Groundwater 101

Santa Margarita Basin GSA
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Objective and Outline

Understanding fundamental hydrogeologic terms and concepts needed for Sustainable Groundwater Management Act (SGMA) and groundwater modeling

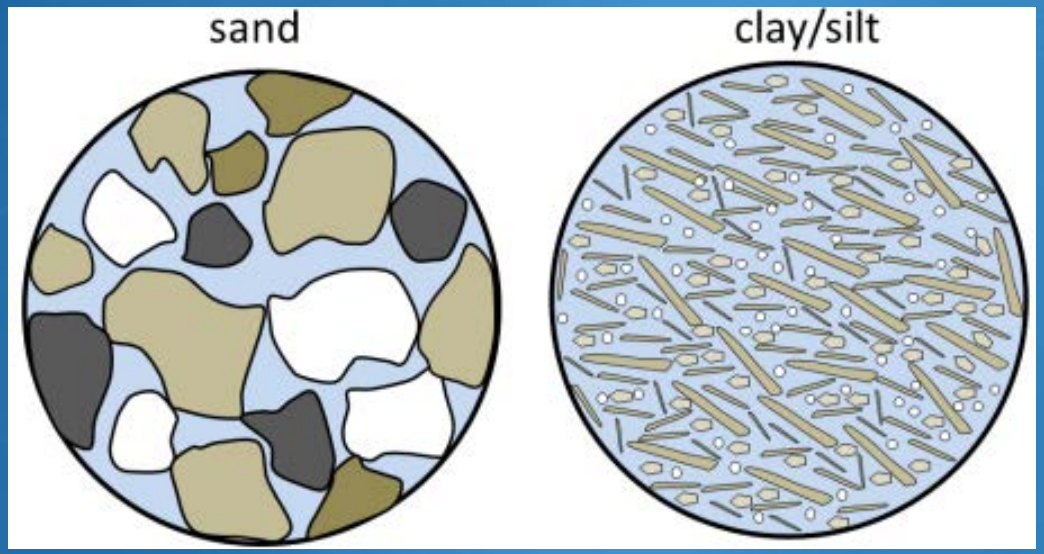
1. Basic groundwater flow and properties
2. Measuring groundwater
3. Groundwater budgets
4. Advanced topics
    a. Groundwater / surface water interactions
    b. Aquifer recharge
    c. Land subsidence

Basic Groundwater Flow & Properties

What is Groundwater?

- Groundwater is water flowing between grains in sediments or in rock fractures
  - This is not the legal definition, it is a practical definition
- Sediments can be sands, gravels, silts, or clays

Few, large pores between sand grains

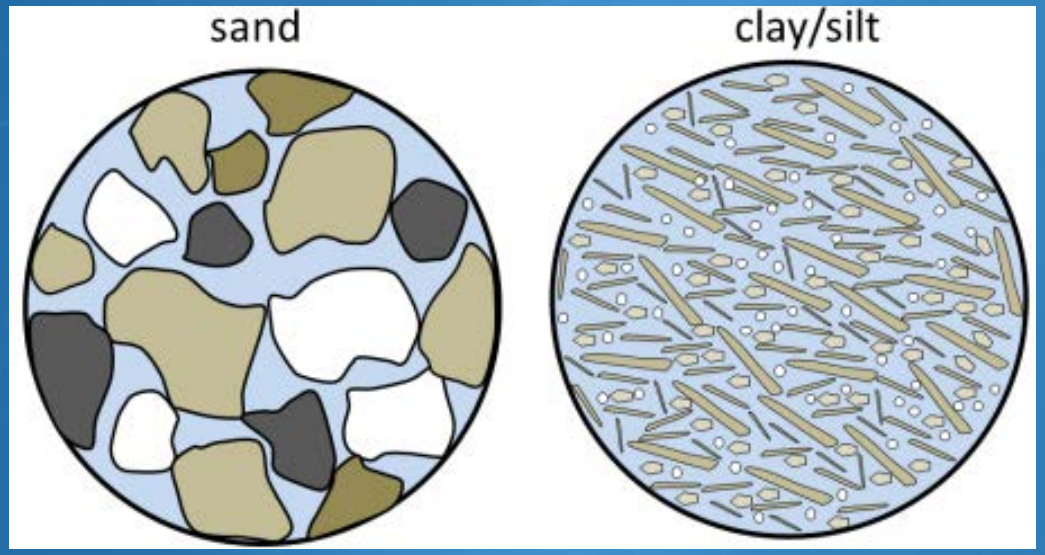


Many, small pores between clay particles

Hydraulic Conductivity (K) - Measures Ease of Flow

- The large pores between the sand grains are larger, allowing water to flow more rapidly. High hydraulic conductivity
- The pores between the clay platelets are small, slowing down the flow of water. Low hydraulic conductivity

