GAM Run 07-16

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EXECUTIVE SUMMARY:

We ran the groundwater availability model for the southern part of the Queen City and Sparta aquifers, which includes the Carrizo-Wilcox Aquifer, using a specified baseline pumpage annually for a 60-year predictive simulation along with average recharge, evapotranspiration rates, and initial streamflows. These model runs indicate that maintaining this baseline pumpage in the model results in the following:

- maximum water level declines of less than 40 feet in the Sparta and Queen City aquifers, with some areas of recovery (increase in water levels);
- maximum water level declines of 130 feet in the Carrizo Aquifer, centering around northern Frio County; and
- water level declines of more than 80 feet in all three zones of the Wilcox Aquifer, also centering on northern Frio County and apparently caused by pumpage in the overlying Carrizo Aquifer.

REQUESTOR:

Mr. Mike Mahoney from the Evergreen Underground Water Conservation District (on behalf of Groundwater Management Area 13).

DESCRIPTION OF REQUEST:

Mr. Mahoney asked us to perform a baseline model run using the groundwater availability model for the southern part of the Queen City, Sparta, and Carrizo-Wilcox aquifers. This baseline model run would be 60-year simulations using initial water levels from the end of the historic calibration simulation and average recharge conditions. Each year of the model run would use the specified baseline pumpage.

METHODS:

The simulation was set up using average recharge and evapotranspiration rates and initial streamflows based on the historic calibration-verification runs, representing 1981 to 1999. These averages were then used for each year of the 60-year predictive simulations along with the 1999 estimated historic pumpage. Resulting water levels and water level declines were then evaluated and are described in the Results section below.

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the groundwater availability model for the southern part of the Queen City, Sparta, and Carrizo-Wilcox aquifers are described individually below:

- We used Version 2.01 of the groundwater availability model for the southern part of the Queen City, Sparta, and Carrizo-Wilcox aquifers.

- See Deeds and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model for the southern part of the Queen City, Sparta, and Carrizo-Wilcox aquifers.

- The model includes eight layers representing: the Sparta Aquifer (layer 1), the Weches Formation (layer 2), the Queen City Aquifer (layer 3), the Reklaw Formation (layer 4), the Carrizo Aquifer (layer 5), the upper Wilcox Aquifer (layer 6), the middle Wilcox Aquifer (layer 7), and the lower Wilcox Aquifer (layer 8).

- Although the layer representing the Sparta Aquifer (layer 1) and the Queen City Aquifer (layer 3) extend to the Rio Grande in the model, the portion of these layers west of the Frio River are not recognized as part of either aquifer. No pumpage is assigned to these layers west of the Frio River, and although results (water levels) are shown for the entire layer in the figures, evaluation of impacts in these areas should be done with care.

- The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) in the entire model for 1999 is 23 feet for the Sparta Aquifer, 18 feet for the Queen City aquifer, and 33 feet for the Carrizo aquifer (Kelley and others, 2004).

- Recharge rates, evapotranspiration rates, and initial streamflows are averages of historic estimates from 1981 to 1999.

- Pumpage used for each year of the 60-year predictive simulation was a baseline pumpage specified by members of Groundwater Management Area 13.

Baseline Pumpage

The baseline pumpage specified by the members of Groundwater Management Area 13 was the 1999 estimated historic pumpage from the transient calibration-verification run with additional pumpage in Gonzales and Caldwell counties. Historic pumpage included in the transient calibration-verification model run, which includes the 1999 pumpage used as the basis for the baseline pumpage, is shown in Appendix A. The locations of cells in each layer of the model that include pumpage in 1999 are also shown in Appendix A.

The following modifications were made to the 1999 estimated historic pumpage for the baseline pumpage data set.

1. An additional 9,000 acre-feet per year of pumpage was added in southwestern Gonzales County to the Carrizo Aquifer (layer 5) to represent the existing Schertz-Seguin well field, which is shown in Figure 1. Specific cells that pumpage was added to in the baseline pumpage data set are shown in Table 1.

2. An additional 645 to 6,000 acre-feet per year of pumpage was added in two cells (rows 57 and 58, column 207) in Caldwell County to the Carrizo Aquifer (layer 5) to represent the Aqua Water Supply Corporation well field (Figure 2). This pumpage will increase over time from 645 acre-feet per year to 6,000 acre-feet per year, as shown in Table 2.

Table 1. Pumpage added to the 1999 estimated historic pumpage for the Schertz-Seguin well field.

Layer	Row	Column	Additional Pumpage (acre-feet per year)
5	65	169	474
5	65	170	474
5	66	168	947
5	66	169	947
5	66	170	947
5	66	171	474
5	66	172	474
5	67	168	947
5	67	169	947
5	67	170	947
5	67	171	947
5	67	172	474

Table 2. Pumpage added to the 1999 estimated historic pumpage for the Aqua Water Supply Corporation well field in Caldwell County (rows 57 and 58, column 207) for the Carrizo Aquifer (layer 5). This pumpage increases over time in five-year increments to a maximum of 6,000 acre-feet per year.

Year	Additional Pumpage (acre-feet/year)
1-5	645
6-10	1,645
11-15	2,645
16-20	3,645
21-25	4,645
26-30	5,645
31-60	6,000

RESULTS:

Included in the results are estimates of the water budgets after running the model for 60 years. The components of the water budget are described below.

- Wells—water produced from wells in each aquifer. In the model this component is always shown as "Outflow" from the water budget, because all wells included in the model produce (rather than inject) water. Wells are modeled in the model using the MODFLOW Well package.

- Springs—water that drains from an aquifer if water levels are above the elevation of the spring. This component is always shown as "Outflow", or discharge, from the water budget. Springs are modeled in the model using the MODFLOW Drain package.

- Recharge—simulates areally distributed recharge due to precipitation falling on the outcrop (where the aquifer is exposed at land surface) areas of aquifers. Recharge is always shown as "Inflow" into the water budget.

- Vertical Leakage (Upward or Downward)—describes the vertical flow, or leakage, between two layers (aquifers or confining units) in the model. This flow is controlled by the water levels in each of the layers and aquifer properties of each layer that define the amount of leakage that can occur. "Inflow" to an aquifer from an overlying or underlying layer will always equal the "Outflow" from the other layer.

- Storage—water stored in the aquifer. The storage component that is included in "Inflow" is water that is removed from storage in the aquifer (that is, water levels decline). The storage component that is included in "Outflow" is water that is added back into storage in the aquifer (that is, water levels increase). This component of the budget is often seen as water both going into and out of the aquifer because this is a regional budget, and water levels will decline in some areas (water is being removed from storage) and will rise in others (water is being added to storage).

- Lateral flow—describes lateral flow within an aquifer between a county and adjacent counties.

- Evapotranspiration—water that flows out of an aquifer due to direct evaporation and plant transpiration. This component of the budget will always be shown as "Outflow". Evapotranspiration is modeled in the model using the MODFLOW Evapotranspiration (EVT) package.

- Rivers and Streams—water that flows between streams and rivers and an aquifer. The direction and amount of flow depends on the water level in the stream or river and the aquifer. In areas where water levels in the stream or river are above the water level in the aquifer, water flows into the aquifer and is shown as

"Inflow" in the budget. In areas where water levels in the aquifer are above the water level in the stream or river, water flows out of the aquifer and into the stream and is shown as "Outflow" in the budget. Rivers and streams are modeled in the model using the MODFLOW Stream package.

- General-Head Boundary (GHB)—The model uses general head boundaries to simulate the lateral aquifer boundaries. In addition, the downdip portions (areas where the layer is confined or covered by other aquifers or geologic formations) of the top are modeled with general head boundaries to simulate the vertical movement of groundwater between the Sparta Aquifer (layer 1) and younger sediments that overlie the Sparta.

The results are described for the four aquifers in the model area; the Sparta Aquifer (layer 1 in the model), the Queen City Aquifer (layer 3), the Carrizo Aquifer (layer 5), and the Wilcox Aquifer (layers 6, 7, and 8). Results for the other units included in the model are not discussed because they are not considered to be aquifers in the region.

A small number of model cells went dry during the model run. Approximately half of these cells went dry during the historic calibration time period, and therefore are not due to conditions from this predictive model run. All of the model cells that went dry during the run are located in the outcrop portions of the model, where the formations pinch out and the aquifer is found under unconfined conditions.

Initial water levels (which are from the end of the transient calibration run- the end of 1999) for the Sparta, Queen City, Carrizo, Upper Wilcox, Middle Wilcox, and Lower Wilcox aquifers are shown in Figures 3 to 8. These figures show the starting water levels for this 60-year predictive model run. These figures all show that water levels are the highest in the outcrop portions of the aquifers located furthest to the north and/or west, and that water levels decrease as groundwater flows downdip, generally to the south and/or east. Initial heads or water levels in the Carrizo and Wilcox aquifers show a large cone of depression that has formed in Frio, LaSalle, Dimmit, and Zavala counties.

Water levels at the end of the 60-year predictive simulation for the Sparta, Queen City, Carrizo, Upper Wilcox, Middle Wilcox, and Lower Wilcox aquifers are shown in Figures 9 to 14. Water levels at the end of the 60-year runs are very similar to initial water levels (Figures 3 to 8). Because differences between initial water levels and water levels after 60 years of pumpage are difficult to discern in these figures, water level change maps were made. A water level change map shows the difference between the initial water levels (1999) and the water levels at the end of the 60-year run (2060).

Water level changes over the 60-year predictive simulation for the Sparta, Queen City, Carrizo, Upper Wilcox, Middle Wilcox, and Lower Wilcox aquifers are shown in Figures 15 to 20. These figures indicate the following:

- Water level declines throughout most of Groundwater Management Area 13 in the Sparta Aquifer (Figure 15) are zero to 30 feet, although small areas with some

water level recovery is seen in the southern and northern portions of the model area.

- Water level declines in the Queen City Aquifer (Figure 16) are between zero and 40 feet in most of the model area. As with the Sparta Aquifer, the southern and northern portions of the model area show some water level recovery. In northwestern Webb and central Zavala counties water level recoveries of more than 50 feet are shown.

- Water level declines in the Carrizo Aquifer (Figure 17) are predicted to be very large over the next 60 years in some areas, primarily around an area in northern Frio County. Water level declines of over 130 feet are predicted in this area. Large parts of the southern and northern portions of the model area are predicted to show water level recovery over the next 60 years if pumpage similar to 1999 is maintained. Cones of depression can be observed in western Gonzales County and in eastern Caldwell County around the well fields added the baseline pumpage file.

- Water level declines in the Upper and Middle Wilcox aquifers (Figures 18 and 19) show similar patterns as the Carrizo Aquifer, with large water level declines focused around northern Frio County and water level recovery in the southern and northern portions of the model area if pumpage similar to 1999 is maintained. for 60 years. Much of this is due to water level changes in the Carrizo Aquifer (layer 5) because there is very little pumpage in Frio County in the Wilcox Aquifer in 1999 (Appendix A).

- Water level declines in the Lower Wilcox Aquifer (Figure 20) are up to 80 feet in the area in northern Frio County. As with the Upper and Middle Wilcox aquifers, much of this is due to water level changes in the Carrizo Aquifer (layer 5) because there is very little pumpage in Frio County in the Wilcox Aquifer in 1999 (Appendix A). Most of the rest of this aquifer is predicted to show water level recovery over the next 60 years if 1999 pumpage is maintained.

In general, areas of recovery are found where no pumpage is included in the model in 1999.

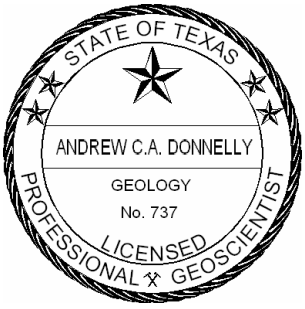
Because some of the desired future conditions (DFCs) for the groundwater management area may be based on discharge to springs or baseflow to rivers and streams, we also pulled the water budgets for each of these components for each county in the model area. These budgets are provided in Table 3. The components of the water budget are divided up into “In” and “Out”, representing water that is coming into and leaving from the budget. As might be expected, water from wells is only in the “Out” column, representing water that is pulled out of the budget or aquifer system from wells. Likewise, recharge is only found in the “In” column. Streams and rivers, however, have values in both the “In” and “Out” columns. This is because some streams lose water to the aquifer, and some gain water from the aquifer depending on the water levels in the aquifer. Also included in these budgets are

values for vertical leakage to overlying and underlying formations as well as lateral inflow from adjacent counties. Future model runs can be compared to these budgets to determine the impact of additional pumpage compared to this baseline run.

REFERENCES:

Deeds, N., Kelley, V., Fryar, D., Jones, T., Whallon, A. J., and Dean, K. E., 2003, Groundwater Availability Model for the Southern Carrizo-Wilcox Aquifer: contract report to the Texas Water Development Board, 452 p.

Kelley, V. A., Deeds, N. E., Fryar, D. G., and Nicot, J. P., 2004, Groundwater availability models for the Queen City and Sparta aquifers: contract report to the Texas Water Development Board, 867 p.



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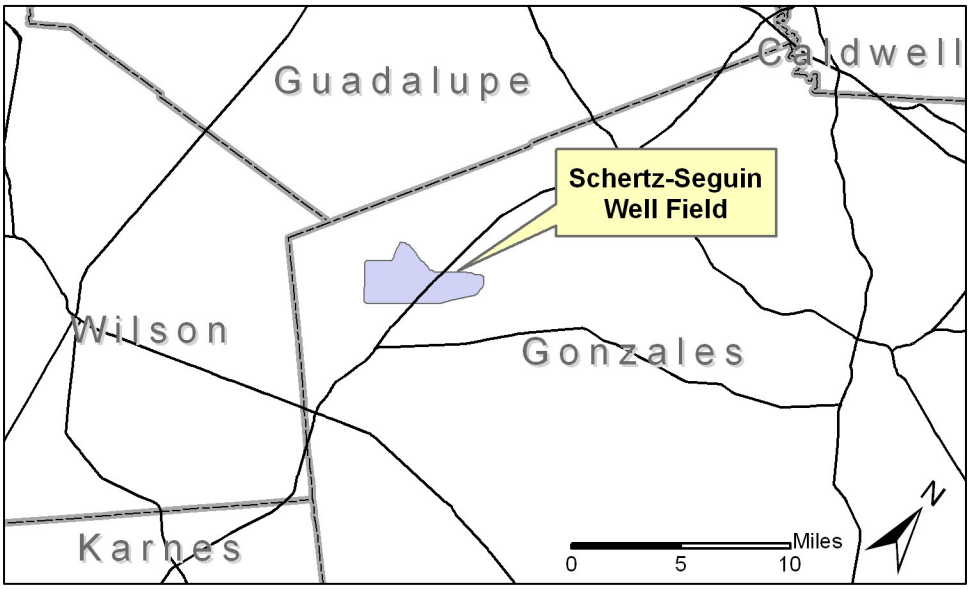

Figure 1. Approximate location of the Schertz-Seguin well field in Gonzales County.

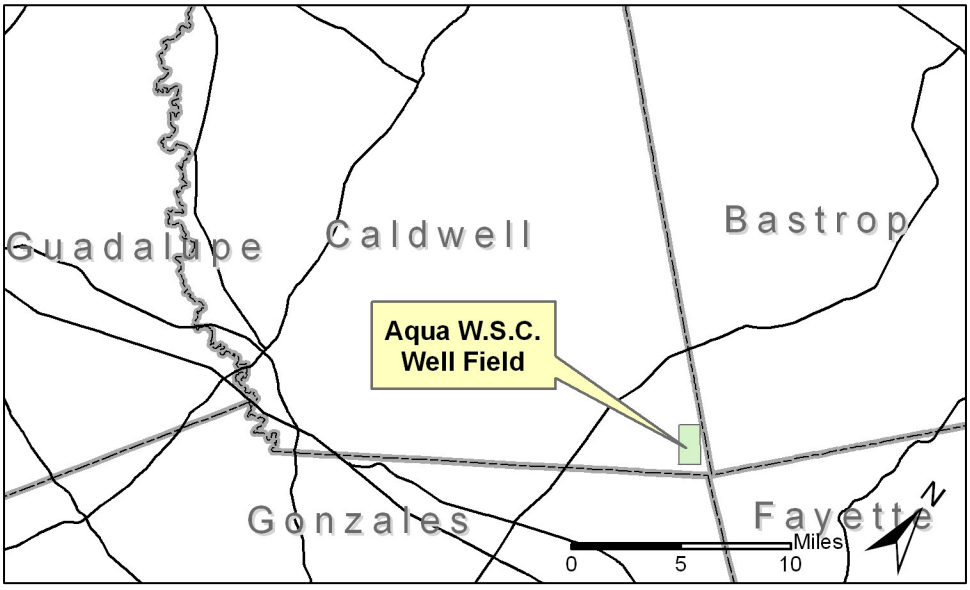

Figure 2. Approximate location of the Aqua Water Supply Corporation (WSC) well field in Caldwell County.

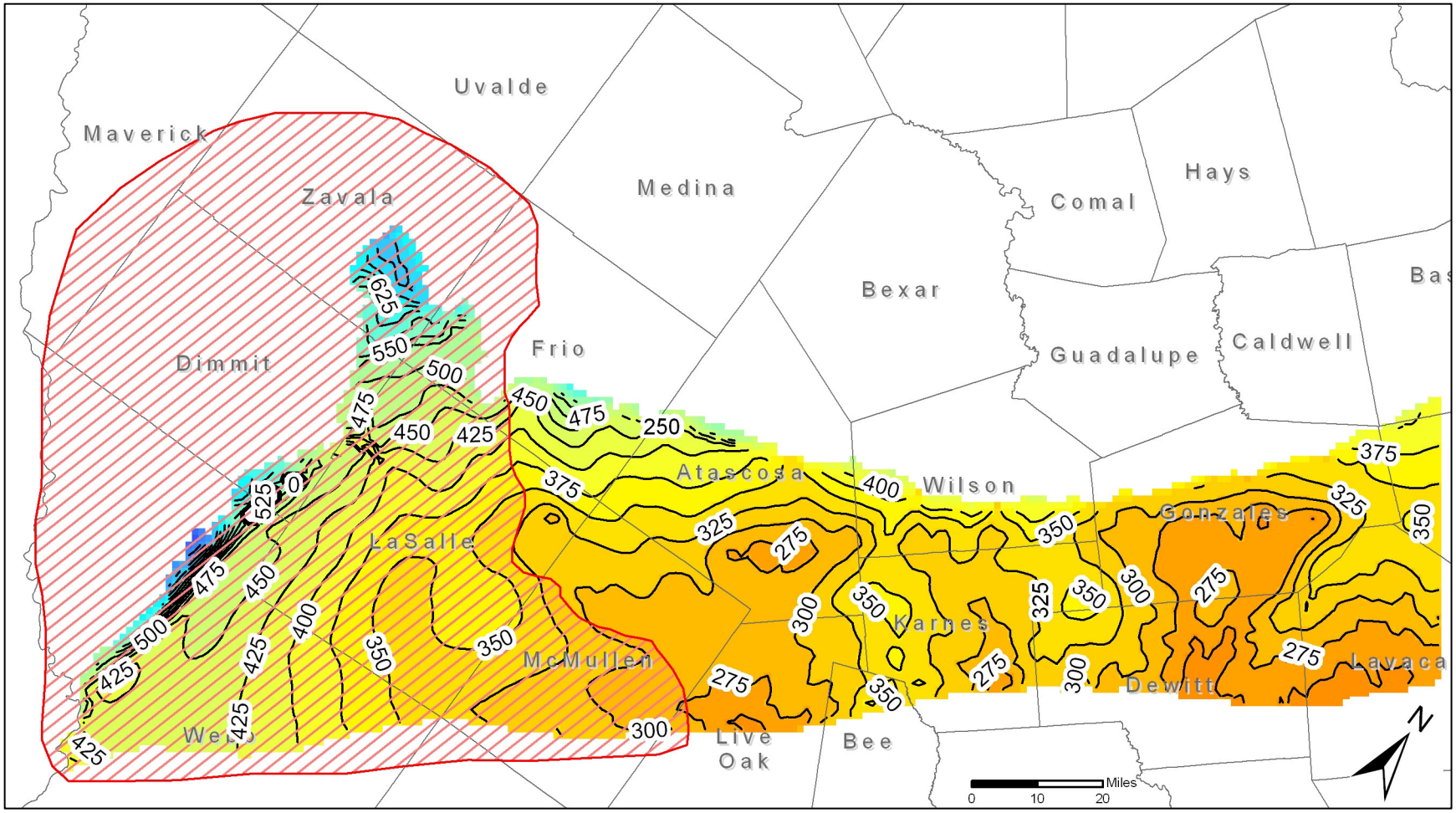

Figure 3. Initial water level elevations for the predictive model run in the Sparta Aquifer from the southern part of the Queen City, Sparta, and Carrizo-Wilcox aquifers groundwater availability model. Water level elevations are in feet above mean sea level. Contour interval is 25 feet. The area west of the Frio River (shown in red) is not considered to be part of the Sparta Aquifer and does not have any pumpage assigned to it.

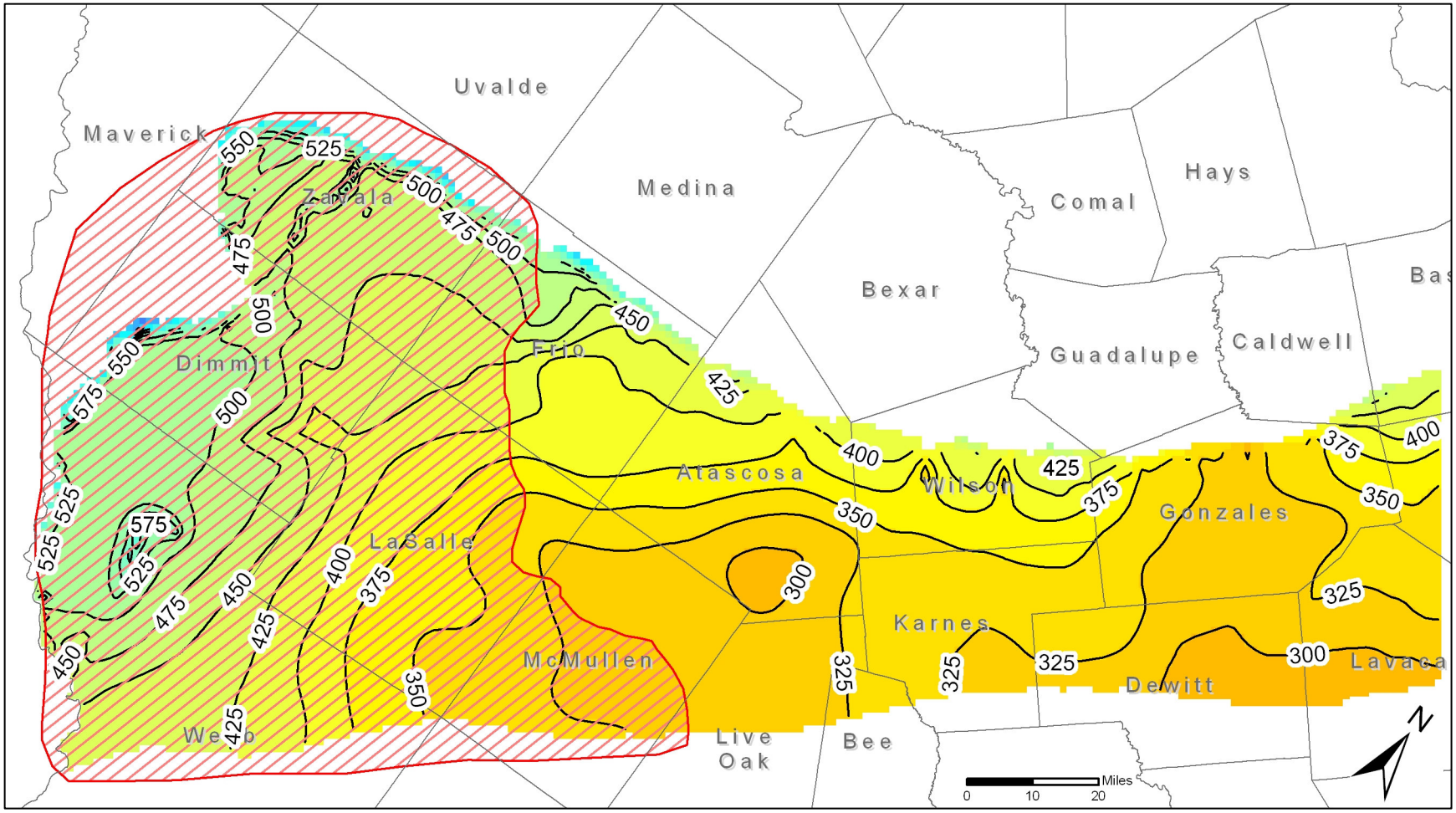

Figure 4. Initial water level elevations for the predictive model run in the Queen City Aquifer from the southern part of the Queen City, Sparta, and Carrizo-Wilcox aquifers groundwater availability model. Water level elevations are in feet above mean sea level. Contour interval is 25 feet. The area west of the Frio River (shown in red) is not considered to be part of the Queen City Aquifer and does not have any pumpage assigned to it.

