West Turlock Subbasin Groundwater Sustainability Agency (WTSGSA)

East Turlock Subbasin Groundwater Sustainability Agency (ETSGSA)

Turlock Subbasin Groundwater Sustainability Plan (GSP) Technical Workshop No. 3

Joint Technical Advisory Committees (TACs) Meeting

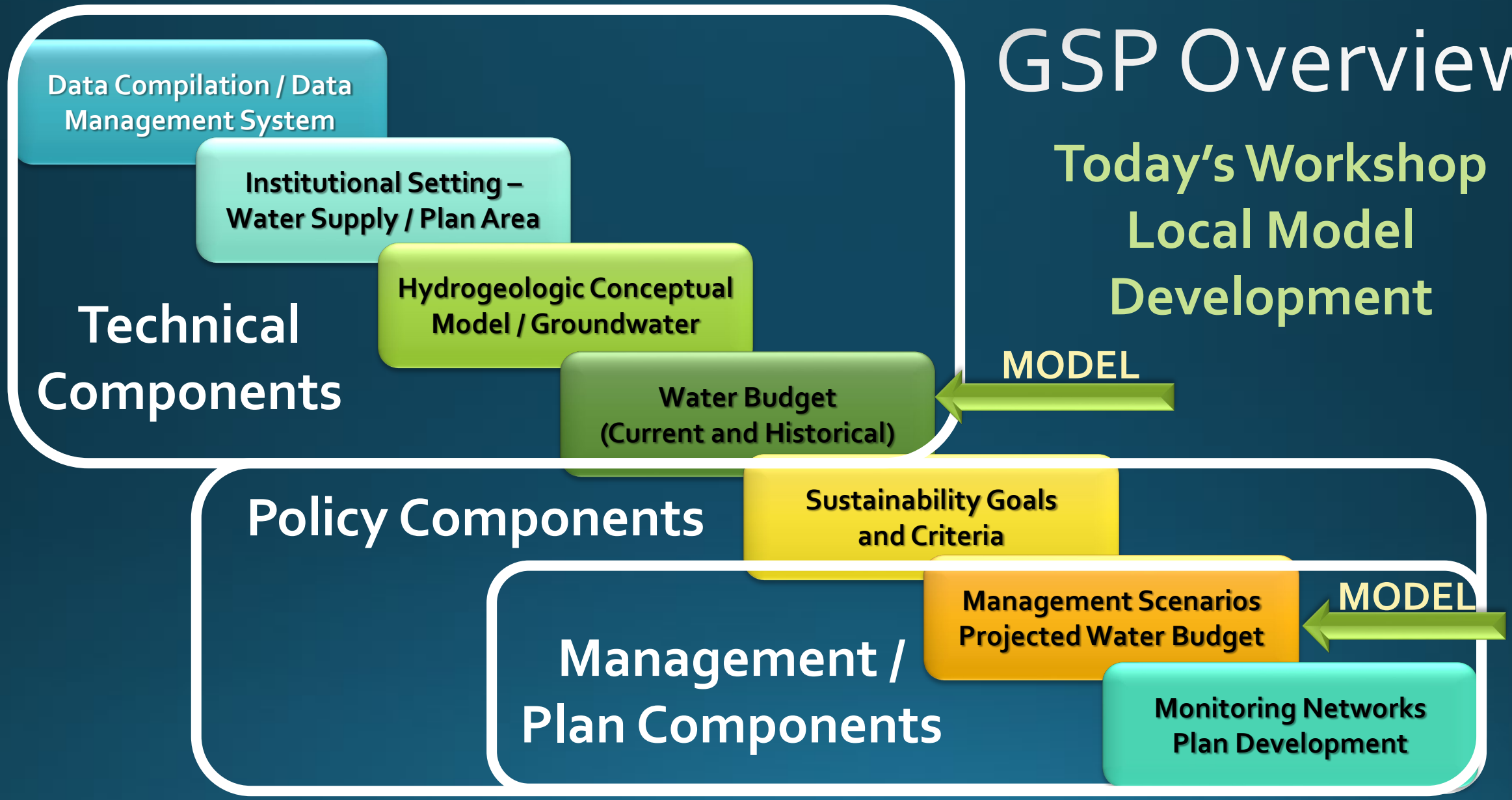
May 23, 2019

WOODARD &CURRAN

TODD GROUNDWATER

GSP Overview

Today's Workshop
Local Model Development



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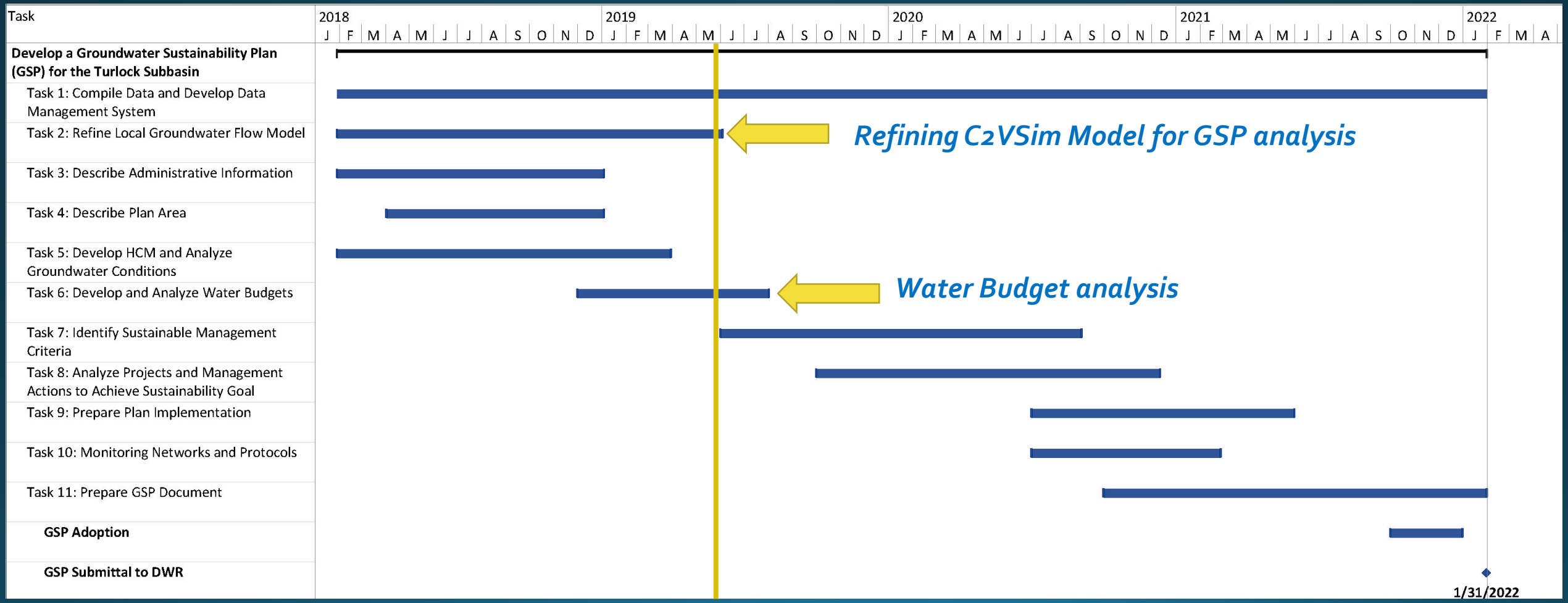
GSP Schedule



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We are here

TODD GROUNDWATER

Sustainability Indicators

Chronic Lowering of Water Levels

Reduction of Groundwater Storage

Water Budget Analysis informs this (and other) sustainability indicators

Degradation of Water Quality caused by management actions

Land subsidence affecting land use

Depletion of Interconnected Surface Water affecting beneficial use

If a sustainability indicator is determined to be significant and unreasonable , then it is an Undesirable Result

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Local Model Development and Water Budget Analysis

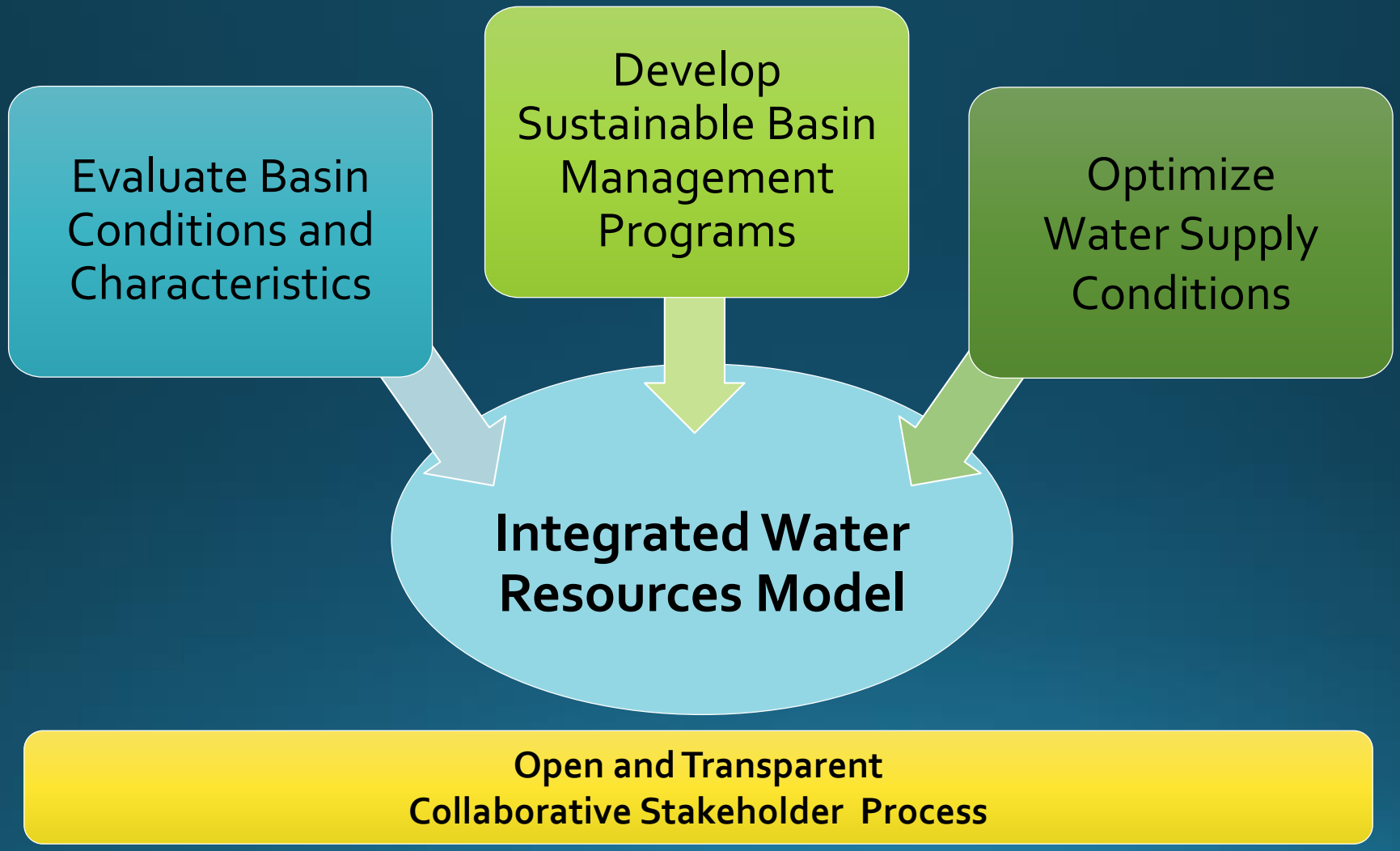
- Results are **DRAFT**
- Model calibration is ongoing
- Issues have been identified for additional revision
- What else needs to be considered?
- Appreciate questions and input from the TACs!

TODD GROUNDWATER

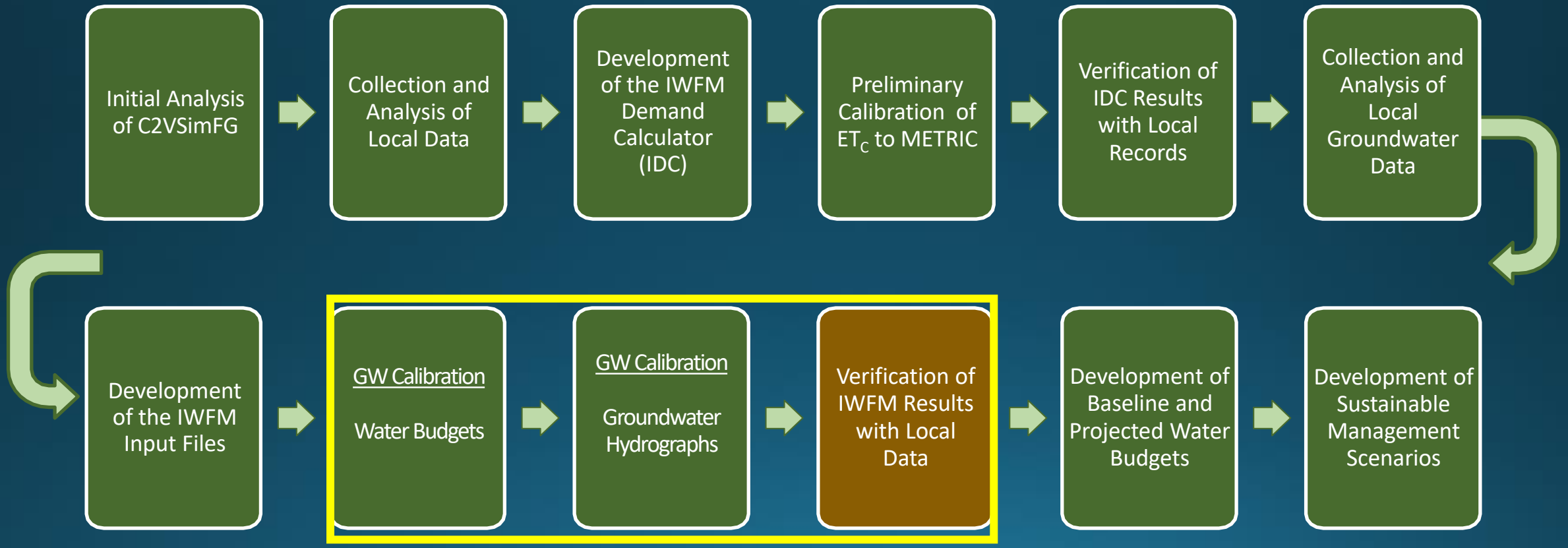
Agenda

1. Background Information
2. IWFM Demand Calculator (IDC) Updates
   - Review of Model Input Data
   - Review of Land and Water Use Budgets
3. IWFM Aquifer Calibration
   - Review of Model Input Data
   - Review of Groundwater Budgets
   - Review of GWL Hydrographs

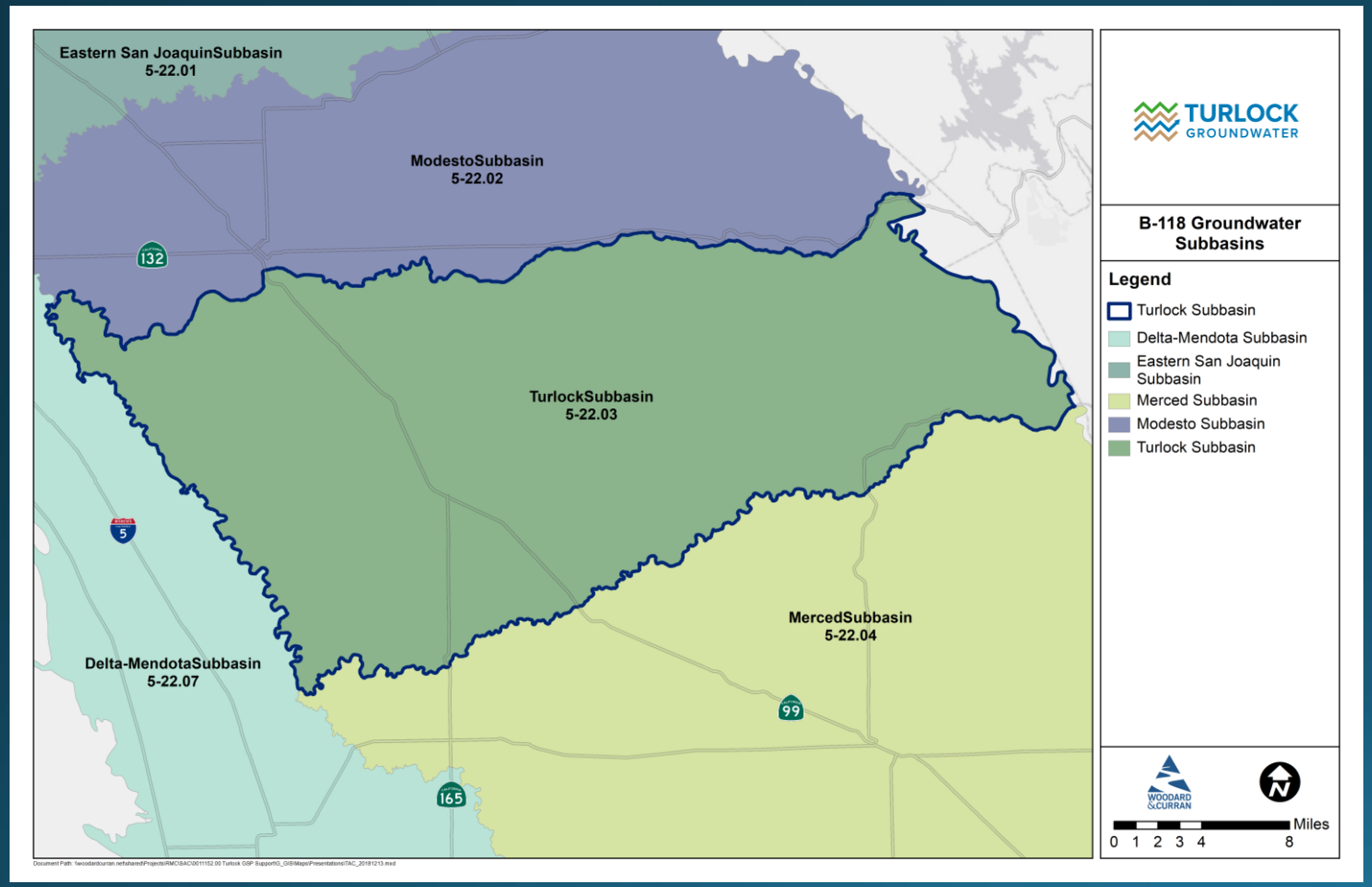
Goals for C2VSimFG-Turlock



Model Development Process



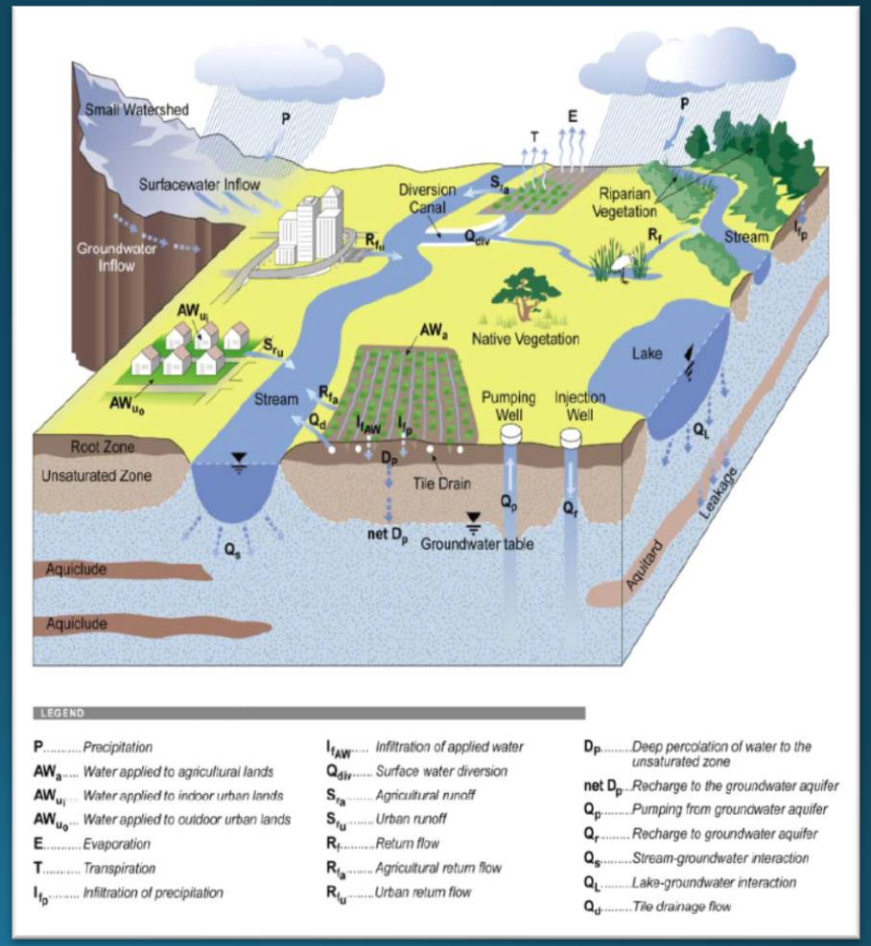
Model Study Area



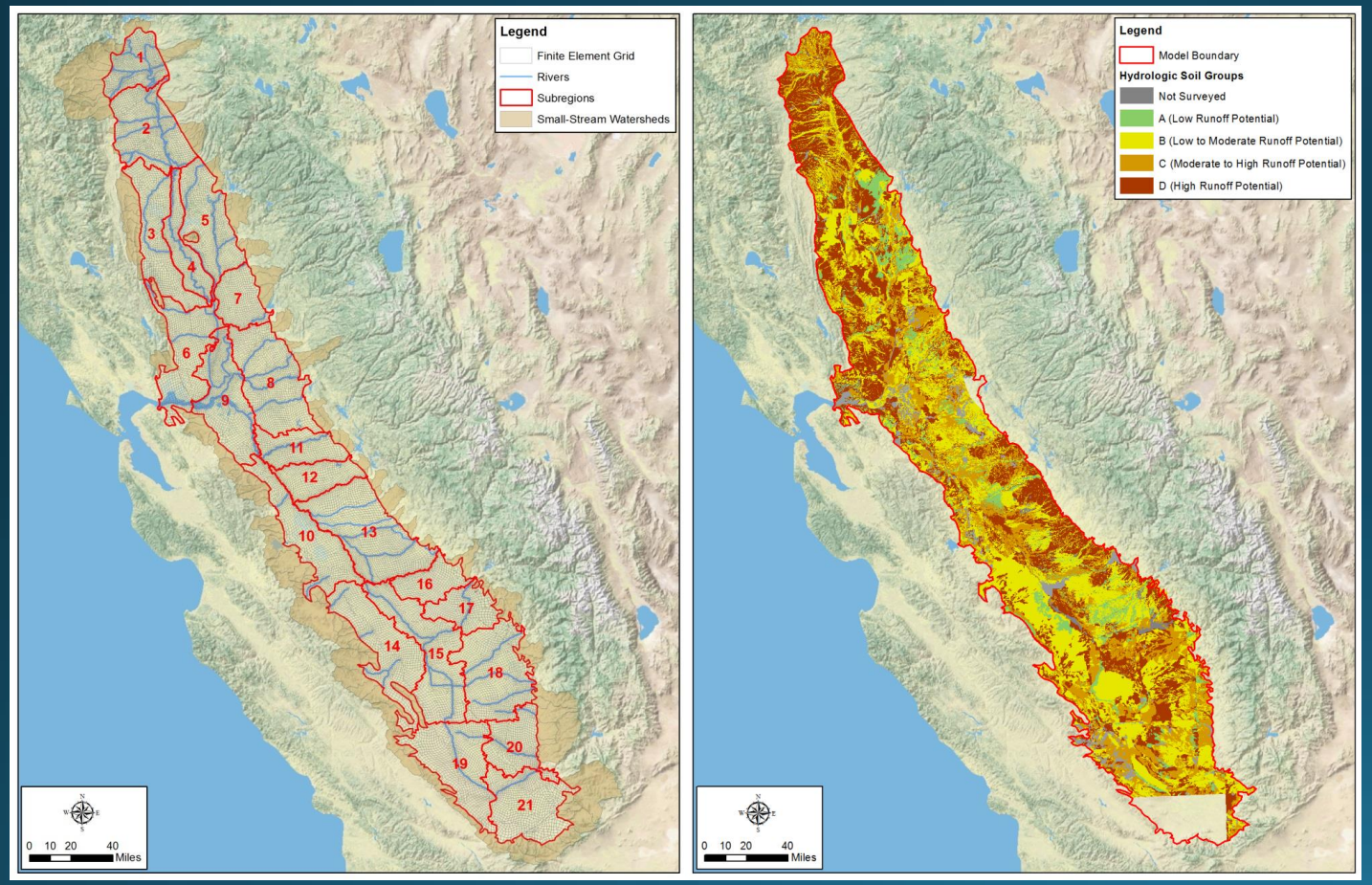
- Basin Characteristics
  - Historical Conditions
  - Natural Conditions
  - Stream-Aquifer Interaction
  - Land Subsidence
  - Water Quality
- SGMA Support
  - Groundwater Sustainability
  - Groundwater Banking
  - Project Benefits Assessment

Numerical Model Platform

- **I**ntegrated **W**ater **F**low **M**odel (IWFM)
- Developed and Supported by DWR
- Used in numerous basins throughout the state
- Recommended for SGMA and GSP Development



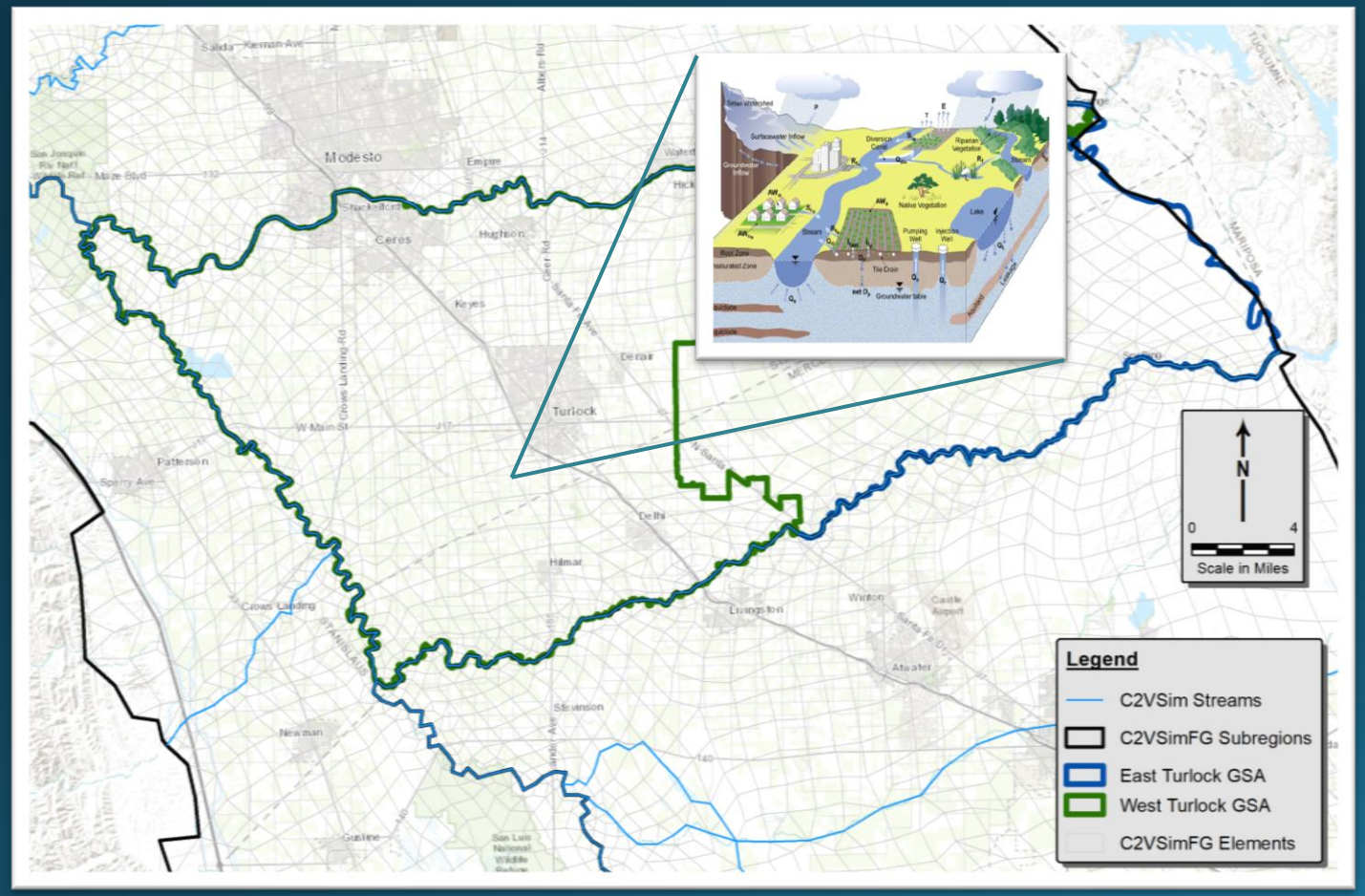
IWFM in the Central Valley



C2VSimFG Grid Statistics

- 30,179 Nodes
  - Stream Lines
  - Agency Boundaries
  - ¼ Mile Discretization
- 32,537 Elements
  - Ave. Size = 400 Acres
  - 13,256,118 Total Acres
- 110 Stream Reaches

