GMA 12

Preliminary QC/Sparta/C-W Modeling Results and discussion of the Yegua-Jackson and Brazos River Alluvium Aquifers

by

GMA 12 Consultant Team

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Model Layers- Aquifer

- Layer 1- Colorado and Brazos River Alluvium
- Layer 2- Shallow flow systems
- Layer 3- Sparta Aquifer
- Layer 4- Weches Formation
- Layer 5- Queen City Aquifer
- Layer 6- Reklaw Formation
- Layer 7- Carrizo Aquifer
- Layer 8- Calvert Bluff Aquifer
- Layer 9- Simsboro Aquifer
- Layer 10- Hooper Aquifer

Model Run S-7 and S-8

- Sparta, Queen City, and Carrizo-Wilcox Aquifers
- All runs- estimated historic pumpage for 2011 to 2018
- S-7- Minor corrections of Run S-2 (anticipated ramp up of pumpage for 2019 to 2070).
- S-8- Last run where modifications to pumpage for each GCD was made to try and meet the current DFCs.

Model S-9

- Started with Pumping from Model S-7
- Adjust S-7 pumping by aquifers to achieve the DFCs set for the entire GMA-12 region
- Constraints were placed on adjustments to pumping
  - Do not increase pumping in an aquifer.
  - Do not decrease pumping in an aquifer by more than 50%

Current GMA 12 DFCs

Aquifer	Current DFCs (1999 to 2069)					
	GMA 12	LPGCD	BVGCD	POGCD	METGCD	FCGCD
Sparta	16	5	12	28	5	47
Queen City	16	15	12	30	2	64
Carrizo	75	62	61	67	80	110
Calvert Bluff	114	100	125	149	90	
Simsboro	228	240	295	318	138	
Hooper	168	165	207	205	125	

Current DFCs and Average Drawdown From Run S-7

Aquifer	Average Drawdown from 2009 to 2069 for Run S-7					
	GMA 12	LPGCD	BVGCD	POGCD	METGCD	FCGCD
Sparta	30	20	47	17	25	40
Queen City	29	26	41	19	21	66
Carrizo	99	140	77	177	49	125
Calvert Bluff	111	162	97	183	60	
Simsboro	207	334	214	355	82	
Hooper	131	183	153	222	74	

Aquifer	Current DFCs (1999 to 2069)					
	GMA 12	LPGCD	BVGCD	POGCD	METGCD	FCGCD
Sparta	16	5	12	28	5	47
Queen City	16	15	12	30	2	64
Carrizo	75	62	61	67	80	110
Calvert Bluff	114	100	125	149	90	
Simsboro	228	240	295	318	138	
Hooper	168	165	207	205	125	

Note: Different time periods for the tables

Results from PS-9

Aquifer	Fraction of PS-7 Pumping	1999 -2069 (current)			2009 - 2069 (PS-9)		
		DFC	MAG	MAG/ DFC	Avg. Drawdown	MAG	MAG / DD
Sparta	0.50	16	24,292	1,518	15	11,950	817
Queen City	0.50	16	6,700	419	17	4,231	255
Carrizo	0.62	75	41,167	549	74	32,237	436
Calvert Bluff	1.00	114	10,927	96	100	16,341	164
Simsboro	1.00	228	192,565	845	201	364,861	1,811
Hooper	1.00	168	15,357	91	127	14,289	113
Total			291,008			443,908	3,595

- Revised GAM may have less groundwater production per drawdown for Sparta, Queen City, and Carrizo than does former GAM
  - Revisit boundary conditions between Sparta and Yegua-Jackson
  - Revisit hydraulic properties
- Revised GAM may have more groundwater production per drawdown for Calvert Bluff, Simsboro, and Hooper than does former GAM
  - Somewhat expected because of revised fault locations and properties
  - Revisit hydraulic properties

Results from PS-9: LPGCD & BVGCD

Aquifer	LPGCD						BVGCD					
	DFC		MAG		Production/ DD		DFC		MAG		Production/ DD	
	Current	PS-9	Current	PS-9	Current	PS-9	Current	PS-9	Current	PS-9	Current	PS-9
Sparta	5	12	2,393	1,332	479	109	12	21	9,019	6,280	752	299
Queen City	15	17	1,315	857	88	51	12	21	1,200	633	100	30
Carrizo	62	106	12,052	9,064	194	86	61	57	5,494	3,354	90	59
Calvert Bluff	100	146	3,984	5,529	40	38	125	88	1,757	1,742	14	20
Simsboro	240	326	30,303	131,085	126	402	295	207	96,198	144,240	326	697
Hooper	165	178	1,255	3,253	8	18	207	147	2,000	2,119	10	14
Total			51,302	151,120					115,668	158,369		

- LPGCD
  - PS-9 has notable increase in total "MAG"
  - PS-9 has notably less production per drawdown in Sparta and Carrizo
  - PS-9 has notably more production per drawdown in Simsboro
- BVGCD
  - PS-9 has notable increase in total 'MAG"
  - PS-9 has notably less production per drawdown in Sparta and Queen City
  - PS-9 has notably more production per drawdown in Simsboro

Results from PS-9: POSGCD & METGCD

Aquifer	POSGCD						METGCD					
	DFC		MAG		Production/ DD		DFC		MAG		Production/ DD	
	Current	PS-9	Current	PS-9	Current	PS-9	Current	PS-9	Current	PS-9	Current	PS-9
Sparta	28	6	6,735	1,245	241	224	5	12	3,343	1,652	669	137
Queen City	30	9	504	510	17	59	2	12	974	880	487	72
Carrizo	67	132	7,058	9,945	105	75	80	37	11,090	6,535	139	177
Calvert Bluff	149	165	1,036	4,635	7	28	90	50	3,915	4,236	44	84
Simsboro	318	347	48,503	81,788	153	236	138	73	7,173	7,850	52	108
Hooper	205	217	4,422	3,042	22	14	125	66	5,501	4,599	44	70
Total			68,258	101,165					31,996	25,751		

- POSGCD
  - PS-9 has notable increase in total "MAG"
  - PS-9 has less production per drawdown in Carrizo and Hooper
  - PS-9 has notably more production per drawdown in Simsboro and Queen City
- METGCD
  - PS-9 has a lower total 'MAG"
  - PS-9 has notably less production per drawdown in Sparta and Queen City
  - PS-9 has notably more production per drawdown in Simsboro

Results from PS-9: FCGCD

Aquifer	FCGCD DFC					
	DFC		MAG		Production/ DD	
	Current	PS-9	Current	PS-9	Current	PS-9
Sparta	47	24	2,802	1,407	60	58
Queen City	64	42	2,708	1,352	42	32
Carrizo	110	86	5,474	3,162	50	37
Calvert Bluff						
Simsboro						
Hooper						
Total			10,984	5,921		

