Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Baseline Water Quality Study
Study Plan Section 5.5

Final Study Plan

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

July 2013

5.5. Baseline Water Quality Study

On December 14, 2012, Alaska Energy Authority (AEA) filed with the Federal Energy Regulatory Commission (FERC or Commission) its Revised Study Plan (RSP), which included 58 individual study plans (AEA 2012). Included within the RSP was the Baseline Water Quality Study, Section 5.5. RSP Section 5.5 focuses on the methods for assessing the effects of the proposed Project and its operations on water quality in the Susitna River basin.

On February 1, 2013, FERC staff issued its study determination (February 1 SPD) for 44 of the 58 studies, approving 31 studies as filed and 13 with modifications. FERC requested additional information prior to issuing the study plan determination for the remaining 14 studies. On March 1, 2013, AEA filed the Quality Assurance Project Plan for Baseline Water Quality Monitoring Sampling and Analysis Activities (WQ QAPP). On April 1, 2013 FERC issued its study determination (April 1 SPD) for the remaining 14 studies. RSP Section 5.5 was one of the 13 studies approved with modifications. In its April 1 SPD, FERC recommended the following:

Standard Operating Procedures (SAP) and Quality Assurance Project Plan (QAPP)

- *We recommend that AEA employ EPA Method 1631E for laboratory analysis of total mercury in water, sediments, and fish tissue, and EPA Method 1630 for laboratory analysis of methylmercury in water and fish tissue. We recommend that AEA apply Method 1669 (Clean Hands/Dirty Hands) for all mercury field sampling.*
- *We recommend that AEA utilize the TRVs as an additional benchmark when evaluating the need for additional baseline water quality data collection.*

AEA has included FERC's modification requests in the WQ QAPP. Information in the QAPP supersedes relevant details within this Final Study Plan.

5.5.1. General Description of the Proposed Study

The collective goal of the water quality studies is to assess the effects of the proposed Project and its operations on water quality in the Susitna River basin, which will inform 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 resulting riverine portion of the drainage once the dam is in place 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 data set will be used in the water quality modeling study to predict Project impacts under various operations (Section 5.6).
- Add three years of current stream temperature and meteorological data to the existing data. An effort will be made to collect continuous water temperature data year-round, with the understanding that records may be interrupted by equipment damage during river floods, ice formation around the monitoring devices, ice break-up and physical damage to the anchoring devices, or removal by unauthorized visitors to a site.
- 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.
- Perform a pilot thermal imaging assessment of a portion (between Talkeetna and Devils Canyon) of the Susitna River. Discussion of thermal refugia data collection is located in Section 5.5.4.9.

5.5.2. Existing Information and Need for Additional Information

Historical water quality data available for the study area includes water temperature data, some general water quality data, and limited metals data primarily collected during the 1980s (URS 2011). Additional data has been recently collected by the U.S. Geological Survey (USGS) at limited mainstem Susitna sites describing flow, in situ, general, and metals parameters. The following is a summary of existing water quality data:

Lower Susitna from Cook Inlet to the Susitna – Chulitna –Talkeetna confluence (River Mile 0-98)

- Large amounts of data were collected in this reach during the 1980s. Very little data are available that describe current water quality conditions.
- Metals data are not available for the mouth of the Chulitna River. The influence of major tributaries (Chulitna and Talkeetna rivers) on Susitna River water quality conditions is unknown. There are no monitoring stations in receiving water at these mainstem locations.
- Metals data are not available for the Skwentna River or the Yentna River.
- Continuous temperature data, general water quality data, and metals data are not available for the Susitna River mainstem and sloughs potentially used for spawning and rearing habitat.

Middle Susitna River and tributaries from the Susitna – Chulitna–Talkeetna confluence to the mouth of Devils Canyon (River Mile 98-150)

- The source(s) for metals detected at high concentrations in the mainstem Susitna River is unknown.
- Current data reflects large spatial data gaps between the upper river and the mid to lower portions of the river.
- Continuous temperature data are not available for the Susitna River mainstem, tributary, and sloughs potentially used for spawning and rearing.

Middle Susitna River from Devils Canyon to the proposed Watana Dam site (River Mile 150-184)

- Temperature data are not available above and below most tributaries on the mainstem Susitna River.
- Overall, very limited surface water data are available for this reach.
- Metals monitoring data do not exist or are limited.
- Concentrations of metals in sediment immediately below the proposed Project are unknown. Metals in these sediments may become mobile once the Project begins operation.

- Monitoring of Susitna River mainstem and sloughs (ambient conditions and metals) is needed for determining the potential for metal bioaccumulation in fishes.

Upper Susitna River including headwaters and tributaries above the proposed Watana Dam site (River Mile 184-313)

- Surface water and sediment analysis for metals are not available for the Susitna River mainstem, only for one tributary.
- Information on concentrations of metals in media and current water quality conditions is needed to predict if toxics can be released in a reservoir environment.
- Continuous temperature data are not available for Susitna River mainstem, tributary, and sloughs potentially used for spawning and rearing.

Overall

- Limited fish tissue sampling has been performed in the Susitna River by ADEC and USGS (ADEC 2012; Frenzel 2000).

A large-scale assessment of water quality conditions throughout the Susitna River drainage has not been completed. The proposed overall assessment will be used to establish background water quality parameters. This need was identified in the Data Gap Analysis for Water Quality (URS 2011).

Water temperature monitoring was primarily done in the middle river portion of the Project area during the 1980s. The purpose for collection of this data was to model post-dam temperature conditions and to predict the potential for impact on thermal refugia for fish downstream of the proposed dam site. An expanded network of continuous temperature monitoring data and water quality data (including sediment, surface water, and potentially pore water) collection is required for the Project because of the following:

- More information is needed to define existing thermal refugia throughout the Susitna drainage.
- Limited information is available on natural, background conditions for water quality.
- It is unknown if seasonal patterns exist for select water quality parameters.
- Additional information is required for calibrating the water quality model to be used (Section 5.6). More recent water quality data will be used for predicting reservoir conditions and predicting riverine conditions downstream of the proposed dam.

The current proposal includes expansion of the temperature monitoring effort from river mile (RM) 15.1 to 233.4, encompassing both the lower end of the riverine portion of the Project area and above the proposed area of inundation by the reservoir. Monitoring sites are located at the same sites characterized during the 1980s studies, as well as at additional sites. Monitoring of areas of the mainstem Susitna River or tributaries with high metals concentrations or temperature measurements (based on the Data Gap Analysis for Water Quality (URS 2011) will confirm previous observations and will describe the persistence of any water quality exceedances that might exist.

Locations in the mainstem Susitna River and tributaries where high metals concentrations were historically identified in surface water lack sediment analysis data to determine potential sources that can be mobilized. The linkage between sediment sources, mobilization into the water column (dissolved form), and the potential for bioaccumulation in fish tissue presents a potential human health concern with respect to mercury contamination. The consumption of mercury in fish tissue will be addressed by co-locating a limited number of surface water, sediment, and fish tissue monitoring sites (and sampling events) where there is the greatest likelihood for bioaccumulation. The proposed Project may have the potential to exacerbate bioaccumulation of toxics beyond that occurring under current conditions. The initial monitoring will identify select monitoring locations and media (e.g., surface water, pore water, and sediment) for sampling and suggest the need for more detailed, site-specific sampling if a potential risk from bioaccumulation is found.

The available historical data are not continuous over time or over spatial areas of the Susitna drainage. The discontinuities in the data record limit the opportunity for conducting a complete assessment of current water quality conditions that define natural background, the spatial extent of higher than expected concentrations of metals (and select parameters), and identification of source and timing of pollutant entry into the Susitna drainage. The expanded data record beyond existing information will be used to develop a model of the proposed reservoir and for evaluating water quality changes in the existing riverine system resulting from reservoir operations.

5.5.3. Study Area

The study area for water quality monitoring includes the Susitna River from RM 15.1 to RM 233.4, and select tributaries within the proposed transmission lines and access corridors. Water quality and water temperature data loggers were installed at 33 of 39 sites identified in Table 5.5-1 and Figure 5.5-1 as part of the 2012 Baseline Water Quality Study.

5.5.4. Study Methods

The Baseline Water Quality Study has several components that address needs for water quality modeling and for detecting the location and magnitude of water quality issues. The proposed water quality monitoring locations and water quality parameter list fill in substantial data gaps throughout the project area from historical data collected beginning 1975 through 2003 (URS 2011). Besides the utility of water quality data in calibrating the water quality model, establishment of a comprehensive baseline of water quality descriptions will be useful for comparison to historical water quality data and future scenarios based on model predictions and with future data collection.

