Update on Monitoring Program

November 10, 2015

POSCD Offices

Milam, TX

Presented by:

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Agenda

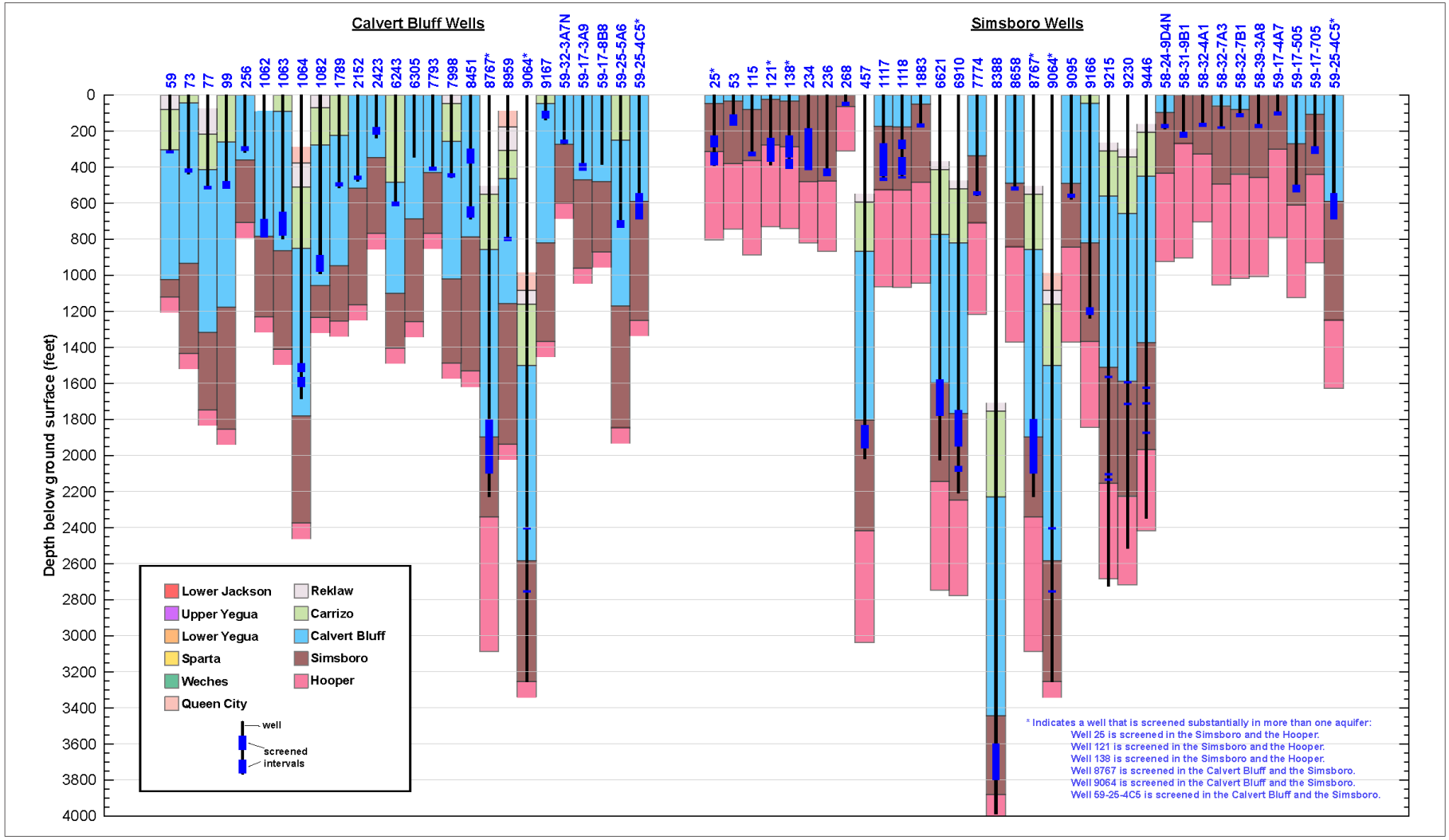
- Monitoring Data
  - Well Assignments
  - Hydrographs
- Calculated Drawdowns versus DFCs
- Methods
  - Averaging of Single Point Values
  - Interpolating Values Across Areas
- Discussion Topics/Possible Future Actions
  - Well Assignments
  - Monitoring Locations
  - Shallow Zone Delineation
  - Analysis Methods

Well Assignments

- Previous Classification Approach
  - Assign Wells based on GAM Surfaces
  - Assignments Modified by “30%” rule for some Aquifers

- Today’s Classification Approach
  - Assign Wells based on GAM Surfaces
    - ~90 wells screened in only one aquifer
    - ~10 wells screened across two aquifers
  - Deemed More Defensible than TWDB and Previous POSGCD Approach
    - Discussions with TWDB
    - TCEQ Regulatory Perspective

Calvert Bluff and Simsboro Wells



Wells Plotted with Aquifer Positions

Calvert Bluff and Simsboro Wells

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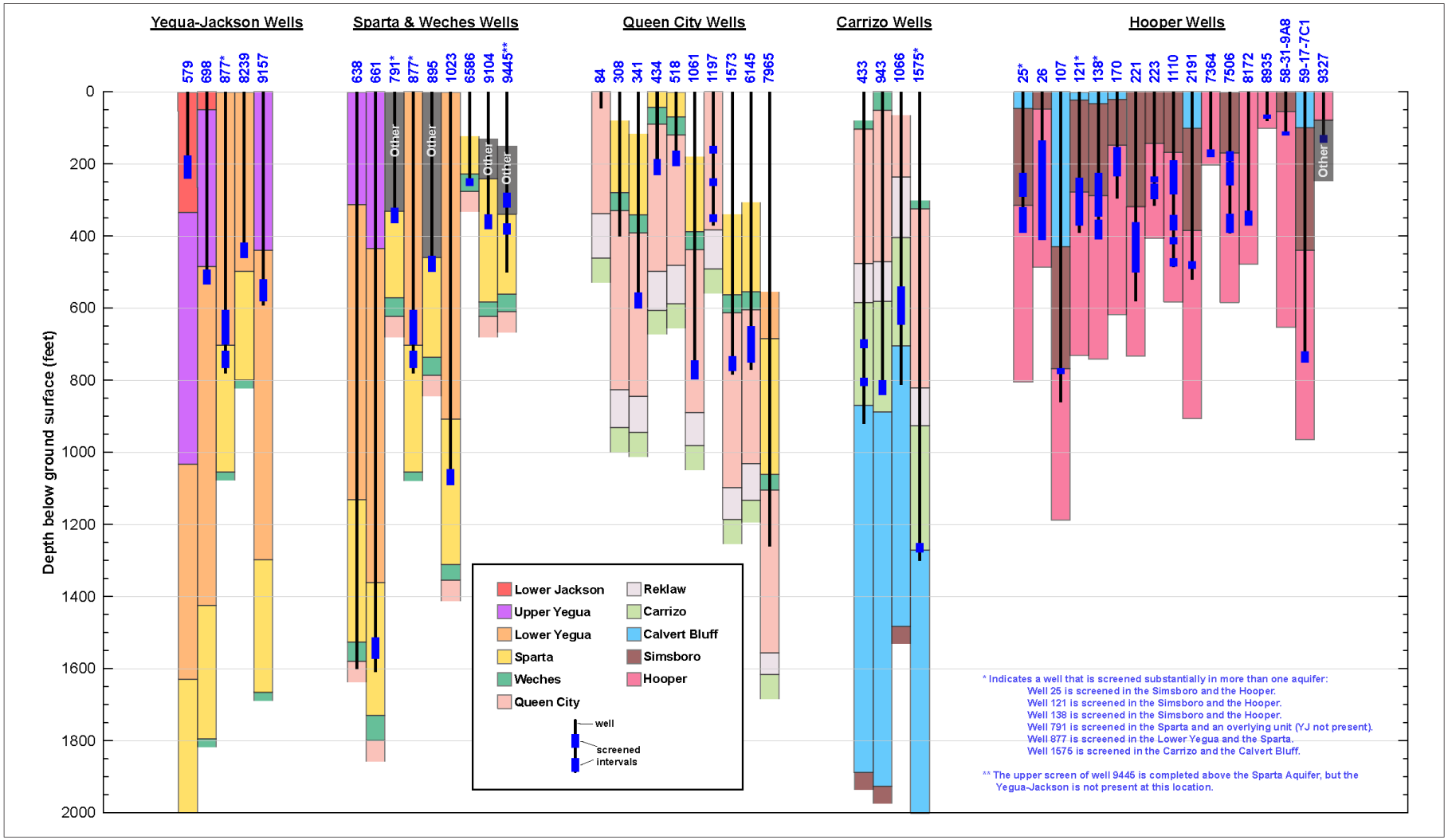
Sparta, Queen City, Carrizo, Hooper, and Yegua-Jackson Wells



