Supplement to GAM run 08-16

by Richard Smith, P.G.
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 936-0877
September 30, 2008

EXECUTIVE SUMMARY:

Groundwater Management Area 1 requested a groundwater availability model run to determine if retaining three different volumes of groundwater after 50 years of pumping in the Ogallala Aquifer in three predetermined geographical subdivisions in Groundwater Management Area 1 (Figure 1) is feasible. This supplement is the presentation of the results of running the groundwater availability model for the southern part of the Ogallala Aquifer using the conditions for Subdivision 3. The conditions appear feasible and result in 50 percent of the aquifer volume remaining after 50 years.

REQUESTOR:

Mr. Steve Walthour with the North Plains Groundwater Conservation District on behalf of Groundwater Management Area 1.

DESCRIPTION OF REQUEST:

The groundwater conservation districts in Groundwater Management Area 1 requested a groundwater availability model run to determine if retaining different volumes of groundwater after fifty years of pumping in the Ogallala Aquifer in three subdivisions of the groundwater management area (Figure 1) was feasible. The three subdivisions are as follows:

- Subdivision 1 is comprised of Dallam, Hartley, Moore, and Sherman counties;
- Subdivision 2 is comprised of Hutchinson County north of the Canadian River and Hansford, Lipscomb, Ochiltree, and Hemphill counties; and
- Subdivision 3 is comprised of Hutchinson County south of the Canadian River and Armstrong, Carson, Donley, Gray, Oldham, Potter, Randall, Roberts, and Wheeler counties.

The districts requested that the Texas Water Development Board (TWDB) provide the draft managed available groundwater estimates in the management area based upon the draft desired future condition of the Ogallala Aquifer for each subdivision as follows:

- Subdivision 1 is to achieve at least 40 percent of the 2008 total aquifer storage remaining in 2058. The TWDB shall calculate the amount of managed available groundwater for the 50 year period with an initial amount of available groundwater set at 1,331,500 acre feet for the first year. This starting point will decrease at a fixed percent throughout the 50 years to achieve the desired future condition of the Ogallala Aquifer goal for the subdivision.

- Subdivision 2 is to have at least 60 percent of the total aquifer storage remaining in 2058. The TWDB shall estimate the managed available groundwater volume by reducing the baseline total aquifer storage in each district by no more than one percent. The initial available groundwater will be one percent of the 2005 volume as determined from the model.
- Subdivision 3 is to have at least 50 percent of the baseline total aquifer storage remaining in 2058. TWDB shall estimate the managed available groundwater volume by reducing the total aquifer storage by no more than 1.25 percent annually.

Based on the pumping rates established in GAM Run 07-31 (Smith, November 8, 2007) the districts requested that the area-wide pumping rates be applied to the northern and southern parts of the Ogallala Aquifer groundwater availability models for a fifty year period with 2005 as the baseline year. This was achieved in GAM Run 08-16 (Draft) dated July 31, 2008 for the northern part of the Ogallala Aquifer. To complete the analysis, the Southern Ogallala Model was run using the same criteria as Subdivision 3.

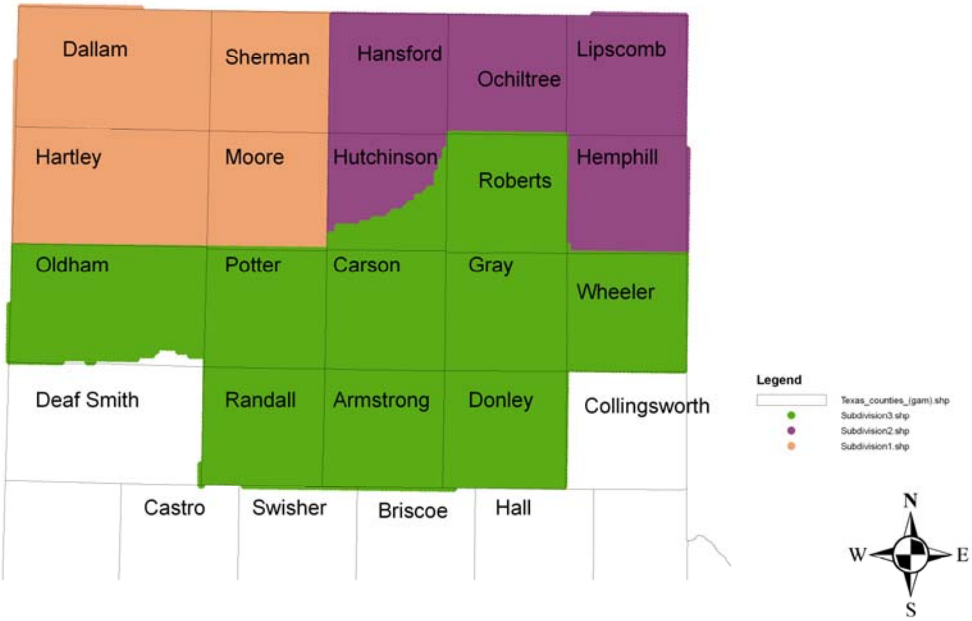

Figure 1. Subdivisions requested by the groundwater conservation districts in Groundwater Management Area 1.

METHODS:

To address the request, we did the following steps:

- We selected a stress period in the southern portion of the Ogallala Aquifer model which best approximated water level information and volume information supplied by the United States Geological Survey (USGS) for 2006. The United

States Geological Survey information corresponds to stress period 133 (model year 2009) in the model which became the base year. This overall model volume in this stress period approximates the United States Geological Survey volume.

- Initial pumping rates were calculated on a cell-by-cell basis based on either the volume or maximum percent declines described in the request above plus the average recharge. We then annually decreased pumping by a set percent rate to achieve the desired final volumes of water as described in the request above.
- The pumping rates per grid cell were used to create a new well file which was then used as input to the model.
- The model was run to simulate projections for fifty years.
- Water levels for the base year and final year of the simulation, as well as the base of the aquifer and hydraulic properties, were exported from the model to ArcGIS© to compare and analyze the volume remaining in the aquifer.
- The model was then zoned by county, basin, region, and groundwater conservation district. Pumpage was extracted from the model to develop a table of the managed available groundwater for the aquifer, county, basin, region, and groundwater conservation district/non groundwater conservation district level.

PARAMETERS AND ASSUMPTIONS:

- We used version 1.01 of the groundwater availability model for the southern part of the Ogallala Aquifer (Blandford and others, 2003)
- See Blandford and others (2003) for assumptions and limitations of the model for the southern part of the Ogallala Aquifer. Root mean squared error for this model is 47 feet. This error will have more of an effect on model results where the aquifer is thin.
- Average recharge used in the model was based on a percentage of precipitation for the 1950 through 1990 period of record. Since this includes the 1950s drought of record, the average recharge used for this analysis is considered a conservative estimate.
- For Randall, Potter, and Armstrong counties, which are partially included in both the northern and southern parts of the Ogallala Aquifer groundwater availability models, we will combine the results of the volume calculation from each model to get full county totals. However, this report only includes the results from the groundwater availability model for the southern portion of the Ogallala Aquifer. It should be noted that we will use the volume calculated from each model for that segment of the county covered as the starting point for the annual pumping rate calculation which would result in a fifty percent decline over a fifty year period.
- It should be noted that in GAM Run 08-16 (Draft) results for Dallam and Hartley counties in Subdivision 1 also include the Rita Blanca Aquifer.

RESULTS:

Table 1 gives the starting volumes and the final volumes as calculated from the model at the end of the 50 year simulation for each of the three counties. The rates of decline, percentage decrease in pumping compared with the previous stress period, were adjusted to achieve the desired future condition of the Ogallala Aquifer requested for each subdivision. The starting pumpage was reduced by 1.25 percent in each of the three counties. It should be noted that recharge was added back into the initial value which accounts for a larger initial available groundwater value than a simple 1.25 percent of the starting volume.

All numbers are in acre-feet per year. Tables 2 shows the tabulated results for each county and final county totals respectively. Recharge was added back into each pumping value for each stress period. The declines are different since the starting volumes and the final volumes are different for each county.

Appendix A presents the water levels throughout Groundwater Management Area 1 starting with the base year of 2009. Maps are presented for each decade through 2058. White areas or cells are generally areas beyond the borders of the models or are inactive cells which no longer contain pumping, recharge or flow components.

REFERENCES:

Blandford, T.N., Blazer, D.J., Calhoun, K.C., Dutton, A.R., Naing, T., Reedy, R.C., and Scanlon, B.R., 2003, Groundwater availability of the southern Ogallala aquifer in Texas and New Mexico—Numerical Simulations Through 2050: Final Report prepared for the Texas Water Development Board by Daniel B. Stephens & Associates, Inc., 158 p.

Smith, R, 2008, GAM Run 08-16, Texas Water Development Board, 14 p.

STATE OF TEXAS
Richard M. Smith
Geology
No. 472
LICENSED PROFESSIONAL GEOSCIENTIST

The seal appearing on this document was authorized by Richard M. Smith, P.G., on September 10, 2008.

Table 1: Calculation of volumes from the groundwater availability model for the southern portion of the Ogallala Aquifer for Potter, Randall and Armstrong counties.

County	Starting volume in acre-feet	Yearly pumping decline rate in percent	Final volume in acre-feet	Final percentage remaining
Potter	315,406	0.00000	158,300	50
Randall	4,654,056	0.00050	2,310,238	50
Armstrong	512,815	0.03450	258,273	50

Table 2: Potter, Randall and Armstrong counties predictive managed available groundwater estimates for 2009 to 2033 reported in acre-feet per year.

