REVIEW OF EXISTING WATER TEMPERATURE MODEL RESULTS AND DATA COLLECTION – DRAFT FINAL

INTRODUCTION

The Alaska Energy Authority (AEA) is preparing a License Application that will be submitted to the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project (Project) through the Integrated Licensing Process (ILP). The Project is located on the Susitna River, an approximately 300 mile long river in the Southcentral region of Alaska. The Project's dam site will be located at River Mile (RM) 184. The results of this study and of other proposed studies will provide information needed to support the FERC's National Environmental Policy Act (NEPA) analysis for the Project license.

Construction and operation of the Project as described in the Pre-application Document (PAD, AEA 2011) will affect flow regimes and water temperatures downstream of the proposed dam site. This study plan outlines the objectives and methods for reviewing historical 1980s modeling results and collecting meteorological and stream temperature data that will provide a foundation for the 2013 and 2014 formal FERC studies.

STUDY OBJECTIVES

The objective of this 2012 WQ-S1 Review of Existing Water Temperature Model Results and Data Collection Study is to provide a foundation for the 2013-2014 water temperature modeling study for reservoir and stream temperatures. The specific objectives are as follows:

- Evaluate the 1980s water temperature model results and determine the applicability of the past results to the currently proposed Project.
- Initiate collection of stream temperature and meteorological data that will be needed for the 2013 and 2014 studies.

STUDY AREA

The study area includes the Susitna River within the proposed Watana Reservoir and downstream of the proposed Watana Dam. Water quality studies will be conducted from river mile 10.1 (Susitna River above Alexander Creek) to river mile 233.4 (at Oshetna Creek, just above the upper extent of the proposed reservoir area). The proposed dam would be located at river mile 184.5. The dam would create a reservoir 39 miles long and up to 2 miles wide, with a normal reservoir surface area of approximately 22,500 acres and a normal maximum pool elevation of 2,000 feet.

NEXUS BETWEEN PROJECT AND RESOURCE TO BE STUDIED AND HOW THE RESULTS WILL BE USED

The Project's operations will modify the flow and water temperature in the Susitna River downstream of the proposed reservoir. Reservoir operation and storage levels will affect water temperature in the reservoir and influence outflow water temperatures. Alteration of the water temperature in the Susitna River could modify river ice conditions, which in turn could impact channel morphology and riparian vegetation, as well as the suitability and productivity of aquatic

habitats. This could include the lower river, which is the habitat of forage fish for the Cook Inlet Beluga whale.

The results of the 2012 study will be used to further develop plans for additional studies in 2013/14, assess effects of the proposed Project, and to identify protection, mitigation and enhancement (PME) measures in the reservoir and in Project-affected river reaches downstream of the dam.

This study addresses some aspects of the following issues identified in the PAD (AEA 2011) for which existing information appears to be insufficient:

- WQ-S2: Potential effects of reservoir filling, Project operations, including reservoir surface elevation fluctuations, on temperature, turbidity, total dissolved/suspended solids, dissolved oxygen, pH, metals, and chemical/nutrient (fecal coliform, total phosphate, soluble reactive phosphorus, total nitrogen, ammonia nitrogen, nitrate+nitrite-nitrogen) characteristics within the reservoir.
- WQ-S3: Potential effect of Project operations on temperature, turbidity, total dissolved/suspended solids, dissolved oxygen, pH, metals, and chemical/nutrient (fecal coliform, total phosphate, soluble reactive phosphorus, total nitrogen, ammonia nitrogen, nitrate+nitrite-nitrogen) characteristics of the mainstem river downstream from the proposed Susitna-Watana Dam Site (RM 184).

