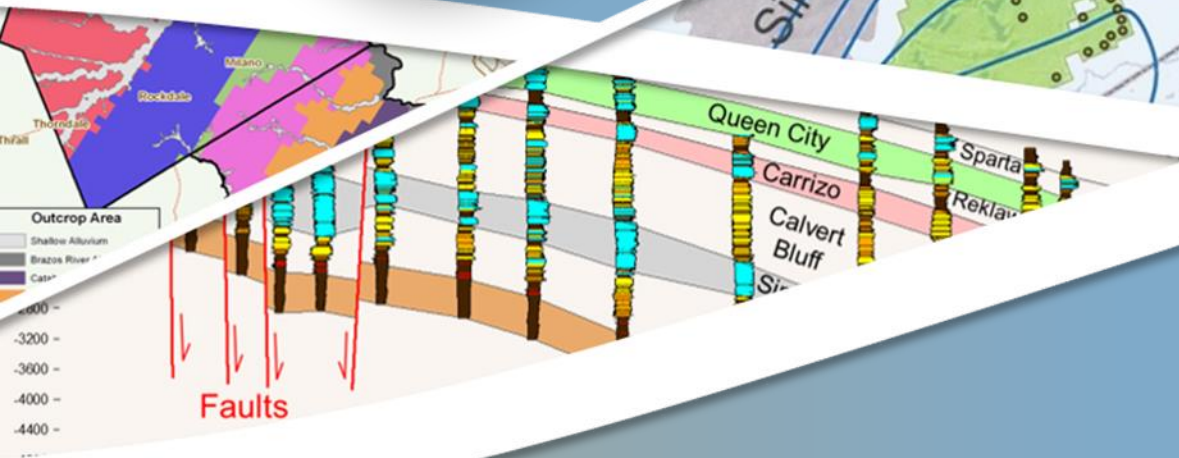


Groundwater Monitoring Update and Investigation into Alternative Definitions for Shallow Monitoring Zone

Presented To:



Presented By:

Steve Young

Jevon Harding

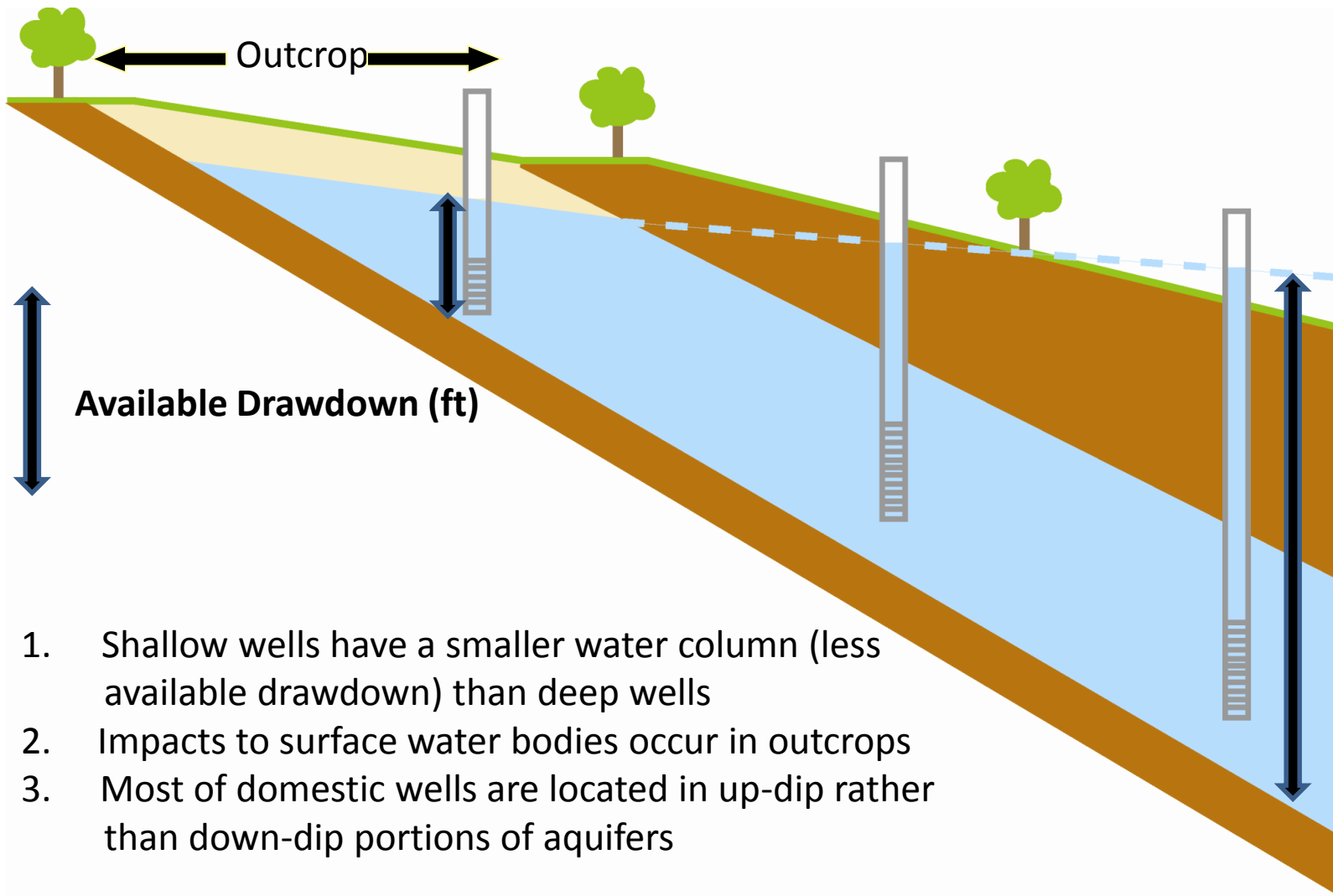


March 8, 2016

Outline

- Rationale for Monitoring Shallow Zone
- Analysis of Monitoring Data for DFC Compliance
 - Recap November 2015 presentation (2000 – 2012)
 - Calculations for 2000 – 2014
- Shallow Zone
 - Lateral and Vertical Extent
 - Water Level Measurements
- Recommended Options

Rationale for Shallow Monitoring Zone



November 2015 Presentation

- Investigated Different Spatial Analyses

- Point Locations: Drawdowns at individual wells
- Areas: Average drawdowns across a region based on interpolation of drawdowns at well locations

x			
			x

- Investigated Different Temporal Analyses

- Three-year period
- Five-year period
- Seven-year period

Average Period	Year 2012
3-year	2011, 2012, 2013
5-year	2010,2011, 2012, 2013,2014
7-year	2009,2010,2011, 2012, 2013,2014,2015