Year	Potter South Ogallala GAM	Potter North Ogallala GAM	Potter Total	Randall South Ogallala GAM	Randall North Ogallala GAM	Randall Total	Armstrong South Ogallala GAM	Armstrong North Ogallala GAM	Armstrong Total
2009	3,858	35,232	39,090	81,922	18,432	100,354	9,487	46,070	55,557
2010	3,856	35,082	38,938	81,919	18,362	100,281	9,168	45,903	55,071
2011	3,855	34,932	38,787	81,905	18,293	100,198	8,860	45,737	54,597
2012	3,853	34,784	38,637	81,904	18,224	100,128	8,563	45,572	54,135
2013	3,852	34,637	38,489	81,898	18,155	100,053	8,276	45,407	53,683
2014	3,851	34,490	38,341	81,876	18,087	99,963	7,999	45,243	53,242
2015	3,849	34,344	38,193	81,874	18,018	99,892	7,731	45,080	52,811
2016	3,848	34,199	38,047	81,866	17,950	99,816	7,473	44,917	52,390
2017	3,846	34,055	37,901	81,852	17,883	99,735	7,224	44,755	51,979
2018	3,845	33,911	37,756	81,842	17,815	99,657	6,983	44,593	51,576
2019	3,843	33,769	37,612	81,818	17,748	99,566	6,750	44,432	51,182
2020	3,842	33,627	37,469	81,794	17,681	99,475	6,526	44,272	50,798
2021	3,840	33,486	37,326	81,780	17,614	99,394	6,309	44,112	50,421
2022	3,839	33,346	37,185	81,756	17,548	99,304	6,100	43,953	50,053
2023	3,838	33,206	37,044	81,733	17,482	99,215	5,898	43,795	49,693
2024	3,836	33,068	36,904	81,732	17,416	99,148	5,703	43,637	49,340
2025	3,835	32,930	36,765	81,708	17,350	99,058	5,515	43,480	48,995
2026	3,833	32,550	36,383	81,683	17,285	98,968	5,333	43,323	48,656
2027	3,832	32,180	36,012	81,659	17,220	98,879	5,157	43,167	48,324
2028	3,830	31,813	35,643	81,648	17,155	98,803	4,988	43,012	48,000
2029	3,829	31,458	35,287	81,623	17,090	98,713	4,824	42,857	47,681
2030	3,827	31,335	35,162	81,599	17,026	98,625	4,666	42,703	47,369
2031	3,826	31,213	35,039	81,575	16,962	98,537	4,513	42,550	47,063
2032	3,825	31,092	34,917	81,551	16,898	98,449	4,366	42,397	46,763
2033	3,823	30,971	34,794	81,526	16,834	98,360	4,224	42,244	46,468

Table 2(cont): Potter, Randall and Armstrong counties predictive managed available groundwater estimates for 2034 to 2058 reported in acre-feet per year.

Year	Potter South Ogallala GAM	Potter North Ogallala GAM	Potter Total	Randall South Ogallala GAM	Randall North Ogallala GAM	Randall Total	Armstrong South Ogallala GAM	Armstrong North Ogallala GAM	Armstrong Total
2034	3,822	30,850	34,672	81,502	16,771	98,273	4,087	42,093	46,180
2035	3,820	30,731	34,551	81,478	16,708	98,186	3,954	41,942	45,896
2036	3,819	30,397	34,216	81,453	16,645	98,098	3,826	41,791	45,617
2037	3,817	30,281	34,098	81,441	16,582	98,023	3,702	41,641	45,343
2038	3,816	30,165	33,981	81,417	16,520	97,937	3,583	41,492	45,075
2039	3,814	30,051	33,865	81,392	16,458	97,850	3,468	41,343	44,811
2040	3,813	29,936	33,749	81,368	16,396	97,764	3,357	41,195	44,552
2041	3,678	29,620	33,298	81,343	16,334	97,677	3,249	41,047	44,296
2042	3,679	29,510	33,189	81,319	16,273	97,592	3,146	40,900	44,046
2043	3,681	29,399	33,080	81,295	16,212	97,507	3,046	40,753	43,799
2044	3,682	29,290	32,972	81,270	16,151	97,421	2,949	40,607	43,556
2045	3,683	29,180	32,863	81,246	16,090	97,336	2,856	40,462	43,318
2046	3,685	28,885	32,570	81,221	16,029	97,250	2,766	40,317	43,083
2047	3,686	28,779	32,465	81,197	15,969	97,166	2,679	40,173	42,852
2048	3,688	28,673	32,361	81,172	15,909	97,081	2,595	40,029	42,624
2049	3,689	28,568	32,257	81,148	15,849	96,997	2,513	39,886	42,399
2050	3,690	28,464	32,154	81,123	15,790	96,913	2,435	39,744	42,179
2051	3,692	28,359	32,051	81,099	15,731	96,830	2,360	39,602	41,962
2052	3,693	28,256	31,949	81,074	15,672	96,746	2,287	39,460	41,747
2053	3,695	28,152	31,847	81,050	15,613	96,663	2,216	39,319	41,535
2054	3,696	28,049	31,745	81,025	15,554	96,579	2,148	39,179	41,327
2055	3,697	27,947	31,644	81,000	15,496	96,496	2,082	39,039	41,121
2056	3,699	27,845	31,544	80,976	15,438	96,414	2,019	38,900	40,919
2057	3,700	27,712	31,412	80,951	15,380	96,331	1,958	38,761	40,719
2058	3,702	27,593	31,295	80,927	15,322	96,249	1,899	38,580	40,479

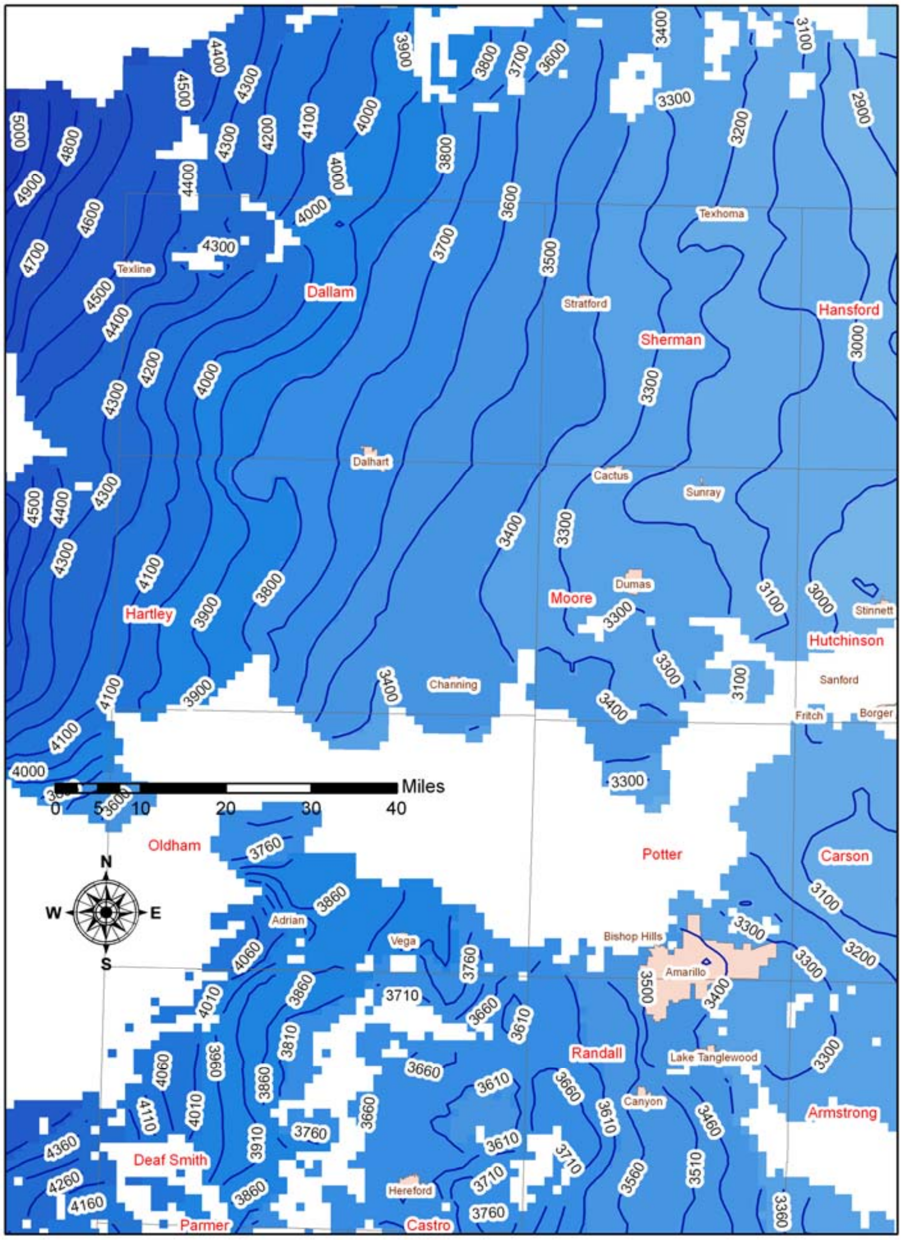

Figure 2: Baseline year 2009 for the northwestern section of Groundwater Management Area 1. White areas are beyond the boundary of the models or are inactive cells within the models.

