



Components of the Hydrogeologic Conceptual Model of the Vina Subbasin

Technical Webinar-Preliminary Basin Setting Results
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Hydrogeologic Conceptual Model (HCM) Fundamentally:

Provides an understanding of the general physical characteristics related to regional hydrology, land use, geology and geologic structure, water quality, principal aquifers, and principal aquitards of the Basin Setting

Provides the context to develop water budgets, mathematical models (ex. Butte Basin Groundwater Model), and monitoring networks

Excerpt from Hydrogeologic Conceptual Model BMP

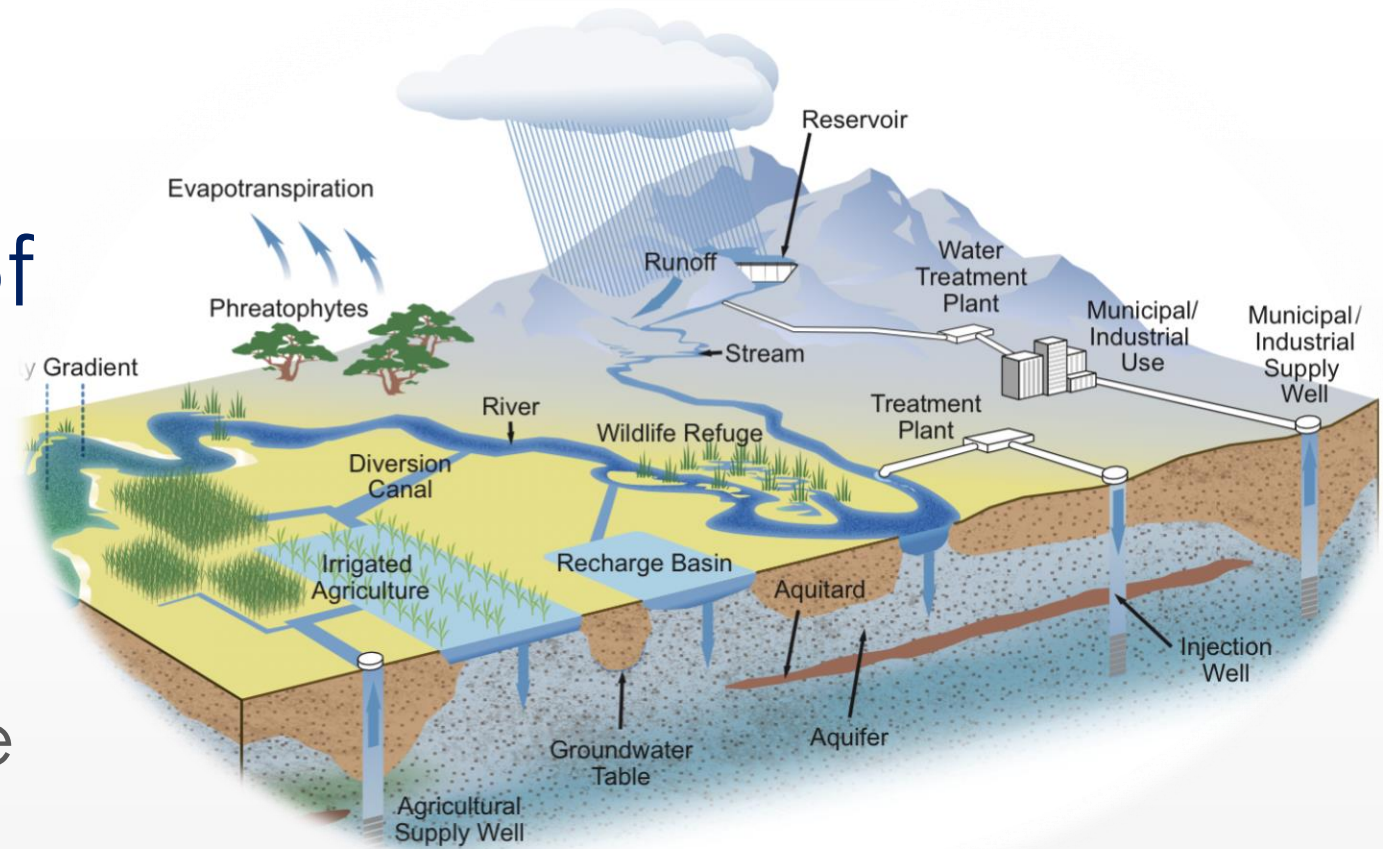
https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_HCM_Final_2016-12-23.pdf

HCM Components

- Graphical and narrative description of the physical components of the basin
- At least two scaled cross-sections
- Map(s) of physical characteristics
 - Topographic information
 - Surficial geology
 - Soil characteristics
 - Delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas
 - Surface water bodies
 - Source and point of delivery for local and imported water supplies

**How does water get INTO
the Vina subbasin?
How does it get OUT?**

Physical Characteristics of the Landscape



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Irrigated agriculture

City of Chico

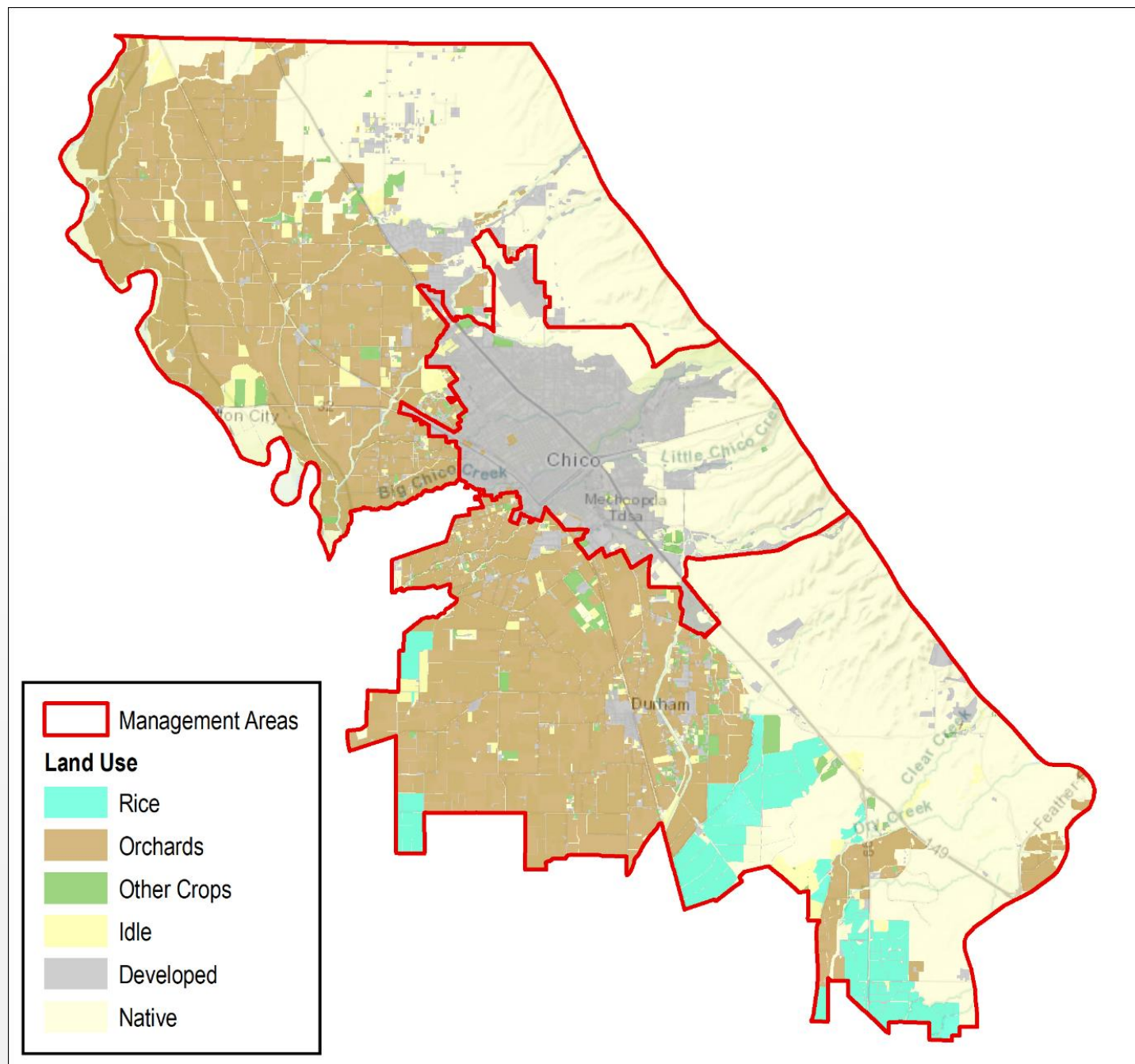
Rural residential (ex. Durham)

Major River: Sacramento River

Creeks and Streams (ex. Butte Creek, Big Chico Creek)

