Gulf Coast Aquifer Hydrology and Update on Development of Nueces County Groundwater Model

Presentation to Corpus Christi City Council
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by:
Steven Young Ph.D, PE, PG
Nicholas Winklemann, PE

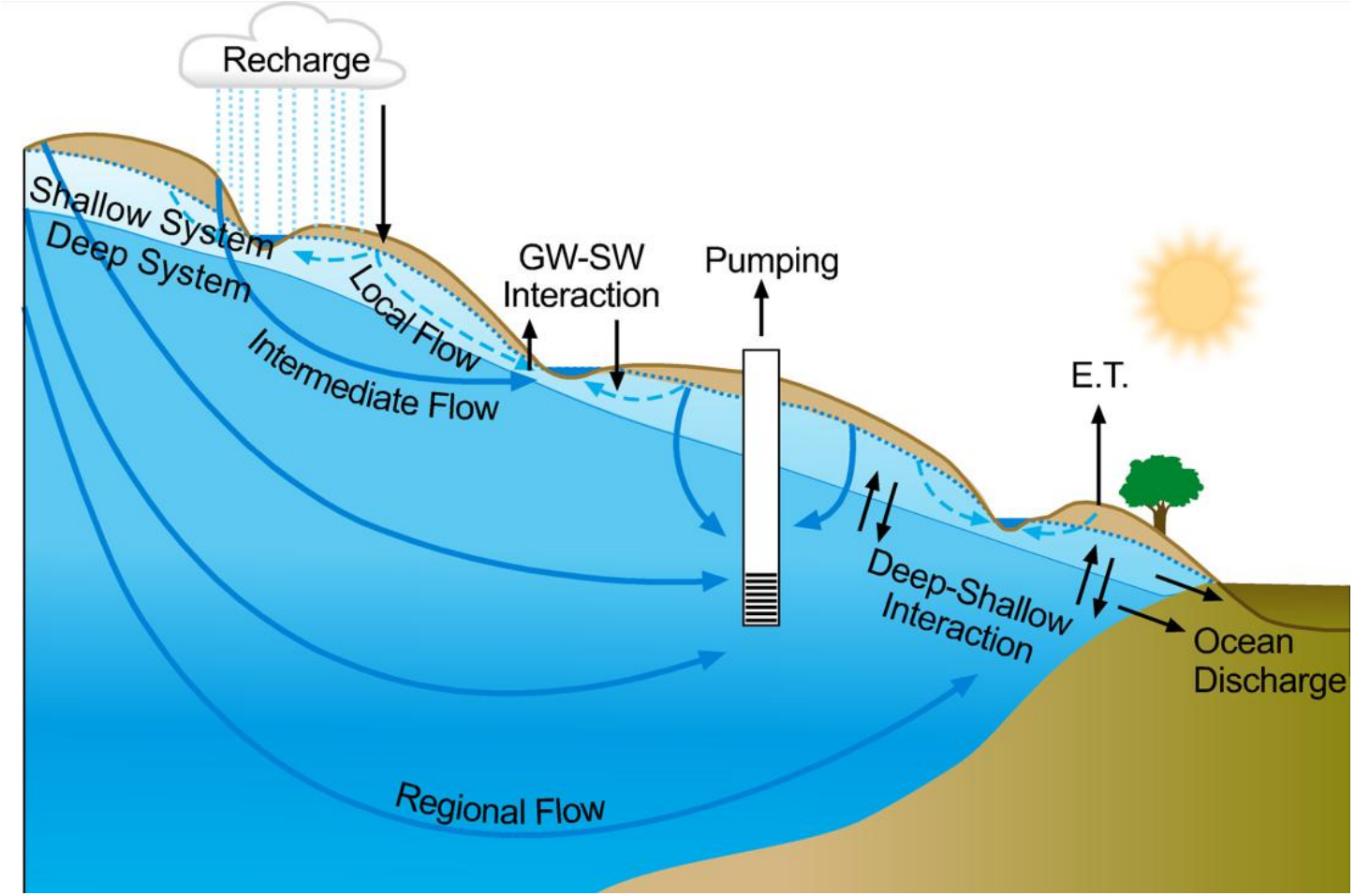
Gulf Coast Discussion Items

- Gulf Coast Overview
- Previous Work in San Patricio and Nueces County
- Groundwater Model for Nueces County
- Interim Model Calibration Results
- Review Well Design for Nueces Brackish Wellfields
- Summary of Model Development, Performance, and Planned Improvements
- Model Applications

Gulf Coast Aquifer System

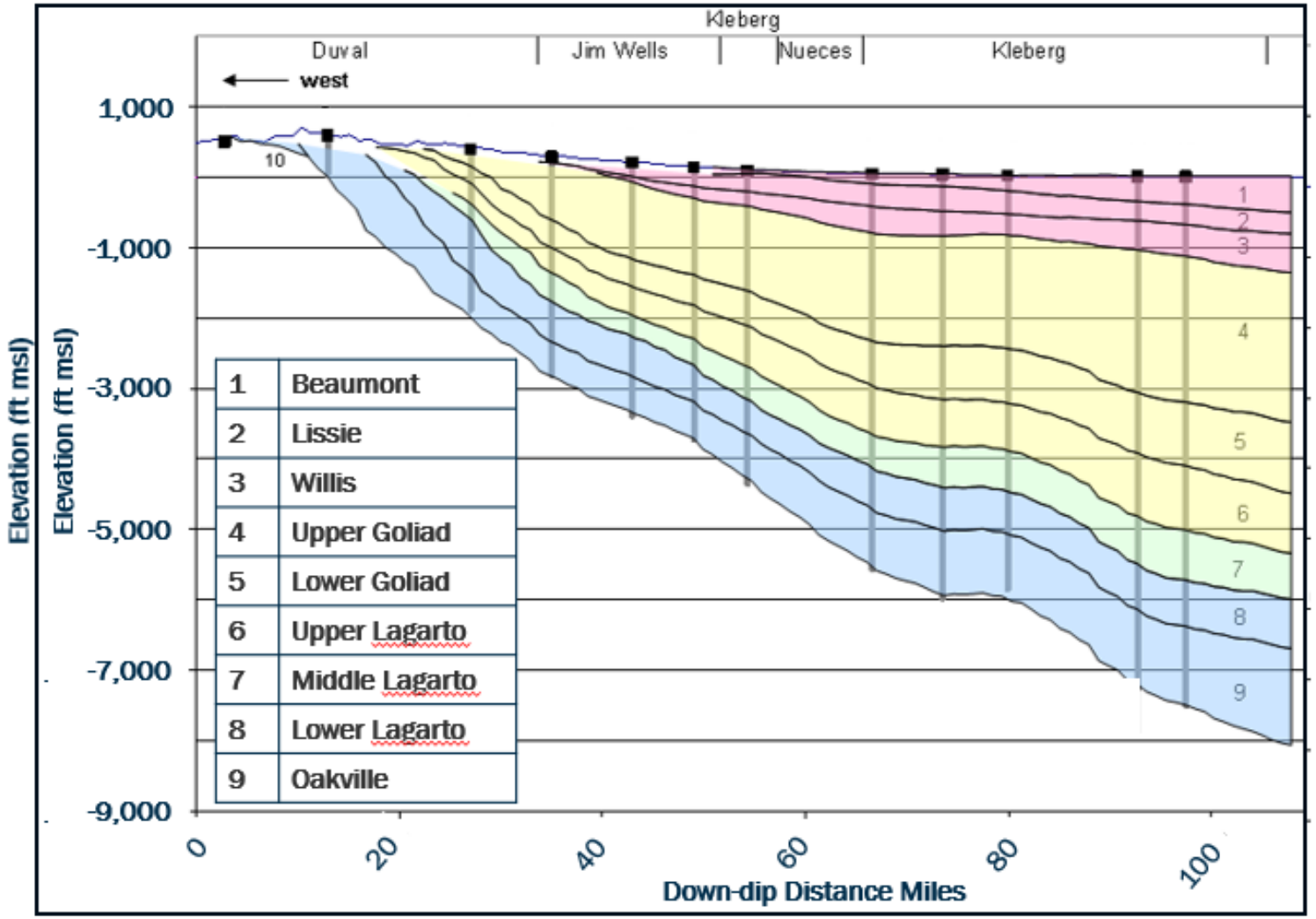
Location &
Groundwater Management Areas

Generalized Groundwater Flow System



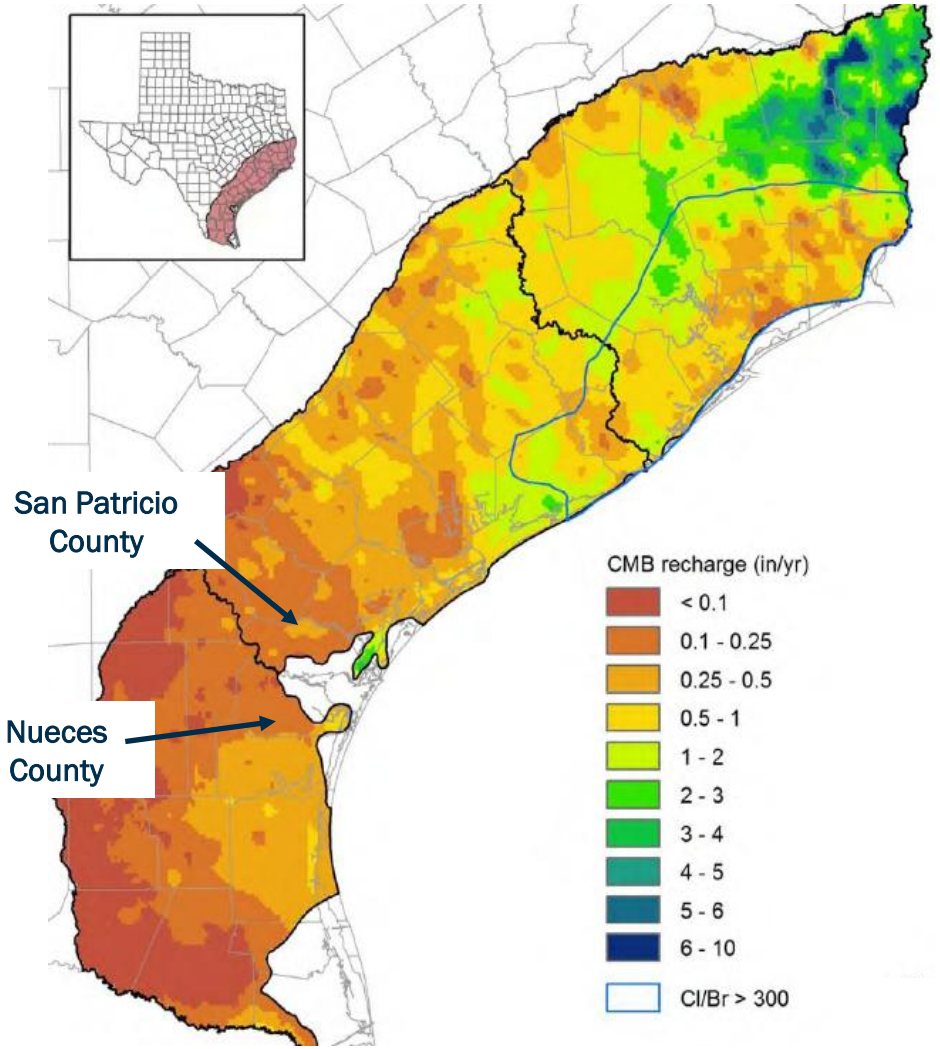
Gulf Coast Aquifer System: South Texas

Est. Age (M.Y)	Geologic Unit	Hydrogeologic Unit
0.7	Beaumont	CHICOT AQUIFER
1.6	Lissie	
3.8	Willis	
11.2	Upper Goliad	EVANGELINE AQUIFER
14.5	Lower Goliad	
17.8	Upper Lagarto	
	Middle Lagarto	BURKEVILLE
	Lower Lagarto	JASPER AQUIFER
24.2	Oakville	
32	Frio	CATAHOULA
34	Vicksburg	



