CWEMF
CALIFORNIA
Water & Environmental
Modeling Forum

**California Water and Environmental Modeling Forum**

# 2026 ANNUAL MEETING PROGRAM

# AM XXXII

## Better Data, Better Models, Better Outcomes: Valuing Consistency and Transparency

## ORGANIZATIONAL MEMBERS

California Department of Water Resources

California State Water Resources Control Board

Contra Costa Water District

Delta Stewardship Council

East Bay Municipal Utility District

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Vivek Bedekar, Convener

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Ben Bray, Secretary

Jesse Jankowski, Past Convener

Sujoy Roy, Executive Director

Cover image created by Ben Bray and Lauryn Bray using Gemini on April 9, 2026.

# KEYNOTE ADDRESS

## Michael L. Anderson, Ph.D., P.E.

Michael Anderson is the State Climatologist for California, a collaborative position between the State and the National Oceanographic and Atmospheric Administration to provide climate data services for the state. Michael began working in the Department of Water Resources Division of Flood Management (DWR-DFM) Forecasting Section in July 2005 and became State Climatologist in 2007. Currently Dr. Anderson works in the Director's Office of the Department of Water Resources providing technical knowledge and advice for climate resilient resources management.

**Keynote Address Title: Raising Managed Water Capability in a Changing Climate**

Abstract: A warming world is changing watersheds and weather affecting the timing, pace, and scale of water movement across the landscape. As these changes amplify, impacts are being seen across water management and are expected to amplify in the coming decades. In a collaborative effort with the research community, advances are underway in observations, forecasts and their use supporting resource management. These partnerships are improving capacity to manage water as it shows up to increase its beneficial use while mitigating hazard from the extremes of too much or too little. In this talk, the past, present, and future of water management are explored while highlighting some recent innovations and setting the stage for what comes next.

# Celebration of Maury Roos

For nearly 65 years, Maury Roos shaped California's water management, regularly contributing to CWEMF and mentoring water professionals worldwide. His interest in water began on his family's almond farm in Ripon, where nighttime irrigation first sparked his curiosity "*trying to detect from the starlight where the water was going.*" – Maury Roos 2015 Groundwater Act Blog interview.

After earning an engineering degree from San Jose State, Maury joined the newly formed Department of Water Resources in 1957. Over 43 years of full-time service, plus 21 more as a retired annuitant, he made lasting contributions in hydrology, flood and water supply forecasting, reservoir operations, and early climate-change analysis. He helped modernize hydrologic methods from slide-rule calculations to computer-based systems, founded DWR's Hydrology Flood Center, served as Chief Hydrologist, and led major flood response efforts in 1986 and 1997, and later mentoring staff during the 2006 floods. Maury also created the 8-station precipitation index, helped develop Water Year type designations, and contributed to many editions of the California Water Plan (Bulletin 160).

Maury was among the first to detect climate-driven shifts in Sierra Nevada snowmelt noting that "*since the snowpack and runoff are so variable … the way to look at it for trends was to compare the ratio of the snowmelt volume with the total water year. I did that, and lo and behold, it looked like there was a declining slope starting in the 1960s.*" He presented his findings in 1987 at the Pacific Climate Workshop and coauthored *The Impacts of Global Warming on California* (1989).

Maury shared his expertise globally through the International Commission on Irrigation and Drainage, traveling to Australia, China, Holland, Indonesia, India, Iran, Mexico, Pakistan, South Korea, and Turkey. His distinguished career earned the 2005 CWEMF Career Award and the 2018 ASCE Life Member Award.

Maury Roos at his desk at the CA Department of Water Resources

# SUMMARY OF SESSIONS

## Monday, April 20

| Time | Session | Moderator | Room |
|---|---|---|---|
| 8:00–8:30 | Registration | | Sierra Hallway |
| 8:30–10:15 | 1. Reclamation Model Development (Part 1) | Lauren Thatch | Sierra 1 |
| | 2. Modernization of the California Water Plan | Paul Shipman | Sierra 2 |
| | 3. Multi-Dimensional Modeling of Hydrodynamics and Transport Processes the San Francisco Estuary | Edward Gross | Sutter |
| 10:15–10:30 | Break | | |
| 10:30–12:15 | 4. CalSim Updates and Applications | Jamel Lehyan | Sierra 1 |
| | 5. Lessons Learned from the DWR Watershed Resilience Pilot Program | Eric Tsai | Sierra 2 |
| | 6. Building Integrated Forecasting, Operations, and Planning Frameworks for Water and Power Resource Management | Eric Mork | Sutter |
| 12:15–1:00 | Lunch | | |
| 1:00–2:00 | CWEMF Awards Ceremony | Tariq Kadir | |
| 2:00–2:05 | Break | | |
| 2:05–3:15 | Pop-up Talks | Stacy Tanaka | |
| 3:15–3:30 | Break | | |
| 3:30–5:15 | 7. Updates in CalSim Development | Zachary Roy | Sierra 1 |
| | 8. News from the Klamath Basin | Yung-Hsin Sun | Sierra 2 |
| | 9. Modelling Operational Risks Arising from the Joint Operations of the Central Valley and State Water Projects | Harrison Zeff | Sutter |
| 5:30–8:00 | Business Meeting and Social | | |

# SUMMARY OF SESSIONS

## Tuesday, April 21

| Time | Session | Moderator | Room |
|---|---|---|---|
| 7:30–8:00 | Registration | | Sierra Hallway |
| 8:00–9:45 | 10. An Update on the COEQWAL Project: Understanding and Communicating Alternative California Water Futures Across Multiple Domains | James Gilbert | Sierra 1 |
| | 11. Incorporation of FIRO-MAR into the 2027 Central Valley Flood Protection Plan Update | Francisco Flores-López | Sierra 2 |
| | 12. Decision-Support Modeling for Managed Recharge and Recovery Projects | Hai Huang; Mesut Cayar | Sutter |
| 9:45–10:00 | Break | | |
| 10:00–11:45 | 13. Reclamation Model Development (Part 2) | Cameron Koizumi | Sierra 1 |
| | 14. DWR's Basin Characterization Program: From Data Collection and Digitization to Maps, Models, and Analysis | Mesut Cayar | Sierra 2 |
| | 15. Evaluating Delta Operations and Objectives (Rules) Using Historical Daily Data | Rich Satkowski | Sutter |
| 11:45–12:30 | Lunch | | |
| 12:30–1:10 | Keynote Address, Dr. Michael L. Anderson | Abdul Khan | Sierra 1 |
| 1:10–1:15 | Break | | |
| 1:15–3:00 | 16. Updates in CalSim Hydrology | Ryan Lucas | Sierra 1 |
| | 17. Collaborative Modeling in the Delta: Exploring Feasibility Using Three Use Cases | Michelle Stern | Sierra 2 |
| | 18. Advancing Subsidence Modeling: Exploring Critical Head, Data Gaps, Compaction Mechanics, and Predictive Uncertainty | John Ellis; Leila Saberi | Sutter |
| 3:00–3:15 | Break | | |
| 3:15–5:00 | 19. Integrated Modeling and Innovative Decision Support Systems for Smart Water Resources Management | Nigel Chen | Sierra 1 |
| | 20. MF-OWHM Session at 2026 CWEMF Conference | Scott Boyce; Steffen Mehl; Randall Hanson | Sierra 2 |
| | 21. Climate Change and Extreme Rainfall and Flooding Events | Yuchuan Lai | Sutter |
| 5:00–7:00 | Poster Session and Social | Stacy Tanaka | Sierra1 |

# SUMMARY OF SESSIONS

## Wednesday, April 22

| Time | Session | Moderator | Room |
|---|---|---|---|
| 7:30–8:00 | Registration | | Sierra Hallway |
| 8:00–9:45 | 22. Reclamation Developments in Secondary Modeling | Drew Loney | Sierra 1 |
| | 23. Machine Learning Applications in Water Resources (Part 1) | Tariq Kadir | Sierra 2 |
| | 24. Water Accounting: The Importance (and Challenge) of Measuring Water in the Field to Ground-truth Our Models | Brandon Ertis | Sutter |
| 9:45–10:00 | Break | | |
| 10:00–11:45 | 25. Developments in 2026 on Historical Hydrology and Calibration of the CalSim Historical Model | James Polsinelli | Sierra 1 |
| | 26. Machine Learning Applications in Water Resources (Part 2) | Kevin He | Sierra 2 |
| | 27. Strengthening Demand and Process Representation in WEAP: Advanced Data Integration for Statewide Planning | Marina Mautner | Sutter |
| 11:45–1:15 | Lunch | | |
| 1:15–3:00 | 28. Updates to DWR's C2VSim Fine Grid Model Development | Craig Altare | Sierra 1 |
| | 29. Recent Updates of the DWR Delta Emergency Response Tool – Automation, Optimization, and Machine Learning | John DeGeorge; Khalida Fazel | Sierra 2 |
| | 30. Recent Advances in SacWAM and SJWAM | Charles Young | Sutter |
| 3:00–3:15 | Break | | |
| 3:15–5:00 | 31. Sites Reservoir Modeling Updates | Reed Thayer | Sierra 1 |
| | 32. Developments in Open Water Data | Christina McCready; Paul Shipman | Sierra 2 |

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## MONDAY EVENING SOCIAL

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# 2026 ANNUAL MEETING SPONSORS (CONT'D)

## TUESDAY EVENING SOCIAL

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# 2026 ANNUAL MEETING SPONSORS (CONT'D)

## LUNCHES

## REFRESHMENTS

## California Water and Environmental Modeling Forum

Promoting Excellence and Consensus in Water and Environmental Modeling

3697 Mt. Diablo Blvd, Suite 150, Lafayette, CA 94549 • cwemf@cwemf.org • www.cwemf.org


Dear CWEMF Members and Friends,

Welcome to the 32nd CWEMF Annual Meeting. On behalf of the California Water and Environmental Modeling Forum, I welcome this community of practitioners, researchers, and decision-makers dedicated to advancing water and environmental modeling.

CWEMF is a nonprofit organization that brings together professionals from state and federal agencies, academia, water agencies, and the consulting community, all focused on modeling. It serves as a platform for water resources and environmental professionals and stakeholders to openly communicate, exchange ideas, and advance the application of modeling in decision-making. In addition to the annual meeting, CWEMF supports this mission through workshops and by providing unbiased peer review of models.

This year's theme focuses on valuing consistency and transparency in data. Open and accessible data are something we often take for granted. Through my recent international experience, I was reminded that data, freely available, abundant, and easily accessible, are not a given everywhere. As a community, we should continue to value and maintain the quality, accessibility, and transparency of data that underpin our work. High-quality data are the foundation of what we do as modelers. It enables consistency, builds confidence in our analyses, and ultimately supports informed and defensible decisions.

Our keynote speaker, Dr. Michael Anderson, State Climatologist with California DWR, will discuss how a warming climate is reshaping watersheds and water management, and how advances in observations and forecasting are improving our ability to manage both drought and extreme events.

I would like to extend my sincere appreciation to our sponsors, volunteers, organizers, and steering committee members whose time, effort, and support make this meeting possible.

I hope you have an engaging and rewarding experience at CWEMF. We encourage your participation and welcome your feedback on how we can continue to improve, whether through new ideas, suggestions, or perspectives you would like to share. We look forward to continuing this work together in the years ahead.

Sincerely,

Vivek Bedekar

Convener, CWEMF

# CONTENTS

# AGENDA

## Monday, April 20

### 8:00–8:30 am – Registration in Sierra Hallway

### 8:30–10:15 am

### Session 1. Reclamation Model Development (Part 1)

***Moderator: Lauren Thatch (USBR, lthatch@usbr.gov)***
***Location: Sierra 1***

1. Water Temperature Model Platform Planning Model Development – Ryan Lucas (USBR); Randi Field (USBR)

2. Real-Time CVP Delta Operations and Fisheries Assessments – Adam Witt (Stantec); Levi Brekke (Stantec)

3. CalSimHydroV2 OSTRICH Calibration – Lauren Thatch (USBR)

4. CalSimPy: Making the CalSim3 Data-Handling Process Easier – James Gilbert (NOAA, UCSC)

5. Rollout and Community Engagement of the Central Valley Project Water Temperature Modeling Platform – Yung-Hsin Sun (Sunzi Consulting)

### Session 2. Modernization of the California Water Plan

***Moderator: Paul Shipman (DWR, paul.shipman@water.ca.gov)***
***Location: Sierra 2***

1. Modernization of the California Water Plan through implementation of new legislation (SB 659 and SB 72) – Jose Alarcon (DWR); Karandev Singh (DWR)

2. Modernization of approach to developing resource management strategies (RMS) and update to RMS contents – Megan Fidell (DWR)

3. Modernizing data tools for public access though the Watershed Hub – Lucian Filler (DWR); Melissa Stine (Woodard & Curran)

4. Modernizing metrics and data for future scenarios – California Environmental Flows Framework – Caileen Yu (DWR)

5. Modernized population allocation for urban water use planning: automated Census population estimation across different boundaries using parcels and building footprints – James Common (DWR); Melika Mani (DWR)

## Session 3. Multi-Dimensional Modeling of Hydrodynamics and Transport Processes the San Francisco Estuary

***Moderator: Edward Gross (GEI, ed@rmanet.com)***
***Location: Sutter***

1. Using Inflow Fingerprinting to Predict Dissolved Organic Carbon Distribution and infer Contributions from Marsh Plants and Aquatic Vegetation in the Sacramento-San Joaquin Delta – Edward Gross (RMA/GEI)

2. Hydrodynamic Modeling of Fish Passage Structures, the Trilogy – Rusty Holleman (RMA/GEI)

3. Estimating Zooplankton Transport from Suisun Marsh Duck Pond Effluent using a Multi-Model Approach – Scott Burdick-Yahya (RMA/GEI)

4. An Open, Reproducible 3D Community Model for San Francisco Bay-Delta Environmental Hydrodynamics – Stendert Laan (Deltares USA)

## 10:30–12:15 am

## Session 4. CalSim Updates and Applications

***Moderator: Jamel Lehyan (DWR, Jamel.Lehyan@water.ca.gov)***
***Location: Sierra 1***

1. 2025 Delivery Capability Report Updates – Jonathan Byers (DWR)

2. SWP Adaptation Strategy Results – Zachary Roy (DWR)

3. Integrating Watershed Management and System Operations – Karandev Singh (DWR)

4. LTO Action 5 – Cameron Koizumi (USBR)

5. A New View of Water — Upper American River Watershed Case Study – Yung-Hsin Sun (Sunzi Consulting); Jared Soares (Batker Consulting)

## Session 5. Lessons Learned from the DWR Watershed Resilience Pilot Program

***Moderator: Eric Tsai (DWR, eric.tsai@water.ca.gov)***
***Location: Sierra 2***

1. Watershed Resilience Pilot Program: Statewide Context and Program Overview – Eric Tsai (DWR)

2. American Watershed Pilot: Regional Climate Resilience Planning – Regional Water Authority Representative

3. Calaveras Watershed Pilot: Climate Vulnerability and Adaptation Strategies – Stockton East Water District Representative

4. Russian Watershed Pilot: Integrating Climate Resilience at the Watershed Scale – Sonoma Water Agency Representative

5. Pajaro Watershed Pilot: Multi-Sector Climate Risk Assessment – Pajaro Valley Water Management Agency Representative

6. Ventura Watershed Pilot: Building Watershed Resilience through Collaboration – Ventura County Resource Conservation District Representative

## Session 6. Building Integrated Forecasting, Operations, and Planning Frameworks for Water and Power Resource Management

***Moderator: Eric Mork***
***Location: Sutter***

1. An Overview of the California-Nevada River Forecast Center and the Role They Play in Forecast Informed Reservoir Operations – Brett Whitin (California Nevada River Forecast Center)

2. Russian River Forecast Informed Reservoir Operations – Planning to Implementation – Chris Delaney (Sonoma Water)

3. The Story of TVA's River and Reservoir Management – Matthew G. Montgomery (TVA)

4. Keeping the lights on with the Colorado River Storage Project – Matija Pavicevic (Argonne National Lab)

5. Bulletin 120 Water Supply Forecasts in a Changing Climate – Jacob Kollen (DWR)

## 12:15–1:00 pm

## Lunch

Provided if registered by early bird deadline.

## 1:00–2:00 pm

## CWEMF Awards Ceremony

## 2:05–3:15 pm

## Pop-up Talks

## 3:30–5:15 pm

## Session 7. Updates in CalSim Development

***Moderator: Zachary Roy (DWR, zachary.roy@water.ca.gov)***
***Location: Sierra 1***

1. CalSim Solvers Benchmarking – Jon Herman (UC Davis)

2. CalSim Cycle Structure – Thomas FitzHugh (Stantec)

3. CVP California Allocation Module Development – Cameron Koizumi (USBR)

4. WRESL+ Compiler Updates – Hamed Zamanisabzi (DWR)

## Session 8. News from the Klamath Basin

***Moderator: Yung-Hsin Sun (Sunzi Consulting, sun.yunghsin@sunziconsulting.com)***
***Location: Sierra 2***

1. Integrated Surface-Water and Groundwater Modeling of the Shasta River Watershed – Vivek Bedekar (SSP&A); John Riverson (Paradigm)

2. What Would the River Do: The Question behind the Klamath River Basin Revised Natural Flow Study – Caroline Ubing (USBR)

3. Disappearing Act of Water: Simulated changes in open water evaporation across Upper Klamath Basin as a result of agricultural development and reservoir impoundment – Kristin Mikkelson (USBR)

4. The Situation was Fluid (Pun Intended): Modeling Exchange Flows between the Klamath River and Pre-development Lower Klamath Lake – Colin Byrne (USBR)

5. Managing the Unknown Unknown: The Klamath Project Operations in the Post-Dam Removal Era – Brock Phillips (USBR); Viktor Stromberg (USBR)

## Session 9. Modelling Operational Risks Arising from the Joint Operations of the Central Valley and State Water Projects

***Moderator: Harrison Zeff (University of North Carolina at Chapel Hill, zeff@live.unc.edu)***
***Location: Sutter***

1. Managing water market-based financial risks with California Water Index futures contracts – Dan Li

(University of North Carolina at Chapel Hill)

2. California reservoir network optimization with daily ensemble hydrologic forecasts – Jonathan Herman (University of California, Davis)

3. Exploring opportunities for energy storage within the Central Valley Project – Quentin Ploussard (Argonne National Laboratory)

4. Assessing financial risk due to hydrometeorological variability: A case study using WAPA's hydropower customers – Ahmed Hamed (University of North Carolina at Chapel Hill)

5. SGMA Implementation through Modelling and Economics – Tori Laird; Duncan MacEwan (ERA Economics)

6. Statewide Economic Modelling at the Groundwater Sustainability Agency (GSA) Resolution – Brooks Ronspies; Josh Virene (ERA Economics)

## 5:30–8:00 pm

## Business Meeting and Social

# AGENDA

## Tuesday, April 21

### 7:30–8:00 am – Registration in Sierra Hallway

### 8:00–9:45 am

### Session 10. An Update on the COEQWAL Project: Understanding and Communicating Alternative California Water Futures Across Multiple Domains

***Moderator: James Gilbert (UC Santa Cruz, james.gilbert@noaa.gov)***
***Location: Sierra 1***

1. COEQWAL: A collaboratory for water equity and resilience – Ted Grantham (UC Berkeley)

2. Future Hydroclimates from Physical and Statistical Models – Morgan Levy (UC San Diego)

3. Exploring an Expanded Scope of Operational Alternatives for California – James Gilbert (UC Santa Cruz)

4. Interpreting scenario outcomes: metrics, tiered thresholds, and trade-offs – Wietske Medema (UC Berkeley)

5. Building a FAIR Collaboratory for Equity in Water Allocation – Nancy Thomas (UC Berkeley)

### Session 11. Incorporation of FIRO-MAR into the 2027 Central Valley Flood Protection Plan Update

***Moderator: Francisco Flores-López (DWR, Francisco.FloresLopez@water.ca.gov)***
***Location: Sierra 2***

1. Theory and Background for Generation of Synthetic Ensemble Forecasts – Zach Brodeur (CW3E)

2. Application of Synthetic Ensemble Forecasts to Scaled Central Valley Hydrology Study Inflow Events – Wyatt Arnold (DWR)

3. Development and Application of FIRO-MAR Reservoir Operations in HEC-ResSim – Aleksander Vdovichenko (DWR)

4. Reducing Flood Risks through FIRO-MAR in the San Joaquin Basin – David Arrate (DWR)

5. Managing Forecast Uncertainty in Operational Decisions on the Russian River – Michael Konieczki

(HDR)

## Session 12. Decision-Support Modeling for Managed Recharge and Recovery Projects

***Moderators: Hai Huang (Tetra Tech, hai.huang@tetratech.com);***
***Mesut Cayar (Woodard & Curran, mcayar@woodardcurran.com)***
***Location: Sutter***

1. Grid-Based Analysis of Recharge Benefits for Stream Depletion Mitigation in Yuba Subbasins – Sercan Ceyhan (Woodard & Curran); Reuben Dandurand (Woodard & Curran)

2. Modeling ASR with a Focus on the Regulator – Neil Deeds (INTRA); Abhishek Singh (INTRA)

3. How fast does recharge reach groundwater? Transit times and preferential flow in deep vadose zones – Helen E. Dahlke (UC Davis)

4. MercedMAR – Automation and visualization for managed aquifer recharge scenarios in the Merced subbasin – Andres Diaz (Woodard & Curran); Melissa Stine (Woodard & Curran)

## 10:00–11:45 am

## Session 13. Reclamation Model Development (Part 2)

***Moderator: Cameron Koizumi (USBR, ckoizumi@usbr.gov)***
***Location: Sierra 1***

1. To Kill a Spreadsheet – Streamlining CalSim Input Development and Extension – Frankie Nuffer-Rodriguez (USBR)

2. CalSim Explorer – Nancy Parker (USBR); Kunxuan Wang (USBR)

3. CalSim3 Dynamic Fallowing Framework – Bridget Childs (Stantec)

4. Klamath Modeling using WRIMs – Nancy Parker (USBR)

5. Trinity LTO Operations Modeling – Kunxuan Wang (USBR)

## Session 14. DWR's Basin Characterization Program: From Data Collection and Digitization to Maps, Models, and Analysis

***Moderator: Mesut Cayar (Woodard & Curran, mcayar@woodardcurran.com)***
***Location: Sierra 2***

1. DWR's Basin Characterization Program – Update 2026 – Katherine Dlubac (DWR)

2. Digitization of well lithology and geophysical logs for the DWR Statewide AEM and Basin Characterization Program – Julie Chambon (Ramboll)

3. BCTools – DWR's Open-Source Toolset for Rapid, Data-Driven Basin Characterization – Jack Baer (Woodard & Curran); Vivek Bedekar (SSP&A)

4. Large-Scale Sedimentary Texture Modeling with AEM Data: Insights from the Central Valley – Jack Baer (Woodard & Curran); Michael Ou (SSP&A)

5. Aquifer Recharge Potential in Practice: Lessons from Western San Joaquin and Sacramento Valley – Nicole Jacobsen (Woodard & Curran)

### Session 15. Evaluating Delta Operations and Objectives (Rules) Using Historical Daily Data

***Moderator: Rich Satkowski (SWRCB, retired, rsatkowski@aol.com)***
***Location: Sutter***

1. Introducing Delta 3D: Delta Daily Data Display Tool – Russ Brown (Russ Brown River Consulting)

2. Benefits of Using Daily Data for Evaluating Delta Outflow and Seawater Intrusion – Anne Huber (ICF)

3. Highlighting the Importance of Daily Data for Water Quality Modeling – Mike Deas (Watercourse Engineering)

4. Evaluating Fish Effects from Flows and Exports Using Daily Flows and Fish Data – Russ Brown (Russ Brown River Consulting)

## 11:45–12:30 pm

## Lunch

Provided if registered by early bird deadline.

## 12:30–1:10 pm

## Keynote Address

## 1:15–3:00 pm

### Session 16. Updates in CalSim Hydrology

***Moderator: Ryan Lucas (USBR, rlucas@usbr.gov)***
***Location: Sierra 1***

1. C2VSIM 2025 Coarse Grid Calibration – Steven Jepsen (DWR); Ali Ghaseminejad (DWR)

2. Crop ET Updates and comparisons with OpenET – Lauren Thatch (USBR)

3. Climate Change Analysis for California Central Valley Project Long Term Planning – Tapash Das (Jacobs); Drew Loney (USBR)

4. Development of CSHydroV2 Pre- and Post-Processor Tools – Ruian Dong (DWR)

5. Updates to CalSim3 Existing Conditions Land Use Dataset – Mina Shahed Behrouz (Stantec)

### Session 17. Collaborative Modeling in the Delta: Exploring Feasibility Using Three Use Cases

***Moderator: Michelle Stern (Delta Stewardship Council, Michelle.Stern@deltacouncil.ca.gov)***
***Location: Sierra 2***

1. Solving complex management questions with the help of a Delta Modeling Collaboratory – Lisamarie Windham-Myers (USGS, Delta Stewardship Council)

2. Developing modeling applications to support cyanobacterial harmful algal bloom management in the Sacramento-San Joaquin Delta, California – Keith Bouma-Gregson (USGS); Dave Senn (San Francisco Estuary Institute)

3. Managing Salinity in the Delta: An integrated modeling-collaboratory approach for research on infrastructure and management solutions – Josue Medellin-Azuara (UC Merced)

4. Managing tidal wetlands to optimize food webs in the Sacramento-San Joaquin Delta, California – Matt Young (USGS, California Water Science Center)

5. Laying the foundation for a Delta Modeling Collaboratory: a project-based collaborative modeling approach to complex management challenges – Michelle Stern (Delta Stewardship Council)

### Session 18. Advancing Subsidence Modeling: Exploring Critical Head, Data Gaps, Compaction Mechanics, and Predictive Uncertainty

***Moderators: John Ellis (INTERA, jellis@intera.com);***
***Leila Saberi (INTERA, LSaberi@intera.com)***
***Location: Sutter***

1. Critical Heads, Critical Decisions: Subsidence and Critical Head Trends in the Central Valley. – John

Ellis (INTERA); Leila Saberi (INTERA)

2. Short Records, Longer Consequences: How Data Gaps Shape Subsidence Forecasts. – Leila Saberi (INTERA); John Ellis (INTERA)

3. The Subsurface Time Machine: Modeling Compaction Dynamics. – Joseph Hughes (INTERA)

4. Why Matching the Past Doesn't Tell the Future: Implications of Model Non-Uniqueness – Jeremy White (INTERA)

5. Decomposition of Inelastic and Elastic Components of Total Subsidence for Model Calibration Evaluation – Raghavendra Suribhatla (Haley & Aldrich)

## 3:15–5:00 pm

## Session 19. Integrated Modeling and Innovative Decision Support Systems for Smart Water Resources Management

***Moderator: Nigel Chen (EKI, nchen@ekiconsult.com)***
***Location: Sierra 1***

1. Opportunities and Challenges in Using Multiple Model for Regional Groundwater Management in the Salinas Valley – Stephen Hundt (Montgomery & Associates, M&A)

2. Integrated Hydrogeologic Investigations, Groundwater Modeling and Decision Support Tool Development in the Livermore Valley Basin – Aaron Lewis (EKI); Nathan Cutler (EKI)

3. Machine Learning Guided Optimization (MLGO!) – Patick Wickham (M&A)

4. Building Trust in Regional Water Planning: An Interactive MCDA Framework for Consensus Building in the Ipswich River Basin – Ayman Alafifi (EKI); Dawn Flores (EKI)

5. Advancing adaptive decision-making through an Environmental Water Manager (EWM) role to enhance the ecological resilience of Western U.S. river systems – Zach Brodeur (CW3E, UCSD)

6. MODFLOW-IDC (MF-IDC) A New Integrated Hydrologic Modeling Tool from California for the Rest of the World – Adrien Camille (Woodard & Curran); Ahmed Ali

## Session 20. MF-OWHM Session at 2026 CWEMF Conference

***Moderator: Scott Boyce (UC Davis);***
***Steffen Mehl;***
***Randall Hanson (One-Water Hydrologic, randythanson@gmail.com)***
***Location: Sierra 2***

1. New Conjunctive Water Management books and Model Exercises – Randall Hanson (One-Water Hydrologic)

2. MF-OWHM: Status update and upcoming features – Scott Boyce (UC Davis)

3. Modeling Future Groundwater Depletion to Evaluate Sustainability Goals set under the Sustainable Groundwater Management Act in the Critically Overdrafted Basins of the Central Valley, California, USA (2020 - 2070) – Logan Platt (USGS, SDSU, UCSD)

4. Simulating Future Flow and Salt Transport in the Delta-Mendota Subbasin – Barbara Dalgish; Mohamed Nassar (LSCE)

5. Toward solute transport modeling framework through an Integrated hydrogeological model – Mohamed Nassar (LSCE)

6. Evaluating seawater intrusion under climate change model updates and uncertainty analysis for Pajaro Valley, California – Marrisa Earl (INTERA)

7. A River Runs Through It: Subsurface Connectivity and Exchanges Between the Salinas River and Groundwater Subbasins – Wes Henson (EKI, USGS)

## Session 21. Climate Change and Extreme Rainfall and Flooding Events

***Moderator: Yuchuan Lai (Tetra Tech, yuchuan.lai@tetratech.com)***
***Location: Sutter***

1. Analyzing climate modeling in the Central Valley: Nexus of statistics and data analysis tools – Chakri Malakpet (HDR); Asphota Wasti (HDR)

2. A stochastic watershed modeling framework for rainfall-runoff simulations – Chakri Malakpet (HDR)

3. Probabilistic Extreme Rainfall Projections under Climate Change: Applying Extreme Value Analysis with A Climate-Model-Informed Bayesian Approach – Yuchuan Lai (Tetra Tech)

4. Effects of Climate Change on City of San Diego Public Facilities and Operations – Syed Azhar Ali (Jacobs); Tapash Das (Jacobs)

## 5:00–7:00 pm

## Poster Session

# AGENDA

## Wednesday, April 22

### 7:30–8:00 am – Registration in Sierra Hallway

### 8:00–9:45 am

### Session 22. Reclamation Developments in Secondary Modeling

***Moderator: Drew Loney (USBR, dloney@usbr.gov)***
***Location: Sierra 1***

1. WTMP Development (Facilitated Adoption and Historical Reanalysis) – Mechele Pacheco (USBR)

2. Quantifying Sensitivity of Water Temperature Target Schedule to Meteorological Conditions – Melanie Holland (USBR)

3. Trinity Water Temperature Modeling for the Long-Term Operations – Mussie Beyene (USBR)

4. San Joaquin River Water Quality Model in CalSim 3 – Yuan Hui (Stantec)

5. Folsom Temperature Control Shutter Modeling – Drew Loney (USBR)

### Session 23. Machine Learning Applications in Water Resources (Part 1)

***Moderator: Tariq Kadir (Civil Engineer, retired, tkcalwater@gmail.com)***
***Location: Sierra 2***

1. Machine Learning Approaches for Predicting Reference Evapotranspiration and Irrigated Areas – Andre Daccache (UC Davis)

2. Machine Learning Approaches for Estimating Aquifer Hydraulic Properties from Step-Drawdown Pump Tests: A Case Study in Central Valley, California – Behrooz Etebari (DWR), Graham Fogg (UC Davis)

3. Leveraging AI for Predicting Fallow Land and Resource Allocation in the San Joaquin Valley of California – Abid Sarwar (UC Merced)

4. Applying AI/Machine Learning Algorithms for Forecasting California Water Year Types – Tariq Kadir (DWR, retired)

## Session 24. Water Accounting: The Importance (and Challenge) of Measuring Water in the Field to Ground-truth Our Models

***Moderator: Brandon Ertis (Davids Engineering, brandon@davidsengineering.com)***
***Location: Sutter***

1. Groundwater Demand Management: Quantifying crop consumptive use to support groundwater sustainability under the Sustainable Groundwater Management Act (SGMA) – Daniel Smith (Davids Engineering)

2. Increasing streamflow data availability through the California Stream Gaging Improvement Program (CalSIP) – Jeff Davids (Davids Engineering)

3. Field study to validate applied water estimates developed using an IDC model application – Brandon Ertis (Davids Engineering); Hannah Romero (El Dorado Water Agency)

4. Better Models Need Better Measurements - Characterizing Stream-Aquifer Exchanges with Stream Reach Water Budgets – Jeff Davids (Davids Engineering)

5. Leveraging Satellite-Based Evapotranspiration to Support Sustainable Water Management in California – A.J. Purdy (CSUMB; NASA-ARC); Lan Liang (DWR)

## 10:00–11:45 am

## Session 25. Developments in 2026 on Historical Hydrology and Calibration of the CalSim Historical Model

***Moderator: James Polsinelli (DWR, james.polsinelli@water.ca.gov)***
***Location: Sierra 1***

1. CSHydro Updates: Transition from Legacy CSHydro to the IDC Based Integrated Framework – Mohammad Hasan (DWR); Jay Wang (DWR)

2. Historical CalSim 3 GW-DLL Calibration – Sercan Ceyhan (Woodard & Curran); Puneet Khatavkar (Stantec)

3. CalSim3 Historical Hydrology Model (CS3HIST) – Bridget Childs (Stantec)

4. Surface Water Calibration of the CalSim3 Historical Hydrology Model (CS3HIST) – James Polsinelli (DWR)

## Session 26. Machine Learning Applications in Water Resources (Part 2)

***Moderator: Kevin He (DWR, Kevin.He@water.ca.gov)***
***Location: Sierra 2***

1. Deep Learning for Daily Streamflow Prediction across Hydroclimatic Regions in California – Yu-Chieh

(Jay) Chao (UC Davis); Wyatt Arnold (DWR)

2. Real-Time Multi-Ion Forecasting in the South Delta Using Hydrodynamically Informed Machine Learning – Peyman Namadi (DWR)

3. Predicting the Microcystis Visual Index (MVI) using a data-driven approach to support Harmful Algal Bloom management in the Delta – Gourab Kumer Saha (DWR)

4. Machine Learning Applications in the Delta: Review and Outlook – Kevin He (DWR)

5. Transfer Learning for Multi-Fidelity Surrogate Modeling of Delta Salinity Under Extended Drought and Climate Scenarios – Sabi Can Ruso (UC Berkeley); Eli Ateljevich (DWR)

## Session 27. Strengthening Demand and Process Representation in WEAP: Advanced Data Integration for Statewide Planning

***Moderator: Marina Mautner (SEI, marina.mautner@sei.org)***
***Location: Sutter***

1. Updates to Central Valley WEAP model for California Water Plan Update 2028: enhancements to irrigation demands and groundwater processes – Brian Joyce (SEI)

2. Implementing WEAP to incorporate California's South Coast and San Fransico Bay regions into the 2028 Water Plan Update – Andrea Carlos (SEI)

3. Designing a modular, cloud-based crop-mapping system for the SacWAM modeling workflow – Marina Mautner (SEI)

4. Early-season crop identification to support irrigation demand and return flow representation in WEAP-based planning models – Romina Díaz Gómez (SEI)

## 11:45–12:30 pm

## Lunch

At area restaurants.

