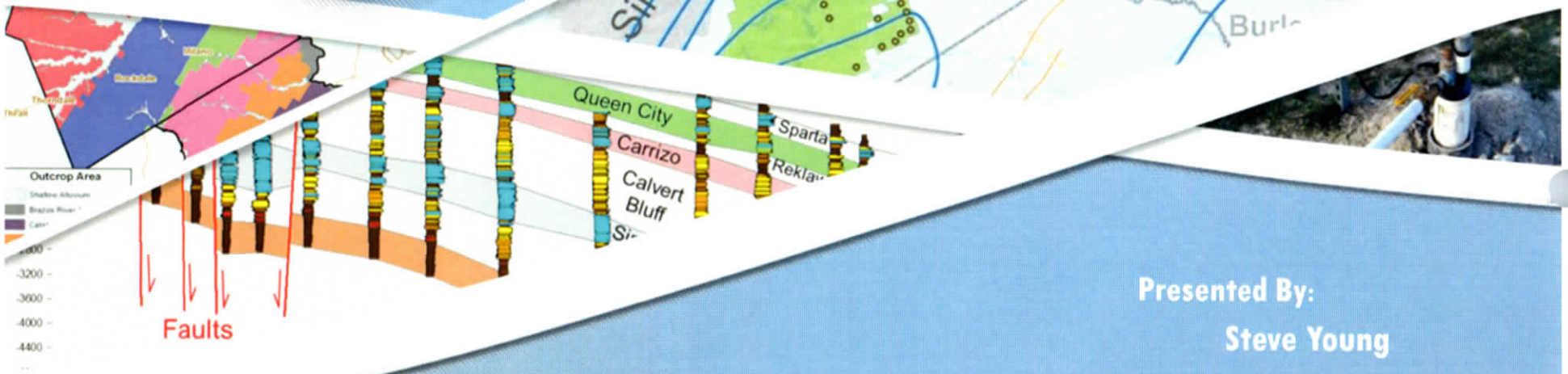
Desired Future Committee Meeting: Investigation into Methods for Developing Fair Share

Presented To:

POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT



Presented By:

Steve Young

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

March 9 2017

Approach to Fair Share Concept

- Factors that Could be used for Basis of Fair Share
  - Surface acreage
  - Groundwater in storage underlying acreage
  - Aquifer production capacity underlying acreage
  - A combination of the three factors above
- Review Several Mathematical Options for Transforming (or Scaling) Factors to Production Rate (af/acre)
- Example Maps of Production Rates
  - Single aquifers
  - All aquifers

Using Surface Acreage for Basis of Fair Share

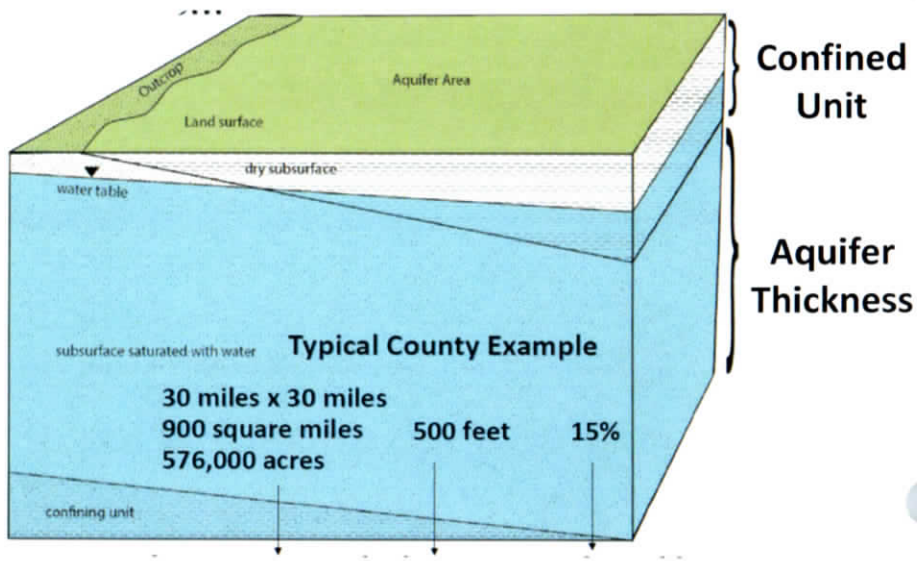
- Fair share is a uniform production rate across an aquifer or management zone
  - Coorelative right based on contiguous acreage
  - POSGCD current maximum production rate is 2 acre-ft/acre
- Potential Strengths
  - Simple to implement
  - Little opportunity for challenging production calculations
- Potential Weaknesses
  - Ignores amount of groundwater underlying land
  - Ignores aquifer production capacity underlying land

Groundwater in Storage in POSGCD

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, & Hossten

** equivalent of 415 feet of water above the district



Storage volume = area x thickness x drainable porosity

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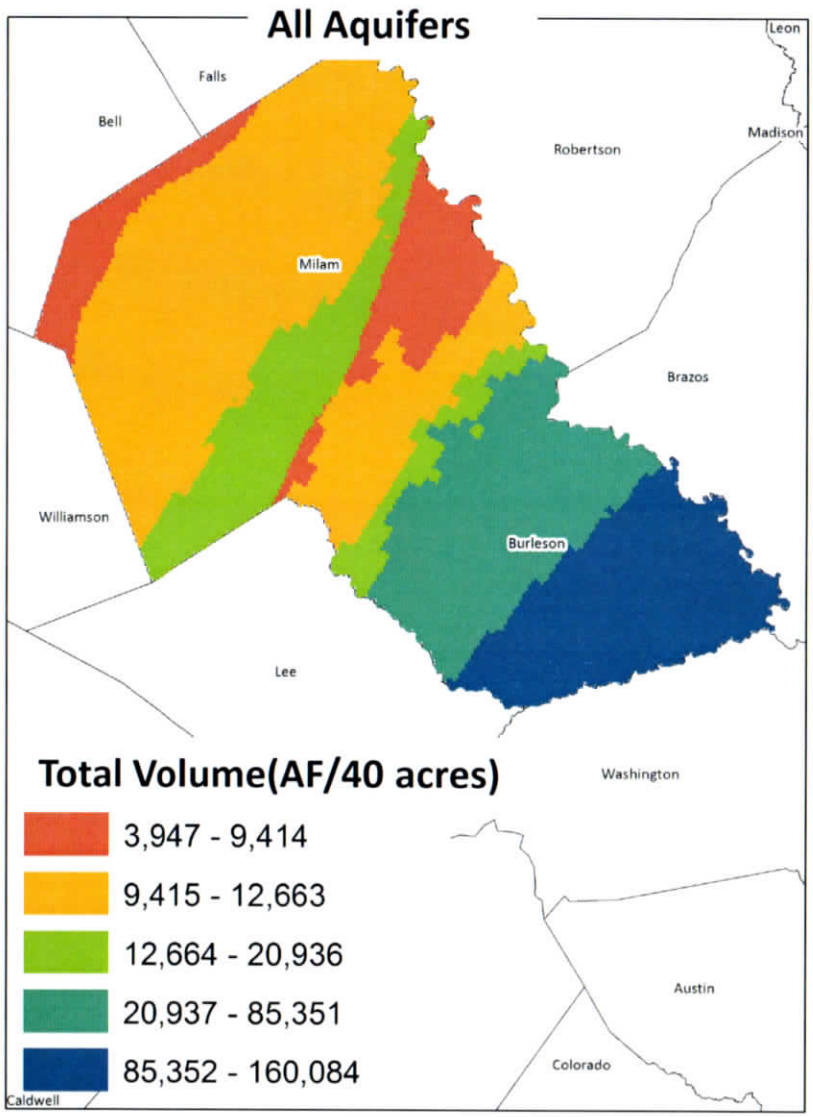
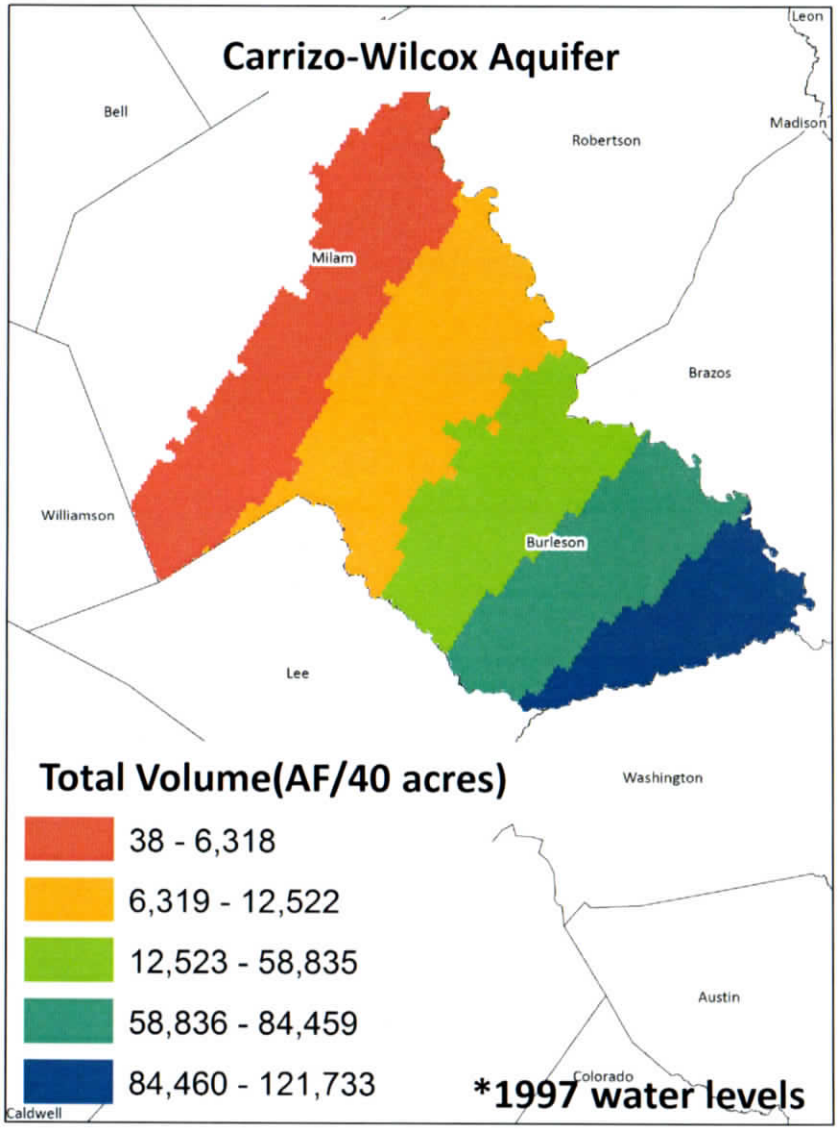
Distribution of Groundwater in Storage Across District





* Brazos River Alluvium Aquifer is not Included In All Aquifer Calculation

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Groundwater Production Capacity in POSGCD

Aquifer(s)	Production Capacity (10^4 ft^2*mi^2/dy)	% Production Capacity	Area (sq miles)	Average Trans. (ft^2/day)
Upper Trinity	17	0.8%	807	211
Lower Trinity*	143	6.6%	807	591
Sparta	31	1.4%	576	532
Queen City	46	2.1%	753	608
Carrizo	277	12.7%	835	3,311
Calvert Bluff	238	10.9%	1024	2,322
Simsboro	1,005	46.1%	1132	8,874
Hooper	397	18.2%	1237	3,207
subtotal	1,916	88.0%	4229	4,530
Yegua-Jackson	25	1.1%	291	847
total	2,177	100.0%	7464	

