Texas Water Development Board

P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.texas.gov
Phone (512) 463-7847, Fax (512) 475-2053

TO: Board Members

THROUGH: Melanie Callahan, Executive Administrator
Robert E. Mace, Deputy Executive Administrator, Water Science and Conservation
Kenneth L. Petersen, General Counsel

FROM: Larry French, Director, Groundwater Resources
Joe Reynolds, Attorney
Shirley Wade, Groundwater Availability Modeling

DATE: February 22, 2012

SUBJECT: **Briefing, discussion, and possible action** on appeals of the reasonableness of the Desired Future Condition adopted by the groundwater conservation districts in Groundwater Management Area 13 for the Sparta, Weches, Queen City, Reklaw, Carrizo, and Wilcox Aquifers

ACTION REQUESTED

Staff recommends that the Board find that the desired future condition (DFC) adopted by the groundwater conservation districts (Districts) in Groundwater Management Area 13 (GMA 13) for the Sparta, Weches, Queen City, Reklaw, Carrizo, and Wilcox Aquifers is reasonable based on the analysis set out in this report.

BACKGROUND

This report and the attached technical report constitute the staff analysis of petitions filed by legally defined interests in groundwater in GMA 13. These petitions appeal the adoption of the DFC for the Sparta, Weches, Queen City, Reklaw, Carrizo, and Wilcox aquifers. This analysis discusses whether the DFC is unreasonable based on the evidence in the record.

Legislative History

The 79th Legislature provided that a person with a legally defined interest in the groundwater in a GMA could file a petition with the Texas Water Development Board (TWDB) appealing the approval of a DFC by Districts in that GMA. The Legislature placed the burden on the petitioner to provide evidence that the Districts did not establish a reasonable DFC. But the Legislature did not define “reasonable,” nor did it provide any guidelines for the TWDB to use in determining whether

a DFC is reasonable.[1] The final determination of a DFC is, in fact, the responsibility of the Districts in the GMA.[2]

The 82nd Legislature amended the statute to provide a more detailed process for Districts to follow in approving a DFC.[3] Effective September 1, 2011, Districts are required to prepare a detailed report on the DFC approval process that documents the consideration of certain criteria and the application of a balancing test and to develop a record of public participation and responses to any public comments.

These revised statutory requirements for adoption of a DFC do not apply, however, to the GMA 13 DFC review under consideration, as the DFC was adopted before the changes made by the 82nd Legislature became effective. The determination to review appeals of DFCs adopted before the changes in statute under the statute in place at the time of adoption was discussed by the Board on October 19, 2011.

The 82nd Legislature did not change the basic process for an appeal of a DFC to the TWDB.[4] Notwithstanding any findings by the TWDB that a DFC is unreasonable, the final determination of a DFC remains the responsibility of the Districts in the GMA.[5]

Procedural History

On April 9, 2010, the Districts in GMA 13[6] adopted the following DFC, pursuant to Texas Water Code § 36.108:

> Scenario 4 [of GAM Run 09-034], and an average drawdown of 23 feet, for the Sparta, Weches, Queen City, Reklaw, Carrizo, and Wilcox Aquifers.

Administratively complete petitions were submitted by the Canyon Regional Water Authority (Canyon Regional) on February 22, 2011, and by the Hays Caldwell Public Utility Agency (Hays Caldwell) on April 4, 2011. Canyon Regional is a member of Hays Caldwell[7], but each party filed a separate petition. Even so, the petitions relate to similar issues and, therefore, are considered together.

TWDB staff held a hearing on the Canyon Regional and Hays Caldwell petitions on December 5, 2011, in Pleasanton, Texas, to take testimony and evidence from the petitioners and the Districts. The record remained open until December 19, 2011, to receive additional evidence from other

---

[1] *See* Tex. Water Code § 36.108(l)-(n).
[2] *See* Tex. Water Code § 36.108(n).
[3] Acts 2011, S.B. 727 and S.B. 660, 82nd Leg., R.S..
[4] *See* new Tex. Water Code § 36.1083, eff. 9/1/2011.
[5] *See* new Tex. Water Code § 36.1083(d), eff. 9/1/2011 comp. to former Tex Water Code § 36.108(n).
[6] Edwards Aquifer Authority, Evergreen Underground Water Conservation District, Gonzales County Underground Water Conservation District, Guadalupe County Groundwater Conservation District, McMullen Groundwater Conservation District, Medina County Groundwater Conservation District, Plum Creek Conservation District, Uvalde County Underground Water Conservation District, and Wintergarden Groundwater Conservation District.
[7] HCPUA Petition, pg. 3.

interested persons, as required by 31 Tex. Admin. Code § 356.44(f). The TWDB received no additional evidence, and the hearing record was closed.

Summary of the Arguments

Canyon Regional was created by act of the Legislature to develop water from the Edwards Aquifer and to serve member entities consisting of municipalities, districts, and water supply corporations.[8] Canyon Regional currently holds production and transport permits from Gonzales County Underground Water Conservation District (Gonzales County District) and the Guadalupe County Groundwater Conservation District (Guadalupe County District) for more than 4,000 acre feet per year of Carrizo Aquifer groundwater.[9]

Hays Caldwell was created under Chapter 572, Local Government Code,[10] by the cities of Kyle, Buda, and San Marcos, and Canyon Regional to secure a long term water supply for its member entities. Hays Caldwell has filed applications with the Gonzales County District for authorization to withdraw and transport 10,300 acre feet per year of groundwater from the Carrizo Aquifer.[11]

Canyon Regional and Hays Caldwell (Petitioners) challenge the reasonableness of the DFC adopted by the Districts in GMA 13 on the same grounds. To summarize, they find the DFC unreasonable because:

1) The DFC is not physically possible;

2) Adverse socio-economic impacts are expected to occur because adoption of the DFC is tantamount to saying that groundwater cannot be produced from one of the state's most prolific aquifers, and water supply needs of the population along the IH-35 corridor will not be met;

3) The adopted DFC is inconsistent with the state's policy and legislative directives because, as a result of the DFC, the amount of water that may be permitted each year is significantly less than what the adopted regional water plans call for;

4) The adopted DFC negatively impacts the private property rights of Hays Caldwell and Canyon Regional who have leased water rights associated with over 15,000 acres, and who want to exercise their property rights in their groundwater by using those rights for development and transport to customers; and

5) The adopted DFC impedes the reasonable and prudent development of the state's groundwater resources by limiting water production at a time when the Texas economy can least afford to be short of available water supplies.[12]

Analysis of Issues Raised

[8] Hearing Transcript, pg. 14.
[9] CRWA Pet. pg. 2.
[10] Relating to the creation and operation of public utility agencies.
[11] Hays Caldwell Pet., pg. 3.
[12] Hays Caldwell Petition.

Attachment A is staff's technical analysis of certain issues raised by the petitions. Reference to that analysis will be made as appropriate throughout this discussion.

TWDB rules provide that the Board shall base any recommended revisions to the desired future conditions only on evidence in the hearing record.[13] In addition, the Board is to consider the following criteria when determining whether a desired future condition is reasonable:

> (1) the adopted desired future conditions are physically possible and the consideration given groundwater use;
>
> (2) the socio-economic impacts reasonably expected to occur;
>
> (3) the environmental impacts including, but not limited to, impacts to spring flow or other interaction between groundwater and surface water;
>
> (4) the state's policy and legislative directives;
>
> (5) the impact on private property rights;
>
> (6) the reasonable and prudent development of the state's groundwater resources; and
>
> (7) any other information relevant to the specific desired future condition.[14]

Consequently, this report will be organized around the criteria listed above. Arguments from the Petitioners and from the Districts will be presented, followed by staff's analysis. Because they are closely aligned in this appeal, the arguments of Hays Caldwell and Canyon Regional will be discussed together.

1. The DFC is physically possible.

Petitioners

The Petitioners assert that the DFC is not physically possible for a number of reasons:

- The Districts appear to have "adopted" a specific set of inputs to a single groundwater availability model run to produce a GMA-wide drawdown to be averaged across six hydrogeologic zones;
- The selection of 23 feet of average drawdown through all the aquifers is not supported by the definition of a DFC;
- By adopting Scenario 4 from GAM Run 09-034, the Districts have relied on an inaccurate and misleading set of computer inputs and assumptions that do not accurately reflect currently permitted projects;

[13] 31 TAC § 356.45(c).
[14] *Id.*

- The GMA-wide average drawdown was adopted without a corresponding methodology for calculating the "average" drawdown, creates significant uncertainty, and will effectively be impossible to implement;
- Individual district decisions will affect decisions in other districts although there is no legislative structure in place for the management of groundwater on a GMA-wide, multiple-district, multiple-aquifer basis.[15]

The Districts

The Districts respond that the DFC is a planning tool.[16] Assuming that the DFC is unachievable and that average drawdowns cannot be monitored is a preconception on the part of the Petitioners. The Districts are not required to describe their monitoring process at the DFC stage of the process.[17]

Staff

Any model run involves the selection of specific pumping inputs for the model to use in running its calculations. For GMA 13, a number of hydrostratigraphic, water level, and groundwater pumping inputs from a variety of sources, including the Districts and water suppliers, were used. In addition, groundwater pumping inputs have varied in time and location as the Districts and other interested groups have identified and modified water project parameters. The pumping outputs, or MAG amounts, are provided in the GAM Run for county-basin-GMA-Regional Water Planning Area splits and are not provided at a finer scale such as well field locations.

The models used for these calculations are regional in scale. Thus, they infer that if a specified amount of pumping is located in a particular region of the model then the aquifer system, as a whole, may react in a particular way.

The models are intended to be used as a planning tool and not at the permit-specific scale described by the Petitioners. Each GAM Run includes a statement of limitations, which reads in part:

> Because the application of the groundwater model was designed to address regional scale questions, the results are more effective on a regional scale . . . . It is important for groundwater conservation districts to monitor groundwater pumping and overall conditions of the aquifer.[18]

What the Petitioners describe as inputs that are "faulty" or "inaccurate" are simply alternatives to the Petitioners' preferred inputs. The differences do not make these inputs "faulty" or "inaccurate" per se. Identifying labels were used by the modeler to assist the modeler in tracking the various elements of inputs for each run. But those labels do not apply to the model's outputs and are not controlling on later permitting decisions. The Districts are free to manage their MAG amounts at any location and for any permit application within their District.

---

[15] Hays Caldwell Pet, pg. 3-5.
[16] *Id.* at 73
[17] Hearing Transcript, pg. 71
[18] *See for example,* Draft Report GAM Run 11-007, "Groundwater Management Area 13 Model Runs to Estimate Drawdowns under Assumed Future Pumping for Queen City, Sparta, and Carrizo-Wilcox Aquifers," May 11, 2011, pg. 7-8.

Petitioners focus a great deal on the contents of the GAM Run out of a concern that their projects may have been left out of the calculations and therefore left out of any future planning or permitting the Districts might do. But any impacts to the Petitioners' projects cannot be determined until applications are made and permit decisions are rendered once the MAG is fully determined.

The DFC is a goal, a statement of the desired future condition of the aquifer. As the Districts themselves point out, each District within GMA 13 must revise its management plan to address the DFC, and, in turn, must adopt rules that will support those management plans.[19] The future stages of this process are where the Districts will define the methods they intend to use in calculating the average drawdown.

