GMA 14 Model Update
Predictive Scenarios Comparison

Groundwater Management Area 14

April 30, 2025

Outline

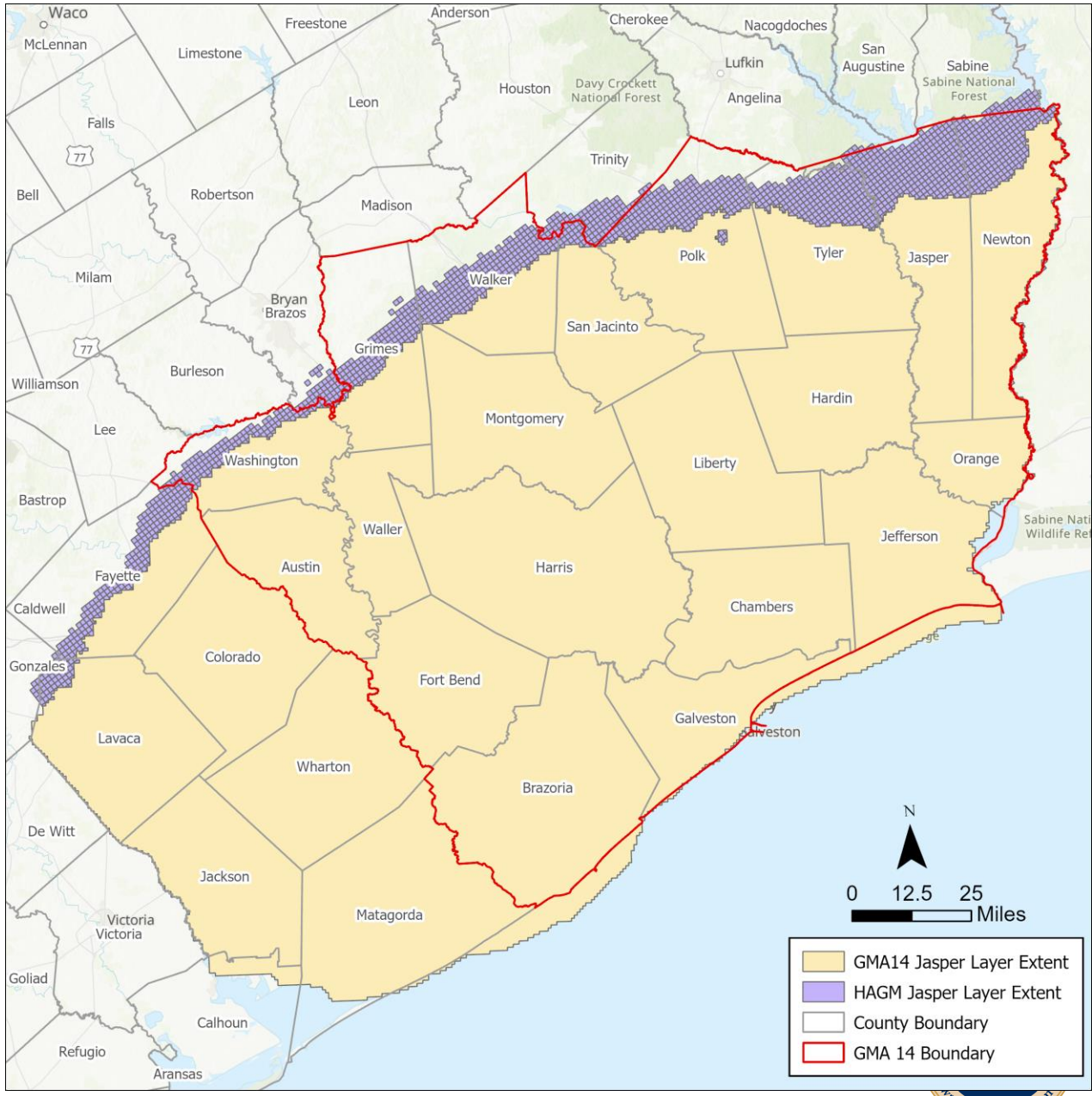
- 2021 joint planning round modeling approach/metrics
- Model outcrop changes
- Approach to developing modeling results comparison
- Modeling results comparison
- Discuss other evaluation metrics
- Discuss possible predictive simulation(s)

2021 Joint Planning Modeling

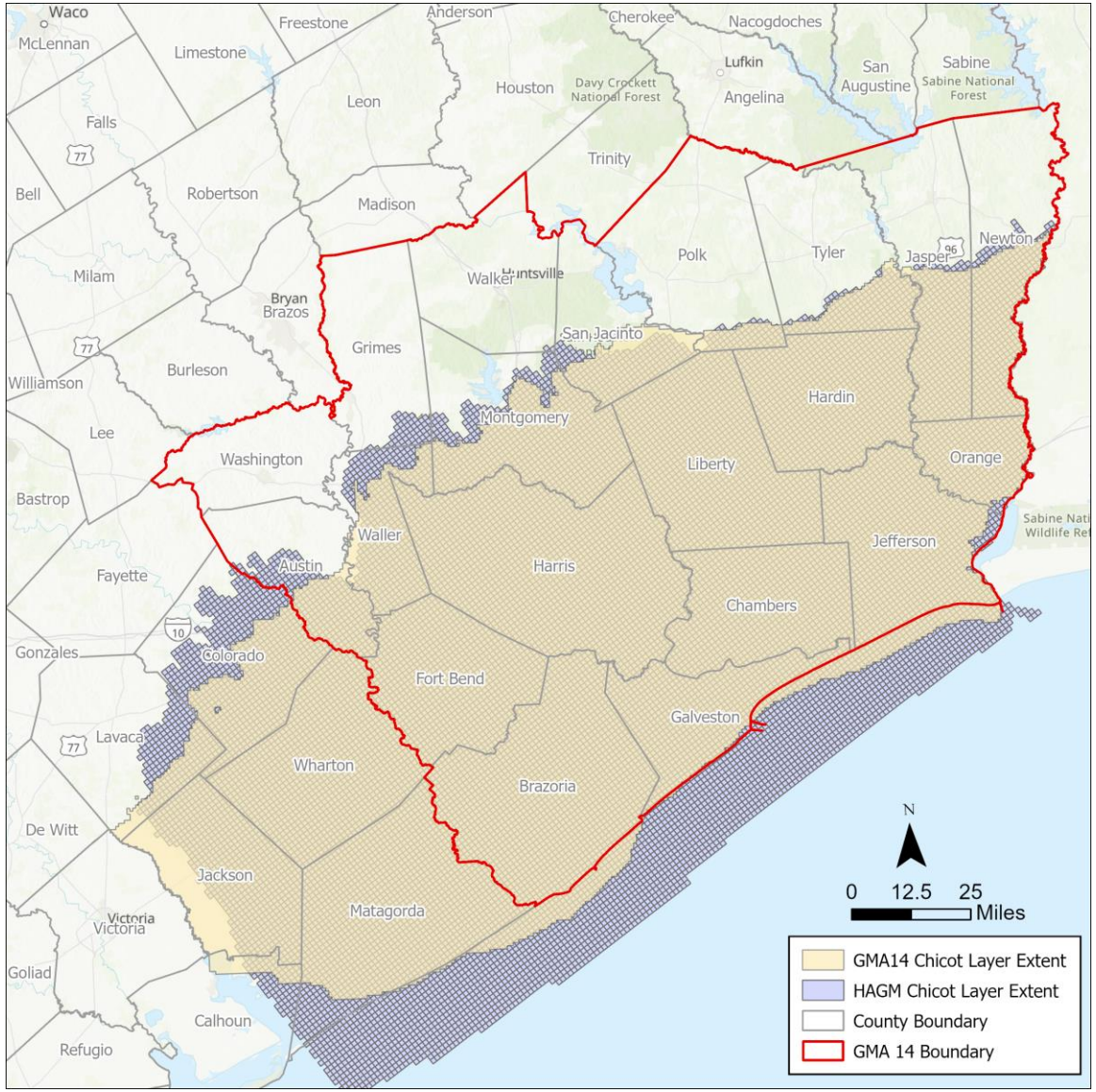
- Difference between 12/31/2009 and 12/31/2080
- Two Criteria – Whichever is met first is the limiting factor
  - 70 percent median remaining available drawdown
    - Calculated at all well locations from TWDB databases
    - Available drawdown set as the difference between the simulated water level and the bottom of the well
  - One foot of average additional subsidence calculated as average difference for all model cells in a county
- Pumping allowed to change in all areas except subsidence districts to meet criteria

