West Turlock Subbasin Groundwater Sustainability Agency
East Turlock Subbasin Groundwater Sustainability Agency

Turlock Subbasin Groundwater Sustainability Plan (GSP) Technical Workshop No. 1

Joint Technical Advisory Committees (TACs) Meeting

August 23, 2018

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Presentation Outline

- Workshop Objectives
- GSP Process and Timeline
- Technical Analyses and Sustainability Indicators
- Plan Area Section of the GSP
- Basin Setting Section of the GSP
  - Hydrogeologic Conceptual Model (HCM)
  - Groundwater Conditions
- Next Steps

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TAC Workshop Objectives

- Provide an update on technical work to date using **draft work products**
- Allow TAC members to consider **how the technical work informs the GSP**
- Provide an opportunity for the TAC and stakeholders to **suggest data or other considerations** to incorporate into the analysis
- Provide information that the **TAC/GSA members can discuss and share with community stakeholders**

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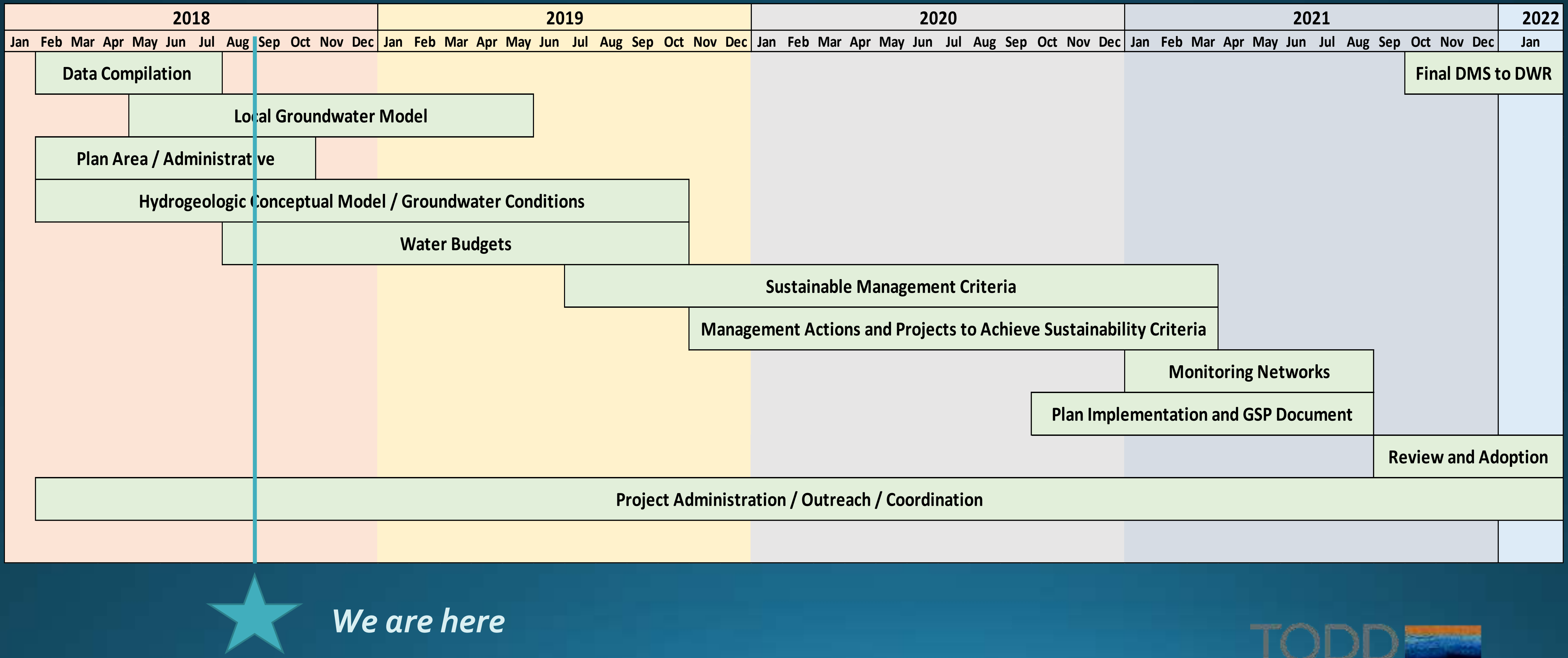
Turlock Subbasin GSP Process and Timeline



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GSP Overview

Technical Components

- Data Compilation / Data Management System
- Institutional Setting – Water Supply / Plan Area
- Hydrogeologic Conceptual Model / Groundwater
- Water Budget (Current and Historical)

Policy Components

- Sustainability Goals and Criteria

Management / Plan Components

- Management Scenarios Projected Water Budget
- Monitoring Networks Plan Development

Today's Workshop

Sustainability Indicators

- Chronic Lowering of Water Levels
- Reduction of Groundwater Storage
- Degradation of Water Quality
- 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

Sustainability Indicator Analysis

- Rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin
- Sustainable yield, calculated based on historical trends, water year type, and projected water use in the basin
- Number of supply wells, volume of water, or location of an isocontour exceeding constituents of concern, considering state and federal standards
- Rate and extent of subsidence that interferes with surface land use supported by identification of land/property interests affected or likely to be affected.
- Depletion that has adverse impacts on beneficial use of surface water supported by the location, quantity, and timing of depletions; assumes use of a numerical model or equally effective method or tool.

Considerations for Turlock Subbasin

- Consider beneficial uses of wells; problems during the recent drought? Historic low levels?
- Develop operational range of storage, with an emergency supply
- Title 22, basin plan objectives, GAMA, GeoTracker, CV-Salts/ILP; also consider naturally-occurring constituents
- Subsidence does not currently interfere with land uses; evaluate texture data for future susceptibility
- Interconnected Surface Water and Groundwater Dependent Ecosystems (GDEs) –model gaining and losing reaches on rivers; support with other analyses (e.g., temperature data)

Metrics and Minimum Thresholds to Define Undesirable Results

- Minimum water level at representative monitoring points
- Volume of supply in storage; water levels as a proxy
- Poor water quality spatially or at depth? Possible water levels as a proxy?
- Land subsidence – water levels as a proxy
- GDEs downstream? Possible water levels as a proxy?

Highlights the need for a robust water level monitoring network

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Plan Area
GSP Requirements

What are the Institutional and Water Supply Conditions?

- Agencies and Jurisdictional Boundaries
- Existing Land Use
- Water Sources and Use
- Water Resources Monitoring
- Water Resources Management Programs
- Land Use Planning Elements

Agencies and Jurisdictional Boundaries

- Subbasin 544 mi²
- WTSGSA 327 mi² (60% of Plan Area)
- ETSGSA 217 mi² (40% Plan Area)

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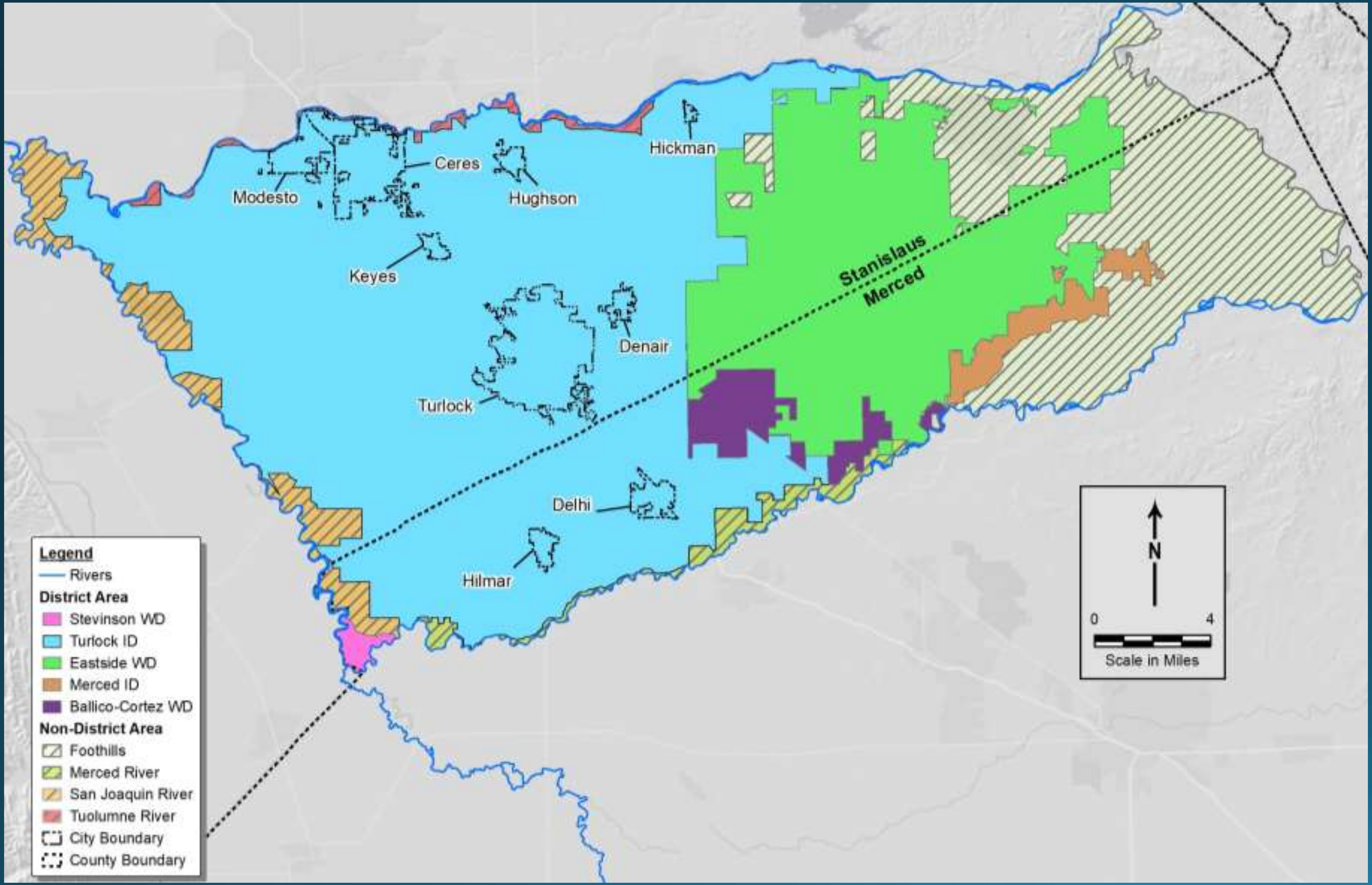
Agencies and Jurisdictional Boundaries



- 9 Municipalities and Urban Communities
- 5 Irrigation and Water Districts
- 106,091 acres (30%) Non-District Areas in eastern subbasin and along river boundaries

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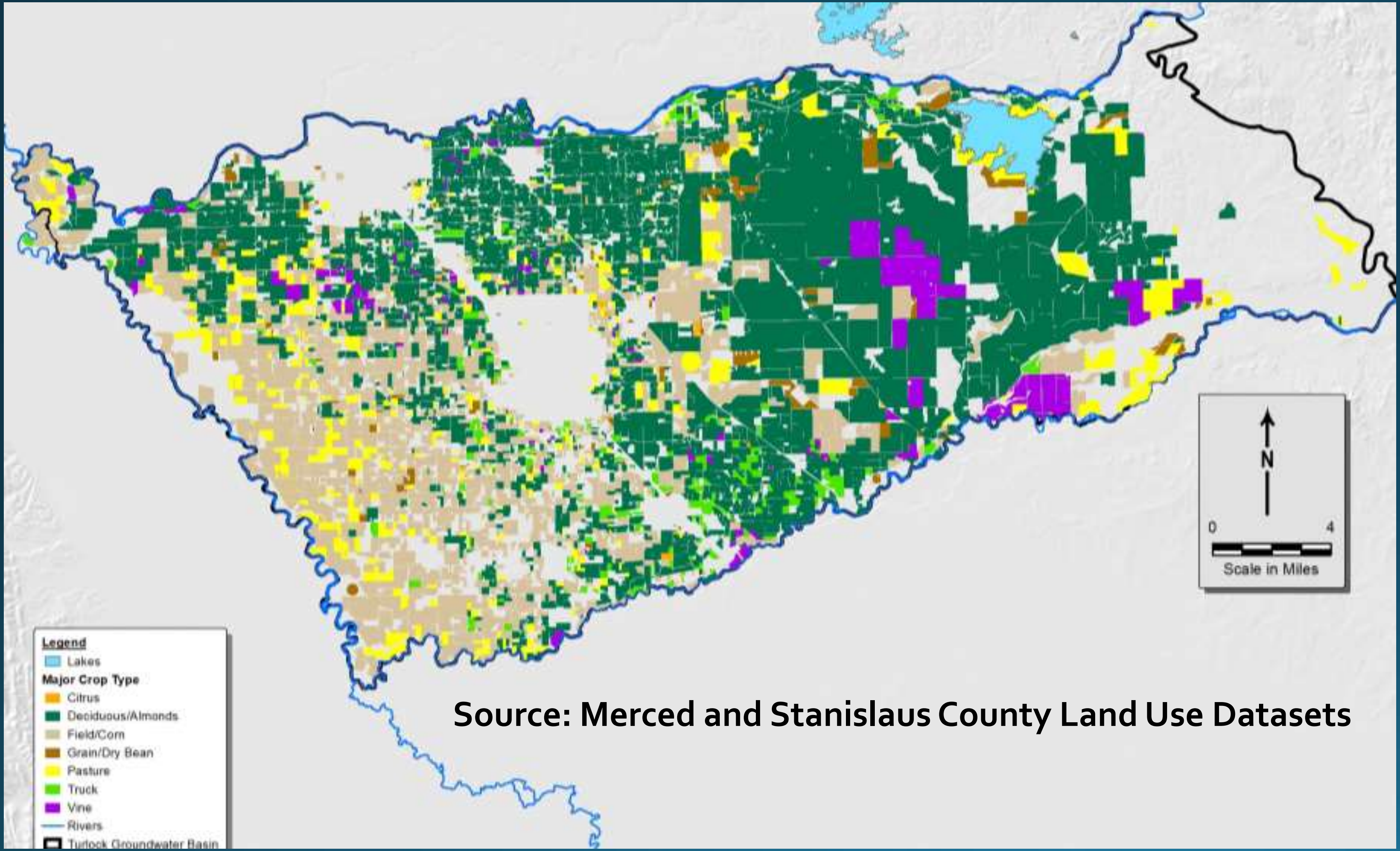
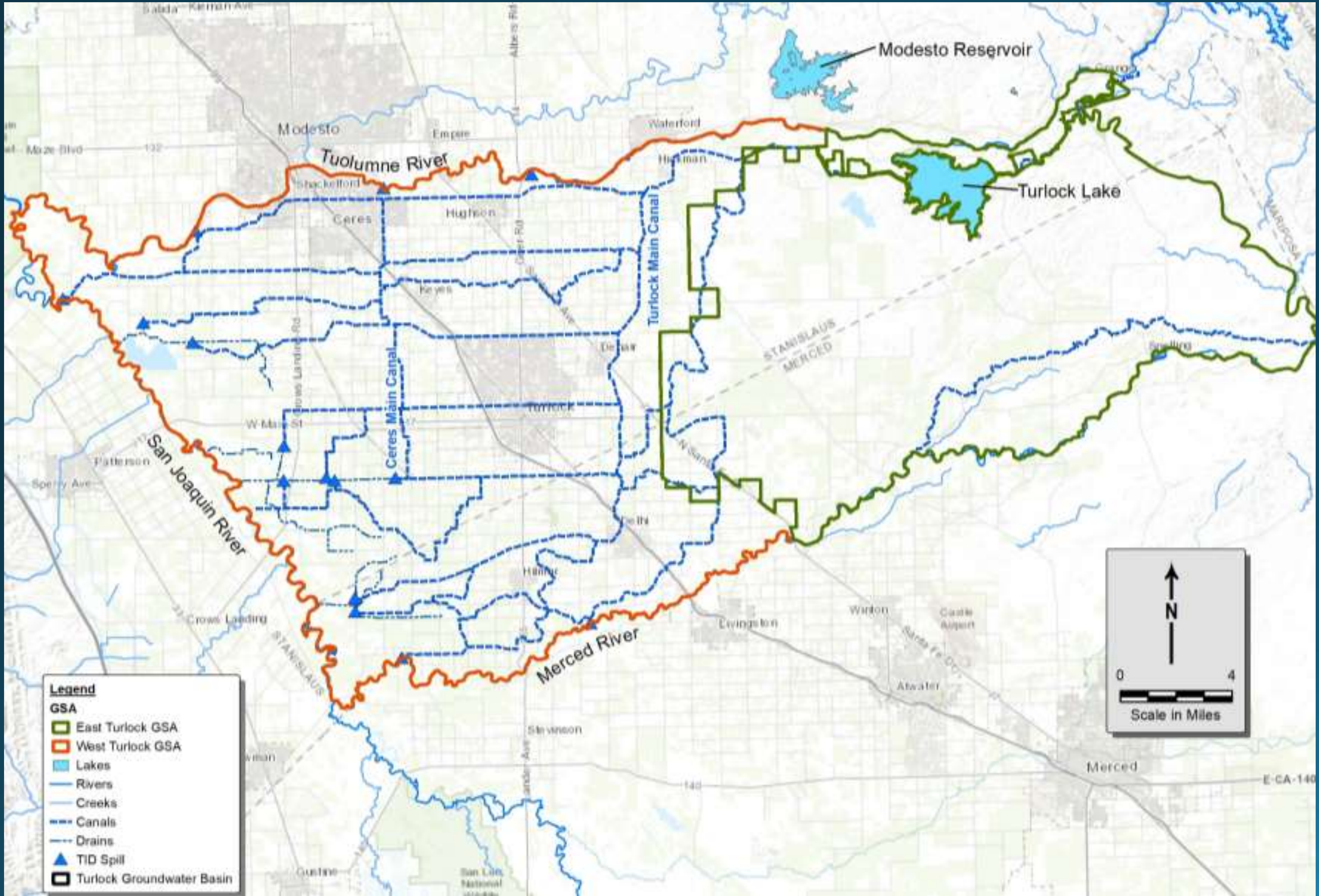
Existing Land Use 2014



Source: Merced and Stanislaus County Land Use Datasets

- 235,676 acres Irrigated Agriculture (68% basin)
- 17,463 acres Urban (5% basin)
- 95,048 acres Non-irrigated Agriculture and Undeveloped (27% basin) (includes surface water, i.e., Turlock Lake)

Surface Water Supply and Infrastructure



- Surface water from the Tuolumne and Merced Rivers
- Groundwater
- No imported water sources

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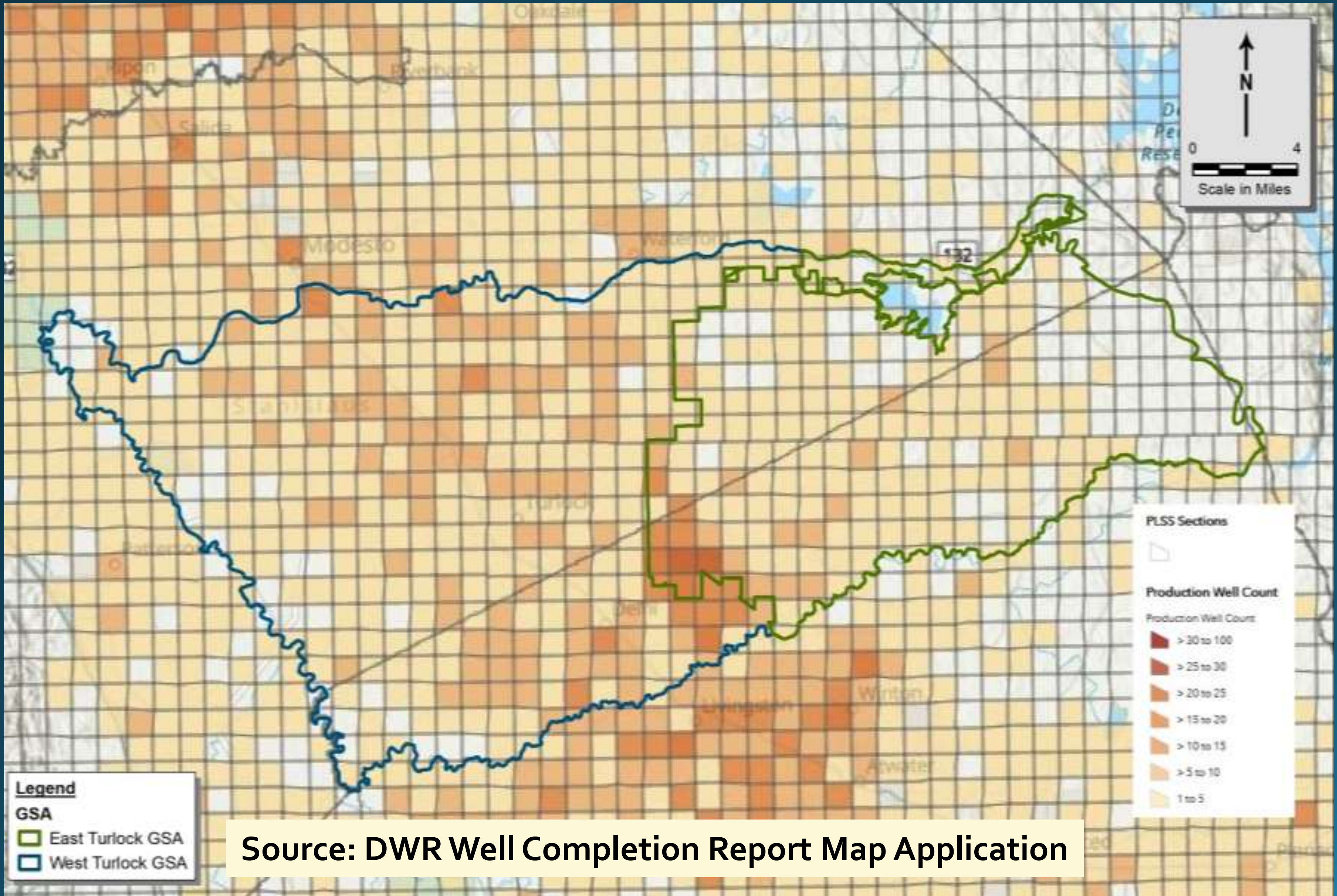
Density of Production Wells



Source: DWR Well Completion Report Map Application

- Number of Production Wells per square mile
- Includes agricultural, domestic, municipal, commercial, and industrial wells
- DWR lists 6,916 wells in the 2018 Basin Prioritization

