ORIGINAL
State Water Resources Control Board
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Agency Secretary
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Governor

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FEDERAL ENERGY REGULATORY COMMISSION

AUG 15 2005

Magalie R. Salas, Secretary
Federal Energy Regulatory Commission
888 First Street, N. E.
Washington, DC 20426

Dear Ms. Salas:

CONCERNS WITH WATER QUALITY MODEL, KLAMATH HYDROELECTRIC PROJECT, FERC #2082

PacifiCorp contracted with Water Course Engineering to develop a water quality model to evaluate the impacts of the Klamath Hydroelectric Project (Project) on water temperature and water quality. During model development PacifiCorp agreed to develop a number of with-out-project (WOP) model runs that would provide insight on the Project's contribution to water quality standards violations. The WOP runs for all water quality parameters have not been submitted as promised. At a meeting on November 23, 2004, Mike Deas with Watercourse Engineering stated that the model runs would be completed by December of 2004, and the documentation would be completed by January 2005. In Additional Information Request (AIR) WQ-3, the Federal Energy Regulatory Commission (FERC) asked for input and output files for all of the modeling runs. This information was submitted in April 2005, on a set of 26 CDs. The files on the CDs were disorganized and difficult or impossible to use. While the FERC asked for input and output files, model code may be needed in addition to the files in order to duplicate runs. Additional information will be required to determine whether the model is "appropriate' and if it can accurately predict different scenarios.

The Bureau of Land Management and the Karuk Tribe hired Scott Wells with Portland State University, to perform a review of the model. Dr. Well's identified significant issues with the model (report dated May 3, 2004). At the request of stakeholders, PacifiCorp hired Dr. Wells to work with Watercourse Engineering to implement the model review comments. In their response to AIR GN-2, PacifiCorp stated, "PacifiCorp's responses have been reviewed by Dr. Wells and his feedback has been included. As modeling is still being completed, the interaction with Dr. Wells will continue. Therefore, the material in Appendix A is considered as draft documentation". It is not clear when a final model calibration report, incorporating peer review comments by Dr. Wells, will be submitted.

The response to GN-2 provided some validation information on certain water quality parameters. The ability of the model to predict some parameters is poor. PacifiCorp stated in the report that "Discussion of model performance and results will be forthcoming in the final model documentation". It is unknown to us when PacifiCorp will submit the final model documentation.

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The U.S. Environmental Protection Agency, Oregon Department of Environmental Quality, and the California North Coast Regional Water Quality Control Board are currently developing a Total Maximum Daily Load (TMDL) for the Klamath River. PacifiCorp agreed to submit an executable version of the model to Tetra Tech (contractor) for use in development of the TMDL for the Klamath River. An executable version of the model was submitted, but without the WOP runs included. Tetra Tech has reviewed the model and has identified changes that need to be made so the model meets TMDL development requirements (enclosed). State Water Resources Control Board (State Water Board) staff are concerned that the current model performance is not adequate for use in evaluating Project alternatives. State Water Board staff encourage the FERC to require submission of a model by PacifiCorp that is calibrated, validated, and peer reviewed by Dr. Wells.

The State Water Board will need a water quality model for the environmental review and water quality certification processes. If State Water Board staff determine the model submitted by PacifiCorp is not adequate, it will either be modified, or a new model will be developed. State Water Board staff would be pleased to work with FERC staff and other stakeholders to resolve problems with the model. Please contact me at (916) 341-5341 if you have any questions.

Sincerely,

Russ J. Kanz
Staff Environmental Scientist

Enclosure

cc: Klamath Service List

Mark Filippini
U.S. EPA Region 10
1200 Sixth Avenue
Seattle, WA 98101

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TETRA TECH, INC.

July 13, 2005

Mr. Mark Filippini
U.S. EPA, Region 10
1200 Sixth Avenue
Seattle, WA 98101

Re: Tetra Tech Klamath River Model Development

Dear Mr. Filippini:

Tetra Tech reviewed the Revised Klamath River Water Quality Model provided by PacifiCorp through Dr. Mike Deas from Watercourse Engineering on April 8, 2005. Since that date, we have been developing our own version of the Klamath River Model to meet TMDL development requirements. In doing so, we have begun making modifications to the Revised Klamath River Water Quality Model. The purpose of this letter is to identify the changes that we have begun and will continue to make.

If you have any questions, please contact me at 703-385-6000 x155.

Sincerely,

/s/
Andrew Parker
Director, Water Resources Modeling and Assessment Group
Tetra Tech, Inc.
Fairfax, VA

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1. *CBOD/Organic Matter Unification*

It is our opinion that BOD should not be modeled in addition to organic matter. As such, we have eliminated the BOD compartment in the modeling system for both the riverine and impoundment sections.