Data will be collected from multiple aquatic media including surface water, sediment, and fish tissue. Continuous temperature monitoring will inform the predictive model on how the mainstem river and tributaries will respond to Project operations and if changes in water quality conditions could affect aquatic life use and survival in the Project area. In addition, several other requirements of the 401 Water Quality Certification Process will be addressed with collection and description of additional data, including the following:

- Conducting a water quality baseline assessment
- Describing how existing and designated uses are met
- Using appropriate field methods and models
- Using acceptable data quality assurance methods
- Scheduling of technical work to meet deadlines
- Deriving load calculations of potential pollutants (pre-Project conditions)

Two types of water quality monitoring activities will be implemented: (1) routine monitoring for characterizing water quality baseline conditions, and (2) a single, comprehensive survey for a larger array of parameters (Section 5.5.4.5). Frequency of sampling water quality parameters varies by category and potential for mobilization and bioavailability. Most of the general water quality parameters and select metals will be sampled on a monthly basis because each parameter has been demonstrated to be present in one or both of surface water and sediment (URS 2011). An initial screening survey has been proposed for several other toxics that might be detected in sediment and tissue samples (Table 5.5-4). The single surveys for toxics in sediment, tissue, or water will trigger additional study for extent of contamination and potential timing of exposure if results exceed criteria or thresholds (e.g., LAETs, LC_{50}s, Ecological Toxicity Reference Values (TRVs), etc.). The general list of water quality parameters and metals will be used in calibrating the water quality model (Section 5.6) in both a riverine and reservoir environment.

Twelve mainstem Susitna River monitoring sites are located below the proposed dam site and two mainstem sites above this location. Six sloughs will be monitored that represent a combination of physical settings in the drainage and that are known to support important fish-rearing habitat. Tributaries to the Susitna River will be monitored and include those contributing large portions of the lower river flow including the Talkeetna, Chulitna, Deshka, and Yentna rivers. A partial list of the remaining tributaries that will be monitored represent important spawning and rearing habitat for anadromous and resident fisheries and include Gold Creek, Portage Creek, Tsusena Creek, Watana Creek, and Oshetna Creek. The operation of temperature monitoring sites will continue as part of water quality monitoring activities in 2013/2014. These sites were selected based on the following rationale:

- Adequate representation of locations throughout the Susitna River and tributaries above and below the proposed dam site for the purpose of a baseline water quality characterization.
- Location on tributaries where proposed access road-crossing impacts might occur during and after construction (upstream/downstream sampling points on each crossing).
- Preliminary consultation with licensing participants including co-location with other study sites (e.g., instream flow, ice processes).
- Access and land ownership issues.
- Eight of the sites are mainstem monitoring sites that were previously used for SNTEMP modeling (see Section 5.6) in the 1980s. Thirty-one of the sites are Susitna River mainstem, tributary, or slough locations, most of which were monitored in the 1980s.

Monitoring sites are spaced at approximately five-mile intervals so that the various factors that influence water quality conditions are captured and support the development (and calibration) of the water quality model. Frequency of sites along the length of the river is important for capturing localized effects from tributaries and from past and current human activity. Additional sampling to characterize variability in water quality conditions on six cross-sections of the river will be completed. This objective for this sampling strategy will address potential influence of channel complexity (multiple channels, braiding, etc.) on both the Susitna River and tributary water quality. These data will also enable the water quality model (Section 5.6) to predict conditions in 3-dimensions (longitudinally, vertically, and laterally).

5.5.4.1. Water Temperature Data Collection

Water temperatures are being recorded in 15-minute intervals using Onset TidbiT v2 water temperature data loggers (or equivalent instrumentation). Data collection began in late June 2012 and will continue through the winter of 2012/2013. At this time it is unclear if the equipment will survive physical damage or interruption of temperature logging from ice break-up and sedimentation during the winter. Temperature data has been retrieved from 33 of 39 sites representing a partial or whole record from third week in July 2012 through end of September 2012. Deployment and continuous temperature data logging will continue for each of the two following years (2013 and 2014) using the same apparatus and deployment strategy at all 39 sites. The TidbiT v2 (or equivalent) has a precision sensor for plus or minus 0.4 degrees Fahrenheit (°F) (0.2 degrees Celsius [°C]) accuracy over an operational range of -4°F to 158°F (-20°C to 70°C). Data readout is available in less than 30 seconds via an Optic USB interface.

To reduce the possibility of data loss, a redundant set of data loggers will be used at each site (where possible). In general, the two sets of sensors will be installed differently (depending on site characteristics). One logger will be inserted into the bottom of an 8.2-foot (2.5-meter) length of perforated steel pipe housing that is fastened to a large bank structure via clamps and rock bolts. A shorter or longer perforated steel pipe may be used depending on location of suitable anchoring places. The logger will be attached to a cable that allows it to be easily retrieved for downloads. To prevent theft or vandalism, the top pipe cap will contain a locking mechanism that can only be opened using the appropriate Allen key. The second set of temperature loggers will be anchored to a 2-foot section of a steel rail and buoyed to record continuous bottom, mid, and surface temperature conditions throughout the water column. The anchor rail will be placed at a channel location that is accessible during routine site visits and will be attached with a steel cable to a post that is driven into the bank or to some other structure. The proposed installation procedures may require some alteration based on site-specific conditions.

The sensors will be situated in the river to record water temperatures that are representative of the mainstem or slough being monitored, avoiding areas of groundwater upwelling, unmixed tributary flow, direct sun exposure, and isolated pools that may affect the quality of the data.

The 2012 Fish and Aquatics Instream Flow Study installed water-level loggers with temperature recording capability at several study sites and are further described in Section 8.5.4.4 of the Fish and Aquatic Instream Flow Study Plan.

Where these study sites overlap the water temperature monitoring study sites (Figure 5.5-1), the water-level logger temperature sensors may be used. However, a redundant TidbiT v2 would be deployed at these sites for backup temperature recording, especially for year-round temperature monitoring.

5.5.4.2. Meteorological Data Collection

Meteorological (MET) data collection stations were installed in three new locations during 2012. Table 5.5-2 lists those MET station locations as well as three additional MET stations to be installed, if needed, by the Water Quality Modeling Study (Section 5.6).

The three MET stations installed in 2012 are located between RM 136.8 and RM 224.0. One MET station near the Susitna-Watana Dam site was established above the projected height of the pool elevation and proposed dam height. The upland MET station was established at about the

2,300-foot elevation on the north side of the river, in the area of the proposed field camp, and will record snowfall data and precipitation. The near river site MET station was located on the north abutment just above river level based on the suitability of location for establishing the structure.

Existing MET stations were fitted with additional monitoring equipment to expand data collection that meets project needs and to use historical information collected from each of these sites (Table 5.5-2). Data records from other studies will be used, wherever available, to help generate information for the required parameters needed for construction of the water quality models (Section 5.6). The linkage between historical records and continuing data records may be used in evaluating the utility of 1980s temperature data for modeling.

All six possible MET stations are spatially distributed on the Susitna River from RM 25.8 to RM 224.0 and represent a range of distinct physical settings throughout the Project area. MET stations transfer data generated at 15 minute intervals by a telemetry system and stored on a digital server in Talkeetna, AK. The three additional MET station sites may be necessary if current site placement is inadequate to represent the needs of water quality model development. This determination will be made in the spring of 2013. Parameters measured by each of the MET stations will be compared with the nearest down-gradient site and evaluated for adequacy of representation of weather conditions in that reach. If data recorded between successive sites are distinctly different, then additional sites will be proposed so that weather descriptions for use in the water quality model calibration phase (Section 5.6) will be improved with greater detail.

5.5.4.3. MET Station Parameters

MET stations will collect parameters that support the activities of the engineering design team and the development of the water quality temperature model. Snow depth will be estimated from the precipitation gage with the onset of the winter season. Evapotranspiration is measurable within deciduous canopies; however, the MET station placement will not be under vegetation canopies so that parameters (like wind speed, etc.) necessary for establishing conditions on the reservoir can be measured. Precipitation will be an added parameter to each station beginning in 2013 and estimated as snow depth as the season progresses following October 2013. Solar radiation will be measured using proposed meteorological instruments and solar degree days derived from these measurements. The following is a comprehensive list of parameters required for use in this Project and will be measured by each of the MET stations:

- Temperature (maximum, minimum, mean)
- Relative humidity
- Barometric pressure
- Precipitation
- Wind speed (maximum, minimum, mean)
- Wind direction
- Wind gust (maximum)
- Wind gust direction
- Solar degree days (from solar radiation)

5.5.4.3.1 MET Station Installation and Monitoring Protocol

Each MET station will consist of, at a minimum, a 10-foot (3-meter) tripod with mounted monitoring instrumentation to measure the parameters identified above (Figure 5.5-2). The station loggers will have sufficient ports and programming capacity to allow for the installation of instrumentation to collect additional MET parameters as required. Such installation and re-programming can occur at any time without disruption of the data collection program.

MET station installation is intended to provide instrumentation that will work continuously with little maintenance and produce high quality data through a telemetry system.

