

CALIFORNIA DEPARTMENT OF WATER RESOURCES

Watershed Resilience Pilot Program

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Watershed Resilience Program Intent and Outcomes



Program Intent

Empower local water leaders with the capacity to prepare for climate change impacts across water sectors at the watershed scale



Equity

Build and support inclusive and diverse watershed networks



Climate Science

Inform sound resilience planning with quantitative climate vulnerability and adaptation analysis



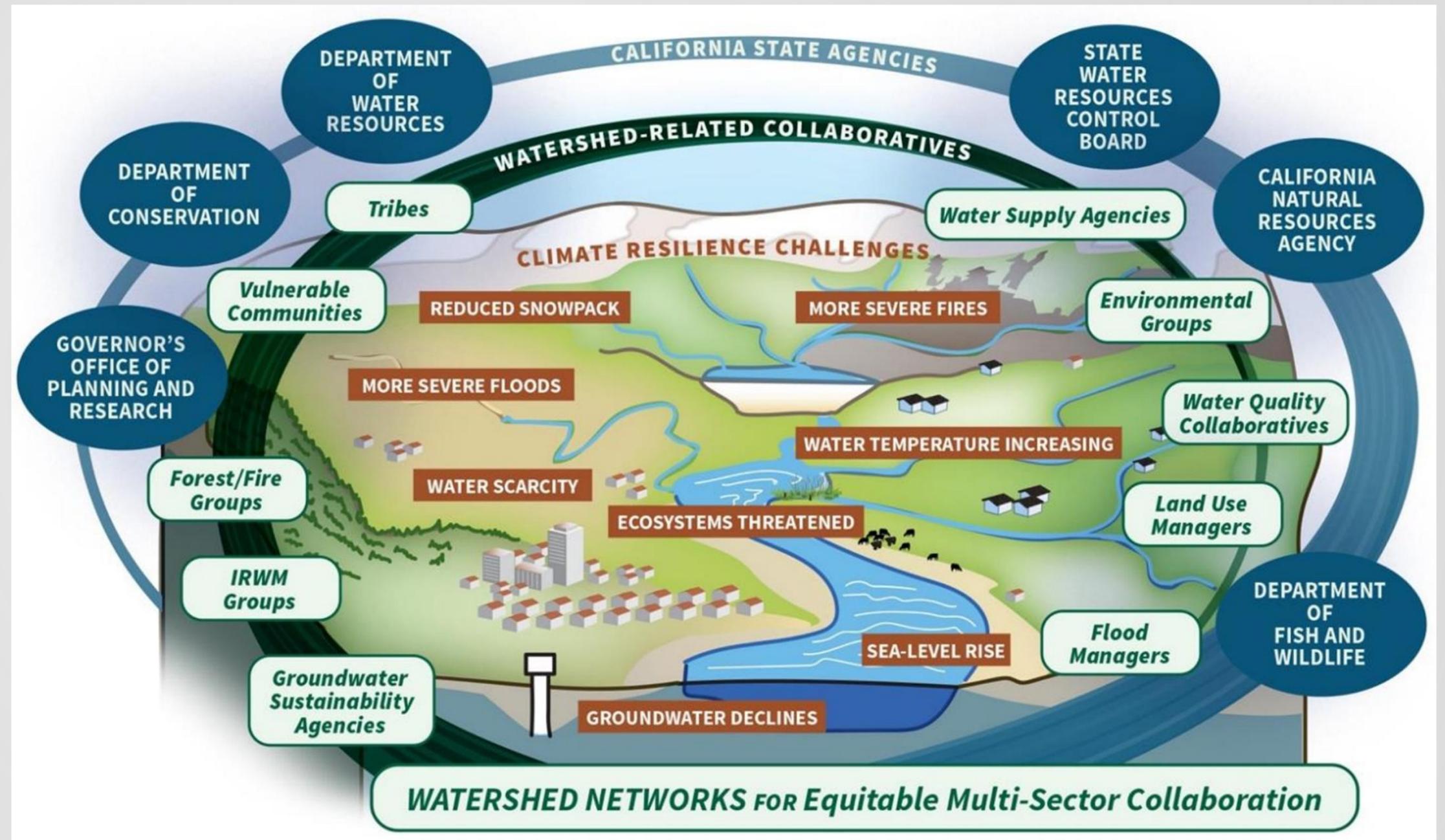
Scale

Incentivize planning on a hydrologically appropriate scale, from headwaters to groundwater basins



Watershed Networks

Update 2023 underscores the importance of supporting programs to incentivize robust watershed-specific climate vulnerability analyses and adaptation plans, followed by investments in multi-sector collaborations and solutions at the watershed scale



2024 Watershed Resilience Pilot Program Awards

Watersheds	Lead Agency
American River	Regional Water Authority
Calaveras River	Stockton East Water District
Pajaro River	Pajaro Valley Water Management Agency
Russian River	Sonoma Water Agency
Ventura River	Ventura RCD



Pilot Scope of Work

Task 1a: Define Watershed



Task 1b: Identify Community Participation Gaps

Task 1c: Build Inclusive Networks



Task 2: Explore Climate Hazards



Task 3: Assess Climate Vulnerabilities and Risks



Task 4: Develop and Evaluate Adaptation Strategies for Projects



Task 5: Develop Implementation Strategy



Task 6: Develop Performance Tracking Metrics



Task 7: Develop Watershed Resilience Plan



Lessons Learned

- Program flexibility meets regions where they are. Each pilot is unique to each watershed
- Organizing watershed networks has increased collaboration across upper and lower watershed, laying groundwork for surface water/groundwater integration
- Tribal engagement assistance/support is greatly needed



Resource Management Strategies

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30+ Resource Management Strategies

11 Updated for Update 2023

Reduce Water Demand

- Agricultural Water Use Efficiency
- Urban Water Use Efficiency

Improve Operational Efficiency & Transfers

- Reservoir Reoperation

Increase Water Supply

- Conjunctive Water Management
- Desalination – Brackish & Seawater
- Precipitation Enhancement
- Municipal Recycled Water

Improve Water Quality

- Urban Stormwater Runoff Capture & Management

Practice Resource Stewardship

- Recharge Area Identification, Utilization, and Protection
- Watershed Management

Improve Flood Management

- Flood Management

People & Culture



RMSs that have not been updated since 2013

Improve Operational Efficiency & Transfers

- Conveyance – Delta
- Conveyance – Regional / Local
- Water Transfers

Increase Water Supply

- Surface Storage – CALFED
- Surface Storage – Regional / Local

Other

- Crop Idling,
- Dewvaporation,
- Fog Collection,
- Irrigated Land Retirement,
- Rainfed Agriculture,
- Snow Fences,
- Waterbag Transport

Improve Water Quality

- Drinking Water Treatment & Distribution
- Groundwater / Aquifer Remediation
- Matching Quality to Use
- Pollution Prevention
- Salt & Salinity Management

Practice Resource Stewardship

- Agricultural Lands Stewardship
- Ecosystem Restoration
- Forest Management
- Land Use Planning & Management
- Sediment Management

People & Culture

- Economic Incentives (Loans, Grants & Water Pricing)
- Outreach & Engagement
- Water & Culture
- Water-Dependent Recreation



RMS that might be expanded or developed

Other

- Crop Idling,
- Dewvaporation,
- Fog Collection,
- Irrigated Land Retirement,
- Rainfed Agriculture,
- Snow Fences,
- Waterbag Transport

New?

- Dam Removal
- **Remote Sensing**
- Infrastructure Modernization



Making the RMSs more than text

- Quantifying water yield from individual RMSs
- Quantifying water yield from RMSs in combination
- Comparing water yield for bundles of RMSs



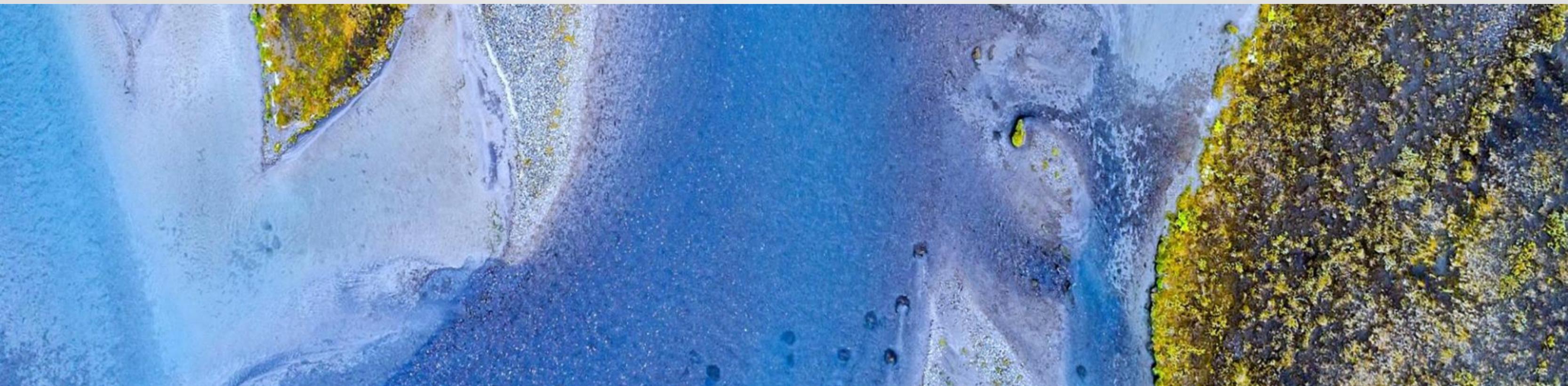
Watershed Hub

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CALIFORNIA DEPARTMENT OF WATER RESOURCES

The DWR Watershed Hub

2025 CWEMF, MAY 12, 2025



Lucian Filler, Program Manager

Watershed Hub Background

- Developed as part of DWR's Watershed Resilience Program
- Will support collaboration needed to develop cost effective, multi-benefit management strategies for addressing climate change effects across water sectors by watershed
- Will help with assessing current levels of sectoral resilience at the watershed scale and for tracking future conditions statewide



Welcome to the **WATERSHED HUB**

The Watershed Hub provides a snapshot of projects, data, conditions, vulnerabilities, and trends based on indicators in each watershed to support Watershed Networks, show progress toward sustainability and resiliency, address vulnerabilities, identify and track multi-benefit projects, assess return on investment, and inform funding decisions.

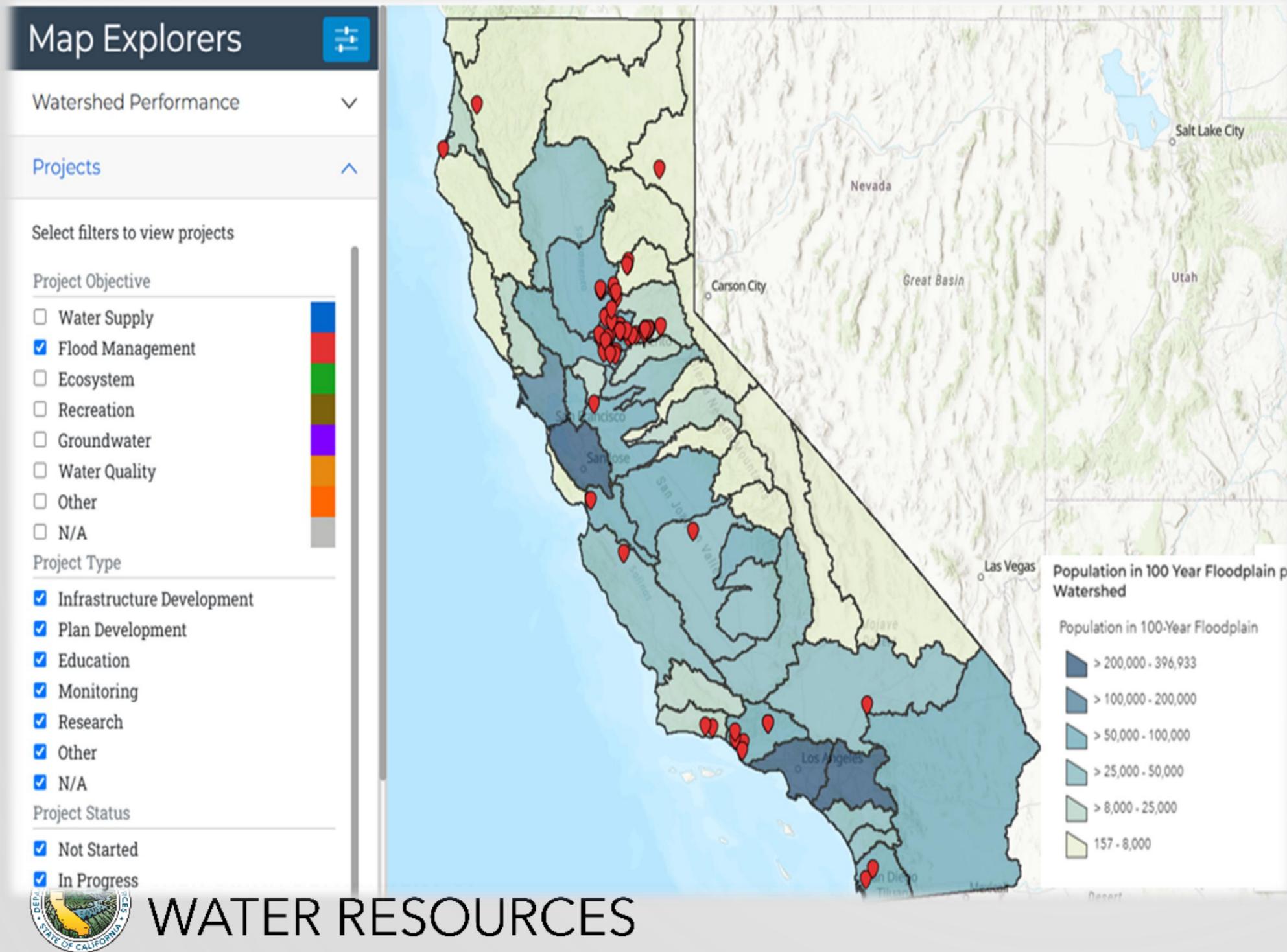
[Explore Watersheds](#)

[Explore Projects](#)

[Explore Water Budgets](#)

