GAM RUN 16-029 MAG: MODELED AVAILABLE GROUNDWATER FOR THE AQUIFERS IN GROUNDWATER MANAGEMENT AREA 1

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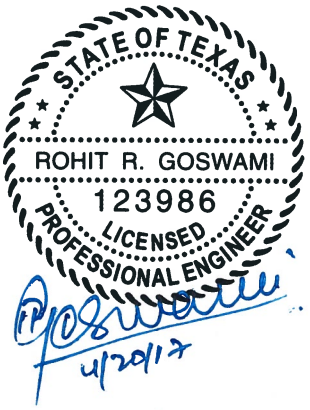
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Section
(512) 463-0495
April 19, 2017



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EXECUTIVE SUMMARY:

The modeled available groundwater for Groundwater Management Area 1 for the Ogallala Aquifer (inclusive of the Rita Blanca Aquifer) is summarized by decade for the groundwater conservation districts (Table 1) and for use in the regional water planning process (Table 2). The modeled available groundwater estimates range from 3,553,273 acre-feet per year in 2020 to 2,236,434 acre-feet per year in 2062 (Table 1). The modeled available groundwater for Groundwater Management Area 1 for the Dockum Aquifer is summarized by decade for the groundwater conservation districts (Table 3) and for use in the regional water planning process (Table 4). The modeled available groundwater estimates for the Dockum Aquifer range from 261,079 acre-feet per year in 2020 to 229,900 acre-feet per year in 2062 (Table 4). The modeled available groundwater estimates were extracted from results of a model run using the groundwater availability model for the High Plains Aquifer System (version 1.01). The model run files, which meet the desired future conditions for the relevant aquifers in Groundwater Management Area 1, were submitted to the Texas Water Development Board (TWDB) as part of the Desired Future Conditions Explanatory Report for Groundwater Management Area 1 (Deeds and Walthour, 2016). The Executive Administrator of the TWDB determined that the explanatory report and other materials were administratively complete on March 10, 2017.

REQUESTOR:

Mr. Kyle G. Ingham, chair of Groundwater Management Area 1.

DESCRIPTION OF REQUEST:

On December 16, 2016, Mr. Kyle G. Ingham provided the TWDB with the desired future conditions of the Ogallala Aquifer (inclusive of the Rita Blanca Aquifer) and the Dockum Aquifer adopted by the groundwater conservation districts in Groundwater Management Area 1 on November 2, 2016. The Blaine Aquifer in Wheeler County was designated non-relevant. The desired future conditions for the aquifers in Groundwater Management Area 1, as described in Resolution No. 2016-2, are described below:

Ogallala Aquifer (inclusive of the Rita Blanca Aquifer)

- At least 40 percent of volume in storage remaining in 50 years, for the period 2012-2062 collectively in Dallam, Hartley, Moore, and Sherman counties;
- At least 50 percent of volume in storage remaining in 50 years, for the period 2012-2062 collectively in Hansford, Lipscomb, and Ochiltree counties and that portion of Hutchinson County with North Plains [Groundwater Conservation District;]
- At least 50 percent of volume in storage remaining in 50 years, for the period 2012-2062 in Carson, Donley, Gray, Hutchinson, Oldham, Roberts, and Wheeler counties; and portions of Armstrong and Potter counties within the Panhandle [Groundwater Conservation District];
- At least 80 percent of volume in storage remaining in 50 years, for the period 2012-2062, within the Hemphill County;
- Approximately 20 feet of total average drawdown in 50 years for the period 2012-2062 collectively in Randall County and in Armstrong and Potter counties within the High Plains [Underground Water Conservation District No. 1].

Dockum Aquifer

- At least 40 percent of the available drawdown remaining in 50 years for the period 2012-2062 collectively for Dallam, Hartley, Moore, and Sherman counties[;]
- No more than 30 feet average decline in water levels in 50 years for the period 2012-2062 collectively in Carson and Oldham counties and in Armstrong and Potter counties within the Panhandle [Groundwater Conservation District]; and
- The total average drawdown is approximately 40 feet in 50 years for the period 2012-2062, collectively in Randall County, and in Armstrong and Potter counties within the High Plains [Underground Water Conservation District No. 1].