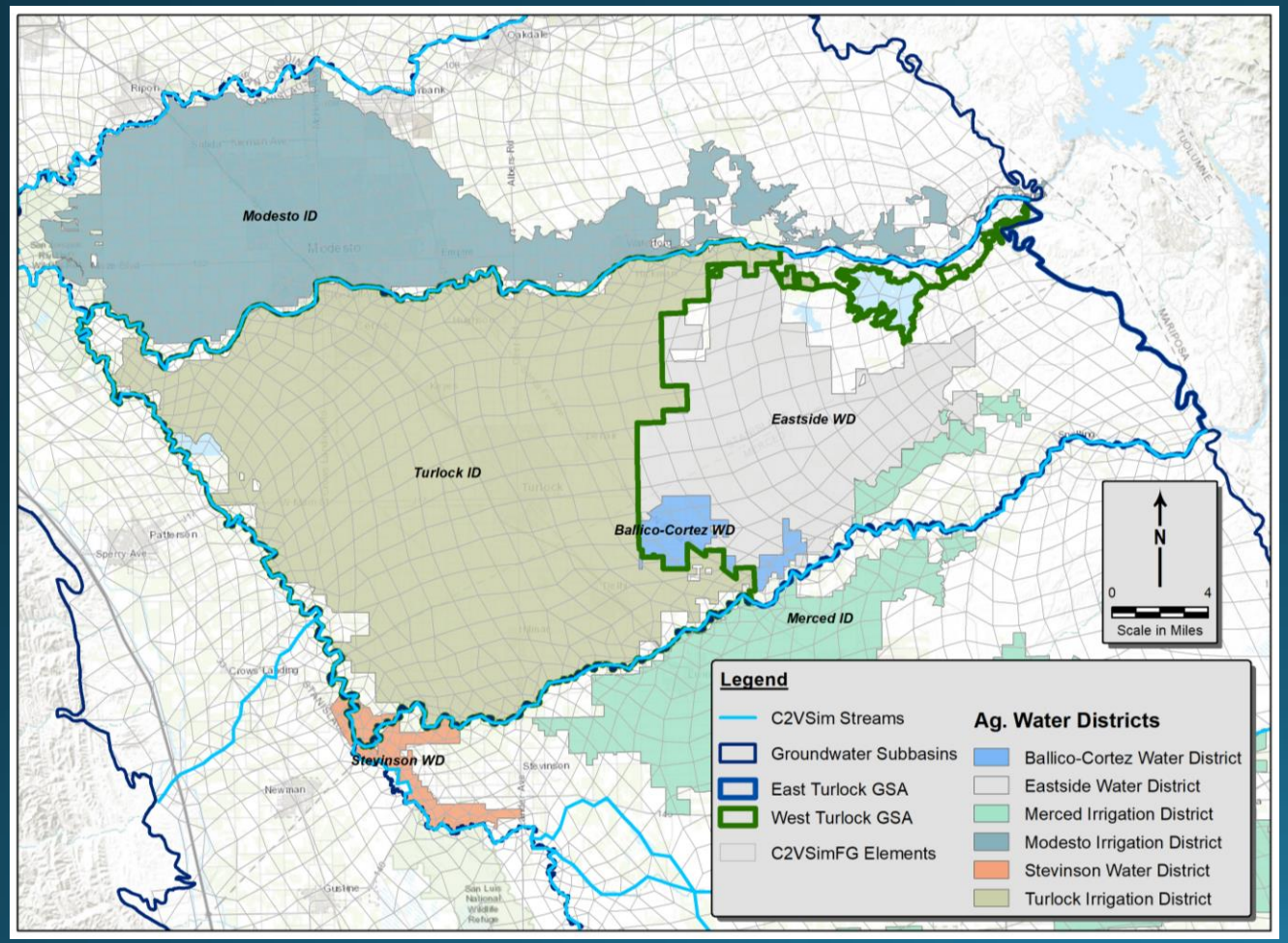
C2VSimFG in the Turlock Subbasin



Grid Statistics

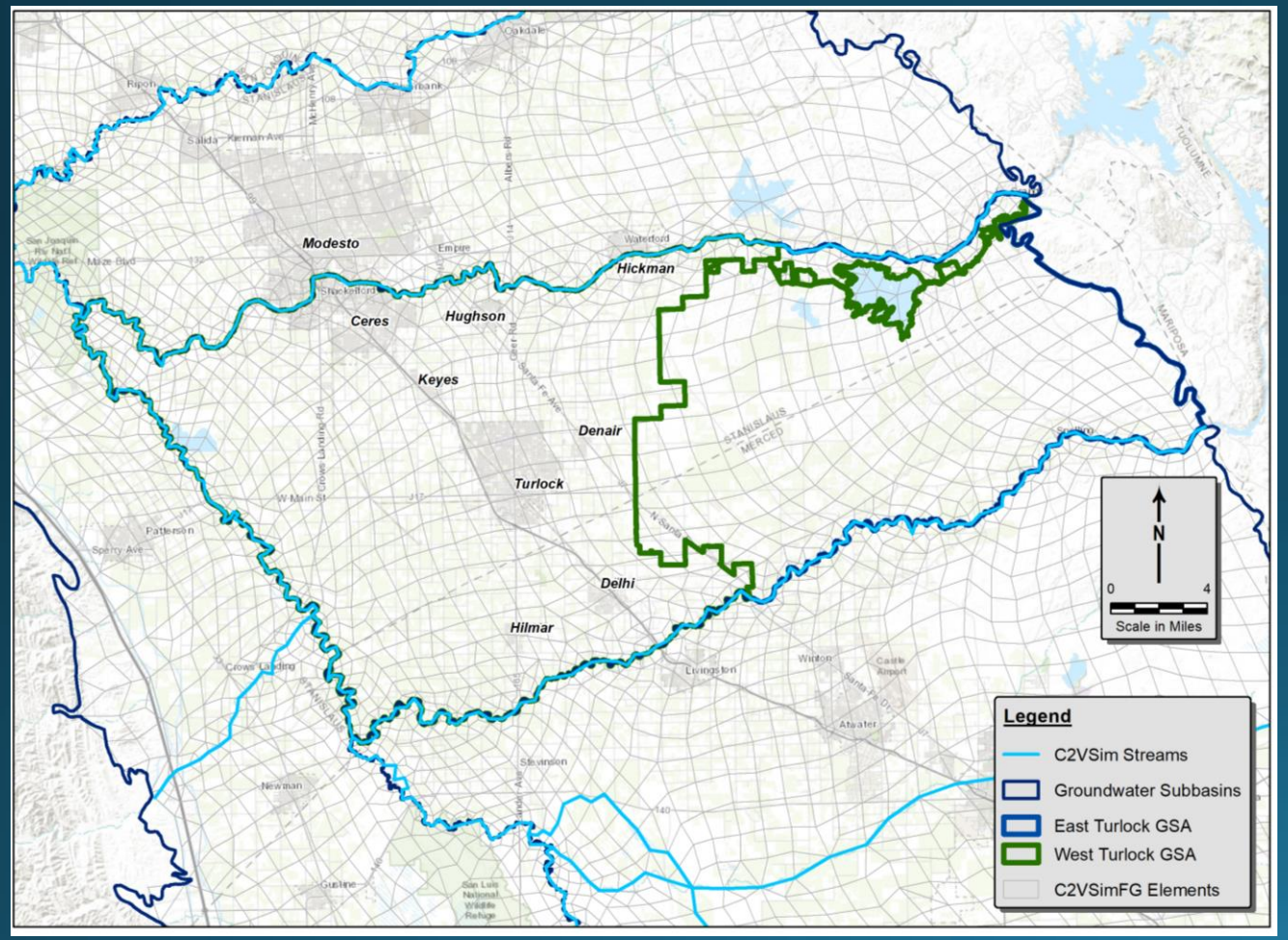
- 865 Nodes
  - Stream Lines
  - Agency Boundaries
  - 1.5-Mile Discretization
- 960 Elements
  - Ave. Size = 362 Acres
  - 348,000 Total Acres
- 4 Stream Reaches

Turlock Subbasin Ag. Agencies



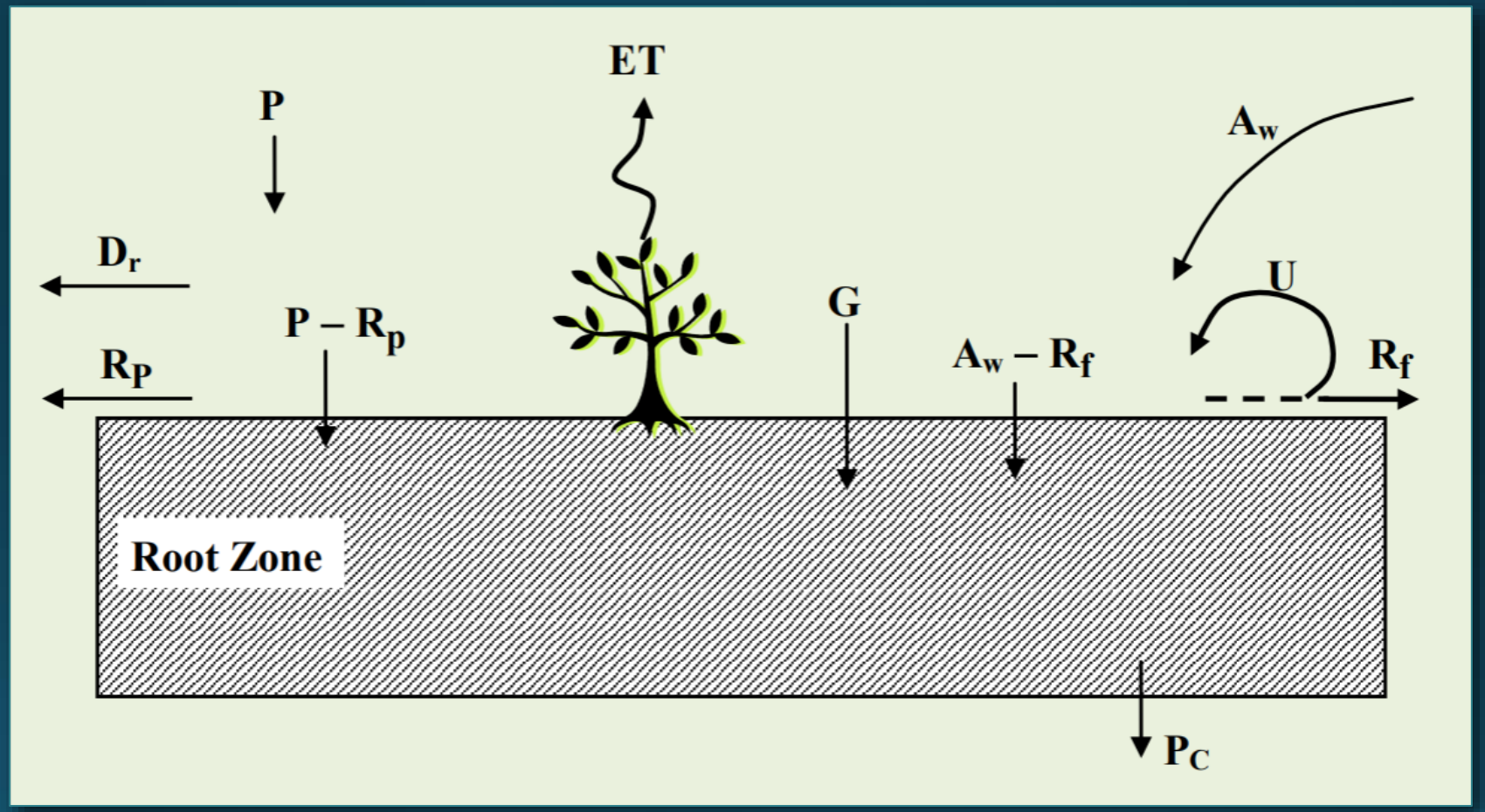
- Entirely encompasses:
  - Turlock ID
  - Eastside WD
  - Ballico-Cortez WD
- Partially encompasses:
  - Merced ID
  - Stevinson WD

Turlock Subbasin Urban Areas



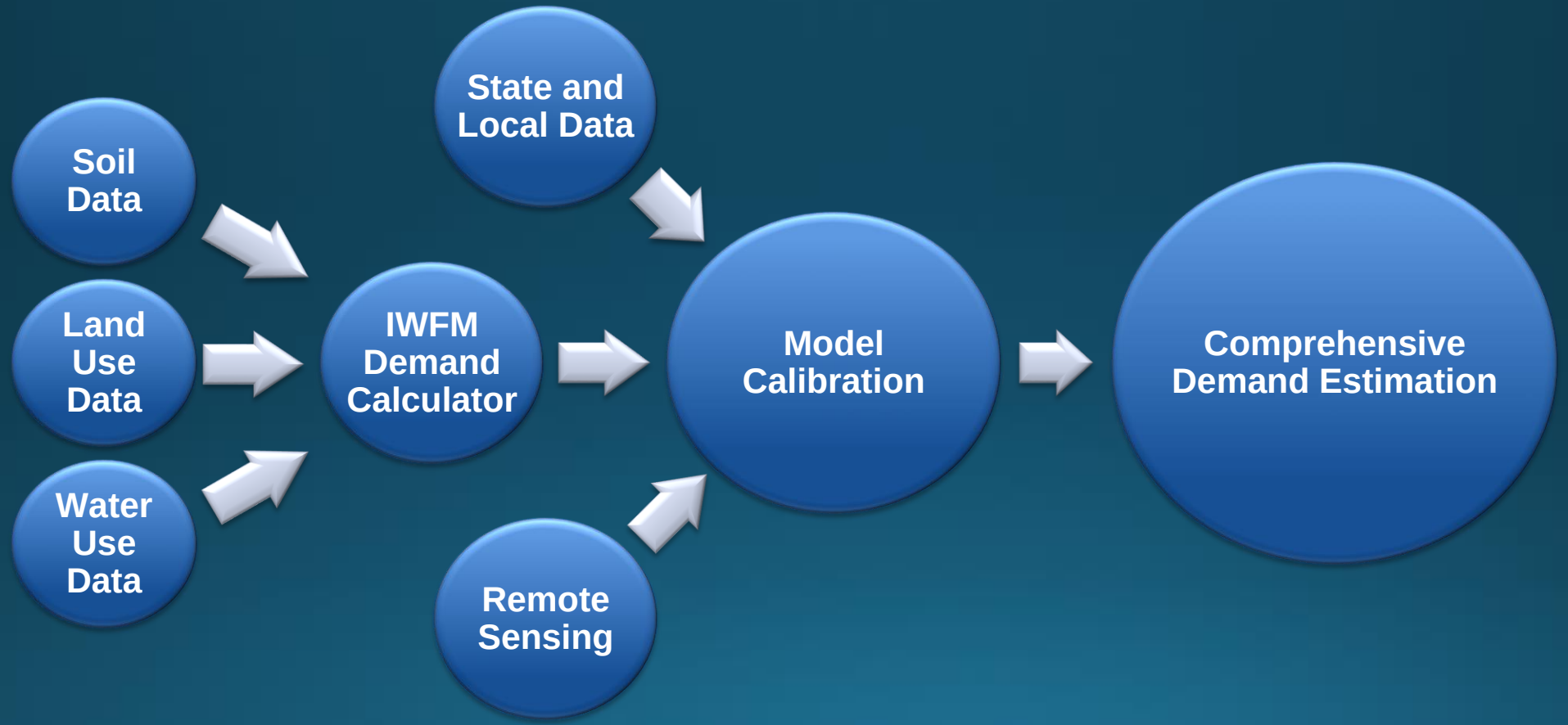
- West GSA:
  - Modesto
  - Ceres
  - Hughson
  - Keyes
  - Hickman
  - Denair
  - Delhi
  - Hilmar
  - Turlock
- East GSA:
  - Unincorporated Areas

The IWFM Demand Calculator (IDC)



Source: IDC 2015 Theoretical Documentation and User's Manual, August 2017

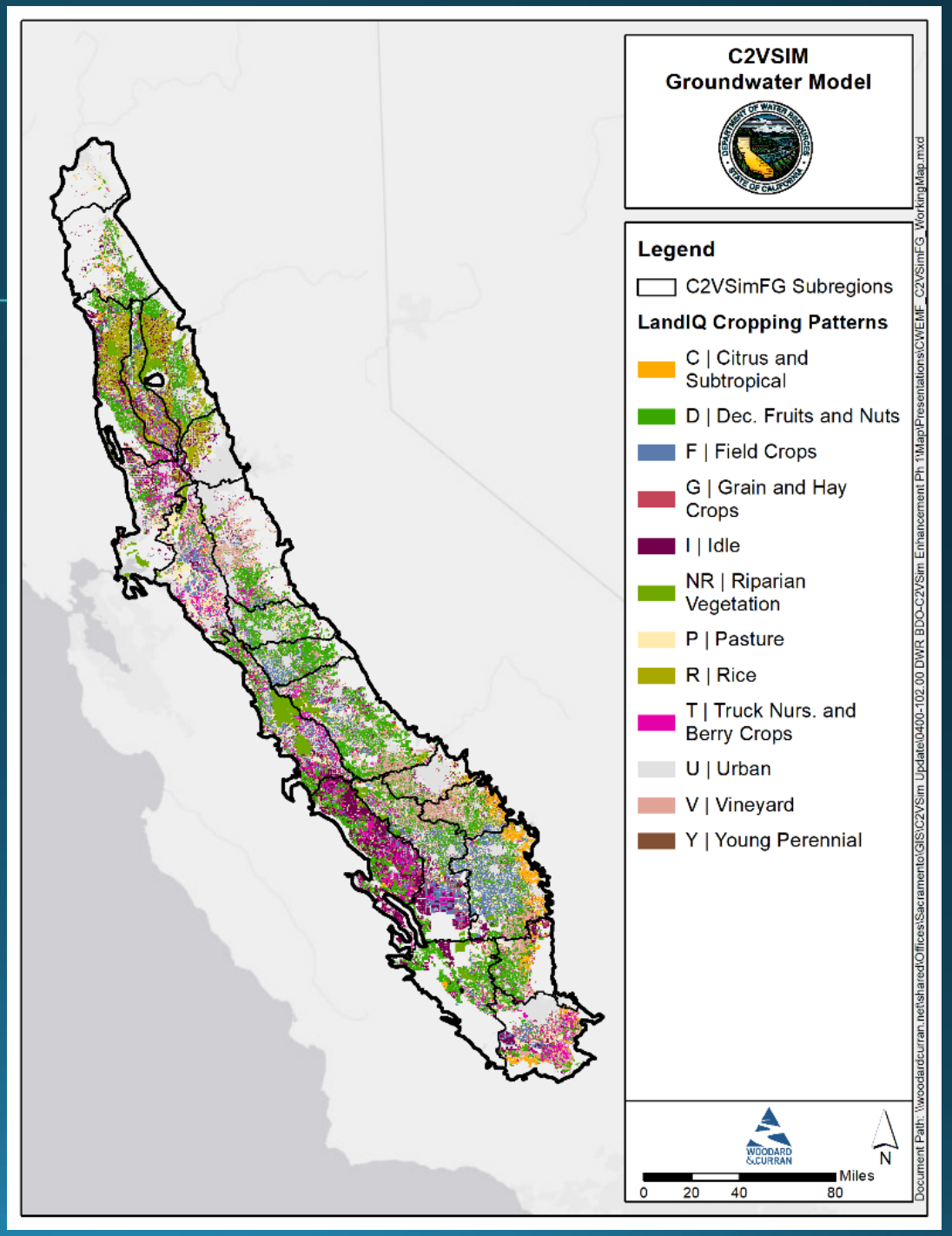
C2VSimFG-Turlock IDC Development



Land Use Data

Data Sources

- DWR County Land Use Surveys
- DWR Statewide (LandIQ) Land Use
- DWR Quad Map-Based Land Use
- DWR Decadal Estimated Land Use
- Locally Refined Data (AWMP)



Turlock Subbasin

Land Use

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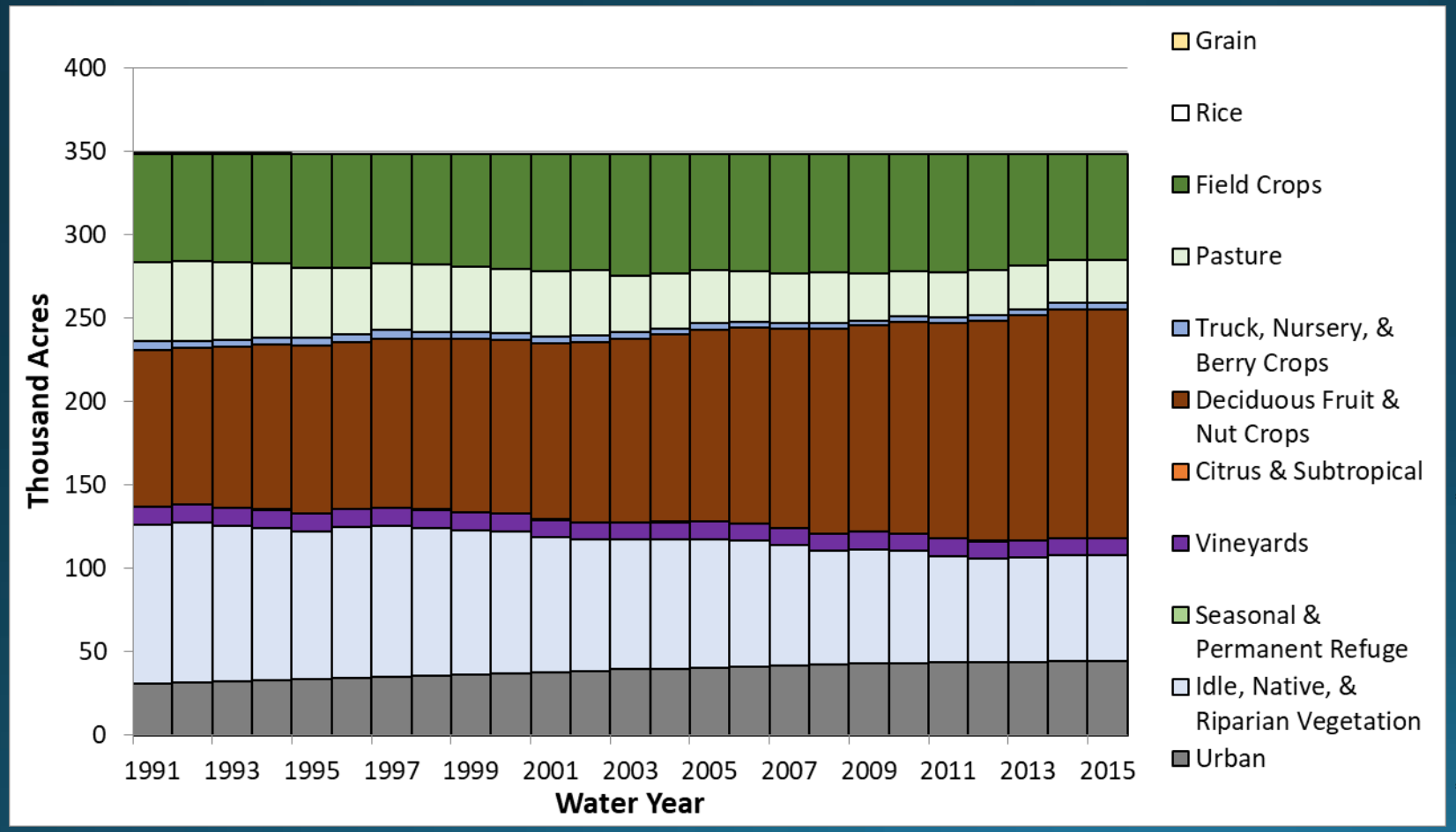

Land Use	2015 Acres
Grain	0
Rice	0
Field Crops	63,149
Pasture	26,124
Truck, Nursery, & Berry Crops	3,554
Deciduous Fruit & Nut Crops	137,427
Citrus & Subtropical	140
Vineyards	10,151
Total Ag. Acreage	240,545
Seasonal & Permanent Refuge	0
Idle, Native, & Riparian Vegetation	63,549
Urban	44,245
TOTAL	348,338

West Turlock Subbasin GSA

Land Use

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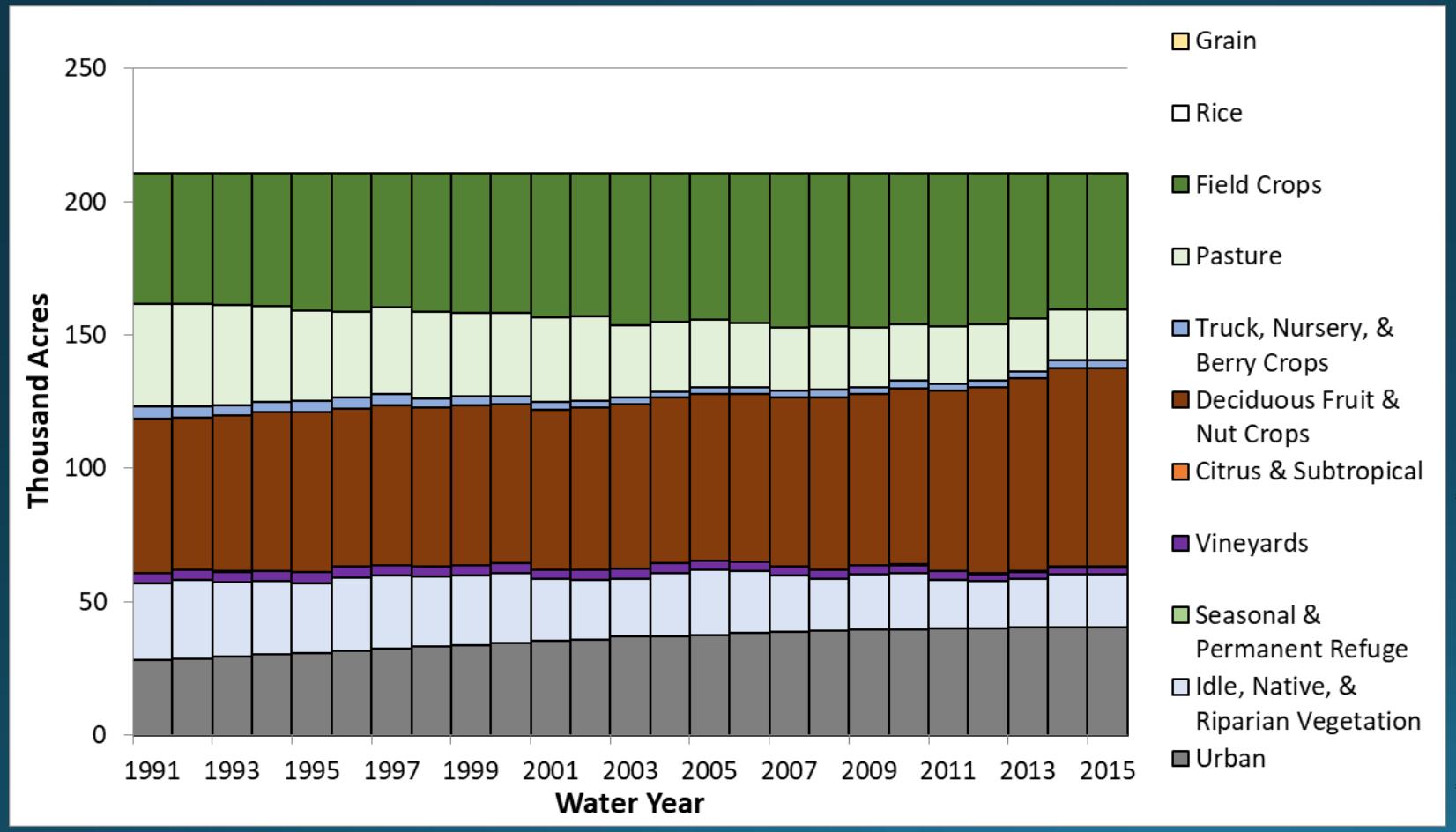

Land Use	2015 Acres
Grain	0
Rice	0
Field Crops	51,145
Pasture	19,194
Truck, Nursery, & Berry Crops	3,018
Deciduous Fruit & Nut Crops	74,374
Citrus & Subtropical	125
Vineyards	2,492
Total Ag. Acreage	150,349
Seasonal & Permanent Refuge	0
Idle, Native, & Riparian Vegetation	19,877
Urban	40,503
TOTAL	210,728

East Turlock Subbasin GSA

Land Use

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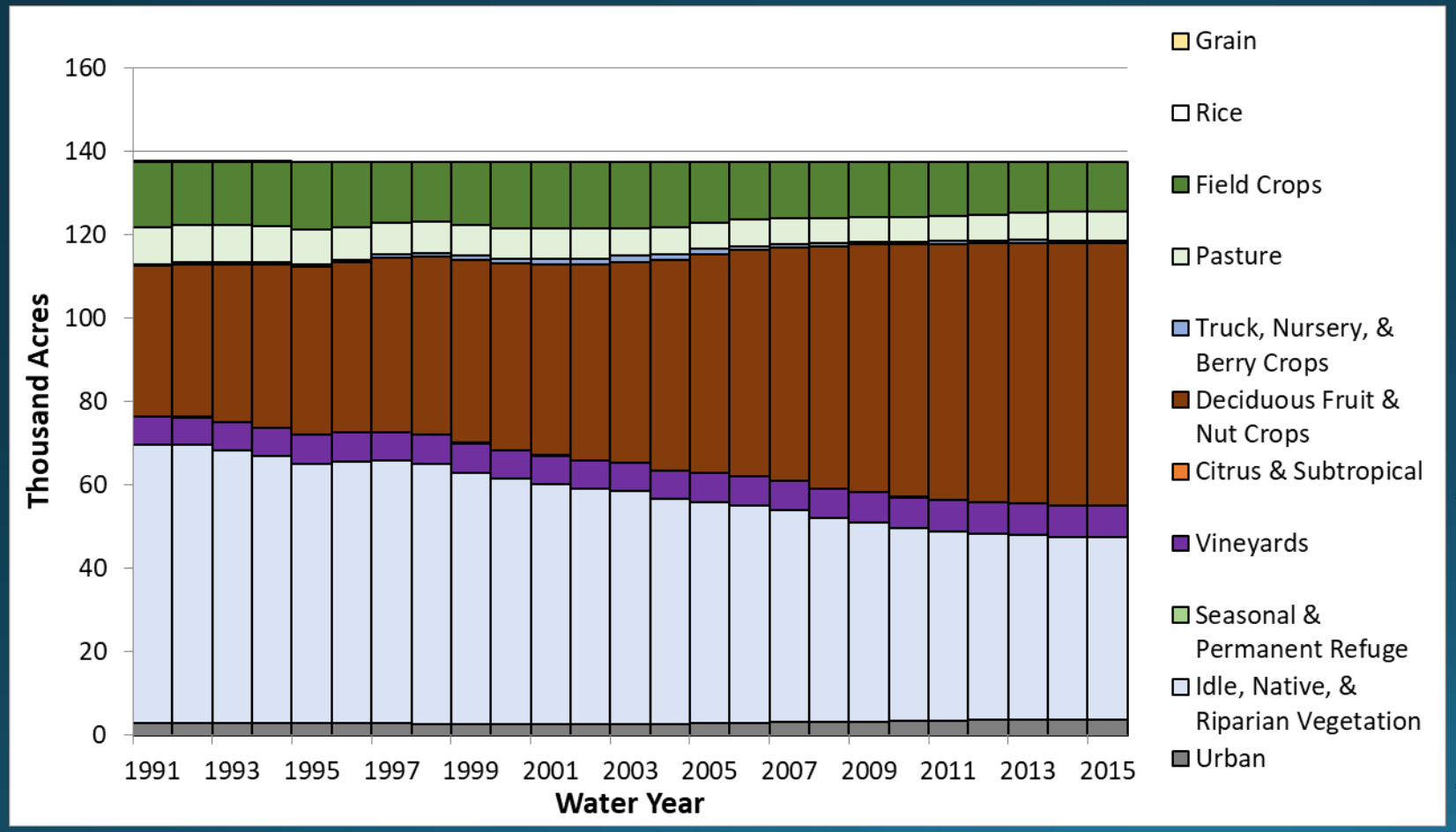
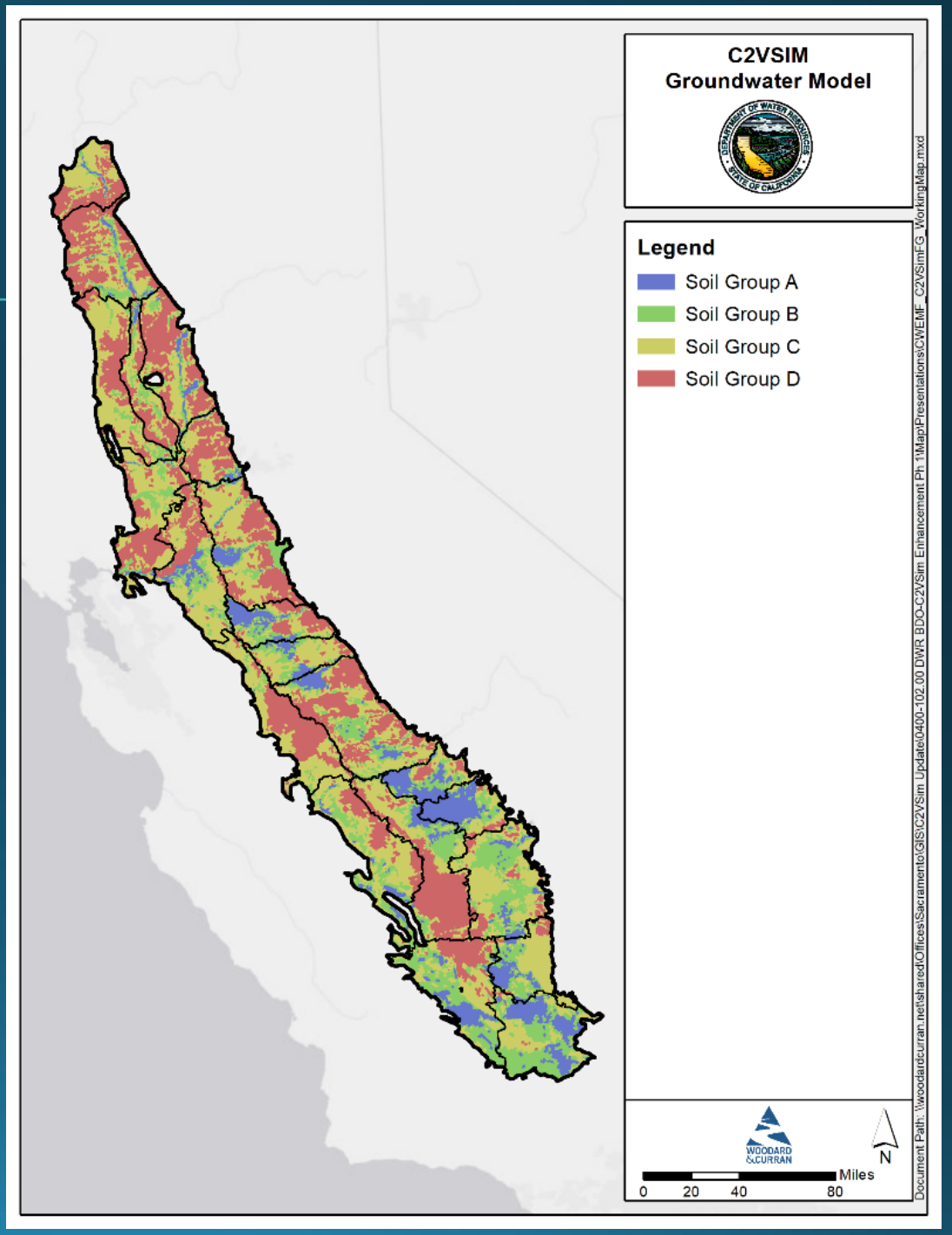