Wells Plotted with Aquifer Positions

Yegua-Jackson, Sparta & Weches, Queen City, Carrizo, and Hooper Wells

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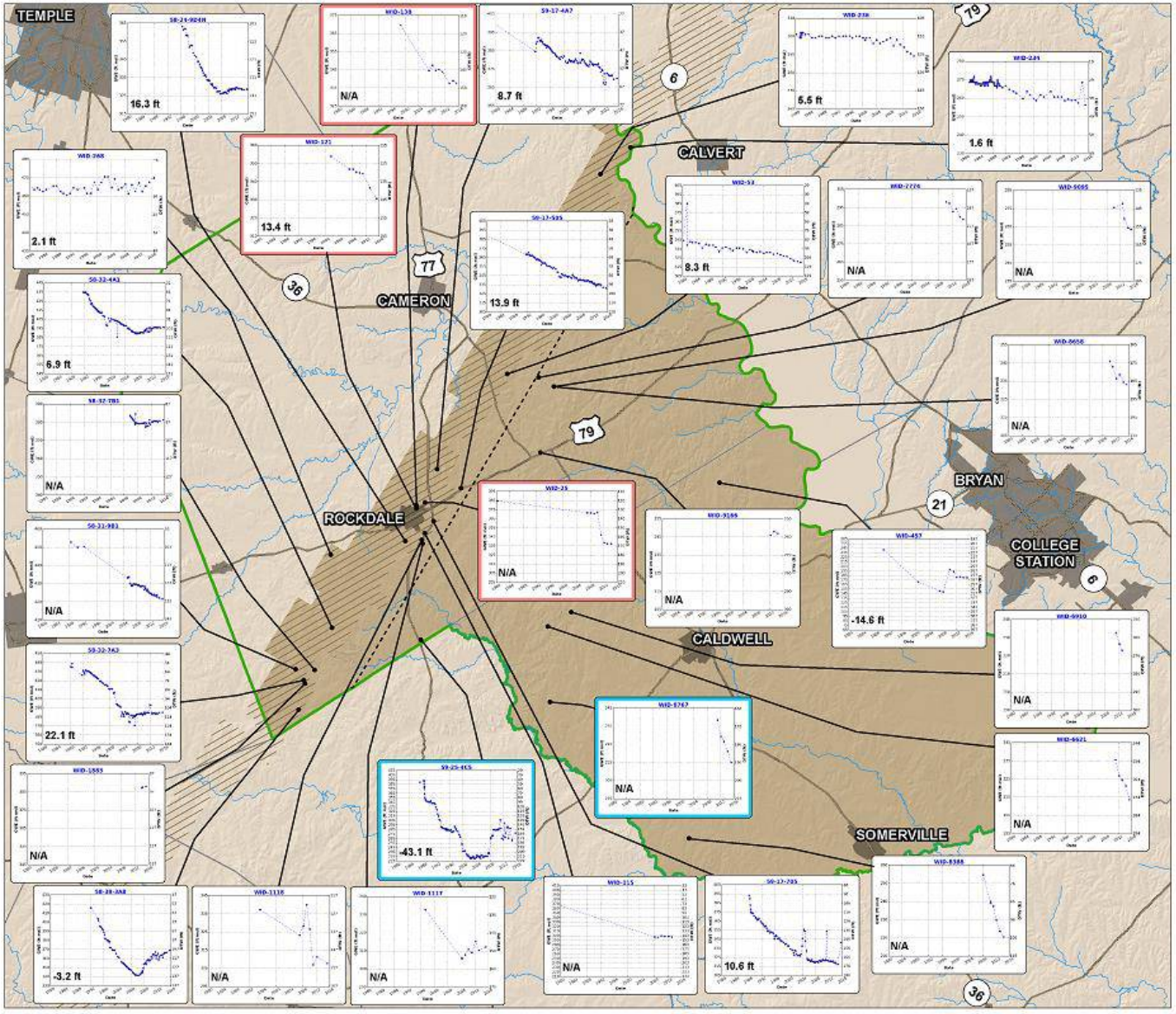
Comparisons of Well Assignments

Wells Screened in Only One Aquifer That TWDB Has Assigned					
Aquifer	TWDB	Screen Match	Aquifer Above	Aquifer Below	Other
Hooper	8	7	1	0	0
Simsboro	18	12	2	2	2
Calvert Bluff	10	9	0	1	0
Carrizo	2	1	0	1	0
Queen City	8	8	0	0	0
Sparta	5	4	0	1	0
BRAA	7	7	0	0	0
Yegua-Jackson	3	3	0	0	0
Wilcox*	4	0	0	0	0
COUNT	65				

* 1 Simsboro, 1 Hooper, 2 Calvert Bluff

Aquifer	TWDB	Well Assignments Based on Partitioning Screen Interval Into Aquifer Layers*									
		Hooper	Simsboro	Calvert Bluff	Carrizo	Queen City	Sparta	Yegua - Jackson	BRAA	Other	ND
ND	31	3	13	8	0	2	1	0	0	2	2
Hooper	9	7	2	0	0	0	0	0	0	0	0
Simsboro	21	4	13	2	2	0	0	0	0	0	0
Calvert Bluff	10	0	1	9	0	0	0	0	0	0	0
Carrizo	2	0	0	1	1	0	0	0	0	0	0
Queen City	9	0	0	0	0	8	1	0	0	0	0
Sparta	7	0	0	0	0	0	5	2	0	0	0
BRAA	7	0	0	0	0	0	0	0	7	0	0
Yegua-Jackson	3	0	0	0	0	0	0	3	0	0	0
Wilcox	4	1	1	2	0	0	0	0	0	0	0
COUNT	103	*15*	*30*	*22*	*3*	*10*	*7*	*5*	*7*	*2*	*2*
	* Partitioning bases solely on length of well screen, aquifer transmissivity not considered										

Hydrographs: Simsboro Example



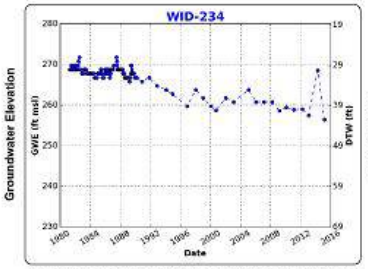
Simsboro Hydrographs

Post Oak Savannah Groundwater Conservation District

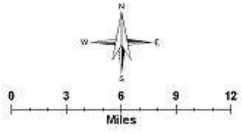
Legend

- POS GCD Boundary
- County lines
- Municipalities
- Unconfined Zone (Simsboro)
- Shallow Zone Extent (Simsboro)
- Simsboro Management Zone
- Major roads
- Rivers
- Well locations
- Hydrograph for well screened in both the Simsboro and the Hooper
- Hydrograph for well screened in both the Simsboro and the Calvert Bluff

POSGCD Well ID or Alcoa Well Name



Water levels are shown for years 1980 to the end of 2016 (plots generated in October 2015)



Map shown in the GAM coordinate system
North American Datum 1983
Projection: Albers
False Easting: 4921250
False Northing: 19685020
Central Meridian: -100.0
Standard Parallel 1: 27.5
Standard Parallel 2: 35.0
Latitude of Origin: 31.25
Linear Unit: US Foot

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Comparison Between DFC and Calculated Average Drawdown

