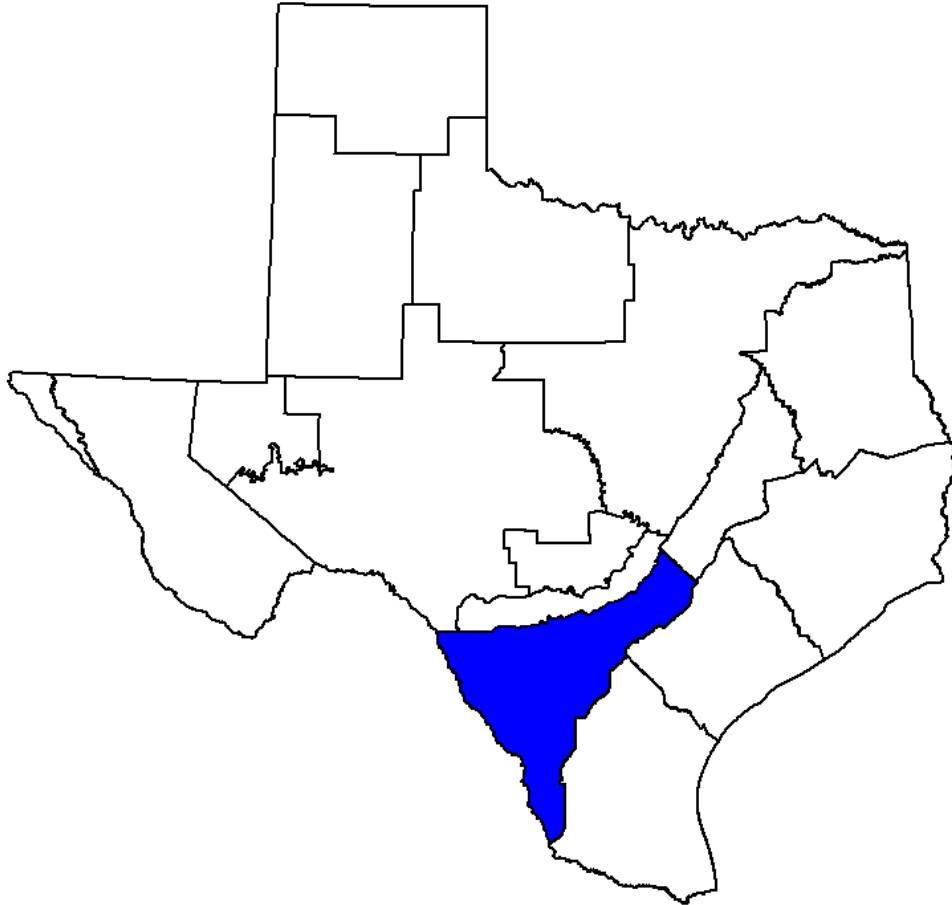


**GMA 13 Model Simulation Documentation:
Wintergarden GCD Scenario**



Prepared for:
Groundwater Management Area 13

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March 2, 2026

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Professional Engineer and Professional Geoscientist Seals

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Draft Report for Review – To be Stamped when Finalized

1.0 Introduction

1.1 Wintergarden GCD Request

In response to the request made at the GMA 13 meeting of February 13, 2026, Wintergarden Groundwater Conservation District (Wintergarden GCD or WGCD) provided input on further adjustments to pumping to complete an updated simulation for the joint planning process. This request was transmitted by email dated February 26, 2026.

The email referenced one of the slides in the PowerPoint presentation that was given at the GMA 13 meeting of February 13, 2026. That slide (Slide 127) is reproduced below as Table 1. The highlighted cells are unchanged from the presentation to draw attention to specific Carrizo-Wilcox Aquifer pumping assumptions that were made for the “MAG Simulation” that needed additional review and input from the GCDs.

