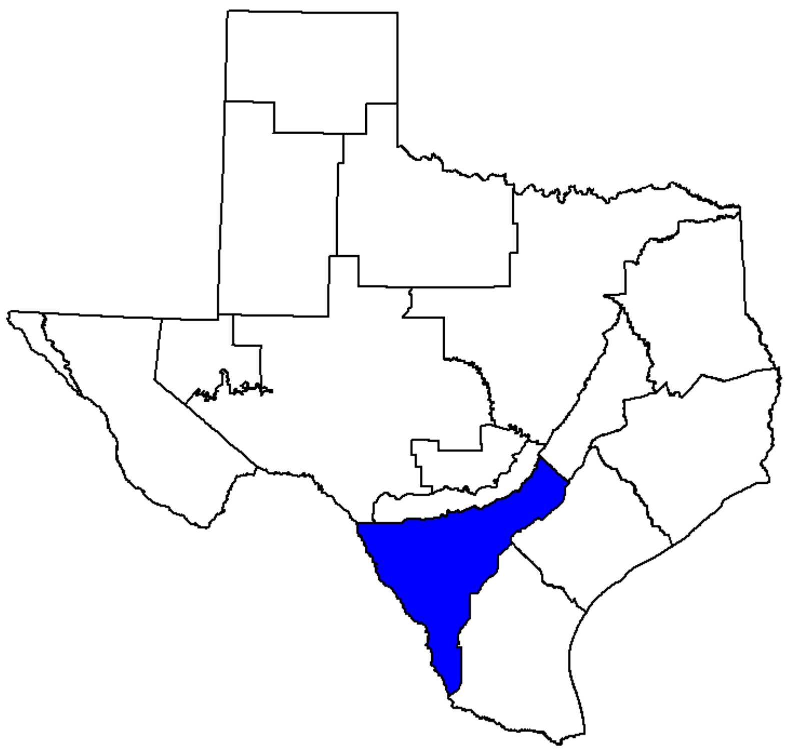
Proposed Desired Future Condition Explanatory Report (Draft 2) Carrizo-Wilcox/Queen City/Sparta Aquifers for Groundwater Management Area 13



William R. Hutchison, Ph.D., P.E., P.G.
Independent Groundwater Consultant
9305 Jamaica Beach
Jamaica Beach, TX 77554
512-745-0599
billhutch@texasgw.com

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1.0 Groundwater Management Area 13

Groundwater Management Area 13 is one of sixteen groundwater management areas in Texas, and covers a large portion of the southwest part of the state (Figure 1).

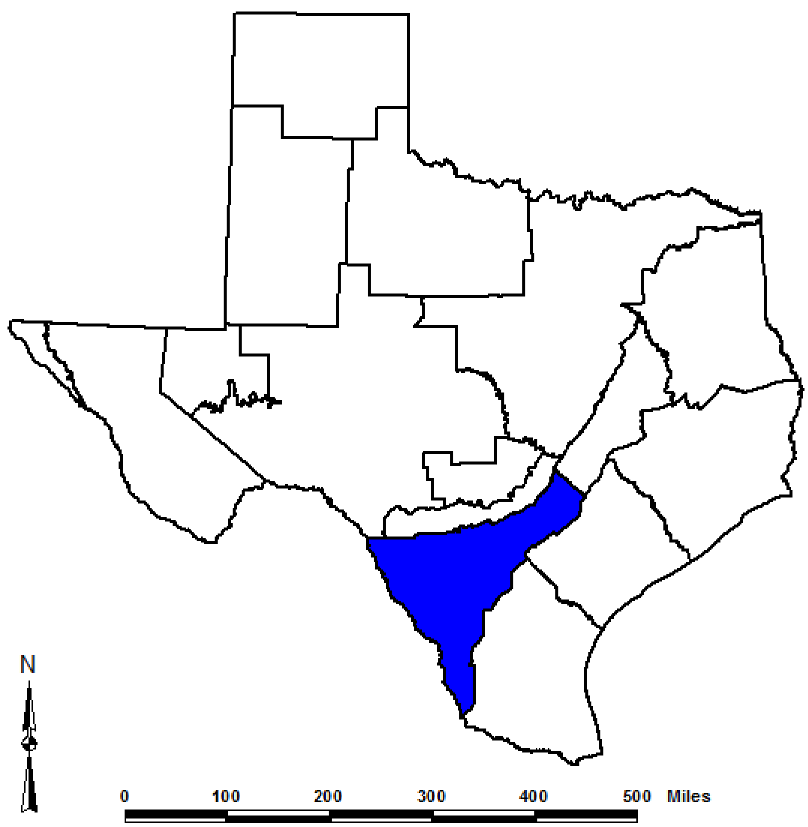

Figure 1. Groundwater Management Area 13

Groundwater Management Area 13 covers all or portions of the following counties: Atascosa, Bexar, Caldwell, Dimmit, Frio, Gonzales, Guadalupe, Karnes, La Salle, Maverick, McMullen, Medina, Uvalde, Webb, Wilson, Zapata, and Zavala (Figure 2).

There are nine groundwater conservation districts in Groundwater Management Area 13: Evergreen Underground Water Conservation District, Gonzales County Underground Water Conservation District, Guadalupe County Groundwater Conservation District, Edwards Aquifer

Authority, McMullen Groundwater Conservation District, Medina County Groundwater Conservation District, Plum Creek Conservation District, Uvalde County Underground Water Conservation District, and Wintergarden Groundwater Conservation District (Figure 3). Please note that as shown in Figure 3, the Edwards Aquifer Authority overlaps other groundwater conservation districts in a small portion of Atascosa County, and larger parts of Caldwell, Guadalupe, Medina, and Uvalde counties.