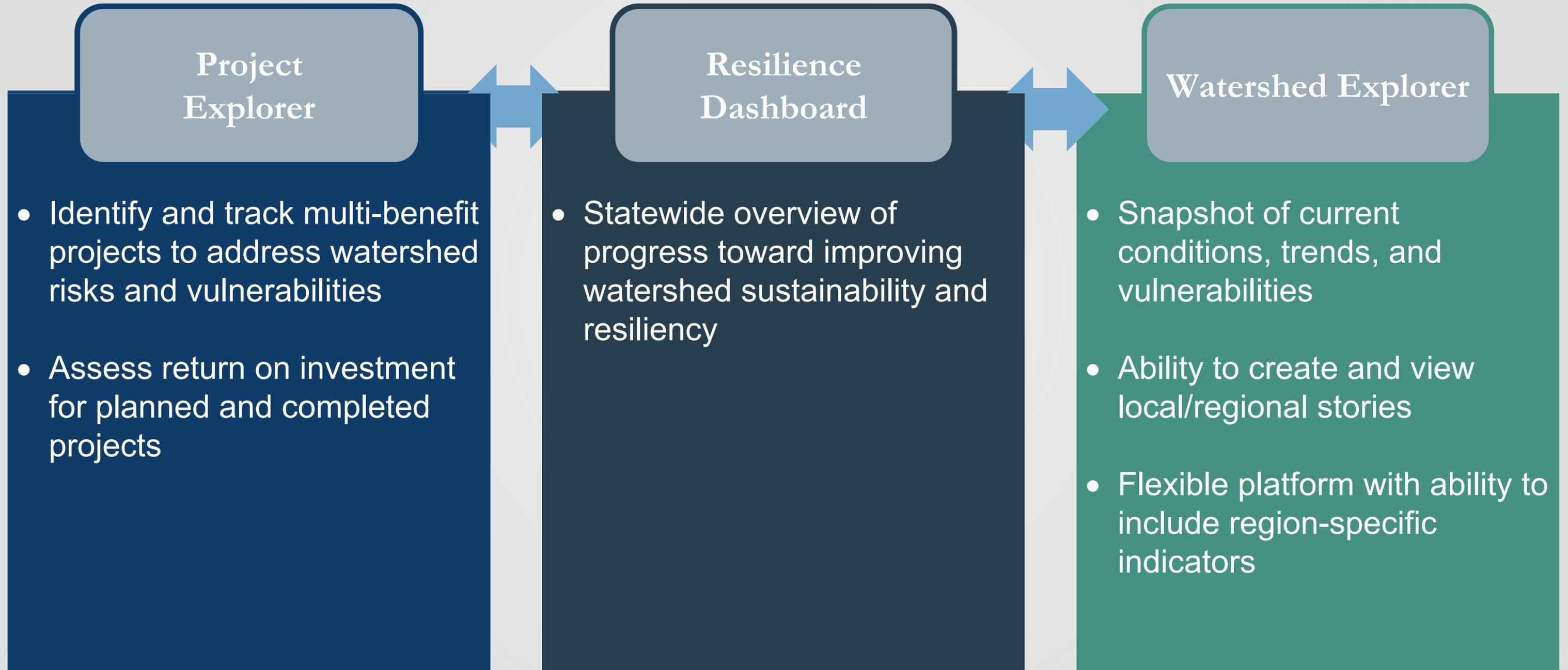
[Explore the Resilience Toolkit](#)

What the Watershed Hub Can Help Us Answer



- What are the status and trends of California's watersheds' resilience and associated natural and built backbone infrastructure?
- What are the greatest challenges and accomplishments in each watershed and where is progress being made towards resilience?
- Where and what type of historical and current investments have been made?

Conceptual Hub Architecture





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Explore Watersheds

Explore Projects

Explore Water Budgets

Explore the Resilience Toolkit



Next Steps



Continue to Include various open-source modeling tools to analyze relevant open-source data by water sector.



Increased modeling to provide trends analysis that will inform water management and planning decisions, better allocate resources, and assist in developing management responses cross water sectors at appropriate scale(s).



Hub will be increasingly improved to used track performance across water sectors to evaluate effectiveness of funding provided for management actions used to improve watershed resiliency and sustainability.



Future releases of the Watershed Hub will provide watershed networks with the ability to upload their unique watershed data, including specific metrics and indicators, project data, and other useful information for their networks.



Thank You!

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- ❖ [California Water Plan Update 2023](#)
- ❖ [Watershed Hub Resilience Indicators and Metrics](#)



Water Use and Supply Balances

How is water used in California and where does it come from?

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Acknowledgements, WSB Team

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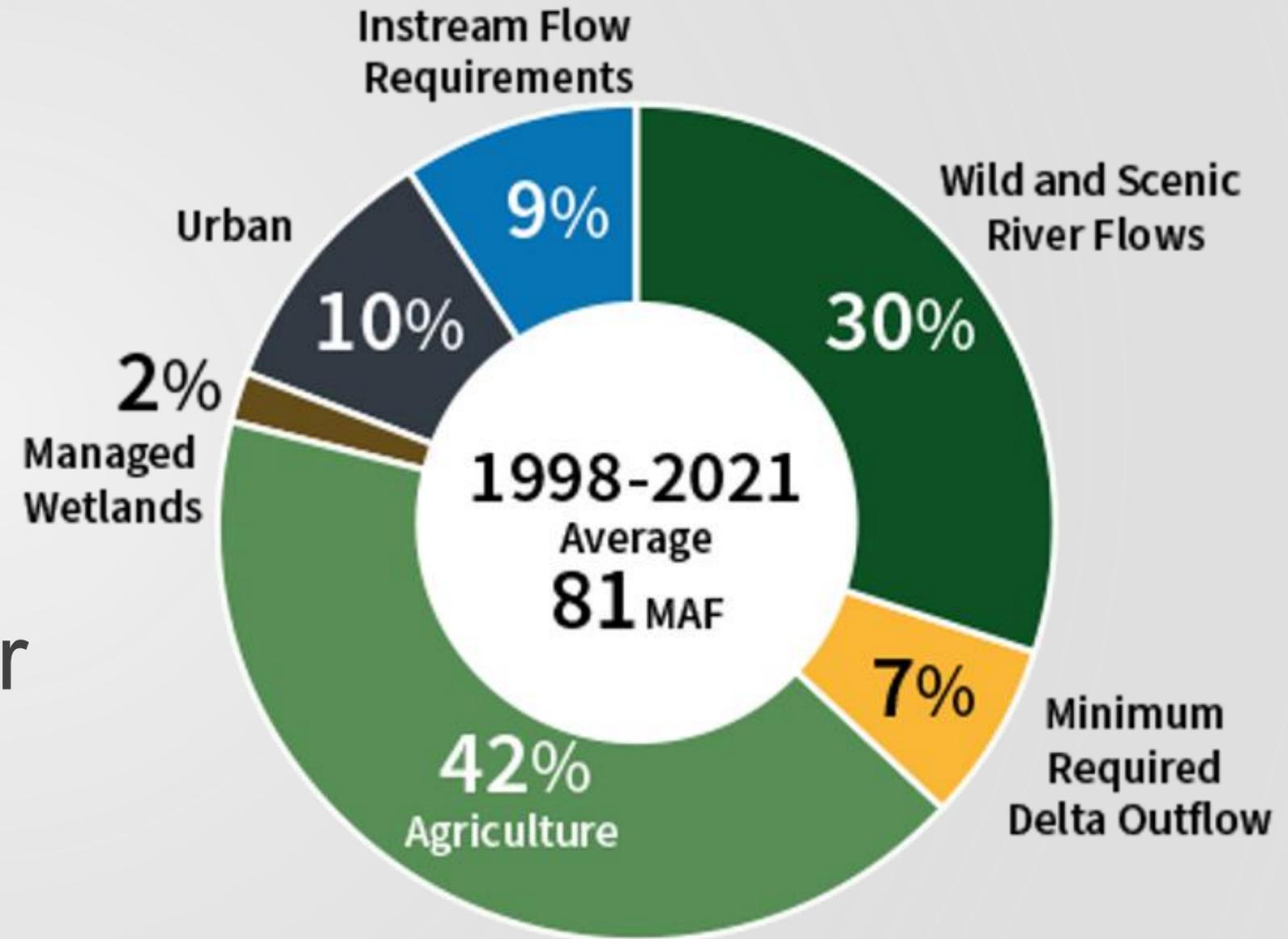
Acknowledgements, Data Users

- CWP Future Scenarios
- CWP Regional Summaries
- CWP RMSs
- GW Update 2025
- SGMO
- C2VSim
- CalSim 3
- Security and Emergency Mgmt Program
- PPIC
- LA Times
- Colorado River Board
- POLITICO
- Greater Sac. Economic Council
- Pacific Institute
- Sacramento Bee
- CalMatters
- Water Education Foundation



California Water Plan

- Required by Water Code
- Updated every 5 years
- Annual data releases
- WY 2017, 2021-2024
- WY 2022 released this year



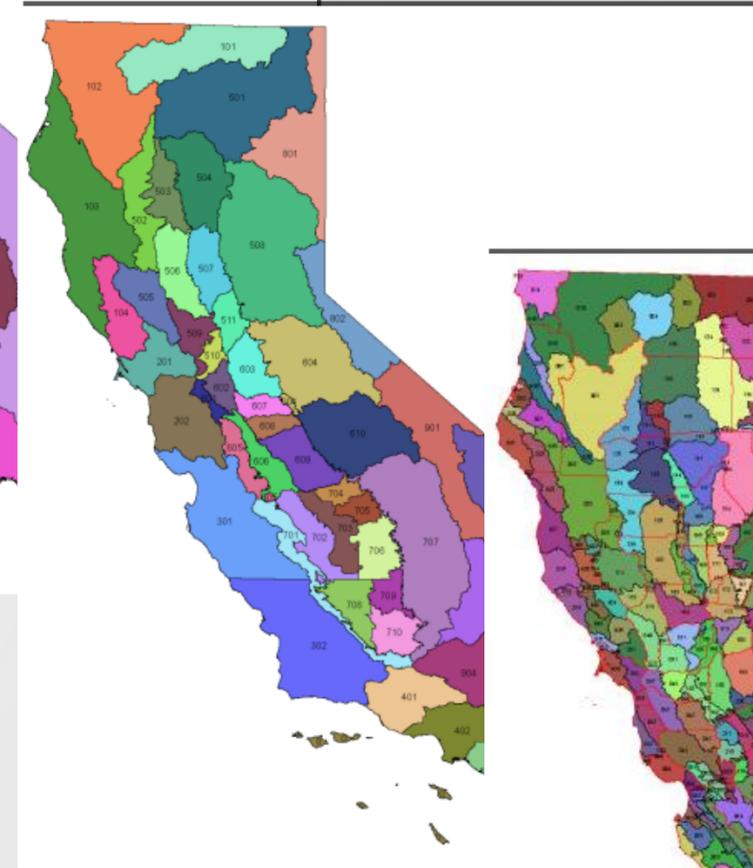
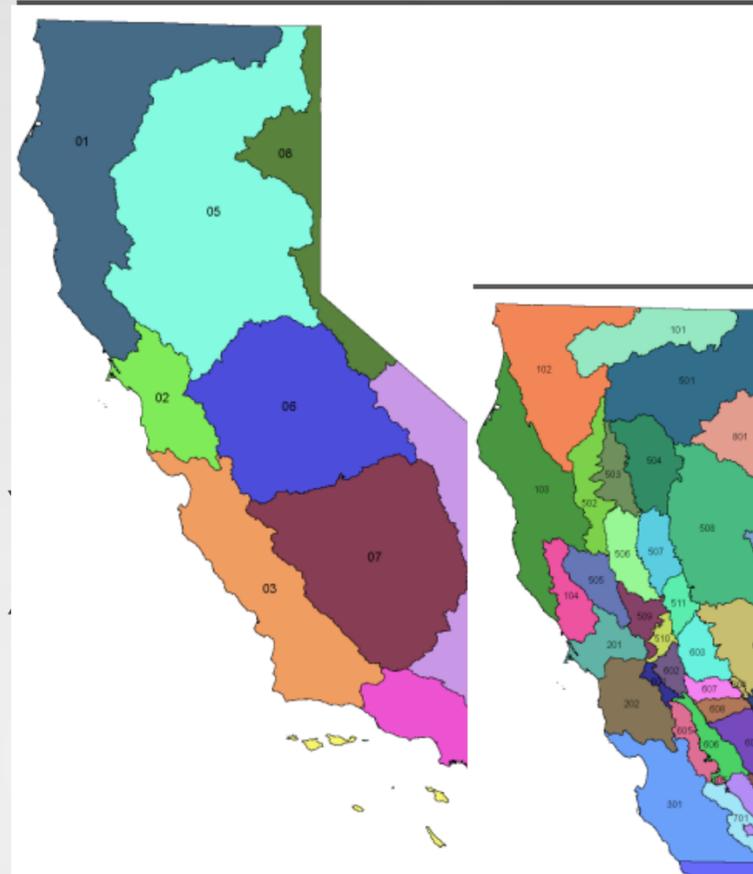
Release Timeline

- Collaboration
 - Working with multiple agencies to collect data
 - Analysis is done and combined by multiple offices within DWR
- Improving QA/QC
- Reports water balance data annually
- Improving technology and transparency
- Complex data sets



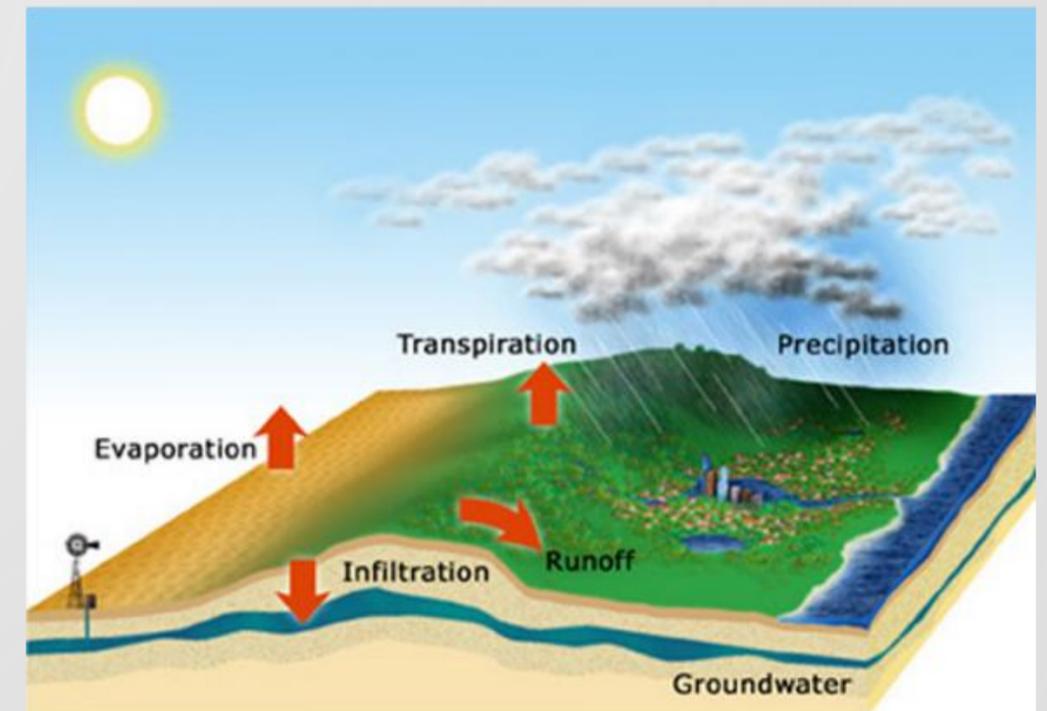
Spatial Units

- State (CA)
- Hydrologic region (HR)
- Planning area (PA)
- Detailed Analysis Unit by County (DAUCO)



What is a Water Balance?