## 1:15–3:00 pm

## Session 28. Updates to DWR's C2VSim Fine Grid Model

***Moderator: Craig Altare (DWR, craig.altare@water.ca.gov)***
***Location: Sierra 1***

1. Overview of DWR's C2VSimFG Application and Planned Updates for Version 2 – Uditha Bandara (DWR)

2. Updating the Central Valley Groundwater Level Observation Dataset – Kyle Hardage (DWR)

3. Revisions to the Representation of Pumping Wells in C2VSimFG – Andres Guillen (DWR)

4. New Developments in the Surface Water Components of C2VSimFG – Guobiao Huang (DWR)

## Session 29. Recent updates of the DWR Delta Emergency Response Tool – Automation, Optimization, and Machine Learning

***Moderators: John DeGeorge (GEI, jfdegeorge@rmanet.com);***
***Khalida Fazel (DWR, Khalida.Fazel@water.ca.gov)***
***Location: Sierra 2***

1. Overview of the Delta Emergency Response Tool – Abdullah Karim (DWR)

2. Delta Flood Emergency Management Plan Supplement C – Alyssa Virgil (DWR)

3. Optimization of temporary barrier placement to reduce water supply impacts after a levee failure event – Ryan Ripken (RMA/GEI)

4. Application of Reinforcement Learning to create a Machine Learning Agent that can play the Delta Recovery Game – John DeGeorge (RMA/GEI)

## Session 30. Recent Advances in SacWAM and SJWAM Development

***Moderator: Charles Young (SEI, chuck.young@sei.org)***
***Location: Sutter***

1. Forecasting Central Valley Runoff and Operations Using NMME 7-Month Forecasts – Chuck Young (SEI)

2. Operations based on Water Right Priority Dates in SacWAM and SJWAM – Puneet Khatavkar (Stantec)

3. Hydro-economic integration in SacWAM for dynamic cropping response to water availability and aquifer levels – Laura Forni (SEI)

4. Streamlining California water management tools: coupling IWFM and WEAP to improve stream–aquifer representation in the Central Valley – Marina Mautner (SEI)

## 3:15–5:00 pm

### Session 31. Sites Reservoir Modeling Updates

***Moderator: Reed Thayer (Jacobs, reed.thayer@jacobs.com)***
***Location: Sierra 1***

1. Sites Project Modeling & Results Processing – Chad Whittington (Jacobs)

2. Lessons Learned in Improving Transfer Logic in CalSim 3 – Reed Thayer (Jacobs)

3. Reservoir and River Water Temperature Modeling for Sites Project – Samaneh Saadat (Jacobs); Sai Nudurupati (Jacobs)

4. Temporal Downscaling of CalSim 3 with USRDOM for the Sites Project – Sai Nudurupati (Jacobs); Chad Whittington (Jacobs)

### Session 32. Developments in Open Water Data

***Moderators: Christina McCready (DWR, Christina.McCready@water.ca.gov);***
***Paul Shipman (DWR, paul.shipman@water.ca.gov)***
***Location: Sierra 2***

1. Artificial Intelligence-enabled Water Monitoring, Analysis, and Prediction System (AIWaterMAPS) – Anmol Vishwakarma (DWR)

2. Catalog of DWR's Major Models – Jose Alarcon (DWR)

3. Digitization of historical climate archive – Alyssa Whitaker (DWR), Mina Shahed Behrouz (Stantec)

4. California Water Data Consortium - Improving the Usability of Data and Data Portals – Robyn Grimm (California Water Data Consortium)

# ABSTRACTS

**Session 1: Reclamation Model Development (Part 1)**
**Session Moderator: Lauren Thatch (USBR)**
**Moderator Email: lthatch@usbr.gov**

This session is the first of two Bureau of Reclamation–focused sessions highlighting recent efforts in model development and application.

### 1-1. Water Temperature Model Platform Planning Model Development

Presenters: Ryan Lucas (USBR); Randi Field (USBR)
Presenters Email Addresses: rlucas@usbr.gov, rfield@usbr.gov
Collaborators: Allan Loney (USBR), Mike Deas (Watercourse Engineering)
Permission to Post pdf of Presentation on CWEMF Website: YES

Reclamation rolled out the Water Temperature Modeling Platform (WTMP) in February 2026. This presentation will discuss the development efforts to advance the WTMP planning model capabilities.

### 1-2. Real-Time CVP Delta Operations and Fisheries Assessments

Presenters: Adam Witt (Stantec); Levi Brekke (Stantec)
Presenters Email Addresses: Adam.Witt@stantec.com; levi.brekke@stantec.com
Collaborators: Josh Israel (USBR), Jo Anna Beck (USBR)
Permission to Post pdf of Presentation on CWEMF Website: YES
Real-time assessments Delta conditions and operations are critical for balancing the water supply goals of the CVP with fish and endangered species protection. Such assessments are used to guide operations on a daily and weekly basis to meet regulatory requirements and annual or seasonal operational objectives. This talk will discuss ongoing Reclamation work to develop credible, rapid, and automated data collection, model output, and assessment to support weekly operations decisions during the OMR management season.

### 1-3. CalSimHydroV2 OSTRICH Calibration

Presenters: Lauren Thatch (USBR)
Presenters Email Addresses: lthatch@usbr.gov
Collaborators: Drew Allan Loney (USBR), Frankie-Nuffer-Rodriquez (USBR)
Permission to Post pdf of Presentation on CWEMF Website: YES

This presentation provides a walkthrough of our calibration setup and a review of initial results from the CalSimHydroV2 model calibration using the Optimization Software Toolkit for Research Involving Computational Heuristics (OSTRICH). OSTRICH is a model-independent tool that enables automated calibration using a range of algorithms, including the genetic algorithms applied in this study.

### 1-4. CalSimPy: Making the CalSim3 Data-Handling Process Easier

Presenters: James Gilbert (NOAA, UCSC)
Presenters Email Addresses: james.gilbert@noaa.gov
Permission to Post pdf of Presentation on CWEMF Website: YES

The CalSim3 modeling process can often involve many large datasets and input files. This process can be especially cumbersome when an aim of a modeling exercise is to make numerous and systematic changes to inputs and quickly review outputs - and not just in CalSim3, but in CalSimHydro and the C2VSim groundwater model. Confronted with these sorts of challenges on several recent projects, I developed Python code to more easily access, modify, and write many parts of the CalSim3 modeling workflow. The effort evolved into a Python library (calsimpy) that includes components for handling CalSimHydro, CalSim3, and CalSim3-C2VSim inputs and outputs. This presentation will provide an overview of the functionality of the calsimpy package as well as illustrations of its use in different applications, including for common modeling data review as well as hydrology resequencing.

**1-5. Rollout and Community Engagement of the Central Valley Project Water Temperature Modeling Platform**

Presenters: Yung-Hsin Sun (Sunzi Consulting)
Presenters Email Addresses: sun.yunghsin@sunziconsulting.com
Collaborators: Ryan Lucas (USBR)
Permission to Post pdf of Presentation on CWEMF Website: YES

The Central Valley Project (CVP) Water Temperature Modeling Platform (WTMP) is a major initiative led by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) to modernize water temperature management tools across the CVP system. Beyond technical advancement, WTMP is designed to strengthen Reclamation's organizational capacity to meet increasingly complex operational challenges. This project is rooted on the community development approach that emphasizes collaboration and transparency throughout its development and rollout phases. After three years of development, WTMP underwent a season-long, facilitated adoption process with stakeholders and interested parties in 2025, forming a key component of its rollout. This process will culminate in a rollout event in February 2026. This presentation examines how the community development approach influenced the quality, usability, and effectiveness of the resulting products, as well as the outcomes of several first-of-their-kind engagement strategies. In addition, the presentation discusses post-rollout engagement efforts aimed at sustaining the community, supporting continued adoption, and guiding future refinements of the model and platform.

**Session 2: Modernization of the California Water Plan**
**Session Moderator: Paul Shipman (DWR)**
**Moderator Email: paul.shipman@water.ca.gov**

DWR is working to modernize the water plan in a variety of ways. First, DWR has new opportunities through recently passed legislation (SB 659 and 72) to update the contents, presentation, and outcomes of the water planning process. Next, we will explore how various work streams are being modernized with new or emerging data, analysis, and techniques. Specifically, we will focus on changes to the resource management strategies, improved access to data through the watershed hub, updated metrics and data in the future scenarios, and finally application of emerging techniques in estimation of urban water use data

**2-1. Modernization of the California Water Plan through implementation of new legislation (SB 659 and SB 72)**

Presenters: Jose Alarcon (DWR), Karandev Singh (DWR)
Presenters Email Addresses: Jose.Alarcon@water.ca.gov; Karandev.Singh@water.ca.gov
Collaborators: Paul Shipman (DWR), Abdul Khan (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

DWR will present new legislation enacted in recent years including SB 659 and SB 72. SB 659 establishes the California Water Supply Solutions Act of 2023 that requires the DWR to develop actionable recommendations to improve the pace of constructing and utilizing groundwater recharge facilities to increase the recharge of the state's groundwater basins. These recommendations will identify immediate and long-term solutions and will be included in the California Water Plan, Update 2028 and each subsequent update thereafter. Collaboration and coordination are core elements of SB 659 implementation. SB 72: The California Water Plan: long-term supply targets revised water code to require the department to expand the membership of the advisory committee to include tribes, labor, and environmental justice interests. The bill requires DWR to develop a plan to identify 9MAF of additional water, water conservation, or water storage capacity to be achieved by 2040 as part of the 2028 update and then update these targets with quantitative analysis as part of the 2033 update. The targets must consider current and future water needs including, but not limited to, urban uses, agricultural uses, tribal uses, and the environment. The bill would require the plan to include specified components, including a discussion of the estimated costs, benefits, and impacts of any project type or action that is recommended by the department within the plan that could help achieve the water supply targets. Finally, the presentation will include an overview of the technical working group for the California Water Plan and opportunities for engagement for Water Plan Updates 2028 and 2033.

**2-2. Modernization of approach to developing resource management strategies (RMS) and update to RMS contents**

Presenters: Megan Fidell (DWR)
Presenters Email Addresses: megan.fidell@water.ca.gov
Collaborators: Hoa Ly, Jennifer Stricklin
Permission to Post pdf of Presentation on CWEMF Website: Yes

For the 2028 California Water Plan Update, the DWR workteam has modernized our work on the Resource Management Strategies in two ways. First, in consultation with our interested parties, we updated the set of strategies that we include in the Water Plan to address current issues in the field. The new RMSs include: Wildfire-Related Management; Dam Removal; Remote Sensing; Multi-benefit Land Repurposing. In addition, the Resource Management Strategy team is exploring using AI to write the initial drafts of the RMSs, and using our subject matter experts to validate the resulting text. Although we worry about the accuracy of AI-drafted material, we are confident that have sufficient layers of validation to bring the work to the public. We further trust that people who attend our public workshops will give us necessary feedback to validate the Resource Management Strategies.

**2-3. Modernizing data tools for public access though the Watershed Hub**

Presenters: Lucian Filler (DWR), Melissa Stine (Woodard & Curran)
Presenters Email Addresses: Lucian.Filler@water.ca.gov; MStine@woodardcurran.com
Collaborators: Eric Tsai (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Watershed Hub provides a snapshot of projects, data, conditions, and trends based on indicators in each watershed to support watershed networks, show progress toward sustainability and resiliency, display vulnerabilities and risks, identify and track multi-benefit projects, provide data related to return on investment, and inform funding decisions. The Watershed Hub will be an integral part of SB 72 implementation. SB 72 calls for tracking of local projects and actions to achieve nine million acre-feet of additional water, water conservation, or water storage capacity to be achieved by 2040. This presentation will include an early look at the watershed network tool that is being planned to track projects towards that goal for the Water Plan update 2028.

**2-4. Modernizing metrics and data for future scenarios – California Environmental Flows Framework**

Presenters: Caileen Yu (DWR)
Presenters Email Addresses: caileen.yu@water.ca.gov
Collaborators: Paul Shipman (DWR), Kris Taniguchi-Quan (SCCWRP), Bronwen Stanford (The Nature Conservancy)
Permission to Post pdf of Presentation on CWEMF Website: Yes

In line with the modernization of the California Water Plan mandate, the Future Scenarios project is updating its evaluation of environmental water needs using the California Environmental Flows Framework (CEFF). DWR simulates California's water systems' response to range of future scenarios using the WEAP model and evaluates whether different water needs are fulfilled. In the past, DWR used minimum required instream flow volumes to evaluate environmental water needs. With this coming Water Plan update, DWR is piloting methods to better evaluate both mandated and non-regulated instream environmental water needs using CEFF functional flows. CEFF uses functional flows (e.g. flow components) to quantify streamflow components in different seasons that provide physical, biogeochemical, and biological ecosystem functions. Using CEFF functional flow metrics, DWR created a generalized workflow to formulate functional flow hydrographs for a range of water year types at each HUC8, then quantifies the functional flow volumes for each season. At each HUC8, DWR then evaluates seasonal and annual unmet environmental water need, based on the functional flow volumes. This update brings the California Water Plan into alignment with state-of-the-science understanding of ecosystem-driven environmental water needs and aims to provide statewide, screening level information about unmet environmental water needs.

**2-5. Modernized population allocation for urban water use planning: automated Census population estimation across different boundaries using parcels and building footprints**

Presenters: James Common (DWR); Melika Mani (DWR)
Presenters Email Addresses: James.Common@water.ca.gov; Melika.Mani@water.ca.gov
Collaborators: Salma Kibrya (DWR), Paul Shipman (DWR), Clayton Guiraud (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The purpose of this study was to better project population into different spatial areas. Previous studies have found that population to be the most representative proxy for residential urban water use. DWR explored various methods to estimate population by various spatial analysis units. Starting with pre-made ESRI tools for object detection, DWR assessed accuracy and compared it against existing building footprint datasets. DWR staff concurrently explored use of parcel data instead of building footprints for suitability as a proxy, noting that parcel data also contains zoning information useful for differentiation of residential from other types. DWR developed a consistent and reproducible strategy for estimating which DAU-County(s) each census block is located in, and subsequently the housing and population numbers, was developed using GIS-based data and tools. Various methods were explored to then distribute the population of a census block across the DAU-County(s) and these results went through post-processing review to meet specific criteria. Finally, DWR developed a spatially independent application of their tools that can be used to do similar work.

## Session 3: Multi-Dimensional Modeling of Hydrodynamics and Transport Processes the San Francisco Estuary

**Session Moderator: Ed Gross (GEI)**
**Moderator Email: ed@rmanet.com**

As management questions in the San Francisco Estuary become increasingly complex, multi-dimensional models are essential for resolving the fine-scale physics that drive system-wide dynamics. This session presents diverse model applications focused on the Sacramento-San Joaquin Delta which demonstrate how 2D and 3D models are being used to characterize hydrodynamics, transport pathways, mixing mechanisms, and resulting constituent concentrations across varying spatial scales.

### 3-1. Using Inflow Fingerprinting to Predict Dissolved Organic Carbon Distribution and infer Contributions from Marsh Plants and Aquatic Vegetation in the Sacramento-San Joaquin Delta

Presenters: Edward Gross (RMA/GEI)
Presenters Email Addresses: ed@rmanet.com
Collaborators: Rusty Holleman, Scott Burdick, Tamara Kraus, Brian Bergamaschi, Matt Young
Permission to Post pdf of Presentation on CWEMF Website: Yes

Low food web productivity in the northern San Francisco Estuary limits the growth and fecundity of native fish species, contributing to observed long-term population declines. The bioavailable portion of dissolved organic carbon (DOC) and particulate organic carbon (POC) from freshwater inflows, wetlands and aquatic vegetation, fuels the detrital food web utilized by pelagic fish. We quantified unknown loading from sources of DOC using a novel tracer-based DOC prediction approach and extensive DOC samples distributed throughout the California Delta. The proposed model predicted DOC reliably during a summer-fall period and estimated credible DOC inputs to the estuary and was validated using high-speed mapping observations of fluorescent dissolved organic matter (fDOM) collected concurrently with the DOC samples but over a larger spatial extent. DOC contributions from marsh and aquatic vegetation substantially affected surrounding regions, but far-field concentrations were primarily driven by refractory DOC from source waters.

### 3-2. Hydrodynamic Modeling of Fish Passage Structures, the Trilogy

Presenters: Rusty Holleman (RMA/GEI)
Presenters Email Addresses: rusty@rmanet.com
Collaborators: Ben Saenz, DWR staff
Permission to Post pdf of Presentation on CWEMF Website: No

DWR's South Delta Gates Project is investigating the replacement of temporary agricultural barriers in the Sacramento-San Joaquin Delta with permanent, operable gates. The proposed structures are intended to improve both water level management and fish passage. Analysis and iteration of the structure designs called for an approach that could efficiently consider many designs, account for hydrodynamic features at fish-relevant scales, and still capture how the proposed structures would affect water levels and circulation at regional scales.

A trio of hydraulic and hydrodynamic models spanning a broad range of spatial and temporal scales have been developed to support design of the fish passage. We describe how 3D OpenFOAM CFD models, 2D high-resolution HEC-RAS models, and Estuary-scale 1D DSM2 models were used to efficiently investigate the performance of potential designs. OpenFOAM CFD modeling provided a detailed view of velocities and a reference for calibration of HEC-RAS models. Tidal HEC-RAS 2D models estimated velocities within the fishway and reach-scale hydrodynamics. DSM2 simulations utilized HEC-RAS results to parameterize the structures and also supplied tidal boundary conditions to reach-scale models.

Freely available codes, including open-source CFD and CAD tools, supported a modeling process that fosters collaboration and permits external replication of results.

### 3-3. Estimating Zooplankton Transport from Suisun Marsh Duck Pond Effluent using a Multi-Model Approach

Presenters: Scott Burdick-Yahya (RMA/GEI)
Presenters Email Addresses: ScoBur4575@geiconsultants.com
Collaborators: Steve Andrews (GEI), Rosemary Hartman (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Suisun Marsh contains a large number of private and government owned and operated duck pond habitats. These habitats connect to the surrounding sloughs via flap gates that, when operated, allow the ponds to drain through gravity during low tide. Effluent water from the ponds is rich in zooplankton and other planktonic communities as a result of higher nutrient concentrations and longer residence times. Zooplankton are a crucial food web element for Suisun Marsh fish such as Delta Smelt and other aquatic organisms. In this study, Suisun Marsh duck pond outflows from structures draining using gravity are estimated using a set of HEC-RAS models. The HEC-RAS Suisun Marsh duck pond models were originally created to identify ponds that are slow or unable to drain using gravity. Estimated flow timeseries from the HEC-RAS models at each structure are input into a previously calibrated RMA Bay-Delta Model to better understand effluent fate and transport through Suisun Marsh. A tracer concentration, representing zooplankton, is applied to the duck pond effluent flow in the RMA Bay-Delta model. Heatmaps and point concentration time series are output from the model to determine zooplankton availability and concentrations during different times of the year and Suisun Marsh Salinity Control Gate operations. A spatially variable loss coefficient is also applied to in order to represent predation.

### 3-4. An Open, Reproducible Community Model for San Francisco Bay-Delta Environmental Hydrodynamics

Presenters: Stendert Laan (Deltares USA)
Presenters Email Addresses: stendert.laan@deltares-usa.us
Collaborators: Mick van der Wegen (Deltares, The Netherlands), Kees Nederhoff (Deltares USA)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Public agencies, researchers, and engineering and consulting practitioners need modeling tools that are credible, transparent, reproducible, and maintainable as decision needs evolve. We present the San Francisco Bay-Delta Community Model (www.d3d-baydelta.org), a freely available, open-source implementation in Delft3D Flexible Mesh (D-Flow FM).

The domain spans from the Pacific Ocean through San Francisco Bay into the Delta, enabling nesting in regional and global ocean models and reducing the need for interior boundary assumptions within the Bay. A multi-layer vertical discretization resolves stratification, mixing, and baroclinic circulation critical to salinity and temperature dynamics. The configuration is designed for modular extensions (e.g., particle tracking, fine-sediment dynamics, and water-quality processes). A lightweight depth-averaged variant can downscale sea level rise scenarios and compute climatological extremes along the Bay shoreline.

This talk emphasizes transferable infrastructure rather than a single case study: a validated baseline configuration, standardized forcing and boundary workflows, and consistent diagnostics for skill assessment and intercomparison. We illustrate how the model supports management questions including salinity intrusion under changing inflows and sea level, heat and stratification dynamics, evaluation of operational or infrastructure scenarios, and assessment of water-quality and sediment-related hypotheses. We conclude with practical pathways for adoption: how to run, adapt, and contribute improvements.

## Session 4: CalSim Updates and Applications
**Session Moderator: Jamel Lehyan (DWR)**
**Moderator Email: Jamel.Lehyan@water.ca.gov**

The California Department of Water Resources (DWR), United States Bureau of Reclamation (USBR), and consultants continuously work on updating, improving, and applying the CalSim 3 model for use in water resources planning studies. This session will provide an overview of recent updates to the CalSim 3 model and present important study applications of the model.

### 4-1. 2025 Delivery Capability Report Updates

Presenters: Jonathan Byers (DWR)
Presenters Email Addresses: jonathan.byers@water.ca.gov
Collaborators: Erik Reyes (DWR), Nazrul Islam (DWR), Andrew Schwarz (DWR), Richard Chen (DWR), James Polsinelli (DWR), Mohammad Hasan (DWR), Jianzhong Wang (DWR), Raymond Hoang (DWR), Nicole Osorio (DWR), Zachary Roy (DWR), Jamel Lehyan (DWR), Chris Quan (DWR), Devinder Dhillon (DWR), Malinda Wimalaratne (DWR), Hamed Zamanisabzi (DWR), Auhona Zaki (DWR), Nancy Parker (USBR), Tom FitzHugh (Stantec), Andy Draper (Stantec), Bridget Childs (Stantec), Dan Easton (MBK), Shankar Parvathinathan (MBK), Yiwei Cheng (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The California Department of Water Resources released the draft State Water Project Delivery Capability Report (DCR) for 2025 at the end of December. The DCR is used widely both within and outside the SWP for water supply planning. This presentation will provide an overview of the latest updates for the DCR existing conditions compared with the previous 2023 DCR. Updates include code fixes and adjustments to the baseline CS3 model, mainly attributed to the new SWP Incidental Take Permit (ITP) and the federal Biological Opinions (Long-Term Operations of the CVP/SWP).

### 4-2. SWP Adaptation Strategy Results

Presenters: Zachary Roy (DWR)
Presenters Email Addresses: zachary.roy@water.ca.gov
Collaborators: Raymond Hoang (DWR), John Andrew (DWR), Erik Reyes (DWR), Jesse Dillon (DWR), David Rennie (DWR), Carolyn Buckman (DWR), Molly White (DWR), Aaron Miller (DWR), Nazrul Islam (DWR), Zachary Roy (DWR), Jonathan Byers (DWR), Yiwei Cheng (DWR), Nicole Osorio (DWR), Jamel Lehyan (DWR), Mohammad Hasan (DWR), Z.Q. Richard Chen (DWR), Christopher Quan (DWR). Romain Maendly (DWR), Wyatt Arnold (DWR), Alejandro Perez (DWR), Thomas FitzHugh (Stantec), Puneet Khatavkar

(Stantec), Yuan Hui (Stantec), Jeffrey Weaver (HDR), Chandra Chilmakuri (State Water Contractors), Manny Bahia (State Water Contractors)
Permission to Post pdf of Presentation on CWEMF Website: Yes

This talk will discuss SWP's Adaptation Strategy, the first of its kind. This Plan outlines numerous strategies that the SWP is implementing to adapt to climate change including 5 key strategies (Enhanced Asset Management, Forecast Informed Reservoir Operations, Delta Conveyance, California Aqueduct Subsidence project, and South of Delta storage) that are modeled in CalSim3 to quantitatively evaluate how these strategies alone and in combination help prepare the SWP for a hotter more extreme future. The talk will cover the future conditions that have been evaluated, the results of the analysis showing how each strategy provides climate resiliency, and key findings and priorities for implementation of these strategies. The talk will also briefly cover what is next for DWR adaption planning and modeling.

**4-3. Integrating Watershed Management and System Operations**

Presenters: Karandev Singh (DWR)
Presenters Email Addresses: eric.tsai@water.ca.gov; karandev.singh@water.ca.gov
Collaborators: Eric Tsai (DWR); Karandev Singh (DWR); David Arrate (DWR); Wyatt Arnold (DWR); Alex Vidovichenko (DWR); Mehrdad Bastani (DWR); Begum Rushi (DWR); Francisco Flores-Lopez (DWR); James Weiking (DWR, retired); Walter Bourez (MBK); Shankar Parvathinathan (MBK); Dan Easton (MBK); Gerardo Carillo (MBK)
Permission to Post pdf of Presentation on CWEMF Website: Yes

This presentation examines the integrated performance of the San Joaquin Basin Watershed Studies and the State Water Project (SWP) Adaptation Strategy using CalSim. Following a brief overview of the Watershed Studies, the analysis focuses on how combined actions—such as FIRO, managed aquifer recharge, and conveyance improvements—interact across the system. Preliminary findings indicate that, when integrated, the portfolio has the potential to deliver robust multi-benefit outcomes, including improved water supply reliability, flood risk reduction, groundwater recharge, ecosystem enhancements, and expanded benefits for vulnerable communities.

**4-4. LTO Action 5**

Presenters: Cameron Koizumi (USBR)
Presenters Email Addresses: ckoizumi@usbr.gov
Collaborators: Nancy Parker (USBR), Ryan Lucas (USBR), Walter Bourez (MBK)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Record of Decision for Action 5 was signed on December 4th, 2025, amending the Long-Term Operations for the CVP that were implemented in 2024. In CalSim, Action 5 increases water supply by formalizing the removal of Fall X2 and through changes to OMR Management which increased export capacity. This presentation will detail the changes made to operations in CalSim and effects of those changes.

**4-5. A New View of Water — Upper American River Watershed Case Study**

Presenters: Yung-Hsin Sun (Sunzi Consulting); Jared Soares (Batker Consulting)
Presenters Email Addresses: sun.yunghsin@sunziconsulting.com; jsoares@eqmecon.com
Collaborators: David Batker; Rebecca Guo
Permission to Post pdf of Presentation on CWEMF Website: Yes

California formally recognizes its source watersheds as essential components of statewide water infrastructure, and the upper American River watershed is a key contributor. This watershed supports both regional and statewide water supplies, sustaining California's economy through an interconnected system of reservoirs, conveyance facilities, and water management operations. The relationship between source watersheds and downstream beneficiaries has gained increasing attention as more frequent and severe wildfires and droughts drive the need for resilient investment strategies for a sustainable future. Supported by El Dorado Water Agency, this study builds on simulated statewide water allocations using long-term water supply modeling tools, including CalSim 3 for the Central Valley Project/State Water Project system and the compatible ARIOps model for the upper American River watershed. Applying the benefit transfer method, this study assesses potential economic values of municipal and industrial, agricultural, and environmental uses supported by water originating from the upper American River watershed. Estimated values are derived from both at-source (market-based transfer values) and on-site (end-user) perspectives across multiple regions in California. Initial study results conservatively suggest that water originating from the upper American River watershed exceeds $1 billion per year in long-term average water allocation conditions. The estimated aggregated at-source values range from $1.1 billion to $1.5 billion annually, while the estimated on-site values range from $3.2 billion to $11.1 billion per year, reflecting additional local investments for end-use delivery. Application of this valuation framework within the American River Watershed Forecast-Informed Reservoir Operations Program is currently under development.