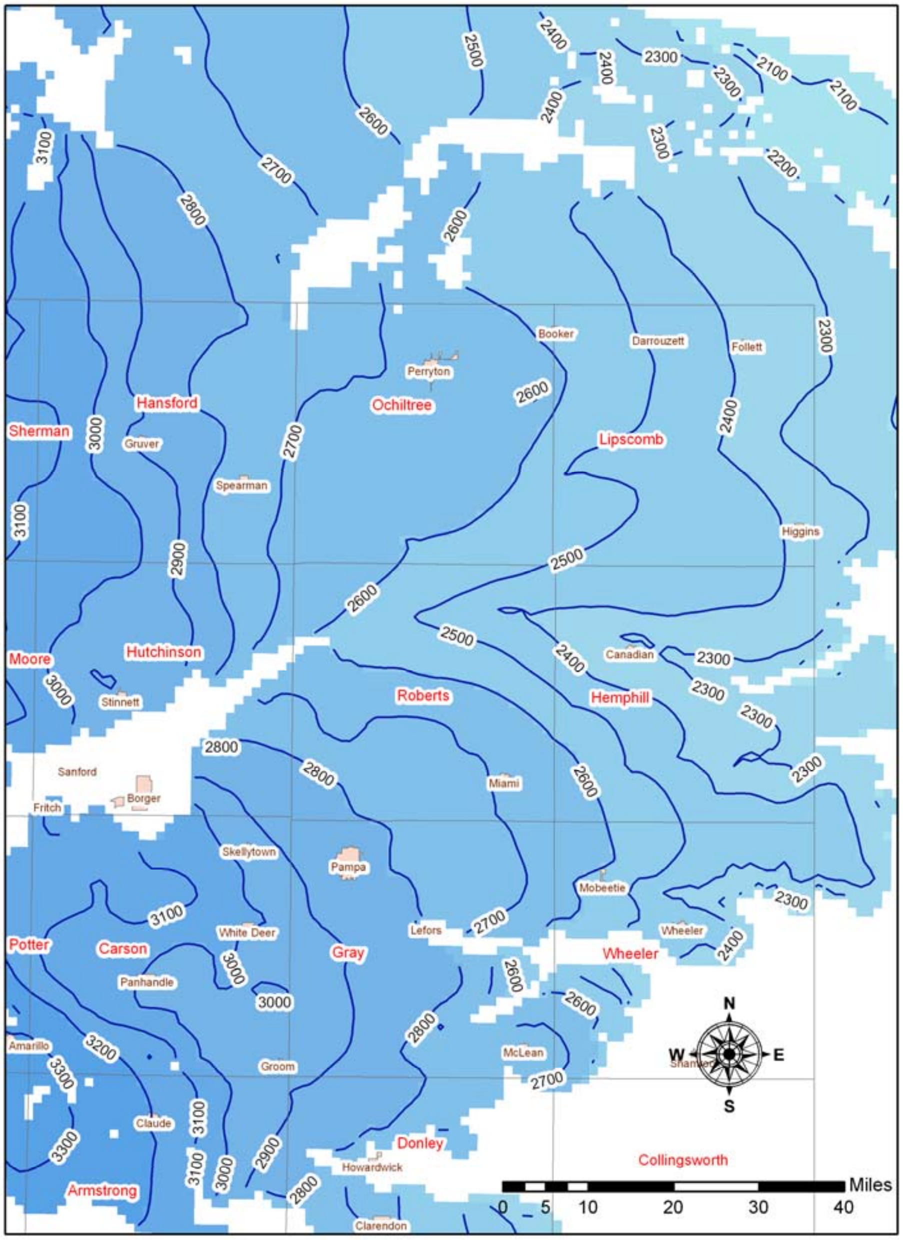

Figure 3: Baseline year 2009 for the northeastern section of Groundwater Management Area 1. White areas are beyond the boundary of the models or are inactive cells within the models.

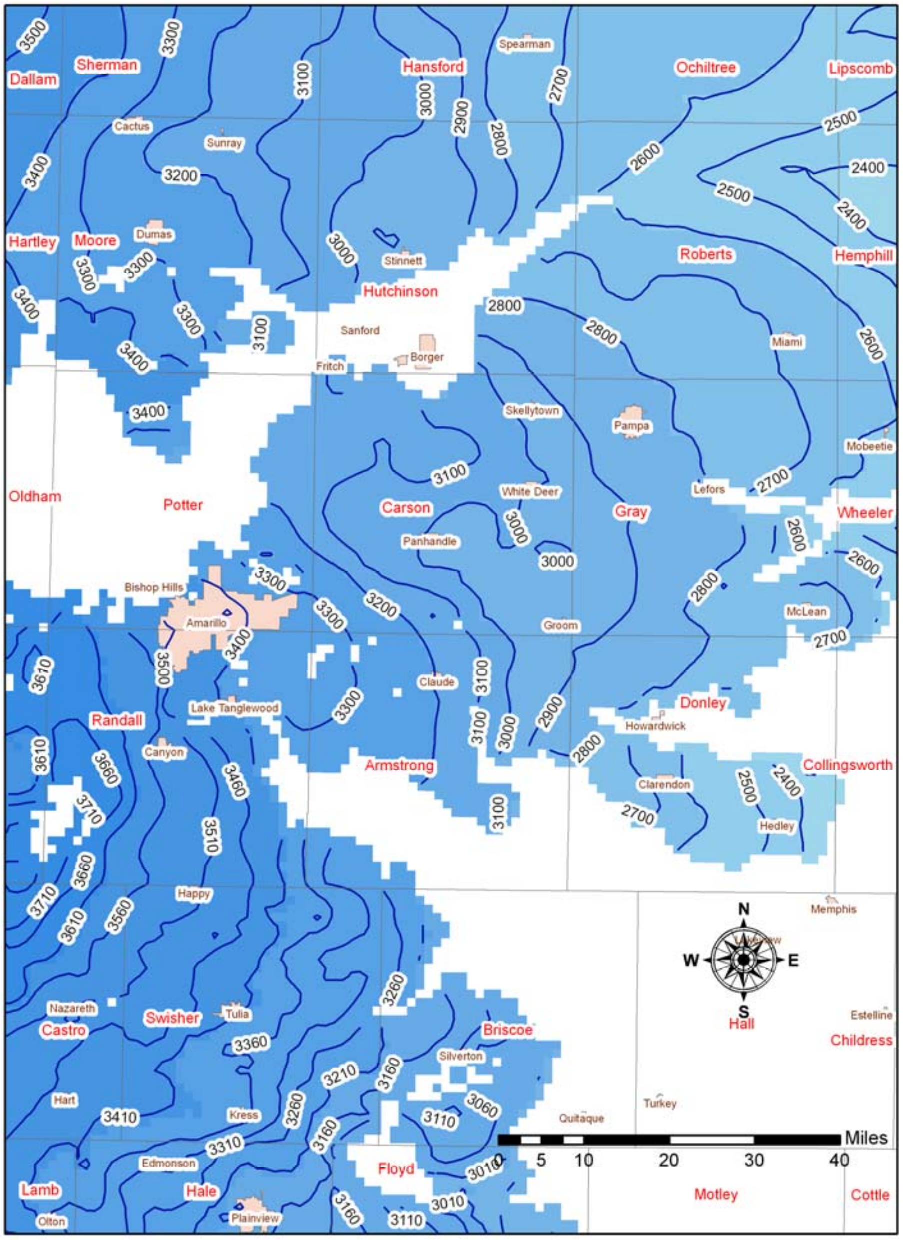

Figure 4: Baseline year 2009 for the south-central section of Groundwater Management Area 1. White areas are beyond the boundary of the models or are inactive cells within the models.

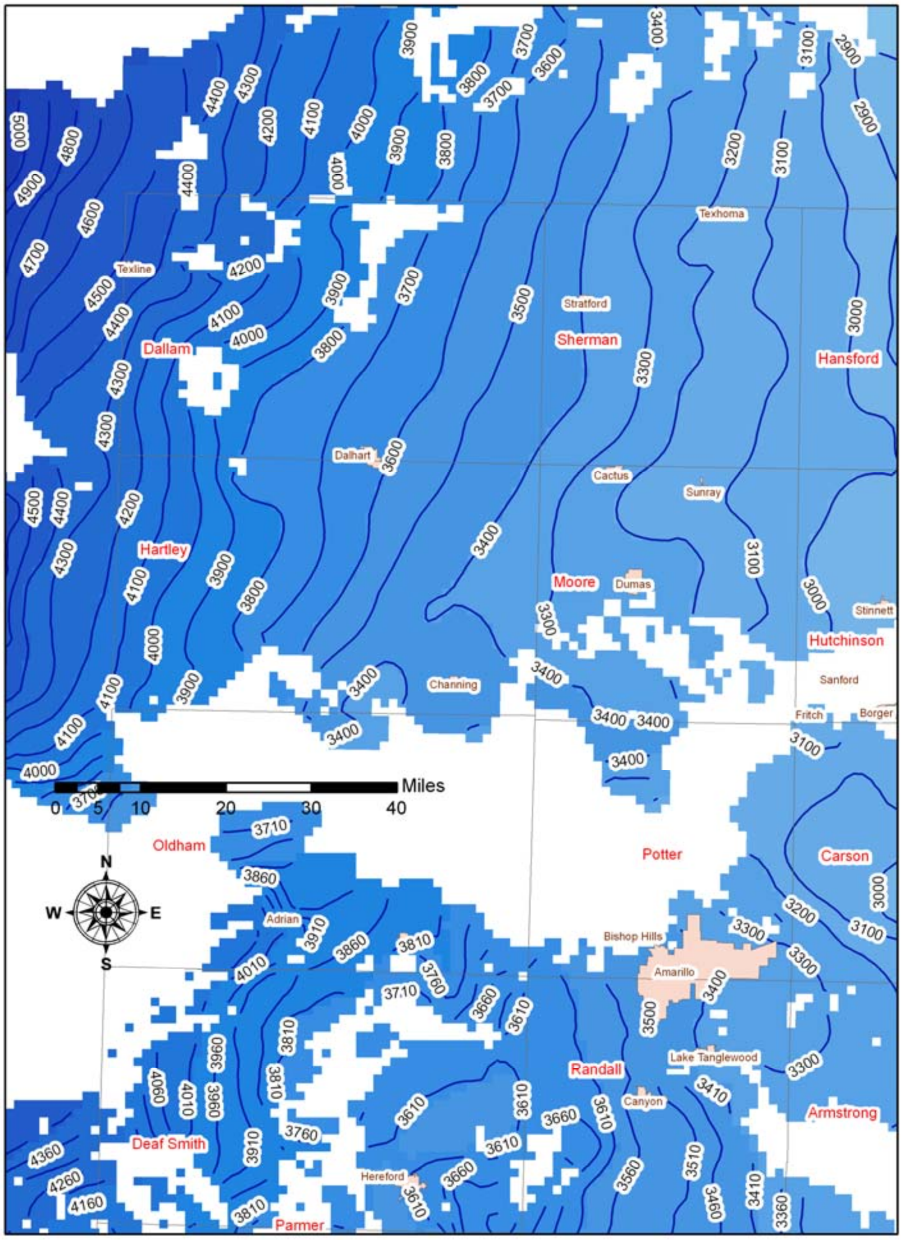

Figure 5: Predicted water levels in 2019 for the northwestern section of Groundwater Management Area 1. White areas are beyond the boundary of the models or are inactive cells within the models.