Table 1. Factors Applied to Initial "MAG Simulation"

County	Carrizo-Wilcox Aquifer				
	2017 Pumping (AF/yr)	MAG (AF/yr)	Actual Factor	Factor Used in Simulation	Input Pumping for Simulation (AF/yr)
Atascosa	42,694	59,982	1.40	1.40	59,982
Bexar	16,837	70,145	4.17	4.17	70,145
Caldwell	3,247	49,635	15.29	15.29	49,635
Dimmit	59,089	3,895	0.07	1.30	76,816
Frio	100,729	114,827	1.14	1.14	114,827
Gonzales	54,279	103,707	1.91	1.91	103,707
Guadalupe	7,603	55,637	7.32	7.32	55,637
Karnes	416	1,043	2.51	2.51	1,043
LaSalle	25,704	6,554	0.25	1.30	33,415
Maverick	1,682	547	0.33	1.30	2,187
McMullen	4,639	7,789	1.68	1.68	7,789
Medina	3,637	2,635	0.72	0.72	2,635
Uvalde	123	0	0.00	1.00	123
Webb	6,380	912	0.14	6.17	39,380
Wilson	24,985	125,670	5.03	5.03	125,670
Zavala	46,692	38,303	0.82	1.30	60,700

The pumping is organized by county. The 2017 pumping represents the Carrizo-Wilcox Aquifer pumping in the last year of the calibration period. This pumping was used in the baseline scenario discussed at the February 13, 2026 GMA 13 meeting.

The MAG column is the maximum MAG value that appears in the 2022 TWDB MAG report from the last round of joint planning. These values were provided by TWDB by decade (from 2020 to

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2080) and varied in each county (some counties had values that increased, some counties had values that decreased, some counties had both increases and decreases through the period). The value in Table 1 is the maximum of the decadal MAG value.

The “Actual Factor” column is simply the MAG column divided by the baseline column. An “actual Factor” less than 1.0 means that, that the maximum MAG from the last round of joint planning is less than the 2017 pumping. In a simulation, if pumping is set to a value less than the 2017 pumping, groundwater levels would be expected to rise, and based on the model output, it would signal that a GCD would be obligated to implement pumping curtailments in order to meet the DFC. WGCD specially requested that these “Actual Factors” be used in the next GMA 13 Model simulation for Dimmit, LaSalle, Webb, and Zavala counties, effectively meaning that WGCD wanted to keep its existing MAGs.

The column labeled “Factor Used in Simulation” represents the multiplier that was applied to the 2017 pumping for the “MAG Simulation” discussed at the February 13, 2026 GMA 13 meeting. The result is in the column “Input Pumping for Simulation” for the “MAG Simulation”. Specifically, the “MAG Simulation” was focused on adjusting pumping to levels that were at least slightly above the 2017 pumping. It can be seen that several counties already had a MAG that was much higher than the 2017 pumping in order to accommodate expected increases in pumping.

1.2 Discussion of Wintergarden GCD Request

Three of the yellow cells in Table 1 (Dimmit, LaSalle, and Zavala counties) are the counties of WGCD. These counties all had MAGs that were less than 2017 pumping. The initial assumption of applying a factor of 1.30 was made to initially evaluate the effects of an increase in pumping in the context of all the other changes to pumping in GMA 13.

In addition, Webb County was increased by a factor of 6.17 to accommodate a proposed increase in pumping by Legacy WSC. Independent of the Legacy WSC request, it can be seen that the current MAG is less than the 2017 pumping in Webb County.

At the time, it was expected that WGCD may decide to adjust the factors of 1.30 to something slightly less than 1.30 in recognition that pumping may slightly increase between now and 2080. However, the input from WGCD was to develop a simulation that current MAG pumping should be used for Dimmit, LaSalle, Webb, and Zavala counties, which means the simulation would involve large pumping reduction in the simulation as compared to historic pumping.

This technical memorandum documents a simulation that included baseline pumping in all counties, except Dimmit, LaSalle, Webb, and Zavala counties. Pumping in those four counties was reduced to match the current MAG values (as requested by WGCD). Results of the output from the simulation include:

- Carrizo-Wilcox Aquifer pumping by county
- Average drawdown by county and groundwater conservation district
- HB 2078 analysis to assess feasibility of meeting the resulting DFC

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Finally, this Technical Memorandum includes a review of the estimates of historic groundwater pumping and provided data in five counties near WGCD, including estimates and data provided by WGCD. These estimates are important in understanding the context of the 2017 pumping amounts in WGCD used in the simulations. These estimates and data were reviewed at previous GMA 13 meetings as the model was being updated.

It is unclear if WGCD is misinterpreting how the 2017 pumping and current MAG values are related in terms of groundwater elevation response, or if there is a lack of confidence in the GMA 13 Model to provide reliable information for the joint planning process.