METHODS:

The groundwater availability model for the High Plains Aquifer System was run using the model files submitted with the explanatory report. The modeled available groundwater values were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Annual pumping rates for the Ogallala Aquifer (inclusive of the Rita Blanca Aquifer) and Dockum Aquifer were divided by county and groundwater conservation district, subtotaled by groundwater conservation district, and then summed for all of Groundwater Management Area 1 (Figures 1 and 3 and Tables 1 and 3). Modeled available groundwater for the Ogallala Aquifer (inclusive of the Rita Blanca Aquifer) and Dockum Aquifer were also divided by county, river basin, regional water planning area, and groundwater conservation district (Figures 2 and 4 and Tables 2 and 4).

Modeled Available Groundwater and Permitting

Chapter 36 of the Texas Water Code defines "modeled available groundwater" as the estimated average amount of water that may be produced annually to achieve a desired future condition. Groundwater conservation districts are required to consider modeled available groundwater, along with several other factors, when issuing permits in order to manage groundwater production to achieve the desired future condition(s). The other factors districts must consider include annual precipitation and production patterns, the estimated amount of pumping exempt from permitting, existing permits, and a reasonable estimate of actual groundwater production under existing permits.

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the groundwater availability are described below:

- Version 1.01 of the groundwater availability model for the High Plains Aquifer System was used for this analysis. See Deeds and Jigmond (2015) for assumptions and limitations of the groundwater availability model.
- This groundwater availability model includes 4 layers which generally represent the Ogallala Aquifer and other younger geologic units (Layer 1), geologic units that directly overlie the Dockum Aquifer, the Rita Blanca and Edwards-Trinity (High Plains) aquifers (Layer 2), upper portion of the Dockum Aquifer (Layer 3), and the lower portion of the Dockum Aquifer (Layer 4).
- The model was run with MODFLOW-NWT (Niswonger and others, 2011) which is based on MODFLOW-2005 (Harbaugh, 2005).
- The analysis assumed model extent within Texas for all aquifers except for the Rita Blanca Aquifer, which assumed the official TWDB mapped aquifer boundary.

- Only the cells in Lower Dockum (Layer 4) were considered while processing results (desired future conditions and modeled available groundwater) for the Dockum Aquifer. The Groundwater Management Area consultant, Dr. Deeds (INTERA, Incorporated), confirmed this on March 6, 2017, in response to a clarification letter sent by Groundwater staff to Groundwater Management Area 1 on February 27, 2017. Mr. Ingham, chair of Groundwater Management Area 1, agreed with the assumptions while responding to the clarification letter on March 21, 2017.

RESULTS:

The modeled available groundwater estimates for the Ogallala Aquifer (including the Rita Blanca Aquifer) range from 3,553,273 acre-feet per year in 2020 to 2,236,434 acre-feet per year in 2062 (Table 1). The modeled available groundwater estimates for the Dockum Aquifer range from 261,079 acre-feet per year in 2020 to 229,900 acre-feet per year in 2062 (Table 3). Modeled available groundwater estimates for each aquifer are summarized by groundwater conservation district and by county, river basin, and regional water planning area for use in the regional water planning process (Figures 1 to 4 and Tables1 to 4). Small differences of values between table summaries are due to rounding.

