GAM run 03-28

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Texas Water Development Board
Groundwater Availability Modeling Section
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REQUESTOR:

Gary Westbrook, Post Oak Savannah Groundwater Conservation District.

DESCRIPTION OF REQUEST:

Post Oak Savannah Groundwater Conservation District requested the following pumping scenario from the Central Carrizo-Wilcox Groundwater Availability Model (GAM):

- Add a total of 26 - 3,000 gpm wells to the Simsboro aquifer in Robertson, Burleson, and Lee counties according to the following schedule:

  2004 – 4 wells in Burleson County
  2005 – 4 wells in Robertson County
  2006 – 3 wells in Lee County
  2007 – 4 wells in Burleson County
  2008 – 3 wells in Lee County, 4 wells in Robertson County
  2010 – 4 wells in Burleson County

  for a total of 125,800 acre-ft/year.

- Distribute the 26 wells according to Figure 1.

- Do not add any wells after 2010; however, run the model with the 26 new wells in place until 2040.

Water budgets for a previous scenario involving only new wells in Burleson County (GAM run 03-26) and the above scenario were also requested along with a map of the distribution of hydraulic conductivities for the model.

METHODS:

To address the request, we:

- Added wells pumping at 3,000 gpm or 4,840 acre-feet/year to the existing 2001-2010 pumpage files. The pumpage distribution in 2010 was continued for 30 years until 2040.
- Plotted model head distribution in the Simsboro aquifer for 2001, 2005, 2010, 2020, 2030, and 2040.

- Extracted water budgets from the model output files for the present scenario (Scenario 2) and a previous scenario (Scenario 1: GAM run 03-26).

PARAMETERS AND ASSUMPTIONS:

For the period 2001 – 2010 it is assumed that the pumpage in all other aquifers and in all other counties is what was modeled in the predictive GAM runs reported in Dutton and others (2003). Those pumping distributions are based on the regional water planning group demand predictions. For the period from 2011 – 2040, the pumping distribution is the same as in 2010.

RESULTS:

Distribution of Heads in the Simsboro Aquifer

The locations of the new wells are shown in Figure 1. The shading in the model cells indicates when the wells were added. Darker cells were added later. Light gray cells were added in 2004, black cells were added in 2010.

The distribution of heads in the Simsboro aquifer for 2001 is shown in Figure 2 for comparison with the head distribution after the wells were added. The distribution of heads in the Simsboro for 2005 after 8 wells have been added is shown in Figure 3. Heads for 2010 after 26 wells have been added is shown in Figure 4. The head distributions after an additional 10 years, 20 years, and 30 years of pumping are shown in Figures 5, 6, and 7 respectively.

Figure 2 shows that the heads in the Simsboro aquifer in Burleson County are between 150 and 250 feet above sea level in 2001 before the addition of the new wells. Figure 3 shows a cone of depression in 2005 centered around northwest Brazos and southwest Robertson counties after 8 wells were added. The Simsboro aquifer heads in Burleson County are simulated to be between 0 and 100 feet above sea level in 2005. Figure 4 shows the head distribution in 2010 after the 26 new wells have been added. The heads in northwest Burleson County in Figure 4 are more than 400 feet below sea level and by 2020 the heads in the center of the cone of depression are more than 500 feet below sea level (Figure 5).

Comparison of Figures 6 and 7 shows little change in the cone of depression from 2030 to 2040.

Water Budgets

The water budgets for the Central Carrizo-Wilcox GAM are shown in Table 1. The flow terms for the Simsboro aquifer (layer 5) are bold text in cases where new wells were added. Inspection of the flow terms for the Simsboro for Scenario 2 in Burleson County

indicates that most of the water extracted in pumping (58,000 acre-ft) is derived from lateral flow(x flow in - 36,000 acre-ft). An additional 19,000 acre-ft comes from cross-formational flow (z flow in) and about 3,000 acre-ft comes from storage.

Hydraulic Conductivity Map

A map showing the distribution of hydraulic conductivities used in the model is shown in Figure 8. The conductivities are given in units of feet per day. Figure 8 indicates that in Burleson County the hydraulic conductivities range from 5 to 20 feet/day.

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.

Table 1 Flow budget in acre-feet/year from the Central Carrizo-Wilcox GAM for Robertson, Burleson, Milam, and Lee counties for two pumping scenarios. The Simsboro (Layer 5) flows are in bold text for the cases where new pumping was added.