A Campbell Scientific CR1000 data logger will be used to record data. The archiving interval for all MET parameters will be 15 minutes, with a 2-year storage capacity. The MET station will be powered by a 12 Vdc 8 amp-hour battery and a 20-watt solar panel complete with charge regulator.

To protect the stations from wildlife intrusion and to discourage any potential vandalism, the stations may be protected by fencing as appropriate.

5.5.4.3.2 Satellite or Radio Telemetry Communications System

Real-time data will be downloaded from MET stations using satellite transmission or radio telemetry hardware. This will enable study staff to download, inspect, and archive the data as well as monitor station operational parameters for signs of problems without visiting the site. The communication will ensure that problems, if they occur, are resolved promptly to minimize data loss between service periods.

5.5.4.4. Baseline Water Quality Monitoring

The purpose of the Baseline Water Quality Study is to collect baseline water quality information that will support an assessment of the effects of the proposed Project operations on water quality in the Susitna River basin. Effects of the proposed Project operations will be determined by using baseline water quality monitoring data in the EFDC (Environmental Fluid Dynamics Code) model described in Section 5.6, Water Quality Modeling Study. There are two types of monitoring programs proposed for characterizing surface water conditions that are distinguished by the frequency of water sampling and the density of sampling effort in a localized area (Baseline Water Quality Monitoring and Focus Area Monitoring). The large-scale monitoring program (at sites from RM 15.1 to RM 233.4) will be used to calibrate the Susitna River water quality model.

Baseline water quality collection can be broken into two components: in situ water quality sampling and general water quality sampling. In situ water quality sampling consists of on-site monthly measurements of physical parameters at fixed locations using field equipment. General water quality sampling will consist of monthly grab samples that will be sent to an off-site laboratory for analysis. The laboratory will have at a minimum, National Environmental Laboratory Accreditation Program (NELAP) certification in order to generate credible data for use by state, federal, and tribal regulatory programs for evaluating current and future water quality conditions. In general, these samples represent water quality components that cannot be easily measured in situ, such as metals concentrations, nitrates, etc.

Water quality data collection will be at the locations in bold in Table 5.5-1. The initial sampling will be expanded if general water quality, metals in surface water, or metals in fish tissue exceed criteria or thresholds. Additional contiguous sample sites will be visited on this list beginning the following sampling month wherever criteria or thresholds have been exceeded by individual parameters. This proposed spacing follows accepted practice when segmenting large river systems for development of Total Maximum Daily Load (TMDL) water quality models. Sampling during winter months will be focused on locations where flow data is currently collected (or was historically collected by USGS) and will be used for water quality modeling (Section 5.6).

5.5.4.4.1 Monitoring Parameters

Water quality samples will be analyzed for several parameters reported in Table 5.5-3. Metals monitoring for total and dissolved fractions in surface water include the full set of parameters used by ADEC in fish health consumption screening. The creation of a reservoir and potential alteration of surface water downstream of the proposed dam site may change characteristics of groundwater in the upper and middle Susitna basin. The water quality parameters identified in Table 5.5-3 will address the influence surface water may have on adjoining groundwater supplies in the vicinity of each sampling site. Changes to groundwater quality may have an effect on drinking water supplies, so several parameters included on the inorganic chemical contaminants list have been included as part of this sampling program (ADEC 2003). The criteria that will be used for comparison with sampling results are the drinking water primary maximum contaminant levels.

Additional parameters will be measured from all sites in a single survey that occurs during low water conditions (e.g., August/September) in the Susitna basin. The following is a list of pollutants for which Alaska Water Quality Standards have established water quality criteria (18 ACC 70.020(b)) for protecting designated uses in fresh water:

- Continuous temperature monitoring program
  - Temperature, already included as part of the continuous temperature monitoring program.
- In situ monitoring program
  - pH, included as part of the monthly water quality sampling routine.
  - Color, categorical observation.
  - Residues, categorical assessment (floating solids, debris, sludge, deposits, foam, or scum).
- General water quality program
  - Dissolved gas, included in the monitoring program (dissolved oxygen).
  - Dissolved inorganic substances (total dissolved solids), included in monthly monitoring.
  - Turbidity, already included as part of the monthly water quality sampling routine.
  - Toxic and other deleterious organic and inorganic, already included in monitoring for metals and mercury/methylmercury (organometals).
- One-time survey

- — Fecal coliform bacteria, included in monthly monitoring.
- — Sediment, already included in assessing mercury and other metals from sediments.
- — Petroleum hydrocarbons, oil, and grease, included in a one-time survey.
- — Radioactivity; radionuclide concentrations to be generated from surface water samples.
- — Toxic and other deleterious organic and inorganic, already included in monitoring for metals and mercury/methylmercury (organometals).

Table 5.5-4 lists the water quality parameters to be collected and their frequency of collection.

5.5.4.4.2 Sampling Protocol

Water quality grab samples will be collected during each site visit in a representative portion of the stream channel/water body, using methods consistent with ADEC and U.S. Environmental Protection Agency (EPA) protocols and regulatory requirements for sampling ambient water and trace metal water quality criteria.

Mainstem areas of the river not immediately influenced by a tributary will be characterized with a single grab sample. Areas of the mainstem with an upstream tributary that may influence the nearshore zone or are well-mixed with the mainstem will be characterized by collecting samples at two locations: in the tributary and in the mainstem upstream of the tributary confluence. All samples will be collected from a well-mixed portion of the river/tributary.

These samples will be collected on approximately a monthly basis (four samples from June to September) and used for calibrating the same model framework used for predicting temperature. The period for collecting surface water samples will begin at ice break-up and extend to beginning of ice formation on the river. Limited winter sampling (once in December, and again in March) will be conducted where existing or historic USGS sites are located. Review of existing data (URS 2011) indicated that few criteria exceedances occur with metals concentrations during the winter months. Existing data show that conventional water quality parameters do not change during the winter months and appear to be mediated by constancy in flow and by water temperature. Initial assessment of this existing data suggests that samples be collected twice during the winter months for analysis of early and late season conditions when the hydrograph declines (near the beginning of winter) and when the hydrograph begins to increase (near the beginning of spring). If the 2013 data sets suggest that metals and other general water quality parameters exceed criteria or thresholds, then an expanded 2014 water quality monitoring program will be conducted to characterize conditions on a monthly basis throughout the winter months.

Water quality indicators like conductivity (specific conductance) have been suggested as a surrogate measure for transfer of metals from groundwater to surface water or in mobilization of metals within the river channel. Should the one-time survey for metals at each of the sampling sites show elevated concentrations of select parameters, then sampling of a full list of metals will be conducted one time that analyzes groundwater concentrations in order to adequately characterize current conditions. Available USGS data from select continuous gaging stations will be reviewed for increases in specific conductance during monthly and seasonal intervals, and these results will be used to determine if further metals sampling is warranted during additional winter months.

Water quality grab samples will be collected during each site visit along a transect of the stream channel/water body, using methods consistent with ADEC and EPA protocols and regulatory requirements for sampling ambient water and trace metal water quality criteria.

Mainstem areas of the river not immediately influenced by a tributary will be characterized with a single transect. Areas of the mainstem with an upstream tributary that may influence the nearshore zone or that are well-mixed with the mainstem will be characterized by collecting samples at two transect locations: in the tributary and in the mainstem upstream of the tributary confluence. Samples will be collected at 3 equi-distant locations along each transect (i.e. 25% from left bank, 50% from left bank, and 75% from left bank). Samples will be collected from a depth of 0.5 meters below the surface as well as 0.5 meters above the bottom. This will ensure that variations in concentrations, especially metals, are captured and adequately characterized throughout the study area.

Variation of water quality in a river cross-section is often significant and is most likely to occur because of incomplete mixing of upstream tributary inflows, point-source discharges, or variations in velocity and channel geometry. Water quality profiles at each location on each site transect will be conducted for field water quality parameters (e.g., temperature, pH, dissolved oxygen, and conductivity) to determine the extent of vertical and lateral mixing.Additional details of the sampling methods will be provided in a combined Sampling and Analysis Plan (SAP) and the Quality Assurance Project Plan (QAPP) for this study. More detail describing study design, field sampling procedures, and evaluation of data quality is provided in the Baseline Water Quality Monitoring QAPP (Attachment 5-1).

