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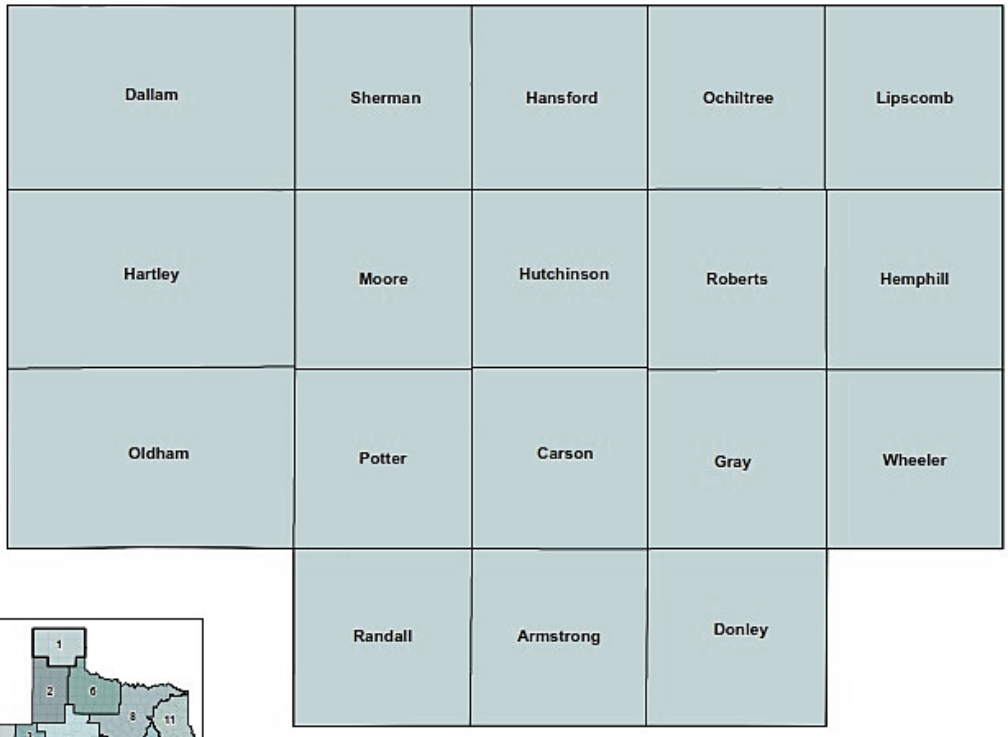
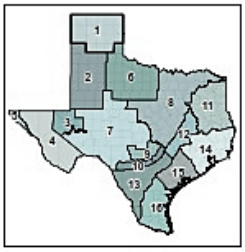
Desired Future Conditions Explanatory Report

February 2026





Groundwater Management Area #1

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FEBRUARY 17, 2026

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Desired Future Conditions Explanatory Report

February 2026

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FEBRUARY 17, 2026

Executive Summary

Groundwater Management Area (GMA) 1 Groundwater Conservation Districts (GCDs or Districts) prepared this Explanatory Report for Desired Future Conditions (DFCs) for the Ogallala, Rita Blanca, and Dockum aquifers to comply with the requirements of Texas Water Code (TWC), Section 36.108 and administrative rules of the Texas Water Development Board (TWDB) found in Title 31 Texas Administrative Code (TAC) Chapter 356. The Districts include all of Hemphill County Underground Water Conservation District (Hemphill UWCD), North Plains Groundwater Conservation District (North Plains GCD), Panhandle Groundwater Conservation District (Panhandle GCD), and part of High Plains Underground Water Conservation District No. 1 (High Plains UWCD).

The GCDs located in GMA 1 are local political subdivisions of the state pursuant to TWC Chapter 36 and their specific enabling statutes. GMA 1 Districts fulfilled the requirements for adopting DFCs through cooperation and joint planning efforts.

On Month DD, 2026, GMA 1 Districts Representatives unanimously adopted DFCs for the relevant aquifers within the management area.

The Ogallala Aquifer and the Rita Blanca Aquifer are combined for joint-planning purposes. Any references to the "Ogallala Aquifer" in this document shall also include and apply to any groundwater in the Rita Blanca Aquifer in GMA 1.

Ogallala Aquifer (Inclusive of Rita Blanca):

The Ogallala Aquifer DFCs proposed by GMA 1 are as follows:

- At least 40 percent of volume in storage remaining after the 60-year period between 2020 and 2080 in Dallam, Hartley, Moore, and Sherman counties.
- At least 50 percent of volume in storage remaining after the 60-year period between 2020 and 2080 in Hansford, Hutchinson, Lipscomb, Ochiltree, Carson, Donley, Gray, Roberts, Wheeler, and Oldham Counties; and within the Panhandle District portions of Armstrong and Potter Counties.
- At least 80 percent of volume in storage remaining after the 60-year period between 2020 and 2080 in Hemphill County.
- Approximately 20 feet of total average drawdown after the 50-year period between 2020 and 2070 in Randall County and within High Plains District in Armstrong and in Potter Counties, with less than 23 feet of total average drawdown by 2080 at the end of the planning period.

Dockum Aquifer:

- At least 40 percent of the average available drawdown remaining after the 50-year period between 2020 and 2070 for Dallam, Hartley, Moore, and Sherman counties, with at least 35 percent remaining by 2080 at the end of the planning period.
- No more than 30 feet average decline in water levels after the 60-year period between 2020 and 2080 in Oldham and Carson counties and the Panhandle District portions of Potter and Armstrong counties.

- Approximately 40 feet average decline in water levels after the 50-year period between 2020 and 2070 in Randall County and within High Plains District in Armstrong and Potter counties, with less than 43 feet of average decline by 2080 at the end of the planning period.

Additionally, GMA 1 District Representatives determined that the Blaine Aquifer in Wheeler County is non-relevant for joint planning purposes, as provided by in Title 31, TAC Chapter 356. This Explanatory Report incorporates the requisite documentation regarding the Blaine Aquifer's non-relevant determination by GMA 1.

GMA 1 District Representatives held 7 meetings over a three-year period for the purposes of joint planning in the management area, including July 18, 2024; November 14th, 2024; February 4th, 2025; September 23, 2025; December 11th, 2025; February 24th, 2026; and May #, 2026.

Professional Engineer / Geoscientist Seal(s)

Brief summary of sections worked on, contributions, expertise applied as required by contract, etc.

Name

(Insert seal)

License Type

Date

Brief summary of sections worked on, contributions, expertise applied as required by contract, etc.

Name

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License Type

Date

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Acronyms and Abbreviations

%	percent
CRMWA	Canadian River Municipal Water Authority
DFC	Desired Future Conditions
CDF	Cumulative Density Function
ET	evapotranspiration
GAM	groundwater availability model
GCD or District	Groundwater Conservation District
GMA	Groundwater Management Area
Hemphill UWCD	Hemphill County Underground Water Conservation District
High Plains UWCD	High Plains Underground Water Conservation District No. 1
HPASGAM	High Plains Aquifer System GAM
INTERA	INTERA Incorporated
MAG	modeled available groundwater
North Plains GCD	North Plains Groundwater Conservation District
Panhandle GCD	Panhandle Groundwater Conservation District
PRWP	Panhandle Regional Water Plan
PWPA	Panhandle Water Planning Area
SWP	State Water Plan
TAC	Texas Administrative Code
TERS	total estimated recoverable storage
TWC	Texas Water Code
TWDB	Texas Water Development Board
WUG	water user group
WUS	Water Use Survey

1.0 Groundwater Management Area 1 Joint Planning

Texas Water Code (TWC) Section 36.108(d-2) requires that desired future conditions (DFCs) proposed as part of joint planning in a management area must provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area. Groundwater Management Area (GMA) 1 groundwater conservation districts (GCDs or Districts) established different DFCs throughout the management area based on a combination of policy and technical considerations that provide both for continued economic development of the area and the reasonable long-term management of groundwater resources.

GMA 1 Districts are local political subdivisions of the state pursuant to TWC Chapter 36 and their specific enabling statutes. Each GMA 1 District fulfills the requirements of TWC Section 36 through cooperation and joint planning efforts. Oldham County, along with portions of Hartley, Hutchinson, Moore, and Randall counties, fall outside the jurisdiction of a GCD but are served for joint planning purposes by the GMA 1 Districts. The GMA 1 Districts last adopted DFCs within GMA 1 for the Ogallala Aquifer and the Dockum Aquifer on August 26, 2021.

TWC Section 36.108(d-3) requires that District representatives in a groundwater management area adopt DFCs for all relevant aquifers in the management area. The districts must also produce an Explanatory Report documenting the process and factors considered and submit it to the Texas Water Development Board (TWDB). This Explanatory Report documents that GMA 1 District Representatives considered all required Factors included in TWC Section 36.108(d)(1–9) during this round of joint planning.

TWC Chapter 36 requires districts within a management area to consider groundwater availability models (GAMs) and other data or information for the management area when proposing DFCs for the relevant aquifers within the management area for adoption. GMA 1 proposed DFCs for adoption on February 24, 2026, as required by TWC Section 36.108 (d-5). Consistent with TWC Section 36.108(d), before proposing DFCs as required under TWC Section 36.108(d-2), GMA 1 District Representatives considered the following factors:

1. Aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another.
2. The water supply needs and water management strategies included in the state water plan.
3. Hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge.
4. Other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water.
5. The impact on subsidence.
6. Socioeconomic impacts reasonably expected to occur.
7. The impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater.
8. The feasibility of achieving the desired future condition.

9. Any other information relevant to the specific desired future conditions.

GMA 1 District Representatives determined all the information they considered to be applicable to one or more of the factors listed above.

After considering and documenting each of the factors described above and other relevant scientific and hydrogeological data, if available, the Districts may establish different DFCs for:

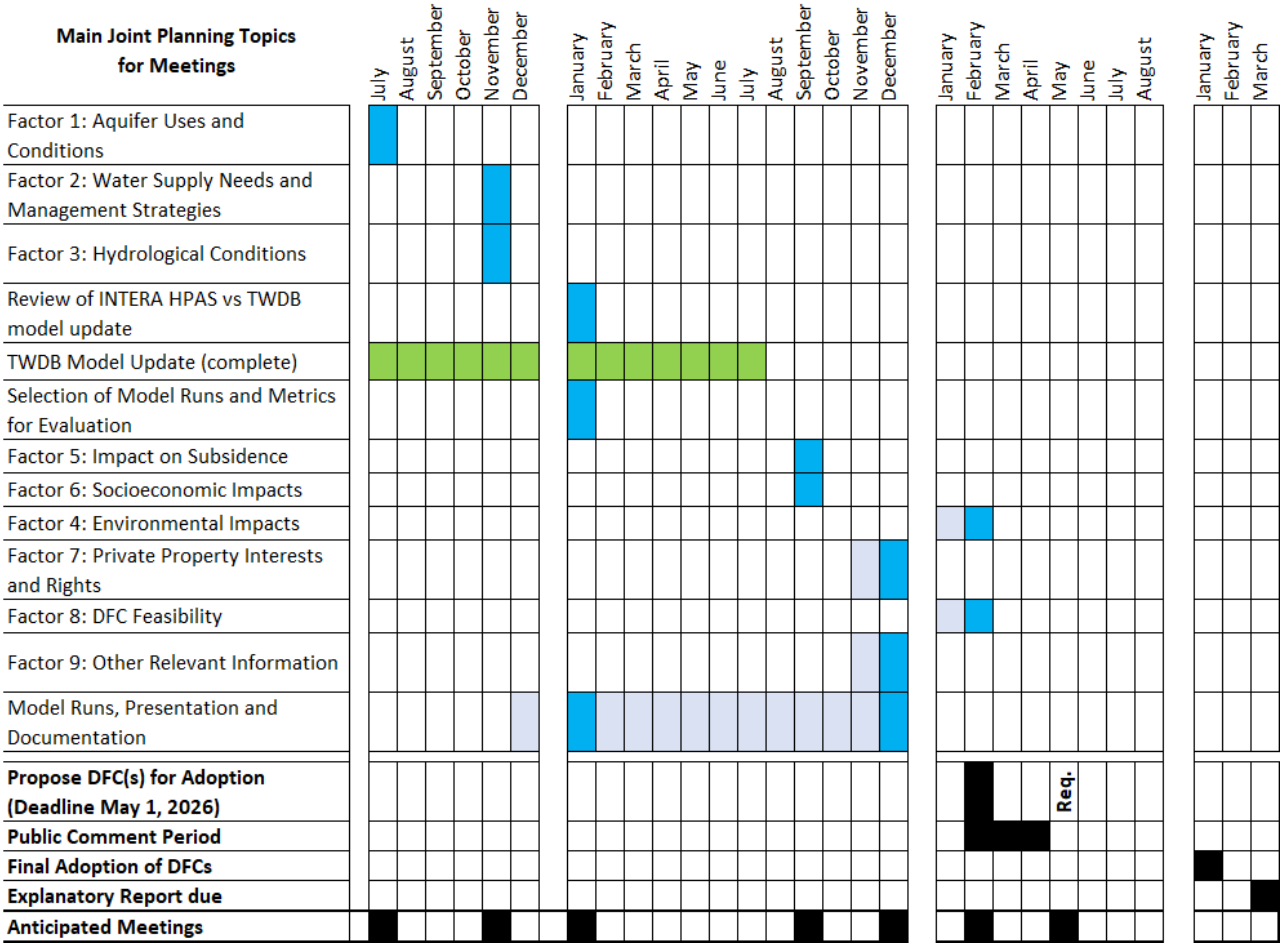
1. Each aquifer, subdivision of an aquifer, or geologic strata located in whole or in part within the boundaries of the management area; or
2. Each geographic area overlying an aquifer in whole or in part or subdivision of an aquifer within the boundaries of the management area.

This Explanatory Report:

1. Identifies each DFC.
2. Provides the policy and technical justifications for each desired future condition.
3. Documents that the Factors under Section 36.108(d) were considered by the districts and discusses how the adopted DFCs impact each factor.
4. Lists other DFC options considered, if any, and the reasons why those options were not adopted.
5. Discusses reasons why recommendations from public comments received by the districts were or were not incorporated into the DFCs.

GMA 1 District Representatives held 7 meetings over a three-year period for the purposes of joint planning in the management area including July 18, 2024; November 14th, 2024; February 4th, 2025; September 23, 2025; December 11th, 2025; February 24th, 2026; and May #, 2026. **Table 1-1** shows the meeting dates during which the GMA 1 District Representatives considered each of the above required factors.

Table 1-1. Schedule for GMA 1 Joint Planning including meeting dates dedicated to reviewing and considering each of the required factors under TWC Section 36.108(d).



2.0 Groundwater Management Area 1 Description

TWC Chapter 36 requires GCDs located entirely or partially within a GMA designated by TWDB to propose for adoption DFCs for the relevant aquifers within each GCD by May 1, 2026. A DFC is defined as a quantitative description, adopted in accordance with TWC Section 36.108, of the desired condition of the groundwater resources in a management area at one or more specified future times. GMA 1 includes: Armstrong, Carson, Dallam, Donley, Gray, Hansford, Hartley, Hemphill, Hutchinson, Lipscomb, Moore, Ochiltree, Oldham, Potter, Randall, Roberts, Sherman, and Wheeler counties in the Texas Panhandle.

GMA 1 is located entirely within and consists of 18 out of the 21 counties in TWDB Region A, also referred to as the Panhandle Water Planning Area (PWPA). According to the 2022 State Water Plan (SWP), GMA 1 is among the largest groundwater-producing regions in the state, with the Ogallala Aquifer serving as the dominant source of groundwater. The 2026 Panhandle Regional Water Plan (PRWP) estimates that, in 2030, approximately 90 percent of water demands in the Region will be used for agricultural purposes. The area included 1.4 percent (%) of the total state population in 2020, while accounting for about fifteen percent of the State's annual water demand. According to the 2026 PRWP, in 2020, groundwater provided 99% of total supply, surface water accounted less than one percent, and other supplies (e.g., direct reuse and surface water supplies that cannot be easily quantified—stock ponds) accounted for less than one percent of total supply in the PWPA. Due to the scarcity of locally developable surface water supplies, any additional water needed for the basin will likely come from groundwater or reuse of existing supplies. According to the 2022 SWP, statewide annual existing groundwater supply is anticipated to decline about 32% from 2020 to 2070, and the report cites reduced availability from managed depletion in the Ogallala Aquifer as a primary reason for this decline.

All or parts of 17 counties in GMA 1 are served by four GCDs, as follows:

- Hemphill County Underground Water Conservation District (Hemphill UWCD), established in 1997, serving Hemphill County.
- High Plains Underground Water Conservation District No. 1 (High Plains UWCD), established in 1951, serving portions of Armstrong, Potter, and Randall counties, with the remainder of the district located in GMA 2.
- North Plains Groundwater Conservation District (North Plains GCD), established in 1955, serving all or part of Dallam, Hansford, Hartley, Hutchinson, Lipscomb, Moore, Ochiltree, and Sherman counties.
- Panhandle Groundwater Conservation District (Panhandle GCD), established in 1956, serving all or part of Armstrong, Carson, Donley, Gray, Hutchinson, Potter, Roberts, and Wheeler counties.

Oldham County and portions of Hartley, Hutchinson, Moore, and Randall counties are unserved by a GCD. The GCDs are collectively referenced to in this report as "GMA 1 Districts." A map of GMA 1 District boundaries is shown in **Figure 2-1**. The TWDB has identified one major aquifer (Ogallala Aquifer) and three minor aquifers (Blaine, Dockum and Rita Blanca aquifers) in GMA 1. **Figure 2-2** is a map of the major aquifers in GMA 1. **Figure 2-3** is a map of the minor aquifers in GMA 1.

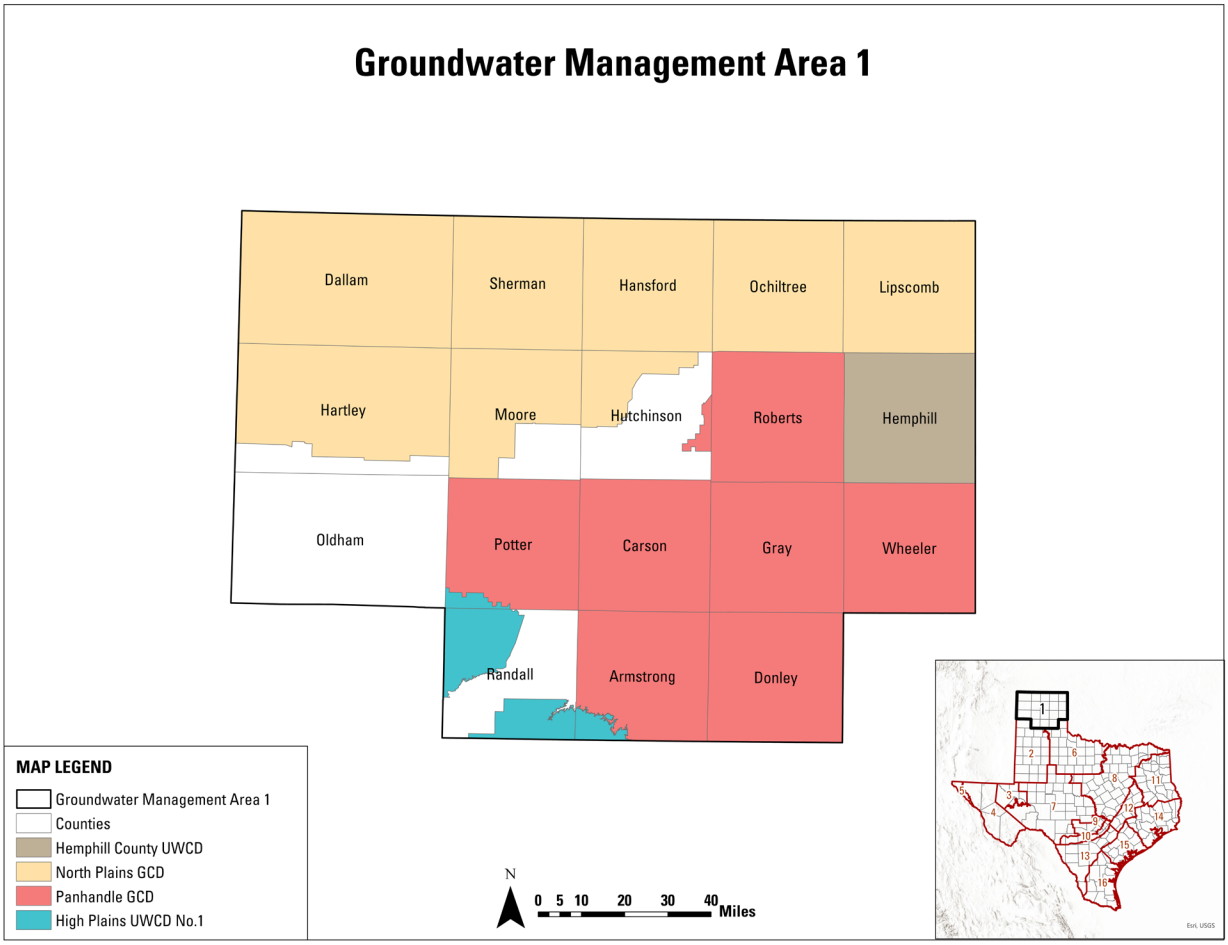
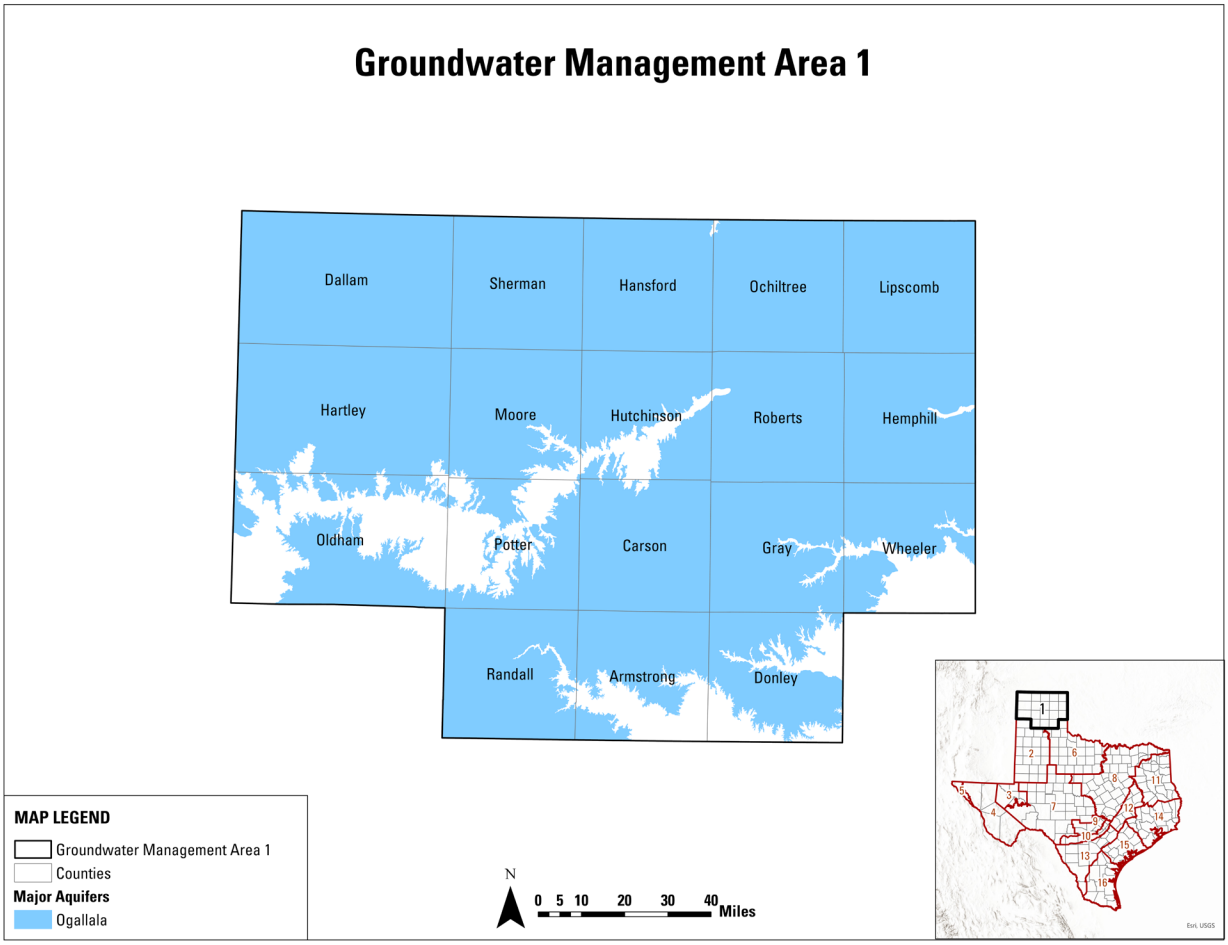


Figure 2-1. GMA 1 District boundaries (TWDB, 2026).



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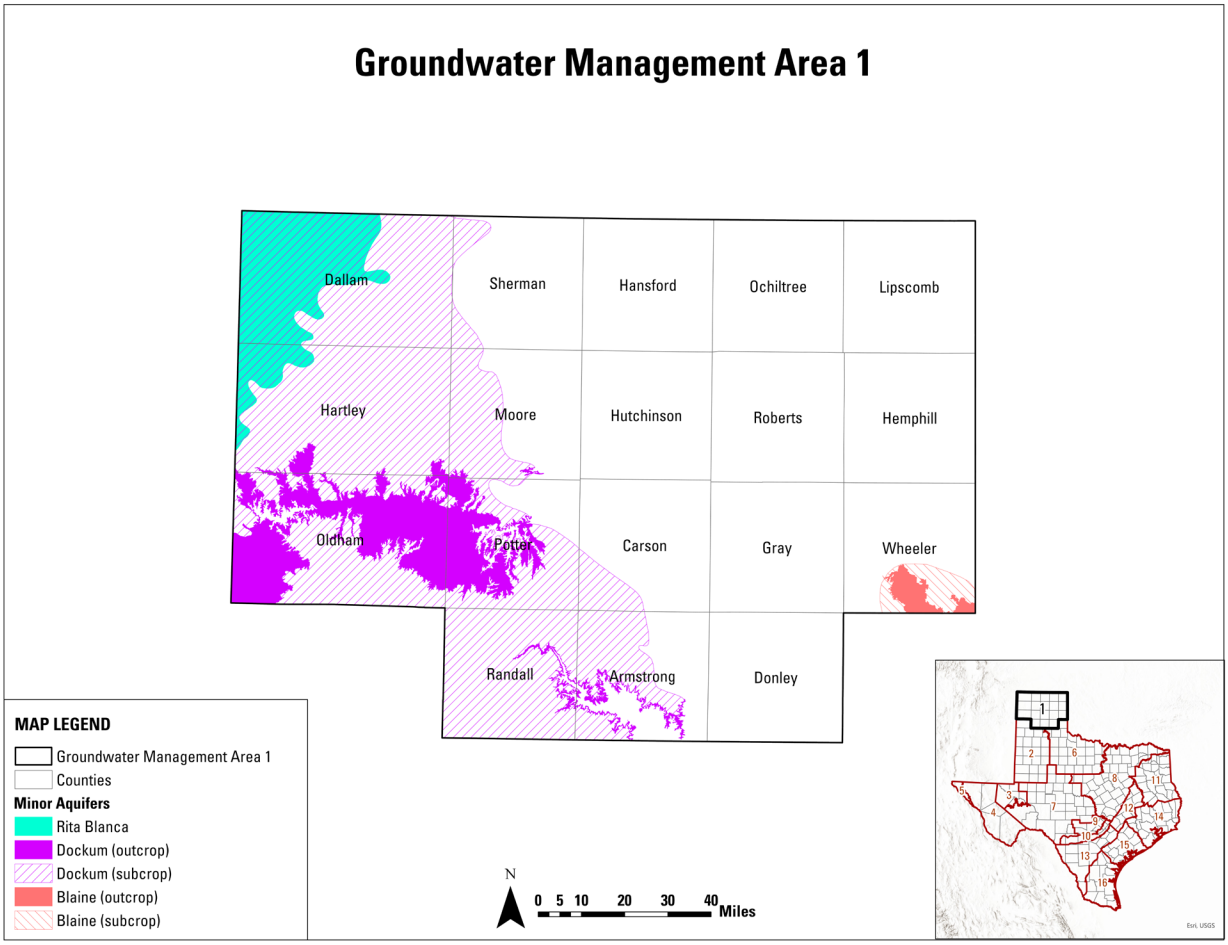


Figure 2-3. GMA 1 Minor Aquifers (TWDB, 2026).

