IMPROVING WATER PLANNING IN TEXAS

The Critical but Overlooked Link Between Desired Future Conditions and the State Water Plan

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Abstract

This report explains the process by which Texas Groundwater Conservation Districts (GCDs) have executed their statutorily required planning function to arrive at a Desired Future Condition (DFC) and the inextricable link that exists between DFC development and state water planning. We first provide background information on legislative history, Groundwater Management Area (GMA) joint planning, and the DFC process itself. The report describes the important and inextricable linkage between DFC development, Modeled Available Groundwater (MAG) determination and how this does or does not inform regional and state water planning efforts. To highlight the limitation of an "administrative review" of explanatory reports submitted in support of DFC by various GCDs and GMAs, we identify technical and significant differences in both documenting and justifying adherence to statutory requirements regarding the development of the DFCs. Recognizing that not all GCDs are created equal or have similar and sustainable funding for the development of the DFCs, we highlight differing processes and perspective views from a few GCDs based on our review of their explanatory reports. Lastly, recognizing the myriad of challenges and limitations, we provide recommendations of how the DFC process could be enhanced for the benefit of all users and uses, including the preservation of groundwater resources to ensure their sustainability.

Key Words

Acronym/Initialism	Descriptive Name
DFC	Desired Future Condition
GCD	Groundwater Conservation District
GMA	Groundwater Management Area
GW/SW	Groundwater - Surface Water
MAG	Modeled Available Groundwater
TCEQ	Texas Commission on Environmental Quality
TWDB	Texas Water Development Board
TWC or WC	Texas Water Code
WAM	Water Availability Model

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Introduction

Texas prides itself on a regionally driven water planning process that ensures the state is prepared for drought by identifying water supply strategies that will meet water demands during a recurrence of the worst recorded drought in Texas history, known as "the drought of record." According to the Texas Water Development Board, the State Water Plan provides "Texas with a clear and credible path to providing water to protect its growing economy and the more than 50 million Texans anticipated to be here by 2070."[1] However, as this report explores, with respect to groundwater planning and availability, Texas' water planning process is flawed, placing water supplies and communities at risk.

Groundwater is arguably the most important water supply in Texas. More than 50 percent of the state's total water supply comes from groundwater in 9 major and 21 minor aquifers. Groundwater also sustains an average of 30% of the surface water flowing in Texas rivers, a critical source of water for the state as well.[2] Furthermore, in rural communities across Texas, groundwater from domestic wells is the sole source of water for landowners.

For purposes of state water planning, groundwater is a significant water supply strategy to address water demands during drought. In the 2022 State Water Plan, for example, regional water planning groups recommended over 920,000 acre-feet of groundwater to meet future water needs, approximately 12 percent of the total recommended water strategies in the plan. Surface water from the state's rivers continues to be the largest water source on which strategies are based, providing over 2.8 million acre-feet per year to water user groups, approximately 37 percent of the total recommended water supply strategies.[3] Given the significance of surface water in meeting the state's future water demands, it is important to reemphasize that groundwater contributes a significant portion of surface water flow in rivers, particularly during drought when a lack of rainfall reduces runoff.

As this report reveals, many of the water supply strategies in the State Water Plan that are sourced from groundwater, unfortunately, are developed without an understanding of whether the groundwater supply is sustainable in the future. In fact, groundwater availability in the State Water Plan is premised on unsustainable planning goals that allow aquifers to decline over time, threatening the reliability of groundwater as a water supply in the future. And because the State Water Plan does not consider how declining aquifer levels diminish surface water in reservoirs and rivers, surface water supply strategies in the plan are not as reliable as we might think. The reasons for these flaws are complex but boil down to a lack of clear sustainability mandates in groundwater planning and management, lack of sufficient and sustainable funding and a lack of

data and science. Improvements to groundwater planning in Texas are sorely needed to ensure state water planning is sound and to ensure that Texans have sustainable water supplies in the future.

This report provides a background and overview of the statutory history and framework that governs groundwater planning in Texas, referred to as the desired future condition or DFC process. There are many other articles that provide a more detailed discussion of the law and regulations, which we have included as references at the end of this report. The intent of this report is to examine and critique the flaws in the current DFC framework and the impact these flaws have on water planning in Texas and to provide recommendations for how the process can be improved. Consistency in regulatory requirements drives our desire to limit the areas for potential process enhancement. To be clear, none of our recommendations call for, nor should they be interpreted as a call for, the modification or erosion of the purview GCDs have over groundwater. On the contrary, our recommendations should enhance GCDs' responsibility to protect ownership rights to groundwater.

Background

Legislative History

The history of ownership and regulation of groundwater resources has evolved through time. For purposes of this report, and its DFC centric review, we focus on the most recent legislative action that defines the process and relevance for proper development of DFCs - and its inextricable link to state water planning.

Texas Water Code provisions and legislative action make it clear that the expressed preference for groundwater resource management in Texas is at the local level, by Groundwater Conservation Districts (GCDs), which consequently, are organized along county or administrative boundaries as opposed to regional aquifer or hydrogeological boundaries.[4] S.B. 1 in 1997 codified the state's preference for management of groundwater by local GCDs and created initial requirements for the development of GCD management plans.[5] In addition, our current regional and state water planning process, calling for a "bottom-up" approach, is rooted in the passage of Senate Bill 1.

Although local management of groundwater is preferred in Texas, the fragmented regulatory structure that it created posed challenges for regional water planning and groundwater availability. To address this fragmented regulatory structure and "to help generate groundwater policies that considered the shared groundwater resources among the GCDs," the Legislature passed H.B. 1763, which required GCDs over the same aquifer to participate in joint planning within their groundwater management area and to develop DFCs.[6] Interestingly, the provisions in H.B. 1763 that created the DFC process were added by Senator Robert Duncan (Lubbock) through a Senate floor amendment that was approved with very little discussion just a few days before the conclusion of the 79th Legislative Session.[7]

By 2011, when the TWDB was up for Sunset Review, it was apparent that GCDs needed additional parameters and guidance beyond the framework established by HB 1763 in setting DFCs. H.B. 1763 left the process open-ended and ill-defined and this had implications for regional water planning. The Sunset Advisory Commission recognized that:

> *evolving processes associated with groundwater affect the Board's ability to effectively conduct statewide water planning and ultimately affect the management of this vital resource. Much of this controversy surrounds a joint planning process in which groundwater districts join together to make decisions about the future condition of aquifers they manage. The idea behind joint planning is to get local groundwater districts to work cooperatively, using acceptable scientific information, to guide decisions about an aquifer's desired future condition.*[8]

To improve the joint planning process as recommended by the Sunset Advisory Commission, Senate Bill 660, the TWDB Sunset Bill in 2011, added additional elements to the joint planning process to provide GCDs with guidance to ensure proposed DFCs were reasonable. Sunset reviews often lead to significant policy changes and charges to the agency under review, and S.B. 660 certainly was a vehicle of change. Aside from adding meeting posting and transparency requirements to Chapter 36 of the Water Code, the bill also codified the nine elements to be considered in the development of a DFC, described in more detail below.

The origin of the nine elements is rooted in pre-S.B. 660 TWDB rules on how the TWDB determined the reasonable nature of an established DFC when a challenge to a DFC was in play. The Sunset review resulted in moving the nine elements from an agency rule to a statutory requirement. The final Bill analysis of the Enrolled version of S.B. 660, specific to the changes in the bill impacting groundwater planning and DFC development states:

> *The bill requires groundwater management areas to document factors or criteria considered in adopting DFCs and to submit that documentation in an explanatory report to TWDB. S.B. 660 also requires a representative of a district in each groundwater management area that overlaps with a regional water planning group to serve as a voting member of that regional water planning group. The bill requires that regional water planning groups use DFCs in place at the time of adoption of TWDB's State Water Plan in the next water planning cycle.*

GCDs and GMAs have now had two DFC development cycles governed by the changes called for under S.B. 660. We acknowledge that consistency in regulatory requirements is important over time to determine deficiencies and recommended changes. Two DFC cycles under the same regulatory requirements is not a significant amount of time. Yet, as described below, we have identified areas where improvement in DFC development could lead to better management of groundwater resources by GCDs and improved state water planning.