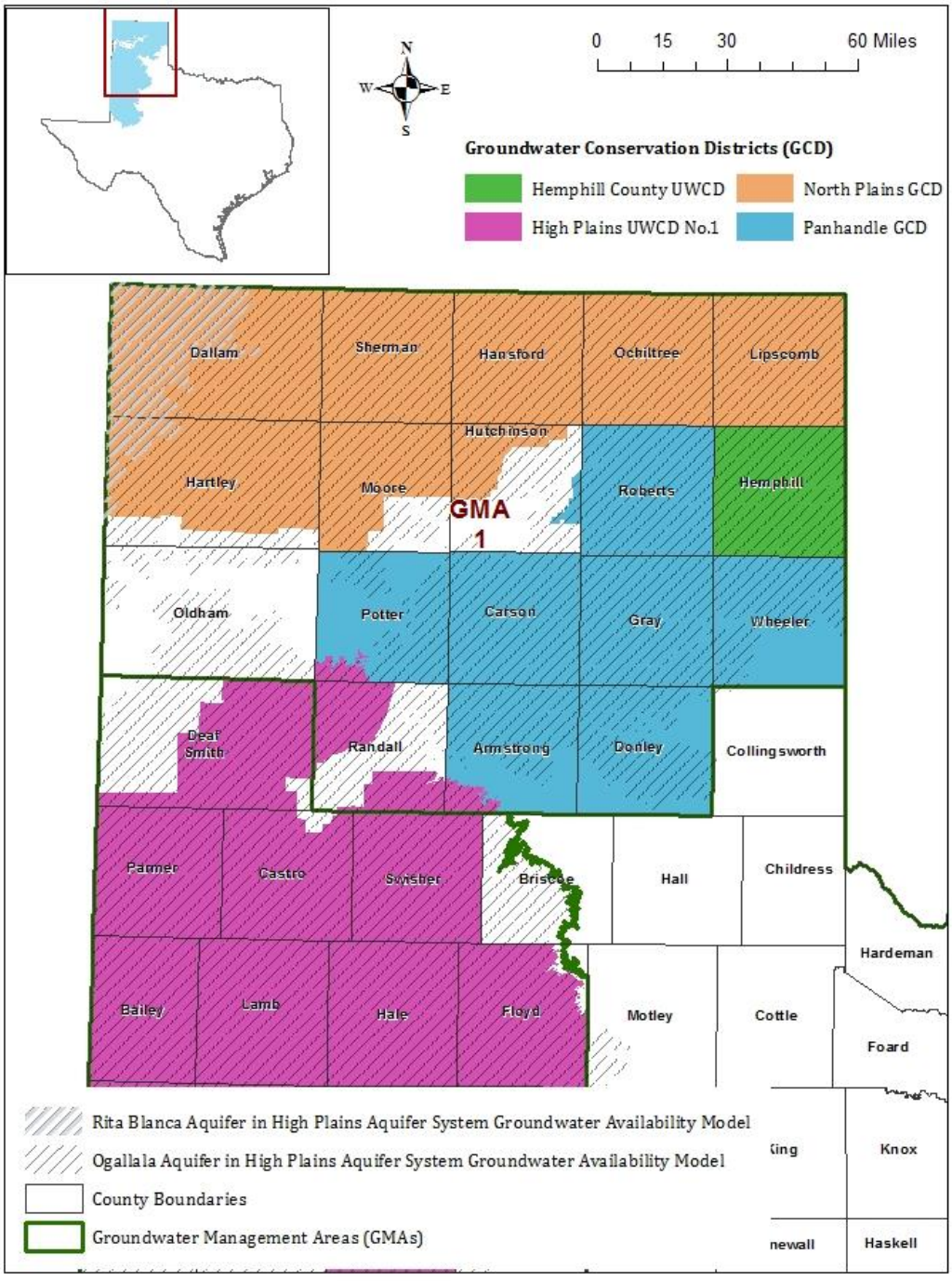

FIGURE 1. MAP SHOWING THE OGALLALA AND RITA BLANCA AQUIFERS AND GROUNDWATER CONSERVATION DISTRICTS IN GROUNDWATER MANAGEMENT AREA 1 OVERLAIN BY THE GROUNDWATER AVAILABILITY MODEL EXTENT FOR THE HIGH PLAINS AQUIFER SYSTEM.

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA AND RITA BLANCA AQUIFERS IN GROUNDWATER MANAGEMENT AREA 1 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE (2020 TO 2060) AND THE YEAR 2062. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2020	2030	2040	2050	2060	2062
High Plains UWCD No. 1	Armstrong	Ogallala	1,286	1,048	866	723	610	591
High Plains UWCD No. 1	Potter	Ogallala	225	225	225	223	221	221
High Plains UWCD No. 1	Randall	Ogallala	39,084	37,987	32,477	28,334	25,018	24,459
High Plains UWCD No. 1 Total		**Ogallala**	**40,595**	**39,260**	**33,568**	**29,280**	**25,849**	**25,271**
Hemphill County UWCD Total	Hemphill	Ogallala	52,196	52,218	52,267	52,305	52,336	52,341
North Plains GCD	Dallam	Ogallala/Rita Blanca	387,471	287,205	225,573	166,890	112,864	103,258
North Plains GCD	Hansford	Ogallala	275,016	272,656	271,226	270,281	269,589	269,479
North Plains GCD	Hartley	Ogallala	397,585	271,523	212,321	154,433	100,407	90,842
North Plains GCD	Hutchinson	Ogallala	62,803	64,522	65,652	66,075	66,027	65,956
North Plains GCD	Lipscomb	Ogallala	266,809	266,710	266,640	266,591	266,559	266,557
North Plains GCD	Moore	Ogallala	214,853	172,621	139,322	105,016	73,384	67,650
North Plains GCD	Ochiltree	Ogallala	243,778	243,932	244,002	244,051	244,082	244,085
North Plains GCD	Sherman	Ogallala	398,056	348,895	281,690	212,744	148,552	136,776
North Plains GCD Total		**Ogallala/Rita Blanca**	**2,246,371**	**1,928,064**	**1,706,426**	**1,486,081**	**1,281,464**	**1,244,603**