Land Use	2015 Acres
Grain	0
Rice	0
Field Crops	12,004
Pasture	6,930
Truck, Nursery, & Berry Crops	536
Deciduous Fruit & Nut Crops	63,053
Citrus & Subtropical	14
Vineyards	7,659
Total Ag. Acreage	90,196
Seasonal & Permanent Refuge	0
Idle, Native, & Riparian Vegetation	43,672
Urban	3,742
TOTAL	137,610

Soil Parameters

SSURGO and STATSGO

- Elemental Discretization
- Soil Hydrologic Group
- Input Parameters
  - Hydraulic Conductivity
  - Pore Size Distribution Index
  - Total Porosity
  - Field Capacity
  - Wilting Point

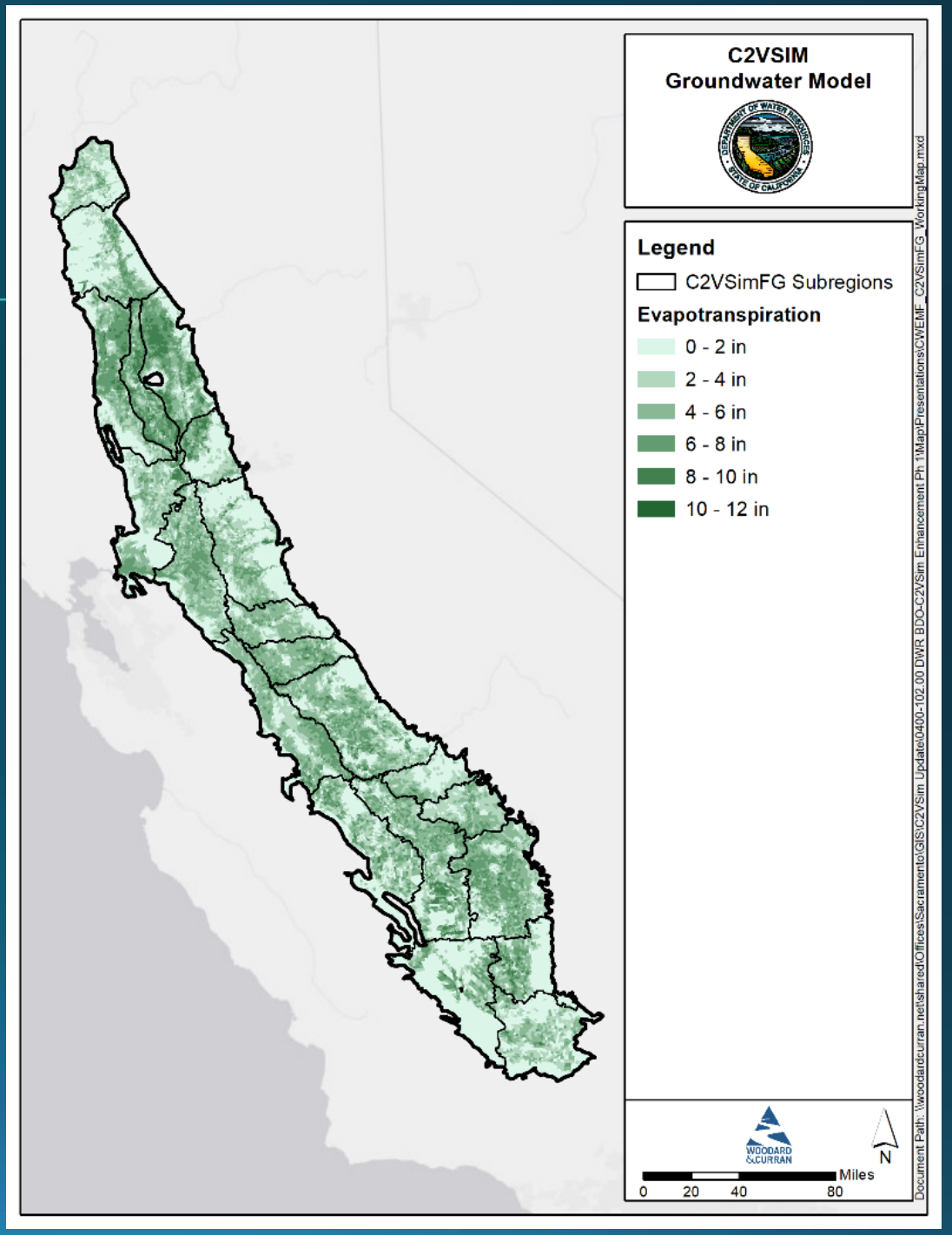


Evapotranspiration

Data Sources

- C2VSim-CG-r374g
- CalSIMETAW
- Irrigation Training and Research Center (ITRC)
- Locally Refined Data (AWMP)

- Remote Sensing
  - Formation Environmental
  - METRIC



Turlock Subbasin

Population

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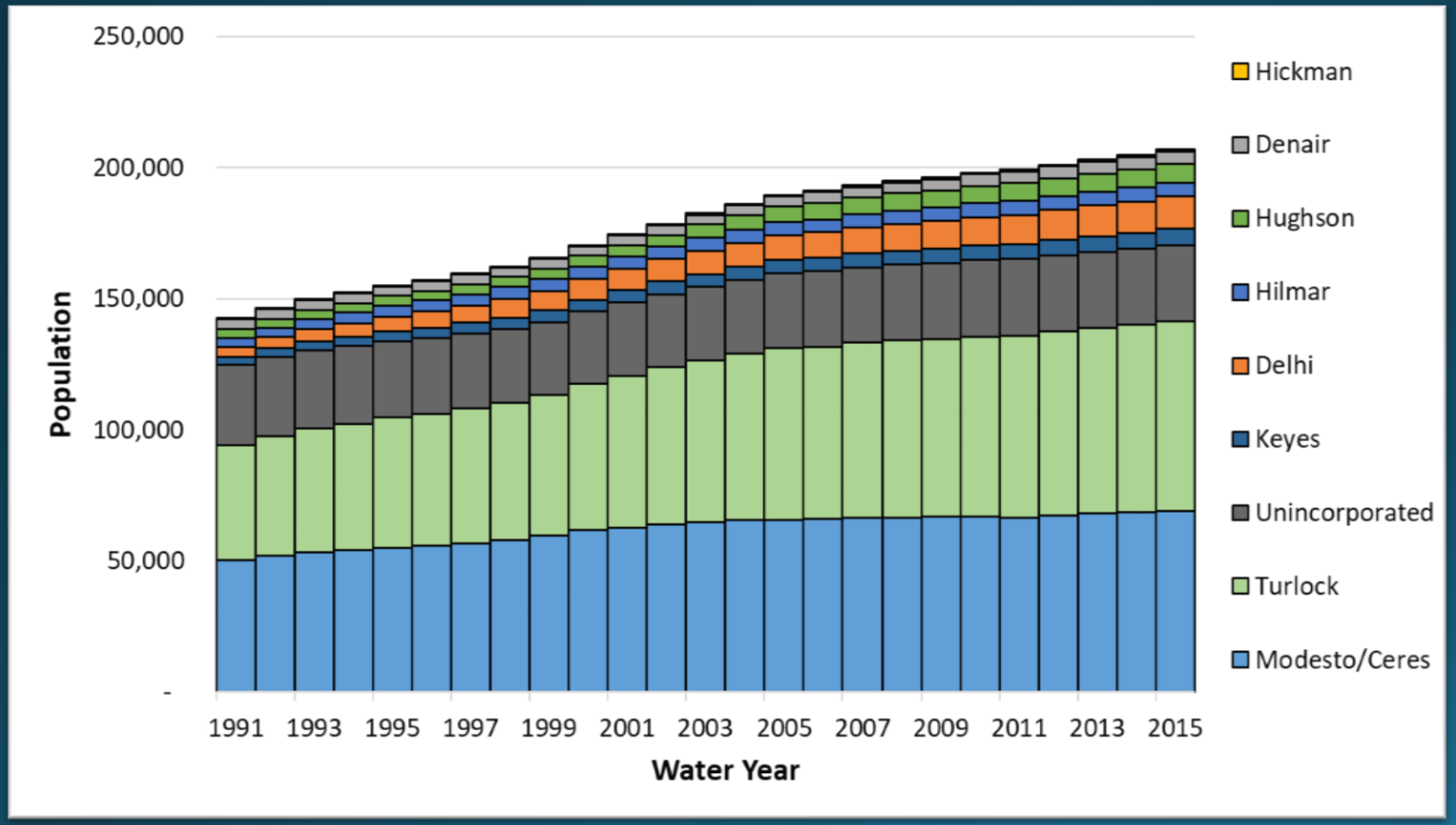

Water Year	Population
1991	301,943
1992	310,911
1993	318,265
1994	323,724
1995	328,810
1996	333,487
1997	339,467
1998	345,951
1999	353,646
2000	365,117
2001	372,420
2002	380,611
2003	387,935
2004	394,040
2005	397,919
2006	400,193
2007	403,138
2008	405,687
2009	407,608
2010	409,796
2011	410,007
2012	413,835
2013	418,373
2014	421,626
2015	425,557

Turlock Subbasin

Per Capita Water Use

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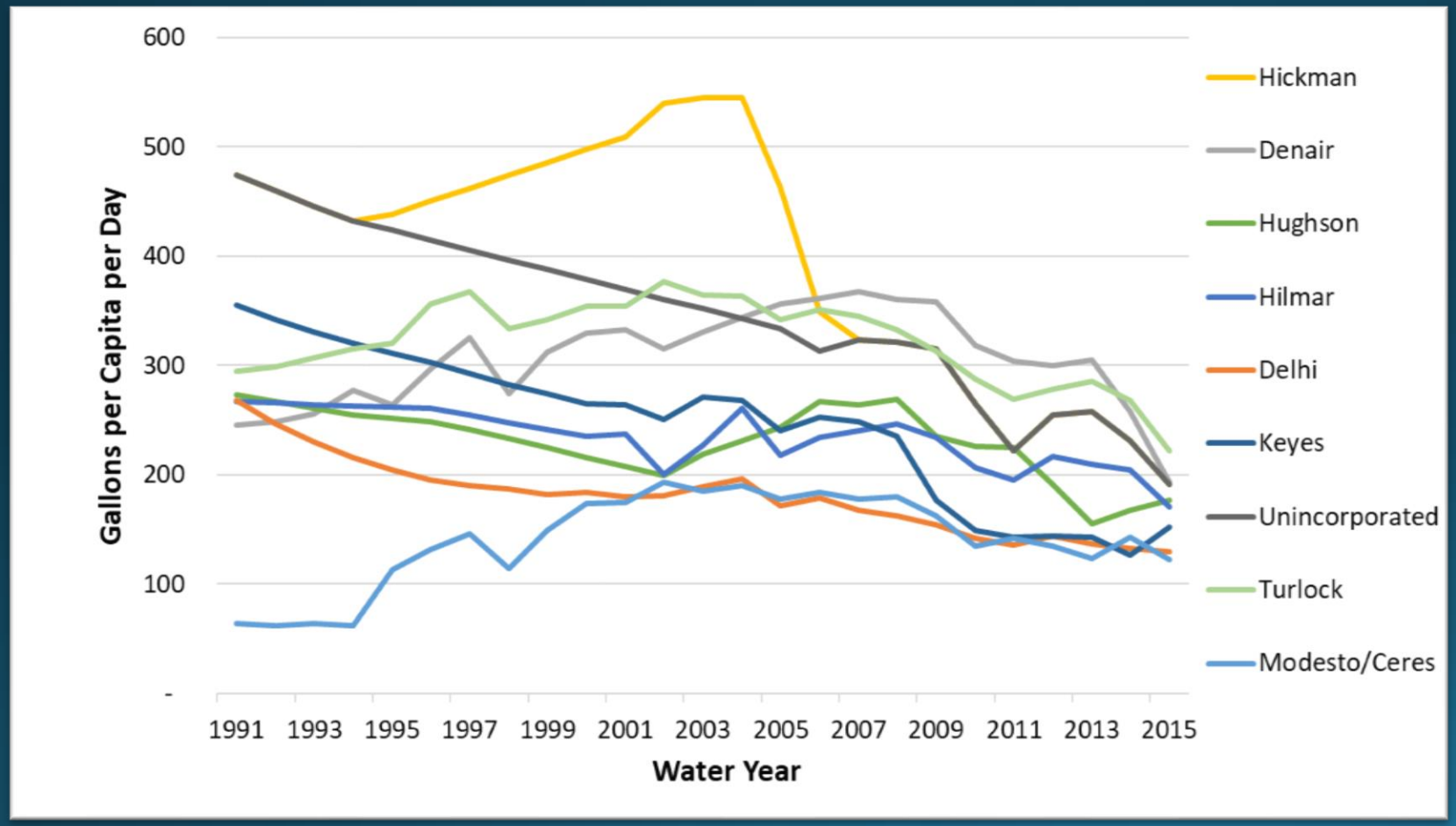

City	2013	2015
Hickman	258	191
Denair	305	193
Hughson	155	177
Hilmar	210	170
Delhi	136	129
Keyes	142	152
Unincorporated	258	191
Turlock	286	222
Modesto/Ceres	123	122

Turlock Subbasin

Total Urban Demand

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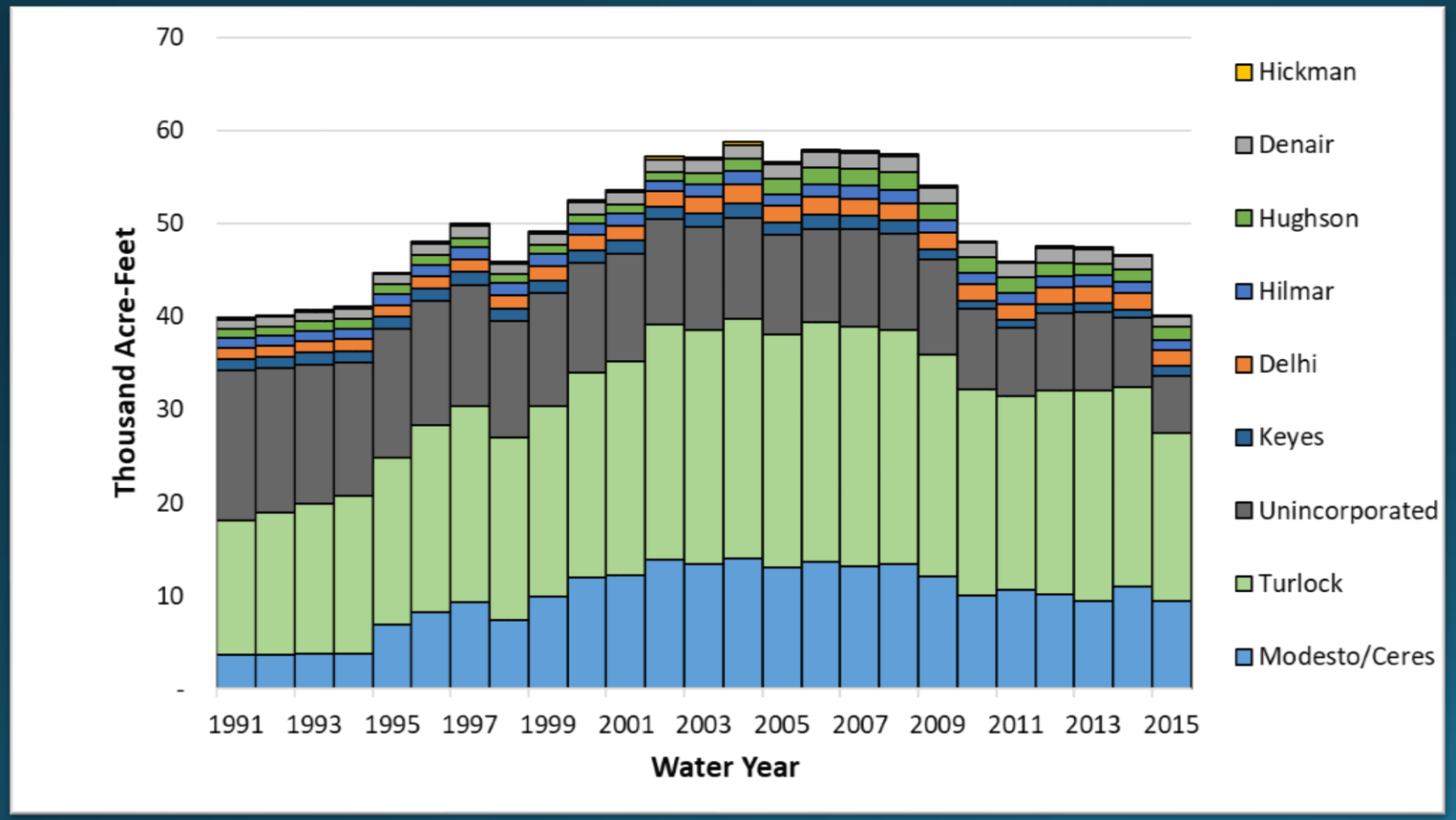

Water Year	AF
1991	39,855
1992	40,139
1993	40,678
1994	41,035
1995	44,723
1996	48,002
1997	49,924
1998	45,885
1999	49,131
2000	52,526
2001	53,620
2002	57,144
2003	57,106
2004	58,775
2005	56,645
2006	57,870
2007	57,821
2008	57,464
2009	54,041
2010	48,078
2011	45,890
2012	47,563
2013	47,454
2014	46,649
2015	40,096

Model Basic Features

- Historical Period of Record: 1991-2015
- Hydrogeologic Layering:
  - 4 Basic Model Layers
  - 3 Principal Aquifers
- GSAs defined per C2VSimFG Grid
- Hydrologic Features:
  - Merced, San Joaquin, & Tuolumne Rivers

Land & Water Use Budgets

Turlock Subbasin

Agricultural Land and Water Use Budget

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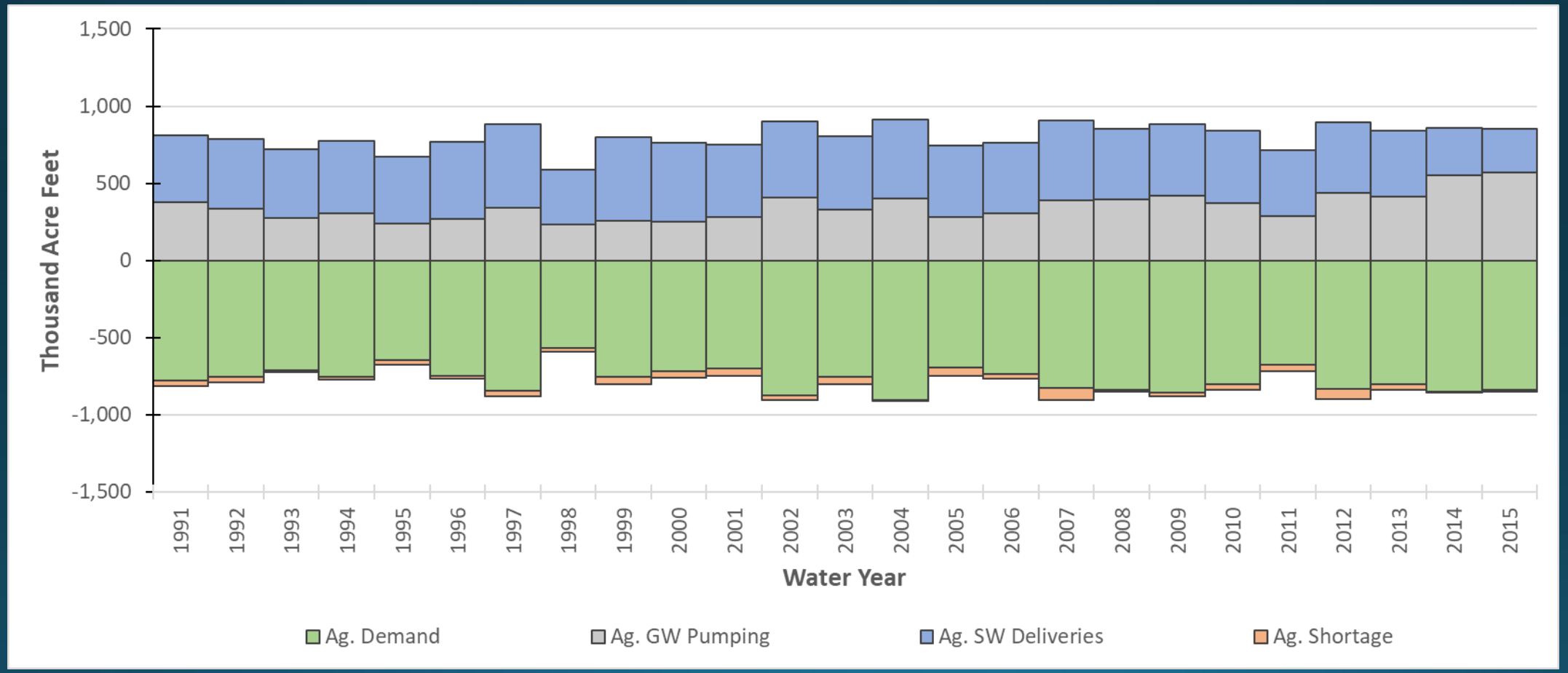

Turlock Subbasin

Urban Land and Water Use Budget

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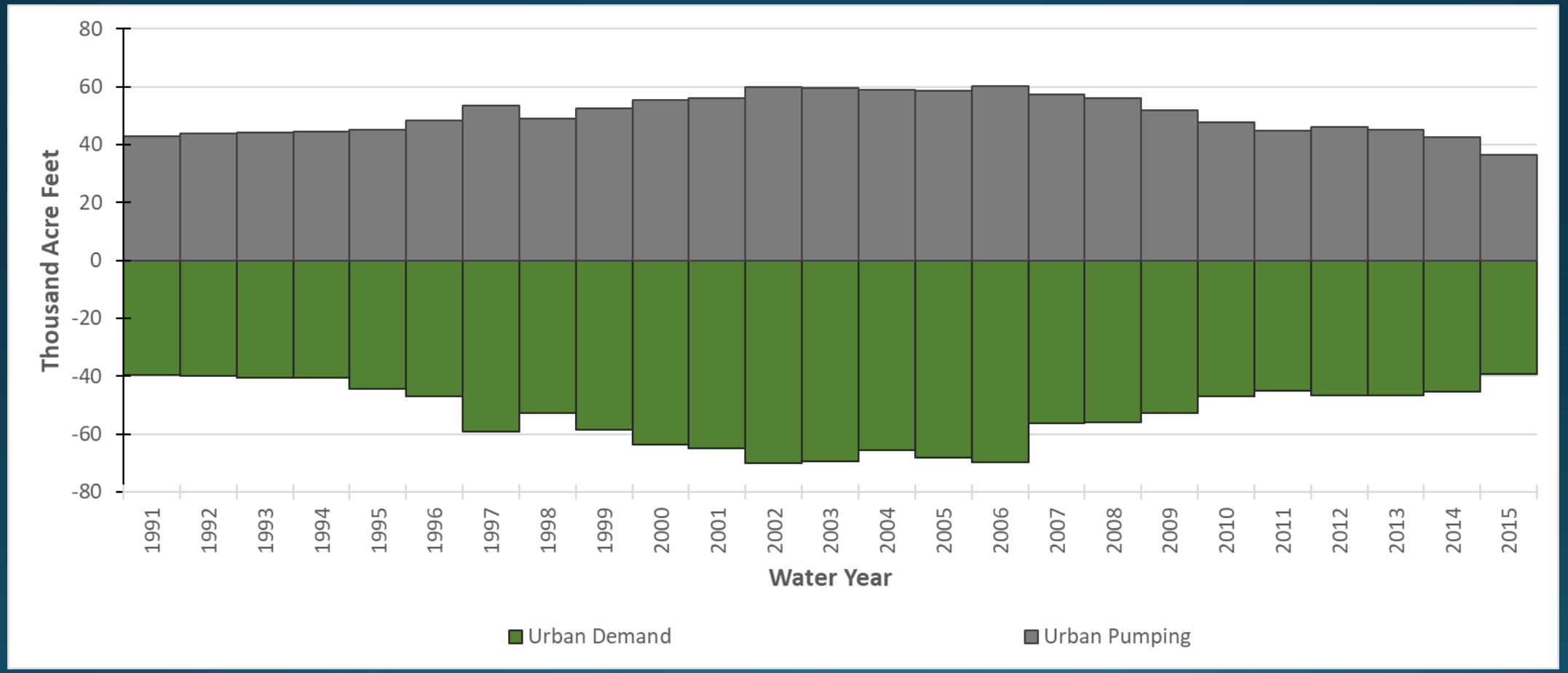

West Turlock Subbasin GSA

Agricultural Land and Water Use Budget

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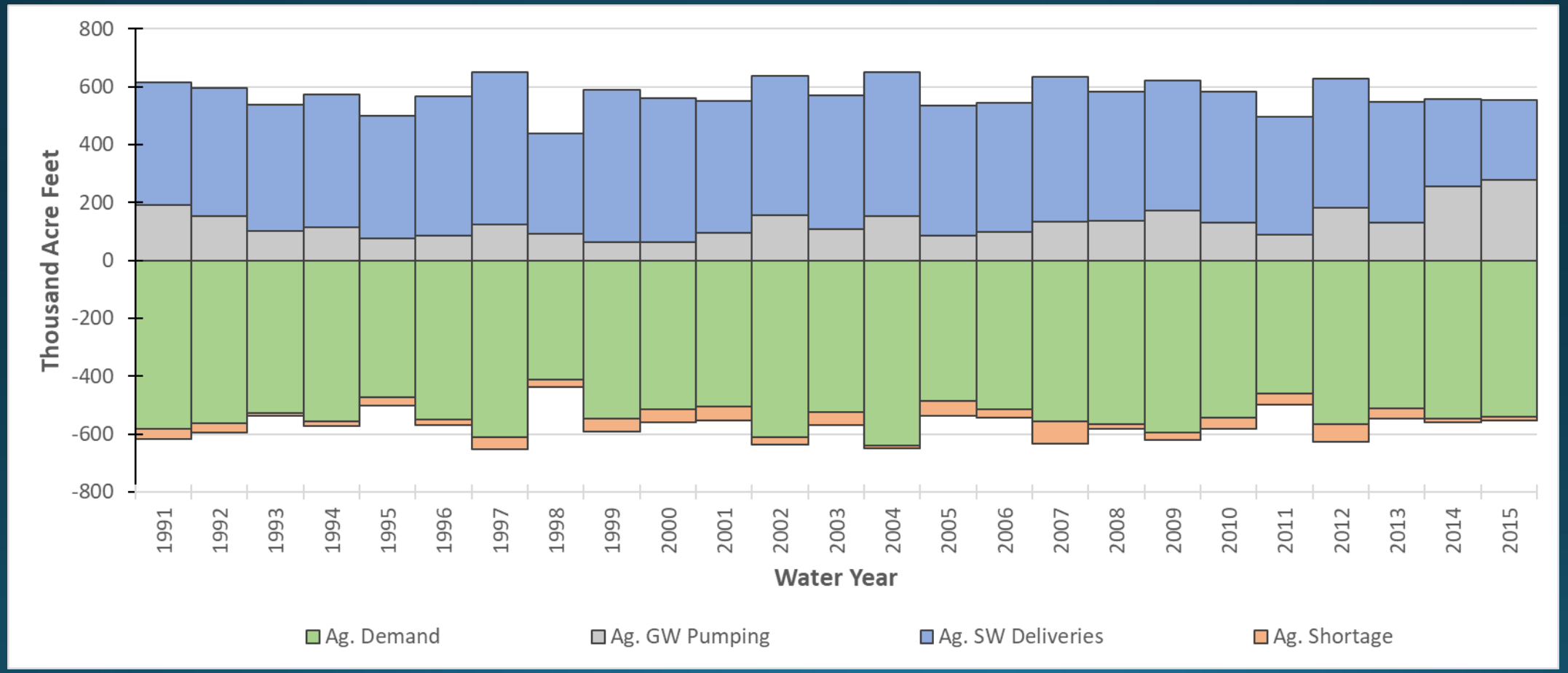

East Turlock Subbasin GSA

Urban Land and Water Use Budget

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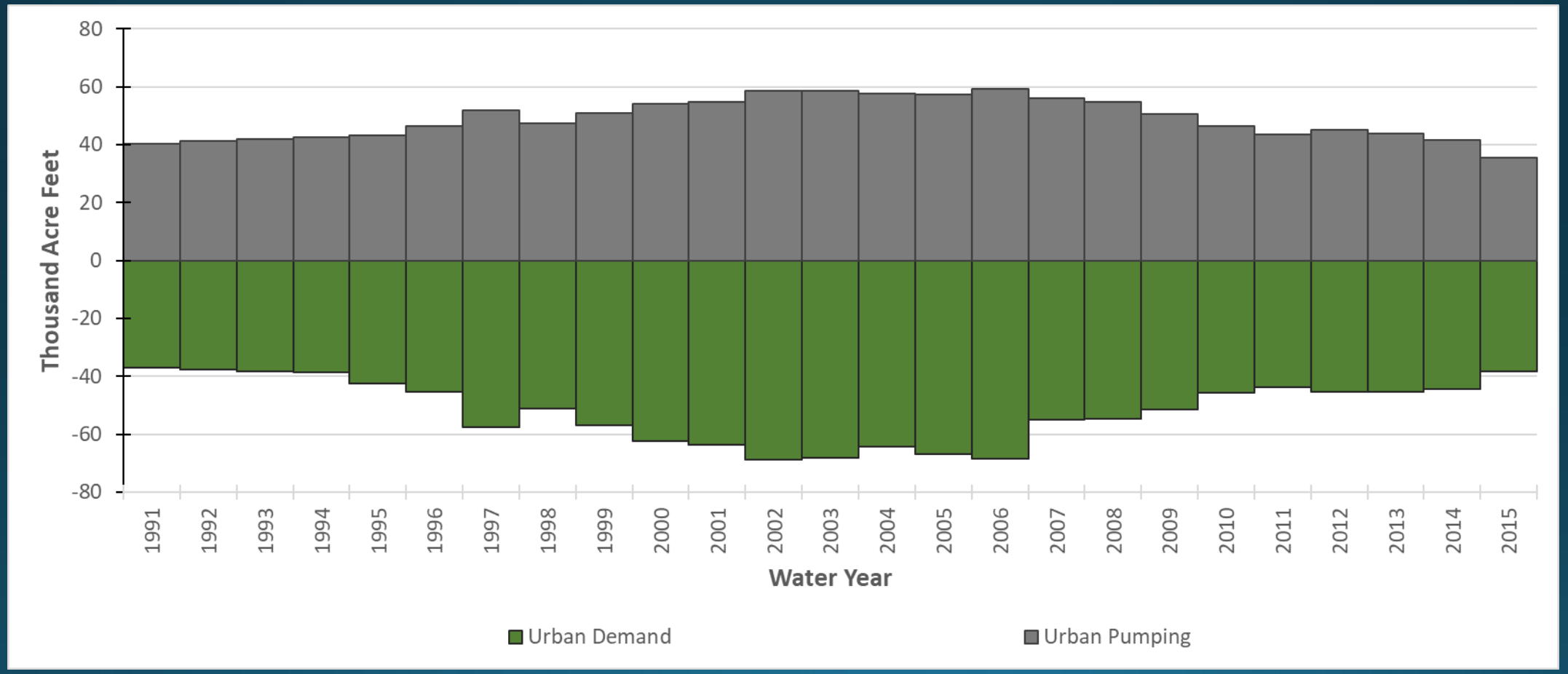