It is important to note that as S.B. 660 was being enacted, a most significant element of legislative duties was taking place – budget development. Texas prides itself in its budget process that caps spending to predictable spending limits and available revenue. Available revenue can be a great limiting factor as it has been for past budget cycles, and certainly in 2011 when new requirements were called for under S.B. 660. That approved budget resulted in significant reductions in available funding to the TWDB for groundwater modeling and science. In recent decades the TWDB has been charged and funded to develop its lending capacity as the state's water bank. This is a critical function of the TWDB. However, this focus on lending and funding needed infrastructure resulted in a disproportionate impact to the TWDBs other equally critical functions of planning and science. Modeling efforts that assist planners and regulators in determining water availability have been significantly reduced in funding since 2011. This is noteworthy as GCDs are not funded by the TWDB to undertake their critical DFC development process. As noted at the recent Senate Water, Agriculture and Rural Affairs and House Natural Resources committee meetings, not all GCDs have similar funding capacity to undertake these efforts. Those disparities are magnified when the state enacts new requirements of GCDs as occurred in 2011 under S.B. 660 – without commensurate and sustainable funding. Therefore, we accept that perceived process deficiencies can also be driven more so by inadequate funding.

Groundwater Management Area Joint Planning

Groundwater management and planning are critical elements of the state water planning process. The long-term management goals or DFCs that GCDs adopt inform the availability of groundwater under the regional and ultimately the state water planning process.
Section 36.108 of the Water Code, which was enacted by passage of S.B. 660 in 2011, describes this process, referred to as joint planning. GCDs with jurisdiction over shared aquifers work together in a groundwater management area (GMA) to establish desired future conditions for these aquifers. The TWDB determines the boundaries of GMAs, which generally follow the hydrogeological boundaries of aquifers across Texas. Together, GCDs within a GMA determine the desired future conditions for aquifers within their jurisdiction that are relevant to joint planning. GCDs are required to develop DFCs every five years.

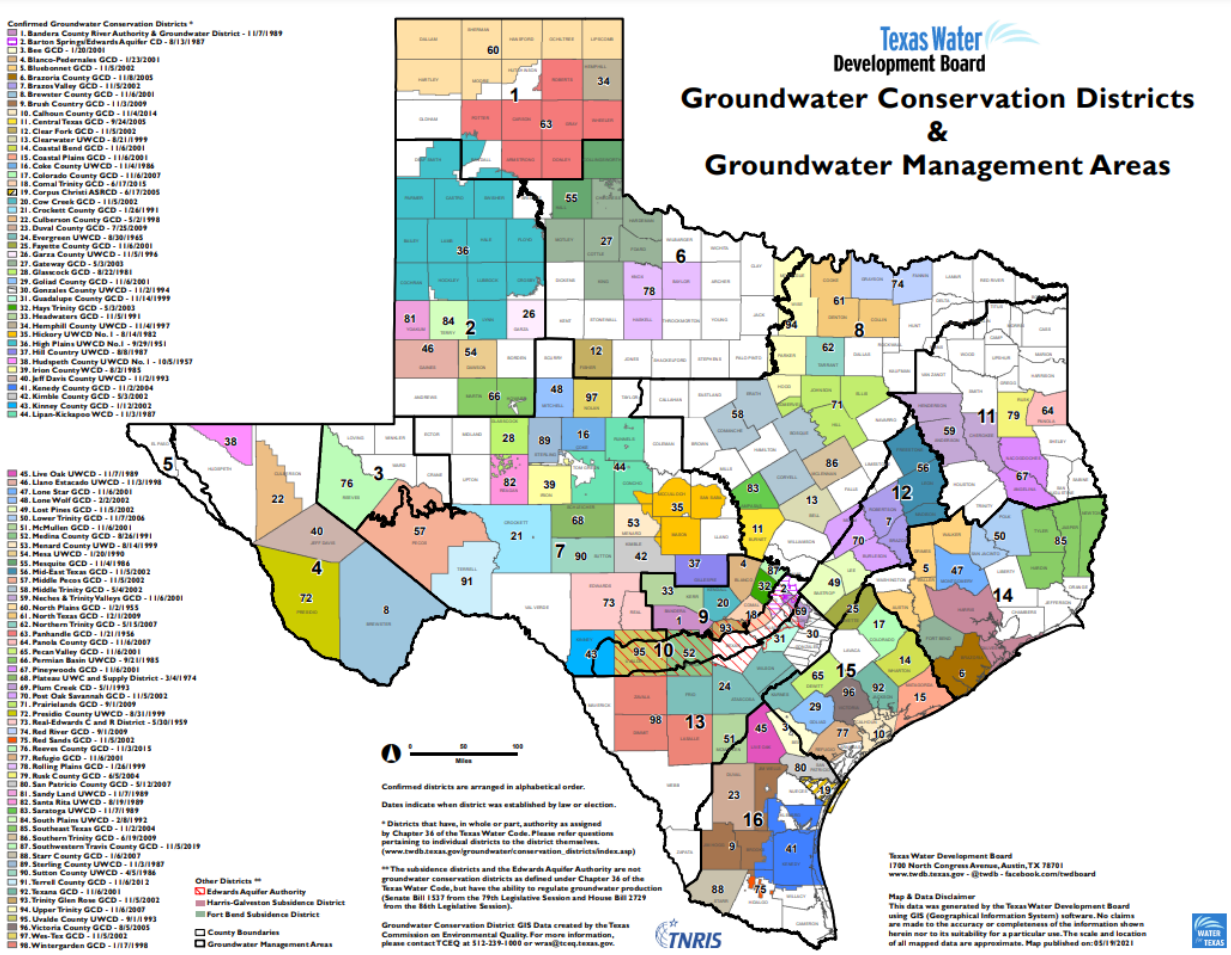

Figure 1. Groundwater Management Areas and Groundwater Conservation Districts. Source: Texas Water Development Board

DFC Process

DFCs are defined as the "the desired, quantified conditions of groundwater resources (such as water levels, water quality, springflow, or saturated thickness) at a specified time or times in the future" — essentially a long-term objective for how much groundwater will remain in the aquifer in 50 years.[9] To assist GCDs with adoption of DFCs, TWDB provides GCDs with regional groundwater availability models or GAMs as required by Tex. Water Code 16.012(l). GCDs must consider the GAMs provided by the TWDB when adopting DFCs. In addition to consideration of the GAM, under 36.108(d), GCDs are required to consider nine factors when adopting DFCs:

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 as recognized under Section 36.002.
8. The feasibility of achieving the desired future condition.
9. Any other information relevant to the specific desired future conditions.

DFCs must balance the highest practicable level of groundwater production against conserving and preserving groundwater and preventing waste and subsidence. Tex. Water Code § 36.108(d-1). GCDs in each GMA submit their DFCs to the TWDB in an explanatory report, which provides policy and technical justification for the DFC, as well as documentation that the nine factors under Section 36.108(d) were considered by the districts and a discussion of how the adopted desired future conditions impact each factor. The TWDB determines whether the explanatory report is administratively complete. This process is set out in TWDB's rules under 31 TAC § 356.33.

Modeled Available Groundwater

Under Section 36.1084(b), the TWDB is required to provide the modeled available groundwater (MAG) for the aquifer— the amount of groundwater that can be pumped and achieve the DFC – to GCDs and regional water planning groups. Additionally, under Section 36.1132, the TWDB is required to provide GCDs with an estimate of the current and projected amount of groundwater produced under exemptions within the district, as these exempt pumping volumes are included in the MAG.