*Hensell, Pearsall, & Hossten

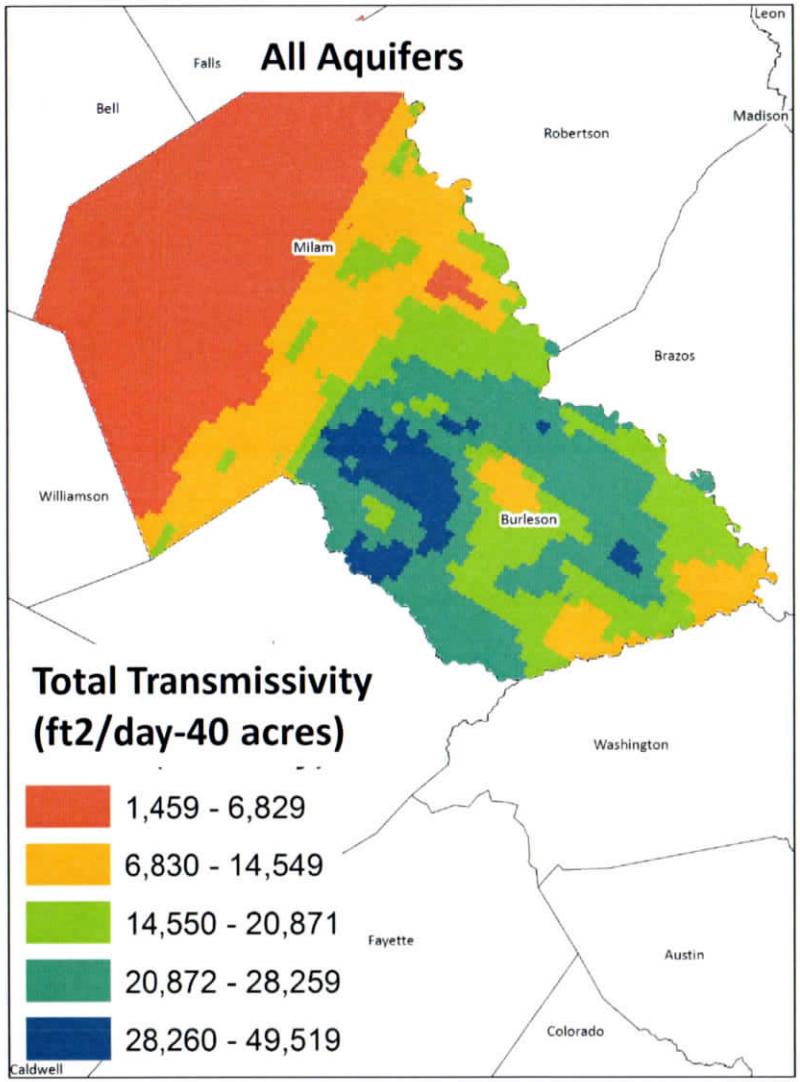
Transmissivity = K * B

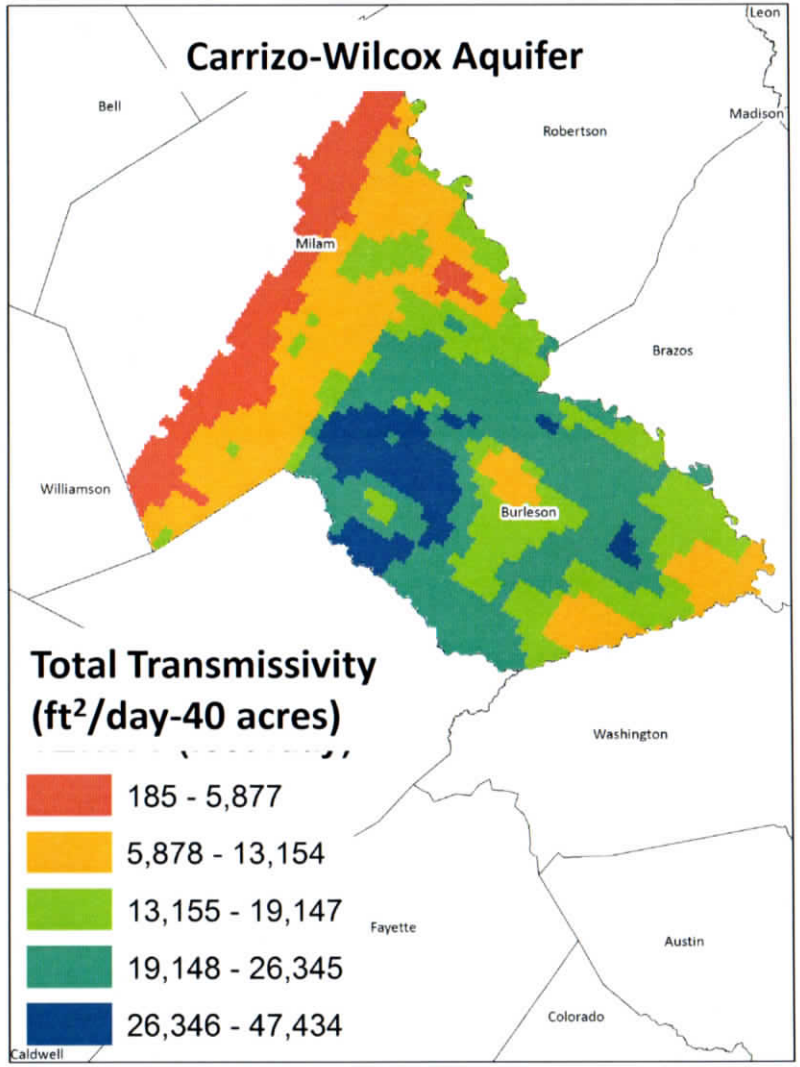
K = hydraulic conductivity (ft/day)
B = aquifer thickness (ft)

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 Across District





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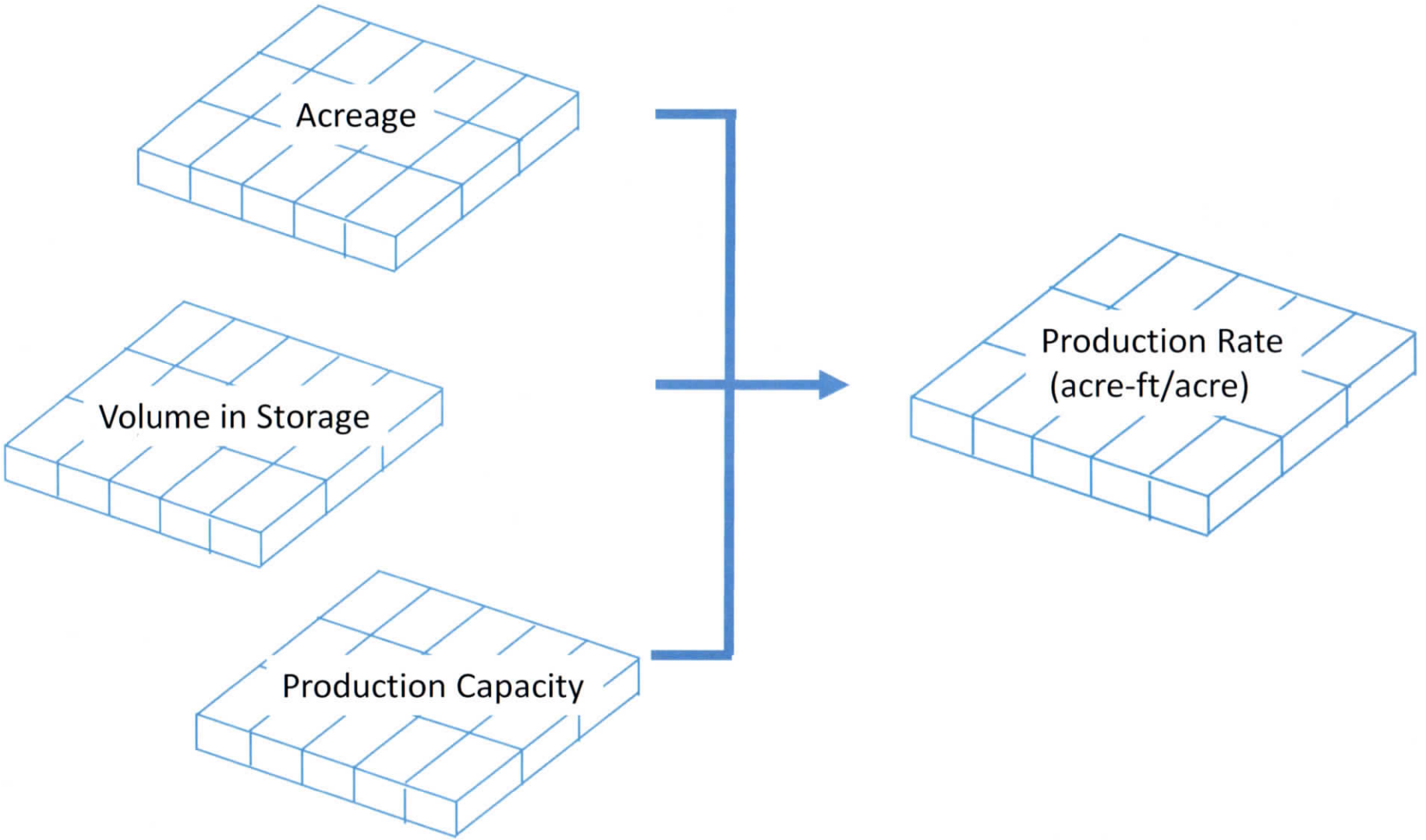
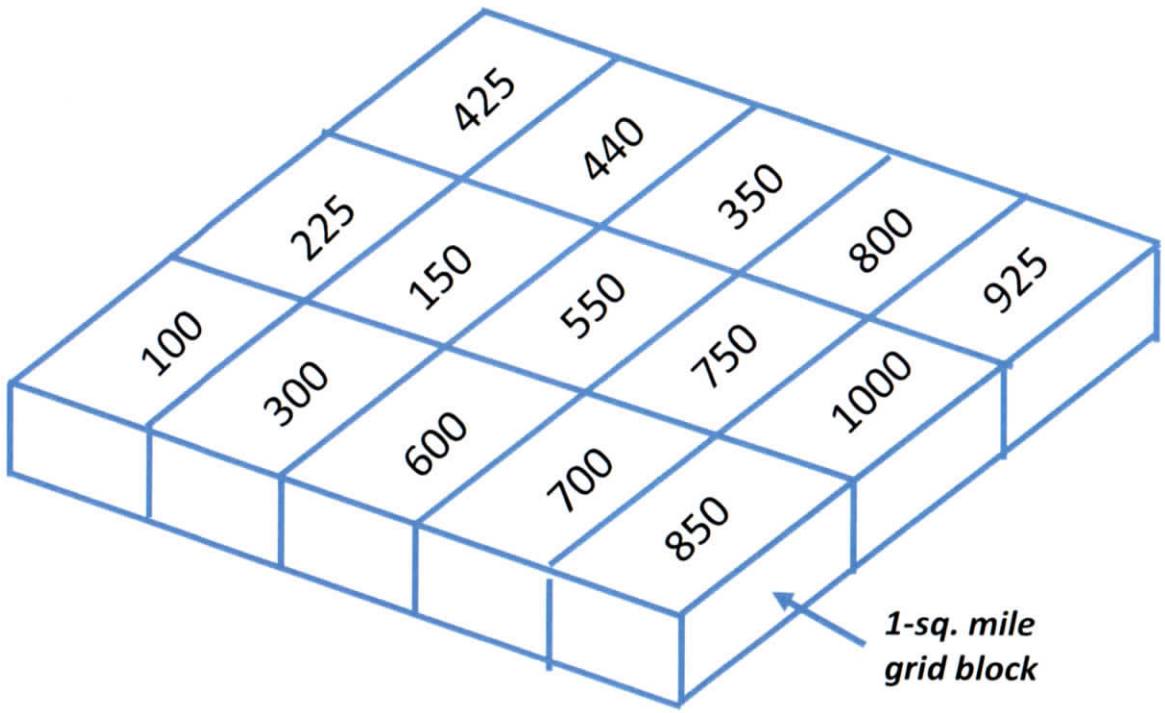
Transforming Fair-Share Factors to Production Rate



An Example of Fair Share Based on Total Storage: for 15 mi^2 aquifer

Spatial Distribution of Storage (AF) in a Single Aquifer*



Ranking	Storage Value (AF)
1	100
2	150
3	225
4	300
5	350
6	425
7	440
8	550
9	600
10	700
11	750
12	800
13	850
14	925
15	1000

