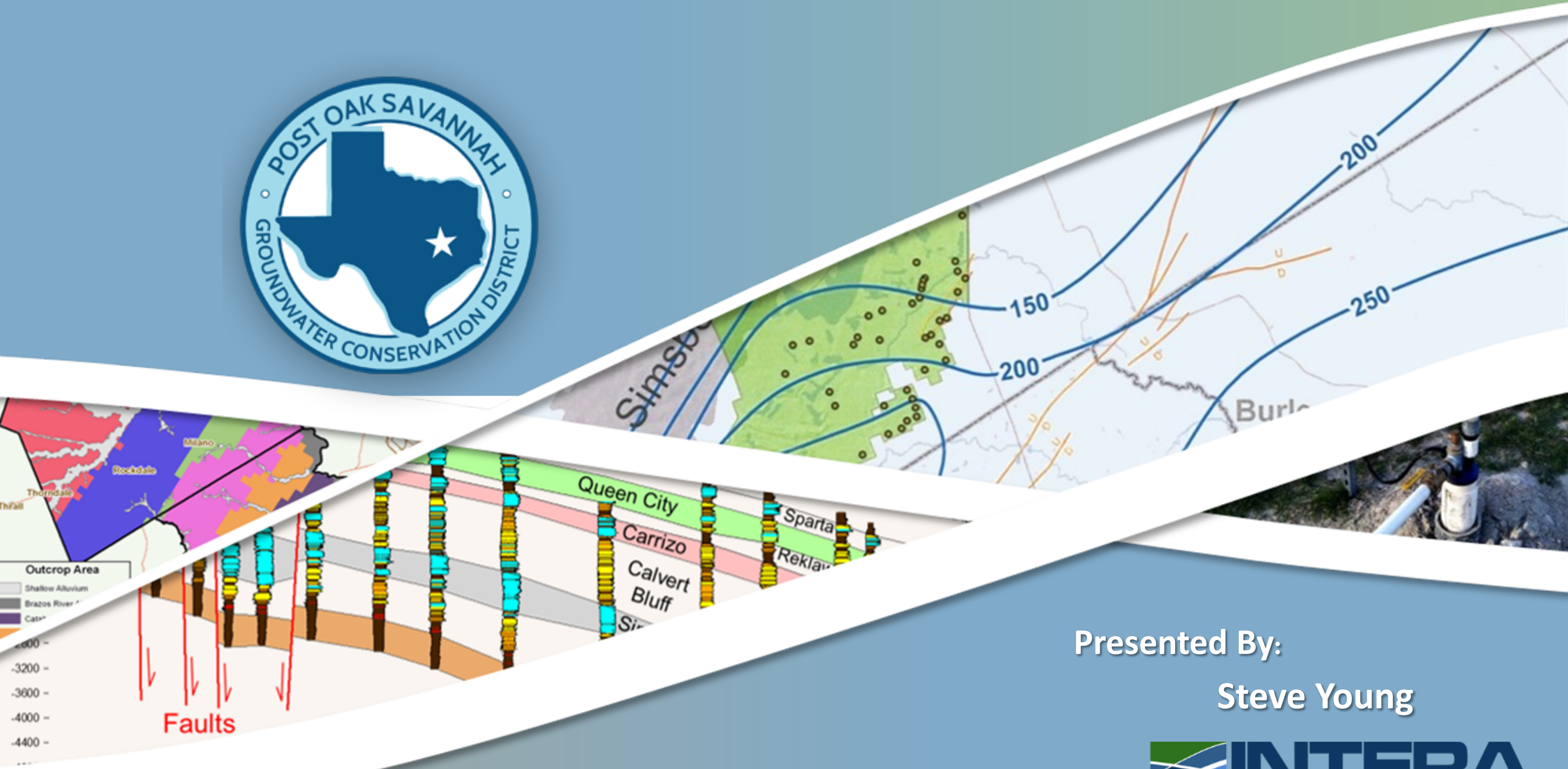
POSGCD Desired Future Conditions Committee



Presented By:

Steve Young

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

March 8, 2022

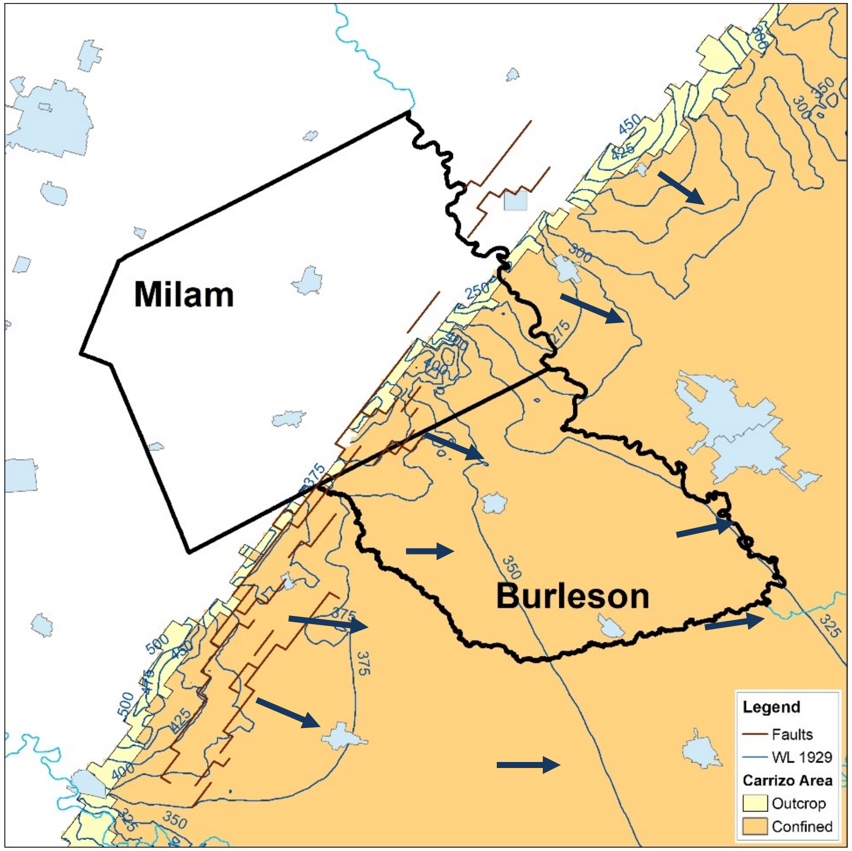
Outline

- Simulation of Simsboro and Carrizo Aquifer WLs from DFC GAM Run for GMA 12 (12 minutes)
- DFC Compliance Based on Revised Analysis Methods (25 minutes)
- Boundaries for "Management Zones" Associated with DFCs (20 minutes)
- Maximum Production Volumes Based on Permitted Acreage (30 minutes)
- Compatibility of DFCs and PDLs (10 minutes)
- Update on GMA 12 Joint Planning (2 minutes)
- Questions (until 5:00 pm)