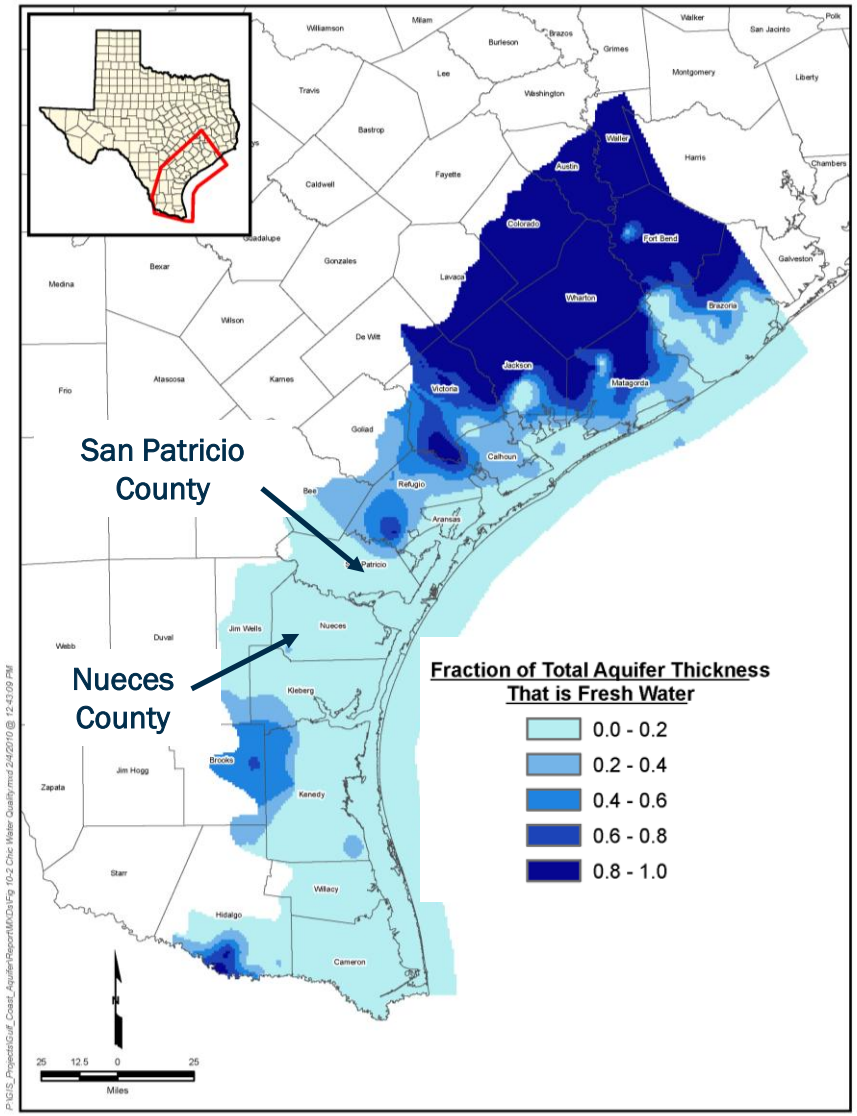
Gulf Coast Aquifer: Recharge and Water Quality

Estimated Recharge (in/yr)*



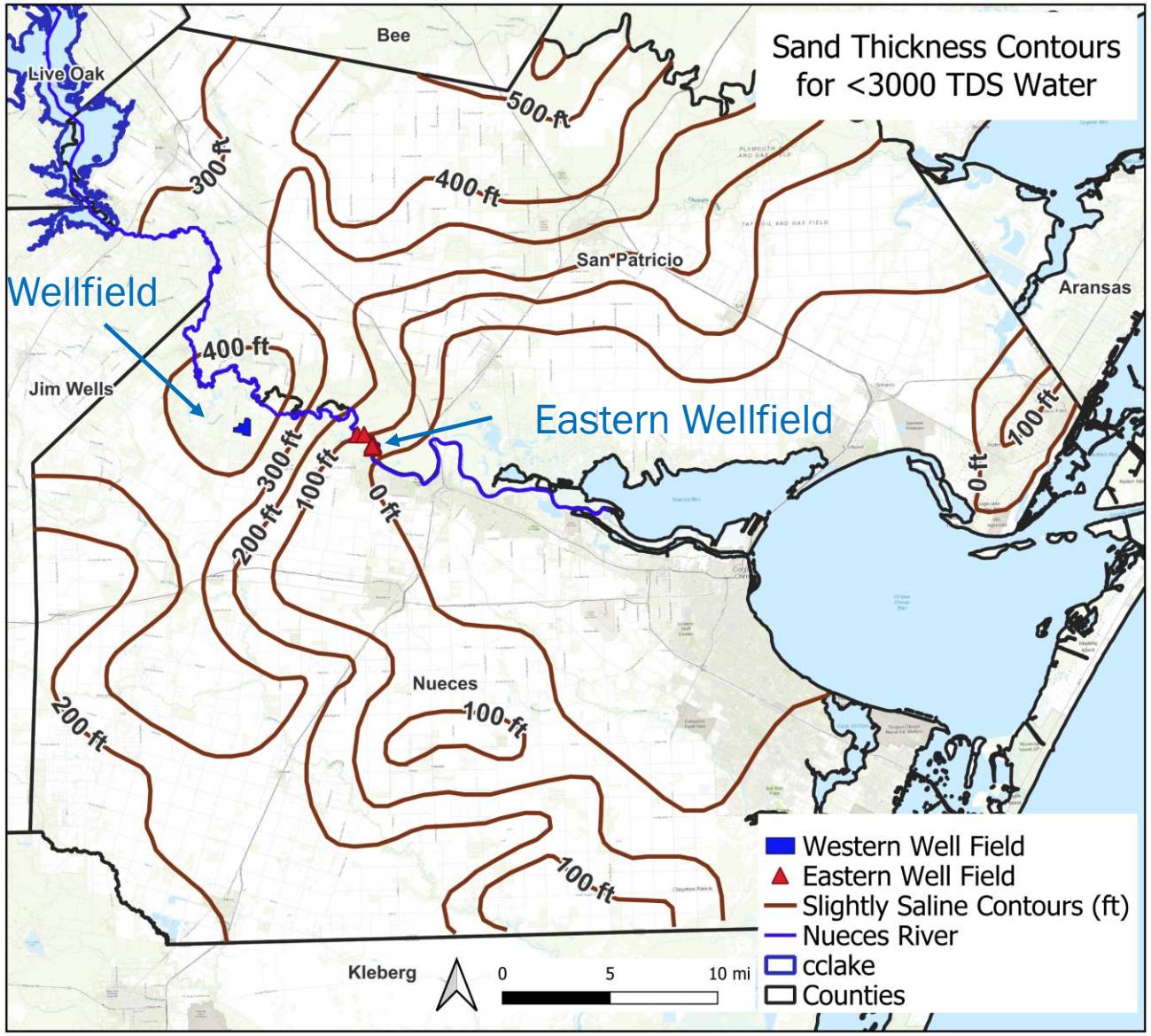
* BEG Study based on chloride mass balance

Occurrence of Fresh Water



INTERA's Previous Work: 2012-2013

- Map Sand Thicknesses
- Map Water Quality
- Review Aquifer Tests
- Review GW Regulations
- Recommend Potential Sites