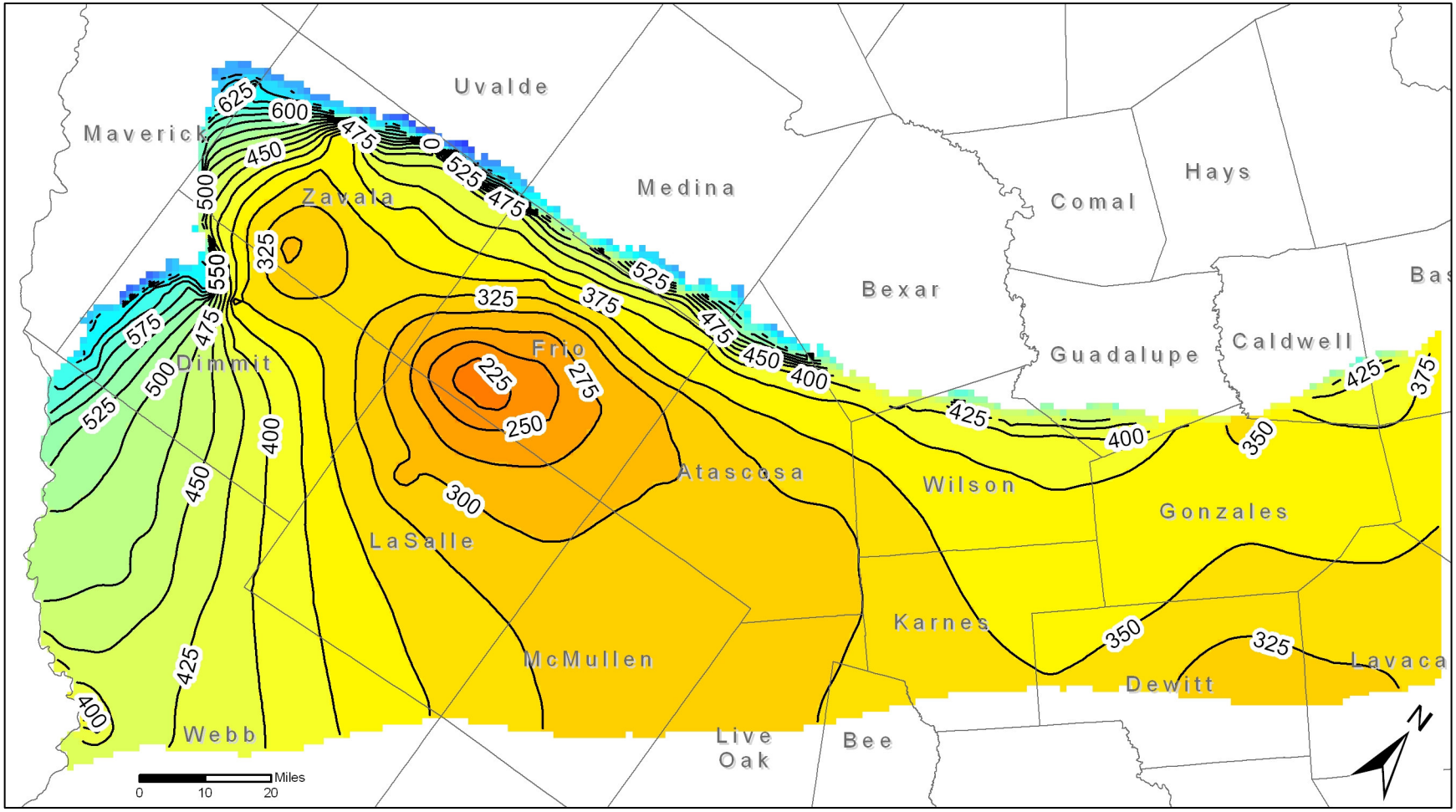

Figure 5. Initial water level elevations for the predictive model run in the Carrizo Aquifer from the southern part of the Queen City, Sparta, and Carrizo-Wilcox aquifers groundwater availability model. Water level elevations are in feet above mean sea level. Contour interval is 25 feet.

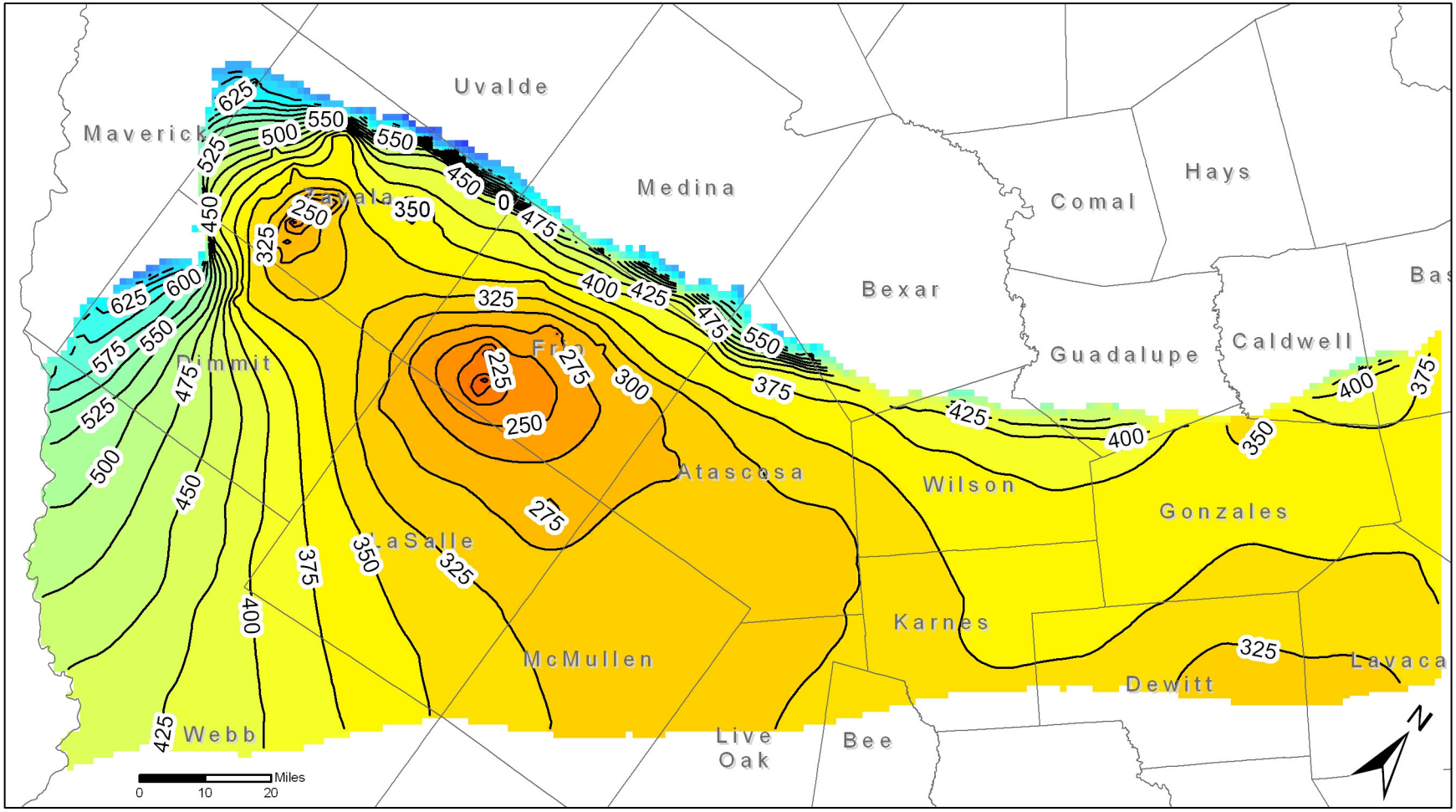

Figure 6. Initial water level elevations for the predictive model run in the Upper Wilcox Aquifer from the southern part of the Queen City, Sparta, and Carrizo-Wilcox aquifers groundwater availability model. Water level elevations are in feet above mean sea level. Contour interval is 25 feet.

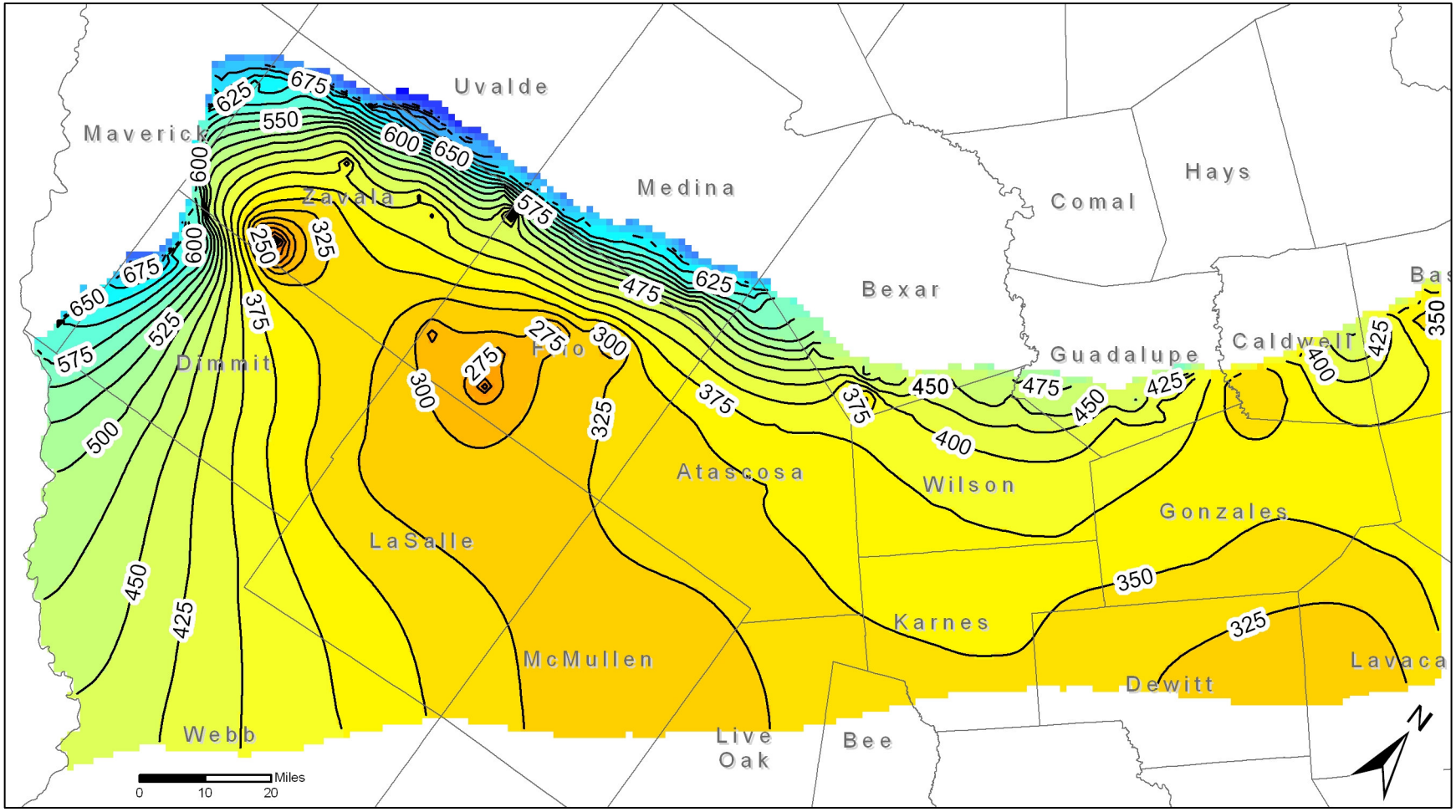

Figure 7. Initial water level elevations for the predictive model run in the Middle Wilcox Aquifer from the southern part of the Queen City, Sparta, and Carrizo-Wilcox aquifers groundwater availability model. Water level elevations are in feet above mean sea level. Contour interval is 25 feet.

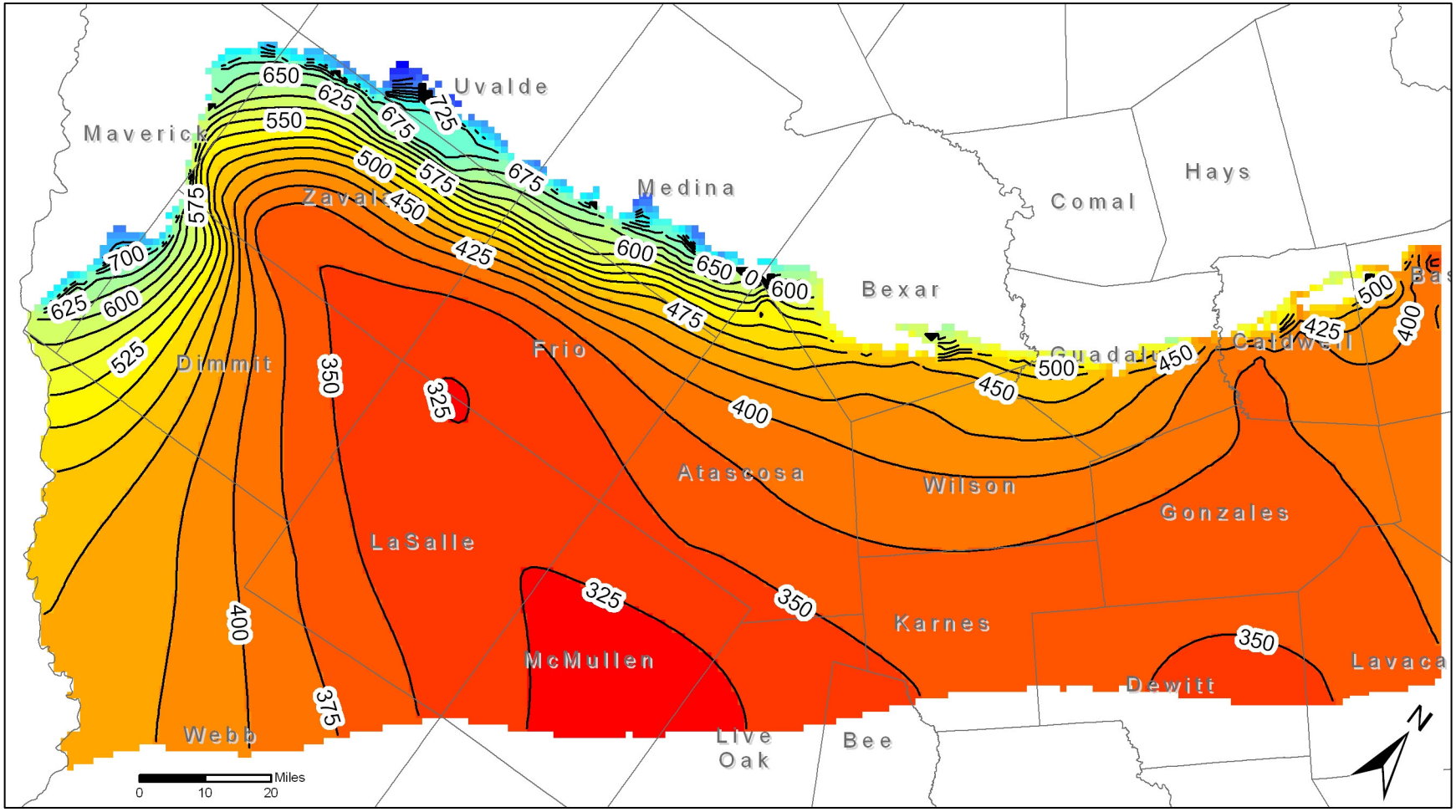

Figure 8. Initial water level elevations for the predictive model run in the Lower Wilcox Aquifer from the southern part of the Queen City, Sparta, and Carrizo-Wilcox aquifers groundwater availability model. Water level elevations are in feet above mean sea level. Contour interval is 25 feet.

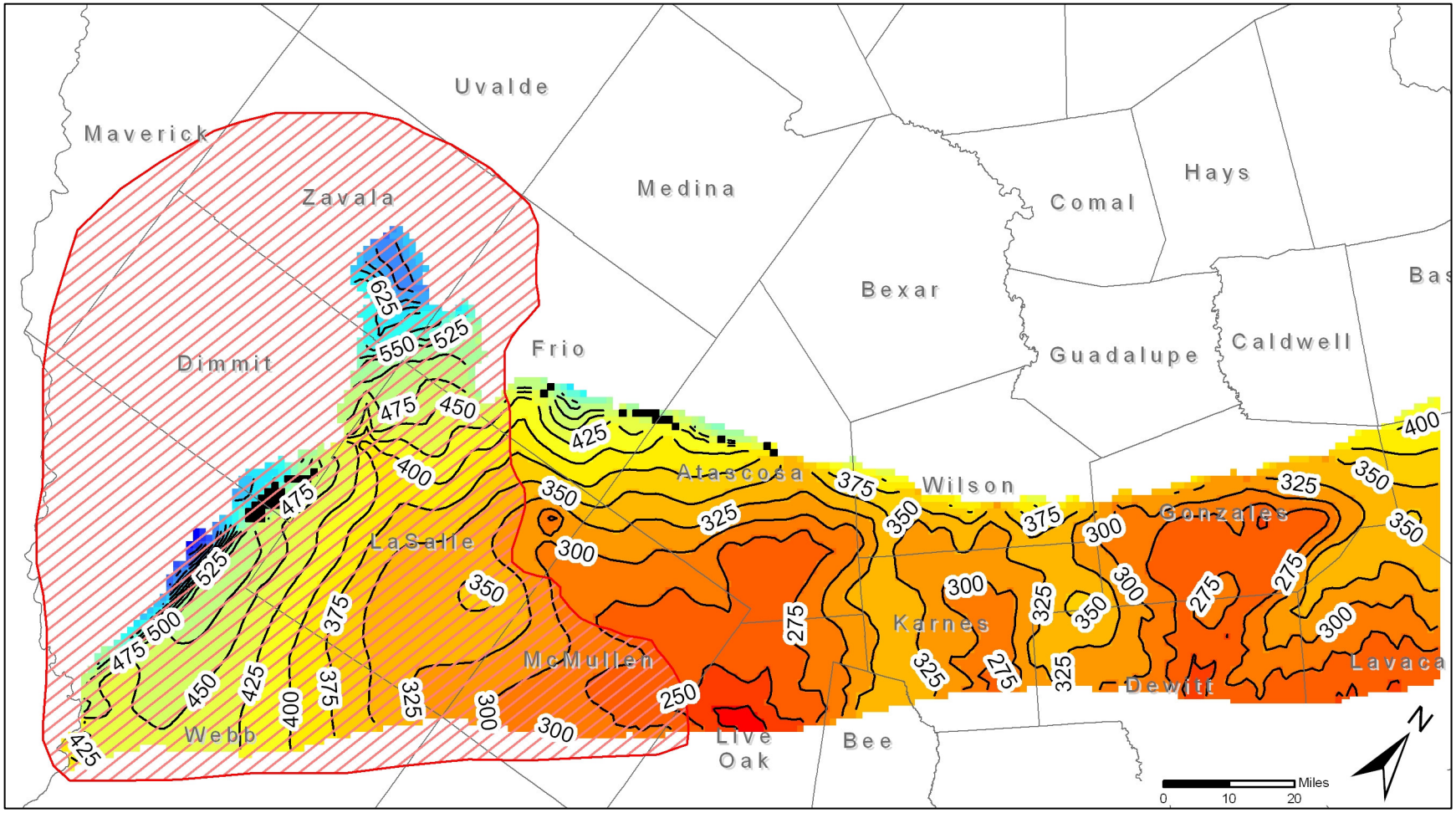

Figure 9. Water level elevations after 60 years using 1999 pumpage in the Sparta Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 25 feet. Dry model cells are shown in black. The area west of the Frio River (shown in red) is not considered to be part of the Sparta Aquifer and does not have any pumpage assigned to it.

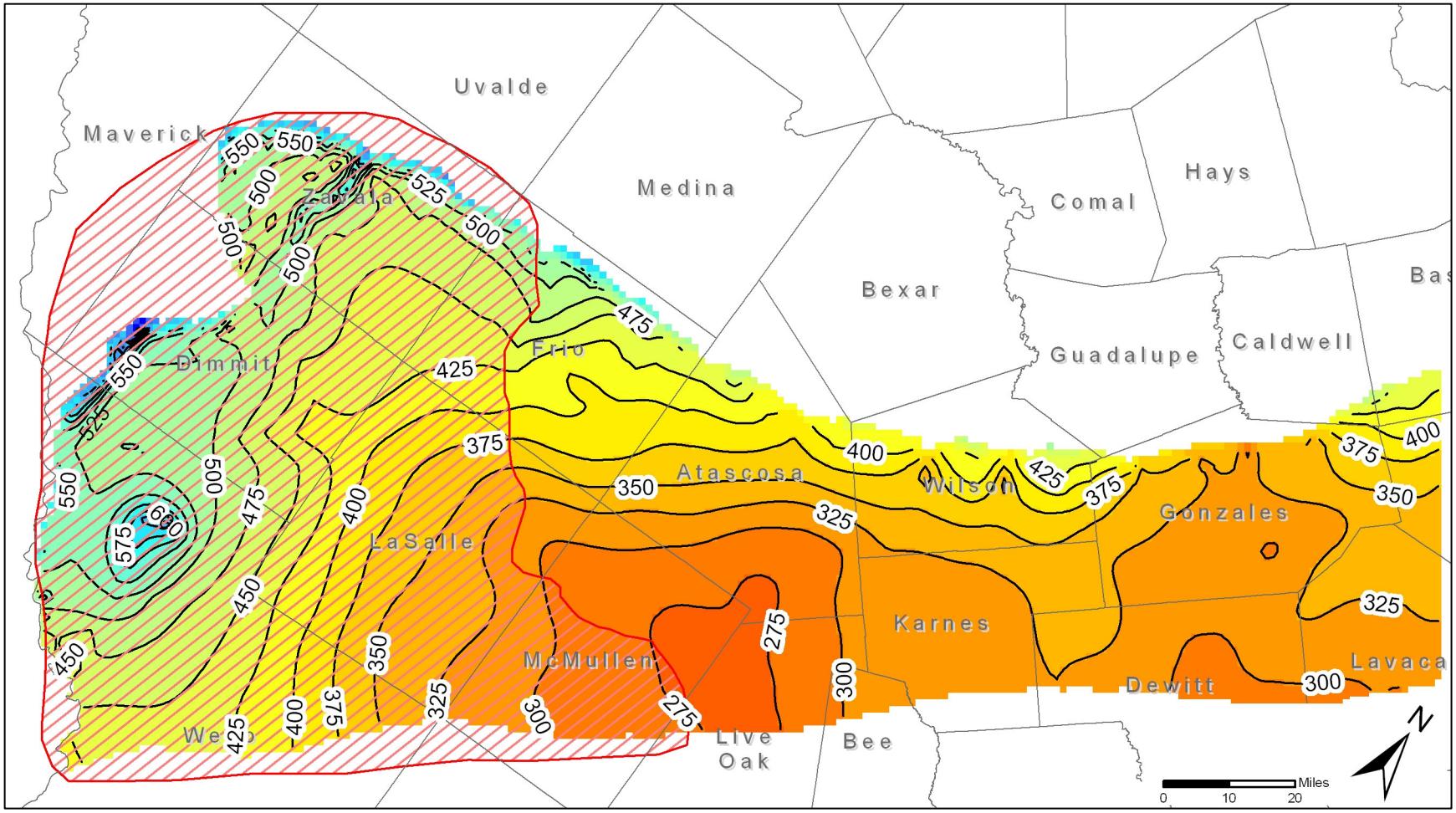

Figure 10. Water level elevations after 60 years using 1999 pumpage in the Queen City Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 25 feet. Dry model cells are shown in black. The area west of the Frio River (shown in red) is not considered to be part of the Queen City Aquifer and does not have any pumpage assigned to it.

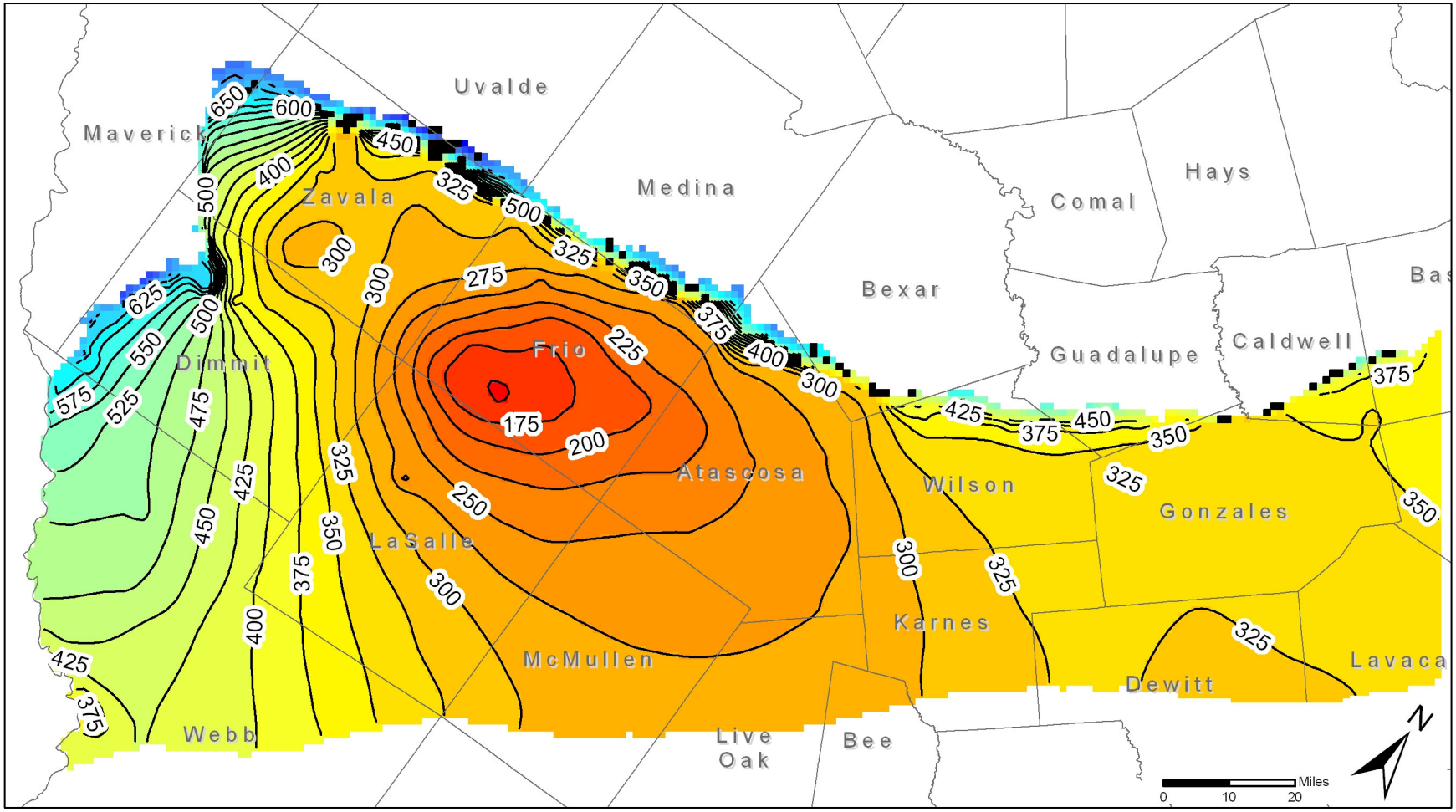

Figure 11. Water level elevations after 60 years using 1999 pumpage in the Carrizo Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 25 feet. Dry model cells are shown in black.