3.0 Ogallala Aquifer Description and Desired Future Conditions

3.1 Ogallala Aquifer and Rita Blanca Aquifer Description

3.1.1 Ogallala Aquifer

The Ogallala Aquifer is the largest water resource in the Great Plains. It is primarily an unconfined or water table aquifer that extends approximately 174,000 square miles from South Dakota, through Wyoming, Nebraska, Colorado, Kansas, New Mexico, and Oklahoma, to the Texas South Plains. In Texas, the Ogallala covers about 36,000 square miles through all or parts of 48 counties.

As the Southern Rocky Mountains began to uplift and the Cretaceous seas retreated, streams flowing east and southeast from the mountains cut channels into the pre-Ogallala surface of Permian, Triassic, Jurassic and Cretaceous strata. These streams—along with eolian processes—transported large sediment quantities east and southeast from the Rocky Mountains, filling in the channels and creating a thick blanket of coalescing clay, silt, and sand deposits of the Ogallala and associated formations. Eventually, a combination of the climate becoming more arid and the Pecos River incising northward through the Ogallala Formation in New Mexico isolated the Ogallala in Texas from its Southern Rocky Mountains water and sediment source. Uplift continued, and the Texas High Plains surface tilted southeastward (Knowles and others, 1984). Today, the Ogallala formation's thickness ranges from zero to more than 900 feet in the Texas High Plains and is controlled, in part, by the depth of the sediment filled channels (paleochannels) at the base of the formation as well as by dissolution of salt in older rock strata below the formation. Today, the Ogallala's greatest sediment thicknesses and groundwater saturated thicknesses in Texas occur in the northeastern part of the Panhandle.

Interbedded sequences of unconsolidated to poorly consolidated clay, silt, and sands—with minor sequences of gravel—constitute most of the sediment deposited in the Ogallala Formation. The sands are generally tan, cream, yellow, or reddish brown; very fine to coarse-grained; sub-angular to sub-rounded; and poorly to well sorted. The gravel is usually associated with sand, silt, and clay. On the Texas High Plains, the Ogallala Formation is generally capped by caliche near the surface. In addition to these caliche layers, caliche also occurs at depth and may represent older soil horizons.

Driller's logs describe Permian and Triassic sediment beneath the Ogallala Formation as a combination of red clay, red sand, and silt or red beds. Where Cretaceous sediment underlies the Ogallala, widespread yellow, blue, or black clay marks the unconformity. In local areas, the base of the Ogallala can be obscured by pre-Ogallala sediment with similar characteristics to basal Ogallala sand and gravel. The Ogallala Aquifer is partially hydraulically connected to underlying sandstones of the Cretaceous- and Jurassic-age Rita Blanca Aquifer in Dallam and Hartley counties and to the Santa Rosa sandstone at the base of the Triassic-age Dockum Group and to Cretaceous-age limestone of the Edwards Trinity Aquifer near Lubbock.

The Ogallala Aquifer is segregated into northern and southern portions by Palo Duro Canyon and a groundwater divide, both located along the Prairie Dog Town Fork of the Red River. Groundwater in the aquifer's northern portion generally flows eastward and discharges through wells into the Canadian River and tributaries of the Red River in the eastern Panhandle or flows into Oklahoma. The aquifer is

laterally hydraulically connected, except where the Canadian River has eroded through the formation. The distribution of the depths of wells is shown in **Figure 3-1**. Over 36,000 wells are shown in Figure 3-1 using data from the TWDB Groundwater Database and Submitted Drillers Reports Database. Most, though not all, of these wells are completed into the Ogallala Aquifer.

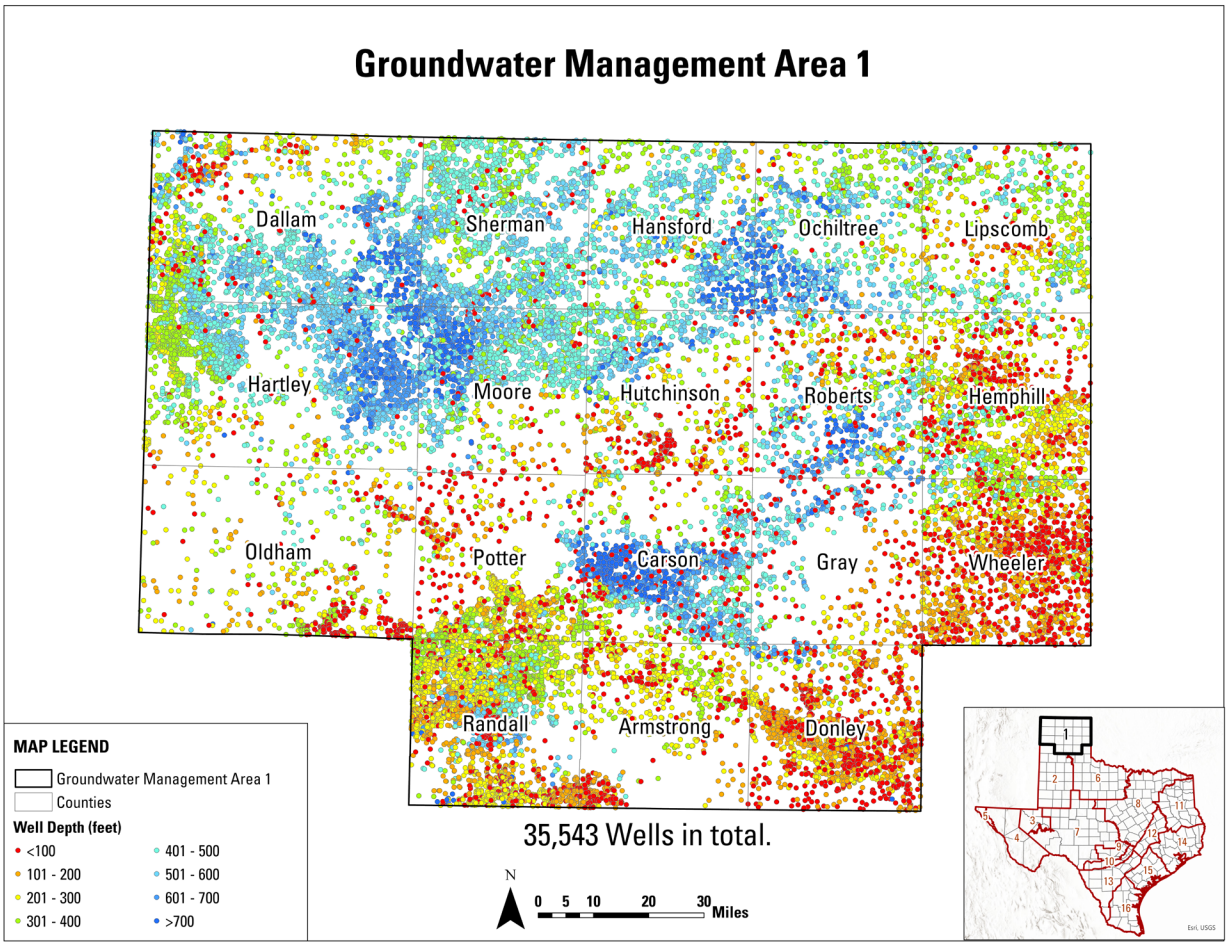


Figure 3-1. Map of well depths in GMA 1.

3.1.2 Rita Blanca Aquifer

The Rita Blanca Aquifer, in Texas, is in northwest Dallam and Hartley counties. The aquifer is composed of Jurassic- to Cretaceous-age sediments that subcrop or truncate below the Ogallala sediments and overlie the older Dockum sediments. Christian (1989) described the sediments within the Rita Blanca Aquifer as follows:

- Graneros Shale: Marine shale with fine-grained mixed clastic sediment and limestone (Cretaceous).
- Dakota Group: (undifferentiated, Glencairn Formation & Lytle Sandstone) fine- to coarse-grained sandstone, variegated clay, and pebbly beds (Cretaceous).
- Morrison Formation: mudstone, sandstone, siltstone, and limestone (Jurassic).
- Exeter Sandstone: coarse, evenly laminated, sandstone (Jurassic).

Cross-sections of geologic strata that comprise the Rita Blanca Aquifer modified from Christian (1989) are shown in **Figure 3-2**. The irregular lines between the rock strata in the cross-sections show unconformities, buried erosional surfaces where part of the geologic record has been removed. The cross-sections illustrate the paleochannels (ancient sediment-filled stream and river channels) created at the base of the Ogallala sediments.

According to TWDB Report 380 (George and others, 2011), groundwater production occurs from the coarse-grained sand and gravel layers of the Lytle and Dakota sediments as well as in the Exeter Sandstone and the Morrison Formation. In places, the Rita Blanca Aquifer is hydraulically connected to the overlying Ogallala Aquifer and the underlying Dockum Aquifer. Though the report elaborated that irrigation accounts for most of the groundwater use from this aquifer, it noted that Texline uses the aquifer for municipal water supply.

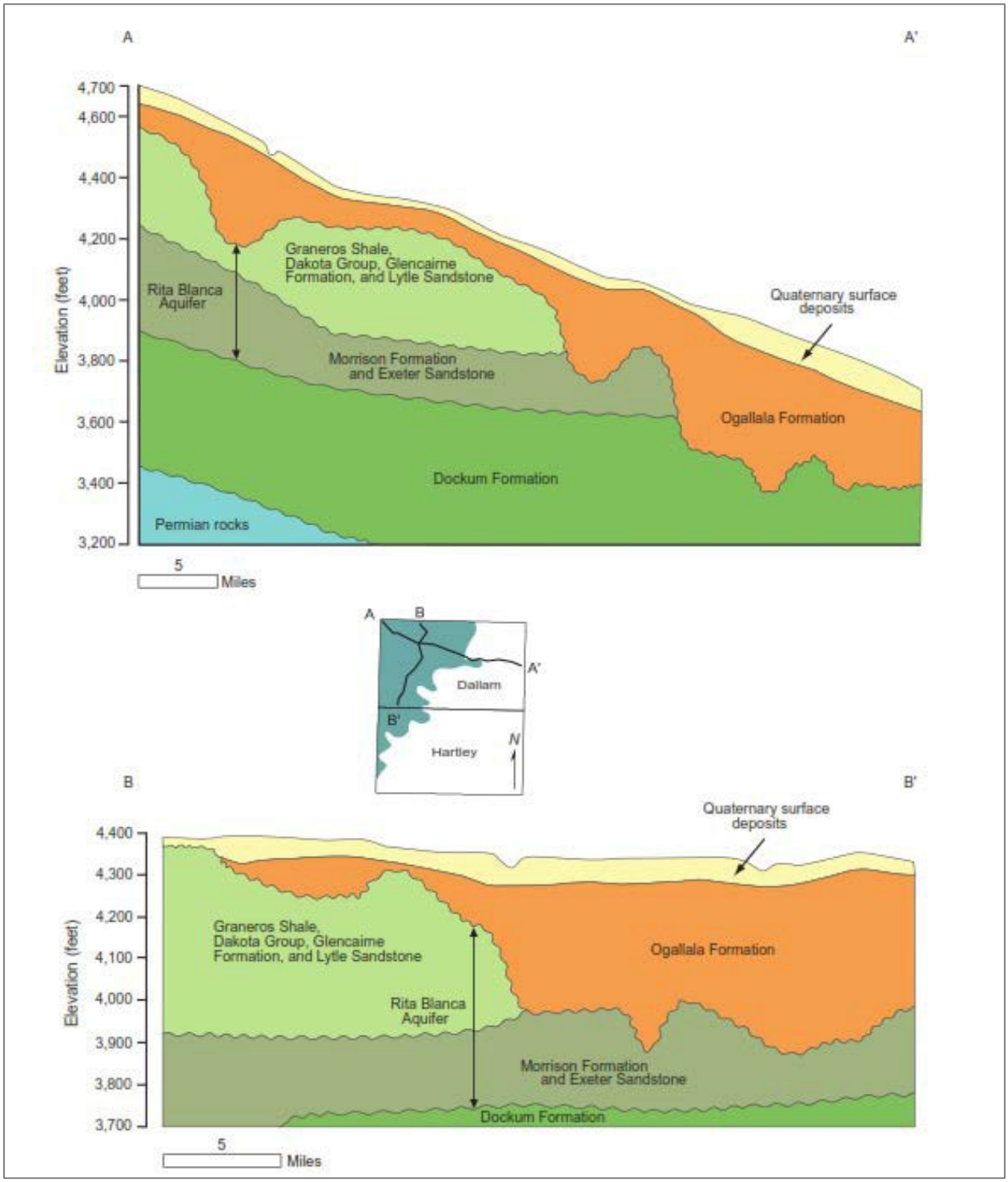


Figure 3-2. Cross Sections of the Rita Blanca Aquifer compared with the Ogallala and Dockum aquifers (modified from Christian, 1989).

3.2 Desired Future Conditions

GMA 1 District Representatives unanimously adopted DFCs for the Ogallala Aquifer by resolution on Month DD, 2026. The Ogallala Aquifer (inclusive of Rita Blanca) DFCs adopted by GMA 1 are as follows:

- At least 40 percent of volume in storage remaining after the 60-year period between 2020 and 2080 in Dallam, Hartley, Moore, and Sherman counties.
- At least 50 percent of volume in storage remaining after the 60-year period between 2020 and 2080 in Hansford, Hutchinson, Lipscomb, Ochiltree, Carson, Donley, Gray, Roberts, Wheeler, and Oldham Counties; and within the Panhandle District portions of Armstrong and Potter Counties.
- At least 80 percent of volume in storage remaining after the 60-year period between 2020 and 2080 in Hemphill County.
- Approximately 20 feet of total average drawdown after the 50-year period between 2020 and 2070 in Randall County and within High Plains District in Armstrong and in Potter Counties, with less than 23 feet of total average drawdown by 2080 at the end of the planning period.

The resolution adopting DFCs for the Ogallala Aquifer is provided in **Appendix A** – DFC Documents. Documentation for this meeting including meeting postings, agenda package, and meeting supplements are provided in **Appendix B** - Meeting Documentation. The areas described by the DFCs above are shown in **Figure 3-3**.

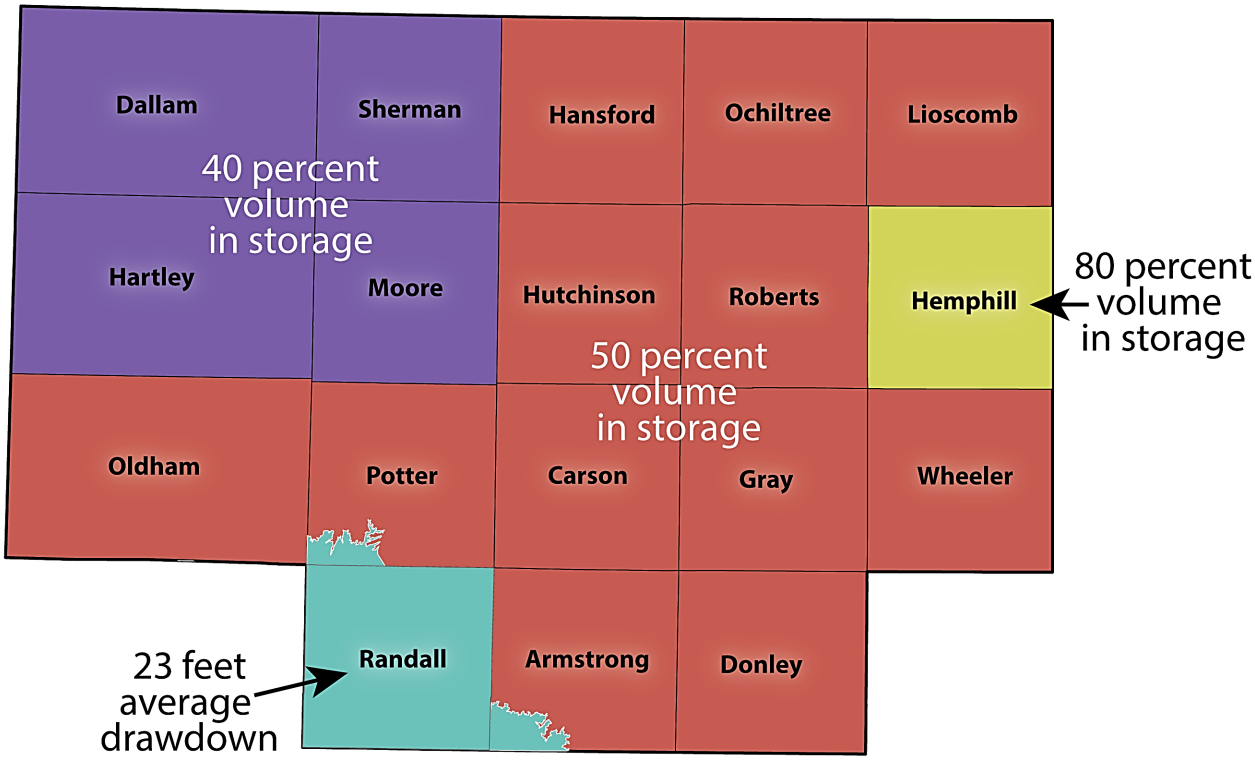


Figure 3-3. GMA 1 Ogallala Aquifer DFCs map.

3.3 Policy and Technical Justification

TWC Section 36.108(d-2) requires that DFCs proposed as part of joint planning in the management area must provide "a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area." GMA 1 District Representatives established different DFCs throughout the management area based on a combination of policy and technical considerations that support continued economic development of the area while providing for the reasonable long-term management of groundwater resources consistent with TWC Section 36.1071(a).

3.3.1 Policy Justification

GMA 1 Districts are local political subdivisions of the state pursuant to Chapter 36, and their specific enabling statutes created under Section 52, Article III, or Section 59, Article XVI, Texas Constitution. GMA 1 Districts provide for the conservation, preservation, protection, recharging, and prevention of waste of groundwater, and of groundwater reservoirs or their subdivisions consistent with the objectives of the Texas Constitution within their jurisdiction. In consideration of DFCs, each of the GMA 1 Districts reviewed their management plans and regulatory structures used in each of their jurisdictional areas based on their collective groundwater management experience. Each GMA 1 District fulfills the requirements of TWC Section 36.108 through cooperation and joint planning efforts with other GCDs in the GMA. Oldham County and portions of Hartley, Hutchinson, Moore, and Randall counties are outside the jurisdiction of a GCD but are served for joint planning purposes by the GMA 1 District Representatives. The GMA 1 Districts last adopted DFCs within GMA 1 for the Ogallala Aquifer in 2021.

The GMA 1 Districts understand the relevance of the different adopted DFCs for the management area and that DFCs are more than numbers. The Ogallala Aquifer is the only groundwater supply in eight out of eighteen counties and is the primary water supply in the remaining ten counties in GMA 1. The aquifer is essentially the only reliable water source for most of GMA 1, as well as a water source for water transported out of the management area. The development of different Ogallala DFCs across the management area strikes a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste.

The DFCs are designed to balance agricultural, municipal, and industrial water needs while also supporting spring flows and ecotourism, all of which are important drivers of the Texas Panhandle economy. GMA 1 Districts are aware of the relation of water to current and future property values as well as the economic and social value of leaving water for future generations when the GMA 1 Districts address current and future needs.

3.3.2 Technical Justification

GMA 1 District Representatives combine the Rita Blanca and Ogallala aquifers because of their functional relationship from a hydrogeological perspective. Any references to the "Ogallala Aquifer" in this report shall also include and apply to any groundwater in the Rita Blanca Aquifer.

GMA 1 District Representatives adopted an Ogallala DFC for Dallam, Hartley, Moore and Sherman counties, collectively, based on at least 40 percent of volume in storage remaining after the 60-year period between 2020 and 2080 because those counties are experiencing:

- High agriculture usage of the aquifer,
- Above average rate of decline,
- Very limited stream flow, and
- High agriculture economic impacts.

Setting a higher percent of volume in storage remaining would require massive reductions in agriculture groundwater pumping, increasing the adverse economic impacts to the area and individual property owners.

GMA 1 Districts adopted an Ogallala Aquifer DFC of at least 50 percent of the volume in storage remaining after the 60-year period between 2020 and 2080 in Carson, Donley, Gray, Hansford, Hutchinson, Lipscomb, Ochiltree, Oldham, Roberts, and Wheeler counties because these areas are experiencing and are projected to continue to experience:

- Moderate agriculture usage of the aquifer,
- Significant municipal groundwater pumping in the area,
- Average rates of decline,
- Minimal stream flow, and
- Moderate agriculture and municipal economic impact.

GMA 1 District Representatives adopted an Ogallala Aquifer DFC in Randall County and within the High Plains UWCD in Armstrong and in Potter counties, collectively, of approximately 20 feet of total average drawdown after the 60-year period between 2020 and 2080 for the same conditions listed above and to provide the same consistent management framework that is used within the High Plains UWCD in GMA 2. Based on current water use and projected future water user group (WUG) demand and needs, the adopted DFCs for these counties collectively should provide adequate water available for current and future growth while encouraging conservation.

GMA 1 District Representatives adopted an Ogallala Aquifer DFC in Hemphill County of at least 80% of volume in storage remaining after the 60-year period between 2020 and 2080 because of its profound differences from the rest of the management area. Some of these conditions include:

- Minimal agriculture usage of the aquifer,
- Minimal rate of decline,
- Relatively extensive stream flow for the planning area, and
- Water related ecotourism economic impact.

Hemphill County groundwater use is generally far less than use in adjacent counties and that of most of the rest of the management area. Hemphill County contains more spring and other natural discharge to streams and rivers than any other county in the GMA because of local hydrogeological conditions. The adopted DFC allows for substantial growth in groundwater demand over the next fifty years while protecting spring discharge, stream flow, and ecotourism. The DFC will provide groundwater availability

at least two times higher than the TWDB-estimated water use in the area while protecting springs and seeps that enhance Canadian River flow.

Except for Randall County and portions of High Plains UWCD in Armstrong and Potter counties, GMA 1 District Representatives adopted "percent of volume in storage remaining after the 60-year period between 2020 and 2080." This is similar to previous Region A planning goals and covers the planning horizon through 2080 to align with the regional water planning process. Today, over 80% of all non-exempt aquifer withdrawals are measured volumetrically in GMA 1. GMA 1 Districts have incorporated DFCs into management plans, rules, and procedures for monitoring and tracking the achievement of adopted DFCs.

GMA 1 District Representatives adopted aquifer drawdown for those portions of the High Plains UWCD and all of Randall County. Aquifer drawdown is the preferred joint planning metric for groundwater management in GMA 2, where over 90% of the High Plains UWCD is located. GMA 1 District Representatives adopted different DFCs to allow for future growth while promoting conservation. In considering the nine factors under TWC Section 36.108(d), GMA 1 District Representatives utilized numerous information sources while considering DFC options and before adopting final DFCs.

To evaluate the DFC options and the adopted DFCs, INTERA Incorporated (INTERA) used the High Plains Aquifer System GAM (HPASGAM), specifically the updated model version developed by Cawthon and others (2025), which supersedes the earlier Deeds and Jigmond (2015) implementation and serves as the official GAM for the region. The HPASGAM is a regional groundwater flow model that incorporates the Ogallala, Rita Blanca, Edwards-Trinity (High Plains), and Dockum aquifers.

The 2025 update extends the original transient simulation period from 1930–2012 through 2020, using the same model formulation as the original except for an updated well package based on more recent pumping data. Aside from reduced recharge values in Howard County, the model configuration prior to 2012 is unchanged, and no additional calibration occurred as part of the update. In 2025, TWDB accepted the updated HPASGAM as the official GAM for the region.

The model was used to understand the anticipated pumping and impacts associated with the DFCs. Links to the model input files associated with the DFCs are included in **Appendix C** – Model Run Documentation so the Executive Administrator of TWDB can use them to confirm predictive run results and estimate modeled available groundwater (MAG).

For development of the DFCs, 2020 served as the reference year across all of GMA 1. This represents a change from the previous planning cycle, in which Randall County and the High Plains UWCD portions of GMA 1 used 2012 as the reference year, while the remainder of GMA 1 used 2018. For the predictive simulation, the last simulated year is 2080. The HPASGAM predictive run input file shows that, to achieve the adopted DFCs in GMA 1, the Ogallala Aquifer (and Rita Blanca Aquifer) pumping will decline from approximately 3,103,900 acre-feet/year in 2020 to 1,440,000 acre-feet/year by 2080. **Table 3-1** is a compilation of modeled pumping levels based on the adopted DFCs.

Documentation for GMA 1 meetings identified in Table 1-1—including meeting postings, agenda package, sign-in sheets, and meeting supplements—are provided in Appendix B - Meeting Documentation.

Table 3-1. Ogallala/Rita Blanca Aquifer modeled pumping levels based on the adopted DFCs in acre-feet/year.