In Situ Water Quality Sampling. During each site visit, in situ measurements of dissolved oxygen, pH, specific conductance, redox potential, turbidity, and water temperature will be made. A Hanna Instruments HI 98703 Portable Turbidity Meter will be used to measure turbidity, while a Hydrolab® datasonde (MS5) will be used to measure the remaining field parameters during each site visit. Continuous turbidity measurement may be conducted with the Hydrolab datasonde at select locations (e.g., former/current USGS sites where turbidity data are available from the 1980s) and operated during summer and winter conditions. The following list of former and current USGS mainstem Susitna River monitoring sites will be considered for continuous turbidity monitoring: Susitna Station, Sunshine, Gold Creek, Tsusena Creek, and near Cantwell. These locations have historic and current flow data that will be used in water quality modeling (Section 5.6) of effects on turbidity from Project operations. Continuous logging of water quality parameters using a multi-parameter probe (e.g., temperature, pH, dissolved oxygen, and conductivity) may be placed at Focus Area locations (identified in Section 5.5.4.5). The period of deployment will be focused on summer months June through September (four months) as water conditions permit deployment and routine download of data. Maintenance of a multi-parameter probe and risk from damage is high during winter months. Also, freezing conditions will damage sensor apparatus and the logging unit if enclosed by formation of ice.

Standard techniques for pre- and post-sampling calibration of in situ instrumentation will be used to ensure quality of data generation and will follow accepted practice. If calibration failure is observed during a site visit, field data will be corrected according to equipment manufacturer's instructions.

General Water Quality Sampling. Sampling will avoid eddies, pools, and deadwater. Sampling will avoid unnecessary collection of sediments in water samples, and touching the inside or lip of the sample container. Samples will be delivered to EPA-approved laboratories within the holding time frame. Each batch of samples will have a separate completed chain of custody sheet. A field duplicate will be collected for 10 percent of samples (i.e., 1 for every 10 water grab samples). Laboratory quality control samples including duplicate, spiked, and blank samples will be prepared and processed by the laboratory.

Quality Assurance/Quality Control (QA/QC) samples will include field duplicates, matrix spikes, duplicate matrix spikes, and rinsate blanks for non-dedicated field sampling equipment. The results of the analyses will be used in data validation to determine the quality, bias, and usability of the data generated.

Sample numbers will be recorded on field data sheets immediately after collection. Samples intended for the laboratory will be stored in coolers and kept under the custody of the field team at all times. Samples will be shipped to the laboratory in coolers with ice and cooled to approximately 4°C. Chain of custody records and other sampling documentation will be kept in sealed plastic bags (Ziploc®) and taped inside the lid of the coolers prior to shipment. A temperature blank will accompany each cooler shipped. Packaging, marking, labeling, and shipping of samples will be in compliance with all regulations promulgated by the U. S. Department of Transportation in the Code of Federal Regulations, 49 CFR 171-177.

Water quality samples will be labeled with the date and time that the sample is collected and preserved/filtered (as appropriate), then stored and delivered to a state-certified water quality laboratory for analyses in accordance with maximum holding periods. A chain of custody record will be maintained with the samples at all times.

The state-certified laboratory will report (electronically and in hard copy) each chemical parameter analyzed with the laboratory method detection limit, reporting limit, and practical quantification limit. The laboratory will attempt to attain reporting detection limits that are at or below the applicable regulatory criteria and will provide all laboratory QA/QC documentation.

The procedures used for collection of water quality samples will follow protocols from ADEC and EPA Region 10 (Pacific Northwest). Water samples will be analyzed by a laboratory accredited by ADEC or recognized under NELAP. Water quality data will be summarized in a report with appropriate graphics and tables with respect to Alaska State Water Quality Standards (ADEC 2005) and any applicable federal standards.

Additional details of the sampling procedures and laboratory protocols is included in the SAP and QAPP.

5.5.4.5. Water Quality Characterization in Focus Areas

The second type of water quality monitoring is distinguished from the large-scale program by a higher density of sampling within a pre-defined reach length and a higher frequency of sample collection (greater than once per month). The purpose for the intensive water quality monitoring in select Focus Areas of the proposed Project area is to evaluate effects from dam operations on resident and anadromous fisheries. Potential Focus Areas in the middle river portion of the Susitna drainage have been selected in consultation with the water resources leads. The Focus Area sites are fully discussed in the Instream Flow Study Plan in Section 8.5.4.2.

Changes in water quality conditions from Project operations may influence usable habitat by individual species of fish and various life stages. Water quality conditions influence usability of areas within the river and sloughs by supporting required physicochemical characteristics that range from metabolic needs to predator avoidance. Adequate temperature and dissolved oxygen concentrations are required to sustain basic metabolic needs and these can differ for life stages of a species. Successful predator avoidance improves survivability of a population and this is commonly achieved by using physical structures in the aquatic environment. In the case of water quality, early life stages of a species may benefit from increased turbidity in the water column. Changes to turbidity in the water column may result in increased predation on certain life stages of fish and present a negative impact to a population.

The Focus Areas will have a higher density of sampling locations, in contrast to the mainstem network, so that prediction of change in water quality conditions from Project operations can be made with a higher degree of resolution. The resolution expected for predicting conditions will be as short as 100-meter (m) longitudinal distances within the Focus Areas. Depending on the length of the Focus Area, transects will be spaced every 100 m to 500 m and water quality samples collected at three locations along each transect. The collection locations along a transect will be in open water areas and have 3 to 5 collection points. These will be discrete samples taken at each collection point. The density of monitoring locations within the Focus Areas will be used as a grid to detect and describe groundwater input. Plumes of groundwater input to a Focus Area will be traceable using thermal data or conductivity. The area of groundwater input will be described using the monitoring grid network represented by the transects and sampling points along each transect. The location of open water transects and piezometers will be coordinated with the Instream Flow Study (Section 8) and the Groundwater Study (Section 7.5) to efficiently implement common elements in each of the studies. Piezometers will be installed as part of the Water Quality Monitoring Study so that surface water and groundwater samples are collected at the same time for determination of influence of groundwater on surface water. Collection of groundwater and surface water during each site visit will be used to evaluate the influence of groundwater on surface water quality. Frequency of sampling will be every 2 weeks for a total duration of 6 weeks and coordinated with the Instream Flow and Groundwater studies.

Water quality parameters measured in Focus Areas will be used to calibrate the EFDC model, but at a higher level of resolution than used for the main channel beginning from RM 15.1 and ending at RM 233.4 in the Susitna River. The focus for EFDC model predictions will be on the following parameters that could affect habitat used by anadromous and resident fish in this drainage:

Field Parameters

- Water temperature
- Dissolved oxygen
- Conductivity
- pH

General Chemistry

- Turbidity
- Hardness
- Total nitrogen
- Nitrate+nitrite-nitrogen
- Total phosphorus

- Soluble reactive phosphorus

Metals

- Mercury (total)
- Methylmercury (dissolved)
- Aluminum (dissolved and total)
- Iron (dissolved and total)

The water quality parameter list is divided further into two categories: (1) contaminants of concern (e.g., metals), and (2) general water quality conditions that may adversely affect fish species.

Inclusion of the nutrient parameters will be used to inform the productivity studies and potentially be used to develop habitat suitability criteria (HSC) curves for select aquatic communities. Response of biological communities like periphyton and benthic macroinvertebrates to nutrient concentrations will be predicted for alternative operational scenarios.

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

This task is designed to gather specific information on the distribution of Susitna River sediment contaminants of concern in potential source areas. In general, all sediment samples will be 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 will be analyzed for total metals, including aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, and zinc. In addition, sediment size and total organic carbon (TOC) will be included to evaluate whether these parameters are predictors for elevated metal concentrations. Samples will be collected just below and above the proposed dam site. Additional samples will be collected near the mouths of tributaries near the proposed dam site, including Fog, Deadman, Watana, Tsusena, Kosina, Jay, and Goose creeks, and the Oshetna River. The purpose of this sampling will be to determine where metals, if found in the water or sediment, originate in the drainage. Toxics modeling will be conducted to address potential for bioavailability in resident aquatic life. Comparison of bioaccumulation of metals in tissue analysis with results from sediment samples will inform on potential for transfer mechanisms between source and fate.

Two types of modeling analysis will be completed: (1) pathway model analysis, and (2) numerical modeling using EFDC (Section 5.6). First, pathway models will be constructed for preliminary evaluation of potential for transfer between media (e.g., sediment–pore water, pore water–surface water, surface water–fish tissue). Exposure concentrations will be estimated for each toxic within the medium sampled (e.g., sediment, pore water, surface water) and companion parameters (e.g., hardness and pH) will be collected that enable calculation of chronic and acute toxics concentrations to aquatic life. Potential for transfer of toxics between media will be facilitated by surrounding physicochemical conditions like low dissolved oxygen conditions, low pH resulting from low dissolved oxygen concentrations, or low redox potential. These companion field measurements will be made along with all media sampled at each site. Transfer potential of toxics between media will be identified under two conditions: (1) when field parameters listed above are at levels that result in mobilization of toxics between media, and (2) when toxics mobilize along a concentration gradient and transfer from high concentration to media with a lower concentration. Potential for bioaccumulation in aquatic life is determined when chronic thresholds for toxics exposure in a medium are identified. Potential for mortality is determined when acute criteria for toxics in a medium are exceeded.

