BLUEBONNET GROUNDWATER CONSERVATION DISTRICT

Public Hearing on Proposed Desired Future Conditions

Wednesday, May 26, 2021
6:00 PM

Bluebonnet Groundwater Conservation District
Board Room, Suite B & C
303 East Washington Avenue
Navasota, Texas

AGENDA

1. **Call to order at 6:00PM.**

3. **Discussion and possible action regarding the proposed desired future conditions ("DFCs") for the Gulf Coast Aquifer, Carrizo-Wilcox Aquifer, and Yegua-Jackson Aquifer underlying Austin, Grimes, Walker, and/or Waller Counties, Texas, in accordance with Section 36.108(d-2) of the Texas Water Code**. The acceptable percent median available drawdown remaining in 2080 and no more than an average additional subsidence between 2009 and 2080 of the Gulf Coast Aquifer. For Bluebonnet GCD, the relevant proposed DFCs include the following:

   The Member Districts of Groundwater Management Area 14 ("GMA 14") propose the following Desired Future Conditions ("DFCs") for the Gulf Coast Aquifer within Austin, Brazoria, Chambers, Grimes, Hardin, Jasper, Jefferson, Liberty, Montgomery, Newton, Orange, Polk, San Jacinto, Tyler, Walker, Waller, and Washington counties:

   In each county in GMA 14, no less than 70 percent median available drawdown remaining in 2080 and no more than an average of 1.0 additional foot of subsidence between 2009 and 2080.

   The model simulation consistent with the above proposed DFCs was developed by using the Houston Area Groundwater Model (HAGM) and adjusting the pumping distribution in each county starting with the distribution used in the 2016 round of joint planning in GMA 14.

   a. Presentation of materials related to the proposed DFCs by Dr. Bill Hutchison (see ***Attachment "A": Implementation of GMA 14 Desired Future Conditions)***
   b. Summary of the current joint planning cycle regarding the proposed DFCs development
   c. Draft implementation plan regarding the proposed DFCs (see ***Attachment "B": Proposed Implementation of GMA 14 Desired Future Condition for Bluebonnet GCD)***
   d. Development of District Summary Report for submission to GMA 14.

A presentation of materials related to the proposed DFCs was provided for context and clarity of the third-round joint planning process. The presentation detailed an overview of the joint planning process, summary of GMA 14 process to date, proposed DFC from GMA 14 meeting of April 9, 2021, proposed implementation of DFC for Bluebonnet GCD, and background on Lone Star GCD issues. The presentation provided background and context of the proposed DFC since there was no accompanying detailed resolution or draft explanatory report to rely on in addition to providing a proposed and recommended approach to implementing the proposed DFC at the BGCD level which will differ from 2010 and 2016 due to the common reservoir approach in this round of joint planning. The DFC is expressed as a GMA 14-wide statement and statute requires the District to adopt the DFCs applicable to the district as defined in the resolution and explanatory report and the management plan includes a management goal to address the DFC adopted by the district with a management objective specific and time-based statement of future outcomes that are linked to the management goal. BGCD's approach would take the single GMA 14-wide DFC statement and quantify it for use as a management goal and objective for the management plan. The HAGM simulation that was the basis for the DFC provides BGCD-specific drawdown and subsidence information and future pumping which is not specifically relevant for the purposes of management activities, but useful information. These BGCD-specific results for the basis for BGCD-specific DFC. The three functions of a GCD being planning (i.e. joint planning and DFCs), management (i.e. management plan goals and objectives), and regulation or policy (i.e. District rules of the implementation and achievement of management). The application of the DFC to BGCD begins with the multi-metric HAGM simulation constraints of median available drawdown remaining, average additional subsidence, limited pumping increase and specification of initial pumping distribution. The BGCD DFC would utilize average drawdown by county-aquifer unit and maximum subsidence from the specific HAGM simulation to bridge the transition from planning to management specific to BGCD using the simulation results and bridging the transition from management to regulation in the hydrogeologic reports.

2. Public Comment

Ron Kelling, a property owner in Austin County and Deputy General Manager of the San Jacinto River Authority, provided comments regarding negative impacts the proposed DFC will have. (*see* ***Attachment "C" for Kelling comments)***

Ed Shackelford, who is replacing Ron Kelling as Deputy General Manager of the San Jacinto River Authority, provided comments regarding concerns over LSGCD pursuing a DFC that does not include a metric for subsidence. (see ***Attachment "D" for Shackelford comments)***

4. Adjourned at 6:38PM.

The Board approved the above minutes of the Public Hearing at Bluebonnet Groundwater Conservation District, held on May 26, 2021, on September 15, 2021.

____
J Jared Patout, President

ATTEST:

____
James Morrison, Secretary

Comments Submitted to
Bluebonnet Groundwater Conservation District
Public Hearing on Proposed Desired Future Conditions
May 26, 2021

Good evening to the Board members and staff of the Bluebonnet Groundwater Conservation District ("Bluebonnet GCD"). My name is Ron Kelling. I am a property owner in Austin County within the Bluebonnet GCD. I am also the Deputy General Manager of the San Jacinto River Authority. I offer the following comments on the proposed desired future condition ("DFC") for the Gulf Coast Aquifer.

First, I want thank you Board members for your service in the role as stewards of our water resources.

Second, I want to thank Zach Holland, General Manager of the Bluebonnet GCD, for his work in achieving the mission of the district, and his extensive efforts collaborating with the other groundwater conservation district ("GCD") general managers within Groundwater Management Area 14 ("GMA 14") to identify, evaluate and develop a common, practical DFC for our underground aquifers.

During the lengthy and arduous process, the member GCDs of GMA14 thoroughly evaluated three different DFCs. The DFC selected for comments by the public and consideration by the GCD Boards includes "no less than 70 percent median available drawdown remaining in 2080 and no more than an average of 1.0 additional foot of subsidence between 2009 and 2080" with the model simulation consistent with the above proposed DFCs "developed by using the Houston Area Groundwater Model (HAGM) and adjusting the pumping distribution in each county using the distribution used in the 2016 round of joint planning in GMA 14".

It is critical that the final adopted DFC include the metric regarding subsidence so that this important criteria that is specifically identified in Chapter 36 of the Texas Water Code be kept in the forefront of effective groundwater management practices in the area.

I am concerned about the negative impacts the proposed DFC will have on all current and future citizens of this area, including lowering of the aquifer water levels/pressures and the potential irreversible subsidence. Therefore, please consider the following DFC that was one of three DFCs that has already been thoroughly evaluated by GMA 14 as an alternative:

- *no less than 80 percent median available drawdown remaining in 2080*, and
- no more than an average of 1.0 additional foot of subsidence between 2009 and 2080,
- with a model simulation consistent with the above proposed DFCs developed by using the HAGM and adjusting the pumping distribution in each county using the distribution used in the 2016 round of joint planning in GMA 14.

I request your support of this alternative DFC for the following reasons:

1. It considers all nine factors as required by Texas Water Code Section 36.108(d).

2. It provides 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 as required by Texas Water Code Section 36.108(d-2).

3. It provides sustainable supply of groundwater as a strategy to meet long-term needs for current and future generations of the area as described in the 2021 Regional Water Plan developed by the Texas Water Development Board.

4. It results in less declines on the aquifer water levels/pressures thus minimizing negative impacts for water suppliers and citizens.

5. It reduces negative impacts on all property owners resulting from irreversible subsidence.

I appreciate the opportunity that you have allowed me to present these comments to you.

Thank you,

Ron Kelly

Ron Kelling

San Jacinto
River Authority

Comments Submitted to
Bluebonnet Groundwater Conservation District

Public Hearing on GMA-14 Proposed Desired Future Conditions

May 26, 2021

Good evening Board of Directors and staff.

My name is Ed Shackelford, I am the Director of Utility Operations for the San Jacinto River Authority and offer the following comments on the GMA -14 proposed desired future conditions ("DFC") for the Gulf Coast Aquifer on behalf of SJRA. The focus of my comments are related to the subsidence component of the DFCs.

I offer my appreciation for your willingness to serve your community in this very worthwhile pursuit of managing groundwater withdrawals in your district and being willing to hear comments that impact all of GMA-14.

The DFC proposed for public comment and consideration includes:

- No less than 70 percent median available drawdown remaining in 2080
- No more than an average of 1.0 additional foot of subsidence between 2009 thru 2080 based on the Houston Area Groundwater Model (HAGM)
- Adjusting the pumping distribution in each county using the distribution used in the 2016 round of joint planning

I have almost 44 years as a professional engineer in the civil engineering business of which almost 20 years in the public sector. I worked for the City of Baytown, Texas which included the Brownwood Subdivision, one of the poster children for subsidence, over 9-feet of subsidence due primarily to groundwater withdrawal. Ultimately, a levee was constructed around the subdivision to protect the homes from flooding. I also worked for Harris County Precinct 4 which included the City of Jersey Village. Jersey Village experienced subsidence due to the City of Houston massive water well field (10) that were capable of pumping in excess of 10 MGD which resulted in the Jersey Village area sinking 3 to 4 feet thus creating extensive flooding in this area since.

The clays within the aquifer do not consolidate uniformly, creating large surface pockets of areas that do not drain as efficiently as they did prior to subsidence. Areas that use to drain, either do not drain or drain much slower because the original land slope has been altered due to the clays within the aquifer consolidating. The consolidation only occurs within a certain distance of the water well. Montgomery County is experiencing subsidence due to groundwater withdrawal.

Our comments are offered because LSGCD is pursuing a DFC that does not include a metric for subsidence. In order for the GMA-14 area to thrive and continue to grow in population and economic diversity and not create new drainage issues, SJRA believes it is critical for the adopted DFCs include the following:

- No less than 80 percent median available drawdown remaining in 2080, and
- No more than an average of 1.0 additional foot of subsidence between 2009 and 2080,
- With a model simulation consistent with the above proposed DFC developed by using the HAGM and adjusting the pumping distribution in each county using the same distribution used in the 2016 regional planning.

SJRA supports this alternative DFC for following reasons:

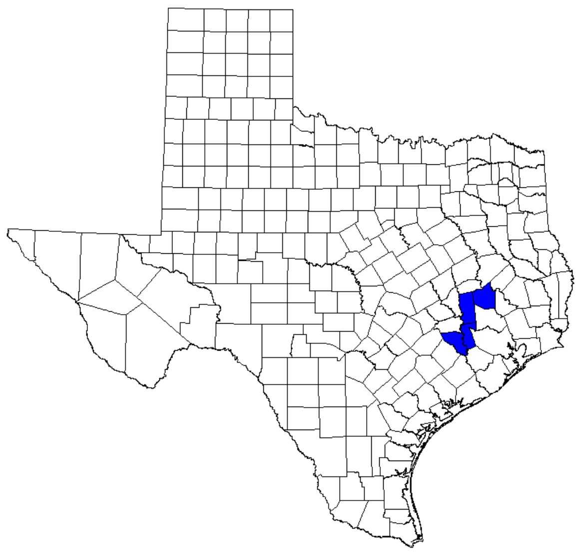
1. Considers all nine (9) factors required by Texas Water Code Section 36.108(d)
2. Provides a balance between the highest practical level of groundwater production and conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence per Texas Water Code 36.108 (d-2)
3. Provides sustainable supply of groundwater as a strategy to meet long-term needs for current and future generations as described in the 2021 Regional Water Plan developed by the Texas Water Development Board
4. Stabilizes aquifer water levels/pressures to minimize negative impacts for water suppliers and citizens.
5. Reduces negative impacts on all property owners resulting from irreversible subsidence.

Thank you for the opportunity to offer SJRA's comments.

Ed Shackelford, PE
Director of Utility Operations
Office – 936.588.3111
Cell – 832.754.2074
Email – eshackelford@sjra.net

Final Report

Implementation of GMA 14 Desired Future Condition Based on Multi-Metric Simulation (70% Available Drawdown, 1 Foot of Subsidence, 30K Pumping Limit, 2016 Pumping Distribution)



Prepared for:

Zach Holland
General Manager
Bluebonnet Groundwater Conservation District
P.O. Box 269
Navasota, TX 77868-0269

Prepared by:

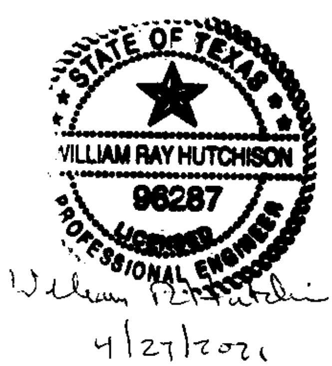
William R. Hutchison, Ph.D., P.E., P.G.
Independent Groundwater Consultant
9305 Jamaica Beach
Jamaica Beach, TX 77554
512-745-0599
billhutch@texasgw.com

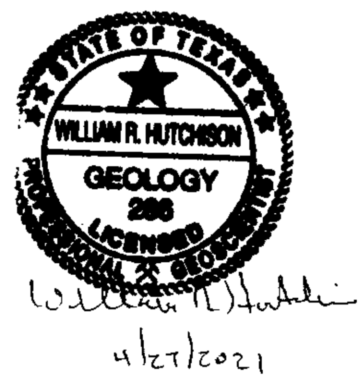
April 27, 2021

Professional Engineer and Professional Geoscientist Seals

This report was prepared by William R. Hutchison, Ph.D., P.E., P.G., who is licensed in the State of Texas as follows:

- Professional Engineer (Geological and Civil) No. 96287
- Engineering Firm Registration No. 14526
- Professional Geoscientist (Geology) No. 286





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1.0 Introduction

1.1 Joint Planning Process in GMA 14

The Groundwater Conservation Districts in Groundwater Management Area 14 have reviewed a series of balancing and multi-metric simulations with the updated Northern Gulf Coast Groundwater Availability Model (also known as the Houston Area Groundwater Model, or HAGM) as part of the third round of Joint Planning. Ultimately, the review of these simulations and the consideration of nine statutory factors will result the adoption of desired future conditions for Groundwater Management Area 14. Joint planning can be summarized as a three-step process:

1. After considering the nine factors and applying a balancing test, the Groundwater Conservation Districts propose for adoption desired future conditions for the relevant aquifers within the management area.
2. Once proposed, a 90-day public comment period begins that includes at least one public hearing in each Groundwater Conservation District. Each Groundwater Conservation District compiles a summary of relevant comments, any suggested revisions to the proposed desired future conditions, and the basis for the revisions.
3. After receipt of all the summary reports from the Groundwater Conservation Districts, Groundwater Management area representatives meet, consider any suggested revisions, and finally adopt the desired future conditions for the management area.

During the discussion of the nine factors and the review of early simulations that focused on hydrogeologic issues of the Gulf Coast Aquifer, there was a stated objective by the Groundwater Conservation District representatives to develop a desired future condition statement that was applicable for the entirety of Groundwater Management Area 14.

Developing a GMA-wide DFC was in response to deficiencies in the Desired Future Condition statements and Joint Planning process during the second round of joint planning that ended in 2016. These deficiencies in the second round were identified in a petition filed against the Lone Star Groundwater Conservation District that challenged the reasonableness of the desired future conditions for Montgomery County.

As part of the implementation a GMA-wide DFC, the Groundwater Management Area 14 consultant developed a series of multi-metric HAGM simulations. These simulations featured pumping adjustments to all counties in GMA 14 (except Fort Bend, Galveston, and Harris counties) that were made consistent with certain constraints and thresholds.

1.2 Proposed Desired Future Condition

On April 9, 2021, the groundwater conservation districts in Groundwater Management Area 14 unanimously proposed a desired future condition as follows:

> ***In each county in GMA 14, no less than 70 percent median available drawdown remaining in 2080 and no more than an average of 1.0 additional foot of subsidence between 2009 and 2080.***

Unfortunately, the language of the statement is insufficient to fully describe the simulation that was used as a basis for the proposed desired future condition. A more complete description of the various assumptions and constraints is provided below:

- 70 percent median available drawdown remaining in 2080 (using 2009 as a base condition),
- No more than 1 ft additional average subsidence in 2080 (using 2009 as a base condition),
- Pumping in a county is no more than 30,000 above the maximum projected water demand between 2020 and 2070 as defined in the current state water plan,
- The initial pumping distribution was taken from the 2016 modeled available groundwater simulation of the HAGM for the second round of desired future conditions.

Details of these constraints and assumptions will be fully documented in the Groundwater Management Area 14 Explanatory Report and associated technical reports.

1.2 Implementation of Desired Future Condition in Bluebonnet GCD

The deadline for final adoption of the desired future condition by Groundwater Management Area 14 is January 5, 2022. Once the desired future condition is adopted by the groundwater conservation districts in Groundwater Management Area 14 (step 3 above), the Texas Water Development Board reviews the submitted resolution, explanatory report, and model runs for administrative completeness. Once the Texas Water Development Board sends a letter acknowledging administrative completeness, each district is then required to adopt the desired future conditions applicable to the district as defined in the resolution and report (Texas Water Code Section 36.108 d-4).