- POSGCD
  - PS-9 has notable decrease in total "MAG"

Summary

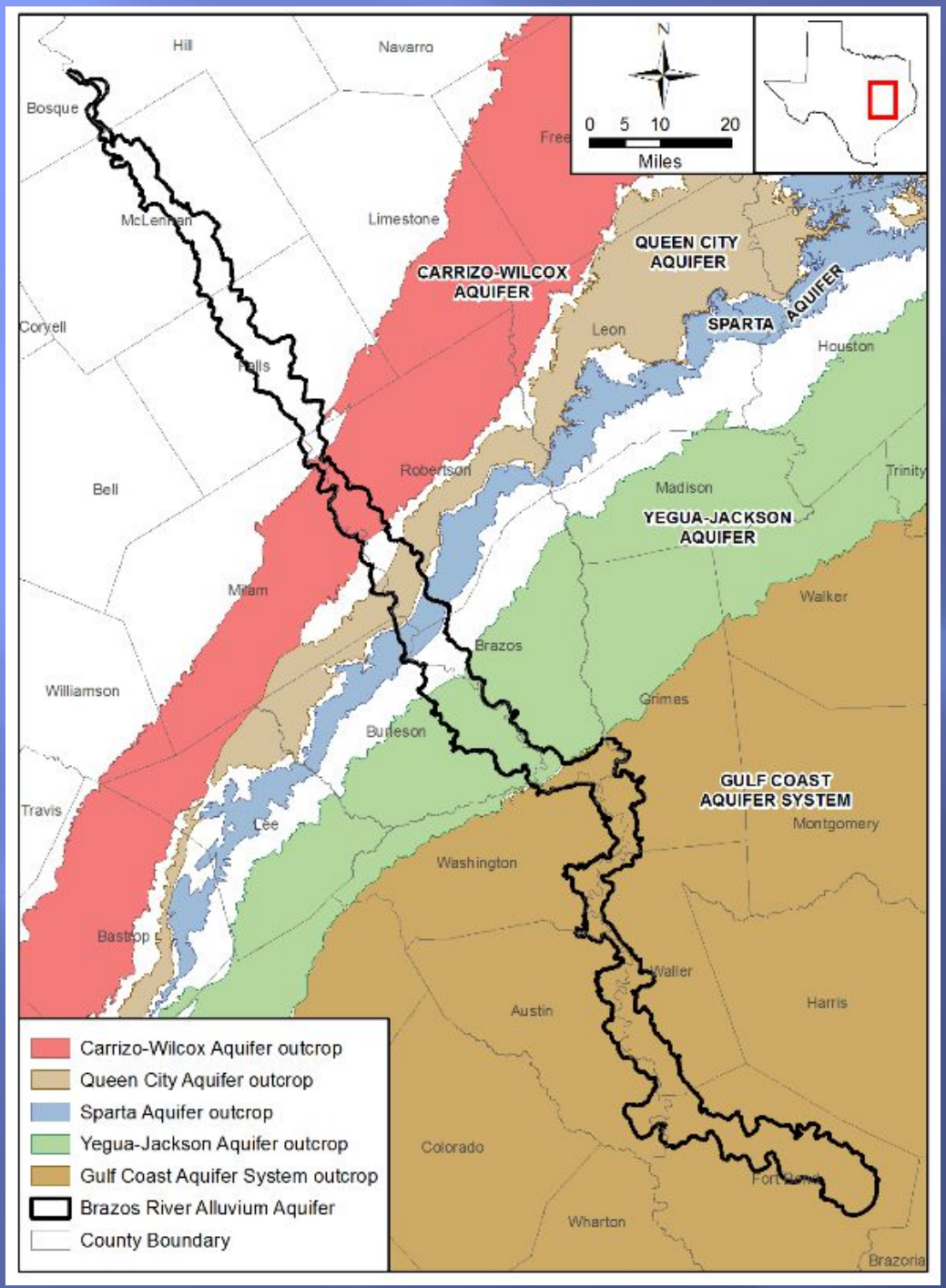
- Comparison of Revised GAM and Former GAM
  - Sparta is generally less productive
  - Simsboro is more productive
  - Mixed results for other aquifers
- Results from S-8 and S-9 Indicate that Existing DFCs are not Compatible
- Large differences between GAM and Major Assumptions in S-7 Pumping Suggests that 10% Uncertainty in Predicted Drawdowns is Low