- An accounting of water inputs and outputs for a given spatial unit during a time interval
- Used to describe the flow of water into and out of a spatial unit
 - Simplified version is (Inflow) Precipitation (P) = (Outflow) Runoff (Q) + Evapotranspiration (ET) + Change in Storage (ΔS)



Components in Water Balance Workbook

A water balance can help with understanding supply and use of water throughout the state by analyzing population, land use, climate, geography and hydrology



Supplies:

Deliveries, Diversions,
Groundwater Pumping



Uses:

Agricultural, Urban,
Managed Wetlands,
Environmental, System



California Water

About 60 percent of the water that falls on California evaporates or is used by vegetation.

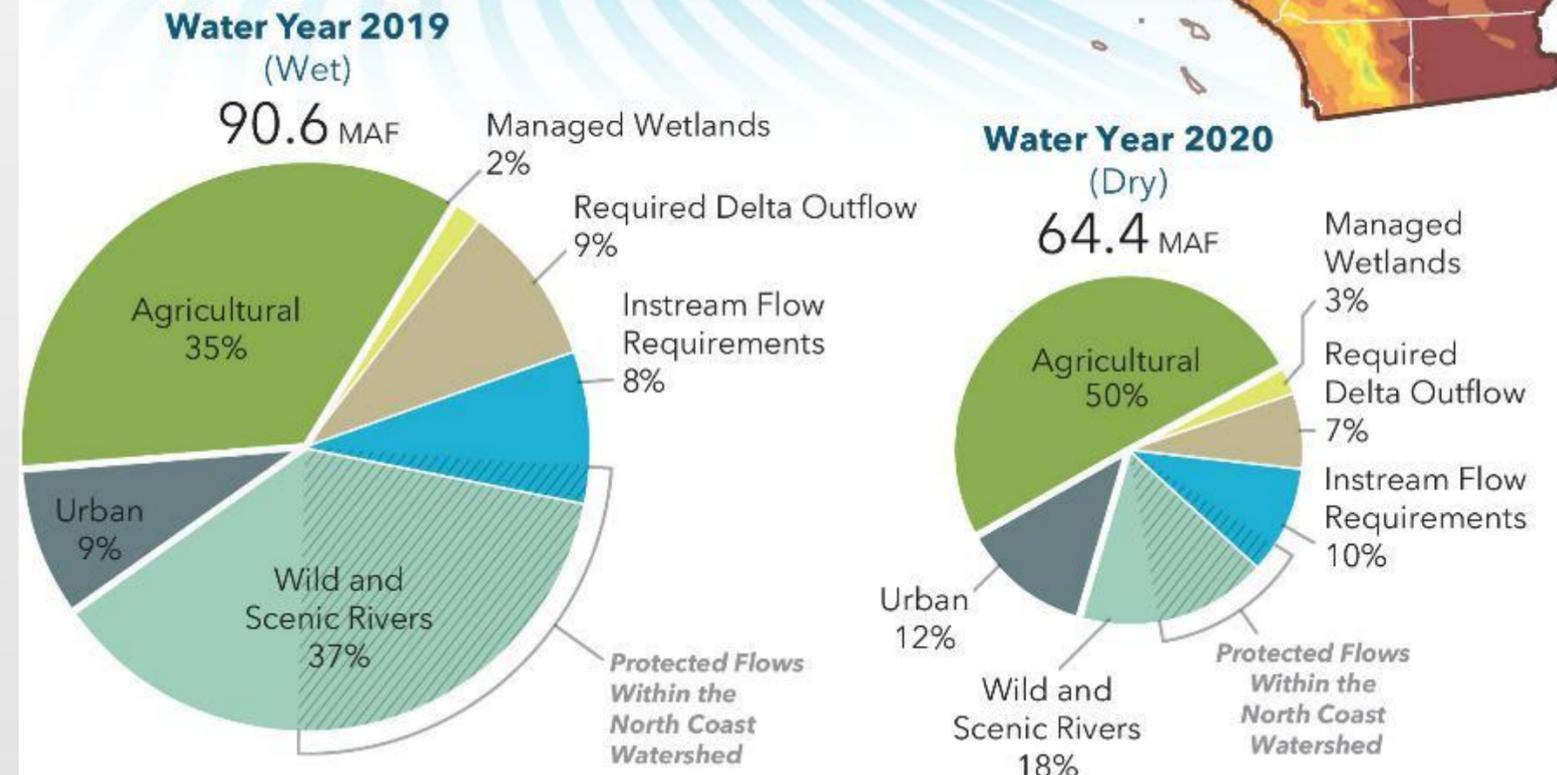
Evapotranspiration
Approximately 115 MAF

Another 20 million acre-feet flows in protected rivers, on the North Coast.

Protected Flows
(mostly North Coast region)
Approximately 20 MAF

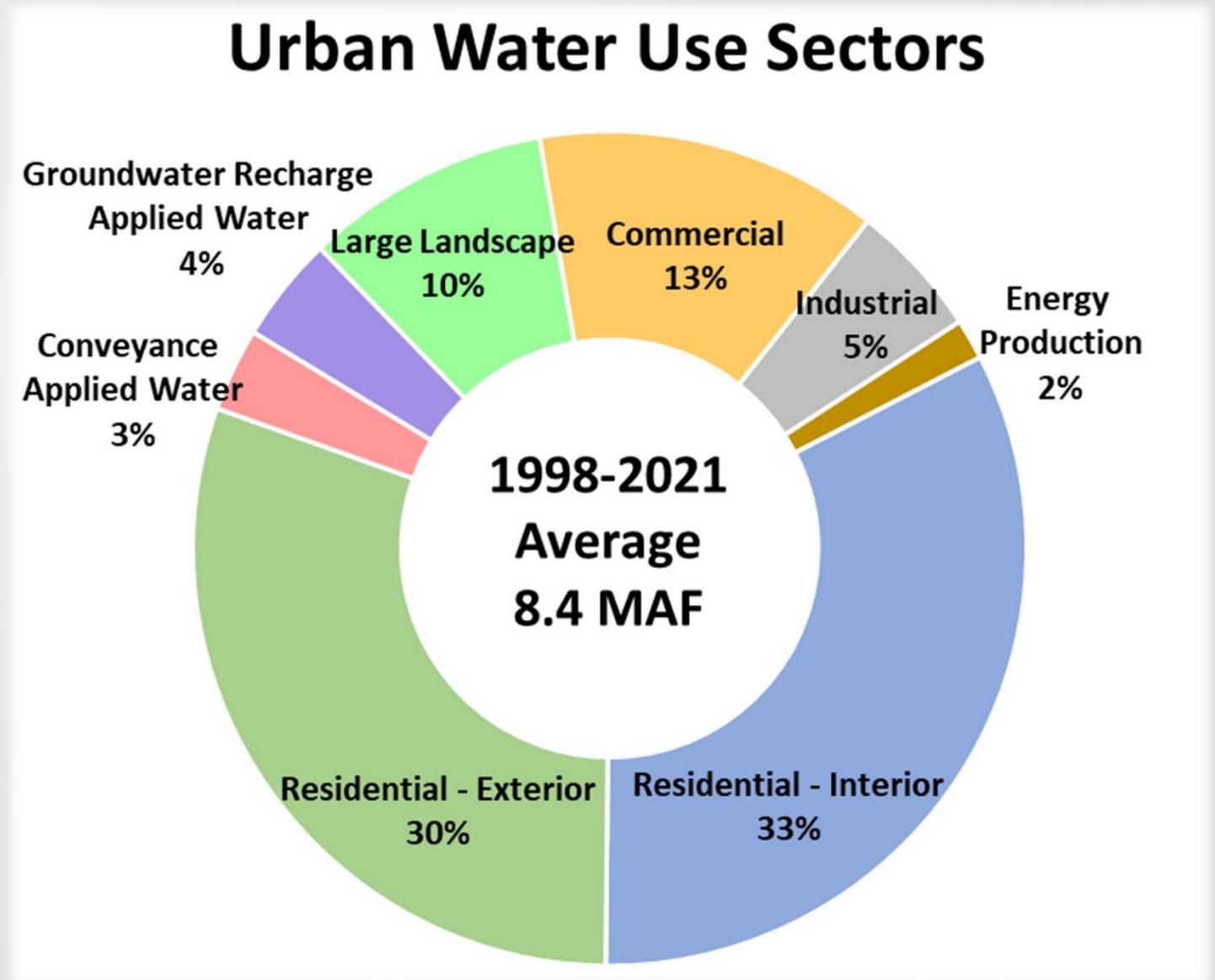
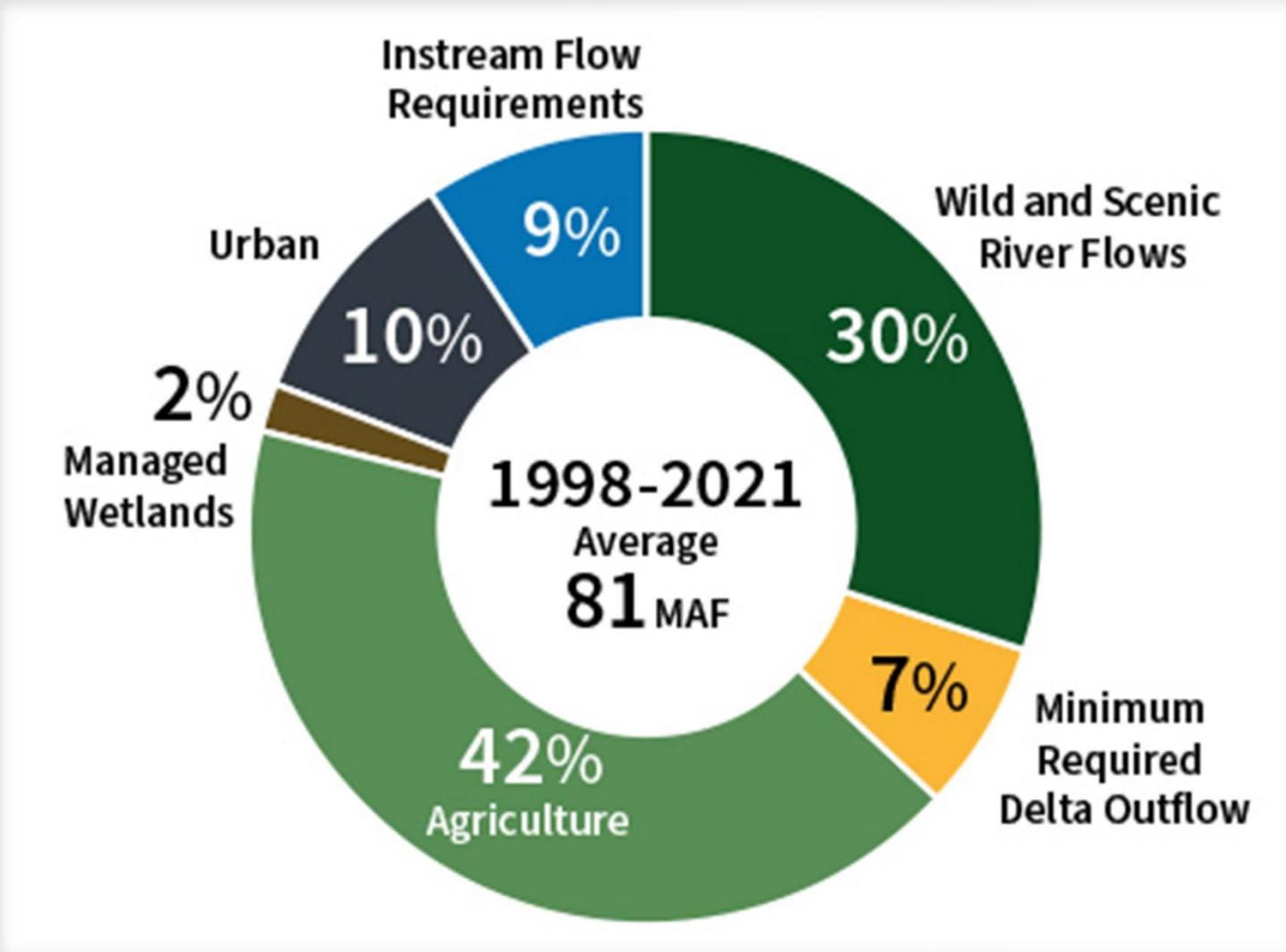
The rest goes toward the state's agricultural, urban, and other environmental needs.