Most of the contaminants of interest are typically associated with fine sediments, rather than with coarse-grained sandy sediment or rocky substrates. Therefore, the goal of the sampling will be to obtain sediments with at least 5 percent fines (i.e., particle size less than 0.0025 inches [63 micrometers], or passing through a #230 sieve). At some locations, however, larger-sized sediments may be all that are available.

The sediment samples will be collected using an Ekman dredge or a modified Van Veen grab sampler. Sampling devices will be deployed from a boat. Samples may also be collected by wading into shallow nearshore areas. To the extent possible, samples will consist of the top 6 inches (15 centimeters) of sediment. Comparison of results from the Susitna drainage will be made with other studies for Blue Lake, Eklutna Lake, and Bradley Lake when similar data are available and where physical settings are comparable.

5.5.4.7. Baseline Metals Levels in Fish Tissue

Two screening level tasks will be conducted. The first will be for methylmercury in sport fish. Methylmercury bioaccumulates and the highest concentrations are typically in the muscle tissue of adult predatory fish. Final determination of tissue type(s) for analysis will be coordinated with ADEC's Division of Environmental Health and guidance on fish tissue sampling. Results can be shared by ADEC with the State Health Department to develop fish consumption advice, if necessary. Target fish species in the vicinity of the Watana Reservoir will be Dolly Varden, Arctic grayling, whitefish species, long nose sucker, lake trout, burbot, and resident rainbow trout. If possible, filets will be sampled from seven adult individuals from each species. Adult fish from each of the species will be collected in order to estimate the metals concentrations in fish tissue (metals to be analyzed in fish tissue are listed in Table 5.5-3). Collection times for fish samples will occur in late August and early September. Filet samples will be analyzed for methyl and total mercury.

Liver samples will also be collected from burbot and analyzed for mercury, methylmercury, arsenic, cadmium, and selenium.

Field procedures will be consistent with those outlined in applicable Alaska state and/or EPA sampling protocols (USEPA 2000). Clean nylon nets and polyethylene gloves will be used during fish tissue collection. The species, fork length, and weight of each fish will be recorded. Fish will be placed in Teflon® sheets and into zipper-closure bags and placed immediately on ice. Fish samples will be submitted to a state-certified analytical laboratory for individual fish muscle tissue analysis. Results will be reported with respect to applicable Alaska and federal standards as well as published scientific literature based on both field observations and controlled laboratory experiments.

Results from fish tissue analysis will also be used as a description of bioaccumulative baseline toxics prior to the proposed Project. Results from the toxics pathways model and from the numeric model will be used to determine how the proposed Project may increase the potential of current metals concentrations to become bioavailable. The projected water conditions in the reservoir will be estimated and current results for metals concentrations re-evaluated for determining potential toxicities to resident and anadromous fish species. Detection of mercury in fish tissue and sediment will prompt further study of naturally occurring concentrations in soils and plants and how parent geology contributes to concentrations of this toxic in both compartments of the landscape. The focused study will estimate the extent and magnitude of mercury contamination so that an estimate of increased bioavailability might be made once the reservoir inundates areas where high concentrations of mercury are sequestered. Detectable concentrations of mercury may prompt additional sampling and analysis of tissues in the benthic macroinvertebrate community. The biomagnification of mercury contamination from sediments and plants to the fish community may be facilitated through consumption of contaminated food sources like the benthic macroinvertebrates. Contamination of this component of a trophic level may also be a conduit for mercury biomagnification in waterfowl and other wildlife that consume this food source.

5.5.4.8. Technical Report on Results

The technical report will include a description of the study goals and objectives, assumptions made, sample methods, analytical results, models used, and other background information. Field data, laboratory report, and quality assurance information will be attached.

A summary data report will be constructed that includes a description of patterns and an explanation for field parameters and general chemistry conditions. The origin of patterns in water quality data sets collected as part of this study may be due to seasonal influence (e.g., changes mediated by climate patterns), influence of tributary water chemistry on mainstem conditions, or in the case of sloughs may be moderated by groundwater influence.

The intensity of sampling effort is expected to be greater at Focus Areas and so resolution of changes in field parameters, general chemistry, and metals chemistry is expected to be described in finer detail. Spatial water quality conditions will be described in greater detail at these Focus Areas (Section 5.5.4.5) and be sampled every two weeks. Select field parameters (water temperature and dissolved oxygen concentration) will be collected on a continuous basis and downloaded during each of the Focus Area visits and will be able to describe daily diurnal patterns from these data.

Comparison of data will be made with existing and appropriate water quality criteria, sediment thresholds, and fish tissue screening levels. Surface water results will be compared to Alaska Water Quality Standards (18 ACC 70.020(b)) for protection of beneficial uses in fresh water. Sediment and fish tissue results will be compared to the Screening Quick Reference Tables (SQuiRTs) used by the National Oceanic and Atmospheric Administration (NOAA) to determine if thresholds for toxicity to aquatic life have been exceeded.

The focused effort in characterizing current mercury conditions through monitoring and modeling in the vicinity of the proposed dam site is described further in Sections 5.6 and 5.7. A general description of the approach and reporting of results for the mercury study is summarized here.

Mercury will be modeled using three methods:

1. Water quality modeling of the reservoir will predict whether the conditions for the formation of methylmercury will be present, and where in the reservoir this may occur.

2. The linear model of Harris and Hutchinson (2008) will provide an initial prediction of peak mercury concentrations in fish.
3. The phosphorous release model will be used to evaluate when peak methylmercury production may occur.

The report will include a conceptual model showing mercury inputs to the reservoir, mercury methylation, mercury circulation among different media (fish, air, water, sediment, etc.), and bioabsorption and transfer. Strategies to manage mercury methylation, bioaccumulation, and biomagnification will be reviewed (Mailman et al. 2006).

Sediment, water, and tissue results from toxics analysis will use NOAA Screening Quick Reference Tables (SQuiRTs). These are thresholds used as screening values for evaluation of toxics and potential effect to aquatic life in several media and will be implemented where ADEC water quality, sediment, or tissue criteria are not available.

An example for SQuiRT values can be found at the following website:

http://mapping2.orr.noaa.gov/portal/sanfranciscobay/sfb_html/pdfs/otherreports/squirt.pdf

Specific thresholds and criteria for toxics in each of the media will be included in a QAPP. The Water Resources Technical Workgroup will be consulted before final criteria and thresholds are finalized and used to interpret toxics monitoring results from sediment, water, and fish tissue.

5.5.4.9. Pilot Thermal Imaging Assessment of a Portion of the Susitna River

Thermal imagery data using Forward Looking Infra-Red (FLIR) technology of the entire middle portion of the Susitna River was collected in October 2012. The data from the thermal imaging will be ground-truthed and the applicability and resolution of the data will be determined in terms of identifying water temperatures and thermal refugia/upwelling. Ground-truthing will occur by using the existing continuous temperature monitoring data from buoy systems and bank installation equipment for the 2012 Temperature Monitoring Study. In coordination with the instream flow and fish studies, a determination will be made as to whether thermal imaging data will be applicable and whether or not additional thermal imagery will be collected during the 2013 field season to characterize river temperature conditions. The results of the thermal imaging pilot test will be available by January 2013.

If the pilot study is successful, then a description of thermal refugia throughout the Project area can be mapped using aerial imagery calibrated with on-the-ground verification. The verification data used will be collected at the same time as the aerial imagery (or nearly the same time) using the established continuous temperature monitoring network and additional grab sample temperature readings where there may be gaps, such as in select sloughs. The elements described in the following sections are important considerations for data collection, specifications for data quality, and strategy for relating digital imagery and actual river surface water temperatures.

If the thermal imaging is not successful, the study component will be reevaluated. Future actions will depend on the causes of the failure. Potential causes for failure could include:

- Poor timing for the data acquisition flight.
- Insufficient differences in temperature between groundwater and surface water.
- Complex missing or dilution of the groundwater signal.

Potential solutions would include:

- Hand held FLIR meters that could be used during stream side studies, and a more focused thermal mapping task within focus areas using hand-held temperature meters and probes may prove useful.
- Use of documentation of open water leads as a substitute.
- Outfit the R44 helicopter to take advantage of regular field presence. Thermal imagery could be shot all summer long and brief intervals of ideal conditions could be used.
- The Focus Area results represent habitat identified as representative of the most important for fisheries use as described by the rational for site selection in Section 8.5.4.2 of the RSP. These results can be extrapolated to similar reaches, side channels, and sloughs in other areas of the Susitna drainage not directly monitored in this study to determine thermal refugia for fish.

5.5.4.10. Re-fly the thermal imaging under better conditions (a greater contrast in temperature between groundwater and surface water). **Radiant Temperature**

Remotely sensed thermal images allow for spatially distributed measurements of radiant temperatures in the river. Radiant temperature measurements are made only on the surface layer of the water (top 4 inches [10 centimeters]). Temperature readings can vary depending on the amount of suspended sediment in the water and the turbidity of the water. Collection of data will occur near the end of October when the freeze begins and the contrast between cold surface water and warmer groundwater influence is accentuated. The suspended sediment and turbidity will be diminished during this period of the year when the glacial flour content in the water column from glacial meltwater is reduced.