East Turlock Subbasin GSA

Agricultural Land and Water Use Budget

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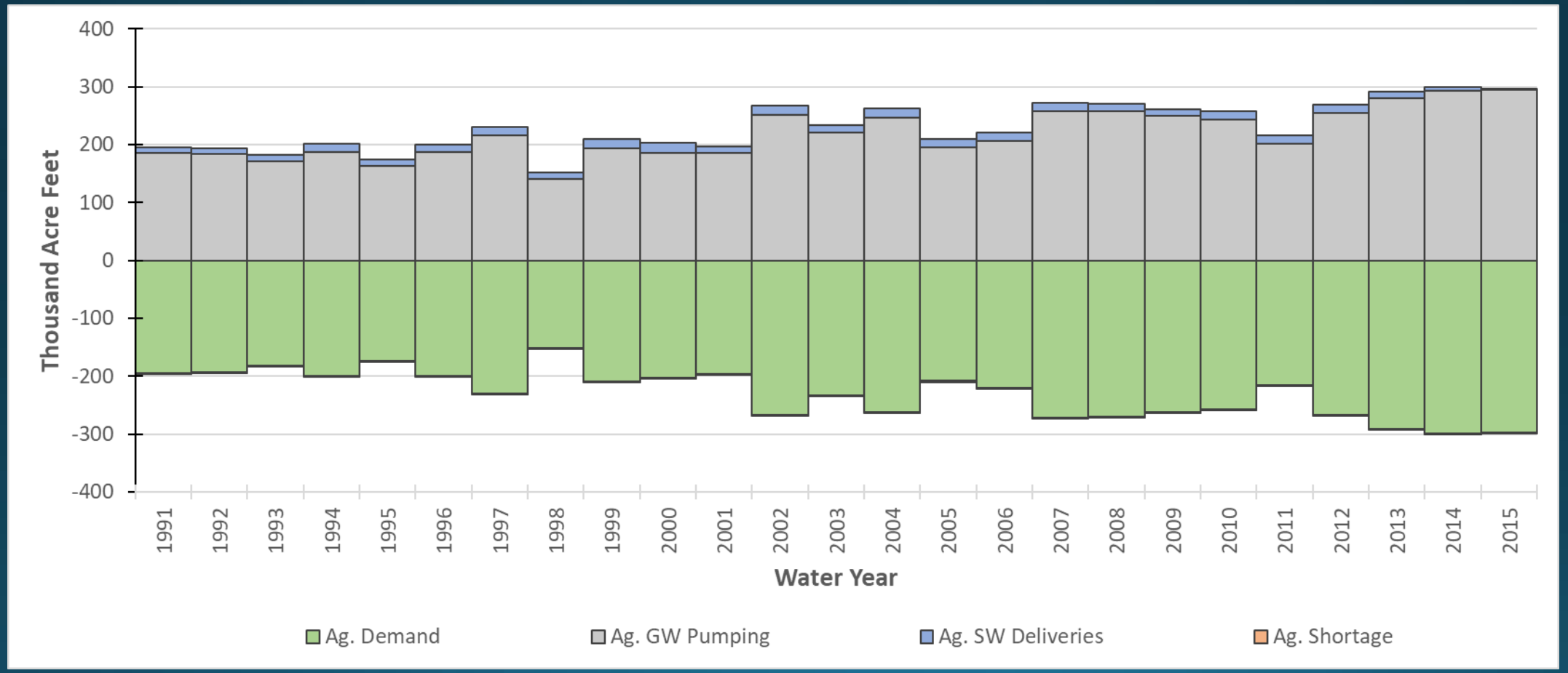

East Turlock Subbasin GSA

Urban Land and Water Use Budget

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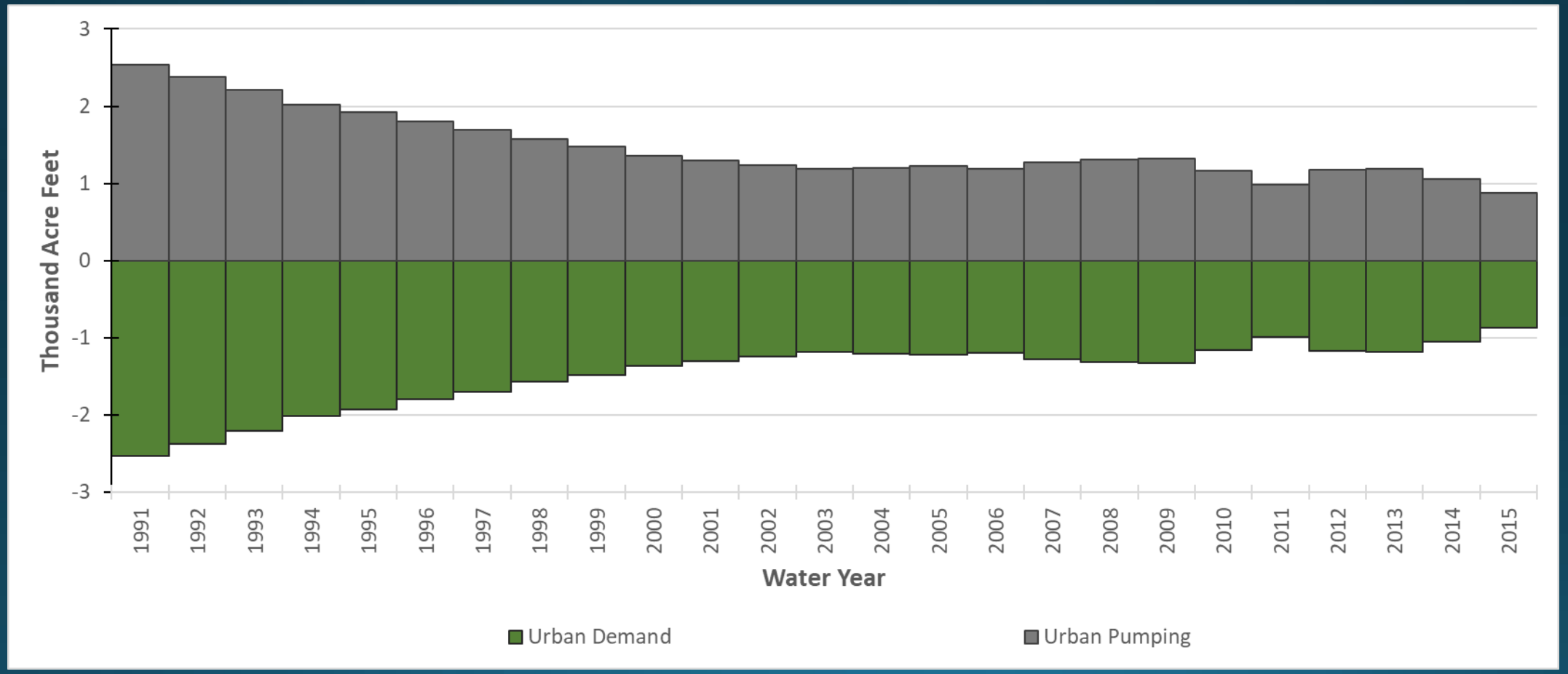
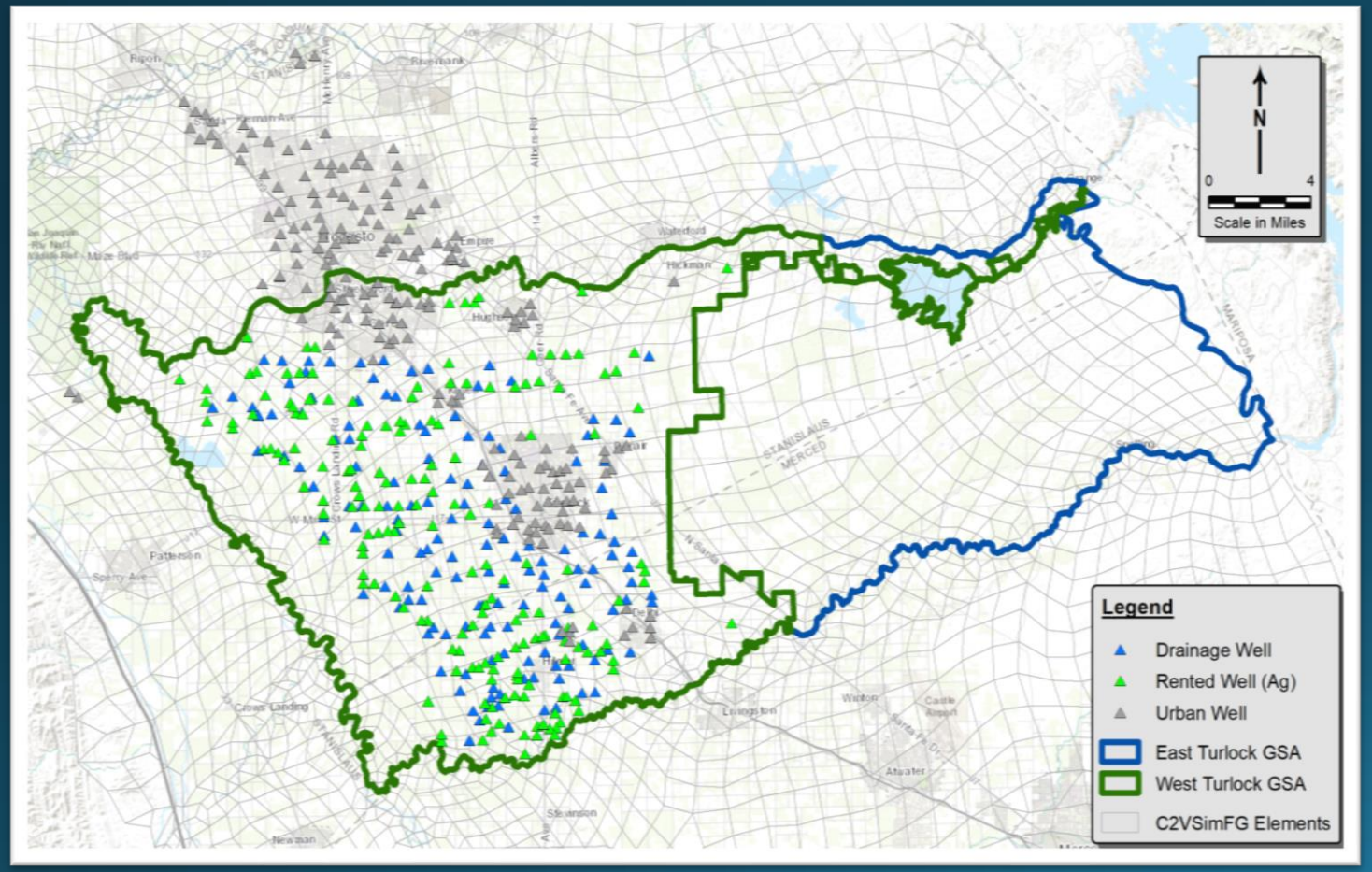


Groundwater System

Groundwater System Refinements

- GW Pumping by Well for Municipalities
- Ag Pumping
  - Rented Wells Pumping
  - Drainage Wells
  - Private Pumping Estimates
- Additional Observed GW Level Data for Calibration
- Coordination with the HCM Work during model calibration

Pumping Wells in the Model



- Incorporated Urban Wells, TID Rented Wells, and Drainage Wells
  - Rented Wells meet Ag Demand
- 605 Wells in Total
  - 202 Urban Wells
  - 251 Rented
  - 152 Drainage

Historical TID GW Production

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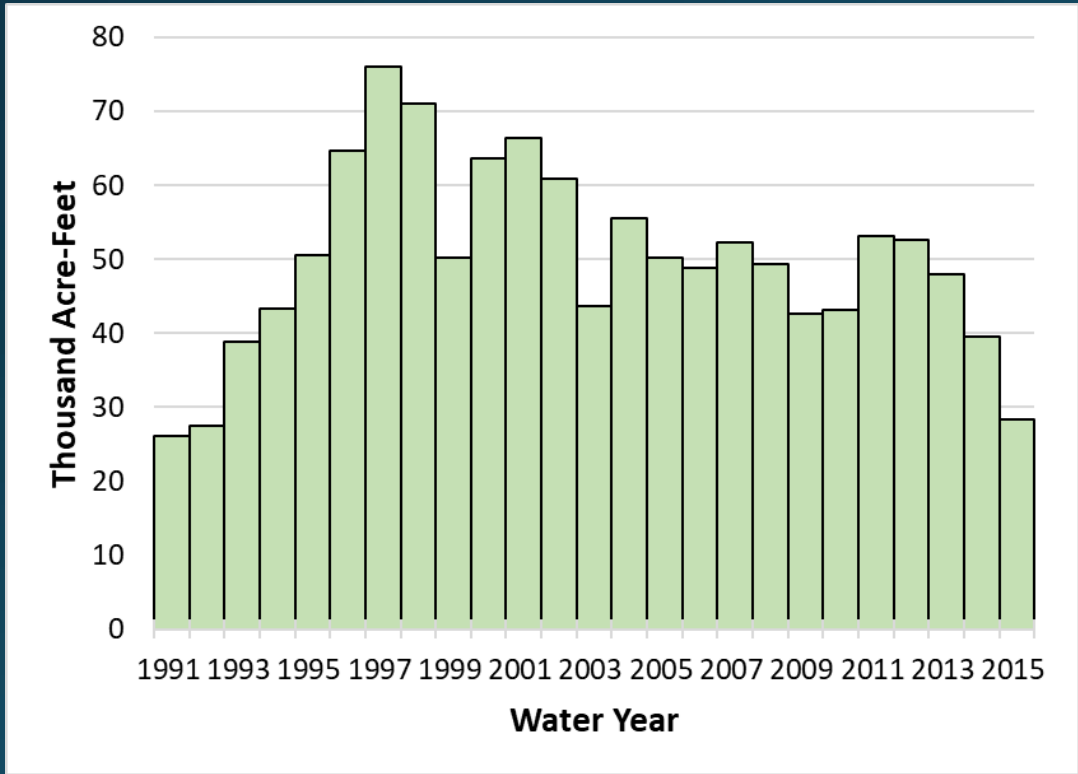
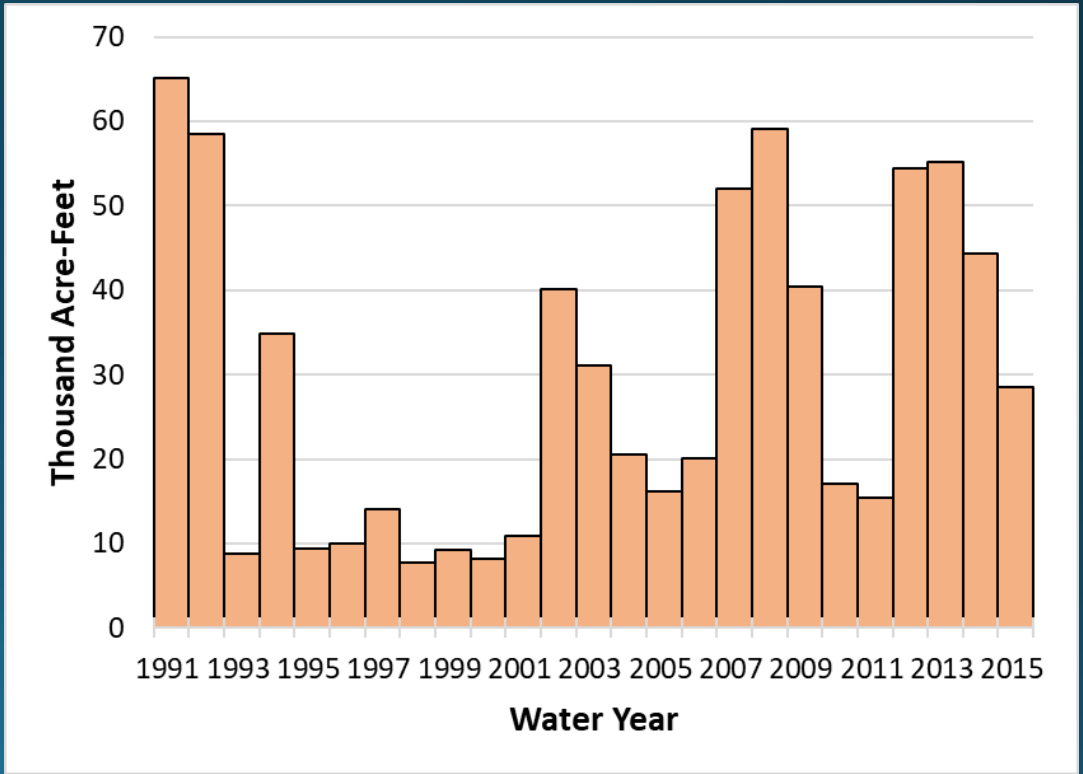
Drainage Well Pumping



Rented Well Pumping



Municipal Pumping

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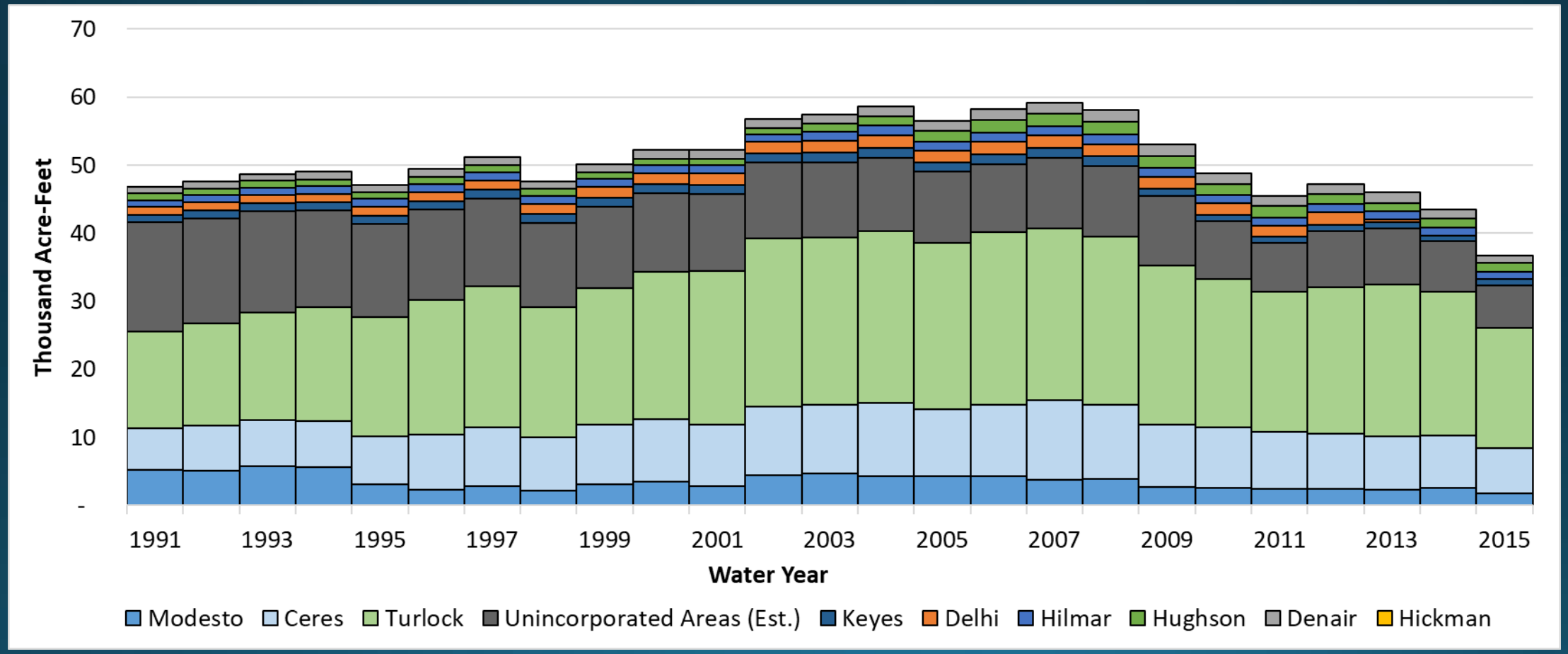
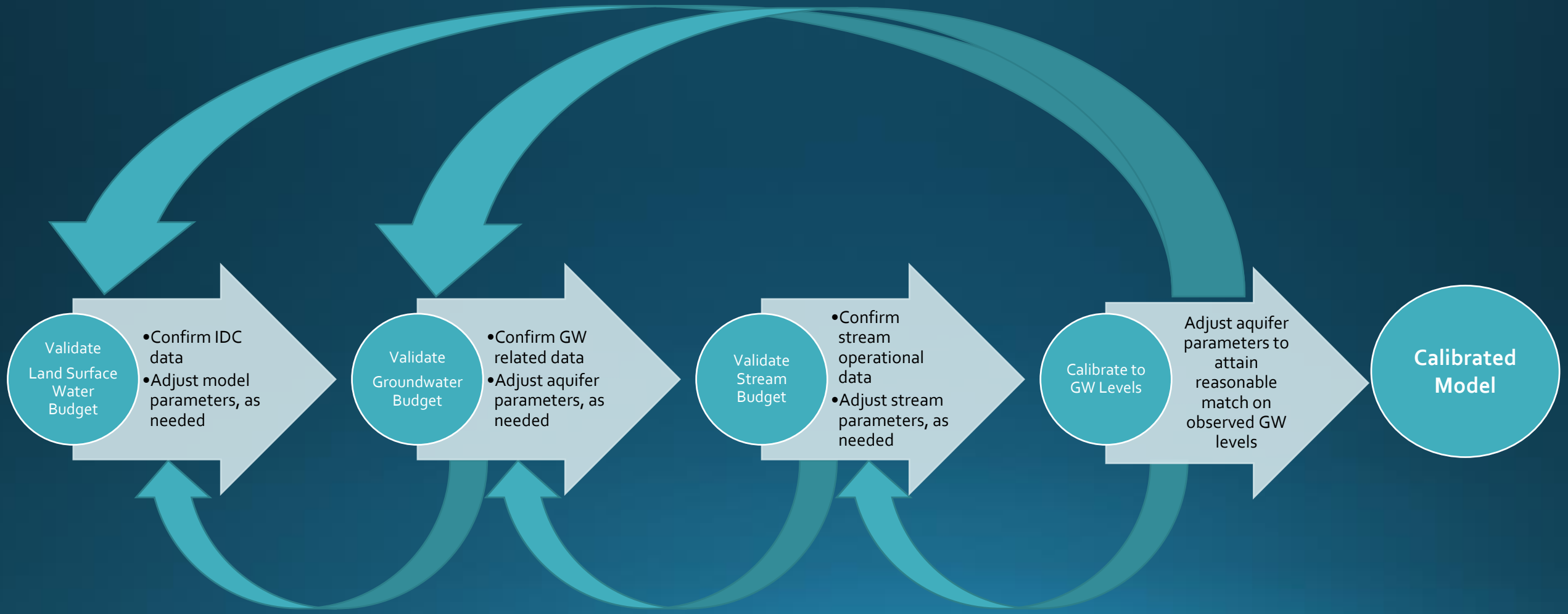
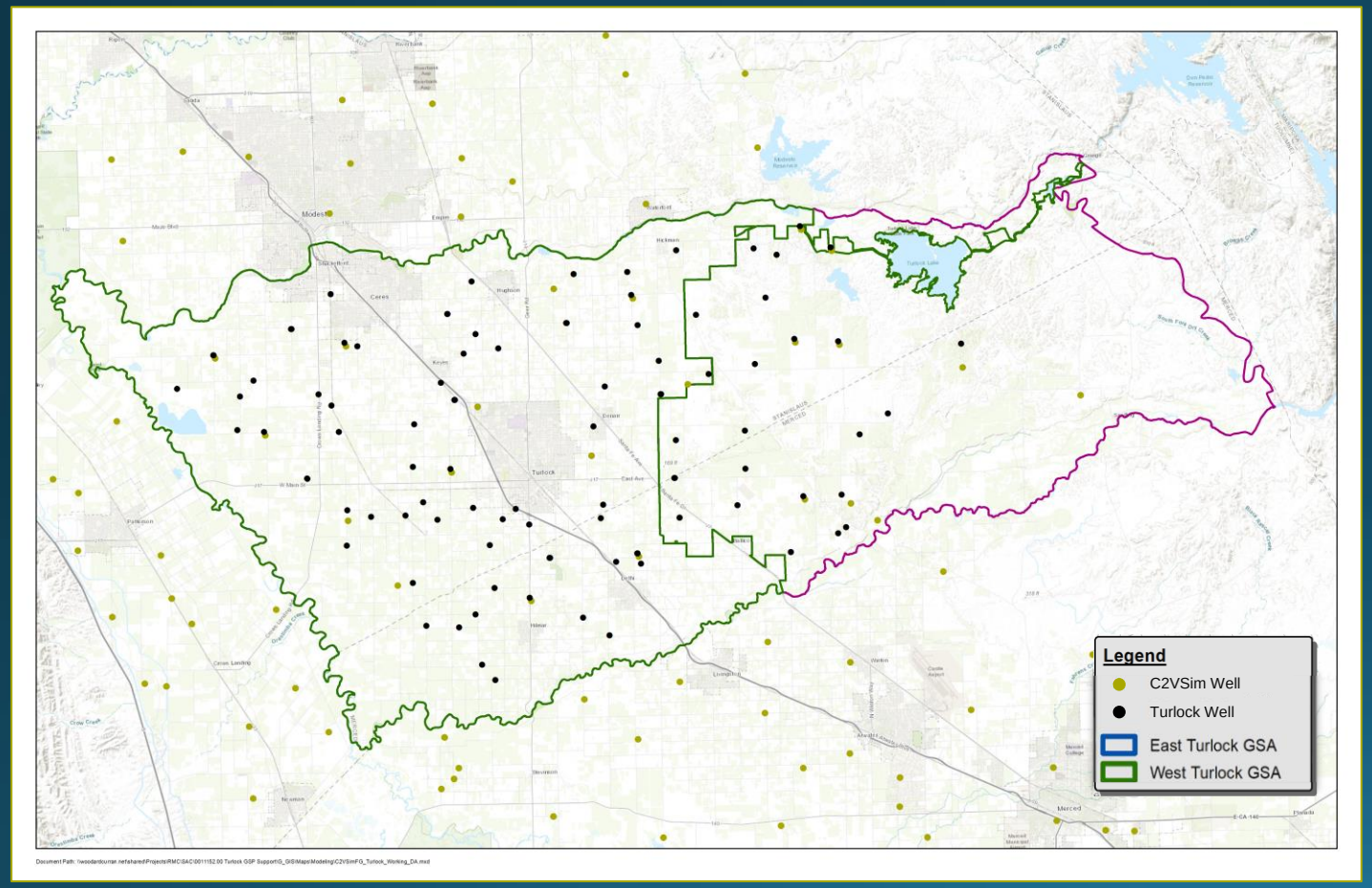


Model Calibration Process



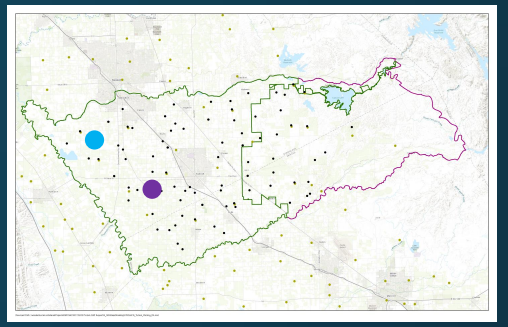
GWE Hydrographs

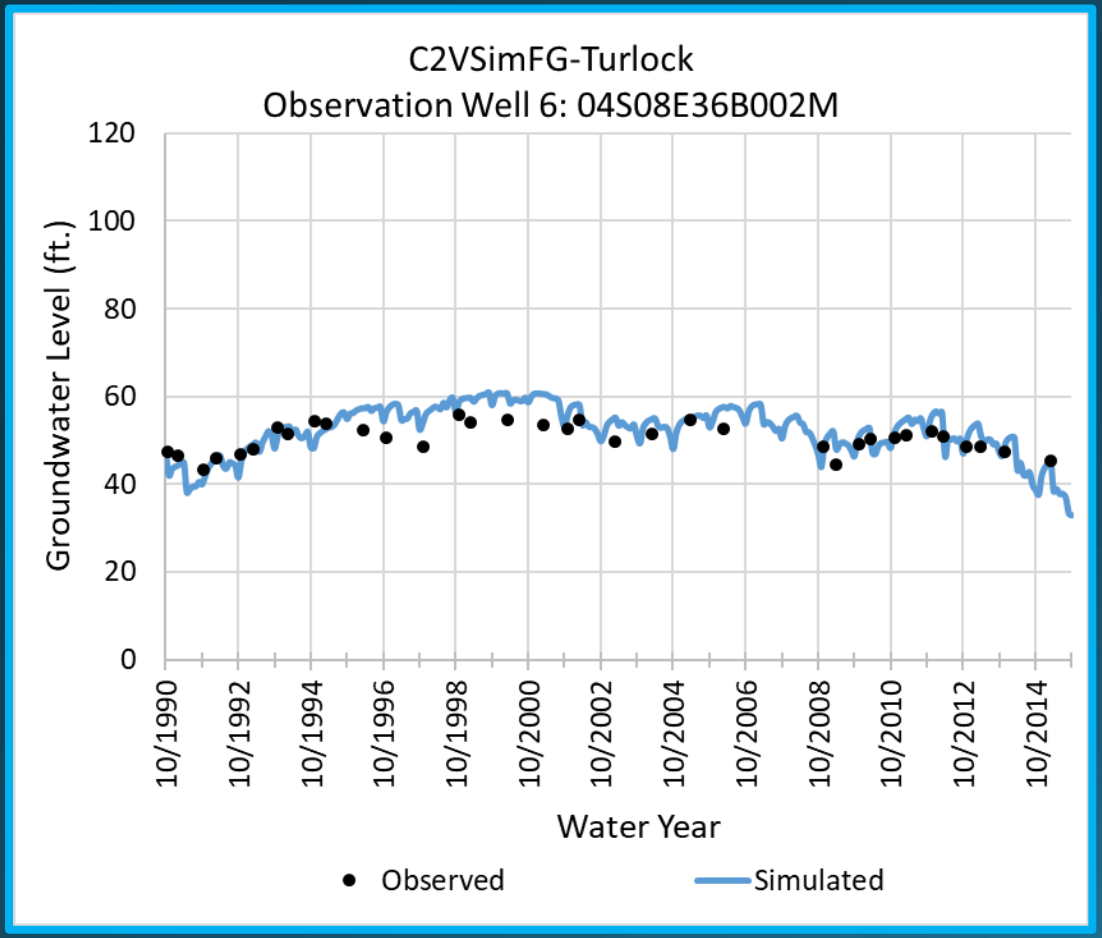
Observed GW Elevation Data



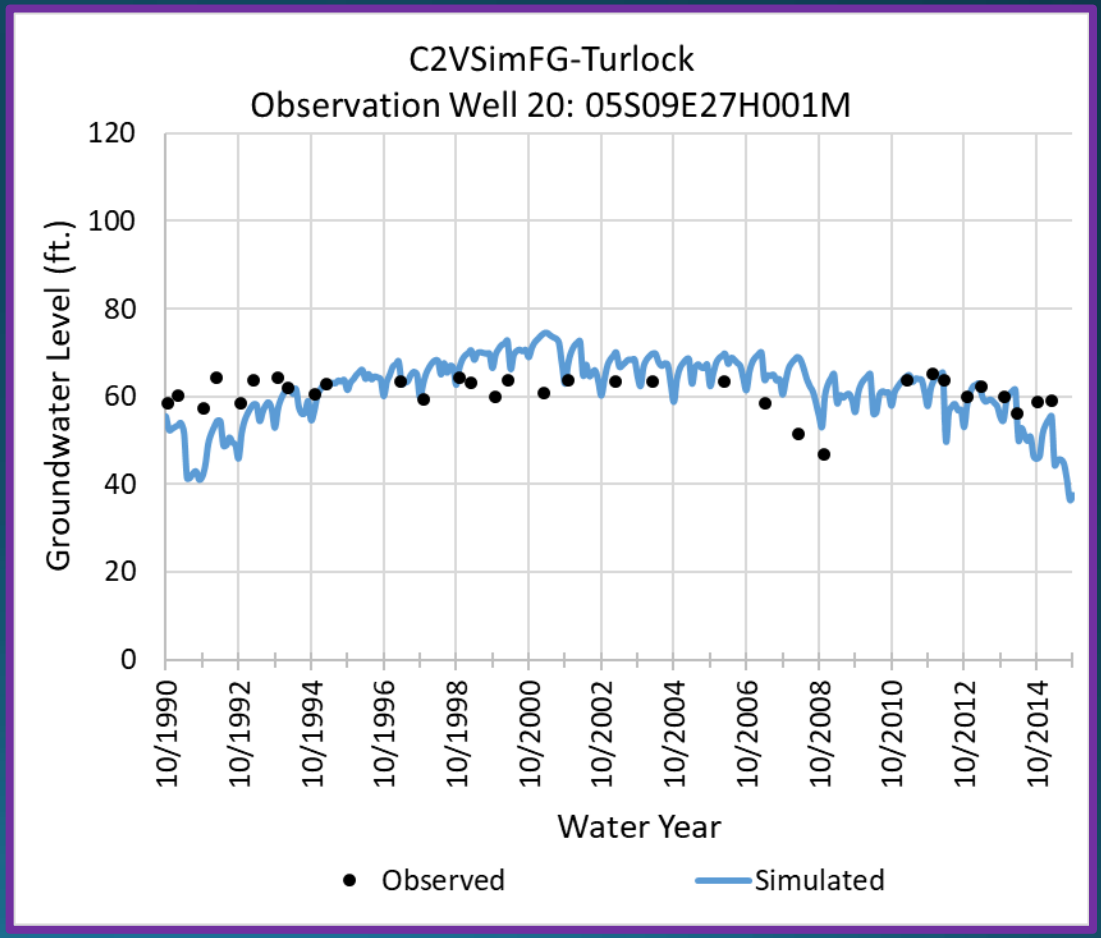
- **22 Existing C2VSimFG Calibration Wells**
- **125 Local Calibration Wells**
  - Ranging from January 1990 to April 2019
  - 57 measurements per Well on Average