Aquifer	Management Zone	Desired Future Condition Average[1]	Number of Wells with Three-year Average				Average Based on Measured Water Levels in Same Wells in POSGCD from 2000 to 2012				Average Based on Interpolated Points		DFC Compliant[4]	Percent of Average Drawdown of DFC[5]
			2000		2012		Number of Wells	Straight Average	Group by Cluster	Four Zones in Shallow	All 2000 Wells and All 2012 Wells	Only Wells Common to 2000 and 2012[2]		
			POSGCD	All	POSGCD	All								
Sparta	Shallow	10	0		0		0	na	na	na	22.2	3.6	yes	36.0%
	Entire	30	3	12	6	27	3	4.6	4.6		33.6	3.5	yes	11.7%
Queen City	Shallow	10	4		5		4	2.5	3.0	3	12	3.1	yes	31.0%
	Entire	30	5	12	9	24	5	2.8	3.2		17.3	3.1	yes	10.3%
Carrizo	Shallow	20	0		1		0	na	na	na	7.7	6.5	yes	32.5%
	Entire	65	1	7	4	11	1	10.1	10.1		33.9	6.7	yes	10.3%
Calvert Bluff (Upper Wilcox)	Shallow	20	8		17		7	9.2	9.1	11.2	-11.1	0	yes	0.0%
	Entire	140	11	18	20	33	11	-1.7	-7.5		-6	-11.4	yes	-8.1%
Simsboro (Middle Wilcox)	Shallow	20	12		19		12	8.9	7.8	6	12	9.6	yes	48.0%
	Entire	300	14	31	29	71	14	3.5	-0.4		20.3	11.1	yes	3.7%
Hooper (Lower Wilcox)	Shallow	20	4		9		4	5.9	5.9	5.6	40	6.2	yes	31.0%
	Entire	180	5	6	11	25	5	7.4	7.4		84.5	7.1	yes	3.9%
Yegua Jackson	Shallow	15	0		0		0	na	na	na	na	na	unknown	unknown
	Entire	100	1	9	4	27	1	7.3	7.3		12.3	16.4	yes	16.4%
Brazos River Alluvium	Milam	5					0	na					unknown	unknown
	Burleson[3]	6					7	4.5	5.0	5.1			yes	81.1%

[1] all DFCs are from Jan. 2000 to Dec. 2059 except the BRAA DFC, which is from Jan. 2010 to Dec. 2059

[2] best estimate of calculated average drawdown from 2000 to 2012

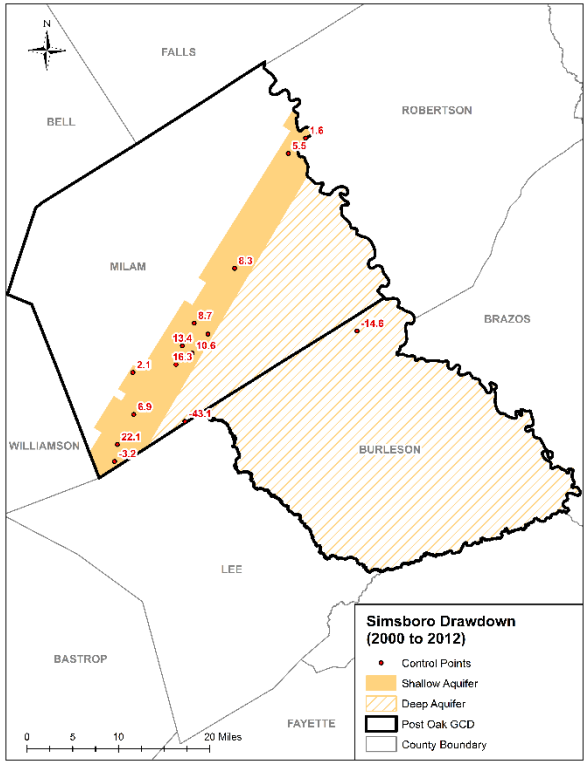
[3] number of wells from 2010 to 2014

[4] likely is based on review of all available data; insuff. data requires additional information

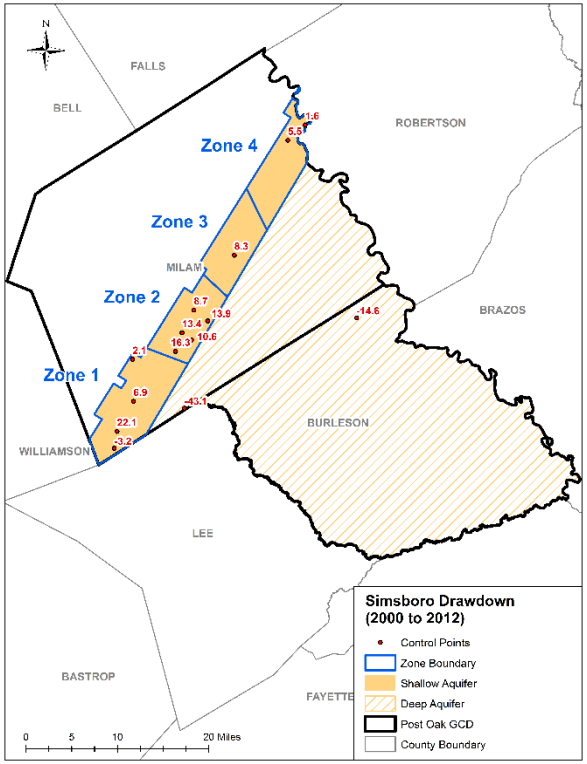
[5] Threshold Level 1 criteria is 60%

Averaging of Single Points: Simsboro

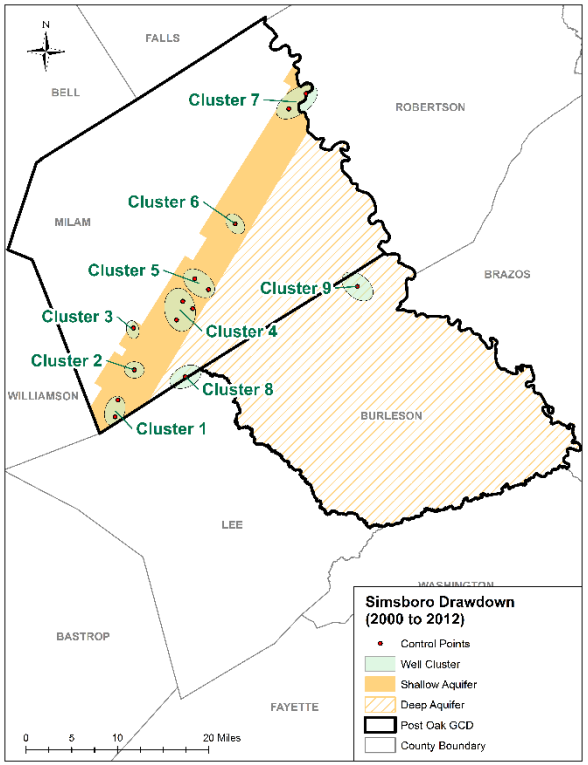
Straight Average
(shallow: 8.9 ft, entire 3.5 ft)



Four Zones in Shallow
(shallow: 6 ft)

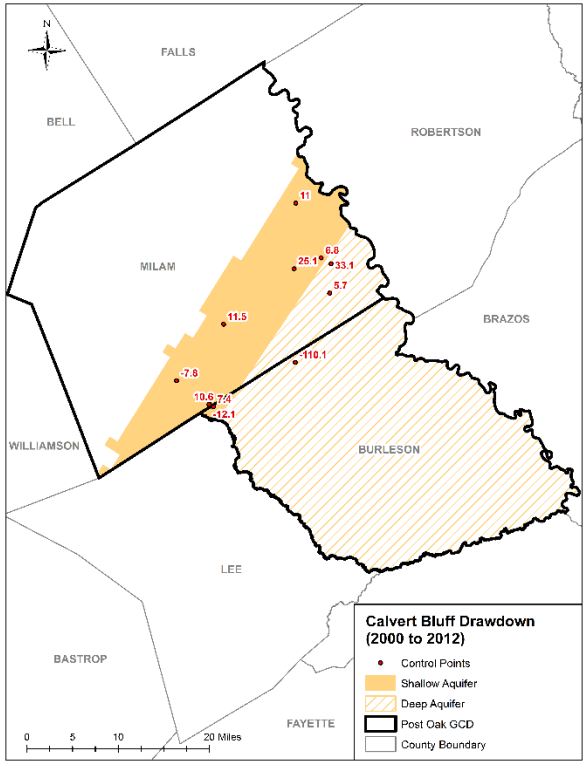


Group by Cluster
(shallow: 8.6 ft, entire: 1.8)