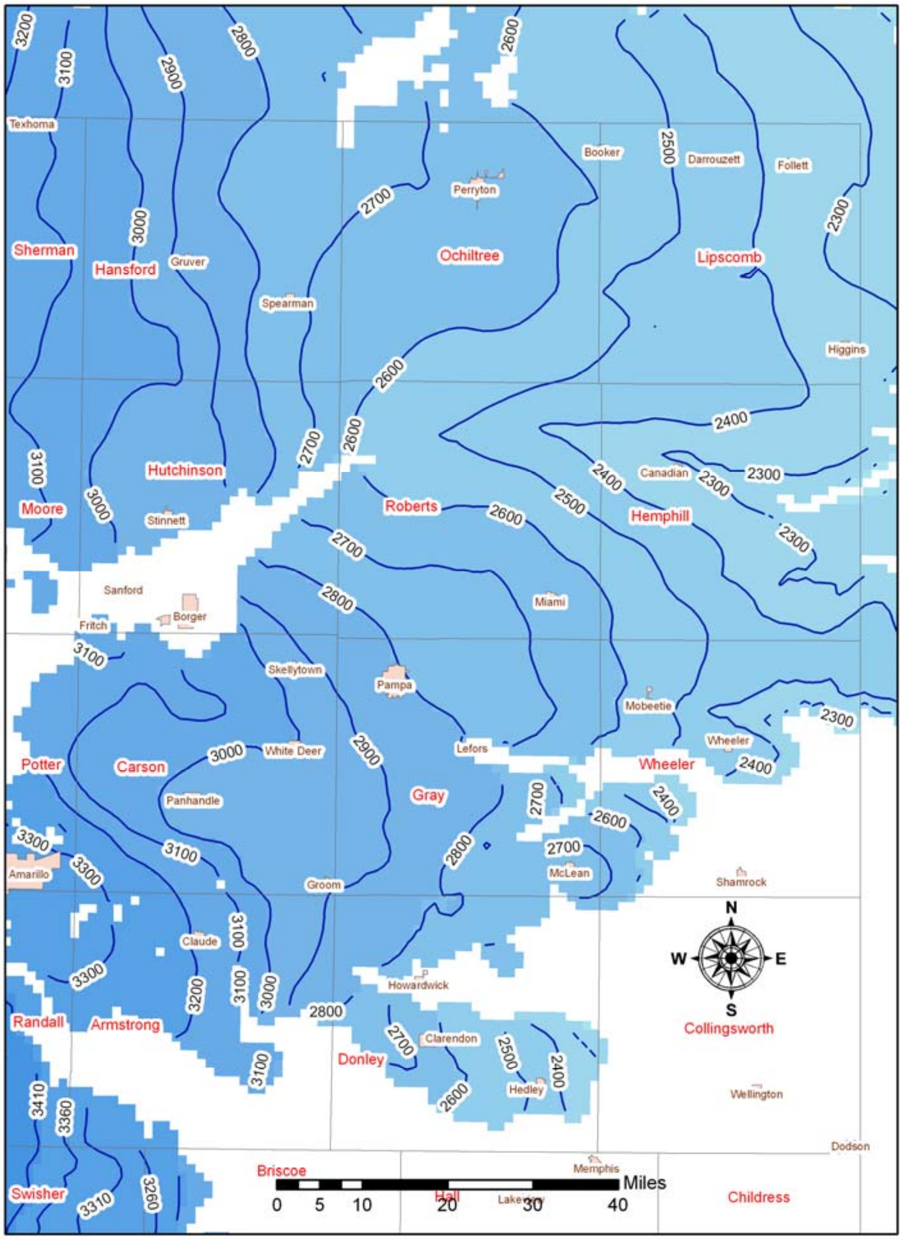

Figure 6: Predicted water levels in 2019 for the northeastern section of Groundwater Management Area 1. White areas are beyond the boundary of the models or are inactive cells within the models.

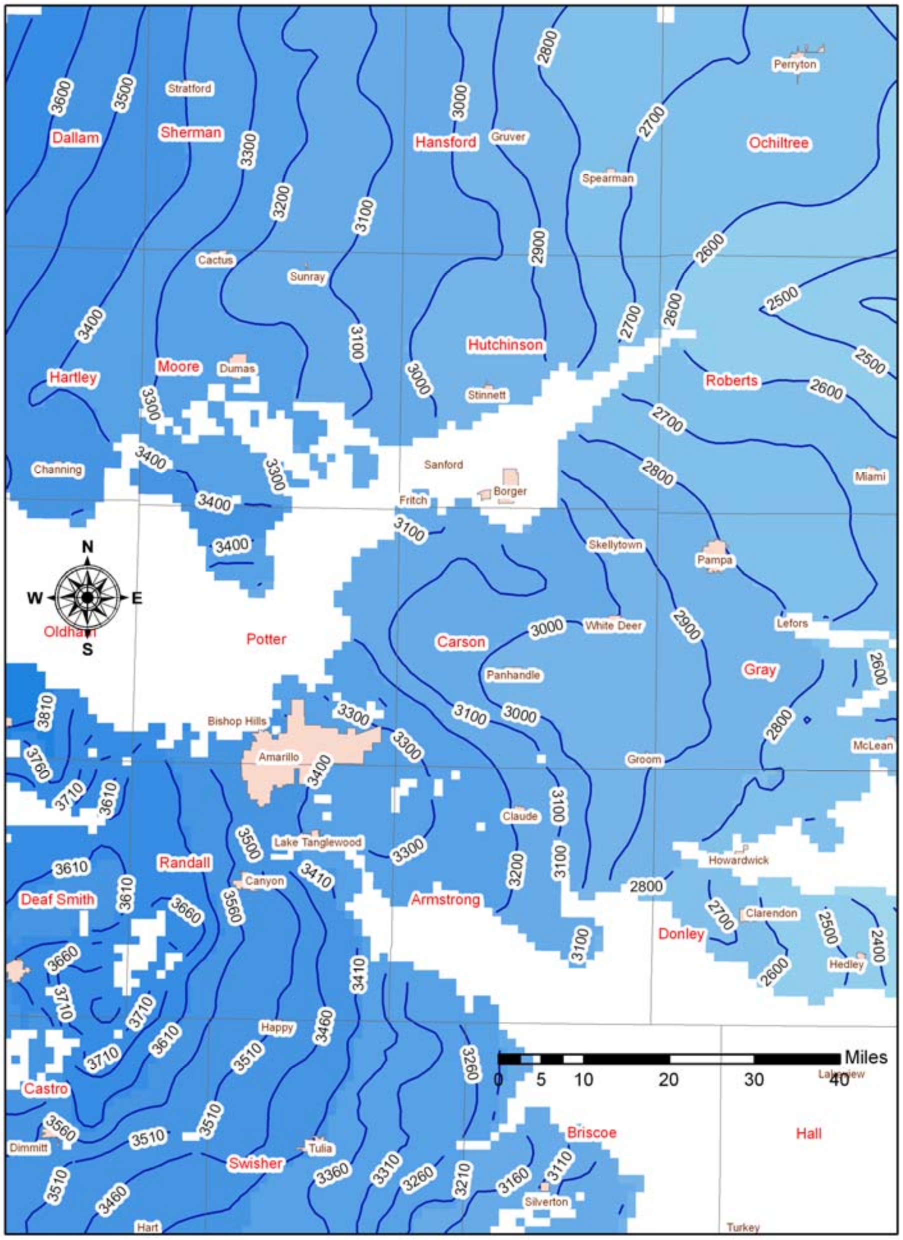

Figure 7: Predicted water levels in 2019 for the south-central section of Groundwater Management Area #1. White areas are beyond the boundary of the models or are inactive cells within the models.

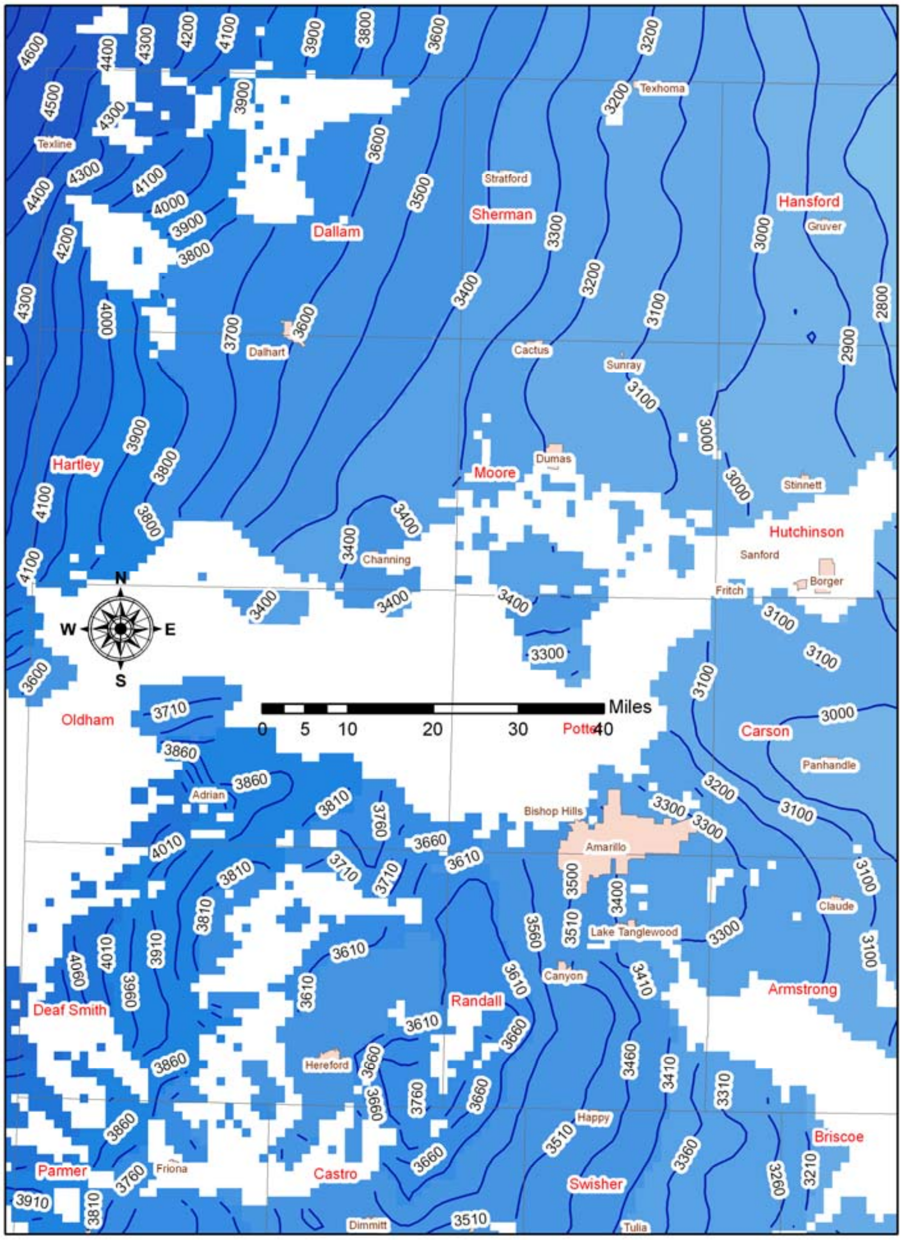

Figure 8: Predicted water levels in 2029 for the northwestern section of Groundwater Management Area #1. White areas are beyond the boundary of the models or are inactive cells within the models.