- Investigated Different Criteria for Selecting Wells Used in Analyses

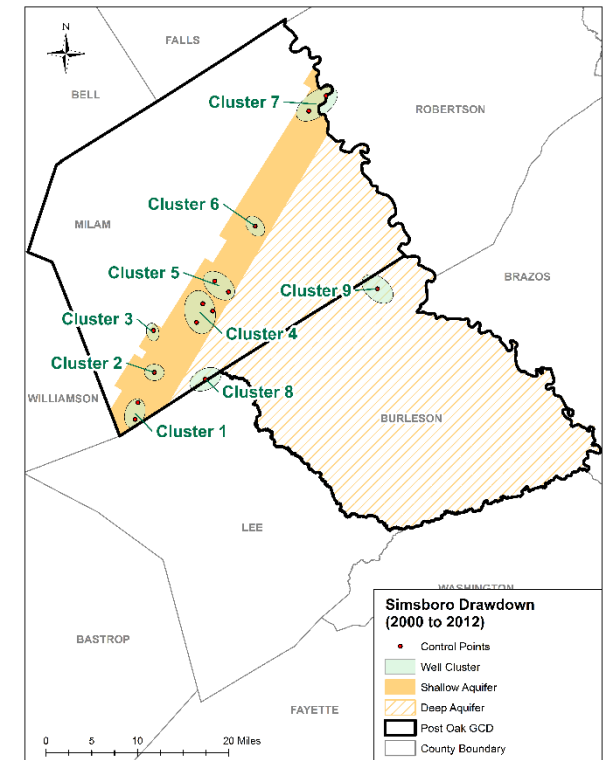
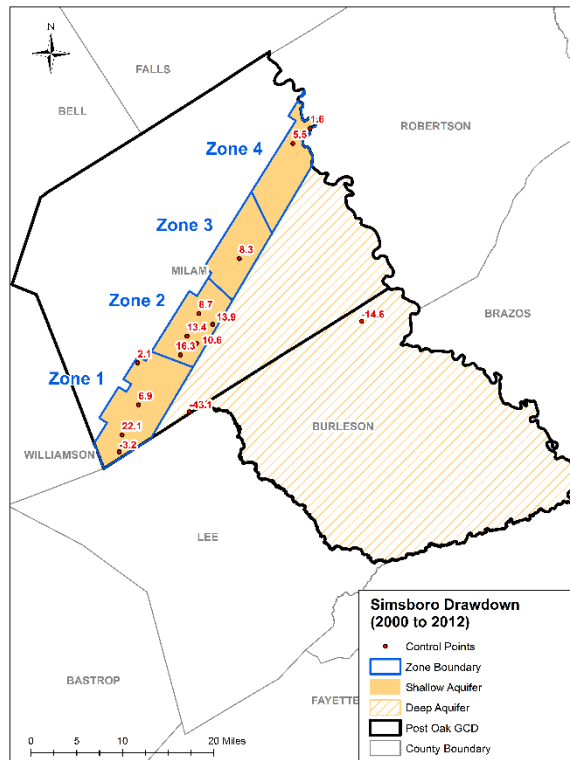
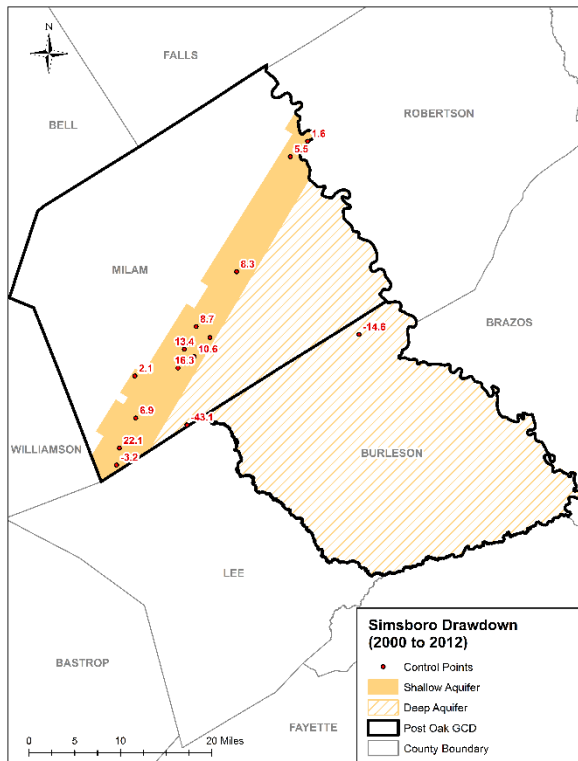
- Only wells with water levels for 2000 and 2012 (same set of wells used to calculate average water levels for two times)
- All wells with water level in 2000 and all wells with water levels in 2012 (different set of wells used to calculate average water levels for two times)

Averaging of Single Points: Simsboro

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

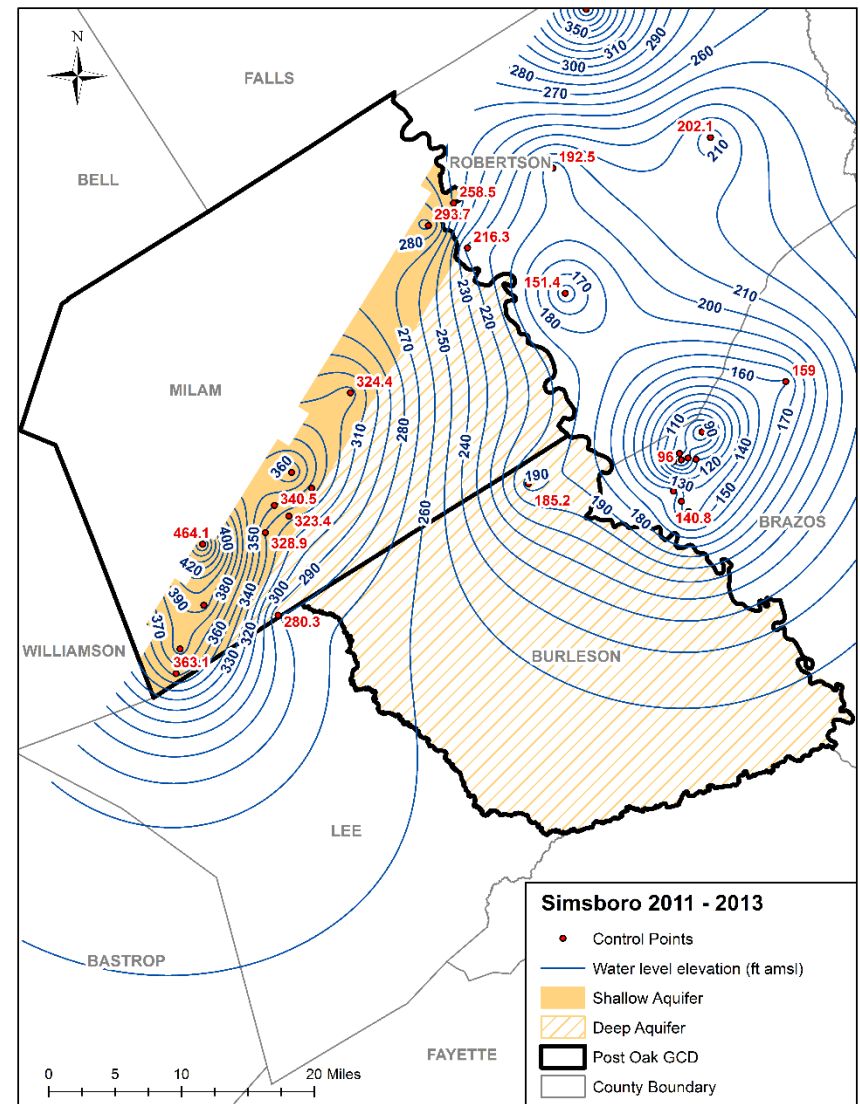
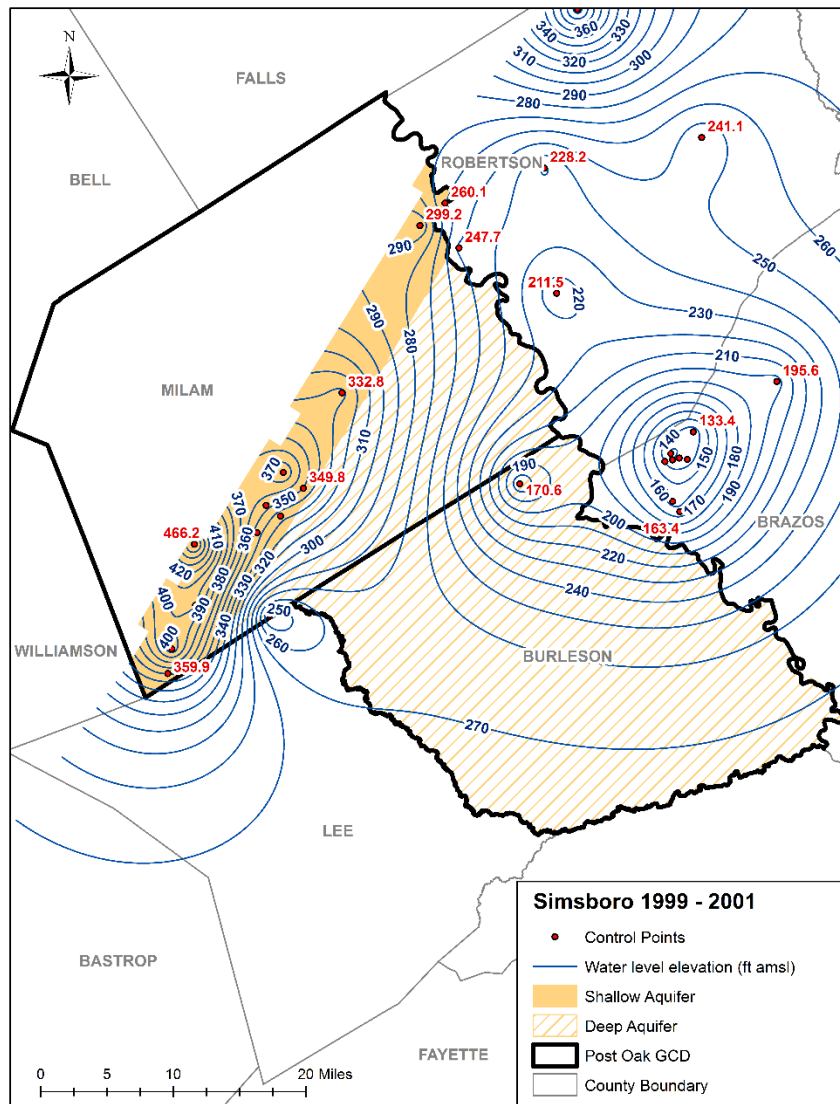
Four Zones in Shallow
(shallow: 6 ft)

Group by Cluster
(shallow: 7.8 ft, entire: -0.4)



Note: 1) three-year averages for used to assign water levels for 2000 and 2012
2) negative values indicate rebound