### Session 5: Lessons Learned from the DWR Watershed Resilience Pilot Program

**Session Moderator: Eric Tsai (DWR)**
**Moderator Email: eric.tsai@water.ca.gov**

In 2024, DWR launched a Watershed Resilience Pilot Program that focuses on managing water from headwaters to outflow at a watershed scale, prioritizing equity and inclusiveness, analyzing climate risks and adaptations at the watershed level, collaborating across water, flood, groundwater, water quality, forest/fire, ecosystem, and land use sectors, and developing metrics to track outcomes regionally and statewide.

The pilot program is the application of the policies described in the California Water Plan Update 2023, which emphasized the need for watershed-based solutions, climate resilience, and equity through collaboration with local partners to address climate extremes. The Watershed Resilience Program is an evolution of the Integrated Regional Water Management (IRWM) Program.

In 2024, the pilot program funded regional climate resilience planning projects in five different watersheds throughout the state: Calaveras, Pajaro, American, Russian, and Ventura. Each watershed organized a diverse watershed network, defined their watershed, conducted water budgets, analyzed multi-sector climate vulnerabilities, prioritized climate risks, developed adaptation strategies, identified performance tracking metrics, and documented their efforts in a Watershed Resilience Plan. All pilots will conclude in April 2026, and results will guide future DWR funding efforts.

This session will feature a panel with representatives from each of the five watershed pilots, moderated by Eric Tsai, DWR manager of the Watershed Resilience Pilot Program. After a five-minute introduction from DWR providing context and background, each watershed pilot representative will give a 15-minute presentation. Given the technical nature of CWEMF, presentations will focus on climate vulnerability assessments, prioritization of climate risks, and development and evaluation of climate adaptation strategies.

**5-1. Watershed Resilience Pilot Program: Statewide Context and Program Overview**

Presenters: Eric Tsai (DWR)
Presenters Email Addresses: Eric.Tsai@water.ca.gov
Permission to Post pdf of Presentation on CWEMF Website: Yes

**5-2. American Watershed Pilot: Regional Climate Resilience Planning**

Presenters: Regional Water Authority Representative
Permission to Post pdf of Presentation on CWEMF Website: Yes

**5-3. Calaveras Watershed Pilot: Climate Vulnerability and Adaptation Strategies**

Presenters: Stockton East Water District Representative
Permission to Post pdf of Presentation on CWEMF Website: Yes

**5-4. Russian Watershed Pilot: Integrating Climate Resilience at the Watershed Scale**

Presenters: Sonoma Water Agency Representative
Permission to Post pdf of Presentation on CWEMF Website: Yes

**5-5. Pajaro Watershed Pilot: Multi-Sector Climate Risk Assessment**

Presenters: Pajaro Valley Water Management Agency Representative
Permission to Post pdf of Presentation on CWEMF Website: Yes

**5-6. Ventura Watershed Pilot: Building Watershed Resilience through Collaboration**

Presenters: Ventura County Resource Conservation District Representative
Permission to Post pdf of Presentation on CWEMF Website: Yes

## Session 6: Building Integrated Forecasting, Operations, and Planning Frameworks for Water and Power Resource Management

**Session Moderator: Eric Mork**

This session will explore diverse approaches to integrating forecasting, operations, and planning in water resource and power management across various entities in the United States. Featuring case studies from the Tennessee Valley Authority, Sonoma Water, California Nevada River Forecast Center, and the Colorado River Storage Project. Speakers will demonstrate how advanced modeling and data-driven strategies enhance resilience and optimize complex water-energy systems. Presentations will also delve into the challenges encountered on the path to their current operational successes, providing valuable perspectives and transferable lessons that can inform and benefit water and energy modeling efforts both within California and beyond.

**6-1. An Overview of the California-Nevada River Forecast Center and the Role They Play in Forecast Informed Reservoir Operations**

Presenters: Brett Whitin (California Nevada River Forecast Center)
Presenters Email Addresses: brett.whitin@noaa.gov
Permission to Post pdf of Presentation on CWEMF Website: Yes

The California-Nevada River Forecast Center (CNRFC) is a field office of the National Weather Service

(NWS), and is co-located with the California Department of Water Resources (DWR) and United States Bureau of Reclamation (USBR) at the Joint Operations Center in Sacramento, CA. River forecasts are issued jointly by the CNRFC and DWR daily, and more frequently during high water events. Forecasts are issued for over 300 locations throughout California and Nevada including 80 reservoir inflow forecast locations. The primary streamflow forecast services include a single value 5-day forecast, and 365-day ensemble forecasts. The ensemble forecasts are created using the Hydrologic Ensemble Forecast Service (HEFS). Over the past decade, the CNRFC has been working closely with the water management community to assist in integrating HEFS forecasts into risk-informed reservoir release strategies for both short and long term objectives. Much of this work has come through Forecast Informed Reservoir Operations (FIRO) studies. This talk will provide an overview of CNRFC streamflow products and services and the role they play in supporting forecast informed reservoir operations within California.

### 6-2. Russian River Forecast Informed Reservoir Operations – Planning to Implementation

Presenters: Chris Delaney (Sonoma Water)
Presenters Email Addresses: chris.delaney@scwa.ca.gov
Collaborators: John Mendoza (Sonoma Water), Jay Jasperse (Sonoma Water), Patrick Sing (USACE), Mike Konieczki (HDR), Brett Whitin (CNRFC)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Lake Mendocino, located near the headwaters of the Russian River, has been plagued by water supply challenges due to changes in operations in 2006 of the Potter Valley Project (PVP), a small hydro-electric facility owned and operated by Pacific Gas and Electric located a short distance upstream of Lake Mendocino that diverts water from the Eel River and discharges to the Russian River for the production of hydropower. Sonoma Water began working with the U.S. Army Corps of Engineers (USACE) in 2014 to evaluate the viability of Forecast Informed Reservoir Operations (FIRO) for Lake Mendocino to effort to help alleviate the water supply reliability issues caused by changes in operation of the PVP and improve flood control management. Sonoma water assisted in the development of methodologies, models, and analysis that were critical to demonstrate the viability of FIRO, which led to 8-years of interim implementation (2018-2025) and ultimately full implementation through the modification of the Lake Mendocino Water Control Manual this past Fall. Based on the success at Lake Mendocino, Sonoma Water is currently working with the USACE to evaluate FIRO at Lake Sonoma, the largest reservoir in the Russian River watershed. Sonoma Water has also developed FIRO decision support tools that utilize hydrologic forecasts issued from the California Nevada River Forecast Center to support real time operations at Lake Mendocino and Lake Sonoma.

### 6-3. The Story of TVA's River and Reservoir Management

Presenters: Matthew G. Montgomery (TVA)
Presenters Email Addresses: mgmontgomery0@tva.gov
Collaborators: James Everett (TVA)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Tennessee Valley Authority (TVA) boasts a nearly century-long legacy of integrated river and reservoir management, rooted in its mission to serve the people of the United States through electricity, environmental stewardship, and economic development. This presentation by James Everett, TVA's River Management lead, will trace the evolution of TVA's sophisticated decision support value chain, highlighting its systematic approach from data collection and validation through integrated and calibrated models, to optimization with uncertainty, and visualization of solutions for informed decisions.

The discussion will cover TVA's programmatic areas in Reservoir and River Management, including Water Quality Support (Reservoir Release Improvements, Hydrothermal Program), Navigation Program, and Hydrologic Impacts and Risk Evaluation (HIRE), which encompasses hydraulics, hydrology, flood risk, and water supply programs. Mr. Everett will detail how TVA's River Forecast Center, staffed 24/7, continuously monitors the river system, leveraging advanced modeling from its origins in empirical relationships to today's rapid expansion of computing power, probabilistic forecasting, and real-time operations. The presentation will showcase TVA's deployment of Riverware for 6-hour and 1-hour optimization and simulation, illustrating its application in creating hourly hydropower schedules, daily flow forecasts, and long-term hydro forecasts. Finally, the session will underscore how TVA's consolidation of modeling tools and systems, embracing big data and AI, accelerates decision-making and ensures resilient and sustainable management of its vast water and power resources.

**6-4. Keeping the lights on with the Colorado River Storage Project**

Presenters: Matija Pavicevic (Argonne National Lab)
Presenters Email Addresses: mpavicevic@anl.gov
Collaborators: Ao Yu (ANL), Quintin Ploussard (ANL), Jerry Wilhite (WAPA)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Large hydropower reservoirs on the Colorado River increasingly operate at the intersection of hydrologic volatility, competitive electricity markets, and stringent environmental requirements. This talk frames “keeping the lights on” as an operations problem: how to schedule storage and releases so that hydropower remains reliable and economically competitive while also meeting downstream flow and temperature objectives that can constrain when and how water is used.

We introduce a risk-informed reservoir management approach for the Aspinall Cascade within the Colorado River Storage Project that is aligned with the Colorado River Mid-term Modeling System (CRMMS) 24 month study process. The central concept is to treat forecast error as an operational input: historical CRMMS inflow and release errors are repurposed to generate ensembles of plausible “virtual water years,” preserving temporal structure and cascade mass balance. These ensembles are evaluated with an hourly hydromarket co-optimization model that jointly schedules generation, day-ahead and real-time trading, and ancillary services subject to elevation, ramping, and drawdown constraints, while operational “guardrails” maintain feasible storage and release trajectories.

**6-5. Bulletin 120 Water Supply Forecasts in a Changing Climate**

Presenters: Jacob Kollen (DWR)
Presenters Email Addresses: Jacob.Kollen@water.ca.gov
Permission to Post pdf of Presentation on CWEMF Website: Yes

The California Cooperative Snow Surveys program was established by the State Engineer in 1928 to cooperatively collect snow data used to forecast seasonal surface water supplies across California. The program has been administered by the California Department of Water Resources since inception in 1956. The program currently includes more than 50 cooperating organizations and has evolved alongside advances in observational and forecasting technologies.

Motivated by the anticipated impacts of climate change on precipitation and snowpack in California, a flurry of forecast modernization efforts has been undertaken in recent years. This presentation covers challenges faced this water year and provides an overview of modernization efforts addressing limitations in the program's observational network, forecasting capabilities, and decision-support systems.

Observational efforts include robust station builds, expansion of soil moisture monitors, and establishing a cold content monitoring initiative. Forecasting upgrades include the integration of two neural network derived products, a 6-day quantitative precipitation forecast product and a daily spatially distributed snow product. Decision-support system efforts include the launch of Bulletin 120 Operations Tool, a forecast operations software, and the launch of SnowTrax, a data driven public facing website.

Together, these efforts aim to strengthen forecast accuracy and usability under increasingly variable hydroclimate conditions.

## Session 7: Updates in CalSim Development

**Session Moderator: Zachary Roy (DWR)**
**Moderator Email: zachary.roy@water.ca.gov**

CalSim and its associated tools continue to evolve to meet increasingly complex water management challenges and questions. This session highlights a variety of recent enhancements to the CalSim toolbox.

### 7-1. CalSim Solvers Benchmarking

Presenters: Jon Herman (UC Davis)
Presenters Email Addresses: jdherman@ucdavis.edu
Collaborators: Samarth Singh; Yiwei Cheng; Zachary Roy; Jamel Lehyan
Permission to Post pdf of Presentation on CWEMF Website: Yes

The CalSim3 model depends on mixed-integer linear programming solvers whose runtimes may vary substantially depending on problem size and complexity. CalSim3 currently uses the open-source CBC solver by default, but can also use commercial solvers such as XA and Gurobi.

This study benchmarks CBC, XA, and Gurobi solvers using the 1921–2021 CalSim3 runs from the 2023 Delivery Capability Report. Analyses include solver runtime in serial and parallel modes, comparison of decision variables and objectives, and sensitivity to solver parameters and infeasibility handling. Results show significant speed improvements using commercial solvers with similar solution quality, though solver behavior varies under multi-threading and infeasibility conditions.

### 7-2. CalSim Cycle Structure

Presenters: Thomas FitzHugh (Stantec)
Presenters Email Addresses: thomas.fitzhugh@stantec.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

CalSim3 uses optimization modeling concepts to simulate SWP and CVP operations, solving more than 35,000 mixed-integer linear programming problems during a typical run. To manage this complexity, CalSim employs a series of interdependent solution cycles.

This presentation explains the CalSim3 cycle structure, describes the purpose of each cycle, and illustrates when cycle modifications are needed to represent new operations.

### 7-3. CVP California Allocation Module Development

Presenters: Cameron Koizumi (USBR)
Presenters Email Addresses: ckoizumi@usbr.gov
Collaborators: Raymond Hoang; Tom FitzHugh
Permission to Post pdf of Presentation on CWEMF Website: Yes

Central Valley Project allocations in CalSim are currently determined through correlations between water supply and export capacity, with parameters manually adjusted. The California Allocation Module (CAM) has been developed as a potential replacement to unify CVP and SWP allocation methodologies.

CAM is a multi-step optimization module that uses forecasted inflows to maximize allocations while meeting regulatory requirements and maintaining user-defined storage levels. This presentation describes CAM and ongoing efforts to adopt this new allocation approach.

### 7-4. WRESL+ Compiler Updates

Presenters: Hamed Zamanisabzi (DWR)
Presenters Email Addresses: hamed.zamanisabzi@water.ca.gov
Collaborators: Nicky Sandhu; Hao Xie; Can Dogrul; Zachary Roy
Permission to Post pdf of Presentation on CWEMF Website: Yes

WRESL+ is the core language used within the WRIMS framework to define optimization-based water resources models. Its compiler, built on ANTLR, parses model logic into internal structures used by WRIMS solvers.

This presentation provides an update on the migration from ANTLR version 3 to version 4, driven by the need for improved maintainability, extensibility, and compatibility with modern Java tools. The update focuses on simplifying grammar specifications, improving error handling, and maintaining backward compatibility to support future model development.

## Session 8: News from the Klamath Basin

**Session Moderator: Yung-Hsin Sun (Sunzi Consulting)**
**Moderator Email: sun.yunghsin@sunziconsulting.com**

Over the past two years, few river basins have drawn as much attention as the Klamath River Basin. The removal of four hydropower dams, together with the completion of nearly 14,000 acres of wetland restoration through the Agency Lake–Barnes Unit Reconnection Project in Upper Klamath Lake, has fundamentally reshaped the basin's physical and operational landscape. These changes introduce a new management context characterized by significant opportunities, operational challenges, and uncertainty.

State and federal agencies are advancing a range of water management efforts in response to these major physical changes and address persist challenges. These efforts are supported by improved modeling tools, technological advancements, best practices, and enhanced collaboration. This session highlights selected technical studies and efforts that address evolving management needs in the basin.

**8-1. Integrated Surface-Water and Groundwater Modeling of the Shasta River Watershed**

Presenters: Vivek Bedekar (SSP&A), John Riverson (Paradigm)
Presenters Email Addresses: vivekb@sspa.com; john.riverson@ulteig.com
Collaborators: Ashish Kondal (Paradigm), Jack Wang (SSP&A), Ali Tasdighi (Paradigm), Shahab Araghinejad (State Water Resources Control Board)
Permission to Post pdf of Presentation on CWEMF Website: Yes

An integrated hydrologic modeling framework was developed for the Shasta Watershed to improve understanding of watershed processes and to support water-resources management. The modeling approach explicitly couples surface-water and groundwater systems, incorporating key meteorological drivers including precipitation (rainfall and snowfall), evaporation, and evapotranspiration. Natural hydrologic processes such as runoff, interflow, baseflow, and spring discharge were represented, with particular emphasis on the watershed's unique hydrogeologic setting, including spring flows sustained by volcanic features such as lava tubes.

**8-2. What Would the River Do: The Question behind the Klamath River Basin Revised Natural Flow Study**

Presenters: Caroline Ubing (USBR)
Presenters Email Addresses: cubing@usbr.gov
Collaborators: Jonathan Traum (USGS)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Klamath River Basin Revised Natural Flow Study (NFS) is designed to improve understanding of natural streamflow conditions under pre-development scenarios and to better characterize relationships among hydrology, Klamath Project operations, and aquatic ecosystems throughout the basin. The study is designed to produce a foundational natural flow framework for the period from 1981 through 2020 that can support scenario planning, evaluation of "what-if" conditions, and informed water management decision-making. Development of the NFS follows a phased and iterative approach. Initial efforts focus on the upper watershed within the Klamath Project area, with future phases planned for the lower watershed. The resulting datasets, tools, and models are intended to support a wide range of applications, including habitat suitability assessments, drought planning, streamflow forecasting, water operations analyses, and other water resources investigations.

The revised NFS reflects a significant expansion of the earlier natural flow efforts conducted in the mid-2000s by incorporating updated data, methods, and modeling approaches, as well as overall process for study development. This presentation provides an overview of the study's vision, scope, key technical elements, and phased implementation strategy, as well as the stakeholder engagement process designed to promote transparency and collaborative development.

**8-3. Disappearing Act of Water: Simulated Changes in Open Water Evaporation Across Upper Klamath Basin as a Result of Agricultural Development and Reservoir Impoundment**

Presenters: Kristin Mikkelson (USBR)
Presenters Email Addresses: kmikkelson@usbr.gov
Collaborators: Marketa McGuire (USBR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Over the past 150 years, anthropogenic modifications in the Upper Klamath River Basin have fundamentally altered the regional hydrologic budget. Open-water evaporation is a key but often underexamined component of this budget, particularly in basins that have experienced extensive drainage of shallow lakes and wetlands alongside dam and reservoir construction.

In this study, we quantify changes in open-water evaporation under pre-development (circa 1850) and current conditions (water years 1981–2020) using a newly developed daily lake evaporation model. The analysis integrates observed water surface elevations, area–capacity relationships, remotely sensed surface water extents, and historical maps to estimate evaporation rates and volumes across the basin. Climate forcings are held constant between scenarios to isolate the effects of changes in waterbody depth and surface area on evaporative losses.

Results indicate that while evaporation rates are similar between pre-development and current conditions, annual evaporative volumes were 36% to 87% higher under pre-development conditions, primarily due to the presence of extensive shallow lakes that have since been drained for agricultural development. Uncertainty is quantified by accounting for biases in meteorological forcings, advective heat fluxes, and limited knowledge of daily waterbody depths. These findings suggest that historical water management and landscape modifications substantially influenced evaporative losses. Applying adaptative changes in these practices could potentially offset the projected 16% increases in global mean annual lake evaporation rates by the end of the 21st century under climate change conditions.

**8-4. The Situation was Fluid (Pun Intended): Modeling Exchange Flows between the Klamath River and Pre-development Lower Klamath Lake**

Presenters: Colin Byrne (USBR)
Presenters Email Addresses: cbyrne@usbr.gov
Collaborators: Marketa McGuire (USBR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

As part of the Klamath River Basin Revised Natural Flow Study, hydraulic modeling of surficial flows was conducted at key locations of water storage and exchange important to the calculation of daily flow estimates. One of those locations was the length of the Klamath River between the Link River outlet and Keno, Oregon.

In pre-development conditions, the Klamath River could lose water through the Lost River Slough or exchange water with the historically larger Lower Klamath Lake. The Klamath River-Lower Klamath Lake system was a highly complex, large wetland and dependent on antecedent streamflow and water surface elevation conditions in the river and lake, respectively. Therefore, a two-dimensional modeling approach of the exchange was conducted to produce a reasonable prediction of the streamflow exchange between the two water bodies.

Using the Sedimentation and River Hydraulics – Two-Dimensional model, unsteady and steady modeling scenarios were run, and a quasi-unsteady modeling analysis was conducted to provide information for daily flow prediction at Keno, OR. Predictions of Klamath River losses to the Lost River Slough and exchange flows with Lower Klamath Lake were calculated for a range of possible lake water surface elevations and Klamath River discharges resulting in a look-up table to be used in daily flow calculations. Calibration of the model was sensitive to the assigned effective wetland elevation. Results indicate that the Klamath Lake-Lower Klamath Lake system was self-moderating but that large quantities of water could be diverted out of the Klamath River through the Lost River Slough during flood events.

**8-5. Managing the Unknown Unknown: The Klamath Project Operations in the Post-Dam Removal Era**

Presenters: Brock Phillips (USBR); Viktor Stromberg (USBR)
Presenters Email Addresses: bphillips@usbr.gov; vstromberg@usbr.gov
Collaborators: Yung-Hsin Sun (Sunzi Consulting)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Operating a multipurpose water project under multiple authorities and regulatory requirements is inherently complex. The Klamath Project has a long and highly contested operational history. Concurrent with dam removal activities, US Department of the Interior, Bureau of Reclamation and resource agencies worked with stakeholders to develop a new operational framework to guide project operations in the post–dam removal era.

The resulting framework, prescribed in the 2024 Biological Opinions, is intended to more effectively balance agricultural water supply, environmental objectives, and Tribal cultural practices. Key elements include the use of combined hydrologic forecasts; basin-specific indices and decision-support tools; newly established water accounts with defined accumulation and use protocols; and more integrated operations designed to increase flexibility and incentivize collaboration among water users and stakeholders. An After-Action Review process was also conducted to distill operational lessons learned during consultation and dam removal, informing the design of post-removal operations.

The first year of Klamath Project operations provides an opportunity to evaluate the validity of assumed conditions and the effectiveness of newly established operational strategies and protocols. This presentation summarizes the technical basis for the new operational framework, highlights outcomes from first-year operations, and provides a summary of potential adaptive management considerations and operational adjustments moving forward.

## Session 9: Modelling Operational Risks Arising from the Joint Operations of the Central Valley and State Water Projects

**Session Moderator: Harrison Zeff (University of North Carolina at Chapel Hill)**
**Moderator Email: zeff@live.unc.edu**

Operational decisions related to complex water system involve tradeoffs between multiple social, economic, and environmental objectives. In many cases, these tradeoffs are evaluated at the coarse temporal and spatial scales required by long-term planning models, but water users and other stakeholders can be subject to risks that emerge from variability across much smaller scales. Planning for and mitigating these risks requires operational models capable of simulating this variability under a wide range of potential future scenarios. This session will present several modelling activities that use novel modelling tools to simulate State Water Project (SWP) and Central Valley Project (CVP) operations under uncertain future conditions at a daily timestep. The session brings together researchers working to make highly resolved projections of hydropower generation, water markets, energy storage, and forecast-informed reservoir operations (FIRO) related to SWP and CVP operations. Presentations will illustrate the challenges in developing, validating, and maintaining such models, as well as the opportunities they provide decision-makers to supplement existing operational models with more detailed short- and mid-term forecasts.

### 9-1. Managing water market-based financial risks with California Water Index futures contracts

Presenters: Dan Li (University of North Carolina at Chapel Hill)
Presenters Email Addresses: danli@unc.edu
Collaborators: Harrison B Zeff (University of North Carolina at Chapel Hill), Rohini Gupta (Cornell University), and Gregory W Characklis (University of North Carolina at Chapel Hill)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Well-designed water markets can help to reallocate limited water supplies to higher-value uses, easing financial pressures caused by drought. However, markets in water-scarce regions are often thin and volatile. Interannual hydrologic variability can drive sharp price fluctuations, exposing both buyers and sellers to significant financial risk. California's jointly operated State Water Project (SWP) and Central Valley Project (CVP) play an integral role in one of the world's most active and institutionally complex water markets. Using a daily timestep simulation model of SWP and CVP operations, we evaluate water price indices under an ensemble of future streamflow conditions in an effort to predict future prices at 1-, 3-, and 6-month time horizons that match typical decision timeframes for large California water users. Our results reveal strong short-term predictability from lagged prices and increasing dominance of reservoir storage at longer horizons, with r-squared values of 0.9, 0.79, and0.61 for 1-, 3-, and 6-month forecasts. Hedging strategies that incorporate forecast-uncertainty filters reduce tail risk and expected water costs by 14.1% and 16.7%, respectively, when using 6-month futures with a 50% hedging target. This scalable framework offers a structured way to quantify forecast capacity and assess financial risk management strategies in water markets.

**9-2. California reservoir network optimization with daily ensemble hydrologic forecasts**

Presenters: Jonathan Herman (University of California, Davis)
Presenters Email Addresses: jdherman@ucdavis.edu
Permission to Post pdf of Presentation on CWEMF Website: Yes

Many of the water supply opportunities in California depend on the safe conveyance of infrequent, high magnitude flood events. However, there is a gap in timescale and spatial scale between the operational models used for flood control and the water supply models used for system-level planning. This study develops a model for the Sacramento-San Joaquin system that combines the benefits of both approaches: network optimization with routing and daily ensemble hydrologic forecasts. A model predictive control method is used to maintain target storage and downstream constraints, leading to a convex optimization problem solved on a rolling horizon. The ensemble forecasts are updated daily using a recently developed hindcast dataset from CNRFC HEFS. Results for the flood event of record (1997) show that the HEFS policy achieves most of the possible benefit of a perfect short-term (14-day) forecast. Extensions to CVP/SWP water supply modeling with seasonal forecasts are ongoing, aiming to support downstream storage and groundwater banking opportunities while maintaining environmental flows.

**9-3. Exploring opportunities for energy storage within the Central Valley Project**

Presenters: Quentin Ploussard (Argonne National Laboratory)
Presenters Email Addresses: qploussard@anl.gov
Permission to Post pdf of Presentation on CWEMF Website: Yes

The power grid is rapidly changing, and energy storage is increasingly needed to efficiently incorporate renewables during times of excess. The Central Valley Project and State Water Project are both major producers and users of energy on the bulk electrical grid. Their operations effect grid efficiency and provide large amounts of flexible generating capacity which can be used to balance energy supply and demand, as well as provide a variety of grid services. The Department of Energy has funded investigations to evaluate the potential to incorporate energy storage within the CVP. This presentation simulates CVP operations at a daily timestep to evaluate potential for increased pumped storage hydropower at San Luis Reservoir and battery hybridization options for the CVP.

**9-4. Assessing financial risk due to hydrometeorological variability: A case study using WAPA's hydropower customers**

Presenters: Ahmed Hamed (University of North Carolina at Chapel Hill)
Presenters Email Addresses: ahmedh@unc.edu
Collaborators: Yash Amonkar (University of North Carolina at Chapel Hill), Eric Mork (Western Area Power Authority), and Gregory W. Characklis (University of North Carolina at Chapel Hill)
Permission to Post pdf of Presentation on CWEMF Website: Yes

California's large water management projects operate under multiple, competing objectives that limit application of simple statistical or optimization-based procedures. System operations are governed by a strict hierarchy in which environmental flow requirements are prioritized first, followed by agricultural and urban water deliveries, and finally hydropower generation. Consequently, reservoir operations are not optimized for energy production, and hydropower variability emerges from rules-driven reservoir release decisions. To address this challenge, we employ CALFEWS, an open-source, rules-based daily simulation model of surface water operations across California's Central Valley. CALFEWS explicitly integrates environmental, regulatory, flood-control, and delivery constraints. Furthermore, the daily temporal resolution is critical for capturing operational dynamics that directly affect hydropower generation yet are obscured at coarser timesteps. Using CALFEWS, we generate daily forecasts of hydropower generation for the Central Valley Project (CVP) and demonstrate CALFEWS' forecasting skill. We further translate forecast skill into economic relevance by evaluating financial risk faced by Western Area Power Administration's (WAPA) customers. WAPA markets surplus CVP hydropower as a percentage-based resource. This contractual structure exposes customers to volumetric supply risk primarily driven by hydrometeorological variability. Customers meet hydropower shortfalls through purchases in the spot and forward electricity markets, often during periods of elevated prices. By quantifying financial losses associated with hydropower forecast errors and supply risk, this framework highlights the monetary value of improved, rule-consistent hydropower forecasting for federal power agencies, utilities, and public-sector energy consumers.

**9-5. SGMA Implementation through Modelling and Economics**

Presenters: Tori Laird; Duncan MacEwan (ERA Economics)
Presenters Email Addresses: tori@eraeconomics.com; duncan@eraeconomics.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

Achieving groundwater sustainability under the Sustainable Groundwater Management Act (SGMA) requires integrated modeling frameworks that couple hydrogeologic simulation with economic analysis. This presentation examines how advanced modeling approaches can evaluate management scenarios, optimize project portfolios, and inform economically viable pathways to GSP implementation.
We present methodologies for linking groundwater models with economic optimization frameworks to assess sustainability strategies. Our approach uses calibrated groundwater models to simulate hydrologic responses to management actions—including demand reduction, recharge enhancement, and pumping modifications—and then feeds these outputs into economic models that evaluate costs, benefits, and distributional impacts across stakeholder groups.

Key modeling applications include scenario analysis of alternative management portfolios, optimization of incentive program design, and sensitivity analysis of economic parameters affecting program feasibility. We demonstrate how coupled models can quantify trade-offs between management alternatives, assess timing and sequencing of projects, and evaluate long-term sustainability under different climate and economic conditions.

Case studies from the Napa Valley, Salinas Valley, and Madera Subbasins illustrate practical modeling workflows. In Napa Valley, we demonstrate integration of interconnected surface water modeling, groundwater dependent ecosystem assessments, and economic analysis of demand management incentives tailored to the wine industry and agricultural stakeholders. Additional examples address data integration challenges, calibration approaches for economic parameters, and methods for translating model outputs into actionable management recommendations.

This work demonstrates that integrated hydro-economic modeling provides essential decision support for SGMA implementation, enabling stakeholders to evaluate sustainability pathways using quantitative, transparent frameworks that account for agricultural economics, community impacts, and environmental objectives.

### 9-6. Statewide Economic Modelling at the Groundwater Sustainability Agency (GSA) Resolution

Presenters: Brooks Ronspies; Josh Virene (ERA Economics))
Presenters Email Addresses: Brooks@eraeconomics.com, Josh@eraeconomics.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

Evaluating economic impacts of water policy and management decisions requires modeling frameworks that operate at spatial scales consistent with water budgets. This presentation describes development and application of a statewide economic model calibrated to individual GSA boundaries, enabling comprehensive assessment of water policy impacts, project evaluation, and water transfer prices across California's diverse groundwater basins.

We present a coupled modeling approach linking agricultural production models with economic analysis at GSA resolution. The framework integrates GSA-level water budgets—accounting for planned projects, demand management programs, and historical water supply variability—with detailed agricultural enterprise budgets calibrated to current market conditions. Model calibration utilized stakeholder interviews and published data sources to ensure accurate representation of local production systems, costs, and economic returns across different cropping patterns and management practices.

The modeling framework quantifies economic impacts across multiple applications: SGMA implementation scenario analysis, statewide water policy evaluation, individual project cost-benefit assessment, and water transfer pricing analysis. The GSA-scale resolution enables identification of geographic variation in economic outcomes, supporting targeted policy design and understanding of distributional impacts.

Applications span the San Joaquin Valley and Sacramento Valley, demonstrating the model's versatility for informing diverse water management decisions across California's major agricultural regions. We present an interactive R Shiny tool developed to visualize GSA water budgets and sustainable yield calculations, providing stakeholders with accessible platforms for exploring water availability and economic trade-offs under different management scenarios.

