GAM run 07-44

by Richard Smith, P.G.
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 936-0877
February 25, 2008

REQUESTOR:

Mr. Jason Coleman with the South Plains Underground Water Conservation District on behalf of Groundwater Management Area 2.

EXECUTIVE SUMMARY:

We ran the groundwater availability model for the southern part of the Ogallala Aquifer for fifty year scenarios with pumping rates based on one, two, and 0.64 feet of decline. The 0.64 foot decline scenario corresponds to the average decline across the entire groundwater management area for the most recent 10 year period. The resulting water budgets showed that the application of average decline for the projected period of fifty years results in the fewest number of cells dewatering. However, the one and two foot scenarios appear to more closely approximate the pumping conditions exhibited during the last year of the transient phase of the groundwater availability model run.

DESCRIPTION OF REQUEST:

Mr. Jason Coleman, with the South Plains Underground Water Conservation District, requested a determination of the volume pumped in each year within each of the seven districts comprising Groundwater Management Area 2 for the time period of 2000 through 2050 in order to achieve one foot of drawdown, two feet of drawdown, and 0.64 feet of drawdown,

METHODS:

To address the request, we did the following steps, we

- used ArcGIS version 9.1 to calculate the volume for each cell in the southern part of the Ogallala Aquifer groundwater availability model which correspond to one foot of drawdown, two feet of drawdown, and 0.64 feet of drawdown;
- multiplied the area of each cell (one square mile) by the amount of drawdown and then by the specific yield, and then added the average recharge per cell;
- created three well files to reflect the respective pumping scenarios;
- ran the model for 2000 through 2050 and exported the results to create maps showing on a decade by decade basis the changes in saturated thickness; and

- and, lastly, exported the water budgets for each year in the 50 year projection and created tables showing the amount of managed available groundwater (MAG) for each district for each year in each of the three scenarios.

PARAMETERS AND ASSUMPTIONS:

- We used version 1.01 of the groundwater availability model for the southern part of the Ogallala Aquifer (2003, Blandford and others).
- See Blandford and others (2003) for assumptions and limitations of the groundwater availability model for the southern part of the Ogallala Aquifer. Root mean squared error for this model is 47 feet.
- Average recharge used in the groundwater availability 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.
- The drawdown in the third scenario (an average of 0.64 feet) is based on a table generated by Jason Coleman with the South Plains Underground Water Conservation District showing drawdowns throughout the twenty-two county area covered by Groundwater Management Area 2 (See Table 4). The drawdowns are generally from 1998 through 2007 with total coverage from 2003 through 2007.

RESULTS:

Table 1 shows the managed available groundwater for each of the seven districts comprising Groundwater Management Area 2 using average drawdown per year based on ten years of record (See Table 4). The districts include:

- Garza County Underground and Fresh Water Conservation District,
- High Plains Underground Water Conservation District No 1,
- Llano Estacado Underground Water Conservation District,
- Mesa Underground Water Conservation District,
- Permian Basin Underground Water Conservation District,
- Sandy Land Underground Water Conservation District, and
- South Plains Underground Water Conservation District.

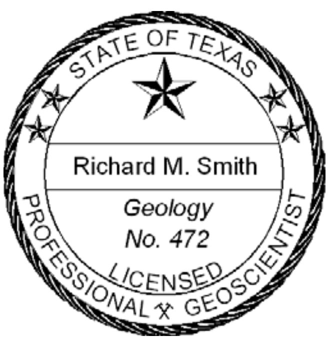
The year 1999 is included on all the tables to reflect the last year of pumping that is used in the groundwater availability model for the southern part of the Ogallala Aquifer. In the case of average drawdown, the Garza, Mesa, and the Permian Basin districts have pumping rates in 1999 well below the 2000 pumping rate designed to achieve 0.64 feet of drawdown per year. In contrast, the High Plains, Llano Estacado, Sandy Land, and South Plains districts have pumping rates at the end of the transient period (1999) well in excess of the average pumping rate shown in year 2000, the first year of the fifty year projection. Examination of Tables 2 and 3 (one foot drawdown and two feet of drawdown respectively) shows pumping rates somewhere between one and two feet that correspond to the 1999 pumping values. The pumping rates in those tables more closely correspond to the last year of pumping in the transient model (1999).

Figures 1 and 2 in Appendix A are the baseline saturated thickness for all three scenarios. Figures 3 through 12 present the saturated thickness of the southern part of the Ogallala Aquifer for the average; that is, the 0.64 foot drawdown per year across the entire aquifer. Figures 13 through 22 show the saturated thickness of the southern part of the Ogallala Aquifer with one foot of drawdown per year across the aquifer. Figures 23 through 32 indicate the saturated thickness across the aquifer with two feet of drawdown per year.

Based on an examination of the figures in Appendix A, as expected, the southern part of the Ogallala Aquifer is least impacted with 0.64 feet of drawdown per year and most affected by two feet of drawdown per year. The one foot scenario actually retains large areas of saturated thickness throughout the region for the entire projected period (See Figure 21 and 22). In contrast, the two foot scenario has large swaths of inactive cells occurring during the course of the simulation. This affects the value for managed available groundwater since as the cells become inactive, they no longer contribute pumping to the model and the available volume decreases.

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.



The seal appearing on this document was authorized by Richard M. Smith, P.G. on March 4, 2008

Year	Garza County Underground and FWCD Pumping (acre-feet per year)	High Plains UWCD No 1 Pumping (acre-feet per year)	Llano Estacado UWCD Pumping (acre-feet per year)	Mesa UWCD Pumping (acre-feet per year)	Permian Basin UWCD Pumping (acre-feet per year)	Sandy Land UWCD Pumping (acre-feet per year)	South Plains UWCD Pumping (acre-feet per year)
1999	1,313	1,813,448	311,939	32,261	18,299	75,475	96,160
2000	8,444	650,841	79,793	48,253	91,509	42,258	50,055
2001	8,444	649,724	79,793	48,253	91,134	42,258	50,055
2002	8,444	648,656	79,731	48,253	90,727	42,196	50,055
2003	8,444	648,183	79,669	48,253	90,361	42,196	50,055
2004	8,444	647,588	79,669	48,253	90,283	42,196	49,992
2005	8,444	646,855	79,669	48,253	89,820	42,132	49,992
2006	8,444	646,522	79,607	48,253	89,423	42,132	49,992
2007	8,444	645,574	79,607	48,253	88,867	42,070	49,992
2008	8,444	645,229	79,607	48,253	88,663	42,070	49,992
2009	8,444	644,497	79,483	48,253	88,189	42,070	49,930
2010	8,444	643,799	79,483	48,253	87,757	42,006	49,930
2011	8,444	643,379	79,483	48,253	87,040	41,818	49,930
2012	8,444	642,856	79,483	48,253	86,174	41,628	49,930
2013	8,444	642,190	79,483	48,253	85,800	41,565	49,930
2014	8,444	641,553	79,483	48,253	85,422	41,484	49,930
2015	8,444	641,195	79,420	48,253	85,160	41,411	49,930
2016	8,444	640,065	79,420	48,253	84,539	41,036	49,930
2017	8,444	639,759	79,420	48,178	83,617	41,036	49,930
2018	8,444	639,038	79,158	48,178	83,396	40,912	49,930
2019	8,444	638,062	79,158	48,178	82,849	40,770	49,930
2020	8,444	637,418	79,158	48,178	82,394	40,641	49,868
2021	8,444	636,602	79,158	48,178	81,602	40,516	49,868
2022	8,444	636,115	79,158	48,178	81,161	40,386	49,868
2023	8,444	635,404	79,158	48,178	80,103	40,386	49,806
2024	8,444	635,047	79,158	48,178	79,609	39,979	49,806
2025	8,444	634,035	79,158	48,178	78,577	39,917	49,806

Table 1: Average drawdown of 0.64 feet was applied across the entire aquifer estimated from the average decline for the last ten years (1998-2007) across the entire southern part of the Ogallala Aquifer (See Table 4). The year 1999 is the last year of transient pumping actually applied in the southern part of the Ogallala Aquifer groundwater availability model. Decreases in volume indicate increases in inactive cells within the model for that year. FWCD is the abbreviation for Fresh Water Conservation District and UWCD I is the abbreviation for Underground Water Conservation District.

Year	Garza County Underground and FWCD Pumping (acre-feet per year)	High Plains UWCD No 1 Pumping (acre-feet per year)	Llano Estacado UWCD Pumping (acre-feet per year)	Mesa UWCD Pumping (acre-feet per year)	Permian Basin UWCD Pumping (acre-feet per year)	Sandy Land UWCD Pumping (acre-feet per year)	South Plains UWCD Pumping (acre-feet per year)
2026	8,444	633,445	79,034	48,178	78,301	39,855	49,806
2027	8,444	632,949	79,034	48,178	77,683	39,783	49,806
2028	8,444	632,378	79,034	48,178	77,019	39,576	49,806
2029	8,444	631,888	79,034	48,178	76,680	39,514	49,730
2030	8,444	631,113	79,034	48,178	76,209	39,440	49,730
2031	8,444	630,254	79,034	48,178	75,734	39,238	49,730
2032	8,444	629,116	79,034	48,178	75,138	39,042	49,668
2033	8,444	627,786	79,034	48,178	74,927	38,699	49,668
2034	8,444	627,007	79,034	48,178	74,377	38,509	49,668
2035	8,444	626,056	79,034	48,178	74,173	38,323	49,668
2036	8,444	625,326	78,910	48,178	73,971	38,179	49,668
2037	8,444	624,545	78,910	48,178	73,416	37,922	49,668
2038	8,444	623,804	78,910	48,178	73,140	37,536	49,606
2039	8,369	623,110	78,848	48,178	72,396	37,213	49,544
2040	8,369	621,920	78,848	48,178	72,016	36,629	49,482
2041	8,369	620,238	78,848	48,178	71,719	36,443	49,404
2042	8,369	619,118	78,848	48,178	71,120	36,376	49,404
2043	8,369	618,200	78,848	48,178	70,842	36,172	49,404
2044	8,369	617,054	78,848	48,178	70,492	35,924	49,404
2045	8,369	615,849	78,786	48,178	70,063	35,675	49,404
2046	8,369	615,054	78,662	48,178	69,183	35,280	49,404
2047	8,369	613,588	78,662	48,178	68,912	35,085	49,404
2048	8,369	612,350	78,600	48,178	68,653	34,898	49,342
2049	8,369	611,610	78,537	48,178	68,326	34,637	49,342
2050	8,296	610,199	78,475	48,178	68,116	34,513	49,280

Table 1 (cont.): Average drawdown of 0.64 feet was applied across the entire aquifer estimated from the average decline for the last ten years (1998-2007) across the entire southern part of the Ogallala Aquifer (See Table 4). The year 1999 is the last year of transient pumping actually applied in the southern part of the Ogallala Aquifer groundwater availability model. Decreases in volume indicate increases in inactive cells within the model for that year. FWCD is the abbreviation for Fresh Water Conservation District and UWCD I is the abbreviation for Underground Water Conservation District.

Year	Garza County Underground and FWCD Pumping (acre-feet per year)	High Plains UWCD No 1 Pumping (acre-feet per year)	Llano Estacado UWCD Pumping (acre-feet per year)	Mesa UWCD Pumping (acre-feet per year)	Permian Basin UWCD Pumping (acre-feet per year)	Sandy Land UWCD Pumping (acre-feet per year)	South Plains UWCD Pumping (acre-feet per year)
1999	1,313	1,813,448	311,939	32,261	18,299	75,475	96,160
2000	13,247	1,014,447	143,279	80,260	130,032	76,656	88,636
2001	13,247	1,012,110	143,182	80,260	129,351	76,558	88,636
2002	13,247	1,010,843	143,084	80,260	128,864	76,558	88,539
2003	13,247	1,009,480	143,084	80,260	128,377	76,364	88,539
2004	13,247	1,007,824	142,987	80,260	127,792	76,266	88,539
2005	13,247	1,006,363	142,987	80,260	126,623	76,266	88,441
2006	13,247	1,004,415	142,792	80,260	126,039	76,169	88,441
2007	13,247	1,002,954	142,792	80,260	124,480	75,779	88,441
2008	13,247	1,001,687	142,792	80,260	123,312	75,487	88,441
2009	13,247	1,000,129	142,792	80,260	122,727	75,487	88,441
2010	13,247	998,473	142,695	80,260	121,169	74,805	88,441
2011	13,247	997,012	142,500	80,162	120,390	74,513	88,441
2012	13,247	995,454	142,402	80,162	119,318	74,221	88,344
2013	13,247	993,506	142,402	80,162	118,539	74,026	88,344
2014	13,247	991,850	142,305	80,162	117,467	73,734	88,247
2015	13,247	990,389	142,305	80,162	116,299	73,441	88,247
2016	13,247	988,441	142,110	80,162	114,351	72,760	88,247
2017	13,247	987,369	142,110	80,162	113,279	72,370	88,149
2018	13,247	985,713	142,110	80,162	111,623	71,786	88,149
2019	13,247	983,765	142,110	80,162	110,552	71,591	88,149
2020	13,247	982,110	142,110	80,162	109,578	70,909	88,052
2021	13,149	979,285	142,110	80,162	108,117	70,325	87,954
2022	13,149	976,655	142,013	80,162	107,338	69,838	87,954
2023	13,149	974,804	141,915	80,162	106,656	69,253	87,760
2024	13,149	972,759	141,915	80,162	105,974	67,890	87,662
2025	13,149	969,934	141,818	80,162	105,097	66,721	87,662

Table 2: Pumping values for a uniform drawdown of one foot across the entire southern part of the Ogallala Aquifer. The year 1999 is the last year of the transient southern part of the Ogallala Aquifer groundwater availability model with pumping volumes that are in the model. Decreases in volume indicate increases in inactive cells within the model. FWCD is the abbreviation for Fresh Water Conservation District and UWCD I is the abbreviation for Underground Water Conservation District.

Year	Garza County Underground and FWCD Pumping (acre-feet per year)	High Plains UWCD No 1 Pumping (acre-feet per year)	Llano Estacado UWCD Pumping (acre-feet per year)	Mesa UWCD Pumping (acre-feet per year)	Permian Basin UWCD Pumping (acre-feet per year)	Sandy Land UWCD Pumping (acre-feet per year)	South Plains UWCD Pumping (acre-feet per year)
2026	13,149	966,915	141,818	80,162	104,123	65,844	87,662
2027	13,149	964,187	141,818	80,162	103,344	65,260	87,662
2028	13,149	961,850	141,818	80,162	102,662	64,870	87,662
2029	13,052	958,830	141,623	80,162	101,786	63,896	87,565
2030	13,052	955,908	141,428	80,162	100,714	62,922	87,370
2031	13,052	953,571	141,331	80,162	99,838	62,338	87,273
2032	13,052	950,064	141,136	80,162	98,961	61,656	87,273
2033	13,052	945,973	141,039	80,162	97,987	60,682	87,175
2034	13,052	943,051	140,941	80,162	97,305	60,000	87,175
2035	13,052	938,571	140,941	79,967	96,039	59,123	87,175
2036	12,955	935,649	140,747	79,870	95,454	58,344	87,175
2037	12,955	932,434	140,747	79,870	94,578	57,565	87,078
2038	12,955	927,954	140,649	79,870	93,409	56,980	86,980
2039	12,955	925,713	140,649	79,870	92,045	56,591	86,980
2040	12,857	922,597	140,649	79,870	90,974	55,617	86,980
2041	12,857	919,188	140,357	79,870	90,195	55,519	86,980
2042	12,857	915,973	140,357	79,870	89,805	55,130	86,786
2043	12,857	912,564	140,357	79,870	89,416	54,448	86,786
2044	12,857	909,545	140,260	79,870	88,539	53,961	86,688
2045	12,857	906,428	140,162	79,870	87,662	53,279	86,688
2046	12,857	902,824	139,967	79,870	87,273	52,890	86,688
2047	12,857	899,123	139,870	79,870	86,591	52,403	86,591
2048	12,857	895,519	139,870	79,870	85,812	51,721	86,493
2049	12,857	891,720	139,480	79,870	84,838	51,039	86,493
2050	12,857	889,382	139,383	79,773	83,669	50,455	86,493

Table 2 (Cont): Pumping values for a uniform drawdown of one foot across the entire southern part of the Ogallala Aquifer. The year 1999 is the last year of the transient southern part of the Ogallala Aquifer groundwater availability model with pumping volumes that are in the model. Decreases in volume indicate increases in inactive cells within the model. FWCD is the abbreviation for Fresh Water Conservation District and UWCD I is the abbreviation for Underground Water Conservation District.

Year	Garza County Underground and FWCD Pumping (acre-feet per year)	High Plains UWCD No 1 Pumping (acre-feet per year)	Llano Estacado UWCD Pumping (acre-feet per year)	Mesa UWCD Pumping (acre-feet per year)	Permian Basin UWCD Pumping (acre-feet per year)	Sandy Land UWCD Pumping (acre-feet per year)	South Plains UWCD Pumping (acre-feet per year)
1999	1,313	1,813,448	311,939	32,261	18,299	75,475	96,160
2000	26,303	2,007,322	284,301	159,363	256,838	152,014	175,996
2001	26,303	1,999,972	283,334	159,363	254,711	151,047	175,803
2002	26,303	1,990,302	282,947	159,363	251,229	150,660	175,609
2003	26,303	1,983,533	282,367	159,363	246,975	149,693	175,609
2004	26,303	1,975,217	282,174	159,170	242,913	148,533	175,609
2005	26,303	1,967,481	281,594	159,170	238,272	146,212	175,609
2006	26,303	1,958,971	281,400	159,170	234,017	144,278	175,222
2007	26,303	1,949,881	281,013	159,170	229,955	142,151	175,029
2008	26,303	1,940,598	280,433	159,170	222,993	140,990	175,029
2009	26,109	1,931,508	280,433	159,170	217,964	138,863	175,029
2010	26,109	1,919,711	280,046	159,170	213,323	135,575	174,642
2011	25,916	1,905,592	279,466	159,170	211,002	132,094	174,062
2012	25,916	1,893,408	278,886	159,170	207,327	125,711	173,869
2013	25,916	1,879,483	278,499	159,170	204,039	121,650	173,675
2014	25,722	1,861,883	277,919	158,590	200,365	117,975	173,675
2015	25,529	1,846,411	276,565	158,590	197,464	113,334	173,288
2016	25,529	1,829,392	275,792	158,010	192,822	107,725	173,095
2017	25,529	1,813,339	275,211	157,429	189,534	104,824	173,095
2018	25,529	1,792,645	274,438	157,429	185,279	101,536	172,902
2019	25,529	1,773,112	273,664	157,429	181,218	97,088	171,935
2020	25,336	1,754,352	272,697	157,236	177,156	91,479	170,387
2021	25,336	1,737,719	272,117	157,043	173,869	87,418	169,034
2022	25,336	1,720,313	271,150	157,043	171,354	84,323	167,680
2023	25,336	1,697,878	269,990	157,043	168,647	81,809	166,519
2024	25,336	1,676,604	269,216	156,269	164,392	77,361	165,166
2025	25,142	1,658,811	268,249	155,882	161,297	74,460	163,425

Table 3: Pumping values for a uniform drawdown of two feet across the entire southern part of theOgallala Aquifer. The year 1999 is the last year of the transient southern part of the Ogallala Aquifer groundwater availability model with pumping volumes that are in the model. Decreases in volume indicate increases in inactive cells within the model. FWCD is the abbreviation for Fresh Water Conservation District and UWCD I is the abbreviation for Underground Water Conservation District.

