Cuyama Groundwater Basin Water Availability Study 2008-2013

Santa Barbara County Water Agency and the U.S. Geological Survey

Santa Barbara County Public Works Department
Thomas Fayram, Deputy Public Works Director, Water Resources
Matt Naftaly, Water Agency Manager

U.S. Geological Survey
Randall Hanson, Research Hydrologist, Retired

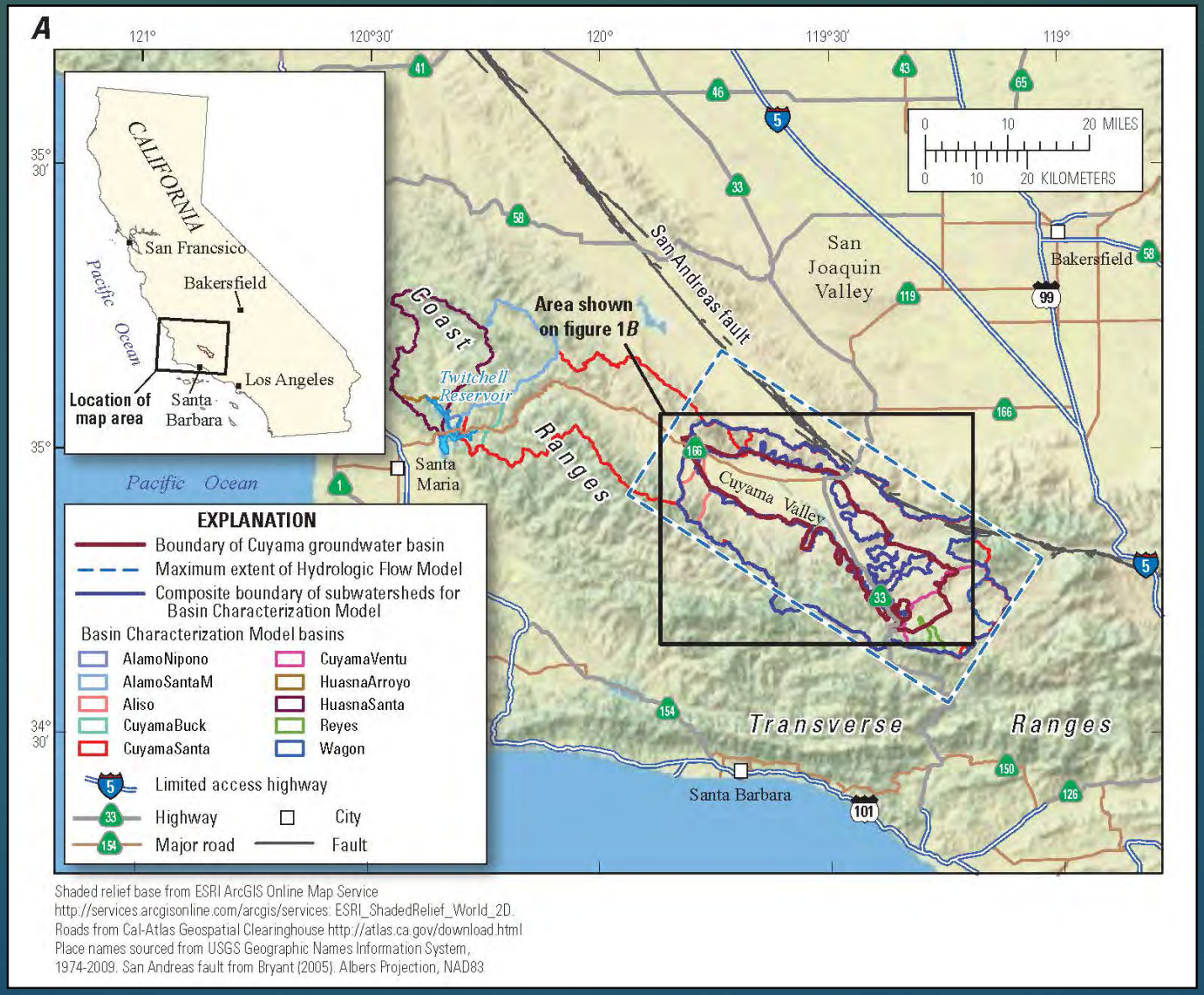
Presentation by
Claudia Faunt, Supervisory Hydrologist

Project Chief

Randall Hanson, U.S. Geological Survey
Research Hydrologist (recently retired)

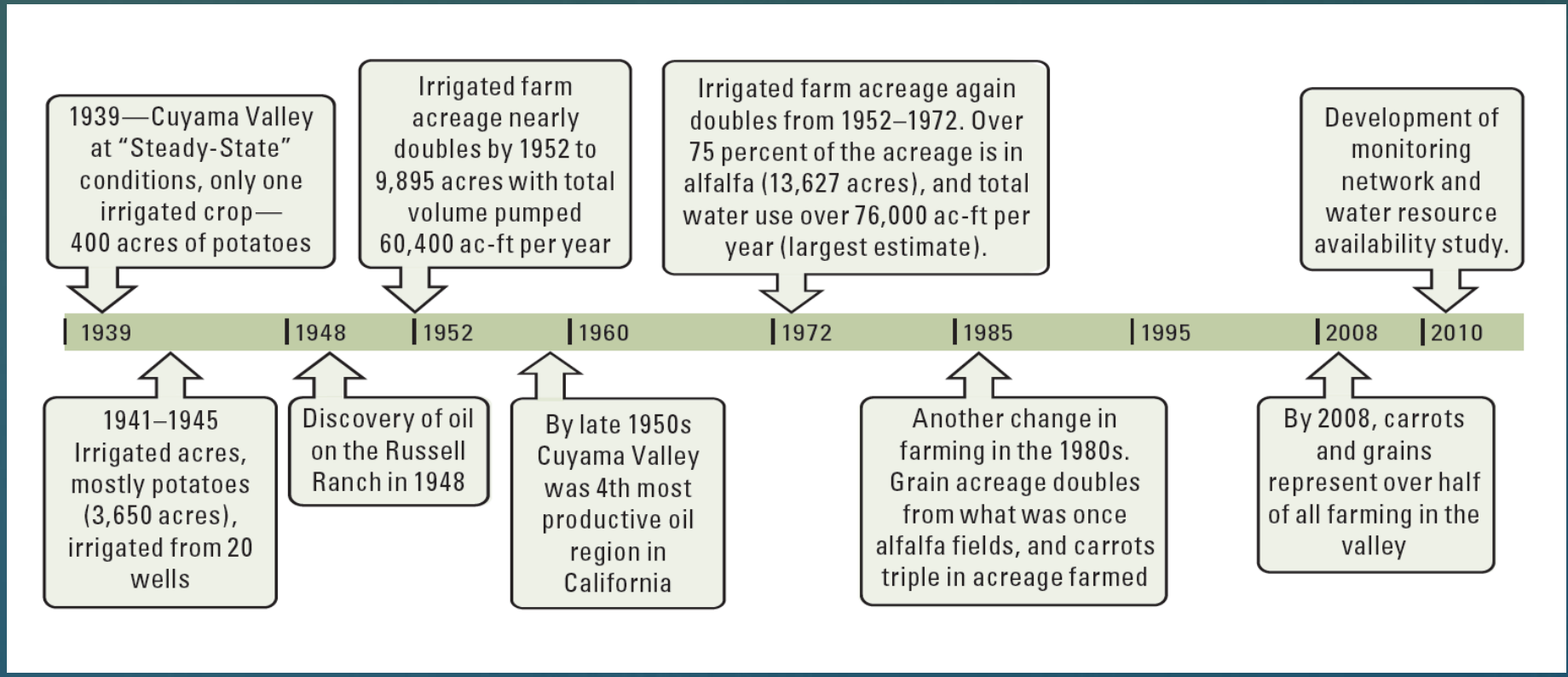
- 35 Years experience in all aspects of hydrogeology
- Expertise in Groundwater Flow Systems
- Expertise in Modeling and Computer Simulations
- Previous work nationally and internationally

Vicinity Map of the Cuyama Valley Area



Shaded relief base from ESRI ArcGIS Online Map Service
http://services.arcgisonline.com/arcgis/services: ESRI_ShadedRelief_World_2D.
Roads from Cal-Atlas Geospatial Clearinghouse http://atlas.ca.gov/download.html
Place names sourced from USGS Geographic Names Information System,
1974-2009. San Andreas fault from Bryant (2005). Albers Projection, NAD83

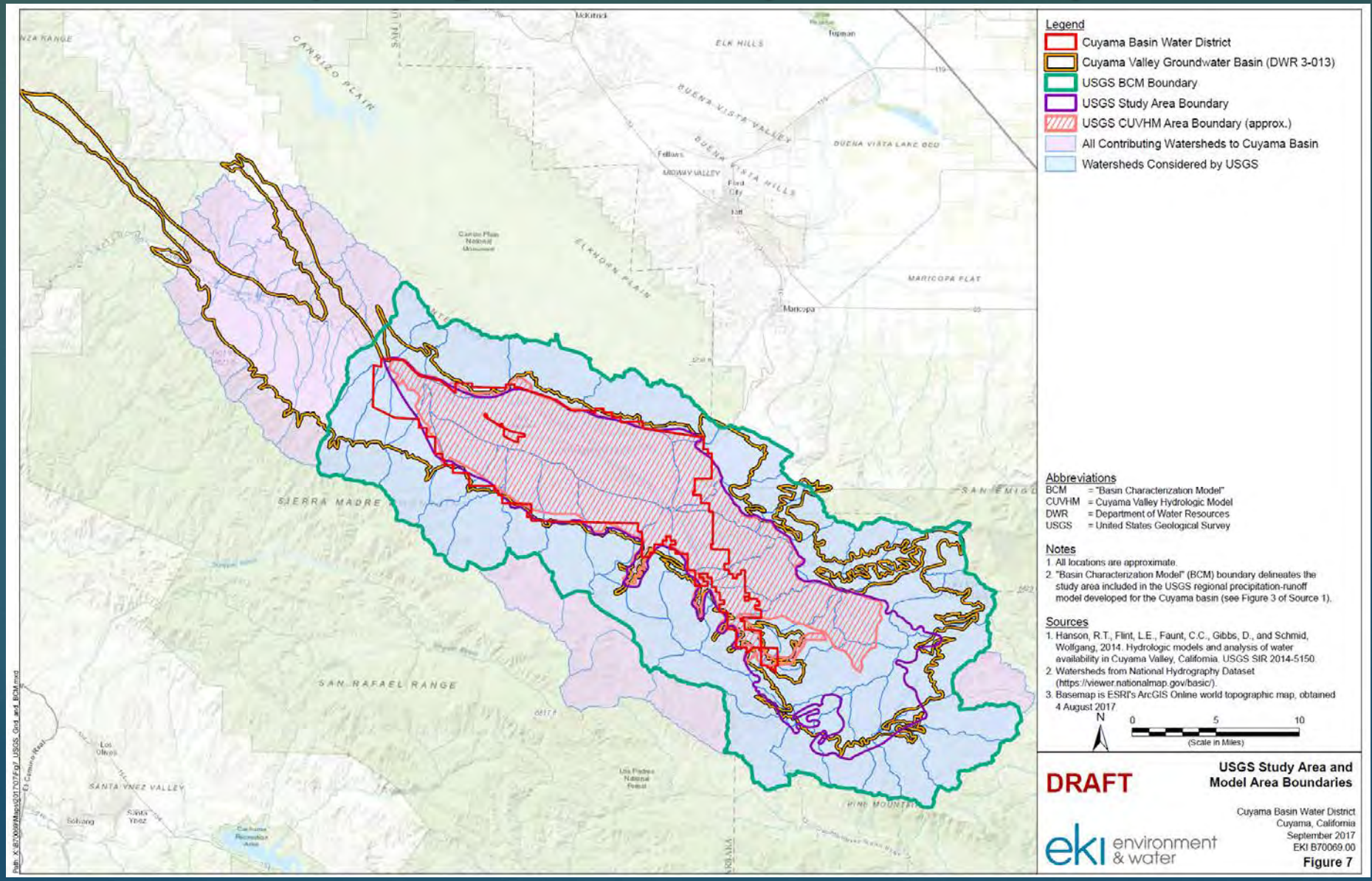
Development timeline



Need for Project

- The Cuyama Groundwater Basin is a sole source aquifer
- Water planning is important:
  - Land use changes
  - Periodic Droughts and other weather related cycles
  - Past studies suggest that there may be a basin imbalance
  - Historic record of water level decline in many wells
  - SGMA requires groundwater management of the basin; however, SGMA did not exist when study was designed

Vicinity Map of the Cuyama Valley Area



Stakeholders

- Santa Barbara County Water Agency
- U. S. Geological Survey
- Agricultural Interests
- Overlying Land Owners
- New Cuyama Community Services District
- Constituents of the Ventucopa Area

Study Objective

Update our understanding of the Cuyama Valley's groundwater resources

- Aquifer System
- Recharge and Discharge
- Ground-Water Levels and Movement
- Water Quality

Develop a hydrologic model to simulate groundwater conditions under different climatic and water-use scenarios

History and Schedule

- Originally approved by Board in 2008
- Executed “Amendments” in 2009, 2010, 2011 and 2012
- Stakeholders meeting in New Cuyama conducted August 14, 2014
- Board Hearing – Fall 2014
- Project website where all reports and data can be accessed:

  http://ca.water.usgs.gov/user_projects/cuyama/

USGS Reports Completed

USGS
science for a changing world

Prepared in cooperation with the County of Santa Barbara

Geology, Water-Quality, Hydrology, and Geomechanics of the Cuyama Valley Groundwater Basin, California, 2008–12

Scientific Investigations Report 2013–5108

U.S. Department of the Interior
U.S. Geological Survey

USGS
science for a changing world

Prepared in cooperation with the Water Agency Division of the Santa Barbara County Department of Public Works

Construction of 3-D Geologic Framework and Textural Models for Cuyama Valley Groundwater Basin, California

Scientific Investigations Report 2013-5127

U.S. Department of the Interior
U.S. Geological Survey

USGS
science for a changing world

Prepared in cooperation with County of Santa Barbara Publics Works

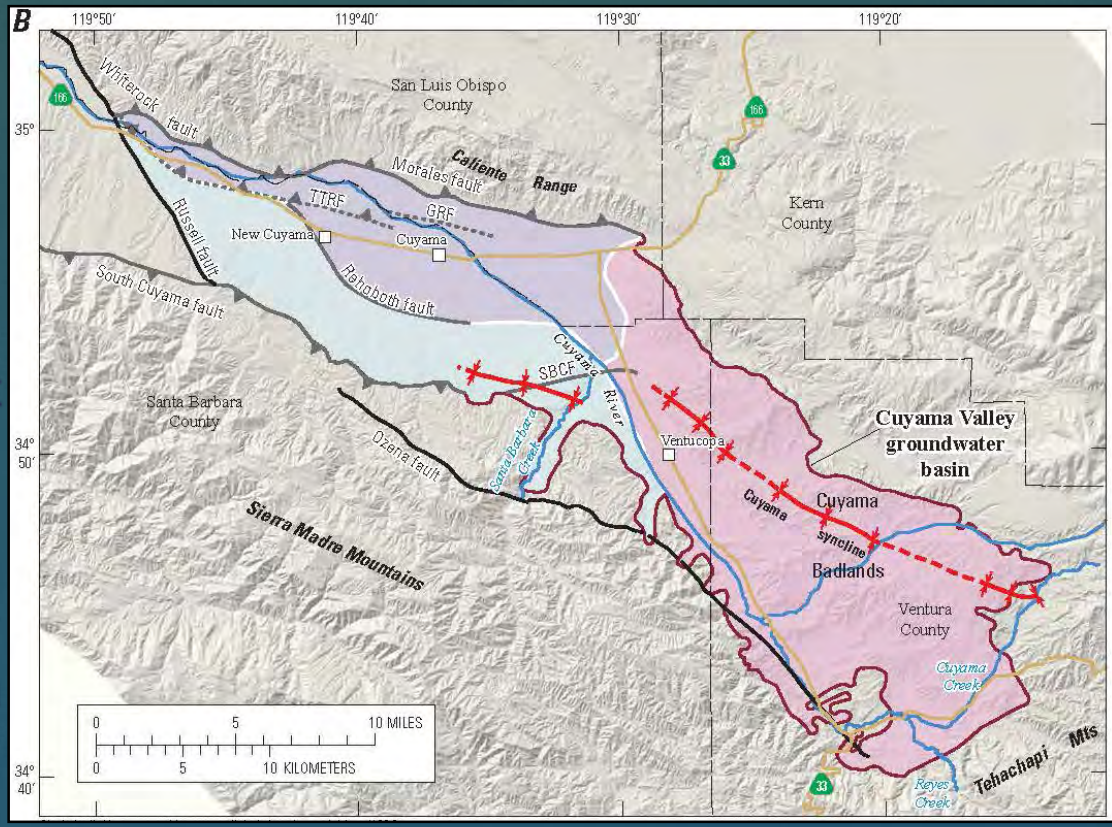
Hydrologic Models and Analysis of Water Availability in Cuyama Valley, California