Additionally, in the current CE-QUAL-W2 models for the impoundments, particulate organic matter is not included in the tributary and distributed boundary condition files. This may result in an underestimation of particulate organic matter into the system. Therefore, for the major tributaries that are highly productive, such as the Lost River Diversion Channel, particulate organic matter loading was represented based on data and appropriate assumptions. Concentration boundary condition files were thus modified.

2. Upper Lake Ewauna/Keno Reservoir Model Fine-tuning

Designation of the two dominant boundary conditions into Upper Lake Ewauna/Keno Reservoir (Link River and Lost River Diversion Channel) was limiting the predictability of the model (particularly with respect to the nutrient budget, phytoplankton fate and transport, and organic matter). This was largely due to data limitations. Therefore, we applied artificial neural networks (ANN) to help improve the boundary conditions and resulting lake model prediction. This proposed approach involved training a NN model to represent the source-response relationship between the water quality at Miller Island and the concentration at Link River and LRDC boundary, and then using the Miller Island data to inversely derive the boundary condition at Link River and LRDC.

Application of NN to improve the calibration in Lake Ewauna involved an iterative process. First, the existing Lake Ewauna model was run with different sets of boundary conditions at Link River and LRDC. The simulated water quality at Miller Island and the flows and water quality at Link River and LRDC were then used to develop a series of NN models. The NN network structure for this study was a three-layer feed-forward structure with one input layer, one hidden layer, and one output layer. Three nodes were included in the input layer, each representing the simulated water quality at Miller Island, the flow at Link River, and the flow at LRDC. Two nodes were included in the output layer, each representing the boundary condition concentration at Link River and LRDC. The NN were trained using the data obtained from the Lake Ewauna hydrodynamic and water quality model. After the model was trained, the observed water quality data at Miller Island were plugged into the NN models to obtain an estimation of the boundary condition at Link River and LRDC. The above process was repeated for several iterations. For each iteration, if the simulated water quality at Miller Island was not satisfactory, the new training data obtained from the previous iterations, as well as additional training data obtained through applying a jittering method were used to train the new generation of NN model.

The performance of the Lake Ewauna model in reproducing the observed water quality at Miller Island has been improved significantly. It should be noted that this approach only

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works for improving the model performance for the upper section of the Lake since the impact from the major boundary conditions were not significantly dampened.

3. Lower Lake Ewauna Algae Calibration Improvement

Phytoplankton biomass in Lake Ewauna shows significant variability from upstream to downstream, i.e., from Miller Island (upstream) to Hwy66. Observed levels reduce dramatically. This trend, however, is not mimicked by the model. The simulated algae biomass (based on the model provided) is similar at both locations. This model behavior can be explained by the large upstream inflow that causes water to flow quickly from upstream to downstream. The algae biomass is transported with this quick moving water from upstream to downstream in a relatively short time, causing similar concentrations.

It appears that with the existing kinetic structure in the model, it is impossible to reproduce this type of spatial distribution of algae biomass. Dr. Deas noticed that sometimes during the summer period the entire Lake Ewauna water column becomes hypoxic, and even anoxic. He communicated this observation to many lake and algae researchers around the world, and the information he collected led him to believe that the summer hypoxia/anoxia was related to the spatial variability in algae biomass in Lake Ewauna. Available data showed no other explanation for the observed phenomenon.

Algae need oxygen to respire. Thus, when oxygen levels become low or depleted, algae metabolism is expected to be impacted. Growth is likely to be slowed down and death/excretion is likely to increase. Based on discussions with Dr. Deas, Tetra Tech has begun implementing a code modification to the existing CE-QUAL-W2 model to account for the dependence of algae metabolism on dissolved oxygen concentrations, as well as the length of time algae are exposed to hypoxic/anoxic conditions.

4. Half-saturation for Algae Growth

Currently, algae concentrations are relatively low in the RMA11 models (i.e., low growth rates). Tetra Tech plans to increase the half-saturation value for light inhibition of algae growth to decrease algae concentrations.

5. Quantify Reaeration in the Copco Dam to Iron Gate Reservoir Headwaters Reach

In the current model for the Iron Gate segment, predicted DO profiles do not correlate well with observations. Anoxic conditions occur in the metalimnion although DO is higher in the hypolimnion. Tetra Tech identified that this could be caused by neglecting dam reaeration from Copco Dam in the current model. Further analysis of the dam reaeration at Copco Dam, as well as its implications on the DO profile in Iron Gate reservoir, will be conducted in an attempt to improve model performance.

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