GAM Run 08-06

by Andrew C. A. Donnelly, P.G.
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-3132
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EXECUTIVE SUMMARY:

We ran the groundwater availability model for the northern part of the Trinity Aquifer for a 50-year predictive time period. Average recharge conditions were used for the first forty-seven years of the predictive portion of the simulation, followed by the three-year drought-of-record. Pumpage used in each year of the model run was specified by the groundwater conservation districts in Groundwater Management Area 8. The only difference between this run and GAM Run 08-05 is a change in pumpage in Coryell County from 3,000 acre-feet per year to 3,777 acre-feet per year. This change in pumpage resulted in a change of less than five feet in the water level in Coryell County, and lesser amounts in adjacent counties.

Results of this model run indicated that water levels after 50 years of specified pumpage decreased in all of the aquifers of interest throughout the model area. Water level declines were less than 25 feet in the farthest updip portions of each aquifer and increased downdip. All aquifers showed maximum water level declines in excess of 300 feet over the 50-year predictive time period and also showed localized areas of higher water level declines around heavy pumping centers. Water level declines in these localized areas were nearly 700 feet for some aquifers.

REQUESTOR:

Ms. Cheryl Maxwell from the Clearwater Underground Water Conservation District (on behalf of Groundwater Management Area 8).

DESCRIPTION OF REQUEST:

Ms. Maxwell asked for a model run using the groundwater availability model for the northern part of the Trinity Aquifer. This model run would be for a 50-year predictive time period. Average recharge conditions were used for the first forty-seven years of the predictive portion of the simulation, followed by the three-year drought-of-record. Pumpage used in each year of the model run was specified by Groundwater Management Area 8.

METHODS:

Average streamflows and evapotranspiration rates were used for each year of the predictive simulation. Average recharge was used for the first forty-seven years of the simulation, followed by a three-year drought-of-record. Resulting water levels and drawdowns were then evaluated and are described in the Results section below.

PARAMETERS AND ASSUMPTIONS:

The groundwater availability model for the northern part of the Trinity Aquifer was used for this model run. The parameters and assumptions for this model are described below:

- We are using version 1.01 of the groundwater availability model for the northern part of the Trinity Aquifer for this run. See Bené and others (2004) for assumptions and limitations of the model.

- The model includes seven layers, representing the Woodbine Aquifer (Layer 1), the Washita and Fredericksburg Series (Layer 2), the Paluxy Aquifer (Layer 3), the Glen Rose Formation (Layer 4), the Hensell Aquifer (Layer 5), the Pearsall/Cow Creek/Hammett/Sligo Formation (Layer 6), and the Hosston Aquifer (Layer 7). The Woodbine, Paluxy, Hensell, and Hosston layers are the main aquifers used in the region.

- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) for the four main aquifers in the model (Woodbine, Paluxy, Hensell, and Hosston) for the calibration and verification time periods (1980 to 2000) ranged from approximately 37 to 75 feet. The root mean squared error was less than ten percent of the maximum change in water levels across the model (Bené and others, 2004).

- We used average annual recharge conditions based on climate data from 1980 to 1999 for the simulation. The last three years of the simulation used drought-of-record recharge conditions, which were defined as the years 1954-56.

- The model uses the MODFLOW stream-routing package to simulate the interaction between the aquifer(s) and major intermittent streams flowing in the region. Flow both from the stream to the aquifer and from the aquifer to the stream is allowed, and the direction of flow is determined by the water levels in the aquifer and stream during each stress period in the simulation.

Specified Pumpage

Each year of the predictive model run used pumpage specified by Groundwater Management Area 8. The following specifications on the pumpage were given by the groundwater management area for this model run:

- The simulation should maintain the existing model spatial pumping distribution except in Delta, Hunt, Kaufman, and Lamar counties.

- In Delta, Hunt, Kaufman, and Lamar counties the spatial pumping distribution should be uniform.

- The simulation should maintain the existing distribution of pumping by layer (as a percentage of the total Trinity Aquifer pumping within a county area) for layers 3, 4, 5, 6, and 7; except where specified otherwise.

- Pumping should be held constant for each area for which a pumping amount is specified, in other words, by county total for the Trinity Aquifer or by a layer specified within a county.

In addition to these general guidelines, specific pumpage totals for each county in the model were given by Groundwater Management Area 8. These totals are shown in Tables 1 through 4.

Table 1. Specified annual pumpage for the Woodbine Aquifer (layer 1) used in this model simulation. All pumpage is reported in acre-feet per year.

County	Specified pumpage	County	Specified pumpage
Collin	2,500	Lamar	3,658
Delta	16	Limestone	33
Fannin	3,300	Navarro	300
Grayson	12,100	Red River	170
Hunt	2,840	Rockwall	144
Kaufman	200		

Table 2. Specified annual pumpage for the Trinity Aquifer (layers 3, 4, 5, and 7) used in this model simulation. All pumpage is reported in acre-feet per year.

County	Specified pumpage	County	Specified pumpage
Brown	2,085	Lamar	1,320
Callahan	3,787	Lampasas	3,164
Collin	2,100	Limestone	66
Comanche	27,000	McLennan	20,689
Coryell	3,777	Milam	321
Delta	364	Mills	2,400
Eastland	4,853	Montague	2,682
Erath	32,000	Navarro	1,873
Falls	161	Red River	528
Fannin	700	Rockwall	958
Grayson	9,400	Taylor	679
Hamilton	2,146	Travis	3,900
Hunt	551	Williamson	1,810
Kaufman	1,184		

Table 3. Specified annual pumpage for the Woodbine and Trinity aquifers combined (layers 1, 3, 4, 5, and 7) used in this model simulation. All pumpage is reported in acre-feet per year.

County	Specified pumpage	County	Specified pumpage
Bosque	7,509	Hood	11,064
Cooke	7,018	Johnson	17,767
Dallas	7,807	Parker	15,389
Denton	23,442	Somervell	2,485
Ellis	9,403	Tarrant	19,615
Hill	5,412	Wise	9,801

Table 4. Specified annual pumpage by layer for Bell and Burnet counties used in this model simulation. All pumpage is reported in acre-feet per year.

Layer*	Bell County	Burnet County
	Specified pumpage	Specified pumpage
Layer 3	112	200
Layer 4	880	200
Layer 5	1,100	700
Layer 6	0	0
Layer 7	5,000	2,500

*- Paluxy Aquifer (Layer 3), the Glen Rose Formation (Layer 4), the Hensell Aquifer (Layer 5), the Pearsall/Cow Creek/Hammett/Sligo Formation (Layer 6), and the Hosston Aquifer (Layer 7).

The latest year (1999) from the estimated historic pumpage from the calibrated groundwater availability model was used as the basis for the spatial distribution for the predictive pumpage dataset. The details of how the baseline pumpage dataset was constructed is included in the GAM07-09 report (Donnelly, 2007). The baseline pumpage was increased or decreased to the specified totals shown in Tables 1 to 4 using a factor based on the county pumpage in the 1999 pumpage data set and the desired total. This pumpage was increased or decreased to the specified totals shown in Tables 1 to 4 using a factor based on the county pumpage in the 1999 pumpage data set and the desired total. This resulted in a predictive pumpage data set with the same spatial distribution as in the 1999 data set, as requested by the groundwater management area. The predictive pumpage was held constant throughout the 50-year predictive simulation.

Several changes to the original pumpage totals specified above were made. Delta County was specified to have 16 acre-feet per year of pumpage from the Woodbine Aquifer (layer 1) and 364 acre-feet per year of pumpage from the Trinity Aquifer (layers 3, 4, 5, and 7), and Kaufman County was specified to have 1,184 acre-feet per year of pumpage from the Trinity Aquifer (layers 3, 4, 5, and 7). However, no pumpage was present in the historic pumpage estimates for these counties from these aquifers. Therefore, we used a uniform pumping distribution in Delta and Kaufman counties.

In addition, several counties and/or model layers were not specified in the original request. Counties with no specified pumpage are shown in Table 5. Neither layers 2 (Washita and Fredericksburg Series) nor 6 (Pearsall/Cow Creek/Hammett/Sligo Formation) were specified for counties in most of the model area. In all of these cases, the estimated historic pumpage for 1999 was used in the predictive model run.

Table 5. Annual pumpage used for non-specified counties/areas in the model simulation. These totals are based on historic pumpage totals from the 1999 groundwater availability model. All pumpage is reported in acre-feet per year.

County	Annual pumpage
Bastrop	4
Jack	11
Lee	5
Palo Pinto	12
Non-Texas	9,541

RESULTS:

Included in the results are estimates of the water budgets after running the model for 50 years. A groundwater budget summarizes how the model estimates water entering and leaving the aquifer. The components of the water budget are described below.

- Wells—water produced from wells in each aquifer. 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 using the MODFLOW Well package.

- Recharge—simulates areally distributed recharge due to precipitation falling on the outcrop areas of aquifers. Recharge is always shown as “Inflow” into the water budget. Recharge is modeled using the MODFLOW Recharge package.

- 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 using the MODFLOW Evapotranspiration package. In this model the Evapotranspiration package also represents groundwater discharge via small seeps and springs and larger spring discharge to streams not specifically modeled by the Stream package (Bené and others, 2004).

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

- Change in storage—changes in the 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 level declines). The storage component that is included in "Outflow" is water that is added back into storage in the aquifer (that is, water level increases). 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.

- Rivers and streams—water that flows between perennial 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 out of the stream 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 using the MODFLOW Streamflow-routing package.

- Reservoirs—water that flows between reservoirs and an aquifer. The direction and amount of flow depends on the water level in the reservoir and the aquifer. In areas where water levels in the reservoir are above the water level in the aquifer, water flows into the aquifer and out of the reservoir and is shown as "Inflow" in the budget. In areas where water levels in the aquifer are above the water level in the reservoir, water flows out of the aquifer and into the reservoir and is shown as "Outflow" in the budget. Reservoirs are modeled using the MODFLOW River package.

- Inter-aquifer flow—The model uses general-head boundaries (GHBs) to simulate the movement of water between the Woodbine Aquifer and overlying wedge of younger deposits. The model also uses general-head boundaries to simulate the interaction of the aquifers with the Colorado River.

The results of the model run are described for the individual aquifers of interest; the Woodbine Aquifer (layer 1), the Paluxy Aquifer (layer 3), the Glen Rose Formation (layer 4), the Hensell Aquifer (layer 5), and the Hosston Aquifer (layer 7).

Water levels from the end of the transient calibration portion of the model run (the end of 1999/beginning of 2000) for layers 1, 3, 4, 5, and 7 are shown in Figures 1 to 5, respectively. These figures show the starting water levels for the 50-year predictive portion of the model run. These figures all show generally the same trend in initial water levels—higher water levels in the outcrop portions of the aquifers in the north and west, with water levels decreasing downdip (to the south and east). All of these figures also show the large cones of depression that have formed around large pumping centers, where decades of pumpage have significantly decreased water levels. These are especially noticeable in Ellis and Collin counties in the Woodbine Aquifer (layer 1; Figure 1), and the Dallas-Fort Worth and Waco areas in the Trinity Aquifer (layers 3, 4, 5, and 7; Figures 2 to 5).

Water levels at the end of the 50-year predictive portion of the simulation for layers 1, 3, 4, 5, and 7 are shown in Figures 6 to 10, respectively. Water levels at the end of the 50-year runs show similar trends to initial water levels (Figures 1 to 5); except that water levels in the heavily pumped areas are significantly lower than at the start of the model run. Because differences between initial water levels and water levels after 50 years of pumpage are sometimes difficult to quantify in these figures, maps of water level changes were made. A water level change map shows the difference between the water levels at the start and end of the 50-year predictive model run.

Water level changes over the 50-year predictive portion of the model simulation for layers 1, 3, 4, 5, and 7 are shown in Figures 11 to 15, respectively. Figure 11 indicates that water levels in the Woodbine Aquifer (layer 1) decrease over most of the model area over the 50-year predictive portion of the run. These changes range from less than 25 feet near the outcrop areas to over 400 feet in the large pumping centers over the 50-year predictive time period.

Figure 12 indicates that water levels are predicted to decrease throughout the model area in the Paluxy Aquifer (layer 3), with decreases generally less than 25 feet in the farthest updip extent of the aquifer, increasing to greater than 275 feet in the farthest downdip portions of the aquifer. Localized areas of even higher water level declines are found around the highest production areas of this aquifer, specifically on the Navarro-Ellis County line and in the northeast Dallas area in Rockwall County. Water levels have decreased more than 400 feet in these areas over the 50-year predictive time period.

Figure 13 indicates that water levels are also predicted to decrease throughout the model area in the Glen Rose Formation (layer 4), with decreases generally less than 25 feet in the farthest updip extent of the aquifer, increasing to greater than 400 feet in the farthest downdip portions of the aquifer.

Figure 14 indicates that water levels are also predicted to decrease throughout the model area in the Hensell Aquifer (layer 5), with decreases generally less than 25 feet in the farthest updip extent of the aquifer, increasing to greater than 475 feet in the farthest downdip portions of the aquifer. A large, localized area of higher water level declines are found in the Waco area in McLennan County. Water levels have decreased more than 550 feet in this area over the 50-year predictive time period.

Figure 15 indicates that water levels are also predicted to decrease throughout the model area in the Hosston Aquifer (layer 7), with decreases generally less than 25 feet in the farthest updip extent of the aquifer, increasing to greater than 500 feet in the farthest downdip portions of the aquifer. A large, localized area of higher water level declines are found in the Waco area in McLennan County. Water levels have decreased nearly 800 feet in this area over the 50-year predictive time period. Several other smaller localized areas of higher water level declines can be seen in Figure 15, including in Denton, Tarrant, Dallas, Johnson, Bosque, and Hill counties.

In addition to the drawdown figures, a summary table of average drawdowns for each layer in each county in the model area has been included in Table 6.

Because some of the desired future conditions for the groundwater management area may be based on discharge to springs or baseflow to rivers and streams, we also evaluated the water budgets for each of these components for each county in the model area. These budgets are provided in Appendix A. 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 removed from the aquifer 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 stream reaches 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 run. It should be noted that pumpage totals from the county budgets presented in Appendix A may be less than the specified pumpage given in Tables 1 to 4 due to the presence of dry cells. When a cell goes dry during the model run that cell is made inactive and therefore the pumpage from that cell is not included in the water budget.

Table 6. Average water level changes by county and aquifer. Negative values indicate an average lowering of water levels while a positive value indicates an increase in water levels. A dashed line indicates the aquifer does not exist or was not modeled for a particular county.

