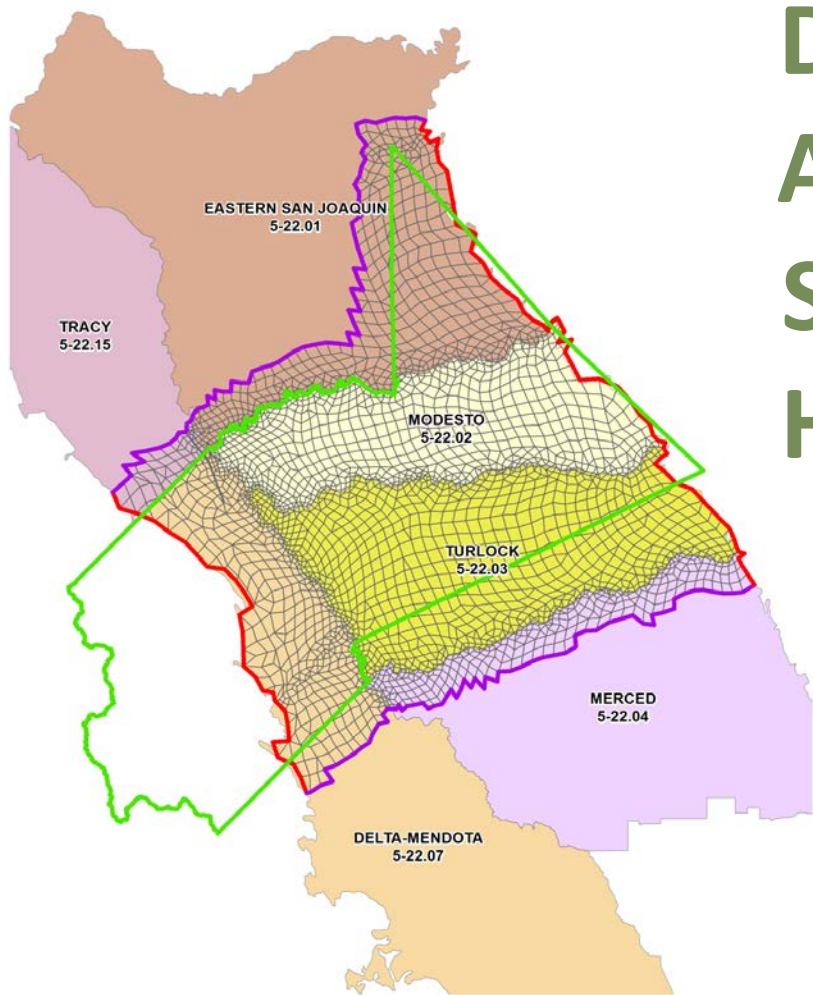


Development and Application of the Stanislaus County Hydrologic Model

26th GRA Annual Meeting
October 3, 2017

JACOBSON | JAMES
& a s s o c i a t e s , i n c



Acknowledgments

The Stanislaus County Hydrologic Model is part of an project financed under the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Sustainable Groundwater Planning Grant Program), administered by State of California, Department of Water Resources.

Local Contributors Include:

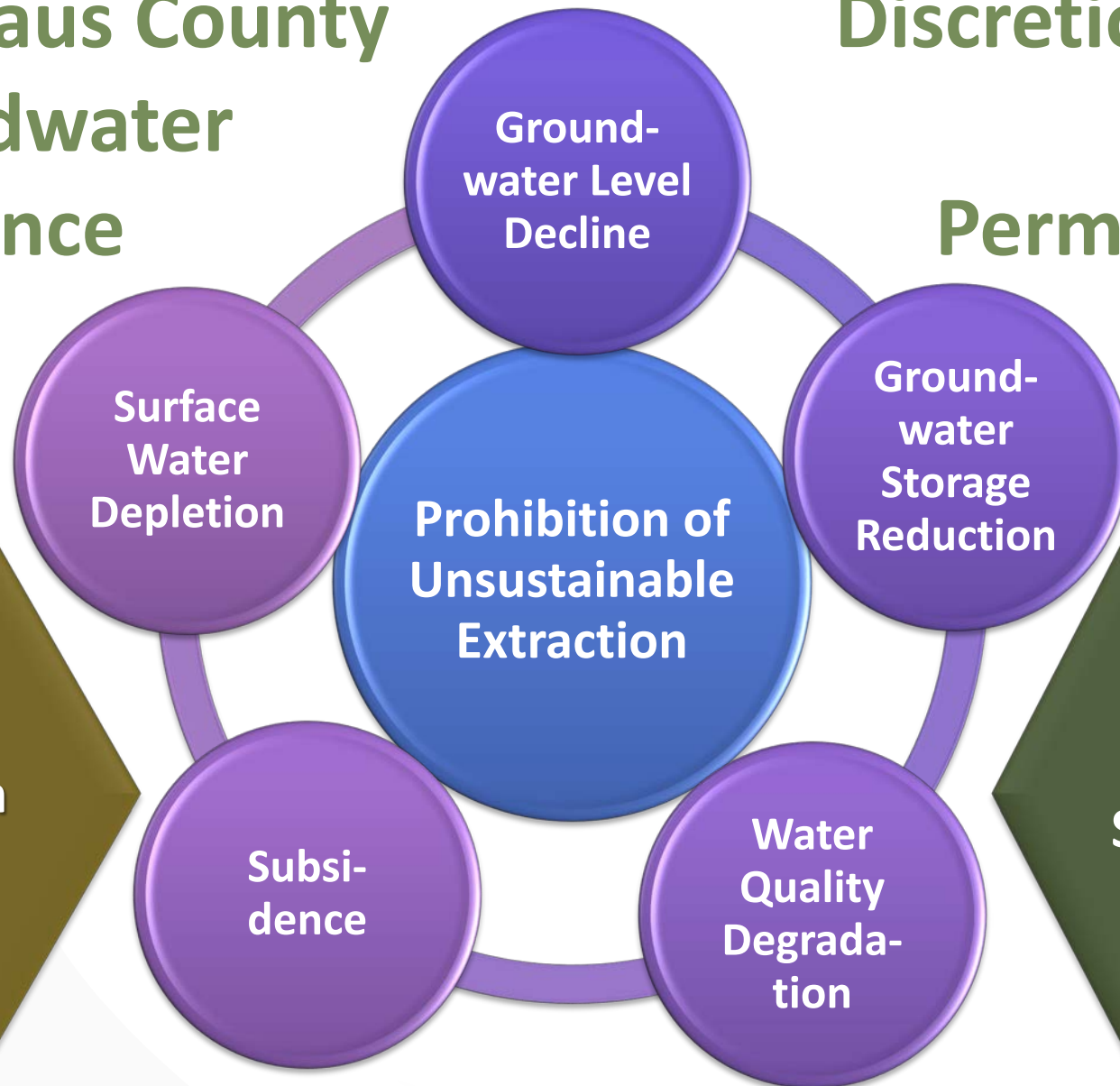
Stanislaus County	City of Patterson	Oakdale ID	Rock Creek WD
City of Modesto	City of Newman	Eastside WD	Trinitas Farming
City of Turlock	City of Waterford	Del Puerto WD	MCCV
City of Ceres	City of Hughson	West Stanislaus ID	Agricultural Preservation Alliance, Inc.
City of Riverbank	Turlock ID	Central Calif. ID	
City of Oakdale	Modesto ID	Patterson ID	

Outline

- ✓ **Overview and modeling objectives**
- ✓ **Basic model construction**
- ✓ **Hydraulic conductivity refinements**
- ✓ **Water budget**
 - Subregions
 - Agricultural water budget adjustments
 - Municipal and industrial pumping
 - Rural domestic pumping
- ✓ **Calibration**
- ✓ **Findings**