* Aquifer is partition into 15 grid cells, each of which is 1 square mile

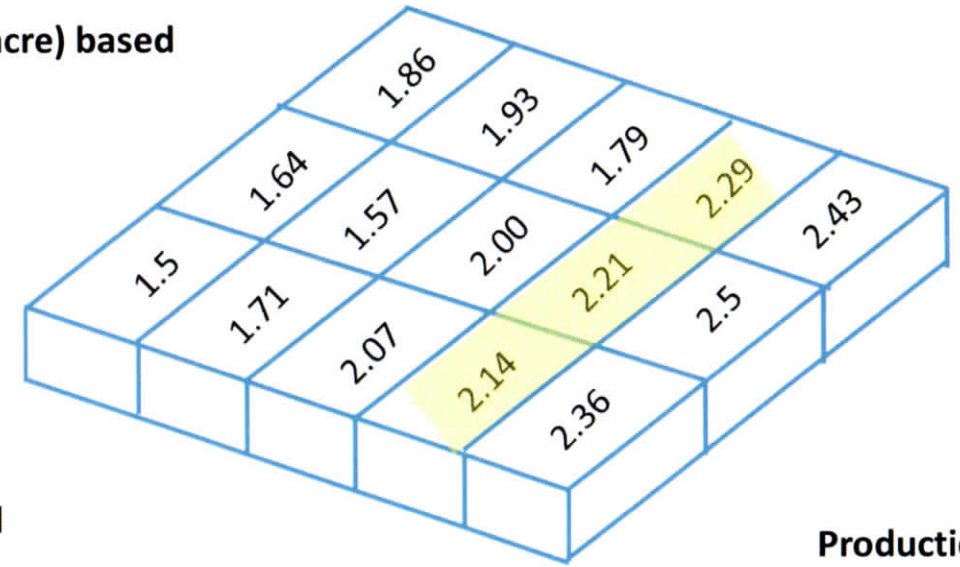
An Example of Fair Share Based on Total Storage: for 15 mi^2 aquifer

- Set a median value and a range of values for Production Rate (af/acre)
  - Median = 2 af/acre
  - Minimum= 1.5 af/acre
  - Maximum = 2.5 af/acre
- Map Storage Values per grid block to a Production Rate (af/acre) based on an assumed relationship
  - based on a uniform intervals
  - based on linear interpolation
  - based on logarithmic interpolation

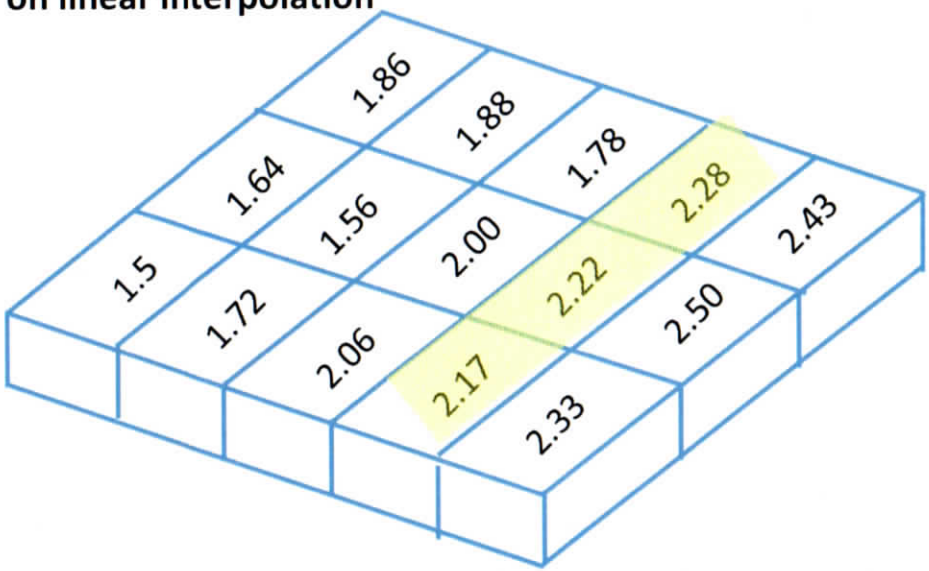
Ranking	Storage Value (AF)	Production Rate (af/acre)		
		uniform	linear	log
1	**100**	**1.50**	**1.50**	**1.50**
2	150	1.57	1.56	1.62
3	225	1.64	1.64	1.74
4	300	1.71	1.72	1.82
5	350	1.79	1.78	1.87
6	425	1.86	1.86	1.92
7	440	1.93	1.88	1.93
8	**550**	**2.00**	**2.00**	**2.00**
9	600	2.07	2.06	2.07
10	700	2.14	2.17	2.20
11	750	2.21	2.22	2.26
12	800	2.29	2.28	2.31
13	850	2.36	2.33	2.36
14	925	2.43	2.42	2.43
15	**1000**	**2.50**	**2.50**	**2.50**
Average		2.00	1.99	2.04

Examples of Spatial Distribution of Production Rate Based on Groundwater in Storage

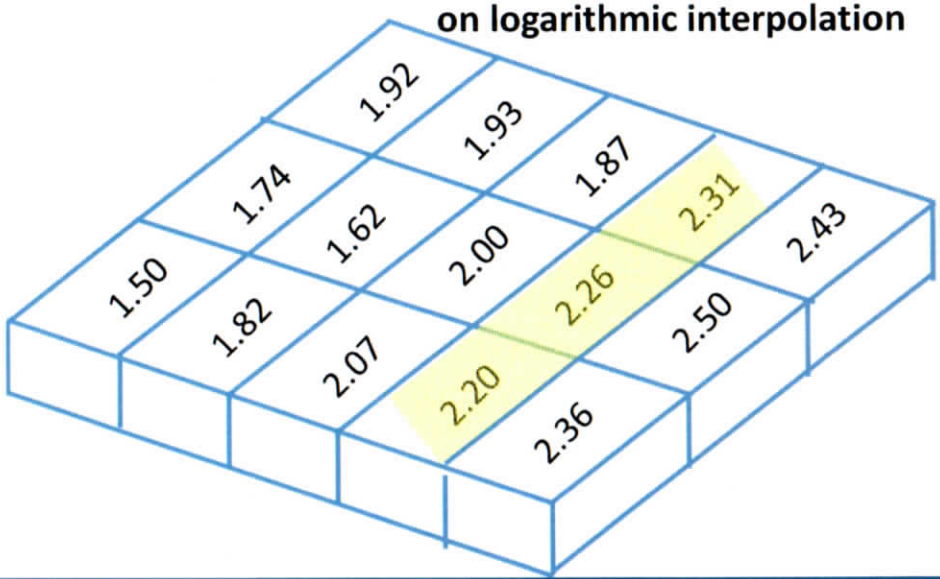
Production Rate (af/acre) based on uniform-intervals



Production Rate (af/acre) based on linear interpolation



Production Rate (af/acre) based on logarithmic interpolation



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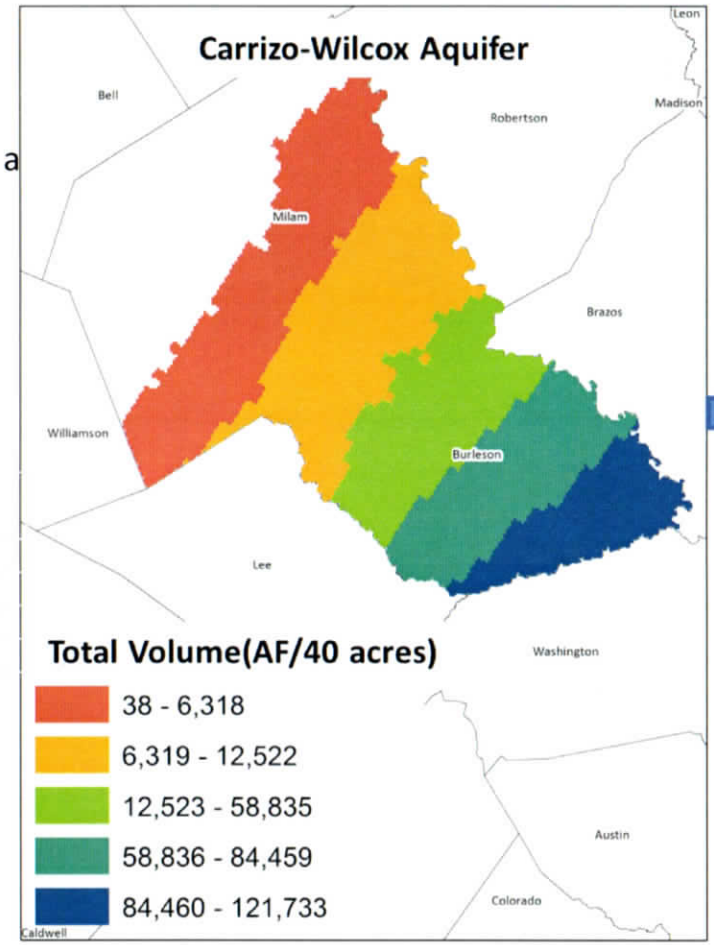
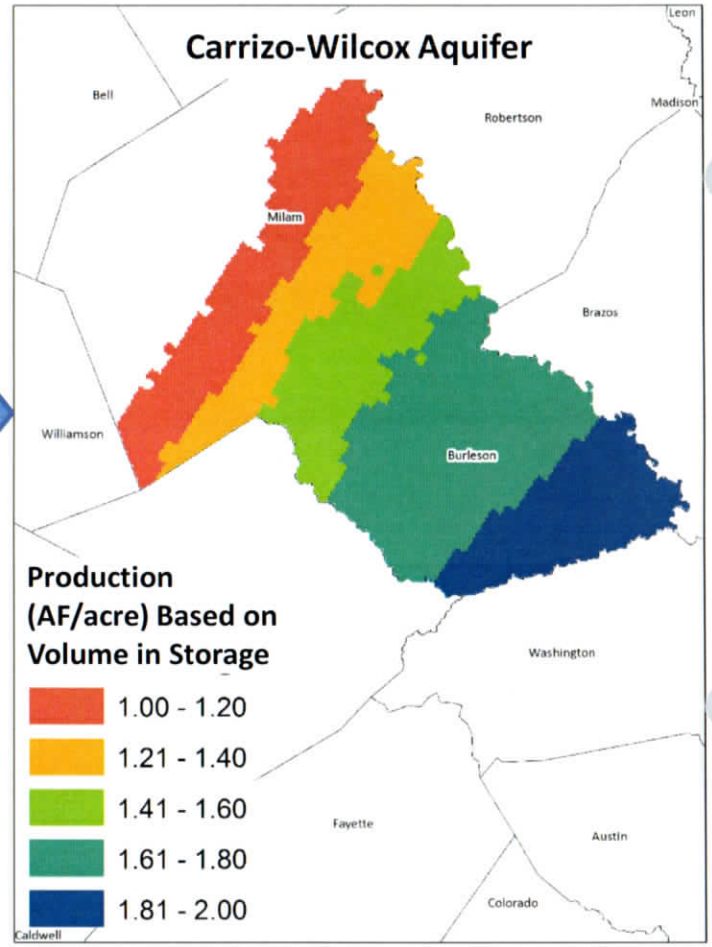
Example for Carrizo-Wilcox Aquifer: Production Rate (af/acre) based on Groundwater in Storage

- Map Storage Values to a Production based on linear interpolation
- Production Rates

Production (acre/ft)			Aquifer(s)
Min.	Med.	Max.	
1	1.5	2	Carrizo Calvert Bluff Simsboro Hooper





