Status Report Regarding Updated Groundwater Availability Model for GMA 12

Presented to
BVGCD Board of Directors
By
WSP USA
November 8, 2018

The Previous GAM

- Used MODFLOW code
- Uniform one-mile grid spacing
- Eight layers
- Very flow restrictive to sometimes sealing faults in parts of the model area
- Calibration period 1980-1999

The Updated GAM

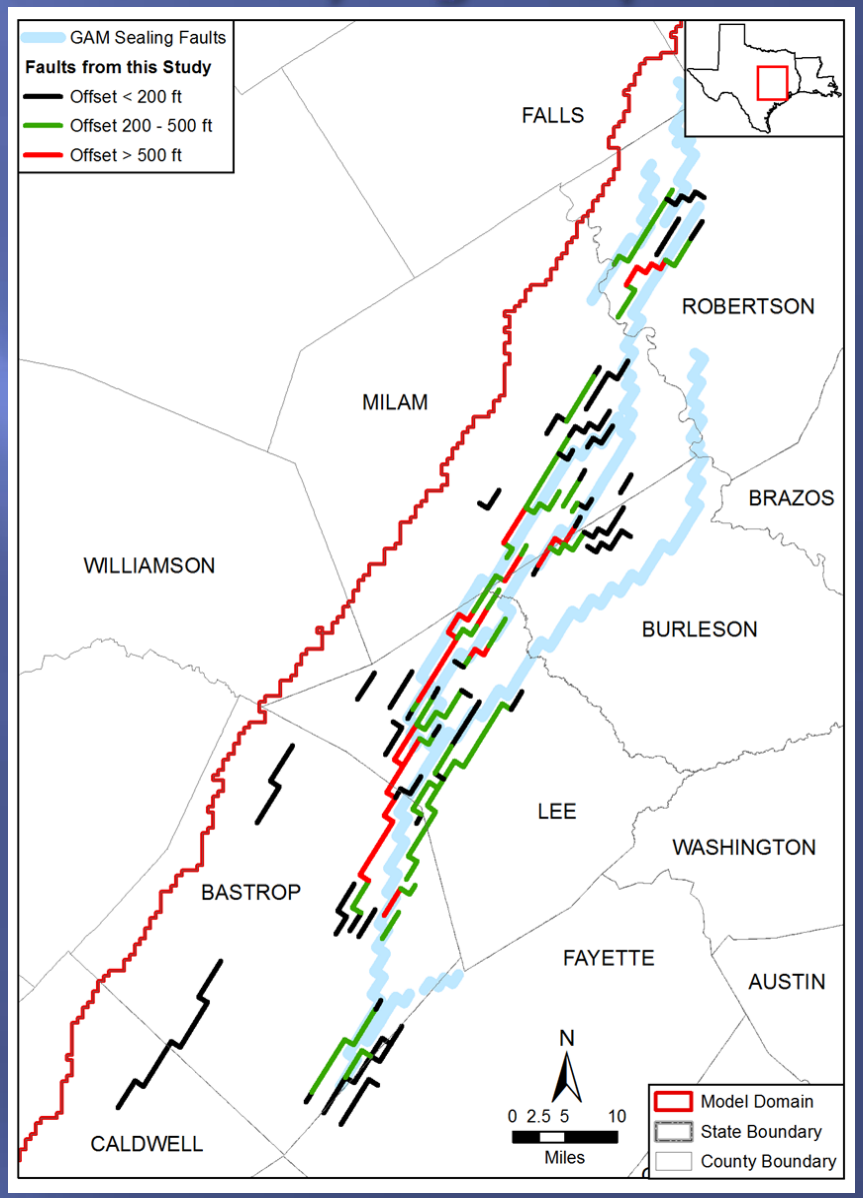
- MODFLOW-USG (unstructured grid)
- Non-uniform grid
- Ten layers
- Updated faults not as sealing and restrictive of groundwater flow
- Calibration period 1930-2010

Model Differences

- Addition of two new model layers:
  - River alluvium
  - Shallow groundwater flow system
- Updating of location and characteristics of faults
- Calibration time period 1930-2010
- Grid refinement around rivers and streams, mainly in Colorado River basin
- Improving surface water-groundwater interactions *(grid refinement, two new layers)*
- Some localized changes in aquifer properties and structure

Updated Fault Representation: Smaller Footprint and Faults with Varying Properties