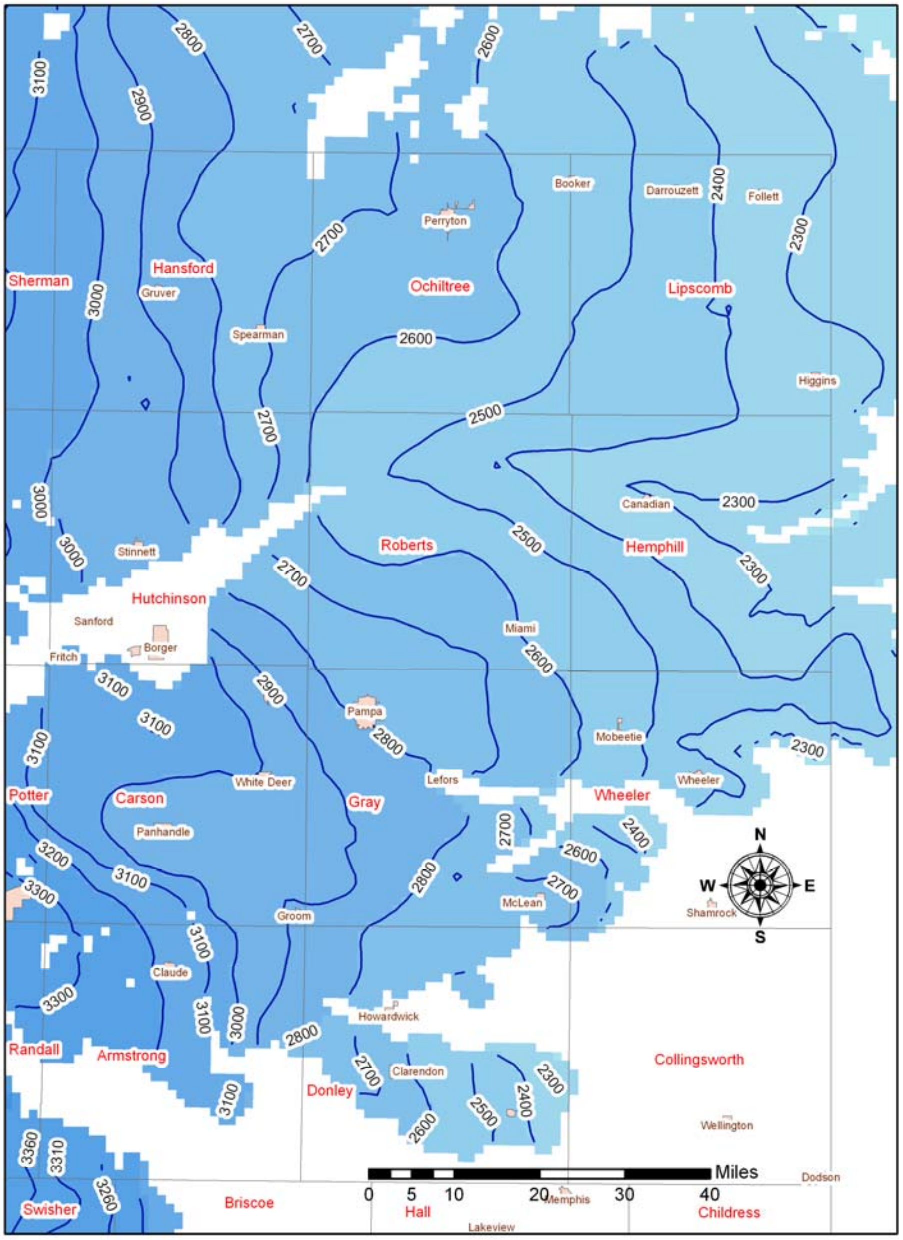

Figure 9: Predicted water levels in 2029 for the northeastern section of Groundwater Management Area #1. White areas are beyond the boundary of the models or are inactive cells within the models.

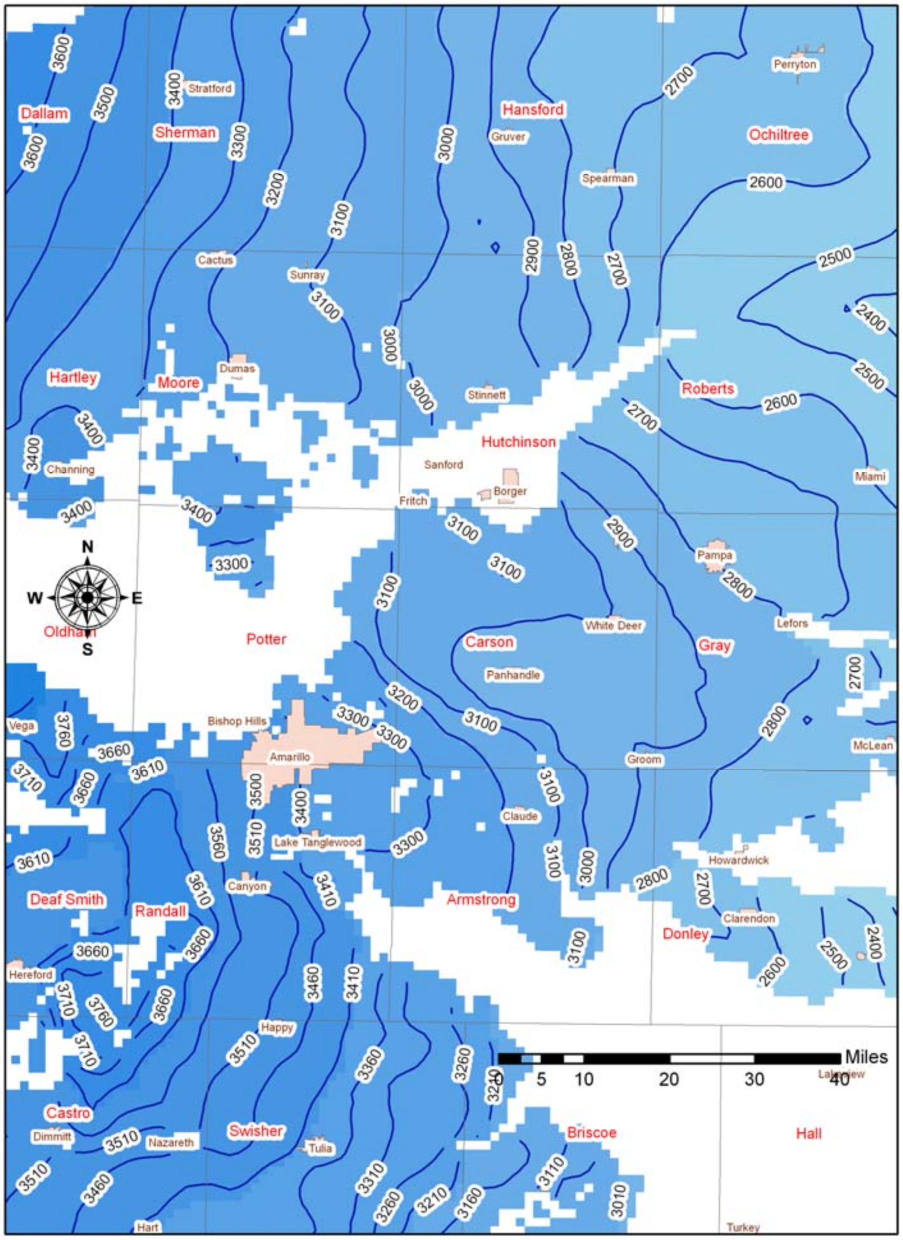

Figure 10: Predicted water levels in 2029 for the south-central section of Groundwater Management Area #1. White areas are beyond the boundary of the models or are inactive cells within the models.

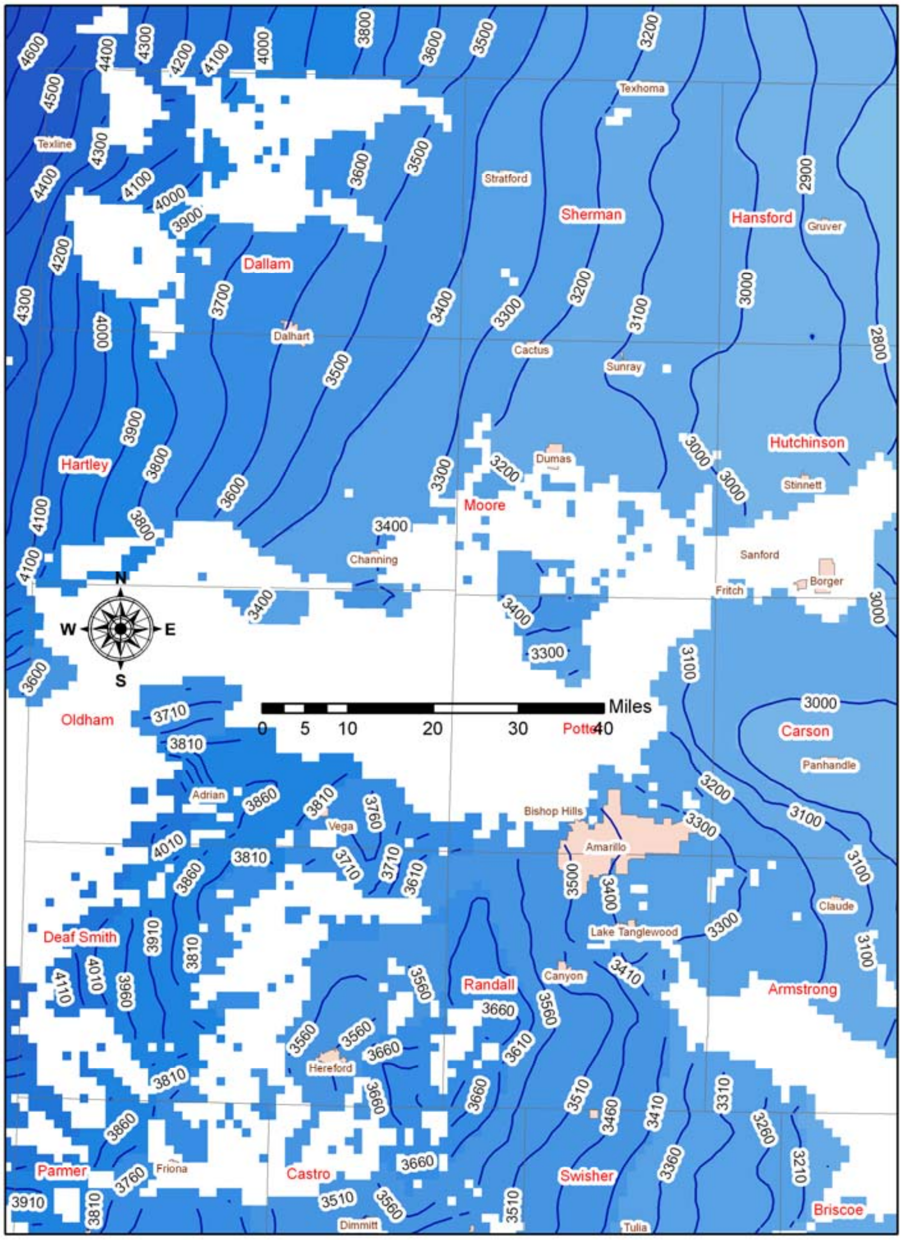

Figure 11: Predicted water levels in 2039 for the northwestern section of Groundwater Management Area #1. White areas are beyond the boundary of the models or are inactive cells within the models.