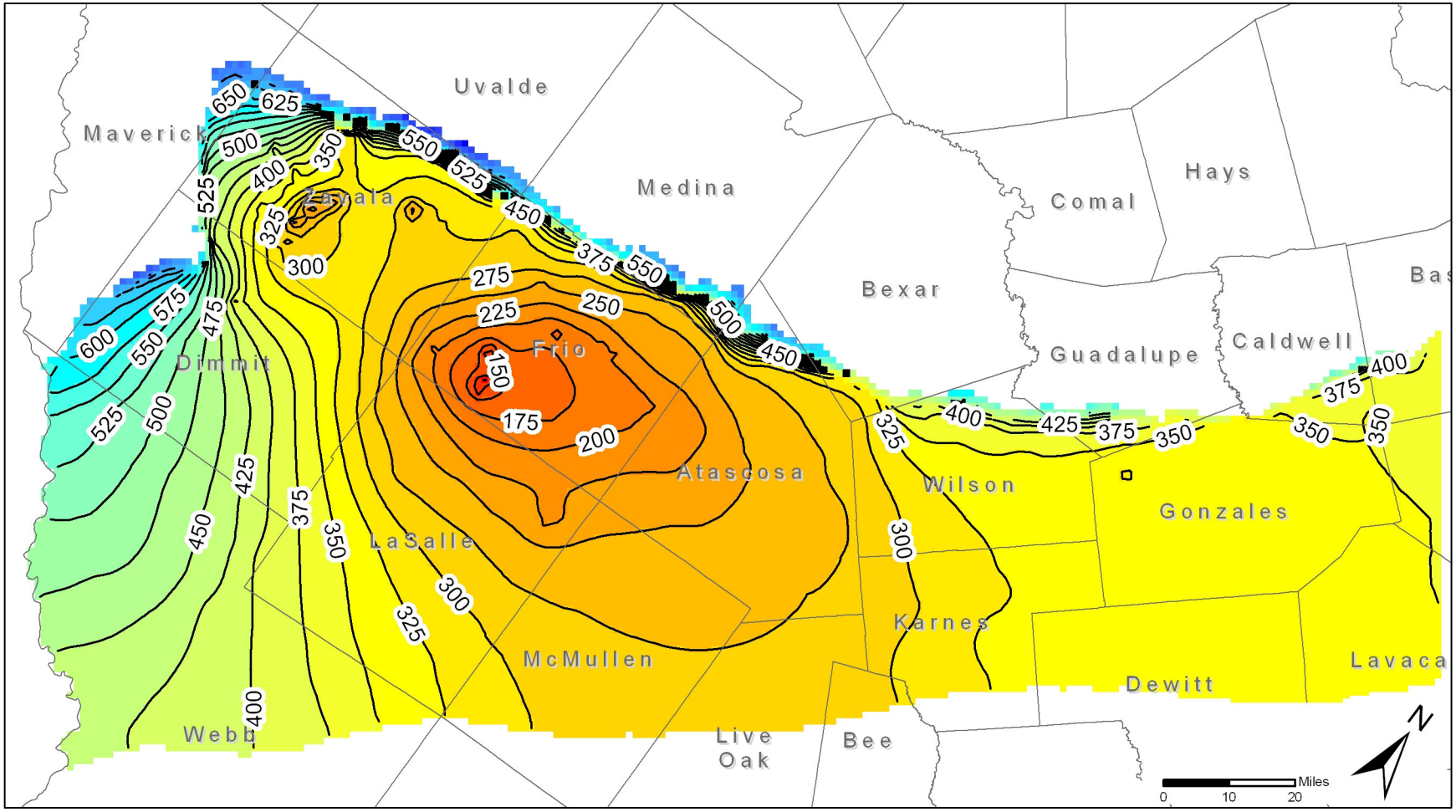

Figure 12. Water level elevations after 60 years using 1999 pumpage in the Upper Wilcox Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 25 feet. Dry model cells are shown in black.

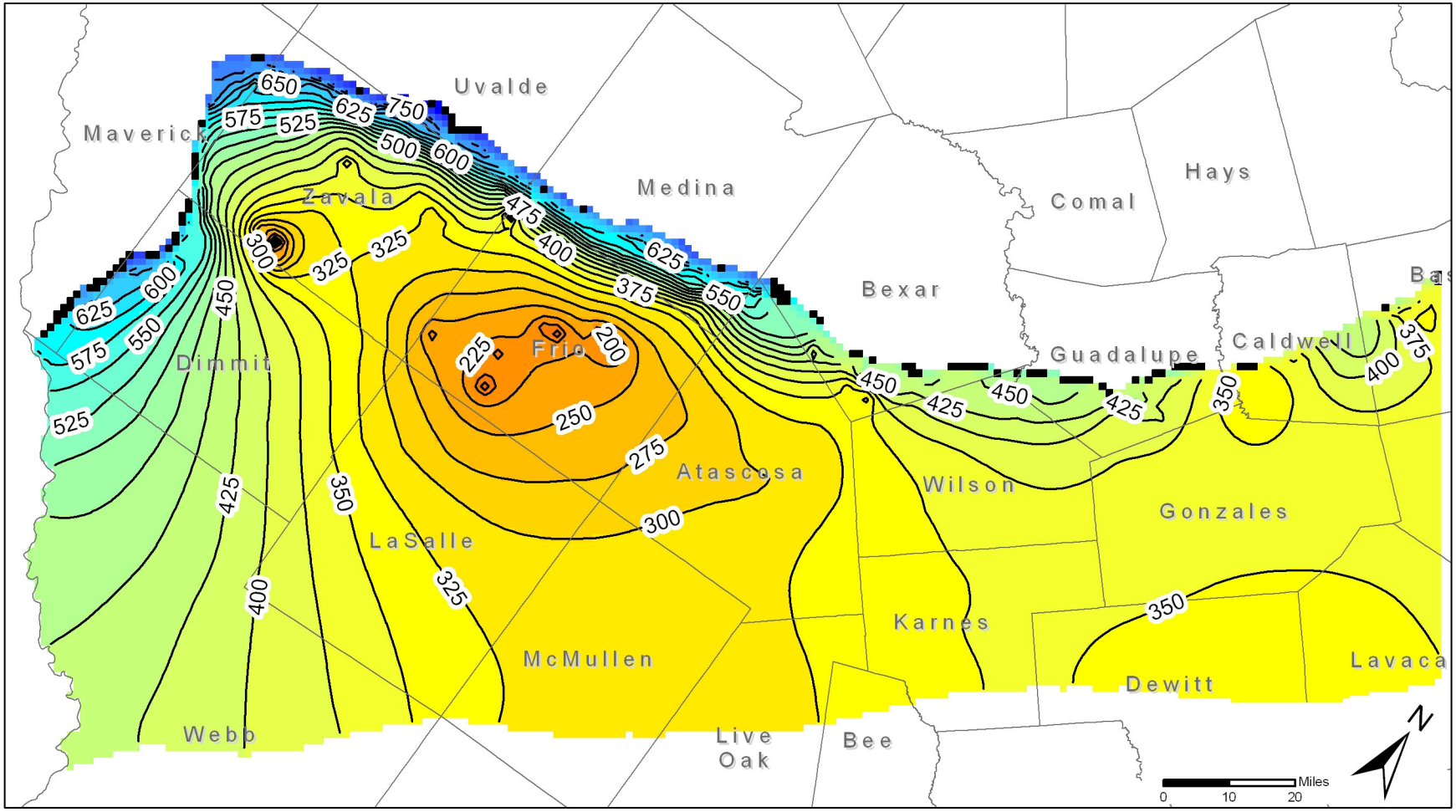

Figure 13. Water level elevations after 60 years using 1999 pumpage in the Middle Wilcox Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 25 feet. Dry model cells are shown in black.

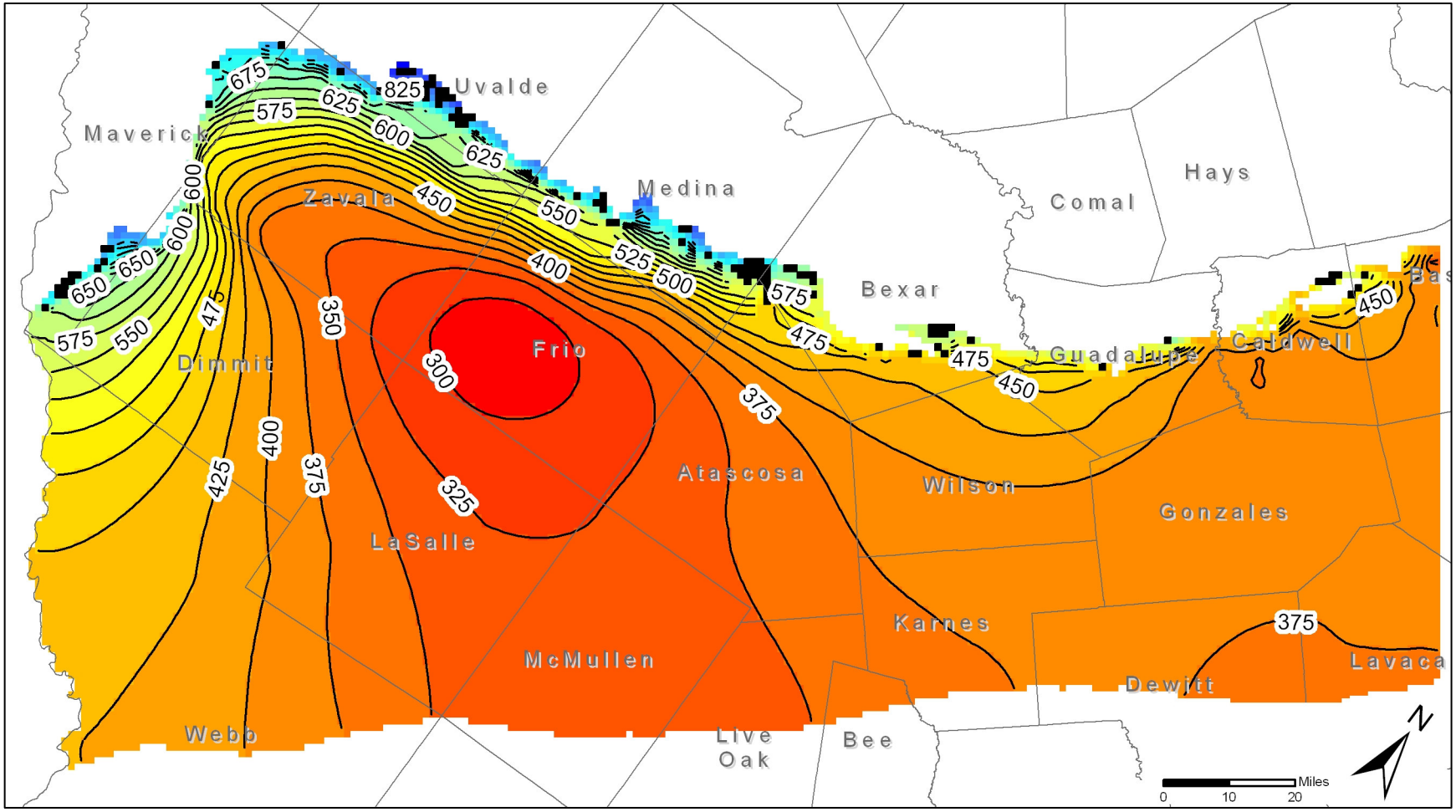

Figure 14. Water level elevations after 60 years using 1999 pumpage in the Lower Wilcox Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 25 feet. Dry model cells are shown in black.

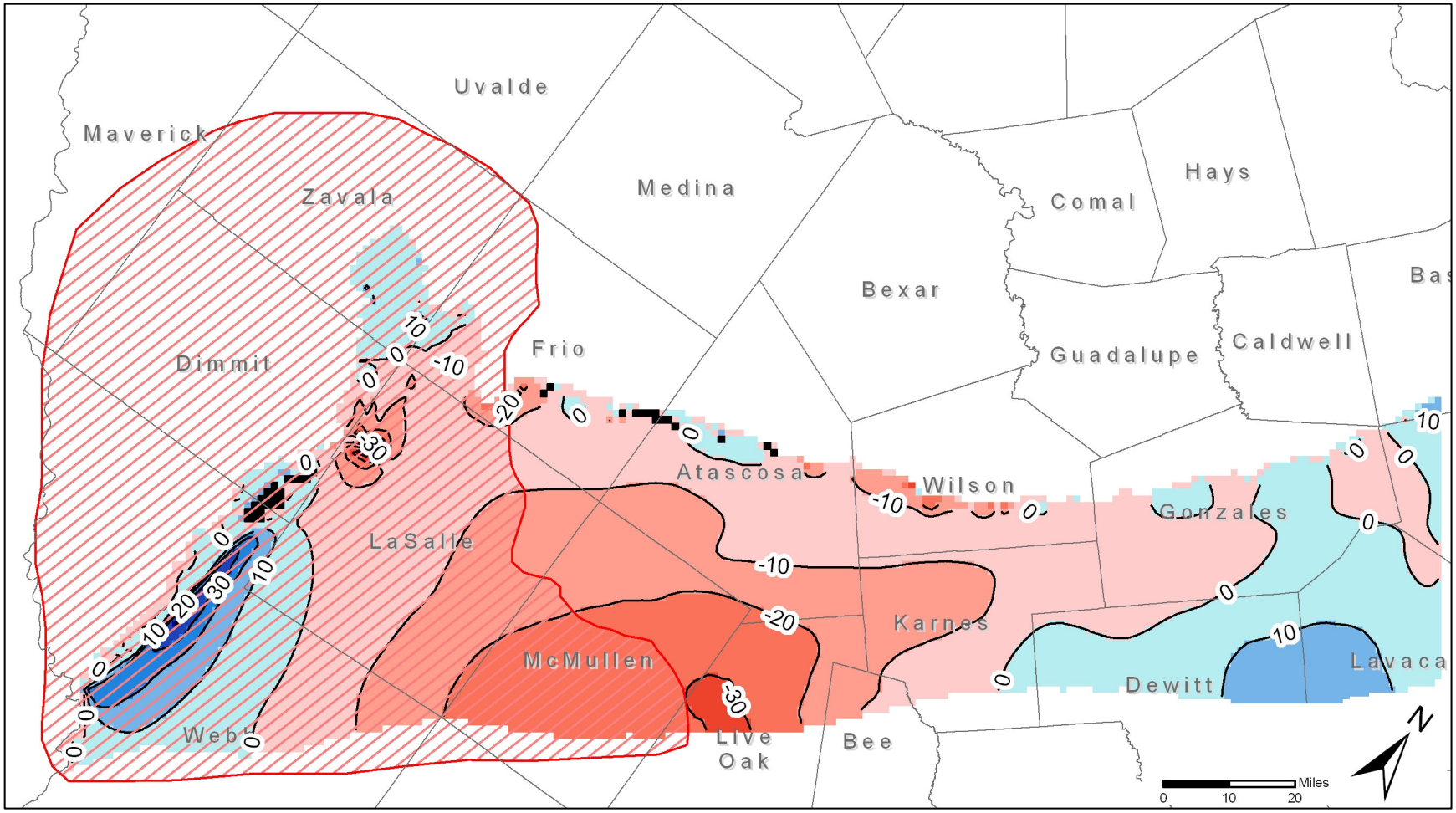

Figure 15. Water level changes after 60 years using 1999 pumpage in the Sparta Aquifer. Water level changes are in feet. Contour interval is 10 feet. Areas of increasing water levels are shown in blue. Areas of decreasing water levels are shown in red. Dry model cells are shown in black. The area west of the Frio River (shown in red) is not considered to be part of the Sparta Aquifer and does not have any pumpage assigned to it.

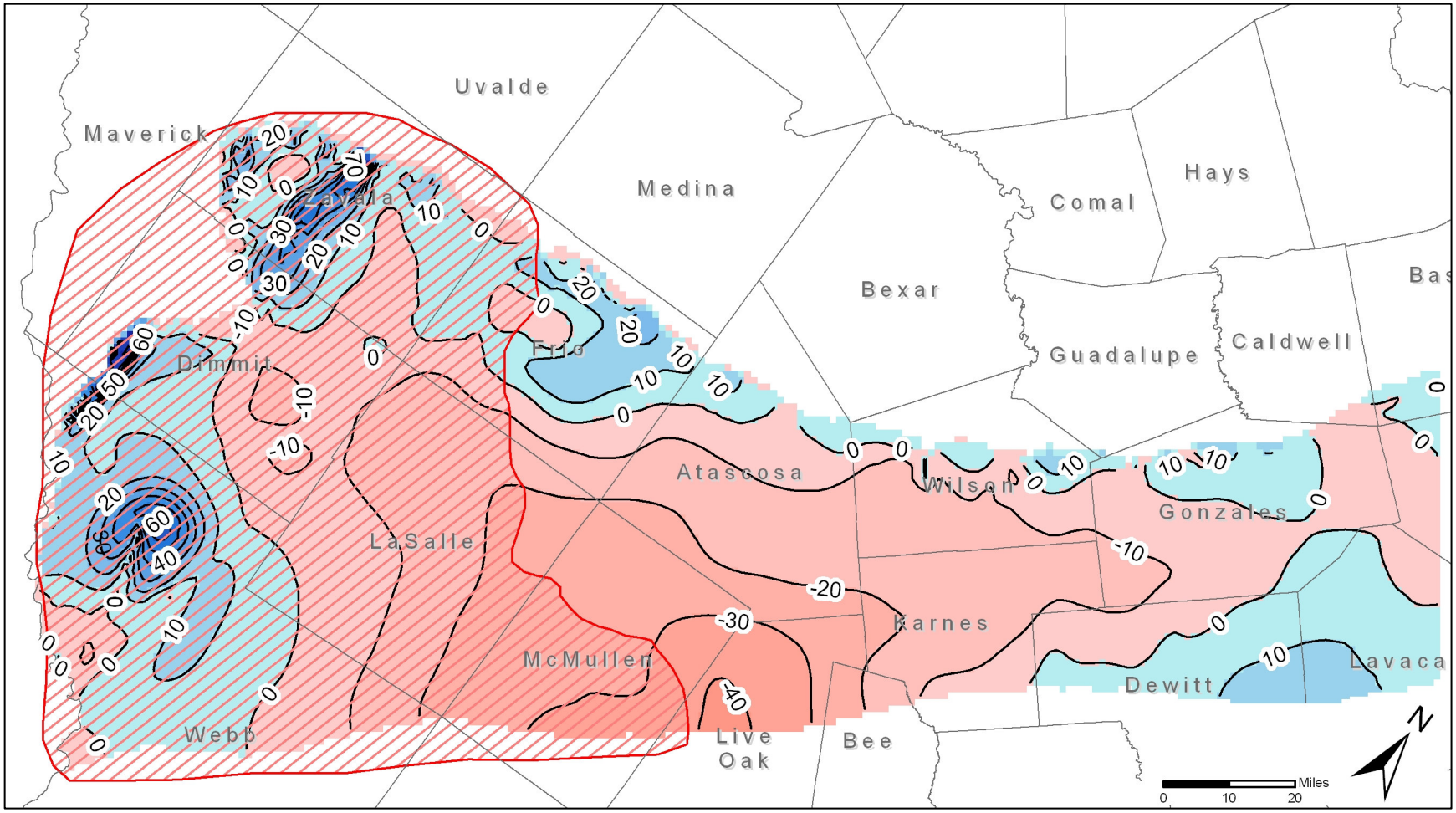

Figure 16. Water level changes after 60 years using 1999 pumpage in the Queen City Aquifer. Water level changes are in feet. Contour interval is 10 feet. Areas of increasing water levels are shown in blue. Areas of decreasing water levels are shown in red. Dry model cells are shown in black. The area west of the Frio River (shown in red) is not considered to be part of the Queen City Aquifer and does not have any pumpage assigned to it.

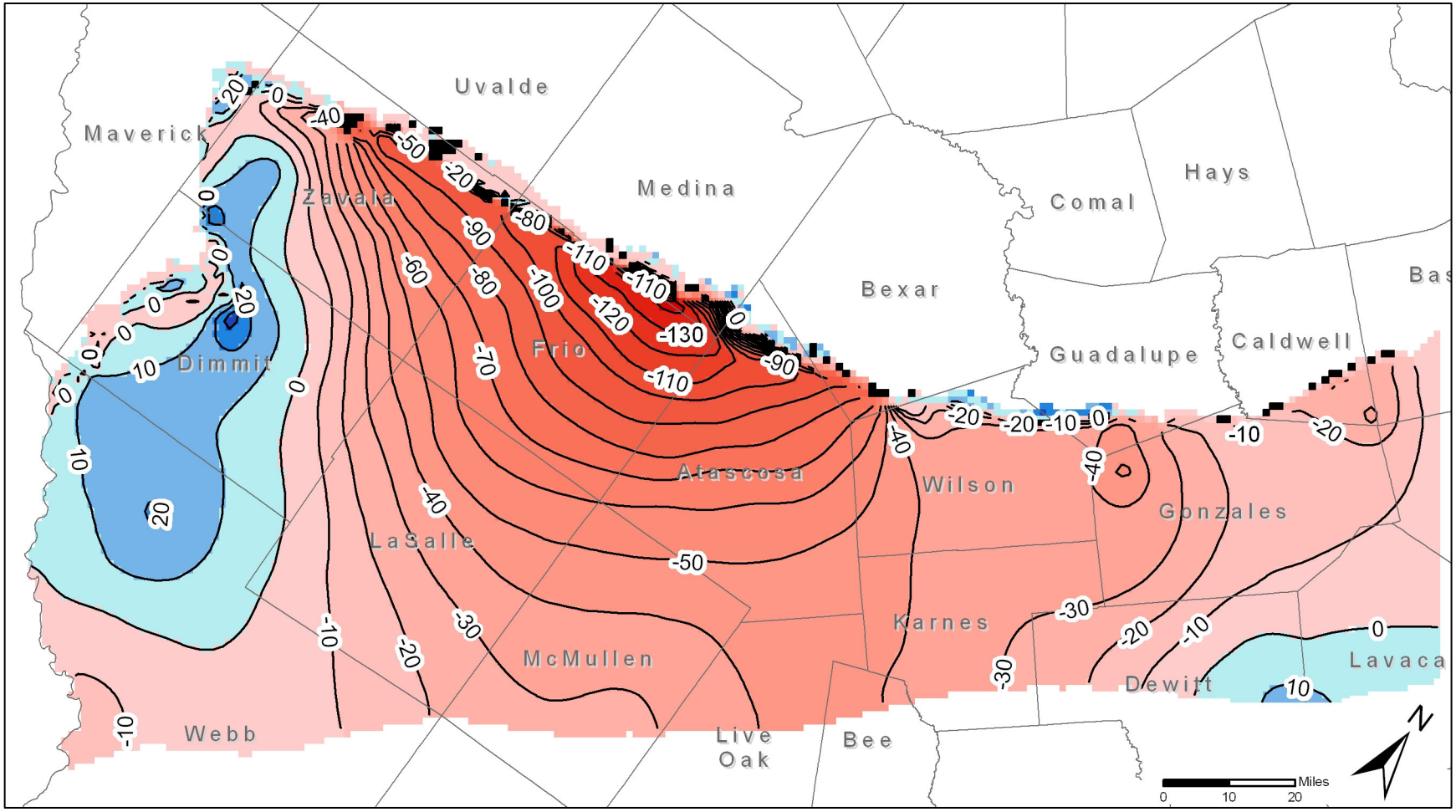

Figure 17. Water level changes after 60 years using 1999 pumpage in the Carrizo Aquifer. Water level changes are in feet. Contour interval is 10 feet. Areas of increasing water levels are shown in blue. Areas of decreasing water levels are shown in red. Dry model cells are shown in black.