In the February 26, 2026 email, Ms. Farmer noted that there is a WGCD Board meeting on March 11, 2026 to discuss this issue further. One of the main objectives of this Technical Memorandum is to provide a concise summary of the implications of the WGCD request for use by WGCD in providing input to the joint planning process that will inform the WGCD Board at their upcoming meeting.

1.3 Model File Development

The simulation documented in this Technical Memorandum (named the WGCD Scenario) used the R95 Baseline scenario (termed the Baseline Scenario for purposes of this Technical Memorandum) for all files except the WEL file. As discussed at the GMA 13 meeting of February 13, 2026, the R95 Baseline assumed 95 percent of average recharge and groundwater pumping held constant at 2017 amounts (the last year of the calibrated model) through 2080.

As noted above, the development of this scenario started with the same WEL files from the R95 Baseline Scenario as modified in Dimmit, LaSalle, Webb, and Zavala counties. The Fortran program (*WGCDScenpump.exe*) read the model grid file and the county-level pumping factors (*PumpFac.csv*) to reduce pumping in those four counties in the Carrizo-Wilcox Aquifer. The new WEL file (*WGCDScen.wel*) was then used with the other R95 Baseline Scenario files to complete the simulation.

All files used in the simulation (including output) can be downloaded from:

https://drive.google.com/drive/folders/1qDNvene_hxpGGVk0eElBkSfLUqVpYibh?usp=sharing

2.0 Simulation Results

The model output was processed to evaluate the following:

- Carrizo-Wilcox Aquifer pumping by county
- Average drawdown by county and groundwater conservation district
- HB 2078 analysis to assess feasibility of meeting the resulting DFC

2.1 Pumping

Groundwater pumping in the GMA 13 Model is specified through the WEL file. One of the features of MODFLOW 6 (the underlying code of the GMA 13 Model) is that reductions in pumping are applied when the groundwater elevation approaches the bottom of a cell. Therefore, input pumping and output pumping may not be the same. Consequently, pumping was obtained from the model output file named *GMA13-WGCDScen.cbb* using the Fortan post-processor *getpump.exe*.

Output pumping for the Carrizo-Wilcox Aquifer for the baseline simulation and the WGCD Scenario simulation are presented on the right side of Table 1. For context, the left side of Table 1 presents a comparison of the baseline simulation and the current Modeled Available Groundwater (MAG) values. The MAGs were reported by decade from 2020 to 2080 by TWDB in 2022 (GAM Run 21-018 MAG). The reported values vary by decade, and only the maximum value is presented in Table 1.

Table 2. Groundwater Pumping Comparison - Baseline and WGCD Scenarios

County	Baseline	Curret MAG (Maximum)	MAG-Baseline	County	Baseline	WGCD Request	WGCD Request - Baseline
Atascosa	42,934	59,982	17,048	Atascosa	42,934	42,936	2
Bexar	16,621	70,145	53,524	Bexar	16,621	16,632	11
Caldwell	3,698	49,635	45,937	Caldwell	3,698	3,698	0
Dimmit	55,692	3,895	-51,797	Dimmit	55,692	4,346	-51,346
Frio	100,729	114,827	14,098	Frio	100,729	100,729	0
Gonzales	54,574	103,707	49,133	Gonzales	54,574	54,574	0
Guadalupe	7,562	55,637	48,075	Guadalupe	7,562	7,562	0
Karnes	450	1,043	593	Karnes	450	450	0
LaSalle	25,704	6,554	-19,150	LaSalle	25,704	7,019	-18,685
Maverick	1,632	547	-1,085	Maverick	1,632	1,663	31
McMullen	4,647	7,789	3,142	McMullen	4,647	4,647	0
Medina	3,712	2,635	-1,077	Medina	3,712	3,721	9
Uvalde	126	0	-126	Uvalde	126	126	0
Webb	6,494	912	-5,582	Webb	6,494	1,015	-5,479
Wilson	24,983	125,670	100,687	Wilson	24,983	24,983	0
Zavala	46,686	38,303	-8,383	Zavala	46,686	38,549	-8,137

Please note that the decreases in WGCD total 78,168 AF/yr (a 61 percent decrease from 2017 pumping). In addition, Webb County pumping in this scenario represents an 84 percent decrease from the 2017 pumping. This reduction in pumping results in minor increases in pumping three other counties due to increasing groundwater levels in those counties.

