BUREAU OF RECLAMATION

CVP Water Temperature Modeling Platform, Modeling Technical Committee – Meeting #2

Thursday, October 7, 2021; 1pm - 4pm

Meeting Objectives

Establish common understanding of project status and upcoming topics of Modeling Technical Committee (MTC). Review and provide comments on model selection and modeling framework selection and recommendations for implementation.

Agenda

See *20211007 WTMP_MTC02_Agenda_Accessibility.pdf*

Attendees

See *20211007 WTMP_MTC02_Attendees_Accessibility.pdf*

Handout

See *20211007 WTMP_MTC02_Handout_Accessibility.pdf*

Worksheets

See *20211007 WTMP_MTC02_Worksheets_Accessibility.pdf*

Technical Memoranda Distributed Prior to the MTC02 Meeting for Review

Two Technical Memoranda (TMs) were distributed to MTC members for review with specific questions through email on 9/17, along with MTC02 meeting notification. The comments were due on 10/8, three weeks after the distribution.

- DRAFT *TM: Water Temperature Modeling Platform: Model Framework Selection and Design* (version: 20210916 v2)
- DRAFT *TM: Water Temperature Modeling Platform: Model Selection* (version: 20210916 v2)

Four questions for the MTC members to address when reviewing the draft TM on modeling framework selection:

- Are the identified needs of a modeling framework appropriate for achieving the WTMP goal and anticipated outcome?
- Are the identified selection criteria for a modeling framework appropriate to address the needs of WTMP?
- Did we miss any important options in the broad scan of available modeling frameworks for consideration?
- Is the evaluation of the identified modeling framework reasonable based on the identified selection criteria?

Four questions for the MTC members to address when reviewing the draft TM on model selection:

- Are the identified needs of models for different applications (system, reservoir, and river) appropriate for WTMP applications?
- Are the identified selection criteria for models for different applications (system, reservoir, and river) appropriate to address the needs of WTMP?
- Did we miss any important options in the broad scan of available models for consideration?
- Is the evaluation of identified models for different applications (system, reservoir, and river) reasonable based on the identified selection criteria?

Summary

This second meeting was to keep MTC participants updated and informed of progress of the WTMP and request input from MTC members on the modeling framework selection and model selection for WTMP implementation. To facilitate the discussion, Reclamation distributed two draft TMs on September 17, 2020, that document the process and recommendation for modeling framework selection and model selection and requested MTC participants to provide input and comments on the questions outlined above. The second meeting featured a welcoming remark from Reclamation and included introductory sessions to clarify the purpose and expectation; technical sessions on model selection and modeling framework selection for WTMP implementation; introduced topics on linkage and consistency between system models and detailed models and non-basin dependent model preparation; and next steps. The project team presented each topic with a prepared presentation and conducted discussion based on previously distributed questions for the MTC members one at a time, with ample opportunities for follow-up questions and exchanges. This 3-hour online meeting was attended by about 80 participants. The presentation provided detail of the topics for discussion. The next MTC meeting is scheduled on 6 January 2022 from 1 pm to 4 pm to continue discussing the modeling framework selection; modeling framework implementation; water temperature model selection; consistency between system model and detailed models;

common model preparation and considerations; and initial discussion for Sacramento-Trinity River Water Temperature Model.

Meeting Logistics and Welcome Remark

Mr. Yung-Hsin Sun (Stantec) went through the logistic and expectations of the meeting. The meeting format and protocols were consistent with the kickoff meeting held on 1 July 2021 that kicked-off to collaborate on the development of the CVP WTMP, covering the Sacramento, American, and Stanislaus River systems. Since the first MTC meeting, Reclamation distributed two draft TMs on September 17, 2021, along with questions for MTC to consider and provide input. The two draft TM document the process and recommendation for modeling framework selection and model selection. The focus of this second MTC meeting is to present highlights on the modeling framework selection and model selection as discussed in detail in the first MTC meeting and request input from MTC participants on specific questions on the processes and findings for modeling selection and modeling framework selection. Mr. Sun went through the set of questions one at a time to allow for ample opportunities for questions and exchanges. An open dialogue was also provided afterward to allow more follow-up questions and exchange. The comments on both TMs are due on October 8, 2021, to Randi Field (Reclamation) via email. Comments will be incorporated into the revised TM which will be posted on the project website on a later date. The project website includes a description of the CVP WTMP project, current news and announcements, MTC meeting materials and summary, and project products.