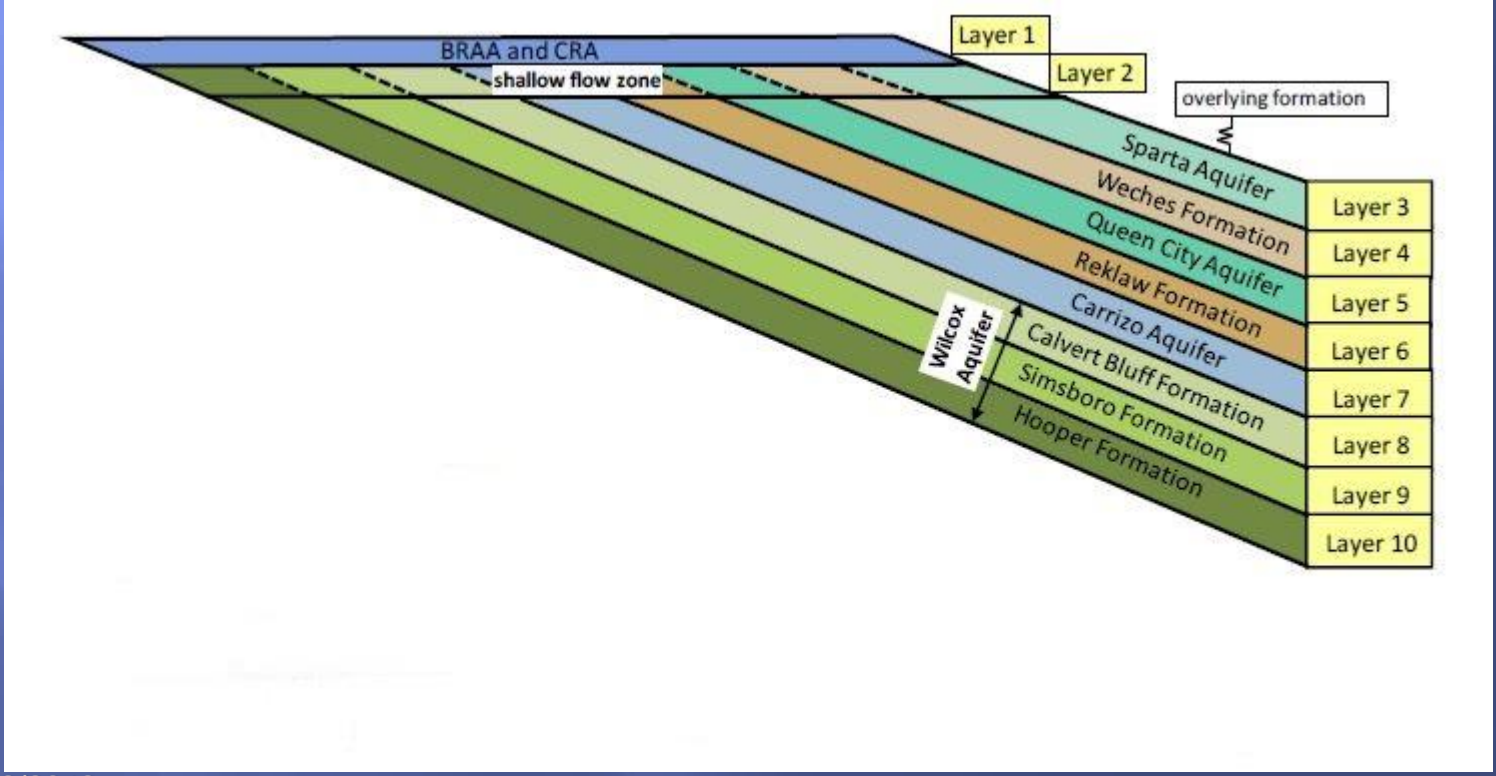
- Faults mapped using geophysical logs
- Properties of faults determined by analysis of pumping tests
- Less obstruction to groundwater flow