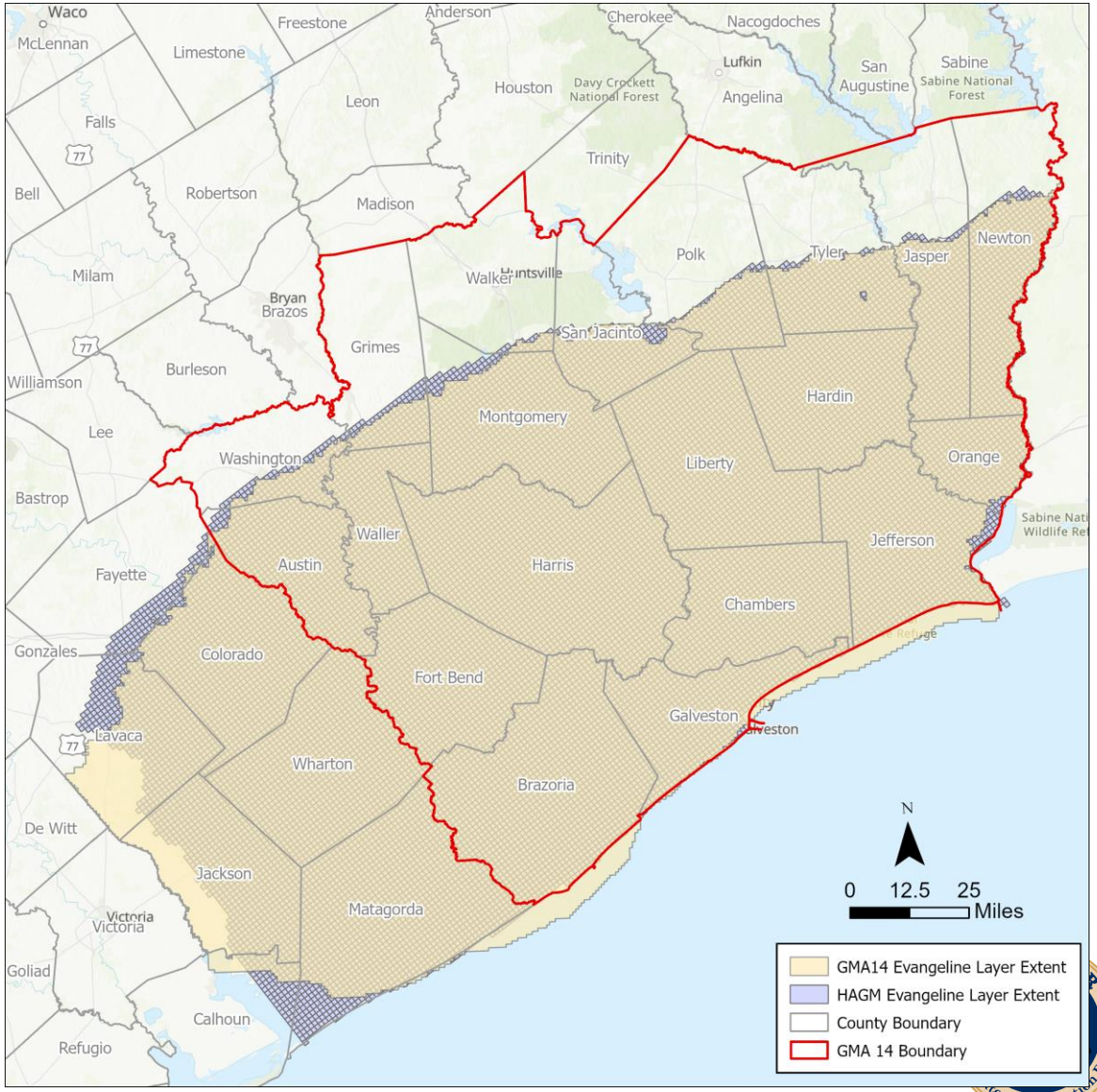
HAGM and GMA 14 Outcrop Differences

- Outcrop of aquifer layers adjusted in GULF-2023 / GMA 14 Model
- No pumping applied in Layer 1 (model surficial layer)
- Required pumping distribution to be adjusted to maintain MAG values