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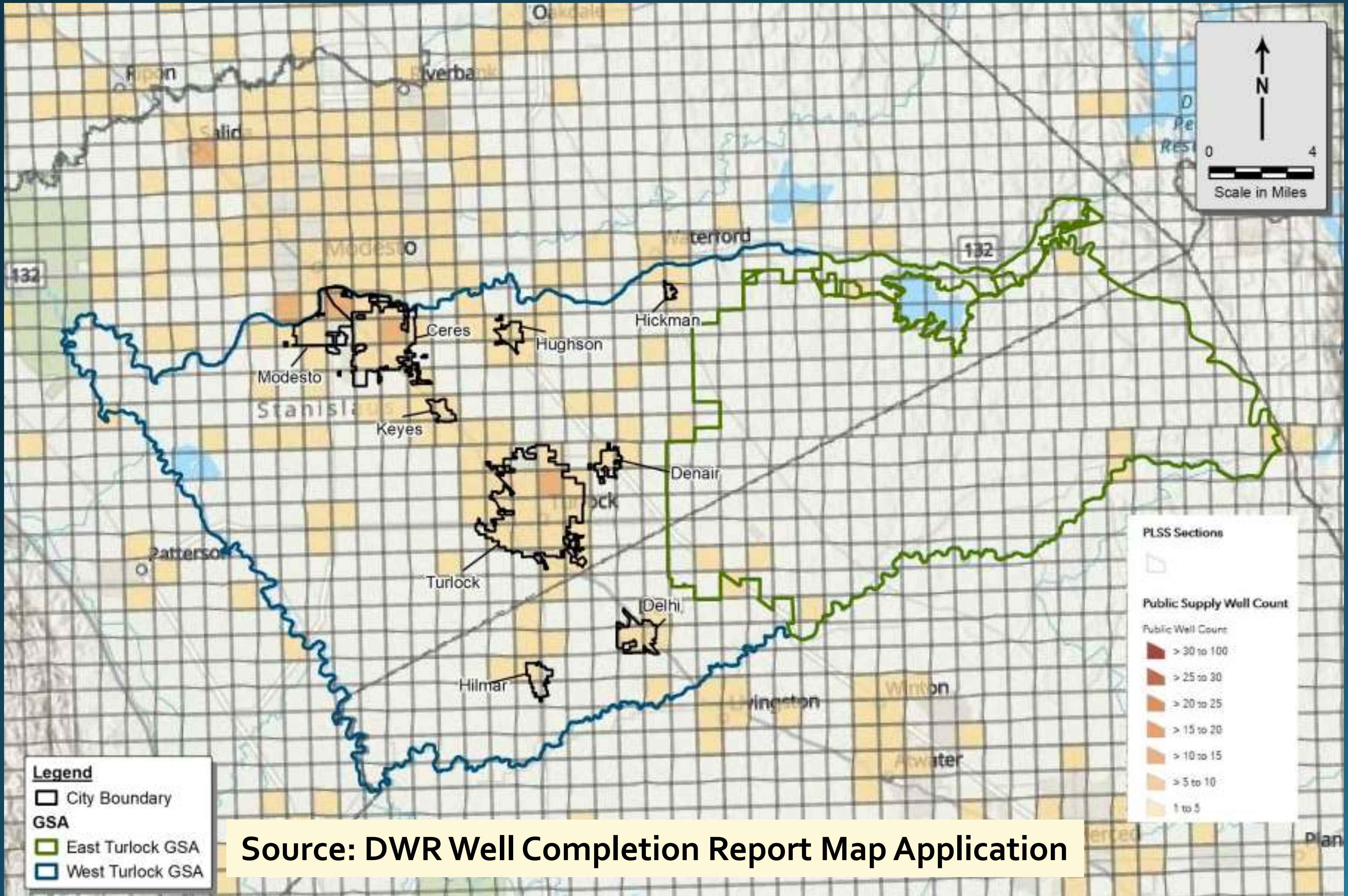
Density of Public Water Supply Wells



Source: DWR Well Completion Report Map Application

- Number of Public Water Supply Wells per square mile
- Largest density associated with municipalities
- Small community services districts
- DWR lists 175 PWS wells in the 2018 Basin Prioritization

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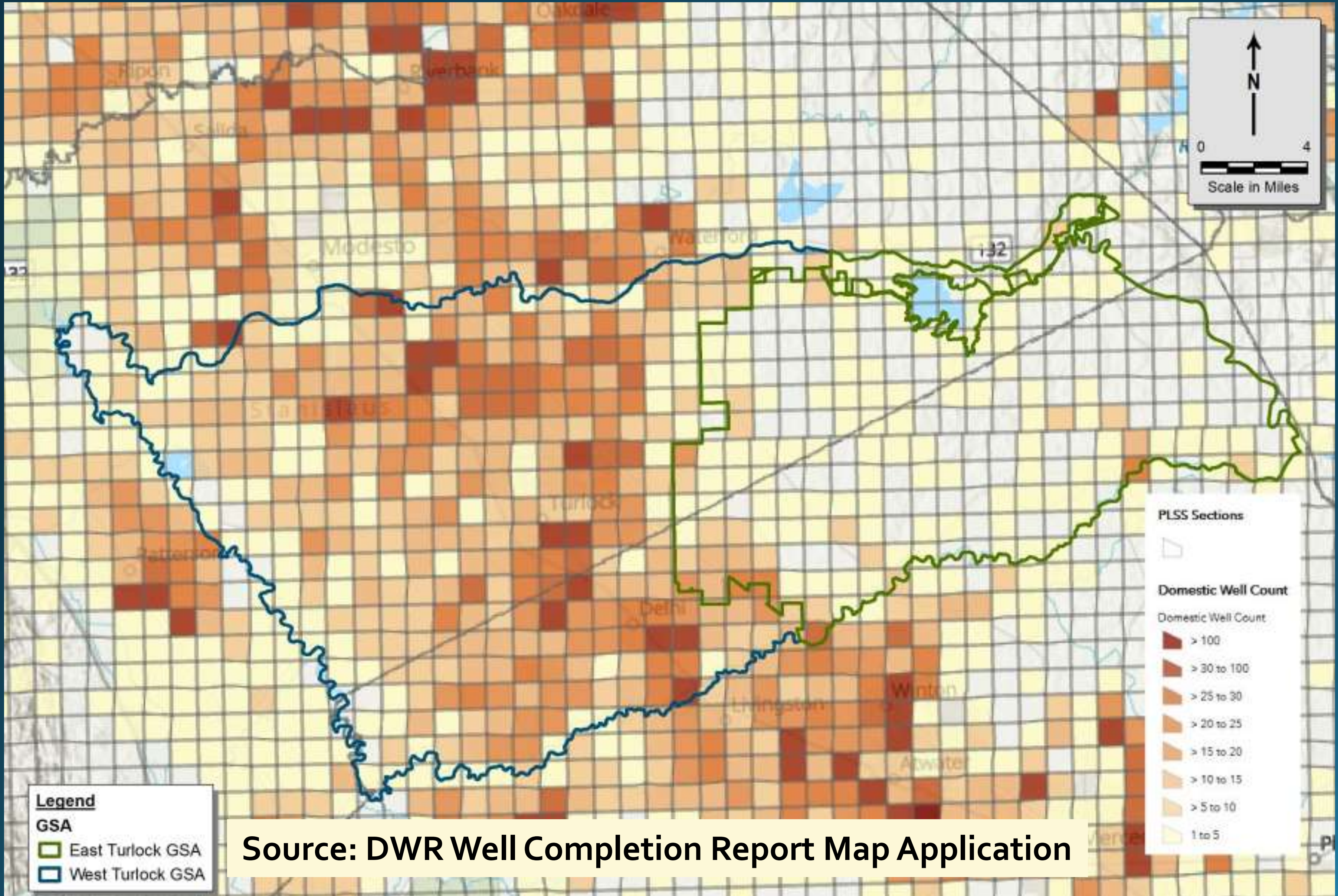
Density of Domestic Wells



Source: DWR Well Completion Report Map Application

- Number of domestic wells per square mile
- Largest density in the western subbasin; smaller number of wells in the east
- Did wells go dry during the recent drought? If so, where?

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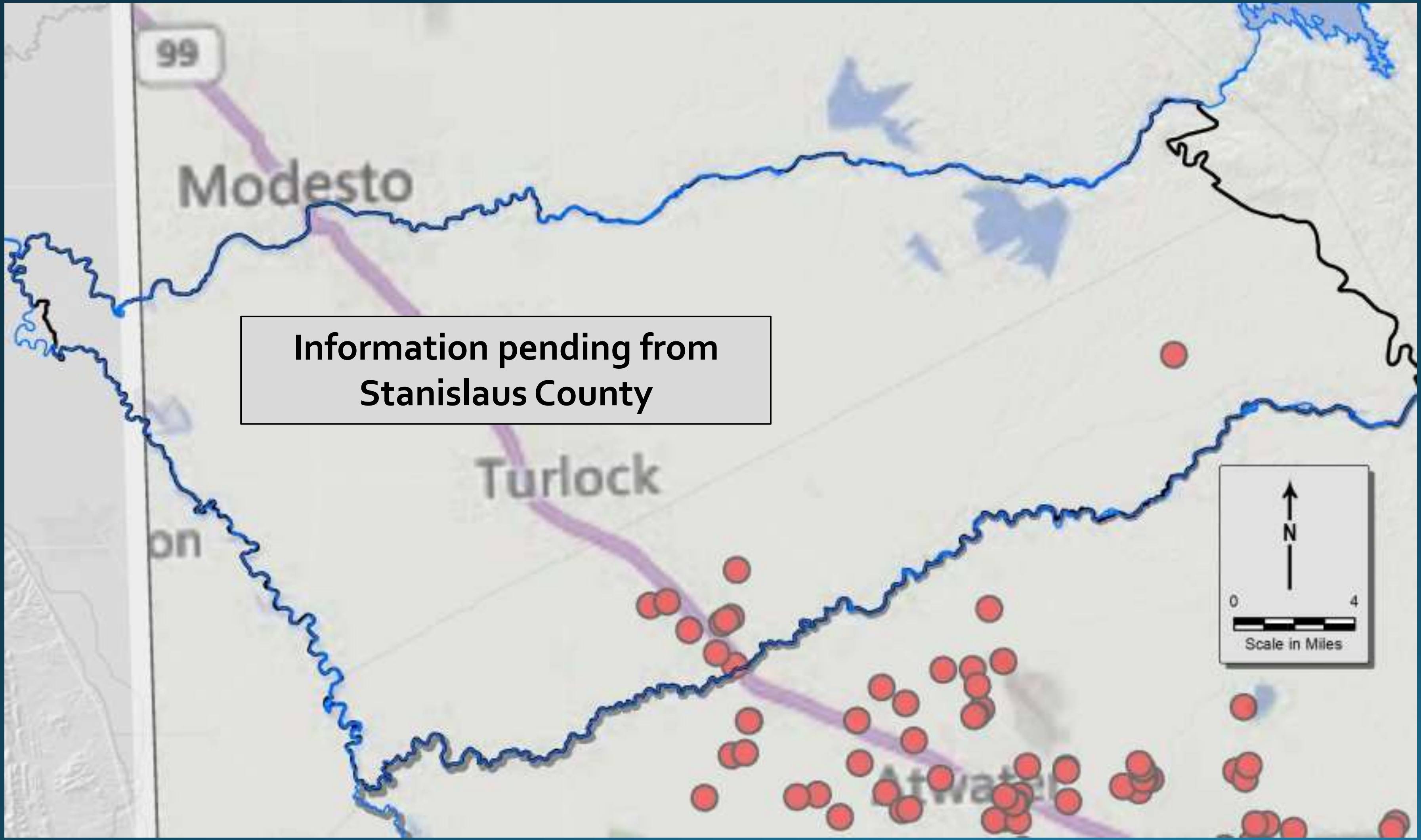
Water Hauling Locations in Merced County



- Indication of domestic wells that went dry during the drought
- Sustainability analysis considers impacts to beneficial uses of wells
- Constraints on basin operation if pumps are shallow
- Possible GSP strategies for assisting domestic supply?

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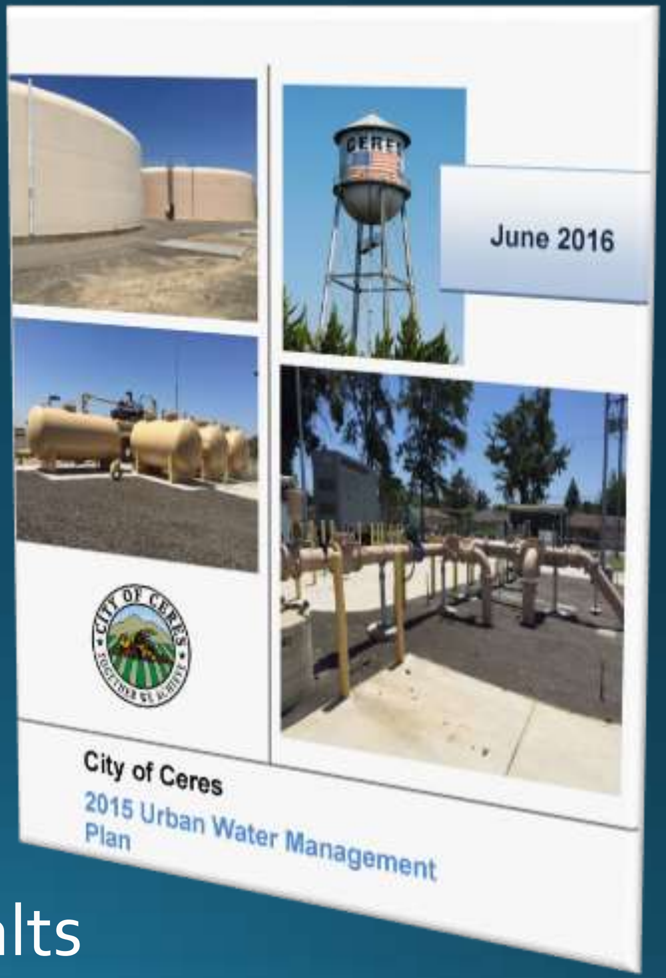
Plan Area – Water Resources Programs

- Enhanced groundwater recharge
- Water Conservation
- Monitoring Networks
- Planning documents
    - Urban Water Management Plans
    - Groundwater Management Plans
    - Agricultural Water Management Plans
    - Irrigated Lands Program – Groundwater Assessment Report (GAR)
    - Salt and Nutrient Management Plans – CV Salts



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Land Use Planning

- Merced County General Plan – Water Element and Groundwater Ordinance
- Stanislaus County Groundwater Ordinance and Discretionary Well Permitting and Management Program
- Other General Plans – Turlock, Ceres, Hughson
- How General Plans could affect GSP
  - Do they increase water demands?
  - Do they limit movement of supplies?

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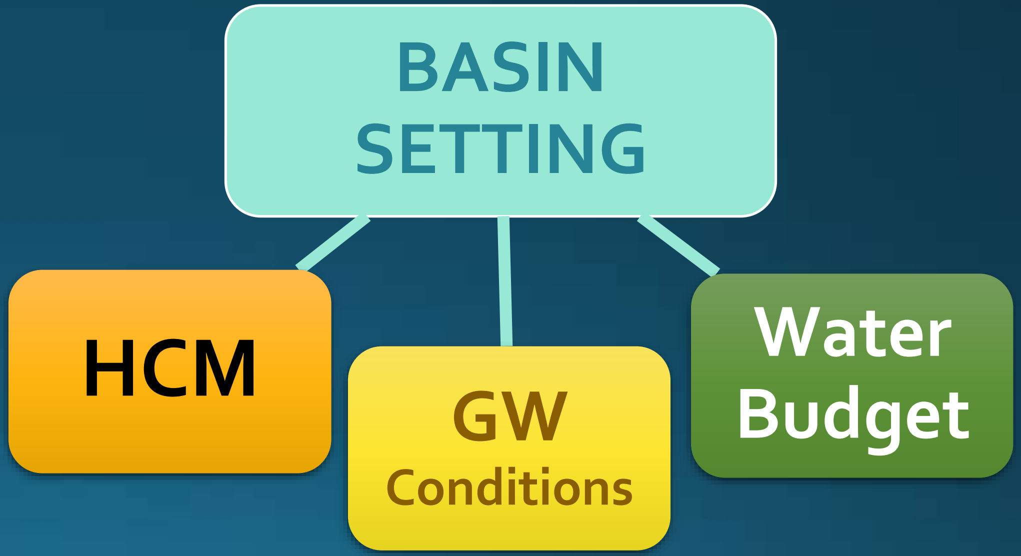
GSP Requirements for Basin Setting

- Hydrogeologic Conceptual Model (HCM)
- Groundwater Conditions
- Water Budget Analysis
  - Historical and Current periods
  - Uses groundwater model

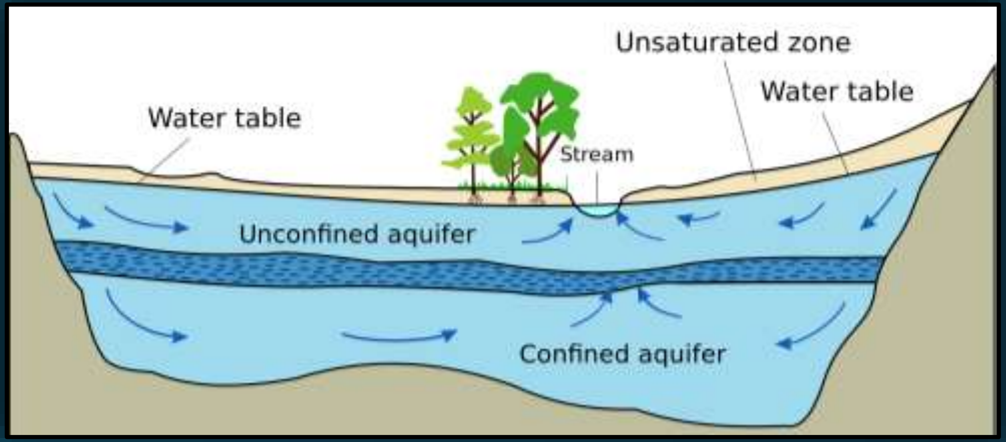


Hydrogeologic Conceptual Model GSP Requirements

What does the groundwater basin look like?

- Physical Setting
  - Topography
  - Geologic and structural setting
  - Surface geology, soils
  - Hydrology
- Groundwater Basin and Aquifers
  - Basin geometry, lateral boundaries and bottom
  - Principal aquifers and aquitards and properties
  - Stratigraphic and structural changes

Groundwater Conditions GSP Requirements



What are the current and historical groundwater conditions?

- Hydrographs (changes in groundwater levels over time)
- Groundwater elevation contour maps
- Changes in groundwater in storage (between seasonal highs)
- Groundwater quality
- Land subsidence
- Groundwater Dependent Ecosystems (if applicable)

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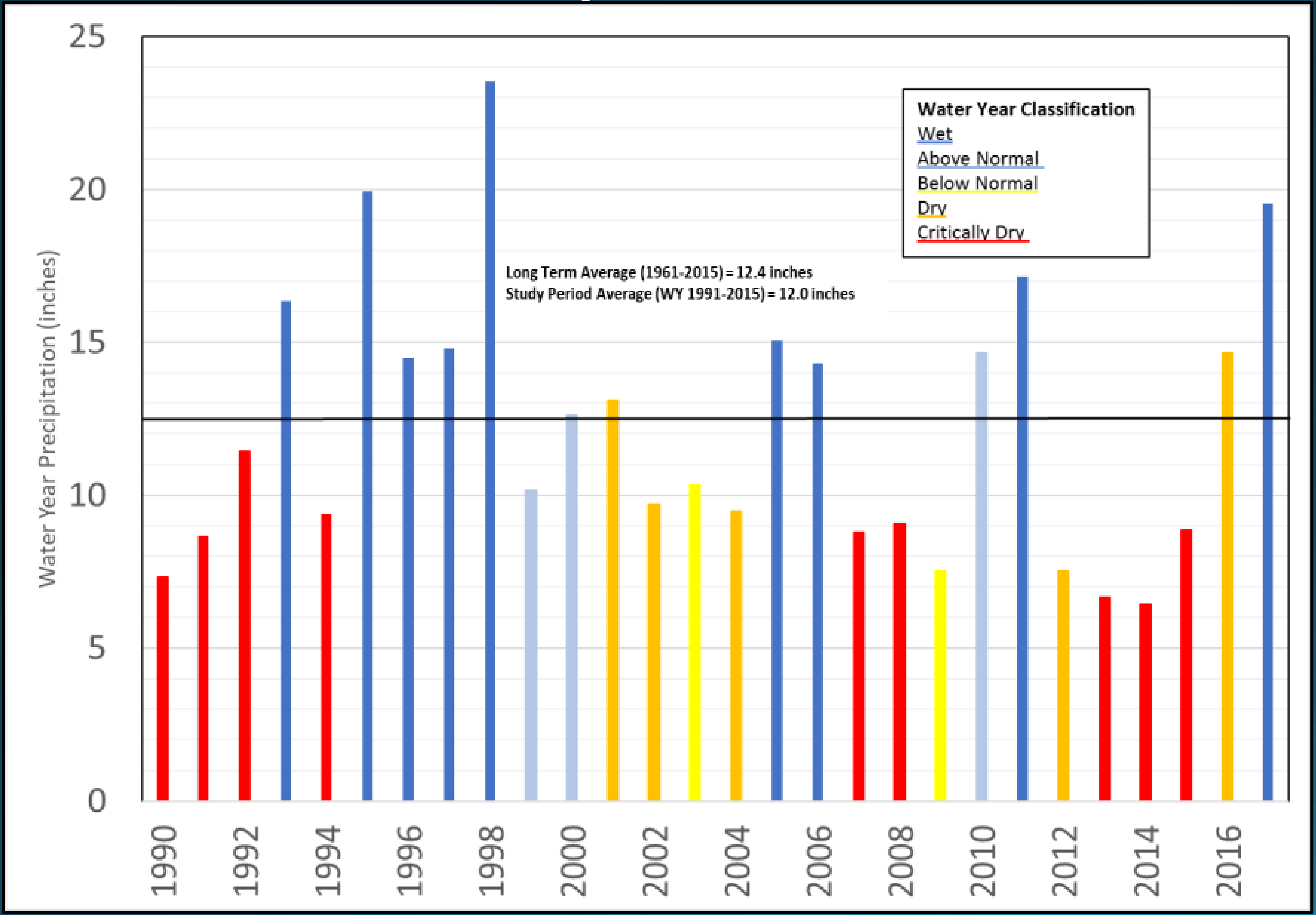
Annual Precipitation



- NOAA Site 049073 (Jan 1990-July 2002)
- CIMIS Denair (#168) and Denair II (#206) (August 2002-present)
- DWR Water Year Classification for San Joaquin Valley