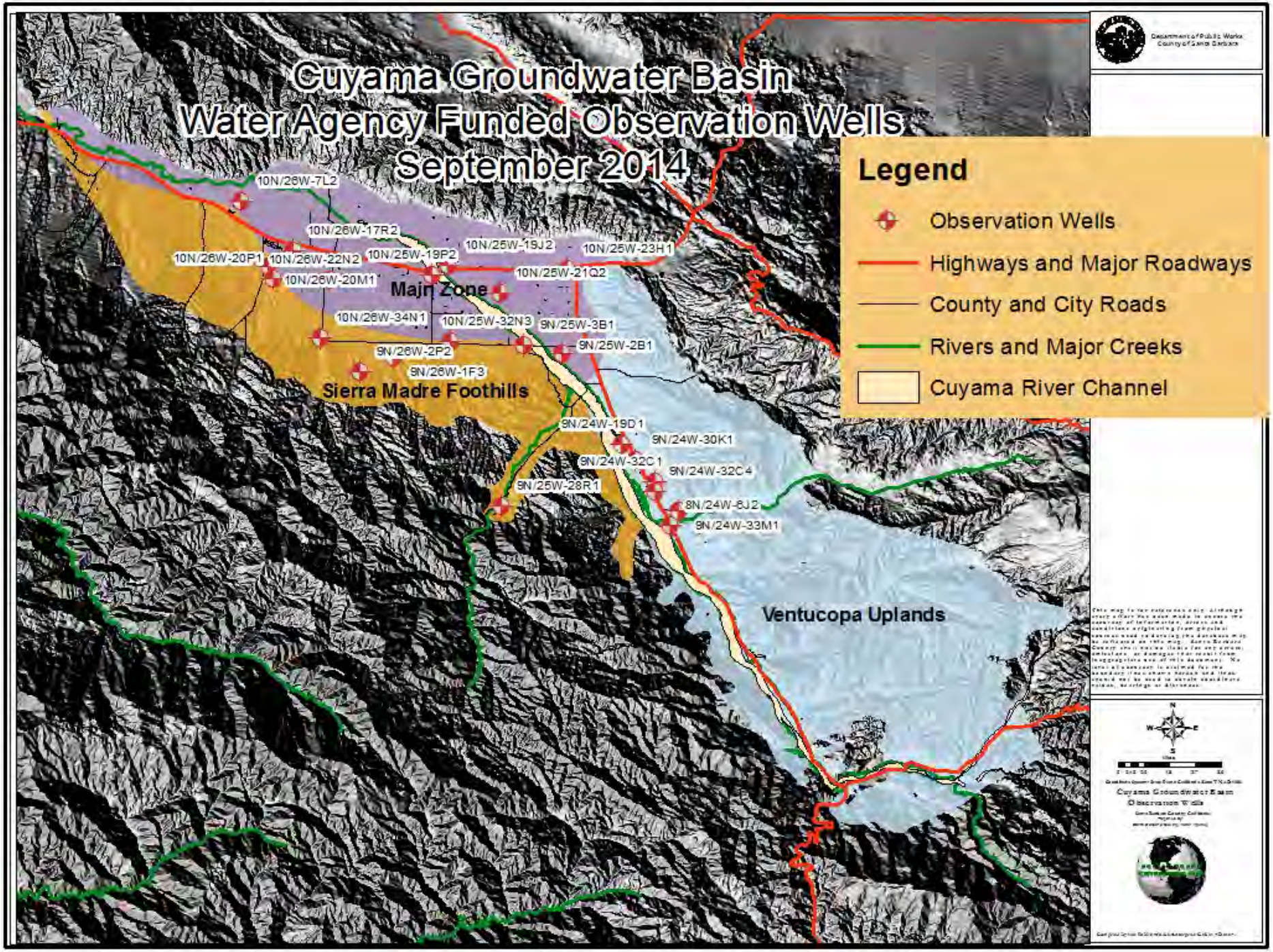
Scientific Investigations Report 2014-5150

U.S. Department of the Interior
U.S. Geological Survey

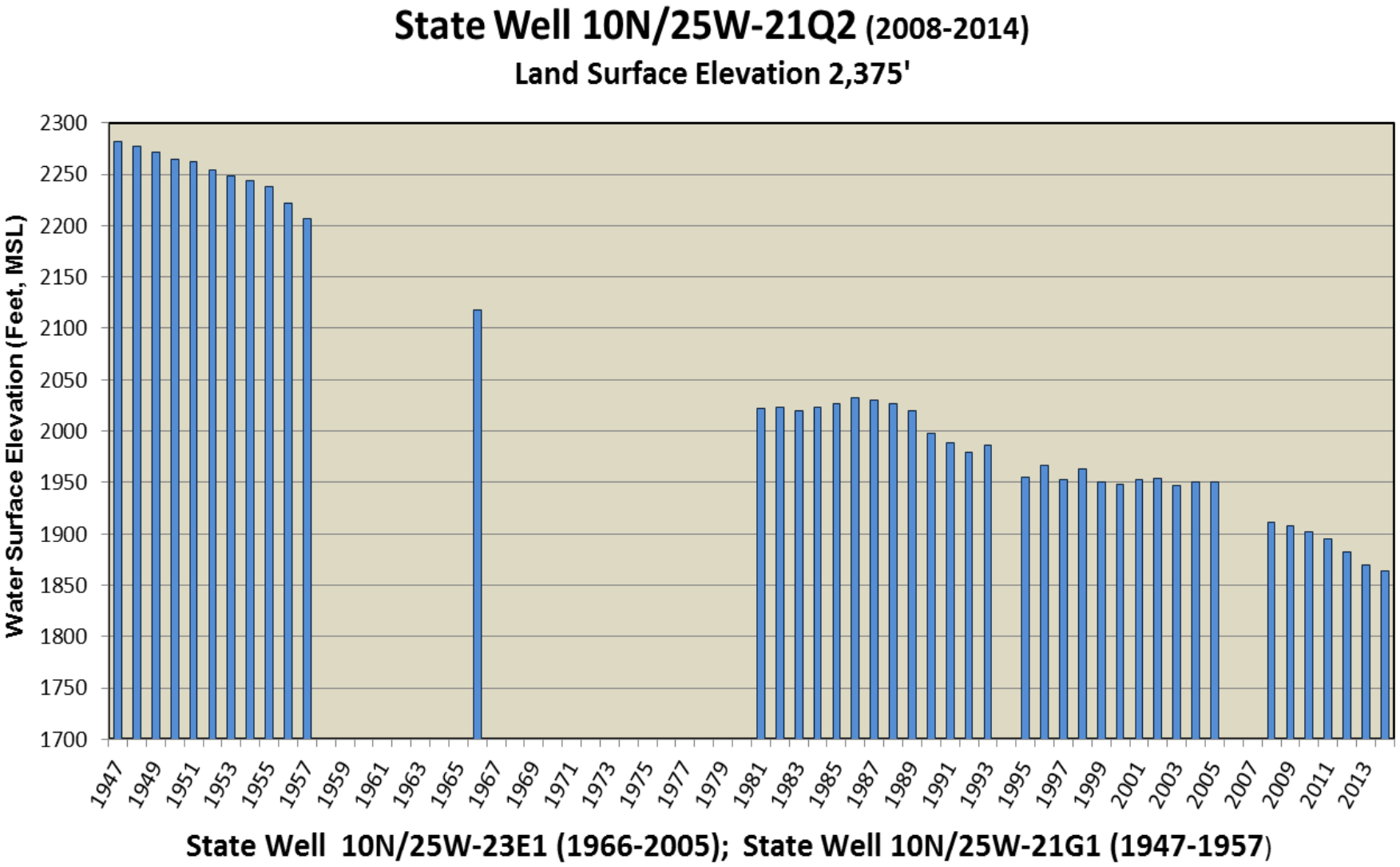
Summary of Findings

- Three partially fault bounded subregions in the Basin with “little” flow between
  - **Main Zone**
  - ***Ventucopa* Uplands**
  - **Sierra Madre Foothills**
- Groundwater recharge, which occurs primarily in wet years, is not sufficient to replenish the storage depletion driven by current demands
- Imbalance of about 30,000 acre-feet per year for overall model area
- Very poor water quality; Calcium-Magnesium Sulfate dominated with total dissolved solids on the order of 2000 ppm on average
- Water “age” up to 33,000 years

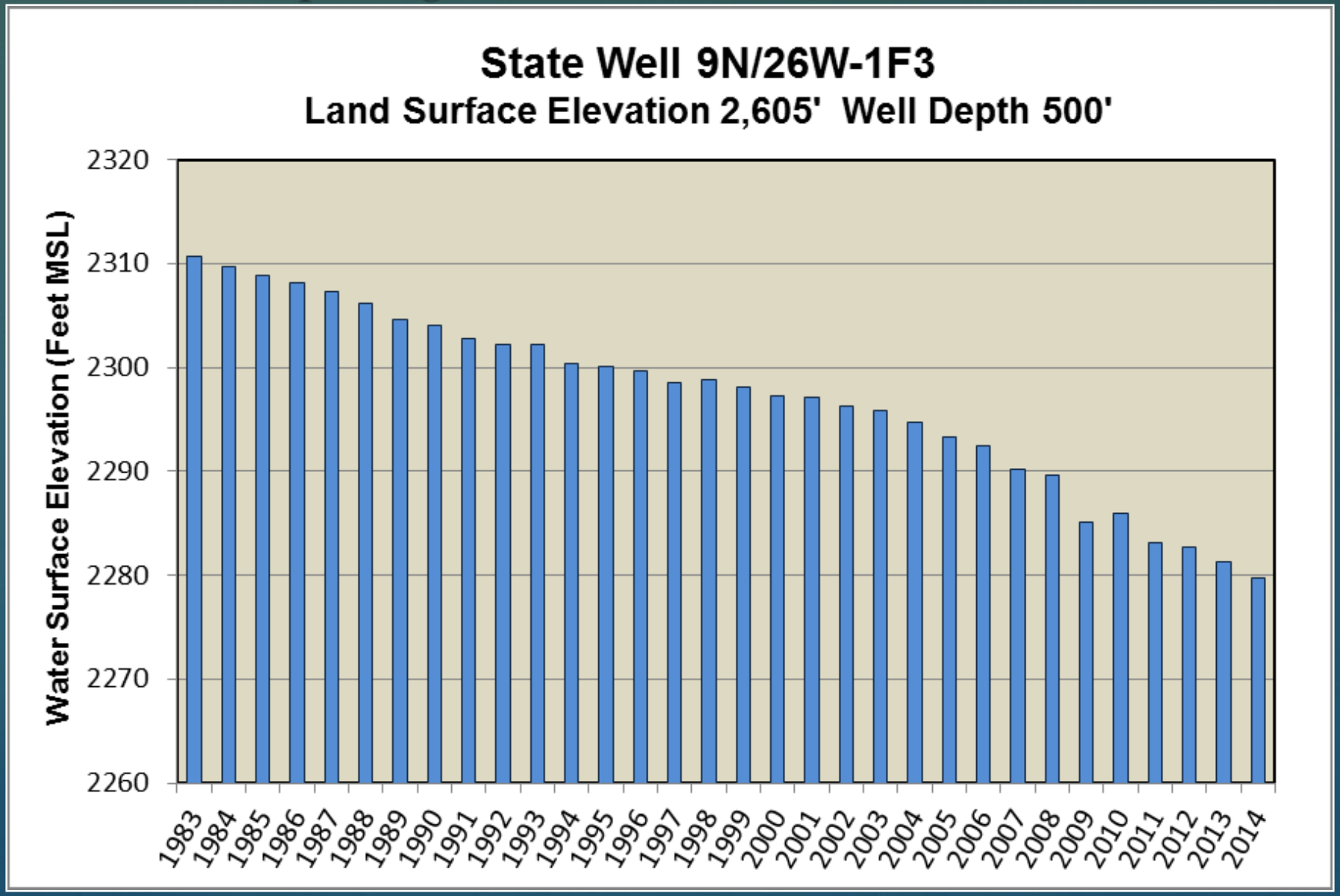



Cuyama Groundwater Basin
Water Agency Funded Observation Wells
September 2014
Legend
Observation Wells
Highways and Major Roadways
County and City Roads
Rivers and Major Creeks
Cuyama River Channel
10N/26W-7L2
10N/26W-17R2
10N/26W-20P1
10N/26W-22N2
10N/25W-19P2
10N/25W-19J2
10N/25W-23H1
10N/25W-21Q2
10N/26W-20M1
Main Zone
10N/26W-34N1
10N/25W-32N3
9N/25W-3B1
9N/25W-2B1
9N/26W-2P2
9N/26W-1F3
Sierra Madre Foothills
9N/24W-19D1
9N/24W-30K1
9N/24W-32C1
9N/24W-32C4
9N/25W-28R1
8N/24W-6J2
9N/24W-33M1
Ventucopa Uplands

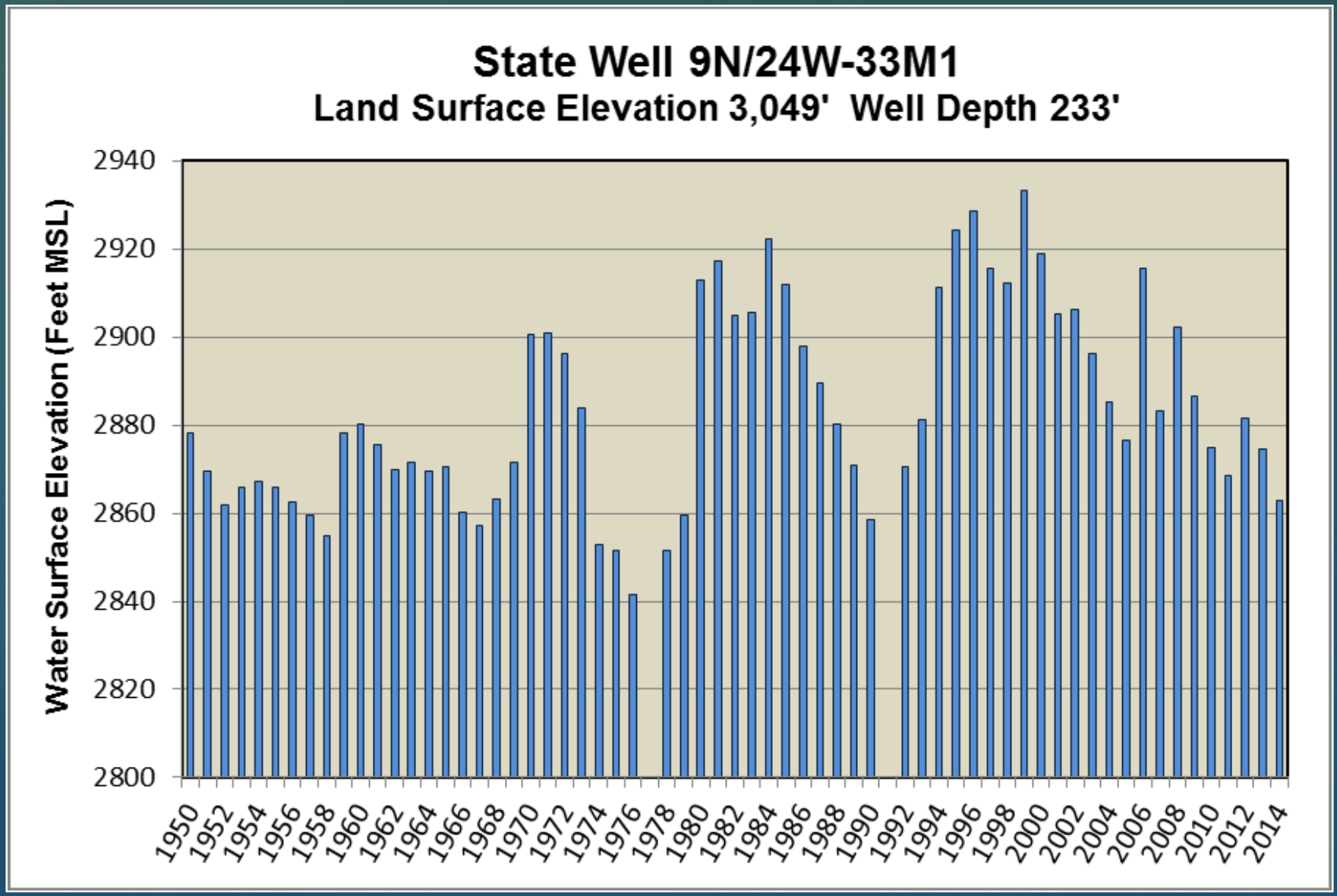
Main Zone Representative Hydrograph depicting water level declines of up to 400’ since around 1950

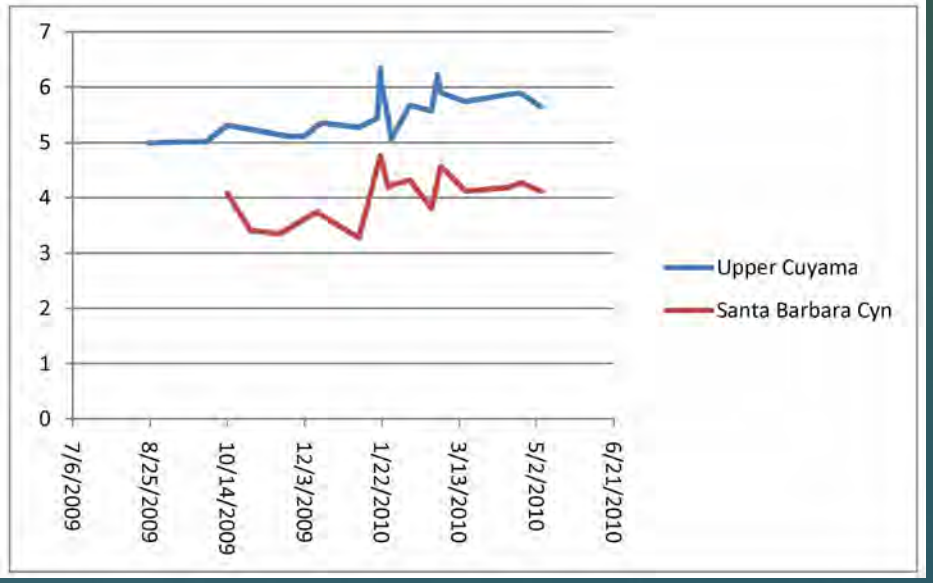


Sierra Madre Zone Representative Hydrograph depicting declines of over 30′ since 1983



