GAM run 03-17

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REQUESTOR:

Fayette County Groundwater Conservation District

DESCRIPTION OF REQUEST:

Fayette County Groundwater Conservation District requested the following information for the aquifers in their county:

- Recharge values from the Central Carrizo-Wilcox Groundwater Availability Model,
- Total useable groundwater in the Carrizo aquifer, and
- Optimized well spacings for the Carrizo, Queen City/Sparta and Gulf Coast aquifers based on 3,500 gpd (2.4 gpm).

METHODS:

To address the request, we:

- Ran the predictive (2000-2050) model for the Central Carrizo-Wilcox aquifer Groundwater Availability Model (Dutton and others, 2003) and queried the budget files for each aquifer layer in Fayette County for the year 2050 with long-term average recharge.
- Estimated groundwater storage by calculating layer thickness for each model cell (layer top elevation minus bottom elevation), multiplying by cell area (1 mi^2) and specific yield, and summing all of the model cells within Fayette County.
- Extracted transmissivity and storativity values from the Central Carrizo-Wilcox GAM for the Carrizo and Simsboro units.
- Estimated transmissivity for the Queen City aquifer from the draft Conceptual Model report of the Queen City-Sparta GAM (INTERA, 2003).
- Obtained transmissivity and storativity values for the Sparta aquifer and several Gulf Coast aquifer units from TWDB Report 56 (Rogers, 1967), Availability and Quality of Ground Water in Fayette County, TX.
- Used the Theis equation, an analytical model, to create plots of drawdown versus well separation to be used by Fayette County GCD to determine optimal well spacing for each aquifer unit.

PARAMETERS AND ASSUMPTIONS:

Parameters used in the analytical model calculations are listed in Table 2. A period of 50 years was selected to estimate drawdown due to long-term pumping.

The analytical model used to create plots of drawdown versus well separation has the following assumptions (Kruseman and De Ridder, 1983):

- The aquifer is confined,
- The flow to the well is not in steady-state,
- The water removed from storage is discharged instantaneously with decline of head,
- The diameter of the pumping well is very small so well storage can be neglected,
- The pumped well penetrates the entire aquifer thickness, and
- Drawdowns are not influenced by either impermeable boundaries or constant water supplies.

RESULTS:

Recharge

The Carrizo-Wilcox model does not have any direct infiltration recharge in Fayette County. However, TWDB rules concerning groundwater management plan certification define recharge as "The addition of water from precipitation or runoff by seepage or infiltration to an aquifer from the land surface, streams, or lakes directly into a formation or indirectly by way of leakage from another formation." Leakage into the aquifers is listed in the columns “upper Z flow in and lower Z flow in” (Table 1).

Other budget items besides recharge were extracted from the model and are also shown in Table 1.

Aquifer Storage

The total volume of storage in Fayette County for the Carrizo aquifer layer in the model is 49,000,000[1] acre-ft. However, it should be noted that the water in the Carrizo-Wilcox aquifer in the downdip portion in the eastern half of Fayette County has total dissolved solid concentrations greater than 1,000 mg/L (Dutton and others, 2003; Figure 27); therefore, at least half of the total storage is not potable.

[1] Rounded to two significant digits.

Drawdown versus well separation

Plots of drawdown versus well separation were created for each of the aquifer units listed in Table 2. The plots are shown in Figures 1 – 6. The plots can be used to optimize well spacings by choosing a maximum allowable drawdown on the vertical axis, intersecting the curve and reading the well separation from the horizontal axis. For example on Figure 4, for the Catahoula Tuff, with a maximum allowed drawdown of ten feet, the minimum well separation would be 1,500 feet. Figures 2, 3, 5, and 6 all show very little drawdown, even with very small separation. This is because the pumping rate is fairly low, only 3,500 gpd (2.4 gpm), and the transmissivities are fairly high.

REFERENCES:

Dutton, A. R., Harden, R., Nicot, J. P., and O' Rourke, D., 2003, Groundwater Availability Model for the Central part of the Carrizo-Wilcox Aquifer in Texas: Final Report prepared for the Texas Water Development Board.