This work provides decision-makers with quantitative tools for evaluating water policies and projects while accounting for regional economic diversity and groundwater basin characteristics statewide.

**Session 10: An Update on the COEQWAL Project: Understanding and Communicating Alternative California Water Futures Across Multiple Domains**
**Session Moderator: James Gilbert (UC Santa Cruz)**
**Moderator Email: james.gilbert@noaa.gov**

This session provides updates on the collaborative UC-led COEQWAL (COllaboratories for EQuity in Water ALlocations) project. The project brings together academic research teams, agencies, and diverse publics to co-create scenarios representing combinations of possible water policy and operational changes under plausible future climates. A COEQWAL session at the 2025 CWEMF meeting outlined the project goals and described the types of scenarios and outcomes being developed. The presentations in this year's session will highlight progress in operations and climate change scenario implementation, analysis to synthesize outcomes across CalSim3 and related models, as well as the community-informed data platform and website.

**10-1. COEQWAL: A collaboratory for water equity and resilience**

Presenters: Ted Grantham (UC Berkeley)
Presenters Email Addresses: tgrantham@berkeley.edu
Collaborators: James Gilbert (UC Santa Cruz), Wietske Medema (UC Berkeley), Eric Danner (UC Santa Cruz), Morgan Levy (UC San Diego), Brett Milligan (UC Davis), Jill Fantauzza (UC Berkeley)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Building an equitable and resilient water future for California requires new tools to enhance engagement and diversify participation in water allocation-decision making. To meet this need, we launched COEQWAL (COllaboratory for EQuity in Water Allocations), in which academic research teams are partnering with agencies and community partners to co-create scenarios of water policy, infrastructural, and operational changes under future climates. Alternative water futures are being evaluated using a statewide water planning model, CalSim3, and are hosted on a public data platform, where users can access, filter, and investigate scenario outcomes and tradeoffs through data visualizations and storytelling methods. This talk will highlight research findings and approaches that seek to engage diverse audiences, enhance water literacy, and promote participatory water planning in California.

**10-2. Future Hydroclimates from Physical and Statistical Models**

Presenters: Morgan Levy (UC San Diego)
Presenters Email Addresses: mclevy@ucsd.edu
Collaborators: Sudarshana Mukhopadhyay (UC San Diego); Lu Su (UC San Diego); Dan Cayan (UC San Diego)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Efforts by government agencies and academic communities have led to the development of complex physical model-based meteorological and hydrological projections, as well as efficient and flexible statistical model-based projections such as those from stochastic weather generators. Both approaches are being used in California water resource planning, but there has been limited evaluation of differences between these products and the hydroclimate futures they represent. We present an initial assessment of projected changes in temperature, precipitation, and unimpaired streamflow within and across major California water supply watersheds and climate projection sources. For the physically-based projections, we employ LOCA2 downscaled CMIP6 precipitation and temperature datasets and associated Variable Infiltration Capacity (VIC) hydrologic model simulations. The statistical projections come from a stochastic weather generator developed for the California Department of Water Resources, similarly used to drive hydrologic model simulations. While temperature projections are relatively consistent across models, basin precipitation, flow, and flow timing differ by season, warming level, and latitudinal position. These differences are greatest at higher warming levels and reflect contrasting representations of seasonal shifts and regional variability in physical versus statistical models. This work is intended to inform water resources modeling under a changing climate, with the recognition that uncertainty and variability in climate products pose significant modeling and communication challenges in the water management sector.

**10-3. Exploring an Expanded Scope of Operational Alternatives for California**

Presenters: James Gilbert (UC Santa Cruz)
Presenters Email Addresses: james.gilbert@ucsc.edu
Collaborators: Ted Grantham (UC Berkeley), Eric Danner (UC Santa Cruz), Brett Milligan (UC Davis), Nancy Thomas (UC Berkeley), Wietske Medema (UC Berkeley), Morgan Levy (UC San Diego), Dino Bellugi (UC Berkeley), Iftikhar Islam (UC Santa Cruz), Abhinav Sharma (UC Santa Cruz)
Permission to Post pdf of Presentation on CWEMF Website: Yes

A major goal of the COEQWAL project is to consider operational policies that expand beyond the options commonly evaluated for official agency analysis. Using multiple rounds of feedback from a steering committee and engaged community members, we identified areas for water management alternatives that build upon or complement recent or ongoing agency proposals. We crafted the resulting COEQWAL CalSim3 scenarios to be exploratory and informative - to help those interested in understanding the consequences (both good and bad) of emphasizing particular policies and actions. These actions include variations in current operations, groundwater sustainability interventions, enhanced functional flows on Delta tributaries, prioritization of drinking water, and assorted regulatory modifications. This presentation provides a summary of the development and implementation of these scenarios in CalSim3 as well as selected results that highlight the range of outcomes being produced.

**10-4. Interpreting scenario outcomes: metrics, tiered thresholds, and trade-offs**

Presenters: Wietske Medema (UC Berkeley)
Presenters Email Addresses: wmedema@berkeley.edu
Collaborators: Ted Grantham (UC Berkeley)
Permission to Post pdf of Presentation on CWEMF Website: Yes

As climate pressures intensify, water management decisions increasingly rely on modeled scenarios that generate large volumes of complex outputs. A central challenge is not only producing these scenarios but enabling shared interpretation across diverse priorities and perspectives. This presentation introduces an interpretive framework developed through COEQWAL (Collaboratory for Equity in Water Allocations) to support transparent and actionable understanding of scenario outcomes.

The framework integrates performance metrics, tiered thresholds, and trade-off visualizations. Tiered thresholds translate technical outputs into meaningful condition ranges - from critical to thriving - grounded in ecological function and water system performance. These thresholds provide a consistent structure for interpreting outcomes across sectors and outcome types.

Trade-off visualizations reveal how outcomes move together or diverge under different management strategies, highlighting tensions and synergies across objectives.

Rather than prescribing optimal solutions, this approach creates a structured and transparent space for comparing scenarios and making underlying assumptions explicit. By shifting the focus from model outputs to interpretation, this framework helps make complex information more legible, comparable, and useful for decision-making under uncertainty.

### 10-5. Building a FAIR Collaboratory for Equity in Water Allocation

Presenters: Nancy Thomas (UC Berkeley)
Presenters Email Addresses: nethomas@berkeley.edu
Collaborators: Jill Fantauzza (UC Berkeley), Ted Grantham (UC Berkeley), Wietske Medema (UC Berkeley), James Gilbert (UC Santa Cruz), Meli Jimenez Araya (UC Berkeley), Yun-Hsin Kuo (UC Davis), and Yuyu Kawakami (UC Davis)
Permission to Post pdf of Presentation on CWEMF Website: Yes

California's water planning relies on complex system models like CalSim3, which generate massive datasets historically accessible only to specialized technical experts. This data bottleneck restricts broader stakeholder participation in critical water management decisions. The Collaboratory for Equity in Water Allocation (COEQWAL) advances water science by engaging diverse water users—communities, farmers, cities, Tribal Nations, and environmental managers—to co-envision a more just and sustainable water future.

Through this collaborative process, we're building an interactive, cloud-based data platform and web application. Built on FAIR (Findable, Accessible, Interoperable, and Reusable) data principles, the application serves as a centralized hub that translates complex CalSim3 simulation outputs into actionable insights. The COEQWAL web platform is the primary entry point for communities and user groups to interact with these alternative scenarios and explore performance metrics, potential trade-offs and co-benefits across different water futures.

This presentation highlights how COEQWAL's open-source architecture and collaborative design processes support diverse user needs, and how plain language summaries and compelling visualizations can help water users engage effectively with decision-makers and foster more equitable water governance.

## Session 11: Incorporation of FIRO-MAR into the 2027 Central Valley Flood Protection Plan Update

**Session Moderator: Francisco Flores-López (DWR)**
**Moderator Email: Francisco.FloresLopez@water.ca.gov**

Forecast Informed Reservoir Operations (FIRO) has gained strong institutional support as an adaptive strategy to improve flood risk management while enhancing water supply and ecosystem outcomes. However, robust evaluation of FIRO policies is constrained by the limited temporal extent and extremity of available high-resolution hindcast datasets. This session presents recent advances in synthetic ensemble forecasting and their application to FIRO-MAR (FIRO–Managed Aquifer Recharge) implementation and assessment in California's San Joaquin Basin as part of the Central Valley Flood Protection Update 2027.

The session has presentations structure around four parts:

We describe the theoretical foundations and validation of synthetic ensemble forecasting methods designed to emulate operational ensemble forecast systems, enabling stochastic generation of forecast sequences that preserve skill characteristics while representing a much broader range of plausible hydrologic extremes.

These theoretical synthetic forecasts are then applied to scaled Central Valley hydrology inflow events.

This part describes the methodology and validation results for generating synthetic Hydrologic Ensemble Forecast Service (sHEFS) forecasts calibrated to NOAA's 42-member GEFS v12 hindcast dataset (October 1989–September 2023) for key Central Valley reservoir inflow locations including Oroville, Folsom, and San Joaquin River basin sites.

Building on this forecasting framework, we present the development and implementation of FIRO-MAR reservoir operations within HEC-ResSim, incorporating ensemble forecast operations, risk-based release decisions, and operational constraints to jointly support flood risk reduction, groundwater recharge, and ecosystem management.

Finally, we demonstrate basin-scale flood risk reduction benefits of FIRO-MAR using integrated hydraulic and economic modeling as part of the 2027 Central Valley Flood Protection Plan Update, highlighting changes in flow, stage, and volume across seven San Joaquin River tributaries and cumulative mainstem impacts. Together, these efforts illustrate how synthetic forecasting and integrated operations modeling can strengthen confidence in FIRO-MAR strategies under current and future climate extremes.

**11-1. Theory and Background for Generation of Synthetic Ensemble Forecasts**

Presenters: Zach Brodeur (CW3E)
Presenters Email Addresses: zpb4@cornell.edu
Permission to Post pdf of Presentation on CWEMF Website:

FIRO has emerged as a promising adaptive management strategy with strong sociopolitical and institutional support, underscoring the need to develop approaches to evaluate the robustness of candidate FIRO policies against a wide range of plausible extremes. However, the high-resolution hindcasts that are required to train, test, and evaluate these FIRO policies are limited in timespan (~35 years, 1990 – present) and confined to the extreme events occurring within that historical period. Synthetic forecasting is potential solution to this challenge, enabling the stochastic generation of forecast sequences that mimic the skill characteristics of current forecasting systems against any set of plausible 'observations' (i.e. actual observations, simulations, or projections). The significantly richer hindcast datasets derived from the synthetic forecasting procedure can enable the extensive robustness testing needed to build operational and institutional trust in FIRO policy implementation.

In this presentation, I will discuss the recent development of synthetic forecasting approaches capable of emulating ensemble forecast systems (e.g. the NOAA/NWS HEFS) that are core elements of ongoing FIRO implementation efforts in the U.S. I will provide some of the basic theory behind these synthetic ensemble forecasting algorithms and the approaches used to evaluate their parity to the parent hindcasts in both basic probabilistic forecast attributes and operations-based performance testing. Lastly, I will discuss the importance of this detailed validation procedure towards building operational trust in synthetic hindcasts, particularly in their ability to represent plausible forecasts for extremes much more severe than those in the parent hindcast record (e.g. scaled or synthetically generated events).

**11-2. Application of Synthetic Ensemble Forecasts to Scaled Central Valley Hydrology Study Inflow Events**

Presenters: Wyatt Arnold (DWR)
Presenters Email Addresses: Wyatt.Arnold@water.ca.gov
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Ensemble streamflow forecasts are critical inputs to Forecast Informed Reservoir Operations (FIRO), yet the historical hindcasts used to evaluate FIRO policies are limited in timespan (~35 years) and confined to the extreme events occurring within that period. To support the FIRO-MAR analysis for the 2027 CVFPP Update, synthetic ensemble forecasts were developed to provide plausible forecast sequences for design events that exceed the historical record.

This presentation will describe the methodology for generating synthetic Hydrologic Ensemble Forecast Service (sHEFS) forecasts calibrated to NOAA's 42-member GEFS v12 hindcast dataset (October 1989–September 2023) for key Central Valley reservoir inflow locations including Oroville, Folsom, and San Joaquin River basin sites. I will discuss how hourly HEFS hindcasts were processed into daily averages across 15-day lead times and how synthetic forecast parameters were optimized by comparing ensemble continuous ranked probability scores between HEFS and sHEFS for high-flow periods.

I will present validation results demonstrating that sHEFS reproduces HEFS forecast characteristics across multiple metrics including CRPS skill scores, ensemble spread, and rank histograms for extreme events. Finally, I will show how the calibrated synthetic forecast generator was applied to Central Valley Hydrology Study (CVHS) design events scaled from 10% to 340% of historical magnitudes, enabling the ensemble-based reservoir operations modeling presented in this session.

**11-3. Development and Application of FIRO-MAR Reservoir Operations in HEC-ResSim**

Presenters: Aleksander Vdovichenko (DWR)
Presenters Email Addresses: Aleksander.Vdovichenko@water.ca.gov
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Initially, the FIRO-MAR strategy was developed for the San Joaquin Basin Flood-MAR Watershed Studies and applied to seven tributary reservoirs to support benefits for the flood control, water supply, and ecosystem water management sectors. As a next step, the FIRO-MAR strategy has been incorporated into the State Systemwide Investment Approach of the 2027 CVFPP Update. Using the hydraulic and economic modeling tools of the CVFPP, the flood risk reduction potential of FIRO-MAR strategy is being evaluated throughout the San Joaquin River Basin focusing on the cumulative effect at Vernalis.

The FIRO-MAR strategy modifies reservoir operations and establishes a FIRO space to improve management of flood flows, increase applied recharge and establish an eco-pool account to enhance ecosystem management flows and deliveries using stored water in the FIRO space. The FIRO-MAR strategy incorporates Ensemble Forecast Operation (EFO) using a 1-to-7-day synthetic ensemble forecast (n = 42 members), acknowledging forecast accuracy and uncertainty. FIRO-MAR consists of two types of new reservoir releases: a conservation space pre-release and a FIRO space release. The FIRO space is based upon reservoir characteristics, including gross storage, flood control space, release capacity, and downstream channel capacity. Generally, the controlling factor is how quickly the FIRO space can be evacuated over a 5-day period within downstream channel capacity constraints. The EFO is driven by a risk tolerance curve corresponding to non-exceedance levels of the calculated release.

This presentation highlights the main components of operations that strategically combine FIRO and MAR and demonstrates the flood control benefits of the operations.

**11-4. Reducing Flood Risks through FIRO-MAR in the San Joaquin Basin**

Presenters: David Arrate (DWR)
Presenters Email Addresses: David.Arrate@water.ca.gov
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The Integrated Forecast Informed Resource Management (I-FIRM) strategy was developed for the San Joaquin Basin Flood-MAR Watershed Studies to analyze and quantity benefits for the flood control, water supply, and ecosystem water management sectors. A major component of the I-FIRM strategy is FIRO-MAR. The FIRO-MAR component has been incorporated into the State Systemwide Investment Approach of the 2027 CVFPP Update. Using the hydraulic and economic modeling tools of the CVFPP, the flood risk reduction potential of FIRO-MAR is being evaluated throughout the San Joaquin River Basin.

This presentation will first provide an overview of the San Joaquin Basin Flood-MAR Watershed Studies, including details of the I-FIRM strategy and results on the impacts of climate change to groundwater and environmental sectors and the benefits of the I-FIRM strategy on these sectors. The presentation will then focus on the preliminary flood benefit results of FIRO-MAR in the San Joaquin Basin as they apply to the 2027 CVFPP Update. The results will show change in flow, stage, and volume on each of the seven tributaries of the San Joaquin River Basin (Calaveras, Stanislaus, Tuolumne, Merced, Chowchilla, Fresno, and Upper San Joaquin rivers) and the cumulative effects of FIRO-MAR on the mainstem of the San Joaquin River.

**11-5. Managing Forecast Uncertainty in Operational Decisions on the Russian River**

Presenters: Michael Konieczki (HDR)
Presenters Email Addresses: Michael.Konieczki@hdrinc.com
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This presentation describes modernized reservoir operations at Lake Mendocino, outlines decision support tools water manages use, and provides examples of improved water management decisions realized in recent years by incorporating forecast uncertainty in decision making. Unique opportunities exist at Lake Mendocino for improved water management with forecast informed reservoir operations (FIRO) because atmospheric rivers (ARs) are a major source of reservoir inflows and there have been reductions of inter-basin diversions via the Potter Valley Project that have historically augmented spring refills. In recent years, gaging networks, data acquisition, hydrologic and hydraulics analysis, weather modeling, and computational power have dramatically improved in the basin and correspondingly so has forecast skill. Accordingly, reservoir managers are leveraging this increase in forecast skill to inform their operational decision-making within the regulatory constraints of water storage permits and established storage rules and “curves.”

To leverage improved forecasts for better decision support, operational rules at Lake Mendocino have been reconfigured to use reservoir inflow forecasts provided by the California Nevada River Forecast Center. These rules are codified in the newly updated Lake Mendocino Water Control Manual (WCM) developed by USACE San Francisco District and signed in October 2025.

**Session 12: Decision-Support Modeling for Managed Recharge and Recovery Projects**
**Session Moderator: Hai Huang (Tetra Tech); Mesut Cayar (Woodard & Curran)**
**Moderator Email: hai.huang@tetratech.com; mcayar@woodardcurran.com**

Increasing climate variability is imposing more challenges in obtaining a sustainable long-term supply of fresh water. Various forms of Managed Aquifer Recharge (MAR) approaches, e.g., Flood-MAR, Agricultural (Ag)-MAR and Aquifer Storage and Recovery (ASR) wells, are important subbasin scale practice for managing groundwater more sustainably. This session will explore quantitative analysis and modeling methods for designing and operation of these types of groundwater recharge & recovery projects, and for minimizing potential environment impacts associated with various MAR operations. The session provides a unique opportunity to bring together operators, hydrologists, hydrogeologists, geochemists, and groundwater modelers to discuss on the types of modeling needs to support long-term recharge, storage and recovery needs from both the water quantity and water quality perspectives.

**12-1. Grid-Based Analysis of Recharge Benefits for Stream Depletion Mitigation in Yuba Subbasins**

Presenters: Sercan Ceyhan (Woodard & Curran); Reuben Dandurand (Woodard & Curran)
Presenters Email Addresses: MCeyhan@woodardcurran.com; Reuben.Dandurand@woodardcurran.com
Collaborators: Charles Johnck (Yuba Water Agency); Kyle Morgado (Yuba Water Agency); Jim Blanke (Woodard & Curran)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Groundwater use in the Central Valley can cause streamflow depletion, impacting water availability and ecosystem health. This study evaluates the potential of targeted recharge projects to mitigate streamflow depletion using a grid-based approach with the Yuba Groundwater Model (YGM). A uniform recharge event of 2,400 acre-feet over six months was simulated at 40 nodal locations across the YGM domain. The resulting reduction in stream depletion was quantified as the Stream Accretion Factor (SAF).

Results highlight the importance of spatial prioritization for recharge projects to optimize both streamflow and groundwater storage outcomes. This grid-based analysis provides a screening tool for identifying high-benefit recharge sites and informs strategies for water transfers, drought resilience, and ecosystem support. Future work should refine these results based on specific recharge volumes and site conditions.

**12-2. Modeling ASR with a Focus on the Regulator**

Presenters: Neil Deeds (INTERA); Abhishek Singh (INTERA)
Presenters Email Addresses: ndeeds@intera.com; asingh@intera.com
Collaborators: Water Replenishment District
Permission to Post pdf of Presentation on CWEMF Website: Yes

Aquifer Storage and Recovery (ASR) is increasingly adopted as a drought-resilience strategy, yet successful implementation depends on demonstrating, to regulators, that injection and recovery operations will maintain hydraulic control, protect water quality, and avoid impacts to existing groundwater users. As a result, modeling plays a central role in regulatory evaluations of ASR feasibility, wellfield design, and operational compliance.

This presentation synthesizes modeling approaches commonly applied in ASR regulatory submittals. Analytic and analytic-element tools, such as Theis-based solutions and TTIM, provide rapid estimates of drawdown/uplift, interwell interference, and simplified recoverability using formulations like the Bear & Jacobs (1965) front-tracking method. These methods are valuable for early screening and pre-application consultation but have limited ability to represent heterogeneity, boundaries of regulatory concern, or mixing behavior.

Numerical models (MODFLOW, MF6) support regulatory expectations for evaluating layered aquifer systems, potential third-party impacts, and site-specific constraints such as subsidence susceptibility. Coupled transport modeling, from particle tracking to full three-dimensional simulations, enables defensible predictions of recharge-water migration, residence times, dispersive mixing, and recovered-water quality. Variable-density methods are essential in brackish and coastal settings where buoyancy affects bubble geometry and recoverability.

Case studies from California and Texas illustrate how these modeling approaches support ASR siting, hydraulic-control demonstrations, and water-quality evaluations, emphasizing alignment of model complexity with regulatory requirements and data availability.

### 12-3. How fast does recharge reach groundwater? Transit times and preferential flow in deep vadose zones

Presenters: Helen E. Dahlke (UC Davis)
Presenters Email Addresses: hdahlke@ucdavis.edu
Collaborators: Tiantian Zhou (University of California, Davis); Paolo Nasta (University of Naples); Dong Zhang (China Re Catastrophe Risk Management Company Ltd.); Jiří Šimůnek (University of California, Riverside); Anran Liao (Tsinghua University); Giuseppe Brunetti, (University of Calabria)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Understanding how fast recharge reaches groundwater is critical for evaluating managed aquifer recharge (MAR) efficiency and groundwater vulnerability to contamination. Recharge transit times through deep vadose zones are strongly influenced by soil stratification and preferential flow, yet quantifying these effects remains challenging, particularly in multilayered systems typical of agricultural basins. In this study, we quantify recharge transit times through a 70 m vadose zone using physically based simulations with HYDRUS-1D and three established tracer-based approaches: (i) particle tracking, (ii) peak displacement analysis, and (iii) convolution integral–based transit time distribution (TTD) analysis. We compare transport behavior across three representative multilayered soil profiles and evaluate how vadose zone architecture controls recharge travel times and age distributions at the groundwater table. Results show that particle tracking yields the shortest transit times, representing piston-flow advection without dispersion, while peak displacement produces intermediate estimates that reflect advective–dispersive transport but neglect tailing. TTD analysis yields the longest apparent ages by capturing the full age spectrum, including slow matrix flow and long-tail contributions. These differences demonstrate that recharge travel times depend strongly on the selected modeling framework and interpretation method. To explore the role of preferential flow and stratification, we simulated 3,600 combinations of soil textures in the deep vadose zone. Coarse layers can either accelerate or delay recharge depending on their vertical position and saturation state, highlighting the complex and non-intuitive role of layering. Mutual information analysis identifies key controlling layers that govern groundwater age variability. These findings demonstrate that vadose zone structure exerts a first-order control on recharge transit times and groundwater vulnerability. Accounting for preferential flow and stratification is therefore essential when evaluating MAR performance, contaminant transport risk, and recharge effectiveness in deep unsaturated zones.

### 12-4. MercedMAR – Automation and visualization for managed aquifer recharge scenarios in the Merced Subbasin

Presenters: Andres Diaz (Woodard & Curran), Melissa Stine (Woodard & Curran)
Presenters Email Addresses: adiaz@woodardcurran.com; mstine@woodardcurran.com
Collaborators: Dominick Amador (Woodard & Curran), Ali Taghavi (Woodard & Curran)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Recent advancements in available subsurface datasets, basin characterization tools, and texture modeling have opened new possibilities for evaluating recharge potential across California's groundwater basins. Building on these developments, the California Department of Water Resources (DWR) created the Aquifer Recharge Potential (ARP) analysis to help evaluate suitable locations for managed aquifer recharge (MAR) projects.

ARP combines three-dimensional subsurface texture modeling, enhanced by the incorporation of

Airborne Electromagnetic (AEM) survey data, with a multi-factor scoring system to evaluate recharge potential across California's groundwater basins. This presentation will begin with a high-level overview of the ARP development process, including how the subsurface framework, soil conditions, and depth-to-water datasets are integrated to produce actionable maps. These maps not only support site selection for recharge projects but also help identify locations where deep aquifer recharge could mitigate subsidence risks.

Two case studies where the ARP analysis has been applied will be highlighted: the Western San Joaquin and Sacramento Valley investigation areas. These examples illustrate how understanding subsurface connectivity, impeding clay layers, and variations in the water table and soil conditions can influence site selection for different recharge methods based on specific project goals.

By combining technical insights with practical applications, this session will provide key takeaways for applying ARP analyses in other regions, enabling local water managers to design projects that enhance groundwater sustainability and long-term water supply reliability.

**Session 13: Reclamation Model Development (Part 2)**
**Session Moderator: Cameron Koizumi (USBR)**
**Moderator Email: ckoizumi@usbr.gov**

This session is a collection of model development efforts that the Bureau of Reclamation and their contractors have been pursuing over the last year.

**13-1. To Kill a Spreadsheet – Streamlining CalSim Input Development and Extension**

Presenters: Frankie Nuffer-Rodriguez (USBR)
Presenters Email Addresses: fnufferrodriguez@usbr.gov
Collaborators: Lauren Thatch (USBR), Ryan Lucas (USBR), Kunxuan Wang (USBR), Cameron Koizumi (USBR), Drew Loney (USBR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

This project is an effort to modernize and improve the methods used to generate the inputs for CalSim. In the past when the CalSim inputs were generated or extended, it took months to assemble the data and calculate the new inputs needed. These calculations were done in hundreds of interconnected spreadsheets. The purpose of this project is to transition these calculations out of spreadsheets and into Python. This transition reduces the chance of errors and reduces the time needed to do an extension. Data is also now stored in one location instead of being repeated over multiple spreadsheets. Once this effort has been completed, future extensions will be much faster to complete.

This effort is an ongoing project in preparation for the next extension. Currently the reservoir evaporation rates have all been transferred into Python and the rim inflows are in the process of being transferred. All the Sacramento River Hydrologic Region rim inflows have been moved into Python. After replicating the previous values, an initial pass at improving data consistency has been done. In the future, the remaining rim inflows will be incorporated, and a more in-depth review of the methods and decisions will be done.

## 13-2. CalSim Explorer

Presenters: Nancy Parker (USBR), Kunxuan Wang (USBR)
Presenters Email Addresses: nparker@usbr.gov; kwang@usbr.gov
Collaborators: Ryan Lucas (USBR), Cameron Koizumi (USBR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The CalSim Explorer (CalSim Builder) is a sequence of model examples that is intended to help new modelers learn WRIMS, CVP/SWP operations, and the regulatory and hydrology elements in CalSim. It has become a springboard to migrating Reclamation's Exploratory Modeling Suite, initially developed with CalSimII for the 2021 LTO Consultation, to a CalSim3 template for support of ongoing analysis and upcoming re-consultation. Layering CVP operations over multiple new runs is producing fresh perspectives that foster better understanding of the capabilities and limits of CVP facilities to meet a range of project purposes. Both the Builder and Exploratory development processes are sparking new concepts in how CalSim logic can be expanded to best serve a broad range of planning and operational analysis needs.

## 13-3. CalSim3 Dynamic Fallowing Framework

Presenters: Bridget Childs (Stantec)
Presenters Email Addresses: bridget.childs@stantec.com
Collaborators: Nancy Parker (USBR), Ryan Lucas (USBR), Andy Draper (Stantec), Puneet Khatavkar (Stantec), Tom Fitzhugh (Stantec)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The CalSim3 model simulation of Central Valley Project (CVP) and State Water Project (SWP) operations assumes a fixed level of development (e.g., 2020, 2040) under which facilities, contracts, regulatory requirements, and land use are held constant. In recent years, there has been increasing interest in revisiting how to more accurately simulate irrigation demands during dry years and drought. During these dry periods, farmers frequently respond to water shortages by fallowing annual crop land and selling available water supplies. A fixed land-use during dry years deviates from a realistic representation of agricultural water demands and system operations. Realistic modeling of project operations under water scarcity is becoming more important as climate change continues to stress the CVP/SWP system. There are already a couple of instances in the CalSim3 model where dynamic land fallowing has been implemented (e.g., Sacramento and Feather River Voluntary Agreements); however, these use cases are not scalable for model-wide implementation. This presentation proposes a scalable framework for dynamic land fallowing/variable land use in CalSim3 considering model structure constraints (e.g., pre-processing, cycle structure, WRESL coding limitations), discusses preliminary results, and shares future considerations/directions.

## 13-4. Klamath Modeling using WRIMs

Presenters: Nancy Parker (USBR)
Presenters Email Addresses: nparker@usbr.gov
Collaborators: Dan Easton (MBK), Dave Felstul (USBR), Vik Stromberg (USBR), Brock Philips (USBR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

A 2026 Operations Plan was developed for the Klamath Project, tiering from modeling performed for the 2024 Biological Opinion. New analyses using the WRIMS-based Klamath Basin Planning Model are now proceeding in support of a 2025 DOI initiative to re-consult. Bookend Studies, akin to CVP Exploratory Modeling, highlight the limits of project facility capabilities. Strawman model templates provide a framework within which parties to the consultation can examine tradeoffs of multiple Long-Term Operations scenarios.

**13-5. Trinity LTO Operations Modeling**

Presenters: Kunxuan Wang (USBR)
Presenters Email Addresses: kwang@usbr.gov
Collaborators: Nancy Parker (Reclamation), Ryan Lucas (Reclamation)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Trinity River Division is currently undergoing re-consultation of Long-Term Operations (LTO). As part of this effort, several alternative operational scenarios have been developed for evaluation. This presentation focuses on the operations modeling conducted using CalSim 3. We provide an overview of the alternatives, explain the approach and key considerations in model implementation, and present a comparative analysis of results across the proposed LTO alternatives.

**Session 14: DWR's Basin Characterization Program: From Data Collection and Digitization to Maps, Models, and Analysis**
**Session Moderator: Mesut Cayar (Woodard & Curran)**
**Moderator Email: mcayar@woodardcurran.com**

The California Department of Water Resources (DWR) Groundwater Basin Characterization Program builds on California's Groundwater (Bulletin 118) to improve understanding of the state's aquifer systems and support implementation of the Sustainable Groundwater Management Act (SGMA). The program integrates newly collected and digitized datasets with innovative tools and workflows to produce publicly accessible maps, models, and analyses that inform groundwater management across California.

This session will provide an update on the Basin Characterization Program and highlight recent advances in statewide data digitization, Airborne Electromagnetic (AEM)–based subsurface modeling, and DWR's open-source BCTools software for rapid, data-driven basin characterization. Presentations will also share lessons learned from large-scale sedimentary texture modeling in the Central Valley.
The session concludes with applied examples of Aquifer Recharge Potential (ARP) analyses in the Western San Joaquin and Sacramento Valleys, demonstrating how basin characterization products are being translated into actionable insights for managed aquifer recharge (MAR), groundwater modeling, and long-term water-supply sustainability.