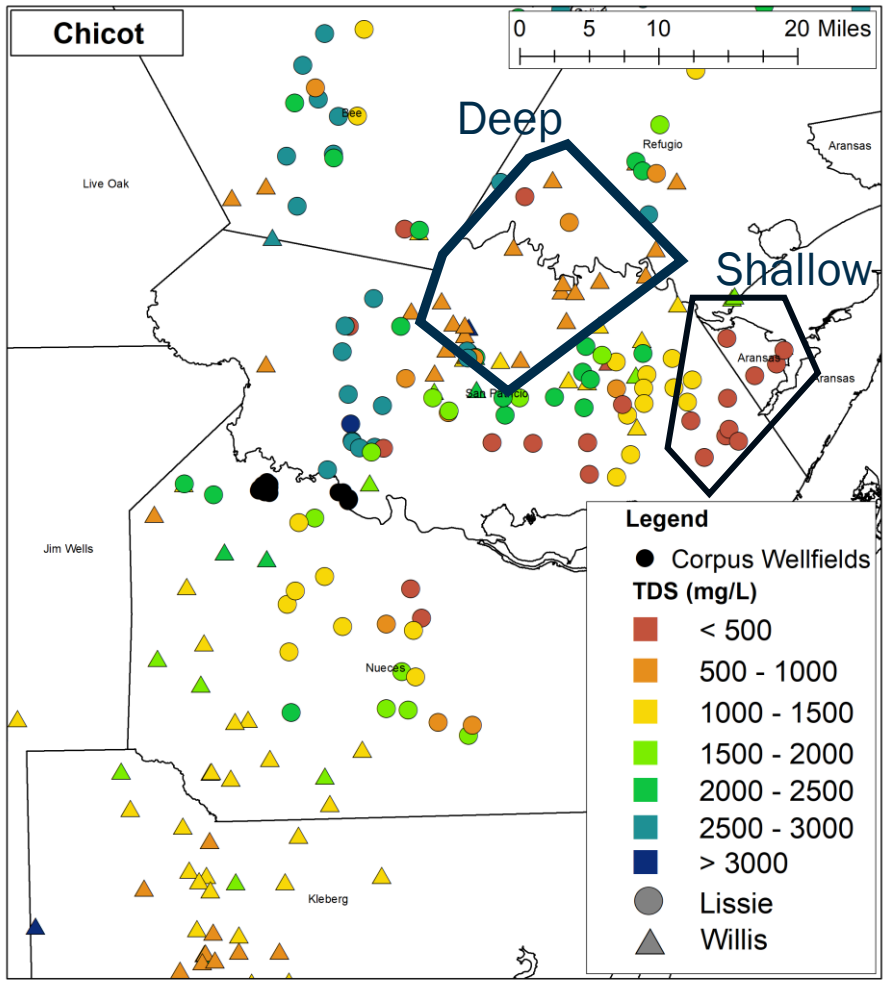


From Shafter, 1968

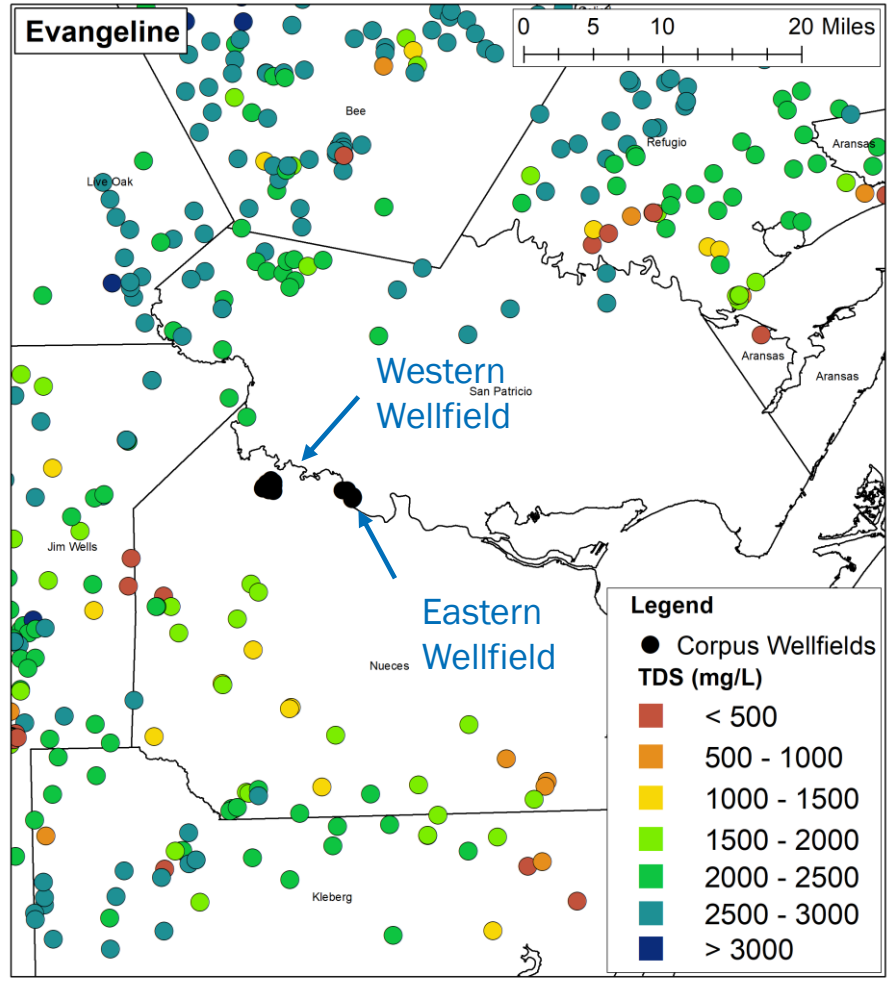
Measured Total Dissolved Solids (mg/L)

- Freshwater (<1000 mg/L)
  - < 500
  - 500 - 1000
- Slightly Saline (1000 – 3000 mg/l)
  - 1000 - 1500
  - 1500 - 2000
  - 2000 - 2500
  - 2500 - 3000
- Moderately Saline (3000–10000 mg/l)
  - > 3000

Chicot – Two Freshwater Regions

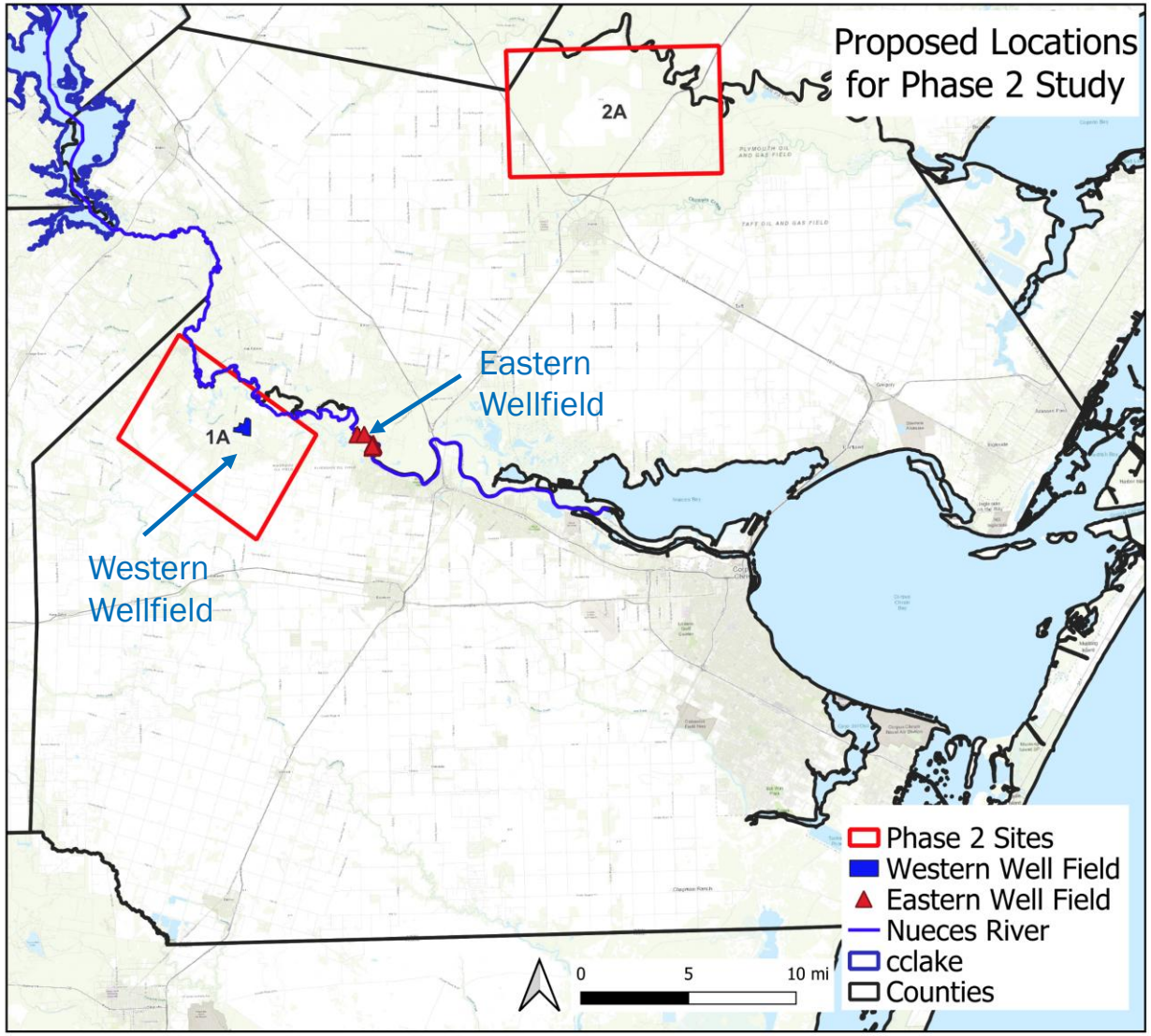


Evangeline – No Freshwater Regions



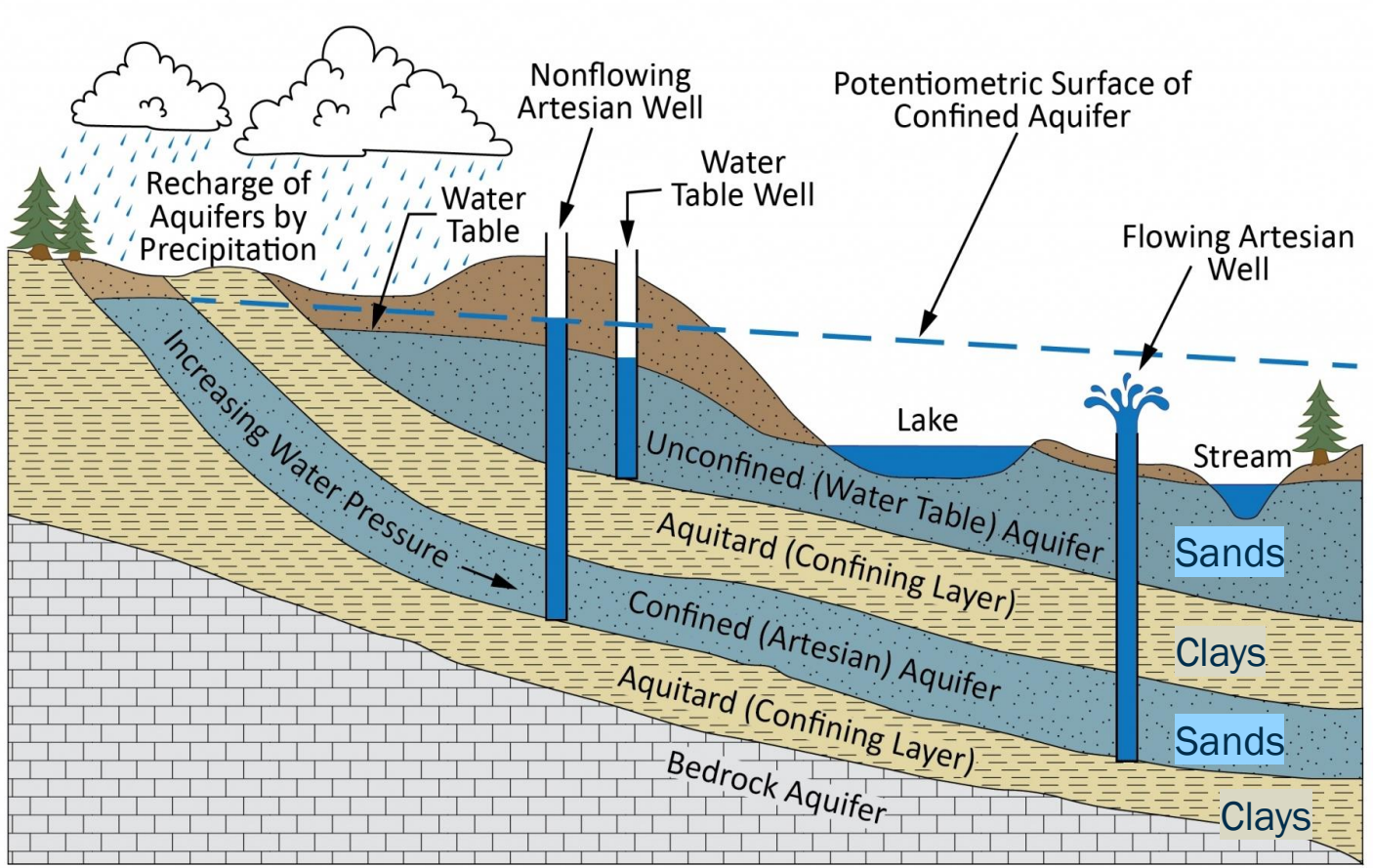
Proposed Six Location of Phase 2 Study (2013)

- 1A
  - No GCD regulations
  - Slightly Saline Water
  - 7,000 to 20,000 AFY
- 2A
  - Fresh water in Lower Chicot
  - 10,000 to 20,000 AFY
  - Away from injection wells
  - Close to Mary Rhodes pipeline
  - GCD regulations