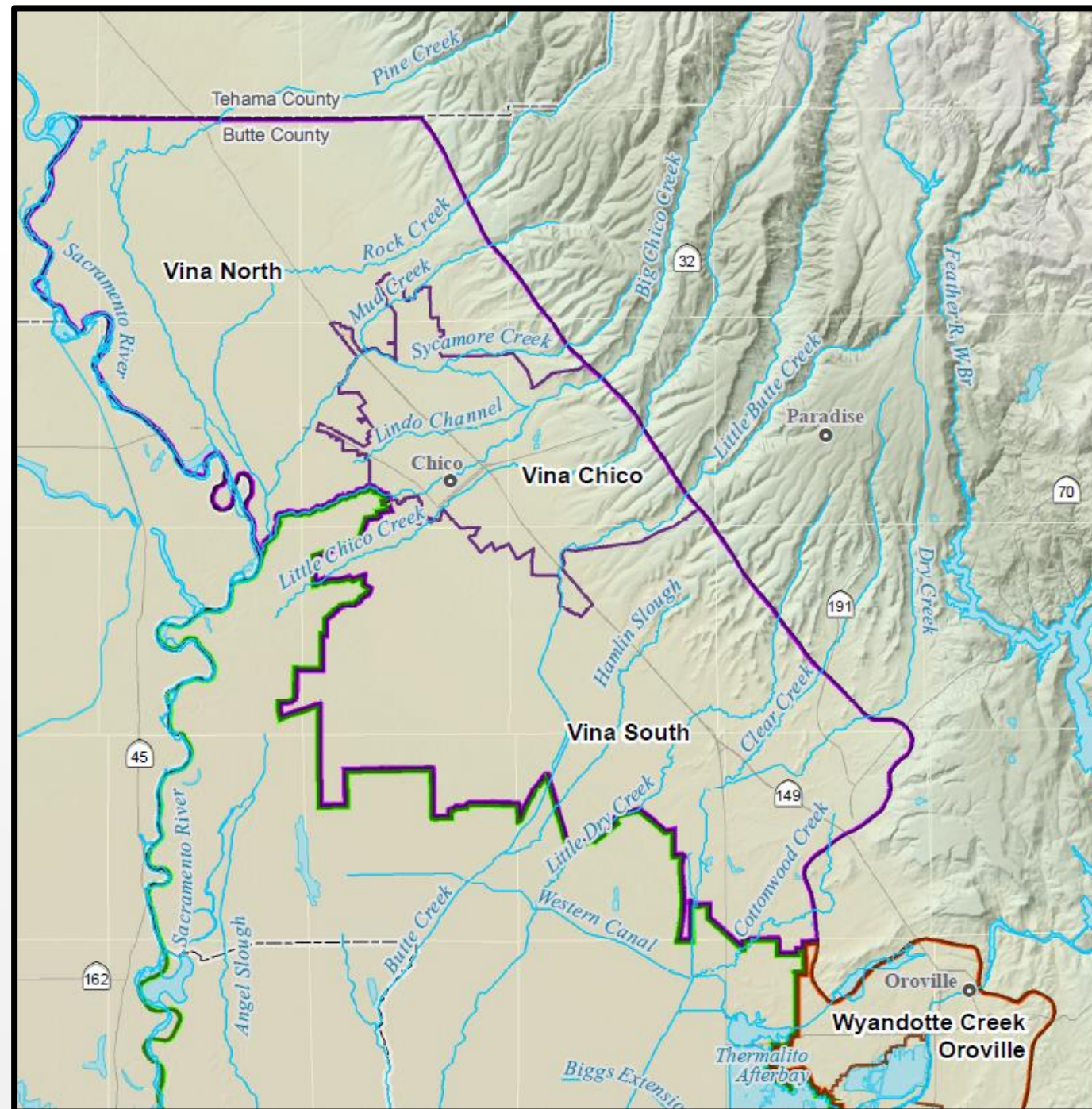
Riparian areas and ecosystems

Land Use



Surface Water Hydrology

- Sacramento River
- Butte Creek
- Big Chico Creek
- Pine Creek, Rock Creek, Lindo Channel, Hamlin Slough, Little Dry Creek, Clear Creek and others










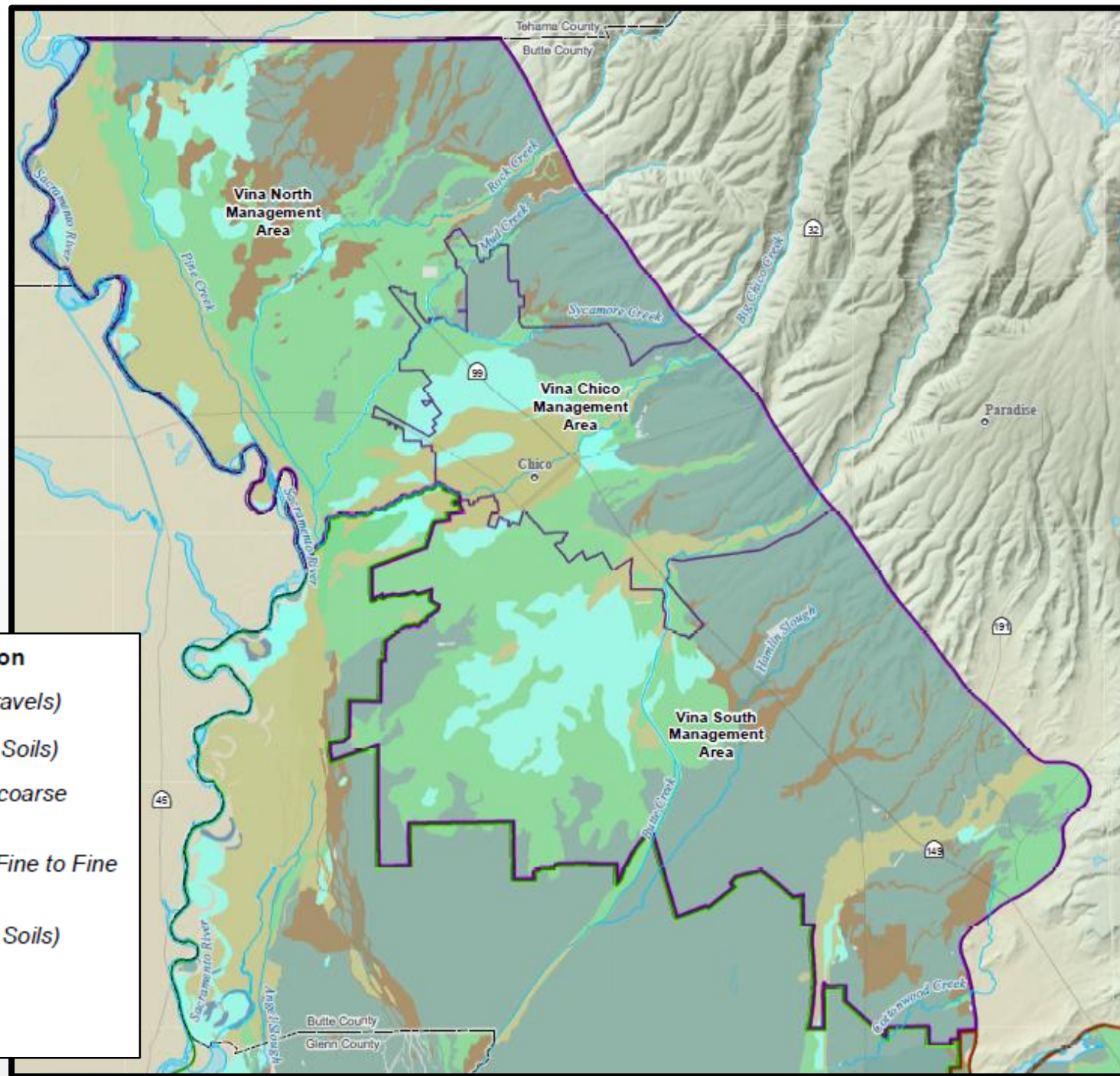
Soils

Soil Characteristics
Affect:

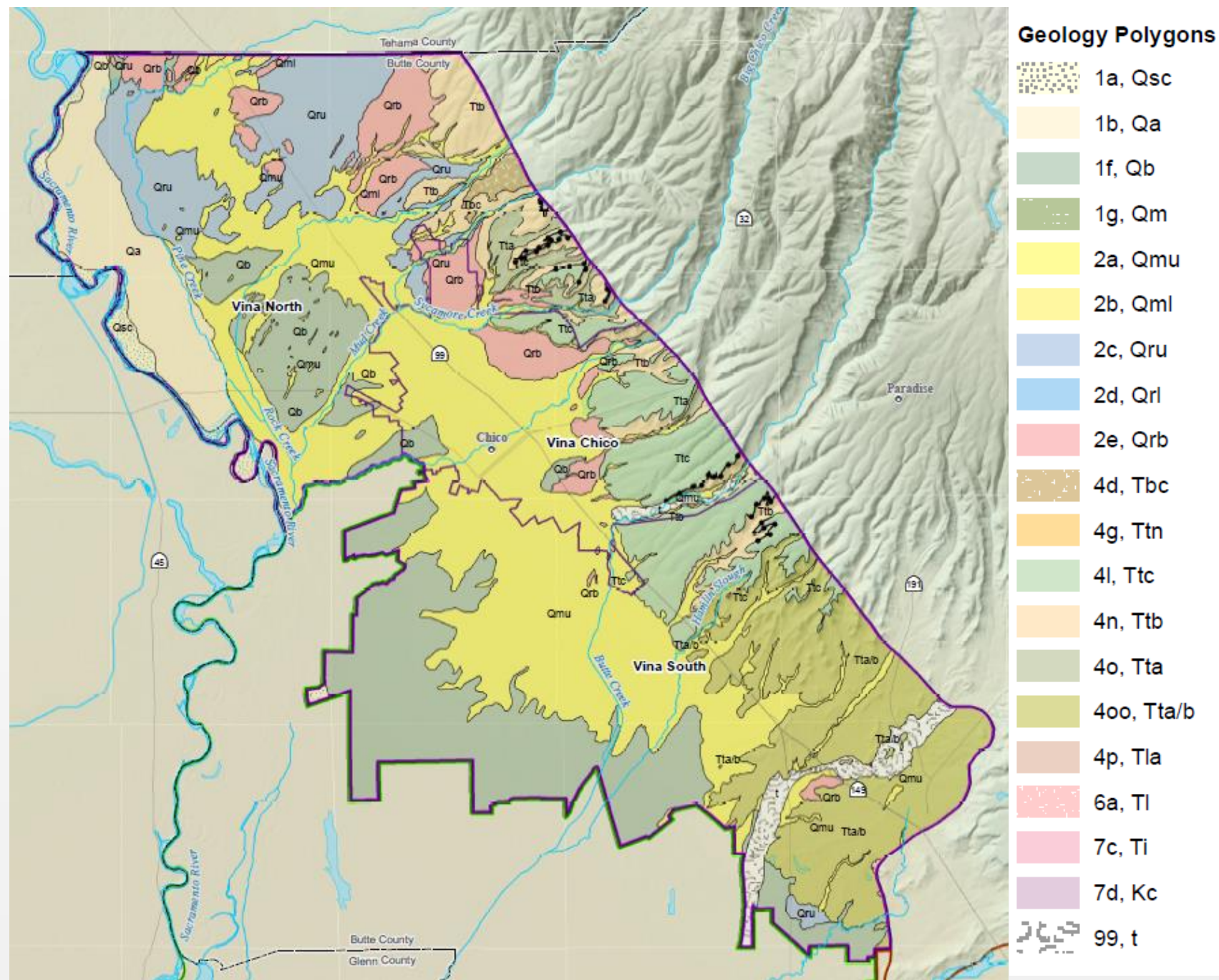
- Land Use: what crops are grown where
- Recharge (percolation rates)