District	County	2030	2040	2050	2060	2070	2080
Hemphill County UWCD	Hemphill	35,670	41,026	44,247	46,204	47,482	48,056
Hemphill County UWCD Total		**35,670**	**41,026**	**44,247**	**46,204**	**47,482**	**48,056**
High Plains UWCD No.1	Armstrong	1,169	1,026	899	783	687	604
	Potter	3,398	3,010	2,736	2,482	2,253	1,992
	Randall	25,997	24,937	23,721	22,012	20,238	18,273
High Plains UWCD No.1 Total		**30,564**	**28,973**	**27,356**	**25,277**	**23,178**	**20,869**
North Plains GCD	Dallam	290,104	241,499	173,686	120,511	75,293	22,977
	Hansford	251,537	241,078	228,247	214,390	203,017	191,370
	Hartley	366,259	264,588	171,698	111,200	66,045	16,693
	Hutchinson	66,675	64,862	62,456	59,023	56,765	53,928
	Lipscomb	224,782	219,862	210,120	197,711	185,283	172,517
	Moore	213,242	185,846	122,277	76,276	42,950	13,747
	Ochiltree	217,336	207,060	194,975	181,361	169,194	156,905
	Sherman	309,027	261,345	188,089	127,506	75,291	25,431
North Plains GCD Total		**1,938,962**	**1,686,140**	**1,351,548**	**1,087,978**	**873,838**	**653,568**
Panhandle GCD	Armstrong	43,953	38,873	34,352	29,921	26,135	23,081
	Carson	155,137	149,828	140,445	130,277	120,841	110,708
	Donley	78,016	77,745	73,888	68,573	62,708	55,354
	Gray	182,439	175,380	163,726	149,486	136,542	124,431
	Hutchinson	10,351	11,700	11,873	11,469	11,018	9,813
	Potter	19,727	17,258	14,838	12,513	10,531	8,636
	Roberts	409,717	398,625	375,316	348,383	323,551	292,714
	Wheeler	109,823	110,829	108,253	102,604	96,730	90,315
Panhandle GCD Total		**1,009,163**	**980,238**	**922,691**	**853,226**	**788,056**	**715,052**
No District-County Total	Hartley	18,842	19,506	13,961	9,036	4,769	893
	Hutchinson	33,582	29,206	24,832	21,478	18,940	17,446
	Moore	9,084	8,664	6,362	4,176	2,327	684
	Oldham	33,135	31,331	28,322	24,756	21,590	18,297
	Randall	30,606	26,505	22,455	18,795	15,943	13,225
No District-County Total		**125,249**	**115,212**	**95,932**	**78,241**	**63,569**	**50,545**

3.4 Ogallala Aquifer Factor Consideration

Presentations associated with the consideration of required factors under TWC Section 36.108(d) are included in **Appendix D** – Factor Analysis. Each of these factors is described individually for the Ogallala Aquifer in the following subsections.

3.4.1 Aquifer Uses or Conditions

TWC Section 36.108(d)(1) requires District Representatives to consider aquifer uses and conditions within the management area, including conditions that differ substantially from one geographic area to another.

District Representatives adopted different DFCs within GMA 1 based on varying aquifer uses and conditions, including: physical landscape and land use, concentrated pumping centers, estimated groundwater use and predicted demands by county and by WUG; differing aquifer elevations, water level declines, saturated thicknesses, and depth to base of the aquifer differ substantially from one geographic area to another. GMA 1 District Representatives considered aquifer uses and conditions for the aquifers within the management area during meetings identified in Table 1-1.

GMA 1 District Representatives considered aquifer uses by WUGs collectively, including: municipal, irrigated agriculture, livestock, manufacturing, steam electric, and mining. As part of the consideration, the representatives reviewed TWDB Historical Water Use Survey (WUS) data collected for the 2022 SWP and GMA 1 Districts' information. **Figure 3-4** (top) shows the projected distribution of water demand by use-type between 2030 and 2080. Figure 3-4 (bottom) shows the projected demands developed by TWDB for the 2022 SWP compared to the WUS data.

Water demand projections presented in the 2022 SWP indicate that the total water demand in the PWPA will decrease from 2.1 million acre-feet in 2020 to approximately 1.6 million acre-feet by 2070. This decline is primarily attributed to anticipated long-term groundwater drawdowns associated with irrigated agriculture, which are expected to reduce irrigation well yields over time, particularly in Dallam, Hartley, Moore, and Sherman counties. According to the WUS, irrigation use represents between 91 and 93% of the total aquifer pumping in GMA 1 during the 12-year period from 2011 to 2022. Because irrigation accounts for most of the water used in GMA 1, it is important to consider the uncertainty associated with irrigation demand projections. The methodology used to develop irrigation projections is based on current and expected trends in the agricultural sector, which are contingent upon many factors including market forces, government subsidies, fuel prices, and resource availability. **Figure 3-5** shows historical irrigation estimates and projected water demands based on estimates made for the 2022 SWPs for GMA 1.

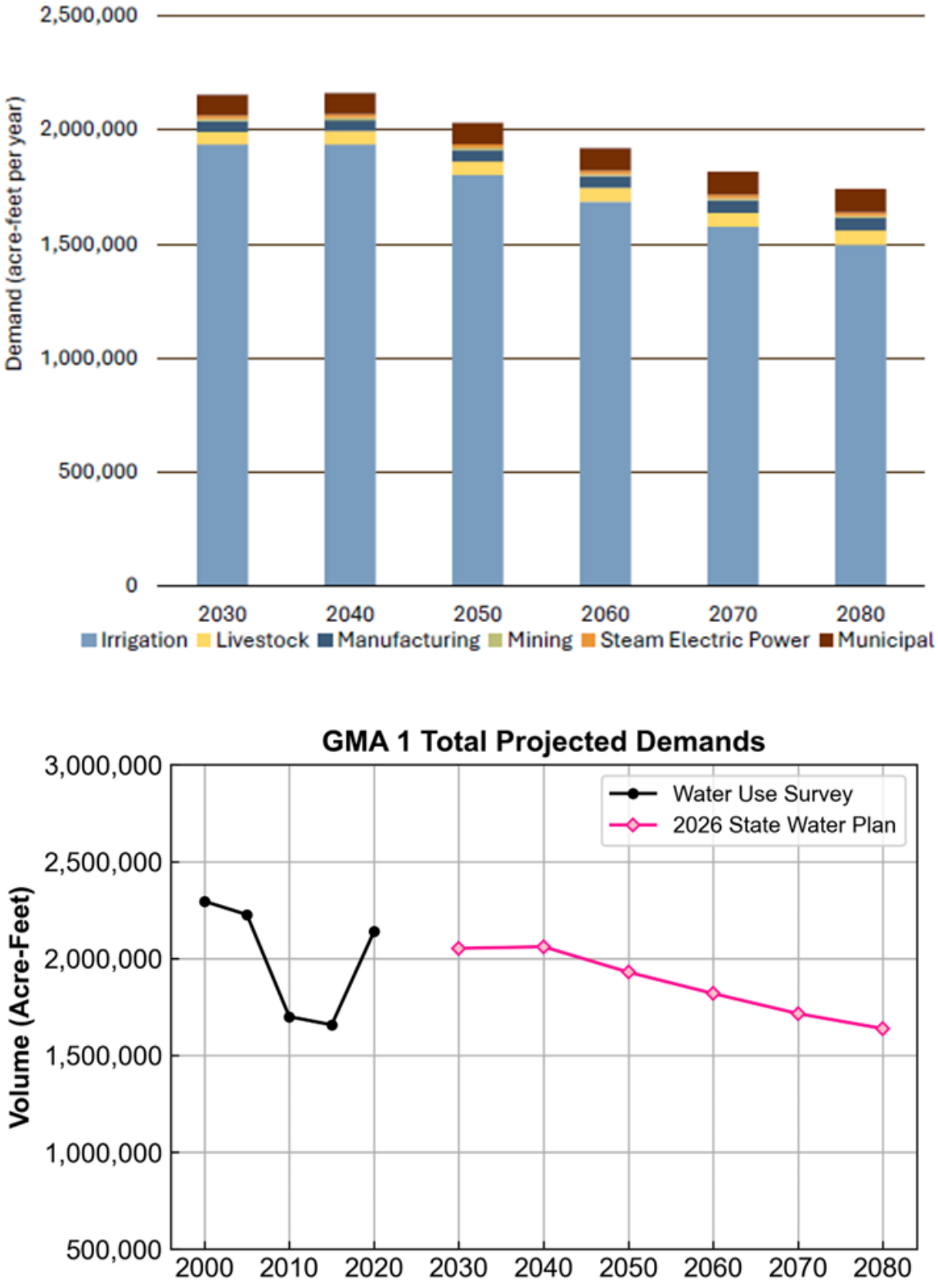


Figure 3-4. Projected total water use for GMA 1 by use type from 2030 to 2080.

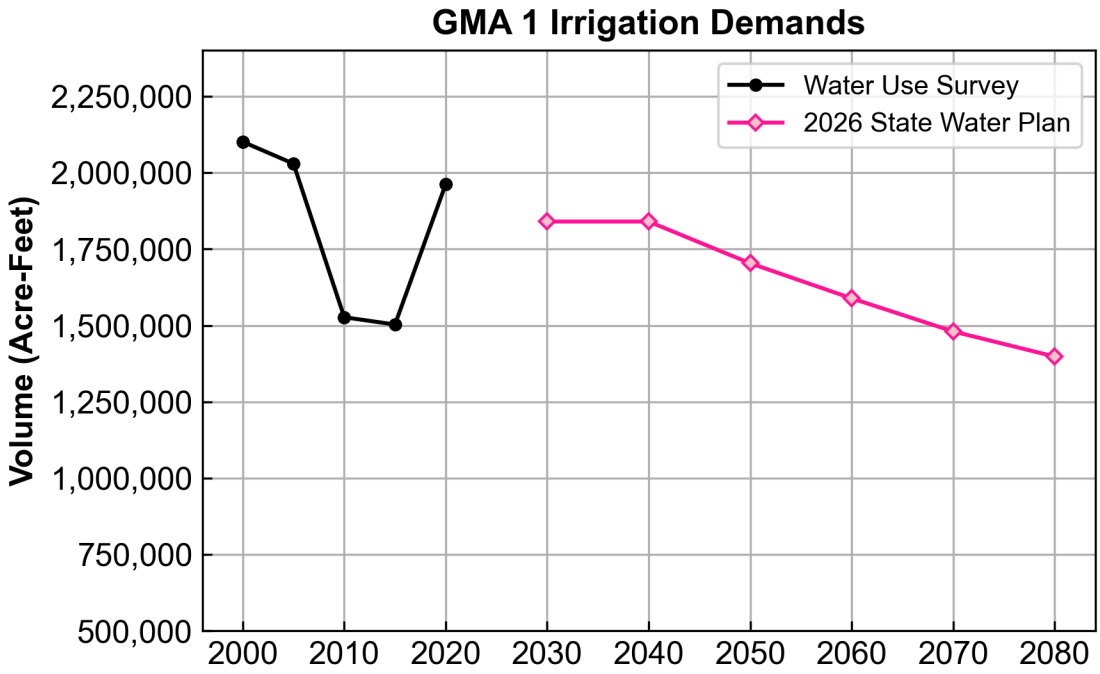


Figure 3-5. Historical water use for irrigation and projected irrigation demand for GMA 1 from 2030 to 2080.

Municipal groundwater use represents the second largest water demand category (between 4 and 8% annually) during the twelve-year period from 2005 to 2017. Projections from the 2026 PRWP suggest that municipal demand will increase from 89,541 acre-feet per year in 2030 to 101,883 acre-feet per year in 2080. The population of GMA 1 is projected to increase from approximately 396,144 in 2030 to 460,134 in 2080 (PRWPG, 2025). Based on the WUS, the total municipal water use in GMA 1 was 88,489 acre-feet in 2020, which is approximately four percent of total water demand in the management area (**Table 3-2**). The City of Amarillo in Randall county accounts for most of the municipal water use in GMA 1. Though Roberts County has relatively little municipal use within the county, groundwater pumping from well fields to replace diminishing surface water supplies is a significant source of the water pumped for municipal purposes in Potter and Randall counties through the City of Amarillo as well as for the member cities of Canadian River Municipal Water Authority (CRMWA) both inside and outside of GMA 1. Historical municipal water use and projected municipal water demand from the 2022 SWP is shown in **Figure 3-6**.

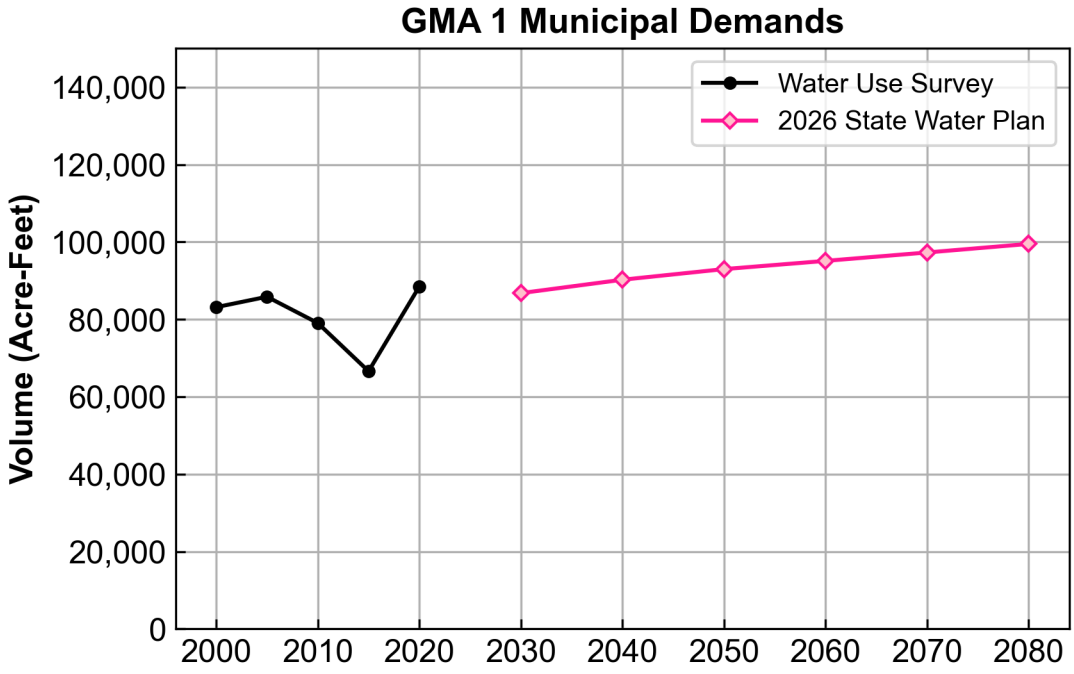


Figure 3-6. Historical municipal water use and projected municipal demand for GMA 1 from 2030 to 2080.

Industrial water use includes mining, manufacturing, and power generation activities, which all represent relatively small proportions of the water demand in GMA 1. Historical water use associated with mining activities and projected future activity are shown in **Figure 3-7**. Mining activities in GMA 1 consist primarily of oil and gas extraction and removal of industrial minerals such as sand, gravel, and gypsum. Recent development of natural gas within the eastern portion of GMA 1 has increased mining water use in Hemphill, Lipscomb, Ochiltree, Roberts, and Wheeler counties (PRWPG, 2025). Mining groundwater demand accounted for less than 0.5% of the total water demand in GMA 1.

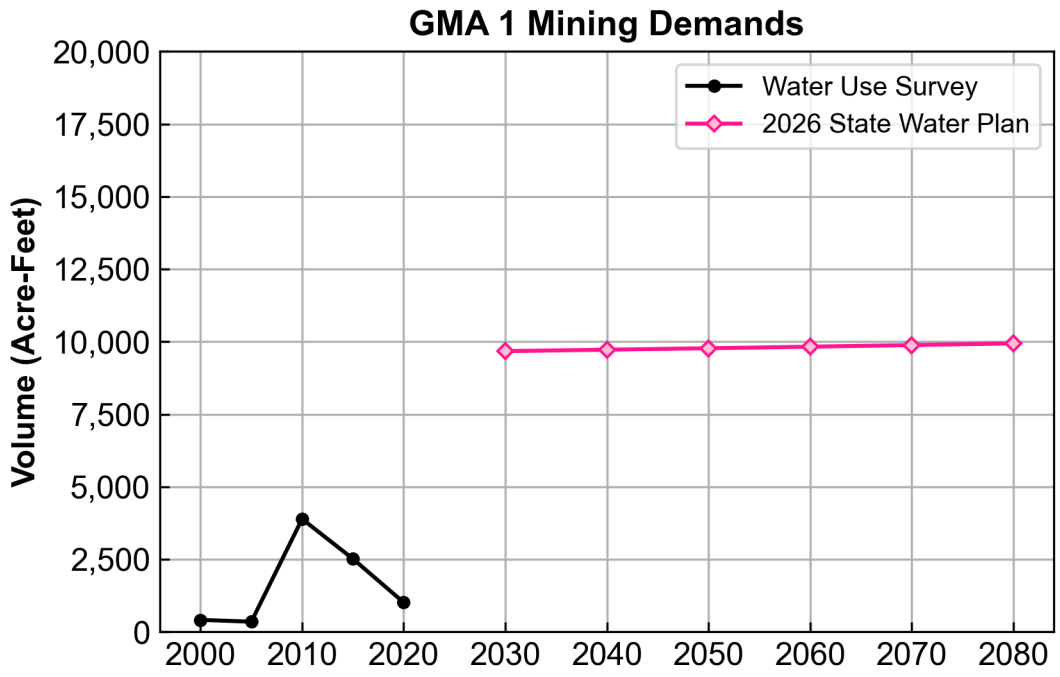


Figure 3-7. Historical mining water use and projected mining demand for GMA 1 from 2030 to 2080.

Figure 3-8 shows the projected water demand of manufacturing users in GMA 1. Data from the 2022 SWP suggests that manufacturing demand is expected to increase from approximately 46,000 acre-feet per year in 2030 to 55,000 acre-feet per year in 2080. Power generation demand (not pictured) is expected to stay constant at approximately 15,000 acre-feet per year from 2030 to 2080.

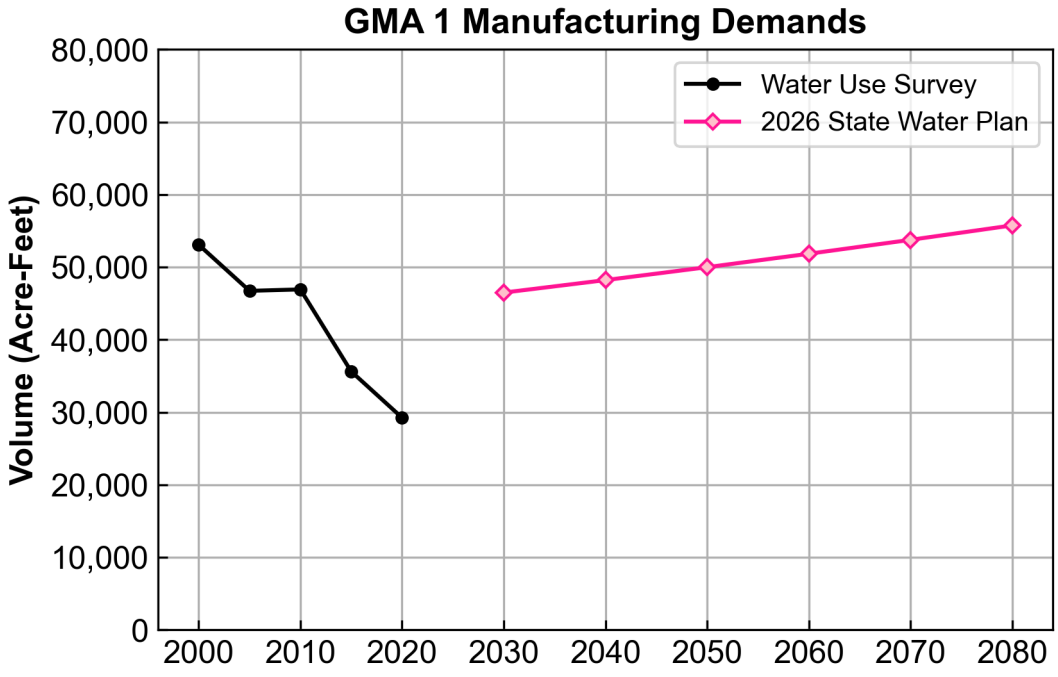


Figure 3-8. Historical manufacturing water use and projected manufacturing demand for GMA 1 from 2030 to 2080.

Figure 3-9 shows historical livestock water use and projected future demand. In 2022, livestock use accounted for about 2.5% of the total water used in GMA 1. Livestock water use is expected to increase approximately 5,000 acre-feet from 2030 to 2080.

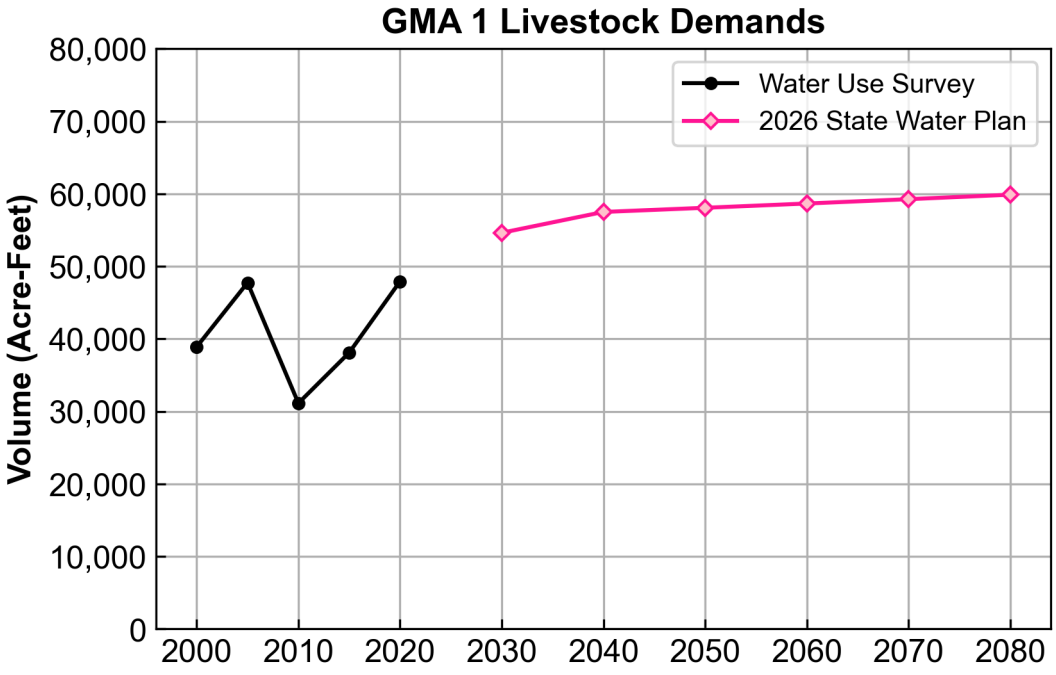


Figure 3-9. Historical livestock water use and projected livestock demand for GMA 1 from 2030 to 2080.

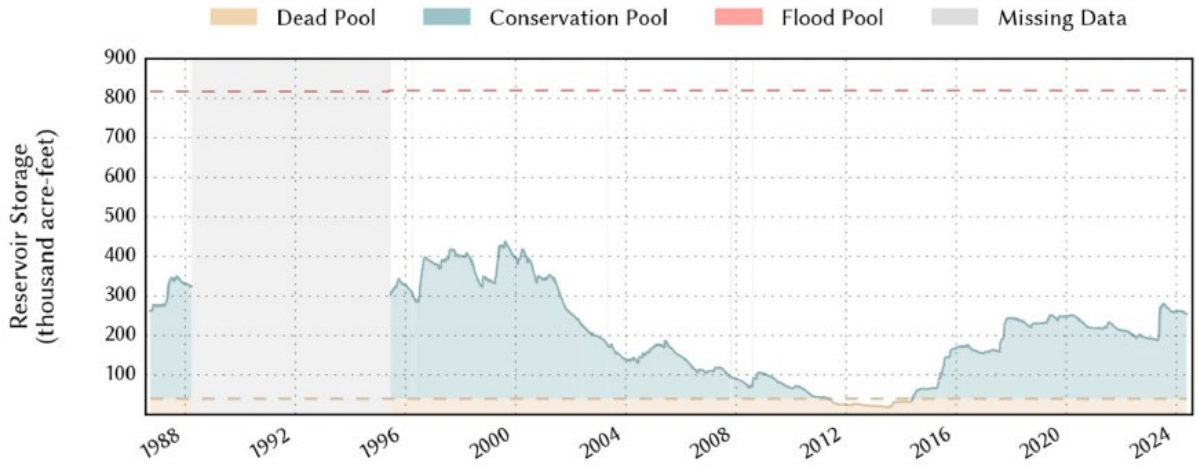
Table 3-2. Projected water demands for GMA 1 in acre-feet/year (2022 State Water Plan).

County	2010	2020	2030	2040	2050	2060	2070
Armstrong	7,051	7,079	7,079	7,084	7,089	7,094	7,099
Carson	112,800	100,953	100,970	100,991	101,006	101,026	101,048
Dallam	350,849	349,186	349,596	311,927	279,642	255,665	237,693
Donley	36,787	34,028	34,006	33,983	33,975	33,967	33,958
Gray	47,218	42,991	42,991	42,898	42,786	42,677	42,572
Hansford	202,625	182,211	182,350	182,475	182,618	182,761	182,910
Hartley	413,029	412,425	413,312	367,432	334,325	306,358	283,477
Hemphill	10,098	9,245	9,255	9,244	9,244	9,245	9,245
Hutchinson	97,469	86,600	87,041	87,481	87,947	88,463	89,033
Lipscomb	57,345	46,720	46,722	46,712	46,713	46,715	46,718
Moore	217,008	220,858	222,530	208,873	190,389	169,304	151,822
Ochiltree	111,186	93,086	93,262	93,384	93,501	93,620	93,738
Oldham	7,195	7,266	7,236	7,195	7,151	7,106	7,063
Potter	51,945	56,849	57,116	57,000	56,504	56,026	55,566
Randall	54,234	54,764	58,783	62,676	66,440	70,224	74,018
Roberts	10,760	10,845	10,846	10,851	10,858	10,867	10,876
Sherman	328,508	314,269	314,373	275,903	245,701	211,293	188,194
Wheeler	23,463	23,346	23,356	23,342	23,333	23,324	23,316
Total	**2,139,570**	**2,052,721**	**2,060,824**	**1,929,451**	**1,819,222**	**1,715,735**	**1,638,346**

In 2011, groundwater use peaked because of a regional and statewide drought, further development of agriculture water use, and an ongoing regional trend of switching from surface water sources to groundwater from the Ogallala Aquifer. The CRMWA's development of groundwater resources to offset declining surface water availability is an example of this trend. CRMWA historically has provided water from Lake Meredith on the Canadian River to its member cities in the Texas Panhandle in GMA 1 and the Texas High Plains in GMA 2 as far south as Lamesa, Texas. Beginning in late 2001, CRMWA began supplementing water from Lake Meredith by blending groundwater from well fields in Roberts County to meet its water supply obligations to its member cities. Those member cities also supplement CRMWA supplies locally with groundwater from their own wells. Volumetric totals of water provided to municipalities by CRMWA in 2021 is presented in **Table 3-3**, and historical reservoir storage in Lake Meredith is presented in **Figure 3-10**.

Table 3-3. Canadian River Water Municipal Authority surface water and groundwater use in 2021 in acre-feet (PRWPG, 2025).

City	Municipal Water Supplied by CRMWA (ac-ft/yr)		
	Surface Water CRMWA	Groundwater CRMWA	Total
Amarillo	7,467	21,481	**28,948**
Borger	763	2,850	**3,613**
Pampa	466	2,113	**2,579**
Total	**8,696**	**26,444**	**35,140**



Source: TWDB, www.waterdatafortexas.org

Figure 3-10. Historical Content for Lake Meredith (PRWPG, 2025).

3.4.2 Water Supply Needs and Water Management Strategies Included in the State Water Plan.

TWC Section 36.108(d)(2) requires that District Representatives consider the water supply needs and water management strategies included in the state water plan. GMA 1 Districts considered water demand data, water supply needs, and management strategies developed for the 2022 SWP. GMA 1 District Representatives considered water supply needs and water management strategies within GMA 1 during meetings identified in Table 1-1.