**14-1. DWR's Basin Characterization Program – Update 2026**

Presenters: Katherine Dlubac (DWR)
Presenters Email Addresses: Katherine.dlubac@water.ca.gov
Collaborators: Steven Springhorn (DWR), Benjamin Brezing (DWR), Craig Altare (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The California Department of Water Resources (DWR) has a long history of characterizing the state's groundwater basins through California's Groundwater (Bulletin 118). Building on this foundation, DWR's Groundwater Basin Characterization Program provides the latest data, tools, and information to help local communities better understand and manage California's aquifer systems.
Through this program, DWR conducts statewide, regional, and local groundwater evaluations to improve

understanding of groundwater aquifer systems. These investigations include digitizing existing information and collecting new data as needed. All collected and digitized data are integrated and analyzed using innovative tools to produce maps and models that describe aquifer materials, aquifer structure, key aquifer units, and recharge pathways. These products are updated and maintained by DWR.

To support data access and equity, all program datasets, tools, maps, and models are published on the California Natural Resources Agency Open Data Portal and are accessible through online, GIS-based visualization tools that serve as a central hub for exploring groundwater data across California. This presentation will provide an update on recently collected and digitized data, analysis tools and workflows, developed maps and models, and data visualization platforms.

### 14-2. Digitization of well lithology and geophysical logs for the DWR Statewide AEM and Basin Characterization Program

Presenters: Julie Chambon (Ramboll)
Presenters Email Addresses: jchambon@ramboll.com
Collaborators: Paul Thorn (Ramboll), Timothy Parker (Ramboll), David Shimabukuro (Eclogite), Katherine Dlubac (DWR), Steven Springhorn (DWR), and Benjamin Brezing (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

California's Department of Water Resources conducted a state-wide AEM survey, collecting over 25,000 km of resistivity data. As part of this program, well lithology descriptions and geophysical well logs were collected and digitized in the PLSS sections where the resistivity data were collected.

The objective was to identify and digitize two high quality wells and all available geophysical logs per section. To qualify as high quality, wells must be confirmed to be within 50 meters of the registered coordinates, have a minimum depth of 100' and an average description interval of less than 100'. Well coordinates were verified using maps and location descriptions from the WCR's and identification of well installations on aerial photos. When more than two wells were located in a given section, the wells deeper than 1000' or having a detailed lithology description were prioritized. For the geophysical logs, all logs measuring resistivity were digitized.

For the Basin Characterization Program, digitization of lithology and geophysical logs was conducted in sections that were not previously covered. The same criteria for the lithology was used, however, all wells deeper than 1000' were digitized.

In total, the team located and digitized 15,829 lithology logs and 1,477 geophysical logs during the state-wide AEM survey, with an additional 2,583 lithology logs and 568 geophysical logs from the Basin Characterization Program, providing a unique database to support sustainable groundwater management efforts. This presentation will summarize the data digitization efforts, evaluation of the process over time, key metrics, and lessons learned.

### 14-3. BCTools – DWR's Open-Source Toolset for Rapid, Data-Driven Basin Characterization

Presenters: Jack Baer (Woodard & Curran); Vivek Bedekar (SSP&A)
Presenters Email Addresses: jbaer@woodardcurran.com; vivekb@sspa.com
Collaborators: Nicole Jacobsen (Woodard & Curran), Tori Ward (Woodard & Curran), Mesut Cayar (Woodard & Curran), Sercan Ceyhan (Woodard & Curran), Michael Ou (SSP&A), Leland Scantlebury (SSP&A), Katherine Dlubac (DWR), Steven Springhorn (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Understanding California's aquifer systems is crucial to achieving groundwater sustainability. Yet as available subsurface datasets grow larger and more diverse, integrating and interpreting them becomes increasingly challenging. To address this, the California Department of Water Resources (DWR) has developed BCTools, free software that enables users to rapidly build conceptual and numerical hydrogeologic models that incorporate DWR's statewide airborne electromagnetic (AEM) surveys, newly digitized and compiled subsurface datasets, and user-provided data.

BCTools is a collection of five complementary software tools released earlier this year, including the Data2HSM suite, Data2Texture, and Texture2Par. These tools leverage machine learning and geostatistics to rapidly and quantitatively characterize groundwater basins, and can construct models of aquifer parameters, lithology, hydrostratigraphy, and more using data from AEM surveys, boring logs, and other available datasets. The tools can work together or individually, depending on users' needs, and can support tasks such as building or refining groundwater models, generating aquifer parameters, identifying potential aquifer recharge sites, and more. This presentation will share progress and updates incorporated into the first full public release of BCTools, describe planned improvements, and provide examples of different tool applications.

Combined with DWR's new datasets, this toolset offers a pathway to faster, higher-resolution, and more objective basin characterization, enabling improved groundwater model calibration, more informed siting of managed aquifer recharge (MAR) projects, and more sustainable groundwater management.

### 14-4. Large-Scale Sedimentary Texture Modeling with AEM Data: Insights from the Central Valley

Presenters: Jack Baer (Woodard & Curran); Michael Ou (SSP&A)
Presenters Email Addresses: jbaer@woodardcurran.com; mou@sspa.com
Collaborators: Nicole Jacobsen (Woodard & Curran), Mesut Cayar (Woodard & Curran), Vivek Bedekar (SSP&A), Katherine Dlubac (DWR), Steven Springhorn (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The California Department of Water Resources (DWR) statewide airborne electromagnetic (AEM) surveys offer a wealth of new data to improve understanding of the state's aquifer systems. But while these datasets offer tremendous insight, their size and complexity present unique considerations for developing three-dimensional (3D) sedimentary texture models. Building texture models over large sedimentary basins adds another layer of complexity, particularly in a region as geologically heterogeneous as California's Central Valley.

This presentation provides insights into addressing both sets of challenges simultaneously, offering lessons learned from 3D texture model development for the Sacramento and Western San Joaquin Valleys. It will begin with guidance on integrating AEM and boring log data through co-kriging, including a review of objective methods for cleaning and filtering large boring log datasets, plus insights into co-kriging with large datasets with variable data densities and sampling biases.

Next, the presentation will discuss a strategy for kriging and co-kriging in large, heterogeneous basins. Models are split into subdomains based on geomorphic provinces, and directional, anisotropic variograms are fitted and refined for each zone based on expected depositional patterns. Subdomains are then recombined into a contiguous texture model through a model stitching algorithm. The presentation will close with a discussion of model review and validation, plus a glimpse of planned future texture modeling efforts.

The methods and insights shared in this session provide a first step toward more data-rich, high-resolution, and geologically realistic texture models that can improve downstream products such as groundwater models and aquifer recharge potential maps.

### 14-5. Aquifer Recharge Potential in Practice: Lessons from Western San Joaquin and Sacramento Valley

Presenters: Nicole Jacobsen (Woodard & Curran)
Presenters Email Addresses: jjacobsen@woodardcurran.com
Collaborators: Jack Baer (Woodard & Curran), Mesut Cayar (Woodard & Curran), Kyle Nordquist (Woodard & Curran), Katherine Dlubac (DWR), Steven Springhorn (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Recent advancements in available subsurface datasets, basin characterization tools, and texture modeling have opened new possibilities for evaluating recharge potential across California's groundwater basins. Building on these developments, the California Department of Water Resources (DWR) created the Aquifer Recharge Potential (ARP) analysis to help evaluate suitable locations for managed aquifer recharge (MAR) projects.

ARP combines three-dimensional subsurface texture modeling, enhanced by the incorporation of Airborne Electromagnetic (AEM) survey data, with a multi-factor scoring system to evaluate recharge potential across California's groundwater basins. This presentation will begin with a high-level overview of the ARP development process, including how the subsurface framework, soil conditions, and depth-to-water datasets are integrated to produce actionable maps. These maps not only support site selection for recharge projects but also help identify locations where deep aquifer recharge could mitigate subsidence risks.

Two case studies where the ARP analysis has been applied will be highlighted: the Western San Joaquin and Sacramento Valley investigation areas. These examples illustrate how understanding subsurface connectivity, impeding clay layers, and variations in the water table and soil conditions can influence site selection for different recharge methods based on specific project goals.
By combining technical insights with practical applications, this session will provide key takeaways for applying ARP analyses in other regions, enabling local water managers to design projects that enhance groundwater sustainability and long-term water supply reliability.

## Session 15: Evaluating Delta Operations and Objectives (Rules) Using Historical Daily Data
**Session Moderator: Rich Satkowski (SWRCB, retired)**
**Moderator Email: rsatkowski@aol.com**

### 15-1. Introducing Delta 3D: Delta Daily Data Display Tool

Presenters: Russ Brown (Russ Brown River Consulting)
Presenters Email Addresses: russbrownriverconsulting@gmail.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

Historical data are the source of our modeling ideas, provide most of our model inputs and allow model calibration and verification. Historical daily data of all kinds, including fish data (counts from trawls, rotary screw traps, and CVP and SWP salvage facilities) could be compiled by CWEMF in cooperation with IEP agencies, to provide a consistent record of the historical conditions observed in the Delta over the past 50 years (i.e., 1976-2025). A daily data display tool, Delta-3D, could allow the seasonal patterns and daily events to be displayed with graphs that show the effects of the Delta objectives and upstream minimum flows (rules) to be visualized and better understood. Various data analysis calculations could be included in Delta 3D. One example is calculating the daily objectives and displaying them to identify the daily minimum required outflow and maximum allowed exports. Another example is the calculation of net channel flows, based on measured tidal flows or modeling results. The need to include daily fish data in the evaluation of Delta operations on fish will be described, with some examples of modeling projects that combined flows with daily fish trawl and salvage data. One goal of this presentation is to stimulate ideas for other daily data calculations that could be included in Delta 3D. Another goal is to encourage the modeling of fish habitat conditions on fish effects (growth, survival) so that impact analysis of Delta operations on fish could be more accurately quantified.

**15-2. Benefits of Using Daily Data for Evaluating Delta Outflow and Seawater Intrusion**

Presenters: Anne Huber (ICF)
Presenters Email Addresses: anne.huber@icf.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

Evaluation of daily Delta outflow and electrical conductivity (EC) data provides an example of the usefulness of daily data. Daily flows and daily EC data (minimum, mean, maximum) for water years 2011, 2014, and 2015 were compiled and graphically displayed to explore the relationship between Delta outflow and salinity intrusion. The data show how salinity varies longitudinally and vertically through the San Francisco Estuary as well as how the salinity gradients vary in response to tidal flow and net outflow. At any given location, the daily range of EC values caused by tidal excursion is much greater than vertical stratification. Various calculations using the measured data were used to explore the relationship between Delta outflow, X2, and EC at locations in the western Delta. The 2014 and 2015 data indicate that during periods of low flow, measured EC values were higher than expected based on estimated net daily outflow values from the DAYFLOW dataset. Calculations of effective outflow based on the measured EC from the western Delta stations might provide a better estimate of effective Delta outflow than the DAYFLOW values during some periods of low Delta outflow (e.g., <10,000 cfs). Much more can likely be learned from additional evaluation of the Delta daily flows and EC data.

**15-3. Highlighting the Importance of Daily Data for Water Quality Modeling**

Presenters: Mike Deas (Watercourse Engineering)
Presenters Email Addresses: mike.deas@watercourseinc.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

Water quality modeling is dependent on a wide range of measured data, including system geometry, and time series observations of flow, temperature, water quality constituents, and meteorology. As these data acquired for use in modeling, analysts commonly review the information for quality and completeness in forming boundary conditions and calibration data that can provide insight into the spatial and temporal domains of the modeling application. In many cases, this process is often limited to availability and a rigorous analysis of this invaluable information to more fully understand critical system processes is bypassed. In many cases, a careful assessment of field data can identify key processes, relationships, range of system responses, and an overall improved insight into system characterization. This not only informs model development and calibration but also improves development of alternative analyses (scenarios) and model output interpretation. Simulation modeling provides a valuable tool to explore wide range of potential future outcomes, support planning in complex systems, and improve evidence-based strategic management. However, without a clear understanding of historic and existing conditions (system responses, variability, inter-relationships), models are subject to poor model performance, increased uncertainty, lack of confidence, and ultimately less-than-desirable outcomes (decisions). Examples of including historical data analysis within modeling projects will be illustrated with examples where the data was used in pre-modeling analysis and how this ultimately supported model selection, development, calibration, and application.

**15-4. Evaluating Fish Effects from Flows and Exports Using Daily Flows and Fish Data**

Presenters: Russ Brown (Russ Brown River Consulting)
Presenters Email Addresses: russbrownriverconsulting@gmail.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

Because storm runoff, fish spawning or fish migration may occur within a month, daily data are needed to track and understand these events. Our best views of Delta processes are revealed in daily data. Simulation of the Environmental Water Account in 2000 was an example of daily modeling of fish protection from export reduction. Daily models of the Delta flows were combined with daily fish counts from the CVP and SWP salvage data. The display of daily flows and fish data in a series of graphs allowed the effects of changes in the export pumping on increased outflow and reduced entrainment to be accurately estimated. Another example was the evaluation of the effects of the Head of Old River barrier on SJR fish entrainment, using a combination of daily flows, daily EC, daily SJR fish trawl catch and salvage counts to track the juvenile Chinook and splittail (in wet years) to the CVP and SWP exports. The flow pathways to the exports were use to estimate fish movement to the exports. Other possible daily analyses of Delta and tributary fish data will be mentioned (i.e., length-frequency patterns for summer tow-net data, daily migration patterns from rotary screw traps). Daily modeling of the effects of daily flows, salinity, temperature and turbidity on fish are needed for accurate estimates of project impacts and Delta objective benefits.

## Session 16: Updates in CalSim Hydrology

**Session Moderator: Ryan Lucas (USBR)**
**Moderator Email: rlucas@usbr.gov**

The hydrologic inputs play a vital role in CalSim performance and application. This session highlights several recent advances in hydrologic inputs including calibration, application pre- and post-processing tools.

**16-1. C2VSIM 2025 Coarse Grid Calibration**

Presenters: Steven Jepsen (DWR); Ali Ghaseminejad (DWR)
Presenters Email Addresses: Steven.Jepsen@water.ca.gov; Ali.Ghaseminejad@water.ca.gov
Collaborators: Can Dogrul (DWR), Yiwei Cheng (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

There is currently a goal of bringing two models into spatial alignment with one another, the CalSim 3 model and the coarse grid version of the California Central Valley Groundwater-Surface Water Simulation Model (C2VSimCG). Alignment of these two models would facilitate the transfer of hydrologic parameters from C2VSimCG, a deterministic physically based model, to the CalSim 3 model. This talk describes work undertaken to refine inputs and estimate hydrologic parameters in the current version of C2VSimCG, C2VSimCG v2025. Following improvements to the Integrated Water Flow Model engine (IWFM) and model forcings (potential ET and land use), a PEST calibration was applied to estimate parameters of the aquifer/aquitard, streambed, unsaturated zone, root zone, and evapotranspiration. Resulting groundwater levels in Central Valley were overestimated by 0.7 feet, and streamflow volumes overestimated by 2,300 acre-ft per month (0.71%), during the water year 1984–2015 calibration period. This work provides a procedural framework for future iterations and highlights the need to employ parameter reduction methods required for highly parameterized inversion at the scale of the Central Valley. Alignment of CalSim3 and C2VSimCG is ongoing.

### 16-2. Crop ET Updates and comparisons with OpenET

Presenters: Lauren Thatch (USBR)
Presenters Email Addresses: lthatch@usbr.gov
Collaborators: Chris Pearson (DRI), Justin Huntington (DRI), Peter ReVelle (DRI), and Sayantan 'Monty' Majumdar (DRI)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Presentation of an updated CalSimHydro crop evapotranspiration dataset developed using the ET-Demands model with a FAO-56 dual crop coefficient approach and an updated ASCE-PM–based reference ET dataset. Results are compared with OpenET and the existing CalSimHydro crop ET dataset.

### 16-3. Climate Change Analysis for California Central Valley Project Long Term Planning

Presenters: Tapash Das (Jacobs); Drew Loney (USBR)
Presenters Email Addresses: tapash.das@jacobs.com; dloney@usbr.gov
Collaborators: Kunxuan Wang (USBR), Syed Azhar Ali (Jacobs), Tung Nguyen (Jacobs), Daniel Cayan (Scripps Institution of Oceanography), Alexander Weyant (Scripps Institution of Oceanography)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The implications of climate change for Reclamation's resources in California—and more specifically the Central Valley Project (CVP) are varied and significant. Understanding historical and recent climate conditions, as well as how the climate is expected to change in the future, will influence policies, management, and operations of the CVP. The CVP extends four hundred miles from north to south across the heart of California, consisting of six major storage facilities and numerous smaller facilities. Although these facilities are cooperatively managed for multiple benefits, the primary goals of the CVP are water delivery and environmental compliance. Estimating water availability for these purposes is complicated by the geographic extent of the project, the number and diversity of facilities, the federal partnership with the California State Water Project (SWP), and the multitude of environmental regulations that must be satisfied. The CVP has therefore relied heavily on the CalSim model, which represents both the CVP/SWP infrastructure and management requirements, and facilitates the application of those constraints to new hydrological conditions.

Reclamation has been working to develop the capability to produce climate-informed CalSim inputs to support the analyses required for decision-making under a high degree of uncertainty—analyses that must consider a broad range of factors and potential changes within the CVP. This presentation will describe the improved workflow developed to support this effort.

### 16-4. Development of CSHydroV2 Pre- and Post-Processor Tools

Presenters: Ruian Dong (DWR)
Presenters Email Addresses: ruian.dong@water.ca.gov
Collaborators: Polsinelli (DWR), Mohammad Hasan (DWR), Jay Wang (DWR), Z.Q. Richard Chen (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

A set of preprocessing and post-processing tools for the new CalSim3 Valley Floor Surface Hydrology Modeling Package (CSHydroV2) is being developed. CSHydroV2 is used to compute rainfall surface runoff, simulate agricultural water requirements and urban water use, and route water through the root zone at Sacramento and San Joquin Basin. The tools enable the users to examine and modify the model parameters, run the model in selected demand units/small watersheds, visualize the results and provide a transparent view of the surface hydrologic simulation process for various different land uses. We will describe the preprocessing and post-processing tools in detail and demonstrate the usage of the tools in this presentation.

**16-5. Updates to CalSim3 Existing Conditions Land Use Dataset**

Presenters: Mina Shahed Behrouz (Stantec)
Presenters Email Addresses: Mina.ShahedBehrouz@stantec.com
Collaborators: Bridget Childs (Stantec), Andy Draper (Stantec), Roja Kaveh Garna (Stantec), Puneet Khatavkar (Stantec), Samuel Price (Dynamic Geospatial Solutions), Ryan Lucas (USBR), Nancy Parker (USBR), Lauren Thatch (USBR), James Polsinelli (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The CalSim3 model assumes a fixed level of development, including adopting constant land use across the model's period of simulation. For the past decade CalSim3 has historically relied on temporally and spatially interpolated county land use surveys spanning from 2004-2013. This presentation will discuss implementation of 2020 remote-sensing–derived Land IQ land use data into the Delivery Capability Report 2023 CalSim3 baseline model. Benefits of using this dataset include implementing updated land use information, including multi-cropping representation, as well as enabling explicit representation of fallowed/idle acreage. Where there were gaps in the 2020 Land IQ land use data, the land use layer was stitched with interpolated county land use survey layers and C2VSIM datasets. CalSimHydro inputs and parameters were updated to accommodate multi-cropped and fallowed/idle crop categories. Results show significant land use shifts at the Water Budget Area scale, including nearly doubling of almond-pistachio acreage, decreasing native vegetation acreage, and increasing urban area acreage. CalSimHydro outputs show demand-unit-specific impacts to applied water and associated changes in field-level deep percolation and tailwater. Changes in CalSim3 outputs show net surface water deliveries declined, groundwater pumping increased, and increased in stream–groundwater losses across the model domain. Average annual inflow to the Delta increased due to increased winter-time surface runoff. Future consideration and implementation of updated remotely sensed land use datasets in CalSim3 is expected and these updates can enable future hydrology revisions such as variable land use representation. This approach provides a reproducible pathway for future CS3 updates as remote-sensing datasets advance.

## Session 17: Collaborative Modeling in the Delta: Exploring Feasibility Using Three Use Cases
**Session Moderator: Michelle Stern (Delta Stewardship Council)**
**Moderator Email: Michelle.Stern@deltacouncil.ca.gov**

**17-1. Illuminating the dark corners of estuarine science challenges with the help of a Delta Modeling Collaboratory**

Presenters: Lisamarie Windham-Myers (USGS, Delta Stewardship Council)
Presenters Email Addresses: lisamarie.windham-myers@deltacouncil.ca.gov
Permission to Post pdf of Presentation on CWEMF Website: Yes

Open and integrated modeling holds tremendous promise for advancing actionable science. For at least 30 years, the CWEMF community has generated a collaborative culture that the Delta Modeling Collaboratory is supporting and elevating for long term answers to legacy and emerging problems. We have initiated scoping projects for 3 estuarine challenges with immediate influences on both actions and stress-testing for resource management. Prediction of harmful algal blooms, management of salinity intrusion to the Delta, and restoration of tidal wetlands foodwebs all require system-level science. We propose that multiple viewpoints and approaches can illuminate pathways to address these challenges. We also propose that an independent, long lived, and accessible collaboratory framework can support the Delta science network to accelerate the pace of discovery and confidence in responses to environmental challenges.

**17-2. Developing modeling applications to support cyanobacterial harmful algal bloom management in the Sacramento-San Joaquin Delta, California**

Presenters: Keith Bouma-Gregson (USGS), David Senn (San Francisco Estuary Institute)
Presenters Email Addresses: kbouma-gregson@usgs.gov; davids@sfei.org
Permission to Post pdf of Presentation on CWEMF Website: Yes

Cyanobacterial harmful algal blooms (CHABs) occur when cyanobacterial cells grow rapidly and accrue high amounts of biomass, creating blooms that can be toxic and affect the ecosystem and human health. Understanding CHABs has become a science and management priority in the Sacramento-San Joaquin Delta (the Delta), and models offer distinct approaches for enhancing the understanding of the factors that control CHAB dynamics, anticipating or forecasting CHAB occurrences, or assessing the impact of different management scenarios or outcomes on CHAB dynamics. This presentation shares the results of a CHAB modeling "Use Case" report, part of a larger integrated modeling collaboratory project to develop shared modeling resources for the Delta, led by the Delta Stewardship Council's Delta Science Program. The goals of this Use Case report are to identify frameworks for using models to support CHABs research and management in the Delta and to assess resources that could be developed to broadly enhance modeling applications. To this end, the report identifies three approaches that could be implemented in the near-term as initial steps to expand modeling efforts on CHABs research. The report also identifies additional resources that could be developed and made broadly available to support CHABs modeling efforts. Ultimately, the report helps to extend and refine our understanding of how different modeling approaches can support CHABs management in the Delta and signposts tangible next steps for future exploration and development. At the same time, it identifies key modeling resource needs and approaches that are common to different management issues.

**17-3. Managing Salinity in the Delta: An integrated modeling-collaboratory approach for research on infrastructure and management solutions**

Presenters: Josue Medellin-Azuara (UC Merced)
Presenters Email Addresses: jmedellin@ucmerced.edu
Collaborators: Yu Cai (UC Merced), Eli Ateljevich (Department of Water Resources), Stephen Elser (Delta Science Program), Greg Gartrell, Brett Milligan (UC Davis), Michelle Leinfelder-Miles (UC Division of Agriculture and Natural Resources), Jay Lund (UC Davis)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Salinity intrusion in the Sacramento–San Joaquin Delta is a system-scale constraint shaping water operations, infrastructure performance, ecosystems, agriculture, and Delta communities under increasing climate volatility and sea-level rise. While decades of hydrodynamic modeling and monitoring have improved predictive capacity, fragmented workflows, inconsistent documentation, and limited interoperability across models and datasets constrain transparent and reusable analysis. We propose a Salinity Management Collaboratory as a standing framework to integrate modeling, data stewardship, and scenario evaluation across agencies and institutions. This works explores a Collaboratory approach analysis around three complementary research pathways: (1) Structural Containment (engineered gates, levees, barriers), (2) Ecological Attenuation (landscape and geomorphic reconfiguration such as Franks Tract Futures), and (3) Hydrodynamic Connectivity (Physics-to-Fish–informed salinity–habitat dynamics). The Collaboratory emphasizes standardized stress-testing, shared scenario libraries (drought, sea-level rise, levee failure), emulator development for rapid screening, and transparent comparison of salinity redistribution across sectors.

By lowering transaction costs of model comparison and data reuse, this framework aims to support more durable, cross-sector dialogue on salinity risk, trade-offs, and adaptation pathways and generate a template for profiling research on infrastructure and operational solutions to manage salinity in the Delta.

**17-4. Managing tidal wetlands to optimize food webs in the Sacramento-San Joaquin Delta, California**

Presenters: Matthew Young (USGS, California Water Science Center)
Presenters Email Addresses: mjyoung@usgs.gov
Collaborators: Rosemary Hartman (Department of Water Resources), Denise Colombano (Delta Science Program)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Sacramento San Joaquin Delta is complex, with small-scale habitat differences impacting food web structure. Tidal wetland restoration, mandated as mitigation for the impact of water project operations on native fish populations, is thought to result in substantial increases to local prey availability, as well as a host of other benefits. Given what is known about the importance of habitat heterogeneity as a driver of food web structure, the purported food web benefits of tidal wetlands are likely, albeit not fully demonstrated. As such, the Interagency Ecological Program (IEP) Synthesis Team is working to collate and interpret existing data on tidal wetlands in the Sacramento San Joaquin Delta. The project goal is to address uncertainties around primary and secondary productivity in tidal wetlands relative to other habitats in the Delta, as well as demonstrate potential benefits to desirable fish species. Here, we describe the efforts of the IEP Synthesis Team to understand tidal wetland food webs, and discuss how collaborative synthesis efforts can act as a template for broader collaboratory support and success.

**17-5. Laying the foundation for a Delta Modeling Collaboratory: a project-based collaborative modeling approach to complex management challenges**

Presenters: Michelle Stern (Delta Science Program)
Presenters Email Addresses: michelle.stern@deltacouncil.ca.gov
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Delta is a complex social-ecological system influenced by multiple environmental and social drivers, including precipitation, tides, climate change, agriculture, and urban water operations. Managing this system requires assembling vast data using modeling, synthesis science, and decision-support tools. In 2025, the Delta Science Program launched three use-case projects to assess integrated modeling feasibility for key management themes: 1) predicting cyanobacterial harmful algal blooms; 2) evaluating salinity intrusion and management actions; and 3) restoring tidal wetland food webs. Diverse teams from academic institutions, government, and NGOs created project "profiles" identifying potential modeling approaches, existing leverageable resources, and critical gaps. Operating these three projects simultaneously provides unique benefits by highlighting synergies, facilitating resource sharing, and enabling prioritization of activities supporting multiple initiatives. This holistic approach generates benefits for each individual project while establishing the foundation for the Delta Modeling

Collaboratory—an intentional community of modelers and modeling resources supporting integrated modeling projects. The Collaboratory's overarching vision is establishing a geographically based community centered on collaboration, innovation, and resource sharing. This framework not only advances individual project goals but creates a sustainable platform for ongoing Delta modeling efforts, enhancing the region's capacity for integrated environmental management and decision-making through coordinated scientific resources and expertise.

**Session 18: Advancing Subsidence Modeling: Exploring Critical Head, Data Gaps, Compaction Mechanics, and Predictive Uncertainty**
**Session Moderator: John Ellis (INTERA); Leila Saberi (INTERA)**
**Moderator Email: jellis@intera.com; LSaberi@intera.com**

Land subsidence remains one of the most consequential challenges for groundwater sustainability in California, with implications for conveyance capacity, infrastructure integrity, groundwater storage loss, and long-term compliance with SGMA. As agencies expand the use of numerical modeling to forecast future subsidence and support critical head management, an increasing need exists to understand how model assumptions, data limitations, and interbed architecture shape subsidence predictions and associated uncertainty. This session focuses on 1-D subsidence modeling using MODFLOW 6 and the CSUB package, emphasizing insights offered by vertically focused models.

The first presentation assesses subsidence and critical head trends across the Central Valley, using empirical datasets, modeling analysis, and data from DWR Bulletin 118 to examine representative critical heads, spatial variability, and the magnitude and timing required for inelastic compaction to initiate or cease. The second presentation evaluates how shortened subsidence and groundwater-level records influence predictive uncertainty, demonstrating how reduced monitoring histories can bias parameter estimation, delay characterization, and future subsidence forecasts—issues that are highly relevant as many GSAs rely on limited historical data. The third presentation explores time as the governing dimension of subsidence, contrasting delay versus no-delay interbeds and demonstrating how interbed architecture, number of interbeds, and vertical hydraulic conductivity collectively control lag behavior, preconsolidation head movement, and long-term compaction trajectories. The final presentation focuses on calibration pitfalls, showing how structural or parametric tradeoffs can produce models that fit observed data well yet produce inaccurate forecasts. Through sensitivity analysis, multi-objective calibration, and emphasis on rebound behavior and preconsolidation head estimation, it illustrates how to detect “plausible but wrong” models.

Together, these presentations provide a practical and scientifically grounded exploration of subsidence modeling, showing how targeted vertical analyses can support SGMA compliance, guide data-collection priorities, and clarify where simplification is appropriate and where it is not. This session will offer practitioners and decision-makers a deeper understanding of the data and structural controls that govern the reliability of subsidence modeling, with direct relevance to critical head management, model design, and long-term groundwater sustainability planning.

**18-1. Critical Heads, Critical Decisions: Subsidence and Critical Head Trends in the Central Valley**

Presenters: John Ellis (INTERA); Leila Saberi (INTERA)
Presenters Email Addresses: ellis@intera.com; lsaberi@intera.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

Land subsidence caused by groundwater extraction has long been a significant challenge in California, with impacts including infrastructure damage, permanent loss of groundwater storage, and many millions of dollars in associated costs. Minimizing and preventing future subsidence requires raising groundwater levels above critical head levels, which often aren't the same as the historical lows. Effective management of land subsidence under SGMA requires defensible estimates of critical head and a clear understanding of when groundwater-level declines translate into irreversible compaction. This presentation synthesizes empirical observations and modeling results from locations across the Central Valley to examine spatial and temporal trends in critical head, informed by Bulletin 118. Using a combination of long-term groundwater-level records, subsidence observations, and 1-D MODFLOW CSUB modeling, we evaluate how representative critical heads are defined, how they vary across hydrogeologic settings, and how long and how far groundwater levels must decline below critical head to initiate or re-initiate inelastic subsidence. Results highlight that critical head exceedance is not instantaneous, and that both magnitude and duration of exceedance matter—particularly in systems with significant interbed lag. The presentation discusses implications for defining measurable objectives, interpreting short-term excursions below critical head, and translating modeling results into practical SGMA management decisions.