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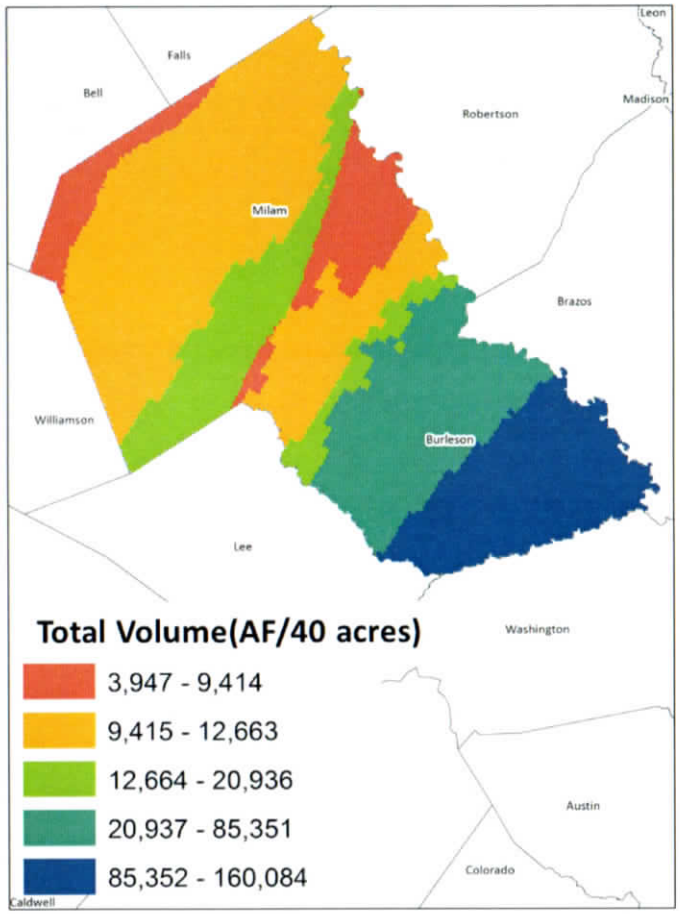
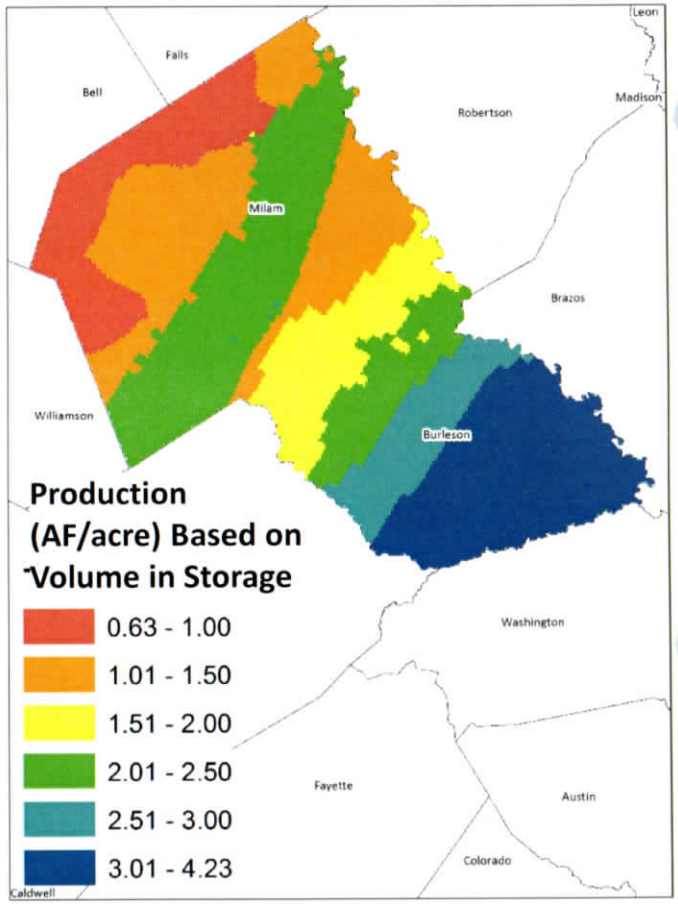
Example for all Aquifer: Production Rate (af/acre) based Solely on Storage

- Map Storage Values to a Production based on linear interpolation
- Production Rates

Production (acre/ft) Min.	Med.	Max.	Aquifer(s)
0.25	0.5	0.75	Upper Trinity Lower Trinity
0.25	0.5	0.75	Sparta
0.25	0.5	0.75	Queen City
1	1.5	2	Carrizo Calvert Bluff Simsboro Hooper
0.25	0.5	0.75	Yegua-Jackson





* Brazos River Alluvium Aquifer is not Included In All Aquifer Calculation

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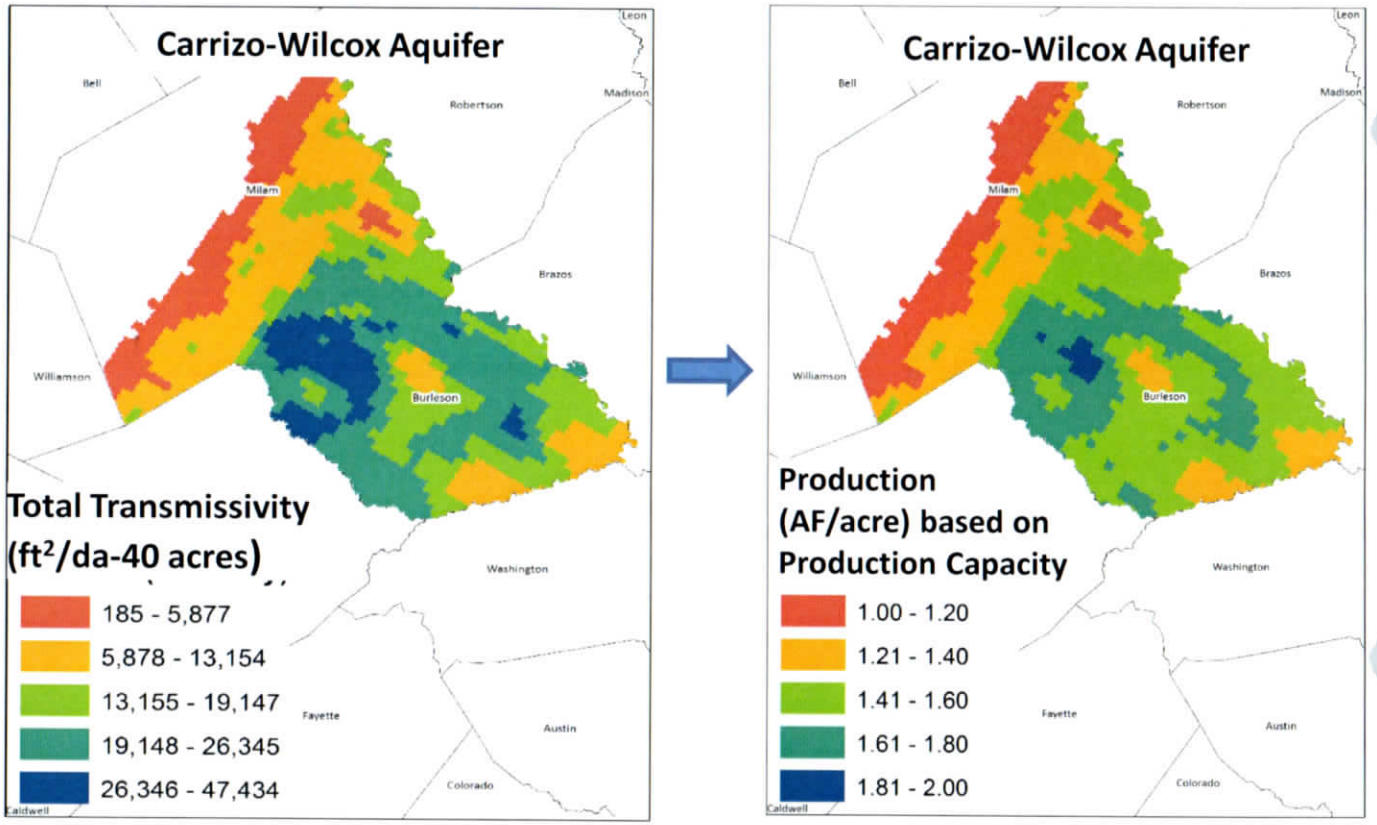
Example for Carrizo-Wilcox Aquifer: Production Rate (af/acre) based Solely on Production Capacity

- Map Storage Values to a Production based on linear interpolation
- Production Rates

Production (acre/ft)			Aquifer(s)
Min.	Med.	Max.	
1	1.5	2	Carrizo Calvert Bluff Simsboro Hooper



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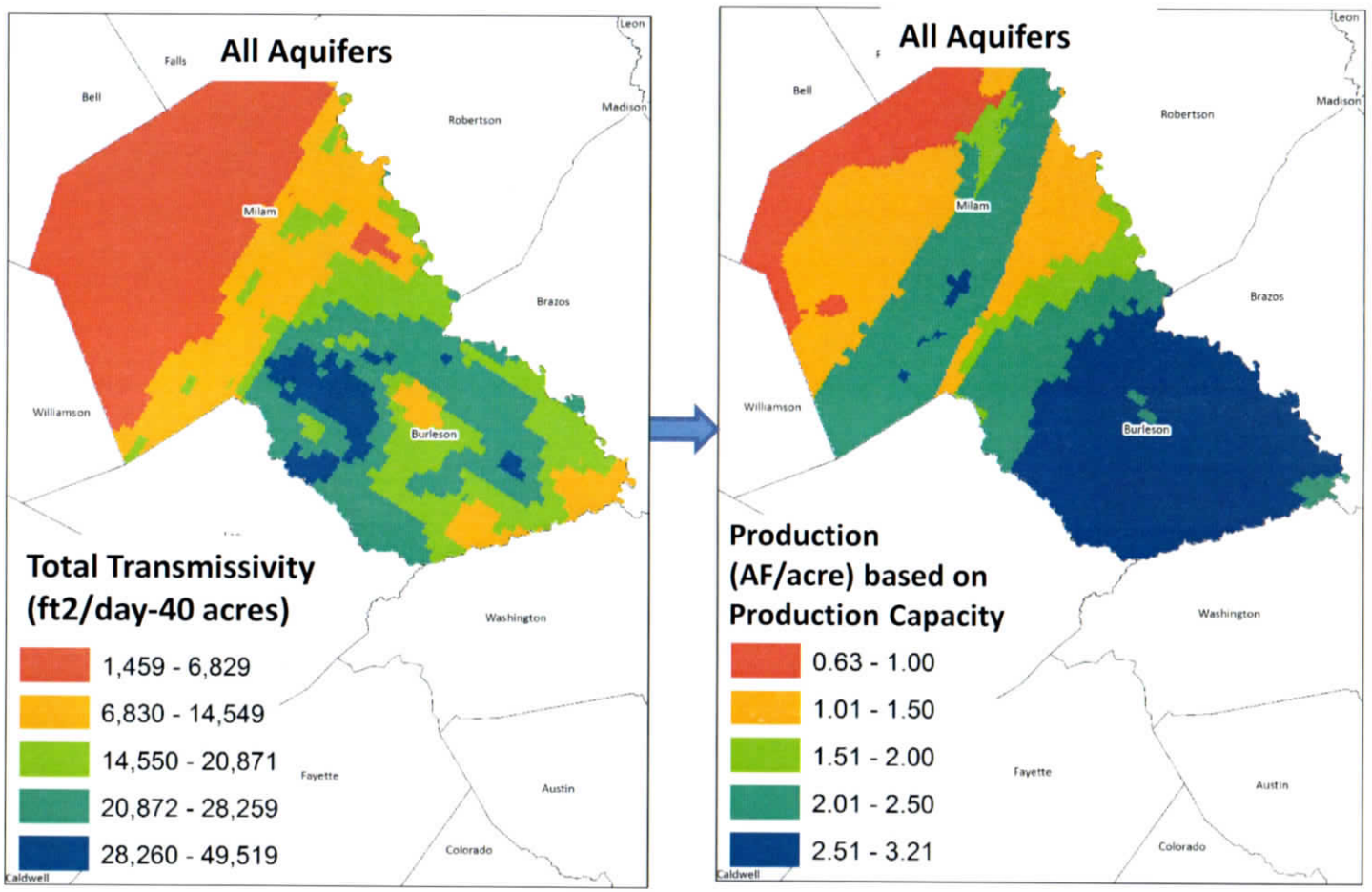
Example for All Aquifers: Production Rate (af/acre) based Production Capacity

- Map Storage Values to a Production based on linear interpolation
- Production Rates

Production (acre/ft) Min.	Med.	Max.	Aquifer(s)
0.25	0.5	0.75	Upper Trinity
0.25	0.5	0.75	Lower Trinity
0.25	0.5	0.75	Sparta
0.25	0.5	0.75	Queen City
1	1.5	2	Carrizo Calvert Bluff Simsboro
0.25	0.5	0.75	Hooper Yegua-Jackson



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Process for Implementing Fair Share Using a Maximum Production Rate

- Select Factors for Determining Spatial Variability in Maximum Production Rate. Used storage and production capacity in this presentation
  - Surface acreage
  - Groundwater in storage underlying acreage
  - Aquifer production capacity underlying acreage
- Set Maximum, Median, and Minimum for Production Rate per Aquifer. Example used in this presentation:

Production (acre/ft)			Aquifer(s)
Min.	Med.	Max.	
0.25	0.5	0.75	Upper Trinity
			Lower Trinity
0.25	0.5	0.75	Sparta
0.25	0.5	0.75	Queen City