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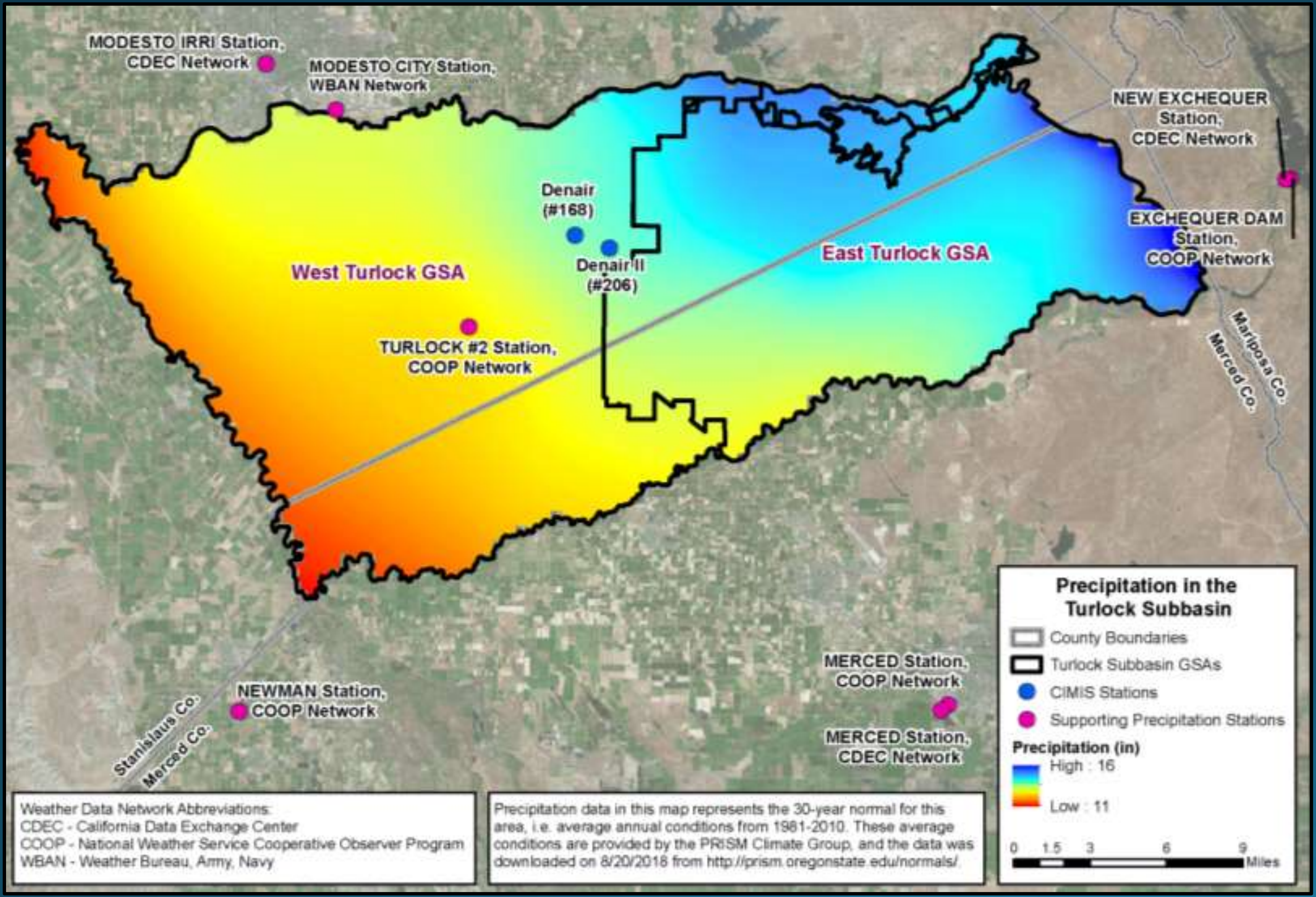
Average Annual Precipitation 1981-2010



- Data from PRISM, 30-year average
- Ranges from 11 to 16 inches per year
- Precipitation data used in C2VSim

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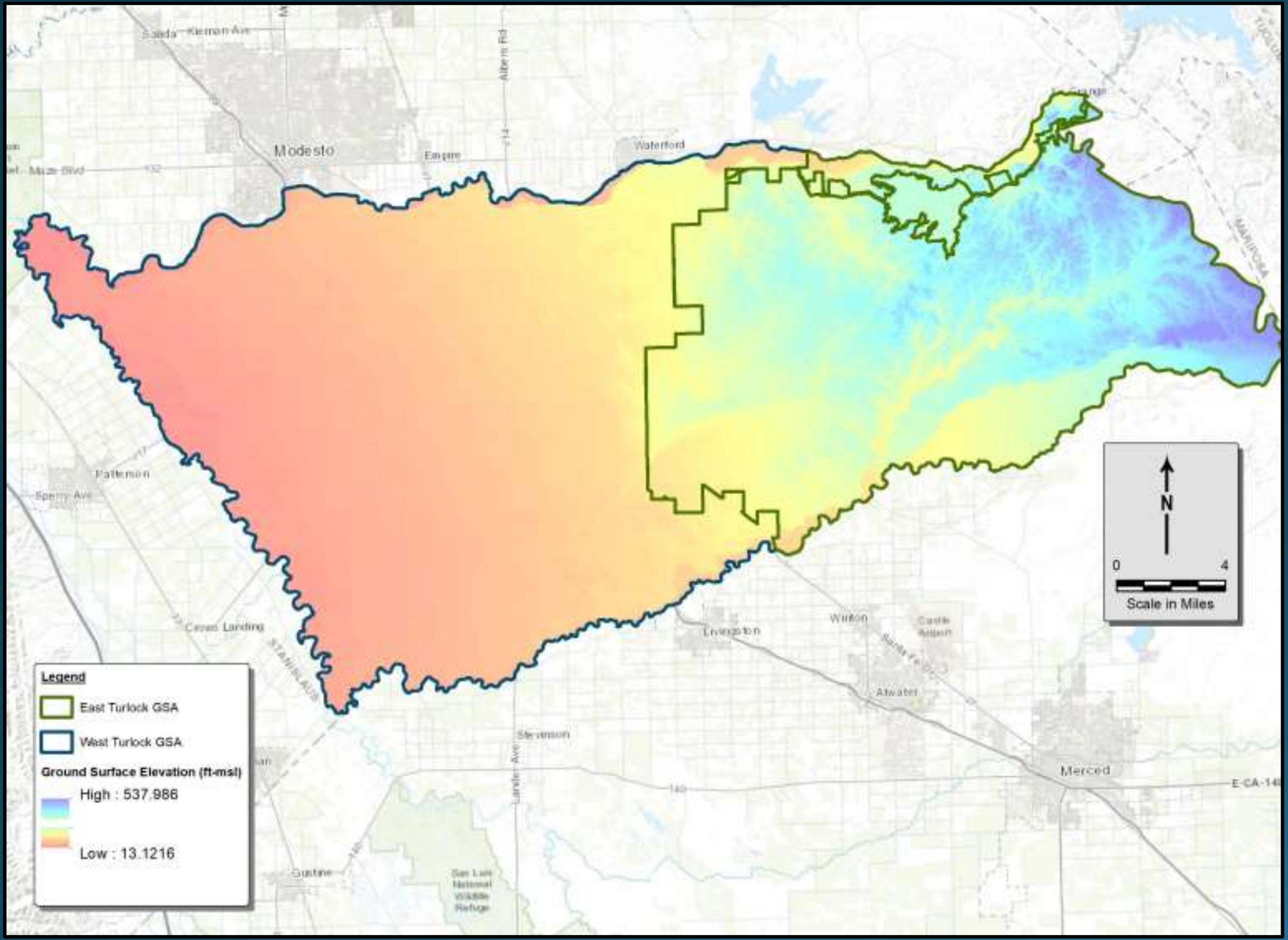
Ground Surface Elevation



- Elevations range from about 530 feet msl in the east to about 15 feet msl in the west.
- WTSGSA is relatively flat
- ETSGSA is hilly and dissected

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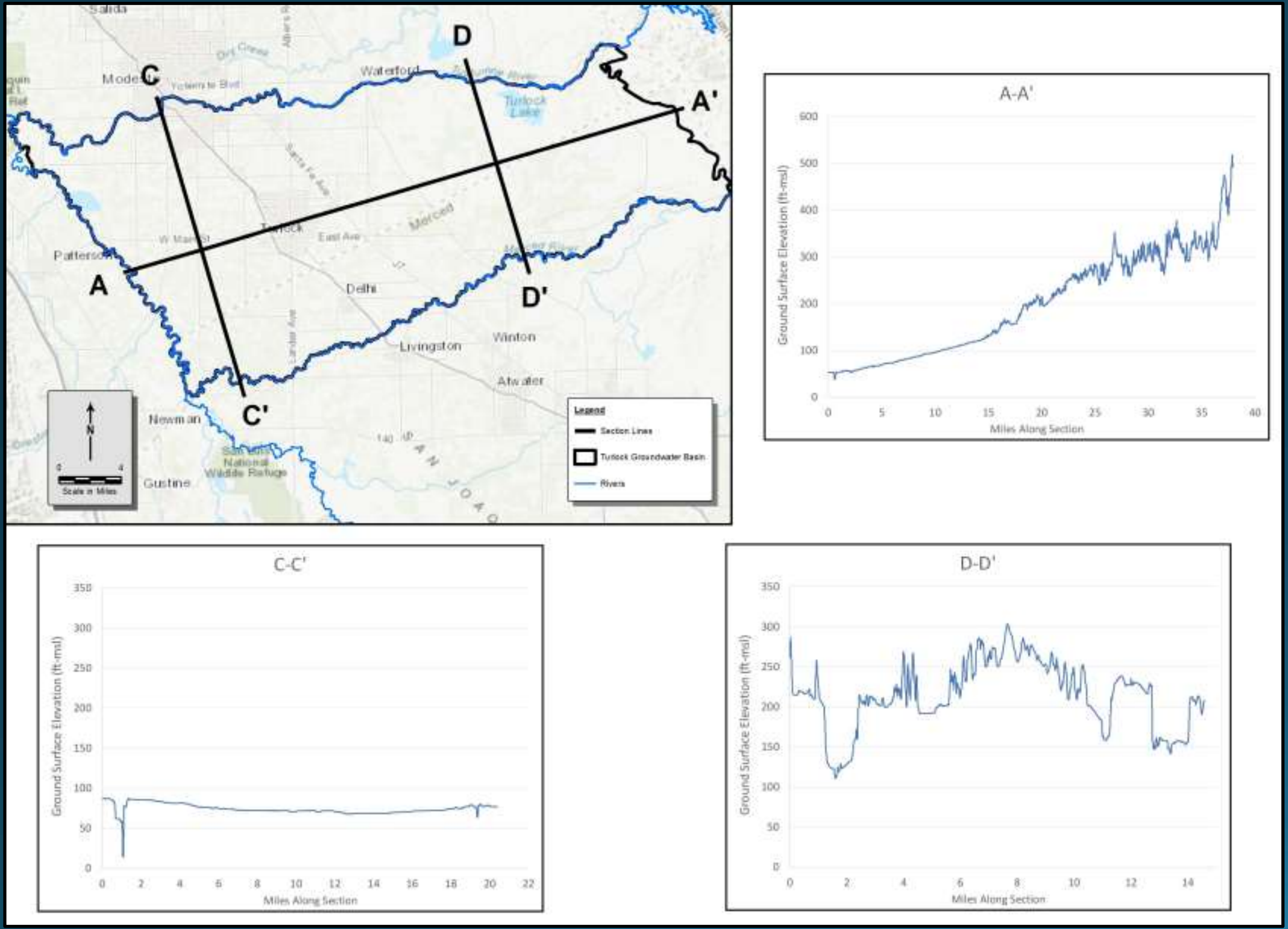
Topographic Profiles



- A-A: Ground surface dips to the west, ranging from +500 ft msl to less than 50 ft msl.
- C-C: Relatively flat in the west.
- D-D: Hilly and dissected in the east.

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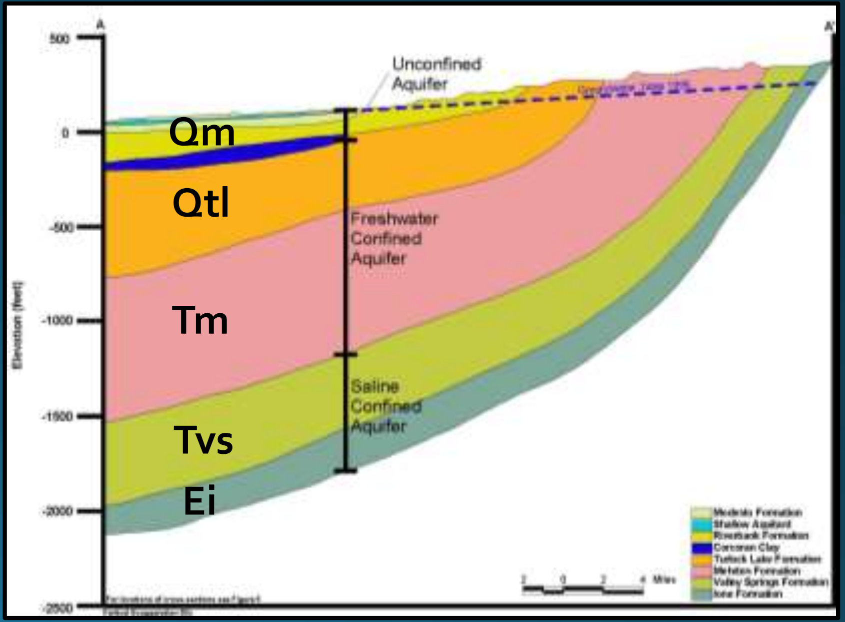
Plan Area Geologic Map

- Younger sediments in west
- Older sediments in east dip west into the valley below younger units



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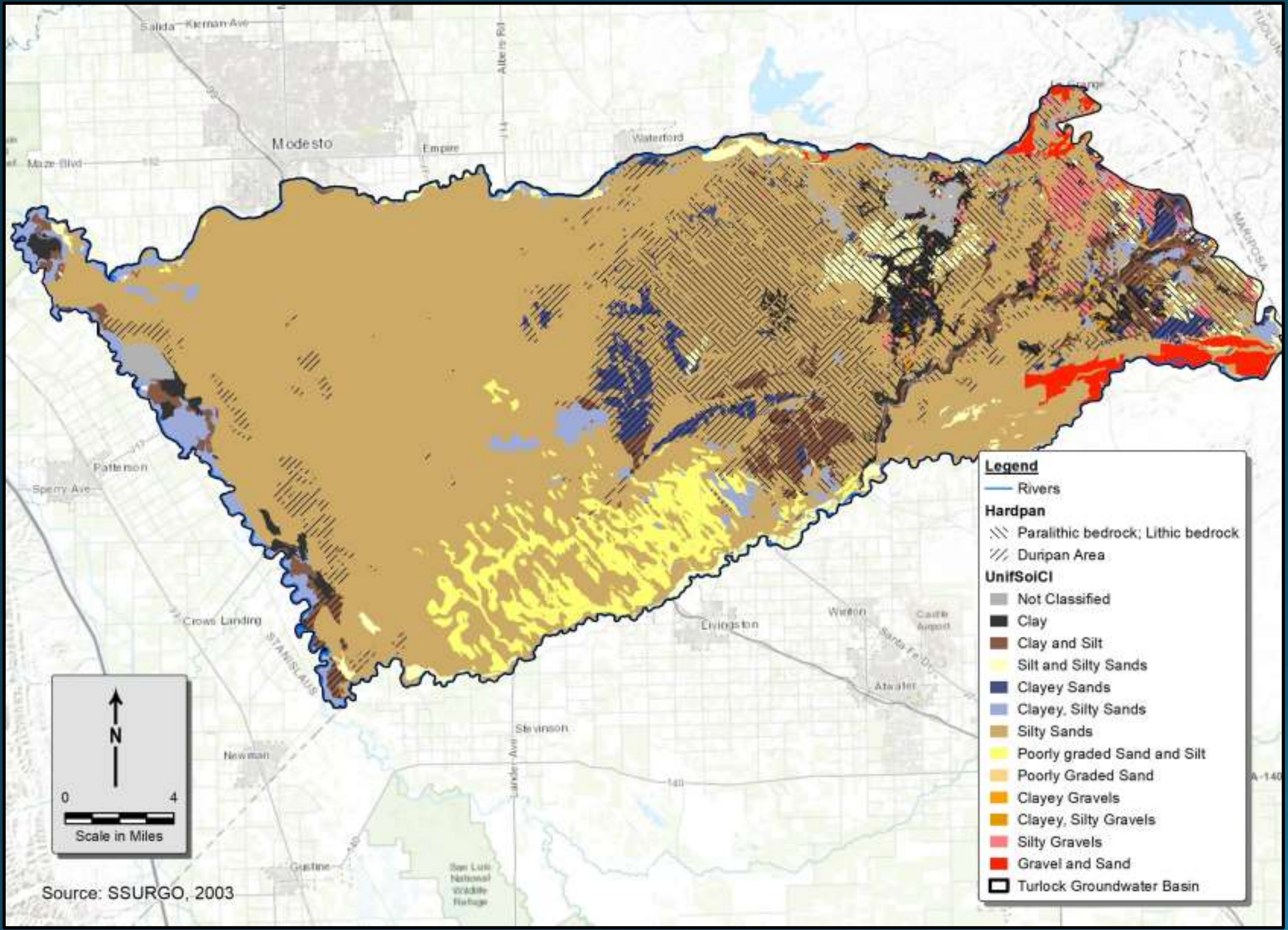
Plan Area Soils and Restrictive Layers



- Soils used in C2VSim
- Restrictive layers limit natural recharge in portions of the eastern subbasin
- Clay-rich soils in west limit infiltration and create perched conditions locally

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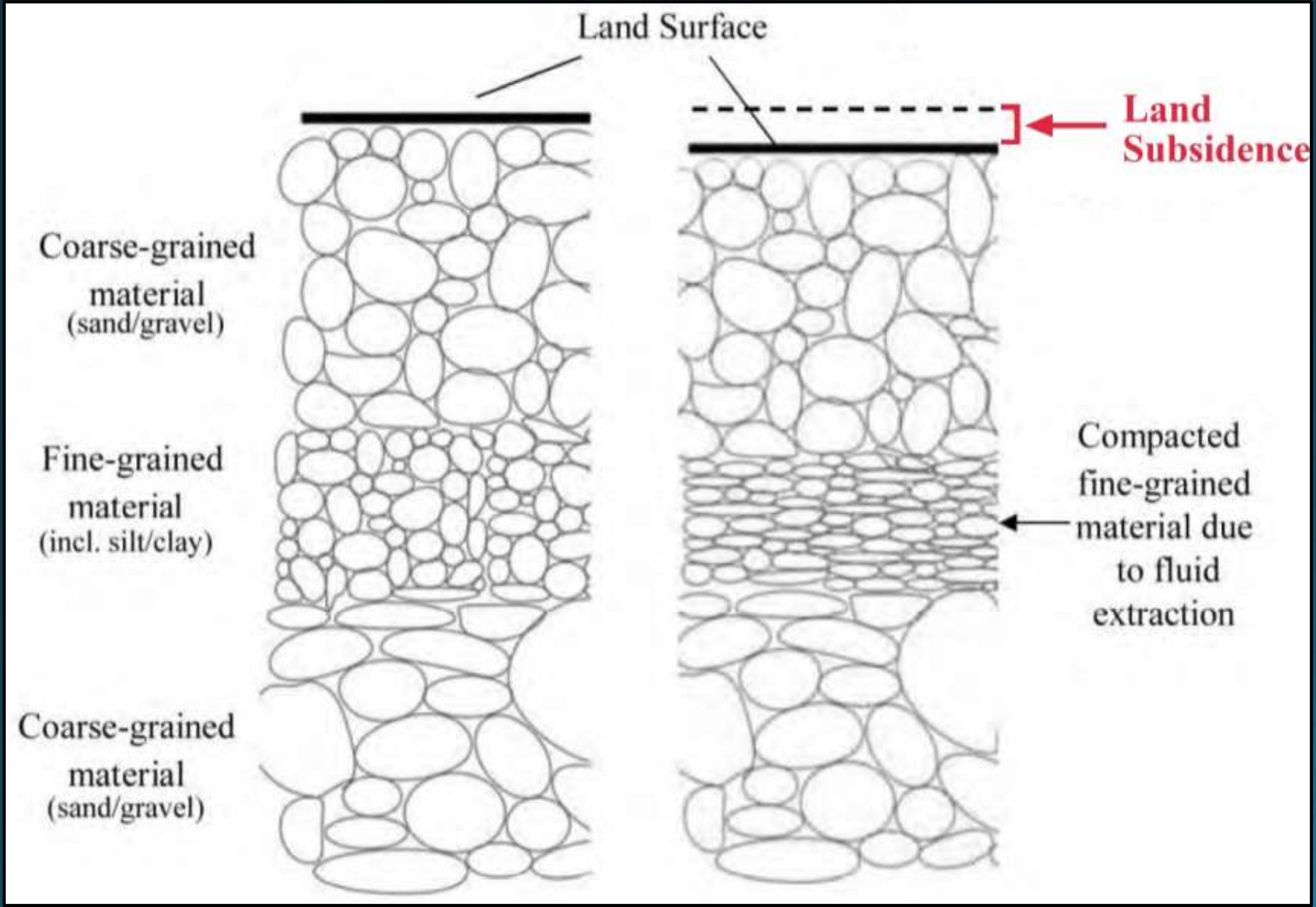
Conceptual Diagram - Land Subsidence



- Declining water levels decrease pore pressure
- Can lead to subsurface compaction
- Most of the deformation in the Central Valley is associated with the Corcoran Clay

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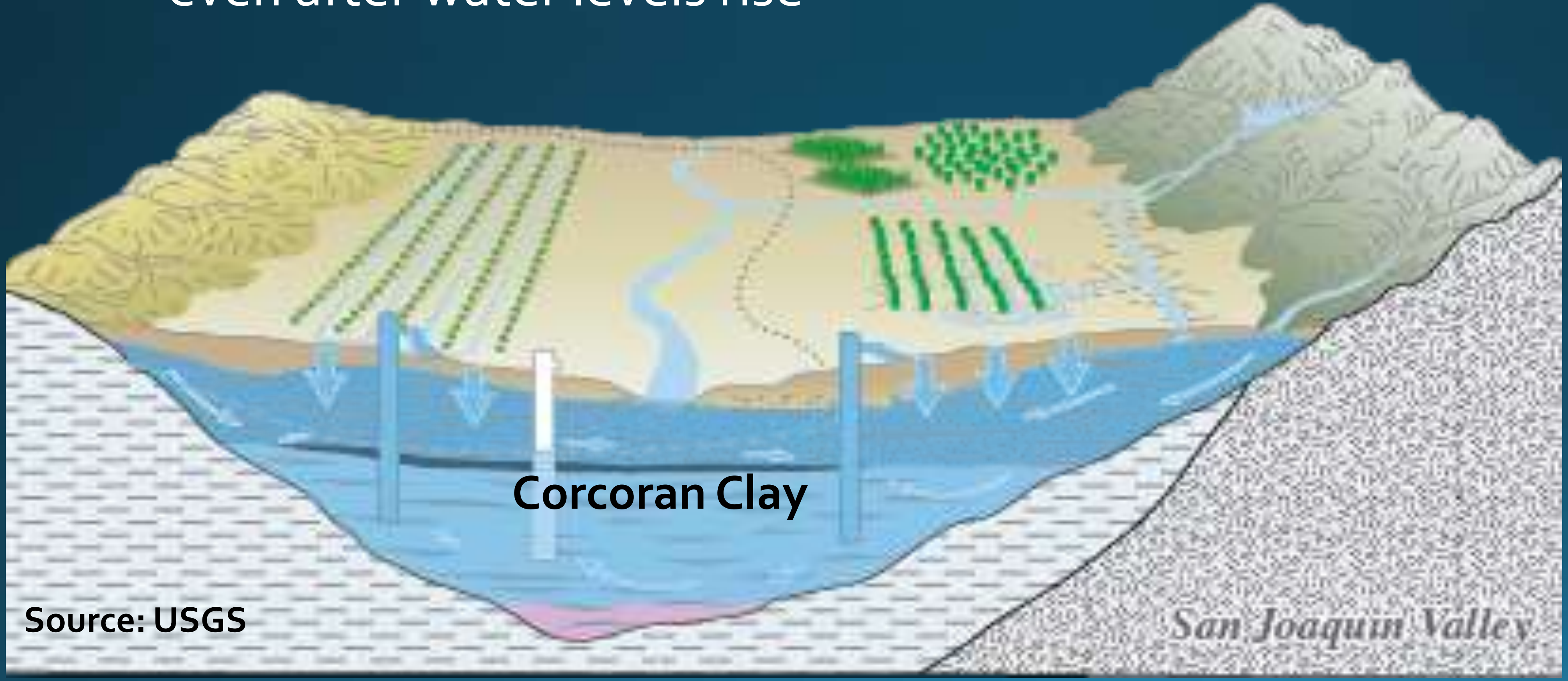
Corcoran Clay and Land Subsidence

