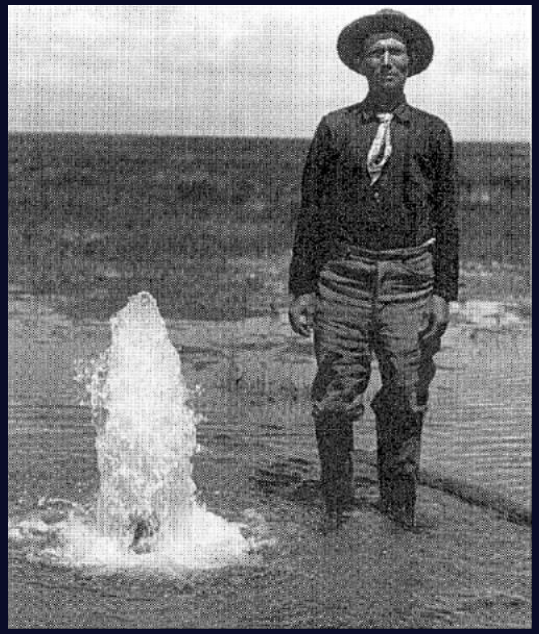
Introduction to the Science of Groundwater



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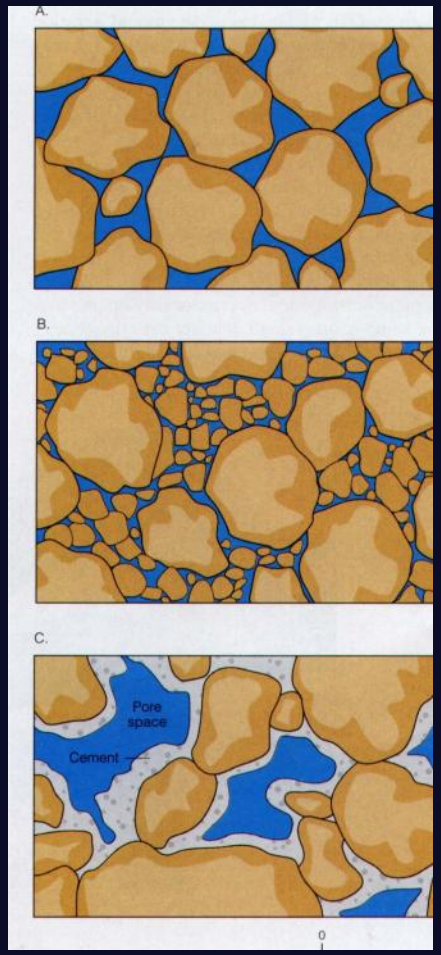
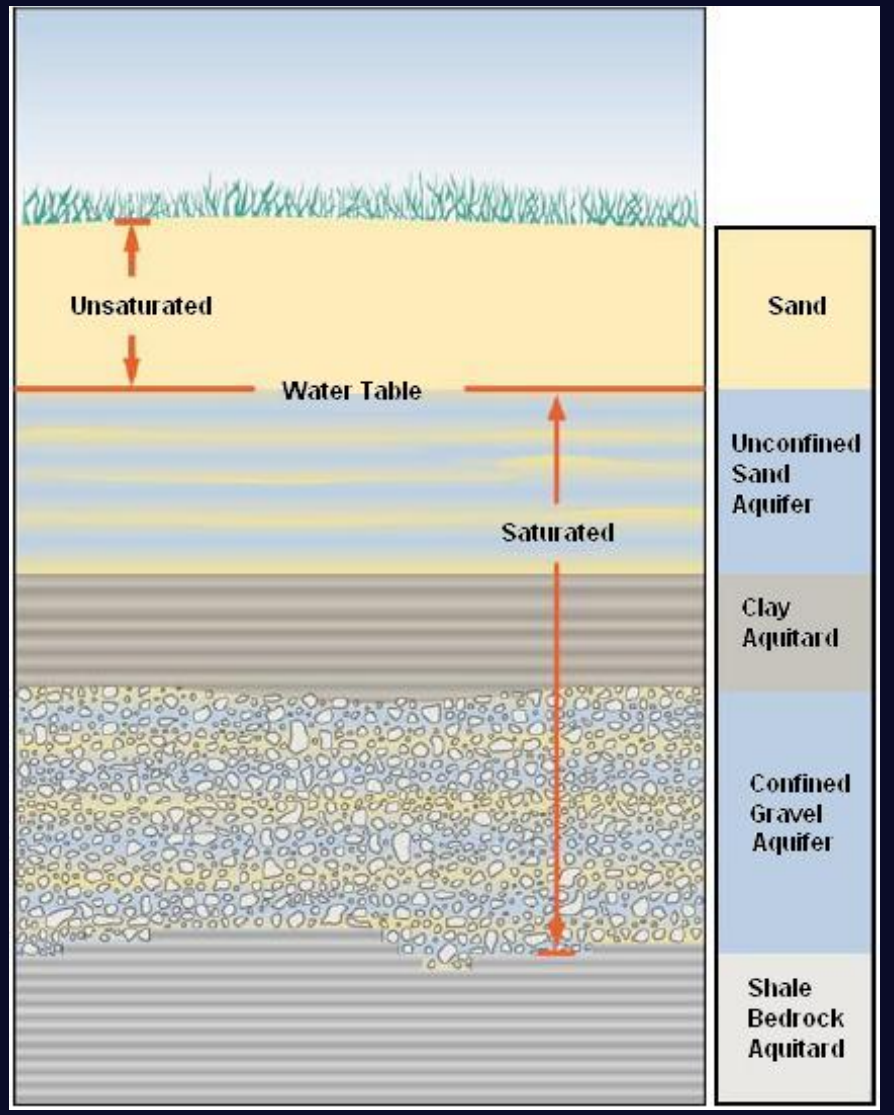
What is groundwater?

Groundwater occurs in small pore spaces within rock and alluvium (unconsolidated sediment)

