BUREAU OF RECLAMATION

CVP Water Temperature Modeling Platform, Modeling Technical Committee – Meeting #3

Thursday, January 6, 2022; 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 *20220106 WTMP_MTC03_Agenda_Accessibility.pdf*

Attendees

See *20220106 WTMP_MTC03_Attendees_Accessibility.pdf*

Data Needs Transmittal and Draft Habitat/Data Information Distributed Prior to the MTC03 Meeting for Review

- Two items were distributed to MTC members for review with specific questions through email on 12/20/2021, along with MTC03 meeting notification. These two items were discussed in the MTC meeting. The comments were due on 1/7/2022, immediately after the MTC03 meeting.
    - DRAFT Data Needs Transmittal (version: 20211216)
    - DRAFT Habitat Data Information (version: 20211216)

Summary

The MTC met to establish a common understanding of project status and upcoming topics ; provide opportunities for input on interim products and collaboration; and provide opportunities for input on engagement and process. To facilitate the discussion, Reclamation distributed two items on 12/20/21. The first item was a data request to assist in understanding certain physical processes and confirming certain assumptions used in the modeling. The second item was a request for feedback on accuracy, characterization, and applicability to the modeling outlined above. The third MTC

meeting was conducted in a consistent format as the previous MTC meetings. The main topics included the introduction of development of the Sacramento/Trinity River Water Temperature Model, and follow-up discussions on linkage and consistency between the system model and detailed models and common model preparation and considerations and closure discussion on modeling framework and model selection TMs. Opportunities were afforded for follow-up questions and exchange of ideas. For transparency, the schedule delay in posting the final draft TMs was shared with the MTC while emphasizing the ongoing effort in working with Reclamation's Web team for implementation. The data request was briefly discussed with stakeholder input. The habitat data review was deferred to a subgroup meeting with interested parties. An open discussion about ways to improve MTC engagement and functions for collaborative WTMP development was conducted and the MTC members were positive about the use of subgroup functions. This 3-hour online meeting was attended by about 70 participants. The next MTC meeting is scheduled on 4/7/22 from 1 pm to 4 pm.

Meeting Logistics and Welcome Remark

Mr. Yung-Hsin Sun (Stantec) went through the logistics and expectations of the meeting. Since the second MTC meeting, Reclamation has finalized the modeling framework selection and model selection TMs. The main focus of this third MTC meeting is to start introducing the details of river system model development starting with the Sacramento/Trinity system and to solicit feedback from MTC participants on basin-specific or topic-specific items related to understanding certain physical processes and confirming certain assumptions used in the modeling and critical habitat information. The comments are due on 1/7/22, to Ms. Randi Field (Reclamation) via email. Comments will be incorporated and 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 recapped for the group the objective of the WTMP to have an effective and efficient management of cold-water resources for downstream regulatory and environmental requirements within the context of an uncertain environment. The first two MTC meetings set the stage and covered the basics of WTMP project. This third MTC meeting is starting to focus on the details of the river system model development starting with the Sacramento/Trinity system. With the project progressed, there was an anticipated need for basin-specific or topic-specific subgroup discussions if MTC members are interested in more in-depth collaboration and discussion. Ms. Field described the vision for the WTMP project to modernize systemwide water temperature modeling and analytics; develop professional standards and foster transparency; consistent use for real-time, seasonal, and long-term planning; and accommodate continued technological advancement.

Featured Discussion: Sacramento/Trinity Water Temperature Models

The first technical session was presented by Mr. Mike Deas (Watercourse) on the concept of the Sacramento/Trinity Water Temperature models. Modeling is a major topic of the MTC03 meeting and likely for the next three MTC meetings to conclude. The MTC03 meeting will focus on introducing the system and model development approach and to receive early input on model development approach and underlying data. The details covered in the MTC03 meeting include system overview, temperature control tools, WTMP model representations, and WTMP model data requirements. Request MTC participants input on the following:

- Did we miss any important features?
- Did we overlook any critical model data?