Once the district adopts the desired future condition, Texas Water Code Section 36.1071 (7) requires that the district's management plan include a management goal that addresses the desired future condition adopted by the district. The Texas Administrative Code (Chapter 356.52) requires that the management objectives be specific and time-based statements of future outcomes that are linked to a management goal. Also, performance standards for each management objective are required to evaluate the effectiveness and efficiency of district activities.

The implementation of the desired future condition for Bluebonnet GCD involves taking the single GMA 14-wide desired future statement and quantifying it for use as a management goal and objective for inclusion in the district's management plan. The HAGM simulation that serves as the basis for the GMA 14-wide desired future condition can provide the district-specific drawdown and subsidence information that acts as the foundation for the adopted desired future condition that is adopted by Bluebonnet GCD.

1.3 Report Objectives

The main objective of this report is to present the model results from the simulation that formed the basis of the GMA-wide desired future condition that was proposed by the groundwater conservation districts of Groundwater Management Area 14 on April 9, 2021 that are relevant to the Bluebonnet Groundwater Conservation District (Austin, Grimes, Walker, and Waller counties). These results include:

- Annual pumping for each county-aquifer unit in Bluebonnet GCD
- Annual average drawdown for each county-aquifer unit in Bluebonnet GCD
- Annual average and maximum subsidence in each county in Bluebonnet GCD

Through these results, the Bluebonnet GCD-specific desired future conditions are identified that form the basis for inclusion in the district's management plan. This represents the link between planning activities and management activities of Bluebonnet GCD. As developed in this report, the link between management activities and regulatory activities involves the Phase I and Phase II hydrogeologic reports and analyses required of all large well permit applicants. Finally, this report provides an initial comparison of actual and simulated drawdowns that is described in the district's management plan.

1.4 Recommended Bluebonnet GCD-Specific Desired Future Conditions

As developed in this report, the recommended desired future conditions applicable to Bluebonnet GCD that are based on the GMA 14-wide desired future conditions are listed in Table 1. The expected modeled available groundwater values are also provided in the table.

Table 1. Recommended BGCD-Specific DFCs
Based on GMA 14-Wide DFC: 70% Available Drawdown Remaining, One Foot Additional Average Subsidence, 30K Pumping Increase Limit, 2016 Pumping Distribution

County	Aquifer	Recommended BGCD-Specific Desired Future Conditions		Expected Modeled Available Groundwater (Pumping in AF/yr from 2010 to 2080)
		Average Drawdown in ft from 2009 to 2080	Maximum Subsidence in ft from 1890 to 2080	
Austin	Chicot	54	3.39	2,892
	Evangeline	38		41,706
	Burkeville	39		0
	Jasper	165		1,971
Grimes	Chicot	35	0.25	0
	Evangeline	26		15,907
	Burkeville	26		0
	Jasper	147		35,546
Walker	Chicot	1	0.17	0
	Evangeline	16		3,141
	Burkeville	7		0
	Jasper	96		39,279
Waller	Chicot	50	5.39	791
	Evangeline	59		54,336
	Burkeville	60		0
	Jasper	218		329

2.0 HAGM Simulation

The HAGM files used for this report were obtained from Wade Oliver of INTERA, the technical consultant for Groundwater Management Area 14. The output control file was modified from the obtained version. The modified file specifies head and cell-by-cell output for all stress periods in the predictive period (2010 to 2080). Table 2 summarizes the input files and Table 3 summarizes the output files used for this report.

Table 2. HAGM Simulation Input Files

Package	FORTRAN Unit Number	File Name	File Date
Basic	1	HAGM_BT_base_2080.bas	6/19/2012
Discretization	14	HAGM_BT_base_2080.dis	3/19/2020
Block Center Flow	11	HAGM_BT_base_2080.bcf	8/23/2013
Well	12	HAGM_BT_base_pest_2080.wel	4/30/2020
General Head Boundary	23	HAGM_BT_base_2080.ghb	3/19/2020
Output Control	22	HAGM_rev20210312.oc	3/12/2021
Solver (Strongly Implicit Method)	21	HAGM_BT_base_2080.sip	6/15/2012
Subsidence	19	HAGM_BT_base_2080.sub	4/17/2014

Table 3. HAGM Simulation Output Files

Output Type	FORTRAN Unit Number	File Name	File Date
Standard (List File)	7	HAGM_BT_base_2080.lst	4/26/2021
Data(binary)	50	HAGM_BT_base_2080.cbb	4/26/2021
Data(binary)	30	HAGM_BT_base_2080.hds	4/26/2021
Data(binary)	31	HAGM_BT_base_2080.ddn	4/26/2021
Data(binary)	150	HAGM_BT_base_subsidence_2080.hds	4/26/2021
Data(binary)	151	HAGM_BT_base_compaction_2080.hds	4/26/2021
Data(binary)	152	HAGM_BT_base_interbedcomp_2080.hds	4/26/2021
Data(binary)	153	HAGM_BT_base_displacement_2080.hds	4/26/2021
Data(binary)	154	HAGM_BT_base_nodelay_precon_2080.hds	4/26/2021
Data(binary)	155	HAGM_BT_base_delay_precon_2080.hds	4/26/2021

3.0 Simulated Pumping

3.1 Post-Processing of Simulation Results

Simulated pumping results were extracted from the cell-by-cell output file with the FORTRAN post-processor *getpump.exe*. Source code for the post-processor is presented in Appendix A. The program:

- Reads the cell-by-cell output file,
- Reads a list of counties in Groundwater Management Area 14,
- Reads the HAGM grid file,
- Sums pumping for each stress period by county-aquifer unit and total pumping in each county.

The program writes three sets of output files:

- A set of 5 files that list pumping for each aquifer by county for each of the four model layers (Chicot, Evangeline, Burkeville, and Jasper) and a total for all model layers from 1989 to 2080.
- A set of 4 files list pumping for each county in the Bluebonnet Groundwater Conservation District (Austin, Grimes, Walker, and Waller). Each column in the output file represents a model layer. The last column is a county total.
- A set of 4 files that list pumping in a modeled available groundwater format for each aquifer. The columns represent the decadal pumping from 2010 to 2080.

3.2 Simulated Bluebonnet GCD Pumping

Simulated pumping results are graphically presented as follows:

- Figure 1 – Austin County
- Figure 2 – Grimes County
- Figure 3 – Walker County
- Figure 4 – Waller County

Please note that in Austin County and Waller counties, the primary aquifer is the Evangeline. In Grimes County, most of the pumping is from the Jasper with significant pumping also from the Evangeline. Pumping in Walker County is primarily from the Jasper Aquifer.

Also please note that in each county, the simulated pumping from 2010 to 2080 is substantially increased as compared to historic pumping as defined by the HAGM. In addition, the increases are assumed to occur in 2010 and are held constant through 2080. The increases are generally due to the specified constraint of finding pumping associated with 70 percent available drawdown remaining in 2080.

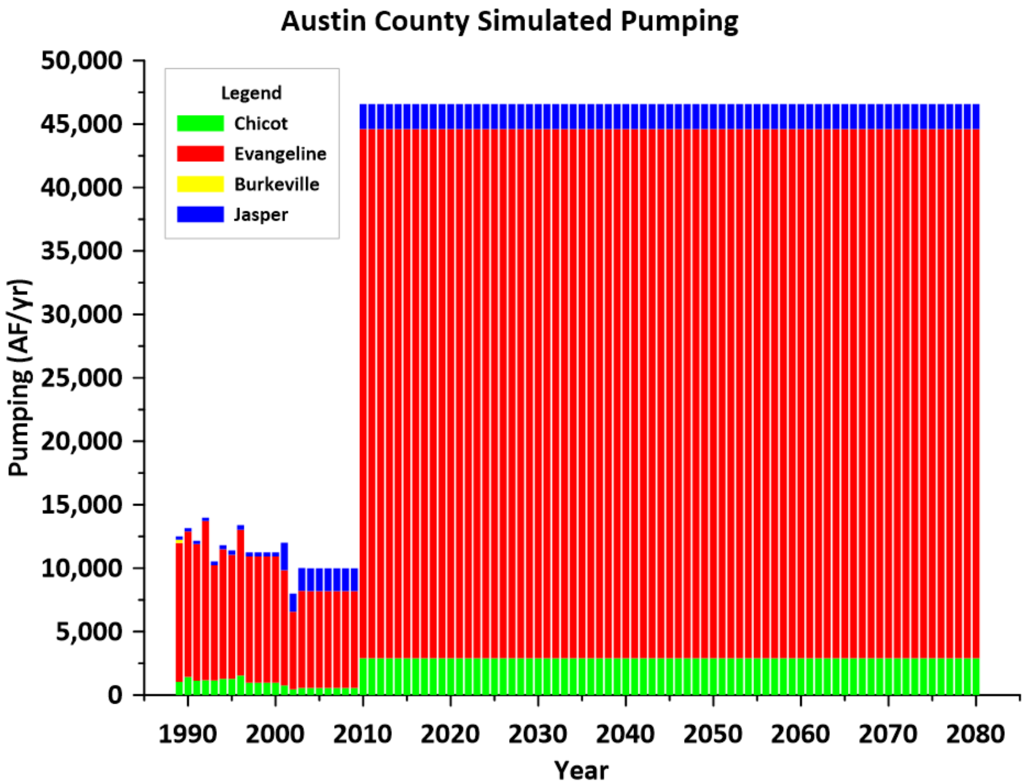


Figure 1. Simulated Pumping - Austin County

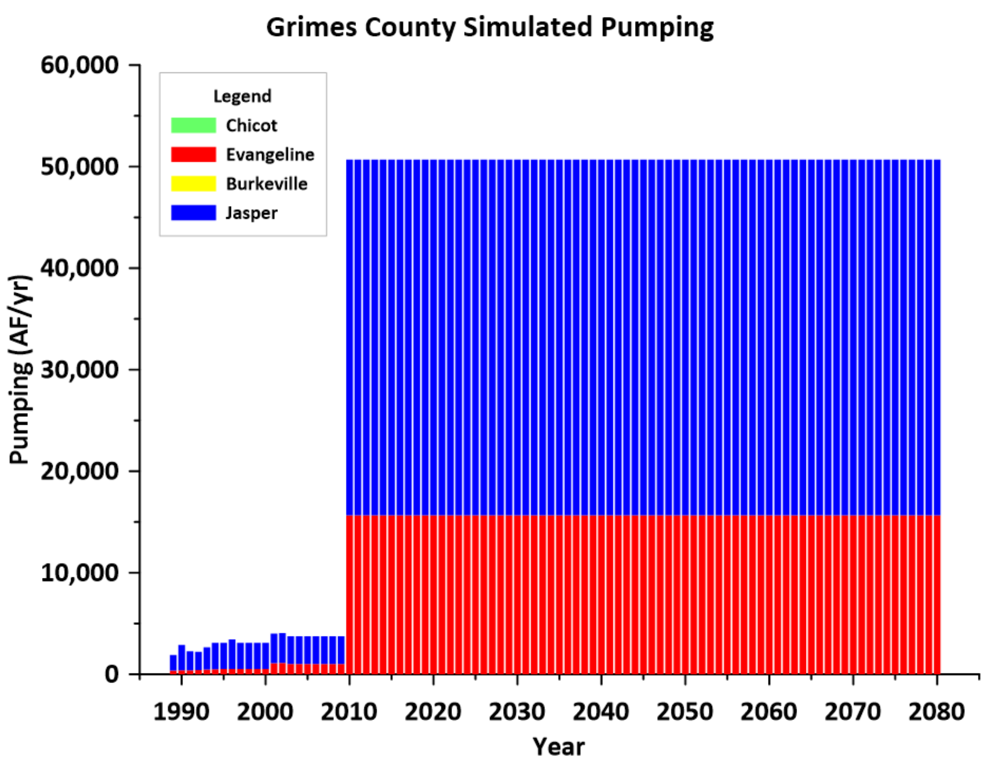


Figure 2. Simulated Pumping – Grimes County

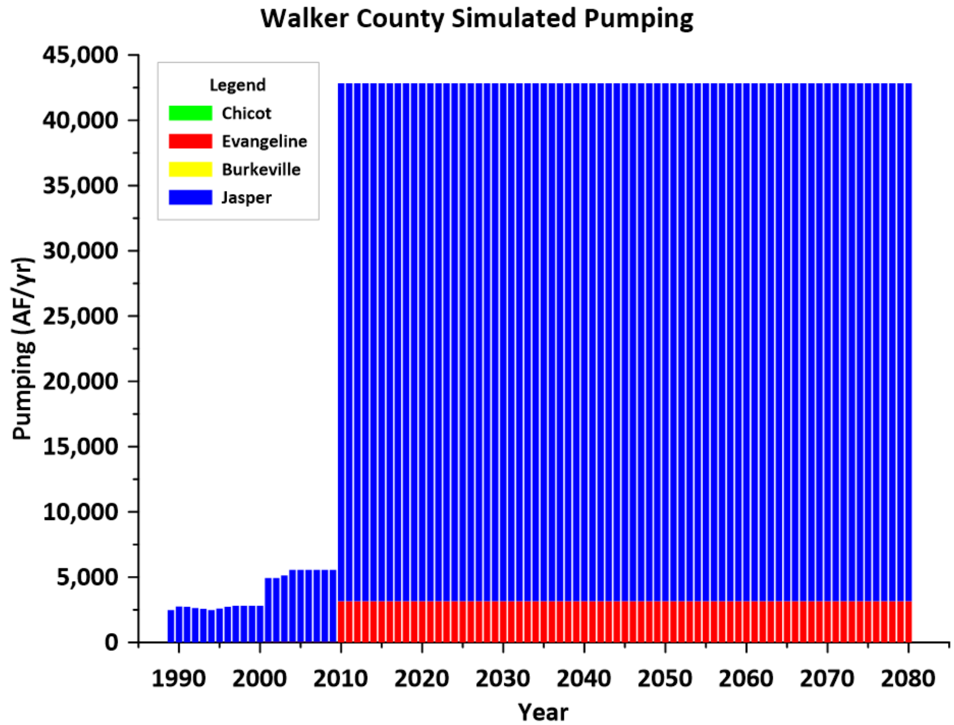


Figure 3. Simulated Pumping – Walker County

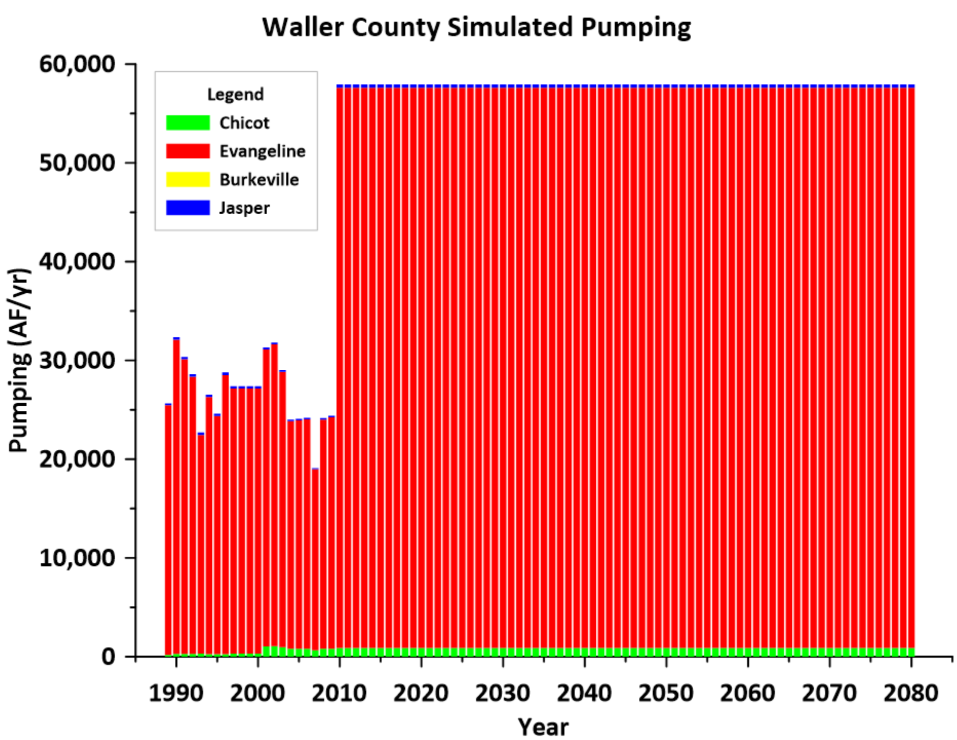


Figure 4. Simulated Pumping – Waller County

3.2 Comparison of Simulated Future Pumping with Historic Pumping and Existing Modeled Available Groundwater

Table 4 presents a comparison of the current Modeled Available Groundwater (MAG) with the simulated pumping from the simulation. It is expected that the simulated pumping from 2010 to 2080 will be the new modeled available groundwater values.

The table also presents the historic pumping in 2009 used by the HAGM, the current MAG from the HAGM simulation used in the second round of joint planning, and the difference between the pumping used in this HAGM simulation and the current MAG.

