780204	-149.68536			X		X	X	X						Important side

PRM	Description	Latitude (WGS84)	Longitude (WGS84)	Water Temperature							Water Quality Monitoring					Location Rationale
				Historic		Current					Historic		Current			
				W	S	S	W	S	W	S	W	S	S	W	S	
						2012	2012-2013	2013	2013-2014	2014			2013	2013-2014	2014	
																channel habitat
142.2[1]	Indian River	62.78635	-149.65878					X	X	X			X		X	Major Tributary
142.3	Susitna above Indian River	62.785776	-149.64890			X	X	X		X			X		X	Historic (1980s) monitoring site
143.6	Slough 19	62.793819	-149.614255			X		X	X	X						Important side channel habitat
143.6	LRX 53	62.79427	-149.61327		X	X		X	X	X						Historic (1980s) monitoring site
145.6	Slough 21	62.814667	-149.575329			X		X		X						Important side channel habitat
152.2	Susitna below Portage Creek	62.830397	-149.382743			X	X			X			X		X	Downstream of major tributary
152.3[1]	Portage Creek	62.830379	-149.380289			X				X						Major Tributary
152.7	Susitna above Portage Creek	62.827002	-149. 827002			X	X			X		X	X		X	Historic (1980s) monitoring site
168.1	Susitna	62.791696	-148.993825							X						Mid-point between neighboring sites
183.1	Susitna below Tsusena Creek	62.81348	-148.656868			X				X						Downstream of major tributary
184.8	Susitna River ab. Tsusena Creek	62.821783	-148.606809							X				X		Major Tributary
187.2	Susitna at Watana Dam site	62.82260	-148.55300		X		X			X			X		X	Boundary condition between the reservoir and riverine models
196.8	Susitna River above Watana Creek	62.82960	-148.25900							X						Major tributary stream to the proposed reservoir
209.2	Susitna River above Kosina Creek	62.78220	-147.94000			X	X	X	X	X						Major tributary stream to the proposed reservoir
225.5	Susitna near Cantwell	62.70520	-147.53800											X		Uppermost mainstem site in the proposed reservoir
235.2[2]	Oshetna River	62.63961	-147.383109			X	X	X	X	X			X		X	Major tributary in the Project Area

Notes:

PRM=Susitna River Project River Mile

W= Winter

S=Summer

[1] indicates the Susitna River PRM at the confluence of the tributary (samples collected from the tributary)

[2] indicates an alternate monitoring location from PRM 225.5 due to river inaccessibility by helicopter during summer sample collection (continuous temperature data was collected in the tributary and water quality samples were collected on the Susitna River above the tributary)

Table 4.3-1. Sample Location and Frequency for Monthly Baseline Water Quality Sampling

Project River Mile (PRM)[1]	Description	Sample Date(s)		
		Summer 2013	Winter 2014	Summer 2014
29.9	Susitna Station	6/25/2013	1/28/2014	6/24/2014
		7/19/2013	3/10/2014	7/23/2014
		8/19/2013		8/14/2014
		9/15/2013		9/11/2014
32.5	Yentna River	6/26/2013		6/24/2014
		8/18/2013		7/23/2014
		7/19/2013		8/14/2014
		9/15/2013		9/11/2014
33.6	Susitna above Yentna	6/27/2013		6/24/2014
		8/19/2013		7/23/2014
		7/20/2013		8/14/2014
		9/16/2013		9/11/2014
45.1	Deshka River	6/28/2013		6/24/2014
		8/19/2013		7/23/2014
		7/19/2013		8/14/2014
		9/16/2013		9/11/2014
59.9	Susitna	6/29/2013		6/24/2014
		7/19/2013		7/23/2014
		8/19/2013		8/14/2014
		9/17/2013		9/11/2014
87.8	Susitna at Parks Highway East	6/21/2013	1/28/2014	6/19/2014
		7/17/2013	3/10/2014	7/22/2014
		8/17/2013		8/13/2014
		9/14/2013		9/9/2014
102.4	Chulitna River	6/24/2013		6/19/2014
		7/16/2013		7/22/2014
		8/17/2013		8/13/2014
		9/13/2013		9/9/2014
102.8	Talkeetna River	6/22/2013		6/19/2014
		7/15/2013		7/22/2014
		8/16/2013		8/13/2014
		9/9/2013		9/9/2014

Project River Mile (PRM)[1]	Description	Sample Date(s)		
		Summer 2013	Winter 2014	Summer 2014
107	Susitna River near Talkeetna	6/21/2013		6/19/2014
		7/18/2013		7/22/2014
		8/16/2013		8/13/2014
		9/9/2013		9/9/2014
124.2	Curry Fishwheel Camp	6/22/2013		6/19/2014
		7/18/2013		7/22/2014
		8/15/2013		8/12/2014
		9/10/2013		9/9/2014
140.1	Gold Creek	6/23/2013	1/30/2014	6/18/2014
		7/17/2013	3/12/2014	7/21/2014
		8/17/2013		8/12/2014
		9/10/2013		9/8/2014
142.2	Indian River	6/23/2013		6/18/2014
		7/16/2013		7/21/2014
		8/14/2013		8/11/2014
		9/11/2013		9/8/2014
142.3	Susitna above Indian River	6/24/2013		6/18/2014
		7/15/2013		7/21/2014
		8/13/2013		8/11/2014
		9/11/2013		9/8/2014
152.3[1]	Portage Creek	7/30/2013		6/18/2014
		8/14/2013		7/21/2014
		9/12/2013		8/11/2014
				9/8/2014
152.7	Susitna above Portage Creek	7/30/2013		6/18/2014
		8/14/2013		7/21/2014
		9/12/2013		8/11/2014
				9/8/2014
174	Above Dam Point Sample	8/18/2013		
		8/31/2013		
		9/20/2013		
185[1]	Susitna above Tsusena Creek		1/29/2014	
			3/11/2014	

Project River Mile (PRM)[1]	Description	Sample Date(s)		
		Summer 2013	Winter 2014	Summer 2014
187.2/187.7[1]	Susitna at Watana Dam Site	7/2/2013		6/22/2014
		7/22/2013		7/20/2014
		8/18/2013		8/11/2014
		8/31/2013		9/14/2014
		9/20/2013		
225	Susitna at Cantwell		1/29/2014	
			3/11/2014	
235/235.2[1]	Oshetna Creek	7/2/2013		6/22/2014
		7/22/2013		7/20/2014
		8/31/2013		8/11/2014
		9/20/2013		9/14/2014

Notes:

1 Sites slightly modified due to helicopter landing access with no expected differences in water quality parameters.

Table 4.3-2. Water Quality Study Sampling Parameters and Schedule

Parameter	Baseline Water Quality (collected monthly)	Focus Areas (3 sampling events; sampling every 2 weeks)		Mercury Assessment (one-time survey)[2]		
		Surface Water	Ground Water	Sediment (Total)	Porewater (Dissolved)	Tissue (Total)
In Situ Water Quality Parameters						
Water Temperature	2013/2014	2013/2014	2013/2014	2013/2014	2013/2014	
Dissolved Oxygen	2013/2014	2013/2014	2013/2014	2013/2014		
pH	2013/2014	2013/2014	2013/2014	2013/2014	2013/2014	
Specific Conductance	2013/2014	2013/2014	2013/2014	2013/2014		
Turbidity	2013/2014	2013/2014	2013/2014	2013/2014		
Redox Potential	2013/2014	2013/2014	2013/2014	2013/2014		
Color	2013		2013			
Residues	2013[1]					
Other Water Quality Parameters (grab samples for laboratory analysis)						
Hardness	2013	2013	2013/2014		2013/2014	
Alkalinity	2013				2013/2014	
Nitrate/Nitrite	2013	2013/2014	2014			
Ammonia as N	2013	2013	2014			
Total Kjeldahl Nitrogen	2013	2013/2014	2013/2014			
Total Phosphorus	2013/2014	2013/2014	2013/2014			
Orthophosphate	2013/2014	2013	2013/2014			
Chlorophyll-a	2013/2014	2013	2013			
Total Dissolved Solids	2013/2014					
Total Suspended Solids	2013/2014					
Total Organic Carbon	2013/2014[1]	2013	2013/2014	2013/2014		
Dissolved Organic Carbon	2013/2014	2013	2013/2014		2013/2014	
Fecal Coliform	2013[1]					
Petroleum Hydrocarbons	2013[1]					
Radioactivity	2013[1]					
Metals						
Aluminum	2013/2014[1]	2013/2014	2013/2014	2013	2013/2014	
Arsenic	2013/2014	2014		2013/2014	2013	2013
Barium	2013/2014	2014				
Beryllium	2013/2014					

Parameter	Baseline Water Quality (collected monthly)	Focus Areas (3 sampling events; sampling every 2 weeks)		Mercury Assessment (one-time survey)[2]		
		Surface Water	Ground Water	Sediment (Total)	Porewater (Dissolved)	Tissue (Total)
Cadmium	2013/2014			2013/2014	2013/2014	2013
Calcium	2013/2014	2013	2013		2013/2014	
Chromium (Total)	2013/2014[1]			2013		
Cobalt	2013/2014					
Copper	2013/2014			2013/2014	2013/2014	
Iron	2013/2014	2013/2014	2013/2014	2013/2014	2013/2014	
Lead	2013/2014			2013/2014	2013/2014	
Manganese	2013/2014	2014				
Magnesium	2013/2014	2013	2013		2013/2014	
Mercury	2013/2014	2013/2014 (total)	2013/2014 (total)	2013/2014	2013/2014	2013
Methyl mercury	2013/2014 (dissolved)	2013 (dissolved)	2014 (dissolved)			2013
Molybdenum	2013/2014					
Nickel	2013/2014			2013/2014	2013/2014	
Selenium	2013/2014[1]			2013/2014	2013/2014	2013
Thallium	2013/2014					
Vanadium	2013/2014					
Zinc	2013/2014			2013/2014	2013/2014	
Sediment Size				2013/2014		
Total Solids				2013/2014		2013

Notes:

1 One-time survey

2 Refer to ISR Section 5.7 for details

Metals in surface water were analyzed for dissolved and total concentrations.

Table 5.1. Location of Data on the Project Website

Data Description	File Location
2013 Data	
2013 Continuous Water Temperature Monitoring	http://gis.suhydro.org/isr/05-Water_Quality/5.5-Baseline_Water_Quality/ISR_5.5_WQ_AppendixA_Continuous_Temp_Mon/
2013 Meteorological Data	http://gis.suhydro.org/isr/05-Water_Quality/5.5-Baseline_Water_Quality/
2013 Baseline Water Quality Field Data	http://gis.suhydro.org/isr/05-Water_Quality/5.5-Baseline_Water_Quality/ISR_5.5_WQ_AppendixD_Baseline_WQ_FieldData/
2013 Baseline Water Quality Chlorophyll *a* Data	http://gis.suhydro.org/isr/05-Water_Quality/5.5-Baseline_Water_Quality/ISR_5.5_WQ_AppendixE_Basline_WQ_Chla/
2013 Focus Area Water Quality Field Data	http://gis.suhydro.org/isr/05-Water_Quality/5.5-Baseline_Water_Quality/ISR_5.5_WQ_AppendixG_FocusArea_FieldData/
2013 Focus Area Water Quality Chlorophyll *a* Data	http://gis.suhydro.org/isr/05-Water_Quality/5.5-Baseline_Water_Quality/ISR_5.5_WQ_AppendixH_FocusArea_Chl/
2013 Baseline Water Quality Laboratory Data	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2013%20Lab%20Data/
2013 Focus Area Water Quality Laboratory Data	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2013%20Lab%20Data/
2013 Focus Area Groundwater Quality Data	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2013%20Lab%20Data/
2013 Sediment and Porewater Field Data	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2013%20Lab%20Data/
2013 Sediment and Porewater Laboratory Data	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2013%20Lab%20Data/
2013 Fish Tissue Metals Data	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2013%20Lab%20Data/

Data Description	File Location
2014 Data	
2014 Continuous Water Temperature Monitoring	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20Continuous%20Temperature%20Data%20QC3%5b1%5d/ http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20Continuous%20Temperature%20Data%20QC3%5b2%5d/
2014 Meteorological Data	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20MET%20Station%20Data%20QC3/
2014 Baseline Water Quality Field Data	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20Baseline%20Winter%20Field%20Data%20QC3/ http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20Baseline%20Summer%20Field%20Data%20QC3/
2014 Baseline Water Quality Laboratory Data	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20Baseline%20Winter%20Lab%20Data%20QC3/ http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20Baseline%20Summer%20Lab%20Data%20QC3/
2014 Total Phosphorus Data (Corrected)	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20Corrected%20TP%20Data%20QC3/
2014 Focus Area Water Quality Field Data	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20Focus%20Area%20Summer%20Field%20Data%20QC3/

Data Description	File Location
2014 Focus Area Water Quality Lab Data	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20Focus%20Area%20Winter%20Lab%20Data%20QC3/ http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20Focus%20Area%20Summer%20Lab%20Data%20QC3/
2014 Sediment and Porewater Field Data	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20Sediment%20Porewater%20Field%20Data%20QC3/
2014 Sediment and Porewater Lab Data	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20Sediment%20Lab%20Data%20QC3/ http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20Porewater%20Lab%20Data%20QC3/
2014 Focus Area Winter Groundwater Quality Data	http://gis.suhydro.org/Post_ISR/05-Water_Quality/5.5-Baseline_Water_Quality/ISR-MTG_5_5_WQ_2014_LabData/SuWa%20WQ%202014%20Focus%20Area%20Winter%20GW%20Well%20Lab%20Data%20QC3/

Table 5.1-1. Summary of Quality Assurance Results (2013)

<table>
<tr><th colspan="5">Rejected Samples (Applicable to a Small Group of Water Quality Parameters)</th></tr>
<tr><th></th><th>No. Observations*</th><th colspan="2">No. Rejected Samples**</th><th>% Rejected Samples</th></tr>
<tr><td>Baseline</td><td>19,828</td><td colspan="2">1,711</td><td>9%</td></tr>
<tr><td>Focus Area</td><td>4,217</td><td colspan="2">1,399</td><td>33%</td></tr>
<tr><th colspan="5">Holding Time Exceedances</th></tr>
<tr><th></th><th>No. Observations</th><th colspan="2">No. Qualified Samples outside hold time</th><th>% Qualified due to holding time exceedance</th></tr>
<tr><td>Baseline</td><td>19,828</td><td colspan="2">6 (Orthophosphate and Nitrate/Nitrite were “J” qualified ***)</td><td>0.03%</td></tr>
<tr><td>Focus Area</td><td>4,217</td><td colspan="2">0</td><td>0</td></tr>
<tr><th colspan="5">Temperature Exceedances in Coolers****</th></tr>
<tr><th></th><th>Total No. Sample Bottles</th><th>No. Sample Bottles in Coolers above $6^{o}C$</th><th>No. Sample Bottles in Coolers below $0^{o}C$</th><th>% Exceeding Transport Cooler Temperature Acceptance Limits</th></tr>
<tr><td>Baseline + Focus Area</td><td>10,496</td><td>256</td><td>416</td><td>2.4% above $6^{o}C$
4% below $0^{o}C$;
Only a fraction of parameters were qualified in the spreadsheet database as minor cooler temperature excursions above or below the acceptance limits. This sample transport issue does not affect results for each parameter uniformly.</td></tr>
</table>

* Observation = individual parameter (e.g., total Al) from a specific site (e.g., bottom, river left at PRM 45.1) on a particular date.

** Sample rejected due to one or more the following issues: MDL too high, suspected matrix interference, bottle contamination, interaction with preservation, unreasonable concentration based on river location/condition, and/or split sample results. Parameters rejected from 2013 data collection have been re-sampled in 2014 and undergoing quality assurance review as of 10/30/2014.

*** ”J” qualified = The analyte was positively identified; the associated value is the approximate concentration of the analyte in the sample.

**** The temperature blank in each cooler was used to determine exceedances, thus they are reported by the number of sample bottles per cooler.

Table 5.1-2. Summary of Quality Assurance Results (2014)

Rejected Samples (Applicable to a Small Group of Water Quality Parameters)			
	No. Observations*	***No. Rejected Samples*****	***% Rejected Samples***
Baseline (Winter)	1,151	0	0%
Focus Area (Winter)	682	1	0.1%
Baseline (Summer)	995	81	8%
Focus Area (Summer)	1,040	47	5%
Sediment/Porewater	537	0	0%
Holding Time Exceedances			
	No. Observations	***No. Samples outside hold time***	***% Qualified due to holding time exceedance******
Baseline (Winter)	1,151	12	0%
Focus Area (Winter)	682	25	0%
Baseline (Summer)	995	39	0%
Focus Area (Summer)	1,040	0	0%
Sediment/Porewater	537	0	0%

* Observation = individual parameter (e.g., total Al) from a specific site (e.g., bottom, river middle at PRM 45.1) on a particular date.

** All but two of the samples rejected in 2014 were for Total Phosphorus analysis. Rejected Total Phosphorus data has been corrected based on further lab analysis and is included in a corrected Total Phosphorus database for Baseline and Focus Area 2014 data. The other two rejected samples were for chlorophyll a in a field blank collected in the winter and for TKN collected in the summer. For the TKN sample the parent sample was rejected and the duplicate sample was used for assessment.

*** No sample results were qualified due to exceedance of holding times. Sample results were within the expected concentration range outlined in the QAPP and based on historical and recently collected data.

Table 6.1-1 Historic (1980s) and Current (2013 - 2014) Field Parameters

Project River Mile		187.2	152.7	142.3	140.1	124.2	107	102.4	88.3	32.5	29.9
Description		Susitna at Watana Dam site	Susitna above Portage Creek	Susitna above Indian River	Gold Creek	Curry Fishwheel Camp	Talkeetna*	Chulitna River	Susitna at Parks Highway West (current data collected from EAST)	Yentna River*	Susitna Station
Temp (°C)	Historic Winter	--	--	--	≈0	--	--	≈0	≈0	≈0	≈0
	Current Winter	--	--	--	0	--	--	--	0	--	0
	Historic Summer	1.9-14.4	--	--	4.5-14.1	2.7-15.3	2.9-16.4	3.8-9.5	5-14	3.9-11.6	2.5-14.8
	Current Summer	2.6-14.8	7.5-12.0	7.3-15.0	7.5-14.2	7.6-15.1	8.0-14.3	4.6-8.3	7.3-11.7	7.4-10.4	7.5-12.1
Dissolved oxygen (mg/L)	Historic Winter	--	--	--	10.9-16.2	--	--	--	12.8-14.4	10.9-11.1	9.9-12.7
	Current Winter	--	--	--	13.9-14.5	--	--	--	12.8-14.6	--	10.8-13.9
	Historic Summer	9.9-11.6	10.9-14.8	--	8.5-12.7	10.1-13.9	9.8-12.0	--	9-13.4	10.4-12.1	9-12.3
	Current Summer	10.1-12.47	10.4-12.6	10.4-12.4	10.5-12.5	10.0-12.5	10.2-11.9	12.0-13.6	10.7-13.7	11.5-12.0	10.9-12.53
pH	Historic Winter	--	--	--	7.6-8.0	--	--	≈7.1	7.8-8.2	7.1-7.9	7.5-7.6
	Current Winter	--	--	--	7.3-7.7	--	--	--	7.1-7.2	--	6.9-7.0
	Historic Summer	8-8.2	6.8-8.2	--	7.5-8.3	6.8-8.0	7.4-8.0	7.2-8.1	7.1-8.3	7.4-8.3	7.5-8.5
	Current Summer	7.4-8.5	7.1-8.5	7.6-8.6	7.7-8.6	7.6-8.3	7.6-8.4	7.8-8.7	7.8-8.5	8.0-8.6	7.5-9.4

Project River Mile		187.2	152.7	142.3	140.1	124.2	107	102.4	88.3	32.5	29.9
Description		Susitna at Watana Dam site	Susitna above Portage Creek	Susitna above Indian River	Gold Creek	Curry Fishwheel Camp	Talkeetna*	Chulitna River	Susitna at Parks Highway West (current data collected from EAST)	Yentna River*	Susitna Station
Conductivity (µmhos/cm)	Historic Winter	--	--	--	84-300	--	--	≈115	159-240	189-216	180-225
	Current Winter	--	--	--	241-263	--	--	--	190-220	--	136-216
	Historic Summer	--	--	--	87-227	--	--	101-144	80-170	93-142	96-154
	Current Summer	137.8-178.5	122.2-164.7	122-162.8	116-161.5	131-166.6	122-168.8	106.4-145.9	122-156.9	135.9-167	116.1-170

Notes:

ND = non-detection

"—"= data unavailable

*Indicates major tributary sampling location

Table 6.1-2. Ranges in Historic (1980s) and Current (2013 – 2014) Water Quality Monitoring Data

Project River Mile		187.2	152.7	142.3	140.1	124.2	107	102.4	88.3	32.5	29.9
Description		Susitna at Watana Dam site	Susitna above Portage Creek	Susitna above Indian River	Gold Creek	Curry Fishwheel Camp	Talkeetna*	Chulitna River	Susitna at Parks Highway West (current data collected from EAST)	Yentna River*	Susitna Station
Orthophosphate (mg/L)	Historic Winter	--	--	--	0.03-0.09	--	--	<0.01	0.031-0.12	<0.01	<0.01
	Current Winter	--	--	--	0.005 - 0.006	--	--	--	0.001 - 0.003	--	ND - 0.002
	Historic Summer	--	--	--	0-0.184	--	--	<0.01	0.031-0.061	<0.01	<0.01
	Current Summer	ND - 0.032	ND - 0.011	ND - 0.007	ND - 0.011	ND - 0.007	ND - 0.041	ND - 0.019	ND - 0.027	ND - 0.008	ND - 0.019
Turbidity (NTU)	Historic Winter	--	--	--	0.1-0.7	--	--	--	0.5-2.7	--	1-3
	Current Winter	--	--	--	--	--	--	--	--	--	--
	Historic Summer	--	45-200	--	23-290	20-396	16-480	--	43-500	30-220	up to 790
	Current Summer	18 - 650	90 - 600	75 - 400	50 - 1000	90 - 500	160 - 500	310 - 900	130 - 1300	110 - 950	110 - 950
TSS (mg/L)	Historic Summer	--	52-482	--	--	39-512	5.5-8.0	--	--	--	--
	Current Summer	41.9 - 578	81 - 650	73 - 426	64 - 1050	99 - 480	186 - 488	470 - 1170	162 - 1420	186 - 744	194 - 780
TDS (mg/L)	Historic Summer	--	--	--	55-140	--	--	--	--	--	--
	Current Summer	100 - 154	87 - 146	92 - 174	72 - 156	70 - 132	66 - 154	92 - 166	44 - 138	62 - 152	82 - 190

Project River Mile		187.2	152.7	142.3	140.1	124.2	107	102.4	88.3	32.5	29.9
Description		Susitna at Watana Dam site	Susitna above Portage Creek	Susitna above Indian River	Gold Creek	Curry Fishwheel Camp	Talkeetna*	Chulitna River	Susitna at Parks Highway West (current data collected from EAST)	Yentna River*	Susitna Station
Total Hardness (mg/L)	Historic Summer	--	--	--	--	--	--	--	44-72	--	44-66
	Current Summer	58 - 71	54 - 65	53 - 66	49 - 67	53 - 107	52 - 70	48 - 74	52 - 72	59 - 121	53 - 73
Total Alkalinity (mg/L)	Historic Summer	--	--	--	23-87	--	--	--	--	--	36-57
	Current Summer	49 - 53	41 - 53	40 - 54	35 - 55	41 - 54	42 - 54	34 - 53	41 - 49	40 - 50	40 - 53
Total Organic Carbon (mg/L)	Historic Summer	--	1.4-3.8	--		--	--	--	1.7-3.2	--	2.7-11
	Current Summer	2.4	2.29 - 2.39	1.92 - 2.14	1.7 - 2.02	1.8 - 3.43	1.9 - 2.09	1.71 - 1.92	2.05 - 2.42	1.98 - 2.76	2.1 - 3.68
Chlorophyll-a (µg/L)	Historic Summer	--	--	--	--	--	--	--	--	--	ND-1.2
	Current Summer	0 - 0.53	0 - 1.9	0 - 1.3	0 - 0.87	0 - 1.3	0 - 1.3	0 - 2.5	0 - 2.5	0 - 1.4	0 - 1.2
Total Coliform Bacteria (colonies/100 ml)	Historic Summer	--	--		--	--	--	--	--	--	≤ 20
	Current Summer	0	14 - 22	9 - 12	9 - 27	12 - 20	6 - 26	7 - 15	6 - 18	8 - 18	7 - 18

Notes:

ND = non-detection

"—"= data unavailable

*Indicates major tributary sampling location

Table 6.1-3 Historic (1980s) and Current (2013 – 2014) Total Metals

Project River Mile		187.2	152.7	142.3	140.1	124.2	107	102.4	88.3	32.5	29.9
Description		Susitna at Watana Dam site	Susitna above Portage Creek	Susitna above Indian River	Gold Creek	Curry Fishwheel Camp	Talkeetna*	Chulitna River	Susitna at Parks Highway West (current data collected from EAST)	Yentna River*	Susitna Station
Al (total) (µg/L)	Historic Summer	--	--	--	≈13000	--	--	--	up to 15000	--	--
	Current Summer	470 - 7990	959 - 5630	564 - 5830	476 - 5680	452 - 7350	420 - 7980	2341 - 20800	1650 - 19400	1249 - 23029	790 - 22584
As (total) (µg/L)	Historic Winter	--	--	--	1	--	--	--	1-2	--	1-3
	Current Winter	--	--	--	ND	--	--	--	ND	--	ND
	Historic Summer	--	--	--	2-12	--	--	--	1-3	--	7-40
	Current Summer	1.89 - 11.8	ND - 11.4	ND - 8.8	1.7 - 16.3	ND - 9.8	ND - 10.9	4.5 - 37.5	2.8 - 32.5	3.8 - 26.1	3.2 - 23.5
Ba (total) (µg/L)	Historic Winter	--	--	--	≤ 100	--	--	--	100	--	100
	Current Winter	--	--	--	50	--	--	--	38	--	35
	Historic Summer	--	--	--	100-500	--	--	--	100-500	--	up to 400
	Current Summer	89.0 - 788	39.4 - 516	37.9 - 434	34.7 - 883	37.9 - 454	35.6 - 434	66.3 - 905	49.9 - 795	41.4 - 382	37.7 - 413
Cd (total) (µg/L)	Historic Summer	--	--		0-30	--	--	--	0-35	--	≤ 1
	Current Summer	0.05 - 1.12	0.12 - 0.77	ND - 0.434	0.07 - 0.86	0.12 - 0.49	0.19 - 0.66	0.29 - 0.66	0.14 - 0.78	0.13 - 0.52	0.13 - 0.45

Project River Mile		187.2	152.7	142.3	140.1	124.2	107	102.4	88.3	32.5	29.9
Description		Susitna at Watana Dam site	Susitna above Portage Creek	Susitna above Indian River	Gold Creek	Curry Fishwheel Camp	Talkeetna*	Chulitna River	Susitna at Parks Highway West (current data collected from EAST)	Yentna River*	Susitna Station
Se (total) (µg/L)	Historic Summer	--	--	--	≤ 1	--	--	--	0-1	--	≤ 1
	Current Summer	0.55	0.37 - 0.55	0.47 - 0.69	0.39 - 0.55	0.41 - 0.58	0.45 - 0.62	ND	0.62 - 0.91	0.57 - 0.78	0.48 - 0.71
Cu (total) (µg/L)	Historic Summer	--	--	--	15-190	--	--	--	0-35	--	30-90
	Current Summer	3.93 - 43.9	7.83 - 37.1	7.22 - 31.3	4.21 - 68.7	7.87 - 33.5	11.1 - 33.4	27.4 - 64	13.8 - 73	11.4 - 39.1	11.5 - 41.6
Fe (total) (µg/L)	Historic Winter	--	--	--	≈120	--	--	≈0	110-1100	--	240-720
	Current Winter	--	--	--	54 - 64	--	--	--	89 - 628	--	132 - 207
	Historic Summer	--	--	--	430-24000	--	--	up to 4300	7600-32000	--	7900-42000
	Current Summer	8550 - 9430	1325 - 7160	958 - 7430	802 - 7010	743 - 9106	688 - 9935	3760 - 31091	2364 - 27403	2151 - 31889	1507 - 30894
Pb (total) (µg/L)	Historic Summer	--	--	--	≤ 200	--	--	--	2-13	--	≤ 200
	Current Summer	0.38 - 7.86	1.3 - 5.99	1.04 - 4.64	0.64 - 9.29	1.22 - 4.46	ND - 4.98	7.52 - 17.5	2.88 - 18.7	3.17 - 10.9	2.59 - 10.7