Next, Ms. Randi Field (Reclamation) provided welcoming remarks and gave an overview of the objective of the WTMP is to have an effective and efficient management of resources for downstream regulatory and environmental requirements within the context of an uncertain environment. Randi described that the modeling framework will accommodate two types of models: system and component models. System models represent networks of reservoir and river reaches and can be used alone or in concert with discrete component models. Component models represent discrete reservoir or river reaches with different levels of resolution and complexity. They can be used alone or in concert with a system model for addressing different questions or interests. These system and component models reside in a modeling framework, which is like a container with necessary features for communicating among models and interfacing with users. The goal of the WTMP is to provide realistic predictions of downstream water temperatures with sufficient confidence to carry out the necessary planning for seasonal, real-time, and long-term study applications while also describing situational risk and uncertainty.

Featured Discussion: Modeling Framework Selection for WTMP Application

The first technical session was presented by Mr. John DeGeorge (RMA) on the concept of a modeling framework to organize and streamline the model application and management, and the status of framework selection. The objective of a modeling framework is to enhance accuracy, efficiency, consistency, adaptability, and transparency of the WTMP. The framework should accommodate the needs of different levels of users (e.g., model developers, expert modeler, power users, model operator, and IT support) in performing their tasks assisted with programmed

functions and utilities. The modeling framework will allow Reclamation to focus more on the strategies for water temperature management but less on mechanism of model operation and maintenance.

Mr. DeGeorge provided a summary of intended functions for a modeling framework to meet Reclamation's water temperature management needs, and selection criteria based on the identified needs. The general requirements for the modeling framework are:

- Efficiently use several models, individually or in a sequence
- Support workflows for several typical modeling activities
- Utilize common boundary conditions and operational controls across models
- Create reports using common formats across models
- Manage updates of model executable programs and configuration data sets
- Allow for introduction of new modeling tools over time
- Focus on the efficiency of production modeling activities

Details are provided in the meeting handouts and the draft TMs is the modeling selection criteria.

The modeling framework evaluation criteria are:

- Model compatibility
- Model coupling
- Workflow
- Model configurations and data management
- User interface
- Data storage service location
- Computation service location
- Modeling software interface service location

The project team then performed the evaluation based on selection criteria for identified framework options through a broad scan of existing platforms. The eight modeling frameworks that were evaluated are:

- Object Modeling System/Cloud Services Integration Platform (OMS3/CSIP), Colorado State University
- Earth System Modeling Framework (ESMF), NASA, NOAA, NCAR, DoD
- HydroCouple, University of Utah
- Community Surface Dynamics Modeling Systems (CSDMS), University of Colorado
- Delft FEWS, Deltares
- Delta Shell, Deltares

- HEC-Watershed Analysis Tool (HEC-WAT), USACE Hydrologic Engineering Center
- HEC-Real-Time Simulation (HEC-RTS), USACE Hydrologic Engineering Center

The HEC-WAT was recommended for implementation because the platform is maintained and supported by USACE, free for use, compatible for local and cloud-based implementation, compatible with the selected models for system, reservoir and river applications, and build-in capabilities in customized interface and functions for required data management and tasks.

A proof of concept showed that HEC-WAT can link and execute both system and detailed models successfully. The initial development of a use case workflow plug-in for HEC-WAT was successful and initial implementation of common reporting was successful.

Questions and Answers:

- A participant requested clarification about if they wanted forecasted water temperature for a particular watershed every three months who on the modeling framework team would be able to produce the information

  The project team responded that a model end-user can work with a model operator (a person who carries out modeling studies) to generate this information.

- A participant requested clarification about the meaning of 'importance' in the criteria table for the modeling framework.

  The project team responded that importance reflects the level of needs for providing certain function in the modeling framework.

- A participant requested clarification if you can select an individual model within the modeling framework for analysis or if all models within the modeling framework have to be run together to generate results?

  The project team responded within the models within the modeling framework can be run individually or in series depending on the required analysis.

Featured Discussion: Model Selection for WTMP Application

After the modeling framework selection discussion, Mr. Mike Deas (Watercourse) described the purpose of developing model selection criteria was to screen for potential models for implementation into the modeling framework. Criteria were assessed based on a high/medium/low priority and were also identified as required/preferred. The selection criteria are important and necessary to ensure models fit the project needs, are computationally efficient, and provide appropriate resolution. The criteria for model selection to meet project objectives and goals are:

- Numerical model representation

- Linkage with other models
- Input and output
- Model support and documentation
- CVP features
- Qualitative

The identified system models and components models for the WTMP are:

- System Models
    - CE-QUAL-W2
    - DYRESM
    - HEC-5Q
    - HEC-ResSim
    - Riverware
- Component Models
    - Reservoir: CE-QUAL-W2, DYESM, HEC-5Q, HEC-ResSiM, Riverware
    - River: CE-QUAL-RIV1, CE-QUAL-W2, EPD-Riv1, Heat Source, HEC-5Q, HEC-RAS, HEC-ResSim, QUAL-2K, RAFT, RBM10, RMA2/RMA4, Riverware, RMS(ADYN/RQUAL)

Models identified for inclusion in the modeling framework as discussed in further detail in the draft TM. The draft TM also includes a discussion of models that were not selected and why. Generally, models that were not selected were inconsistent with the goals of the WTMP at this current phase of development, as well as deficiencies or other reasons outlined in the TM.