The Petitioners refer to the definition of a desired future condition as proof that the DFC is unreasonable because the DFC is not specific for each aquifer and therefore fails to meet the definition. Under the relevant statute and regulations, a *regional* DFC is not inherently unreasonable. The definition of a DFC in TWDB rules states that a DFC is the desired, quantified condition of groundwater resources for a specified aquifer within a management area at a specified time or times in the future.[20] Section 36.108 of the Water Code also states that the Districts *may* establish different desired future conditions for each aquifer, subdivision of an aquifer, or geologic strata located in whole or in part within the boundaries of the management area.[21] The definition states that the Districts must specify the aquifer or aquifers to which the DFC applies. The Districts specified the aquifer—in this case several aquifers. The fact that more than one aquifer is involved does not mean that the Districts *must* adopt different DFCs for the different aquifers. The language in the rule is discretionary, not mandatory. In fact, GAM Run 09-034 shows not only the overall drawdown for the management area but also the average drawdown for each county by aquifer and the average drawdown overall by aquifer.[22] This detailed information was available to the Districts when making their decision, but they were not required to incorporate that information in the development of the DFC. Adopting a GMA-wide drawdown to be averaged across six hydrogeologic zones is not inherently unreasonable.

Petitioners claim the DFC is unreasonable because it means that decisions in individual districts will affect decisions in other districts.[23] But joint planning as envisioned in Section 36.108 of the Water Code is precisely an attempt to get groundwater management districts to manage groundwater on a regional, multi-district, multi-aquifer basis.[24] A DFC that challenges Districts in a GMA to work together to achieve a GMA-wide DFC is reasonable because it asks the Districts to fulfill the mandate of the statute.

---

[19] Hearing Tran., pg. 64.
[20] 31 TAC 356.2(8)
[21] Tex. Water Code § 36.108(d)(1).
[22] GAM Run 09-034, Table 5, pg. 11.
[23] Hays Caldwell Pet., pg. 5.
[24] *See* Hays Caldwell Pet., pg. 5.

2. Consider socio-economic impacts that are reasonably expected to occur.

Petitioners

Petitioners assert that adopting the DFC is the equivalent of saying that groundwater cannot be produced to meet the needs of Petitioners' customers. Then Petitioners recite the "adverse social and economic consequences of unmet water needs estimated in the 2007 State Water Plan and the 2011 South Central Texas Regional Water Plan" (Region L) to support their assertion.[25]

The Districts

The Districts respond that, in the planning process, they looked at all aquifers, all groundwater resources, and then based a decision on the total usable amount of groundwater available.[26] The Districts then compared the numbers in GMA Draft MAG Report 10-012 for estimated total annual pumping in Caldwell and Gonzales counties with water planning numbers to show that availability in those counties far exceeds the 2007 and 2012 state water plans.[27]

Staff

Economic impacts of different pumping scenarios are difficult to quantify, in part because GMAs are not coterminous with regional water planning areas. Staff's Technical Analysis attached to this report sets out State Water Plan availability numbers for 2007 and 2012, and the 2012 State Water Plan supplies and strategies. The numbers for the state water plan come from the regional planners, in this case the South Central Texas Regional Water Planning Group that plans for Region L. But even these numbers must be carefully considered.

For the Carrizo-Wilcox Aquifer, the 2012 State Water Plan availability number exceeds the draft MAG from the GMA 13 DFC by about 50,000 acre-feet per year in 2060. This difference, however, is not due to lower MAG amounts in Caldwell, Gonzales, and Guadalupe counties. Rather, it is due to lower MAG amounts in Frio County, and, to a lesser extent, in Dimmit and La Salle counties. For Caldwell County, the MAG exceeds the 2012 State Water Plan groundwater availability for the period from 2010 through 2060 by almost twice the state water plan availability amount. In Gonzales County, the MAG exceeds the 2012 State Water Plan groundwater availability after 2020; and the MAG for Guadalupe County does not exceed the state water plan availability numbers until half way through the planning cycle. It is not clear why this is the case in Guadalupe County; but the impact will be discussed further below.

3. Consider environmental impacts including but, not limited to, impacts to spring flow or other interaction between groundwater and surface water.

Parties do not raise any environmental concerns.

[25] *Id.* at 6; Hearing Trans. at pg. 46-47.
[26] Transcript, pg. 59.
[27] Transcript, pg. 68-69.

4. Consider the state's policy and legislative directives.

Petitioners

Petitioners assert that the MAG is significantly less than what the adopted regional water plans call for.[28] They claim that, based on a comparison done by the Bureau of Economic Geology of the draft MAG calculated by the TWDB and the water supply projects included in the 2011 regional water plans, there is a deficit of 84,793 acre feet per year in 2010 and a deficit of 158,902 acre feet per year in 2060. Petitioners conclude by stating that the water management strategies identified and adopted during the regional planning process that rely on the Carrizo Aquifer in Caldwell and Gonzales counties cannot be implemented, undermining a decade of water planning.[29]

Districts

The Districts state that every project in the regional plan that involves the use of groundwater has a note stating that:

> part or all of the water needed by this water management strategy is anticipated to be supplied from locations within the jurisdiction of a groundwater conservation district and may exceed the amount of available water identified in the district's approved management plan, or it may for other reasons not be permitted by the district. The amount of water needed by this water management strategy that exceeds the available water in the district's management plan, or for other reasons is not permitted by the district, cannot be implemented as part of this water management strategy unless and until all necessary permits are received from the district. The amount of water needed by this water management strategy that exceeds the available water in the district's management plan, or for other reasons is not permitted by the district, introduces an added element of uncertainty to reliance upon this water management strategy, and therefore, additional supplies may be needed for this water management strategy.[30]

Thus, the Districts conclude, everybody is aware that just because a strategy is in the water plan, does not mean that the strategy will be developed or that it will be developed completely through groundwater. There are other options available to meet water needs that cannot be met by the MAG.[31]

Staff

In reviewing and compiling the state and regional water plans, aggregate strategies may overdraft the available groundwater. This was done in order to avoid second-guessing local planners and decision-makers in future permitting and other decisions. Consequently, one has to take into account that the strategies discussed in the regional and state water plans may require more water than is indicated in water availability numbers. This is illustrated in Figures 8, 9, 10, and 11 in the Technical Analysis.

---

[28] Hays Caldwell Pet., pg. 6.
[29] *Id.* at 7.
[30] Transcript, pg. 80; *See for example*, 2011 Region L Regional Water Plan, Vol. II, pg 4C.15-19, 4C.16-30, and 4C.17-12.
[31] *Id.* at 80.

In Caldwell County, the MAG provides almost twice the amount needed for the State Water Plan supplies and strategies. Consequently, the proposed DFC does not inhibit implementation of strategies in the State Water Plan or undermine the planning process in Caldwell County.

In Gonzales County, the MAG is greater than the State Water Plan availability volume for much of the planning period, but supplies and strategies are greater than the draft MAG for all of the planning period. State Water Plan availability is less than supplies and strategies, however, for the planning period, which suggests that the strategies that will actually be employed remain to be determined.

For Guadalupe County, the MAG is less than State Water Plan availability for half the planning period and greater than the State Water Plan availability for half the planning period. The MAG is also less than supplies and strategies for the planning period; but the State Water Plan availability also is less than supplies and strategies for the planning period. Thus, again, it is difficult to project which strategies will actually be developed.

In all cases presented, the MAG exceeds the estimated maximum sustainable pumping and historical use. This suggests that the Districts acknowledge the need for additional production.

For GMA 13, the MAG is less than both the State Water Plan availability and the State Water Plan supplies and strategies. This may be due, however, to lower numbers in some of the more rural counties in the GMA and overdrafting in several counties. Based on the overestimation of supplies and strategies, projecting what supplies and strategies will be over the long term is difficult. This does not, however, suggest that the proposed DFC is unreasonable, only that adjustments will need to be made as conditions change, the Districts develop and implement their management plans, and water planning projections are adjusted to reflect future developments.

5. Consider the impact on private property rights.

Petitioners

Petitioners testify that Hays Caldwell and Canyon Regional have invested in production rights, project planning and permitting, and have leased thousands of acres in groundwater rights within the Gonzales County District. They assert that these investments risk being lost if the DFC is unreasonably low.

Districts

The Districts, for their part, state that no one is guaranteed groundwater. The Petitioners and all others have to apply for a permit.[32]

Staff

Petitioners express concern that an unreasonably low DFC will, in addition to having socioeconomic consequences, harm the Petitioners personally and dramatically if the adopted DFC results in denial or reduction of Petitioners' permits and opportunity to develop their projects. But

[32] Hearing Trans., pg. 76.

restrictions imposed by the Districts to manage and permit groundwater production will be determined in the future.

As already noted, the Draft MAG in Caldwell County, a county that was central to the Petitioners' interests, exceeds the amount needed for 2012 State Water Plan existing supplies and strategies throughout the planning period. Figure 8 of the Technical Analysis shows that the 2012 State Water Plan existing supplies and strategies exceed the Draft MAG beginning around 2020. The difference, however, ranges from around 12,000 acre-feet per year in 2020 to about 42,000 acre-feet per year in 2060. Because the Region L Regional Water Plan allows for supplies and strategies to exceed available groundwater, this gap does not appear to be unmanageable as a state water planning matter and thus does not render the DFC unreasonable. The challenge will be in how the Districts manage the available groundwater and make permitting decisions. As staff has noted before, the risk, if any, to the Petitioners' property rights will become an issue when the Petitioners approach the Districts for the permits they need to develop their projects.

6. Consider the reasonable and prudent development of the state's groundwater resources.

Petitioners

Petitioners claim that the DFC does not allow for the reasonable and prudent development of the state's groundwater resources. The DFC would preclude development of the available groundwater resources in the face of significant increases in water demand.[33] By adopting an unreasonably low DFC, the region will be underutilizing a major resource in a significant way.[34]

Districts

The Districts state that they attempted to identify potential pumping in areas that have been identified as having future needs.[35]

Staff

Table 2 of the Technical Analysis shows estimated storage volume in the Carrizo-Wilcox Aquifer to be 1.9 billion acre feet. Estimated maximum sustainable pumping is 285,849 acre feet per year. The MAG ranges from 375,654 acre feet per year in 2010 to 403,998 acre feet per year in 2060. As Figure 8 in the Technical Analysis shows, the MAG exceeds estimated maximum sustainable pumping over the entire planning period. In addition, the MAG far exceeds the estimated exempt use over the same period, suggesting that there is sufficient room between exempt use and the MAG for the Districts to consider requests for additional water production, contrary to Petitioners' assertion. At a time of growing demand in the area, the Districts appear to be taking a reasonable approach to establishing a base line for planning to meet future demand.

Closing

Staff notes two particular issues that arose in this appeal. First, as the Districts note, the DFC process is iterative. Establishing a DFC involves an initial statement of the DFC, defining and weighing a number of factors to achieve that DFC, looking at the results and making adjustments,

[33] Hays Caldwell Pet., pg. 10.
[34] Hearing Trans., pg 51.
[35] Hearing Trans., pg. 58.

then repeating the process until a satisfactory DFC has been defined for the aquifer or aquifers. Districts are charged with then reviewing their DFCs every five years. Consequently, while the current DFC is projected over a 50-year planning horizon, it will be reviewed much sooner than that and more than once over the 50-year planning period.

The second issue relates to the next steps in the statutory process outlined in Chapter 36 of the Water Code. Once the DFC is final and the MAG is provided, the Districts must create management plans that incorporate the MAG. In turn, they must adopt rules that will support the management plans. Then they will grant permits based on the management plans and rules. The history of GAM analyses presented in Section 2 of the Technical Analysis shows the efforts by the Districts to consider a number of pumping scenarios before adopting the DFC. The success of this effort will depend on the management plans and rules that the Districts develop to implement their DFC.

RECOMMENDATION

Staff recommends that the Board find that the DFC adopted by the Districts in GMA 13 for the Sparta, Weches, Queen City, Reklaw, Carrizo, and Wilcox aquifers is reasonable after considering the petitions, the testimony and evidence presented at the hearings, and staff's summary and analysis of that evidence. The reasonableness of the DFC with respect to fulfillment of the state's policy and legislative directives, socio-economic impacts, and the exercise of personal property rights will depend on the way in which the Districts incorporate the MAG into their management plans and rules and make related decisions regarding permit authorizations and administration.