INTERA Inc, 2003, Conceptual Model for the Queen City and Sparta Aquifers, Draft Report.

Kruseman, G. P. and de Ridder, N. A., 1983, Analysis and Evaluation of Pumping Test Data, International Institute for Land Reclamation and Improvement/IRLI, The Netherlands, 200 p.

Rogers, L. T., 1967, Availability and Quality of Ground Water in Fayette County, Texas: Texas Water Development Board Report 56, 117 p.

Table 1. Fayette County flow budget for the Central Carrizo-Wilcox aquifer model in acre-feet per year.

Aquifer	Lyr	Storage	X-flow in	X-flow out	upper Z flow in	upper Z flow out	lower Z flow in	lower Z flow out	Wells	Recharge	ET	GHB	Streams	Total In	Total Out	% diff
Average Recharge Conditions																
Carrizo-Wilcox	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	1	275	-291	0	0	3	-5,888	0	0	0	5,898	0	6,178	-6,178	0
	3	23	5,035	-10,390	5,888	-3	35	-582	-5	0	0	0	0	10,981	-10,981	0
	4	43	1,684	-975	582	-35	0	-1,299	0	0	0	0	0	2,309	-2,309	0
	5	75	2,358	-4,665	1,299	0	934	0	-1	0	0	0	0	4,665	-4,665	0
	6	59	2,976	-2,101	0	-934	0	0	0	0	0	0	0	3,035	-3,035	0
	All	**200**	**12,328**	**-18,420**	**7,769**	**-972**	**972**	**-7,769**	**-6**	**0**	**0**	**5,898**	**0**	**27,168**	**-27,168**	**0**

Notes:

1. Layer 1: Alluvium
2. Layer 2: Reklaw unit
3. Layer 3: Carrizo aquifer
4. Layer 4: Calvert Bluff
5. Layer 5: Simsboro
6. Layer 6: Hooper
7. All: sum of layers 1,2, 3, 4, 5, and 6
8. **GHB** refers to flow into or out of the top of the Reklaw.
9. **ET** refers to groundwater extraction due to evapotranspiration.
10. **X-flow in** refers to lateral flow into the county.
11. **X-flow out** refers to lateral flow out of the county.
12. **upper - Z-flow in** refers to flow into the layer from the layer above.
13. **upper - Z-flow out** refers to flow out of the layer into the layer above.
14. **lower - Z-flow in** refers to flow into the layer from the layer below.
15. **lower - Z-flow out** refers to flow out of the layer into the layer below.
16. **Wells** is for pumping input.
17. A negative sign refers to flow out of the layer in the county.
18. A positive sign refers to flow into the layer in the county.
19. The numbers are rounded to the nearest 1 acre-ft.

Table 2. Aquifer parameters used in analytical model

Aquifer unit	Pumping rate (gpd)	Transmissivity (gpd/ft)	Storativity	Time (years)	Data Source
Oakville Sandstone	3,500	5,192	0.00013	50	Rogers, 1967
Queen City	3,500	17,000	0.0002	50	INTERA, 2003
Sparta Sand	3,500	13,000	0.0004	50	Rogers, 1967
Catahoula Tuff	3,500	4,538	0.018	50	Rogers, 1967
Carrizo	3,500	15,445	0.000719	50	Dutton and others, 2003
Simsboro	3,500	37,285	0.0000465	50	Dutton and others, 2003