- Paleo Lake Deposits - Regional Aquitard
- Much of the deformation is below the top of the clay (confined aquifer)
- Clay compaction is very slow and subsidence continues for a long time, even after water levels rise



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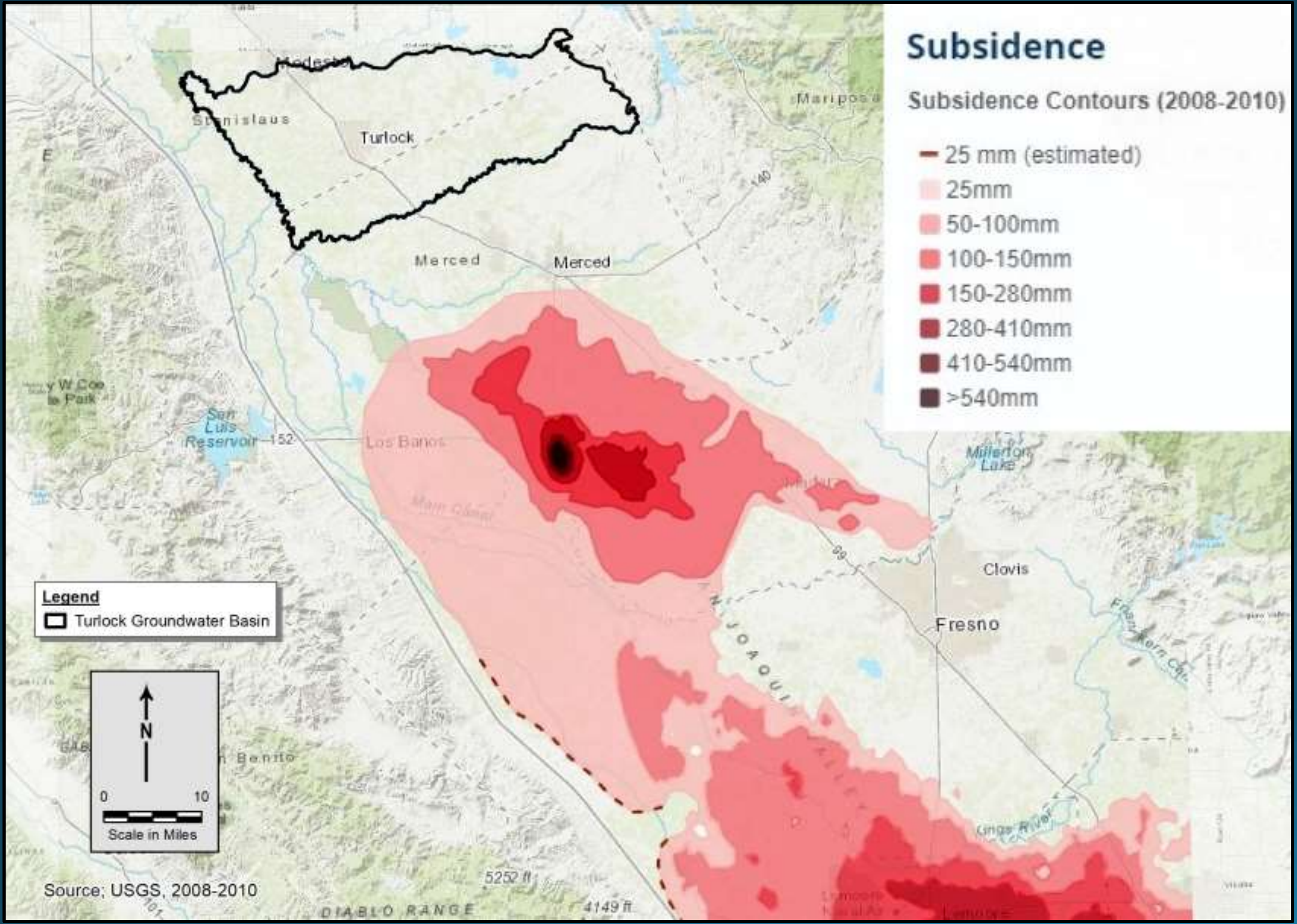
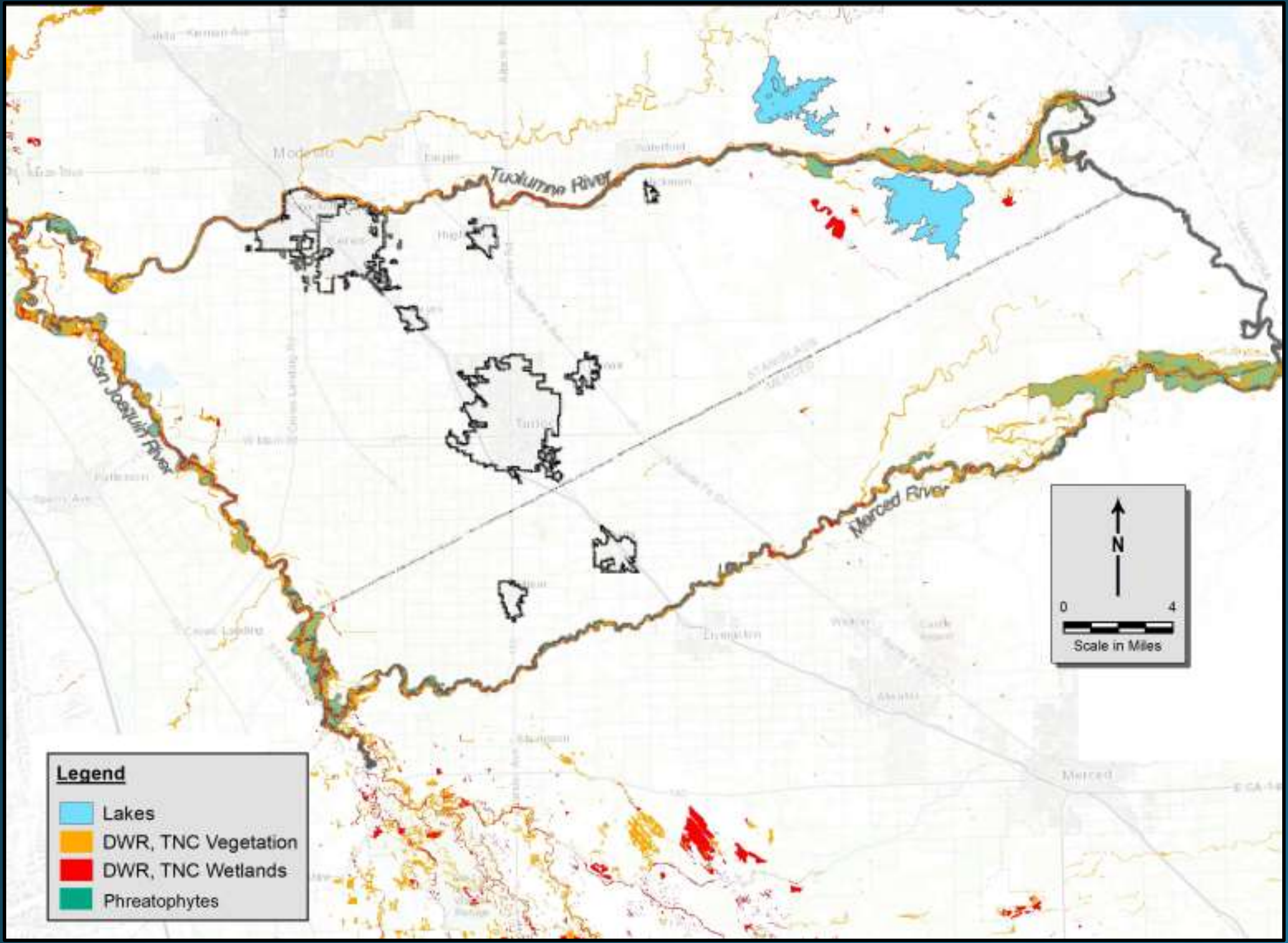
Subsidence South of Turlock Subbasin



- Historical subsidence is not a significant issue in Turlock Subbasin, but has occurred south of the Turlock Subbasin
- Lowering of water levels could result in compaction in western Turlock Subbasin
- Important to understand the extent and thickness of the Corcoran Clay

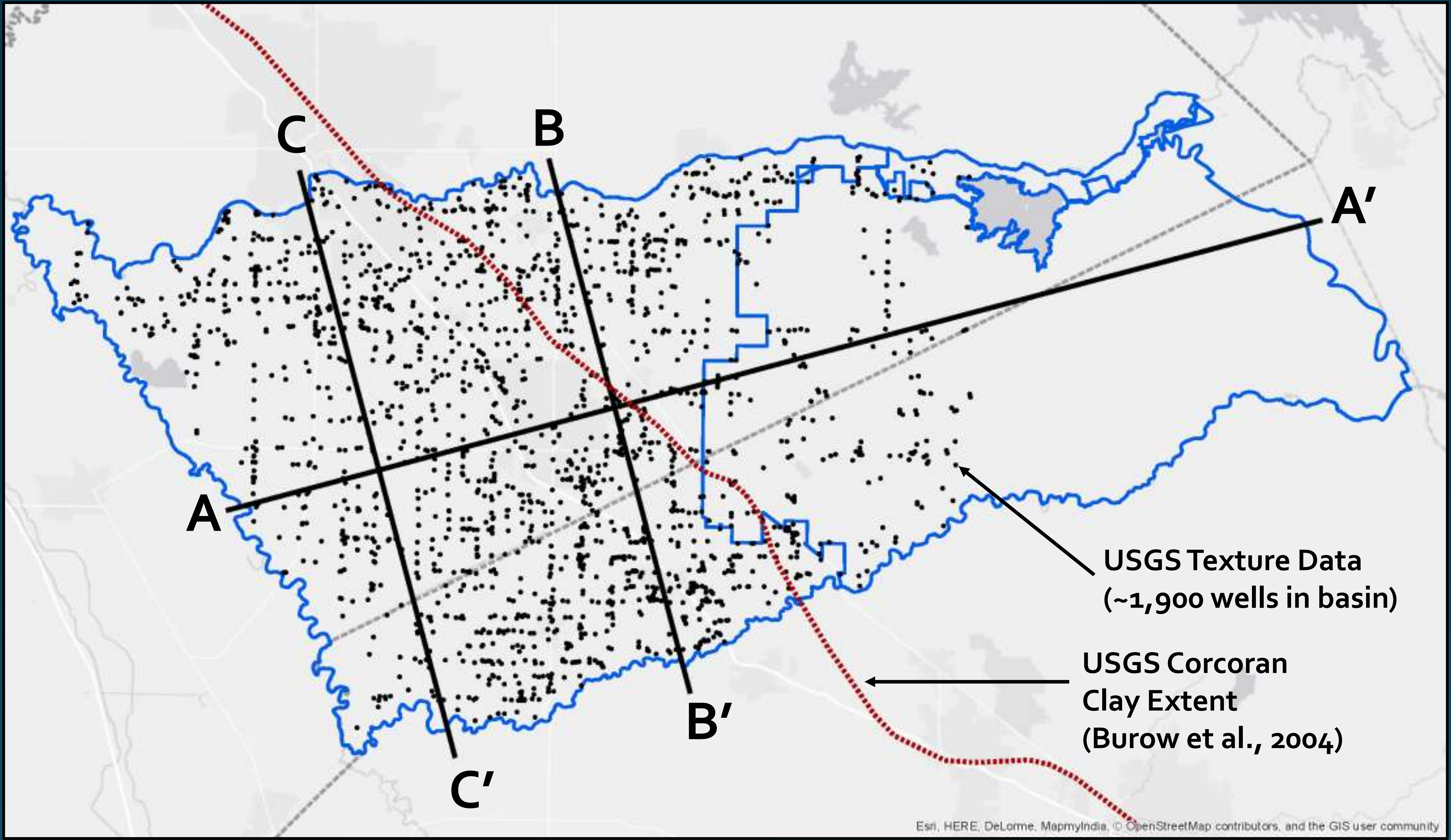
Phreatophytes and Vegetation Mapping



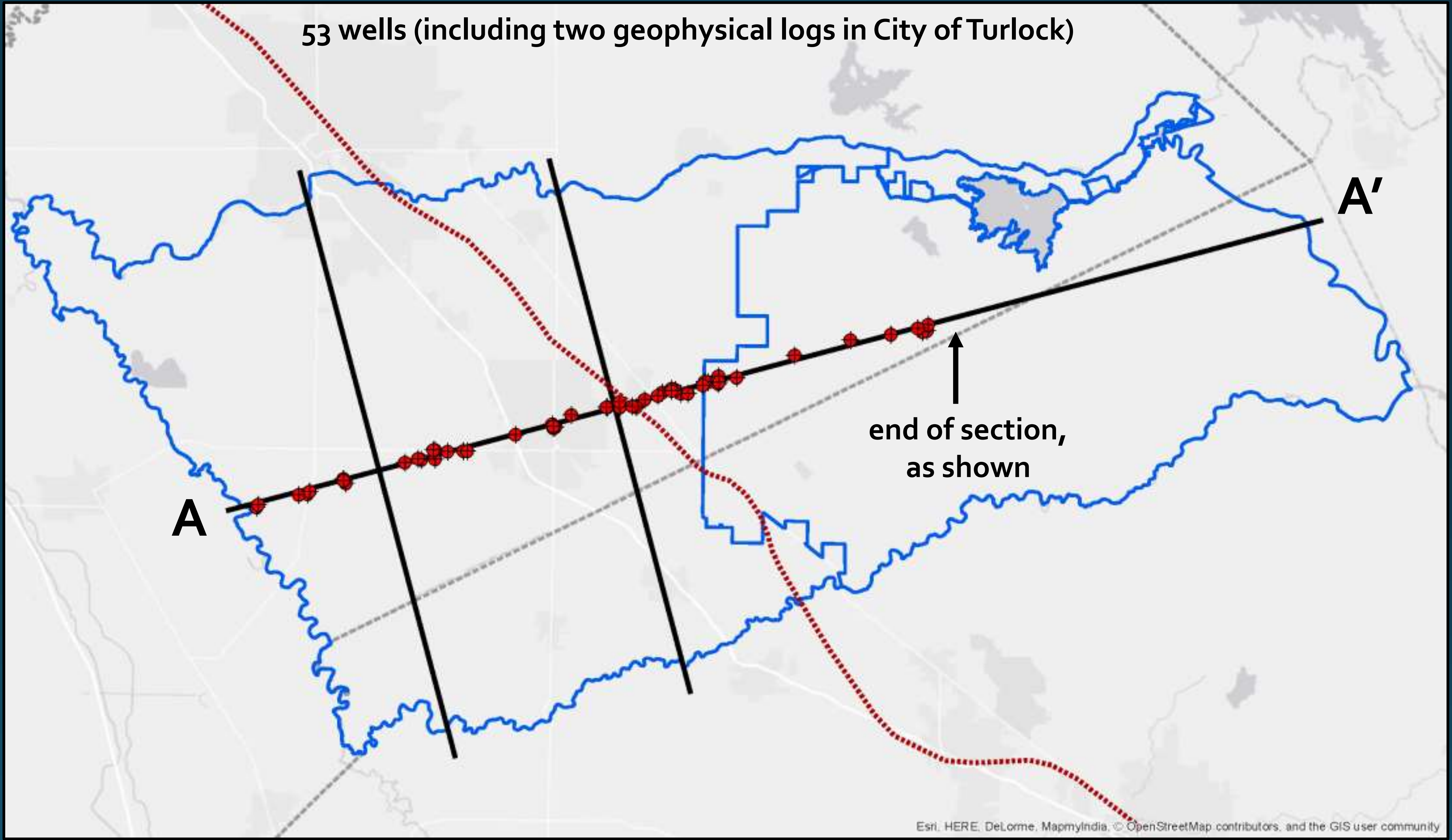
- Vegetative mapping by The Nature Conservancy (TNC) in partnership with DWR
- Methods and Guidance on *Groundwater Resources Hub*
- Phreatophytes mapped in the TID groundwater model
- Maps require ground-truthing – for example, vegetation along eastern river areas are along historically losing reaches of the river

The presence of vegetation does not necessarily indicate a GDE

Texture Data and Cross Section Transects

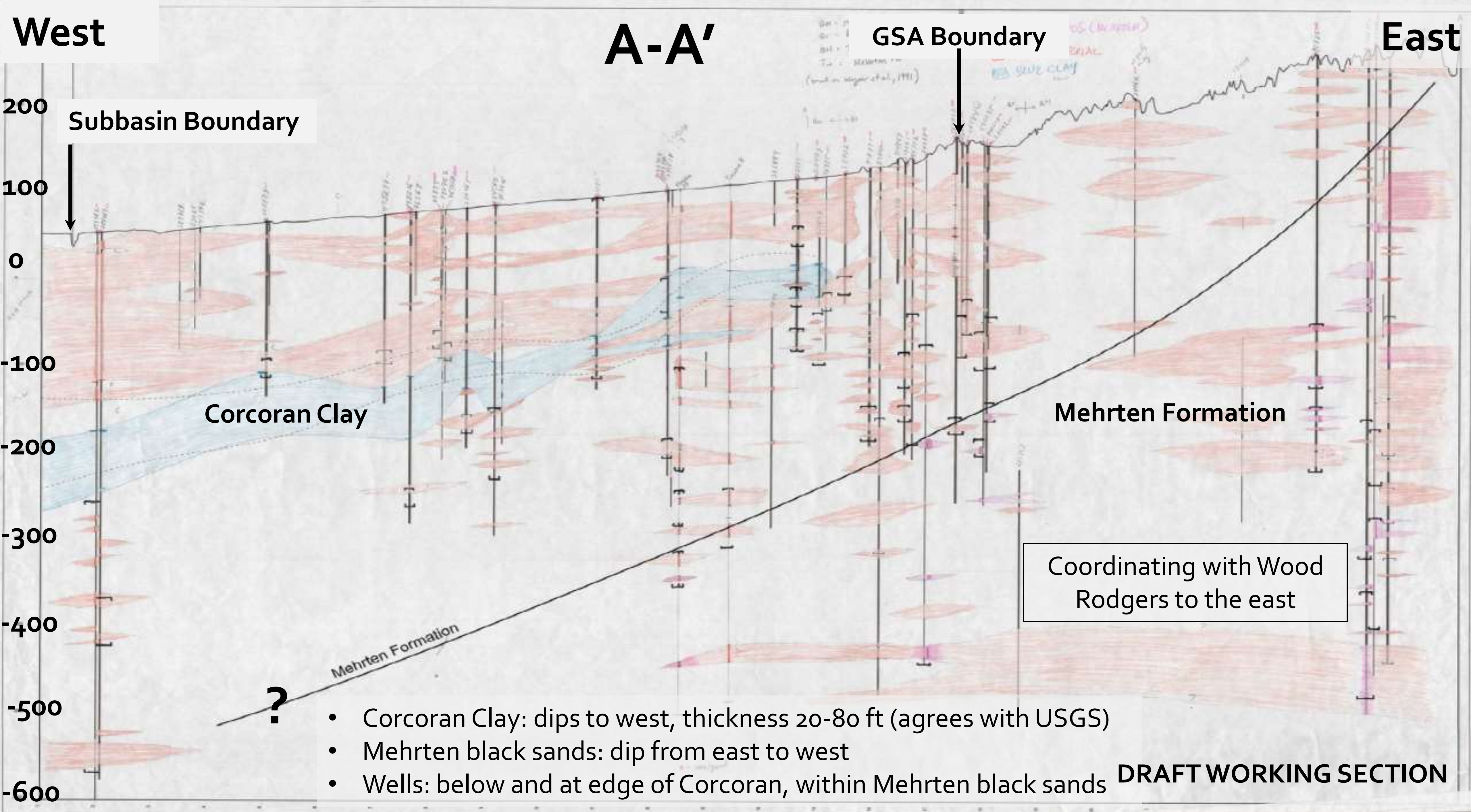


A-A′



53 wells (including two geophysical logs in City of Turlock)
A′
A
end of section, as shown
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

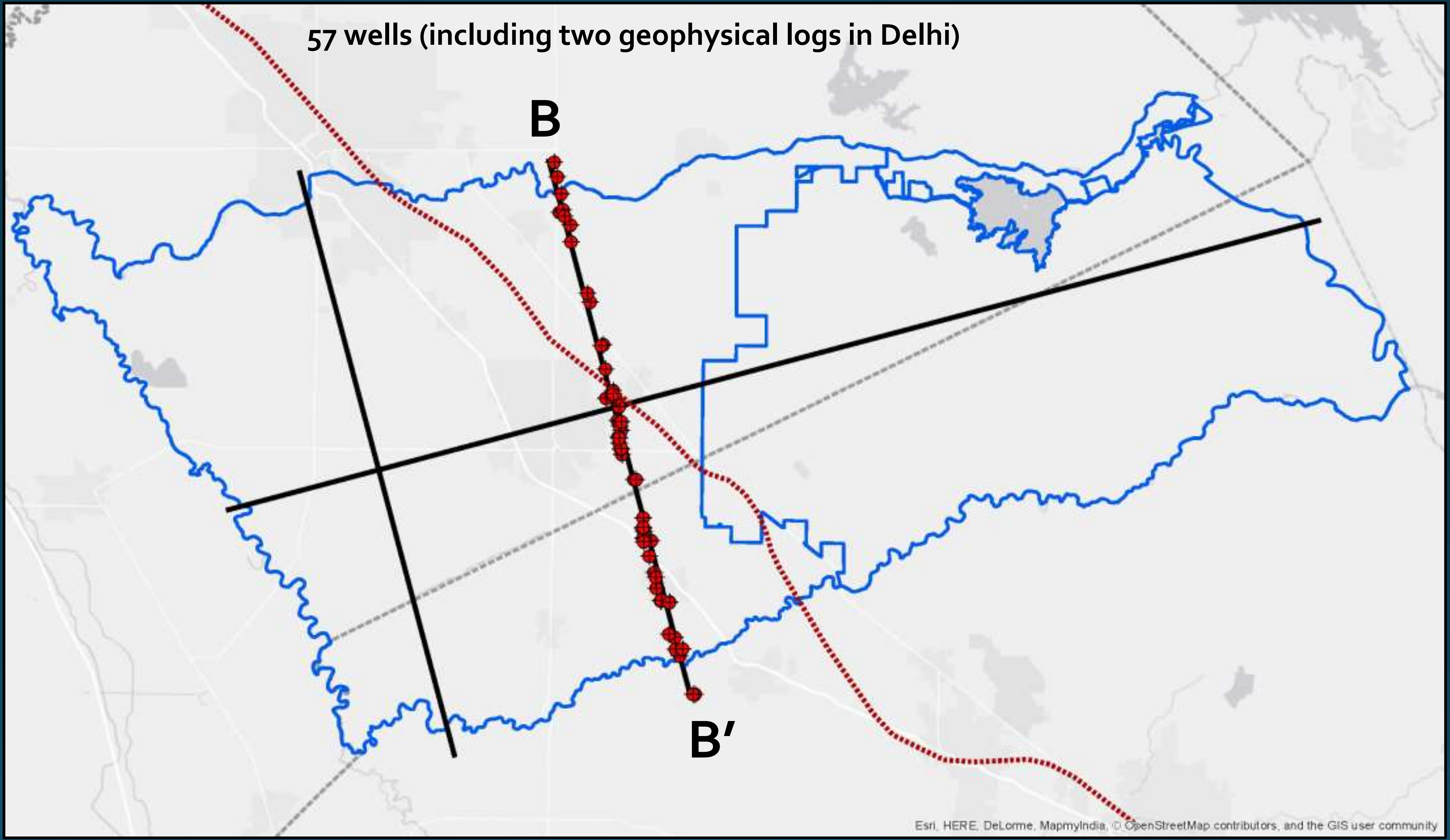
A-A’