Remaining Water (example years)
Quantities include North Coast protected flows, shown as shaded areas

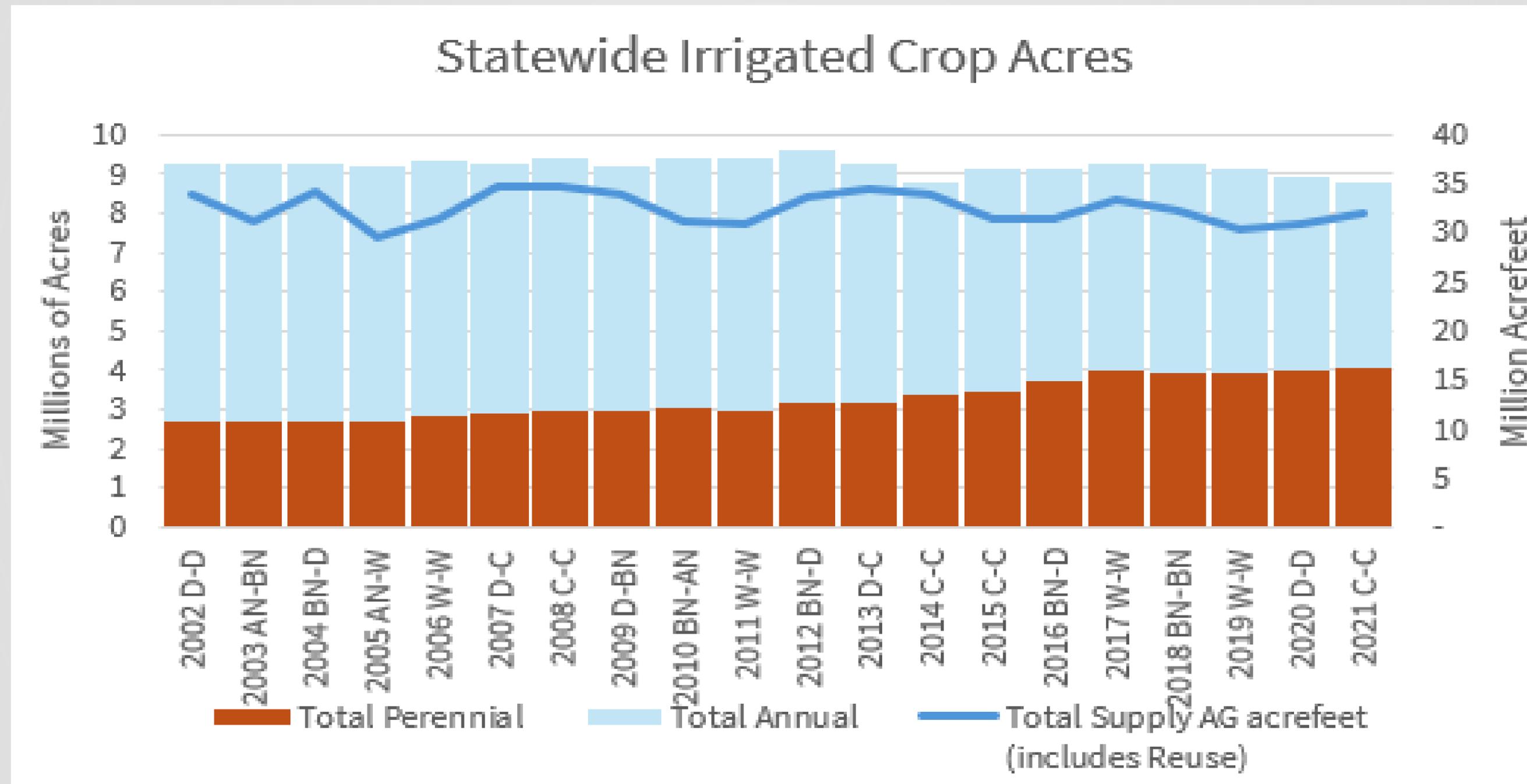


Urban Water Use

Where Does California's Water Go?



Agriculture Water Use

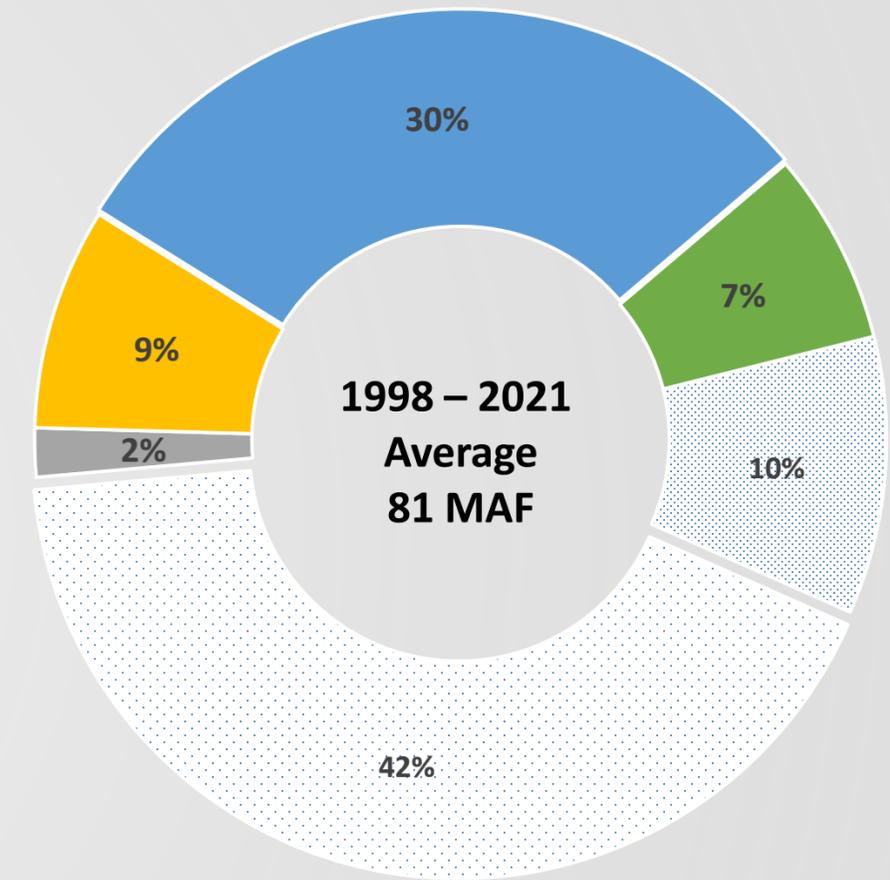


Environmental Water

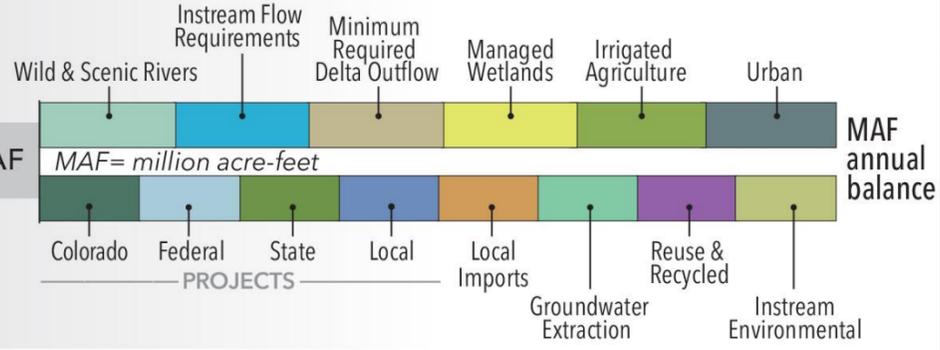
- **Environmental Water Components**

- Managed Wetlands
- Instream Flow Requirements
- Wild and Scenic River Flows
- Minimum Required Delta Outflow

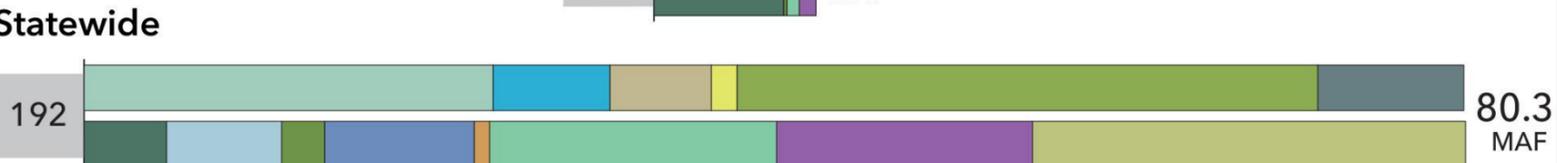
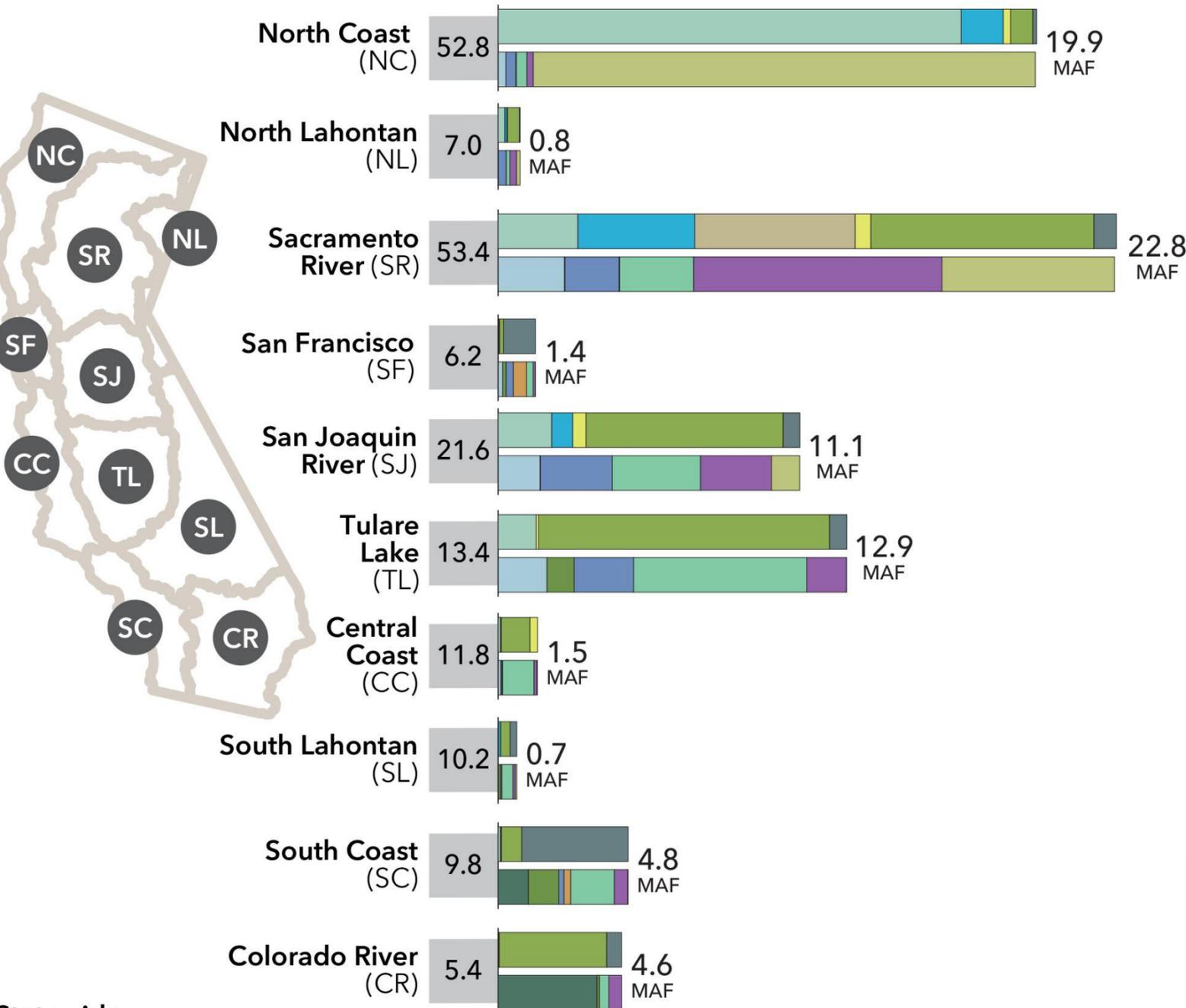
- Environmental Water Use constituted about **48%** of the 1998-2021 average water use in California.