County	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	Stream	Reserv. Leakage	Total In	Total Out	% diff
Scenario 1: New Pumping in Burleson County Only																	
Robertson	1	106	30	-293	0	0	2,709	-197	0	2,357	-1,214	0	-3,498	0	5,202	-5,202	0
	2	335	316	-415	197	-2,709	2,845	-4,456	0	779	-935	4,056	-13	0	8,529	-8,529	0
	3	619	4,361	-8,021	4,456	-2,845	1,613	-2,131	-1,783	11,459	-6,554	0	-1,174	0	22,508	-22,508	0
	4	8,824	4,210	-4,836	2,131	-1,613	1,380	-12,612	-1,378	6,918	-2,776	0	-504	257	23,719	-23,719	0
	5	19,607	48,565	-64,554	12,612	-1,380	4,198	-103	-23,193	6,722	-2,474	0	0	0	91,704	-91,704	0
	6	1,815	12,725	-10,677	103	-4,198	0	0	-330	588	-26	0	0	0	15,231	-15,231	0
	All	31,306	70,206	-88,796	19,500	-12,745	12,745	-19,500	-26,684	28,823	-13,979	4,056	-5,188	257	166,892	-166,892	0
Burleson	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	62	680	-744	0	0	19	-7,354	0	71	0	7,266	0	0	8,099	-8,099	0
	3	332	6,641	-7,115	7,354	-19	0	-3,900	-3,293	0	0	0	0	0	14,327	-14,327	0
	4	1,130	7,135	-1,753	3,900	0	0	-10,375	-39	0	0	0	0	0	12,166	-12,166	0
	5	**2,258**	**107,609**	**-32,863**	**10,375**	**0**	**9,428**	**0**	**-96,807**	**0**	**0**	**0**	**0**	**0**	**129,670**	**-129,670**	**0**
	6	1,152	11,371	-3,087	0	-9,428	0	0	-8	0	0	0	0	0	12,524	-12,524	0
	All	4,935	133,437	-45,561	21,630	-9,447	9,447	-21,630	-100,148	71	0	7,266	0	0	176,786	-176,785	0
Milam	1	620	439	-176	0	0	4,591	-597	0	3,798	-2,885	0	-5,790	0	9,448	-9,448	0
	2	1,049	194	-214	597	-4,591	4,246	-1,679	0	940	-365	-177	0	0	7,025	-7,025	0
	3	2,546	534	-4,232	1,679	-4,246	3,616	-2,212	-330	5,428	-2,783	0	0	0	13,802	-13,802	0
	4	9,147	958	-4,242	2,212	-3,616	3,240	-10,405	-472	4,718	-1,259	0	-324	44	20,318	-20,319	0
	5	33,126	22,338	-57,681	10,405	-3,240	2,913	-46	-19,933	12,548	-433	0	0	0	81,330	-81,333	0
	6	5,896	2,998	-6,520	46	-2,913	0	0	-906	2,982	-1,583	0	0	0	11,922	-11,922	0
	All	52,385	27,459	-73,065	14,938	-18,605	18,605	-14,938	-21,642	30,414	-9,308	-177	-6,114	44	143,845	-143,849	0
Lee	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	210	367	-260	0	0	17	-12,054	0	358	-369	11,576	155	0	12,683	-12,683	0
	3	1,898	21,774	-8,250	12,054	-17	6	-1,505	-26,864	3,296	-381	0	-2,010	0	39,028	-39,028	0
	4	4,808	5,594	-3,832	1,505	-6	0	-9,649	-602	2,114	-39	0	106	0	14,128	-14,128	0
	5	15,256	48,198	-54,259	9,649	0	7,736	-24	-28,151	1,954	-401	0	45	0	82,837	-82,836	0
	6	1,699	14,504	-8,741	24	-7,736	0	0	-52	301	0	0	0	0	16,529	-16,529	0
	All	23,870	90,437	-75,342	23,232	-7,759	7,759	-23,232	-55,669	8,023	-1,190	11,576	-1,704	0	165,204	-165,203	0

County	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	Stream	Reserv. Leakage	Total In	Total Out	% diff
Scenario 2: New Pumping in Lee, Burleson, and Robertson Counties																	
Robertson	1	111	30	-292	0	0	2,700	-200	0	2,357	-1,213	0	-3,492	0	5,198	-5,198	0
	2	365	316	-414	200	-2,700	2,822	-4,624	0	779	-929	4,197	-13	0	8,680	-8,680	0
	3	744	4,418	-8,083	4,624	-2,822	1,606	-2,491	-1,783	11,459	-6,513	0	-1,159	0	22,852	-22,852	0
	4	10,527	4,780	-5,146	2,491	-1,606	1,376	-15,049	-1,378	6,918	-2,700	0	-470	257	26,349	-26,349	0
	5	**27,206**	**77,549**	**-66,717**	**15,049**	**-1,376**	**6,072**	**-125**	**-61,911**	**6,722**	**-2,470**	**0**	**0**	**0**	**132,599**	**-132,599**	**0**
	6	2,281	14,241	-10,806	125	-6,072	0	0	-330	588	-26	0	0	0	17,234	-17,234	0
	All	41,235	101,334	-91,459	22,489	-14,576	14,576	-22,489	-65,402	28,823	-13,851	4,197	-5,134	257	212,912	-212,911	0
Burleson	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	53	689	-738	0	0	12	-7,380	0	48	0	7,317	0	0	8,118	-8,118	0
	3	373	6,787	-7,292	7,380	-12	0	-3,938	-3,298	0	0	0	0	0	14,540	-14,540	0
	4	1,407	6,173	-1,438	3,938	0	0	-10,044	-36	0	0	0	0	0	11,518	-11,518	0
	5	**3,101**	**66,745**	**-30,739**	**10,044**	**0**	**8,938**	**0**	**-58,089**	**0**	**0**	**0**	**0**	**0**	**88,829**	**-88,828**	**0**
	6	1,506	10,229	-2,788	0	-8,938	0	0	-8	0	0	0	0	0	11,734	-11,734	0
	All	6,439	90,623	-42,994	21,362	-8,951	8,951	-21,362	-61,432	48	0	7,317	0	0	134,740	-134,739	0
Milam	1	675	439	-176	0	0	4,489	-612	0	3,798	-2,863	0	-5,750	0	9,400	-9,400	0
	2	1,108	194	-214	612	-4,489	4,138	-1,748	0	940	-366	-174	0	0	6,991	-6,991	0
	3	2,637	537	-4,255	1,748	-4,138	3,510	-2,352	-330	5,428	-2,785	0	0	0	13,861	-13,861	0
	4	9,586	961	-4,368	2,352	-3,510	3,153	-10,890	-472	4,718	-1,250	0	-324	44	20,814	-20,814	0
	5	36,698	20,670	-60,202	10,890	-3,153	2,963	-47	-19,933	12,548	-436	0	0	0	83,767	-83,771	0
	6	6,393	3,008	-6,974	47	-2,963	0	0	-906	2,982	-1,586	0	0	0	12,430	-12,430	0
	All	57,097	25,808	-76,190	15,648	-18,252	18,252	-15,648	-21,642	30,414	-9,287	-174	-6,074	44	147,263	-147,266	0
Lee	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	211	367	-260	0	0	17	-12,058	0	358	-370	11,580	155	0	12,688	-12,688	0
	3	1,939	21,777	-8,247	12,058	-17	5	-1,556	-26,864	3,296	-381	0	-2,012	0	39,076	-39,076	0
	4	5,248	5,530	-3,480	1,556	-5	0	-10,434	-602	2,114	-40	0	113	0	14,561	-14,561	0
	5	**17,393**	**55,389**	**-36,161**	**10,434**	**0**	**8,563**	**-25**	**-57,190**	**1,954**	**-401**	**0**	**45**	**0**	**93,778**	**-93,777**	**0**
	6	1,989	14,822	-8,522	25	-8,563	0	0	-52	301	0	0	0	0	17,137	-17,137	0
	All	26,779	97,886	-56,669	24,073	-8,585	8,585	-24,073	-84,708	8,023	-1,192	11,580	-1,699	0	177,240	-177,238	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.