Hydrologic Group - Dominant Condition

	A - High Infiltration (Sands or Gravels)
	A/D - Very Slow Infiltration (Clay Soils)
	B - Moderate Infiltration (Fine to coarse Soils)
	C - Slow Infiltration (Moderately Fine to Fine Soils)
	C/D - Very Slow Infiltration (Clay Soils)
	D - Very Slow Infiltration
	No Data

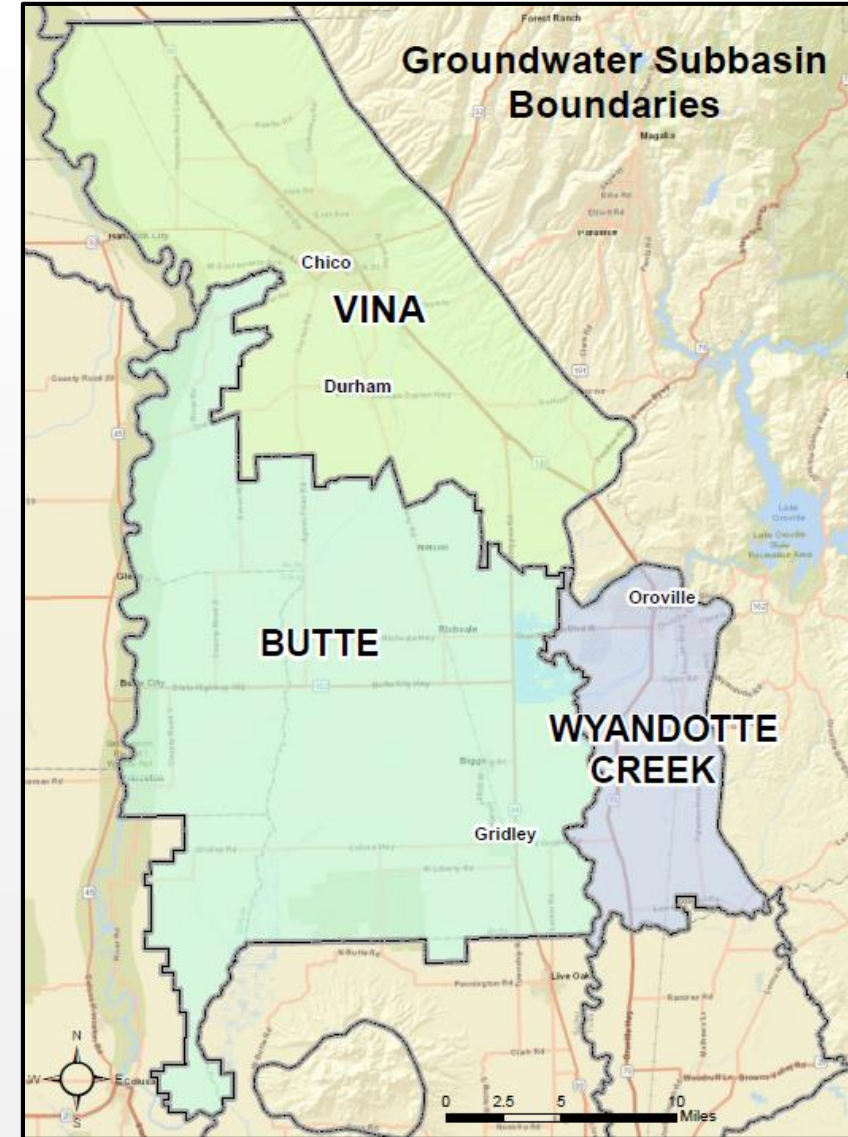


Surficial Geology



How does water get INTO the Vina Subbasin?

- **Groundwater Recharge:** Downward flow of water reaching the water table
 - Difficult to directly measure and to estimate. Inherent uncertainty in any method
 - Best to use multiple lines of evidence to understand and estimate recharge
- Potential water sources include:
 - Precipitation
 - Applied water for irrigation
 - Rivers/Creeks/Streams
- **Subsurface Groundwater Flow**



Potential Recharge Processes

- **Over a broad area**
 - Precipitation, irrigation (i.e. applied water)



Potential Recharge Processes

- **Over a broad area**
 - Precipitation, irrigation (i.e. applied water)
- **At a specific location**
 - Rivers, streams, bodies of water
- **Managed aquifer recharge**
 - Ponding, field flooding, In-lieu