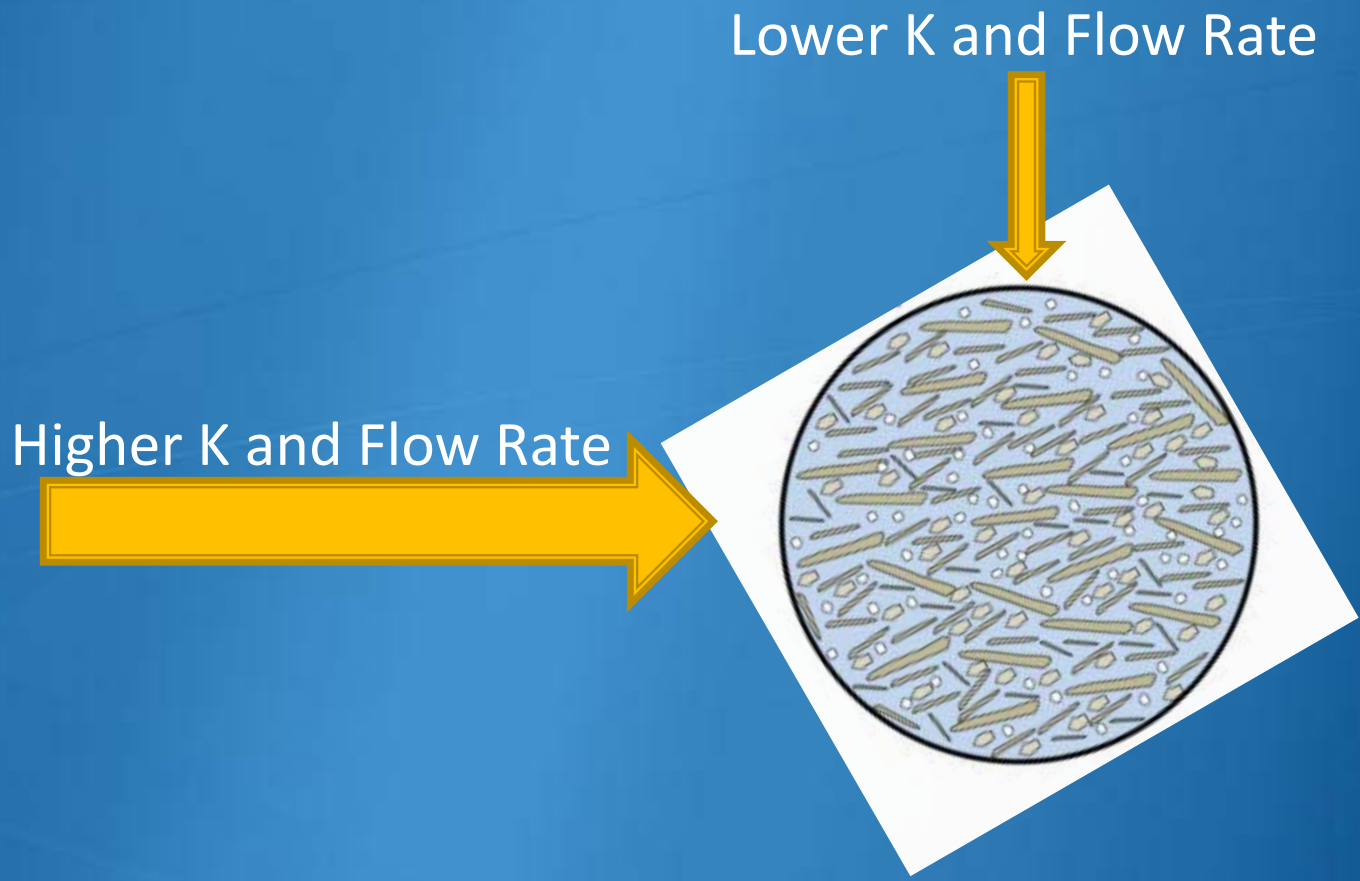
Few, large pores between sand grains



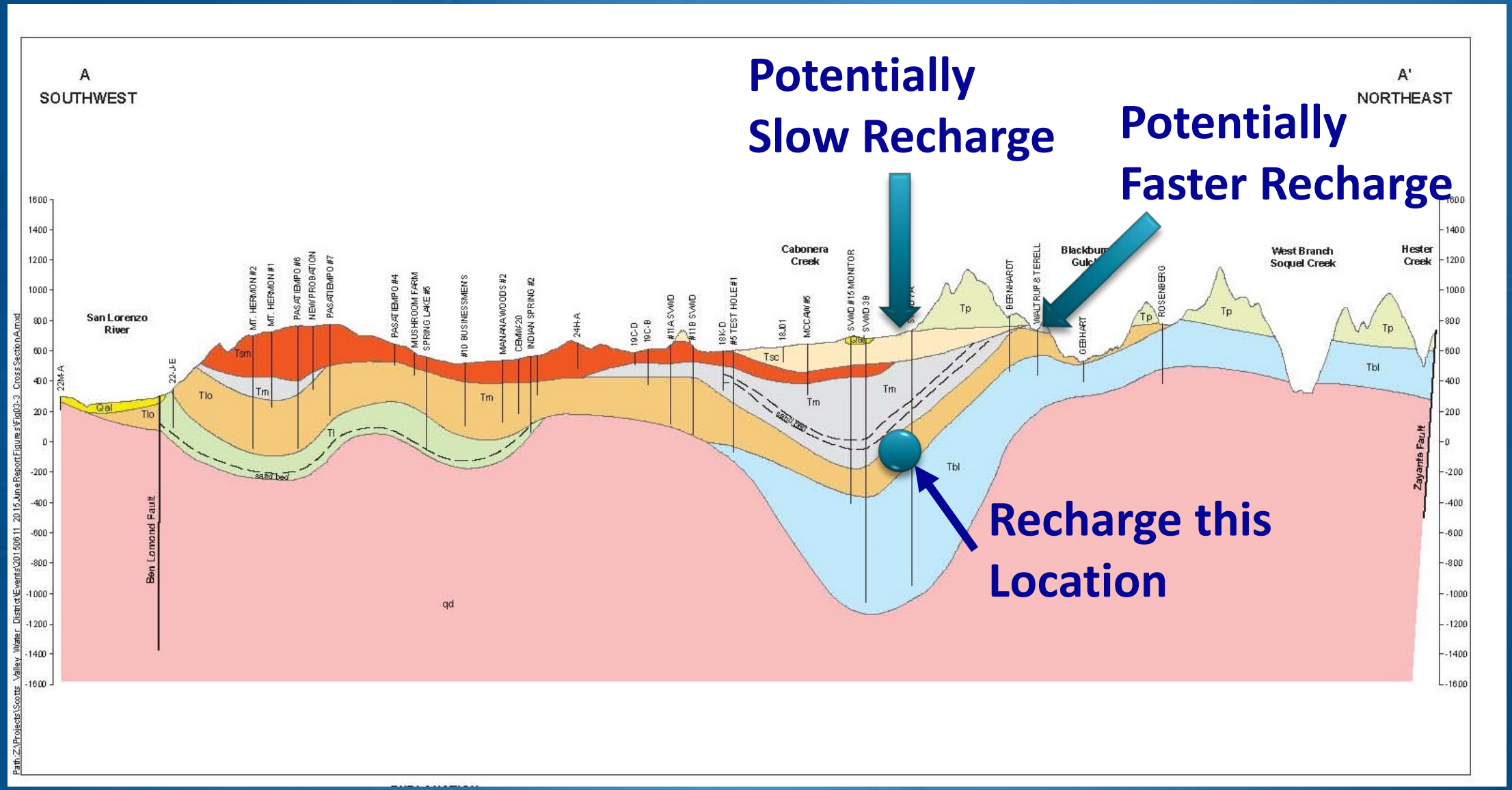
Many, small pores between clay particles

Directional Hydraulic Conductivity (Anisotropy)

Water molecules “bump into” fewer clay particles moving horizontally than moving vertically

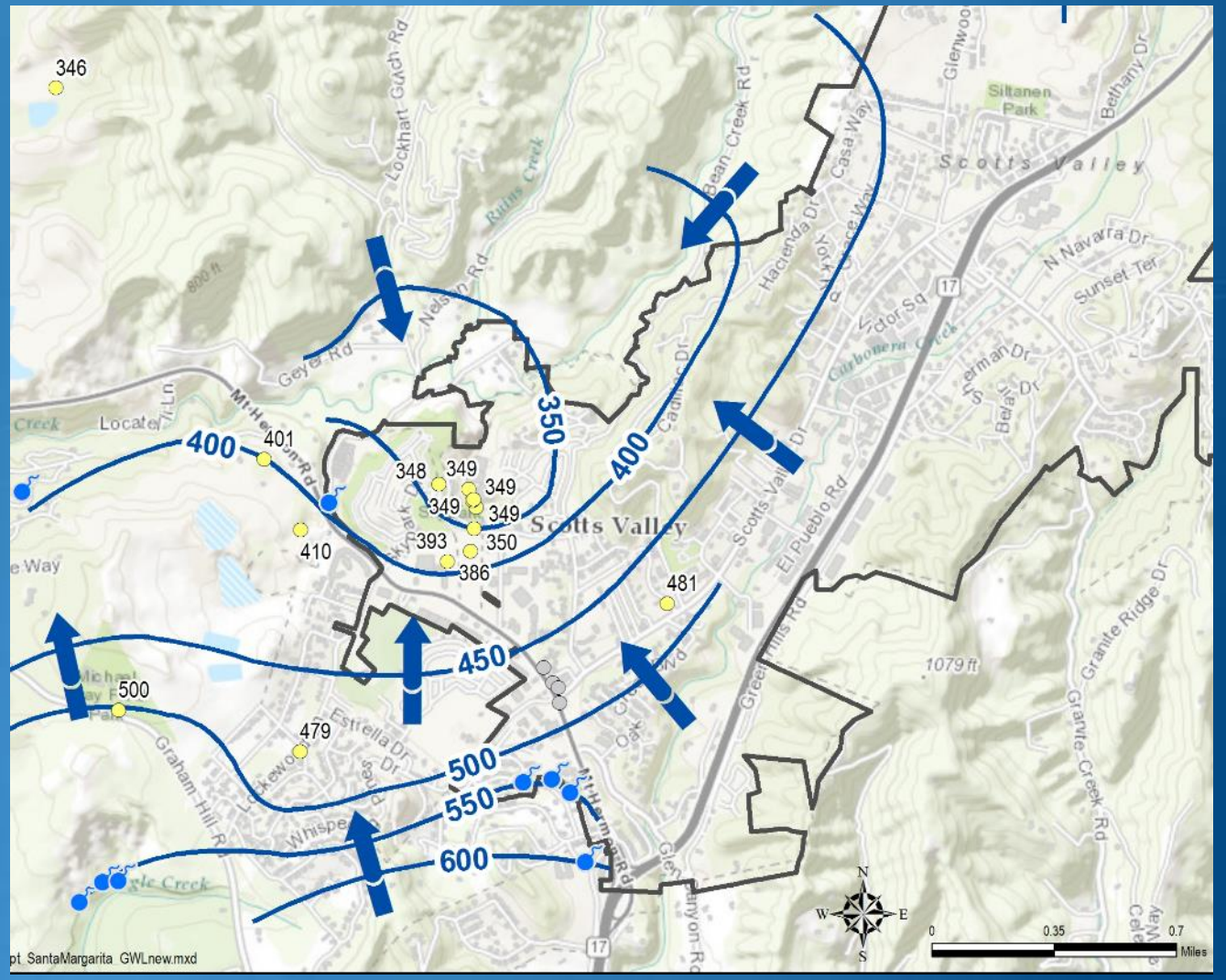


Directional Hydraulic Conductivity (Anisotropy)

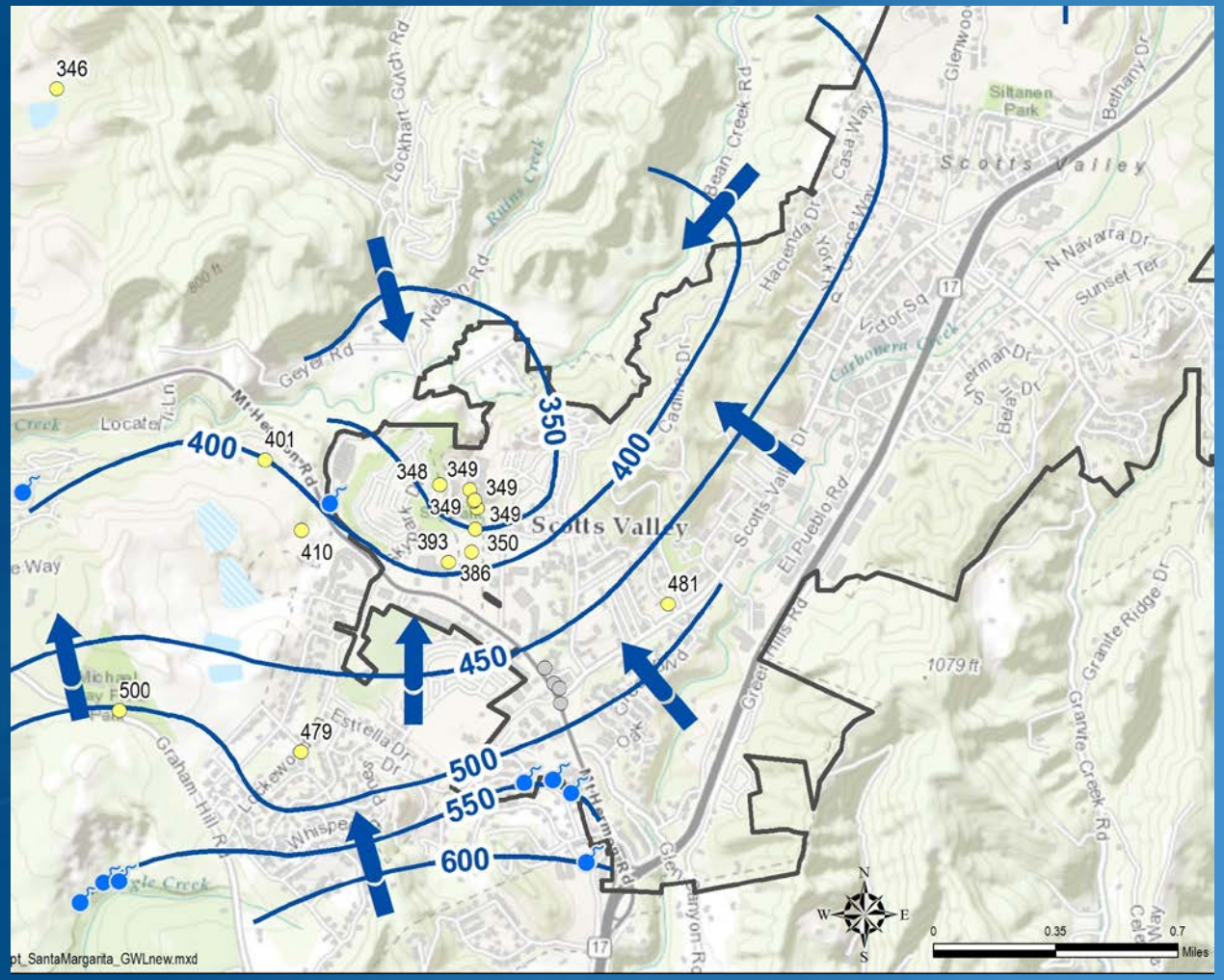


Groundwater Flow

- Water flows from high to low elevations
- A contour line represents equal groundwater elevation
- Groundwater elevation (or head) is the level of groundwater above or below sea level