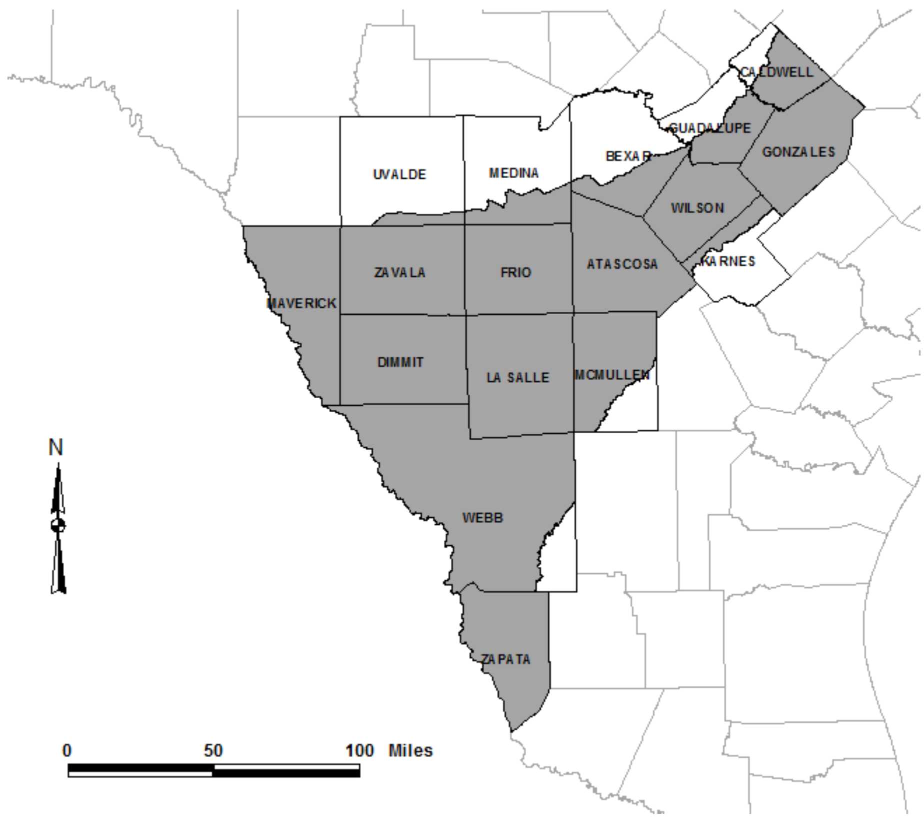

Figure 2. Counties Entirely or Partially in GMA 13

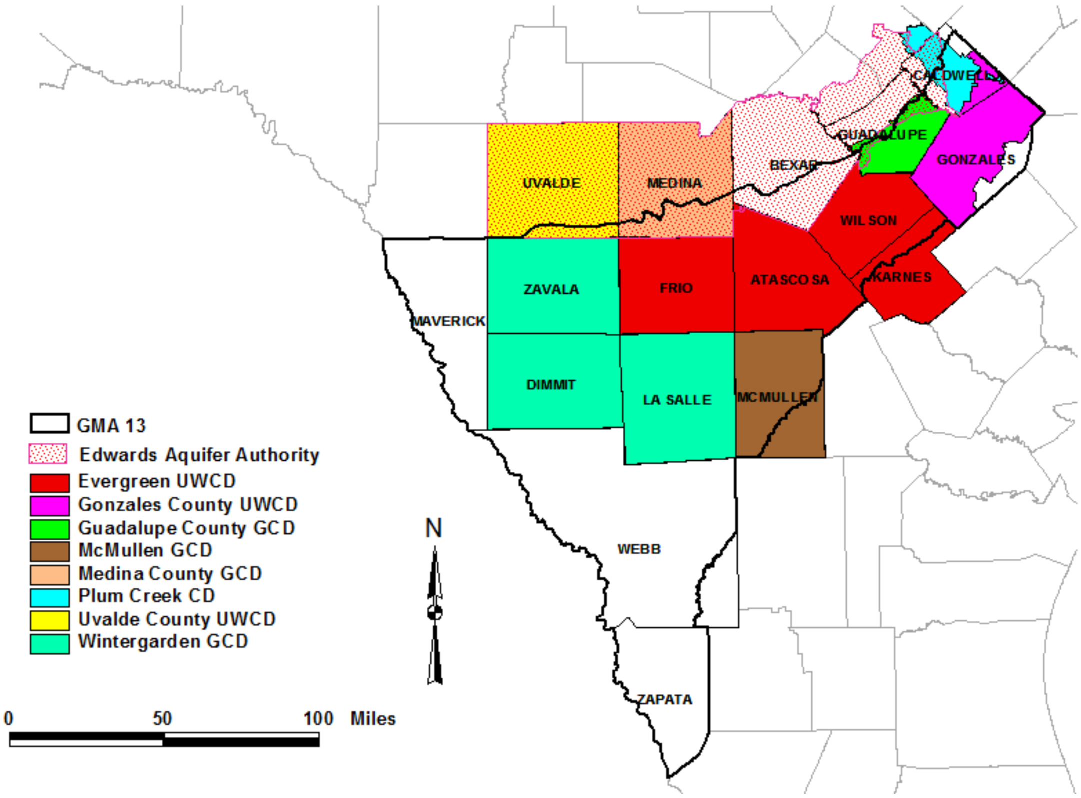

Figure 3. Groundwater Conservation Districts in GMA 13

2.0 Proposed Desired Future Condition

Due to limitations with the model as described in Technical Memorandum 16-08, two proposed desired future conditions were selected for the Carrizo-Wilcox/Queen City/Sparta aquifers as described below.