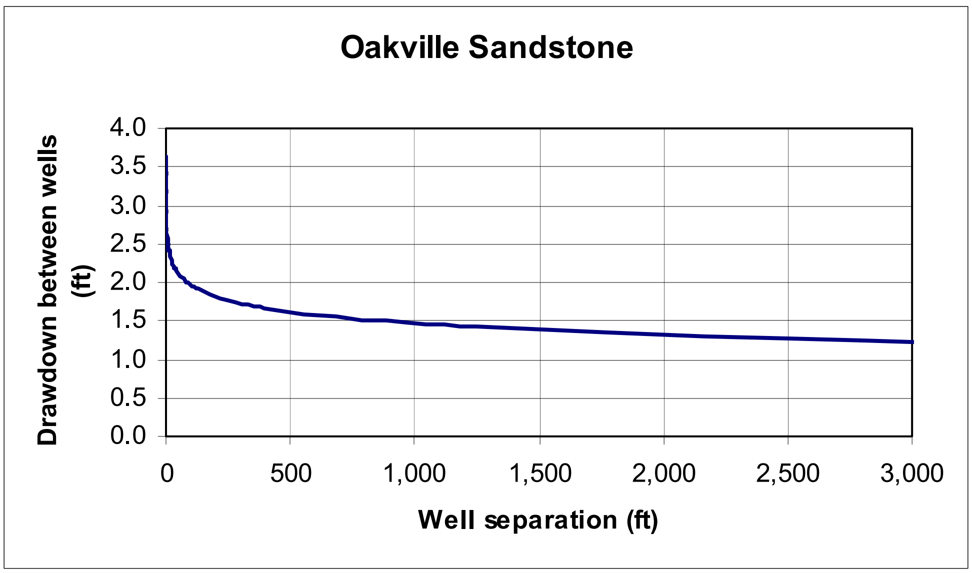

Figure 1. Drawdown versus well separation for a 3,500 gpd (2.4 gpm) pumping well in the Oakville Sandstone based on the Theis equation.

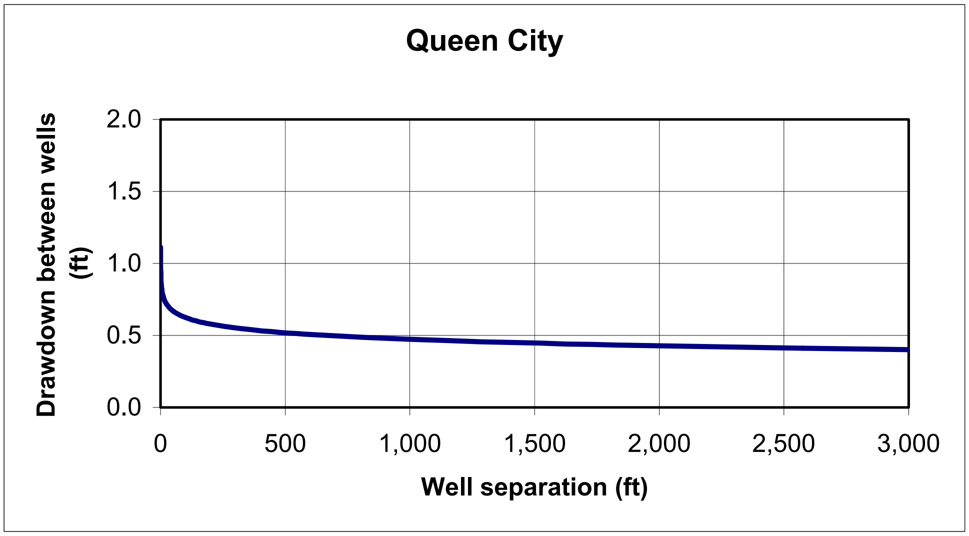

Figure 2. Drawdown versus well separation for a 3,500 gpd (2.4 gpm) pumping well in the Queen City aquifer based on the Theis equation.