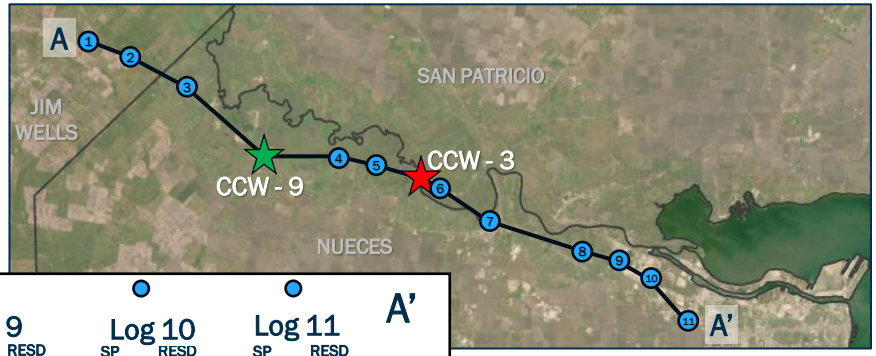


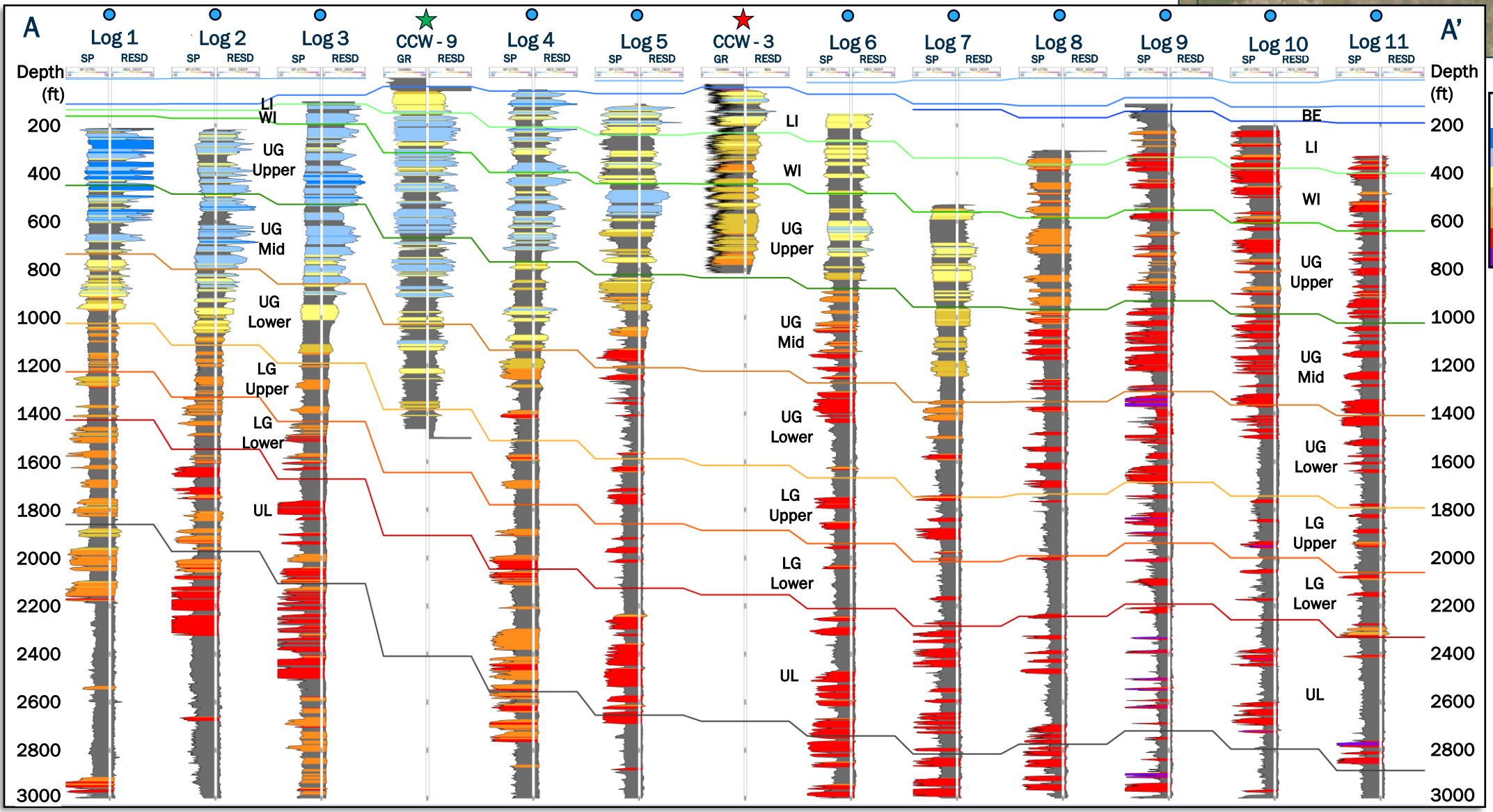
Conceptualization of Regional Groundwater Flow

- Horizontal Flow Controlled by Sands
  - Sand percent – horizontal hydraulic conductivity
  - Sand thickness & percent– transmissivity
- Vertical Flow Controlled by Clays
  - Clay percent – vertical hydraulic conductivity
  - Clay thickness & percent – vertical conductance
- Available Drawdown
  - Height of water column in a well above the top of the aquifer
  - Sometimes call the pressure head
- Confined Aquifer Response to Pumping
  - Orders of magnitude quicker than unsaturated aquifers
  - Recovers 50% of drawdown in a few days after pumping for several years



Nueces County Cross Section



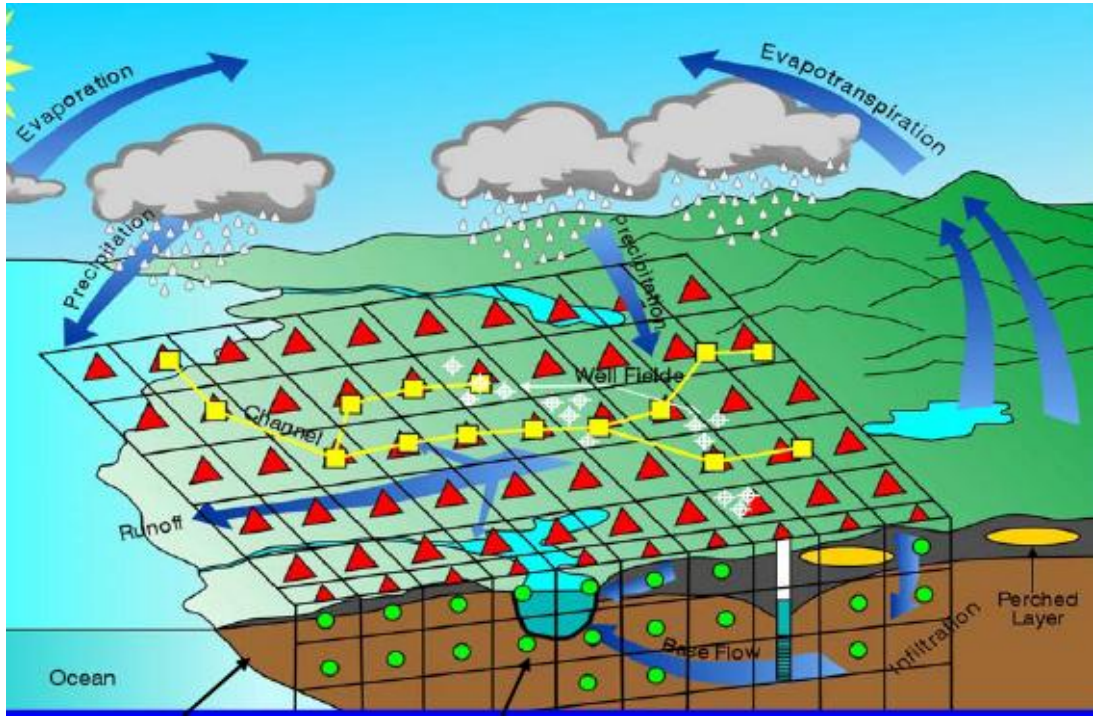


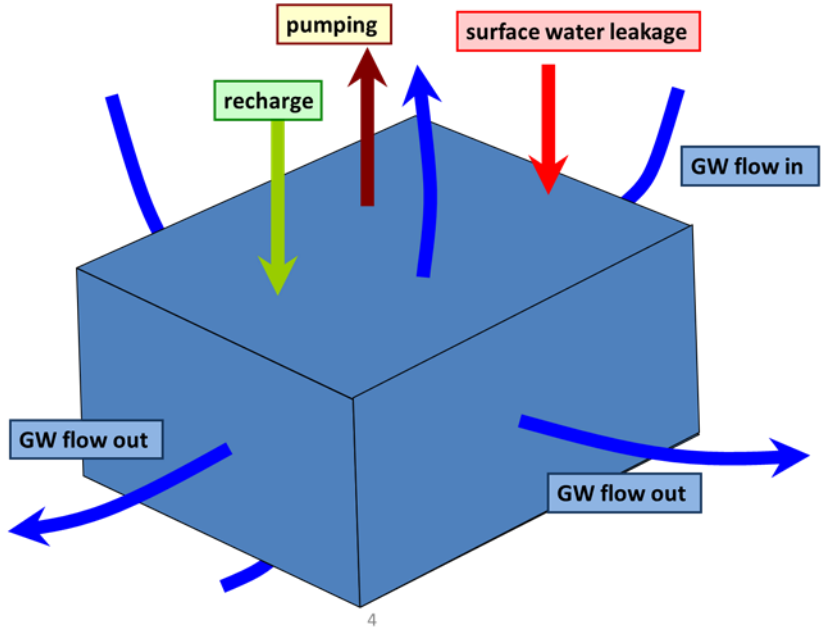
Quality	TDS (mg/L)
Fresh	< 1,000
Slightly Saline - L	1,000 – 2,000
Slightly Saline - H	2,000 – 3,000
Mod Saline - L	3,000 – 5,000
Mod Saline - H	5,000 – 10,000
Very Saline	10,000 – 35,000
Brine	> 35,000

INTERA

Description of a Groundwater Model

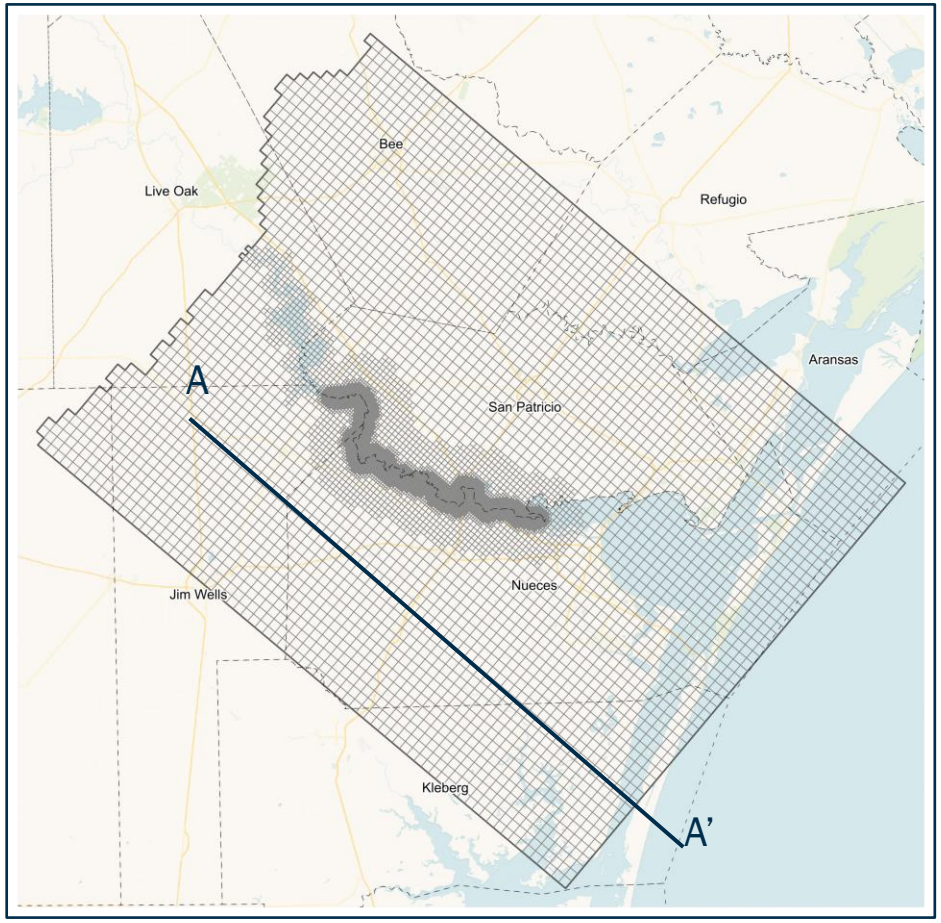
- a tool that integrates data and hydrology to predict groundwater flow
- the tool acts like a big Excel spreadsheet where grid cells physically represent “blocks” of aquifer material
- water levels are predicted by solving for a water balance at each block using equations describing groundwater flow