County	Average water level change (feet)				
	Woodbine Aquifer (Layer 1)	Paluxy Aquifer (Layer 3)	Glen Rose Formation (Layer 4)	Hensell Aquifer (Layer 5)	Hosston Aquifer (Layer 7)
Bastrop	-162	-248	-214	-211	-215
Bell	-43	-134	-155	-286	-319
Bosque	--	-26	-33	-201	-220
Bowie	-72	-44	-41	-44	-45
Brown	--	0	0	-1	-1
Burnet	--	-1	-1	-11	-29
Callahan	--	--	--	0	-2
Collin	-154	-298	-247	-224	-236
Comanche	--	0	0	-2	-11
Cooke	0	-26	-42	-60	-78
Coryell	--	-15	-15	-156	-179
Dallas	-112	-240	-224	-263	-290
Delta	-404	-175	-162	-162	-159
Denton	-16	-98	-134	-180	-214
Eastland	--	0	0	0	0
Ellis	-102	-265	-283	-336	-362
Erath	--	-1	-1	-11	-27
Falls	-60	-279	-354	-459	-480
Fannin	-186	-212	-196	-182	-181
Franklin	-354	-116	-105	-106	-106
Grayson	-28	-175	-161	-160	-165
Hamilton	--	0	-2	-39	-51
Henderson	-180	-304	-313	-340	-356
Hill	-87	-209	-253	-381	-406
Hood	--	-1	-2	-16	-56
Hopkins	-408	-153	-139	-142	-140
Hunt	-353	-286	-245	-215	-223
Jack	--	0	0	0	-3
Johnson	-4	-37	-83	-208	-234
Kaufman	-211	-303	-286	-295	-312
Lamar	-297	-132	-130	-136	-134
Lampasas	--	0	-1	-12	-23
Lee	-142	-248	-243	-246	-243
Limestone	-168	-328	-392	-475	-492
McLennan	-61	-251	-291	-489	-527
Milam	-90	-252	-294	-337	-344
Mills	--	0	0	-3	-12
Montague	--	0	-1	-3	-12
Navarro	-177	-344	-353	-399	-413
Palo Pinto	--	--	--	--	0
Parker	--	-5	-6	-16	-40

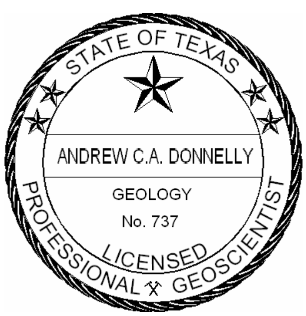
Table 6. continued

County	Average waterlevel change (feet)				
	Woodbine Aquifer (Layer 1)	Paluxy Aquifer (Layer 3)	Glen Rose Formation (Layer 4)	Hensell Aquifer (Layer 5)	Hosston Aquifer (Layer 7)
Red River	-202	-82	-77	-78	-78
Robertson	-59	-260	-335	-406	-441
Rockwall	-241	-346	-272	-248	-265
Somervell	--	-1	-4	-53	-113
Tarrant	-2	-33	-75	-160	-173
Taylor	--	--	--	--	-3
Titus	-270	-86	-80	-82	-82
Travis	-107	-124	-61	-98	-116
Williamson	-107	-108	-88	-142	-166
Wise	--	-4	-14	-23	-53

REFERENCES:

Bené, J., Harden, B., O'Rourke, D., Donnelly, A., and Yelderman, J., 2004, Northern Trinity/Woodbine Groundwater Availability Model: contract report to the Texas Water Development Board by R.W. Harden and Associates, 391 p.

Donnelly, Andrew C. A., 2007, GAM Run 07-09, Texas Water Development Board GAM Run Report, 71 p.



The seal appearing on this document was authorized by Andrew C.A. Donnelly, P.G. 737, on February 11, 2008.

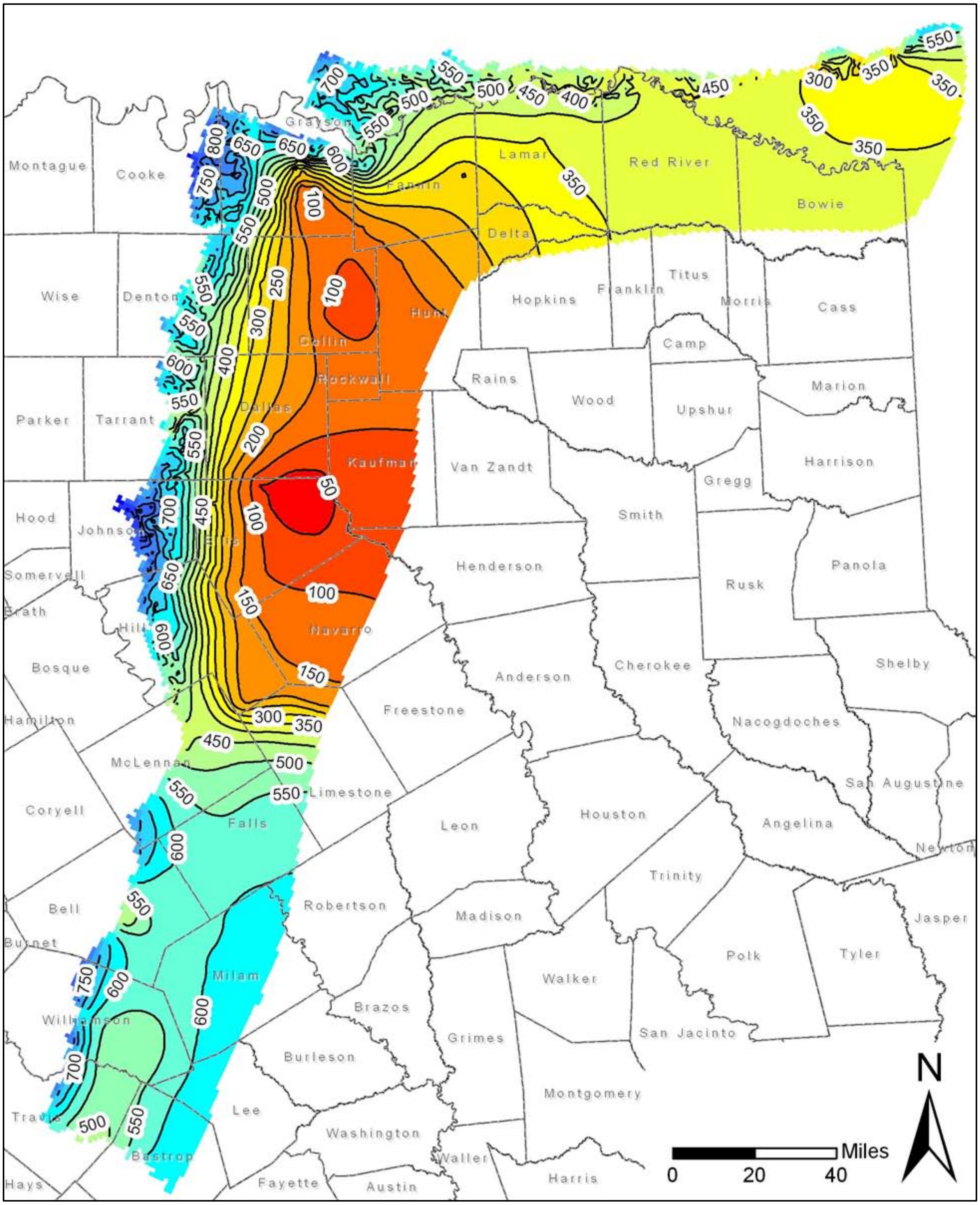


Figure 1. Initial water level elevations for the predictive model run in layer 1 (Woodbine Aquifer) of the groundwater availability model for northern part of the Trinity Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 50 feet.

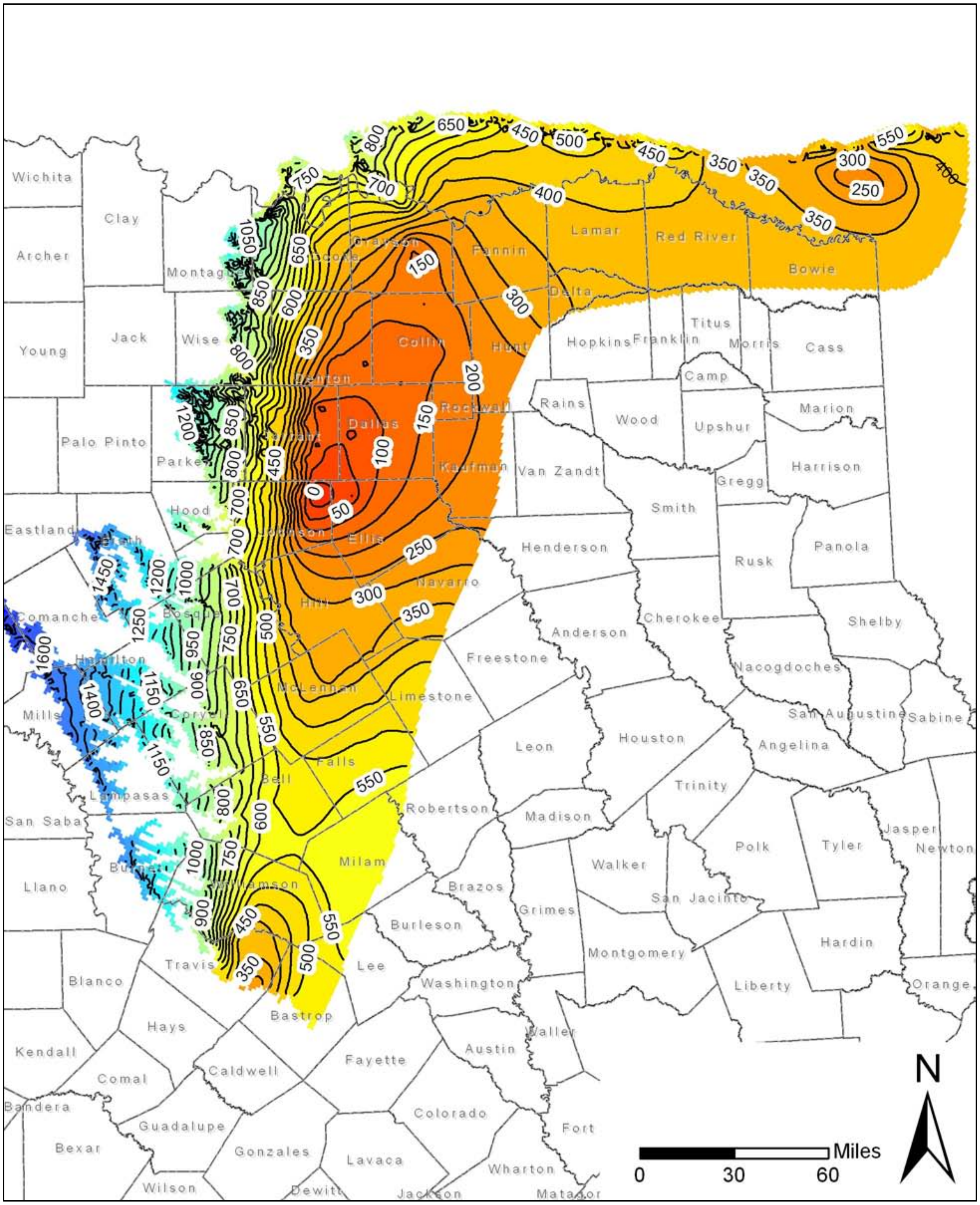


Figure 2. Initial water level elevations for the predictive model run in layer 3 (Paluxy Aquifer) of the groundwater availability model for northern part of the Trinity Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 50 feet.

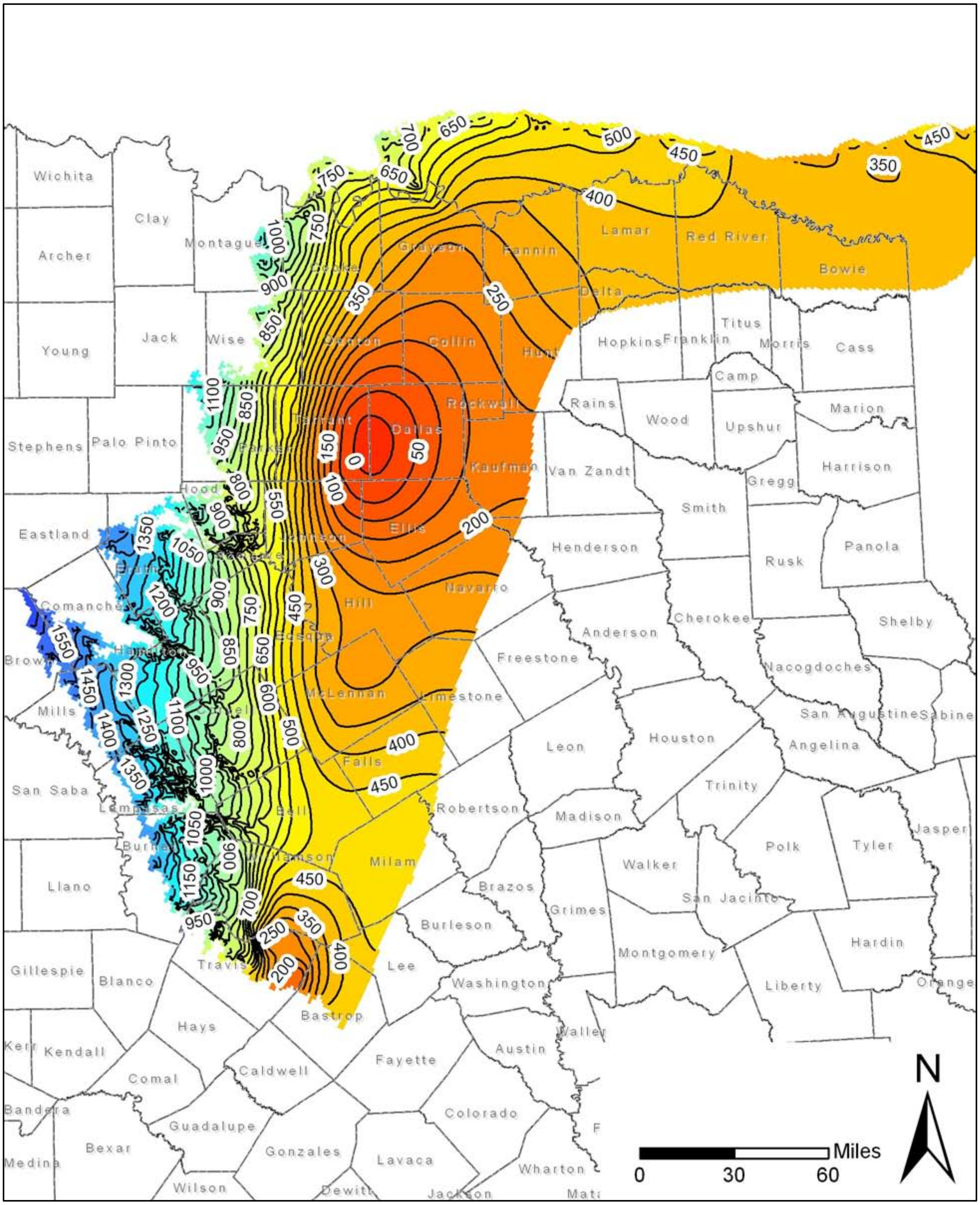


Figure 3. Initial water level elevations for the predictive model run in layer 4 (Glen Rose Formation) of the groundwater availability model for northern part of the Trinity Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 50 feet.