Hydraulic Gradient (i)



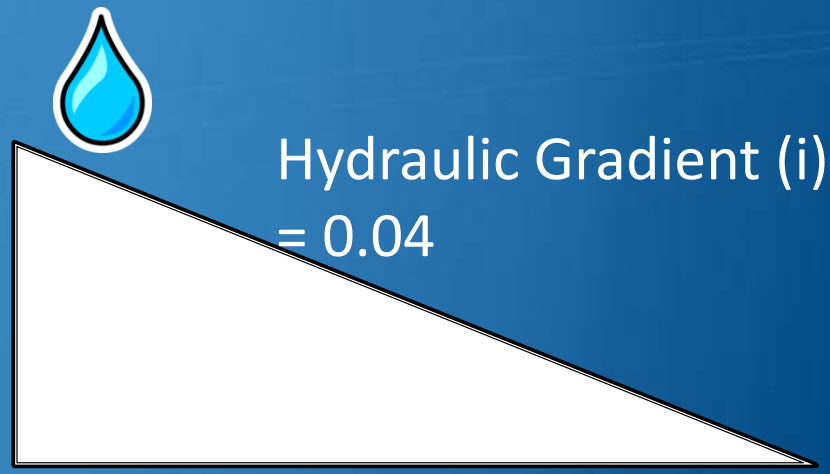
Hydraulic gradient (i)

$$\frac{\text{Elevation drop}}{\text{Horizontal distance}}$$

500 ft amsl

Elevation Drop = 50 ft

450 ft amsl



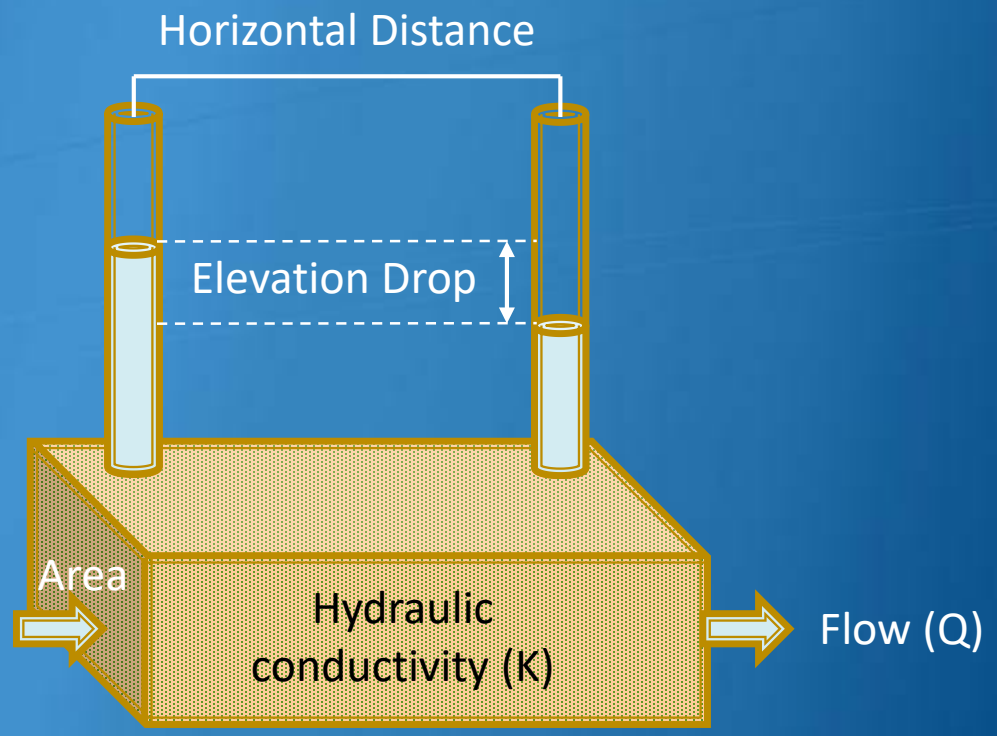
amsl = above mean sea level

Darcy's Law of Groundwater Flow

Groundwater Flow (Q)
depends on:

1. Hydraulic conductivity (K)
2. Hydraulic gradient (i)
3. Cross-sectional area of flow (A)

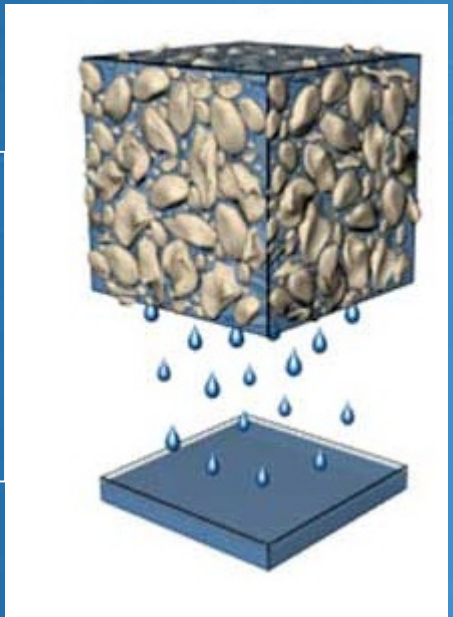
$$Q = KiA$$



Storage and Specific Yield (Sy)

- Storage – how much water is in the pores of an aquifer
- Most storage changes occur in shallow unconfined aquifers
- Specific Yield is the amount of water that drains from an unconfined aquifer

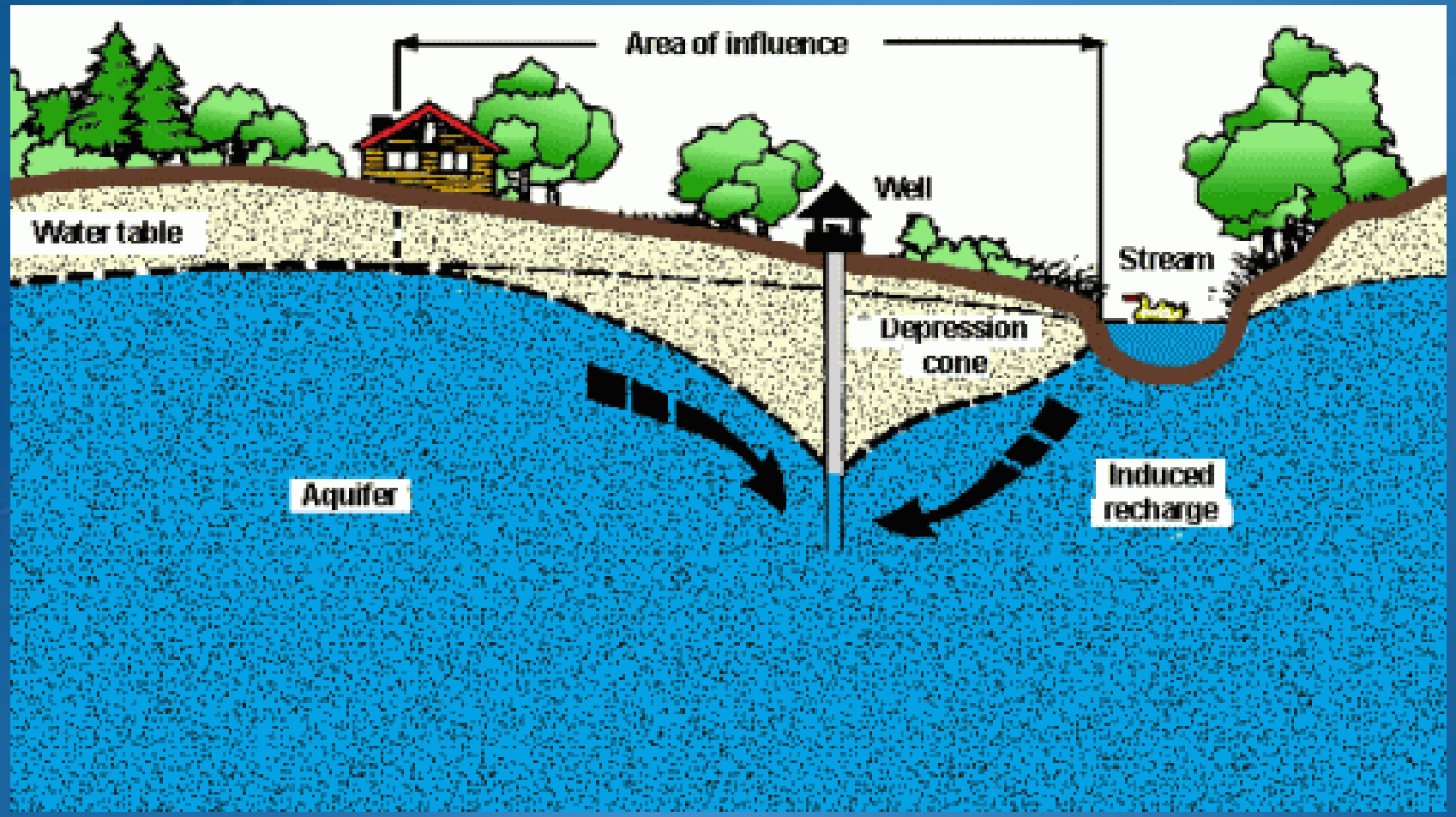
For an Sy of 0.17, two inches of recharge raises groundwater levels in your well almost one foot