2.2 Average Drawdown

Average drawdown in the Carrizo-Wilcox Aquifer was calculated annually from the model output file (*GMA13-WGCDScen.hds*) using the Fortran post-processor named *getdd.exe*. Please note that drawdown is based on a baseline year of 2017 (the last year of the calibration period).

Average drawdown in 2080 for the Carrizo-Wilcox Aquifer by county is presented on the left side of Table 2, and average drawdown for the Carrizo-Wilcox Aquifer by groundwater conservation district (GCD) is presented on the right side of Table 2. Both sides of the table, the baseline drawdown and the WGCD Scenario drawdown are presented. Please note that the outcrop and downdip areas are calculated separately.

Table 3. Average Drawdown in 2080 Comparison - Baseline and WGCD Scenarios

County	Average Drawdown (ft - 2017 Baseline)			
	Baseline Pumping		WGCD Request	
	Outcrop	Downdip	Outcrop	Downdip
Atascosa	3	9	-3	-15
Bexar	3	3	3	2
Caldwell	7	9	7	9
Dimmit	87	129	-85	-171
Frio	28	50	-7	-51
Gonzales	20	18	20	17
Guadalupe	13	18	13	18
Karnes	0	10	0	8
LaSalle	0	91	0	-117
Maverick	14	25	-3	-13
McMullen	0	52	0	-71
Medina	7	10	3	4
Uvalde	5	6	-3	-3
Webb	39	99	-5	-105
Wilson	4	6	4	6
Zavala	28	69	-40	-121

GCD	Average Drawdown (ft - 2017 Baseline)			
	Baseline		WGCD Request	
	Outcrop	Downdip	Outcrop	Downdip
EUWCD	11	23	-2	-21
GCUWCD	16	17	16	17
GCGCD	13	18	13	18
MGCD	0	52	0	-71
MCGCD	7	10	3	4
PCCD	5	5	5	5
UCUWCD	5	6	-3	-3
WGCD	60	96	-64	-134

Note: Baseline Pumping is 2017 pumping constant from 2018 to 2080

Note: Baseline Pumping is 2017 pumping constant from 2018 to 2080

Please note that the negative drawdowns that appear in many counties represent groundwater elevation recovery. Overall, in WGCD, the recovery would be 134 feet in 2080 compared to 2017 levels. In the individual counties of WGCD, average recovery would be:

- Dimmit County: 171 ft
- LaSalle County: 117 ft
- Zavala County: 121 ft

The recovery in Webb County (the other county with a large pumping reduction specified in this scenario) is estimated to be 105 ft.

Many other counties in GMA 13 would also experience groundwater level recoveries. For example, McMullen County would have a drawdown of 52 ft under the baseline scenario, but a 71 ft recovery under the WGCD scenario. In Atascosa County, a 9 ft drawdown under the baseline scenario would be a 15 ft recovery under the WGCD Scenario.

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These recoveries would have significant implications if they were used as DFCs in the current round of joint planning. Please recall that TWDB will use the GMA 13 Model to develop the pumping that would achieve the DFC. The input on pumping amounts provided on February 26, 2026 by WGCD would result in groundwater level recoveries that would result in groundwater elevation recoveries. If future pumping were to continue at near historic levels, it is doubtful that DFCs could be achieved in Wintergarden GCD under the WGCD Scenario, and pumping curtailments in Wintergarden GCD would be needed to meet the DFCs.

3.0 HB 2078 Analysis

HB 2078 requires that GMAs and GCDs routinely compare actual data and DFCs to assess achievement. A DFC Comparison Analysis was provided at the August 15, 2025 GMA 13 meeting in response to Dr. Ron Green's presentation at the April 11, 2025 GMA 13 meeting. Dr. Green's presentation misapplied how DFCs should be interpreted when comparing DFCs with actual groundwater elevation data.

Specifically, my presentation on August 15, 2025 concluded that Wintergarden GCD is not meeting the DFC adopted in 2021 because:

- Pumping in the GAM simulation used to develop the DFC in 2021 was too low (a flaw in the old GAM that has since been corrected).
- Application of the pumping in the DFC simulation was flawed

Lessons learned from that evaluation were applied to the simulations that were developed and presented at the February 13, 2026 GMA 13 meeting and in these simulations documented in this Technical Memorandum.

Aside from meeting the specific requirements of HB 2078, this method originally outlined on August 15, 2025 and expanded in the presentation on February 13, 2026 to assess DFC achievement is viewed as a key element of Joint Planning Factor 8 (Feasibility of Achieving DFC).