The first proposed desired future condition for the Carrizo-Wilcox/Queen City/Sparta Aquifers in Groundwater Management Area 13 is that 75 percent of the saturated thickness at the end of 2012 remains in 2070. This desired future condition is considered feasible despite model predictions to the contrary as detailed in Technical Memorandum 16-08.

In addition, a secondary proposed desired future condition for the Carrizo-Wilcox/Queen City/Sparta Aquifers in Groundwater Management Area 13 is an average drawdown of 48 feet for all of GMA 13. The drawdown is calculated from the end of 2012 conditions to the year 2070. This desired future condition is consistent with Scenario 9 as detailed in GMA 13 Technical Memorandum 16-01 and GMA 13 Technical Memorandum 16-08.

The vote to send the proposed desired future conditions to the groundwater conservation districts was taken at the April 27, 2016 meeting of GMA 13. Appendix A is the final resolution for the desired future conditions.

The geographic area covered by the proposed desired future condition is defined by the grid file for the Groundwater Availability Model of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Kelly and others, 2004). This file (qcsp_s_grid_poly052212.csv) was downloaded from the Texas Water Development Board website:

http://www.twdb.state.tx.us/groundwater/models/gam/qcsp/qcsp.as

3.0 Policy Justification

As developed more fully in this report, the proposed desired future condition was adopted after considering:

- Aquifer uses and conditions within Groundwater Management Area 13
- Water supply needs and water management strategies included in the 2012 State Water Plan
- Hydrologic conditions within Groundwater Management Area 13 including total estimated recoverable storage, average annual recharge, inflows, and discharge
- Other environmental impacts, including spring flow and other interactions between groundwater and surface water
- The impact on subsidence
- Socioeconomic impacts reasonably expected to occur
- The impact on the interests and rights in private property, including ownership and the rights of landowners and their lessees and assigns in Groundwater Management Area 13 in groundwater as recognized under Texas Water Code Section 36.002
- The feasibility of achieving the desired future condition
- Other information

In addition, the proposed desired future condition provides a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater in Groundwater Management Area 13.

There is no set formula or equation for calculating groundwater availability. This is because an estimate of groundwater availability requires the blending of policy and science. Given that the tools for scientific analysis (groundwater models) contain limitations and uncertainty, policy provides the guidance and defines the bounds that science can use to calculate groundwater availability.

The maximum amount of groundwater available is the amount of water stored in the aquifer plus groundwater "captured" by wells. The captured groundwater includes induced inflow into an area by pumping and reductions in natural discharge (e.g. spring flow surface water base flow). This is the extreme case where the goal is to entirely deplete, or mine, the aquifer. GMA 13 rejected this policy because it conflicts with the mission to conserve, preserve and protect the aquifers. One common definition of groundwater availability is the amount of water that can be recovered annually over a specified planning period without causing irreversible harm. The irreversible harm can include drying up existing wells and spring flow depletion, and are dependent on local conditions and policies. GMA 13 is in general agreement with this policy of determining groundwater availability because it coincides with the mission to conserve, preserve, and protect the aquifers.

After agreeing on a policy to estimate groundwater availability, the next step was to define the factors that would cause irreversible harm due to the impacts of such production on the system.

These factors include:

- Economics of producing water from depth
- Intrusion of poor water quality due to changes in vertical flow gradients
- Interaction between stream flow and groundwater
- Changes in groundwater evapotranspiration rates
- Groundwater storage recovery rates
- Timeframe of pumping capture and sustainable pumpage

As developed more fully below, many of these factors could only be considered on a qualitative level since the available tools to evaluate these impacts have limitations and uncertainty.

4.0 Technical Justification

The proposed desired future condition for the Carrizo-Wilcox/Queen City/Sparta Aquifers was developed based on simulations of alternative scenarios of future pumping using the Groundwater Availability Model (GAM) of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Kelley and others, 2004). This GAM superseded the GAM of the southern Carrizo-Wilcox Aquifer (Deeds and others, 2003). The GAM used in this process was developed to make predictions of groundwater availability through 2050 based on current projections of groundwater demands during drought-of-record conditions (Kelley and others, 2004, pg. xxvii). The calibration period for the GAM was 1980 to 1989, and the verification period was 1990 to 1999. The documentation for the GAM stated that the GAM provides an "integrated tool for the assessment of water management strategies to directly benefit state planners, Regional Water Planning Groups (RWPGs), and Groundwater Conservation Districts (GCDs)". Furthermore, the documentation stated that based on the model grid (one square mile), the GAM is "not capable of predicting aquifer responses at specific points such as a particular well", and that the GAM is "accurate at the scale of tens of miles, which is adequate to understand groundwater availability at the regional scale" (Kelley and others, 2004, pg. xxviii).

Conceptually, the model simulates groundwater flow in eight layers as shown in Figure 4. Due to the vertical interaction between aquifer units that is simulated in the GAM, the proposed desired future condition for all three aquifers were developed together.