Please note that the total simulated pumping is over four times the historic pumping (as simulated by the HAGM in 2009) and over twice the previous modeled available groundwater.

Table 4. Comparison of Existing MAG with Simulated Pumping

County	Aquifer	Historic Simulated Pumping (2009) in AF/yr	Current MAG (2010 to 2070) in AF/yr	Simulated Pumping (2010 to 2080) in AF/yr	Expected Increase in MAG (AF/yr)
Austin	Chicot	562	1,005	2,892	1,887
	Evangeline	7,632	14,517	41,706	27,189
	Burkeville	0	0	0	0
	Jasper	1,802	76	1,971	1,895
Grimes	Chicot	0	0	0	0
	Evangeline	1,023	8,759	15,907	7,148
	Burkeville	0	371	0	-371
	Jasper	2,712	8,624	35,546	26,922
Walker	Chicot	0	0	0	0
	Evangeline	41	2,000	3,141	1,141
	Burkeville	0	0	0	0
	Jasper	5,520	15,973	39,279	23,306
Waller	Chicot	811	300	791	491
	Evangeline	23,423	40,993	54,336	13,343
	Burkeville	0	0	0	0
	Jasper	152	300	329	29
Total	**All Aquifers**	**43,678**	**92,918**	**195,898**	**102,980**

4.0 Simulated Average Drawdown

4.1 Post-Processing Simulation Results

Average drawdown for each county-aquifer unit was calculated using the FORTRAN post-processor *getavgdd.exe*. Source code for *getavgdd.exe* is presented in Appendix B. The program:

- Reads a file that identifies the dates associated with each stress period,
- Reads a list of counties in Groundwater Management Area 14 and the associated file names for county-level output,
- Reads the HAGM grid file,
- Counts the number of cells in each county-aquifer unit and writes the counts to an output file,
- Reads the binary head output file from the simulation and calculates drawdown for each cell for each stress period using 2009 as the base year,
- Calculates the average drawdown for each county-aquifer unit by dividing the sum of the drawdowns in each county-aquifer unit by the number of cells in the county-aquifer unit,
- Writes annual county drawdowns for each aquifer unit and for the county as a whole,
- Writes drawdown summaries for each aquifer unit by county for the year 2080.

4.2 Simulated Bluebonnet GCD Average Drawdown

Average drawdown graphs from 1980 to 2080 (using 2009 as the base year) are presented as follows:

- Figure 5 – Austin County
- Figure 6 – Grimes County
- Figure 7 – Walker County
- Figure 8 – Waller County

Based on a comparison of the pumping increases shown in the previous section (summarized in Table 4 in the previous section), it appears that the Jasper Aquifer drawdown in Austin and Waller counties is largely due to increases in pumping outside of these counties as opposed to pumping within these counties.

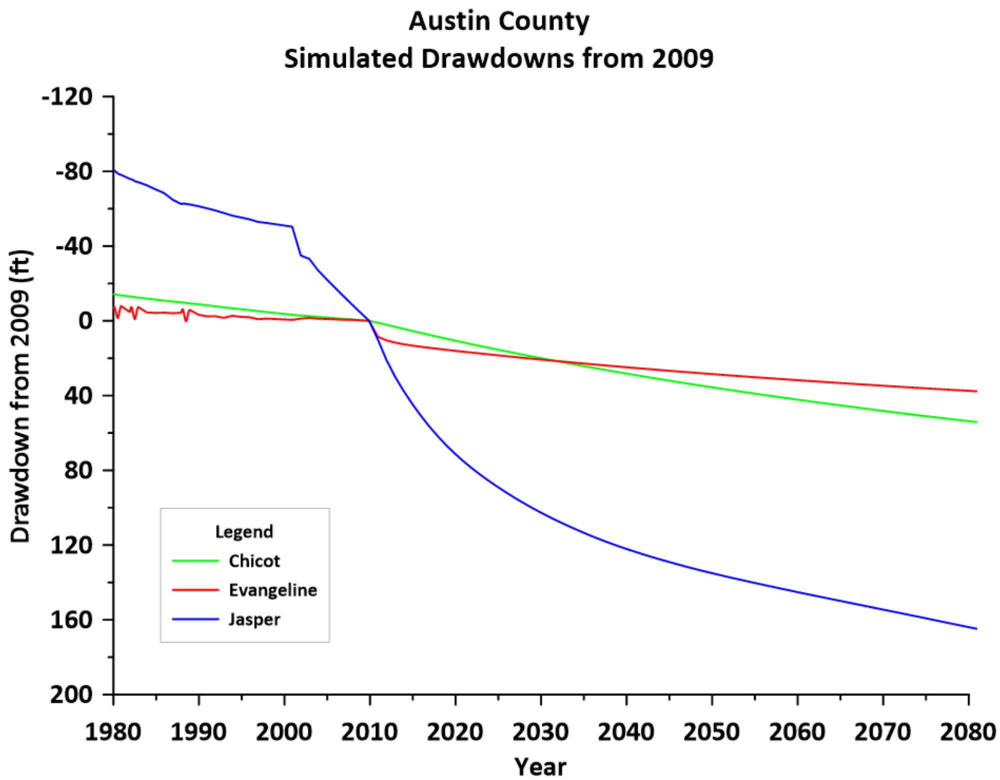


Figure 5. Simulated Average Drawdown - Austin County

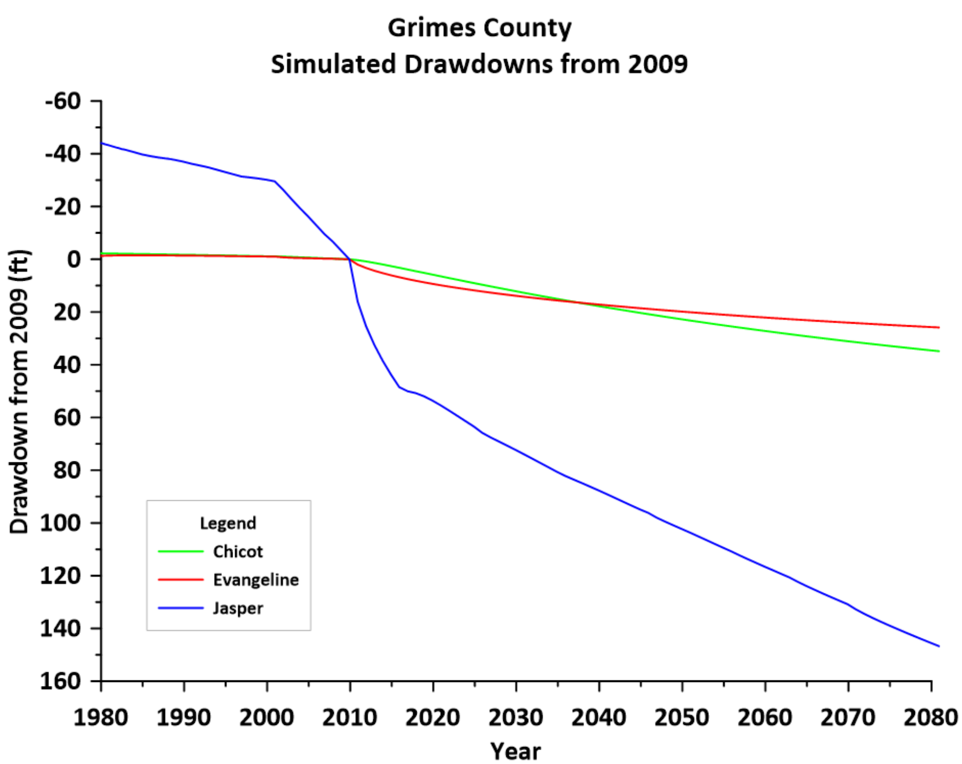


Figure 6. Simulated Average Drawdown - Grimes County

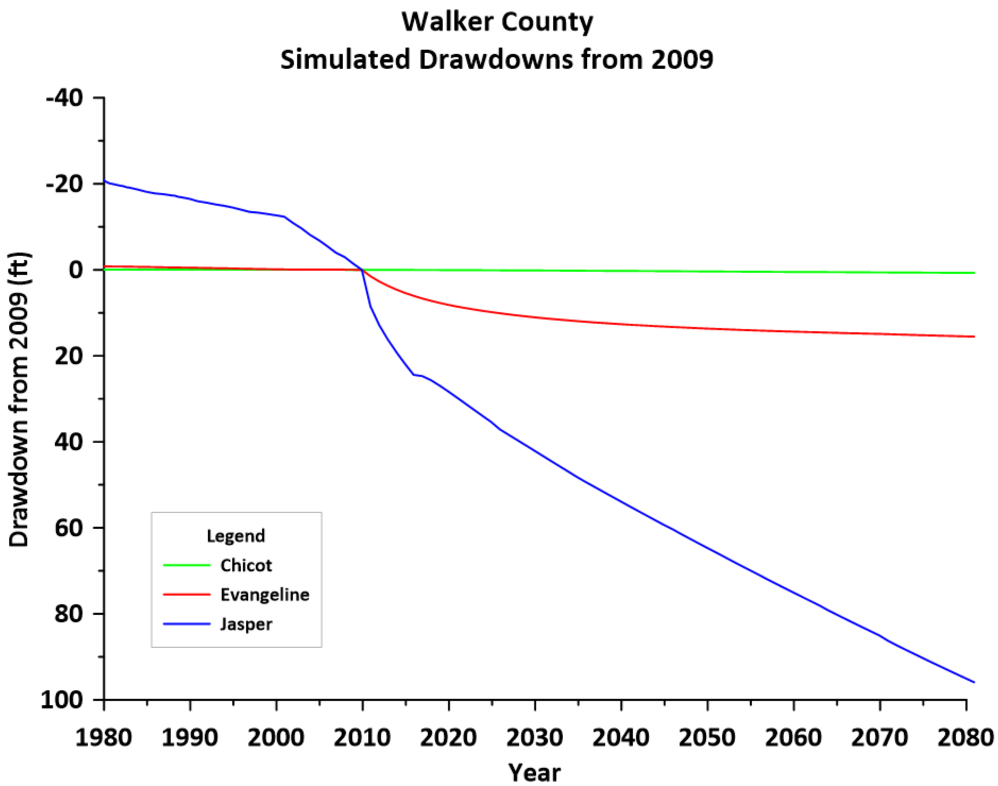


Figure 7. Simulated Average Drawdown - Walker County

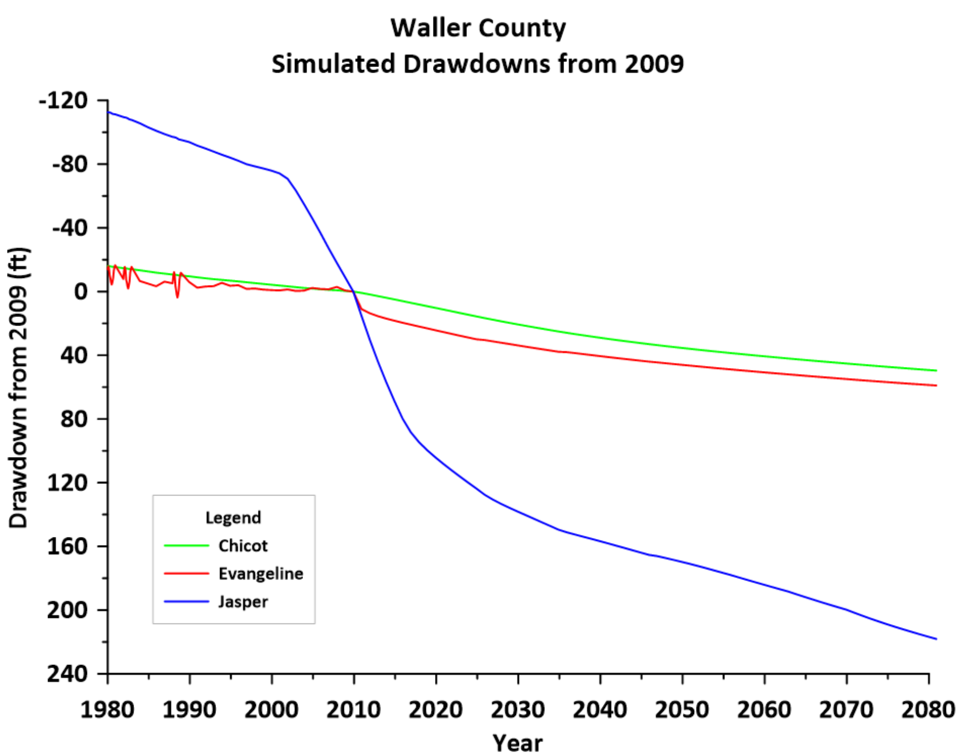


Figure 8. Simulated Average Drawdown - Waller County

4.3 Comparison of Simulated Average Drawdowns with Current Desired Future Conditions

Table 5 presents a comparison of the current desired future conditions (DFCs) and calculated average drawdowns from the HAGM simulation for three time periods. The current DFC is a drawdown calculation from 2009 to 2070. The calculated average drawdowns from this HAGM simulation include:

- 2009 to 2026 (for use in future comparisons before the 4th round of joint planning)
- 2009 to 2070 (for direct comparison with the current desired future condition)
- 2009 to 2080 (covers the full period of the simulation, and represents the Bluebonnet GCD-specific DFC that would be adopted)

Table 5. Current DFCs and Calculated Drawdowns from HAGM Simulation

County	Aquifer	Current DFC (ft of drawdown from 2009 to 2070)	Average Drawdown from Simulation (ft drawdown from 2009 to 2026)	Average Drawdown from Simulation (ft drawdown from 2009 to 2070)	Average Drawdown from Simulation (ft drawdown from 2009 to 2080)
Austin	Chicot	39	17	49	54
	Evangeline	23	19	35	38
	Burkeville	23	20	36	39
	Jasper	76	95	155	168
Grimes	Chicot	5	10	31	35
	Evangeline	5	13	24	26
	Burkeville	6	11	24	26
	Jasper	52	68	133	147
Walker	Chicot	N/A	0	1	1
	Evangeline	9	10	15	16
	Burkeville	4	3	6	7
	Jasper	42	38	86	96
Waller	Chicot	39	18	46	50
	Evangeline	39	31	55	59
	Burkeville	40	32	56	60
	Jasper	101	131	200	218

A comparison of the last two columns of Table 5, shows that drawdown continues to increase from 2070 to 2080, which means the hydraulic system under the specified pumping has not reached a state of near equilibrium. This may be a limitation of the HAGM, which has been criticized as an inadequate model for the purposes of joint planning (e.g. Hutchison, 2014a and 2014b).

Comparing the current DFC and the average drawdown from 2009 to 2070 yields the conclusion that the increased pumping of this simulation as compared to the simulation that was the basis for the current DFC results in increased drawdown. The increased drawdown is a combined result of increased pumping in the individual county and the result of increased pumping in surrounding counties.

The calculated average drawdown from 2009 to 2026 represents the short-term drawdown that will be compared to actual data over the next five years (i.e. before the 4th round of joint planning is completed). This is significant because it is anticipated that a new groundwater flow model will be available for use in the next round of joint planning. It is expected that the new model will correct some of the known limitations with the HAGM and may be a more appropriate tool for use in the joint planning process. Because of the anticipated improvements in the new groundwater flow model, it is important to keep perspective of how these results will be used in the future and the strong possibility that results from the next model will be different and, hopefully, more reliable.

5.0 Simulated Subsidence

5.1 BGCD Rule Regarding Subsidence

Bluebonnet GCD Rule 8.18 prohibits the production of groundwater that causes the potential of measurable subsidence. The potential for measurable subsidence must be addressed by applicants and permitees in Phase I and Phase II hydrogeologic reports required under Rule 8.5F. If the District has reason to believe that a non-exempt well has the potential to cause measurable subsidence, the District may, after notice and the opportunity for hearing, take all actions it deems necessary, in accordance with this Rule 8.18, to address the potential subsidence.

As documented in Hutchison (2014b), comparison of measured and simulated subsidence in the HAGM is better than the previous GAM (North Gulf Coast Groundwater Availability Model). However, as shown in Figure 9 (Figure 17 of Hutchison, 2014b), the calibration comparison of measured and simulated subsidence is generally plus or minus one foot. Currently, the rule definition of "measurable subsidence" is guided by the calibration of the HAGM. In general, Phase I and Phase II reports that include simulation results of less than one foot of additional subsidence are regarded as satisfying the threshold pumping that will not cause "measurable subsidence".