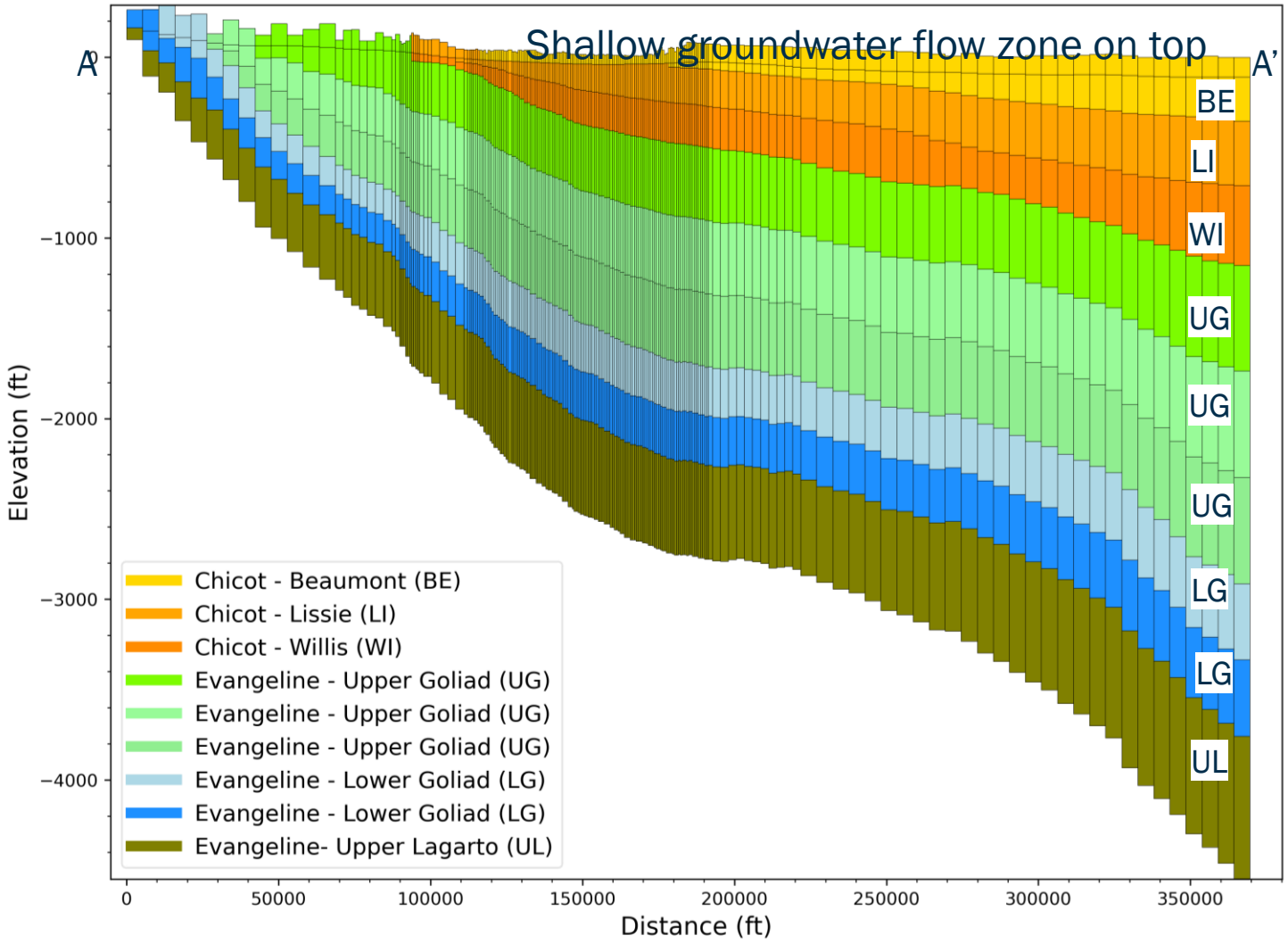




Note: Schematic from MODHMS MODFLOW Manual

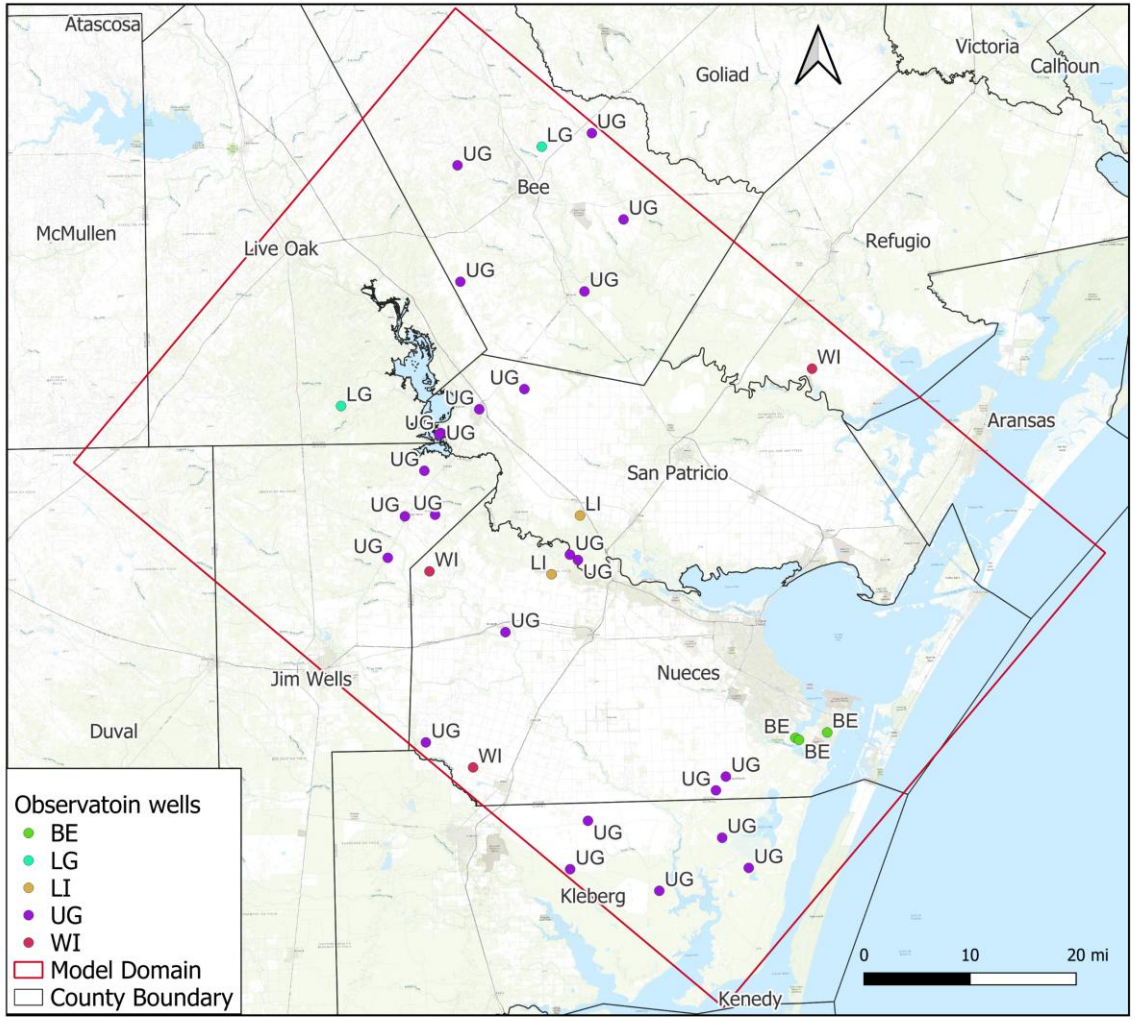
Nueces GW Model: Numerical Grid and Layers

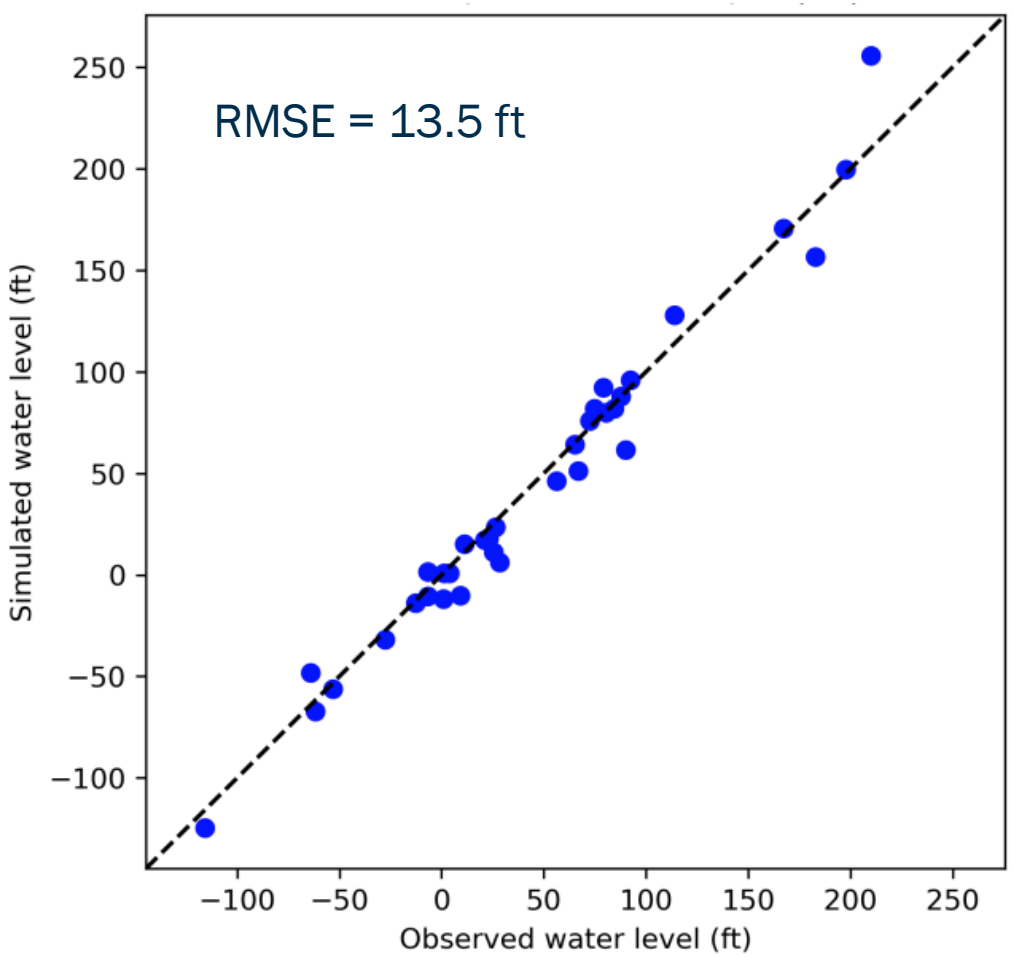




Note: Model develop to evaluate wellfields along Nueces River
Evangeline Laguana model includes ~95% of Refugio County