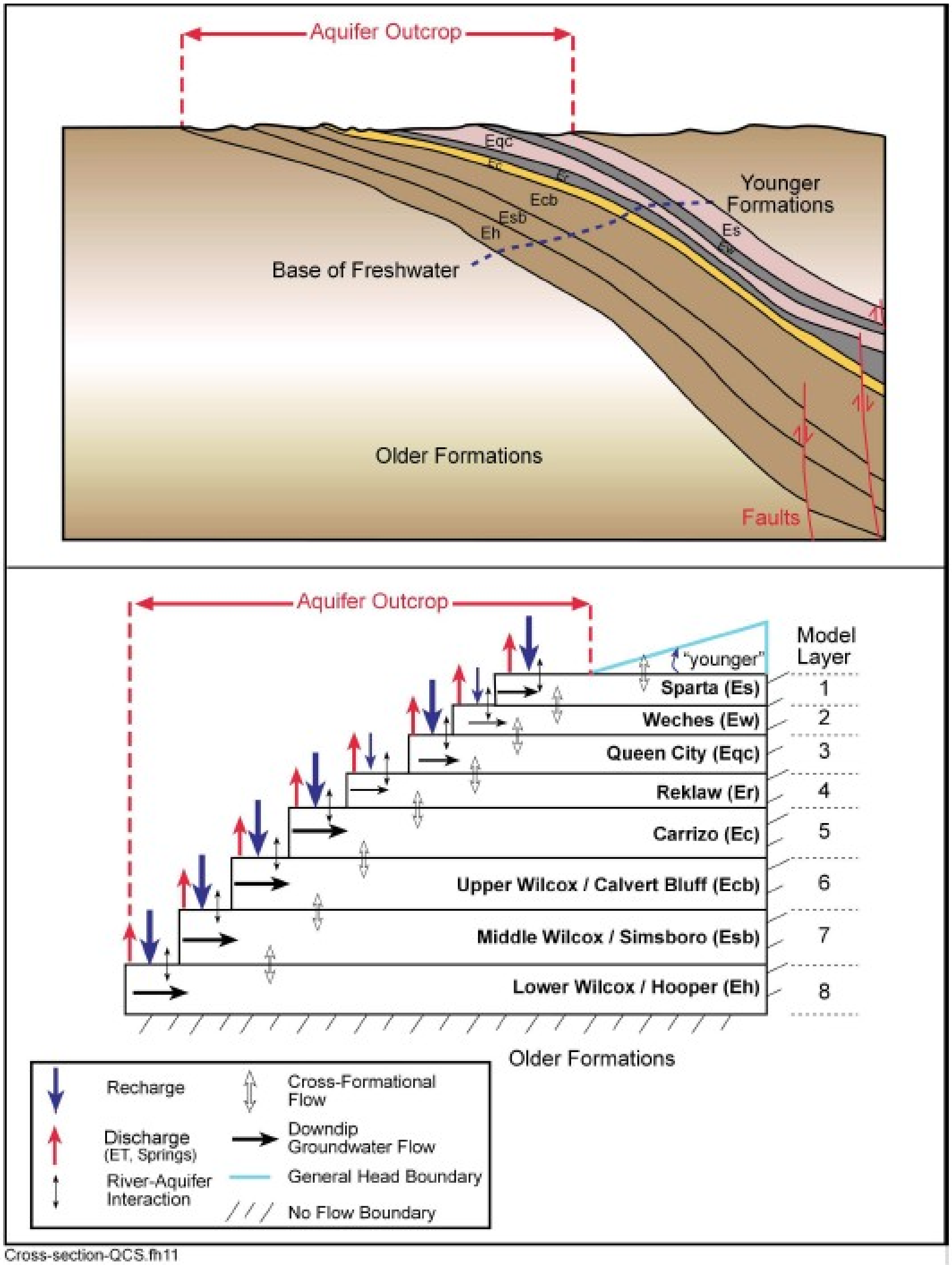

Figure 4. Conceptual Model of Flow (from Kelley and others, 2004, Figure 5.1)

The limitations of the groundwater model for use in this process were of particular importance to GMA 13 and to stakeholders. Early in the process, GMA 13 completed a study to compare model results with actual groundwater elevation data. This report (known as the Task 0 report), demonstrated that predicted drawdowns and model predictions were not always in agreement.

GMA 13 reviewed various existing TWDB reports estimating groundwater availability and compared those to the MAGs developed by the TWDB for the existing DFCs. A summary of those results is presented in the Table below.

TWDB Report No.	County	Aquifer	Trough-Method Availability Estimate (ac-ft/yr)	2060 MAG (ac-ft/yr)
4	Gonzales	Carrizo	85,000	69,371
210	Gonzales/Wilson	Carrizo	47,800	77,670
238	River Basin - Rio G., Guad., S.A., Nueces	Carrizo-Wilcox	174,400	403,192
Trans-TX	Gonzales	Carrizo-Wilcox	90,400	101,432
	Wilson	Carrizo-Wilcox	80,200	114,165
	Atascosa	Carrizo-Wilcox	85,600	75,808
	Bastrop	Carrizo-Wilcox	60,000	N/A

The analysis shows that the MAGs developed under the current DFCs are generally within the groundwater availability estimates in the TWDB Reports.

Report 238 states that approximately 174,400 ac-ft of groundwater as effective recharge is available annually for development in the Rio Grande, Guadalupe, San Antonio, and Nueces River Basins from 1977 to 2030 from the Carrizo-Wilcox Aquifer. This estimate is based on pumpage under assumed conditions (trough method) and is related to the ability of the aquifer to transmit water from the outcrop area to the areas of pumping. Only effective recharge would be available for development if the 400 ft water level constraints are to apply after 2030. Although recharge from precipitation to the Carrizo-Wilcox Aquifer appears to be more than adequate to supply the quantity of water that is calculated as effective recharge, the aquifers transmissive capacity limits the amount of annual effective recharge.