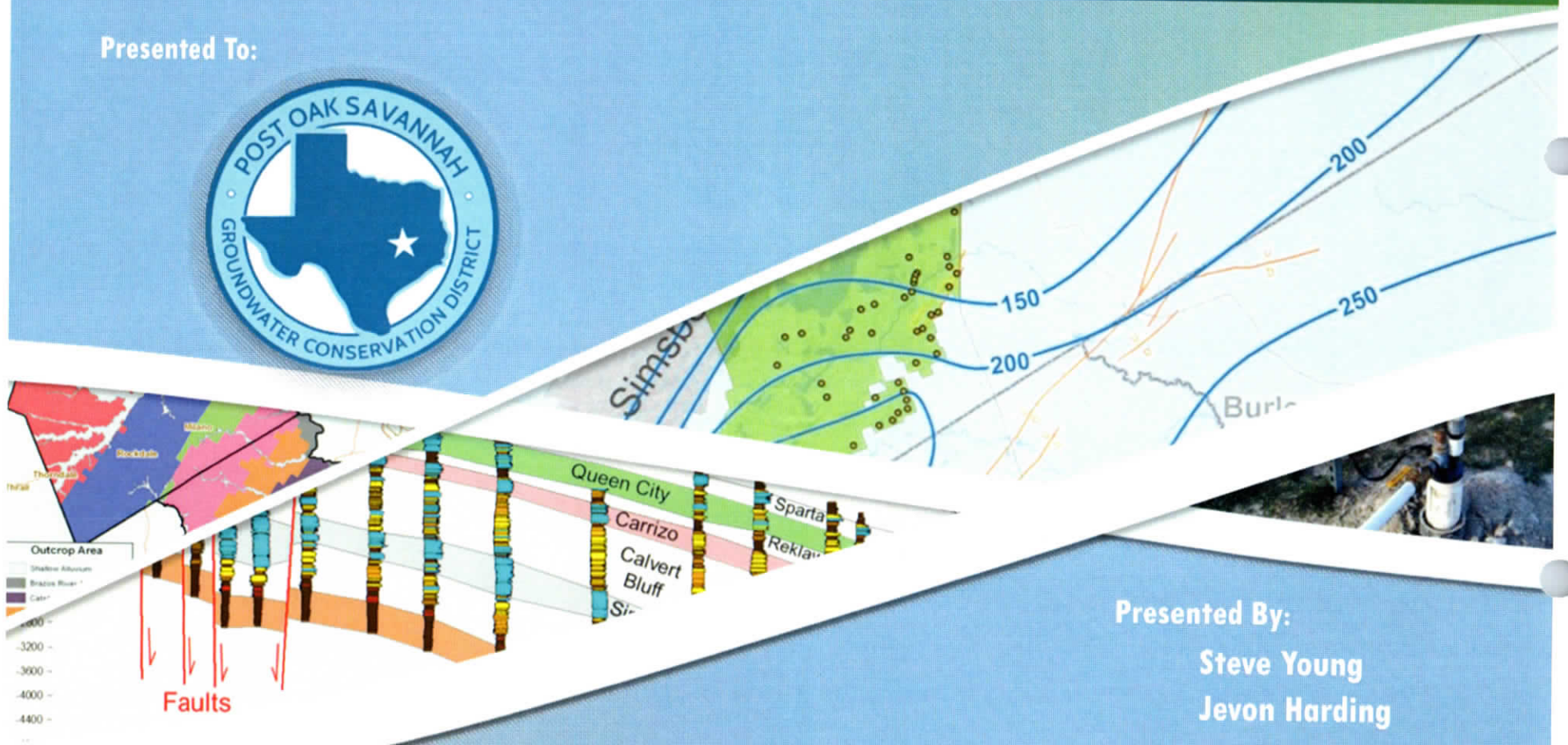
Production (acre/ft)			Aquifer(s)
Min.	Med.	Max.	
1	1.5	2	Carrizo
			Calvert Bluff
			Simsboro
			Hooper
0.25	0.5	0.75	Yegua-Jackson

- Develop map for production rate (af/acre). Used linear interpolation for this presentation
  - Uniform-intervals
  - Linear interpolation
  - Logrithmic interpolation

Desired Future Committee Meeting: Review of Abengoa Vista Ridge Permit for Adjusted Well Locations

Presented To:

POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT



Presented By:

Steve Young

Jevon Harding

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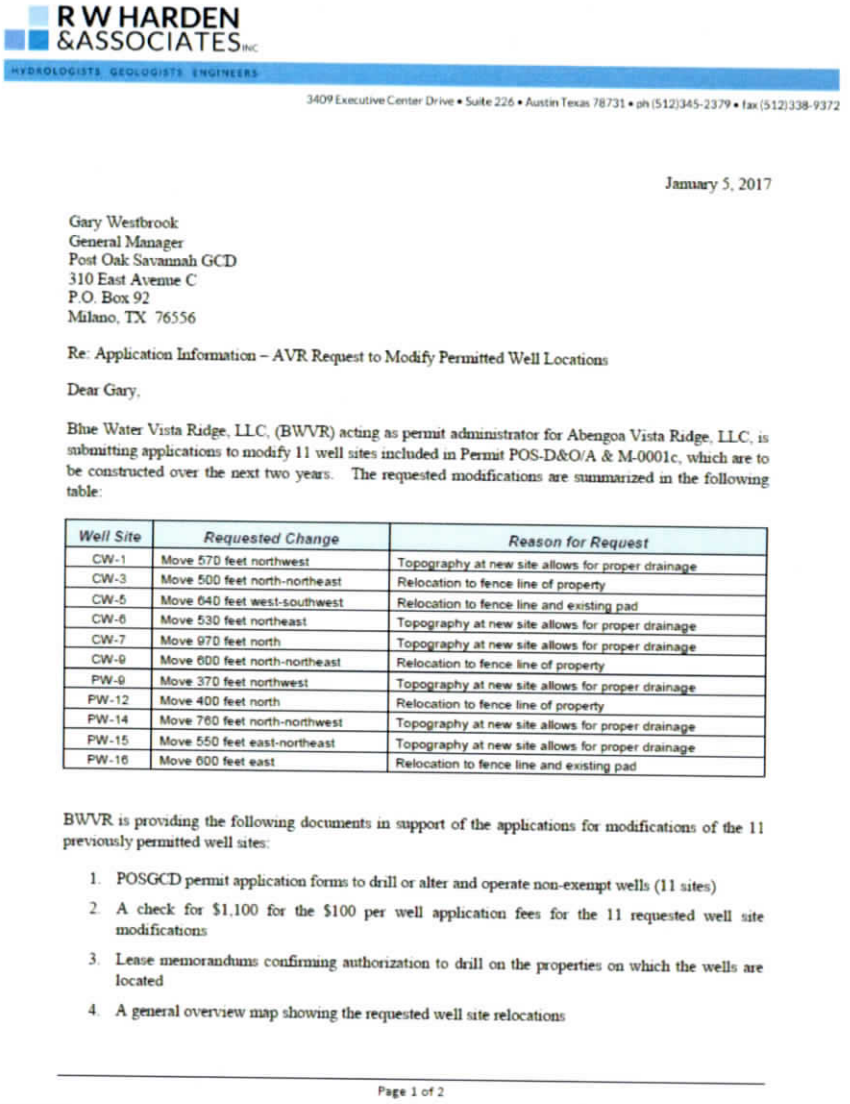
March 9, 2017

Outline

- Summary of Findings
- Recommendations
- Carrizo Wells
  - Spacing to Property Line
  - Well Spacing
- Simsboro Wells
  - Spacing to Property Line
  - Well Spacing



R W HARDEN &ASSOCIATES INC
HYDROLOGISTS GEOLOGISTS ENGINEERS
3409 Executive Center Drive • Suite 226 • Austin Texas 78731 • ph (512)345-2379 • fax (512)338-9372

January 5, 2017

Gary Westbrook
General Manager
Post Oak Savannah GCD
310 East Avenue C
P.O. Box 92
Milano, TX 76556

Re: Application Information – AVR Request to Modify Permitted Well Locations

Dear Gary,

Blue Water Vista Ridge, LLC, (BWVR) acting as permit administrator for Abengoa Vista Ridge, LLC, is submitting applications to modify 11 well sites included in Permit POS-D&O/A & M-0001c, which are to be constructed over the next two years. The requested modifications are summarized in the following table:

Well Site	Requested Change	Reason for Request
CW-1	Move 570 feet northwest	Topography at new site allows for proper drainage
CW-3	Move 500 feet north-northeast	Relocation to fence line of property
CW-5	Move 640 feet west-southwest	Relocation to fence line and existing pad
CW-6	Move 530 feet northeast	Topography at new site allows for proper drainage
CW-7	Move 970 feet north	Topography at new site allows for proper drainage
CW-9	Move 600 feet north-northeast	Relocation to fence line of property
PW-9	Move 370 feet northwest	Topography at new site allows for proper drainage
PW-12	Move 400 feet north	Relocation to fence line of property
PW-14	Move 760 feet north-northwest	Topography at new site allows for proper drainage
PW-15	Move 550 feet east-northeast	Topography at new site allows for proper drainage
PW-16	Move 600 feet east	Relocation to fence line and existing pad

BWVR is providing the following documents in support of the applications for modifications of the 11 previously permitted well sites:

1. POSGCD permit application forms to drill or alter and operate non-exempt wells (11 sites)
2. A check for $1,100 for the $100 per well application fees for the 11 requested well site modifications
3. Lease memorandums confirming authorization to drill on the properties on which the wells are located
4. A general overview map showing the requested well site relocations

Page 1 of 2

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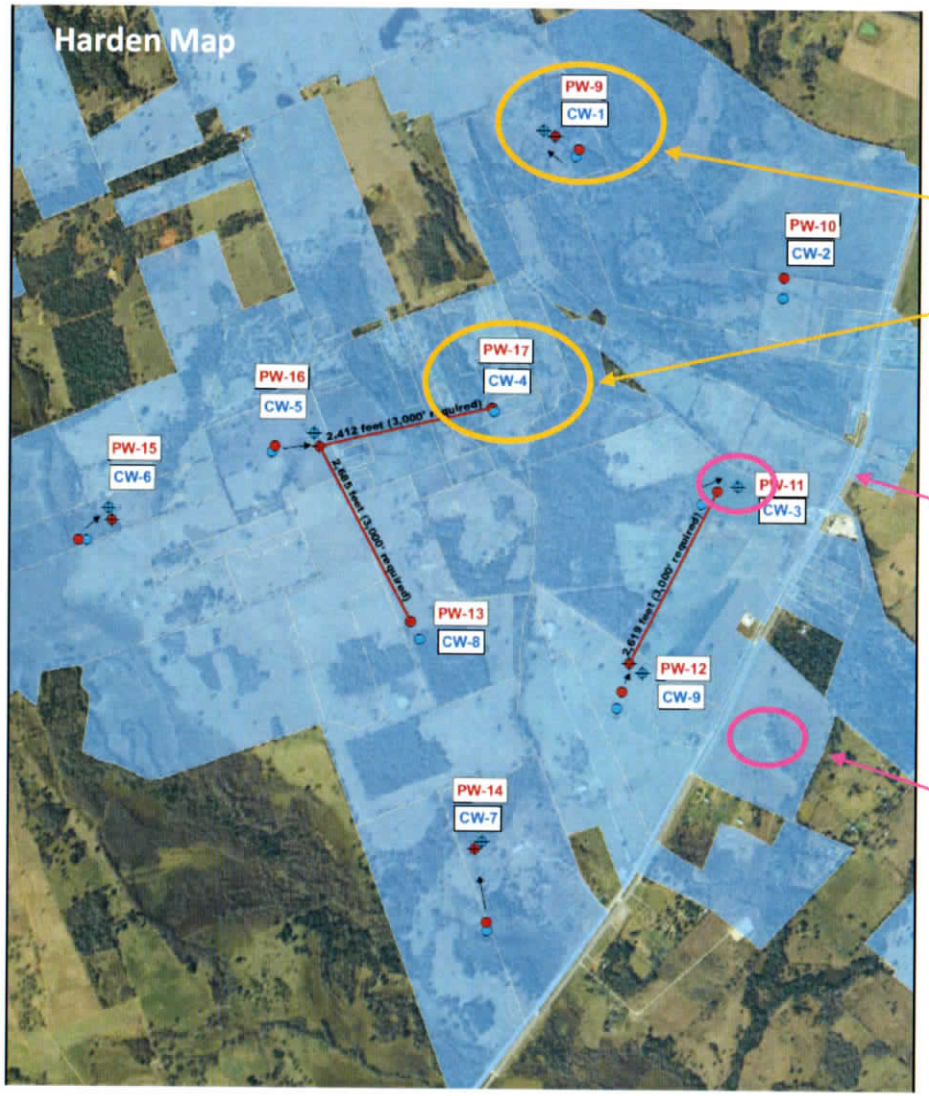
Summary of Findings