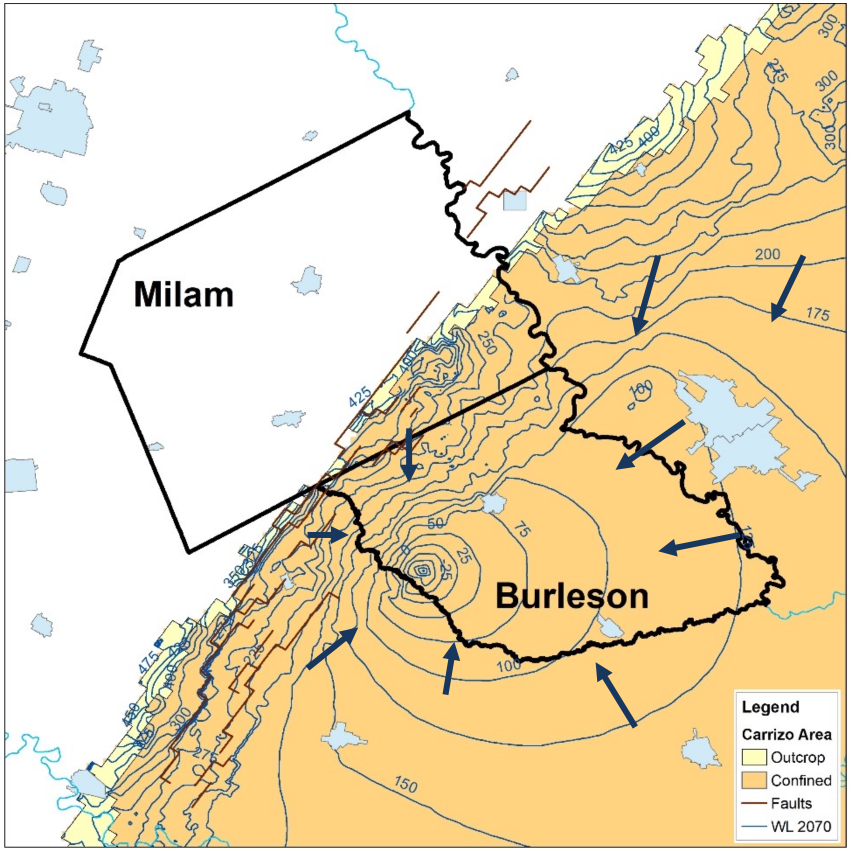
Review of S-19 DFC GAM Run for GMA 12

Carrizo Simulated Water Level

1929

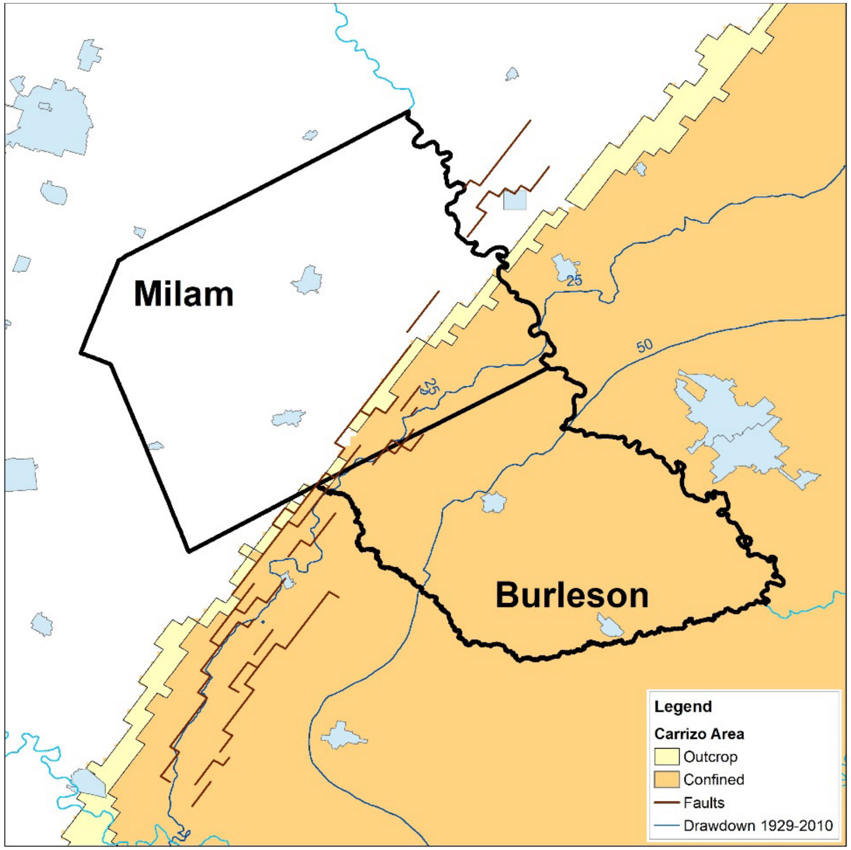


2070

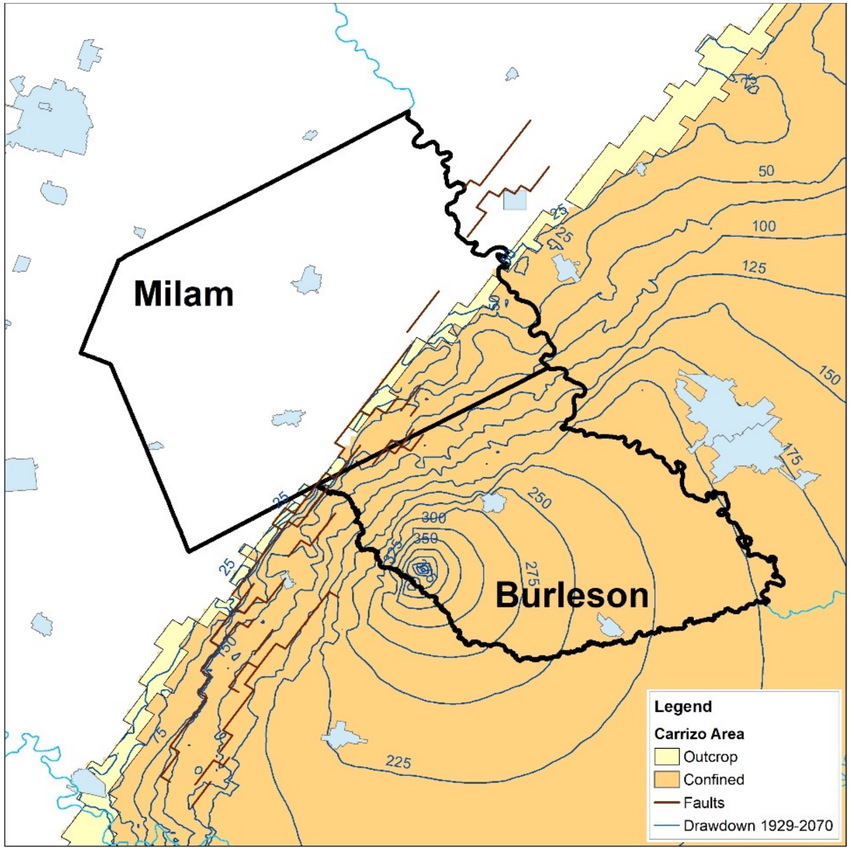


Carrizo Simulated Drawdowns

1929 -2010

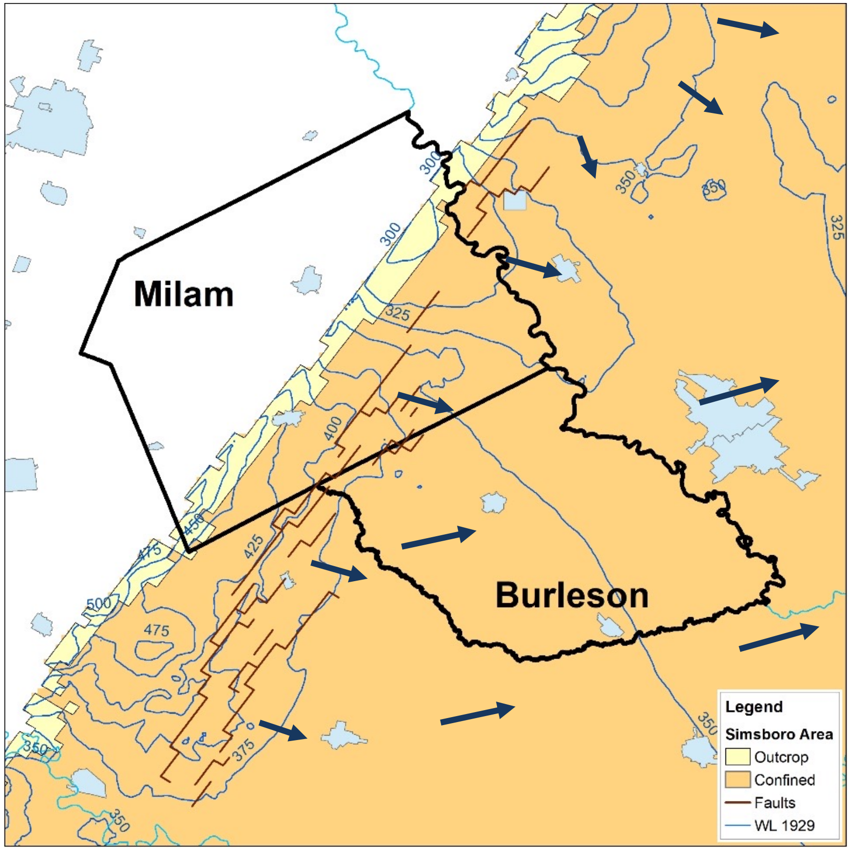


2010-2070

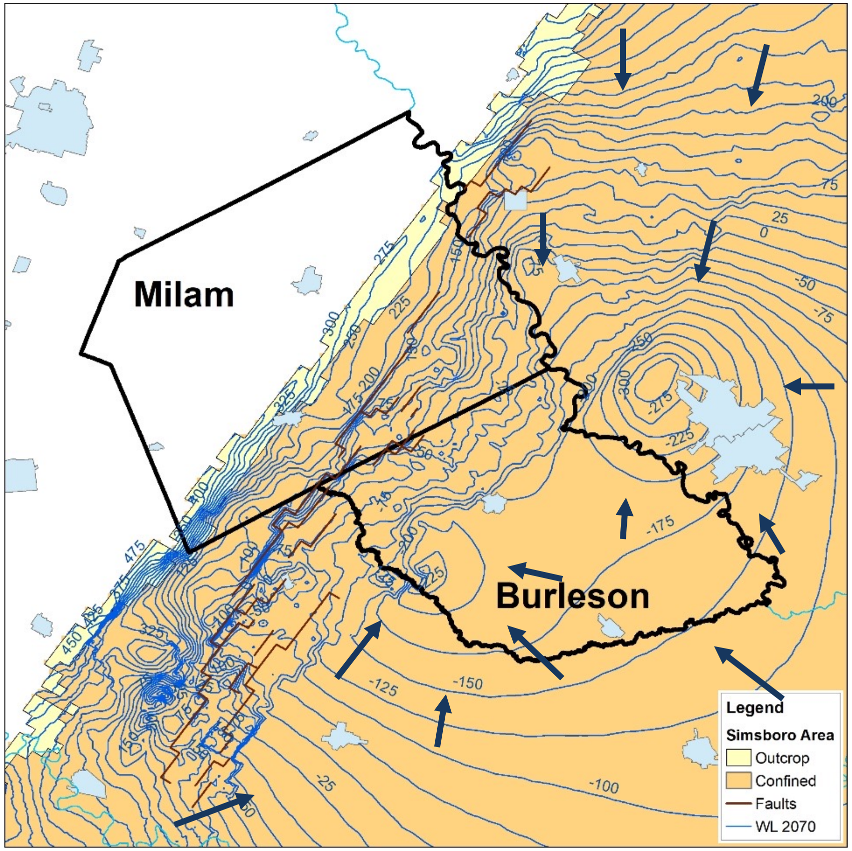


Simsboro Simulated Water Level

1929

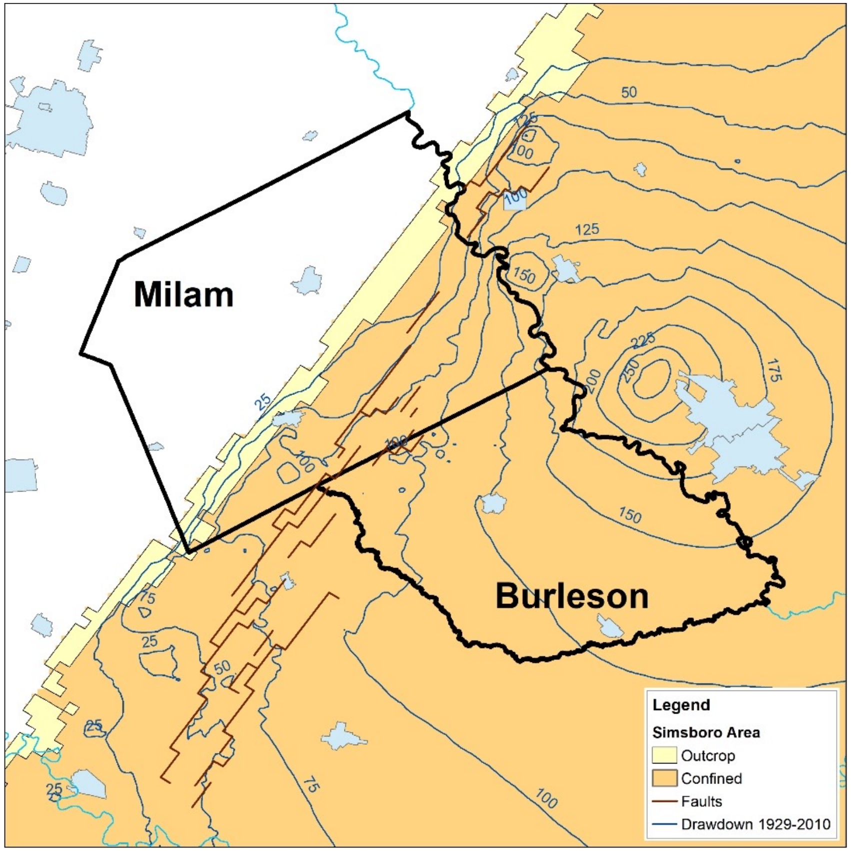


2070

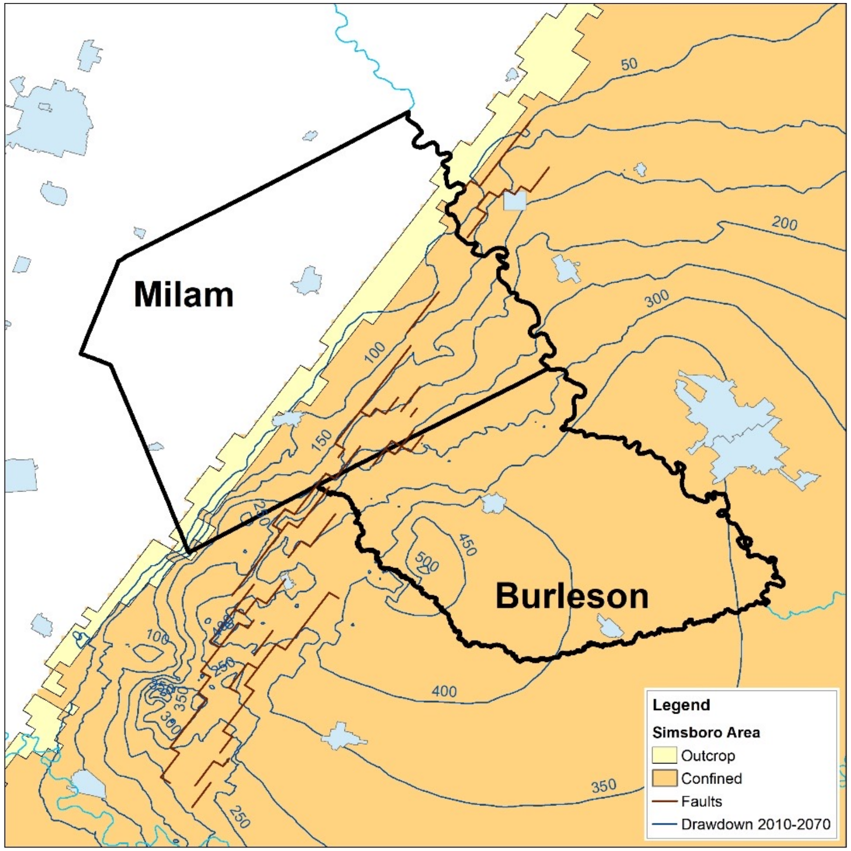


Simsboro Simulated Drawdowns

1929 -2010



2010-2070



Summary

- Observations
  - Significant trends/patterns exists in the water level contours and drawdown contours
  - 2010-2070 drawdowns vary between ~ 50 feet to 300-450 feet
  - Outside of the well fields, drawdowns are generally greater in deeper than shallower portions of the aquifer
- Implications to Interpolation of Measured Water Levels for DFC compliance
  - Shallow water levels/drawdowns cannot be reliably extrapolated to deep zones without secondary information
  - Data outside of a POSGCD is needed in order to properly interpret data inside POSGCD
  - Location of data as similar importance than the amount of data

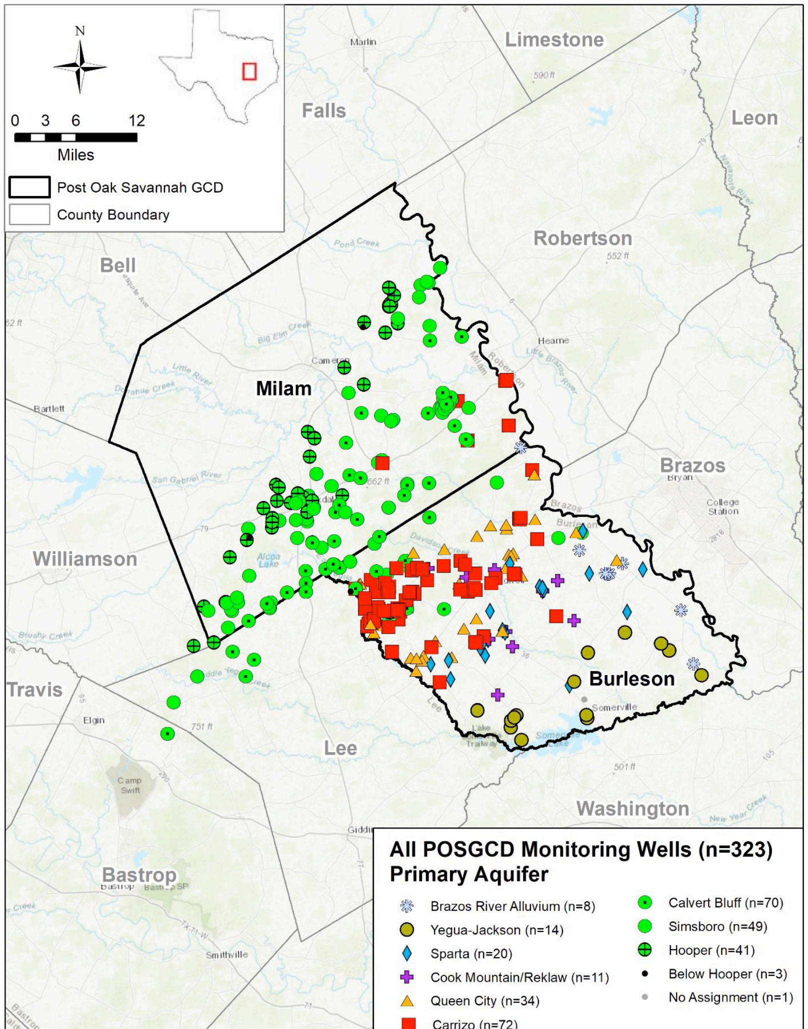
DFC Compliance Based on Revised Analysis Methods

Major Updates to Guidance Document

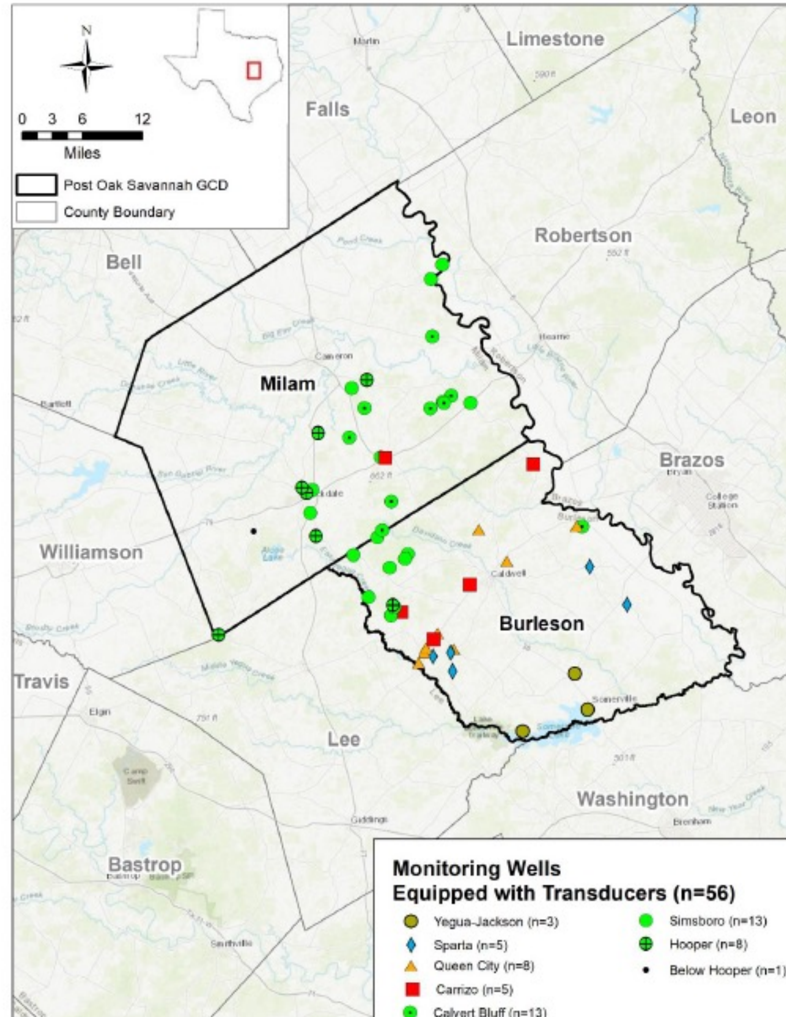
- Addition of Transducer Wells
- Update Monitoring Well Information Including Aquifer Assignments
- Averaging Period Changed from November 1 to April to January 1 to April 30
- Option to Use Common Wells or All Available Wells for Each Year
- Expanded Data Analysis Methods to Include Two Geostatistical Methods
  - Kriged Water Levels
  - Kriged Residual

Monitoring Wells: Addition of Transducer Wells

Total= 323 (109 in 2018)

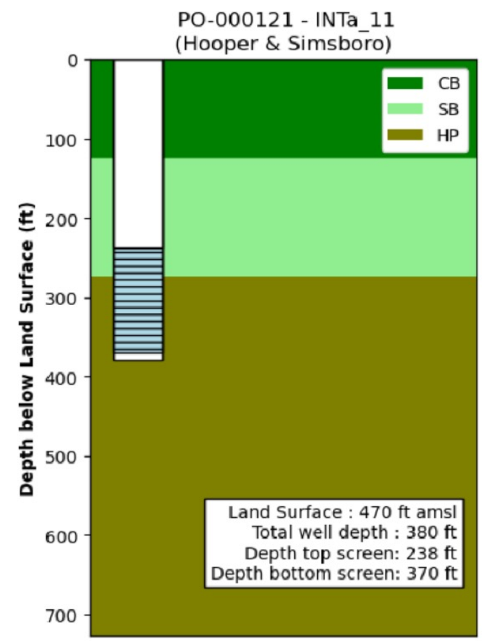


w/Transducer =55 (20 in 2018)



Monitoring Wells: Aquifer Assignment

- 70% of the well screen needs to be in an aquifer
- Using information from GAM and geophysical logs



Coordination with TWDB on Well Information (memo sent June 2021)

Requested Changes :
1) 134 Well locations
2) 30 Aquifer assignments
3) 13 wells with different completion information

Status of Review:
1) Well locations approved, waiting for TWDB database update
2) Well construction approved except for one well
3) Will not complete aquifer assignment until 2022