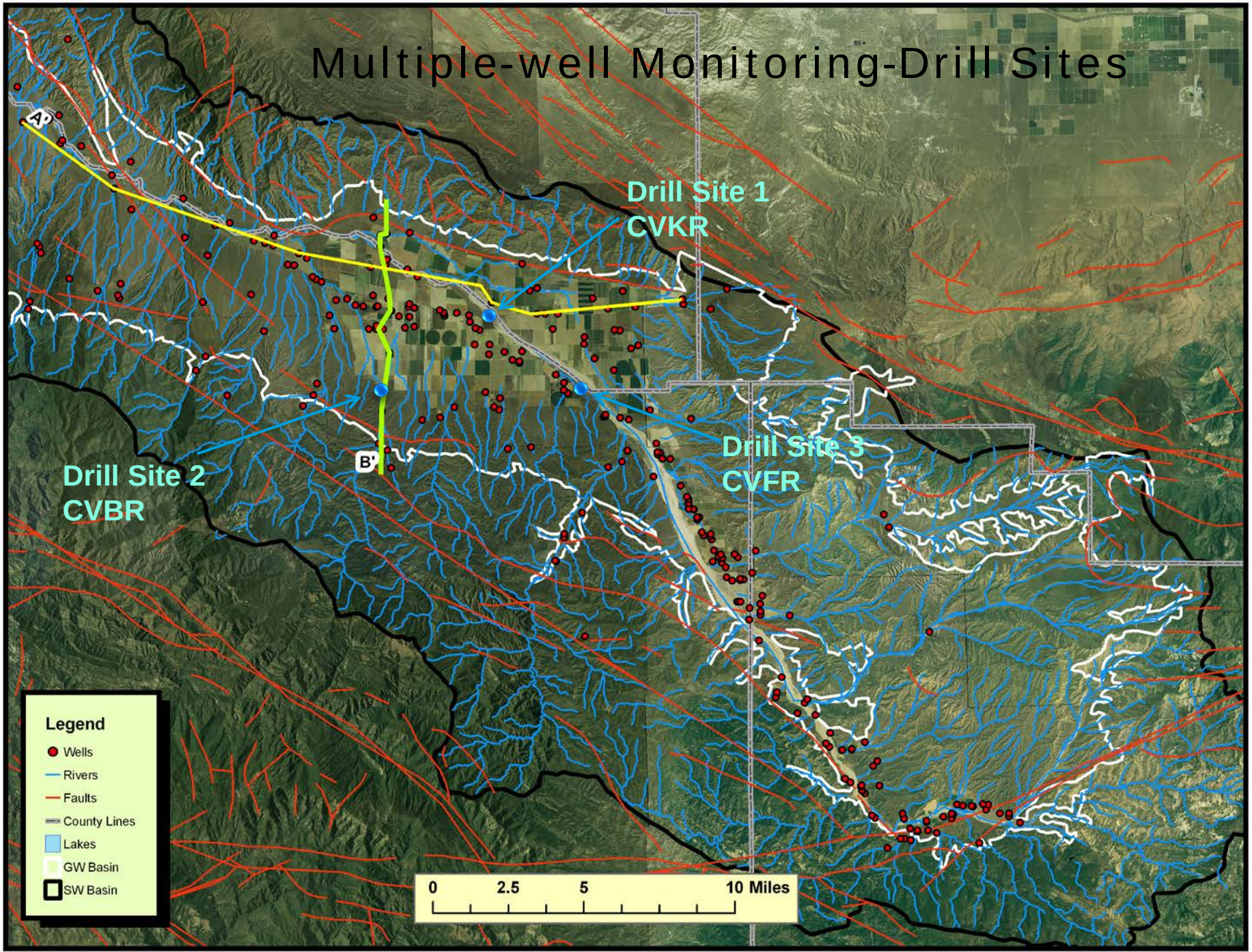
Ventucopa Uplands Representative Hydrograph depicting periodic rises and falls as a direct function of climate





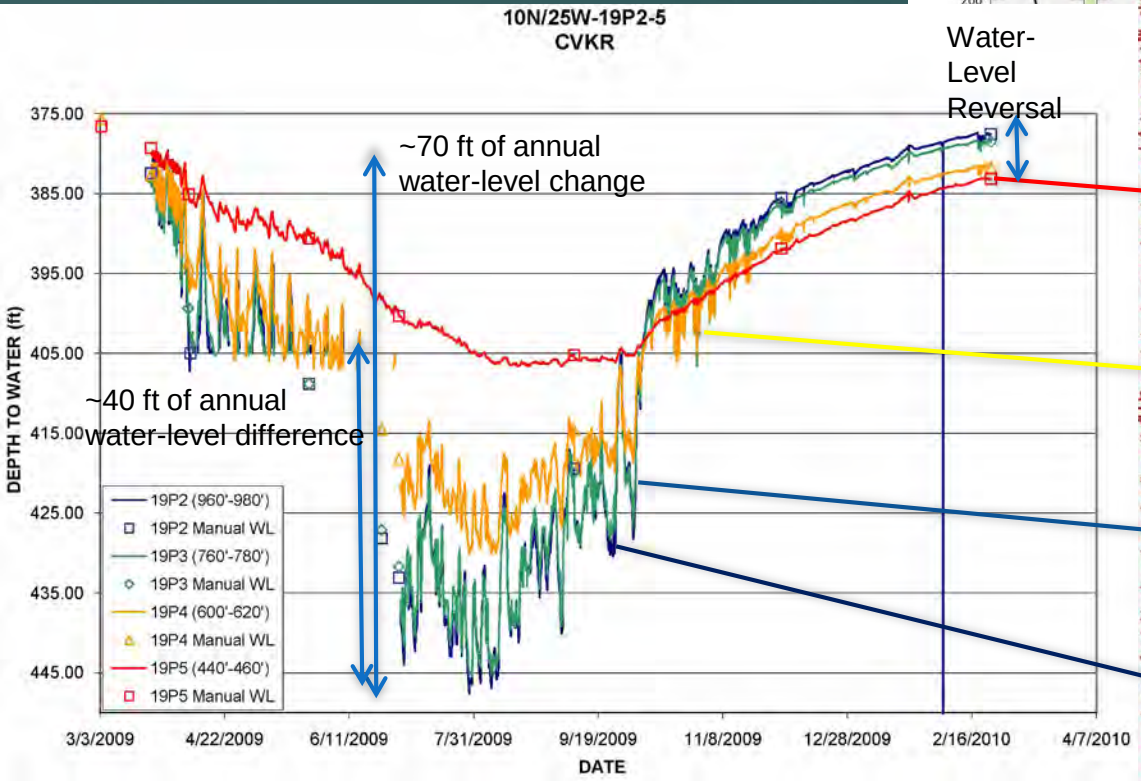
New Downward Looking Radar Continuous Stream gaging site on Upper Cuyama River at Ventucopa (11136500)

New Streamflow Gage on Santa Barbara Canyon – Reyes Ranch SANTA BARBARA CYN C NR VENTUCOPA CA (11136600)


Multiple-well Monitoring-Drill Sites
A'
B'
Drill Site 1
CVKR
Drill Site 2
CVBR
Drill Site 3
CVFR
Legend
Wells
Rivers
Faults
County Lines
Lakes
GW Basin
SW Basin
0
2.5
5
10 Miles

Bell Road Multiple-Well Monitoring Site -- CVBR

Recent Water-Level History at CVKR Site



Water-Level Reversal

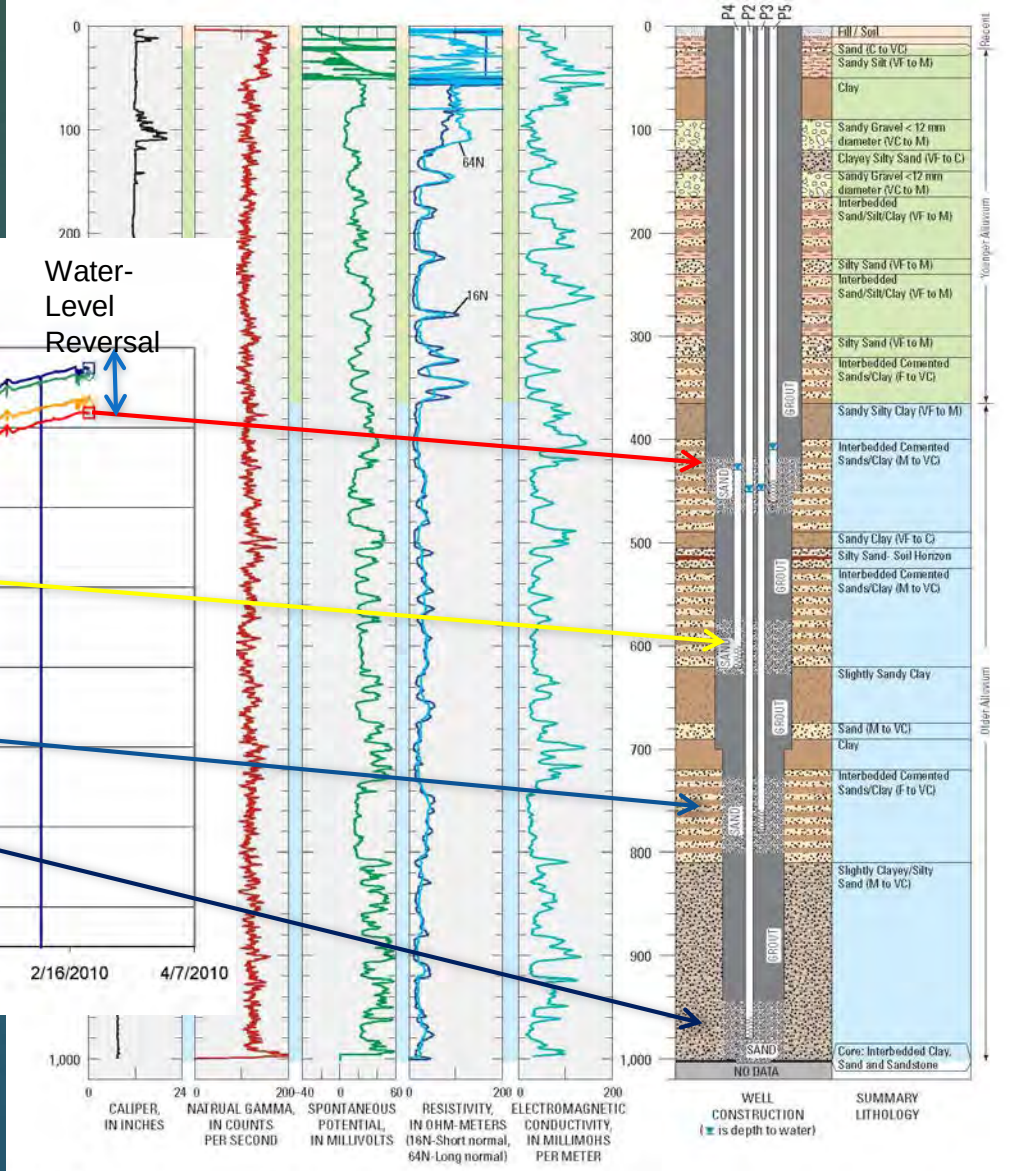


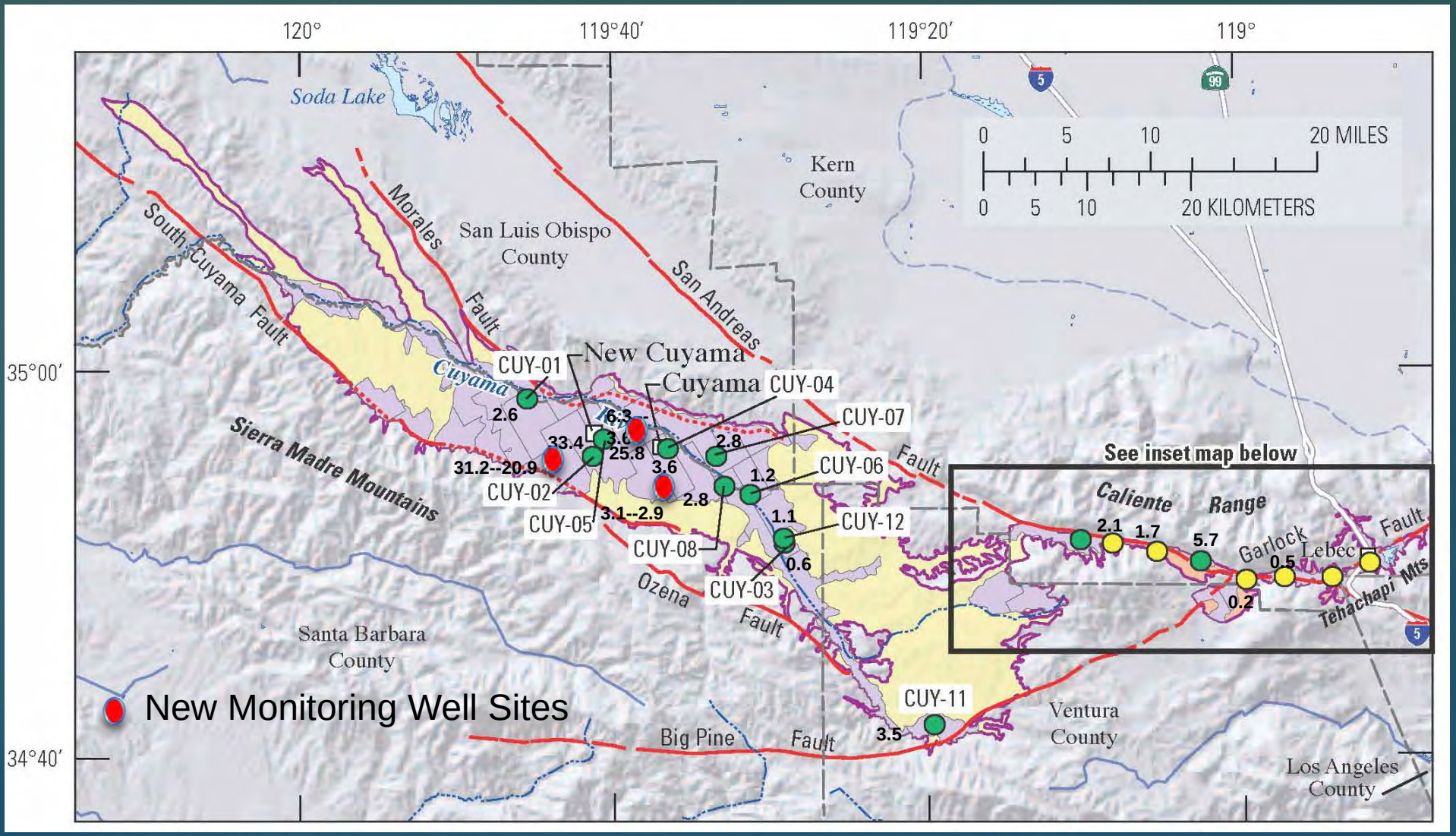
Figure 2. Well construction, summary lithology, and geophysical log data from multiple-well monitoring site CVKR, Cuyama Valley, California.

Water -Level Change Plus Water Level Difference Drive Additional Land Subsidence

Water-Quality Monitoring

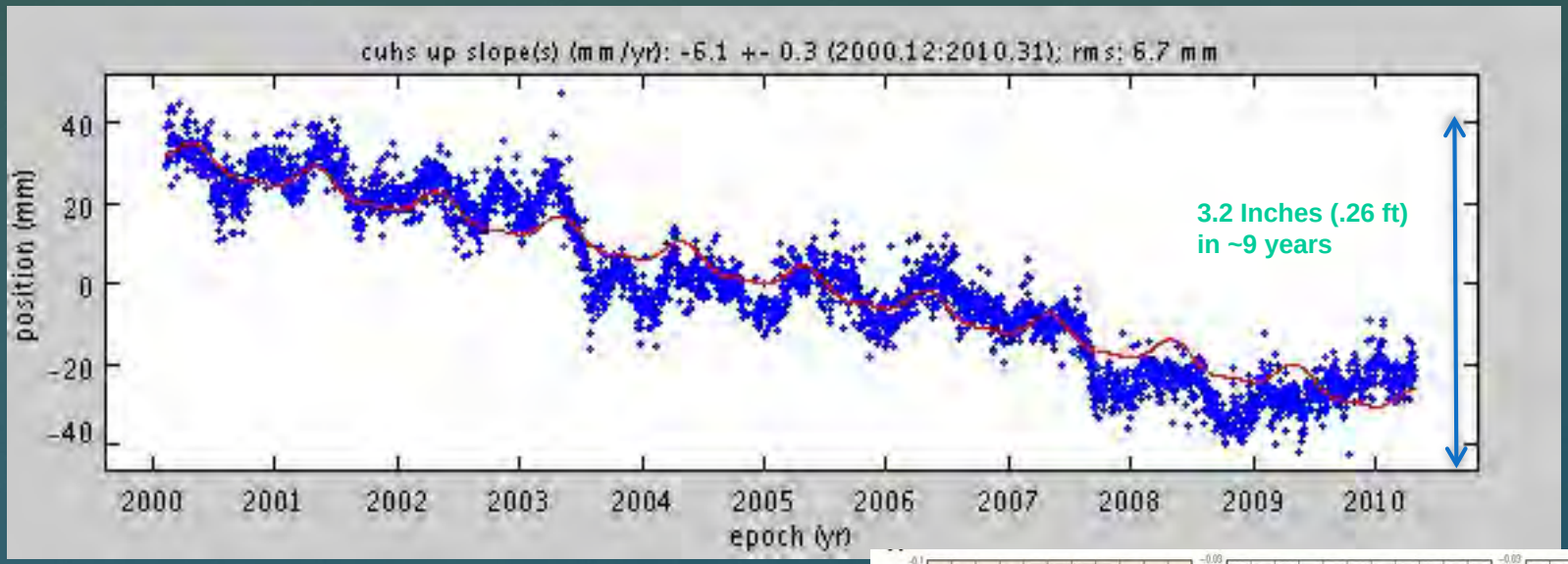
- Major ion chemistry, Total Dissolved Solits (TDS)
- Nutrients, Trace Elements
- Source and age of ground water
- (500 - >33,000 years before present)

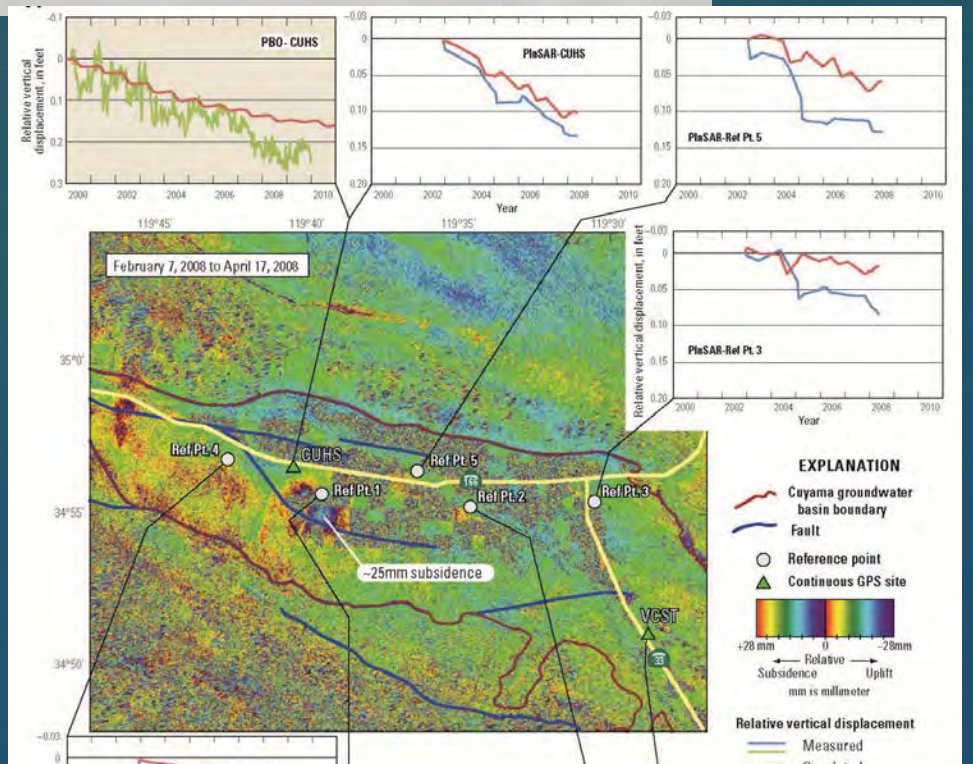
Uncorrected Age Dates of Groundwater in Cuyama Valley Aquifers in Thousands of Years before Present