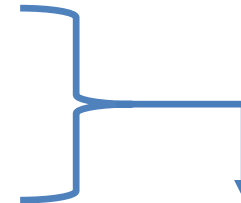
Interpolating Values Across Areas: Simsboro (same wells in 2012 and in 2000)



Comparison Between DFC and Calculated Average Drawdown from 2000 to 2012

Selected Method

- 1) Area Averages
- 2) 3-year Period
- 3) 2000 & 2012 Water Levels



Aquifer	Managem ent 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		
			POSG CD	All	POSG CD	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%

Comparison Between DFC and Calculated Average Drawdown from 2000 to 2014

Aquifer	Management Zone	Desired Future Condition Average	Average Based on Interpolated Points				DFC Compliant (2014)	Percent of Average Drawdown of DFC (2014)
			All Wells		Only Wells Common with 2000			
			2012	2014	2012	2014		
Calvert Bluff (Upper Wilcox)	Unconfined	20	---	-4.1	---	2.9	Yes	14.6
	Shallow	20	-11.1	-11.0	0	1.3	Yes	6.7
	Entire	140	-6	-2.7	-11.4	-11.5	Yes	-8.2
Simsboro (Middle Wilcox)	Unconfined	20	---	9.8	---	11.5	Yes	57.3
	Shallow	20	12	10.8	9.6	10.8	Yes	54.0
	Entire	300	20.3	43.6	11.1	14.0	Yes	4.7
Hooper (Lower Wilcox)	Unconfined	20	---	39.0	---	7.0	Yes	34.8
	Shallow	20	40	42.4	6.2	7.2	Yes	36.1
	Entire	180	84.5	89.2	7.1	8.0	Yes	4.5

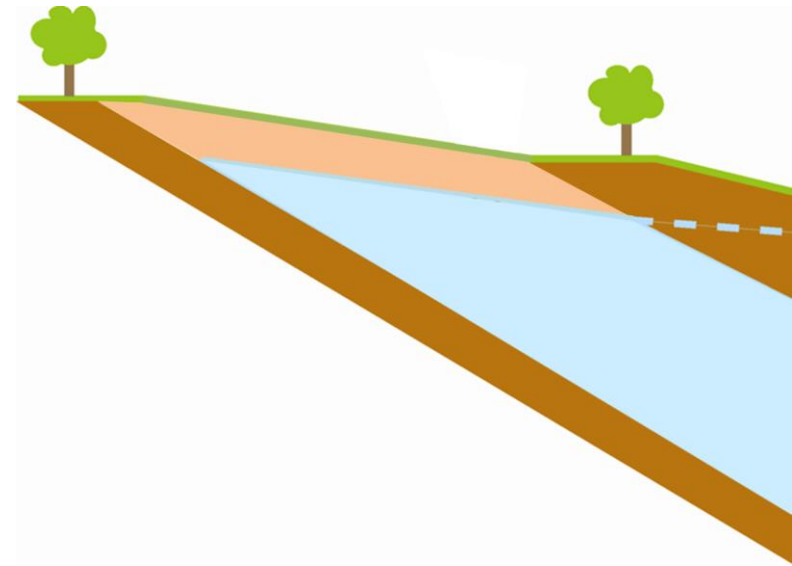
Options for Defining Shallow Monitoring Zone

- Lateral Dimension

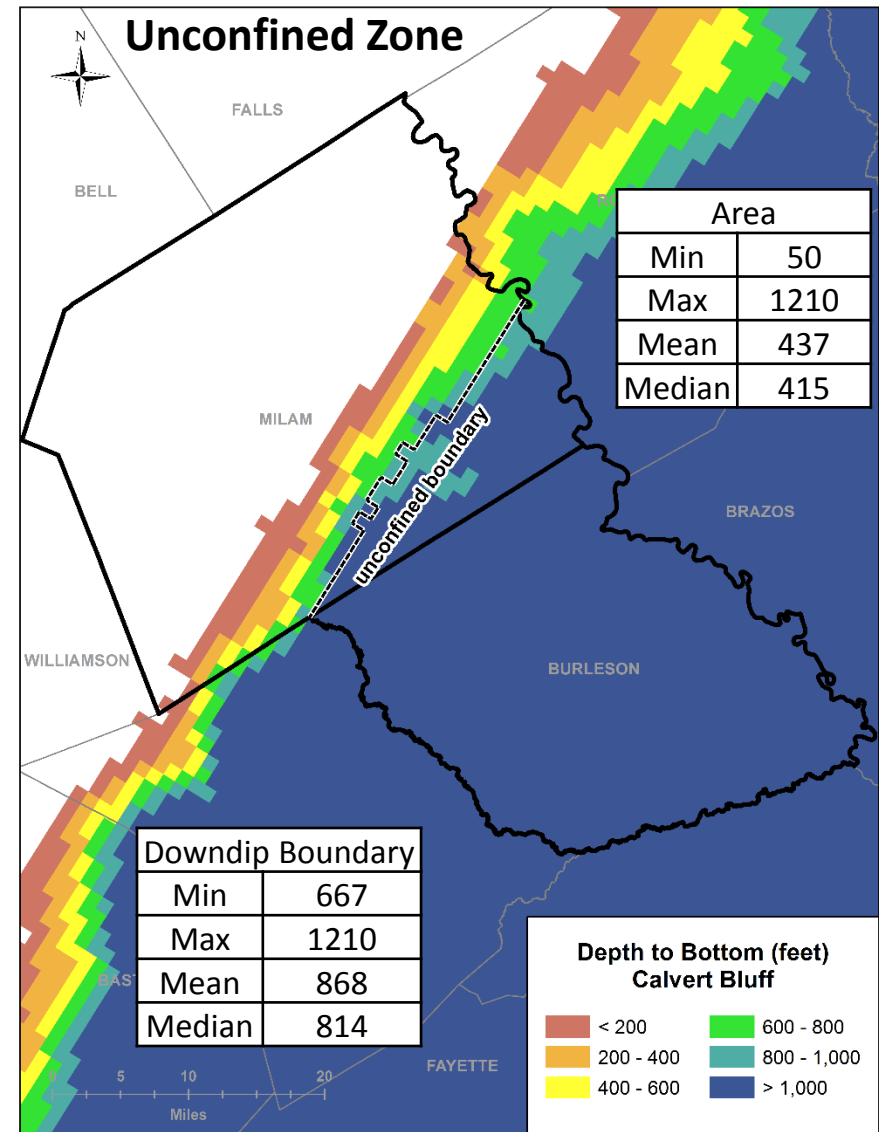
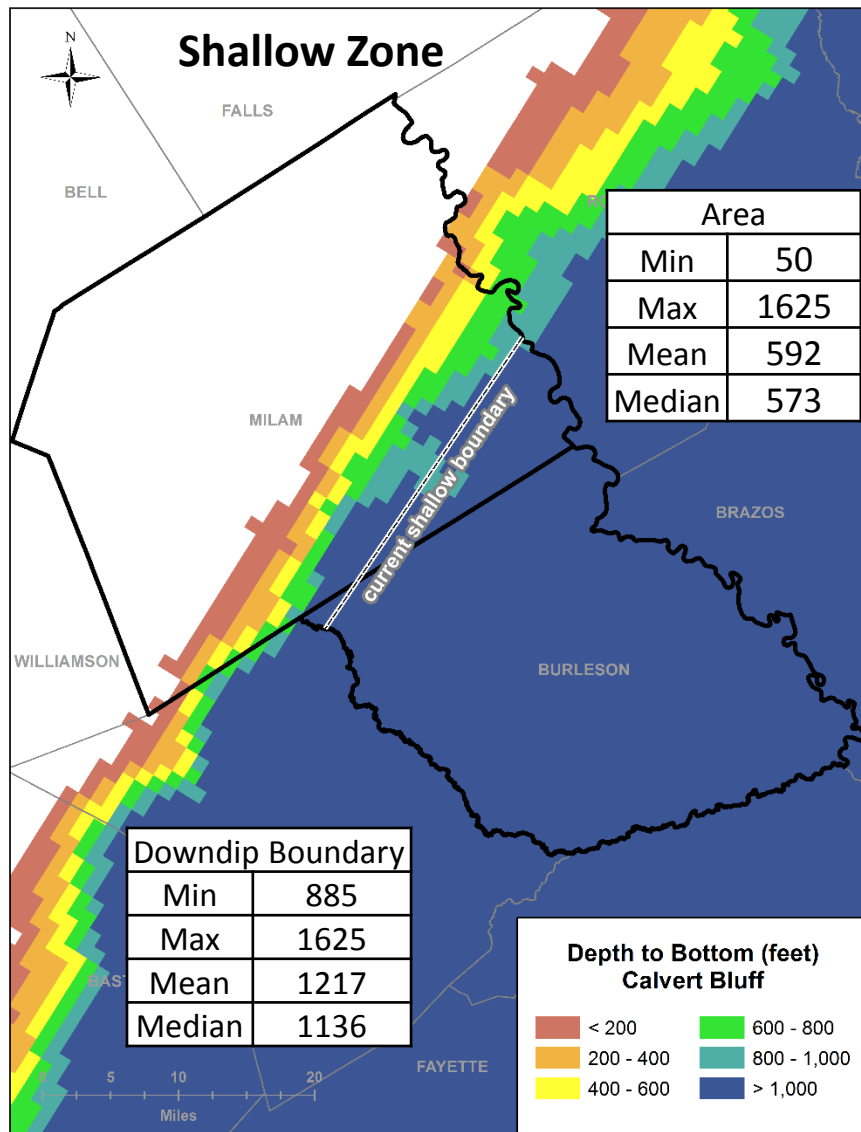
- Outcrop: aquifer is at ground surface
- Unconfined: water level is below top of aquifer
- Fault zone: area where groundwater flow is impacted by faults
- Other: political boundary, geographical feature