EXISTING INFORMATION

Stream temperature data were collected in the mainstem Susitna River during the 1980s. These data were used both as input values and calibration data for the 1980s stream water temperature model (Stream Network Temperature Model [SNTEMP]; Theurer et al. 1984) and reservoir water temperature model (Dynamic Reservoir Simulation Model [DYRESM]); Imberger and Patterson 1981). SNTEMP is a one-dimensional river water temperature model. DYRESM is a one-dimensional hydrodynamics model used to predict the vertical distribution of temperature and density in lakes and reservoirs.

Results from the 1980s water temperature modeling studies are contained in the reports listed in Table 1. These reports are available digitally at the Alaska Resources Information and Library Service (ARLIS).

Table 1

List of Arctic Environmental Information and Data Center (AEIDC)

Susitna Hydroelectric Project Stream Temperature Reports

Report Title	Date	APA Document Number
Methodological Approach to Quantitative Impact Assessment for the Proposed Susitna Hydroelectric Project	1983a	90
Stream Flow and Temperature Modeling in the Susitna Basin, Alaska	1983b	862
Effects of Project-Related Changes in Temperature, Turbidity and Stream Discharge on Upper Susitna Salmon Resources During June – Sept	1984a	454
Examination of Susitna River Discharge and Temperature Changes Due to the Proposed Susitna Hydroelectric Project	1984b	861
Assessment of the Effects of the Proposed SHP on Instream Temperature and Fishery Resources in the Watana to Talkeetna Reach Vol. 1 & 2	1984c,d	2330, 2331
Assessment of the Effects of the Proposed SHP on Instream Temperature and Fish Resources in the Watana to Talkeetna Reach	1985	2706

Additional data sources were reviewed prior to preparation of this study as part of the Data Gap Analysis Report (URS 2011). The Data Gap Analysis Report focused on summarization and evaluation of existing data for use in the Susitna-Watana FERC license application. Technical information used for the evaluation was collected over the past 30 years with the bulk of water quality information (e.g., conventional parameters and metals) more than 20 years old. The results of this data gap analysis indicated that elevated surface water temperatures periodically occur in important spawning and migration salmonid habitat and that more current temperature data would be useful for verifying previous temperature exceedances and describing the extent of temperature issues.

METHODS

SAP and QAPP

A Sampling and Analysis Plan (SAP) and a Quality Assurance Project Plan (QAPP) will be prepared as part of implementation of this 2012 study plan. The SAP and QAPP is standard documentation prepared before any water quality sampling and model development begins. These documents follow guidelines for the State of Alaska and U.S. Environmental Protection Agency Region 10 Credible Data Policy (ADEC 2005).

Evaluate 1980s Water Temperature Modeling Results

The 1980s SNTEMP and DYRESM model results will be evaluated to determine the applicability of the results to the current proposed Project for the purpose of guiding the development of the 2013-2014 study plans (e.g., water quality, fish, ice, instream flow, production).

a. SNTEMP and DYRESM predictive capabilities and associated assumptions will be evaluated to determine if the model results are appropriate for application to current conditions and the proposed Project. Any critical limitations will be identified.

b. The models' general configuration, input parameters, and quality of calibration/validation will be evaluated. The accuracy of representation for current and proposed conditions will be ascertained.

c. 1980s river flows and release schedules will be analyzed and compared to recent records to determine the applicability of these historic flow and release data to the current proposed Project.

d. If the existing temperature models and results are applicable to the current proposed Project, results will be synthesized to evaluate the potential effects of the proposed Project on water temperature and guide the design of the 2013-2014 study plans.

e. Coordination with other resource studies (e.g., water quality, ice, fish, instream flow, production) will occur to assist in developing 2013-2014 study plans that appropriately anticipate potential water temperature effects of the proposed Project.

Water Temperature Data Collection

Overview

1980s water temperature data and monitoring locations (Figure 1) have been evaluated to determine which of the historic locations should be monitored for the 2012 study. Locations were evaluated based on (1) adequate representation of locations throughout the Susitna River and tributaries above and below the proposed dam site; (2) preliminary consultation with AEA and licensing participants; and (3) anticipation of other studies and study sites (e.g., instream flow, ice processes). Characterization of water temperature will be completed in a variety of riverine locations.