Data Analysis Method for Calculating Average Drawdowns

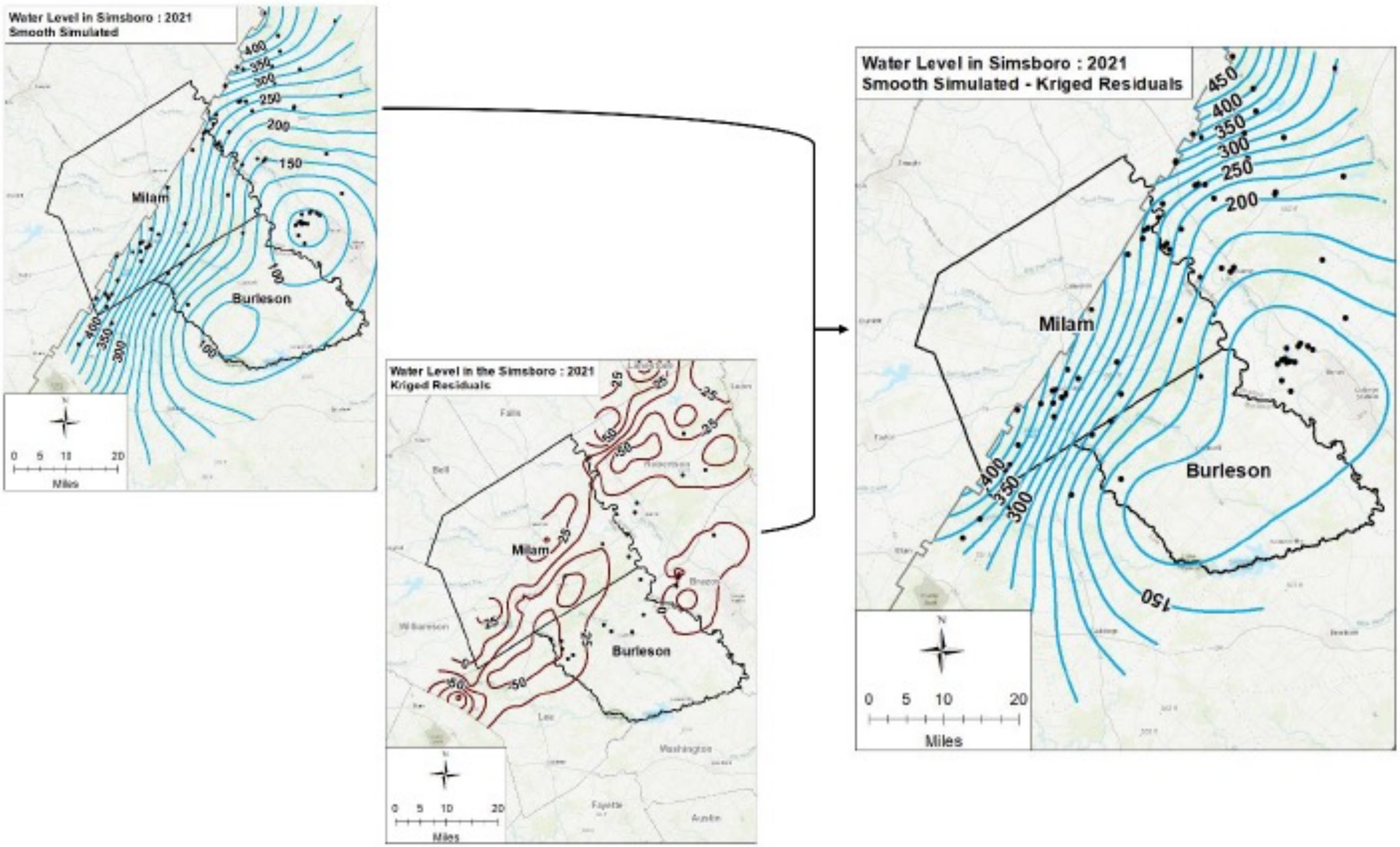
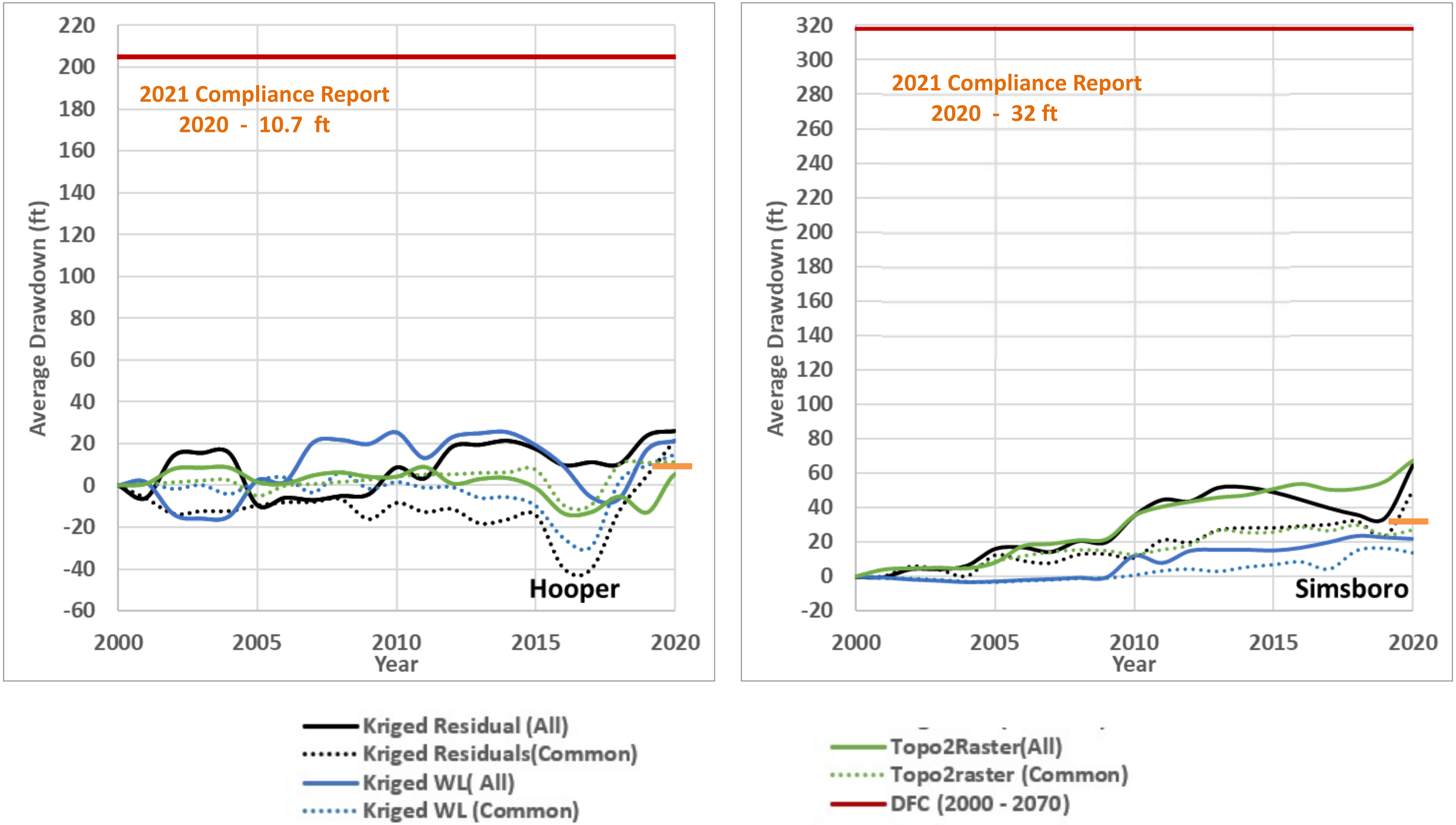
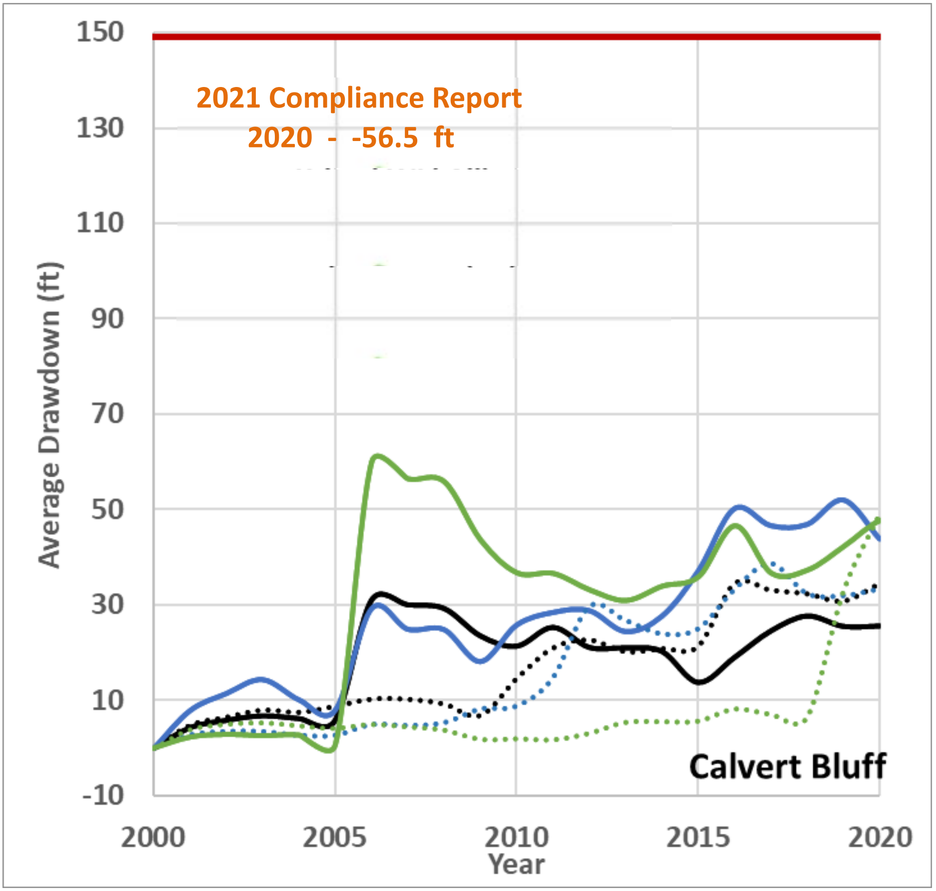


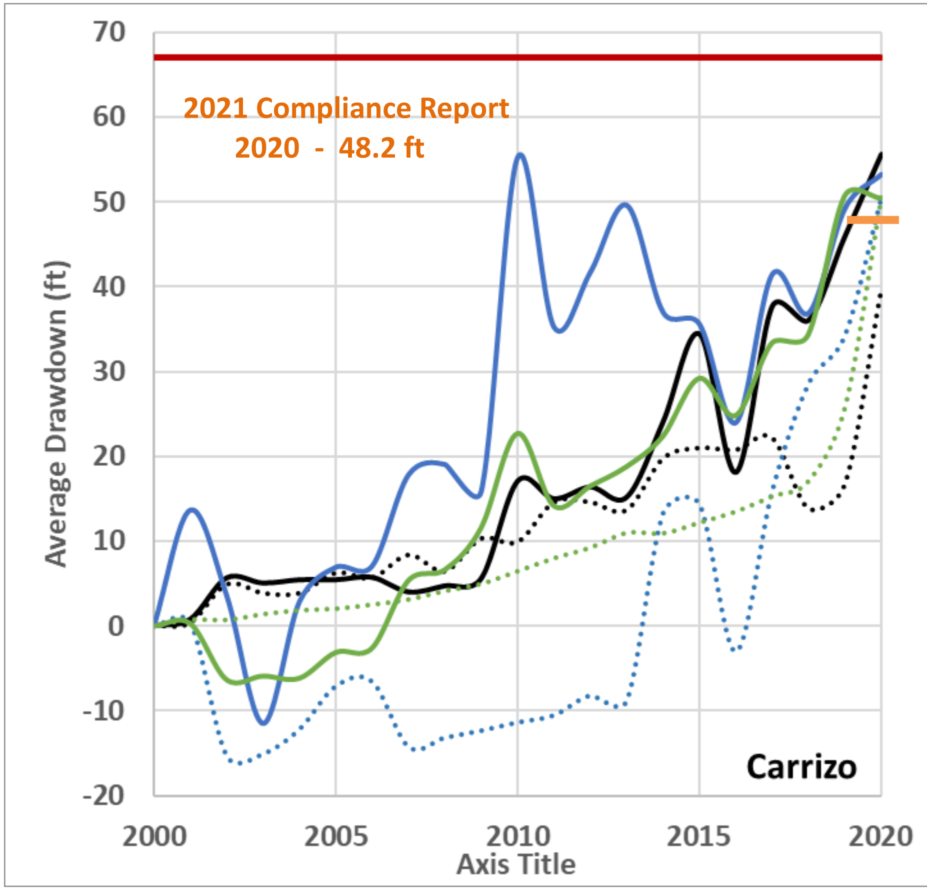
Figure J-2 Diagram showing steps to combine simulated water level surface (left) and Kriged residuals (middle; simulated minus measured water level) to generate final water level surface (right).

Revised Averaged Drawdowns (draft): Hooper & Simsboro

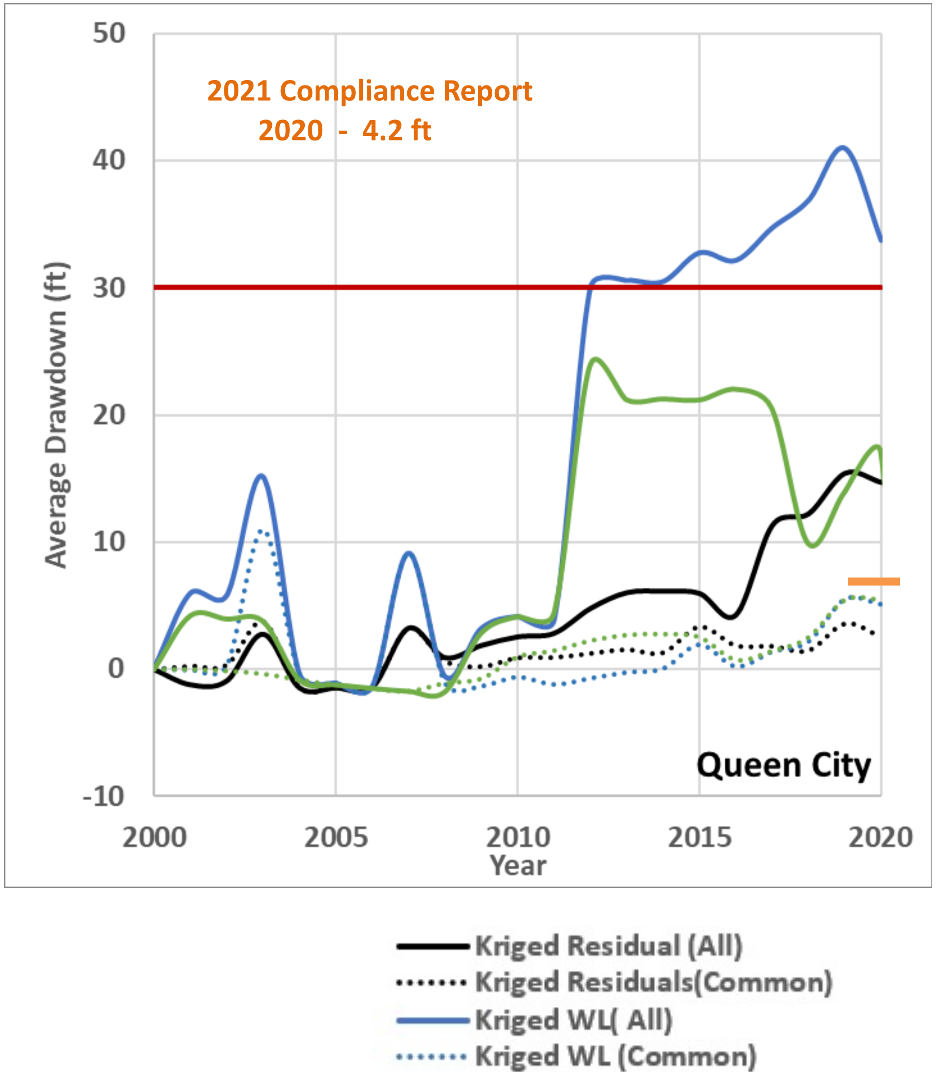


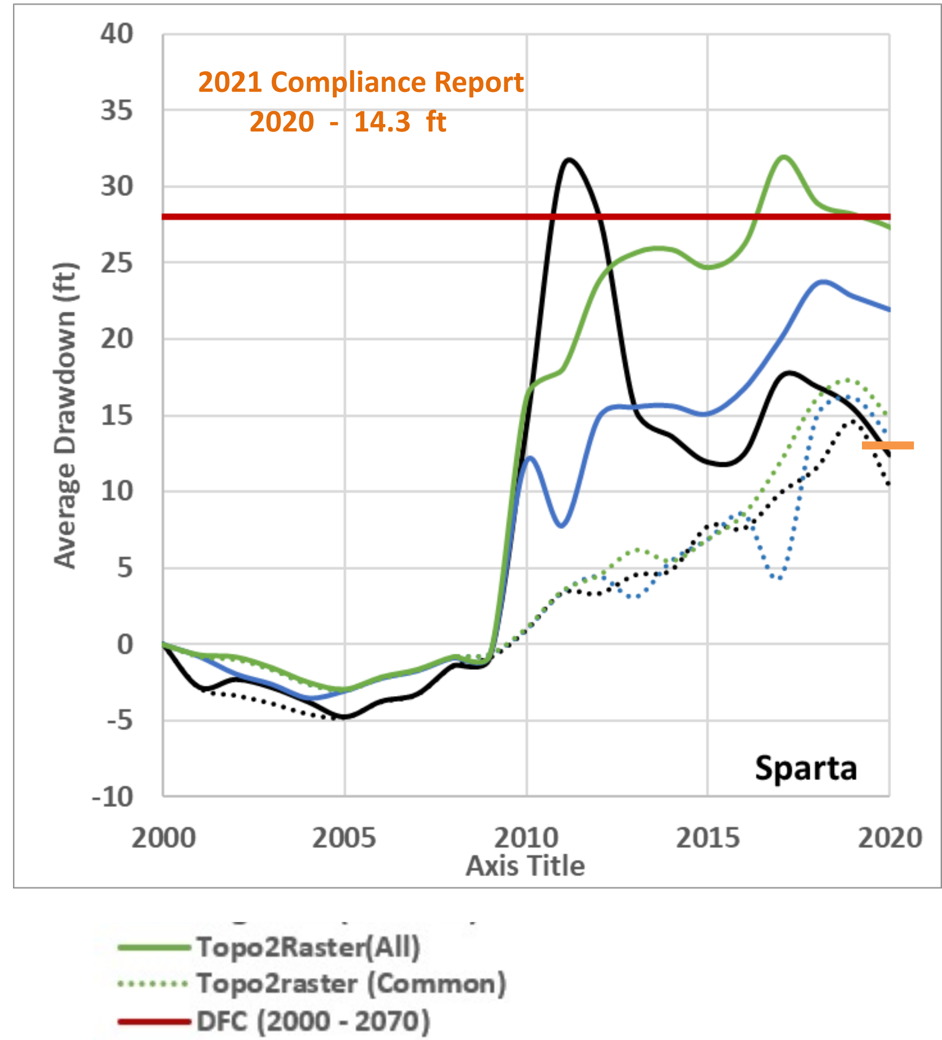
Revised Average Drawdowns (draft): Calvert Bluff & Carrizo