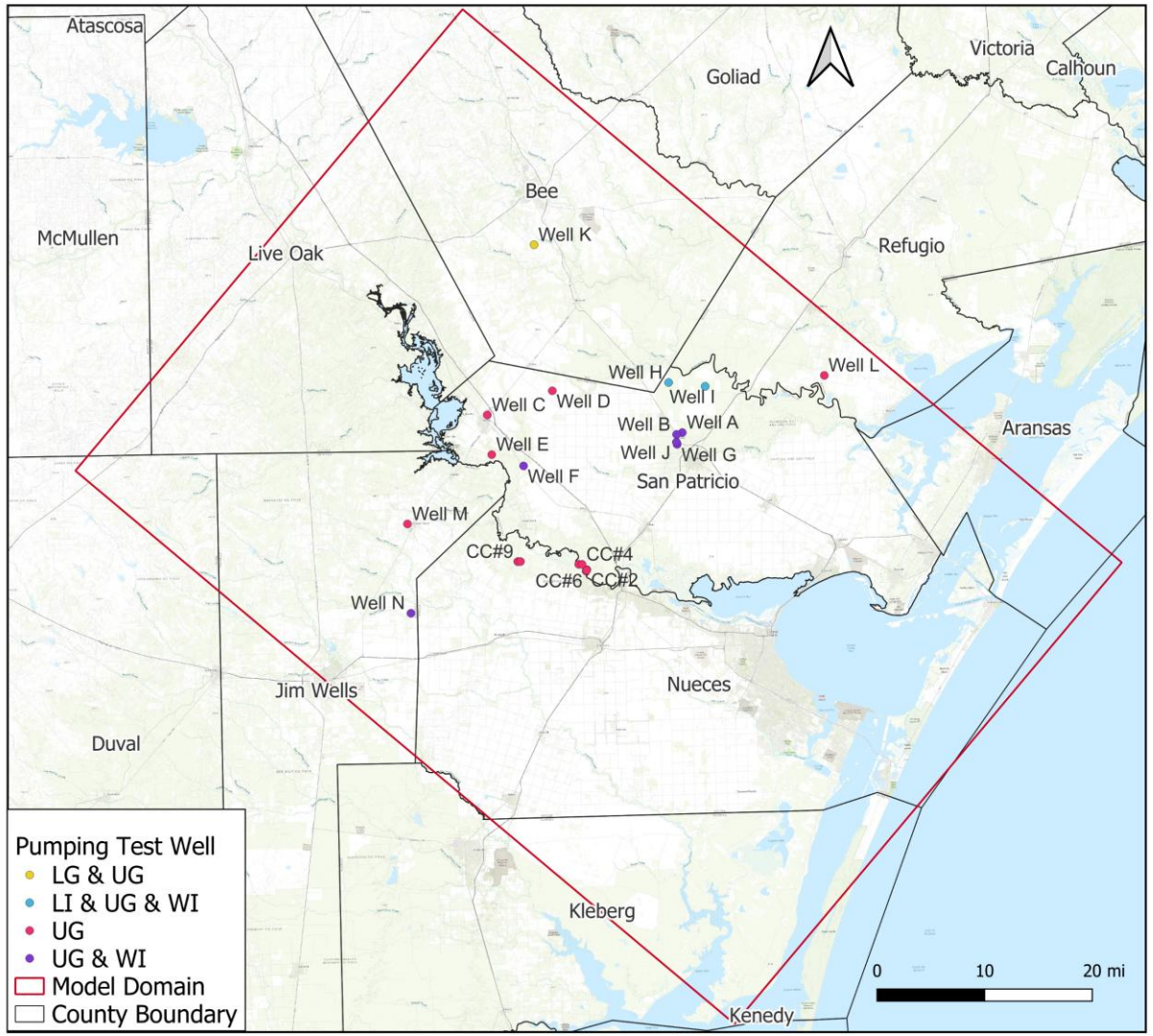
Water Levels: Simulated vs Observed

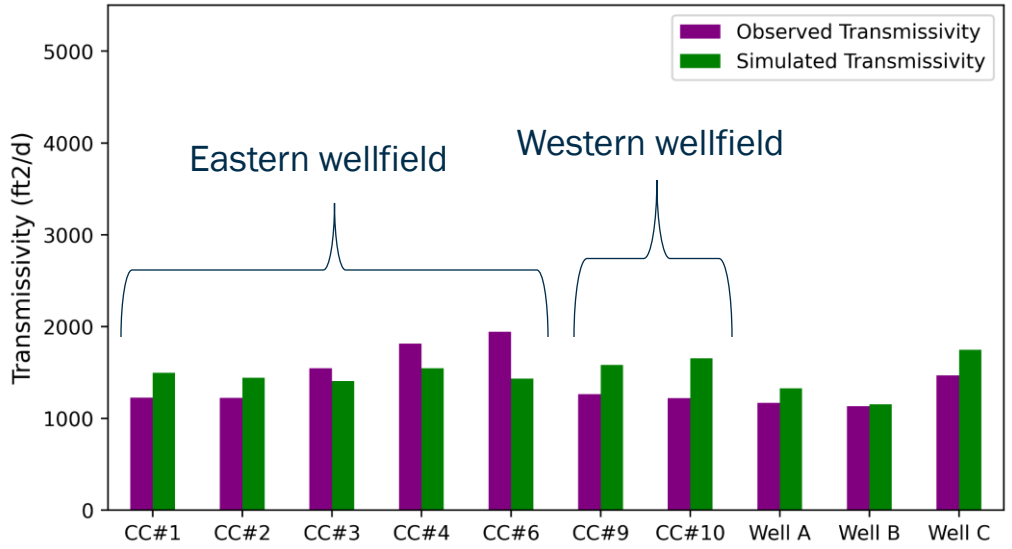


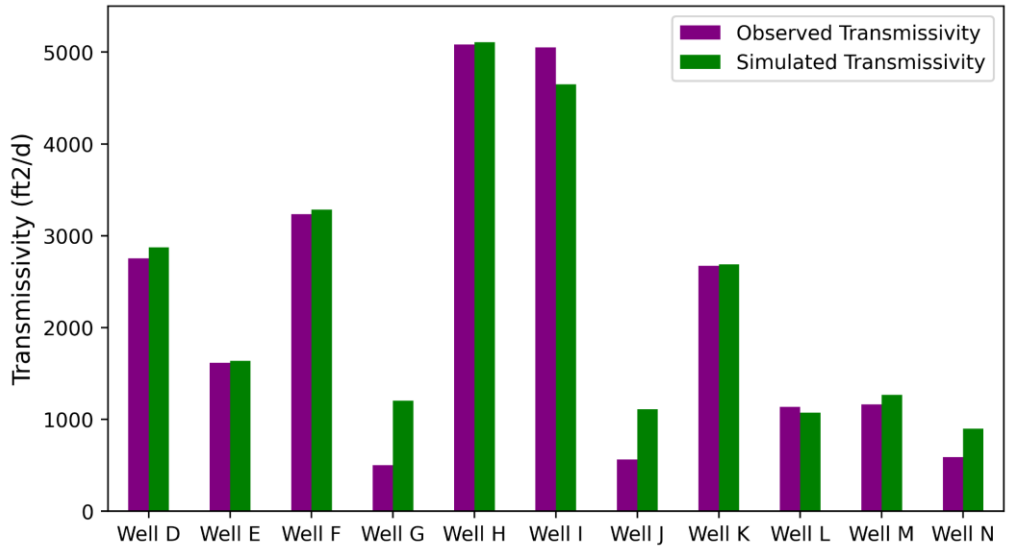


INTERA Model - water level fitting at steady state.

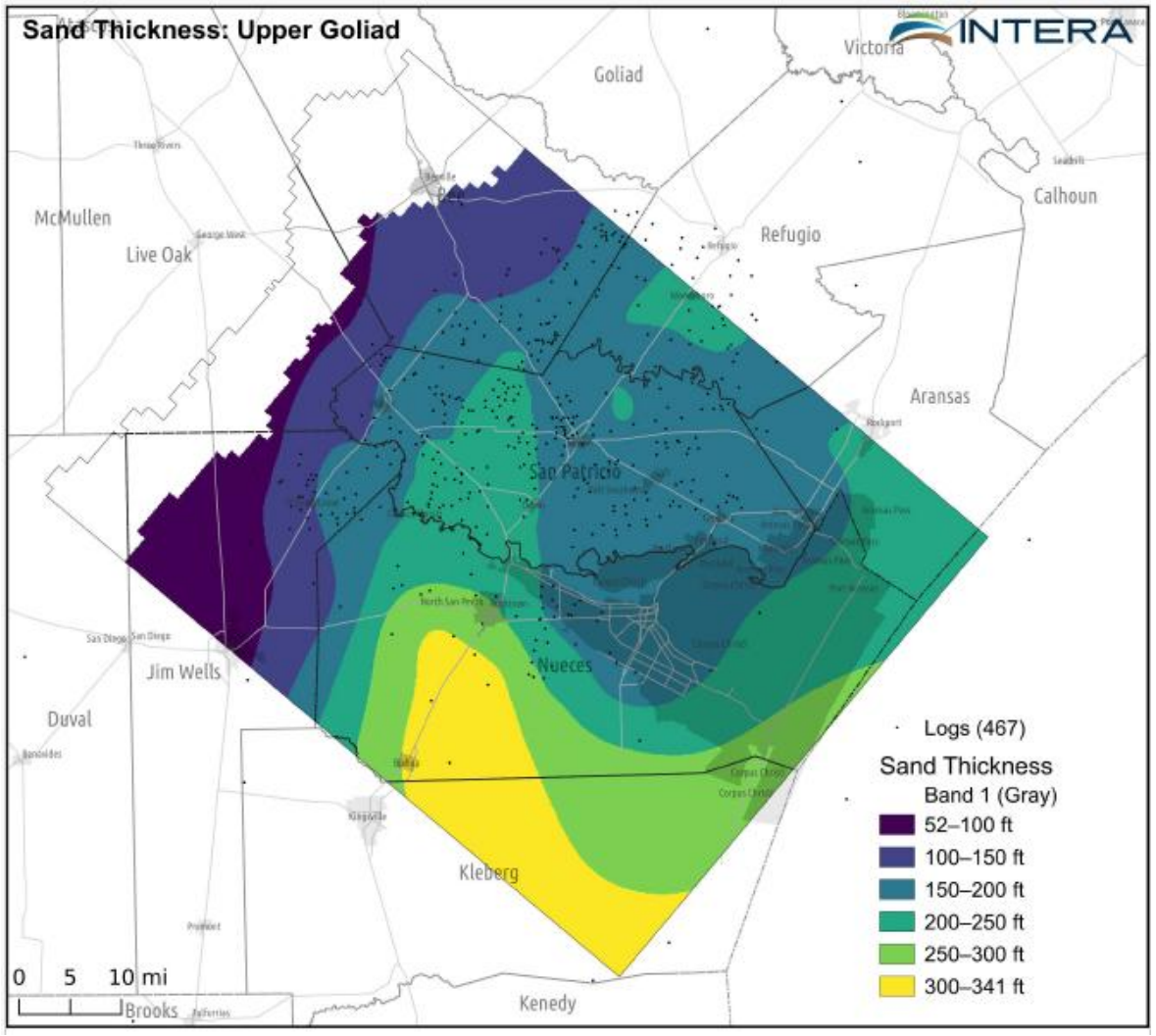
Transmissivity: Simulated versus Observed