Water temperature data loggers will be installed at 38 sites identified in Table 2 and Figure 2. Eight of the sites are mainstem monitoring sites that were previously used for SNTEMP modeling (1980s). Thirty of the sites are mainstem, tributary, or slough locations, most of which were monitored in the 1980s. Locations for sites are suggested for several reasons: 1) they provide good coverage of the mainstem for temperature modeling, 2) they provide coverage where important fish habitat is known, 3) sites represent influence of major tributaries that may influence thermal refugia downstream, and 4) the sites extend an existing data record beginning from the 1980s to present in order to determine if conditions have changed and how this impacts thermal refugia under current conditions.

Figure 1 – June to September Stream temperature Data Collection Stations 1980 to 1982 for the APA Susitna Hydroelectric Project

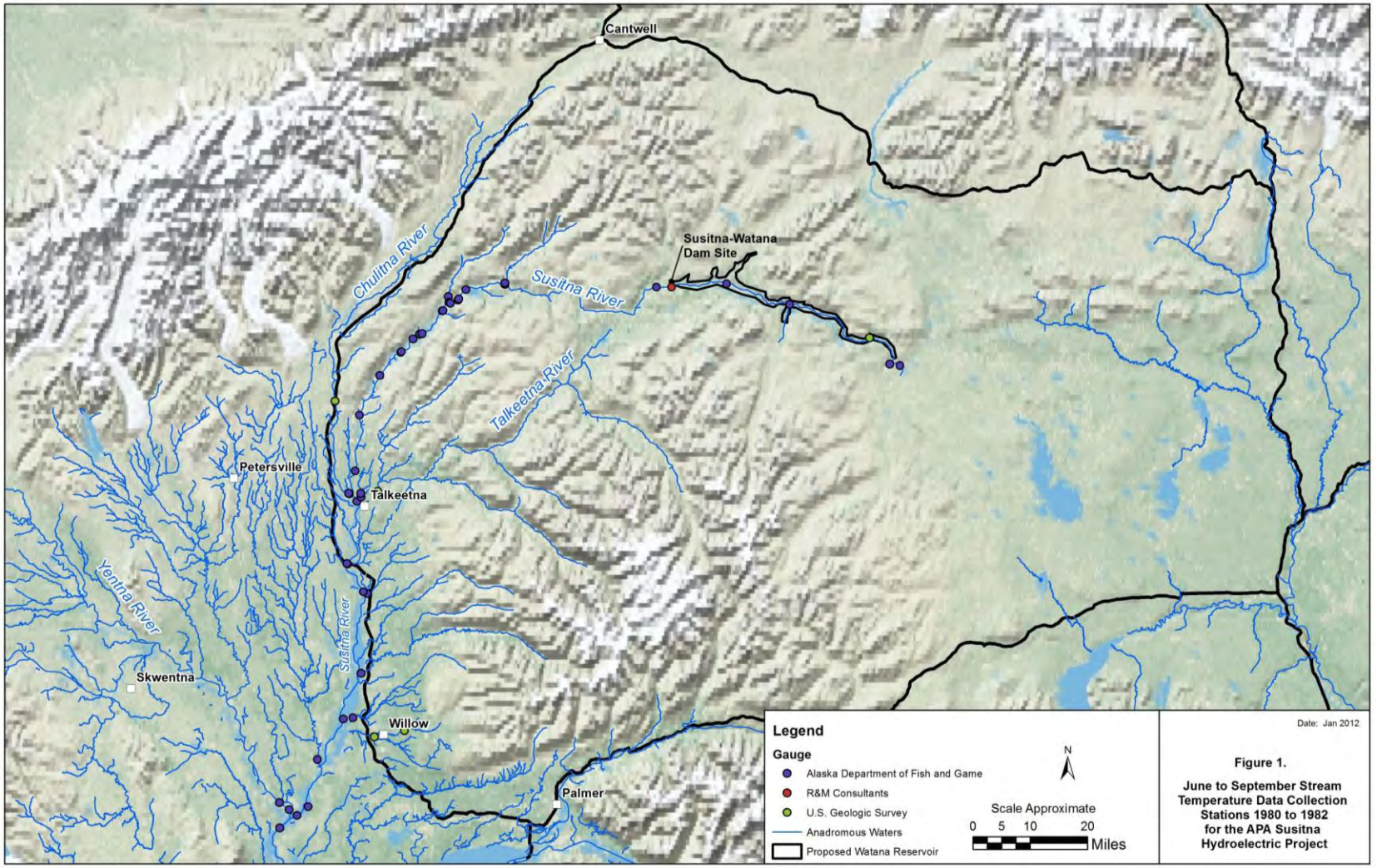

Table 2. Proposed Susitna River Basin Temperature Monitoring Sites

Susitna River Mile	Description	Susitna River Slough ID	Latitude (decimal degrees)	Longitude (decimal degrees)
10.1	Susitna above Alexander Creek	NA	61.4014	-150.519
25.8	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	Deshka River	NA	61.7098	-150.324
55.0[1]	Susitna	NA	61.8589	-150.18
83.8	Susitna at Parks Highway East	NA	62.175	-150.174
83.9	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]	Talkeetna	NA	62.3943	-150.134
113.0[2]	LRX 18	NA	62.5243	-150.112
120.7[2]	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	--	9	62.7022	-149.843
130.8[2]	LRX 35	NA	62.714	-149.81
136.5	Susitna near Gold Creek	NA	62.7672	-149.694
136.8	Gold Creek	NA	62.7676	-149.691
138.0[1]	--	16B	62.7812	-149.674
138.6	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	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	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
206.8	Kosina Creek	NA	62.7822	-147.94
223.7	Susitna near Cantwell	NA	62.7052	147.538
233.4	Oshetna Creek	NA	62.6402	-147.383

[1] Site not sampled for 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.