Groundwater Hydrographs



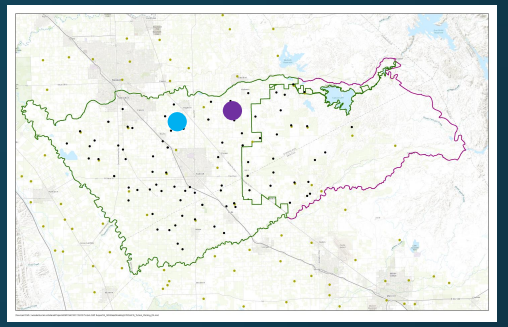


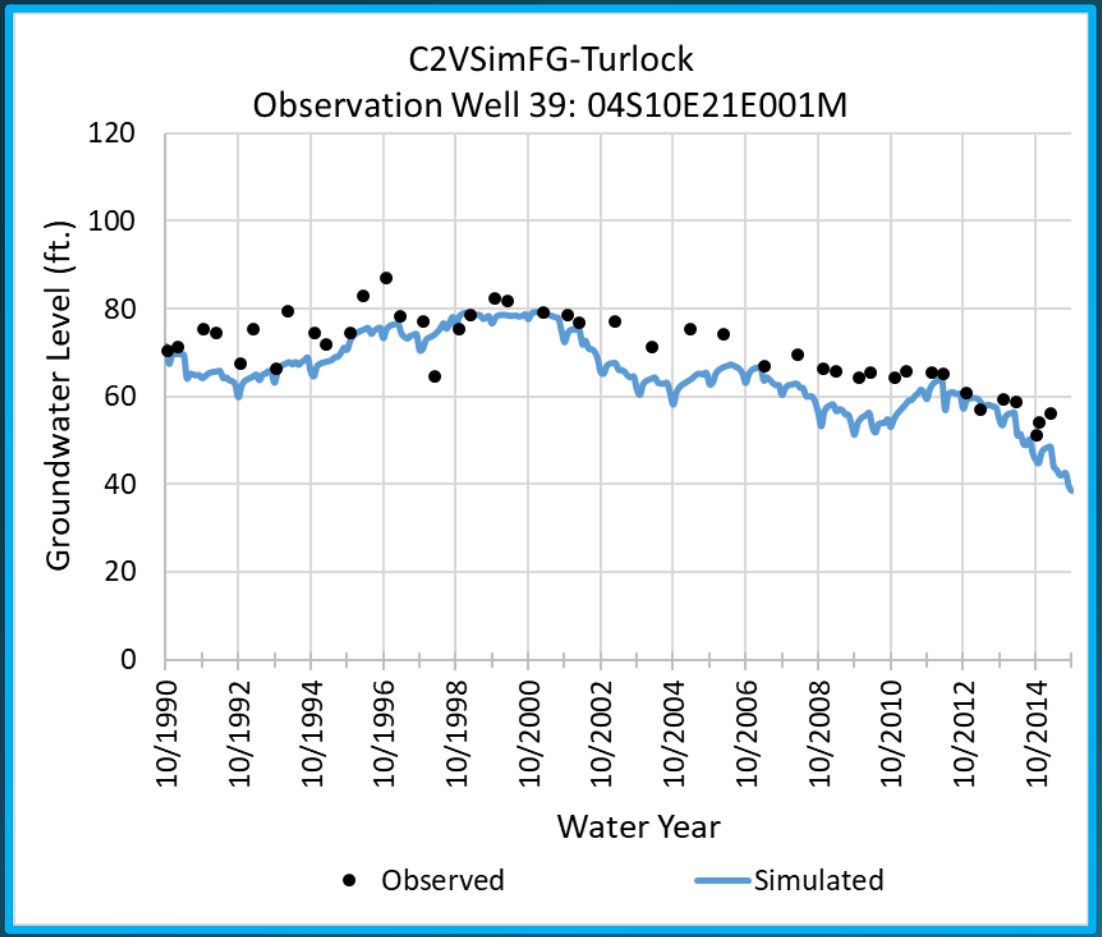
Above Corcoran



Above Corcoran

Groundwater Hydrographs





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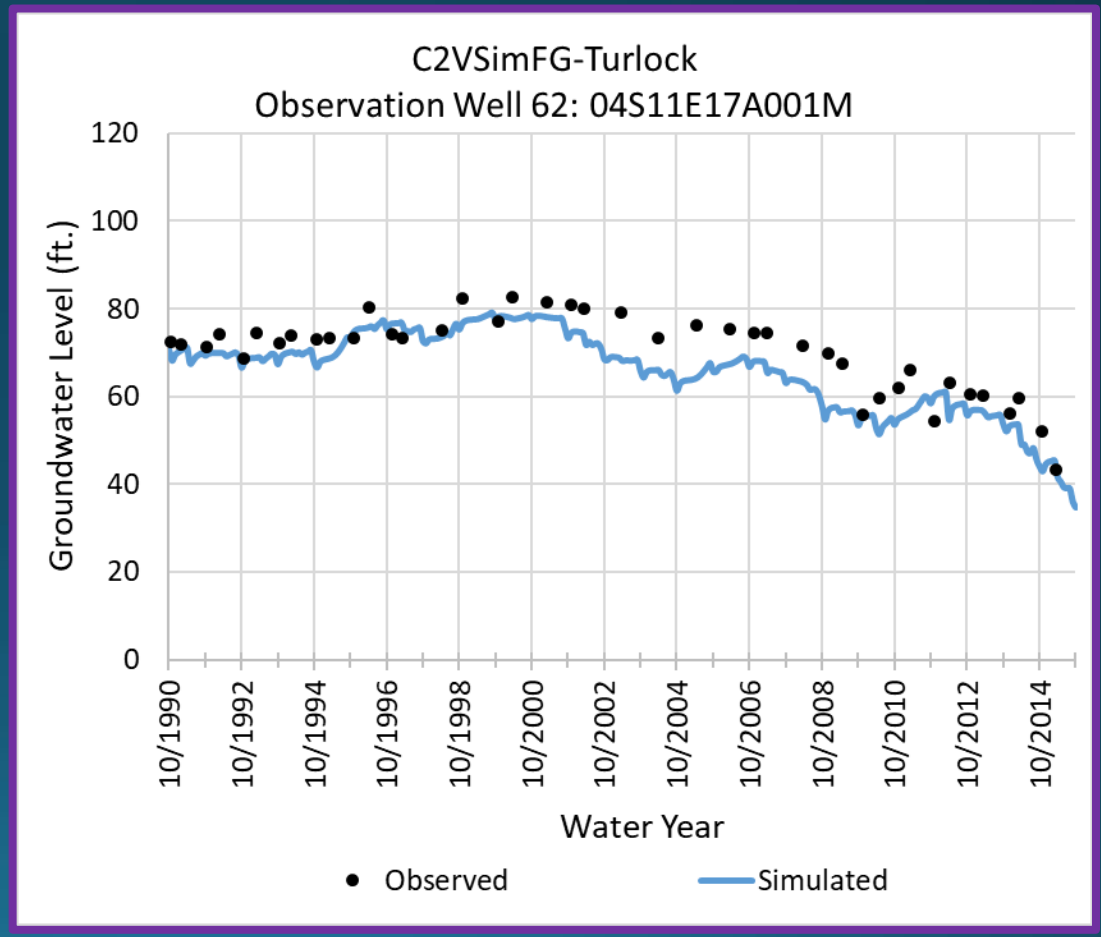
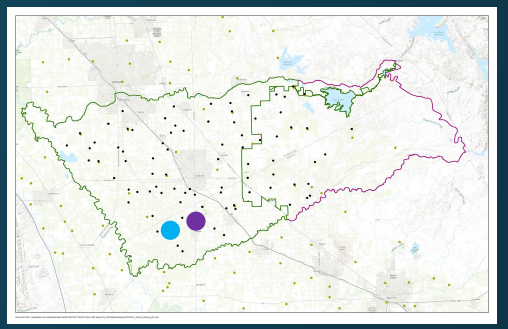
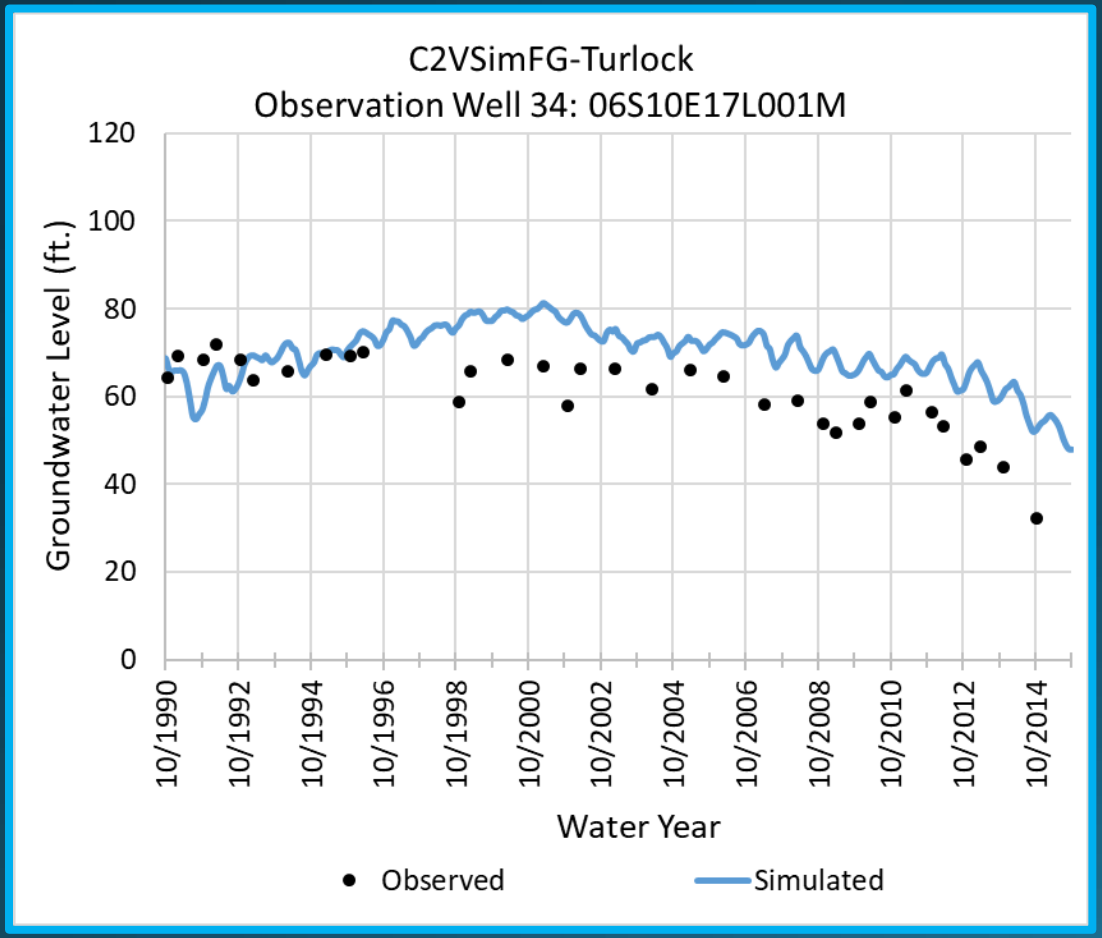


Outside of Corcoran

Groundwater Hydrographs





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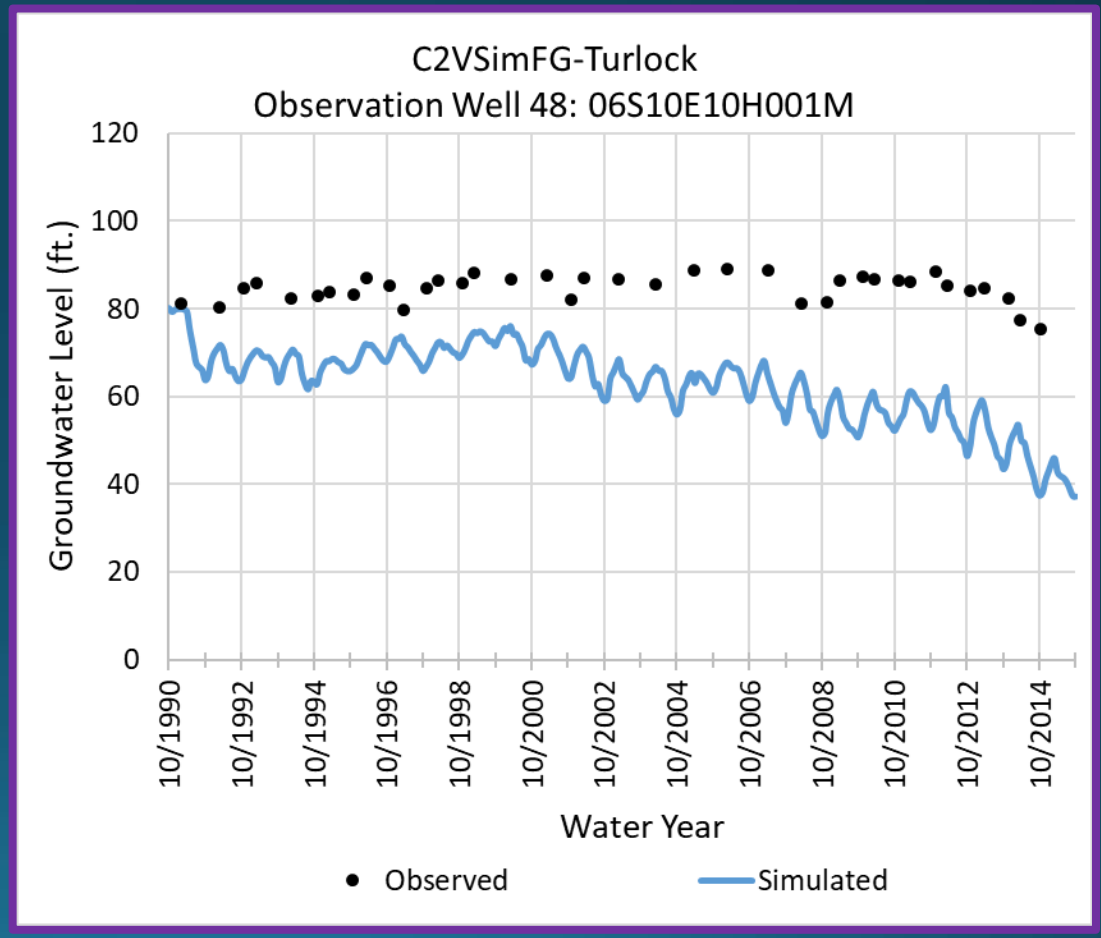
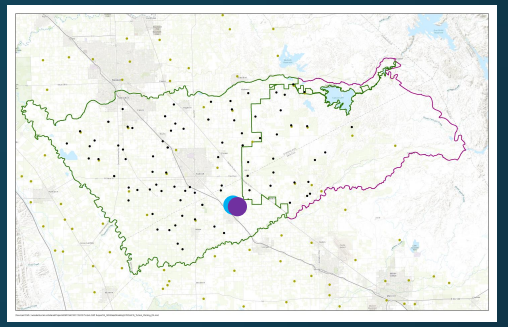
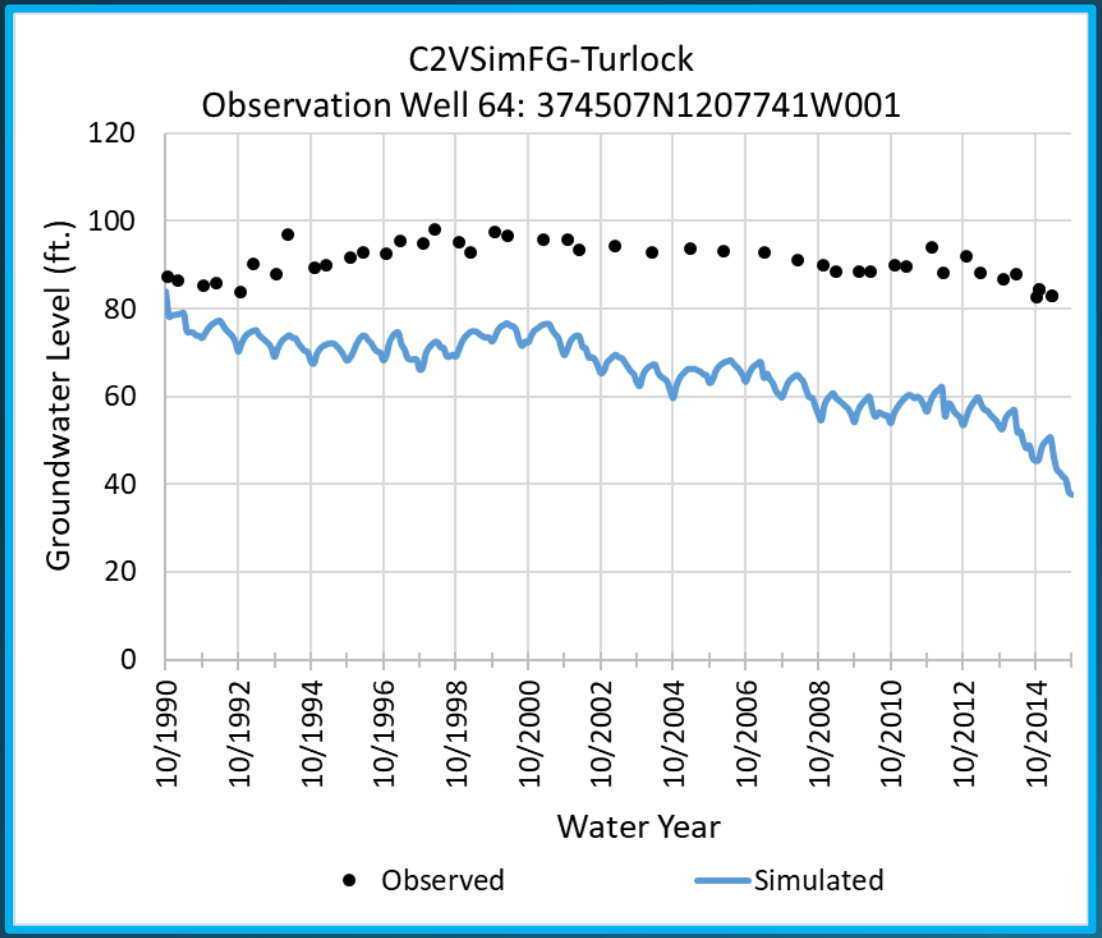