Chicot & Evangeline Outcrop Differences

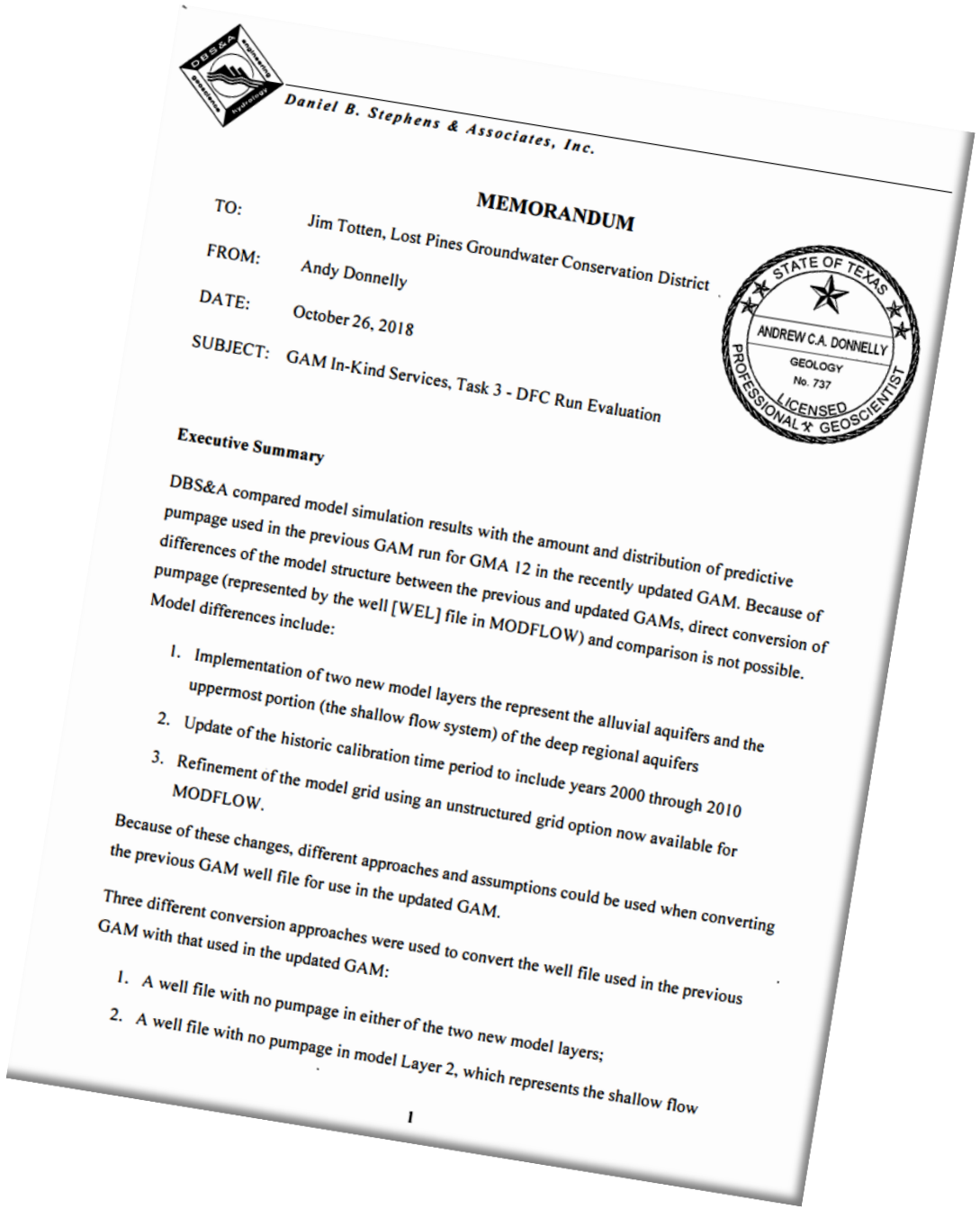




GMA 14 Model Predictive Scenarios

- Used base model only
- Results at the 2021 Joint Planning MAG Pumping
  - Use the HAGM pumping file from last round
  - Set the layer and county pumping = to the 2021 Joint Planning MAG values
  - Had to modify pumping distribution slightly to match 2021 Joint Planning MAG values
- Pumping at the 2021 Joint Planning Modeling Criteria
  - Create the initial pumping distribution based on the 2021 Joint Planning MAG
  - Use PEST++ to refine pumping to meet a 2021 Joint Planning modeling criteria
- Use pumping files in GULF-2023 for comparison of results
  - Predictive simulations would not converge
  - Results shown use the GULF-2023 pumping distribution with a multiplier to increase pumping to the 2021 Joint Planning MAG

GMA 12 Model Update in 2018



Daniel B. Stephens & Associates, Inc.

MEMORANDUM

TO: Jim Totten, Lost Pines Groundwater Conservation District

FROM: Andy Donnelly

DATE: October 26, 2018

SUBJECT: GAM In-Kind Services, Task 3 - DFC Run Evaluation

STATE OF TEXAS
ANDREW C.A. DONNELLY
GEOLOGY
No. 737
LICENSED
PROFESSIONAL GEOSCIENTIST

Executive Summary

DBS&A compared model simulation results with the amount and distribution of predictive pumpage used in the previous GAM run for GMA 12 in the recently updated GAM. Because of differences of the model structure between the previous and updated GAMs, direct conversion of pumpage (represented by the well [WEL] file in MODFLOW) and comparison is not possible. Model differences include:

1. Implementation of two new model layers the represent the alluvial aquifers and the uppermost portion (the shallow flow system) of the deep regional aquifers
2. Update of the historic calibration time period to include years 2000 through 2010
3. Refinement of the model grid using an unstructured grid option now available for MODFLOW.

Because of these changes, different approaches and assumptions could be used when converting the previous GAM well file for use in the updated GAM.

Three different conversion approaches were used to convert the well file used in the previous GAM with that used in the updated GAM:

1. A well file with no pumpage in either of the two new model layers;
2. A well file with no pumpage in model Layer 2, which represents the shallow flow

1

GMA 12 Comparison

New GAM

Table 6. Range of drawdowns calculated for the three simulations using the updated GAM.