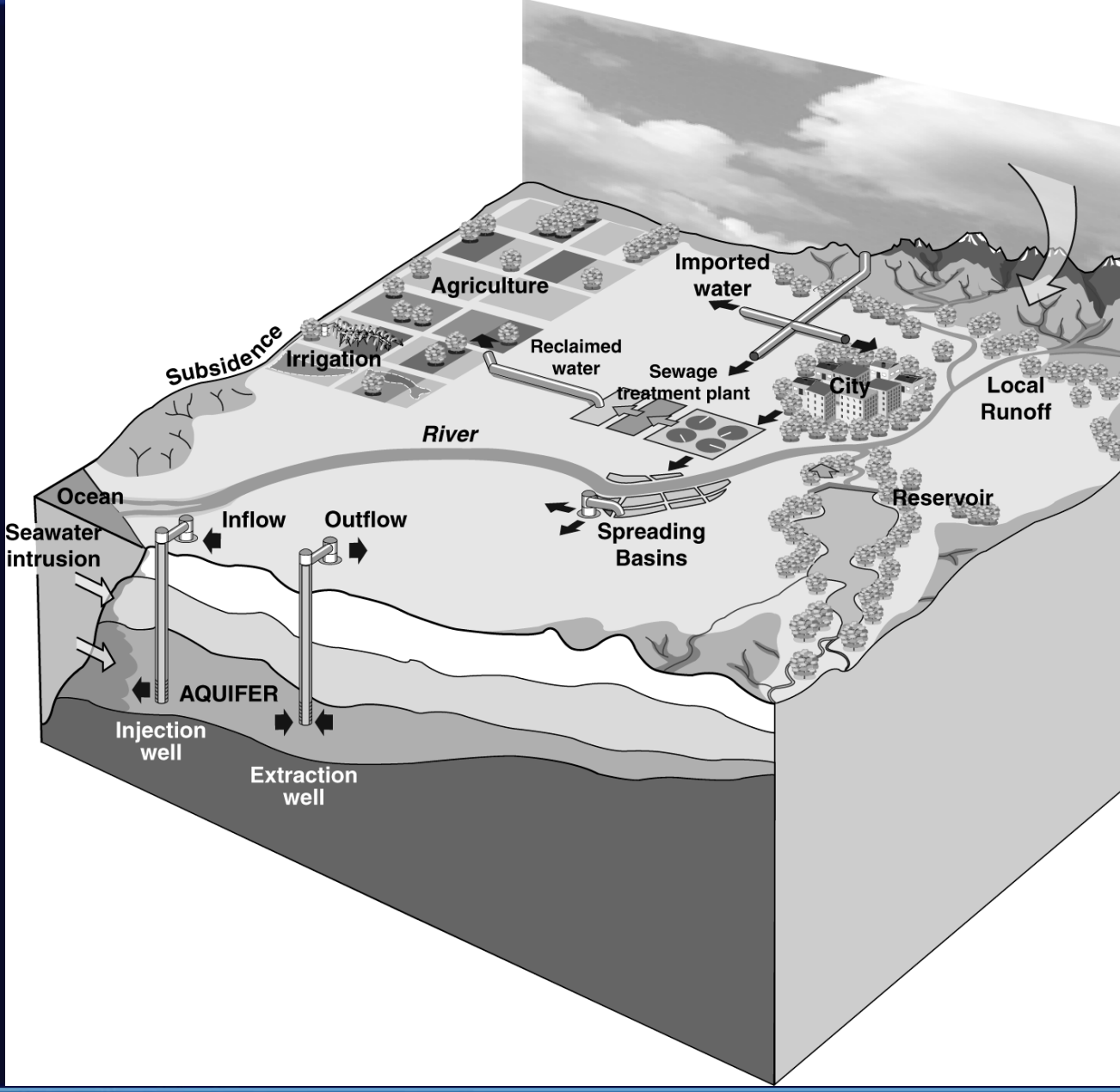




Where does groundwater come from? (recharge)

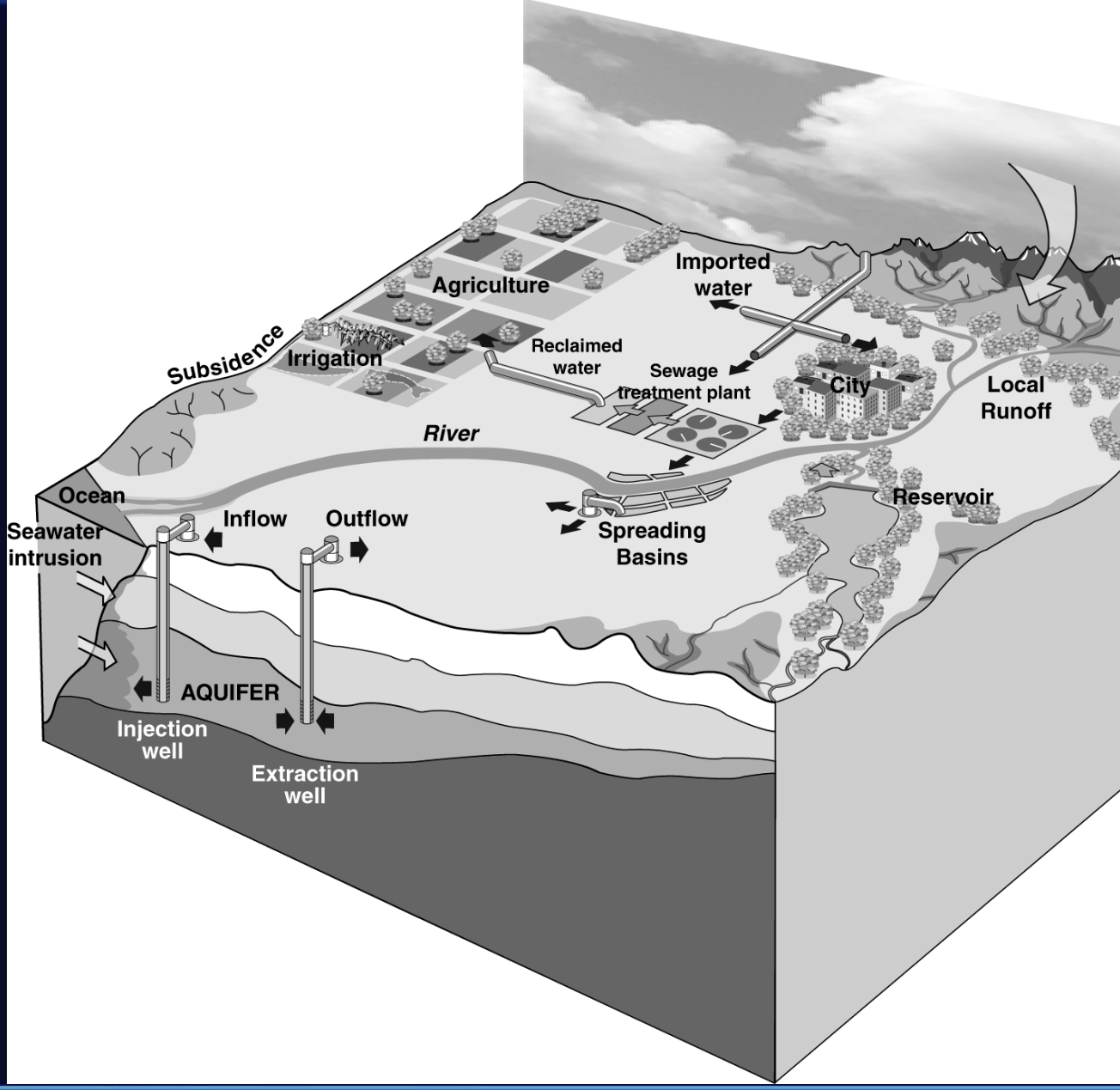
Many possible sources, including

- Precipitation
- Streams/lakes
- Irrigation
- Managed aquifer recharge
- Subsurface flow



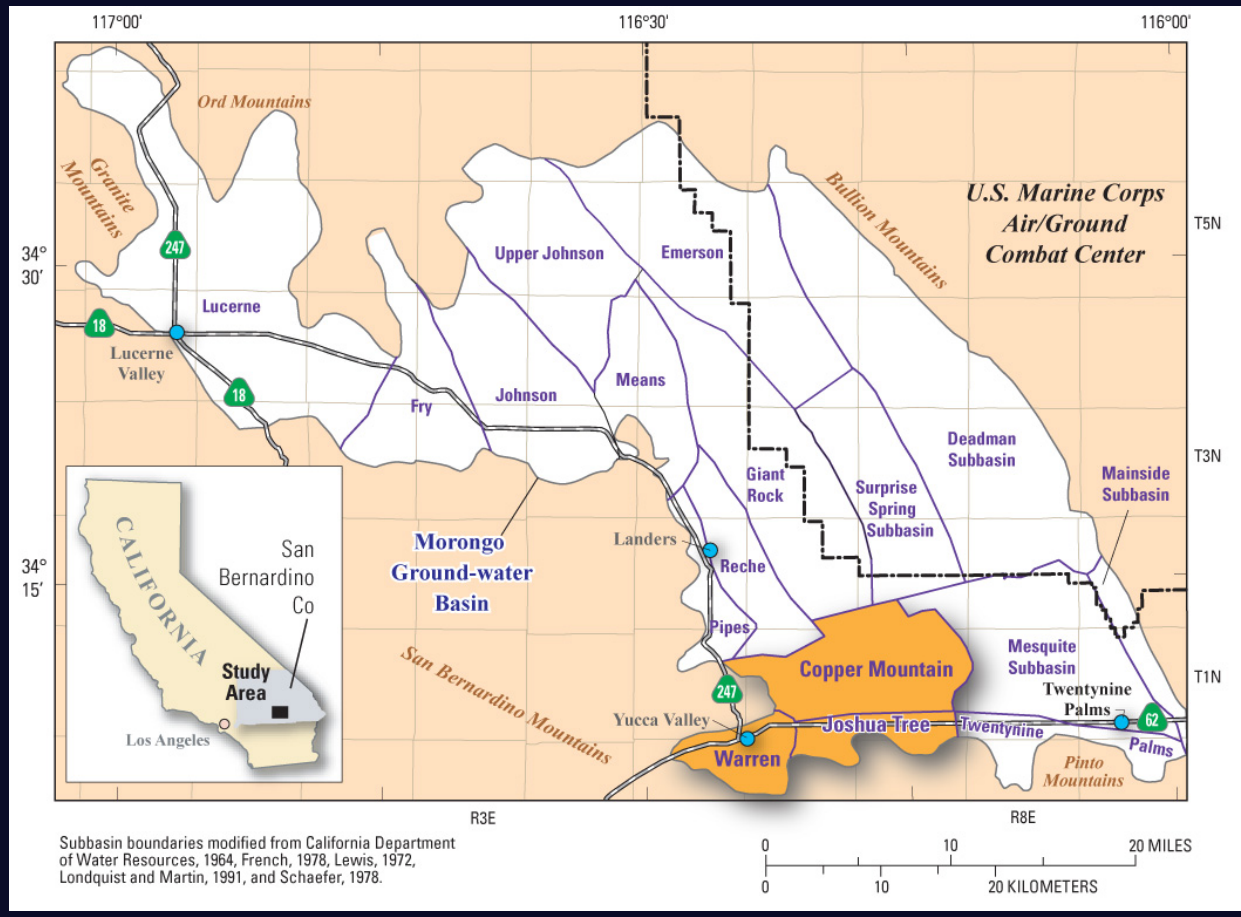
Where does groundwater go? (discharge)

- Streams, lakes, wetlands, the ocean
- Evapotranspiration
- Springs, seeps
- Wells
- Drains
- Subsurface flow
- Etc.