Table 1 (Continued)

Groundwater Conservation District	County	Aquifer	2020	2030	2040	2050	2060	2062
Panhandle GCD	Armstrong	Ogallala	57,984	53,414	48,170	43,462	38,860	38,080
Panhandle GCD	Carson	Ogallala	192,135	184,263	169,931	153,767	137,215	134,055
Panhandle GCD	Donley	Ogallala	74,808	76,289	72,962	67,873	62,058	60,901
Panhandle GCD	Gray	Ogallala	181,105	175,267	162,653	148,713	134,431	131,744
Panhandle GCD	Hutchinson	Ogallala	15,734	16,740	15,156	13,324	11,742	11,455
Panhandle GCD	Potter	Ogallala	16,969	15,820	14,442	13,162	11,836	11,609
Panhandle GCD	Roberts	Ogallala	430,618	455,129	427,218	390,247	350,459	342,748
Panhandle GCD	Wheeler	Ogallala	130,425	138,810	137,385	132,312	124,778	123,309
Panhandle GCD Total		**Ogallala**	**1,099,778**	**1,115,732**	**1,047,917**	**962,860**	**871,379**	**853,901**
No District-County	Hartley	Ogallala	19,528	17,639	14,527	11,147	8,016	7,458
No District-County	Moore	Ogallala	8,932	8,598	7,592	6,186	4,788	4,532
No District-County	Oldham	Ogallala	44,599	40,203	33,423	26,207	19,590	18,617
No District-County	Randall	Ogallala	24,826	23,945	21,864	19,471	17,012	16,541
No District-County	Hutchinson	Ogallala	16,448	14,432	13,353	12,973	13,089	13,170
No District-County Total		**Ogallala**	**114,333**	**104,817**	**90,759**	**75,984**	**62,495**	**60,318**
GMA 1 - Total		**Ogallala/Rita Blanca**	**3,553,273**	**3,240,091**	**2,930,937**	**2,606,510**	**2,293,523**	**2,236,434**