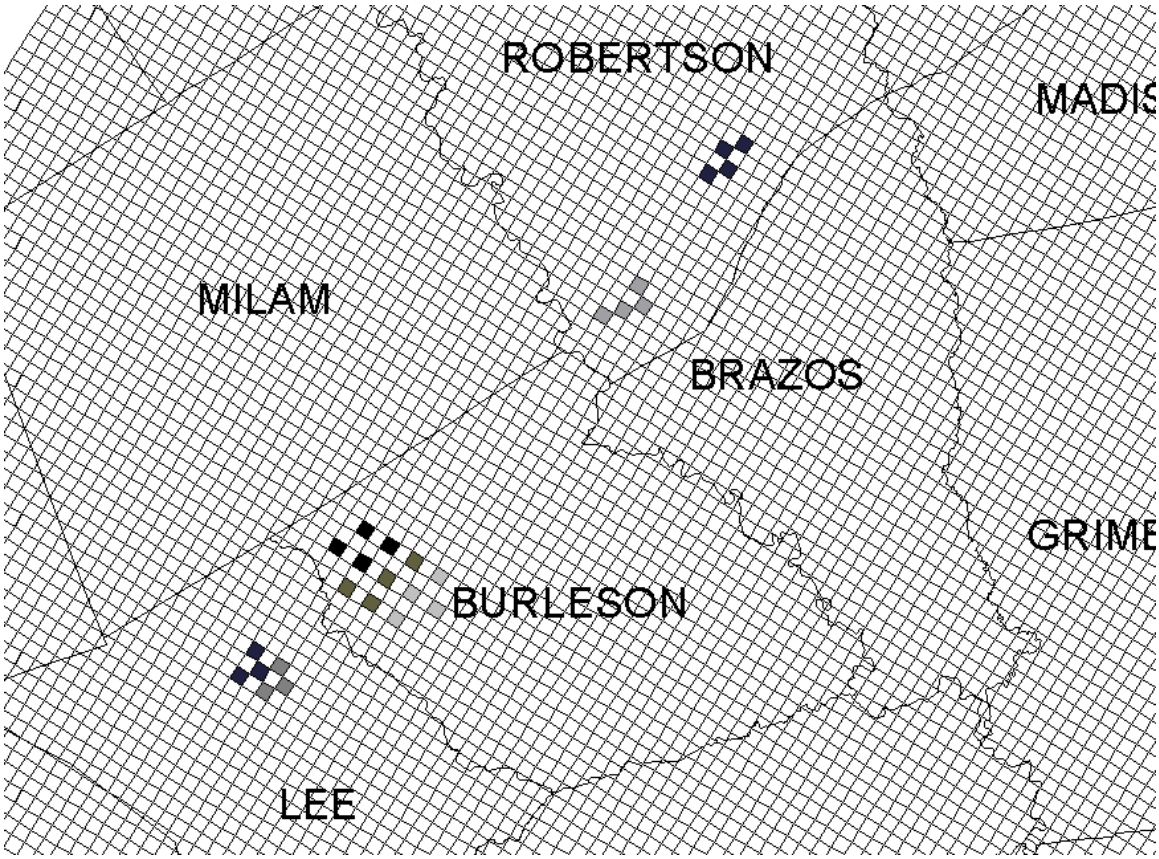

Figure 1. Central Carrizo-Wilcox model grid. The grid cells containing new wells are shaded. The darker the shading, the later the wells were added. Light gray cells were added in 2004, black cells were added in 2010.