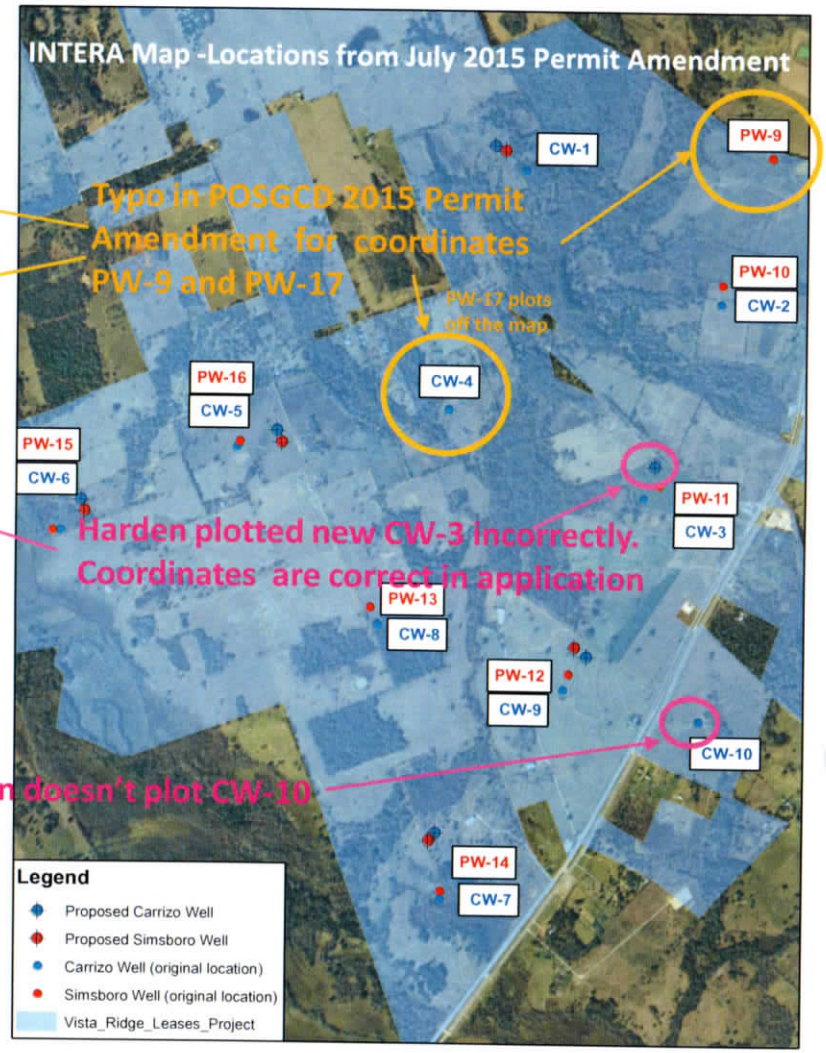
- Confirmed that well spacing and property spacing are accurately presented in application with two minor exceptions:
  - Revised location of CW-3 is not plotted per submitted coordinates (minor adjustment required in figure)
  - Planned well CW-10 not plotted (distance From CW-9 is 1,859 ft but to met well spacing requirement the distance should be 1,950 ft)
- All revised well locations are located in the same model grid cell as the old well locations so model predictions will not change
- Ten Carrizo wells and Nine Simsboro wells satisfy well and property with three exceptions
  - Spacing between PW-16 & PW-13 should be 3,000 ft but is 2,685 ft
  - Spacing between PW-16 & PW-17 should be 3,000 ft but is 2,412 ft
  - Spacing between PW-12 & PW-12 should be 3,000 ft but is 2,617 ft
- Reproduced permit figures to check permit application for accuracy
  - Identified to typos in coordinates for PW-9 and PW-17 in POSGCD July 2015 Permit Admendment
  - No checks performed on lease boundary – Lease boundary provided by Harden and Associates

Recommendations Regarding Permit

- Recommend that Board grant variance to well spacing requirements for three Simsboro wells with appropriate conditions. Granting the variance will not increase risks to operation of existing wells or to district achieving their DFCs. Recommend that the variance be limited to the life of the Abengoa Vista Ridge Project.
- If above variance is granted , the application meets all POSGCD permit spacing requirements. Recommend that POSGCD approve the permit.

Notes Regarding Well Locations in Site Map





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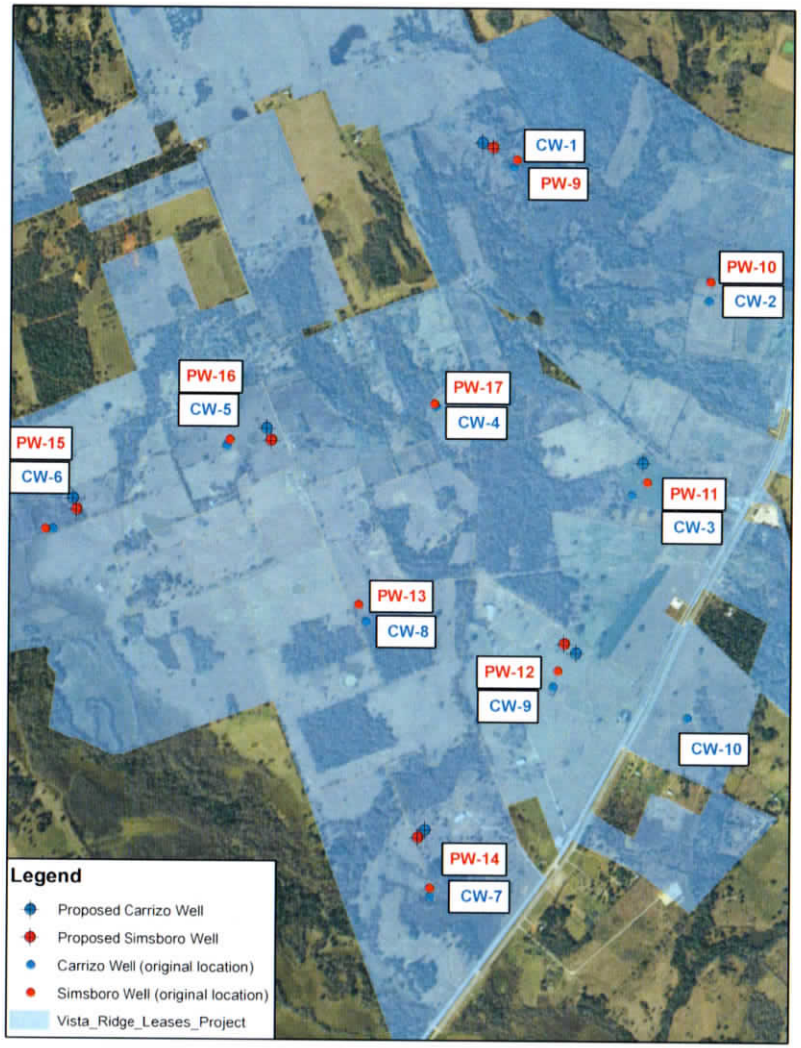
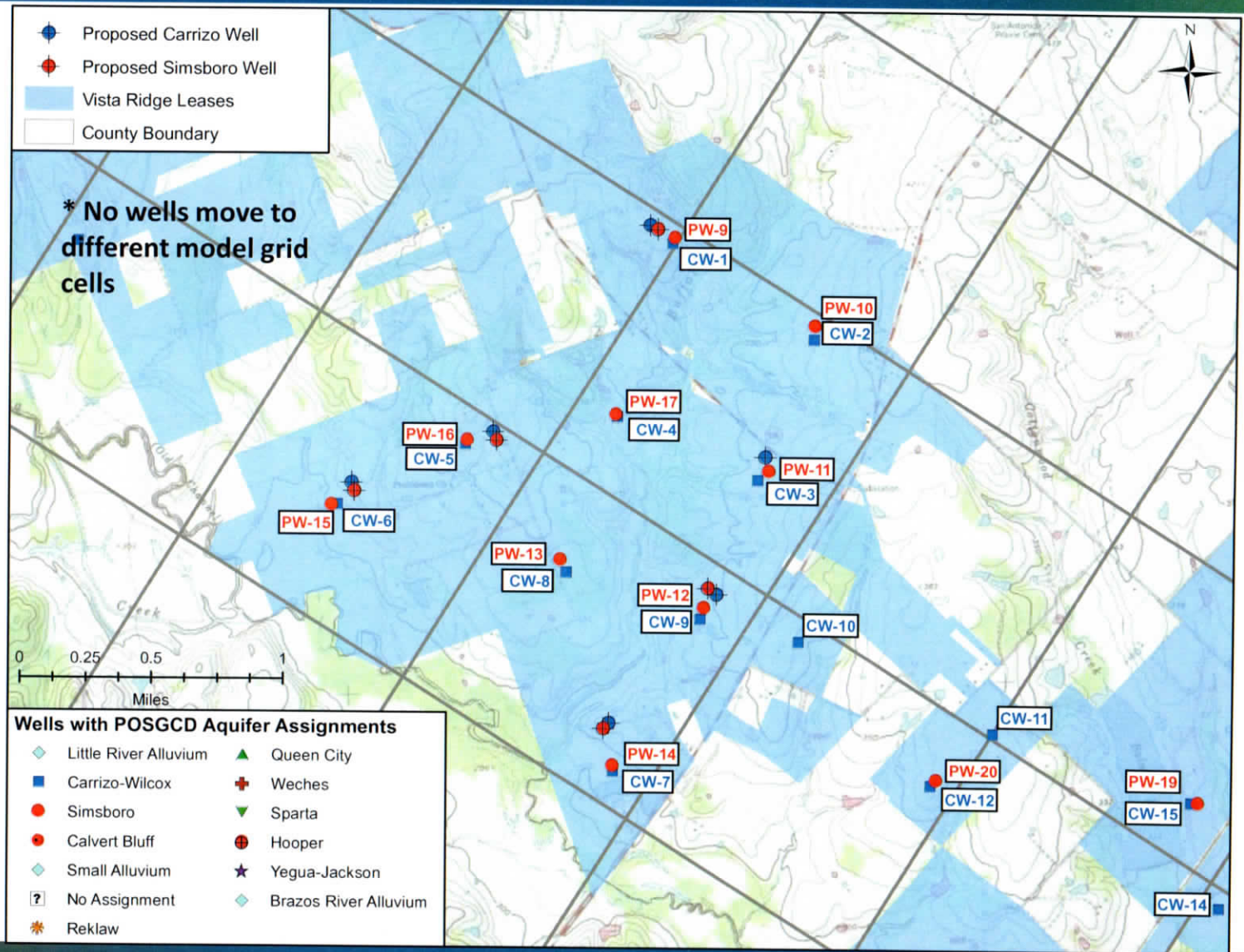
Final Site Map



Well Site	Requested Change by Abengoa Vista Ridge	INTERA Calculated Change
CW-1	Move 570 ft northwest	568 ft
CW-3	Move 500 ft north-northeast	495 ft
CW-5	Move 640 ft west-southwest	635 ft
CW-6	Move 530 ft northeast	532 ft
CW-7	Move 970 ft north	965 ft
CW-9	Move 600 ft north-northeast	598 ft
PW-9	Move 370 ft northwest	369 ft
PW-12	Move 400 ft north	405 ft
PW-14	Move 760 ft north-northwest	753 ft
PW-15	Move 550 east-northeast	547 ft
PW-16	Move 600 ft east	612 ft

Demonstration that Old and New Well Locations Remain in the same 1-mile by 1-mile GAM Grid Block