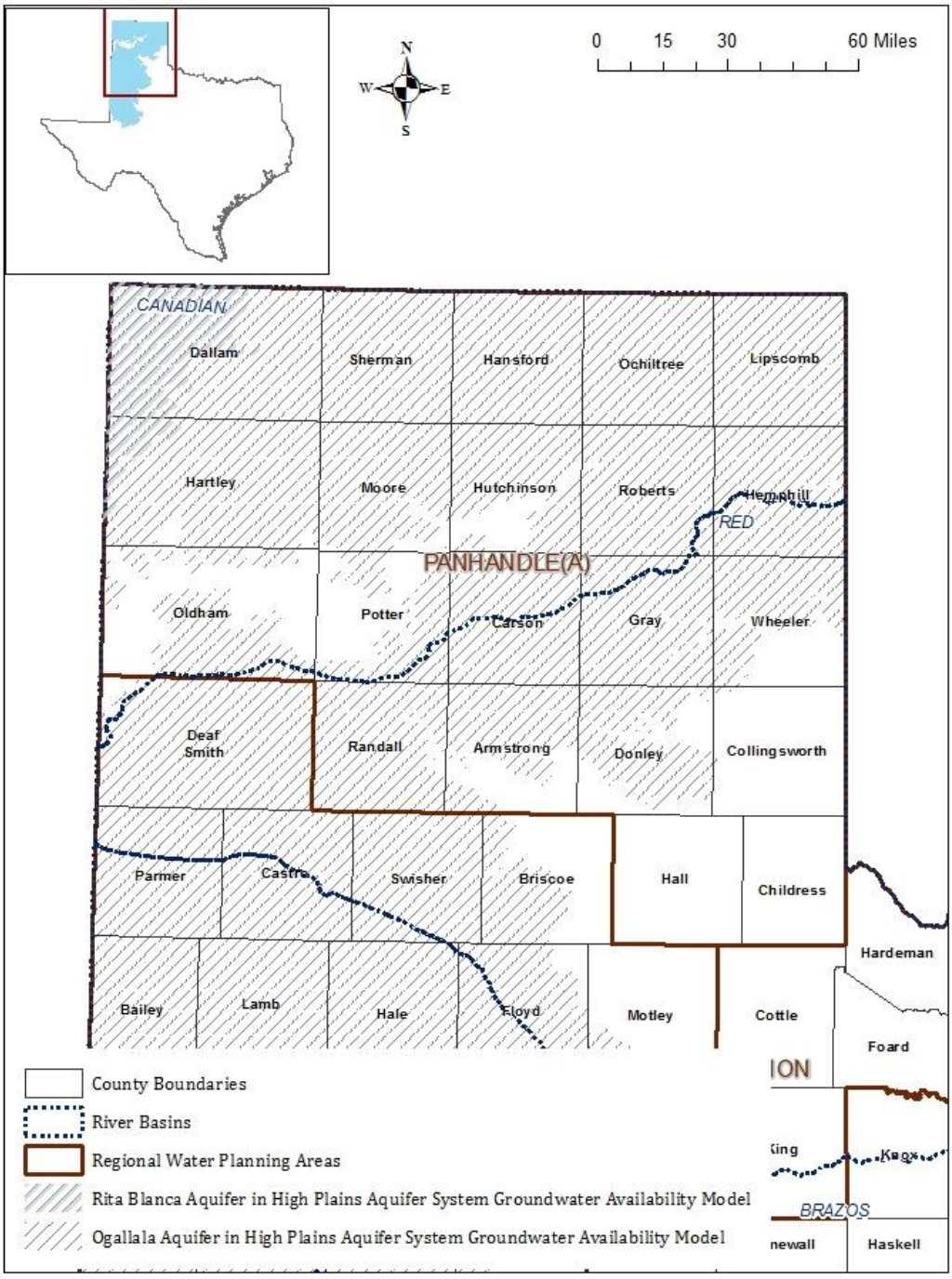

FIGURE 2. MAP SHOWING THE OGALLALA AND RITA BLANCA AQUIFERS AND REGIONAL WATER PLANNING AREAS, COUNTIES, AND RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 1 OVERLAIN BY THE GROUNDWATER AVAILABILITY MODEL EXTENT FOR THE HIGH PLAINS AQUIFER SYSTEM.

TABLE 2. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE OGALLALA AND RITA BLANCA AQUIFERS IN GROUNDWATER MANAGEMENT AREA 1 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA) FOR EACH DECADE (2020 TO 2060). VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Aquifer	2020	2030	2040	2050	2060
Armstrong	A	Red	Ogallala	59,270	54,462	49,036	44,185	39,470
Carson	A	Canadian	Ogallala	77,157	74,542	69,042	62,520	55,902
Carson	A	Red	Ogallala	114,978	109,721	100,889	91,247	81,313
Dallam	A	Canadian	Ogallala/Rita Blanca	387,471	287,205	225,573	166,890	112,864
Donley	A	Red	Ogallala	74,808	76,289	72,962	67,873	62,058
Gray	A	Canadian	Ogallala	44,778	42,146	37,337	32,130	27,432
Gray	A	Red	Ogallala	136,327	133,121	125,316	116,583	106,999
Hansford	A	Canadian	Ogallala	275,016	272,656	271,226	270,281	269,589
Hartley	A	Canadian	Ogallala	417,113	289,162	226,848	165,580	108,423
Hemphill	A	Canadian	Ogallala	27,789	30,260	31,999	33,363	34,058
Hemphill	A	Red	Ogallala	24,407	21,958	20,268	18,942	18,278
Hutchinson	A	Canadian	Ogallala	94,985	95,694	94,161	92,372	90,858
Lipscomb	A	Canadian	Ogallala	266,809	266,710	266,640	266,591	266,559
Moore	A	Canadian	Ogallala	223,785	181,219	146,914	111,202	78,172
Ochiltree	A	Canadian	Ogallala	243,778	243,932	244,002	244,051	244,082
Oldham	A	Canadian	Ogallala	37,367	34,376	29,078	23,039	17,800
Oldham	A	Red	Ogallala	7,232	5,827	4,345	3,168	1,790
Potter	A	Canadian	Ogallala	9,552	9,196	8,519	7,898	7,214
Potter	A	Red	Ogallala	7,642	6,849	6,148	5,487	4,843
Randall	A	Red	Ogallala	63,910	61,932	54,341	47,805	42,030
Roberts	A	Canadian	Ogallala	408,968	430,269	401,642	365,119	326,457
Roberts	A	Red	Ogallala	21,650	24,860	25,576	25,128	24,002
Sherman	A	Canadian	Ogallala	398,056	348,895	281,690	212,744	148,552
Wheeler	A	Red	Ogallala	130,425	138,810	137,385	132,312	124,778
GMA 1 Total				**3,553,273**	**3,240,091**	**2,930,937**	**2,606,510**	**2,293,523**