Attachment(s): Technical Analysis of Petitions

TECHNICAL ANALYSIS OF PETITIONS

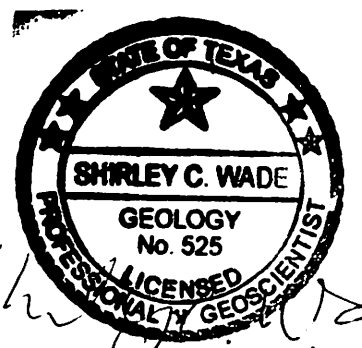
CHALLENGING THE REASONABLENESS OF THE DESIRED FUTURE CONDITIONS FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS IN GROUNDWATER MANAGEMENT AREA 13

Petitioners:
Canyon Regional Water Authority
Hays Caldwell Public Utility Agency

Prepared by:
Shirley C. Wade, Ph.D., P.G.
Texas Water Development Board
Groundwater Resources Division

Prepared for:
Texas Water Development Board
March 1, 2012 Board Meeting

February 22, 2012



The seal appearing on this technical analysis was authorized by Shirley C. Wade, P.G. 525 on February 22, 2012.

EXECUTIVE SUMMARY

We have summarized information from groundwater availability model (GAM) runs and the state water plan to provide context to issues raised in two petitions appealing the reasonableness of the desired future conditions for the Carrizo-Wilcox, Queen City, and Sparta aquifers in Groundwater Management Area 13. For GAM runs involving various pumping scenarios we plotted average drawdown versus pumping for all of Groundwater Management Area 13 and for Caldwell, Gonzales, and Guadalupe counties. Drawdown in Gonzales County was well correlated with total Gonzales County pumping, and drawdown in Guadalupe and Caldwell counties and Groundwater Management Area 13 was fairly well correlated with total pumping. The correlations suggest that the average drawdown is mainly a function of total pumping and is not extremely sensitive to the specific area of pumping.

We also compared draft modeled available groundwater amounts with regional water planning data, water use survey data, and estimates of maximum sustainable pumping. For the Carrizo-Wilcox Aquifer in Groundwater Management Area 13 the groundwater availability in the 2012 State Water Plan exceeds the draft modeled available groundwater by about 90,000 acre-feet per year in 2010 and 50,000 acre-feet per year in 2060. However, for Caldwell, Gonzales, and Guadalupe counties the draft modeled available groundwater exceeds groundwater availability in the 2012 State Water Plan for at least half of the planning period. The draft modeled available groundwater amounts for all of Groundwater Management Area 13 as well as Caldwell, Gonzales, and Guadalupe counties exceed estimated maximum sustainable pumping and historical use.

SECTION 1: INTRODUCTION

This document is a summary of technical information to provide context to the issues raised in two petitions appealing the reasonableness of the desired future conditions for the Carrizo-Wilcox, Queen City, and Sparta aquifers (Figure 1)adopted by groundwater conservation districts (Figure 2) within Groundwater Management Area 13. This report accompanies the staff evaluation of the issues raised in the petitions filed by Canyon Regional Water Authority and Hays Caldwell Public Utility Agency. In this technical report we draw no conclusions about the merits of the issues raised in the petitions.

To help address the technical aspects of the petitions we have summarized the eight groundwater availability model runs performed for Groundwater Management Area 13 (Section 2), and we have compiled groundwater use data from the TWDB Online Water Use Survey (TWDB, 2012) as well as groundwater availability from the 2006 (Amended 2009) South Central Texas Regional Water Plan (South Central Texas Regional Water Planning Group, 2009) and groundwater availability and recommended water management strategies from the 2011 South Central Texas Regional Water Plan (South Central Texas Regional Water Planning Group, 2011) (both part of the 2012 State Water plan) (Section 3).

SECTION 2: GROUNDWATER AVAILABILITY MODEL RUNS

TWDB staff completed eight groundwater availability modeling analysis reports for Groundwater Management Area 13 to help the groundwater conservation districts develop their statements of desired future conditions. The districts selected an average drawdown of 23 feet resulting from Scenario 4 of GAM Run 09-034 (Wade and Jigmond, 2010) as their desired future condition for the Carrizo-Wilcox, Queen City, and Sparta aquifers. The eight model reports described below were requested by Mike Mahoney on behalf of Groundwater Management Area 13.

GAM Run 06-29
Donnelly (2007a)

GAM Run 06-29 was a baseline modeling run using 1999 estimated historic pumping for each year of a 61-year simulation. In the model run we used average values of recharge, evapotranspiration, and streamflow conditions for each year. The average values for recharge, evapotranspiration, and streamflow conditions are the average of the annual values from the 1980 to 1999 historical calibration period for the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Kelley and others, 2004). We summarized the model run results with water budget tables and maps of drawdown.

GAM Run 07-16
Donnelly (2007b)

For GAM Run 07-16 we added additional pumping to the baseline 1999 Carrizo Aquifer pumping in Caldwell and Gonzales counties. We added up to 6,000 acre feet per year in Caldwell County and 9,000 acre-feet per year to Gonzales County in locations specified by the districts. As with GAM Run 06-29 we used average values of recharge, evapotranspiration, and streamflow conditions for each year of a 61-year simulation. We summarized the model run results with water budget tables and maps of drawdown.

GAM Run 07-17
Donnelly (2007c)

For GAM Run 07-17 we based the pumping distribution on GAM Run 07-16. District representatives specified modified pumping totals for their counties. In most cases they increased the county pumping totals from the 1999 baseline amounts to the 2007 State Water Plan groundwater availability amounts. To bring county totals up to the 2007 State Water Plan amounts, we uniformly increased the pumping throughout each county. In addition we responded to requests from the districts and added 6,400 acre feet per year to the Carrizo Aquifer in specified locations in Bexar County and 14,000 acre-feet per year to the middle and

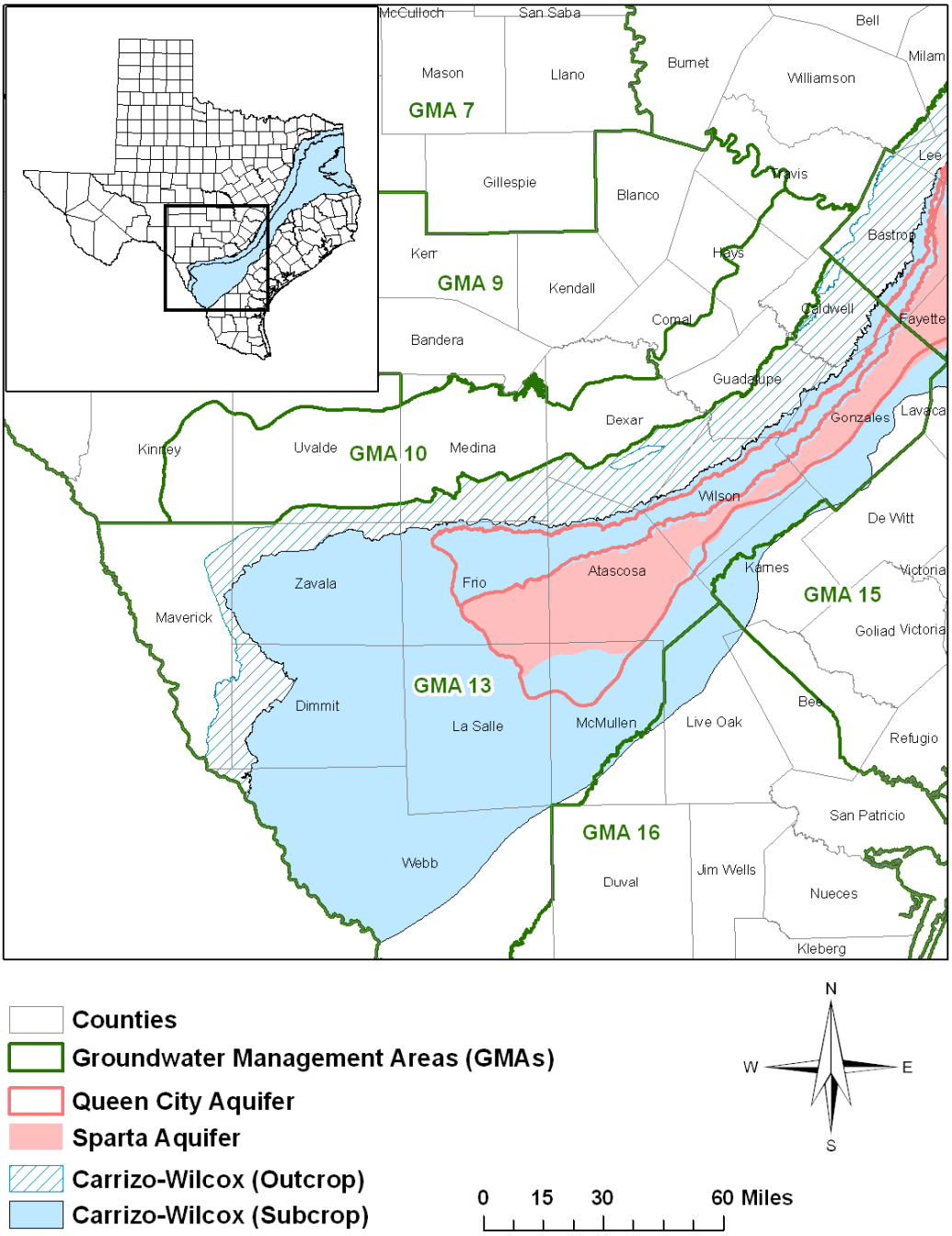


FIGURE 1. LOCATION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS IN GROUNDWATER MANAGEMENT AREA 13.