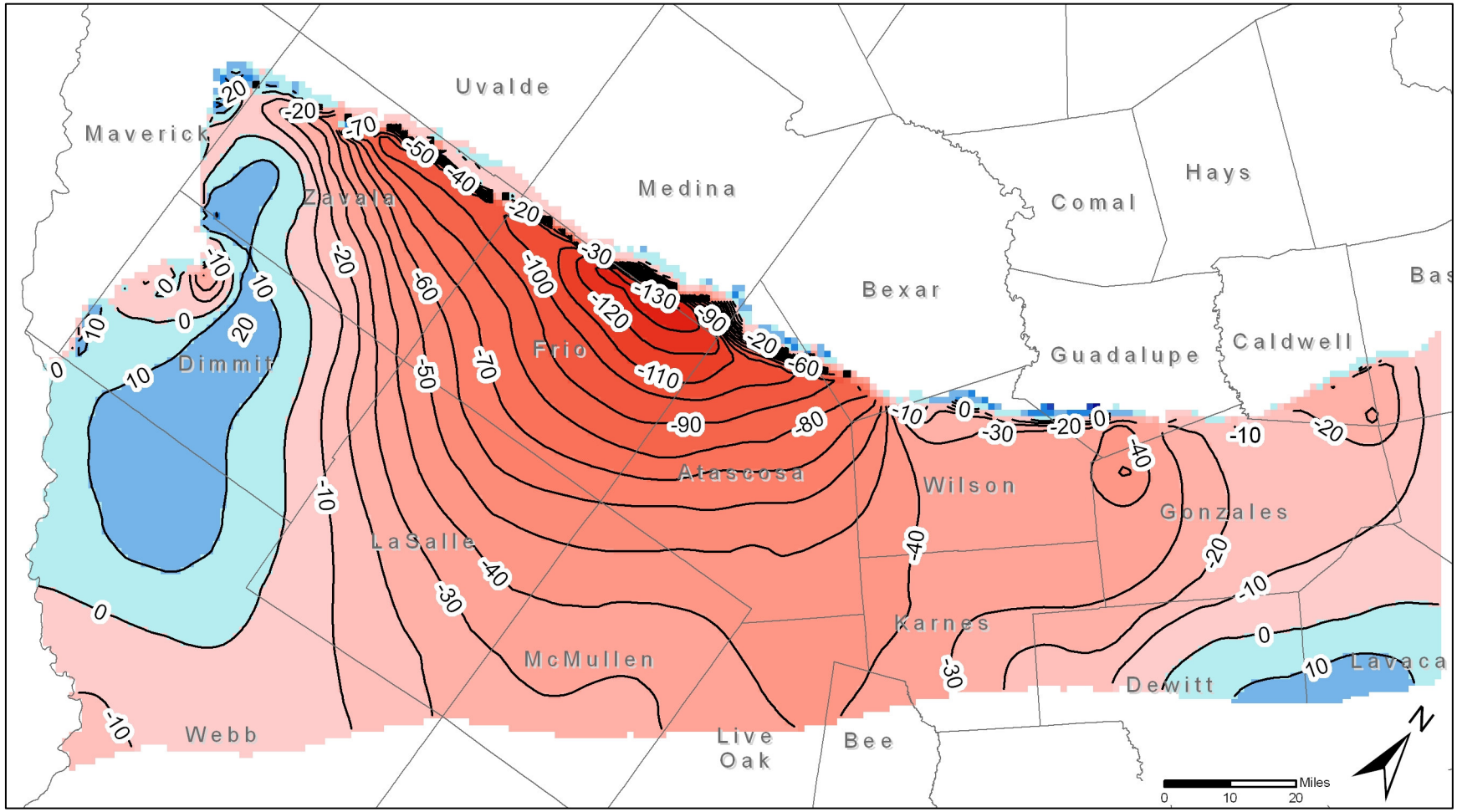

Figure 18. Water level changes after 60 years using 1999 pumpage in the Upper Wilcox Aquifer. Water level changes re in feet. Contour interval is 10 feet. Areas of increasing water levels are shown in blue. Areas of decreasing water levels are shown in red. Dry model cells are shown in black.

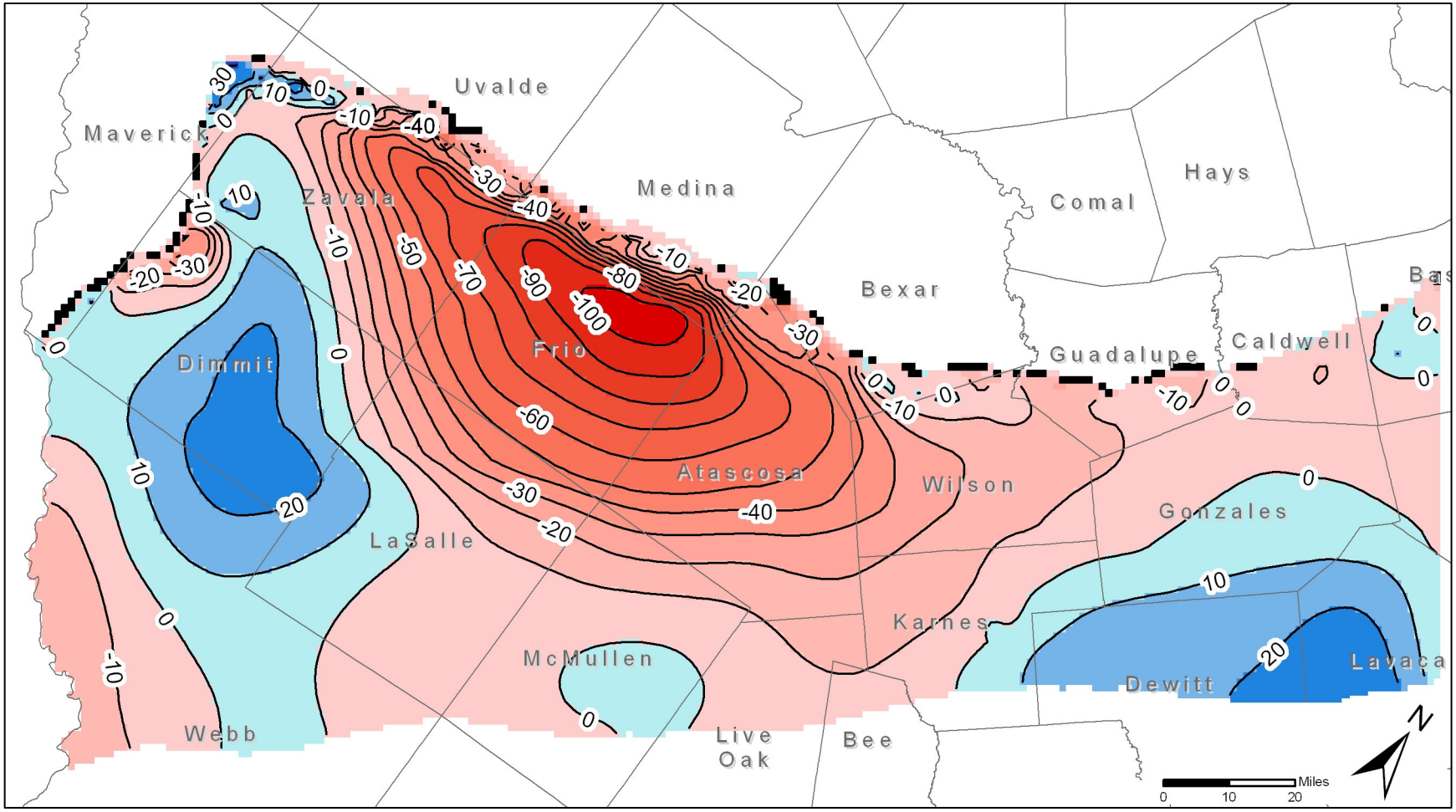

Figure 19. Water level changes after 60 years using 1999 pumpage in the Middle Wilcox Aquifer. Water level changes are in feet. Contour interval is 10 feet. Areas of increasing water levels are shown in blue. Areas of decreasing water levels are shown in red. Dry model cells are shown in black.

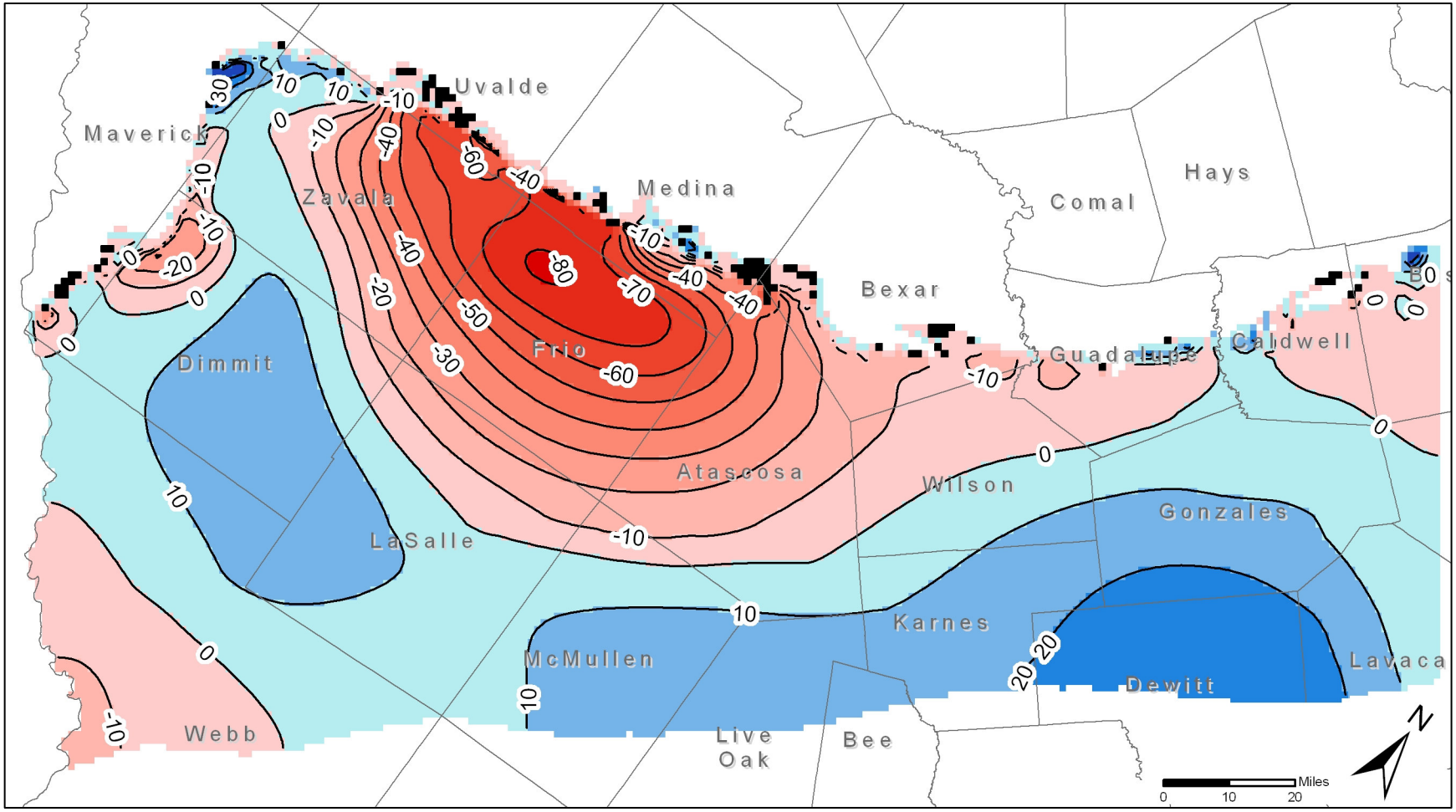

Figure 20. Water level changes after 60 years using 1999 pumpage in the Lower Wilcox Aquifer. Water level changes are in feet. Contour interval is 10 feet. Areas of increasing water levels are shown in blue. Areas of decreasing water levels are shown in red. Dry model cells are shown in black.

Appendix A

Summary of Historic Pumpage in the Groundwater Availability Model for the Southern Part of the Queen City-Sparta Aquifer

Table A-1. Summary of total estimated historic pumpage included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer (in acre-feet per year).

Year	Total	Atascosa	Bastrop	Bee	Bexar	Caldwell	De Witt	Dimmit	Fayette	Frio	Gonzales	Guadalupe
1975	32,126	1,035	52	0	17	251	0	17,118	0	1,560	142	0
1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	37,104	1,035	52	0	17	251	0	17,118	0	6,421	142	0
1979	327,407	77,597	468	60	12,234	2,865	6	22,243	81	78,047	4,526	3,861
1980	327,555	77,597	468	60	12,234	2,913	6	22,243	79	78,047	4,629	3,861
1981	281,163	52,340	498	64	12,673	2,686	5	17,409	75	78,621	4,703	4,963
1982	289,084	53,126	511	65	13,160	3,201	5	17,831	71	78,736	4,534	4,950
1983	262,702	44,371	531	68	14,065	3,235	5	16,335	65	63,486	4,039	5,037
1984	329,323	43,909	561	72	16,658	3,485	4	20,518	59	92,170	3,558	7,351
1985	259,736	40,682	561	67	14,175	3,155	3	23,385	61	51,274	3,411	4,736
1986	226,305	52,637	575	62	14,621	3,430	3	14,350	61	69,454	3,247	4,631
1987	199,251	36,222	595	63	15,103	3,338	3	9,248	64	68,002	3,615	4,476
1988	282,247	46,432	625	64	15,646	3,360	4	13,877	62	89,101	4,372	4,317
1989	325,006	61,538	687	66	14,904	3,272	4	11,041	64	98,942	4,229	5,786
1990	295,985	57,249	719	67	15,780	3,962	5	9,318	60	84,115	5,003	5,829
1991	297,715	59,575	697	66	16,012	3,094	4	6,931	60	91,869	3,935	5,677
1992	270,569	46,517	700	65	14,925	3,884	4	6,766	63	88,314	3,972	6,175
1993	274,952	54,020	714	80	16,236	3,468	2	9,152	79	100,028	3,001	5,090
1994	290,076	53,643	751	69	15,186	3,618	1	7,835	109	109,070	2,986	5,064
1995	293,281	56,239	766	73	17,250	3,613	2	9,018	102	103,886	3,268	5,320
1996	294,472	57,944	819	74	17,664	4,047	1	8,750	98	95,128	3,528	5,583
1997	228,731	46,922	782	74	16,597	3,527	1	4,977	100	61,260	3,521	5,573
1998	298,448	63,088	761	76	16,016	3,658	1	5,326	77	109,472	3,947	5,700
1999	289,087	56,491	786	77	16,871	3,766	1	4,477	81	110,157	3,397	6,073

Table A-1. (continued)

Year	Karnes	La Salle	Lavaca	Live Oak	Maverick	McMullen	Medina	Uvalde	Webb	Wilson	Zavala
1975	0	5,224	0	0	0	45	394	0	9	55	6,225
1976	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0
1978	0	5,265	0	0	0	45	394	0	9	55	6,301
1979	1,557	12,165	1	114	2,001	416	8,442	4,924	351	10,010	85,439
1980	1,557	12,165	1	114	2,001	416	8,442	4,924	351	10,010	85,439
1981	1,524	9,571	1	73	2,337	383	4,406	1,971	662	9,076	77,123
1982	1,913	9,251	1	71	2,384	1,150	4,417	1,856	677	9,492	81,683
1983	1,169	6,106	1	57	2,416	1,477	4,391	1,744	691	9,887	83,527
1984	1,020	10,886	1	56	2,070	1,544	18,690	608	427	11,062	94,616
1985	745	4,453	1	51	2,522	1,155	1,256	585	283	9,646	97,530
1986	724	4,087	1	70	1,127	1,475	1,602	445	250	9,826	43,628
1987	766	3,738	1	43	1,167	1,597	1,707	467	187	10,215	38,632
1988	832	3,928	1	57	4,697	1,779	1,667	506	235	12,149	78,535
1989	723	7,627	1	83	1,790	1,514	1,883	590	600	13,470	96,193
1990	715	7,646	1	77	5,011	1,550	1,707	587	587	15,853	80,144
1991	673	7,830	1	81	5,116	1,687	1,892	563	2,514	14,781	74,660
1992	586	9,443	1	61	5,212	1,542	1,853	558	1,077	16,835	62,015
1993	568	8,473	1	73	1,488	1,633	1,779	560	775	12,830	54,903
1994	569	7,312	1	73	1,894	1,570	6,875	568	575	14,645	57,662
1995	519	6,734	1	78	2,559	1,524	7,538	582	812	13,899	59,498
1996	481	8,945	1	80	2,658	1,517	7,604	602	910	18,343	59,694
1997	472	6,243	1	61	1,796	1,716	4,913	588	703	16,374	52,531
1998	464	10,801	1	86	3,223	1,808	4,957	591	872	17,480	50,042
1999	471	9,603	1	85	3,298	120	5,008	596	915	18,050	48,763

Table A-2. Summary of estimated historic pumpage in the Sparta Aquifer (layer 1) included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer (in acre-feet per year).

Year	Total	Atascosa	Bastrop	Fayette	Frio	Gonzales	La Salle	Wilson
1975	173	4	0	0	0	136	0	33
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	173	4	0	0	0	136	0	33
1979	4,624	835	63	37	39	440	3,134	76
1980	5,214	1,034	47	71	66	633	3,140	224
1981	4,515	859	45	68	68	590	2,646	240
1982	3,859	681	43	63	69	559	2,197	246
1983	3,160	506	41	58	70	501	1,728	257
1984	2,520	337	39	52	71	470	1,277	273
1985	1,461	339	30	55	66	467	230	275
1986	1,417	337	26	55	65	434	220	279
1987	1,434	340	28	58	66	444	210	287
1988	1,498	360	30	56	67	454	228	302
1989	1,745	403	36	58	71	468	355	354
1990	1,778	418	36	53	72	468	360	372
1991	1,750	426	37	54	75	431	357	370
1992	1,795	419	38	56	76	429	405	372
1993	1,806	427	35	66	76	427	379	395
1994	2,552	440	31	95	84	435	1,054	412
1995	2,524	464	29	88	82	463	961	436
1996	2,932	479	34	84	81	500	1,301	453
1997	2,630	489	25	86	85	586	892	467
1998	2,894	502	7	64	87	549	1,202	483
1999	3,050	517	7	66	87	552	1,316	504

Table A-3. Summary of estimated historic pumpage in the Queen City Aquifer (layer 3) included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer (in acre-feet per year).

Year	Total	Atascosa	Bastrop	Caldwell	Fayette	Frio	Gonzales	La Salle	Wilson
1975	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0
1979	6,710	4,714	92	0	39	842	794	7	222
1980	6,269	4,515	109	47	3	815	704	1	74
1981	5,266	3,594	106	51	3	850	581	1	80
1982	4,253	2,673	102	52	3	883	456	1	82
1983	3,243	1,752	98	55	3	917	330	1	86
1984	2,239	832	95	60	3	950	206	2	91
1985	1,753	764	91	59	3	538	204	1	92
1986	2,179	997	88	65	3	723	209	1	93
1987	1,844	660	93	67	3	712	211	1	96
1988	2,236	839	98	67	3	914	212	1	101
1989	2,687	1,171	101	60	3	1,018	213	2	119
1990	2,494	1,090	101	61	3	872	240	2	125
1991	2,521	1,142	104	61	4	861	223	2	124
1992	2,277	894	107	59	4	835	252	2	125
1993	2,540	1,047	108	61	8	939	242	2	133
1994	1,656	984	114	100	13	70	235	2	139
1995	1,752	1,038	113	116	10	69	257	2	147
1996	1,766	1,065	126	120	10	61	229	2	152
1997	1,516	850	106	110	11	63	218	2	157
1998	1,627	951	83	103	11	68	246	2	163
1999	1,675	964	88	132	12	66	240	2	170

Table A-4. Summary of estimated historic pumpage in the Carrizo Aquifer (layer 5) included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer (in acre-feet per year).

Year	Total	Atascosa	Bastrop	Bee	Bexar	Caldwell	De Witt	Dimmit	Fayette	Frio	Gonzales	Guadalupe
1975	13,166	1,029	0	0	0	0	0	5,884	0	1,499	6	0
1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	18,143	1,029	0	0	0	0	0	5,884	0	6,360	6	0
1979	238,519	68,925	54	15	3,169	208	6	10,326	5	70,119	3,225	334
1980	238,519	68,925	54	15	3,169	208	6	10,326	5	70,119	3,225	334
1981	204,121	45,017	58	16	3,117	223	5	8,139	4	70,539	3,458	378
1982	211,382	46,942	61	16	3,212	230	5	8,347	4	70,681	3,443	392
1983	189,231	40,066	64	17	3,430	242	5	7,743	4	56,799	3,131	418
1984	233,292	40,542	70	18	3,688	263	4	9,513	3	82,735	2,807	462
1985	186,661	37,601	70	17	3,321	252	3	10,702	3	46,101	2,668	451
1986	170,373	48,676	73	16	3,406	273	3	6,846	3	62,339	2,534	469
1987	148,914	33,573	75	16	3,482	282	3	4,698	3	61,014	2,887	479
1988	213,320	43,081	79	16	3,647	285	4	6,763	3	80,021	3,627	499
1989	250,207	57,439	85	17	3,521	253	4	5,589	3	88,781	3,471	572
1990	224,326	52,837	90	17	3,805	279	5	4,940	3	75,523	4,209	563
1991	228,782	54,973	83	16	3,748	254	4	3,958	3	82,547	3,204	563
1992	205,312	42,909	83	16	3,505	285	4	3,840	3	79,313	3,214	836
1993	213,040	50,501	86	20	3,963	264	2	4,978	5	89,861	2,265	1,080
1994	224,147	50,504	91	17	3,037	273	1	4,373	1	98,819	2,250	939
1995	224,201	52,927	93	18	3,577	269	2	4,992	3	94,089	2,482	958
1996	223,750	54,534	99	18	3,636	276	1	4,877	3	86,228	2,733	1,001
1997	170,915	44,138	95	19	3,471	257	1	3,117	3	55,531	2,651	990
1998	232,550	58,736	98	19	3,355	253	1	3,284	2	99,140	3,084	1,065
1999	223,218	52,419	100	19	3,513	279	1	2,917	2	99,802	2,538	1,224

Table A-4. (continued)

Year	Karnes	La Salle	Lavaca	Live Oak	Maverick	McMullen	Medina	Uvalde	Webb	Wilson	Zavala
1975	0	4,136	0	0	0	45	394	0	9	0	165
1976	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0
1978	0	4,176	0	0	0	45	394	0	9	0	241
1979	1,557	6,180	1	114	491	415	2,258	268	331	8,962	61,556
1980	1,557	6,180	1	114	491	415	2,258	268	331	8,962	61,556
1981	1,524	4,794	1	73	591	381	1,252	284	641	8,039	55,588
1982	1,913	4,893	1	71	591	1,149	1,254	290	655	8,402	58,832
1983	1,169	3,111	1	57	591	1,474	1,221	302	670	8,767	59,949
1984	1,020	6,620	0	56	418	1,543	4,870	321	407	9,757	68,175
1985	745	2,946	0	51	616	1,154	413	302	266	8,508	70,470
1986	724	2,763	0	70	15	1,475	534	262	234	8,669	30,988
1987	766	2,550	0	43	14	1,593	559	282	170	9,017	27,406
1988	832	2,675	0	57	1,515	1,774	585	272	217	10,783	56,585
1989	723	5,103	0	83	186	1,514	661	313	578	11,984	69,328
1990	715	4,933	0	77	1,518	1,549	590	324	566	14,124	57,659
1991	673	5,084	1	81	1,562	1,686	651	311	2,488	13,129	53,763
1992	586	6,076	1	61	1,617	1,542	635	315	1,062	15,017	44,392
1993	568	5,503	1	73	17	1,632	636	324	760	11,296	39,207
1994	569	4,344	1	73	119	1,570	1,938	328	560	12,876	41,465
1995	519	4,034	1	78	394	1,524	2,097	335	794	12,161	42,854
1996	481	5,224	1	80	416	1,516	2,098	342	888	16,305	42,994
1997	472	3,714	1	61	17	1,716	1,362	347	686	14,425	37,841
1998	464	6,508	1	86	596	1,808	1,462	353	853	15,450	35,932
1999	471	5,684	1	85	596	120	1,477	358	896	15,986	34,731

Table A-5. Summary of estimated historic pumpage in the Upper Wilcox Aquifer (layer 6) included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer (in acre-feet per year).