Spatial Resolution

The key to good data quality is determining the pixel size of the thermal infra-red (TIR) sensor and how that relates to the near-bank environment. Best practice is three pure-water pixels (ensures that the digital image represented by any three contiguous pixels discriminates water from land). Very fine resolution (0.7 to 3.3 feet [0.2 to 1 meter]) imagery is best used to determine groundwater springs and cold water seeps. Larger pixels can be useful for determining characteristic patterns of latitude and longitude thermal variation in riverine landscapes.

5.5.4.11. Calibrating Temperature

Water temperatures change during the day; therefore, measurements should occur near the same time each day and when water temperature is most stable (early afternoon). Data used from the continuous temperature probes throughout the middle reach will be the same time interval as thermal imaging collected at each location. Site selection for validation sampling will be determined by channel accessibility and where there is not known influences of tributaries or seeps in the area. Hand-held ground imaging radiometers can provide validation as long as the precision is at least as good as that expected from airborne TIR measurements. Availability of historical satellite imagery for thermal analysis will be investigated. Historical thermal imagery may enable exploration of potential trends in water temperature both spatially and temporally.

5.5.4.12. Groundwater Quality in Selected Habitats

The purpose of studying groundwater quality will be to characterize the water quality differences between a set of key productive aquatic habitat types (three to five sites) and a set of non-productive habitat types (three to five sites) that are related to the absence or presence of groundwater upwelling to improve the understanding of the water quality differences and related groundwater/surface water processes. Concern for sensitive fisheries habitat in floodplain shallow alluvial aquifers and changes to this habitat from Project operations is the focus for identifying environmental conditions that will affect food-chain elements (e.g., periphyton and benthic macroinvertebrates). The groundwater/surface water exchange (Section 7.5) is expected to influence the energy flow from primary producers (periphyton) to consumers at an intermediate level in the trophic food web (Section 9.8, River Productivity Study). An estimate of density and mass for each of these trophic food web components in target habitats will represent production of the food base and be compared against production necessary to support current fisheries populations. These sites will be co-located within the Focus Areas (Section 5.5.4.5) in order to measure groundwater input and influence on surface water chemistry.

Basic water chemistry information (temperature, dissolved oxygen [DO], conductivity, pH, turbidity, redox potential) that defines habitat conditions will be collected at selected instream flow, fish population, and riparian study sites. These data will be used to characterize groundwater and surface water interactions.

5.5.5. Consistency with Generally Accepted Scientific Practice

Studies, field investigations, laboratory testing, engineering analysis, etc. will be performed in accordance with general industry accepted scientific and engineering practices. The methods and work efforts outlined in this study plan are the same or consistent with analyses used by applicants and licensees and relied upon by FERC in other hydroelectric licensing proceedings.

The process for developing and implementing a water quality monitoring program ensures that high quality data is generated for use in regulatory decision-making and management of aquatic resources. Products like the: Quality Assurance Project Plan, use of NELAP Certified laboratory to analyze water samples, and sampling design for appropriate characterization of current water quality will ensure that complete documentation improves performance in implementing the Study Design.

5.5.6. Schedule

Baseline Water Quality Study elements will be completed in several stages and based on the timeline shown in Table 5.5-5. The thermal imaging data was acquired in October 2012, and will be processed and available for use in January 2013. Met stations were installed in August of 2012, and will collect data till the end of the project. The QAPP and SAP has been completed and is attached to this RSP. It will continue to be refined as the project goes forward. The temperature sensors were deployed in the river in August of 2012. They will continue recording data till the third quarter of 2014. It is anticipated that the sensors will have to be periodically replaced due to damage by ice, current, or battery replacement. Water quality monitoring will start in March 2013, and continue periodically throughout the remainder of the year. Sediment and fish tissue sampling will occur in July and August. Some fish tissue sampling has already been completed, in August of 2012. Data management will occur throughout the data acquisition phase of the project. The initial study repot will be completed by December 2014, with the final due in the first quarter of 2015.

5.5.7. Relationship with Other Studies

A flow chart describing interdependencies (Figure 5.5-3) outlines origin of existing data and related historical studies, specific output for each element of the Water Quality studies, and where the output information generated in the Water Quality studies will be directed. This chart provides detail describing flow of information related to the Water Quality studies, from historical data collection to current data collection. Data were examined in a Water Quality Data Gap Analysis (URS 2011), and this information was used, in part, to assist in making decisions about the current design for the Baseline Water Quality Monitoring Study and for ensuring that the current modeling effort would be able to compare the 1980s study results with results of planned modeling efforts.

Integral portions of this interdependency chart are results from the Ice Processes Study and from the Fish and Aquatic Instream Flow Study. The Ice Processes Study will support water quality model development (Section 5.6) with information about timing and conditions for ice formation and ice break-up. The Fish and Aquatic Instream Flow Study represents the effort to develop a hydraulic routing model that will be coupled with the EFDC water quality model. Water quality monitoring efforts for field parameters, general chemistry, and metals (including mercury) will be used as a calibration data set for developing the predictive EFDC model.

5.5.8. Level of Effort and Cost

The estimated cost for the Water Quality Baseline Monitoring Study in the Susitna basin in 2013 and 2014 is approximately $6,000,000, not including the cost of the thermal imaging.

5.5.9. Literature Cited

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5.5.10. Tables

Table 5.5-1. Proposed Susitna River Basin Temperature and Water Quality Monitoring Sites.

Susitna River Mile	Description	Susitna River Slough ID	Latitude (decimal degrees)	Longitude (decimal degrees)
15.1	Susitna above Alexander Creek	NA	61.4014	-150.519
25.8[3]	Susitna Station	NA	61.5454	-150.516
28.0	Yentna River	NA	61.589	-150.468
29.5	Susitna above Yentna	NA	61.5752	-150.248
40.6[3]	Deshka River	NA	61.7098	-150.324
55.0[1]	Susitna	NA	61.8589	-150.18
83.8[3]	Susitna at Parks Highway East	NA	62.175	-150.174
83.9[3]	Susitna at Parks Highway West	NA	62.1765	-150.177
97.0	LRX 1	NA	62.3223	-150.127
97.2	Talkeetna River	NA	62.3418	-150.106
98.5	Chulitna River	NA	62.5574	-150.236
103.0[2,3]	Talkeetna	NA	62.3943	-150.134
113.0[2]	LRX 18	NA	62.5243	-150.112
120.7[2,3]	Curry Fishwheel Camp	NA	62.6178	-150.012
126.0	--	8A	62.6707	-149.903
126.1[2]	LRX 29	NA	62.6718	-149.902
129.2[3]	--	9	62.7022	-149.843
130.8[2]	LRX 35	NA	62.714	-149.81
135.3	--	11	62.7555	-149.7111
136.5	Susitna near Gold Creek	NA	62.7672	-149.694
136.8[3]	Gold Creek	NA	62.7676	-149.691
138.0[1]	--	16B	62.7812	-149.674
138.6[3]	Indian River	NA	62.8009	-149.664
138.7[2]	Susitna above Indian River	NA	62.7857	-149.651
140.0	--	19	62.7929	-149.615
140.1[2]	LRX 53	NA	62.7948	-149.613
142.0	--	21	62.8163	-149.576
148.0	Susitna below Portage Creek	NA	62.8316	-149.406
148.8[2]	Susitna above Portage Creek	NA	62.8286	-149.379
148.8	Portage Creek	NA	62.8317	-149.379
148.8[3]	Susitna above Portage Creek	NA	62.8279	-149.377
165.0[1]	Susitna	NA	62.7899	-148.997
180.3[1]	Susitna below Tsusena Creek	NA	62.8157	-148.652
181.3[3]	Tsusena Creek	NA	62.8224	-148.613
184.5[1]	Susitna at Watana Dam site	NA	62.8226	-148.533
194.1	Watana Creek	NA	62.8296	-148.259

Susitna River Mile	Description	Susitna River Slough ID	Latitude (decimal degrees)	Longitude (decimal degrees)
206.8	Kosina Creek	NA	62.7822	-147.94
223.7[3]	**Susitna near Cantwell**	**NA**	**62.7052**	**147.538**
233.4	Oshetna Creek	NA	62.6402	-147.383

1 Site not sampled for water quality or temperature in the 1980s or location moved slightly from original location.
2 Proposed mainstem Susitna River temperature monitoring sites for purposes of 1980s SNTEMP model evaluation.
3 Locations with overlap of water quality temperature monitoring sites with other studies.
Locations in bold font represent that both temperature and water quality samples are collected from a site.

Table 5.5-2. Proposed Susitna-Watana Meteorological Stations.