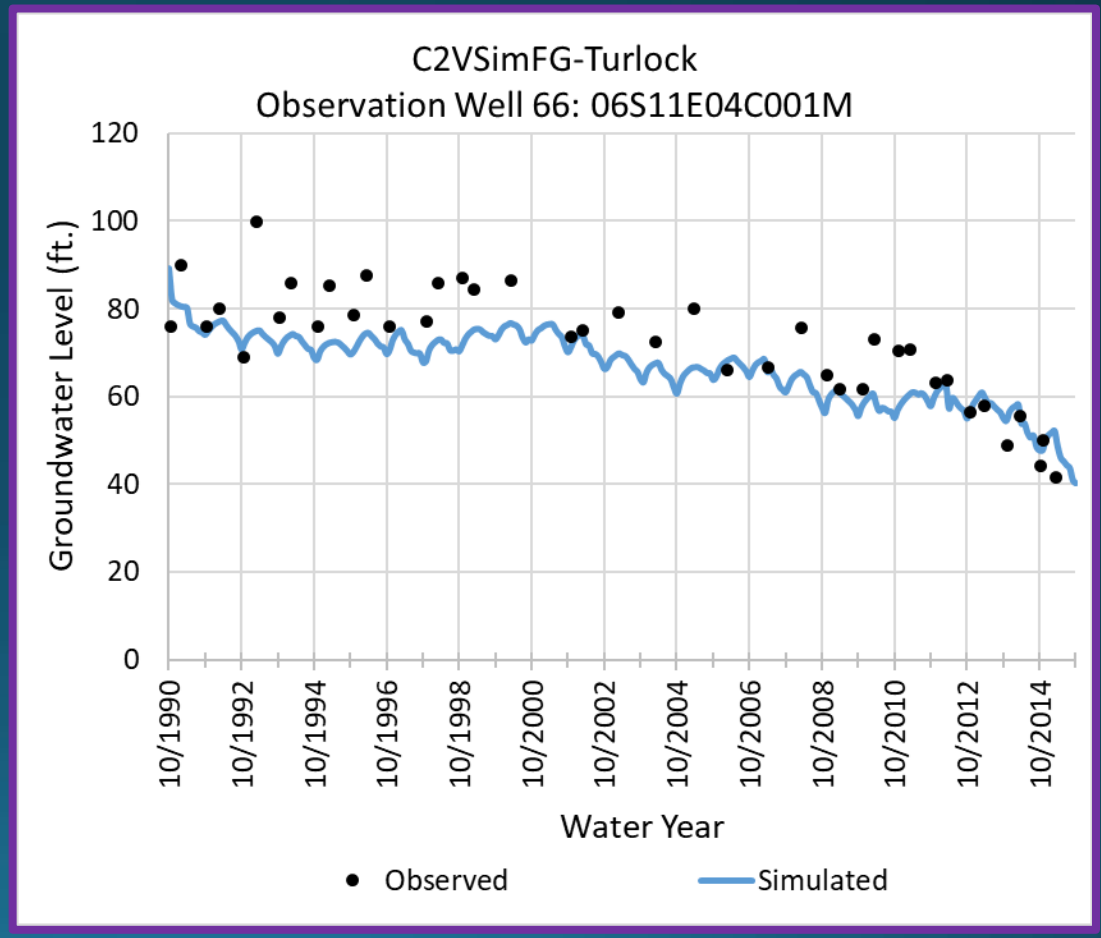
Above Corcoran

Groundwater Hydrographs



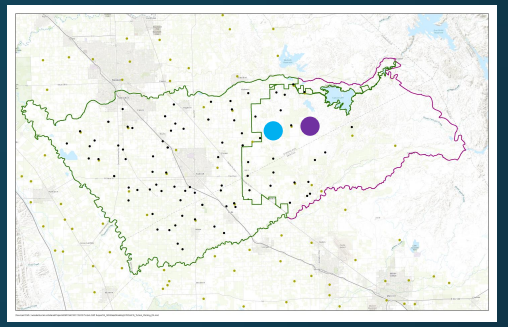


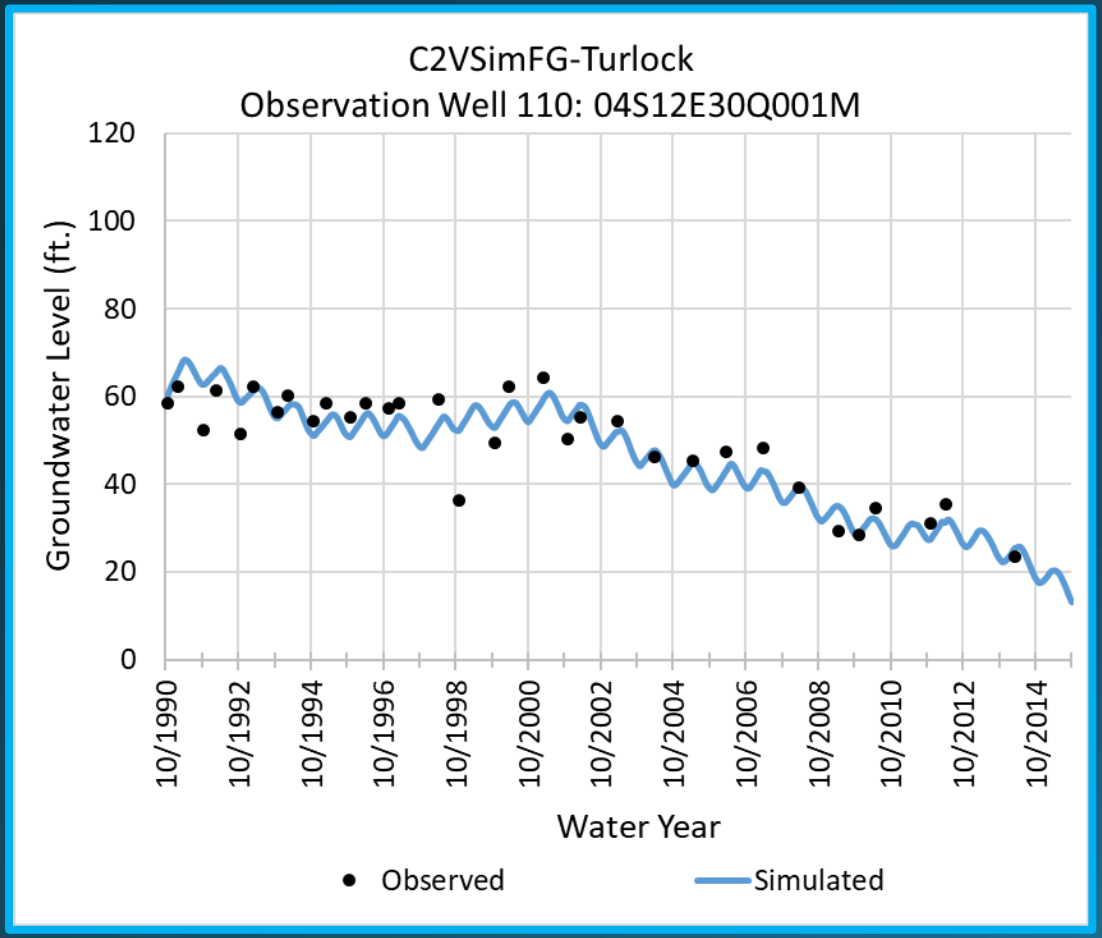
Near edge of Corcoran



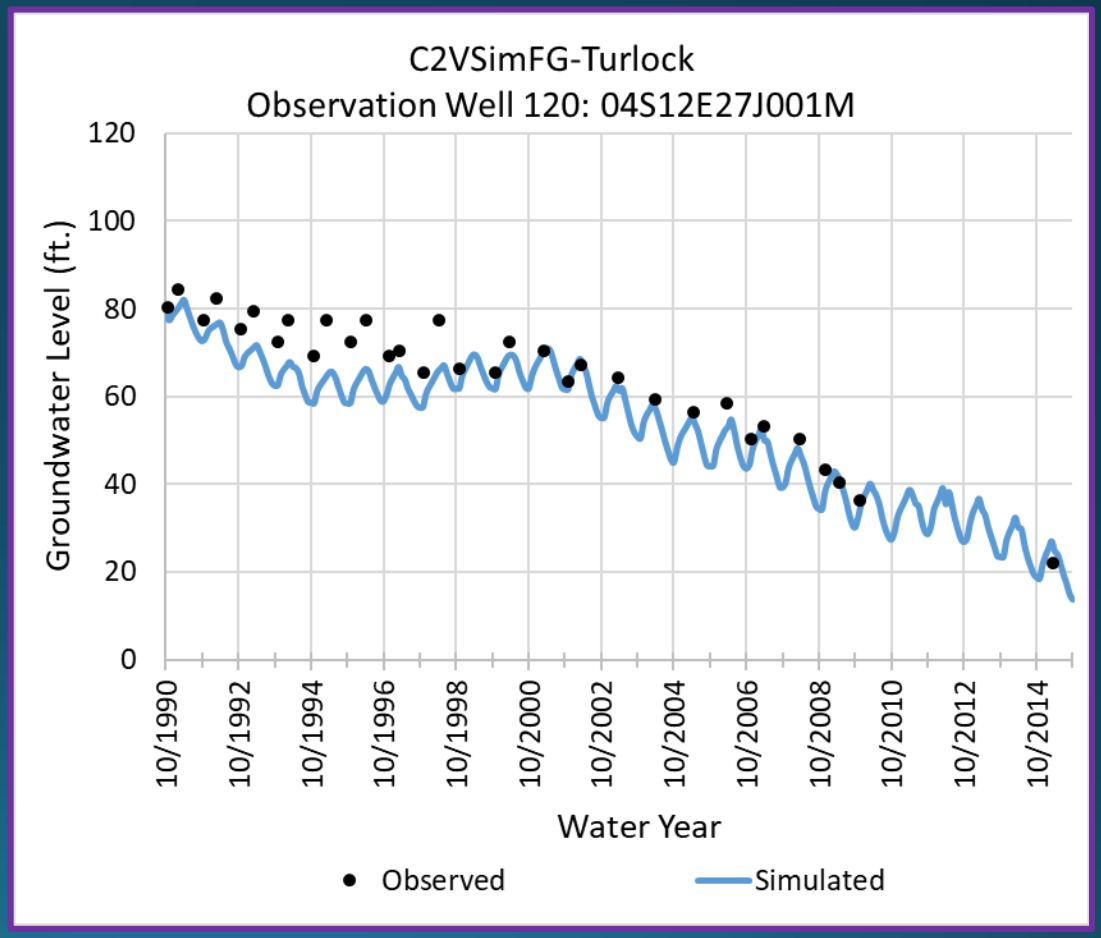
Above Corcoran

Groundwater Hydrographs



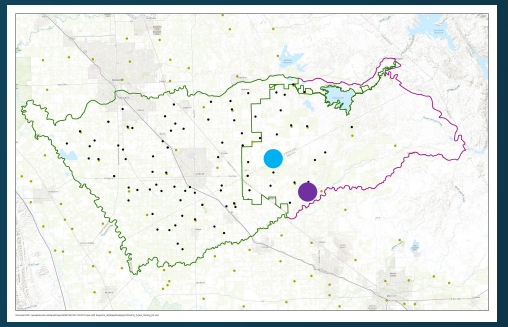


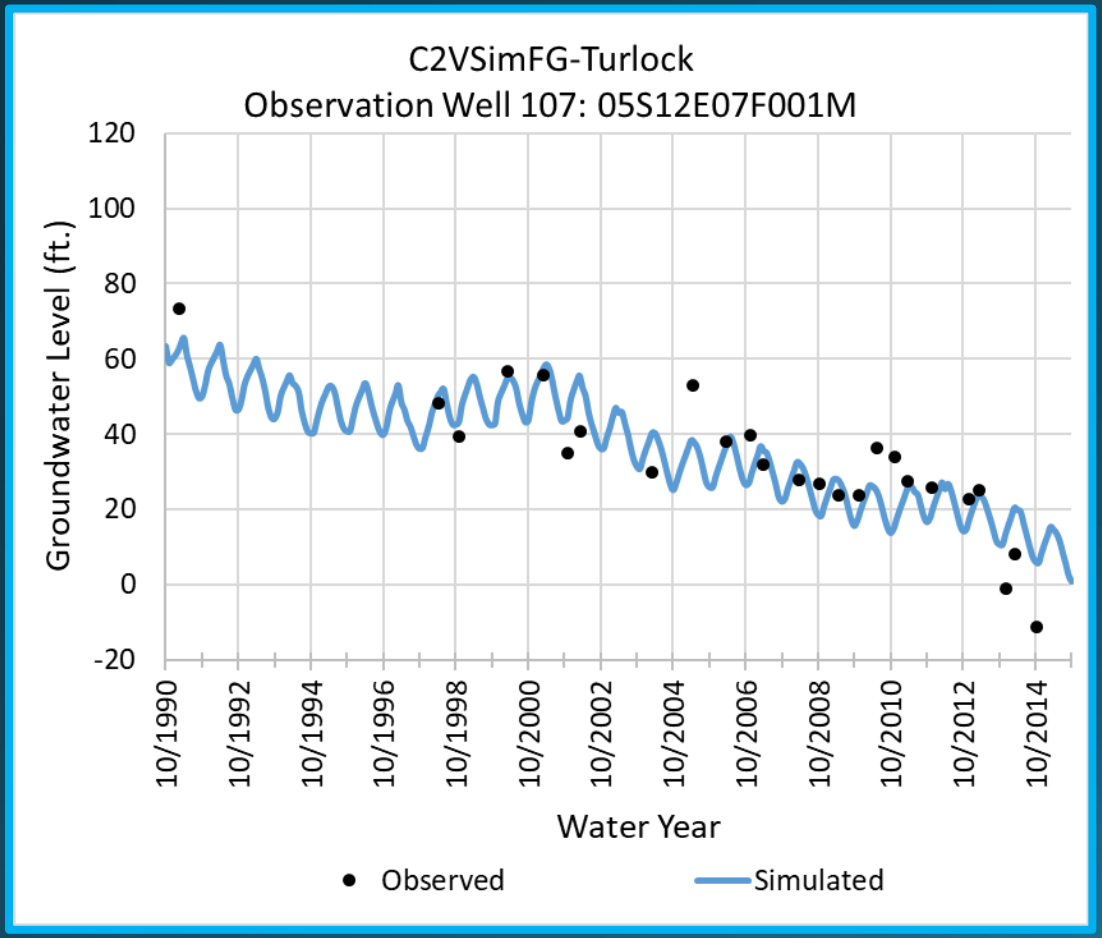
Outside of Corcoran



Outside of Corcoran

Groundwater Hydrographs





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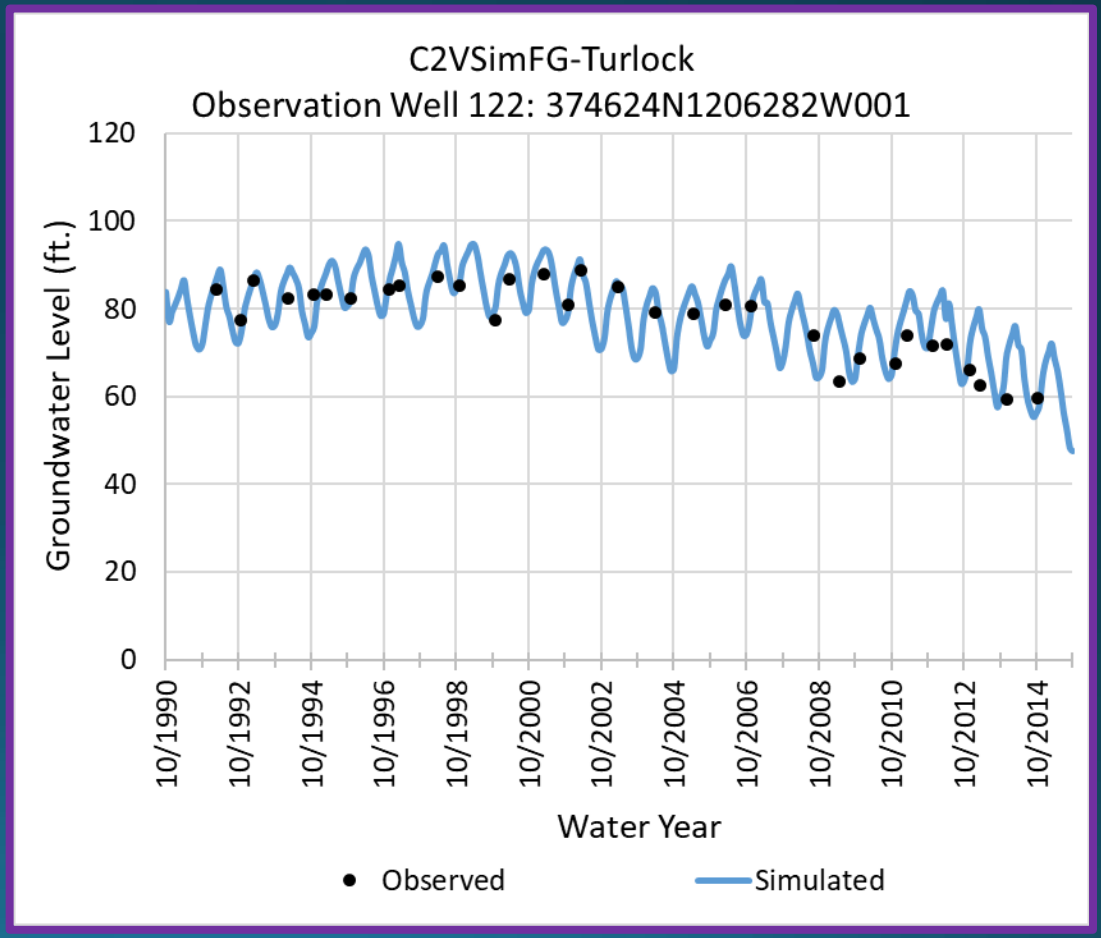
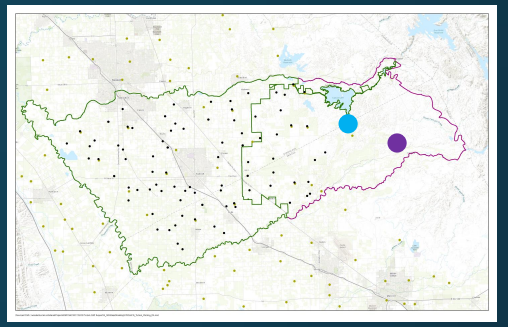
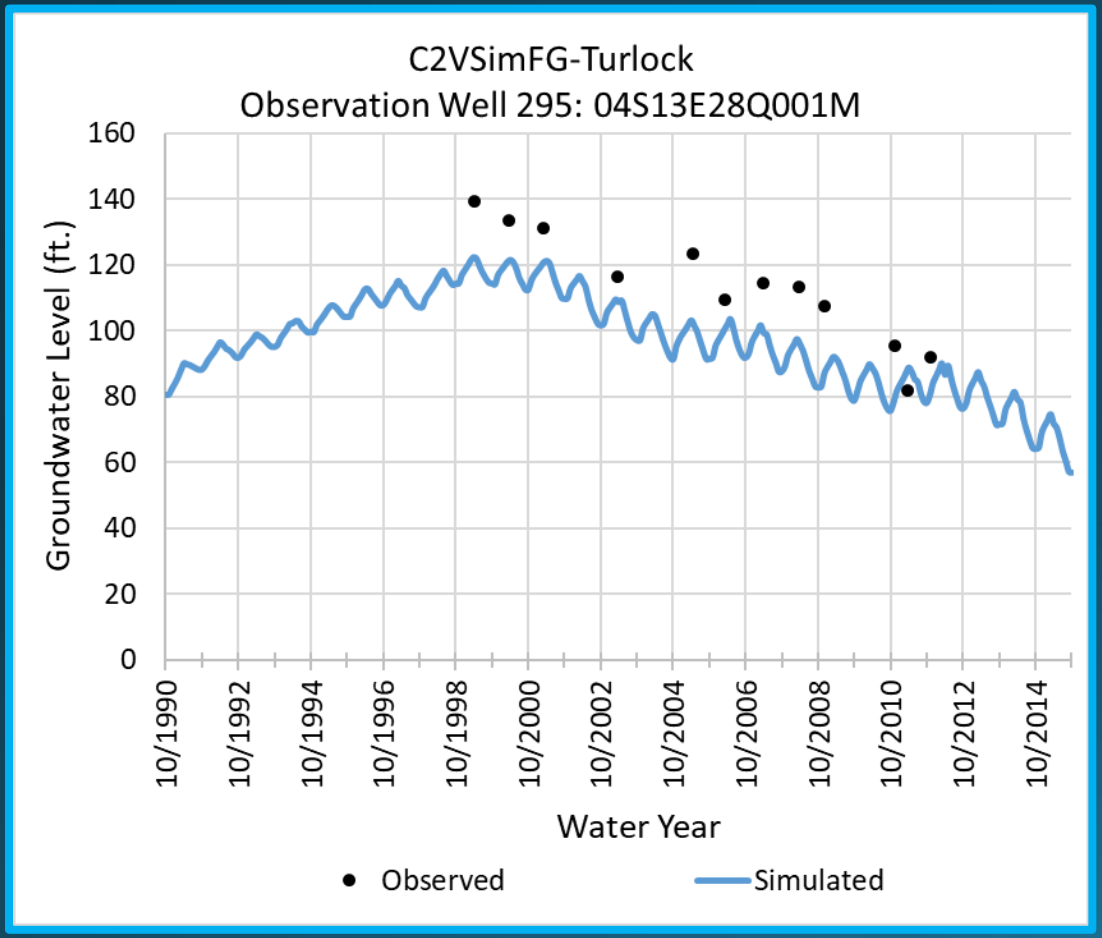


Outside of Corcoran

Groundwater Hydrographs





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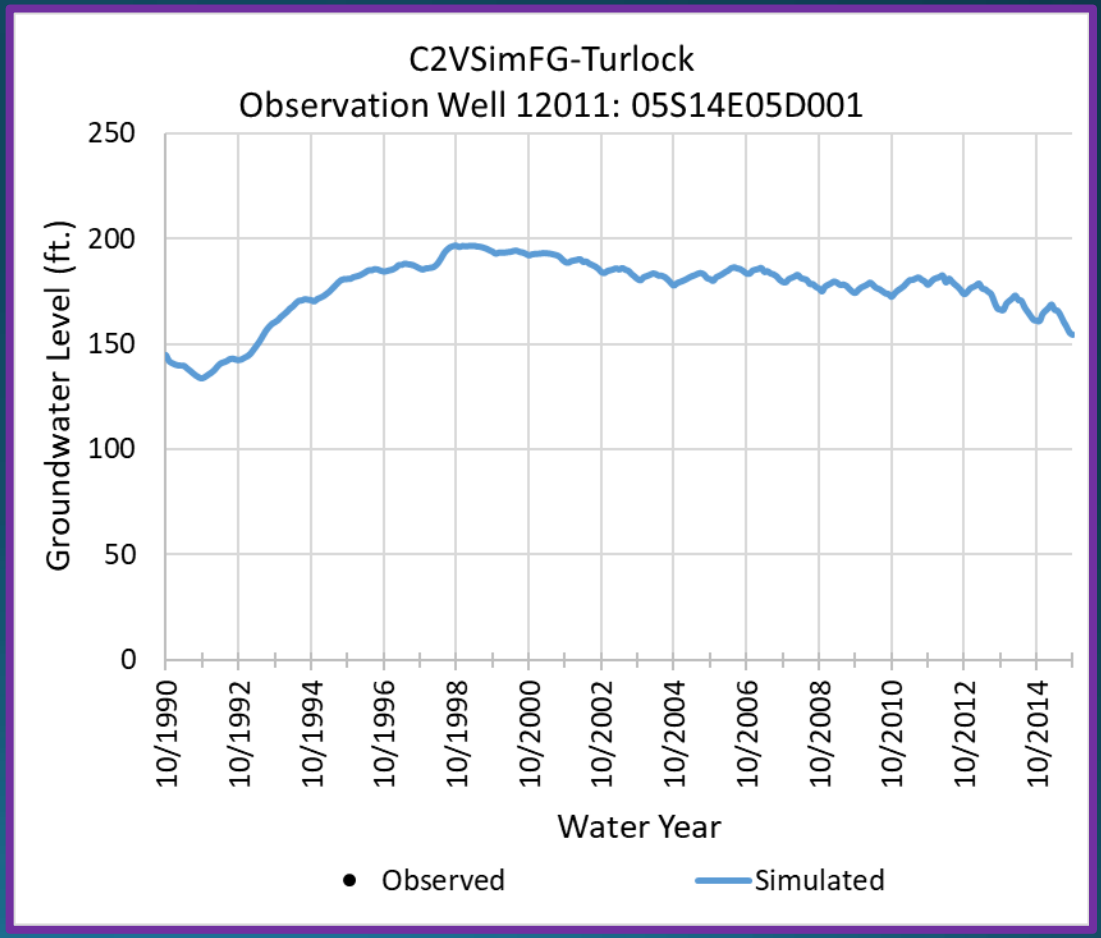
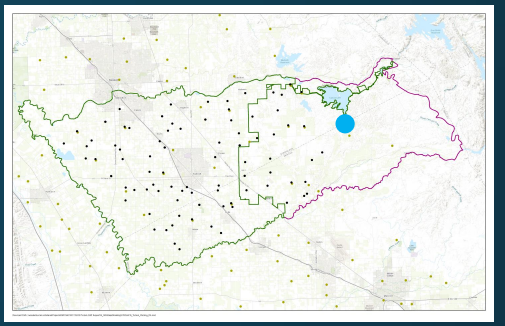
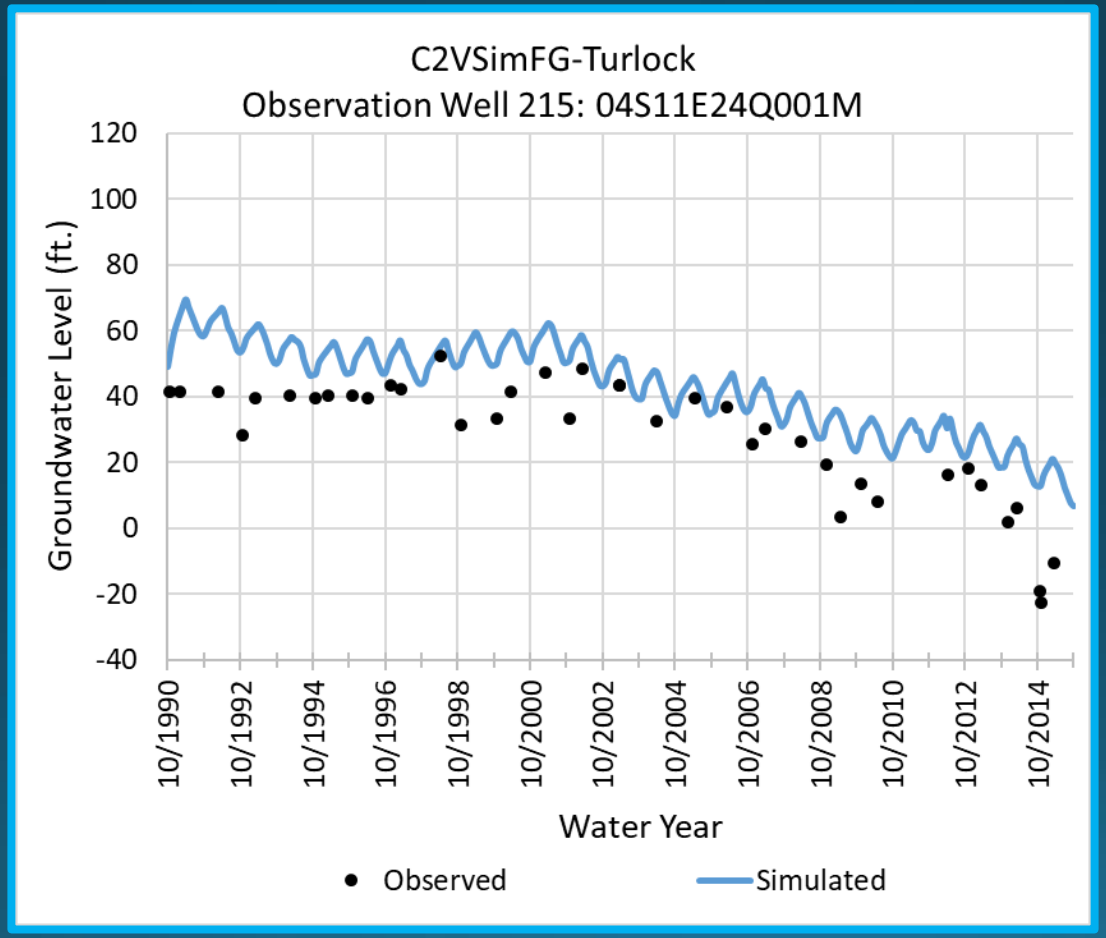


Outside of Corcoran

Groundwater Hydrographs

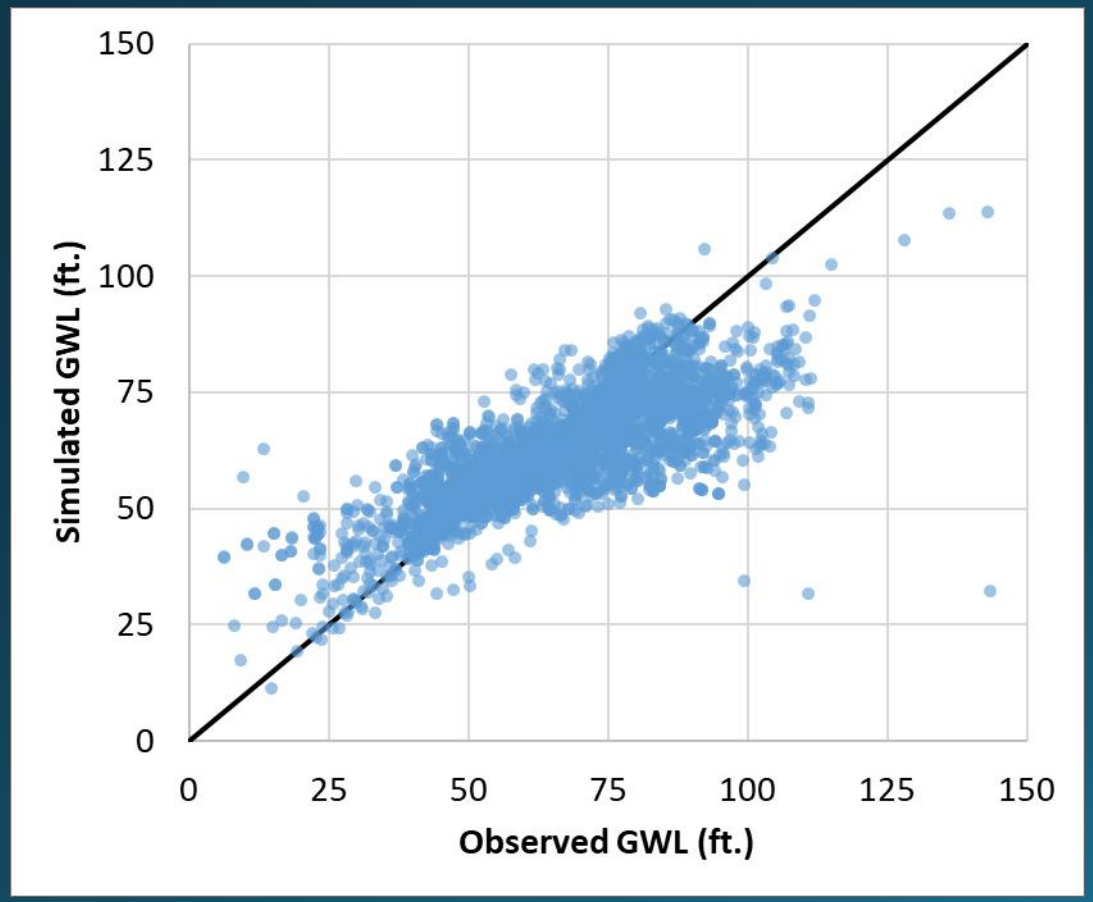


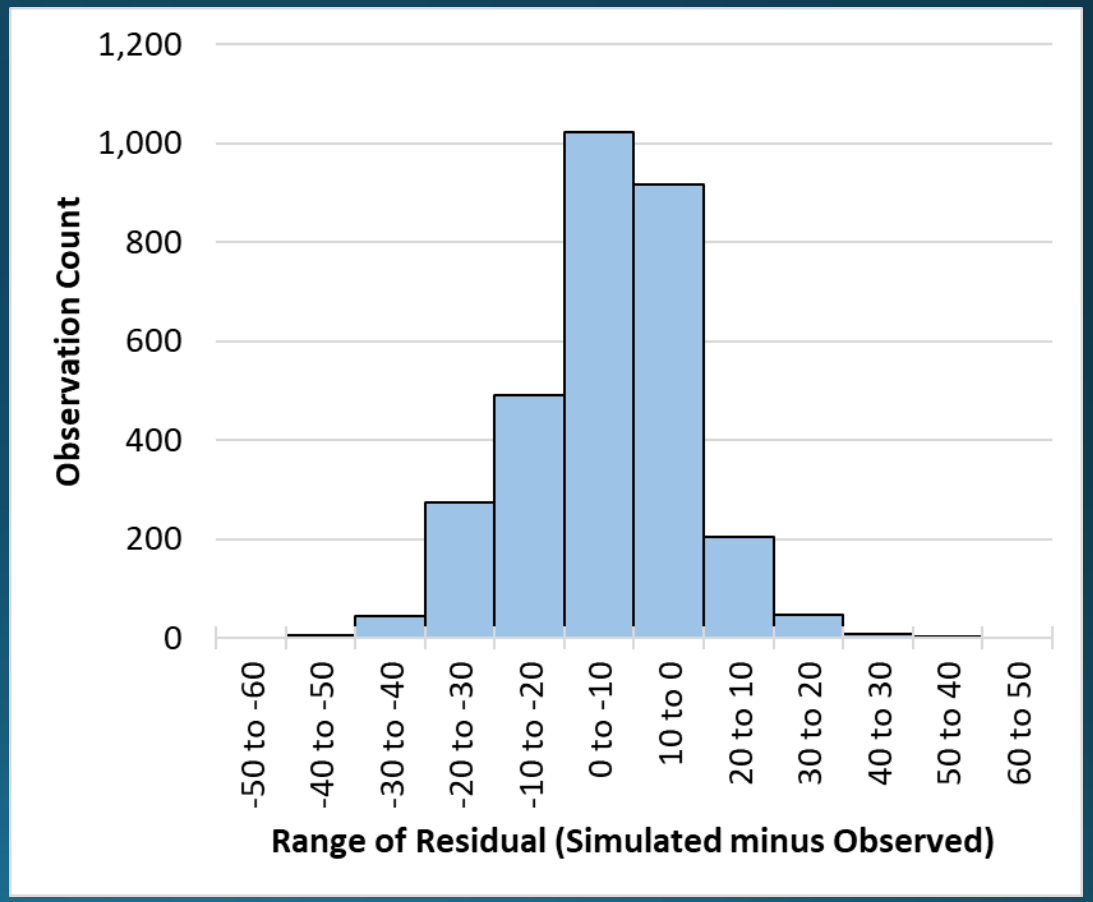


Outside of Corcoran

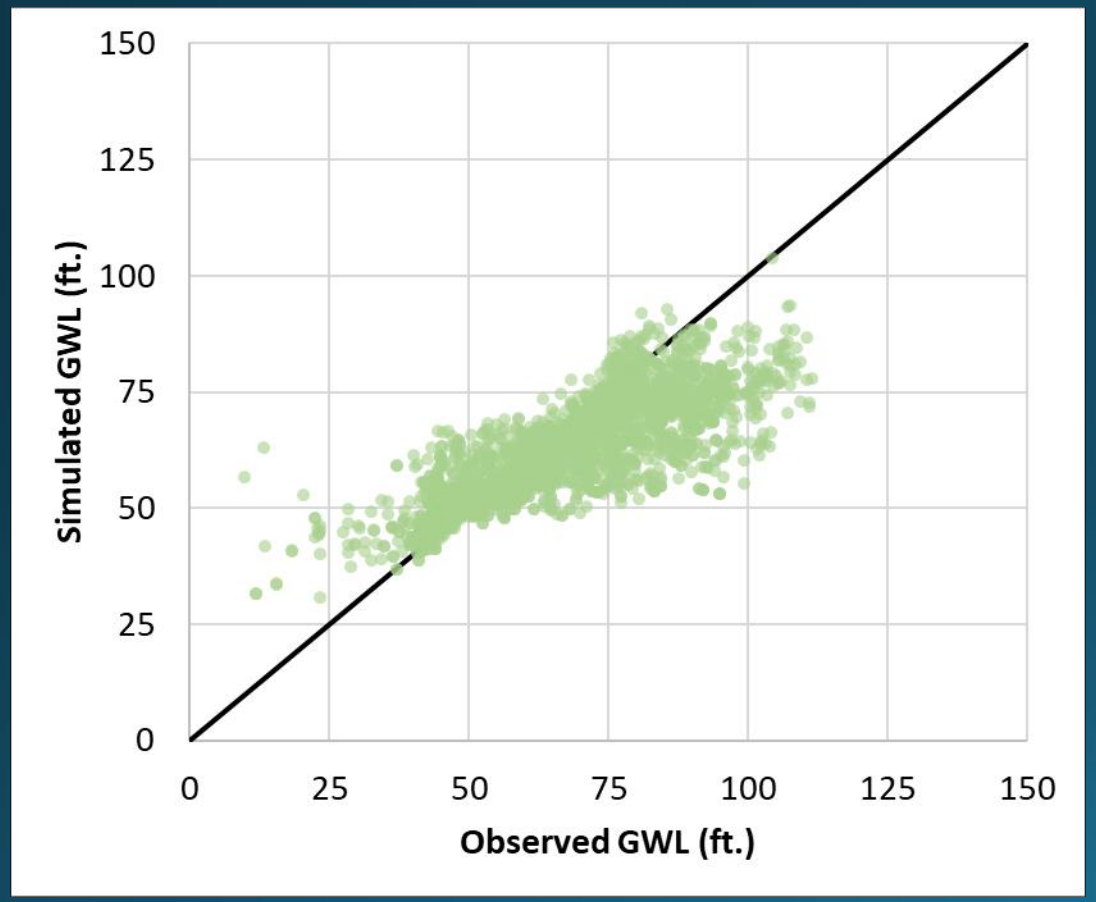
Observed & Simulated GWLs

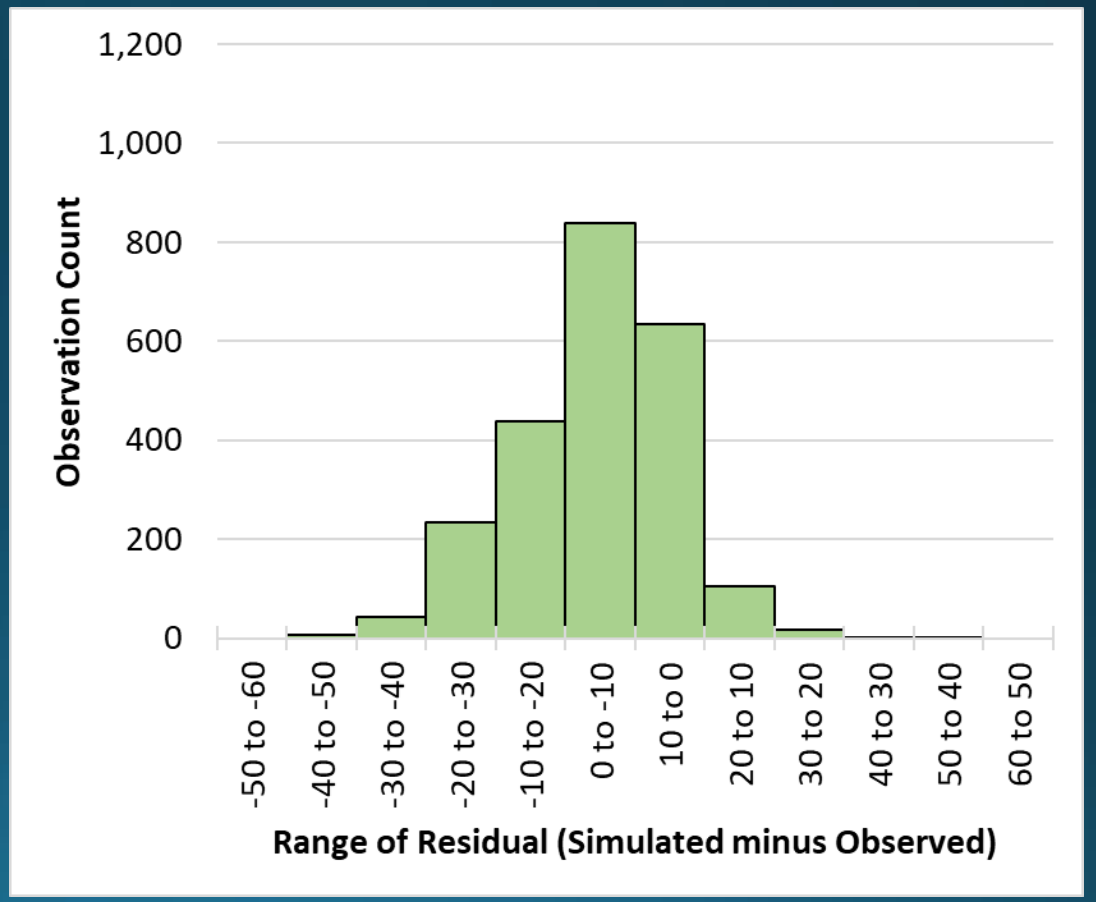
Observed vs. Simulated GWLs
Turlock Subbasin



