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Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Water Quality Modeling Study
Study Plan Section 5.6

Initial Study Report
Part C: Executive Summary and Section 7

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

Tetra Tech, Inc./URS Corporation

June 2014

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EXECUTIVE SUMMARY

Water Quality Modeling Study 5.6	
Purpose	The objective for Study 5.6 is to develop a water quality model for the reservoir and riverine portions of the Project area. Water quality models predict water temperature and water quality conditions in both portions of the Susitna Basin; above the proposed dam site and the riverine portion below that location. Historic and current data used as part of the modeling process includes, but is not limited to: temperature, dissolved oxygen, fine suspended sediment and turbidity, chlorophyll-a, and nutrients.
Status	The models are defined by curvilinear horizontal grids that define the 3-dimensional (reservoir) and 2-dimensional (riverine) models. The reservoir hydrodynamic model has been tested using the 1984 historical inflow and a corresponding load following outflow. The model successfully simulated the one year period which has an approximately 148 foot variation in reservoir pool level. Future model simulations will be based on a 200 foot pool level variation reflected by maximum drawdown in the reservoir. The river hydrodynamic model has been tested using the 1984 historical flow and the 1984 load flowing flow from the reservoir without accounting for ice cover. Subsequent to these tests, the reservoir model was used to simulate hydrodynamics and water temperature for two three-year periods 1974-1976 and 1979-1981 as part of the Instream Flow riverine modeling Proof of Concept demonstration. The water quality riverine model was used to simulate these same periods for pre-Project and post-Project conditions. The riverine model includes a coarse 2-dimensional coverage of the river between the dam site and PRM 30 and a fine resolution inset in the region encompassing Focus Area FA-128 (Slough 8a).
Study Components	Selection of the water quality model Environmental Fluid Dynamics Code (EFDC) for development of reservoir and riverine models has been finalized. Configuration for the reservoir and riverine EFDC models has been completed for hydrodynamics, temperature, and fine suspended sediment. Spatial resolution of the models will be tested by comparing predicted output for temperature and water quality parameters at fine and coarse grid sizes. The EFDC has been parameterized for both reservoir and riverine models. Initial calibration of the riverine model has been successfully completed using the historical stage, flow and temperature data. Since the reservoir model cannot be calibrated to actual data, its performance is evaluated by simulating water level fluctuation and the annual temperature cycle expected in the reservoir.
2013 Variances	AEA implemented the methods as described in the Study Plan with no variances.

Water Quality Modeling Study 5.6	
Steps to Complete the Study	Modeling tasks are ongoing through 2015 as the model is further calibrated and incoming data provides improved accuracy. In order to complete the study, AEA will perform the following steps: • The reservoir model vertical resolution will be finalized (RSP Section 5.6.4.8.2) • The annual time scale predictions for temperature, ice cover and thickness will be evaluated for reasonableness by comparison with other high latitude or high altitude reservoir observations determined from literature review (RSP Section 5.6.4.8). • The reservoir water quality model and mercury cycling model will be configured and simulation results evaluated for reasonableness of predictions (RSP Section 5.6.4.8, ISR Section 5.2). • Trapping of fine, less than 125 micron, inorganic sediment in the reservoir will be evaluated (RSP Section 5.6.4.6.3, ISR Section 5.2 and 5.3). • Coordination of reservoir trap efficiency and sediment accumulation between the Water Quality Modeling Study (Study 5.6) and the Geomorphology Study (Study 6.6) will occur. • The reservoir model will be used to simulate various operational scenarios embedded in selected years of the 60 year hydrologic record (RSP Section 5.6.4.8, ISR Section 5.2 and 5.3). • The downstream river water quality model configuration will be completed and configured for pre- and post-Project conditions and calibrated for pre-Project conditions using observational data (RSP Section 5.6.4.8, ISR Sections 5.2 and 5.3). • The configuration and calibration will be updated as additional bathymetric and water quality data become available (RSP Section 5.6.4.8, ISR Sections 5.2 and 5.3). • A selected present monitoring period in 2013 or 2014 will be used for validation of the pre-Project configuration of the model (RSP Section 5.6.4, ISR Sections 5.2 and 5.3). • The spatial resolution and embedded high local resolution grids of the Focus Areas (FAs) will be finalized and additional calibration conducted in the Focus Areas (RSP Section 5.6.4.8.1, ISR Section 5.4). • Calibration of FA water quality riverine models for turbidity is based on derivation of values from the relationship with total suspended solids. The plan for generating turbidity values will be from regression models developed for a turbidity range of ≤ 200 NTUs and another model that accounts for turbidity > 200 NTUs. • After these activities are complete, the reservoir and riverine models will be used to evaluate water quality impacts under various alternative operational scenarios (RSP Section 5.6.4.8, ISR Section 6). • The pre-project river model will be simultaneously used to simulate