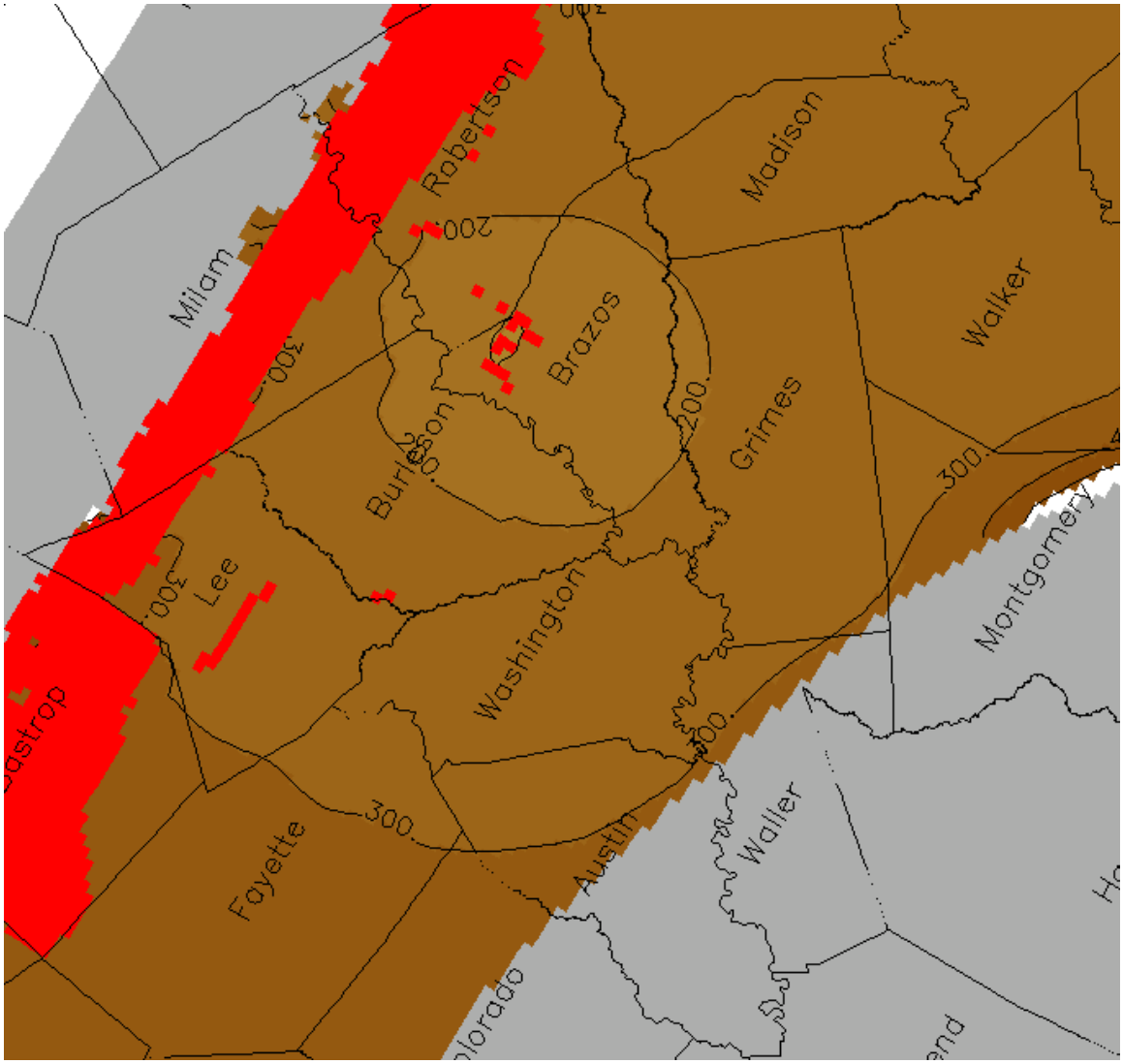

Figure 2. Heads in the Simsboro (feet above sea level) in 2001 before wells were added. Red (or shaded) squares indicate the location of model grid cells with pumping.