GCD or County	Average Aquifer Drawdown (feet) measured from January 2011 through December 2070					
	Sparta	Queen City	Carrizo	Calvert Bluff	Simsboro	Hooper
Brazos Valley GCD	39-41	33-38	66-73	77-84	143-150	115-123
Fayette County GCD	34-35	65	134-135	Declared as non-relevant		
Lost Pines GCD	24-25	27-28	98-99	85-89	138-143	103-105
Mid-East Texas GCD	26-27	19-20	41-42	40-42	50-52	47-48
Post Oak Savannah GCD	62-64	31-33	103-107	110-114	191-198	151-152
Falls County	--	--	--	--	9-15	5
Limestone County	--	--	--	9-12	8-10	7
Navarro County	--	--	--	0.1-0.3	0.2-0.5	0.2
Williamson County	--	--	--	28	23-32	14
GMA-12	***36-37***	***34-36***	***80-84***	***79-83***	***126-131***	***106-107***

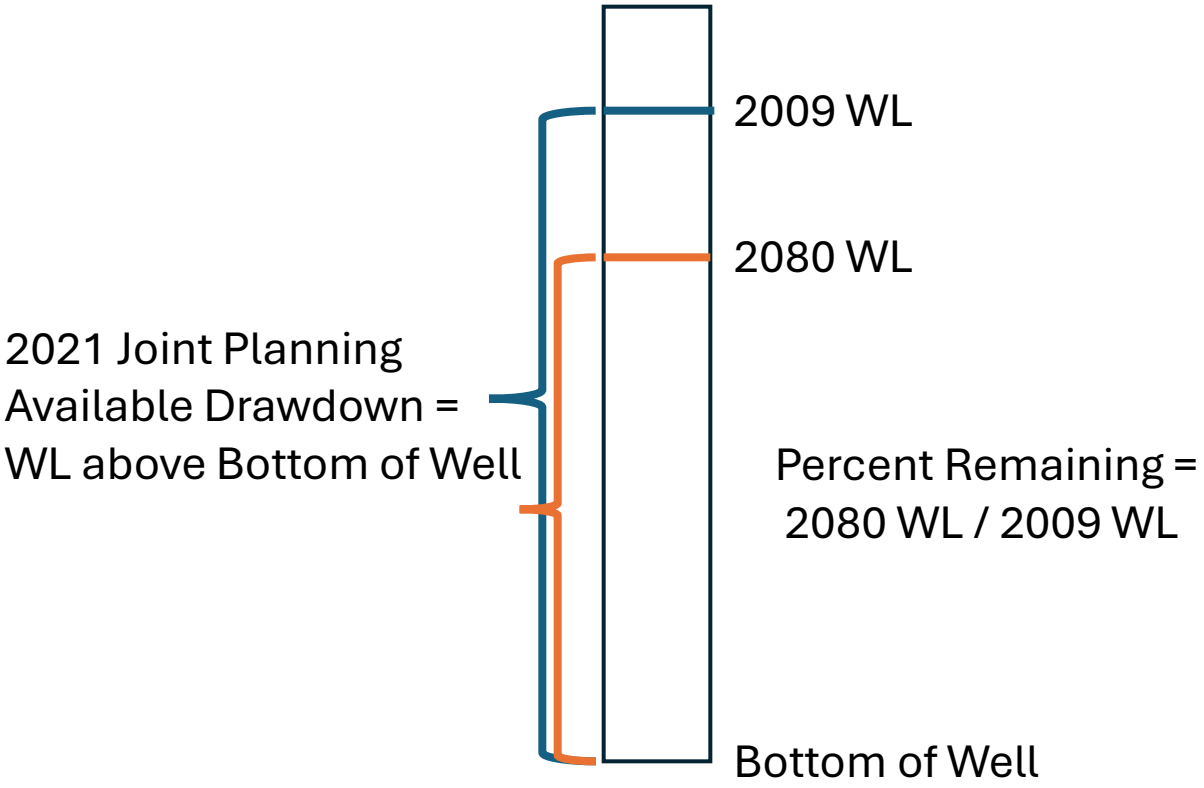
Old GAM

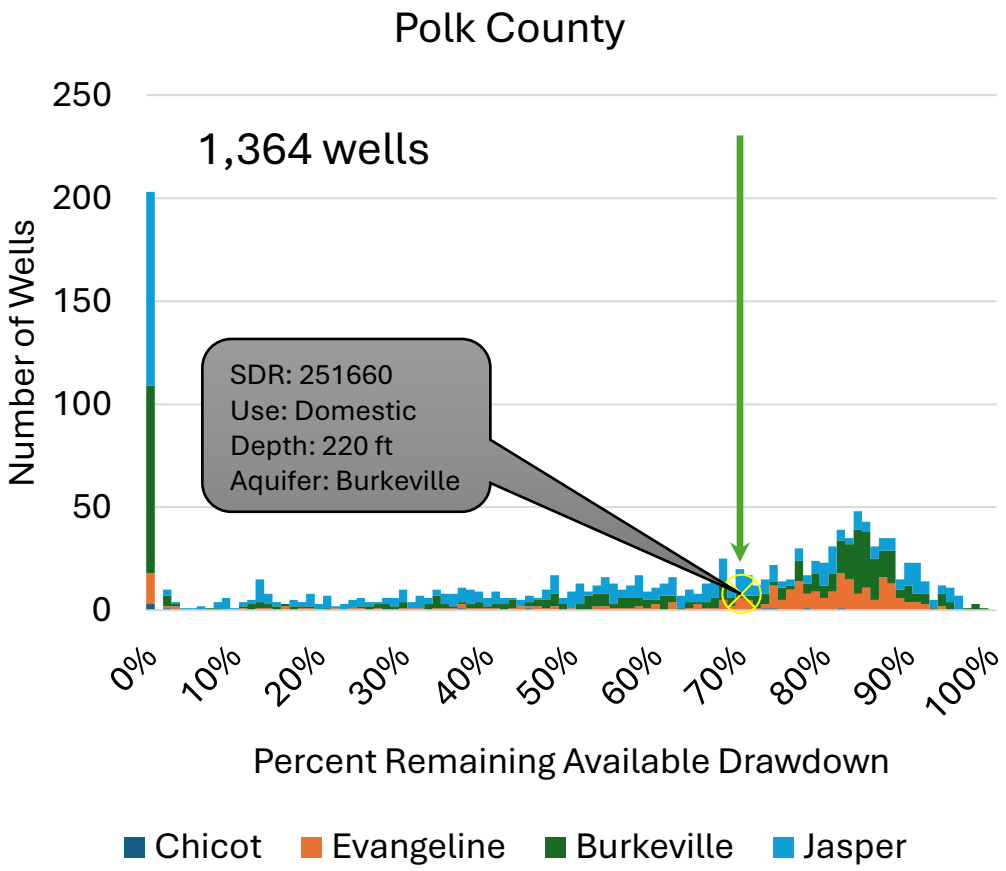
Table 7. Drawdowns calculated using the previous GAM.