- Vertical Dimension

- Maximum Depth below ground surface
- Minimum Elevation

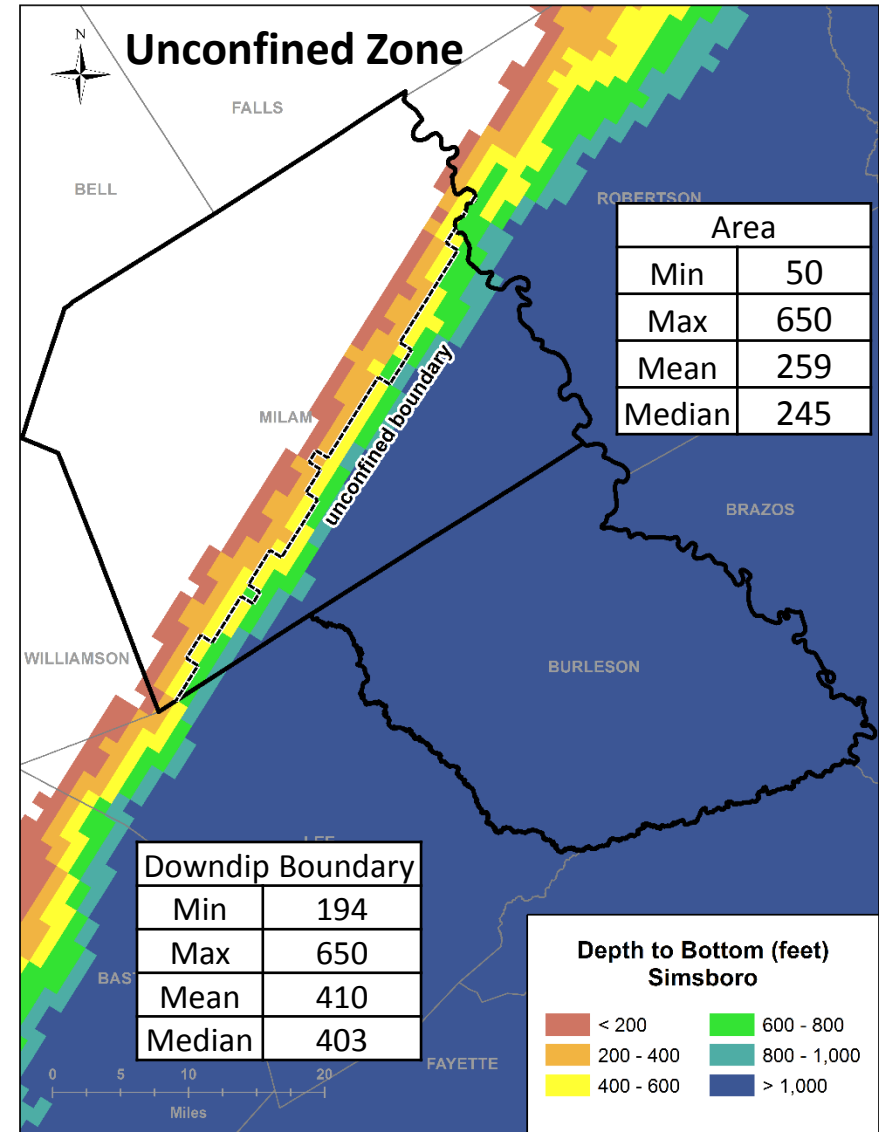
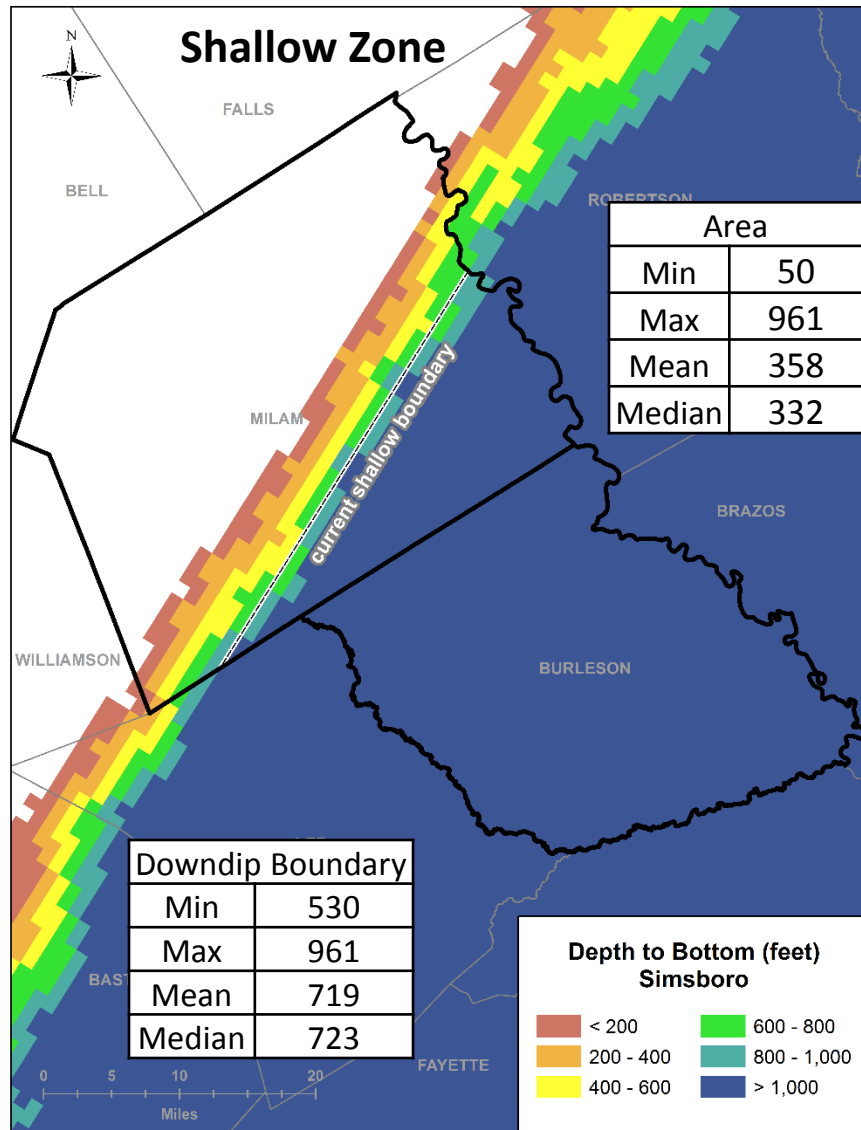