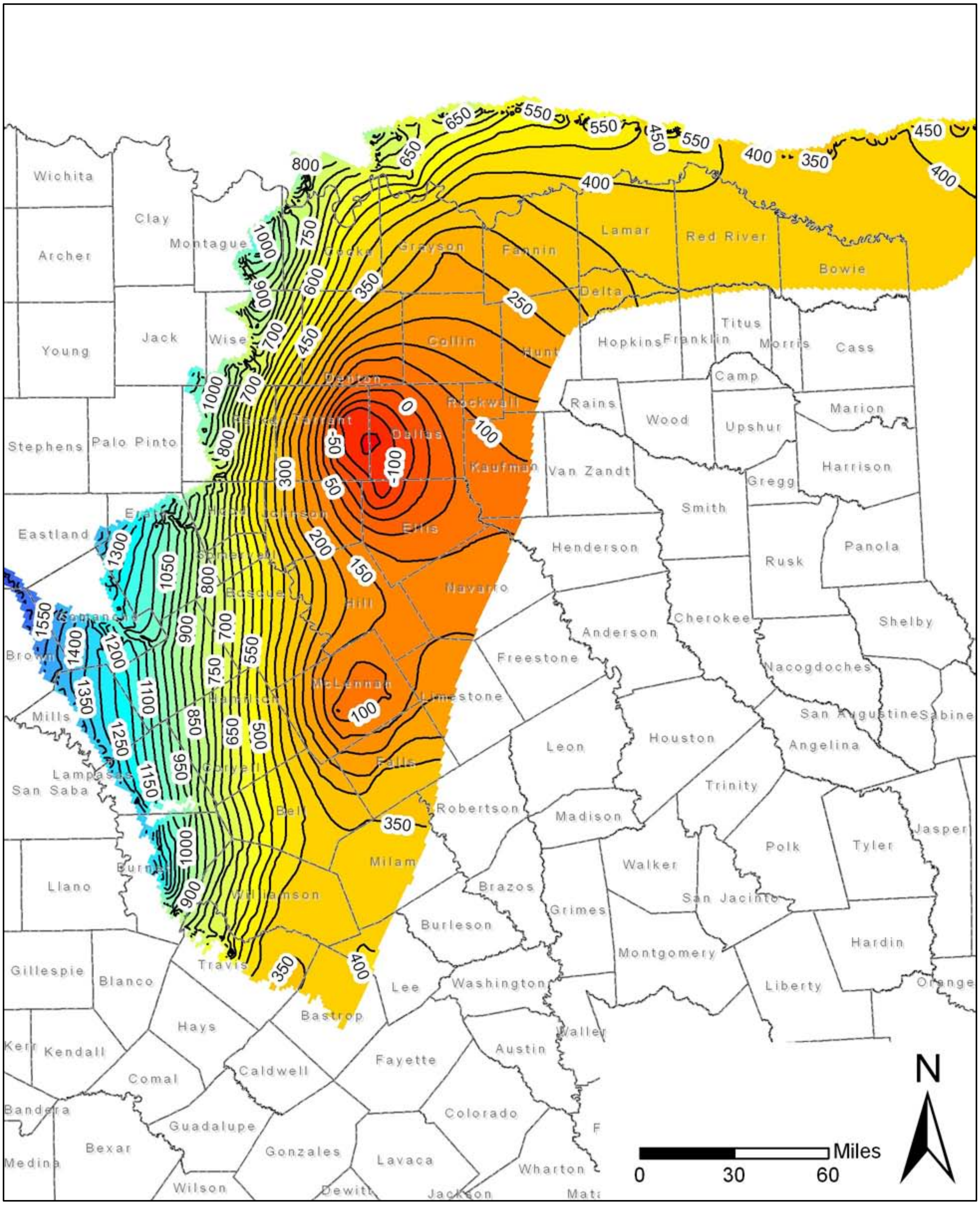


Figure 4. Initial water level elevations for the predictive model run in layer 5 (Hensell Aquifer) of the groundwater availability model for northern part of the Trinity Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 50 feet. Dry cells are shown in black.

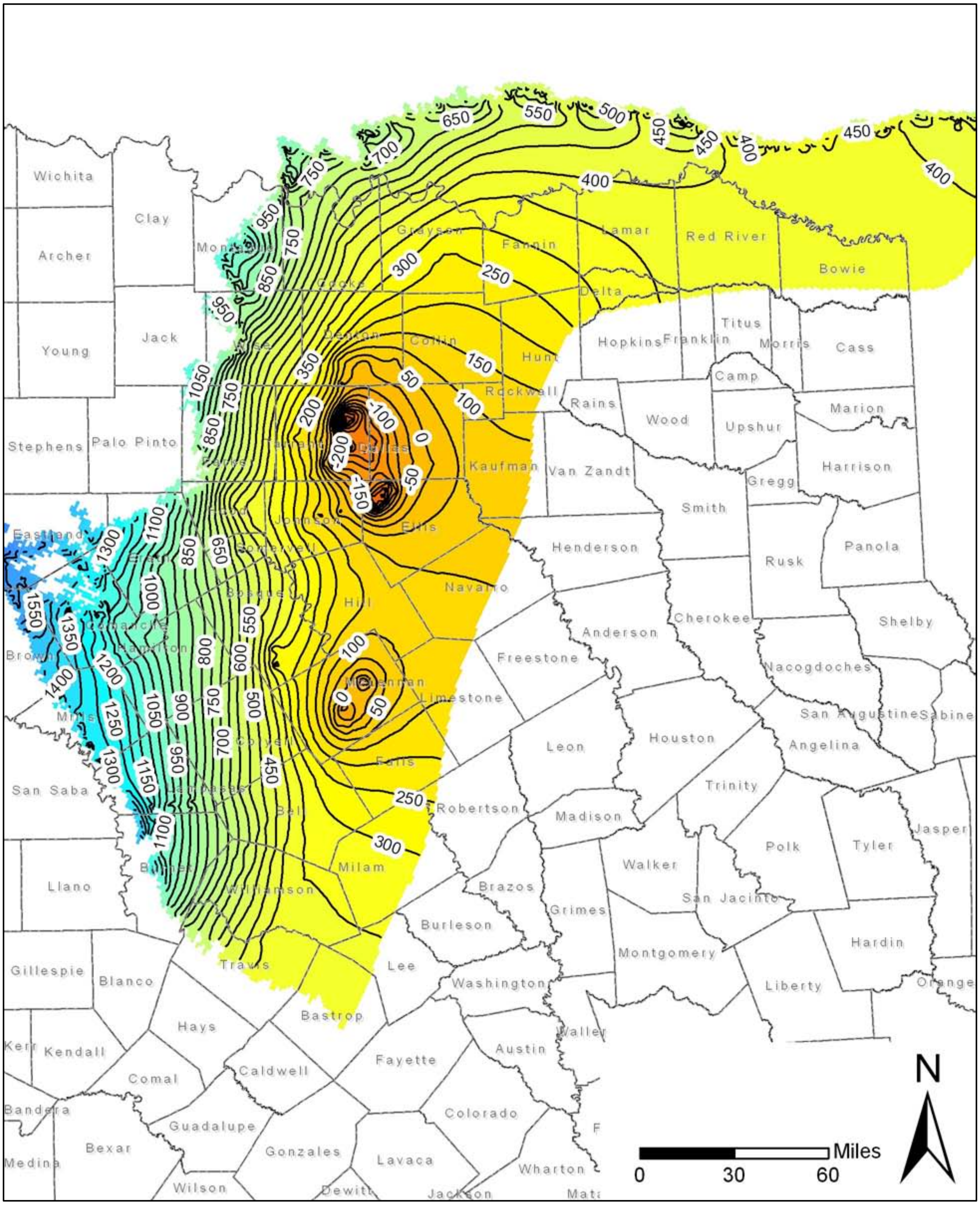


Figure 5. Initial water level elevations for the predictive model run in layer 7 (Hosston Aquifer) of the groundwater availability model for northern part of the Trinity Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 50 feet. Dry cells are shown in black.

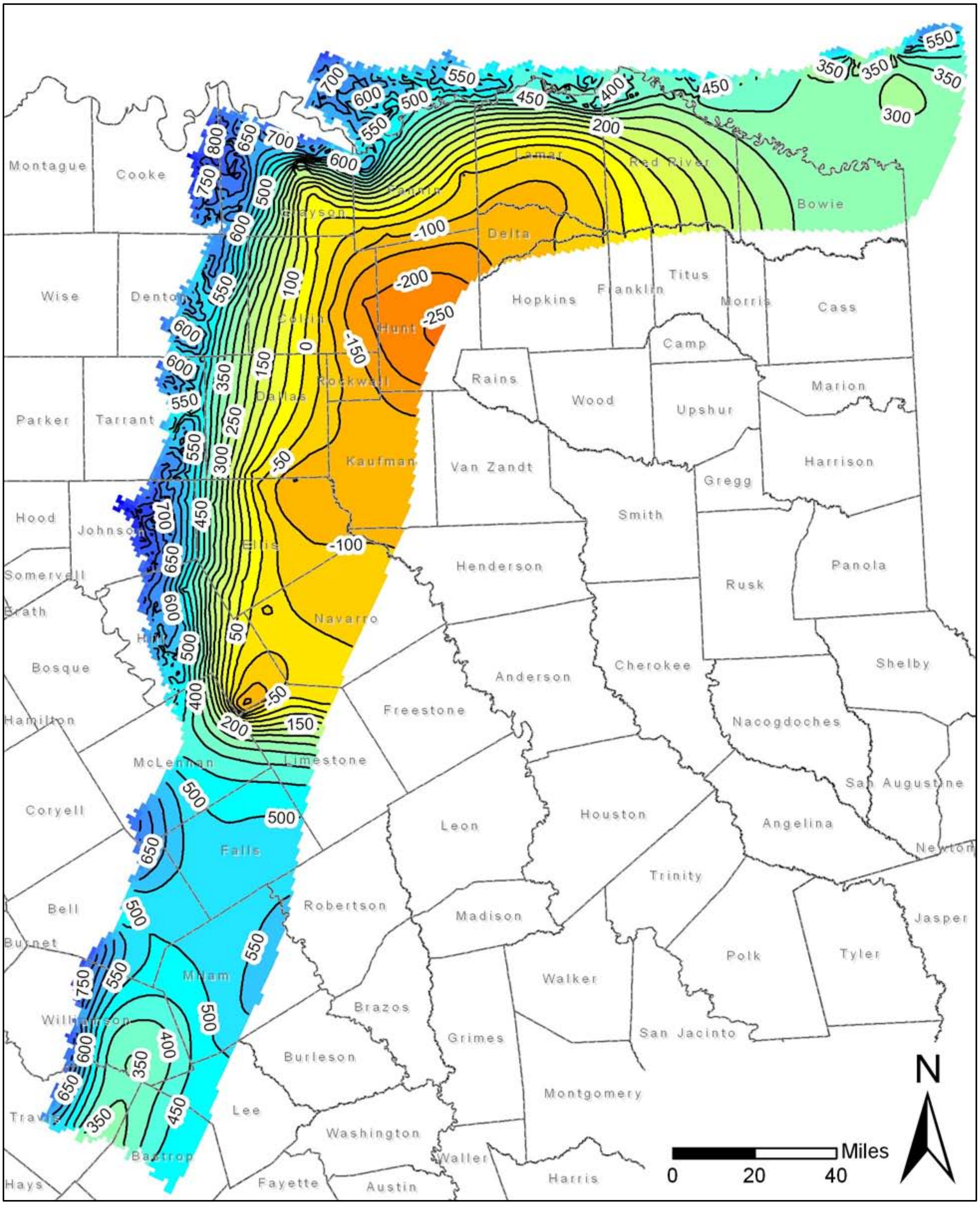


Figure 6. Water level elevations after 50 years using the specified pumpage in layer 1 (Woodbine Aquifer). Water level elevations are in feet above mean sea level. Contour interval is 50 feet.