GCD or County	Average Aquifer Drawdown (feet) measured from January 2011 through December 2070					
	Sparta	Queen City	Carrizo	Calvert Bluff	Simsboro	Hooper
Brazos Valley GCD	12	12	61	125	295	207
Fayette County GCD	47	64	110	Declared as non-relevant		
Lost Pines GCD	4	16	68	110	251	181
Mid-East Texas GCD	1	-3.2	81	90	138	126
Post Oak Savannah GCD	28	30	67	149	322	206
Falls County	--	--	--	--	-2	27
Limestone County	--	--	--	11	51	53
Navarro County	--	--	--	-1	6	6
Williamson County	--	--	--	-11	47	68
GMA-12	***16***	***16***	***75***	***115***	***231***	***171***

Comparison of Model Results using 2021 Joint Planning MAG

70 Percent Median Remaining Available Drawdown

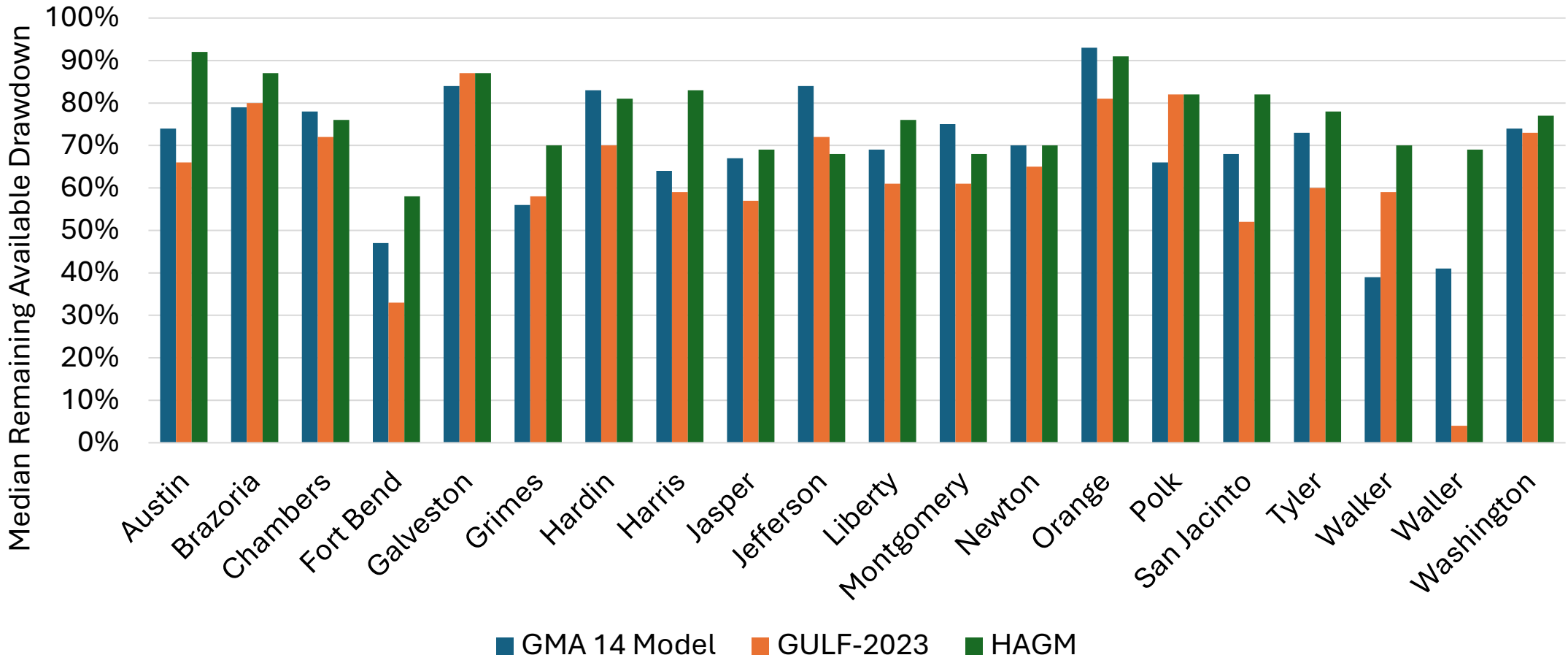




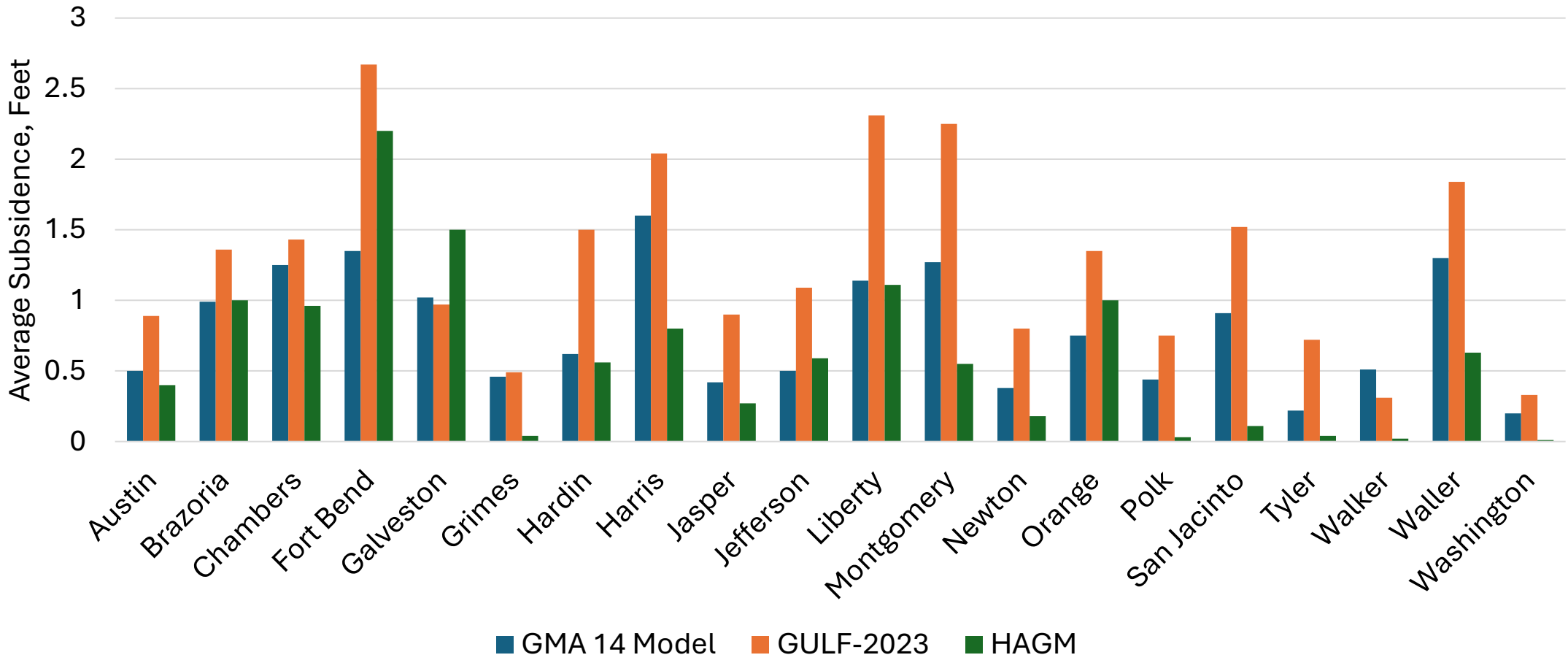
Results at 2021 Joint Planning MAG – 2009 - 2080