Almost all Samples have little to no Tritium except in Ventucopa Area ➔ Little to No Modern Recharge (Last 50-60 years)

Subsidence Evaluation





Model Development

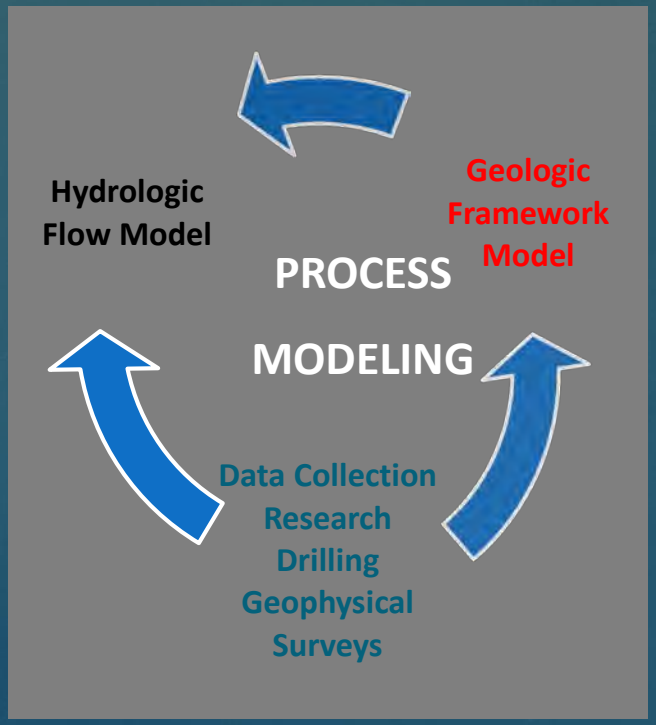
1) ***Geologic Framework Model*** ➔ *Geologic and Hydrogeologic Units*
2) ***Hydrologic Models***

(a) Water-Budget--Runoff model ➔ Basin Characterization Model (BCM) of entire watershed (entire state updated and released)

(b) Hydrologic Flow Model ➔ MODFLOW with the Farm Process (MF-OWHM)

-Simulates pumpage, subsidence, and streamflow for changing landuse for water years 1950-2010

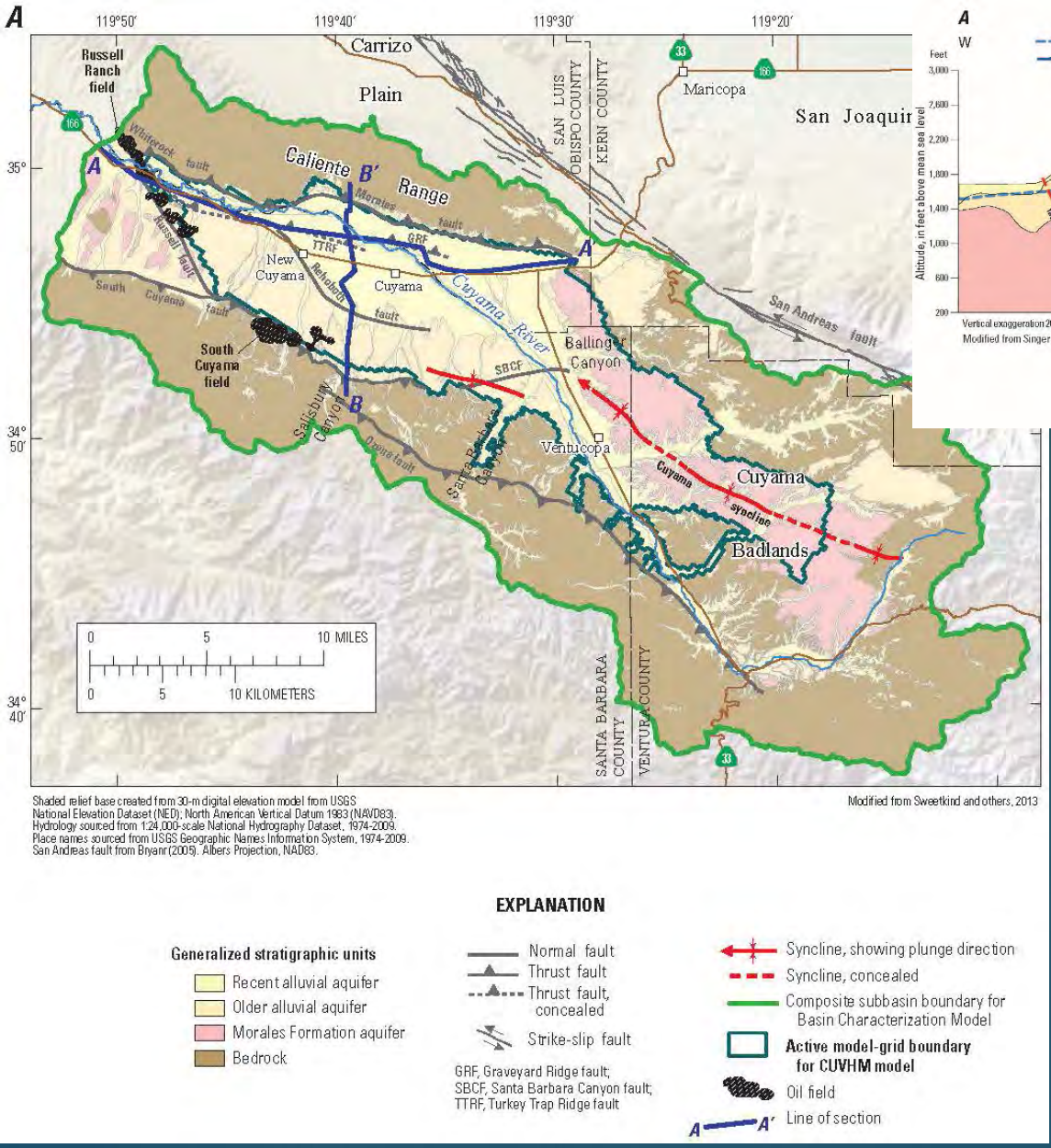
-Constrained by groundwater levels and subsidence



Model Features

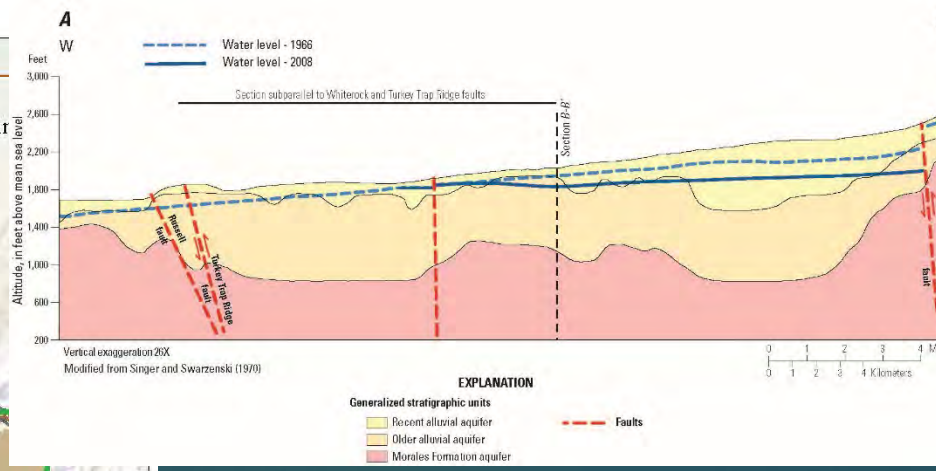
- The combined use and movement of water on the landscape, streams, and aquifers were simulated with an integrated hydrologic model called MODFLOW-OWHM (One Water Hydrologic Model, Hanson and others, 2014).
- The Basin Characteristics Model was used to estimate the recharge and runoff from all of the surrounding watersheds (Hanson and others, 2014).
- A 3-D stratigraphic and texture model was developed to characterize the hydraulic properties and the layering and structure of the aquifers (figs. 3, 4; Sweetkind and others, 2013).
- Data were compiled to simulate changing land ownership, land use, wells, streamflow, and climate.

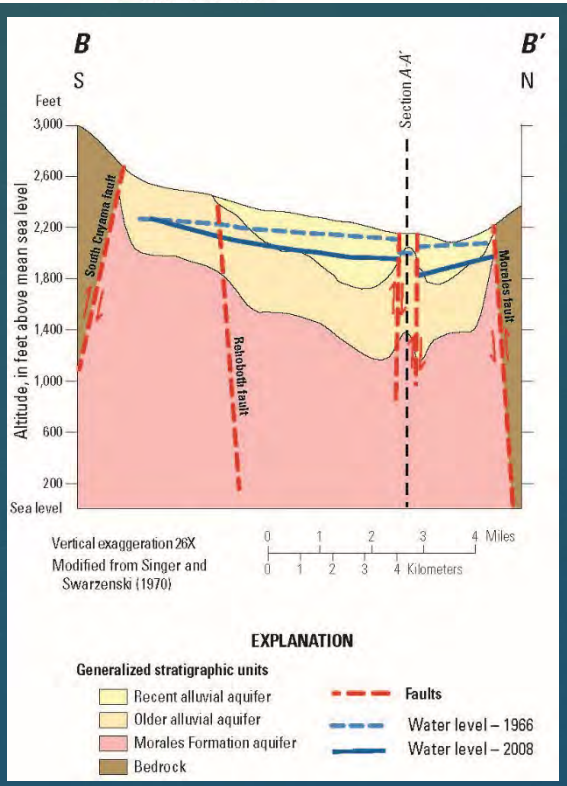
New version for entire state at 279 m available



Shaded relief base created from 30-m digital elevation model from USGS National Elevation Dataset (NED); North American Vertical Datum 1983 (NAVD83). Hydrology sourced from 1:24,000-scale National Hydrography Dataset, 1974-2009. Place names sourced from USGS Geographic Names Information System, 1974-2009. San Andreas fault from Bryant (2005). Albers Projection, NAD83.

Modified from Sweetkind and others, 2013





EXPLANATION

Generalized stratigraphic units

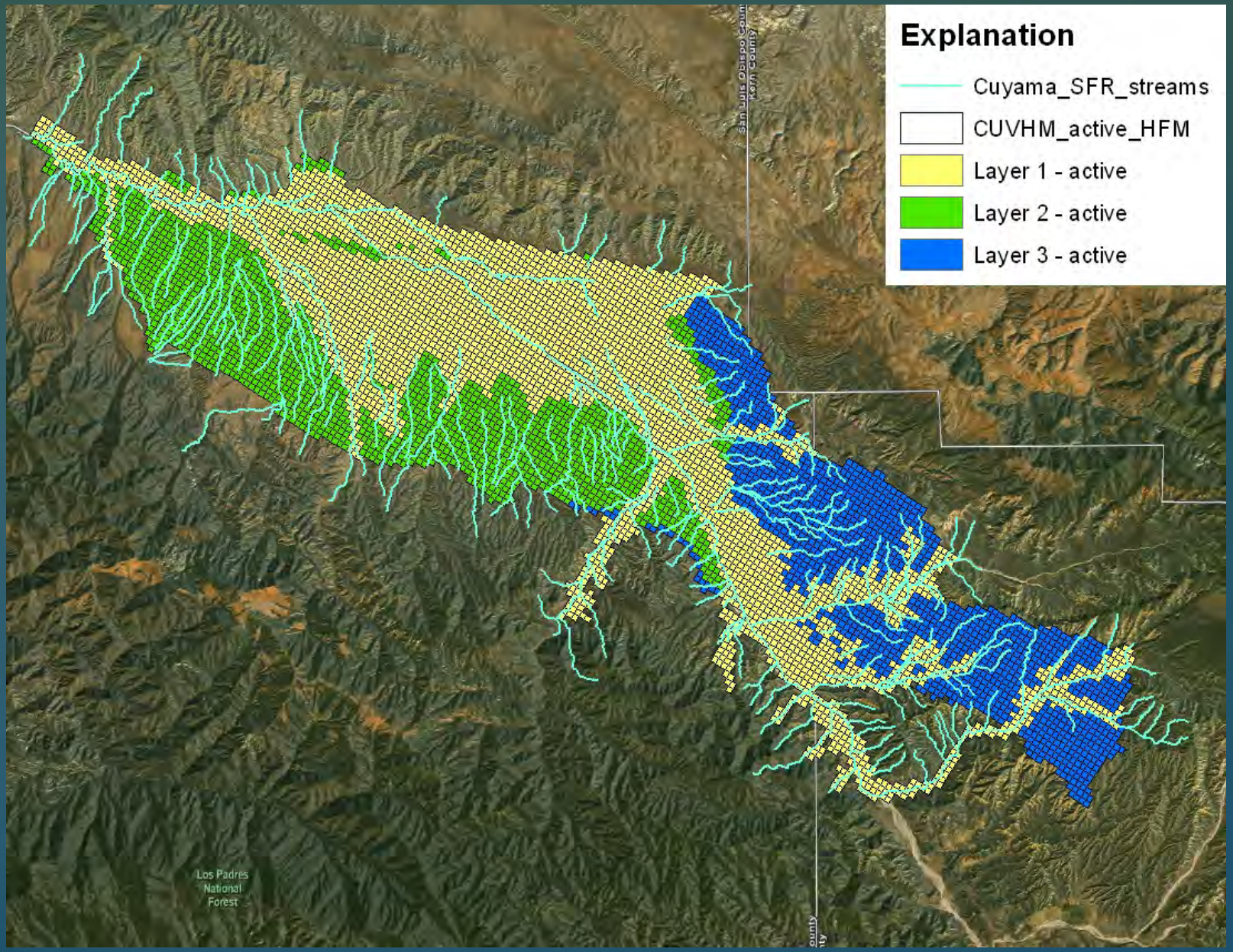
- Recent alluvial aquifer
- Older alluvial aquifer
- Morales Formation aquifer
- Bedrock

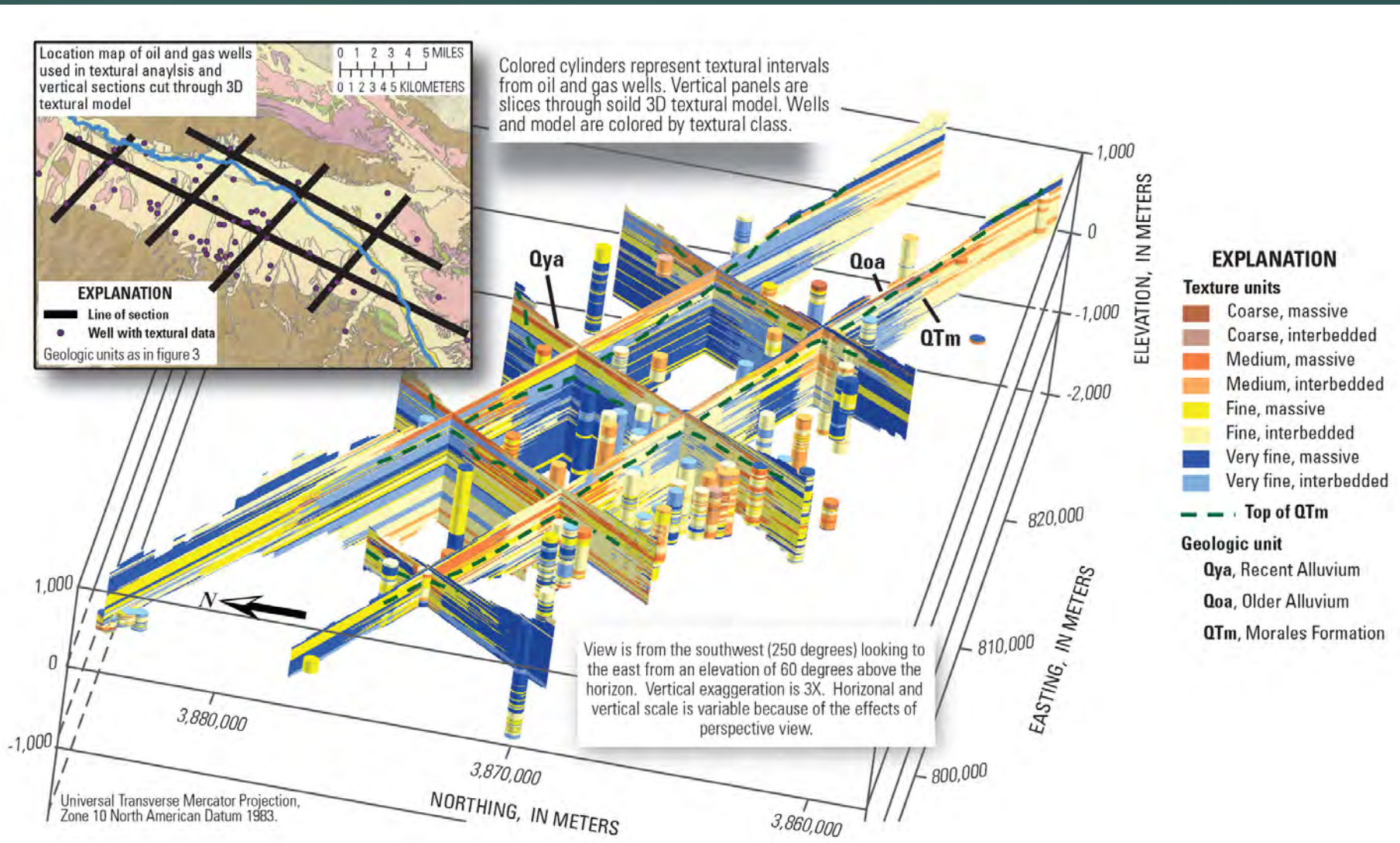
- Normal fault
- Thrust fault
- Thrust fault, concealed
- Strike-slip fault