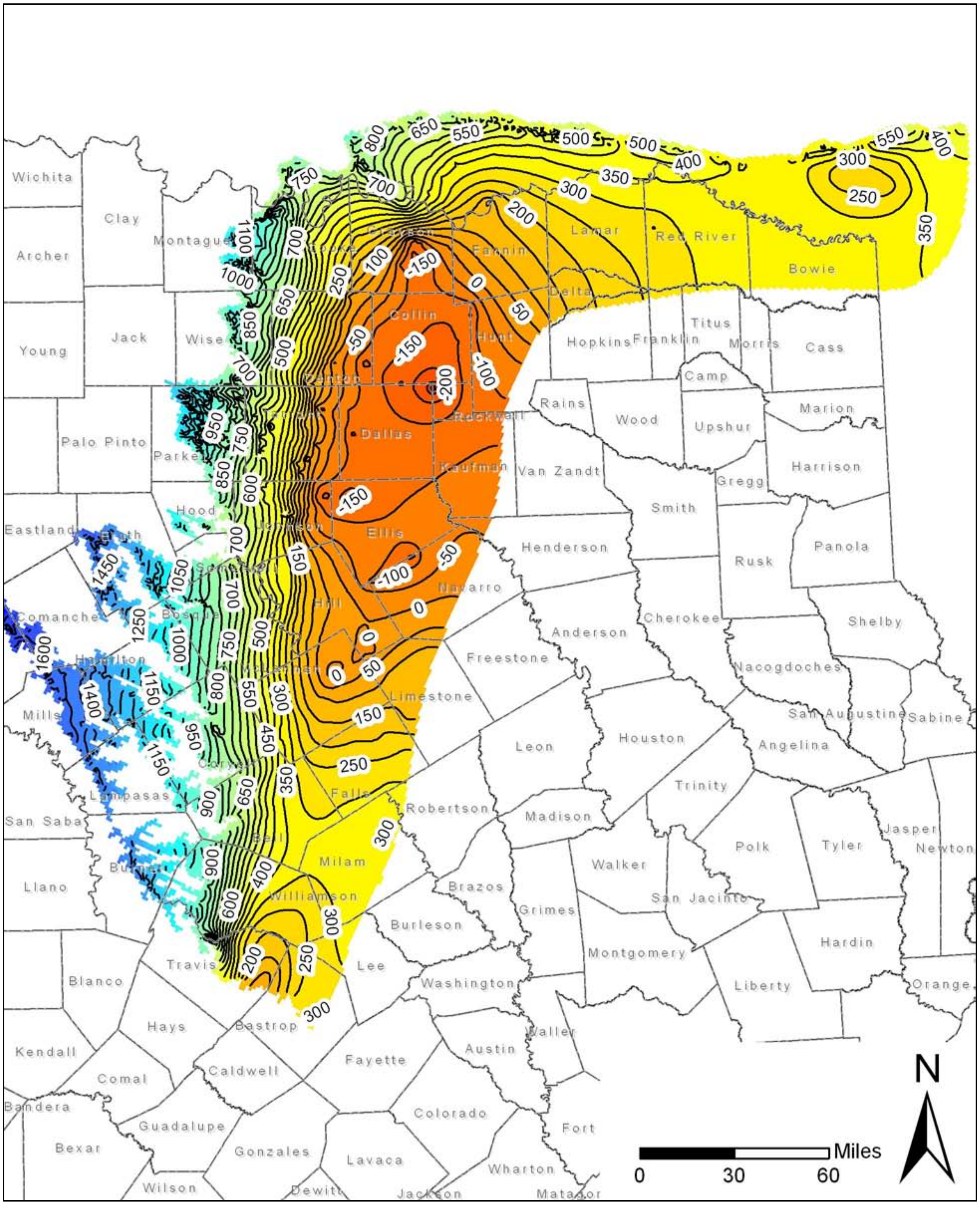


Figure 7. Water level elevations after 50 years using the specified pumpage in layer 3 (Paluxy Aquifer). Water level elevations are in feet above mean sea level. Contour interval is 50 feet. Dry cells are shown in black.

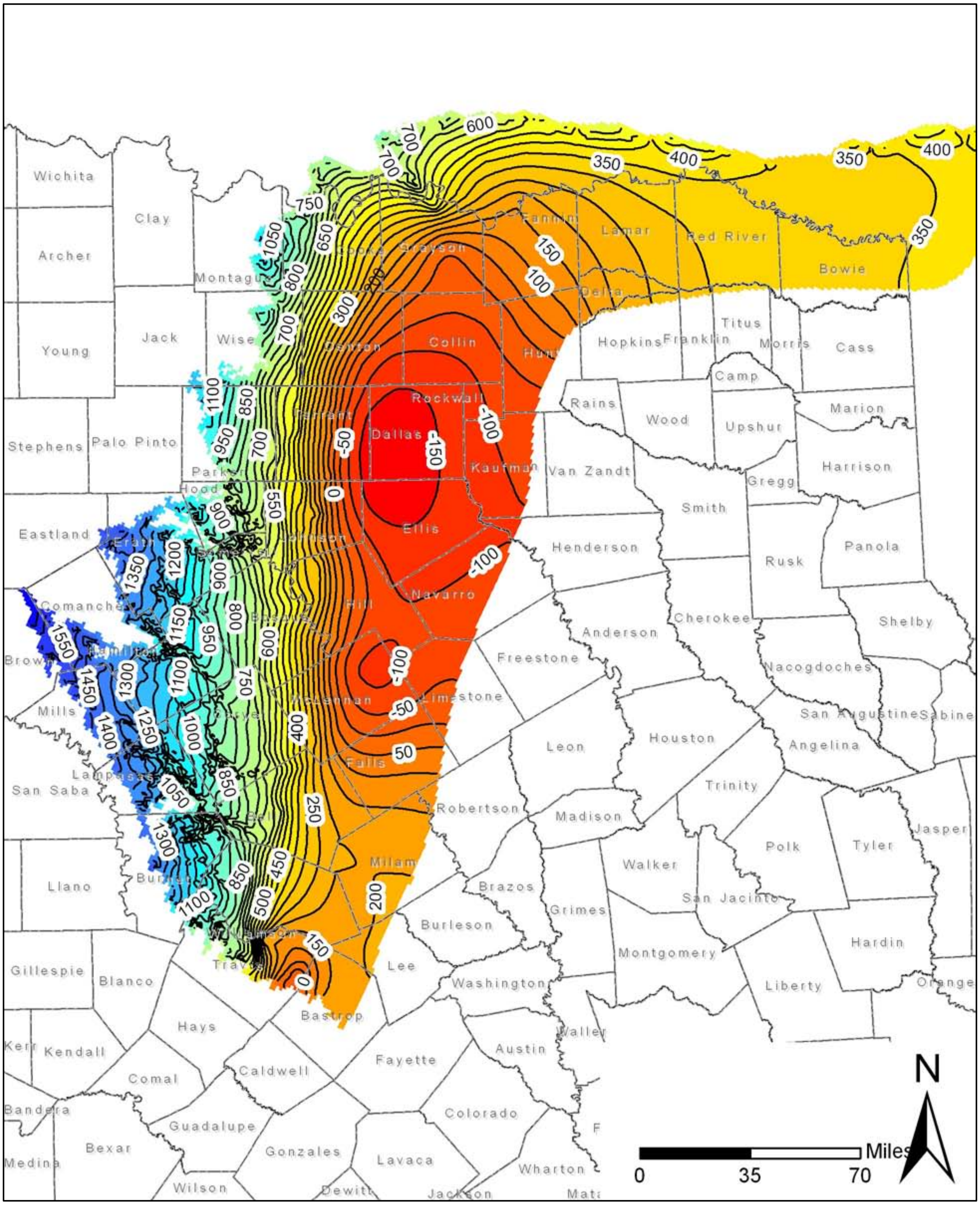


Figure 8. Water level elevations after 50 years using the specified pumpage in layer 4 (Glen Rose Formation). Water level elevations are in feet above mean sea level. Contour interval is 50 feet. Dry cells are shown in black.

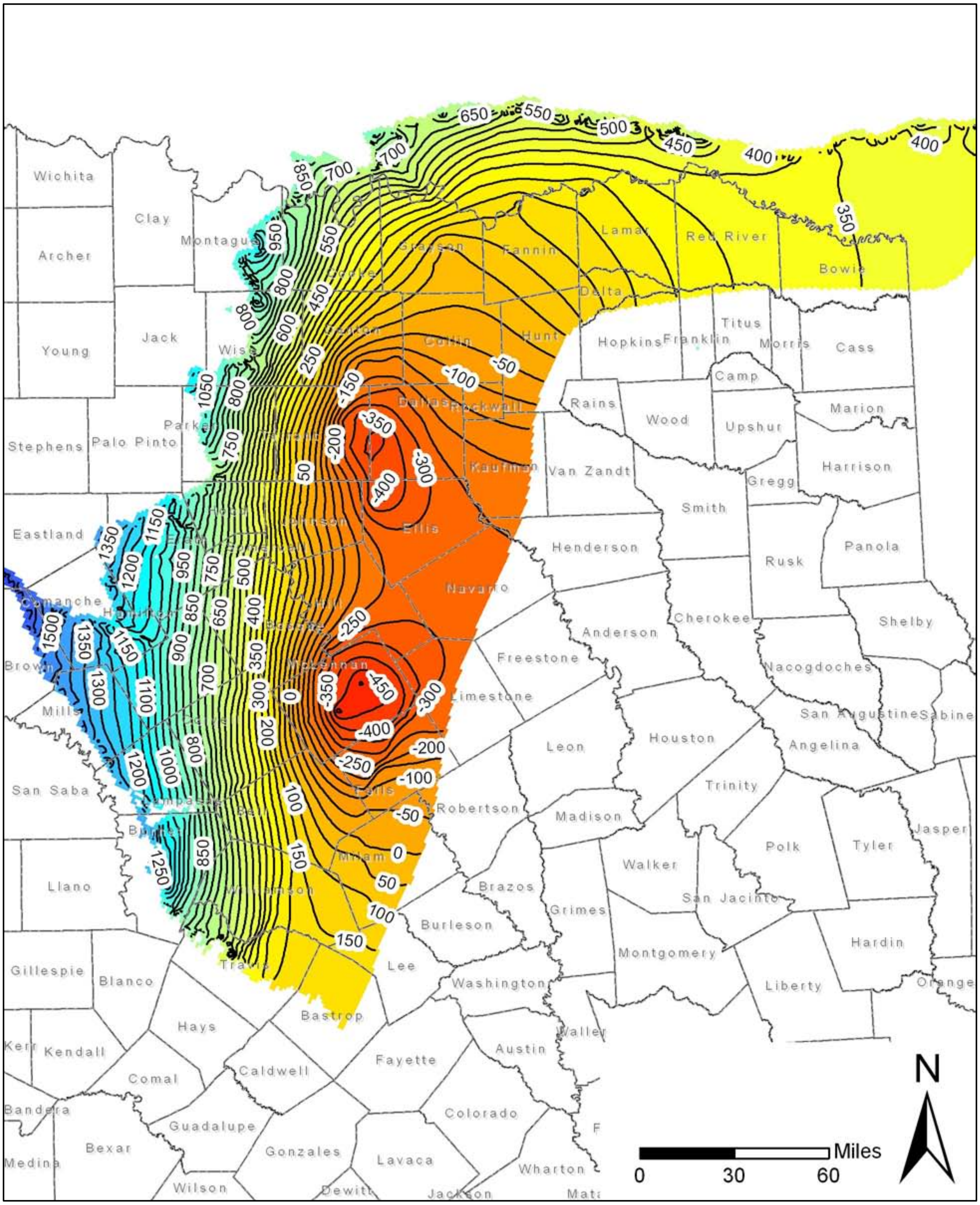


Figure 9. Water level elevations after 50 years using the specified pumpage in layer 5 (Hensell Aquifer). Water level elevations are in feet above mean sea level. Contour interval is 50 feet. Dry cells are shown in black.

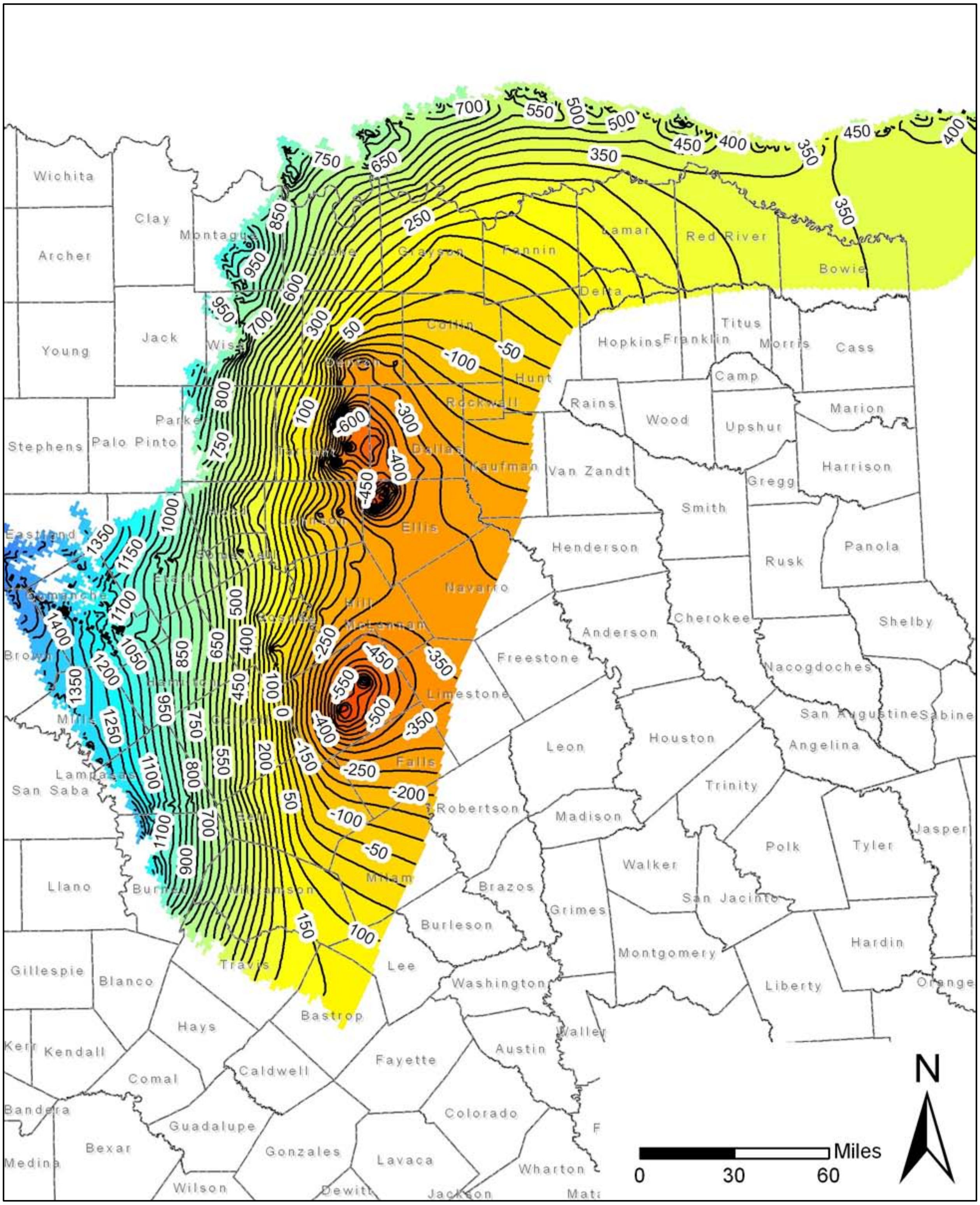


Figure 10. Water level elevations after 50 years using the specified pumpage in layer 7 (Hosston Aquifer). Water level elevations are in feet above mean sea level. Contour interval is 50 feet. Dry cells are shown in black.