Drain 1 cubic foot of saturated sediments

Get 0.15 to 0.3 cubic foot of water
(Sy commonly between 0.15 and 0.3 for sands)

Effects of Groundwater Pumping



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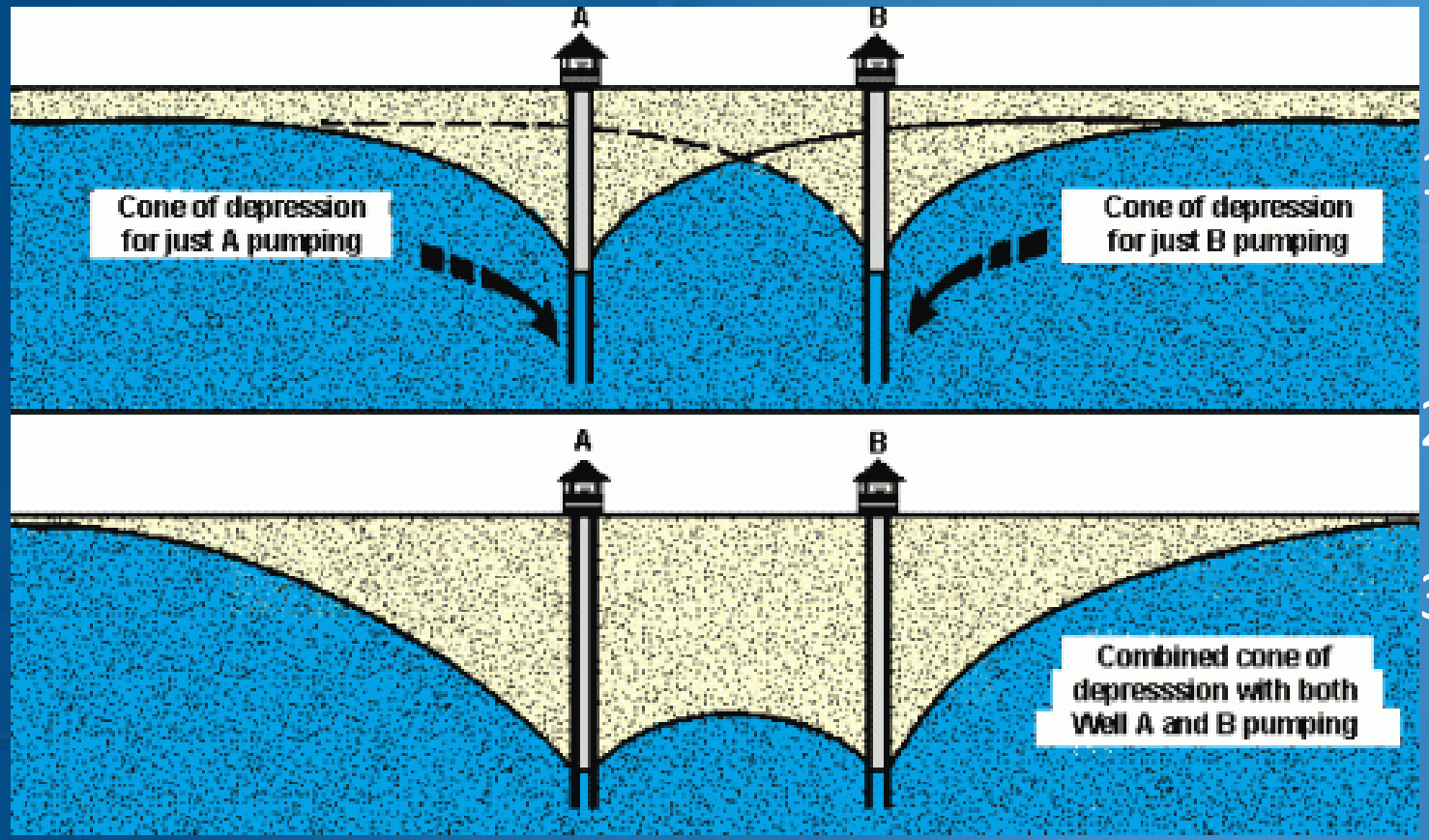
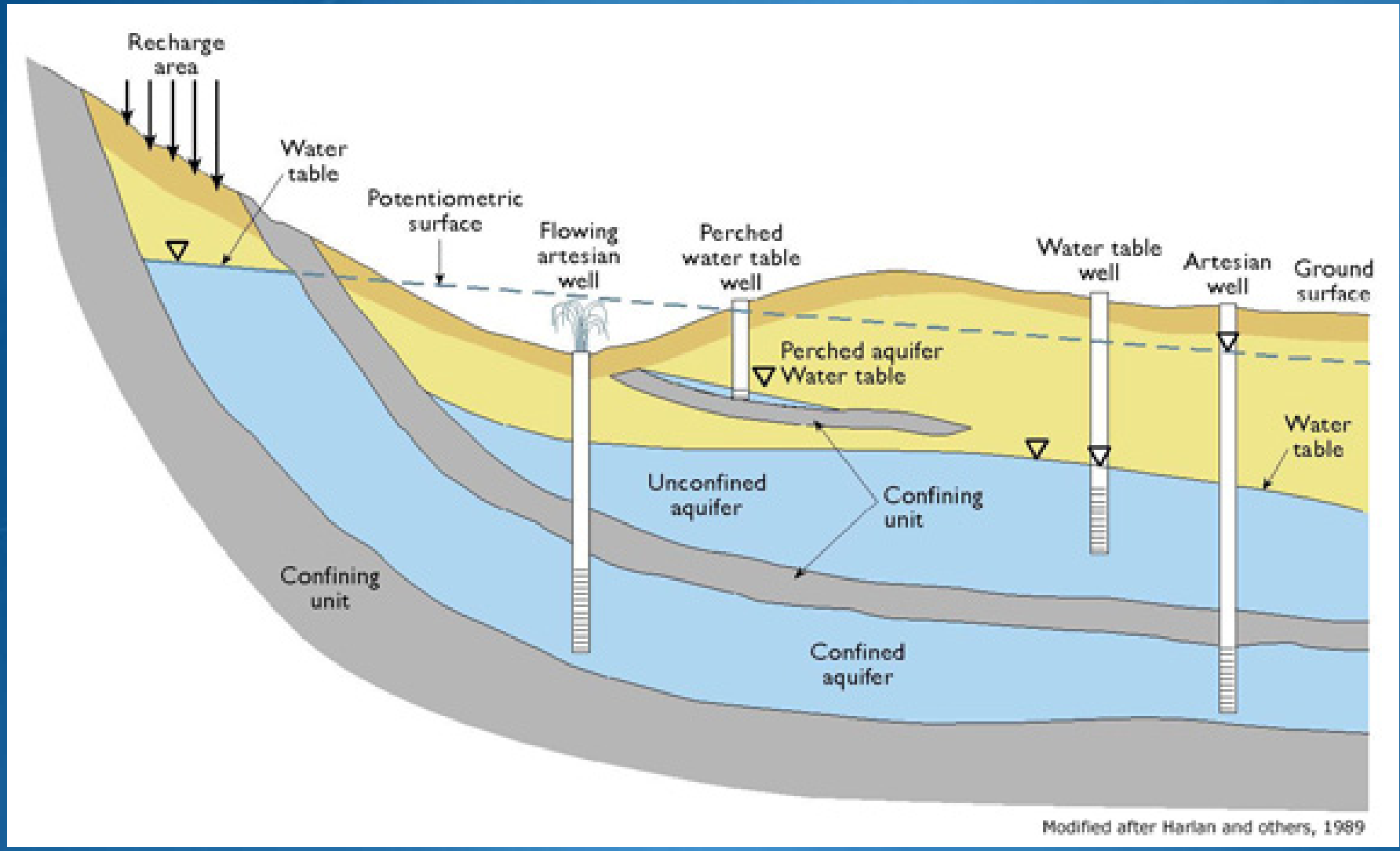