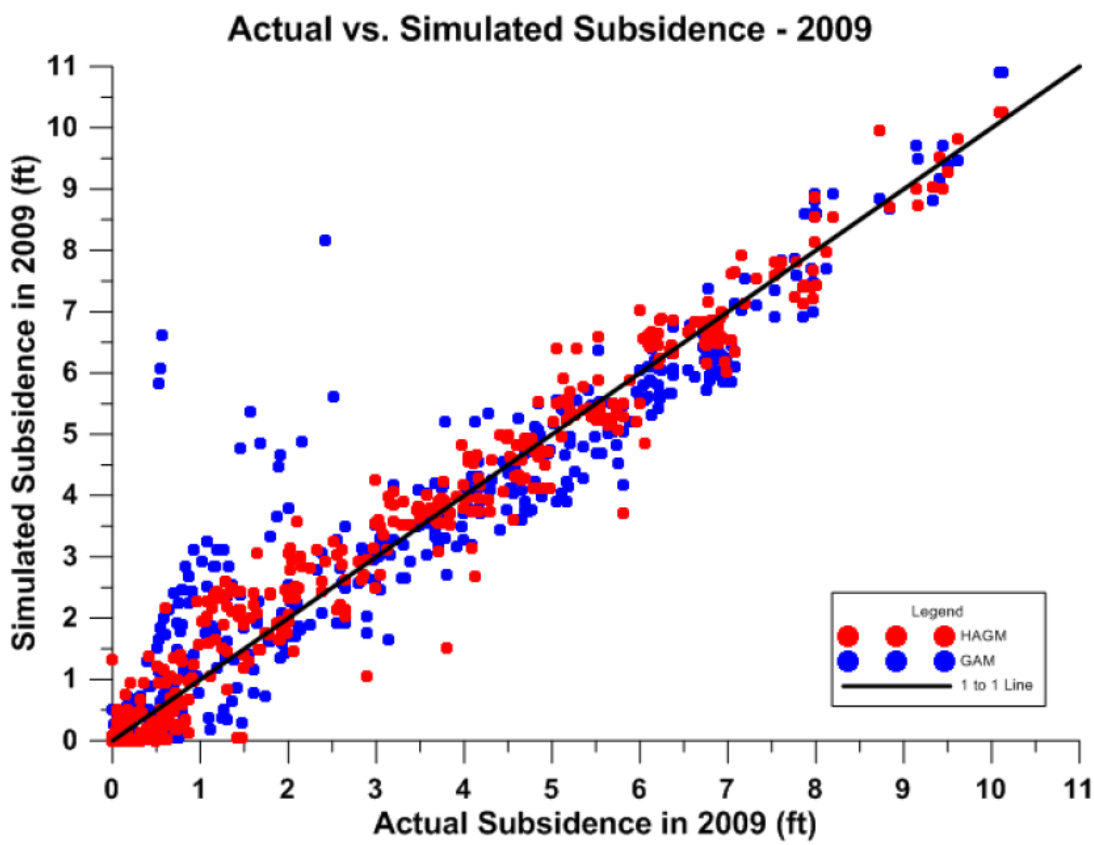


Figure 9. Comparison of Actual Subsidence from 1906 to 2000 and Estimated Subsidence from 1891 to 2009 from the GAM and HAGM

5.2 Post-Processing Simulation Results

Subsidence for each county was calculated using the FORTRAN post-processor *getsub.exe*. Source code for *getsub.exe* is presented in Appendix C. The program:

- Reads a file that identifies the dates associated with each stress period,
- Reads a list of counties in Groundwater Management Area 14,
- Reads the HAGM grid file,
- Counts the number of cells in each county-aquifer unit and writes the counts to an output file,
- Reads the binary subsidence file from the simulation and sums the subsidence results and finds the maximum subsidence for each county,
- Calculates the average subsidence for each county by dividing the sum of the subsidence values in each county by the number of cells in the county,
- Reads a file with file names for each county and writes county output (average subsidence and maximum subsidence),
- Writes 2080 subsidence results for each county in a single file.

5.3 Simulated Bluebonnet GCD Average and Maximum Subsidence

Average and maximum subsidence graphs from 1980 to 2080 (using 1890 as the base year) are presented as follows:

- Figure 10 – Austin County
- Figure 11 – Grimes County
- Figure 12 – Walker County
- Figure 13 – Waller County

Please note that the graphs suggest that subsidence does not appear to be a significant concern in Grimes and Walker counties (i.e. maximum subsidence in 2080 less than 0.5 ft). However, in Austin and Waller counties, the results presented requires some additional discussion as detailed below after a discussion of the relationship between average and maximum subsidence.

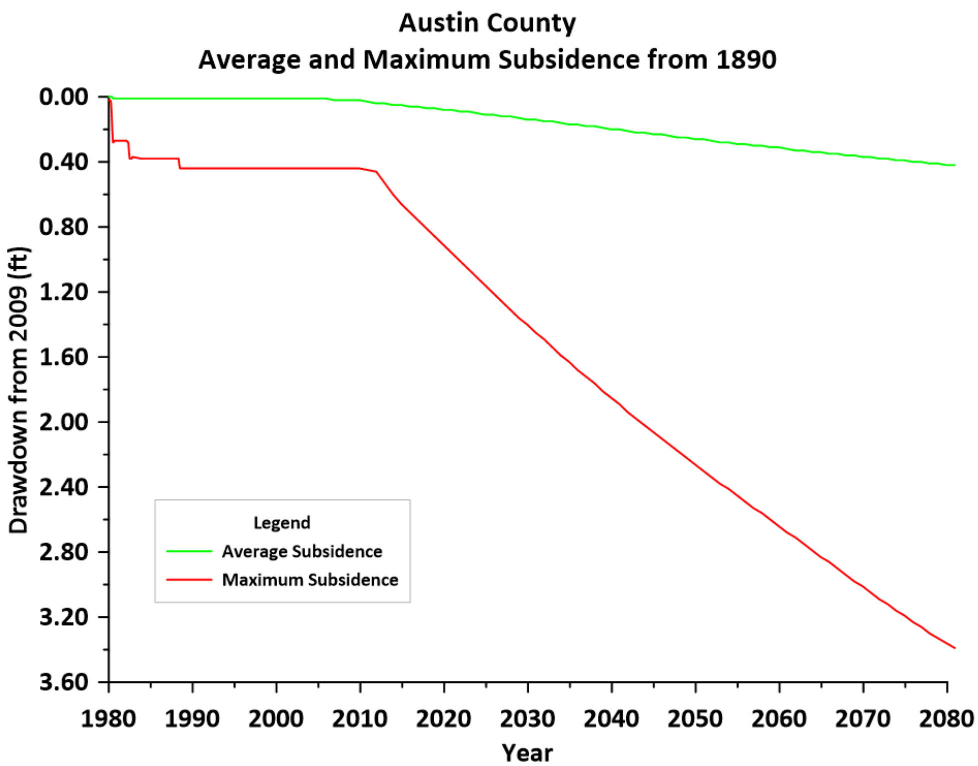


Figure 10. Average and Maximum Subsidence - Austin County

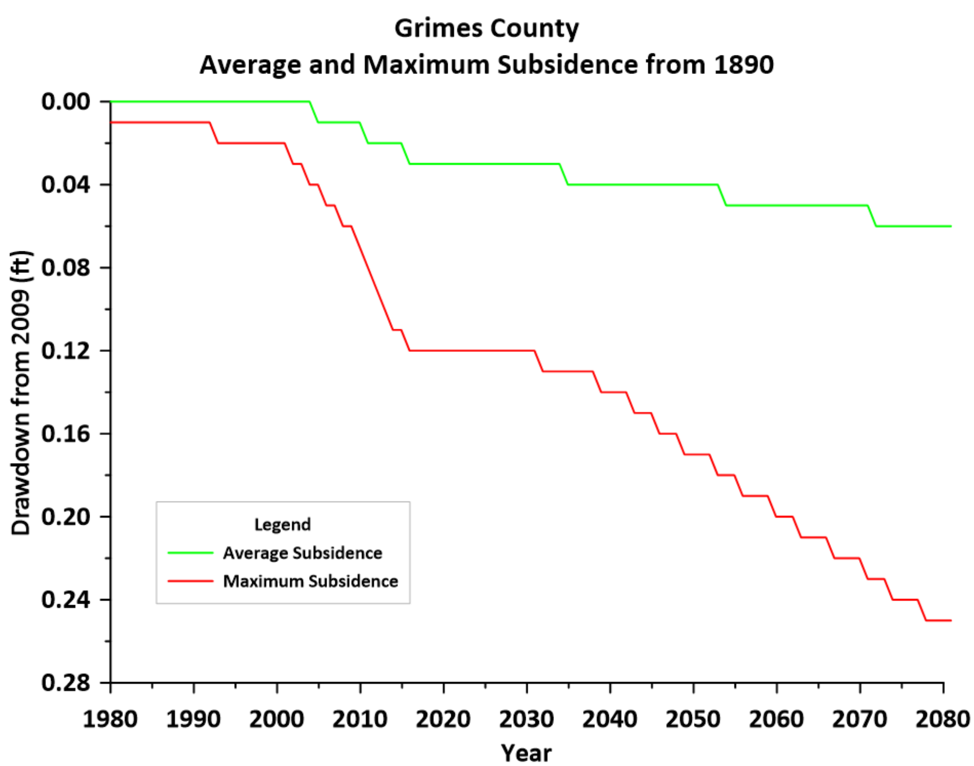


Figure 11. Average and Maximum Subsidence - Grimes County

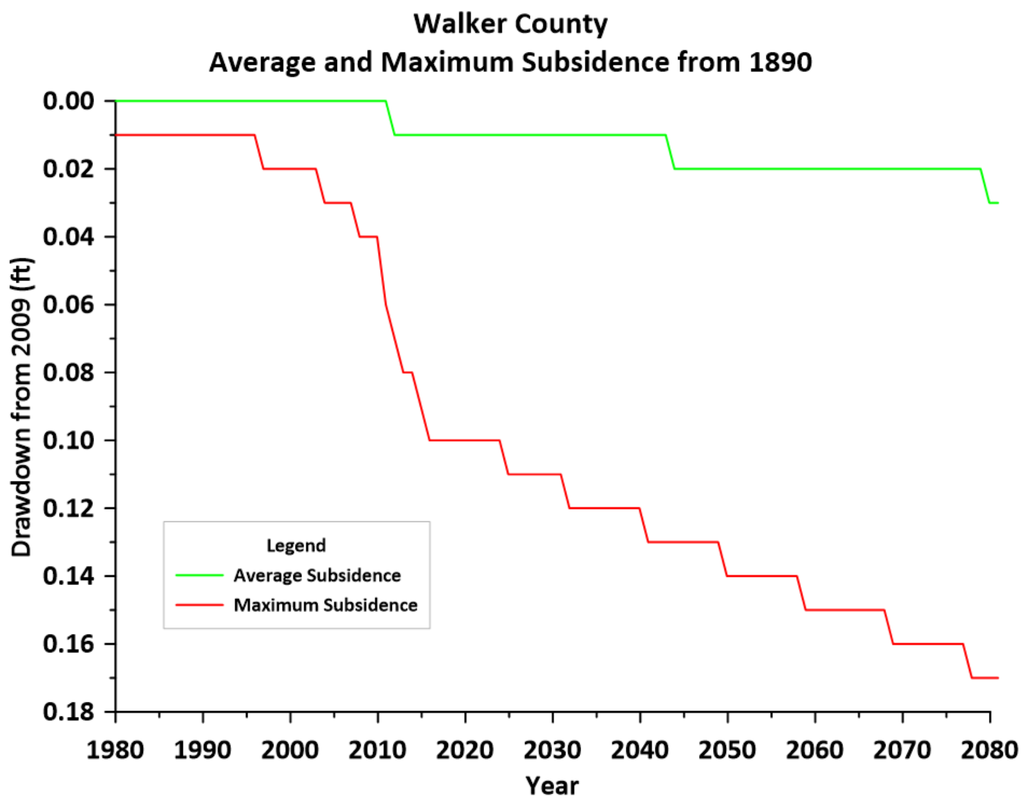


Figure 12. Average and Maximum Subsidence - Walker County

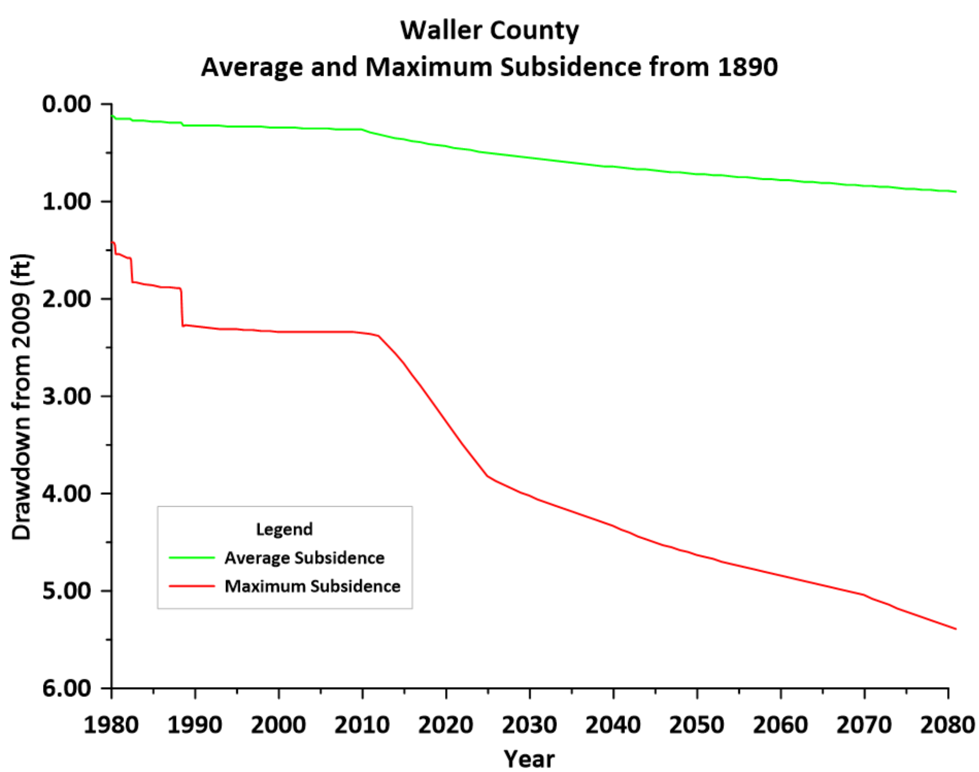


Figure 13. Average and Maximum Subsidence - Waller County

5.4 Interpretation of Average and Maximum Subsidence

At the April 29, 2020 meeting of Groundwater Management Area 14, the relationship between average additional subsidence and maximum additional subsidence was discussed based on simulation results from several different scenarios from Wade Oliver of INTERA (the GMA 14 technical consultant). Figure 14 represents a plot of average additional subsidence versus maximum additional subsidence for each county in Groundwater Management Area 14 for all the simulations that had been completed at that time.

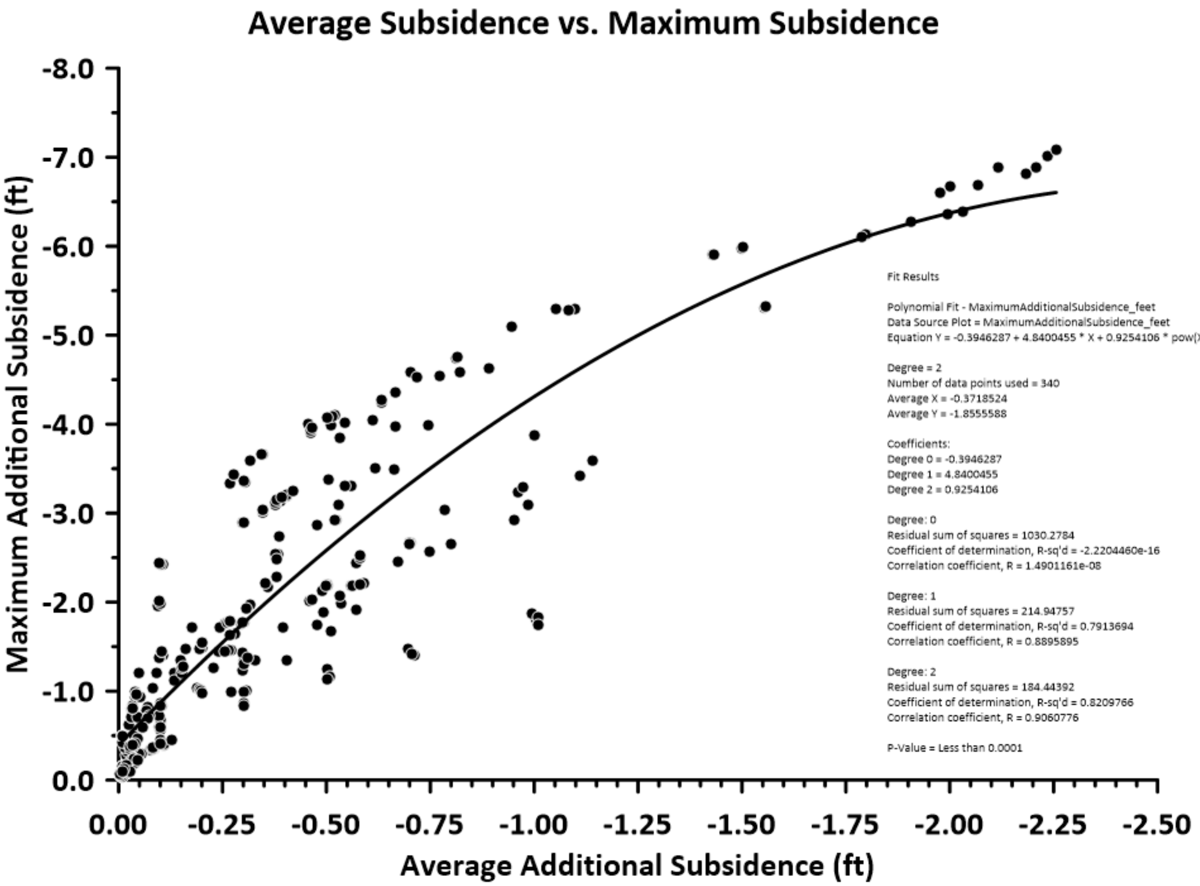


Figure 14. Average Additional Subsidence vs. Maximum Additional Subsidence - HAGM Simulations

5.5 Comparison of Simulated Maximum Subsidence with Current Desired Future Conditions

In 2016, the desired future condition that was adopted by the groundwater conservation districts of Groundwater Management Area 14 included a maximum subsidence desired future condition for each of the counties in the Bluebonnet GCD. No other counties in Groundwater Management Area 14 GCD had included subsidence as part of the desired future condition statement. Because Bluebonnet GCD has a specific rule regarding the avoidance of subsidence, Bluebonnet GCD requested that the maximum subsidence be included to provided consistency and a link between the district's three areas of focus:

- Planning activities (joint planning and desired future conditions)
- Management activities (district management plan)
- Regulatory activities (rules and permit review procedures)

Table 6 presents the current subsidence-based desired future condition values and four subsidence results for each county from the HAGM simulation that is the subject of this report.