Brazos River Alluvium

Development of DFCs

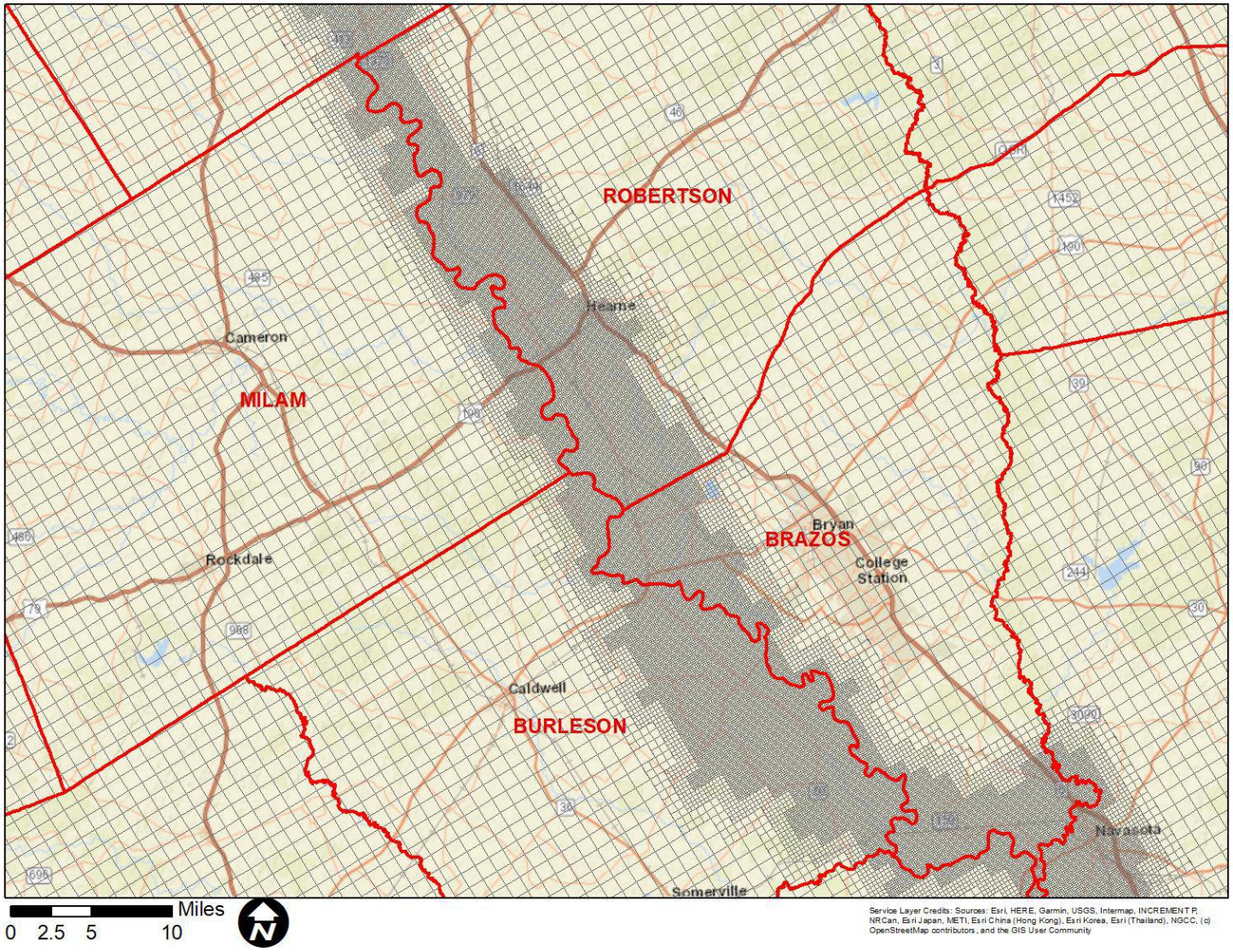
- Use the Brazos River Alluvium Aquifer GAM completed in 2016, the same GAM used to develop MAGS in the GMA 12 2016 planning cycle
- Develop distribution of pumping consistent with areas of irrigated agriculture in Milam, Burleson, Robertson and Brazos counties
- Consider pumping history in the counties and past effects of pumping when developing future DFCs

Extent of Brazos River Alluvium Model

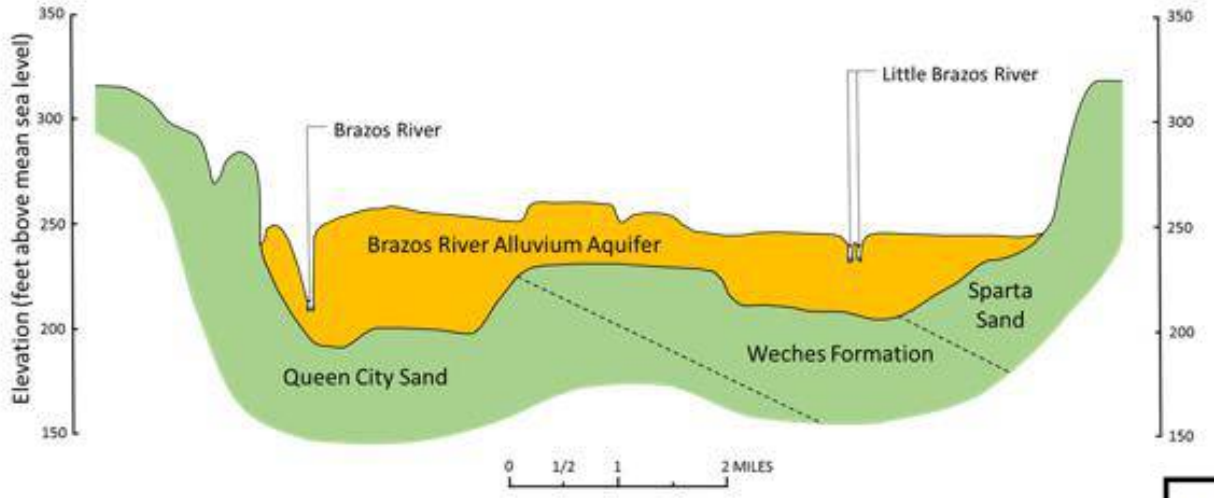


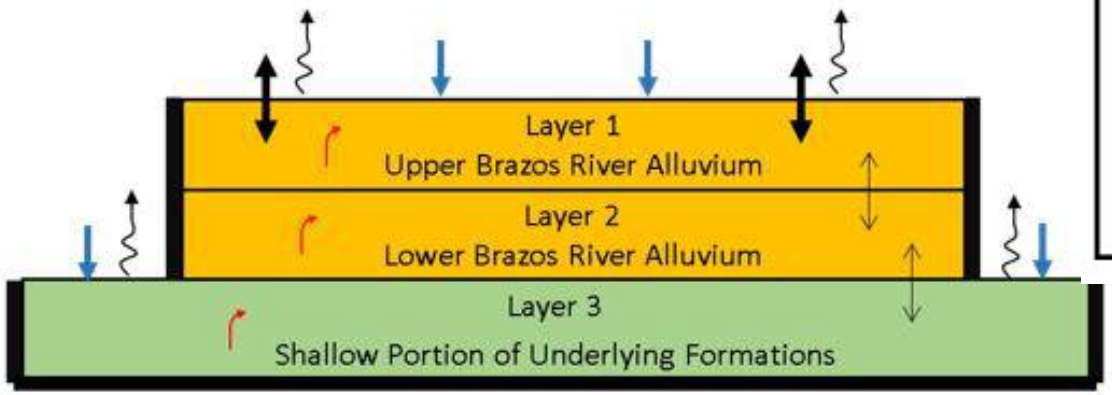
From: Final Numerical Model Report for the Brazos River Alluvium Aquifer Groundwater Availability Model, August 2016