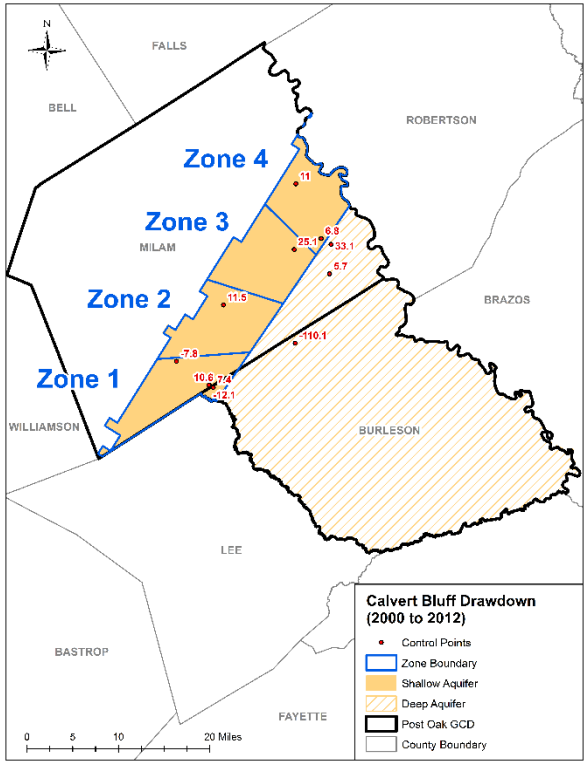


Averaging of Single Points: Calvert Bluff

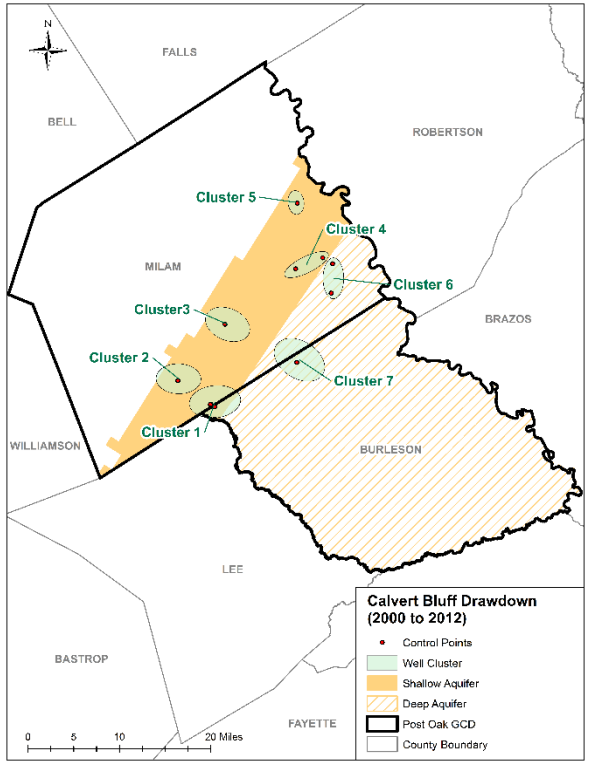
Straight Average
(shallow: 9.2 ft, entire: -1.7 ft)



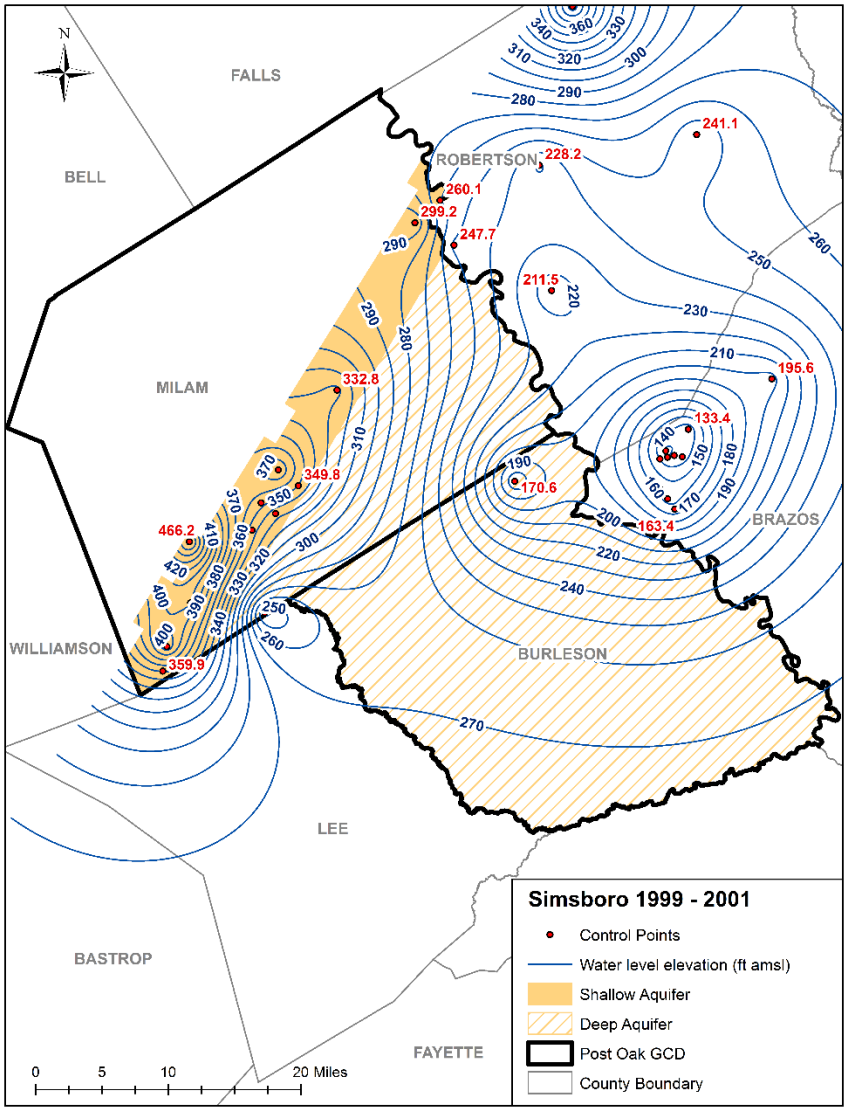
Four Zones in Shallow
(shallow: 11.2 ft)

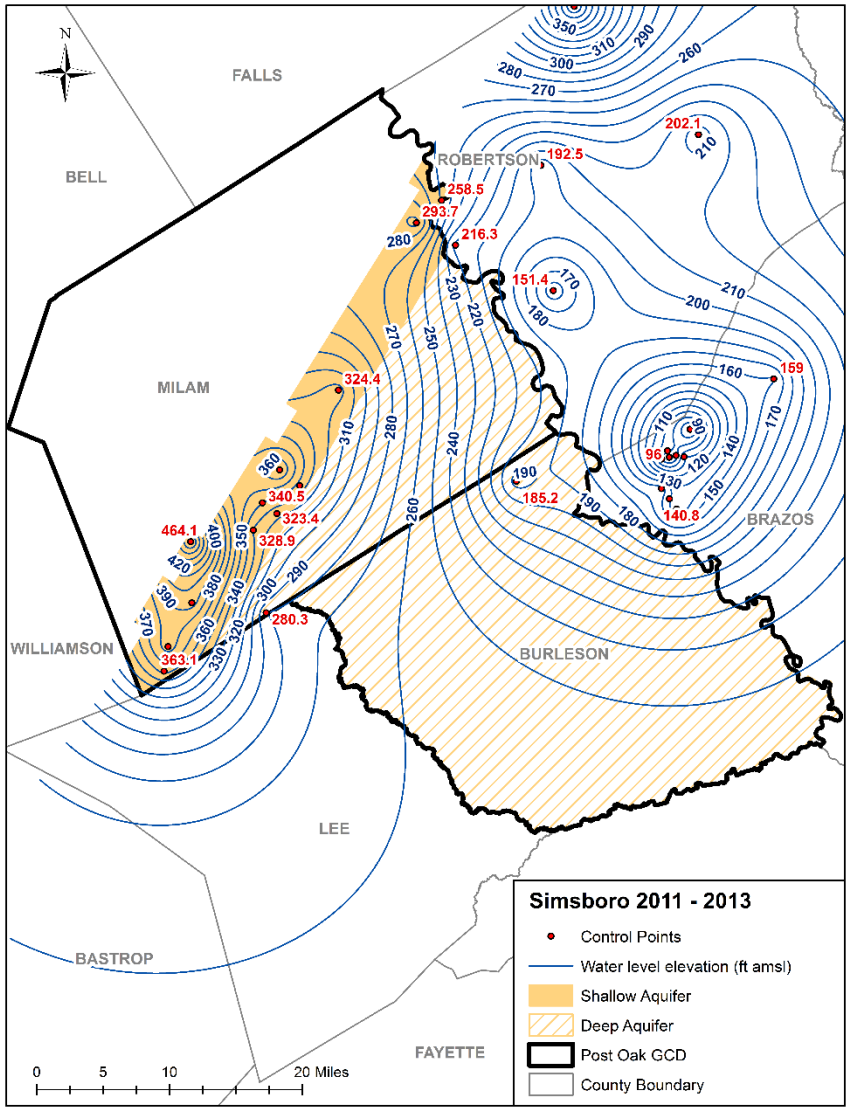


Group by Cluster
(shallow: 9.1 ft, entire: -7.5)