Source: Intera GMA 12 Meeting Presentation Regarding GAM Update, October 2018

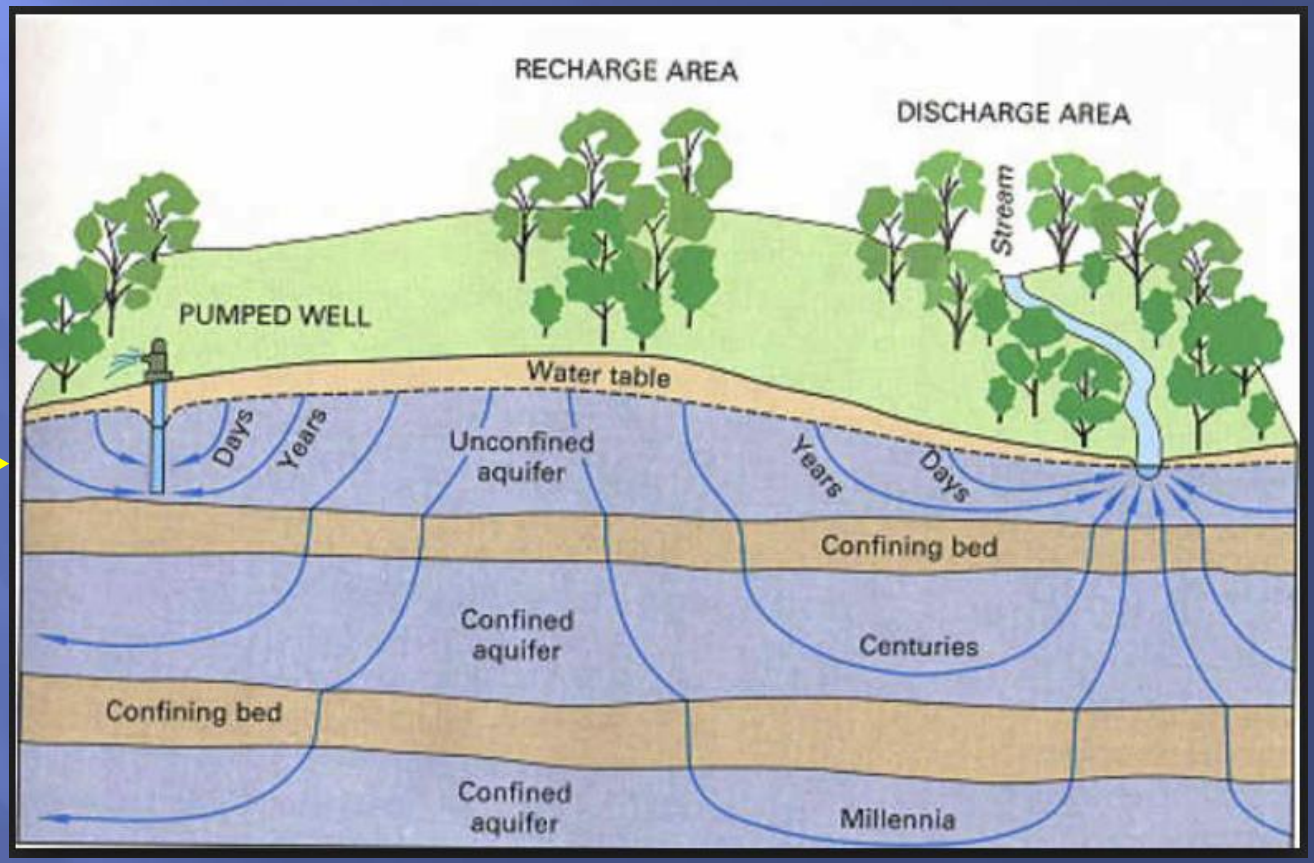
Additional Layers

- Updated GAM includes two new layers
  - Layer 1- River alluvium
  - Layer 2- Shallow groundwater flow systems