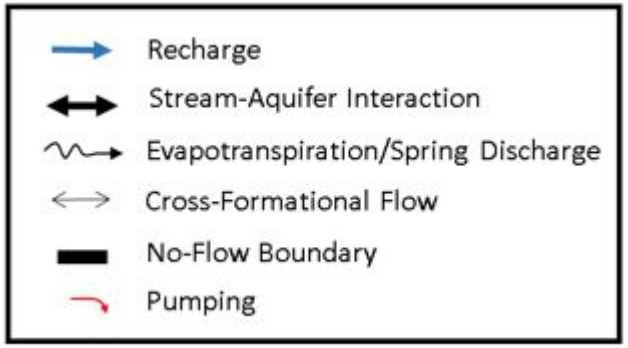
Model Grid for the BRAA GAM



Model Layer in BRAA GAM



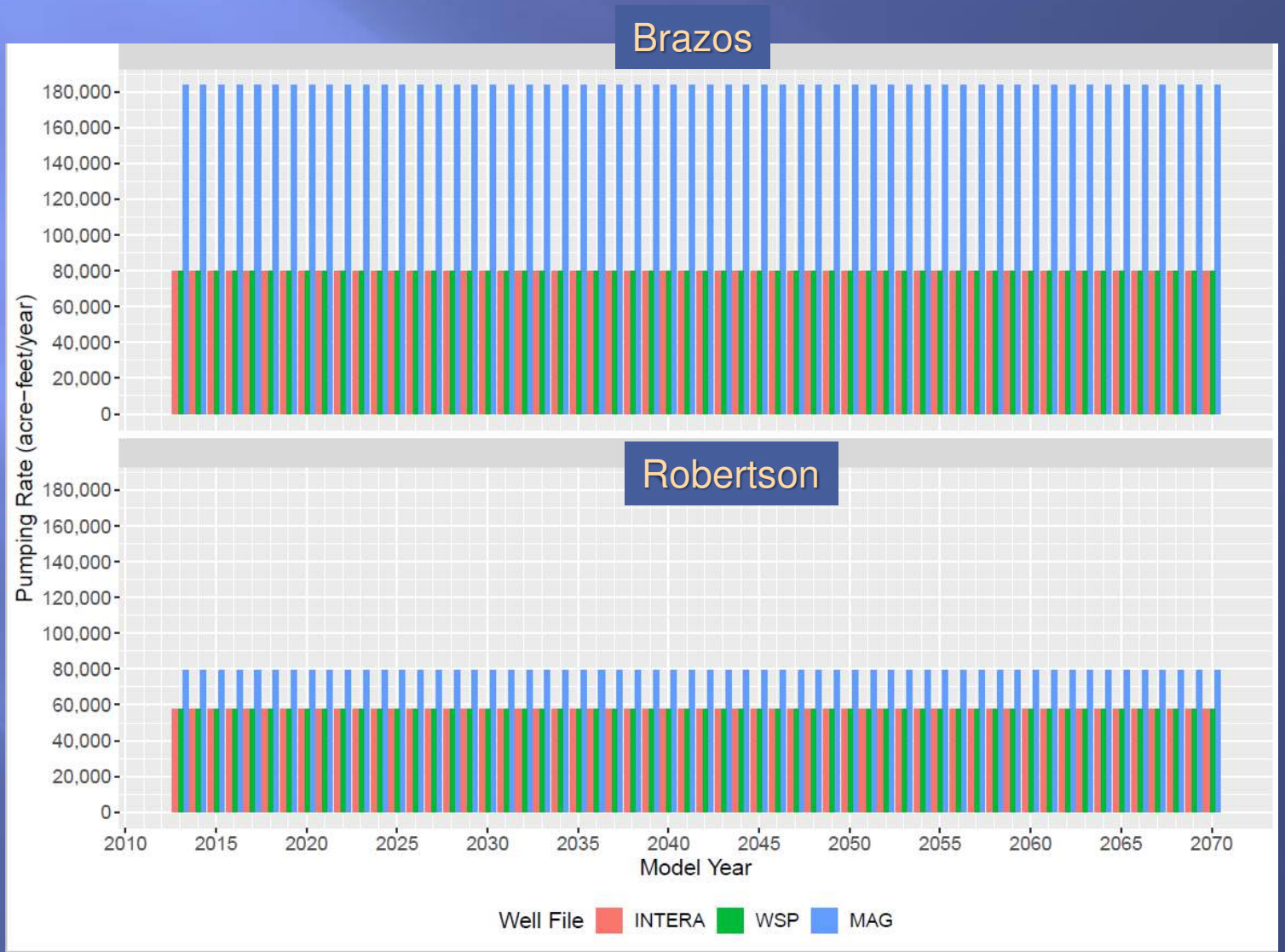




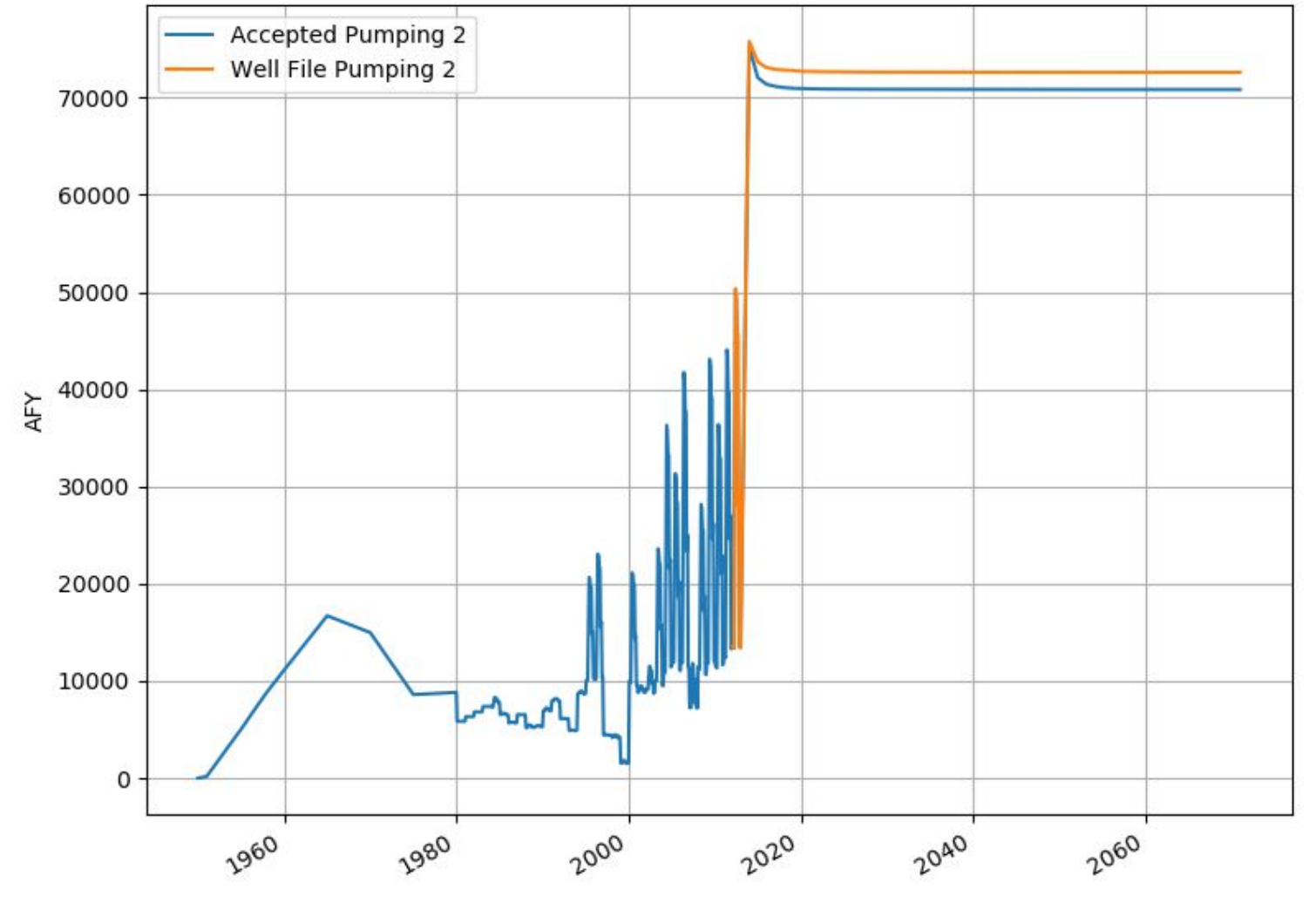
Modified TWDB MAG Run

- Reduced pumping in wells where initial pumping rates could not be sustained
- Avoided adding future pumping in same grid cells that include a river node
- Keep all the same hydraulic boundaries used by TWDB MAG Run