Year	Garza County Underground and FWCD Pumping (acre-feet per year)	High Plains UWCD No 1 Pumping (acre-feet per year)	Llano Estacado UWCD Pumping (acre-feet per year)	Mesa UWCD Pumping (acre-feet per year)	Permian Basin UWCD Pumping (acre-feet per year)	Sandy Land UWCD Pumping (acre-feet per year)	South Plains UWCD Pumping (acre-feet per year)
2026	25,142	1,643,339	267,475	155,495	156,656	69,625	161,297
2027	24,949	1,625,352	266,508	155,109	153,755	67,304	160,137
2028	24,949	1,610,267	266,508	154,142	149,693	64,596	158,203
2029	24,369	1,591,700	265,735	153,755	147,566	60,728	156,656
2030	24,369	1,574,101	263,801	153,175	144,471	56,280	153,948
2031	24,175	1,557,662	262,253	151,434	142,924	53,959	151,434
2032	23,788	1,536,581	260,319	150,467	140,217	51,638	148,146
2033	23,595	1,517,434	259,933	149,113	137,896	47,964	145,438
2034	23,402	1,501,382	257,612	147,953	134,995	44,676	142,537
2035	22,821	1,482,621	256,065	146,405	132,481	41,581	140,410
2036	22,435	1,464,055	254,904	145,825	129,966	38,100	137,316
2037	21,854	1,442,394	253,937	144,665	125,905	35,199	132,674
2038	21,468	1,420,539	251,810	143,311	123,391	33,459	128,999
2039	21,468	1,397,525	250,649	141,570	121,843	31,331	124,358
2040	20,887	1,381,085	247,361	139,830	118,556	28,430	118,749
2041	20,501	1,362,906	243,880	137,896	116,235	26,690	115,074
2042	20,114	1,343,372	240,979	136,349	113,914	23,982	109,852
2043	19,534	1,322,098	238,658	134,801	109,852	22,628	107,532
2044	19,340	1,299,663	236,724	134,415	108,112	19,727	104,050
2045	19,340	1,281,096	232,663	132,481	103,664	17,986	101,536
2046	18,373	1,261,950	229,955	131,707	100,569	16,246	97,668
2047	18,180	1,244,350	227,248	131,127	97,281	15,472	95,347
2048	17,986	1,223,269	224,347	129,579	93,993	13,151	91,866
2049	17,986	1,203,735	220,672	127,065	90,899	11,411	87,224
2050	17,793	1,186,716	215,450	124,744	86,838	9,864	85,484

Table 3: (Cont) Pumping values for a uniform drawdown of two feet across the entire southern part of the Ogallala Aquifer. The year 1999 is the last year of the transient southern part of theOgallala Aquifer groundwater availability model with pumping volumes that are in the model. Decreases in volume indicate increases in inactive cells within the model. FWCD is the abbreviation for Fresh Water Conservation District and UWCD I is the abbreviation for Underground Water Conservation District.

County	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	10 Year Average	5 Year Average
Armstrong	0.42	0.46	0.55	0.49	0.55	0.54	0.72	0.69	0.67	0.55	0.56	0.63
Bailey	-0.53	-0.62	-0.44	-0.43	-0.33	-0.27	-0.25	0.26	-0.15	-0.12	-0.29	-0.11
Castro	-1.76	-1.92	-1.67	-1.79	-1.67	-1.61	-1.33	-1.13	-1.40	-1.21	-1.55	-1.34
Cochran	-0.74	-0.80	-0.72	-0.74	-0.62	-0.62	-0.68	-0.33	-0.64	-0.39	-0.63	-0.53
Crosby	-0.50	-0.56	-0.37	-0.14	-0.08	-0.16	0.07	0.09	-0.54	-0.75	-0.29	-0.26
Dawson	-0.45	-3.50	-2.17	-0.76	-2.43	-1.92	-2.41	0.93	-1.35	-1.22	-1.53	-1.19
Deaf Smith	-0.40	-0.36	-0.26	-0.30	-0.32	-0.42	-0.25	-0.02	-0.24	-0.21	-0.28	-0.23
Floyd	-0.63	-0.78	-0.62	-0.53	-0.39	-0.41	-0.45	-0.15	-0.79	-1.02	-0.58	-0.56
Gaines	-1.50	-3.80	0.20	-1.30	-2.50	-1.20	-3.30	1.00	-0.90	-1.20	-1.45	-1.12
Garza						-2.40	-2.40	2.20	0.20	-1.61	na	-0.80
Hale	-1.56	-1.67	-1.46	-1.43	-1.30	-1.31	-0.94	-0.54	-1.39	-1.51	-1.31	-1.14
Hockley	-0.50	-0.55	-0.41	-0.50	-0.42	-0.46	-0.47	-0.26	-0.61	-0.83	-0.50	-0.53
Howard						0.92	0.54	2.18	0.24	-0.46	na	0.69
Lamb	-1.37	-1.39	-1.24	-1.23	-1.24	-1.20	-1.02	-0.64	-0.93	-0.75	-1.10	-0.91
Lubbock	-0.50	-0.61	-0.50	-0.44	-0.42	-0.35	-0.28	-0.18	-0.71	-1.30	-0.53	-0.56
Lynn	-0.36	-0.52	-0.22	-0.23	-0.06	0.10	0.35	0.99	-0.36	-1.03	-0.13	0.01
Martin						1.32	1.17	1.24	-1.57	0.04	na	0.44
Parmer	-1.64	-1.60	-1.43	-1.45	-1.40	-1.31	-1.12	-0.65	-1.27	-1.14	-1.30	-1.10
Potter	-0.03	-0.01	-0.04	0.29	0.50	-0.04	0.31	0.11	-0.09	-0.12	0.09	0.03
Randall	0.07	0.04	0.02	0.08	-0.04	-0.07	-0.03	0.08	-0.05	-0.18	-0.01	-0.05
Terry	-0.95	-3.13	-1.79	-1.65	-1.38	-1.45	-1.46	1.09	0.33	-1.06	-1.15	-0.51
Yoakum	-0.01	-2.40	-0.90	-1.90	-1.10	-1.40	-1.10	-0.50	-0.90	-0.80	-1.10	-0.94
Yearly Avg.	*-0.68*	*-1.25*	*-0.71*	*-0.73*	*-0.77*	*-0.62*	*-0.65*	0.29	-0.57	*-0.74*		

Table 4: Supplied by Mr. Jason Coleman with the South Plains Underground Water Conservation District, this table shows water level declines and increases within individual counties of Groundwater Management Area 2. Negative values are declines and positive values are increases. The overall average is - 0.64 feet.

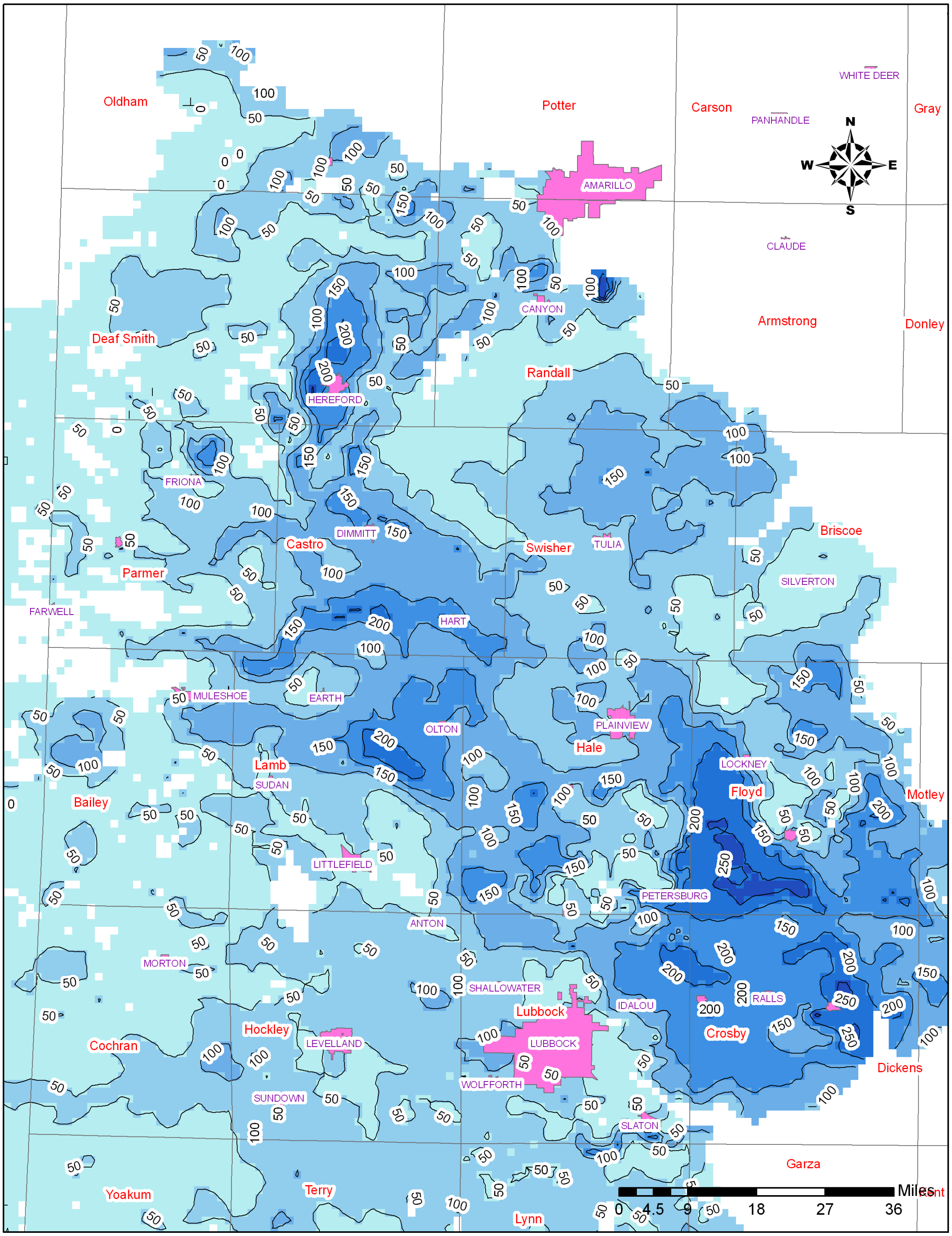


Figure 1: Map of saturated thickness in year 2000 for the northern half of the Southern Ogallala Aquifer. White cells are inactive and the contour interval is 50 feet.

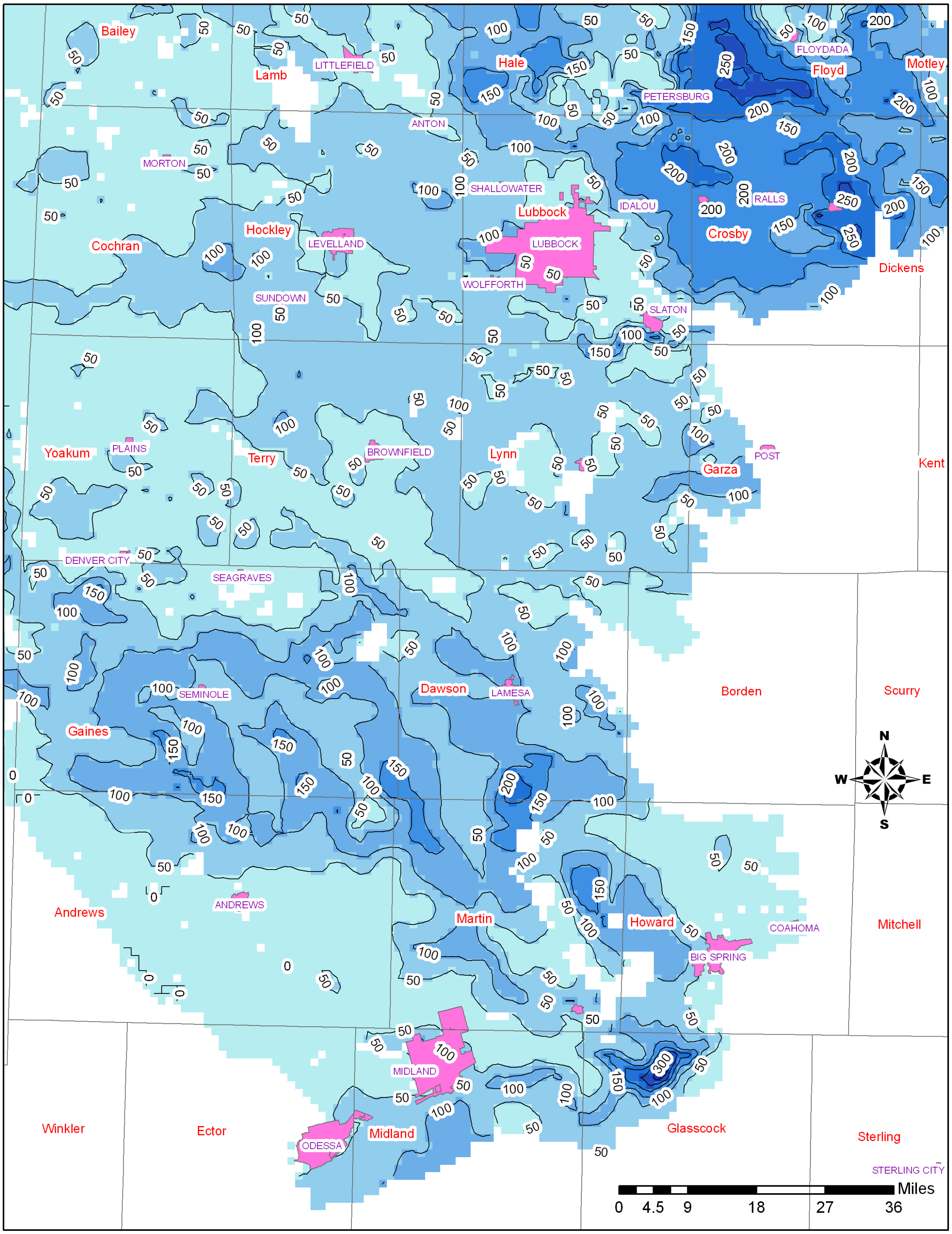


Figure 2: Map of saturated thickness in year 2000 for the southern half of the Southern Ogallala aquifer. White cells are inactive and the contour interval is 50 feet.

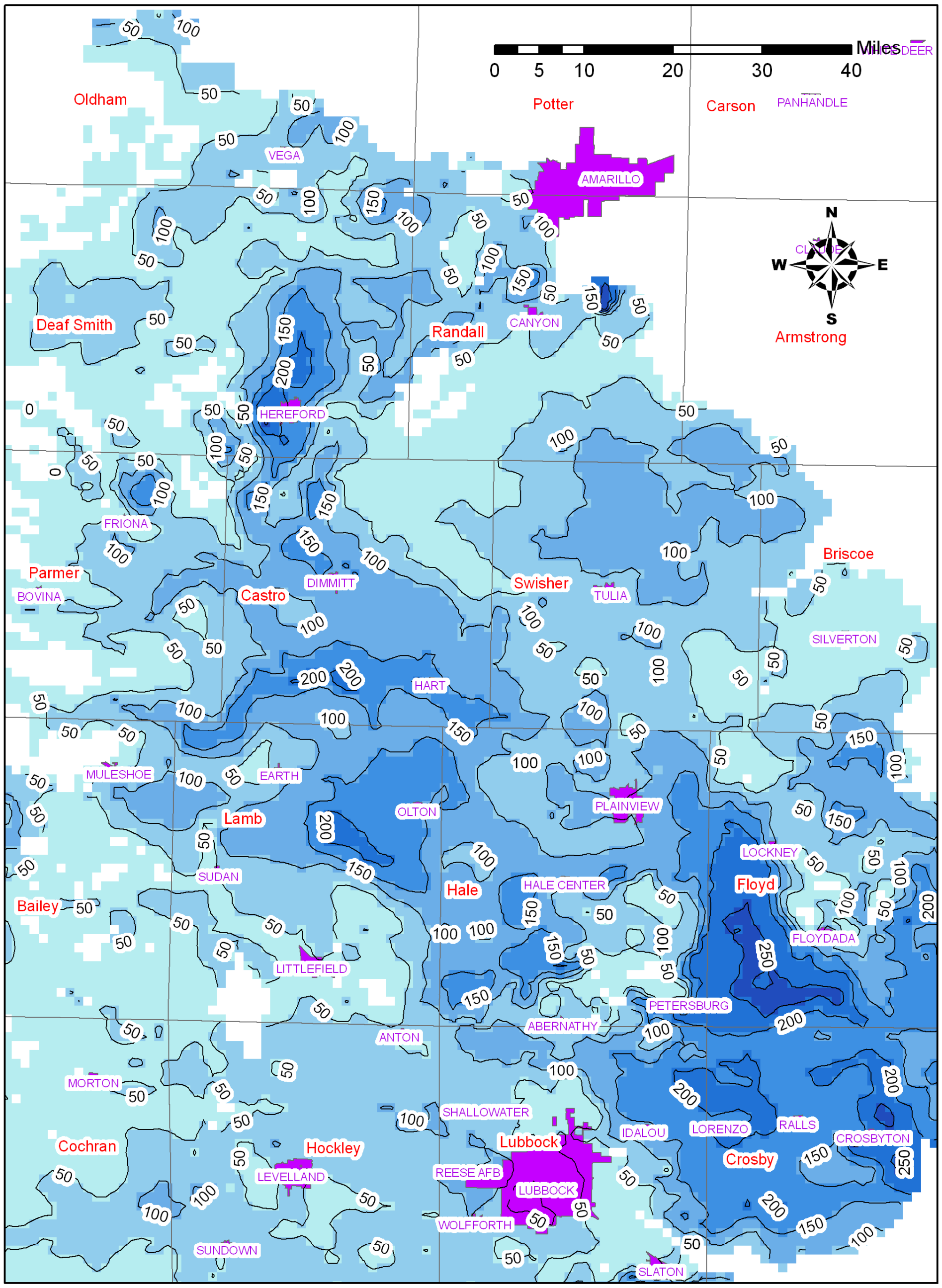


Figure 3: Map of saturated thickness in 2010 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals a 0.64 foot decline per year. Contour interval is 50 feet and white cells are inactive.