County	GMA 14 Model		GULF-2023		HAGM	
	Subsidence	Median Percent Rem. Available Drawdown	Subsidence	Median Percent Rem. Available Drawdown	Subsidence	Median Percent Rem. Available Drawdown
Austin	0.50	74%	0.89	66%	0.40	92%
Brazoria	0.99	79%	1.36	80%	1.00	87%
Chambers	1.25	78%	1.43	72%	0.96	76%
Fort Bend	1.35	47%	2.67	33%	2.20	58%
Galveston	1.02	84%	0.97	87%	1.50	87%
Grimes	0.46	56%	0.49	58%	0.04	70%
Hardin	0.62	83%	1.50	70%	0.56	81%
Harris	1.60	64%	2.04	59%	0.80	83%
Jasper	0.42	67%	0.90	57%	0.27	69%
Jefferson	0.50	84%	1.09	72%	0.59	68%
Liberty	1.14	69%	2.31	61%	1.11	76%
Montgomery	1.27	75%	2.25	61%	0.55	68%
Newton	0.38	70%	0.80	65%	0.18	70%
Orange	0.75	93%	1.35	81%	1.00	91%
Polk	0.44	66%	0.75	82%	0.03	82%
San Jacinto	0.91	68%	1.52	52%	0.11	82%
Tyler	0.22	73%	0.72	60%	0.04	78%
Walker	0.51	39%	0.31	59%	0.02	70%
Waller	1.30	41%	1.84	4%	0.63	69%
Washington	0.20	74%	0.33	73%	0.01	77%

Median Remaining Available Drawdown at 2021 Joint Planning MAG – 2009 - 2080



Average Additional Subsidence at 2021 Joint Planning MAG – 2009 - 2080



Results at 2021 Joint Planning MAG – 2018 - 2080

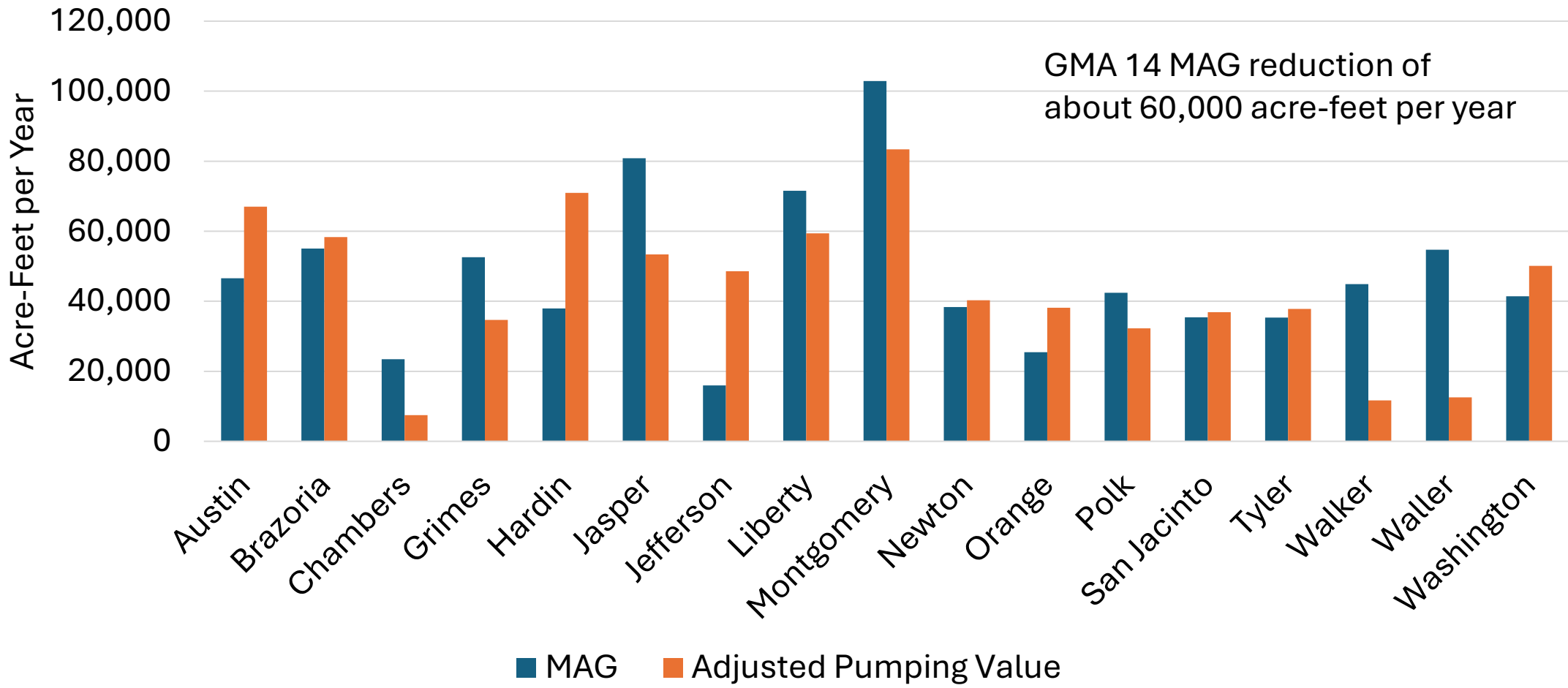
County	GMA 14 Model		GULF-2023		HAGM	
	Subsidence	Median Percent Rem. Available Drawdown	Subsidence	Median Percent Rem. Available Drawdown	Subsidence	Median Percent Rem. Available Drawdown
Austin	0.45	75%	0.84	68%	0.40	92%
Brazoria	0.90	80%	1.29	79%	1.01	87%
Chambers	1.20	82%	1.34	74%	0.96	76%
Fort Bend	1.19	48%	2.50	33%	2.27	58%
Galveston	0.95	86%	0.92	86%	1.50	87%
Grimes	0.43	58%	0.47	60%	0.05	70%
Hardin	0.59	84%	1.42	70%	0.56	81%
Harris	1.37	68%	1.87	60%	0.83	83%
Jasper	0.38	70%	0.85	58%	0.28	69%
Jefferson	0.48	86%	1.03	72%	0.57	68%
Liberty	1.07	75%	2.22	62%	1.11	76%
Montgomery	1.03	78%	1.97	65%	0.56	68%
Newton	0.35	73%	0.77	66%	0.18	70%
Orange	0.70	94%	1.29	81%	0.97	91%
Polk	0.42	70%	0.74	82%	0.04	82%
San Jacinto	0.84	71%	1.47	53%	0.11	82%
Tyler	0.20	77%	0.70	61%	0.04	78%
Walker	0.48	42%	0.29	60%	0.02	70%
Waller	1.18	48%	1.72	5%	0.64	69%
Washington	0.18	75%	0.32	74%	0.01	77%