Revised Average Drawdowns (draft): Queen City & Sparta



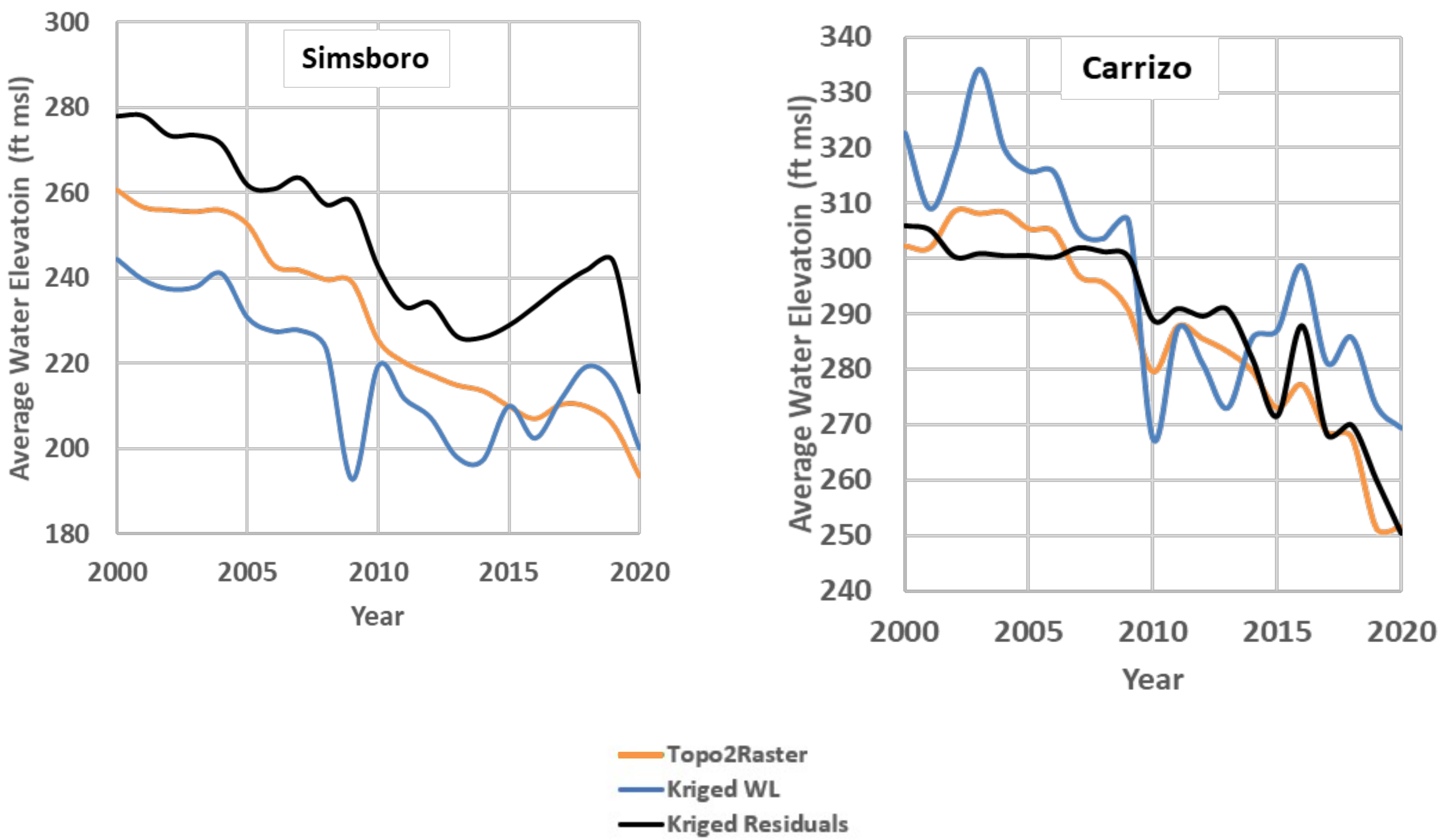


Summary of Calculated Average Drawdowns for 2000-2020

- Use of common wells consistently produces less drawdown
- Variability among annual drawdowns much less for Carrizo-Wilcox aquifers than for Queen City and Sparta aquifers
- The differences among three methods can vary significantly among successive years
- Results are sensitive to outliers (WLs need to be carefully checked)
- Results are sensitive to non-POSGCD WL data
- Kriged Residual Method produces most consistent set of water level contours

Aquifer	Current Method: Topo2Raster (common wells)	Revised Method (all wells)		
		Kriged Residuals	Kriged WLs	Topo2Raster
Sparta	14.3	12.3	21.9	14.8
Queen City	4.2	14.6	33.6	5.5
Carrizo	48.2	55.6	53.2	50.5
Calvert Bluff	-56.5	24.6	43.8	47.8
Simsboro	32	64.5	44.3	67.3
Hooper	10.7	25.8	21.4	11.1

Calculated Average Water Levels (con't)



Summary

- Analysis Method
  - Primary: Kriging with Residuals
  - Secondary: Kriging with Water Levels, Topo2raster
- Aquifer Assignment
  - Geological Analysis & Water Levels
  - GAM Surfaces
- Well Selection
  - All available wells for each year
  - Use 70% threshold for application
- Water Levels
  - Examine hydrographs trends against pumping trends
  - Check documentation of well condition during pumping

On-going Work

- Additional TWDB & Adjacent GCD Coordination
  - Well Data
  - Aquifer Surfaces

- Prioritize Water Level Measurements
  - “70%” wells
  - “Isolated” wells
  - Investigate Option of Using Index Wells

- Technical Analysis
  - Assessment of confidence limits for each method
  - Improvements to POSGCD operation model
  - Consideration of water level considerations

Boundaries for "Management Zones" Associated with DFCs

Review of Management Zones

RULE 16.1. MANAGEMENT ZONES. Groundwater availability will be conserved, preserved and protected by well spacing, permit requirements, and~~/or~~ limiting water drawdown levels within the Management Zones listed in Section 5 of the Management Plan. The District's rules and regulations will be adopted and enforced in compliance with *Chapter 36, Texas Water Code,* and the Board will take action as needed to accomplish the Desired Future Conditions.

MP Section 5. Management Zones. The District is divided into groundwater management zones for the purpose of evaluating and managing groundwater resources recognizing the different characteristics and anticipated future development of the aquifers in the District.

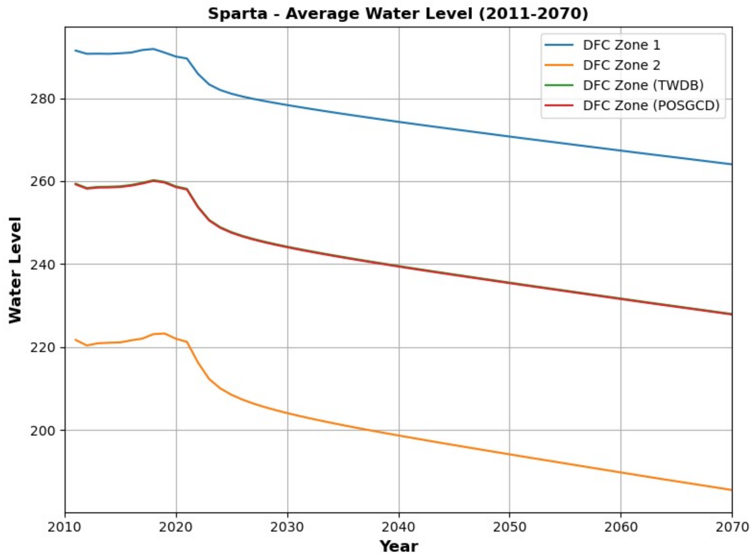
The District will establish and enforce Rules for the spacing of wells, the maximum allowable production of groundwater per acre of land located over an aquifer, require permits for production, regulate drawdown and provide for a reduction in the maximum allowable production and permitted production of groundwater per acre of land based on the different surface and subsurface characteristics and different evaluation and monitoring within the Management Zones.

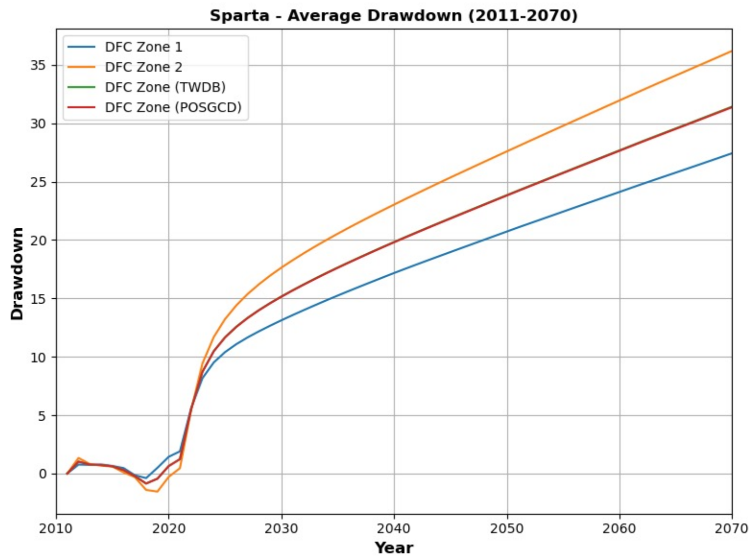
TWC 36.108 (d-1). After considering and documenting the factors described by Subsection (d) and other relevant scientific and hydrogeological data, the districts may establish different desired future conditions for: (1) each aquifer, subdivision of an aquifer, or geologic strata located in whole or in part within the boundaries of the management area; or (2) each geographic area overlying an aquifer in whole or in part or subdivision of an aquifer within the boundaries of the management area

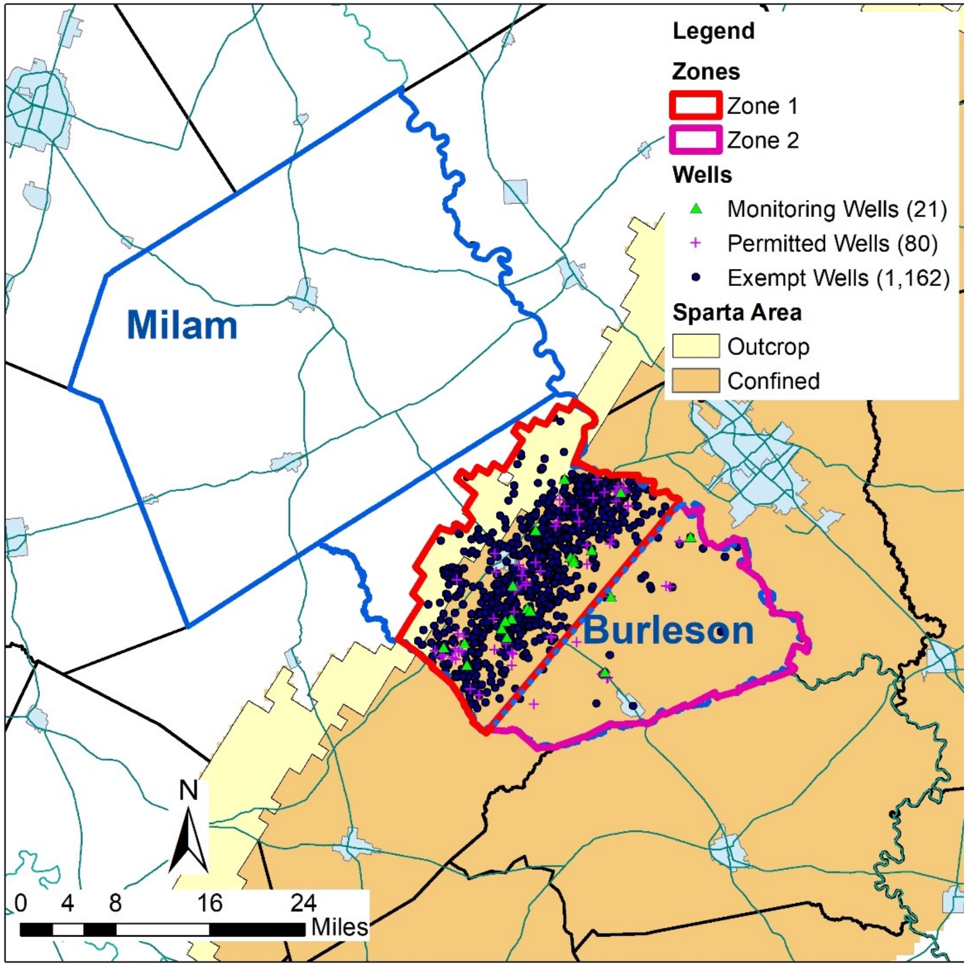
DFC Areas and Management Zones

- Current Approach
  - DFC area boundaries match the boundary of the entire aquifer in POSGCD which also matches the boundaries of the Management Zones
  - Difficult to monitor and difficult to protect areas near outcrops where majority of exempt well exist
- Alternative Approach
  - Partition Management Zones into multiple DFC Areas based location of existing wells
  - Improve protection of wells near outcrop and shallow regions of the aquifer
  - Improve opportunity to successfully monitor and enforce DFC compliance