Project River Mile		187.2	152.7	142.3	140.1	124.2	107	102.4	88.3	32.5	29.9
Description		Susitna at Watana Dam site	Susitna above Portage Creek	Susitna above Indian River	Gold Creek	Curry Fishwheel Camp	Talkeetna*	Chulitna River	Susitna at Parks Highway West (current data collected from EAST)	Yentna River*	Susitna Station
Mn (total) (µg/L)	Historic Winter	--	--	--	≤ 20	--	--	≈10	2-10	--	30-40
	Current Winter	--	--	--	ND	--	--	--	19	--	9
	Historic Summer	--	--		10-390	--	--	20-280	170-670	--	320-870
	Current Summer	20.9 - 172	37.6 - 157	41.1 - 149	29.4 - 144	24.9 - 174	22.5 - 189	97.3 - 618	59.1 - 547	89.4 - 745	68.8 - 702
Hg (total) (µg/L)	Historic Summer	--	--		2-13	--	--	--	0.1-0.6	--	≤ 1
	Current Summer	0.83 - 22.0	2.94 - 25.8	1.92 - 23.1	1.53 - 21.1	1.09 - 18.5	1.02 - 25.3	4.95 - 54.5	3.49 - 80.1	8.43 - 33.6	6.09 - 32.1
Ni (total) (µg/L)	Historic Summer	--	--		≤ 50	--	--	--	18-30	--	1-2
	Current Summer	4.33 - 49.2	9.56 - 40.7	8.48 - 42.4	5.41 - 75.9	9.44 - 38.3	12.8 - 33.8	37.1 - 85.9	15.9 - 80.9	12.9 - 44.3	12.3 - 46.6
Zn (total) (µg/L)	Historic Summer	--	--	--	20-120	--	--	--	40-200	--	80-180
	Current Summer	8.62 - 106	19.1 - 98.2	17.5 - 77.3	10.8 - 163	19.5 - 80	27 - 86.3	72.9 - 191	33.5 - 202	30.7 - 124	29.2 - 121

Notes:

ND = non-detection

"—"= data unavailable

*Indicates major tributary sampling location

Table 6.1-4. Historic (1980s) and Current (2013 – 2014) Dissolved Metals

Project River Mile		187.2	152.7	142.3	140.1	124.2	107	102.4	88.3	32.5	29.9
Description		Susitna at Watana Dam site	Susitna above Portage Creek	Susitna above Indian River	Gold Creek	Curry Fishwheel Camp	Talkeetna*	Chulitna River	Susitna at Parks Highway West (current data collected from EAST)	Yentna River*	Susitna Station
Al (dissolved) (µg/L)	Historic Winter	--	--		≈10	--	--	--	10-30	--	--
	Current Winter	--	--	--	ND - 3	--	--	--	4 - 9	--	4 - 22
	Historic Summer	--	--		20-120	--	--	--	40-200	--	40-350
	Current Summer	18.9 - 1030	22.9 - 117	20.1 -105	40.1 - 122	36.1 - 237	36.4 - 2880	72.7 - 700.4	49.6 - 198	32 - 189	35 - 133
As (dissolved) (µg/L)	Historic Winter	--	--	--	0	--	--	--	≈2	--	0-0.1
	Current Winter	--	--	--	ND	--	--	--	ND	--	ND
	Historic Summer	--	--	--	3-6	--	--	--	4-15	--	0.3-0.6
	Current Summer	0.63 - 1.35	0.72 - 1.21	0.79 - 1.24	0.77 - 1.63	0.83 - 1.16	0.87 - 1.74	1.12 - 5.16	0.93 - 5.36	1.16 - 1.73	1.1 - 1.81
Ba (dissolved) (µg/L)	Historic Winter	--	--	--	≤ 100	--	--	--	25-100	--	≈40
	Current Winter	--	--	--	48	--	--	--	35	--	26
	Historic Summer	--	--	--	0-44	--	--	--	0-70	--	20-200
	Current Summer	36.9 - 69.7	34.0 - 49.5	32.8 - 47.9	27 - 73.8	32.1 - 46	32.6 - 88.9	14.1 - 69.9	17.4 - 111	15.9 - 23.4	17.7 - 27.5

Project River Mile		187.2	152.7	142.3	140.1	124.2	107	102.4	88.3	32.5	29.9
Description		Susitna at Watana Dam site	Susitna above Portage Creek	Susitna above Indian River	Gold Creek	Curry Fishwheel Camp	Talkeetna*	Chulitna River	Susitna at Parks Highway West (current data collected from EAST)	Yentna River*	Susitna Station
Cd (dissolved) (µg/L)	Historic Summer	--	--	--	0-20	--	--	--	0-24	--	≤ 2
	Current Summer	ND - 0.06	ND - 0.02	ND - 0.02	ND - 0.06	ND - 0.04	ND - 0.07	ND - 0.08	ND - 0.11	ND - 0.52	ND - 0.02
Se (dissolved) (µg/L)	Historic Summer	--	--	--	≤ 1	--	--	--	0	--	≤ 1
	Current Summer	0.52	0.36 - 0.58	0.57 - 0.62	0.45 - 0.58	0.48 - 0.57	0.47 - 0.66	0.71 - 0.87	0.51 - 0.79	0.51 - 0.66	0.51 - 0.68
Ca (dissolved) (µg/L)	Historic Winter	--	--	--	18-39	--	--	≈19	18-39	--	24-31
	Current Winter	--	--	--	19100	--	--	--	11600	--	14300
	Historic Summer	--	--	--	10-37	--	--	14-18	10-37	--	15-22
	Current Summer	19000 - 22300	17600 - 21700	17100 - 21900	15700 - 22500	17100 - 21300	17300 - 22600	14200 - 21626	16900 - 20100	17700 - 20000	16200 - 22200
Cu (dissolved) (µg/L)	Historic Summer	--	--	--	15-190	--	--	--	16-63	--	29-89
	Current Summer	0.56 - 2.46	0.53 - 1.23	0.58 - 1.09	0.44 - 2.58	0.28 - 4.77	0.42 - 2.91	0.24 - 6.8	0.09 - 9.62	0.33 - 1.02	0.34 - 1.39

Project River Mile		187.2	152.7	142.3	140.1	124.2	107	102.4	88.3	32.5	29.9
Description		Susitna at Watana Dam site	Susitna above Portage Creek	Susitna above Indian River	Gold Creek	Curry Fishwheel Camp	Talkeetna*	Chulitna River	Susitna at Parks Highway West (current data collected from EAST)	Yentna River*	Susitna Station
Fe (dissolved) (µg/L)	Historic Winter	--	--	--	≈110	--	--	--	120-1100	--	300-400
	Current Winter	--	--	--	ND	--	--	--	ND	--	59 - 109
	Historic Summer	--	--	--	4600-24000	--	--	--	7400-32000	--	7800-38000
	Current Summer	19.4 - 1480	15.8 - 249	16.4 - 120	18.5 - 1680	27.4 - 171	ND - 2000	11.5 - 5530	6.41 - 7310	9.63 - 480	7.19 - 190
Pb (dissolved) (µg/L)	Historic Summer	--	--	--	0-47	--	--	--	--	--	14-94
	Current Summer	ND - 0.31	ND - 0.07	ND - 0.04	ND - 0.42	ND - 0.07	ND - 0.46	ND - 1.77	ND - 2.06	ND - 0.19	ND - 0.11
Mg (dissolved) (µg/L)	Historic Winter	--	--	--	3.2-10	--	--	≈1.9	2.9-10	--	3.6-5.0
	Current Winter	--	--	--	4680	--	--	--	4260	--	5040
	Historic Summer	--	--	--	0.3-7.8	--	--	2.5-4.1	1.2-7.8	--	2-3.3
	Current Summer	2350 - 3570	2290 - 2730	2380 - 2730	2320 - 2940	2220 - 2750	2040 - 3160	2950 - 5640	2460 - 5390	3230 - 4540	2700 - 4690

Project River Mile		187.2	152.7	142.3	140.1	124.2	107	102.4	88.3	32.5	29.9
Description		Susitna at Watana Dam site	Susitna above Portage Creek	Susitna above Indian River	Gold Creek	Curry Fishwheel Camp	Talkeetna*	Chulitna River	Susitna at Parks Highway West (current data collected from EAST)	Yentna River*	Susitna Station
Mn (dissolved) (µg/L)	Historic Winter	--	--	--	7-10	--	--	--	10-30	--	0-30
	Current Winter	--	--	--	ND	--	--	--	6	--	9
	Historic Summer	--	--	--	70-390	--	--	--	160-660	--	320-850
	Current Summer	2.86 - 29.2	2.53 - 7.38	2.31 - 5.78	1.75 - 35.8	2.79 - 7.58	2.47 - 37	4.86 - 118	1.85 - 151	1.21 - 12.4	1.3 - 17.9
Hg (dissolved) (µg/L)	Historic Summer	--	--	--	0.1-0.4	--	--	--	0.1-0.6	--	≤ 1
	Current Summer (ng/L)	ND - 1.46	ND - 0.958	ND - 12.3	ND - 0.82	ND - 2.28	ND - 1.21	ND - 3.54	ND - 1.54	ND - 0.874	ND - 1.48
Ni (dissolved) (µg/L)	Historic Summer	--	--	--	8-29	--	--	--	16-51	--	32-52
	Current Summer	1.46 - 3.53	0.674 - 1.98	0.988 - 1.81	0.78 - 4.18	0.689 - 2.11	1.05 - 3.97	0.924 - 9.14	0.856 - 10.8	0.742 - 1.71	0.793 - 1.5
Zn (dissolved) (µg/L)	Historic Summer	--	--	--	20-110	--	--	--	0-190	--	80-180
	Current Summer	0.75 - 7.59	0.657 - 2.77	ND - 1.72	0.569 - 17.3	ND - 3.73	0.495 - 8.35	0.545 - 21.2	ND - 26.8	0.578 - 4.87	0.517 - 4.26

Notes:

ND = non-detection "—"= data unavailable *Indicates major tributary sampling location

Table 6.3-1 Summary of Criteria and Standards for Select Uses and Constituents[1]

Freshwater Use Class/ Subclass	Color (color units)	Dissolved Oxygen (mg/L[2])	Dissolved Inorganic Substances[3] (mg/L)	pH (s.u.[4])	Sediment	Temperature
			Water Supply			
Drinking, culinary, and food processing	May not exceed 15 or natural condition	4 or more	500; chlorine or sulfate cannot exceed 250	6.0 to 8.5	No measurable increase in settleable solids above natural conditions	59°F or less
Agriculture, including irrigation, stock watering	NA[3]	Greater than 3	1,000; limits on SAR(6), others	5.0 to 9.0	Free of grains over 0.074 millimeters; may not exceed 200 mg/L for extended periods[5]	86°F or less
Aquaculture	May not exceed 50 or natural condition	Greater than 7	1,000 or no adverse effect	6.5 to 8.5; within 0.5 pH unit of natural conditions	No interference with established water supply treatment levels	68°F or less at all times(8)
Industrial	May not cause detrimental effects on established water supply treatment levels	May not cause detrimental effects on established water supply treatment levels	No scaling or corrosion	5.0 to 9.0	No interference with established water supply treatment levels	77°F or less
			Water Recreation			
Contact recreation	May not exceed 15 or natural condition	4 or more	NA[3]	6.5 to 8.5; buffering restrictions	No measurable increase in settleable solids above natural	86°F or less

Freshwater Use Class/ Subclass	Color (color units)	Dissolved Oxygen (mg/L[2])	Dissolved Inorganic Substances[3] (mg/L)	pH (s.u.[4])	Sediment	Temperature
Secondary recreation	May not interfere with or make the water unfit or unsafe for the use	4 or more	NA[3]	6.5 to 8.5; buffering restrictions	No hazard to incidental human contact or use interference	NA[3]
Growth and Propagation of Fish, Shellfish, other Aquatic Life, and Wildlife						
No subclass	May not exceed 50 or natural condition	7 to 17[7]	1,000 or no adverse effect	6.5 to 8.5; within 0.5 pH unit of natural conditions	Restrictions on percentage of 0.1 to 4 mm grains in spawning gravels; no adverse habitat effects	68°F or less at all times[(8)]

Notes:

1. Values and narrative standards have been simplified for this table. Additional detail is presented in 18 AAC 70.020(b). Other pollutants include fecal coliform bacteria; petroleum hydrocarbons, oil, and grease; radioactivity; floating solids; debris and residues; toxic and deleterious substances; and turbidity.
2. Mg/L = milligrams per liter
3. Only total dissolved solids (TDS) concentrations are indicated, where applicable.
4. s.u. = standard unit
5. NA = not applicable.
6. SAR = sodium adsorption ratio. Limits also are specified for sodium percentage and residual carbonate.
7. Depends on irrigation application method (sprinkler, flood, etc.).
8. In addition, maximums of 59°F within fish migration routes and rearing areas and 55.4°F for spawning and incubation areas; other weekly average temperature limits apply.
9. Standard is for anadromous fish. In addition, standards for non-anadromous fish, concentrations in interstitial gravels used for spawning, and a maximum 110 percent of saturation apply.

Source: ADEC 2012a, 18 AAC 70.020(b).

Table 6.3-2 ADEC Freshwater Quality Criteria for Select Constituents

Constituent	Drinking Water[1] (µg/L)	Stock Water[1] (µg/L)	Irrigation Water[1] (µg/L)	Aquatic Life, Acute[1,2] (µg/L)	Aquatic Life, Chronic[1,2] (µg/L)	Human Health	
						Consumption of Water and Aquatic Organisms[1] (µg/L)	Consumption of Aquatic Organisms Only[1] (µg/L)
Alkalinity	–	–	–	–	20,000 minimum	–	–
Aluminum	–	–	5,000 T	750 T	87 T	–	–
Antimony	6	–	–	–	–	14	4,300
Arsenic[3]	10	50	100	340 D	150 D	–	–
Barium	2,000	–	–	–	–	–	–
Beryllium	4	–	100	–	–	–	–
Boron	–	750	–	–	–	–	–
Cadmium	5	10	10	0.52 D	0.09 D	–	–
Chloride	–	–	–	860,000	230,000	–	–
Chromium (total)	100 T	100 T	–	–	–	–	–
Chromium III[3]	–	–	–	183.1 D	23.8 D	–	–
Chromium VI[3]	–	50	–	16 D	11 D	–	–
Cobalt	–	–	50	–	–	–	–
Copper[3]	–	–	200	3.64 D	2.74 D	1,300	–
Iron	–	–	5,000	–	1,000	–	–
Lead[3]	–	50	5,000	13.88 D	0.54 D	–	–
Manganese	–	–	200	–	–	50	100
Mercury (inorganic)[3]	2	–	–	1.4 D	0.77 D	0.05	0.051
Molybdenum	–	–	10	–	–	–	–

Constituent	Drinking Water[1] (µg/L)	Stock Water[1] (µg/L)	Irrigation Water[1] (µg/L)	Aquatic Life, Acute[1,2] (µg/L)	Aquatic Life, Chronic[1,2] (µg/L)	Human Health: Consumption of Water and Aquatic Organisms[1] (µg/L)	Human Health: Consumption of Aquatic Organisms Only[1] (µg/L)
Nickel	–	–	200	D	D	–	–
Nitrate (as Nitrogen)	10,000	–	–	–	–	–	–
Nitrite (as Nitrogen)	1,000	–	–	–	–	–	–
Nitrate + Nitrite	10,000	–	–	–	–	–	–
Selenium	50	10	20	Fraction Dependent	5.0 T	–	–
Silver[3]	–	–	–	0.3 D	–	–	–
Thallium	2	–	–	–	–	1.7	6.3
Vanadium	–	–	100	–	–	–	–
Zinc[3]	–	–	2,000	36.2 D	36.5 D	9,100	69,000

Notes:

1. µg/L = micrograms per liter; T = total recoverable; D = dissolved.
2. Acute values typically are 1-hour averages; chronic values typically are 4-day averages.
3. Hardness-dependent criteria for aquatic life are arbitrarily derived using a default of 25 mg/L hardness.

Source: ADEC 2008

Table 6.3-3 Water Quality Standards (NOAA SQuiRTs)

Parameter (µg/L)	NOAA SQuiRT (µg/L)
Total Alkalinity	NS
Total Al	750 A, 87 C
Total As	66 A, 31 C
Total Ba	110 A, 3.9 C
Total Cd	1.05 A, 0.162 C
Total Cu	7.29 A, 5.2 C
Total Fe	1,000 C
Total Hg	1.4 A, 0.77 C
Total Pb	33.8 A, 1.3 C
Total Mn	2,300 A, 80 C
Total Ni	261 A, 29 C
Total Se	186 A, 5 C
Total Zn	67 A, C
Al Dissolved	750 A, 87 C
As Dissolved	66 A, 31 C
Ba Dissolved	110 A, 3.9 C
Cd Dissolved	5.22 C, 0.81 C
Cu Dissolved	5.0 A, 5.0 C
Fe Dissolved	1,000 C
Hg Dissolved	1.2 A, 0.65 C
Pb Dissolved	177 A, 177C

Parameter (µg/L)	NOAA SQuiRT (µg/L)
Mn Dissolved	2,300 A, 90 C
Ni Dissolved	260 A, 28.9 C
Se dissolved	186 A, 5 C
Zn Dissolved	65.1 A, 65.7 C

Notes:

Cd, Cr, Cu, Pb, Hg, Ni, Au, and Zn regulatory standards adjusted for hardness, filtering.
A= Acute, C = Chronic.

10. FIGURES

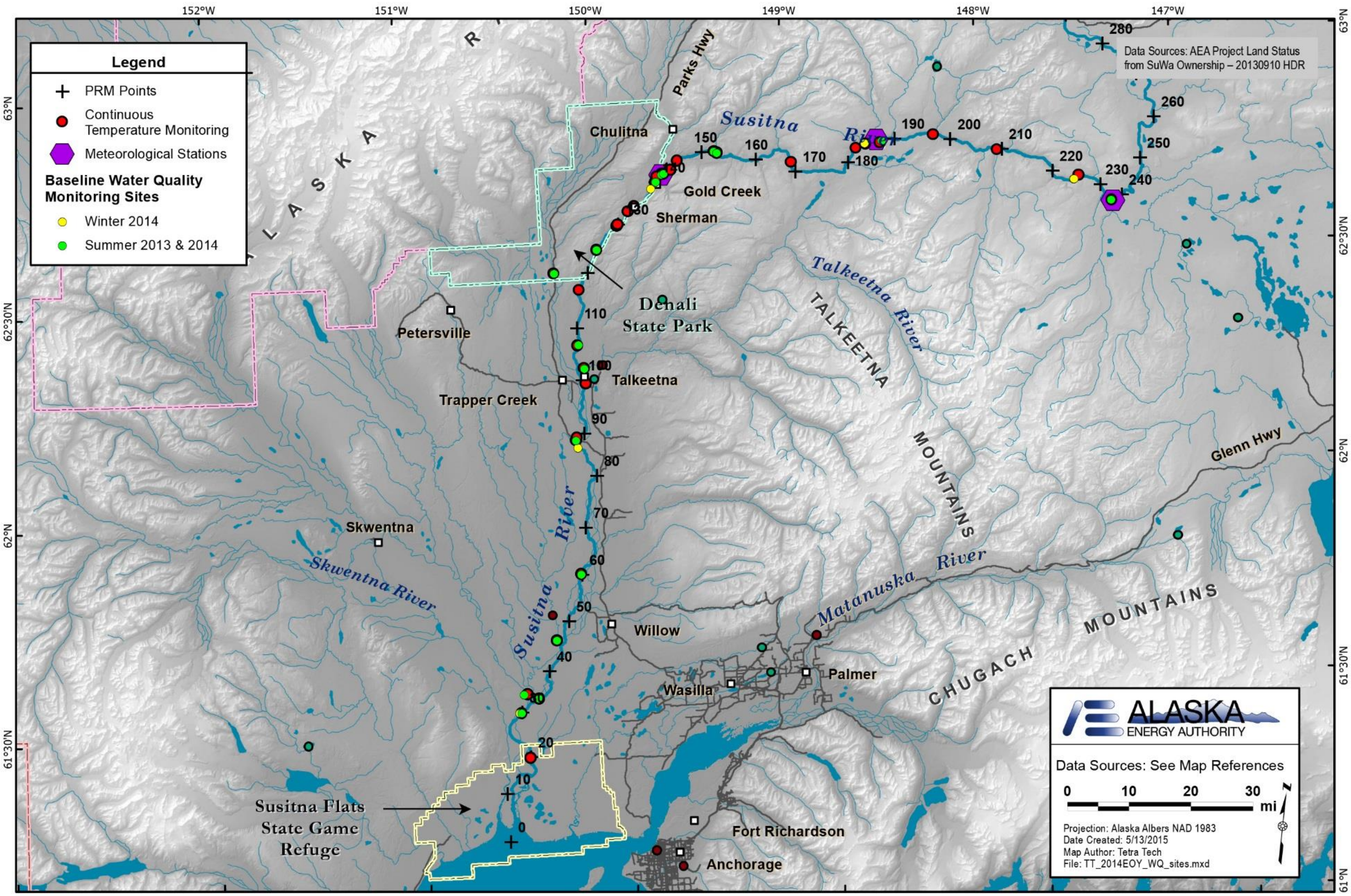

Figure 4.1-1. Water Temperature Sites for the Susitna-Watana Hydroelectric Project

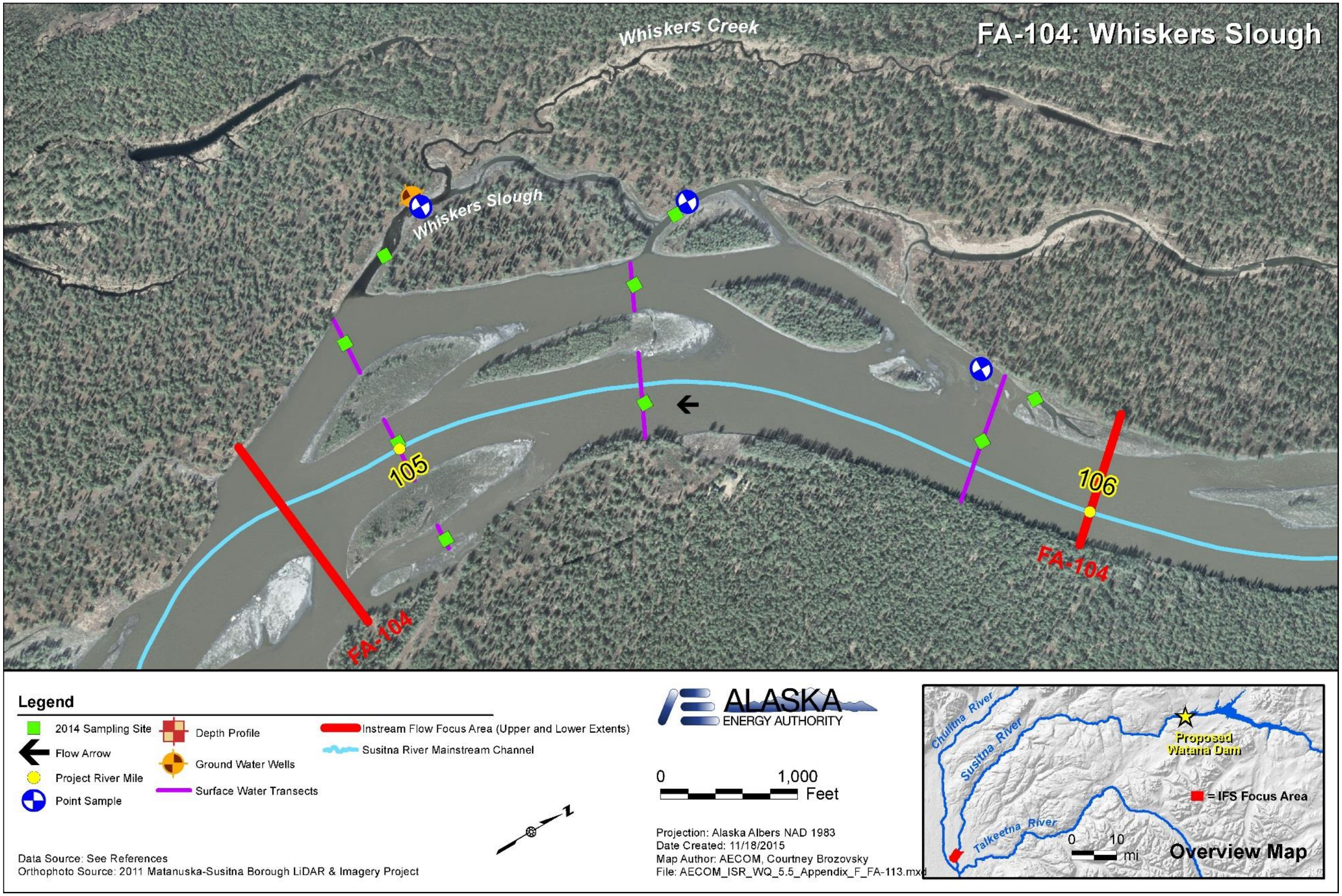

Figure 4.4-1. Detail of FA-104: Whiskers Slough. 2014 surface water sampling locations in FA-104 (July 2014 and September 2014)

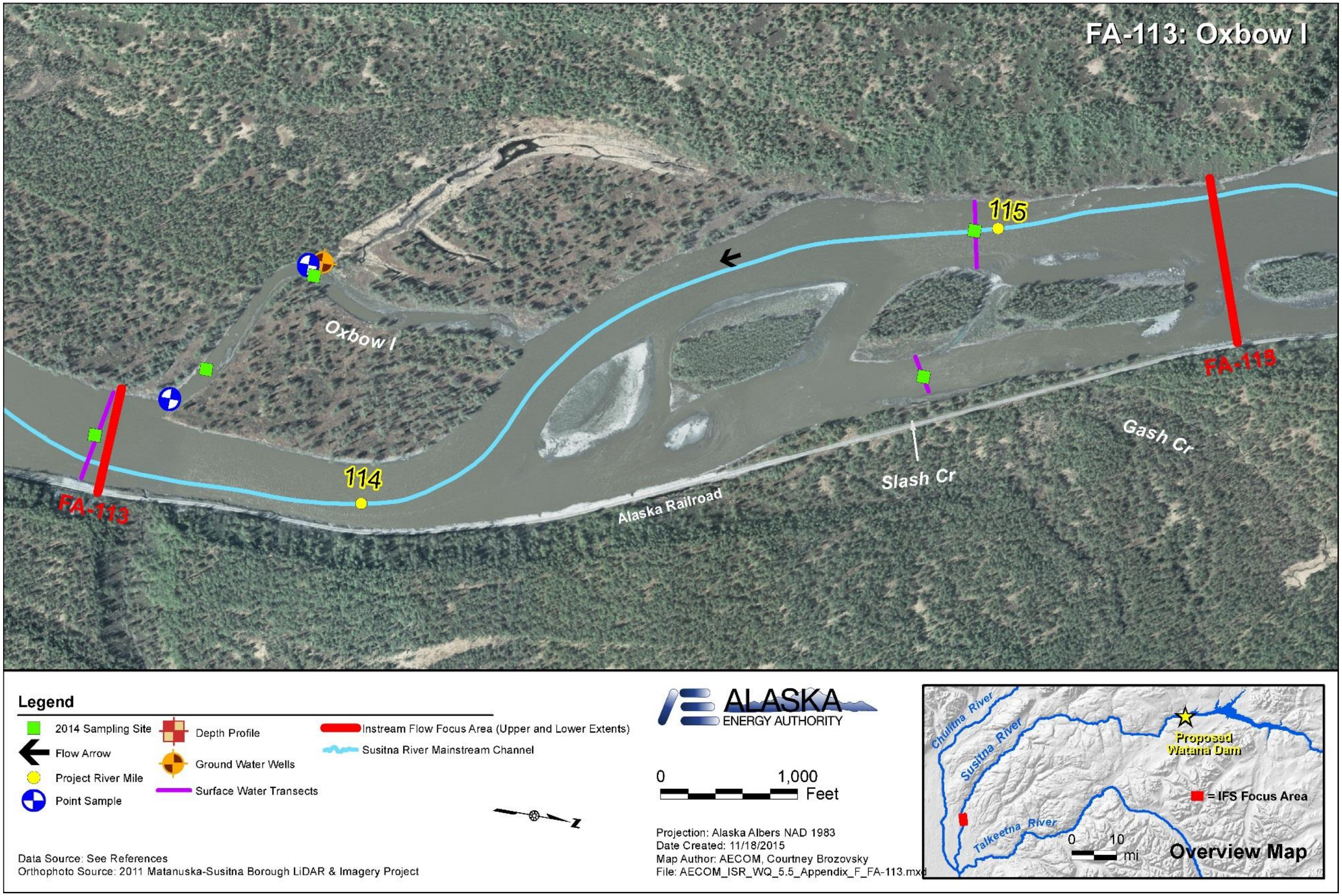

Figure 4.4-2. Detail of FA-113: Oxbow I. 2014 surface water sampling locations in FA-113 (July 2014 and September 2014)