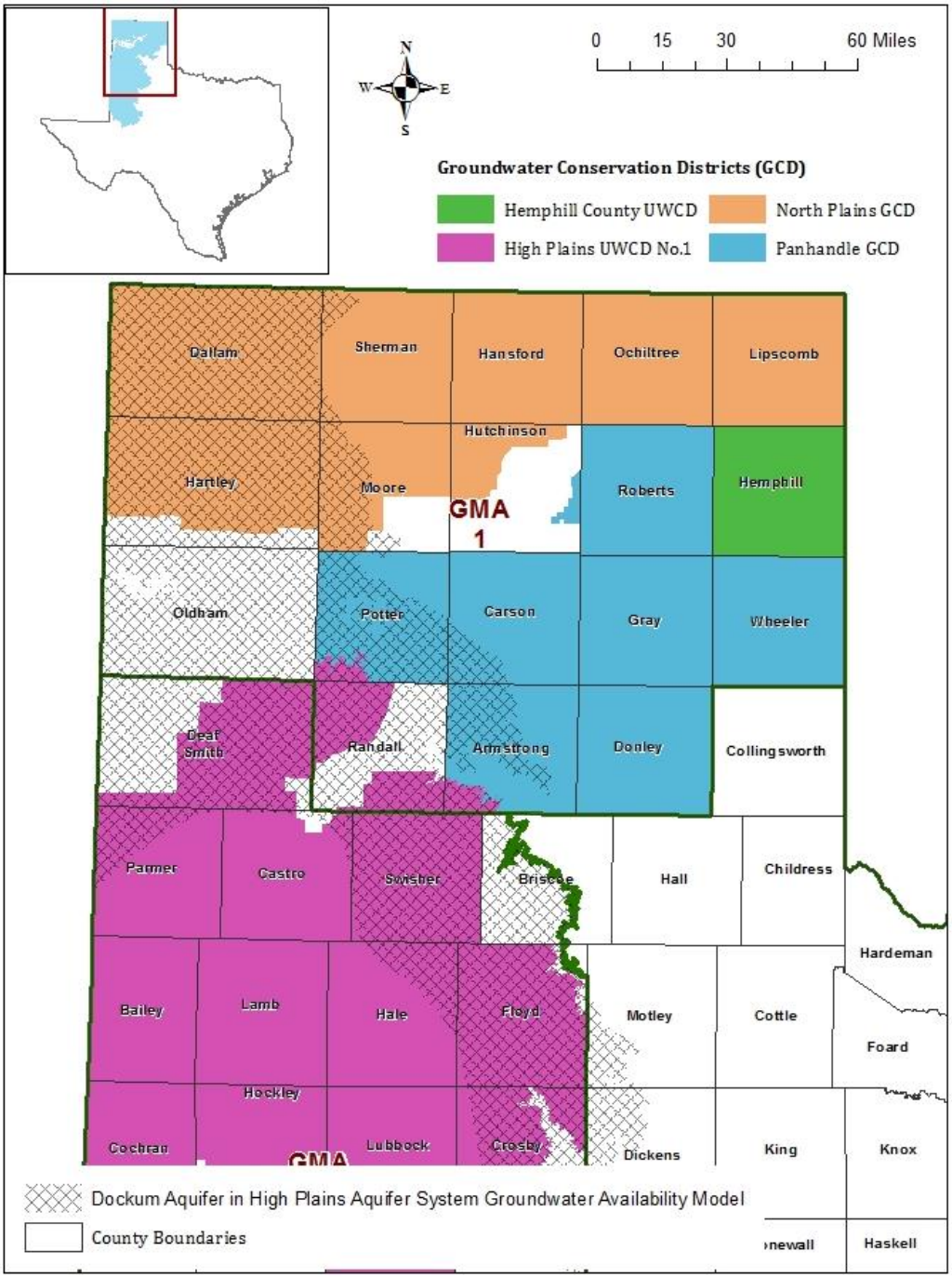

FIGURE 3. MAP SHOWING THE DOCKUM AQUIFER AND GROUNDWATER CONSERVATION DISTRICTS IN GROUNDWATER MANAGEMENT AREA 1 OVERLAIN BY THE GROUNDWATER AVAILABILITY MODEL EXTENT FOR THE HIGH PLAINS AQUIFER SYSTEM.