### 18-2. Short Records, Longer Consequences: How Data Gaps Shape Subsidence Forecasts

Presenters: Leila Saberi (INTERA), John Ellis (INTERA)
Presenters Email Addresses: lsaberi@intera.com; ellis@intera.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

Many subsidence models are calibrated using limited subsidence observations but somewhat longer groundwater-level histories—a common condition for GSAs across California. This presentation quantifies how shortened monitoring records affect subsidence model calibration and predictive uncertainty by systematically truncating long-term groundwater-level and subsidence datasets and recalibrating 1-D MODFOW CSUB models. Multiple scenarios are explored, including full subsidence and water-level records, short subsidence records paired with long water-level histories, and cases where both records are limited. Results demonstrate that long groundwater-level histories alone are insufficient to constrain key subsidence-related parameters such as elastic and inelastic skeletal storage, interbed vertical hydraulic conductivity, and preconsolidation head. In particular, incomplete subsidence records reduce the model's ability to distinguish elastic from inelastic deformation and to characterize lag behavior, leading to biased estimates of critical head and increased uncertainty in future subsidence forecasts. The analysis highlights the importance of capturing multiple stress cycles and rebound periods and provides insight into how data limitations propagate uncertainty into long-term predictions used for SGMA planning.

### 18-3. The Subsurface Time Machine: Modeling Compaction Dynamics.

Presenters: Joseph Hughes (INTERA)
Presenters Email Addresses: jdhughes@intera.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

Time, not just depth, is a governing dimension of subsidence. This presentation uses 1-D MODFLOW CSUB models to explore how interbed representation controls lag behavior, critical head evolution, and long-term compaction trajectories. The first part of the presentation contrasts delay versus no-delay interbeds, showing how models that omit delay artificially shorten system memory, accelerate preconsolidation head ratcheting, and distort future subsidence predictions under recovery or stabilization scenarios. The second part examines how many delay interbeds are needed to realistically capture subsurface behavior, progressing from single equivalent interbeds to multi-interbed configurations and demonstrating the diminishing returns of excessive discretization. Sensitivity tests highlight the dominant role of interbed thickness and vertical hydraulic conductivity in setting characteristic response times. The presentation illustrates how simplified vertical models can clarify subsidence mechanics while avoiding unnecessary complexity.

**18-4. Why Matching the Past Doesn't Tell the Future: Implications of Model Non-Uniqueness**

Presenters: Jeremy White (INTERA)
Presenters Email Addresses: jwhite@intera.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

Subsidence models are commonly calibrated/history-matched to observations of groundwater-level and deformation histories. However, a strong fit to these historical observation data does not guarantee robust forecasts of future potential deformation. This presentation highlights how information sparsity leads to an inability to uniquely inform individual (uncertain) model inputs and instead yields combinations of model inputs that are conditioned by observation data and expert knowledge. These calibrated combinations of model inputs all adequately reproduce observed compaction and water-level trends yet yield non-trivial uncertainty in future predictions of subsidence. Using a fixed set of monitoring data and identical calibration targets, we construct several calibrated 1-D models that differ only in their interbed hydraulic parameters and structural assumptions, including vertical hydraulic conductivity, interbed thickness, elastic and inelastic skeletal storage, and preconsolidation head. Despite comparable calibration performance, these models exhibit a wide range of predictive differences under identical future water-level scenarios, with differences in the timing, magnitude, and persistence of inelastic subsidence. The presentation illustrates diagnostic approaches for identifying these "plausible but not unique" models, including sensitivity analysis, ensemble comparisons, and evaluation of deformation response during recovery periods. Additionally, a discussion is provided on what model inputs are most important and/or sensitive in subsidence modeling for making robust predictions related to future compaction and critical head in delay-bed formulations. Findings emphasize the importance of recognizing non-uniqueness in subsidence modeling and support the use of ensemble-based forecasts and targeted monitoring to reduce decision risk under SGMA.

**18-5. Decomposition of Inelastic and Elastic Components of Total Subsidence for Model Calibration Evaluation**

Presenters: Raghavendra Suribhatla (Haley & Aldrich)
Presenters Email Addresses:
Permission to Post pdf of Presentation on CWEMF Website:

Subsidence in Central Valley has been occurring since 1920's and comprises of both elastic and inelastic components. Historical and recent extensometer data also indicate ongoing long-term compaction of clay interbeds below the Corcoran Clay. Parameterizing and calibrating basin-scale groundwater models to simulate all the contributions to total subsidence presents a significant challenge, further complicated due to lack of accurate groundwater extraction & land use data, aquifer heterogeneity, sparse extensometer network, and limited InSAR coverage among others. We present a methodology for evaluating model-simulated total subsidence based on the Independent Component Analysis (ICA) technique applied to InSAR data. The ICA technique has recently been applied to decompose Central Valley InSAR vertical displacement time-series from 2015-2019 and estimate the elastic and inelastic components. We demonstrate the ICA methodology using simulation results from the Central Valley C2VSim and CVHM2 models and compare the elastic and inelastic components to those estimated using InSAR. We present approaches for 'detrending' of total subsidence and isolation of elastic component.

This approach is expected to be particularly useful for calibration of short term models whose simulation periods may be less than the characteristic compaction time of clay interbeds.

**Session 19: Integrated Modeling and Innovative Decision Support Systems for Smart Water Resources Management**
**Session Moderator: Nigel Chen (EKI)**
**Moderator Email: nchen@ekiconsult.com**

Water agencies and districts are increasingly facing operational challenges—from uncertain surface-water allocations and hydrologic extremes to groundwater overdraft, subsidence risks, sea water intrusions and evolving regulatory constraints. This session will highlight how integrated surface-water and groundwater modeling tools, combined with innovative decision-support tools (DSTs), can help agencies navigate both real-time and long-range operational challenges to inform best-practice decision making.

Presentations may showcase coupled hydrologic modeling systems (e.g., MODFLOW, GSFLOW, IWFM), stream–aquifer interaction analysis, conveyance and recharge operations modeling, surface-water availability forecasting, groundwater production optimization, and subsidence-risk evaluation. Speakers may also demonstrate integrated DSTs that merge numerical models, machine-learning surrogates, remote sensing, monitoring networks, and water-operations datasets to support pumping decisions, recharge siting, drought-contingency planning, and climate-stress testing.

The session will emphasize practical, operationally relevant solutions, illustrating how integrated modeling frameworks and user-focused DSTs can help agencies manage constrained water supplies, communicate tradeoffs, improve decision transparency, and build resilient strategies under rapidly evolving hydrologic and regulatory conditions.

**19-1. Opportunities and Challenges in Using Multiple Model for Regional Groundwater Management in the Salinas Valley**

Presenters: Stephen Hundt (M&A)
Presenters Email Addresses: shundt@elmontgomery.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

Managing groundwater in the Salinas Valley requires tools that capture both the integrated surface-groundwater system and seawater intrusion processes to adequately evaluate potential management approaches. In this presentation, we share how two complementary modeling approaches expand the range of issues and projects that can be evaluated—from analyzing stream-aquifer interactions to seawater intrusion mitigation. The first model simulates regional groundwater flow and stream-aquifer exchange, including reservoir and diversion operations, while the second model simulates variable-density groundwater flow and solute transport to evaluate seawater intrusion in the principal aquifers. We will discuss the practical challenges of maintaining calibration consistency across models with shared spatial domains and how these tools strengthen the technical basis for scenario-based water-resource planning for long-term sustainability.

**19-2. Integrated Hydrogeologic Investigations, Groundwater Modeling and Decision Support Tool Development in the Livermore Valley Basin**

Presenters: Aaron Lewis (EKI); Nathan Cutler (EKI)
Presenters Email Addresses: alewis@ekiconsult.com; ncutler@ekiconsult.com
Collaborators: Anona Dutton (EKI); Ahmad-Ali Behroozmand (Geophysical Imaging Partners)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Zone 7 Water Agency serves drinking water to over 270,000 residents within the Livermore Valley Basin and is responsible for managing Basin-wide groundwater and interconnected surface water resources to quantitative thresholds imposed by the Sustainable Groundwater Management Act (SGMA). Zone 7 and its engineering consultant EKI Environment & Water, Inc. recently completed an ambitious project designed to address existing data gaps, improve the conceptual understanding of Basin hydrogeology, and develop a suite of innovative tools that will collectively enhance the Agency's abilities to manage the Basin to long-term SGMA compliance.

The Project consisted of six phases involving: (1) geophysical field investigations and aquifer pumping tests; (2) 3D hydrogeologic conceptual model development in Leapfrog; (3) historical groundwater model development and calibration in MODFLOW 6; (4) "child" model development and coupling using MODFLOW 6's local grid refinement functionality; (5) predictive per- and polyfluoroalkyl substances (PFAS) fate and transport modeling evaluations in support of water supply project feasibility analyses; and (6) integrated Decision Support Tool (DST) app development in RShiny.

This presentation will provide an overview and touch on lessons learned in implementing Zone 7's integrated hydrogeologic investigations, modeling, and planning project under the SGMA regulatory regime. Technical concepts such as Leapfrog geologic model integration into MODFLOW 6, parent-child flow and transport model coupling routines, regional PFAS modeling evaluations, and DST app development and cloud deployment will be explored in greater detail, and results will be discussed in the context of improving Zone 7's adaptive management and decision-making capabilities.

**19-3. Machine Learning Guided Optimization (MLGO!)**

Presenters: Patrick Wickham (M&A)
Presenters Email Addresses: pwickham@elmontgomery.com
Collaborators: Cameron Tana, Timothy Bayley, Dan Graf
Permission to Post pdf of Presentation on CWEMF Website: Yes

The future of California water supply relies on effective implementation of groundwater sustainability projects and water resource optimization, which is often informed by iterative groundwater modeling. Here we introduce an automated self-learning workflow for optimizing projects using a physical groundwater model called Machine Learning Guided Optimization (MLGO!). This workflow frees the modeling team to examine intricacies of project implementation and has the potential to discover configurations that may not be identified by traditional optimization. MLGO was used to optimize sustainability project configurations in a critically overdrafted coastal Basin at risk of seawater intrusion, and to evaluate sustainable and economic dewatering of a planned gold mine.

**19-4. Building Trust in Regional Water Planning: An Interactive MCDA Framework for Consensus Building in the Ipswich River Basin**

Presenters: Ayman Alafifi (EKI), Dawn Flores (EKI)
Presenters Email Addresses: aalafifi@ekiconsult.com; dflores@ekiconsult.com
Permission to Post pdf of Presentation on CWEMF Website: No

Multi-criteria decision analysis (MCDA) is commonly used in regional planning to compare alternatives and support prioritization, yet it is often implemented through facilitated workshops supported by static spreadsheets, where key steps such as scoring, weighting, and normalization occur outside the workshop setting. While workshops are valuable, this approach limits transparency, iteration, and stakeholder ownership making it difficult to build trust and alignment across communities engaged in shared decision-making.

This presentation will describe the MCDA process, technical framework, and facilitation approach, with a focus on how the tool was designed to be replicated and sustained beyond a single planning effort. The session will highlight lessons learned in building a flexible, modular MCDA framework that supports ongoing use, iterative refinement, and adaptation to new assumptions, stakeholders, and planning contexts. Rather than treating MCDA as a one-time workshop output, the approach demonstrates how interactive decision support tools can be embedded into regular regional planning workflows to support long-term collaboration, transparency, and informed decision-making.

We will highlight the MCDA decision support tool developed for the North Shore Water Resilience Task Force (NSWRTF) by the Metropolitan Area Planning Council (MAPC), in collaboration with EKI Environment and Water. This web-based MCDA decision support tool supports 18 communities across the Ipswich River Basin as they evaluate infrastructure investments and inter-community water sharing programs in a highly constrained and interconnected watershed. The tool is designed for practical, real-time use during planning and facilitation, and was custom-made to allow for stakeholders to adjust key variables in support of the decision making process.

**19-5. Advancing adaptive decision-making through an Environmental Water Manager (EWM) role to enhance the ecological resilience of Western U.S. river systems**

Presenters: Zach Brodeur (CW3E, UC San Diego)
Presenters Email Addresses: zpbrodeur@ucsd.edu
Collaborators: Sai-Veena Sunkara (Cornell University), Gopal Penny (Environmental Defense Fund), Maurice Hall (Environmental Defense Fund), Patrick Reed (Cornell University)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Despite years of focused conservation efforts, Western U.S. river systems have faced precipitous declines in freshwater species. To reverse this trend, recent research and real-world practice have advocated for ecological flow management approaches that treat ecological health on equal footing with other system objectives. The complex adaptive decision-making context needed to support these system-level approaches motivates the need for a manager with the institutional authority and agency to be responsive to evolving conditions. The concept of an Environmental Water Manager (EWM) has been proposed as a mechanism to ensure that water budgets allocated to the environment are employed to enhance ecological resilience while navigating other competing water use objectives. Effective allocation decisions require the EWM to utilize information across multiple timescales (past, present, short-to-long term future) and integrate it into environmental release decisions that best meet ecological water quantity, quality, and timing targets that are balanced with other system requirements. In this work, we explore this EWM challenge through a modeling framework that captures the state-aware, multi-timescale, and multi-objective aspects of the problem. We develop a coupled systems and temperature modeling framework that allows us to support adaptive EWM decision-making using realistic information sources, including long-range (365-day) hydrologic ensemble forecasts and stream temperature state information. Our results clarify the important tradeoffs that emerge in environmental flow decision-making across timescales, show the value of different information sources and the impacts of their uncertainty, and illustrate the potential for EWM adaptive decision making to promote ecological resilience.

**19-6. MODFLOW-IDC (MF-IDC) A New Integrated Hydrologic Modeling Tool from California for the Rest of the World**

Presenters: Adrien Camille, Ahmed Ali
Presenters Email Addresses: ACamille@woodardcurran.com; AhmedShakirAli.Ali@woodardcurran.com
Collaborators: Reza Namvar (Woodard & Curran); Adrien Camille (Woodard & Curran); and Ahmed Ali (Woodard & Curran)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Integrated water resources management requires tools that capture how land and irrigation processes influence groundwater conditions. Successful development and application of IWFM and IDC models have mostly been limited to California. In contrast, MODFLOW has been the groundwater model of choice outside California. This abstract presents a coupling approach between the IWFM Demand Calculator (IDC) and MODFLOW 6 and development of MF-IDC model. MF-IDC will provide valuable groundwater experience in California to the rest of the world.

IDC simulates surface water deliveries, crop water use, and root zone water balance, including infiltration, soil moisture storage, evapotranspiration, and deep percolation. A key IDC output is percolation below the root zone, representing downward flux through the soil profile that can contribute to groundwater recharge.

IDC-computed root zone percolation was converted to recharge rates in an RCH file and spatially mapped to the MODFLOW 6 domain. The resulting recharge in the RCH file is applied as time-varying input to MODFLOW 6, which simulates groundwater flow and groundwater-level response across the aquifer system. The methodology emphasizes spatial and temporal consistency by aligning discretization through a mapping procedure between IDC output units and the MODFLOW 6 grid, and by synchronizing time stepping so recharge is applied to the appropriate stress periods.

MF-IDC explicitly links land-surface and root zone fluxes to groundwater processes, enabling more realistic evaluation of recharge patterns associated with irrigation and land use. The approach provides a practical pathway for incorporating IDC-derived recharge into MODFLOW 6 simulations for planning and management applications.

## Session 20: MF-OWHM Sessions at 2026 CWEMF Conference

**Session Moderator: Scott Boyce; Steffen Mehl; Randall Hanson**
**Moderator Email: randythanson@gmail.com**

**20-1. New Conjunctive Water Management books and Model Exercises**

Presenters: Randall Hanson (One-Water Hydrologic)
Presenters Email Addresses: RandyTHanson@gmail.com
Collaborators: Richard Evans (Jacobs)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Conjunctive Water Management (CWM) is the process of using water from multiple sources for consumptive purposes within a sustainability framework. The planned CWM of all waters has the potential to offer major benefits in terms of economic, social, and environmental outcomes through improved efficiencies and sustainability of water resources. Adopting a planned approach results in the greatest potential for the optimal capture, storage, abstraction, and reuse systems of all water sources. This results in a sustainability framework that encompasses the monitoring, analysis, and management of all the water, all the time everywhere. New “Smart-Valley” monitoring networks and integrated Hydrologic Modelling (IHM) tools can now be used to create a more holistic CWM sustainability framework that needs to be combined with new governance and financial support.

MF-OWHM is an essential IHM tool for CWM analysis of supply-and-demand budgetary framework that includes all flows, land use and climate. This provides additional coupling for supply-constrained and demand-driven use and movement of water. Detailed land use associated with wells and surface-water deliveries in specific water-balance subregions facilitates subregional supply-and-demand accounting with changing water sources, land use, and land ownership through time. Additional observation types can further constrain calibration plus climate-change or alternative sustainability scenarios, with enhanced model replication of use and movement of water and land use. IHM modelling facilitates analysis of climate variability, droughts, and capture from extreme wet events. These supply-and-demand drivers are an integral part of the sustainability analysis, any related management, and governance spanning periods of years to centuries.

### 20-2. MF-OWHM: Status update and upcoming features

Presenters: Scott E. Boyce
Presenters Email Addresses: seboyce@ucdavis.edu
Permission to Post pdf of Presentation on CWEMF Website: No

MODFLOW One-Water Hydrologic Flow Model (MF-OWHM) is a MODFLOW-based program for conjunctive use simulation. MF-OWHM simulates saturated groundwater flow (three-dimensional); surface-water flow (one- and two-dimensional); landscape and irrigated agriculture; estimation of unknown agricultural irrigation and additional irrigation requirements for salinity flushing; reservoir operations and management; aquifer compaction and subsidence; seawater intrusion by a sharp-interface assumption; karst-aquifer and fractured-bedrock flow; and vertical unsaturated groundwater flow (one-dimensional). This presentation will discuss the current status of the MF-OWHM source code (https://code.usgs.gov/modflow/mf-owhm), new features implemented in the last year, and planned updates in the coming future.

### 20-3. Modeling Future Groundwater Depletion to Evaluate Sustainability Goals set under the Sustainable Groundwater Management Act in the Critically Overdrafted Basins of the Central Valley, California, USA (2020 - 2070)

Presenters: Logan Platt (USGS, SDSU, UC San Diego)
Presenters Email Addresses: lplatt@sdsu.edu
Collaborators: Mathew Weingarten (SDSU), Claudia Faunt (USGS), Jon Traum (USGS), Scott Boyce (USGS; UC Davis)
Permission to Post pdf of Presentation on CWEMF Website: No

In 2014, California’s Sustainable Groundwater Management Act (SGMA) mandated local agencies to devise and implement Groundwater Sustainability Plans (GSPs) to address critically overdrafted conditions throughout the state’s aquifers. However, the feasibility of these agencies’ sustainability goals has not previously been assessed through a regional-scale, integrative lens. Here, we develop and analyze a novel, basin-wide database of 936 sustainability indicator wells located within Central Valley subbasins designated as critically overdafted, most of which lie in the San Joaquin Valley. Our database shows 2040 groundwater elevation goals vary widely from 60 meters above to 80 meters below 2020 levels, with variability within and between adjacent subbasins. To evaluate the feasibility of achieving these goals, we coupled the database with a regional hydrologic model (Central Valley Hydrologic Model version 2) and simulated multiple future pumping scenarios. Results show that under increased groundwater demand, 60% to 70% of indicator wells may fail to meet their 2040 goals. Even a 50% reduction from 2020 demand levels leaves nearly 40% of wells failing to meet their sustainability thresholds by 2040. Baseline models show that by 2070, up to 70% of wells could fail to meet their goals due to large-scale, spatially connected regions of groundwater depletion. This integrated framework, linking the first region-wide compilation of SGMA indicator wells with a regional groundwater model, demonstrates that many local sustainability goals may be unattainable with substantial (up to 50%) reductions in pumping. Additional management interventions, such as expanded recharge or coordinated demand reductions, may help achieve sustainability goals.

**20-4. Simulating Future Flow and Salt Transport in the Delta-Mendota Subbasin**

Presenters: Barbara Dalgish (LSCE)
Presenters Email Addresses: bdalgish@lsce.com
Collaborators: Mohamed Nassar (LSCE), Randall Hanson (One-Water Hydrologic), and Vicki Kretsinger Grabert (LSCE)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Salinity accumulation in the Central Valley is a key water management challenge and a central focus of the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) Salt Control Program and the Prioritization & Optimization Study. An archetype analysis conducted in the Delta-Mendota Subbasin developed a new modeling framework to evaluate different salinity modeling techniques for a 100-year future scenario.

The refined local flow and solute transport model was derived from the U.S. Geological Survey's Central Valley Hydrologic Model (CVHM2) and incorporates new approaches to link land surface and subsurface processes for both flow and solute transport simulations. This framework enables tracking of salt movement under transient hydrologic conditions.

The approach employed for tracking salt transport and accumulation in the subsurface involves integrating outputs from a separate land surface simulation platform, the Soil and Water Assessment Tool (SWAT). Results from the land surface model (agricultural groundwater pumping and deep percolation) are incorporated directly into the groundwater model to represent land surface processes and associated water demands. This integrated approach provides insight into projected future Total Dissolved Solids (TDS) concentrations across multiple spatial scales, including more local, focused areas, and allows evaluation of potential impacts to domestic, agricultural, and municipal wells.

This archetype modeling experience demonstrates a transferable toolkit that can be applied to other areas in the Central Valley to help prioritize groundwater with current and/or future emerging salinity concerns, and optimize potential future water and salt management activities or projects aimed at limiting groundwater degradation and subsurface salt accumulation.

**20-5. Toward solute transport modeling framework through an Integrated hydrogeological model**

Presenters: Mohamed Nassar (LSCE)
Presenters Email Addresses: mnassar@lsce.com
Collaborators: Steffen Mehl (Chico State University), Randall Hanson (One-Water Hydrologic), Scott Boyce (USGS, UCD)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Managing groundwater salinity is a priority for many regions in the Central Valley where decades of irrigated agriculture as well as industrial operations have led to an increase in salinity concentrations in groundwater. The Sustainable Groundwater Management Act (SGMA) specifically calls out water quality as one of the undesirable results, but the two most widely used tools for groundwater modeling (IWFM and MODFLOW) do not have direct functionality for simulating the mass accumulation and transport of salinity from the landscape to the groundwater systems via deep percolation and back again via groundwater pumping and applied water.

This work provides a framework of salinity fate and transport via landscape, surface water, and groundwater processes in a dynamic integration concept by considering the primary transport flow paths. This work presents an initial approach based on modifying MF-OWHM and MT3D-USGS to include these linkages between these transport flow paths at the process level. This is based on a mass-conservation approach including process related to direct application of saline water, evapoconcentration in the root zone, transport through the groundwater system, and reapplication of saline groundwater to the landscape from pumping.

**20-6. Evaluating seawater intrusion under climate change model updates and uncertainty analysis for Pajaro Valley, California**

Presenters: Marrisa Earl (INTERA)
Presenters Email Addresses: mearll@intera.com
Collaborators: Wes Henson, Scott Boyce, Pajaro Valley Water Management Agency
Permission to Post pdf of Presentation on CWEMF Website: Yes

This presentation demonstrates the application of MODFLOW-OWHM Version 2 (MF-OWHMv2) to evaluate seawater intrusion (SI) under changing climate conditions in the Pajaro Valley, California. The Pajaro Valley Hydrologic Model (PVHM), an integrated groundwater–surface water model developed as a decision support tool for basin management, was updated and extended using MF-OWHMv2. Key model updates include improved representation of pumping and recharge, and a revised coastal general head boundary using equivalent freshwater head to approximate seawater intrusion without variable-density modeling. The updated model was applied to simulate future hydrologic conditions (2013–2099) using an ensemble of downscaled climate projections representing dry, average, and wet scenarios. A first-order second moment (FOSM) approach is used to estimate posterior predictive uncertainty and evaluate uncertainty in groundwater levels and seawater intrusion forecasts. The analysis quantifies parameter contributions to forecast uncertainty and constrains forecast outcomes. These results inform development of protective thresholds for groundwater sustainability indicators under climate uncertainty. This work demonstrates how MF-OWHMv2 can be applied as a practical and efficient alternative to variable-density modeling for evaluating seawater intrusion in support of SGMA-related planning.

**20-7. A River Runs Through It: Subsurface Connectivity and Exchanges Between the Salinas River and Groundwater Subbasins**

Presenters: Wes Henson
Presenters Email Addresses: wes@wesleyhenson.com
Collaborators: Wesley Henson, Randy Hanson, Scott Boyce, Joseph Hevesi, Elizabeth Jachens
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Salinas Valley in Monterey and San Luis Obispo Counties, California, is a vital agricultural hub, producing up to half of the U.S. supply of crops like lettuce, celery, broccoli, and spinach. This productivity results in significant demand for the region's water resources. Water supply is increasingly strained by climate variability. Conjunctive water management is used in the basin as water availability often doesn't align with the time or location of agricultural water demands. Surface water is limited by variable precipitation and streamflow, and although the valley has two reservoirs that store surface water, the only conveyance is the Salinas River. Substantial stream seepage makes it challenging to deliver surface water to farms throughout the valley. Thus, groundwater is used extensively to meet water demands resulting in groundwater depletion, surface water loss, and seawater intrusion. To better understand groundwater and surface water availability, the Salinas Valley Integrated Hydrologic Model was developed through a cooperative partnership. This modeling tool integrates geologic, watershed, historical, and operational data to simulate water use and support improved water management strategies under current and future conditions. Improvements in efficiency, surface water supply and storage projects, and valley-wide sustainability coordination present opportunities to mitigate the undesirable effects of unsustainable groundwater use. Substantial connectivity and subsurface flows between groundwater subbasins and the Salinas River underscore the importance of using a regional tool to evaluate and manage water resources. Tools that encompass the entire Salinas Valley are essential for analyses of water availability and use under changing land use, agricultural practices, climate conditions, and reservoir operations.

## Session 21: Climate Change and Extreme Rainfall and Flooding Events

**Session Moderator: Yuchuan Lai (Tetra Tech)**
**Moderator Email: yuchuan.lai@tetratech.com**

### 21-1. Analyzing climate modeling in the Central Valley: Nexus of statistics and data analysis tools

Presenters: Chakri Malakpet (HDR); Asphota Wasti (HDR)
Presenters Email Addresses: Chakri.Malakpet@hdrinc.com
Collaborators: Chong Vang (DWR), Michael Konieczki (HDR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The California Department of Water Resources (DWR) is preparing the 2027 Update of the Central Valley Flood Protection Plan (CVFPP), which is California's strategic blueprint for improving flood risk management in the Central Valley. The CVFPP develops strategies to prioritize the State's investment in flood management over a 30-year planning horizon, to promote multi-benefit projects, and to integrate and improve ecosystem functions associated with flood-risk-reduction projects.

In support of the 2027 CVFPP Update, DWR is conducting technical evaluations to quantify flood risk for the areas protected by the State Plan of Flood Control (SPFC) under current and future climate conditions. A key technical evaluation to support this study includes climate analysis using a macro-scale watershed hydrologic model of the California region. This model was used to simulate historical and future climate scenario conditions, informed by DWR's preferred climate change approach, and integrated with the latest downscaled future climate projections to assess hydrologic changes throughout the system. This presentation will provide an overview of the climate and watershed modeling approaches, statistical methodologies adopted to develop estimates of flood frequency curves, and how data analysis tools helped to gain insights into the analysis results to ensure consistency with the standards and guidelines.

### 21-2. A stochastic watershed modeling framework for rainfall-runoff simulations

Presenters: Chakri Malakpet (HDR)
Presenters Email Addresses: Chakri.Malakpet@hdrinc.com
Collaborators: William Sicke (HDR), Nathan Pingel (HDR), Thomas Molls (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Stochastic watershed modeling (SWM) frameworks are an important tool for evaluating water resource systems. These include a deterministic watershed model within a stochastic analysis framework and are applied to generate ensembles of runoff traces, with each trace representing a model simulation, that more directly represent the variability and uncertainty in hydrologic conditions within the watershed. The ensembles of runoff traces allow for a comprehensive evaluation of runoff volume and exceedance probabilities of various thresholds in water resource systems operations including flood, water supply, and environmental operations. This information can be used to reduce systematic bias in estimating extreme events runoff volume that can result from using deterministic watershed models only, and thus provide improved estimates for better water resources management.

The California Department of Water Resources (DWR) has developed a watershed model within a SWM framework for the Lake Oroville watershed to generate ensembles of runoff simulations to help develop information for their risk-based assessments for Oroville Dam. This presentation will provide an overview of the SWM framework developed for this project using HEC-WAT, the deterministic hydrologic model (HEC-HMS) used in the analysis, and the uncertainties analyzed in the precipitation, temperature, snowpack, and model parameters. A summary of the data sources and computational resources employed for the analysis will be presented, along with the comparison of results of the runoff hydrograph generated using previously calibrated parameters and the results of the stochastic analysis. The lessons learned and suggestions for implementation for other studies will be discussed.

### 21-3. Probabilistic Extreme Rainfall Projections under Climate Change: Applying Extreme Value Analysis with A Climate-Model-Informed Bayesian Approach

Presenters: Yuchuan Lai (Tetra Tech)
Presenters Email Addresses: yuchuan.lai@tetratech.com
Collaborators: Byeongseong Choi (University of Texas at Arlington), Sujoy B. Roy (Tetra Tech)
Permission to Post pdf of Presentation on CWEMF Website: Yes

A major challenge of adapting to future climate change is incorporating forward-looking climate information—typically from global climate models (GCMs) with downscaling—into historical-observation-based design values such as intensity-duration-frequency (IDF) curves for extreme rainfall. The IDF curves traditionally rely on parametric distributions (e.g., Generalized Extreme Value, GEV, distributions) with stationarity assumptions to quantify uncertainty (i.e., from aleatoric, random processes), which need to be updated and integrated with climate change consideration, including its associated epistemic uncertainty. We propose a Bayesian framework using a state space model to mathematically describe and analyze local extreme rainfall as a function of global warming level (GWL), with endogenous parameters linking GWL and local extremes to exogenous forcings (e.g., greenhouse gases). This method processes and uses climate model simulations as a prior belief, which is then updated with historical observations, effectively bridging model results and historical data while avoiding the commonly used adjustment factors and their associated methodological uncertainties. Case studies are conducted for multiple cities in California and nationwide using local weather station data to investigate the historical and projected future changes in local rainfall extremes. Given the increasing needs of forward-looking, local extreme rainfall information for adaptation, this work offers a practical, locally focused methodology—consistent with extreme value analysis and reliability-based designs—to estimate and project future extreme rainfall and IDF curves.

**21-4. Effects of Climate Change on City of San Diego Public Facilities and Operations**

Presenters: Syed Azhar Ali (Jacobs); Tapash Das (Jacobs)
Presenters Email Addresses: syed.ali2@jacobs.com; tapash.das@jacobs.com
Collaborators: Armin Munevar (Jacobs), Paula Silva (Jacobs), Mark Elliott (Jacobs)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The City of San Diego Public Utilities Department (PUD) manages one of the most complex integrated water, wastewater, and recycled water systems, encompassing dams, conveyance infrastructure, treatment facilities, pump stations, and extensive distribution and collection networks. Climate-driven hazards, including sea level rise, flooding, drought, wildfires, and extreme heat, pose increasing risks to these systems and will challenge future operations. As part of its first Integrated Master Plan (IMP), PUD is conducting a comprehensive climate vulnerability assessment to support development of a prioritized Capital Improvement Program.