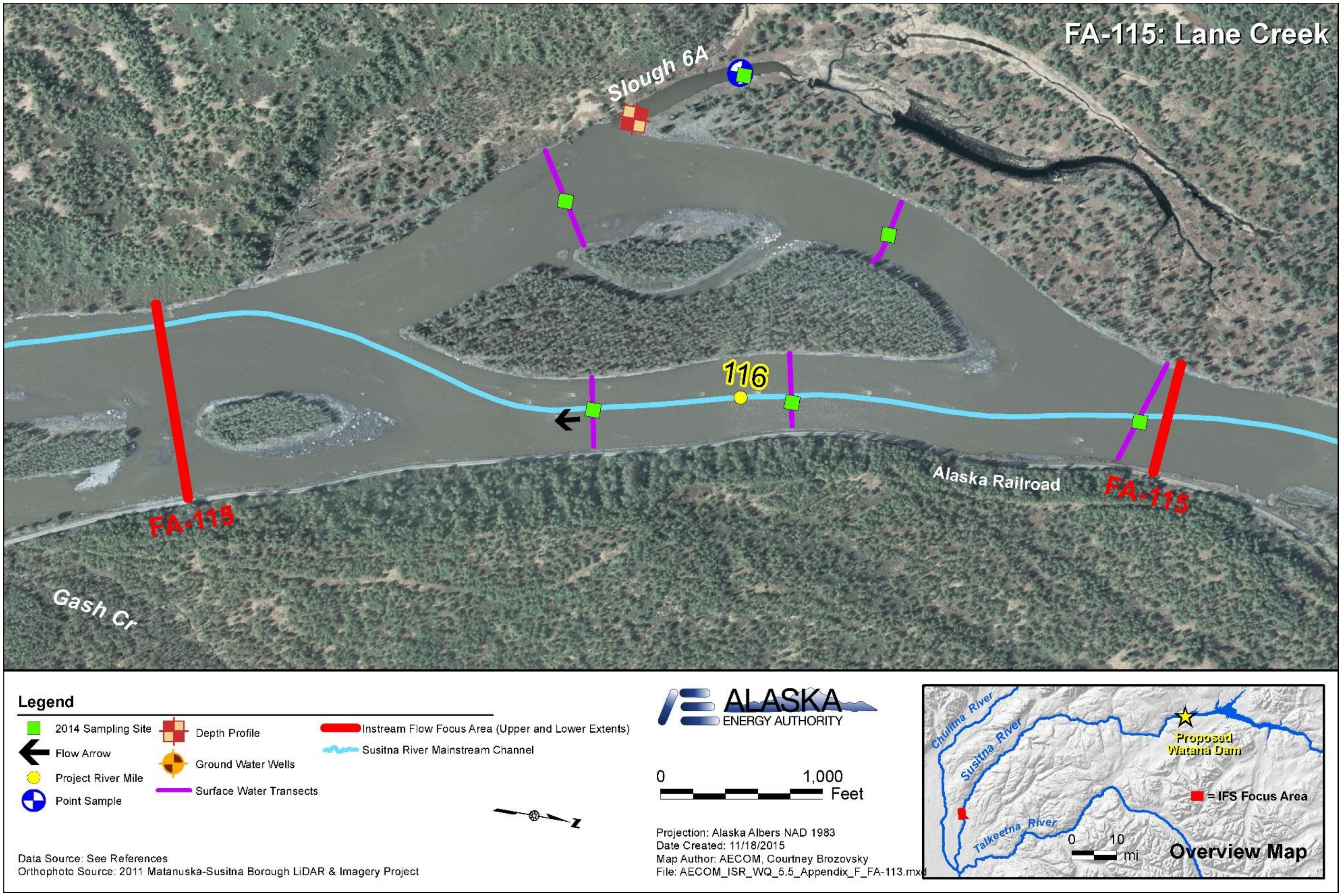

Figure 4.4-3. Detail of FA-115: Slough 6A. 2014 surface water sampling locations in FA-115 (July 2014 and September 2014)

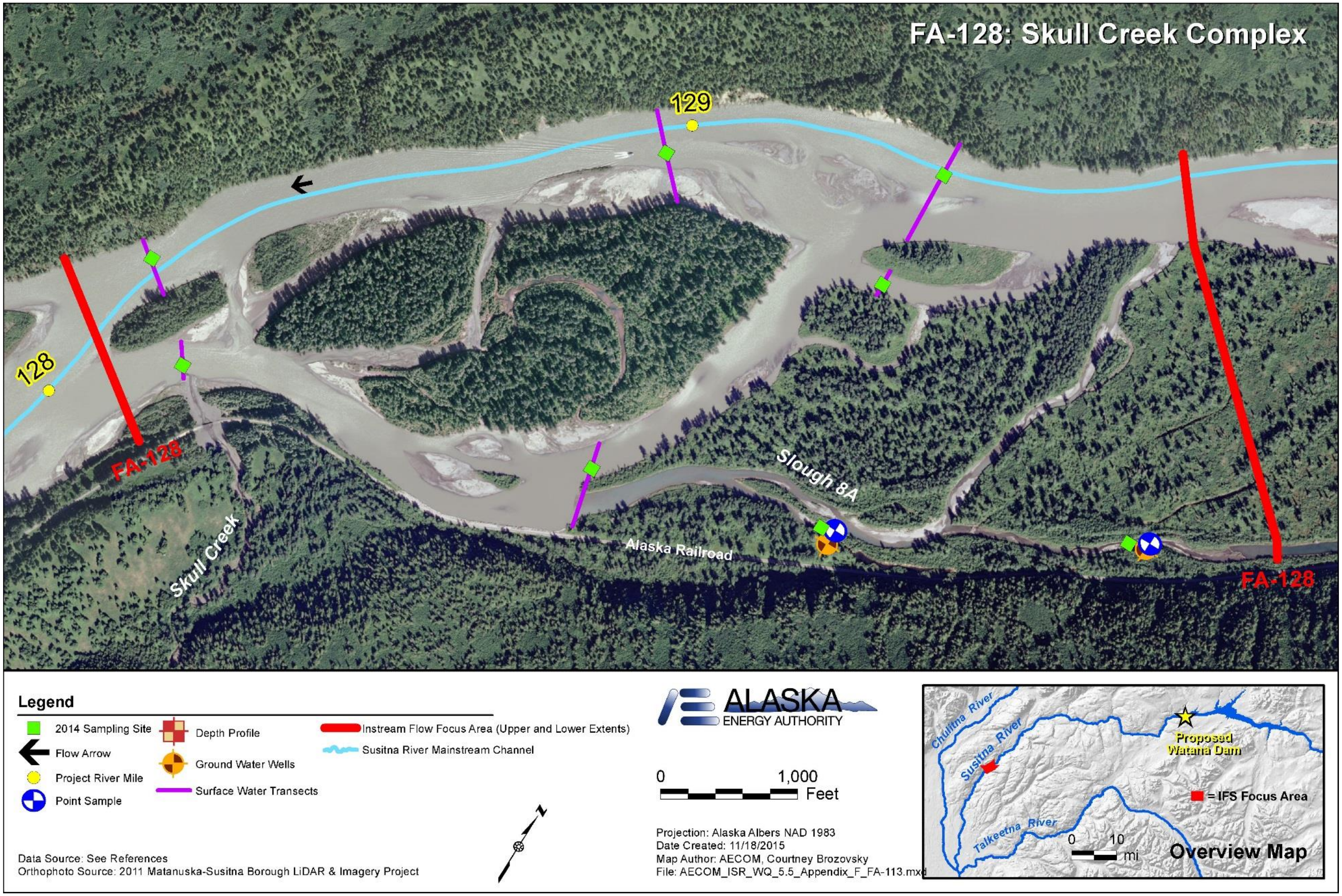

Figure 4.4-4. Detail of FA-128: Slough 8A. 2014 surface water sampling locations in FA-128 (July 2014 and September 2014)

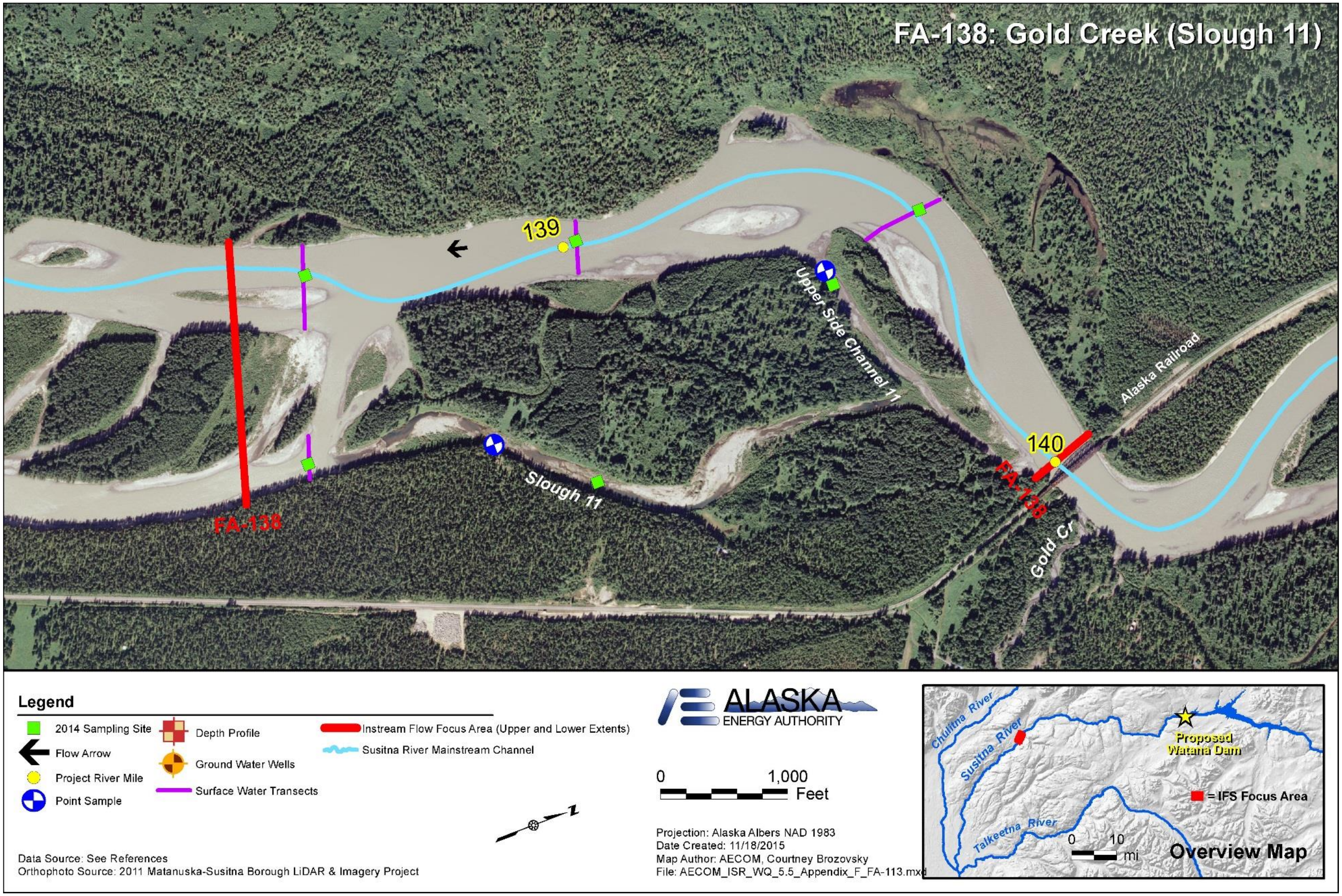

Figure 4.4-5. Detail of FA-138: Gold Creek. 2014 surface water sampling locations in FA-138 (July 2014 and September 2014)

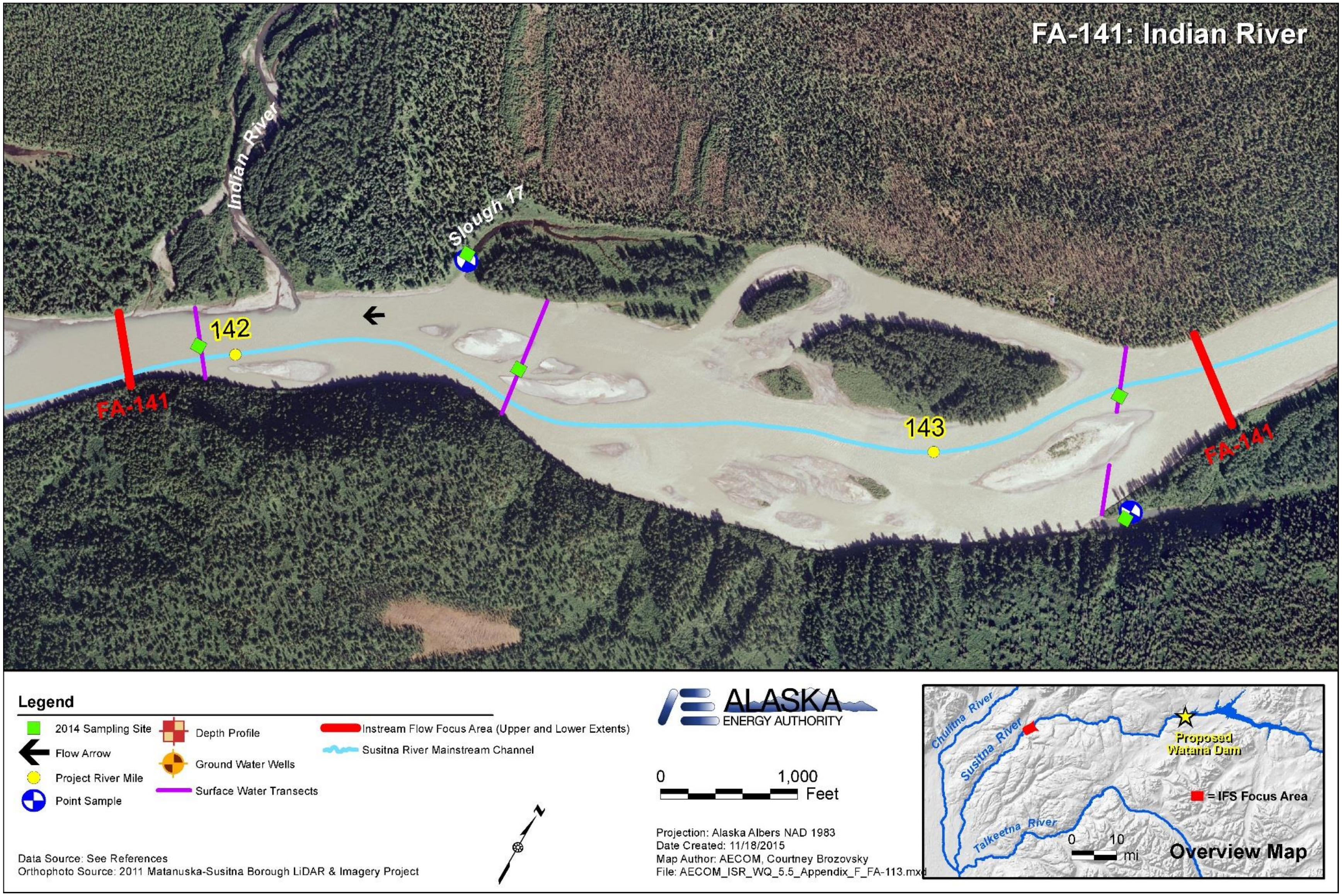

Figure 4.4-6. Detail of FA-141: Indian River. 2014 surface water sampling locations in FA-141 (July 2014 and September 2014)

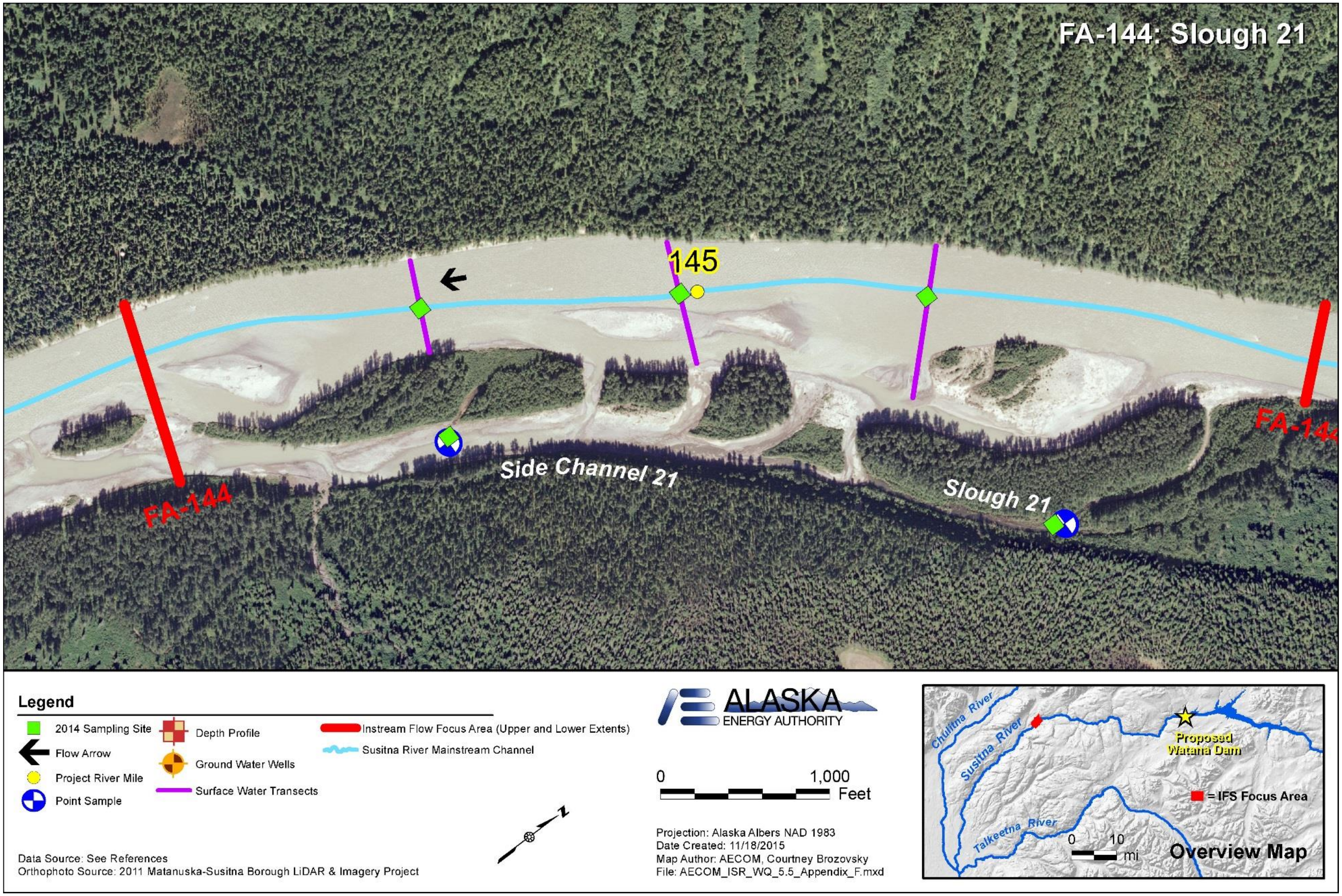

Figure 4.4-7. Detail of FA-144: Slough 21. 2014 surface water sampling locations in FA-144 (July 2014 and September 2014)

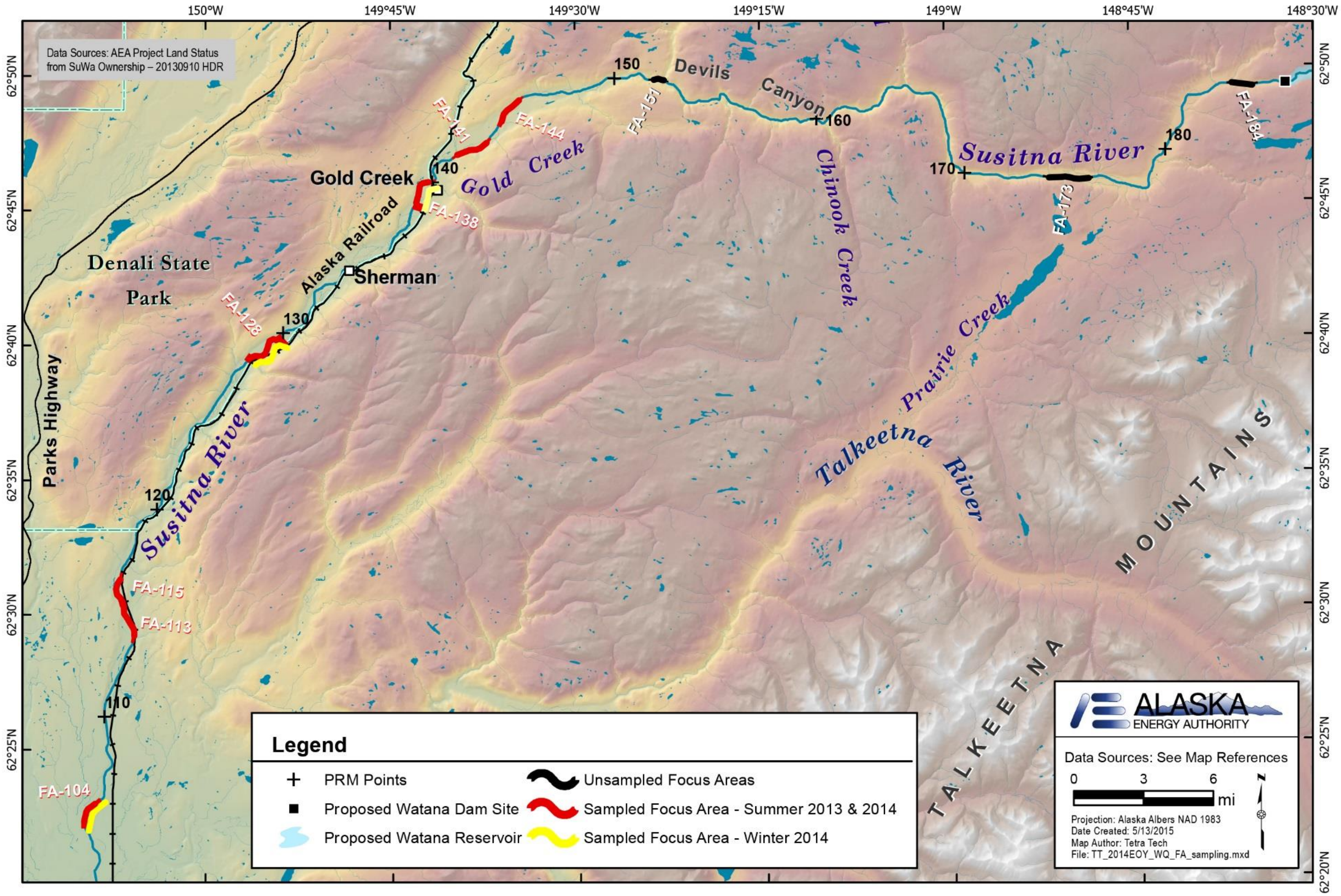

Figure 4.4-8. Focus Areas Sampled for Water Quality in the Middle River

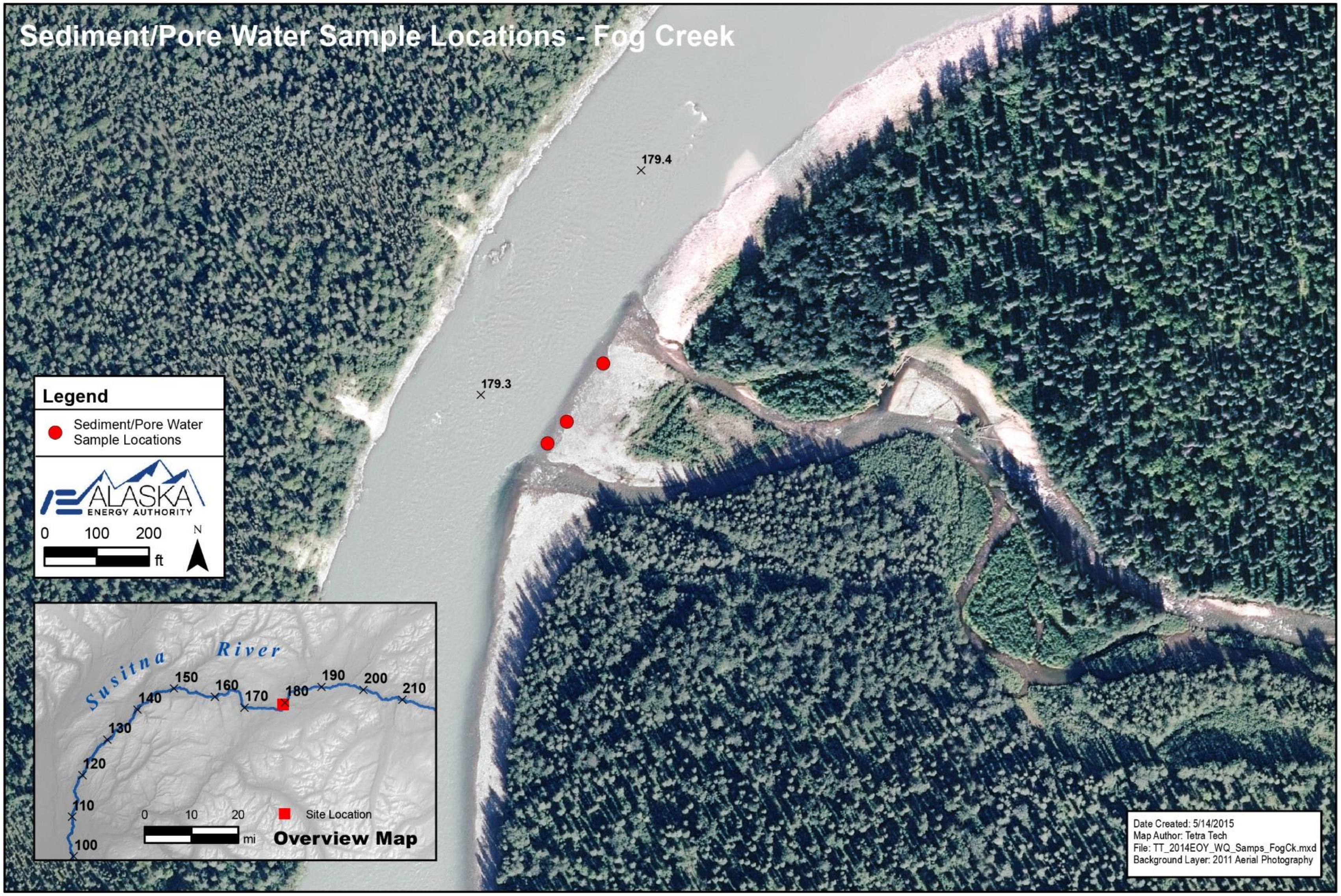

Figure 4.6-1. Susitna Sediment and Porewater Sampling locations at Mouth of Fog Creek