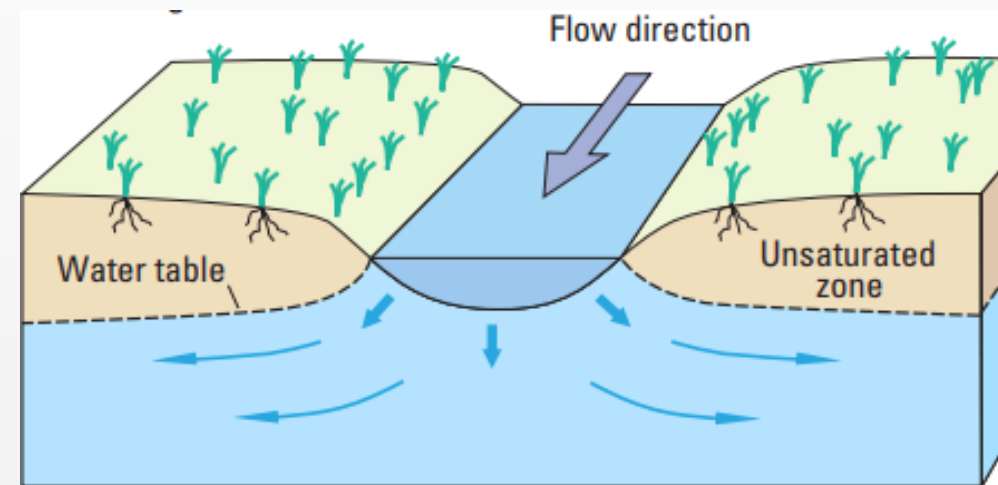


Image Credit: USGS Circular 1376

Dependent on the connectivity to the aquifer system

Recharge is Dependent on Aquifer Characteristics

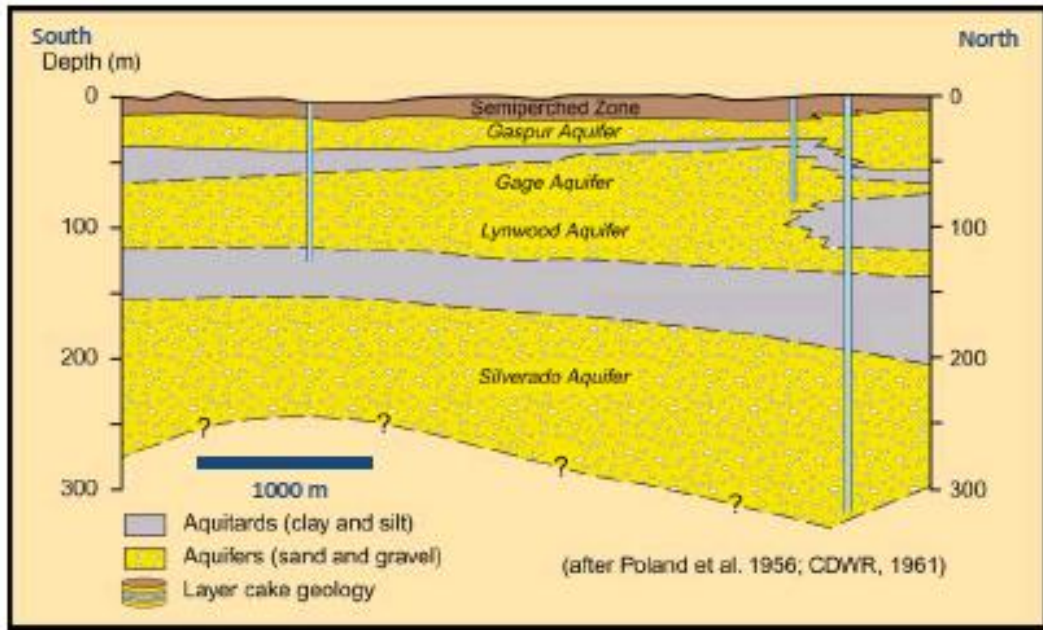


Image Credit: Rick Cramer, Burns & McDonnell

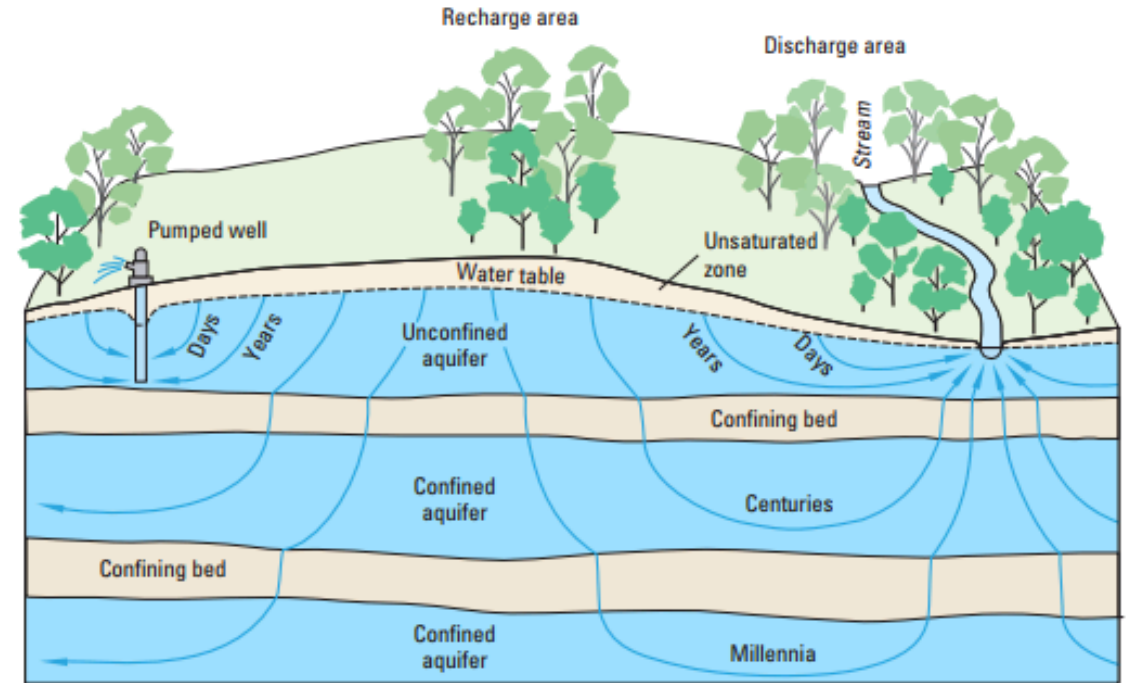
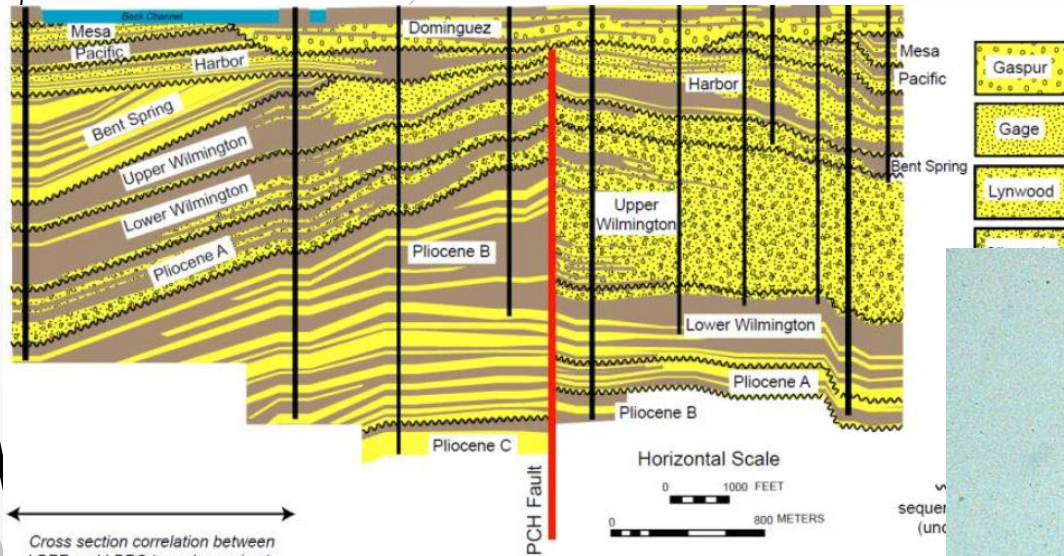


Image Credit: USGS Circular 1376

“Layer Cake” aquifer stratigraphy depict continuous layers

Recharge is Dependent on Aquifer Characteristics



From Ehman and Edwards (2014)

Image Credit: Rick Cramer, Burns & McDonnell

BETTER Visual for Sacramento Valley Groundwater System:

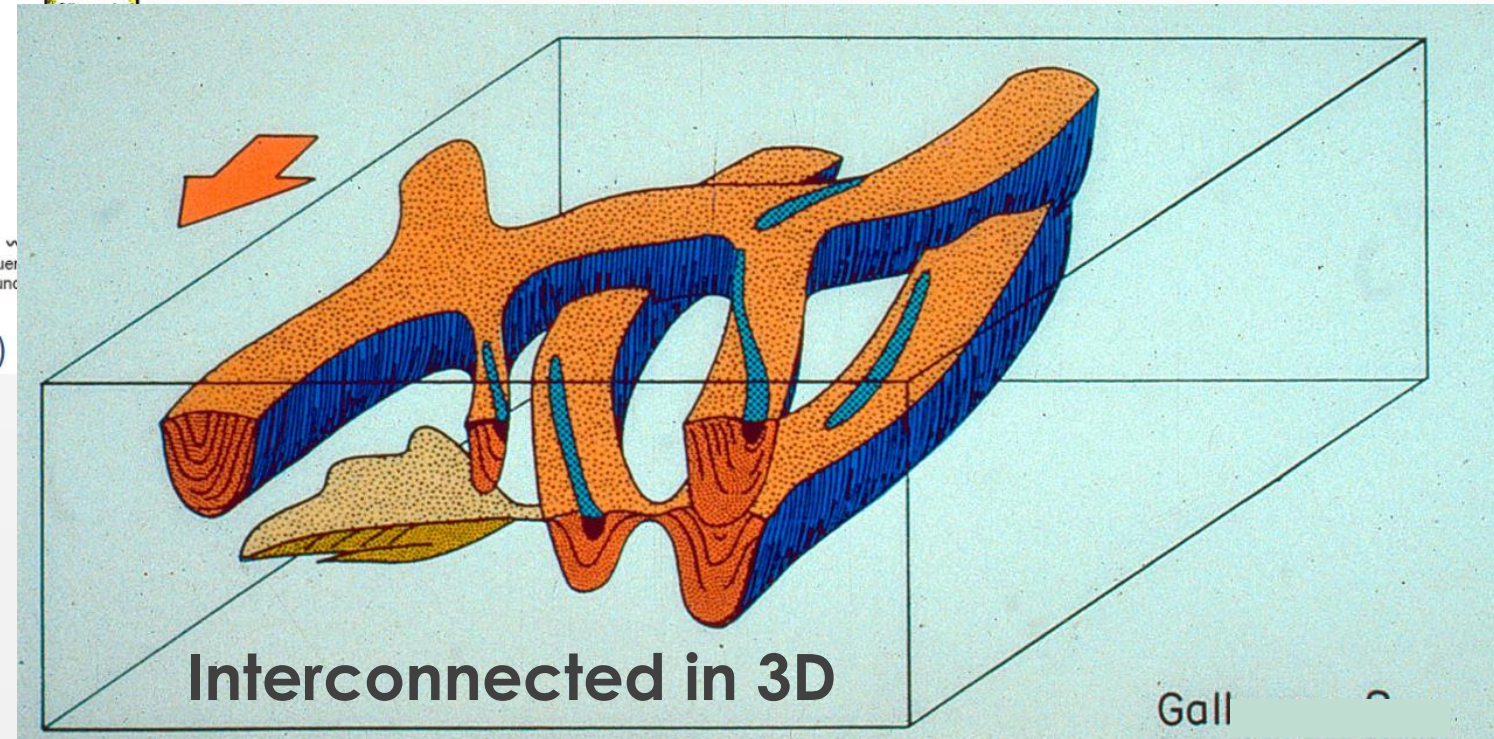
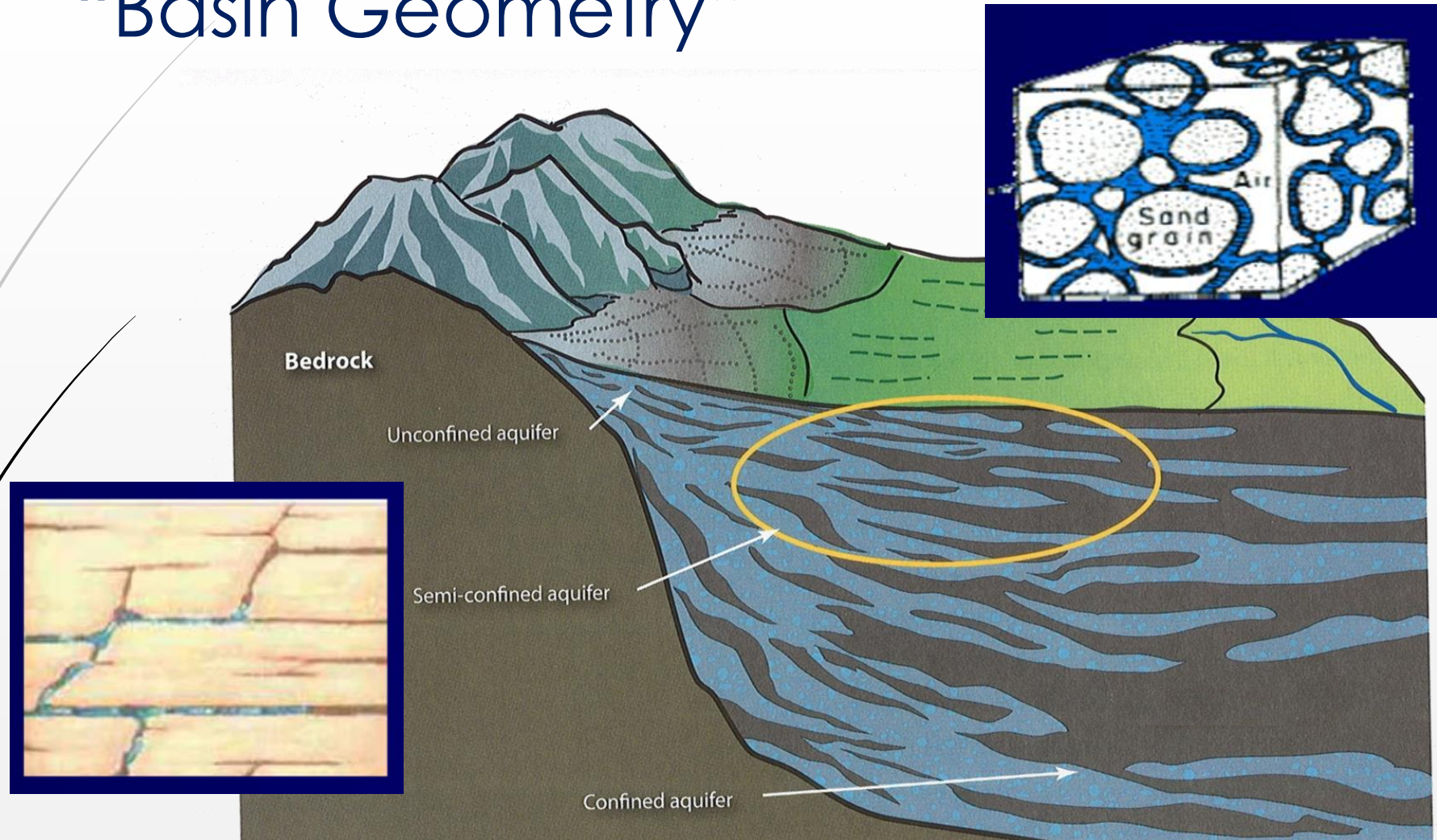


Image Credit: Galloway & Hobday

Diving In Below the Ground Surface...