Table 6. Current DFC and Maximum Subsidence Results from HAGM Simulation

County	Current DFC - Maximum Subsidence from 1890 to 2070 (ft)	Simulated Maximum Subsidence (ft)				Simulated Additional Subsidence (ft from 2009)		
		1890 to 2009	1890 to 2026	1890 to 2070	1890 to 2080	2009 to 2026	2009 to 2070	2009 to 2080
Austin	2.83	0.44	1.26	3.05	3.39	0.82	2.61	2.95
Grimes	0.12	0.07	0.12	0.23	0.25	0.05	0.16	0.18
Walker	0.04	0.04	0.11	0.16	0.17	0.07	0.12	0.13
Waller	4.73	2.35	3.91	5.08	5.39	1.56	2.73	3.04

The first subsidence column is the current desired future condition (DFC) which is expressed as the maximum subsidence from 1890 to 2070 in feet. This was obtained from the results of the HAGM simulation that formed the basis for all the desired future conditions for the second round of joint planning. The next four columns present the results of the current HAGM simulation that is the subject of this report for four different time periods:

- 1890 to 2009 (the calibration period of the HAGM to establish a baseline of "current" subsidence)
- 1890 to 2026 (the simulated subsidence through the year 2026)
- 1890 to 2070 (for direct comparison with the current desired future condition)
- 1890 to 2080 (the full simulation period)

The final three columns represent the simulated additional subsidence from the base year 2009 for three time periods: 2009 to 2026, 2009 to 2070, and 2009 to 2080. The 2009 to 2026 period is significant because the fourth round of joint planning (proposed deadline of May 1, 2026) will presumably use a new and improved groundwater model currently under development.

The differences between the current DFC and the 1890 to 2070 subsidence are all less than one foot. Also, the differences between the current DFC and the 1890 to 2080 are also all less than one foot. Thus, it appears, based on the calibration of the HAGM, that the differences may not be significant.

The "current" subsidence (1890 to 2009) column shows that the only maximum subsidence value above one foot is in Waller County. The simulated subsidence is a result of pumping in Waller County and surrounding counties as demonstrated in Hutchison (2014b).

The columns that represent "additional" subsidence and are greater than one foot in Austin and Waller counties. This values are not necessarily significant relative to Bluebonnet GCD management and regulatory activities for the following reasons:

- Previous work in the area (Hutchison 2014b) demonstrated that much of the drawdown and associated subsidence is the result of pumping outside of the regulatory authority of the Bluebonnet GCD,
- The simulation assumed that total pumping in all counties would increase beginning in 2010. This higher pumping was assumed constant from 2010 to 2080. Actual pumping from 2010 to present is likely closer to the 2009 value than the assumed increase used in the simulation. Therefore, it is unlikely that the drawdown estimated by the simulation has occurred. Because of the established link between groundwater pumping, drawdown, and subsidence, it is unlikely that this amount of subsidence is likely before 2026.

The Bluebonnet GCD permit process requires that permit applicants evaluate the potential for subsidence for all proposed large well production permits. The joint planning process provides a reasonable foundation for the review of any permit applications, but the results are not considered regulatory limits by Bluebonnet GCD.

Based on the values provided above, permit applications for large increases in pumping are unlikely to be constrained by subsidence in Grimes and Walker counties. Permit applications in Austin and Waller counties will require more permit-specific review with particular attention to the relative contribution of any predictive subsidence from pumping within the Bluebonnet GCD and the relative contribution of any predictive subsidence from pumping in surrounding counties. The next section provides some more details on how the HAGM model results associated with the joint planning process can inform permit application review.

6.0 Simulated Drawdown versus Simulated Subsidence

6.1 Post-Processing Simulation Results

HAGM results for drawdown and subsidence for all cells within the Bluebonnet GCD were extracted from model output using the FORTRAN post-processor *ddsub.exe*. Source code for *ddsub.exe* is presented in Appendix D. The program:

- Reads the HAGM grid file,
- Reads the binary head output file and calculates drawdown for each model layer using 2009 as the base year,
- Reads the binary subsidence output file and calculates "additional" subsidence using 2009 as the base year,
- Writes "additional" subsidence and model layer drawdown output for all of Bluebonnet GCD, each county of Bluebonnet GCD (Austin, Grimes, Walker and Waller).

6.2 Simulated BGCD Aquifer Drawdown versus Additional Subsidence

The results for the main aquifers are presented as follows:

- Figure 15 (Chicot Aquifer – HAGM Layer 1)
- Figure 16 (Evangeline Aquifer – HAGM Layer 2)
- Figure 17 (Jasper Aquifer – HAGM Layer 4)

For each plot, each data point represents a drawdown result and an additional subsidence result from one cell and from one stress period. Because drawdown and subsidence tend to increase with time (2010 to 2080), there are near-linear trends within the plot that represent the drawdown-subsidence relationship for an individual cell through time. There is a polynomial best fit line also shown on each plot.

From these plots, the best fit line suggests the following relationships:

- For the Chicot Aquifer, a drawdown of about 60 feet would be needed to achieve one foot of subsidence,
- For the Evangeline Aquifer, a drawdown of about 100 feet would be needed to achieve one foot of subsidence,
- For the Jasper Aquifer, a drawdown of about 325 feet would be needed to achieve one foot of subsidence.

From the plots, it can also be seen that there is considerable variability in the drawdown-subsidence relationship. From a planning perspective, this variability is not necessarily limiting. From a management or regulatory perspective, this degree of variability would be an issue of concern without additional data or analysis, which is the primary reason for the Bluebonnet GCD Phase I and Phase II hydrogeologic report requirements related to permit applications.

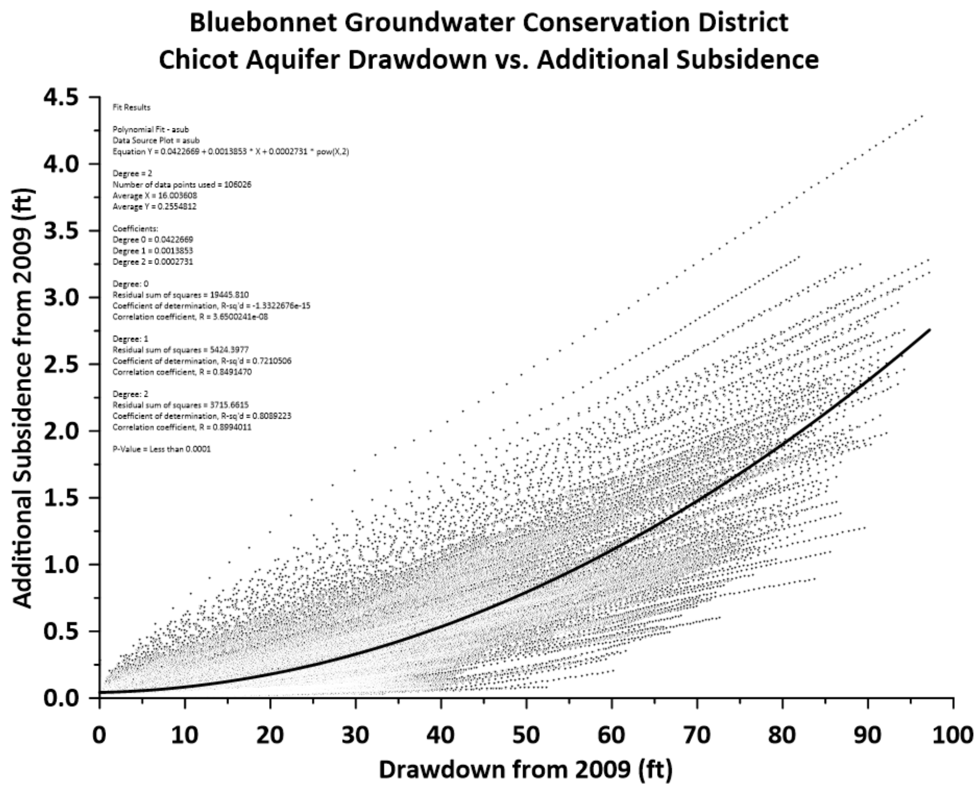


Figure 15. BGCD Drawdown vs. Additional Subsidence - Chicot Aquifer

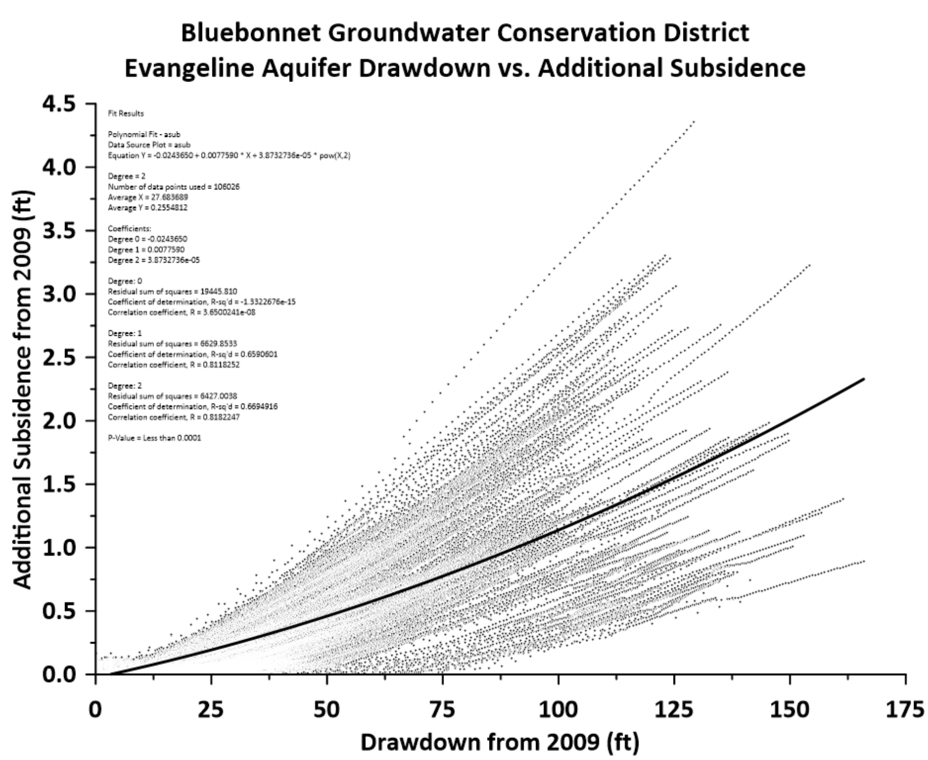


Figure 16. BGCD Drawdown vs. Additional Subsidence - Evangeline Aquifer

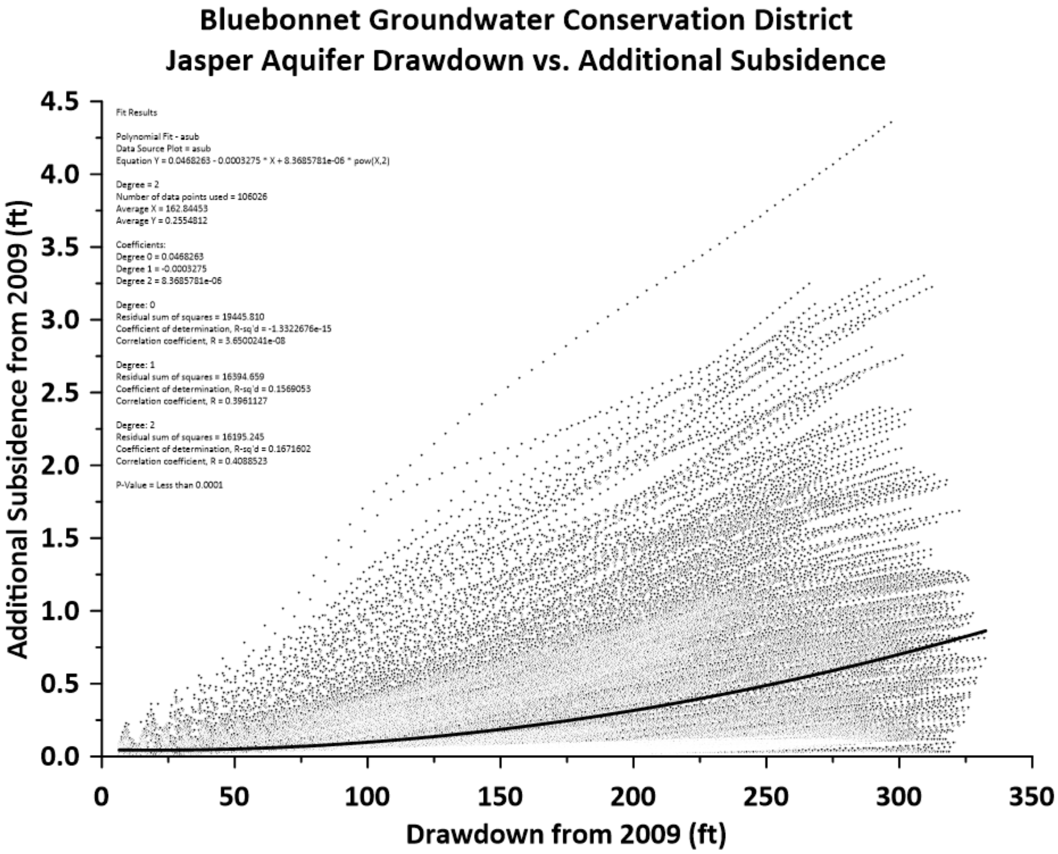


Figure 17. BGCD Drawdown vs. Additional Subsidence - Jasper Aquifer

6.3 Simulated County-Specific Drawdown versus Additional Subsidence

Based on the analysis of the previous section, subsidence is not a significant concern in Grimes and Walker counties and could be an issue of concern in Austin and Waller counties. In addition, due to limitations of the HAGM, the simulated relationship between drawdown and additional subsidence for the Jasper Aquifer may not be reliable. County and aquifer specific plots of drawdown versus additional subsidence are presented as follows:

- Figure 18 – Austin County, Chicot Aquifer
- Figure 19 – Austin County, Evangeline Aquifer
- Figure 20 – Waller County, Chicot Aquifer
- Figure 21 – Waller County, Evangeline Aquifer

For each plot, each data point represents a drawdown result and an additional subsidence result from one cell and from one stress period. Because drawdown and subsidence tend to increase with time (2010 to 2080), there are near-linear trends within the plot that represent the drawdown-subsidence relationship for an individual cell through time. There is a polynomial best fit line also shown on each plot.