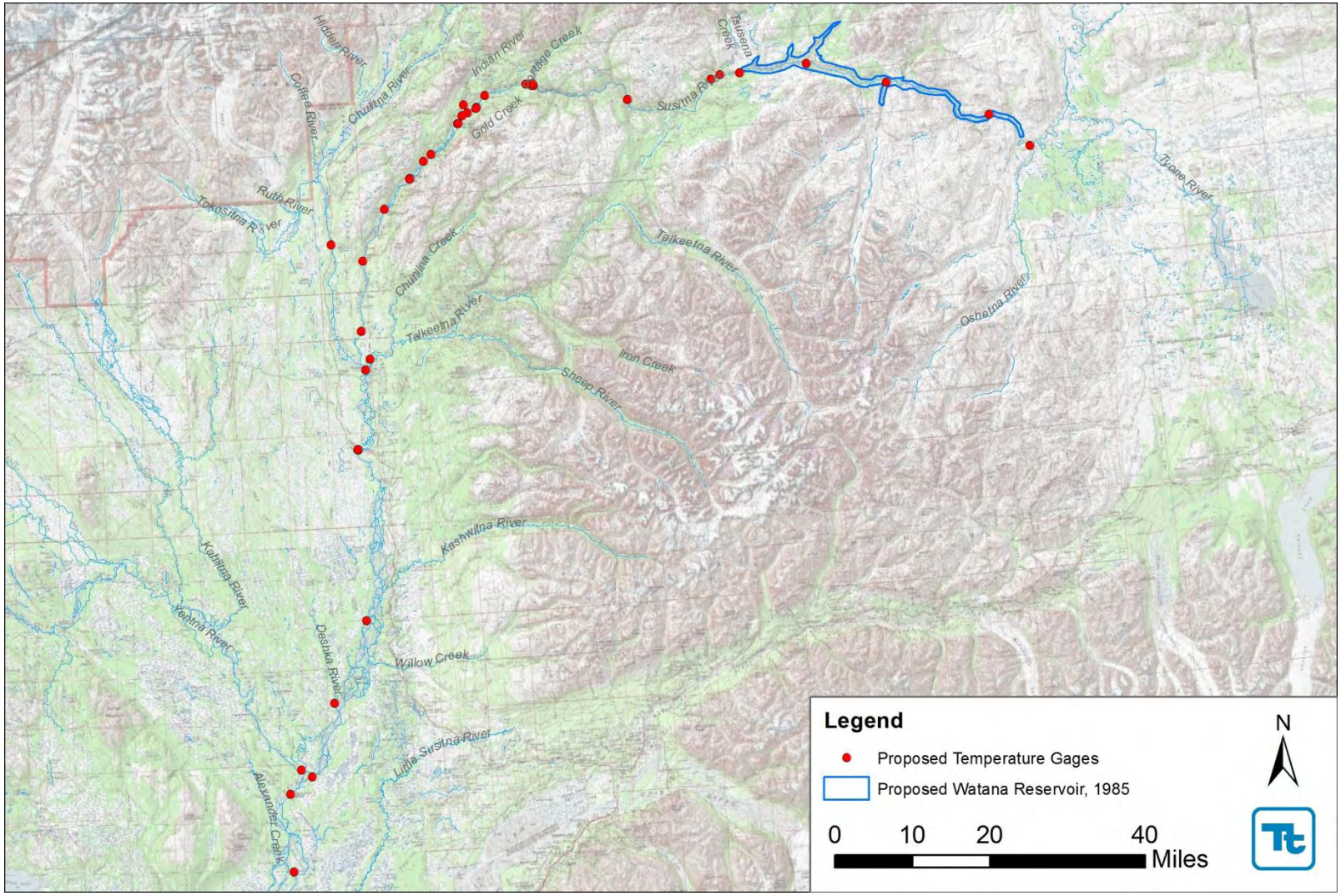

Figure 2 Proposed 2012 Stream Temperature Data Collection Sites for the Susitna-Watana Hydroelectric Project.

Installation and Monitoring Protocol

Water temperatures will be recorded in 15-minute intervals using Onset TidbiT v2 water temperature data loggers (or equivalent instrumentation). The TidbiT v2 (or equivalent) has a precision sensor for ±0.2°C accuracy over an operational range of -20° to 70°C (-4° to 158°F). Data readout is available in less than 30 seconds via an Optic USB interface. Temperature probe calibration forms and field deployment forms are located in Appendix A.

To reduce the possibility of data loss, a redundant data logger will be used at each site. In general, two sets of sensors will be installed in different fashions (depending on site characteristics). One logger will be inserted into the bottom of a 2.5-meter (8.2-foot) length of perforated steel pipe housing which is fastened to a large bank structure via clamps and rock bolts. The TidbiT® (or equivalent instrument) will be attached to a rope which allows it to be easily retrieved for downloads. The top pipe cap will contain a locking mechanism which can only be opened using the appropriate Allen key to prevent theft or vandalism. The second set of temperature loggers will be anchored to a concrete block and buoyed so that a bottom, mid, and surface logger record continuous temperature conditions throughout the water column (fewer temperature loggers may be deployed depending on site characteristics). The block will be placed in a location of the channel that is accessible and retrievable during routine site visits and the apparatus will be attached with a steel cable to a post which 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 which 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 instream flow study (F-S5) will install water-level loggers with temperature recording capability at several study sites that are yet to be determined. Where these study sites overlap the water temperature monitoring study sites (Figure 2), the water-level logger temperature sensors may be used. A redundant TidbiT v2, however, would be deployed at these sites for backup temperature recording.