Year	Total	Atascosa	Bastrop	Bee	Bexar	Dimmit	Frio	Gonzales
1975	13,040	0	0	0	1	9,643	61	0
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	13,040	0	0	0	1	9,643	61	0
1979	32,636	143	28	15	1	9,979	4,171	3
1980	32,636	143	28	15	1	9,979	4,171	3
1981	28,284	125	31	16	1	7,729	4,240	4
1982	29,286	124	32	16	1	7,913	4,203	4
1983	27,152	118	34	17	1	7,168	3,372	4
1984	34,478	117	37	18	1	9,177	4,981	3
1985	32,305	81	38	17	0	10,573	2,703	3
1986	19,090	51	40	16	0	6,311	3,743	2
1987	15,503	32	41	16	0	3,831	3,673	3
1988	26,546	34	43	16	0	5,967	4,793	4
1989	29,392	36	47	17	0	4,577	5,370	3
1990	25,604	33	50	17	1	3,631	4,535	4
1991	23,910	35	49	16	0	2,465	4,972	3
1992	22,064	26	49	16	0	2,440	4,798	3
1993	21,385	31	50	20	1	3,482	5,427	1
1994	21,222	31	53	17	0	2,878	5,985	1
1995	21,700	33	55	18	0	3,346	5,718	1
1996	21,803	34	58	18	0	3,231	5,193	1
1997	15,937	26	57	19	0	1,557	3,306	1
1998	20,145	36	58	19	0	1,710	6,034	1
1999	19,078	36	60	19	0	1,321	6,049	1

Table A-5. (continued)

Year	Guadalupe	La Salle	Maverick	McMullen	Medina	Webb	Wilson	Zavala
1975	0	1,089	0	0	0	0	13	2,234
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	0	1,089	0	0	0	0	13	2,234
1979	0	2,844	253	1	64	16	20	15,098
1980	0	2,844	253	1	64	16	20	15,098
1981	1	2,130	302	1	31	17	18	13,640
1982	1	2,160	304	0	31	17	20	14,461
1983	1	1,266	305	2	30	17	21	14,797
1984	1	2,987	226	0	145	14	23	16,747
1985	0	1,277	317	0	5	13	20	17,257
1986	0	1,102	40	0	7	13	20	7,743
1987	0	977	42	4	8	14	22	6,841
1988	0	1,025	738	5	7	15	26	13,873
1989	0	2,168	129	0	8	17	26	16,993
1990	1	2,352	770	0	7	17	37	14,150
1991	0	2,386	740	0	8	20	34	13,181
1992	1	2,960	766	0	8	10	41	10,945
1993	0	2,590	1	0	7	10	27	9,737
1994	0	1,912	49	0	48	11	32	10,203
1995	0	1,737	181	0	53	13	29	10,516
1996	0	2,418	191	0	54	16	42	10,545
1997	0	1,635	1	0	32	11	36	9,255
1998	0	3,088	276	0	31	13	39	8,837
1999	0	2,602	276	0	31	13	40	8,629

Table A-6. Summary of estimated historic pumpage in the Middle Wilcox Aquifer (layer 7) included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer (in acre-feet per year).

Year	Total	Atascosa	Bastrop	Bee	Bexar	Caldwell	Dimmit	Frio
1975	5,721	0	52	0	0	251	1,592	0
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	5,721	0	52	0	0	251	1,592	0
1979	22,275	668	141	15	4,280	908	1,736	2,829
1980	22,275	668	141	15	4,280	908	1,736	2,829
1981	21,852	539	157	16	5,134	902	1,373	2,877
1982	22,751	531	166	16	5,377	1,017	1,401	2,852
1983	22,976	411	178	17	5,868	1,045	1,268	2,290
1984	28,009	432	195	18	6,558	1,129	1,634	3,378
1985	24,015	397	202	17	6,122	1,040	1,894	1,835
1986	19,939	521	212	16	6,306	1,123	1,060	2,542
1987	19,247	347	218	16	6,660	1,122	621	2,495
1988	24,393	442	229	16	6,843	1,132	1,013	3,253
1989	26,217	558	254	17	6,444	1,070	768	3,642
1990	25,008	592	270	17	6,592	1,240	650	3,064
1991	24,599	620	248	16	6,894	1,030	432	3,360
1992	23,255	484	247	16	6,442	1,233	419	3,242
1993	22,951	484	254	20	6,871	1,116	606	3,668
1994	22,532	454	270	17	5,415	1,149	500	4,048
1995	24,097	481	279	18	6,626	1,128	588	3,867
1996	24,299	496	293	18	6,720	1,269	557	3,511
1997	21,119	401	292	19	6,380	1,103	250	2,239
1998	23,230	633	300	19	6,232	1,116	273	4,079
1999	23,947	598	309	19	6,633	1,169	189	4,089

Table A-6. (continued)

Year	Gonzales	Guadalupe	Maverick	Medina	Uvalde	Webb	Wilson	Zavala
1975	0	0	0	0	0	0	0	3,826
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	3,826
1979	64	1,754	407	1,085	238	4	380	7,766
1980	64	1,754	407	1,085	238	4	380	7,766
1981	70	2,092	463	696	159	4	369	6,999
1982	72	2,135	481	703	160	4	389	7,445
1983	73	2,238	493	707	161	4	404	7,820
1984	71	2,778	475	2,129	142	4	456	8,609
1985	70	2,293	514	400	140	3	410	8,678
1986	68	2,334	389	444	92	3	417	4,412
1987	70	2,339	409	460	94	2	435	3,959
1988	74	2,381	741	456	119	3	501	7,189
1989	74	2,868	533	534	141	4	533	8,778
1990	82	2,843	865	534	134	4	644	7,478
1991	73	2,820	895	546	127	5	614	6,918
1992	74	2,833	895	544	119	4	684	6,020
1993	65	2,678	548	579	116	5	563	5,377
1994	64	2,742	633	1,089	119	4	649	5,378
1995	64	2,911	706	1,177	122	5	631	5,492
1996	65	3,024	733	1,199	124	5	765	5,520
1997	64	3,044	672	936	120	5	721	4,872
1998	66	3,097	827	955	120	5	754	4,754
1999	66	3,240	856	980	120	6	772	4,901

Table A-7. Summary of estimated historic pumpage in the Lower Wilcox Aquifer (layer 8) included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer (in acre-feet per year).

Year	Total	Atascosa	Bastrop	Bee	Bexar	Caldwell	Dimmit	Frio	Guadalupe	Maverick	Medina	Uvalde	Webb	Wilson	Zavala
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	22,643	2,311	90	15	4,784	1,749	202	47	1,772	850	5,035	4,418	1	350	1,020
1980	22,643	2,311	90	15	4,784	1,749	202	47	1,772	850	5,035	4,418	1	350	1,020
1981	17,125	2,207	101	16	4,421	1,510	168	47	2,492	981	2,428	1,528	1	329	896
1982	17,553	2,174	107	16	4,570	1,902	170	47	2,423	1,008	2,430	1,405	1	354	945
1983	16,940	1,519	114	17	4,767	1,893	157	38	2,380	1,026	2,433	1,281	1	354	961
1984	28,785	1,648	125	18	6,411	2,034	195	55	4,110	952	11,546	145	1	461	1,085
1985	13,540	1,501	129	17	4,732	1,804	216	30	1,992	1,075	437	142	1	341	1,124
1986	13,308	2,056	136	16	4,909	1,968	133	42	1,828	682	616	90	0	347	485
1987	12,309	1,269	140	16	4,961	1,867	99	41	1,658	702	681	91	0	359	426
1988	14,254	1,676	146	16	5,156	1,875	134	53	1,436	1,702	619	116	0	436	887
1989	14,758	1,931	163	17	4,938	1,888	107	60	2,346	942	681	135	1	454	1,095
1990	16,773	2,279	172	17	5,382	2,380	97	48	2,423	1,857	577	130	1	552	858
1991	16,154	2,380	177	16	5,369	1,750	76	53	2,293	1,919	687	125	1	509	798
1992	15,866	1,786	176	16	4,977	2,306	68	51	2,506	1,934	666	124	1	595	659
1993	13,230	1,530	181	20	5,401	2,026	86	57	1,331	922	557	119	1	416	582
1994	17,967	1,229	192	17	6,732	2,097	84	63	1,383	1,094	3,800	121	0	536	616
1995	19,007	1,296	199	18	7,047	2,099	92	61	1,451	1,278	4,211	124	1	495	636
1996	19,921	1,336	209	18	7,307	2,382	85	55	1,558	1,318	4,253	136	1	627	636
1997	16,614	1,018	208	19	6,746	2,056	53	35	1,540	1,106	2,584	121	1	567	562
1998	18,002	2,229	215	19	6,428	2,186	59	64	1,538	1,524	2,509	118	1	592	520
1999	18,119	1,956	221	19	6,725	2,186	50	64	1,608	1,570	2,520	118	1	578	502

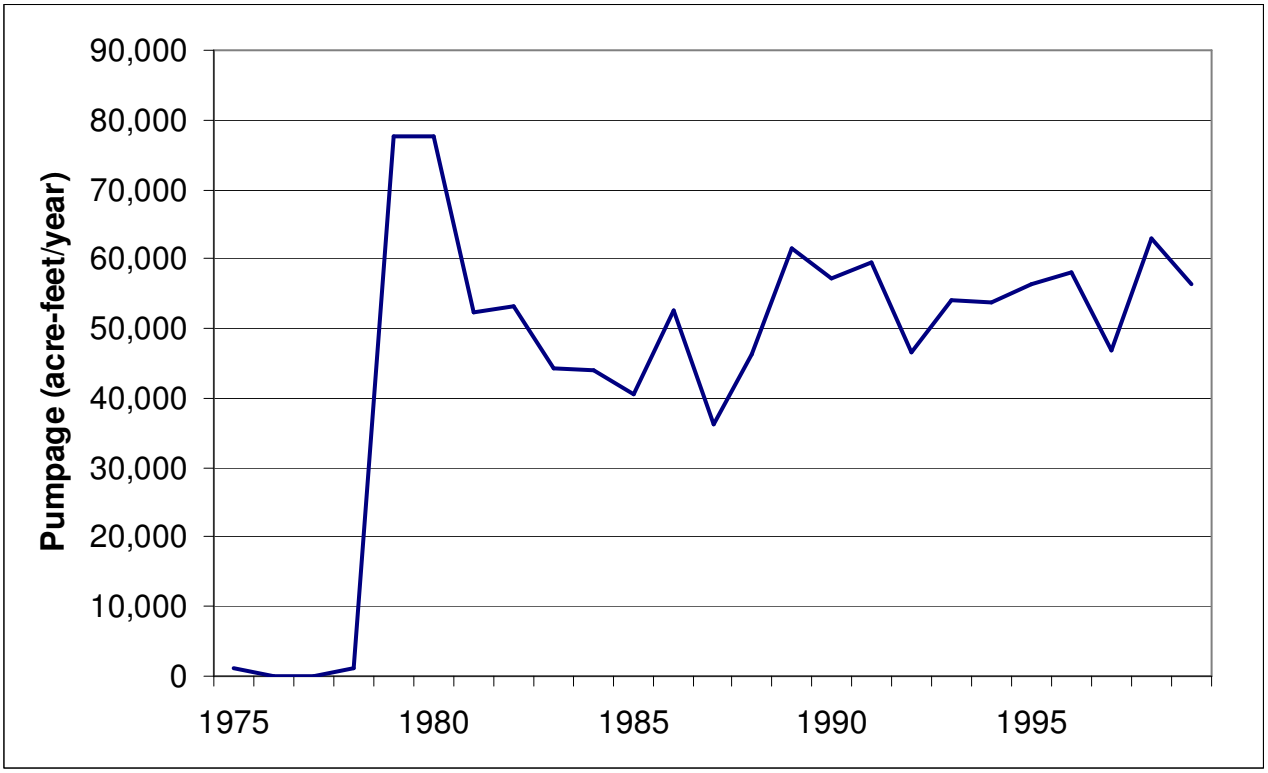

Figure A-1- Total pumpage in Atascosa County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

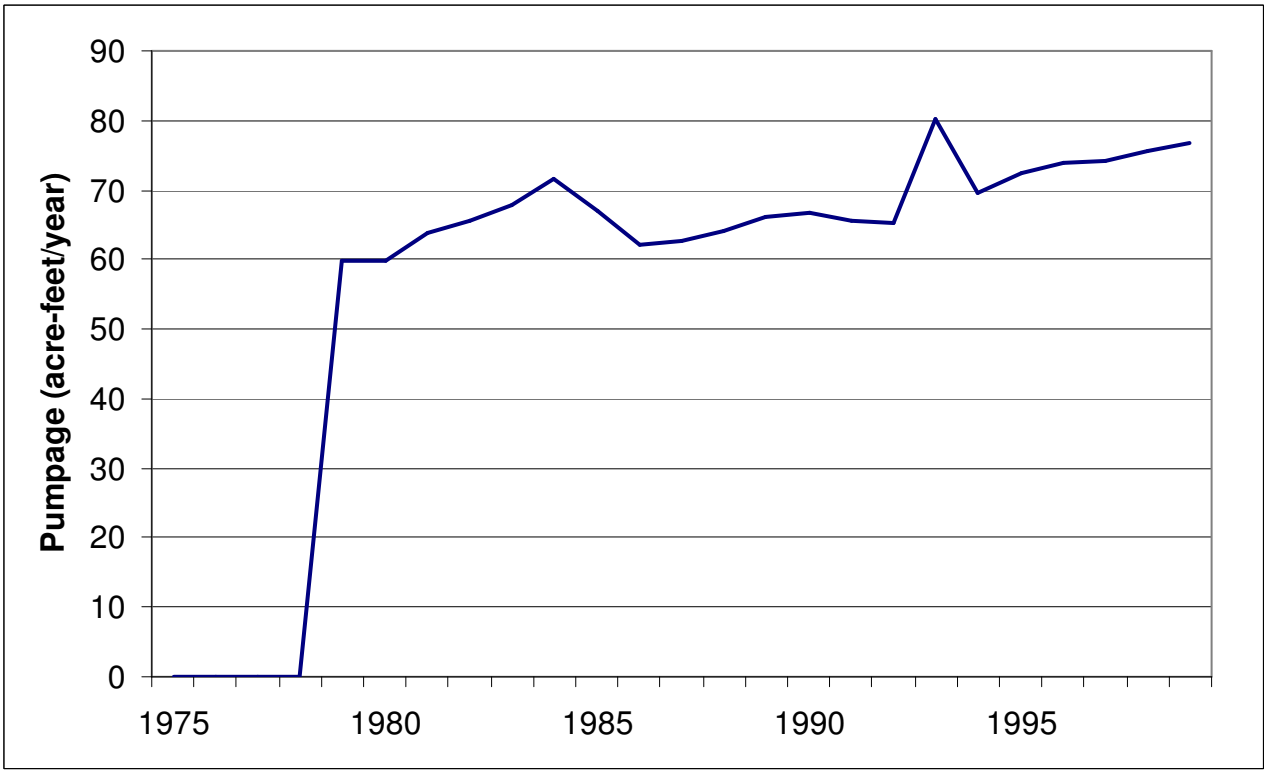

Figure A-2- Total pumpage in Bee County included in groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

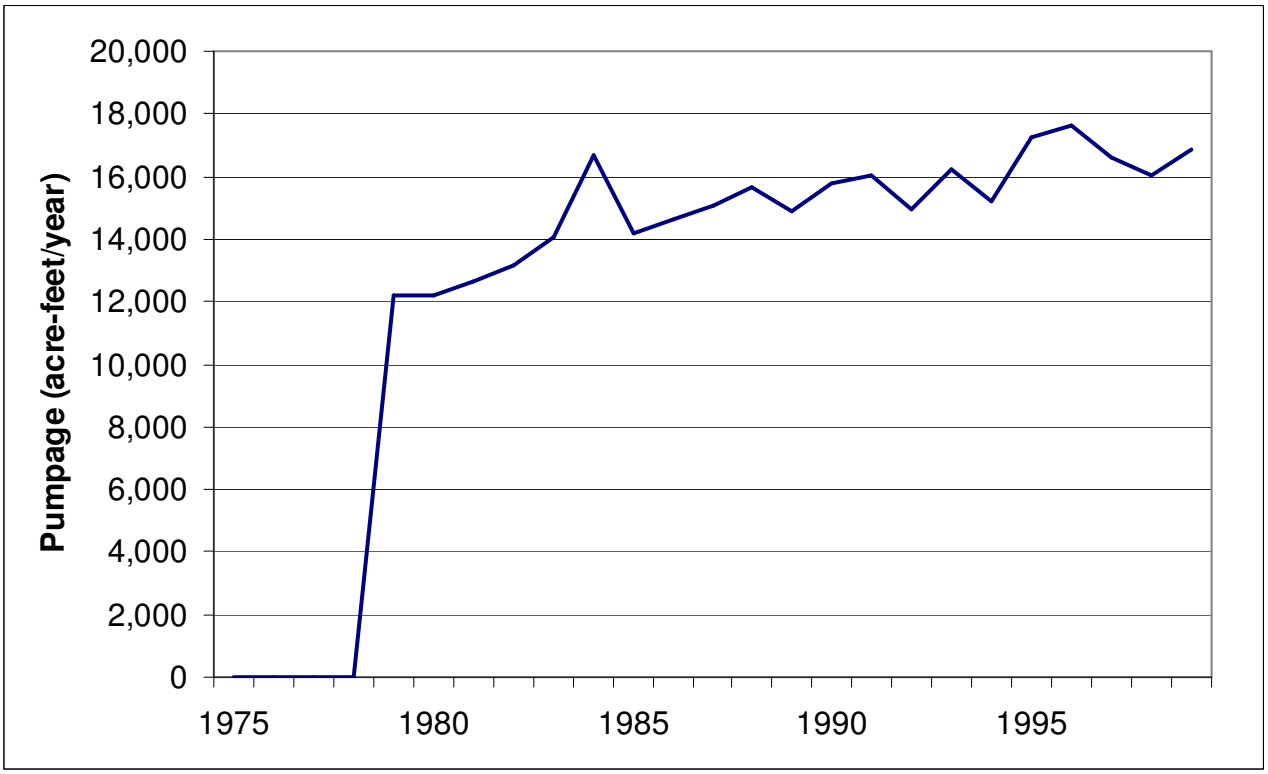

Figure A-3- Total pumpage in Bexar County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

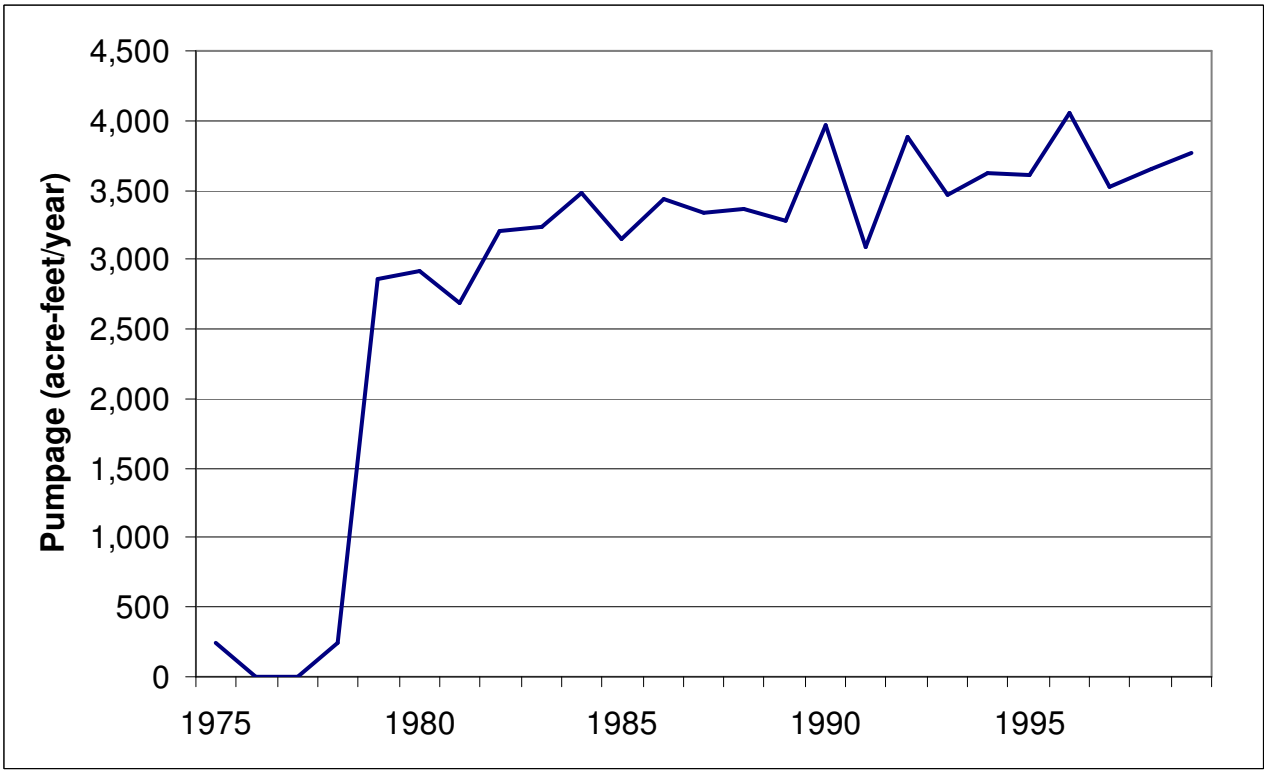

Figure A-4- Total pumpage in Caldwell County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

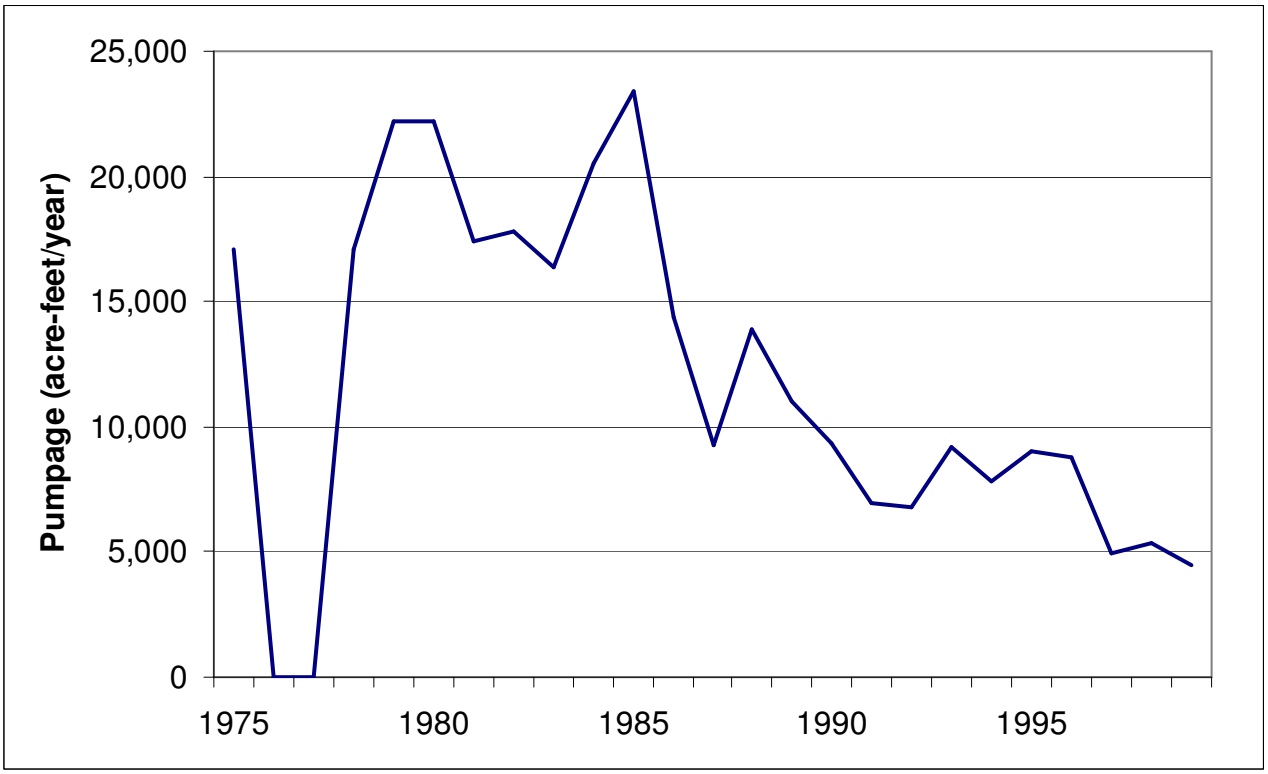

Figure A-5- Total pumpage in Dimmit County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

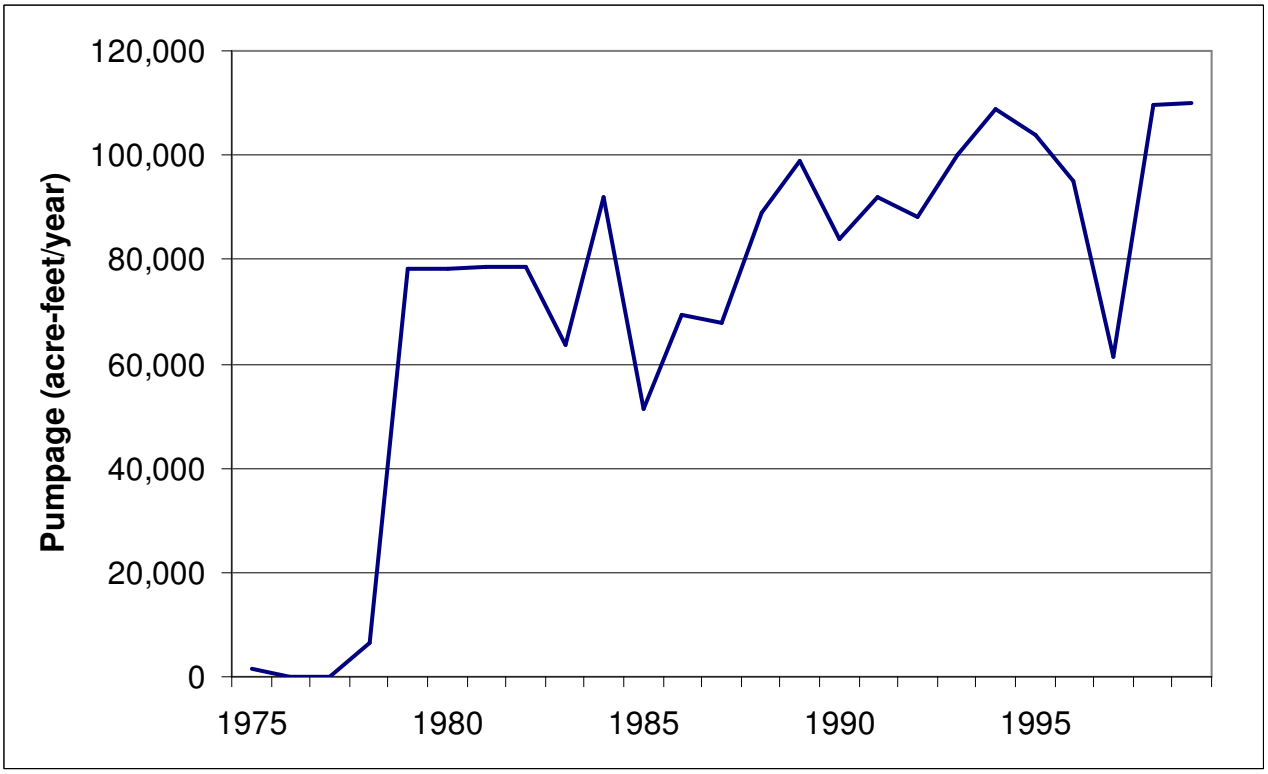

Figure A-6- Total pumpage in Frio County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