Applied Water Use



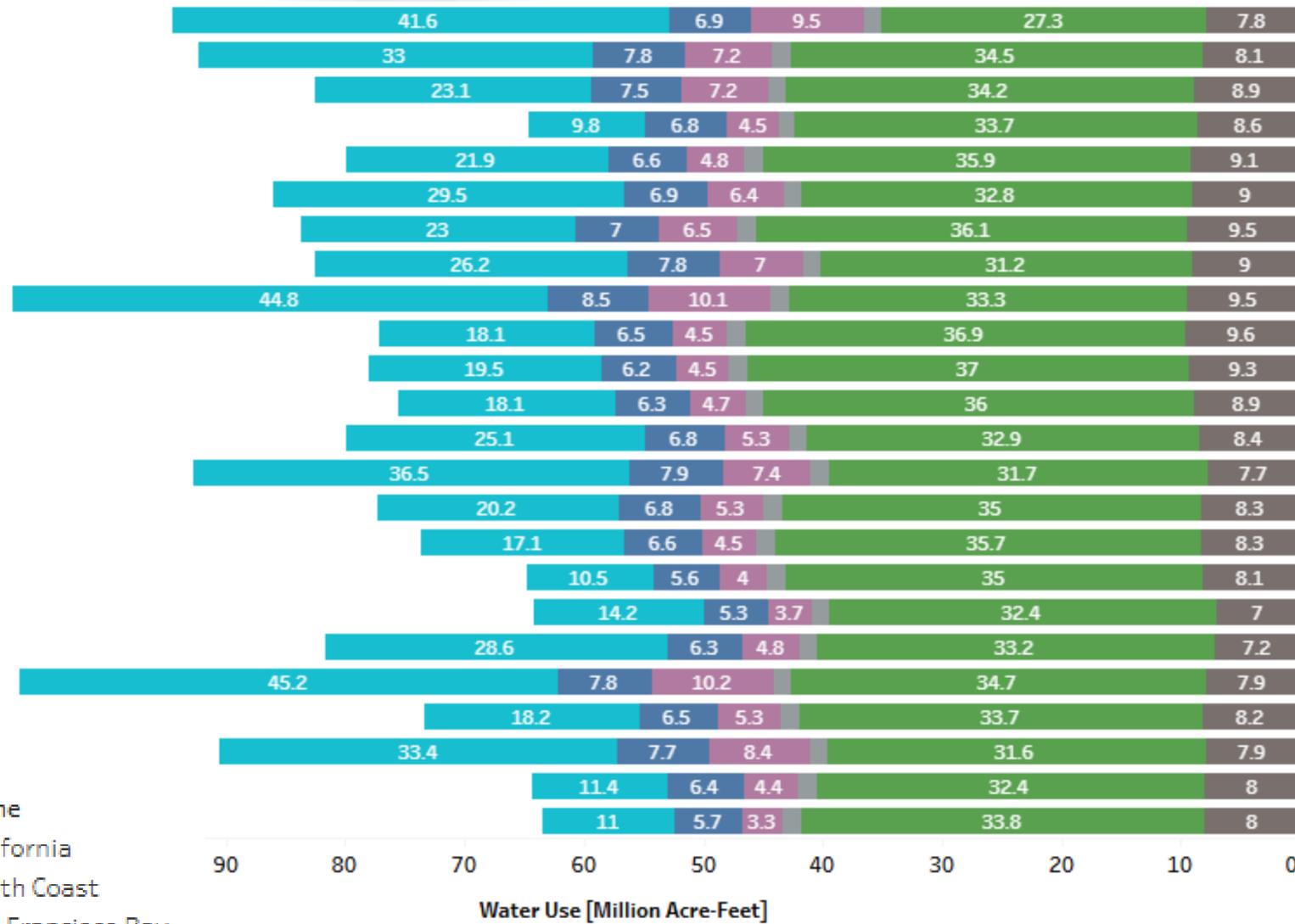
Dedicated and Developed Water Supply



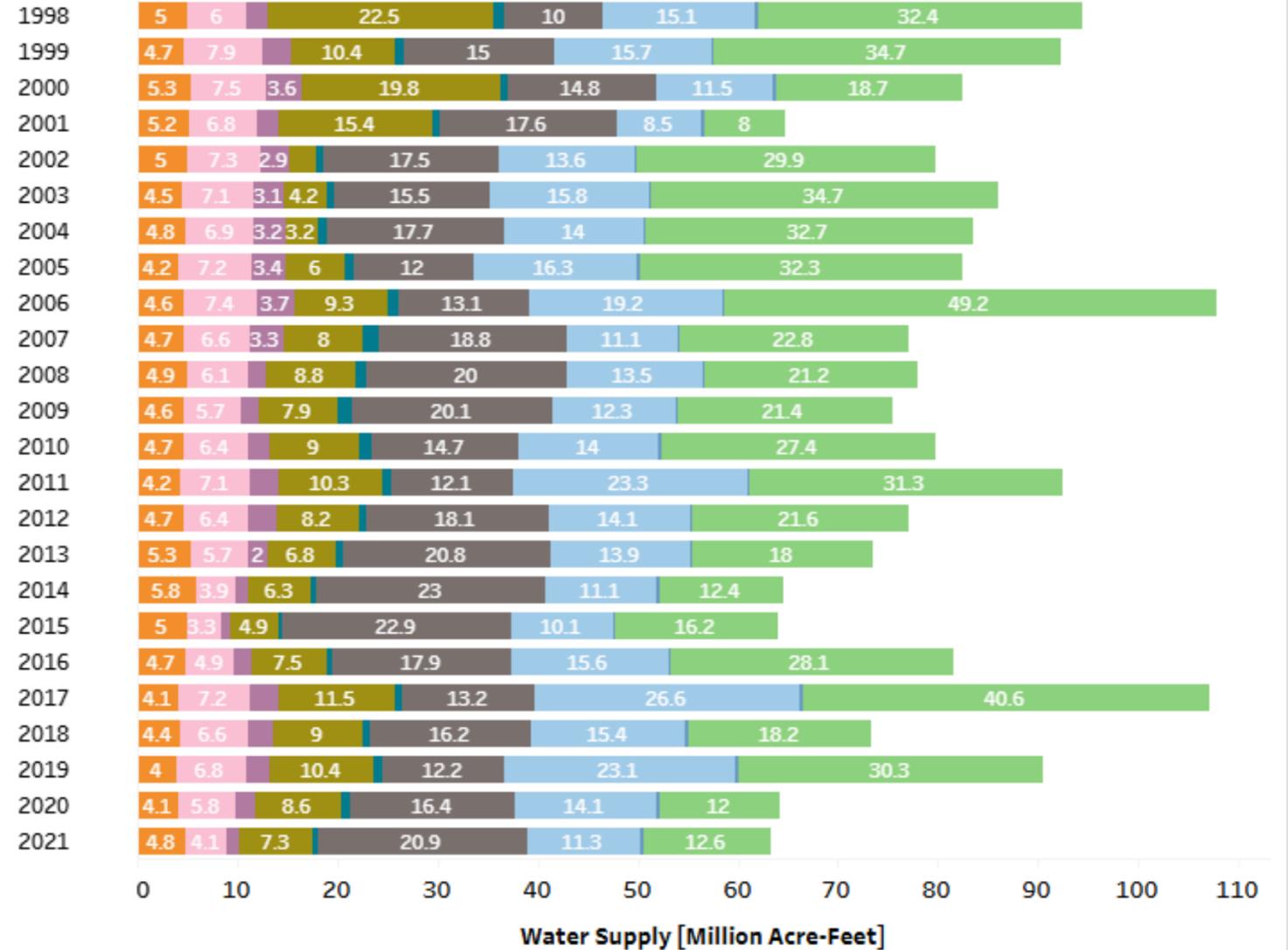
Avg. Water Use and Supply HRs

- ↑ Urban use: SC
- ↑ Ag use: TL
- ↑ Envr: NC
- ↑ Local supply: SJ
- ↑ State supply: SC
- ↑ Fed supply: SR
- ↑ GW supply: TL

California



Water Year



HR Name

- California
- North Coast
- San Francisco Bay
- Central Coast
- South Coast
- Sacramento River
- San Joaquin River
- Tulare Lake
- North Lahontan
- South Lahontan
- Colorado River

Use

- Wild & Scenic River
- Instream Flow
- Req. Delta Outflow
- Managed Wetlands
- Irrigated Agriculture
- Urban

Select Decimal Places

1 Decimal

Supply

- Instream Environmentals
- Recycled Water
- Reuse Water
- Ground Water
- Local Imports
- Local Projects
- State Project
- Federal Projects
- Colorado Project



Update 2023 Water Balance Automation Standard Operating Procedures

OWIA Standard Operating Procedures

Version 2024-05-06 11:48

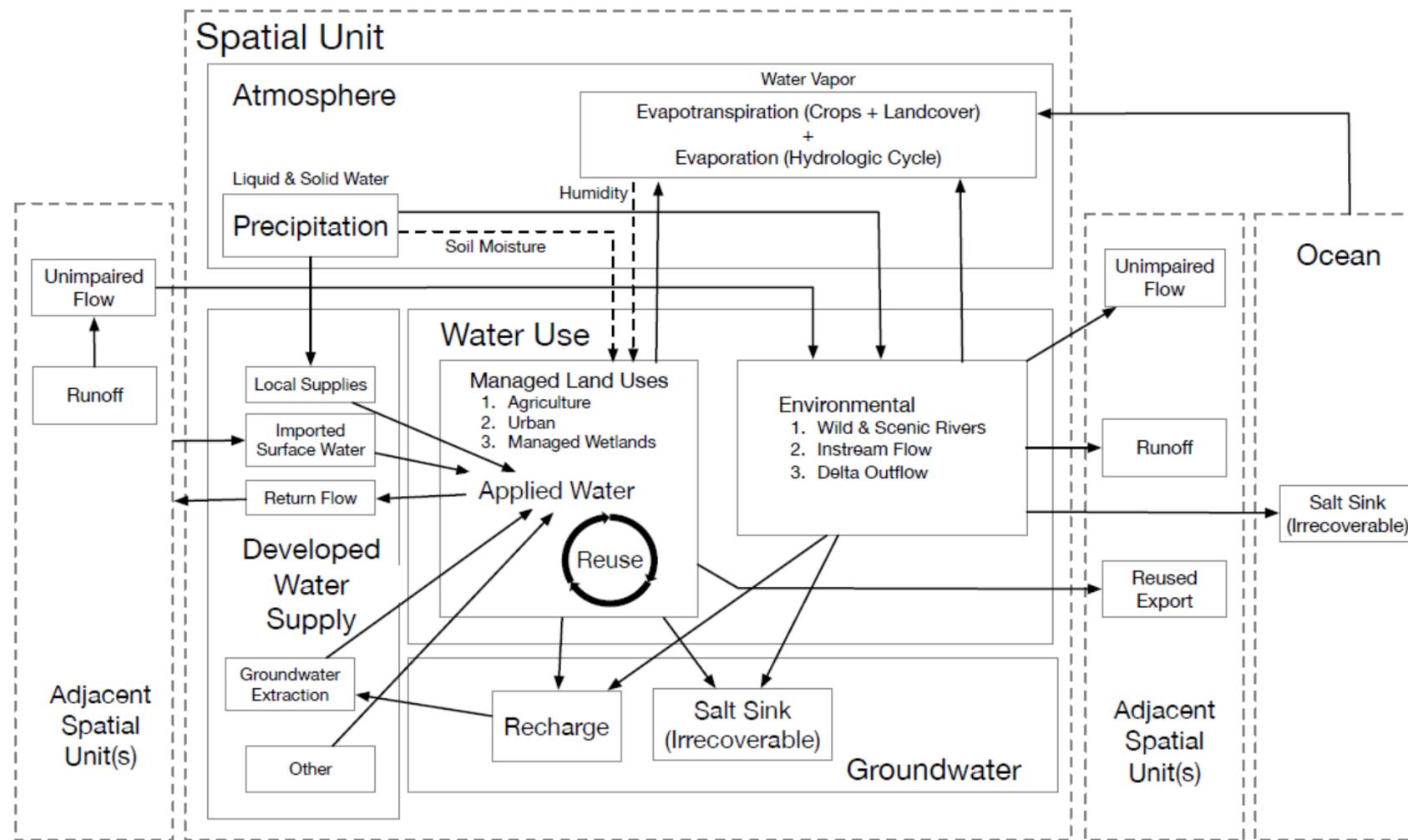


Figure 2: Overview of water balance components.

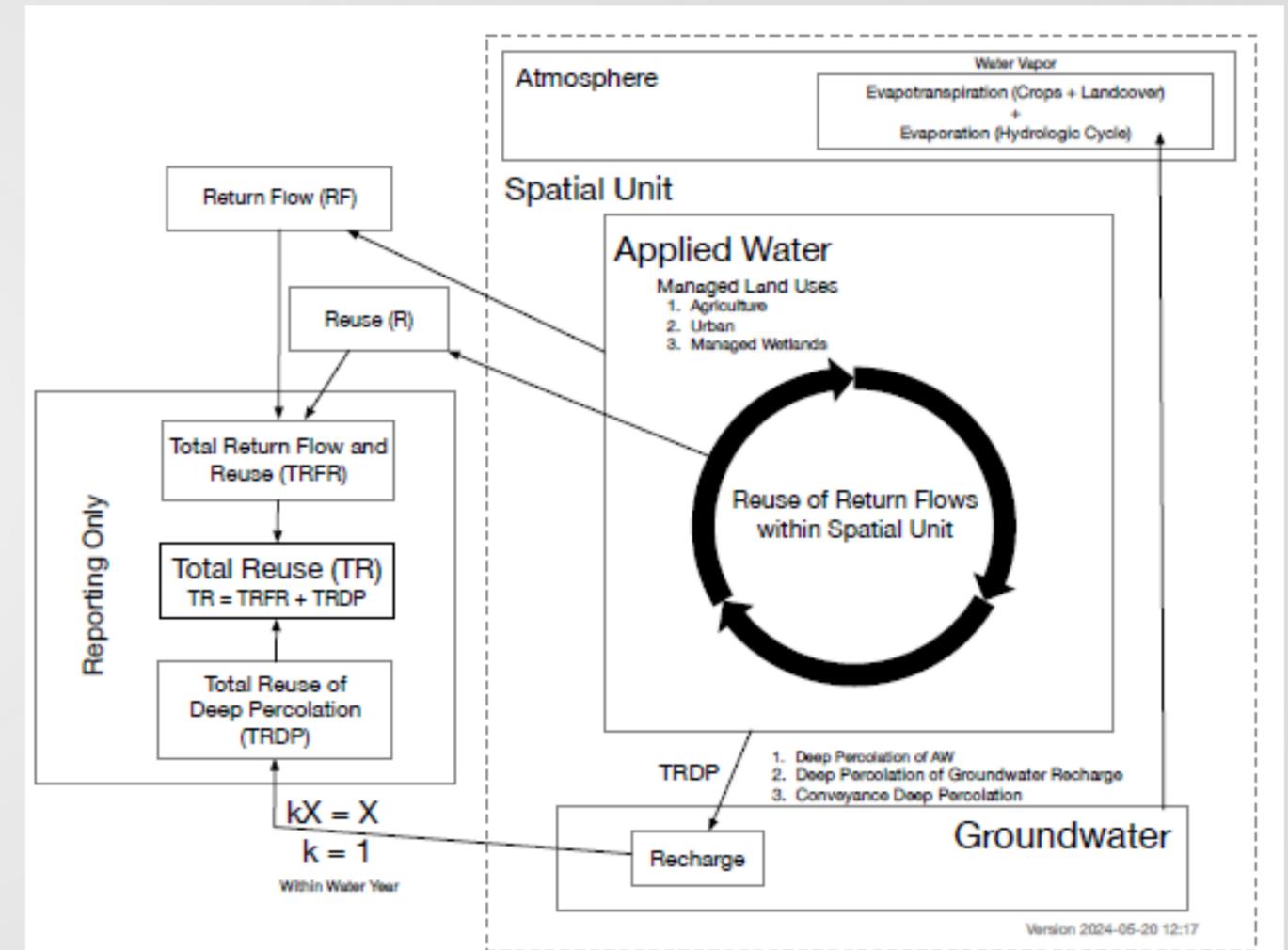


Figure 3: Reuse of water supply. Note that the circle labelled *Reuse* in Figure 2 is labelled *Reuse of Return Flows within Spatial Unit* here.



Update 2023 Water Balance Automation Standard Operating Procedures

OWIA Standard Operating Procedures

1118 Glossary - Water Plan

1119 A

1120 **acre-foot** The volume of water that would cover 1 acre to a depth of 1 foot; equal to 43,560 cubic feet or
1121 325,851 gallons.