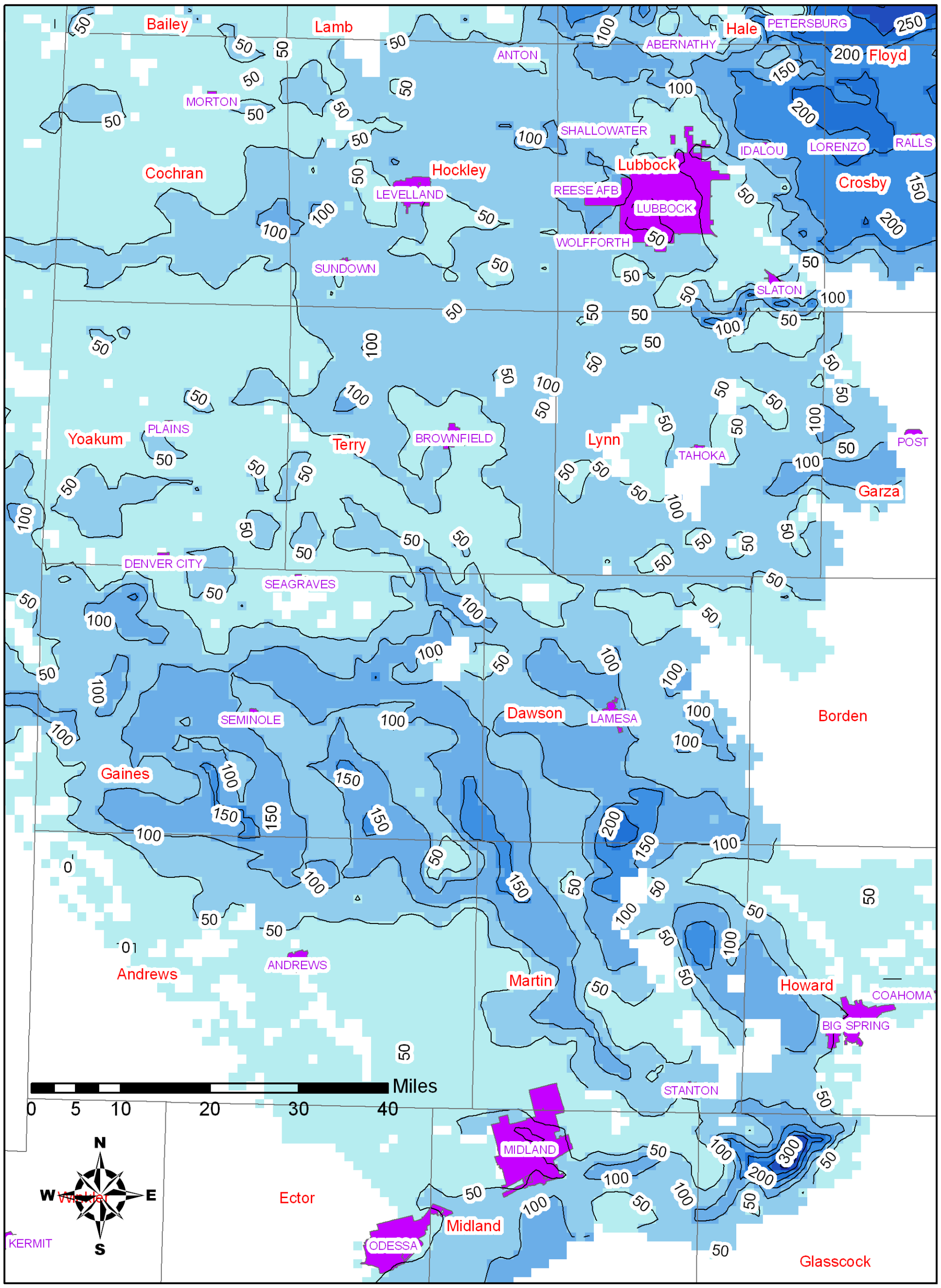


Figure 4: Map of saturated thickness in 2010 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals a 0.64 foot decline per year. Contour interval is 50 feet and white cells are inactive.

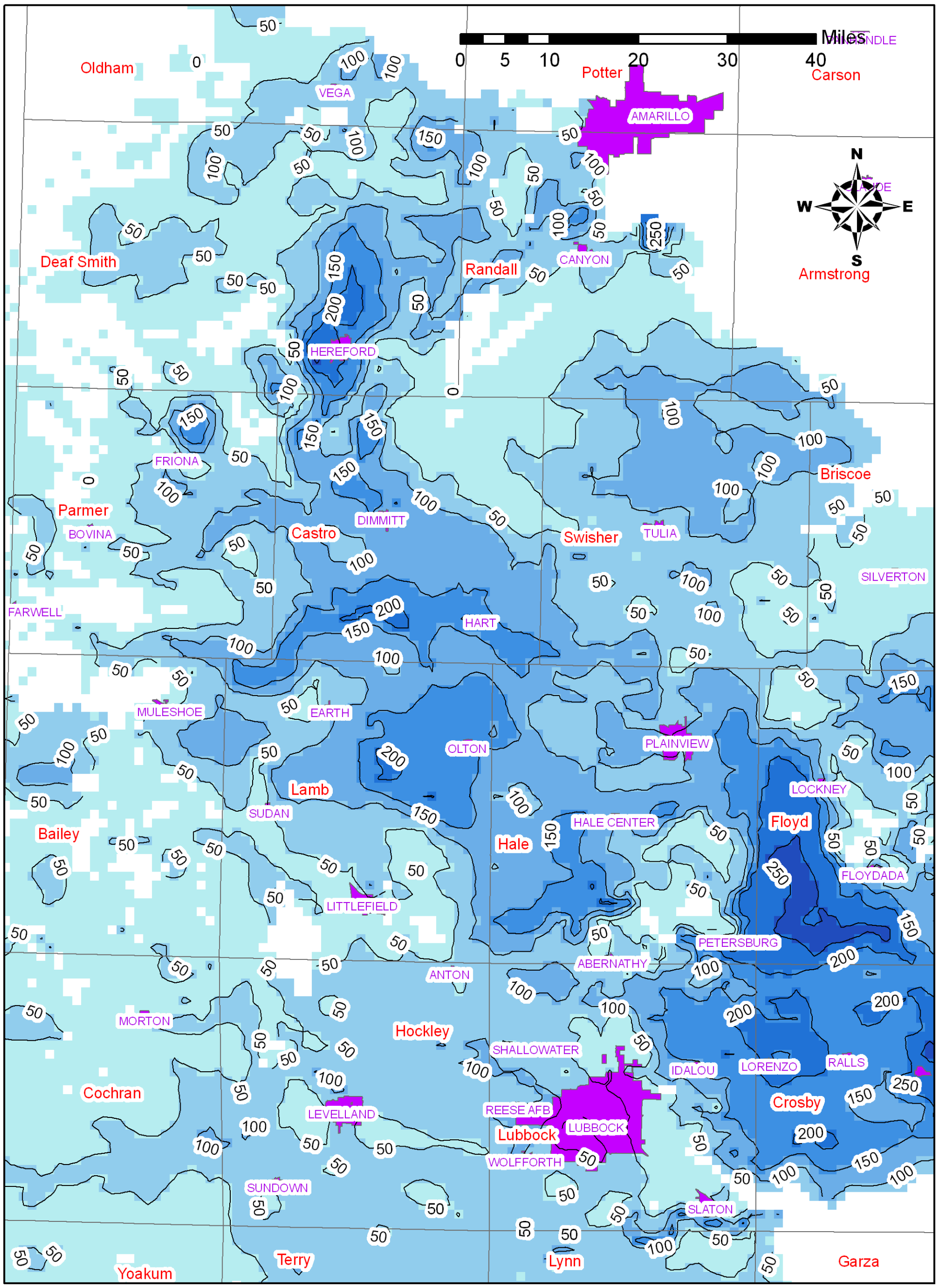


Figure 5: Map of saturated thickness in 2020 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals a 0.64 foot decline per year. Contour interval is 50 feet and white cells are inactive.

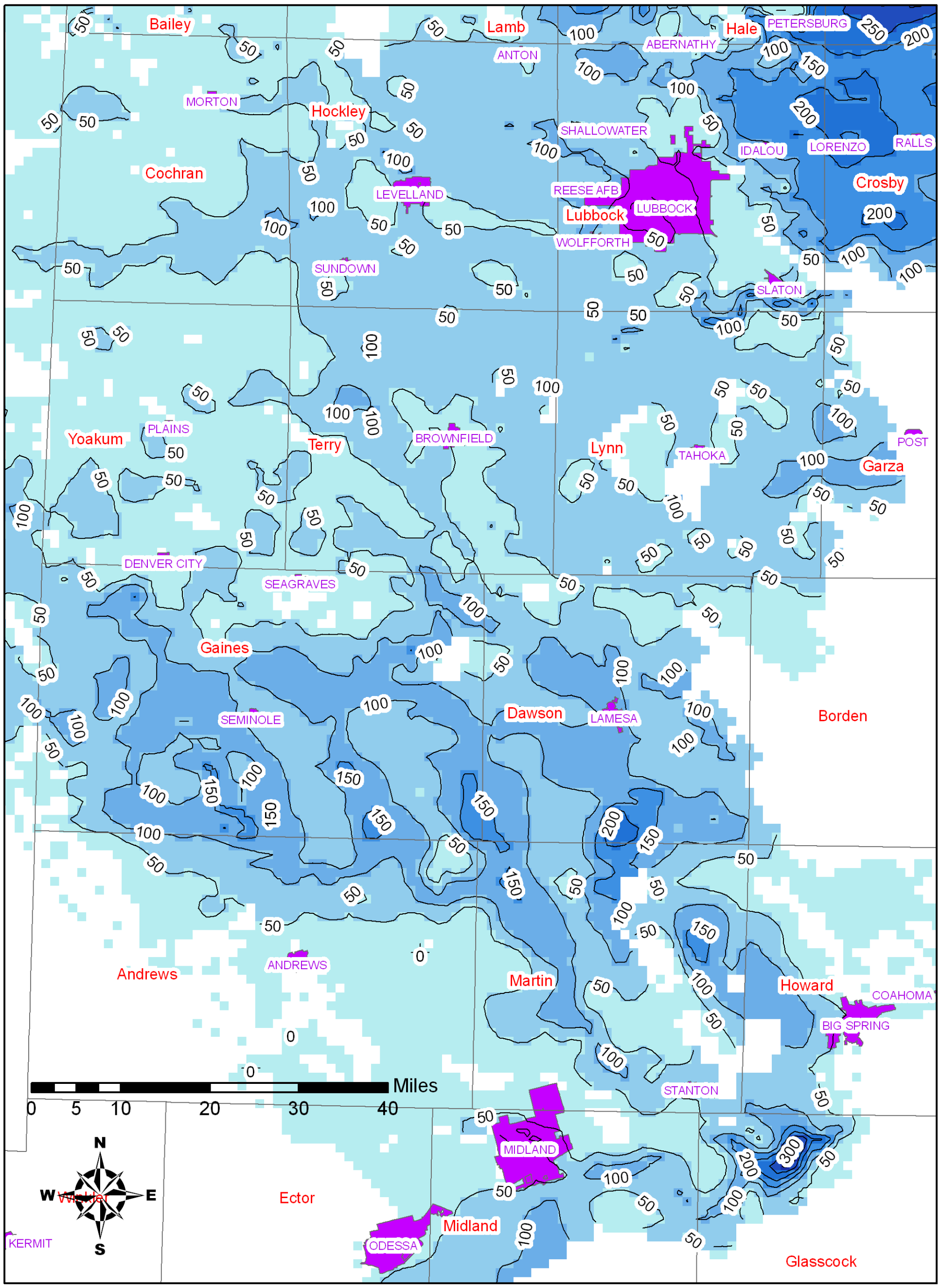


Figure 6: Map of saturated thickness in 2020 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals a 0.64 foot decline per year. Contour interval is 50 feet and white cells are inactive.

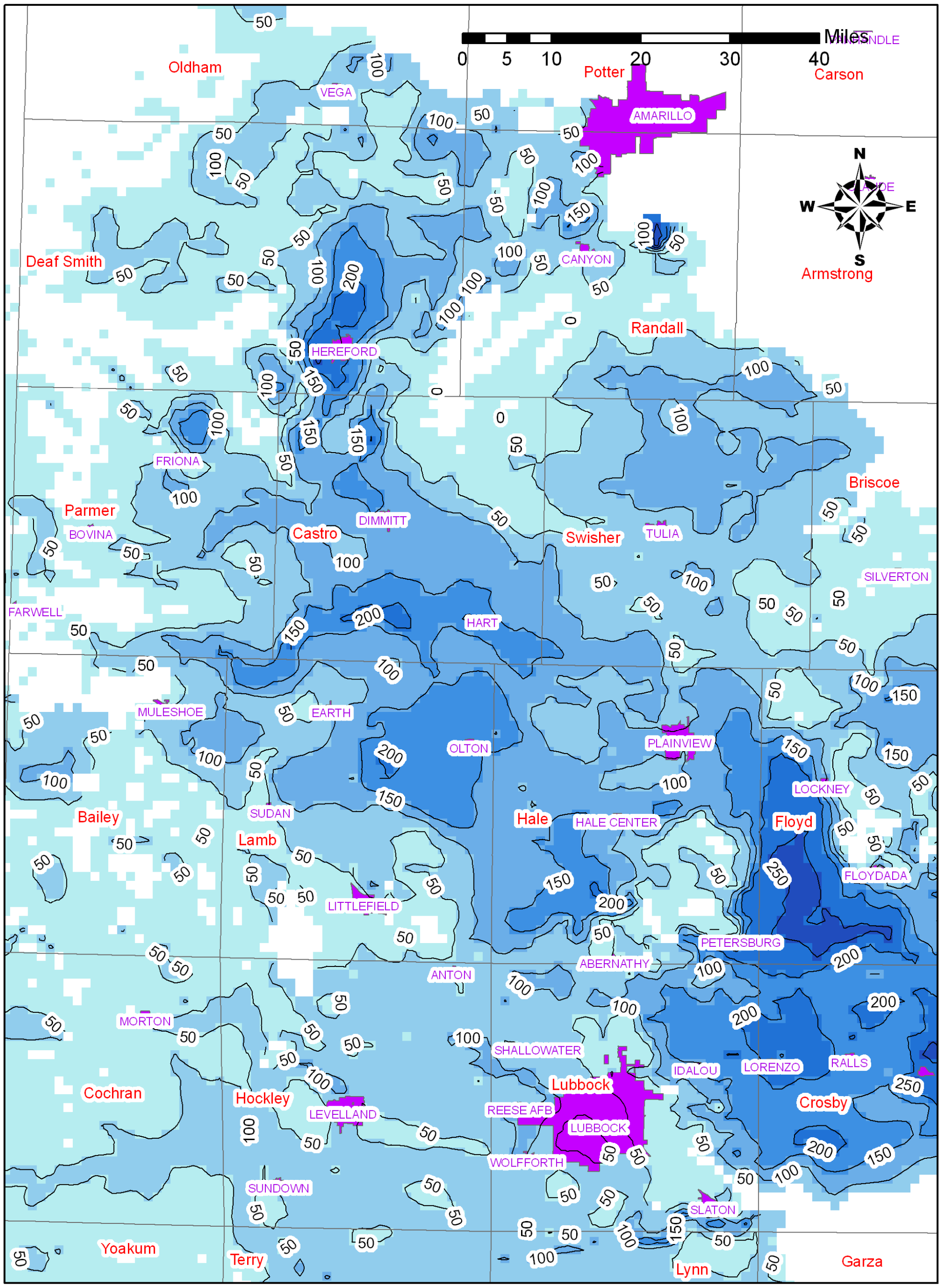


Figure 7: Map of saturated thickness in 2030 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals a 0.64 foot decline per year. Contour interval is 50 feet and white cells are inactive.

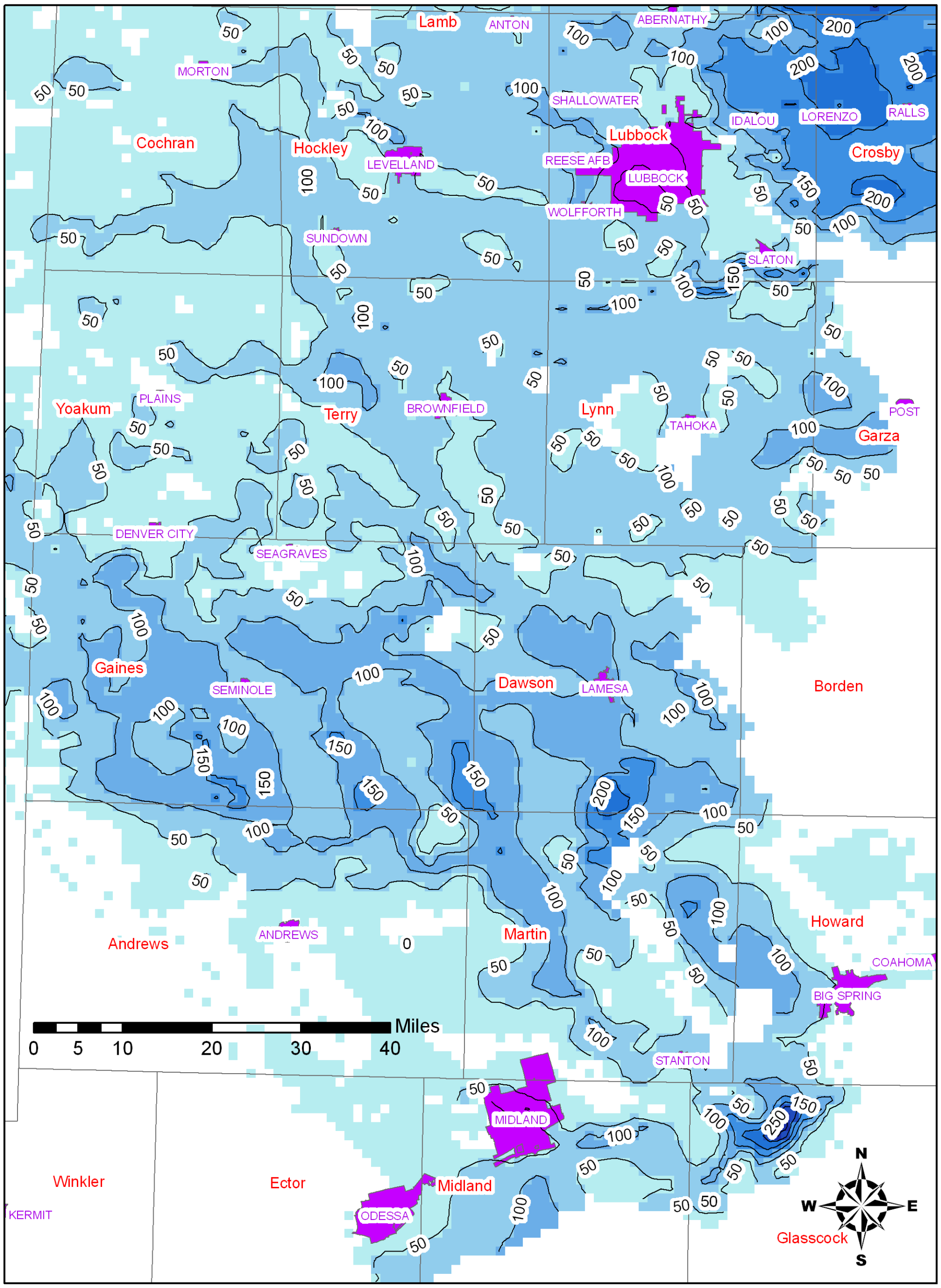


Figure 8: Map of saturated thickness in 2030 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals a 0.64 foot decline per year. Contour interval is 50 feet and white cells are inactive.