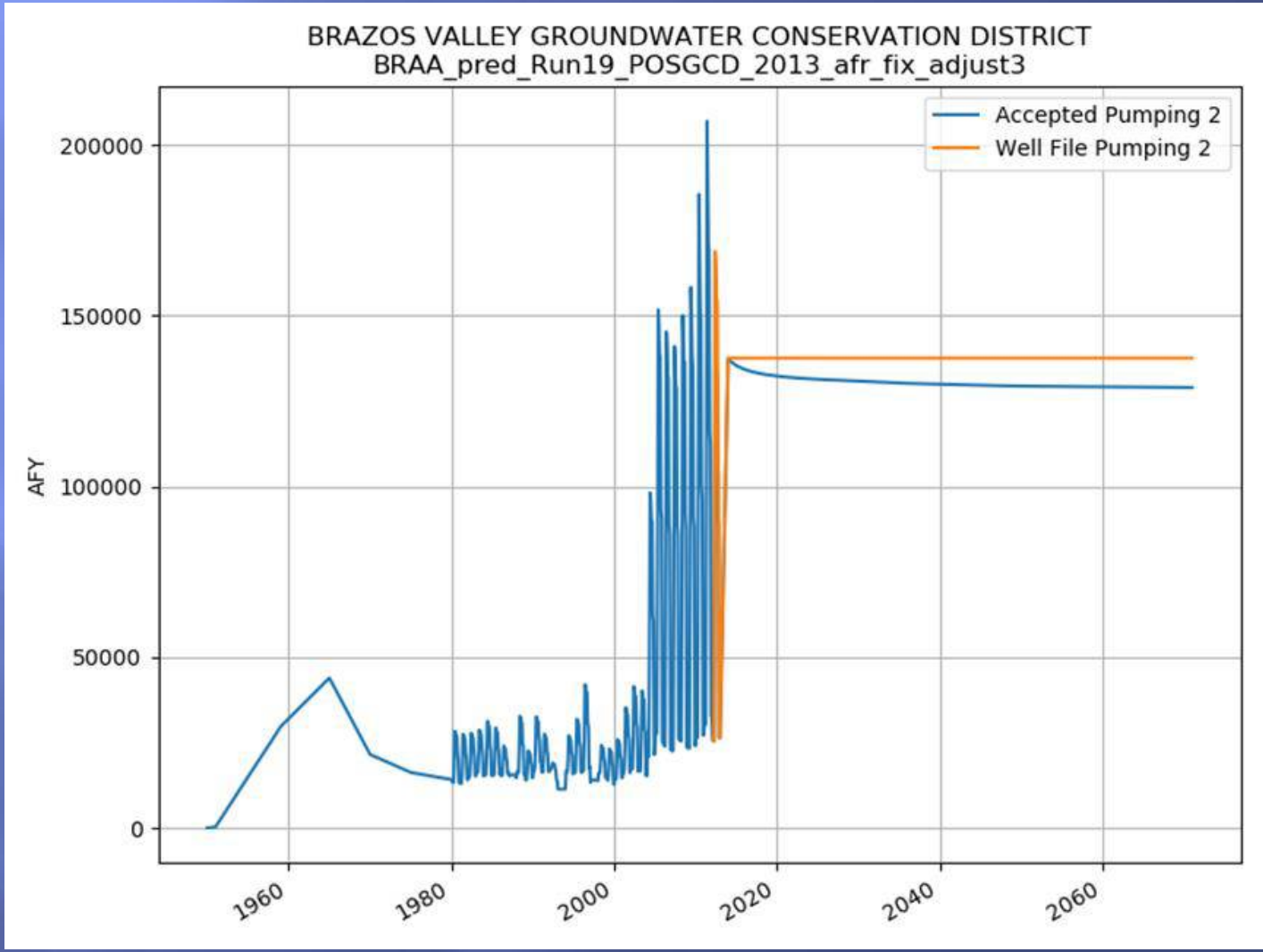
Comparison of Well Files For BVGCD



Comparison of Input and Output Pumping by District: POSGCD

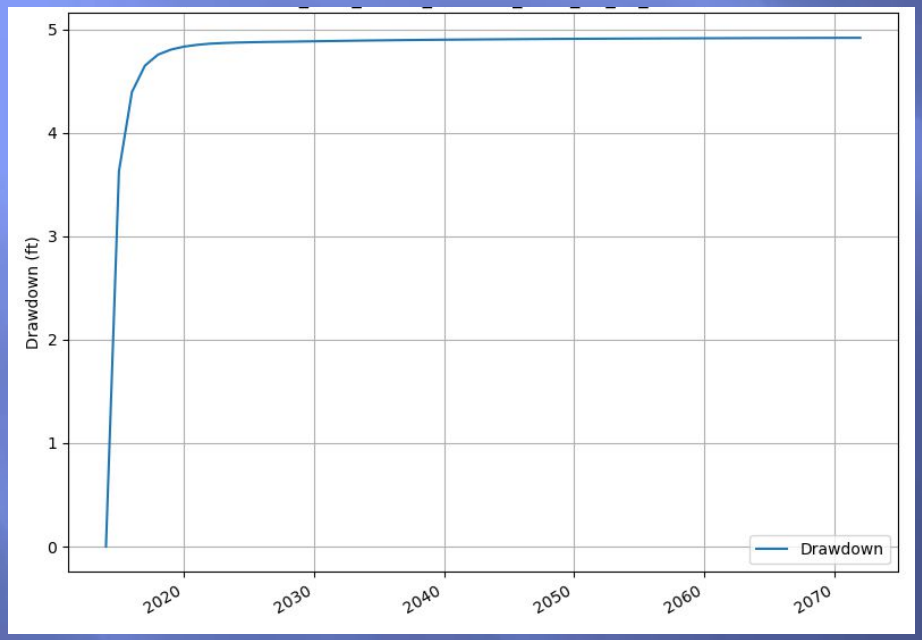


Comparison of Input and Output Pumping by District: BVGCD

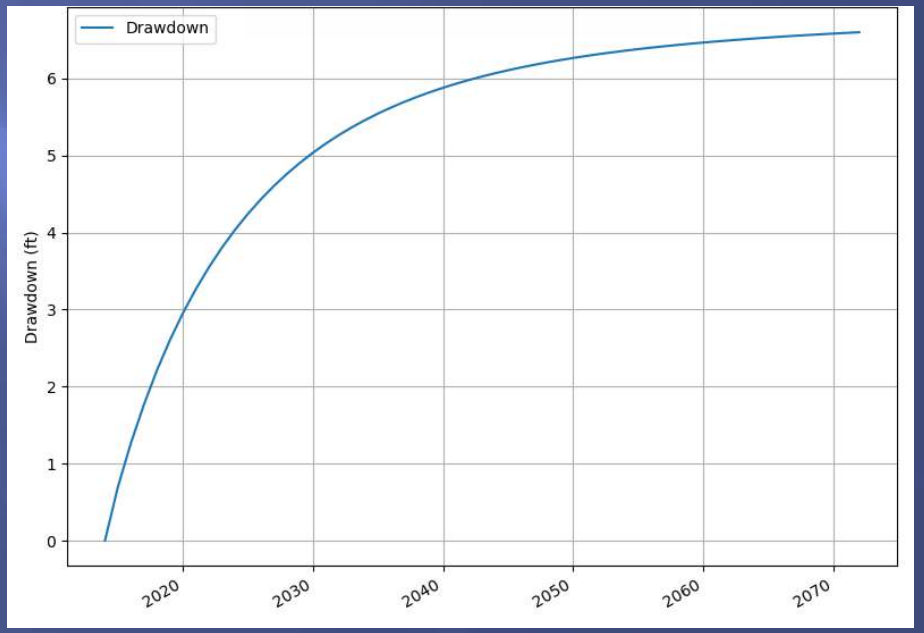


Average Drawdown in Alluvium: POSGCD

Milam

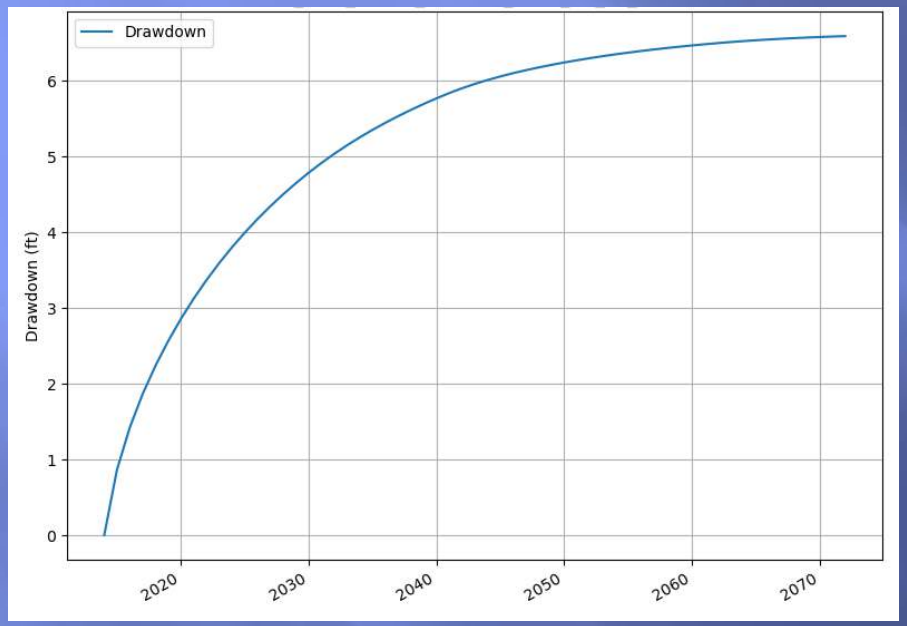


Burleson

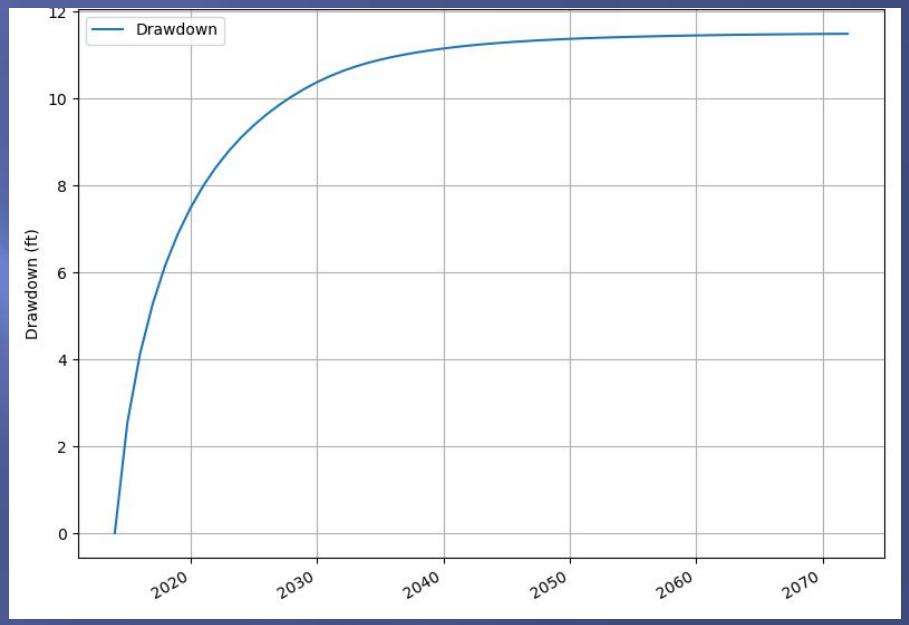


Average Drawdown in Alluvium: BVGCD

Robertson



Brazos



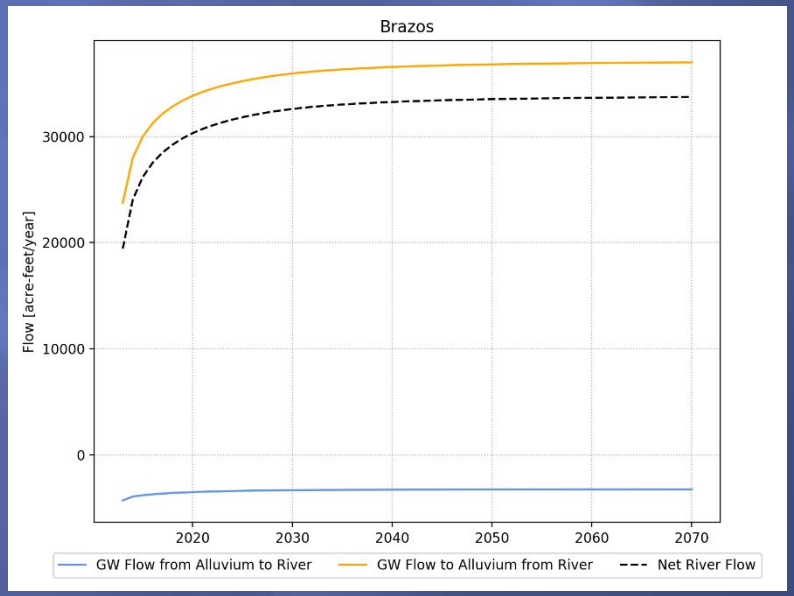
Reduction in Saturated Thickness

North Zone: 30%

South Zone: 44%

Surface Water-Groundwater Interaction

County	Flow From Alluvium to River (AFY)		Flow From River to Alluvium (AFY)		Net Flow (AFY)		Reduction in GW Contribution to River Flow (AFY) from 2013 to 2070
	2013	2070	2013	2070	2013	2070	
Milam	-1,158	-741	28,676	33,235	27,518	32,494	4,976
Robertson	-1,049	-711	22,288	27,245	21,240	26,534	5,294
Brazos	-4,305	-3,268	23,738	36,996	19,433	33,728	14,295
Burleson	-2,804	-1,851	22,194	34,206	19,391	32,355	12,964