Stanislaus County Groundwater Ordinance

Discretionary Well Permitting

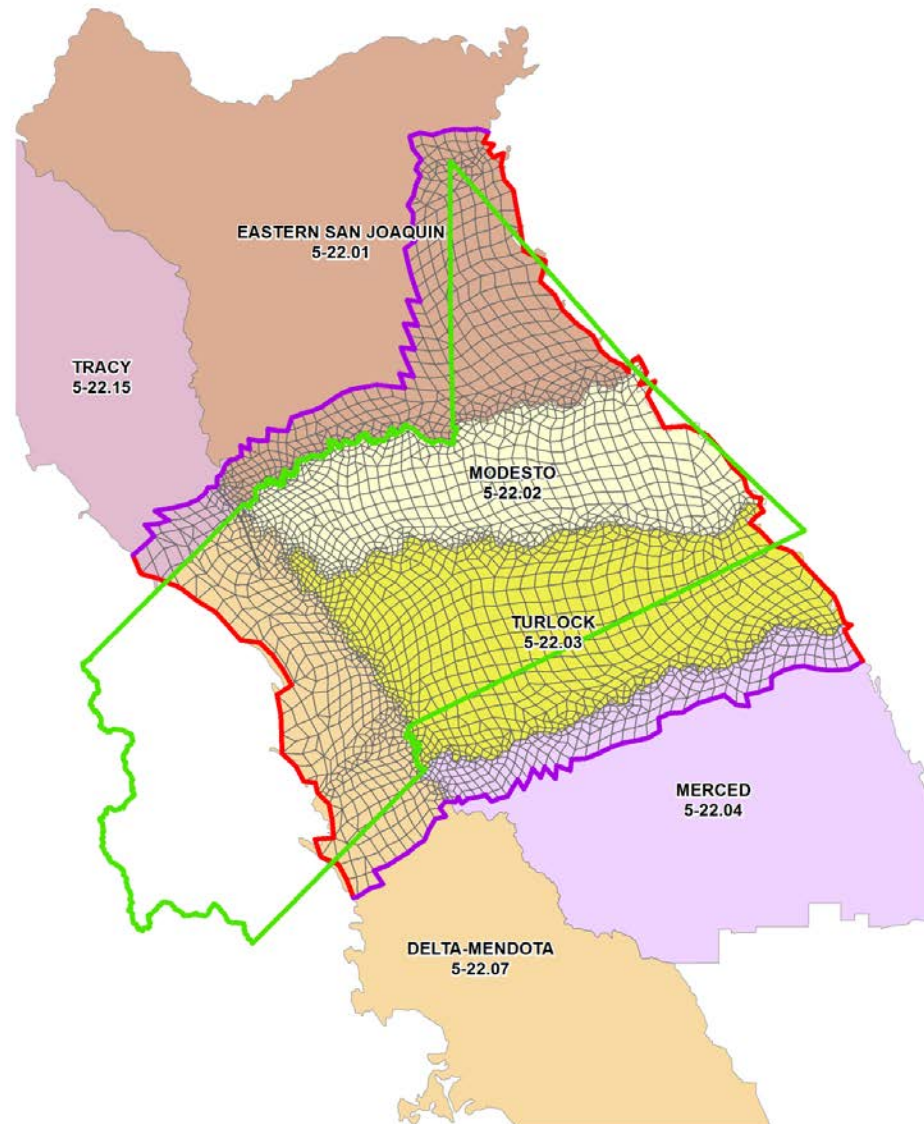


County
Exercises
Deliberation
and
Judgment

Applicant
Provides
Substantial
Evidence

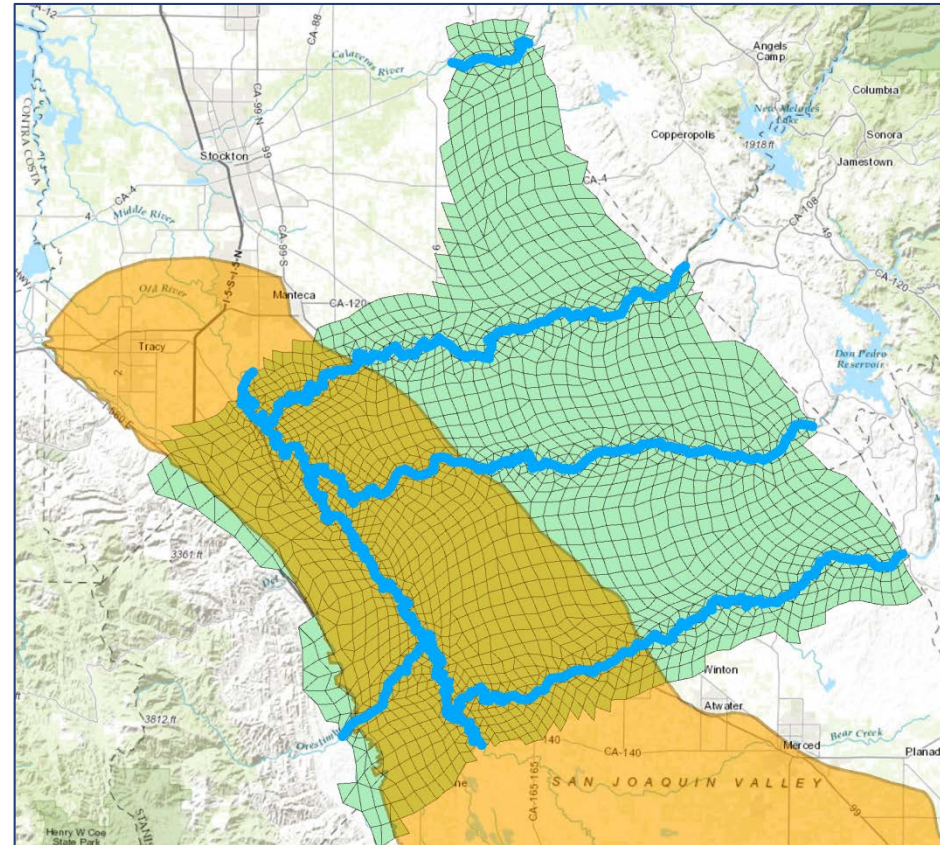
Modeling Objectives

- ✓ **Develop a “county-wide” model for WY 1991-2015:**
 - Includes the entire Turlock Subbasin
 - Adequate to evaluate potential impacts associated with Groundwater Ordinance implementation
 - Updated an existing regional model with local data from stakeholders, plans, reports, and other models
- ✓ **Provide data that is helpful to GSAs:**
 - Compile data and references in a searchable library
 - Make the model available for preliminary evaluation of questions of interest



