



COLUSA AND GLENN GROUNDWATER AUTHORITIES

# **Colusa Subbasin**

## **Joint Technical Advisory Committee**

### **GSP Development**

5/8/2020

May 8, 2020

# Discussion Topics

- GSP Development Overview
- Monitoring Network Review
- Model Development
- Projected Water Budget Scenarios
- Minimum Threshold and Measurable Objective Approach
- Next Steps

# GSP Development Overview

## Knowledge Building

- **Basin Setting**
  - Hydrogeologic Conceptual Model (HCM)
  - Historical and Current Groundwater Conditions
  - Draft Water Budgets
- **Existing Monitoring Network Evaluation**
- **Integrated Hydrologic Model Development and Calibration**
- **Sustainable Management Criteria Approaches**

## Initial GSP Development

- **Basin Setting**
  - Groundwater Dependent Ecosystems
  - Updated Water Budgets
  - Management Area Overview
- **Draft GSP Monitoring Network**
- **Draft Sustainable Management Criteria**
- **Initial Projects and Management Actions**

## GSP Refinements

- **Basin Setting**
  - Draft Management Areas
- **Draft GSP Chapters**
- **Updated GSP Monitoring Network**
- **Updated Sustainable Management Criteria**
- **Projects and Management Actions (PMAs) Evaluation and Analysis**
- **Draft Funding Mechanisms**

## GSP Prep and Adoption

- **Basin Setting**
  - Updated Management Areas
- **Data Management System**
- **Updated PMAs**
- **Updated Funding Mechanisms**
- **Complete Draft GSP**

**GSP Adoption and Submittal**

**Stakeholder Engagement and Outreach**

# **Monitoring Network Review (Potential Action Item)**

# Monitoring Network Review

FINAL REPORT | MAY 2018

## Monitoring Network Assessment Report

Prepared for

**The County of Colusa  
and County of Glenn**

Project No. 277-16-16-06



Prepared by  
Anna Raimor

7/18/18



Reviewed by  
Kenneth Loy, PG 7009

7/18/18

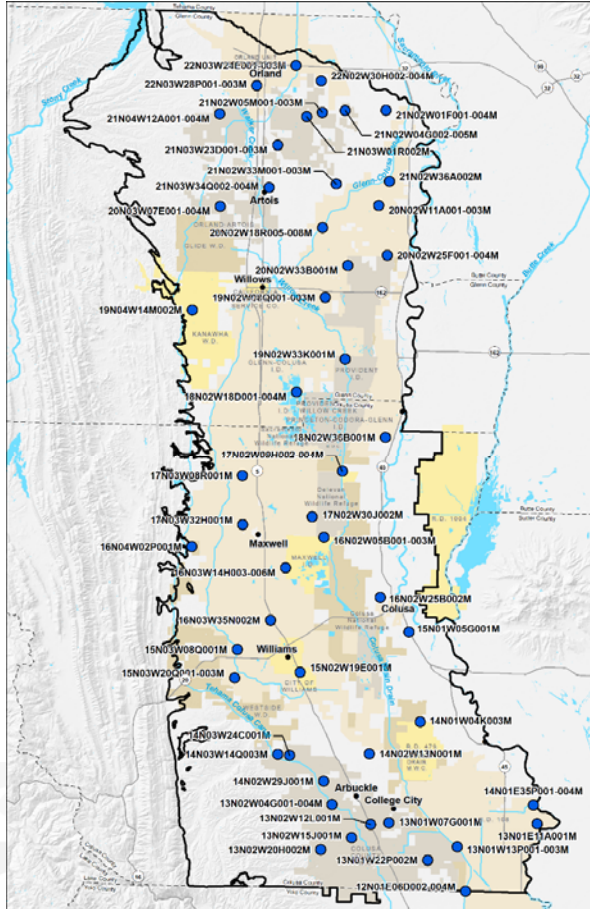


WEST YOST ASSOCIATES  
DAVIDS ENGINEERING, INC.



- Preliminary Assessment Completed July 2018, per SGMA Regulations and DWR Guidance Documents
- Builds on Existing Networks and Programs:
  - County Monitoring Well Networks
  - DWR Land Subsidence Networks
  - Irrigated Lands and Other Water Quality Monitoring Programs
  - USGS, DWR and Local Agency Stream Gages
- Vetted with DWR and Published on County Websites (download links also included in Staff Report in Meeting Packet)

# Monitoring Network Proposed Recommendation



- Request Formal Action by TAC to Recommend CGA and GGA Boards:
- Direct Consultant Team to Proceed with GSP Development Using Networks Identified in 2018 Monitoring Network Assessment Report
- While Recognizing:
  - Not all Locations will be used for Development of Sustainable Management Criteria (SMC)
  - Locations may be added during GSP Development with TAC and Stakeholder Input

## **Proposed Action** (Agenda Item 4.a)

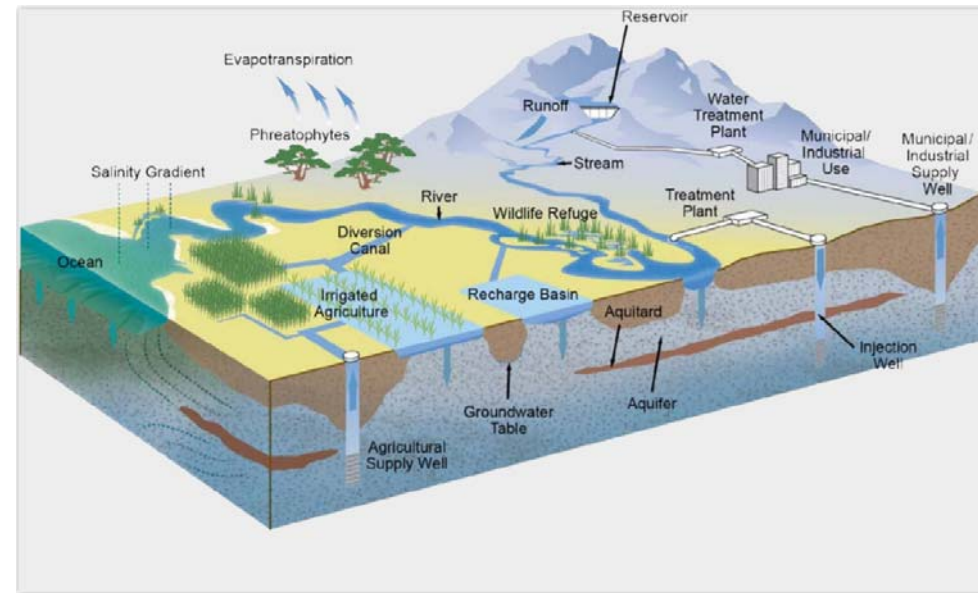
*The TAC recommends that the CGA and GGA boards approve the consultant team to proceed with the existing monitoring networks for initial GSP development, recognizing that SMC may not be developed for each existing monitoring location, and additional monitoring locations may be added during GSP development and implementation with TAC and stakeholder input.*

# **Model Development (Information Item)**



# What is an Integrated Hydrologic Model?

- Simplification of the real world
- Numerical computer model
- Performs hydrologic calculations over space and time
- Represents land surface, surface water, and groundwater systems
- Inputs consist of available data and parameters (and estimates)
- Calculates interactions within and between systems

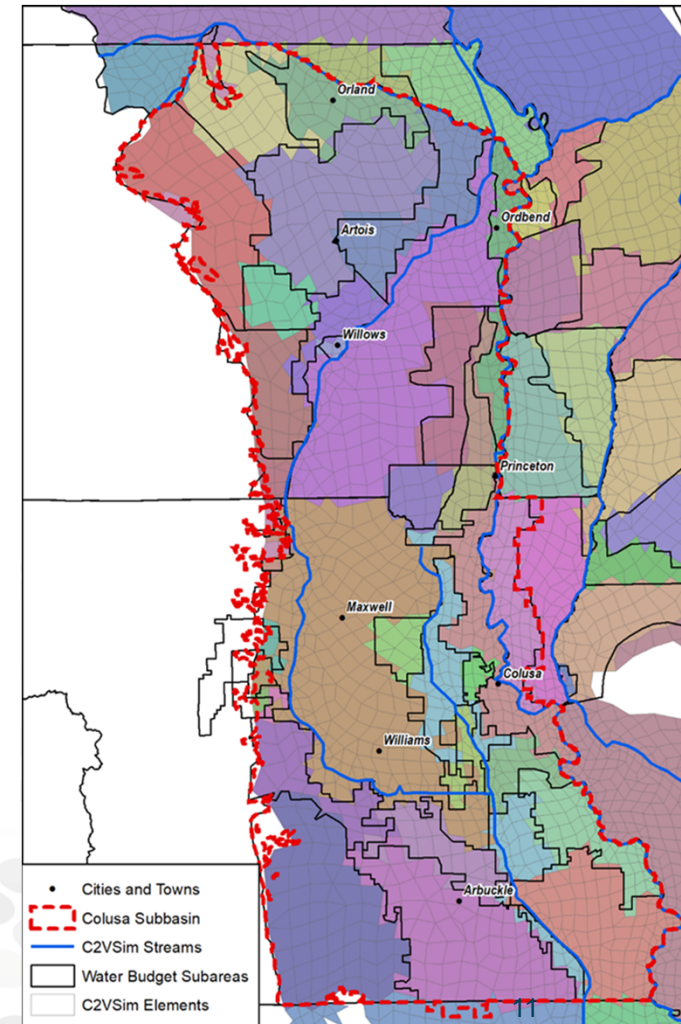


# How Are Models Used in SGMA?

- Develop estimates of flows, groundwater levels, change in groundwater storage, etc.
- Improve understanding of how the system behaved historically across a range of hydrology and supplies
- Develop understanding of how the system may behave in the future under potential changes from historical conditions
- Support the development of Sustainable Management Criteria (though monitoring data is critical)
- Support the evaluation of Projects and Management Actions

# California Central Valley Groundwater-Surface Water Simulation Model (C2VSim)

- Widely Used for SGMA
- Fine Grid Beta 2 Released April 2019
- Local Refinements to Date
  - Land Use
  - Diversions
  - Evapotranspiration
  - Soils
  - Irrigation Operations and Efficiency
  - Urban Demands

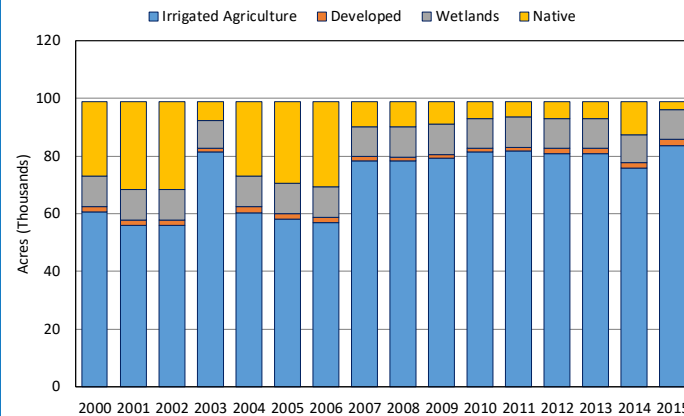


# Land Use Refinements

- Example: Glenn County Settlement Contractor Area
- Observations
  - Overestimation of Native Vegetation
  - Underestimation of Rice Acres
  - Overestimation of Orchard Acres
- Refinements Made for Full Subbasin