“Basin Geometry”



Multiple Studies to Better Understand Butte County Groundwater

- Lower Tuscan Aquifer Investigation, 2013
- Stable Isotope Recharge Study, 2017
- Airborne Electromagnetic (AEM) Survey, ongoing
- Water Budget Development, ongoing
 - Water Inventory & Analysis Report, 2016
- Groundwater Level Monitoring, ongoing

Lower Tuscan Aquifer Investigation, 2013

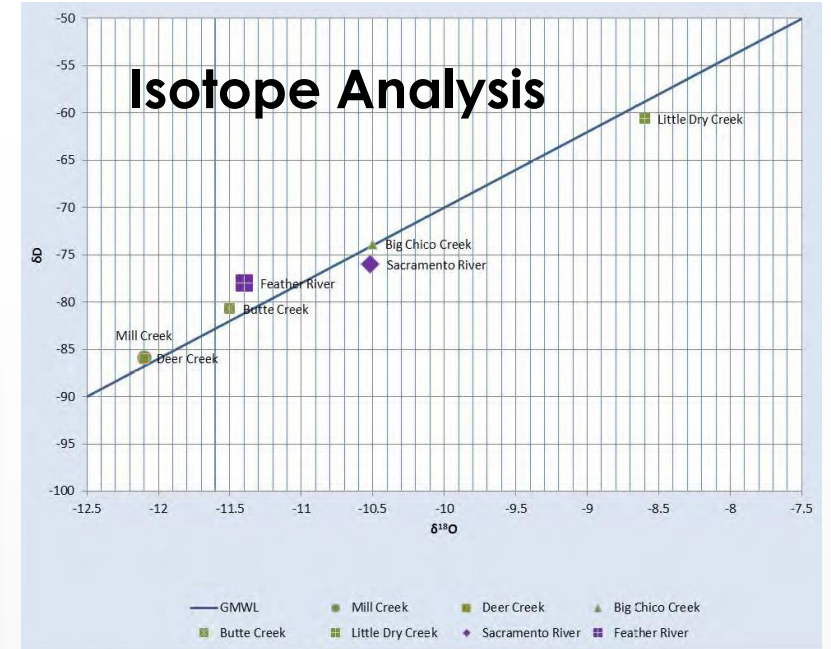
New Monitoring Wells



Infiltration



Isotope Analysis



Measuring Stream Flow

What We Learned

- Recharge from streams crossing Tuscan outcrop in canyon reaches is minimal or at least comparatively small
 - Likely broad areal recharge is dominant in Tuscan outcrop area
- Significant recharge potential of shallow alluvial aquifer to deeper Tuscan Formation aquifer materials
 - Vertically connected? How and where?
- Tuscan Formation characteristics variable
- Significant leakage through aquitards separating other aquifer zones
- Recommendations for future studies
 - More stable isotope sampling and analysis



Stable Isotope Recharge Project

Background:

- Stable Isotopes of Oxygen and Hydrogen

Naturally occurring components of water that can be used to identify likely sources of groundwater recharge

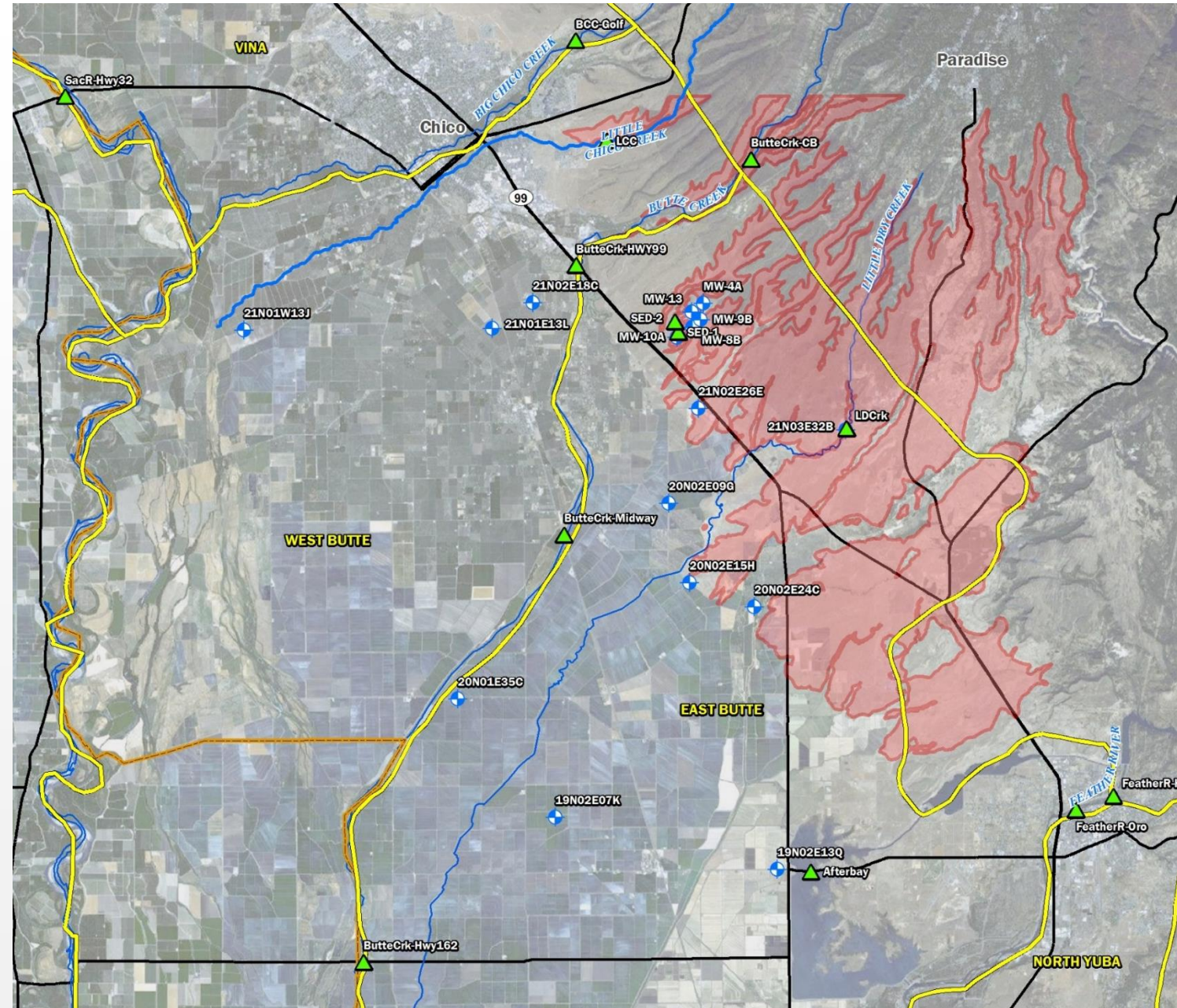
- Primary study goal

to develop a better understanding of overall recharge mechanisms and sources in general area of Butte Creek

Stable Isotope Recharge Project

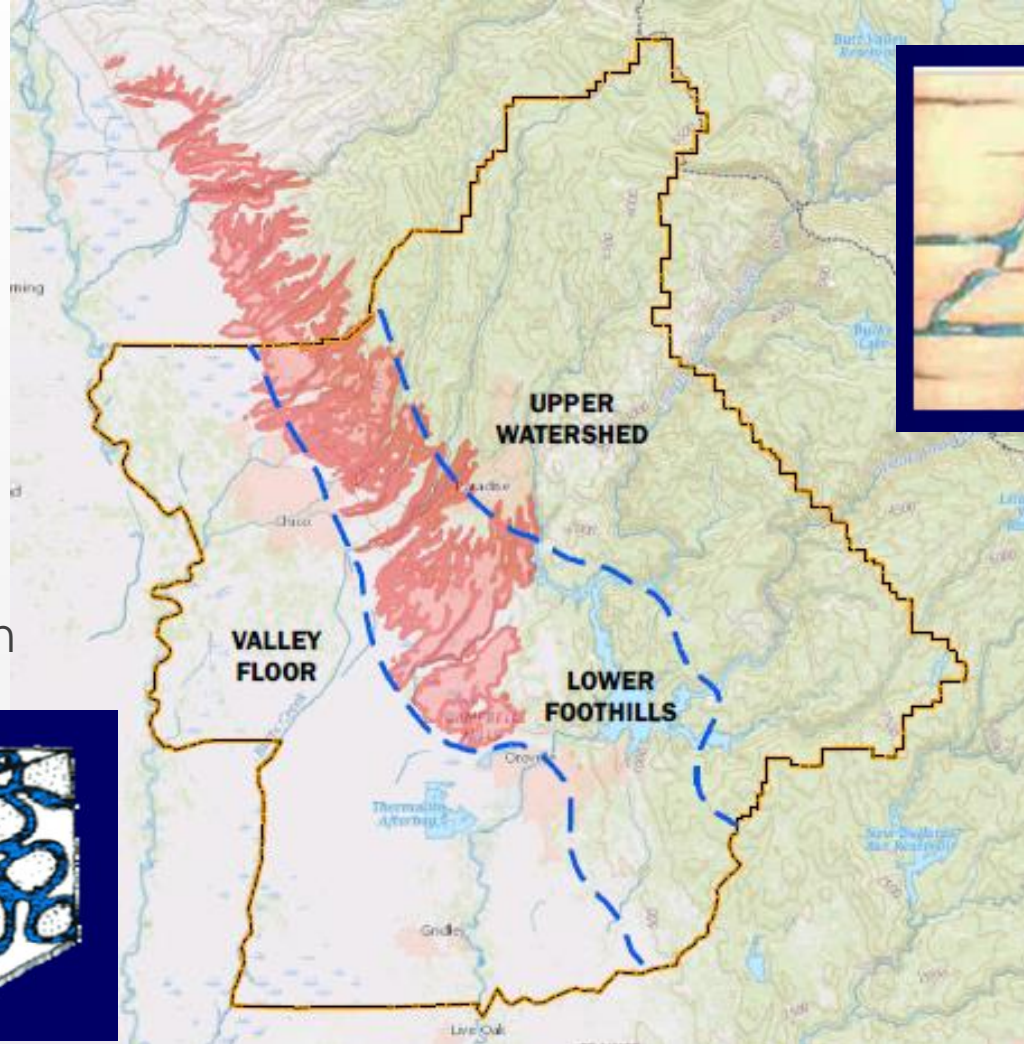
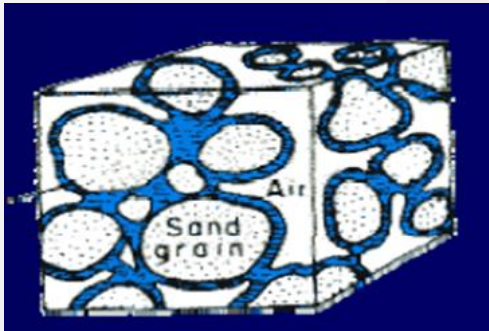
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Surface Water & Groundwater Samples