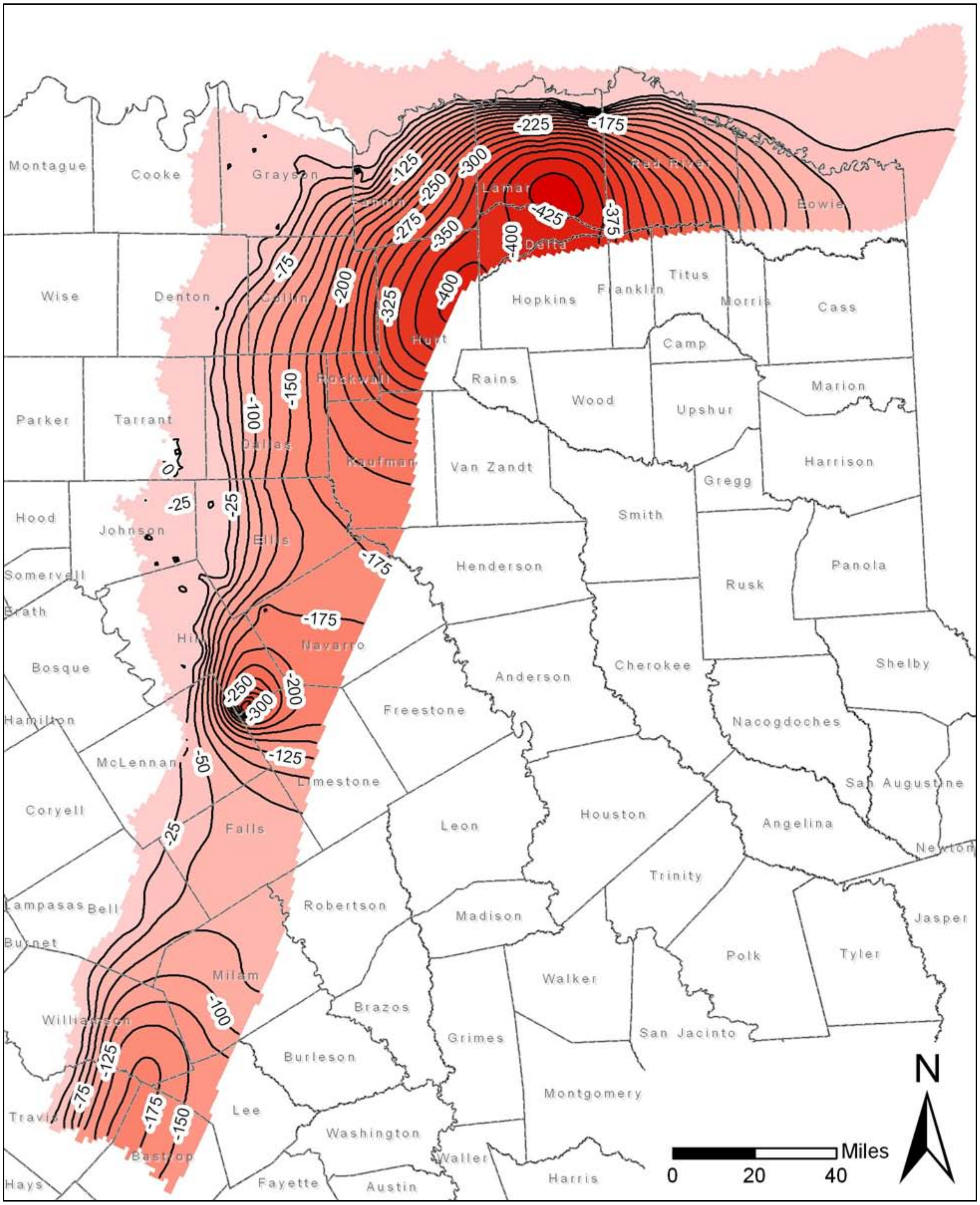


Figure 11. Changes in water levels after 50 years using the specified pumpage in layer 1 (Woodbine Aquifer). Water level changes are in feet. Contour interval is 25 feet. Decreases in water levels (drawdowns) are shown in red.

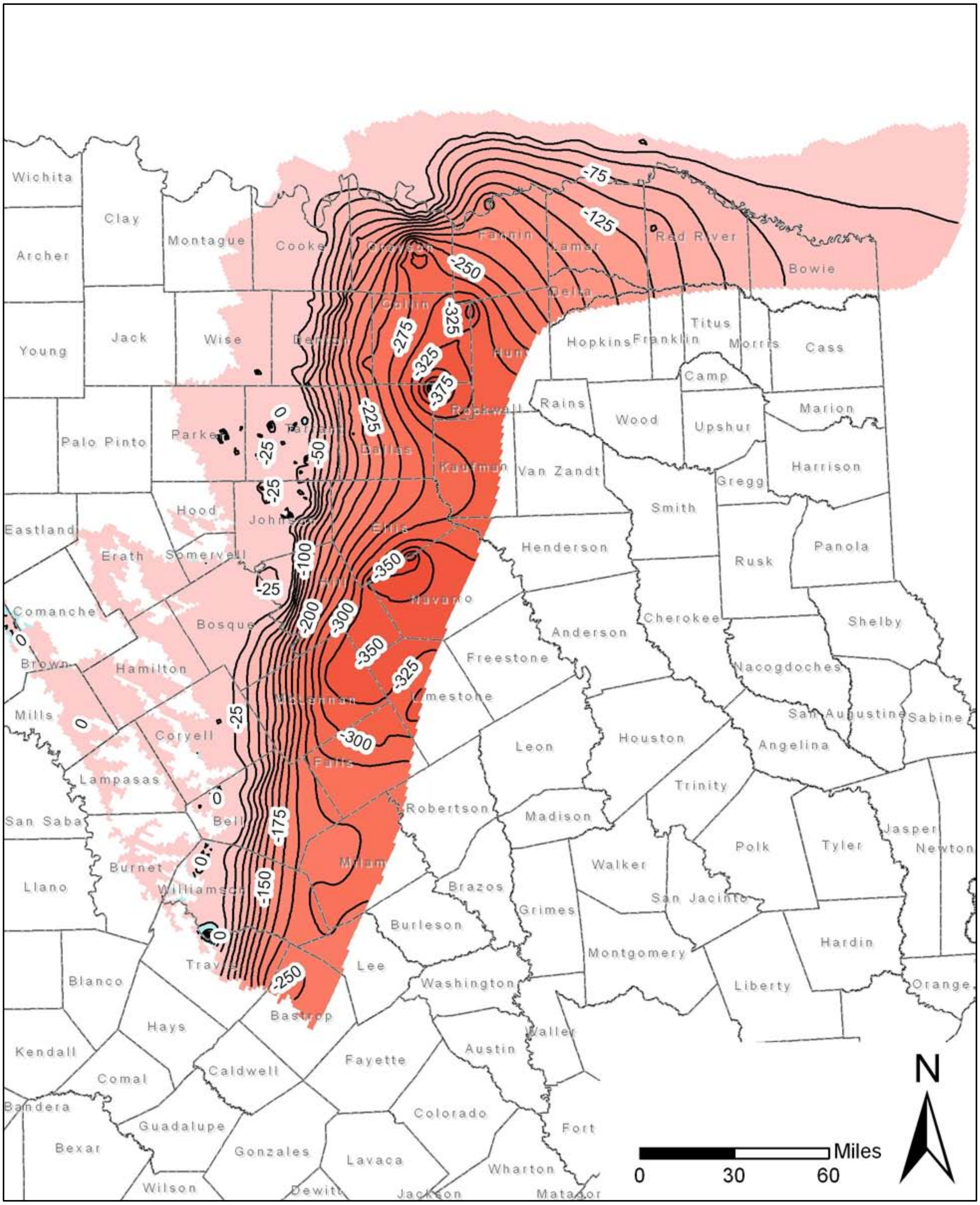


Figure 12. Changes in water levels after 50 years using the specified pumpage in layer 3 (Paluxy Aquifer). Water level changes are in feet. Contour interval is 25 feet. Decreases in water levels (drawdowns) are shown in red. Increases in water levels are shown in blue. Dry cells are shown in black.

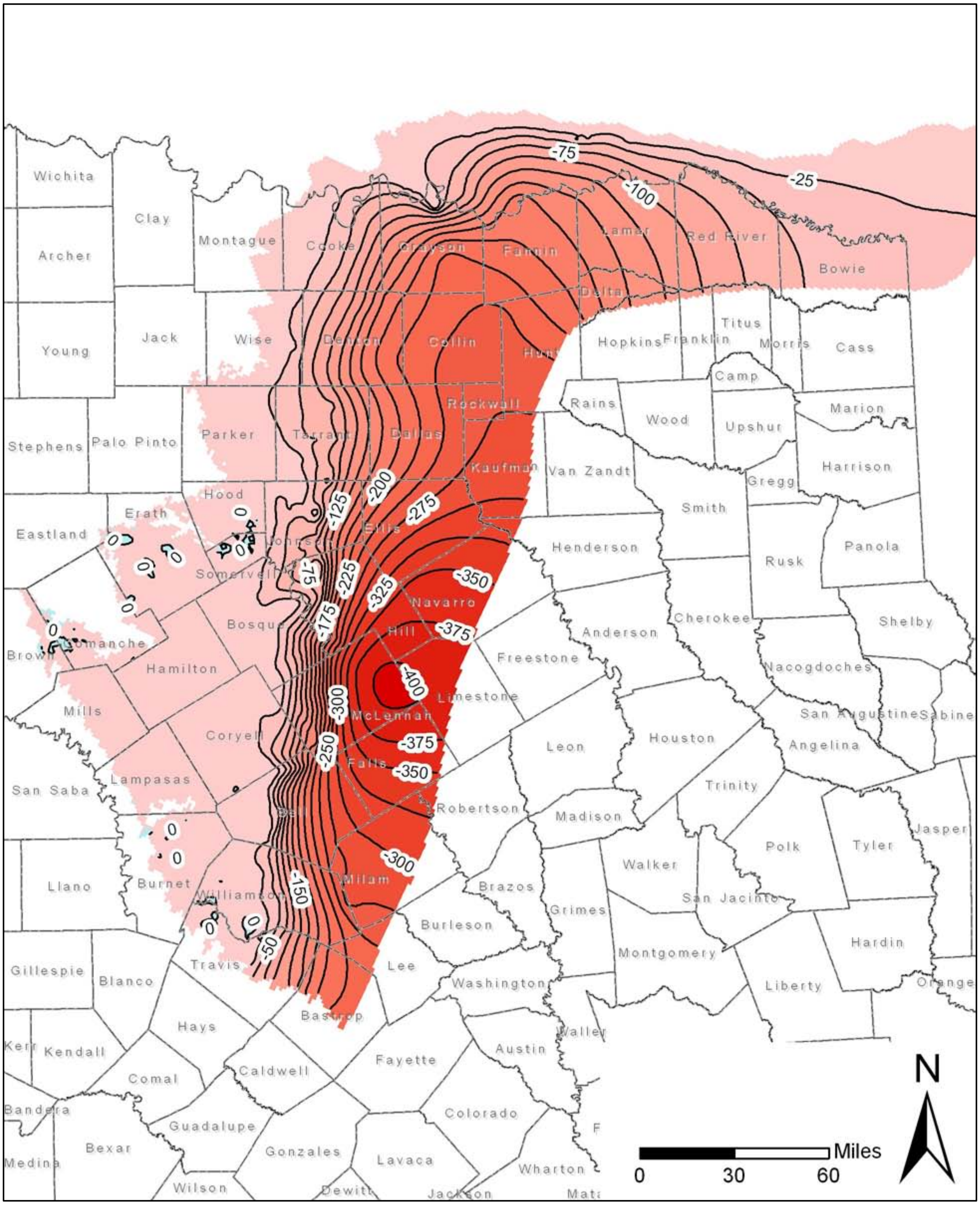


Figure 13. Changes in water levels after 50 years using the specified pumpage in layer 4 (Glen Rose Formation). Water level changes are in feet. Contour interval is 25 feet. Decreases in water levels (drawdowns) are shown in red. Increases in water levels are shown in blue. Dry cells are shown in black.

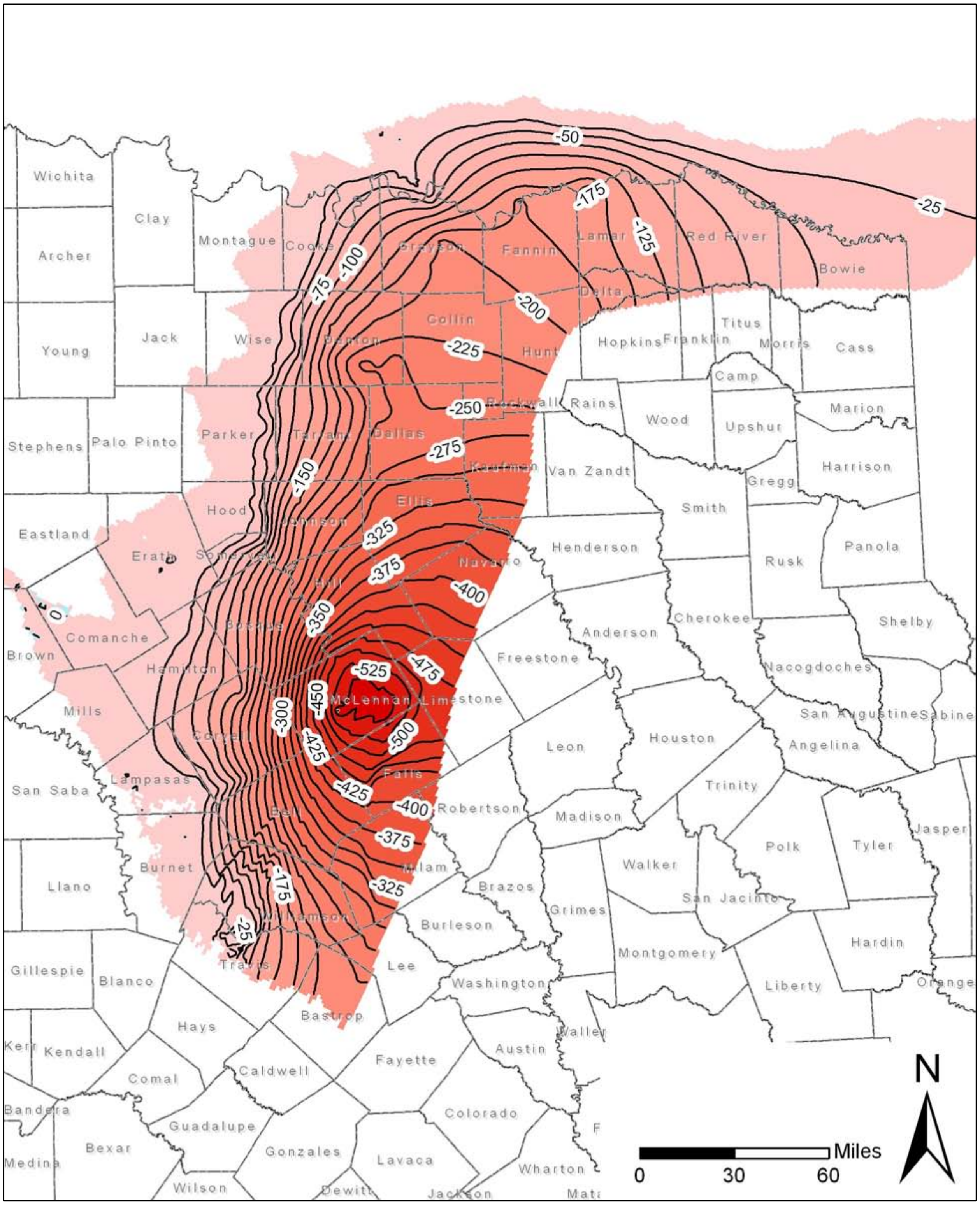


Figure 14. Changes in water levels after 50 years using the specified pumpage in layer 5 (Hensell Aquifer). Water level changes are in feet. Contour interval is 25 feet. Decreases in water levels (drawdowns) are shown in red. Increases in water levels are shown in blue. Dry cells are shown in black.