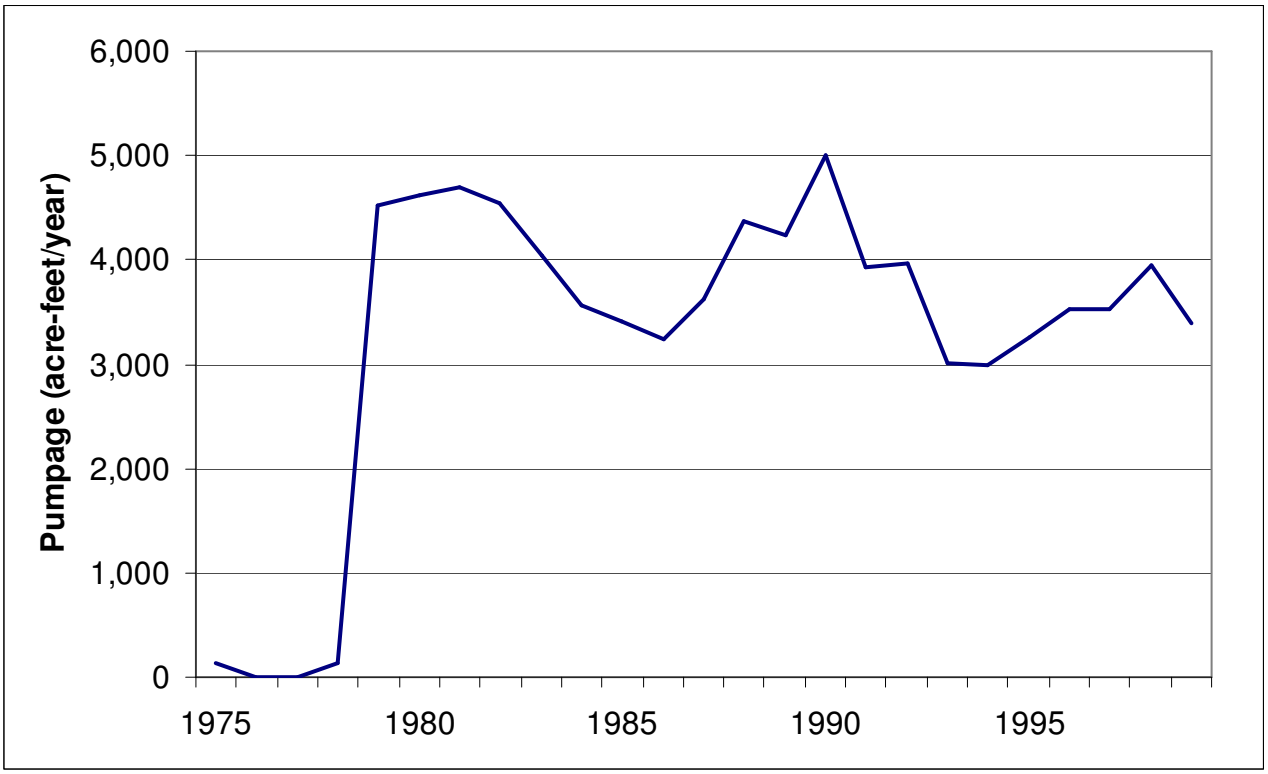

Figure A-7- Total pumpage in Gonzales County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

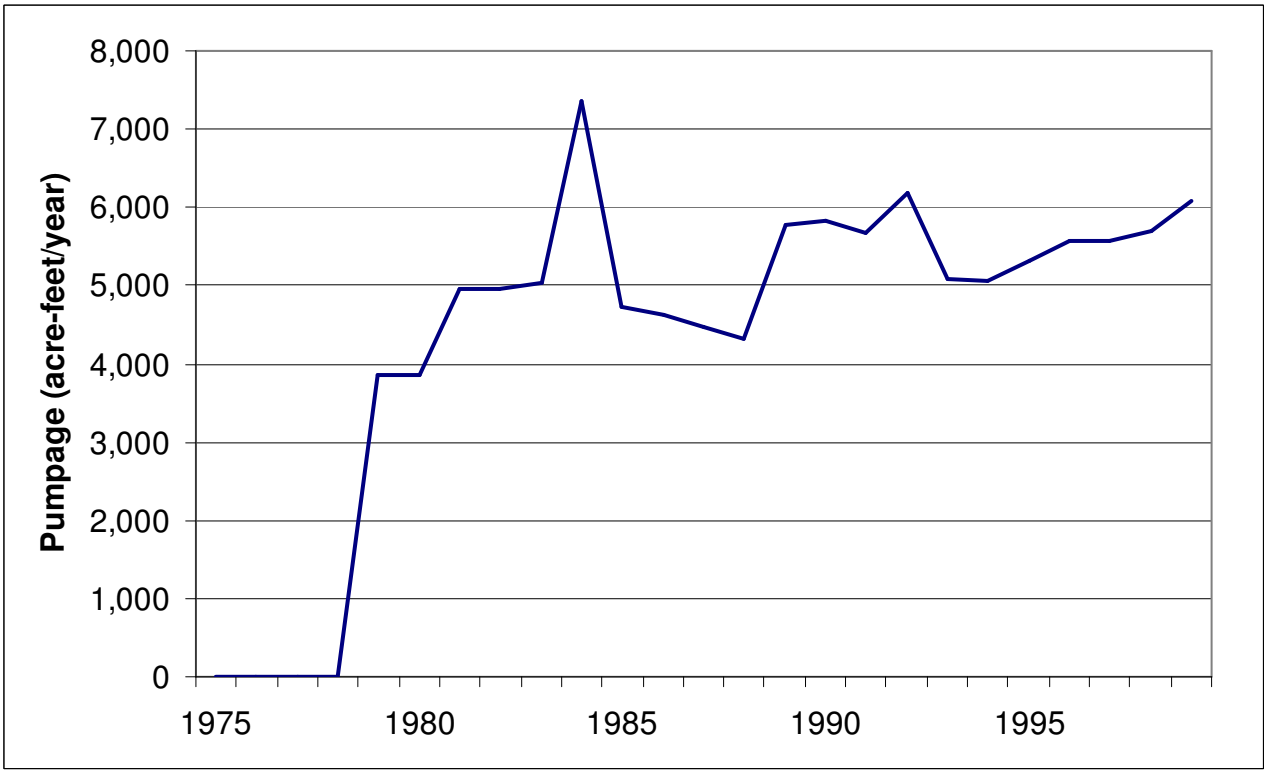

Figure A-8- Total pumpage in Guadalupe County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

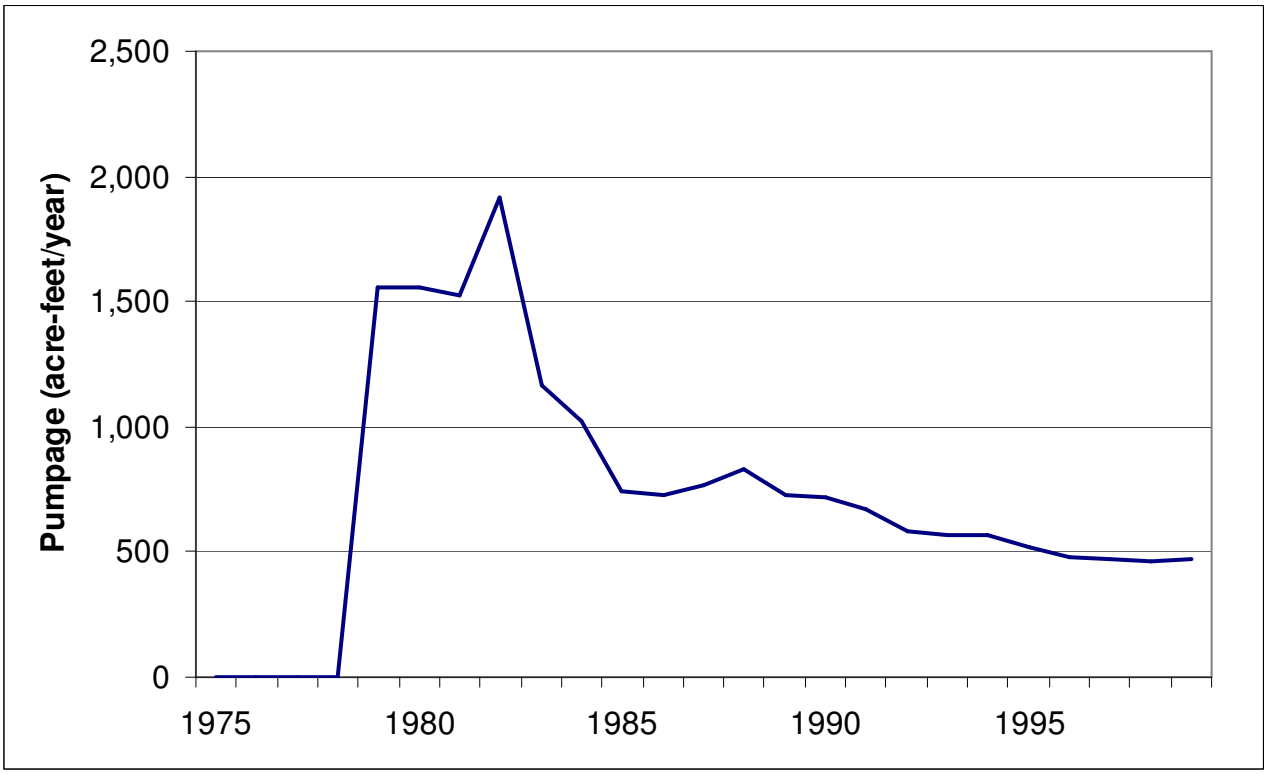

Figure A-9- Total pumpage in Karnes County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

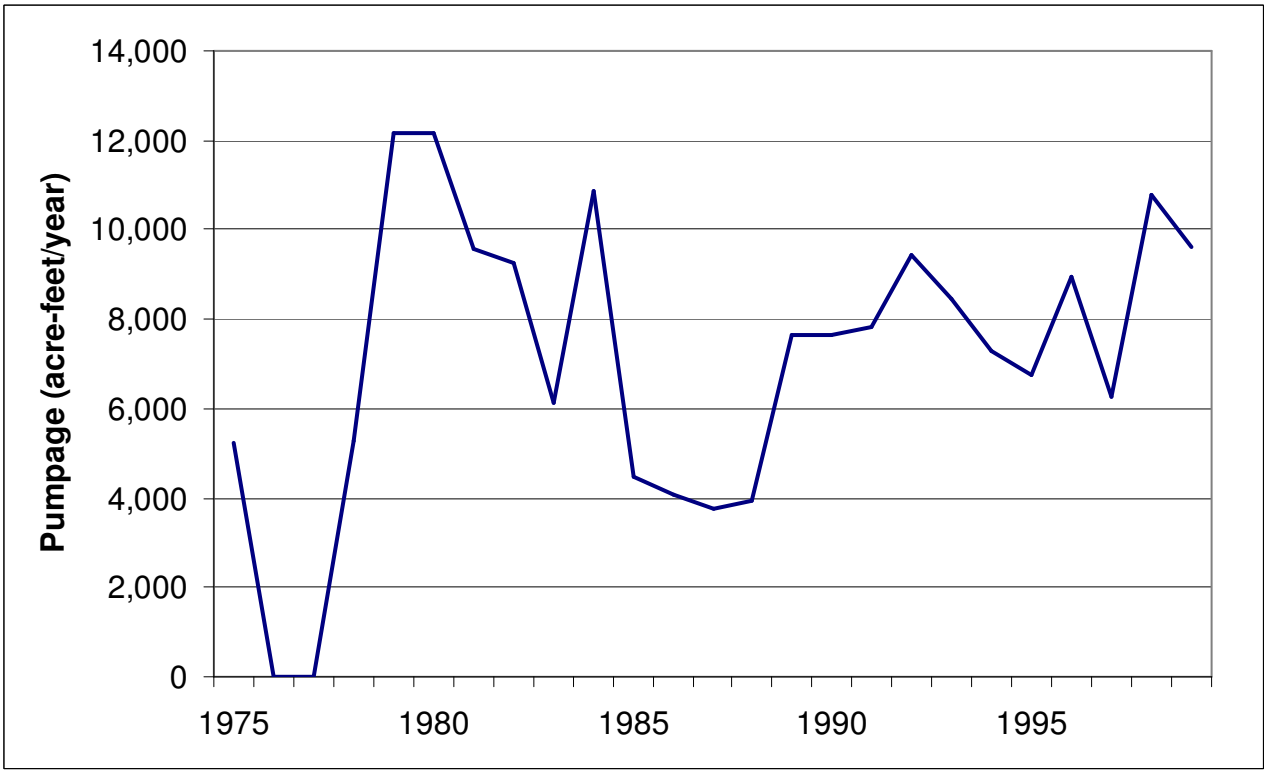

Figure A-10- Total pumpage in LaSalle County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

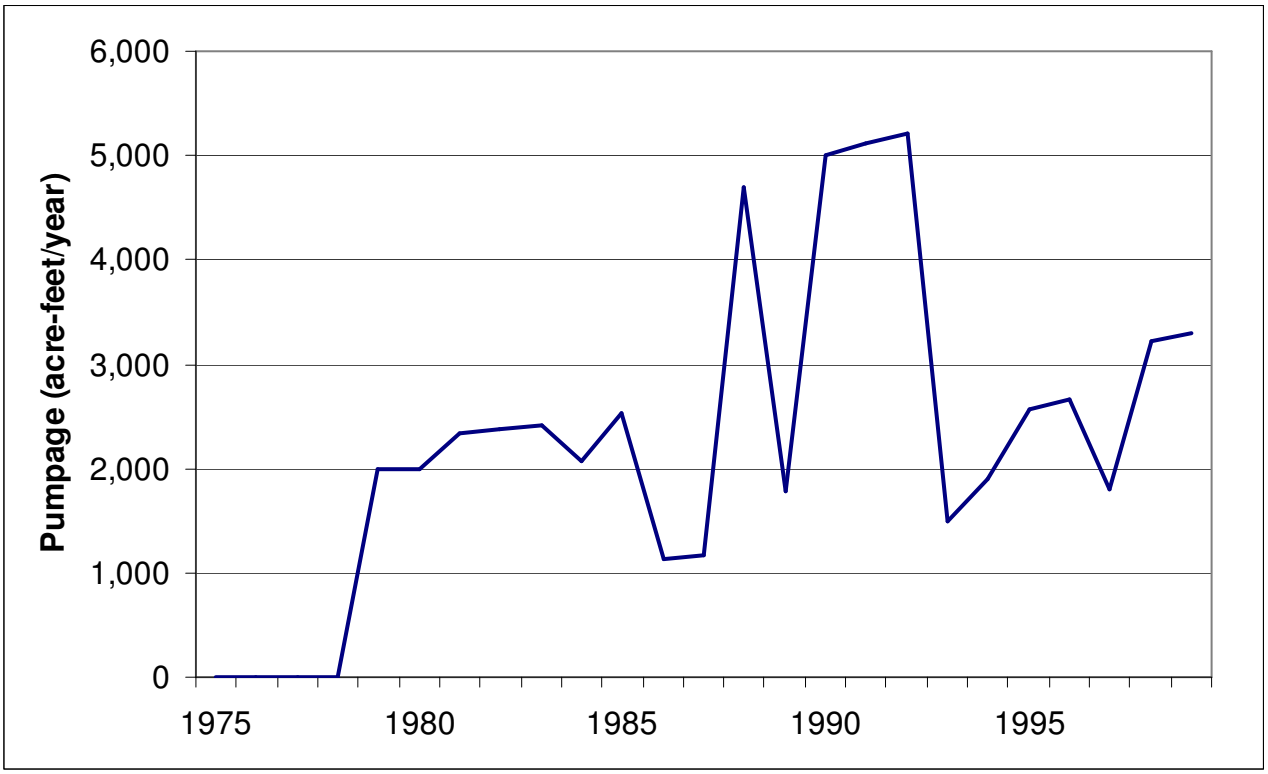

Figure A-11- Total pumpage in Maverick County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

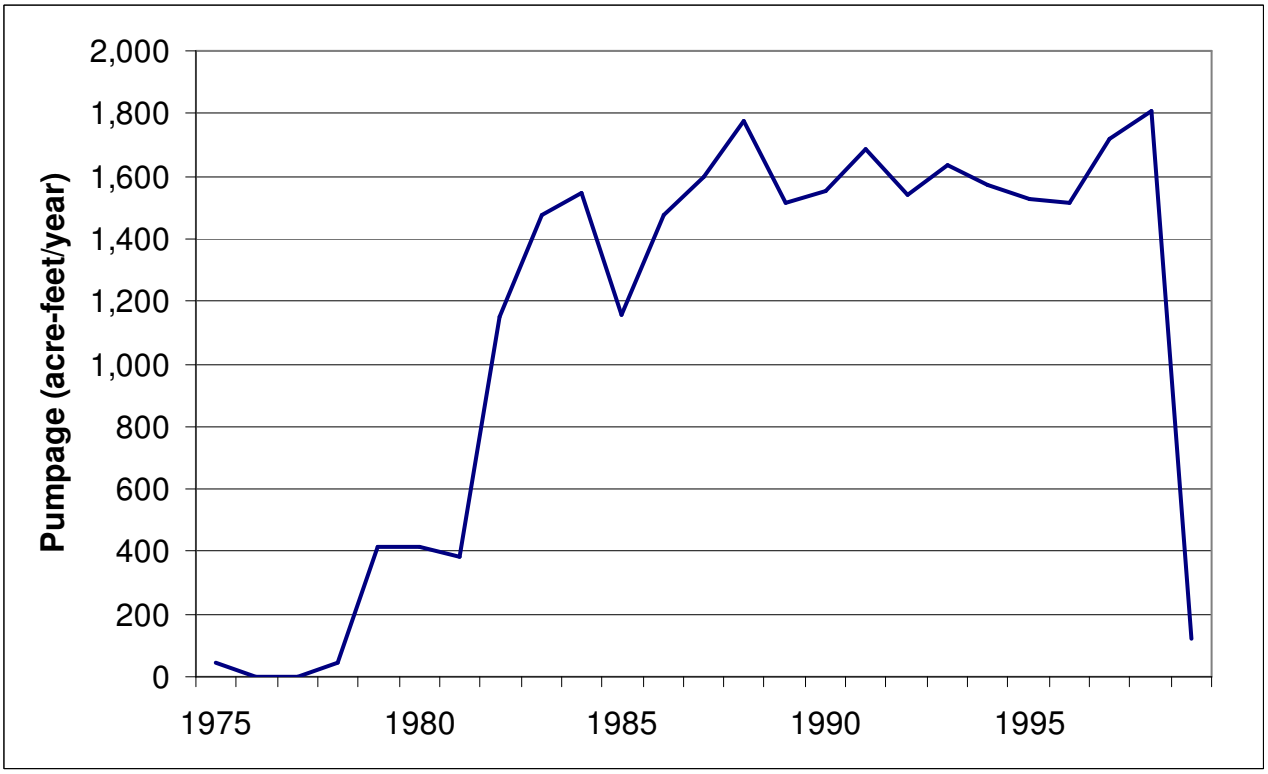

Figure A-12- Total pumpage in McMullen County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

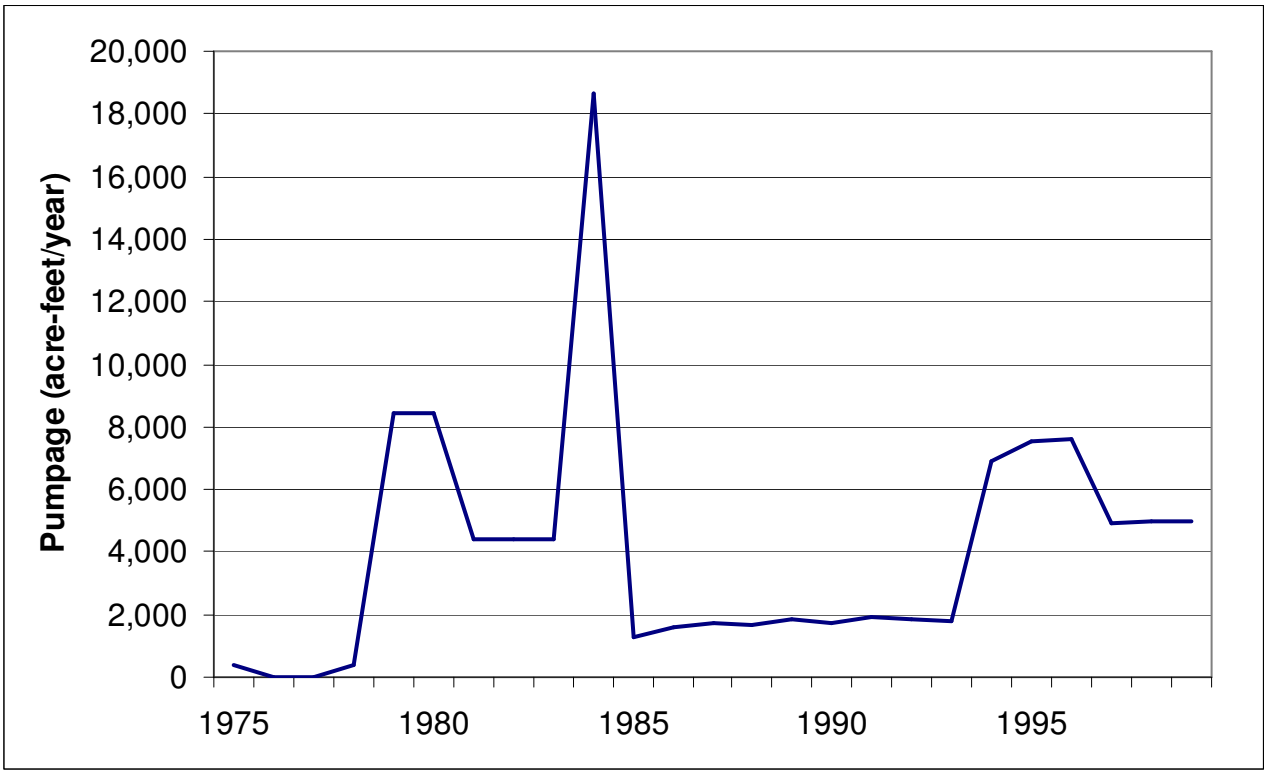

Figure A-13- Total pumpage in Medina County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

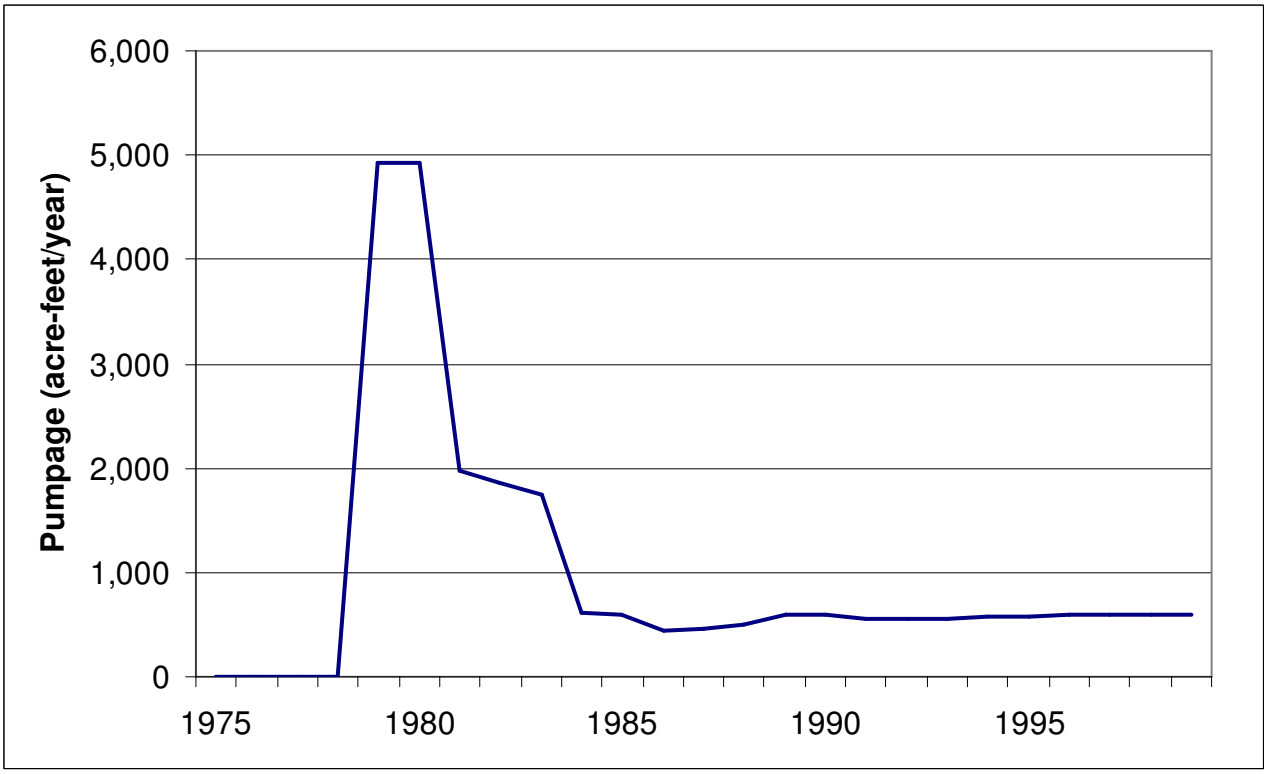

Figure A-14- Total pumpage in Uvalde County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