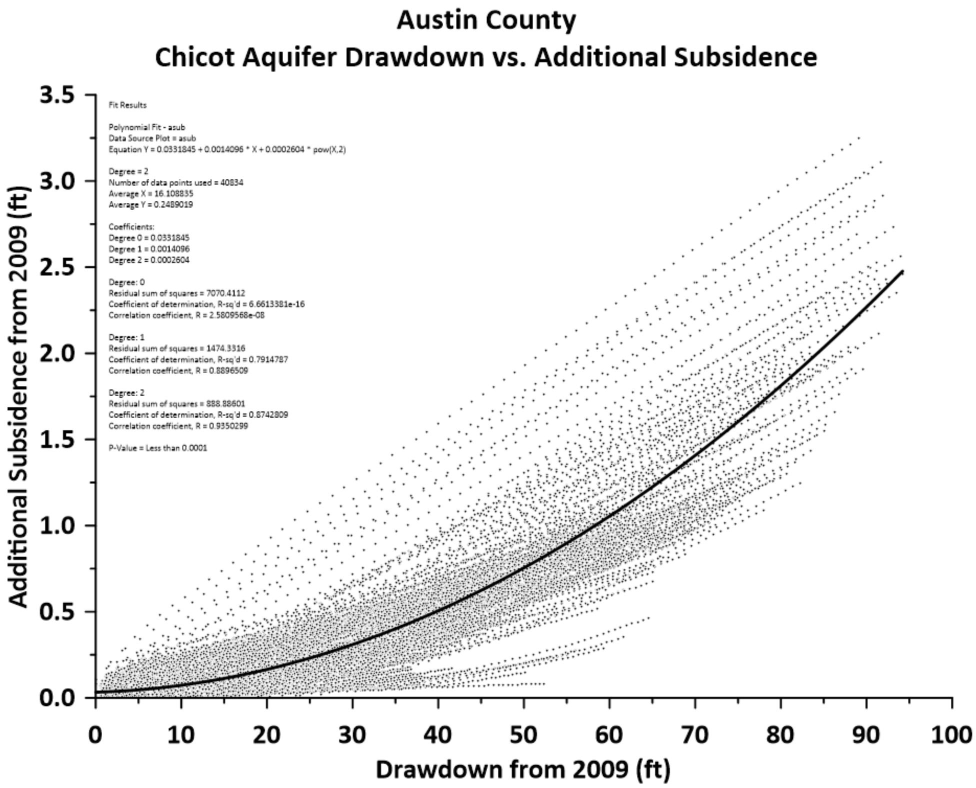


Figure 18. Austin County Drawdown vs. Additional Subsidence - Chicot Aquifer

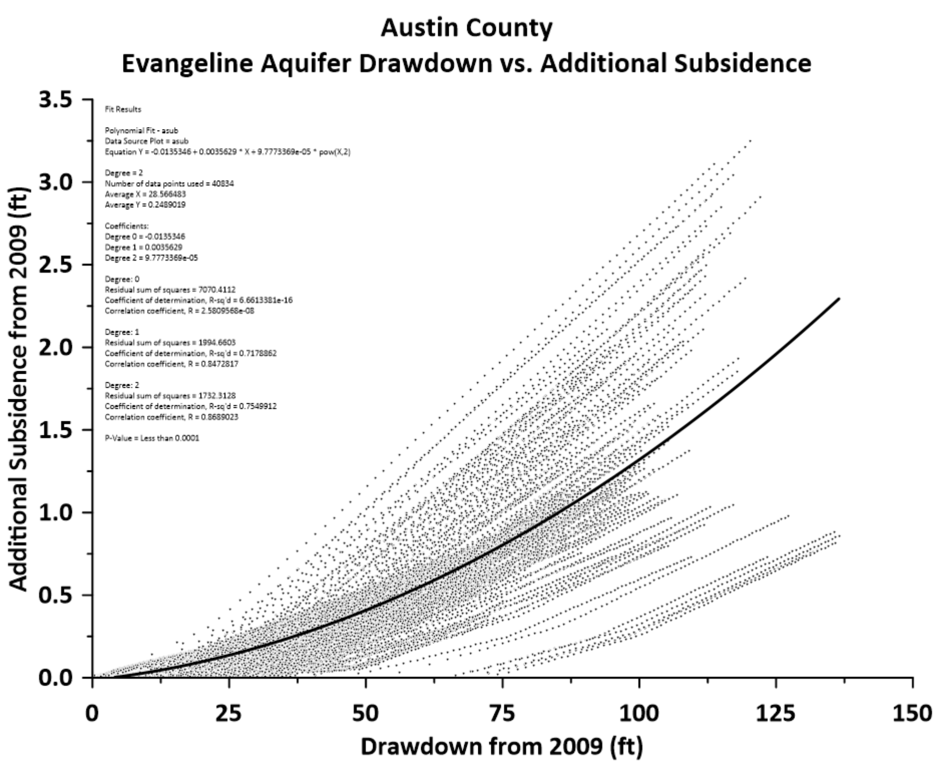


Figure 19. Austin County Drawdown vs. Additional Subsidence - Evangeline Aquifer

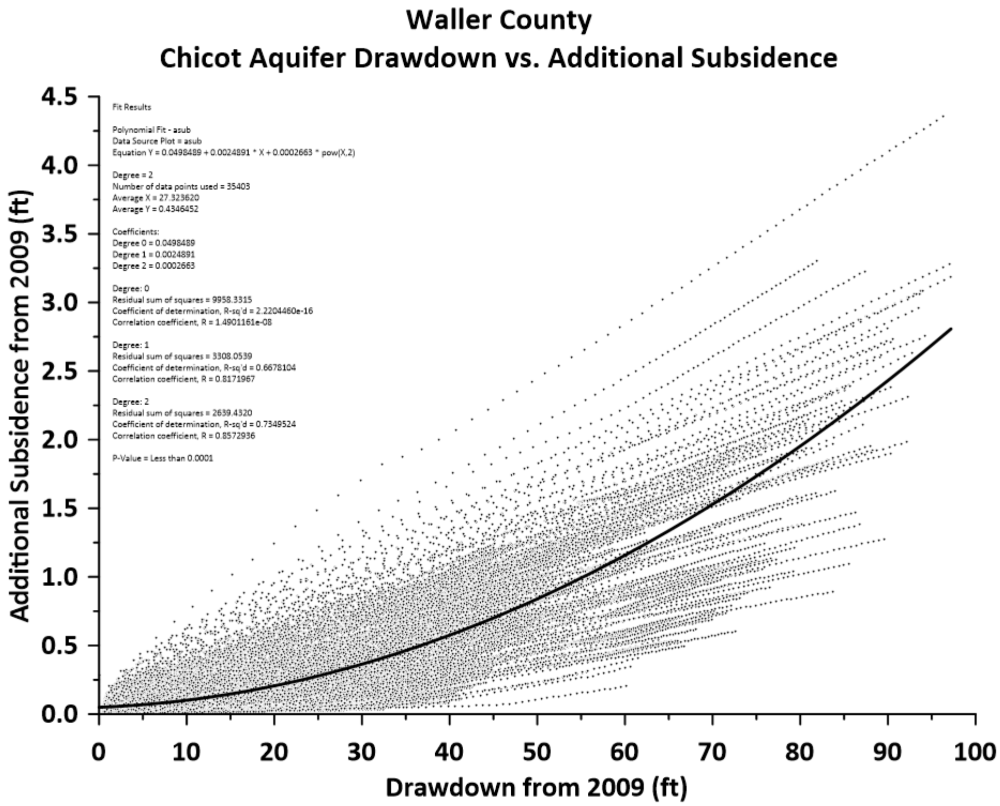


Figure 20. Waller County Drawdown vs. Additional Subsidence - Chicot Aquifer

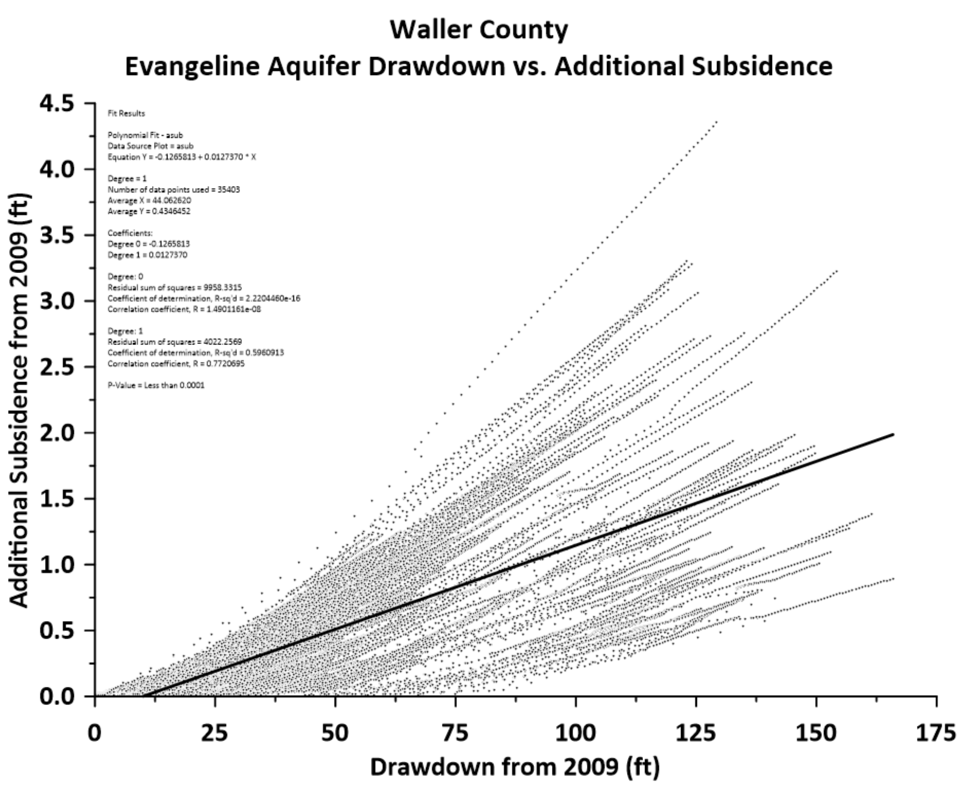


Figure 21. Waller County Drawdown vs. Additional Subsidence - Evangeline Aquifer

The Austin County plots (Figures 18 and 19) show:

- In the most vulnerable places of Austin County, a Chicot Aquifer drawdown of about 25 feet would result in about one foot of additional subsidence, and an Evangeline Aquifer drawdown of about 50 feet would result in about one foot of additional subsidence.
- Based on the best fit line, a Chicot Aquifer drawdown of about 60 feet would result in about one foot of drawdown, and an Evangeline Aquifer drawdown of about 80 feet would result in about one foot of additional subsidence

The Waller County plots (Figures 20 and 21) show:

- In the most vulnerable places of Waller County, a Chicot Aquifer drawdown of about 20 feet would result in about one foot of additional subsidence, and an Evangeline Aquifer drawdown of about 50 feet would result in about one foot of additional subsidence.
- Based on the best fit line, a Chicot Aquifer drawdown of about 60 feet would result in about one foot of additional subsidence, and an Evangeline Aquifer drawdown of about 100 feet would result in about one foot of additional subsidence.

These observations provide some guidance to evaluating future Phase I or Phase II hydrogeologic results for new permit applications. They are not intended to be absolute limits but provide a foundation upon which to review predicted drawdowns in the context of subsidence. Indeed, the need for site-specific data is evident in a groundwater management or regulation context that is quite different than how these results are viewed in a planning context.

7.0 Comparison of Measured and Simulated Drawdowns

Hutchison (2021) completed a comparison of measured drawdown data with simulated drawdown results from the HAGM simulation that was the basis for the 2016 desired future condition. This approach to compare measured drawdown and simulated drawdown on a well-by-well basis has been used over the last several years by Bluebonnet GCD to track desired future condition progress as documented in the management plan. The comparison is also at the foundation of the Phase I hydrogeologic reports required of large well permit applications.

Because the HAGM was calibrated from 1890 to 2009, and the predictive simulations used for joint planning include predictive pumping from 2010 to the end of the simulation, it is possible to complete a comparison of measured drawdown and simulated drawdown from 2010 to 2020 of the simulation covered in this report.

7.1 Measured Drawdowns

Hutchison (2021) documented the process used to process TWDB Groundwater Database groundwater elevations to usable measured drawdowns for all of Groundwater Management Area 14. The resulting file from that process (*agwe2009base.dat*) was used in this effort.

7.2 Post-Processing Simulation Results

HAGM results for simulated drawdown for all cells within the Bluebonnet GCD were extracted from model output using the FORTRAN post-processor *getdd.exe*. Source code for *getdd.exe* is presented in Appendix E. The program:

- Reads the HAGM binary head output file and calculates drawdowns using 2009 as the base year,
- Reads the actual drawdown data from Hutchison (2021) that includes the layer, row, column, and stress period of the actual drawdown,
- Writes the actual drawdown and simulated drawdown for each data point in the actual drawdown file.

The resulting file from the post-processor was imported into Excel and data from the four counties were extracted. The entire output and the data from the four counties were saved in an Excel file named *BluebonnetCompare.xlsx*. One sheet has the results for all of GMA 14, and each county in the Bluebonnet GCD (Austin, Grimes, Walker, and Waller) has an individual sheet.

7.3 Actual Drawdown versus Simulated Drawdown

Figure 22 presents the comparison of actual drawdown and simulated drawdown that is color coded for each county. Please note that the diagonal line represents the one-to-one relationship between actual and simulated drawdown (actual drawdown and simulated drawdown are equal). The vertical line on the right side of the graph represents zero actual drawdown (data points to the right of the line represent negative drawdown, or groundwater level recovery, data points to the left of the line represent positive drawdown, or groundwater level decline).

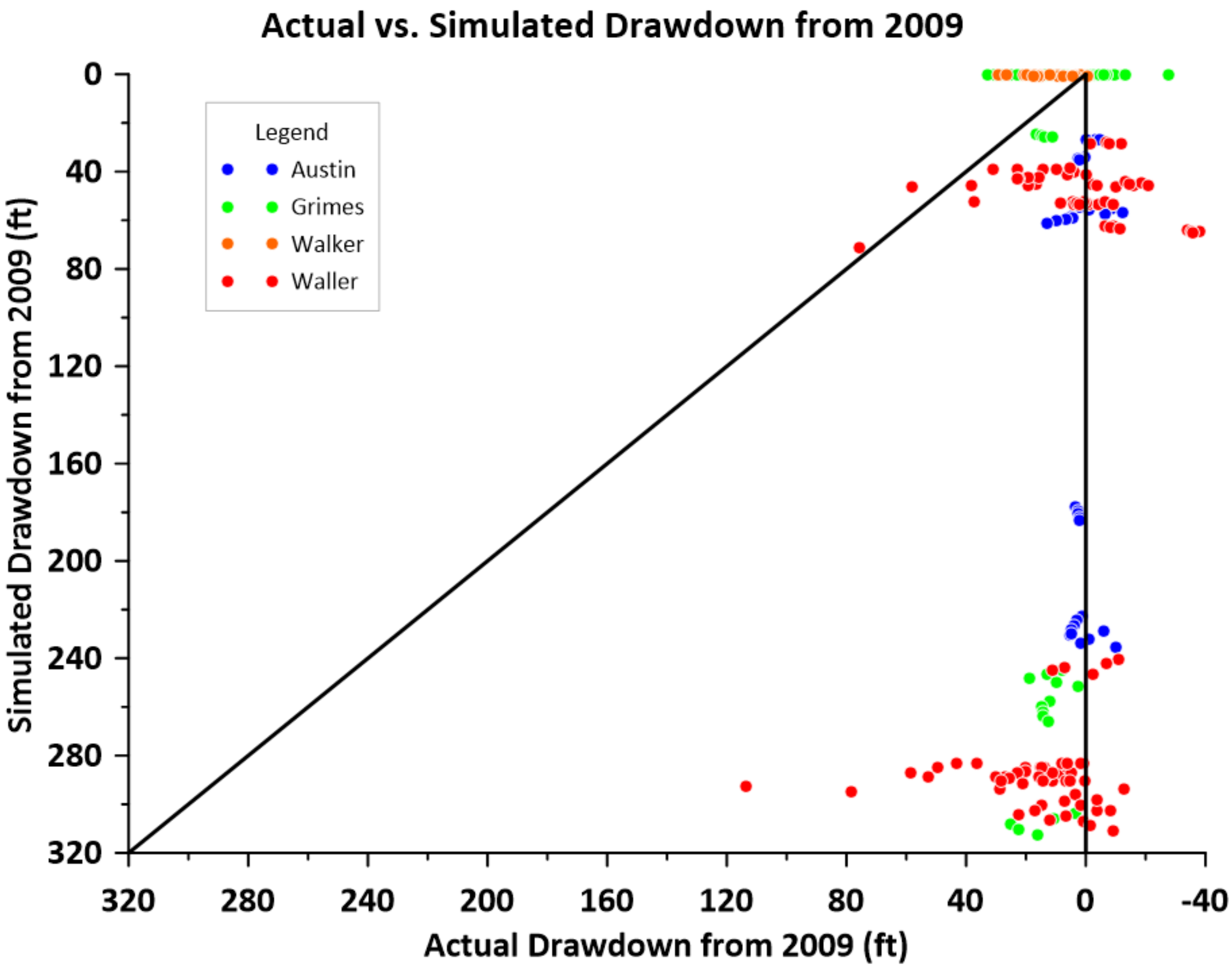


Figure 22. Actual vs. Simulated Drawdown from 2009

Please note that the highest actual drawdown is nearly 120 feet, while there are numerous instances where simulated drawdown is greater than 250 feet. The simulated drawdown values are associated with simulated pumping that is significantly higher than historic pumping, and, as has been discussed, is likely not realistic.