Susitna River Mile	Description	Station Status (New / Existing)	Latitude (Decimal degrees)	Longitude (Decimal degrees)
44.3	Willow Creek	Existing (Talkeetna RWIS)	61.765	-150.0503
80.0	Susitna River near Sunshine Gage	Existing (Talkeetna RWIS)	62.1381	-150.1155
95.9	Susitna River at Talkeetna	Existing (Talkeetna Airport)	62.32	-150.095
136.8	Susitna River at Indian River	New	62.8009	-149.664
184.1	Susitna River at Watana Dam Camp (upland on bench)	New	62.8226	-148.5330
224.0	Susitna River above Cantwell	New	62.7052	-147.53799

Note: Our ability to upgrade existing met stations is currently being evaluated. If existing met stations cannot be upgraded, new met stations may be installed.

Table 5.5-3. Parameters for water quality monitoring and laboratory analysis (Baseline Water Quality Monitoring and Focus Area monitoring).

Parameter	Analysis Method	Sample Holding Times
In Situ Water Quality Parameters		
Dissolved Oxygen (DO)	Water Quality Meter	Not Applicable
pH	Water Quality Meter	Not Applicable
Water Temperature	Water Quality Meter	Not Applicable
Specific Conductance	Water Quality Meter	Not Applicable
Turbidity	Water Quality Meter	Not Applicable
Redox Potential	Water Quality Meter	Not Applicable
Color	Platinum-Cobalt Scale (SM)	Not Applicable
Residues	Defined in 18 ACC 70	Not Applicable
General Water Quality Parameters (grab samples for laboratory analysis)		
Hardness	EPA - 130.2	180 days
Nitrate/Nitrite	EPA - 353.2	48 hours

Parameter	Analysis Method	Sample Holding Times
Alkalinity	EPA - 2320	14 days
Ammonia as N	EPA - 350.1	28 days
Total Kjeldahl Nitrogen	EPA - 351.2	28 days
Total Phosphorus	EPA - 365.3	28 days
Ortho-phosphate	EPA - 365.3	48 hours
Chlorophyll-a	SM 10300	28 days
Total Dissolved Solids	EPA - 160.1	7 days
Total Suspended Solids	EPA - 160.2	7 days
Turbidity	EPA - 180.1	48 hours
TOC	EPA - 415.1	28 days
DOC	EPA – 415.1	28 days
Fecal Coliform	EPA 1604	30 hours
Petroleum Hydrocarbons	EPA 602/624 (TAqH) EPA 610/625 (TAH)	14 days
Radionuclides[1]	EPA 900.0, 901.1, 903.1, 904.0, 905.0, Alpha Spectroscopy	5 days
Metals – (Water) Dissolved and Total		
Aluminum	EPA – 6010B/6020A	48 hours
Arsenic	EPA – 6010B/6020A	48 hours
Barium	EPA – 6010B/6020A	48 hours
Beryllium	EPA – 6010B/6020A	48 hours
Cadmium	EPA – 6010B/6020A	48 hours
Chromium (III & IV)	EPA – 6010B/6020A	48 hours
Cobalt	EPA – 6010B/6020A	48 hours
Copper	EPA – 6010B/6020A	48 hours
Iron	EPA – 6010B/6020A	48 hours
Lead	EPA – 6010B/6020A	48 hours
Magnesium	EPA – 6010B/6020A	48 hours
Manganese	EPA – 6010B/6020A	48 hours
Mercury (Total and methylmercury)	EPA – 1631E/1630	48 hours
Molybdenum	EPA – 6010B/6020A	48 hours
Nickel	EPA – 6010B/6020A	48 hours
Selenium	EPA – 6010B/6020A	48 hours

Parameter	Analysis Method	Sample Holding Times
Thallium	EPA – 6010B/6020A	48 hours
Vanadium	EPA – 6010B/6020A	48 hours
Zinc	EPA – 6010B/6020A	48 hours
Metals –Sediment (Total)		
Aluminum	EPA - 200.7	180 days
Arsenic	EPA - 200.7	180 days
Cadmium	EPA - 200.7	180 days
Copper	EPA - 200.7	180 days
Iron	EPA - 200.7	180 days
Lead	EPA - 200.7	180 days
Mercury	EPA – 1631E	90 days
Zinc	EPA - 200.7	180 days
Metals – Fish Tissue (Use EPA Sampling Method 1669) (Mercury Assessment Study Plan 5.7 only)		
Total Mercury	EPA – 1631E	7 days
Methylmercury	EPA – 1630	7 days
Arsenic	EPA - 1632, Revision A	7 days
Cadmium	EPA - 1632	7 days
Selenium	EPA - 1632	7 days

Note: List of Radionuclides suggested for analysis includes the following: Americium-241; Cesium-137; Lead-210; Plutonium-238, 239, 240; Potassium-40; Radium-226; Radium-228; Strontium-90; Thorium-230, 232; Uranium-234, 235, 238; Tritium Gross Alpha, Gross Beta

Table 5.5-4. List of water quality parameters and frequency of collection.

Parameter	Task	Frequency of Collection
In Situ Water Quality Parameters		
Dissolved Oxygen (DO)	Baseline WQ and Sediment	Each Sampling Event
pH	Baseline WQ and Sediment	Each Sampling Event
Water Temperature	Baseline WQ and Sediment	Each Sampling Event
Specific Conductance	Baseline WQ and Sediment	Each Sampling Event
Turbidity	Baseline WQ and Sediment	Each Sampling Event
Redox Potential	Baseline WQ and Sediment	Each Sampling Event
Color	Baseline WQ (Visual)	Monthly
Residues	Baseline WQ (Visual)	One Survey-summer
General Water Quality Parameters (grab samples for laboratory analysis)		
Hardness	Baseline WQ	Monthly

Parameter	Task	Frequency of Collection
Alkalinity	Baseline WQ	Monthly
Nitrate/Nitrite	Baseline WQ	Monthly
Ammonia as N	Baseline WQ	Monthly
Total Kjeldahl Nitrogen	Baseline WQ	Monthly
Total Phosphorus	Baseline WQ	Monthly
Ortho-phosphate	Baseline WQ	Monthly
Chlorophyll-a	Baseline WQ	Monthly
Total Dissolved Solids	Baseline WQ	Monthly
Total Suspended Solids	Baseline WQ	Monthly
Turbidity	Baseline WQ	Monthly
TOC	Baseline WQ	One Survey-summer
DOC	Baseline WQ	Monthly
Fecal Coliform	Baseline WQ	One Survey-summer
Petroleum Hydrocarbons	Baseline WQ	One Survey-summer
Radioactivity	Baseline WQ	One Survey-summer
Metals – (Water) Dissolved and Total		
Aluminum	Baseline WQ (Total & Dissolved)	One Survey-summer
Arsenic	Baseline WQ (Total & Dissolved)	Monthly
Barium	Baseline WQ (Total & Dissolved)	Monthly
Beryllium	Baseline WQ (Total & Dissolved)	Monthly
Cadmium	Baseline WQ (Total & Dissolved)	Monthly
Chromium (III & IV)	Baseline WQ (Total & Dissolved)	One Survey-summer
Cobalt	Baseline WQ (Total & Dissolved)	Monthly
Copper	Baseline WQ (Total & Dissolved)	Monthly
Iron	Baseline WQ (Total & Dissolved)	Monthly
Lead	Baseline WQ (Total & Dissolved)	Monthly
Manganese	Baseline WQ (Total & Dissolved)	Monthly
Magnesium	Baseline WQ (Total & Dissolved)	Monthly
Mercury	Baseline WQ (Total & Dissolved)	Monthly
Molybdenum	Baseline WQ (Total & Dissolved)	Monthly
Nickel	Baseline WQ (Total & Dissolved)	Monthly
Selenium	Baseline WQ (Total & Dissolved)	One Survey-summer
Thallium	Baseline WQ (Total & Dissolved)	Monthly
Vanadium	Baseline WQ (Total & Dissolved)	Monthly

Parameter	Task	Frequency of Collection
Zinc	Baseline WQ (Total & Dissolved)	Monthly
Metals –Sediment (Total)		
Aluminum	Sediment Samples	One Survey-summer
Arsenic	Sediment Samples	One Survey-summer
Cadmium	Sediment Samples	One Survey-summer
Copper	Sediment Samples	One Survey-summer
Iron	Sediment Samples	One Survey-summer
Lead	Sediment Samples	One Survey-summer
Mercury	Sediment Samples	One Survey-summer
Zinc	Sediment Samples	One Survey-summer
Metals – Fish Tissue (Use EPA Sampling Method 1669)		
Total Mercury	Fish Tissue Screening	One Survey-late summer
Methylmercury	Fish Tissue Screening	One Survey-late summer
Arsenic	Fish Tissue Screening	One Survey-late summer
Cadmium	Fish Tissue Screening	One Survey-late summer
Selenium	Fish Tissue Screening	One Survey-late summer

Table 5.5-5. Schedule for Implementation of the Baseline Water Quality Study.