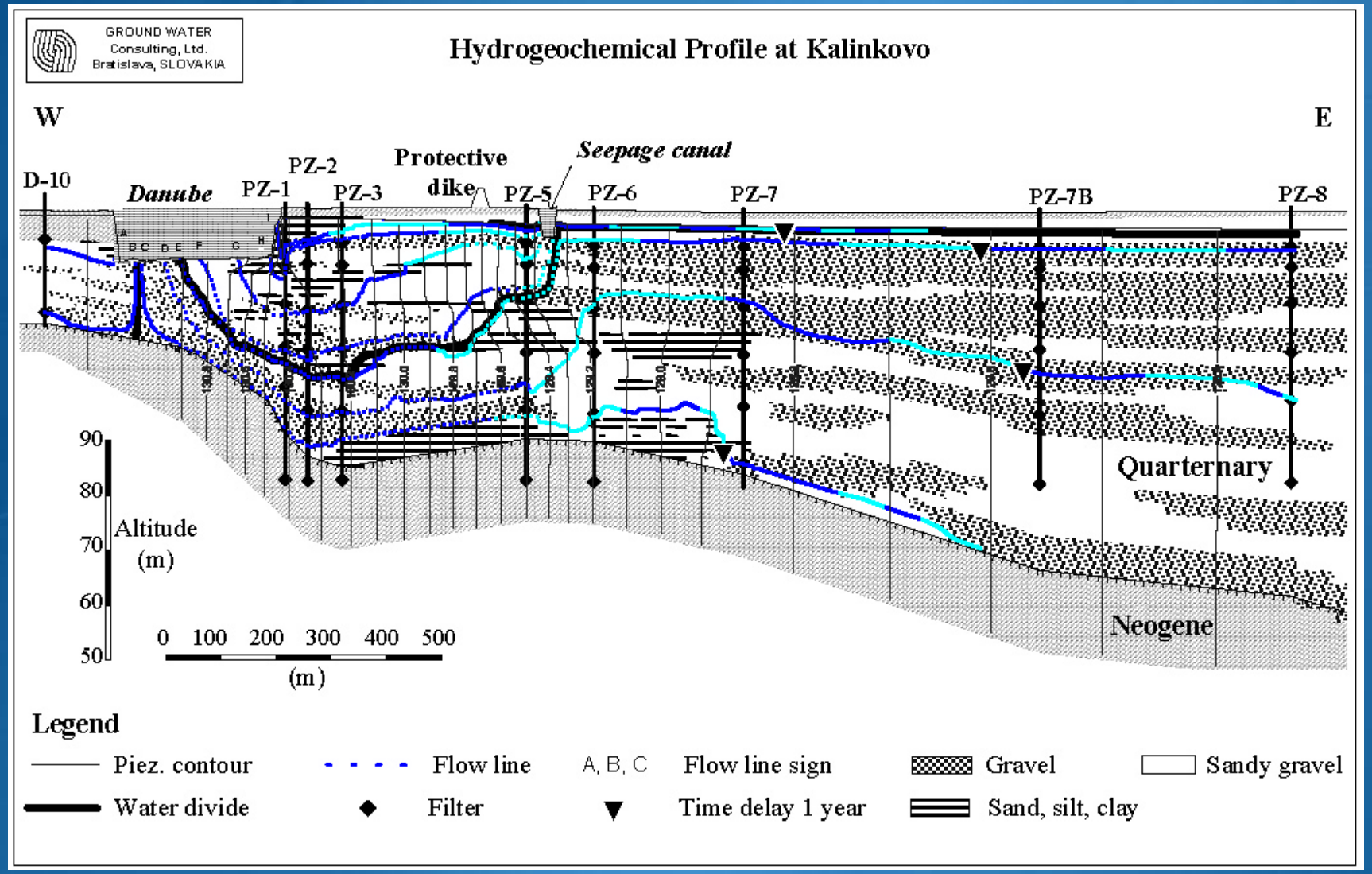
Three Effects

1. Remove Groundwater from storage (lower basin groundwater levels)
2. Cone of depression (locally lower groundwater levels)
3. Interference with nearby wells

Aquifers and Aquitards



Lateral Variability Adds Complexity

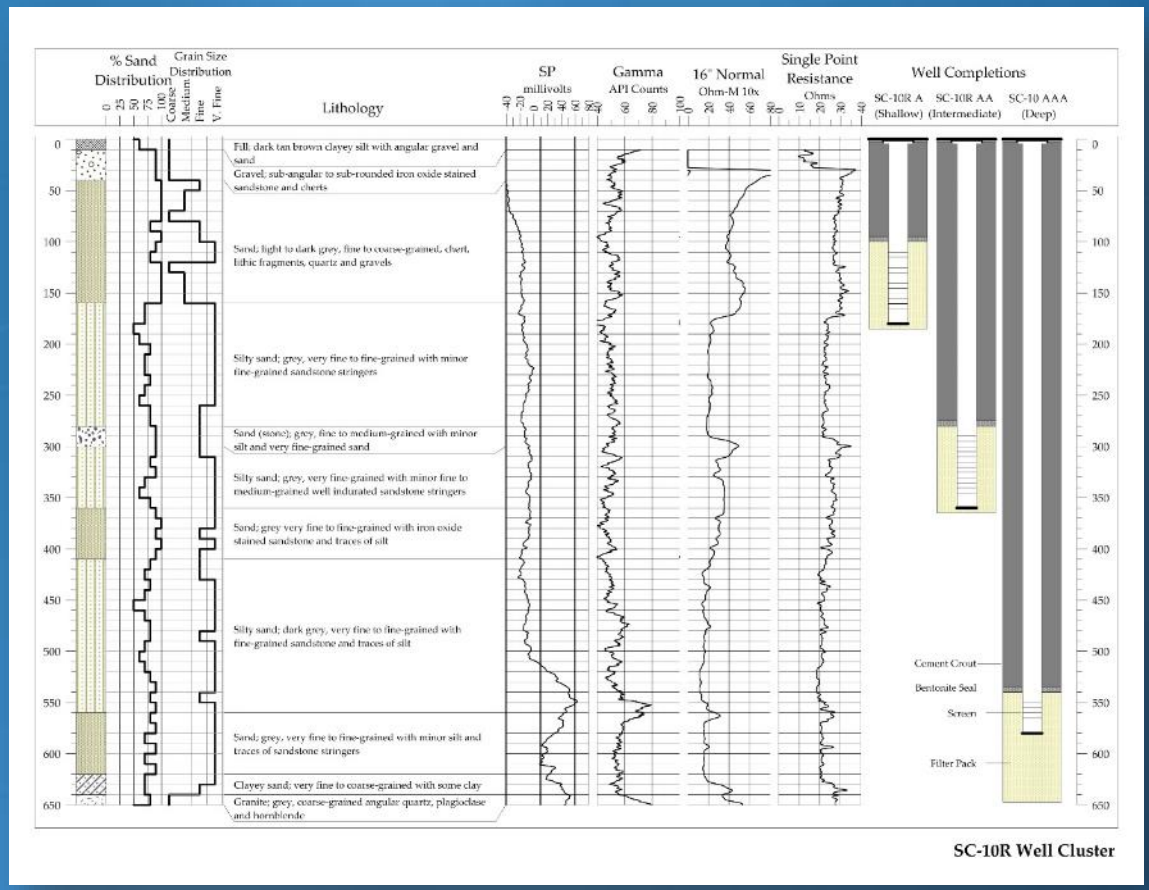


Measuring Groundwater

How do we know what we know?