- Corcoran Clay: dips to west, thickness 20-80 ft (agrees with USGS)
- Mehrten black sands: dip from east to west
- Wells: below and at edge of Corcoran, within Mehrten black sands

DRAFT WORKING SECTION

B-B′


57 wells (including two geophysical logs in Delhi)
B
B′
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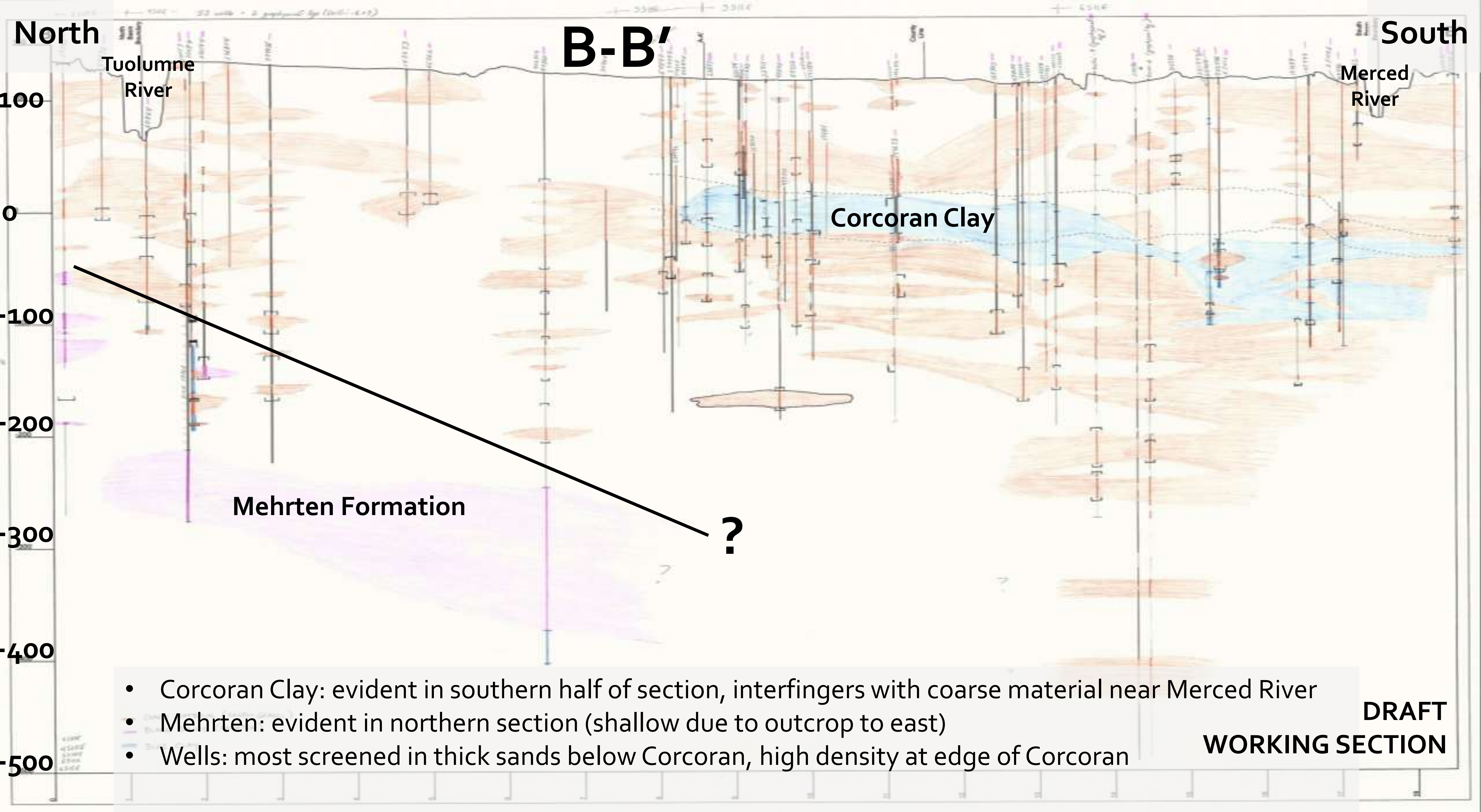
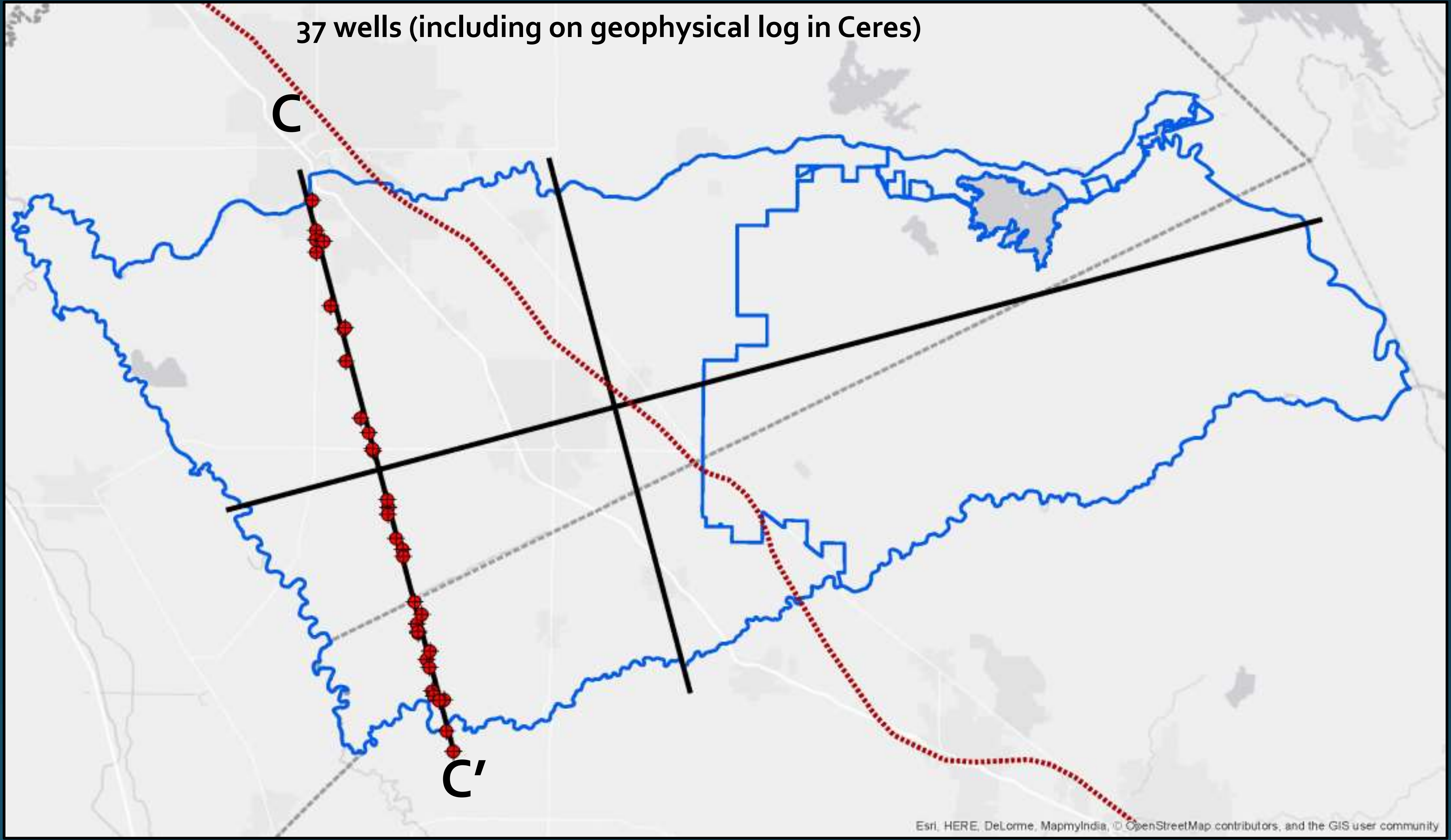
B-B′



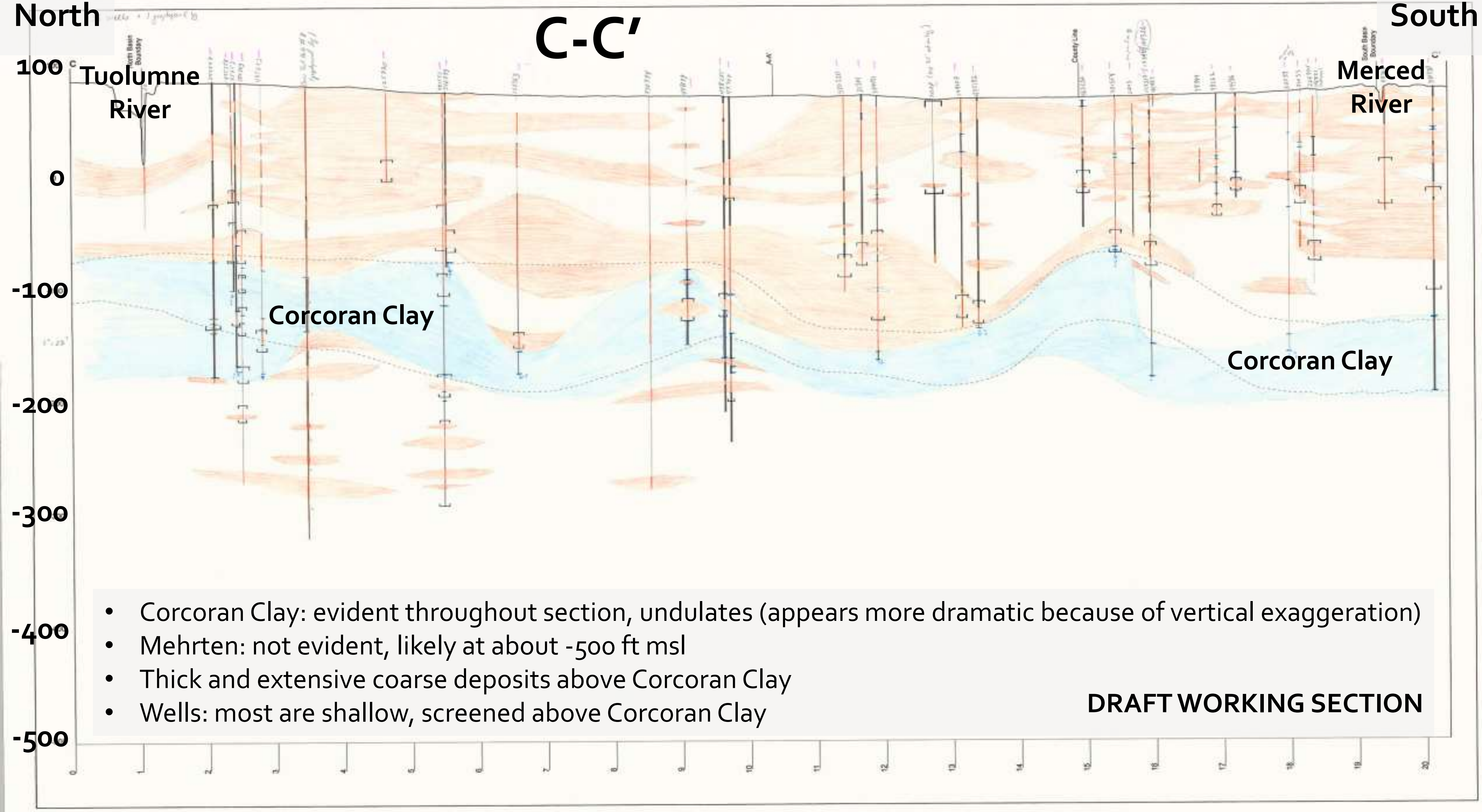
- Corcoran Clay: evident in southern half of section, interfingers with coarse material near Merced River
- Mehrten: evident in northern section (shallow due to outcrop to east)
- Wells: most screened in thick sands below Corcoran, high density at edge of Corcoran

DRAFT
WORKING SECTION

C-C′


37 wells (including on geophysical log in Ceres)
C
C′
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

C-C'



- Corcoran Clay: evident throughout section, undulates (appears more dramatic because of vertical exaggeration)
- Mehrten: not evident, likely at about -500 ft msl
- Thick and extensive coarse deposits above Corcoran Clay
- Wells: most are shallow, screened above Corcoran Clay

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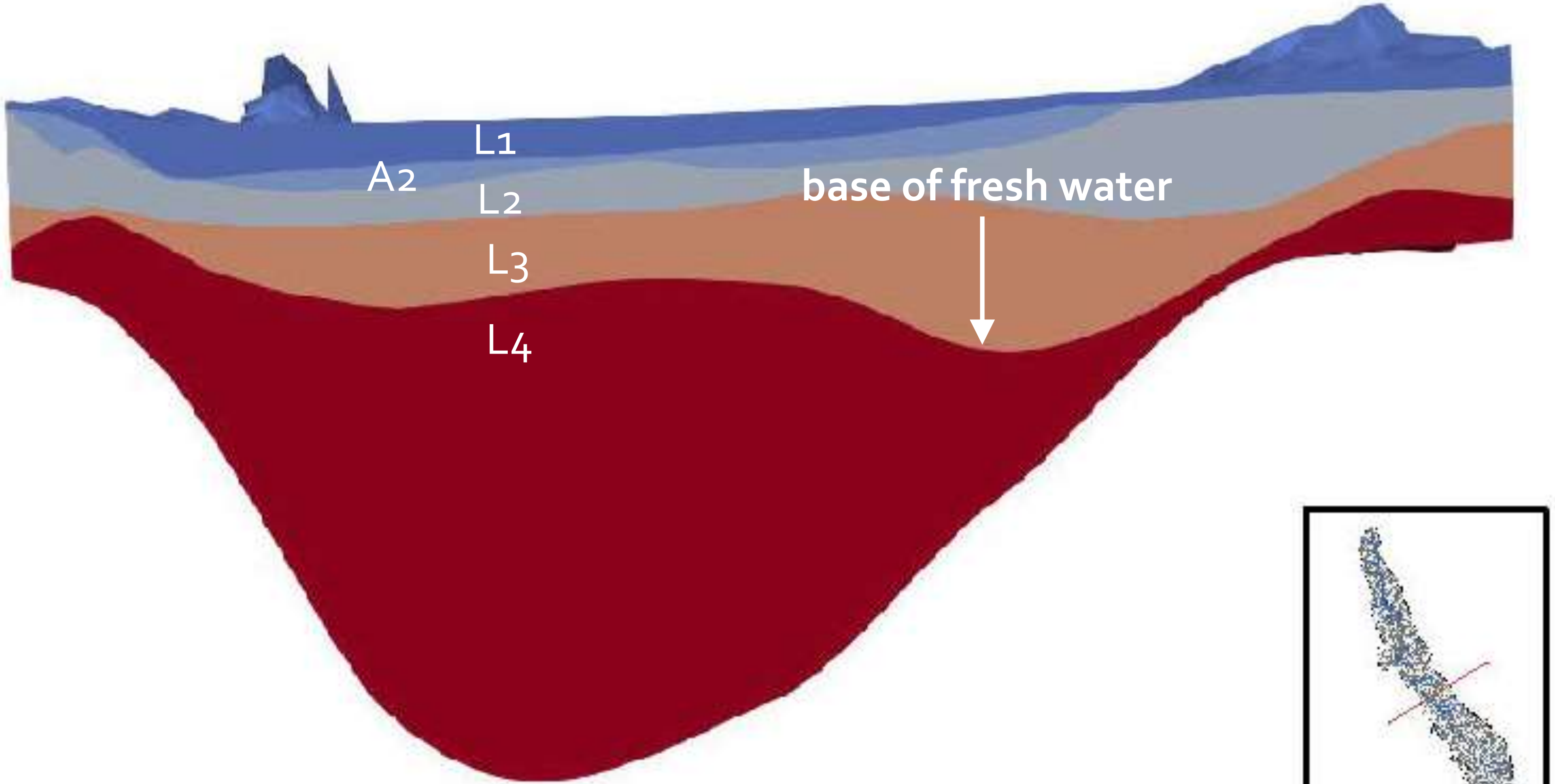
C2VSIM Model Layers



Model Layers of C2VSim Model

- L1: Unconfined aquifer
- A2: Corcoran Clay
- L2: Primary shallow pumping layer
- L3: Deeper pumping layer (bottom of layer is the base of fresh water)
- L4: Saline aquifer (bottom of layer is the base of continental deposits)