1122 **adjudicated** A judicial determination of water rights for a stream or groundwater basin, or parts of those
1123 waters. In the context of an adjudicated groundwater basin, landowners or other parties have turned
1124 to the courts to settle disputes over how much groundwater can be extracted by each party to the
1125 decision. , 60

1126 **applied water** The total amount of water diverted from any source and applied to meet the uses of urban
1127 and agricultural sectors and dedicated to the environment, including water applied for groundwater
1128 recharge. Applied water is the quantity of water delivered to the intake to a city water system,
1129 a factory, or a farm headgate, either directly or by incidental flows to a marsh or wetland for
1130 wildlife areas. For existing instream use, applied water is the portion of the streamflow dedicated
1131 to instream use or reserved under the federal or State Wild and Scenic Rivers acts, or the flow
1132 needed to meet required standards in the Sacramento-San Joaquin Delta. Applied water includes
1133 consumptive use, reuse, and outflows. Applied water includes all sources of supply (surface water,
1134 groundwater, reuse, and recycled water). Agriculture - [AWUAG] Applied Water Use Managed
1135 Wetlands - [AWUMW] Applied Water Use Urban - [AWUURB] Applied Water Use Instream Flow
1136 Requirements - [AWUIFR] Applied Water Use Wild and Scenic Rivers - [AWUWSR] Applied
1137 Water Use Required Delta Outflow - [AWURDO] Applied Water Use , 55, 56, 58, 63

1706 Glossary - Controlled Vocabulary (CV400)

1707 A

- 1708 Agriculture - [AG001] Applied Water - Crop Production [applied water](#) , 44
1709 Agriculture - [AG002] Applied Water - Groundwater Recharge [applied water](#), [groundwater recharge](#) ,
1710 47
1711 Agriculture - [AG003] Evapotranspiration of Applied Water , 46
1712 Agriculture - [AG004] Evaporation and Evapotranspiration of Groundwater Recharge , 47
1713 Agriculture - [AG005] Deep Percolation of Applied Water [deep percolation of applied water](#) , 45
1714 Agriculture - [AG006] Deep Percolation of Applied Water to Salt Sink [deep percolation of applied water](#)
1715 [to salt sink](#) , 45
1716 Agriculture - [AG007] Deep Percolation of Groundwater Recharge , 45
1717 Agriculture - [AG008] Reuse of Return Flows within DAUCO , 51
1718 Agriculture - [AG009A] Return Flow to Oregon [return flow](#) , 50
1719 Agriculture - [AG009B] Return Flow to Nevada [return flow](#) , 50
1720 Agriculture - [AG009C] Return Flow to Mexico [return flow](#) , 50
1721 Agriculture - [AG009D] Deep Percolation to Oregon [deep percolation](#) , 44
1722 Agriculture - [AG009E] Deep Percolation to Nevada [deep percolation](#) , 44
1723 Agriculture - [AG009F] Deep Percolation to Mexico [deep percolation](#) , 44
1724 Agriculture - [AG010A] Return Flow to Salt Sink , 50
1725 Agriculture - [AG010B] Return Flow for Delta Outflow [Delta outflow](#) [return flow](#) , 45, 48, 50
1726 Agriculture - [AG011A] Return Flow to Developed Supply (Other DAUCO within PA) [return flow to](#)
1727 [developed supply](#)
1728 Agriculture - [AG011B] Return Flow to Developed Supply (Other PA) [return flow to developed supply](#)
1729 Agriculture - [AG011C] Return Flow to Developed Supply (Other Region) [return flow to developed](#)
1730 [supply](#)
1731 Agriculture - [AG011D] Return Flow to Carryover Storage for Next Water Year within DAU
1732 Agriculture - [AG012] Return Flows Evaporation and Evapotranspiration [return flows evaporation and](#)
1733 [evapotranspiration](#) , 50
1734 Agriculture - [AG017] Conveyance Evaporation and ETAW , 44
1735 Agriculture - [AG018A] Conveyance Return Flow to Oregon [conveyance](#) , 43
1736 Agriculture - [AG018B] Conveyance Return Flow to Nevada [conveyance](#) , 43
1737 Agriculture - [AG018C] Conveyance Return Flow to Mexico [conveyance](#) , 43
1738 Agriculture - [AG018D] Conveyance Deep Percolation to Oregon [conveyance deep percolation](#) , 43, 44
1739 Agriculture - [AG018E] Conveyance Deep Percolation to Nevada [conveyance deep percolation](#) , 43, 44
1740 Agriculture - [AG018F] Conveyance Deep Percolation to Mexico [conveyance deep percolation](#) , 43, 44
1741 Agriculture - [AG019A] Conveyance Return Flows to Salt Sink [conveyance return flows to salt sink](#) ,
1742 43, 50



Opportunities to Improve



- Annual data releases
- CNRA Open Data, SOPs, Dashboards, Storymaps
- Boundaries
- Refining data (4x4 Grid)
- Local collaboration, increased data – GSAs, Districts
- Water Balance to Water Budget
- Watershed Hub



Update 2028

- Add 5 years data
- Ag water use 4x4 km grid
- Process maps
- Graphic automation
- Dashboard/storymap/hub

What questions do you want answered by the water balances that you can't currently answer?

What format do you prefer to see the answers?



Where can I get details?

[California Water Plan Update 2023](#)

— Supporting Documents

- **Water Portfolios and Balances** — Water portfolios and balances describe the distribution of water throughout the hydrologic cycle, water use by the urban and agricultural sectors, water in the environment, and water supply sources used to meet these uses at the statewide and regional levels.
 - **Update 2023 Water Balances supporting document**
 - **Update 2023 Water Balances Automation Standard Operating Procedures**
 - **Spatial Patterns of Water Supply and Use in California (escholarship.org)**
- **[Update 2023 Water Balances supporting document](#)**
- **[Update 2023 Water Balances Automation Standard Operating Procedures](#)**
- **[Spatial Patterns of Water Supply and Use in California \(\[escholarship.org\]\(https://escholarship.org\)\)](#)**

Where can I get the data?

- **CA Water Plan Data and Tools:**
[Water Plan Data and Tools](#)

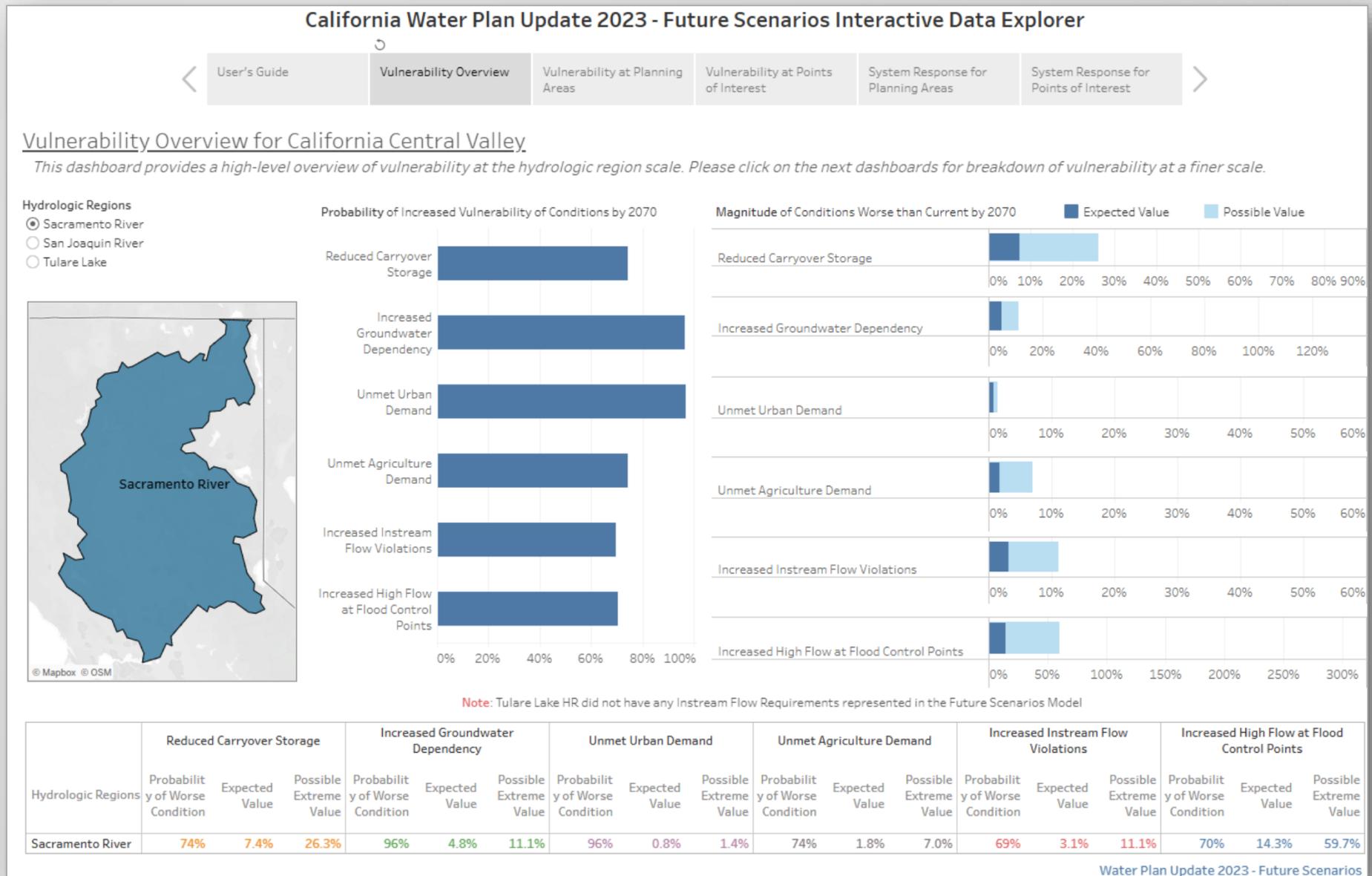
- **CNRA Open Data Platform:**
<https://data.cnra.ca.gov/dataset/water-plan-water-balance-data>



CALIFORNIA DEPARTMENT OF
WATER RESOURCES

Future Scenarios Update 2028

To infinity and beyond! Or at least outside of the Central Valley...



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Vision for update 2028

Why

Improve the understanding of future water vulnerability in California

How

Leverage an interdisciplinary team to analyze the California water system based on representative metrics

What

Update the Future Scenarios model to expand geographic coverage, refine model representation, and incorporate adaptation strategies using best available data and methods



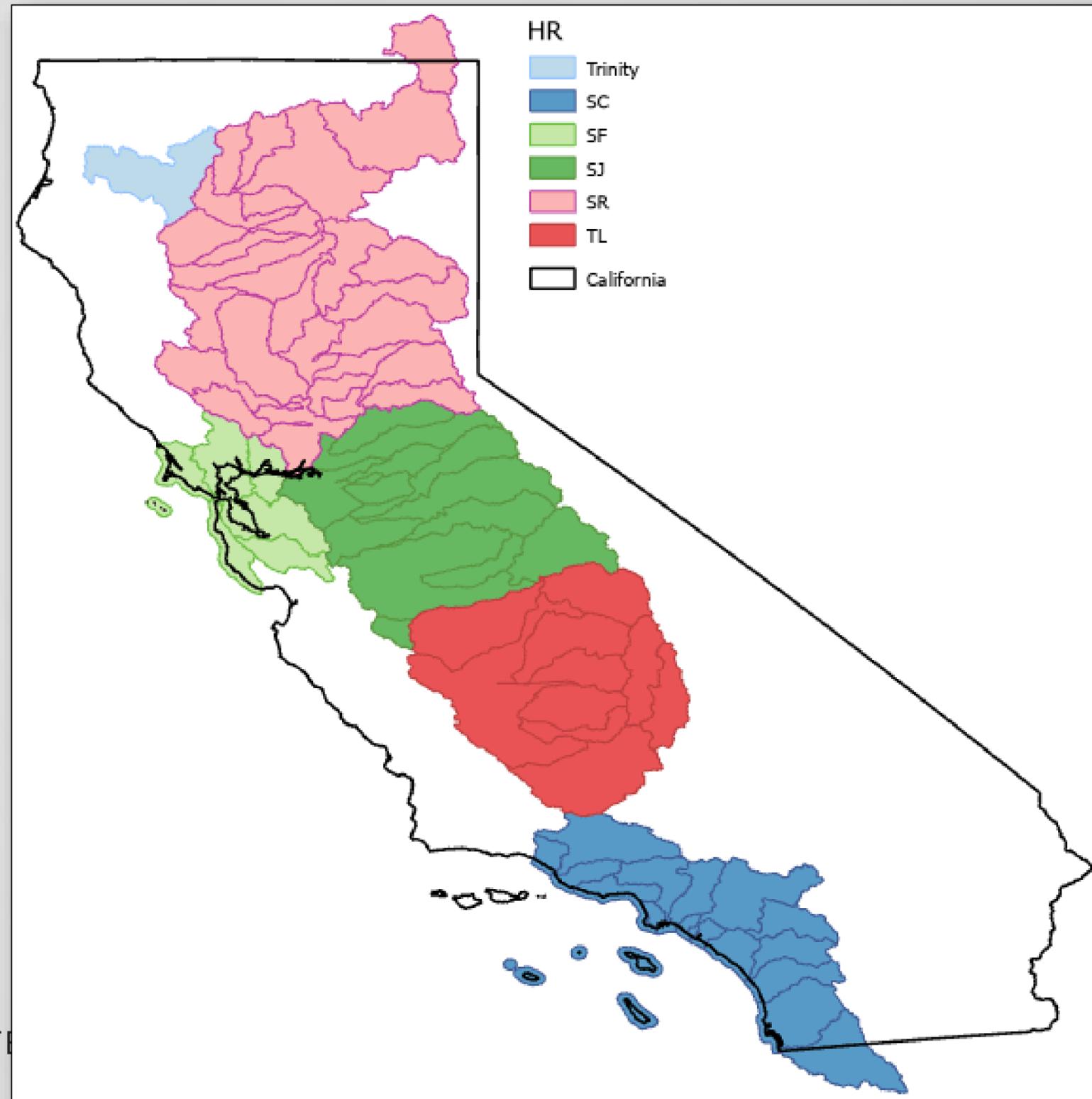
Future Scenarios Enhancements for Update 2028