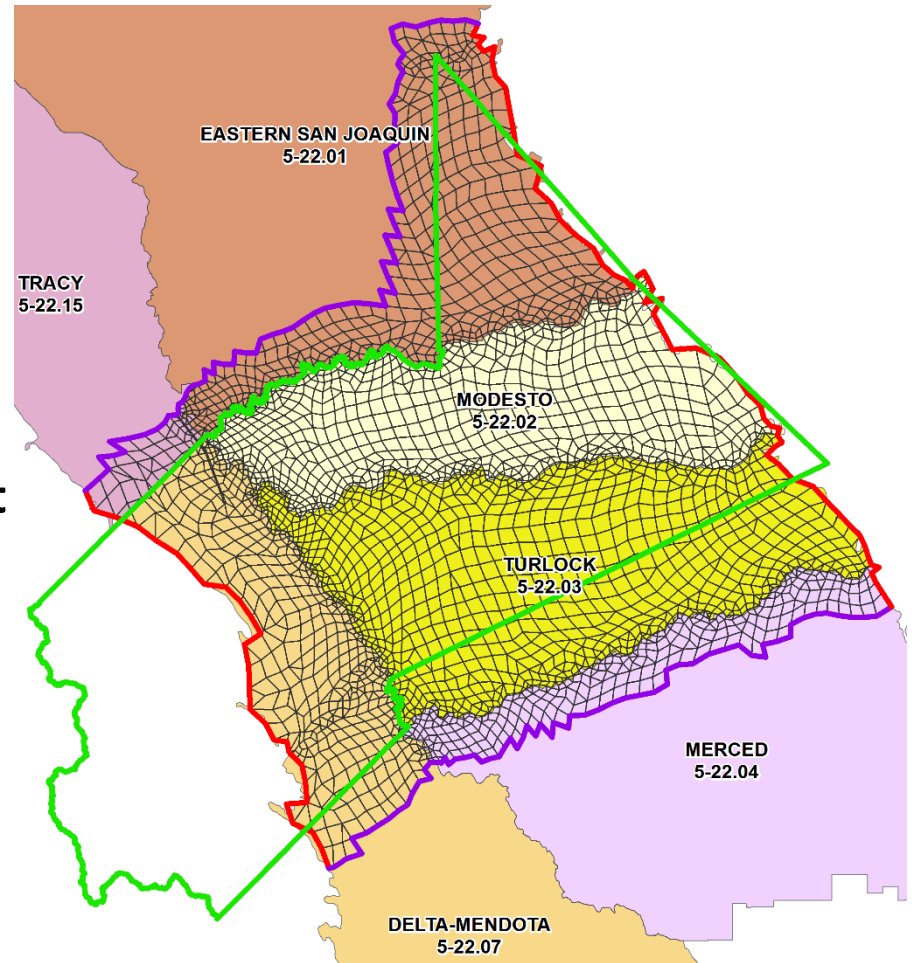
SCHM Basic Construction

- ✓ **Base model extracted from beta C2VSim-FG R374g, using IWFM 3.02 (WY 1922-2009)**
- ✓ **Aquifer Layering**
 - Same as C2VSim
 - Preliminary K values from USGS MERSTAN model (texture-based)
- ✓ **Corcoran Clay**
 - Vertical flow impedance at top of layer 2
 - Thickness and extent of Corcoran Clay from USGS
 - Western extent allows mountain front recharge
 - Preliminary uniform K_v of 10^{-5} ft/day selected based on literature values



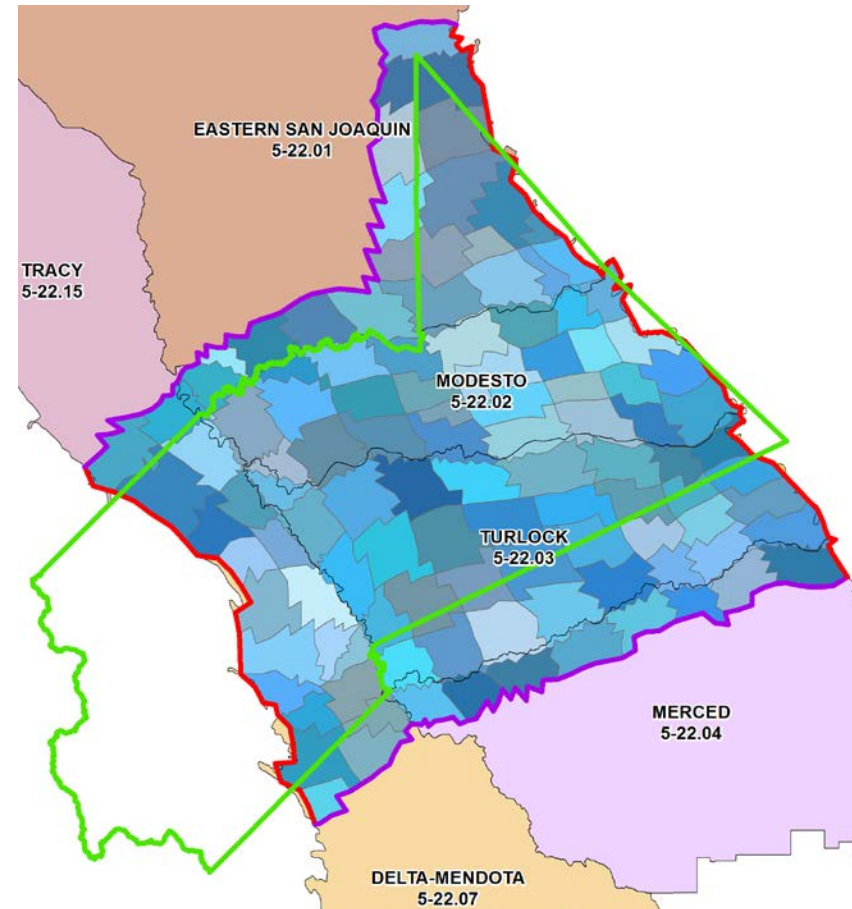
Boundary Conditions

- ✓ **No flow boundaries at mountain fronts**
- ✓ **Time-dependent general head boundaries**
 - Head data from C2VSim output through WY 2009
 - WY 2010-2015 heads derived using C2VSim WY 1985-1990 water level changes to mimic drought



Water Budget Subregions

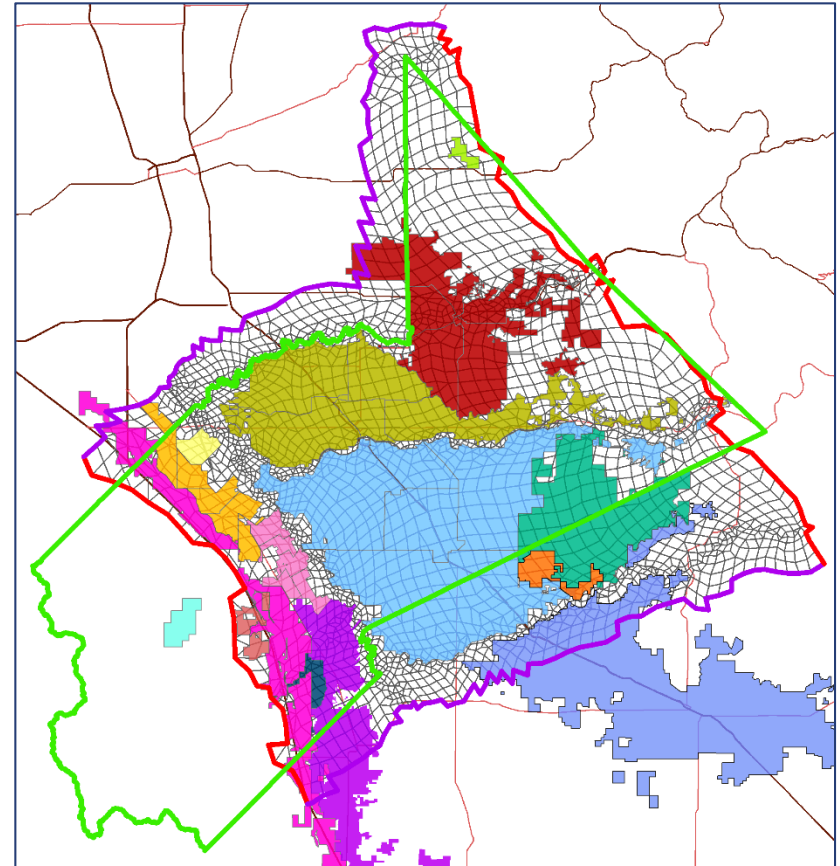
- ✓ **Preliminary land-use data from DWR for yet-to-be released C2VSim 2015**
 - Land use at CG elemental level
 - Based on county survey data, with interpolation/extrapolation for years without surveys.
- ✓ **108 subregions set up to accommodate data**
 - 22 crop categories combined into the old 14 C2VSim categories
 - Crop demand and rooting depths from the old C2VSim
- ✓ **Scaled surface water diversions to new subregions**