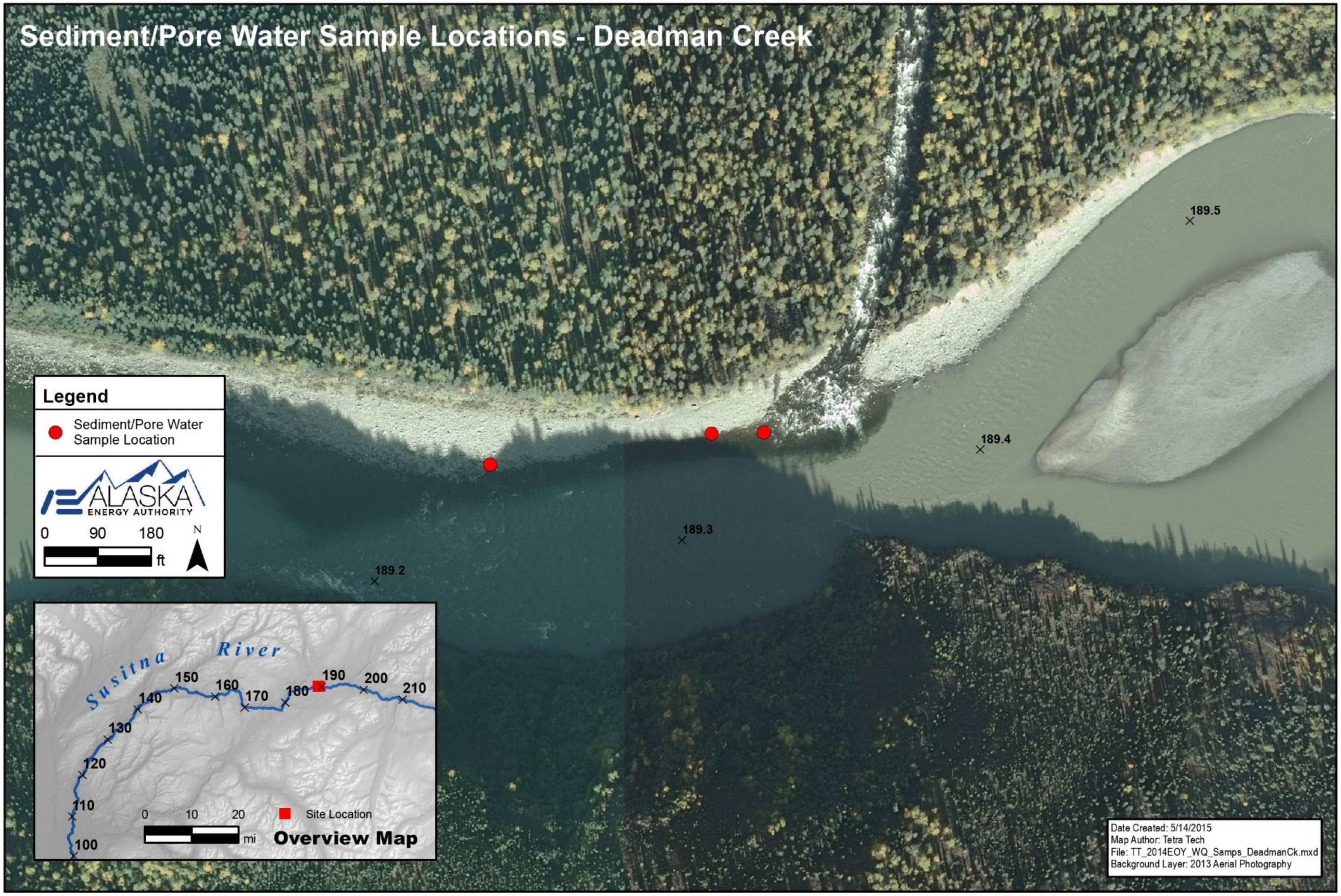

Figure 4.6-2. Susitna Sediment and Porewater Sampling Locations below Deadman Creek

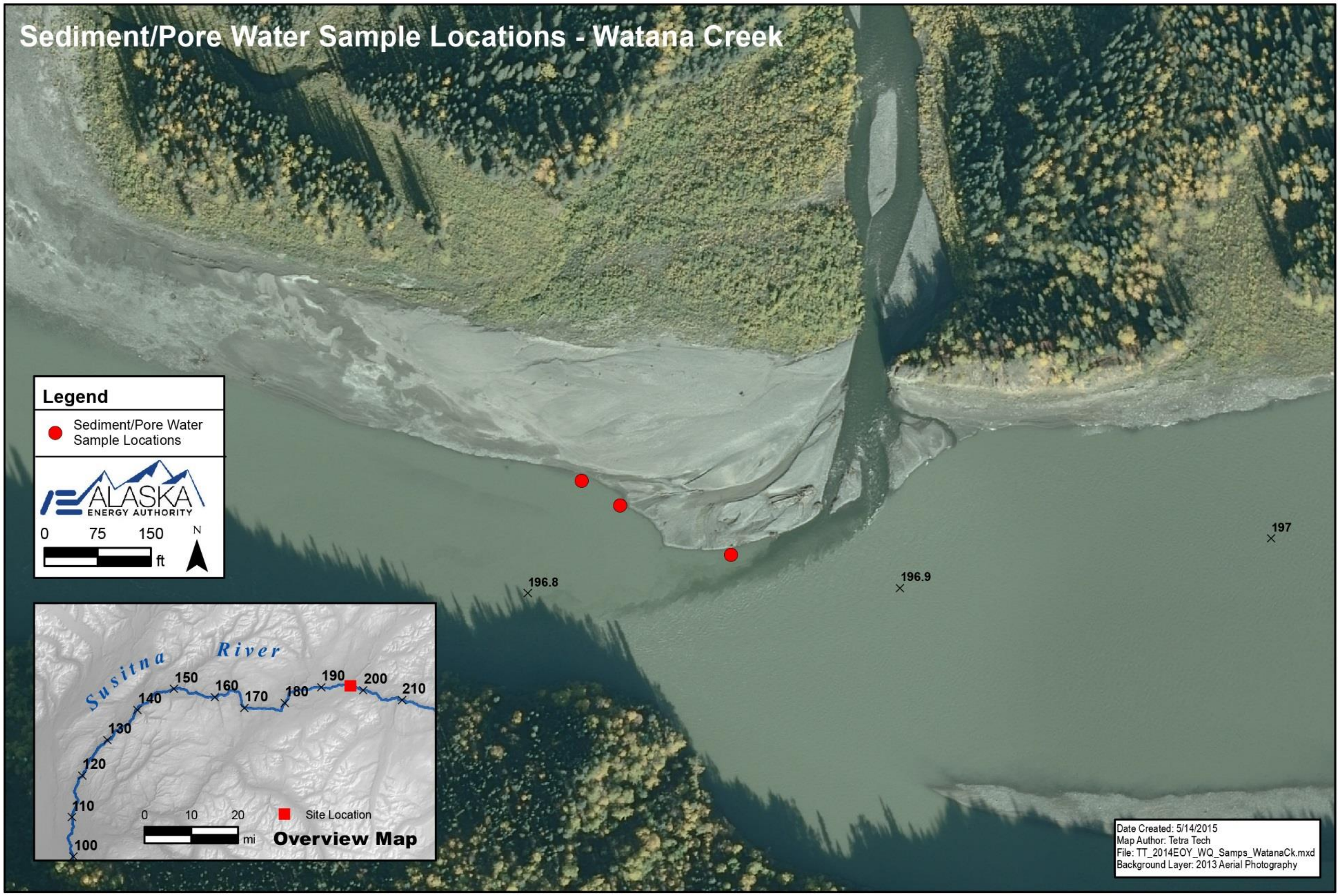

Figure 4.6-3. Susitna Sediment and Porewater Sampling Locations at Mouth of Watana Creek

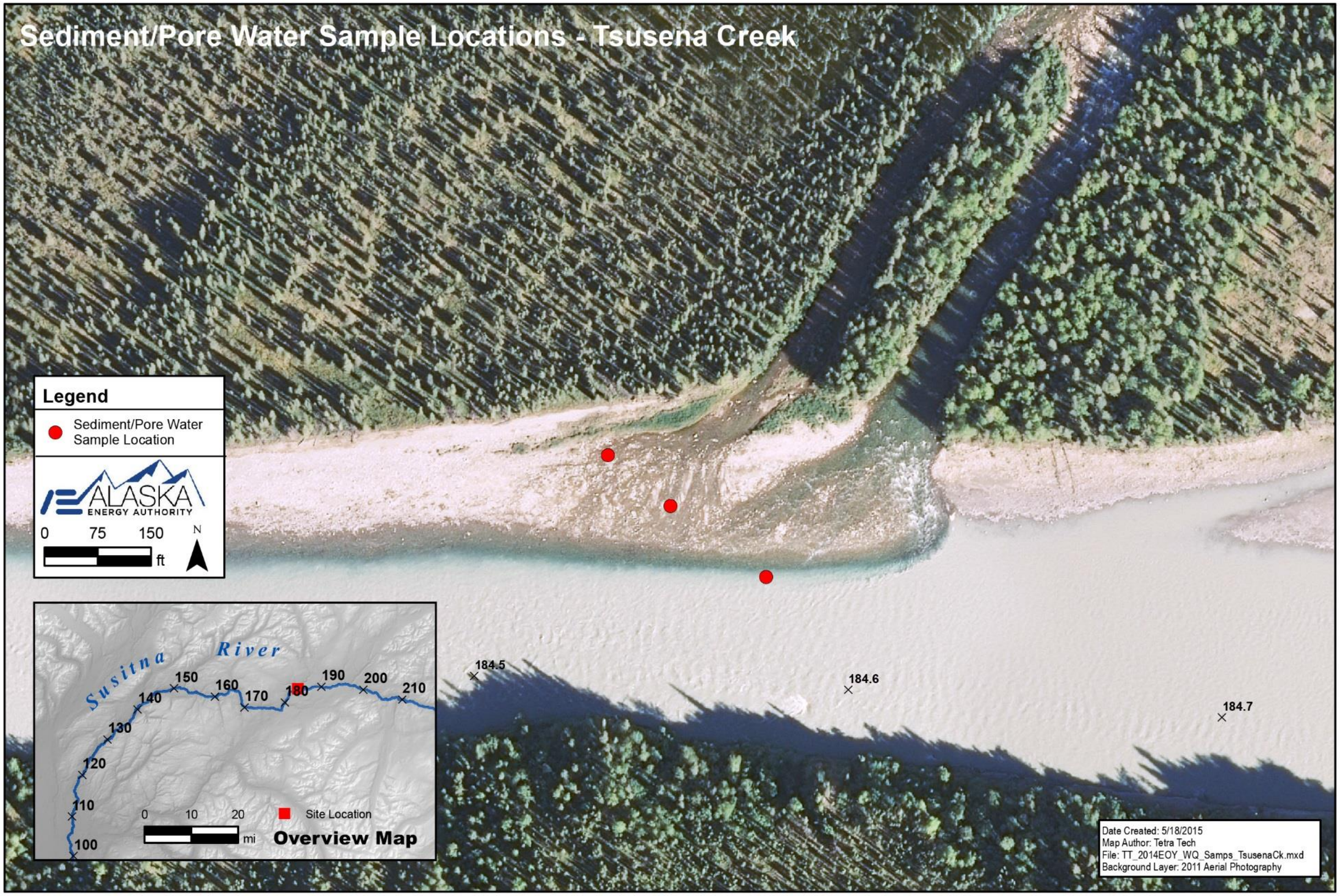

Figure 4.6-4. Susitna Sediment and Porewater Sampling Locations at Mouth of Tsusena Creek

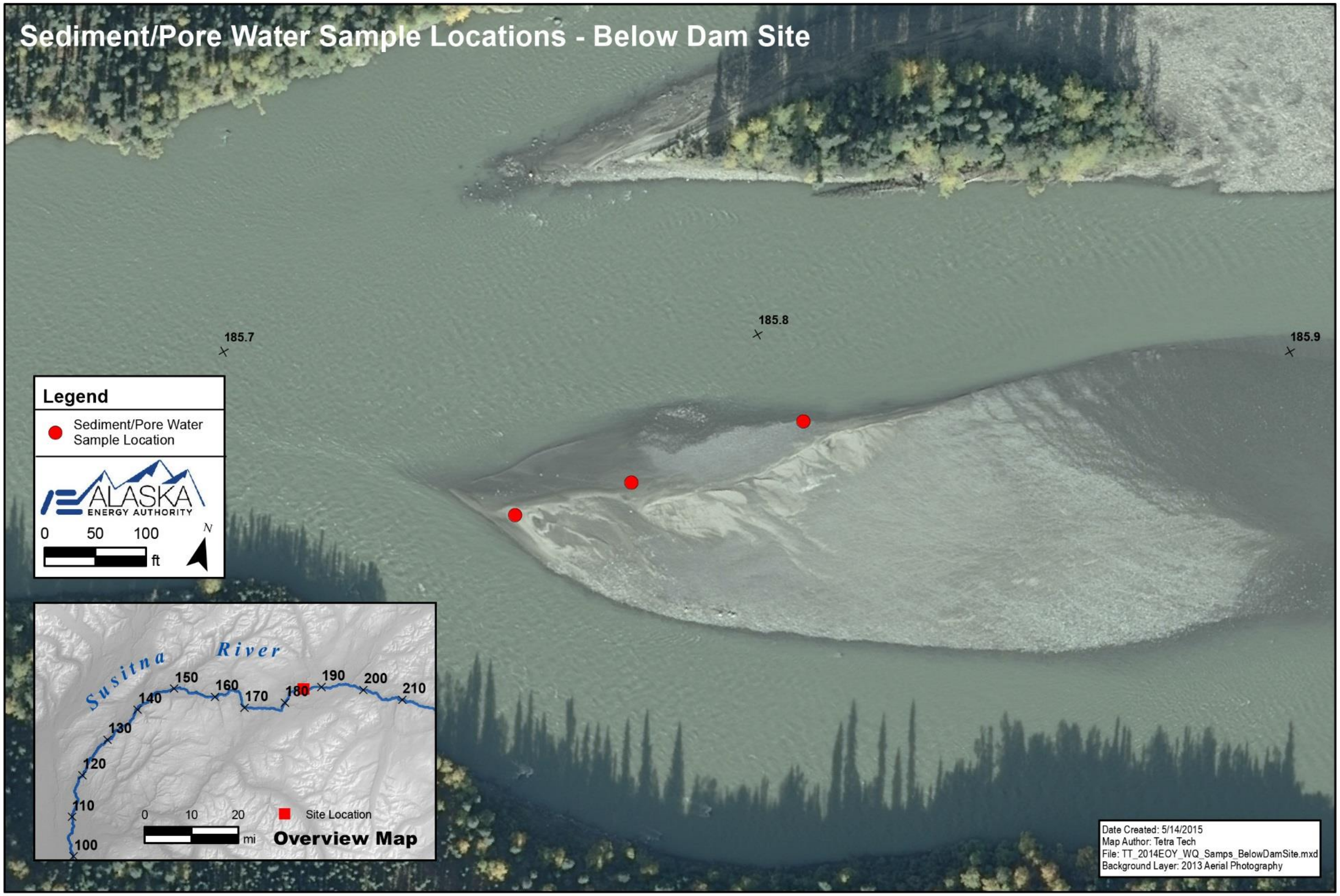

Figure 4.6-5. Susitna Sediment and Porewater Sampling Locations below the Dam Site

Figure 4.6-6. Susitna Sediment and Porewater Sampling Locations above the Dam Site

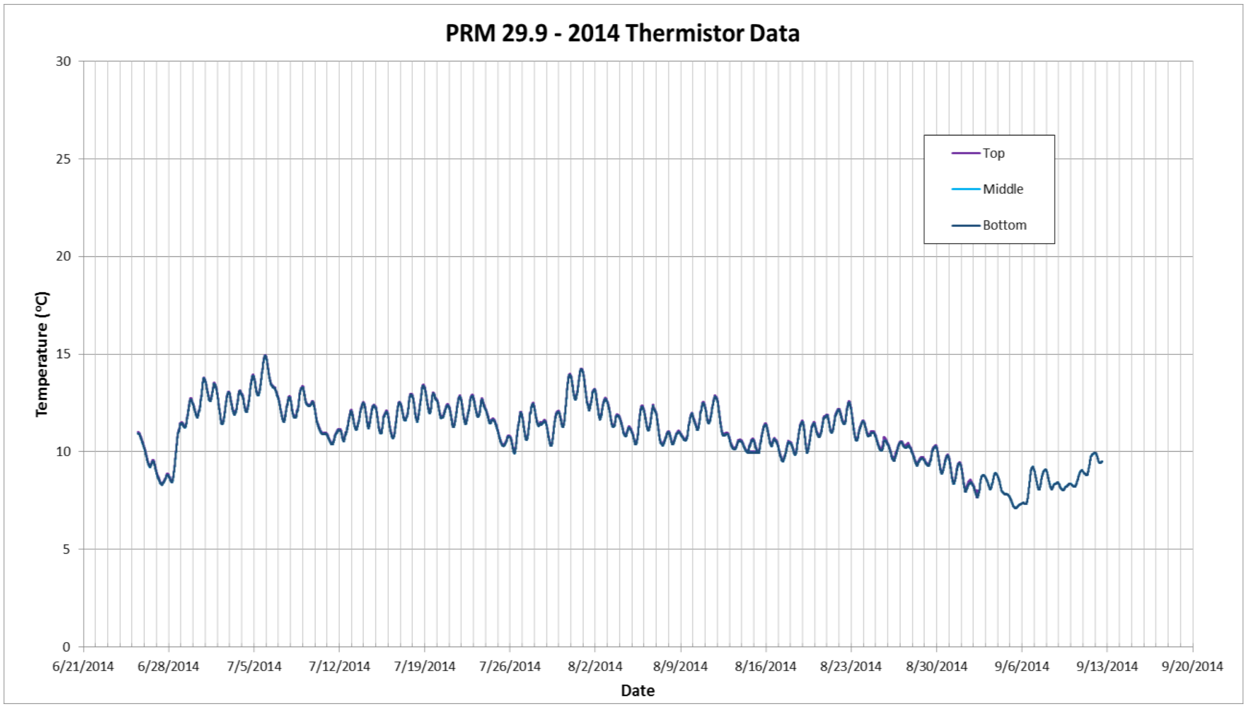

Figure 5.2-1. Thermistor Data at Susitna Station (2014).

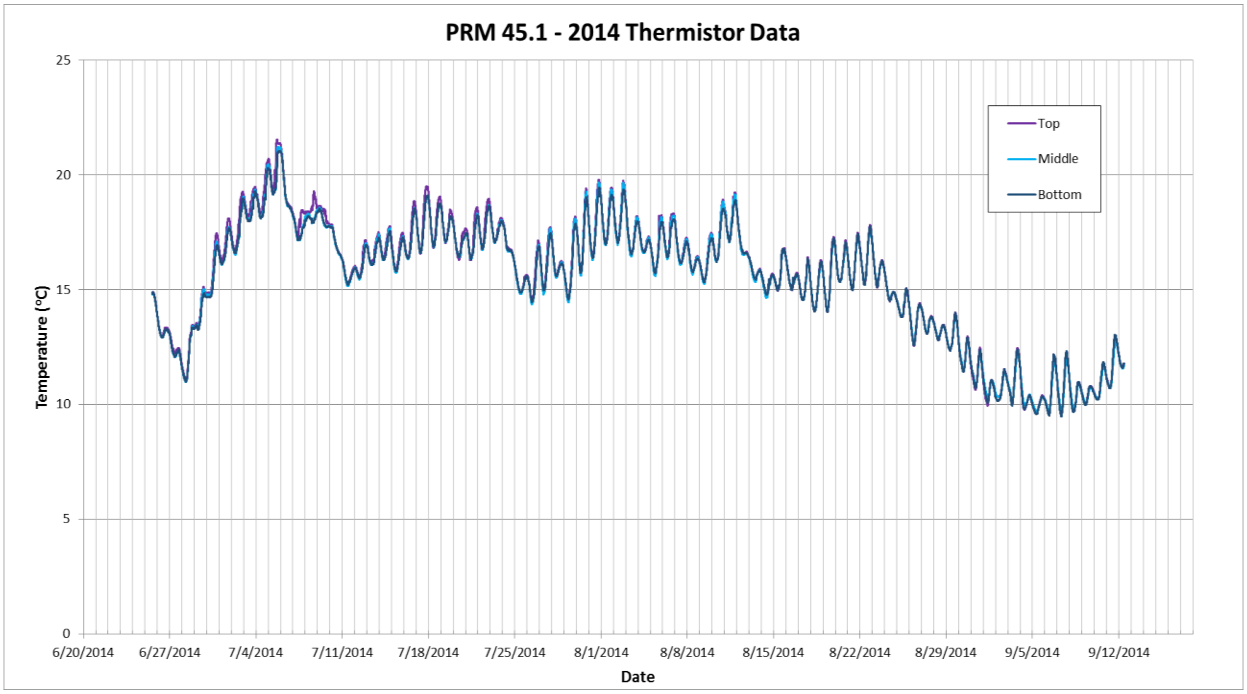

Figure 5.2-2. Thermistor Data at Deshka River (2014).

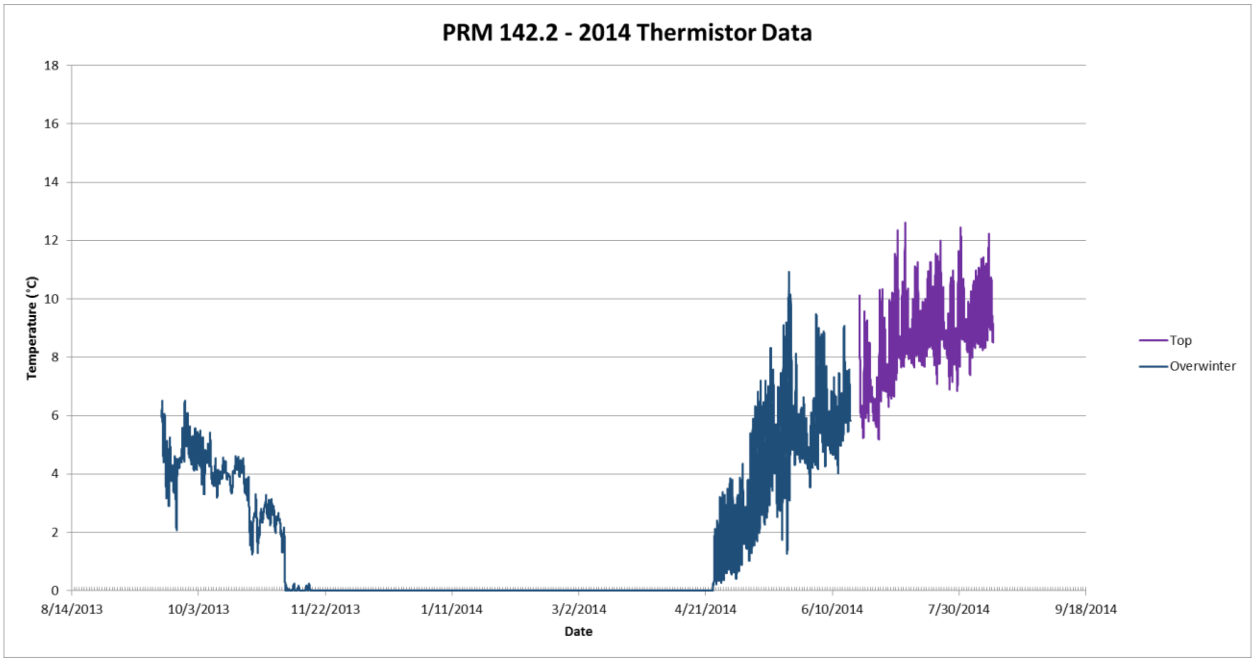

Figure 5.2-3. Thermistor Data at Indian River (Winter 2013 through Summer 2014)

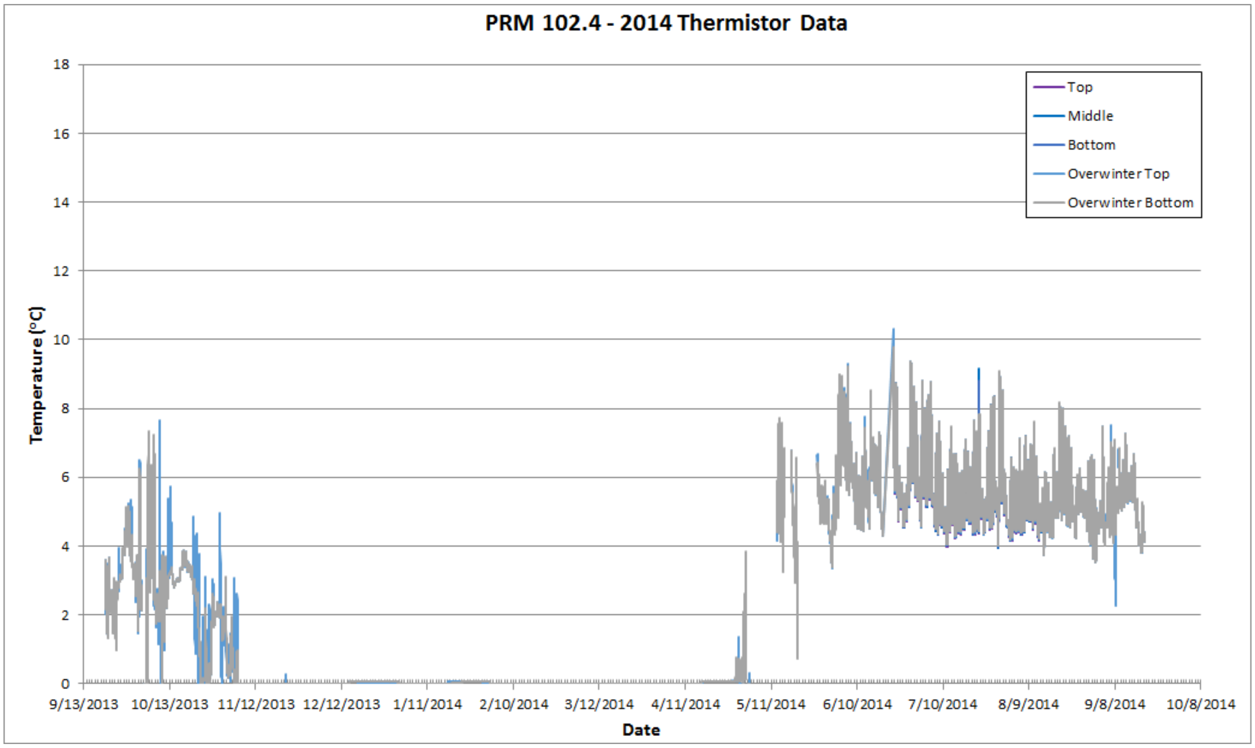

Figure 5.2-4. Thermistor Data at Chulitna River (Winter 2013 through Summer 2014)