3.4.2.1 Water Supply Needs

To estimate water supply needs in the 2022 SWP, the TWDB aggregated data provided by the planning groups detailing total available water supply, existing supplies, and water demands. The 2022 State Water Plan allocates water to WUGs considering geographical availability, infrastructure constraints, legal limits, and contractual limits, as appropriate. “Available water” refers to the maximum volume of raw water that can be withdrawn annually from each source (such as a reservoir or aquifer) during a repeat of the drought of record. “Existing supply” refers to the rate of water use that is already available to existing WUGs.

A water supply “need” occurs when currently developed supplies are insufficient to meet projected demands. GMA 1 estimated developed supplies will be around 1.69 million acre-feet per year in 2030, and total demands will be approximately 2.05 million acre-feet per year in 2030. Thus, the water supply need in 2030 is approximately 370,000 acre-feet in GMA 1 (TWDB, 2022). Water needs are projected to remain relatively constant into the future, as the 2022 SWP identifies just over 360,000 acre-feet of expected water needs in GMA 1 in 2070. The vast majority of volumetric needs are attributed to irrigation demand, while increases in municipal demand are marginal.

The water supply needs in the 2026 PRWP are higher than those presented in the 2022 SWP. According to the 2026 PRWP, the total needs for all WUGs in GMA 1 (excluding the surpluses) are projected to be 408,595 acre-feet per year in 2030, increasing to 488,855 acre-feet per year in 2070. GMA 1 water needs by county according to the 2022 SWP are detailed in **Table 3-4,** and GMA 1 water needs by county according to the 2026 PRWP are detailed in **Table 3-5**. Note that “0” in any table cell indicates a supply surplus. A comparison of when the individual WUG needs begin by county is presented in **Table 3-6**. Note that some counties may have current water supply needs, even if Table 3-6 lists the water supply needs beginning in 2030.

Table 3-4. GMA 1 Water needs by county in acre-feet per year in the 2022 State Water Plan (TWDB, 2022).

County	2030	2040	2050	2060	2070
Armstrong	0	0	0	0	0
Carson	461	586	581	580	580
Dallam	117,238	109,256	93,385	76,444	76,664
Donley	0	0	0	32	66
Gray	160	836	1,384	4,569	5,043
Hansford	20	98	409	751	797
Hartley	193,146	178,101	16,0175	142,147	142,163
Hemphill	0	0	0	0	0
Hutchinson	164	291	394	615	622
Lipscomb	0	97	241	344	372
Moore	51,384	54,658	52,778	50,285	51,003
Ochiltree	0	1	197	563	824
Oldham	0	0	0	0	0
Potter	3,749	9,043	15,202	20,616	24,263
Randall	2,755	7,105	12,204	17,395	20,766
Roberts	0	0	0	0	0
Sherman	0	29,567	38,831	38,207	38,423
Wheeler	0	0	47	132	153
Total	**369,077**	**389,639**	**375,828**	**352,680**	**361,739**

Table 3-5. GMA 1 Water needs by county in acre-feet per year in the 2026 PRWP (PRWPG, 2025).

County	2030	2040	2050	2060	2070
Armstrong			515	1,123	
Carson					
Dallam	156,912	148,470	140,598	133,194	121,228
Donley					
Gray		398	666	793	
Hansford				10	
Hartley	231,320	218,066	206,316	195,498	173,541
Hemphill					
Hutchinson	276	351	449	682	176
Lipscomb	24	63	108	145	
Moore	84,914	82,377	79,062	75,251	75,296
Ochiltree					
Oldham					
Potter	5,955	8,465	11,047	12,204	2,448
Randall	7,797	13,452	19,381	24,227	1,929
Roberts					
Sherman	58,547	53,345	49,322	45,404	33,977
Wheeler	116	185	246	324	5
Total	**545,745**	**524,987**	**507,464**	**488,855**	**408,595**

Table 3-6. Summary of when the individual WUG needs located in each county begin (TWDB, 2022; PRWPG 2025).

County	2022 SWP	2026 PRWP
Armstrong	-	2060
Carson	2030	-
Dallam	2030	2030
Donley	2060	-
Gray	2030	2050
Hansford	2030	2070
Hartley	2030	2030
Hemphill	-	-
Hutchinson	2030	2030
Lipscomb	2040	2040
Moore	2030	2030
Ochiltree	2040	-
Oldham	-	-
Potter	2030	2030
Randall	2030	2030
Roberts	-	-
Sherman	2040	2030
Wheeler	2050	2030

3.4.2.2 Water Management Strategies Included in the State Water Plan.

The 2022 SWP provides key findings and recommendations regarding addressing water supply needs with water management strategies. These findings are as follows:

- Region A recommended water management strategies include, in order of increasing volume, aquifer storage and recovery, increased development of groundwater resources, and demand management.
- Conservation is also a recommended management strategy for Region A, which would include mostly agricultural conservation. Conservation is projected to be a much more cost efficient management strategy in Region A, with a weight-averaged cost of $66 dollars per acre-foot of strategy supply. For comparison, increased development of groundwater would cost approximately $355 dollars per acre-foot.

Region A has 21 WUGs that will rely on the Agricultural conservation strategy, 32 WUGs that will rely on increased usage of groundwater, and 40 WUGs that will rely on the municipal conservation strategy.

3.4.3 Hydrological Conditions

GMA 1 District Representatives considered hydrological conditions, including—for each aquifer in the management area—the total estimated recoverable storage (TERS) as provided by the TWDB Executive Administrator and the average annual recharge, inflows, and discharge during meetings identified in Table 1-1.

3.4.3.1 Total Estimated Recoverable Storage (provided by TWDB)

TWDB defines TERS as the estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25 and 75% of the porosity-adjusted aquifer volume. In other words, TWDB assumes that between 25 and 75% of groundwater held within an aquifer can be removed by pumping. TERS accounting omits a variety of important conditions and aquifer characteristics that limit groundwater production such as well withdrawal rate, well density, hydraulic conductivity, withdrawal costs, aquifer petrology, permeability, and potential water quality degradation. In practice, the TERS calculation represents the approximate percentage of the total storage volume in the water-producing zones of an aquifer; however, only some of the water in those zones is "practicably recoverable." The basis of the TERS calculation requires no specific amount that could be recovered during any planning period. Recovery of all water from TERS would take longer than the joint planning time horizon and at a cost impractical for regional uses. Therefore, TERS accounts for water that cannot be practicably produced for beneficial use at any level in the GMA 1. Unlike TERS, which simply measures volume, the highest practicable level of groundwater production is defined as a rate by measuring a volume produced through time. **Tables 3-7** through **3-10** identify Ogallala Aquifer and Rita Blanca TERS by county and district in GMA 1 from TWDB GAM Task Report 15-006 (Kohlrenken, 2015). Differences in county TERS magnitudes are illustrated by county in **Figure 3-11**.

GMA 1 District Representatives evaluated TERS provided by the TWDB and found that, though TERS provides a total amount of groundwater that can possibly be produced given the discussion above, only a portion of groundwater in storage can be feasibly withdrawn to address the current uses and future anticipated groundwater demands. The TERS values used in this evaluation are those developed for the 2016 planning cycle and have undergone no updates since that time, including following the 2025 update to the underlying groundwater availability model. GMA 1 District Representatives selected DFCs that allow for substantial storage to remain for future demands after the planning period while ensuring that water is available to meet most WUG water demands outlined in the 2022 SWP.

Table 3-7. Ogallala Aquifer TERS by county for GMA 1 (Kohlrenken, 2015)

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Armstrong	4,600,000	1,150,000	3,450,000
Carson	15,000,000	3,750,000	11,250,000
Dallam	15,000,000	3,750,000	11,250,000
Donley	4,400,000	1,100,000	3,300,000
Gray	14,000,000	3,500,000	10,500,000
Hansford	24,000,000	6,000,000	18,000,000
Hartley	17,000,000	4,250,000	12,750,000
Hemphill	15,000,000	3,750,000	11,250,000
Hutchinson	11,000,000	2,750,000	8,250,000
Lipscomb	18,000,000	4,500,000	13,500,000
Moore	10,000,000	2,500,000	7,500,000
Ochiltree	21,000,000	5,250,000	15,750,000
Oldham	2,000,000	500,000	1,500,000
Potter	1,900,000	475,000	1,425,000
Randall	4,800,000	1,200,000	3,600,000
Roberts	30,000,000	7,500,000	22,500,000
Sherman	18,000,000	4,500,000	13,500,000
Wheeler	7,000,000	1,750,000	5,250,000
Total	**232,700,000**	**58,175,000**	**174,525,000**

Table 3-8. Ogallala Aquifer TERS by GCD in GMA 1 (Kohlrenken, 2015).

Groundwater Conservation District	*Total Storage (acre-feet)*	*25% of Total Storage (acre-feet)*	*75% of Total Storage (acre-feet)*
Hemphill County UWCD[5]	15,000,000	3,750,000	11,250,000
High Plains UWCD No.1	3,100,000	775,000	2,325,000
North Plains GCD	130,000,000	32,500,000	97,500,000
Panhandle GCD	77,000,000	19,250,000	57,750,000
No District	9,600,000	2,400,000	7,200,000
Total	**234,700,000**	**58,675,000**	**176,025,000**

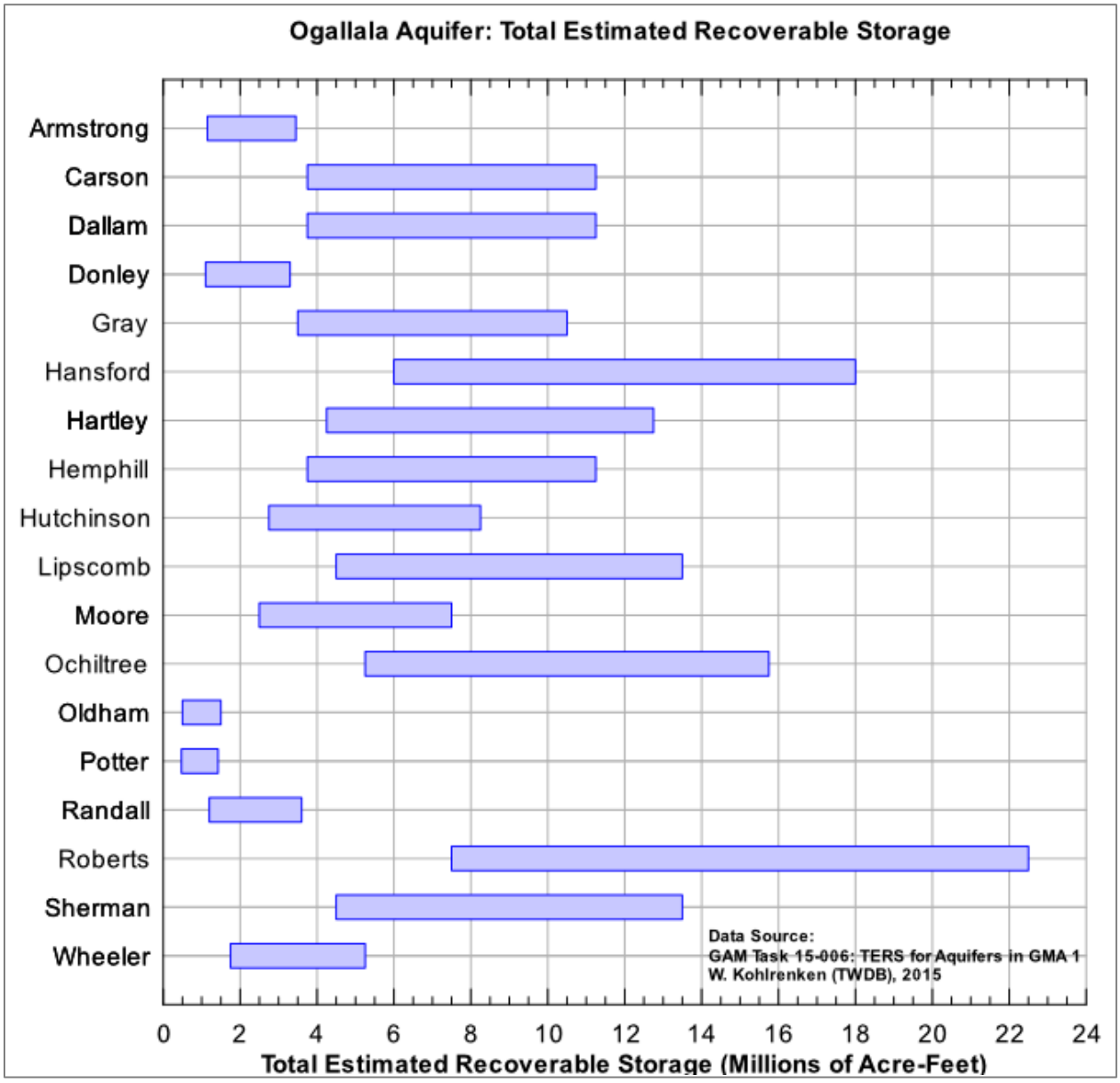


Figure 3-11. Ogallala Aquifer TERS by county for GMA 1 (Kohlrenken, 2015).

Table 3-9. Rita Blanca Aquifer TERS by county for GMA 1 (Kohlrenken, 2015).

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Dallam	9,800,000	2,450,000	7,350,000
Hartley	1,300,000	325,000	975,000
Total	**11,100,000**	**2,775,000**	**8,325,000**

Table 3-10. Rita Blanca Aquifer TERS by GCD in GMA 1 (Kohlrenken, 2015).

Groundwater Conservation District	Total Storage (acre-feet)	25% of Total Storage (acre-feet)	75% of Total Storage (acre-feet)
North Plains GCD	11,000,000	2,750,000	8,250,000
No District	5,500	1,375	4,125
Total	**11,005,500**	**2,751,375**	**8,254,125**

3.4.3.2 Average Annual Recharge, Inflows, and Discharge

In groundwater models, a water budget reflects the relationship between input and output of water through a given area modeled. Water budgets for the Ogallala and Rita Blanca aquifers were developed using the HPASGAM. The HPASGAM calculates a water budget for recharge; evapotranspiration (ET); discharge to springs, draws, and escarpments; flows associated with rivers and reservoirs; aquifer storage; lateral flow; and cross-formational flow. Water budget information using the HPASGAM for the steady state (predevelopment) period is shown in **Table 3-11** and **Table 3-12** for the Ogallala and Rita Blanca aquifers, respectively. The steady-state stress period used to represent predevelopment conditions was excluded from modifications during the 2025 HPASGAM update.

Before pumping began in GMA 1, water inflows generally balanced outflows for the Ogallala and Rita Blanca aquifers without significant aquifer storage (i.e., water level) change. The HPASGAM estimates recharge for the Ogallala was 324,889 acre-feet per year before pumping began. Before development, the Ogallala Aquifer discharged water as ET, springs, rivers, draws, escarpments, lateral and cross-formational flow.

The Rita Blanca Aquifer within GMA 1 receives no direct recharge from precipitation or inflow from rivers because it is neither exposed at the surface nor intersects rivers in the area to receive water. The lack of exposure at the surface also prevents the aquifer from discharging water through ET, springs, rivers, draws, and escarpments. The aquifer received lateral flow from outside of GMA 1 and discharged the water to other aquifers, including the Ogallala and Dockum aquifers.

Additional information on average historical recharge, inflows, discharge and lateral flows are provided to each of the GMA 1 Districts by TWDB for development of the Districts' management plans.

Table 3-11. HPASGAM Water budget for the Ogallala Aquifer by county for the steady-state model (HPASGAM Report).

County	Recharge	ET	Springs	Rivers	Draws	Escarpments	Lateral	Cross-Formational
Armstrong	9,499	-28	-227	-4,313	0	-2,822	127	-2,235
Carson	12,471	-583	0	4,018	0	-206	-15,986	287
Dallam	24,489	-2,416	0	11,778	-389	0	-33,912	451
Donley	17,217	-2,417	-1,567	-15,735	-129	-7,035	9,666	0
Gray	26,145	-1,094	0	-4,840	0	-6,305	-13,907	0
Hansford	11,525	-4,540	0	-13,446	-133	0	6,594	0
Hartley	29,125	-7,346	-69	-14,320	0	-1,825	-4,325	-1,240
Hemphill	33,925	-24,895	-196	-21,966	-112	-3,600	16,844	0
Hutchinson	6,962	-5,977	-426	-18,842	-3,728	-12,165	34,176	0
Lipscomb	29,600	-8,292	0	-3,849	0	0	-17,459	0
Moore	17,353	-1,054	0	-3,600	-1,056	-3,809	-7,535	-298
Ochiltree	12,379	-487	0	1,938	0	0	-13,830	0
Oldham	18,225	-867	-262	-9,361	-1,183	-8,967	6,244	-3,830
Potter	7,110	-577	-199	-184	-263	-2,874	-1,311	-1,703
Randall	10,140	-1,784	-346	-10,779	-1,070	-1,524	8,607	-3,243
Roberts	13,084	-29,422	-4	-18,220	-3,014	-2,785	40,361	0
Sherman	17,547	-406	0	5,975	0	0	-23,170	54
Wheeler	28,093	-4,020	-1,194	-9,592	-2,223	-12,521	1,458	0
Total	**324,889**	**-96,205**	**-4,490**	**-125,338**	**-13,300**	**-66,438**	**-7,358**	**-11,757**

Table 3-12. HPASGAM Water budget for the Rita Blanca Aquifer by county for the steady-state model (HPASGAM Report).

County	Recharge	ET	Springs	Rivers	Draws	Escarpments	Lateral	Cross-Formational
Dallam	0	0	0	0	0	0	500	-500
Hartley	0	0	0	0	0	0	65	-65

Additional information on average historical recharge, inflows, discharge, and lateral flows are provided to each of the GMA 1 Districts by TWDB for development of the Districts' management plans.

3.4.4 Environmental Impacts

GMA 1 District Representatives considered environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water. Because groundwater and surface water are hydrologically linked, reductions in groundwater levels can lead to either reduced outflow to surface water or increased inflow from surface water (or both). Based on the HPASGAM, annual recharge to the

Ogallala Aquifer remained between 325,000 and 327,000 acre-feet per year from 1930 through 2020; a value of 327,000 acre-feet per year was applied for the 2020 to 2080 planning period. Annual discharge from the Ogallala Aquifer to springs, rivers, and draws declined from approximately 205,000 to 34,000 acre-feet per year over the 2020 to 2080 period in the Ogallala. These reductions in discharge adversely affect streamflow within the management area. During the 2016 planning cycle, Hemphill UWCD illustrated the relationship between aquifer pumping and surface-water impacts, as shown in **Figures 3-12** through **3-15**.

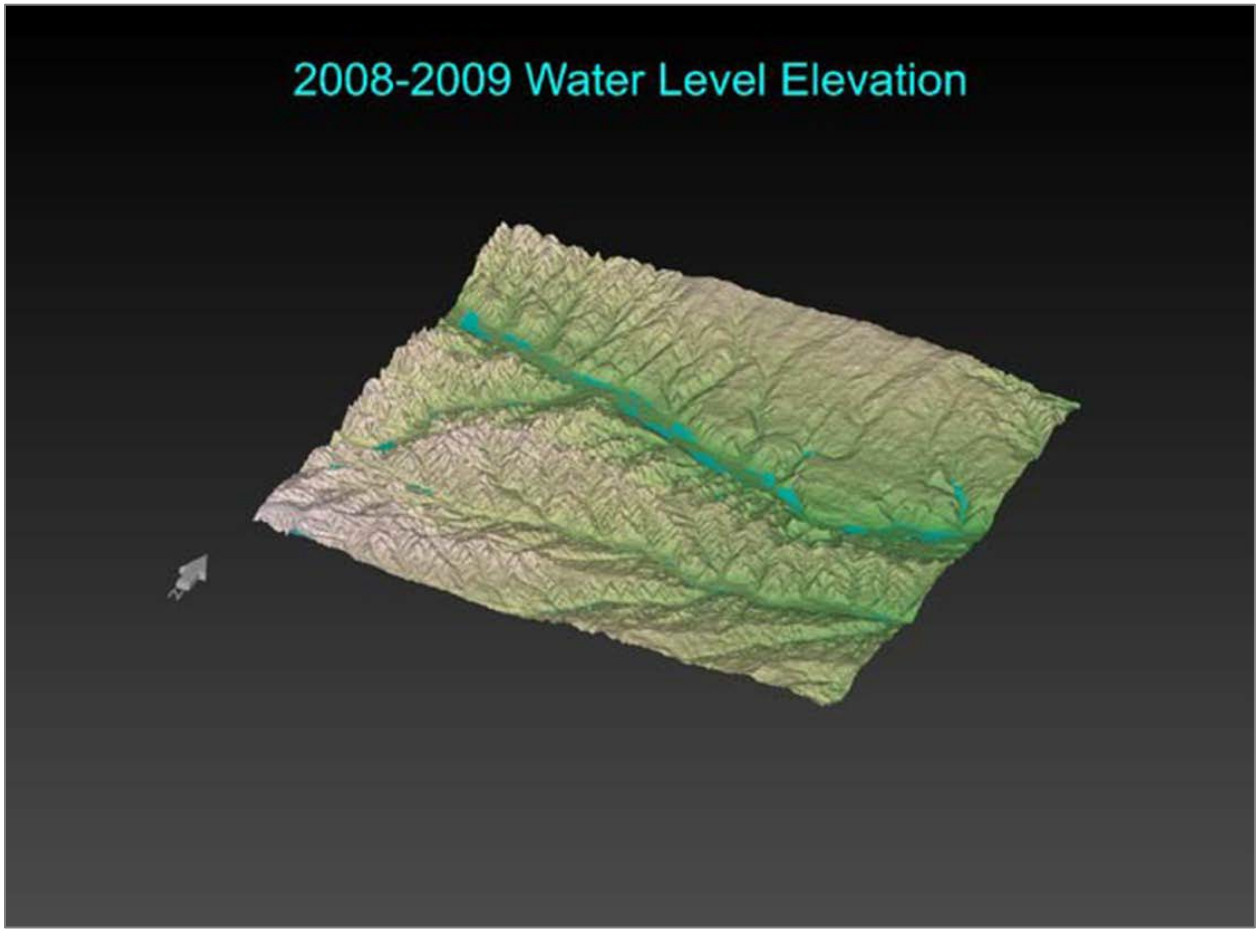


Figure 3-12. 2008-2009 groundwater level elevation impact on surface water in Hemphill County (from Hemphill UWCD 3D Visualization Model). Areas in blue are river/stream segments where groundwater flows from the aquifer to the river/stream.

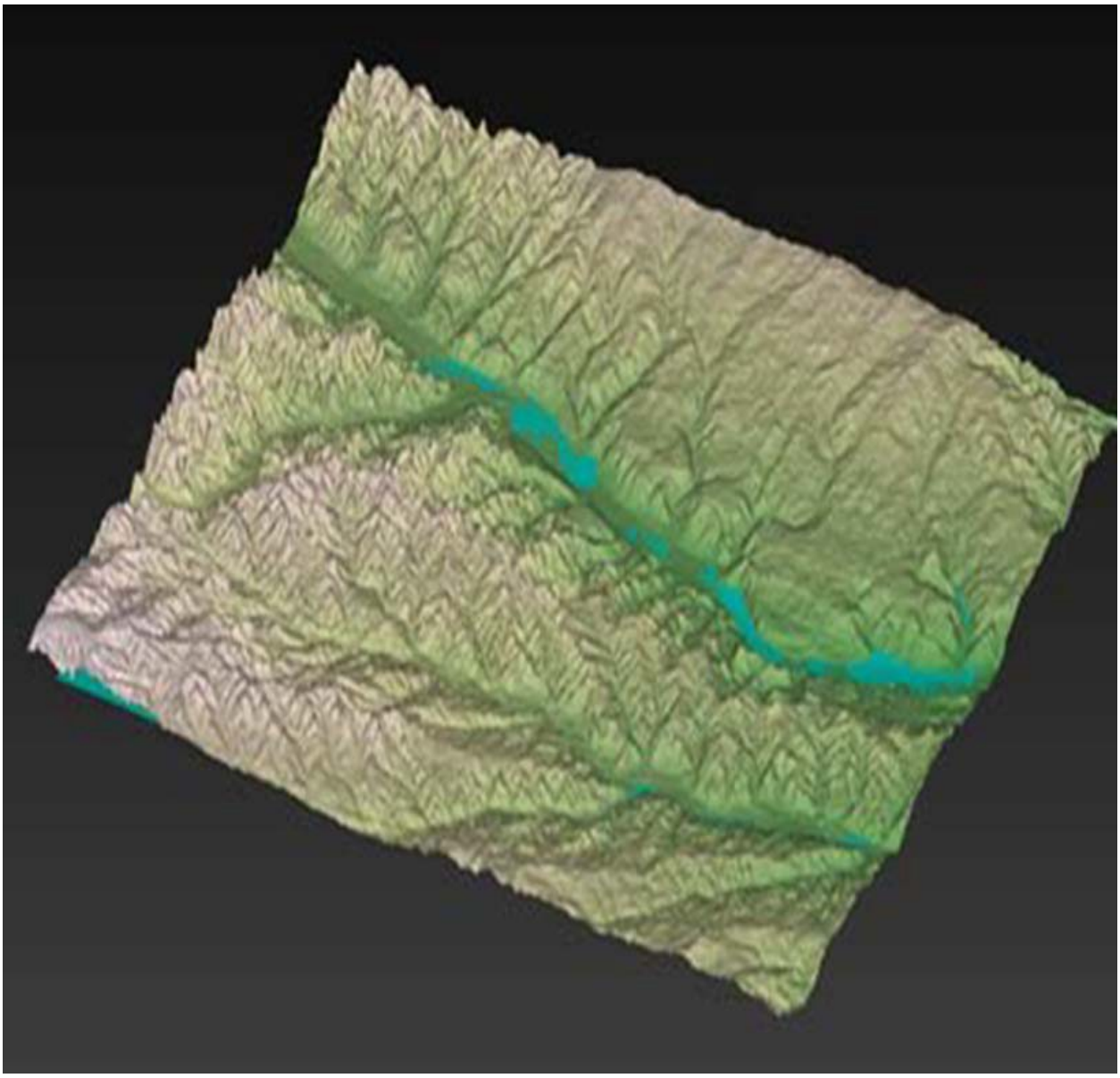


Figure 3-13. Impact to natural discharge with 80 percent remaining in storage (from Hemphill UWCD 3D Visualization Model).