Addition of Layer 2

Layer 2 →

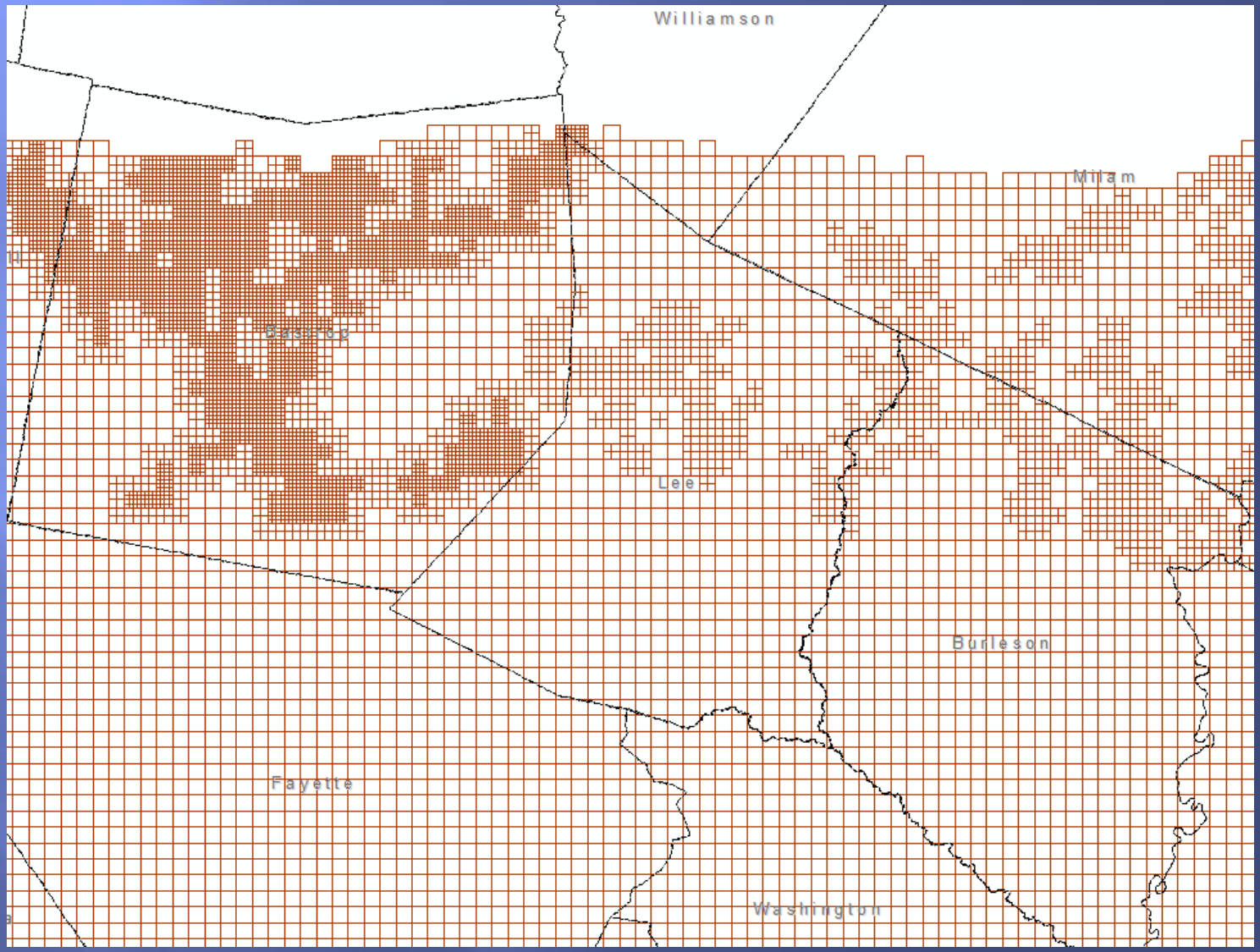


from Winter and others, 1999

Comparison to Updated GAM

- Task performed by LPGCD included running the previous amounts and distribution of pumping in the updated GAM and compare the results
- Direct comparison of results not possible for numerous reasons:
  - Calibration period through 2010 (updated model) vs. 1999 (previous model)
  - Refinement of the grid around rivers and streams
  - Addition of two new model layers
- Methods developed to convert and assess the well file from the previous GAM are still being evaluated

Grid Refinement



Approved DFCs From 2017 Cycle of GMA 12 Planning

GCD or County	Average Aquifer Drawdown (ft) measured from January 2000 through December 2069					
	Sparta	Queen City	Carrizo	Calvert Bluff	Simsboro	Hooper
BVGCD	12	12	61	125	295	207
FCGCD	47	64	110	Declared as non-relevant		
LPGCD	5	15	62	100	240	165
METGCD	5	2	80	90	138	125
POSGCD	28	30	67	149	318	205
Falls	--	--	--	--	-2	27
Limestone	--	--	--	11	50	50
Navarro	--	--	--	-1	3	3
Williamson	--	--	--	-11	47	69
GMA-12	***16***	***16***	***75***	***114***	***228***	***168***

Calibration Time Period Comparison
Previous Model vs. Updated Model

- Previous GAM calibrated through 1999
- Predictive run was 2000 to 2070
- All DFC statements were therefore stated as "Drawdowns from January 2000 to [future date]" with previous model
- Updated GAM calibrated through 2010
- Predictive run is now 2011 to 2070 for current cycle of GMA 12 planning

Drawdown from 2000-2010 using Previous and Updated GAM

GCD or County	Average Aquifer Drawdown (ft) modeled from January 2000 through December 2010											
	Sparta		Queen City		Carrizo		Calvert Bluff		Simsboro		Hooper	
	P	U	P	U	P	U	P	U	P	U	P	U
BVGCD	2	3	1	3	1	6	23	11	88	25	49	14
FCGCD	0	13	0	11	1	10	Declared as non-relevant					
LPGCD	-2	4	-1	4	0	6	9	7	31	9	21	9
METGCD	-1	4	-1	3	16	3	24	3	36	5	32	4
POSGCD	1	3	0	2	-2	6	22	10	66	18	45	11
Falls	-	-	-	-	-	-	-	-	-1	2	3	1
Limestone	-	-	-	-	-	-	1	0.2	16	-0.3	10	-0.2
Navarro	-	-	-	-	-	-	-1	0	2	-0.1	1	-0.1
Williamson	-	-	-	-	-	-	-3	9	15	5	7	4
GMA-12	**0**	**6**	**0**	**4**	**6**	**6**	**19**	**7**	**49**	**12**	**33**	**8**