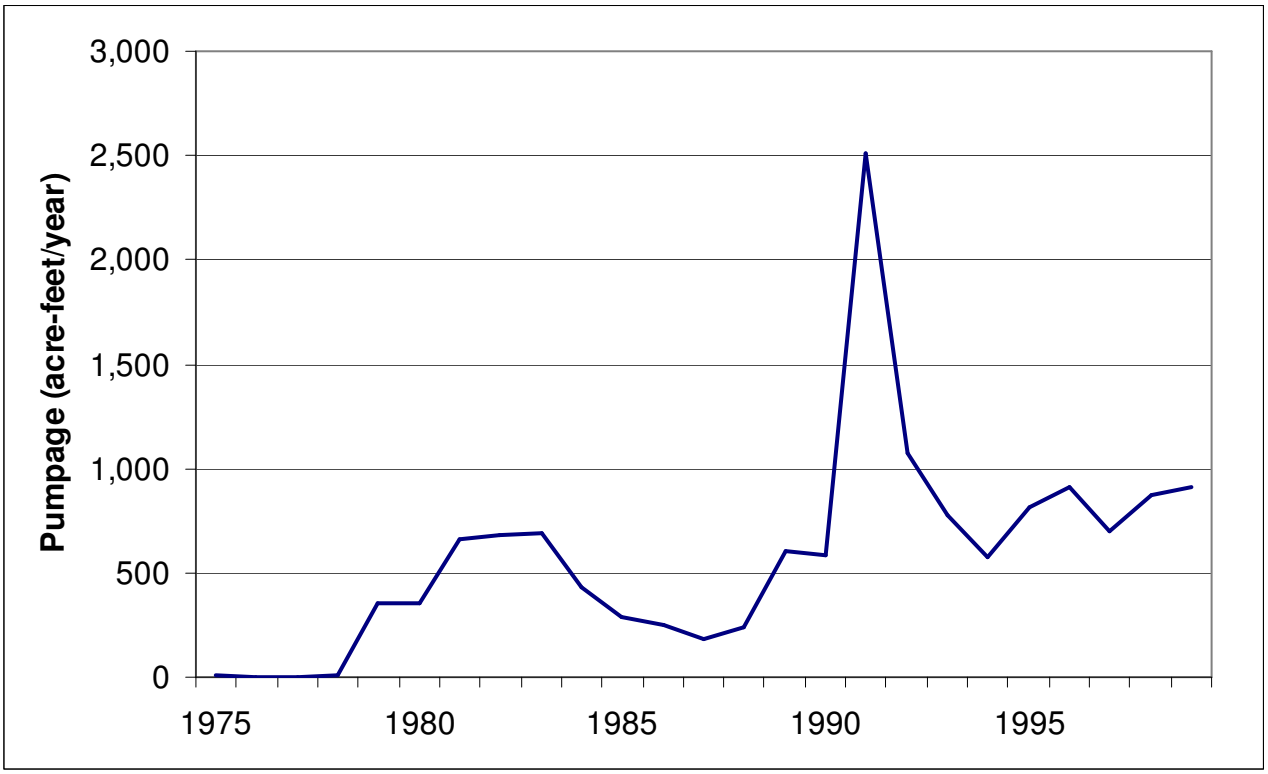

Figure A-15- Total pumpage in Webb County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

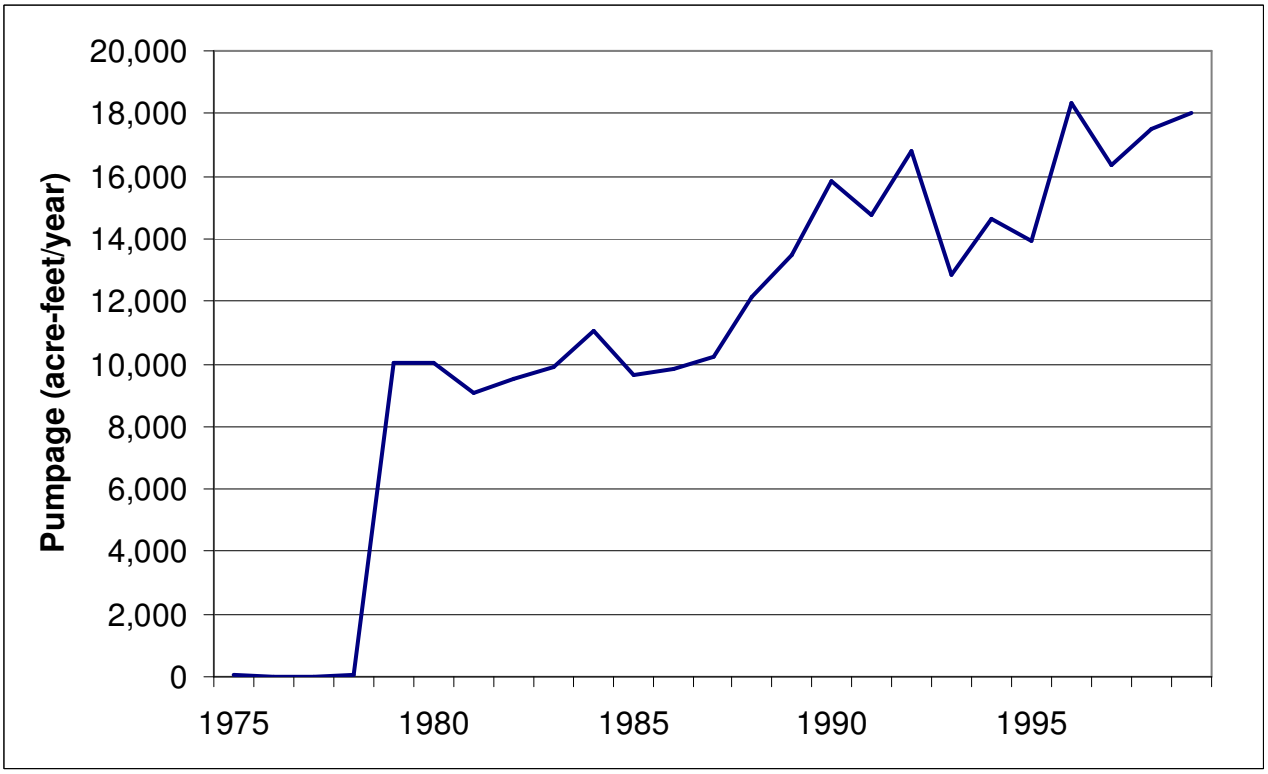

Figure A-16- Total pumpage in Wilson County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

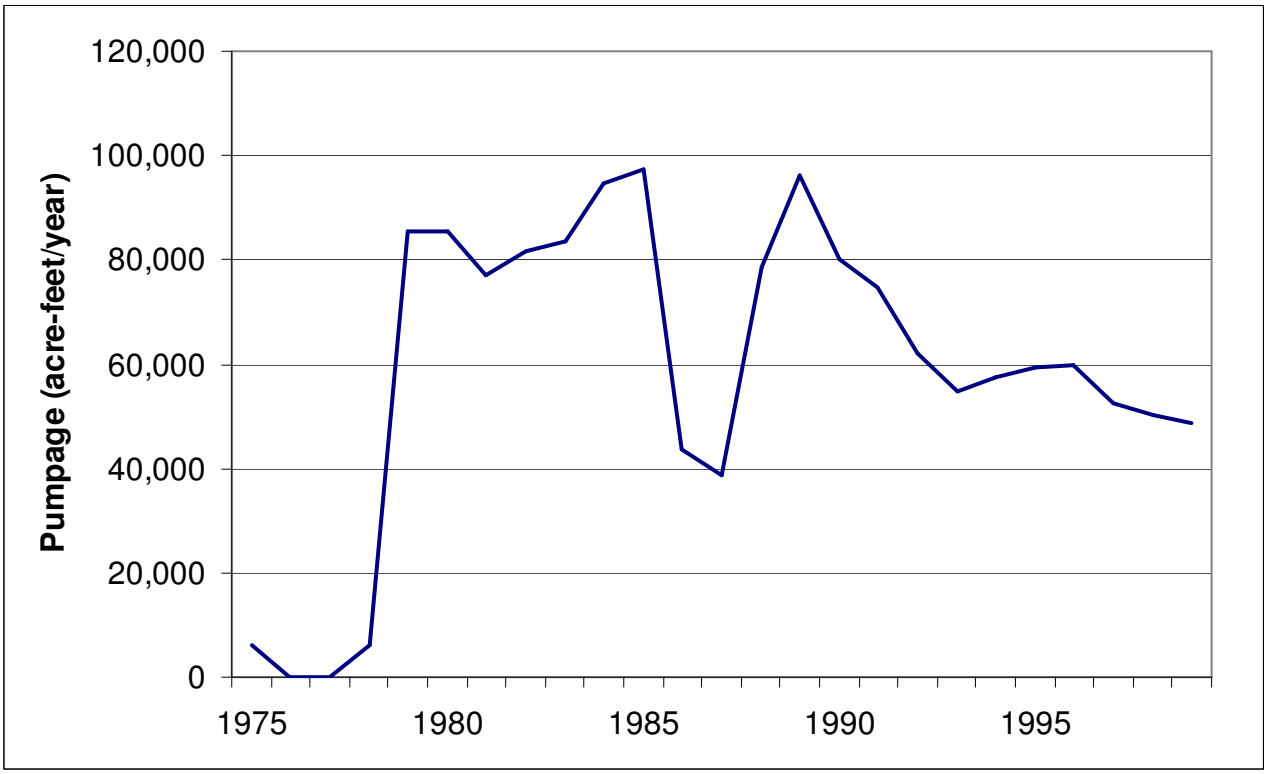

Figure A-17- Total pumpage in Zavala County included in the groundwater availability model for the southern part of the Queen City-Sparta Aquifer.

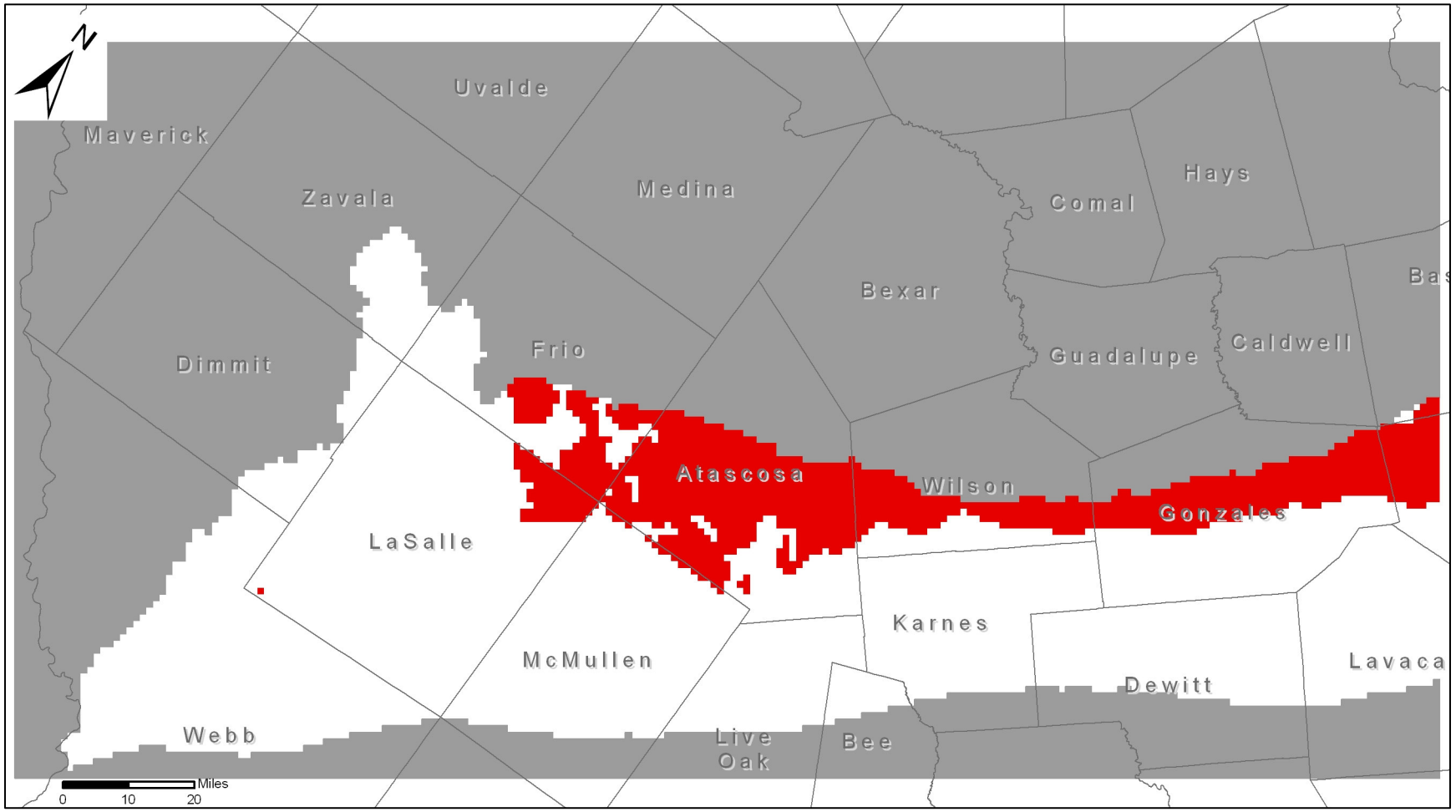

Figure A-18- Location of pumpage included in the groundwater availability model in the Sparta Aquifer (layer 1). Pumpage cells are in red. Active cells in this layer are in white.

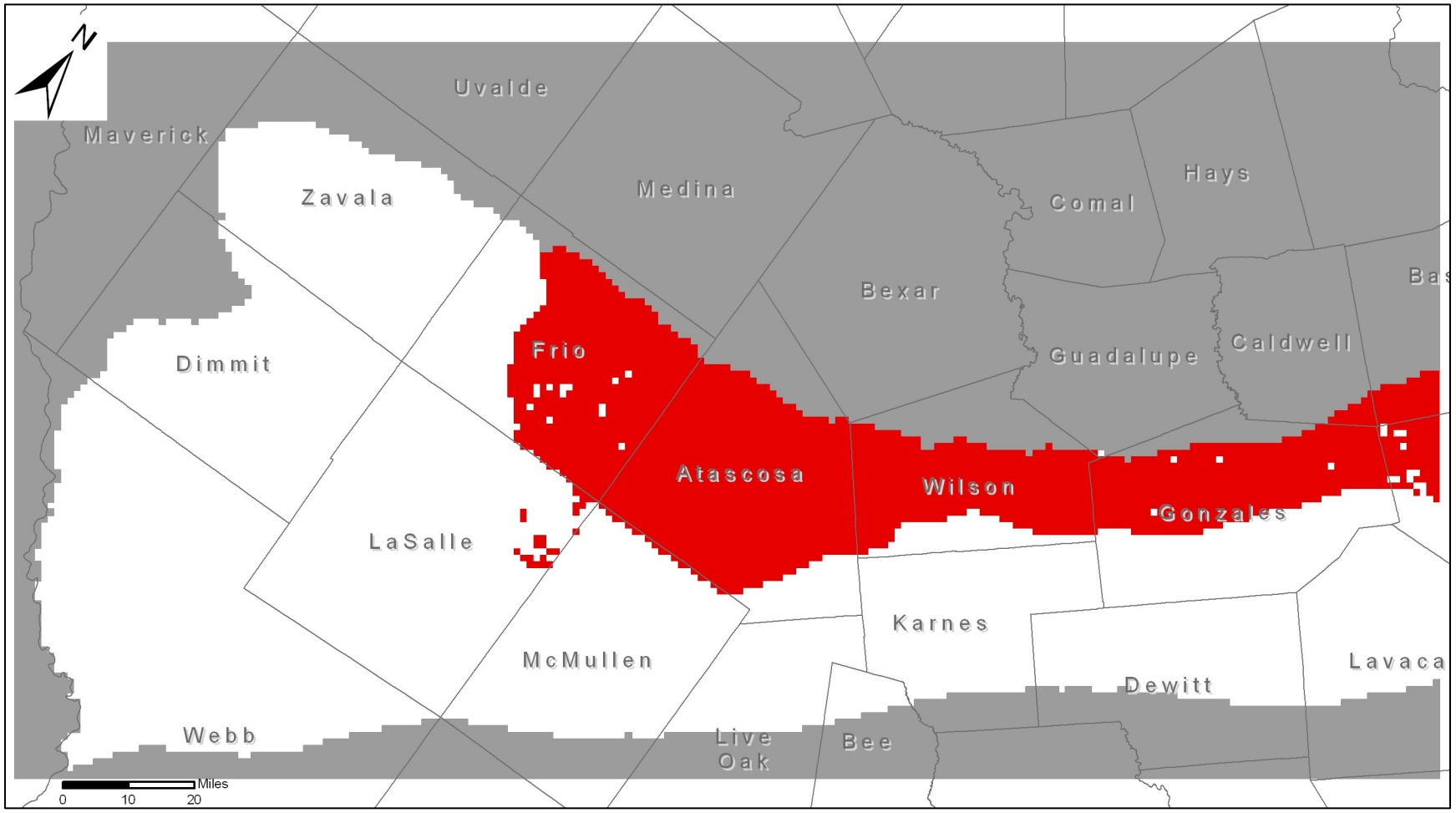

Figure A-19- Location of pumpage included in the groundwater availability model in the Queen City Aquifer (layer 3). Pumpage cells are in red. Active cells in this layer are in white.

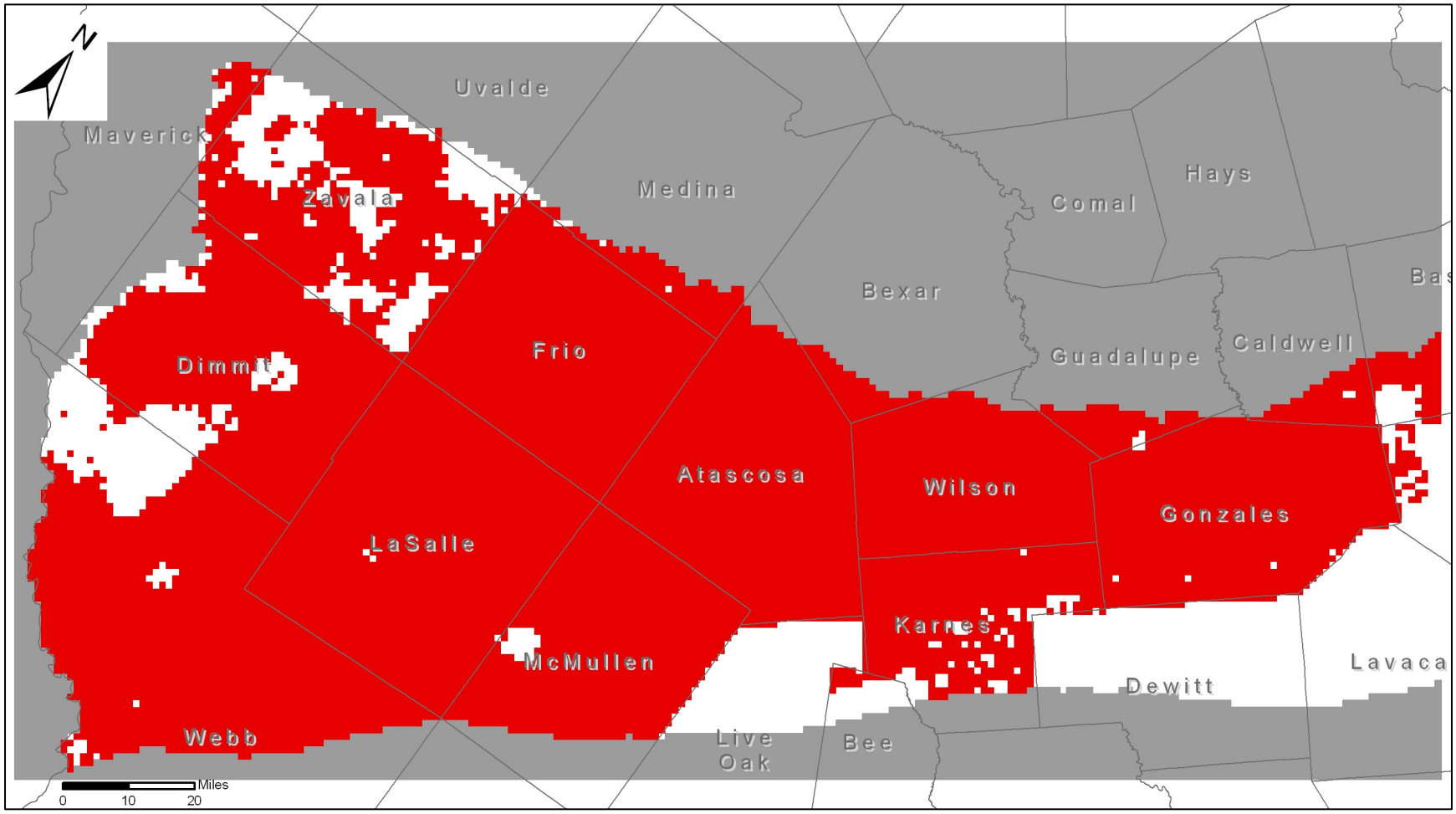

Figure A-20- Location of pumpage included in the groundwater availability model in the Carrizo Aquifer (layer 5). Pumpage cells are in red. Active cells in this layer are in white.

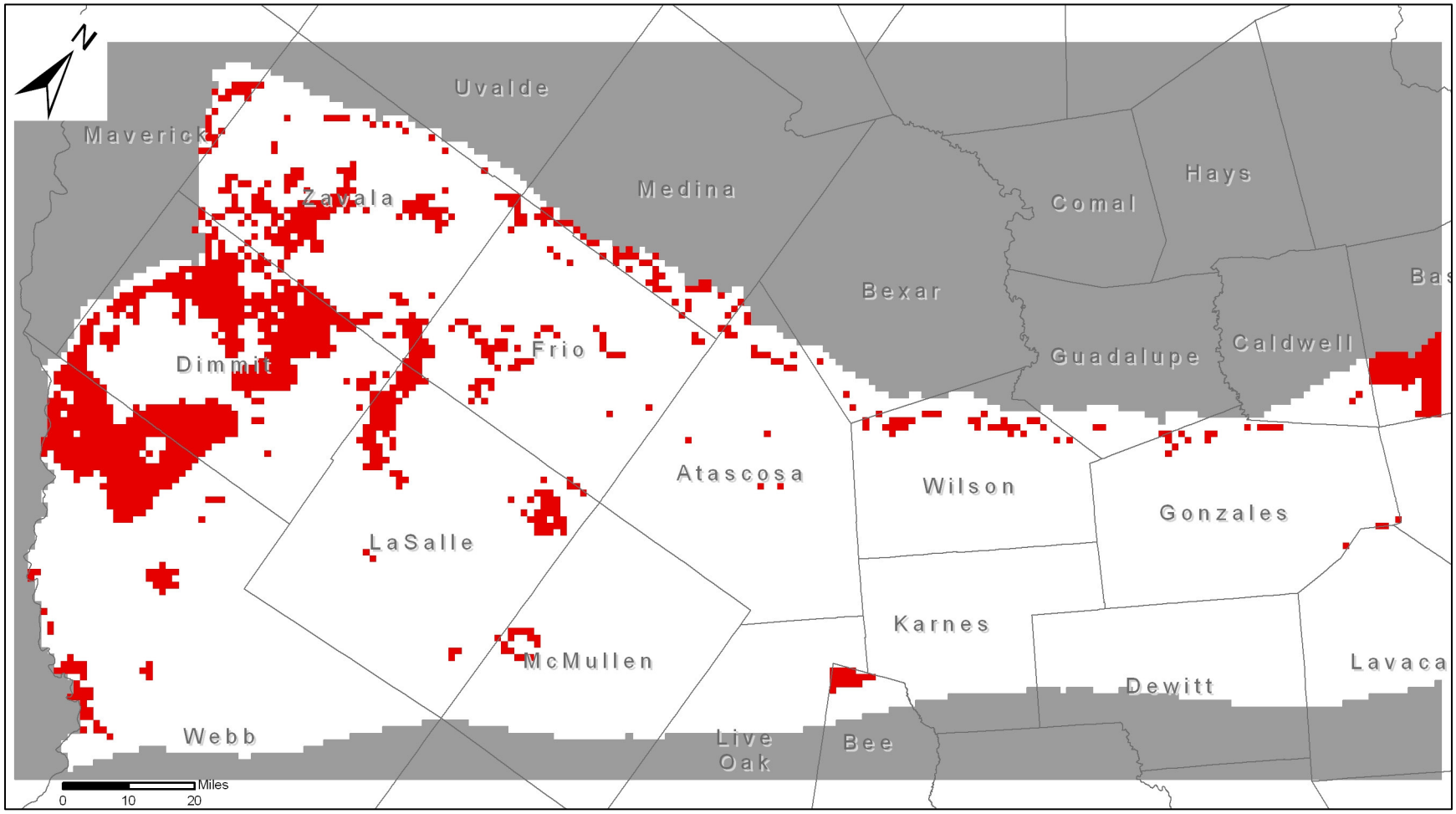

Figure A-21- Location of pumpage included in the groundwater availability model in the Upper Wilcox Aquifer (layer 6). Pumpage cells are in red. Active cells in this layer are in white.