Water Quality Modeling Study 5.6	
	corresponding natural hydrologic conditions necessary for evaluation of the impact of the reservoir on the downstream river (Study Plan 5.6, ISR Section 6).
Highlighted Results and Achievements	The reservoir and riverine models have been configured for hydrodynamics, temperature, and fine suspended sediment. The models have been tested with annual time-scale historical and proposed Project flow scenarios to demonstrate stability and acceptable run-time performance. Test data sets for water temperature generated in 2012 have been used in both the reservoir and riverine models and have been deemed capable of decade time scale simulations. The same data set has been extended into 2013 and used to verify and further refine calibration of the model. Development of the model and calibration with water quality data is on schedule and will meet study objectives. The river model hydrodynamics are being calibrated to 2012 water surface elevation and velocity observations. Model parameterization has been completed for both the large-scale riverine model and the enhancement for the internally-coupled Focus Area riverine models. The riverine model has been configured with horizontal grid cells and tested using the 1984 load following flow from the reservoir without accounting for ice cover. Available water quality data from the 1970s and 1980s has been compared with current monitoring results: water temperature, specific conductance, dissolved oxygen, and pH. Ranges and averages for each of the parameters were comparable between historic and current results and will be combined to expand available data for calibrating the models.

7. COMPLETING THE STUDY

7.1. Proposed Methodologies and Modifications

To complete this study, AEA will implement the methods in the Study Plan with no modifications. These activities include:

- The reservoir model vertical resolution will be finalized (RSP Section 5.6.4.8.2, ISR Section 5.2)
- The annual time scale predictions of temperature, ice cover and thickness will be evaluated for reasonableness by comparison with other high latitude or high altitude reservoir observations determined from literature review (RSP Section 5.6.4.8).
- The reservoir water quality model and mercury cycling model will be configured and simulation results evaluated for reasonableness of predictions (RSP 5.6.4.8, ISR Section 5.2).
- Trapping of fine, less than 125 micron, inorganic sediment in the reservoir will be evaluated (RSP Section 5.6, ISR Sections 5.2 and 5.3).
- Coordination of reservoir trap efficiency and sediment accumulation between the Water Quality Modeling Study (Study 5.6) and the Geomorphology Study (Study 6.6) will occur on the initial simulation of trapping of fine sediment being performed using EFDC model. The Study 5.6 results will be checked against the sediment trapping estimates previously developed by the Geomorphology Study. Finalized trap efficiency estimates will be used to provide the Fluvial Geomorphology Modeling Study (Study 6.6) with sediment outflow from Watana Dam to serve as the upstream sediment supply to the 1-D Bed Evolution Model in the initial simulation of the OS-1 scenario.
- The reservoir model will be used to simulate various alternative operational scenarios embedded in selected years of the 60 year hydrologic record (RSP Section 5.6.4.8, ISR Sections 5.2 and 5.3). The downstream river water quality model configuration will be completed and configured for pre- and post-Project conditions and calibrated for pre-Project conditions using observational data (RSP Section 5.6.4.8, ISR Sections 5.2 and 5.3).
- The configuration and calibration will be updated as additional bathymetric and water quality data become available (RSP Section 5.6.4.8, ISR Sections 5.2 and 5.3).
- A selected present monitoring period in 2013 or 2014 will be used for validation of the pre-Project configuration of the model (RSP Section 5.6.4.8, ISR Sections 5.2 and 5.3).
- The spatial resolution and embedded high local resolution grids of the Focus Areas will be finalized and additional calibration conducted in the Focus Areas (RSP Section 5.6.4.8.1, ISR Section 5.4).
- After these activities are complete, the reservoir and river models will be used to evaluate water quality impacts under various alternative operational scenarios (RSP Section 5.6.4.8, ISR Section 6).
- The pre-Project river model will be simultaneously used to simulate corresponding natural hydrologic conditions necessary for evaluation of the impact of the reservoir on the downstream river (RSP Section 5.6.4.8, ISR Section 6).

7.1.1. Decision Points from Study Plan

7.1.1.1. Lower River Modeling

A decision that will occur in 2014 involves whether to extend the water quality modeling downstream of PRM 29.9. The primary reason to consider extending the water quality modeling below PRM 29.9 is to assist in describing the relationship between river flows, water surface elevation, and Cook Inlet Beluga Whale (CIBW) foraging habitat in the Susitna River, consistent with Objective 3 of CIBW Modified Revised Study Plan (MRSP Section 9.17.1) (see ISR 9.17, Appendix E). This decision will be made in coordination with the Fluvial Geomorphology Modeling (FGM) Study (Study 6.6), which has a coincident decision point as described in ISR Study 6.6, Section 7.1.1.1.2. The CIBW MRSP 9.17 will rely upon these decision points as described in MRSP Section 9.17.4.3.