The MAG has two important roles. First, GCDs use the MAG as a factor in their permitting decisions, as Section 36.1132 requires GCDs to manage total groundwater production on a long-term basis to achieve an applicable desired future condition. Second, the MAG plays an important role in regional water planning decisions. To help the state develop future water supplies, the Water Code tasks regional water planning groups with, among other things, quantifying current and projected population and water demands over a 50-year planning horizon and evaluating and quantifying current water supplies within each region. Chapter 16 of the Water Code requires regional water plans to be consistent with the DFC for the relevant aquifer in the regional planning area and requires regional planning groups to use the MAG volume for groundwater availability. Regional water planning groups may not recommend water management strategies that exceed MAG volumes. Thus, the long-term management goals or DFCs that local GCDs adopt heavily influence the availability of groundwater under the regional and ultimately the state water planning process.

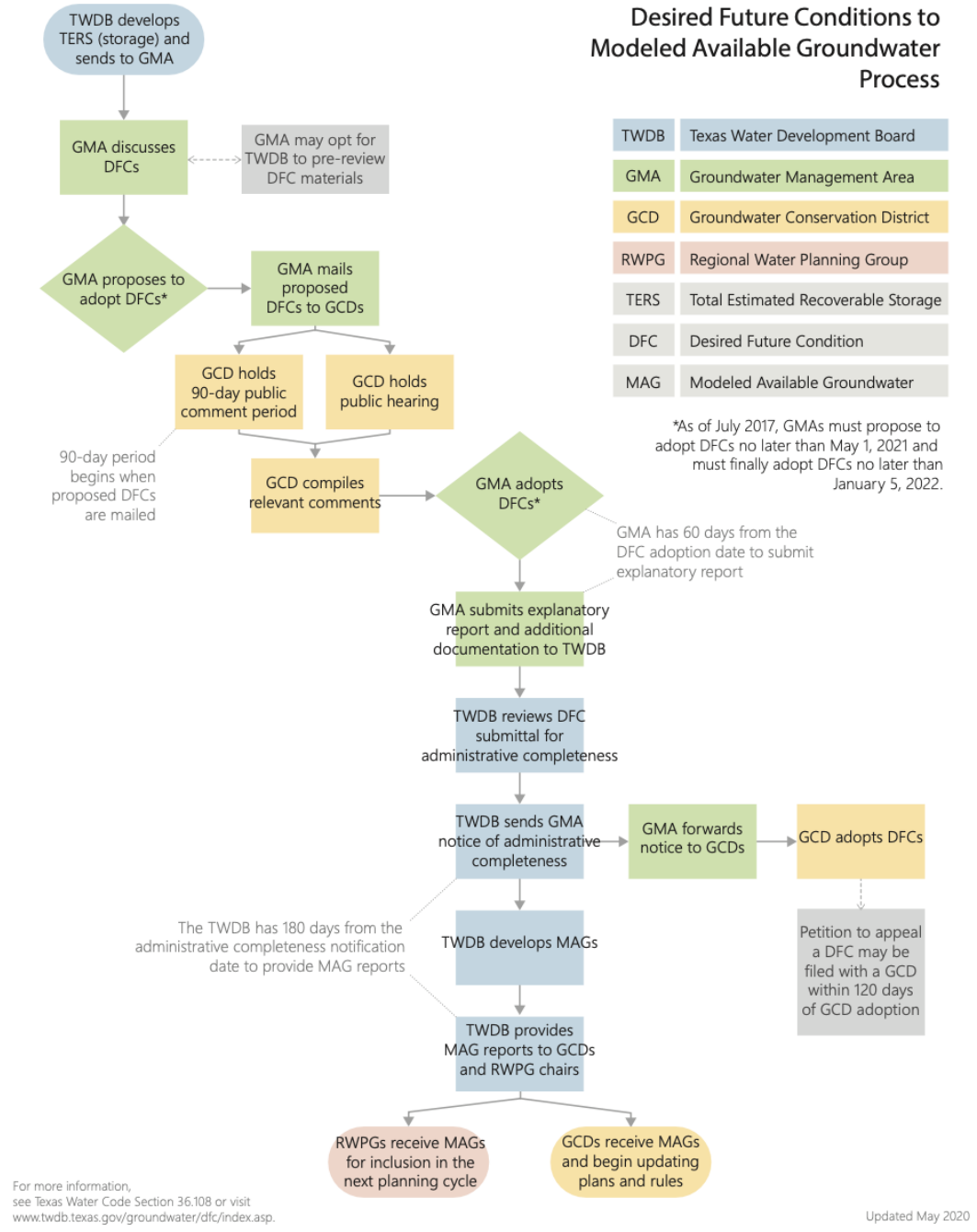

Figure 2. DFC Flow Chart. Source: Texas Water Development Board

Managing to Achieve the DFC

Chapter 36 of the Texas Water Code requires GCDs to develop local management plans that detail how they will achieve certain management goals and particularly, how GCDs will manage groundwater to achieve the DFC. Chapter 36 requires GCDs to address eight goals in their management plans:

1. Most efficient use of groundwater.
2. Controlling and preventing waste.
3. Controlling and preventing subsidence.
4. Addressing conjunctive surface water management issues.
5. Addressing natural resource issues.
6. Addressing drought conditions.
7. Addressing conservation, recharge enhancement, rainwater harvesting, precipitation. enhancement or brush control, where appropriate and cost-effective.
8. Addressing the desired future conditions adopted.

Under Section 36.1071(e)(3), GCDs must include in their management plan estimates of modeled available groundwater; the amount of groundwater being used within the district on an annual basis; the annual amount of recharge from precipitation, if any, to the groundwater resources within the district; for each aquifer, the annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams, and rivers; the annual volume of flow into and out of the district within each aquifer and between aquifers in the district, if a groundwater availability model is available; the projected surface water supply in the district according to the most recently adopted state water plan; and the projected total demand for water in the district according to the most recently adopted state water plan. Under 31 TAC § 356.52, the TWDB provides these estimates for GCDs to include in their management plans.

If requested by a GCD, under Section 36.1071(c), the TWDB must provide technical assistance to the GCDs in development of a management plan. Additionally, under Section 36.107(f), GCDs must submit their management plans to the executive administrator of the Texas Water Development Board for approval; however, this approval is limited to an administrative completeness review, not a substantive review.

Impact on Water Planning

Despite Texas having a regulatory structure to manage groundwater, groundwater levels are declining in many aquifers across the state. According to a study conducted by the Texas Water Development Board, "[t]otal water-level declines in the state's aquifers since 1900 range from less than 50 feet to more than 1,000 feet. The greatest water-level declines are in the Trinity Aquifer, focused in the Dallas–Fort Worth and Waco areas…All of these water-level declines have been caused by groundwater pumping, primarily since the 1950s."[10] A key point from the report is that "groundwater levels in all major and minor aquifers have declined."[11] The DFC process, which was meant to find a balance between the production and conservation of groundwater, has not resulted in groundwater levels being preserved. In fact, a study by the Meadows Center for Water and the Environment revealed "[a]bout 95 percent of locally-expressed desired future conditions are based on water-level declines" and that through the DFC process, "groundwater conservation districts have made almost twice as much groundwater available for use in 2070 than can be produced sustainably in these aquifers."[12] Essentially, this means that "Texas plans to unsustainably produce groundwater from more aquifers in the future," and this will have profound consequences on water planning in Texas as additional unmet needs will be created.[13] What is especially concerning, though, is that these potential implications are difficult for state leaders to ascertain because they are concealed behind a groundwater planning framework (the DFC process) that on all accounts appears robust. In reality, there are flaws in the DFC process that place Texans' water security at risk.