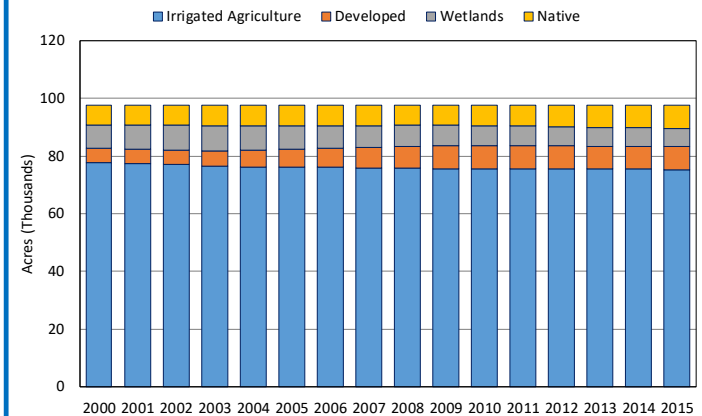
Total Area: C2VSim

C2VSim

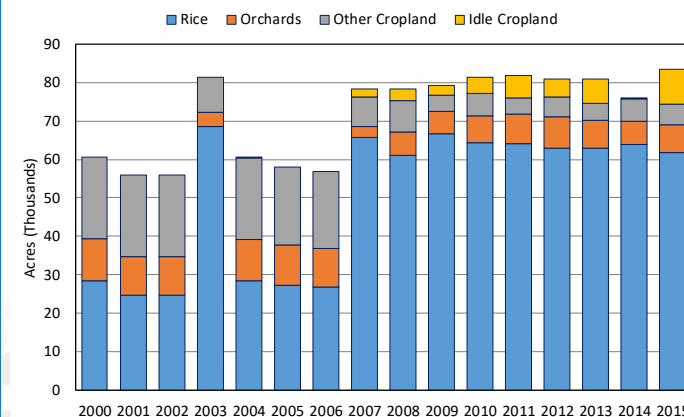


Total Area: Updated Estimates

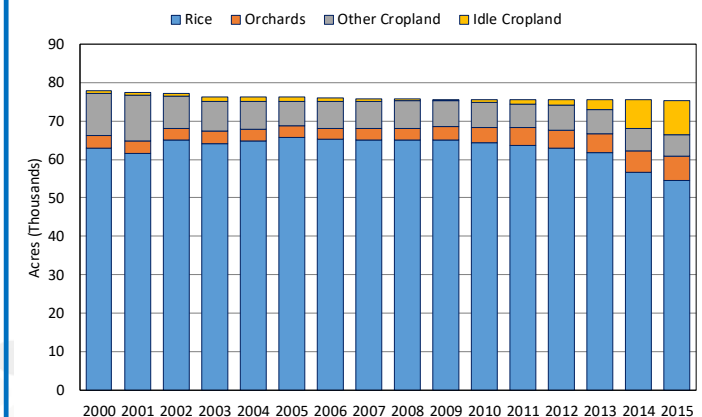
Stressed Basins



Crop Area: C2VSim



Crop Area: Updated Estimates



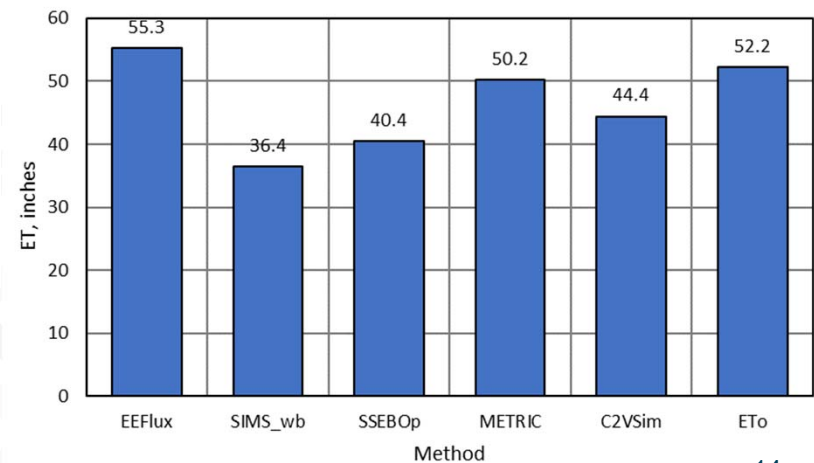
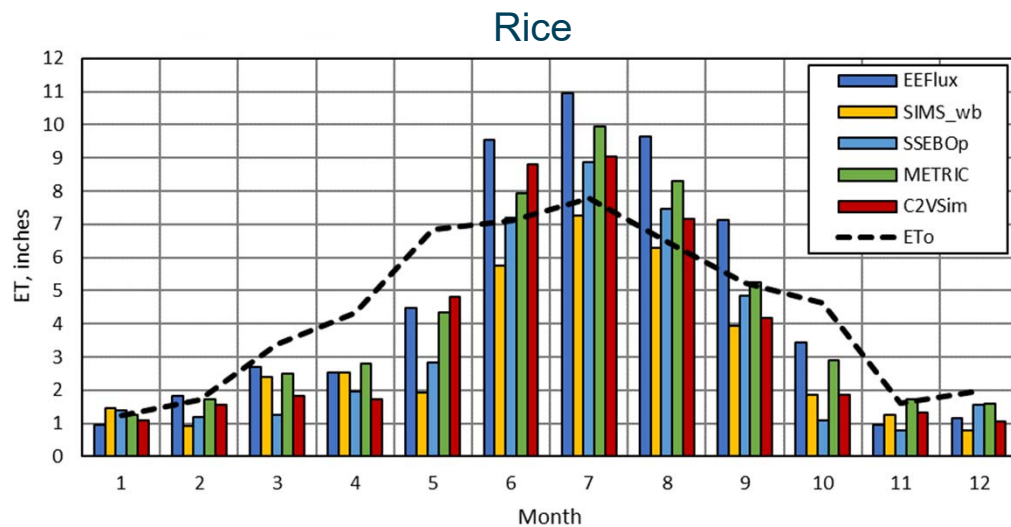
# Diversion Refinements

- Historical Diversions Originally Spread over Entire Surface Water Area Equally
- Need to More Precisely Designate Surface Water Use
- Refinements
  - 26 New Historical Diversion Records Created
  - Based on Monthly USBR Delivery Records and Local Data (e.g. Winter Non-Contract Use)
  - Diversions Assigned to Unique Supplier Service Areas

Div ID	Description
444	CVP to OUWUA South Canal
445	Colusa County WD
446	Orland-Artois WD
447	Glenn-Colusa ID (TC)
448	Westside WD
449	Kanawha WD
450	Glide WD
451	La Grande WD
452	Davis WD
453	4-M WATER DISTRICT
454	Holthouse WD
455	Glenn Valley WD
456	Cortina WD
457	Myers-Marsh MWC
458	Glenn-Colusa ID
459	Reclamation District #108
460	Princeton-Codora-Glenn Irrigation District
461	Provident Irrigation District
462	Sycamore MWC
463	Maxwell Irrigation District
464	Carter Mutual Water Company
465	Misc Sac River Riparian Diversions
466	Misc Sac River Riparian Diversions
467	Misc Sac River Riparian Diversions
468	Andreotti, Arnold and Arthur, et al

# Evapotranspiration (ET) Refinements

- Comparison of C2VSim ET to Satellite Estimates
- Four Independent ET Sources
- Adjustments to Monthly C2VSim ET Inputs
- Generally Relied on METRIC Estimates
- Examples
  - Rice
  - Almonds
  - Alfalfa
  - Tomatoes

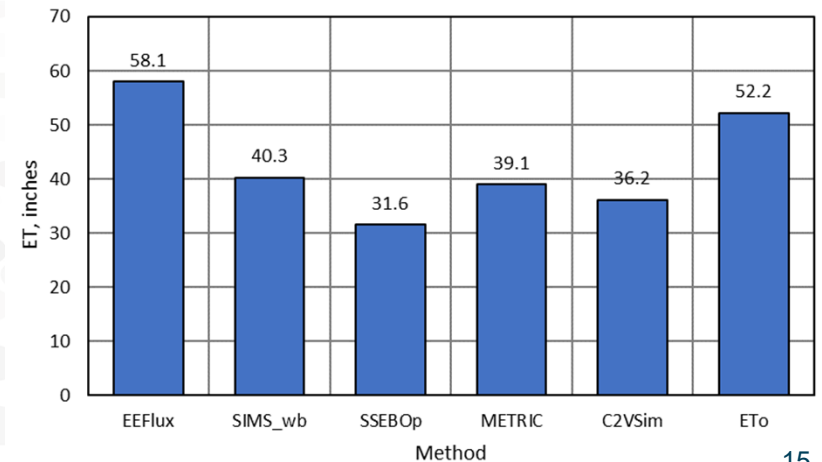
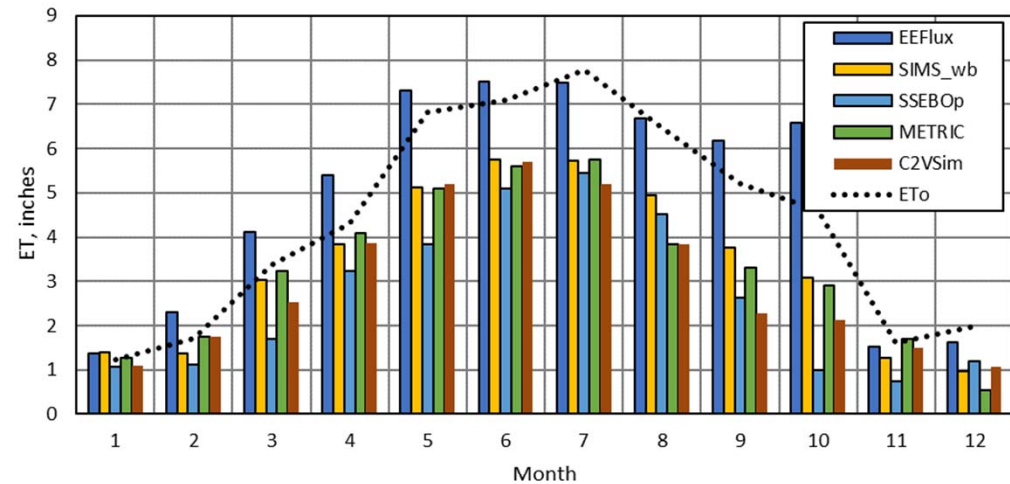




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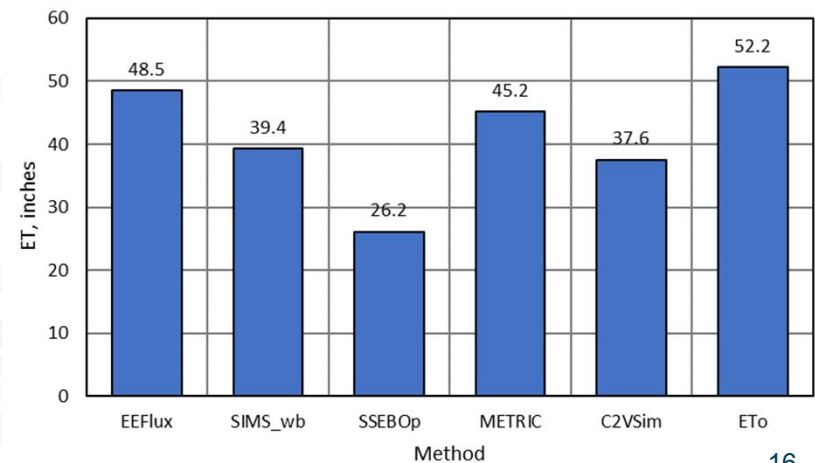
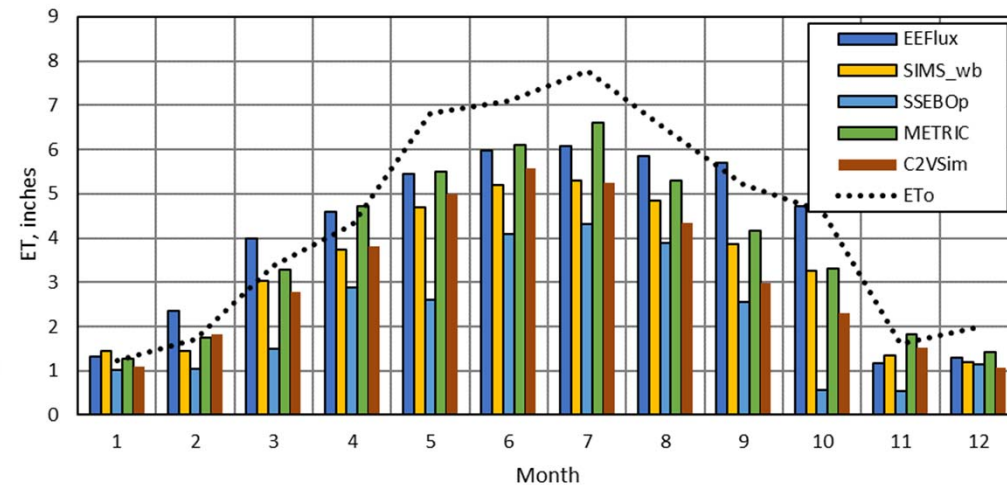
Almonds



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Alfalfa

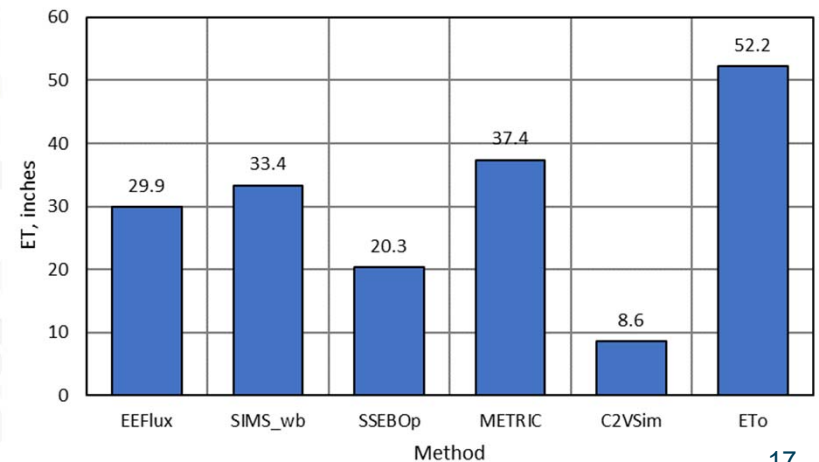
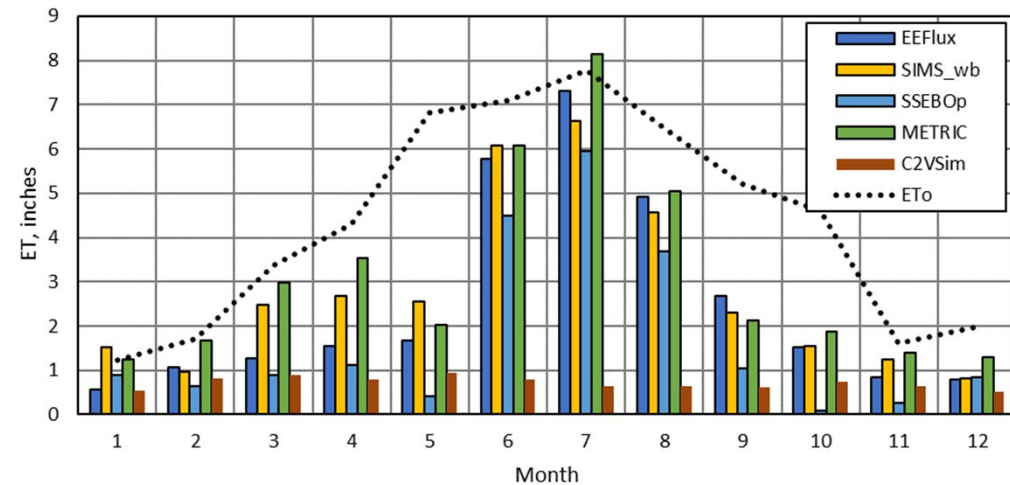