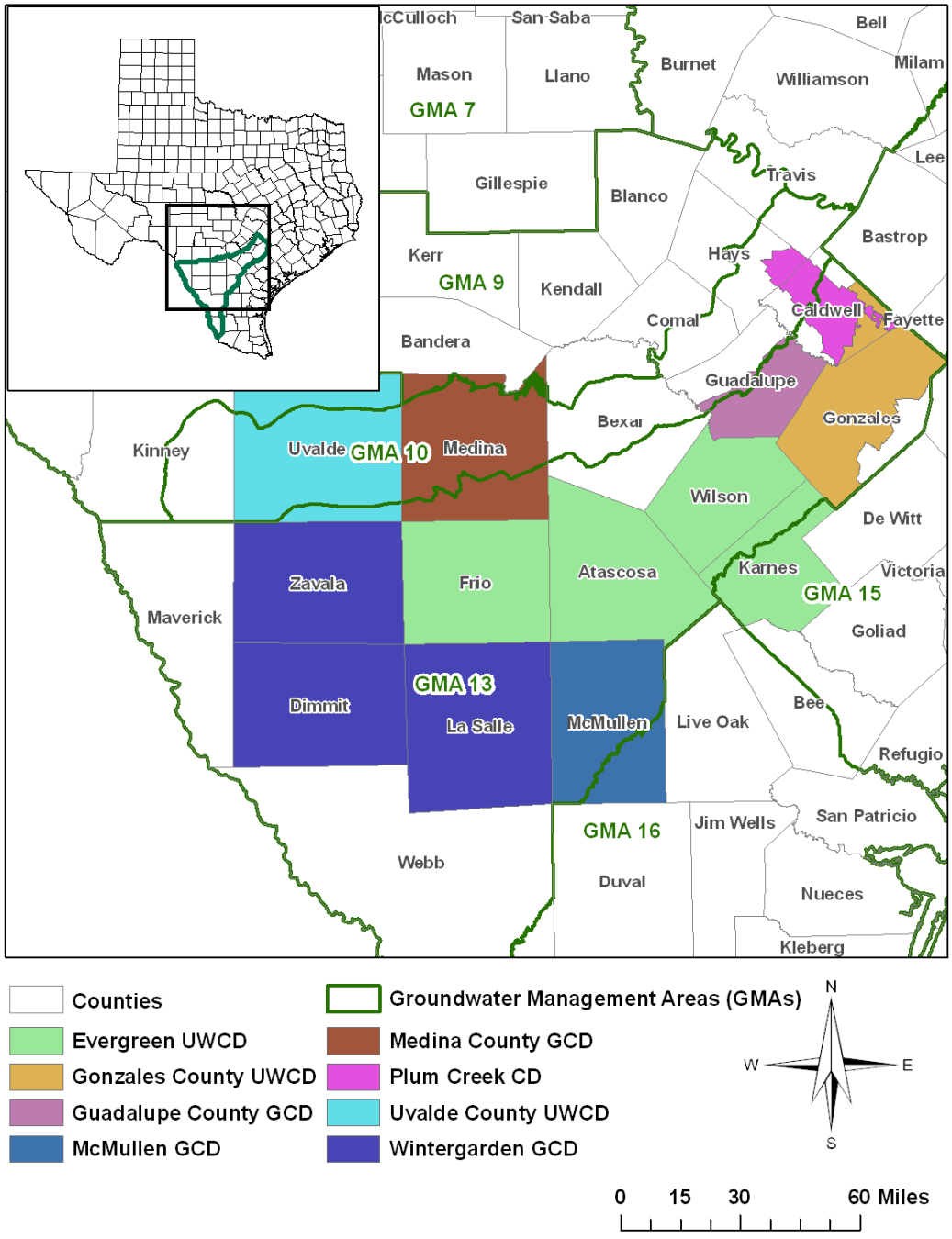


FIGURE 2. GROUNDWATER CONSERVATION DISTRICTS IN GROUNDWATER MANAGEMENT AREA 13. (CD = CONSERVATION DISTRICT; GCD = GROUNDWATER CONSERVATION DISTRICT; UWCD = UNDERGROUND WATER CONSERVATION DISTRICT).

lower Wilcox Aquifer in Atascosa County. Again, we used average values of recharge, evapotranspiration, and streamflow conditions for each year of a 61-year simulation. We summarized the model run results with water budget tables and maps of drawdown.

GAM Runs 08-41, 08-42, and 08-43
Wade (2008a, b, c)

GAM Runs 08-41, 08-42, and 08-43 were high, low, and medium pumping scenarios, respectively. District representatives specified estimates of low, medium, and high amounts of pumping for their counties. To achieve the specified pumping amount for most counties we based the pumping distribution on the baseline 1999 pumping and uniformly increased or decreased the pumping amounts. Exceptions were as follows: Gonzales County was separated into three pumping areas with totals specified for each area; Caldwell County was separated into three pumping areas with pumping specified for each area; pumping was placed in specified locations in the Carrizo Aquifer in Atascosa, Caldwell, Gonzales, Guadalupe, and Wilson counties; and pumping was placed in specified locations in the middle and lower Wilcox Aquifers in Atascosa, Bexar and Wilson counties. As for the previous runs we used average recharge, evapotranspiration, and streamflow conditions for each year of a 61-year simulation. We summarized the model run results with water budget tables and maps of drawdown.

GAM Run 09-34
Wade and Jigmond(2010)

GAM Run 09-34 consisted of model runs using four pumping scenarios. Representatives for the districts provided pumping amounts and locations for scenario 1. They provided the pumping as county totals, totals for sub-county areas, and as specified point locations. The districts provided maps for the sub-county areas and for the specified point locations. Scenario 2 included an additional 5,688 acre-feet per year at specified point locations in western Gonzales County. Scenario 3 included an additional 16,000 acre-feet per year at specified point locations in southeastern Caldwell County and 4,000 acre-feet per year at two additional point locations not included in scenarios 1 and 2. Scenario 4 combined pumping from scenarios 1, 2, and 3. For each scenario we calculated average drawdowns for each layer and for each county and for the entire groundwater management area.

In addition to the four pumping scenarios we also ran the model for each scenario with pumping scaled by 70 percent, 80 percent, 90 percent, 110 percent, 120 percent, and 130 percent. We calculated average drawdown for each percentage and plotted charts of drawdown versus total pumping. Figure 3 illustrates the relationship between pumping and drawdown for the scaled pumping specified for Scenario 4.

As for the previous runs we used average recharge, evapotranspiration, and streamflow conditions for each year of a 61-year simulation. We summarized the model run results with

water budget tables, tables of average drawdown, and charts of average drawdown and provided drawdown maps in an appendix.

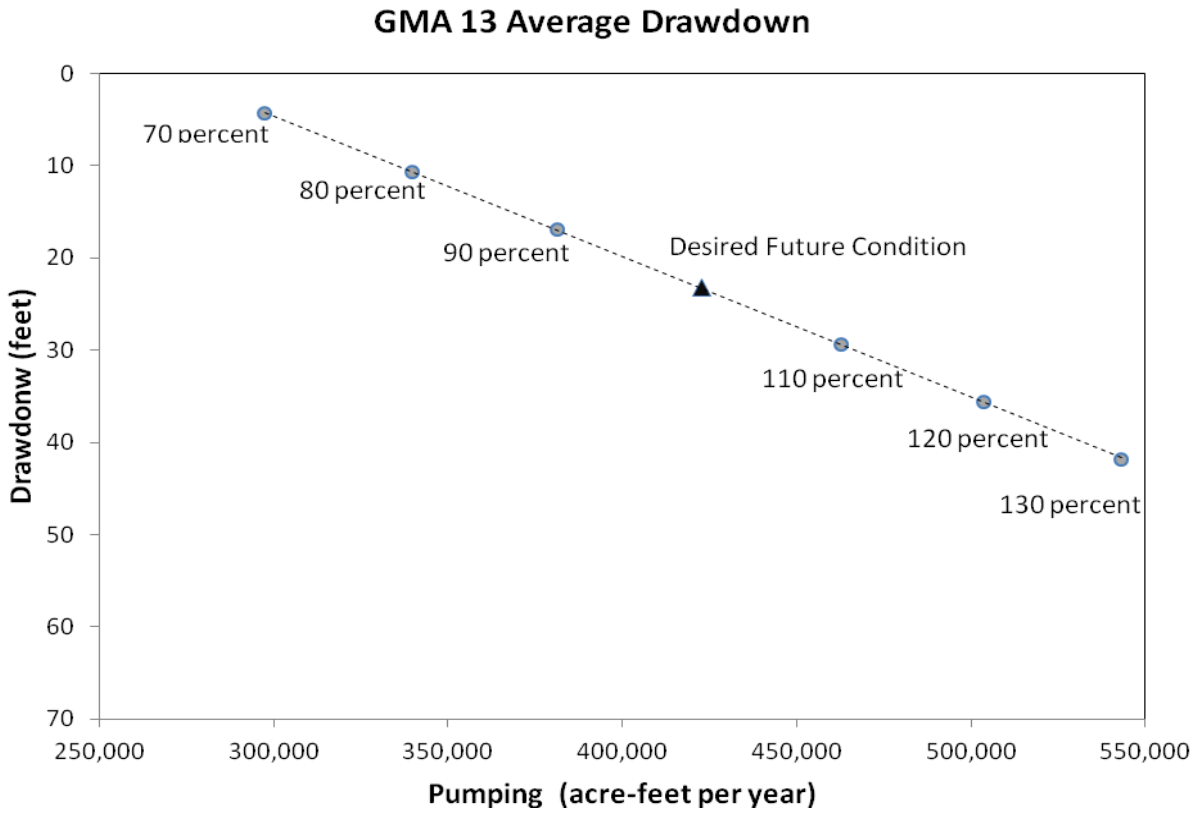


FIGURE 3. AVERAGE DRAWDOWN IN GROUNDWATER MANAGEMENT AREA 13 VERSUS GROUNDWATER MANAGEMENT AREA 13 PUMPING FOR GAM RUN 09-34 (SCENARIO 4) SCALED PUMPING RUNS. THE RUN CORRESPONDING TO THE DESIRED FUTURE CONDITION IS SHOWN WITH THE BLACK TRIANGLE.

Draft GAM Run 11-007 and Draft GAM Run 11-007 Addendum
Wade (2011a, b)

Mike Mahoney requested GAM Run 11-007 on behalf of the districts in Groundwater Management Area 13 as the outcome of a meeting between several district representatives and the petitioners. GAM Run 11-007 consisted of two pumping scenarios, scenario 5a and 5b. Both scenarios included an additional 4,600 acre-feet per year of pumping to the Carrizo Aquifer at new and existing locations in Guadalupe and western Gonzales counties. Scenario 5a included 35,000 acre-feet per year of additional pumping in the Carrizo Aquifer in a downdip location in eastern Gonzales County. Scenario 5b included 35,000 acre-feet per year additional pumping in the Carrizo Aquifer in an updip location in eastern Caldwell County.

As for the previous runs we used average values of recharge, evapotranspiration, and streamflow conditions for each year of a 61-year simulation. We summarized the model run results with water budget tables and tables of average drawdown. In the GAM Run 11-007 addendum we provided drawdown maps and summary tables of water budgets for the historical average, 1999 year pumping and 2060 in scenarios 1 through 5b

Summary of Average Drawdowns and Pumping for Groundwater Management Area 13 GAM Runs

For each GAM Run discussed above we calculated average drawdown for Groundwater Management Area 13 and for Caldwell, Gonzales, and Guadalupe counties (Table 1). We also plotted the average drawdown versus pumping for the runs (Figures 4 through 7). The summary plot for the groundwater management area-wide average drawdown (Figure 4) is similar to the plot of average drawdown versus scaled pumping from GAM Run 09-34 (Figure 3). The summary plot is more scattered than the plot for GAM Run 09-34, but the similarity

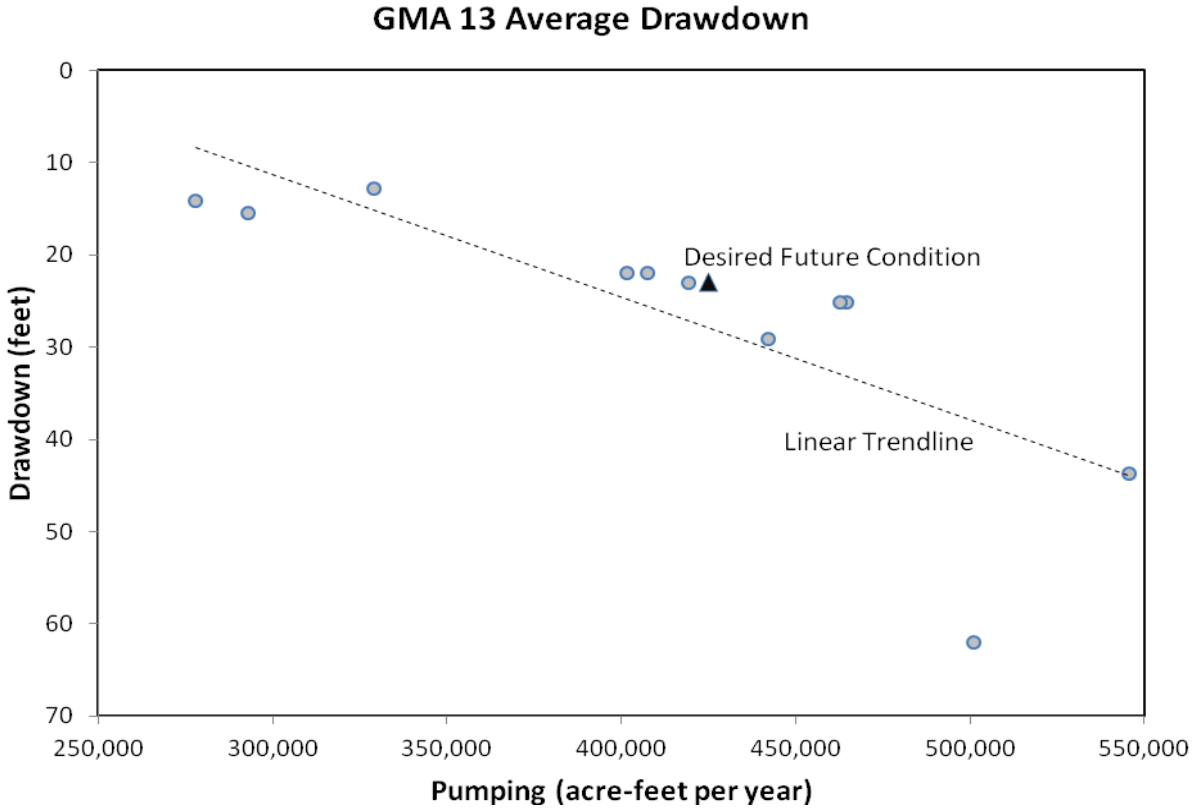


FIGURE 4. AVERAGE DRAWDOWN IN GROUNDWATER MANAGEMENT AREA 13 VERSUS GROUNDWATER MANAGEMENT AREA 13 PUMPING FOR ALL GROUNDWATER MANAGEMENT AREA 13 GAM RUNS. THE RUN CORRESPONDING TO THE DESIRED FUTURE CONDITION IS SHOWN WITH THE BLACK TRIANGLE.