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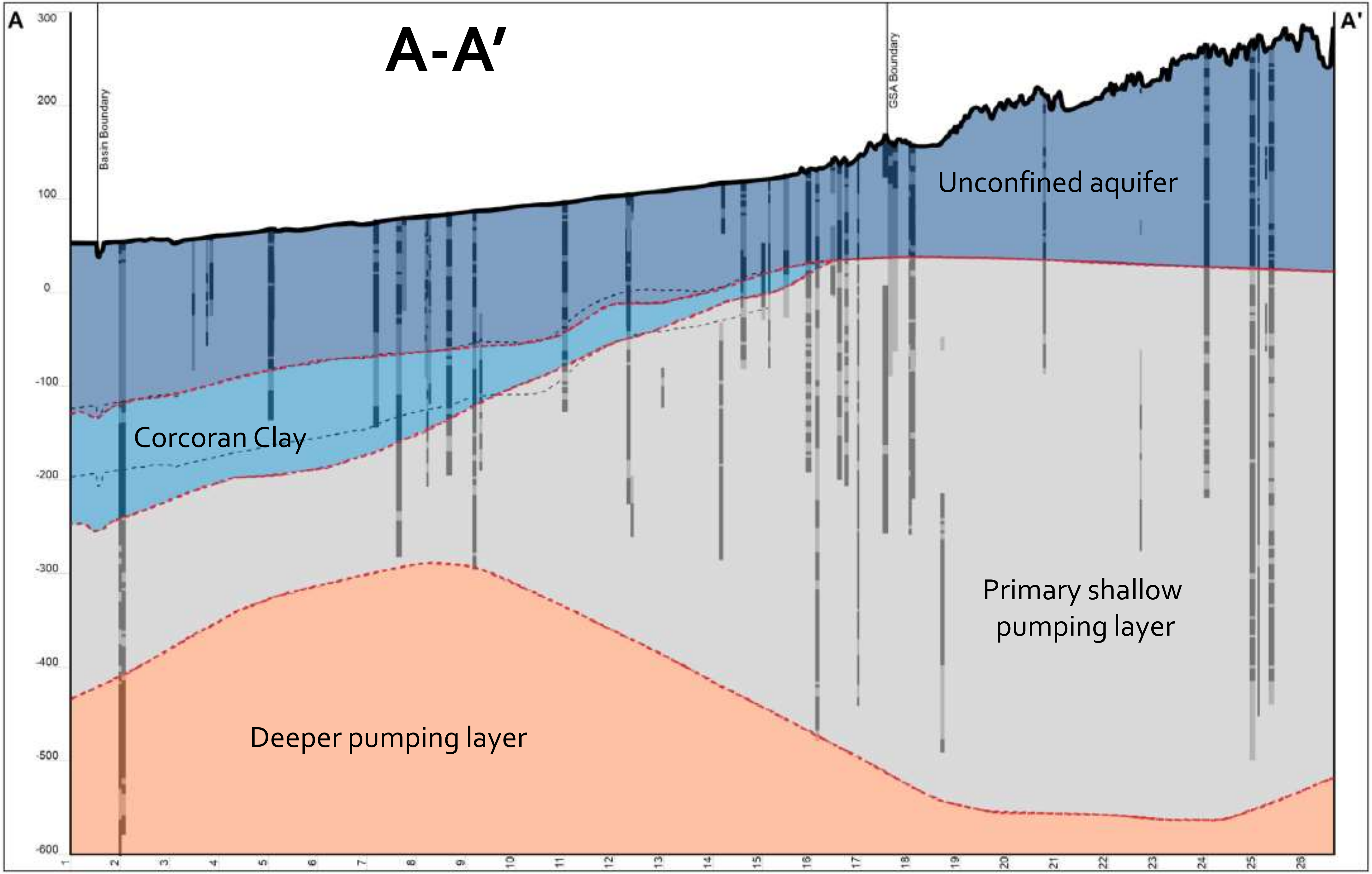
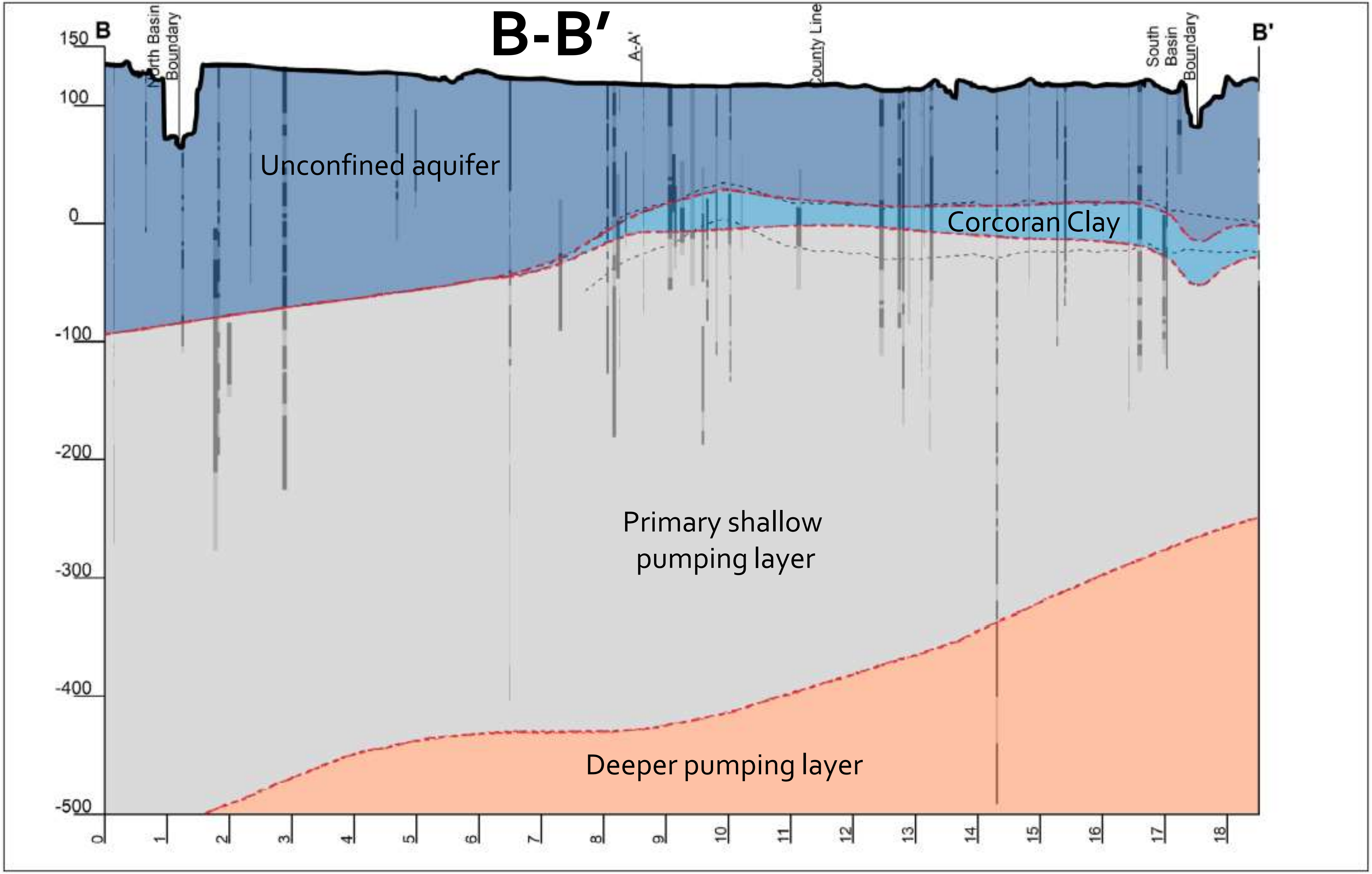
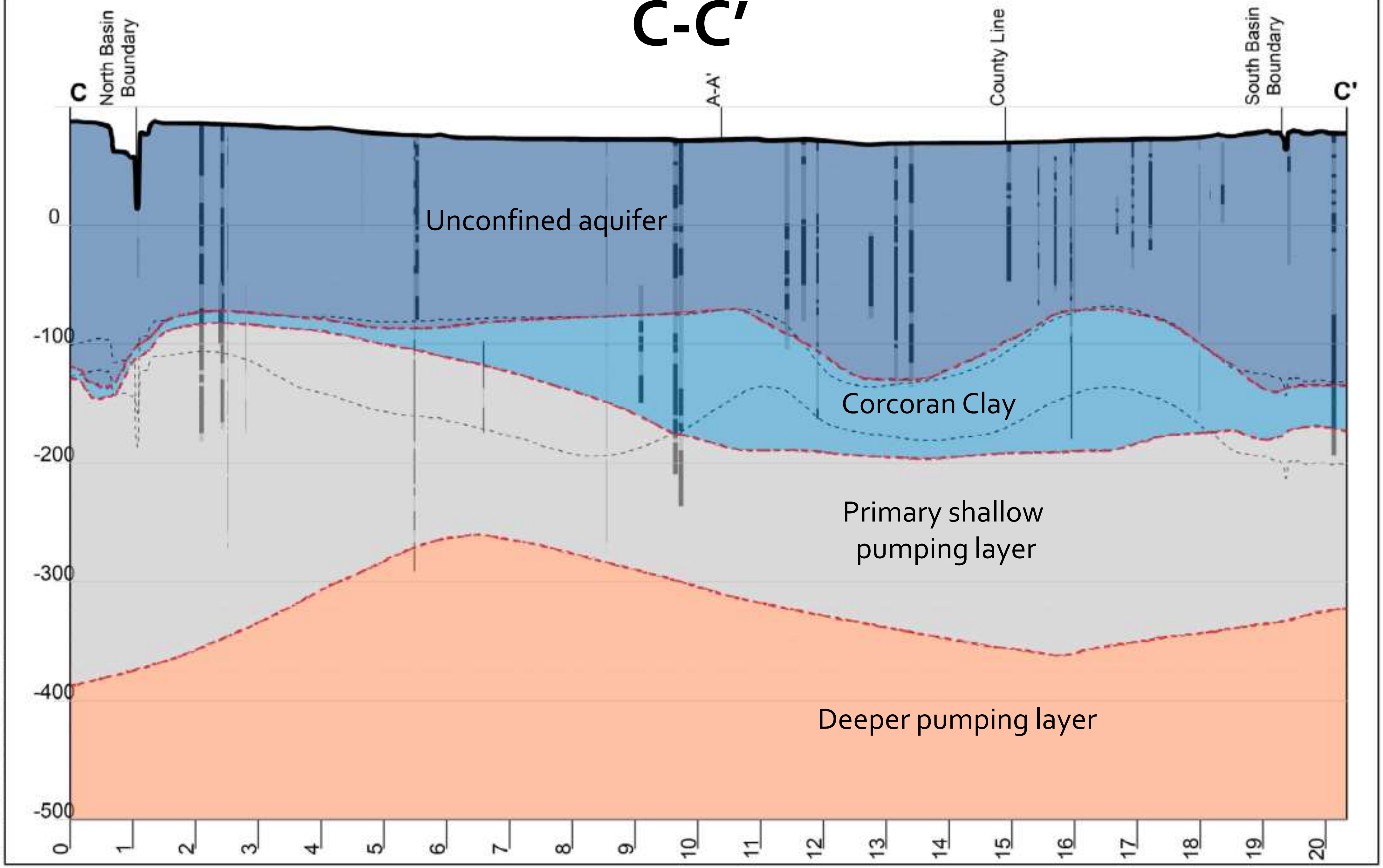
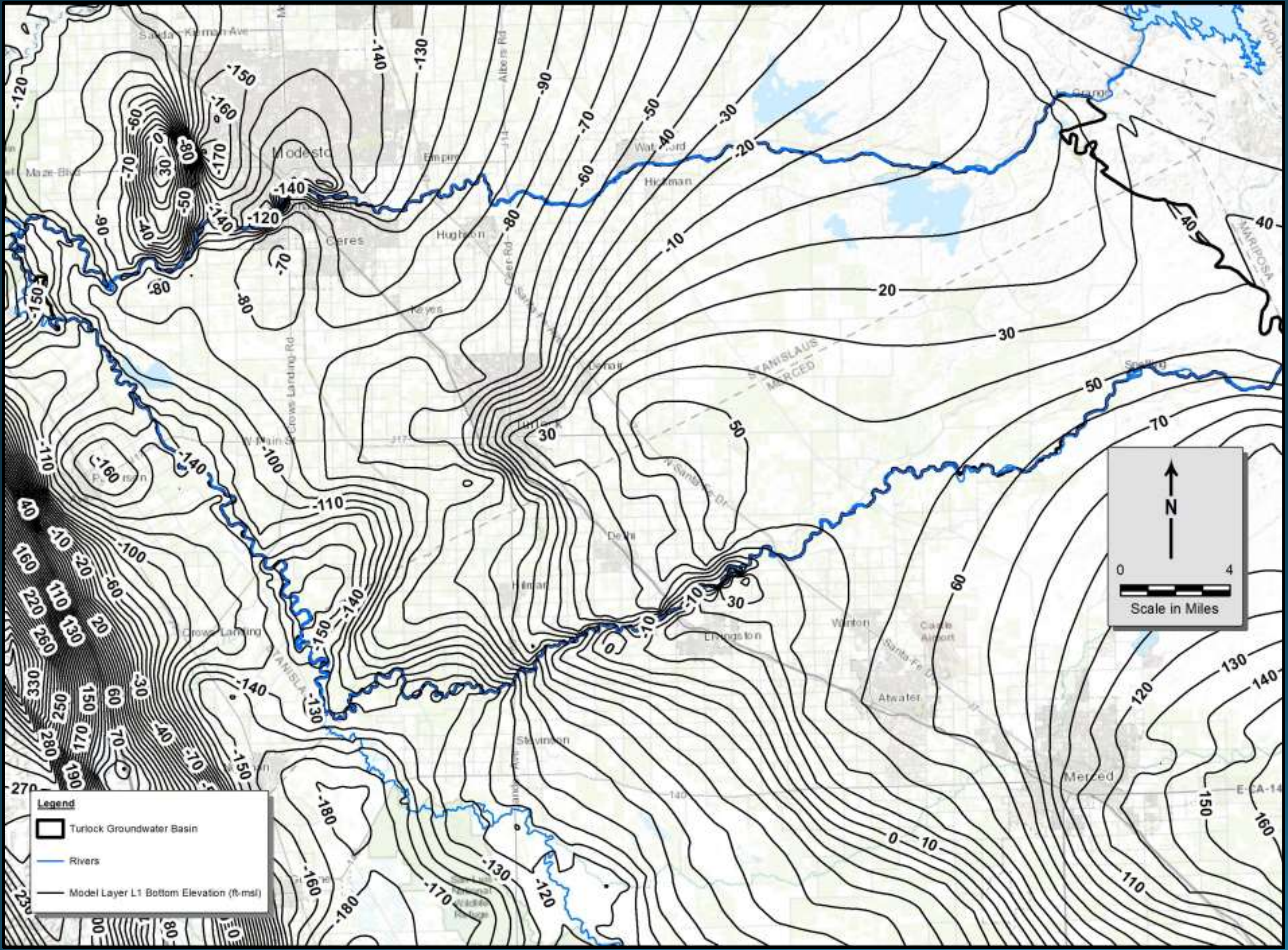


A
A'
A-A'
Basin Boundary
GSA Boundary
Unconfined aquifer
Corcoran Clay
Primary shallow pumping layer
Deeper pumping layer
300
200
100
0
-100
-200
-300
-400
-500
-600


B-B′
B
B'
North Basin Boundary
A-A'
County Line
South Basin Boundary
150
100
0
-100
-200
-300
-400
-500
Unconfined aquifer
Corcoran Clay
Primary shallow pumping layer
Deeper pumping layer
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

C-C’


C
North Basin Boundary
A-A'
County Line
South Basin Boundary
C'
0
-100
-200
-300
-400
-500
Unconfined aquifer
Corcoran Clay
Primary shallow pumping layer
Deeper pumping layer
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20



C2VSim Model Layer L1

(unconfined aquifer)

Bottom elevation contours

(10 foot interval)

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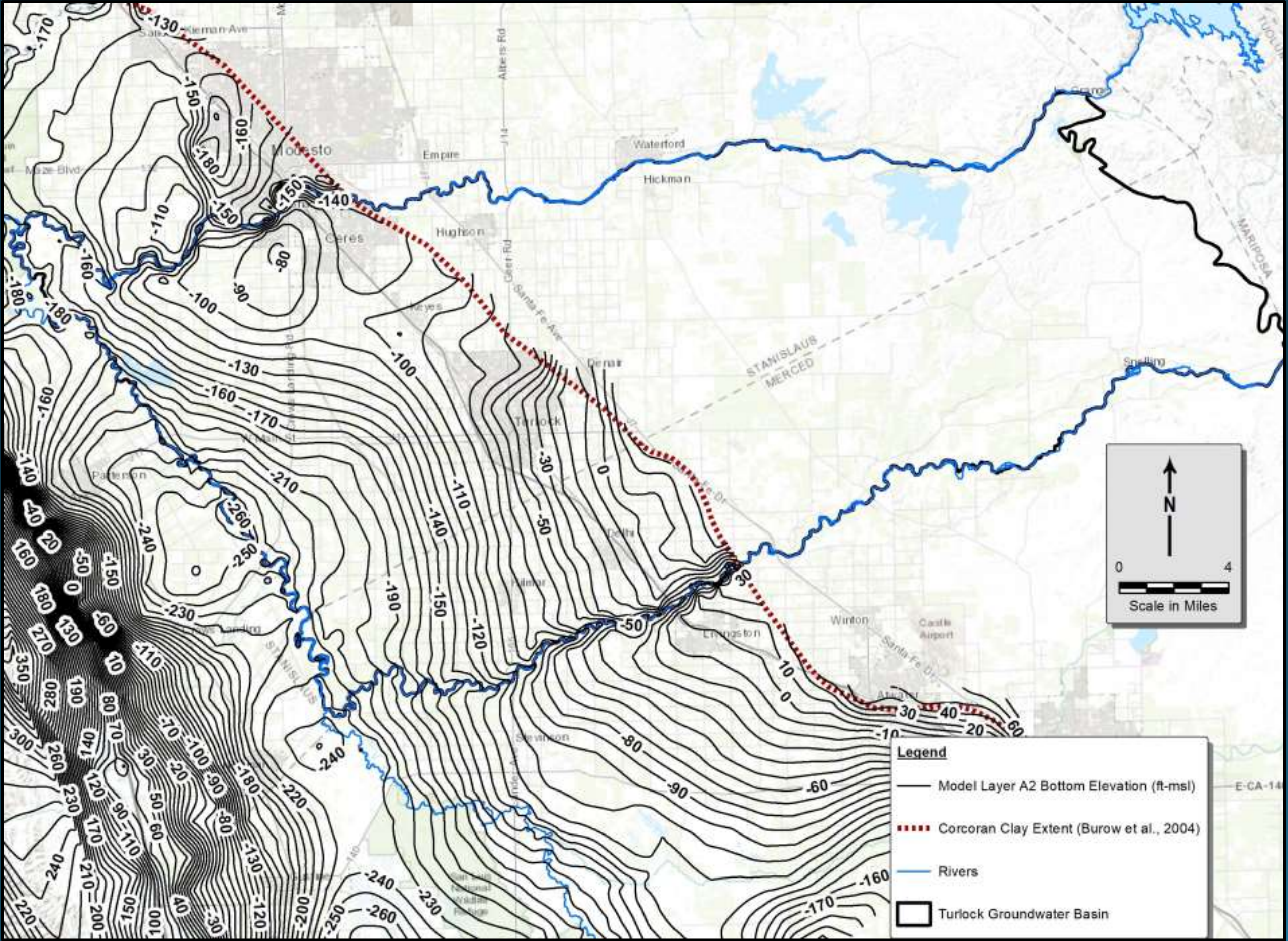
C2VSim Model Layer A2

(Corcoran Clay)



Modified from Page, 1973 for the Central Valley Hydrologic Model (CVHM)

10 ft contour interval

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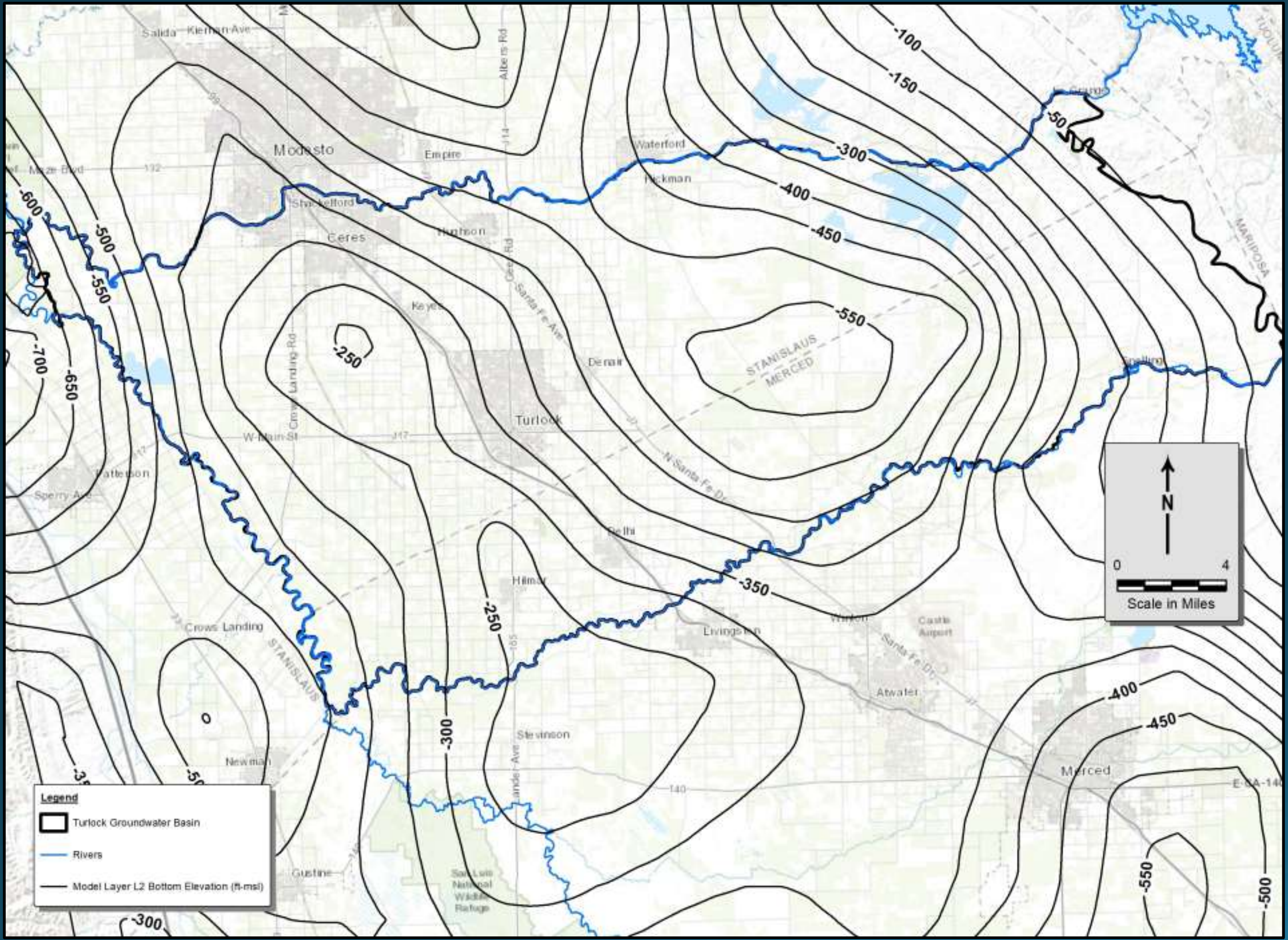

C2VSim Model Layer L2

(Primary Shallow Pumping Layer)

- Model layer designed to incorporate pumping wells.
- Deep wells in ETSGSA

contour interval =50 ft

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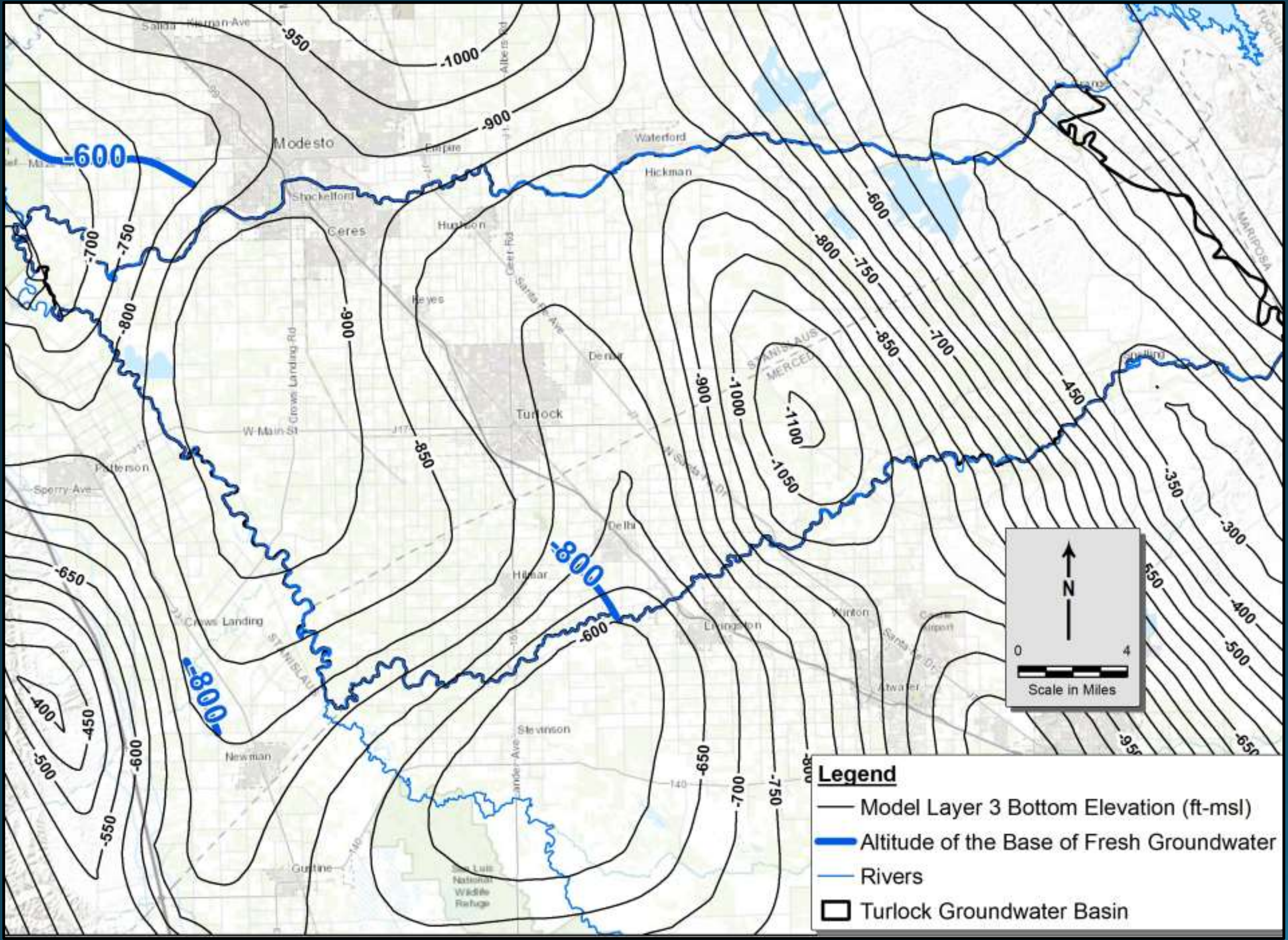
C2VSim Model Layer L3

(Deeper Pumping Layer)

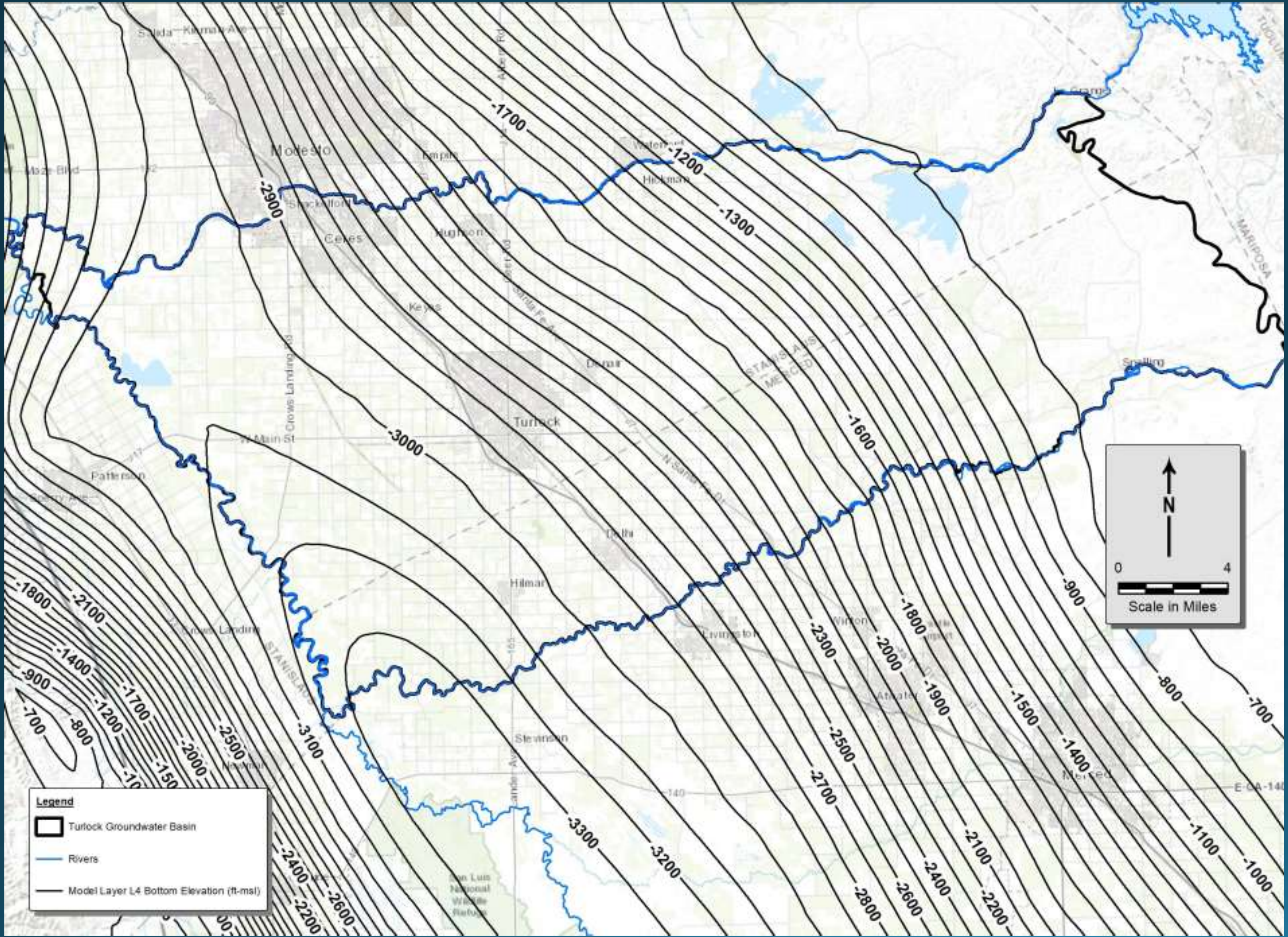


- Bottom of the groundwater basin (base of fresh water)
- Generally agrees with limited data from Page, 1973 (blue contours)

contour interval =50 ft

C2VSim Model Layer L4

(Saline Aquifer)



- Base of model
- Base of continental deposits

contour interval =100 ft

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Model vs. Cross Sections – What Did We Learn?