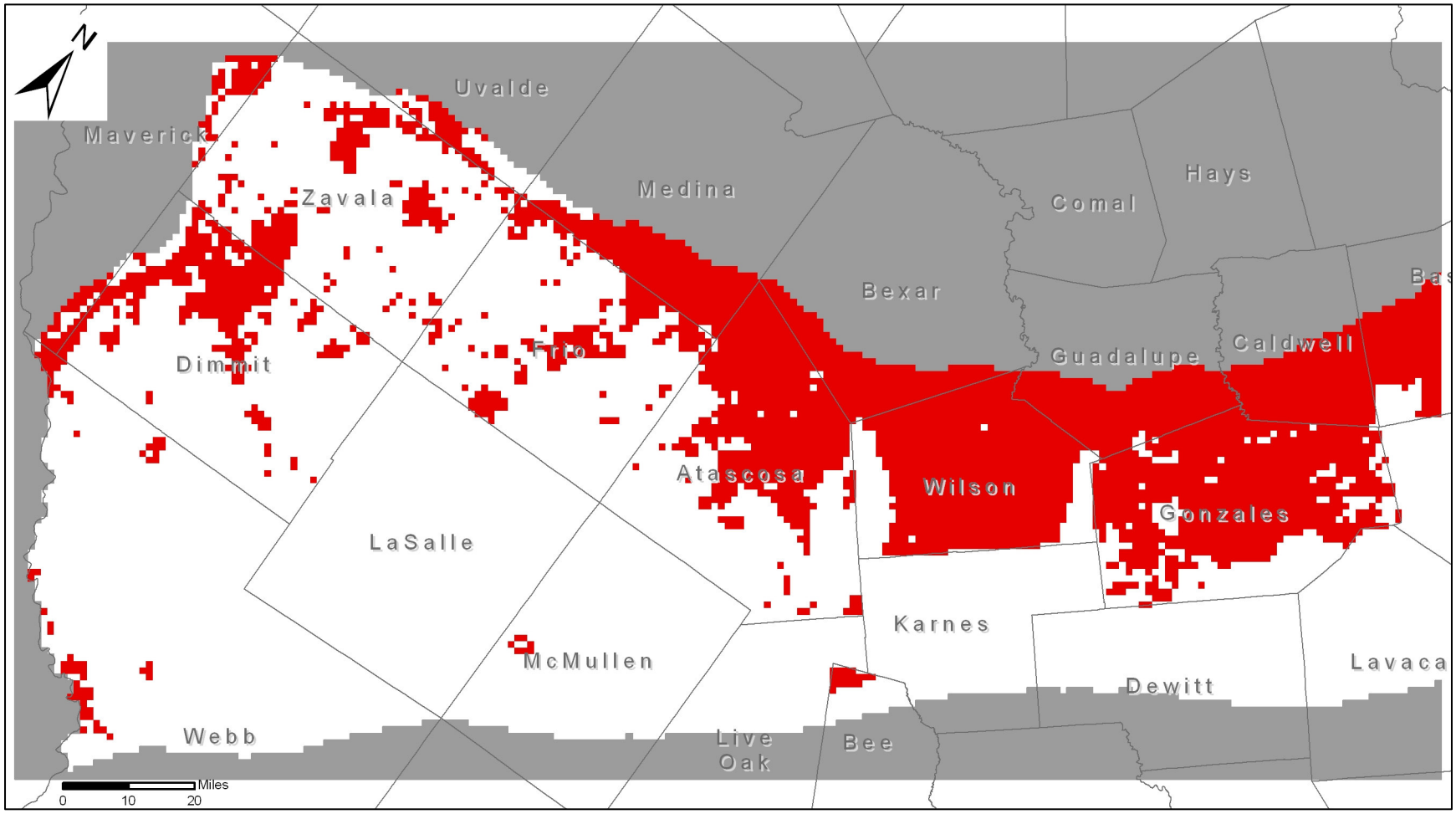

Figure A-22- Location of pumpage included in the groundwater availability model in the Middle Wilcox Aquifer (layer 7). Pumpage cells are in red. Active cells in this layer are in white.

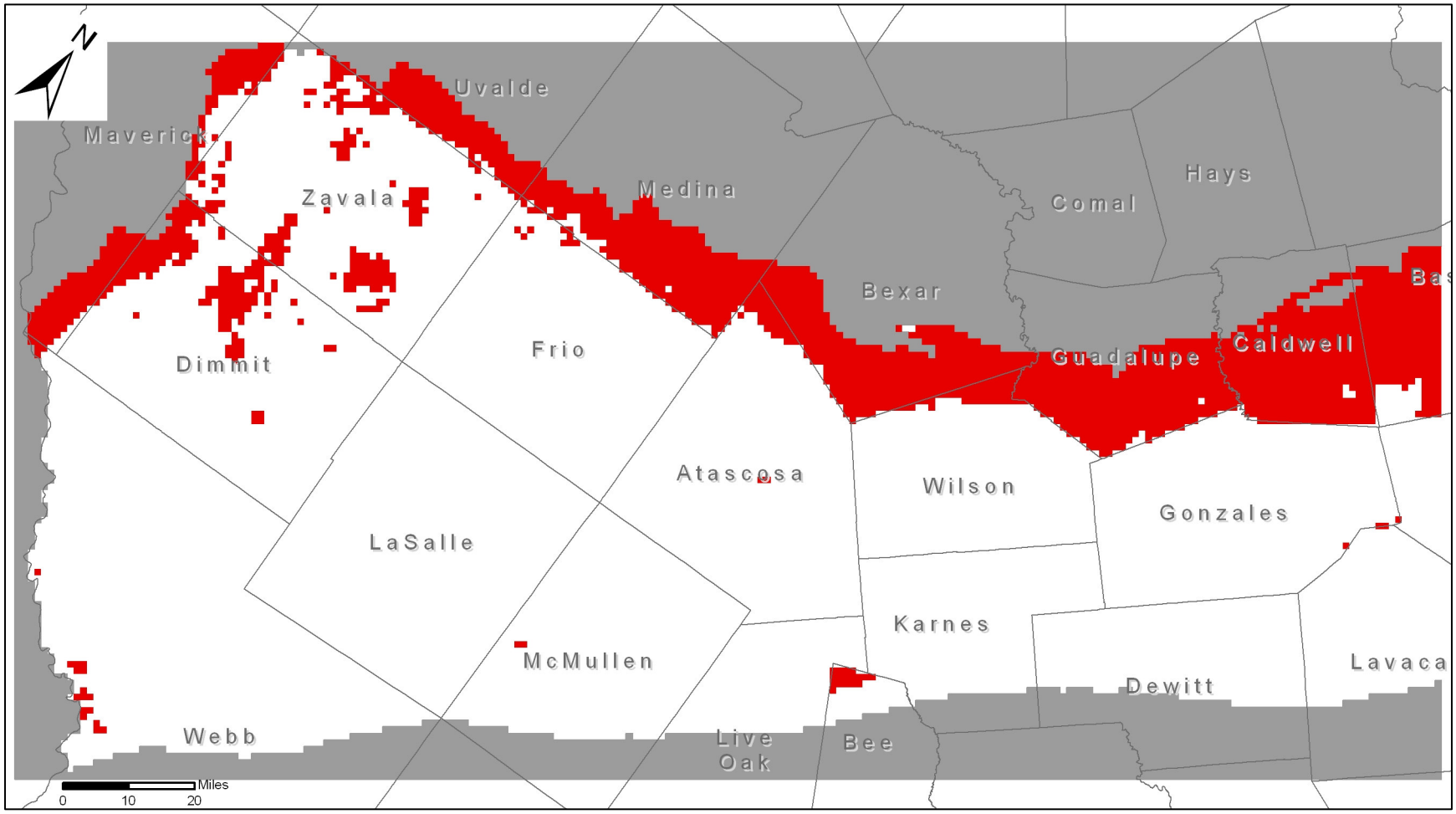

Figure A-23- Location of pumpage included in the groundwater availability model in the Lower Wilcox Aquifer (layer 8). Pumpage cells are in red. Active cells in this layer are in white.

Appendix B

Summary of Budgets
After 60 Years

Table B-1. Annual water budgets for each county in Groundwater Management Area 13 at the end of the 60-year predictive model run using 1999 pumpage in the groundwater availability model for the southern part of the Queen City/Sparta Aquifer (which includes the Carrizo-Wilcox Aquifer). Values are reported in acre-feet per year.

	Atascosa		Bee		Bexar		Caldwell		De Witt		Dimmit		Frio	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Sparta Aquifer														
Storage	344	140	11	0	--	--	--	--	21	0	562	399	1,104	256
Reservoirs (River Package)	0	0	0	0	--	--	--	--	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	--	--	--	--	0	0	0	0	0	0
Lateral Inflow (GHB Package)	4,324	3,904	57	19	--	--	--	--	117	716	259	14	6,332	820
Wells	0	516	0	0	--	--	--	--	0	0	0	0	0	77
Rivers and Streams (Stream Package)	219	488	0	0	--	--	--	--	0	0	487	908	368	215
Recharge	2,306	0	0	0	--	--	--	--	0	0	3,302	0	4,277	0
Evapotranspiration	0	0	0	0	--	--	--	--	0	0	0	154	0	74
Lateral Inflow	719	221	2	1	--	--	--	--	11	21	331	569	326	2,215
Vertical Leakage Downward	2,137	4,780	12	62	--	--	--	--	685	97	2	2,899	0	8,751
Queen City Aquifer														
Storage	846	534	26	0	--	--	6	26	56	0	2,265	8,844	805	5,684
Reservoirs (River Package)	0	0	0	0	--	--	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	--	--	0	0	0	0	0	0	0	0
Lateral Inflow (GHB Package)	0	0	0	0	--	--	0	0	0	0	0	0	0	0
Wells	0	964	0	0	--	--	0	132	0	0	0	0	0	66
Rivers and Streams (Stream Package)	3,277	2,182	0	0	--	--	104	308	0	0	8,794	6,294	7,458	11
Recharge	5,166	0	0	0	--	--	1,144	0	0	0	11,146	0	13,821	0
Evapotranspiration	0	44	0	0	--	--	0	0	0	0	0	0	0	0
Vertical Leakage Upward	4,981	2,019	19	3	--	--	--	--	14	658	3,329	14	9,670	0
Lateral Inflow	2,182	622	2	3	--	--	45	722	4	13	1,628	2,912	652	3,947
Vertical Leakage Downward	23	10,109	0	41	--	--	0	111	614	17	111	9,210	0	22,698

Table B-1. (continued)

	Atascosa		Bee		Bexar		Caldwell		De Witt		Dimmit		Frio	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Carrizo Aquifer														
Storage	12,460	227	21	0	3,366	152	499	2	45	0	130	949	17,996	17
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lateral Inflow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	52,419	0	19	0	2,804	0	6,279	0	1	0	2,917	0	99,802
Rivers and Streams (Stream Package)	1,447	10	0	0	1,880	0	75	0	0	0	841	0	536	0
Recharge	8,119	0	0	0	4,423	0	5,531	0	0	0	5,490	0	1,811	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vertical Leakage Upward	12,595	0	57	0	127	0	1,355	0	0	576	8,994	3	27,022	0
Lateral Inflow	27,795	14,405	224	334	1,439	8,603	3,717	4,853	76	0	691	5,842	51,728	4,590
Vertical Leakage Downward	5,163	518	51	0	533	209	180	223	237	21	2,360	5,173	9,584	4,269
Upper Wilcox Aquifer														
Storage	141	0	29	0	13	17	0	14	64	3	518	245	132	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lateral Inflow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	36	0	19	0	0	0	0	0	0	0	1,321	0	6,049
Rivers and Streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	94	118	0	0
Recharge	0	0	0	0	361	0	0	0	0	0	345	0	0	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vertical Leakage Upward	518	5,163	0	51	209	533	223	180	21	237	5,173	2,360	4,269	9,584
Lateral Inflow	487	160	11	19	7	99	3	26	64	13	1,304	3,143	2,398	91
Vertical Leakage Downward	4,510	296	50	0	229	171	35	42	102	0	1,279	1,525	9,010	86

Table B-1. (continued)

	Atascosa		Bee		Bexar		Caldwell		De Witt		Dimmit		Frio	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Middle Wilcox Aquifer														
Storage	2,116	58	20	0	1,499	5	71	9	0	256	1,188	3	725	0
Reservoirs (River Package)	0	0	0	0	1,604	0	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	0	128	0	19	0	0	0	0	0	0
Lateral Inflow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	598	0	19	0	5,543	0	1,169	0	0	0	189	0	4,089
Rivers and Streams (Stream Package)	642	0	0	0	2,457	753	671	7,940	0	0	271	2	0	0
Recharge	622	0	0	0	2,840	0	4,423	0	0	0	724	0	0	0
Evapotranspiration	0	0	0	0	0	13	0	35	0	0	0	0	0	0
Vertical Leakage Upward	296	4,510	0	50	171	229	42	35	0	102	1,525	1,279	86	9,010
Lateral Inflow	882	777	21	8	348	992	3,598	652	140	0	701	1,984	4,014	243
Vertical Leakage Downward	2,866	1,481	36	0	363	1,620	1,513	459	218	0	1,046	1,999	8,519	2
Lower Wilcox Aquifer														
Storage	728	0	0	25	766	37	6	278	0	183	805	9	647	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	0	48	0	208	0	0	0	0	0	0
Lateral Inflow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	1,527	0	19	0	5,774	0	2,181	0	0	0	50	0	64
Rivers and Streams (Stream Package)	0	0	0	0	3,350	478	563	1,793	0	0	193	0	0	0
Recharge	0	0	0	0	5,306	0	4,665	0	0	0	268	0	0	0
Evapotranspiration	0	0	0	0	0	166	0	411	0	0	0	0	0	0
Vertical Leakage Upward	1,481	2,866	0	36	1,620	363	459	1,513	0	218	1,999	1,046	2	8,519
Lateral Inflow	3,941	1,756	213	133	546	4,723	1,126	434	466	65	2,295	4,455	8,574	640

Table B-1. (continued)

	Gonzales		Guadalupe		Karnes		La Salle		Lavaca		Live Oak		Maverick	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Sparta Aquifer														
Storage	30	218	--	--	79	0	2,802	26	3	1	89	0	--	--
Reservoirs (River Package)	0	0	--	--	0	0	0	0	0	0	0	0	--	--
Springs (Drain Package)	0	26	--	--	0	0	0	0	0	0	0	0	--	--
Lateral Inflow (GHB Package)	397	6,183	--	--	647	999	9,232	6,240	152	721	13	565	--	--
Wells	0	552	--	--	0	0	0	1,316	0	0	0	0	--	--
Rivers and Streams (Stream Package)	0	1,472	--	--	0	0	0	1,841	0	0	0	0	--	--
Recharge	3,081	0	--	--	0	0	1,923	0	0	0	0	0	--	--
Evapotranspiration	0	18	--	--	0	0	0	435	0	0	0	0	--	--
Lateral Inflow	363	33	--	--	102	183	3,084	964	15	59	33	5	--	--
Vertical Leakage Downward	5,093	463	--	--	783	429	1,568	7,788	670	59	448	12	--	--
Queen City Aquifer														
Storage	111	932	0	16	186	0	673	6	6	0	230	0	--	--
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0	--	--
Springs (Drain Package)	0	56	0	0	0	0	0	0	0	0	0	0	--	--
Lateral Inflow (GHB Package)	0	0	0	0	0	0	0	0	0	2	0	0	--	--
Wells	0	240	0	0	0	0	0	2	0	0	0	0	--	--
Rivers and Streams (Stream Package)	410	4,043	0	0	0	0	0	0	0	0	0	0	--	--
Recharge	6,094	0	39	0	0	0	0	0	0	0	0	0	--	--
Evapotranspiration	0	149	0	0	0	0	0	0	0	0	0	0	--	--
Vertical Leakage Upward	702	4,813	--	--	261	616	7,784	1,316	5	654	15	323	--	--
Lateral Inflow	2,001	41	2	5	615	139	5,124	838	7	27	28	14	--	--
Vertical Leakage Downward	1,632	676	0	20	95	402	8	11,428	664	0	98	35	--	--

Table B-1. (continued)

	Gonzales		Guadalupe		Karnes		La Salle		Lavaca		Live Oak		Maverick	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Carrizo Aquifer														
Storage	519	0	1,613	656	174	0	379	0	4	0	135	0	0	715
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lateral Inflow (GHB Package)	0	0	0	0	0	0	0	0	8	125	0	0	0	0
Wells	0	11,538	0	1,224	0	471	0	5,684	0	1	0	85	0	144
Rivers and Streams (Stream Package)	0	4,312	83	84	0	0	0	0	0	0	0	0	444	95
Recharge	1,406	0	7,210	0	0	0	0	0	0	0	0	0	2,108	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vertical Leakage Upward	1,928	1,348	586	6	427	29	12,431	0	0	704	133	13	46	0
Lateral Inflow	14,495	1,902	142	7,462	3,225	4,045	7,557	16,077	919	318	1,063	1,582	4	805
Vertical Leakage Downward	822	69	181	382	735	16	2,515	1,121	241	24	348	0	33	877
Upper Wilcox Aquifer														
Storage	9	13	1	0	116	0	504	0	6	10	183	0	0	111
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lateral Inflow (GHB Package)	0	0	0	0	0	0	0	0	241	0	0	0	0	0
Wells	0	1	0	0	0	0	0	2,602	0	0	0	0	0	136
Rivers and Streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	0	0	52	34
Recharge	0	0	0	0	0	0	0	0	0	0	0	0	85	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vertical Leakage Upward	69	822	382	181	16	735	1,121	2,515	24	241	0	348	877	33
Lateral Inflow	45	15	2	73	16	48	4,000	2,026	10	57	56	179	21	113
Vertical Leakage Downward	731	4	68	198	635	0	1,517	0	27	0	287	0	41	649

Table B-1. (continued)

	Gonzales		Guadalupe		Karnes		La Salle		Lavaca		Live Oak		Maverick	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Middle Wilcox Aquifer														
Storage	39	59	500	0	105	1	439	0	0	244	96	0	3	78
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lateral Inflow (GHB Package)	0	0	0	0	0	0	0	0	64	0	0	0	0	0
Wells	0	66	0	3,047	0	0	0	0	0	0	0	0	0	259
Rivers and Streams (Stream Package)	664	0	2,667	3,137	0	0	0	0	0	0	0	0	903	19
Recharge	125	0	5,639	0	0	0	0	0	0	0	0	0	591	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vertical Leakage Upward	4	731	198	68	0	635	0	1,517	0	27	0	287	649	41
Lateral Inflow	1,232	1,981	981	3,977	65	78	491	655	106	26	33	24	466	859
Vertical Leakage Downward	773	0	715	472	543	0	1,242	0	127	0	182	0	25	1,380
Lower Wilcox Aquifer														
Storage	0	162	133	447	9	82	379	24	0	56	0	88	185	275
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	42	0	0	0	0	0	0	0	0	0	0
Lateral Inflow (GHB Package)	0	0	0	0	0	0	0	0	104	53	0	0	0	0
Wells	0	0	0	1,550	0	0	0	0	0	0	0	0	0	992
Rivers and Streams (Stream Package)	0	0	895	568	0	0	0	0	0	0	0	0	375	49
Recharge	0	0	4,513	0	0	0	0	0	0	0	0	0	1,353	0
Evapotranspiration	0	0	0	66	0	0	0	0	0	0	0	0	0	195
Vertical Leakage Upward	0	773	472	715	0	543	0	1,242	0	127	0	182	1,380	25
Lateral Inflow	1,784	849	743	3,368	1,394	777	2,445	1,557	209	78	549	279	14	1,770

Table B-1. (continued)

	McMullen		Medina		Non-Texas		Uvalde		Webb		Wilson		Zavala	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Sparta Aquifer														
Storage	175	0	--	--	--	--	--	--	21	3,878	856	7	2	1,183
Reservoirs (River Package)	0	0	--	--	--	--	--	--	0	0	0	0	0	0
Springs (Drain Package)	0	0	--	--	--	--	--	--	0	0	0	136	0	0
Lateral Inflow (GHB Package)	933	1,552	--	--	--	--	--	--	5,154	793	1,176	3,431	0	0
Wells	0	0	--	--	--	--	--	--	0	0	0	504	0	0
Rivers and Streams (Stream Package)	0	0	--	--	--	--	--	--	3,938	2,156	88	414	247	62
Recharge	0	0	--	--	--	--	--	--	3,201	0	2,403	0	4,362	0
Evapotranspiration	0	0	--	--	--	--	--	--	0	2,202	0	6	0	0
Lateral Inflow	492	160	--	--	--	--	--	--	240	776	123	410	34	146
Vertical Leakage Downward	889	777	--	--	--	--	--	--	769	3,520	1,109	846	0	3,253
Queen City Aquifer														
Storage	707	0	--	--	--	--	--	--	104	19,833	869	827	330	15,574
Reservoirs (River Package)	0	0	--	--	--	--	--	--	0	0	0	0	0	0
Springs (Drain Package)	0	0	--	--	--	--	--	--	0	0	0	0	0	0
Lateral Inflow (GHB Package)	0	0	--	--	--	--	--	--	0	0	0	0	0	0
Wells	0	0	--	--	--	--	--	--	0	0	0	170	0	0
Rivers and Streams (Stream Package)	0	0	--	--	--	--	--	--	20,882	7,173	1,377	3,447	16,857	0
Recharge	0	0	--	--	--	--	--	--	10,787	0	7,482	0	10,722	0
Evapotranspiration	0	0	--	--	--	--	--	--	0	1,523	0	0	0	0
Vertical Leakage Upward	740	748	--	--	--	--	--	--	4,101	622	1,601	972	2,636	0
Lateral Inflow	1,043	120	--	--	--	--	--	--	732	2,566	61	1,900	1,177	979
Vertical Leakage Downward	56	1,678	--	--	--	--	--	--	166	5,057	19	4,094	0	15,167

Table B-1. (continued)

	McMullen		Medina		Non-Texas		Uvalde		Webb		Wilson		Zavala	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Carrizo Aquifer														
Storage	260	0	4,586	227	0	0	2	1	31	129	3,820	385	8,738	534
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lateral Inflow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	119	0	1,477	0	0	0	0	0	896	0	15,986	0	31,762
Rivers and Streams (Stream Package)	0	0	1,440	44	0	22	658	0	54	0	10,175	110	2,643	0
Recharge	0	0	8,726	0	35	0	1,223	0	529	0	8,696	0	6,602	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	124	0	0	0	0
Vertical Leakage Upward	1,882	16	8	0	1	0	--	--	4,757	1	5,693	0	17,179	34
Lateral Inflow	1,623	4,500	956	13,520	4	2	6	1,566	97	1,675	5,969	19,531	8,537	11,574
Vertical Leakage Downward	893	23	865	1,313	0	17	0	322	410	3,056	2,067	409	7,741	7,535
Upper Wilcox Aquifer														
Storage	530	0	84	26	0	0	8	22	113	100	20	0	216	65
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lateral Inflow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	31	0	0	0	0	0	13	0	40	0	8,294
Rivers and Streams (Stream Package)	0	0	0	0	0	0	0	0	15	201	0	0	0	0
Recharge	0	0	0	0	0	0	100	0	82	0	0	0	304	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	69	0	0	0	0
Vertical Leakage Upward	23	893	1,313	865	17	0	322	0	3,056	410	409	2,067	7,535	7,741
Lateral Inflow	753	1,007	46	477	34	48	1	145	677	2,656	86	17	972	591
Vertical Leakage Downward	596	0	690	734	0	3	0	263	48	542	1,747	138	9,109	1,445

Table B-1. (continued)

	McMullen		Medina		Non-Texas		Uvalde		Webb		Wilson		Zavala	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Middle Wilcox Aquifer														
Storage	271	0	3,293	24	0	0	899	3	81	32	317	0	1,654	361
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lateral Inflow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	980	0	0	0	120	0	6	0	772	0	4,901
Rivers and Streams (Stream Package)	0	0	932	32	0	0	311	10	3,000	2,812	972	1,458	1,417	4
Recharge	0	0	2,619	0	0	0	1,091	0	82	0	968	0	1,006	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	150	0	0	0	0
Vertical Leakage Upward	0	596	734	690	3	0	263	0	542	48	138	1,747	1,445	9,109
Lateral Inflow	82	100	329	2,561	18	19	29	1,001	466	531	1,742	926	2,517	862
Vertical Leakage Downward	343	0	239	3,859	0	3	0	1,460	19	612	1,117	351	9,361	2,164
Lower Wilcox Aquifer														
Storage	95	118	2,286	271	0	0	1,936	76	33	46	126	6	670	523
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lateral Inflow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	1,533	0	0	0	105	0	1	0	578	0	440
Rivers and Streams (Stream Package)	0	0	113	225	0	0	347	15	0	133	119	0	790	84
Recharge	0	0	1,975	0	0	0	1,205	0	15	0	69	0	537	0
Evapotranspiration	0	0	0	327	0	0	0	4	0	42	0	0	0	0
Vertical Leakage Upward	0	343	3,859	239	3	0	1,460	0	612	19	351	1,117	2,164	9,361
Lateral Inflow	678	314	576	6,212	110	113	348	5,094	1,670	2,089	4,500	3,465	7,580	1,333