suggests that similar pumping amounts produce similar area-wide drawdown even if the pumping is in different locations. The drawdown point that is located far below the trendline for the summary plot (Figure 4) is due to a larger fraction of the pumping being located in the Wilcox Aquifer. The hydraulic conductivity of the Wilcox Aquifer is lower than the Carrizo Aquifer and produces greater drawdown for the same amount of pumping.

Table 1 lists the pumping values and drawdown estimates derived from various GAM runs. These relationships are illustrated for each county in Figures 5 through 7.

TABLE 1. TOTAL PUMPING AND AVERAGE DRAWDOWN FOR EIGHT GROUNDWATER MANAGEMENT AREA 13 GAM RUNS.

Area	Groundwater Management Area 13		Caldwell County		Gonzales County		Guadalupe County	
GAM Run	Pumping (ac-ft/yr)	Draw down (ft)	Pumping (ac-ft/yr)	Draw down (ft)	Pumping (ac-ft/yr)	Draw down (ft)	Pumping (ac-ft/yr)	Draw down (ft)
06-29	277,970	14	3,744	-2	3,421	-2	5,815	2
07-16	292,970	15	9,745	2	12,421	5	5,815	5
07-17	500,927	62	15,730	26	40,235	34	10,394	18
08-41	545,484	44	46,162	89	115,239	91	15,454	55
08-42	329,046	13	25,214	33	48,221	35	16,640	26
08-43	442,047	29	36,262	59	78,237	60	17,699	40
09-34 Scenario 1	401,679	22	26,329	51	78,899	55	14,043	30
09-34 Scenario 2	407,367	22	26,329	52	84,587	59	14,043	32
09-34 Scenario 3	419,279	23	43,929	63	78,899	61	14,043	31
09-34 Scenario 4	424,967	23	43,929	63	84,587	65	14,043	32
11-007 Scenario 5a	464,564	25	43,928	75	123,986	82	14,243	33
11-007 Scenario 5b	462,812	25	71,926	81	94,236	80	14,243	33

ft = feet; ac-ft/yr = acre-feet per year; negative drawdowns represent water levels rises

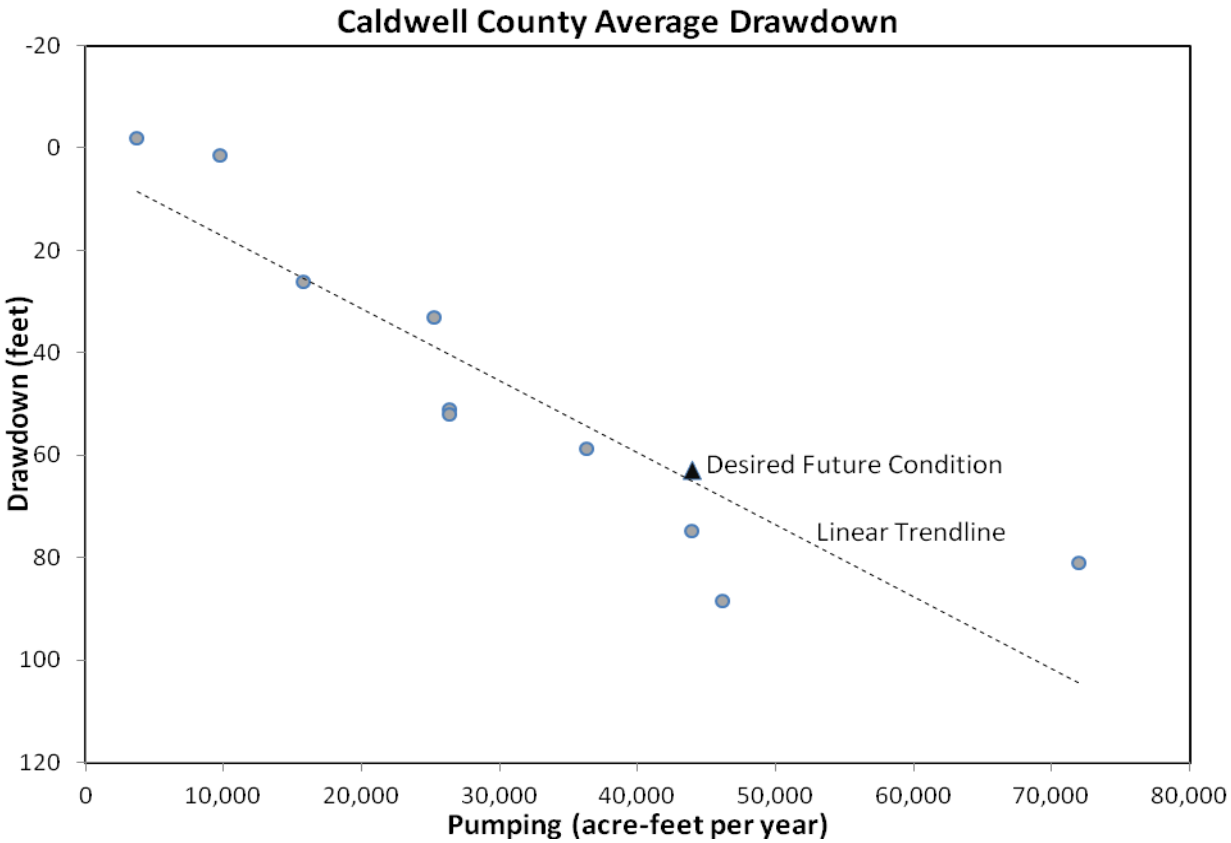


FIGURE 5. AVERAGE DRAWDOWN IN CALDWELL COUNTY VERSUS CALDWELL COUNTY PUMPING FOR ALL GROUNDWATER MANAGEMENT AREA 13 GAM RUNS. THE RUN CORRESPONDING TO THE DESIRED FUTURE CONDITION IS SHOWN WITH THE BLACK TRIANGLE.

Average drawdown is well correlated with pumping for Gonzales County (Figure 6). For most, if not all, of the GAM Runs, increased area-wide pumping was accompanied by increased pumping in Gonzales County. The drawdown plots for Caldwell and Guadalupe counties also fit a linear trend but are somewhat more scattered (Figures 5 and 7). Increased area-wide pumping was not necessarily matched with increased pumping in Caldwell and Guadalupe counties in all eight of the GAM runs.

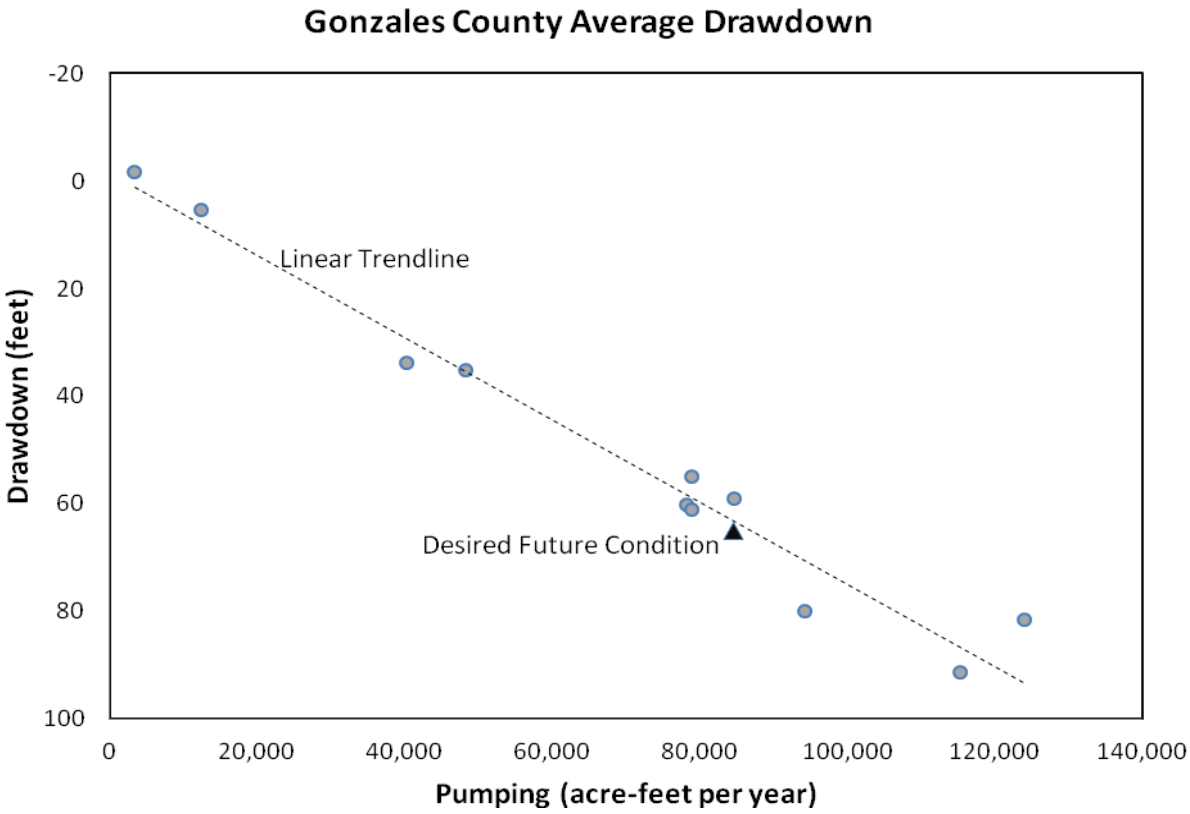


FIGURE 6. AVERAGE DRAWDOWN IN GONZALES COUNTY VERSUS GONZALES COUNTY PUMPING FOR ALL GROUNDWATER MANAGEMENT AREA 13 GAM RUNS. THE RUN CORRESPONDING TO THE DESIRED FUTURE CONDITION IS SHOWN WITH THE BLACK TRIANGLE.