Comparison of Model Pumping using 2021 Joint Planning Criteria

Pumping at 2021 Joint Planning Modeling Criteria

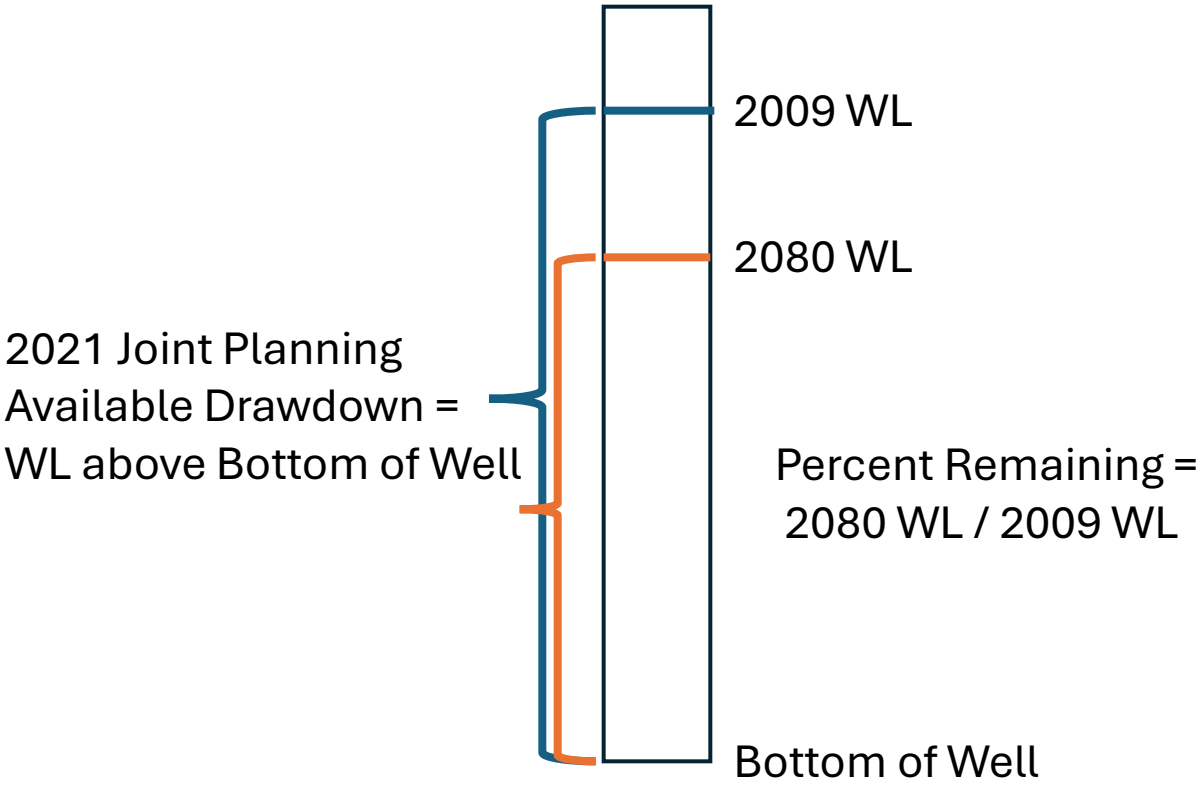
County	Multiplier on MAG	GMA 14 Model			HAGM	
		Adjusted Pumping Value	Subsidence	Median Percent Remaining Available Drawdown	Subsidence	Median Percent Remaining Available Drawdown
Austin	1.44	67,047	0.53	**0.70**	0.40	0.92
Brazoria	1.06	58,337	**1.00**	0.79	1.00	0.87
Chambers	0.32	7,501	**1.00**	0.82	0.96	0.76
Fort Bend	1.00	169,347	1.35	47%	2.20	58%
Galveston	1.00	9,181	1.02	84%	1.50	87%
Grimes	0.66	34,693	0.34	**0.70**	0.04	0.70
Hardin	1.87	70,977	0.89	**0.70**	0.56	0.81
Harris	1.00	228,827	1.60	64%	0.80	83%
Jasper	0.66	53,354	0.39	**0.70**	0.27	0.69
Jefferson	3.04	48,596	0.88	**0.70**	0.59	0.68
Liberty	0.83	59,390	**1.00**	0.73	1.11	0.76
Montgomery	0.81	83,371	**1.00**	0.79	0.55	0.68
Newton	1.05	40,280	0.37	**0.70**	0.18	0.70
Orange	1.50	38,171	**1.00**	0.88	1.00	0.91
Polk	0.76	32,244	0.37	**0.70**	0.03	0.82
San Jacinto	1.04	36,855	0.80	**0.70**	0.11	0.82
Tyler	1.07	37,787	0.22	**0.70**	0.04	0.78
Walker	0.26	11,679	0.27	**0.70**	0.02	0.70
Waller	0.23	12,584	0.79	**0.70**	0.63	0.69
Washington	1.21	50,127	0.21	**0.70**	0.01	0.77