- Update the current future scenarios model
 - Migration of model to USGS HUC-8s to represent watersheds
 - Model refinement to improve water accounting
 - Improved groundwater representation
 - Improved representation of agriculture through more detailed irrigation model
 - New climate dataset from the Weather Generator
 - Updated model datasets
- Expand spatial coverage (toward a statewide model)
- Update vulnerability metrics
- Evaluate adaptation strategies



Migration of model to USGS HUC-8s to represent watersheds

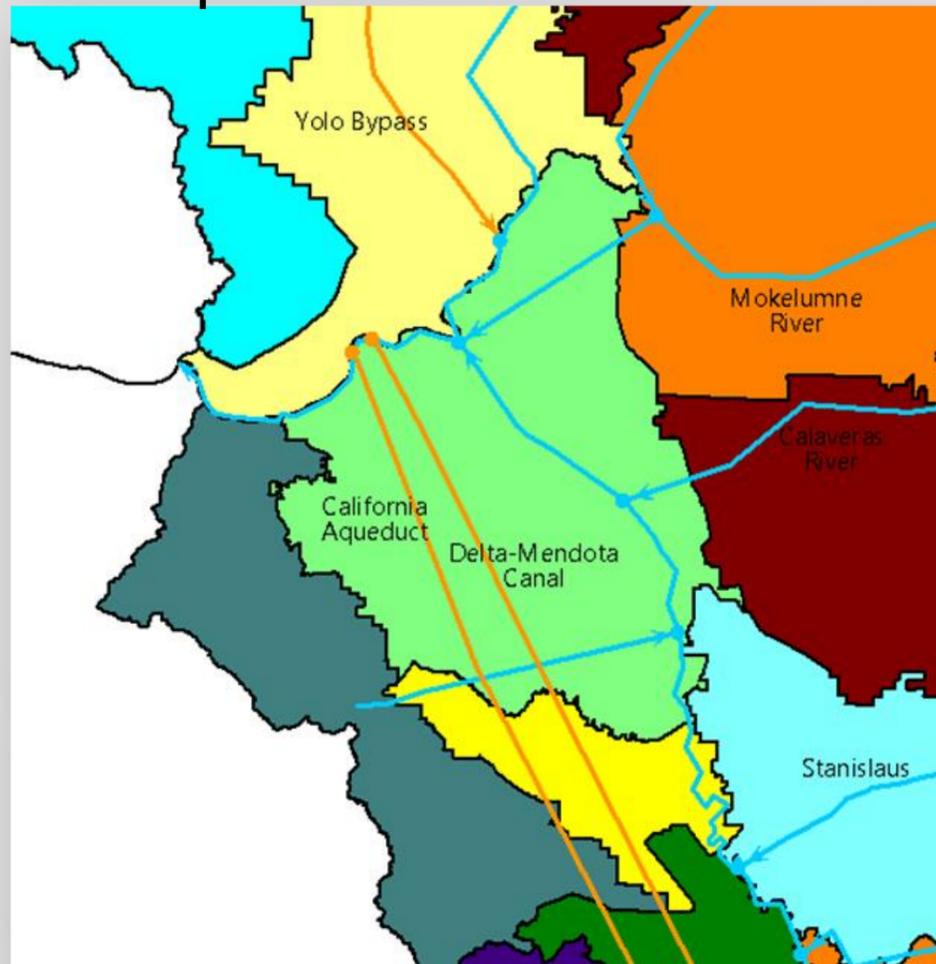
Trinity HUC-8 also included to accurately represent flows into the Sacramento River hydrologic region



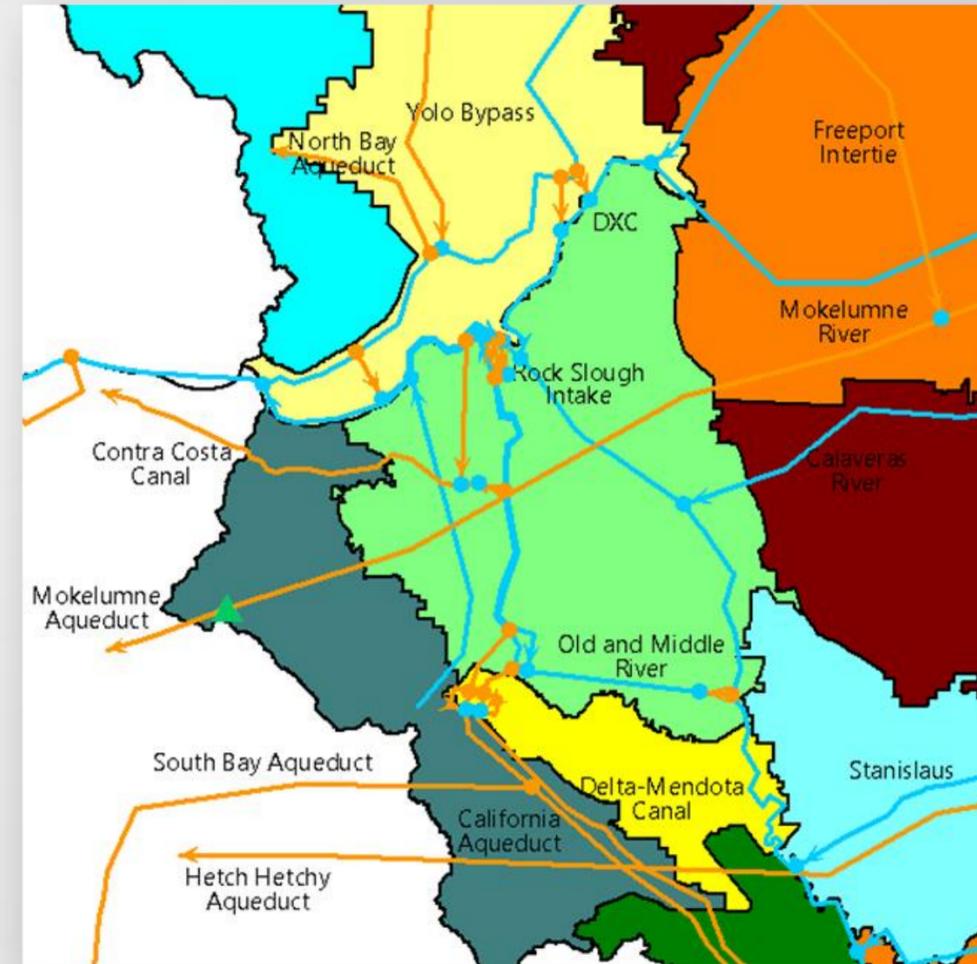
Evolution of the Model for 2023 and 2028

- Updated annual allocations for CVP and SWP reflecting current operations
- Refined representation of Sacramento-San Joaquin Delta

Updates 2013 & 2018



Update 2023 & 2028

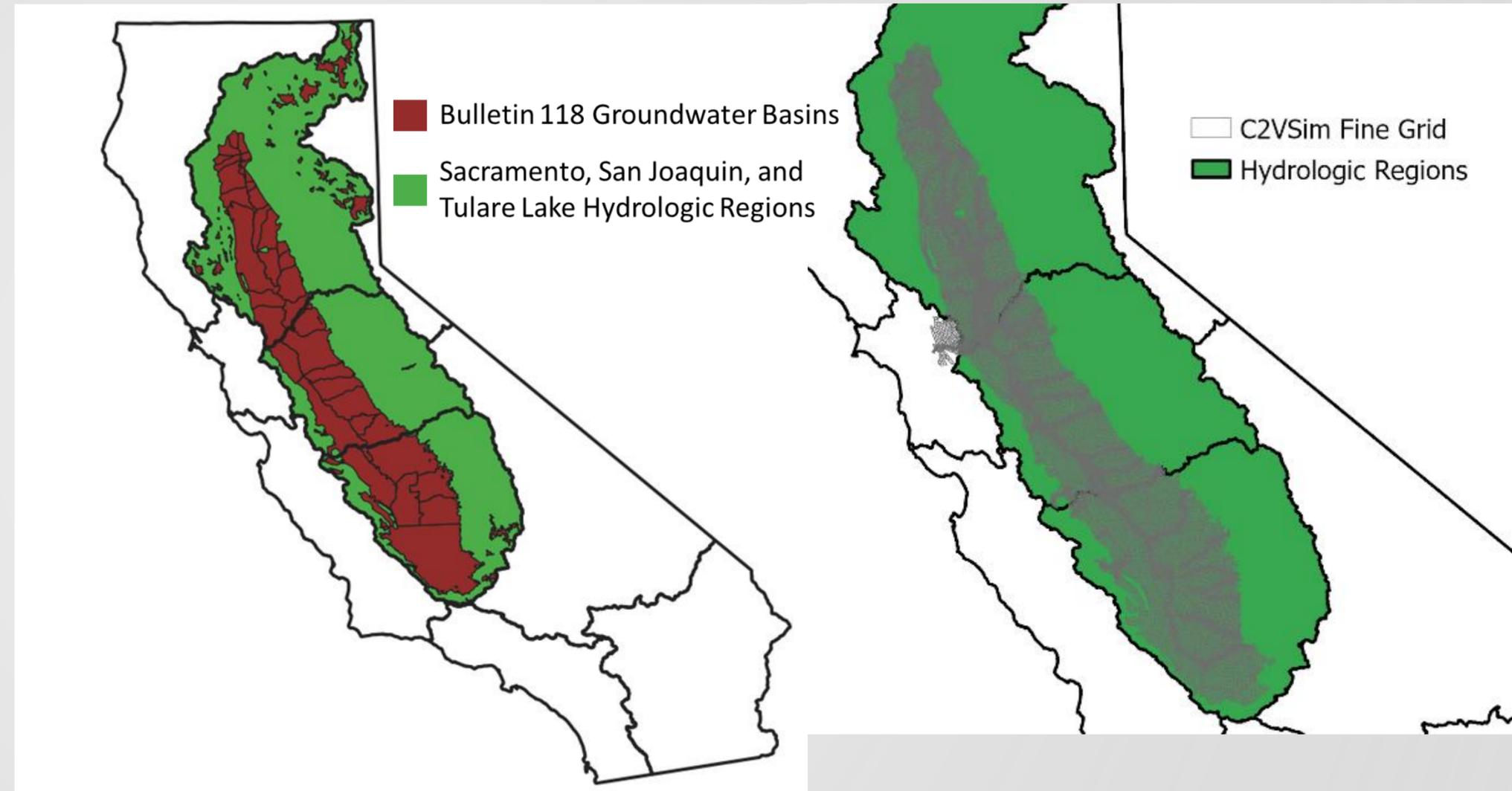


Refinement of groundwater representation

Basin-scale "bucket" model calibrated to multi-layered, distributed groundwater model, C2VSim-FG

This will:

- Ensure consistency between DWR modeling tools
- Provide more reliable model results for groundwater