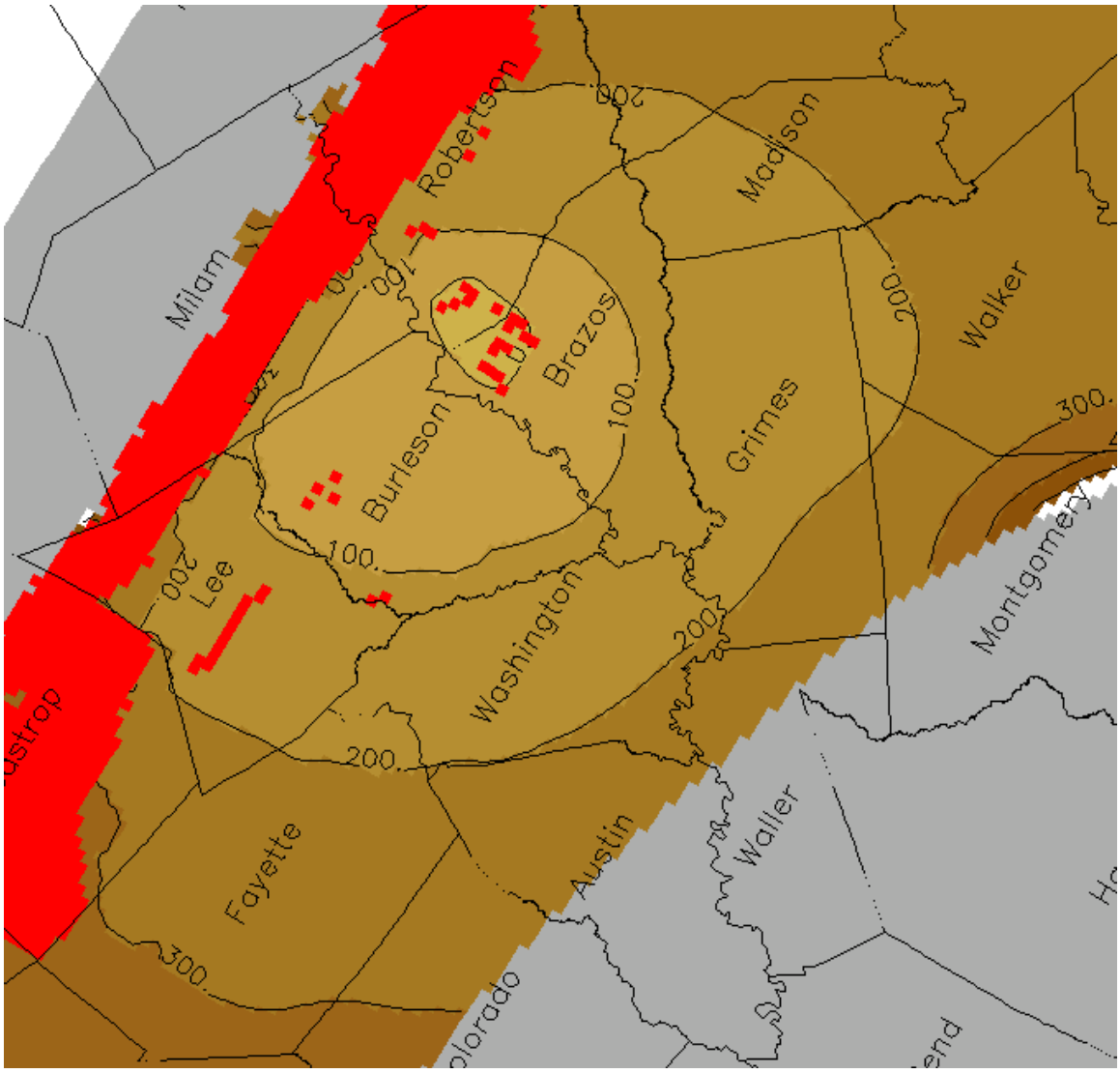

Figure 3. Heads in the Simsboro (positive number indicates feet above sea level; negative number indicates feet below sea level) in 2005 after 8 wells at 3,000 gpm have been added. Heads within the 0 foot contour in northwest Brazos and southwest Robertson counties are below sea level. Red (or shaded) squares indicate the location of model grid cells with pumping.