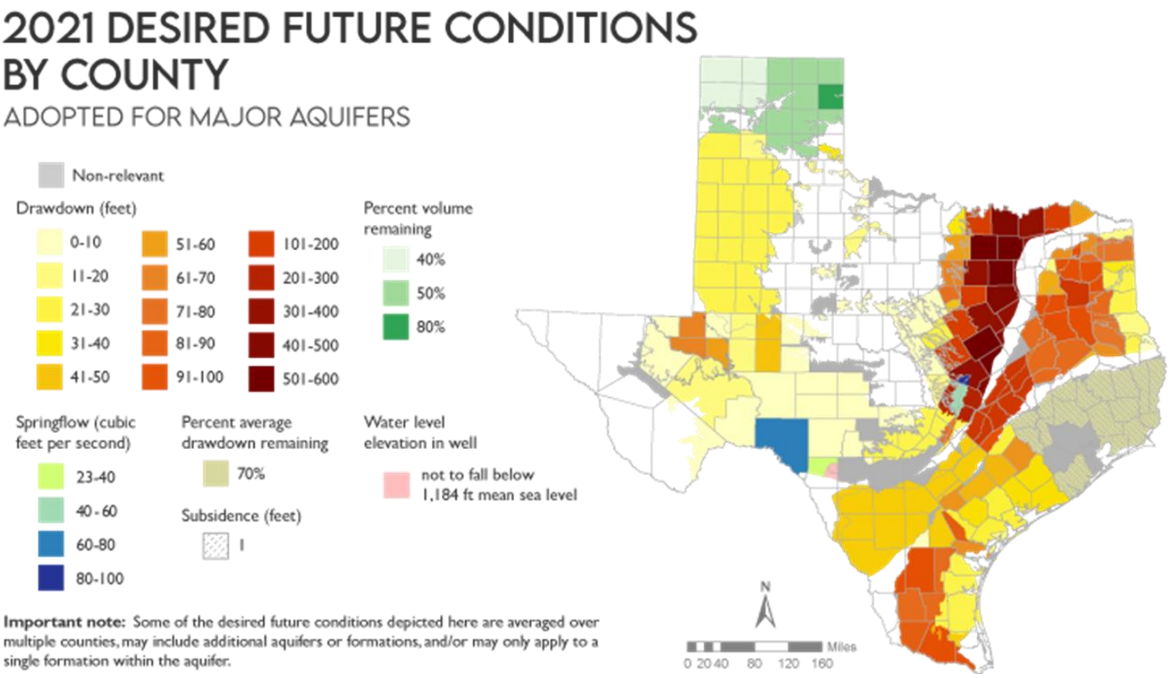

Figure 3. 2021 Desired Future Conditions By County. Source: Texas Water Development Board

As previously stated, the development of DFCs informs regional water planning. DFCs are the basis by which the TWDB develops modeled available groundwater or MAG volumes. It is the MAG volume that informs regional water planning as it relates to groundwater availability to meet current and future water needs/demands. In the DFC Process section above we explore the statutory requirements that GCDs must consider in the proper development of the DFCs. This is critical, because the more robust the consideration of the statutory requirements by the GCDs, the better informed the MAG development process will be. The better developed and informed the MAG, the better regional planning assumptions will be.

Texans may expect that the adoption of the DFC and the acceptance of its explanatory reports to justify the DFC development and subsequent MAG volume determinations are conducted under a robust review by a state agency. The fact, as we will explore in greater detail below, is that DFCs are only subject to an administrative review. Put another way, there is no robust review by a state agency of the submitted data and decisions that in the end must inform our regional water planning process.

Flaws in the DFC Process

As discussed in *Background Section- Legislative History*, as part of the Sunset process, the Legislature amended the DFC process in 2011 and established a more robust framework to inform the development of DFCs. The nine criteria are critical pillars of this process, providing a holistic way for GCDs to examine how a chosen DFC will impact communities in the future. The extent to which GCDs are able to thoroughly make these considerations, however, varies and for some criteria, is lacking. Additionally, there are important components and supports missing from the DFC process that inhibit GCDs from sufficiently evaluating future impacts from a DFC. In this section, we discuss significant challenges or flaws in the DFC process that may impede the effectiveness of the process for long-term planning. It is important to note that despite these flaws, the DFC process does provide a sound framework for GCDs to use to set long-term planning and management goals, but improvements are needed to ensure it remains effective in the future as Texas' water demands increase and supplies decline.

Groundwater Availability Models

Groundwater models are important tools that GCDs use during joint planning. A revealing view of how GCDs and GMAs think and utilize available models can be found in a GMA 7 explanatory report:

> *A groundwater model is a tool that can be used to run "experiments" to better understand the cause-and-effect relationships within a groundwater system as they relate to groundwater management...Much of the consideration of the nine statutory factors involves understanding the effects or the impacts of a*

> *desired future condition (e.g. groundwater-surface water interaction and property rights). The use of the models in this manner in evaluating the impacts of alternative futures is an effective means of developing information for the groundwater conservation districts as they develop desired future conditions.*

The TWDB has a critical statutory responsibility to develop groundwater availability models or GAMs. As described above, these regional models are utilized by GMAs during joint planning to inform the adoption of DFCs and are utilized by the TWDB when calculating the MAG. Thus, they are critical to regional and state water planning in Texas.

The Texas Water Development Board's website on groundwater modeling states the following:

> *Groundwater, along with surface water, is important for maintaining the viability of the state's natural resources, health, and economic development. The projected doubling of the state's population by the year 2060, coupled with the constant threat of drought, makes it imperative that Texas develop effective plans to meet future water needs. Effective planning, however, requires accurate assessments of the availability of water, and assessing the availability of groundwater is often much more difficult than assessing that of surface water.*
>
> *Groundwater is difficult to observe and measure because it resides below the land surface and responds to rainfall much more slowly than rivers and lakes do. Aquifer systems are complex due to flows into and out of the aquifer, the interaction between surface water and groundwater, and the uncertainty of aquifer properties.*
>
> *Because of this complexity, computer models are excellent tools for assessing the effect of pumping and droughts on groundwater availability. Groundwater availability modeling is the process of developing and using computer programs to estimate future trends in the amount of water available in an aquifer and is based on hydrogeologic principles, actual aquifer measurements, and stakeholder guidance.*

As TWDB indicates, development of GAMs requires sound science, verified data, a means to update the data, monitoring efforts, and modeling enhancements. These efforts require predictable and sustained funding.

Inadequate Funding for Modeling and Data

Prior to 2011, the TWDB not only developed GAMs for GMAs to utilize during joint planning, but they also ran specific scenarios using the GAMs to help GCDs make decisions on potential DFCs. For example, the explanatory report for the first round of DFC development for GMA 15 contains the following statements:

> *"Texas Water Development Board (TWDB) staff provided technical guidance and support throughout the DFC development process. Of particular importance to the DFC development process was the numerous predictive simulations of groundwater production scenarios (GAM Runs) and related statistical analyses."*
>
> *"At the request of GMA 15 and GMA 16, TWDB staff developed and published GAM Run 07-12 which was referred to as the "Baseline Run." GAM Run 07-12 simulated the effects of continued groundwater production from the Gulf Coast Aquifer for 60 years (year 2000 through year 2060) in quantities equal to the amount being produced throughout GMA 15 at the end of year 1999."*

GMA 9 mentions that during the first DFC cycle in 2010, "the GMA 9 Committee requested and the TWDB prepared numerous technical reports to analyze various DFC scenarios, some of which consisted of hundreds of individual GAM simulations, to provide thorough technical analyses of the issues."