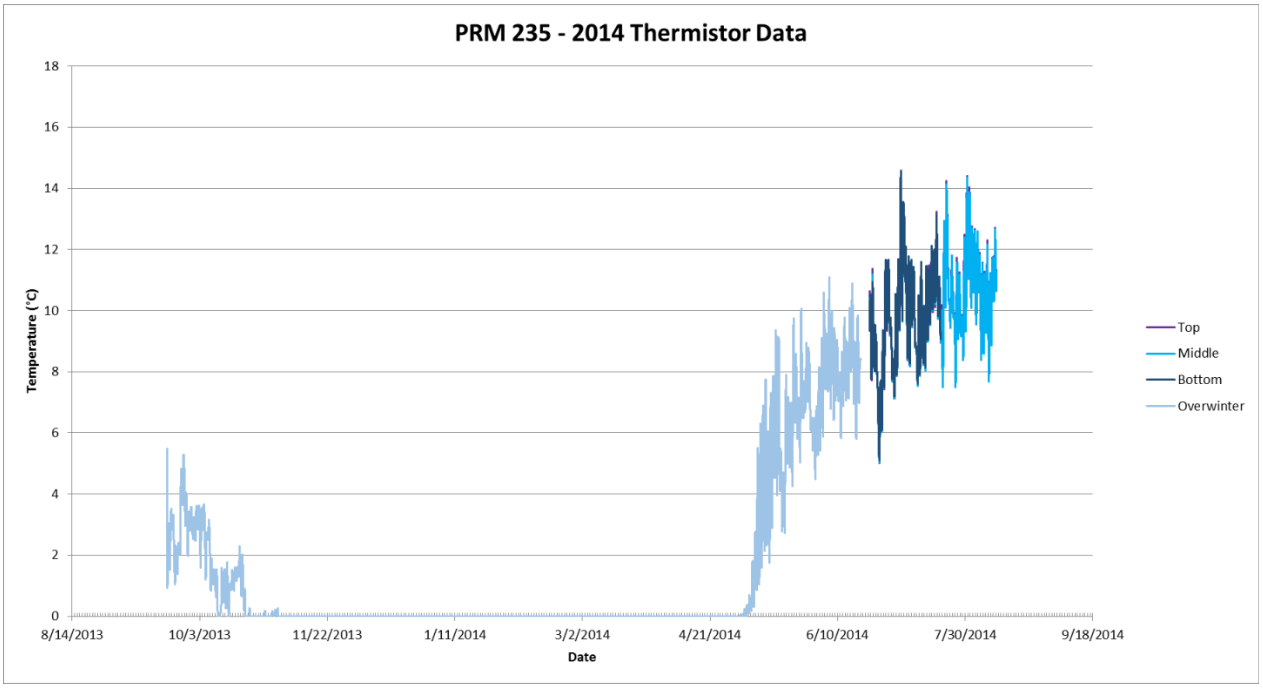

Figure 5.2-5. Thermistor Data Oshetna River (Winter 2013 Through Summer 2014)

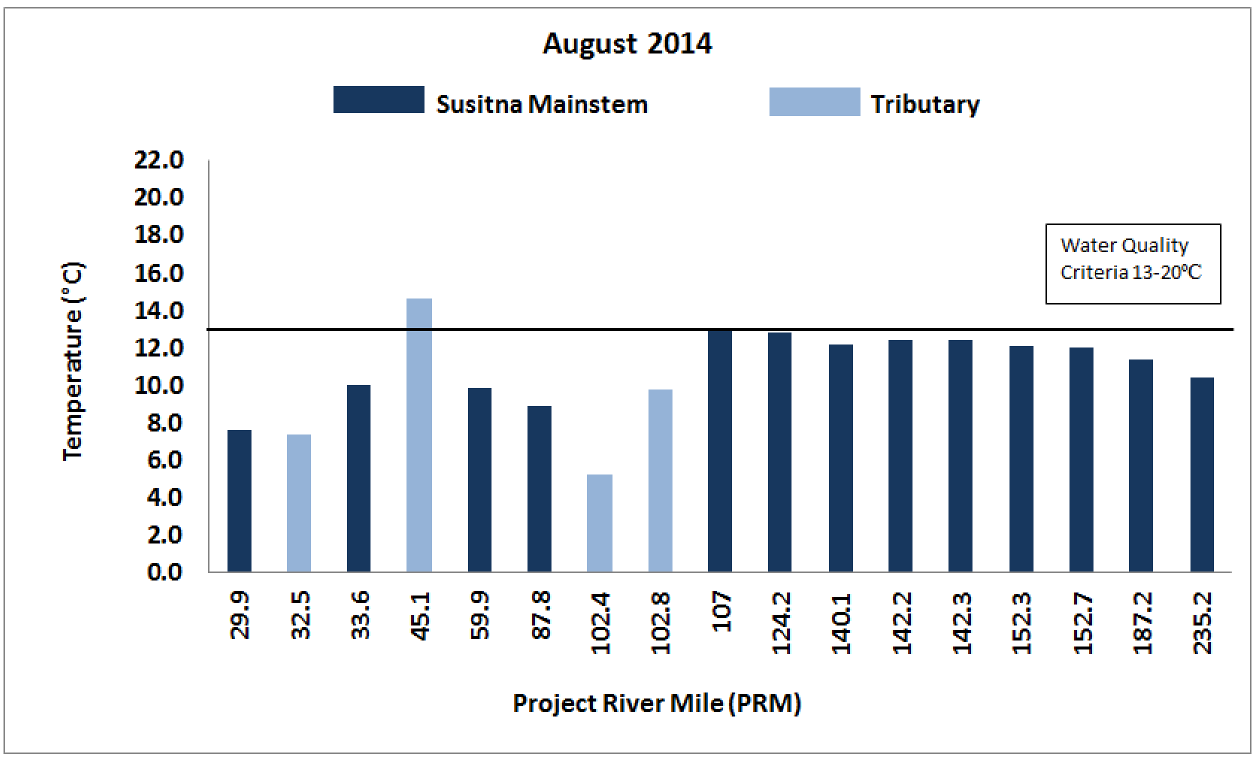

Figure 5.4-1. Field Measurement Temperature by PRM (Summer 2014)

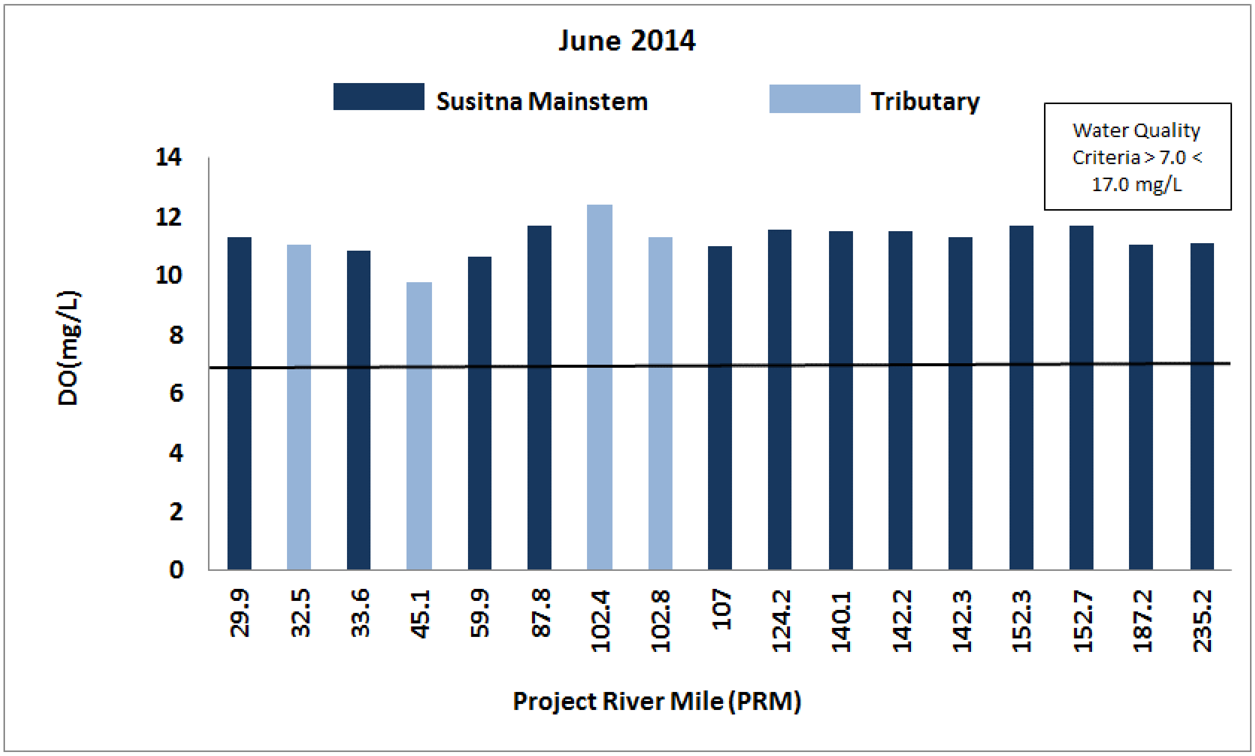

Figure 5.4-2. DO Concentrations by PRM (June 2014)

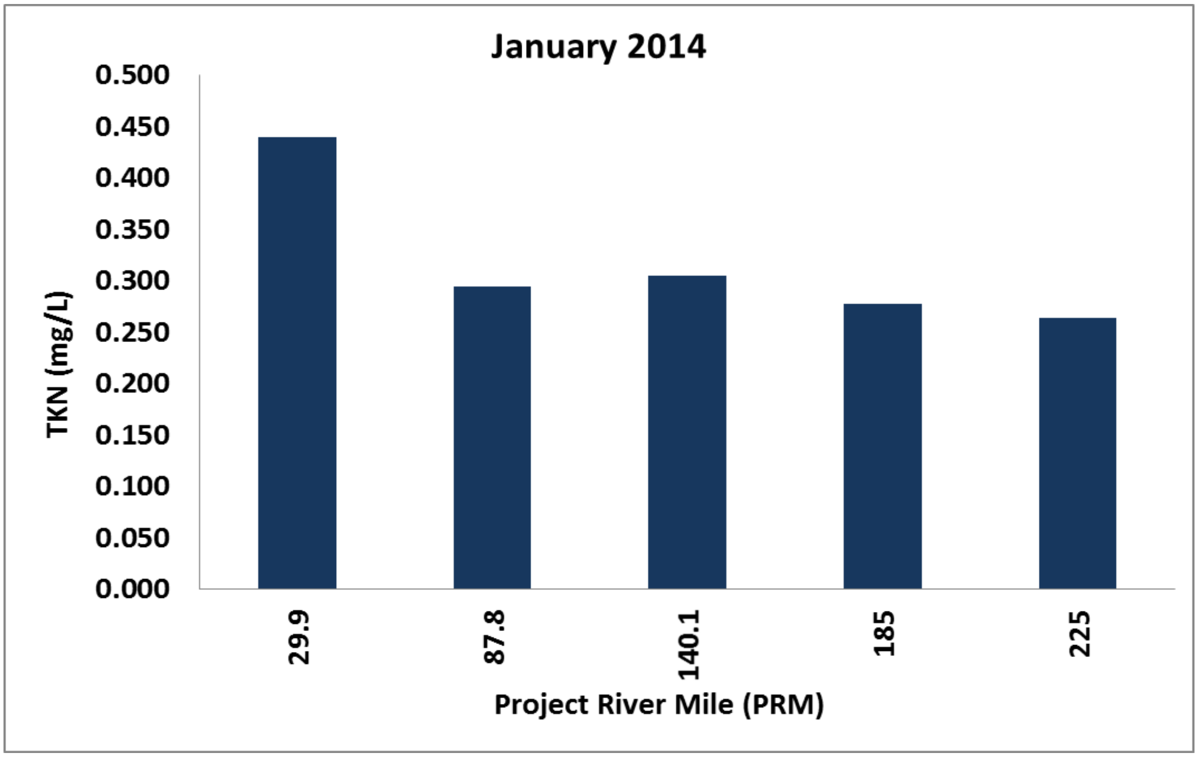

Figure 5.4-3. TKN Concentrations by PRM (January 2014)

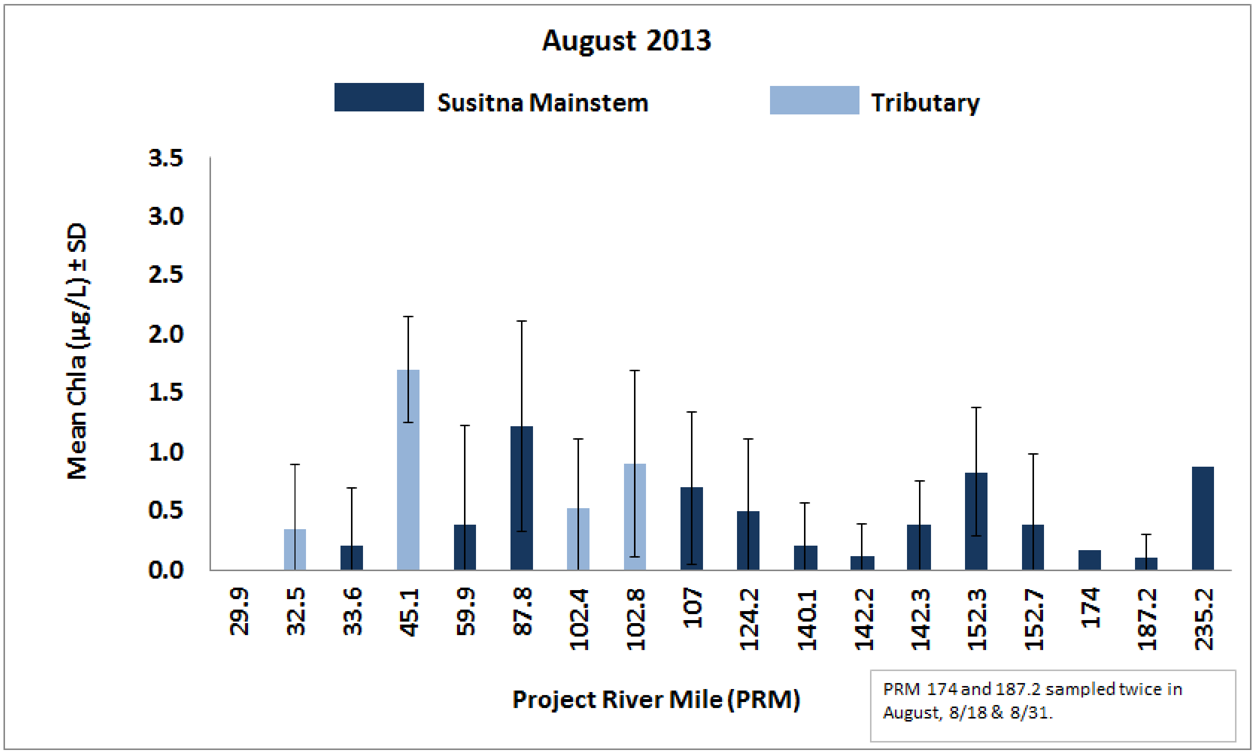

Figure 5.4-4. Chlorophyll a Data by PRM (August 2013)

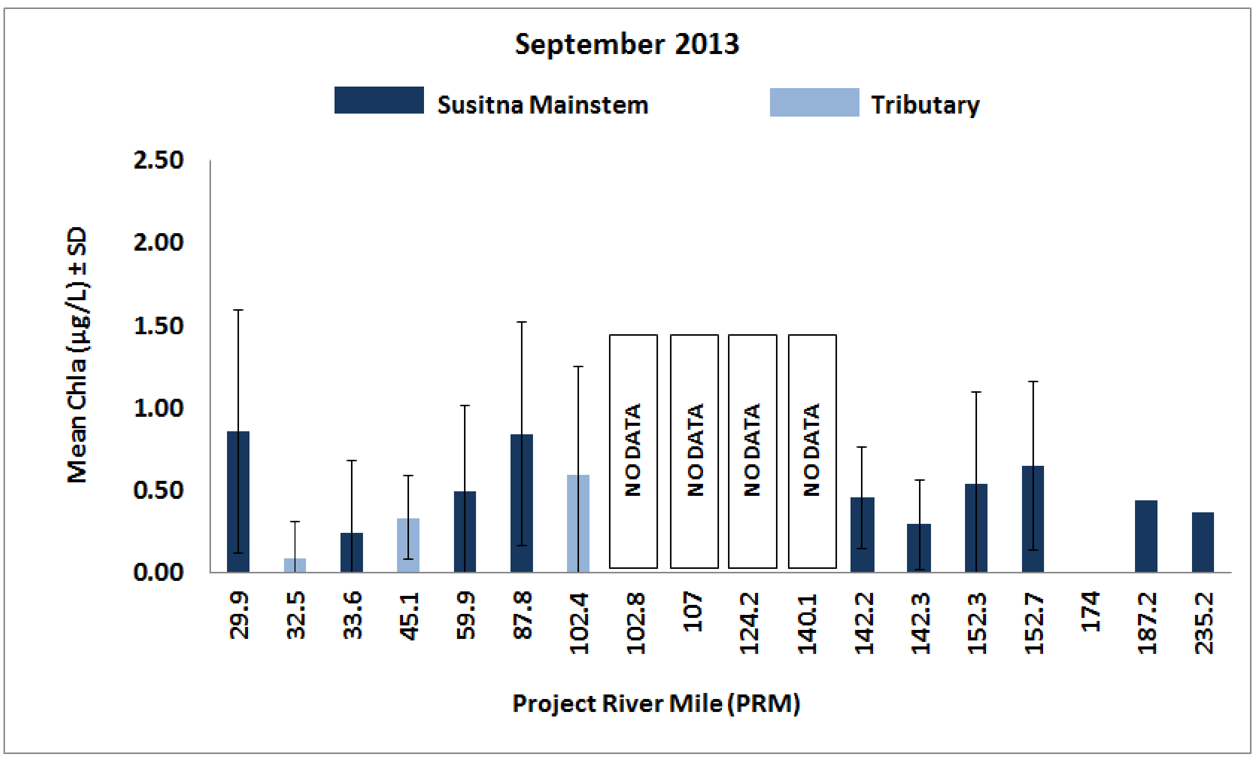

Figure 5.4-5. Chlorophyll a Data by PRM (September 2013)

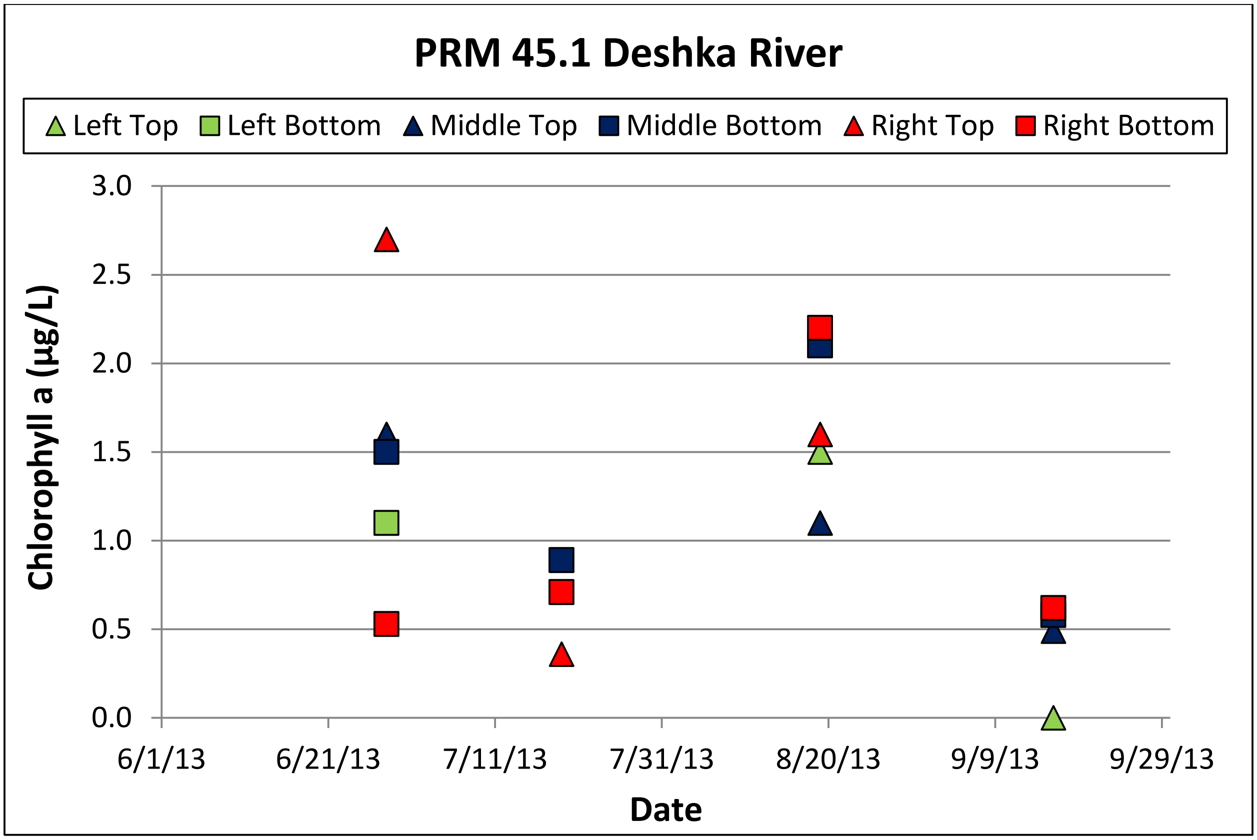

Figure 5.4-6. Chlorophyll a Data at PRM 45.1 (Summer 2013)

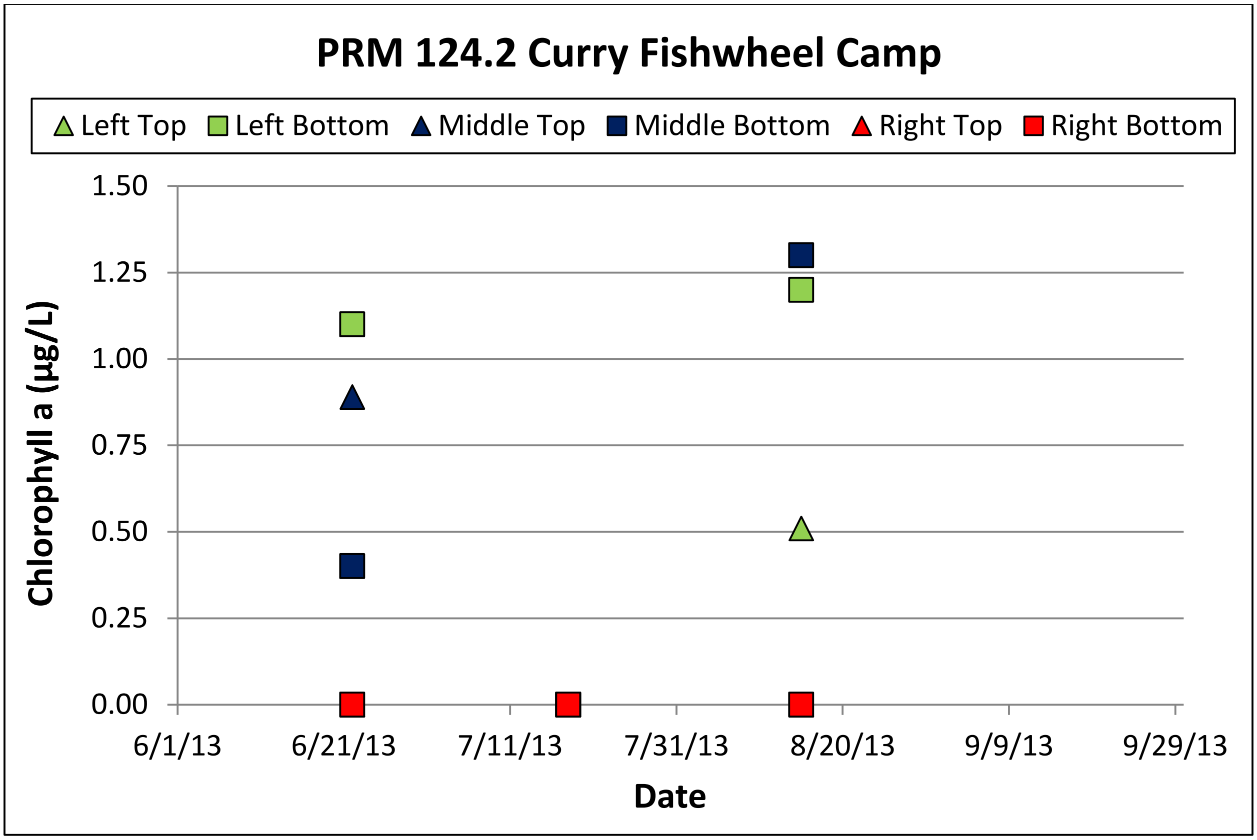

Figure 5.4-7. Chlorophyll a Data at PRM 124.2 (Summer 2013)

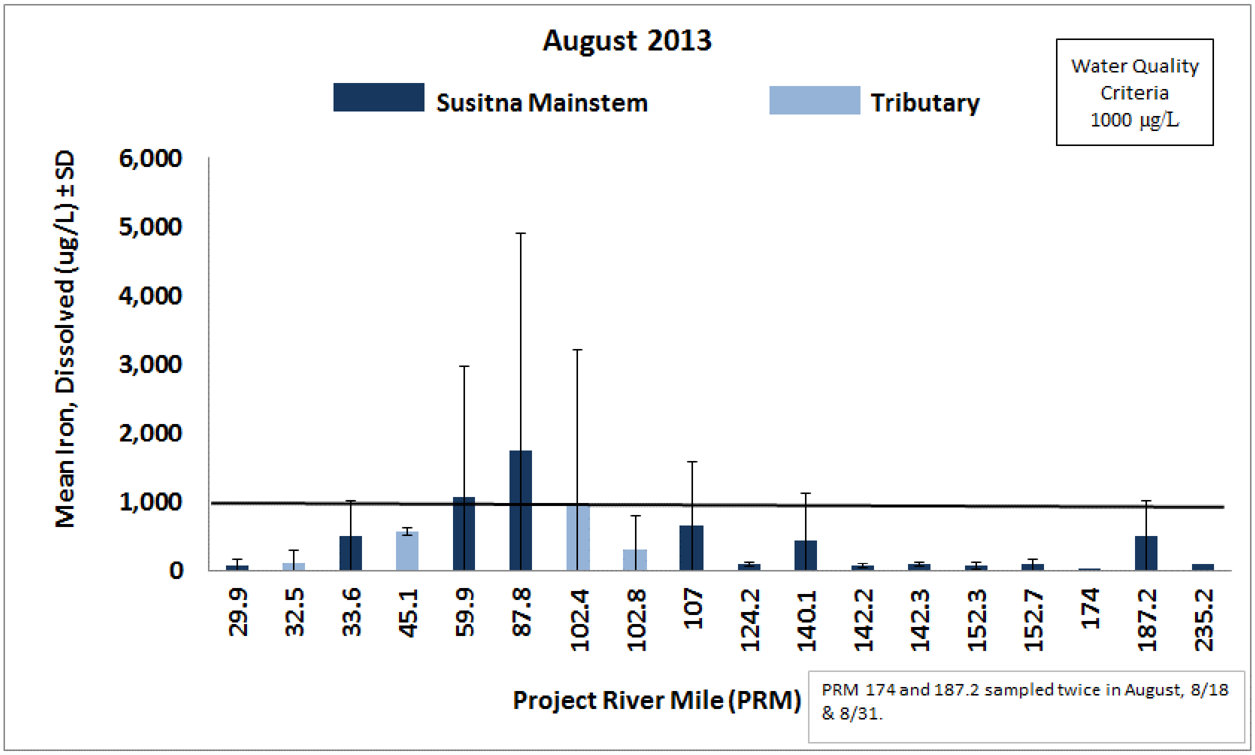

Figure 5.4-8. Mean Baseline Dissolved Iron Concentrations by PRM (August 2013)