GRF, Graveyard Ridge fault;
SBCF, Santa Barbara Canyon fault;
TTRF, Turkey Trap Ridge fault

- Syncline, showing plunge direction
- Syncline, concealed
- Composite subbasin boundary for Basin Characterization Model
- **Active model-grid boundary for CUVHM model**
- Oil field
- A — A' Line of section

Hydrogeologic Framework of Cuyama Valley – Don Sweetkind is lead and could answer questions about structures and faults

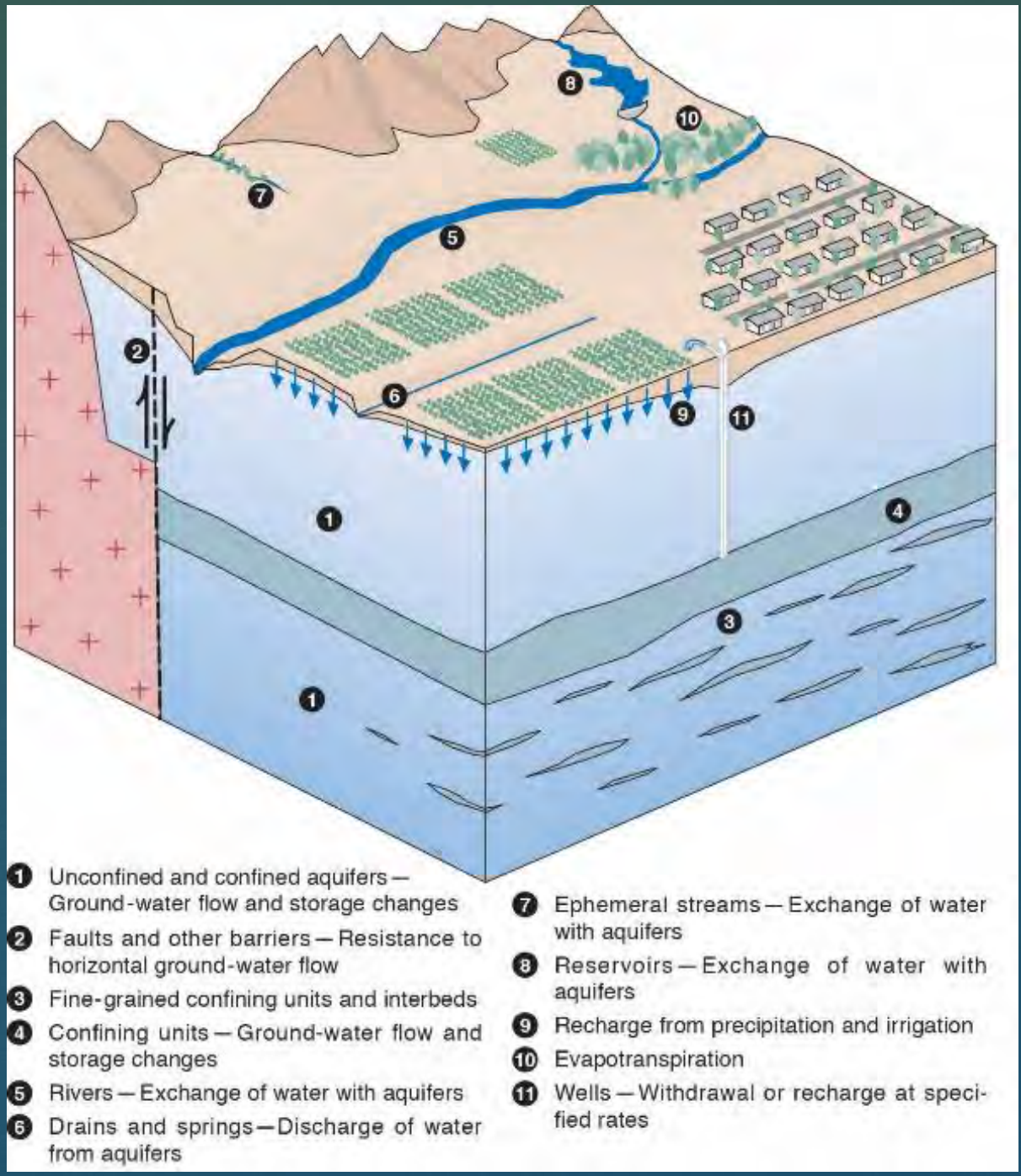

Explanation
Cuyama_SFR_streams
CUVHM_active_HFM
Layer 1 - active
Layer 2 - active
Layer 3 - active
Los Padres National Forest
San Luis Obispo County
Kern County

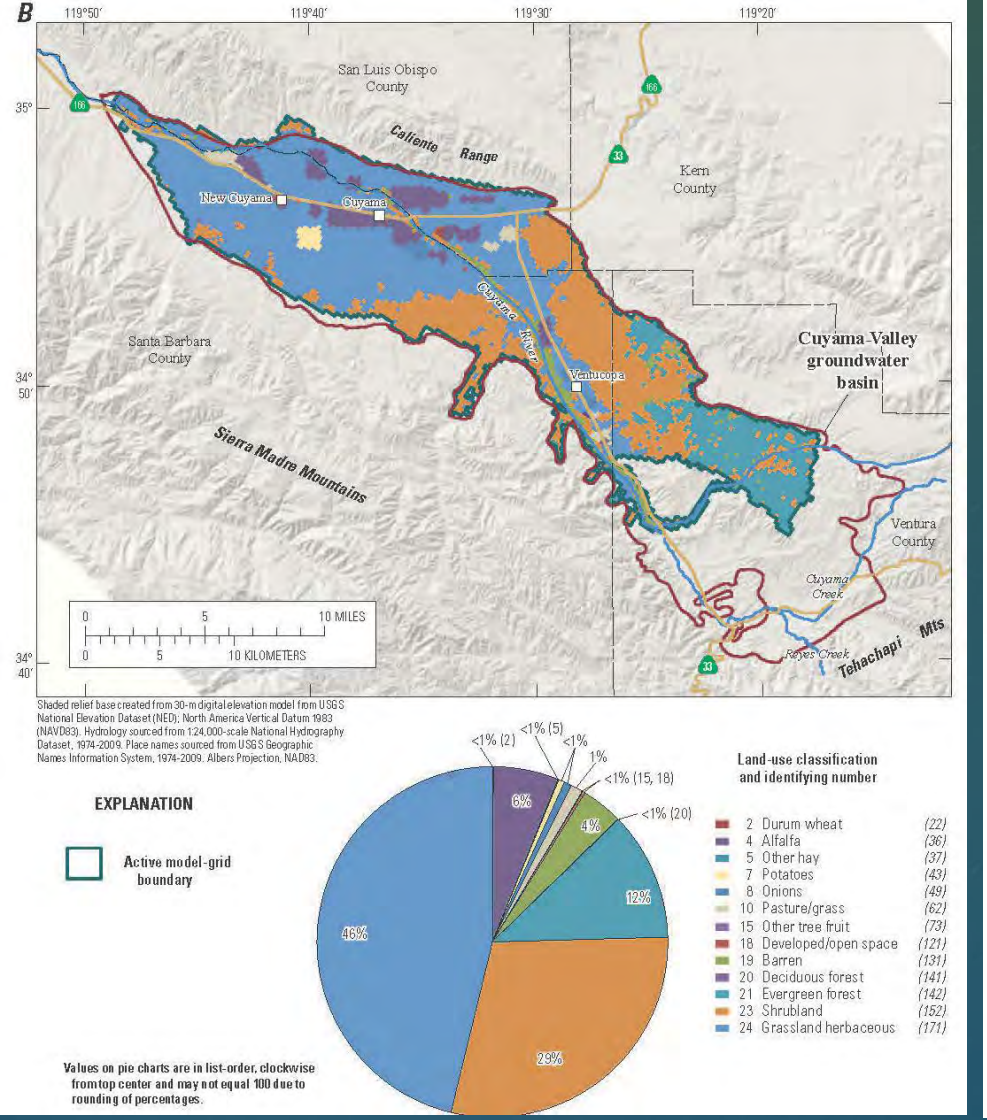


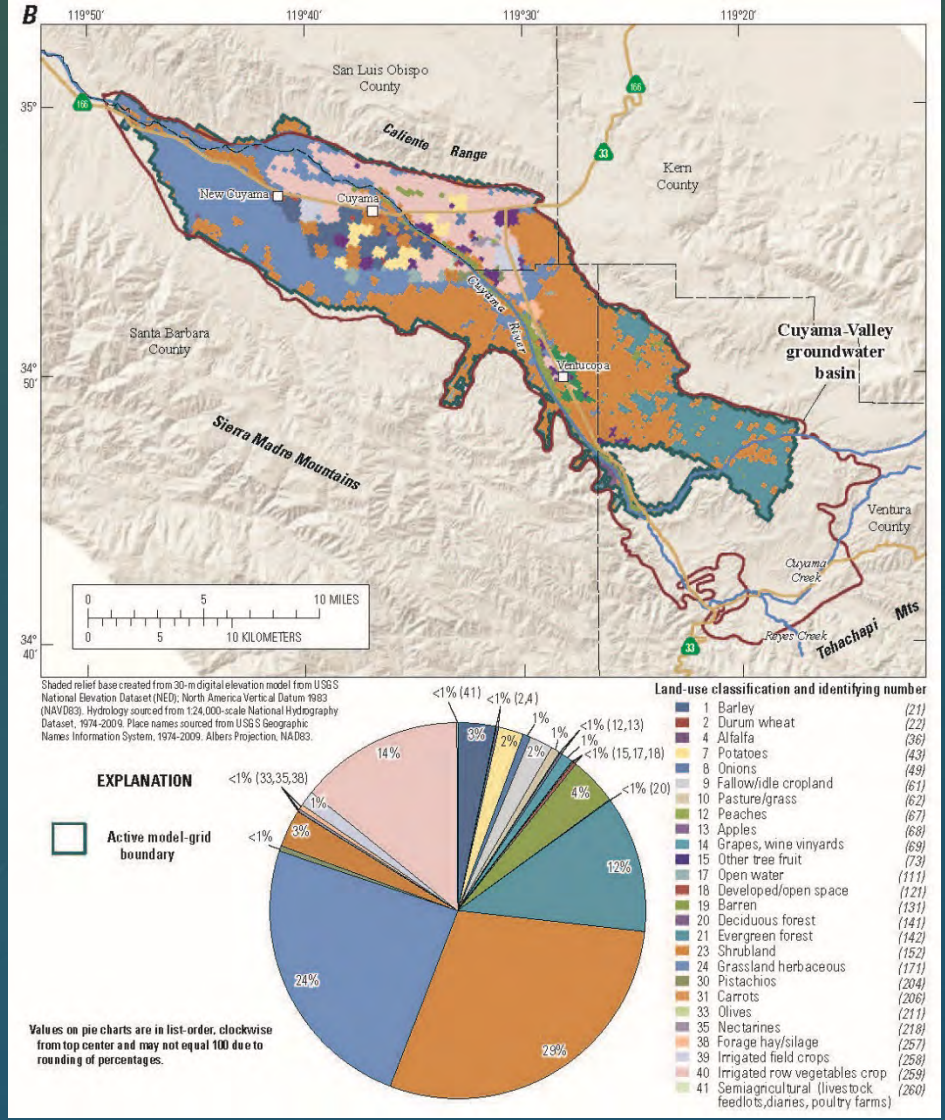
Hydrogeologic Framework of Cuyama Valley

Integrated Hydrologic Model

- Simplification of a real hydrogeologic system
- Is not a unique solution
- Likely all could be improved and question becomes when to stop and use model as a tool
- Data compiled for model is valuable and could be basis for other models
- A tool to estimate water budget
- Supplemental water management tool



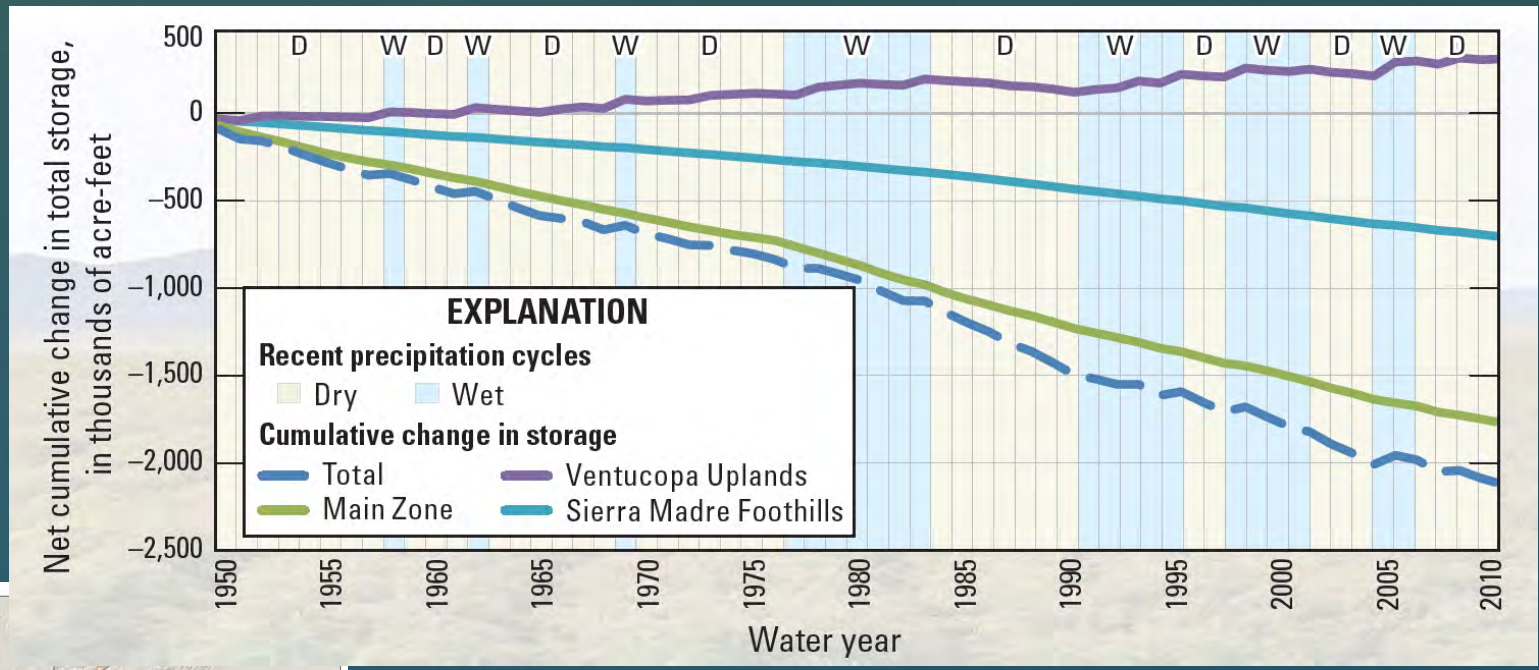




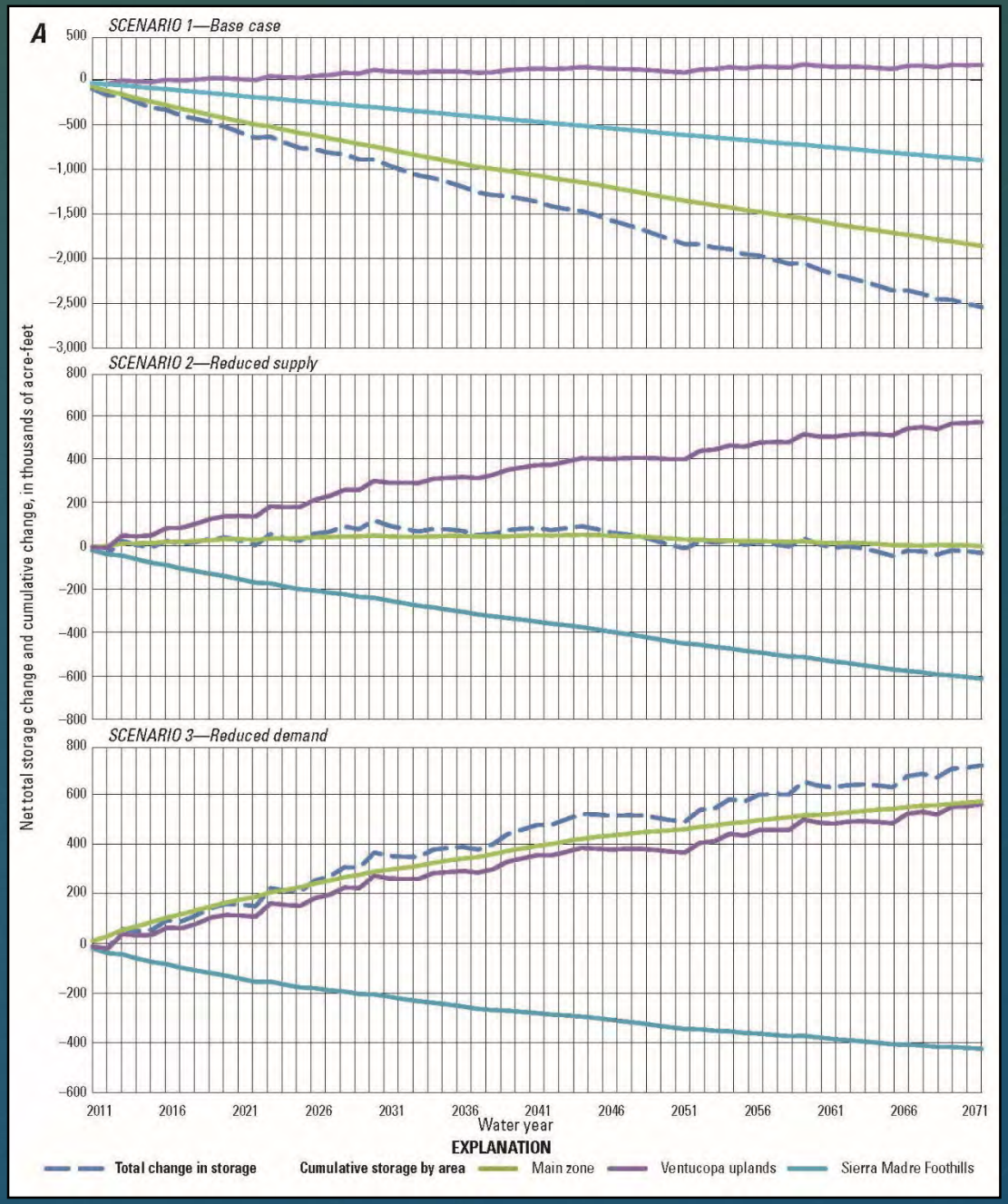
1959 Land Use in Cuyama Valley 2010

Alfalfa – Field Crops- Carrots

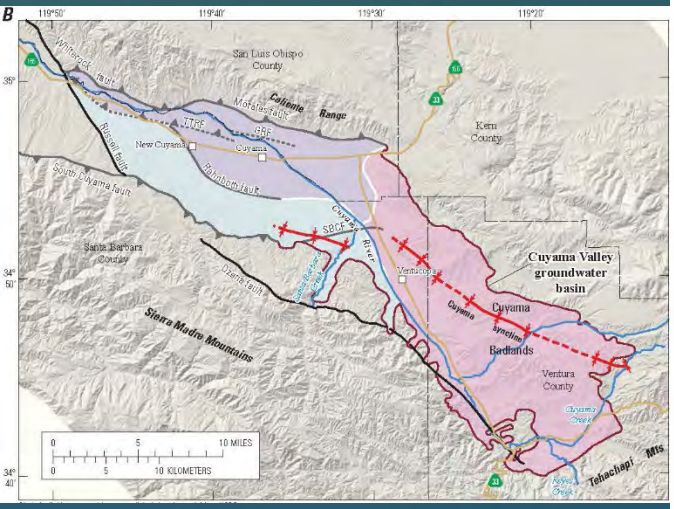
Modeled Changes in Historical Groundwater Storage in Cuyama Valley