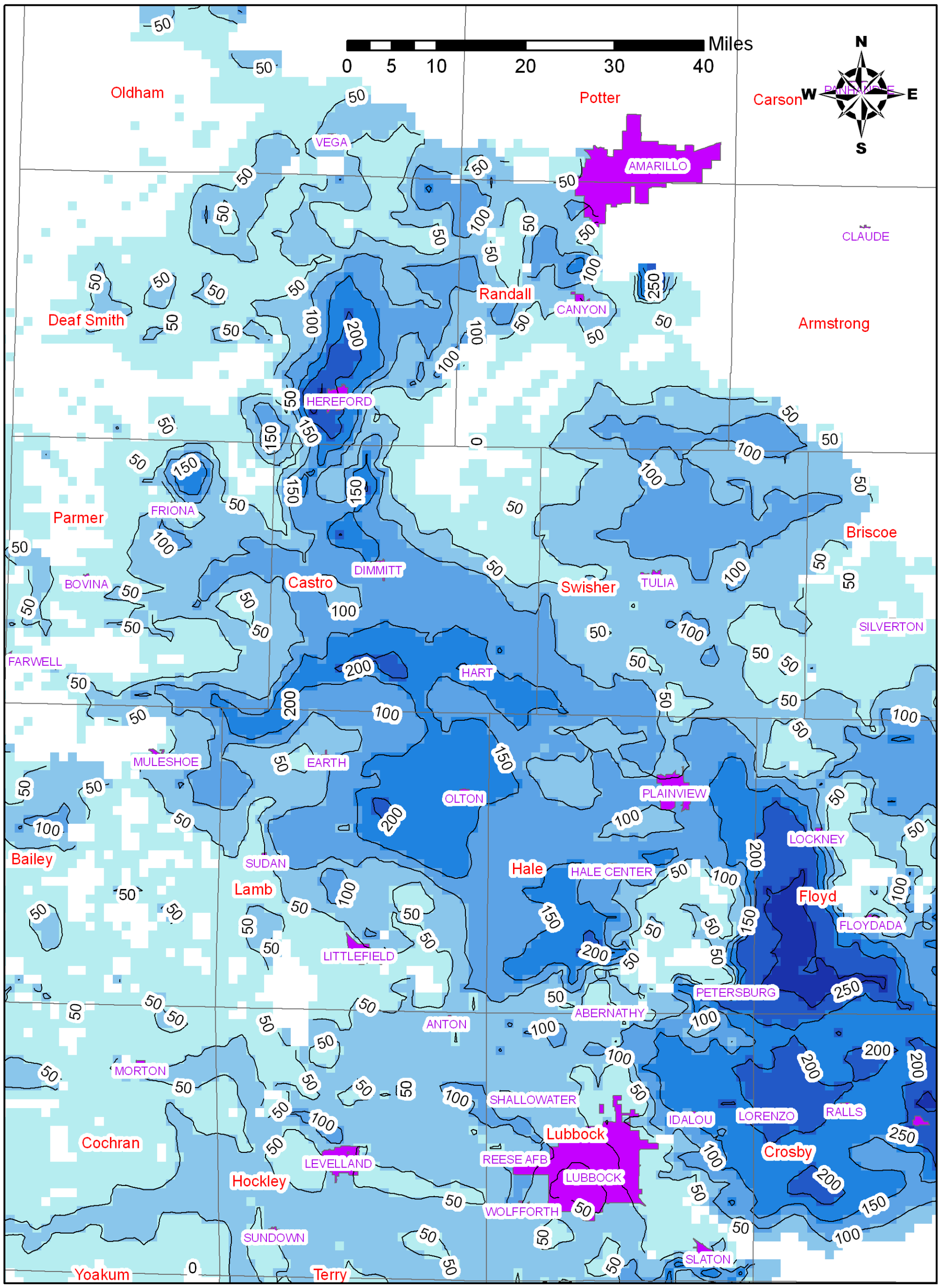


Figure 9: Map of saturated thickness in 2040 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals a 0.64 foot decline per year. Contour interval is 50 feet and white cells are inactive.

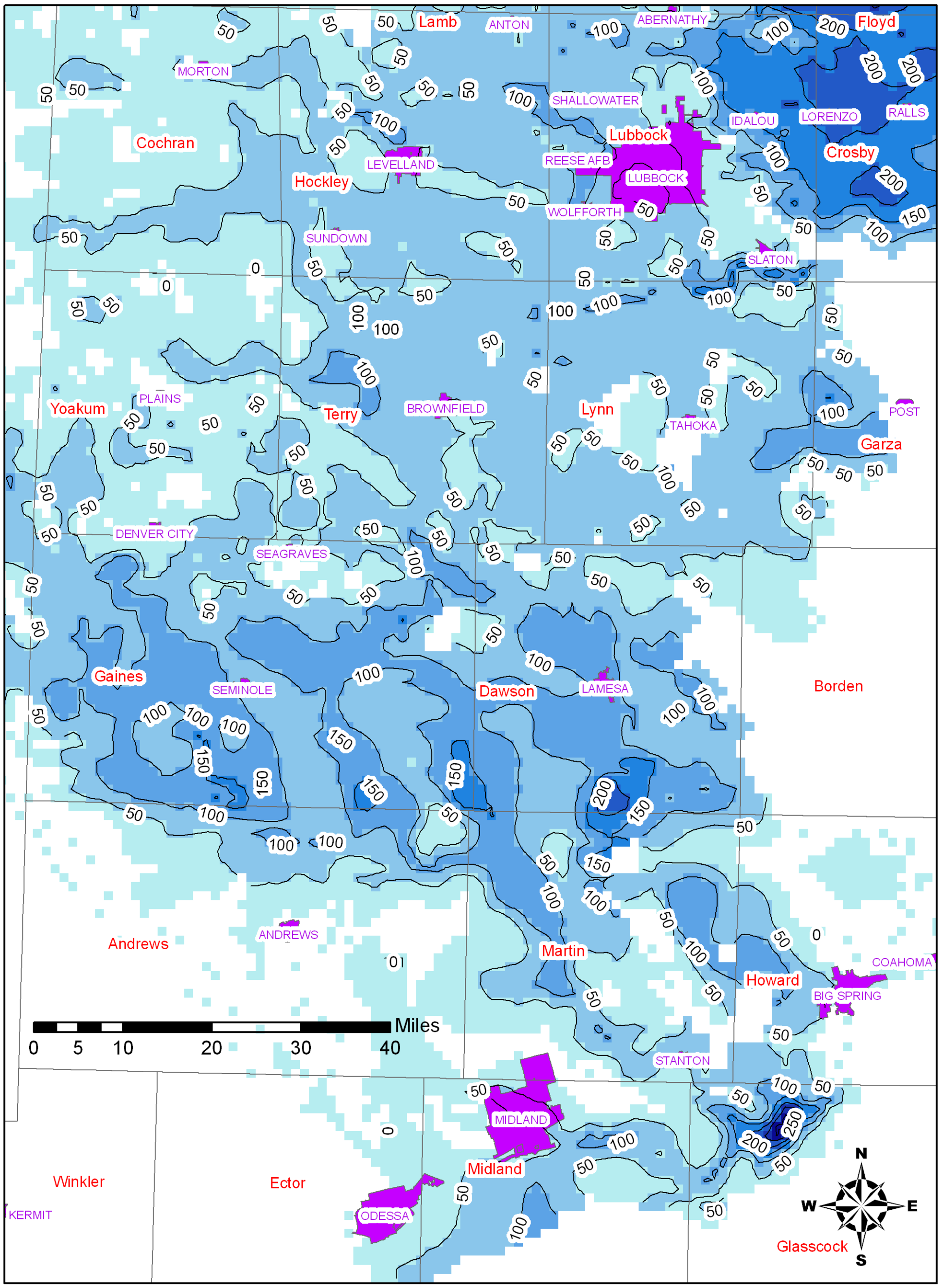


Figure 10: Map of saturated thickness in 2040 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals a 0.64 foot decline per year. Contour interval is 50 feet and white cells are inactive.

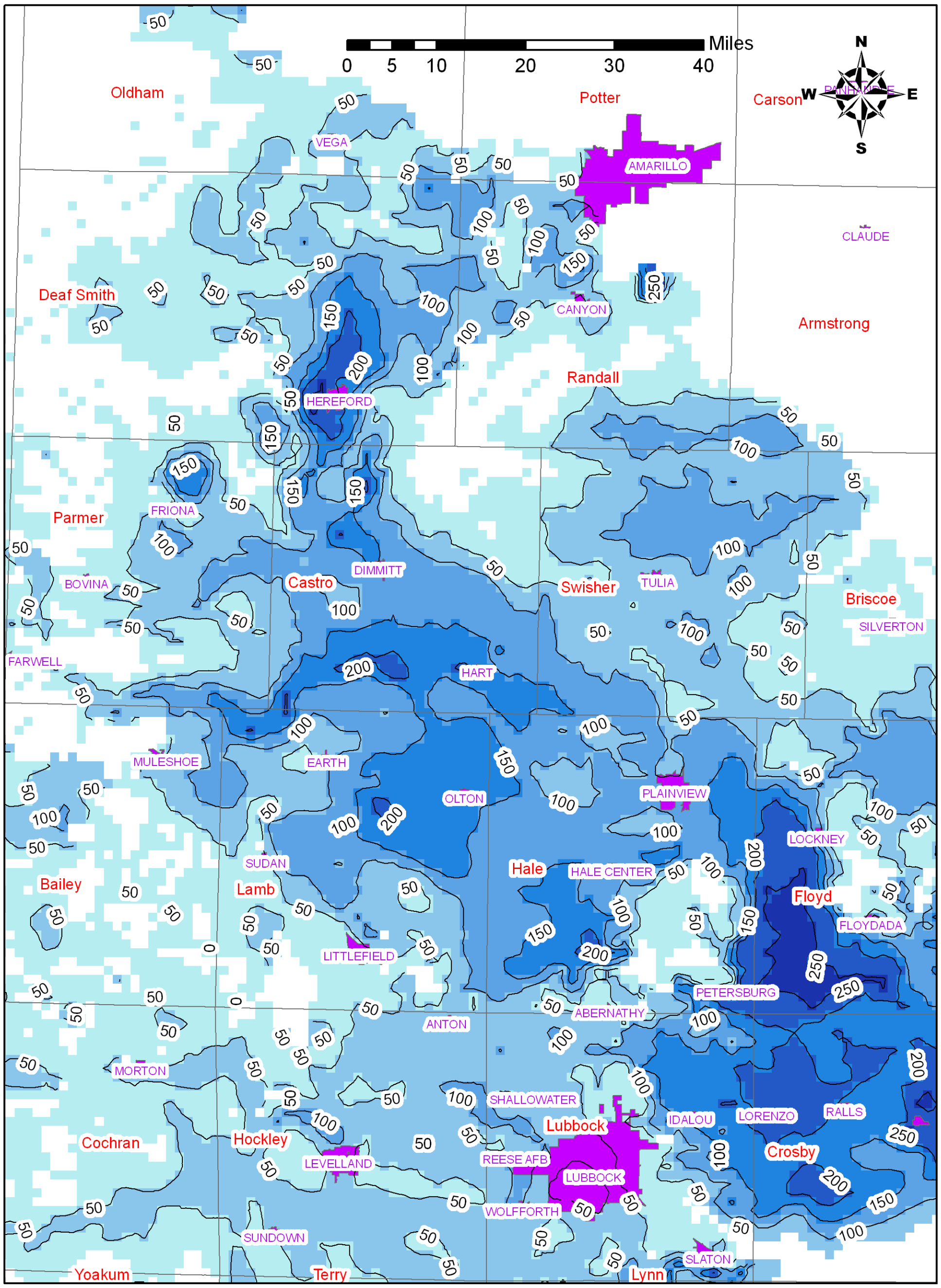


Figure 11: Map of saturated thickness in 2050 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals a 0.64 foot decline per year. Contour interval is 50 feet and white cells are inactive.

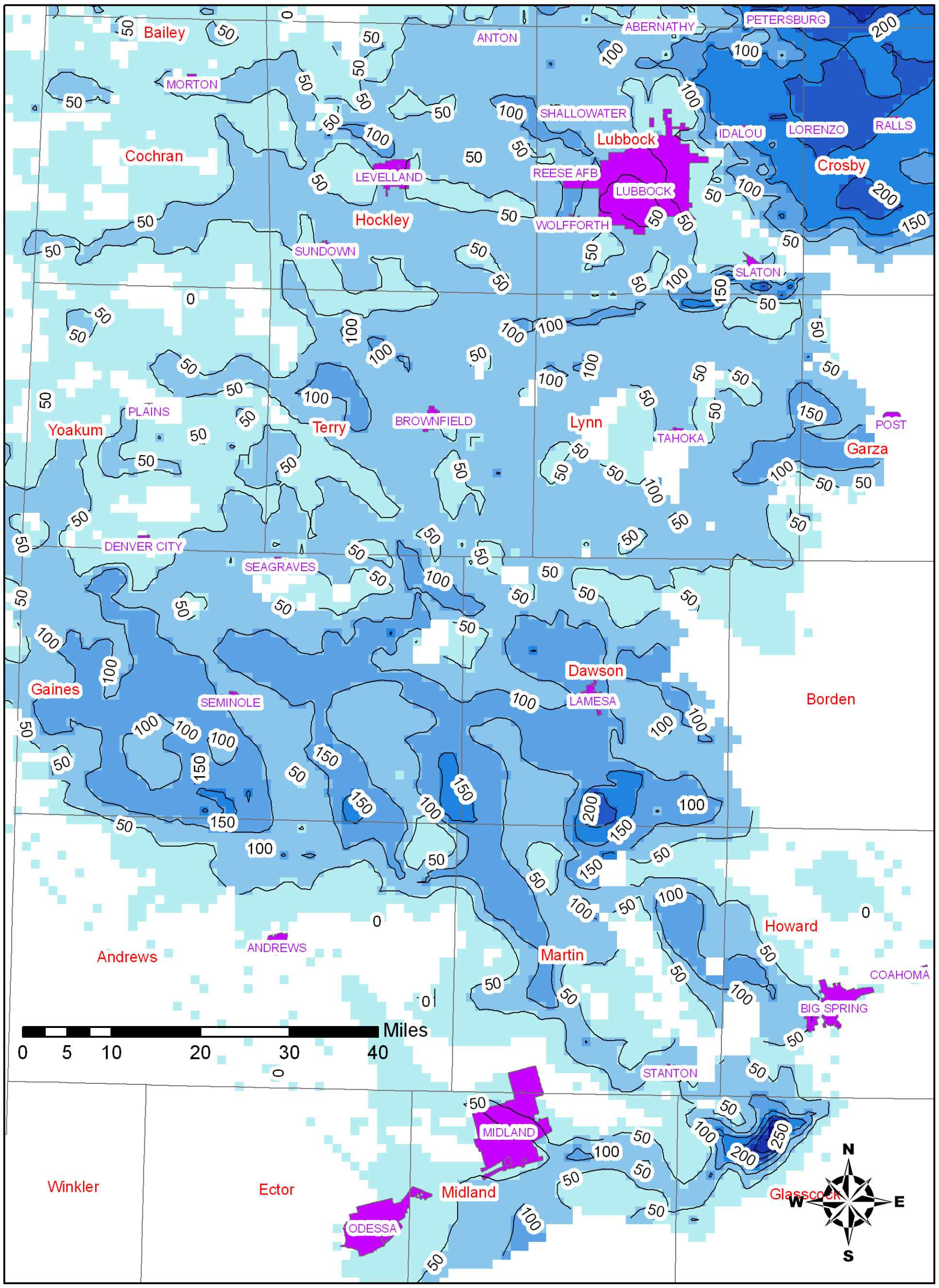


Figure 12: Map of saturated thickness in 2050 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals a 0.64 foot decline per year. Contour interval is 50 feet and white cells are inactive.

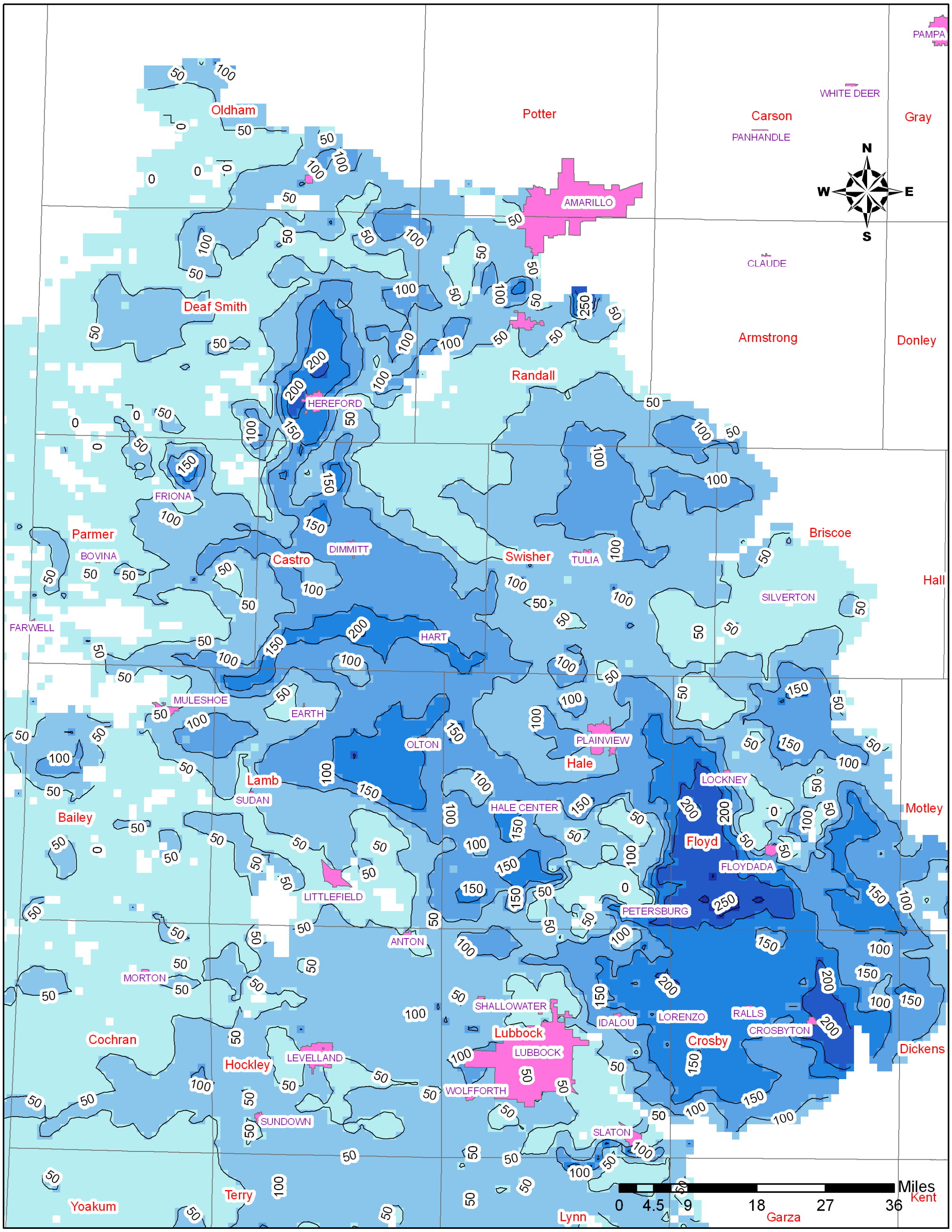


Figure 13: Map of saturated thickness in 2010 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals one foot decline per year. Contour interval is 50 feet and white cells are inactive.