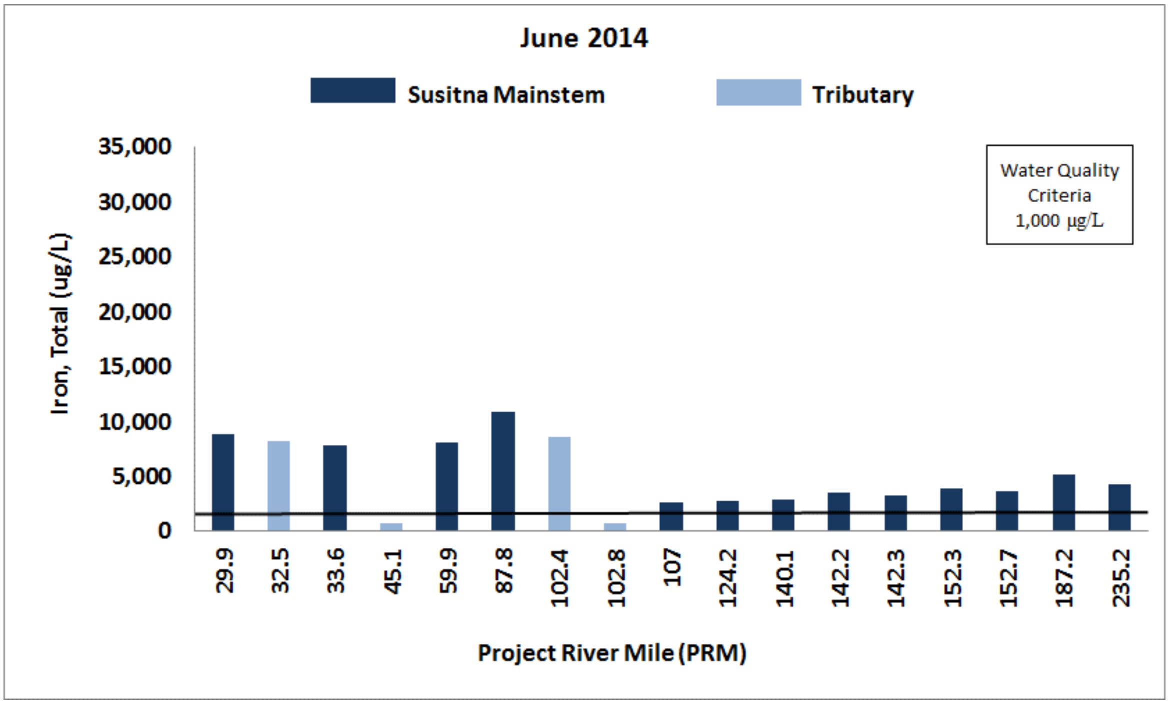

Figure 5.4-9. Total Iron Concentrations by PRM (June 2014)

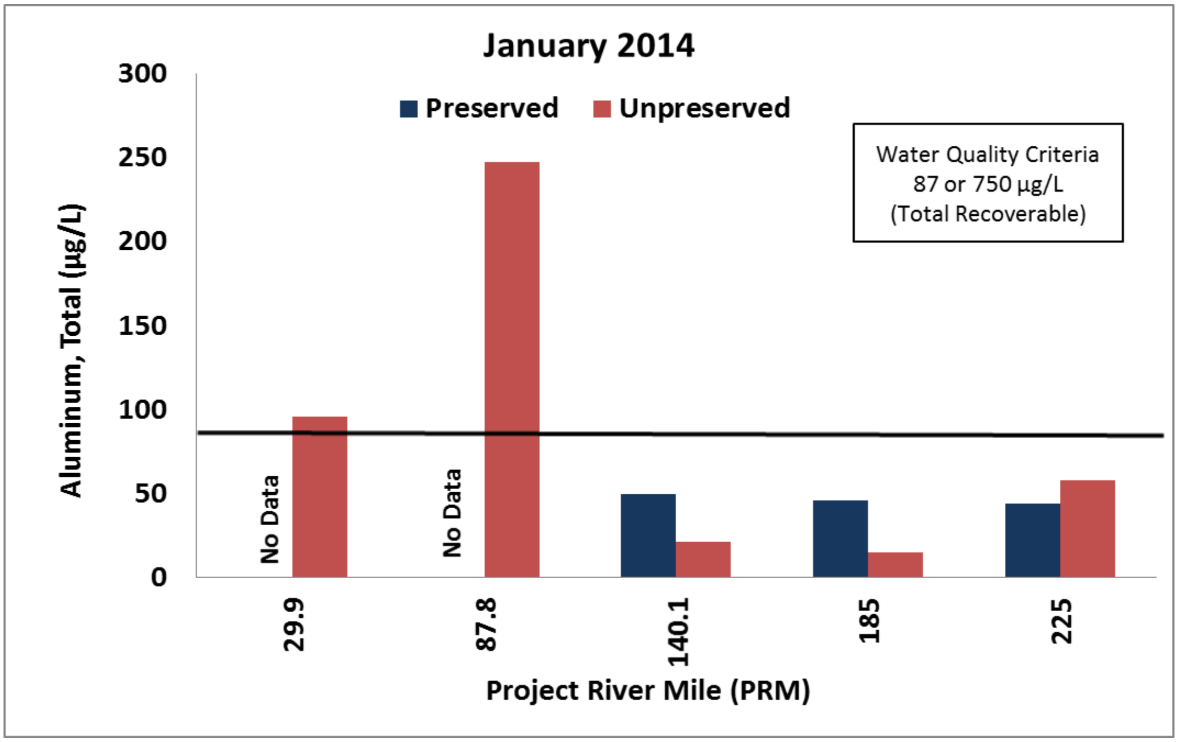

Figure 5.4-10. Total Aluminum Concentrations by PRM (January 2014)

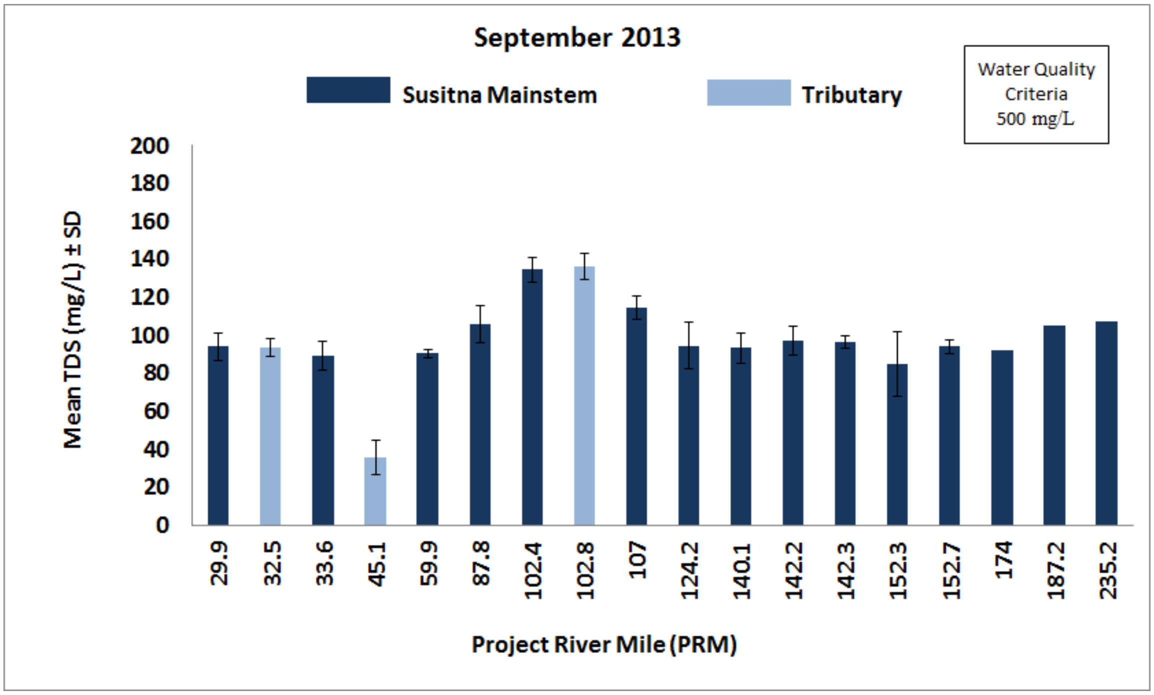

Figure 5.4-11. Mean Baseline TDS Concentrations by PRM (September 2013)

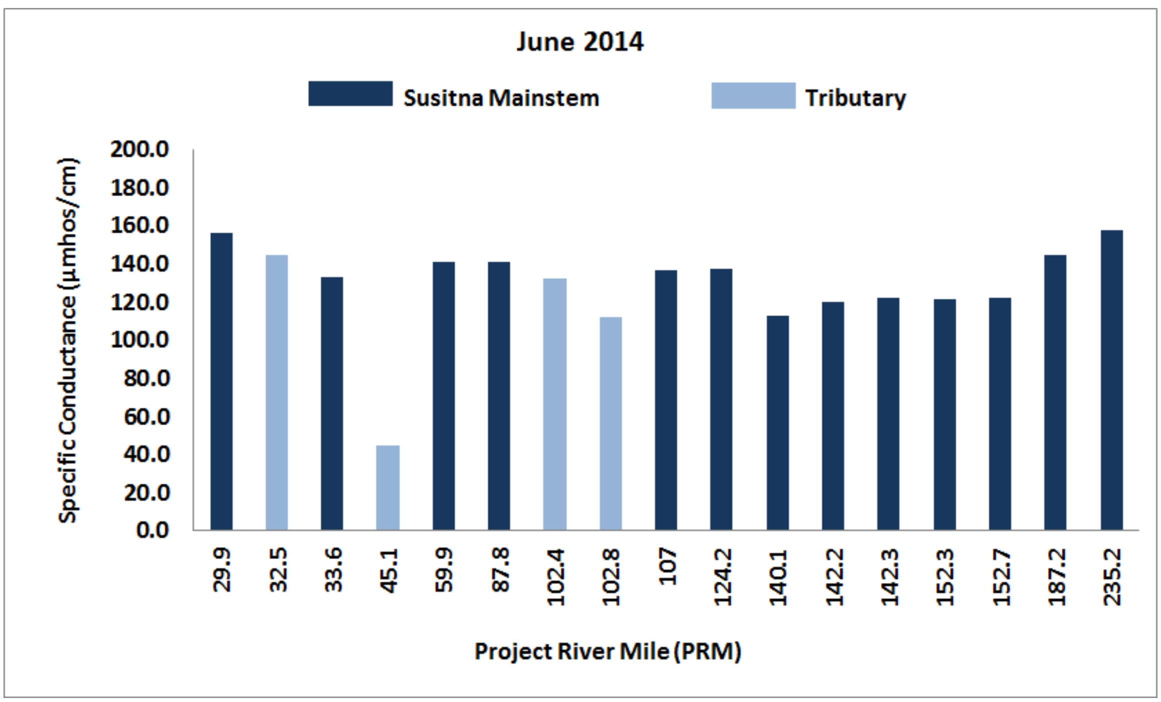

Figure 5.4-12. Specific Conductance by PRM (June 2014)

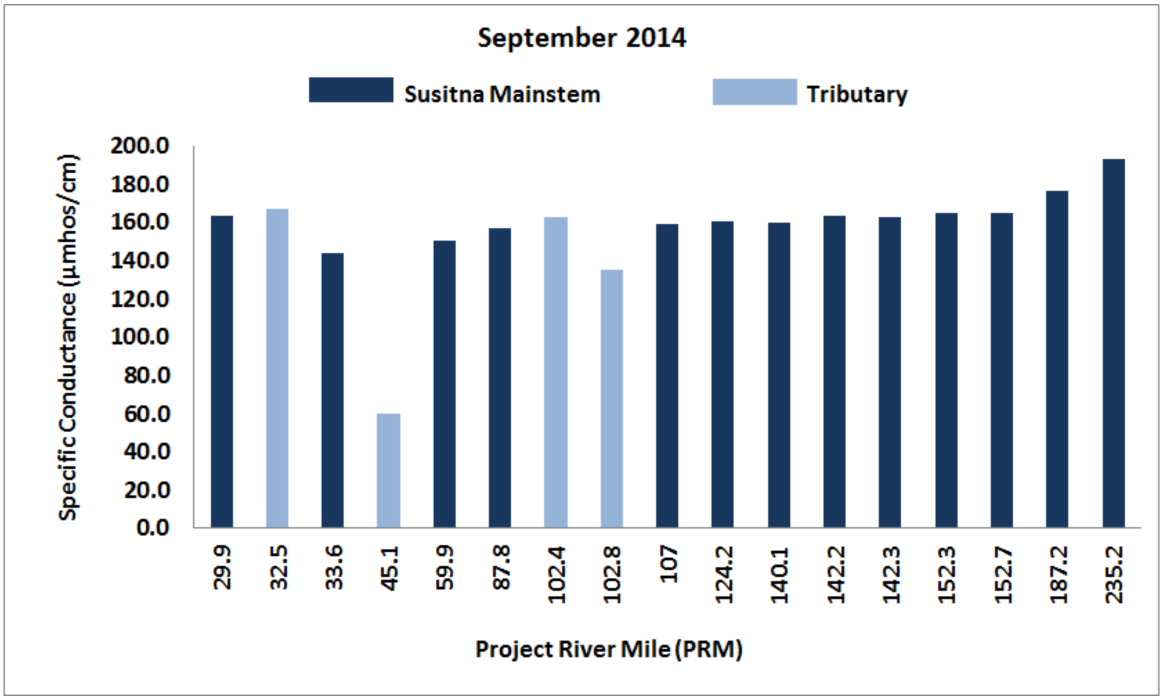

Figure 5.4-13. Specific Conductance by PRM (September 2014)

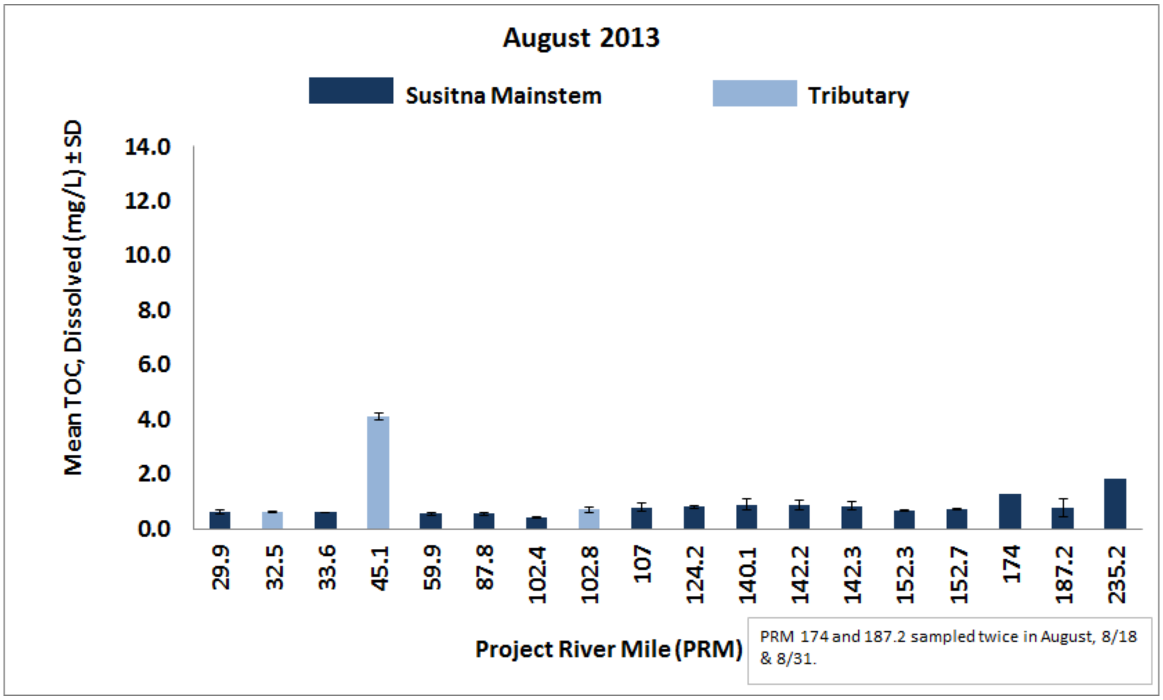

Figure 5.4-14. Mean Baseline TOC concentrations by PRM (August 2013)

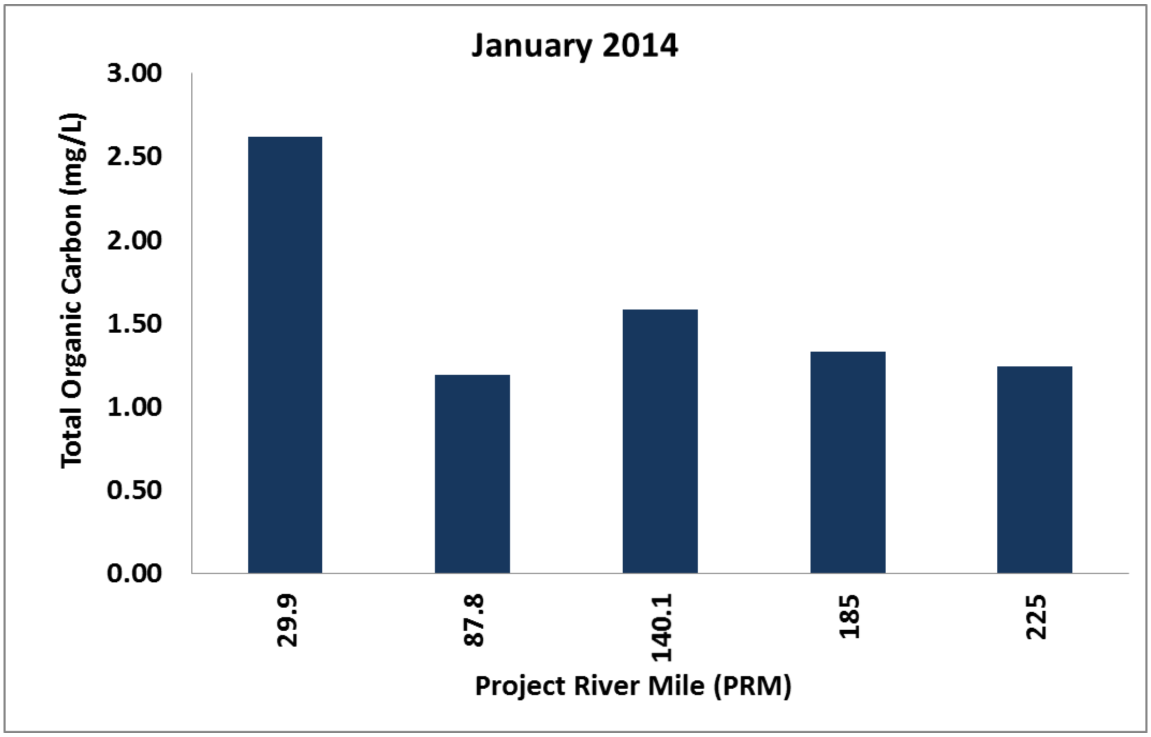

Figure 5.4-15. TOC Concentration by PRM (January 2014)

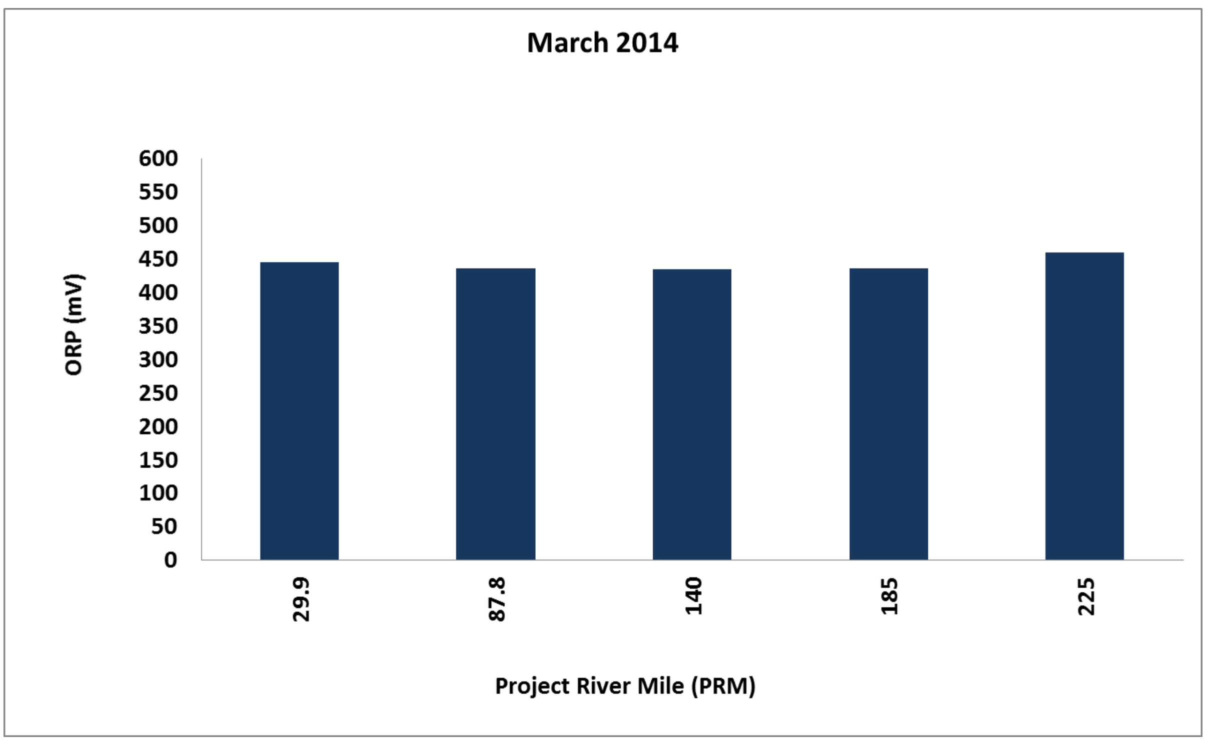

Figure 5.4-16. Redox Potential by PRM (March 2014)

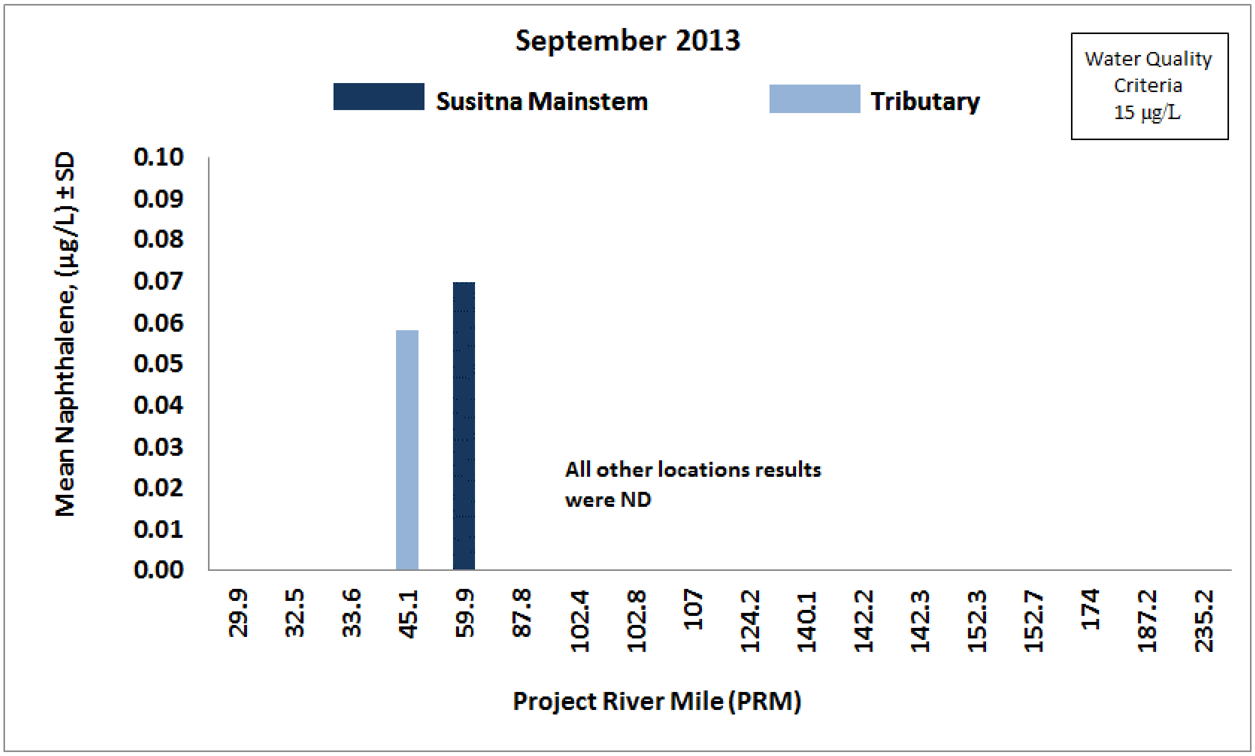

Figure 5.4-17. Mean Baseline Naphthalene Concentrations by PRM (September 2013)

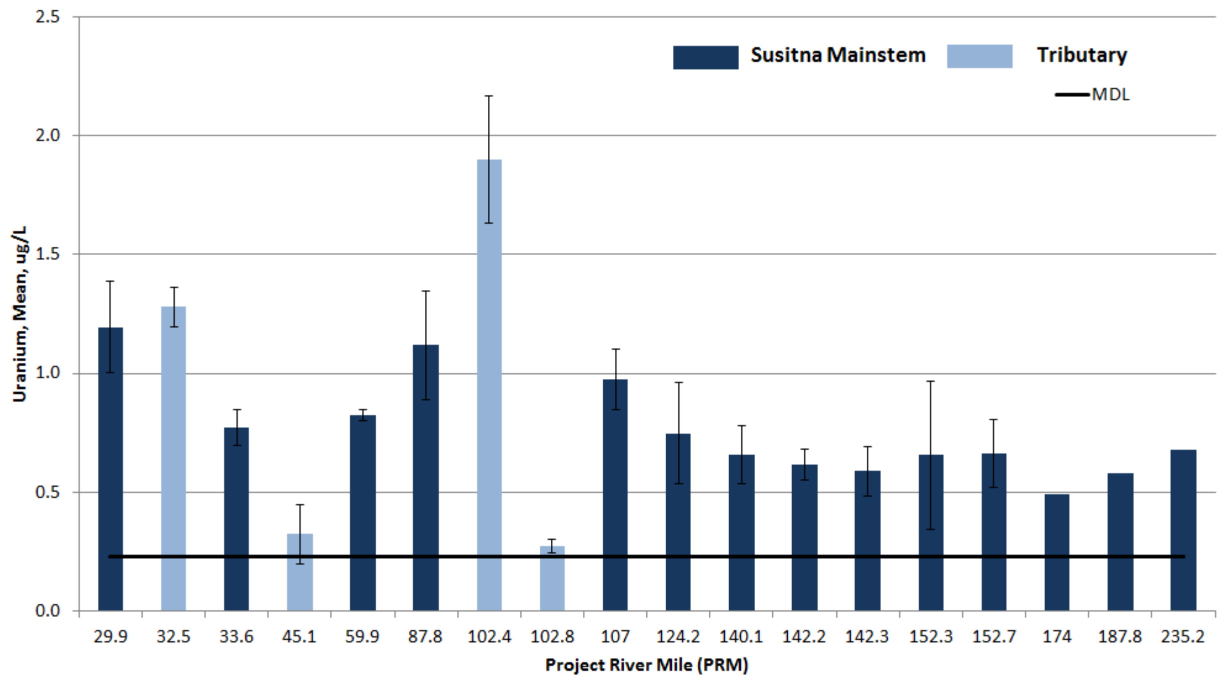

Figure 5.4-188. Mean Baseline Uranium Concentrations by PRM (September 2013)