Agricultural Water Budget Adjustment

✓ Compared/Adjusted Data

- Water diversion, delivery, groundwater pumping, and cropping data
- Compared data from districts, AWMPs, MSRs, other plans, and EWRIMS to data extracted from SCHM for district service areas
- Adjusted ag acreage
- Adjusted diversion allocations and loss fractions to deliveries

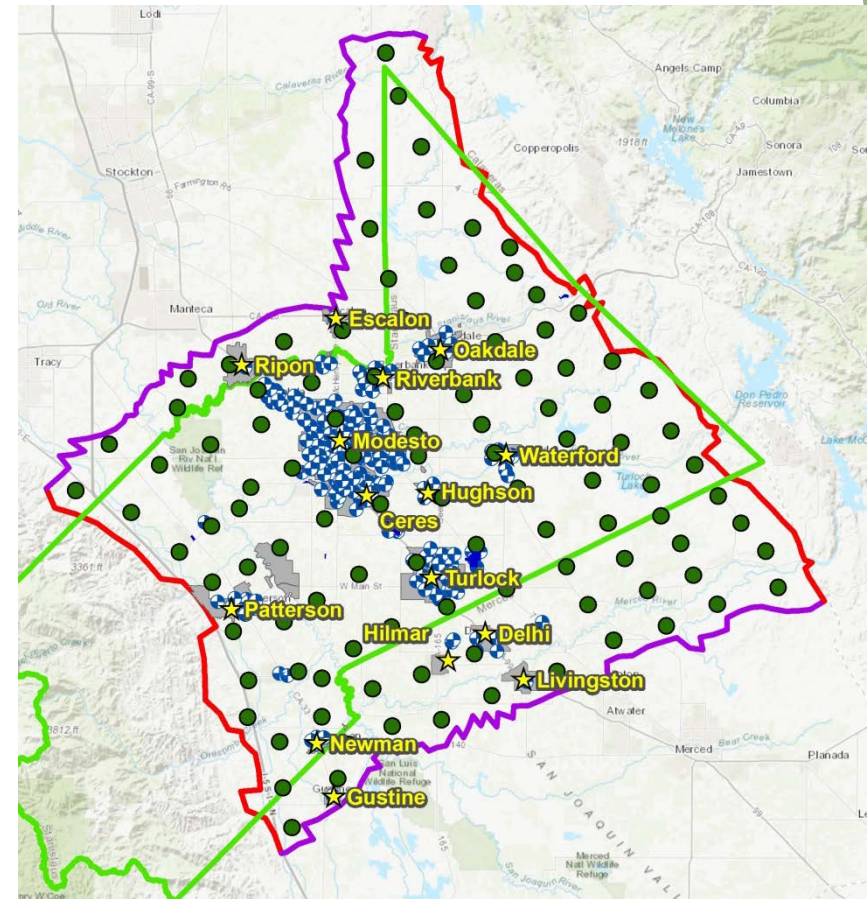


Municipal & Industrial Pumping

- ✓ **220 Municipal Wells**
 - Replaced 12 surrogate M&I wells in C2VSim
 - Data from Stakeholders, MSRs, UWMPs, and other plans/reports
 - Locations, depths and screen intervals

- ✓ **Municipal Pumping**
 - Data from stakeholders, UWMPs, MSRs, other plans
 - Interpolated as needed between data sources
 - Extrapolated as needed based on trends or population data