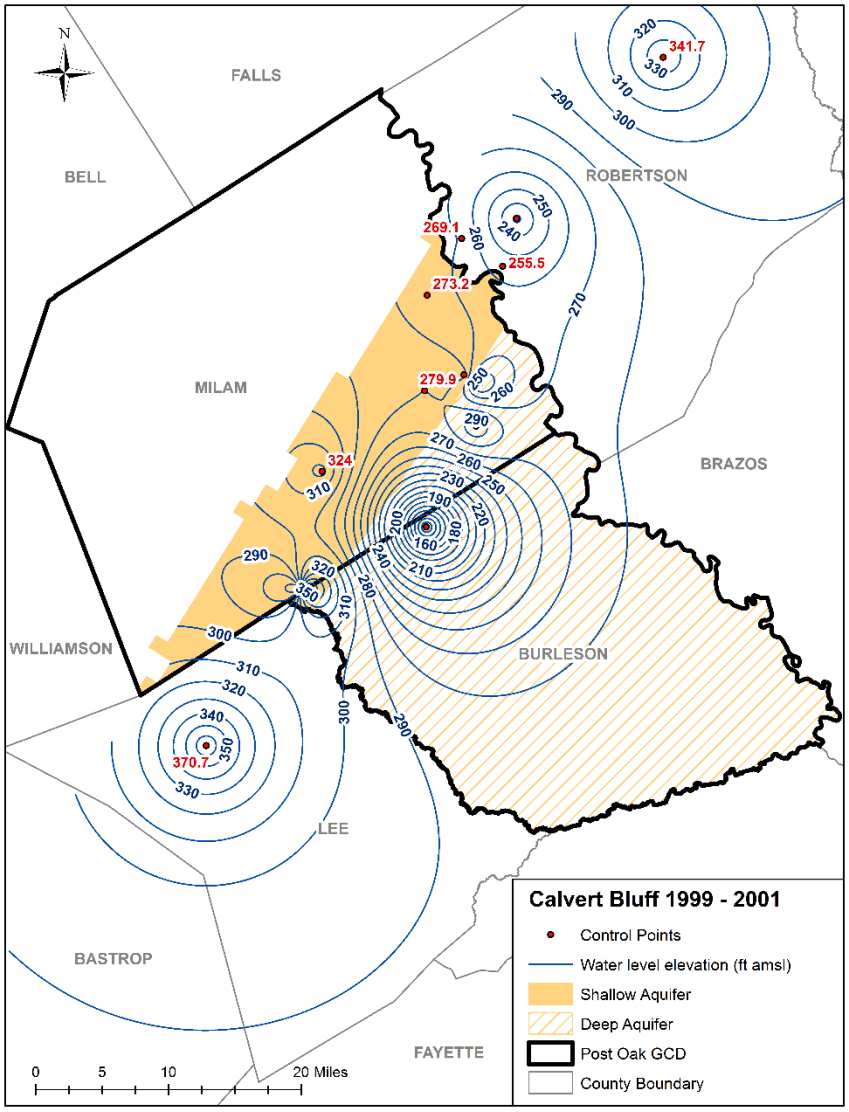


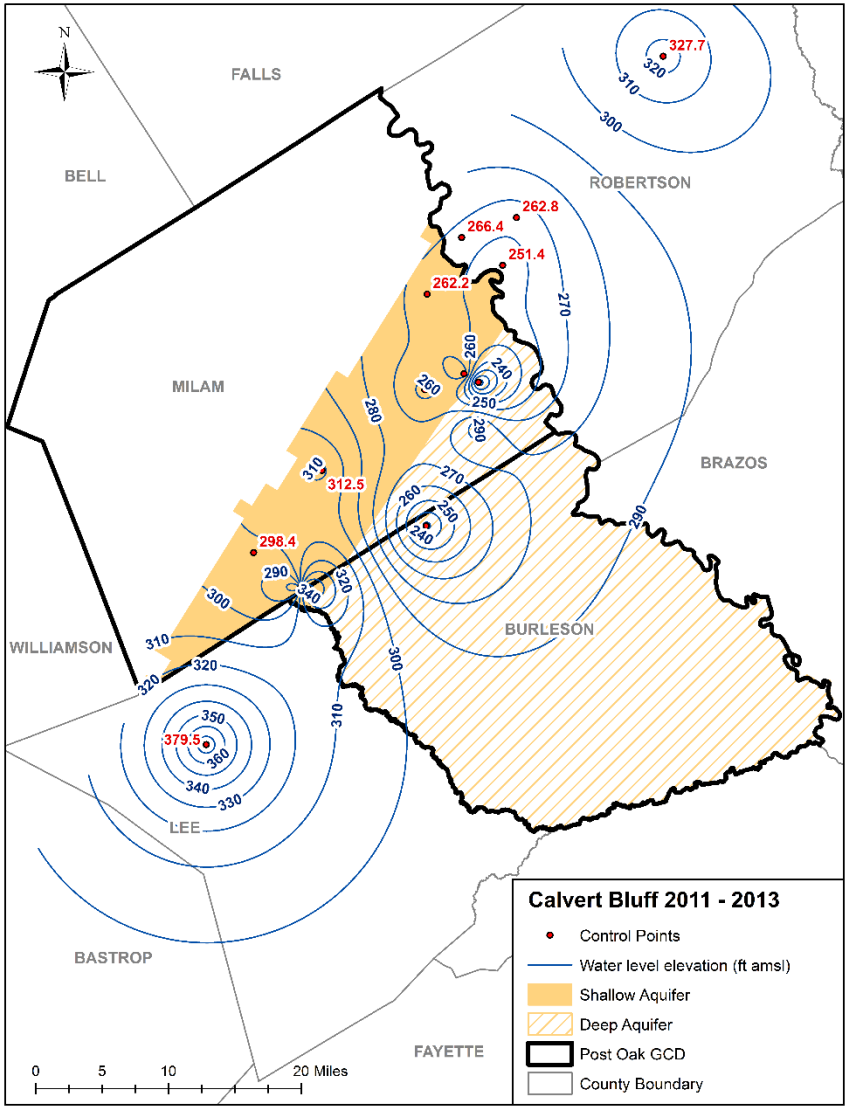
Interpolating Values Across Areas: Simsboro (same wells in 2000 and in 2012)





Interpolating Values Across Areas: Calvert Bluff (same wells in 2000 and in 2012)