As described at the February 13, 2026 meeting:

- Using the TWDB Groundwater Database, 177 wells were identified with a groundwater data point between October 2017 and March 2018 in GMA 13.
- These data were used to assign an end-of-2017 groundwater elevation for use as a baseline in drawdown calculations.
- The TWDB Groundwater Database yielded 749 end-of-year groundwater elevations in these wells from 2018 to 2024.

The presentation on February 13, 2026 demonstrated this method by use of two basic alternative hypothetical assumptions:

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- The baseline scenario is adopted as the basis for the DFC
- The “MAG Scenario” is adopted as the basis for the DFC

At the February 13, 2026 meeting, the results of these analyses were presented for the entire GMA as examples of how the approach could be used. Because the baseline scenario is a continuation of 2017 pumping, it also provided information on the suitability of the GMA 13 model to predict drawdowns from 2018 to 2024.

The presentation of February 13, 2026 was limited to all the wells in GMA 13. This analysis focuses on the wells in Wintergarden GCD. For the Baseline Scenario, the data from Wintergarden GCD were extracted to assess DFC achievement just for WGCD. In addition, the WGCD Scenario results were processed to complete an HB 2078 analysis as if this was the foundation for an adopted DFC. The results are summarized in Table 4 and Figure 1.

Table 4. Actual and Simulated Average Drawdown, 2018 to 2024 - Wintergarden GCD

Year	Data Points	Average Actual Drawdown (ft - 2017 Baseline)	Average Simulated Drawdown (ft - 2017 Baseline)	
			Baseline Scenario	WGCD Scenario
2018	30	9.27	8.42	-21.15
2019	25	6.17	16.75	-33.30
2020	12	16.25	15.30	-44.73
2021	27	9.32	22.55	-44.50
2022	27	23.34	28.47	-56.60
2023	26	18.49	28.53	-57.73
2024	15	20.51	29.53	-53.29
2018 to 2024	162	14.18	21.09	-43.42

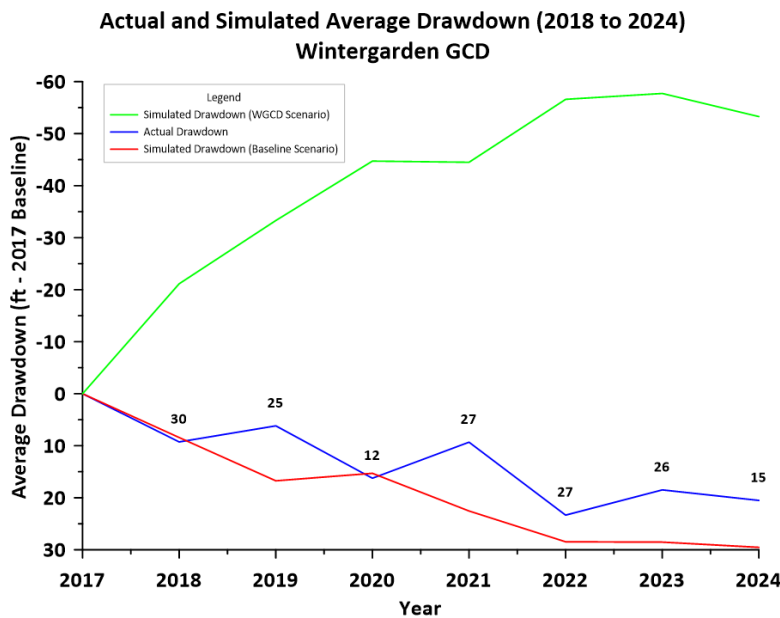


Figure 1. Actual and Simulated Average Drawdown (2018 to 2024) - Wintergarden GCD

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Please note that the actual and simulated average drawdowns for the Baseline Scenario (red and blue lines) agree relatively closely in all years. This suggests that the 2017 pumping is a reasonable representation of pumping from 2018 to 2024. To the extent that the simulated drawdown is slightly higher or lower than the actual drawdown, it is entirely possible that pumping in individual years varied slightly from the 2017 amounts. This comparison builds confidence in the ability of the GMA 13 Model to develop estimates of future drawdown.