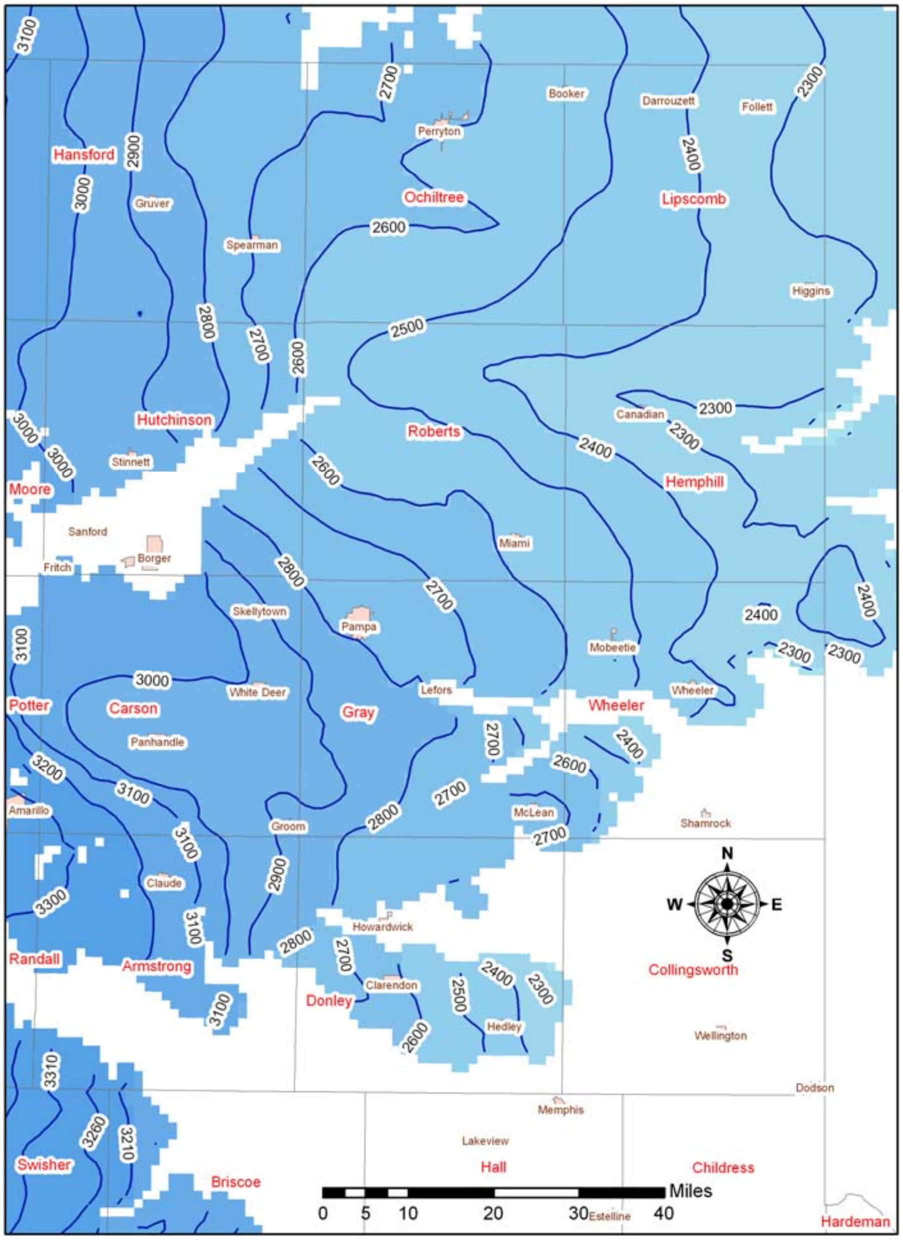

Figure 12: Predicted water levels in 2039 for the northeastern section of Groundwater Management Area #1. White areas are beyond the boundary of the models or are inactive cells within the models.

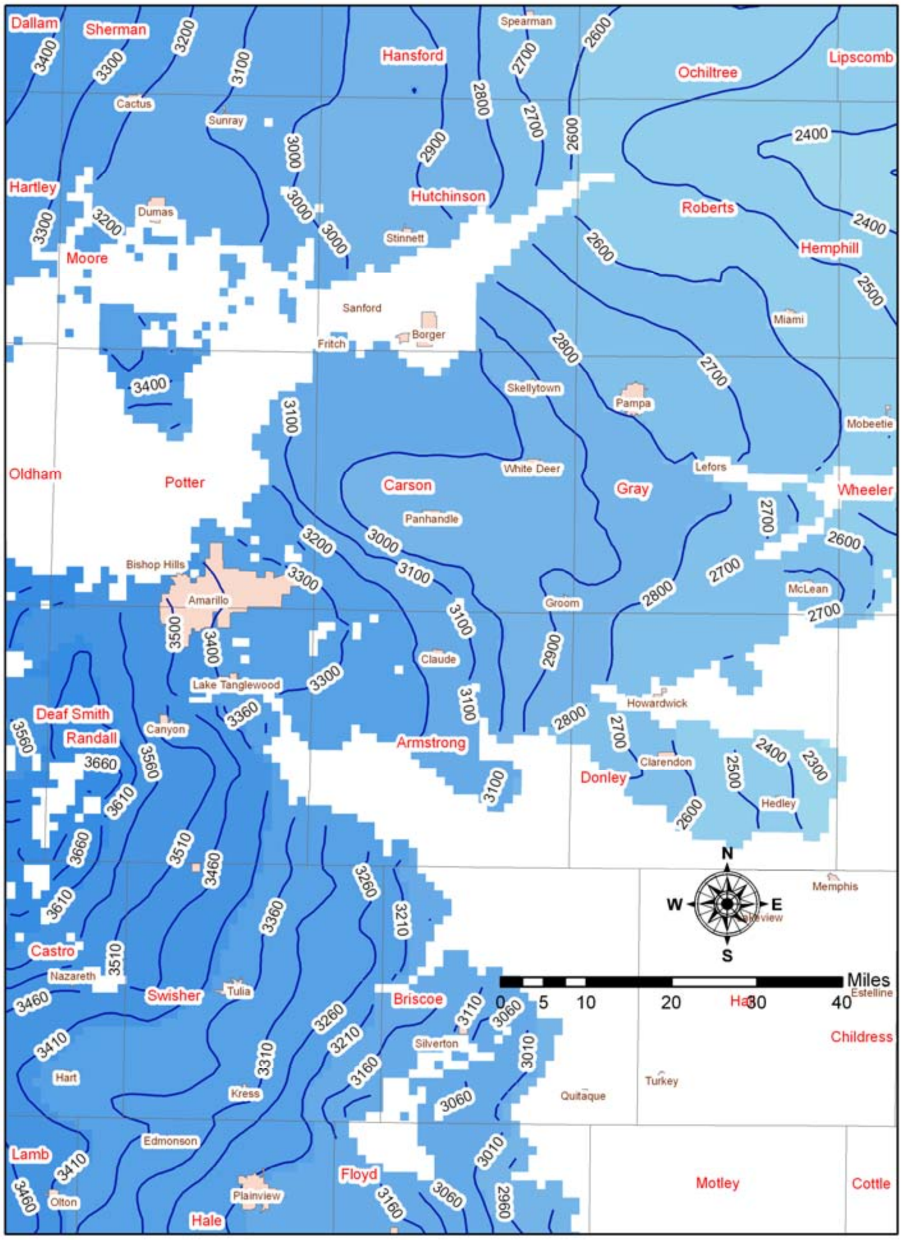

Figure 13: Predicted water levels in 2039 for the south-central section of Groundwater Management Area #1. White areas are beyond the boundary of the models or are inactive cells within the models.