Meteorological Data Collection

Overview

Meteorological (MET) data collection will be initiated and MET stations will be installed at up to eight (8) locations during 2012 between RM 224 and RM 80. The number of proposed installations will be based on availability of data from National Climatic Data Center (NCDC) meteorological stations, which has not yet been determined (see below). Table 3 lists the MET station locations. The exact spatial location will depend on access and suitability of an appropriate site for installing a MET station.

Table 3. Proposed Susitna-Watana Meteorological Stations

Susitna River Mile	Description
80.0	Susitna River near Sunshine Gage
103.0	Susitna River at Talkeetna Camp
120.6	Susitna River at Curry Camp
149.0	Susitna River above Portage Creek
183.5	2 stations below the Watana Dam site at river level (1 each side)
184.5	Susitna River above Watana Dam site (top of valley, north side)
224.0	Susitna River above Cantwell

MET stations above the dam site need to be established at specific locations as requested by Project design engineers. The upland MET station (RM 184.5) will record snowfall data and precipitation. The upland MET station will be established at about the 2,300 foot elevation on the north side of the river, either in the area of the proposed field camp or Borrow Site D area. The dam site MET stations may be located either on the north abutment, low on the abutment, in the vicinity of 100 feet to 1,850 feet elevation, or just above river level (e.g., 1,500+ feet elevation) depending on suitability of locations for establishing the structures. The MET station locations at the dam site will depend on ability to construct a road for maintenance access of the equipment.

A preliminary assessment has determined that an NNDC station already exists and is functional at Talkeetna (ID26528), however, the hours that the station is operational have not been verified. An NNDC meteorological station at Cantwell (ID46406) has a data record available to the public dated through August 2011. The station is likely currently operational and data since October 2011 is undergoing quality assurance.

MET Station Parameters

MET stations are required to collect several types of parameters that will be used by the engineering design team for the proposed dam and will be used to provide inputs to the water quality temperature model. The following is a comprehensive list of parameters required for use in this Project and will be measured continuously by each of the MET stations:

- Temperature – max, min, mean
- Relative humidity
- Precipitation
- Wind speed – maximum, minimum, mean
- Wind direction
- Wind gust – maximum
- Wind gust direction
- Solar degree days

Installation and Monitoring Protocol

Each MET station will consist of a tower with instrumentation to measure and record wind speed and direction, air temperature, relative humidity, barometric pressure, incident solar radiation, and water-equivalent precipitation in 15-minute intervals (Figure 3). The station loggers will have sufficient ports and programming capacity to allow for the installation of instrumentation to collect additional meteorological parameters as required. Such installation and re-programming can occur at any time without disruption of the data collection program.

Figure 3. Example Meteorological Station Installation

MET station installation is intended to provide instrumentation that is sturdy enough to 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 meteorological parameters will be 15 minutes, with a storage capacity to log up to two (2) years of data before filling the memory. The meteorological station is 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 will be protected by fencing as appropriate.

Satellite or Radio Telemetry Communications System

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

STUDY PRODUCTS

Study products to be delivered in 2012, at a minimum, will include:

Interim Technical Memorandum. An interim report describing the 1980s data, models, and reports that were recoverable; a statement regarding the applicability of the recovered work to the current project; and recommendations regarding additional study needs to be addressed in

2013 and 2014 will be prepared. Locations of meteorological stations and thermographs installed in 2012 will be reported in ArcGIS. All map and spatial data products will be delivered in the two-dimensional Alaska Albers Conical Equal Area projection, and North American Datum of 1983 (NAD 83) horizontal datum consistent with Alaska Department of Natural Resources (ADNR) standards.

Geo-spatially Referenced Relational Database. All historic data used in the analysis and data collected during the 2012 field season, including links to photographs, will be checked for quality and delivered in a geospatially-referenced relational database to AEA. This database will form the basis for additional data collection in 2013-2014. All field data must be associated with location information collected using a Global Positioning System (GPS) receiver in unprojected geographic coordinates (latitude/longitude) and the WGS84 datum. Naming conventions of files and data fields, spatial resolution, and metadata descriptions must meet the ADNR standards established for the Susitna-Watana Hydroelectric Project.