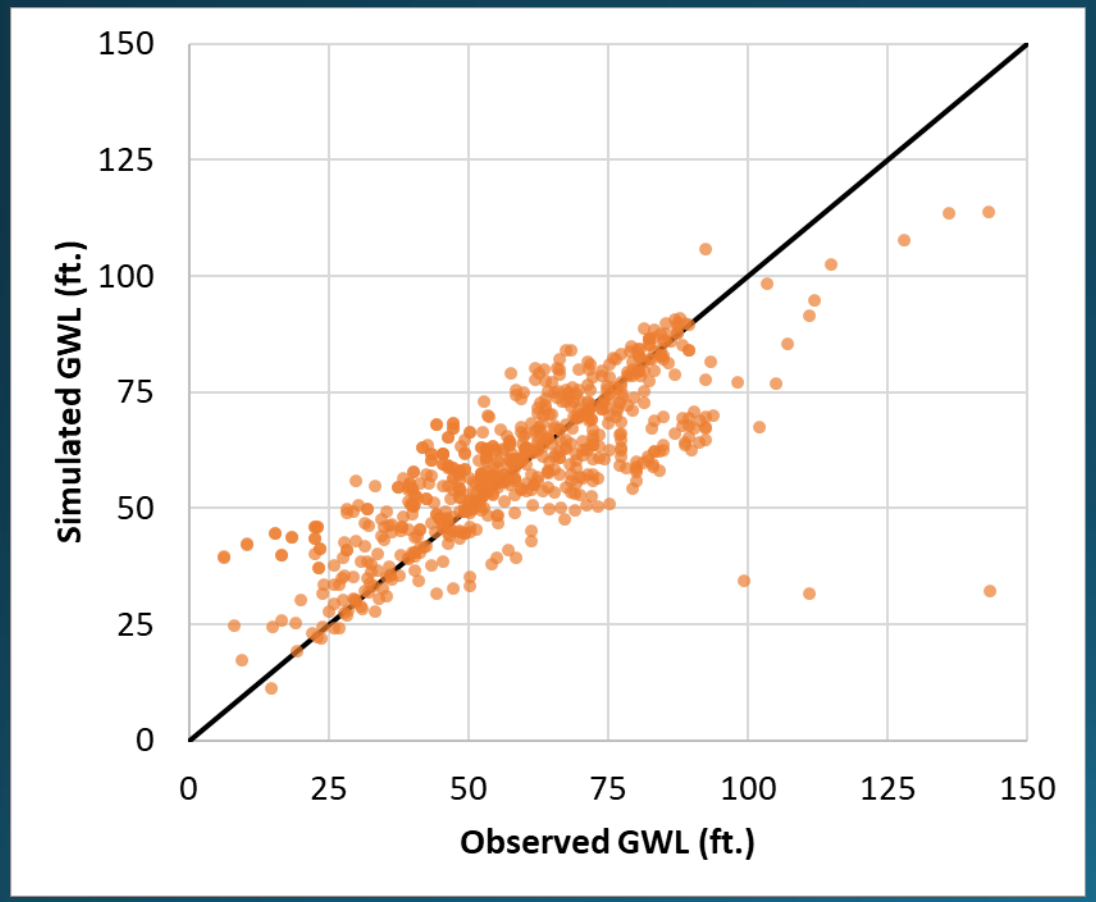


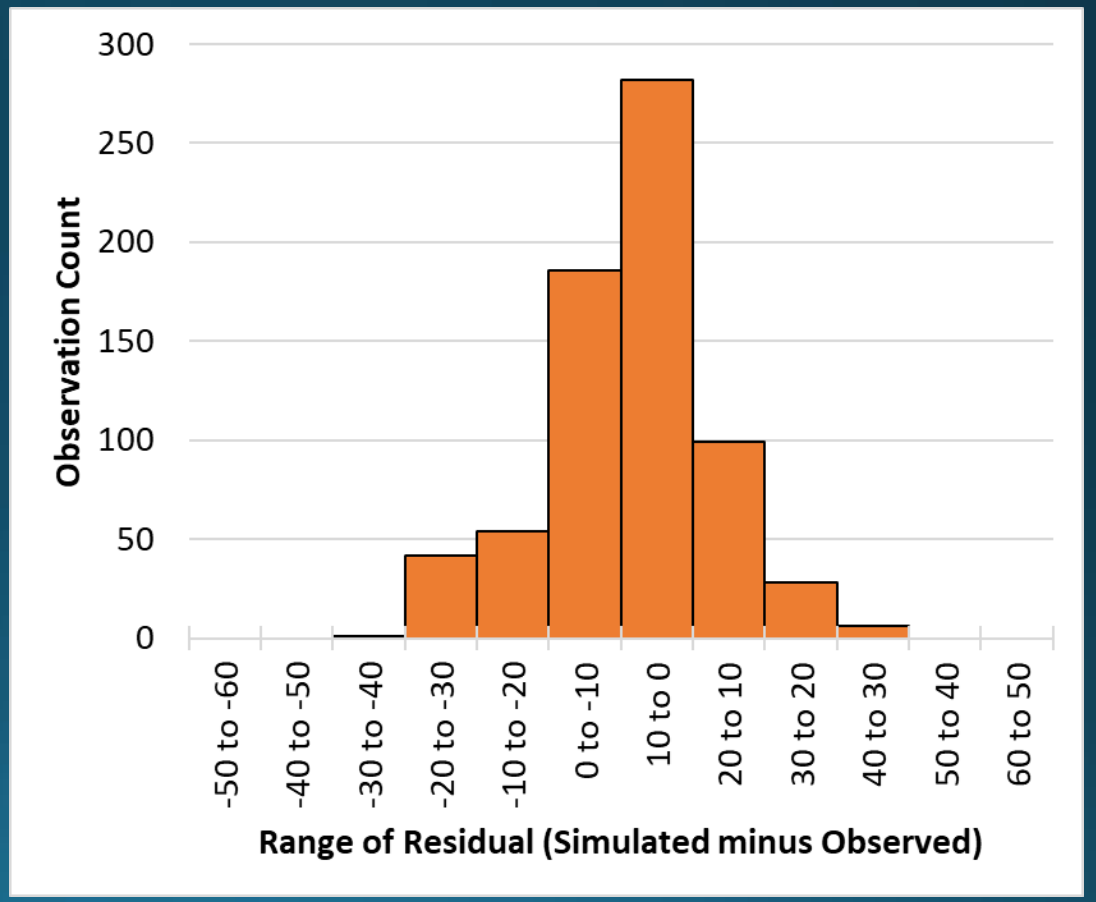
Observed vs. Simulated GWLs
West Turlock Subbasin GSA





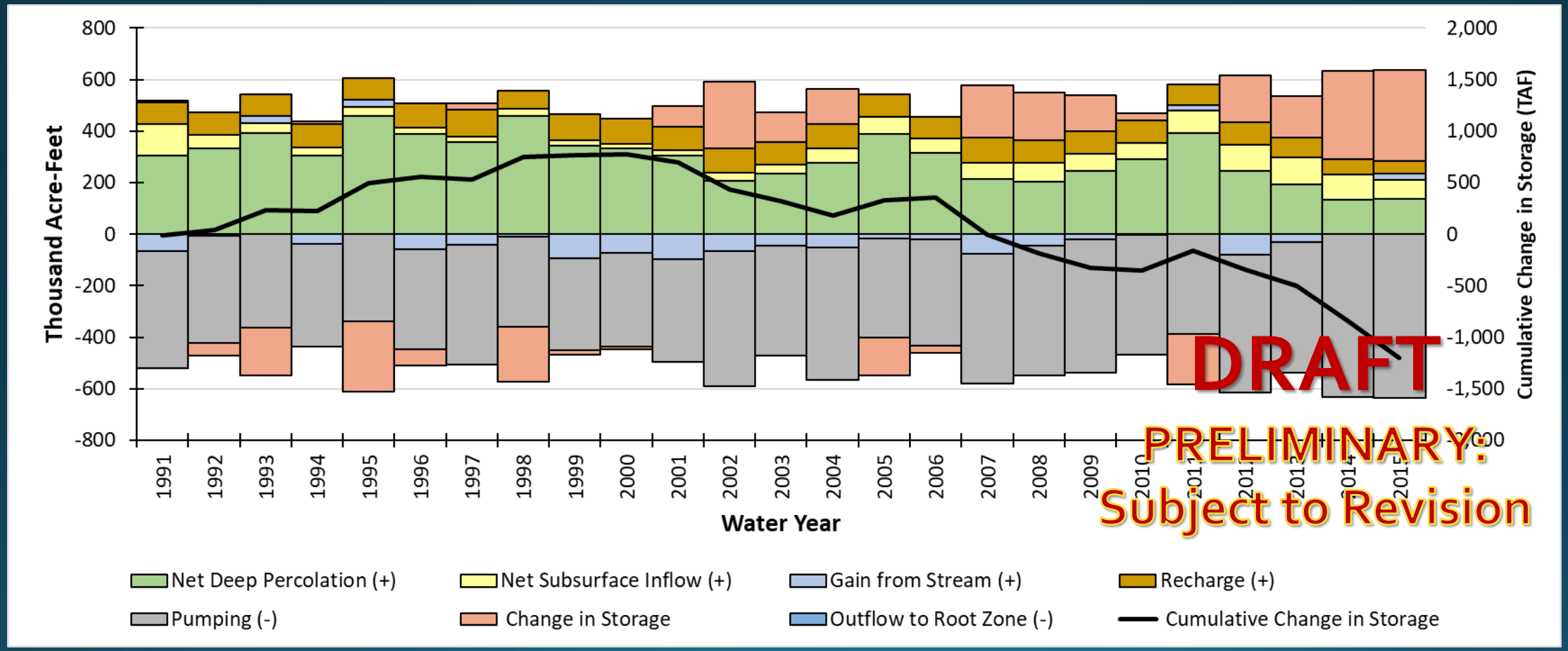
Observed vs. Simulated GWLs
East Turlock Subbasin GSA



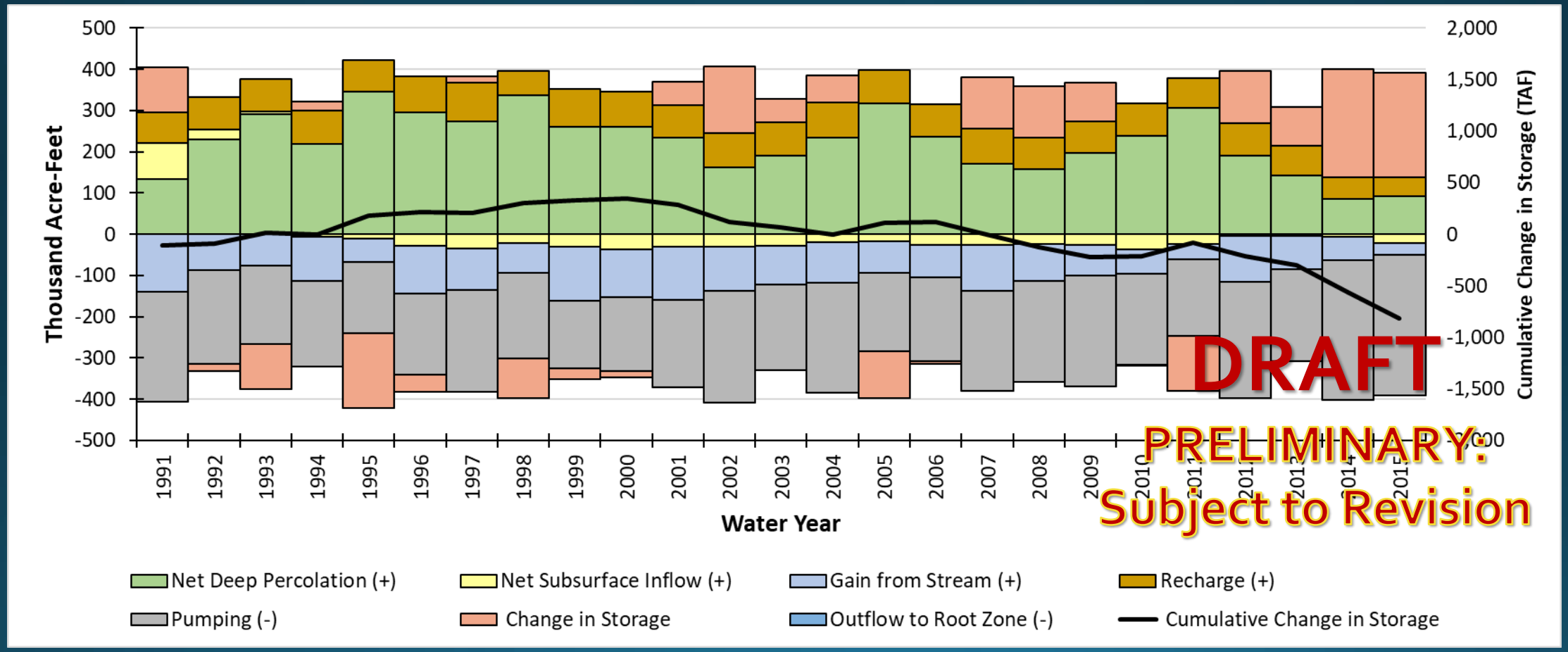


Groundwater Budgets

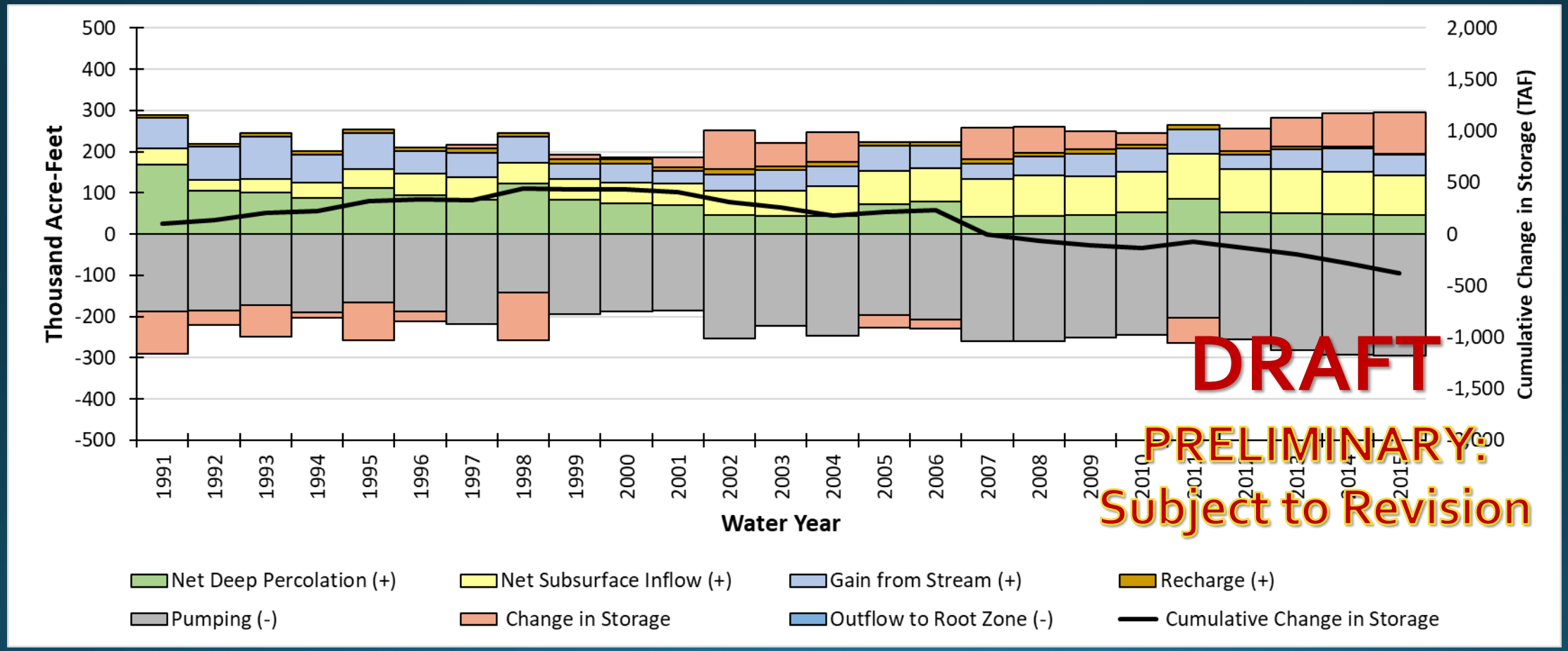
Turlock Subbasin
Groundwater Budget



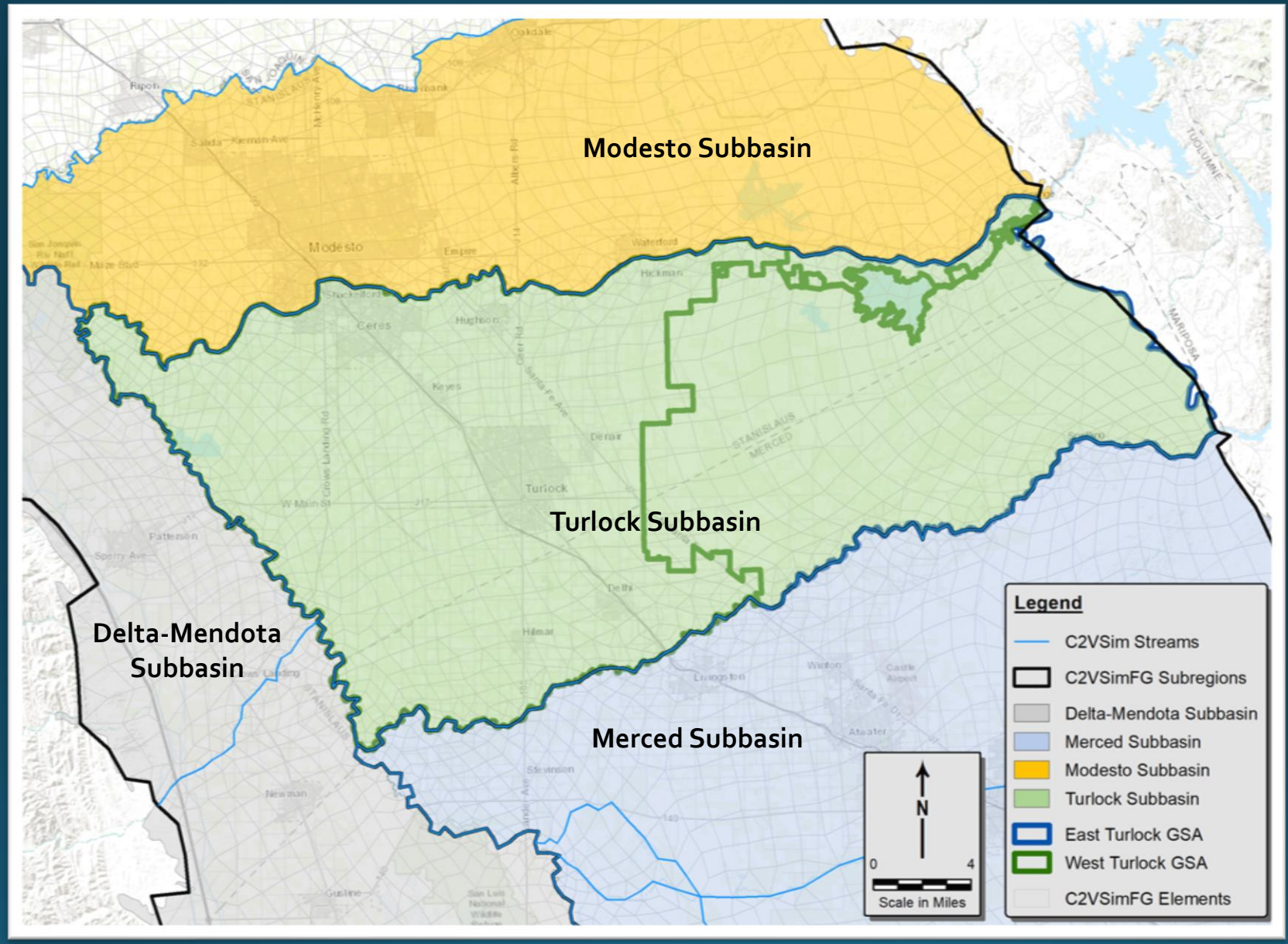
West Turlock Subbasin GSA
Groundwater Budget

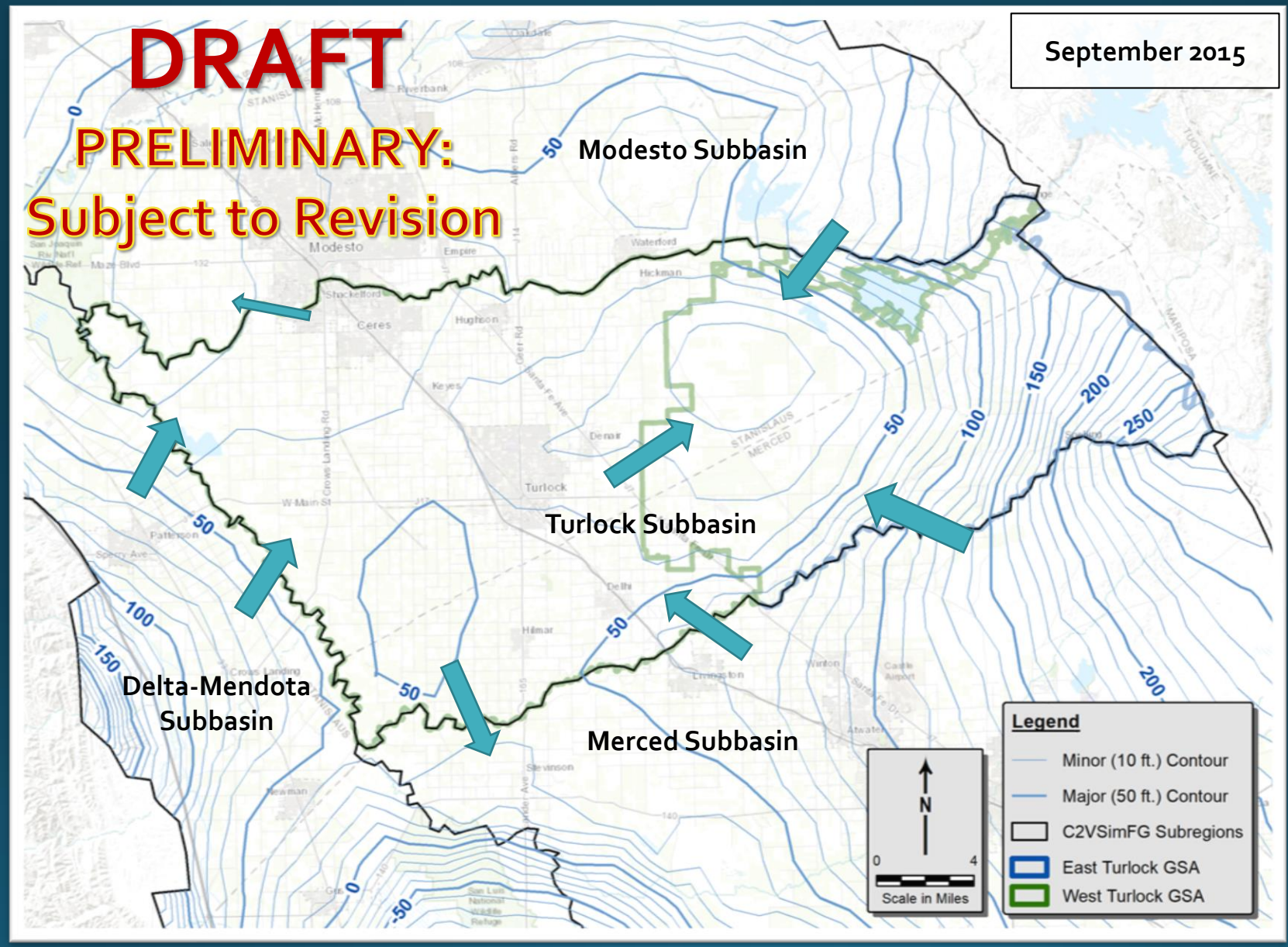


East Turlock Subbasin GSA
Groundwater Budget

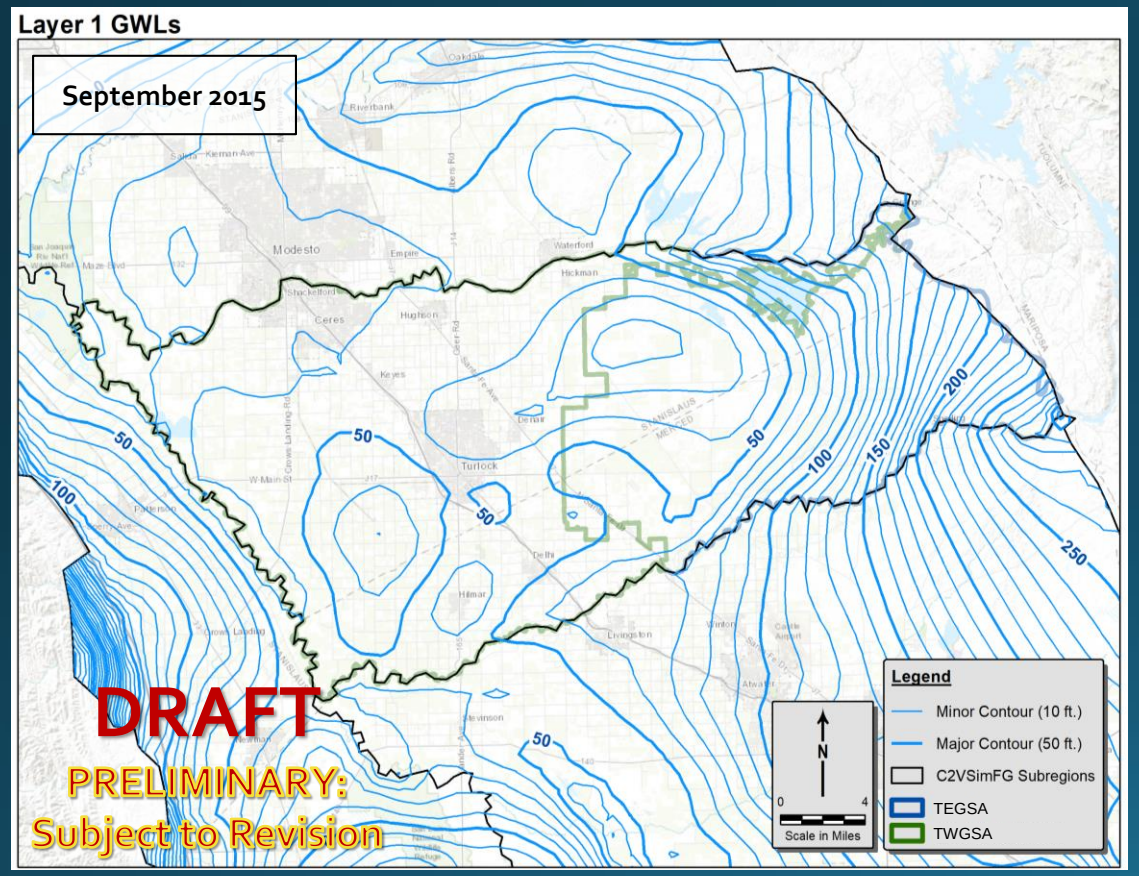


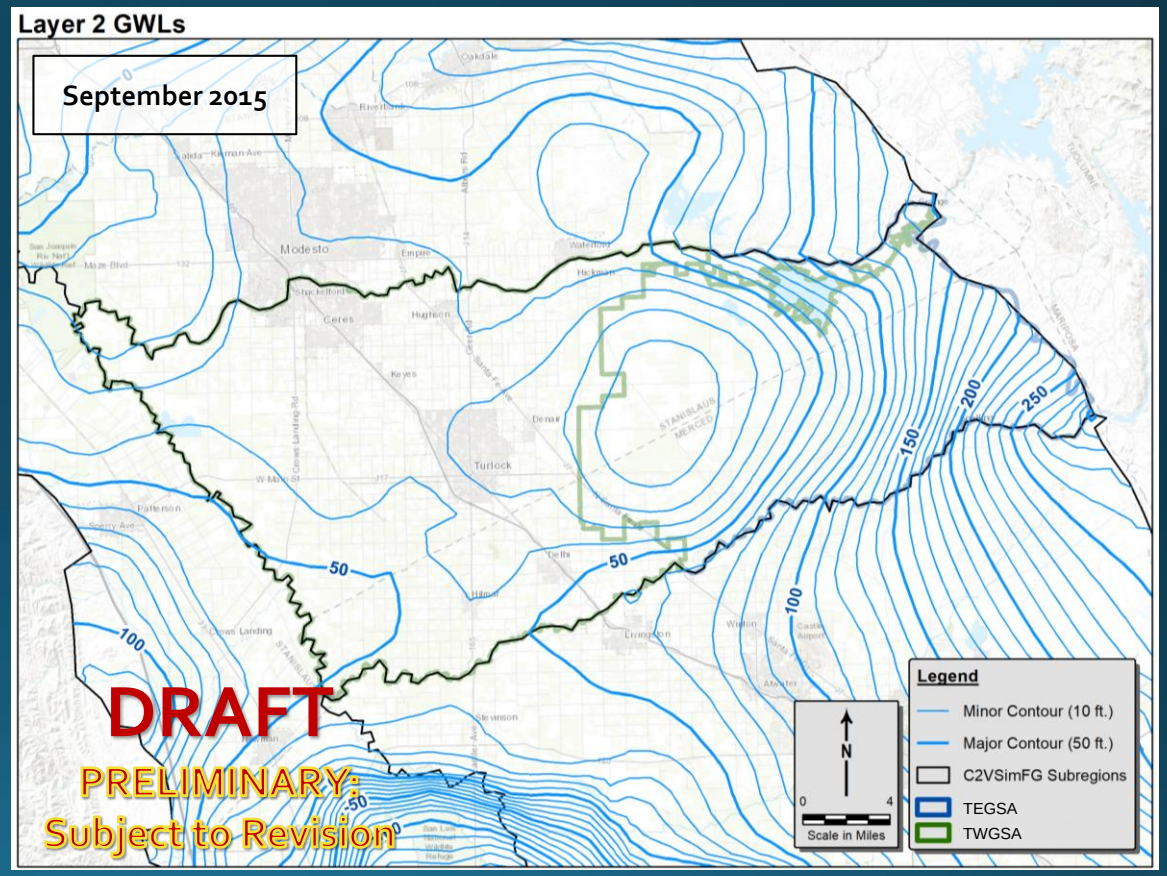
Interbasin Flows


Modesto Subbasin
Turlock Subbasin
Merced Subbasin
Delta-Mendota Subbasin
Legend
C2VSim Streams
C2VSimFG Subregions
Delta-Mendota Subbasin
Merced Subbasin
Modesto Subbasin
Turlock Subbasin
East Turlock GSA
West Turlock GSA
C2VSimFG Elements
N
0
4
Scale in Miles

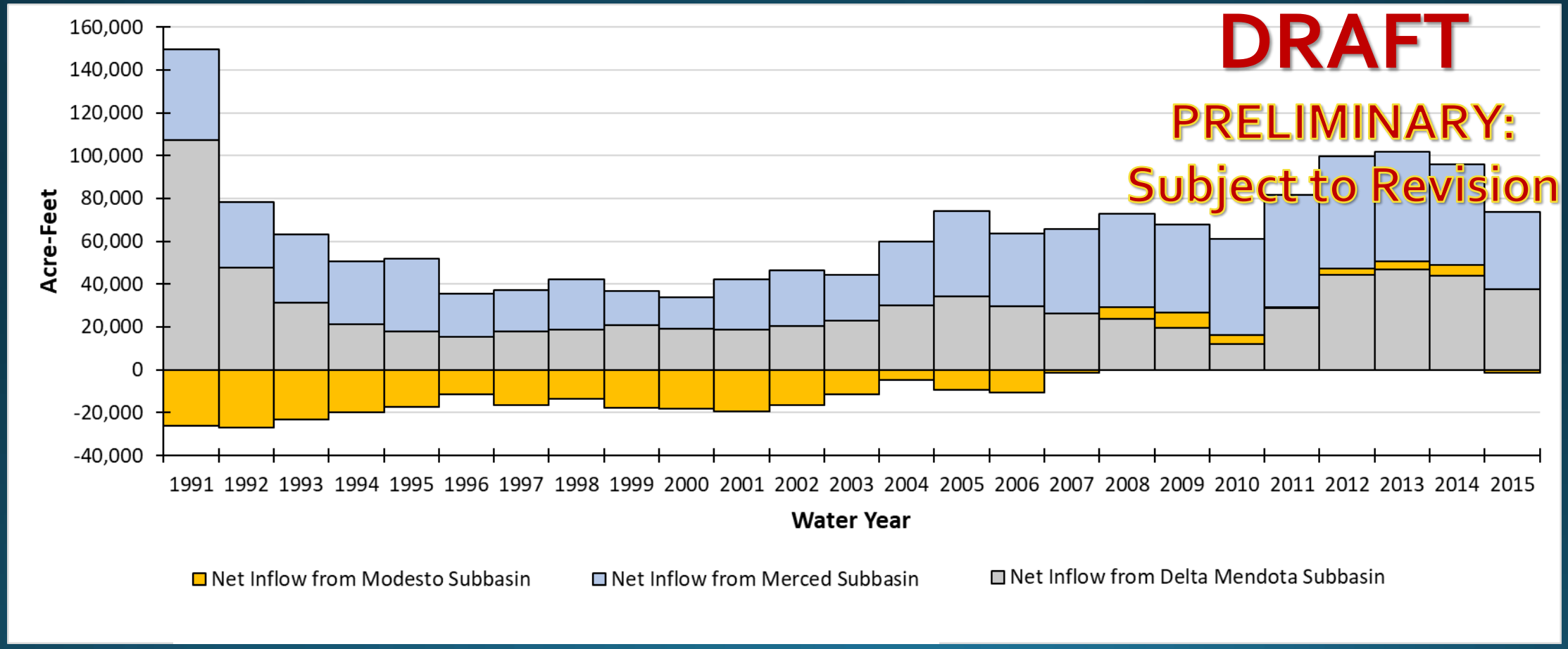

DRAFT
PRELIMINARY:
Subject to Revision
September 2015
Modesto Subbasin
Turlock Subbasin
Merced Subbasin
Delta-Mendota
Subbasin
Legend
Minor (10 ft.) Contour
Major (50 ft.) Contour
C2VSimFG Subregions
East Turlock GSA
West Turlock GSA
N
0
4
Scale in Miles