Scenarios of Future Storage Simulation 2010-2071

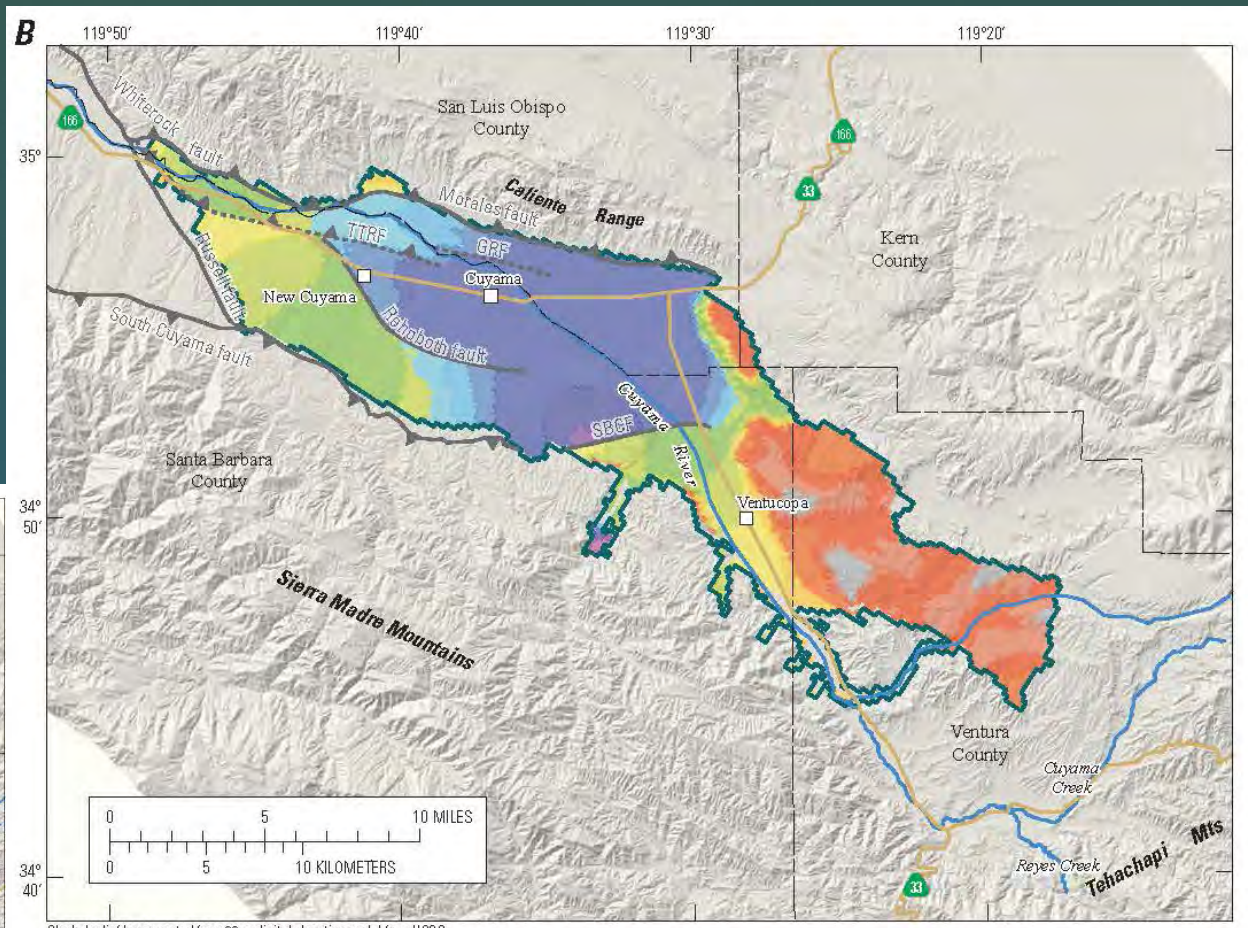


Modeled Additional changes in Projected Groundwater Levels in Cuyama Valley for Base-Case Scenario



Simplified Cuyuma groundwater basin zones

- Main
- Sierra Madre Foothills
- Ventucopa Uplands



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Simulated difference in water-level altitude, in feet, summer 2010 minus summer 2071; interval varies

<–150	>100 to 125
>–150 to –100	>125 to 150
>–100 to –50	>150 to 175
>–50 to 0	>175 to 200
>0 to 1	>200 to 250
>1 to 10	>250 to 275
>10 to 25	>275 to 300
>25 to 50	>300 to 350
>50 to 75	>350 to 400
>75 to 100	

EXPLANATION

- Active model-grid boundary
- Normal fault
- Thrust fault
- Thrust fault, concealed

Incomplete list of Strengths and Weaknesses

Strengths

- Team of expert geologists and hydrologists
- Pulls together and integrates data for area
- Collected new data
- Used to identify areas of more uncertainty and where more information would be most valuable
- Constructed models to be used as tools to understand system
- Updated BCM for state could be useful

and Weaknesses

- Lack of data in study area
- Doesn’t cover entire SGMA groundwater basin (does cover area with historical major stresses)
- Complex area with multiple conceptual models possible
- Structures and faulting are complex and faults traditionally have low sensitivity in models

Suggested next steps

- **Understanding system is a journey**
- **Build on existing data sets and studies**
- **Continue data collection**
- **Use data, analyses, models, and information to guide where to get more information and test conceptual models (multiple models are often good)**
- **Models should be living and change as more information becomes available**
- **May need to expand to understand entire SGMA basin**

Remember that

- every model is a simplification and only as good as the data/interpretations that are available for it
- even if something goes in with a GSP that State does review it and continues to every 5 years -that backstop is an important part of the process

GROUNDWATER USE ←→ INFORMED CHOICES ←→ SUSTAINABILITY

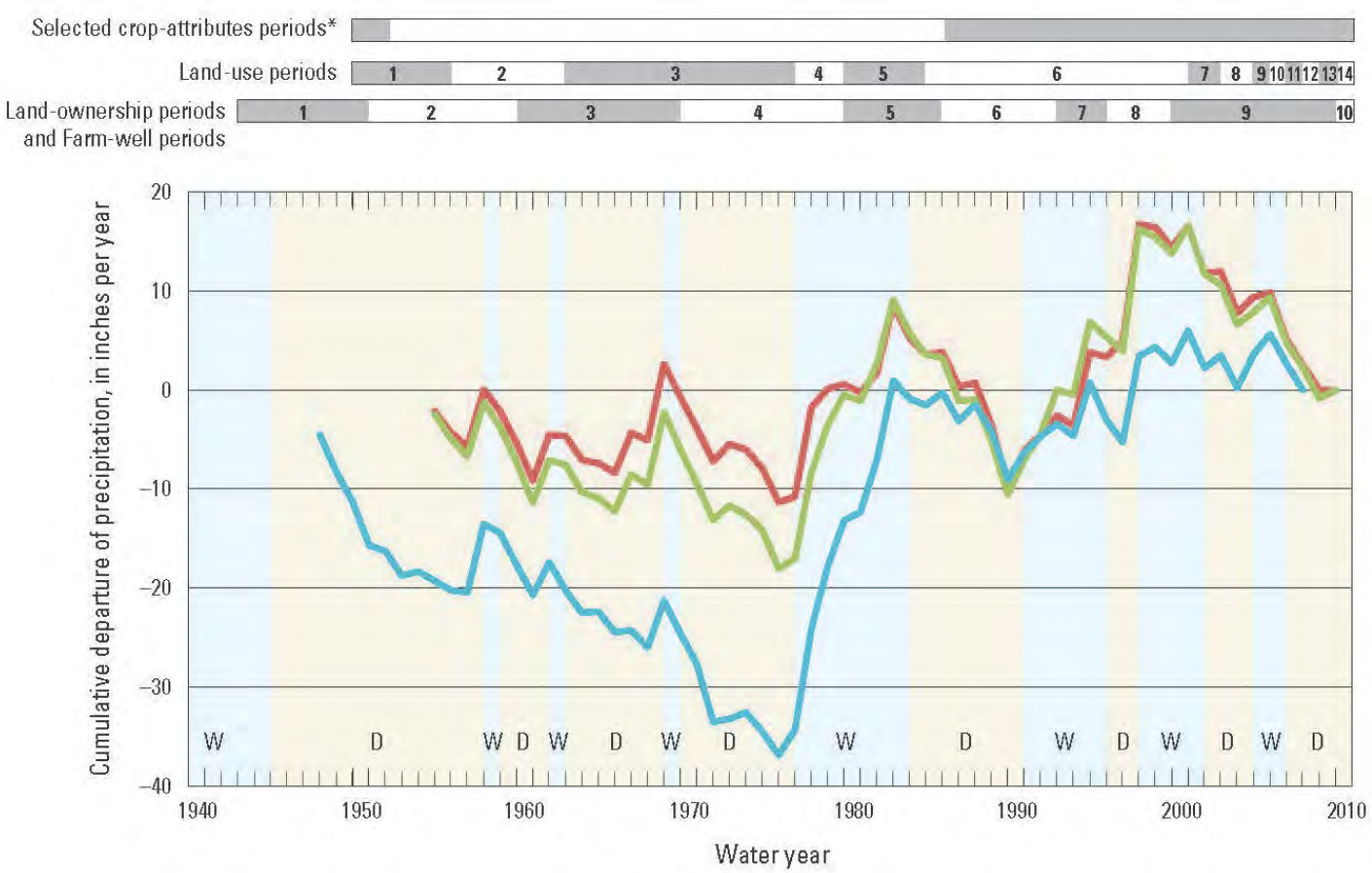
Cuyama Valley, California

USGS science for a changing world

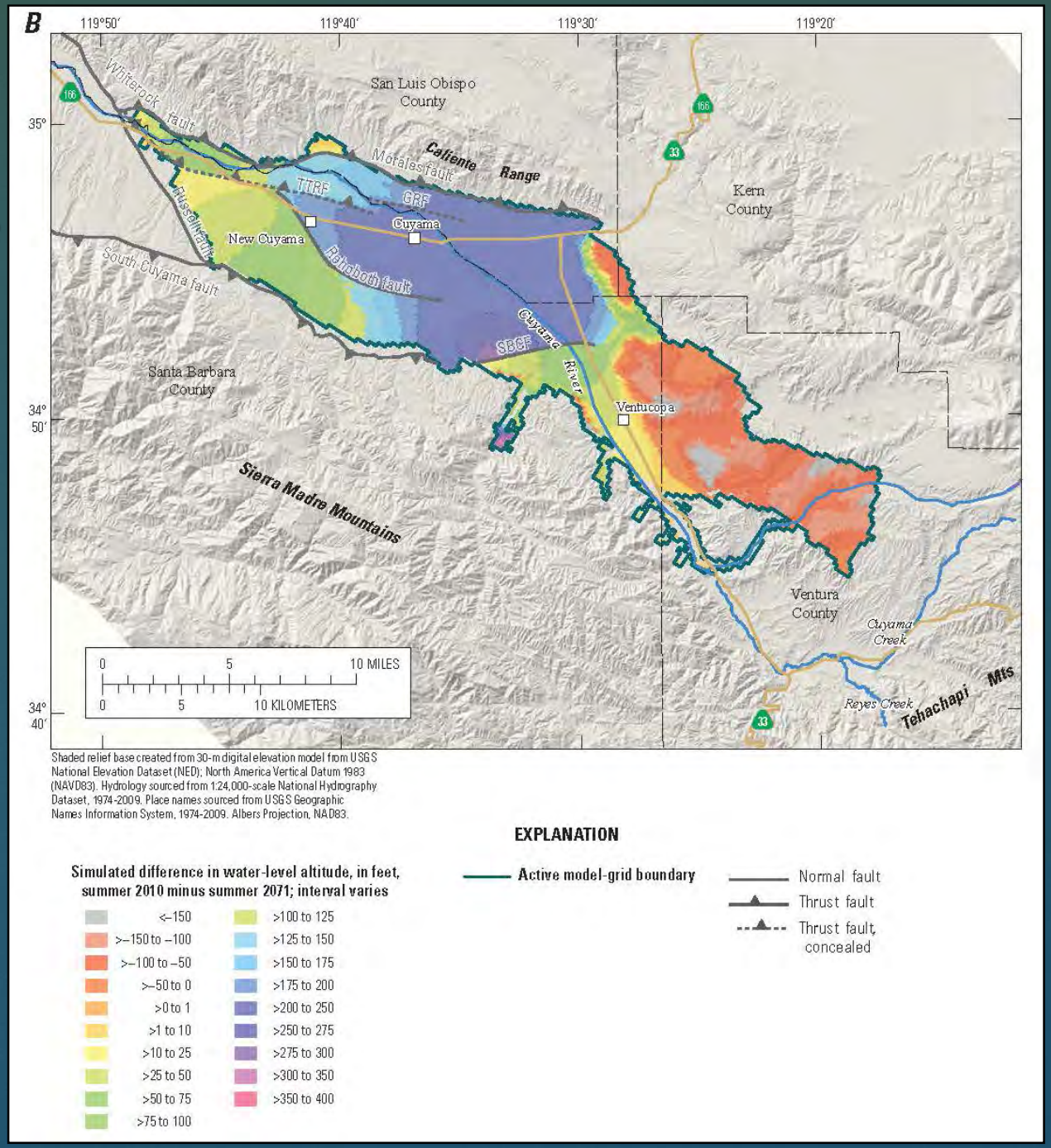

QUESTIONS

Climate and Land- Use Summary

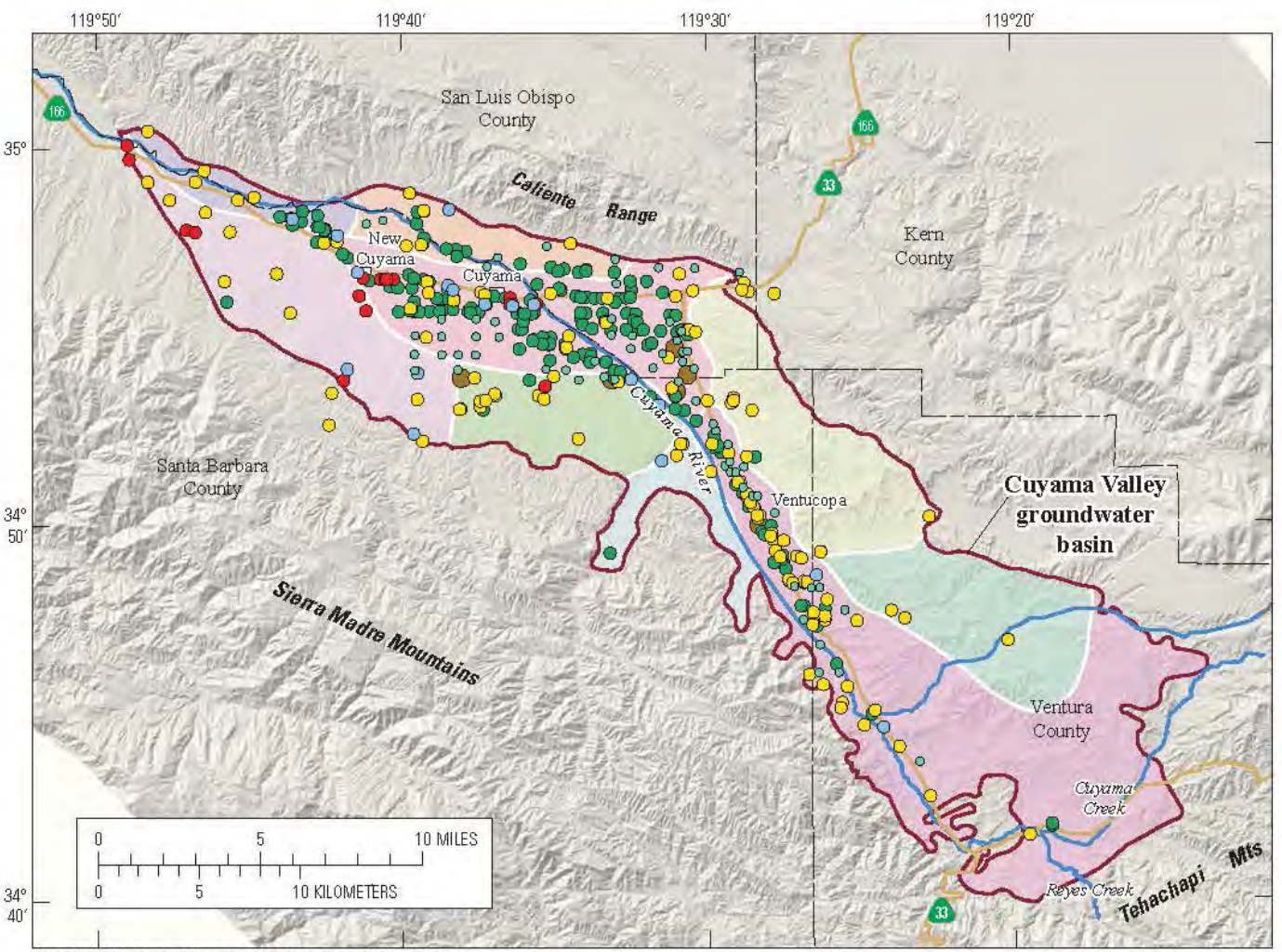
Climate cycles of 27, 22, and 13.5 years all parts of Pacific Decadal Oscillation