# Evapotranspiration Refinements

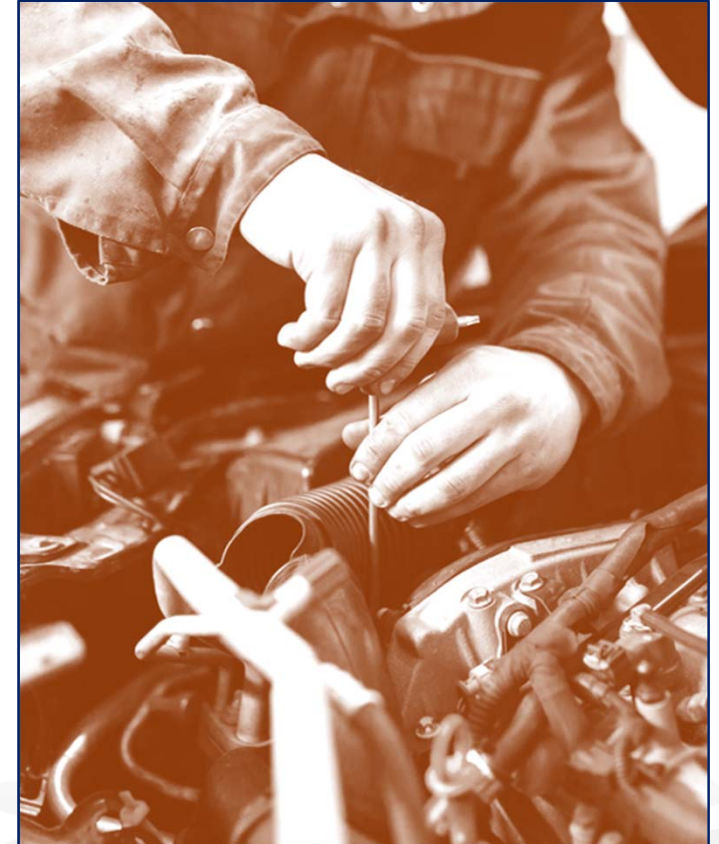
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  - Almonds
  - Alfalfa
  - Tomatoes

Tomatoes



# Other Refinements

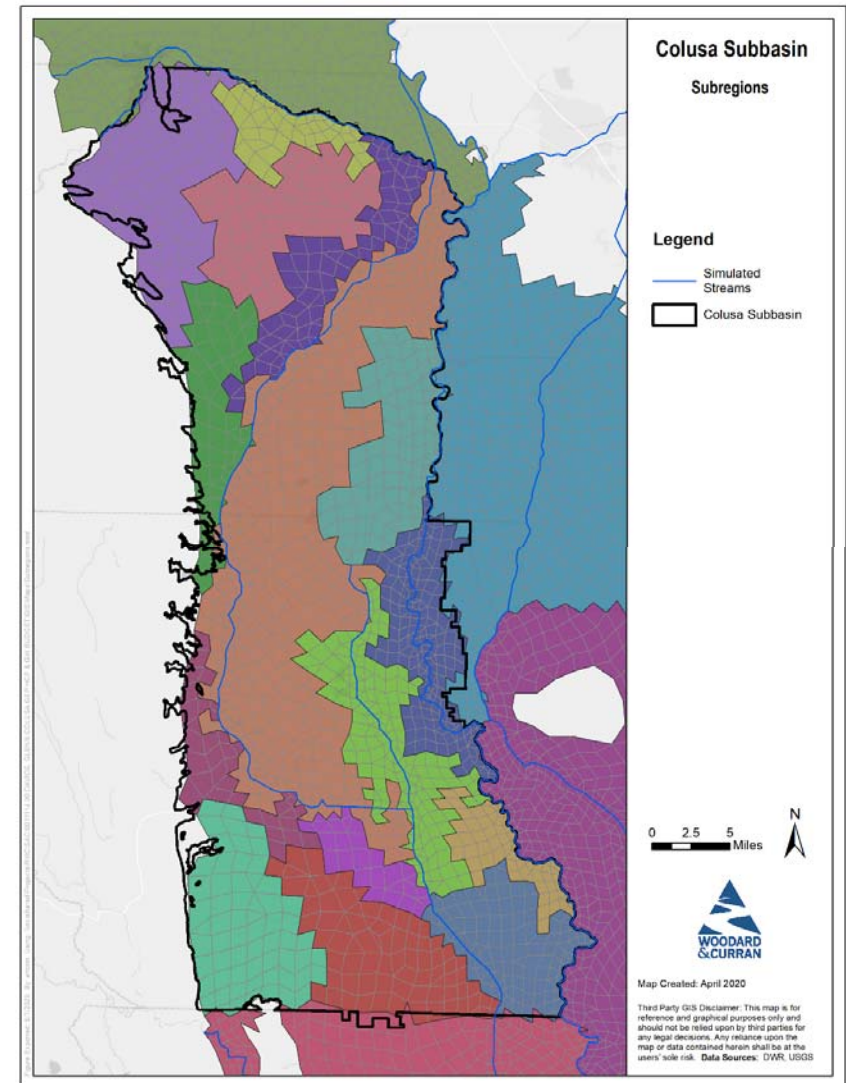
- Rice Percolation Rates
- Irrigation Operations and Efficiency
  - Refined Pond Depths, Tailwater, and Reuse
  - Increased Irrigation Efficiency for Other Crops to Better Match Current Understanding of Grower Practices
- Urban Demands
  - Created Urban Demand Areas
    - Orland, Willows, Williams, Colusa, Arbuckle
  - Updated Population and Per Capita Water Use
    - Willows UWMP
    - Department of Finance
    - SWRCB Water Supplier Reporting Data



# **Model Calibration Status (Information Item)**

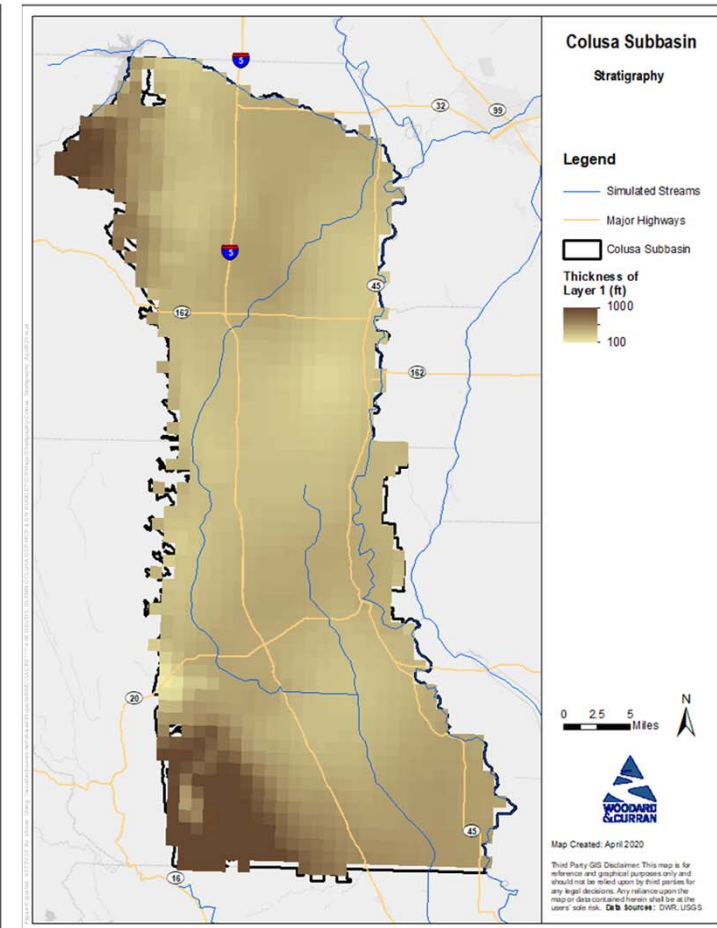
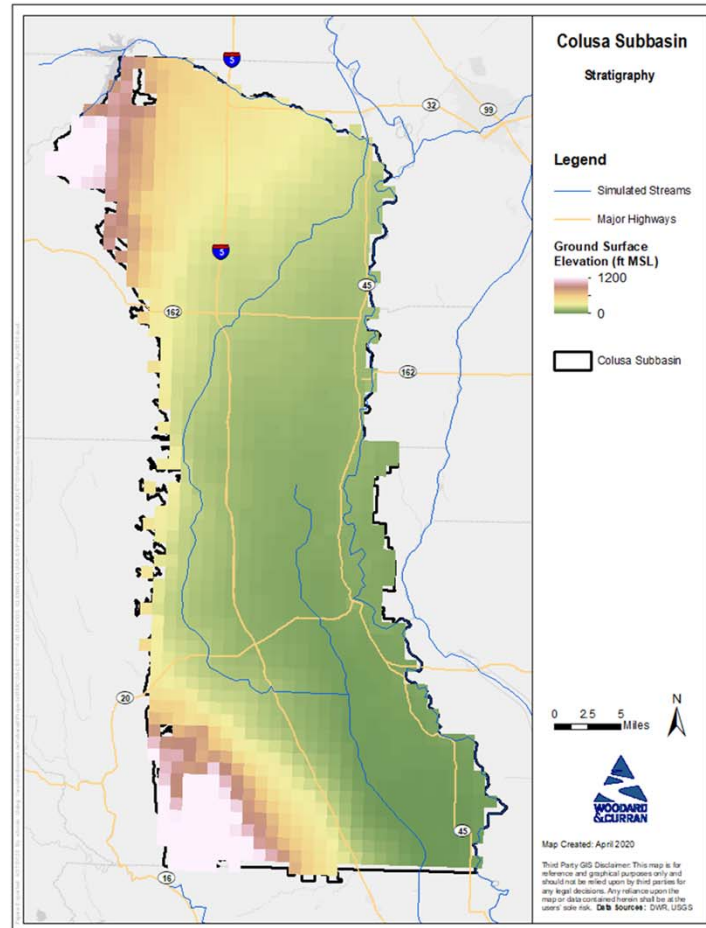
# Model Calibration

- Calibration of Colusa Subbasin Area of DWR C2VSimFG Model With Refinements
  - 1839 Individual Elements
  - 389 Acres, on Average
- Calibration Areas of Focus
  - Streamflow gages
  - Groundwater wells
  - Model subregion water budgets
  - Colusa Subbasin water budgets



# Model Layering

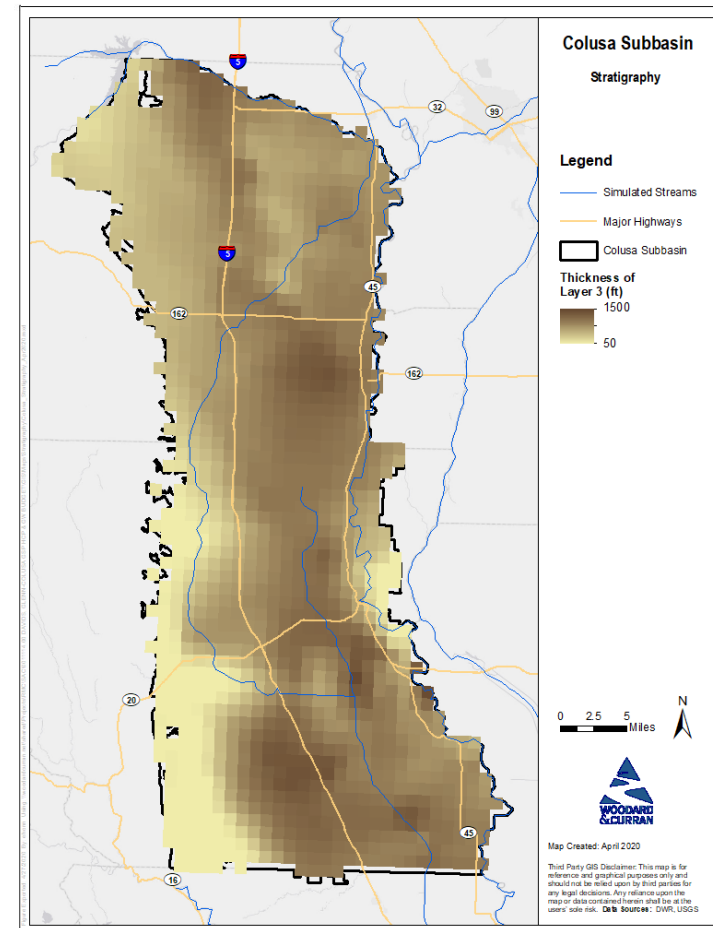
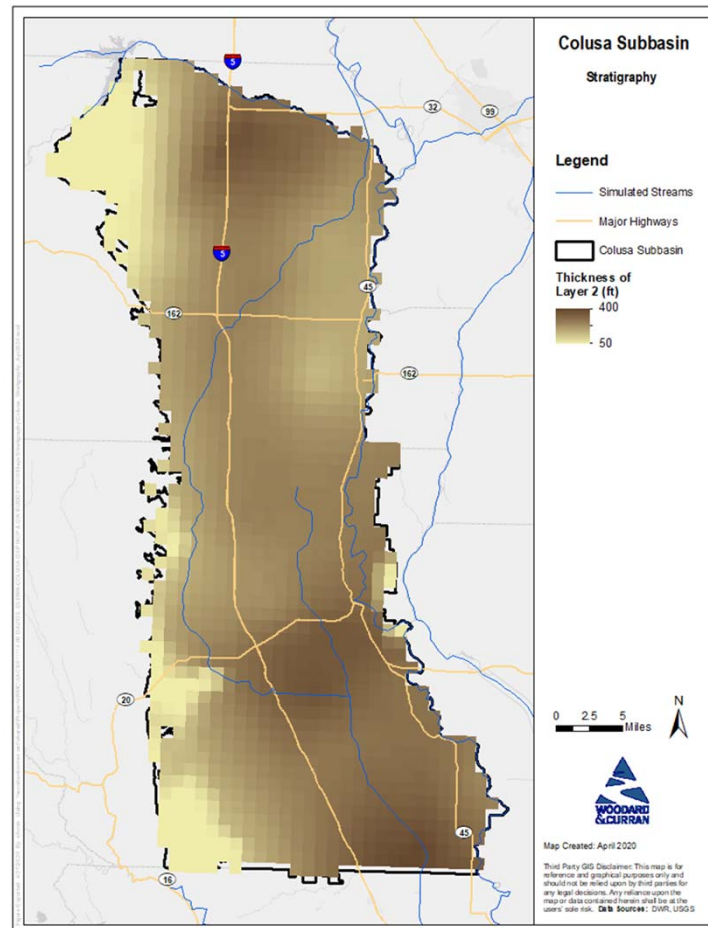
- **Layer 1:** Top unconfined portion of the aquifer. Ground surface elevation (top of Layer 1) is from USGS data at a resolution of 10 meters.