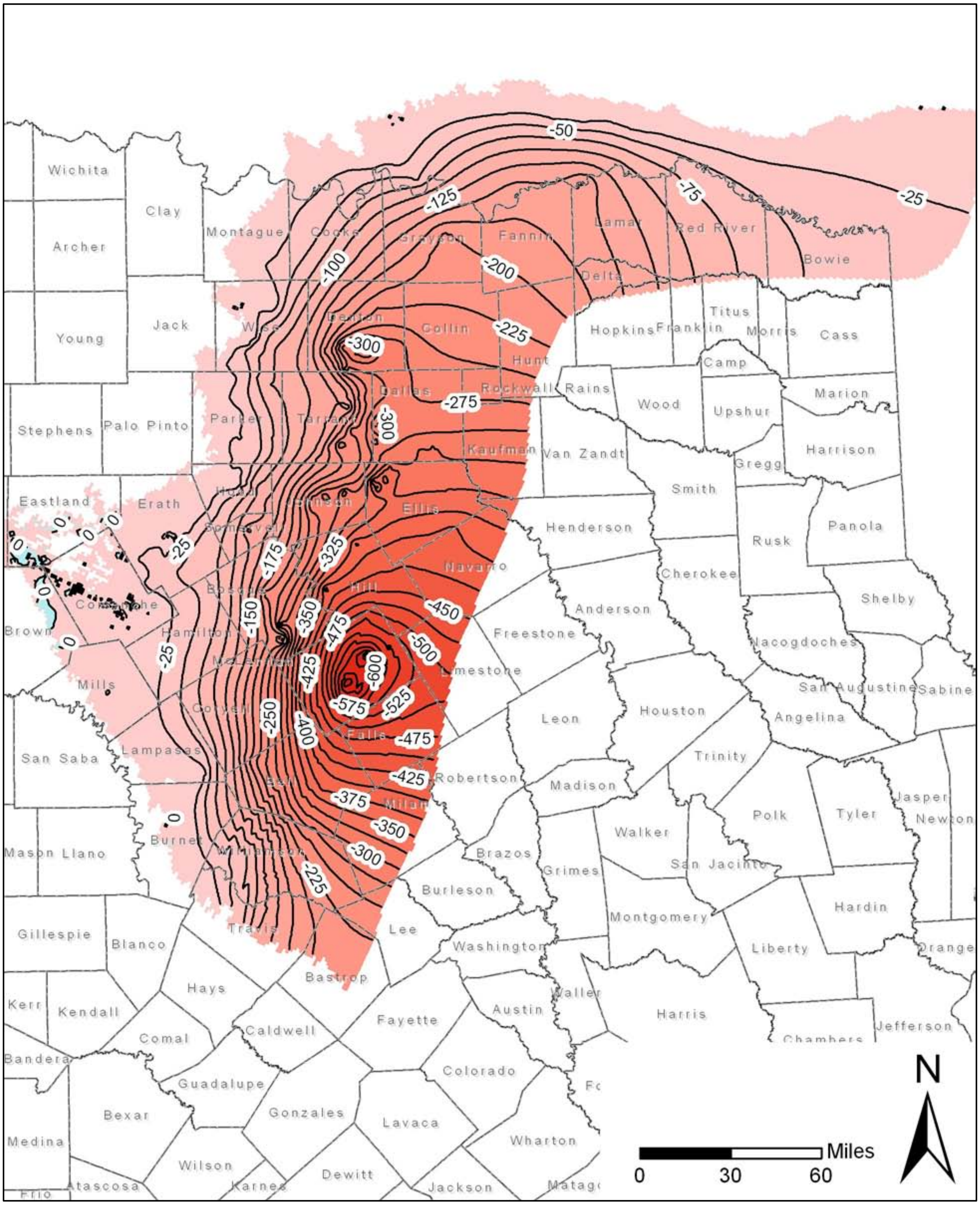


Figure 15. Changes in water levels after 50 years using the specified pumpage in layer 7 (Hosston Aquifer). Water level changes are in feet. Contour interval is 25 feet. Decreases in water levels (drawdowns) are shown in red. Increases in water levels are shown in blue. Dry cells are shown in black.

Appendix A

Summary of Water Budgets After 50 Years

Table A-1. Annual water budgets for each county at the end of the 50-year predictive portion of the model run using the requested baseline pumpage in the groundwater availability model for the northern part of the Trinity Aquifer (in acre-feet per year).

	Non-Texas		Bastrop		Bell		Bosque		Bowie		Brown	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Woodbine Aquifer (Layer 1)												
Change in storage	13,236	0	55	0	29	0	--	--	50	0	--	--
Reservoirs (River Package)	0	0	0	0	0	0	--	--	0	0	--	--
Inter-aquifer flow (GHB Package)	17	6	2	0	11	2	--	--	3	1	--	--
Wells	0	10	0	0	0	0	--	--	0	0	--	--
Rivers and streams (Stream Package)	39	5,054	0	0	3	10	--	--	0	0	--	--
Recharge	63,981	0	0	0	0	0	--	--	0	0	--	--
Evapotranspiration	0	71,020	0	0	0	0	--	--	0	0	--	--
Lateral inflow	666	1,569	0	2	2	5	--	--	18	84	--	--
Vertical leakage downward	17	296	0	55	1	29	--	--	17	3	--	--
Paluxy Aquifer (Layer 3)												
Change in storage	13,117	2	93	0	202	24	1,463	3	41	0	176	0
Reservoirs (River Package)	6	1	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	2	11	0	0	0	0	0	0	0	0	0	0
Wells	0	2,628	0	0	0	95	0	1,003	0	0	0	18
Rivers and streams (Stream Package)	0	1,066	0	0	0	0	0	492	0	0	0	0
Recharge	44,478	0	0	0	61	0	3,699	0	0	0	3,805	0
Evapotranspiration	0	49,978	0	0	0	0	0	3,332	0	0	0	3,649
Vertical leakage upward	889	21	0	15	199	14	361	10	13	0	12	0
Lateral inflow	1,468	4,080	1	3	49	23	468	652	24	93	22	107
Vertical leakage downward	528	2,702	0	76	0	355	0	497	15	0	2	242
Glen Rose Formation (Layer 4)												
Change in storage	421	0	70	0	2,696	0	1,843	0	31	0	120	0
Reservoirs (River Package)	0	0	0	0	15	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	1	0	880	0	258	0	0	0	0
Rivers and streams (Stream Package)	0	0	0	0	276	993	64	322	0	0	0	0
Recharge	0	0	0	0	2,173	0	677	0	0	0	1,937	0
Evapotranspiration	0	0	0	0	0	2,877	0	401	0	0	0	1,909
Vertical leakage upward	2,702	528	76	0	355	0	497	0	0	15	242	2
Lateral inflow	84	240	38	195	1,252	591	913	789	16	34	19	106
Vertical leakage downward	267	2,705	18	6	0	1,426	0	2,224	4	2	0	301

Table A-1. (continued)

	Non-Texas		Bastrop		Bell		Bosque		Bowie		Brown	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Hensell Aquifer (Layer 5)												
Change in storage	13,797	0	85	0	175	0	663	0	36	0	861	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	3,007	0	0	0	1,100	0	1,742	0	0	0	79
Rivers and streams (Stream Package)	0	339	0	0	0	0	0	0	0	0	0	0
Recharge	42,571	0	0	0	0	0	0	0	0	0	3,747	0
Evapotranspiration	0	49,559	0	0	0	0	0	0	0	0	0	3,130
Vertical leakage upward	2,705	267	6	18	1,426	0	2,224	0	2	4	301	0
Lateral inflow	2,227	5,530	0	3	3,671	2,067	7,699	6,354	149	175	67	484
Vertical leakage downward	1,377	3,975	1	71	0	2,105	0	2,490	0	8	0	1,283
Pearsall/Cow Creek/Sligo (Layer)												
Change in storage	486	2	66	0	142	0	42	0	29	0	48	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	0	0	0	0	0	0	0	0	0
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	0	0
Recharge	0	0	0	0	0	0	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	0
Vertical leakage upward	3,975	1,377	71	1	2,105	0	2,490	0	8	0	1,283	0
Lateral inflow	6	12	0	1	13	8	7	8	0	0	0	1
Vertical leakage downward	1,300	4,376	0	135	0	2,253	0	2,530	0	37	0	1,329
Hosston Aquifer (Layer 7)												
Change in storage	16,348	214	74	0	184	0	290	0	36	0	458	3
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	3,554	0	0	0	5,000	0	2,820	0	0	0	1,957
Rivers and streams (Stream Package)	0	273	0	0	0	0	0	0	0	0	0	0
Recharge	47,088	0	0	0	0	0	0	0	0	0	3,457	0
Evapotranspiration	0	56,685	0	0	0	0	0	0	0	0	0	2,866
Vertical leakage upward	4,376	1,300	135	0	2,253	0	2,530	0	37	0	1,329	0
Lateral inflow	2,512	8,298	695	904	6,787	4,223	4,252	4,252	546	619	165	582

Table A-1. (continued)

	Burnet		Callahan		Collin		Comanche		Cooke		Coryell	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Woodbine Aquifer (Layer 1)												
Change in storage	--	--	--	--	407	0	--	--	2,085	0	--	--
Reservoirs (River Package)	--	--	--	--	0	0	--	--	6	0	--	--
Inter-aquifer flow (GHB Package)	--	--	--	--	125	0	--	--	0	0	--	--
Wells	--	--	--	--	0	2,500	--	--	0	154	--	--
Rivers and streams (Stream Package)	--	--	--	--	0	0	--	--	0	0	--	--
Recharge	--	--	--	--	0	0	--	--	8,198	0	--	--
Evapotranspiration	--	--	--	--	0	0	--	--	0	9,829	--	--
Lateral inflow	--	--	--	--	3,711	1,856	--	--	139	438	--	--
Vertical leakage downward	--	--	--	--	113	0	--	--	0	7	--	--
Paluxy Aquifer (Layer 3)												
Change in storage	446	0	--	--	130	0	201	0	6,639	0	706	7
Reservoirs (River Package)	0	0	--	--	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	--	--	0	0	0	0	0	0	0	0
Wells	0	182	--	--	0	1,758	0	13	0	3,532	0	254
Rivers and streams (Stream Package)	0	31	--	--	0	0	0	0	84	842	0	267
Recharge	5,170	0	--	--	0	0	5,356	0	4,407	0	5,690	0
Evapotranspiration	0	5,306	--	--	0	0	0	5,419	0	3,981	0	5,790
Vertical leakage upward	31	4	--	--	229	0	23	0	307	3	224	8
Lateral inflow	2	6	--	--	2,063	976	167	70	1,760	3,363	213	240
Vertical leakage downward	2	122	--	--	312	0	1	245	18	1,496	1	269
Glen Rose Formation (Layer 4)												
Change in storage	2,836	23	--	--	126	0	469	2	37	0	6,044	0
Reservoirs (River Package)	0	0	--	--	0	0	0	0	0	0	6	0
Inter-aquifer flow (GHB Package)	0	0	--	--	0	0	0	0	0	0	0	0
Wells	0	200	--	--	0	0	0	0	0	0	0	783
Rivers and streams (Stream Package)	167	735	--	--	0	0	0	5	0	0	404	736
Recharge	8,779	0	--	--	0	0	8,491	0	0	0	8,029	0
Evapotranspiration	0	8,980	--	--	0	0	0	8,568	0	0	0	10,728
Vertical leakage upward	122	2	--	--	0	312	245	1	1,496	18	269	1
Lateral inflow	268	1,268	--	--	140	58	304	249	44	101	1,004	974
Vertical leakage downward	0	965	--	--	116	11	0	683	8	1,466	0	2,533

Table A-1. (continued)

	Burnet		Callahan		Collin		Comanche		Cooke		Coryell	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Hensell Aquifer (Layer 5)												
Change in storage	3,640	1	119	0	149	0	4,483	1	4,100	0	2,218	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	686	0	124	0	102	0	295	0	1,616	0	1,764
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	241	139	177	0	0
Recharge	1,316	0	661	0	0	0	13,384	0	452	0	0	0
Evapotranspiration	0	1,564	0	503	0	0	0	13,035	0	508	0	0
Vertical leakage upward	965	0	--	--	11	116	683	0	1,466	8	2,533	0
Lateral inflow	263	2,474	13	112	1,826	1,355	955	1,496	3,547	5,479	4,655	5,405
Vertical leakage downward	29	1,488	0	53	0	413	14	4,451	1	1,916	0	2,237
Pearsall/Cow Creek/Sligo (Layer)												
Change in storage	794	0	0	0	122	0	175	61	72	0	40	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	0	0	0	0	0	0	0	0	8
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	0	0
Recharge	0	0	0	0	0	0	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	0
Vertical leakage upward	1,488	29	53	0	413	0	4,451	14	1,916	1	2,237	0
Lateral inflow	1	8	0	0	6	6	1	2	9	9	7	10
Vertical leakage downward	29	2,275	0	53	0	535	13	4,564	0	1,987	0	2,266
Hosston Aquifer (Layer 7)												
Change in storage	2,954	3	3,950	1	151	0	12,250	14	241	0	53	0
Reservoirs (River Package)	0	0	0	0	0	0	19	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	34	0	0	0	0	0	0	0	0	0	0
Wells	0	2,485	0	3,663	0	239	0	22,986	0	1,715	0	913
Rivers and streams (Stream Package)	0	0	0	27	0	0	50	33	0	330	0	0
Recharge	1,010	0	9,425	0	0	0	10,209	0	280	0	0	0
Evapotranspiration	0	746	0	9,615	0	0	0	4,056	0	425	0	0
Vertical leakage upward	2,275	29	53	0	535	0	4,564	13	1,987	0	2,266	0
Lateral inflow	665	3,607	336	458	3,638	4,086	1,078	1,068	5,088	5,125	4,306	5,712