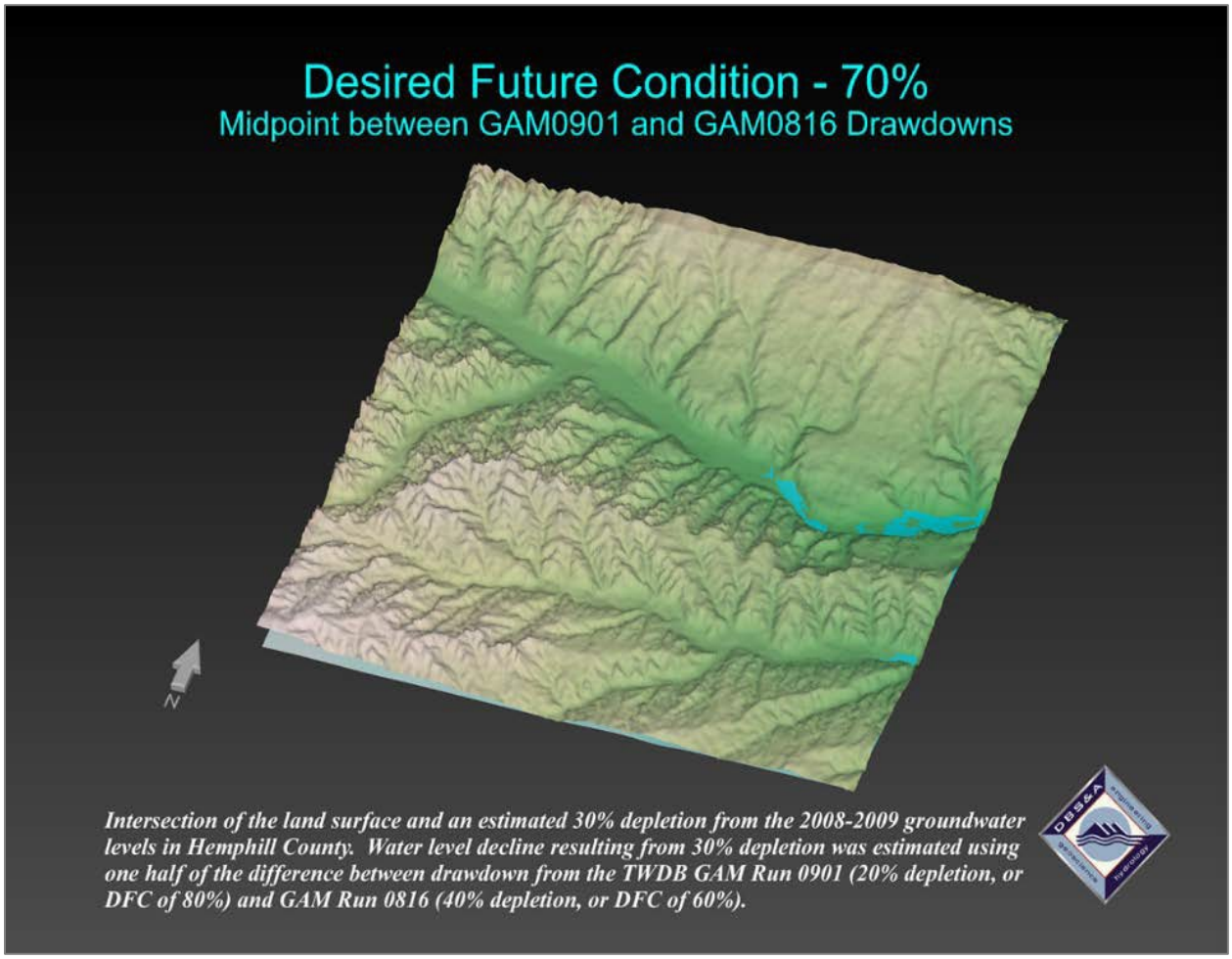


Figure 3-14. Impact to natural discharge with 70 percent remaining in storage (from Hemphill UWCD 3D Visualization Model).

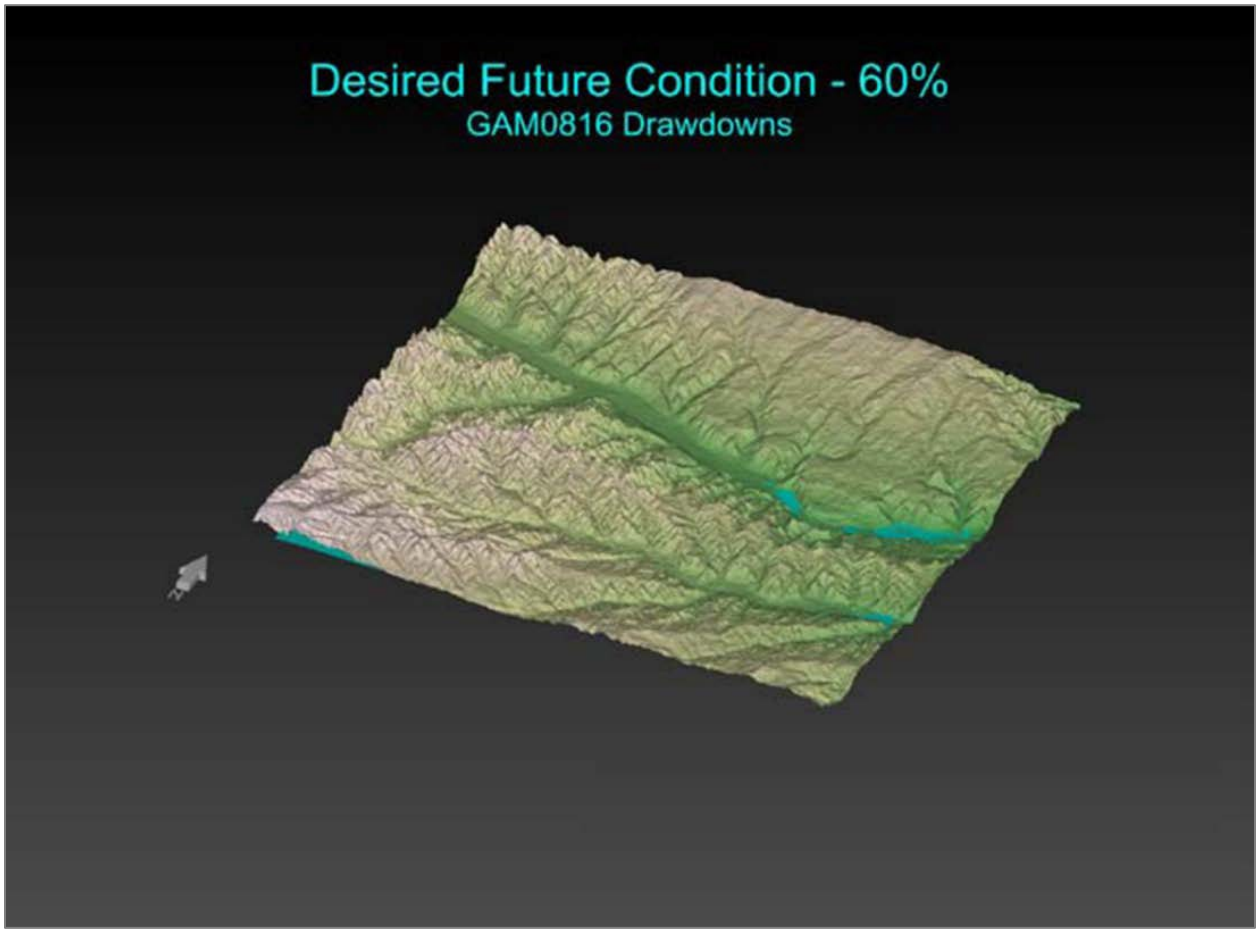


Figure 3-15. Impact to natural discharge with 60 percent remaining in storage (from Hemphill UWCD 3D Visualization Model).

The 2026 PRWP articulates that reservoir development, groundwater development, and invasion by brush have altered natural stream flow patterns in the area. Spring flows in the area have generally declined over the past several decades. Much of the impact to springs is due to groundwater development, the spread of high water use plant species such as mesquite and salt cedar, or the loss of native grasses and other plant cover. High water use plant species have reduced reliable flows for many tributary streams. Reservoir development also changes natural hydrology by diminishing flood flows and capturing low flows. None of the DFCs considered by the GMA 1 will change these issues.

GMA 1 Districts anticipate that groundwater pumping in the Ogallala Aquifer may continue to diminish the groundwater discharge to springs, rivers, draws, and escarpments. This expected trend is shown in **Figure 3-16**, which reflects expected changes to interaction between groundwater and surface water associated with the DFCs. In most of the GMA 1 counties, groundwater currently contributes nothing to river flow. In the counties where groundwater does contribute to river flow (Armstrong, Donley, Gray, Hemphill, Hutchinson, Oldham, Potter, Roberts, and Wheeler), future drawdown due to pumping may induce inflow from perennial surface water bodies during the planning period.

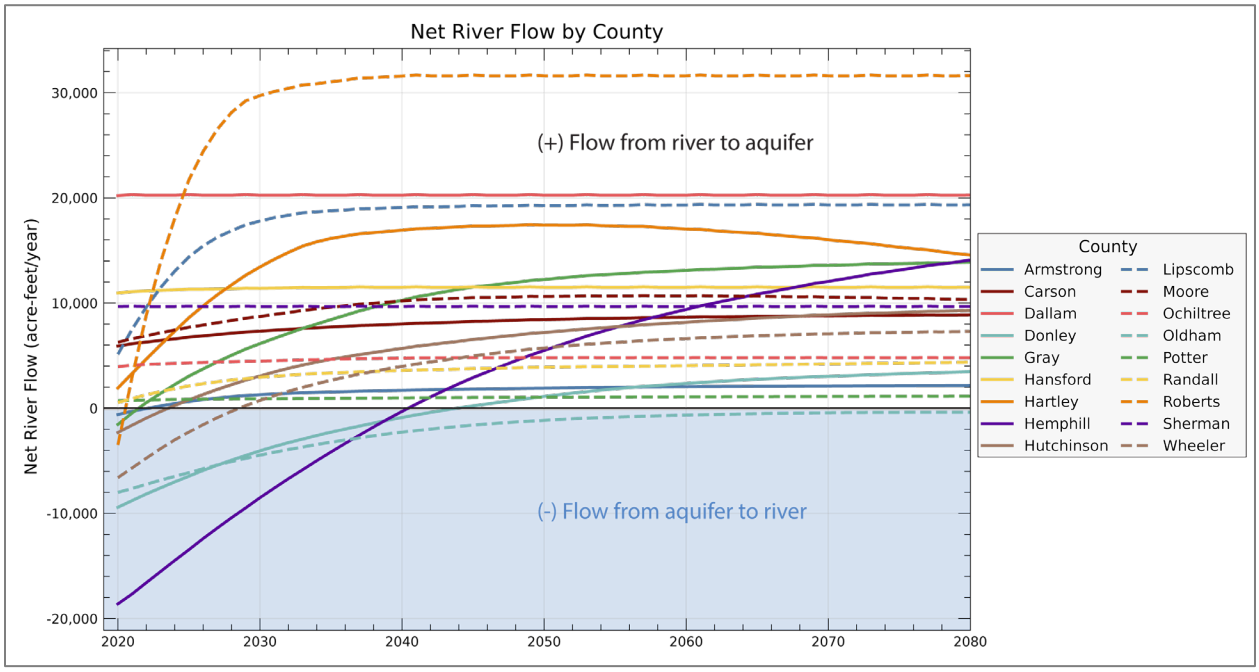


Figure 3-16. Projected interactions between surface water and groundwater, based on the effects of predicted groundwater pumping from the adopted DFCs. Negative numbers imply flow from aquifer to river (gaining rivers), while positive numbers indicate flow from river to aquifer (losing rivers).

3.4.5 Subsidence Impacts

GMA 1 District Representatives considered potential impacts of the adopted DFCs on land subsidence. This included reviewing the causes and mechanisms of land surface subsidence and the results of a recent study on subsidence risk throughout Texas (Furnans and others, 2017). The Furnans and others (2017) study concluded that the Ogallala Aquifer presented a "high" risk of compaction leading to subsidence and the Dockum Aquifer presented a "medium" risk of compaction leading to subsidence. The study was based on review of driller's lithologic logs, historical water level changes, and hydraulic properties in the groundwater availability models.

As noted by the GMA 1 Districts and the US Geological Survey fact sheet on subsidence in the United States (Galloway and others, 2000), no substantial subsidence has historically been observed or linked to groundwater production in GMA 1 despite historical substantial water level declines. After considering the data and methods used in Furnans and others' (2017) subsidence study in the context of other available information on subsidence in the area, the GMA 1 Districts concluded that subsidence has not been an issue and is unlikely to be an issue in GMA 1 in the future under the adopted DFCs.

3.4.6 Socioeconomic Impacts

GMA 1 District Representatives considered socioeconomic impact studies prepared by the TWDB for regional water planning purposes, along with multiple other studies that target areas in GMA 1 based on the DFCs options during joint planning meetings identified in Table 1-1.

In the regional water planning process, there is a quantitative evaluation of socioeconomic impacts, but the impact is limited to what would occur if a water demand were unmet during a repeat of the drought of record. Analysis is limited to the categories of users with an identified water need (i.e., potential shortage). GMA 1 District Representatives reviewed this analysis during the September 22nd, 2025 meeting; however, this analysis has no direct translation to the evaluation of potential socioeconomic effects of the proposed DFC. For this reason, the consideration included discussion on balancing the socioeconomic impacts of developing higher amounts of groundwater (both positive and negative) with the socioeconomic impacts of developing lesser amounts of groundwater (again, both positive and negative).

In addition to the socioeconomic information provided in the 2022 SWP, the GMA 1 Districts reviewed other information that included:

- Economic Impacts of Selected Water Conservation Policies in the Ogallala Aquifer Report (Amosson and others, 2014a).
- Economic Impacts of Groundwater Management Standards in the Panhandle Groundwater Conservation District of Texas (Weinheimer, 2012).
- Evaluation of Changing Land Use and Potential Water Conservation Strategies: North Plains Groundwater Conservation District (Amosson and others, 2014b).
- Farm Level Financial Impacts of Water Policy on the Southern Ogallala Aquifer (Weinheimer, 2008).
- Multi-year water allocation: an economic approach towards future planning and management of declining groundwater resources in the Texas Panhandle (Tewari and others, 2014).
- Socioeconomic Impacts of Projected Water Shortages for the Panhandle (Region A) Regional Water Planning Area Prepared in Support of the 2011 Panhandle Regional Water Plan (Norvell and others, 2010).
- Water Conservation Policy Alternatives for the Ogallala Aquifer in Texas (Johnson and others, 2007).
- Letter of Opinion Concerning Texas Panhandle Land Values: Hemphill UWCD (Scott Land Company LLC and others, 2016).

3.4.7 Private Property Impacts

GMA 1 District Representatives considered the impact on the interests and rights in private property, including ownership, and the rights of landowners and their lessees and assigns in groundwater during the joint planning meetings described in Table 1-1. GMA 1 District Representatives also revisited the private property rights discussion from the previous planning cycle, including a presentation by Keith Good (2015), because it remains largely relevant; accordingly, the discussion is summarized in the text that follows.

In 2015, GMA 1 District Representatives received a presentation by Keith Good—attorney with Lemon, Shearer, Phillips and Good, P.C. —regarding possible DFC impacts on private property rights (Good, 2015). Mr. Good's commentary remains relevant to the current round of joint planning. The highlights of

Mr. Good's presentation were reviewed and considered again during the joint planning process and are summarized in the remainder of this subsection.

The consideration of impacts on private property rights is not new in groundwater management in Texas. Even before it was a required consideration for joint planning, the TWDB, under its rules, considered the impact on private property rights as one of the Factors to determine if an adopted DFC was reasonable if that DFC were petitioned. In EAA vs. Day, the Texas Supreme Court sent a variety of signals regarding regulation by GCDs, including:

- "Unquestionably, the State is empowered to regulate groundwater production."
- "Regulation is essential to groundwater conservation and use."
- The rule of ownership must be considered with the law of capture and is subject to police regulation.
- Each landowner "owns separately, distinctly, and exclusively all the water under his land."
- "Landowners do have a constitutionally compensable interest in groundwater."
- "Groundwater rights are property rights subject to constitutional protection; whatever difficulties may lie in determining adequate compensation for a taking."
- Any meaningful Rules adopted by a District to achieve a DFC may have a potential impact on property rights.
- "Considerations" analyze how property rights could be impacted.
- Impacts are not equated as "takings" in this process.
- Impacts may be viewed as both restricting and benefitting property rights.

Mr. Good condensed the interest groups with property interests and rights related to the production and conservation of groundwater in GMA 1 including:

- Interests and rights that are benefitted or enhanced by the present use of groundwater.
- Interests and rights that are benefitted or enhanced using groundwater soon.
- Interests and rights that are benefitted or enhanced by the ability to use groundwater over the long-term.
- Interests and rights that are benefitted or enhanced by leaving a significant amount of groundwater in place.

By statute and under EAA vs. Day, all landowners have constitutionally protected property rights in groundwater beneath their property. A GMA must consider the rights of all owners of private property, including all owners of groundwater within the GMA. All identified interests have the potential to be "impacted" by groundwater regulation (or the absence of regulation). Existing GCD rules that implement DFCs adopted by GMA 1 impact or affect private property rights by setting well spacing requirements and production limits. Spacing requirements impact where landowners may drill wells. Spacing requirements may also positively impact the property interests of neighboring landowners by reducing the potential for interference between wells. Production limitations currently exist in the GMA 1 Districts. Such rules are designed to prolong the groundwater supply and reduce the drainage of groundwater owned by neighboring landowners.

Some of the potential impacts to private property rights of DFCs associated with higher levels of production include:

- Unobtrusive production restrictions, allowing users to produce more groundwater with limited acreage.
- Could limit water available for future users.
- Increased drainage of groundwater from neighboring landowners.

Some of the potential impacts to private property rights of DFCs associated with lower levels of production include:

- Production limits that may force users to reduce groundwater production or acquire additional groundwater rights.
- Greater water available to meet future needs.
- Minimized well interference and induced drainable from neighboring landowners.

A GMA is expressly allowed to adopt DFCs for the "establishment of DFCs that provide for the reasonable long-term management of groundwater resources. GMA 1 must consider the impact of its DFCs on private property rights in groundwater as recognized under TWC Section 36.002. Owners are entitled to drill for and produce groundwater (subject to regulation by GCDs). Owners are not entitled to capture any amount of groundwater they choose. Section 36.002 grants no GCD the authority to deprive or divest an owner of the rights described by Section 36.002. It is unlikely that GMA 1 DFCs will result in an owner (1) being prohibited from drilling for and producing groundwater or (2) being deprived or divested of groundwater rights described in Section 36.002.

Different DFCs, rules, and policy decisions by the Districts within GMA 1 may impact private property rights differently. Each District's management plan and rules—and the implementation thereof—likely have more potential to "impact" private property rights in groundwater than the DFCs.

In addition to this qualitative review, District Representatives evaluated drawdown-related effects from the current DFC model run by examining available drawdown through time in both the Ogallala and Dockum aquifers. These drawdown impacts for the Ogallala are summarized in **Figures 3-17** and **3-18** showing cumulative distribution functions (CDFs) of available drawdown in 2020 and 2080, along with maps of available drawdown for 2020 and 2080 in **Figures 3-19** and **3-20**. The Dockum Aquifer available drawdown CDFs are shown in Figures 3-21 and 3-22, and the available drawdown maps are shown in **Figures 3-23** and **3-24**.

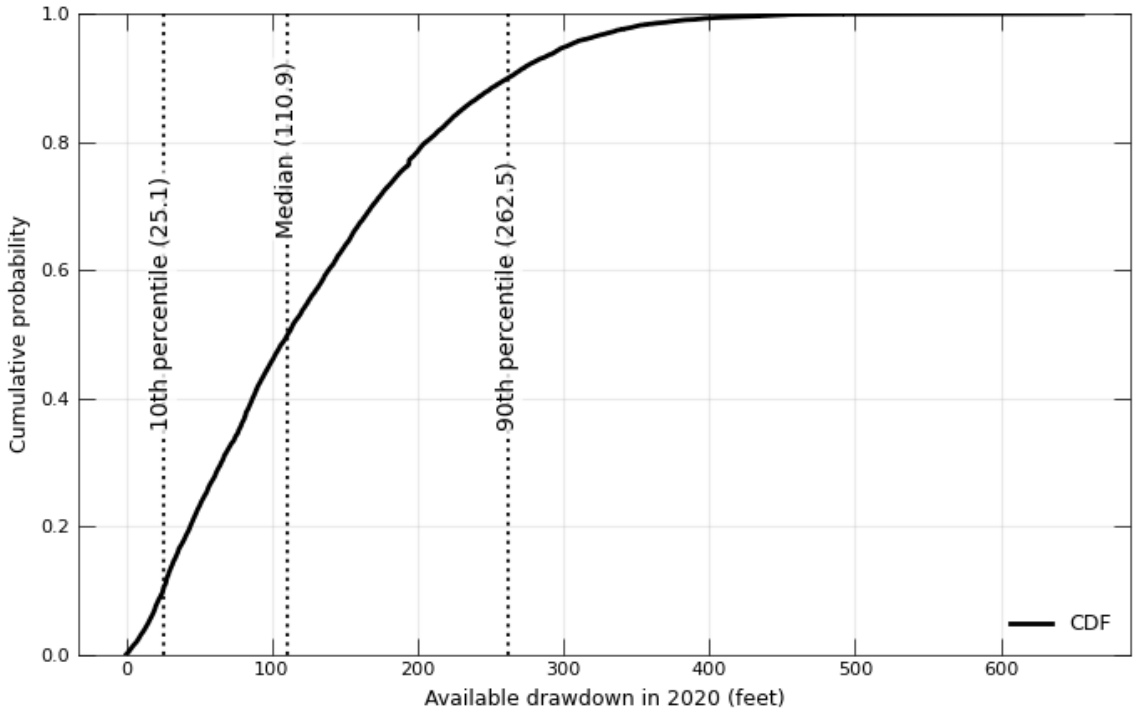


Figure 3-17. Cumulative distribution function (CDF) of available drawdown in the Ogallala aquifer in 2020 (feet) for wells evaluated under the current DFC model run. Vertical dashed lines mark the 10th percentile (25.1 ft), median (110.9 ft), and 90th percentile (262.5 ft) of available drawdown across the evaluated wells.

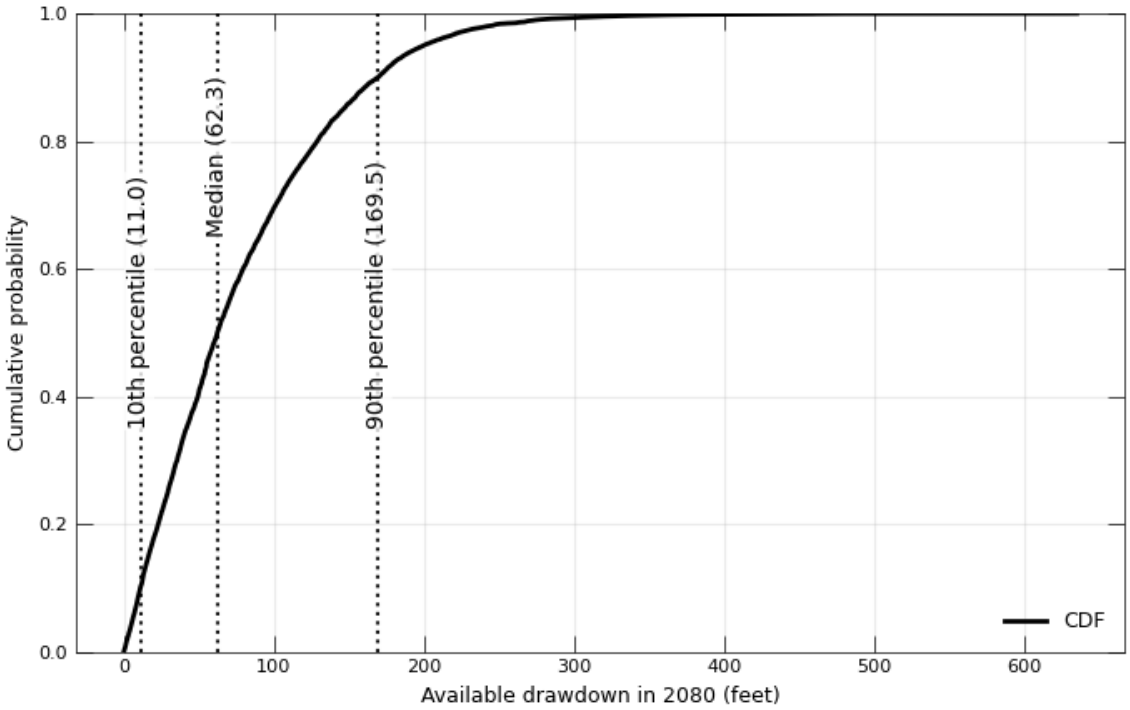


Figure 3-18. Cumulative distribution function (CDF) of available drawdown in the Ogallala aquifer in 2080 (feet) for wells evaluated under the current DFC model run. Vertical dashed lines mark the 10th percentile (11 ft), median (62.3 ft), and 90th percentile (169.5 ft) of available drawdown across the evaluated wells.

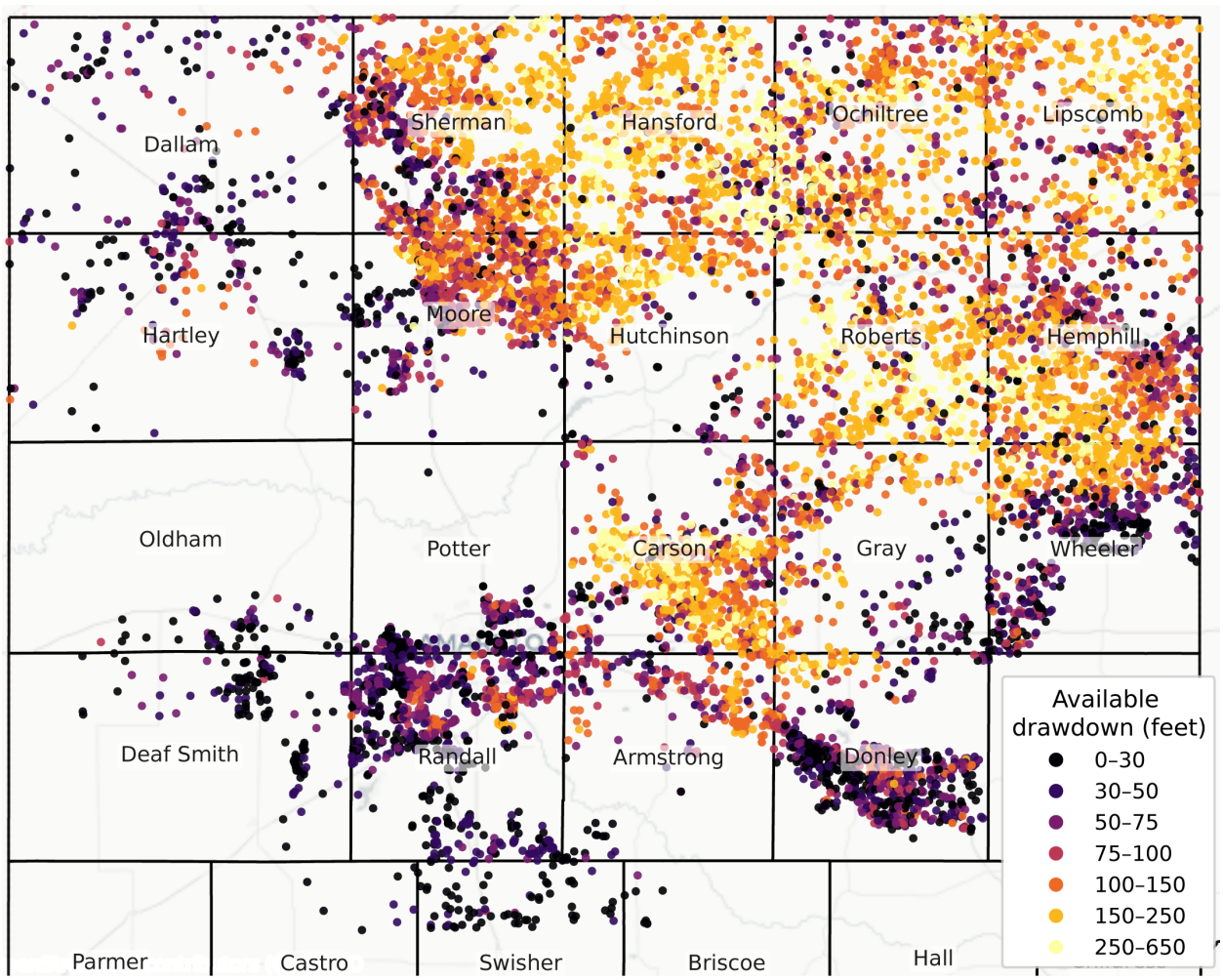


Figure 3-19. Map of available drawdown in the Ogallala aquifer in 2020 (feet) for wells evaluated under the current DFC model run across GMA 1.