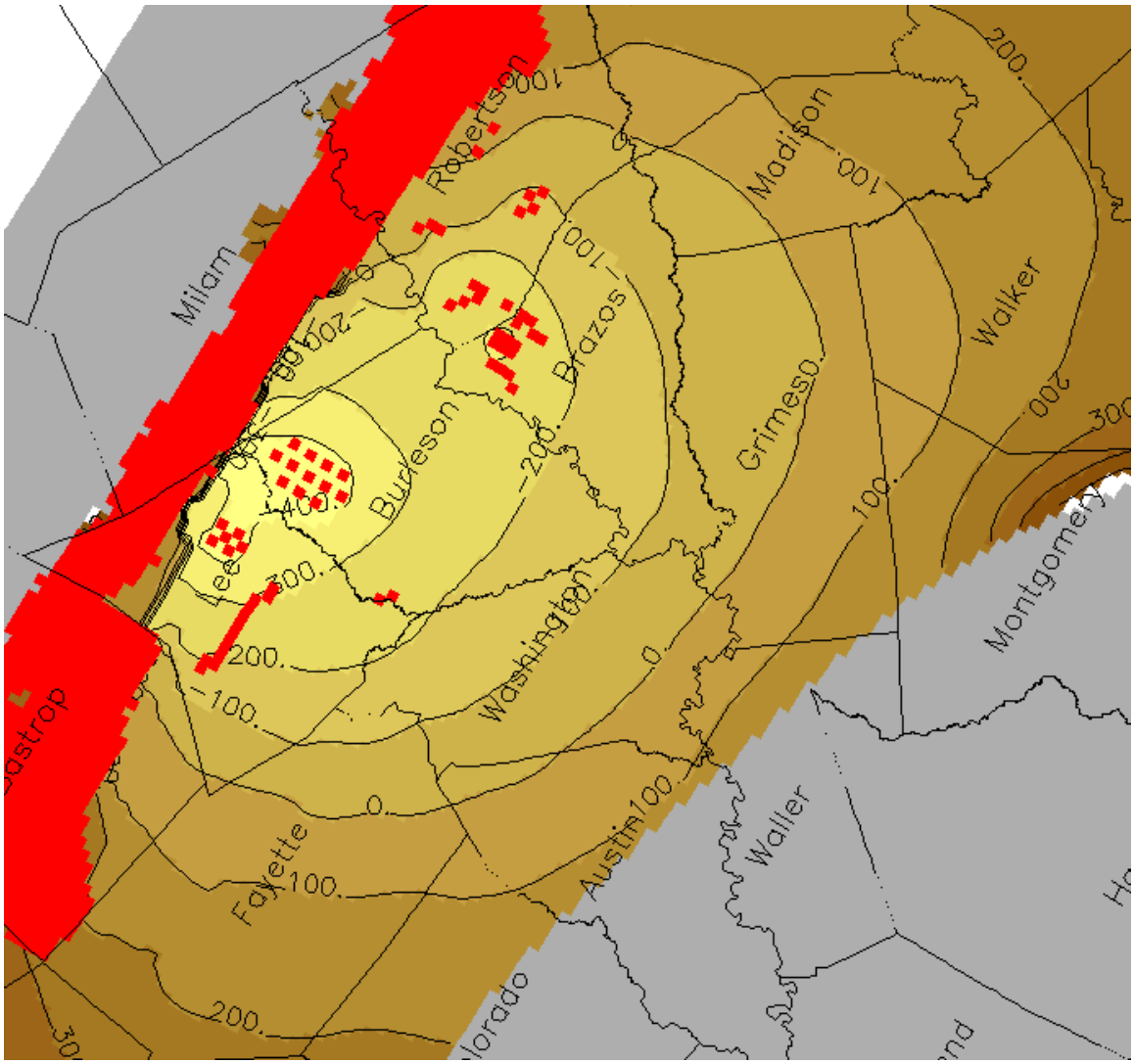

Figure 4. Heads in the Simsboro (positive number indicates feet above sea level; negative number indicates feet below sea level) in 2010 after 26 wells at 3,000 gpm have been added. Red (or shaded) squares indicate the location of model grid cells with pumping.

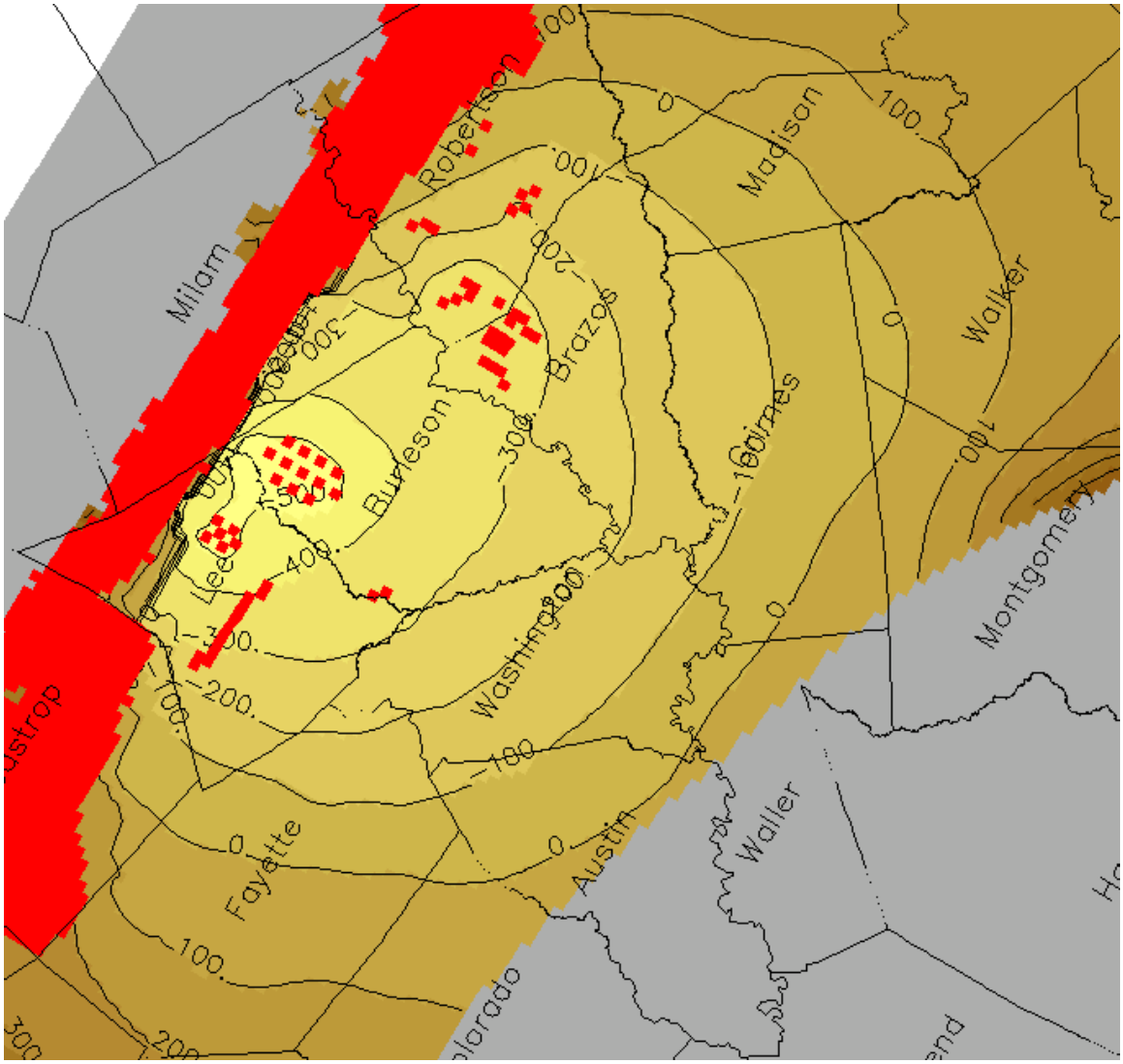

Figure 5. Heads in the Simsboro (positive number indicates feet above sea level; negative number indicates feet below sea level) in 2020 after 10 additional years of pumping. Red (or shaded) squares indicate the location of model grid cells with pumping.