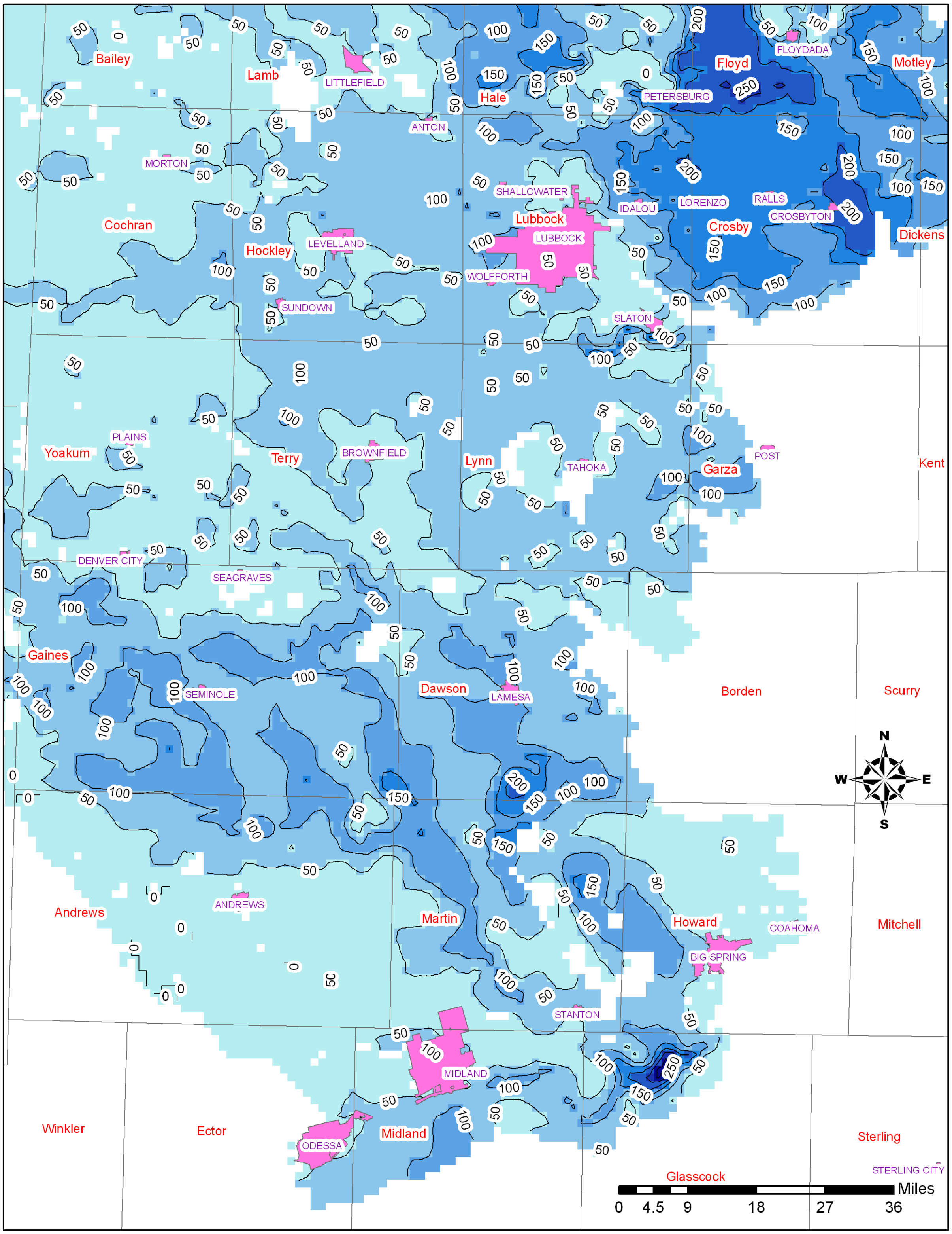


Figure 14: Map of saturated thickness in 2010 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals one foot decline per year. Contour interval is 50 feet and white cells are inactive.

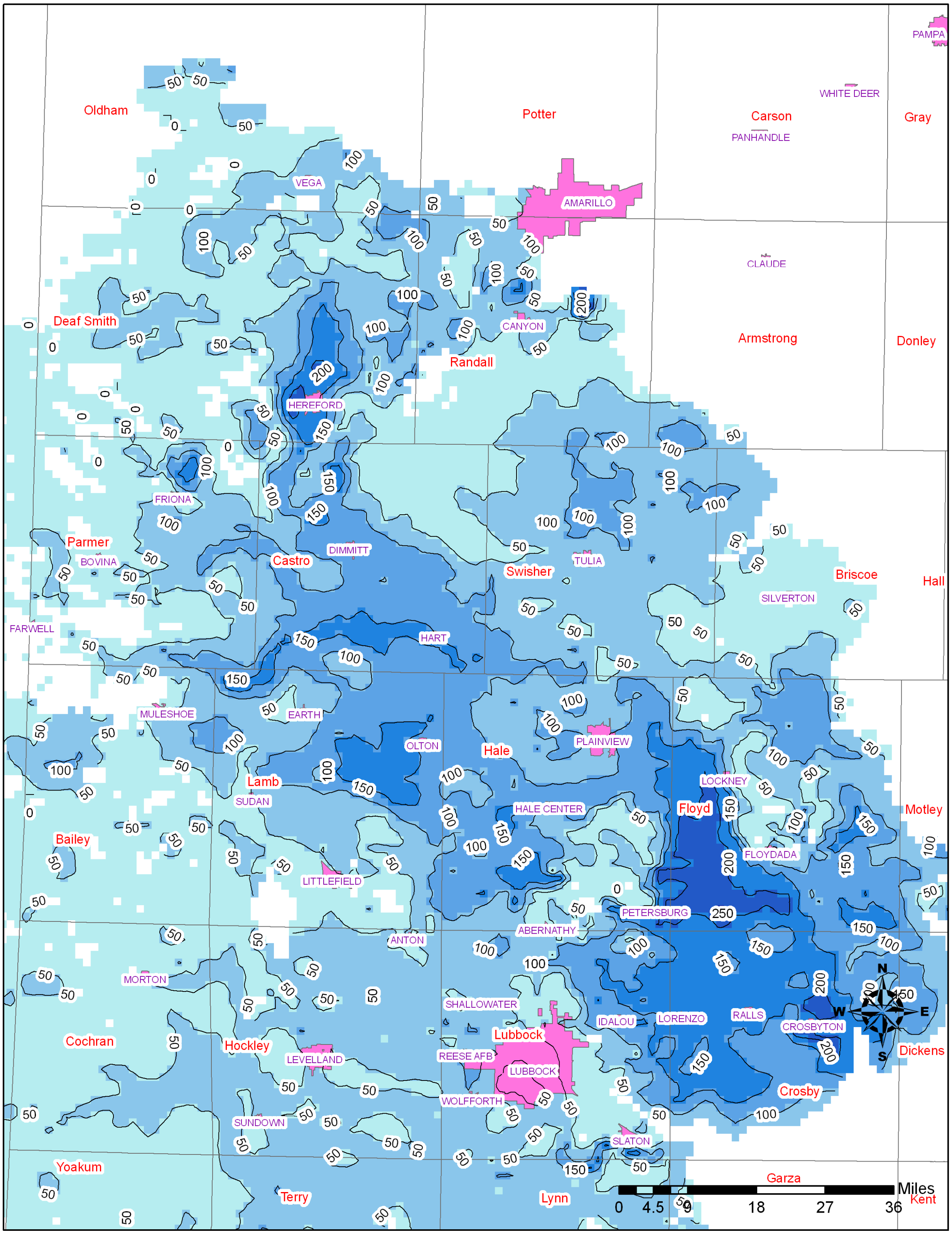


Figure 15: Map of saturated thickness in 2020 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals one foot decline per year. Contour interval is 50 feet and white cells are inactive.

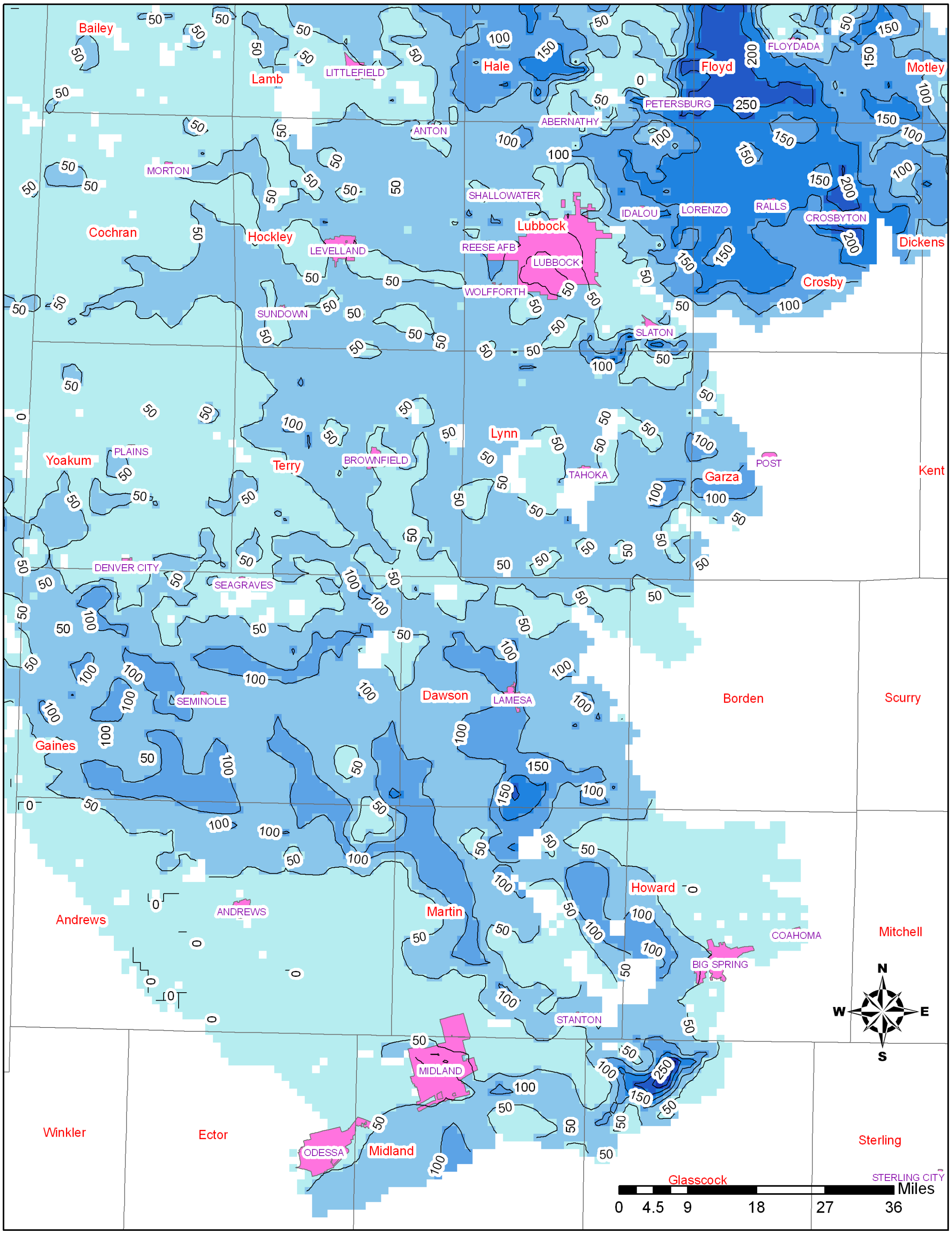


Figure 16: Map of saturated thickness in 2020 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals one foot decline per year. Contour interval is 50 feet and white cells are inactive.

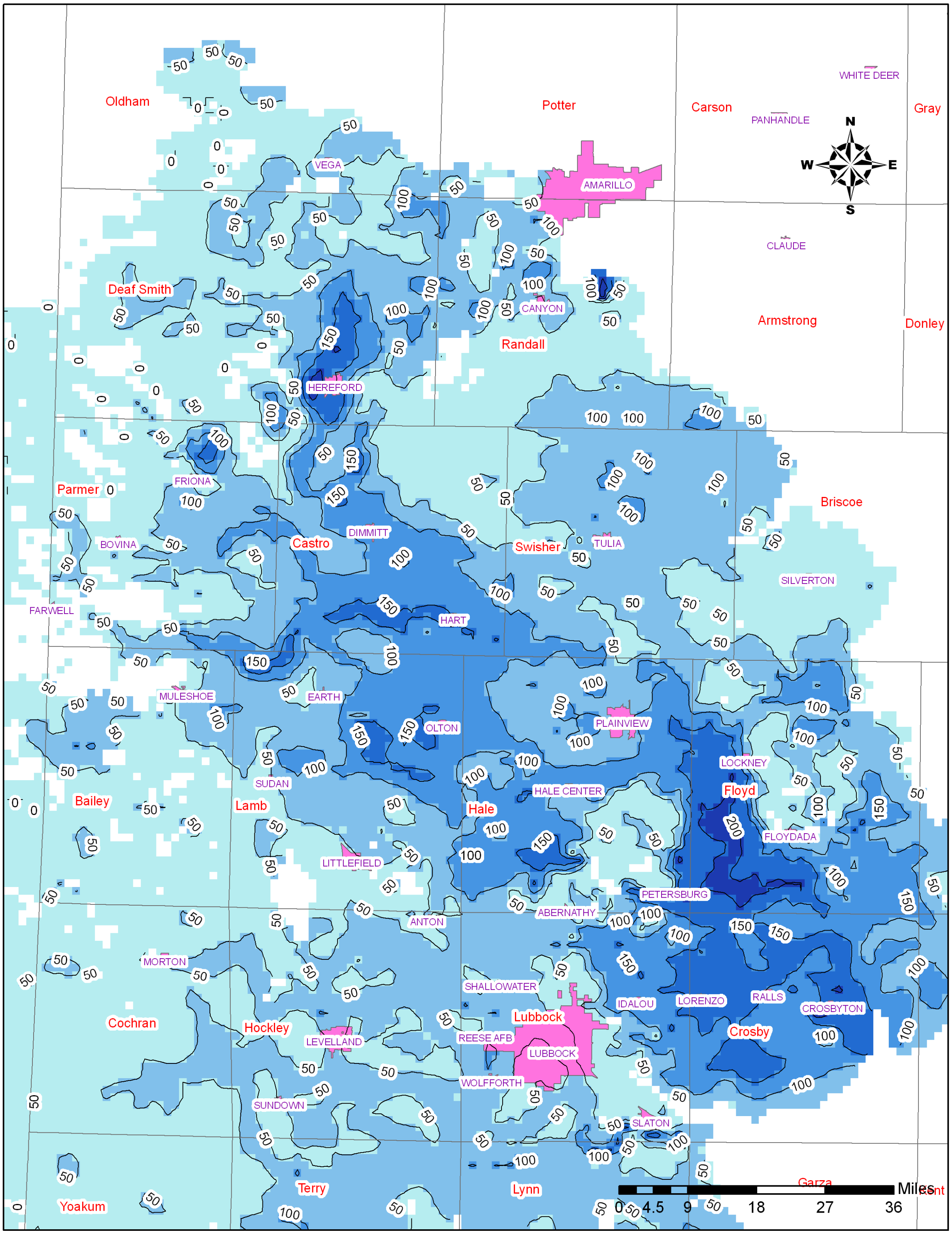


Figure 17: Map of saturated thickness in 2030 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals one foot decline per year. Contour interval is 50 feet and white cells are inactive.