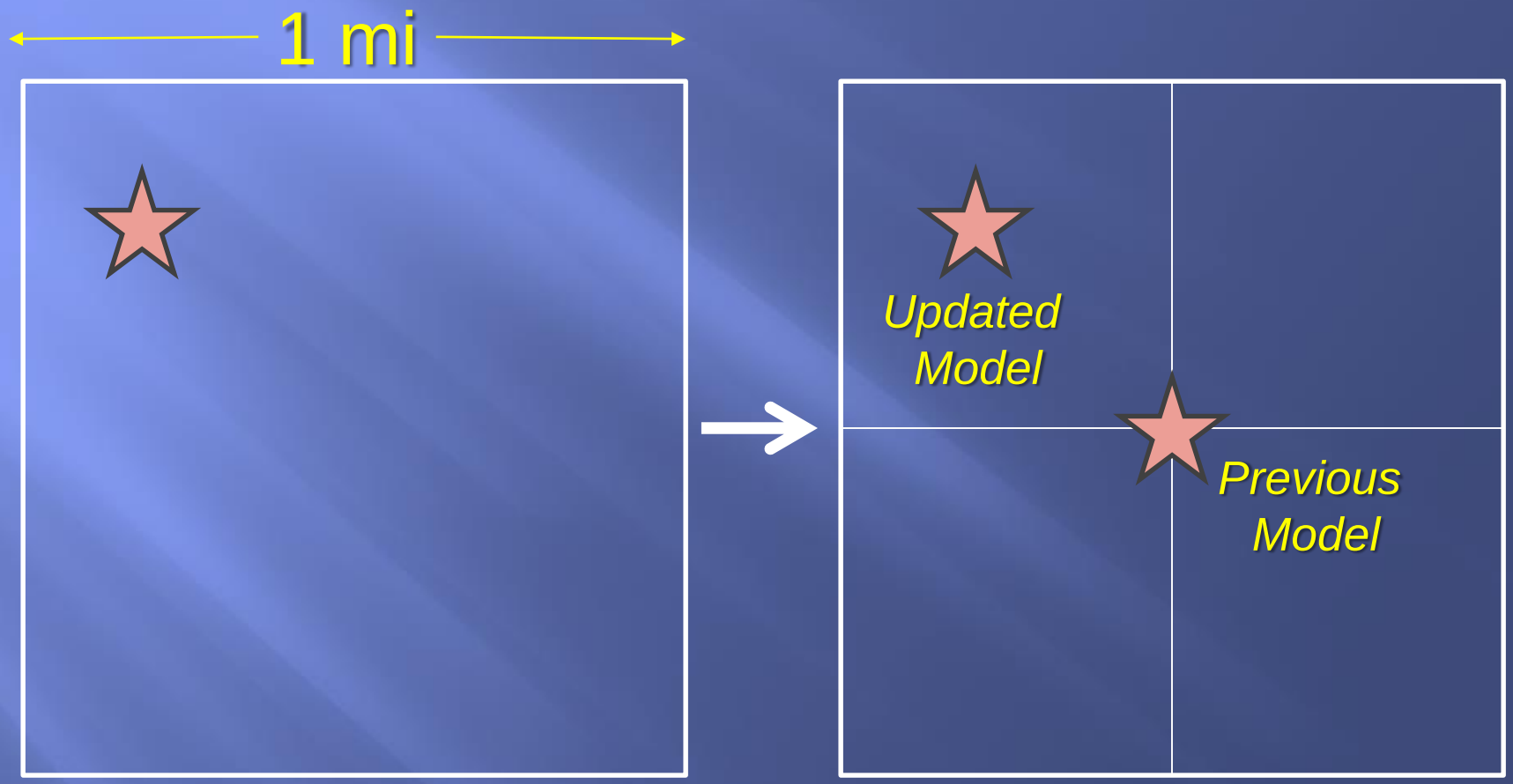
Grid Refinement

- Grid refinement around rivers and streams done to enhance the resolution on surface-water/groundwater interactions
- Selected model cells containing river or streams divided up into either four or sixteen cells per square mile
- Refinement was done by converting the previous MODFLOW model to MODFLOW-USG (unstructured grid)

Grid Refinement

- Had to determine how to divide up the pumping from the 2017 DFC run in cells that had been subdivided
  - Evenly divided the previous pumpage between all new cells in order to replicate previous distribution
- Had to revise analysis of average drawdowns calculations
  - Cell size had to be considered for calculations