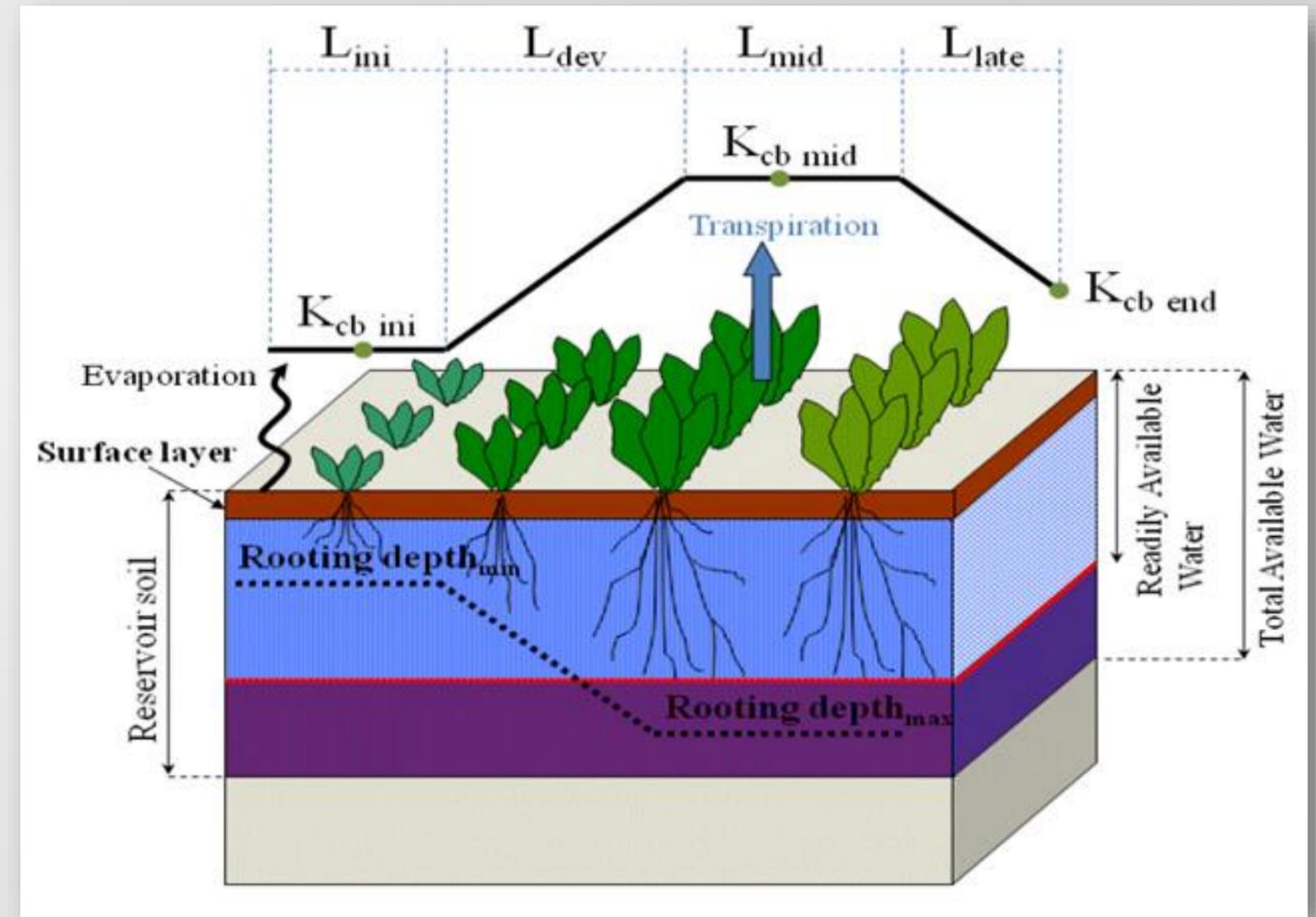


Improving Representation of Agriculture

Refining Agricultural Water Use

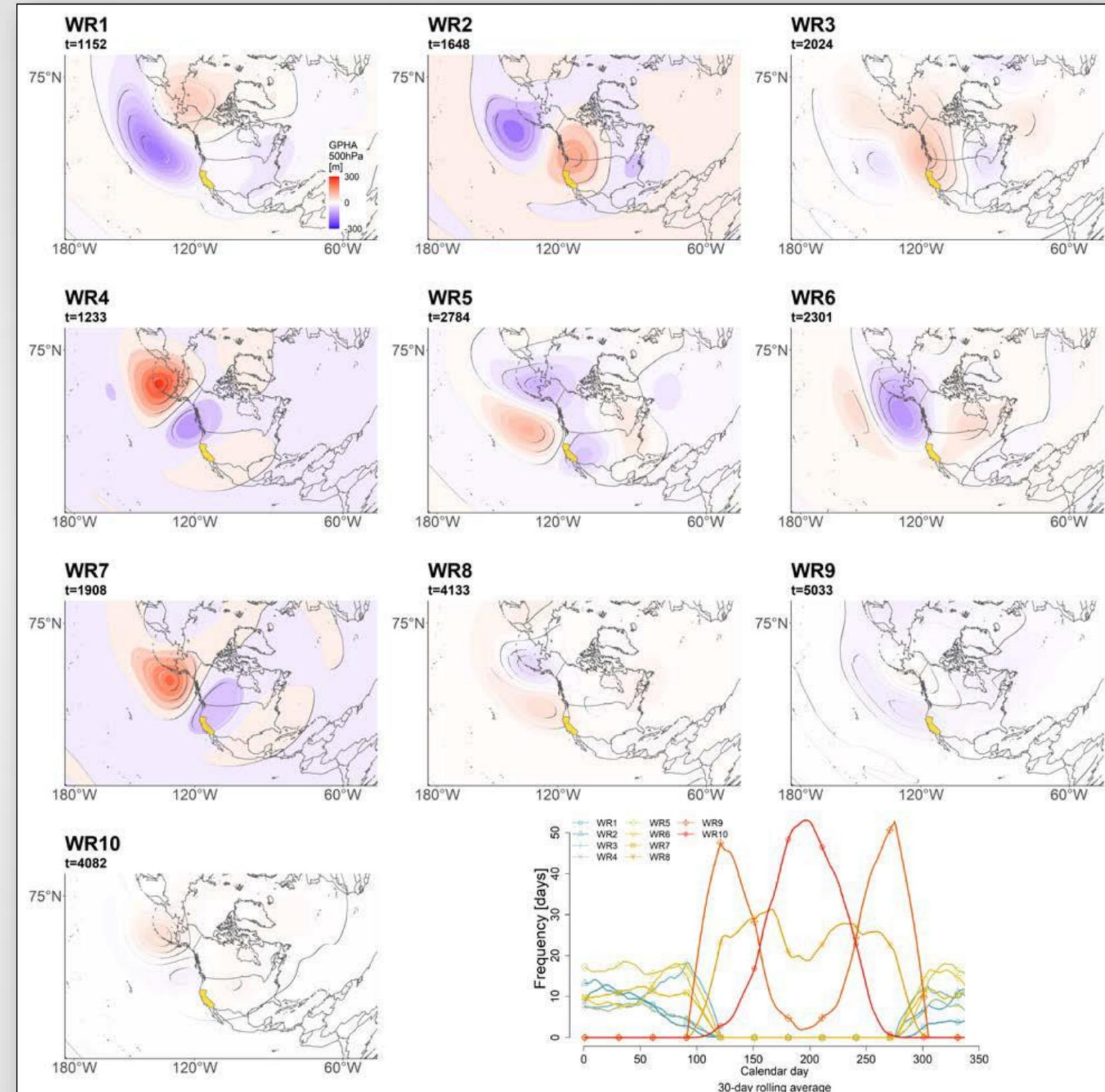
- Updated model will estimate crop water needs and irrigation scheduling (FAO 56)
- Provide easier linkage to economic modeling tools
- Will enable scenarios that consider:
 - Irrigation efficiency
 - Altering irrigation schedules
 - Effect of climate on crop production
 - Shifting planting dates

Conceptual Crop Water Model



Incorporation of the Weather Generator

- The weather generator provides an opportunity for novel weather sequences that are possible but not represented in historical sequences
- Weather generator provides statewide coverage needed for the model expansions as paleo data used in Update 2023 only covers the Central Valley



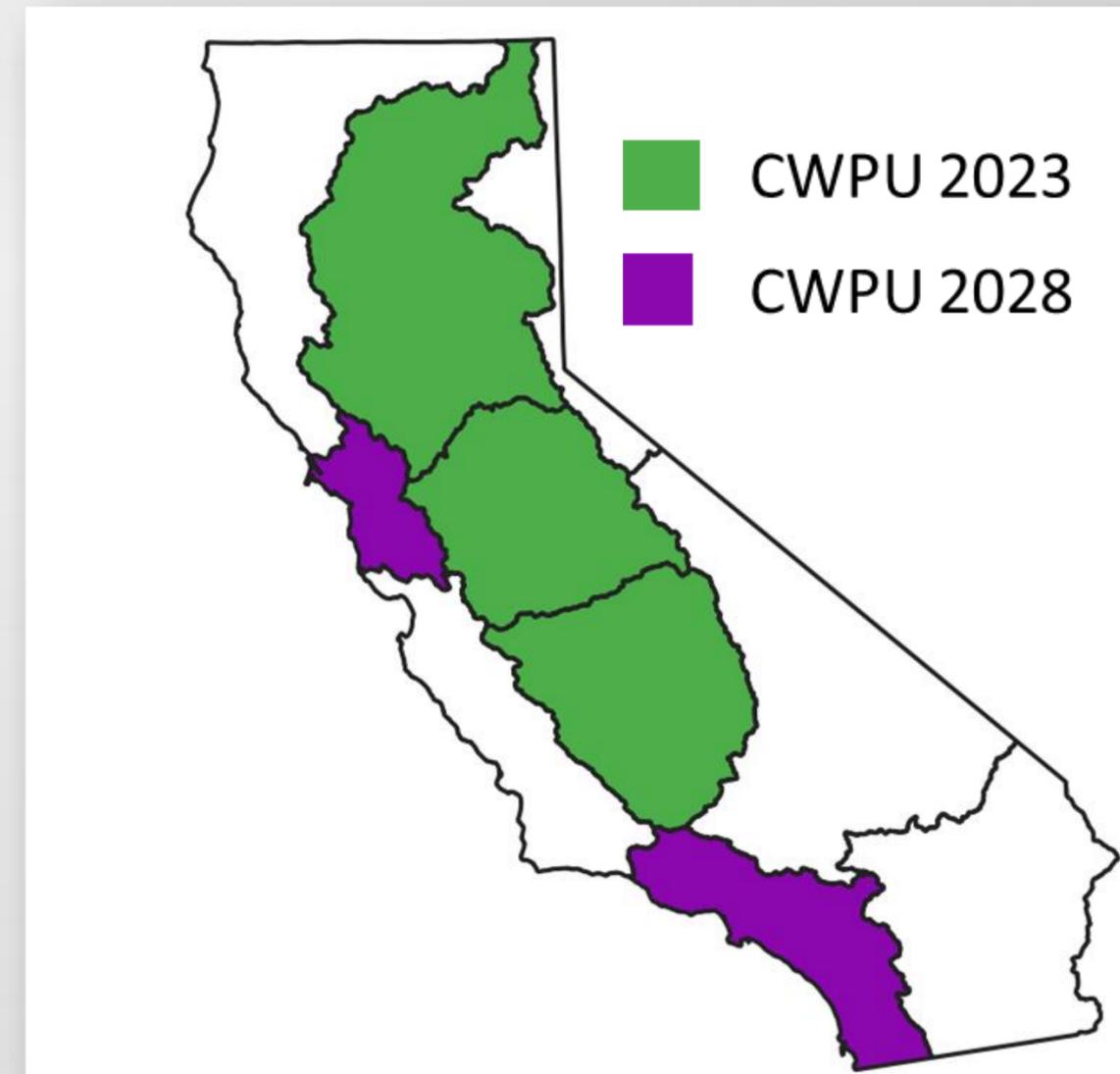
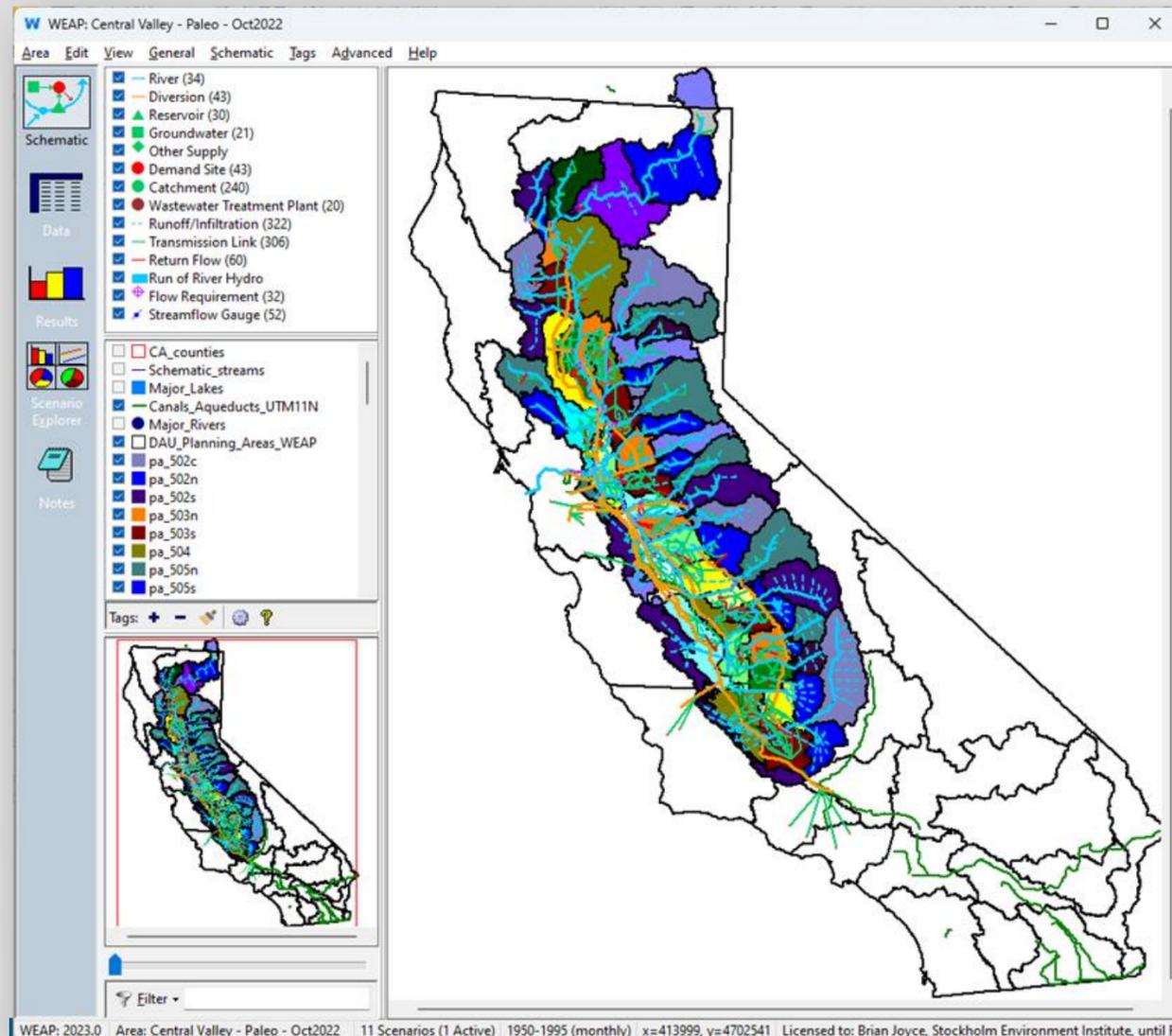
Future Scenarios Model Data Updates

- Climate datasets (precipitation, temperature, windspeed, and relative humidity)
- Urban land use
- Agricultural land use and crop mixes
- Recycled water
- Desalination (Brackish GW & Seawater)
- Groundwater extraction
- Aquifer parameters including stream-groundwater interaction and lateral flow between aquifers
- Import timeseries for Colorado River and Los Angeles Aqueduct
- Reservoir operations for major South Coast reservoirs
- Updated model calibration



Expanding Spatial Coverage Model Refinement and Expansion for Update 2028

- Expanding spatial coverage to include dynamic linkages to San Francisco Bay and South Coast Hydrologic Regions



Future Scenarios Vulnerability Metrics

- **Surface Water** – average end-of-year surface water storage
- ***revised*** **Groundwater** – change in groundwater levels
- **Urban water supply reliability** – % of urban unmet water demand
- **Agricultural water supply reliability** – % of ag unmet water demand
- ***revised*** **Ecosystem** – considering new metrics such as: average winter peak flow, average summer low flow, water temperature estimated from reservoir storage levels
- **Flooding Potential** – 90th percentile winter flow at flood control points
- ***new*** **Drought** – a metric on either frequency or duration, or both, of droughts



Future Scenarios Adaptation Strategies

- Adaptation Strategies are actions or portfolios of actions by which future water vulnerabilities can be reduced or eliminated
- Limited funding available: This means that we would only be able to conduct selected, economically quantifiable adaptation strategies, focused within the Central Valley.
- Possibilities include:
 - Implementation of FIRO-MAR
 - Implementation of actions from GSP plans
 - Implementation of targets from California’s Water Supply Strategy (2022)
 - Additional strategies based on expressed interest and feedback through the Water Plan processes



Future Scenarios 2028 – Decision Points

- Is representing the groundwater aquifers with a single “bucket” enough or should the confined and unconfined portions of aquifers be separated using a “two-bucket” configuration. If so, is there data to support using such a configuration?
- Should we construct a combined model or separate models for hydrologic regions?
- Are the metrics selected appropriate to represent water vulnerability?
- What Adaptation Strategies should we consider?
- Should we use a desktop or a cloud computing environment?