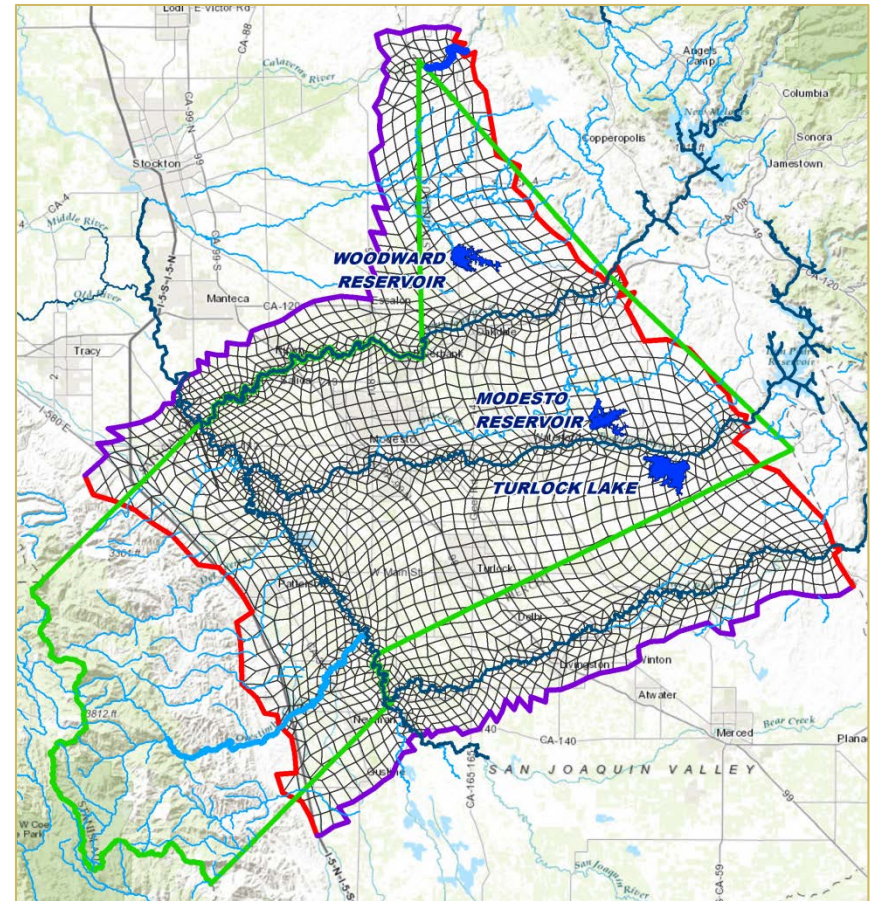
- ✓ **Rural Domestic Pumping**



- Surrogate Rural Domestic Pumping Wells
- M&I Pumping Wells

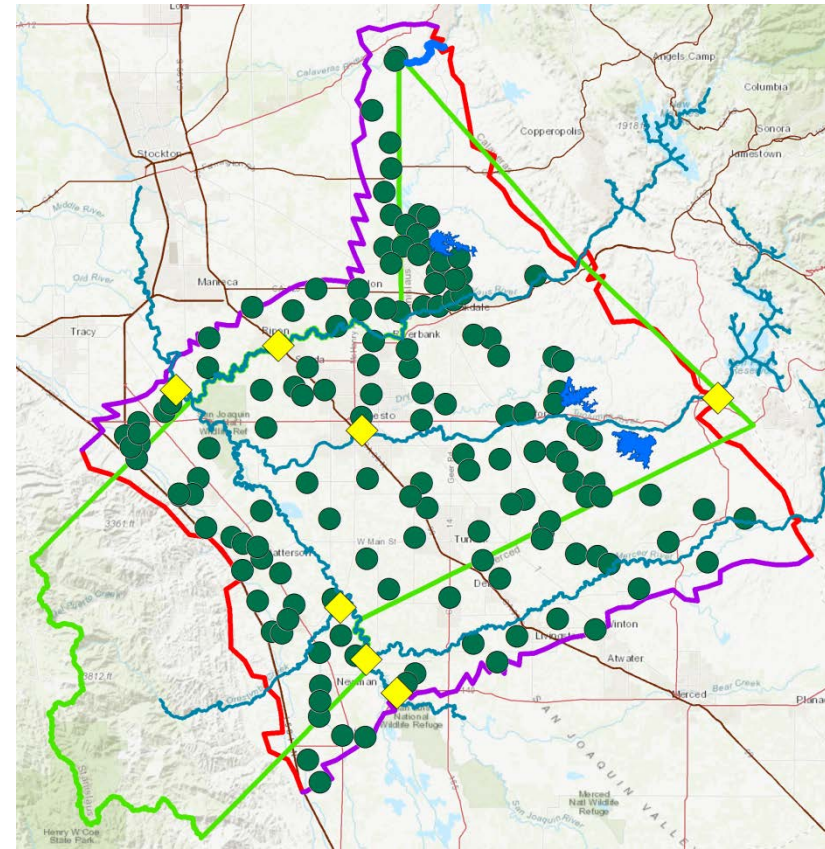
Surface Water

- ✓ **Reservoir Leakage**
 - Water balance data from AWMPs, CEDEC, and/or districts
 - Seasonally adjusted leakage rates, provided or based on ET_0
- ✓ **Streams & Diversions**
 - Stream nodes and conductance values from C2VSim
 - Six major inflows through WY 2009 from C2VSim extended through 2015 using CalSim and gaging station data
 - 24 diversions, WY 2010-2015 from CalSim and gaging station data, allocated to appropriate subregions based on data



Calibration Dataset

- ✓ **Calibration Period 2000 - 2015 (model WY 1991-2015)**
- ✓ **Calibration Wells**
 - 157 wells (some duplicates in two layers)
 - Hydrograph data compiled from C2VSim and/or DWR Water Data Library for WY 1991 - 2015
- ✓ **Gaging Stations**
 - Total of 7 gaging stations covering each major river, and points entering and exiting the model
 - Data from NWIS for WY 1991 - 2015



- ◆ Calibration Gaging Stations
- Calibration Wells

Calibration

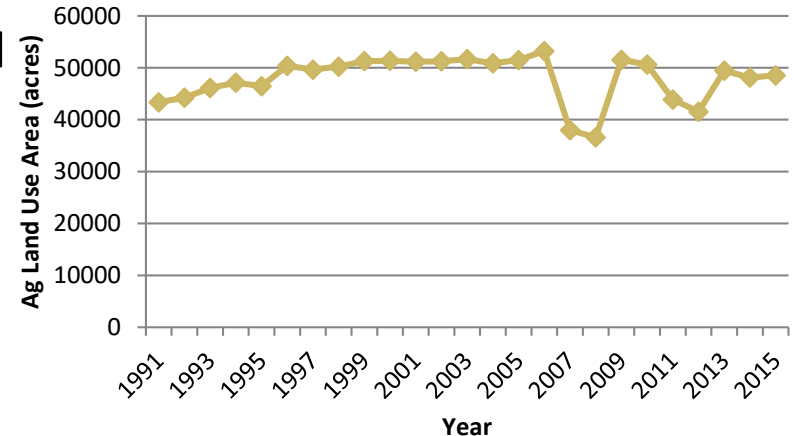
✓ Water Budget Adjustment:

- Diversions/losses to match reported farm gate deliveries
- Irrigation efficiency to match reported pumping
- Ag Acreage to match documented trends in Ag Commissioner data
- Small watershed inflows

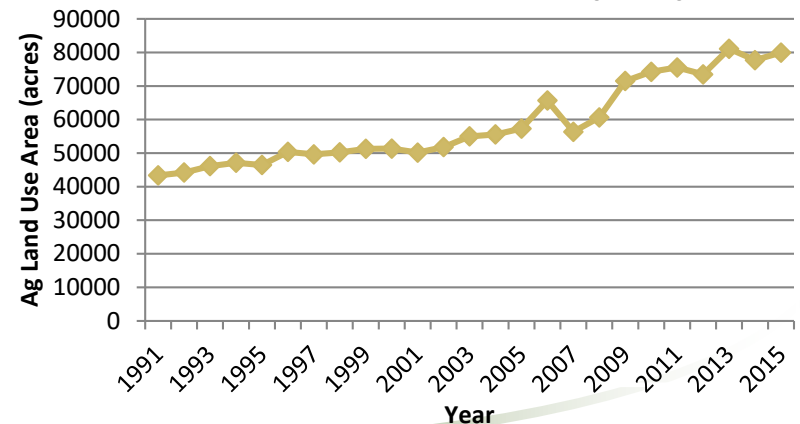
✓ Boundary heads in areas that did not match calibration wells near boundaries

✓ Hydraulic conductivities

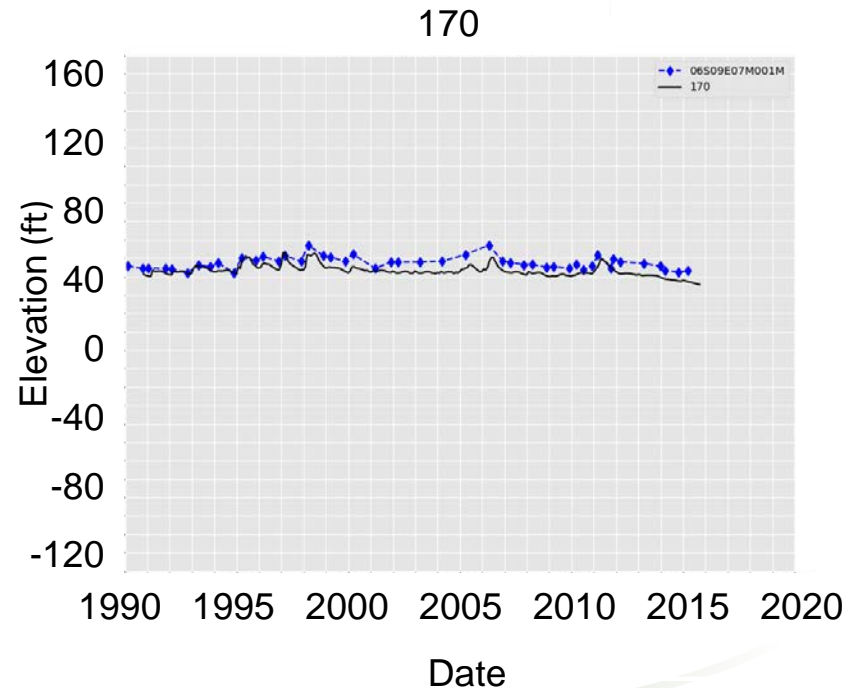
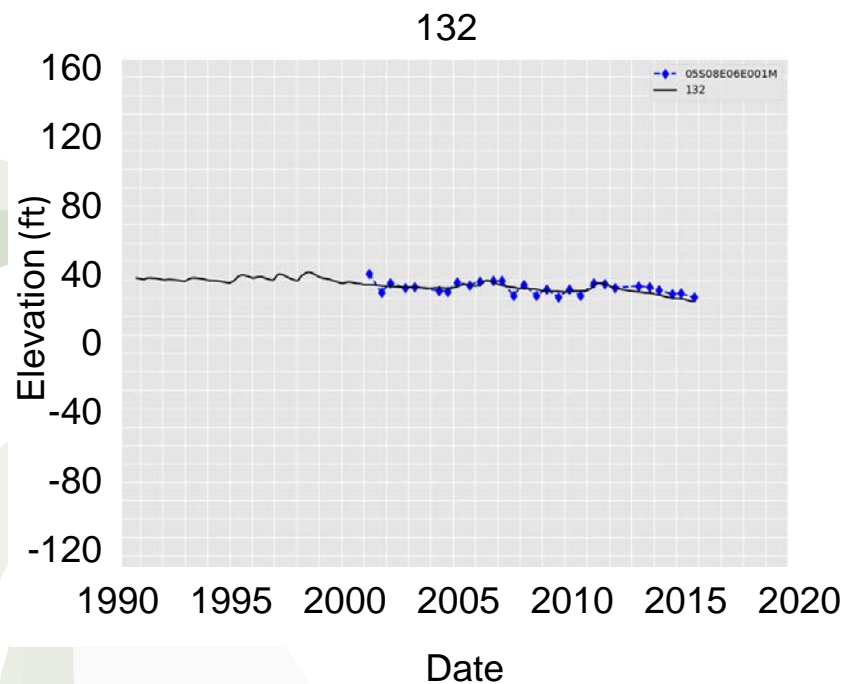
Eastside Water District (Before)