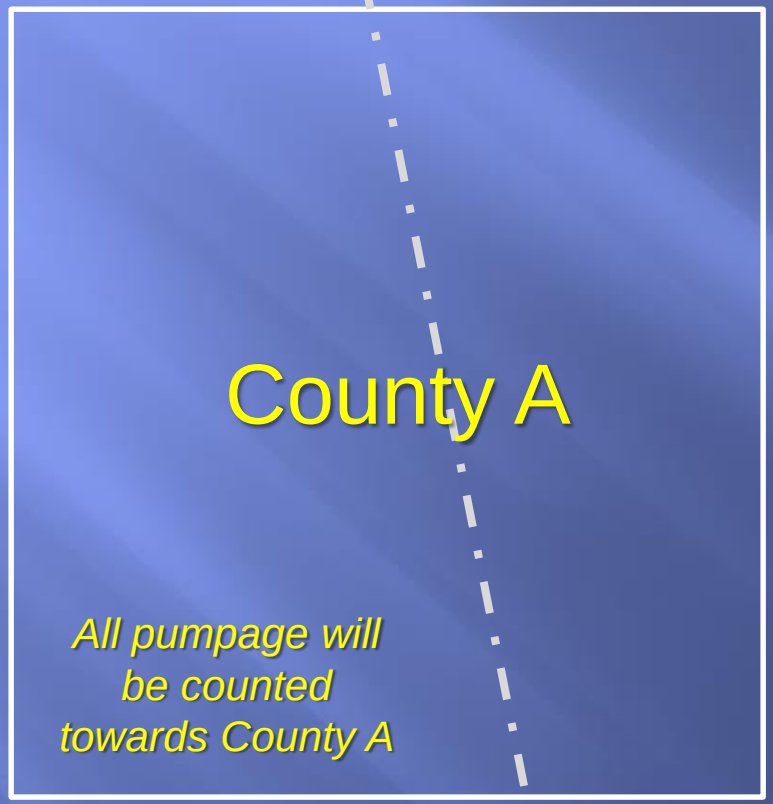
Pumpage



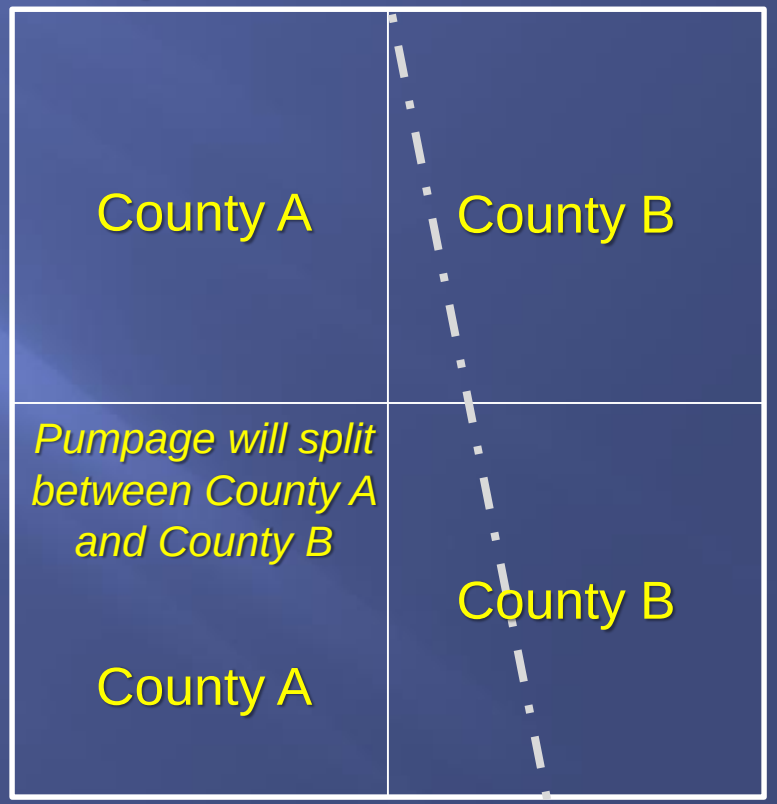
How is a well represented in the converted well file?

County Pumping Totals

Previous Model



Updated Model



Assignment of pumpage to counties will change

Additional Layers

- Updated GAM includes two new layers
  - Layer 1- River alluvium
  - Layer 2- Shallow groundwater flow systems