Consistency!

- Corcoran Clay is at similar elevations and extent
- Pumping wells on cross sections are within the pumping layers (for the most part)
- Mehrten Aquifer is primarily within the Confined Pumping Layers
- Decisions on Principal Aquifers still being considered, but model layers will be a useful guide

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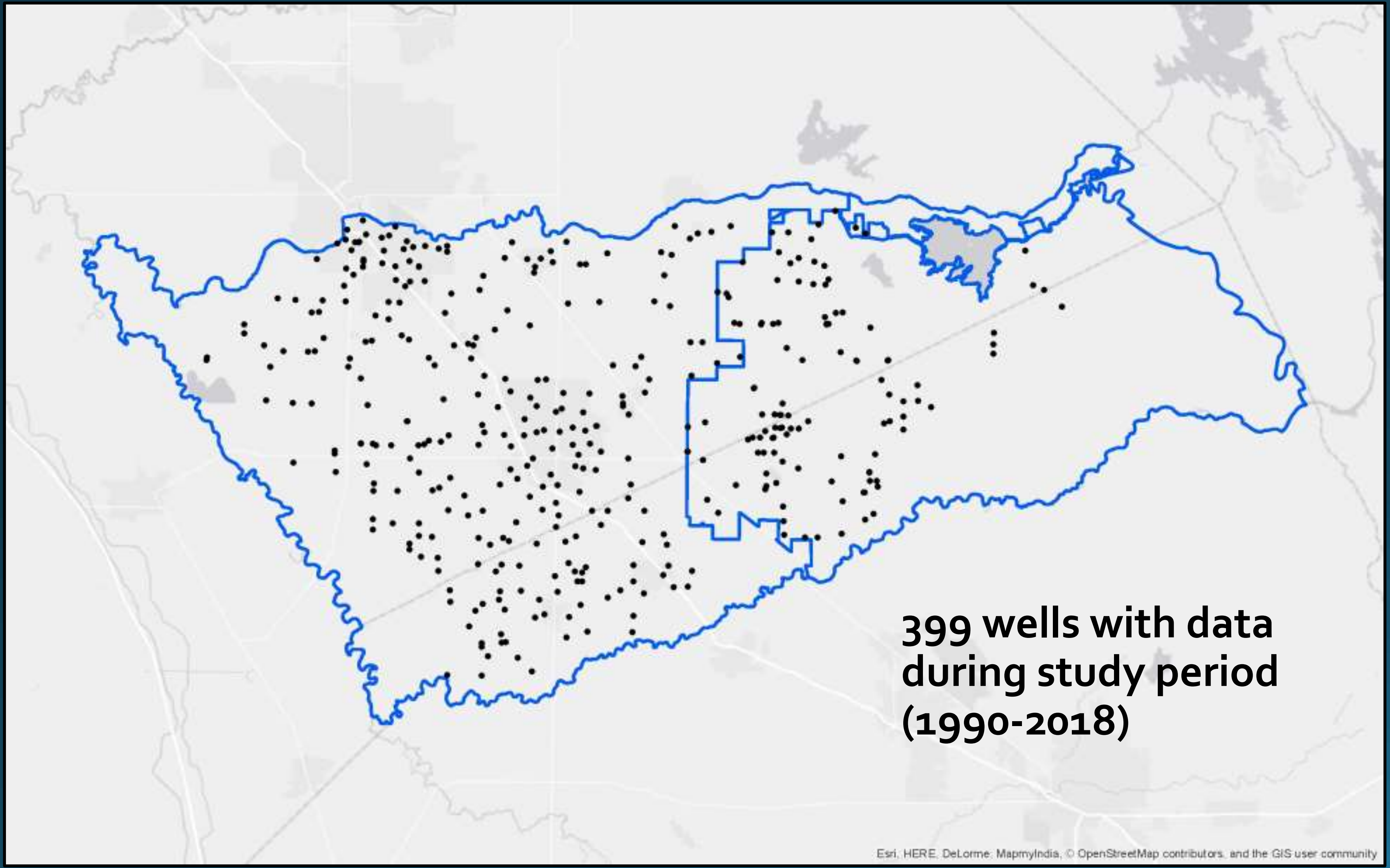
Model Revisions to be Considered

- Soil properties (in the east)
- Deep percolation of applied water (relate to soil properties)
- Crop ET
- Municipal pumping
- Other properties being considered

* Input such as precipitation and surface water deliveries do not require revisions

Available Water Level Data



Data Sources

- DWR Water Data Library (includes CASGEM)
- TID
- EWD
- Municipalities and Urban Communities
- Olam Farming

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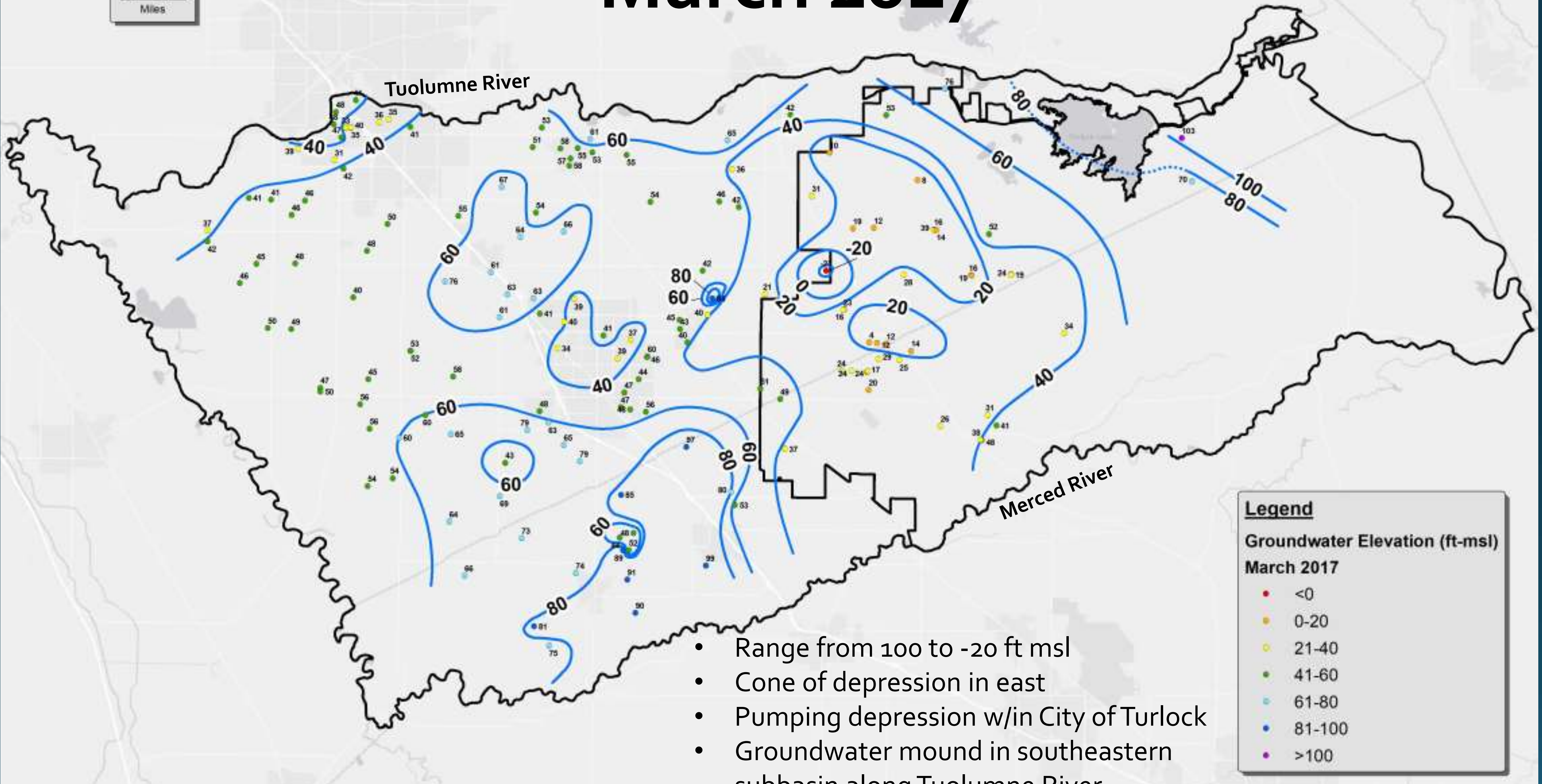
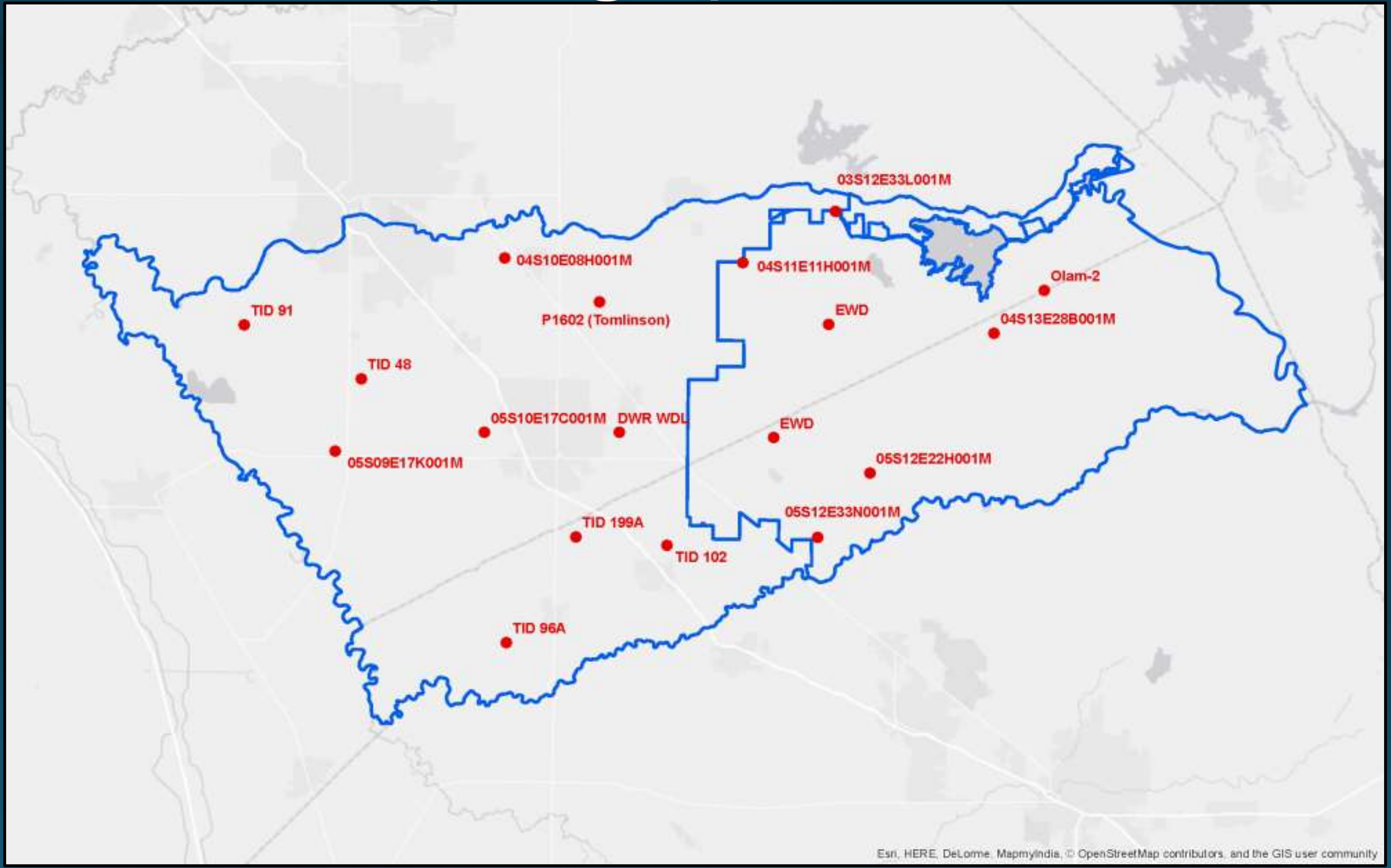
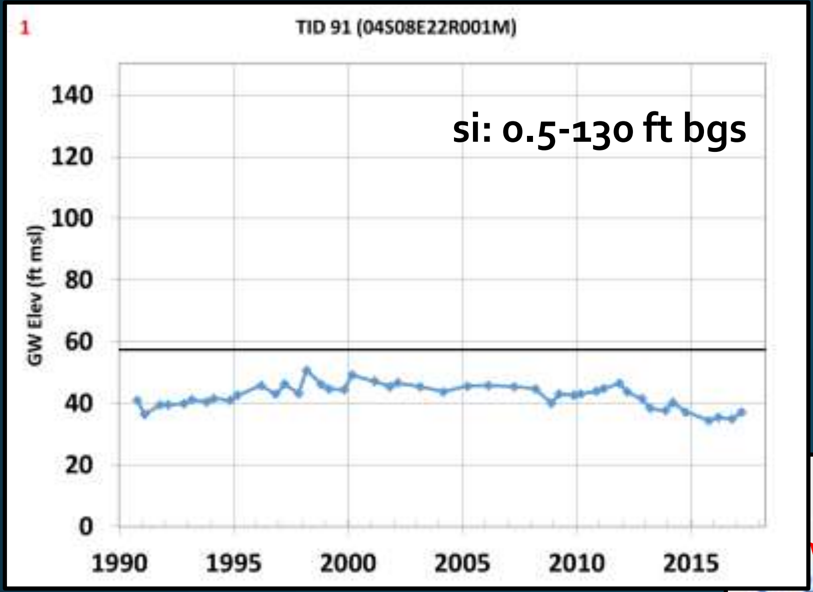
Groundwater Elevation Contours March 2017

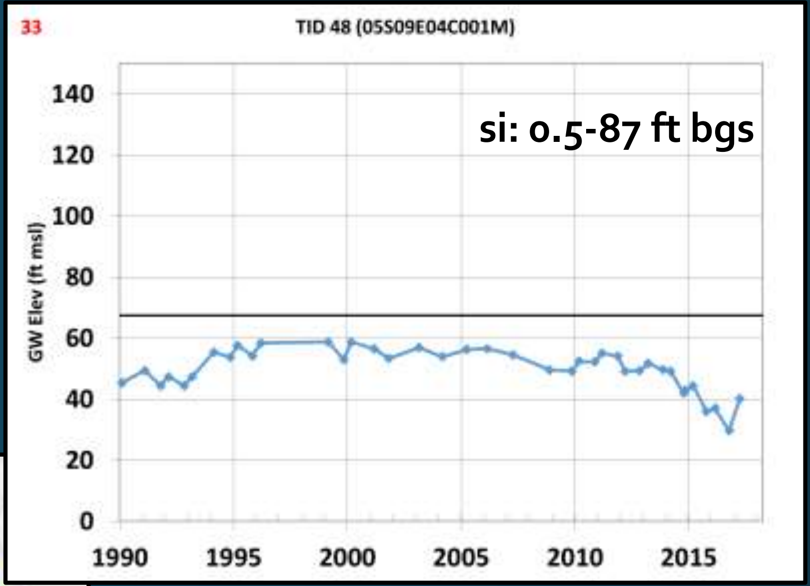


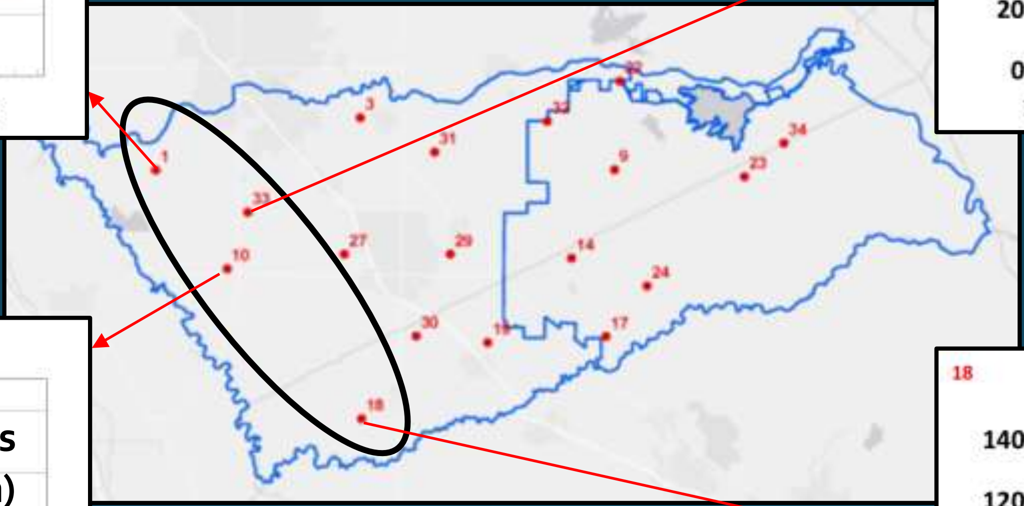
- Range from 100 to -20 ft msl
- Cone of depression in east
- Pumping depression w/in City of Turlock
- Groundwater mound in southeastern subbasin along Tuolumne River