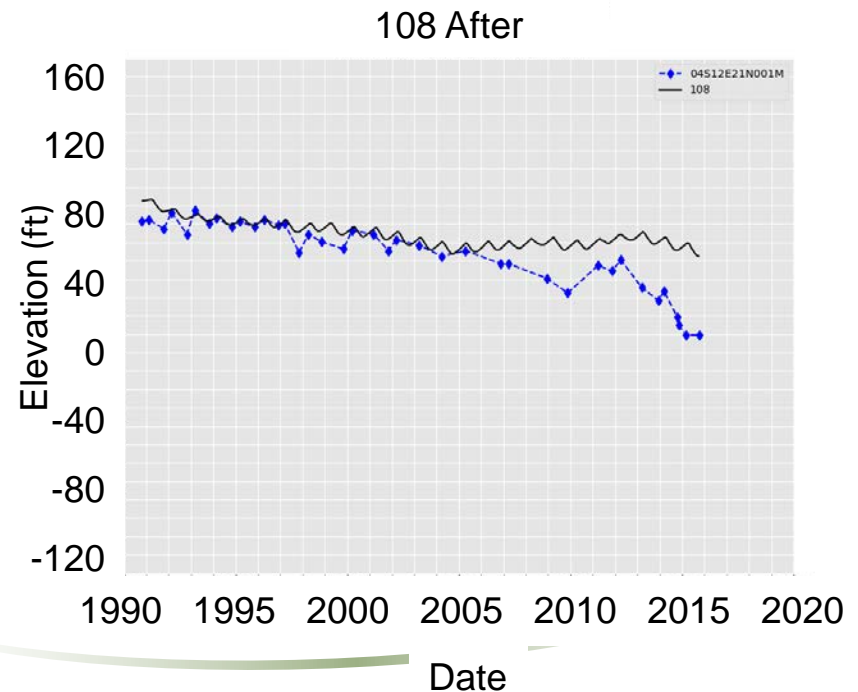
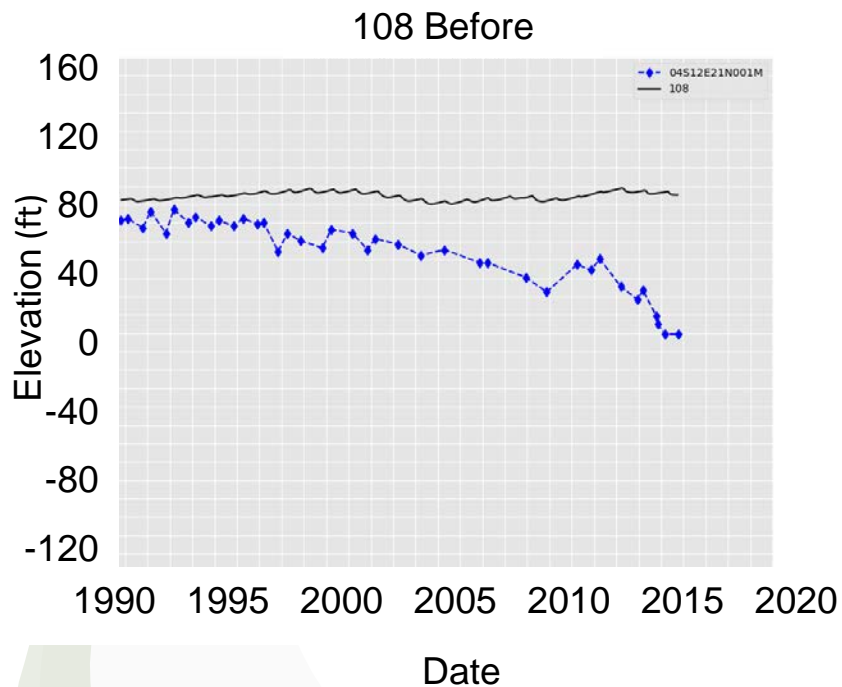
Eastside Water District (Rev)



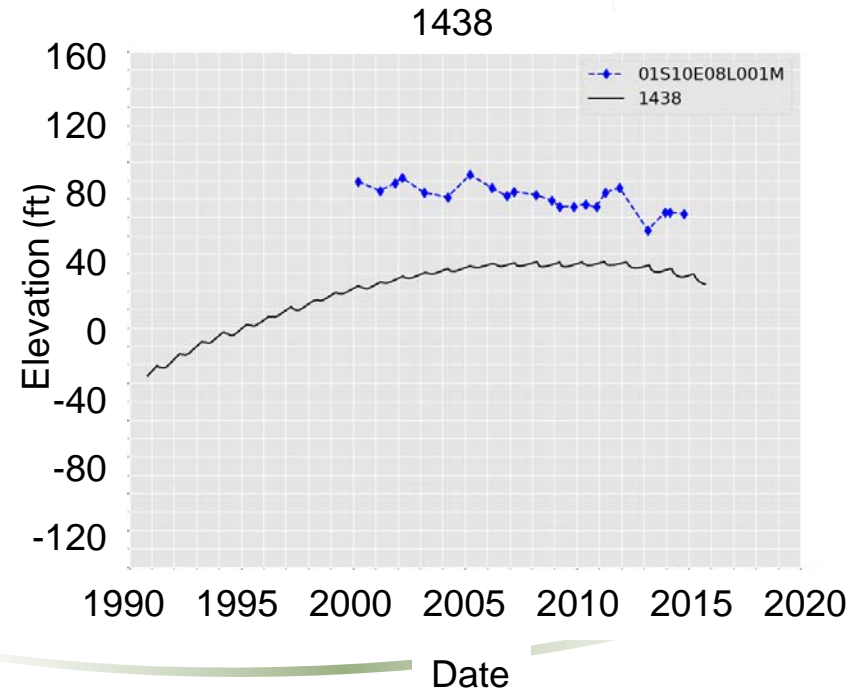
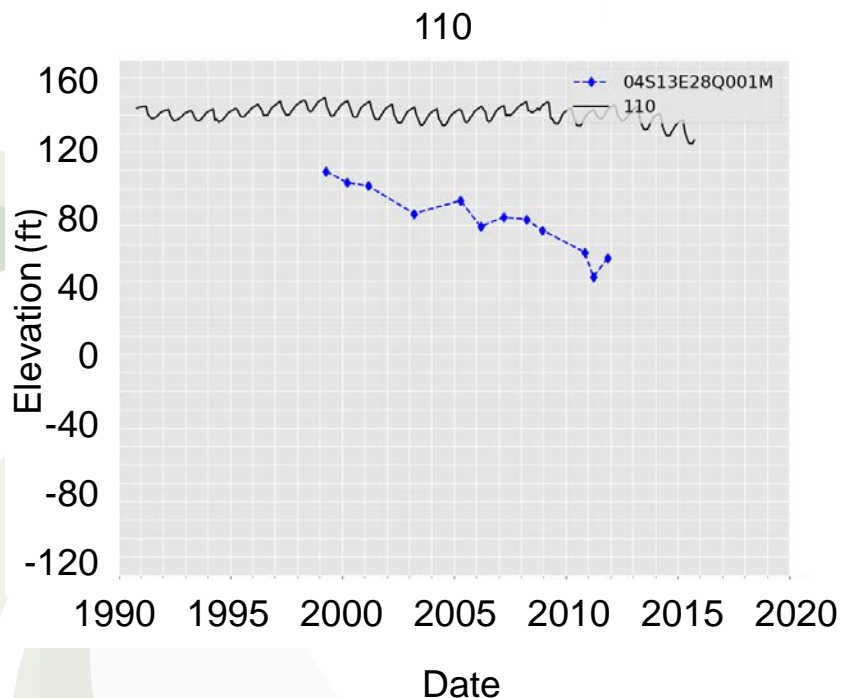
Example Calibration Hydrographs: The Good