Addition of Layer 1

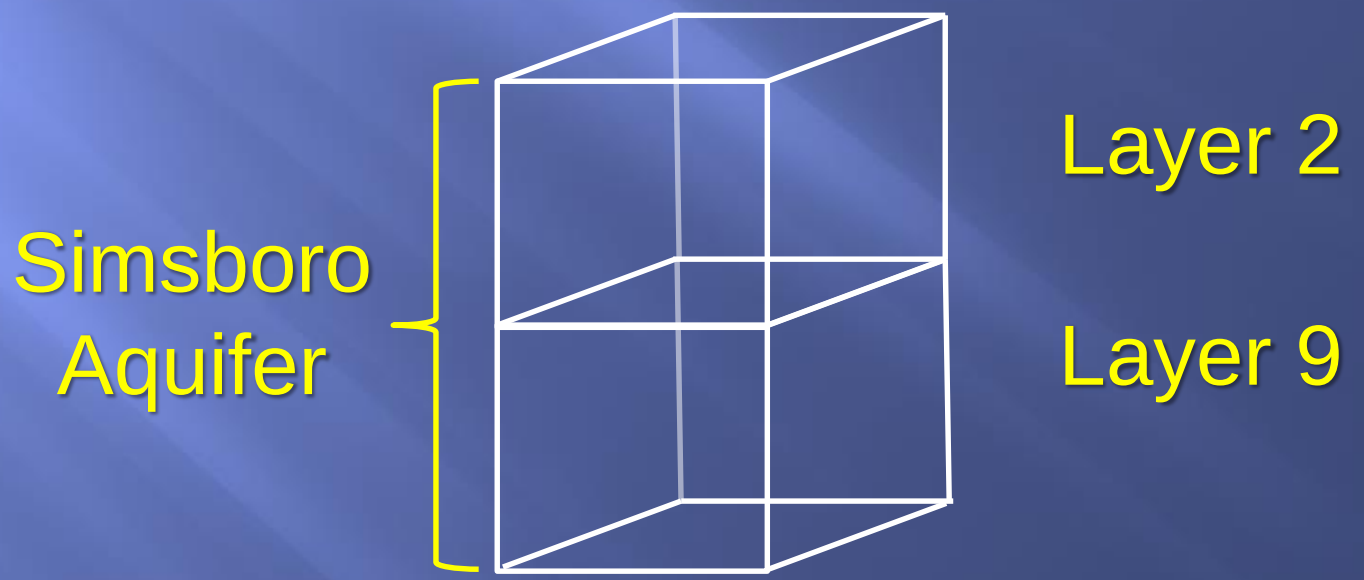
- Layer 1 is only present for the Brazos and Colorado Rivers
- Adds a significant amount of pumping to the model which was not previously included because the alluvium was not present in the previous GAM
- What do we use for the predictive pumping
- Used 2010 pumping for Brazos River Alluvium for each year of the predictive time period

Addition of Layer 2

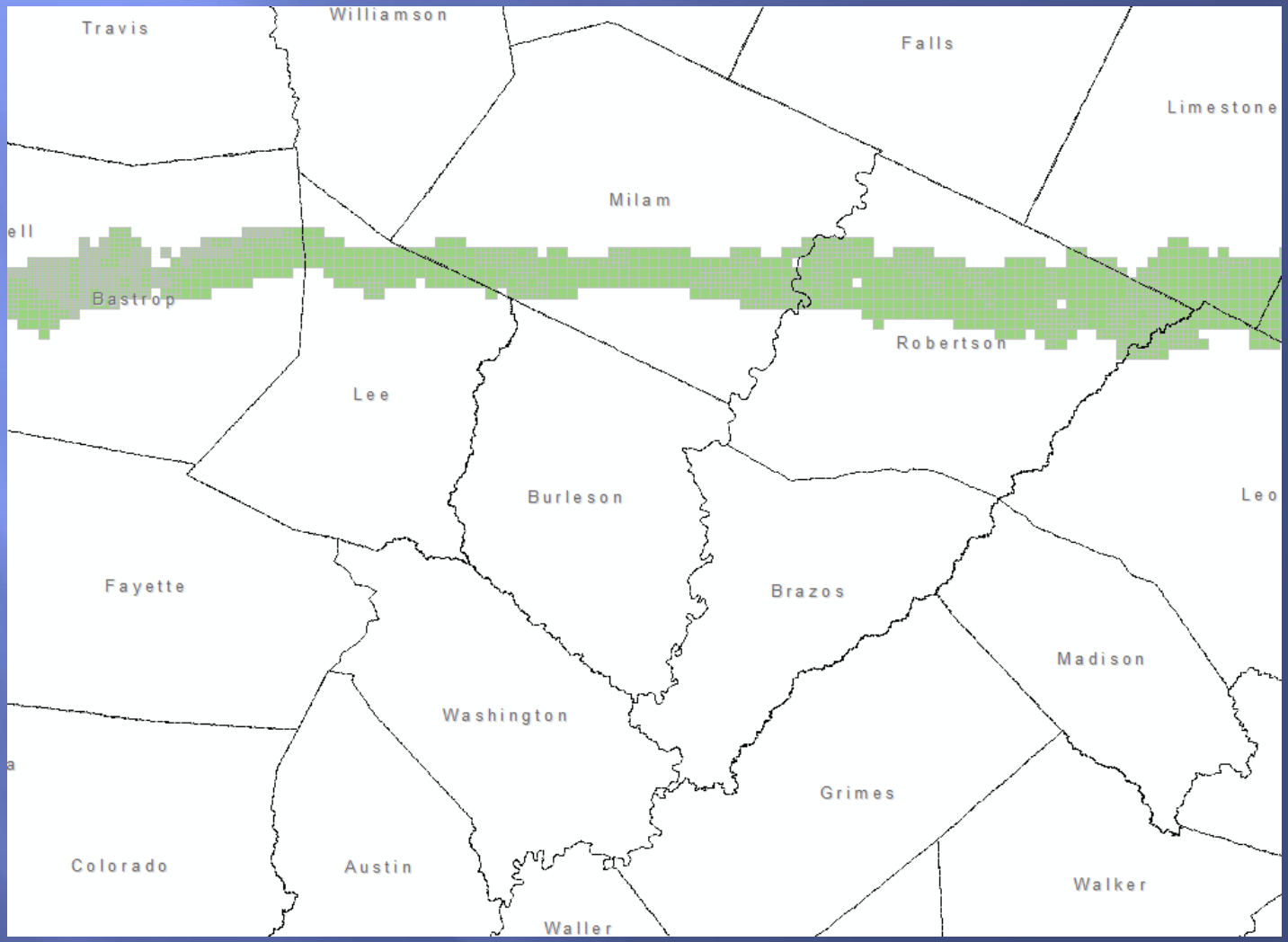
- Layer 2 is the shallow flow systems associated with all of the deeper aquifers
- Layer 2 typically represents the land surface or bottom of the alluvium (top of Layer 2) to 25 to 75 feet below the predevelopment water level (bottom of Layer 2)