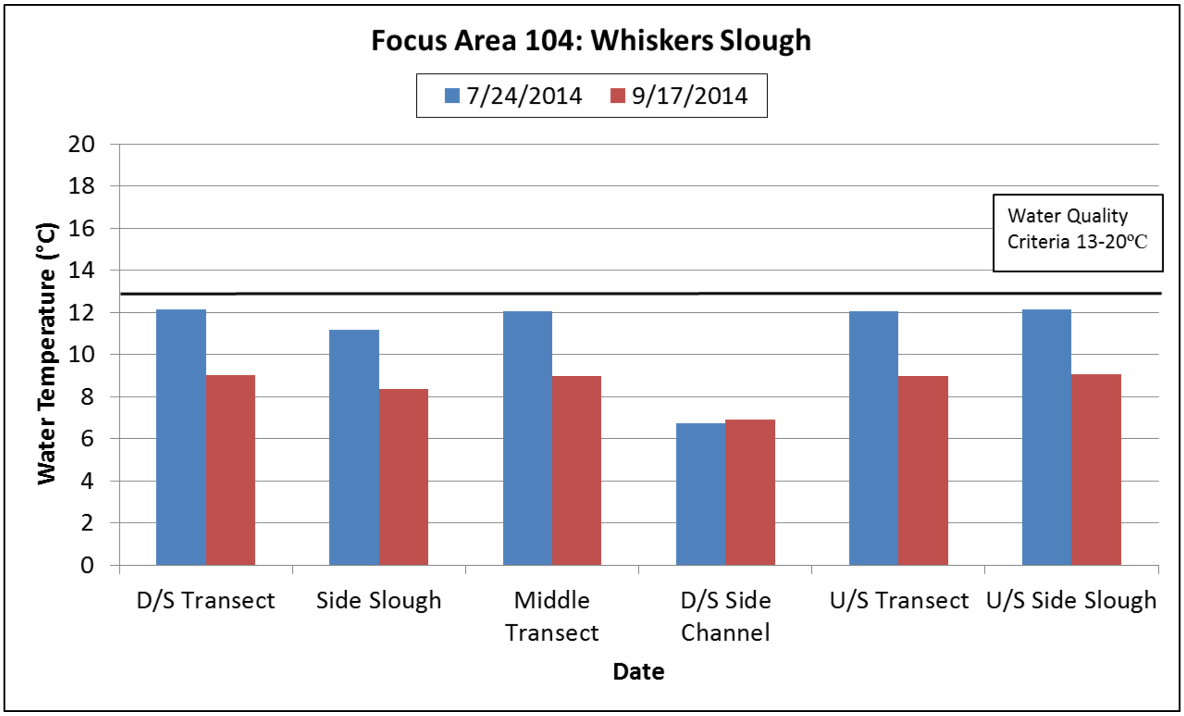

Figure 5.4-199. FA-104 (Whiskers Slough) Temperature Field Measurements (Summer 2014)

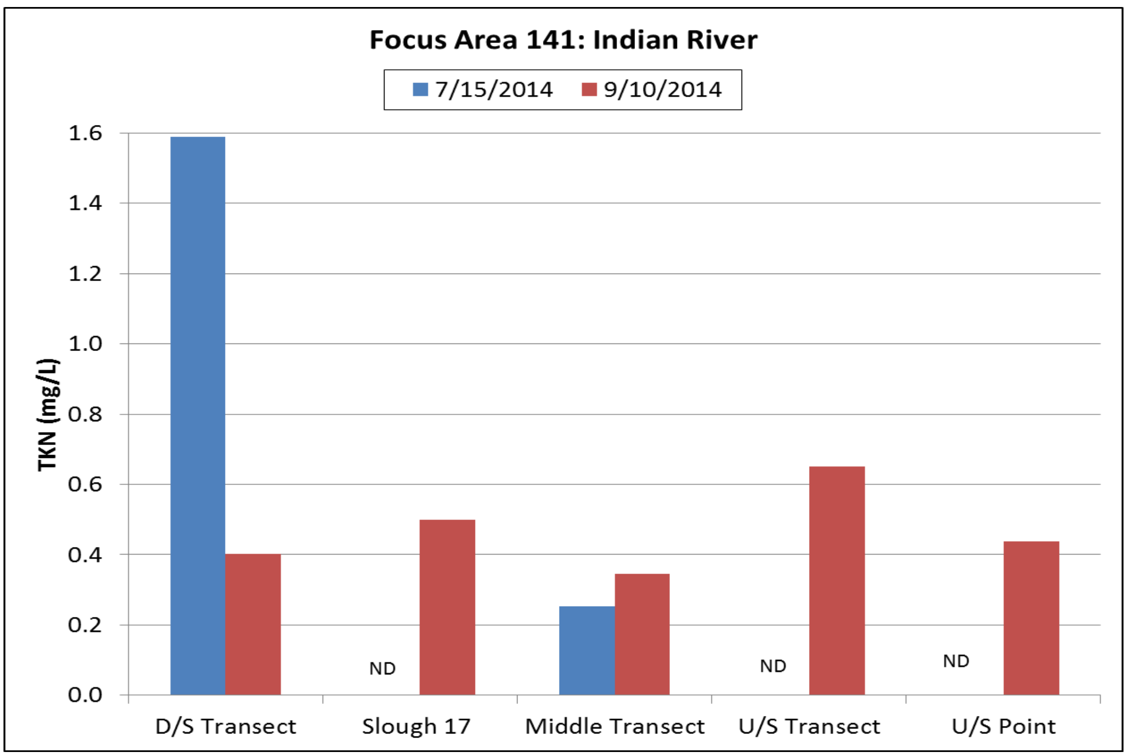

Figure 5.4-20. FA-141 (Indian River) TKN Concentrations (Summer of 2014)

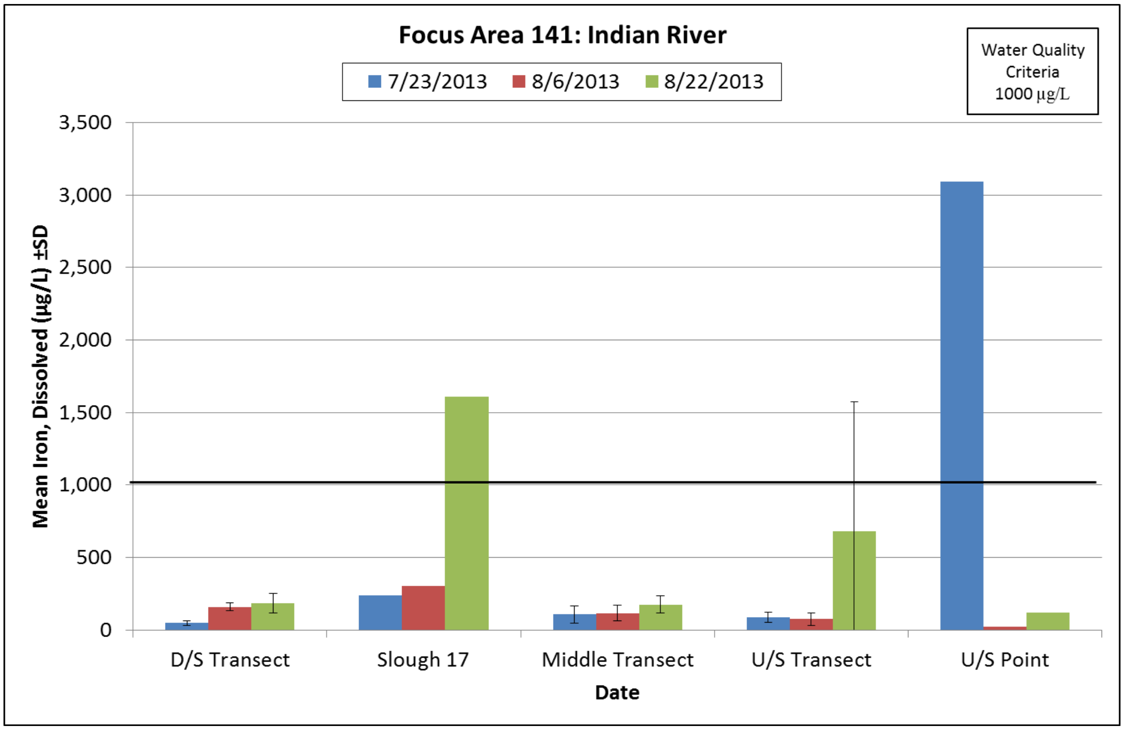

Figure 5.4-20. FA-144 (Slough 21) Mean Dissolved Iron Concentrations (Summer 2013)

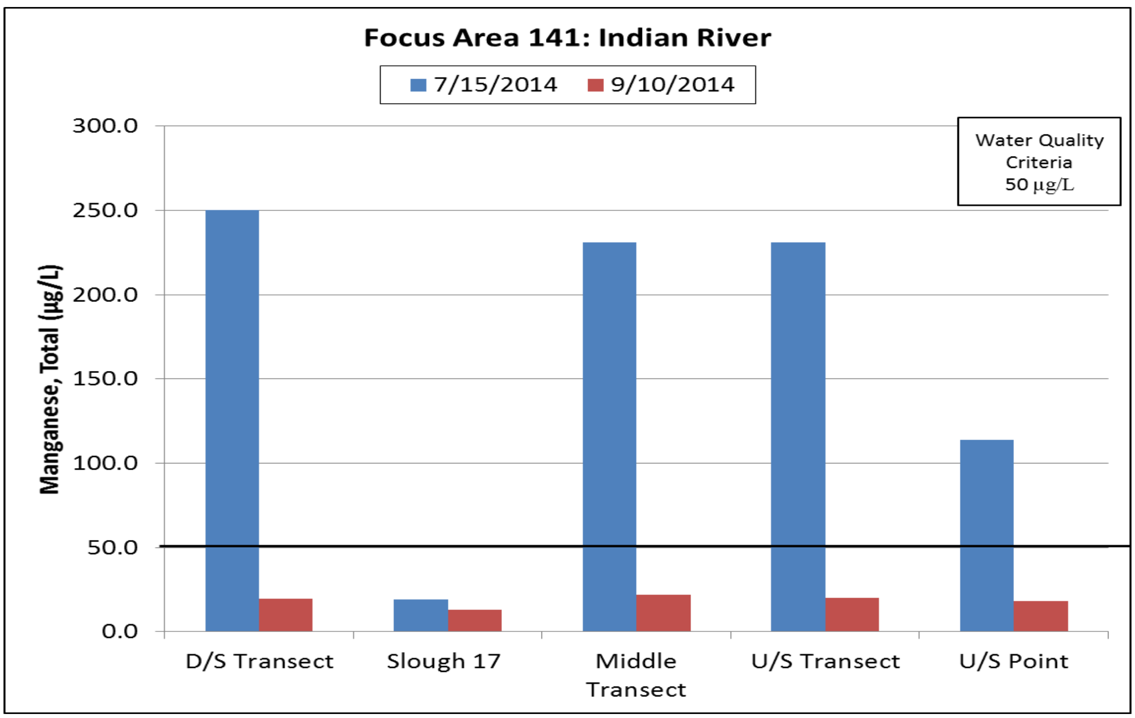

Figure 5.4-212. FA-141 (Indian River) Total Manganese Concentrations (Summer of 2014)

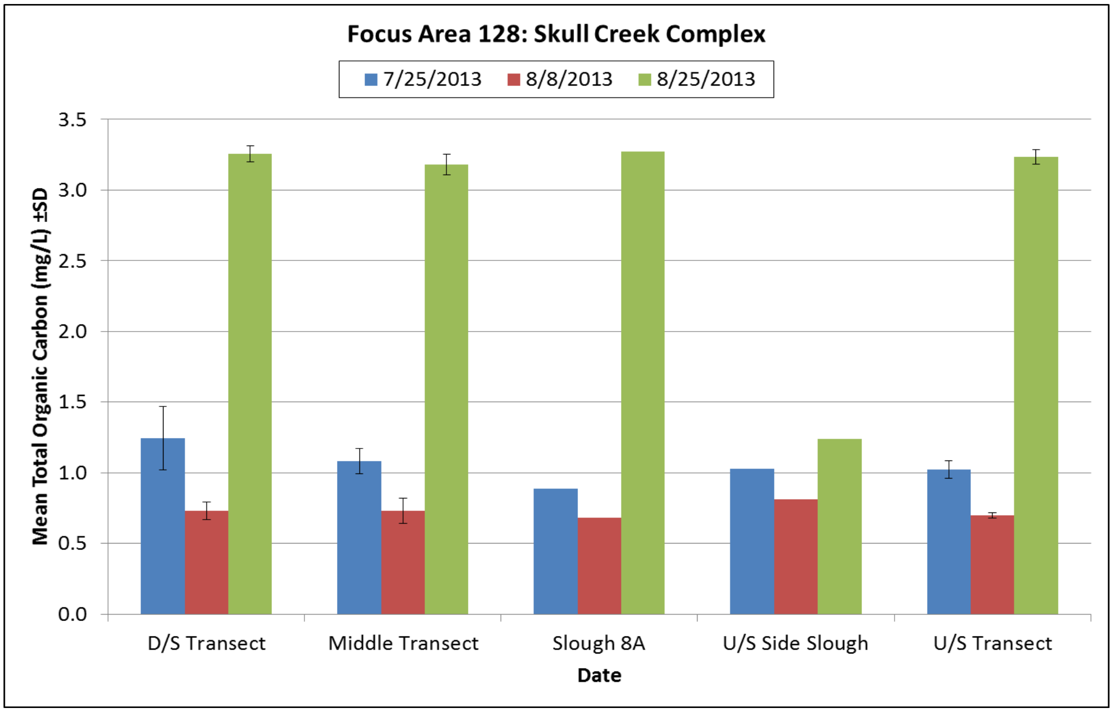

Figure 5.4-22. FA-128 (Slough 8A) Mean TOC Concentrations (Summer 2013)

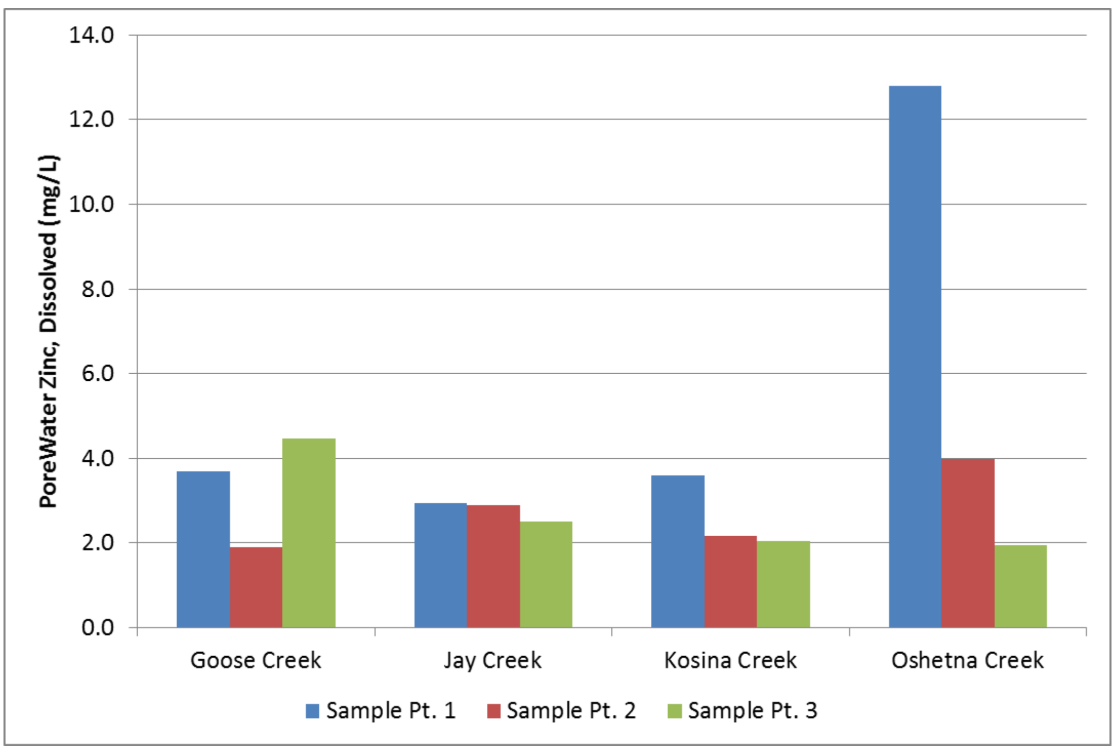

Figure 5.5-1. Porewater Dissolved Zinc Concentrations (2013)

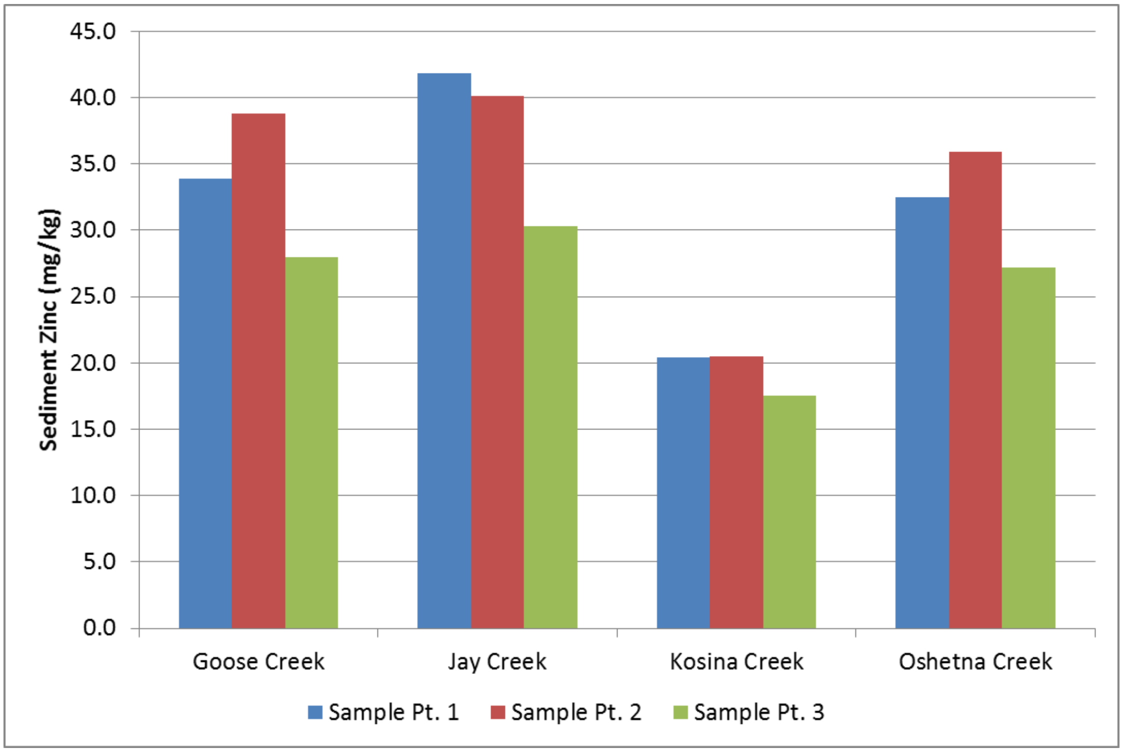

Figure 5.5-2. Sediment Zinc Concentrations (2013)

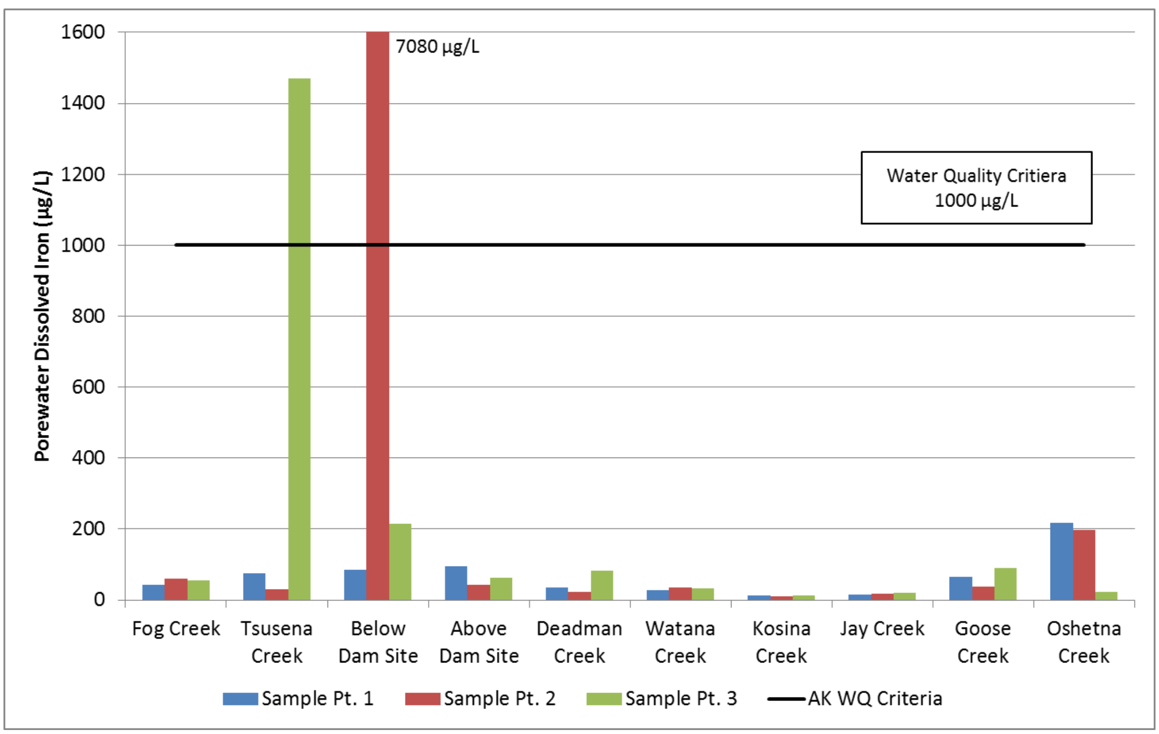

Figure 5.5-3. Porewater Dissolved Iron Concentrations (2014)

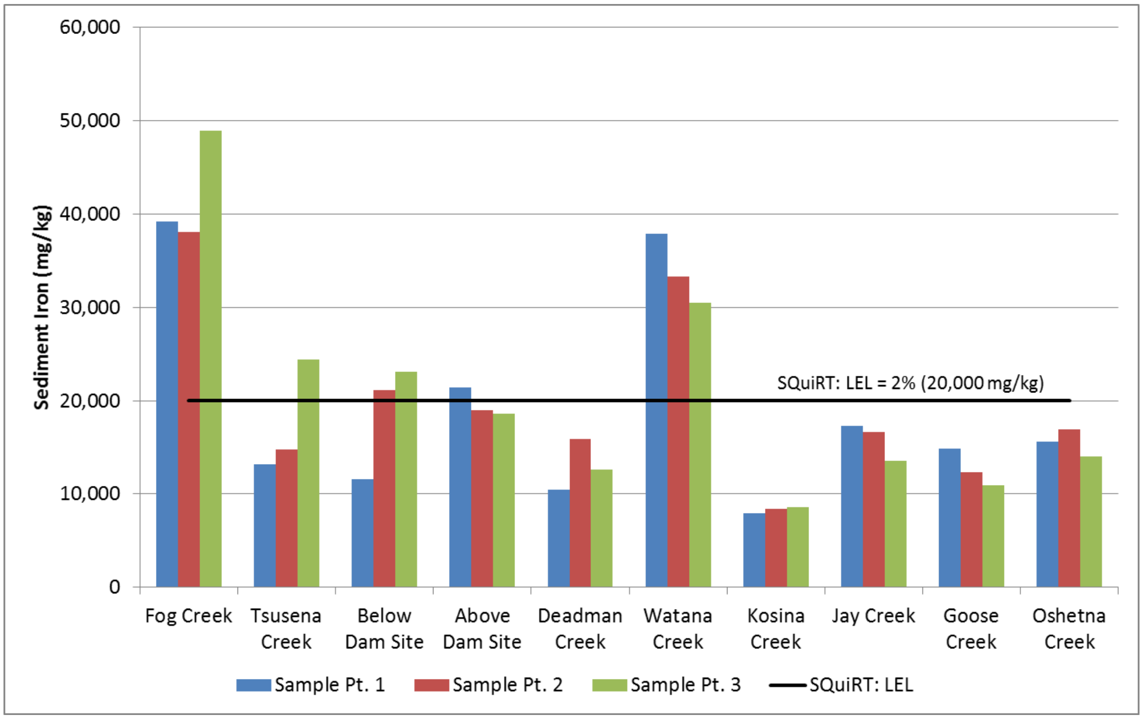

Figure 5.5-4. Sediment Iron Concentrations (2014)

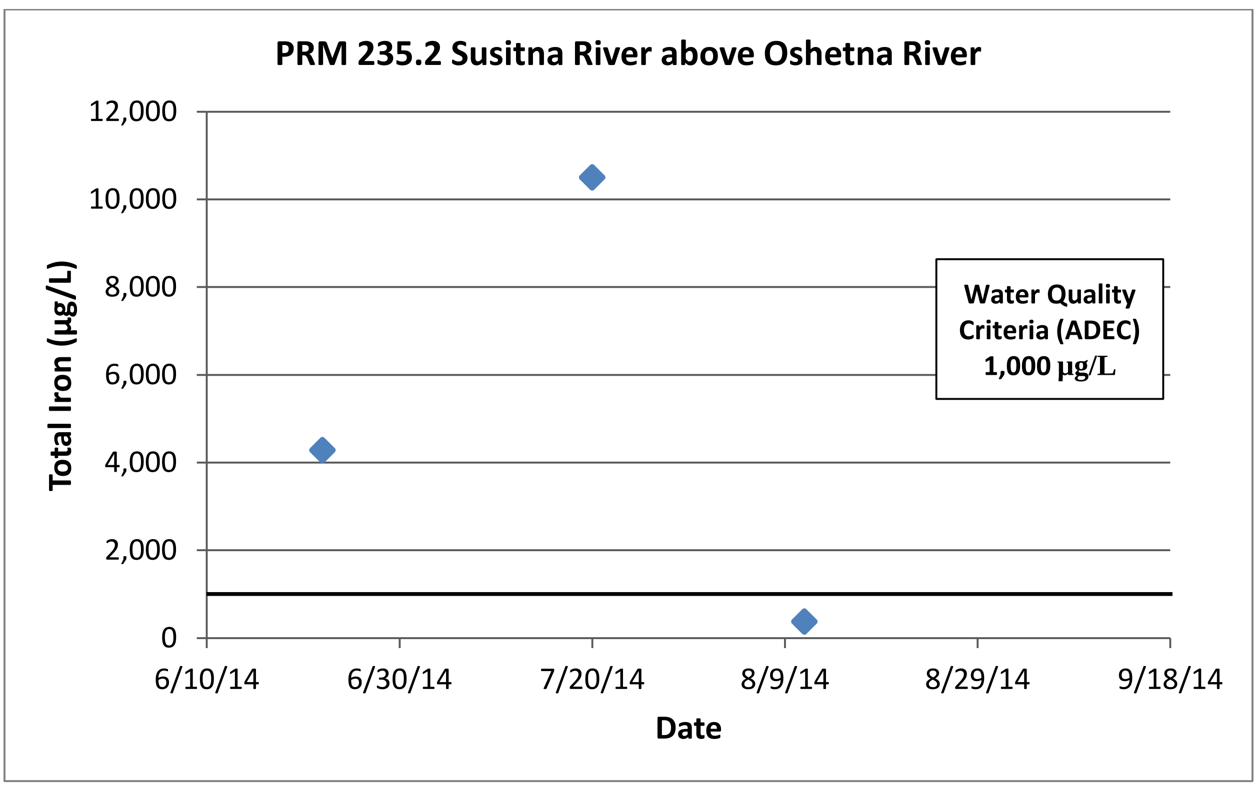

Figure 6.3-1. Surface Water Concentrations for Total Iron at PRM 235.2 (2014)