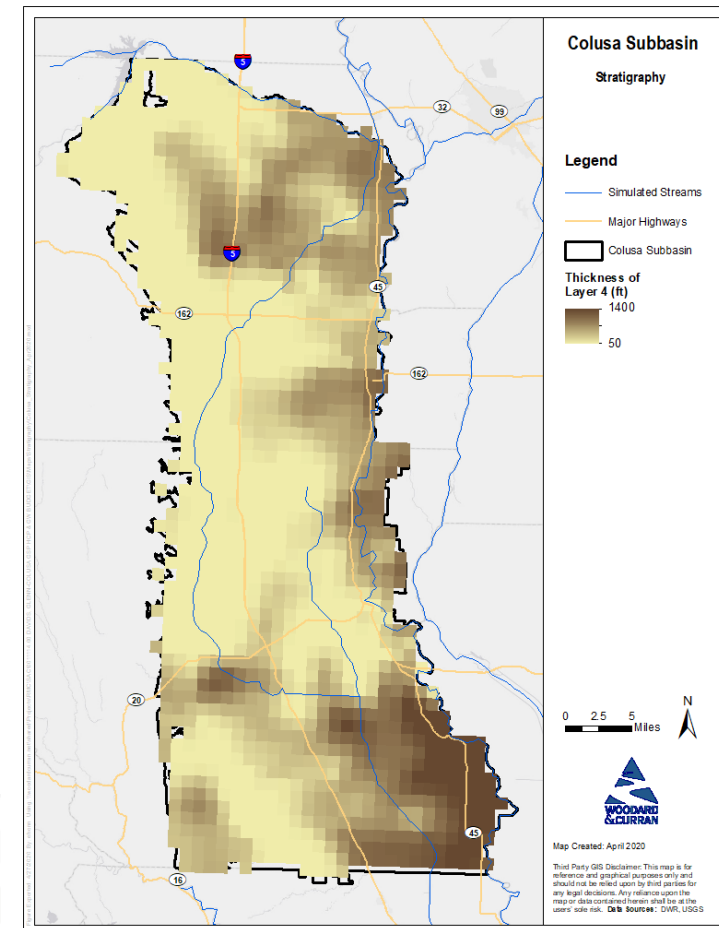
# Model Layering

- **Layer 2:** Primary pumping layer.
- **Layer 3:** Extends to the base of fresh water. Information used to develop the bottom of Layer 3 includes data from Steven Springhorn (DWR), and Williamson et al. 1989.



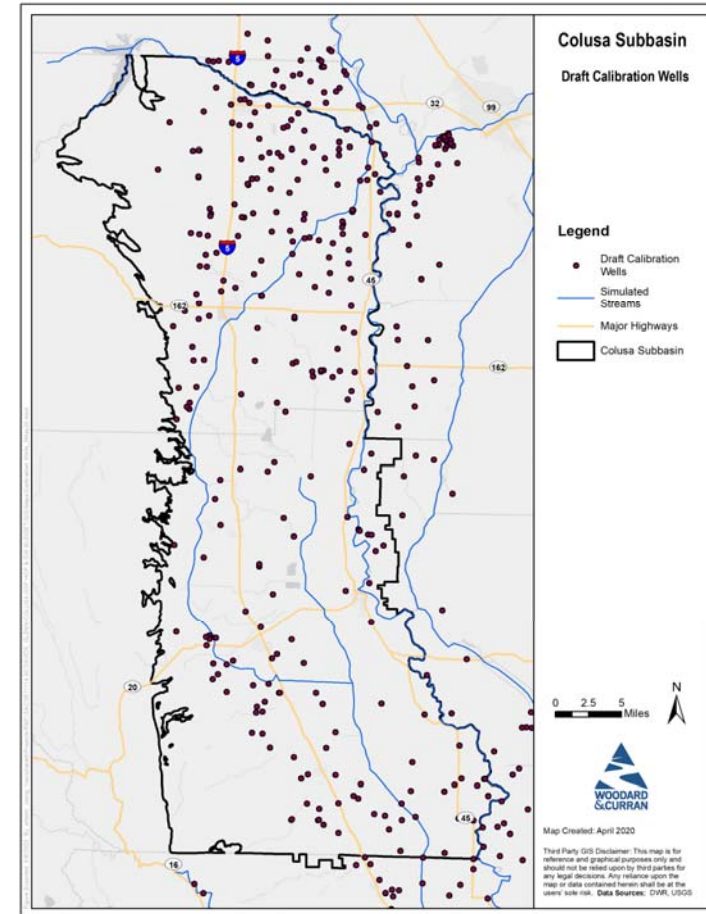
# Model Layering

- **Layer 4:** Saline water ranging from the base of fresh water to the base of continental deposits and is a current non-production zone. Information used in developing the bottom of Layer 4 includes Page's 1974 *Base and Thickness of the Post Eocene Continental Deposits in the Sacramento Valley* and thickness of the aquifer developed by Williamson et al. 1989.



# Calibration Wells

- 740 wells in DWR Water Data Library (WDL) within 5-mile radius of Subbasin
- Filtered out wells based on:
  - No known well depth
  - No measurements between 1990-2015
  - No Spring measurement(s) available (defined as March, April, or May)
- 519 potential calibration wells remaining



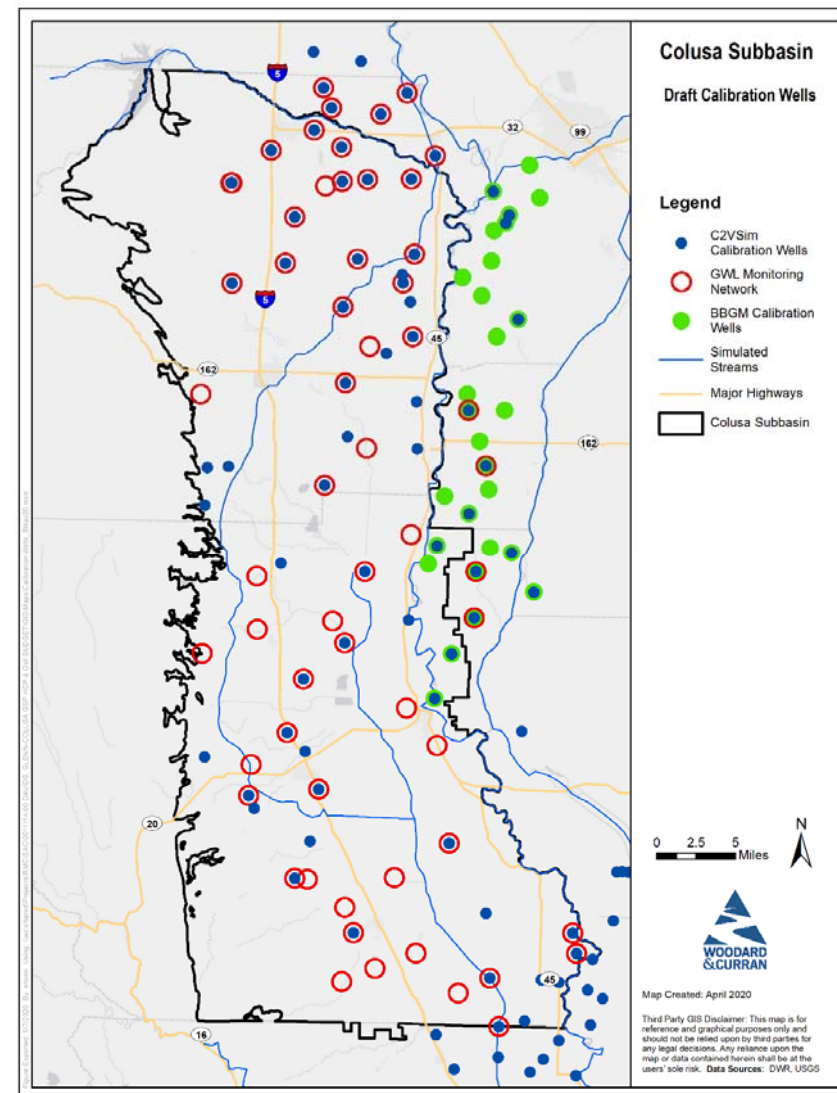


# Calibration Wells

- Keep Wells Included in Overlapping Networks:
  - BBGM calibration wells\*
  - C2VSim calibration wells\*
  - Colusa Subbasin GWL Monitoring Network
- Results in 247 calibration wells

Well Network	Total Wells within 5 mi
GWL Monitoring Network	141
BBGM	47
C2VSim	212