Almost all Data Comes from Groundwater Wells

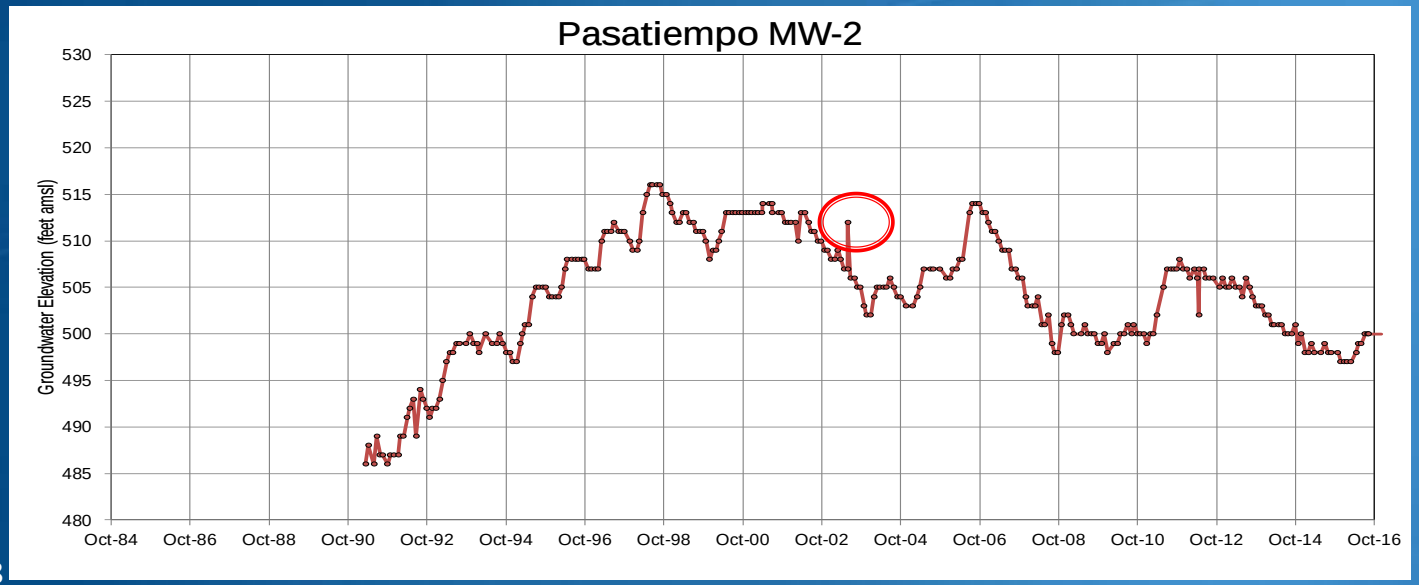
Geology is known from well cuttings

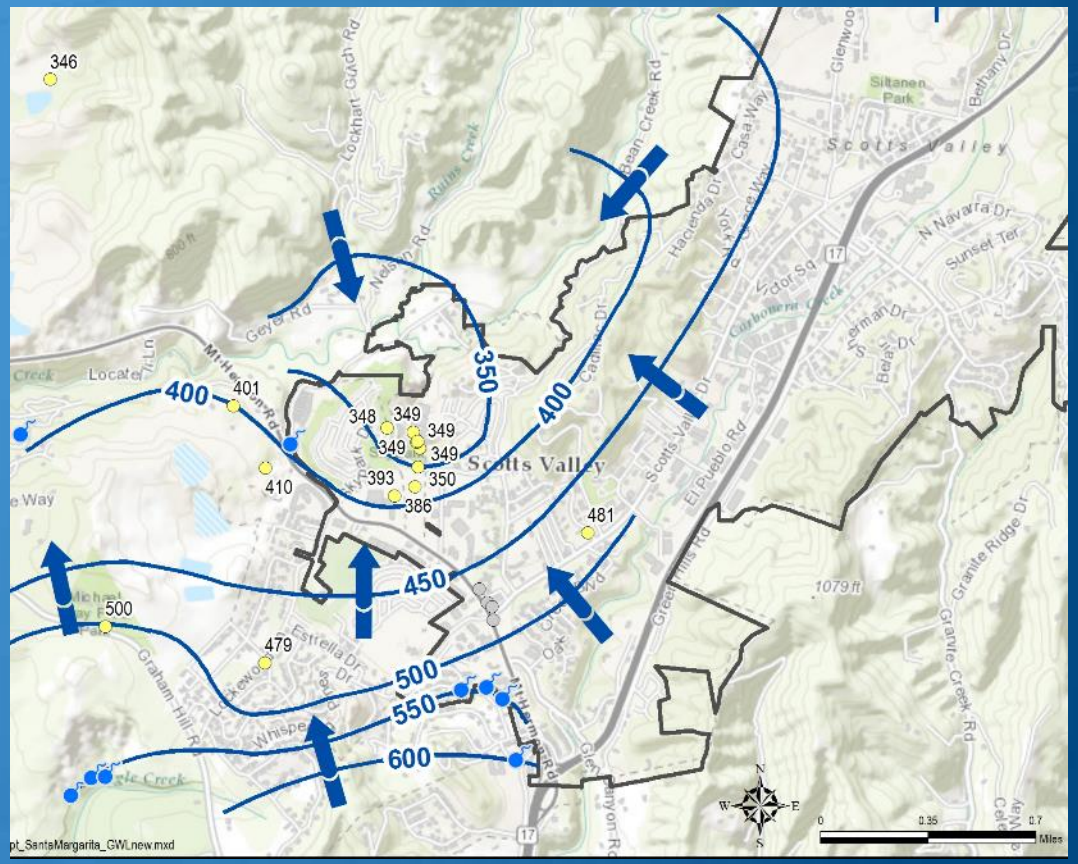


Groundwater Levels

- Basic measurement in hydrogeology
- Used to plot hydrographs
- Used to contour groundwater elevations

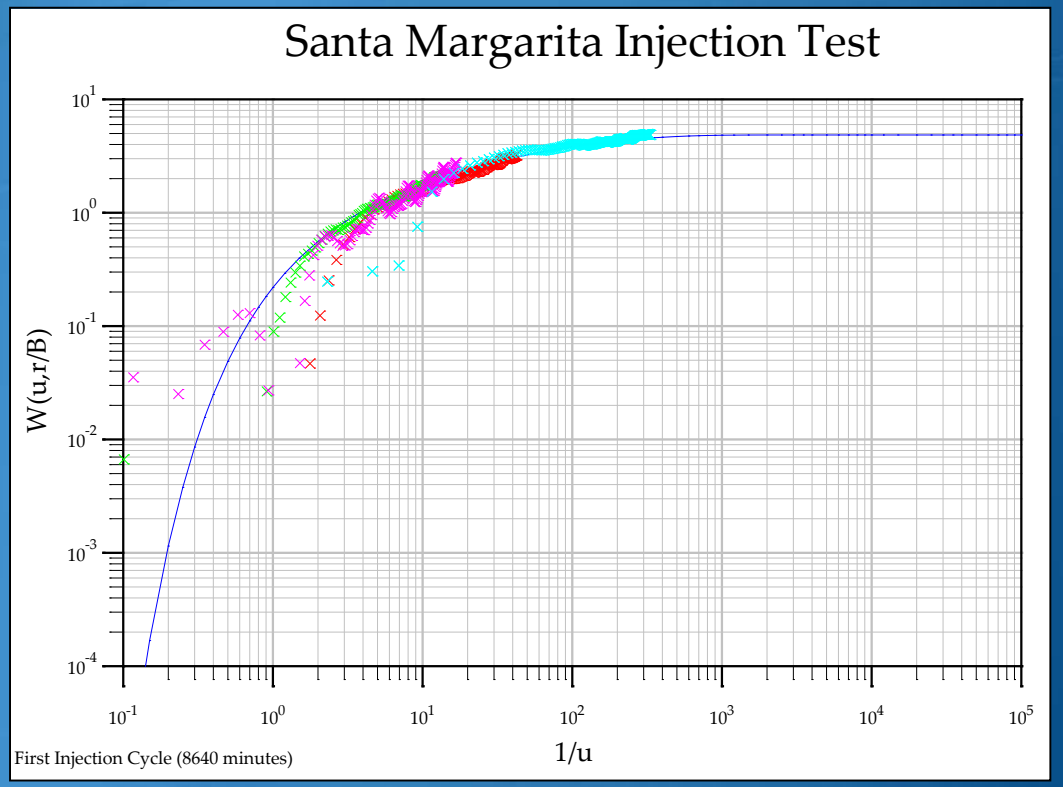
Groundwater Elevation Hydrograph





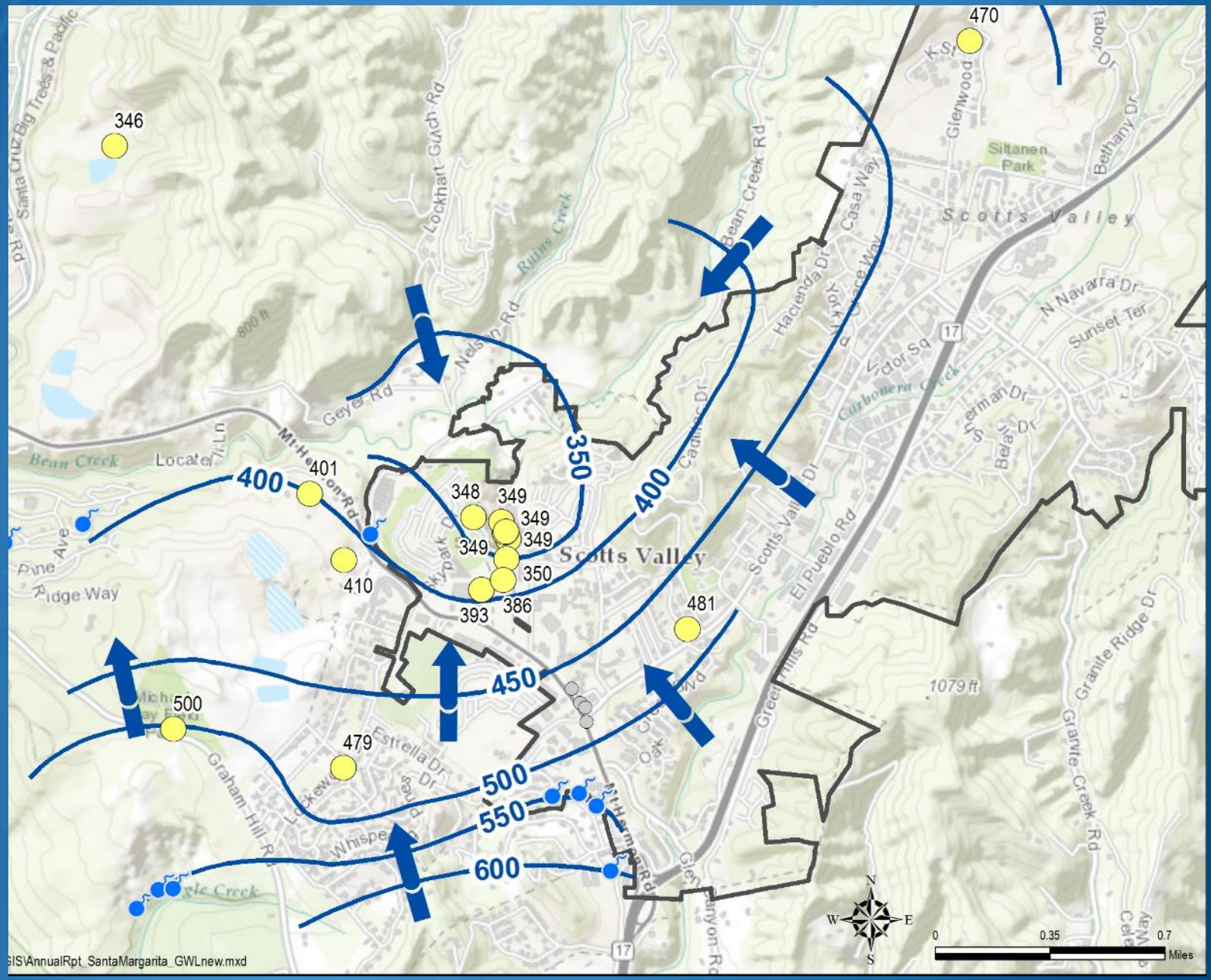
Measuring Aquifer Properties

- Measured at individual wells
- Field measurement of K and SY from aquifer tests of wells
- These are local estimates only