This work by Jacobs Engineering under subcontract to CDM Smith for the city of San Diego evaluates historical and projected climate and hydrologic conditions, assesses the vulnerability of more than 700 facilities across five major system categories, identifies high-risk and interdependent assets, and recommends adaptation strategies to enhance long-term resilience. The evaluation of climate vulnerability under various climate change scenarios is performed by analyzing the projected changes in the following areas: temperature, precipitation, drought, flooding, sea level rise, and wildfire. For the climate change analysis, the projected changes in the vulnerability metrics are estimated for future periods with respect to the historical period. The downscaled climate model projections were used to support climate vulnerability assessment. The Variable Infiltration Capacity (VIC) model was used for the simulation of hydrological conditions along with wildfire and Coastal Storm Modeling System (CoSMoS) simulated flood hazard projections data. The assessment applies indicator-based metrics and incorporates results from hydrologic modeling and downscaled climate projections relevant to the San Diego region. Results quantify the susceptibility of PUD’s infrastructure under future climate conditions and provide guidance for integrating climate adaptation into utility planning and investment.

**Session 22: Reclamation Developments in Secondary Modeling**
**Session Moderator: Drew Loney (USBR)**
**Moderator Email: dloney@usbr.gov**

This session focuses on secondary modeling, that is any modeling that does not directly involve CalSim. Secondary modeling is primarily focused on water quality considerations in both real-time operations and planning.

**22-1. WTMP Development (Facilitated Adoption and Historical Reanalysis)**

Presenters: Mechele Pacheco (USBR)
Presenters Email Addresses: mpacheco@usbr.gov
Collaborators: Drew Allan Loney (USBR), Mussie Beyene (USBR), Melanie Holland (USBR), Ryan Lucas (USBR), Randi Field (USBR), Donna Garcia (USBR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

To build understanding and confidence in the WTMP tools, USBR provided presentations to the CVP stakeholders in the monthly American River Group (ARG) and Sacramento River Group (SRG) meetings. This process allowed the comparison of legacy water temperature modeling forecast tools and new WTMP forecast mode tools. This presentation will cover a summary of the facilitated adoption process and a deep dive into the comparisons. In addition, this presentation will include a historical reanalysis to assess the WTMP tools performance.

**22-2. Quantifying Sensitivity of Water Temperature Target Schedule to Meteorological Conditions**

Presenters: Melanie Holland (USBR)
Presenters Email Addresses: mholland@usbr.gov
Collaborators: Drew Allan Loney (USBR), Mussie Beyene (USBR), Ryan Lucas (USBR), Randi Field (USBR), Donna Garcia (USBR), Mechele Pacheco (USBR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

As the Water Temperature Modeling Platform (WTMP) is adopted to support reservoir operations in California, it is important to quantify the sensitivity temperature performance to meteorological variability. This study evaluates how different climate conditions and hydrologic year types influence water temperature schedule selection on the American River within the WTMP.

**22-3. Trinity Water Temperature Modeling for the Long-Term Operations**

Presenters: Mussie Beyene (USBR)
Presenters Email Addresses: mbeyene@usbr.gov
Collaborators: Drew Allan Loney (USBR), Caileen Yu (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

As part of the Consultation of Long-Term Operation (LTO) for the Trinity River Division of the Central Valley Project (CVP), multiple operations alternatives were developed for consideration with varying temperature objectives. This presentation discusses the development and performance of an integrated temperature model for Trinity Lake, Lewiston Reservoir, and the Trinity River. Additionally, the performance of each operations alternative with respect to its temperature objective will be presented.

**22-4. San Joaquin River Water Quality Model in CalSim 3**

Presenters: Yuan Hui (Stantec)
Presenters Email Addresses: Yuan.Hui@stantec.com
Collaborators: Tom FitzHugh (Stantec), Puneet Khatavkar (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

This project implements San Joaquin River water quality calculation from Frant Dam to Vernalis in main-stem SJR and eastside tributaries in CalSim 3 and considered factors such as natural runoff, tributary inflow, groundwater accretion, agricultural and wetland return flows that could affect SJR salinity. Instead of Electrical Conductivity (EC), Practical Salinity (PS) was applied for salinity mixture calculation in the model assuming perfect mixing, and the outputs were converted to EC for model calibration. This water quality model was calibrated in both CalSim 3 historical model (2000 to 2021) and planning model Initiative 6 Baseline (Action 5, 1921 to 2021) using EC measurements from CDEC and USGS at various gauge stations.

**22-5. Folsom Temperature Control Shutter Modeling**

Presenters: Drew Loney (USBR)
Presenters Email Addresses: dloney@usbr.gov
Collaborators: Lindsay Bearup (USBR), Caroline Ubing (USBR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Folsom Dam Temperature Control Shutters (TCS), originally constructed in 1955, are critical for managing downstream water temperatures to support endangered fish species and meet environmental regulations. The system currently consists of manually operated shutter panels that allow selective withdrawal of reservoir water at different depths. However, the shutters are well beyond their design life and require modernization. This presentation summarizes Reclamation's preliminary modeling to understand the TCS modernization and ongoing design activities.

**Session 23: Machine Learning Applications in Water Resources (Part 1)**
**Session Moderator: Tariq Kadir (Civil Engineer, retired)**
**Moderator Email: tkcalwater@gmail.com**

**23-1. Machine Learning Approaches for Predicting Reference Evapotranspiration and Irrigated Areas**

Presenters: Andre Daccache (UC Davis)
Presenters Email Addresses: adaccache@ucdavis.edu
Collaborators: A. Ahmadi (UC Berkeley), R. Snyder (UC Davis), T. Kadir (DWR) & Z. Bai (UC Davis)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Accurate estimation and forecasting of reference evapotranspiration (ETo) is essential for sustainable water management, particularly in regions where water is scarce and agriculture is heavily dependent on irrigation. In this work, data-driven models to improve the understanding, estimation, and forecasting of ETo using the long-historical climate records from California's CIMIS stations.

Feature importance analysis was applied to identify the relative influence of meteorological variables across seasons and climatic zones. Trend analysis using the Mann–Kendall test demonstrate that many irrigation-intensive regions of California are becoming warmer and drier. A novel machine learning framework, SolarET, was also introduced to estimate daily ETo using solar radiation as the sole input. This approach reduces the need for extensive meteorological instrumentation and reference surfaces. SolarET outperformed commonly used empirical methods such as Priestley–Taylor and Hargreaves–Samani and showed strong performance especially in California's Central Valley.

Comparative analysis between statistical, machine learning, and deep learning models for monthly ETo forecasting, showed that classical statistical approaches such as Holt–Winters exponential smoothing can achieve forecasting accuracy comparable to advanced deep learning models while requiring less data and computational cost. However, applying global learning methodologies to DL models markedly improved forecasting performance yielding RMSE values below 10 mm/month for one-year ahead forecasts on new, unseen stations. The proposed models provide practical tools for irrigation management and water resources planning especially in areas where weather data are scarce or of poor quality.

**23-2. Machine Learning Approaches for Estimating Aquifer Hydraulic Properties from Step-Drawdown Pump Tests: A Case Study in Central Valley, California**

Presenters: Behrooz Etebari (DWR), Graham Fogg (UC Davis)
Presenters Email Addresses: Behrooz.Etebari@water.ca.gov, gefogg@ucdavis.edu
Collaborators:
Permission to Post pdf of Presentation on CWEMF Website: Yes

We present a data-driven and scalable framework for estimating aquifer hydraulic conductivity by integrating specific capacity results with well completion records using machine learning (ML) techniques. The approach applies Random Forest regression to large regional datasets obtained from the California Natural Resources Agency (CNRA) and the Department of Water Resources (DWR) Open Data platforms. Specific capacity values—defined as the ratio of well yield (gpm) to drawdown (ft)—derived from 3–72 hour pumping tests at more than 8,000 wells are combined with well construction information to characterize aquifer hydraulic behavior.

The framework enables efficient processing of heterogeneous datasets and provides spatially distributed estimates of hydraulic conductivity at regional scales. Unlike traditional analytical pumping test interpretations, which are often limited by sparse monitoring data and significant manual processing, the proposed approach offers a consistent and automated method for estimating aquifer properties directly from pumping and well construction records.

Results demonstrate that the ML framework produces robust and reproducible estimates of hydraulic conductivity at basin and sub-basin scales. The methodology supports the development and refinement of hydrogeologic conceptual models and provides Groundwater Sustainability Agencies with a practical tool for leveraging Sustainable Groundwater Management Act (SGMA) datasets to improve regional groundwater assessment and management.

**23-3. Leveraging AI for Predicting Fallow Land and Resource Allocation in the San Joaquin Valley of California**

Presenters: Abid Sarwar (UC Merced)
Presenters Email Addresses: asarwar@ucmerced.edu
Collaborators: Josué Medellín-Azuara (UC Merced); John T. Abatzoglou (UC Merced); Joshua H. Viers (UC Merced)
Permission to Post pdf of Presentation on CWEMF Website: No

California's San Joaquin Valley (SJV) faces increasing water shortages, climate shifts, and environmental issues. Farmers are increasingly fallowing land to conserve water, though predicting where farmland will be idle is difficult. This study uses machine learning and deep learning to forecast fallowing locations and timing. Deep learning models outperform classical models, achieving an F1 score of 0.81 and an accuracy of 0.94, compared to an F1 ≈ 0.67 and an accuracy ≈ 0.89. Using Groundwater Sustainability Agency (GSA) boundaries as our analysis units, we estimate roughly a 20% rise in fallowed acreage across the SJV—and about 25% across all farmland—during water year (WY) 2024 compared with 2022. The largest clusters of predicted fallowing appear in Fresno, Kings, Tulare, and Kern counties. GSAs that rely solely on groundwater show the greatest increase in fallow area (32%), followed by those that depend solely on surface water (29%) and those with mixed supplies (24%). These projections can assist water managers, growers, and land-use planners as they navigate SGMA and develop multi-benefit strategies for repurposing idled land in the SJV.

**23-4. Applying AI/Machine Learning Algorithms for Forecasting California Water Year Types**

Presenters: Tariq Kadir (Civil Engineer, retired)
Presenters Email Addresses: tkcalwater@gmail.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

California's Water Year Type (WYT) Classification categorizes each water year as Wet, Above Normal, Below Normal, Dry, or Critical based on water availability derived from precipitation, snowpack, and resulting runoff outflow runoff from eight upper watersheds of the Central Valley. These classifications guide water supply allocations, environmental protection, hydropower, and flood control. A water year in California spans October 1 through September 30 of the following calendar year.

Forecasting WYT in advance can provide valuable lead time for managing a highly variable and constrained water system. The classification relies on the Water Year Type Index, which aggregates monthly runoff from eight rivers—four contributing to the Sacramento Valley Index (SVI) and four to the San Joaquin Valley Index (SJVI). The California Department of Water Resources typically issues forecasts beginning December 1, updating them monthly through May as additional data improve accuracy.

This work focuses on forecasting WYT at the start of a water year (October 1). Runoff for each of the eight rivers is predicted for the upcoming 12 months using only historical data available prior to October 1st. These forecasts are then used to compute the indices and classify the WYT. The approach applies more than a dozen statistical and machine learning methods, including deep learning and emerging large language model–based forecasting tools. Results are evaluated against the Department of Water Resources' December 1st forecasts (B120) for Water Years 2020–2025.

**Session 24: Water Accounting: The Importance (and Challenge) of Measuring Water in the Field to Ground-truth Our Models**
**Session Moderator: Brandon Ertis (Davids Engineering)**
**Moderator Email: brandon@davidsengineering.com**

Numerical models are necessary for responsible management and stewardship of our water resources, but even the most complex model is a simplification of the true complexity of water moving through the hydrologic cycle and across the landscape, with substantial human influence, over space and time. It is critical for our models to be developed in reference to and utilizing best available information from real-world measurements and monitoring; a classic example of this is calibrating a groundwater model to actual groundwater level measurements. In this session, we will review various data about water and its movement on the land surface, and how they can be utilized to improve our understanding of water resources and the development and application of our numerical models. Although real-world data is messy, through integration of that data into our modeling efforts, we can improve our models with the ultimate goal of improving the water resources on which we all depend. The data types covered in this session include remote-sensing ET estimates, streamflows, applied water for irrigation, and a variety of field data related to interconnected surface waters (ISW).

**24-1. Groundwater Demand Management: Quantifying crop consumptive use to support groundwater sustainability under the Sustainable Groundwater Management Act (SGMA)**

Presenters: Daniel Smith (Davids Engineering)
Presenters Email Addresses: daniel.smith@davidsengineering.com
Collaborators: Stephanie Anagnoson, Tukta Phetasa, Leticia Tapia, Jacinta Cabral, Aleta Allen (Madera County Water and Natural Resources Department)

Permission to Post pdf of Presentation on CWEMF Website: Yes

In response to California's 2014 Sustainable Groundwater Management Act (SGMA), Groundwater Sustainability Agencies (GSAs) throughout California's Central Valley have started to manage agricultural consumptive use of groundwater through allocated limits. Monitoring methods, such as ground-based flowmeters of applied water and remotely sensed evapotranspiration of applied water, are being employed by GSAs and growers under these allocation programs. While groundwater allocation programs can be irreducibly complex, they are often necessary to achieve groundwater sustainability. Successful implementation of a program requires use of the best available data and clear communication of the program and its many facets to growers to ensure that it is operated and enforced in a consistent, fair, and repeatable manner. From 2023 through 2025, Madara County GSAs implemented an allocation program that allowed growers to select one of three measurement methods (Flowmeters, Land IQ [remote sensing method], or IrriWatch [remote sensing method]) as their consumptive use measurement method. To achieve groundwater sustainability in a fair and equitable manner, any uncertainties between methods used to track consumptive use need to be understood and minimized. As a result, for the last three years, the data produced from these measurement methods have been analyzed and compared under the Madera Verification Project and shared publicly. We will explore some of these results and their implications during this presentation.

**24-2. Increasing streamflow data availability through the California Stream Gage Improvement Program (CalSIP)**

Presenters: Jeffrey C. Davids (Davids Engineering)
Presenters Email Addresses: jeff@davidsengineering.com
Collaborators: Ryan Alward (INTERA); Cassie Clark, Lanie Bratz, Nathan Teboul, Erika Sos, Christopher Sortor, Devin Mortensen, Dylan Diep, and Corbin Vincent (Davids Engineering)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The California Stream Gage Improvement Program (CalSIP) is a statewide initiative led by the California Natural Resources Agency and the Department of Water Resources to enhance the state's network of stream gages. Among other applications, these gages are critical for monitoring streamflow, supporting water resource management, flood forecasting, ecological protection, and climate resilience. CalSIP focuses on repairing, upgrading, and expanding the gaging network, prioritizing areas with significant data gaps or high vulnerability to climate change and extreme weather events. By improving data collection and accessibility, CalSIP aims to support better decision-making for sustainable water management across California. In this presentation, we explore a number of important questions and activities in various regions of Northern California that CalSIP is supporting via improved stream gage data. We also explore emerging approaches for quantifying streamflows in previously difficult to measure settings.

**24-3. Field study to validate applied water estimates developed using an IDC model application**

Presenters: Brandon Ertis (Davids Engineering); Hannah Romero (El Dorado Water Agency)
Presenters Email Addresses: brandon@davidsengineering.com; hannah.romero@edcgov.us
Collaborators: Jeff Davids, Grant Davids (Davids Engineering); Hannah Romero, Rebecca Guo (El Dorado Water Agency)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Modeling is essential for long-term planning and evaluating potential future scenarios. El Dorado Water Agency identified long-term water supply-demand imbalance and vulnerability during droughts as primary water resource-related challenges for planned expansion of agriculture in El Dorado County. As part of the planning efforts to understand long-term water demands, an Integrated Water Flow Model (IWFM) Demand Calculator (IDC) model was developed in 2020 to estimate crop water demands and applied water requirements under various existing and projected future climate change conditions. However, at that time, no local applied water data were available to validate the modeled estimates. During the 2024 irrigation season, a field-based study was completed to evaluate existing irrigated agriculture and measure applied water volumes for direct comparison to IDC-modeled estimates. The Study showed that conservative inputs and assumptions used in the prior modeling work led to conservatively low estimates of applied water demands, and actual measurements of applied water in 2024 as part of this Study were substantially higher than those previously estimated. The Study also incorporated in-field distribution uniformity testing to evaluate the Consumptive Use Fraction (CUF), and these measurements were found to closely align with CUF values calculated from OpenET data. The results indicated a relatively high CUF value considering the foothill environment with varying terrain. The Study findings provide increased understanding of existing conditions and a basis for potential refinement of modeled estimates for applied water requirements to inform future planning efforts.

**24-4. Better Models Need Better Measurements - Characterizing Stream-Aquifer Exchanges with Stream Reach Water Budgets**

Presenters: Jeffrey C. Davids (Davids Engineering)
Presenters Email Addresses: jeff@davidsengineering.com
Collaborators: Kyle Morgado and Charles Johnck (Yuba Water Agency); Devin Mortensen, Christopher Sortor, and Brandon Ertis (Davids Engineering, Inc.); Jim Blanke, Mesut Cayar, and Sercan Ceyhan (Woodard and Curran)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Sustainable Groundwater Management Act (SGMA) of 2014 identified the depletion of interconnected surface water (ISW) as one of six potential undesirable results of unsustainable groundwater use. Throughout California, stream-aquifer interactions have been identified as an important data gap for assessing groundwater sustainability that Groundwater Sustainability Agencies (GSAs) must take steps to understand and assess by 2025 (for critically overdrafted subbasins) or 2027 (for non-critically overdrafted subbasins). Model characterizations of stream-aquifer interactions are helpful for evaluating scenarios, but often lack real-world measurements for calibration of streambed conductance, which are necessary for accurately quantifying the magnitude of stream-aquifer interactions. In this presentation, we review the stream-reach water budget methods and results from data collected in 2024 and early 2025 on the Yuba, Feather, and Bear Rivers in Yuba County. Data collection included over 125 periodic discharge measurements and observed diversion and return flows at over 25 locations, including longitudinal water surface elevation and streambed elevation surveys for Feather River from the Thermalito Afterbay to the confluence with the Bear River. With these data, we developed quantitative estimates (and uncertainty) in all terms of the stream-reach water budget including stream inflows and outflows, miscellaneous inflows and outflows (i.e., diversions, drainage inflows, etc.), evapotranspiration, precipitation, and the closure term, net stream gain (NSG). Our work highlights similarities and differences between field observations and the existing groundwater model. Our results highlight the heterogeneity in stream-aquifer interactions and the importance of ground-truthing model representations of stream-aquifer interactions with empirical measurements whenever possible.

**24-5. Leveraging Satellite-Based Evapotranspiration to Support Sustainable Water Management in California**

Presenters: A.J. Purdy (CSUMB; NASA-ARC); Lan Liang (DWR)
Presenters Email Addresses: adpurdy@csumb.edu; lan.liang@water.ca.gov
Collaborators: Conor Doherty (CSUMB; NASA-ARC), Alberto Guzman (CSUMB; NASA-ARC), Jose Rodriguez (CSUMB; NASA-ARC), Lee Johnson (CSUMB; NASA-ARC), Forrest Melton (NASA-ARC), Lydia Bleifuss (OpenET), Sara Larsen (OpenET), Steven Springhorn (DWR), Guobiao Huang (DWR), Craig Altare (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Satellite-based evapotranspiration (ET) datasets are increasingly being used to support water management decisions across California, including the implementation of the Sustainable Groundwater Management Act. The low-latency, high-resolution ET data made available through OpenET's data services provides consumptive water use data to complement field measurements and numerical models in support of these activities. Here, we provide updates on recent OpenET science advances, available resources to support California users, and review OpenET data applications that focus on groundwater and surface water management. We highlight how the integration of OpenET data into hydrologic models, such as C2VSimFG, can improve the representation of surface water diversions, pumping, and recharge to support more effective management.

**Session 25: Developments in 2026 on Historical Hydrology and Calibration of the CalSim Historical Model**
**Session Moderator: James Polsinelli (DWR)**
**Moderator Email: james.polsinelli@water.ca.gov**

There is a new hydrology pre-processor (CalSim Hydro v2) that uses the most recently released IWFM Integrated Demand Calculator and simulates the hydrology entirely within the new IDC, rather than as seven separate modules. A calibration effort has improved the CalSim3-WRIMS based historical model and has improved CalSim3 parameters for both the surface water WRIMS model and groundwater DLL. Calibrated parameters may be brought into the planning model to reduce bias and improve confidence in the results of the model.

**25-1. CSHydro Updates: Transition from Legacy CSHydro to the IDC Based Integrated Framework**

Presenters: Mohammad Hasan (DWR); Jay Wang (DWR)
Presenters Email Addresses: zhiqiang.chen@water.ca.gov; mohammad.hasan@water.ca.gov; Jianzhong.Wang@water.ca.gov
Collaborators: Dogrul (DWR), ZhiQiang Richard Chen (DWR), and James Polsinelli (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

CSHydro provides valley-floor surface hydrology and water-demand inputs for CalSim 3. In the legacy implementation, valley watershed hydrology was represented through a collection of external models that simulated rainfall-runoff, soil infiltration, evapotranspiration, applied water demand, tailwater, wastewater, and deep percolation. These models were executed sequentially to preprocess hydrologic time series for CalSim 3, with key components simulated outside the operational model framework.

CSHydro v2 represents a fundamental architectural upgrade by migrating all hydrologic components onto the Integrated Demand Calculator (IDC). In this framework, rainfall-runoff, soil-moisture routing, evapotranspiration, applied-water demand, return flow and reuse, ponded-crop dynamics, and percolation are solved simultaneously within a single mass-balance formulation. Small-watershed hydrology is now simulated concurrently with valley-floor processes.

CSHydro v2 also strengthens surface–groundwater interaction by computing root-zone percolation, drainage, and storage changes as dynamic fluxes that link land-surface processes to groundwater systems. Additional updates include standardized input/output structures, expanded land- and water-use budgeting, and improved handling of land-use change effects.

### 25-2. Historical CalSim 3 GW-DLL Calibration

Presenters: Sercan Ceyhan (Woodard & Curran); Puneet Khatavkar (Stantec)
Presenters Email Addresses: mceyhan@woodardcurran.com; Puneet.khatavkar@stantec.com
Collaborators: Bridget Childs, Ali Taghavi, Ryan Lucas, Nancy Parker, Lauren Thatch
Permission to Post pdf of Presentation on CWEMF Website: Yes

The GW-DLL module in CalSim 3 plays a critical role in simulating stream–groundwater interactions that directly influence surface water flows and reservoir conditions. Appropriate parameterization of GW-DLL is essential for planning studies relying on CalSim 3.

This presentation describes an integrated workflow and preliminary results for calibrating the GW-DLL and CalSim Hydro preprocessor using PEST, while accounting for uncertainties introduced by the CalSim-Hydro preprocessor. The process, key parameters, observations, and lessons learned are discussed.

### 25-3. CalSim3 Historical Hydrology Model (CS3HIST)

Presenters: Bridget Childs (Stantec)
Presenters Email Addresses: bridget.childs@stantec.com
Collaborators: Andy Draper (Stantec), Mina Shahed-Behrouz (Stantec), Puneet Khatavkar (Stantec), Nancy Parker (USBR), Ryan Lucas (USBR), James Polsinelli (DWR), Richard Chen (DWR), Mohammad Hasan (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The WRIMS-based CalSim3 Historical Hydrology Model (CS3HIST) was developed to refine CalSim3 hydrology and groundwater DLL behavior. USBR and DWR introduced an automated parameter calibration routine using CS3HIST due to its simplified representation, shortened runtime, and historical system constraints.

The model routes historical inflows through the system with reservoir storage and diversions constrained to observed values, while stream–groundwater interaction is dynamically determined by the groundwater DLL. Comparisons to historical gauge data are used to quantify model error and develop bias correction timeseries. Refinement of CS3HIST is ongoing as CalSim3 hydrology evolves.

### 25-4. Surface Water Calibration of the CalSim3 Historical Hydrology Model (CS3HIST)

Presenters: James Polsinelli (DWR)
Presenters Email Addresses: James.Polsinelli@water.ca.gov
Collaborators: Andy Draper (Stantec), Mina Shahed-Behrouz (Stantec), Puneet Khatavkar (Stantec), Nancy Parker (USBR), Ryan Lucas (USBR), James Polsinelli (DWR), Richard Chen (DWR), Mohammad Hasan (DWR), Jay Wang (DWR), Ruian Dong (DWR), Steven Jepsen (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

CS3HIST has undergone substantial surface-water calibration using PEST to estimate thousands of parameters in the CalSim3 and CalSimHydro models. Parameters include loss factors, streambed conductivity, groundwater pumping, soil curve number, evapotranspiration scaling, and rainfall-runoff initial abstraction.

Results are presented in terms of bias correction at key system locations, with the goal of minimizing historical simulation bias. Calibration efforts are ongoing and will continue as new groundwater DLLs, CalSimHydro versions, and modeling domain expansions are developed.

## Session 26: Machine Learning Applications in Water Resources (Part 2)

**Session Moderator: Kevin He (DWR)**
**Moderator Email: Kevin.He@water.ca.gov**

### 26-1. Deep Learning for Daily Streamflow Prediction across Hydroclimatic Regions in California

Presenters: Yu-Chieh (Jay) Chao (UC Davis); Wyatt Arnold (DWR)
Presenters Email Addresses: ycjchao@ucdavis.edu; Wyatt.Arnold@water.ca.gov
Collaborators: Zhaojun Bai, Zhi Ding, Nicky Sandhu, and Kevin He
Permission to Post pdf of Presentation on CWEMF Website: Yes

California's diverse hydroclimatic regions present distinct challenges for accurate streamflow prediction, a critical component of effective water resource management. This study evaluates the efficacy of Long Short-Term Memory (LSTM) networks across over 200 watersheds spanning California's full hydroclimatic gradient â€“ from rainfall-dominated coastal basins to transitional mixed rainâ€“snow watersheds to snowmelt-driven high-elevation catchments.  The proposed deep learning architectures ingest daily meteorological forcings (temperature and precipitation) alongside static physical watershed attributes such as elevation, vegetation cover, slope, aridity, and soil characteristics, enabling a single model to learn the complex, non-linear rainfall-runoff relationships that vary across regions without basin-specific calibration. Preliminary evaluations indicate that the LSTM-based models yield reasonable predictive performance across all three hydroclimatic tiers. Crucially, these deep learning frameworks operate with significantly lower computational overhead than traditional physically based models, and their ability to generalize spatially is an important feature for enabling water resources planning in ungauged basins statewide. The combination of robust accuracy and rapid execution time demonstrates the strong potential of LSTM networks to reliably supplement existing hydrological modeling frameworks. Ultimately, integrating these advanced machine learning approaches can accelerate simulation pipelines, offering enhanced support for both real-time water operations and comprehensive long-term resource planning.

### 26-2. Real-Time Multi-Ion Forecasting in the South Delta Using Hydrodynamically Informed Machine Learning

Presenters: Peyman Namadi (DWR)
Presenters Email Addresses: Peyman.HosseinzadehNamadi@water.ca.gov
Collaborators: Kevin He, Nicky Sandhu
Permission to Post pdf of Presentation on CWEMF Website: Yes

Accurate prediction of ion concentrations in the South Delta is essential for managing agricultural diversions and drinking water supply. Previous modeling approaches primarily relied on lumped predictors such as the X2 position and Water Year Type (WYT), which oversimplify the complex hydrodynamics governing salinity intrusion in the Delta. This study addresses these limitations by developing a Multi-output Random Forest (Multi-RF) model that uses physically meaningful, high-resolution hydrodynamic predictors: hourly-matched electrical conductivity (EC) at 13 monitoring stations and the San Joaquin River boundary, 15-minute flow measurements, daily export pumping rates at Banks (HRO) and Tracy (TRP) facilities, and seasonal barrier operations. Grab sample collection times were used to extract hour-specific EC averages from continuous 15-minute data, preserving tidal phase alignment across a 15-day lag window. Principal Component Analysis reduced 45 lag variables to six components, capturing over 96% of the variance. The model simultaneously predicts seven ion constituents (Cl, $SO_4$, Ca, Mg, Na, Alkalinity, Br) with nowcast $R^2 = 0.949$ and 7-day forecast $R^2 = 0.831$, outperforming both Artificial Neural Network (ANN; average $R^2 = 0.928$) and Parametric Regression (PR; average $R^2 = 0.617$) approaches from prior studies. Leave-One-Station-Out cross-validation further confirmed strong spatial generalization across seven core stations ($R^2 > 0.89$). An operational dashboard was developed that automatically downloads real-time data from CDEC and USGS, generates nowcast and 7-day forecasts three times daily, and distributes results via interactive maps, tables, and email alerts. This system represents the first live multi-ion forecasting framework for the South Delta, providing actionable information for water quality management and operational decision-making.

### 26-3. Predicting the Microcystis Visual Index (MVI) using a data-driven approach to support Harmful Algal Bloom management in the Delta

Presenters: Gourab Kumer Saha (DWR)
Presenters Email Addresses: gourab.saha@water.ca.gov
Collaborators: Ellen Preece, Silvia Angles, Kevin He, Nicky Sandhu
Permission to Post pdf of Presentation on CWEMF Website: Yes

Microcystis-driven harmful algal blooms (HABs) are increasingly becoming a Delta water-quality threat. Proactive HABs management has been challenging due to the limited predictive capability of existing HAB assessment approaches. This study developed a data-driven modeling framework to predict the Microcystis Visual Index (MVI) to support the Delta HAB management. This study selected 1006 MVI samples and associated water quality parameters from 35 stations to develop machine learning (ML) models. For management relevance, the original MVI classifications were reorganized into two operational categories: Minimal Management (MVI 1-2) and Mandatory Management (MVI 3-5). The primary study objective is to accurately predict these management-oriented categories using water-quality parameters. Three ML models, Random Forest (RF), Extreme Gradient Boosting (XGBoost), and Artificial Neural Networks (ANN), were trained using optimized hyperparameters and customized penalty functions. A combined score of accuracy (35%), precision (20%), and recall (45%) was used as the loss function to identify the optimal models. The three models demonstrated comparable performance on the test data: with combined scores of 0.805 for RF, 0.808 for XGBoost, and 0.812 for ANN. Among these models, XGBoost showed the lowest predictive uncertainty: predicted 54% of the test data with low uncertainty and 46% with medium uncertainty. The confusion matrix showed that the XGBoost model accurately predicted Minimal Management 90% of the time (231 out of 257 cases) and Mandatory Management 76% of the time (34 out of 45 cases). The results demonstrate the feasibility of using a data-driven MVI prediction framework to support timely Delta HAB management decisions.

**26-4. Machine Learning Applications in the Delta: Review and Outlook**

Presenters: Kevin He (DWR)
Presenters Email Addresses: kevin.he@water.ca.gov
Collaborators: Nicky Sandhu
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Delta is a critical hub for California's water supply and ecological health, necessitating rapid and accurate modeling for decision-support. This paper reviews three decades of machine learning (ML) applications in the Delta, tracing the evolution from early artificial neural networks (ANNs) developed in the 1990s for salinity estimation to modern integration within operational planning tools like CalSim. Recent advancements highlight a shift toward deep learning and hybrid physics-informed models, expanding applications to water quality forecasting, ecosystem monitoring, toxigenic and disaster risk assessment, and infrastructure resilience. Despite these successes, widespread operational deployment remains constrained by critical gaps in model interoperability, generalizability, interpretability, and operationalization. To address these challenges, we propose a strategic roadmap emphasizing standardized ML development protocols, multi-modal data fusion, digital twins, generative artificial intelligence (AI), explainable AI, and AI agents. This roadmap aims to transform isolated research ML models into a cohesive, transparent, and adaptive decision-support framework for sustainable water and environmental management in the Delta.