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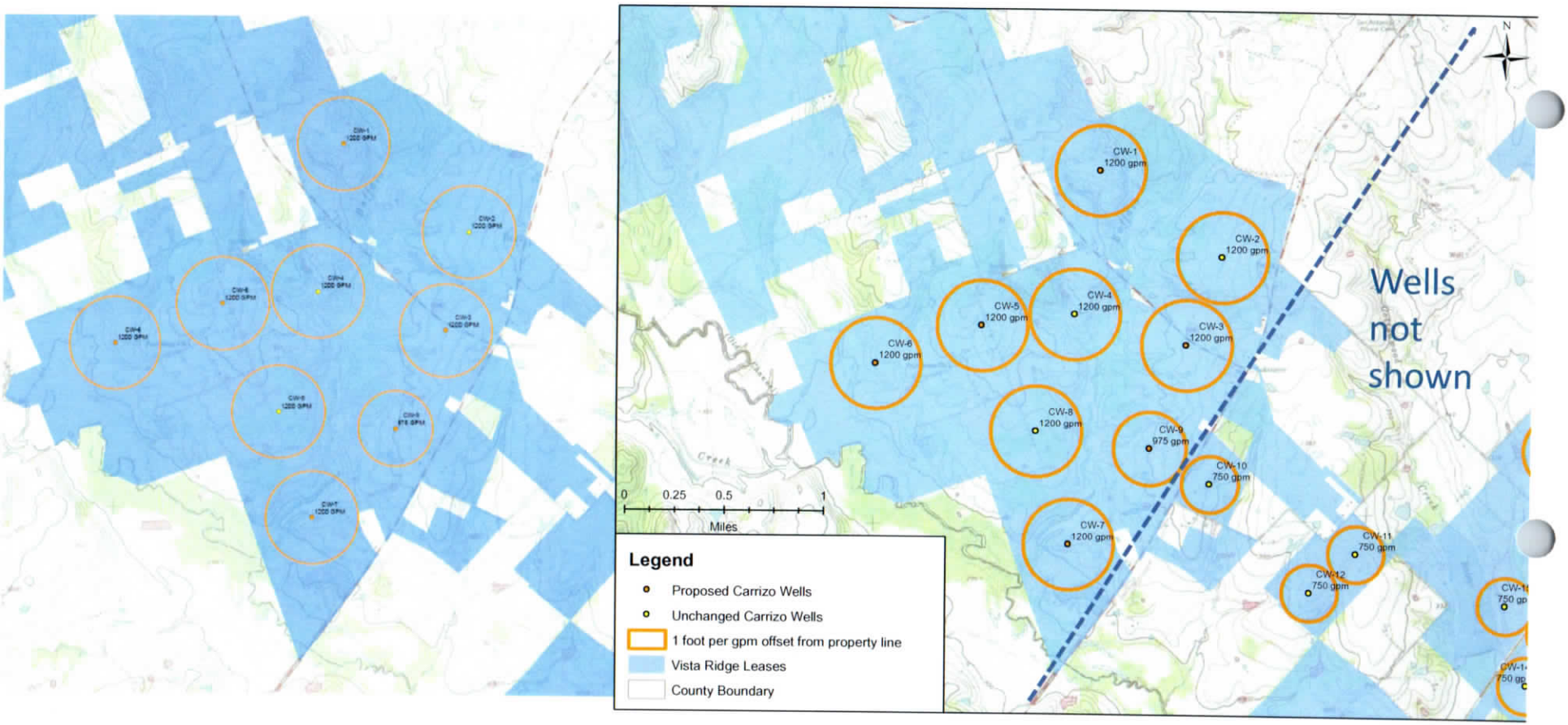
Demonstration that Carrizo Wells Meet Property Line Buffer

Harden Map – Carrizo Property Line buffer

INTERA Map – Carrizo Property Line buffer



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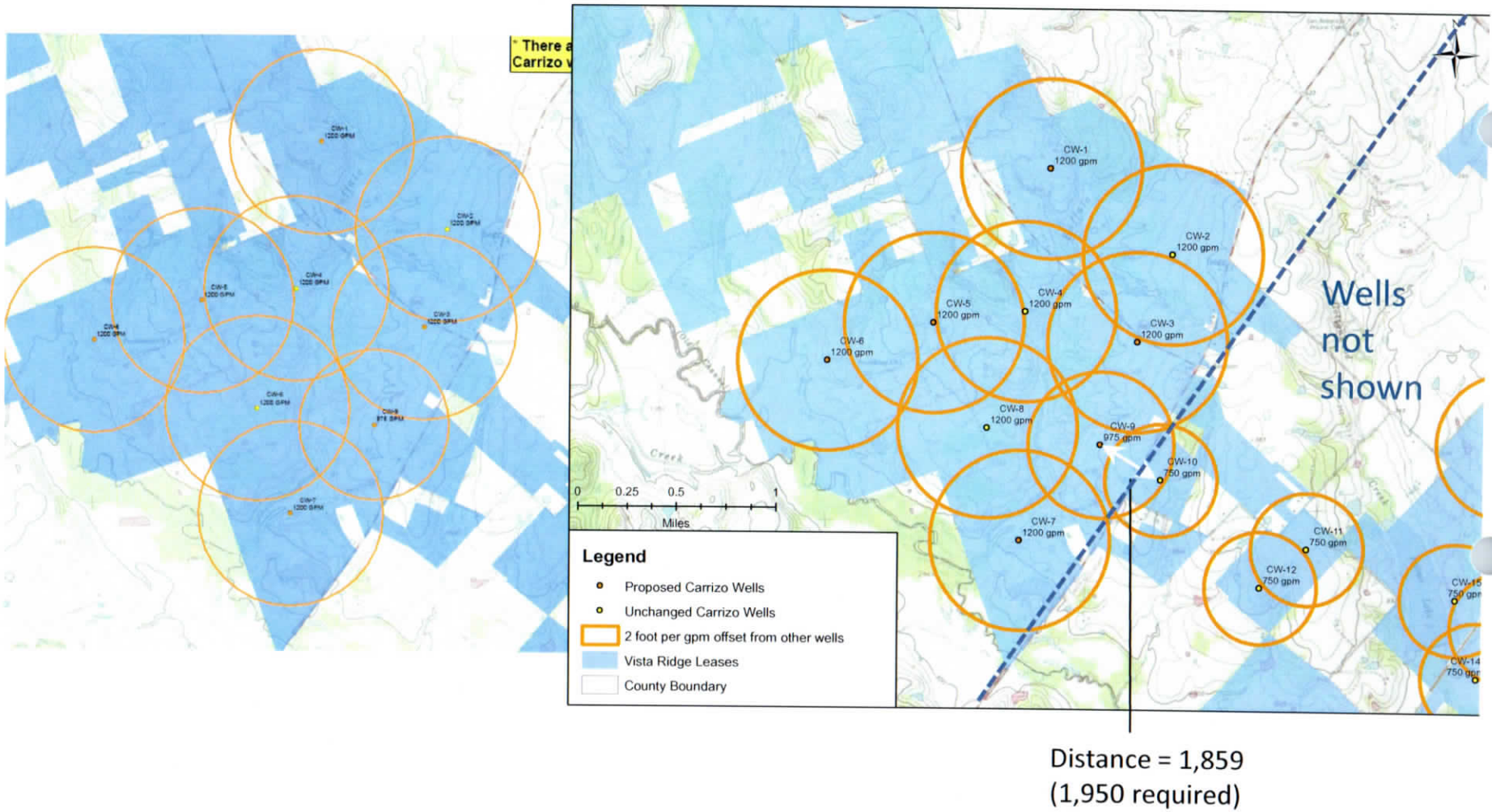
Demonstration that Carrizo Wells Meet Well Spacing: Part 1

Harden Map – Carrizo Well buffer

INTERA Map – Carrizo Well buffer



Distance = 1,859
(1,950 required)

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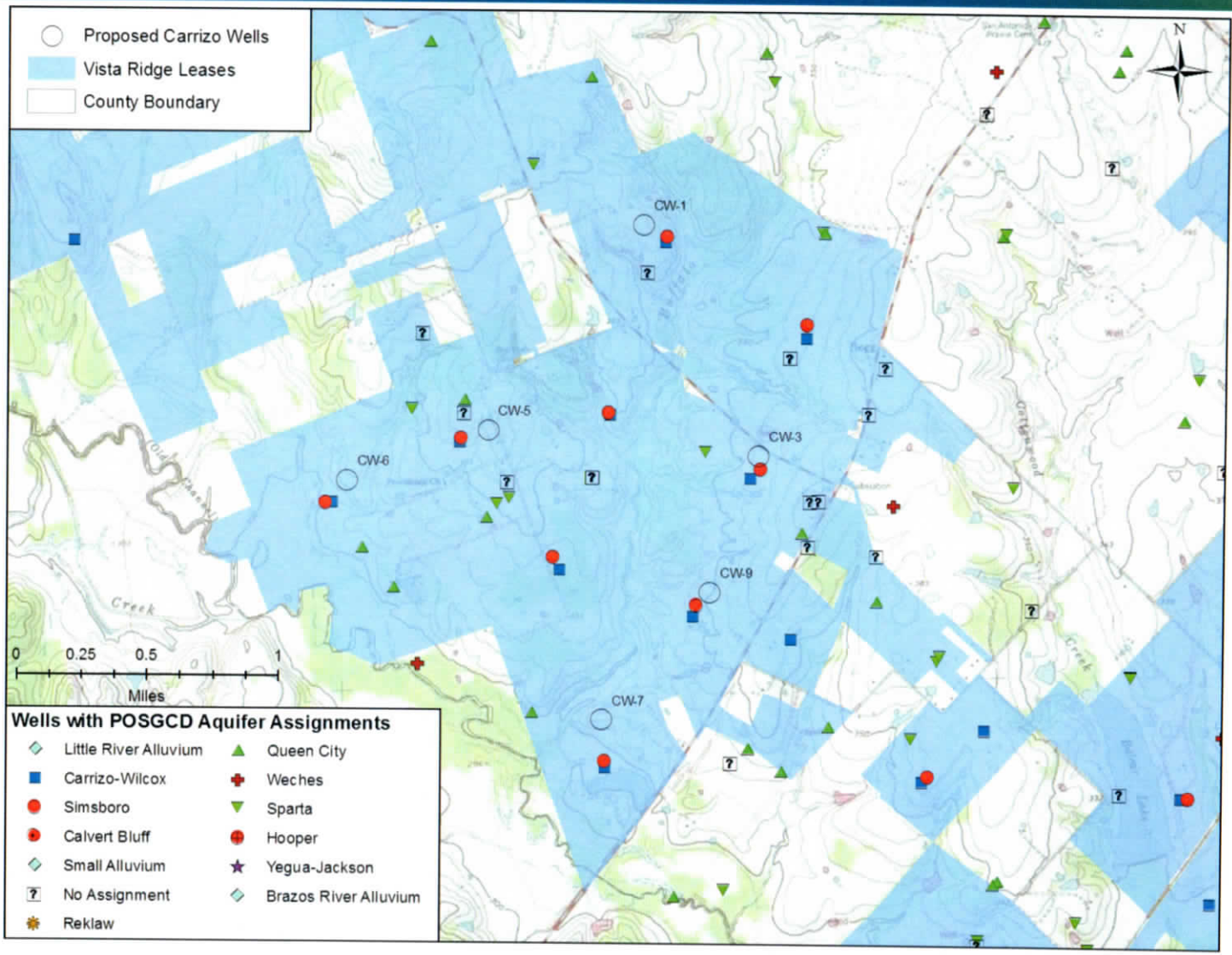
Demonstration that Carrizo Wells Meet Well Spacing: Part 2