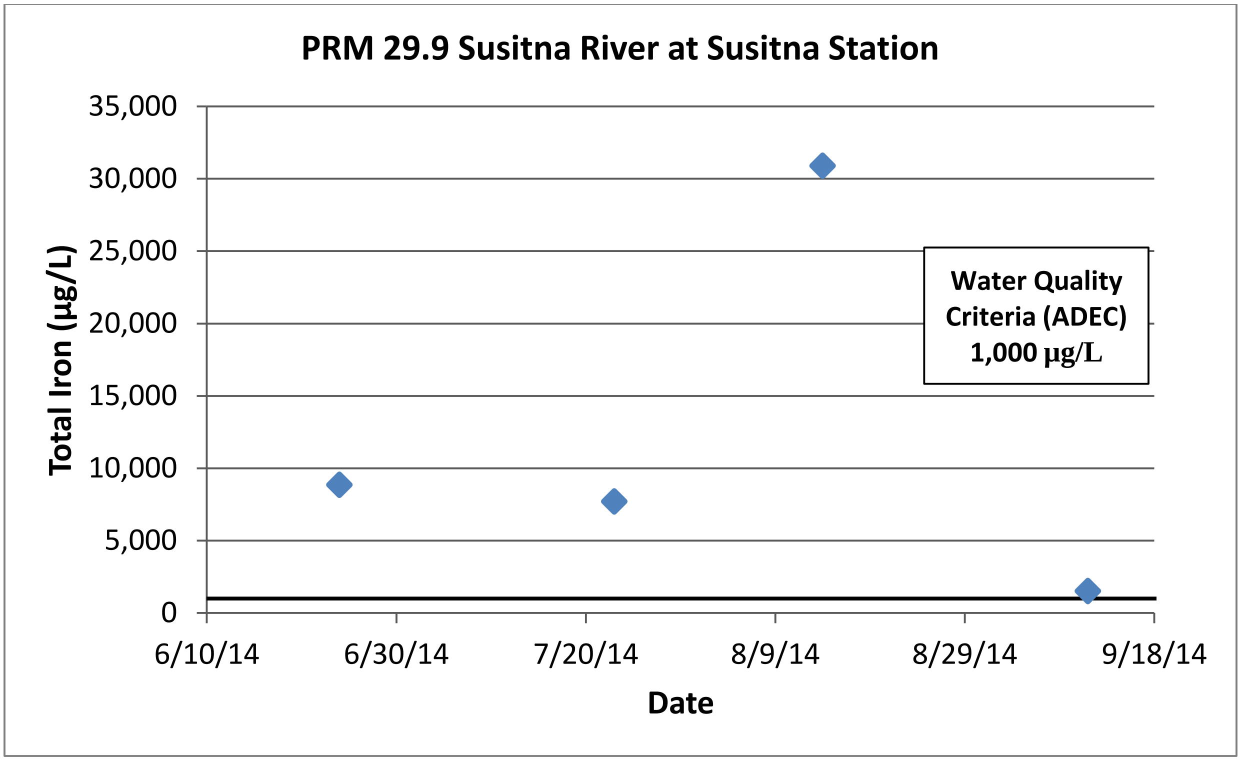

Figure 6.3-2. Surface Water Concentrations for Total Iron at PRM 29.9 (2014)

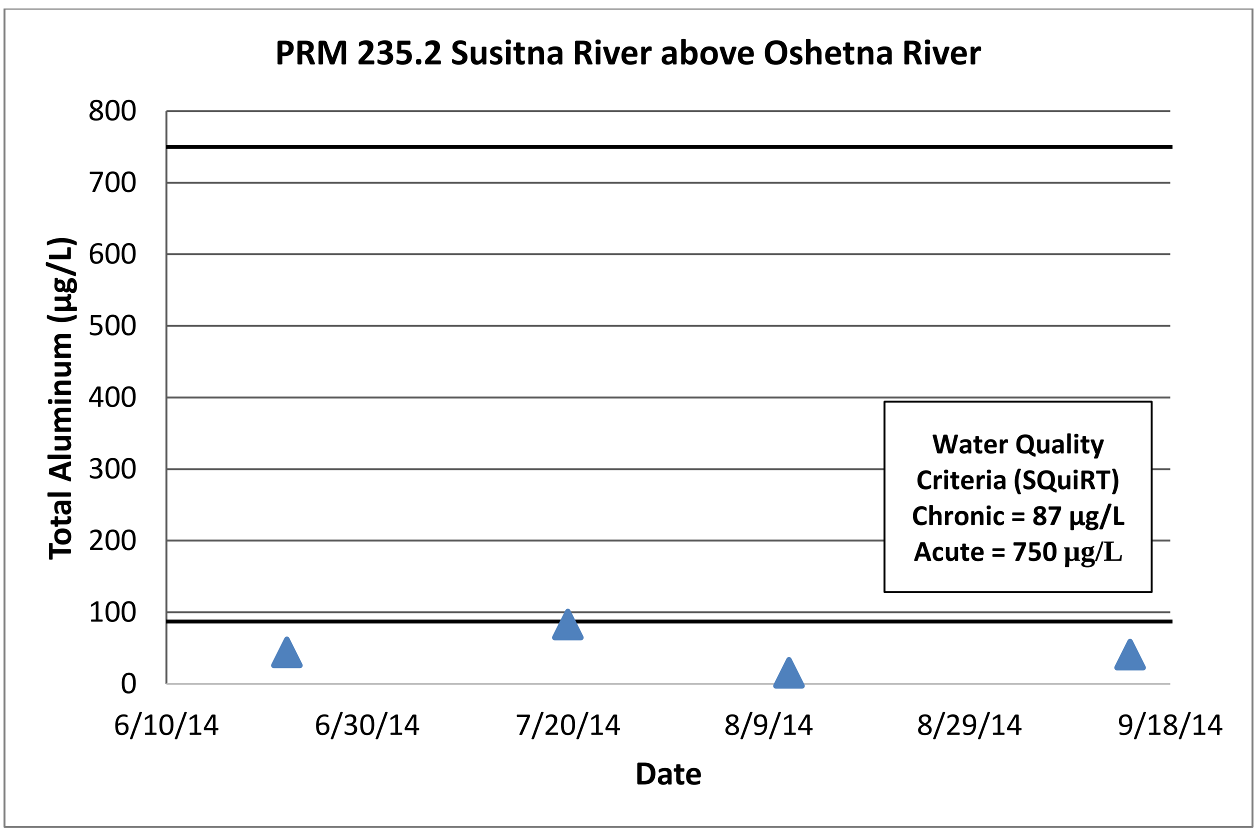

Figure 6.3-3. Surface Water Concentrations of Total Aluminum at PRM 235.2 (2014)

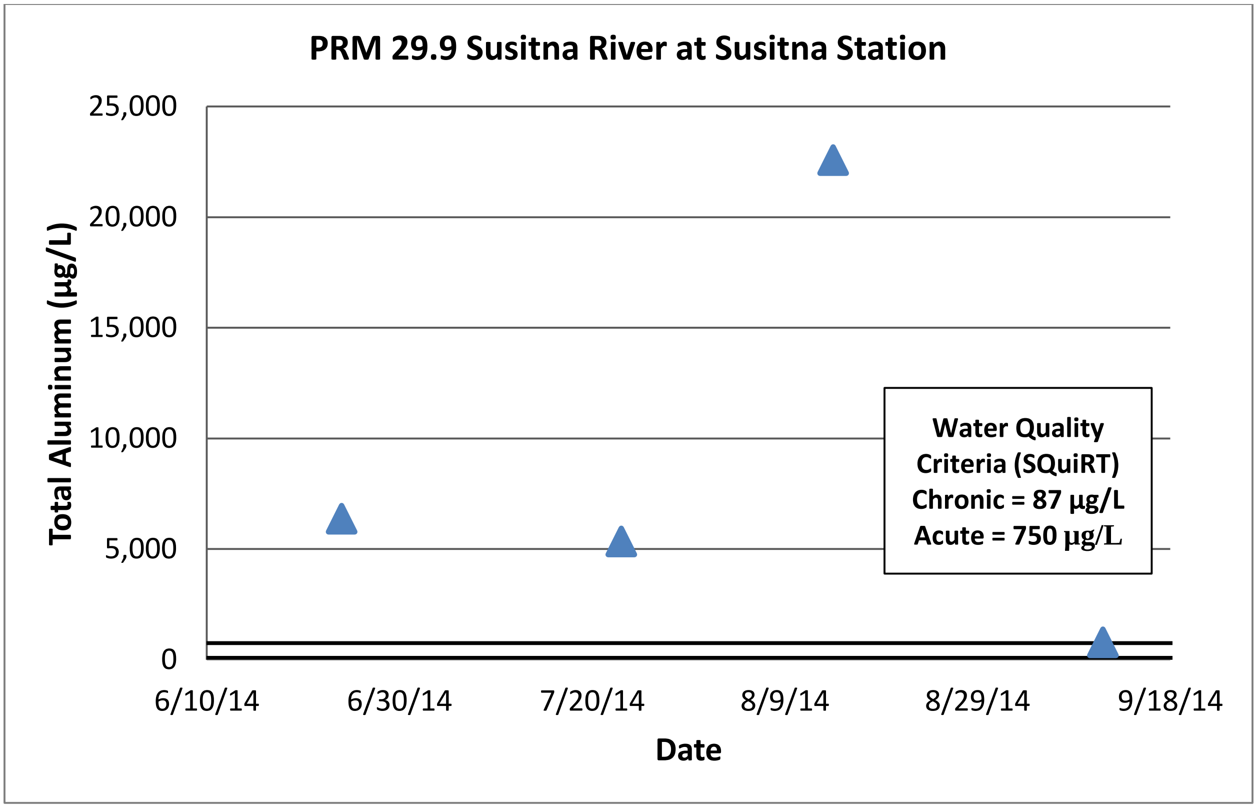

Figure 6.3-4. Surface Water Concentrations of Total Aluminum at PRM 29.9 (2014)

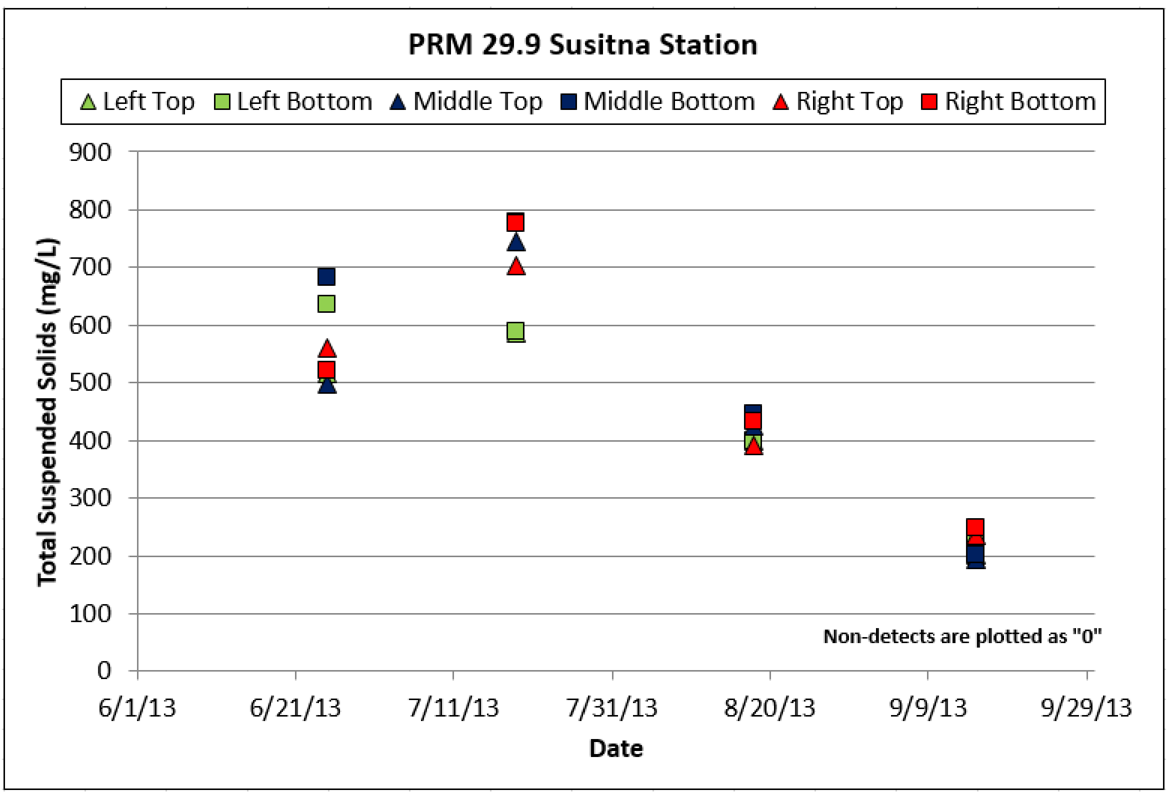

Figure 6.4-1. Surface Water Concentrations for TSS at PRM 29.9 (2013)

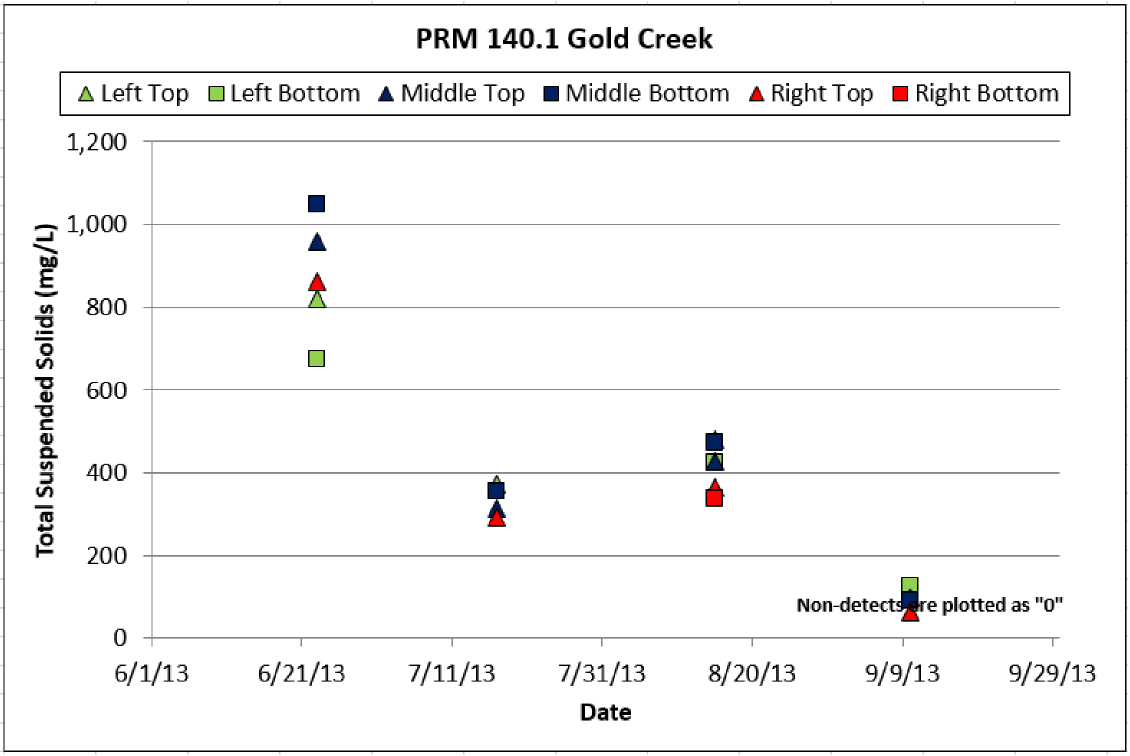

Figure 6.4-2. Surface Water Concentrations for TSS at PRM 140.1 (2013)

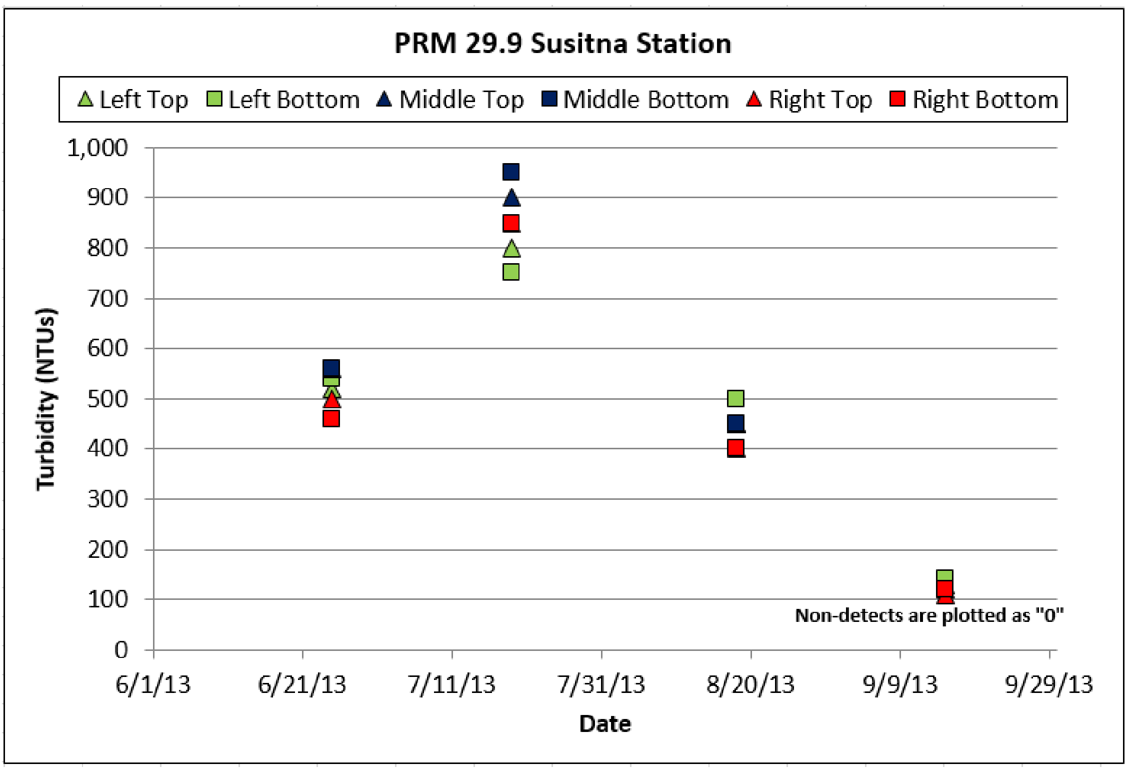

Figure 6.4-3. Surface Water Measurements for Turbidity at PRM 29.9 (2013)

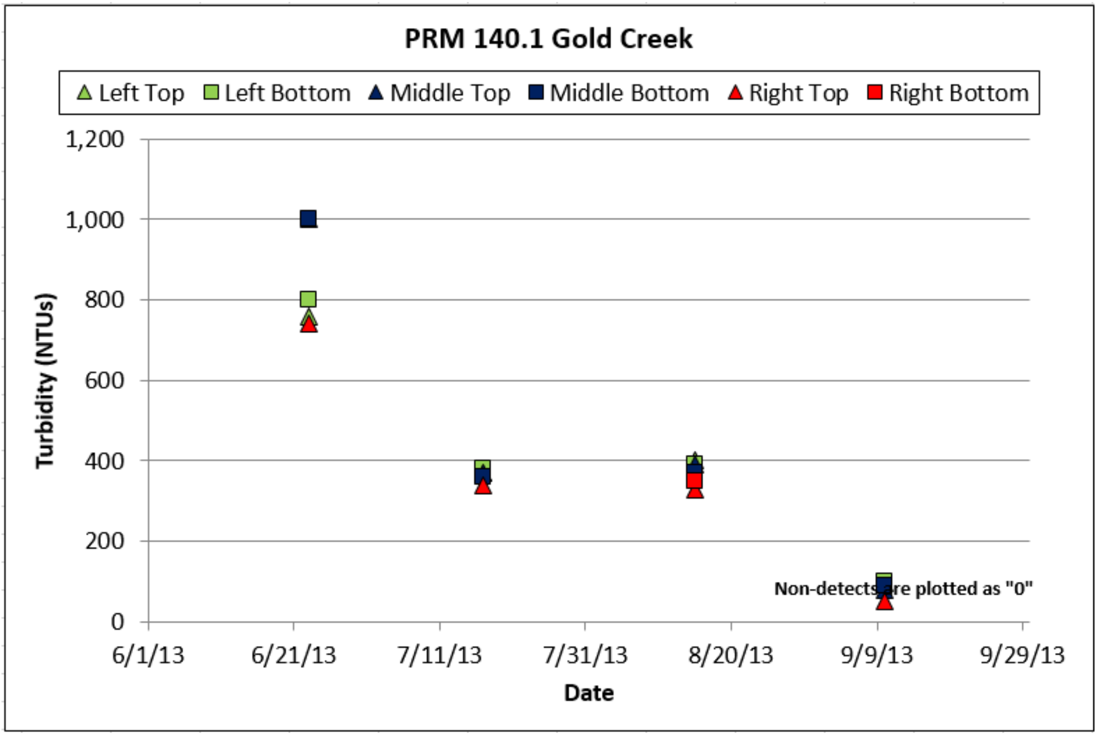

Figure 6.4-4. Surface Water Measurements for Turbidity at PRM 140.1 (2013)

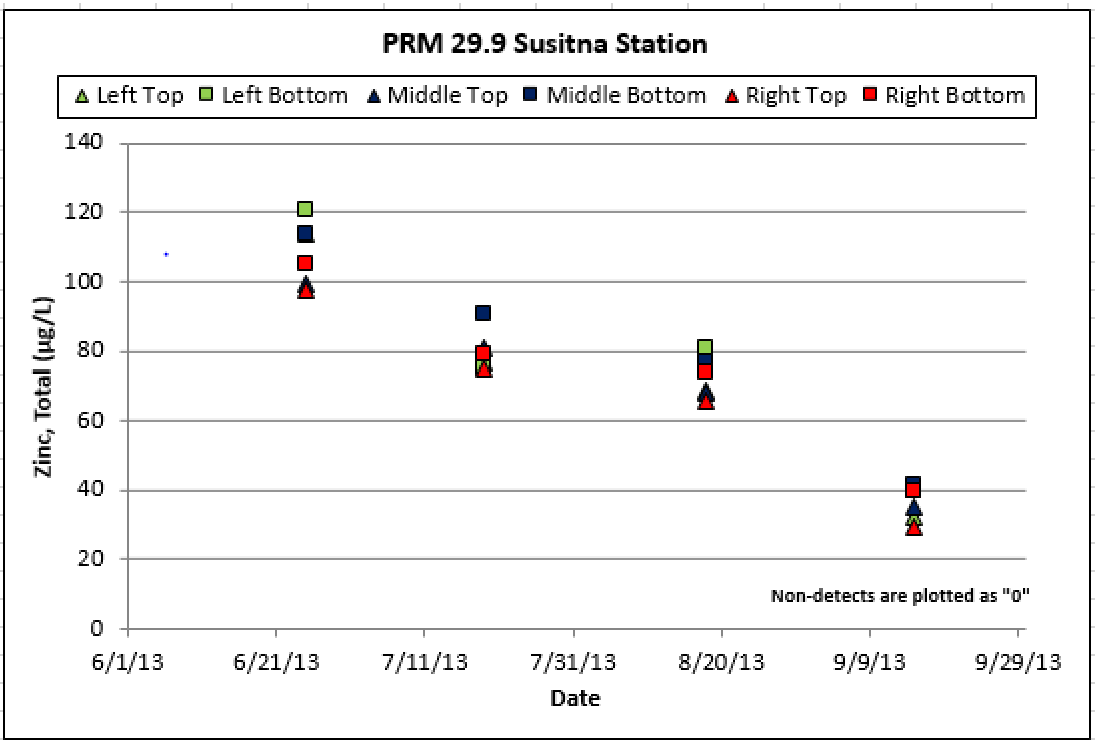

Figure 6.4-5. Surface Water Concentrations for Total Zinc at PRM 29.9 (2013)

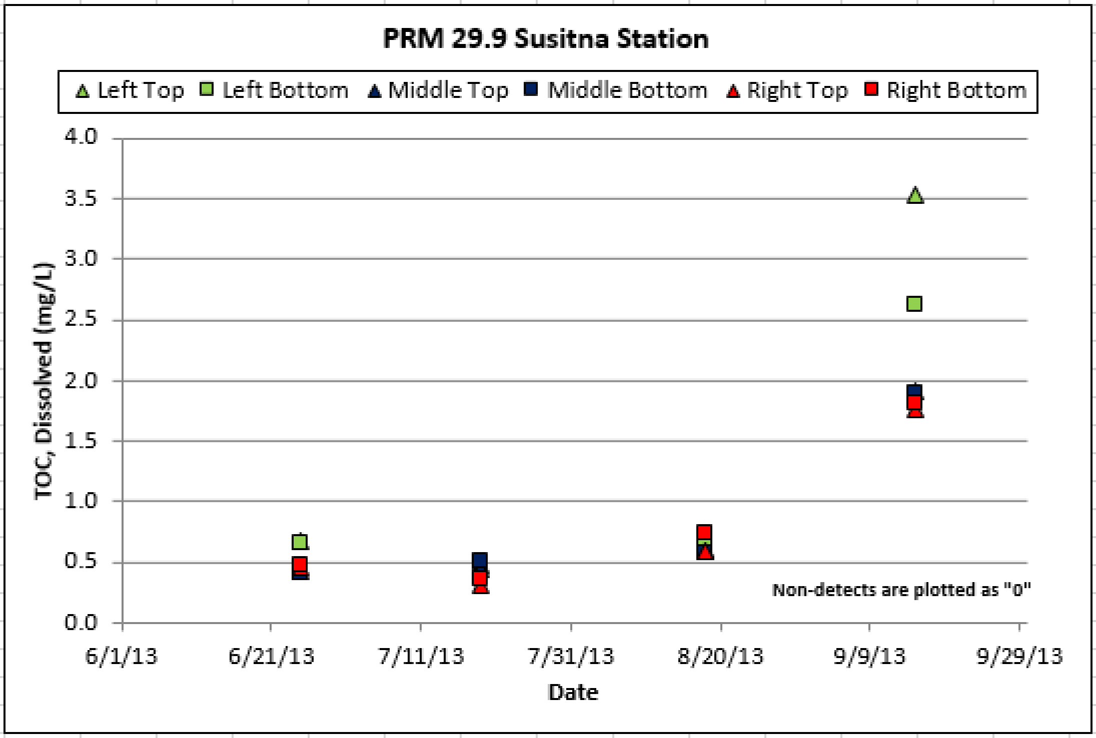

Figure 6.4-6. Surface Water Concentrations for TOC at PRM 29.9 (2013)

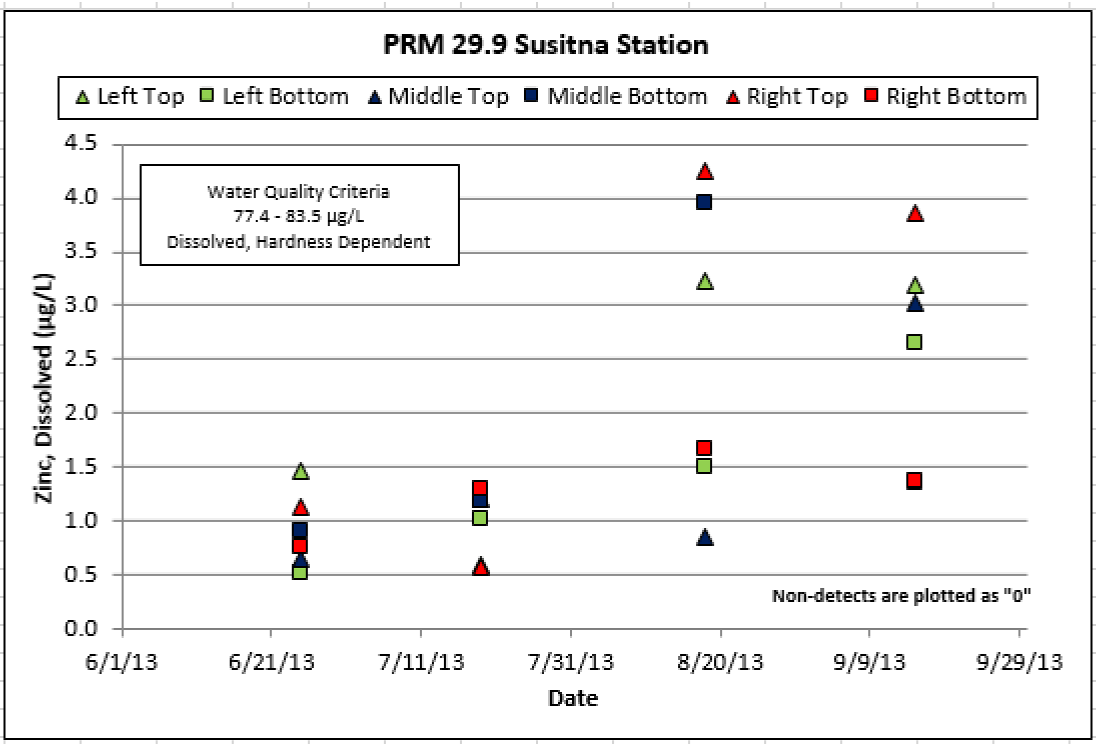

Figure 6.4-7. Surface Water Concentrations for Dissolved Zinc at PRM 29.9 (2013)