Depth to Base of Calvert Bluff



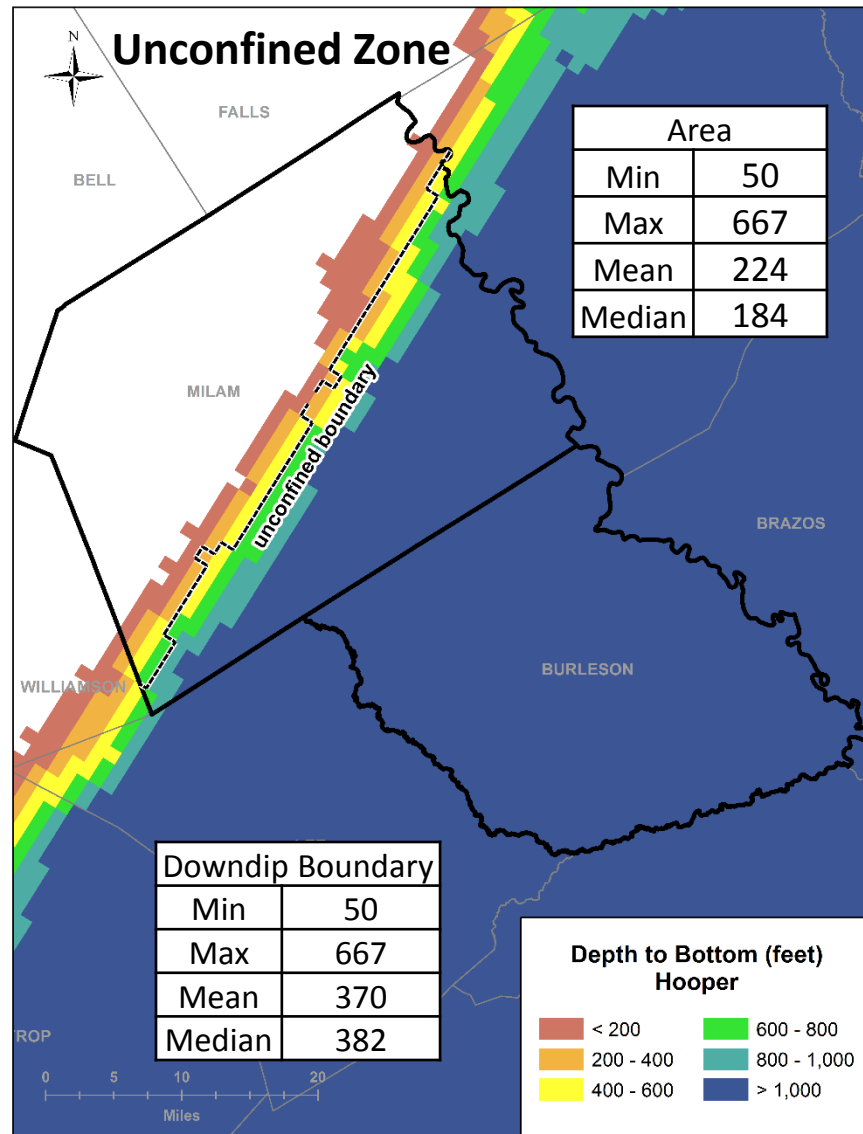
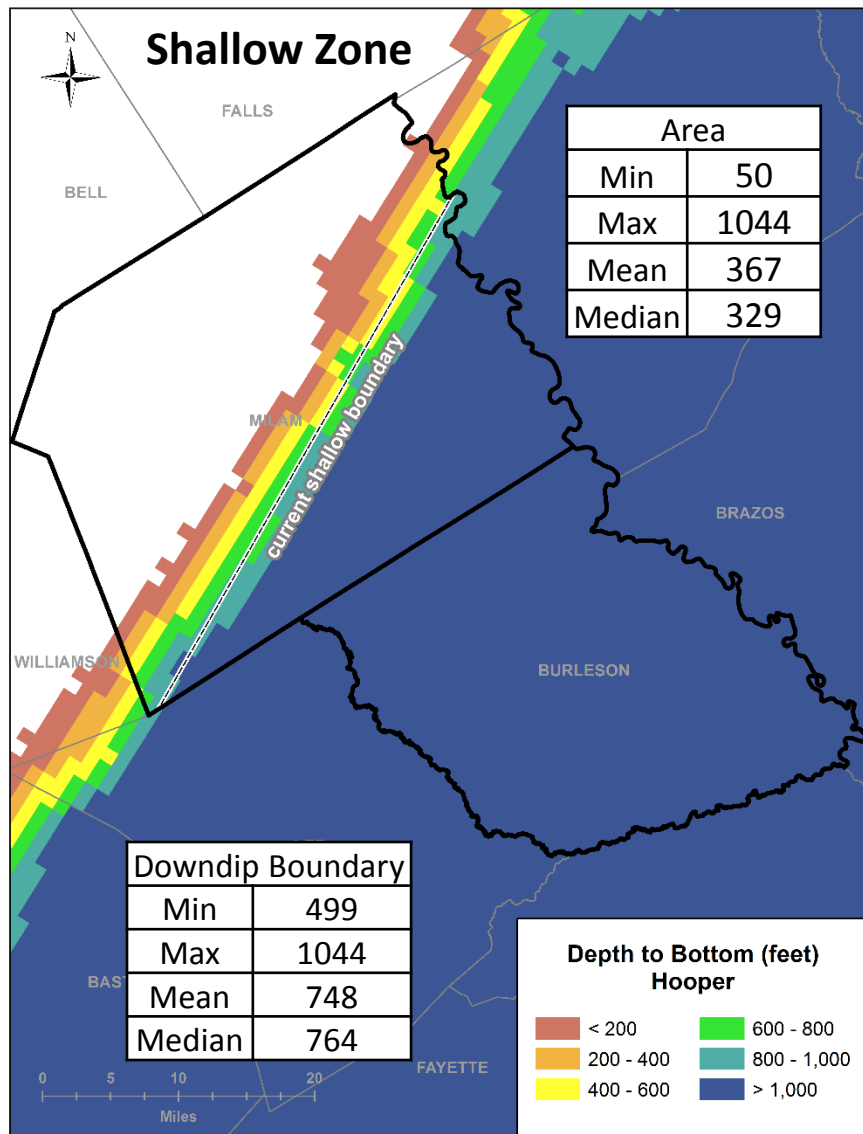
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Depth to Bottom of Simsboro



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Depth to Bottom of Hooper



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Depth to Bottom of Aquifers Within Shallow and Unconfined Areas – Wilcox

- Shallow Area

- Maximum Depth across Area: 961 to 1625 ft
- Maximum at Down Dip Boundary: 961 to 1625 ft
- Average Depth across Area: 358 to 592 ft
- Average Depth Down Dip Boundary: 719 to 1217 ft

- Unconfined Area

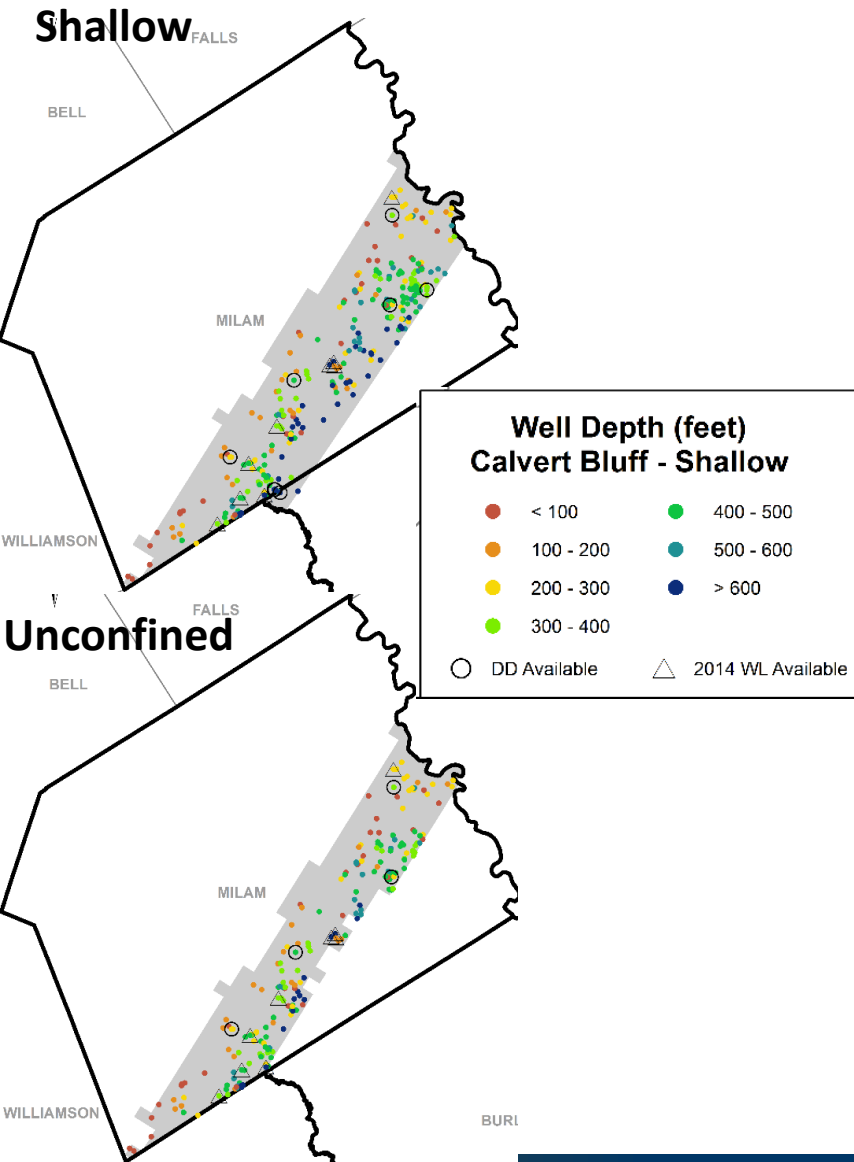
- Maximum Depth across Area: 650 to 1210 ft
- Maximum at Down Dip Boundary: 650 to 1210 ft
- Average Depth across Area: 259 to 437 ft
- Average Depth Down Dip Boundary: 370 to 868 ft