The process of using the groundwater model in developing desired future conditions revolves around the concept of incorporating many of the elements of the nine factors (e.g. current uses and water management strategies in the regional plan). In GMA 13, several model runs were completed and the results discussed prior to adopting a desired future condition. Some critics of the process asserted that the districts were "reverse-engineering" the desired future conditions by specifying pumping (e.g., the modeled available groundwater) and then adopting the resulting drawdown as the desired future condition. However, it must be remembered that among the input parameters for a predictive groundwater model run is pumping, and among the outputs of a predictive groundwater model run is drawdown. Thus, an iterative approach of running several predictive scenarios with models and then evaluating the results is a necessary (and time-consuming) step in the process of developing desired future conditions.

One part of the reverse-engineering critique of the process has been that "science" should be used in the development of desired future conditions. The critique plays on the unfortunate name of the groundwater models in Texas (Groundwater Availability Models) which could suggest that the models yield an availability number. This is simply a mischaracterization of how the models work (i.e. what is a model input and what is a model output).

The critique also relies on a fairly narrow definition of the term *science* and fails to recognize that the adoption of a desired future condition is primarily a policy decision. The call to use science in the development of desired future conditions seems to equate the term *science* with the terms *facts* and *truth*. Although the Latin origin of the word means knowledge, the term *science* also refers to the application of the scientific method. The scientific method is discussed in many textbooks and can be viewed as a means to quantify cause-and-effect relationships and to make useful predictions.

In the case of groundwater management, the scientific method can be used to understand the relationship between groundwater pumping and drawdown, or groundwater pumping and spring flow. 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.

5.0 Factor Consideration

Section 36.108(d) of the Texas Water Code requires that groundwater conservation districts include documentation of how nine listed factors were considered prior to proposing a desired future condition, and how the proposed desired future condition impact each factor. This section of the explanatory report summarizes the information that the groundwater conservation districts used in its deliberations and discussions.

5.1 Aquifer Uses and Conditions

For the purposes of the development of a proposed desired future condition, the groundwater conservation districts in Groundwater Management Area 13 considered the following in the category of aquifer uses (i.e. pumping):

- Estimates of 1999 pumping from the GAM (Kelley and others, 2004)
- Estimates of pumping from 2000 to 2008 from the TWDB Water Use Survey database
- Estimates of pumping from Gonzales County UWCD for the years 2000 to 2011
- Estimates of pumping from Plum Creek CD for the years 2000 to 2011

The information considered by the groundwater conservation districts in Groundwater Management Area 13 is presented in Appendix B.

For the purposes of the development of a proposed desired future condition, the groundwater conservation districts in Groundwater Management Area 13 considered groundwater monitoring data (i.e. groundwater elevations) from wells in the TWDB groundwater database. The monitoring data were compared to groundwater elevation from the calibrated GAM (Kelley and others, 2004), and with future projections of groundwater elevations from Scenario 4 of TWDB GAM Run 09-034 (Wade and Jigmond, 2010) that was the basis of the desired future condition adopted in 2010. This comparison also included evaluating the pumping that was estimated in the calibrated GAM for the period 1980 to 1999, and estimated future pumping associated with Scenario 4 of TWDB GAM Run 09-034 (the basis for the desired future condition adopted in 2010). This evaluation was detailed in a report completed for Groundwater Management Area 13 (Hutchison, 2013), and is included as Appendix C. This report was circulated as a draft report on December 21, 2012 and public comments were solicited and received. The final report was issued on March 20, 2013, and includes a response to those comments.

5.2 Water Supply Needs and Water Management Strategies

Initially, data from the 2012 State Water Plan were used by the groundwater conservation districts of Groundwater Management Area 13 in considering this factor. Specifically, county-by-county data on groundwater sources, groundwater demands, and water management strategies. In addition, data from the Bureau of Economic Geology report that presents estimates of oil and gas water use (Nicot and others, 2012) were considered. SAWS provided an update to pumping projections in southern Bexar County and Gonzales County on June 27, 2013 via email.

Groundwater Conservation District input included:

- Guadalupe County Groundwater Conservation District
- Gonzales County Underground Water Conservation District
- McMullen Groundwater Conservation District
- Plum Creek Conservation District
- Wintergarden Groundwater Conservation District

Tabular summaries of all these data are presented in Appendix D.

Also included in Appendix D is the Modeled Available Groundwater Report (Wade, 2012) that was developed by TWDB associated with the previously developed desired future condition adopted in 2010.

The data and estimates in Appendix D provide a range of estimates of future pumping that were considered in completing the initial eight scenarios that were developed and run with the GAM through the year 2070. A base case (Scenario 4) was developed based on input from the groundwater conservation districts in GMA 13 as follows:

- Pumping in the Carrizo Aquifer in Bexar County was increased as compared to the MAG that was developed from the DFC that was adopted in 2010 in response to a request from SAWS
- Pumping in the Carrizo Aquifer in Gonzales County was increased as compared to the MAG that was developed from the DFC that was adopted in 2010 in response to a request from Gonzales County UWCD
- Pumping the Wilcox Aquifer in Gonzales County was decreased as compared to the MAG that was developed from the DFC that was adopted in 2010 in response to a request from Gonzales County UWCD
- Pumping in the Carrizo Aquifer in McMullen County was increased as compared to the MAG that was developed from the DFC that was adopted in 2010 in response to a request from McMullen GCD

Scenarios 1 to 3 represented incremental reductions of Scenario 4, and Scenarios 4 to 7 represented incremental increases of Scenario 4.