However, in 2011, the Legislature substantially cut the TWDB's budget, and its groundwater modeling program inordinately suffered as compared to other TWDB programs. According to Dr. Robert Mace, the Deputy Executive Administrator at that time, "the Groundwater Availability Modeling Section was hit with about a 40 percent reduction in staffing, about a 50 percent reduction in modeling grants used to develop and improve models, and nearly a 60 percent reduction in its operating budget (such as travel)."[14] Additionally, "the Groundwater Technical Assistance Section suffered a 50 percent reduction in staffing, a 100 percent reduction in groundwater grants, and a 75 percent reduction in its operating budget. Reductions at these levels have consequences for the services we provide."[15]

The TWDB is the state agency that is responsible for ensuring that groundwater modeling and availability assessments for planning purposes are based on the best available science and data. With its budget significantly reduced, the TWDB could no longer assist GCDs with running modeling scenarios and updates, and updates and refinements to the GAMs stalled.[16] It is important to note that this budget cut occurred at the same time as passage of SB 660, which increased joint planning requirements for GCDs. Thus, as time passed, GCDs found themselves in a position of fulfilling new and more substantial regulatory, science-based considerations without the level of support TWDB was able to previously provide.

Currently, the TWDB's entire 2022 budget for the Technical Assistance and Modeling Program (which includes both surface water and groundwater modeling) totals only approximately $2.6

million. Since 2010-11 the Legislature has reduced real dollars for modeling and enhancements by the TWDB from more than $9 million in 2011 dollars, to just $5 million in 2022-2023. Because these dollars are not adjusted for inflation, the current amount represents an even lower investment in Technical Assistance and Modeling compared to the 2010-11 biennium. Additionally, money to enhance these models with local data remains lacking.

Budgetary impacts reduce the TWDB's ability to develop and validate "comprehensive information on each aquifer, such as recharge (amount of water entering the aquifer); geology and how that conveys into the framework of the model; rivers, lakes, and springs; water levels; aquifer properties; and pumping."[17] When funding is reduced the ability for the TWDB to calibrate, update and enhance modeling suffers. Inability to enhance modeling means that models that are designed to view groundwater availability at a larger or regional scale, continue to inappropriately be relied upon by GCDs to determine localized and more site-specific impacts.

A Lack of Refined, Local Models

Consideration of local impacts is an inherent and important part of DFC development as several of the nine criteria require GCDs to understand how a proposed DFC will create local impacts. However, the GAMs were never designed to be utilized by GCDs for this type of local analysis, and as stated above, funding cuts to the GAM program have made it increasingly difficult for the TWDB to update and refine GAMs for GCDs to utilize them for this purpose.

Deficiencies in lack of ability to assess and predict groundwater and surface water interactions, or localized impacts, or assist in the recognition and valuation of impacts to the area of origin have caused water use conflicts, such as the impacts caused by the Vista Ridge project. We must highlight that the concerns currently being discussed due to Vista Ridge will be repeated in other parts of the state – due in part to modeling deficiencies.

Explanatory reports for several GMAs provide a good insight into the need for better modeling:

> *GMA 3: modeling needs to be updated to better understand contributions to water levels from other water producing zones. Updated model anticipated to be completed and in use for the next DFC review cycle.*
>
> *GMA 12: GAMS are not suitable for developing a quantitative relationship between pumping and groundwater-surface water exchange without refinement in their representation of changing surface water levels over time and subsequent validation using measured field data.*
>
> *GMA 13: As discussed during GMA 13 meetings on November 8, 2019 and February 7, 2020, not all pumping inputs are realized in the final model outputs due to the model limitations.*

During the 2016 joint-planning cycle, the GMA 9 Committee concluded that the Trinity Aquifer does not function uniformly across the extent of the GMA 9, and an update to the HCT GAM was needed to include these differences to develop multiple, achievable DFCs.

Some GCDs with stronger funding sources have developed more robust models to mitigate some of these deficiencies. For example, in GMA 12, cooperative efforts between GCDs, river authorities and the Colorado-Lavaca Basin and Bay Area Stakeholder Committee funded development of GAM enhancements to better quantify groundwater and surface water (GW/SW) interactions at their local area of interest. Additionally, GCDs and other private partners in the Blanco River Watershed in GMA 9 have raised money to develop a local integrated groundwater and surface water model to better predict impacts from groundwater pumping in this region.

GCDs with less than adequate funding resources are disproportionately impacted or hindered in their planning and management efforts due to the inadequate modeling. When that occurs, property rights to water are endangered as are planning and permitting efforts to manage groundwater.

Lack of Groundwater and Surface Water Interaction Data

GCDs are required to consider how a proposed DFC will cause environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water. This consideration is critical because groundwater is an important source of flow, especially of ecologically critical baseflow, to surface waterways in many parts of Texas. The TWDB estimates that, statewide, 30% of all surface-water flows in Texas originate from groundwater.[18] According to the TWDB, “eighteen major and minor aquifers contribute between 20 and 50 percent of the flow to streams flowing over their outcrop zones,” and “groundwater contributions to surface water are greatest in East Texas and around major springs in the Hill Country and west Texas.”[19]

In general, water management in Texas treats groundwater and surface water as separate, independent water sources, even though they are connected. For example, surface water losses to groundwater recharge indicate a “losing segment” of a stream or in other words, a stretch of a river that recharges an aquifer. On the other hand, groundwater can provide recharge to a river and these contributions to surface water flow indicate a “gaining segment” of a stream.

The Water Code does recognize the potential interconnectivity between groundwater and surface water resources by requiring the Texas Commission on Environmental Quality (TCEQ) to consider impacts to groundwater when issuing surface water permits and by requiring groundwater conservation districts to consider impacts to surface water when issuing groundwater permits and as mentioned above, impacts to springflow when adopting desired future conditions. In practice, however, real consideration of surface water-groundwater interactions is difficult to make, as the state and GCDs lack highly refined and integrated

groundwater and surface water models and local data needed to understand these interactions in a specific river basin. GAMs do not accurately simulate surface water-groundwater interactions for three main reasons: (1) GAMs were developed to address water issues at relatively large spatial scales, whereas surface water-groundwater interactions occur at a local scale; (2) GAMs use time periods of months to years, whereas accurate modeling of surface water-groundwater interaction requires time periods of hours to days; and (3) GAMs cannot simulate unsaturated flow — the water flowing through the land surface to the water table of an aquifer.

Additionally, although GAMs and the Surface Water Availability Models (WAMS) have the technical capacity to factor in flows from one resource to the other, currently, they function independently of one another. WAMs do not simulate water changes from gaining and losing segments of streams and GAMs currently lack the ability or accuracy to address water movement and volumes at a local or smaller scale. This limitation currently hinders the ability to rely on GAMs and to interface with WAMs to assess GW/SW interactions at a local scale.
As discussed above, the regional GAMs provided by the TWDB are not useful for GCDs to consider how a proposed DFC will impact groundwater and surface water interactions, because they are not refined enough for this type of localized evaluation. Indeed, GMA 12 notes:

> *the groundwater availability models used to set the GMA 12 DFCs are suitable for developing some qualitative relationships between pumping and groundwater-surface water exchange. However, the GAMs are not suitable for developing quantitative relationship between pumping and groundwater-surface water exchange without refinement in their representation of changing surface water levels over time and subsequent validation using measured field data.*

Some GMA's, particularly those with significant groundwater surface water interaction in their region and a high number of springs, spent considerable time discussing springflow and importantly, recognized the need for local data and models to adequately consider how a DFC potentially impacts springflow.