**26-5. Transfer Learning for Multi-Fidelity Surrogate Modeling of Delta Salinity Under Extended Drought and Climate Scenarios**

Presenters: Sabi Can Ruso (UC Berkeley); Eli Ateljevich (DWR)
Presenters Email Addresses: canruso@berkeley.edu; Eli.Ateljevich@water.ca.gov
Collaborators: Lily Tomkovic (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Salinity management proposals in the Delta often involve complex processes such as sea level rise and profound landscape change that can only be resolved by high resolution and expensive to run multi-dimensional models. Understanding the resulting influence on statewide reservoir and project operations -- and the feedback to Delta inflow -- requires accurate surrogates in upstream models such as Calsim. In this talk we describe expanded ANN architectures and training methods that treat multiple Delta futures (climate change, major restoration efforts) all at once as a multitask machine learning problem. We describe tradeoffs in terms of general accuracy and in terms of the fidelity of the contrasts. We address some signal to noise questions and the question "just how different do interventions and scenarios have to be for us to faithfully model the contrasts between them?" An interesting result is that it is often the most remote and challenging stations where we often obtain the best contrast skill.

**Session 27: Strengthening Demand and Process Representation in WEAP: Advanced Data Integration for Statewide Planning**
**Session Moderator: Marina Mautner (SEI)**
**Moderator Email: marina.mautner@sei.org**

Statewide water planning increasingly depends on models that can incorporate improved data, refined demand representations, and updated process understanding while remaining operational within established planning frameworks. This session focuses on recent advances using WEAP to strengthen how agricultural demands, groundwater processes, and regional interactions are represented for the California Water Plan Update 2028, with an emphasis on integrating advanced datasets and methods into decision-relevant workflows.

Presentations cover updates to irrigation demand and groundwater process representation in the Central Valley, implementation of WEAP for coastal regions to support statewide planning, and the design of modular, cloud-based systems that integrate near–real-time and early-season crop information into existing modeling workflows. Together, the talks illustrate how improved data integration can enhance model fidelity and responsiveness without sacrificing transparency or institutional continuity, supporting more robust statewide planning under climate variability and uncertainty.

**27-1. Updates to Central Valley WEAP model for California Water Plan Update 2028: enhancements to irrigation demands and groundwater processes**

Presenters: Brian Joyce (SEI)
Presenters Email Addresses: brian.joyce@sei.org
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Water Evaluation and Adaptation Planning (WEAP) model has been used to support scenario analysis for multiple California Water Plan Updates (CWPU), dating back to CWPU 2008. For the CWPU 2028, an updated WEAP model of the Central Valley has been developed for use in a similar scenario-based planning framework, while benefiting from substantial refinements to the representation of water supplies and demands. These refinements improve the model's ability to evaluate system performance and management tradeoffs under a wide range of future conditions.

The updated model takes advantage of recent advances in the WEAP software to enhance the representation of irrigation water demands as well as both surface water and groundwater hydrology. A key improvement is the simulation of agricultural irrigation demands using a daily irrigation scheduling module based on FAO-56 crop water requirements, allowing for a more physically based and temporally explicit representation of crop water use and irrigation practices. Another important update to the model involved the aligning groundwater hydrology with C2VSIM results. The updated model also incorporates recent changes to operational rules as well as updated regulatory and management requirements relevant to the Central Valley.

This presentation will describe the structure and key updates to the Central Valley WEAP model, outline its application within the Water Plan Update 2028 analytical framework, and discuss how the model supports transparent, stakeholder-informed evaluation of future water management strategies.

**27-2. Implementing WEAP to incorporate California's South Coast and San Fransico Bay regions into the 2028 Water Plan Update**

Presenters: Andrea Carlos Carlos (SEI)
Presenters Email Addresses: andrea.carloscarlos@sei.org
Permission to Post pdf of Presentation on CWEMF Website: Yes

As part of the California Water Plan's effort to expand the geographic scope of its analytical modeling framework for assessing future water supplies and demands, the California Water Plan Update 2028 extends scenario analysis to the South Coast and San Francisco Bay hydrologic regions. These regions are being modeled using the Water Evaluation and Adaptation Planning (WEAP) tool, building directly on the existing Central Valley model and reflecting the strong hydrologic and operational connections between the Central Valley and these two regions.

Resource management in the San Francisco Bay and South Coast regions involves balancing competing objectives for water allocation across agriculture, domestic, commercial, and industrial sectors. Reliance on water imports, coupled with the need to ensure sustainable groundwater water use in these regions, presents a significant management challenge.

This presentation will provide an overview of the structure of the South Coast and San Francisco Bay models, including their connection to the Central Valley model, which simulates Central Valley Project exports to the regions. These models serve as water assessment tools to evaluate competing management objectives. By simulating various climate and demand scenarios, the models help stakeholders understand the implications of different water management strategies and assess how climate change might exacerbate existing challenges by altering precipitation patterns, increasing drought frequency, and affecting overall water supply in the regions.

**27-3. Designing a modular, cloud-based crop-mapping system for the SacWAM modeling workflow**

Presenters: Marina Mautner (SEI)
Presenters Email Addresses: marina.mautner@sei.org
Permission to Post pdf of Presentation on CWEMF Website: Yes

Reliable estimation of irrigated crop area is a persistent challenge for operational water allocation in California's Central Valley, particularly during critically dry years when return flows play a central role in system-wide balancing. This presentation describes a near–real-time crop mapping application developed to support allocation and return flow estimation by providing timely, spatially resolved land-use information across the Central Valley. Developed using the Google Earth Engine Python API, the system integrates Sentinel-2 imagery, OpenET evapotranspiration products, and public land use data to classify crop types using category-specific Random Forest classifiers. Key predictors include NDVI, BSI, ET, DEM, and additional spectral metrics. Outputs are aggregated by Demand Unit aligned with statewide water planning models SacWAM and SJWAM.

The resulting crop type estimates serve as dynamic inputs to the SacWAM and SJWAM models and are published to a visualization platform. These WEAP-based models adjust crop coefficients and growing season timelines based on land use classification, enabling improved estimation of return flows and resulting streamflow throughout the Central Valley's managed network. While state and local agencies rely on multiple data sources for allocation planning, this tool provides an independent, high-resolution method for updating land use assumptions in near real time. Critically, it offers early-season estimates of crop planting behavior which can improve situational awareness and support more adaptive modeling during uncertain or extreme conditions. We will present the system architecture, classification accuracy results from 2019 to 2022 that include both critically dry and wet years, and key lessons learned in building operational tools to support water resource planning.

**27-4. Early-season crop identification to support irrigation demand and return flow representation in WEAP-based planning models**

Presenters: Romina Díaz Gómez (SEI)
Presenters Email Addresses: romina.diazgomez@sei.org
Permission to Post pdf of Presentation on CWEMF Website: Yes

Accurate representation of crop acreage is a critical input to water planning models, particularly in irrigated systems where crop-specific practices strongly influence consumptive use and return flows. In California's Central Valley, rice production plays an outsized role in surface water balances due to flooding practices, while interannual climate variability drives rapid shifts in planting decisions across both summer and winter crops. This study presents an operational remote sensing and machine learning framework for early-season crop identification designed to improve land-use inputs to WEAP-based water allocation models.

We developed a scalable Earth observation approach to map rice, winter crops (alfalfa, wheat, pasture), and fallow land from February through early summer using Random Forest classification with transfer learning. Predictors include multispectral indices from Sentinel-2 imagery (e.g., NDVI, NDWI, NDTI, BSI) and optional evapotranspiration inputs from OpenET, enabling deployment under varying data availability. Models were trained on over 420,000 samples from statewide crop maps and validated across wet, dry, and critically dry years.

Machine learning substantially outperformed threshold-based methods during dry years, when crop signals diverge from typical phenology. Rice and fallow classification accuracy exceeded 80% by April and improved to over 90% by May–June, while winter crop sensitivity reached 87% to 98% by May, prior to peak irrigation demand. Classified crop areas are aggregated to planning demand units and used to dynamically update crop acreage and growing season timing in WEAP models, directly affecting irrigation demand estimation and return flow representation.

## Session 28: Updates to DWR's C2VSim Fine Grid Model

**Session Moderator: Craig Altare (DWR)**
**Moderator Email: craig.altare@water.ca.gov**

This session will provide an overview of the latest updates to one of DWR's integrated groundwater-surface water modeling applications for the Central Valley. The California Central Valley Groundwater–Surface Water Simulation Model Fine Grid version (C2VSimFG) is developed by DWR and used by Groundwater Sustainability Agencies in the Central Valley to support development and implementation of Groundwater Sustainability Plans.

Talks in this session will describe ongoing efforts to update C2VSimFG and will include: (1) an overview of the model and planned enhancements for the next major public release, (2) updates to the groundwater level observation dataset that will be used for calibration of the next version, (3) a major overhaul of how groundwater pumping is represented, and (4) updates related to the representation of surface water in the Central Valley.

### 28-1. Overview of DWR's C2VSimFG Application and Planned Updates for Version 2

Presenters: Uditha Bandara (DWR)
Presenters Email Addresses: Uditha.Bandara@water.ca.gov
Permission to Post pdf of Presentation on CWEMF Website: Yes

The California Department of Water Resources (DWR) has developed and continues to enhance the Fine-Grid Version of the California Central Valley Groundwater–Surface Water Simulation Model (C2VSimFG). In support of the Groundwater Sustainability Plan Regulations, DWR provides C2VSimFG as a planning tool for groundwater managers across the Central Valley implementing the Sustainable Groundwater Management Act (SGMA). Since SGMA's enactment, DWR has released multiple versions of C2VSimFG with significant advancements and extensions to the model time series.

This presentation provides an overview of the evolution of C2VSimFG, with a focus on updates currently in progress for version 2.0. The talk will be useful for GSAs, consultants, and others involved in groundwater planning and SGMA implementation in the Central Valley.

**28-2. Updating the Central Valley Groundwater Level Observation Dataset**

Presenters: Kyle Hardage (DWR)
Presenters Email Addresses: Kyle.Hardage@water.ca.gov
Permission to Post pdf of Presentation on CWEMF Website: Yes

Observed groundwater levels are a key dataset used to calibrate integrated groundwater-surface water models, including the California Department of Water Resources' (DWR) Fine-Grid Version of the California Central Valley Groundwater–Surface Water Simulation Model (C2VSimFG). This presentation describes efforts to improve the groundwater level observation dataset relative to data used in prior C2VSimFG calibration.

These efforts include: (1) combining groundwater level datasets maintained by state and federal entities, (2) comprehensive cleanup using manual and automated methods, and (3) improved linkage between groundwater level observations and monitoring well screen elevations to better assign observations to the appropriate aquifer system and model layers.

**28-3. Revisions to the Representation of Pumping Wells in C2VSimFG**

Presenters: Andres Guillen (DWR)
Presenters Email Addresses: Andres.Guillen@water.ca.gov
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Fine-Grid Version of the California Central Valley Groundwater–Surface Water Simulation Model (C2VSimFG) has been updated to better represent the vertical distribution of groundwater pumping across the Central Valley. This update includes a comprehensive reevaluation of agricultural and urban well pumping depths based on multiple data sources.

This presentation will describe the new production well dataset and its implementation in the upcoming version of C2VSimFG.

**28-4. New Developments in the Surface Water Components of C2VSimFG**

Presenters: Guobiao Huang (DWR)
Presenters Email Addresses: guobiao.huang@water.ca.gov
Collaborators: Nicholas Anchor (DWR); Chloe (Ke) Liu (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Fine-Grid Version of the California Central Valley Groundwater–Surface Water Simulation Model (C2VSimFG) has been updated to address some known issues regarding the simulation of surface water features. This talk will describe significant updates to (1) the model's stream geometry and ratings tables aimed at improving the simulation of surface water and groundwater interaction, (2) the representation of selected surface water features with a constrained head boundary condition, and (3) updates to surface water diversion delivery areas.

## Session 29: Recent updates of the DWR Delta Emergency Response Tool – Automation, Optimization, and Machine Learning

**Session Moderator: John DeGeorge (GEI); Khalida Fazel (DWR)**
**Moderator Email: jfdegeorge@rmanet.com; Khalida.Fazel@water.ca.gov**

The Delta Emergency Response Tool (Delta-ERT) provides rapid reconnaissance level analysis of the water supply impacts associated with levee failure events in the Sacramento-San Joaquin Delta. Concepts for the underlying computational approach originated through the Delta Risk Management Strategy (DRMS) project. The California Department of Water Resources Hydrology and Flood Operations Branch has managed on-going development and enhancement of the Delta-ERT over the last decade. This session focuses on some of the recent enhancements including the use of automation to explore utility of specific recovery strategies, optimization of temporary barrier placement for specific failure events, and application of reinforcement learning to schedule recovery actions based on multiple benefit and cost considerations.

### 29-1. Overview of the Delta Emergency Response Tool

Presenters: Abdullah Karim (DWR)
Presenters Email Addresses: Abdullah.Karim@water.ca.gov
Permission to Post pdf of Presentation on CWEMF Website: No

Summarize the objectives of the DWR Delta Emergency Response Tool and provide a brief history of its development. Provide description of the significant enhancements since the last CWEMF presentation. Provide an overview of how the Delta-ERT supports the Delta Flood Emergency Management Plan (DFEMP).

### 29-2. Delta Flood Emergency Management Plan Supplement C

Presenters: Alyssa Virgil (DWR)
Presenters Email Addresses: alyssa.virgil@water.ca.gov
Permission to Post pdf of Presentation on CWEMF Website: No

A wide range of levee failure events and recovery strategies have been explored with the Delta-ERT computational engine to explore the utility of various strategies. Hundreds of thousands of model runs performed through Python scripting and results extracted and preserved in a relational database that supported post processing and analysis. An overview of this study will be provided, as well as a summary of results.

### 29-3. Optimization of temporary barrier placement to reduce water supply impacts after a levee failure event

Presenters: Ryan Ripken (RMA/GEI)
Presenters Email Addresses: ryan@rmanet.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

Previous work added a feature to quickly suggest good barrier placement strategies based on Machine Learning. To find optimal repair strategies a feature was added that uses randomized optimization and parallel processing to find the best strategies for the user’s current breach scenario. The session will present background information on the randomized optimization methods used and analysis of performance and a demonstration.

**29-4. Application of Reinforcement Learning to create a Machine Learning Agent that can play the Delta Recovery Game.**

Presenters: John F. DeGeorge (RMA/GEI)
Presenters Email Addresses: jfdegeorge@rmanet.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

A version of the Delta-ERT computational engine was reconfigured to accept recovery action decisions on a daily basis, and a reinforcement learning agent was trained to decide which recovery actions would be performed on any given day. Recovery actions included repairing levees, placing or removing temporary barriers, and making pulse releases from upstream reservoirs. The effectiveness of decisions is determined through evaluation of a daily reward function considering multiple aspects of Delta operations such as benefit of making meeting water deliveries requirements and costs associated with levee repairs, barrier replacement and removal and not meeting water quality requirements.

**Session 30: Recent Advances in SacWAM and SJWAM Development**
**Session Moderator: Charles Young (SEI)**
**Moderator Email: chuck.young@sei.org**

In recent years, the State Water Resources Control Board has invested in adding capabilities to the SacWAM and SJWAM models. These enhancements include the addition of a forecasting mode based on the NMME 7-month forecasts, refinement of the representation of water rights in the San Joaquin and Sacramento Valleys, linking the models to the IWFM groundwater DLL, and introducing a economics model for simulation of cropping choices as a function of water availability. In this session we will have presentations that discuss each of these topics.

**30-1. Forecasting Central Valley Runoff and Operations Using NMME 7-Month Forecasts**

Presenters: Chuck Young (SEI)
Presenters Email Addresses: Chuck.Young@sei.org
Permission to Post pdf of Presentation on CWEMF Website: Yes

In the past few years a forecasting functionality has been added to the SacWAM and SJWAM models. This functionality is based on the use of the NMME 7-month ensemble mean forecast as provided by the Climatology Lab at UC Merced. The forecasting system is now running daily with daily updates to historical meteorology and monthly updates to the 7-month forecast. Analyses have been completed of model skill including runoff and operations.

**30-2. Operations based on Water Right Priority Dates in SacWAM and SJWAM**

Presenters: Puneet Khatavkar (Stantec)
Presenters Email Addresses: puneet.khatavkar@stantec.com
Permission to Post pdf of Presentation on CWEMF Website: Yes

SacWAM and SJWAM are built on the WEAP software platform, which enables user-friendly simulation of complex water systems. The primary goal of these models is to provide a framework for evaluating revisions to instream flow and regulatory requirements in the Bay-Delta watershed, particularly in the context of the Water Quality Control Plan for the San Francisco Bay–San Joaquin system.

Currently, operations in SacWAM and SJWAM rely on WEAP's allocation process. In WEAP, water is typically allocated based on the demand priority assigned to each demand site and the supply preference of the transmission links serving that site. While this approach adequately represents demand and supply at the demand-unit level, it does not allow for simulation of water allocations based on the priority dates associated with individual water rights.

A recently added WEAP feature now allows users to assign priorities directly to transmission links rather than demand units. This enhancement makes it possible to model water allocations based on water-right priority dates. This study presents a new approach for simulating reservoir operations and water allocations in SacWAM and SJWAM using priority-date-based water rights as an alternative to the demand-unit priority system. Implementing this new modeling approach will improve the ability of SacWAM and SJWAM to evaluate water-right curtailments for planning and forecasting scenarios.

**30-3. Hydro-economic integration in SacWAM for dynamic cropping response to water availability and aquifer levels**

Presenters: Laura Forni (SEI)
Presenters Email Addresses: Laura.Forni@sei.org
Permission to Post pdf of Presentation on CWEMF Website: Yes

California's agricultural water use and cropping patterns are increasingly shaped by drought, pumping constraints, and shifting surface water availability. Yet many basin-scale planning models represent agricultural land as a fixed component or do not include land response to water on an annual basis. For work supporting the California State Water Resources Control Board, we are developing a hydro-economic enhancement to SacWAM by embedding SWAP-style Positive Mathematical Programming (PMP) behavior in a Python-based algorithm that endogenizes crop choice, fallowing, and water use as surface water availability and aquifer level changes. To ensure spatial consistency with SacWAM's planning architecture, regional crop allocation optimization is bounded by SacWAM decision units, and crop group definitions are harmonized with remotely sensed acreage products in the summertime. We calibrate and test validation performance using observed vs. simulated land/water allocation changes driven by (i) surface water curtailments and (ii) changes in groundwater pumping costs estimated from simulated groundwater table depth produced through the SacWAM–IWFM integration.

**30-4. Streamlining California water management tools: coupling IWFM and WEAP to improve stream–aquifer representation in the Central Valley**

Presenters: Marina Mautner (SEI)
Presenters Email Addresses: Marina.Mautner@sei.org
Permission to Post pdf of Presentation on CWEMF Website: Yes

State-level water allocation and planning decisions rely on accurate representation of surface water availability in streams and managed conveyance systems. During recent droughts in California, stream–aquifer interactions represented within the WEAP-based watershed planning models SacWAM and SJWAM were recognized as critical for supporting near–real-time assessment of water supply conditions under intensive groundwater and surface water management.

Building on this need, we coupled SacWAM/SJWAM to the IWFM-based C2VSIM Coarse Grid model to enhance representation of groundwater–surface water interactions within the statewide planning framework. The coupling architecture enables dynamic exchange of streamflows, pumping, recharge, groundwater heads, and other relevant variables, with alignment of temporal resolution, spatial aggregation, and accounting conventions to ensure consistency across models. Results demonstrate representation of stream–aquifer interactions, recharge, and pumping dynamics during drought conditions that is consistent with established system behavior. Visualization approaches implemented within WEAP are also presented to support analysis and communication of coupled model outputs, illustrating how tighter integration of groundwater process models can enhance the fidelity and decision relevance of statewide planning tools while maintaining transparency and usability.

**Session 31: Sites Reservoir Modeling Updates**
**Session Moderator: Reed Thayer (Jacobs)**
**Moderator Email: reed.thayer@jacobs.com**

The Sites Reservoir project is a proposed 1.47 MAF multi-benefit offstream reservoir that will be constructed west of Maxwell, California. Operations, physical, temperature, and water quality models have been developed and implemented to support planning, feasibility, permitting, and participant decision making. This session provides updates on modeling developments over the last year and lessons learned as stakeholders collaborate to plan this landmark water project.

**31-1. Sites Project Modeling & Results Processing**

Presenters: Chad Whittington (Jacobs)
Presenters Email Addresses: chad.whittington@jacobs.com
Collaborators: Reed Thayer (Jacobs)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Over the past decade, extensive modeling of the Sites Project has supported permitting, feasibility, and design. A critical component has been translating model outputs into interpretable metrics for decision makers.

The Sites Project CalSim 3 model produces outputs readily converted into tables and graphics illustrating effects on water supply, flows, weir spills, and participant deliveries. Post-processing tools and dashboards, including Excel-based tools for public agencies, have been essential in evaluating operational strategies and protecting critical habitat.

**31-2. Lessons Learned in Improving Transfer Logic in CalSim 3**

Presenters: Reed Thayer (Jacobs)
Presenters Email Addresses: reed.thayer@jacobs.com
Collaborators: Chad Whittington (Jacobs)
Permission to Post pdf of Presentation on CWEMF Website: Yes

A planned component of Sites Reservoir operations is a series of transfer arrangements between North of Delta and South of Delta participants. To improve project economic feasibility, surplus supplies may be sold when not needed locally. Two implementation strategies were evaluated in CalSim 3: transfers within reservoir storage and direct, immediate deliveries.

These strategies were assessed to demonstrate impacts on project benefits for participants on both sides of the Delta. Implementation highlighted lessons related to minimizing model complexity, which guided development of a simplified transfer structure that still accounts for through-Delta conveyance impacts.

**31-3. Reservoir and River Water Temperature Modeling for Sites Project**

Presenters: Samaneh Saadat (Jacobs); Sai Nudurupati (Jacobs)
Presenters Email Addresses: Samaneh.Saadat@jacobs.com; Sai.Nudurupati@jacobs.com
Collaborators: Chad Whittington (Jacobs), Drew Loney (USBR), Kyle Winslow (Jacobs)
Permission to Post pdf of Presentation on CWEMF Website: Yes

Accurate water temperature modeling is critical for assessing environmental impacts of the Sites Project. Multiple models were developed and updated to evaluate reservoir, canal, and downstream river temperatures.

For the 2026 Biological Assessment, the HEC5Q model domain was extended to assess Sacramento River temperatures downstream of Sites Reservoir. CE-QUAL-W2 and temperature blending models were also developed. These tools support evaluation of operational strategies and coordination with resource agencies to mitigate impacts to critical habitat.

**31-4. Temporal Downscaling of CalSim 3 with USRDOM for the Sites Project**

Presenters: Sai Nudurupati (Jacobs); Chad Whittington (Jacobs)
Presenters Email Addresses: Sai.Nudurupati@jacobs.com; chad.whittington@jacobs.com
Collaborators: Rob Leaf (Jacobs)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Upper Sacramento River Daily Operations Model (USRDOM) simulates daily operations using CalSim outputs and historical data. Originally developed in 2010, USRDOM explicitly incorporates Sites Project conveyance and storage features.

Recent updates made USRDOM compatible with CalSim 3, including extended simulation periods, updated climate inputs, refined operations logic, and parameter remapping. USRDOM is valuable for evaluating river flows, weir spills, wetland habitat conditions, and facility design specifications that require daily resolution.

**Session 32: Developments in Open Water Data**
**Session Moderator: Christina McCready (DWR); Paul Shipman (DWR)**
**Moderator Email: Christina.McCready@water.ca.gov; paul.shipman@water.ca.gov**

This session is designed to highlight recent developments in open data. The first presentation will demonstrate the Artificial Intelligence-enabled Water Monitoring, Analysis, and Prediction System (AIWaterMAPS). The second presentation will provide a demonstration of DWR's efforts to catalog major models it uses and the datasets that inform those models. The third presentation will give an overview of DWR's efforts to make digitally available over 130,000 pages of historical climate data that it has safeguarded through the years. The last presentation will provide an opportunity for the Water Data Consortium to share an update on recent activities they have engaged in to improve usability of data in the state.

### 32-1. Artificial Intelligence-enabled Water Monitoring, Analysis, and Prediction System (AIWaterMAPS)

Presenters: Anmol Vishwakarma (DWR)
Presenters Email Addresses: Anmol.Vishwakarma@water.ca.gov
Collaborators: Sunil Sinha (Virgina Tech), Nirmala Mahadevan (DWR), Eric Zuniga (SWRCB), Dan Wang (SWRCB)
Permission to Post pdf of Presentation on CWEMF Website: Yes

"Every Drop Counts." Reliable, affordable access to clean water is vital for human health and well-being, ecosystems, and the economy. Such access is affected however by natural, technological, and anthropogenic hazards, by the increasing degradation of natural and built water systems, and by community and water sector inefficiencies and limitations. Given this complexity, an integrative Smart One Water (S1W) framework is indispensable for reliable public water supply. The Artificial Intelligence-enabled Water Monitoring, Analysis, and Prediction System (AIWaterMAPS) will enable transformative water system-of-systems (natural, built, social) assessments and accounting through integration of innovative digital technologies – data fusion, data analytics, and Artificial Intelligence (AI) – with existing local, state, and federal water monitoring for improved public water supply (PWS) provisioning.

### 32-2. Catalog of DWR's Major Models

Presenters: Jose Alarcon (DWR)
Presenters Email Addresses: Jose.Alarcon@water.ca.gov
Collaborators: Abdul Khan (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

DWR's Data and Tools Alignment Subcommittee has developed a catalog and interactive dashboard with input and feedback from DWR programs. The catalog captures the major models and analytical tools developed and used by the Department. The dashboard allows users to filter by hydrologic region, water management category, and model platform. The information in the catalog includes general information, output analysis information, output datasets, input datasets, and associated use cases. The catalog is intended to (1) improve awareness and understanding of major DWR models and analytical tools, (2) help identify and align key processes and functions that utilize DWR data and tools, and (3) serve as a resource during scoping activities for new data and tools development.

### 32-3. Digitization of historical climate archive

Presenters: Alyssa Whitaker (DWR), Mina Shahed Behrouz (Stantec)
Presenters Email Addresses: Alyssa.Whitaker@water.ca.gov; Mina.ShahedBehrouz@stantec.com
Collaborators: Elyssa Lynn (DWR), Paul Shipman (DWR), Katie Hardaker (Stantec)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The California Department of Water Resources (DWR) has safeguarded an extensive collection of historical climate records dating back to the mid-1800s. In alignment with the open-data principles of AB 1755, DWR's Climate Change Program and Open Data Program partnered to modernize this archive and expand public access to precipitation and temperature data collected by a network of voluntary contributors.

DWR contracted with Stantec to support the indexing phase, which included developing detailed criteria for evaluating record applicability and reviewing more than 200,000 individual records. This work consolidated the collection into approximately 130,000 pages organized using five standardized index fields. In the subsequent phase, SyTech Solutions digitized the full set of indexed records into PDF files, which then underwent a quality control review by DWR staff to verify scan accuracy and completeness.

This project represents a major step toward transforming legacy paper records into accessible digital resources that support statewide transparency, climate research, and water management planning. Future work will explore the application of artificial intelligence to extract the data from the scanned documents, enabling public access and enhancing the long-term value of DWR's historical climate archive.

**32-4. California Water Data Consortium - Improving the Usability of Data and Data Portals**

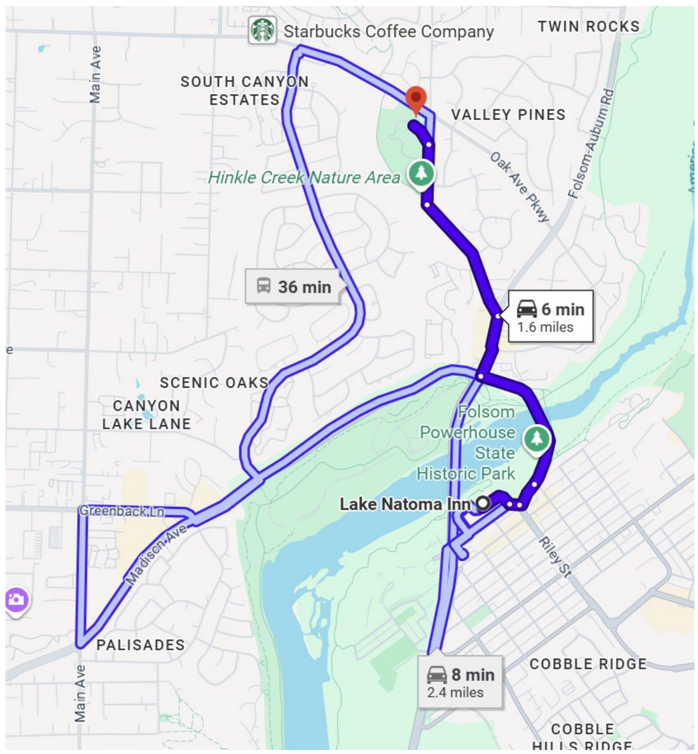
Presenters: Robyn Grimm (California Water Data Consortium)
Presenters Email Addresses: rgrimm@cawaterdata.org
Collaborators: Christina McCready (DWR)
Permission to Post pdf of Presentation on CWEMF Website: Yes

The Water Data Consortium will provide updates on recent activities, including the Groundwater Accounting Platform, a new initiative aimed at streamlining water data reporting, applications and recommendations for the use of real time telemetry across California, and recommendations for how best to leverage and strengthen data infrastructure through updated approaches to future granting programs. The Consortium will also facilitate a continuation of a dialogue initiated at the 2025 CWEMF Annual Meeting, on best practices and tools for water accounting, accessibility and utility of the State's open data portals, and other topics as selected by participants.

# DIRECTIONS TO BUSINESS MEETING

# ROBERT H MILLER III ROTARY CLUB HOUSE:
# 7150 BALDWIN DAM RD, FOLSOM

# MONDAY APRIL 20, 2026




**DIRECTIONS:**

- Take Gold Lake Dr to Riley St (0.1 mi)
    - Head toward Leidesdorff St (0.1 mi)
    - Turn left onto Leidesdorff St (174 ft)
- Take Greenback Ln to Oak Ave 2 min (0.8 mi)
    - Turn left onto Riley St (436 ft)
    - Continue onto Greenback Ln (0.5 mi)
    - Turn right onto Folsom-Auburn Rd (0.2 mi)
- Continue on Oak Ave. Drive to Triplet Ln (0.7 mi)
    - Turn left before McDonald's (0.4 mi)
    - Turn right onto Baldwin Dam Rd (0.2 mi)
    - Baldwin Dam Rd turns slightly left and becomes Triplet Ln
- Destination will be on the right (410 ft)