Mr. Deas provided a summary of the WTMP model representation for the Shasta/Trinity system include reservoir and river attributes and models. The reservoir attributes are:

- Vertical temperature gradient
- Longitudinal gradient (e.g., afterbays, rivers)
- Cold water pool representation through time
- Reservoir operations/release temperatures
- Management actions

The reservoir models include:

- HEC-ResSim (1-D vertical)
- CE-QUAL-W2 (2-D vertical and longitudinal)

The key river attributes include:

- longitudinal temperature gradient
- inflow (e.g., tributaries) and outflows (e.g., diversions)
- in-river reporting locations
- management actions

The river model is:

- HEC-ResSim (1-D longitudinal)

Mr. Deas described the major strategies for developing the Sacramento/Trinity system model. For the Sacramento River system extended the Shasta-Keswick water temperature CE-QUAL-W2 model completed in 2021 included the following:

- Extended simulation period includes 2020 and 2021.
- Extended model includes
    - HEC-ResSim for Shasta Lake and Keswick Reservoir

    - HEC-ResSim for Sacramento River.

The major modeling updates to the Trinity River and Clear Creek Systems include:

- Apply HEC-ResSim and CE-QUAL-W2
    - Trinity Lake, Lewiston Lake
    - Whiskeytown Lake
- Apply HEC-ResSim
    - Trinity River
    - Clear Creek

HEC-ResSim will be applied as a system model and model development data period is from 2000 to 2021.

Mr. Deas gave an overview of the Sacramento/Trinity System including the Sacramento River Basin and Trinity River Basin.

The Sacramento River Basin includes:

- Shasta Lake
- Keswick Reservoir
- Whiskeytown Lake
- Spring Creek Tunnel
- Clear Creek
- Sacramento River

The Trinity River Basin includes:

- Trinity Lake
- Lewiston Lake
- Clear Creek Tunnel
- Trinity River

Mr. Deas provided a summary of the intended active and passive temperature management tools for the Sacramento/Trinity system. Active temperature management tool includes Shasta Dam Temperature Control Device (TCD) facilitated for selective withdrawal. The Shasta Dam TCD includes a selective withdrawal with key features for the gate size, hydraulic constraints, side gate, and leakage. Passive temperature management tools include the temperature control curtains for Lewiston Lake and Whiskeytown Lake.

Mr. Deas reviewed the WTMP modeling data requirements for reservoir and river model data and information for geometry, hydrology, temperature, and meteorology.

The geometry data for the Sacramento River includes:

- Shasta Lake
    - Bathymetry/Stage-Area-Volume (S-A-V)
    - TCD
    - Dam infrastructure (outlets, spillway)
- Keswick Reservoir
    - Bathymetry/S-A-V
    - Spring Creek Powerhouse
    - Dam infrastructure (outlets, spillway)
- Sacramento River
    - Bathymetry (x-y-z yields planform, gradient, and cross section). Bathymetry data is incomplete from approximately Clear Creek to Bend Bridge
    - Diversions/return flows (including ACID diversion dam operation)
    - Tributary confluences
- Whiskeytown Lake
    - Bathymetry/S-A-V
    - Dam infrastructure (outlets, spillway)
    - Spring Creek tunnel facilities
    - Carr Powerhouse
    - Temperature control curtains
- Clear Creek
    - Bathymetry
    - Planform and gradient
    - Cross section

The geometry data for Trinity River includes:

- Trinity Lake
    - Bathymetry/S-A-V
    - Dam infrastructure (outlets, spillway)
- Lewiston Lake
    - Bathymetry/S-A-V
    - Dam infrastructure (including fish hatchery)
    - Clear Creek Tunnel intake
- Trinity River
    - Bathymetry (x-y-z yields planform, gradient, and cross section)
    - Diversions/return flows
    - Tributary confluences

The hydrology data for Sacramento River includes:

- Shasta Lake

    - Inflow
        - Sacramento, McCloud, and Pit rivers
        - Squaw Creek
        - Accretion/depletion
    - Outflow
        - Shasta Dam (spill, river outlets, TCD)
    - Stage
- Keswick Reservoir
    - Inflow
        - Shasta Dam release
        - Spring Creek Powerhouse
        - Spring Creek debris dam
        - Accretion/depletion
    - Outflow
    - Keswick Dam (spill, river gates)
    - Stage
- Sacramento River
    - Inflow
        - Return flows
        - Tributary inflows
        - Accretion/depletion
    - Outflow
        - Division
    - Flow/stage (initial conditions, boundary condition, and/or calibration data)

The hydrology data for Clear Creek includes:

- Whiskeytown Lake
    - Inflow
        - Clear Creek
        - Carr Powerhouse
        - Accretion/depletion
    - Outflow
        - Whiskeytown Dam (spill, river outlets)
        - Spring Creek Tunnel
    - Stage (initial conditions, boundary condition, and/or calibration data)
- Clear Creek
    - Inflow
        - Release from Whiskeytown Dam
        - Accretion/depletion (Whiskeytown Dam to IGO station)

    - Outflow
    - Stage (initial conditions, boundary condition, and/or calibration data)

The hydrology data for Trinity River includes:

- Trinity Lake
    - Inflow
        - Trinity River, East Fork Trinity River, Stuart Fork
        - Accretion/depletion
    - Outflow
        - Trinity Dam (spill, river outlets)
    - Stage
- Lewiston Lake
    - Inflow
        - Trinity Dam release
        - Accretion/depletion
    - Outflow
        - Shasta Dam (spill, river gates, hatchery, Clear Creek Tunnel)
    - Stage
- Trinity River
    - Inflow
        - Return flows
        - Tributary inflows
        - Accretion/depletion
    - Outflow
        - Division
    - Flow/Stage (initial conditions, boundary condition, and/or calibration data)

The temperature data for Sacramento River includes:

- Shasta Lake
    - Inflow Temperature
        - Sacramento, McCloud, and Pit rivers
        - Squaw Creek
        - Accretion/depletion
    - Outflow Temperature (initial condition and/or calibration data)
        - Shasta Dam (tailbay)
    - Vertical Temperature Profiles (initial condition and/or calibration data)
- Keswick Reservoir
    - Inflow Temperature
        - Shasta Dam release

        - Spring Creek Powerhouse
        - Spring Creek debris dam
        - Accretion/depletion
    - Outflow Temperature (initial condition and/or calibration data)
        - Keswick Dam (tailbay)
    - Vertical Temperature Profiles (initial condition and/or calibration data)
- Sacramento River
    - Inflow Temperature
        - Return flows
        - Tributary inflows
        - Accretion/depletion
    - Stream Temperature (initial condition and/or calibration data)

The temperature data for Clear Creek includes:

- Whiskeytown Lake
    - Inflow
        - Clear Creek
        - Carr Powerhouse
        - Accretion/depletion
    - Outflow (initial condition and/or calibration data)
        - Whiskeytown Dam (spill, river outlets)
        - Spring Creek Tunnel
    - Vertical Temperature Profiles (initial condition and/or calibration data)
- Clear Creek
    - Inflow
        - Release from Whiskeytown Dam
        - Accretion/depletion (Whiskeytown Dam to IGO)
        - Stream Temperature (initial condition and/or calibration data)

The temperature data for Trinity River includes:

- Trinity lake
    - Inflow
        - Trinity River, East Fork Trinity River, Stuart Fork
        - Accretion/depletion
    - Outflow (initial condition and/or calibration data)
        - Trinity Dam (spill, river outlets)
    - Vertical Temperature Profiles (initial condition and/or calibration data)
- Lewiston Lake
    - Inflow

        - Trinity Dam release
        - Accretion/depletion
    - Outflow (initial condition and/or calibration data)
        - Shasta Dam (spill, river gates, hatchery, Clear Creek Tunnel)
    - Vertical Temperature Profiles (initial condition and/or calibration data)
- Trinity River
    - Inflow
        - Return flows
        - Tributary inflows
        - Accretion/depletion
    - Stream Temperature (initial condition and/or calibration data)

The meteorology includes:

- Sacramento River System
    - Redding Airport
- Clear Creek System
    - Redding Airport
- Trinity River System
    - Trinity Lake and Lewiston Lake: Trinity Camp (A)
    - Trinity River: Trinity Camp (B)

Questions and Answers:

- How are the gates operated for the Shasta TCD?

  The project team responded that the gates are used in succession from top to bottom and. 35 feet of freeboard above the gate invert are necessary for upper and middle gates to be used alone (hydraulic constraint). If the 35-foot freeboard requirement is not met, at least one gate opening at a lower gate level must be opened. Operations are primarily driven by water elevation, head (freeboard), and timing with desired temperature profile. The TCD can use individual gate levels alone (if hydraulic constraints are met) or can blend two gate levels. does a temperature blend in conjunction with water surface elevation.

- How is leakage represented in the Shasta operations model?

  The project team responded that there are leakage zones in the models identified in earlier modeling work (the Shasta-Keswick W2 model from the previous Sacramento River Settlement Contractors efforts, and Reclamation's HEC-5Q models) and the current WTMP will do so as well. The representation would depend on model specifications. For example, the W2 model and HEC-ResSim may represent leakage differently due to the 2-D (vertical

depth and horizontal reservoir storage layers) and 1-D (vertical depth) representations, respectively.

- Is there sufficient knowledge about how the Shasta TCD gate features and leakage are represented in the model?

  The project team responded that the final model documentation for the Shasta-Keswick operations model includes a detailed description on the linkage between these two features and how that approach was implemented. This document can be distributed to MTC members to help in understanding the modeling approach to include these incompletely characterized flow and temperature conditions of the TCD. If there is interest, we can set up an additional meeting to review the document, TCD representation and operation, and previously completed work.

- Does the temperature blend in the Shasta TCD depend, for example, on the ratio of the upper and middle gates?

  The project team responded that the temperature blend depends, for example, on the ratio of flow into the upper and middle gates. The powerhouse operations also effect the temperature blend (and dam release temperatures). The WTMP team is working on developing a tool and considering the limitations of the tool and model for decision makes.

- Can Shasta operate with a pump-back facility?

  The project team responded that there are no current facilities to support pump-back operations.

- In addition to the upstream inflow, is side flow from a sudden storm event considered in the model?

  The project team responded that the model is not considering side flow at this time. Side flows are not going to create significant impact on temperature or cold-water pool volumes in the reservoir.

<u>Additional Comments and Information Sharing by MTC Members:</u>

- There is available LiDAR data, cross-sectional data, and gaged data for portions of Clear Creek. The project team will follow up on the bathymetry and gaged data.
- The USFWS Lower Clear Creek temperatures are in a new database . The project team will reach out to get the updated database.

Featured Discussion: WTMP linkage and consistency between the system model and detailed models

After the Sacramento/Trinity Water Temperature Models discussion, Mr. Deas described the need for both high resolution, discrete reservoir models that can provide more detailed representations, as well as a modeling system that can accommodate system wide reservoir-river operations in a computationally efficient manner. The example of models include:

- High-Resolution Reservoir Model: CE-QUALW2
- System Model: HEC-ResSim

Model operation and data flow components are both user-driven and framework-driven. User driven model simulations require domain knowledge, plus model, computer system, and data management skills. Developed models reside and are configured to operate in a framework to support use cases (e.g., multiple simulations). The sequence of operations and data flows are automated and easily repeated. The goals of the modeling framework are:

- Linkage and consistency
    - Between a system model with many physical features (less resolution) to feature-specific models (more resolution)
    - Between feature-specific models with different resolutions
    - Between operational scenarios

Mr. Deas described the WTMP information flow, including the Reclamation databases, external data sources, WTMP Data Management System (DMS), WTMP analytics, WTMP reporting support, and external reporting platforms.

Next, Mr. Schuyler (Eyasco) outlined the topics of discussion for the Data Management System (DMS). The DMS objectives are:

- Data acquisition – consolidate time series data from different sources
- Data integrity – track changes to the data from input to the DMS to model-ready data (e.g., track and manage metadata)
- Data management – ease data review, modification, documentation and overall interaction with data

The DMS data types are:

- Time series (most of the data)
    - Flow and temperature used for boundary conditions and forecasting
    - Temperature profiles
- Physical
    - Reservoir and river geometry, reservoir intake descriptions, conveyance capacities

- Operational
    - Reservoir operating rules, TCD management protocols, minimum instream flows

The DMS data attributes are:

- Apply rules for organizing time series data
- Automate collection from online sources
- Use import processes and manual entry methods for time series that are unavailable on-line
- Collect and store metadata that tracks the data source, data quality and data revisions
- Provide visualization tools for post-processing source data (QA/QC, gap-filling, etc.)
- Provide a means for on-demand delivery of model ready time series data to the Model Framework
- Keep track the relationship between model input series and model output for rapid comparison and report preparation

The data processing includes:

- Filter to allow/not allow provisional data
- Apply scale factors and/or offsets (e.g., convert units)
- Flag data that falls outside of user specified acceptable range
- Fill gaps, identify gaps
- Normalize time steps
- Retain raw data

The data processing QA/QC is an important process that can apply linear thresholds to flag data which is outside normal operating limits to improve visualization and speed up the process of producing model ready data. Data gap filling may be completed inside or outside the DMS depending on size of gap and complexity of model required to represent the physical processes. The DMS includes tools for rapid identification and display of data gaps.

The goal of data processing is not only to produce model ready data, but also to track changes and maintain a connection to raw data by using metadata to track any changes to the data in the DMS. Model ready data includes data that can be used directly in the WTMP and comes with the associated metadata. Metadata includes:

- Station metadata (location, owner, data type, etc.)
- Sensor metadata (sensor type, units)
- Event metadata (quality, source)
- Event metadata (modifications)
    - Internal – flag bad data, unit conversion, time steps, fill small gaps
    - External – fill large gaps, model results

The WTMP analytics-DMS nexus information flow includes the DMS, metadata, and WTMP. Other output includes SQL reporting, data export (normalized, pivot), data link to RISE, and data gateway for other applications such as Microsoft PowerBI. RISE will be the interface for data sharing with external parties.

Questions asked to the MTC participants:

- Is the process for preparing model ready data reasonable and adequate?

  No comment or additional suggestions.

- What other metadata in addition to what we have could be useful to broader users once this is completed and shared?

  No comment or additional suggestions.

Questions and Answers:

- How often will data in the framework be updated or made current?

  The project team responded that currently the framework does daily updates and collects data frequently to make the process of adding data to the framework less time consuming.

Additional Comments and Information Sharing by MTC Members:

- It would be useful to model a given hydrology and meteorology on a river topography from different years. The project team acknowledged the input.

Featured Discussion: Common Model Preparation and Elements

Mr. Sun introduced the next discussion topic that focuses on the common model preparation and elements. The two topics for discussion included physical data for model development and habitat data for model application.

Next, Mr. Deas discussed the data request, data support, data inventory, and ongoing activities for the physical data acquisitions in reference to the DRAFT Data Needs Transmittal (version: 20211216) that was previously distributed to MTC members for feedbacks. These were good to have information.

Mr. Deas continued to summarize the ongoing data collection effort. The collected data covers a wide range of types, locations, frequencies, and often reflect commitment to long-term programs. The data came were a wide range of agencies and organizations. Reclamation appreciates and acknowledges the time, energy, and resources necessary to collect comprehensive, high-quality data.

The team reported that the data inventory is near completion and will be distributed to MTC members for review and comment. The purpose of the data inventory is to identify available data

for boundary conditions (as initial conditions) and calibration/validation, prioritize duplicate data sets, identify missing data, and documentation. The data inventory is organized by:

- Station number/abbreviation
- Station name
- Data type
    - Flow and stage
    - Water temperature
    - Meteorology
- Agency (e.g., USBR, USGS, DWR, USFS, etc.)
- Source (e.g., USBR, CDEC, CIMIS, etc.)
- Data frequency
    - Primary (e.g., hourly)
    - Secondary (e.g., daily)
- Priority
    - Function of (a) frequency and (b) source
- Available Period
    - 2000 – 2021, seasonal, variable frequency (e.g., temperature profiles)
- Model use
    - Boundary conditions
    - Initial conditions
    - Calibration/validations

Ongoing data activities include developing data inventories for American and Stanislaus River systems, gathering data for DMS, defining metadata for DMS, identifying data gaps and methods to address gaps, and documentation. Once completed, the data inventory will be sent to MTC members for review and comments, and more importantly, identification of additional data that are available but not collected.

Next, Ms. Field discussed the habitat data which has been collected to establish the status of understanding for biological importance of certain locations in the river system due to the habitat use by fishery species of different life stages. The habitat data can guide the modeling team to develop proper outputs to meet the seasonal and geographical interests for water temperature management.

The habitat/data information is identified by river reach:

- Species/Life-stage
- Importance
- Status of Data
    - Desired/Available

- Type
- Source

In reference to the DRAFT Habitat Data Information (version: 20211216) previously distributed to MTC members, Mr. Field stated that the original focus of the data collection was to collect reach cross-sectional/bathymetric data, but later expanded to relevant information on locations, temperature stations, and studies and temperature models. If interested, Reclamation would like to organize a subgroup meeting to focus on draft habitat data tables. The goal is to fill in any gaps, expand information as necessary, and finalize data tables. The MTC participants were polled for interest in participating in the subgroup. About 10 MTC participants expressed interest in participating in the subgroup. Mr. Sun will follow up with volunteered MTC members for scheduling and further discussion. The results would be shared with the full MTC.

Questions and Answers:

- In regard to Stanislaus River flows below Goodwin, do you have data prior to 2000 or do you just not need data prior to 2000?

  The project team responded that we are just looking for data 2000 to present.

- Is the Habitat Data subgroup going to be watershed specific?

  The project team responded that the Habitat Data subgroup will not be watershed specific although the discussion will be watershed specific.

Additional Comments and Information Sharing by MTC Members:

Bathymetric and LiDAR data are likely to be resurveyed for Trinity River restoration reach this water year.

Featured Discussion: Modeling Framework and Model Selection TMs

The final discussion topic, led by Mr. Deas, provided a summary of comments received for the modeling framework and model selection TMs and the process for finalization.

- The development team received broad comments concerning artificial intelligence, data-driven machine learning models, or Bayesian modeling framework in developing and applying models. Although some of the suggested approaches are not used for the current development, the WTMP is intended to accommodate different approaches to modeling in general (e.g., approaches for model calibration and model application). Phase II of the WTMP will assess uncertainty and could accommodate certain aspects related to these comments as well.
- Another comment received on the TMs was calibration over non-stationary periods, including potential implications of climate change. Because the model will be applied over

the next several decades this may be applicable. Calibration over non-stationary periods is a topic that can be addressed during model development and calibration.

- Comments were made on the peer review for HEC-ResSim. The team reported that HEC validation and peer review exercises typically focused on specific features of the software and included establishing the engineering computation and software requirements and verifying software by testing against known data sets. Technical documentation was published and updated periodically. HEC updated model documentation is forthcoming.
- There were also questions about the solution techniques (e.g., automated process for optimized solution or trial and error). The team expressed that Phase II topics will include the development of the approach. However, for certain river systems, it would follow the current established protocols. For example, a priori system to trade off benefits between two fish species is currently used in the American River system. Current American River modeling process involves iterations through multiple options to arrive at a solution given identified constraints. Phase II activities will also examine this topic further.

The floor was opened for MTC participants to give feedback/ask questions.

Comments from MTC participants:

- Suggestion to allow for seasonal updating process for model data.

Feedback: Improve MTC engagement and functions for collaborative WTMP development

Mr. Sun solicited input from MTC members to further improve the engagement and functions. Mr. Sun reiterated the purpose of MTC engagement for WTMP development and shared the intent to organized subgroup discussions by topic or by watershed as needed. MTC members are welcome to make suggestions. One example we just had was for habitat data development. The intent is to initiate subgroup discussion by basin or by topic and receive input to improve MTC engagement and functions. MTC members were in general agreement on the approach.

Questions and Feedback:

- It would be helpful to understand how hydropower generation operations may affect resulting water temperature. Specifically, in relation to the functions of temperature control curtains in Whiskeytown Lake and Lewiston Lake?
- Suggestion to reach out to Trinity Restoration Program staff to discuss data needs for Trinity flow and temperature data.

Wrap Up and Next Steps

The meeting was concluded with the following next steps.

- Develop interim products for review before the next MTC meeting

    - Data management plan TM
    - Data inventory
- Continue model development and framework implementation and report in the next MTC meeting
- Organize the Habitat Data subgroup to complete habitat data compilation
- Next MTC Meeting: Thursday, 4/7/22; 1pm – 4pm
    - A separate email will be sent out with meeting registration information.
    - Scheduled topics:
        - Continued discussion of DMS
        - Continued discussion for Sacramento/Trinity River Water Temperature model
        - Initial discussion for American River Water Temperature Model