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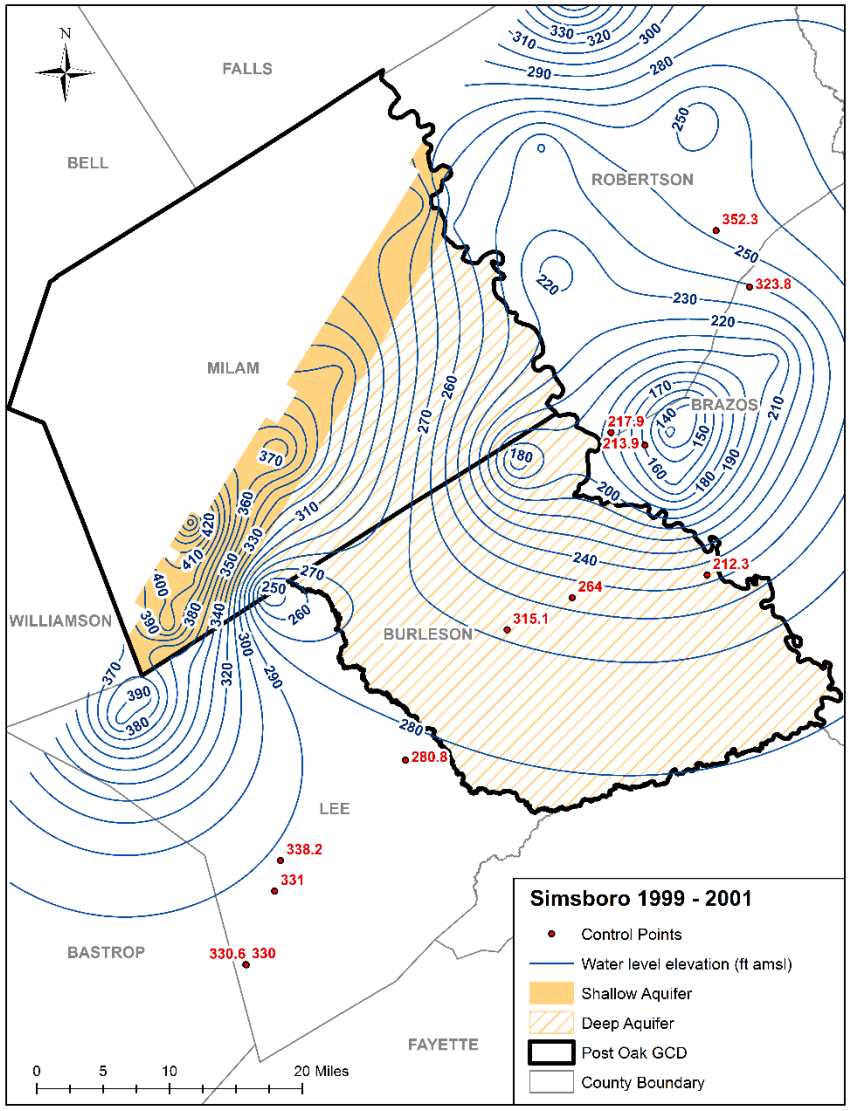
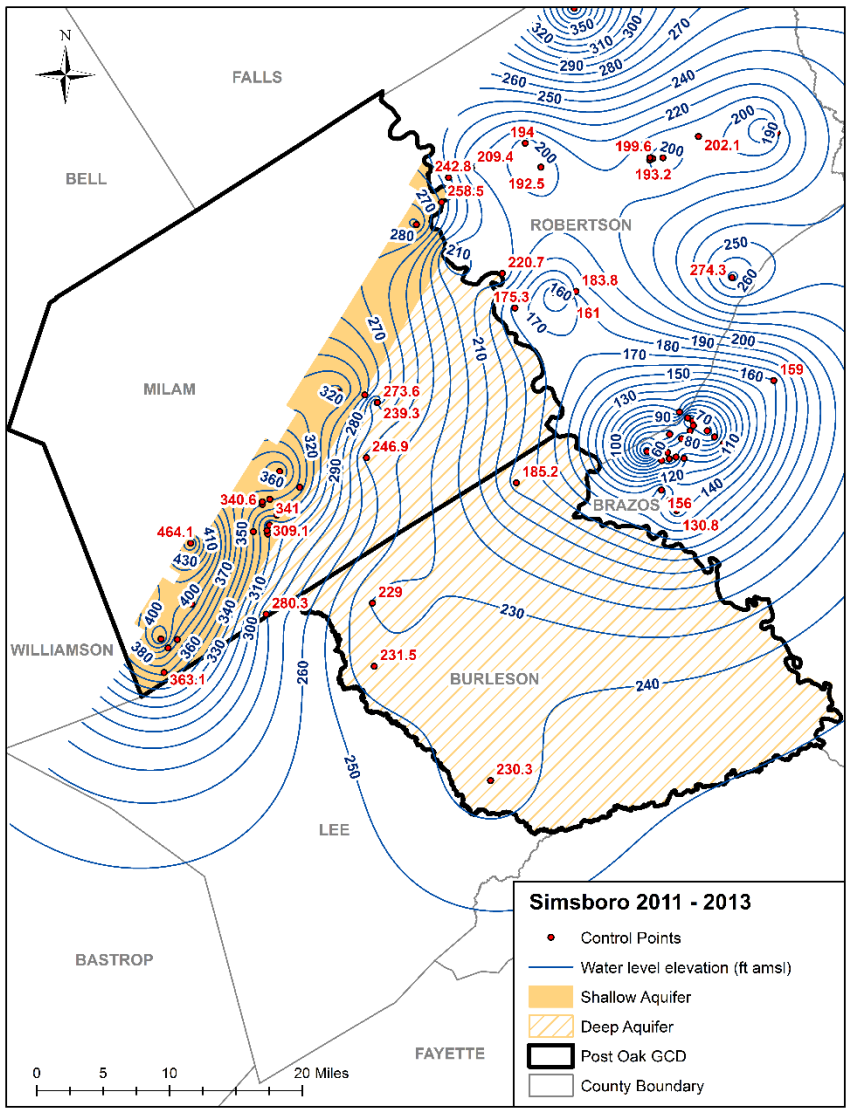
Interpolating Values Across Areas: Simsboro (more wells in 2012 and than in 2000)