Simulated Water Level Declines of an additional 300′ in the Main Zone from 2010 to 2071



Wells in Cuyama Valley



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EXPLANATION

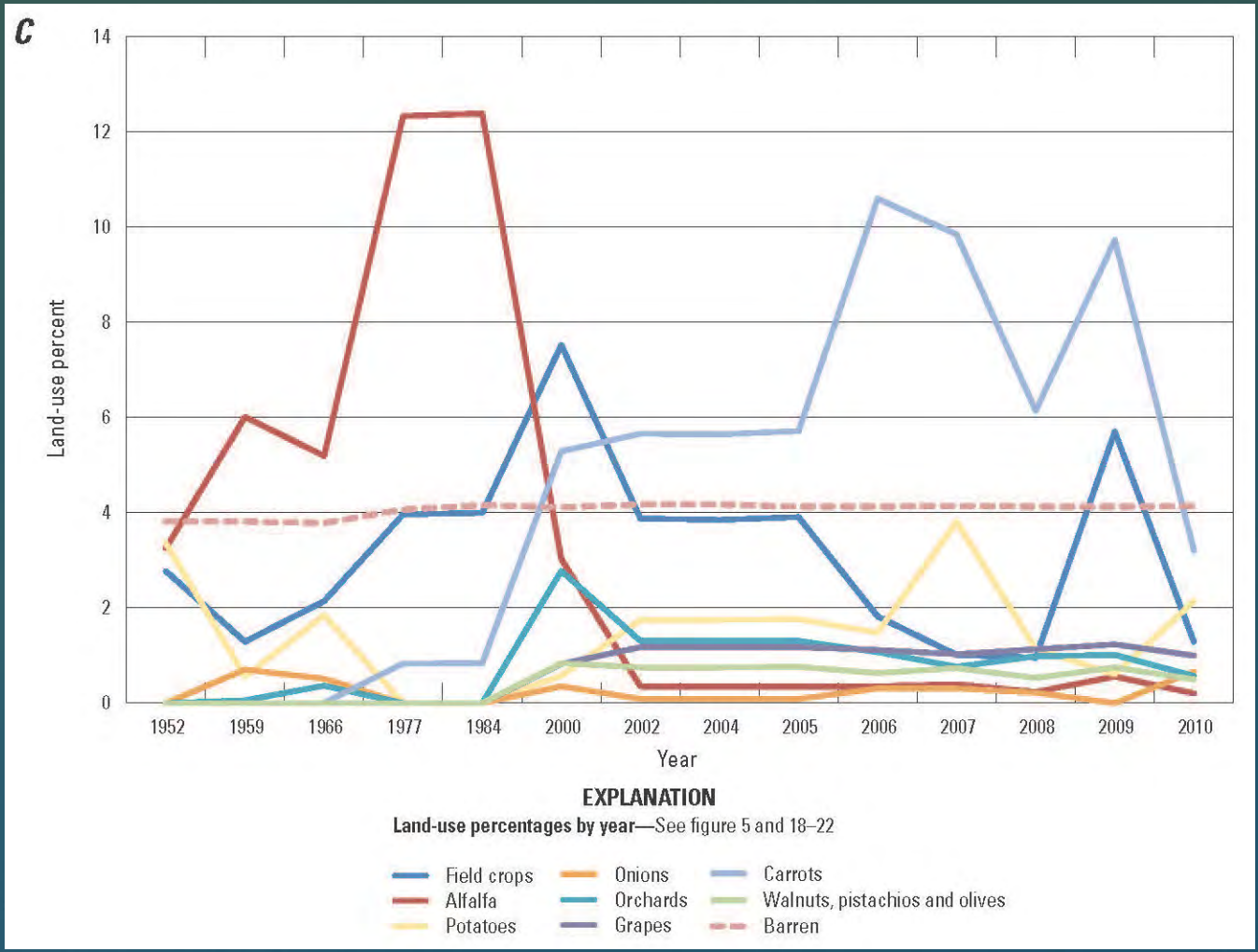
Cuyama groundwater basin subregion

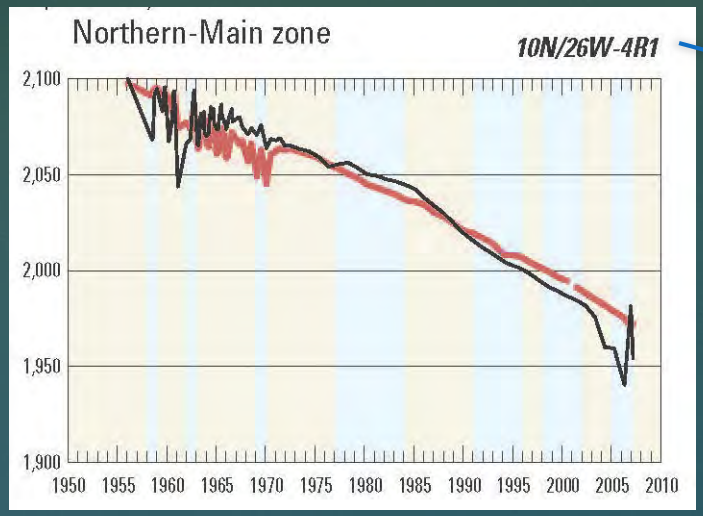
- Caliente Northern-Main
- Central Sierra Madre Foothills
- Northeast Ventucopa Uplands
- Northwestern Sierra Madre Foothills
- Northern Ventucopa Uplands
- Southern Sierra Madre Foothills
- Southern Ventucopa Uplands
- Southern-Main
- Western Basin

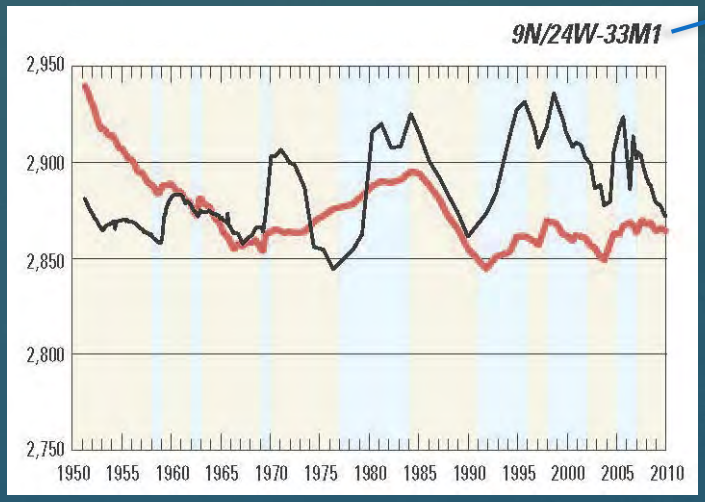
Well and type

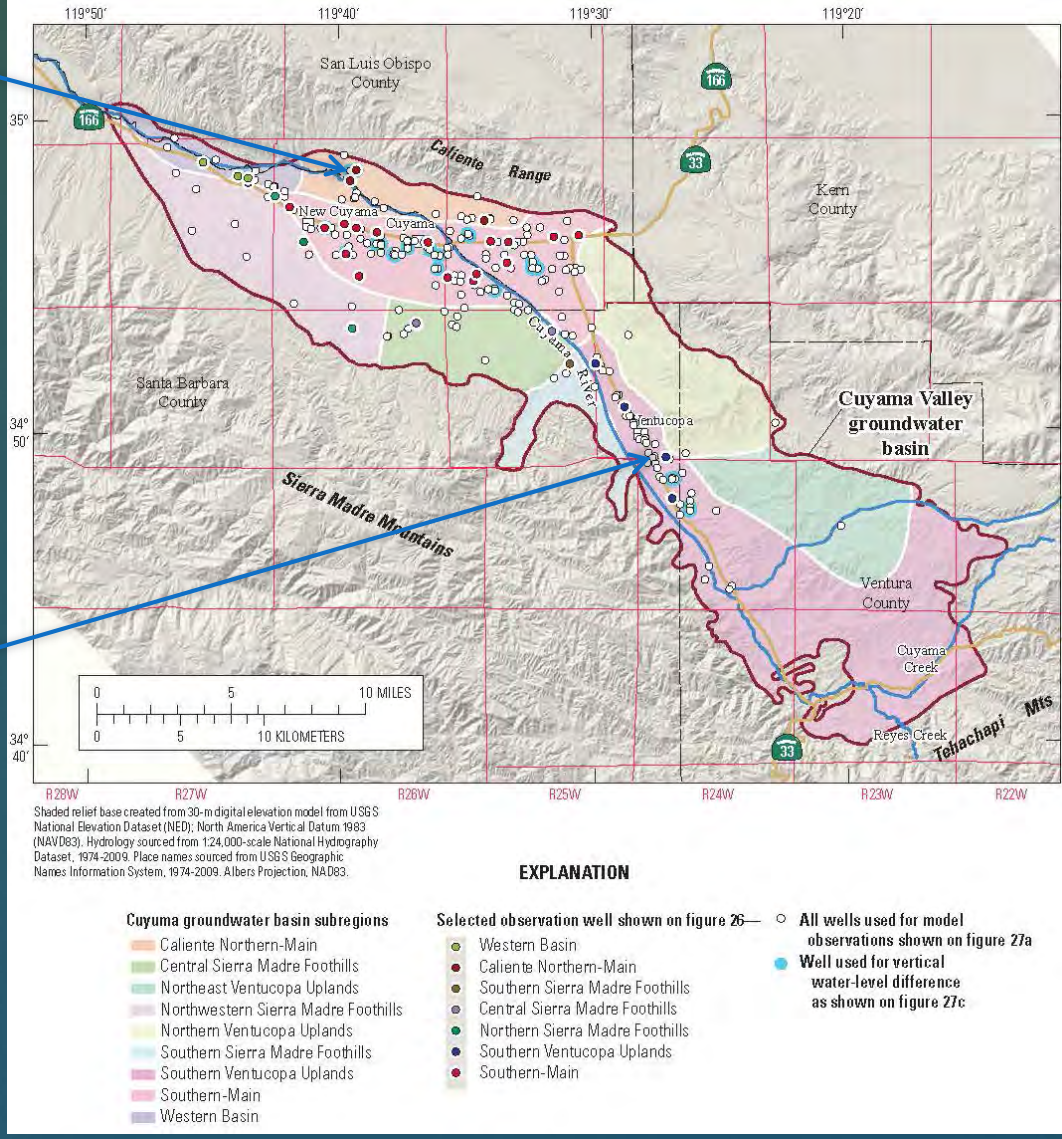
- Agriculture
- Other agriculture
- Domestic
- Municipal and industrial
- Observation
- Virtual

Changes in Agricultural Land Use in Cuyama Valley



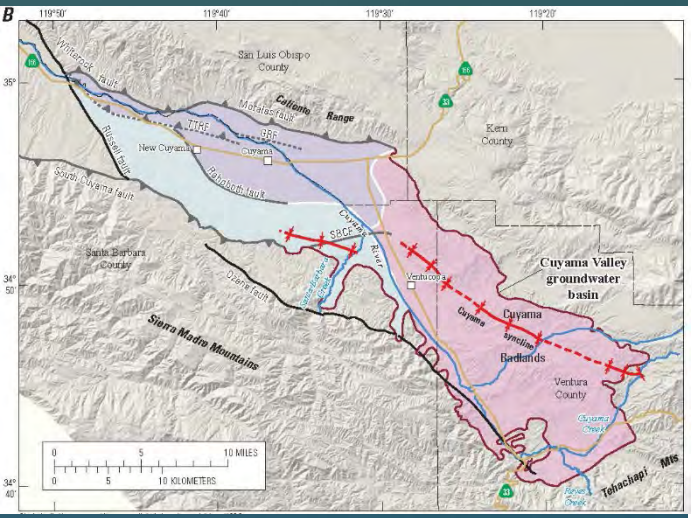






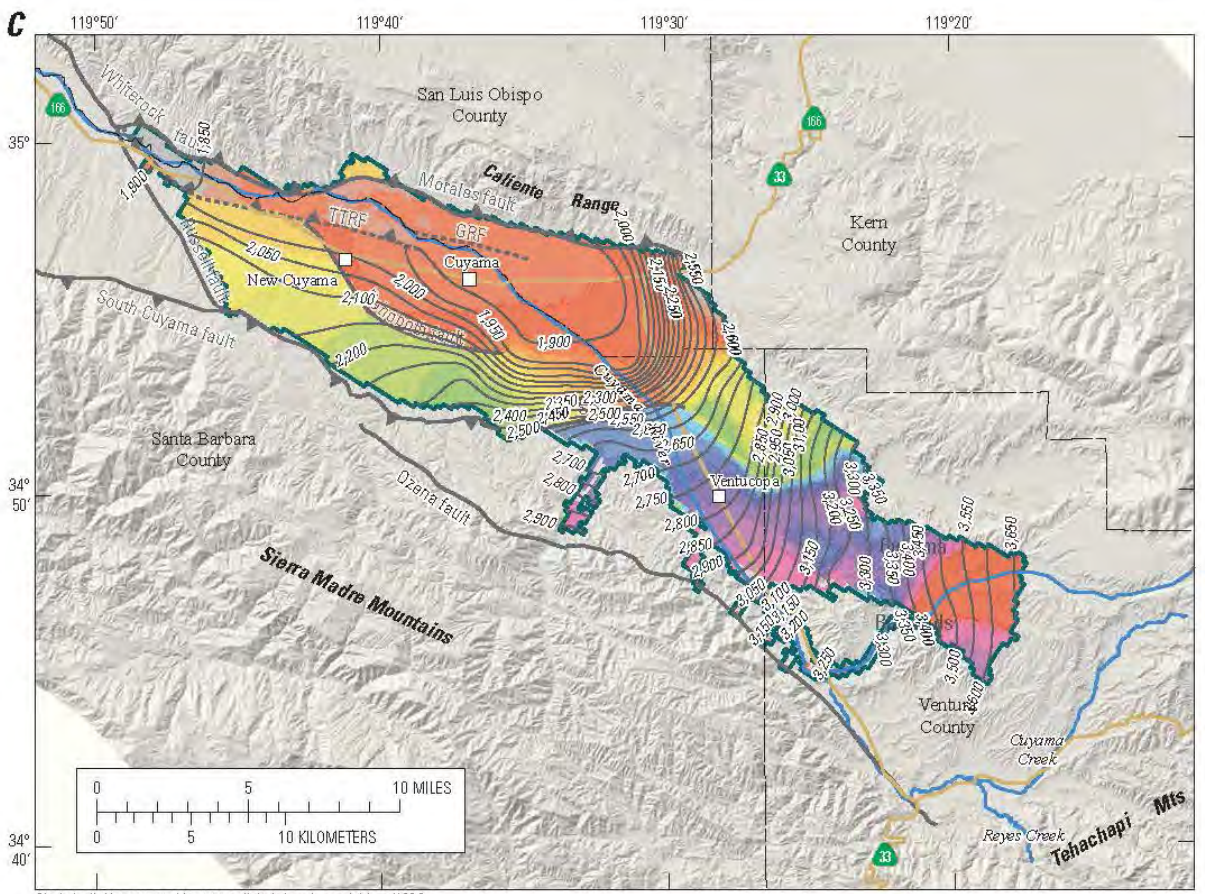
Hydrographs from Cuyama Valley

Modeled and Measured Groundwater levels Summer, 2010 in Cuyama Valley



Simplified Cuyama groundwater basin zones

- Main
- Sierra Madre Foothills
- Ventucopa Uplands



Shaded relief base created from 30-m digital elevation model from USGS National Elevation Dataset (NED); North America Vertical Datum 1983 (NAVD83). Hydrology sourced from 1:24,000-scale National Hydrography Dataset, 1974-2009. Place names sourced from USGS Geographic Names Information System, 1974-2009. Albers Projection, NAD83.