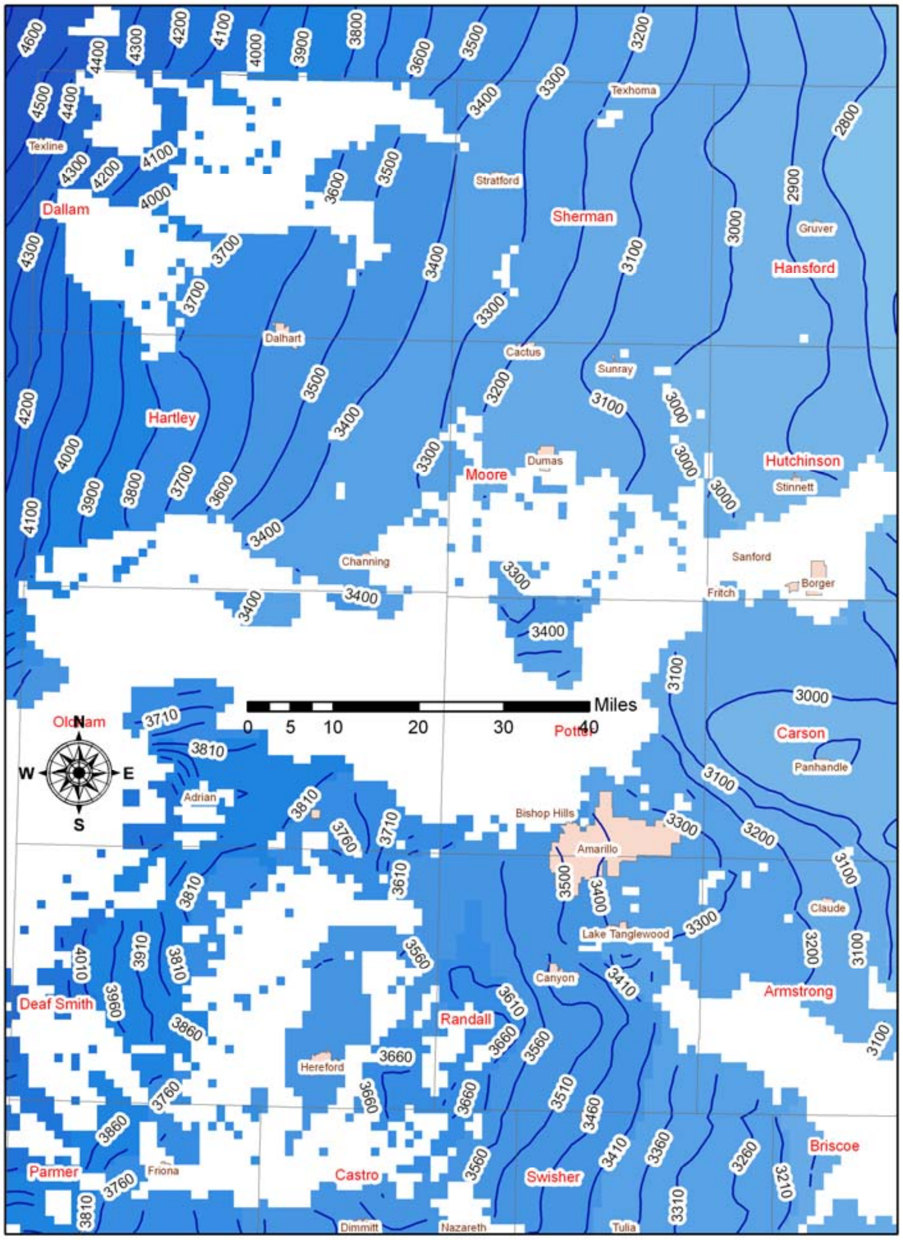

Figure 14: Predicted water levels in 2049 for the northwestern section of Groundwater Management Area #1. White areas are beyond the boundary of the models or are inactive cells within the models.

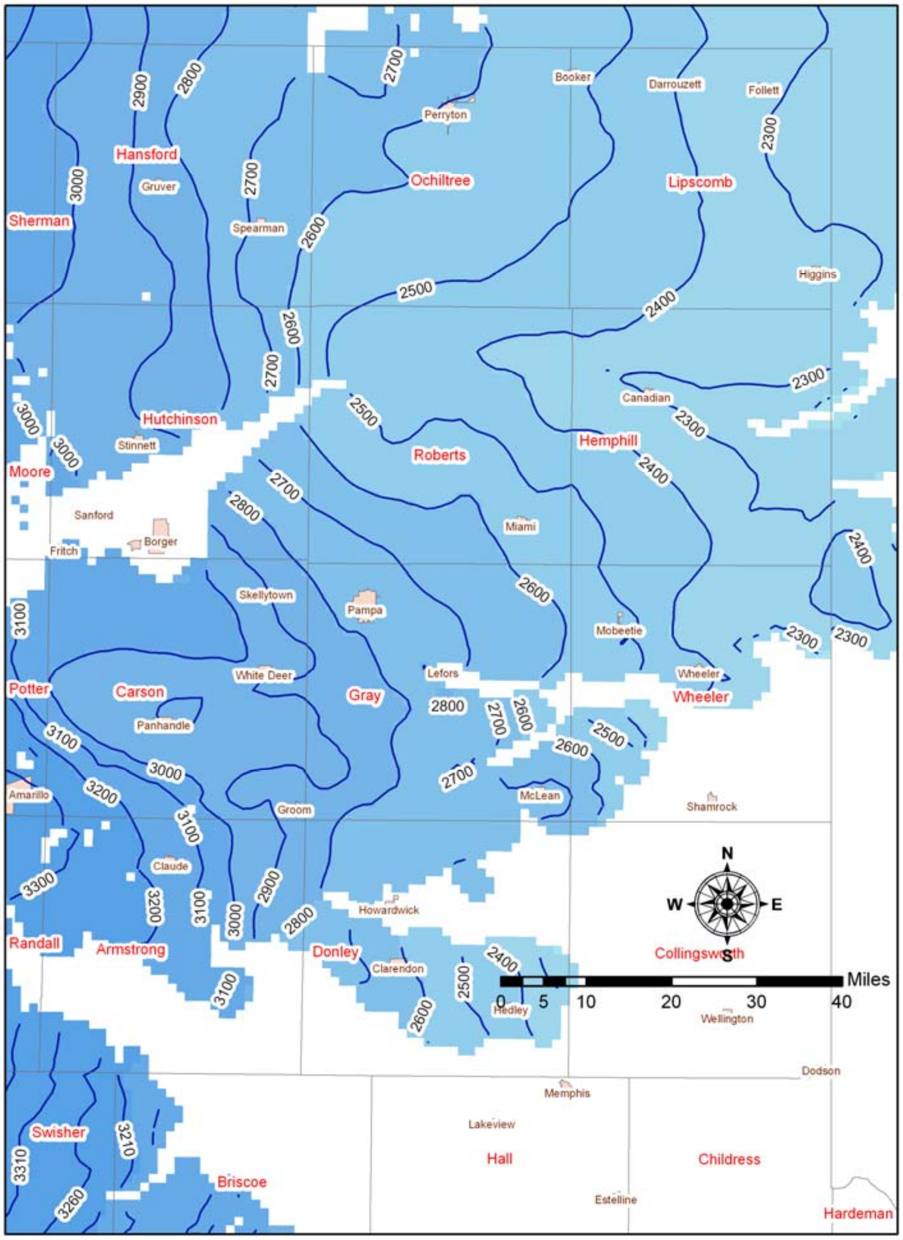

Figure 15: Predicted water levels in 2049 for the northeastern section of Groundwater Management Area #1. White areas are beyond the boundary of the models or are inactive cells within the models.

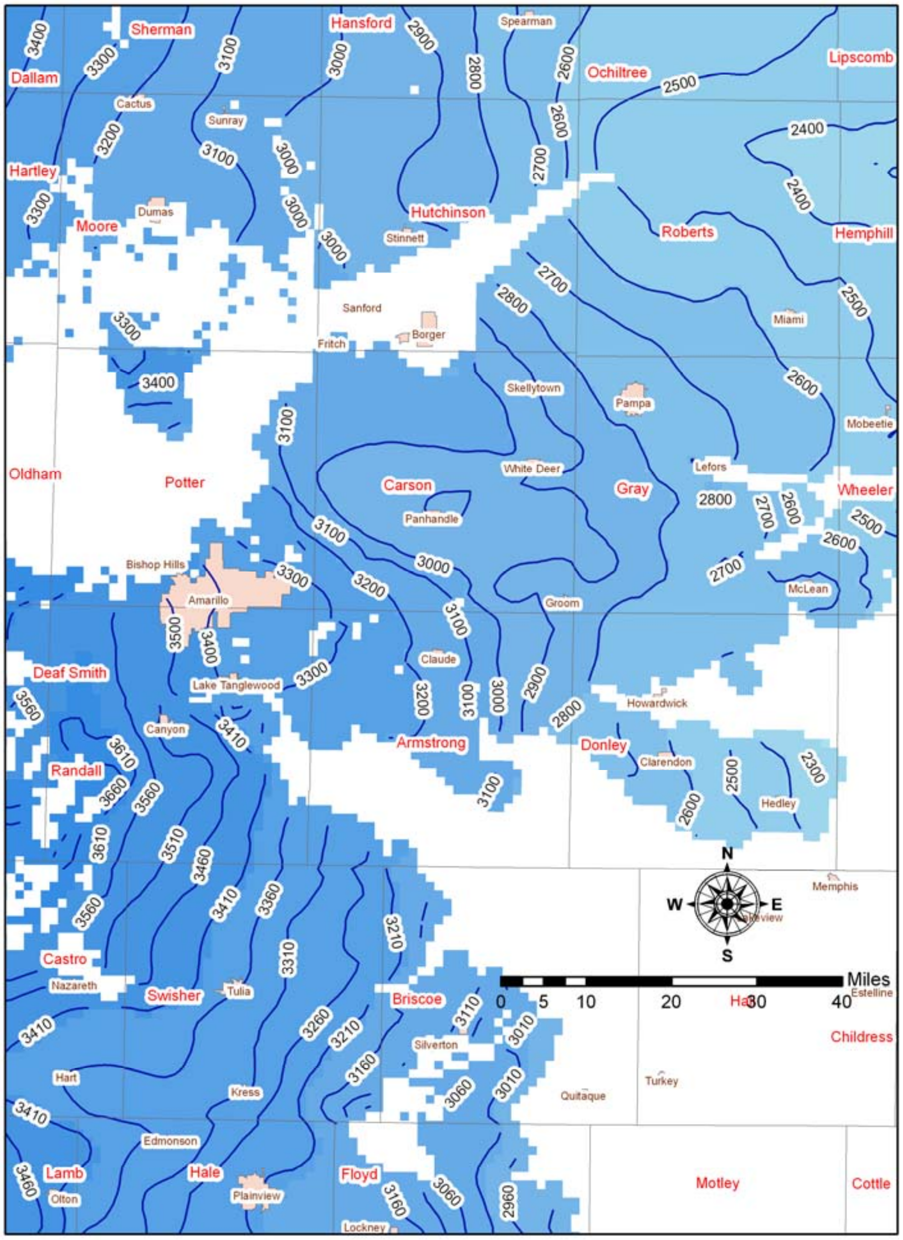

Figure 16: Predicted water levels in 2049 for the south-central section of Groundwater Management Area #1. White areas are beyond the boundary of the models or are inactive cells within the models.