Possible Concerns

1. Wells Deeper than 1,000 feet included
2. Definition of “Shallow” varies with formation

Calvert Bluff: Distribution of Depths of Wells



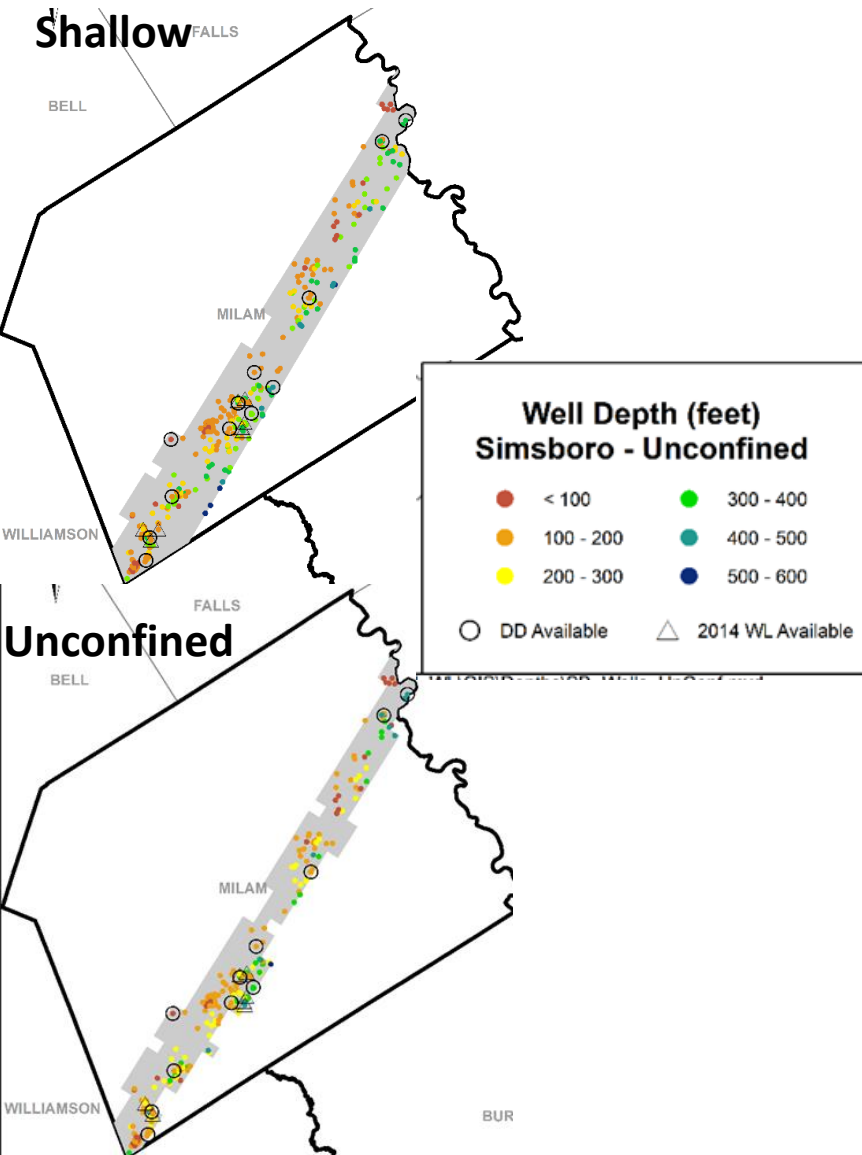
Shallow

Depth	Total	Monitoring	Permit	Exempt
< 100	32	0	4	28
< 200	61	1	5	56
< 300	107	3	6	101
< 400	148	7	7	141
< 500	230	11	8	222
< 600	267	13	9	258
Deep (> 600)	38	5	4	34

Unconfined

Depth	Total	Monitoring	Permit	Exempt
< 100	32	0	4	28
< 200	58	1	5	53
< 300	94	3	6	88
< 400	126	6	7	119
< 500	180	10	8	172
< 600	202	10	8	194
Deep (> 600)	16	3	4	12

Simsboro: Distribution of Depths of Wells



Shallow

Depth	Total	Monitoring	Permit	Exempt
< 100	75	1	45	30
< 200	208	9	48	160
< 300	291	10	50	241
< 400	325	14	54	271
< 500	349	19	58	291
< 600	360	20	60	300

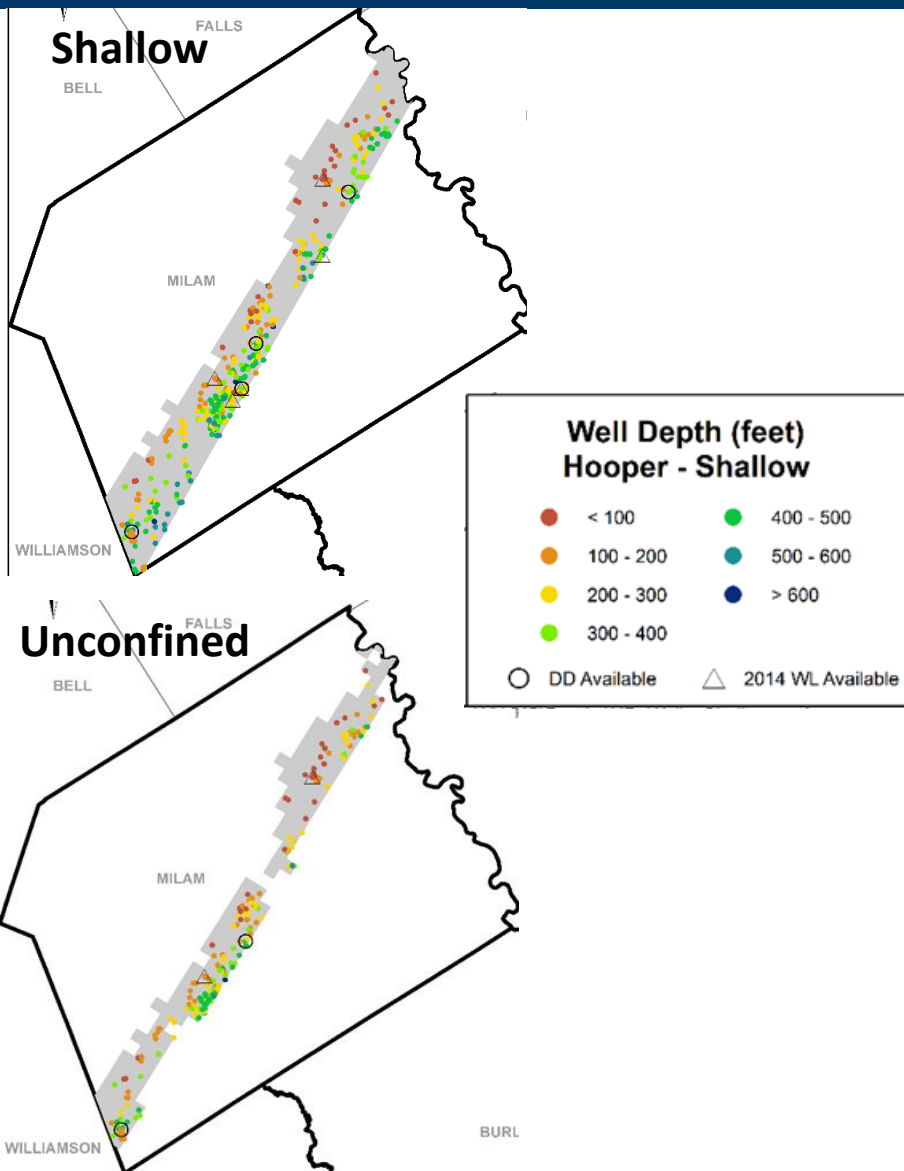
Depth	Total	Monitoring	Permit	Exempt
Deep (> 600)	4	0	1	3

Unconfined

Depth	Total	Monitoring	Permit	Exempt
< 100	37	1	7	30
< 200	162	8	10	152
< 300	221	9	12	209
< 400	247	13	15	232
< 500	261	18	18	243
< 600	263	18	18	245

Depth	Total	Monitoring	Permit	Exempt
Deep (> 600)	0	0	0	0

Hooper: Distribution of Depths of Wells



Shallow

Depth	Total	Monitoring	Permit	Exempt
< 100	37	1	2	35
< 200	108	3	4	104
< 300	204	4	9	195
< 400	307	7	13	294
< 500	401	9	18	383
< 600	418	10	18	400

Depth	Total	Monitoring	Permit	Exempt
Deep (> 600)	5	0	0	5

Unconfined

Depth	Total	Monitoring	Permit	Exempt
< 100	35	1	2	33
< 200	95	3	4	91
< 300	155	3	7	148
< 400	187	4	9	178
< 500	218	5	10	208
< 600	221	5	10	211