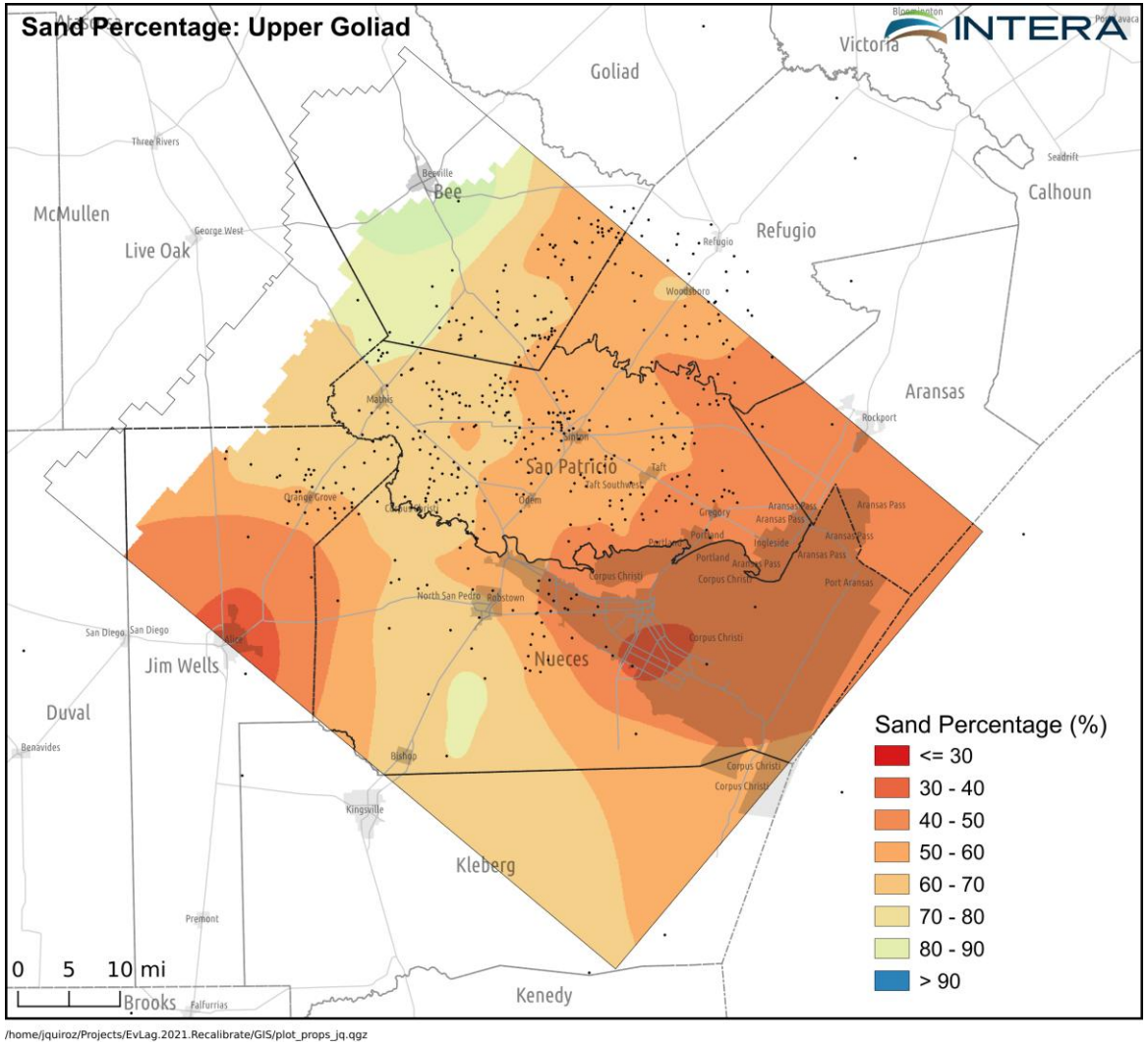




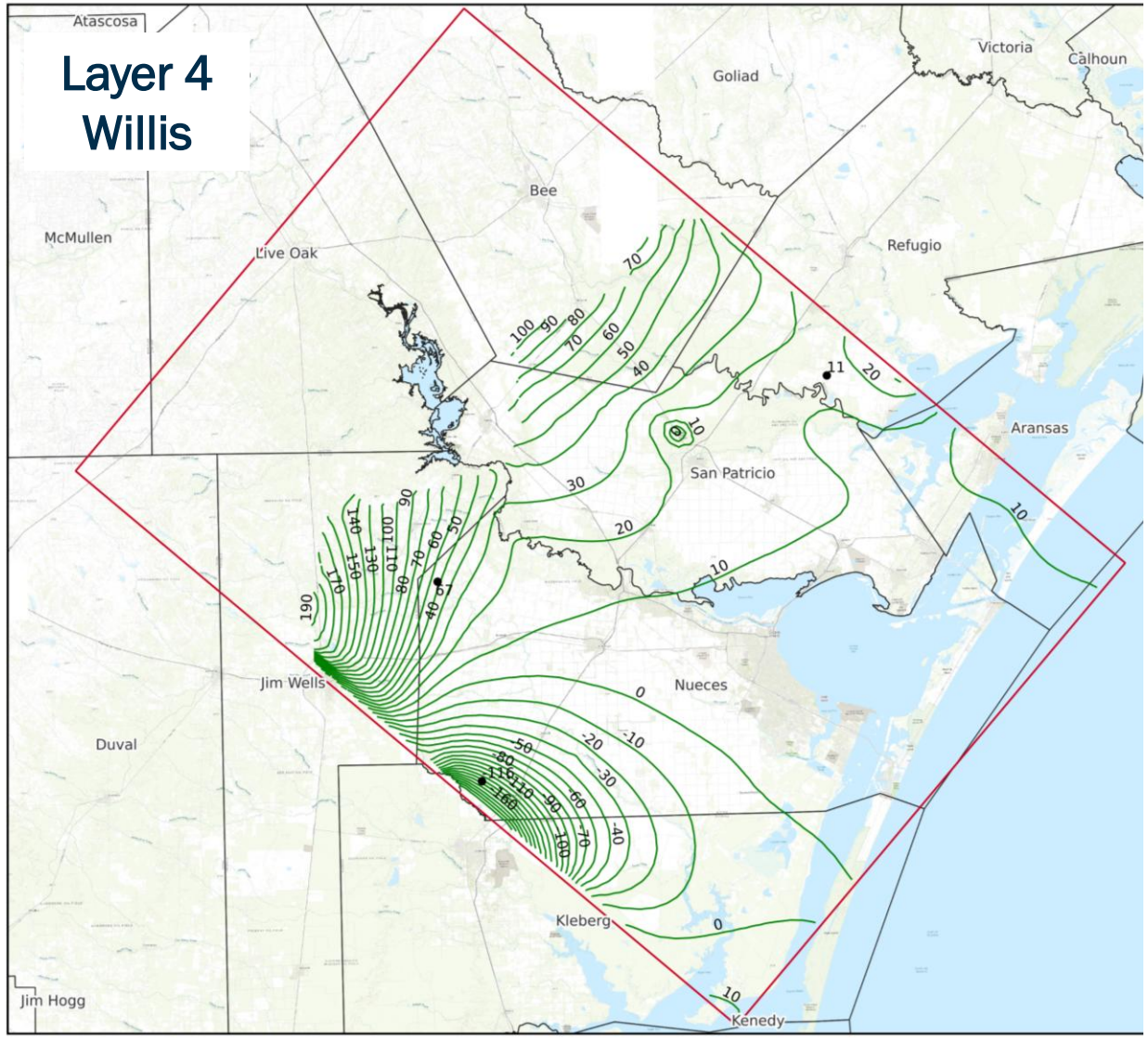


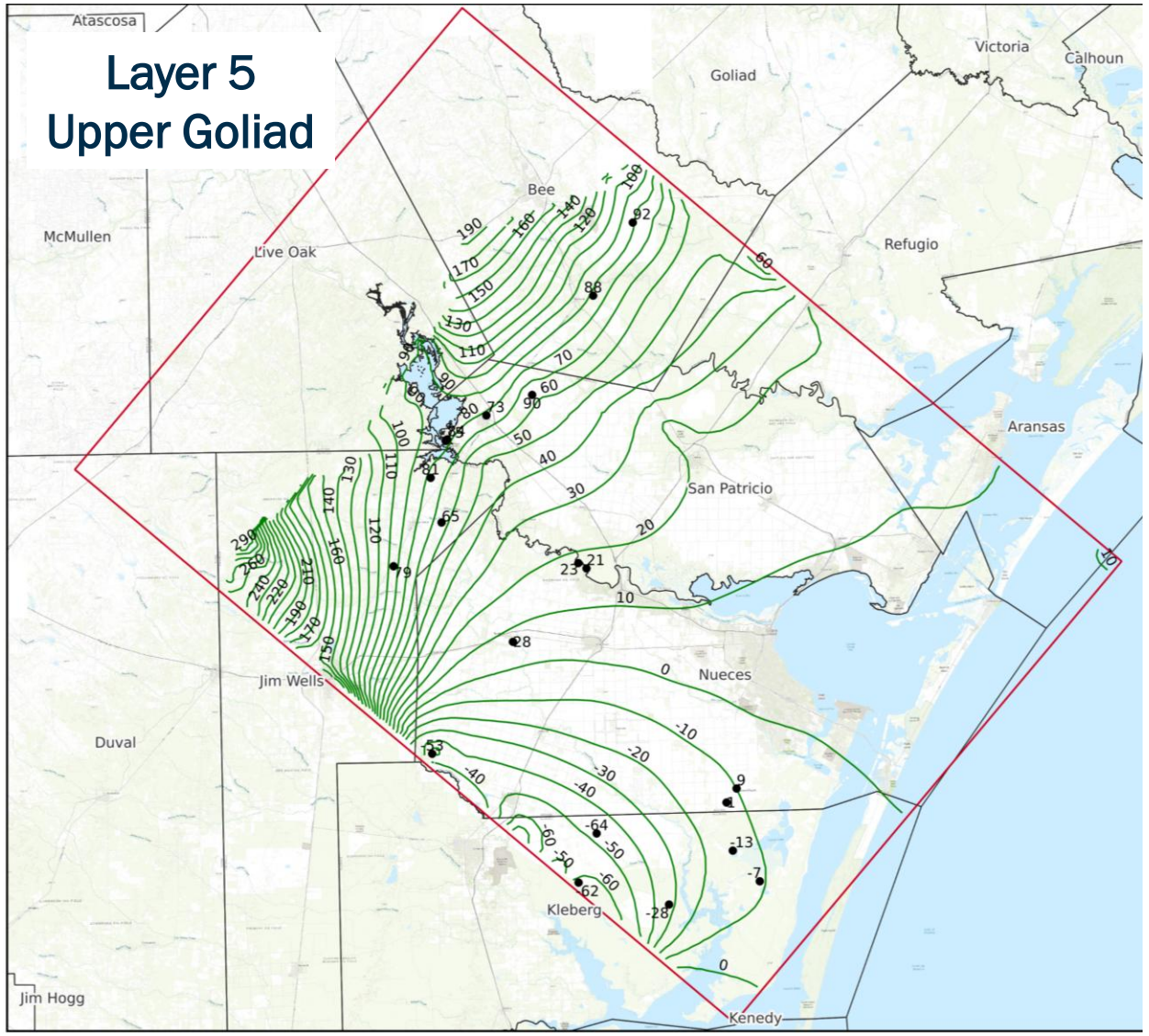
Geophysical Logs & Sand Percents & Thicknesses