TABLE 3. MODELED AVAILABLE GROUNDWATER FOR THE DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 1 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE (2020 TO 2060) AND THE YEAR 2062.VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2020	2030	2040	2050	2060	2062
High Plains UWCD No. 1	Armstrong	Dockum	96	0	0	0	0	0
High Plains UWCD No. 1	Potter	Dockum	21	0	0	0	0	0
High Plains UWCD No. 1	Randall	Dockum	2,189	2,714	2,954	3,111	3,214	3,229
High Plains UWCD No. 1 Total		**Dockum**	**2,306**	**2,714**	**2,954**	**3,111**	**3,214**	**3,229**
North Plains GCD	Dallam	Dockum	14,192	14,188	14,186	14,184	14,184	14,184
North Plains GCD	Moore	Dockum	4,801	4,532	4,493	4,417	4,289	4,261
North Plains GCD	Hartley	Dockum	11,602	10,766	10,524	10,560	10,815	10,895
North Plains GCD	Sherman	Dockum	127	127	127	127	95	93
North Plains GCD Total		**Dockum**	**30,722**	**29,613**	**29,330**	**29,288**	**29,383**	**29,433**
Panhandle GCD	Armstrong	Dockum	7,131	9,024	9,588	9,704	9,535	9,494
Panhandle GCD	Carson	Dockum	68	108	140	169	198	204
Panhandle GCD	Potter	Dockum	38,803	39,113	36,937	34,505	32,008	31,558
Panhandle GCD Total		**Dockum**	**46,002**	**48,245**	**46,665**	**44,378**	**41,741**	**41,256**
No District-County	Hartley	Dockum	43,647	44,269	44,404	44,304	44,022	43,941
No District-County	Moore	Dockum	418	575	527	509	500	498
No District-County	Oldham	Dockum	129,001	128,829	120,518	111,196	101,413	99,736
No District-County	Randall	Dockum	8,983	11,302	11,909	12,002	11,855	11,807
No District- County Total		**Dockum**	**182,049**	**184,975**	**177,358**	**168,011**	**157,790**	**155,982**
GMA 1 Total		**Dockum**	**261,079**	**265,547**	**256,307**	**244,788**	**232,128**	**229,900**