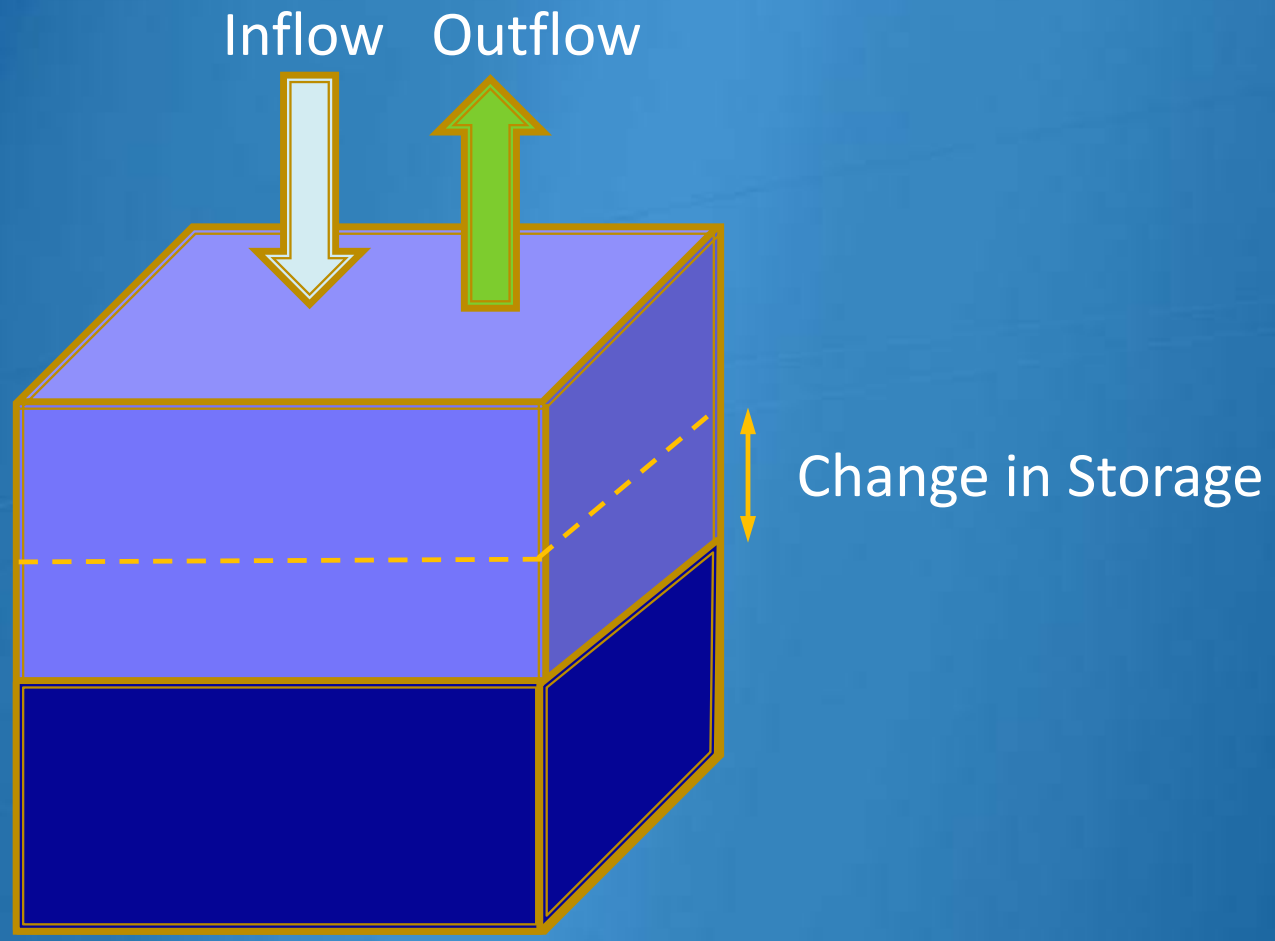
Hydrogeologic Interpretation

- Data only collected at wells
- Everything else is interpretation



Groundwater Budgets

Inflow – Outflow = Change in Storage



Inflow – Outflow = Change in Storage

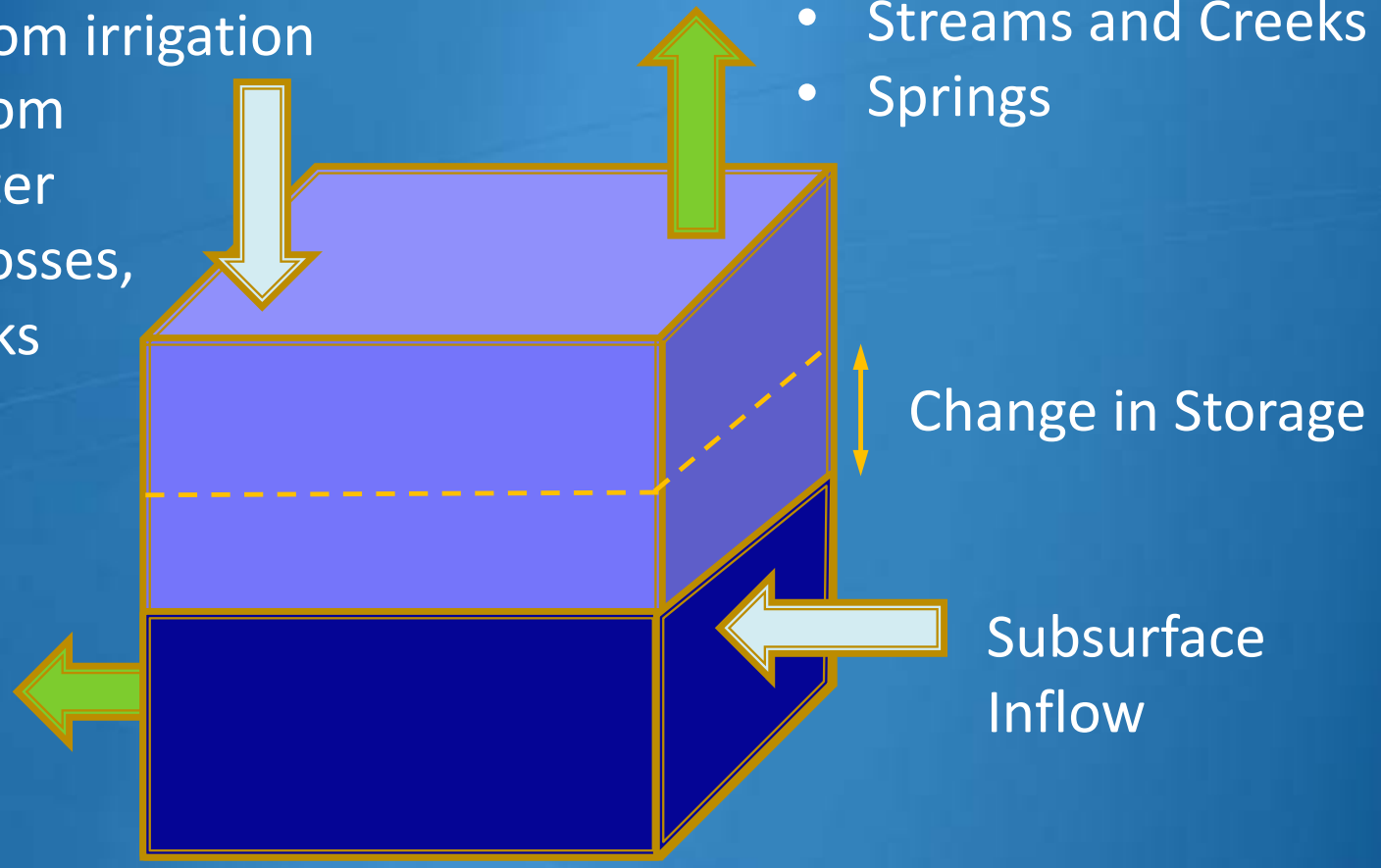
Inflow (Intermittent)

- Direct percolation of precipitation
- Streambed percolation
- Managed aquifer recharge
- Return flow from irrigation
- Return flow from sewer and water transmission losses, and septic tanks

Outflow (Continuous)

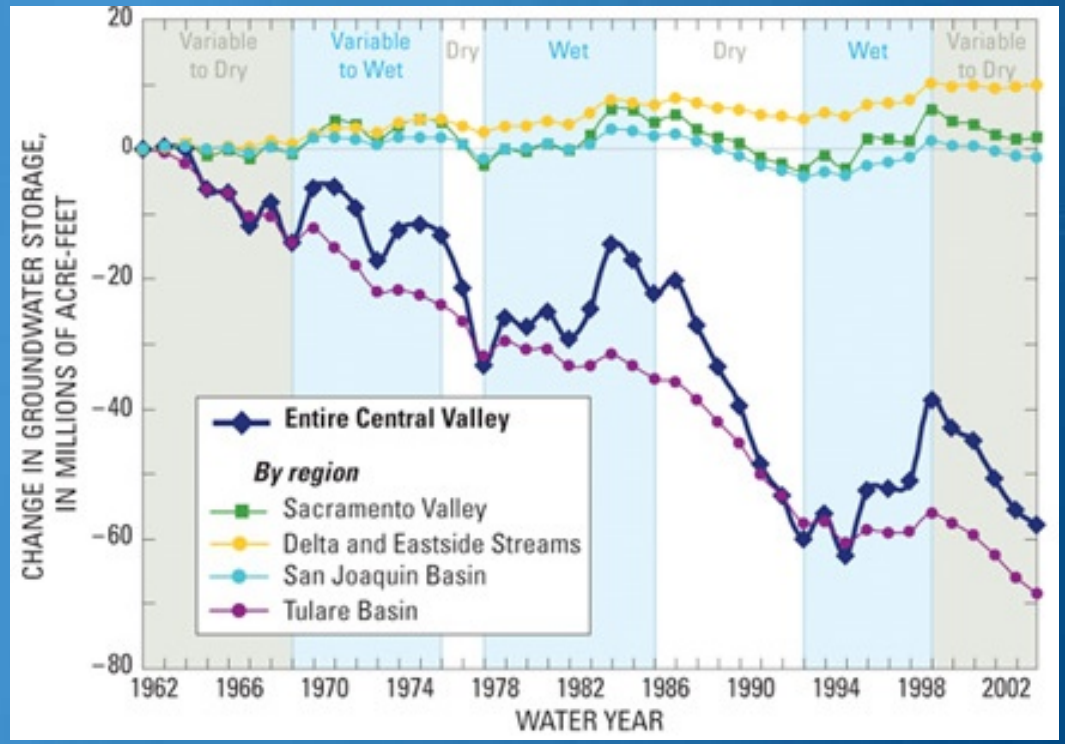
- Evapotranspiration
- Well pumping
- Streams and Creeks
- Springs

Difficult and complex to estimate these items accurately



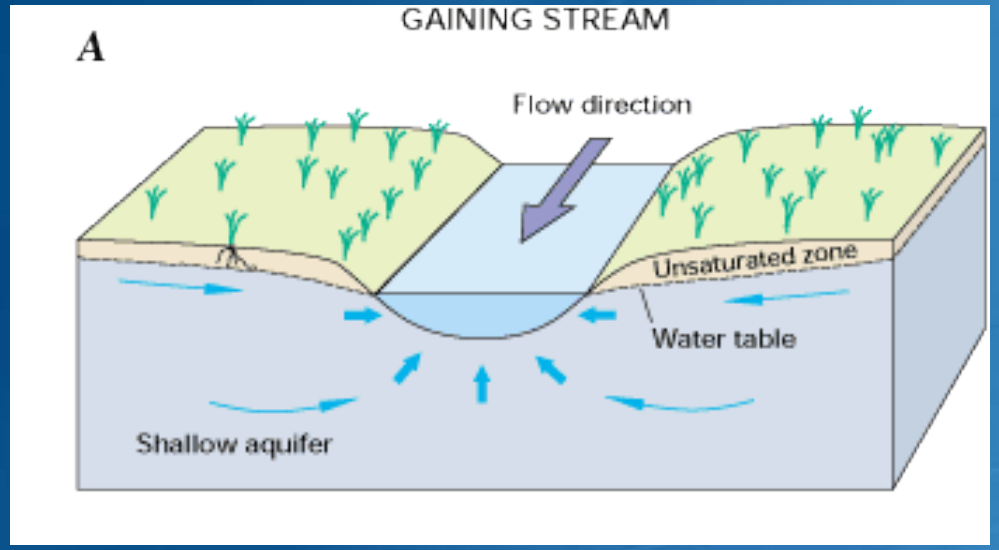
Overdraft

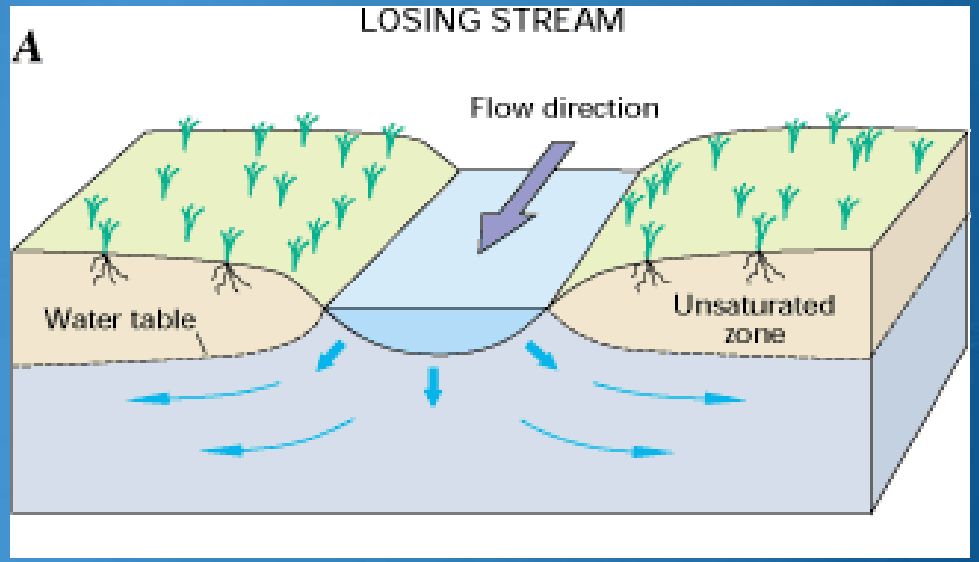
- Overdraft is the persistent loss of USABLE groundwater in storage
  - Usually accompanied by persistent lowering of groundwater elevations
- The State of California has not declared the Santa Margarita Basin as critically overdrafted

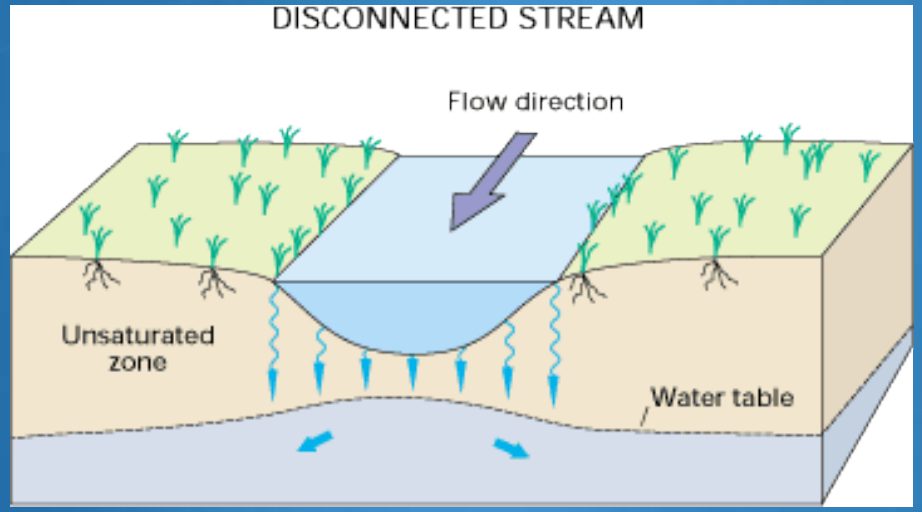


Advanced Topics

Groundwater / Surface Water Interactions







Managed Aquifer Recharge – Water Types

Storm Runoff

River Water

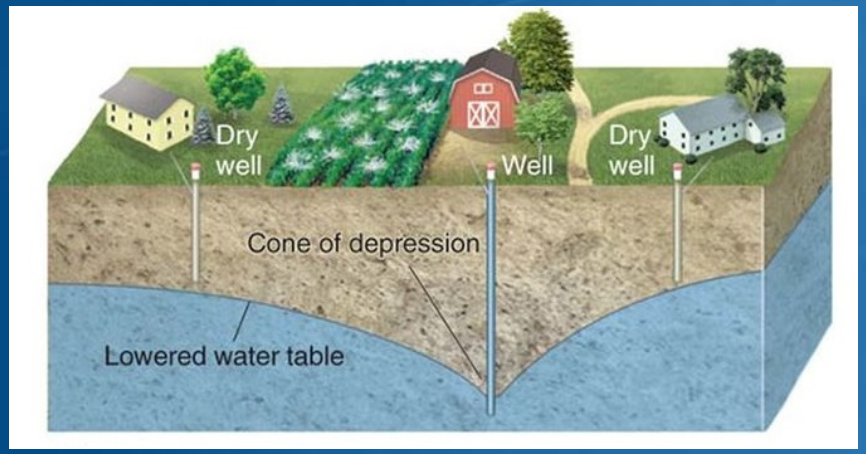
Desalinated Water

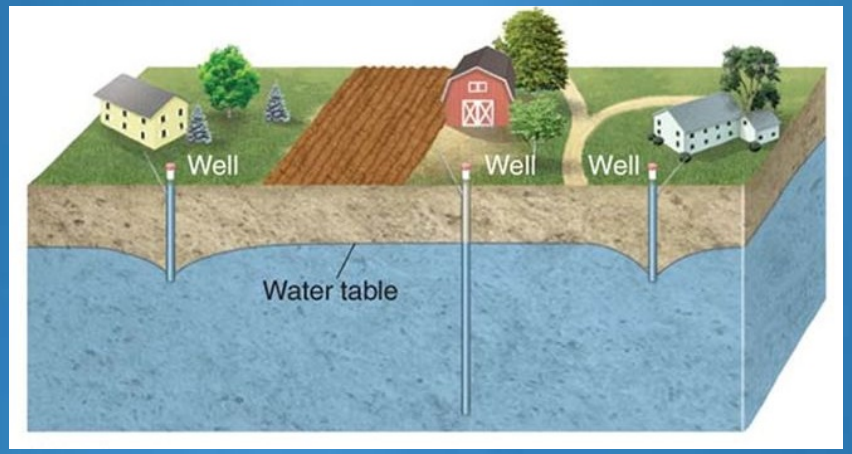
Very Highly Treated Water

Managed Aquifer Recharge Methods

Percolation

In-Lieu





Injection (ASR)

Land Subsidence

- Mining groundwater beneath thick clay layers (e.g., many basins in CA)
- Drainage of organic soils (e.g., Sacramento-San Joaquin Delta)
- Unlikely a problem in the Santa Margarita Basin, but must be addressed

Questions