Technical Memorandum. A technical memorandum summarizing the 2012 results will be prepared and presented to resource agency personnel and other licensing participants, along with spatial data products.

SCHEDULE

The following schedule is for the 2012 scope of work:

Table 4. Schedule for Implementation of WQ-S1: Review of Existing Water Temperature Model Results and Data Collection, 2012 and Production of Associated Deliverables

Milestone	Date of Completion
Technical Workshop Meetings on Final Study Plans for 2012	April 2-6, 2012
Deployment of thermographs and meteorological stations	June 15, 2012
Interim Technical Memorandum	June 29, 2012
Original Data (quality assured)	November 9, 2012
Geospatially-referenced relational database (quality assured)	November 9, 2012
Final Technical Memorandum on 2012 Activity	November 9, 2012

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URS. 2011. AEA Sustina Water Quality and Sediment Transport Data Gap Analysis Report. Prepared by Tetra Tech, URS, and Arctic Hydrologic Consultants. Anchorage, Alaska. 62p.+Appendixes.

APPENDIX A: Temperature Probe Field Data Forms

a. Temperature Logger Calibration Check Form

b. Field Deployment Form

Temperature Logger Calibration Check Form

Date: _____

Temperature Logger Calibration Check Form

Technicians:

_____

	Time	NIST SN-	Thermistor #	Red Liquid SN-	SN-	SN-
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

	Time	NIST SN-	Thermistor #	Red Liquid SN-	SN-	SN-
1						
2						
3						
4						
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10						
11						
12						
13						
14						
15						

Notes:
SN = Serial Number

Field Deployment Form

Continuous Temperature Survey Form

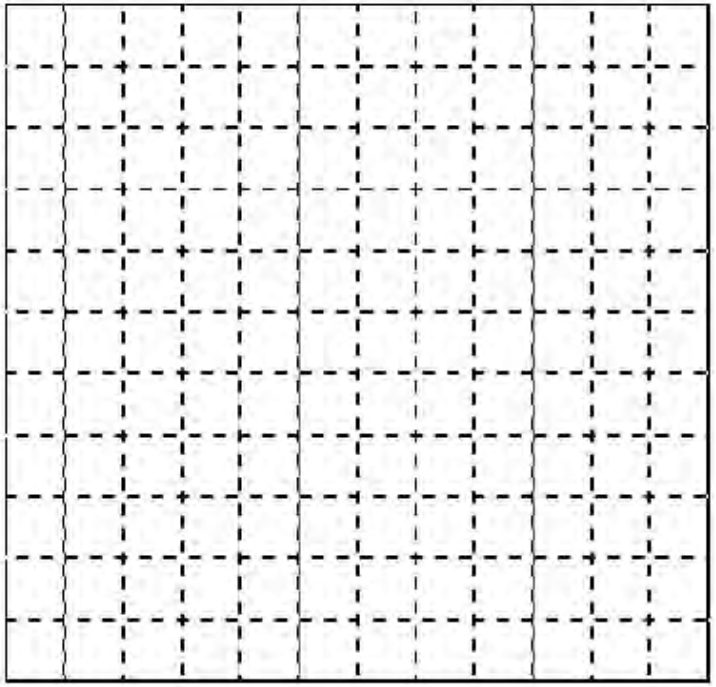
Station #: _____ **Station Name:** _____ **Samplers:** _____

Interval Frequency _____

Water Temperature Logger
I.D. # _____
Water Depth _____ ft Deployment Depth _____ ft
Height (Abv Bottom) _____ ft Retrieval Depth _____ ft

Air Temperature Logger
I.D. # _____
Height (Abv Stream) _____ ft

Date	Time	Water Temp	Air Temp	Weather/ Comments



Air Temperature Logger Location:

Water Temperature Logger Location: