



# Model Selection

Randi Field, Hydrologic Engineer

Reclamation, Central Valley Operations Office



# Model Selection Philosophy

- Methodically identify and document:
  1. Needs of water temperature models for the WTMP
  2. Selection criteria
  3. Candidate models
  4. Model evaluation and comparison
- Solicit feedback from the MTC



# Water Temperature Modeling Platform

- Objective:
  - Effective and efficient management of resources for downstream regulatory and environmental requirements within the context of an uncertain environment.
- Goal:
  - 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.



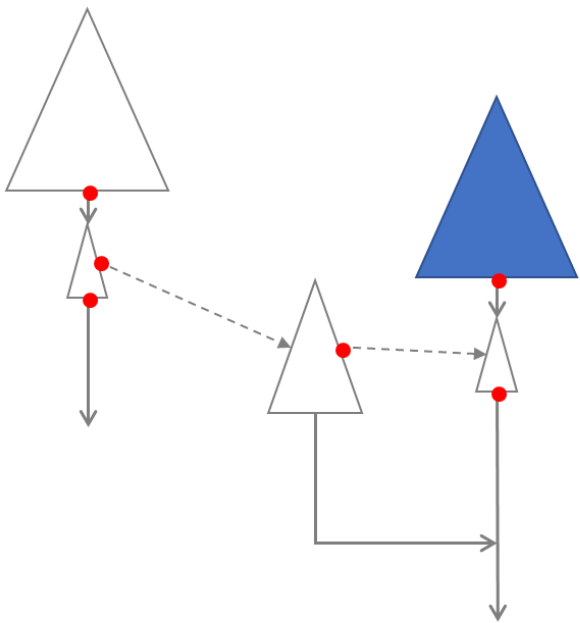
# Role of Models in WTMP

- Models represent reservoir and rivers
  - System models
    - represent networks of reservoir and river reaches
    - can be used alone or in concert with discrete component models
  - Element models
    - represent discrete reservoir or river reaches (more or less complex)
    - can be used alone or in concert with a system model
- These models reside in a modeling framework

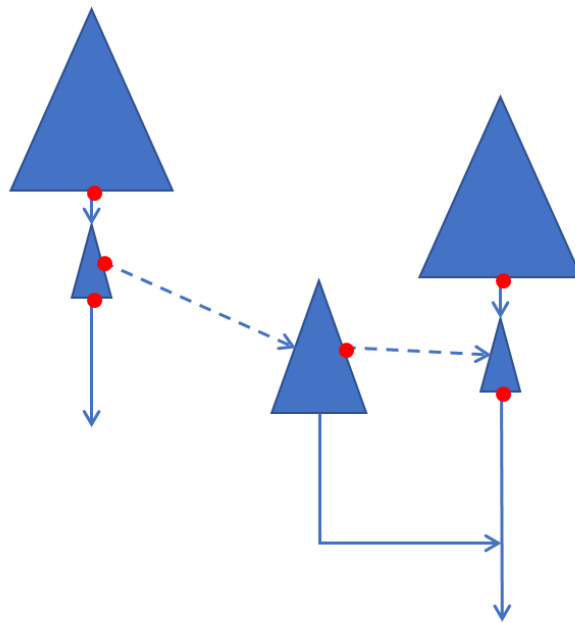


# WTMP: Modeling Framework and Models

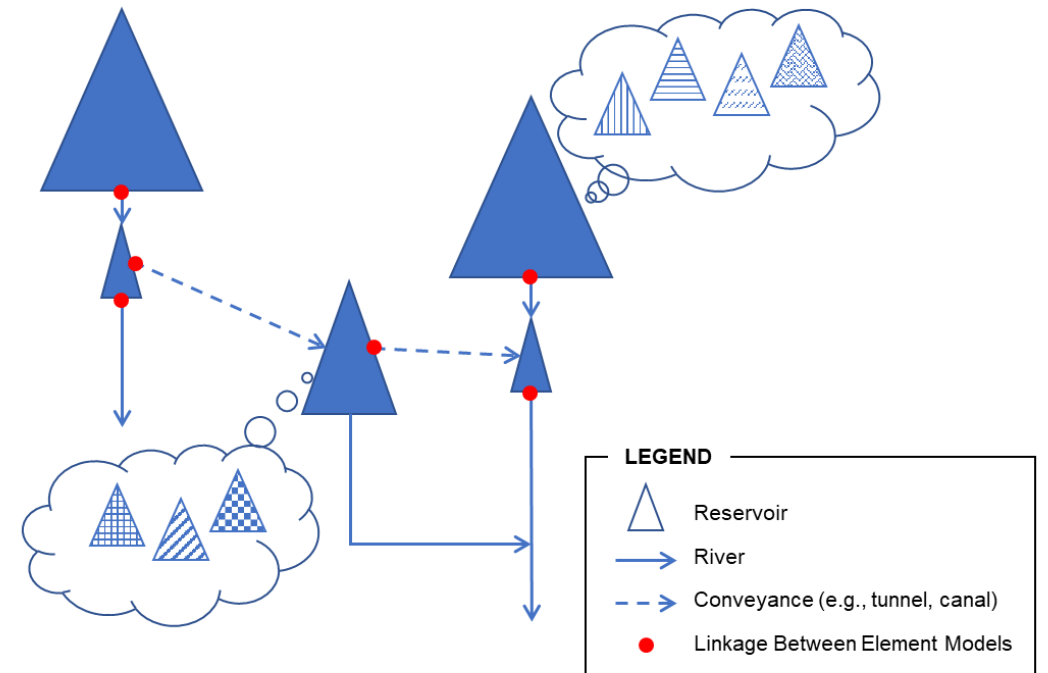
Element Model



Modeling System



Modeling Framework



# Model Dimensionality

- 1-D and 2-D models were selected and tested to represent the reservoirs and riverine systems
- 3-D models were considered, but deferred due to increased data collection, complexity, and computational run time



# Model Selection Criteria: Subcategories

- Numerical Model Criteria – representation of physical system in a model
- Linkage – addresses if models are discrete (reach specific) or system-wide and if framework compatible
- Input/Output (I/O) – model pre- and post-processors and data structures
- Support – user specific information
- CVP Features – ability to represent specific features CVP
- Qualitative – additional qualitative criteria



# Numerical Model Criteria

Criteria	Notes/Comments	Priority
1. Model type (River/Reservoir)	<u>Reservoir</u> (vertical profile and outflow temperature), <u>River</u> (longitudinal temperature)	H
2. Number of dimensions (1, 2)	Tradeoffs between lower/higher dimensional representations and computational efficiency	H
3. System geometric representation	Appropriate spatial resolution to represent reservoir/river element	H
4. Dynamic flow model	Ability to capture flow conditions over a range of time scales (hours, days, months)	H
5. Water temperature representation	Comprehensive heat budget formulation	H
6. Time step	Sub-daily required	H
7. Computational performance consideration	Computation time considered for screening analyses as well as planning analyses	H



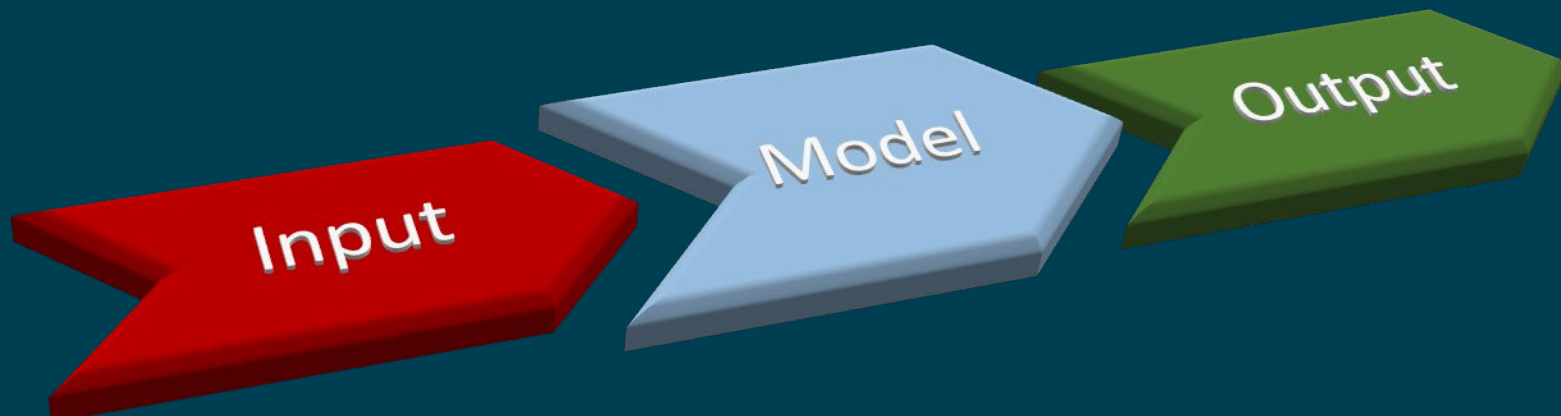
# Linkage Criteria

Criteria	Notes/Comments	Priority
8. System Model or discrete reach	Model can represent entire system (reservoir and river hydrology and water temperature) or a discrete segment/element of system (e.g., reservoir model)	M
9. Modeling framework compatible	Model can share I/O with other models in a framework	H/M



# Input/Output (I/O) Criteria

Criteria	Notes/Comments	Priority
10. Pre-processor	Assess and manage inputs	H
11. Post-processor	Assess, visualize, and report output (graphical and tabular)	H
12. Data structure facilitates model calibration/application	To facilitate modeling, calibration, and error detection	L



# Support Criteria

Criteria	Notes/Comments	Priority
13. Model applications	Model been used in applications similar to this project.	H
14. Actively supported	Actively supported models	H
15. Public domain, peer reviewed, and accessible model modifications	To assess critical model assumptions, verify model modifications, and provide model transparency	H
16. Fee	Model is free or is there a minimal cost for software	H
17. Documentation	Technical reports on model construction (equations, solution methods, testing) and user manuals	H
18. Training and/or user group	Support ongoing model application	M/L



# CVP Features Criteria

Criteria	Notes/Comments	Priority
19. Specific features:	Represent current or planned project facilities	-
A. Temperature control curtains	Lewiston Lake and Whiskeytown Lake	H
B. Submerged weirs/dams	Submerged dam upstream of New Melones Dam	H
C. Selective withdrawal	Shasta Lake and Folsom Lake	H
D. Automated simulations to target tailbay temperature	Model target reservoir release temperatures	H
E. Automated simulations to target river temperature	Model target downstream river temperatures	H
F. Shade	Topographic and/or riparian vegetation shade	M



# Qualitative Criteria

Criteria	Notes/Comments	Priority
20. Qualitative	-	-
A. Ease of use	Relatively easily operated (data input, model run, and output accessed)	M
B. Credibility	A history of successful use and previous peer review or institutional review/support	H
C. Easy to incorporate uncertain input parameters	External (preferred) rather than internal	M
D. Collaboration with model developers	Model developers have an interest in collaboration	M



# Model Selection

- Modeling Objective(s)
- Model Types
  - System
  - Element
    - Reservoir
    - River
  - Framework approach



# Model Selection Criteria for the WTMP

- Purpose: screen potential models for selection and implementation in the WTMP
- Criterion assessed, where feasible, as high/medium /low priority
- Criterion identified as "required" and "preferred"
- Selection criteria are important and necessary to ensure models fit project need
- Computationally efficient
- Selected components with higher resolution



# Model Identification for the WTMP

- Identified system models and component models (reservoir and river models)
- System Models: CE-QUAL-W2, DYRESM, HEC-5Q, HEC-ResSim, Riverware
- Component Models
  - Reservoir: CE-QUAL-W2, DYRESM, 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)
- Model information (Model Selection TM Tables 3-1, 3-2)
- Excluded models (Model Selection TM Tables 3-3, 3-4)





# Model Evaluation for the WTMP

- Broad range of quantitative and qualitative criteria to evaluate range of identified models for inclusion into the WTMP
- Process
  1. Assess criteria
    - System model
    - Component models
      - Reservoir
      - River
  2. Identify models that did not include key processes/representations
    - Numerical model criteria
    - Central Valley Project (CVP) Features
    - Some overlap with other criteria groups



# Model Evaluation for the WTMP

- Process

3. Identify models that best met WTMP objective

- Linkage
- Input/Output
- Modeling support
- Qualitative

4. Identify potential models

- System: HEC-ResSim
- Component:
  - Reservoir: HEC-ResSim, CE-QUAL-W2
  - River: Heat Source, HEC-RAS, HEC-ResSim, and RAFT



# System and Reservoir Models Reviewed

## Based on Numerical Model Criteria

Criteria	Comments	Need	CE-QUAL-W2	DYRESM	HEC-5Q	HEC-ResSim	Riverware
Model type (Discrete/ System)	Is the model a discrete model or a system model?	NA	Discrete	Discrete	System	System	System
Model type (River/ Reservoir)	Is the model designed for predicting vertical distributions and release-water temperatures in a reservoir reach?	Require	Yes	Yes	Yes	Yes	Yes
Short-term forecasting	Within season (days, weeks, months)	Require	Yes	Yes	Yes	Yes	Yes
Long-term planning	Extended simulations (years, decades)	Require	Yes	Yes	Yes	Yes	Yes
Number of dimensions (1, 2)		NA	2	1	1	1	1
System geometric representation	Principal dimension(s): longitudinal/ vertical	NA	Longitudinal/ vertical	Vertical	Longitudinal	Longitudinal	Vertical
System geometric representation	Detailed vertical resolution? (Yes/ No)	Require	Yes	Yes	Yes	Yes	No
Dynamic flow model	Yes/ No	Prefer	Yes	No	Yes	Yes	No
Water temperature representation	Full heat budget: Yes/ No	Require	Yes	Yes	No	Yes	Yes
Time step (capable of sub-daily)	Yes/ No	Require	Yes	Yes	Yes	Yes	Yes
Computational performance consideration	Faster/ Slower	NA	Slower	Faster	Faster	Faster	Unknown

# Model Recommendation and Decision

- System model
  - HEC-ResSim
- Component models
  - Reservoir Model
    - HEC-ResSim
    - CE-QUAL-W2
  - River Model
    - HEC-ResSim
- **Accessible Support**



# Model Selection Documentation

- Technical Memorandum
  - Water Temperature Modeling Platform: Model Selection