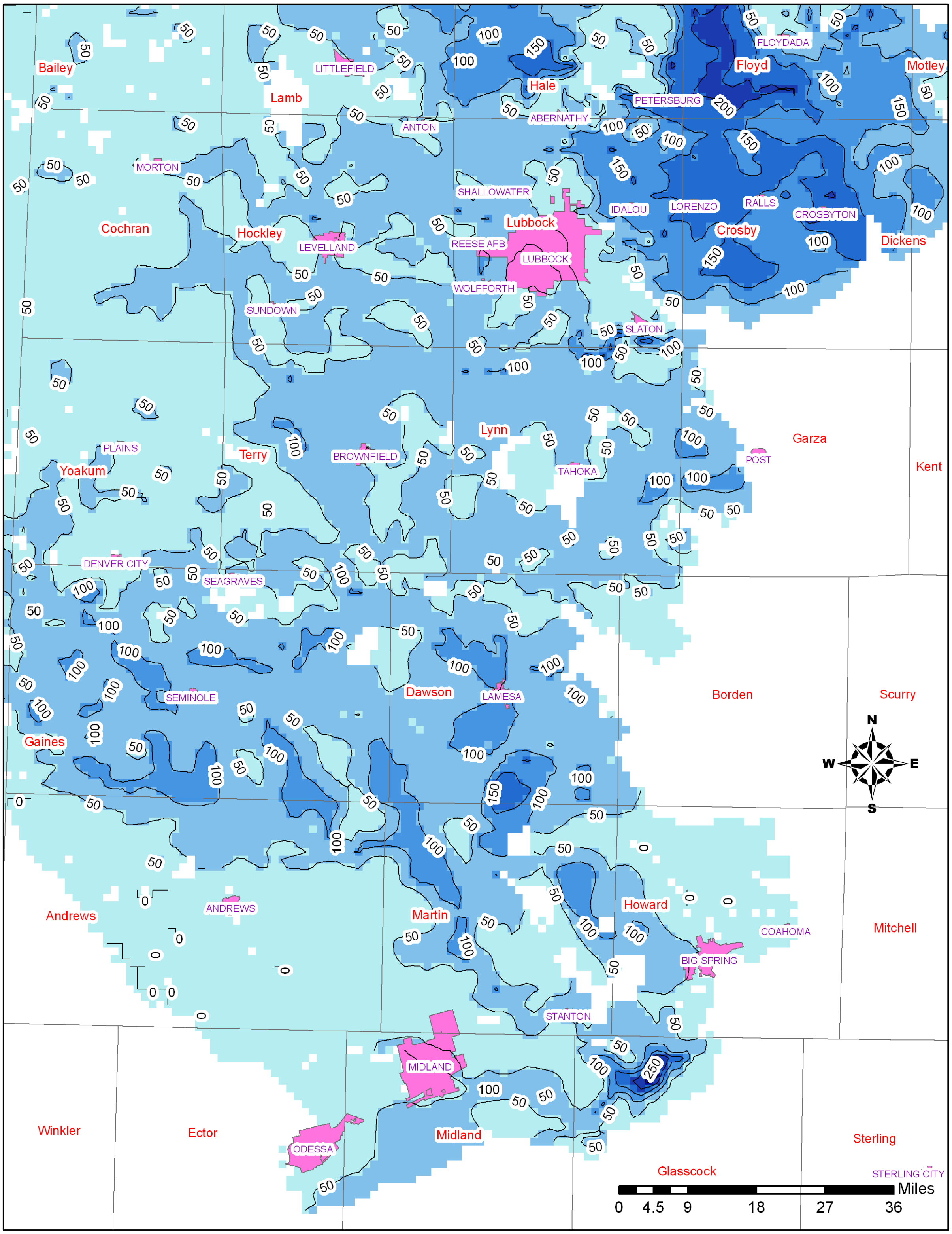


Figure 18: Map of saturated thickness in 2030 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals one foot decline per year. Contour interval is 50 feet and white cells are inactive.

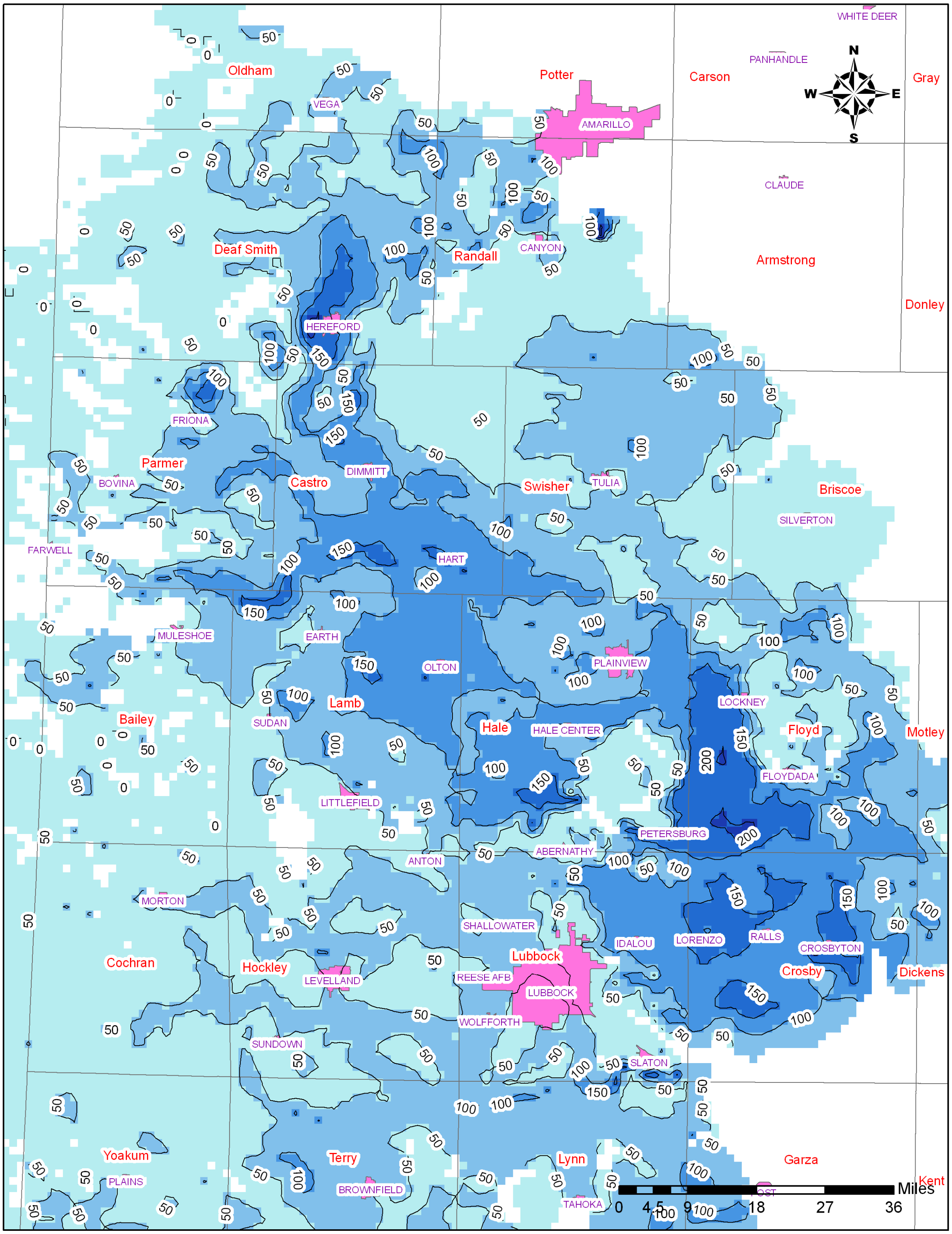


Figure 19: Map of saturated thickness in 2040 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals one foot decline per year. Contour interval is 50 feet and white cells are inactive.

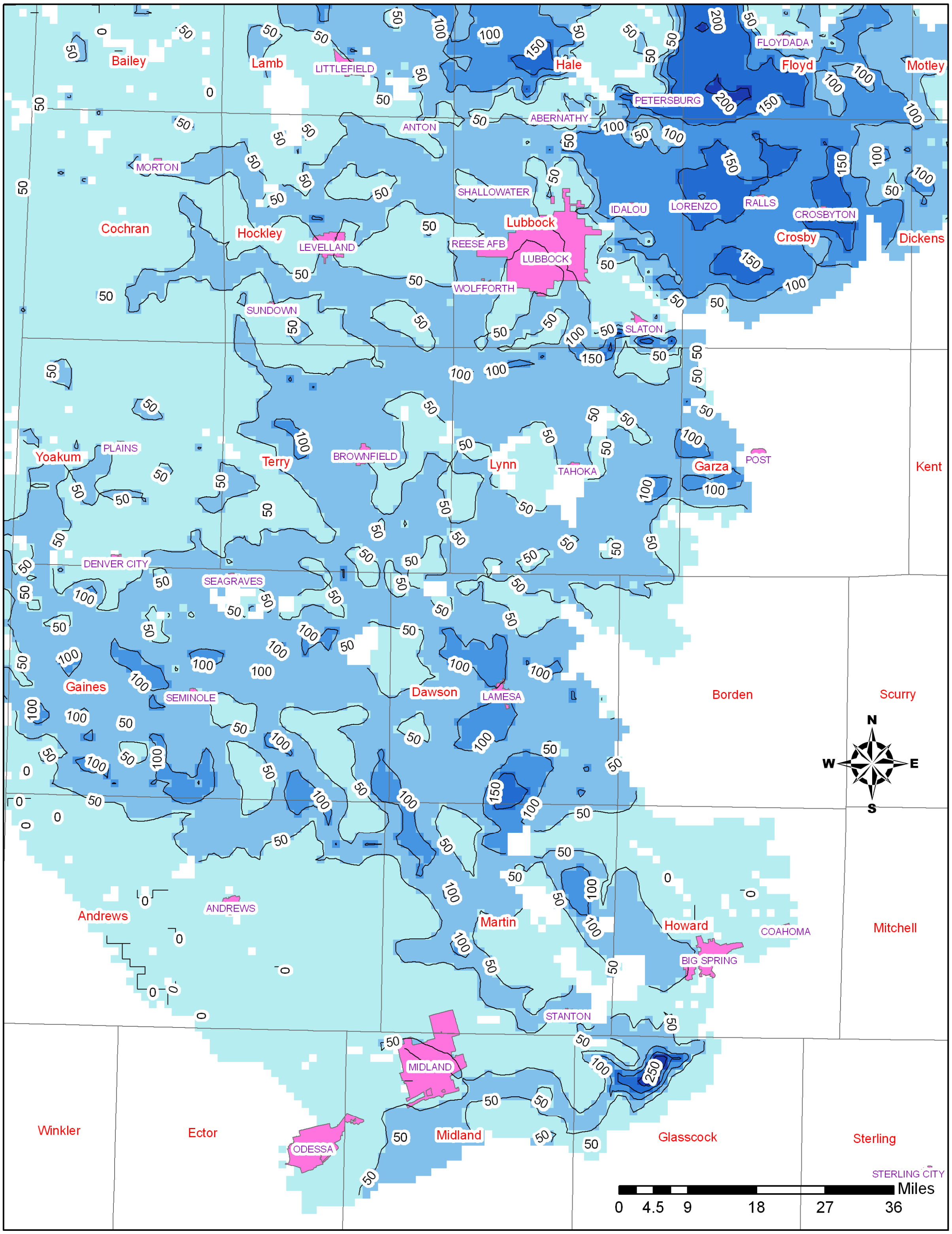


Figure 20: Map of saturated thickness in 2040 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals one foot decline per year. Contour interval is 50 feet and white cells are inactive.

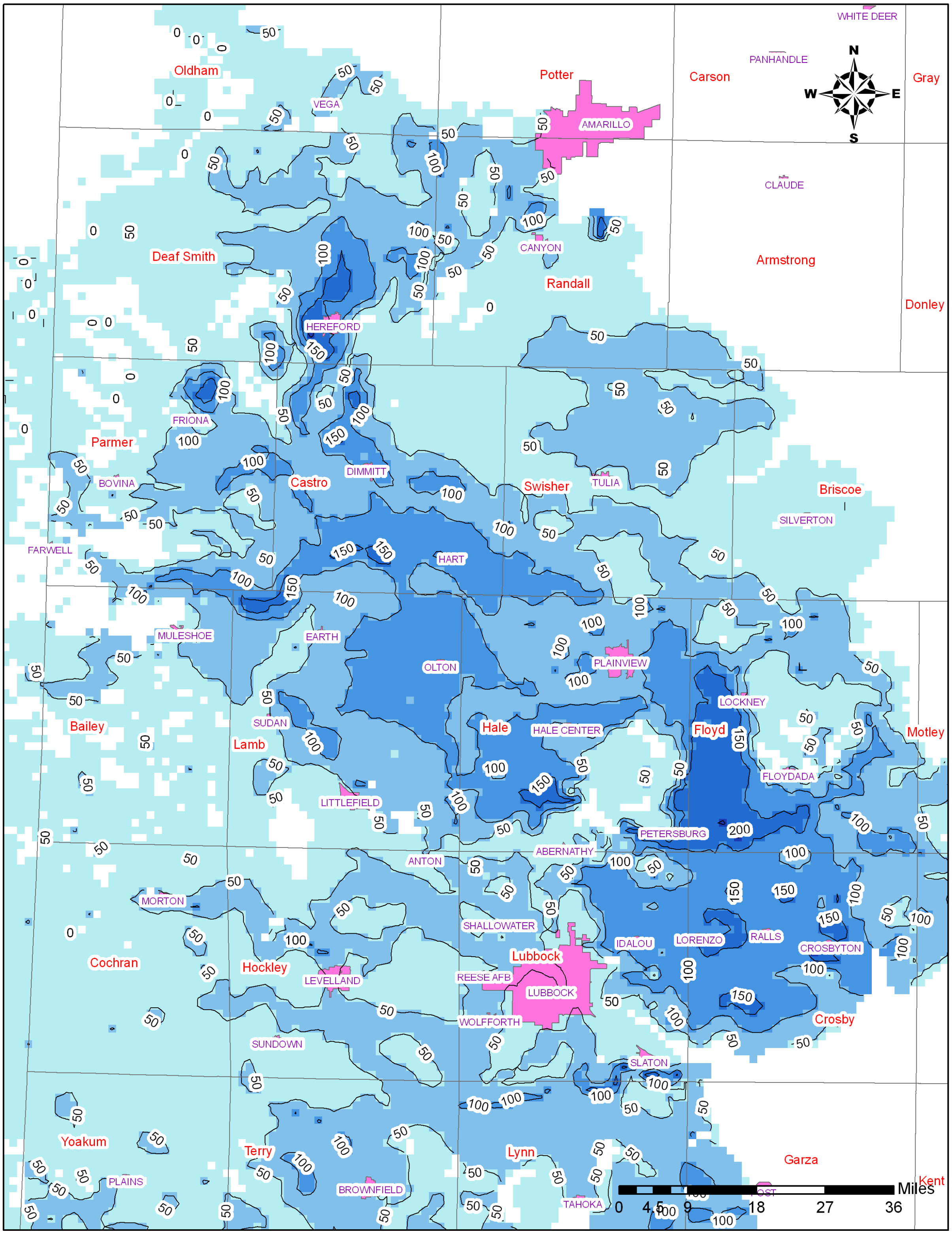


Figure 21: Map of saturated thickness in 2050 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals one foot decline per year. Contour interval is 50 feet and white cells are inactive.

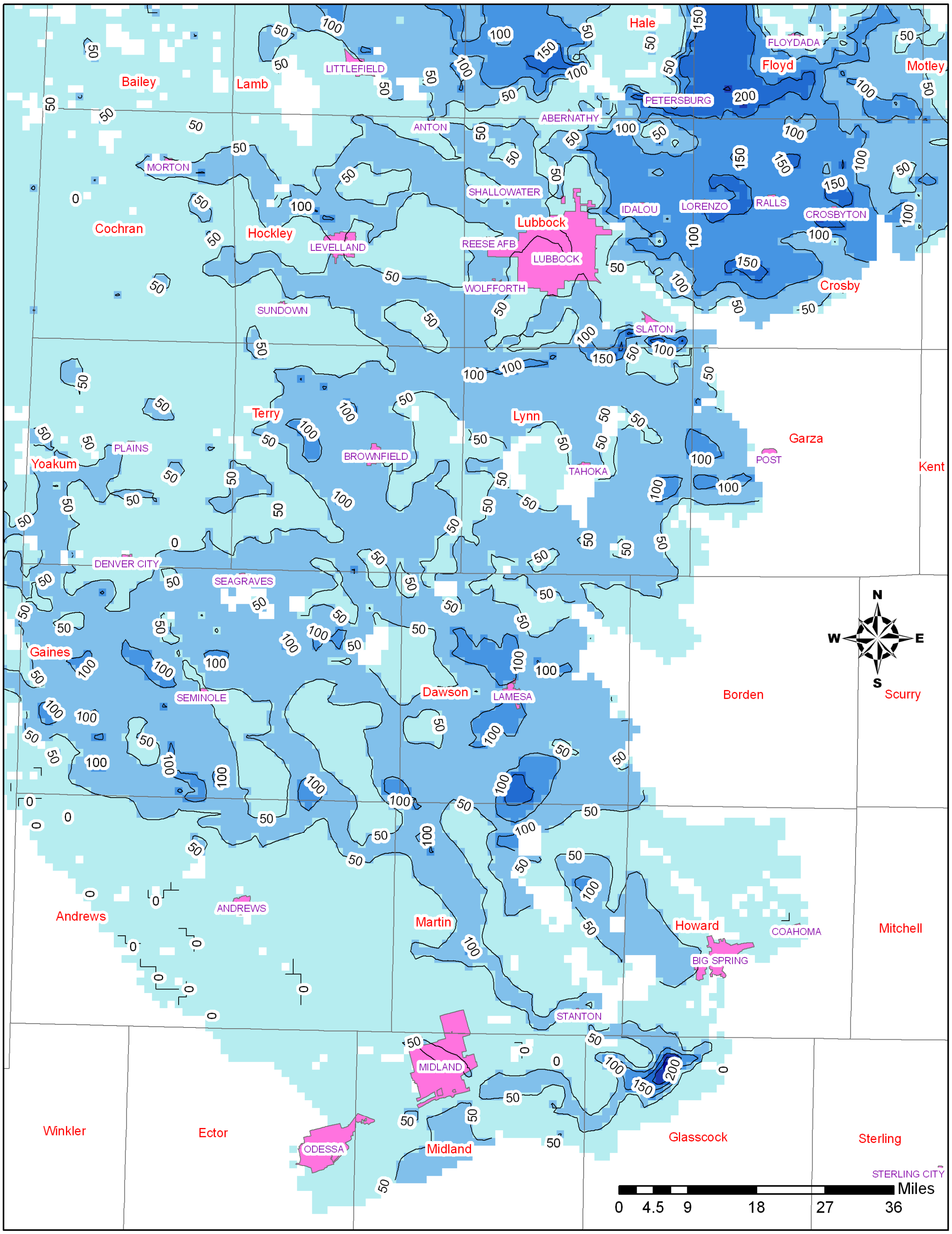


Figure 22: Map of saturated thickness in 2050 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals one foot decline per year. Contour interval is 50 feet and white cells are inactive.