After reviewing the results, Scenario 8 was completed which represented the following changes to Scenario 4:

- Gonzales County UWCD requested that pumping be revised to match the current MAG
- Guadalupe County GCD requested increases in both the Carrizo and Wilcox aquifers

Results of Scenario 8 were completed and reviewed at the GMA 13 meeting of March 13, 2014. As a result of the comments received at the March 13, 2014 meeting, additional pumping was to be included in the next simulation that reflected additional pumping by SAWS. However, due to changes in the administration in GMA 13, the work was left pending.

In considering the request of SAWS to simulate additional pumping, and the potential incremental effect of each entity in GMA 13 requesting similar simulations in the future, a more comprehensive approach was taken to consider all recommended and alternative water management strategies from the Region L plan. Sam Vaugh of HDR provided the initial data on August 22, 2014. However, due to the imminent release of the Region L IPP, it was decided to wait until the IPP was released to ensure that all strategies were current.

A meeting with HDR was held on May 27, 2015 to clarify the strategies and the data contained in the IPP. The IPP contained 12 strategies that were relevant to GMA 13. One of these was a collective strategy called "Local Carrizo Wells" that covered several areas in GMA 13. The pumping for all other strategies totaled 116,000 AF/yr in 2020, and 222,000 AF/yr in 2070.

The IPP distinguished between recommended and alternative strategies in areas where future pumping exceeded the MAG that was set in 2010 on the basis of the DFC that was established by GMA 13. Water management strategies are developed to meet deficits between current supply and future demand as part of the regional planning process. TWDB considers the MAG to be a hard limit, and recommended water management strategies cannot result in pumping that exceeds the MAG. Thus, Region L has included strategies that exceed the MAG as alternative strategies.

Technical Memorandum 16-01 summarizes four simulations that focused on simulating the recommended and alternative water management strategies in the 2015 Region L plan. Scenario 9 includes all pumping from Scenario 8 described above, and all recommended and alternative water management strategies. Scenarios 10 to 12 simulate reductions in all Wilcox Aquifer strategies in order to understand the interaction between the Wilcox and the overlying Carrizo Aquifer. Discussion of the results of these simulations was held at a GMA 13 meeting on January 22, 2016.

Additional discussion of the effects of Scenarios 9 to 12 on the outcrop area are summarized in Technical Memorandum 16-02, and was discussed at the GMA 13 meeting on February 25, 2016. Further investigation of the outcrop area was covered in Technical Memorandum 16-03, and was discussed at the GMA 13 meeting on March 30, 2016. Much of the discussion focused on the limitations of the GAM in simulating the reduction in groundwater storage in the outcrop area.

Finally, Technical Memorandum 16-08 summarizes the drawdown and outcrop results for Scenario 9, which was the basis for the proposed desired future condition. In summary, Scenario 9 included all the future pumping of Scenario 8 plus all recommended and alternative water management strategies in the 2015 Region L plan.

5.3 Hydrologic Conditions within Groundwater Management Area 13

As required by statute, the groundwater conservation districts in Groundwater Management Area 13 considered total estimated recoverable storage, average annual recharge, inflows, and discharge prior to adopting a proposed desired future condition.

5.3.1 Total Estimated Recoverable Storage

As required by statute, the Texas Water Development Board provided the groundwater conservation districts in Groundwater Management Area 13 with estimates of total recoverable storage (Wade and Bradley, 2013). This report is included as Appendix E.

The estimate of total recoverable storage may be a measure of "physical" availability, but is less meaningful in an analysis of groundwater availability as defined by Chapter 36 of the Water Code, and should be viewed with caution. The groundwater availability developed after following the process in Chapter 36 involves consideration of many factors, some technical and some policy-based. In addition, the Texas water Code Sec. 36.108(d-2) states: "*The desired future condition proposed under Subsection (d) 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".* This balancing test illustrates how the total estimated recoverable storage value is by itself meaningless in an analysis of groundwater availability.

As calculated, the TWDB estimated recoverable storage represents the approximate fraction of total storage in the aquifer that is in the producing zones (e.g. sands), not what is "recoverable". Therefore, in most cases, the total estimated recoverable storage is far greater than the highest practicable level of groundwater production.

In addition to the TWDB total recoverable storage report, GMA 13 received a report from a stakeholder regarding selection of DFCs based on use of an acceptable amount of water from aquifer storage through time. A copy of this report is included in Appendix H. The stakeholder followed up on the report with a presentation at the GMA 13 meeting on November 21, 2013. The report in general made a case against GMA 13's current use of drawdown as a DFC and provided an alternative approach founded on changes in aquifer storage or the protection of unique hydrologic features or conditions. This concept was rejected by GMA 13 for several reasons:

- The presentation inaccurately implied that the DFC adopted in 2010 by GMA 13 are arbitrary and were used as a way to limit impacts on exiting users. It also implied that model runs reflect relatively arbitrary model pumpage inputs and that individual groundwater projects were not included in the DFC model.
- The author failed to explain how choosing an aquifer drawdown limit through time is considered arbitrary but choosing an acceptable amount of water in aquifer storage through time is not arbitrary.
- The author stated that artesian pressure declines do not have a meaningful impact on aquifer storage or groundwater flows to surface features and are, therefore, not suitable as DFCs in those respects. GMA 13 generally agrees with this statement, however, artesian pressure declines are important management tools in dipping confined aquifers where pumpage of non-renewable "fossil" groundwater resources occur. It is important to distinguish renewable from non-renewable or "fossil" groundwater. Groundwater pumpage of renewable resources is limited by fluxes or recharge rates, whereas pumpage of non-renewable resources is limited by groundwater storage.
- The author states that managing aquifer storage makes sense because it can be verified

easily and inexpensively through monitoring of the water table levels. However, the accuracy of assessing aquifer storage amounts through monitoring of water table levels is actually rather complex whereas assessing water table drawdown levels is simple and straight forward.