The recommended model for the system model is HEC-ResSim. For the component models, HEC-ResSim and CE-QUAL-W2 were recommended for the reservoir models and HEC-ResSim was recommended for the river models. The models recommended for inclusion in the modeling framework are widely used and/or supported. The models cover the range of CVP features and can handle the complexity of the component models. The draft TM has additional information on the recommended models.

<u>Questions and Answers:</u>

- A participant requested clarification about the meeting handout material that summarizes the criteria associated with CVP features. Automated simulation for downstream river temperature compliance was given a high priority. However, sometimes a project cannot meet those target river temperatures. Can a model output show the number of river miles in compliance at different target temperatures?

The project team responded affirmatively. One can post-process model output of daily river temperature at downstream locations to determine when and where you are meeting different target temperature compliance, and when and where you are not.

- A participant requested clarification about situational risk and uncertainty surrounding temperature model.

  The project team responded that risk and uncertainty relate to operational or hydrologic conditions that can be evaluated by models to help the user in decision making. This is an important topic for Phase II of WTMP development. Phase I is the current phase of building the WTMP modeling framework and selected models for implementation. Once the models and modeling framework has been completed, questions on risk and uncertainty can be evaluated.

- A participant requested clarification about the model ability to assess the dynamics of stratification and its effects on meeting temperature compliance downstream or effecting operations of a selective withdrawal device.

  The project team responded that model's capability in simulating the operations of selective withdrawal devices and producing resulting reservoir temperature profile is an important consideration. A model can include selective withdrawal and temperature curtains that can help in assessing temperature compliance.

- A participant requested clarification if the modeling framework can access real-time data for the models and how this may affect the model selection.

  The project team responded that Phase II of the WTMP development will focus on the ability to use real-time and forecasted data in the modeling framework. The modeling framework will allow for data management of current updated data and real-time data. This is a planned feature, and it does not affect model selection. Phase II will explore how frequently the real-time data needs to be refreshed in the modeling framework. This will be a future topic of discussion in MTC meetings.

- A participant requested clarification if models in the modeling framework would need to be recalibrated based on reduction in projected precipitation and runoff as real-time information is added to the modeling framework.

  The project team responded that the chosen models were based on their use of fundamental physical principles (i.e., conservation of mass and conservation of energy) for inclusion in the modeling framework. The models should still be able to provide information using different projected precipitation and runoff data.

- A participant requested clarification if the Stanislaus River model system will be a model of three linked reservoir models or is there a riverine reach considered in the model system.

  The project team responded that the parameters for the Stanislaus River model are currently being developed and will be shared at future MTC meetings. However, the scope for Stanislaus River model will include the New Melones Reservoir and the river reach down to the confluence of the San Joaquin River. As a reminder, the scope of the Sacramento-Trinity system will include the Trinity River from the Trinity Lake to the Lewiston Lake and from Lewiston Lake to the confluence of the North Fork of the Trinity River, the Whiskeytown Lake and Clear Creek from Whiskeytown Lake to the confluence with the Sacramento River, and the Sacramento River from the Shasta Lake to Bend Bridge. The scope of the American River model will include Folsom Reservoir, Lake Natoma, and the river reach to the confluence of the Sacramento River.

Introductory Topics: Linkage and Consistency Between the System Model and Detailed Models and Non-basin Dependent Preparation

This discussion was introduced to update MTC participants on current and future activities of the WTMP. The topics also will be continued in future MTC meetings.

Mr. John DeGeorge discussed the necessary details that support the model and modeling framework development that are critical for the WTMP's success. The topic was presented today to solicit MTC participants early input and to request assistance in data acquisition, if possible. These topics will also be discussed further in the next MTC meeting.

For linkage and consistency between the system model and detailed models, the key objective is to support both rapid simulation of system operations and appropriate resolution of critical system facilities and components. This requires consistent representation of physical and operational characteristics, common time dependent boundary conditions and operational controls, and standard linkages for passing information between models.