Depth	Total	Monitoring	Permit	Exempt
Deep (> 600)	1	0	0	1

Distribution of Wells Based on Depth

Well Depth < 400 feet

Aquifer	Monitoring Wells	Total Wells
Calvert Bluff	7	148
Simsboro	14	325
Hooper	7	307

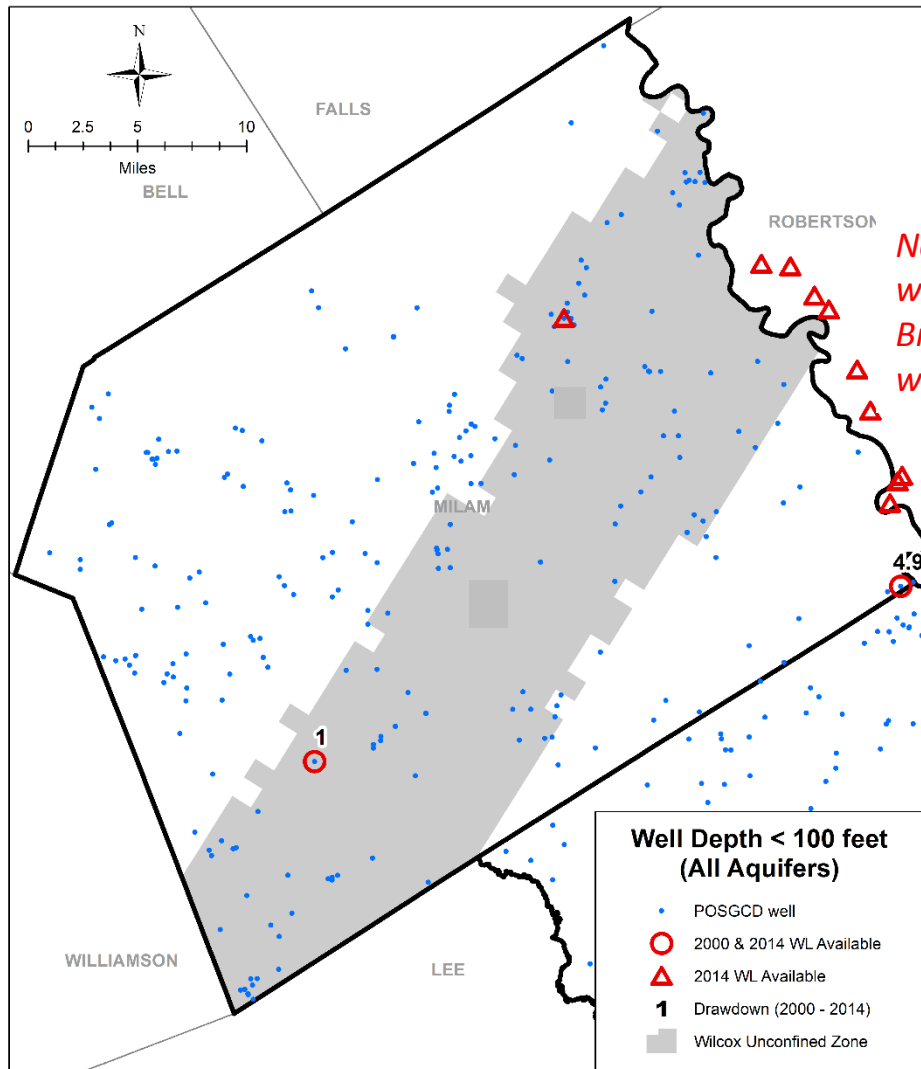
Well Depth < 500 feet

Aquifer	Monitoring Wells	Total Wells
Calvert Bluff	11	230
Simsboro	19	349
Hooper	9	401

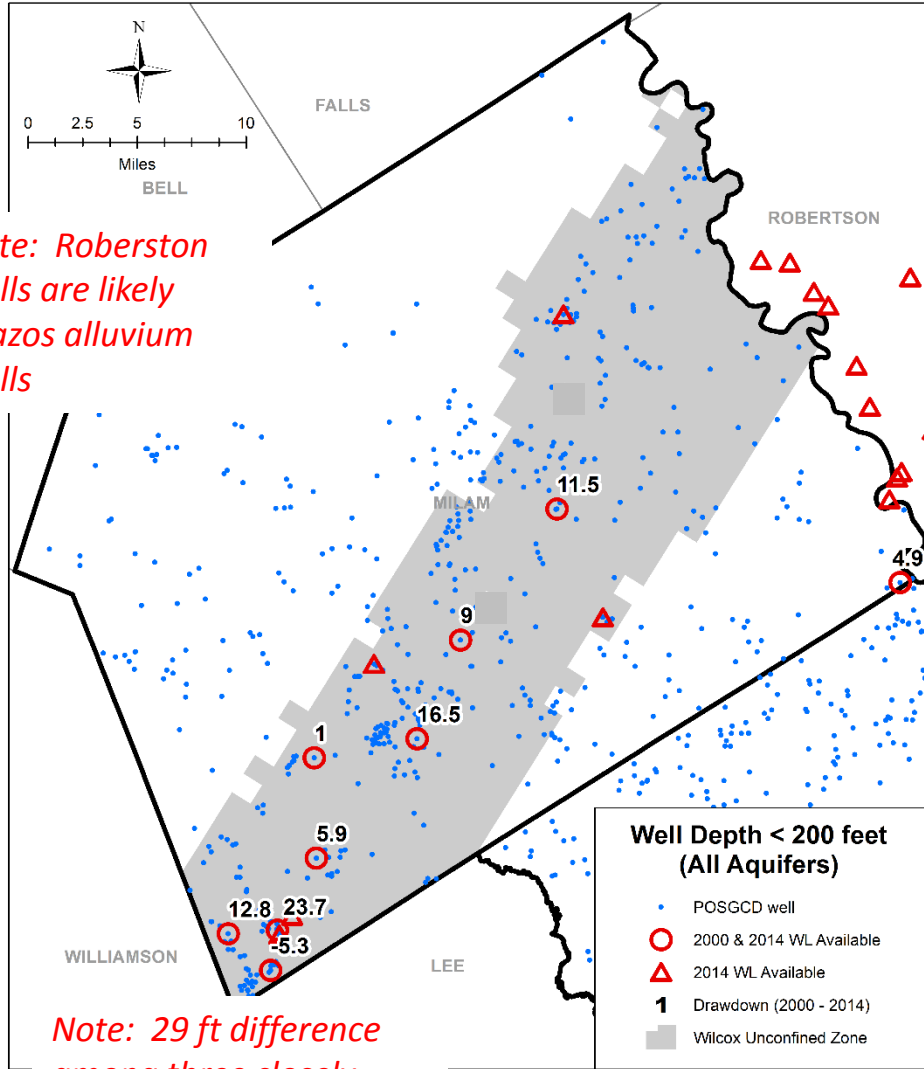
Well Depth < 600 feet

Aquifer	Monitoring Wells	Total Wells
Calvert Bluff	13	367
Simsboro	20	360
Hooper	10	418