Groundwater basins & subbasins

- Basins: An alluvial aquifer or stacked series of aquifers with reasonably defined lateral boundaries and having a defined bottom
- Subbasins: A subdivision of a groundwater basin created by dividing the basin using geologic or hydrologic conditions or institutional boundaries



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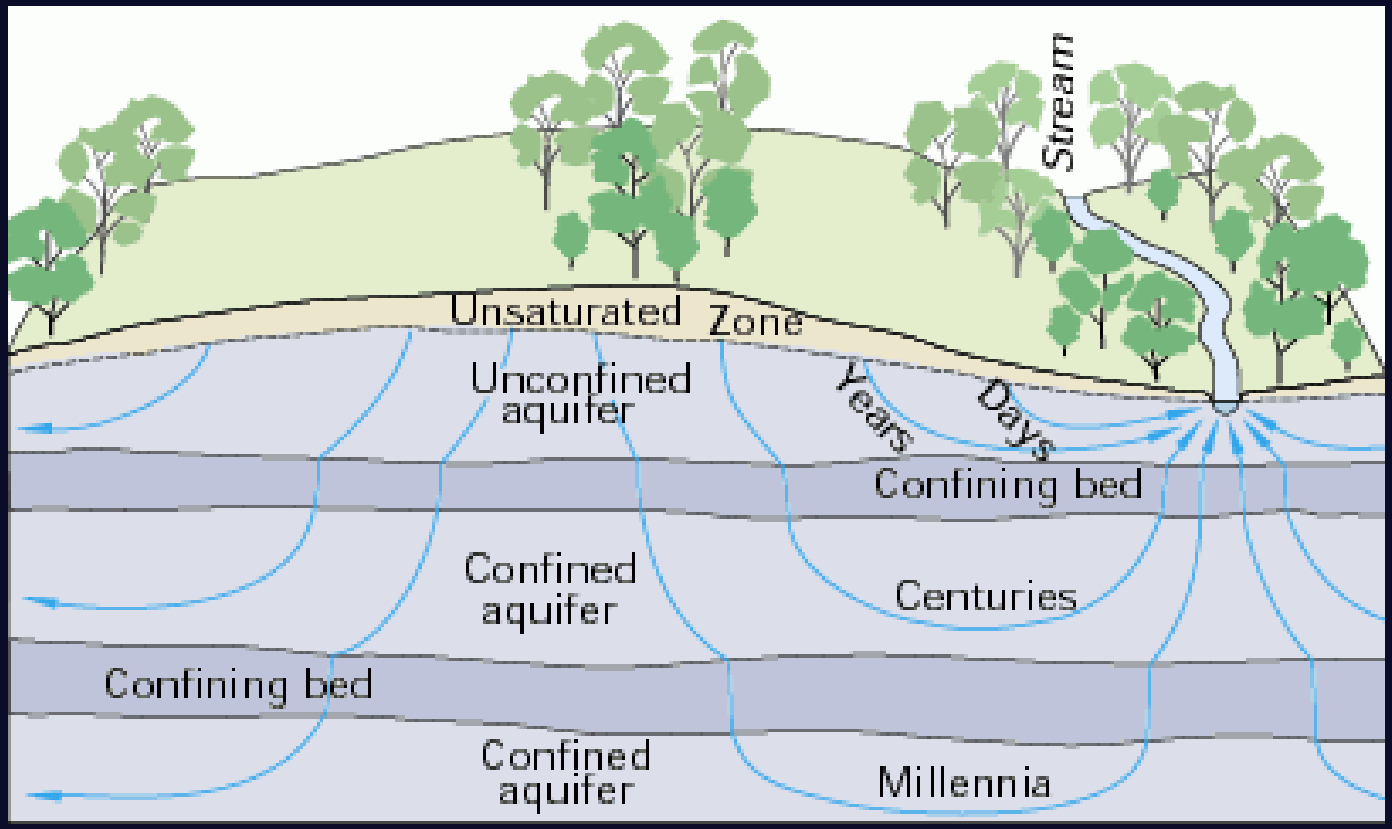
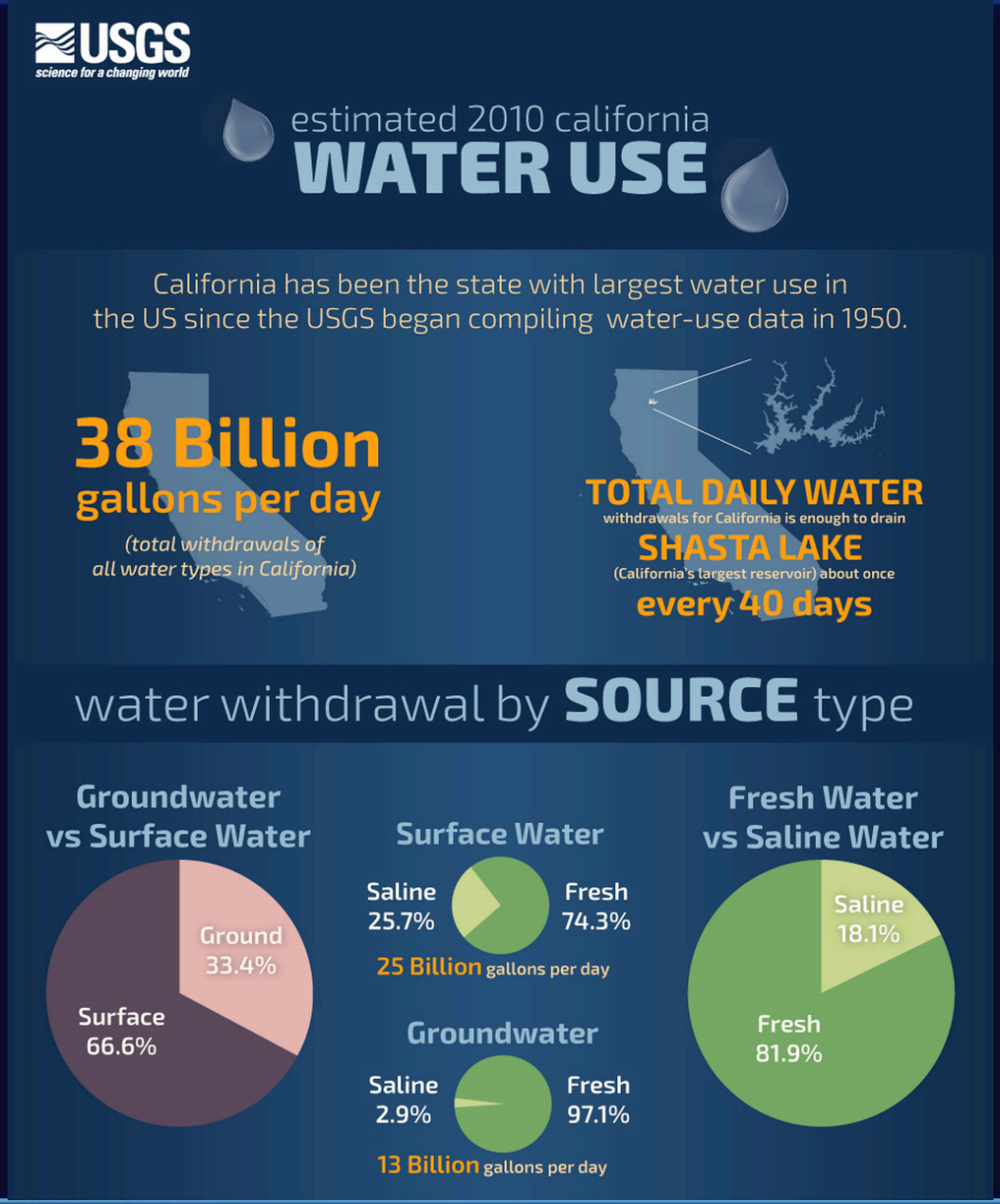
Groundwater flow & age

Groundwater flows down-gradient, from water-level highs to water-level lows.

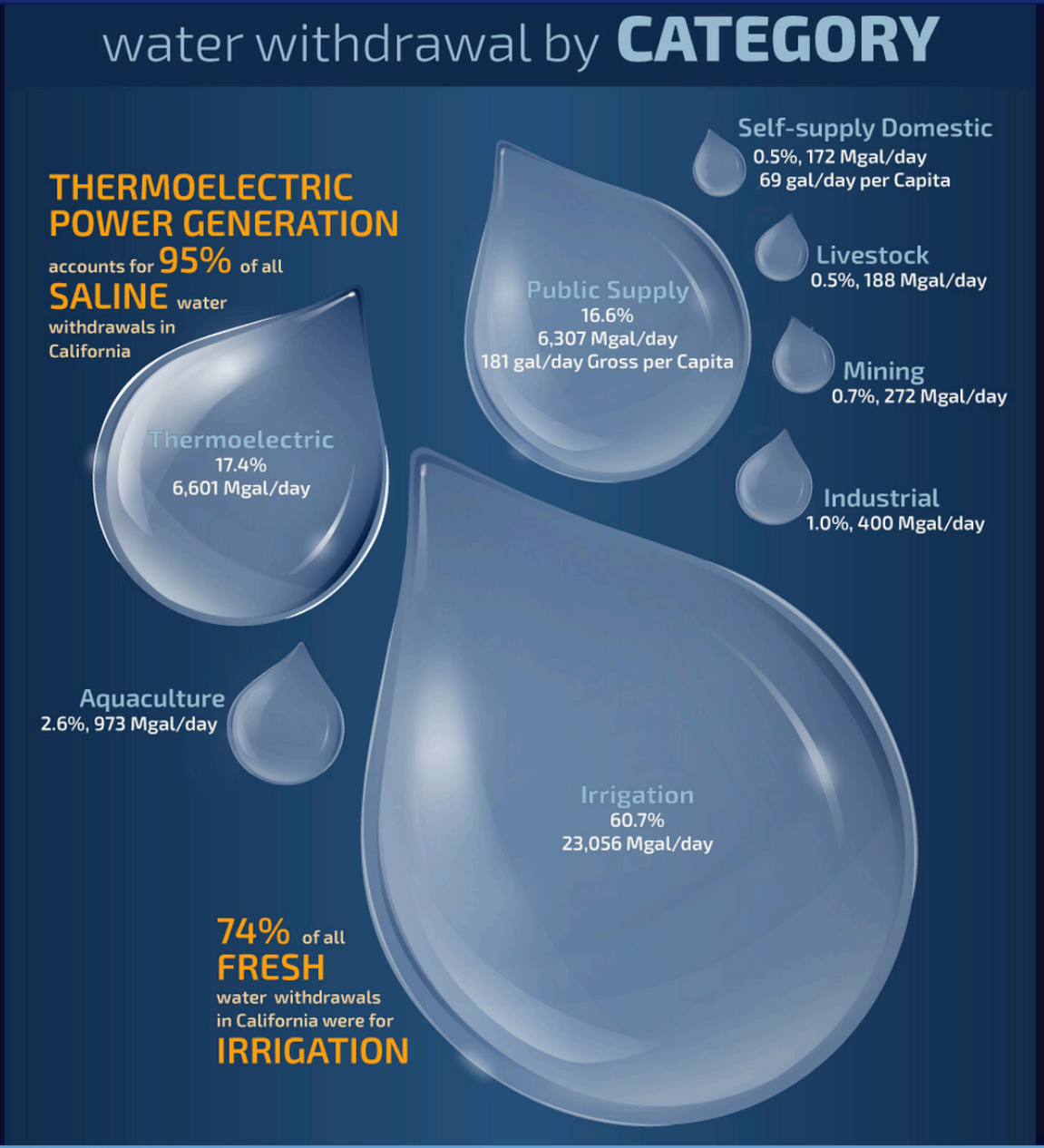


Groundwater Use

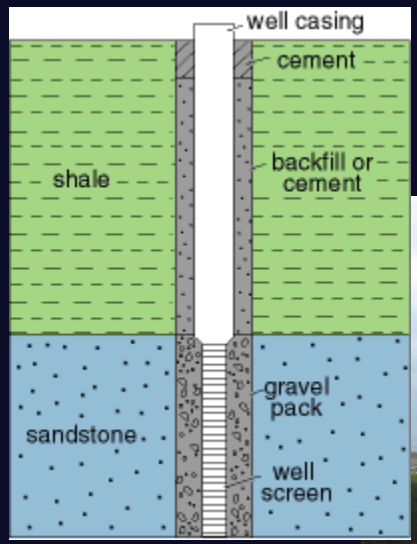


Groundwater Use

There is substantial uncertainty in estimates of groundwater pumping for irrigation in CA.

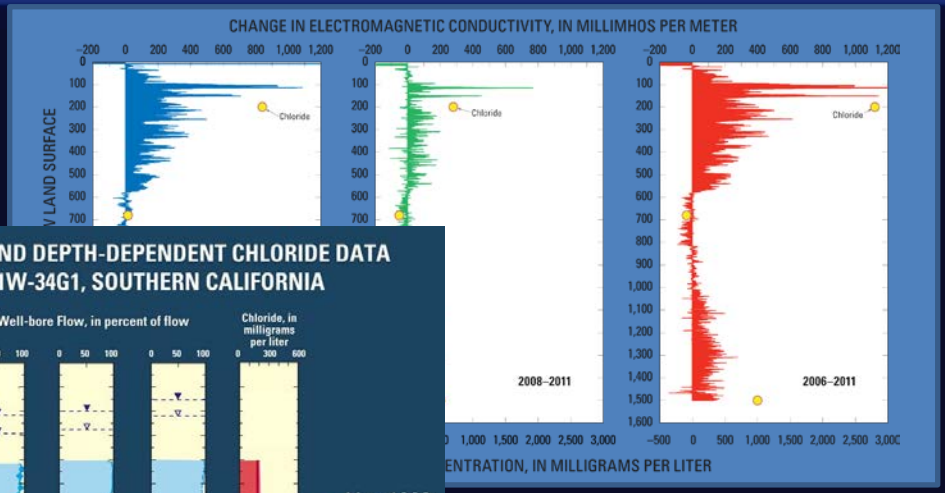


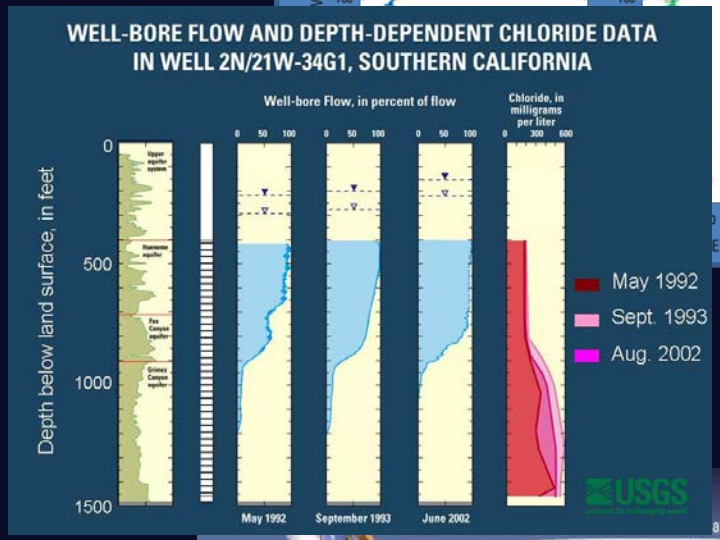
Ways to measure groundwater

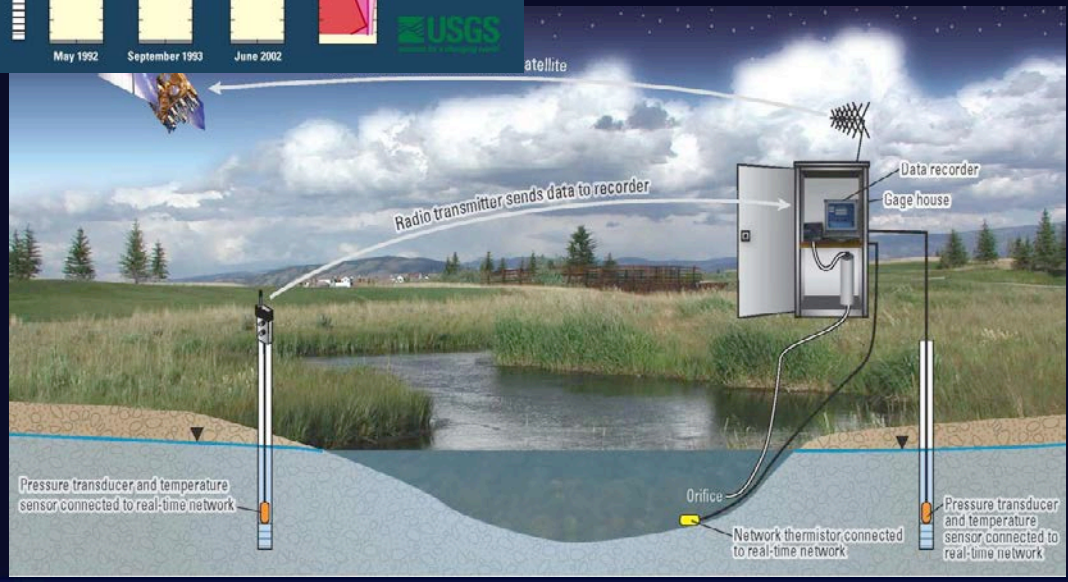


More ways to measure groundwater & aquifer system characteristics

- Borehole & surface geophysics
- Aquifer tests
- Instrumentation of the saturated and unsaturated zones
- Remote sensing
- Well logs
- Etc.



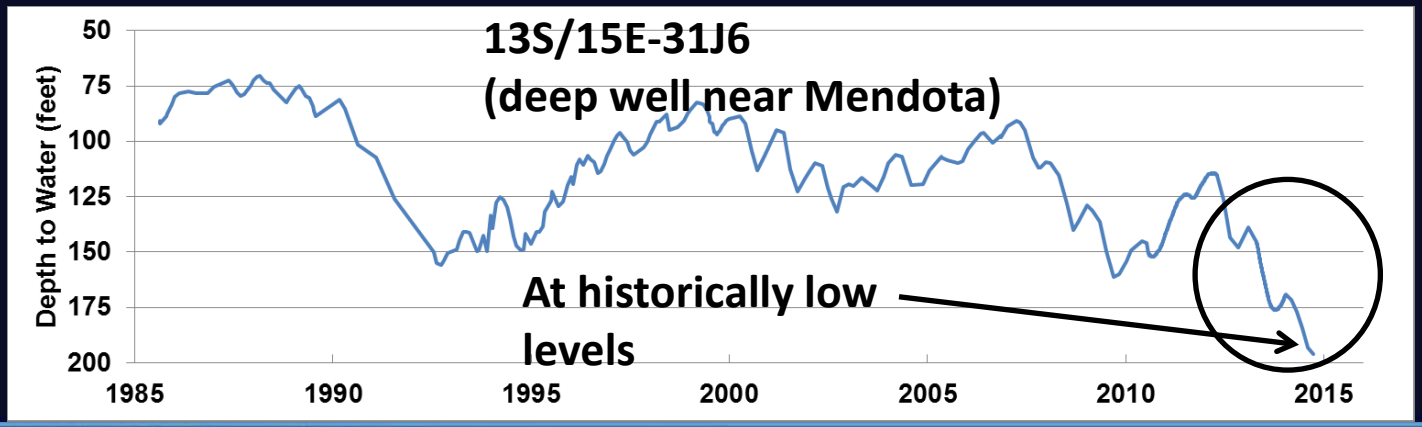




Groundwater trends in CA

In general, long-term (not during drought):

- Desert basins – ***declining***
  - Minimal natural recharge & alternative supplies
- Coastal basins – ***steady*** to ***declining***
  - More natural recharge in north; more active management in south & central
- Central Valley – ***steady*** north, ***declining*** south
  - More natural recharge & SW supplies in north
  - Declines severe in southernmost part of valley



A common question

How much groundwater is there in my basin?

The answer doesn't really matter, because there are many issues associated with groundwater depletion.

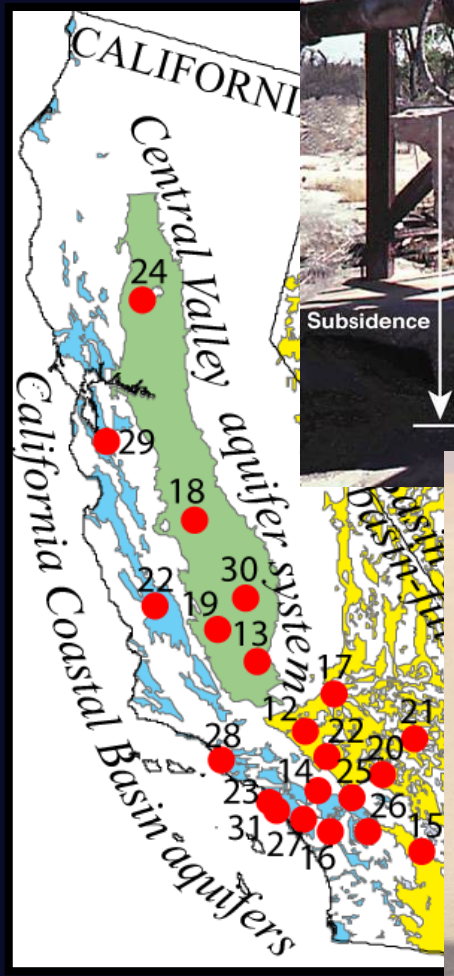
Issues associated with groundwater depletion

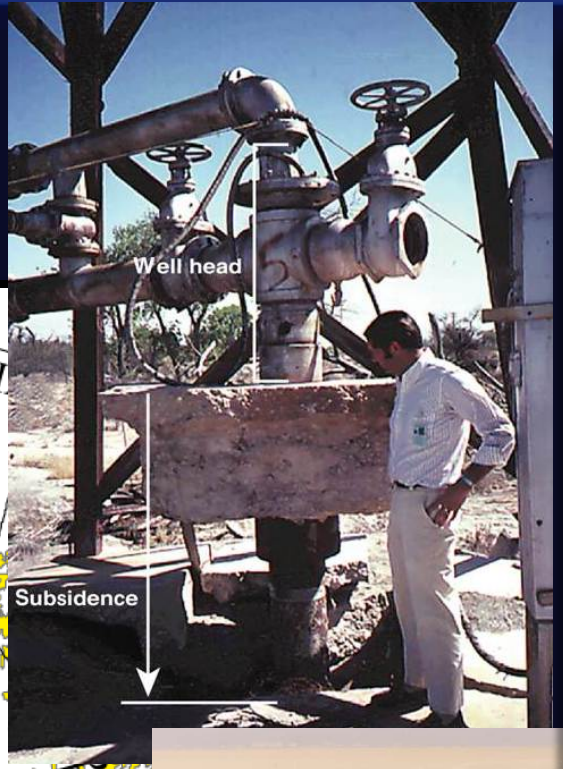
- Land subsidence
- Seawater intrusion
- Degradation of groundwater quality
  - e.g., reliance on older, more mineralized waters
- Depletion of surface water
  - e.g., drying of wetlands, reduced streamflow
- Increased cost of withdrawal
- Loss of (often) most productive aquifer zones

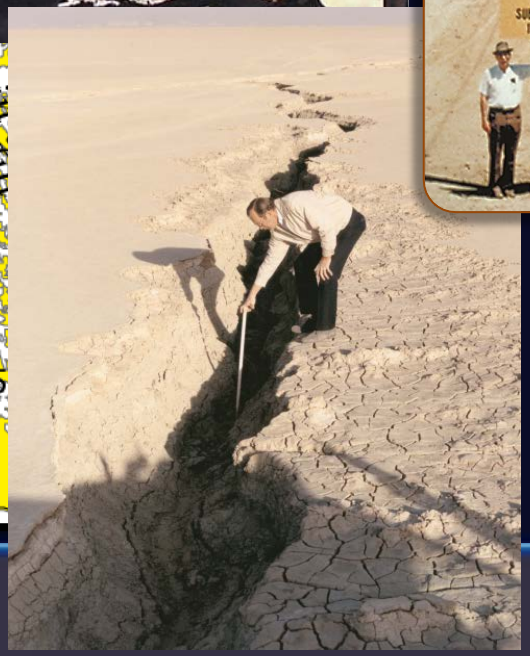
Land subsidence from groundwater withdrawal

Compaction of fine-grained materials in the aquifer system can occur when water levels exceed previous lows.

This causes deformation at land surface, and damages infrastructure.







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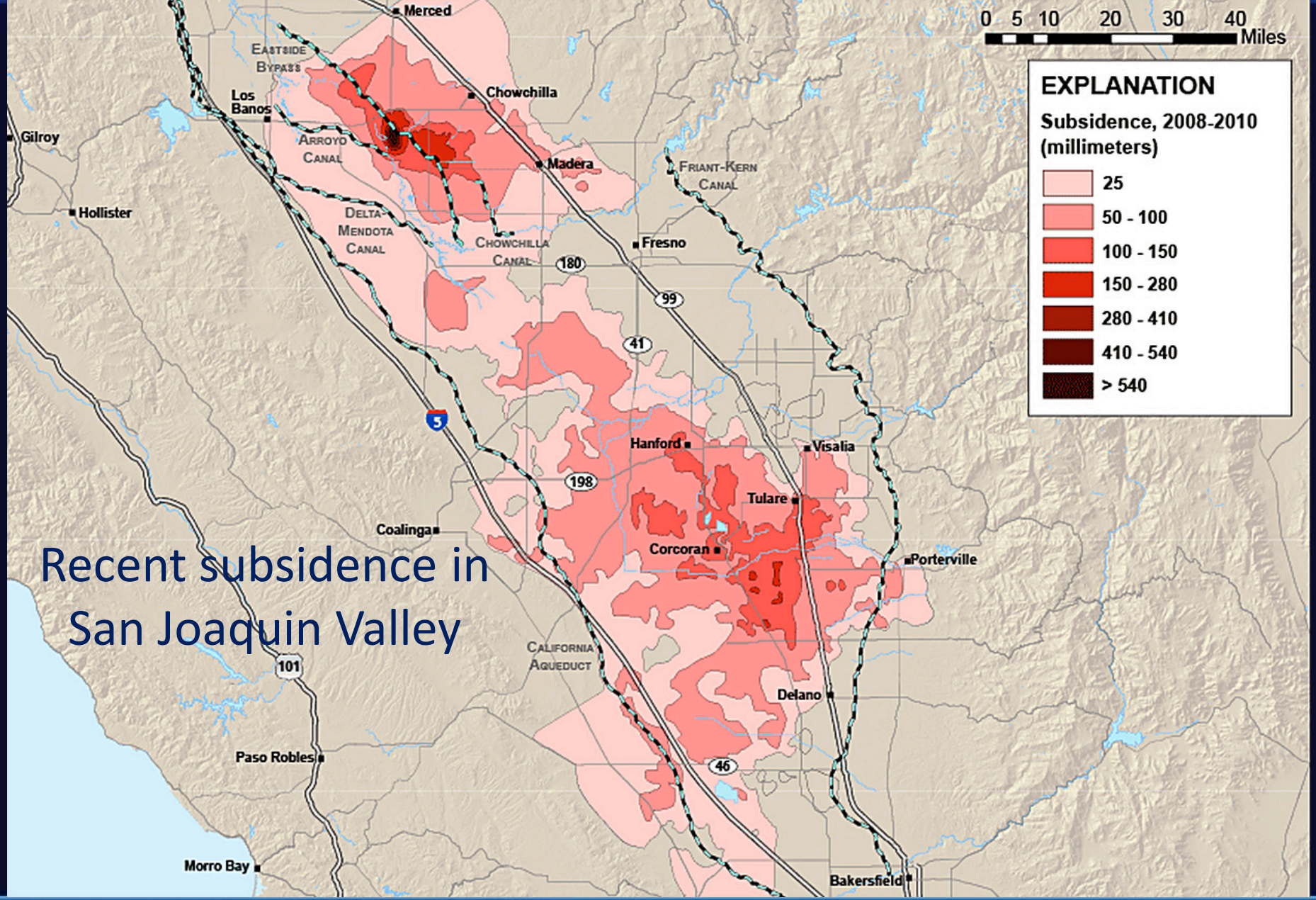

Recent subsidence in San Joaquin Valley

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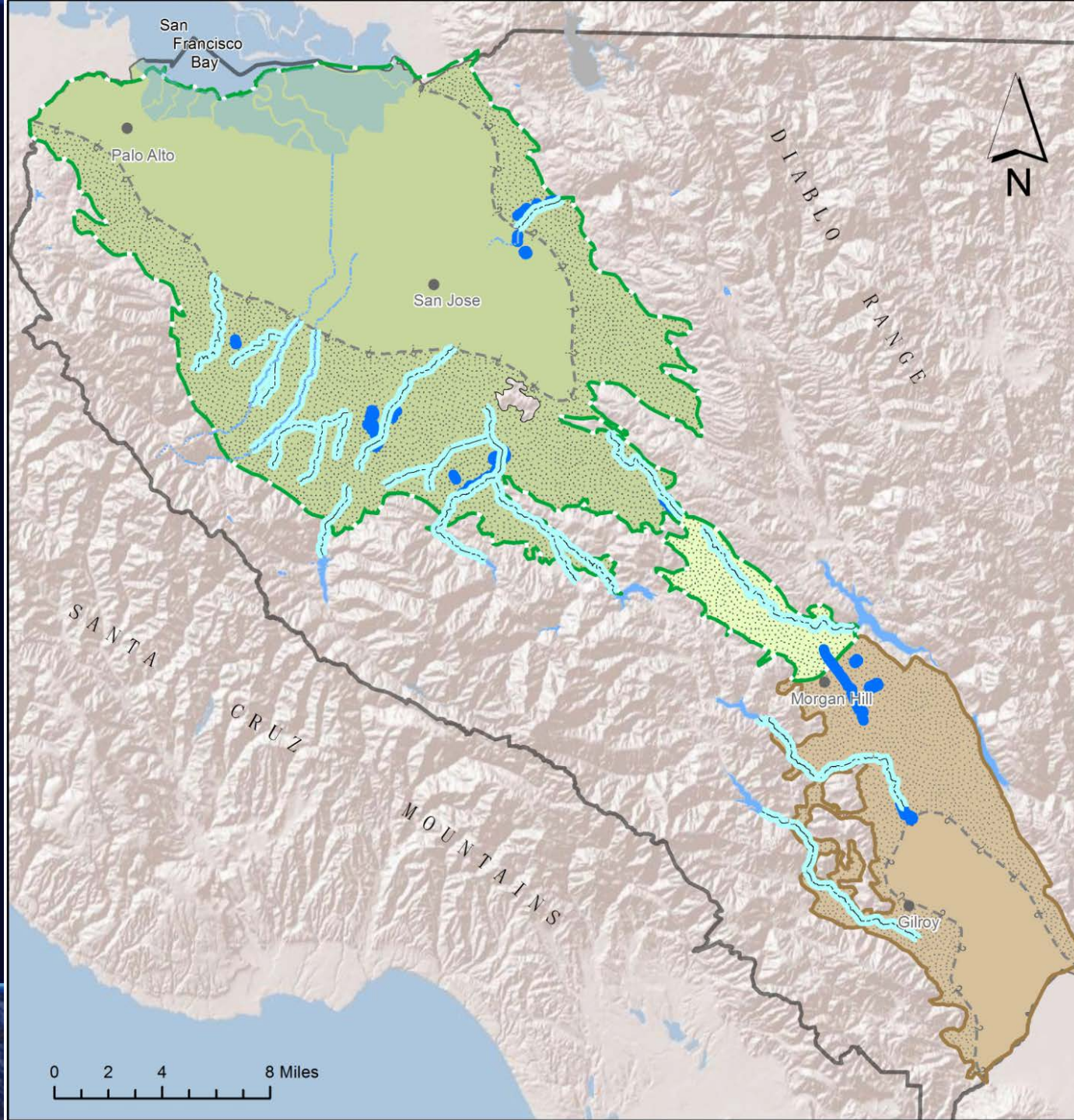
Managing land subsidence

Example: Santa Clara Valley WD

Successful subsidence abatement using managed aquifer recharge



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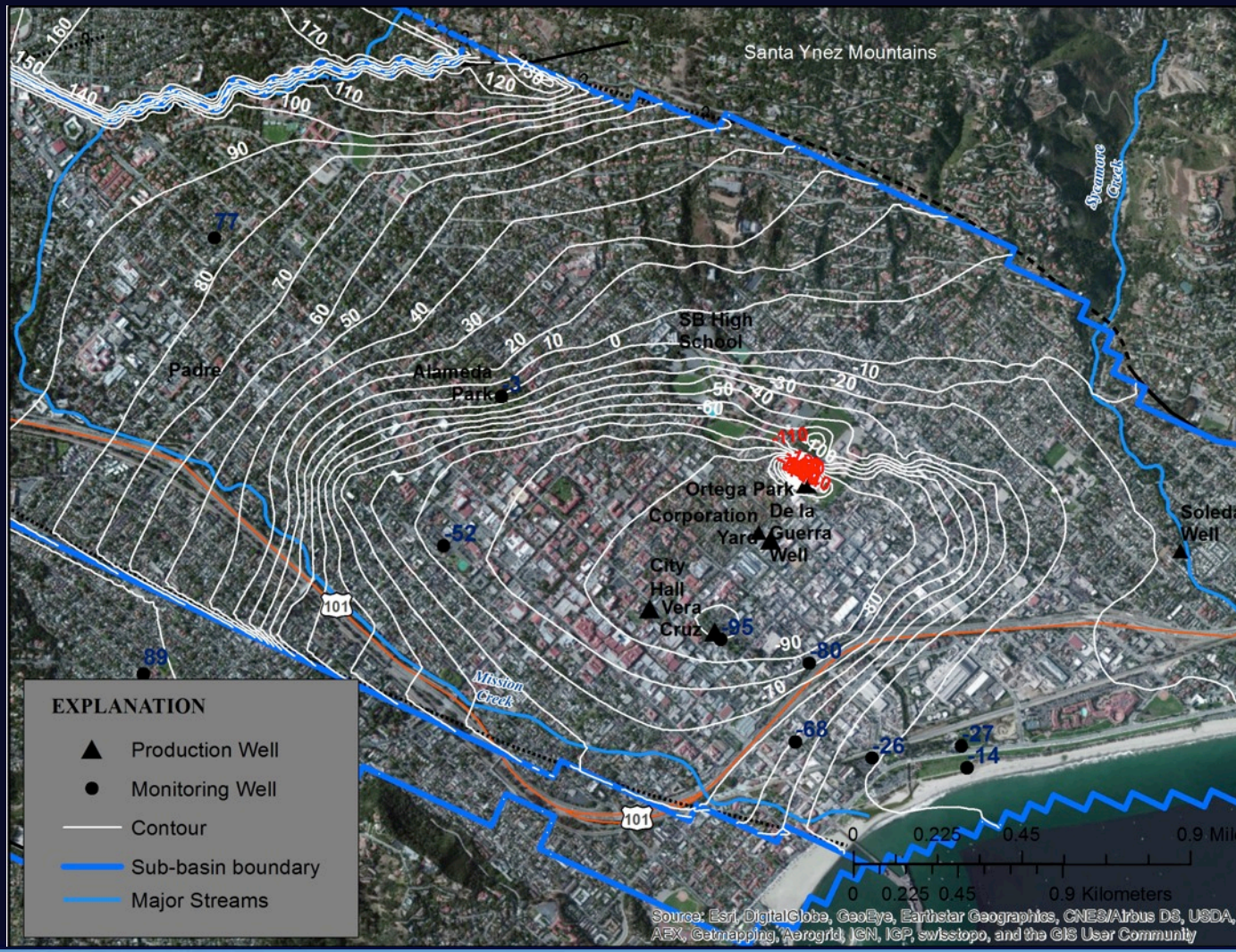
Seawater intrusion

Example: Santa Barbara

Water-levels below sea level at shoreline

This draws seawater toward the aquifer

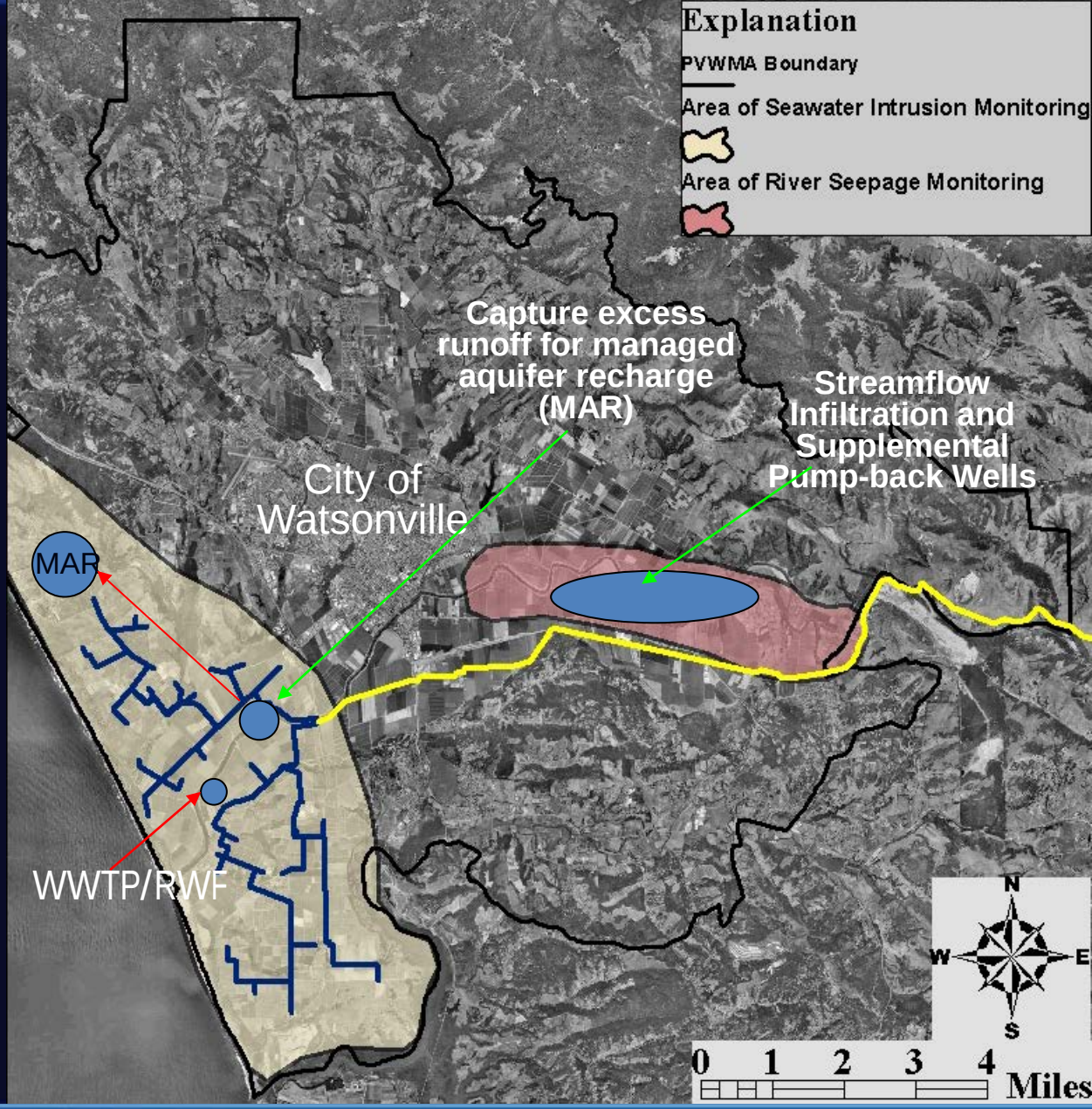


Managing seawater intrusion

Pajaro Valley WMA Management actions:

- Coastal delivery system
- Managed aquifer recharge
- Wastewater treatment

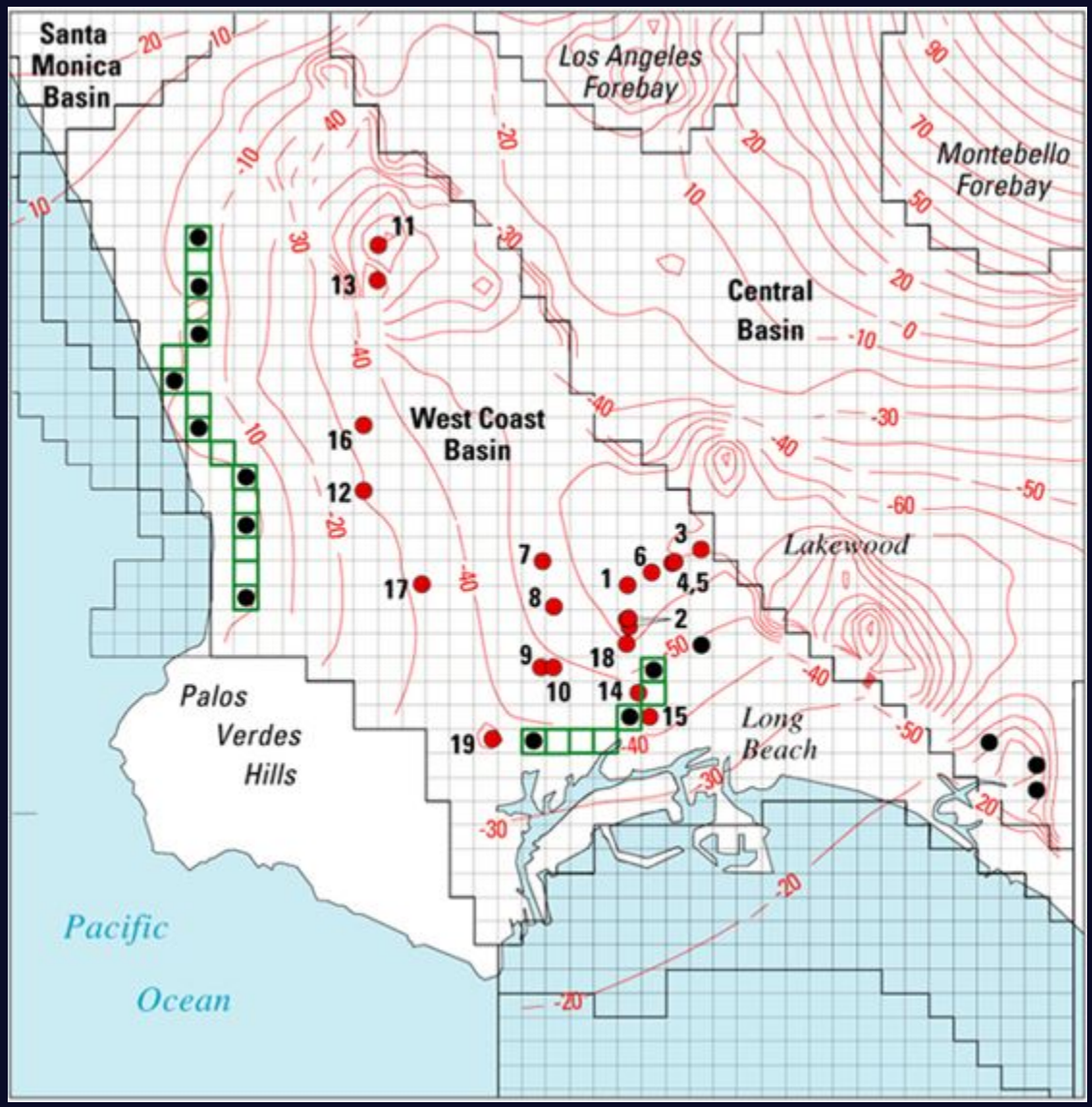
Modeling helped to evaluate effectiveness of actions, and to target other actions.



Managing seawater intrusion

Injection barriers in Los Angeles and Orange County have been very effective

Modeling in LA basin helped with injection barrier/well design

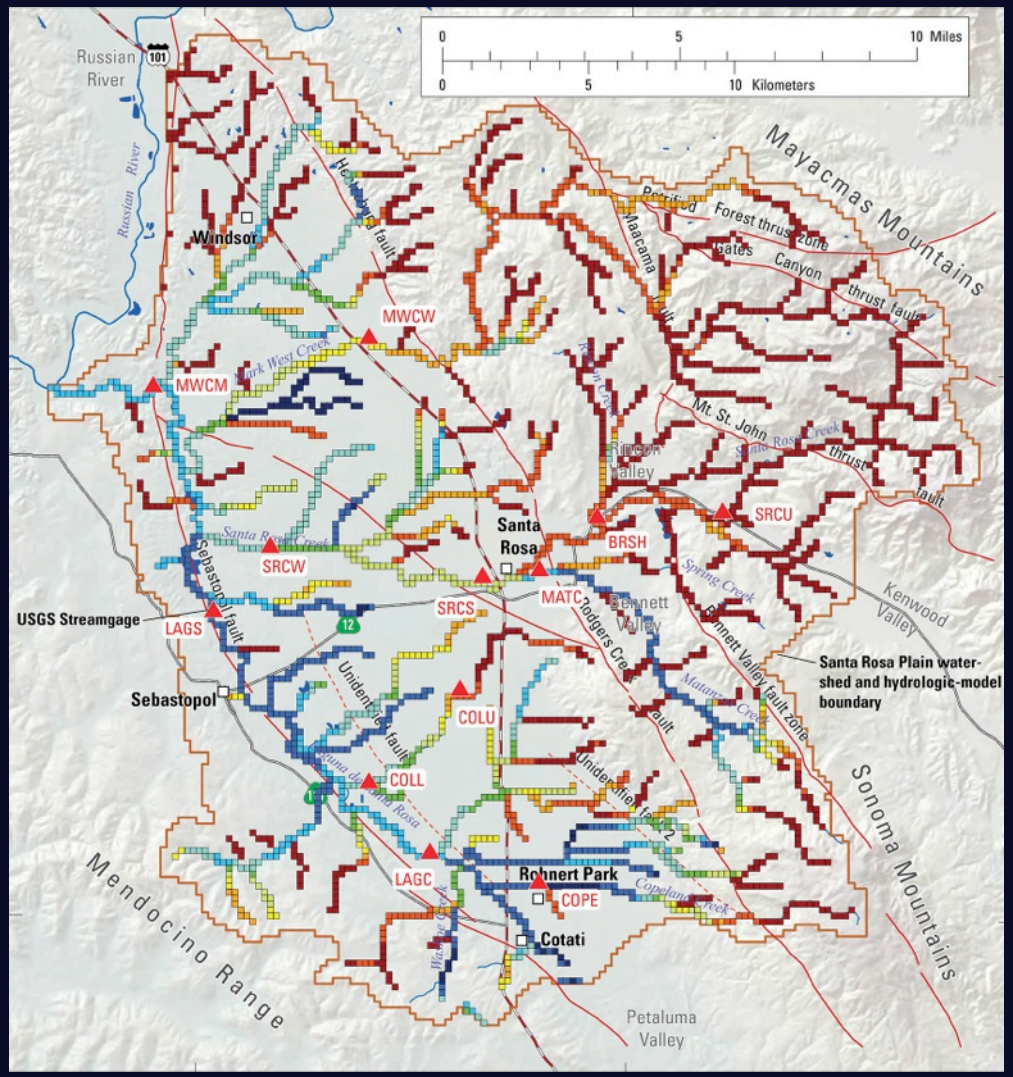


Streamflow depletion

Groundwater and surface water interact, 1-way or 2-way

Example: Santa Rosa Plain, Sonoma Co. WA

Modeling was used to estimate changes in streamflow with climate change, etc.



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Thank you!
Questions?
Contact Steve Phillips for more information:
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