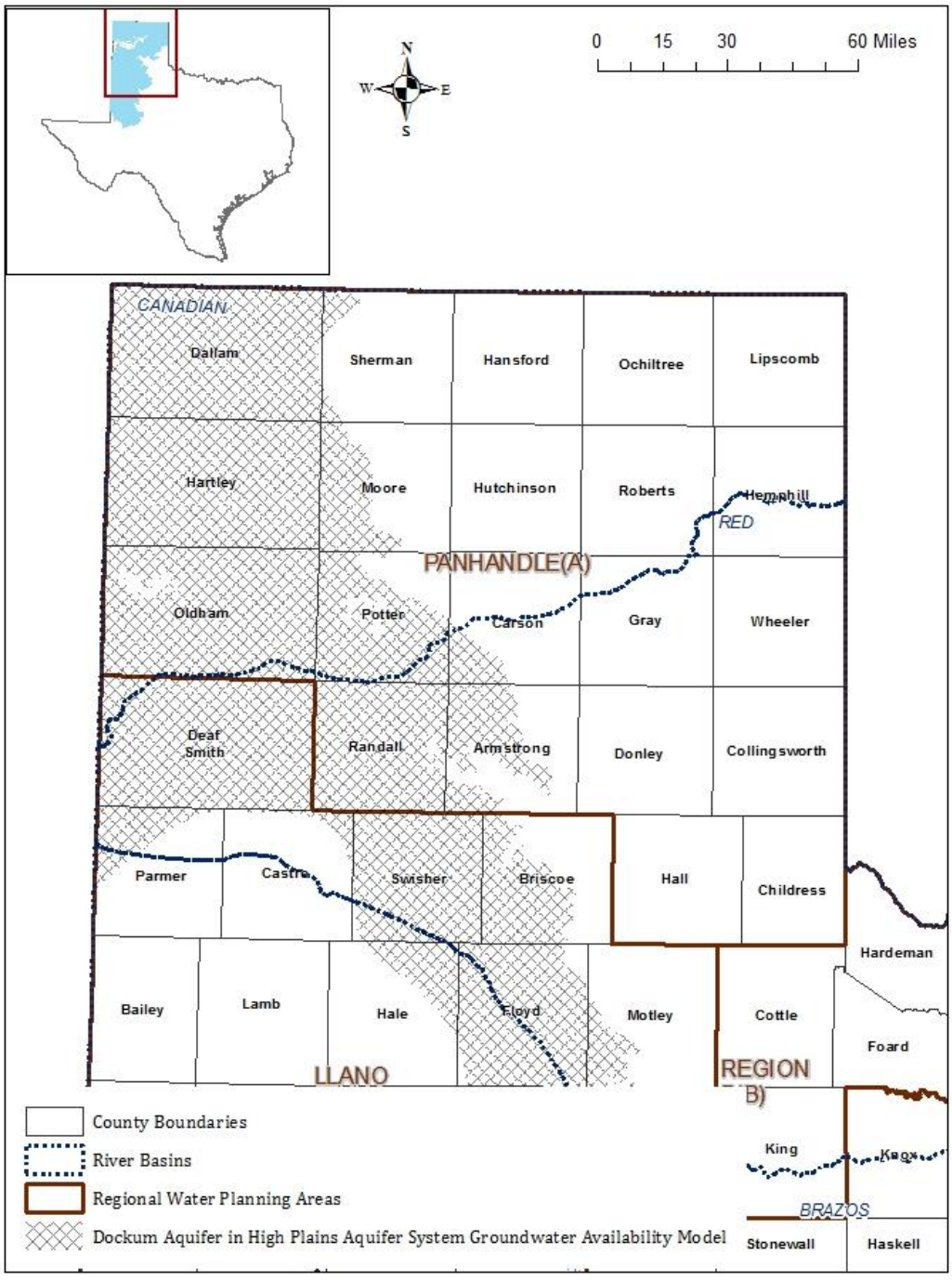

FIGURE 4. MAP SHOWING THE DOCKUM AQUIFER AND REGIONAL WATER PLANNING AREAS, COUNTIES, AND RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 1 OVERLAIN BY THE GROUNDWATER AVAILABILITY MODEL EXTENT FOR THE HIGH PLAINS AQUIFER SYSTEM.

TABLE 4. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 1 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA) FOR EACH DECADE (2020 TO 2060). VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Aquifer	2020	2030	2040	2050	2060
Armstrong	A	Red	Dockum	7,227	9,024	9,588	9,704	9,535
Carson	A	Canadian	Dockum	4	10	15	19	23
Carson	A	Red	Dockum	64	98	125	150	175
Dallam	A	Canadian	Dockum	14,192	14,188	14,186	14,184	14,184
Hartley	A	Canadian	Dockum	55,249	55,035	54,928	54,864	54,837
Moore	A	Canadian	Dockum	5,219	5,107	5,020	4,926	4,789
Oldham	A	Canadian	Dockum	128,938	128,771	120,466	111,146	101,365
Oldham	A	Red	Dockum	63	58	52	50	48
Potter	A	Canadian	Dockum	38,641	38,983	36,832	34,409	31,900
Potter	A	Red	Dockum	183	130	105	96	108
Randall	A	Red	Dockum	11,172	14,016	14,863	15,113	15,069
Sherman	A	Canadian	Dockum	127	127	127	127	95
GMA 1 Total			**Dockum**	**261,079**	**265,547**	**256,307**	**244,788**	**232,128**

LIMITATIONS:

The groundwater model used in completing this analysis is the best available scientific tool that can be used to meet the stated objectives. To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> "Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."

A key aspect of using the groundwater model to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historic pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and streamflow are specific to a particular historic time period.

Because the application of the groundwater model was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations relating to the actual conditions of any aquifer at a particular location or at a particular time.

The TWDB is available to work with groundwater conservation districts to use ongoing data collection programs to compare the predictions of the model against how the aquifer responds to the actual amount and location of pumping. Besides groundwater pumping and use trends, historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

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