5.3.2 Average Annual Recharge, Inflows and Discharge

Although not specifically required in 2010 as it is now, during the development of the existing desired future condition for the Carrizo-Wilcox, Queen City, and Sparta aquifers in 2010, the groundwater conservation districts in Groundwater Management Area 13 considered the historic groundwater budget for GMA 13 as a management unit, and considered the simulated water budget in 2060 for each groundwater conservation district (or county where a groundwater conservation district did not exist) for four alternative scenarios. The information on these water budget comparisons were provided in a PowerPoint presentation at the Groundwater Management Area 13 meeting on February 19, 2010, and in GAM Report 09-034 (Wade and Jigmond, 2010). This information was presented again during the development of this proposed desired future condition.

The groundwater budgets for Groundwater Management Area 13 based on the updated calibration period (2000 to 2011) and Scenario 9 (the basis for the desired future condition) calibrated are summarized in Table 1.

Table 1. Groundwater Budget for Groundwater Management Area 13 (all values in AF/yr)

Inflow	**Average 2000-2011**	**Scenario 9 (2070)**
River and Stream	52,989	110,881
Recharge	206,736	203,106
From Mexico	17	13
GHB	0	15,568
From GMA 10	1,214	1,238
From GMA 12	329	40,744
From GMA 15	0	34,379
From GMA 16	1,034	5,073
Total Inflow	262,321	411,002
Outflow		
Wells	321,056	609,376
Drains	1,420	521
ET	9,208	7,907
GHB	4,733	0
To GMA 15	5,276	0
Total Outflow	341,692	617,804
Inflow-Outflow	-79,371	-206,802
Storage Change	-79,318	-206,747
Model Error	-54	-55

Table 1 shows that pumping would increase from about 320,000 AF/yr in 2000 to 2011 to about 610,000 AF/yr in 2070, about a 290,000 AF/yr increase. About 44 percent of this pumping would come from reduced storage (about 127,000 AF/yr). The pumping would also come from surface water baseflow depletions (about 58,000 AF/yr or about 20 percent of the pumping), and from induced inflows from bordering GMAs (about 75,000 AF/yr from GMAs 12 and 15, or about 28 percent of the pumping).

The pumping increase is mostly in the downdip areas of GMA 13, and the impacts to surface water would be in the outcrop areas. There are several downdip wells in GMA 13 that are near the outcrop/downdip boundary that have the potential to affect the outcrop area. This is in contrast to the wells that are located several miles downdip from the boundary.

The GAM is not necessarily calibrated to a degree where surface water impacts are particularly reliable or can be viewed as quantitative. However, the GAM is the best tool to address this factor. Since the GAM is an imperfect tool, the conclusion of this analysis is that the increased pumping will cause impacts beyond the reduction in storage.

5.4 Other Environmental Impacts, Including Spring Flow and Other Interactions between Groundwater and Surface Water

The evaluation of all water budget components was discussed in Section 5.3.2 above.

Guadalupe Blanco River Authority submitted a letter on February 24, 2016 to Groundwater Management Area 13 that expressed a concern about the cumulative effects of the Carrizo-Wilcox pumpage from the 2016 South Central Regional Water Plan (GAM Simulation Scenario 9) on the potential reduction in streamflow and adverse effects on surface water rights and environmental flows in the Guadalupe and San Antonio River Basins, as well as fresh water inflows to the Guadalupe Estuary.

5.5 Subsidence

Subsidence has not been an issue historically in these aquifers.

5.6 Socioeconomic Impacts

The Texas Water Development Board prepared reports on the socioeconomic impacts of not meeting water needs for each of the Regional Planning Groups during development of the 2011 Regional Water Plans. Because the development of this desired future condition used the State Water Plan demands and water management strategies as an important foundation, it is reasonable to conclude that the socioeconomic impacts associated with this proposed desired future condition can be evaluated in the context of not meeting the listed water management strategies. Groundwater Management Area 13 is covered by Regional Planning Groups L and M. In addition, there is an important water management strategy that is sourced in Gonzales County to meet demands in Regional Planning Group K. The socioeconomic impact reports for Regions K, L, and M are included in Appendix G.

Socioeconomic Impacts to local landowners due to development of water management strategies within GMA 13 must also be taken into account. The Texas Water Development Board is not tasked with preparing reports on the socioeconomic impacts to local landowners, therefore this information must come from the local groundwater districts. There are two groundwater mitigation projects currently on-going in the GMA 13 area. One is operated by the Gonzales County Underground Water Conservation District (GCUWCD) and the other is operated by the San Antonio Water System in an area just outside of GMA 13.

Economic impacts to the local landowners to date can be estimated from one of these mitigation projects. The GCUWCD mitigation project began in 2011 and has spent more than $1,124,000 to date to mitigate the effects of pumpage from large-scale water management strategies. Per well mitigation costs to lower pumps or re-drill water wells deeper has ranged from about $4,200 to $28,000.

5.7 Impact on Private Property Rights

The impact on the interests and rights in private property, including ownership and the rights of landowners and their lessees and assigns in Groundwater Management Area 13 in groundwater is recognized under Texas Water Code Section 36.002.