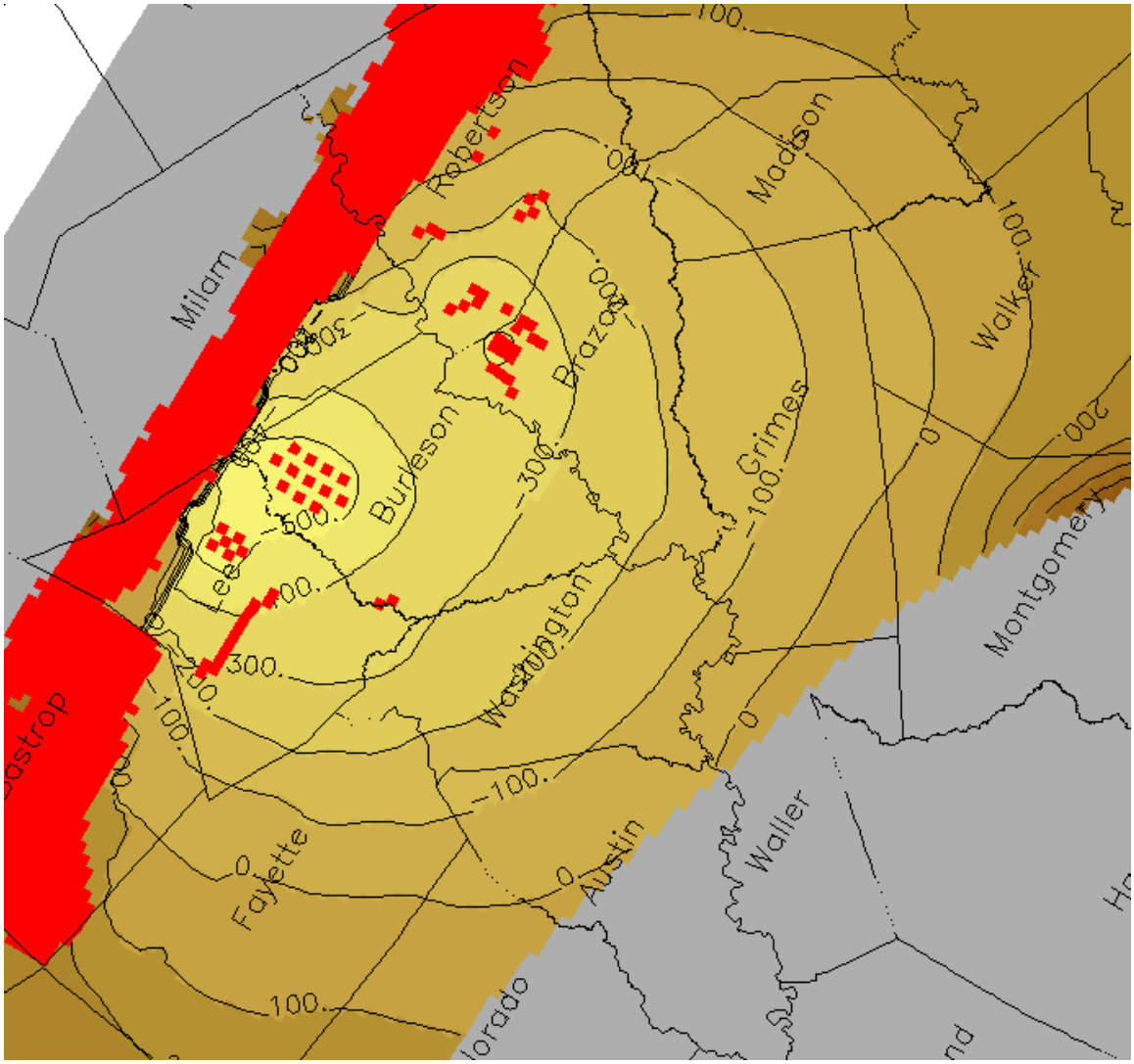

Figure 6. Heads in the Simsboro (positive number indicates feet above sea level; negative number indicates feet below sea level) in 2030 after 20 years of additional pumping. Red (or shaded) squares indicate the location of model grid cells with pumping.