All Aquifers: Shallow Wells

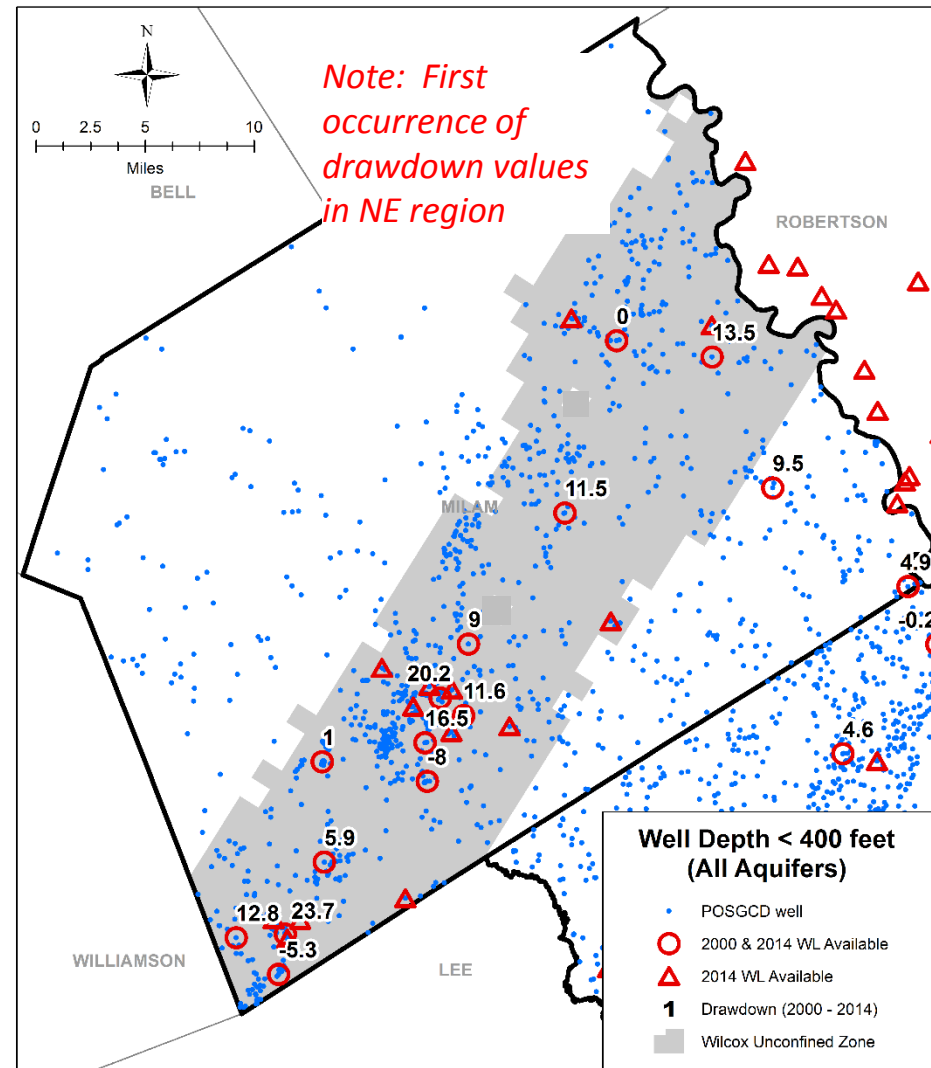
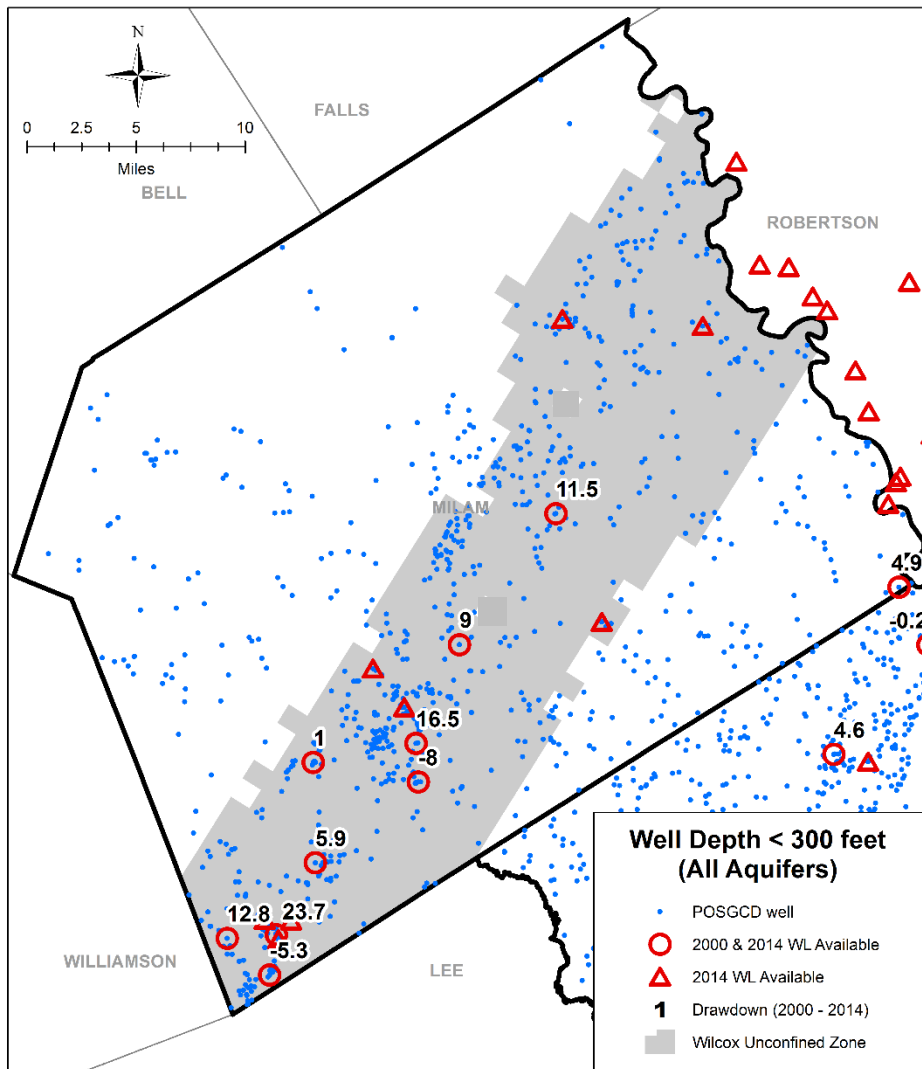


Note: Roberston wells are likely Brazos alluvium wells

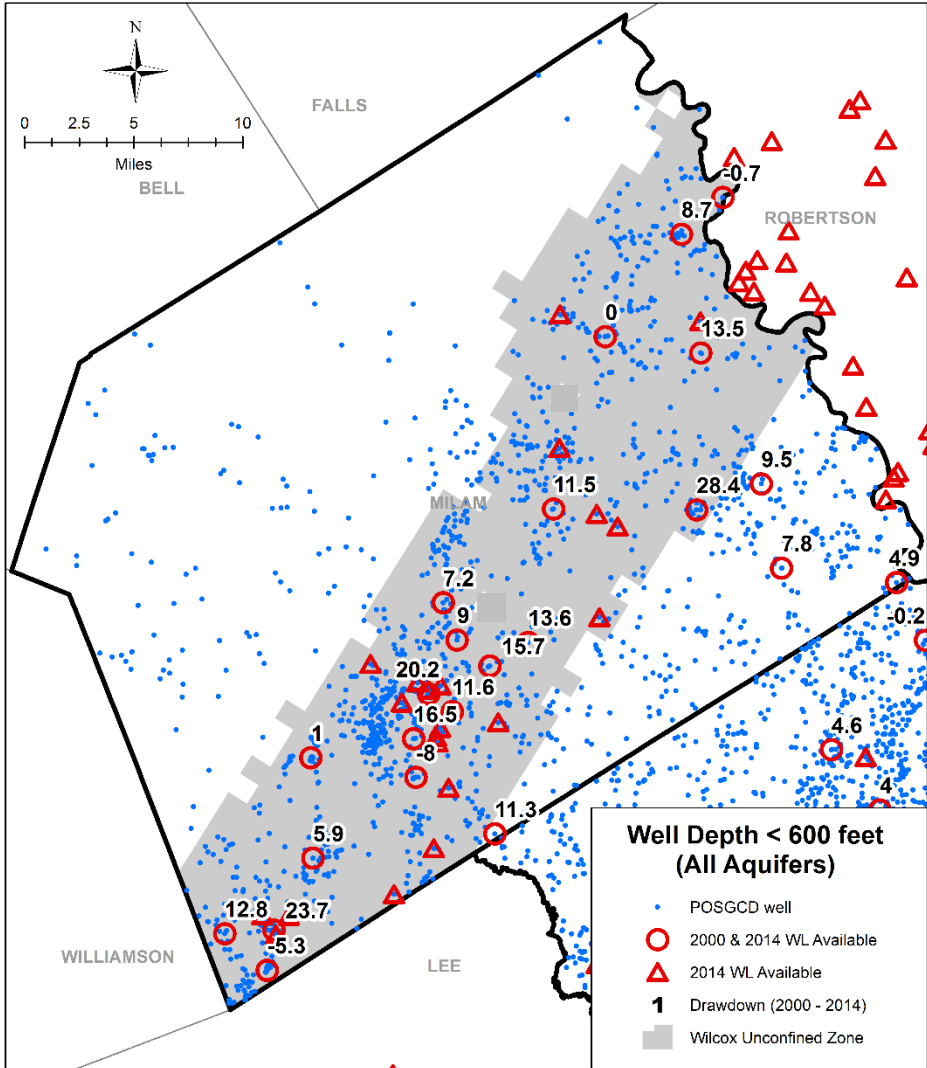


Note: 29 ft difference among three closely spaced wells

All Aquifers: Shallow Wells



All Aquifers: Shallow Wells



Path Forward for Reevaluation of Shallow Monitoring Zone

- Considerations for Shallow Zone Delineation
 - Delineation by aquifer
 - Cut off at 400 to 600 feet maximum well depth
 - Use GAM surfaces to assign wells to aquifers
 - Areal extent should be more similar to unconfined boundary than current shallow boundary
- Consideration for Drawdown Criteria
 - Mitigation Program for Shallow Wheels
 - Estimated Heights of water column in a well
 - above top of screen (most wells should have 200 to 300 feet of water above screen)
 - above bottom of well
 - above bottom of aquifer
 - above base of the Hooper (Hooper may be less than Simsboro)
 - Historical drawdowns (varies between about 5 feet and 100 feet in Simsboro)
 - Total depth to water level in wells (about 100 feet in Simsboro)
 - Predicted drawdowns from Pumping Scenario 6 Simulations