> *GMA 7: The DFC for Val Verde County was based on maintaining an average spring flow that was based on simulations with a groundwater model that was developed for Val Verde County and the City of Del Rio as part of a hydrogeologic study completed by EcoKai Environmental, Inc. (EcoKai, 2014). The overall objective of the study was to determine the correlation and potential impacts of groundwater pumping on local spring flows, lake elevations, and groundwater levels. An understanding of these correlations is necessary to evaluate the potential effects that additional groundwater pumping for export would have on the overall groundwater system. The primary consideration for the desired future conditions in Val Verde and Kinney counties was the preservation of spring flow…The primary consideration in the northeastern portion of GMA 7 was the maintenance of*

groundwater levels to maintain baseflow to the tributaries of the Colorado River.

In 2014, the Kinney County GCD began an intensive effort to monitor groundwater elevations and spring flow in Kinney County. This effort began with instrumenting 13 wells with transducers in 2014, and now includes 33 wells with KCGCD transducers, one stream monitoring point with a KCGCD transducer, a well instrumented by TWDB, and Las Moras Spring (monitored by the USGS).

GMA 9: The representative for HTGCD raised the question regarding the use of local models to develop future DFCs to ensure the protection of spring flow around Jacob's Well and Pleasant Valley Springs. In particular, the GMA 9 Committee and the other meeting participants discussed the use of the Blanco River Aquifer Tool for Water and Understanding Resiliency and Sustainability Trends (BRATWURST) model as a supplement to the HCT GAM. It was pointed out that currently only a conceptual model and not a numerical model of BRATWURST was available. Once available, the numerical model could be folded into the DFC joint-planning process to address local issues in future DFC joint-planning cycles.

It is important to note that the local models referenced above were funded without state dollars either through local public dollars, private dollars, or a combination (although a part of the BRATWURST model was funded through TWDB's Environmental Flows grant program). The lack of funding for GW/SW data and modeling limitations as it relates to GW/SW interactions impact GCDs' ability to properly consider GW/SW interactions in the DFC process and to ensure more sustainable use of water from these sources via conjunctive use. For example, enhancements to GAMs and WAMs could lead to coordination between GCDs, TWDB, and TCEQ as it relates to water availability and considerations of special conditions in permits. These special conditions could be incorporated into permits issued by GCDs for groundwater and the TCEQ for surface water. Sustainability would increase in both source supplies from special conditions where increased surface water diversion could help conserve groundwater when surface water is more abundant. Conversely, when increased groundwater production would be warranted over surface water diversion - particularly during drought and low stream flow conditions. Such coordination would also assist in reducing potential waste of water from production and discharge to a stream of groundwater when the resulting "use" will be increased evaporation.

Unbalanced Socioeconomic Analysis

Under Section 36.108, GCDs are required to consider the socioeconomic impacts reasonably expected to occur from a proposed DFC. This consideration is important. It recognizes that because a DFC is ultimately connected to groundwater availability, it will have an economic impact on a community. Many GCDs, however, lack sufficient data to properly inform this

consideration, which should include an evaluation of how a proposed DFC impacts the economic viability of a community by either allowing too much groundwater pumping or too little.

Currently, many GCDs rely exclusively on the socioeconomic analysis that TWDB provides to regional water planning groups to consider the socioeconomic impact of a DFC; however, this analysis was not designed to be used for groundwater planning. Under the regional water planning process, regional planning groups are required to evaluate the social and economic impacts of not meeting the identified water needs in their regional water plans. 31 TAC 357.40. To assist regional water planning groups with this evaluation, TWDB provides each planning group with a socioeconomic analysis of not meeting water needs for a single year, drought of record. For example, the 2021 Region L plan, summarizing socioeconomic impacts on not meeting water needs states:

> *A TWDB report presenting the socioeconomic impacts of not meeting needs is included as Appendix 6-A. In summary, Region L could experience $16.57 billion in income losses and almost 100,514 job losses in 2020 if no water management strategies (WMSs) are implemented to meet projected shortages. Similarly, Region L could experience $9.38 billion in income losses and about 94,978 job losses in 2070 if no WMSs are implemented to meet projected shortages.*

This analysis, however, does not include the socioeconomic impacts associated with declining aquifer levels from groundwater pumping and drought, which can result in local socioeconomic consequences, such as impacts to groundwater wells or recharge to rivers and streams. This data is critical to a balanced socioeconomic analysis.

In our review of various explanatory reports submitted as part of the latest round of DFC development, specific to socioeconomic impact limitations, several GMAs themselves noted the limitations of relying exclusively on the TWDB's regional water planning socioeconomic analysis for the DFC process.

> GMA 8: *While TWDB assessments are useful to understand the importance of meeting projected water needs, analyses do not evaluate socioeconomic impacts of proposed DFCs at the GMA level and a similar analysis does not exist.*
>
> GMA 9: *This process, however, does not evaluate the socioeconomic impacts of the proposed DFCs at the GMA DFC joint-planning level. Because a similar quantitative tool does not exist to assess the socioeconomic impacts of the proposed DFCs, these discussions during the DFC joint-planning are qualitative considerations"*
>
> GMA 13: *The TWDB prepared information for use by all regional water planning groups for the 2021 regional water plans, including Regions L, M, and N, the three regional water planning groups that cover some portion of*

> *GMA 13. However, these analyses **do not** evaluate socioeconomic impacts of DFCs at the GMA level.*
>
> GMA 14*: While the socioeconomic impact analyses developed for regional water planning is quantitative, they do not directly translate to the evaluation of desired future conditions. This is because they are limited to the impacts of unmet needs, influenced by the availability of other supply sources, and do not consider potential negative socioeconomic impacts associated with groundwater production." "Potential impacts of developing groundwater include subsidence and associated impacts, lowering pumps and/or deepening wells, potential impacts on water quality, impacts on groundwater production efficiency, and influence on economic growth based on water availability…No uniform quantitative analysis has been performed by TWDB or any other entity to directly address the socioeconomic impacts of specific DFCs.*
>
> GMA 15*: The TWDB prepared information for use by all regional water planning groups for the 2021 regional water plans, including Regions K, L, N, and P, the four regional water planning groups that cover some portion of GMA 15. However, these analyses **do not** evaluate socioeconomic impacts of DFCs at the GMA level.*

Some GCDs simply relied on the TWDB socioeconomic analysis to check the socioeconomic box, while others had additional, qualitative discussions related to the socioeconomic impact that a proposed DFC could cause. For example, GMA 12 held numerous public meetings to receive public input from a variety of interest areas such as recreation, real estate, commerce, irrigation and agriculture, political subdivisions, environmental groups, private property, tourism, cities, groundwater developers, river authorities and others. Recognizing that both positive and negative socioeconomic impacts may potentially result from the implementation of a DFC, the GCDs in GMA 12, "aimed to achieve a balance of the positive and negative impacts."

To help inform the evaluation of socioeconomic impacts due to water level declines and the potential need to lower pumps or deepen wells, GCDs in GMA 14 reviewed maps of drawdown in the Chicot, Evangeline and Jasper aquifers for each county. In GMA 8, each GCD responded to a survey asking whether they had specifically evaluated the potential socioeconomic impacts caused by decreased groundwater levels, such as increased production costs, lowering wells, drilling new wells, and developing additional water supplies.

GMA 2 relied on a socioeconomic analysis prepared in 2011 by Texas Tech University and Texas A&M Agrilife. The study compared the economic impacts resulting from the depletion of the Ogallala Aquifer in GMA 2 from groundwater production with the socioeconomic impacts of regulations designed to slow the depletion of the aquifer and concluded that the economic impacts from either scenario were similar. However, this analysis only looked at the economic impacts associated with reduced agricultural production and not on future economic impacts beyond the agricultural sector.