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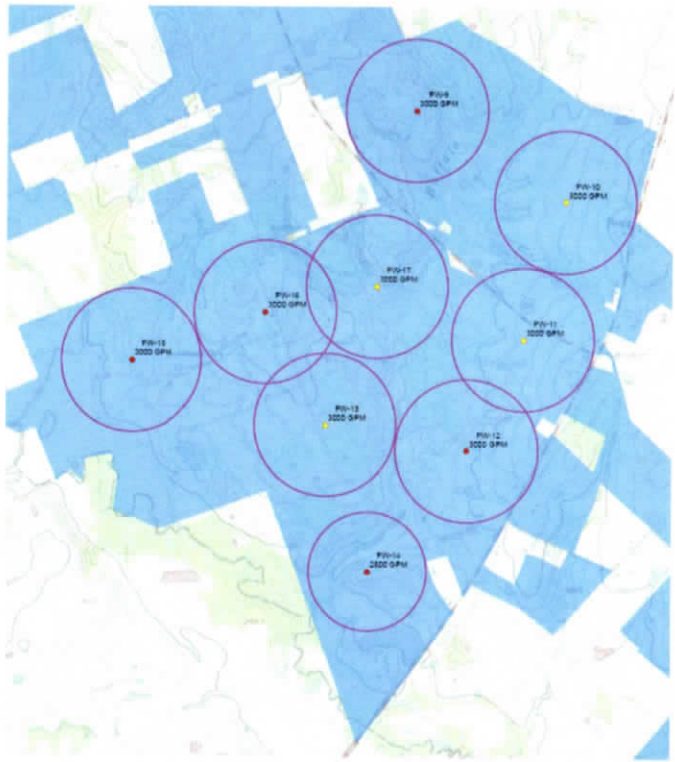
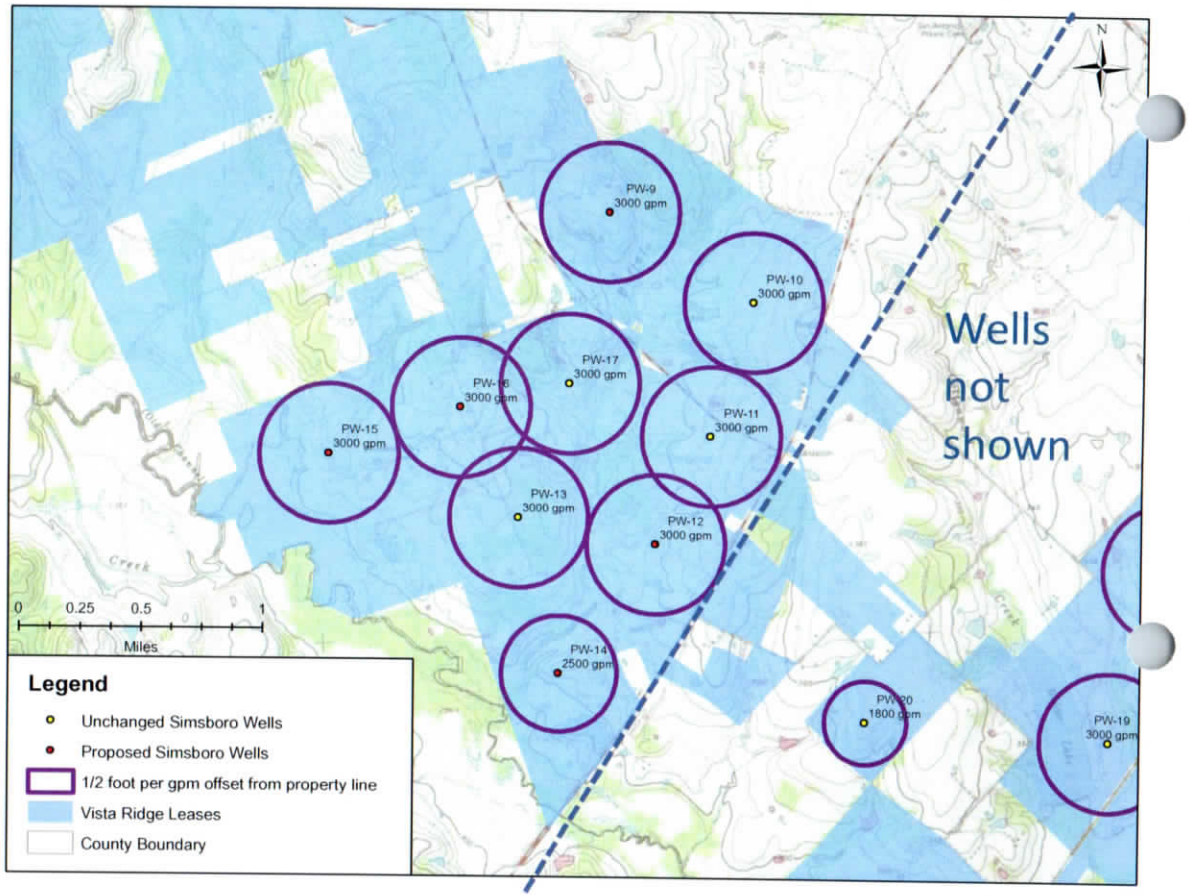
Demonstration that Simsboro Wells Meet Property Line Buffer

Harden Map – Simsboro Property Line buffer



INTERA Map – Simsboro Property Line buffer



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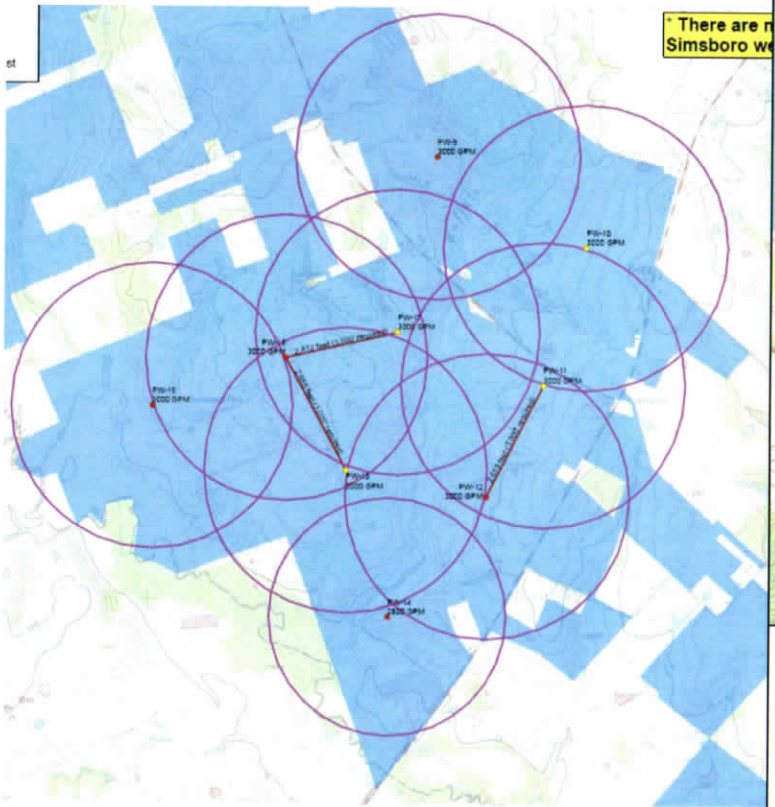
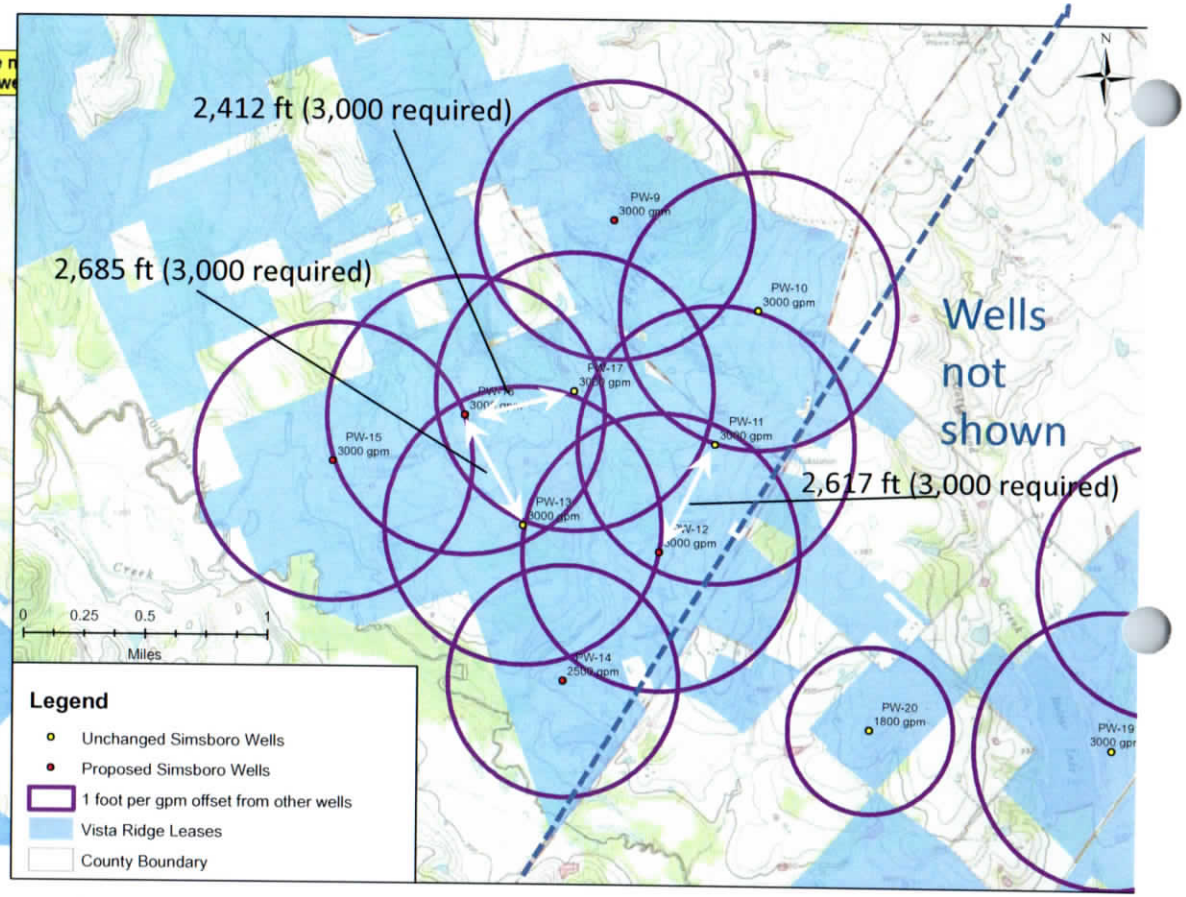
Check on Simsboro Wells Meet Well Spacing Requirements: Part 1

Harden Map – Simsboro Well buffer



INTERA Map – Simsboro Well buffer



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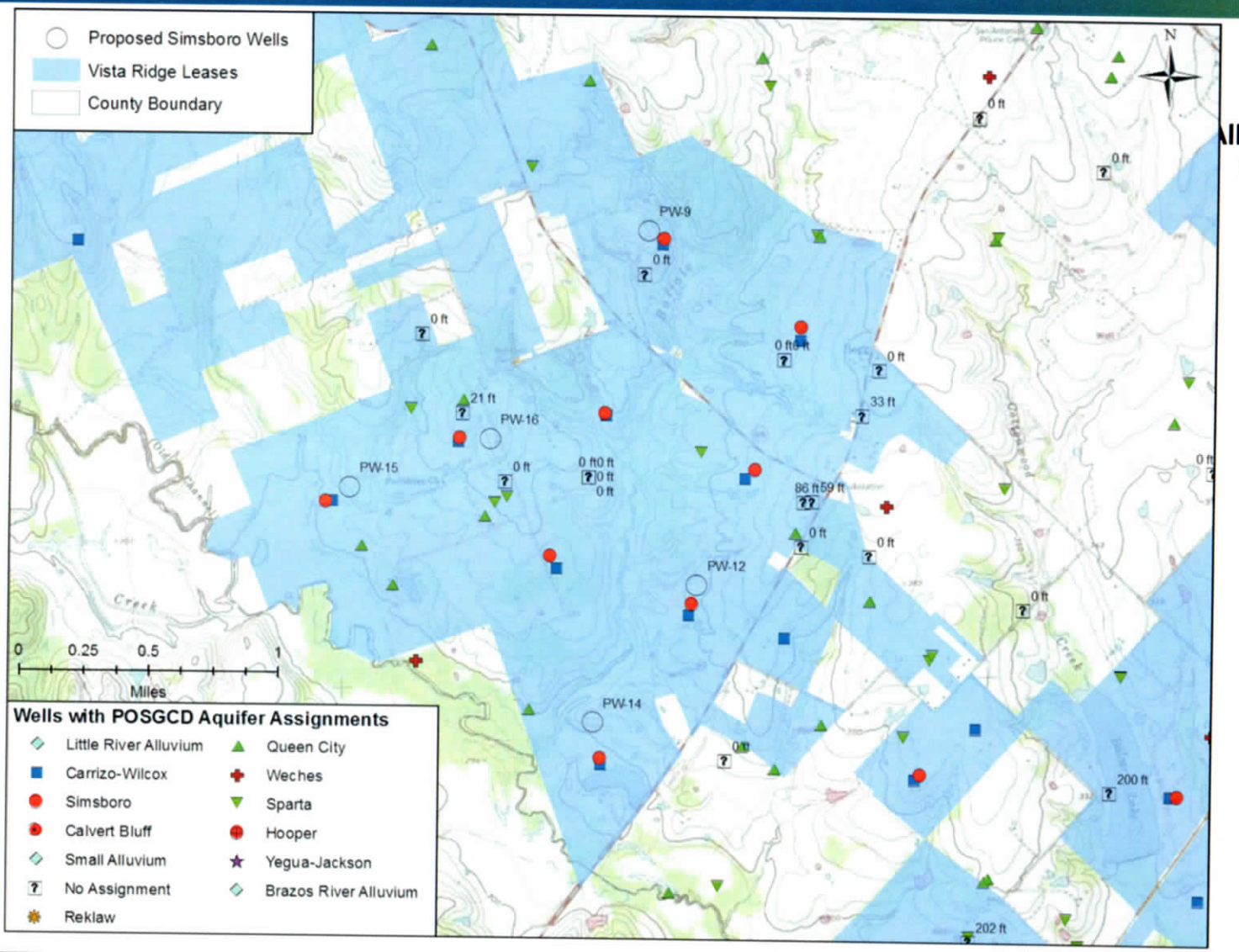
Check on Simsboro Wells Meet Well Spacing Requirements: Part 2

Simsboro

All Nearby Wells



INTERA GEOSCIENCE & ENGINEERING SOLUTIONS