The plot also depicts several data points with simulated drawdown of zero and actual drawdown of between about -40 and 60 feet (the horizontal collection of points at the upper right of the plot). This suggests potential problems with the model predictions in specific parts of Grimes and Walker counties, or an issue with the aquifer designation of the well.

There is a large collection of points near the upper right portion of the graph that show actual drawdowns of between about -40 to 100 feet and simulated drawdowns between about 40 to 80 feet.

Please note that only two points are to the left of or above the diagonal line for points with a non-zero simulated drawdown. For these points, the actual drawdowns are greater than the simulated drawdowns.

Overall, the plot demonstrates the comparison yields the conclusion that actual drawdowns are less than simulated drawdowns. This is due to simulated pumping that is likely higher than actual pumping, and, in some cases, the limitations of the model.

8.0 References

Hutchison, W.R., 2014a. Comparison of Various Input Parameters of the Houston Area Groundwater Model (HAGM) and the Northern Gulf Coast Groundwater Availability Model (GAM) for Austin, Grimes, Walker, and Waller Counties, Texas. Report prepared for Bluebonnet Groundwater Conservation District, Navasota, Texas. January 7, 2014, 46p.

Hutchison, W.R., 2014b. Technical Review of Electro Purification LLC Applications for: 1) Authorization to Drill, Operate, and Aggregate Ten New Wells for Production of Groundwater within the Bluebonnet Groundwater Conservation District, and 2) Out-of-District Transport of Groundwater for Beneficial Uses in Fort Bend County. Report prepared for Bluebonnet Groundwater Conservation District, Navasota, Texas. January 12, 2014, 274p.

Hutchison, W.R., 2021. Comparison of Measured and Simulated Drawdowns in Groundwater Management Area 14. Report prepared for Bluebonnet Groundwater Conservation District, Navasota, Texas. Draft of January 14, 2021, 14p.

Appendix A

Source Code for *getpump.exe*

```
! getpump.exe
!
! read cbb file
! read grid file and list of counties
! sum pumping for each county-aquifer unit
! write summary files
! write summary files for BGCD

! declare arrays

dimension cbb(4,245,137),pump(149,4,137,245)
character*16 text
dimension icolist(20)
character*30 conam(20)
dimension ib(4,137,245),icogrid(137,245),igma(137,245)
dimension sumpump(149,20,5)

! read cbb file

open (1,file='HAGM_BT_base_2080.cbb',form='binary')
open (2,file='cbbheader.dat')

! first steady state stress period

do 100 k=1,7
read (1) kstp,kper,text,ncol,nrow,nlay
write (2,210) kstp,kper,text,ncol,nrow,nlay
210 format (2i10,1x,a16,3i10)
read (1) (((cbb(il,ic,ir),ic=1,245),ir=1,137),il=1,4)
100 continue

! transient stress periods

do 101 isp=2,149
do 102 k=1,8
read (1) kstp,kper,text,ncol,nrow,nlay
write (2,210) kstp,kper,text,ncol,nrow,nlay
read (1) (((cbb(il,ic,ir),ic=1,245),ir=1,137),il=1,4)
if (k.eq.6.and.isp.ge.58) then
do 103 il=1,4
do 104 ir=1,137
do 105 ic=1,245
pump(isp,il,ir,ic)=-cbb(il,ic,ir)*365/43560
105 continue
104 continue
103 continue
```

```
end if
102 continue
101 continue
! read list of counties
open (4,file='gma14counties.csv')
do 400 k=1,20
read (4,*) conam(k),icolist(k)
400 continue
! read grid file
open (5,file='glfc_n_grid_poly082615v2.csv')
read (5,*) text
do 500 k=1,33565
read (5,*) ir,ic,icogrid(ir,ic),(ib(il,ir,ic),il=1,4),igma(ir,ic)
500 continue
! sum pumping by county-aquifer unit
do 600 ir=1,137
do 601 ic=1,245
do 602 ico=1,20
if (icogrid(ir,ic).eq.icolist(ico)) then
do 603 isp=58,149
do 604 il=1,4
sumpump(isp,ico,il)=sumpump(isp,ico,il)+pump(isp,il,ir,ic)
604 continue
603 continue
end if
602 continue
601 continue
600 continue
! sum total pumping in each county
do 700 isp=58,149
do 701 ico=1,20
sumpump(isp,ico,5)=sumpump(isp,ico,1)+sumpump(isp,ico,2)+sumpump(isp,ico,3)+su
mpump(isp,ico,4)
701 continue
700 continue
! write annual pumping results
```

```
open (11,file='annpumpchicot.dat')
open (12,file='annpumpevan.dat')
open (13,file='annpumpburke.dat')
open (14,file='annpumpjasper.dat')
open (15,file='annpumptotal.dat')
open (16,file='annaustin.dat')
open (17,file='anngrimes.dat')
open (18,file='annwalker.dat')
open (19,file='annwaller.dat')
do 800 isp=58,149
iyr=isp+1931
write (11,810) isp,iyr,(sumpump(isp,ico,1),ico=1,20)
write (12,810) isp,iyr,(sumpump(isp,ico,2),ico=1,20)
write (13,810) isp,iyr,(sumpump(isp,ico,3),ico=1,20)
write (14,810) isp,iyr,(sumpump(isp,ico,4),ico=1,20)
write (15,810) isp,iyr,(sumpump(isp,ico,5),ico=1,20)
write (16,811) isp,iyr,(sumpump(isp,1,il),il=1,5)
write (17,811) isp,iyr,(sumpump(isp,6,il),il=1,5)
write (18,811) isp,iyr,(sumpump(isp,18,il),il=1,5)
write (19,811) isp,iyr,(sumpump(isp,19,il),il=1,5)
810 format (2i10,20f10.0)
811 format (2i10,5f10.0)
800 continue

! write decadal pumping results by county

open (21,file='MAGChicot.dat')
open (22,file='MAGEvangeline.dat')
open (23,file='MAGBurkeville.dat')
open (24,file='MAGJasper.dat')
do 900 ico=1,20
write (21,910) conam(ico),(sumpump(isp,ico,1),isp=79,149,10)
write (22,910) conam(ico),(sumpump(isp,ico,2),isp=79,149,10)
write (23,910) conam(ico),(sumpump(isp,ico,3),isp=79,149,10)
write (24,910) conam(ico),(sumpump(isp,ico,4),isp=79,149,10)
910 format (a16,1x,8f10.0)
900 continue


stop
end
```

Appendix B

Source Code for *getavgdd.exe*

```
!  getavgdd.exe
!
!  read gam dates for each stress period
!  read list of GMA 14 counties
!  read GAM grid file
!  count cells in each county-aquifer unit
!  read simulated head file
!  calculate and sum drawdowns
!  read list of county file names
!  write annual drawdowns for each county
!  write summaries of final drawdowns

! declare arrays

character*4 TEXT
dimension ib(4,137,245),hds(149,4,245,137)
dimension xc(137,245),yc(137,245)
dimension TEXT(4)
character*30 text2
dimension icogrid(137,245),igma(137,245),icolist(20),cocount(5,20)
character*16 conam(20)
character*60 fn(21)
dimension sumdd(149,5,21),avgdd(149,5,21),spdate(149)

! initialize arrays

do 11 isp=1,149
do 12 il=1,5
do 13 icnty=1,21
sumdd(isp,il,icnty)=0
avgdd(isp,il,icnty)=0
13 continue
12 continue
11 continue

!  read dates for each stress period

open (1,file='gamspdates.dat')
do 100 isp=1,149
read (1,*) spdate(isp),x1
100 continue

! read list of counties and codes

open (2,file='gma14counties.csv')
do 200 k=1,20
```

```
read (2,*) conam(k),icolist(k)
200 continue

! read GAM grid

open (3,file='glfc_n_grid_poly082615v2.csv')
read (3,*) text
do 300 k=1,33565
read (3,*) ir,ic,icogrid(ir,ic),(ib(il,ir,ic),il=1,4),igma(ir,ic)
300 continue

!  count cells

do 400 il=1,4
do 401 ir=1,137
do 402 ic=1,245
do 403 icnty=1,20
if (icogrid(ir,ic).eq.icolist(icnty).and.igma(ir,ic).eq.14) then
if (ib(il,ir,ic).ne.0) cocount(il,icnty)=cocount(il,icnty)+1
end if
403 continue
402 continue
401 continue
400 continue

! sum layer count to overall county count

do 410 icnty=1,20
cocount(5,icnty)=cocount(1,icnty)+cocount(2,icnty)+cocount(3,icnty)+cocount(4,icnty)
410 continue

! write county count output

open (4,file='countycount.dat')
do 420 icnty=1,20
write (4,430) conam(icnty),(cocount(il,icnty),il=1,5)
430 format (a16,4x,5f10.0)
420 continue

! read hds file

open (6,file='header.dat')
OPEN(5,FILE='HAGM_BT_base_2080.hds',FORM='binary')

500 read(5,end=599) KSTP,KPER,PERTIM,TOTIM,TEXT,NCOL,NROW,IL
write (6,510) k,KSTP,KPER,PERTIM,TOTIM,TEXT,NCOL,NROW,IL
```

```
510 format (3i10,2f15.2,4a4,3i10)
read(5) ((hds(kper,il,IC,IR),IC=1,NCOL),IR=1,NROW)
goto 500
599 continue
! calculate drawdown
do 600 isp=1,149
do 601 il=1,4
do 602 ir=1,137
do 603 ic=1,245
if (ib(il,ir,ic).ne.0) then
dd=hds(78,il,ic,ir)-hds(isp,il,ic,ir)
do 604 icnty=1,20
if (icogrid(ir,ic).eq.icolist(icnty).and.igma(ir,ic).eq.14) then
sumdd(isp,il,icnty)=sumdd(isp,il,icnty)+dd
end if
604 continue
end if
603 continue
602 continue
601 continue
600 continue
! sum drawdowns
do 610 isp=1,149
do 611 il=1,4
do 612 icnty=1,20
sumdd(isp,5,icnty)=sumdd(isp,1,icnty)+sumdd(isp,2,icnty)+sumdd(isp,3,icnty)+sumdd(is
p,4,icnty)
612 continue
611 continue
610 continue
! calculate average drawdowns
do 700 isp=1,149
do 701 il=1,5
do 702 icnty=1,20
if (cocount(il,icnty).gt.0) then
avgdd(isp,il,icnty)=sumdd(isp,il,icnty)/cocount(il,icnty)
else
avgdd(isp,il,icnty)=-9999
```

```
end if
702 continue
701 continue
700 continue

!  write annual county drawdowns

open (8,file='countyfn.dat')
do 801 icnty=1,20
read (8,*) fn(icnty)
open (11,file=fn(icnty))
do 802 isp=1,149
write (11,810) conam(icnty),isp,spdate(isp),(avgdd(isp,il,icnty),il=1,5)
802 continue
810 format (a16,4x,i10,6f10.2)
close (11)
801 continue

!  write drawdown summaries

open (31,'DFCsummary.dat')
open (32,file='Chicot.dat')
open (33,file='Evangeline.dat')
open (34,file='Burkeville.dat')
open (35,file='Jasper.dat')
do 900 icnty=1,20
write (31,910) conam(icnty),(avgdd(149,il,icnty),il=1,4)
910 format (a16,1x,4f10.0)
write (32,911) conam(icnty),avgdd(149,1,icnty)
write (33,911) conam(icnty),avgdd(149,2,icnty)
write (34,911) conam(icnty),avgdd(149,3,icnty)
write (35,911) conam(icnty),avgdd(149,4,icnty)
911 format (a16,1x,f10.2)
900 continue

stop
end
```

Appendix C

Source Code for *getsub.exe*

```
! getsub.exe
!
! read gam dates/sp
! read list of counties and grid file
! count cells in each county
! read subsidence output
! write output files

! declare arrays

character*4 TEXT
dimension ib(4,137,245),sub(149,245,137)
dimension TEXT(4)
character*30 text2
dimension icogrid(137,245),igma(137,245),icolist(20),cocount(5,20)
character*16 conam(20)
character*60 fn(21)
dimension
sumsub(149,20),avgsub(149,20),spdate(149),xmaxsub(149,20),cosubcount(149,20)

! initialize subsidence variables

do 11 isp=1,149
do 13 icnty=1,21
sumsub(isp,icnty)=0
xmaxsub(isp,icnty)=0
13 continue
12 continue
11 continue

! read gam sp dates

open (1,file='gamspdates.dat')
do 100 isp=1,149
read (1,*) spdate(isp),x1
100 continue

! read list of counties

open (2,file='gma14counties.csv')
do 200 k=1,20
read (2,*) conam(k),icolist(k)
200 continue

! read gam grid file

```

```
open (3,file='glfc_n_grid_poly082615v2.csv')
read (3,*) text
do 300 k=1,33565
read (3,*) ir,ic,icogrid(ir,ic),(ib(il,ir,ic),il=1,4),igma(ir,ic)
300 continue
! count cells in each county
do 400 il=1,4
do 401 ir=1,137
do 402 ic=1,245
do 403 icnty=1,20
if (icogrid(ir,ic).eq.icolist(icnty).and.igma(ir,ic).eq.14) then
if (ib(il,ir,ic).ne.0) cocount(il,icnty)=cocount(il,icnty)+1
end if
403 continue
402 continue
401 continue
400 continue
do 410 icnty=1,20
cocount(5,icnty)=cocount(1,icnty)+cocount(2,icnty)+cocount(3,icnty)+cocount(4,icnty)
410 continue
! write county count results
open (4,file='countycount.dat')
do 420 icnty=1,20
write (4,430) conam(icnty),(cocount(il,icnty),il=1,5)
430 format (a16,4x,5f10.0)
420 continue
! read subsidence output file
open (6,file='header.dat')
OPEN(5,FILE='HAGM_BT_base_subsidence_2080.hds',FORM='binary')
500 read(5,end=599) KSTP,KPER,PERTIM,TOTIM,TEXT,NCOL,NROW,IL
write (6,510) iscen,k,KSTP,KPER,PERTIM,TOTIM,TEXT,NCOL,NROW,IL
510 format (4i10,2f15.2,4a4,3i10)
read(5) ((sub(kper,IC,IR),IC=1,NCOL),IR=1,NROW)
goto 500
599 continue
! sum subsidence results for each county and find max subsidence
do 601 isp=1,149
```

```
do 602 ir=1,137
do 603 ic=1,245

do 604 il=1,4
if (ib(il,ir,ic).ne.0) icheck=icheck+1
604 continue

if (icheck.gt.0) then
do 605 icnty=1,20
if (icogrid(ir,ic).eq.icolist(icnty).and.igma(ir,ic).eq.14) then
xmaxsub(isp,icnty)=max(xmaxsub(isp,icnty),sub(isp,ic,ir))
sumsub(isp,icnty)=sumsub(isp,icnty)+sub(isp,ic,ir)
cosubcount(isp,icnty)=cosubcount(isp,icnty)+1
end if
605 continue
end if

icheck=0
603 continue
602 continue
601 continue

! calculate average subsidence

do 701 isp=1,149
do 702 icnty=1,20
if (cosubcount(isp,icnty).gt.0) then
avgsub(isp,icnty)=sumsub(isp,icnty)/cosubcount(isp,icnty)
else
avgsub(isp,icnty)=-9999
end if
702 continue
701 continue

! read county file names and write county output

open (8,file='countyfn.dat')
do 801 icnty=1,20
read (8,*) fn(icnty)
open (11,file=fn(icnty))
do 802 isp=1,149
write (11,810) conam(icnty),isp,spdate(isp),avgsub(isp,icnty),xmaxsub(isp,icnty)
802 continue
810 format (a16,4x,i10,3f10.2)
close (11)
801 continue
```

```
! write 2080 subsidence results

open (31,file='sub2080.dat')
do 900 icnty=1,20
avg1=avgsub(149,icnty)
avg2=avgsub(149,icnty)-avgsub(78,icnty)
xmax1=xmaxsub(149,icnty)
xmax2=xmaxsub(149,icnty)-xmaxsub(78,icnty)
write (31,910) conam(icnty),avg1,avg2,xmax1,xmax2
910 format (a16,1x,4f10.2)
900 continue


stop
end
```