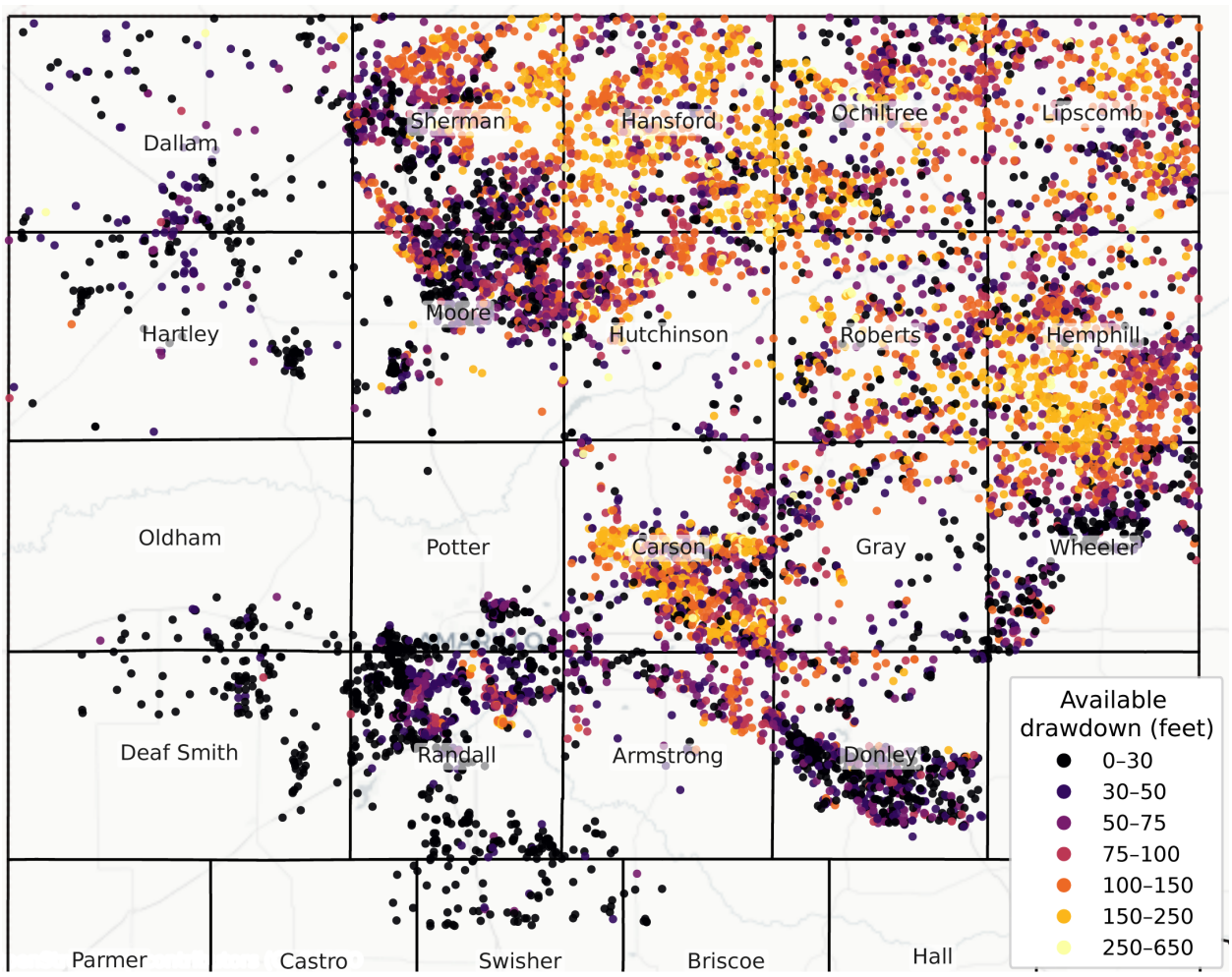


Figure 3-20. Map of available drawdown in the Ogallala aquifer in 2080 (feet) for wells evaluated under the current DFC model run across GMA 1.

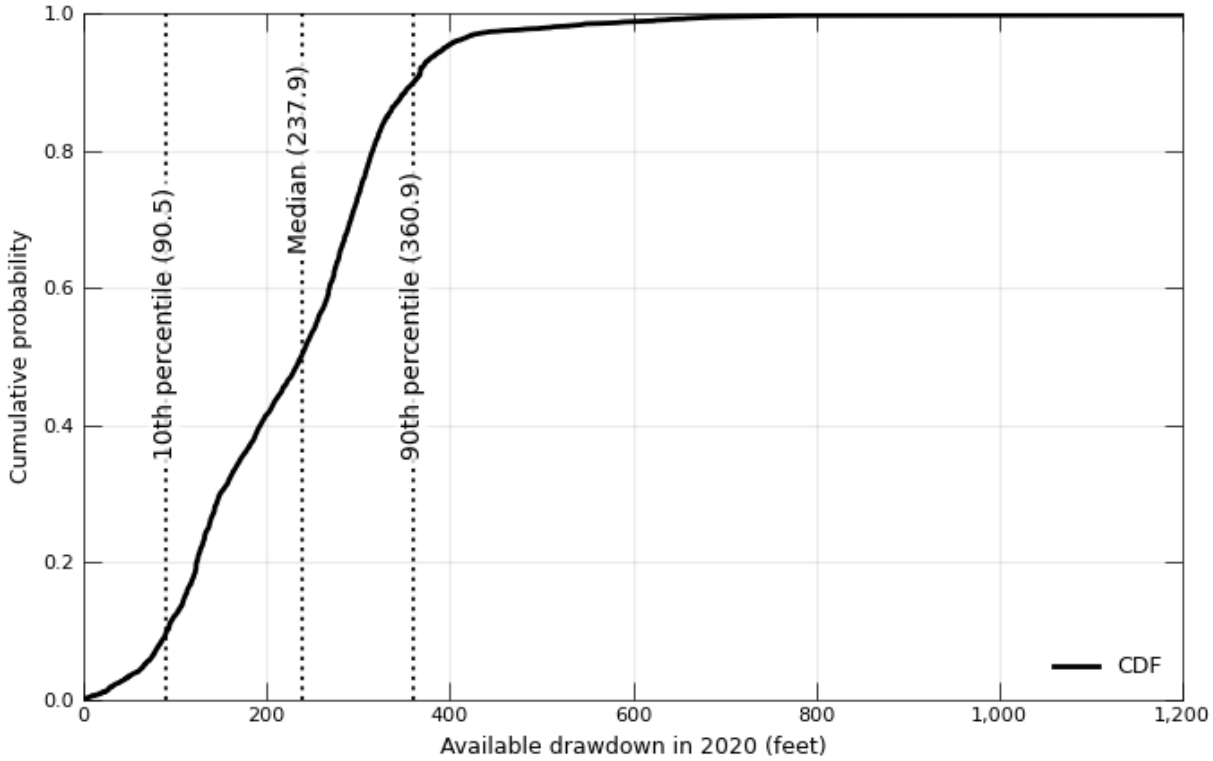


Figure 3-21. Cumulative distribution function (CDF) of available drawdown in the Dockum aquifer in 2020 (feet) for wells evaluated under the current DFC model run. Vertical dashed lines mark the 10th percentile (90.5 ft), median (237.9 ft), and 90th percentile (360.9 ft) of available drawdown across the evaluated wells.

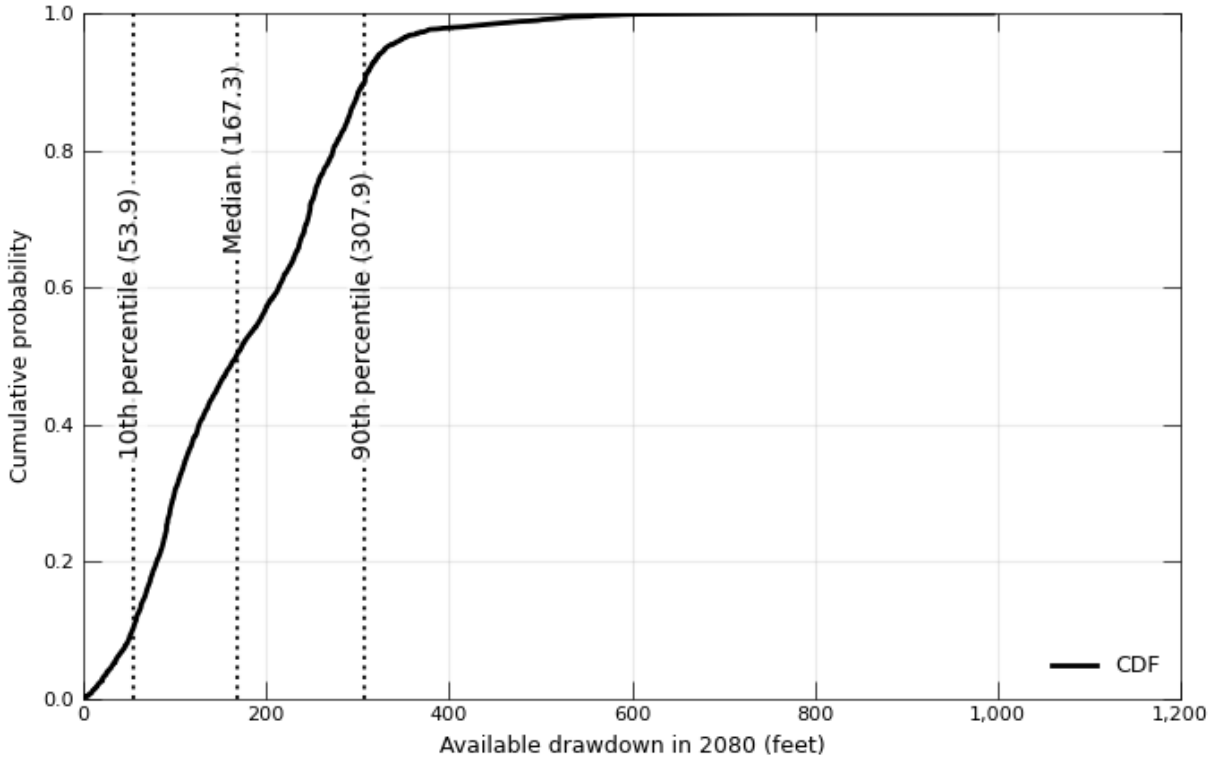


Figure 3-22. Cumulative distribution function (CDF) of available drawdown in the Dockum aquifer in 2080 (feet) for wells evaluated under the current DFC model run. Vertical dashed lines mark the 10th percentile (53.9 ft), median (167.3 ft), and 90th percentile (307.9 ft) of available drawdown across the evaluated wells.



Figure 3-23. Map of available drawdown in the Dockum aquifer in 2020 (feet) for wells evaluated under the current DFC model run across GMA 1.



Figure 3-24. Map of available drawdown in the Dockum aquifer in 2080 (feet) for wells evaluated under the current DFC model run across GMA 1.

3.4.8 Achievement Feasibility

GMA 1 District Representatives considered the feasibility of achieving the adopted DFCs. Conceptually, there are two elements to the feasibility of achieving the DFCs: regulatory feasibility and physical feasibility.

Regulatory feasibility refers to whether the GMA 1 Districts have within the TWC and their respective enabling legislation the regulatory tools necessary to achieve the DFCs. For example, some uses of groundwater (such as for rural, domestic, livestock, or drilling for oil and gas) are generally exempt from production limits by a GCD. If the total expected pumping of these combined uses exceeded the groundwater availability associated with the DFC, then the DFC would clearly be regulatorily infeasible. That is, the Districts would lack the authority to manage groundwater production to achieve the DFCs. As described above, most of the groundwater pumping in GMA 1 is for irrigation and is generally subject to regulatory by GCDs. Further, the groundwater availability associated with the adopted DFCs allows for

considerable continued production for both exempt and non-exempt uses. The GMA 1 Districts considered this information and determined that the adopted DFCs are regulatorily feasible.

Physical feasibility refers to whether the various DFCs in the GMA are achievable concurrently. The physical feasibility is demonstrated by use of the model. The model run associated with the adopted DFCs shows that each of the DFCs for the Ogallala Aquifer (inclusive of the Rita Blanca) as well as the Dockum Aquifer are achievable concurrently.

3.4.9 Other Information

TWC Section 36.108(d)(9) requires the districts to consider any other information relevant to the specific DFCs. The GMA 1 Districts considered whether other information existed that was necessary to review to inform the DFCs and determined that all information necessary was considered under the other eight factors.

3.5 Discussion of Other DFCs considered

In the current round of joint planning, the GMA 1 Districts elected to continue with percent of storage remaining in all areas within GMA 1 except for Randall County and within the High Plains UWCD in Armstrong and Potter counties. High Plains District's jurisdiction primarily lies within GMA 2 and has only 4.6% (345,722 acres) of its jurisdiction within GMA 1. The High Plains UWCD requested that GMA 1 adopt DFCs using feet of drawdown instead of percent storage in the Districts' jurisdictional areas. By establishing DFCs based on feet of aquifer drawdown, High Plains UWCD can better manage the Ogallala Aquifer DFC in GMA 1 with the DFCs set for the rest of its district in GMA 2. The rationale for using feet of drawdown in these areas remains unchanged since the previous planning cycle, and the High Plains UWCD elected to retain the same DFC definition for this planning cycle.

During consideration of the DFC adopted in 2016, Hemphill UWCD evaluated different potential DFCs ranging from 60 to 80% of the Ogallala Aquifer remaining in storage in 50 years. Hemphill UWCD's 3D Visualization Model shows that leaving 80% of the Ogallala Aquifer in storage is a good balance of addressing stream flow while providing for groundwater withdrawals. As shown in Figure 3-13 of this report, even at 80% of the aquifer remaining, part of the Canadian River becomes a losing stream, and subsequent figures show continuing decline of stream flow as pumping increases. The 80% DFC provides the desired balance between production and conservation within the Hemphill UWCD. The technical basis and management rationale for this DFC have remained the same, and Hemphill UWCD elected to retain the same DFC for the current planning cycle.

3.6 Discussion of Other Recommendations

GMA 1 District Representatives provided the public opportunity to comment on the DFC Joint Planning Process or recommend other DFCs at each joint planning meeting. Each District also held respective public hearings to discuss the Proposed DFCs with the public in their local service areas.

3.6.1 Advisory Committees

GMA 1 Districts established no advisory committees for this round of planning, and therefore no comment from such committees were filed.

3.6.2 Public Comments

On February 24th, 2026, the GMA 1 Districts unanimously voted to adopt Proposed DFCs for the major aquifers in the Joint Planning Area.

A public comment period of not less than 90 days began on February 24th, 2026. During the public comment period and after posting notice (as required by TWC Section 36.063), each district held at least one public hearing on proposed DFCs relevant to that district. During the public comment period, the districts made available in their offices a copy of the proposed DFCs and any supporting materials. All documents considered in the joint planning process were organized and posted for the convenience of the public and GMA 1 membership. This included posting materials online at www.panhandlewater.org/gma-1. Individual districts held public hearings during the statutorily required not less than 90-day public input phase prior to the final adoption of DFCs.

After the public hearings and public comment period, the GMA 1 Districts reviewed relevant public comments received at the Month DD, 2026 Joint Planning meeting prior to adopting DFCs.

Through the public input process, GMA 1 Districts received # public comments, all of which were submitted to High Plains District. These summary reports documenting the public hearings conducted and comments received are included in **Appendix E** – Summary Reports and Public Comments Received.

4.0 Dockum Aquifer Description and Desired Future Conditions

4.1 Dockum Aquifer Description

The TWDB defines the Dockum Aquifer as the water-bearing units of the Triassic-aged Dockum Group. The Dockum Group extends through multiple TWDB Regional Water Planning Areas and parts of four GMAs. TWDB Report 359 (Bradley and Kalaswad, 2003) estimated that the Dockum Group's total areal extent is approximately 42,000 square miles in Texas. **Figure 4-1** shows geologic cross sections of the Dockum Group, modified from Bradley and Kalaswad (2003). Though regionally extensive, TWDB classifies the Dockum Aquifer as a minor aquifer because of its generally poor water quality and limited production capacity. Based on water quality data from North Plains GCD, the Lower Dockum Aquifer appears to be of higher water quality in Dallam, Hartley, and Moore counties than further south in the Dockum basin. **Figure 4-2** shows the areal extent of the Dockum Aquifer in Texas (George and others, 2011).

The Dockum Aquifer is in nine counties, primarily in the western portion of GMA 1. The HPASGAM segregates the aquifer into the Upper Dockum and the Lower Dockum. The Lower Dockum is present in the management area and includes:

- The Tecovas Formation, a variegated, sometimes sandy mudstone with interbedded fine- to medium-grained sandstone.
- The Santa Rosa Formation, a red to reddish-brown sandstone and conglomerate.

Groundwater located in the Santa Rosa sandstone and conglomerate provides the highest yields in the aquifer, with the Tecovas sands yielding lesser amounts of water. Locally, all water-bearing sands within the Dockum Aquifer are informally referred to as "Santa Rosa" regardless of whether they are in the Tecovas or Santa Rosa formations of the Dockum Aquifer.

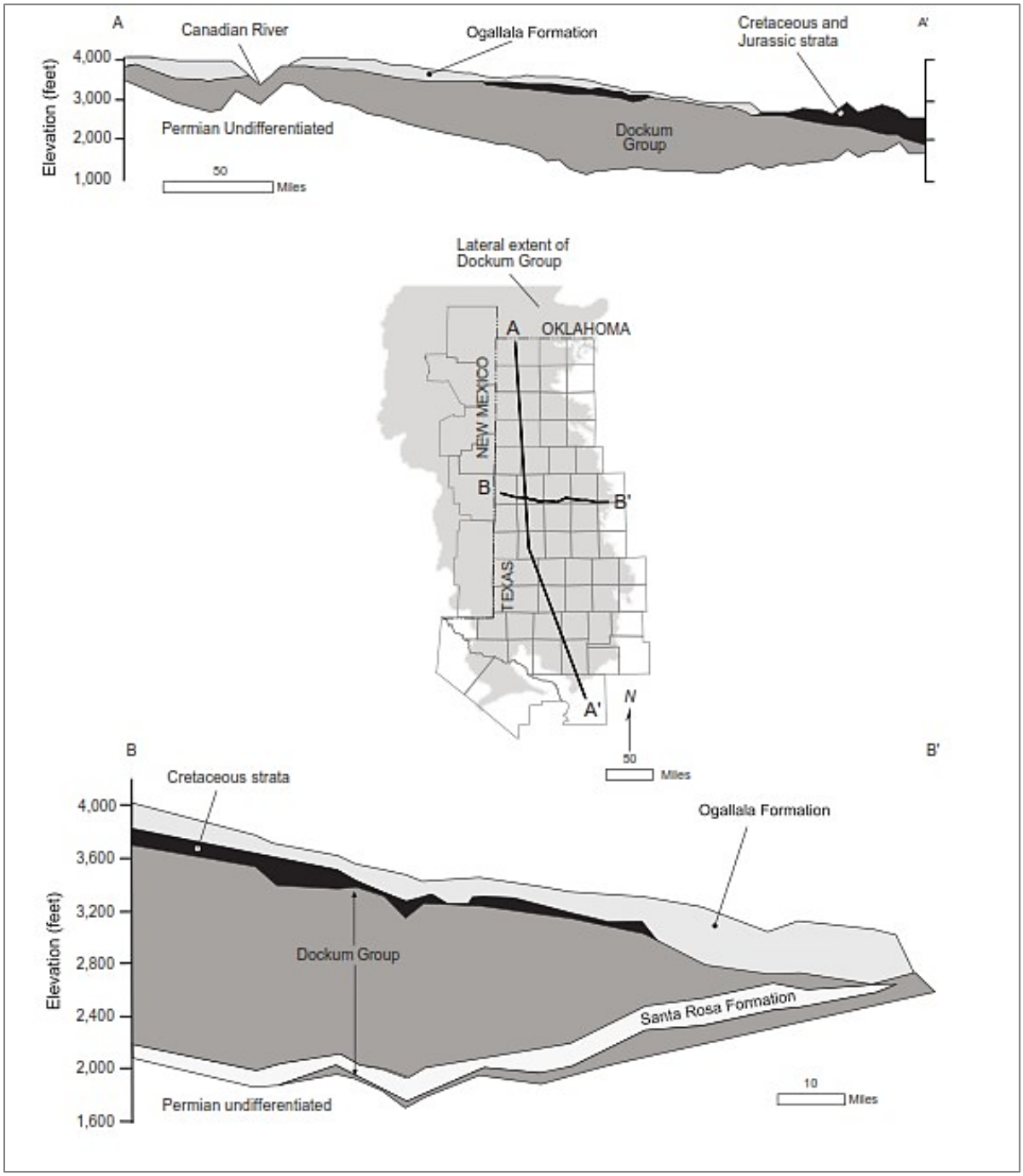


Figure 4-1. Geologic cross sections of the Dockum Group along (A-A') and across (B-B') (modified from Bradley and Kalaswad, 2003).

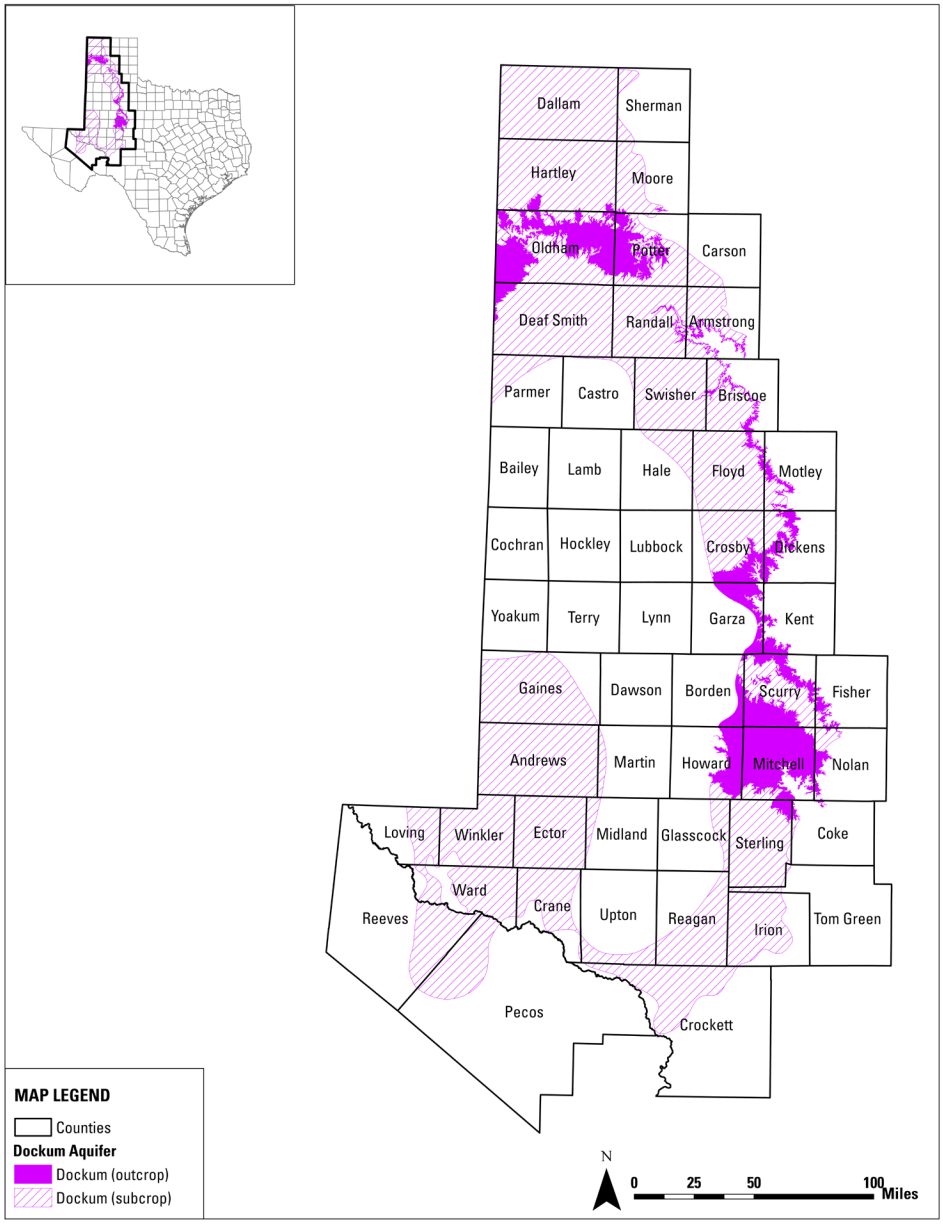


Figure 4-2. Dockum Aquifer areal extent in Texas (George and others, 2011).

4.2 Dockum Aquifer Desired Future Conditions

GMA 1 District Representatives unanimously adopted DFCs for the Dockum Aquifer by resolution on Month DD, 2026.

The Dockum Aquifer DFCs adopted by GMA 1 are as follows:

- At least 40 percent of the average available drawdown remaining after the 50-year period between 2020 and 2070 for Dallam, Hartley, Moore, and Sherman counties, with at least 35 percent remaining by 2080 at the end of the planning period.
- No more than 30 feet average decline in water levels after the 60-year period between 2020 and 2080 in Oldham and Carson counties and the Panhandle District portions of Potter and Armstrong counties
- Approximately 40 feet average decline in water levels after the 50-year period between 2020 and 2070 in Randall County and within High Plains District in Armstrong and Potter counties, with less than 43 feet of average decline by 2080 at the end of the planning period.

The resolution adopting DFCs is provided in Appendix A – DFC Documents. Documentation for this meeting—including meeting postings, agenda package, sign-in sheet, and meeting supplements—is provided in Appendix B- Meeting Documentation. The areas described by the DFCs above are shown in **Figure 4-3**.