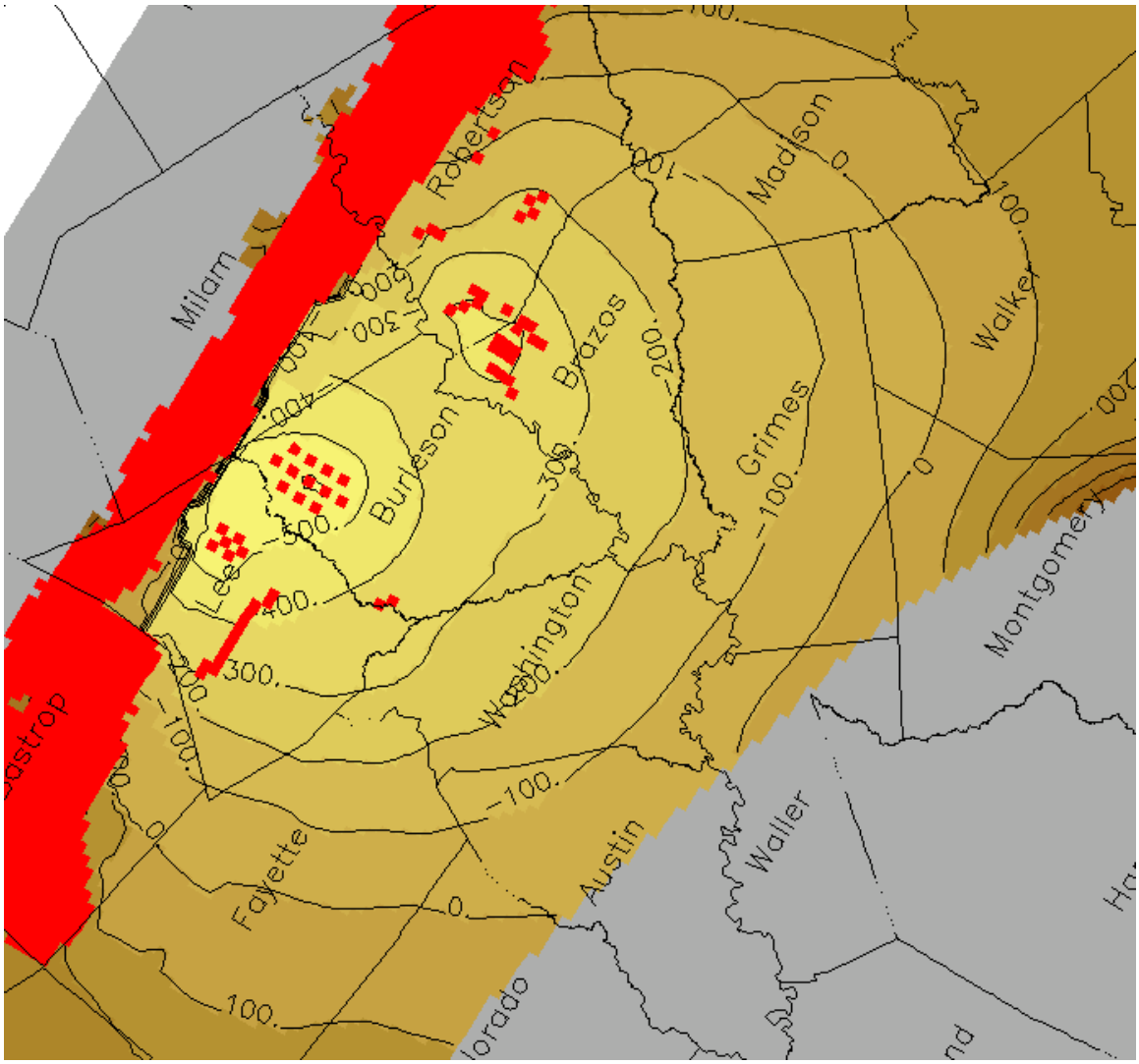

Figure 7. Heads in the Simsboro (positive number indicates feet above sea level; negative number indicates feet below sea level) in 2040 after 30 years of additional pumping. Red (or shaded) squares indicate the location of model grid cells with pumping.

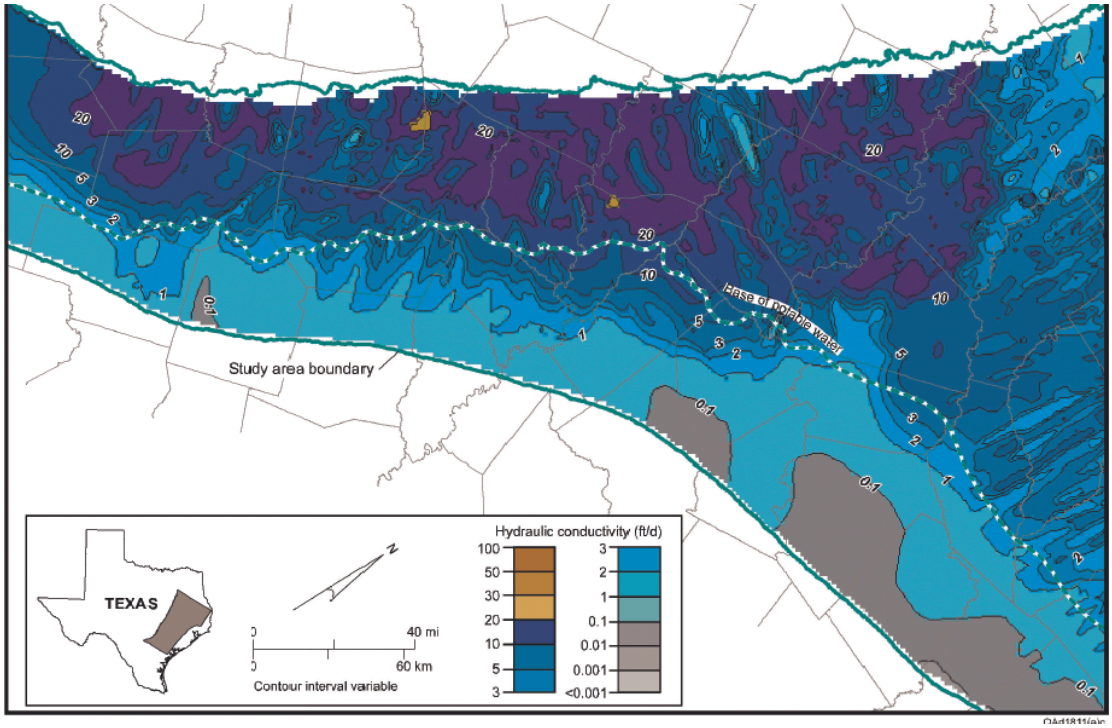

Figure 8. Hydraulic Conductivity distribution for the Central Carrizo-Wilcox GAM (Dutton and others, 2003).