Appendix D

Source Code for *ddsub.exe*

```
! ddsub.exe

! reads GAM grid file
! reads hds file and calculates dd
! reads sub file
! writes cell by cell dd and "additional" subsidence output for BGCD cells

! declare arrays

character*4 TEXT
dimension ib(4,137,245),hds(149,4,245,137),dd(149,4,245,137),sub(149,245,137)
dimension xc(137,245),yc(137,245)
dimension TEXT(4)
character*30 text2
dimension icogrid(137,245),igma(137,245),icolist(20),cocount(5,20)

! read gam grid file

open (2,file='glfc_n_grid_poly082615v2.csv')
read (2,*) text
do 200 k=1,33565
read (2,*) ir,ic,icogrid(ir,ic),(ib(il,ir,ic),il=1,4),igma(ir,ic)
200 continue

! read hds file

open (4,file='headerhds.dat')
OPEN(3,FILE='HAGM_BT_base_2080.hds',FORM='binary')

300 read(3,end=399) KSTP,KPER,PERTIM,TOTIM,TEXT,NCOL,NROW,IL
write (4,310) k,KSTP,KPER,PERTIM,TOTIM,TEXT,NCOL,NROW,IL
310 format (3i10,2f15.2,4a4,3i10)
read(3) ((hds(kper,il,IC,IR),IC=1,NCOL),IR=1,NROW)
goto 300
399 continue

! calculate drawdown

do 400 isp=1,149
do 401 il=1,4
do 402 ir=1,137
do 403 ic=1,245
if (ib(il,ir,ic).ne.0) then
dd(isp,il,ic,ir)=hds(78,il,ic,ir)-hds(isp,il,ic,ir)
if (ib(il,ir,ic).eq.0) dd(isp,il,ic,ir)=-9999
end if
```

```
403 continue
402 continue
401 continue
400 continue

! read subsidence output file

open (6,file='header.dat')
OPEN(5,FILE='HAGM_BT_base_subsidence_2080.hds',FORM='binary')
500 read(5,end=599) KSTP,KPER,PERTIM,TOTIM,TEXT,NCOL,NROW,IL
write (6,510) k,KSTP,KPER,PERTIM,TOTIM,TEXT,NCOL,NROW,IL
510 format (3i10,2f15.2,4a4,3i10)
read(5) ((sub(kper,IC,IR),IC=1,NCOL),IR=1,NROW)
goto 500
599 continue

! BGCD dd and sub results (cell by cell)

open (7,file='BGCDddsub.dat')
open (11,file='Austinddsub.dat')
open (12,file='Grimesddsub.dat')
open (13,file='Walkerddsub.dat')
open (14,file='Wallerddsub.dat')
do 700 ir=1,137
do 701 ic=1,245
do 702 isp=79,149
asub=sub(isp,ic,ir)-sub(78,ic,ir)
if (asub.gt.0.01) then
j0=icogrid(ir,ic)
j1=8
j2=93
j3=236
j4=237
if (j0.eq.j1.or.j0.eq.j2.or.j0.eq.j3.or.j0.eq.j4) then
write (7,710) isp,ir,ic,j0,asub,(dd(isp,il,ic,ir),il=1,4)
if (j0.eq.j1) write (11,710) isp,ir,ic,j0,asub,(dd(isp,il,ic,ir),il=1,4)
if (j0.eq.j2) write (12,710) isp,ir,ic,j0,asub,(dd(isp,il,ic,ir),il=1,4)
if (j0.eq.j3) write (13,710) isp,ir,ic,j0,asub,(dd(isp,il,ic,ir),il=1,4)
if (j0.eq.j4) write (14,710) isp,ir,ic,j0,asub,(dd(isp,il,ic,ir),il=1,4)
710 format (4i10,f12.4,4f10.2)
end if
end if
702 continue
701 continue
700 continue
```

```
stop
end
```

Appendix E

Source Code for *getdd.exe*

```
! getdd.exe
!
! read 2021 DFC hds file (70,1,30K,RunD)
! calculate drawdown
! read actual data file
! write actual and simulated drawdown

! declare arrays

character*4 text
dimension text(4)
dimension hds(149,4,245,137),dd(2010:2020,4,245,137)
character*30 county

! read hds file

open (1,file='HAGM_BT_base_2080.hds',form='binary')
open (2,file='header.dat')
100 read (1,end=199) kstp,kper,pertim,totim,text,ncol,nrow,il
write (2,210) k,kstp,kper,pertim,totim,text,ncol,nrow,il
210 format (3i10,2f15.2,4a4,3i10)
read (1) ((hds(kper,il,ic,ir),ic=1,ncol),ir=1,nrow)
goto 100
199 continue

! calculate drawdowns

do 200 kper=79,149
do 201 il=1,4
do 202 ir=1,137
do 203 ic=1,245
iyr=kper+1931
dd(iyr,il,ic,ir)=hds(78,il,ic,ir)-hds(kper,il,ic,ir)
203 continue
202 continue
201 continue
200 continue

! read actual data
! write actual and simulated drawdowns

open (3,file='agwe2009base.dat')
open (4,file='actsimdd2009base.dat')

do 300 k=1,5975
read (3,*) i1,iwn,il,ir,ic,iyr,basegwe,actgwe,actdd,county
```

```
write (4,410) iwn,il,ir,ic,iyr,actdd,dd(iyr,il,ic,ir),county
410 format (5i10,2f10.2,2x,a20)
300 continue

stop
end
```

Proposed Implementation of GMA 14 Desired Future Condition for Bluebonnet GCD

Bill Hutchison, Ph.D., P.E., P.G.

BGCD Board Meeting

May 26, 2021

BLUEBONNET
Groundwater Conservation District

Topics

- Brief Overview of Joint Planning Process
- Summary of GMA 14 process to date
- Proposed DFC from GMA 14 meeting of April 9, 2021
- Proposed Implementation of DFC for Bluebonnet GCD
- Background on LSGCD Issues
  - Pumping
  - Subsidence

DFCs and MAGs

- Desired Future Condition (DFC)
  - Set by districts in GMA after formal process
  - Mainly a policy goal
- Modeled Available Groundwater (MAG)
  - Pumping that will achieve DFC
  - Calculated by TWDB

Overview of Joint Planning Process

- GMA 14 considers 9 factors and applies balancing test
  - Propose DFCs for adoption
- 90-day public comment period and at least one public hearing in each GCD
  - Each GCD compiles a summary of relevant comment, suggested revisions, and basis for revisions
- Final adoption of DFCs by GMA 14
  - After GMA 14 considers suggested revisions in district summary reports
- Each GCD adopts DFCs applicable to the GCD as defined in the resolution and explanatory report

GMA 14 Process

- Joint Planning is on roughly 5-year cycles
  - First round (2010)
  - Second round (2016)
  - Third round (2021)
- Summary timeline for discussions during third round in GMA 14 meetings:
  - 2016 to 2018: issues related to LSGCD petition from second round
  - 2019 to 2020: consideration of factors and balancing (work led and facilitated by GMA 14 consultant)
  - Early 2021: final work associated with proposing a DFC

Background Timeline – 2016

- April 29, 2016 – GMA 14 approved DFCs
- August 9, 2016 – Lone Star GCD approved DFCs
- December 2, 2016 – Cities of Conroe and Magnolia filed a petition with Lone Star GCD appealing the reasonableness of the DFCs
- December 6, 2016 – Quadvest LP filed a petition with Lone Star GCD appealing the reasonableness of the DFCs
- December 15, 2016 – TWDB issued MAG report (GAM Run 16-024 MAG)

Background Timeline – 2017

- October 10, 2017 – Lone Star GCD changed its policy goals
  - "move away from sustainability"
  - Adopted a management policy that "allows measured aquifer level declines"
- November 6, 2017 – Lone Star GCD and cities of Conroe and Magnolia approved settlement agreement regarding petition
  - Quadvest LP did not dispute settlement
- December 8, 2017 – GMA 14 meeting
  - November 20, 2017 - letter from Lone Star GCD requesting formal consideration of "new or amended" DFC
    - "Run D of Task 3 of the Lone Star GCD Strategic Water Resources Planning Study"
  - GMA 14 voted to consider Run D as part of "3rd round" of Joint Planning

Background Timeline – March 2018

- March 9, 2018 - letter from Lone Star GCD requesting formal consideration of proposal discussed GMA 14 meeting of December 8, 2017 "only as an amendment" to previously adopted DFC
  - Request made due to concerns raised by plaintiffs in petition appeal
- March 21, 2018 - BGCD completed a report that documented complete pumping, drawdown and subsidence results ("Run D" documentation provided by LSGCD presented selected results)
- March 27, 2018 – GMA 14 Meeting
  - Motion to approve formal consideration of Run D as an amended DFC on an accelerated schedule defeated (Vote: 2 for, 3 against)
  - Affirmed a vote taken at the GMA 14 meeting of December 8, 2017
    - Consider Run D as part of "3rd round" of Joint Planning (proposed DFC deadline is May 1, 2021)

Background Timeline – April 2018

- Continued discussion regarding possible adoption of Run D in Montgomery County and no other counties need to change their 2016 DFCs
- BGCD completed seven simulations of model (about 3,500 runs of the model)
  - Report delivered to GMA 14 on April 16, 2018
  - Not feasible to simply assign drawdown from one scenario (i.e. Run D) for one county and assign drawdowns for other counties based on another scenario (i.e. 2016 DFC simulation)
  - Run D is characterized by large increases in Jasper Aquifer pumping in Montgomery County and reduced pumping in Jasper Aquifer in other counties
    - Reduces predicted subsidence due to model limitations
- GMA 14 meeting of April 26, 2018
  - Action: information and analyses from BGCD will be provided to GMA 14 consultant to put Run D into context in joint planning process

Background Timeline – 2019 to 2020

- GMA 14 consultant led and facilitated discussion of nine statutory factors and balancing test
- Discussion focused on developing a remedy to problem identified in 2016 DFC petition by using a "common reservoir approach"
- Consultant's "balancing simulations" also addressed criticisms of "reverse engineering"
- These issues (and more) to be covered in Explanatory Report (required by statute)

LSGCD Run D (2019 and 2020)

- Focus of discussion in 2017 and 2018 due to settlement of LSGCD litigation
- March 27, 2019 - GMA 14 meeting - LSGCD moved to formally withdraw Run D
  - GMA 14 voted unanimously in support of motion
- April 29, 2020 - GMA 14 meeting – Run D was reintroduced as one of three alternative scenarios to develop DFCs by LSGCD

Background Timeline – Early 2021

- BGCD completed comparison of actual drawdowns and simulated drawdowns under current DFC
  - Results show actual drawdowns less than simulated drawdowns (consistent with DFCs)
  - Discussed GMA 14 meeting of January 20, 2021
- GMA 14 discussion led to proposed DFC on April 9, 2021 (January 20^{th}, February 24^{th})
  - Simple statement (no detailed resolution)
  - No draft explanatory report
- Triggers 90-day public comment period
  - Public hearing held at each GCD

Objectives of Today's Presentation

- Provide some background and context of the proposed DFC
  - No detailed resolution
  - No draft explanatory report
- Provide a proposed and recommended approach to implementing at the BGCD level
  - Approach is different than 2010 and 2016 due to common reservoir approach in this round of joint planning
  - No action today (mid 2022)

Proposed DFC

- At GMA 14 meeting of April 9, 2021:
  - ***In each county in GMA 14, no less than 70 percent median available drawdown remaining in 2080 and no more than an average of 1.0 additional foot of subsidence between 2009 and 2080.***

Model Simulations

- Groundwater Availability Model (GAM) of the Northern Portion of the Gulf Coast Aquifer approved by the Texas Water Development Board
  - Houston Area Groundwater Model (HAGM) developed by USGS for the subsidence districts and LSGCD in 2013
  - Approved in 2013 by TWDB despite comments by BGCD and others highlighting the problems and limitations of the model
- GMA 14 consultant ran numerous scenarios
  - LSGCD consultants also ran numerous scenarios
- Model results discussed at GMA 14 meetings

Proposed DFC and GAM Simulation

- Common reservoir approach
- Multi-metric simulation
  - 70 percent median available drawdown remaining in 2080 (using 2009 as a base condition)
  - No more than 1 ft additional subsidence in 2080 (using 2009 as a base condition)
  - Pumping in a county is no more than 30,000 AF above the maximum projected water demand between 2020 and 2070 as defined in the current state water plan
  - The initial pumping distribution was taken from the 2016 modeled available groundwater simulation of the HAGM for the second round of desired future conditions

Proposed Implementation of DFC in Bluebonnet GCD

- DFC is expressed as a GMA 14-wide statement
- Statute requires BGCD to:
  - Adopt the DFCs applicable to the district as defined in the resolution and explanatory report (likely in mid-2022)
  - District's management plan include a management goal that addresses the DFC adopted by the district
    - Texas Administrative Code requires that the management objective be specific and time-based statements of future outcomes that are linked to the management goal

Proposed BGCD Approach

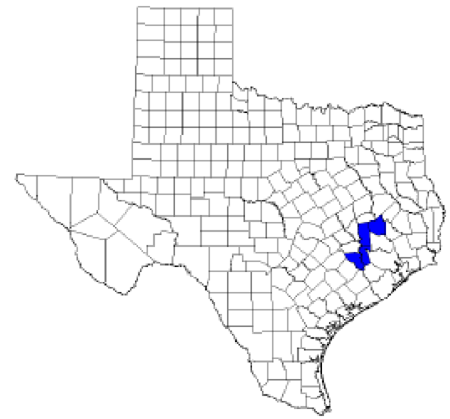
- Take single GMA 14-wide DFC statement
- Quantify it for use as a management goal and objective for BGCD management plan
- HAGM simulation that was the basis for DFC provides:
  - BGCD-specific drawdown and subsidence information
  - Future pumping (not specifically relevant for purposes of management activities, but useful information)
- BGCD-specific results form the basis for BGCD-specific DFC

Proposed BGCD Approach

- Report details proposed approach

Final Report

Implementation of GMA 14 Desired Future Condition
Based on Multi-Metric Simulation
(70% Available Drawdown, 1 Foot of Subsidence, 30K Pumping Limit, 2016 Pumping Distribution)



Prepared for:
Zach Holland
General Manager
Bluebonnet Groundwater Conservation District
P.O. Box 269
Navasota, TX 77868-0269

Prepared by:
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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Summary of Proposed DFC

- HAGM simulation "adjusts" pumping input to achieve all metrics specified in DFC statement
  - Drawdown
  - Subsidence
  - Pumping adjustment capped by 30K constraint
- Proposed DFC expresses GMA-wide condition of aquifer under these constraints
- Results of simulation are used to define BGCD conditions for use in management and regulation

Three Functions of a GCD

- Planning
  - DFCs (Joint Planning)
- Management
  - Goals and Objectives (Management Plan)
- Regulation
  - Implementation and Achievement of Management (Rules)

Summary of BGCD-Specific DFCs

- Higher average drawdown (compared with 2016 DFC)
- Due to higher pumping (compared with 2016 MAG)
  - 2009 Historic BGCD Pumping = 43,678 AF/yr
  - Current MAG (2010 to 2070) = 92,918 AF/yr
  - Expected MAG (2010 to 2080) = 195,898 AF/yr
  - Expected MAG Increase = 102,980 AF/yr

Recommended BGCD-Specific DFCs

County	Aquifer	Recommended BGCD-Specific Desired Future Conditions		Expected Modeled Available Groundwater (Pumping in AF/yr from 2010 to 2080)
		Average Drawdown in ft from 2009 to 2080	Maximum Subsidence in ft from 1890 to 2080	
Austin	Chicot	54	3.39	2,892
	Evangeline	38		41,706
	Burkeville	39		0
	Jasper	165		1,971
Grimes	Chicot	35	0.25	0
	Evangeline	26		15,907
	Burkeville	26		0
	Jasper	147		35,546
Walker	Chicot	1	0.17	0
	Evangeline	16		3,141
	Burkeville	7		0
	Jasper	96		39,279
Waller	Chicot	50	5.39	791
	Evangeline	59		54,336
	Burkeville	60		0
	Jasper	218		329

Application of DFC to BGCD

- Multi-metric HAGM simulation constraints:
  - Median available drawdown remaining
  - Average additional subsidence
  - Limited pumping increase
  - Specification of initial pumping distribution
- Recommended BGCD DFC:
  - Average drawdown by county-aquifer unit
  - Maximum total subsidence
- Report details:
  - Bridging the transition from planning to management specific to BGCD using simulation results
  - Bridging the transition from management to regulation (Phase 1 and Phase 2 reports)

LSGCD Issues - Pumping

- Historically, LSGCD advocated a “reverse-engineering” approach to setting DFCs
  - In 2009-10, started with a MAG of 64,000 AF/yr
    - Ran model to find drawdown associated with that pumping
  - For 2016, no update to approach (new model, single run)
    - Criticized in 2016 petition
- New model simulations by new GMA 14 consultant corrected that problem
- However, focus is still (incorrectly) on MAG
  - LSGCD and public comments

Montgomery County MAG/Pumping

Scenario	**Pumping (AF/yr)**
2010 and 2016 MAG	64,005
Reported Run D (input files)	100,000
Actual Run D (output files)	89,206
Proposed DFC Model Run	97,102
DFC Model Run using Run D Distribution	115,673

LSGCD Issues - Subsidence

- LSGCD opposed to any mention of subsidence in DFC statement
  - LSGCD proposed resolution language - GMA 14 meeting of April 9, 2021
  - Motions to adopt LSGCD resolution and language were defeated
- Final resolution to be adopted later this year with full DFC adoption (opportunity to address)
  - Deadline is January 5, 2022
- GCD must adopt DFCs applicable to the district as defined in the resolution and explanatory report
  - LSGCD's decision on how to "adopt DFCs applicable to the district"

Questions and Discussion

Bill Hutchison, Ph.D., P.E., P.G.

billhutch@texasgw.com

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