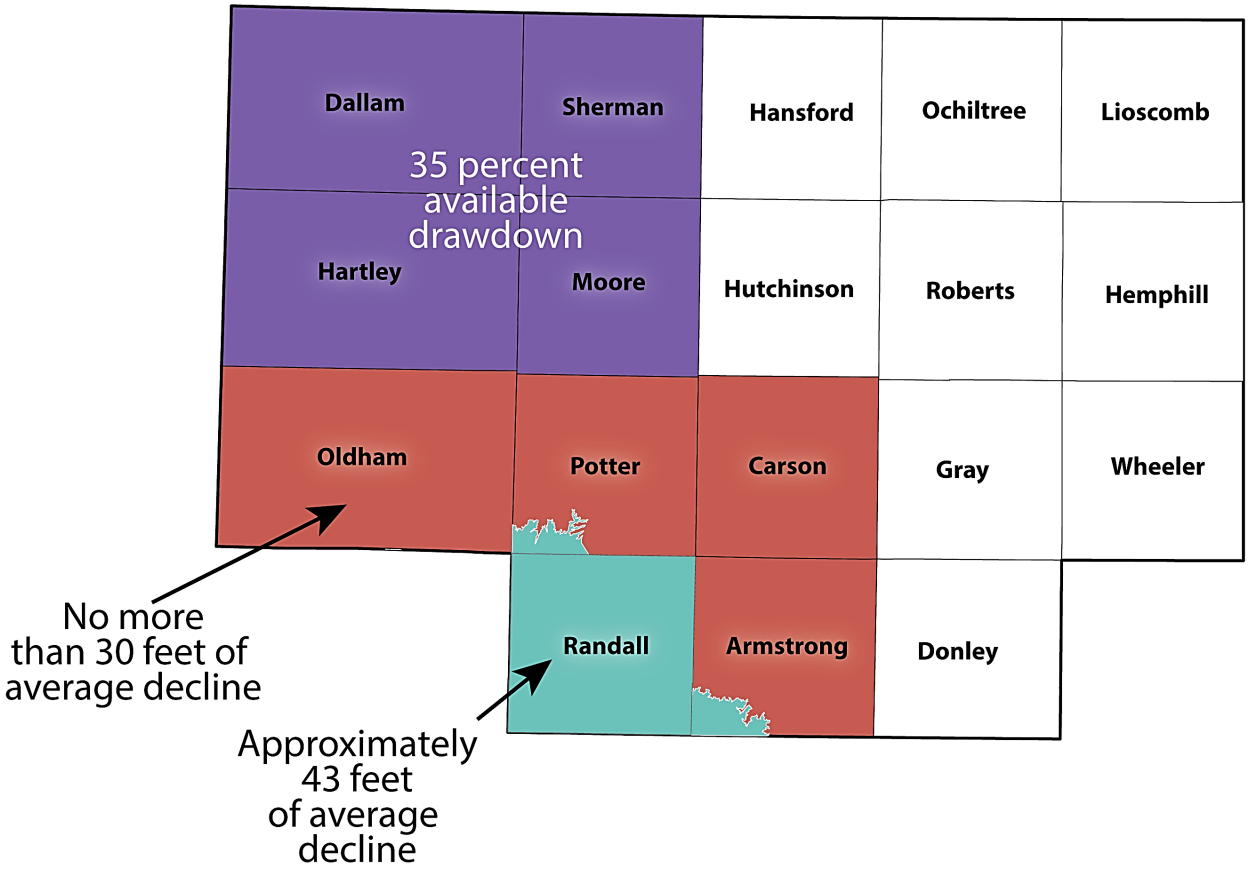


Figure 4-3. GMA 1 Dockum Aquifer DFC Map.

4.3 Policy and Technical Justification

TWC Section 36.108(d-2) requires that DFCs proposed as part of joint planning in the management area must provide "a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area." GMA 1 District Representatives established different DFCs throughout the management area based on a combination of policy and technical considerations that support continued economic development of the area while providing for the reasonable long-term management of groundwater resources consistent with TWC Section 36.1071(a).

4.3.1 Policy Justification

The Dockum Aquifer is in the nine western counties in GMA 1 and is currently designated as a minor regional water supply that will likely be tapped more to offset diminishing Ogallala Aquifer supplies in the future. The development of different Dockum Aquifer DFCs in GMA 1 strikes a balance between the highest practicable level of groundwater production and conservation, preservation, protection, recharging, and prevention of waste.

The estimated modeled pumping levels from the adopted Dockum DFCs significantly exceed the current groundwater pumping and will be used to meet future needs over the planning period while leaving substantial water in the ground for the future in GMA 1.

4.3.2 Technical Justification

The Dockum Aquifer DFCs passed in 2016 allowed for future growth while promoting conservation. GMA 1 District Representatives reviewed the 2016 DFCs and numerous current information sources while considering whether amendments to the 2016 DFCs were needed. To reevaluate the 2016 DFCs, the GMA 1 Districts first updated the reference year from 2012 to 2018 in the HPASGAM (Deeds and Jigmond, 2015) and extended the projection period from 2012-2062 to 2018-2080. With slight modifications to the Dockum Aquifer DFC wording to accommodate the changes above, the GMA 1 Districts evaluated the Dockum Aquifer DFCs. **Table 4-1** compiles the modeled pumping consistent with these DFCs, which declines from approximately 312,000 acre-feet per year in 2020 to 246,000 acre-feet per year in 2080. These pumping estimates far exceed estimates of current use of the Dockum Aquifer and represent a balance that allows for significant future development of the aquifer while conserving water for the future.

Table 4-1. Dockum Aquifer modeled pumping levels based on the adopted DFCs in acre-feet/year.

District	County	2030	2040	2050	2060	2070	2080
High Plains UWCD No.1	Armstrong	1165	248	249	248	249	248
	Potter	2993	2620	2550	2501	2475	2,334
	Randall	9552	10707	9792	8861	8539	8,582
High Plains UWCD No.1 Total		**13,710**	**13,575**	**12,591**	**11,610**	**11,263**	**11,164**
North Plains GCD	Dallam	15,439	14,666	13,988	13,430	13,007	12,498
	Hartley	11,768	11,026	10,332	9,701	9,206	8,784
	Moore	5,309	5,390	5,207	4,847	4,560	4,291
	Sherman	458	424	329	314	311	314
North Plains GCD Total		**32,974**	**31,506**	**29,856**	**28,292**	**27,084**	**25,887**
Panhandle GCD	Armstrong	6,710	7,810	8,375	8,615	8,726	8,715
	Carson	28	28	28	28	31	34
	Potter	36,809	37,240	36,570	35,478	34,394	33,211
Panhandle GCD Total		**43,547**	**45,078**	**44,973**	**44,121**	**43,151**	**41,960**
No District-County	Hartley	52,180	53,286	51,148	47,583	43,823	39,965
	Hutchinson	0	0	0	0	0	0
	Moore	709	862	980	1,078	1,149	1,170
	Oldham	151,285	144,585	134,746	124,132	114,217	104,724
	Randall	17,790	20,450	21,860	22,401	22,510	21,736
No District-County Total		**221,964**	**219,183**	**208,734**	**195,194**	**181,699**	**167,595**

4.4 Dockum Aquifer Factor Consideration

4.4.1 Aquifer Uses or Conditions

The GMA 1 districts considered information on aquifer uses and conditions, including the estimated pumping by aquifer, the distribution of well depths, and the distribution of well yields in each county in GMA 1. The Districts also considered water demands throughout GMA 1, which are independent of the aquifer and more fully presented in the discussion in Section 3.4.1.

Table 4-2 shows the estimated Dockum Aquifer pumping by WUG in GMA 1 between 2015 and 2023 presented in the TWDB's Historical Groundwater Pumpage Estimates (TWDB, 2023). In general, recent pumping of the Dockum Aquifer ranges from between 5,000 and 9,000 acre-feet per year. This is approximately evenly split among use for irrigation, livestock, and municipal supply.

Table 4-3 shows the estimated Dockum Aquifer pumping by county over the same 2015-2023 time period. Moore, Oldham, and Randall counties had higher rates of Dockum production than other counties in GMA 1, though it still represents only a small fraction of water used in these counties. As water levels decline in the Ogallala Aquifer, use of the Dockum Aquifer may increase as conditions become more favorable for development.

Table 4-2. GMA 1 Dockum Aquifer pumping in acre-feet by year and by WUG from 2015-2023 (TWDB, 2025). Values shown as ".%" represent no estimated water use.

Year	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total Dockum Pumpage
2015	2,245 (44.06%)	.%	.%	.%	1,375 (26.99%)	1,475 (28.95%)	5,095
2016	2,374 (40.48%)	.%	.%	.%	1,992 (33.97%)	1,498 (25.55%)	5,864
2017	1,717 (32.25%)	.%	.%	.%	1,672 (31.4%)	1,935 (36.34%)	5,324
2018	1,994 (33.53%)	.%	.%	.%	1,947 (32.74%)	2,006 (33.73%)	5,947
2019	1,781 (31.19%)	.%	.%	.%	1,908 (33.41%)	2,022 (35.41%)	5,711
2020	2,713 (39.63%)	.%	.%	.%	2,084 (30.45%)	2,048 (29.92%)	6,845
2021	3,899 (47.88%)	.%	.%	.%	2,246 (27.58%)	1,998 (24.54%)	8,143
2022	4,204 (47.48%)	.%	.%	.%	2,431 (27.46%)	2,219 (25.06%)	8,854
2023	4,052 (48.23%)	.%	.%	.%	2,200 (26.19%)	2,149 (25.58%)	8,401

Table 4-3. GMA 1 Dockum Aquifer pumping in acre-feet by year and by county from 2015-2023 (TWDB, 2025).

County	2015	2016	2017	2018	2019	2020	2021	2022	2023
Armstrong	68	85	105	113	114	115	121	165	150
Carson	3	3	3	3	3	3	24	25	25
Hartley	940	922	1,157	1,228	1,188	1,213	1,172	1,392	1,365
Moore	1,042	1,281	1,097	1,281	1,195	1,385	1,520	1,630	1,511
Oldham	793	900	952	1,076	1,097	1,011	1,016	1,079	1,002
Potter	572	385	369	343	375	422	768	803	600
Randall	1,677	2,288	1,641	1,903	1,739	2,696	3,522	3,760	3,748
Total Pumpage	**5,095**	**5,864**	**5,324**	**5,947**	**5,711**	**6,845**	**8,143**	**8,854**	**8,401**

4.4.2 Water Supply Needs and Water Management Strategies Included in the State Water Plan.

TWC Section 36.108(d)(2) requires that District Representatives consider the water supply needs and water management strategies included in the State Water Plan. GMA 1 Districts considered data from the 2022 SWP. Information from both regional and state plans are provided in the supporting documentation; however, for the purposes of simplicity, the 2022 SWP is referenced in discussing the water supply needs and water management strategies for GMA 1.

The GMA 1 anticipates that the Dockum Aquifer will be used to supplement the water to address regional water supply needs and water management strategies included in the 2022 SWP. GMA 1 District Representatives used the same information for consideration of water supply needs and water management strategies as for consideration of this Factor in adopting Ogallala Aquifer DFCs. For a more

thorough discussion of GMA 1's consideration of this Factor, please refer to Section 3.4.2—Water Supply Needs and Water Management Strategies—in this Explanatory Report.

GMA 1 District Representatives considered water supply needs and water management strategies within GMA 1 during the DFC joint planning meetings identified in Table 1-1.

4.4.3 Hydrological Conditions

GMA 1 District Representatives considered hydrological conditions; including for each aquifer in the management area the TERS as provided by the TWDB Executive Administrator, as well as the average annual recharge, inflows, and discharge during meetings identified in Table 1-1.

4.4.3.1 Total Estimated Recoverable Storage (provided by TWDB)

TWDB defines TERS as the estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25 and 75% of the porosity-adjusted aquifer volume. In other words, TWDB assumes that between 25 and 75% of groundwater held within an aquifer can be removed by pumping. TERS accounting omits a variety of important conditions and aquifer characteristics that limit groundwater production such as well withdrawal rate, well density, hydraulic conductivity, withdrawal costs, aquifer petrology, permeability, and potential water quality degradation. In practice, the TERS calculation represents the approximate percentage of the total storage volume in the water-producing zones of an aquifer; however, only some of the water in those zones is "practicably recoverable." The basis of the TERS calculation requires no specific amount that could be recovered during any planning period. Recovery of all water from TERS would take longer than the joint planning time horizon and at a cost impractical for regional uses. Therefore, TERS accounts for water that cannot be practicably produced for beneficial use at any level in the GMA 1. Unlike TERS, which simply measures volume, the highest practicable level of groundwater production is defined as a rate by measuring a volume produced through time. **Table 4-4** and **Table 4-5** identify Dockum Aquifer TERS by county and District in GMA 1 from TWDB GAM Task Report 15-006 (Kohlrenken, 2015).

GMA 1 District Representatives evaluated TERS provided by the TWDB and found that, though TERS provides a total amount of groundwater that can possibly be produced given the discussion above, only a portion of groundwater in storage can be feasibly withdrawn to address the current uses and future anticipated groundwater demands. GMA 1 District Representatives selected DFCs that allow for substantial storage to remain for future demands after the planning period while ensuring that water is available to meet most WUG water demands outlined in the 2022 SWP.

Table 4-4. Dockum Aquifer TERS by county in GMA 1 (Kohlrenken, 2015).

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Armstrong	7,000,000	1,750,000	5,250,000
Carson	1,900,000	475,000	1,425,000
Dallam	80,000,000	20,000,000	60,000,000
Hartley	96,000,000	24,000,000	72,000,000
Moore	7,400,000	1,850,000	5,550,000
Oldham	43,000,000	10,750,000	32,250,000
Potter	10,000,000	2,500,000	7,500,000
Randall	46,000,000	11,500,000	34,500,000
Sherman	540,000	135,000	405,000
Total	**291,840,000**	**72,960,000**	**218,880,000**

Table 4-5. Dockum Aquifer TERS by GCD in GMA 1 (Kohlrenken, 2015).

Groundwater Conservation District	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
High Plains UWCD[2] No.1	28,000,000	7,000,000	21,000,000
North Plains GCD	170,000,000	42,500,000	127,500,000
Panhandle GCD	15,000,000	3,750,000	11,250,000
No District	77,000,000	19,250,000	57,750,000
Total	**290,000,000**	**72,500,000**	**217,500,000**

4.4.3.2 Average Annual Recharge, Inflows and Discharge

In groundwater models, a water budget reflects the relationship between input and output of water through a given area modeled. Water budgets for the upper and lower portions of the Dockum Aquifer were developed using the HPASGAM. The HPASGAM calculates a water budget for recharge; ET; discharge to springs, draws, and escarpments; flows associated with rivers and reservoirs; aquifer storage; lateral flow; and cross-formational flow. Water budget information using the HPASGAM for the steady state (predevelopment) period is shown in **Table 4-6** and **Table 4-7** for the upper and lower

portions of the Dockum Aquifer, respectively. Before pumping began in GMA 1, water inflows generally balanced outflows for the Dockum Aquifer without significant aquifer storage (i.e., water level) change. The HPASGAM estimates recharge for the Dockum Aquifer is approximately 8,600 acre-feet per year. This only occurs in the lower portion of the Dockum Aquifer because the upper portion of the Dockum does not outcrop at land surface. **Table 4-8** and **Table 4-9** show the water budgets for 2012 upper and lower portions of the Dockum Aquifer, respectively. With pumping occurring in the aquifer, the main response is, as shown in the water budget, a reduction in storage (i.e., a water level decline). With continued water level declines over time, other water budget terms such as outflow to surface water may also change in response to pumping. This is discussed in more detail in the Environmental Impacts section.

Additional information on average historical recharge, inflows, discharge and lateral flows are provided to each of the GMA 1 Districts by TWDB for development of the Districts' management plans.

Table 4-6. Water budget for the upper Dockum by county for the steady-state model (modified from Deeds and Jigmond, 2015).

County	Recharge	ET	Springs	Rivers	Draws	Escarpments	Lateral	Cross-Formational
Dallam	0	0	0	0	0	0	3	-3
Hartley	0	0	0	0	0	0	4	-4
Moore	0	0	0	0	0	0	0	0
Oldham	0	0	0	0	0	0	-1	1
Potter	0	0	0	0	0	0	0	0
Randall	0	0	0	0	0	0	0	0
Sherman	0	0	0	0	0	0	0	0

Table 4-7. Water budget for the lower Dockum by county for the steady-state model (modified from Deeds and Jigmond, 2015).

County	Recharge	ET	Springs	Rivers	Draws	Escarpments	Lateral	Cross-Formational
Armstrong	226	0	-295	-509	-2,276	0	619	2,235
Carson	0	0	0	0	0	0	287	-287
Dallam	0	0	0	0	0	0	-51	51
Hartley	205	-314	0	969	0	0	-2,170	1,310
Hutchinson	0	0	0	0	0	0	0	0
Moore	64	0	0	-65	0	0	-298	298
Oldham	5,786	-3,674	-120	-10,130	0	0	4,310	3,828
Potter	2,211	-1,106	-22	-3,561	-395	0	1,171	1,703
Randall	80	0	0	-2,557	-748	0	-18	3,243
Sherman	0	0	0	0	0	0	53	-53
Total	**8572**	**-5094**	**-437**	**-15,853**	**-3419**	**0**	**3903**	**12,328**

Table 4-8. Water budget for the upper Dockum by county for year 2012 of the transient model (modified from Deeds and Jigmond, 2015).

County	Recharge	ET	Springs	Rivers	Draws	Escarpments	Reservoirs	Wells	Storage	Lateral	Cross-Formational
Dallam	0	0	0	0	0	0	0	-23	1,131	5	-1,113
Hartley	0	0	0	0	0	0	0	-2	706	4	-708
Moore	0	0	0	0	0	0	0	0	14	0	-14
Oldham	0	0	0	0	0	0	0	-1	7	-2	-4
Potter	0	0	0	0	0	0	0	0	0	0	0
Randall	0	0	0	0	0	0	0	-22	240	-1	-218
Sherman	0	0	0	0	0	0	0	0	0	0	0

Table 4-9. Water budget for the lower Dockum by county for year 2012 of the transient model (modified from Deeds and Jigmond, 2015).

County	Recharge	ET	Springs	Rivers	Draws	Escarpments	Reservoirs	Wells	Storage	Lateral	Cross-Formational
Armstrong	228	0	-295	-509	-2,261	0	0	-173	274	586	2,150
Carson	0	0	0	0	0	0	0	-138	310	174	-347
Dallam	0	0	0	0	0	0	0	-2,757	3,466	22	-731
Hartley	205	-313	0	985	0	0	0	-2,022	3,826	-2,566	-115
Hutchinson	0	0	0	0	0	0	0	0	0	0	0
Moore	64	0	0	-55	0	0	0	-1,605	222	34	1,340
Oldham	5,906	-3,719	-120	-9,813	0	0	0	-1,129	1,112	4,192	3,571
Potter	2,217	-1,078	-22	-3,392	-395	0	0	-1,472	1,443	1,120	1,580
Randall	86	0	0	-2,328	-747	0	0	-2,634	2,811	336	2,476
Sherman	0	0	0	0	0	0	0	-485	252	241	-8
Total	8,706	-5,110	-437	-15,112	-3403	0	0	-12,415	13,716	4,139	9,916

4.4.4 Environmental Impacts

GMA 1 District Representatives considered environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water. Because groundwater and surface water are hydrologically linked, reductions in groundwater levels can lead to either reduced outflow to surface water or increased inflow from surface water (or both). **Figure 4-4** shows the change in net flow between groundwater in the lower portion of the Dockum Aquifer and perennial surface water features as represented in the MODFLOW River Package in HPASGAM. With the substantial increase in pumping associated with the DFC model run, the flow reverses from a net outflow from the Dockum Aquifer to surface water to a net inflow to the Dockum Aquifer from surface water. The change is greatest in Oldham County, where the Dockum Aquifer has a large outcrop area and interacts with the Canadian River.

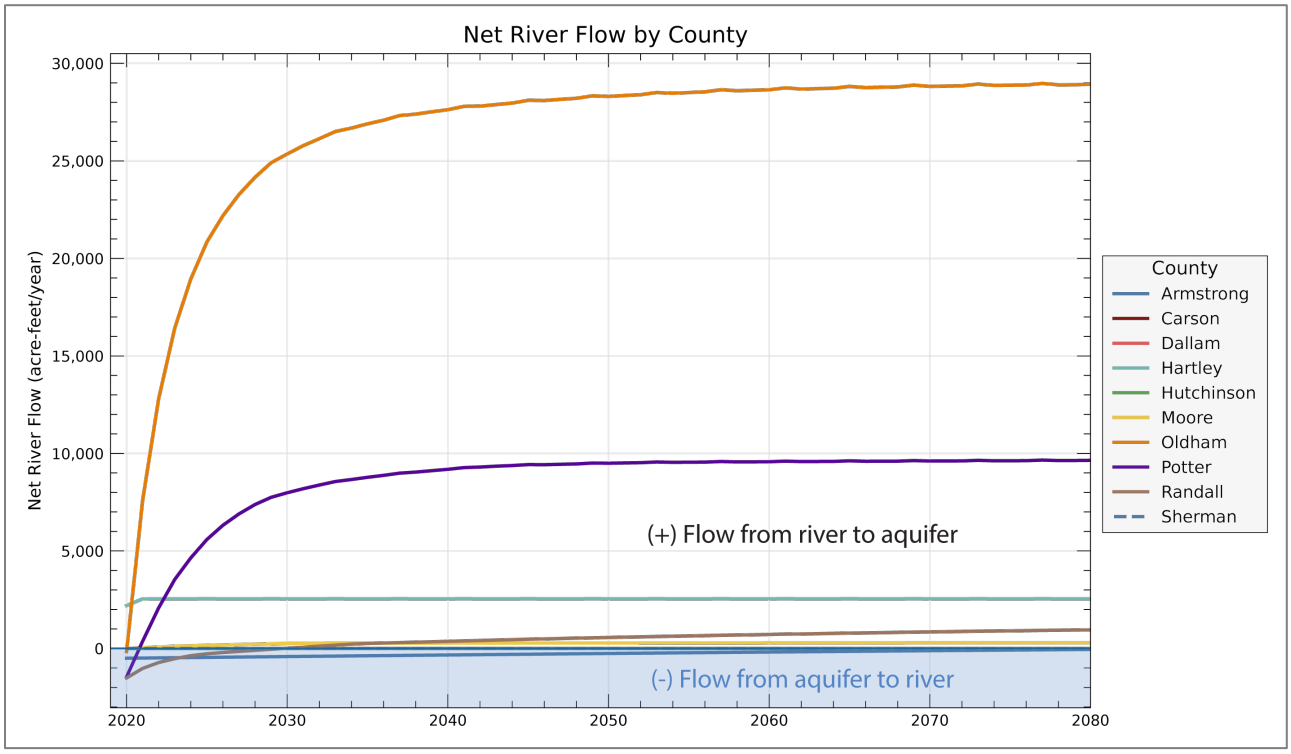


Figure 4-4. Projected interactions between surface water and groundwater for the Lower Dockum Aquifer, based on the effects of predicted groundwater pumping from the adopted DFCs.

4.4.5 Subsidence Impacts

GMA 1 District Representatives considered potential impacts of the adopted DFCs on land subsidence. This included reviewing the causes and mechanisms of land surface subsidence and the results of a recent study on subsidence risk throughout Texas (Furnans and others, 2017). The Furnans and others (2017) study concluded that the Dockum Aquifer presented a "medium" risk of compaction leading to subsidence. The study was based on review of driller's lithologic logs, historical water level changes, and hydraulic properties in the groundwater availability models.

As noted by the GMA 1 Districts and the US Geological Survey fact sheet on subsidence in the United States (Galloway and others, 2000), no substantial subsidence has historically been observed or linked to groundwater production in GMA 1. Though the Dockum Aquifer has not had the substantial development and historical water level declines to the degree the Ogallala Aquifer has, it is also an older (Triassic) geologic unit, more consolidated, and likely less susceptible to subsidence. After considering the data and methods used in Furnans and others' (2017) subsidence study in the context of other available information on subsidence in the area, the GMA 1 Districts concluded that subsidence has not been an issue and is unlikely to be an issue in GMA 1 in the future under the adopted DFCs.

4.4.6 Socioeconomic Impacts

GMA 1 District Representatives considered socioeconomic impact studies prepared by the TWDB for regional water planning purposes, along with multiple other studies that target areas in GMA 1 based on

the DFCs options during joint planning meetings identified in Table 1-1. Additional information about the sources reviewed and considered is provided in Section 3.4.6. Specific to the Dockum Aquifer, the GMA 1 Districts anticipate no significant negative socioeconomic impacts associated with the adopted DFCs. The adopted DFCs allow for substantial additional development of the aquifer, but with projected aquifer impacts unexpected to create substantial negative socioeconomic impacts to existing water users.

4.4.7 Private Property Impacts

GMA 1 District Representatives considered the impact on the interests and rights in private property, including ownership and the rights of landowners and their lessees and assigns in groundwater during joint planning meeting described in Table 1-1. A full discussion of GMA 1's consideration of this Factor is provided under Section 3.4.7—Private Property Impacts—of this Explanatory Report.

4.4.8 Achievement Feasibility

GMA 1 District Representatives considered the feasibility of achieving the adopted DFCs. Conceptually, there are two elements to the feasibility of achieving the DFCs: regulatory feasibility and physical feasibility.

Regulatory feasibility refers to whether the GMA 1 Districts have within the TWC and their respective enabling legislation the regulatory tools necessary to achieve the DFCs. For example, some uses of groundwater (such as for rural, domestic, livestock, or drilling for oil and gas) are generally exempt from production limits by a GCD. If the total expected pumping of these combined uses exceeded the groundwater availability associated with the DFC, then the DFC would clearly be regulatorily infeasible. That is, the Districts would lack the authority to manage groundwater production to achieve the DFCs. As described above, current use of the Dockum Aquifer is small, and the pumping associated with the adopted DFCs far exceeds this amount. The GMA 1 Districts considered this information and determined that the adopted DFCs are regulatorily feasible.

Physical feasibility refers to whether the various DFCs in the GMA are achievable concurrently. The physical feasibility is demonstrated by use of the model. The model run associated with the adopted DFCs shows that each of the DFCs for the Dockum Aquifer are achievable concurrently.

4.4.9 Other Information

TWC Section 36.108(d)(9) requires the districts to consider any other information relevant to the specific DFCs. The GMA 1 Districts considered whether other information existed that was necessary to review to inform the DFCs and determined that all information necessary was considered under the other eight factors.

4.5 Discussion of Other DFCs Considered

GMA 1 District Representatives chose first to evaluate the appropriateness of the DFCs adopted for the Dockum Aquifer during the 2016 round of joint planning, with minor modifications to the base year and extension to 2080 as discussed previously. After reviewing and considering the model results, the GMA 1

representatives determined that the adopted DFCs remain appropriate for the Dockum Aquifer. No other DFC options for the Dockum Aquifer were formally considered.

4.6 Discussion of Other Recommendations

GMA 1 District Representatives provided the public opportunity to comment on the DFC Joint Planning Process or recommend other DFCs at each joint planning meeting. Each District also held respective public hearings to discuss the Proposed DFCs with the public in their local service areas.

4.6.1 Advisory Committees

GMA 1 District Representatives established no advisory committees for this round of planning, and therefore no comment from such committees were filed.