Data management will include gathering and maintaining the time dependent information used to run models. Many systems have missing and/or incomplete data. Data management will include data acquisition and quality review of time dependent observations, deriving time series information from instantaneous observations, archiving of source data used in construction of model data sets, and archiving model data sets. The modeling framework will include managing metadata associated with model runs and have automated pre-processing to prepare model input from common boundary conditions.

The modeling framework will include necessary model linkage and standard reporting. This includes mapping standard boundary conditions or output from an upstream model to the required inputs of a downstream model and automated post-processing to convert model specific output formats to common formats for use in report generation or to export model results. Key modeling results will be archived in the data management system.

The model data development considered spatial and temporal considerations in addition to the types of data used and current data development activities. The spatial domain includes defining the extent of the proposed modeling for the Sacramento-Trinity, American, and Stanislaus River systems. The spatial resolution needs to capture the dynamics of reservoirs and rivers of the system models. This resolution depends on the objective of the models and the numerical methods considered in each model. The calibration/validation period is from 2000 – 2021. This calibration process will not start until next year once provisional data have been verified. The temporal resolution needed will be sub-daily and depend on the numerical methods considered in each model.

The model data development includes the following actions:

- Defining modeling period and necessary data frequency
- Data acquisition
- Data quality analysis and quality control (QA/QC)
- Information metadata
- Documentation
- Data management

The types of data for model development include physical data to represent geometry, facilities, and other spatial information. Operational data includes flow, selective withdrawal, and other information. Time series and similar data include flow, temperature, meteorology, and initial conditions.

Physical data includes the following:

- Reservoirs
    - Stage-Area-Volume table
    - Bathymetry
    - Locations of tributaries
    - Facilities locations, descriptions, and capacities (e.g., dam schematics, diversions)
- Streams
    - Planform and gradient information (x,y,z)
    - Bathymetry and/or channel cross section
    - Location of tributaries
    - Facilities locations, descriptions, and capacities (e.g., discharges, diversions)

Operations data includes the following:

- Reservoirs
    - Rule curves
    - Selective withdrawal facilities operations
    - Temperature compliance strategies (tailbay)
- Rivers
    - Diversion schedules
    - Temperature compliance locations/strategies

Time Series data includes boundary conditions (BC), calibration/validation (C/V) for the following:

- Flow
    - Reservoir
        - Stream inflow (BC)
        - Reservoir releases and diversions (BC, C/V)
        - Reservoir stage (BC, C/V)
        - Other (precipitation, evaporation, seepage)
- Stream
    - Headwater inflow (BC)
    - Tributary inflows and other inflows (BC)
    - Diversions (BC)
    - Stream flow within model domain (BC, C/V)
- Temperature
    - Reservoir
        - Stream inflow and other inflow temperature (BC)
        - Reservoir release temperature (C/V)
        - Reservoir thermal profiles (C/V)
    - Stream
        - Headwater inflow temperature (BC)
        - Tributary inflows and other inflow temperature (BC)
        - Stream flow temperature within model domain (C/V)

- Meteorology
    - Reservoir
        - Solar radiation
        - Wind speed and direction
        - Dew point temperature, wet bulb temperature (or similar vapor pressure term)
        - Air temperature
        - Atmospheric pressure
    - Stream
        - Solar radiation
        - Wind speed
        - Dew point temperature, wet bulb temperature (or similar vapor pressure term)
        - Air temperature
        - Atmospheric pressure
- Initial Conditions
    - Reservoir
        - Initial stage
        - Initial water temperature profile
    - Stream
        - Various (stage, temperature)
        - Model "spin up"

For reservoir flow time series data, reservoir stage is used in conjunction with a stage-volume relationship used to form accretion/depletion term (time series) for reservoir. For stream time series data, stream flow within model domain uses intermediate flow locations within model domain to form accretion/depletion term (time series) for stream reaches. Stage and velocity can also be used in C/V of flow models.

Current data management activities include establishing the initial period for model development (2000 – 2021), developing data inventories, gathering available data, defining metadata, identifying data gaps, and documenting sources of data.

Mr. Deas stated that a list of currently acquired data will be distributed soon to MTC participants for review, comment, and potential contribution of additional data supporting the model development.

Questions and Answers:

None

Wrap Up and Next Steps

The meeting was concluded with the following next steps.

- Next MTC Meeting: Thursday, 6 January 2021; 1pm – 4pm
    - A separate email will be sent out with meeting registration information.
    - Scheduled topics:
        - Continued discussion on modeling framework selection and model selection
        - Consistency between system model and detailed models, common model preparation and considerations
        - Initial discussion for Sacramento-Trinity River Water Temperature Model
        - More on modeling framework implementation