Table A-1. (continued)

	Dallas		Delta		Denton		Eastland		Ellis		Erath	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Woodbine Aquifer (Layer 1)												
Change in storage	1,318	0	14	0	4,941	0	--	--	2,952	0	--	--
Reservoirs (River Package)	0	0	0	0	108	79	--	--	0	0	--	--
Inter-aquifer flow (GHB Package)	130	0	15	0	32	0	--	--	151	0	--	--
Wells	0	2,316	0	16	0	4,132	--	--	0	5,444	--	--
Rivers and streams (Stream Package)	5	0	0	0	22	350	--	--	0	0	--	--
Recharge	50	0	0	0	12,383	0	--	--	0	0	--	--
Evapotranspiration	0	0	0	0	0	11,118	--	--	0	0	--	--
Lateral inflow	3,625	2,883	376	444	483	2,264	--	--	3,155	946	--	--
Vertical leakage downward	76	5	55	0	1	28	--	--	134	2	--	--
Paluxy Aquifer (Layer 3)												
Change in storage	154	0	38	0	7,975	0	35	0	219	0	4,255	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	467	0	0	0	9,804	0	4	0	400	0	4,246
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	0	0
Recharge	0	0	0	0	0	0	239	0	0	0	12,377	0
Evapotranspiration	0	0	0	0	0	0	0	253	0	0	0	12,025
Vertical leakage upward	247	0	3	0	403	0	--	--	238	0	39	0
Lateral inflow	1,266	1,071	649	703	3,892	1,546	7	18	425	338	54	79
Vertical leakage downward	28	157	13	0	46	966	0	5	0	146	0	375
Glen Rose Formation (Layer 4)												
Change in storage	155	0	34	0	51	0	63	0	209	0	3,335	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	0	0	0	0	0	0	0	0	1
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	10	732
Recharge	0	0	0	0	0	0	246	0	0	0	10,850	0
Evapotranspiration	0	0	0	0	0	0	0	197	0	0	0	12,132
Vertical leakage upward	157	28	0	13	966	46	5	0	146	0	375	0
Lateral inflow	186	16	121	120	158	81	23	114	219	29	548	618
Vertical leakage downward	0	455	0	22	22	1,070	0	26	0	544	1	1,636

Table A-1. (continued)

	Dallas		Delta		Denton		Eastland		Ellis		Erath	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Hensell Aquifer (Layer 5)												
Change in storage	192	0	37	0	85	0	392	0	251	0	18,009	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	1,121	0	182	0	3,110	0	79	0	1,142	0	9,273
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	126	416
Recharge	0	0	0	0	0	0	2,574	0	0	0	4,189	0
Evapotranspiration	0	0	0	0	0	0	0	2,525	0	0	0	2,986
Vertical leakage upward	455	0	22	0	1,070	22	26	0	544	0	1,636	1
Lateral inflow	2,016	604	808	654	5,497	1,664	160	127	1,927	431	1,104	4,176
Vertical leakage downward	0	937	0	31	0	1,856	6	427	0	1,149	0	8,212
Pearsall/Cow Creek/Sligo (Layer)												
Change in storage	156	0	30	0	72	0	9	7	204	0	203	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	0	0	0	0	0	0	0	0	0
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	0	0
Recharge	0	0	0	0	0	0	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	0
Vertical leakage upward	937	0	31	0	1,856	0	427	6	1,149	0	8,212	0
Lateral inflow	8	5	4	4	13	5	0	0	10	2	1	3
Vertical leakage downward	0	1,097	0	60	0	1,935	6	429	0	1,361	0	8,413
Hosston Aquifer (Layer 7)												
Change in storage	194	0	35	0	93	0	2,600	47	252	0	8,493	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	3,903	0	182	0	6,395	0	4,630	0	2,417	0	16,016
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	13	0	0	0	0
Recharge	0	0	0	0	0	0	11,485	0	0	0	491	0
Evapotranspiration	0	0	0	0	0	0	0	9,848	0	0	0	226
Vertical leakage upward	1,097	0	60	0	1,935	0	429	6	1,361	0	8,413	0
Lateral inflow	4,216	1,604	3,047	2,961	6,063	1,695	469	439	2,166	1,362	1,154	2,309

Table A-1. (continued)

	Falls		Fannin		Franklin		Grayson		Hamilton		Henderson	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Woodbine Aquifer (Layer 1)												
Change in storage	57	0	3,812	0	2	0	11,859	0	--	--	2	0
Reservoirs (River Package)	0	0	0	0	0	0	9	4	--	--	0	0
Inter-aquifer flow (GHB Package)	0	11	119	0	1	0	117	0	--	--	2	0
Wells	0	0	0	3,300	0	0	0	12,100	--	--	0	0
Rivers and streams (Stream Package)	0	0	295	466	0	0	0	0	--	--	0	0
Recharge	0	0	2,760	0	0	0	14,251	0	--	--	0	0
Evapotranspiration	0	0	0	1,694	0	0	0	14,199	--	--	0	0
Lateral inflow	7	12	1,950	3,582	160	166	1,771	1,730	--	--	95	105
Vertical leakage downward	0	41	113	8	4	0	56	31	--	--	6	0
Paluxy Aquifer (Layer 3)												
Change in storage	261	0	115	0	3	0	1,964	0	1,049	5	14	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	288	0	0	0	4,709	0	291	0	0
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	353	0	0
Recharge	0	0	0	0	0	0	0	0	9,280	0	0	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	9,397	0	0
Vertical leakage upward	112	0	132	0	0	0	362	0	145	0	5	0
Lateral inflow	4	8	1,295	1,356	61	64	3,583	1,353	104	231	21	37
Vertical leakage downward	0	370	106	4	1	0	320	167	0	300	0	4
Glen Rose Formation (Layer 4)												
Change in storage	198	0	102	0	2	0	165	0	3,643	7	13	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	2	0	0	0	0	0	0	0	46	0	0
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	287	1,088	0	0
Recharge	0	0	0	0	0	0	0	0	7,642	0	0	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	8,619	0	0
Vertical leakage upward	370	0	4	106	0	1	167	320	300	0	4	0
Lateral inflow	176	162	120	119	22	23	152	76	568	1,012	5	8
Vertical leakage downward	0	580	29	30	0	1	140	228	0	1,670	0	13

Table A-1. (continued)

	Falls		Fannin		Franklin		Grayson		Hamilton		Henderson	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Hensell Aquifer (Layer 5)												
Change in storage	223	0	118	0	3	0	521	0	3,038	0	14	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	21	0	203	0	0	0	2,345	0	1,110	0	0
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	6	0	0
Recharge	0	0	0	0	0	0	0	0	52	0	0	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	90	0	0
Vertical leakage upward	580	0	30	29	1	0	228	140	1,670	0	13	0
Lateral inflow	616	614	1,268	1,077	100	101	4,173	2,118	3,317	4,687	68	80
Vertical leakage downward	1	785	16	123	0	2	37	356	8	2,193	0	15
Pearsall/Cow Creek/Sligo (Layer)												
Change in storage	174	0	95	0	2	0	76	0	5	0	11	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	0	0	0	0	0	0	0	0	0
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	0	0
Recharge	0	0	0	0	0	0	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	0
Vertical leakage upward	785	1	123	16	2	0	356	37	2,193	8	15	0
Lateral inflow	6	9	4	5	0	0	5	4	3	4	0	1
Vertical leakage downward	0	956	5	206	0	4	14	410	8	2,196	0	26
Hosston Aquifer (Layer 7)												
Change in storage	196	0	117	0	2	0	97	0	7	0	13	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	138	0	209	0	0	0	2,346	0	699	0	0
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	0	0
Recharge	0	0	0	0	0	0	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	0
Vertical leakage upward	956	0	206	5	4	0	410	14	2,196	8	26	0
Lateral inflow	4,798	5,812	2,423	2,532	397	404	5,057	3,204	1,813	3,310	455	493

Table A-1. (continued)

	Hill		Hood		Hopkins		Hunt		Jack		Johnson	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Woodbine Aquifer (Layer 1)												
Change in storage	2,004	4	--	--	4	0	29	0	--	--	2,798	606
Reservoirs (River Package)	32	1	--	--	0	0	0	0	--	--	0	0
Inter-aquifer flow (GHB Package)	106	0	--	--	3	0	56	0	--	--	18	0
Wells	0	2,263	--	--	0	0	0	2,841	--	--	0	4,735
Rivers and streams (Stream Package)	0	272	--	--	0	0	0	0	--	--	0	10
Recharge	7,239	0	--	--	0	0	0	0	--	--	13,031	0
Evapotranspiration	0	6,777	--	--	0	0	0	0	--	--	0	9,247
Lateral inflow	427	551	--	--	180	197	2,742	126	--	--	114	1,337
Vertical leakage downward	72	12	--	--	11	0	140	0	--	--	0	25
Paluxy Aquifer (Layer 3)												
Change in storage	1,017	0	732	2	8	0	130	0	26	0	8,819	1
Reservoirs (River Package)	0	0	1	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	1,254	0	933	0	0	0	551	0	3	0	9,493
Rivers and streams (Stream Package)	0	0	2	501	0	0	0	0	0	0	0	94
Recharge	0	0	5,830	0	0	0	0	0	208	0	79	0
Evapotranspiration	0	0	0	4,819	0	0	0	0	0	241	0	1
Vertical leakage upward	336	0	18	0	0	0	70	0	--	--	330	1
Lateral inflow	667	488	138	383	251	261	1,088	845	12	0	1,217	580
Vertical leakage downward	0	278	0	83	2	0	108	0	0	3	4	281
Glen Rose Formation (Layer 4)												
Change in storage	559	0	1,430	2	7	0	120	0	30	0	486	0
Reservoirs (River Package)	0	0	33	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	10	0	4	0	0	0	0	0	0	0	24
Rivers and streams (Stream Package)	0	0	303	1,541	0	0	0	0	0	0	0	0
Recharge	0	0	10,680	0	0	0	0	0	467	0	0	0
Evapotranspiration	0	0	0	9,572	0	0	0	0	0	450	0	0
Vertical leakage upward	278	0	83	0	0	2	0	108	3	0	281	4
Lateral inflow	426	308	312	895	55	57	104	111	10	28	735	337
Vertical leakage downward	0	945	1	827	0	3	9	14	0	32	0	1,137

Table A-1. (continued)

	Hill		Hood		Hopkins		Hunt		Jack		Johnson	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Hensell Aquifer (Layer 5)												
Change in storage	207	0	7,022	0	8	0	131	0	202	0	423	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	933	0	3,568	0	0	0	0	0	1	0	1,064
Rivers and streams (Stream Package)	0	0	108	438	0	0	0	0	0	0	0	0
Recharge	0	0	2,167	0	0	0	0	0	684	0	0	0
Evapotranspiration	0	0	0	1,116	0	0	0	0	0	806	0	0
Vertical leakage upward	945	0	827	1	3	0	14	9	32	0	1,137	0
Lateral inflow	3,891	2,663	1,633	3,046	285	290	672	693	6	50	4,436	3,372
Vertical leakage downward	0	1,447	0	3,588	0	6	0	115	0	67	21	1,581
Pearsall/Cow Creek/Sligo (Layer)												
Change in storage	170	0	24	0	6	0	105	0	2	0	57	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	0	0	0	0	0	0	0	0	0
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	0	0
Recharge	0	0	0	0	0	0	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	0
Vertical leakage upward	1,447	0	--	--	6	0	115	0	67	0	1,581	21
Lateral inflow	6	8	2	3	1	1	5	5	0	1	6	9
Vertical leakage downward	0	1,616	0	3,611	0	12	0	219	0	69	19	1,632
Hosston Aquifer (Layer 7)												
Change in storage	214	0	2,505	0	7	0	124	0	295	0	73	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	951	0	6,559	0	0	0	0	0	7	0	2,289
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	0	0
Recharge	0	0	132	0	0	0	0	0	1,014	0	0	0
Evapotranspiration	0	0	0	149	0	0	0	0	0	1,310	0	0
Vertical leakage upward	1,616	0	3,611	0	12	0	219	0	69	0	1,632	19
Lateral inflow	2,433	3,312	1,794	1,335	1,281	1,301	2,759	3,103	104	163	1,938	1,336

Table A-1. (continued)

	Kaufman		Lamar		Lampasas		Lee		Limestone		McLennan	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Woodbine Aquifer (Layer 1)												
Change in storage	27	0	2,529	0	--	--	21	0	44	0	101	0
Reservoirs (River Package)	0	0	0	0	--	--	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	34	0	114	0	--	--	0	0	16	0	31	3
Wells	0	200	0	3,657	--	--	0	0	0	33	0	5
Rivers and streams (Stream Package)	0	0	8	1,050	--	--	0	0	0	0	0	29
Recharge	0	0	2,657	0	--	--	0	0	0	0	673	0
Evapotranspiration	0	0	0	2,185	--	--	0	0	0	0	0	697
Lateral inflow	755	702	2,172	764	--	--	1	3	34	88	65	130
Vertical leakage downward	87	0	179	4	--	--	0	19	30	3	10	17
Paluxy Aquifer (Layer 3)												
Change in storage	170	0	100	0	976	0	41	0	162	0	200	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	102	0	0	0	13	0	0	0	0	0	231
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	0	0
Recharge	0	0	0	0	4,434	0	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	5,185	0	0	0	0	0	0
Vertical leakage upward	79	0	26	1	26	1	0	6	48	0	327	0
Lateral inflow	105	249	767	890	23	116	1	2	7	30	270	77
Vertical leakage downward	9	13	19	20	0	143	0	33	0	187	0	490
Glen Rose Formation (Layer 4)												
Change in storage	158	0	87	0	3,397	0	31	0	121	0	820	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	0	0	779	0	1	0	4	0	265
Rivers and streams (Stream Package)	0	0	0	0	69	1,547	0	0	0	0	0	0
Recharge	0	0	0	0	9,528	0	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	9,686	0	0	0	0	0	0
Vertical leakage upward	13	9	20	19	143	0	33	0	187	0	490	0
Lateral inflow	37	74	122	109	265	436	10	58	43	73	697	123
Vertical leakage downward	0	125	0	102	10	965	0	15	0	275	0	1,619