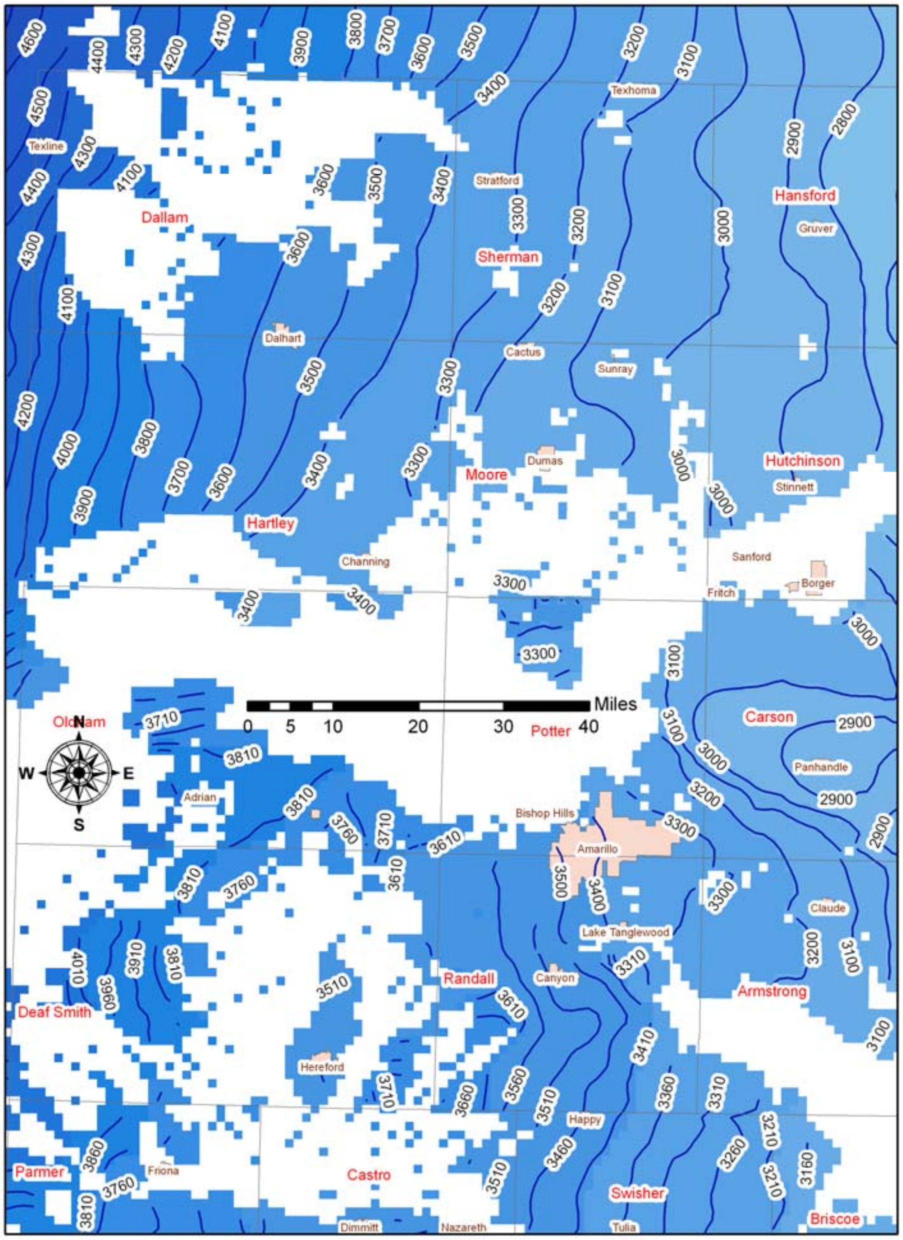

Figure 17: Predicted water levels in 2059 for the northwestern section of Groundwater Management Area #1. White areas are beyond the boundary of the models or are inactive cells within the models.

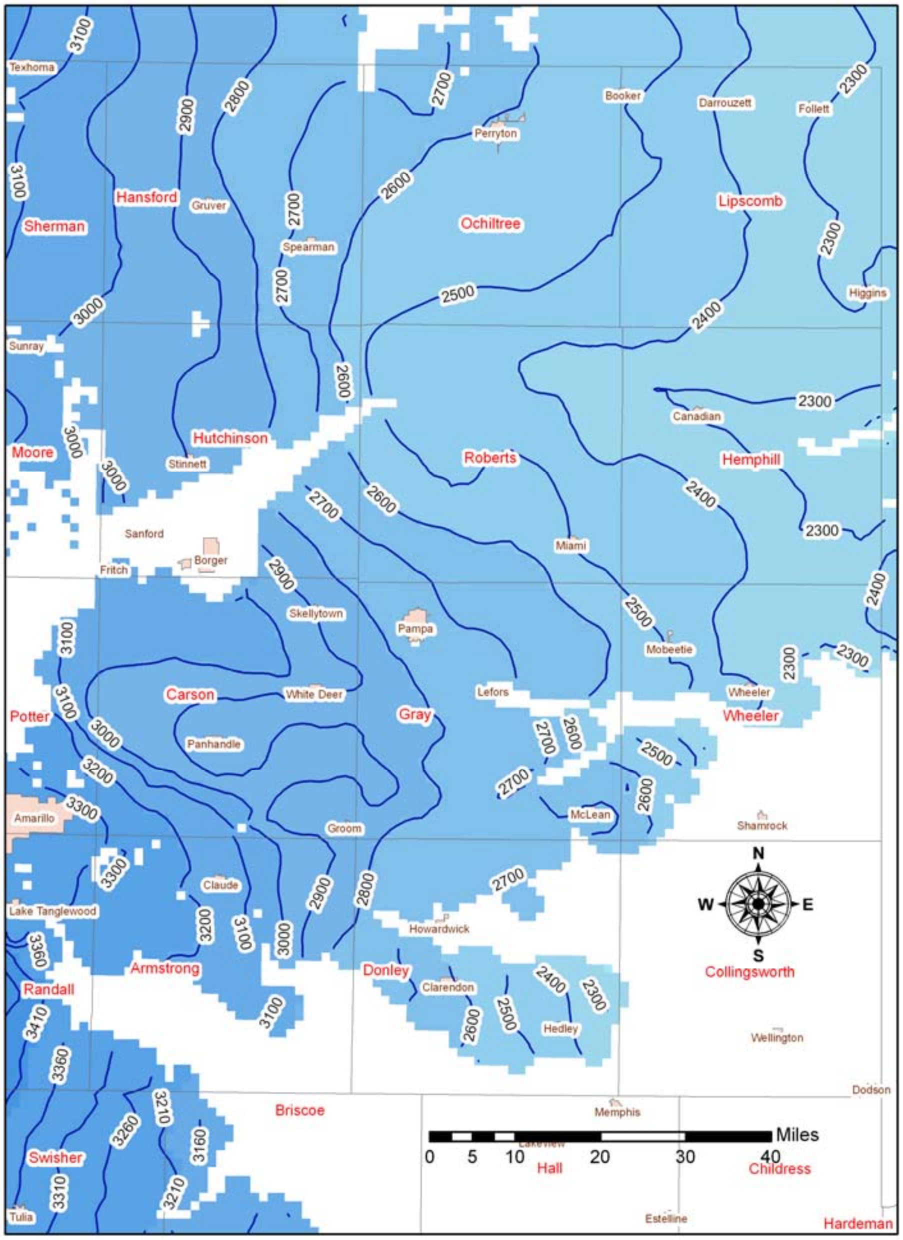

Figure 18: Predicted water levels in 2059 for the northeastern section of Groundwater Management Area #1. White areas are beyond the boundary of the models or are inactive cells within the models.

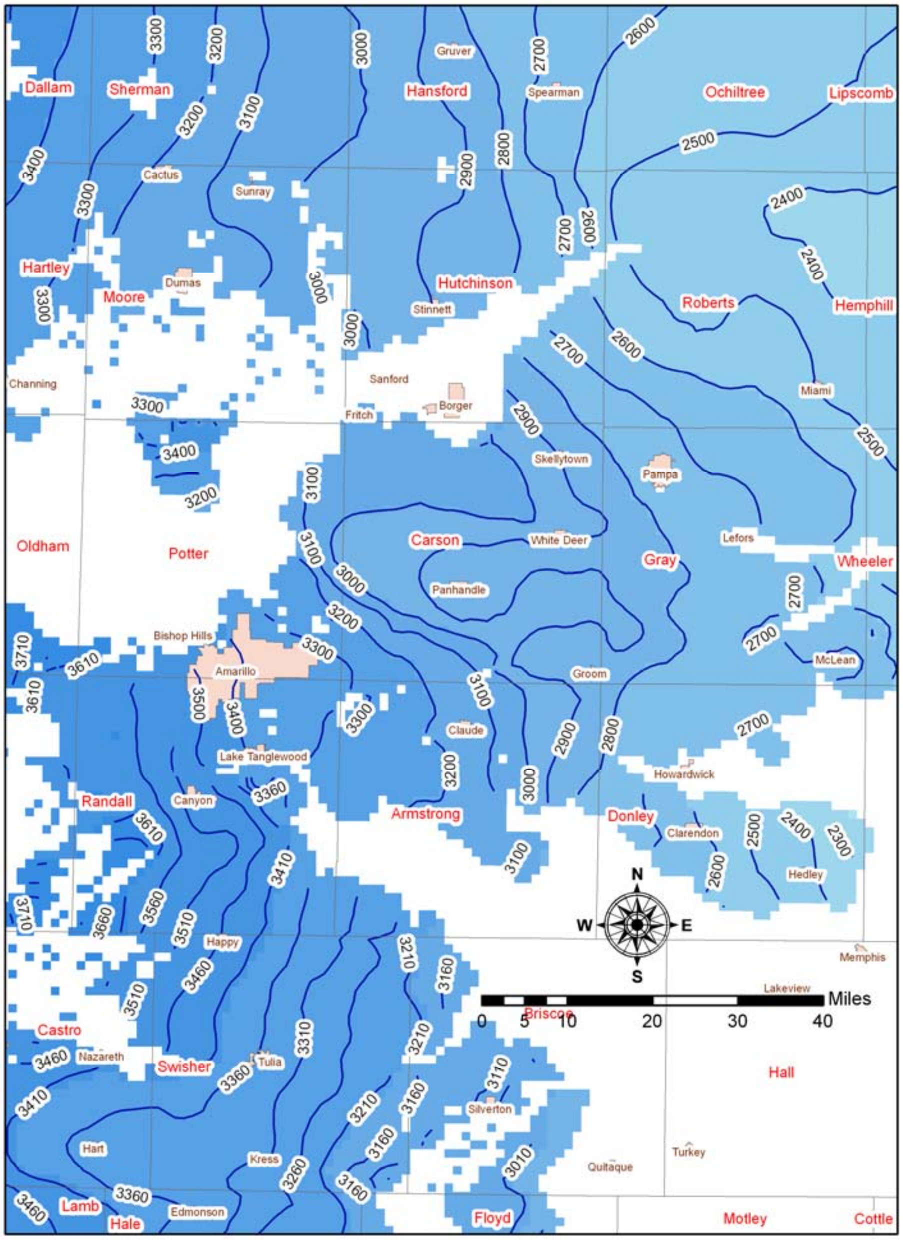

Figure 19: Predicted water levels in 2059 for the south-central section of Groundwater Management Area #1. White areas are beyond the boundary of the models or are inactive cells within the models.