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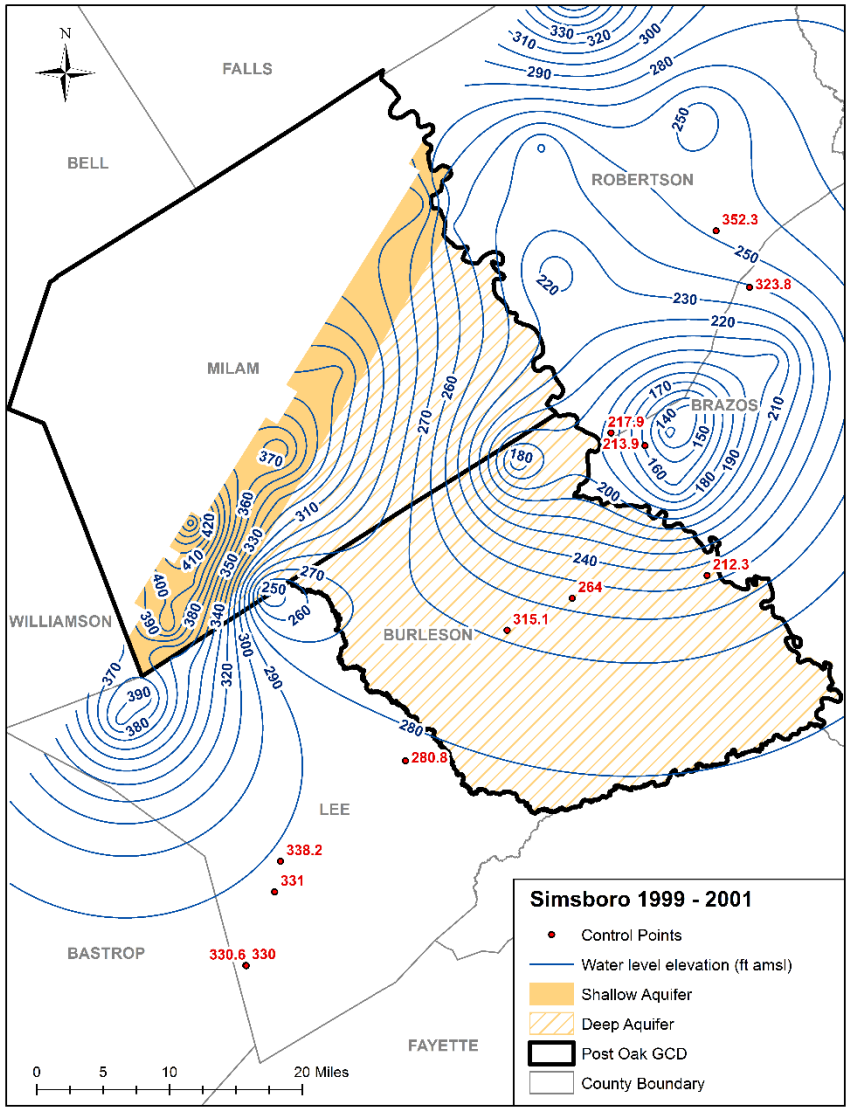
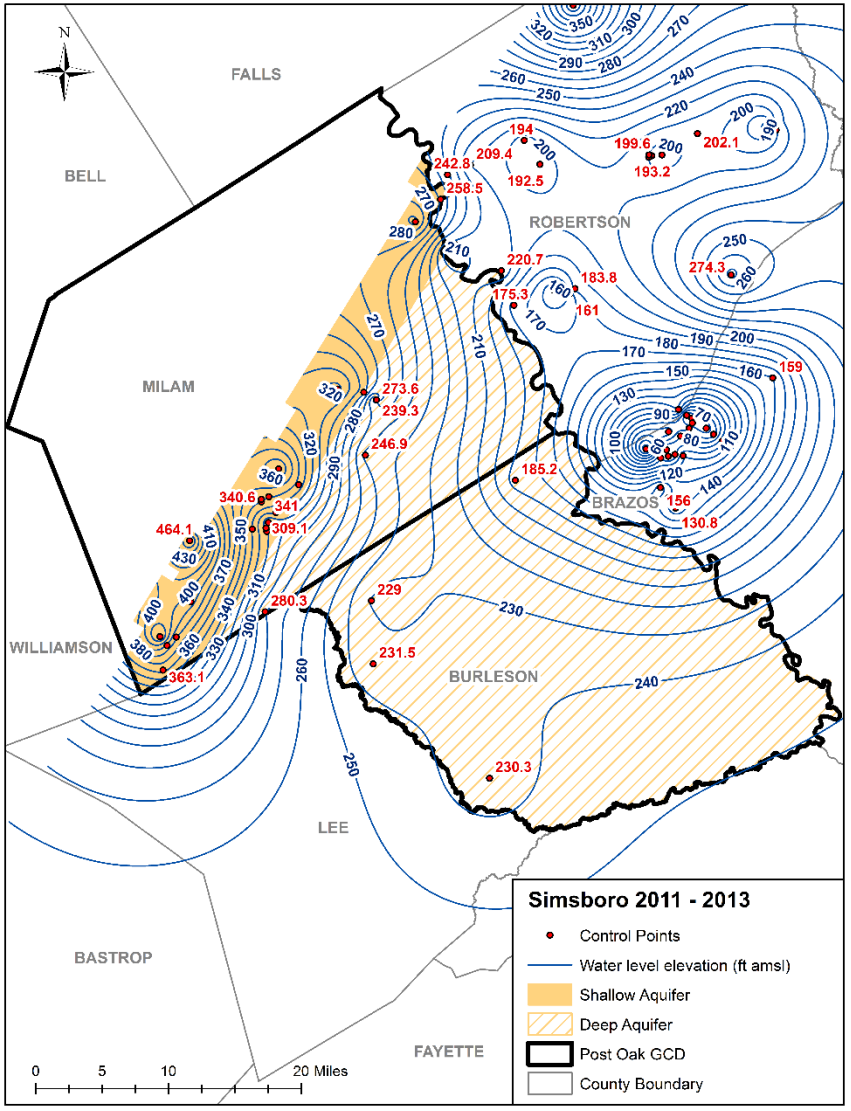
Interpolating Values Across Areas: Calvert Bluff (more wells in 2012 and than in 2000)





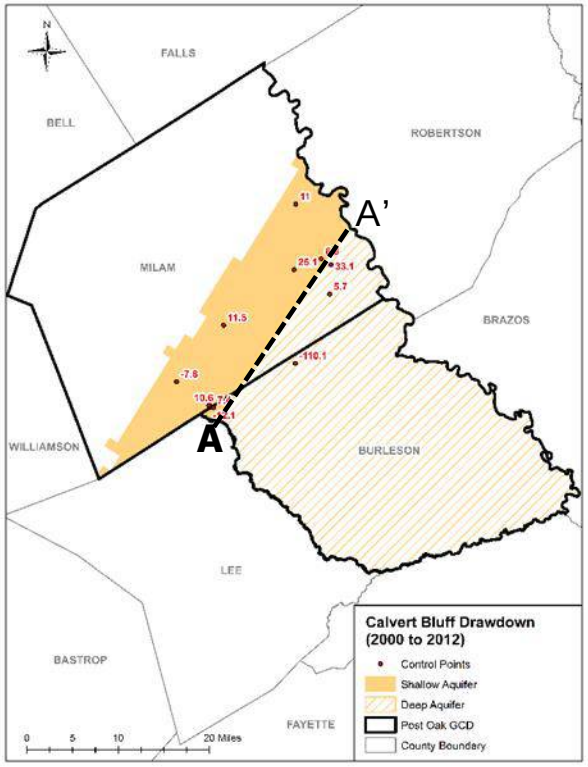
Discussion Topics: Well Assignments

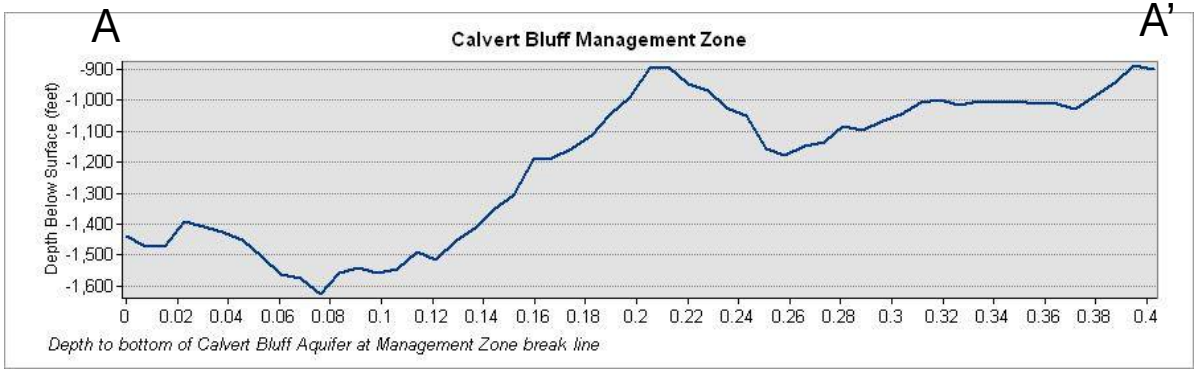
- Meeting with TWDB to Agree to Wells Assignments
  - Considerations beside GAM Aquifer Surfaces
  - Criteria for Well Screens Across Multiple Aquifers
  - Policy or guidelines from TWDB
- Meeting with Other GMA 12 GCDs and TCEQ
  - Consistency of well assignments across GCDs in GMA 12
  - Policy or guidelines from TCEQ

Discussion Topics: Monitoring Locations

- No Coverage
  - Milam Brazos River Alluvium
  - Shallow Yegua Jackson
- Sparse Coverage
  - Shallow Carrizo (1 well)
  - Entire Carrizo (4 wells)
  - Shallow Sparta (1 wells)
- Additional Coverage
  - Down-dip or Deep Areas
  - Southwest of Bryan/College Station