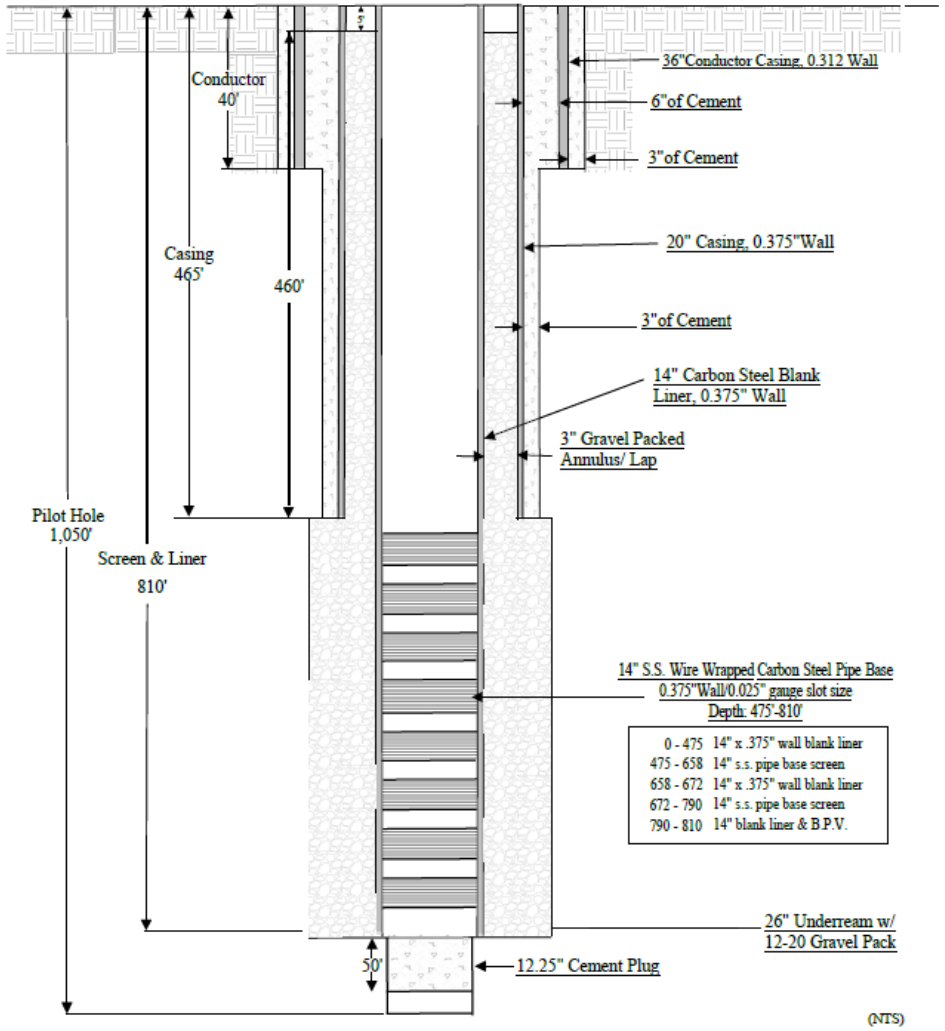
Simulated Water Levels: Preproduction Conditions





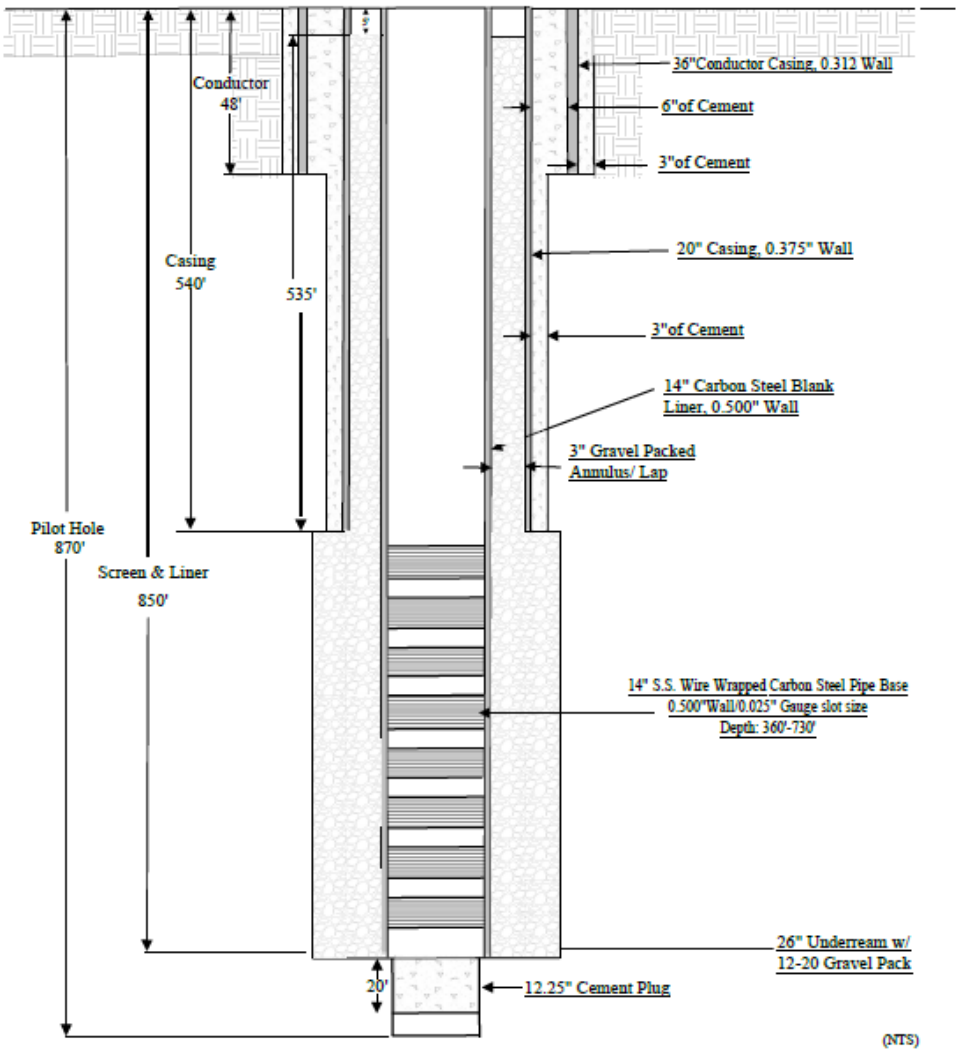
Design of Production Wells

Eastern Well Field



Cross-Sectional Well Drawing_ Corpus Christi Nueces Wells_ Well 1 2/26/2025

Western Well Field



Cross-Sectional Well Drawing_ Corpus Christi_ Nueces Well 12 10/15/2025

Summary: Groundwater Model for Nueces County

- Nueces County Groundwater Model
  - uses 10 layers to represent Chicot and Evangeline aquifers in order to accurately locate pumping intervals and location of existing well (TWDB GAM has 2 layers)
  - shallow groundwater flow zones separate deep pumping wells from river cells
  - uses innovative methods to constrain aquifer hydraulic properties based on result of aquifer pumping tests
  - sand maps and clay maps to constrain aquifer properties to reasonable values in areas between aquifer pumping tests
  - Model calibration to water levels is very good– groundwater flow directions appear to be well constrained
  - The Nueces County Groundwater model was developed to simulate both short-term and long-term pumping conditions for the two well fields in Nueces County.
- On-going Work
  - Plans to include additional aquifer pumping tests in Nueces county
  - Adding additional sand picks and vetting existing sand picks to create an improved constrains for aquifer properties
  - Add additional measured water levels including those measured at Evangeline Laguan Test Wells
  - Incorporate a land subsidence package

Approach to Simulating Land Subsidence

$$\Delta b = \Delta d * \alpha_{eff} * C_t$$

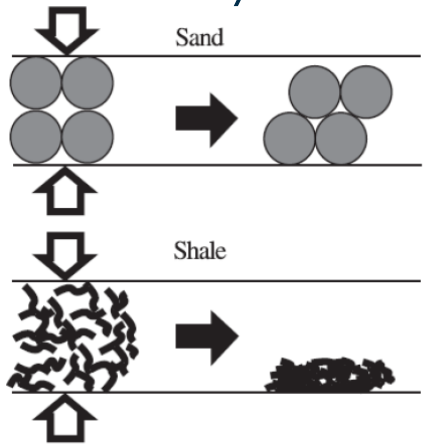
Δb = the thickness that the aquifer has compacted (L)

Δd = Amount of drawdown in the aquifer since predevelopment (L)

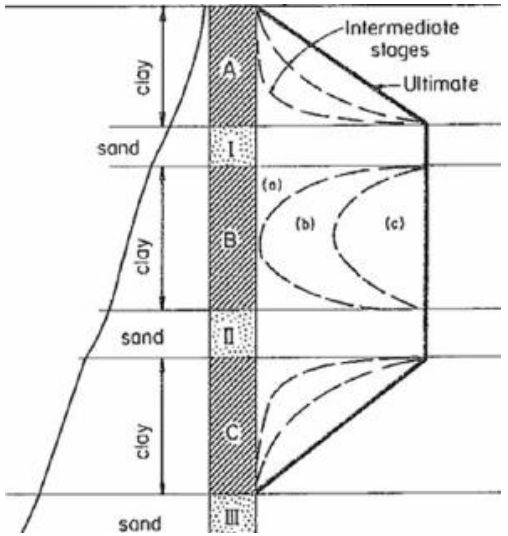
α_{eff} = Effective compressibility coefficient for clays in the aquifer (L^{-1})

C_t = Total thickness of the clay units in the aquifer (L)

Response to Stress/Additional Weight



Process that Causes a Delayed Response



Discussion of Model Application

- Available drawdown above well screen is about 450 ft for Eastern Wellfield and about 530 ft for Western Wellfield
- Model produces >20 MGD for 3-years with keeping about 100 feet of water column above top of screen
- Evaluated drawdown impacts at 3,000 wells in San Patricio and Nueces Counties.
  - 22 wells with simulated drawdowns between 50 to 100 ft
  - 6 well with simulated drawdown between 100 and 150 ft
- Work on-going to adjust spatial distribution of pumping to reduce drawdown impacts
- Monitoring wells exists that will allow Corpus Christi staff to monitoring shallow formations
- Modeling and monitoring data will provide information for wellfields to be managed properly
- Model will be updated as field information becomes available