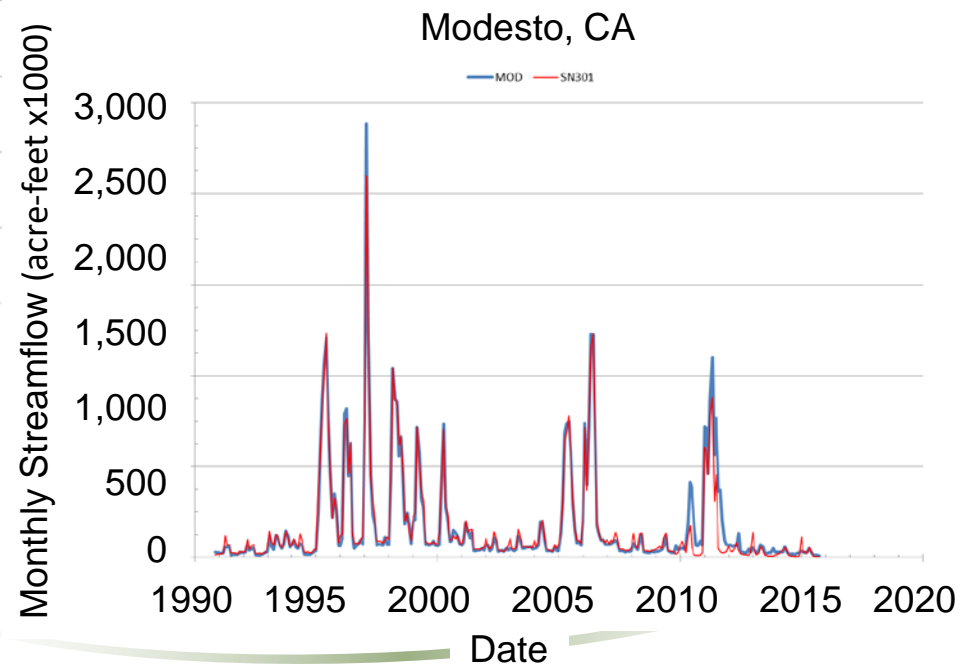
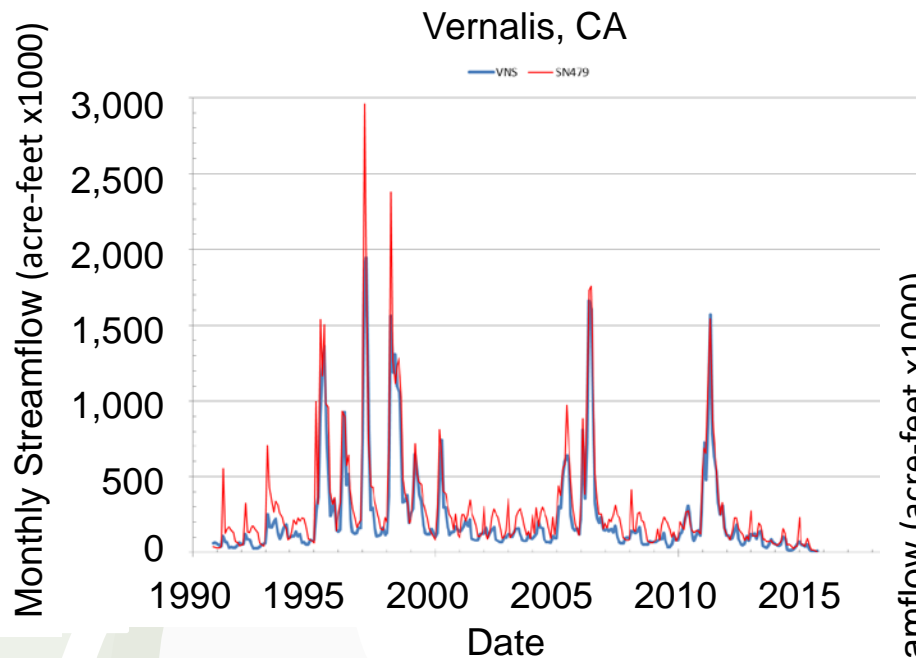
Example Calibration Hydrographs: The Bad



Example Calibration Hydrographs: The Ugly



Example Calibration Hydrographs: Stream Discharge



Findings: Water Budget

- ✓ **A solid water budget is step one!**
- ✓ **Ag water budget**
 - C2VSim irrigated acreage was on average 79% of reported values for five irrigation districts for which data were available, yet model calculated groundwater pumping was on average 129% of reported values
 - C2VSim irrigated acreage averaged 95% of reported values by Turlock Irr. Dist, yet model calculated pumping averaged 76% of reported values
 - High range in reported diversion to farm gate losses
 - Variability in cropping data and water demand must be resolved in future GSP-level modeling
- ✓ **Municipal pumping data a smaller fraction and generally more reliable**

Findings: Discretization

- ✓ **Alignment of elemental land use and water budget subregions with district and municipal boundaries is important to utility and ease of use**
 - Customizing C2VSim for local use with IWFM 3.02 requires manipulating multiple layers of intersecting shapefiles
- ✓ **Discretization affects model utility and ease of use**
- ✓ **GSP-level models will likely require finer discretization**

Thanks to ...

✓ **Jacobson James & Associates**

- **Mike Tietze**
- **Nick Anchor**
- **Jerry O'Neill**
- **Juliet Hutchins**
- **Claudia Corona**