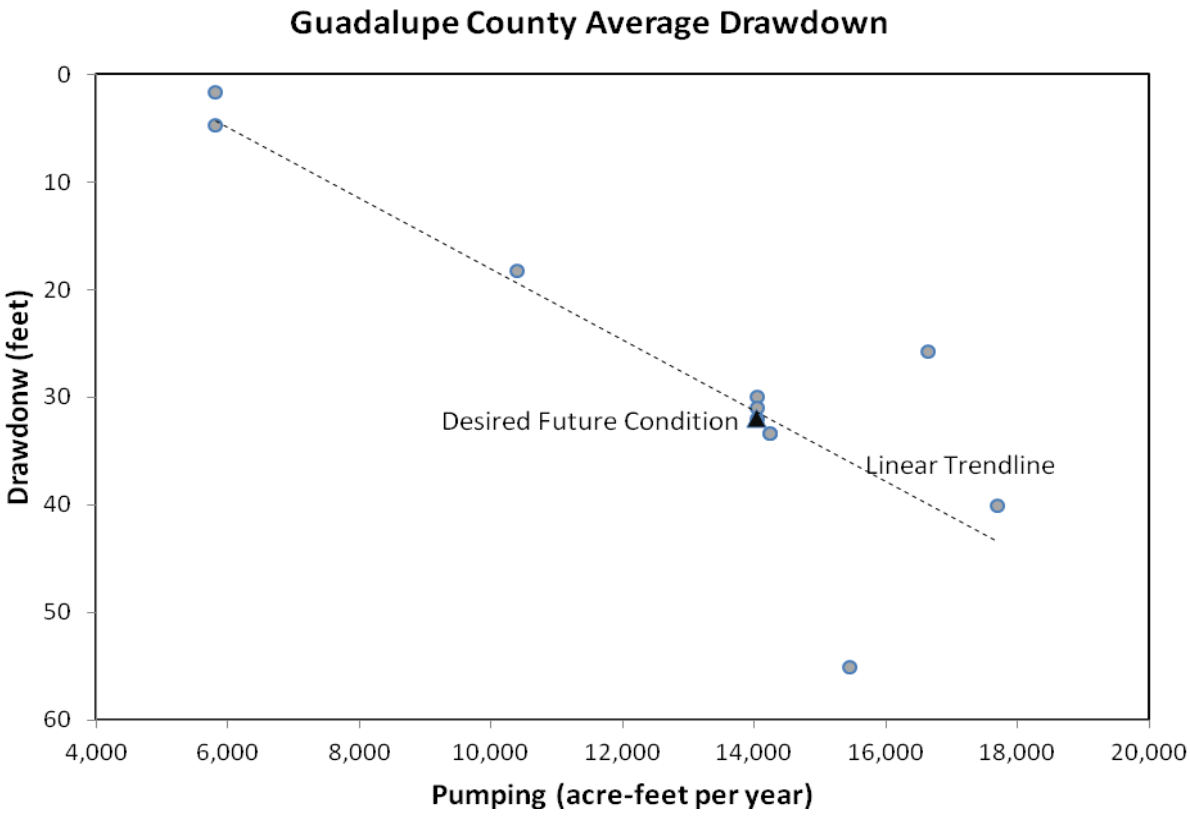


FIGURE 7. AVERAGE DRAWDOWN IN GUADALUPE COUNTY VERSUS GUADALUPE COUNTY PUMPING FOR ALL GROUNDWATER MANAGEMENT AREA 13 GAM RUNS. THE RUN CORRESPONDING TO THE DESIRED FUTURE CONDITION IS SHOWN WITH THE BLACK TRIANGLE.

SECTION 3: COMPARISON OF DRAFT MODELED AVAILABLE GROUNDWATER WITH STATE WATER PLAN GROUNDWATER AVAILABILITY, AND WATER MANAGEMENT STRATEGIES, FOR THE AQUIFERS IN GROUNDWATER MANAGEMENT AREA 13.

To put the modeled available groundwater volumes for Groundwater Management Area 13 into context we have compiled and plotted estimates of historical use, exempt use, groundwater availability from the 2007 and 2012 state water plans as well as 2012 State Water Plan water management strategy volumes for the Carrizo-Wilcox (Table 2; Figure 8), Queen City (Table 3), and Sparta aquifers (Table 4). We have also compiled the same groundwater volumes for the Carrizo-Wilcox Aquifer in Caldwell County (Table 5; Figure 9), Gonzales County (Table 6; Figure 10), and Guadalupe County (Table 7; Figure 11). In addition, we compiled precipitation recharge, estimated maximum sustainable pumping, and total storage volume from the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers.

Historical Groundwater Pumping

The 2008 estimated groundwater pumping (Tables 2 through 7) is from the TWDB Online Water Use Survey data (TWDB, 2011). We also include water use data from 1980 through 2008 on the comparison charts (Figures 8 through 11). The total historical use for the Carrizo-Wilcox in Groundwater Management Area 13 shows a downward trend from 1980 through 2008 (Figure 8). This downward trend is due largely to decreasing irrigation use in Atascosa and Zavala counties. Irrigation use overall decreased from 90 percent of total pumping to 78 percent of total pumping in the 28 year time period.

Estimated Exempt Use

Exempt use is the projected amount of pumping from the aquifer that is exempt from permitting by a groundwater conservation district. Examples of exempt uses include certain domestic and livestock use. Each district may also exempt additional uses as defined by its rules or enabling legislation. TWDB staff developed a standardized method for estimating exempt use for domestic and livestock purposes based on projected changes in population and the distribution of domestic and livestock wells. Because other exempt uses can vary significantly from district to district, estimates of exempt pumping outside domestic and livestock uses were not included in the TWDB estimate (Oliver, 2012).

2007 State Water Plan Groundwater Availability

For the 2006 Regional Water Plan (Amended August 2009; South Central Texas Regional Water Planning Group, 2009), the South-Central Texas Regional Water Planning Group used estimates of groundwater availability from the groundwater management plans of the groundwater conservation districts. For areas without groundwater conservation districts the planning group used estimates from the 2001 South Central Texas Regional Water Plan (South Central Texas Regional Water Planning Group,2001).

2012 State Water Plan Groundwater Availability

For the 2011 Regional Water Plan (South Central Texas Regional Water Planning Group, 2011;TWDB, 2012), the South-Central Texas Regional Water Planning Group used estimates of groundwater availability from the groundwater management plans of the groundwater conservation districts. For areas without groundwater conservation districts they used estimates from the 2006 South Central Texas Regional Water Plan (South Central Texas Regional Water Planning Group, 2009).

2012 State Water Plan Existing Water Supplies plus Recommended Water Management Strategies

Existing water supplies are those supplies that are physically and legally available now and in future decades. They include water that providers have permits or contracts for now and are able to provide to water users with existing infrastructure. Water management strategies include projects for new groundwater development or projects for new conveyance facilities

to move available water supplies to areas of need (South Central Regional Water Planning Group, 2011). Existing groundwater supplies plus recommended groundwater strategies represents possible future use of groundwater, at least according to the plan.

The 2011 Region L Regional Water Plan includes recommended water management strategies that would result in overdrafting the groundwater in certain locations if all the recommended projects were actually implemented. These projects were recognized as 'overdraft' water management strategies in the Region L plan (South Central Texas Regional Water Planning Group, 2011).

The Region L plan acknowledges that implementing many of the recommended water management strategies will require obtaining additional groundwater permits from Ground water Conservation Districts. The Region L plan acknowledges that implementation of groundwater projects is uncertain and contingent upon groundwater permits from various groundwater conservation districts (South Central Texas Regional Water Planning Group, 2011).

In the event that one of the associated, recommended water management strategies becomes infeasible (e.g., due to failure to obtain groundwater pumping permits) the Region L plan includes backup recommended water management strategies and/or alternative water management strategies that could be substituted to meet the associated identified water needs (South Central Texas Regional Water Planning Group, 2011).

The Region L plan acknowledges that all these recommended projects could only be implemented if an additional quantity of groundwater is determined to be available and is permitted by the associated Groundwater Conservation Districts (South Central Texas Regional Water Planning Group, 2011).

Estimated Recharge from Precipitation

We used the groundwater availability model for the southern part of the Carrizo-Wilcox and Queen City and Sparta Aquifers (Kelley and others, 2004) to estimate the recharge from precipitation. We used the average modeled recharge during the historical period (1980 to 1999).

Estimated Maximum Sustainable Pumping

We developed estimates of maximum sustainable pumping using the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Kelley and others, 2004). We determined the maximum rate of pumping that would result in stable water levels after a long period of time (500 years).The estimate does not account for costs associated with a certain level of pumping or possible impacts of pumping such as reduced water quality and decreased outflow to streams and springs.

TABLE 2. GROUNDWATER MANAGEMENT AREA 13 (TOTAL AREA) – CARRIZO-WILCOX AQUIFER ALL VALUES IN ACRE-FEET PER YEAR EXCEPT WHERE NOTED.

Decade	2010	2020	2030	2040	2050	2060
Draft Modeled Available Groundwater	375,654	384,162	392,467	400,302	401,914	403,998
2007 State Water Plan Groundwater Availability	441,925	441,925	431,891	431,891	431,891	431,891
2012 State Water Plan Groundwater Availability	465,690	465,690	458,292	458,292	458,292	458,292
TWDB Estimated Exempt Use	6,045	6,247	6,482	6,749	7,107	7,458
2012 State Water Plan Existing Water Supplies plus Recommended Water Management Strategies	330,429	396,715	407,041	414,411	427,714	445,267
2008 Groundwater Pumping	206,763					
Estimated Recharge	103,990					
Estimated Storage Volume (acre-feet)	1,907,762,000					
Estimated Maximum Sustainable Pumping	285,849					

TABLE 3. GROUNDWATER MANAGEMENT AREA 13 (TOTAL AREA) – QUEEN CITY AQUIFER ALL VALUES IN ACRE-FEET PER YEAR EXCEPT WHERE NOTED.

Decade	2010	2020	2030	2040	2050	2060
Draft Modeled Available Groundwater	16,312	15,976	15,635	15,244	14,878	14,539
2007 State Water Plan Groundwater Availability	27,383	27,383	27,383	27,383	27,383	27,383
2012 State Water Plan Groundwater Availability	24,374	24,374	24,374	24,374	24,374	24,374
TWDB Estimated Exempt Use	1,268	1,288	1,349	1,429	1,554	1,700
2008 Groundwater Pumping	5,438					
Estimated Recharge	66,406					
Estimated Storage Volume (acre-feet)	148,053,000					
Estimated Maximum Sustainable Pumping	10,287					

TABLE 4. GROUNDWATER MANAGEMENT AREA 13 (TOTAL AREA) – SPARTA AQUIFER ALL VALUES IN ACRE-FEET PER YEAR EXCEPT WHERE NOTED.

Decade	2010	2020	2030	2040	2050	2060
Draft Modeled Available Groundwater	6,800	6,680	6,583	6,498	6,422	6,364
2007 State Water Plan Groundwater Availability	9,140	9,140	9,140	9,140	9,140	9,140
2012 State Water Plan Groundwater Availability	9,590	9,590	9,590	9,590	9,590	9,590
TWDB Estimated Exempt Use	857	903	967	1,036	1,124	1,225
2008 Groundwater Pumping	4,140					
Estimated Recharge	24,857					
Estimated Storage Volume (acre-feet)	25,887,000					
Estimated Maximum Sustainable Pumping	4,503					

TABLE 5. GROUNDWATER MANAGEMENT AREA 13 CALDWELL COUNTY – CARRIZO-WILCOX AQUIFER ALL VALUES IN ACRE-FEET PER YEAR EXCEPT WHERE NOTED.