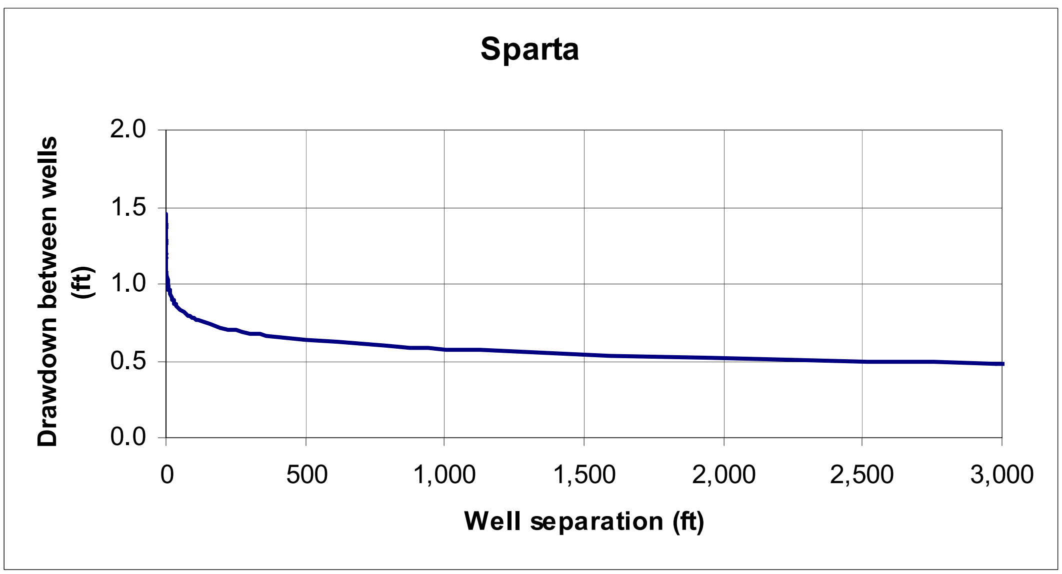

Figure 3. Drawdown versus well separation for a 3,500 gpd (2.4 gpm) pumping well in the Sparta aquifer based on the Theis equation.

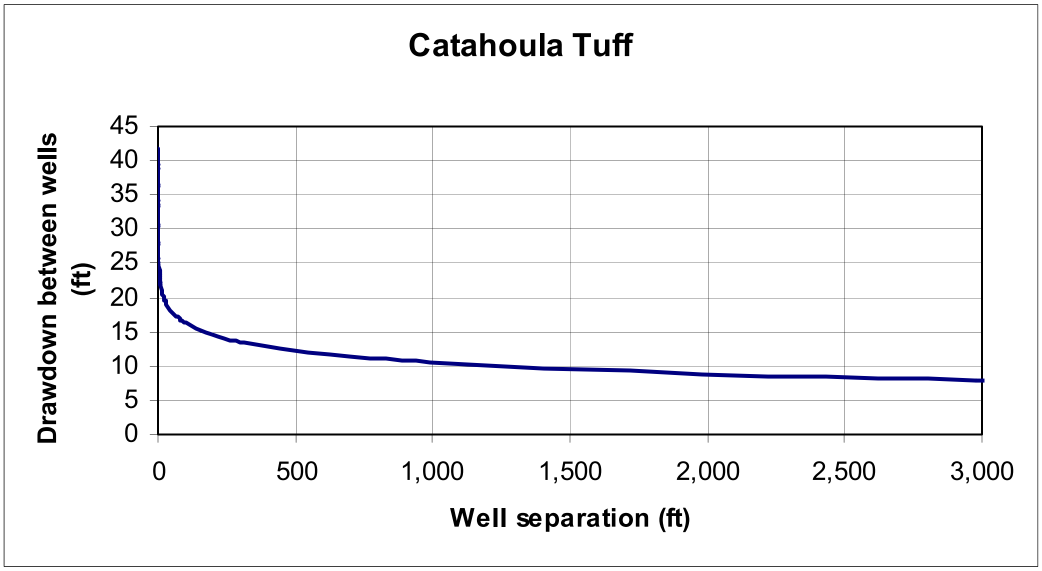

Figure 4. Drawdown versus well separation for a 3,500 gpd (2.4 gpm) pumping well in the Catahoula Tuff based on the Theis equation.