The FGM Study will determine the need to extend the 1-D Bed Evolution Model downstream of PRM 29.9 by comparing pre-Project conditions with the maximum load-following scenario in the modeled area upstream of PRM 29.9. These results will be used estimate the potential for changes to channel geomorphology and hydraulics downstream of PRM 29.9 and in particular the lower portions of the Geomorphic Reach LR-6 (PRM 3.3-23.5), which is the area of most interest in terms of CIBW habitat. The FGM Study comparison will use the results of the 50-year simulations.

This study will use a similar approach to determine the need for extending the EFDC model downstream of PRM 29.9. AEA will compare water quality parameters for pre-Project conditions with water quality parameters for post Project conditions including the maximum load-following scenario in the areas modeled upstream of PRM 29.9. If there is little difference between the water quality parameters between the two simulations, then potential Project effects on CIBW habitat will be considered negligible and the model will not be extended. The water quality comparisons will be performed using representative years (wet, average, and dry years) rather than a 50-year simulation. The results of the simulations will be provided to the CIBW Study (Study 9.17) as well as information on the natural variability of these parameters. Comparisons of the pre-Project, post-Project, and natural variability will be used to make this decision. The water quality parameters will include water temperature, turbidity, and dissolved oxygen during the period of interest for CIBW habitat.

The results of the pre- and post-Project EFDC model runs, evaluation of the decision criteria, and a decision whether to extend the water quality modeling below PRM 29.9 will be presented in a technical memorandum in 2014. Prior to finalizing this technical memorandum, AEA will seek the input of the Fisheries Technical Workgroup.

If the water quality modeling is extended below PRM 29.9 as a result of this decision, additional cross sections will be surveyed for model development and water quality and stage monitoring sites will be established for model input and calibration. The model will be run with a tidal boundary condition at the downstream model boundary rather than a stage-discharge rating curve currently used at PRM 29.9. The model will simulate tidal-influenced water surfaces and currents, the mixing of tidal and river flows, and water quality constituents throughout the estuary area of the model domain. Results from the model would be provided to the CIBW

Study (MRSP Section 9.17) to evaluate potential Project effects on CIBW habitat, including an evaluation of lower trophic levels that sustain the food base for CIBW on the migratory route in the Lower River.

7.1.2. Modifications to Study Plan

No modifications to the Study Plan are needed to complete the study and meet Study Plan objectives.

7.2. Schedule

In general, the schedule for completing the FERC-approved Study Plan is dependent upon several factors, including Project funding levels authorized by the Alaska State Legislature, availability of required data inputs from one individual study to another, unexpected weather delays, the short duration of the summer field season in Alaska, and other events outside the reasonable control of AEA. For these reasons, the Study Plan implementation schedule is subject to change, although at this time AEA expects to complete the FERC-approved Study Plan through the filing of the Updated Study Report by February 1, 2016, in accordance with the ILP schedule issued by FERC on January 28, 2014.

The water quality modeling study is on schedule based on the Revised Study Plan 5.6. Model configuration and calibration was originally anticipated to be complete by the end of 2013 and has been achieved. Hydrodynamic and temperature calibration was completed during the first quarter while water quality calibration will be completed in 2014 (Table 7.2-1).

Activities in 2014 and 2015 will result in further model calibration and help to fine tune the model. Sampling effort in support of the water quality model for 2014 is described in ISR 5.5, Section 7.2 and includes: water temperature data collection, meteorological data collection, water collection at both baseline monitoring sites and Focus Area sites, and the remaining sediment and porewater sites. These data are necessary for refining calibration of the models and partitioned for use as independent data sets for verification of calibration. Additional water quality parameters will be used to calibrate both the reservoir and riverine models as laboratory results confirm finalized data sets through the quality assurance review process. The water quality models will also generate results for select parameters in support of the fisheries resource studies as described by study objectives in the RSP (Section 8.5.1.2). The remaining elements described above in Section 7.1 will continue in 2014 and 2015 to meet scheduled completion of modeling activities.

7.3. Conclusion

AEA has made extensive progress implementing the water quality modeling study, which provides the ground work for completing the development of the reservoir and riverine models. AEA will complete calibration and validation in 2014. Temperature data and level logger data generated for side channels, sloughs, and groundwater by the Fish and Aquatics Instream Flow Study (Study 8.5) were used as additional information to refine calibration of the Focus Area model. Based upon the work completed, and the anticipated work during 2014 and 2015, AEA expects to achieve the objectives (Section 2) for the Water Quality Monitoring Study.