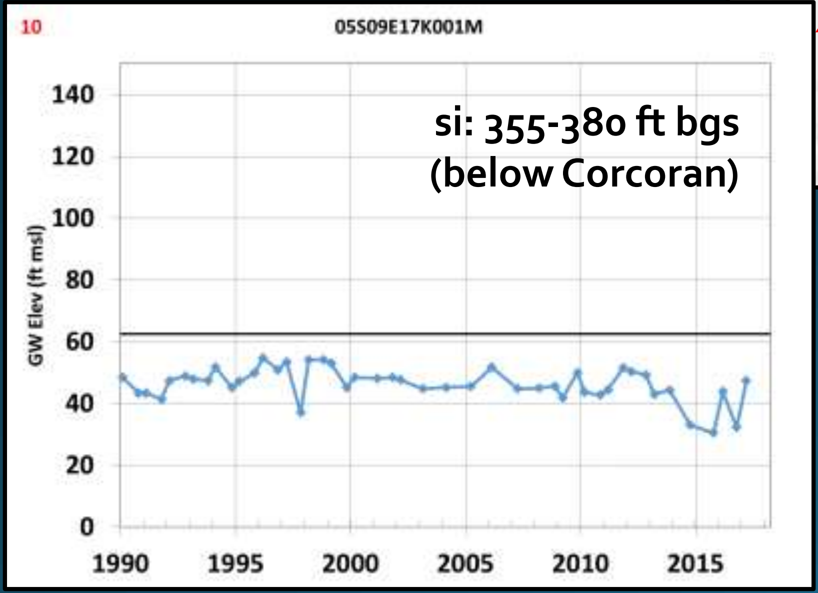
Representative Hydrograph Locations

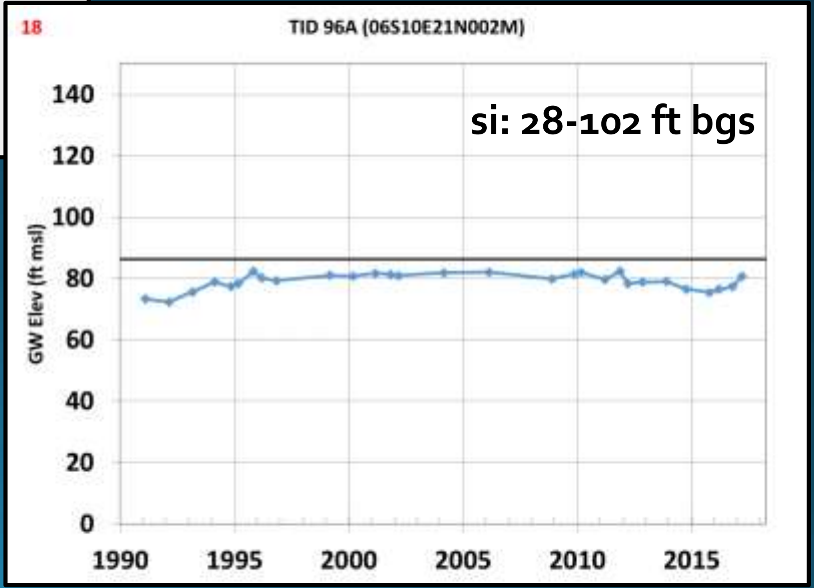




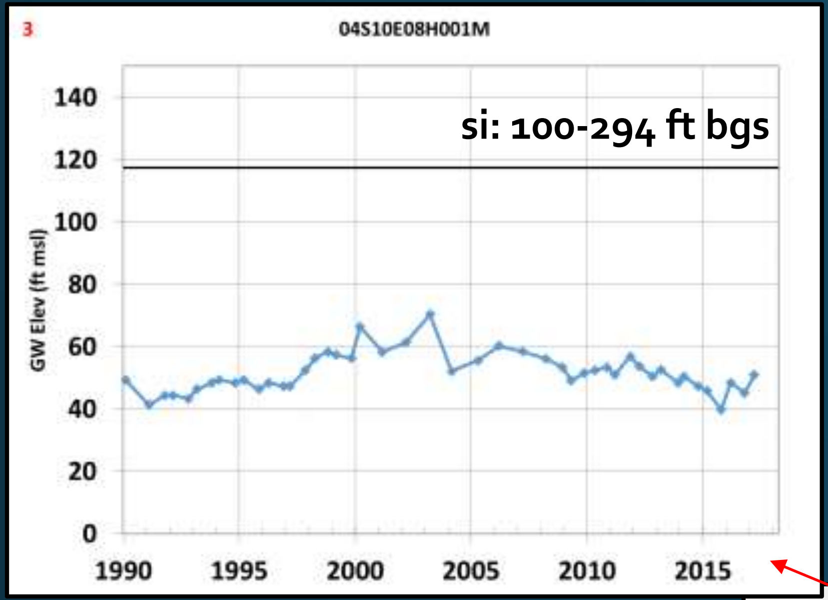


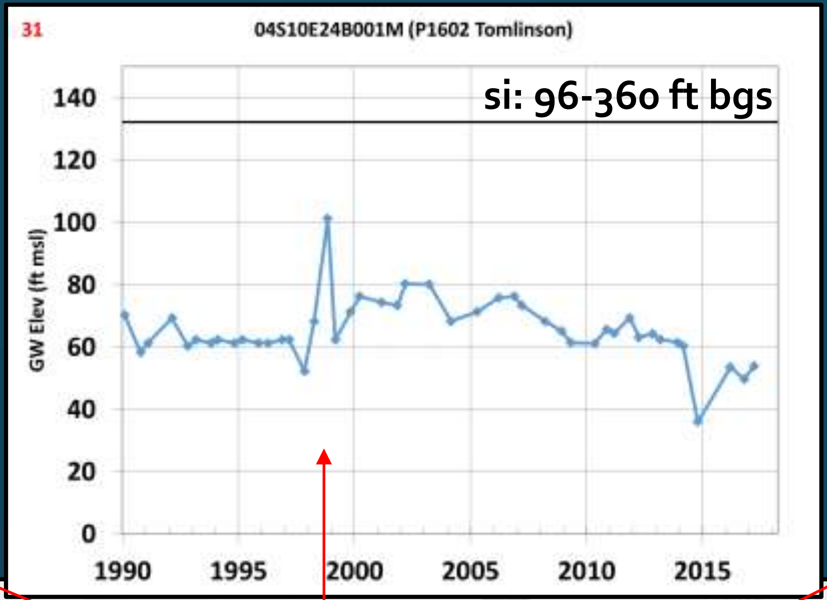


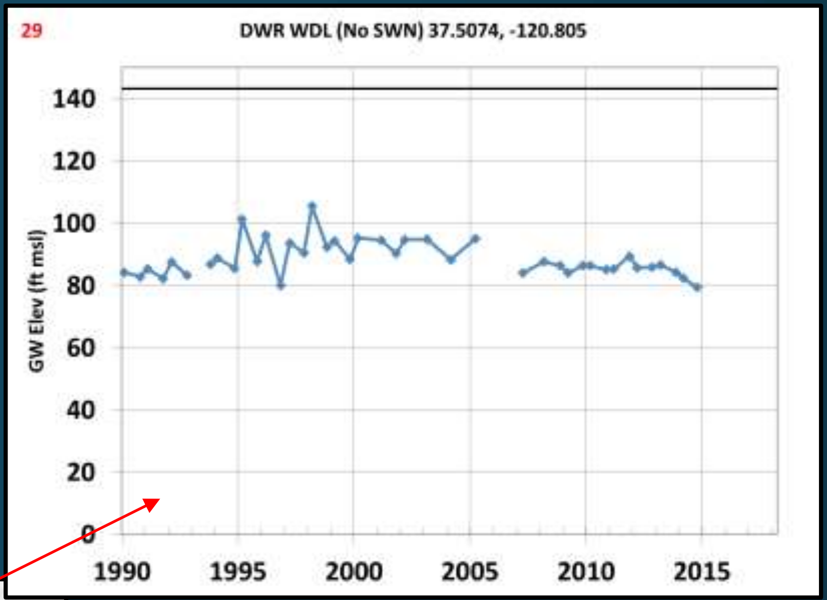


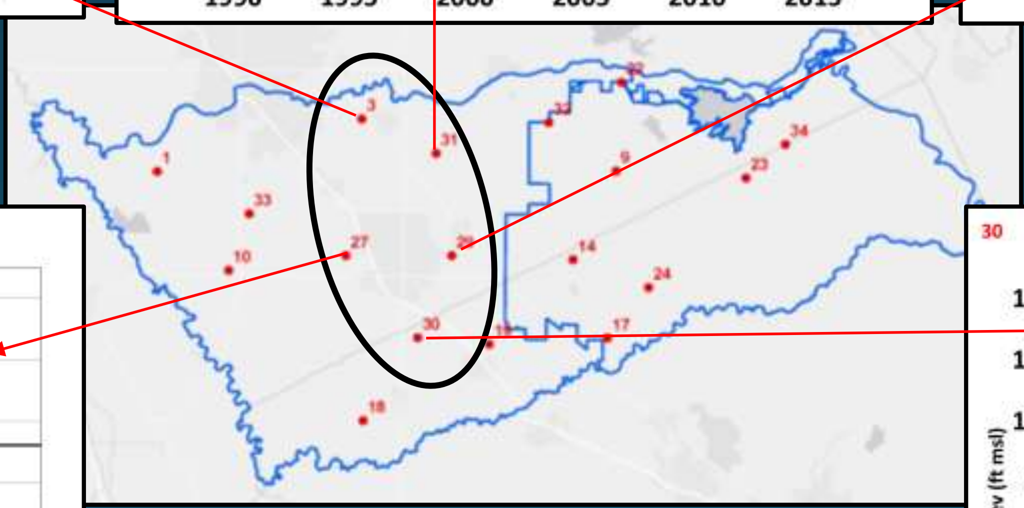


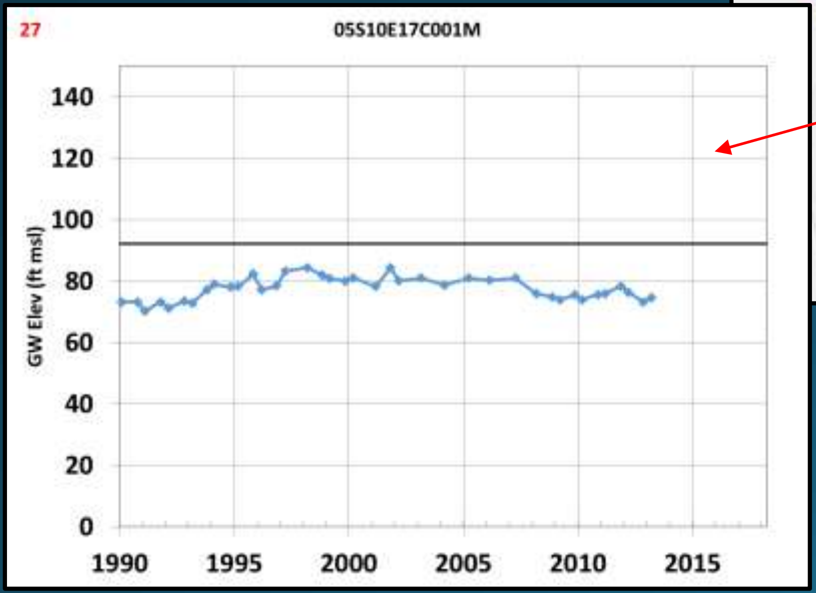
- Groundwater is shallow
- Water levels relatively steady
- GW elevations higher in south
- Pumping variation below Corcoran

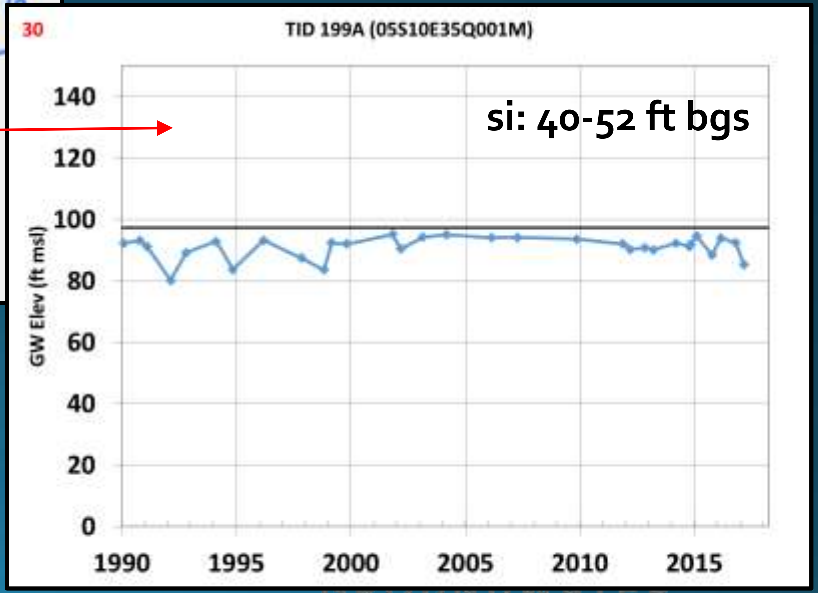




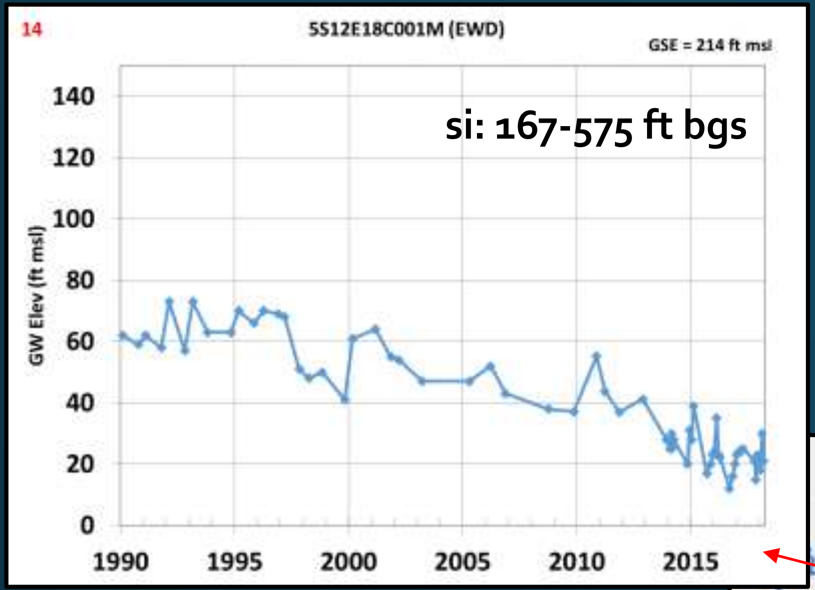


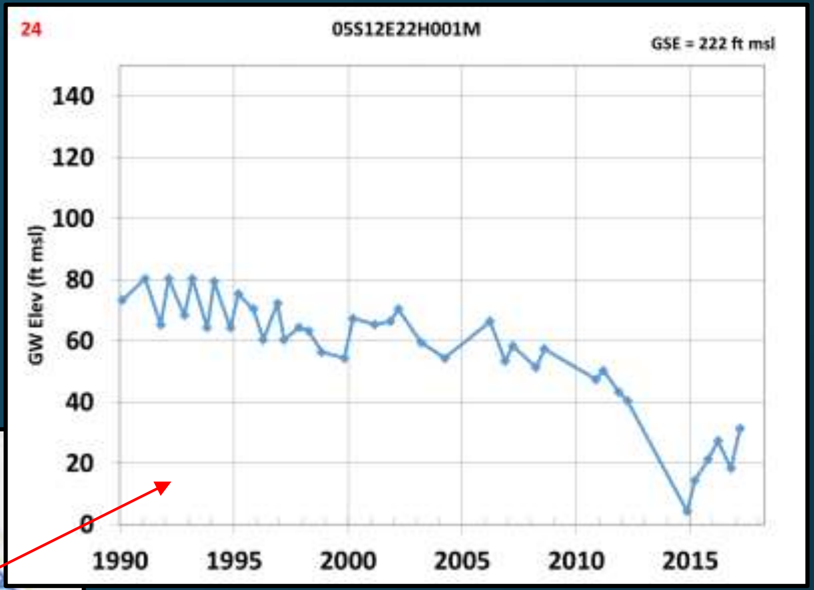


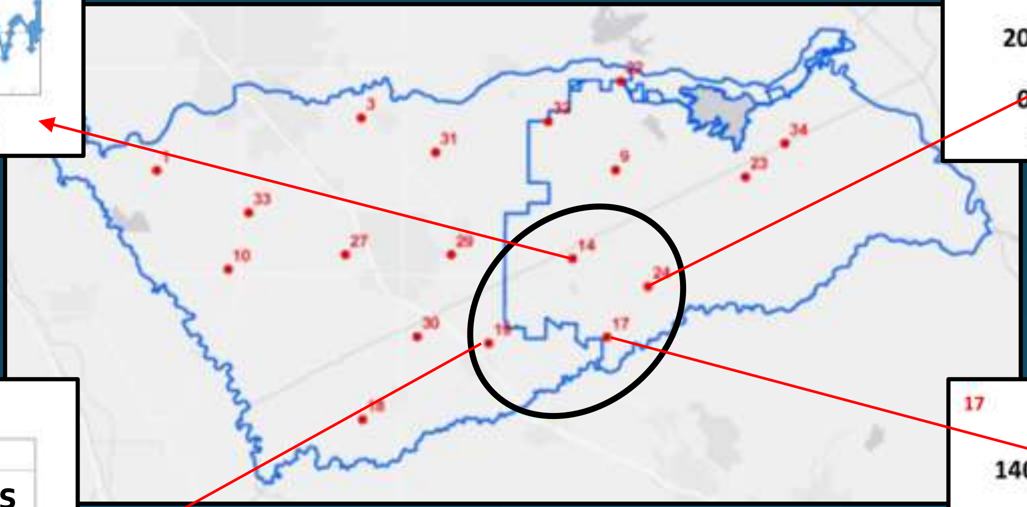


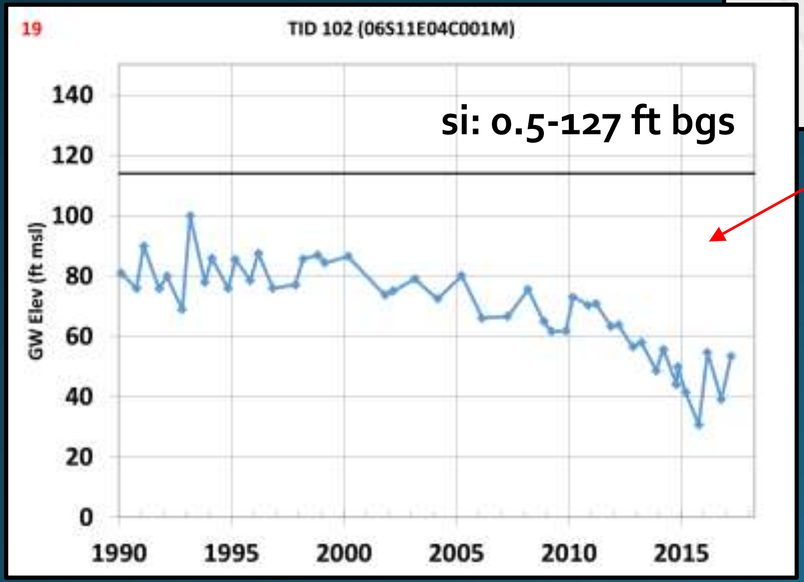


- GW elevations are higher than in west
- North and east: DTW increases, more pumping variability
- Relatively stable water levels in central TID

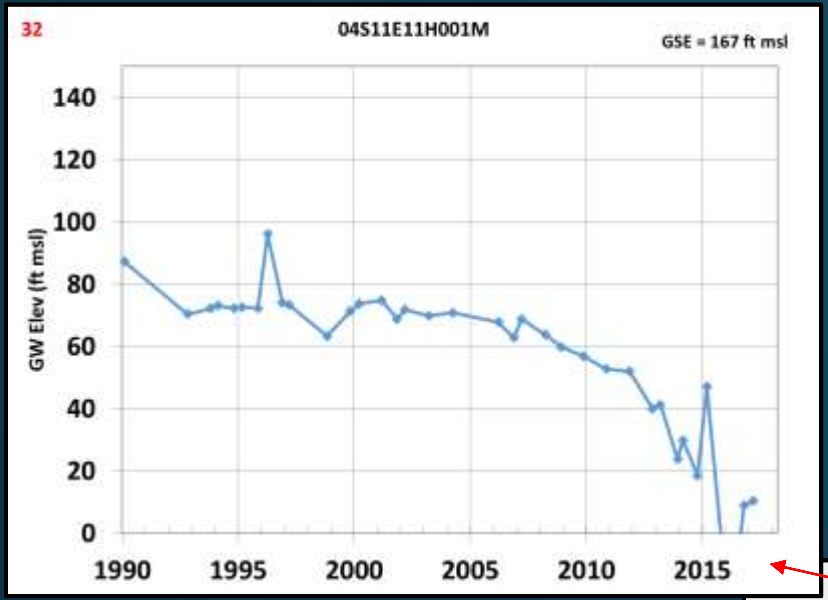


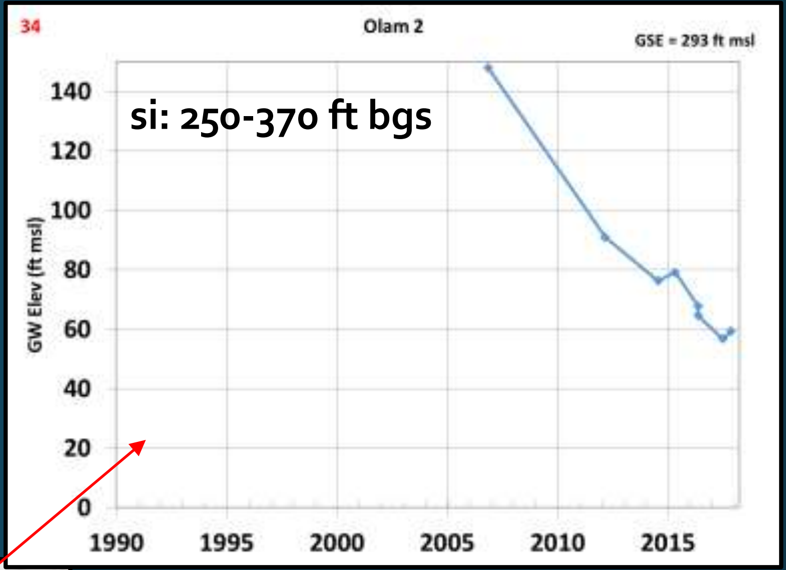


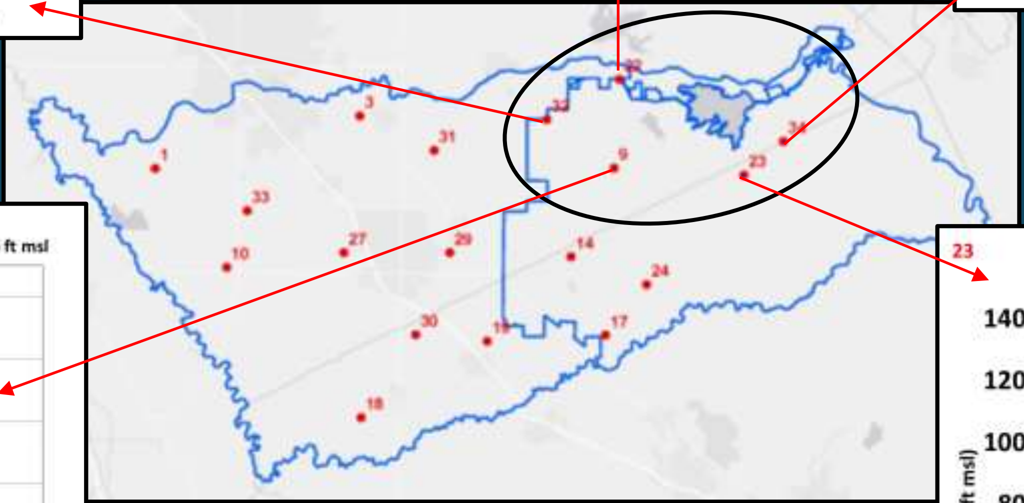


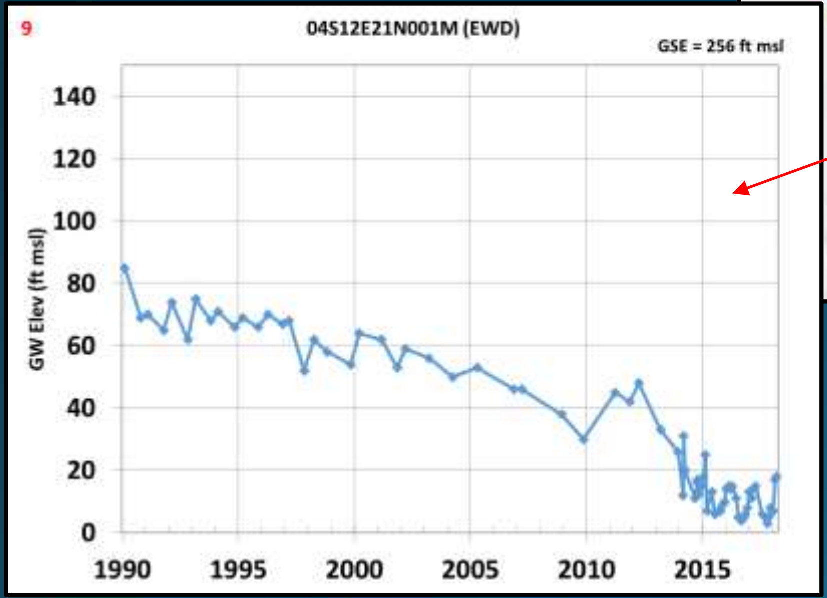


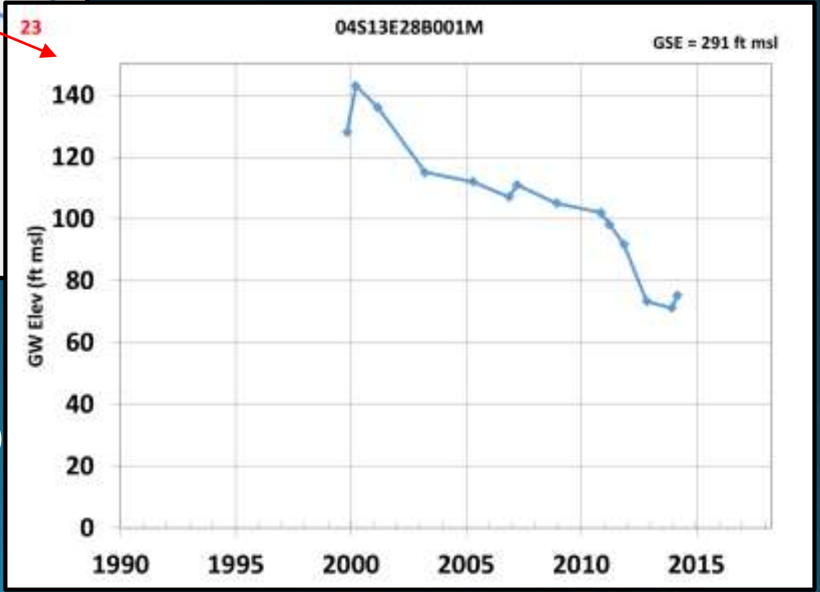
- South/southeastern region of cone of depression
- Declining trends since ~2000
- Declines up to 70 ft (#24), less (~40-50 ft) closer to Merced River (#s 19,17)
- DTW ~200 feet (#s 14, 24)
- Slight rebound since recent drought











- Northern cone and to east
- Declines >70 ft since 2000 in cone (#32)
- Less decline (~20-30 ft) near River (#22)
- Slight rebound since drought
- Limited data in east, declines ~70-90 ft

Next Steps

- Continue Technical Analysis:
  - coordinate with Wood Rodgers in the eastern subbasin
  - updates to the numerical model
- Provide *Administrative Draft* GSP Sections 1 and 2 (Plan Administration Information and Plan Area)
- September 27 TAC meeting:
  - Brief update on technical analysis
  - Comments on *Administrative Draft* Sections 1 and 2
  - Proposal for Groundwater Recharge Assessment Tool (GRAT)