The simulated groundwater recoveries in the Wintergarden GCD Scenario (green line) were previously discussed as the result of simulated pumping reductions in comparison to historic pumping. Notable is that the overall average recovery in Wintergarden GCD previously presented in Table 3 is 134 ft. However, from Table 4, it can be seen that among the monitoring wells from 2018 to 2024, the simulated recovery is only about 43 ft. This highlights the potential danger in using a overall average drawdown or recovery (in 2080) for a county or GCD and attempting to apply it to an average drawdown or recovery of a limited number (or a single) monitoring well during for years long before 2080. Consistent comparison requires use of point-by-point comparisons and appropriate averaging.

4.0 Review of WGCD Pumping Estimates

As noted in the documentation of the GMA 13 Model, groundwater pumping estimates and data were used to update the model. Indeed, an entire section of the documentation of the model was devoted to the WGCD data and estimates that were provided. The incorporation of WGCD data and estimates were first presented to GMA 13 at the meeting on June 14, 2024. They were fully documented in the first report of the GMA 13 Model that was submitted to TWDB (dated September 23, 2024).

During the public comment period of the 2024 version of the model, there were no comments on the pumping estimates used in the WGCD area. The model was updated again in response to other comments, and the 2025 version of the documentation was originally released on October 19, 2025, with a revised version released on December 5, 2025. In both of these 2025 versions, the WGCD data and estimates are fully documented.

After the February 13, 2026 GMA 13 meeting, Dr. Ron Green (consultant for Wintergarden GCD) approached me and expressed concern over the pumping amounts in the model for Wintergarden GCD. I explained that the pumping estimates in the Wintergarden GCD were based on data that Wintergarden GCD and he had previously provided, and that were fully documented in the model reports.

This summary review of the documentation is supplemented with the final calibrated model pumping estimates to demonstrate that the historic pumping estimates in the GMA 13 Model (upon which the 2017 baseline pumping are based), are reasonable and consistent with other estimates and data. The pumping estimates in five counties in and near the Wintergarden GCD area were developed from four primary sources (with years of availability shown):

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- SWRI Model pumping estimates of the Wintergarden GCD area (1930 to 1999)
- TWDB estimates of groundwater pumping (2000 to 2021)
- TWDB estimates of groundwater pumping for irrigation (1985 to 2021)
- WGCD data associated with oil and gas water use (2010 to 2022)

The figures that appear in the GMA 13 Model documentation were reproduced for this Technical Memorandum. The estimates from the “new GAM” (i.e. the Panday and others, 2023 version) were removed from the figures and replaced with pumping estimates from the 2025 version of the GMA 13 Model (the one that is being used for DFC development). These figures are presented as follows:

- Figure 2: Dimmit County
- Figure 3: Frio County
- Figure 4: LaSalle County
- Figure 5: Webb County
- Figure 6: Zavala County

The thick black line represents the GMA 13 Model calibrated pumping and is consistent with the various other estimates and data provided. Please note that the current MAG is presented in the title block each figure to provide some perspective on how the historic pumping compares with the MAG.