Activity	2012				2013				2014				2015
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q
Thermal Imaging (one survey)				—									
MET Station Installation and Data Collection			—	—	—	—	—	—	—	—	—	—	—
QAPP/SAP Preparation and Review			—	—									
Deployment of Temperature Monitoring Apparatus			—	—	—	—	—	—	—	—	—		
Water Quality Monitoring (monthly)						—	—	—					
Sediment Sampling							—						
Fish Tissue Sampling			—				—						
Data Analysis and Management				—	—	—	—	—	—	—	—		
Initial Study Report									Δ				
Updated Study Report													▲

Legend:

——Planned Activity

Δ Initial Study Report

▲ Updated Study Report

5.5.11. Figures

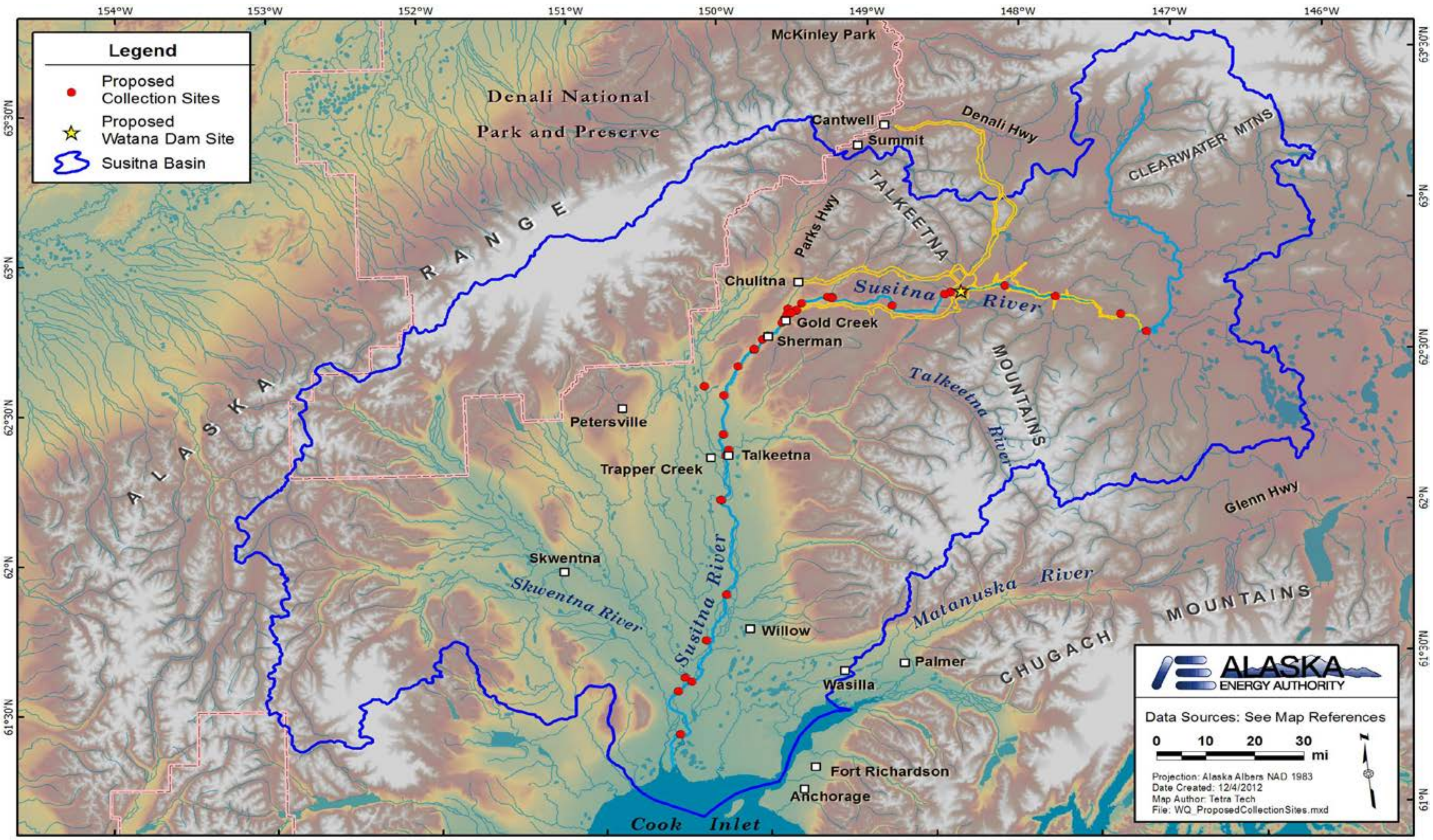

Figure 5.5-1. Proposed 2012 Stream Water Quality and Temperature Data Collection Sites for the Susitna-Watana Hydroelectric Project.

Figure 5.5-2. Example of a 10-foot (3-meter) tripod MET station installed above the proposed Watana Dam site.

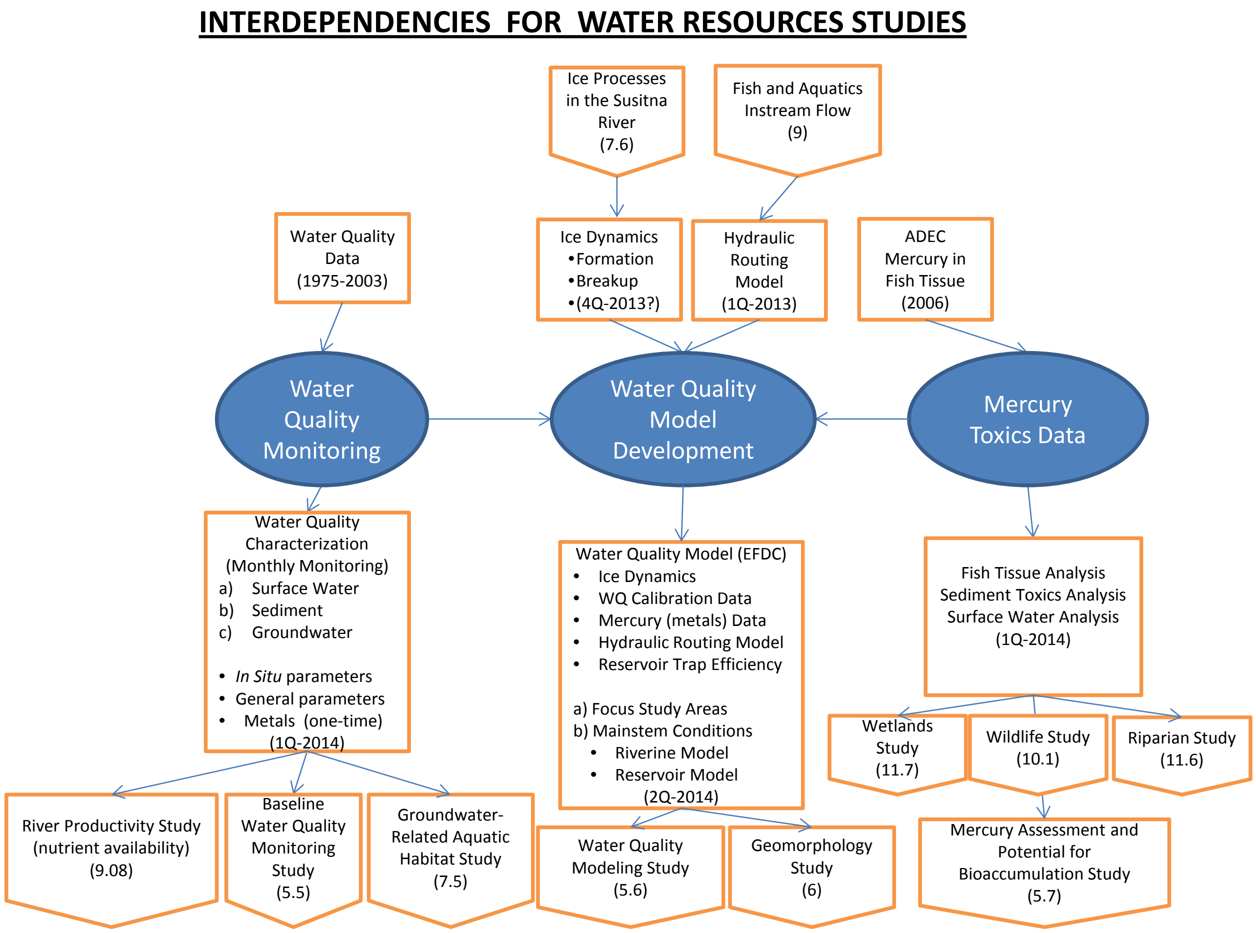

Figure 5.5-3. Interdependencies for water resources studies.