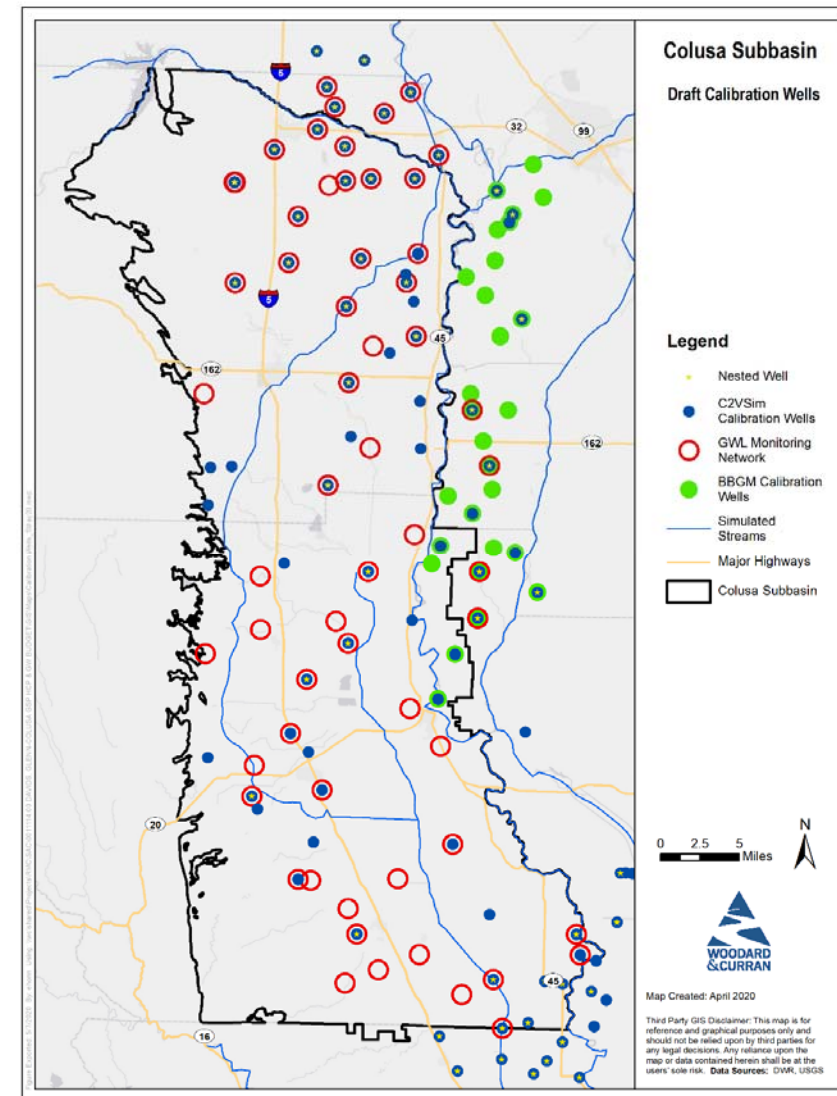
\*If within 5-mile radius



# Calibration Wells

- Calibration Wells Will Continue to Change as Calibration Continues

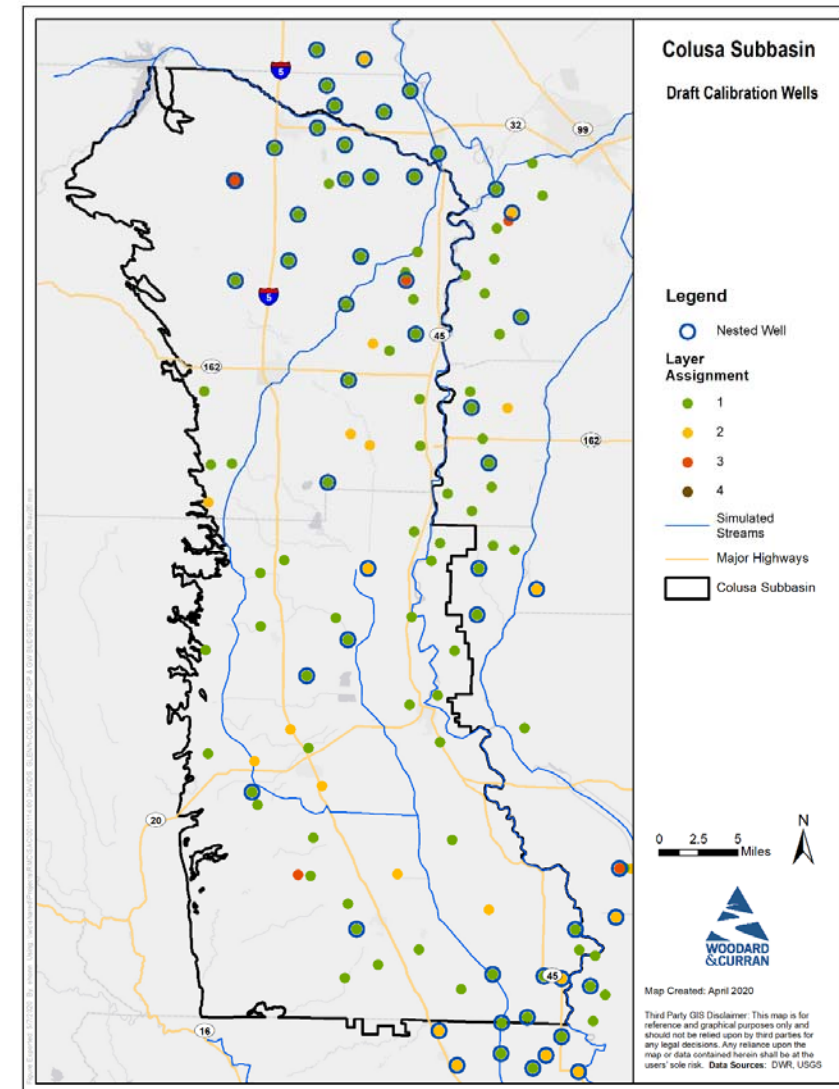
Draft Calibration Wells	Inside Colusa Subbasin	Outside Colusa Subbasin
Nested Wells	86	89
GWL Monitoring Network	108	33
BBGM	4	43
C2VSim	112	100



# Calibration Wells by Layer

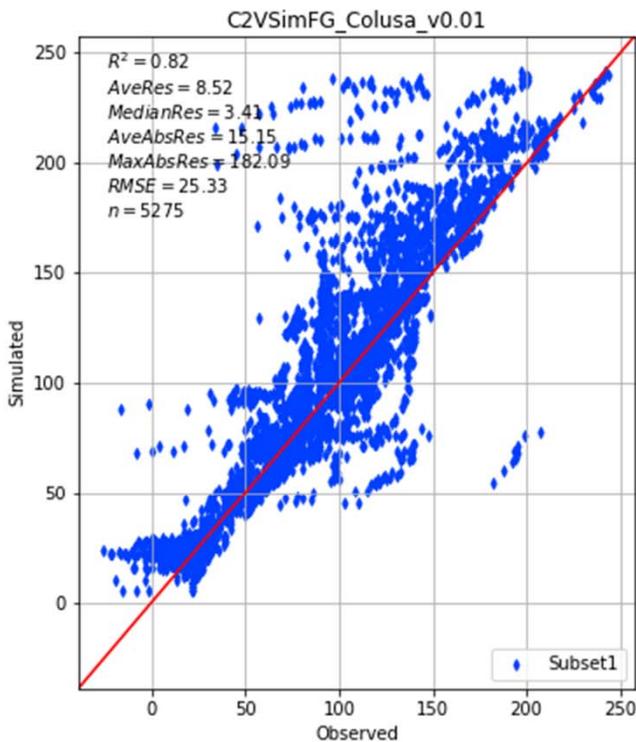
- Assigned to Model Layer Based on Well Top/Bottom Perforations or Total Well Depth

Model Layer	Layer 1	Layer 2	Layer 3	Layer 4
# Wells	135	66	45	1

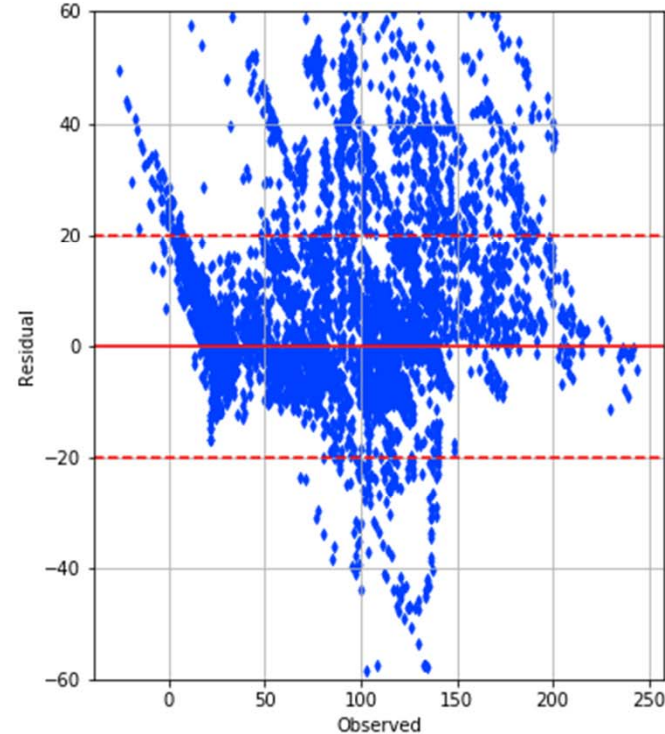


# Calibration Statistics

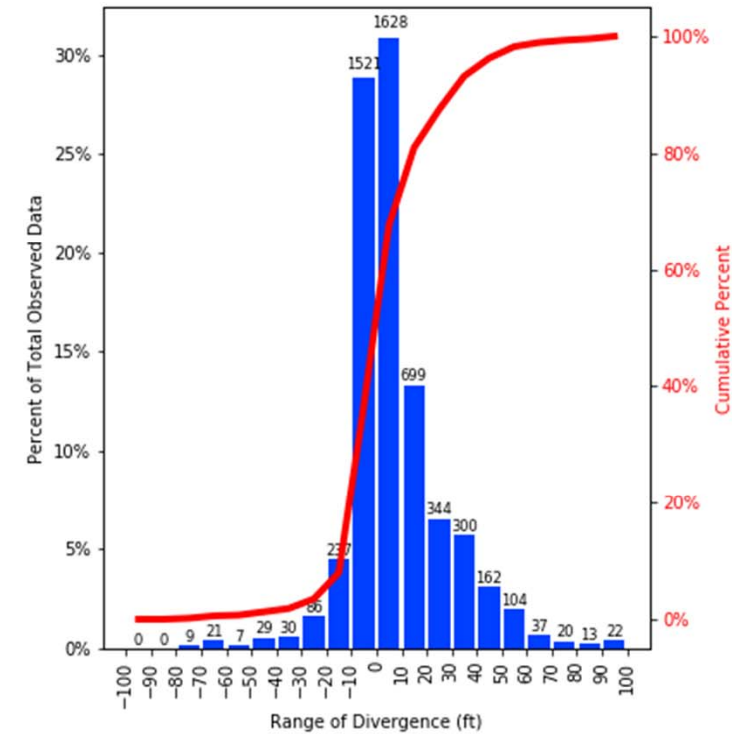
- Statistics Based on Spring Observations (March, April, or May, 1985-2015) for All 247 Wells (Includes Wells outside Colusa Subbasin)



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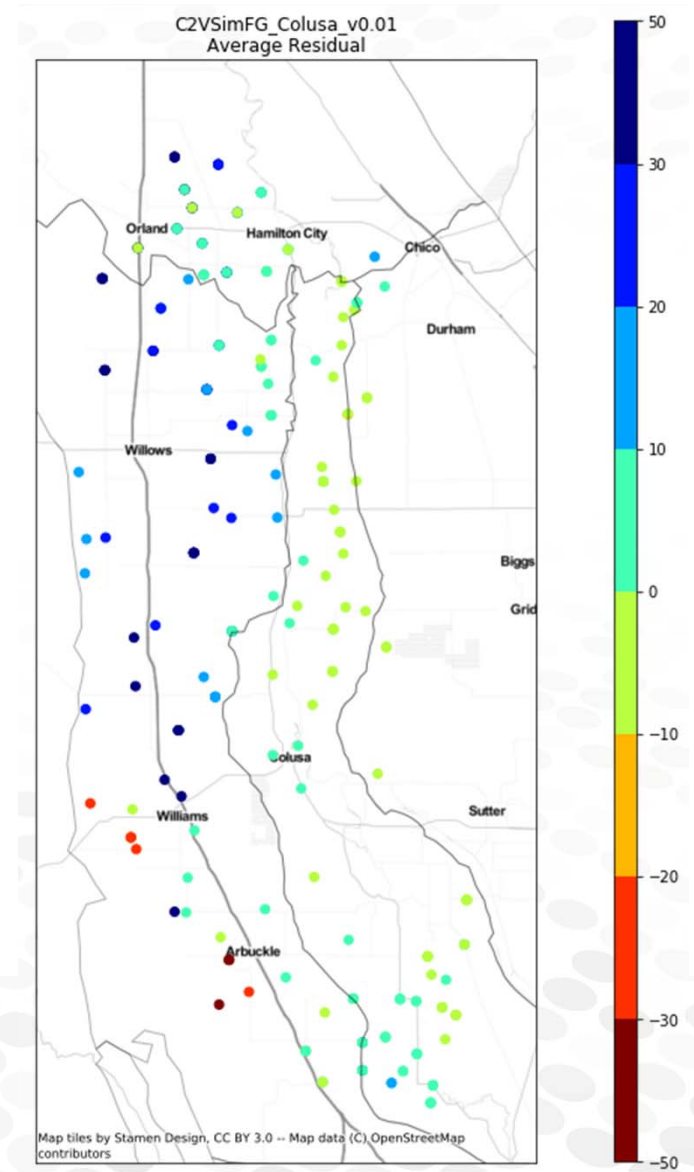


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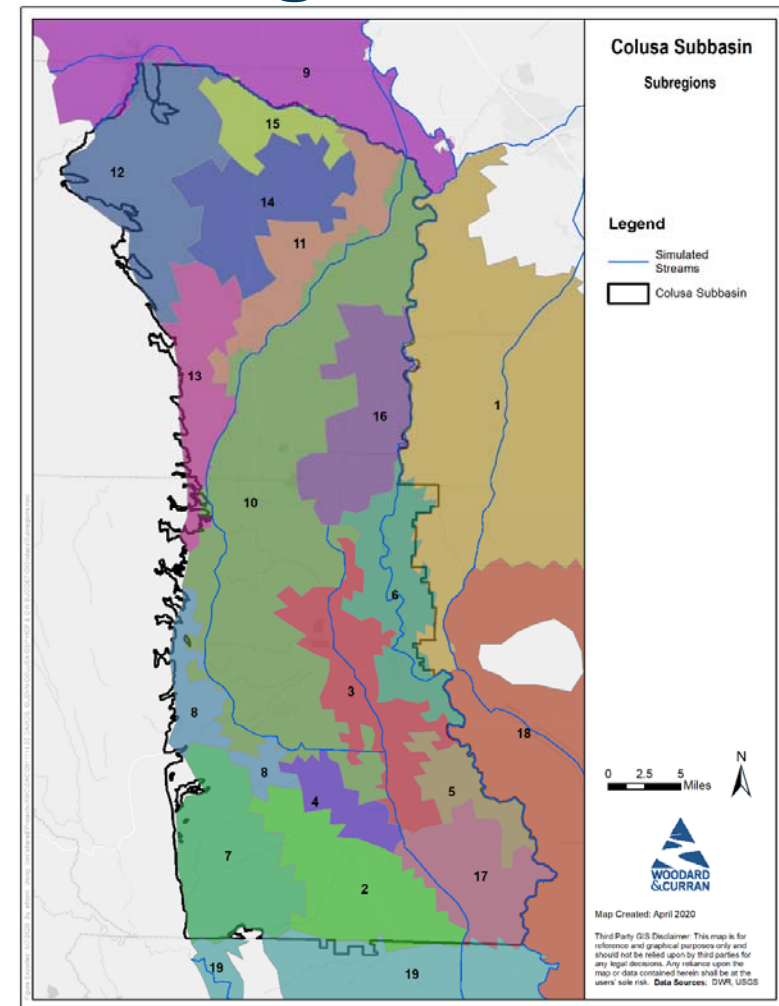
# Calibration Residuals





# Colusa Subbasin Model Subregions

Subregion ID	Subregion Name
1	Butte
2	CCWD
3	Colusa Drain Maxwell
4	Colusa Groundwater South
5	Colusa GW Southeast
6	Colusa Sac River
7	Colusa Southwest
8	Colusa Westside Area
9	Corning
10	GCID
11	Glenn GW Middle
12	Glenn Northwest
13	Glen Westside
14	OAWD
15	OUWUA
16	Prov Prince Willow
17	RD108
18	Sutter
19	Yolo