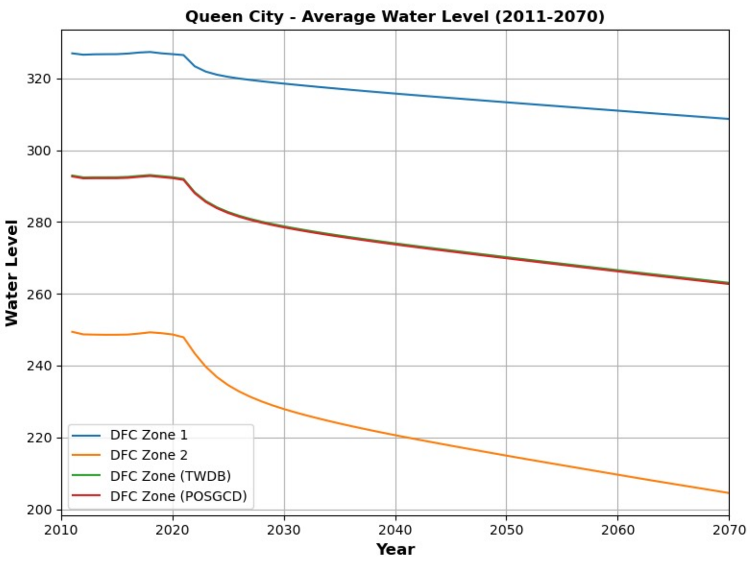
DFC Zones: Sparta

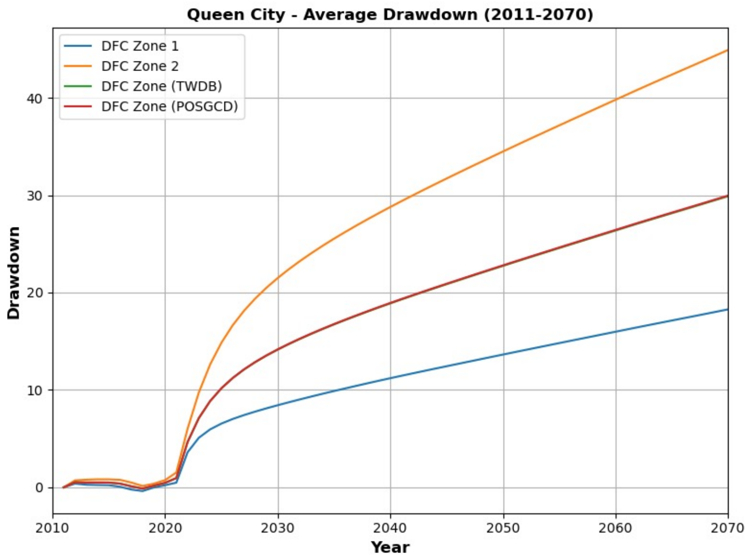


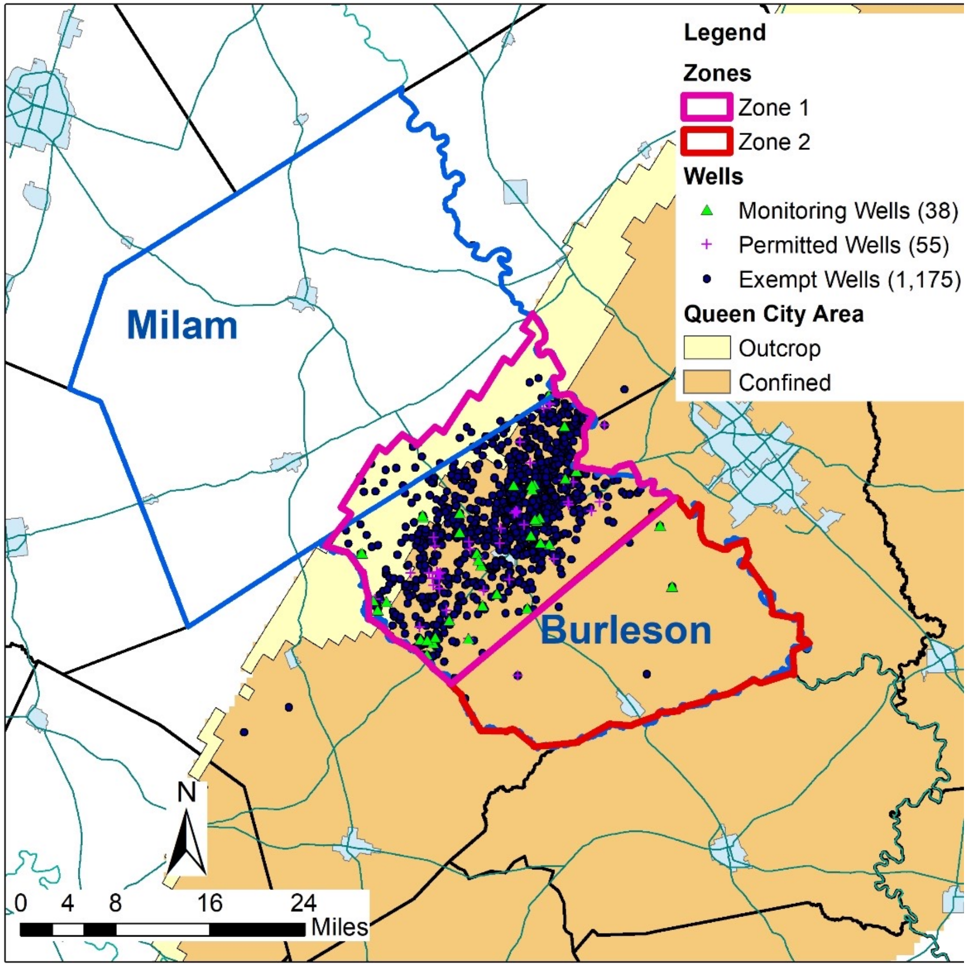




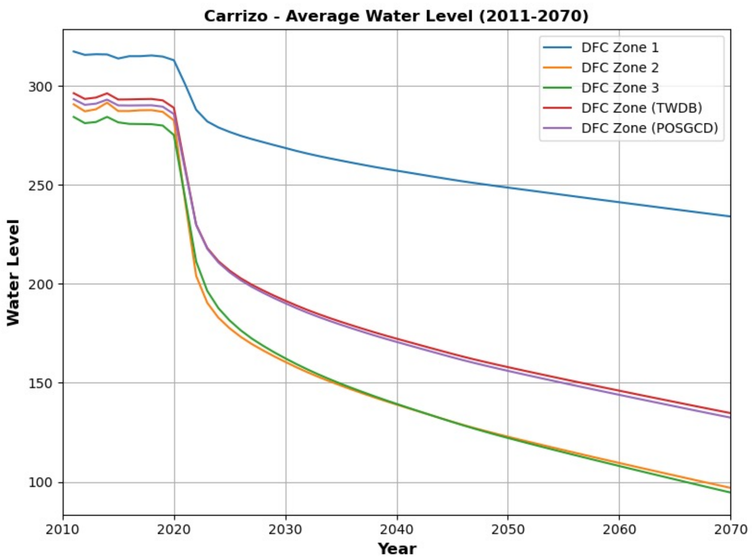
DFC Zones: Queen City

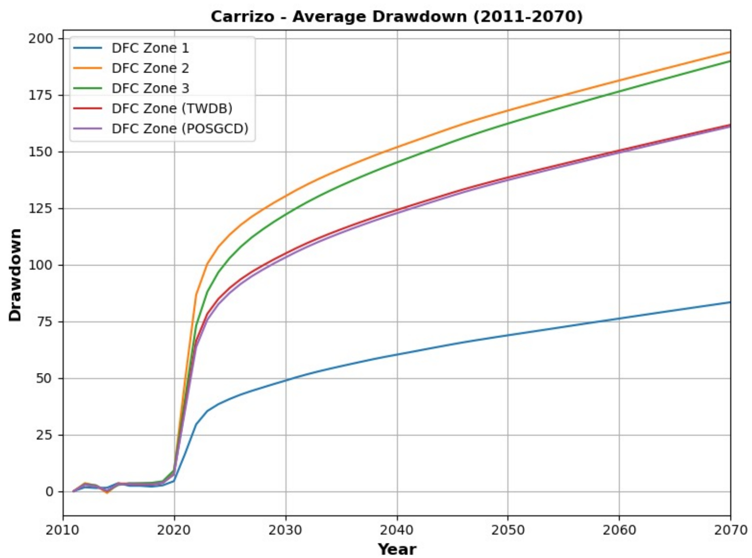


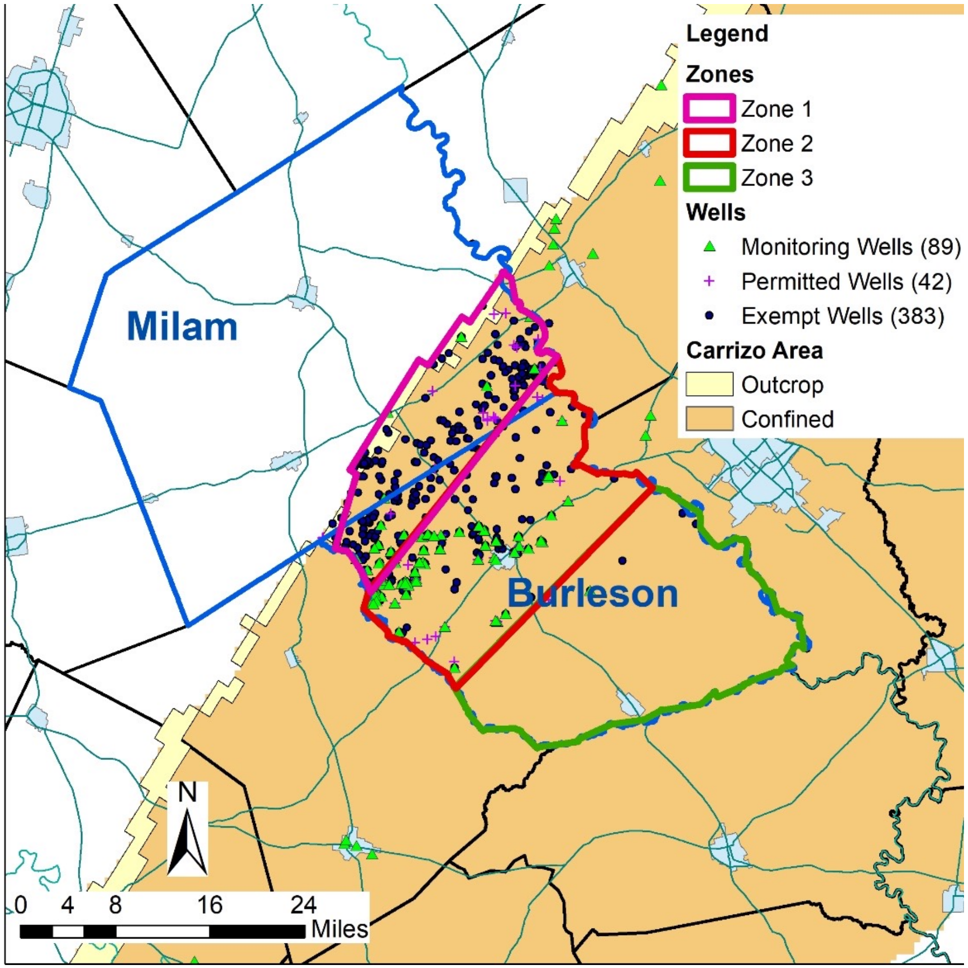




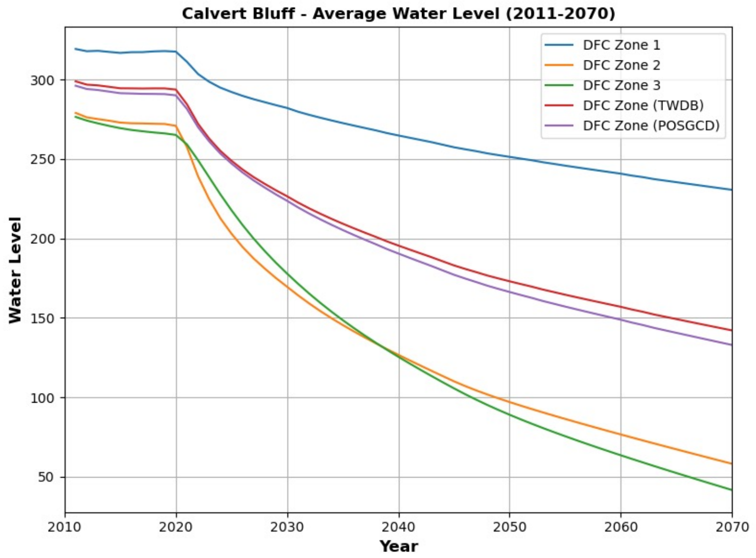
DFC Zones: Carrizo

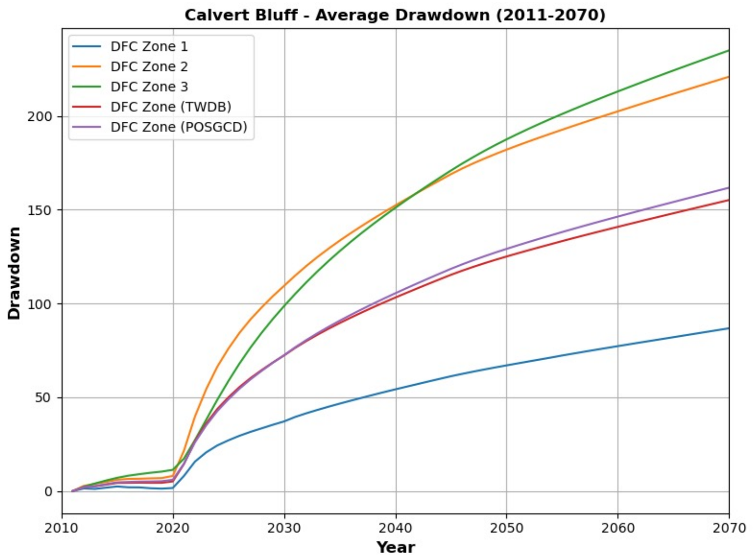


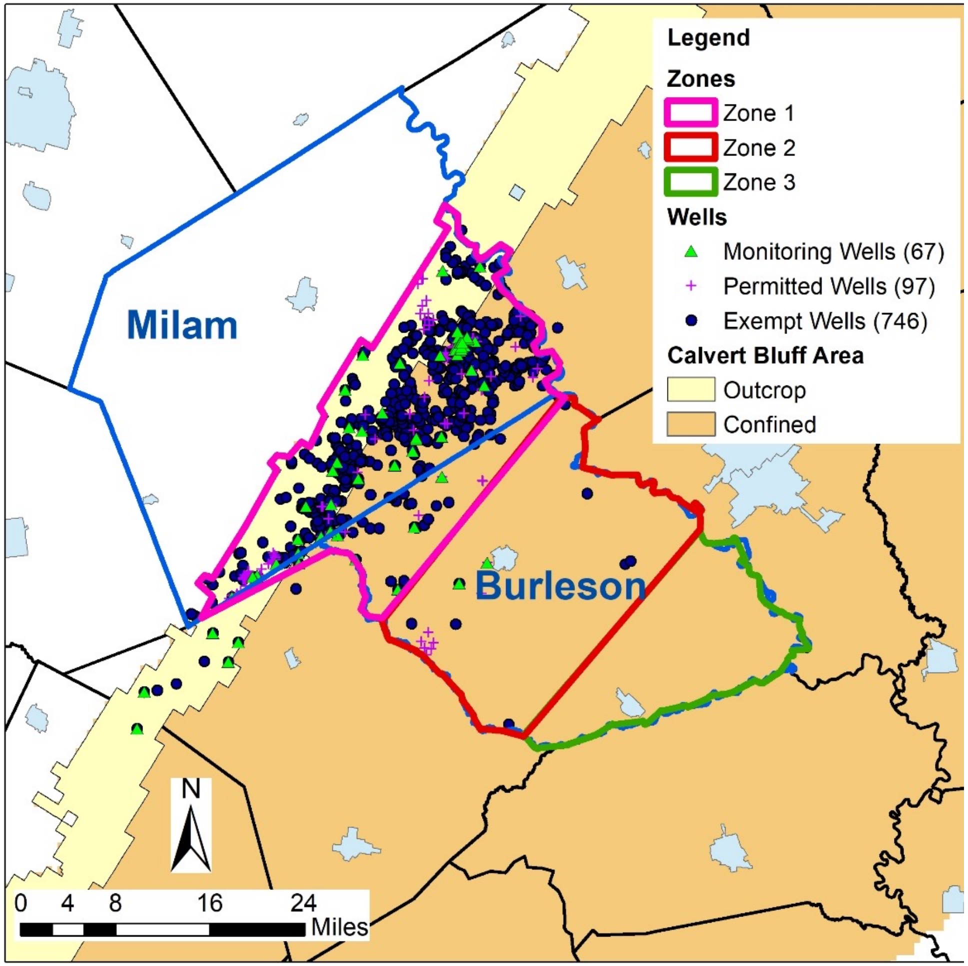




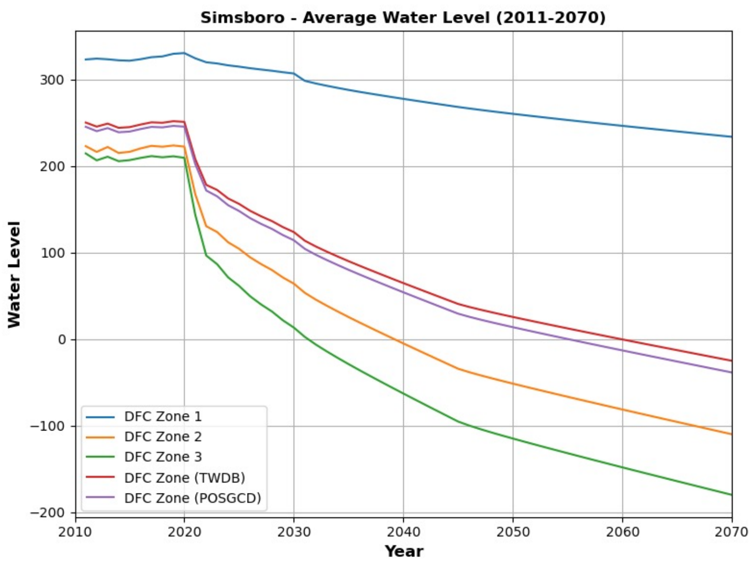
DFC Zones: Calvert Bluff

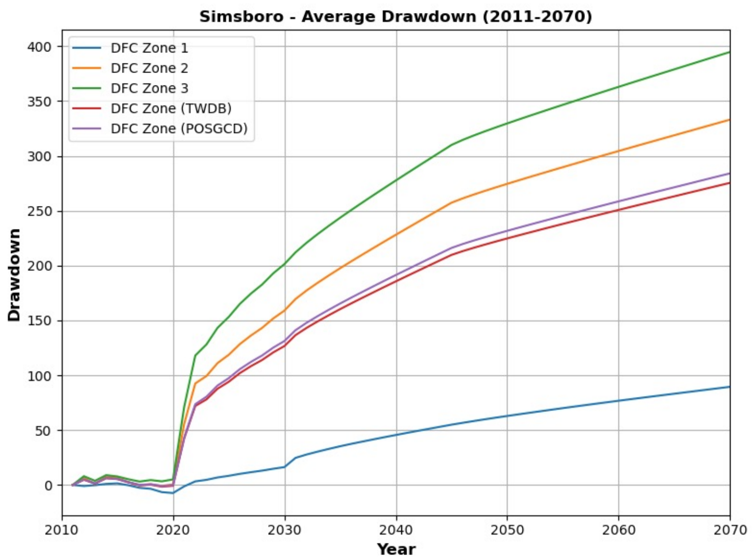


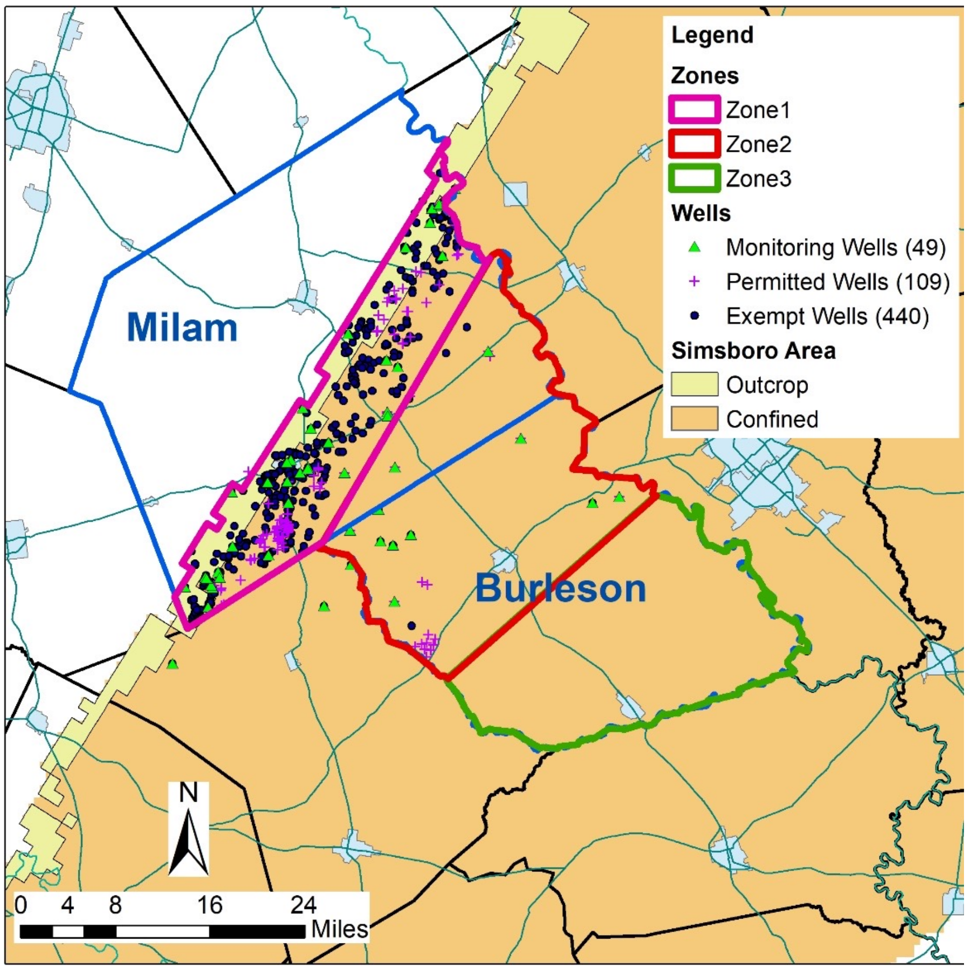




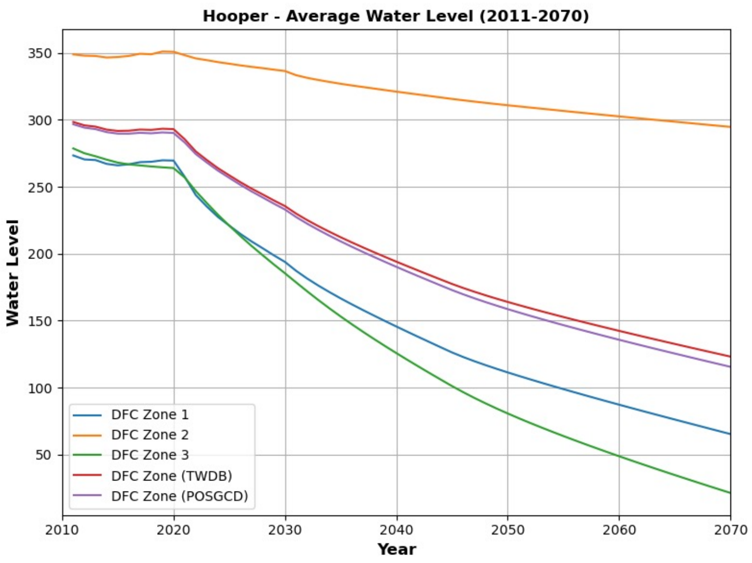
DFC Zones: Simsboro

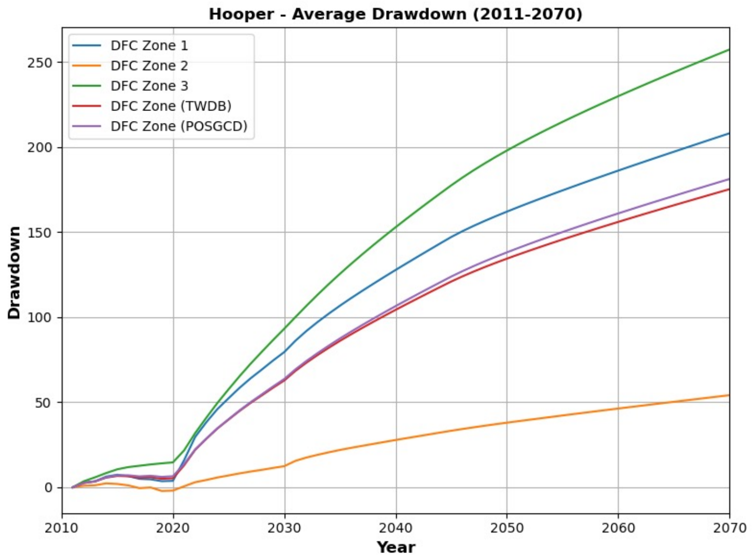


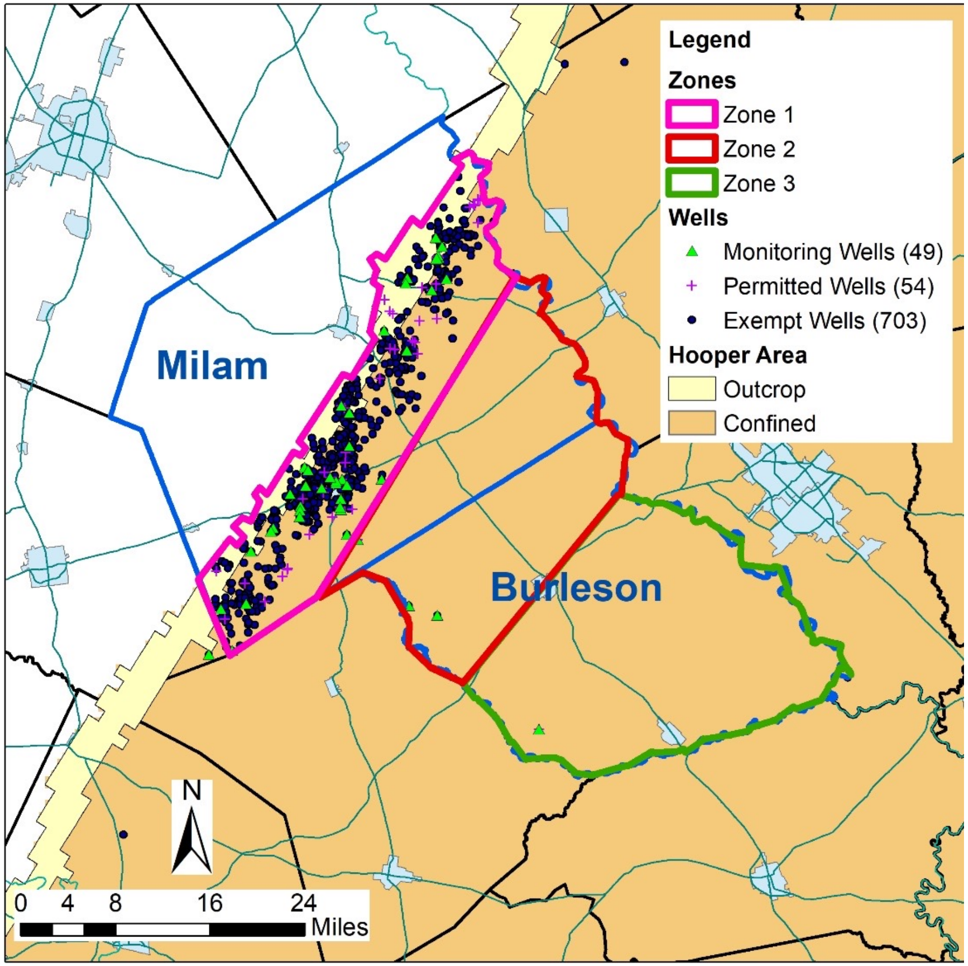




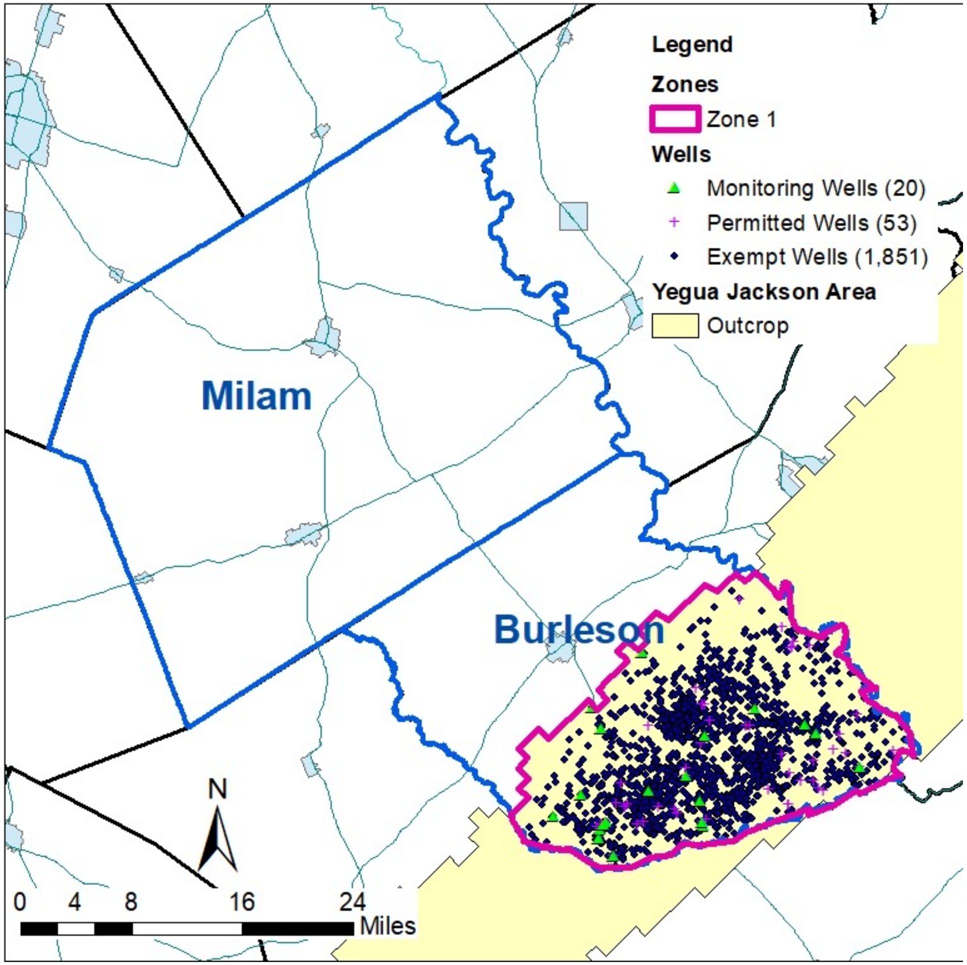
DFC Zones: Hooper





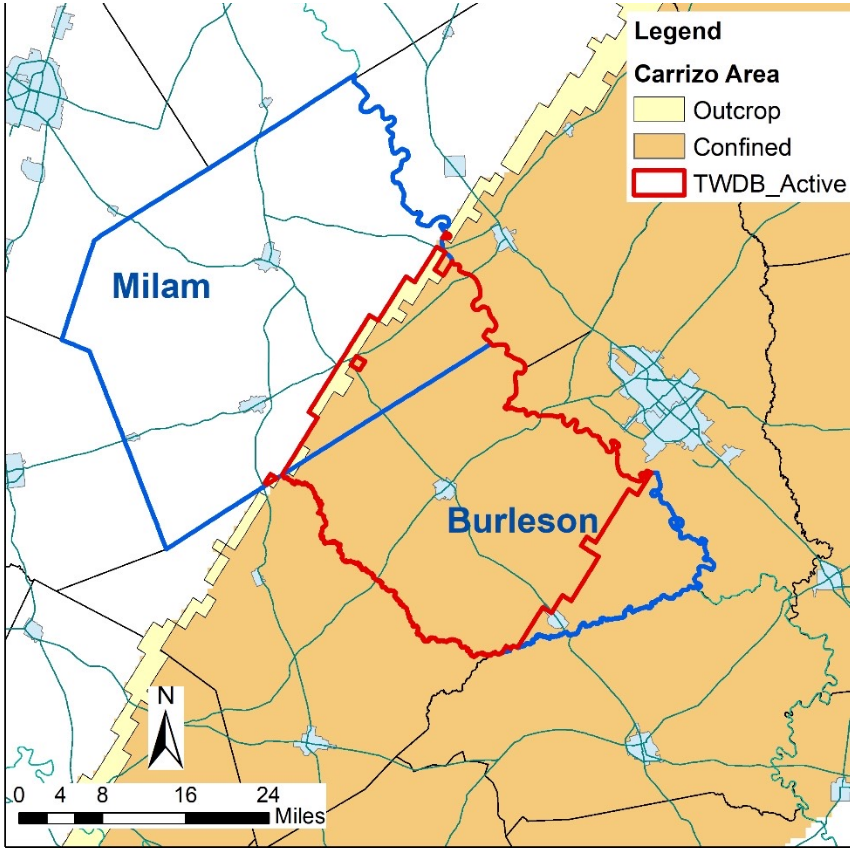


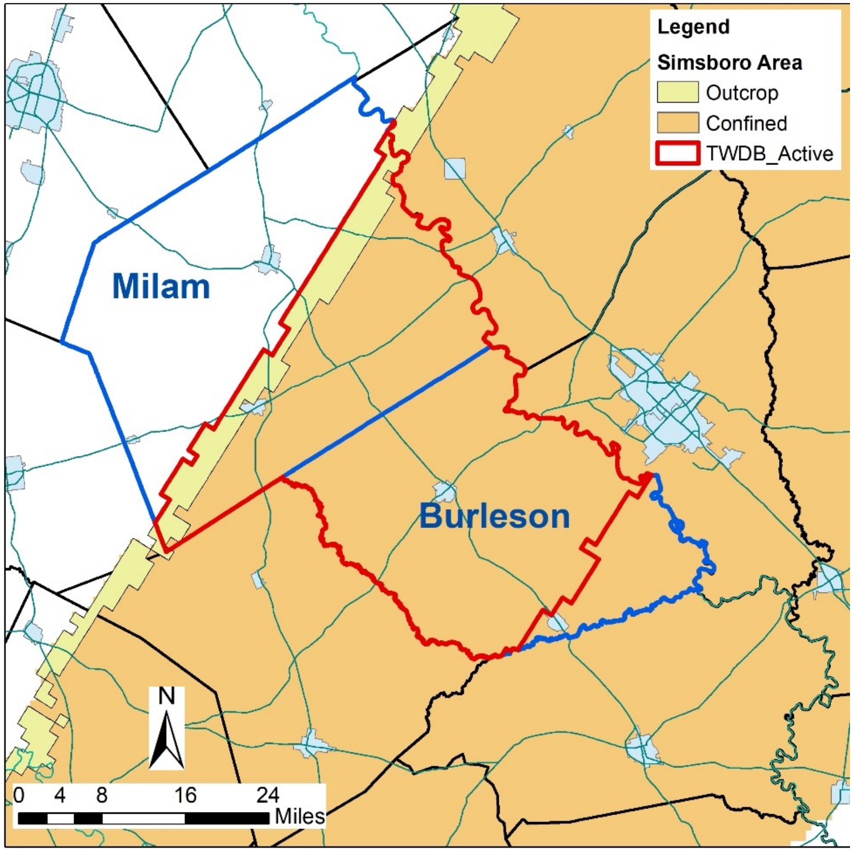
DFC Zones: Yegua Jackson



TWDB Designation of Active Zones