Decade	2010	2020	2030	2040	2050	2060
Draft Modeled Available Groundwater	44,545	44,545	44,137	44,137	43,560	43,560
2007 State Water Plan Groundwater Availability	12,500	12,500	12,500	12,500	12,500	12,500
2012 State Water Plan Groundwater Availability	24,460	24,460	24,460	24,460	24,460	24,460
TWDB Estimated Exempt Use	234	224	203	184	168	153
2012 State Water Plan Existing Water Supplies plus Recommended Water Management Strategies	12,577	20,219	26,286	26,689	27,253	28,626
2008 Groundwater Pumping	1,632					
Estimated Recharge	14,435					
Estimated Storage Volume (acre-feet)	21,123,000					
Estimated Maximum Sustainable Pumping	30,812					

TABLE 6. GROUNDWATER MANAGEMENT AREA 13 GONZALES COUNTY – CARRIZO-WILCOX AQUIFER ALL VALUES IN ACRE-FEET PER YEAR EXCEPT WHERE NOTED.

Decade	2010	2020	2030	2040	2050	2060
Draft Modeled Available Groundwater	52,482	62,315	70,316	75,790	75,969	75,969
2007 State Water Plan Groundwater Availability	28,942	28,942	28,942	28,942	28,942	28,942
2012 State Water Plan Groundwater Availability	60,440	60,440	60,440	60,440	60,440	60,440
TWDB Estimated Exempt Use	1,462	1,215	1,025	890	850	863
2012 State Water Plan Existing Water Supplies plus Recommended Water Management Strategies	28,912	76,715	78,920	83,899	90,512	98,137
2008 Groundwater Pumping	6,770					
Estimated Recharge	1,700					
Estimated Storage Volume (acre-feet)	225,335,000					
Estimated Maximum Sustainable Pumping	53,752					

TABLE 7. GROUNDWATER MANAGEMENT AREA 13 GUADALUPE COUNTY – CARRIZO-WILCOX AQUIFER ALL VALUES IN ACRE-FEET PER YEAR EXCEPT WHERE NOTED.

Decade	2010	2020	2030	2040	2050	2060
Draft Modeled Available Groundwater	10,241	10,833	11,283	13,021	13,541	14,041
2007 State Water Plan Groundwater Availability	12,583	12,583	9,947	9,947	9,947	9,947
2012 State Water Plan Groundwater Availability	12,583	12,583	12,583	12,583	12,583	12,583
TWDB Estimated Exempt Use	326	264	198	127	73	17
2012 State Water Plan Existing Water Supplies plus Recommended Water Management Strategies	14,463	17,988	18,593	19,198	20,004	20,811
2008 Groundwater Pumping	6,231					
Estimated Recharge	17,364					
Estimated Storage Volume (acre-feet)	17,344,000					
Estimated Maximum Sustainable Pumping	9,935					

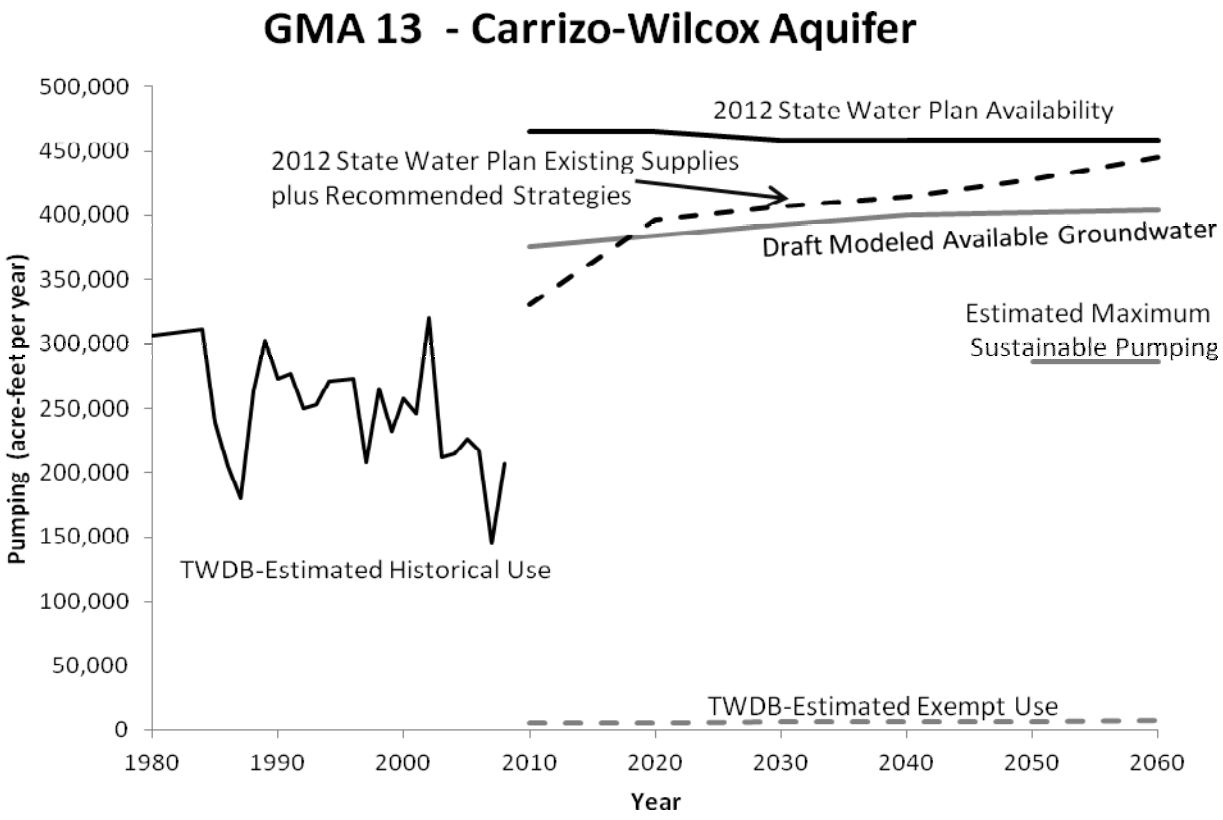


FIGURE 8. COMPARISON OF VARIOUS GROUNDWATER PLANNING AMOUNTS FOR THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 13.

Comparison Summary

For the Carrizo-Wilcox Aquifer in Groundwater Management Area 13 the 2012 State Water Plan groundwater availability exceeds the draft modeled available groundwater by about 90,000 acre-feet per year in 2010 decreasing to 50,000 acre-feet per year by 2060 (Figure 8). The draft modeled available groundwater is greater than the 2012 State Water Plan Existing Water Supplies plus Recommended Water Management Strategies until 2020. However after 2020 Supplies plus Strategies exceed the draft modeled available groundwater for all of Groundwater Management Area 13 (Figure 8).

In Caldwell County the draft modeled available groundwater amount is almost twice the 2012 State Water Plan groundwater availability and the 2012 State Water Plan Existing Water Supplies plus Recommended Water Management Strategies (Figure 9).

In Gonzales County the draft modeled available groundwater exceeds the 2012 State Water Plan groundwater availability after 2020 (Figure 10) and the draft modeled available groundwater amounts exceed the 2012 State Water Plan Existing Water Supplies plus Recommended Water Management Strategies in Gonzales County prior to 2020 (Figure 10). After 2020 the 2012 State Water Plan Existing Water Supplies plus Recommended Water

Management Strategies exceed both the draft modeled available groundwater amounts and the 2012 State Water Plan groundwater availability (Figure 10).

In Guadalupe County the 2012 State Water Plan Existing Water Supplies plus Recommended Water Management Strategies exceed the draft modeled available groundwater (Figure 11). The 2012 State Water Plan groundwater availability exceeds the draft modeled available groundwater until 2040 (Figure 11).

As mentioned above, the 2011 Region L Regional Water Plan includes recommended water management strategies that would result in overdrafting the groundwater in certain locations if all the recommended projects were actually implemented. These projects were recognized as 'overdraft' water management strategies in the Region L plan (South Central Texas Regional Water Planning Group, 2011).

In all cases presented here (Figures 8 through 11), the draft modeled available groundwater amounts exceed the estimated maximum sustainable pumping and historical use.

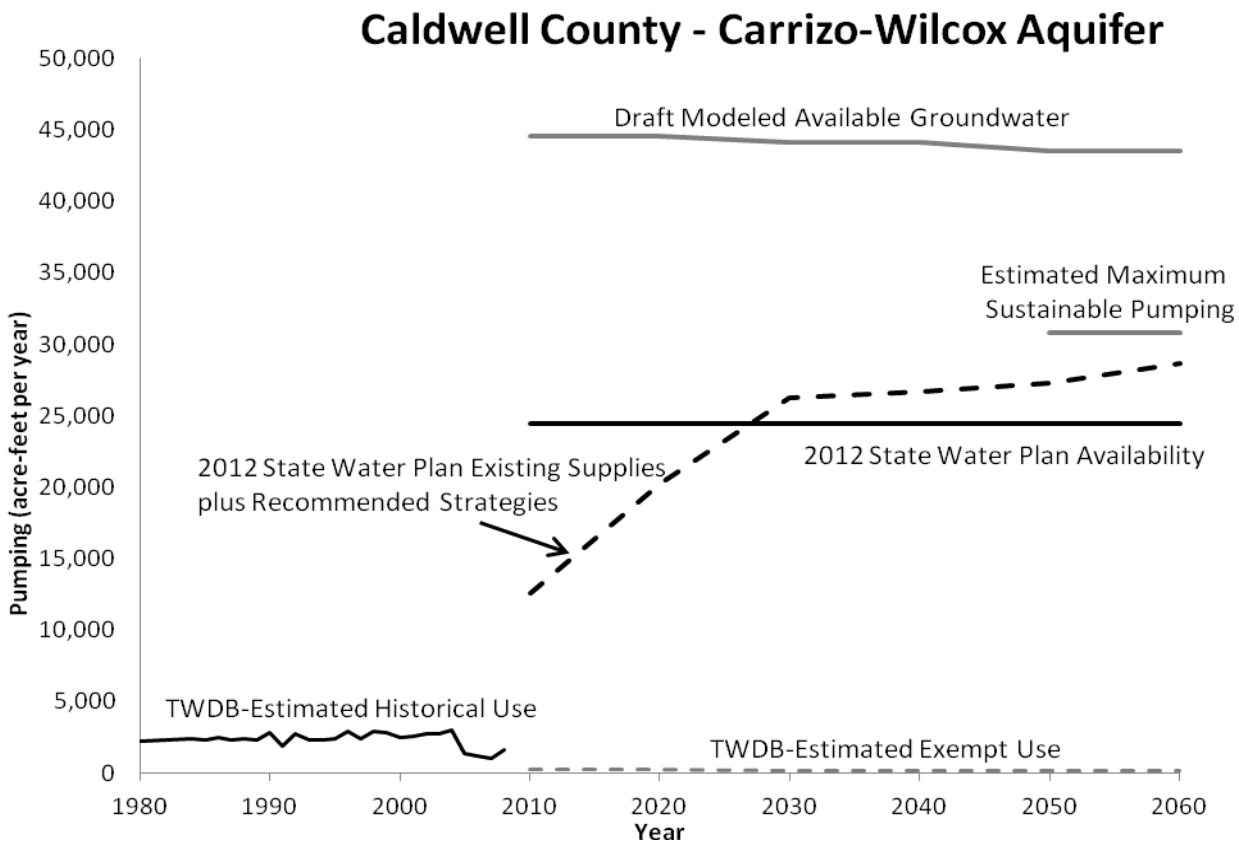


FIGURE 9. COMPARISON OF VARIOUS GROUNDWATER PLANNING AMOUNTS FOR THE CARRIZO-WILCOX AQUIFER IN CALDWELL COUNTY.