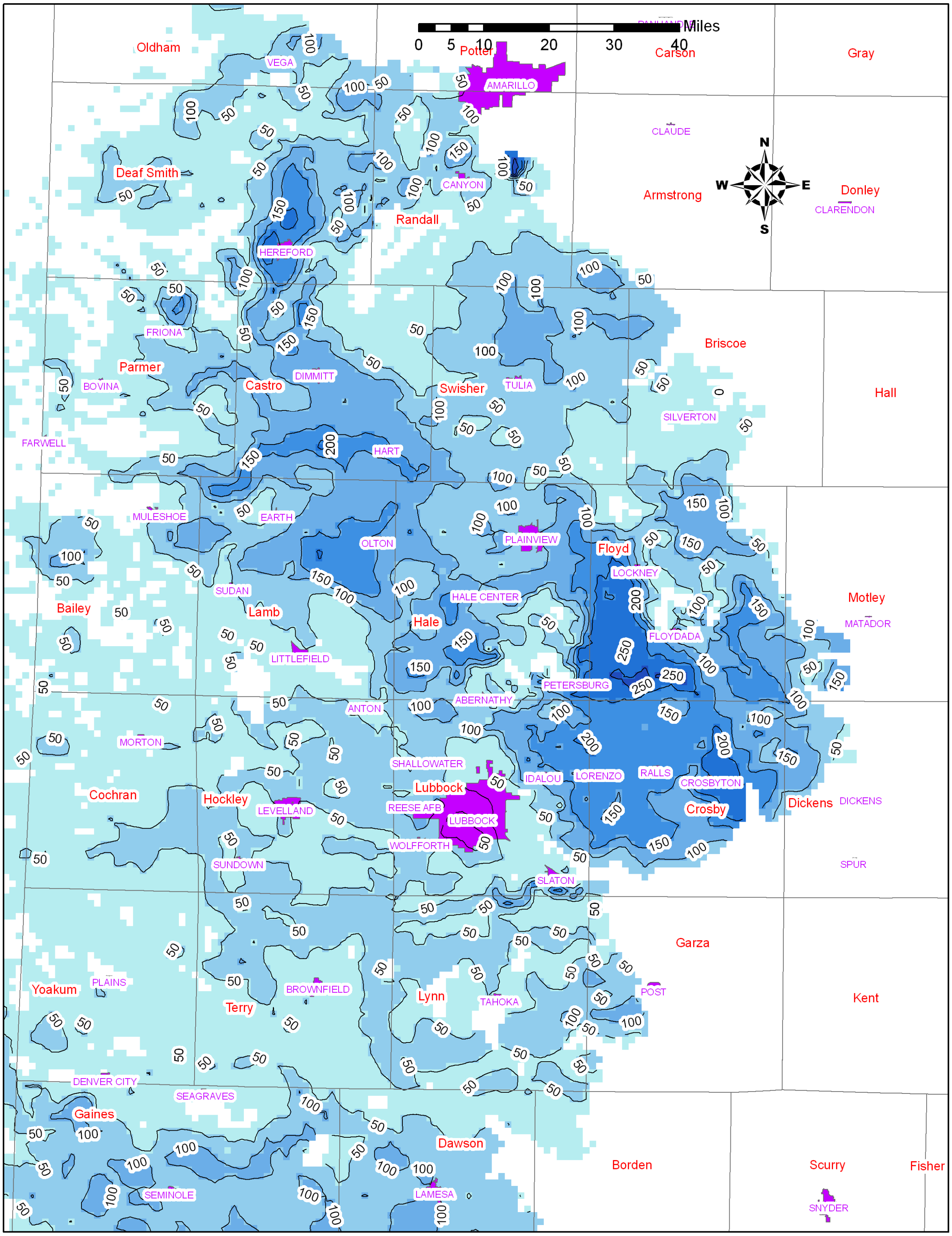


Figure 23: Map of saturated thickness in 2010 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals a two foot decline per year. Contour interval is 50 feet and white cells are inactive.

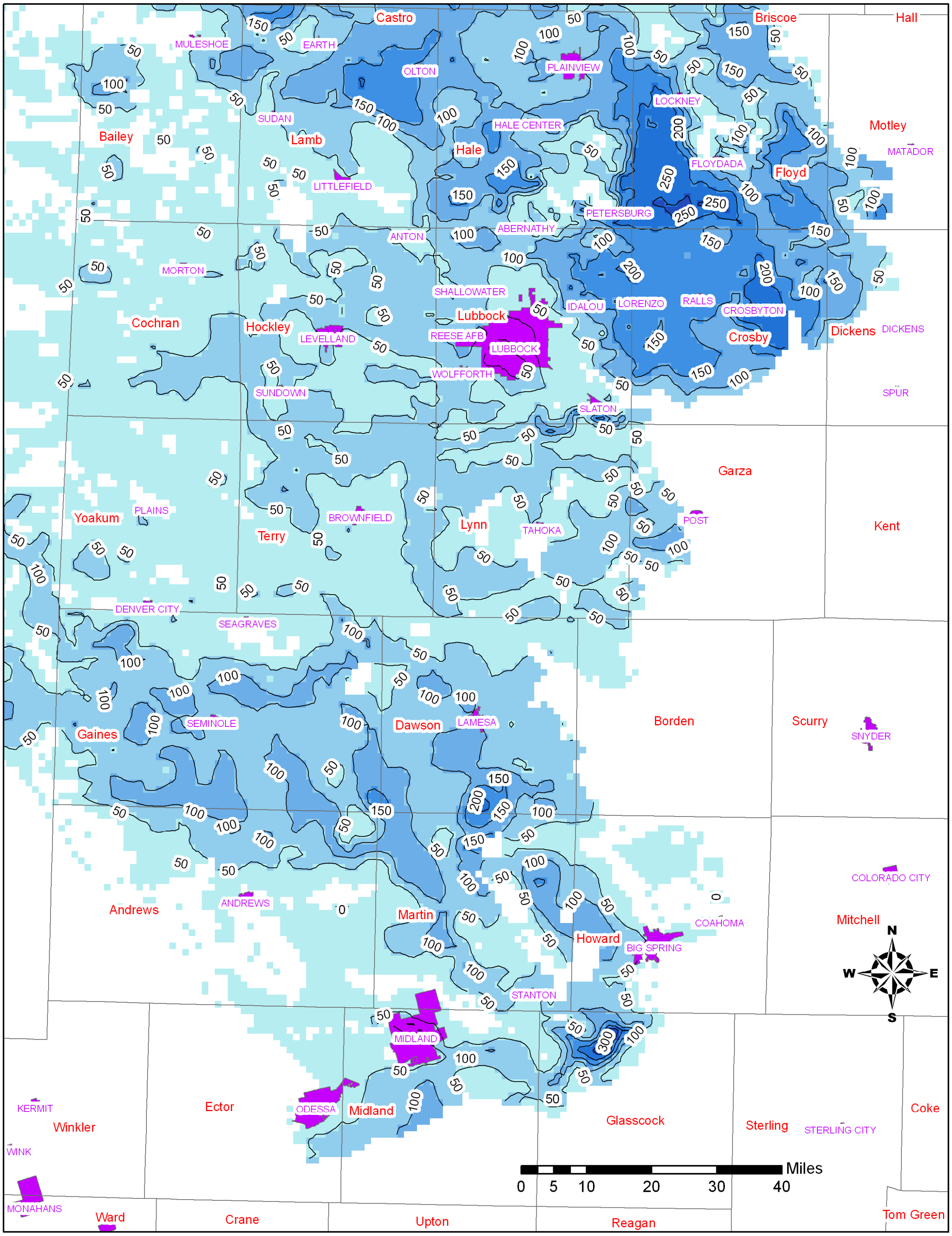


Figure 24: Map of saturated thickness in 2010 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals a two foot decline per year. Contour interval is 50 feet and white cells are inactive.

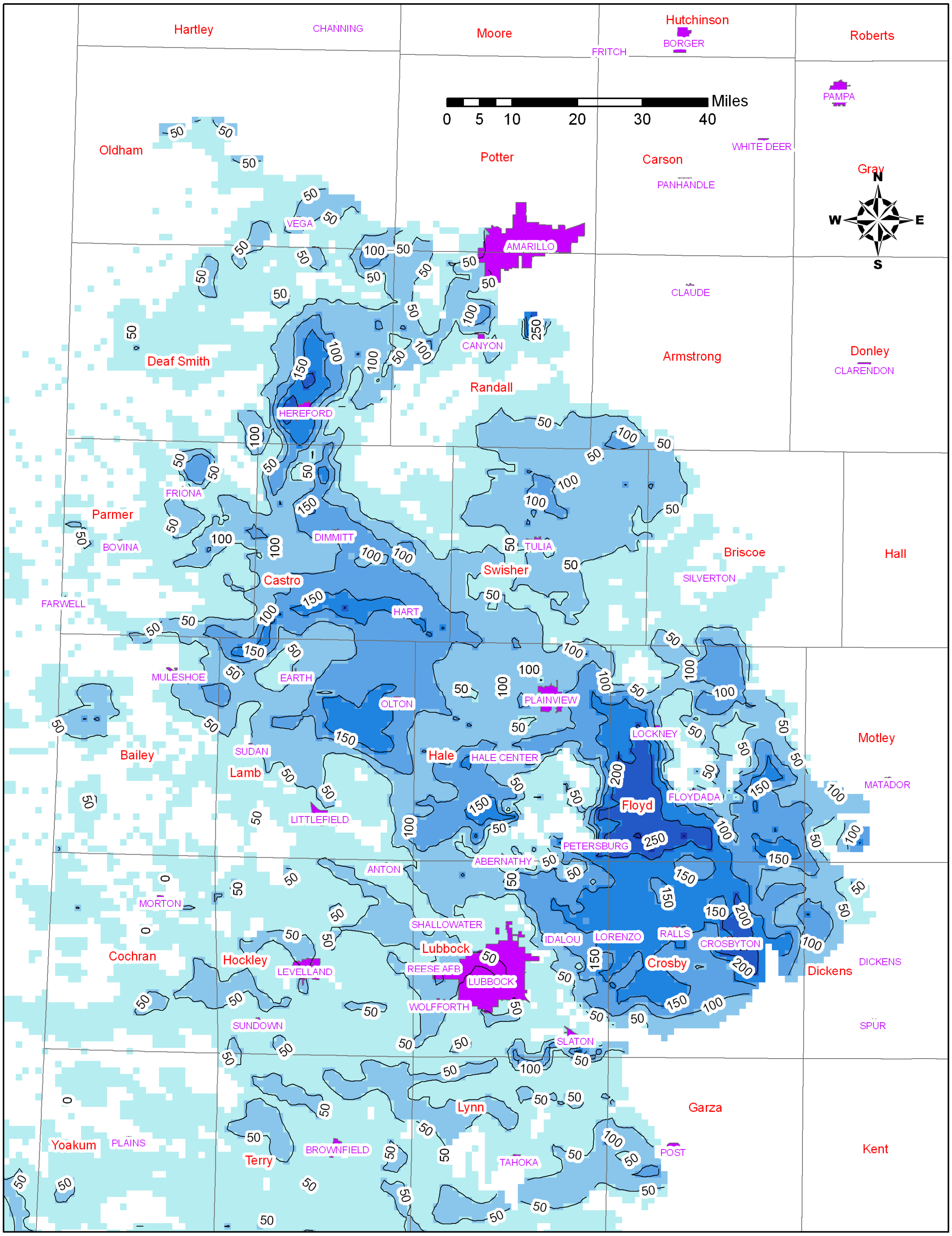


Figure 25: Map of saturated thickness in 2020 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals a two foot decline per year. Contour interval is 50 feet and white cells are inactive

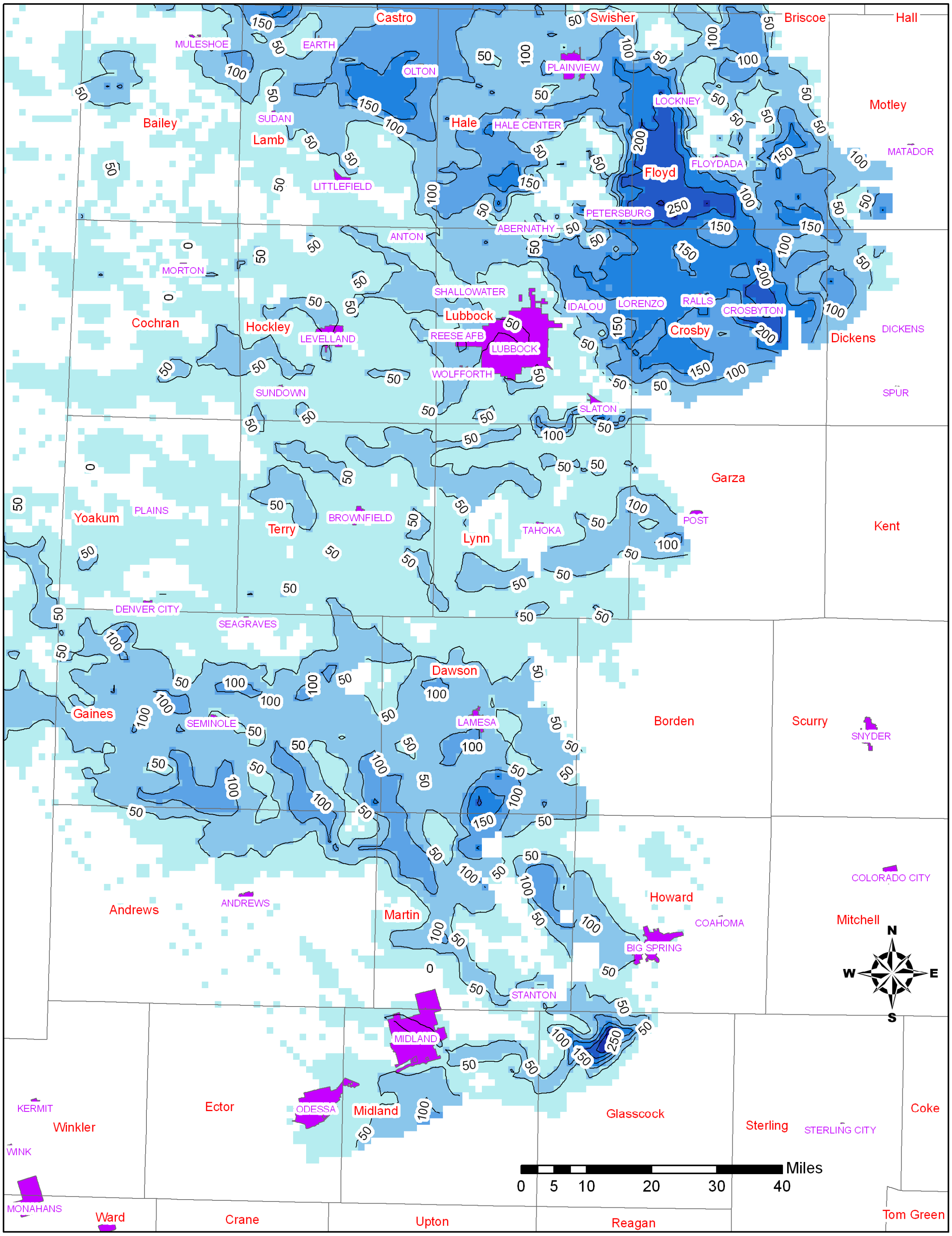


Figure 26: Map of saturated thickness in 2020 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals a two foot decline per year. Contour interval is 50 feet and white cells are inactive.

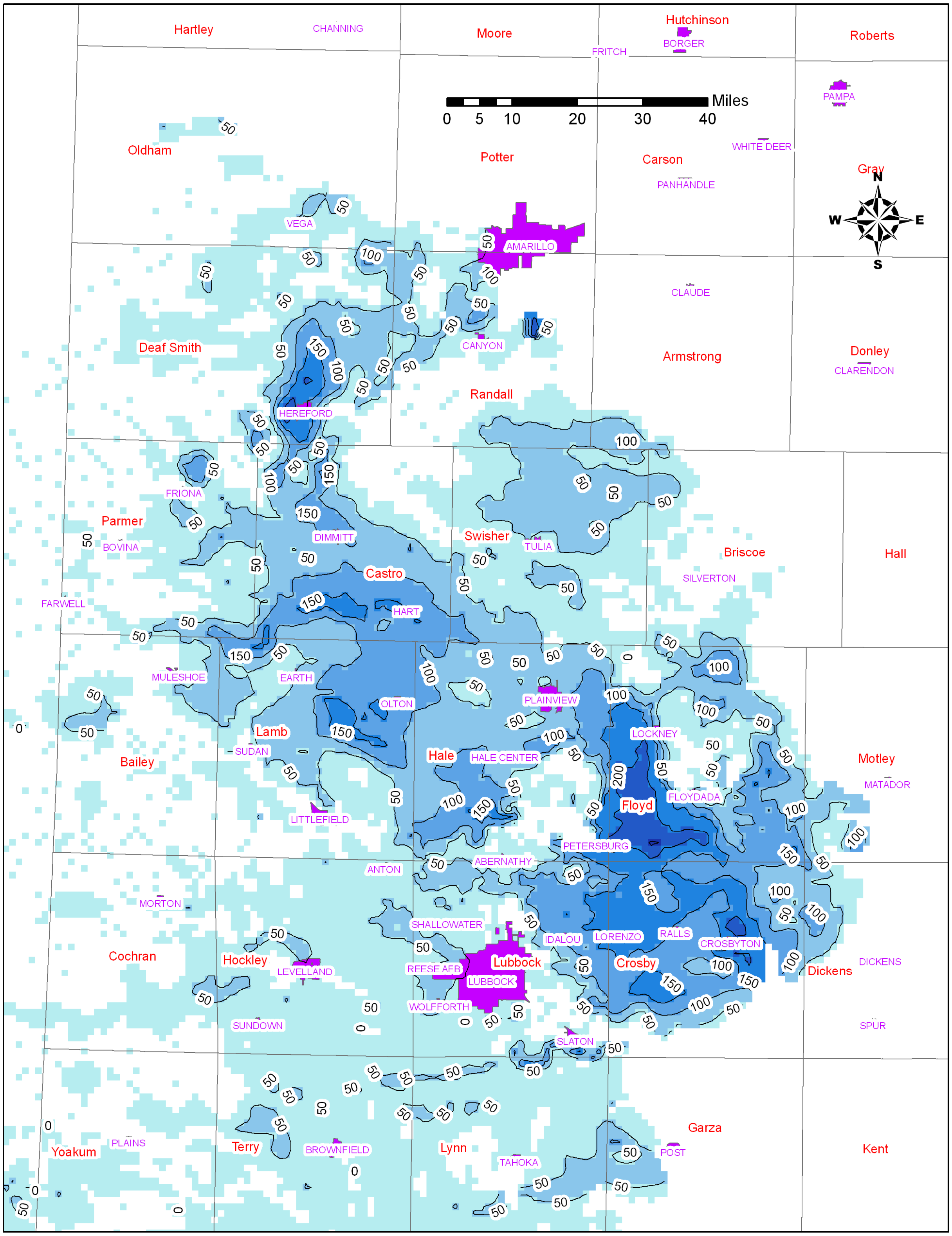


Figure 27: Map of saturated thickness in 2030 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals a two foot decline per year. Contour interval is 50 feet and white cells are inactive.