Recharge Water **Source** Regions

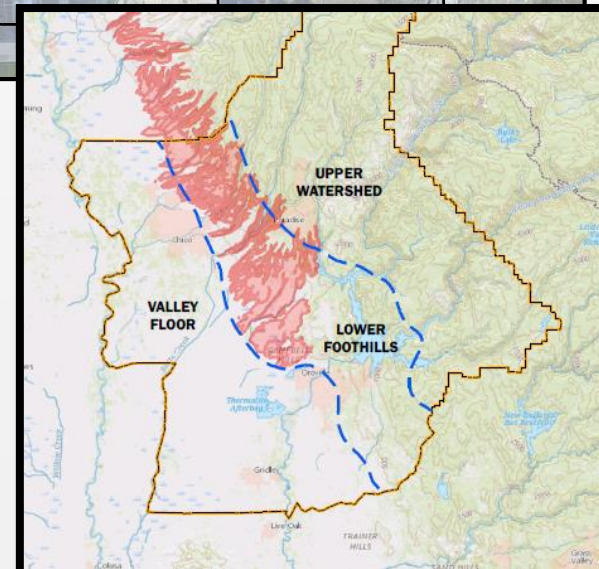
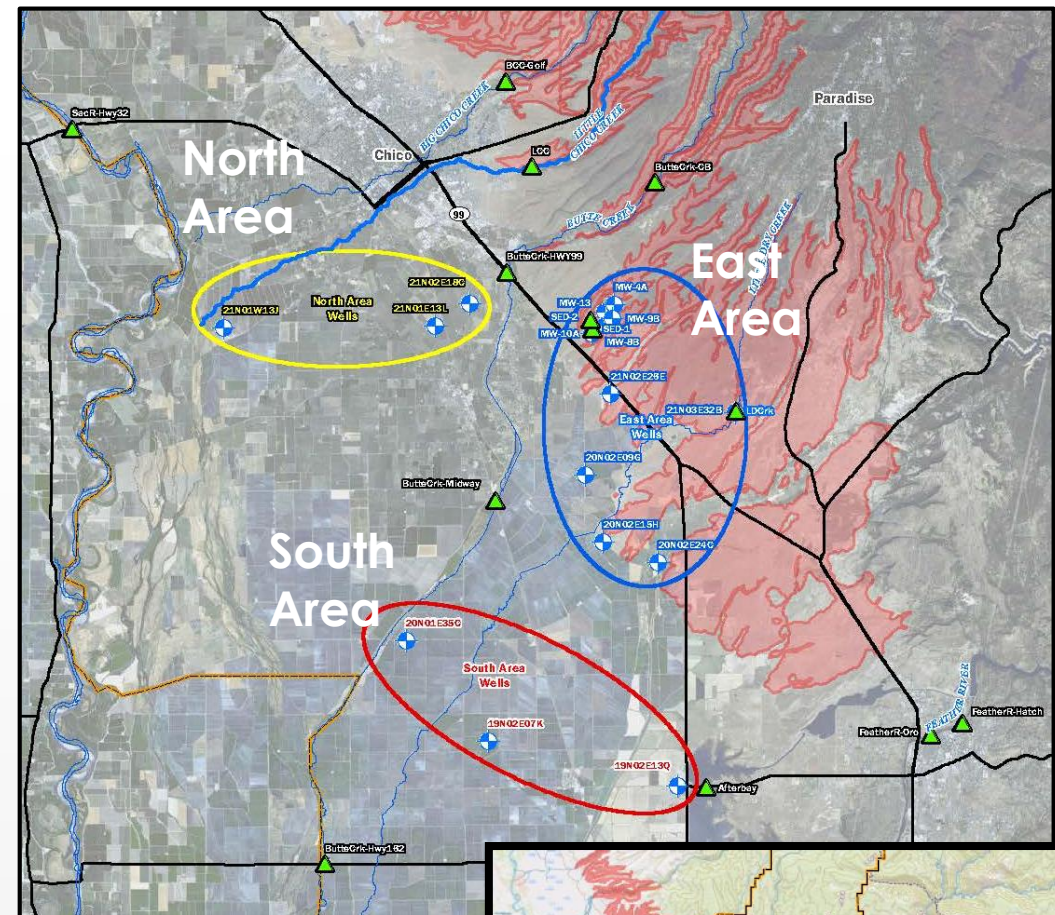
Groundwater Basin



Fractured Rock

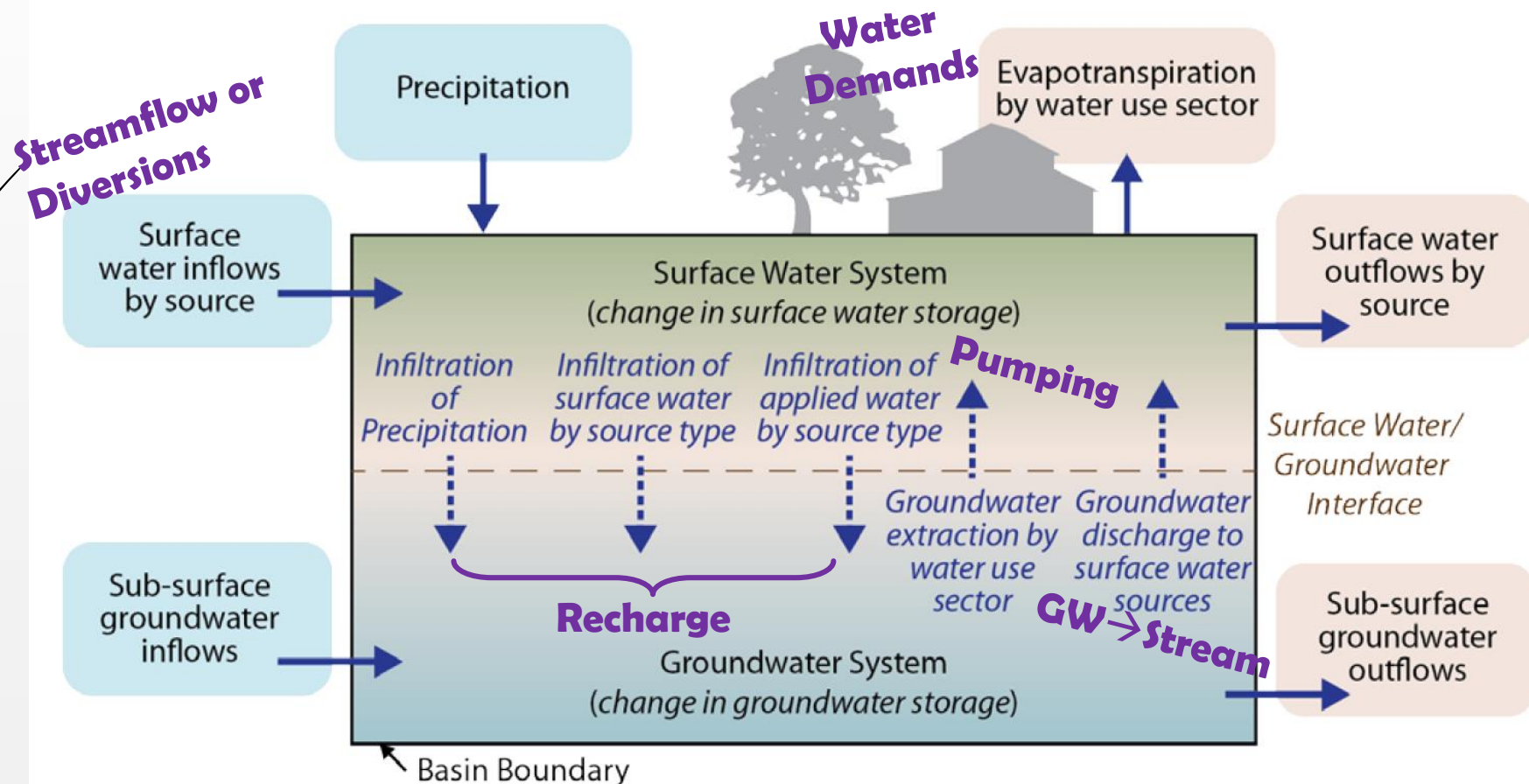
What We Learned

- There is no single source of groundwater recharge throughout Butte County.
- Different parts of the basin are recharged from different sources:
- Butte Creek, Sacramento River important recharge sources to upper portions of the basin (<400 ft) in their vicinity. Pumping may cause some mixing to deeper depths
- Rainfall on Lower Foothills and Valley Floor important recharge source to all depth intervals in the East and South areas
 - Specifics of how and where recharge occurs is unknown.
- Evidence of irrigation water recharging only the shallowest portion (<100 ft) of the groundwater system in the South area