Active Zone is the portion of the aquifer with a Total Dissolved Solids Concentration < 3,000 mg/L





Summary

- Suggested DFC Areas
  - YJ aquifer – 1 area
  - SP and QC aquifers – 2 areas
  - CZ, CB, SB, and HP aquifers – 3 areas

- Benefits over Existing Practice
  - Improved reliability of DFC Compliance calculations
  - Higher probability of enforcing DFC compliance

Maximum Production Volumes Based on Permitted Acreage

POSGCD Current Practice for Maximum Production

- Maximum Production
  - Correlative right based on contiguous acreage
  - Current maximum production rate is 2 acre-ft/acre
- Potential Strengths
  - Simple to implement
  - Little opportunity for challenging production calculations
- Potential Weaknesses
  - Ignores amount of groundwater underlying land
  - Ignores aquifer production capacity underlying land

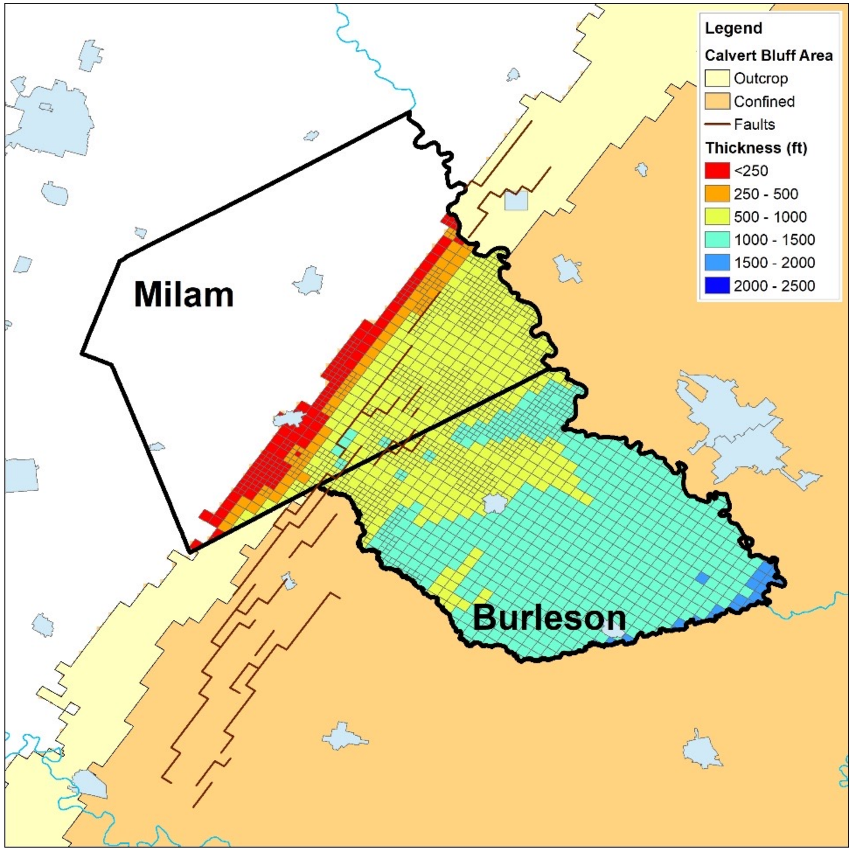
Calculation of Groundwater in Storage

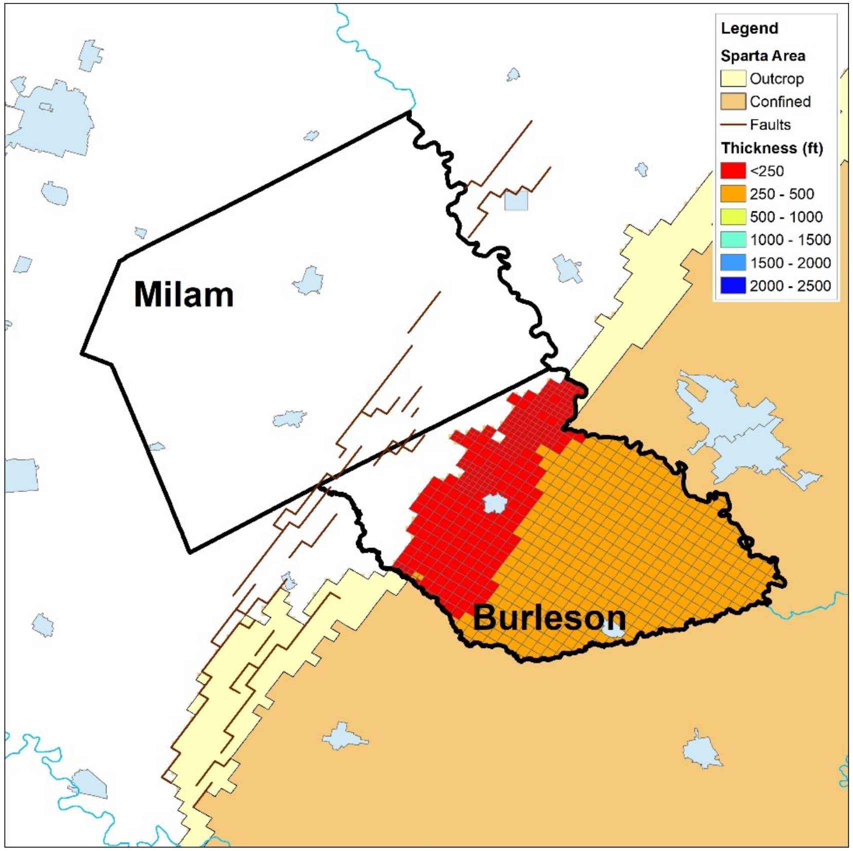
Storage = Sy * B_s

Sy = Specific yield (-)
B = saturated aquifer thickness (ft)