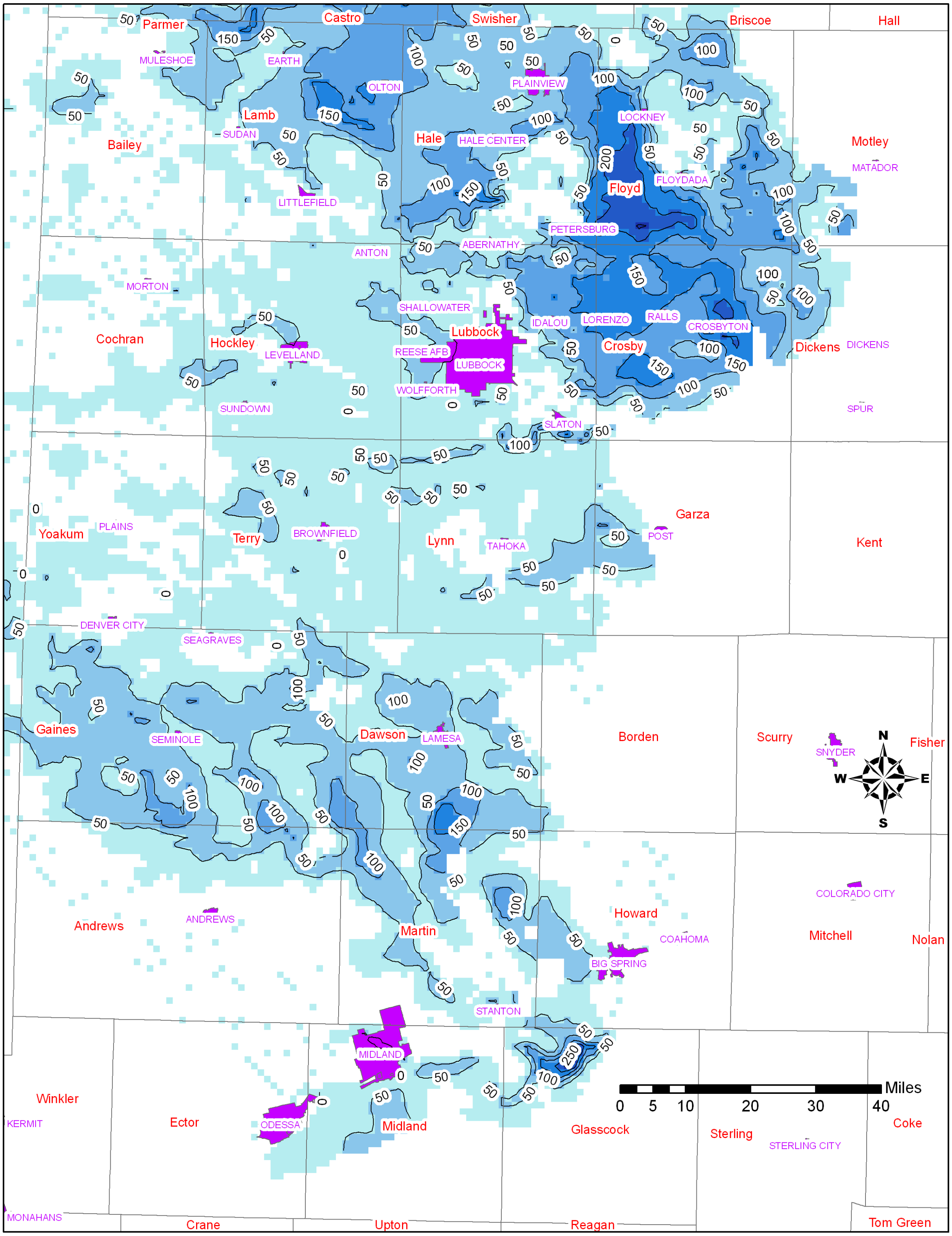


Figure 28: Map of saturated thickness in 2030 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals a two foot decline per year. Contour interval is 50 feet and white cells are inactive.

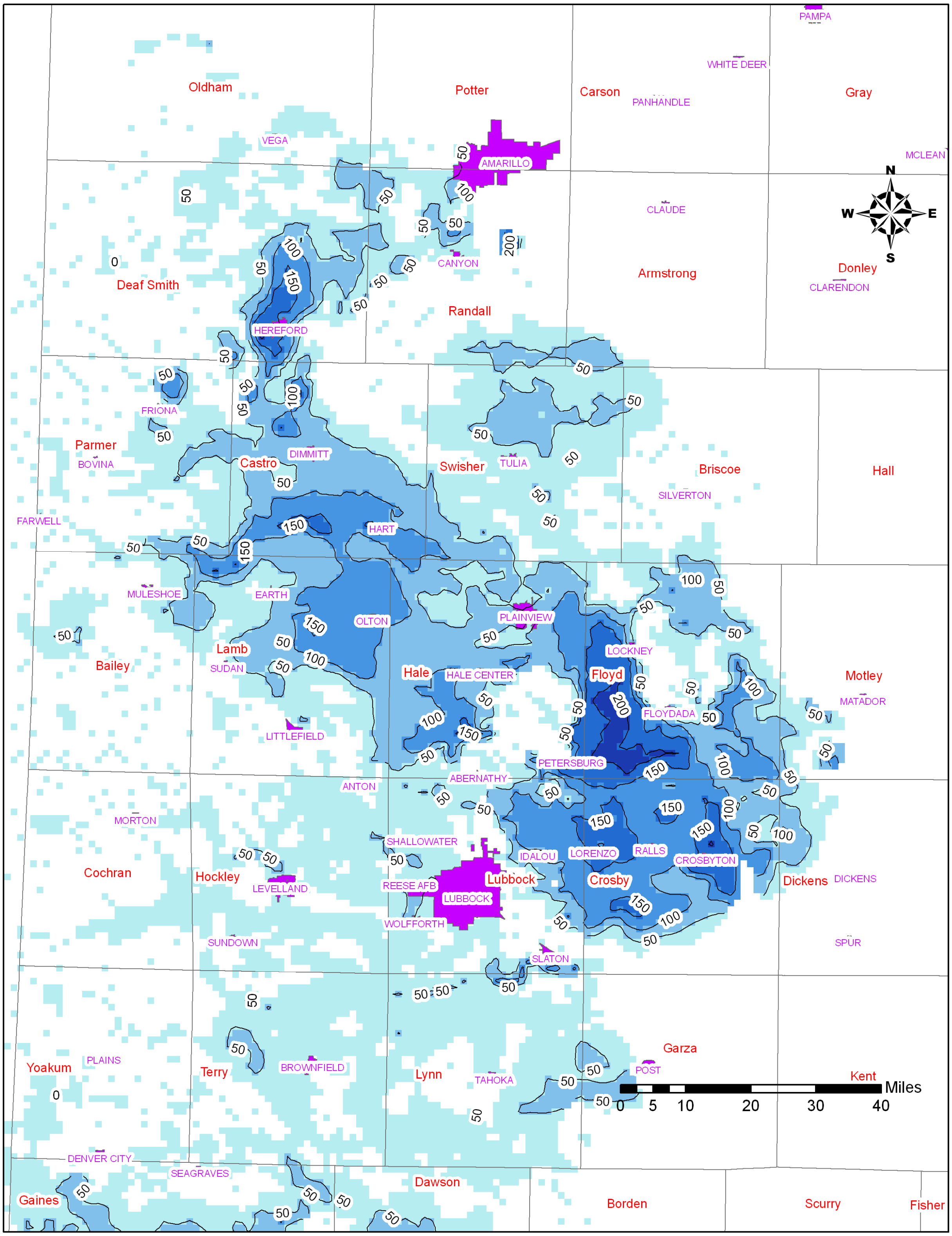


Figure 29: Map of saturated thickness in 2040 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals a two foot decline per year. Contour interval is 50 feet and white cells are inactive.

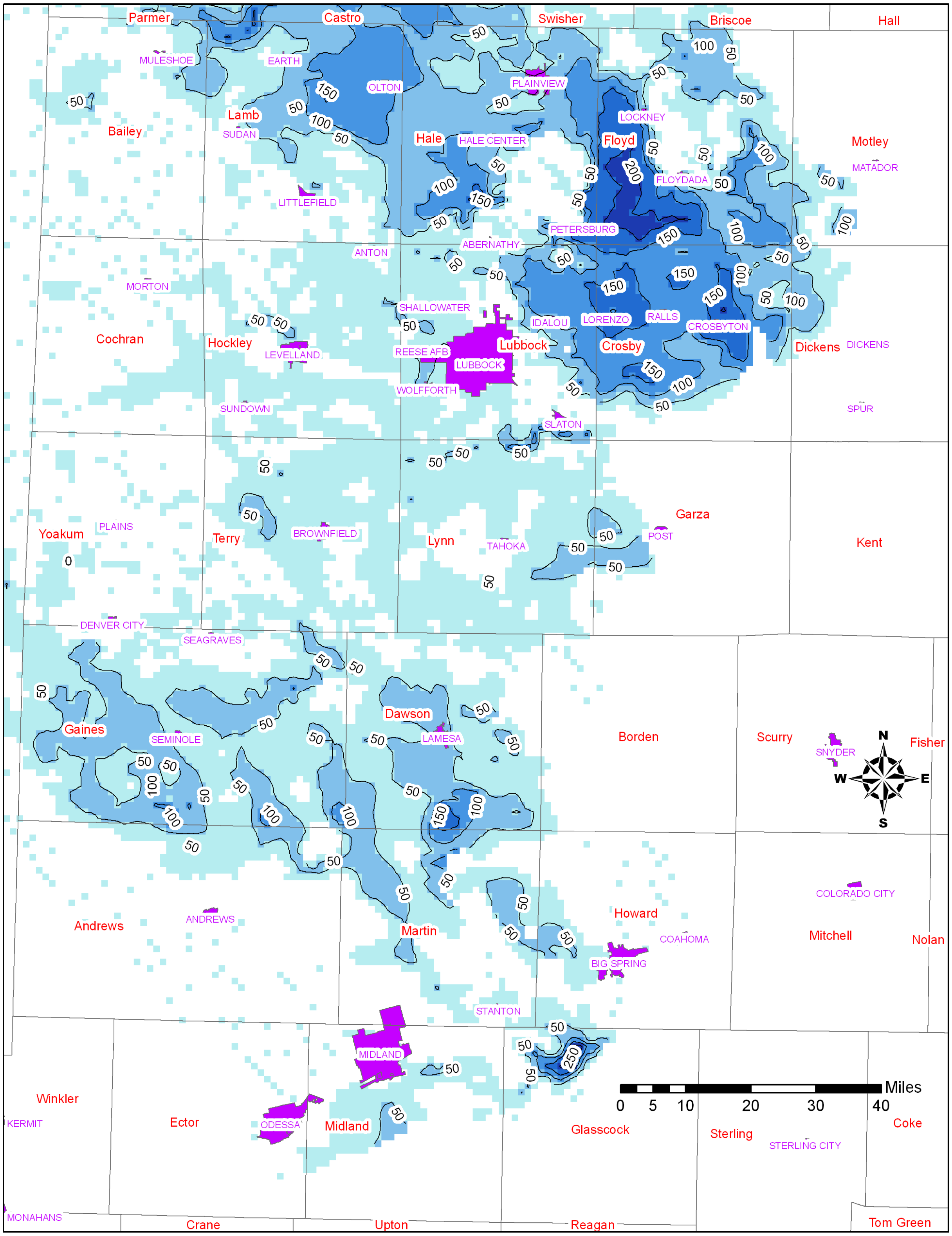


Figure 30: Map of saturated thickness in 2040 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals a two foot decline per year. Contour interval is 50 feet and white cells are inactive.

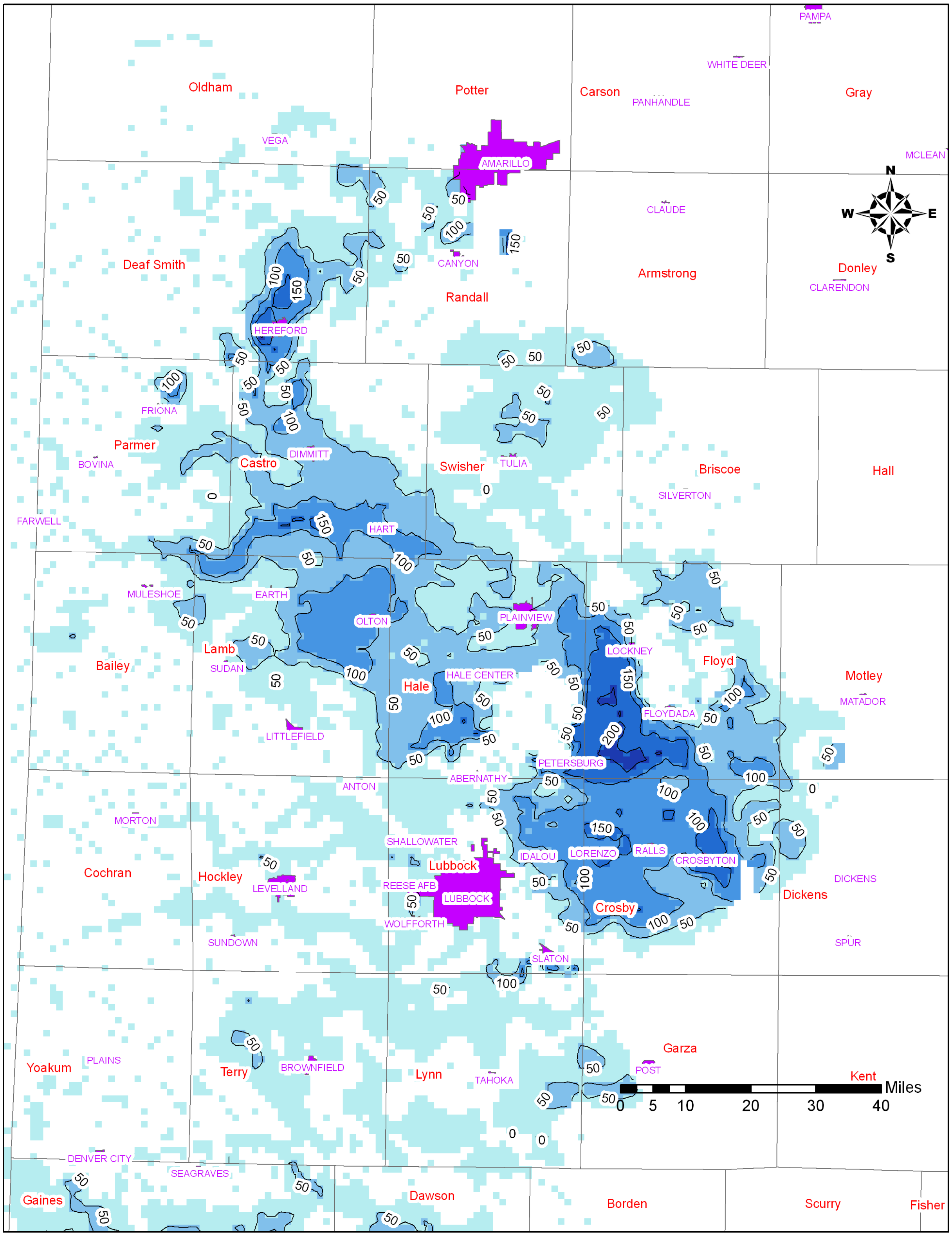


Figure 31: Map of saturated thickness in 2050 for the northern half of the Southern Ogallala Aquifer. Pumping volume equals a two foot decline per year. Contour interval is 50 feet and white cells are inactive.

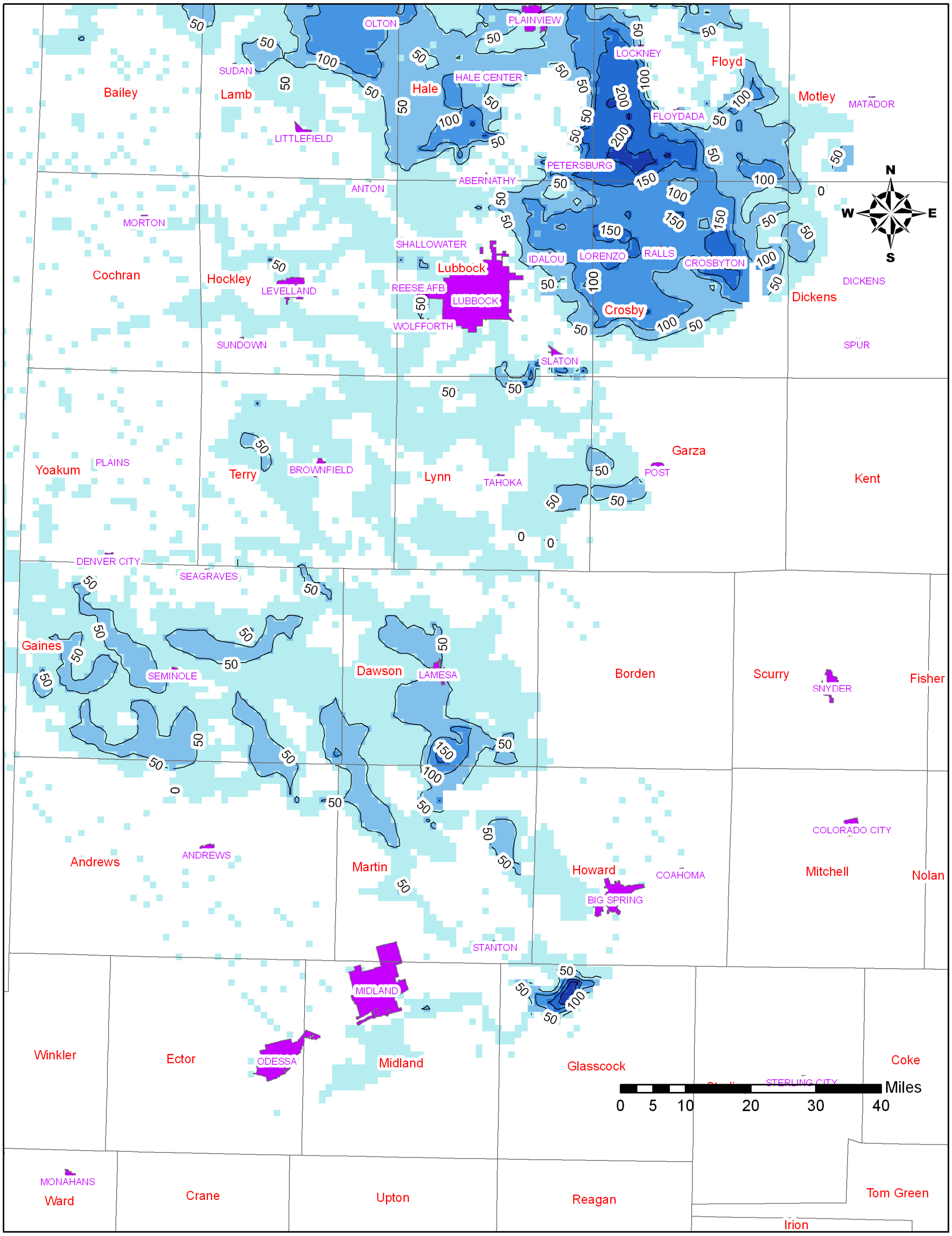


Figure 32: Map of saturated thickness in 2050 for the southern half of the Southern Ogallala Aquifer. Pumping volume equals a two foot decline per year. Contour interval is 50 feet and white cells are inactive.