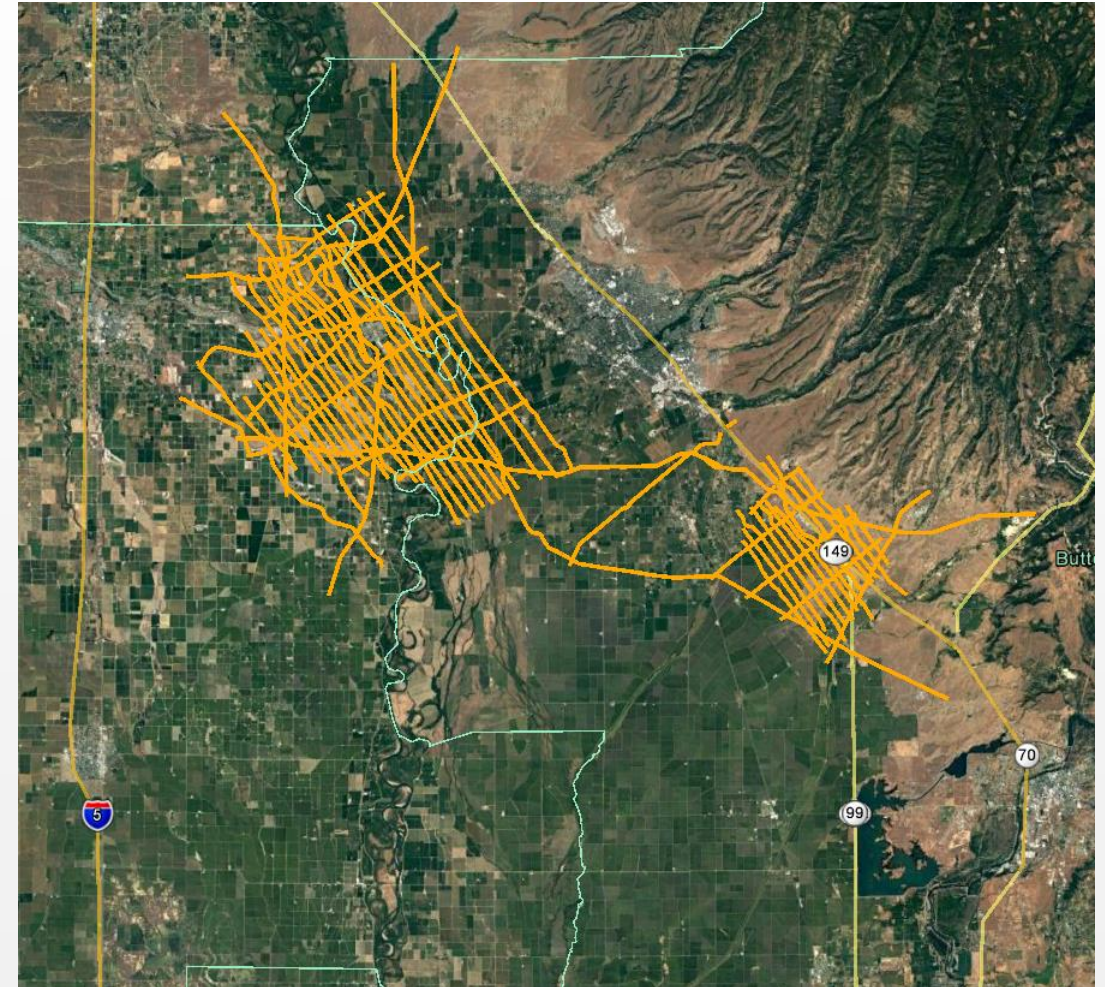
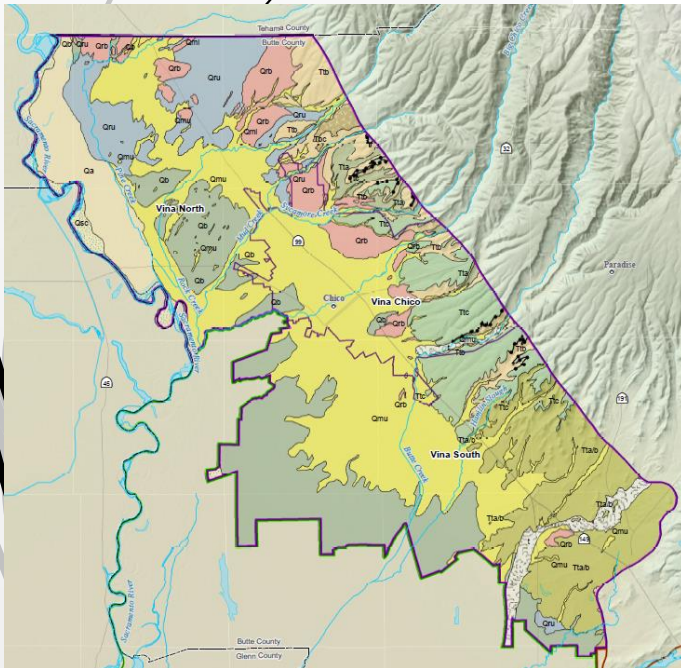
Water Budgets Help:

- Estimate contribution and rate of recharge of different recharge sources
- Indicate their relative importance → guide future studies/data collection
- Define the need for managed recharge in different areas



Innovative Technology and Partnerships

Airborne Electromagnetic (AEM) Survey



Characterize stratigraphy and aquifer structure

- Delineate major aquifer and aquitard units to improve geologic conceptual model
- Assess spatial distribution of clay-rich layers. How extensive are they?
- Examine level of connectivity between upper and lower portions of the Tehama/Tuscan aquifer systems
- Identify hydrostratigraphic layers with similar aquifer characteristics (transmissivity, specific yield, boundaries, sw-gw relationships) for use in groundwater model development

How Does Groundwater get OUT of the Vina Subbasin?

- ▶ Groundwater Pumping
- ▶ Subsurface Groundwater Flow (In or Out)
- ▶ Stream-Groundwater Interaction

Well Infrastructure

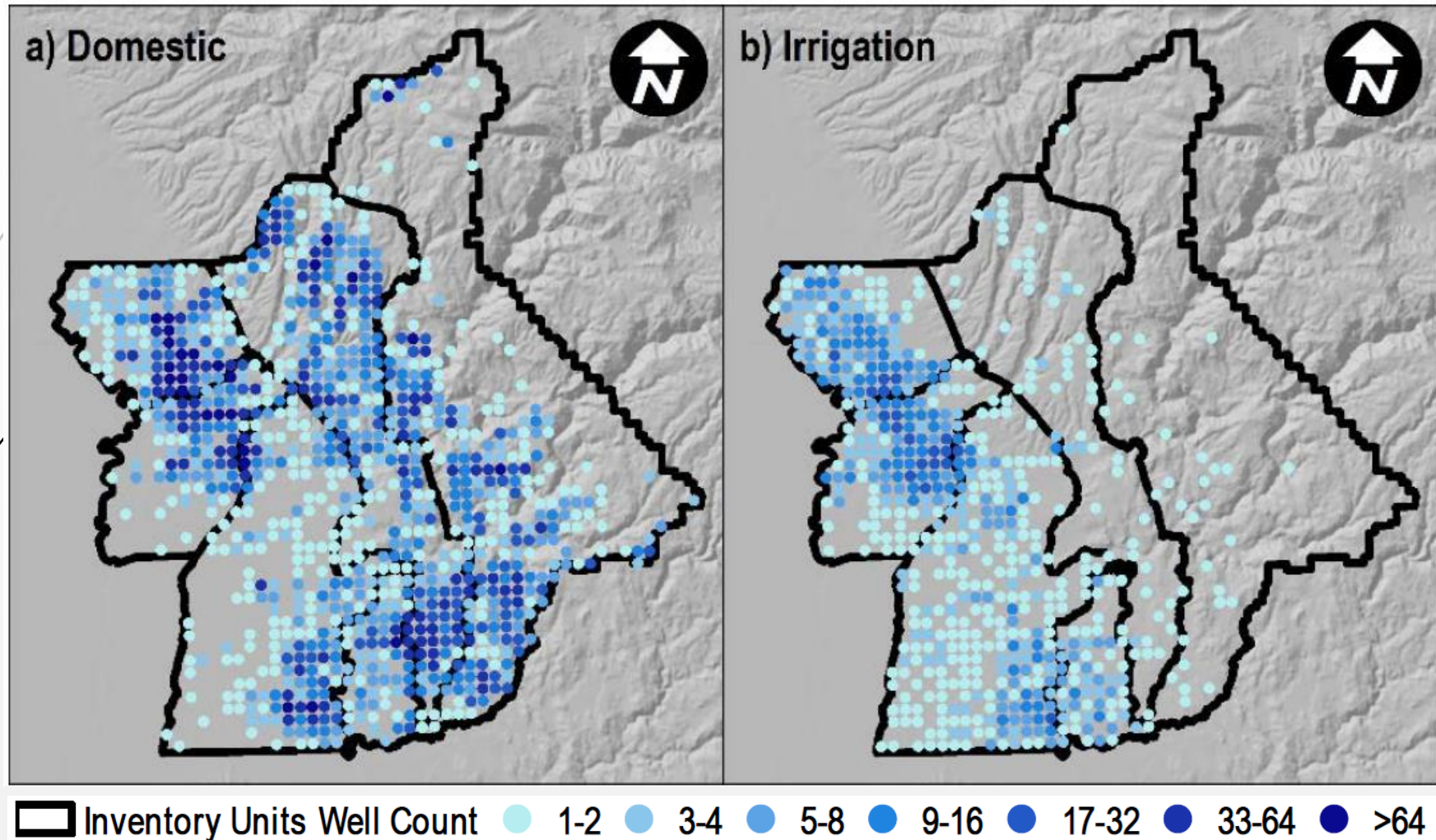
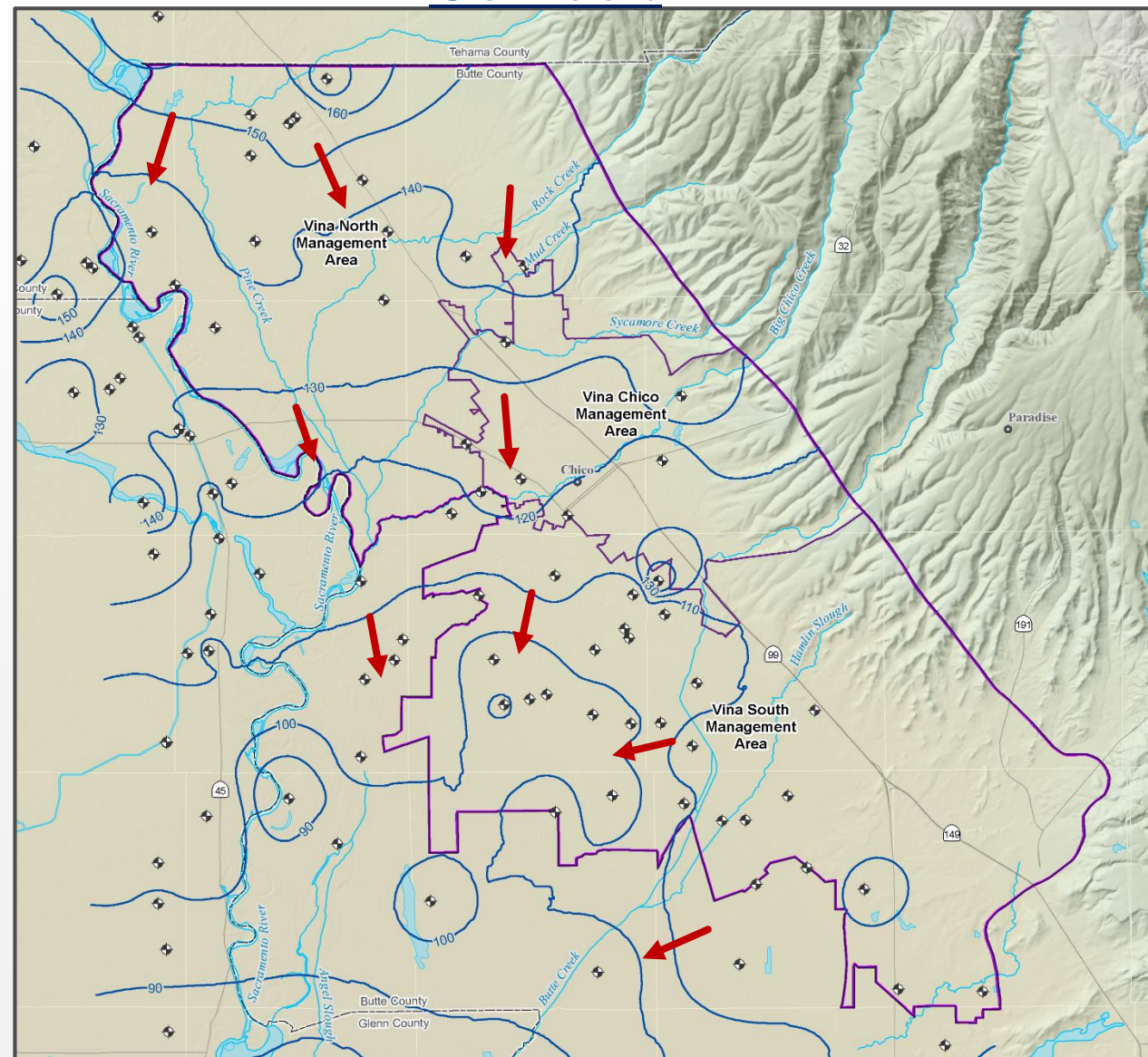