Specific Yield (-)

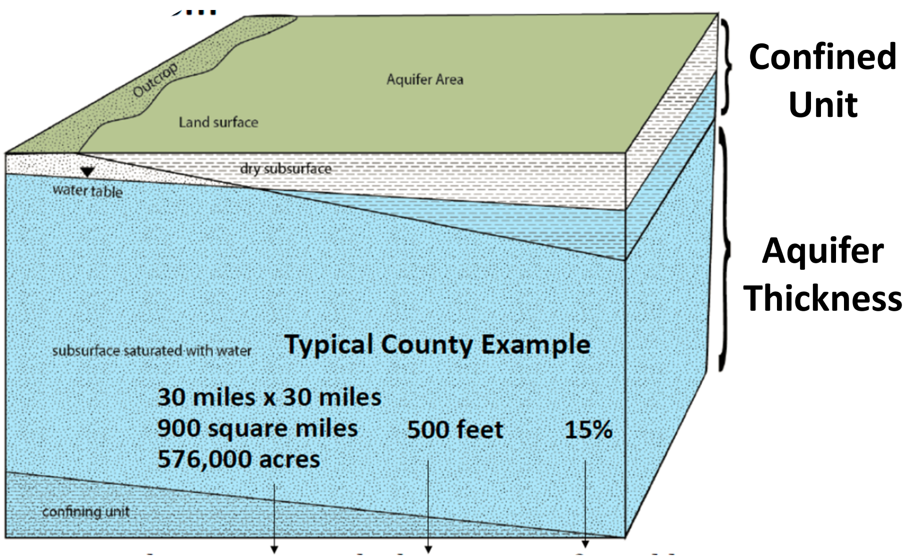
Gravels	0.15 to 0.35
Sands	0.10 to 0.30
Silts	0.03 to 0.20
Clays	0 to 0.05





Groundwater in Storage

Aquifer(s)	Volume in Storage (10^6 AF)	Area (sq miles)	% Total Storage
Upper Trinity	86	807	19.0%
Lower Trinity*	78	807	17.3%
Sparta	16	576	3.5%
Queen City	30	753	6.6%
Carrizo	29	835	6.4%
Calvert Bluff	63	1024	13.9%
Simsboro	53	1132	11.7%
Hooper	55	1237	12.2%
subtotal	200	4229	44.2%
Yegua-Jackson	42	291	9.3%
total	452**		100.0%
*Hensell, Pearsall, & Hosston			
** equivalent of 415 feet of water above the district			



Storage volume = area x thickness x drainable porosity

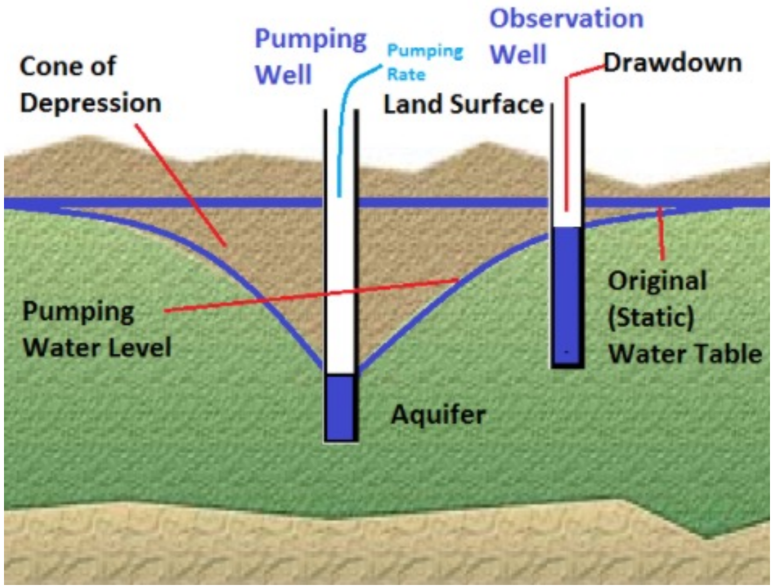
Production Capacity of Aquifer

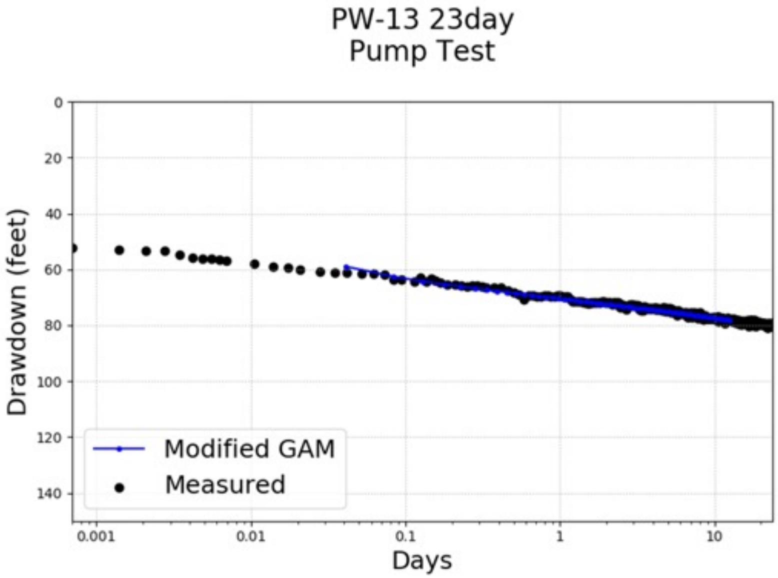
Transmissivity = K * B

K = hydraulic conductivity (ft/day)
B = aquifer thickness (ft)

Hydraulic Conductivity (ft/day)

Gravels	100 to 1000
Sands	1 to 50
Silts	0.01 to 0.5
Clays	1E-5 to 0.005

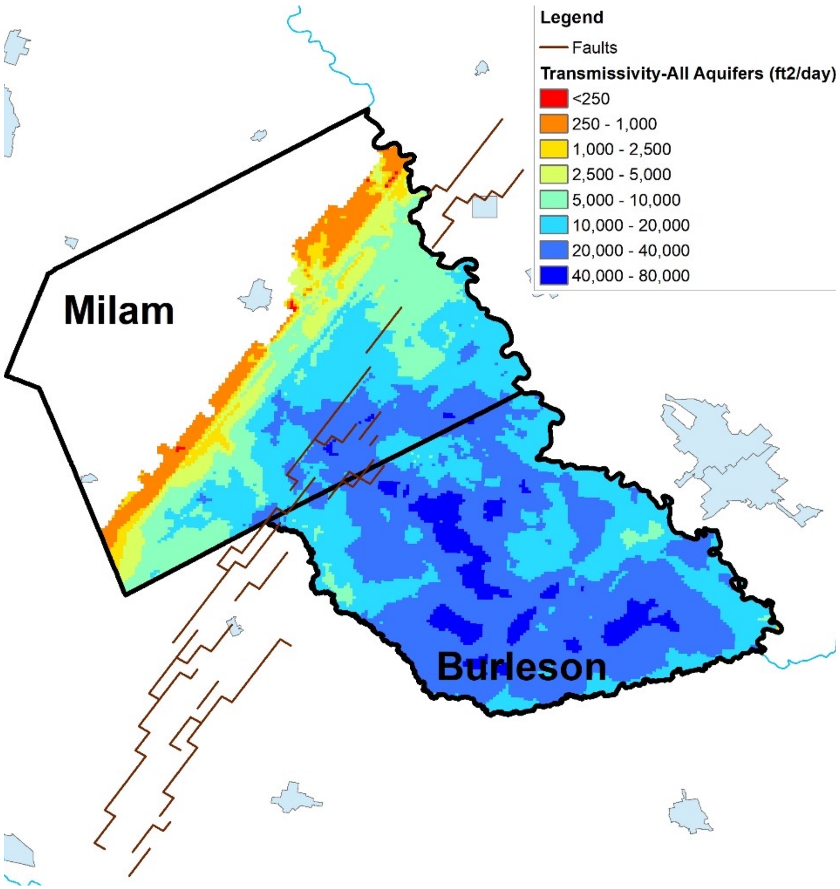




Production Capacity in POSGCD

Aquifers	Production Capacity		Aquifer Property	
	Amount*	Percent	Area (mi^2)	Average Transmissivity (ft^2/day)
Upper Trinity	17	1	807	211
Lower Trinity	14	1	807	591
Sparta	62	3	577	1,066
Queen City	97	4	753	1,286
Carrizo	181	8	832	2,178
Calvert Bluff	179	8	1,025	1,747
Simsboro	1,583	68	1,128	14,035
Hooper	109	5	1,234	885
Yegua Jackson	90	4	368	2,440

* units are 104 ft^2*mi^2/day

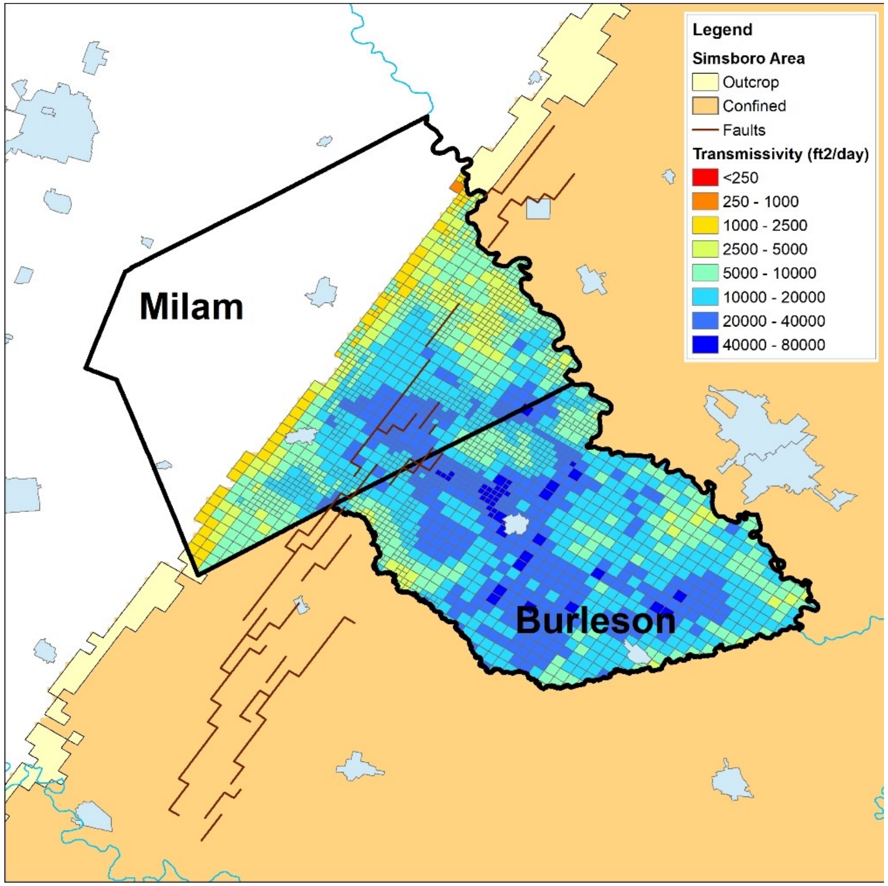


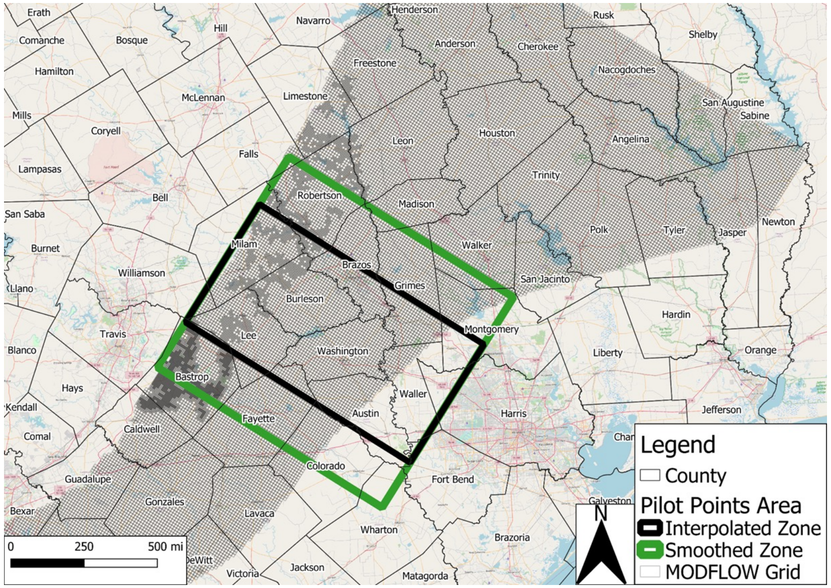
Approach for Establishing Maximum Production Volumes

- Criteria for Aquifer
  - Average Productive Capacity
  - Average Thickness of Aquifer Across Permitted Acreage Determined by POSGCD
  - Hydrogeologic Study Provided by Applicant
- Aquifer Grouping
  - Wilcox Aquifer (Hooper, Simsboro, Calvert Bluff)
  - Carrizo
  - Sparta
  - Queen City
  - Yegua Jackson

Productive Capacity Determined by POSGCD

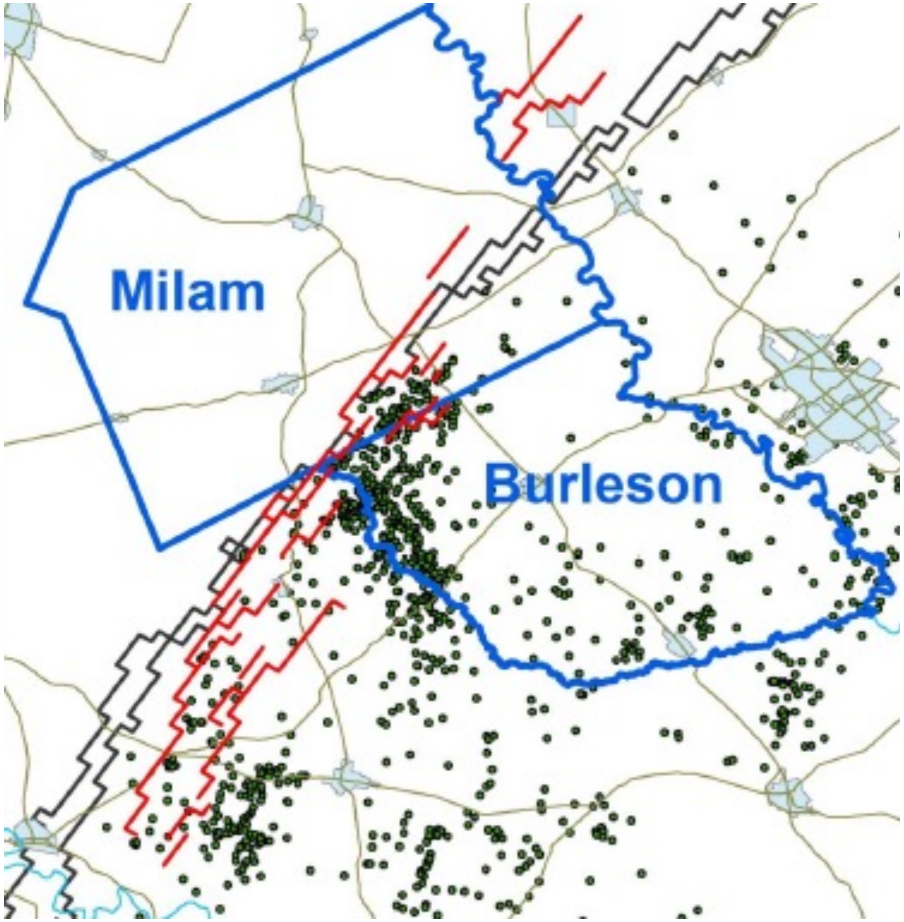
- Transmissivity in GAMs
- Transmissivity in POSGCD Operational Model
- Results from Pumping Tests
- Sand thickness maps





Average Thickness of Aquifer

- Aquifer Thickness in GAM and POSGCD Operational Model
- Analysis of Geophysical Logs
- Geophysical Logs Provided by Applicant



Example Framework for Proposed Approach

- Aquifer Production Capacity
  - Regulate Wilcox as one Aquifer
  - Fix rate for lower capacity aquifer

- Aquifer Thickness
  - Wilcox rate determined by thickness each aquifer
  - Outcrop and less than 250 feet thickness: minimum rate
  - Confined with more than 700 ft thickness: maximum rate

- Maximum Rate for all Aquifers across a permitted area is 2.5 acre-ft/acre

- Maximum Production Allocation is increased if Total Dissolved Solids Concentration > 1,250 mg/L

Aquifer	**Production (acre -ft/acre)**	
	Minimum	**Maximum**
Wilcox (Calvert Bluff) (Simsboro) (Hooper)	0.5	2.5
Carrizo	0.25	0.75
Sparta	0.3	0.3
Queen City	0.3	0.3
Yegua Jackson	0.3	0.3