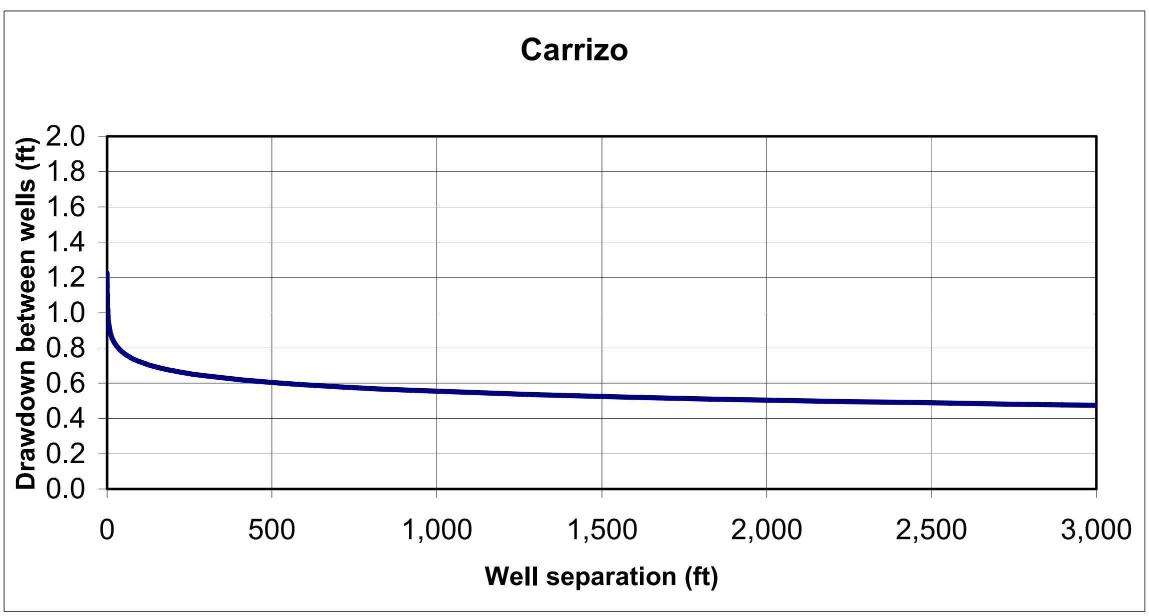

Figure 5. Drawdown versus well separation for a 3,500 gpd (2.4 gpm) pumping well in the Carrizo aquifer based on the Theis equation.

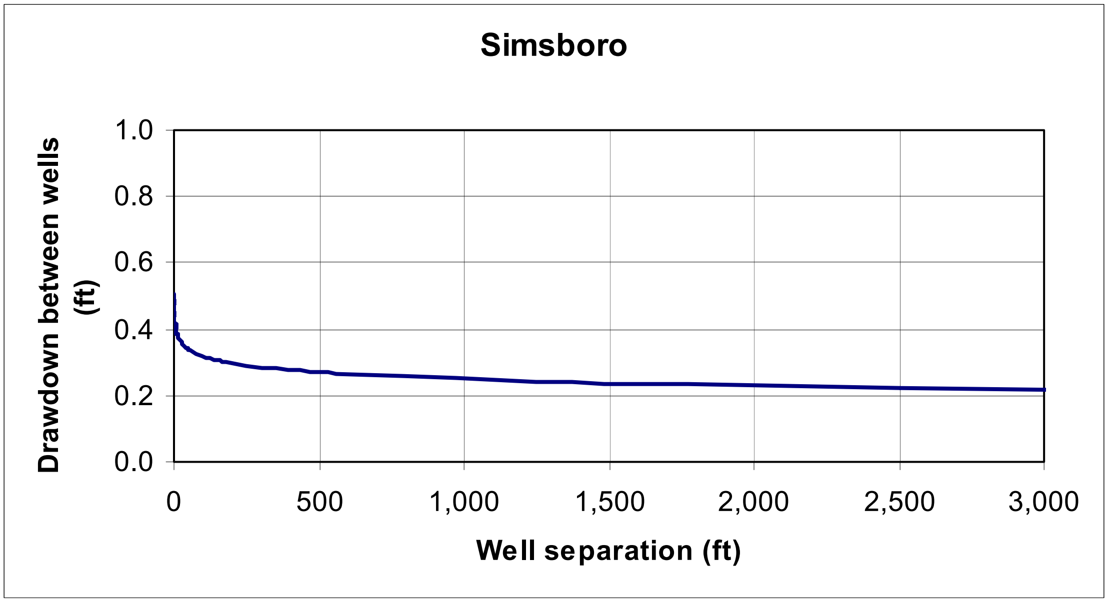

Figure 6. Drawdown versus well separation for a 3,500 gpd (2.4 gpm) pumping well in the Simsboro unit based on the Theis equation.