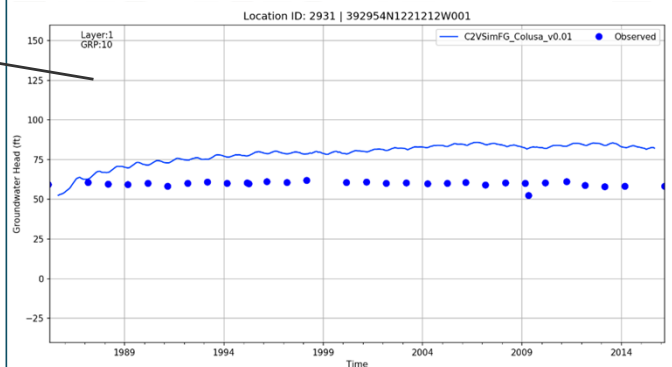
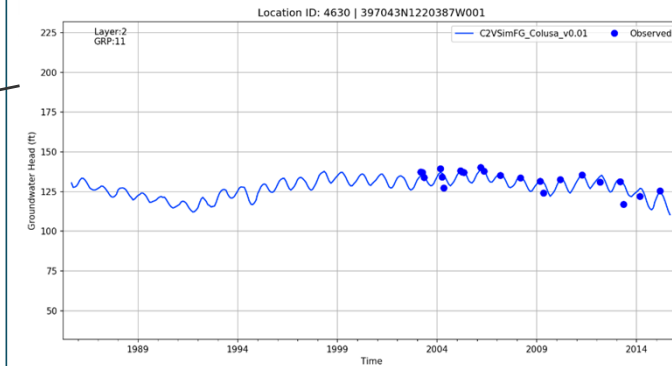
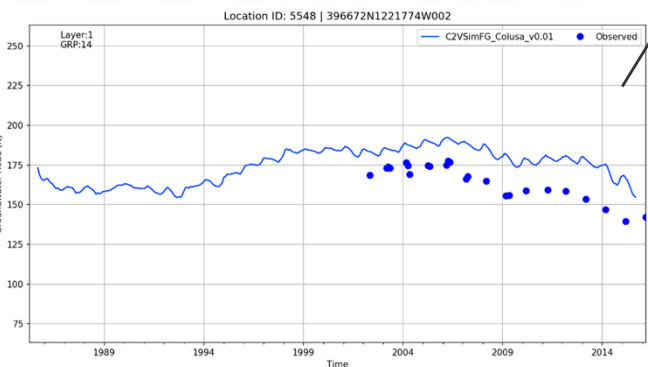
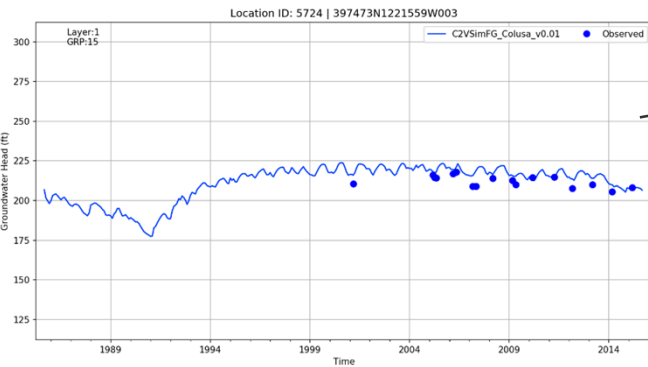
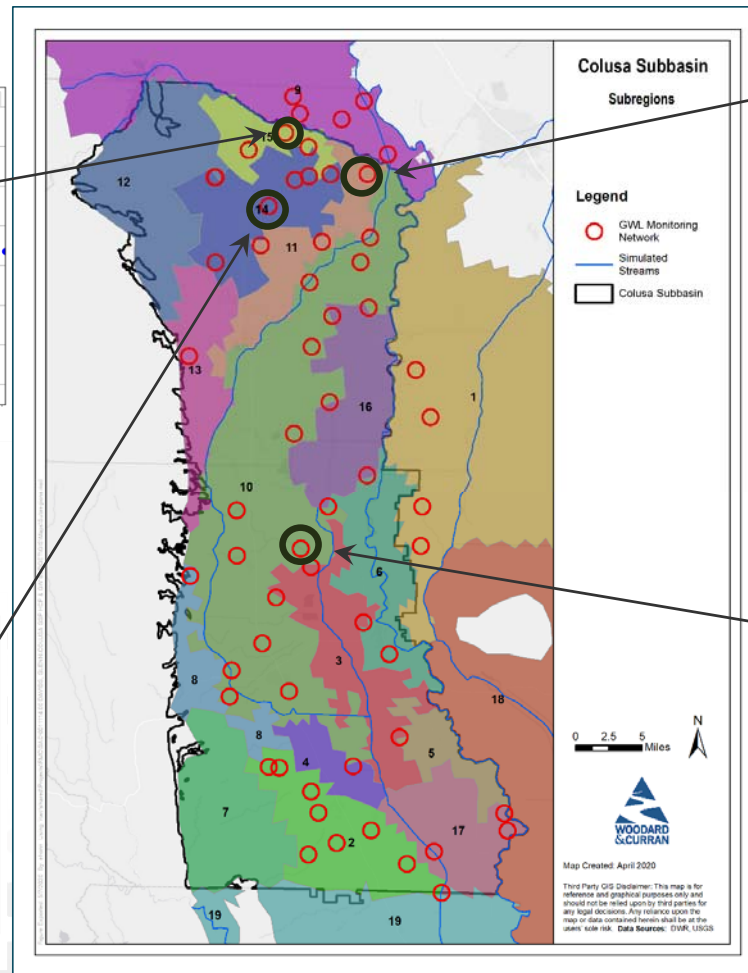


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# Example Hydrographs

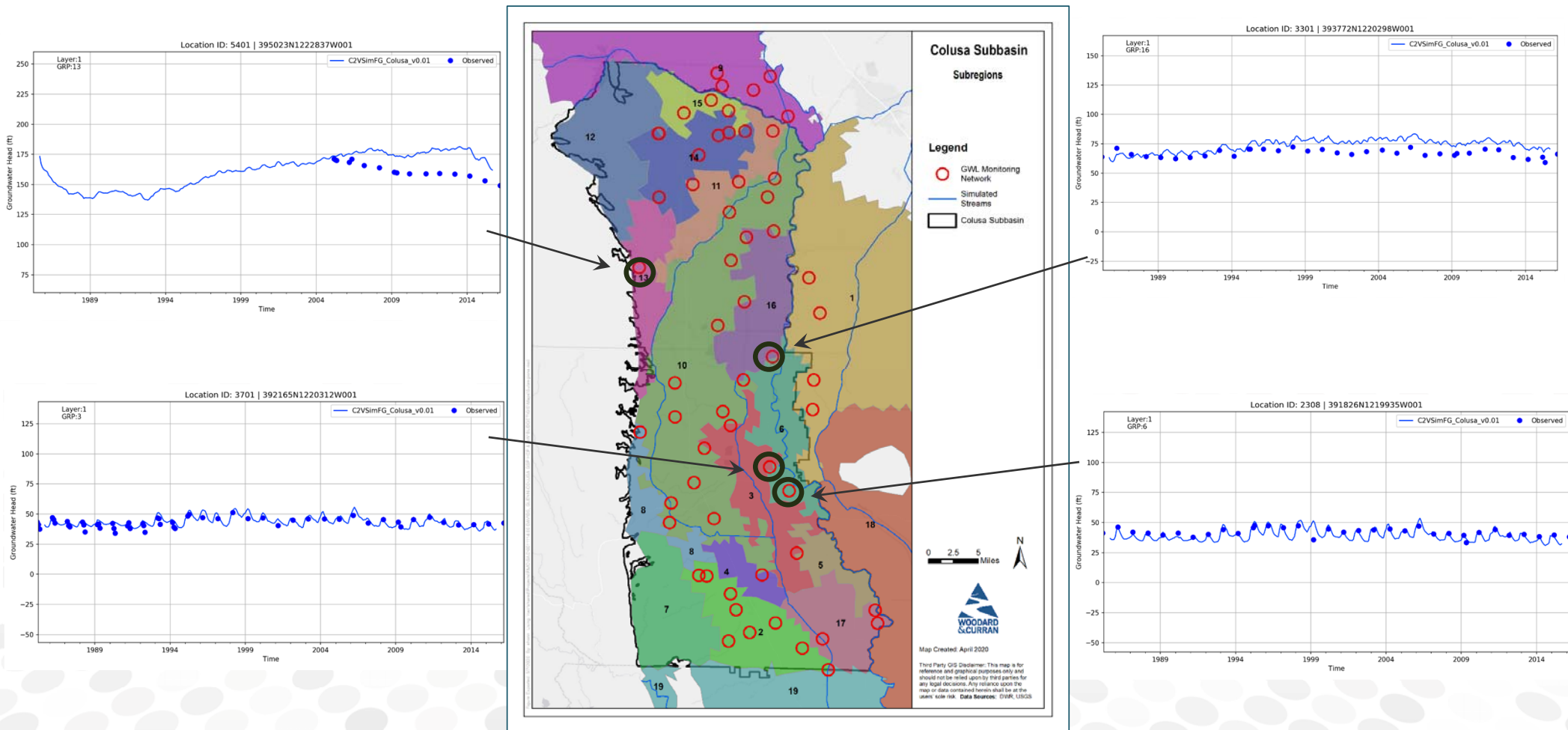


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# Example Hydrographs



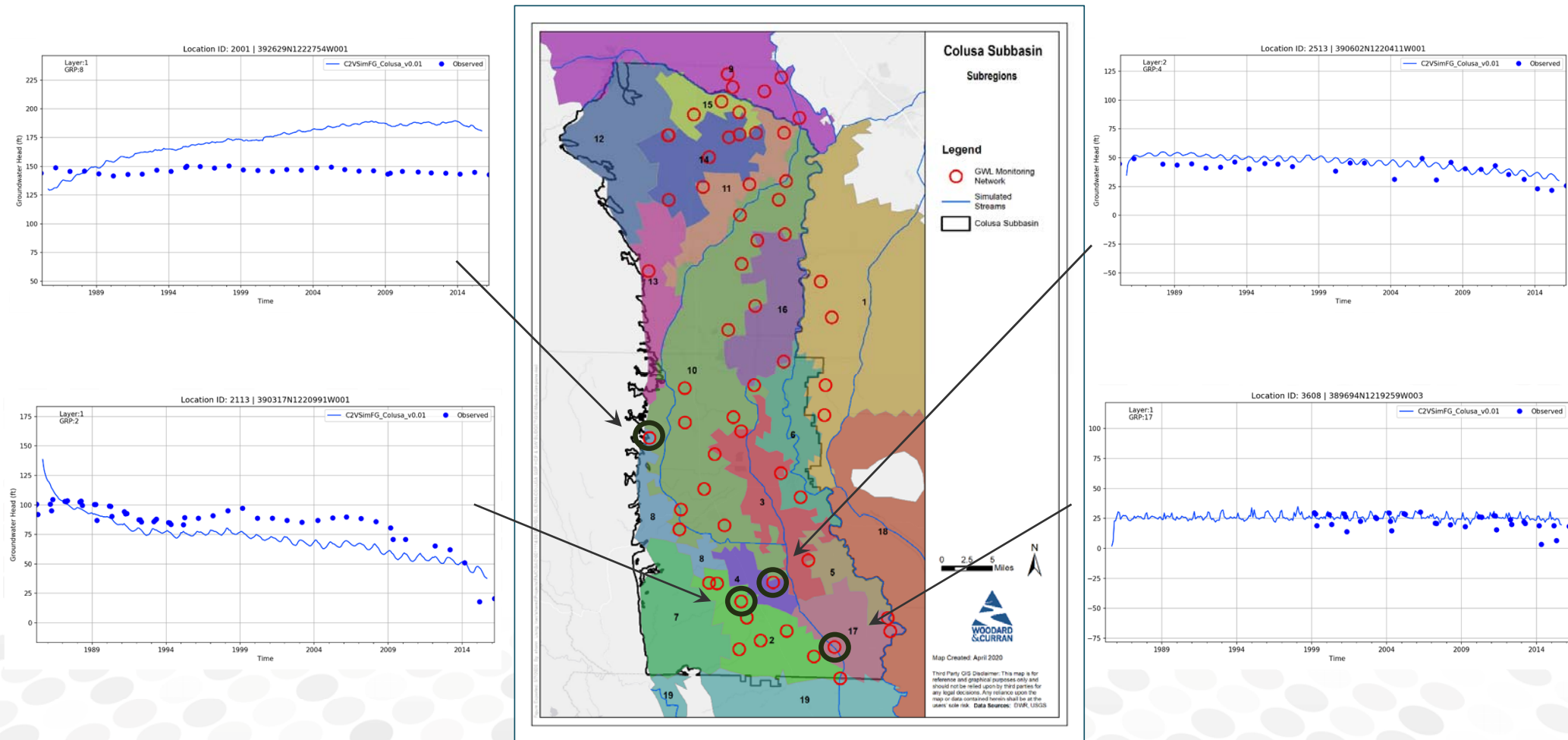
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# Example Hydrographs



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# Google Earth Demo (Time Allowing)

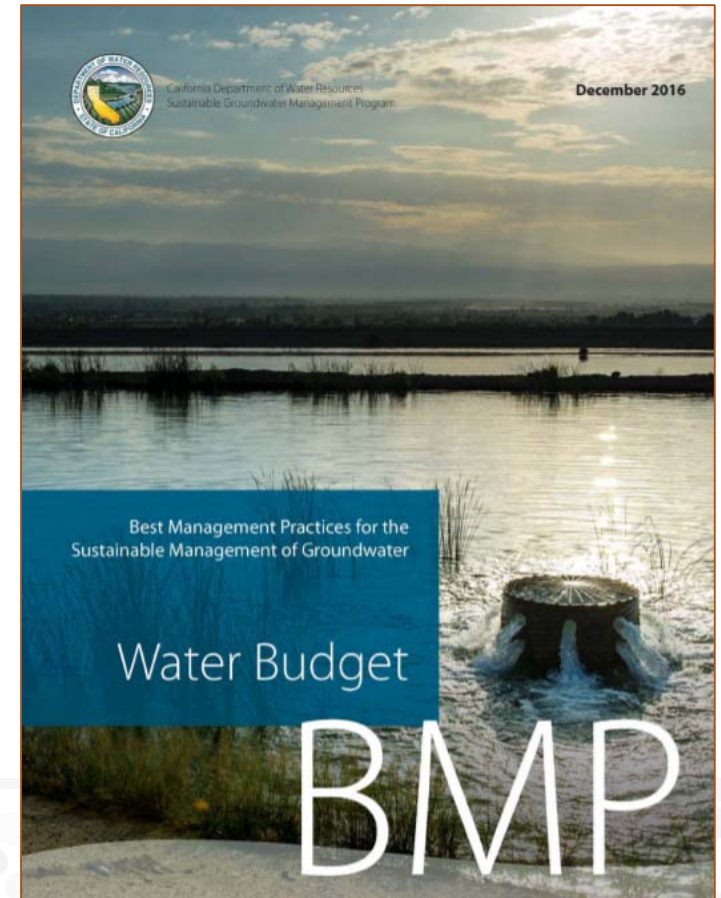
# **Future Water Budget Assumptions (Potential Action Item)**