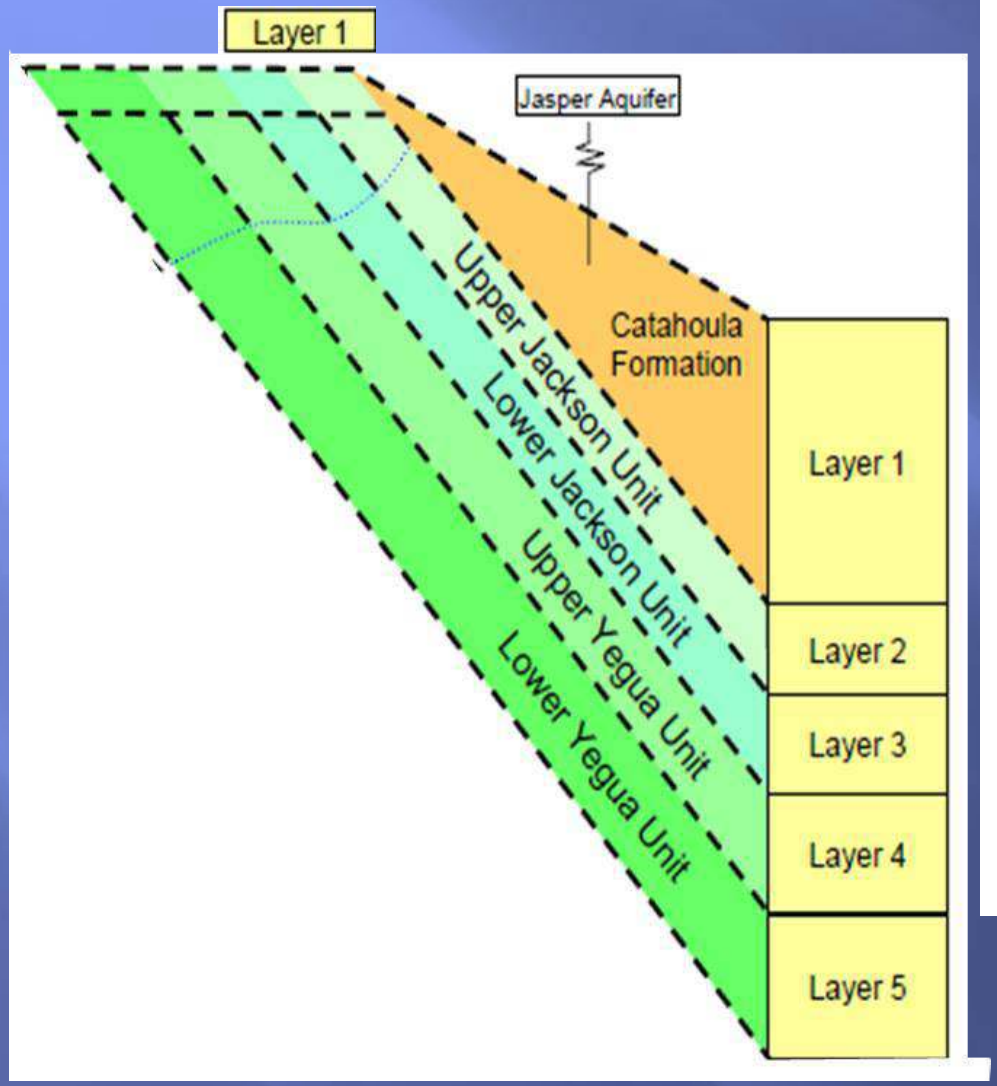


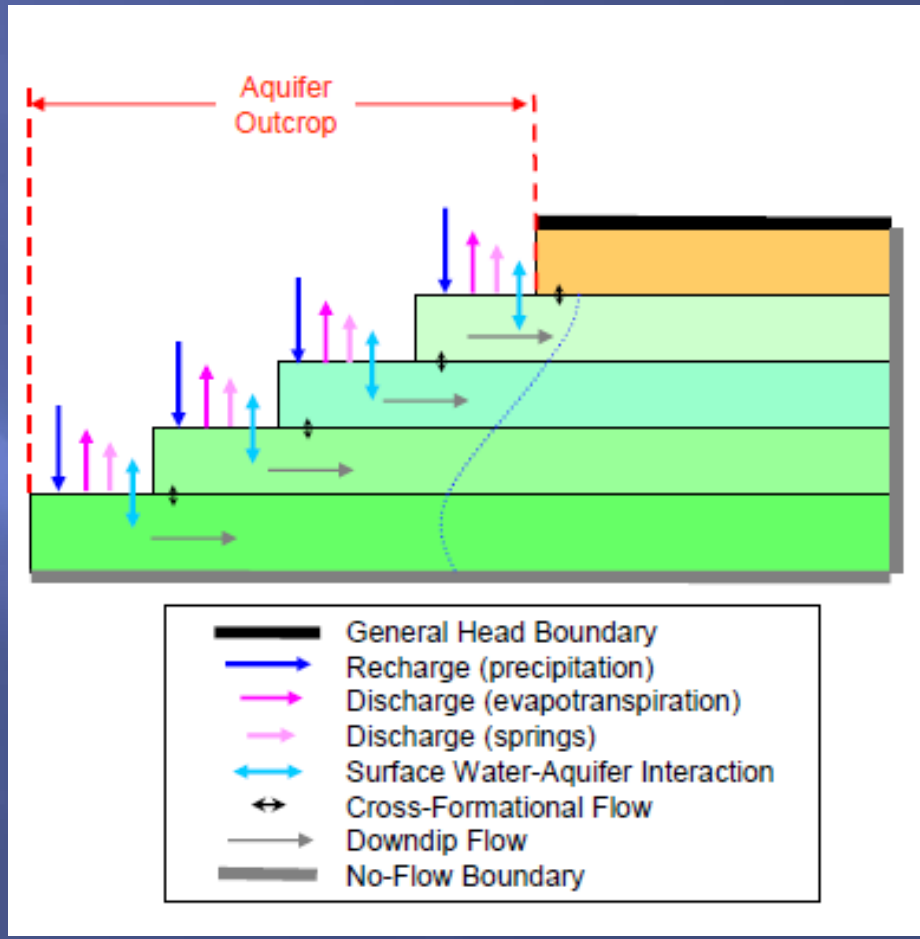
Summary

- Current Simulation Closely Reproduces DFCs
- Resulting MAGs
  - Milam – 38,626 AFY
  - Burleson – 32,306 AFY
  - Robertson – 52,903 AFY
  - Brazos -76,038 AFY
- Approximately 37,500 AFY of the 200,000 AFY pumped in 2070 is from a reduction of groundwater contribution to river flow in 2012

Yegua – Jackson Aquifer

Model Layer in Yegua-Jackson GAM





Current DFCs for Yegua-Jackson

Table 2-2 Adopted DFCs for the Yegua and Jackson Aquifers

GCD	Average Aquifer Drawdown (ft) measured from January 2010 through December 2069		
	Yegua	Jackson	Yegua-Jackson
Brazos Valley GCD	70	114	--
Fayette County GCD	--	--	77
Lost Pines GCD	--	--	--
Mid-East Texas GCD	--	--	7
Post Oak Savannah GCD	--	--	100
GMA-12	--	--	*65*

Lost Pines GCD will declare Yegua-Jackson as a non-relevant aquifer.

Table from GMA 12 Explanatory Report (Donnelly and others, 2018)

ReRun of the TWDB MAG Run

GCD	Existing DFC			With Shallow GW Zone (layer 1)		
	Yegua	Jackson	Yegua-Jackson	Area	Saturated Thickness	Entire Volume
Brazos Valley	70	114	--	73	102	95
Fayette County	--	--	77	77	94	89
Lost Pines	--	--	--	42	49	44
Mid-East Texas	--	--	7	7	8	7
Post Oak Savannah	--	--	100	100	123	118

GCD	Existing DFC			Without Shallow GW Zone (layer 1)		
	Yegua	Jackson	Yegua-Jackson	Area	Saturated Thickness	Entire Volume
Brazos Valley	70	114	--	115	125	125
Fayette County	--	--	77	114	127	127
Lost Pines	--	--	--	86	94	94
Mid-East Texas	--	--	7	13	14	14
Post Oak Savannah	--	--	100	161	162	164

Current MAGs for Yegua-Jackson

TABLE 10 **MODELED AVAILABLE GROUNDWATER FOR THE YEGUA-JACKSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2069. VALUES ARE IN ACRE-FEET PER YEAR.**