In reviewing the explanatory reports for GMAs across the state, it is clear there is no uniform way for GCDs to consider socioeconomic impacts. This in and of itself is not necessarily the problem, as GCDs need flexibility to address local considerations and realities. What is problematic, however, is that across the board, GCDs lack access to a quantitative tool to help them evaluate the socioeconomic impacts that will occur from declining groundwater levels. Consequently, the emphasis in the DFC process is on the socioeconomic impacts associated with the failure to develop water supplies (more groundwater pumping), rather than the failure to manage them sustainably (less groundwater pumping)**.** This means that GCDs are more likely to adopt DFCs that allow more drawdown (and in turn more groundwater availability under state water planning) than could be economically sustainable within their jurisdictions. This places communities' local water supply at risk and could result in additional, unmet water needs in the state water plan; whereas a balanced socioeconomic analysis would allow the State to forecast potential new liabilities from new unmet water needs and the resulting impact this will have on future funding considerations.

No Sustainable Yield Analysis

Ultimately, as required by Section 36.108, DFCs "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." The DFC process does not, however, require GCDs to evaluate how a proposed DFC will impact the sustainability of aquifers, which is important to achieving the balance required by statute. This has huge implications for regional and state water planning in Texas, because as we describe, DFCs inform groundwater availability (MAG) in the state water plan. If DFCs and the resulting MAG overpredict the amount of groundwater available to satisfy regional water supply needs, the state will be faced with unexpected unmet water needs.

Under Section 36.108, when adopting DFCs, GCDs must consider "Hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator." The TWDB defines total estimated recoverable storage (TERS) as "[t]he estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25% and 75% of the porosity-adjusted aquifer volume."[20] In other words, TERS represents the maximum amount of groundwater that may be technologically feasible to recover from an aquifer without regard to other impacts. According to the TWDB, although roughly 25% to 75% of the approximate 16.8 billion acre-feet of freshwater groundwater in Texas may be recoverable, "this range does not account for possible economic, environmental, or legal consequences of such pumping," factors that do set realistic limits on what the highest practicable level of production might be in a certain aquifer.[21] By definition, TERS does not include factors that would cause a GCD to implement regulations to conserve groundwater, or in other words, limit production from an aquifer. These factors include impacts to surface water, recharge, groundwater wells, water quality, subsidence, and whether it is practical or economically feasible to pump such a high volume of water from an aquifer. GMA 12 recognized the flaws in relying on TERS in its explanatory report, stating, "TERS is a "one-

size-fits-all" definition of groundwater based solely on GAM parameters, when in reality the actual amount of recoverable groundwater will vary based on the aquifer type and other conditions." According to hydrogeologists, "with few exceptions, TERS is far greater than the highest practicable level of groundwater production and is not a useful tool for the planning and management of aquifers."[22]

To ensure that DFC evaluations are truly balanced, additional methods of "estimating the limits of groundwater recoverability that account for some of the physical and economic constraints upon yields" are needed. As GMA 9 noted, "Realistically, these numbers should be considered as a very simplistic approach to determining an upper limit volume of available groundwater."[23] To truly understand the impacts of a proposed DFC, GCDs need to know the sustainable yield of the aquifers they regulate. Or in other words, how much groundwater can be pumped from an aquifer without causing groundwater declines? Unlike the TERS volume, the TWDB is not statutorily required to provide sustainable yield volumes to GCDs. This results in an evaluation that is skewed toward production of groundwater rather than sustainability. At a very basic level, one could argue some GCDs do not truly understand how much or how little groundwater they have to work with.

One Way Property Rights

Texas is a property rights state. Our laws and practices are rooted in the respect for and protection of property rights. Groundwater is a recognized property interest and right that accrues to the benefit of the surface landowner. Chapter 36 of the Texas Water code §36.002 states, "The legislature recognizes that a landowner owns the groundwater below the surface of the landowner's land as real property."[24] Additionally, in the 2012 case Edwards Aquifer Authority v. Day (Day), the Texas Supreme Court held that landowners own their groundwater in place but recognized and affirmed a GCDs authority to develop and implement reasonable regulations to manage groundwater.

As mentioned above, GCDs are required to consider "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 as recognized under Section 36.002" when adopting DFCs. This consideration is an extremely difficult one for GCDs to make and currently, for most GMA's is entirely a qualitative analysis.

Our review of the GMAs' explanatory reports revealed that when considering property rights, GMA's utilized different methods to make this consideration. As discussed in the Socioeconomics Section, GMA 2 was one of the few GMAs that utilized a socioeconomic analysis to assist with the property rights consideration. This analysis, however, was limited to understanding how restrictions on pumping would negatively impact farmers' ability to produce, rather than how declining aquifer levels over time impact the property rights of all landowners over the aquifer, including those who may not want to produce. The result was that GMA 2 determined that "property rights are best protected when the pumping is limited only by the physics of groundwater flow and by the economics of pumping groundwater for a beneficial use" rather than through long-term sustainable management. [25]

This type of analysis ignores a landowners' right to conserve groundwater beneath their property. As the Texas Supreme Court discussed in Day, "riparian rights are usufructuary, giving an owner only a right of use, not complete ownership;" therefore, "the non-use of appropriated waters is equivalent to waste."[26] In contrast, "non-use of groundwater conserves the resource," and "[t]o forfeit a landowner's right to groundwater for non-use would encourage waste." [27]

Other GMAs strove to find a balance between "the highest practicable level of groundwater production and the conservation and preservation of groundwater and prevention of waste and subsidence," and argued that by achieving this balance, the property rights of landowners were considered. Below are excerpts from GMA 7 and GMA 12's property rights consideration:

> *GMA 7: The desired future conditions adopted by GMA 7 are consistent with protecting property rights of landowners who are currently pumping groundwater and landowners who have chosen to conserve groundwater by not pumping. All current and projected uses (as defined in the 2021 Region F plan) can be met based on the simulations. In addition, the pumping associated with achieving the desired future condition (the modeled available groundwater) will cause impacts to existing well owners and to surface water. However, as required by Chapter 36 of the Water Code, GMA 7 considered these impacts and balanced them with the increasing demand of water in the GMA 7 area, and concluded that, on balance and with appropriate monitoring and project specific review during the permitting process, the desired future condition is consistent with protection of private property rights.*
>
> *GMA 12: In crafting Desired Future Condition Explanatory Report GMA 12 aimed to balance property interests and rights that are benefited by the use of groundwater in the present, near future and long term and those benefitted by preservation, or leaving groundwater in place. The DFCs adopted by GMA 12 are consistent with protecting property rights of landowners who are currently pumping groundwater and landowners who have chosen to conserve groundwater by not pumping. All current and projected uses, as defined in the Regions C, G, H, and K plans, were considered in developing the adopted desired future conditions. By setting DFCs for the GMA 12 that meet current demands and achieve a balance in providing water availability for growth and preservation, GMA 12 believes the adopted DFCs meet the "balance test" prescribed by Subsection 36.108 (d-2), Texas Water Code.*

With respect to the Vista Ridge project in GMA 12, some landowners who did not wish to participate in the lease or sale of their groundwater for the project, and who are today seeing significant reductions in water level in their wells, seem to have been considered as a lesser property rights interest in the process.

However, without a quantitative analysis of how proposed DFCs will impact groundwater levels and in turn, the rights of landowners to conserve groundwater, GMAs are likely unintentionally, placing greater emphasis on the right to produce groundwater. There are many reasons for this. The balancing test required by Chapter 36, for example, does not exactly promote a true balance - as it forces GCDs to weigh the "highest practicable level of production," with conservation, even if, as we discussed earlier, that level of production is not possible. Lack of data and refined modeling also play a role in the difficulty that GCDs have in considering landowners' rights to conserve groundwater, and of course, the legal pressures that GCDs face in approving permits create an environment where the right to produce groundwater takes precedence. The one-way consideration of property rights has negative implications for water planning in Texas as it may lead to DFCs and MAGs that over prescribe the availability of groundwater for planning purposes.