# Why Develop Future Water Budgets?

- Regulatory Requirement (but they do have value)
- Help Understand Potential Changes and Uncertainty in the Future
- Support Development of Sustainable Management Criteria
- Support Evaluation of Projects and Management Actions
- Considerations
  - Not a Certainty, Rather an Uncertainty
  - Undesirable Results Based on Actual Monitoring
  - Opportunity/Requirement for Adaptive Management over Time

# Projected (“Future”) Water Budget Components

- 50 Years Historical Hydrology (precipitation, evapotranspiration, streamflow)
- Most Recent Land Use and Evapotranspiration
- Climate Change
- Most Recent Water Supply Information
- Projected Population and Per-Capita Urban Water Use

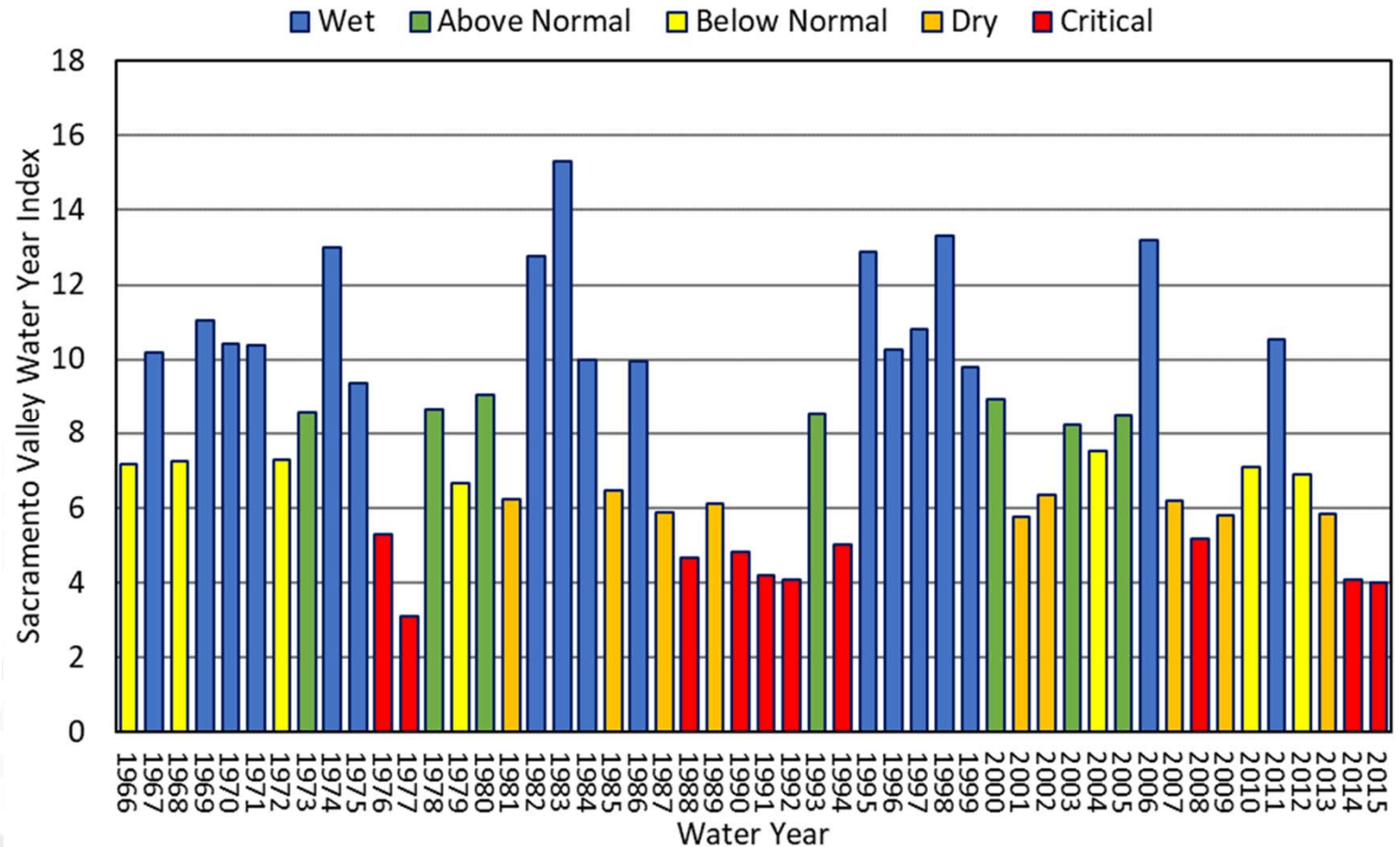


# Proposed Approach

- Refined C2VSimFG Model
- 50 Years of Hydrology from 1966 – 2015
- Recent Historical Land Use Mapped to “Normal” vs. Shasta Critical Years
- DWR 2030 and 2070 Central Tendency Climate Scenarios
- Water Supply from Recent Historical Use
- Urban Demands from Projected Population and Per-Capita Use

# Historical Hydrology

- Sacramento Valley Index  
1906 to 2018  
 avg. = 8.1  
1966 to 2015  
 avg. = 8.0
- Precipitation  
1906 to 2018  
 avg. = 18.0 in  
1966 to 2015  
 avg. = 19.4 in

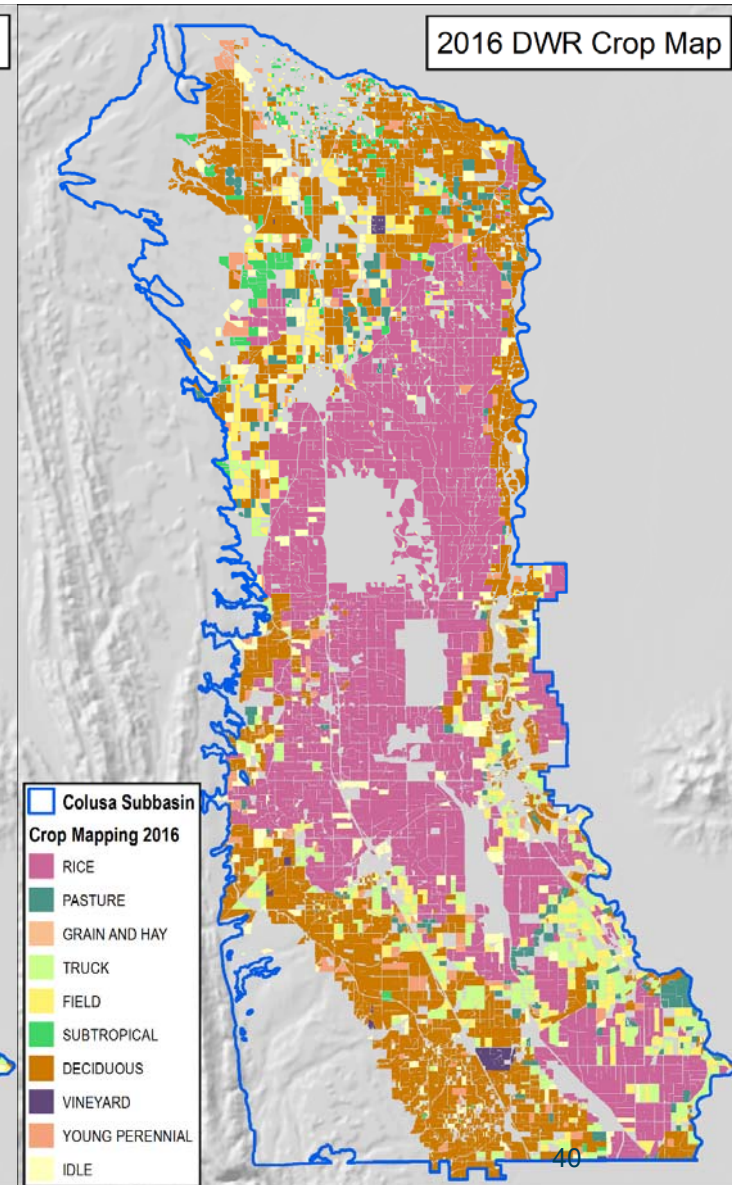
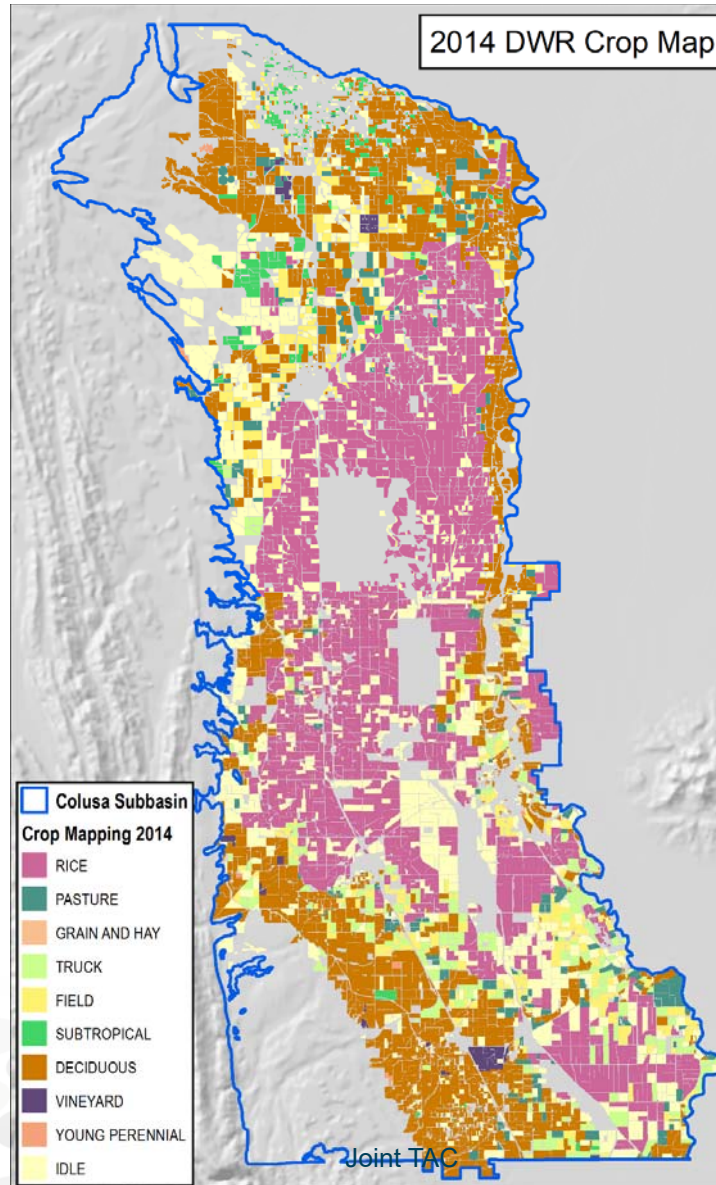




# Land Use

- DWR Land Use Mapping
- Curtailment Year  
2014
- Non-Curtailment Year  
2016  
(2018 if available)