EXPLANATION

Simulated water-level altitude, summer 2010; interval is 50 feet

- <1,750
- >1,750 to 1,800
- >1,850 to 1,850
- >1,850 to 1,900
- >1,900 to 1,950
- >1,950 to 2,000
- >2,000 to 2,050
- >2,050 to 2,100
- >2,100 to 2,150
- >2,150 to 2,200
- >2,200 to 2,250
- >2,250 to 2,300
- >2,300 to 2,350
- >2,350 to 2,400
- >2,400 to 2,450
- >2,450 to 2,500
- >2,500 to 2,550
- >2,550 to 2,600
- >2,600 to 2,650
- >2,650 to 2,700
- >2,700 to 2,750
- >2,750 to 2,800
- >2,800 to 2,850
- >2,850 to 2,900
- >2,900 to 3,000
- >3,000 to 3,100
- >3,100

Active model-grid boundary

~2,250 Water-level altitude, summer 2010; interval is 50 feet

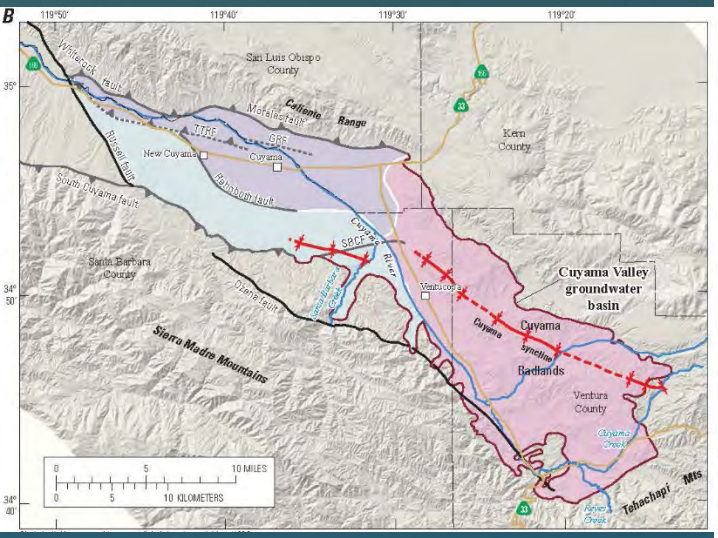
Normal fault

Thrust fault

Thrust fault, concealed

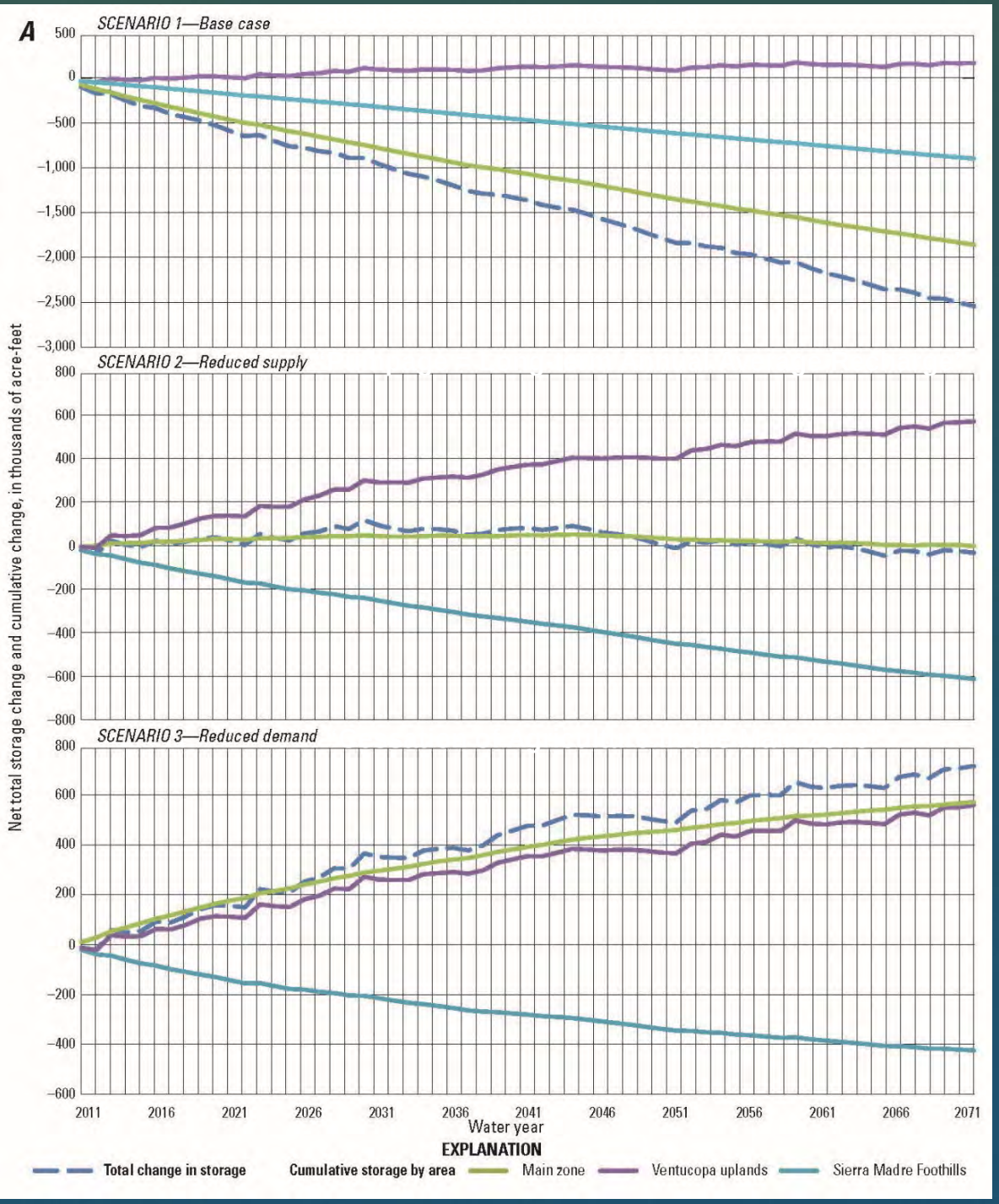
GRF, Graveyard fault;
SBCF, Santa Barbara Canyon fault;
TTRF, Turkey Trap Ridge fault

Modeled Changes in Projected Groundwater Storage in Cuyama Valley

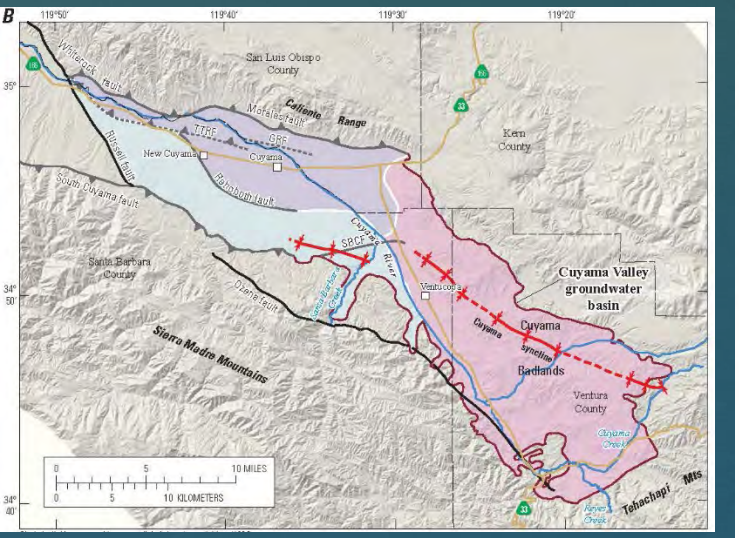


Simplified Cuyuma groundwater basin zones

- Main
- Sierra Madre Foothills
- Ventucopa Uplands

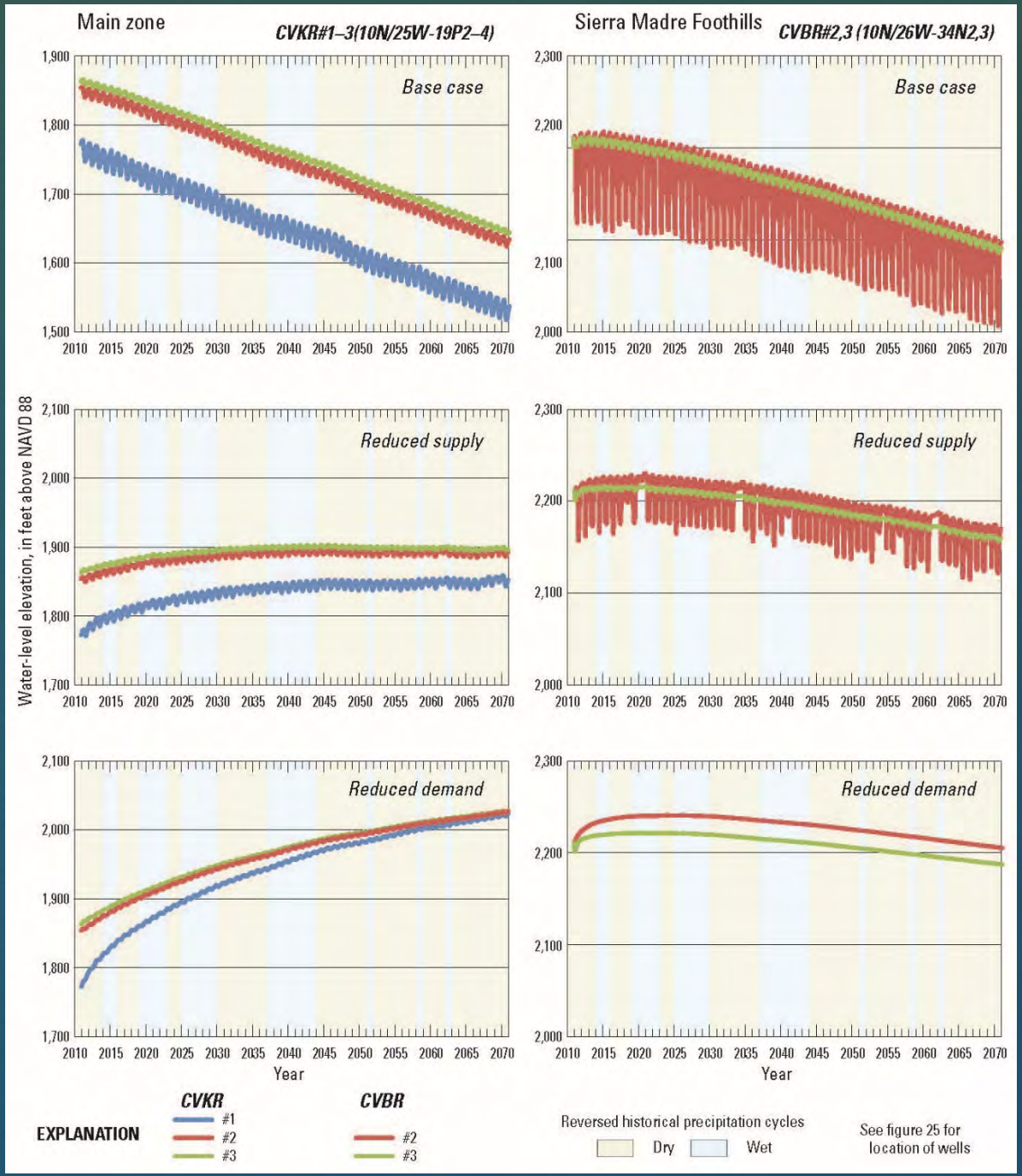


Modeled Changes in Projected Groundwater Levels at CVKR & CVBR in Cuyama Valley

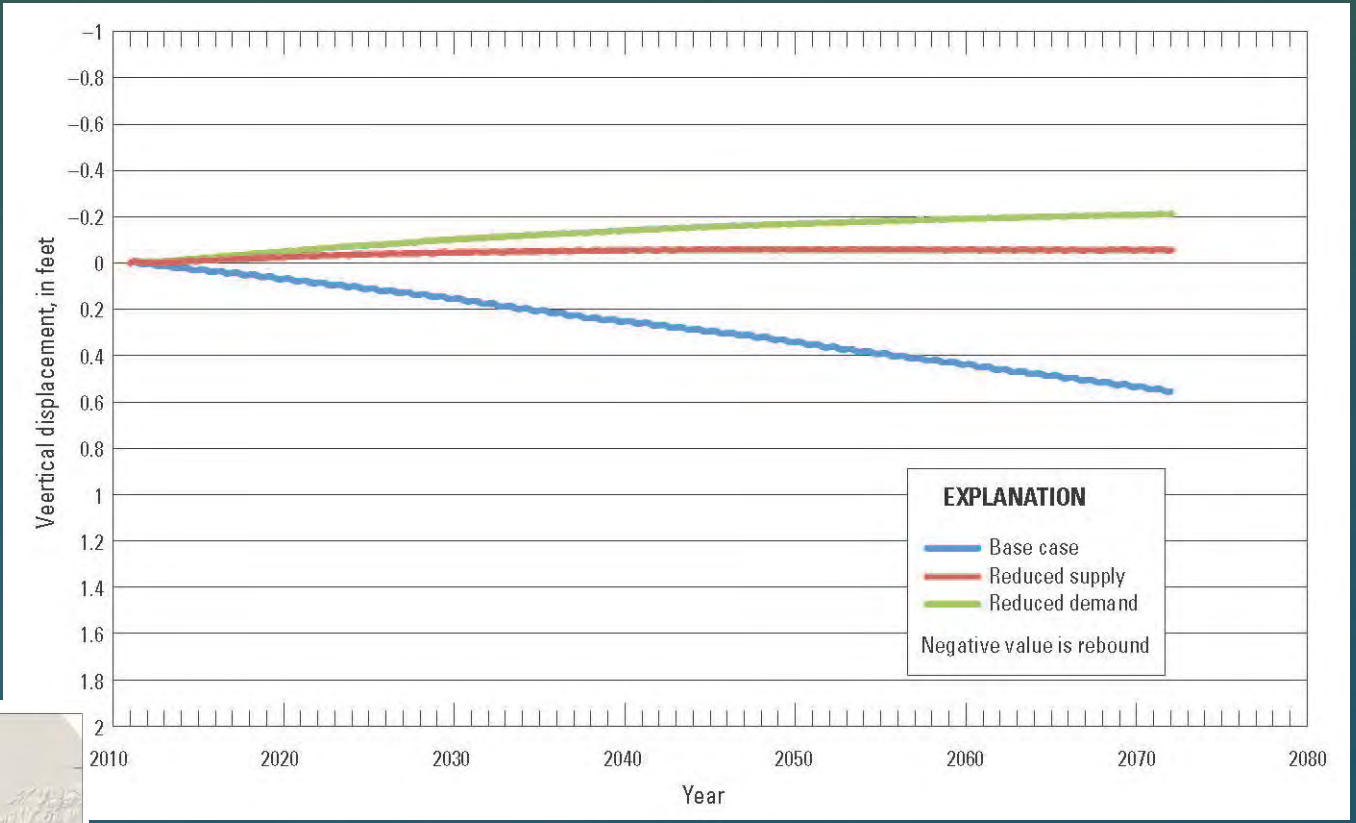


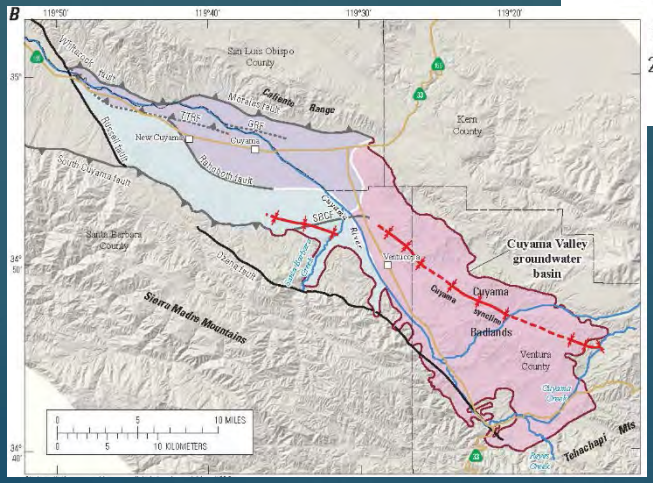
Simplified Cuyuma groundwater basin zones

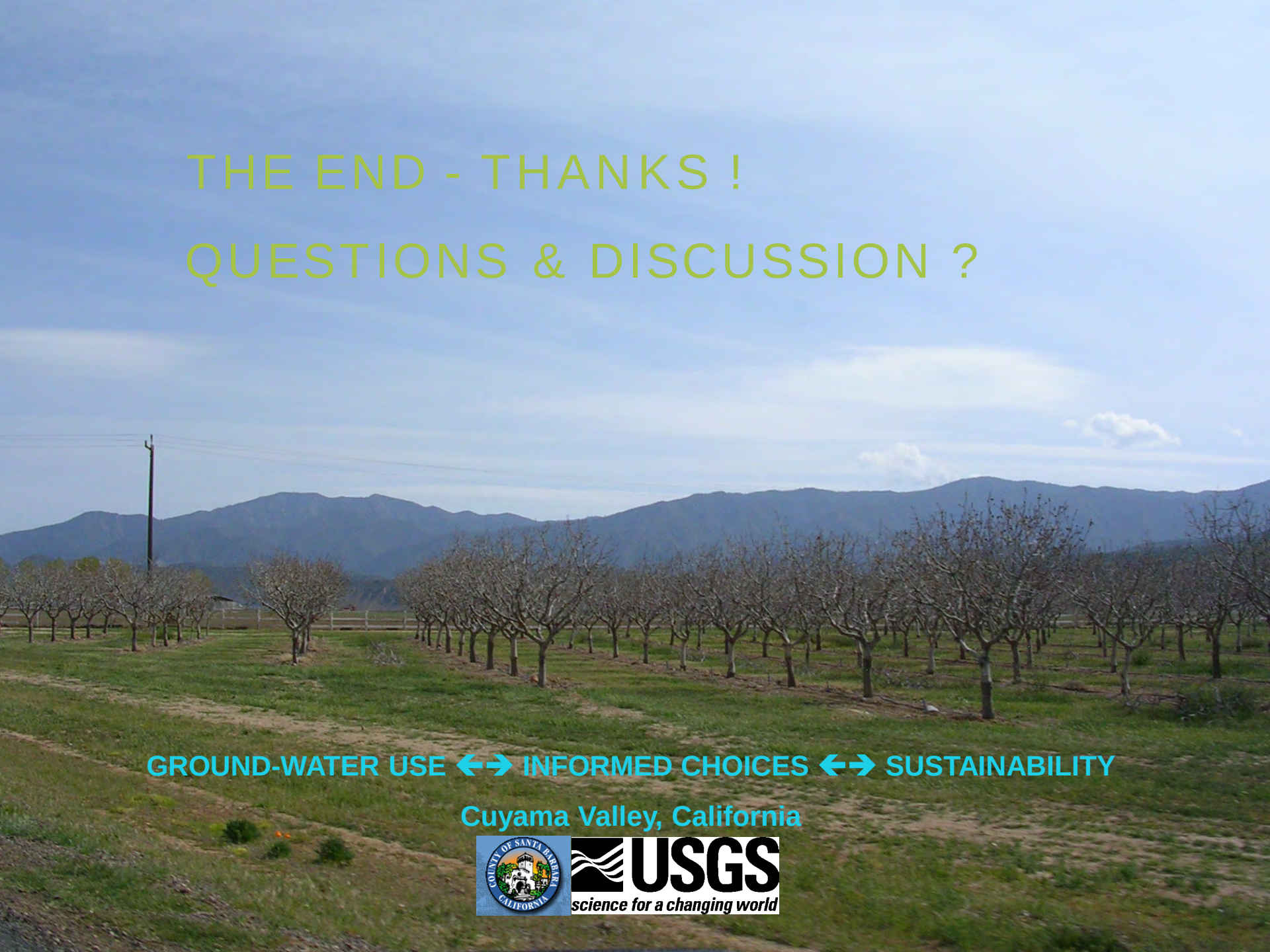
- Main
- Sierra Madre Foothills
- Ventucopa Uplands



Modeled Changes in Projected Potential Land Subsidence at CUHS in Cuyama Valley






THE END - THANKS !
QUESTIONS & DISCUSSION ?
GROUND-WATER USE ←→ INFORMED CHOICES ←→ SUSTAINABILITY
Cuyama Valley, California
COUNTY OF SANTA BARBARA CALIFORNIA
USGS
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