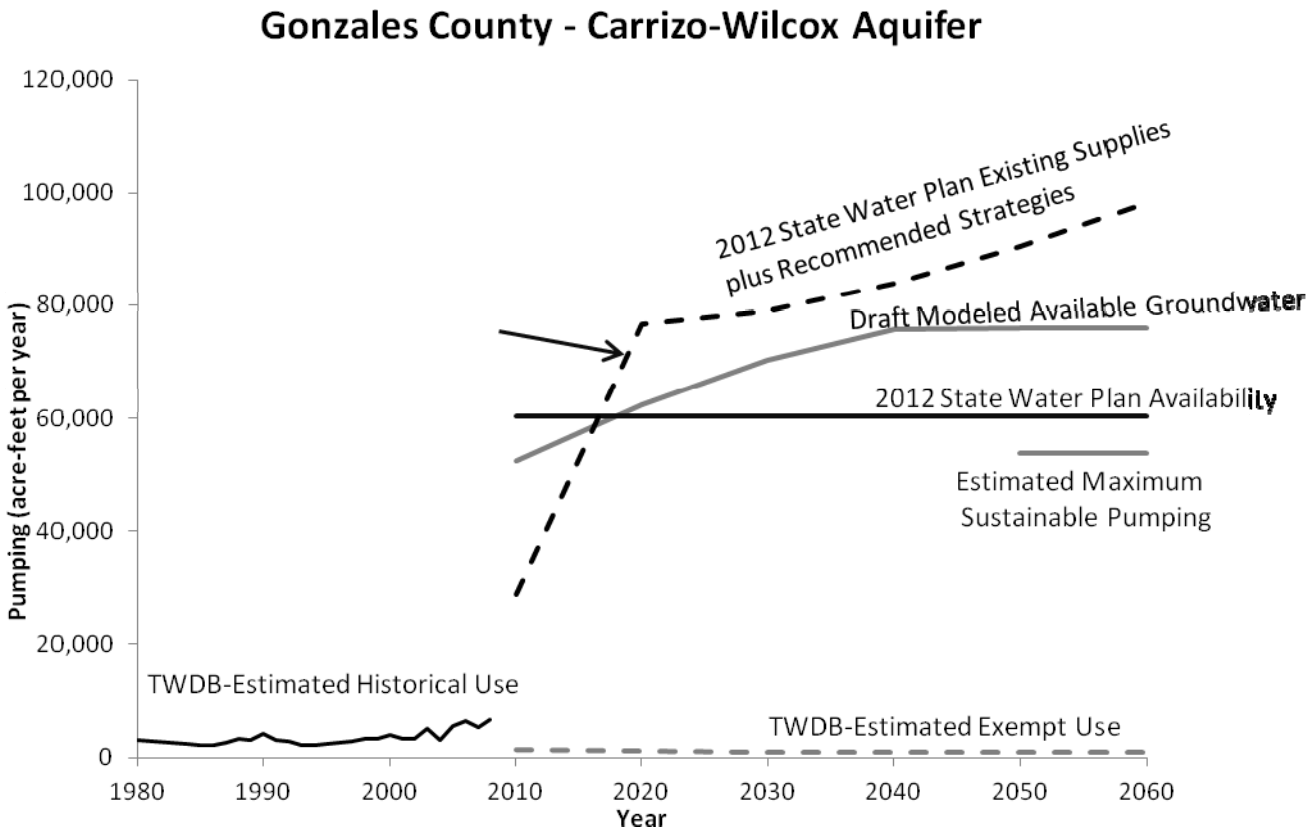


FIGURE 10. COMPARISON OF VARIOUS GROUNDWATER PLANNING AMOUNTS FOR THE CARRIZO-WILCOX AQUIFER IN GONZALES COUNTY.

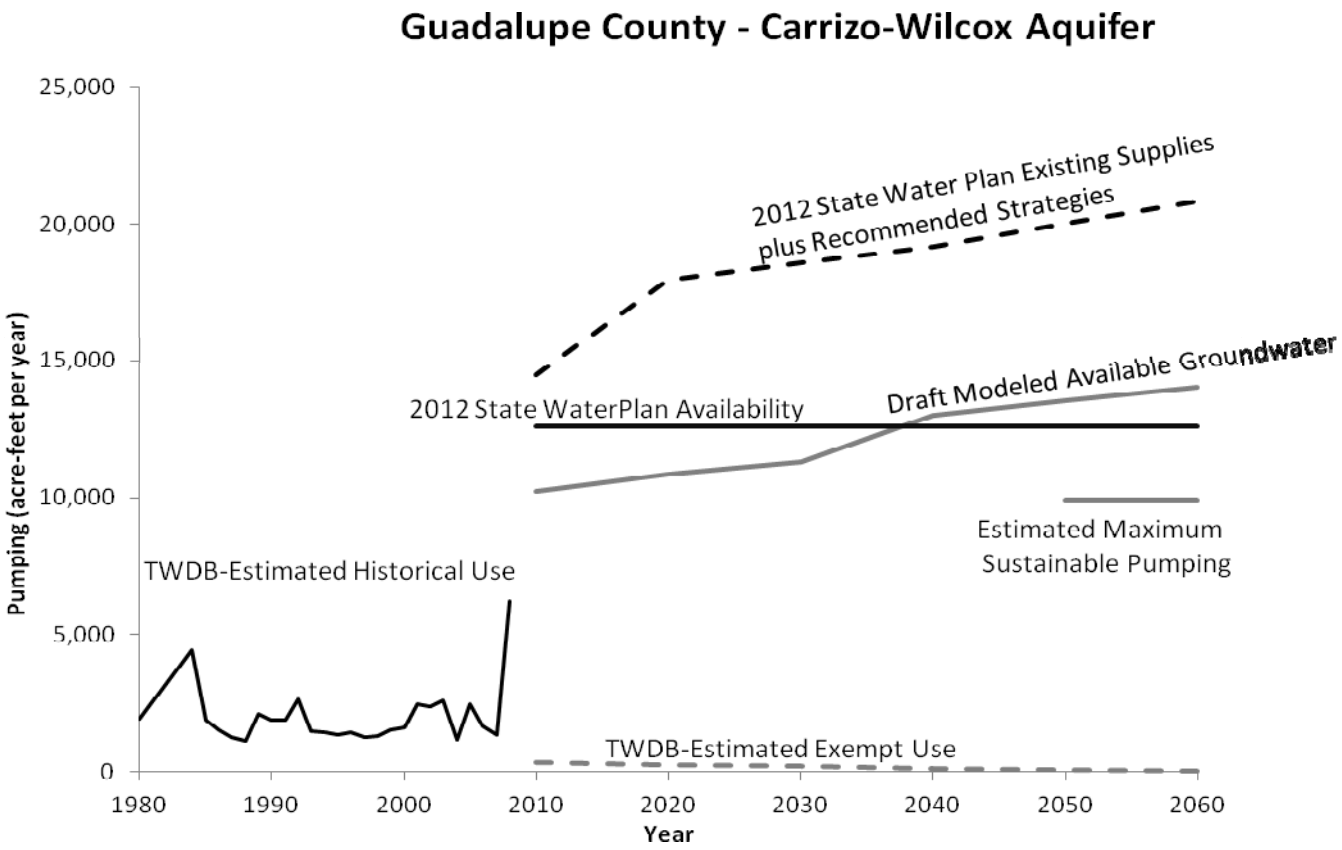


FIGURE 11. COMPARISON OF VARIOUS GROUNDWATER PLANNING AMOUNTS FOR THE CARRIZO-WILCOX AQUIFER IN GUADALUPE COUNTY.

SECTION 4: MODEL PARAMETERS, ASSUMPTIONS, and LIMITATIONS

We used version 2.01 of the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers for this analysis. See Deeds and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers.

The groundwater availability model includes eight layers, which generally correspond to (from top to bottom) the Sparta Aquifer, the Weches Confining Unit, the Queen City Aquifer, the Reklaw Confining Unit, the Carrizo Aquifer, the Upper Wilcox Aquifer, the Middle Wilcox Aquifer, and the Lower Wilcox Aquifer.

The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model is 23 feet for the Sparta Aquifer, 18 feet for the Queen City Aquifer, and 33 feet for the Carrizo Aquifer for the calibration period (1980 to 1990) and 19, 22, and 48 feet for the same aquifers, respectively, in the verification period (1991 to 1999) (Kelley and others, 2004). These root mean square

errors are between seven and ten percent of the range of measured water levels (Kelley and others, 2004).

Groundwater in the Carrizo-Wilcox, Queen City, and Sparta aquifers ranges from fresh to brackish in composition (Kelley and others, 2004). Groundwater with total dissolved solids of less than 1,000 milligrams per liter are considered fresh and total dissolved solids of 1,000 to 10,000 milligrams per liter are considered brackish.

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

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

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

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

It is important for groundwater conservation districts to monitor groundwater pumping and overall conditions of the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

SECTION 5: REFERENCES

Deeds, N., Kelley, V., Fryar, D., Jones, T., Whallon, A.J., and Dean, K.E., 2003, Groundwater Availability Model for the Southern Carrizo-Wilcox Aquifer: Contract report to the Texas Water Development Board, 451 p., http://www.twdb.state.tx.us/gam/czwx_s/CZWX_s_Full_Report.pdf .

Donnelly, A.C.A., 2007a, GAM Run 06-29, Texas Water Development Board GAM Run Report, 59 p.

Donnelly, A.C.A., 2007b, GAM Run 07-16, Texas Water Development Board GAM Run Report, 63 p.

Donnelly, A.C.A., 2007c, GAM Run 07-17, Texas Water Development Board GAM Run Report, 38 p.

Kelley, V.A., Deeds, N.E., Fryar, D.G., and Nicot, J.P., 2004, Groundwater availability models for the Queen City and Sparta aquifers: Contract report to the Texas Water Development Board, 867 p., http://www.twdb.state.tx.us/gam/qc_sp/qc_sp.htm.

Harbaugh, A.W., and McDonald, M.G., 1996. User's Documentation for MODFLOW-96, an Update to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model, U.S. Geological Survey, Open-File Report 96-485, 56 p.

National Research Council, 2007. Models in Environmental Regulatory Decision Making. Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p., http://www.nap.edu/catalog.php?record_id=11972.

Oliver, W.,2012, Technical Analysis of Petitions Challenging the Reasonableness of the Desired Future Conditions in Groundwater Management Area, Attachment 1 to Board Memo for the February 2, 2012 Texas Water Development Board Meeting. Technical Analysis, 48 p.

South Central Texas Regional Water Planning Group, 2001, South Central Texas Regional Water Planning Area Regional Water Plan – Volume 1, variously p.

South Central Texas Regional Water Planning Group, 2009, South Central Texas Regional Water Planning Area 2006 Regional Water Plan – Volume I, Amended August 2009, variously p.

South Central Texas Regional Water Planning Group, 2011, South Central Texas Regional Water Planning Area 2011 Regional Water Plan – Volume I, variously p.

TWDB (Texas Water Development Board), 2011, Water Uses Survey, http://www.twdb.state.tx.us/wushistorical/

TWDB (Texas Water Development Board), 2012, Water for Texas 2012 State Water Plan, 314 p.

Wade, S.C., 2008a, GAM Run 08-41, Texas Water Development Board GAM Run Report, 56 p.

Wade, S.C., 2008b, GAM Run 08-42, Texas Water Development Board GAM Run Report, 56 p.

Wade, S.C., 2008c, GAM Run 08-43, Texas Water Development Board GAM Run Report, 58 p.

Wade, S.C. and Jigmond, M., 2010, GAM Run 09-034, Texas Water Development Board GAM Run Report, 146 p.

Wade, S.C., 2011a, Draft GAM Run 11-007, Texas Water Development Board GAM Run Report, 77 p.

Wade, S.C., 2011b, Draft GAM Run 11-007 Addendum, Texas Water Development Board GAM Run Report, 32 p.