Lack of Technical Review by TWDB

During 2022 interim session hearings of House and Senate committees with purview over groundwater statutory requirements, the impacts to the area of origin (where water is developed from for use in other areas) has drawn much discussion and criticism of modeling use, modeling limitations and the DFC process. One of the DFC development and approval process steps that has garnered critical comment and recommendation is the limitation on the TWDB to conduct **only** an administrative complete review of the submitted DFC by the respective GCDs. Texas Water Code §36.108 (d-4) states:

> *After a district receives notification from the Texas Water Development Board that the desired future conditions resolution and explanatory report under Subsection (d-3) a**re administratively complete**, the district shall adopt the applicable desired future conditions in the resolution and report.*

Administrative complete reviews are common in a regulatory or agency review process. It is a rather simple process. The question to be answered is –has the GCD/GMA submitted document(s) in support of the DFC include the required forms and sections as called for in either statute or rule or both.

Another common practice in a regulatory or statutory review process is a much more substantive **technical review** process. In a technical review, the data, narrative, quantification of impacts, veracity of data supporting conclusions, etc. is tested. A technical review of the DFC documents submitted to the TWDB is not currently authorized by statute.

We understand that the difference in how surface water and groundwater are managed in Texas may in part contribute to why a technical review has not yet been authorized for DFC submittals. As it relates to surface water, the State of Texas owns the resource and authorizes its use via certificates of adjudication or water rights permits administered by the TCEQ. While a water right also establishes a property interest to the allocated volume of water, regulation is

maintained at the state level and in some places by assigned watermasters. Groundwater on the other hand is a property right that is inherent to land ownership. State permitting of groundwater resources is not allowed. Permitting is left to the groundwater conservation districts and local control. Local control and management of groundwater, to some, means that a technical review by the TWDB could shift some of the governance over groundwater to the state. We do not agree with that assertion.

As previously noted in this report, protection of property rights to groundwater is a critical element in groundwater management and DFC development. The recent concerns by landowners in already impacted areas of origin indicate that the DFC process needs modification. A technical review could identify issues where, for example, the robustness of the consideration of the nine elements described previously in this report and required by statute does or does not support the conclusions leading to the DFC adoption. A technical review could assist a GCD, in discharging its local control, to review and revise their own decisions consistent with the deficiencies or recommendations from a more robust technical review - without shifting those changes to a state regulatory agency.

Achieving the DFC

This report has focused on deficiencies in the development of DFCs. It is worth noting that there are additional challenges related to GCDs ability to measure and track achievement with DFCs. As mentioned, Section 36.1132 requires GCDs to manage groundwater to achieve the DFC. Yet, currently, GCDs have no statutory or regulatory guidance to inform monitoring DFC achievement. Consequently, the methods and rigor that GCDs are utilizing to track achievement with a DFC vary, and it is difficult for the public to clearly understand whether a GCD is managing groundwater to achieve a DFC. Without a clear procedure for doing so, the DFC becomes less of a real planning and management goal and more of a moveable, meaningless target.

Absent effective data collection, local users and those who depend on groundwater sources could be planning or counting on a certain reliability in their source supply only to be surprised by impacts that were not predicted or predicted much later in the process. The DFC process requires updates every five years. Effective monitoring can inform the next DFC development cycle. Effective monitoring can also aid in the administration of permit and management plan requirements by GCDs to protect and conserve the groundwater resources they have purview over, and the property interests to that water.

Summary

- GCDs are charged by statute to develop DFCs (TWC §36.108). As part of that process, GCDs are required to consider nine factors enumerated by statute. How well or poorly these considerations are incorporated in the development of the DFCs by the various GCDs can and does lead to poorly developed DFCs.
- TWDB is forced to accept the DFCs adopted by the GCDs. The TWDB lacks authority to actively verify the strength of the DFC process, which can allow poorly developed DFCs to inform the planning process. Currently, the TWDB is limited to an administratively complete review of the submitted DFC documentation. A technical review by the TWDB of the underlying assumptions, data and science is currently not allowed nor taking place.
- Poorly defined and supported DFCs lead to inaccurate MAG development by the TWDB.
- Poorly developed DFCs and associated MAGs inaccurately inform groundwater management regulatory decisions and management plans.
- Poorly developed DFCs and MAGs inaccurately inform regional water planning.
- Poorly developed DFCs and MAGs inaccurately inform the TWDB's required review and approval of GCD management plans.
- Poorly developed DFCs and MAG inaccurately inform funding considerations by the TWDB, specifically with respect to funding water strategies that could inadvertently create new unmet needs. This only serves to increase funding needed for additional water management strategies, thereby increasing the state's costs, which ultimately may get passed on to all Texans.
- Ultimately, MAG development, water management and planning strategies, and funding water projects can be based on inaccurate DFCs over which the TWDB lacks authority. This jeopardizes the property rights of groundwater users and increases the cost of water planning to the state.

Recommendations and Conclusion

There is a critical and inextricable link that exists between the development of DFCs by GCDs and regional and statewide water planning efforts. Inequitable resource allocation for DFC development results in poorer, rural counties and GCDs lacking tools to properly inform groundwater planning and management. These concerns are highlighting the importance of an equitable and robust management and planning effort that identifies deficiencies early on. As we previously mentioned, while we recognize that the current DFC process has only been around for 10 years, without meaningful changes to statute that lead to a more predictive regulatory scheme, we will continue to see negative, unanticipated impacts to local users.

Additionally, inadequate funding hinders the ability of the TWDB to update models and provide technical assistance to GCDs during their DFC development efforts. Funding, however, is not the only limitation to a more effective DFC development process. Adherence to the nine elements in Chapter 36 of the Texas Water Code via robust consideration of the elements with

strong supporting narrative, quantitative tools, and efforts to clearly outline the basis for decisions and findings is needed.

The following recommendations are put forth in the spirit of improving the DFC process and in turn, water planning in Texas:

- The Legislature should appropriate additional funding to TWDB to develop more data and to update and refine Groundwater Availability Models. Additionally, TWDB should identify limitations in these models that today are being relied on to provide answers for which the models were never developed to address.
- Protection of surface water flows and existing surface water rights should be a much more integral component of groundwater availability discussions in the GMA process. This means more active participation by surface water interests in the GMA process and groundwater district decision-making and explicit consideration of springflow contributions to surface water flows.
- The TWDB and the TCEQ should work together to develop standard protocols that guide the incorporation of surface and groundwater resource data into the surface Water Availability Modeling (WAM) and Groundwater Availability Modeling (GAM) analyses. The agencies should also ensure that these and other water resource modeling tools accurately reflect the interconnectivity of the resources to the greatest degree possible given currently available data.
- With assistance from the legislature, the TWDB and the TCEQ should prioritize state funding for developing better science in areas with a strong degree of surface and groundwater interaction, including conducting streamflow gain-loss studies where adequate data is lacking and increasing long-term monitoring of springflows.
- More extensive narrative, modeling, quantitative analysis, and supporting documentation should be provided in explanatory reports as to how proposed DFCs will protect existing private property interests in groundwater in place within the GMA including the interest and desire to conserve the groundwater currently owned in place.
- The state should provide regional water planning groups with a socioeconomic analysis that evaluates impacts related to aquifer depletion or to put in another way, the socioeconomic benefits of managing water resources sustainably. This type of analysis would provide more balance to the planning process. Similarly, this type of analysis can help to incentivize the proper valuation and impacts to the area of origin, and in particular, to landowners impacted by groundwater development that affects an existing user’s right to access and utilize their water.
- The Legislature should clarify and strengthen the authority that the TWDB has in conducting a meaningful review of the GCDs considerations of the 9 statutorily mandated criteria set forth in TWC §36.108 as it relates to the development of the DFCs.
- The Legislature should require the TWDB to model the sustainable yield of aquifers and require GMA to consider this volume when adopting DFCs.

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