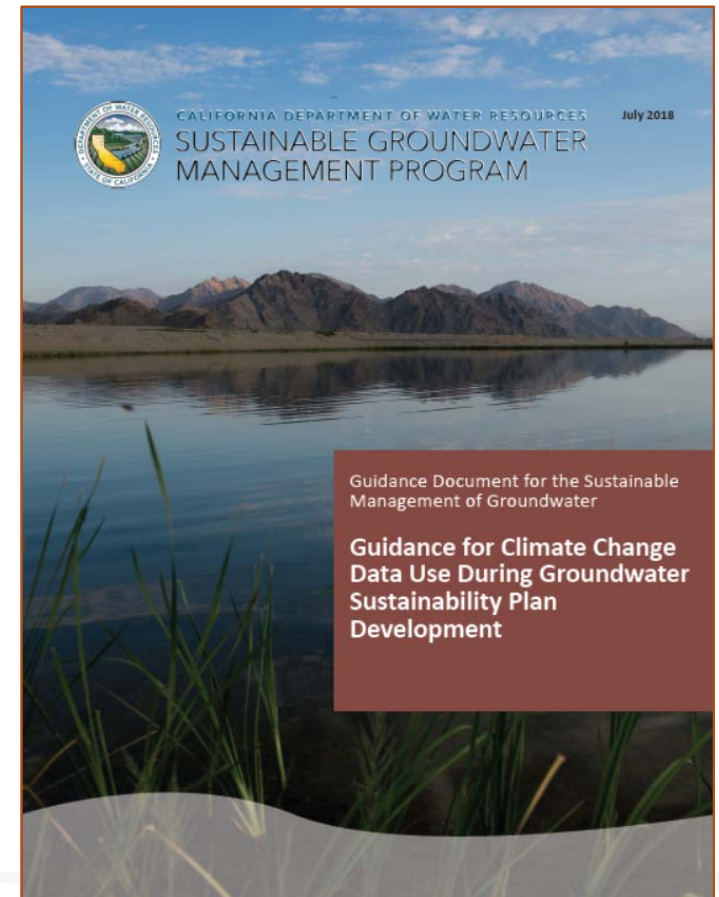
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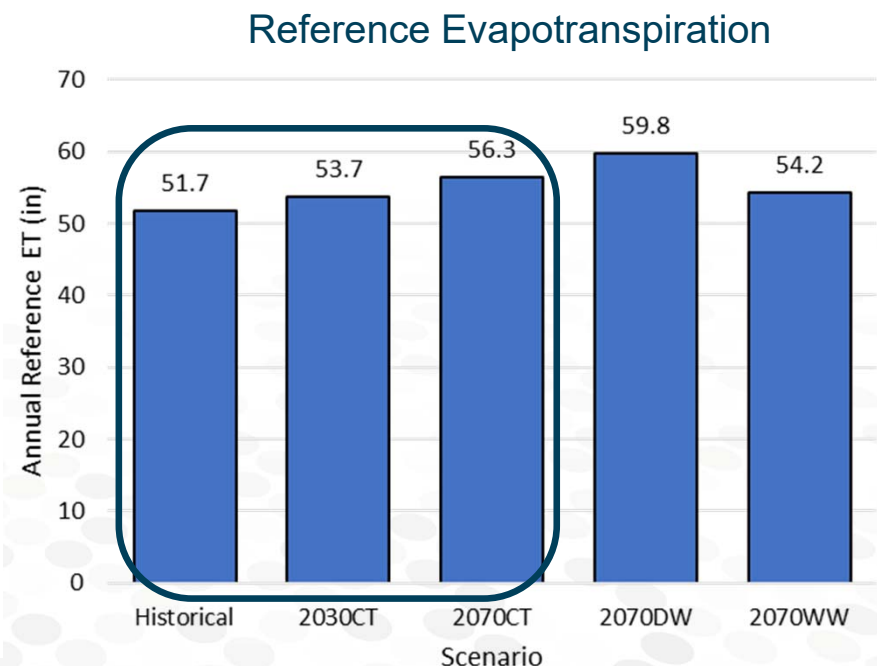
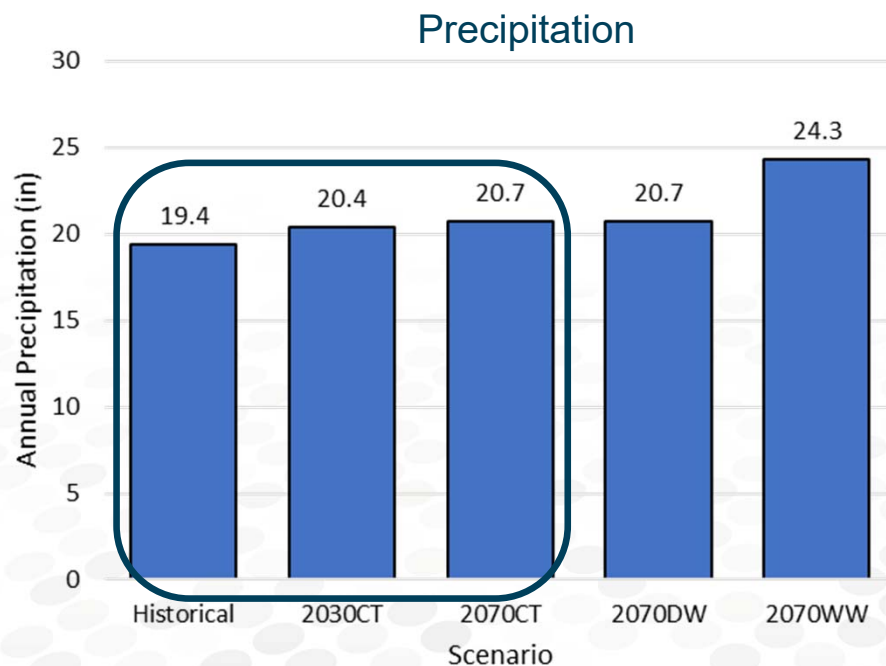
# Climate Change

- Four Scenarios from DWR
  - 2030 Central Tendency
  - 2070 Central Tendency
  - 2070 Drier with Extreme Warming
  - 2070 Wetter with Moderate Warming
- Used to Modify Historical Hydrology and Surface Water Supplies
- Select up to Two Scenarios



# Valley Floor Climate Change Effects

- Annual Average Precipitation and Reference Evapotranspiration



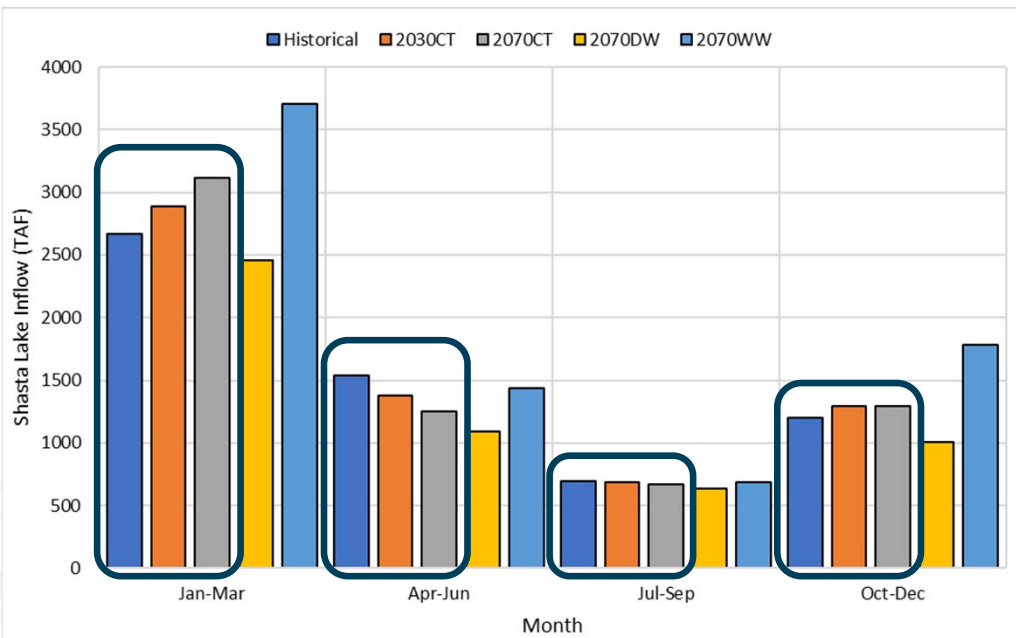
2030CT – 2030 Central Tendency  
2070CT – 2070 Central Tendency

2070DW – 2070 Drier with Extreme Warming  
2070WW – 2070 Wetter with Moderate Warming

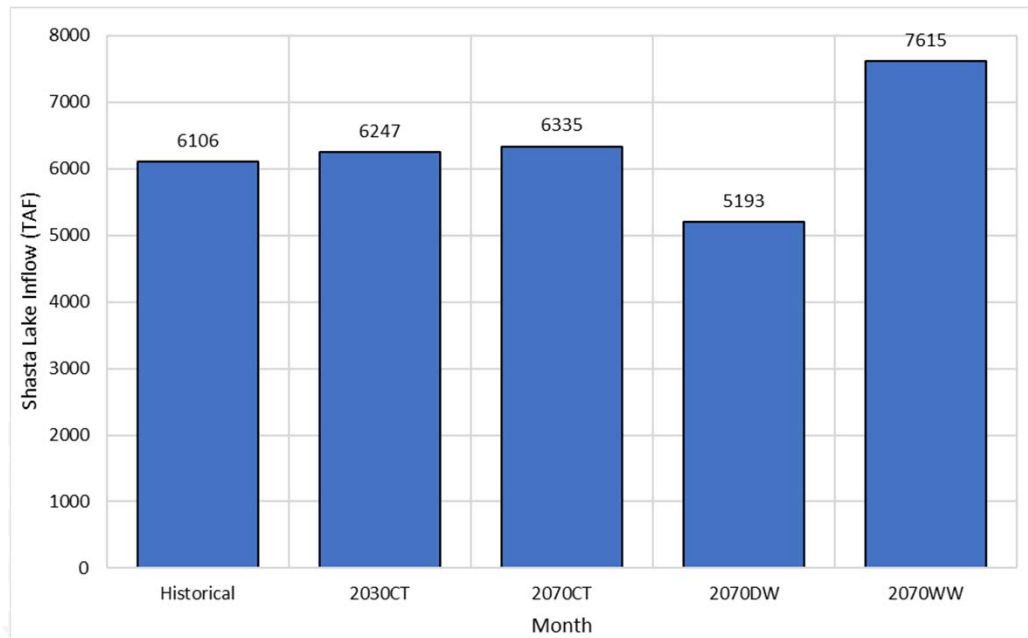
# Lake Shasta Climate Change Effects

- Quarterly and Annual Reservoir Inflows

Quarterly



Annual



2030CT – 2030 Central Tendency  
2070CT – 2070 Central Tendency

2070DW – 2070 Drier with Extreme Warming  
2070WW – 2070 Wetter with Moderate Warming

# Climate Change Scenarios in Other GSPs

- Performed Inventory of Scenarios Selected in 12 Other GSPs
- Observations
  - Almost all rely solely on central tendency scenarios
  - Most only including one scenario

2030CT – 2030 Central Tendency  
2070CT – 2070 Central Tendency  
2070DW – 2070 Drier with Extreme Warming  
2070WW – 2070 Wetter with Moderate Warming

Basin	Climate Change Scenario(s)
Butte	2030CT, 2070CT
Chowchilla	2030CT
Delta-Mendota	2030CT, 2070CT
East Kaweah	2030CT, 2070CT
Eastern San Joaquin	2070CT
Kings	2030CT, 2070CT
Madera	2030CT
Merced	2070CT
North Yuba	2030CT
South Yuba	2030CT
Westside	2030CT
Yolo	2030CT, 2070CT, 2070DW, 2070WW

# Surface Water Supplies

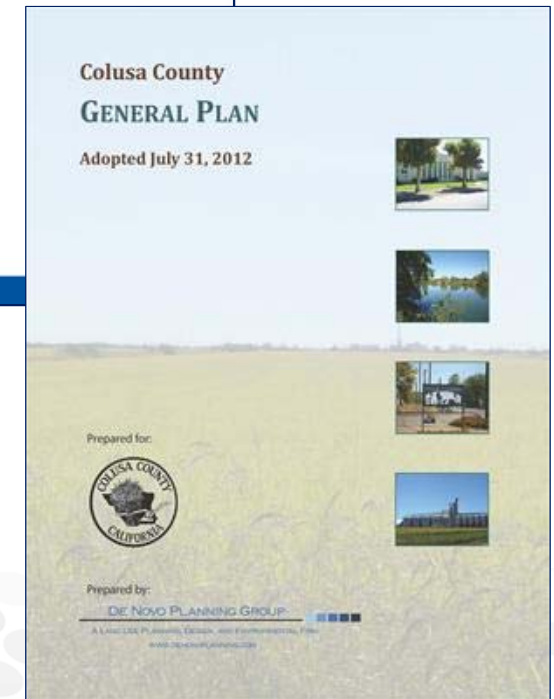
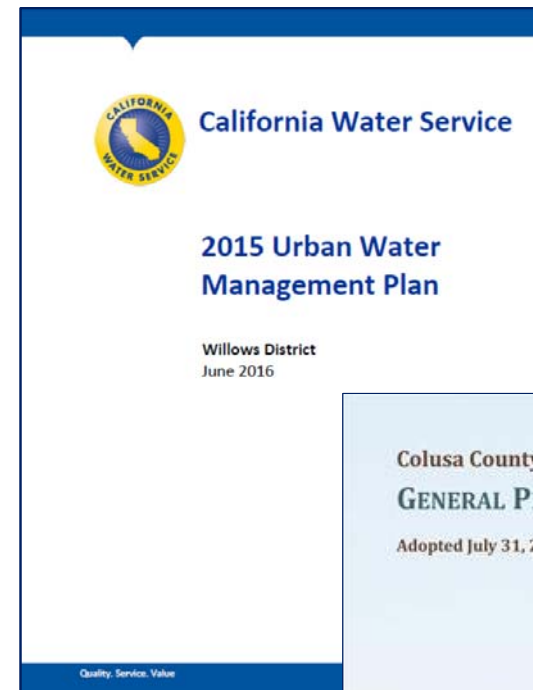
- Largely Dependent upon Lake Shasta Annual Inflows
- Proposed Approach
  - Map/Correlate Recent Diversions Based on Lake Shasta Inflows
    - “Normal” (i.e. Non-Shasta Critical) Years
    - Shasta Critical Years
  - Consult with SW Suppliers
- Additional Details to be Worked Out





# Urban Demands

- Small Portion of Colusa Subbasin Groundwater Demands
- Population Projections
  - CA Department of Finance
  - Urban Water Management Plans
- Per-Capita Water Use
  - Urban Water Management Plans
- Urban Land Use
  - County General Plans





## **Proposed Action** (Agenda Item 4.c)

*The TAC recommends that the CGA and GGA boards approve the consultant team to proceed with development of proposed projected water budget scenarios for initial GSP development, recognizing that further refinements may be made within the proposed general framework with TAC and stakeholder input.*

# **Approaches to Minimum Thresholds and Measurable Objectives (Potential Action Item)**

# Approaches for Minimum Thresholds and Measurable Objectives

- Content to be Added

## **Proposed Action** (Agenda Item 4.d)

*The TAC recommends that the CGA and GGA boards approve the consultant team to proceed with initial development of MTs and MOs, which will be refined through iterative discussions and supporting technical analysis.*

# Additional Discussion