Groundwater Conservation District	County	Aquifer	2010	2020	2030	2040	2050	2060	2069
Brazos Valley GCD	Brazos	Jackson	4,411	4,404	4,402	4,402	4,402	4,402	4,402
Brazos Valley GCD	Brazos	Yegua	2,452	2,452	2,452	2,452	2,452	2,452	2,452
Brazos Valley GCD Total[1]		**Yegua-Jackson**	**6,863**	**6,856**	**6,854**	**6,854**	**6,854**	**6,854**	**6,854**
Fayette County GCD[1]	**Fayette[3]**	**Yegua-Jackson**	**9,262**	**9,262**	**9,262**	**9,262**	**9,262**	**9,261**	**9,261**
Lost Pines GCD[2]	Bastrop	Yegua-Jackson	NR	NR	NR	NR	NR	NR	NR
Lost Pines GCD[2]	Lee	Yegua-Jackson	NR	NR	NR	NR	NR	NR	NR
Lost Pines GCD Total[1,2]		**Yegua-Jackson**	**NR**	**NR**	**NR**	**NR**	**NR**	**NR**	**NR**
Mid-East Texas GCD	Leon	Yegua-Jackson	0	0	0	0	0	0	0
Mid-East Texas GCD	Madison	Yegua-Jackson	809	809	809	809	809	809	809
Mid-East Texas GCD Total[1]		**Yegua-Jackson**	**809**	**809**	**809**	**809**	**809**	**809**	**809**
Post Oak Savannah GCD[1]	**Burleson**	**Yegua-Jackson**	**14,544**	**14,544**	**12,576**	**12,564**	**12,478**	**12,326**	**10,200**
GMA 12 Total[1]		**Yegua-Jackson**	**31,478**	**31,471**	**29,501**	**29,489**	**29,403**	**29,250**	**27,124**

1. Individual estimates are rounded and may not always sum up to the total value displayed.
2. NR: Groundwater Management Area 12 declared the Yegua-Jackson Aquifer not relevant in these areas .
3. Modeled available groundwater values for Fayette County include all of the county (GMA 12 and GMA 15 portions)

Summary

- Calculated DFCs are sensitive to method used to weight the different layers
- Current DFCs are based on weighting all layers the by area covered
- Analysis reproduced current DFCs
- MAGs will be similar to those provided by TWDB

Questions???