Addition of Layer 2

- Results in vertically adjacent cells representing the same aquifer



Location of Vertically Adjacent Cells in Calvert Bluff Aquifer



Vertically Adjacent Cells

- How do we distribute the pumping?
- How do we calculate drawdowns?

Pumping Distribution

- Ran the GAM with and without pumping in Layer 2
- Ultimately should include pumping in the shallow flow system but where and when to include the pumping is uncertain
- Used the trend in shallow system pumping for each county in historic calibration well file to estimate future trend in predictive well file

Pumping Distribution

- Pumping distributed to Layer 2 was compared to the previous shallow system pumping(SP) used in 2017 GMA 12 planning for each county.
  - If the pumping in Layer 2 > , then the pumping in Layer 2 was decreased to the SP level and no pumping was distributed to the lower layer
  - If the pumping in Layer 2 < SP, then this pumping was subtracted from the SP and the remainder was distributed to the lower layer

Drawdown Calculation Options

- Use only the water levels/drawdowns in shallow flow system (Layer 2)
- Use only the water levels/drawdowns in the cell representing the deeper flow system
- Use an average of the water levels/ drawdowns in both the shallow and deep flow systems (straight or weighted average)
- Use the maximum of drawdowns in the shallow and deep flow systems

Runs Conducted

- Run 1- No pumping in Layers 1 or 2
  - Resulted in slightly decreased drawdowns in all aquifers
- Run 2- No pumping in Layer 2
  - Resulted in slightly increased drawdowns in Layers 3-10
- Run 3- Pumping included in all layers
  - This should be the standard method moving forward

Range of Preliminary Results for All Runs – Updated Model

GCD or County	Average Aquifer Drawdown (ft) modeled from January 2011 through December 2070					
	Sparta	Queen City	Carrizo	Calvert Bluff	Simsboro	Hooper
BVGCD	~40	~35-40	~65-75	~80-85	~145-150	~115-125
FCGCD	~35	~65	~135	Declared as non-relevant		
LPGCD	~25	~30	~100	~85-90	~140-145	~105
METGCD	~25	~20	~40	~40	~50	~50
POSGCD	~60-65	~30-35	~105-110	~110-115	~190-200	~150
Falls	--	--	--	--	~10-15	~5
Limestone	--	--	--	~10	~10	~5
Navarro	--	--	--	~0	~0	~0
Williamson	--	--	--	~30	~25-30	~15
GMA 12	***~35***	***~35***	***~80-85***	***~80-85***	***~125-130***	***~105***

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Summary

- Several significant differences between the previous and updated GAMs- faults, calibration time period, grid, layering
- Updated GAM significantly impacts calculated drawdowns from previous GAM run
- It was not possible to do an exact comparison of the previous amount and distribution of pumpage (MAGs) in the updated GAM
  - Multiple ways that PS-12 from 2017 GMA 12 planning can be converted for use in the updated GAM
  - Multiple ways to evaluate results and calculate drawdowns

Summary

- Exclusion of pumpage in Layer 1 (alluvium) decreases the drawdowns by 0 to 8 feet
- Exclusion of pumpage in Layer 2 (shallow flow systems) increases the drawdowns by 0 to 2 feet
- Drawdowns are similar between Runs 1, 2 and 3
- Drawdowns in Sparta and Queen City are higher than using previous GAM
- Drawdowns in Carrizo similar (GMA-wide) as the previous GAM *(but vary by GCD)*
- Drawdowns in all three Wilcox aquifers are lower than using the previous GAM

Summary

- It is apparent that all users *(GMA 12, GCDs, TWDB, etc.)* must come to a consensus as to how the model will be set up and used for joint groundwater planning
- Consultants for GCDs in GMA 12 recommend using the Run 3 method to represent pumping in the shallow flow system plus Brazos River Alluvium. Desired Future Conditions (DFCs) would continue being expressed by aquifer