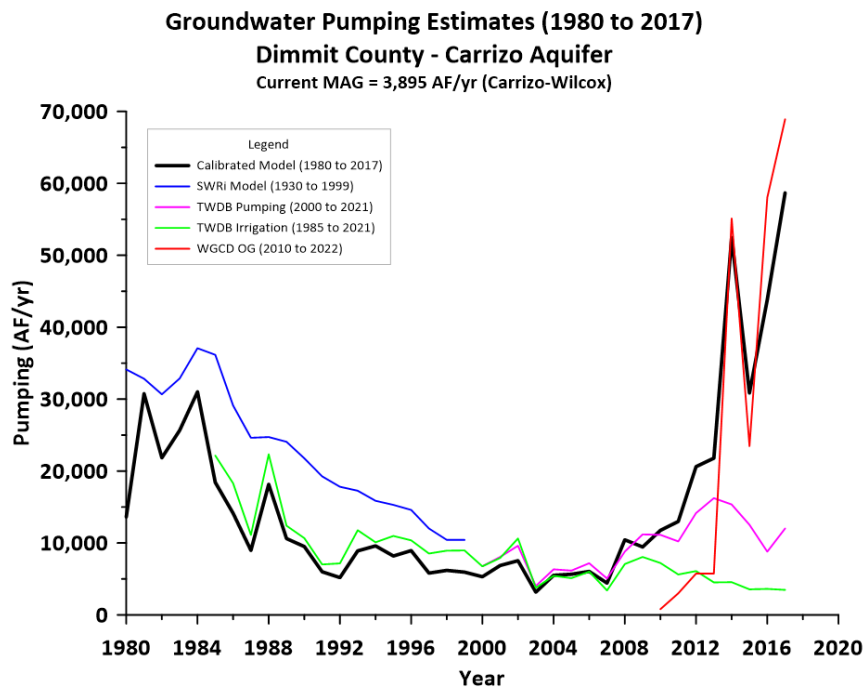


Figure 2. Groundwater Pumping Estimates - Dimmit County

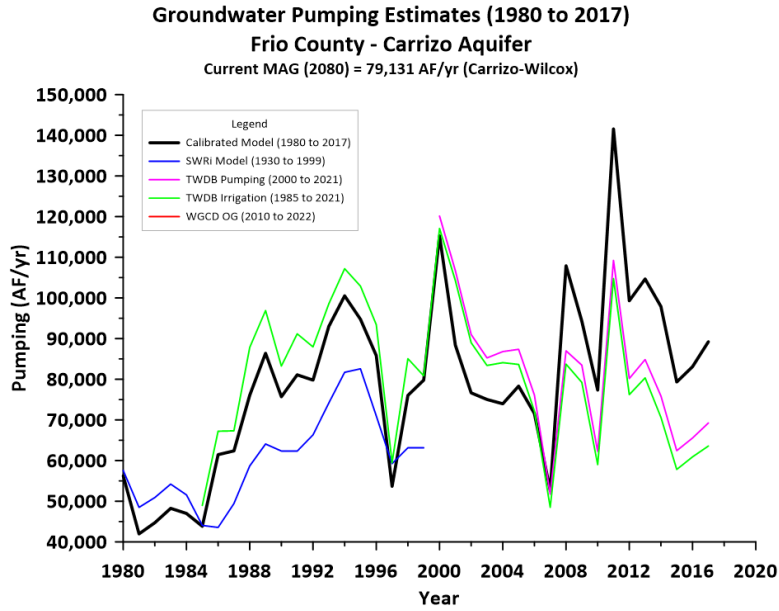


Figure 3. Groundwater Pumping Estimates - Frio County

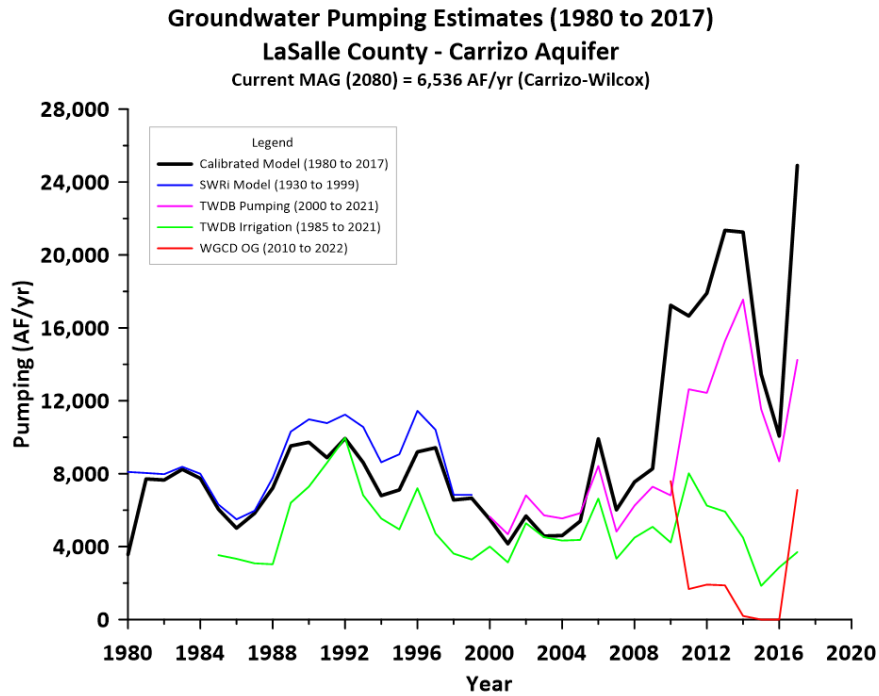