Discussion Topics: Shallow Zone Delineation





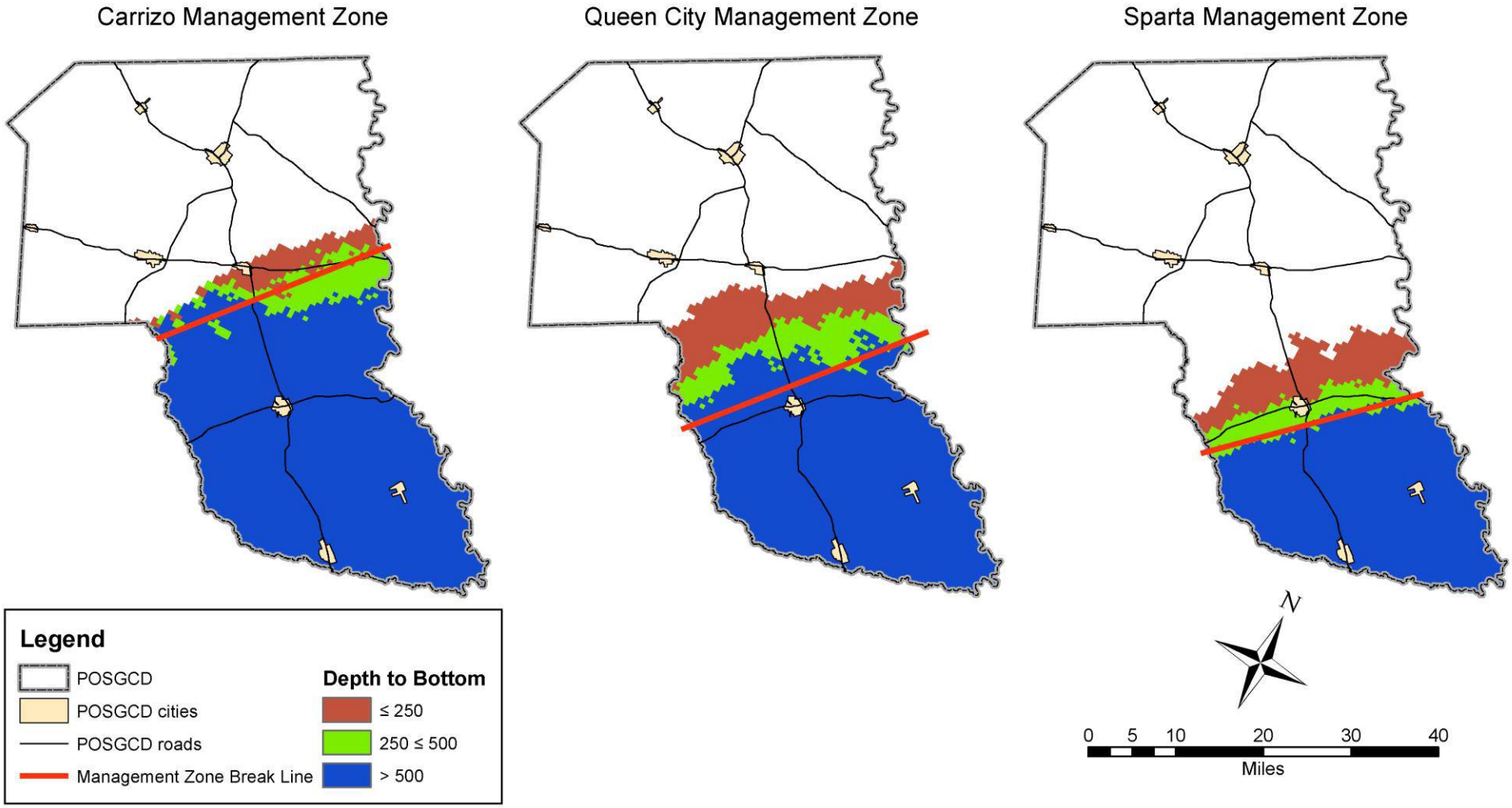
		Depth (ft) to Base of Aquifer					
		Sparta	Queen City	Carrizo	Calvert Bluff	Simsboro	Hooper
At Downdip Extent of Shallow Zone	Average	474	627	425	1221	735	747
	Median	467	658	351	1146	729	772
	Minimum	619	823	693	1639	1174	1185
	Maximum	338	441	206	858	515	493
	Range	281	383	487	780	658	693
At Downdip Extent of Unconfined Zone	Average	294	450	295	972	532	507
	Median	291	468	272	959	535	510
	Minimum	463	688	682	1359	834	924
	Maximum	156	145	3	689	140	51
	Range	307	543	679	670	695	873

Discussion Topics: Shallow Zone Delineation

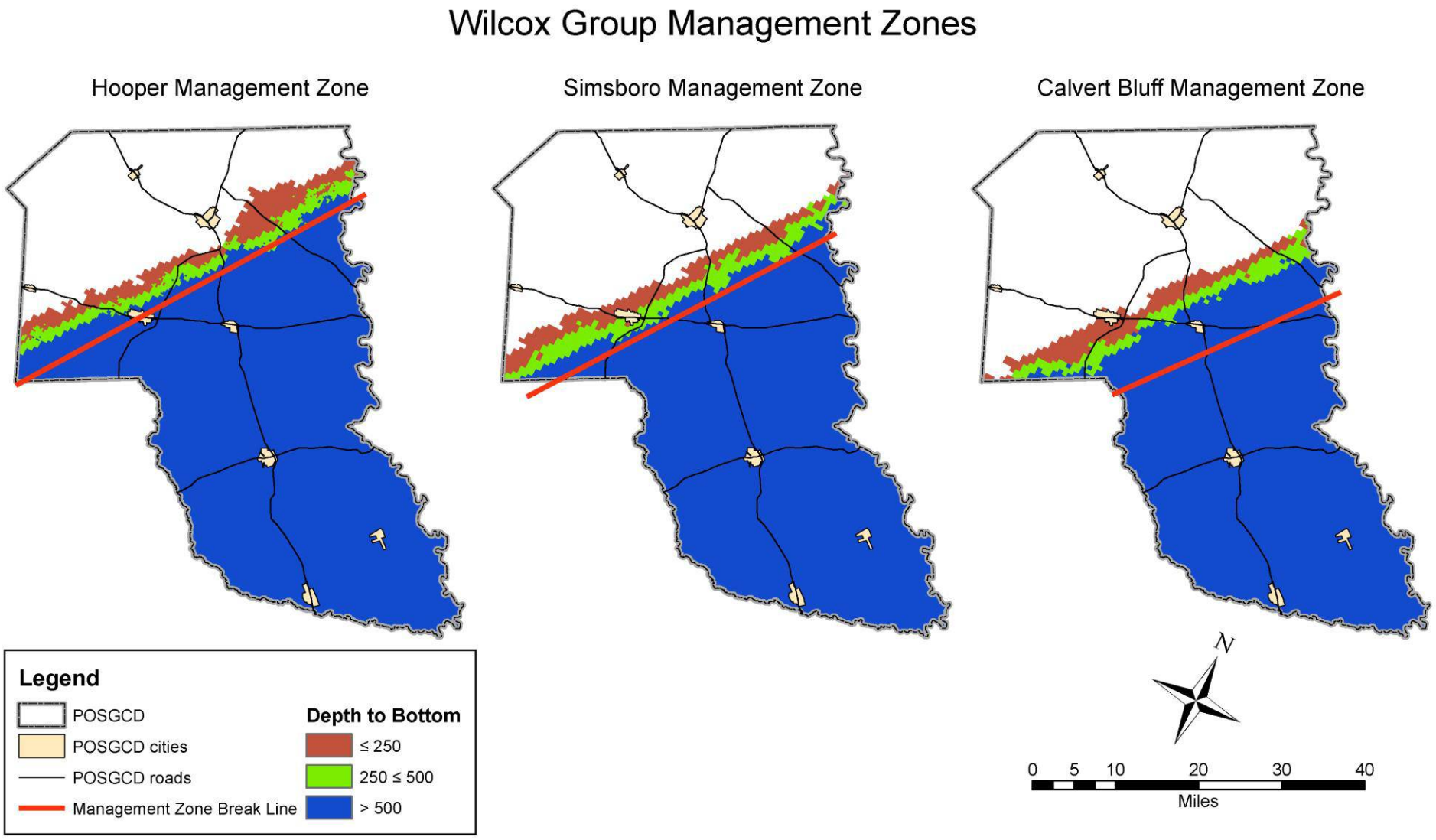
		Depth (ft) to Base of Aquifer					
		Sparta	Queen City	Carrizo	Calvert Bluff	Simsboro	Hooper
Across the Entire Shallow Zone	Average	207	338	277	597	372	377
	Median	174	329	240	570	352	343
Across the Entire Unconfined Zone	Average	131	268	208	453	266	254
	Median	106	215	165	440	251	225

- Shallow Zone Considerations: Aquifer
  - Consistency of Depth Among Different Aquifers
  - Ratio of Drawdown to Well Depth (Available Water Column)
- Shallow Zone Consideration: Wells
  - Depth of Wells
  - Number of Wells

Discussion Topics: Shallow Zone Delineation



Discussion Topics: Shallow Zone Delineation



Discussion Topics: Analysis Methods

- Interim Results
  - Multiple analysis methods are recommended
  - Use of Adjacent GCD data is recommended
  - Advantages and Disadvantages to all analysis methods
- Sources of Uncertainty/Error
  - Localized impacts of pumping are ignored with current methods
  - Partially penetrating wells (do not intersect the full aquifer)
  - Shallow Sparta (1 wells)
- Possible improvements
  - Zones for points guided from model results and pumping distributions
  - “Smart” contouring programs that accounts for groundwater flow and pumping