The desired future conditions adopted by GMA 13 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 2015 Region L plan) were included in Scenario 9 (the basis for the desired future condition). The increase in pumping associated with meeting the Region L water management strategies will cause impacts to exiting well owners and to surface water. However, as required by Chapter 36 of the Water Code, GMA 13 considered these impacts and balanced them with the increasing demand of water in the GMA 13 area, and concluded that, on balance and with appropriate monitoring and project specific review during the permitting process, all the Region L strategies can be included in the desired future condition.

5.8 Feasibility of Achieving the Desired Future Condition

Groundwater levels are routinely monitored by the districts and by the TWDB in GMA 13. Evaluating the monitoring data is a routine task for the districts, and the comparison of these data with the desired future condition and model results that were used to develop the DFCs is covered in each district’s management plan. These comparisons will be useful to guide the update of the DFCs that are required every five years.

5.9 Other Information

James Bene of R.W. Harden & Associates submitted a paper on September 20, 2013 to Groundwater Management Area 13 that discussed the joint planning process. This paper provided one perspective on how to develop desired future conditions. The paper made a number of points that were used in the development of this proposed desired future condition, and is included in this report as Appendix H.

Guadalupe Blanco River Authority submitted a letter on February 24, 2016 to Groundwater Management Area 13 that expressed a concern about the cumulative effects of the Carrizo-Wilcox pumpage from the 2016 South Central Regional Water Plan (GAM Simulation Scenario 9) on the potential reduction in streamflow and adverse effects on surface water rights and environmental flows in the Guadalupe and San Antonio River Basins, as well as fresh water inflows to the Guadalupe Estuary. This letter is included as Appendix I.

James Bene of R.W. Harden & Associates gave a presentation at the March 30, 2016 Groundwater Management Area 13 meeting on modeling surface-groundwater interaction. A copy of this presentation is included as Appendix J.

James Beach of LBG-Guyton Associates gave a presentation at the March 30, 2016 Groundwater Management Area 13 meeting on modeling surface-groundwater interaction. A copy of this presentation is included as Appendix K.

6.0 Discussion of Other Desired Future Conditions Considered

There were 14 scenarios and a total of 51 GAM simulations completed as part of the development of the desired future conditions. Results of these simulations were presented at GMA 13 meetings and in technical memoranda as follows:

- Scenarios 1 to 7 were a collection of initial runs that began with a base case (Scenario 4) based on pumping input from the groundwater conservation districts in GMA 13. Scenarios 1 to 3 were incremental reductions in Scenario 4 pumping, and Scenarios 4 to 7 represented incremental increases in Scenario 4 pumping. These results were discussed at the GMA 13 meeting of October 13, 2013.
- Scenario 8 was based on modifications to Scenario 4 based on input from the groundwater conservation districts (notably Gonzales UWCD and Guadalupe County GCD). Results of Scenario 8 were discussed at the March 13, 2014 GMA 13 meeting
- Scenario 9 was developed to comprehensively consider all recommended and alternative water management strategies, and was ultimately used as the basis for the desired future conditions. The initial results were summarized in Technical Memorandum 16-01 and were discussed at the January 22, 2016 GMA 13 meeting.
- A more detailed analysis of the outcrop area results from Scenario 9 is summarized in Technical Memorandum 16-02, and was discussed at the February 25, 2016 GMA 13 meeting.
- Scenarios 13 and 14 were completed to further evaluate the concept of maintaining threshold saturation in the outcrop area. These scenarios involved completing 34 simulations (18 in Scenario 13 and 16 simulations in Scenario 14). Results were summarized in Technical Memorandum 16-03 and discussed at the March 30, 2016 GMA 13 meeting.
- Technical Memorandum 16-08 was developed to summarize the results of Scenario 9 in a single document since the results had been previously covered in multiple memoranda and discussed at several meetings.

As discussed earlier, desired future conditions based solely on storage were not considered feasible due to the fact that storage based desired future conditions ignore other statutory factors.

7.0 Discussion of Other Recommendations

Public comments were invited and each district held a public hearing on the proposed desired future condition as follows:

Groundwater Conservation District	Date of Public Hearing	Number of Comments Received
Evergreen UWCD		
Gonzales County UWCD	June 14, 2016	3 oral, 5 written
Guadalupe County GCD	June 6, 2016	0
McMullen GCD	June 23, 2016	0
Medina County GCD	June 15, 2016	0
Plum Creek CD	June 21, 2016	0
Uvalde County UWCD	June 14, 2016	0
Wintergarden GCD	August 1, 2016	0

Many of the comments from Gonzales County UWCD did not specifically address the proposed desired future condition. Rather, many of the comments focused on the importance of some of the factors that should be considered. Indeed, much of the discussion at GMA 13 meetings and the simulation results were discussed in the context of the factors, and, through that discussion, the importance of the factors on the process was evaluated.

There were two written comments that recommended that the desired future condition not be changed. This had also been discussed early in the process and was rejected after considering the regional planning water management strategies. If the desired future condition were to remain unchanged, there would be impacts on the ability of the region to meet its future water demands as defined by the Region L water plan.

8.0 References

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List of Appendices

Appendix A – Proposed Desired Future Condition Resolution

Appendix B – Groundwater Use Estimates

Appendix C – Comparison of Groundwater Monitoring Data with Groundwater Model Results, Groundwater Management Area 13

Appendix D – Water Supply Needs and Water Management Strategies Data

Appendix E – TWDB GAM Task 13-036 (Revised): Total Estimated Recoverable Storage for Aquifers in Groundwater Management Area 13

Appendix F – Water Budget Estimates

Appendix G – Socioeconomic Impacts Analyses for Regions K, L, and M

Appendix H – Paper authored by James Bene of R.W. Harden & Associates regarding the Joint Planning Process