Figure 4.38. Distribution of Wells in Butte County by Type.

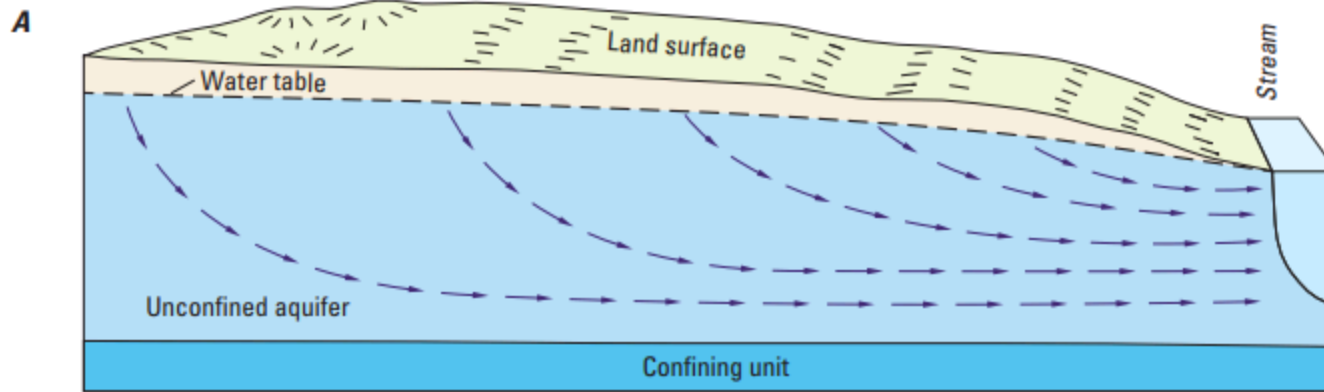
Subsurface Groundwater Flow

- Groundwater flows from “high to low”
- Contour maps of groundwater elevation help estimate direction of flow
- Volume is dependent on aquifer characteristics
- As groundwater levels changes, subsurface flow changes

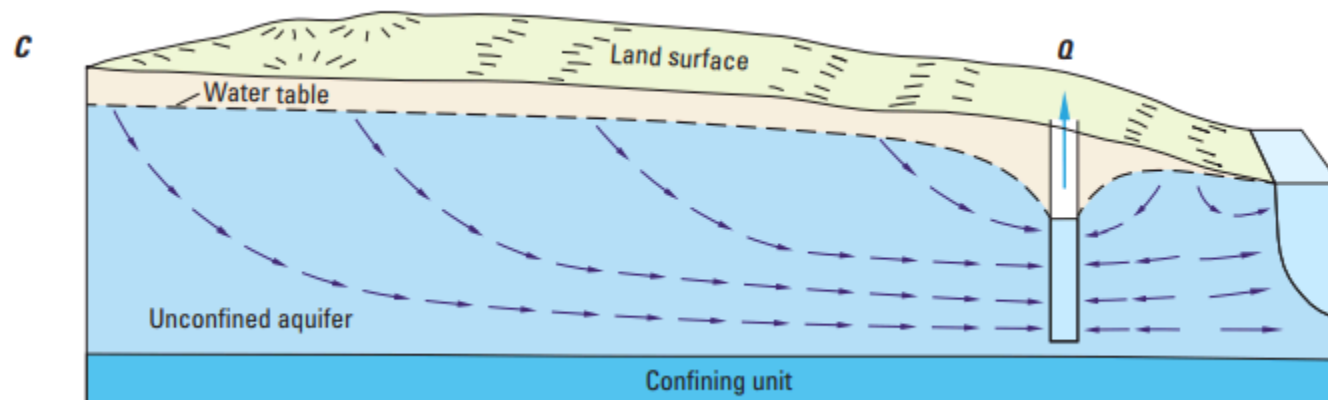
Spring 2019 Groundwater Elevation Contours



Stream-Groundwater Interaction



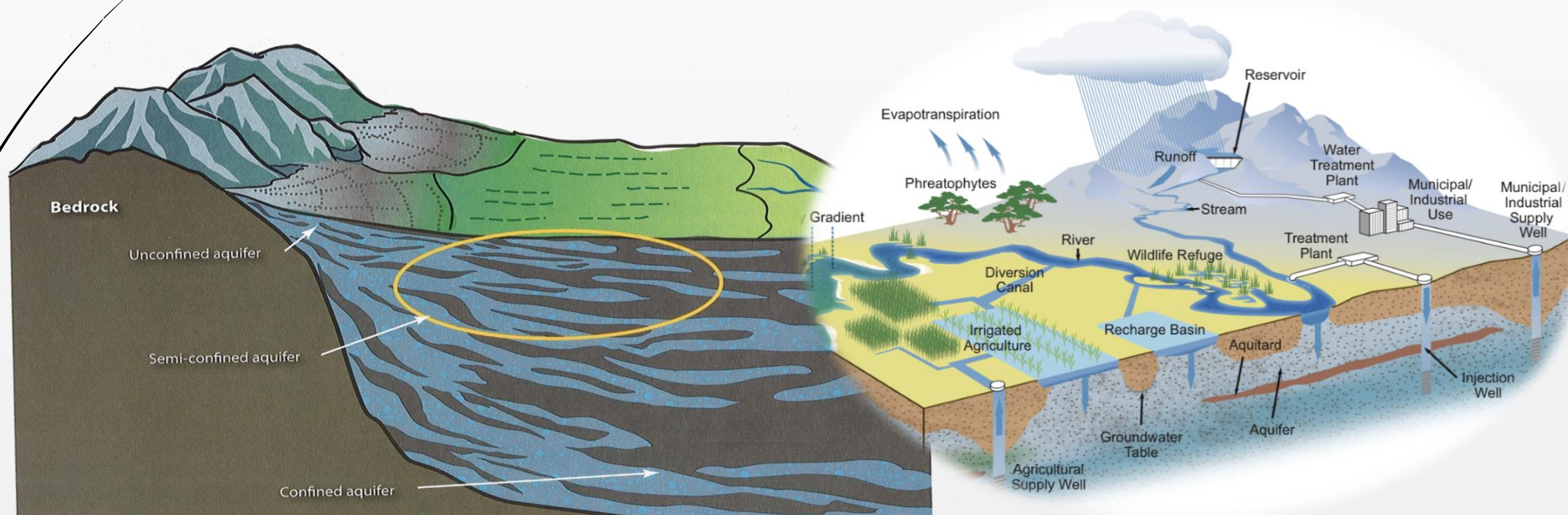
Natural Conditions:
recharge at water table =
discharge at the stream



Pumping: well begins to
“capture” groundwater
that would have gone
to the stream

Summary and Next Steps

- AEM dataset and analysis will be used to better define aquifer systems in the Vina Subbasin and clarify terminology of “shallow, intermediate, deep” zones
- Geologic Cross sections under development





Questions?



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