✓ **Stanislaus County**

- **Walt Ward**

✓ **California Department of Water Resources**

- **Can Dogrul**
- **Charlie Brush**

Extra Slides for Questions

Stanislaus County Groundwater Ordinance

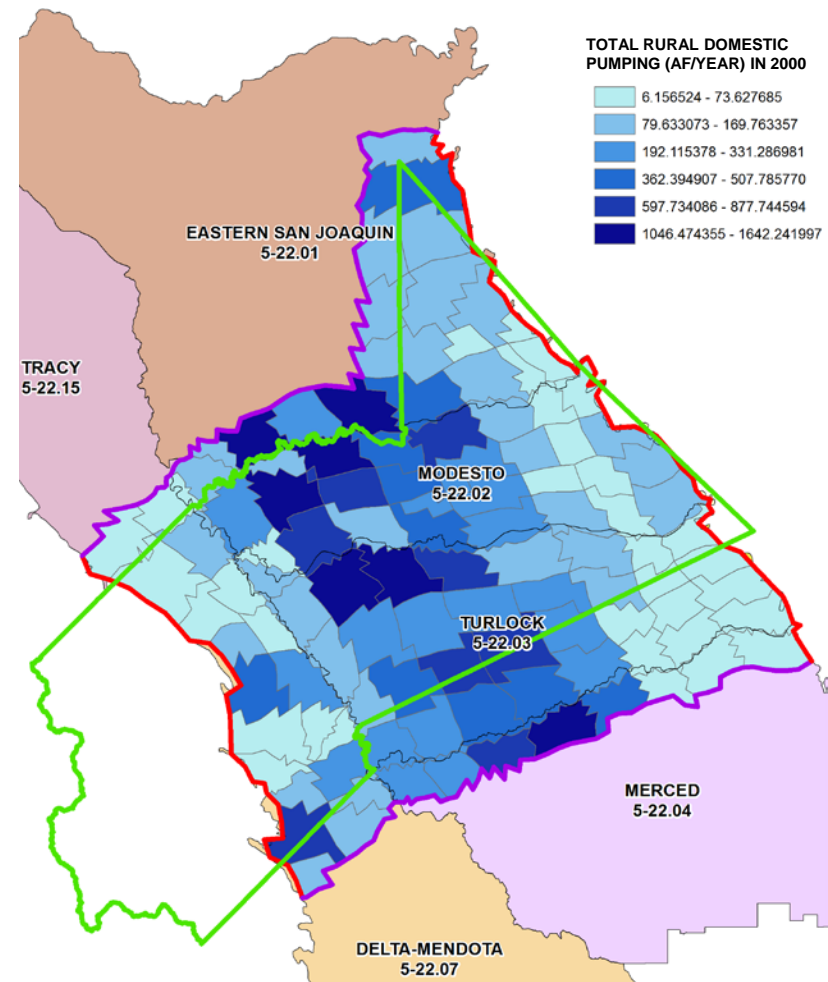
- ✓ **Adopted November 2014 in response to developing groundwater management needs and litigation**
- ✓ **Applies to unincorporated areas not served by agencies with Groundwater Management Plans**
- ✓ **Prohibition against groundwater exports and unsustainable extraction as defined in SGMA**
- ✓ **Discretionary well permitting program based on thresholds for preventing undesirable results**
- ✓ **Discretionary nature of the permits triggers review under CEQA**

Program Environmental Impact Report

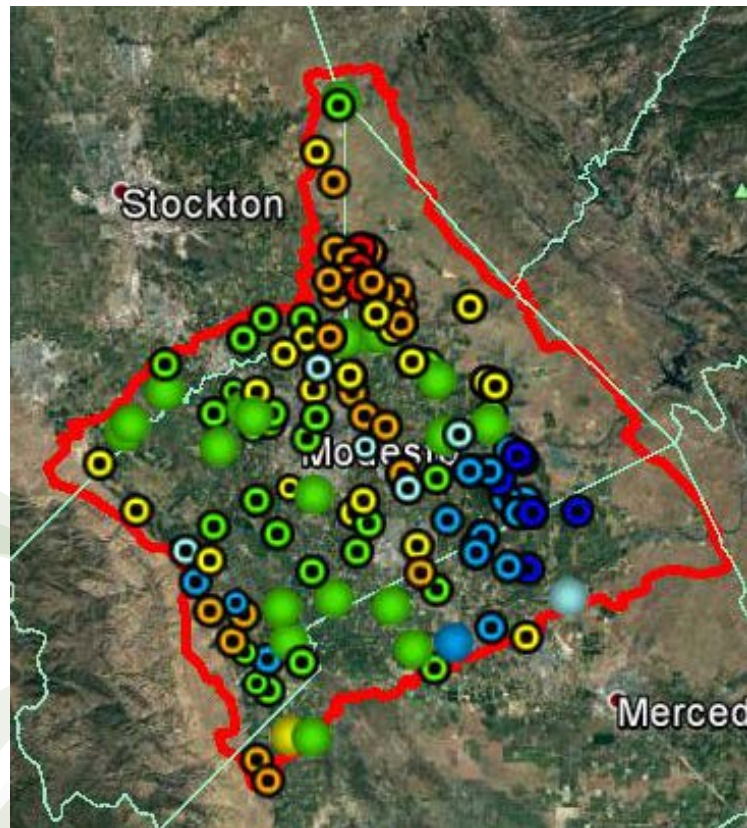
- ✓ **Streamline CEQA review and technical evaluation for discretionary well permit applications**
- ✓ **Create more robust technical basis for well the permitting program**
- ✓ **Undertake data compilation, model construction, and evaluation efforts that will help inform GSAs in groundwater management planning**
- ✓ **Develop a county-wide hydrologic model:**
 - **Simulate head and flow differences between Project and No-Project scenarios in “superposition” mode**
 - **Does not require the same level of precision as models developed for GSPs**

Rural Domestic Pumping

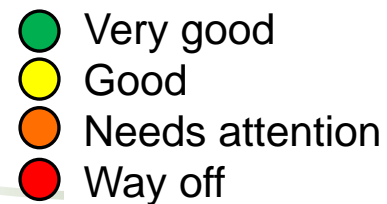
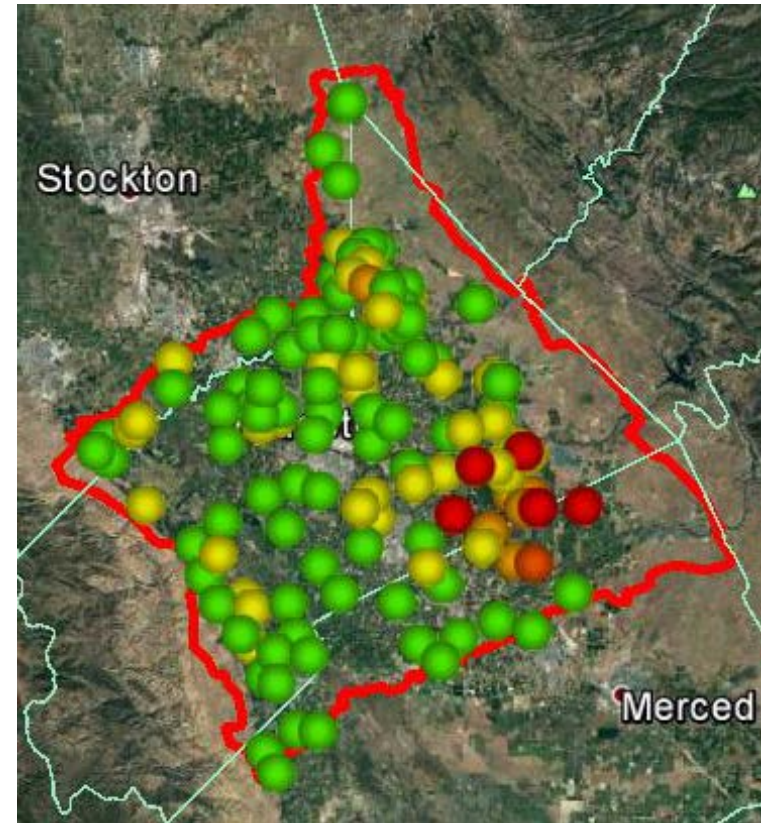
- ✓ Used 2000 Census tract data outside municipal service areas to determine number of rural households not served by districts
- ✓ Extrapolated through 2015 based on population trends
- ✓ Assumed 0.5 AFY/household with 38% return flow based on UWMP data and 2011 Water Use Efficiency Study



Example Calibration Maps



**Hydraulic Head
Difference (ft)**



**Qualitative Trend
Comparison**

Hydrograph Locations