Layer One and Two Subsurface Flows
Turlock Subbasin

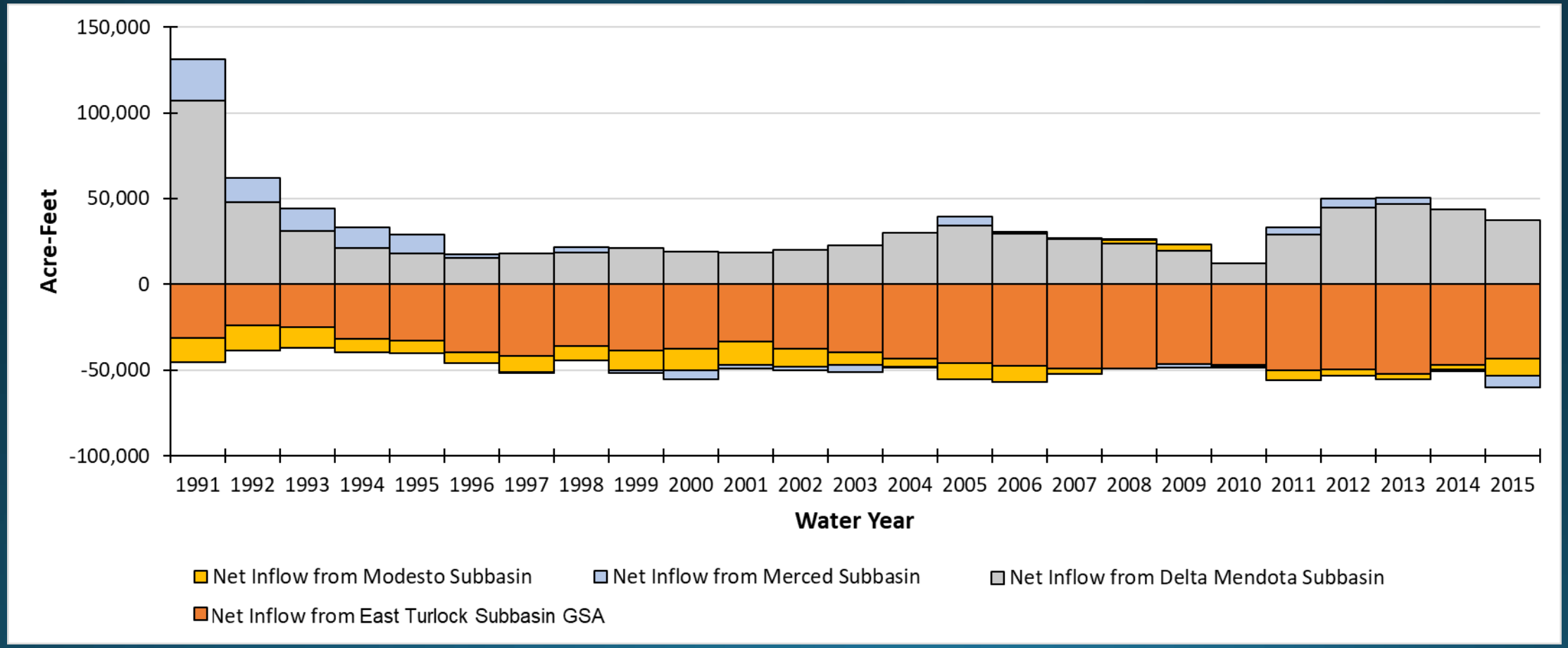




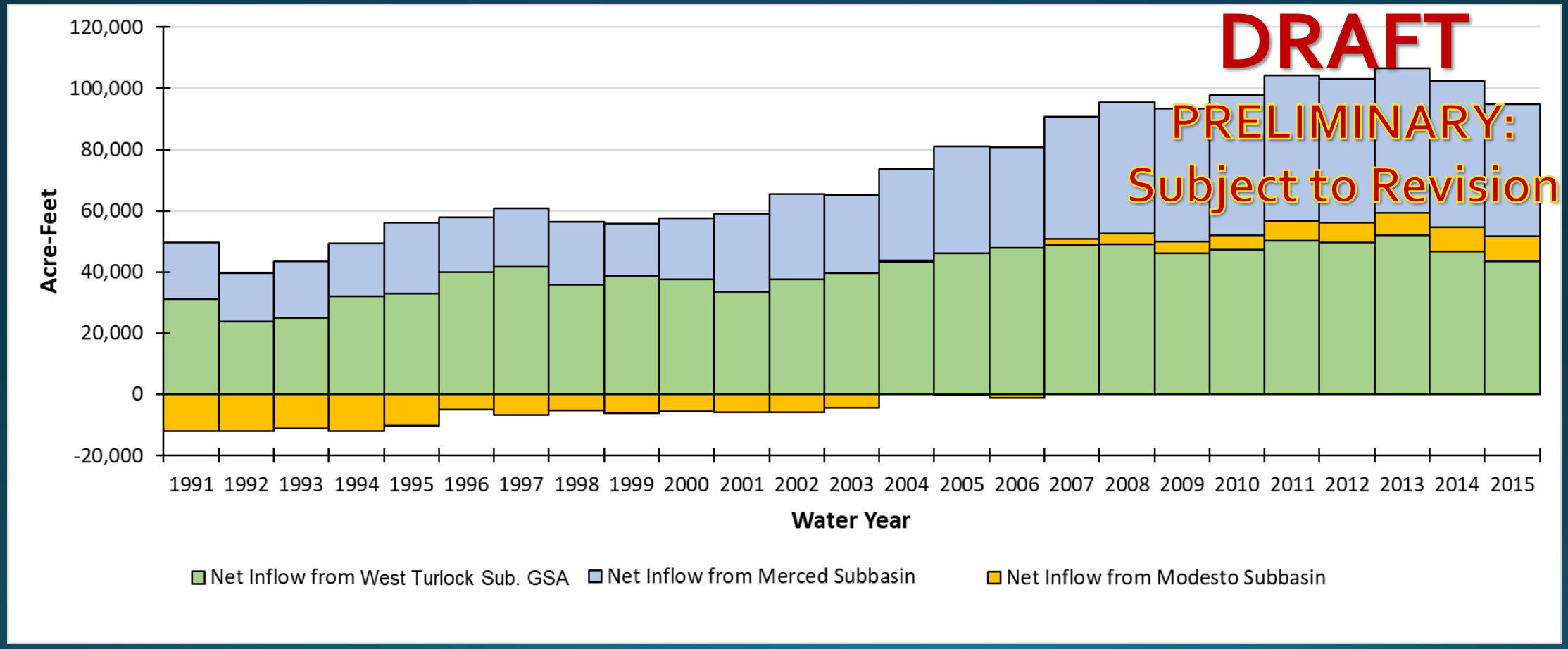
Turlock Subbasin
Subsurface Flows



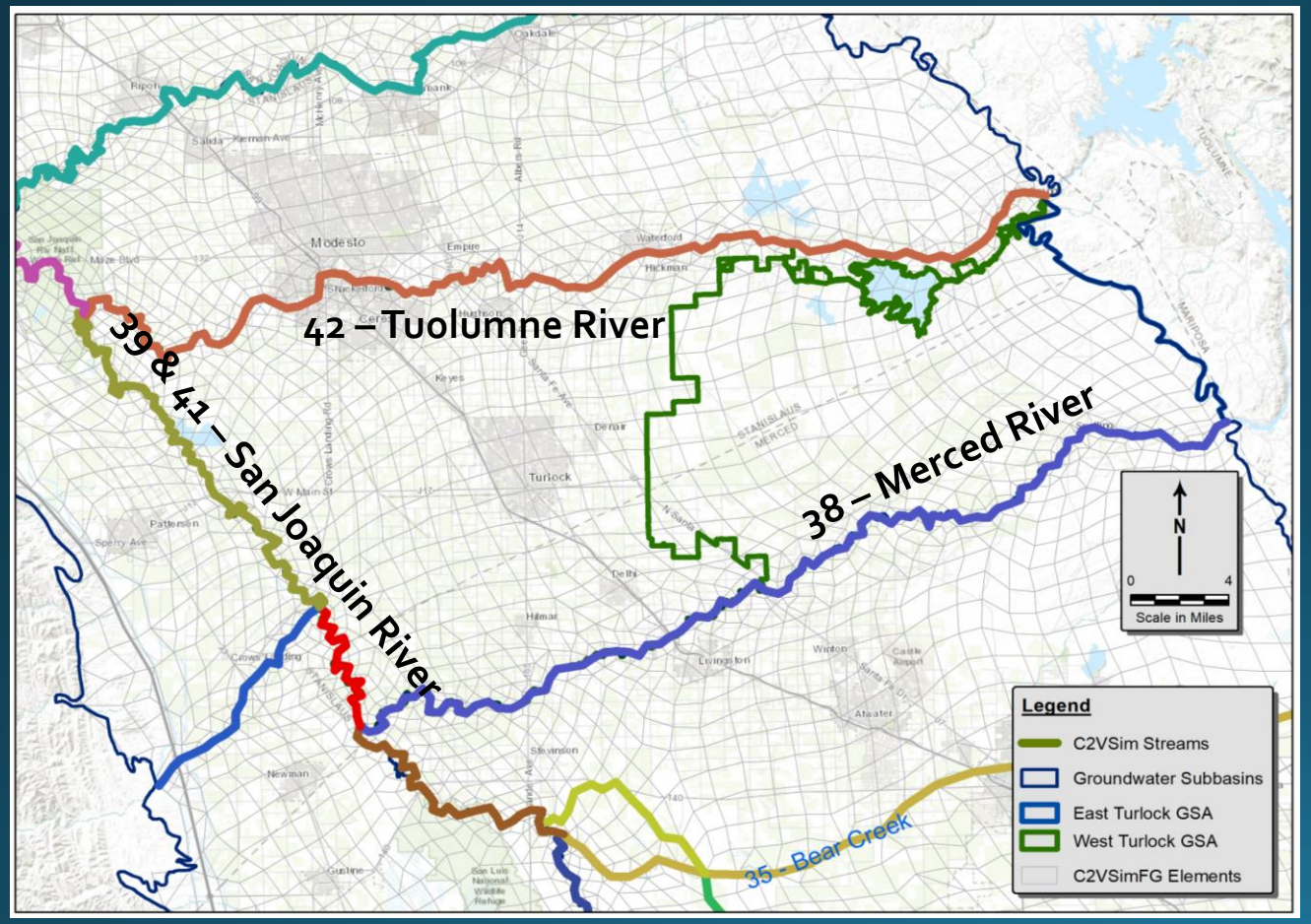
West Turlock Subbasin GSA
Subsurface Flows



East Turlock Subbasin GSA
Subsurface Flows

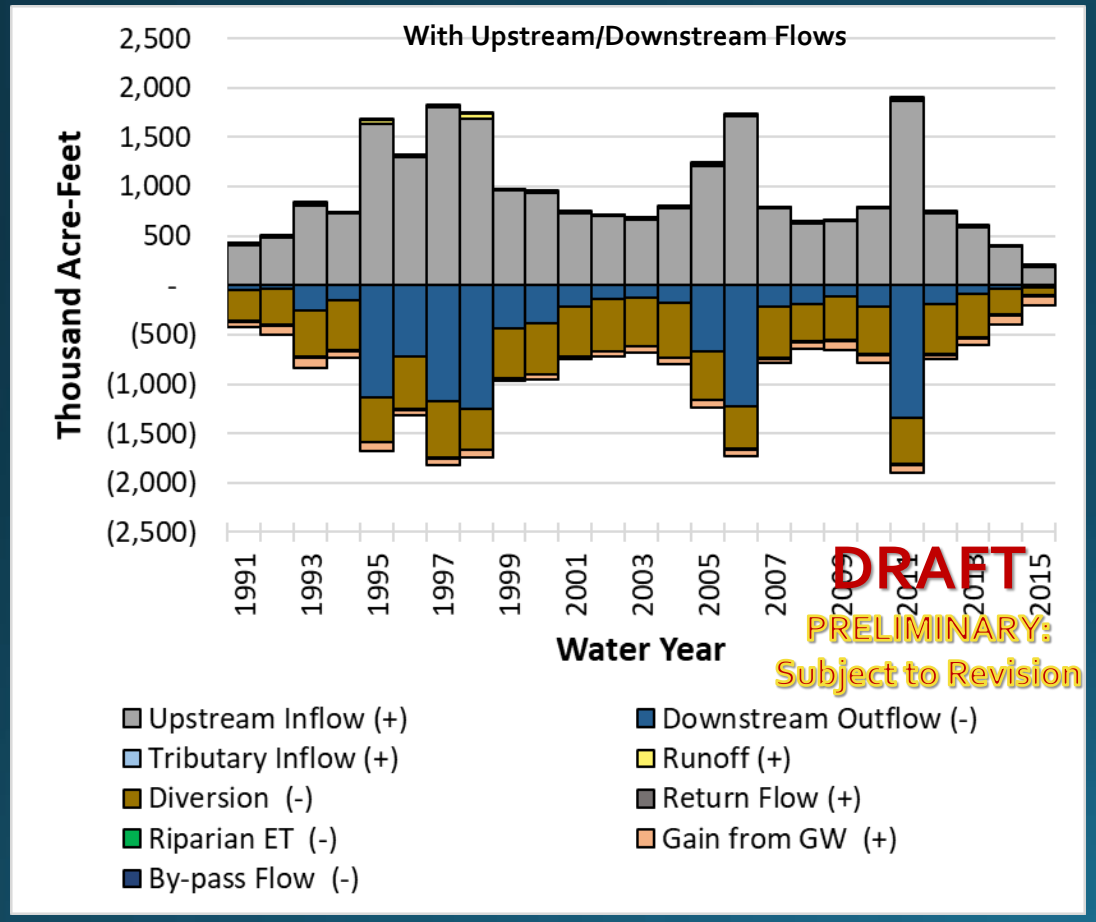


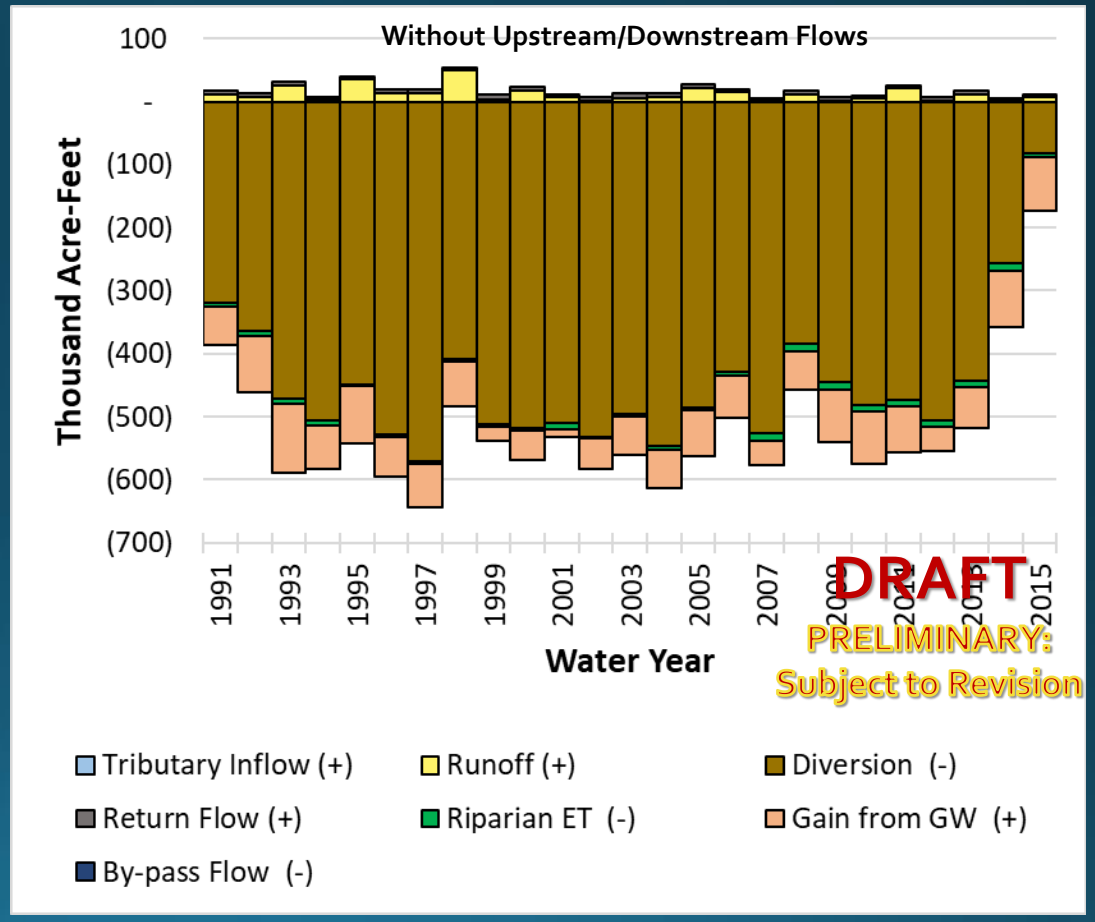
C2VSimFG Stream Reaches



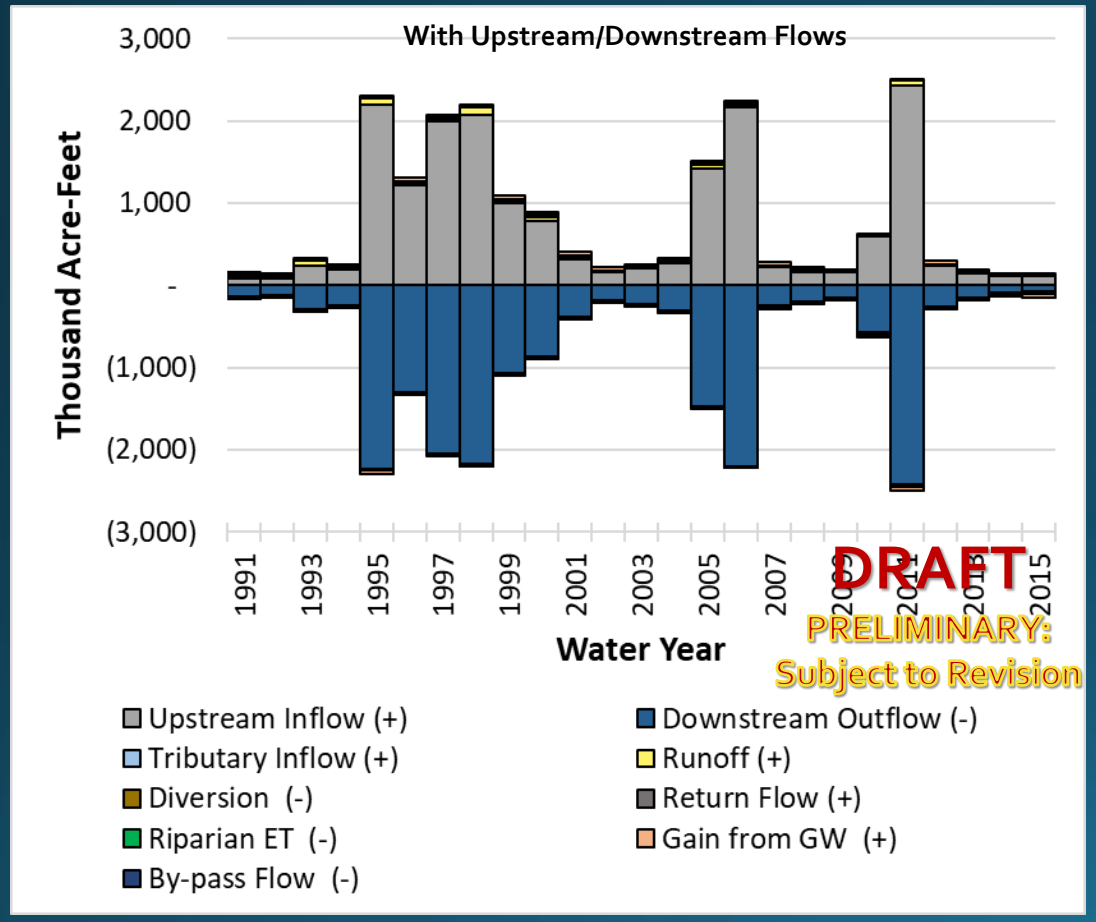
- Four Reaches adjacent to Turlock Subbasin
  - Tuolumne River
  - Merced River
  - San Joaquin River
    (Two Reaches)

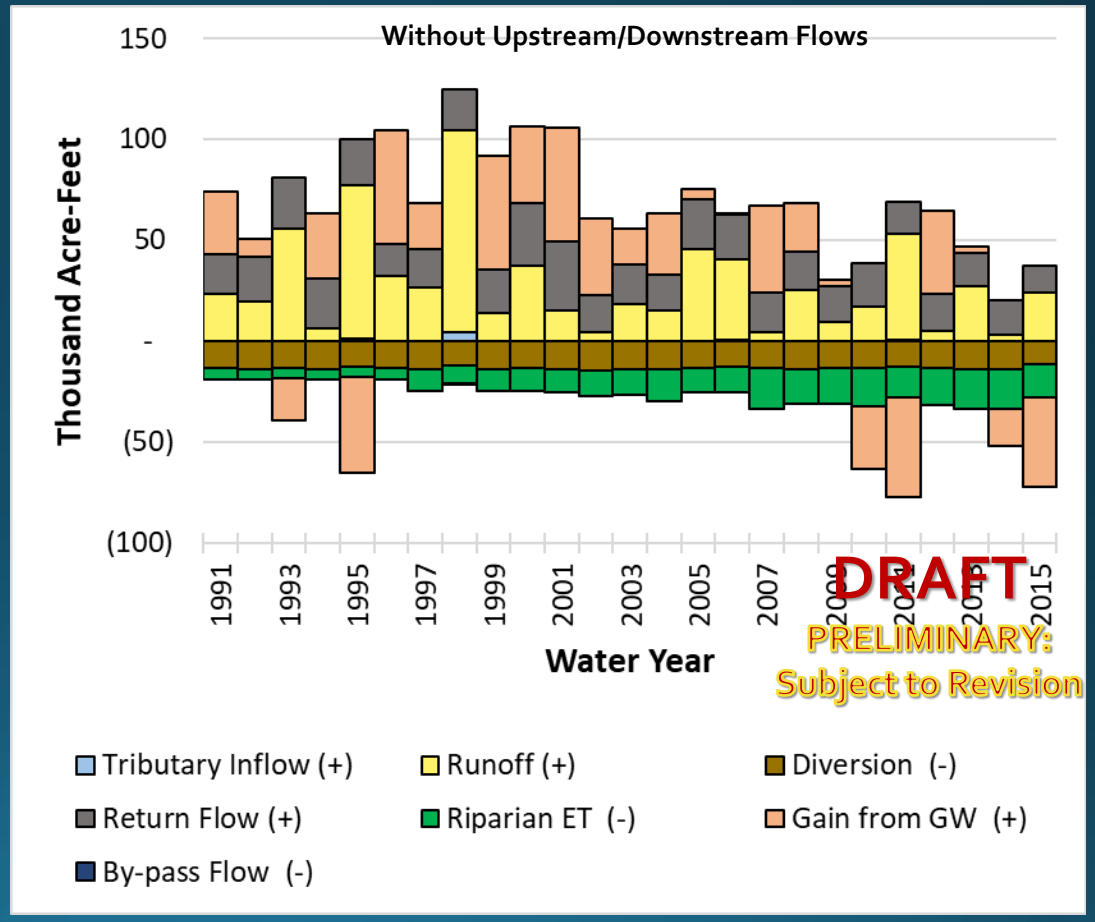
Merced River Budget



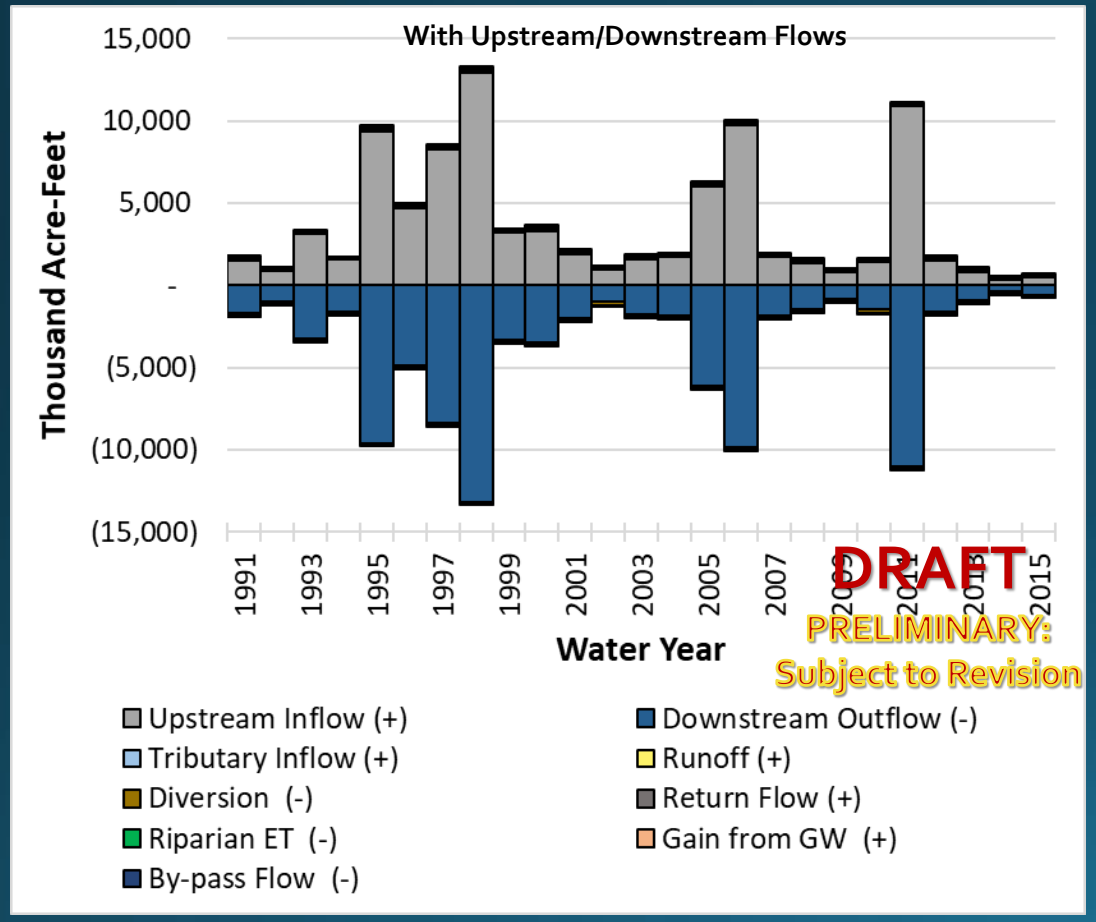


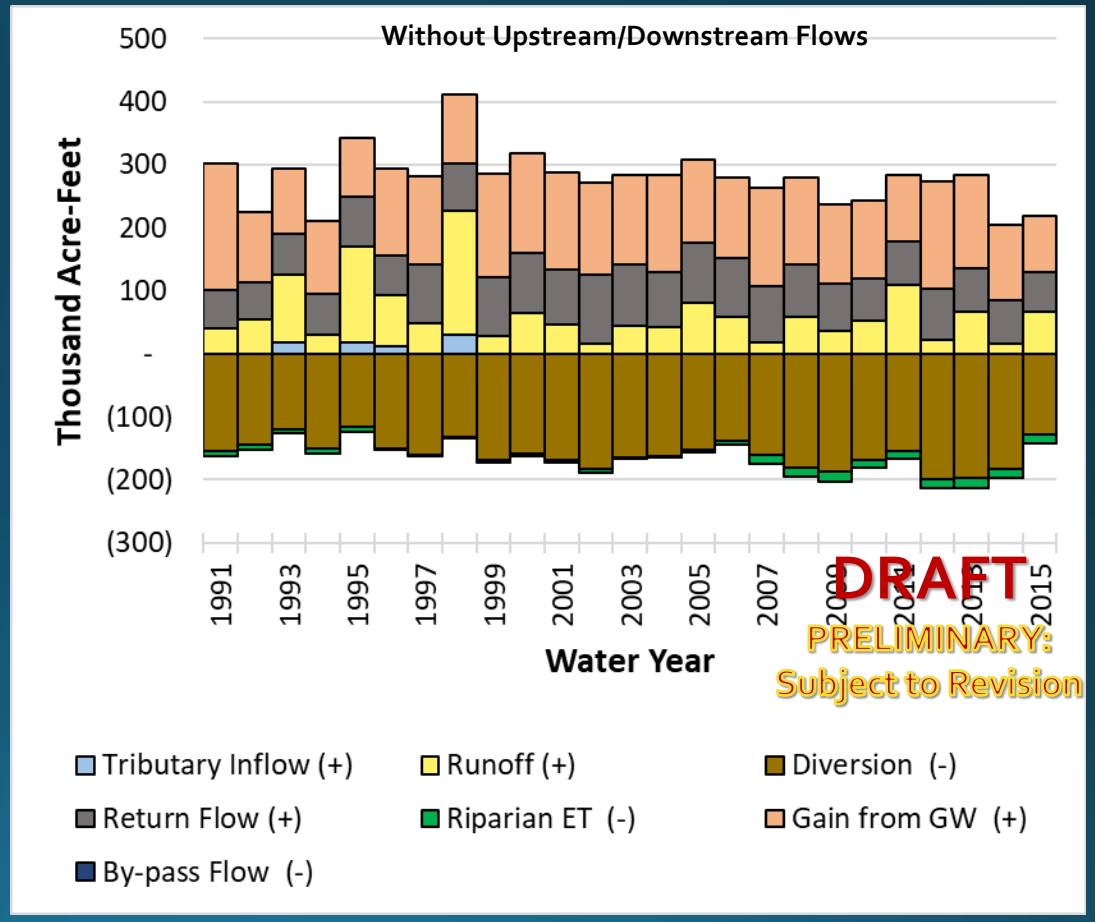
Tuolumne River Budget





San Joaquin River Budget





Next Steps

1. Finalize model calibration with refinements in:
   - Land surface components
   - Aquifer parameters
   - Stream-Aquifer Interactions
   - Boundary Flows
   - Correct Initial Conditions
2. Develop current and projected conditions baselines
3. Perform sustainability analysis
4. Development and analysis of sustainable management scenarios

Thank you for your time