Possible Implementation Approach

- Engage Legal Counsel to Develop a Defensible Approach for Replacing the 2 acre-ft/acre at a Future Date or Event
  - Date could be as great as 40 years into the future
  - Event could be approaching a threshold for a DFC
- Perform Study to Develop for Production Rates to be used for Initial Rule
  - Consider investigating importance of nine factors used for setting DFCs
  - Tied to conservation, preservation, and protection of groundwater resource
  - Include stakeholder input and review
-

Compatibility of DFCs and PDLs

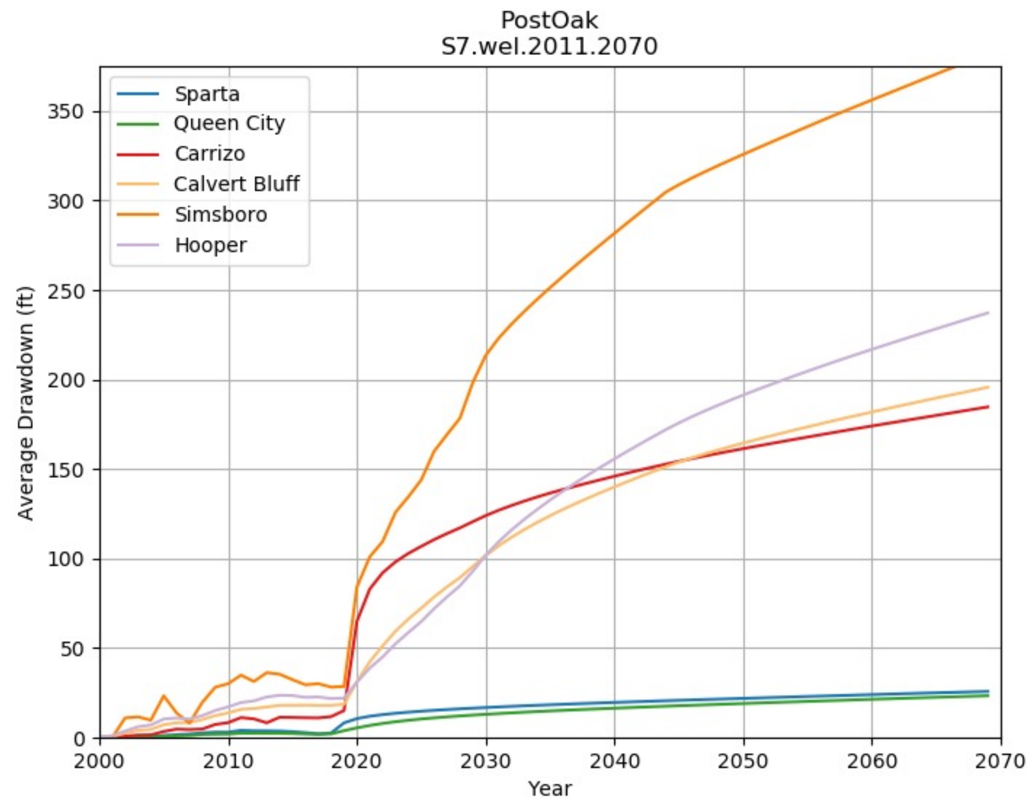
- Discussed in Section 7.3.5 of Management Strategy Report
- TWC Chapter 36.108 d (8)requires that GMA consider the feasibility of achieving the DFC
- GMA 12 has historically used the GAM runs to demonstrates that DFCs are physical possible and compatible
- Examination of the GAM Rules have demonstrated that PDL are exceeded prior to exceeding a DFC for every aquifer
  -

Simulated DFC for PS-7

PS-7 Simulation

Comparison of PS-7 Simulated DFCs and POSGCD DFCs*

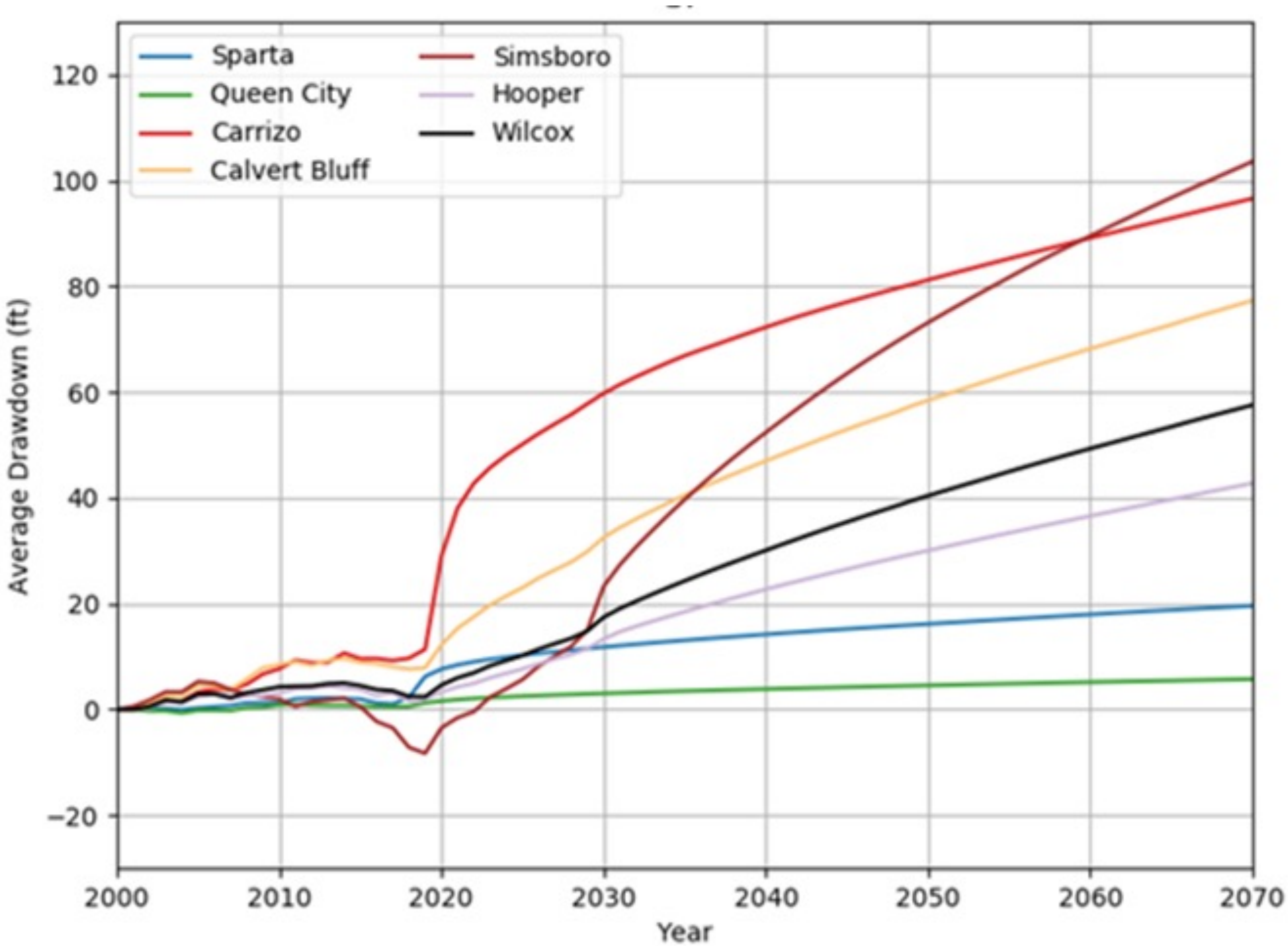
	Current DFC (feet)	Current MAG in 2070	S-7 Drawdown from 2010 to 2070 (feet)	S-7 Pumpage in 2070 (acre-feet)
Sparta	28	6,735	17	1,983
Queen City	30	504	19	1,045
Carrizo	67	7,058	177	18,205
Calvert Bluff	149	1,036	183	4,761
Simsboro	318	48,503	355	85,855
Hooper	205	4,422	222	3,126



* From GMA 12 Sept 2019 presentation (note: different time periods for PS-7 and POSGCD DFCs)

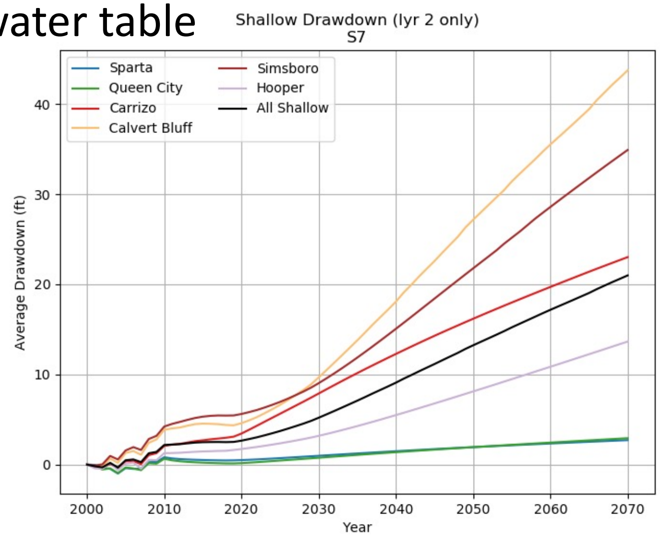
By 2070, DFCs are exceeded for Carrizo, Calvert Bluff, Simsboro, and Hooper Aquifers

Simulated Average Drawdown for Aquifer Depth of 400 feet (simulated PDL)

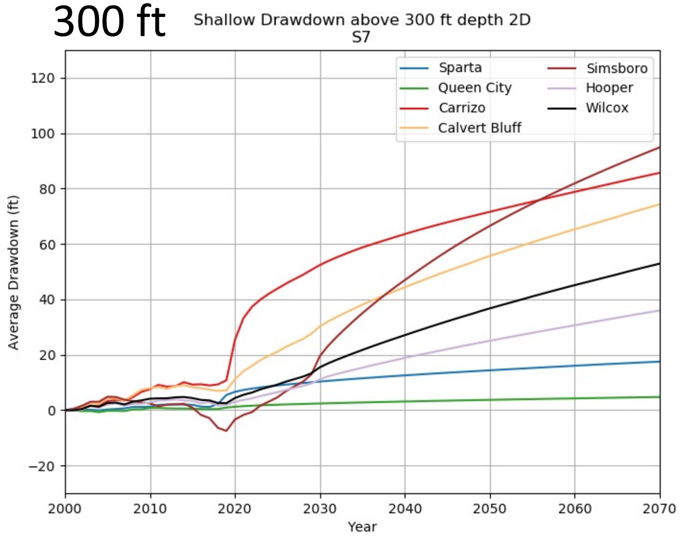


Sensitivity to Depth of Shallow Zone

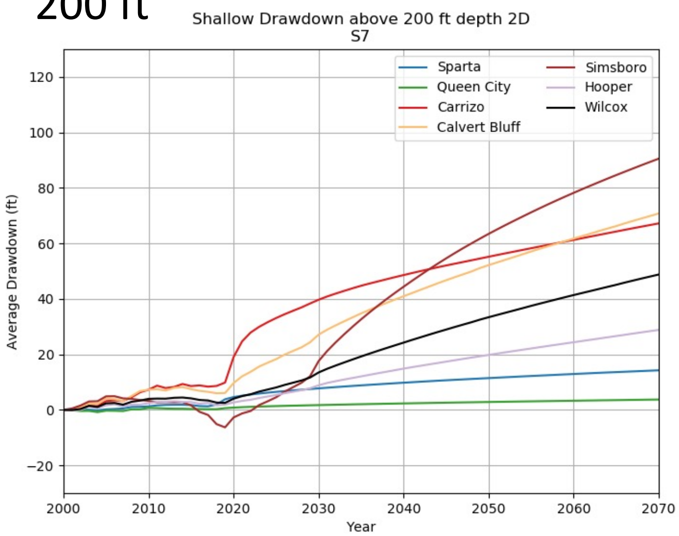
~water table



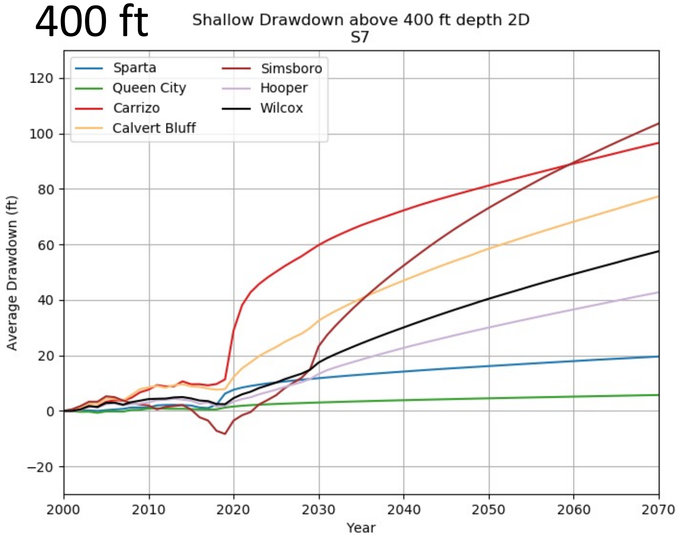
300 ft



200 ft



400 ft



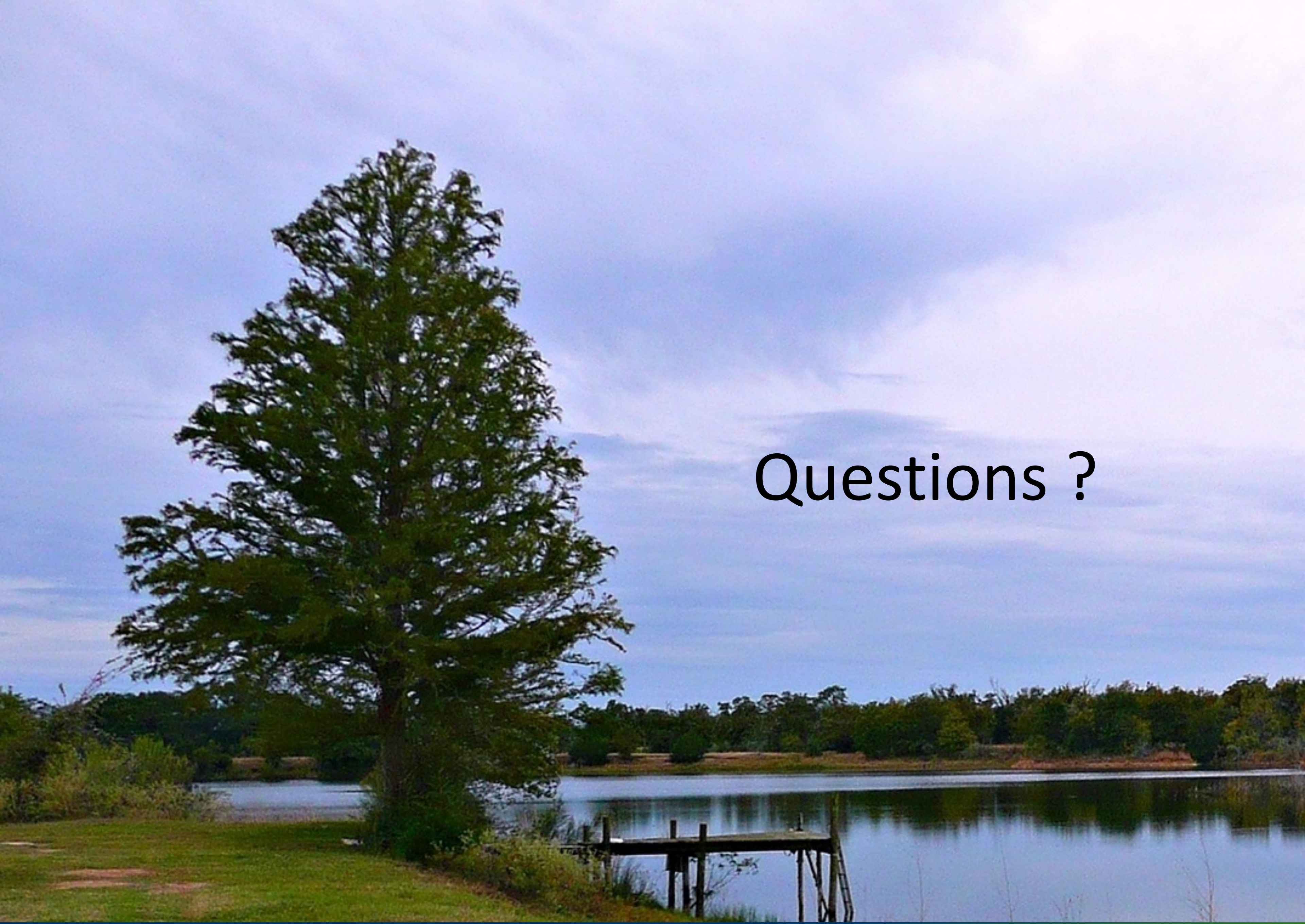
Summary

- Examination of GMA 12 P-7 Run Shows that PDLs of 20 feet are exceeded more than 30 years before DFCs are exceeded for the Carrizo, Calvert Bluff, Simsboro and Hooper Aquifers
- PDLs were originally develop to protect the saturated thickness of the outcrop areas and specifically the decrease in the water table level
- The change in the hydraulic head associated with the middle to lower portion of the aquifer outcrop is a viable substitute for a PDL

Update on GMA 12 Joint Planning

Summary of GMA Activities

- Modeling Activities for 2022
  - Develop approach to estimate production for exempt pumping
  - Construct database for production from permitted pumping
  - Construct baseline pumping file for exempt and permitted wells
- Meetings for 2022
  - Bimonthly
  - Discussions related to Chapter 36 issues



Questions ?