4.6.2 Public Comments

On MONTH DD, YYYY, the GMA 1 Districts unanimously voted to adopt Proposed DFCs for the major aquifers in the Joint Planning Area.

A public comment period of not less than 90 days began on February 24th, 2026. During the public comment period and after posting notice (as required by TWC Section 36.063), each district held at least one public hearing on proposed DFCs relevant to that district. During the public comment period, the districts made available in their offices a copy of the proposed DFCs and any supporting materials. All documents considered in the joint planning process were organized and posted for the convenience of the public and GMA 1 membership. This included posting materials online at www.panhandlewater.org/gma-1. Individual districts held public hearings during the statutorily required not less than 90-day public input phase prior to the final adoption of DFCs.

After the public hearings and public comment period, the GMA 1 Districts reviewed relevant public comments received at the Month DD, 2026 Joint Planning meeting prior to adopting DFCs.

Through the public input process, GMA 1 Districts received # public comments, all of which were submitted to High Plains District. These summary reports documenting the public hearings conducted and comments received are included in Appendix E – Summary Reports and Public Comments Received.

5.0 Why DFCs Changed from Previous Five-year Planning Period

TWC Section 36.108(d-3)(6) requires each management area to explain, in plain language, why an adopted DFC differs from the DFC adopted in the preceding five-year joint planning period. For GMA 1, the primary objective was not to change the substantive management targets reflected in the adopted DFCs. Instead, the DFC planning period was adjusted to better align with statutory planning guidance and the best available science. TWC Section 36.108(d-1a) directs districts to adopt DFCs for each approximately 50-year planning period identified by the executive administrator of the TWDB for state and regional water planning. Under current TWDB guidance, the relevant planning horizon extends through 2080; while the end date is fixed, the start date and exact period length are flexible (consistent with "approximately"). Accordingly, GMA 1 shifted to a 2020 start year to align with the updated groundwater availability model (which is updated through 2020 and provides a consistent reference condition), resulting in a 60-year planning period (2020–2080). This adjustment also supports a move away from the prior "rolling 50-year window" approach toward a clearer, fixed horizon that is simpler to communicate, track, and implement—making district management and progress evaluation more straightforward while maintaining continuity with the intent of the previously adopted DFCs.

As a result of shifting to a fixed 2020–2080 planning horizon, some DFC statements needed to be updated to ensure the management target is achievable across the full 60-year period, rather than being implicitly "smoothed" by the prior rolling 50-year window approach. Under the prior rolling 50-year window method, drawdown targets were not evaluated at a single fixed endpoint. Instead, they were assessed across a series of overlapping 50-year planning periods within the broader horizon—specifically, twelve different 50-year windows fit between 2018 and 2080 (e.g., 2018–2068, 2019–2069, …, 2030–2080). With a fixed 2080 endpoint, the Dockum DFCs must be met explicitly at the end of the planning period, which can make the stated end-point target more stringent (or at least more clearly defined) even if the overall level of water demand represented by the adopted MAG remains broadly similar to last round. In practice, Dockum drawdown targets that were achievable under the rolling-window evaluation could not be demonstrated at the single 2080 endpoint in all areas, so clarifying end-of-period criteria were added: in Dallam, Hartley, Moore, and Sherman counties, the Dockum DFC was modified to include the condition "with at least 35 percent remaining by 2080 at the end of the planning period," and in Randall County and within the High Plains UWCD No. 1 portions of Armstrong and Potter counties, the Dockum DFC was modified to include "with less than 43 feet of average decline by 2080 at the end of the planning period." These additions do not reflect a shift in overall management intent; rather, they ensure the Dockum targets are stated and evaluated in a way that matches the updated 2020–2080 planning framework.

6.0 Summary of GCDs' Progress Toward Achieving DFCs

TWC 36.108(d-3)(7) requires Management Areas to "include a summary of how each district is performing in achieving the desired future conditions." Each member District in GMA 1 has provided a response to this prompt, which is presented in the following subsections.

6.1 North Plains GCD

North Plains GCD (NPGCD) is committed to providing the best management of groundwater resources and making every effort to ensure that an abundant supply of potable water will be available for future generations. The District maintains a network of water level monitoring wells, monitors groundwater production through metering, and conducts scientific investigations within its boundaries to ensure that the best available science is a part of all decision-making processes. Additionally, the DFCs and MAGs from each five-year Joint Planning Period play a pivotal role in NPGCD's management strategies. In order to achieve their adopted DFCs, NPGCD has dictated a groundwater production limit correlated to the size of the producer's property called the "Allowable Annual Production Limit." The District annually reviews groundwater production from the previous year and compares production totals to the most recent MAG to determine whether a reduction of the Allowable Annual Production Limit is necessary to achieve the DFCs.

In 2024, the reported pumping from the Ogallala totaled 1,182,668 acre-feet from Dallam, Hartley, Moore, and Sherman counties, which is 82% of the newly adopted Ogallala and Dockum MAGs for 2020-2030, and 494,291 acre-feet from Hansford, Hutchinson, Lipscomb, and Ochiltree counties, which is 97% of the newly adopted Ogallala and Dockum MAGs for 2020-2030. The production totals are less than the MAG and therefore demonstrate that the District is making progress towards achieving the adopted DFCs.

6.2 Panhandle GCD

For nearly 70 years, the Panhandle Groundwater Conservation District (PGCD) has managed and conserved groundwater resources within its jurisdictional boundaries. In 1998, PGCD adopted the 50/50 Management Standard, which established a long-term conservation goal of maintaining at least 50% of the groundwater in storage over a 50-year planning horizon. This standard serves as the foundation for the District's rules, permitting framework, conservation initiatives, and groundwater management.

TWC Section 36.107 requires GCDs to establish management goals and objectives that address the DFCs. In 2025, House Bill 2078 expanded these requirements by directing GCDs to provide detailed explanations for tracking and achieving DFCs, report on their five-year progress, and explain any changes from the previous planning cycle. To meet these requirements, PGCD monitors groundwater production through flow meters, measures groundwater levels annually, compares results to MAG, and reports the findings to the Board of Directors and the public.

The Ogallala Aquifer is the primary groundwater resource within the Panhandle Groundwater Conservation District and is conserved for the benefit of current and future generations through the adoption of the 50/50 DFC. The 50/50 DFC for the Ogallala Aquifer within PGCD boundaries states that

at least 50 percent of the volume in storage will remain in 50 years. To achieve this, PGCD rules limit production to one acre-foot per contiguous acre tract per year and require annual reporting of production through approved metering methods. The groundwater production reported is then compared with the estimates of MAG. (The term "modeled available groundwater" is defined in Texas Water Code Section 36.001(a)(25) as "the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition.") The MAG for the Ogallala Aquifer in the PGCD provides a District total average of 981,487 acre-feet per year for the 2020 decade (Anaya, 2023). From 2020 through 2024, total groundwater use within the District averaged approximately 309,582 acre-feet per year. Current production from the Ogallala Aquifer within the PGCD is approximately 30% of the MAG target established for this period, demonstrating that groundwater use is consistent with achieving the 50/50 DFC.

The Dockum Aquifer is managed under a different DFC that limits the average water level decline to no more than 30 feet over 50 years. Production limits are the same as those applied to the Ogallala Aquifer, and PGCD monitors groundwater use from the Dockum Aquifer using approved metering methods and groundwater level declines. A comparison of the District's 2020 decade MAG for the Dockum Aquifer of 35,479 acre-feet per year with PGCD's average production from 2020 through 2024 of 5,531 acre-feet per year demonstrates that current groundwater withdrawals are consistent with achieving the adopted DFC (Anaya, 2023). Additionally, PGCD monitoring of groundwater levels shows that, from 2020 through 2025, average water levels declined by approximately 0.05 foot per year, indicating that the Dockum Aquifer is currently meeting its DFCs.

Together, PGCD's conservation programs, maximum production limits, groundwater level monitoring, and annual meter production reviews ensure that groundwater use continues to preserve the longevity of the water resources within the District and that the adopted DFCs are achieved.

6.3 Hemphill County UWCD

Hemphill County UWCD releases an annual report to evaluate their DFC and Decline Rate. To track the DFC, the saturated volume of the aquifer is calculated for each fiscal year, beginning in 2010, from the 3D geological model, which maps a saturated volume from the year's water levels and a static red bed surface. This analysis shows that water in storage is generally consistent yearly and is currently well above the DFC (**Figure 6-1**). The exact volume of water in storage is uncertain, as the estimate depends on assuming a specific yield. Regardless of the assumed specific yield, it is apparent that water levels remain generally steady in Hemphill County.

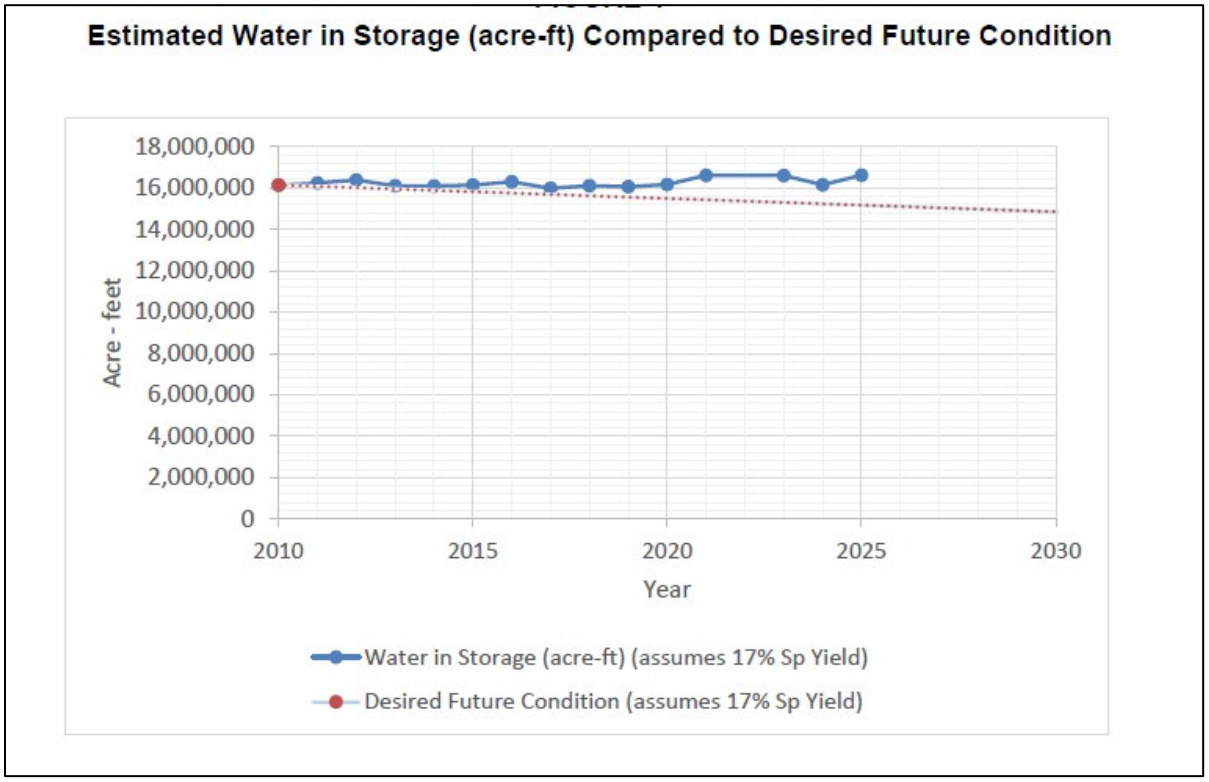


Figure 6-1. Estimated Water in Storage (ac-ft) Compared to the DFC in Hemphill County.

6.4 High Plains UWCD No.1

High Plains Underground Water Conservation District No. 1 (HPUWCD No. 1) reports that no changes to its current approach for tracking progress toward achieving adopted DFCs are planned at this time. The District evaluates annual groundwater-level observations by plotting measured water levels as a time-series and comparing those observations to modeled trend lines. Cumulative groundwater-level changes are then assessed at multiple scales, including both a District-wide basis and across the portion of the District that lies within Groundwater Management Area No. 2 (GMA 2), which comprises the majority of the District's service area. This monitoring and comparison framework provides an ongoing basis for evaluating whether observed conditions are tracking consistently with the adopted DFCs.

7.0 Non-relevant Aquifers

GMA 1 district representatives considered the relevance of the Blaine Aquifer in the overall joint-planning process for adopting DFCs. The Blaine Aquifer occurs only in limited portions of GMA 1—specifically within the Panhandle GCD in Wheeler County. To support the relevancy evaluation, Panhandle GCD prepared a detailed technical review of the Blaine Aquifer in "Panhandle GCD Technical Memorandum: Aquifer Relevancy Determination for the Blaine Aquifer within the Panhandle Groundwater Conservation District & Groundwater Management Area 1" (Ausbrooks, 2025). This memorandum is provided in Appendix F.

The Blaine Aquifer, both within Panhandle GCD and in GMA 1, is isolated to the south- southeastern portion of Wheeler County (see **Figure 7-1**). A more detailed map of the Blaine Aquifer (subcrop only), along with the locations of registered/permitted Blaine Aquifer wells, is illustrated in **Figure 7-2**.

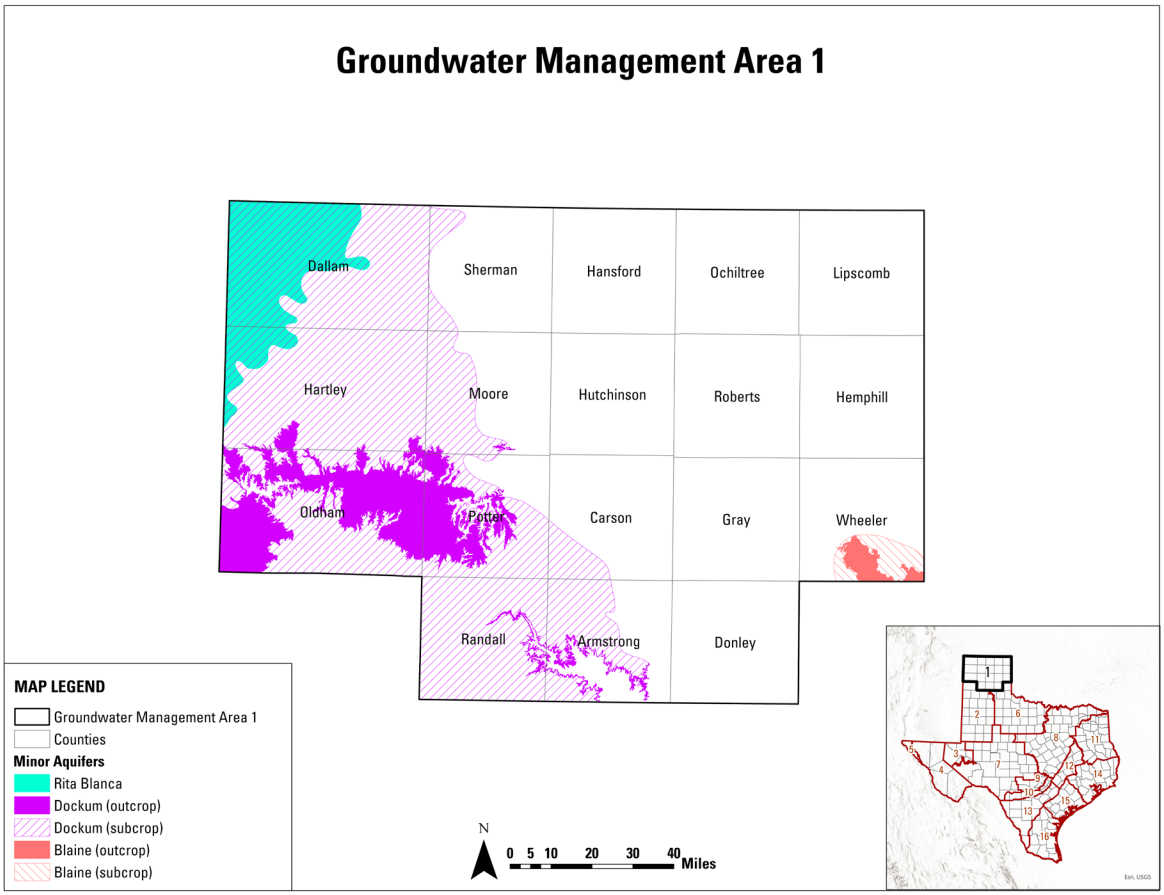


Figure 7-1. Map of minor aquifers designated by the TWDB in GMA 1.

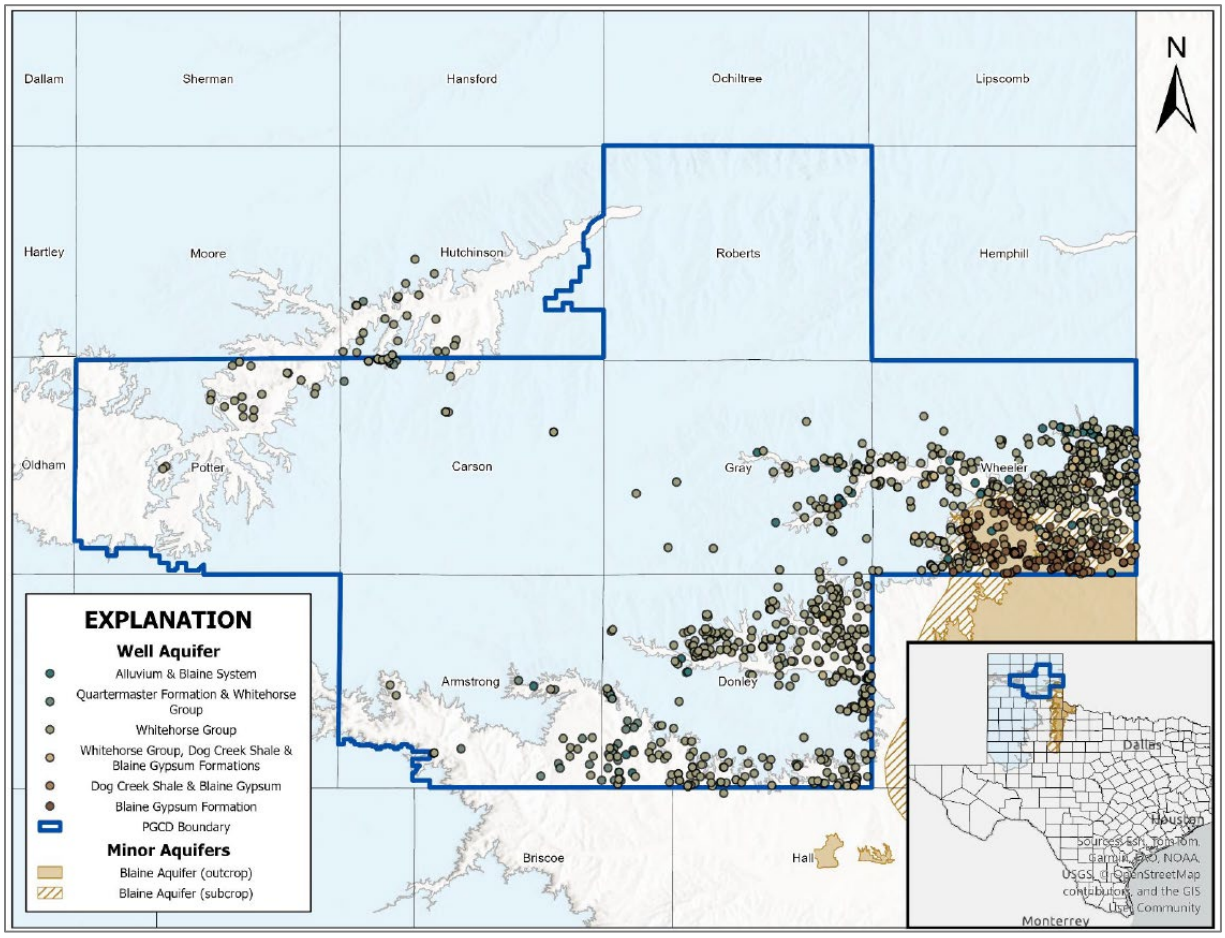


Figure 7-2. Map of the Blaine Aquifer in Wheeler County, including locations of registered/permitted Blaine Aquifer wells (Ausbrooks, 2025).

Table 7-1 includes estimates of TERS for the Blaine Aquifer in Wheeler County (from Kohlrenken, 2013). The limitations of the TERS calculations described for the Ogallala and Dockum aquifers also apply to the Blaine Aquifer.

Due to the very limited use of the Blaine Aquifer in Wheeler County, we feel at this time that insufficient justification exists to develop statements of DFCs, management goals, objectives, performance standards, and rules for the Blaine Aquifer in Wheeler County.

Table 7-1. Total estimated recoverable storage for the Blaine Aquifer in Wheeler County.

County	Total Storage (acre feet)	25 percent of Total Storage (acre feet)	75 percent of Total Storage (acre feet)
Wheeler	6,700,000	1,675,000	5,025,000

Ausbrooks (2025) concluded that, due to the limited use of the Blaine Aquifer in Armstrong, Potter, Gray, Donley, and Wheeler counties, there was insufficient justification to develop DFC statements, management goals and objectives, performance standards, and district rules specific to the Blaine Aquifer within PGCD. The memorandum recommended that the Panhandle GCD Board of Directors request that the GMA 1 district representatives designate the Blaine Aquifer as non-relevant for purposes of joint planning for the current cycle. The GMA 1 district representatives agreed with these findings and, given the very limited use of the Blaine Aquifer in Wheeler County, determined that there is not sufficient justification at this time to develop DFCs or associated management provisions for the Blaine Aquifer as part of GMA 1 joint planning

8.0 References

Amosson, S. 2014a. Economic Impacts of Selected Water Conservation Policies in the Ogallala Aquifer Report.

Amosson, S. 2014b. Evaluation of Changing Land Use and Potential Water Conservation Strategies: North Plains Groundwater Conservation District.

Anaya, R. (2023). GAM RUN 21-007 MAG: Modeled Available Groundwater for the High Plains Aquifer System in Groundwater Management Area 1 (No. GR21-007 MAG). Texas Water Development Board. https://www.twdb.texas.gov/groundwater/docs/GAMruns/GR21-007_MAG.pdf

Ausbrooks, A., 2025. Panhandle GCD Technical Memorandum: Aquifer Relevancy Determination for the Blaine Aquifer within the Panhandle Groundwater Conservation District & Groundwater Management Area 1. September 23, 2025. Prepared for the Panhandle Groundwater Conservation District.

Bradley, R.G., and Kalaswad, S. 2003. The Groundwater Resources of the Dockum Aquifer in Texas: TWDB Report No. 359.

Cawthon and others (2025) Extension of the Groundwater Availability Model for the High Plains Aquifer System through 2020 (version 1.02), TWDB Report.

Christian, P. 1989. Evaluation of Ground-water Resources in Dallam County, Texas: TWDB Report 315.

Deeds, Neil and M. Jigmond. 2015. Final Conceptual Model Report for the High Plains Aquifer System Groundwater Availability Model, Prepared for TWDB: INTERA Incorporated Report.

Furnans, J., Keester, M., Colvin, D., Bauer, J., Barber, J., Gin, G., Danielson, V., Erickson, L., Ryan, R., Khorzad, K., Worsley, A., Snyder, G. 2017. Identification of the Vulnerability of the Major and Minor Aquifers of Texas to Subsidence with Regard to Groundwater Pumping, Final Report. Texas Water Development Board Contract Number 1648308062. 434 p.

Galloway, D.L., Jones, D.R., Ingebritsen, S.E. 2000. Land Subsidence in the United States. U.S. Geological Survey Fact Sheet 165-00. 4 p.

George, P. G., Mace, R. E., and Petrossian, R. 2011. Aquifers of Texas: Texas Water Development Board, Report 380, 182 pg: GMA 1 Joint Planning Committee Meeting – May 30, 2014, February 25, 2016.

Good, K. 2015. Presentation Regarding the Impact on the Interest and Rights in Private Property, Including Ownership and the Rights of Management Area Landowners and their Lessees, Assigns, in Groundwater as Recognized Under Texas Water Code 36.002: GMA 1 Joint Planning Committee Meeting – February 18, 2015.

Hopkins, J., and Muller, C. 2011. Water Quality in the Blaine Aquifer: Texas Water Development Board Report 376, 40 p.

Johnson, Jeff, Johnson, P., Segarra, E., Willis, D., 2007. Water Conservation Policy Alternatives for the Ogallala Aquifer in Texas.

Knowles, T., Nordstrom, P., and Klemt, W.B. 1984. Evaluating the Ground-water Resources of the High Plains of Texas: TDWR Rept. 288, 4 vols.

Kohlrenken, W. 2013. GAM Task 13-025: Total Estimated Recoverable Storage for Aquifers in Groundwater Management Area 1; Texas Water Development Board, GAM Technical Memorandum, 20 p.

_____. 2015. TWDB GAM Task Report 15-006.

Maderak, M. L. 1973. Ground-water Resources of Wheeler and Eastern Gray Counties, Texas: Texas Water Development Board Report 170, 67 p.

Norvell, Stuart and Shaw, Doug 2010. Socioeconomic Impacts of Projected Water Shortages for the Panhandle (Region A) Regional Water Planning Area Prepared in Support of the 2011 Panhandle Regional Water Plan TWDB: GMA 1 Joint Planning Committee Meeting – August 19, 2014.

Panhandle Regional Water Planning Group (PRWPG). 2025. Region A, 2026 Water Plan.

Panhandle Regional Planning Commission (PRPC). 2016. Aquifer maps provided for use by the GMA 1 Joint Planning Committee.

Scott Land Company LLC, Clift Land Brokers and the USFMRA Land Trends. 2016. Letter of Opinion Concerning Texas Panhandle Land Values: Hemphill UWCD.

Tewari, Rachna and others. 2014. Multi-year Water Allocation: an Economic Approach towards Future Planning and Management of Declining Groundwater Resources in the Texas Panhandle, Texas Water Journal: GMA 1 Joint Planning Committee Meeting – August 19, 2014.

Texas Water Development Board (TWDB). 2007.

_____. 2021. Maps of Major and Minor Aquifers in Texas. Accessed online at: https://tnris.org/maps/

_____. 2022. Water for Texas–2022: The State Water Plan, Volumes I and II, variously paginated.

_____. 2023. Historical groundwater pumping records. TWDB Database.

_____. 2025. GIS Data: https://www.twdb.texas.gov/mapping/gisdata.asp#DataHub. TWDB Database

Weinheimer, J., Johnson, P., Johnson, J., Guerrero, B., Amosson, S., 2008. Economic Impacts of Groundwater Management Standards In the Panhandle Groundwater Conservation District of Texas. Department of Agricultural and Applied Economics, Texas Tech University

_____. 2012. Economic Impacts of Groundwater Management Standards in the Panhandle Groundwater Conservation District of Texas.

APPENDIX A

DESIRED FUTURE CONDITION DOCUMENTS

APPENDIX B

MEETING DOCUMENTATION

APPENDIX C

MODEL RUN DOCUMENTATION

APPENDIX D

FACTOR ANALYSIS AND PRESENTATIONS

APPENDIX E

SUMMARY REPORTS AND PUBLIC COMMENTS RECEIVED