Figure 4. Groundwater Pumping Estimates - LaSalle County

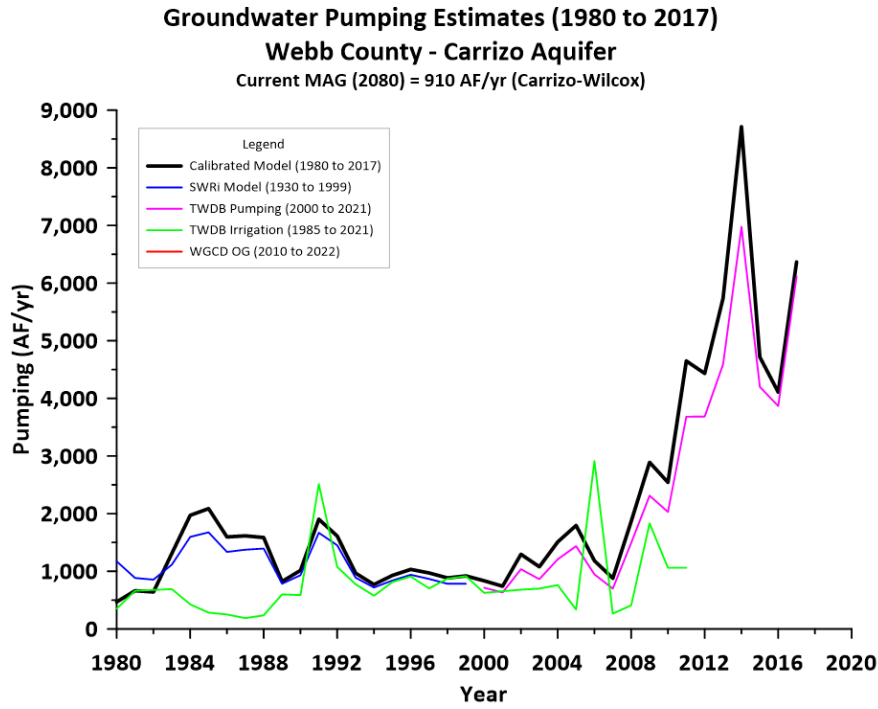


Figure 5. Groundwater Pumping Estimates - Webb County

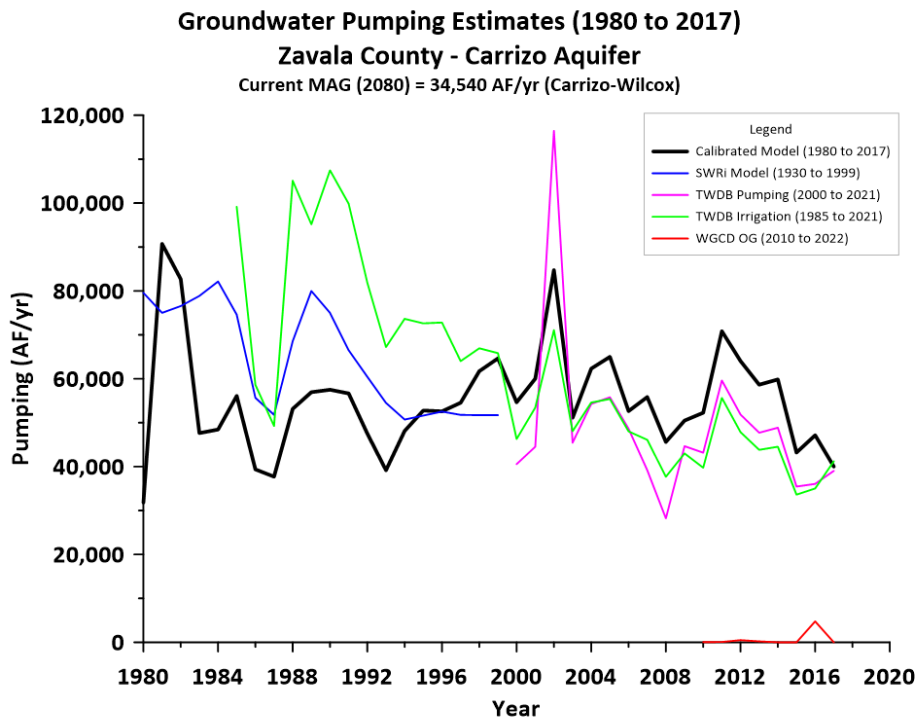


Figure 6. Groundwater Pumping Estimates - Zavala County