Table A-1. (continued)

	Kaufman		Lamar		Lampasas		Lee		Limestone		McLennan	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Hensell Aquifer (Layer 5)												
Change in storage	174	0	99	0	2,724	1	38	0	129	0	227	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	241	0	660	0	889	0	0	0	14	0	4,190
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	0	0
Recharge	0	0	0	0	471	0	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	474	0	0	0	0	0	0
Vertical leakage upward	125	0	102	0	965	10	15	0	275	0	1,619	0
Lateral inflow	426	341	1,428	864	1,134	2,418	3	23	185	326	6,129	489
Vertical leakage downward	0	144	14	118	6	1,508	0	33	0	248	0	3,297
Pearsall/Cow Creek/Sligo (Layer)												
Change in storage	137	0	79	0	158	0	29	0	101	0	186	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	0	0	11	0	0	0	0	0	0
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	0	0
Recharge	0	0	0	0	0	0	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	0
Vertical leakage upward	144	0	118	14	1,508	6	33	0	248	0	3,297	0
Lateral inflow	3	2	4	4	2	4	1	2	2	4	22	1
Vertical leakage downward	0	282	7	190	6	1,654	0	61	0	348	0	3,504
Hosston Aquifer (Layer 7)												
Change in storage	159	0	97	0	1,181	0	31	0	115	0	233	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	840	0	660	0	1,454	0	0	0	48	0	16,003
Rivers and streams (Stream Package)	0	0	0	0	114	0	0	0	0	0	0	0
Recharge	0	0	0	0	1,984	0	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	1,925	0	0	0	0	0	0
Vertical leakage upward	282	0	190	7	1,654	6	61	0	348	0	3,504	0
Lateral inflow	2,359	1,961	2,811	2,431	949	2,496	926	1,019	1,244	1,659	12,849	584

Table A-1. (continued)

	Milam		Mills		Montague		Navarro		Palo Pinto		Parker	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Woodbine Aquifer (Layer 1)												
Change in storage	83	0	--	--	--	--	37	0	--	--	--	--
Reservoirs (River Package)	0	0	--	--	--	--	0	0	--	--	--	--
Inter-aquifer flow (GHB Package)	0	8	--	--	--	--	50	0	--	--	--	--
Wells	0	0	--	--	--	--	0	300	--	--	--	--
Rivers and streams (Stream Package)	0	0	--	--	--	--	0	0	--	--	--	--
Recharge	0	0	--	--	--	--	0	0	--	--	--	--
Evapotranspiration	0	0	--	--	--	--	0	0	--	--	--	--
Lateral inflow	2	5	--	--	--	--	411	301	--	--	--	--
Vertical leakage downward	0	73	--	--	--	--	104	0	--	--	--	--
Paluxy Aquifer (Layer 3)												
Change in storage	261	0	773	0	1,798	0	258	0	--	--	7,447	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	--	--	6	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	--	--	0	0
Wells	0	0	0	6	0	508	0	413	--	--	0	9,866
Rivers and streams (Stream Package)	0	0	0	8	0	498	0	0	--	--	164	164
Recharge	0	0	3,988	0	7,959	0	0	0	--	--	18,464	0
Evapotranspiration	0	0	0	4,517	0	7,985	0	0	--	--	0	14,215
Vertical leakage upward	34	3	93	1	13	0	93	0	--	--	86	0
Lateral inflow	1	4	33	90	137	276	268	94	--	--	381	1,313
Vertical leakage downward	0	290	0	265	24	664	1	113	--	--	0	988
Glen Rose Formation (Layer 4)												
Change in storage	204	0	655	0	7	0	215	0	--	--	895	2
Reservoirs (River Package)	0	0	0	0	0	0	0	0	--	--	2	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	--	--	0	0
Wells	0	183	0	66	0	0	0	0	--	--	0	194
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	--	--	5	14
Recharge	0	0	2,827	0	0	0	0	0	--	--	3,942	0
Evapotranspiration	0	0	0	2,842	0	0	0	0	--	--	0	3,795
Vertical leakage upward	290	0	265	0	664	24	113	1	--	--	988	0
Lateral inflow	140	87	76	286	2	14	29	51	--	--	306	594
Vertical leakage downward	0	364	0	629	15	651	0	305	--	--	0	1,538

Table A-1. (continued)

	Milam		Mills		Montague		Navarro		Palo Pinto		Parker	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Hensell Aquifer (Layer 5)												
Change in storage	237	0	3,894	0	2,744	0	231	0	--	--	4,804	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	--	--	1	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	--	--	0	0
Wells	0	36	0	945	0	364	0	256	--	--	0	1,469
Rivers and streams (Stream Package)	0	0	0	0	0	350	0	0	--	--	84	814
Recharge	0	0	2,588	0	6,389	0	0	0	--	--	2,893	0
Evapotranspiration	0	0	0	2,814	0	6,468	0	0	--	--	0	1,989
Vertical leakage upward	364	0	629	0	651	15	305	0	--	--	1,538	0
Lateral inflow	151	261	466	1,818	59	1,583	276	186	--	--	973	2,672
Vertical leakage downward	0	456	33	2,031	65	1,128	0	370	--	--	0	3,349
Pearsall/Cow Creek/Sligo (Layer)												
Change in storage	183	0	4	0	93	0	183	0	--	--	578	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	--	--	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	--	--	0	0
Wells	0	0	0	0	0	0	0	0	--	--	0	0
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	--	--	0	0
Recharge	0	0	0	0	0	0	0	0	--	--	0	0
Evapotranspiration	0	0	0	0	0	0	0	0	--	--	0	0
Vertical leakage upward	456	0	2,031	33	1,128	65	370	0	--	--	3,349	0
Lateral inflow	3	4	1	2	0	5	1	1	--	--	4	7
Vertical leakage downward	0	637	32	2,033	60	1,211	0	554	--	--	0	3,924
Hosston Aquifer (Layer 7)												
Change in storage	199	0	1,037	0	3,412	0	217	0	196	0	1,720	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	102	0	1,383	0	1,810	0	1,204	0	12	0	3,860
Rivers and streams (Stream Package)	0	0	0	0	0	151	0	0	0	0	0	88
Recharge	0	0	2,383	0	8,566	0	0	0	533	0	3,160	0
Evapotranspiration	0	0	0	3,255	0	8,735	0	0	0	710	0	2,354
Vertical leakage upward	637	0	2,033	32	1,211	60	554	0	--	--	3,924	0
Lateral inflow	3,288	4,022	300	1,083	250	2,683	1,219	785	55	62	712	3,213

Table A-1. (continued)

	Red River		Robertson		Rockwall		Somervell		Tarrant		Taylor	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Woodbine Aquifer (Layer 1)												
Change in storage	1,079	0	3	0	6	0	--	--	3,047	213	--	--
Reservoirs (River Package)	0	0	0	0	0	0	--	--	10	0	--	--
Inter-aquifer flow (GHB Package)	54	0	0	1	11	0	--	--	11	0	--	--
Wells	0	170	0	0	0	144	--	--	0	633	--	--
Rivers and streams (Stream Package)	3	872	0	0	0	0	--	--	68	468	--	--
Recharge	4,000	0	0	0	0	0	--	--	11,966	0	--	--
Evapotranspiration	0	3,524	0	0	0	0	--	--	0	11,569	--	--
Lateral inflow	448	1,136	0	1	811	704	--	--	371	2,562	--	--
Vertical leakage downward	122	3	0	2	21	0	--	--	0	27	--	--
Paluxy Aquifer (Layer 3)												
Change in storage	79	0	14	0	31	0	100	37	11,073	25	--	--
Reservoirs (River Package)	0	0	0	0	0	0	0	0	8	0	--	--
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	--	--
Wells	0	471	0	0	0	958	0	120	0	10,446	--	--
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	213	21	16	--	--
Recharge	0	0	0	0	0	0	3,078	0	1,804	0	--	--
Evapotranspiration	0	0	0	0	0	0	0	2,626	0	1,502	--	--
Vertical leakage upward	8	4	3	0	25	0	16	1	363	1	--	--
Lateral inflow	804	441	0	1	1,174	304	35	154	1,889	2,285	--	--
Vertical leakage downward	28	3	0	16	31	0	0	79	0	884	--	--
Glen Rose Formation (Layer 4)												
Change in storage	68	0	11	0	30	0	649	27	305	0	--	--
Reservoirs (River Package)	0	0	0	0	0	0	7	0	0	0	--	--
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	--	--
Wells	0	0	0	0	0	0	0	134	0	110	--	--
Rivers and streams (Stream Package)	0	0	0	0	0	0	464	2,764	0	0	--	--
Recharge	0	0	0	0	0	0	5,470	0	0	0	--	--
Evapotranspiration	0	0	0	0	0	0	0	3,077	0	0	--	--
Vertical leakage upward	3	28	16	0	0	31	79	0	884	0	--	--
Lateral inflow	85	92	21	29	49	38	578	624	631	170	--	--
Vertical leakage downward	0	37	0	19	0	10	0	621	0	1,540	--	--

Table A-1. (continued)

	Red River		Robertson		Rockwall		Somervell		Tarrant		Taylor	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Hensell Aquifer (Layer 5)												
Change in storage	78	0	12	0	33	0	1,941	0	185	0	--	--
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	--	--
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	--	--
Wells	0	19	0	0	0	0	0	741	0	2,532	--	--
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	--	--
Recharge	0	0	0	0	0	0	0	0	0	0	--	--
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	--	--
Vertical leakage upward	37	0	19	0	10	0	621	0	1,540	0	--	--
Lateral inflow	625	642	77	67	365	370	2,519	3,124	4,499	1,538	--	--
Vertical leakage downward	0	79	0	41	0	37	0	1,217	54	2,208	--	--
Pearsall/Cow Creek/Sligo (Layer)												
Change in storage	62	0	10	0	26	0	3	0	59	0	--	--
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	--	--
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	--	--
Wells	0	0	0	0	0	0	0	0	0	0	--	--
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	--	--
Recharge	0	0	0	0	0	0	0	0	0	0	--	--
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	--	--
Vertical leakage upward	79	0	41	0	37	0	1,217	0	2,208	54	--	--
Lateral inflow	2	2	1	1	2	3	3	3	12	4	--	--
Vertical leakage downward	0	141	0	51	0	63	0	1,219	51	2,272	--	--
Hosston Aquifer (Layer 7)												
Change in storage	76	0	10	0	31	0	44	0	282	0	1,478	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	38	0	0	0	0	0	1,490	0	5,549	0	431
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0	0	0	0	0
Recharge	0	0	0	0	0	0	0	0	0	0	1,647	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	2,444
Vertical leakage upward	141	0	51	0	63	0	1,219	0	2,272	51	--	--
Lateral inflow	1,711	1,891	881	942	1,687	1,781	1,905	1,679	3,798	752	59	310

Table A-1. (continued)

	Titus		Travis		Williamson		Wise	
	In	Out	In	Out	In	Out	In	Out
Woodbine Aquifer (Layer 1)								
Change in storage	3	0	36	0	68	0	--	--
Reservoirs (River Package)	0	0	0	0	0	0	--	--
Inter-aquifer flow (GHB Package)	1	0	16	0	31	0	--	--
Wells	0	0	0	0	0	0	--	--
Rivers and streams (Stream Package)	0	0	0	0	2	1	--	--
Recharge	0	0	0	0	0	0	--	--
Evapotranspiration	0	0	0	0	0	0	--	--
Lateral inflow	130	139	5	2	8	3	--	--
Vertical leakage downward	5	0	0	55	0	105	--	--
Paluxy Aquifer (Layer 3)								
Change in storage	3	0	58	3	164	0	5,232	0
Reservoirs (River Package)	0	0	0	0	0	0	1	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0
Wells	0	0	0	3	0	11	0	2,581
Rivers and streams (Stream Package)	0	0	0	0	0	0	54	816
Recharge	0	0	0	0	13	0	11,503	0
Evapotranspiration	0	0	0	0	0	0	0	10,788
Vertical leakage upward	0	0	34	9	136	40	77	0
Lateral inflow	44	47	21	5	16	26	326	1,898
Vertical leakage downward	1	0	1	94	0	251	2	1,114
Glen Rose Formation (Layer 4)								
Change in storage	2	0	3,754	0	1,845	0	210	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	327	0	0	0	0
Wells	0	0	0	2,627	0	770	0	5
Rivers and streams (Stream Package)	0	0	0	0	58	257	0	21
Recharge	0	0	4,193	0	2,449	0	1,907	0
Evapotranspiration	0	0	0	5,490	0	2,702	0	1,786
Vertical leakage upward	0	1	94	1	251	0	1,114	2
Lateral inflow	18	19	1,149	472	1,050	1,094	63	237
Vertical leakage downward	0	1	70	343	2	832	1	1,242

Table A-1. (continued)

	Titus		Travis		Williamson		Wise	
	In	Out	In	Out	In	Out	In	Out
Hensell Aquifer (Layer 5)								
Change in storage	3	0	990	0	495	0	5,893	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0
Wells	0	0	0	157	0	415	0	1,484
Rivers and streams (Stream Package)	0	0	0	0	0	0	68	559
Recharge	0	0	799	0	0	0	9,032	0
Evapotranspiration	0	0	0	777	0	0	0	8,676
Vertical leakage upward	1	0	343	70	832	2	1,242	1
Lateral inflow	77	78	263	502	2,024	970	533	3,605
Vertical leakage downward	0	2	18	907	0	1,964	27	2,470
Pearsall/Cow Creek/Sligo (Layer)								
Change in storage	2	0	196	0	141	0	883	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	0	0	0	0	0	0
Wells	0	0	0	6	0	1	0	0
Rivers and streams (Stream Package)	0	0	0	0	0	0	0	0
Recharge	0	0	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0	0	0
Vertical leakage upward	2	0	907	18	1,964	0	2,470	27
Lateral inflow	0	0	5	4	9	10	3	11
Vertical leakage downward	0	4	3	1,084	0	2,104	23	3,340
Hosston Aquifer (Layer 7)								
Change in storage	3	0	599	0	175	0	3,498	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0
Inter-aquifer flow (GHB Package)	0	0	60	160	0	0	0	0
Wells	0	0	0	1,114	0	614	0	5,246
Rivers and streams (Stream Package)	0	0	0	0	0	0	13	177
Recharge	0	0	0	0	0	0	7,670	0
Evapotranspiration	0	0	0	0	0	0	0	6,733
Vertical leakage upward	4	0	1,084	3	2,104	0	3,340	23
Lateral inflow	320	327	1,843	2,309	4,374	6,039	1,097	3,438