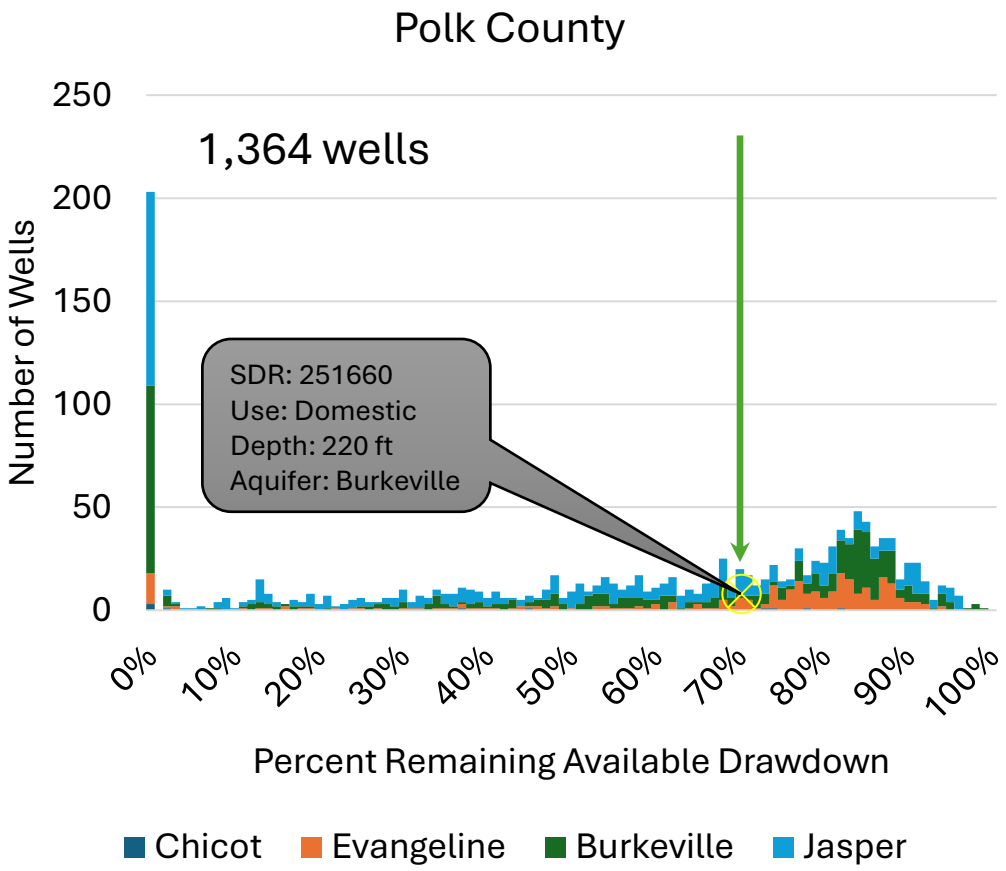
Pumping at 2021 Joint Planning Modeling Criteria



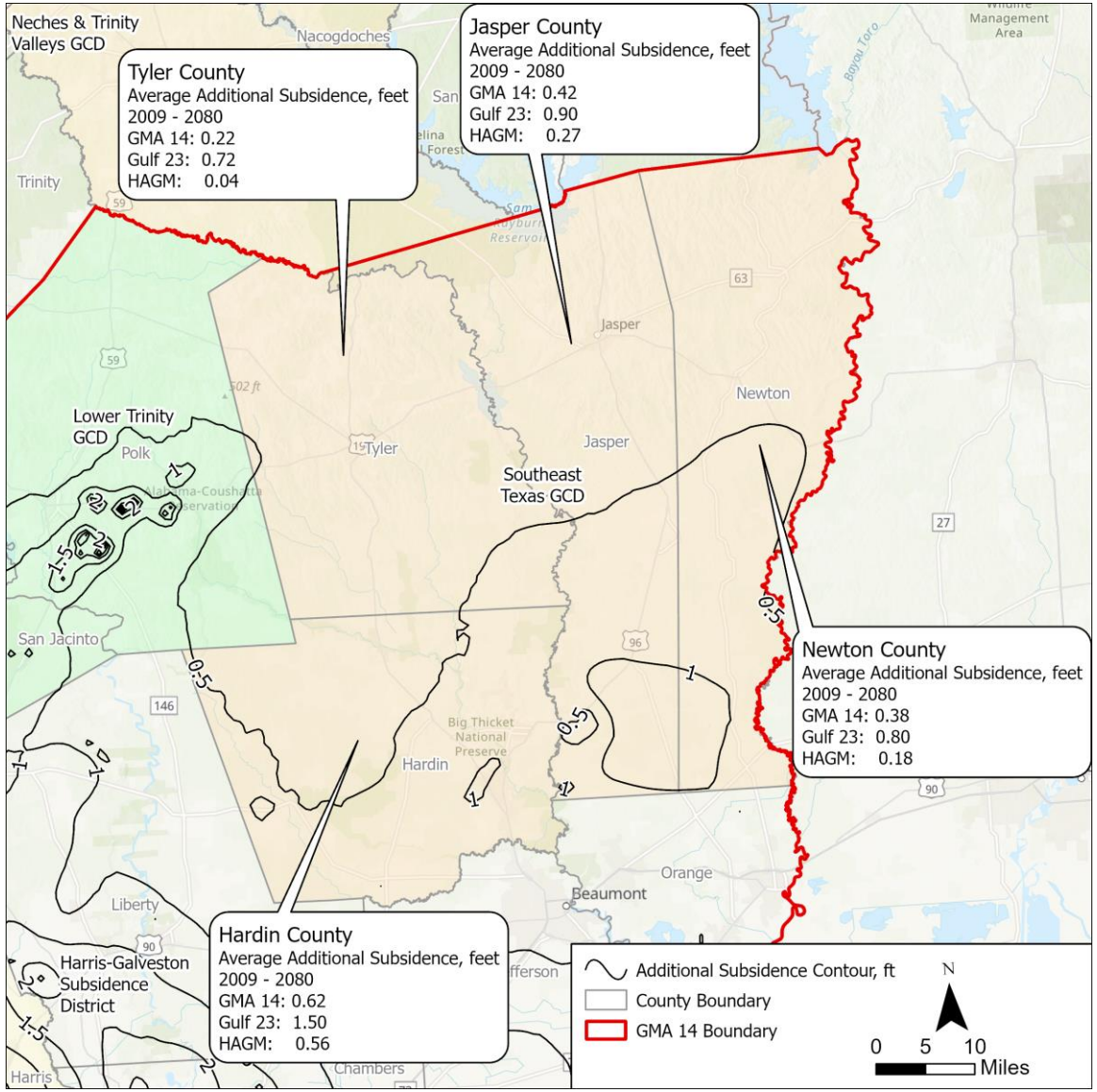
Comparison of Model Results for each District using 2021 Joint Planning MAG

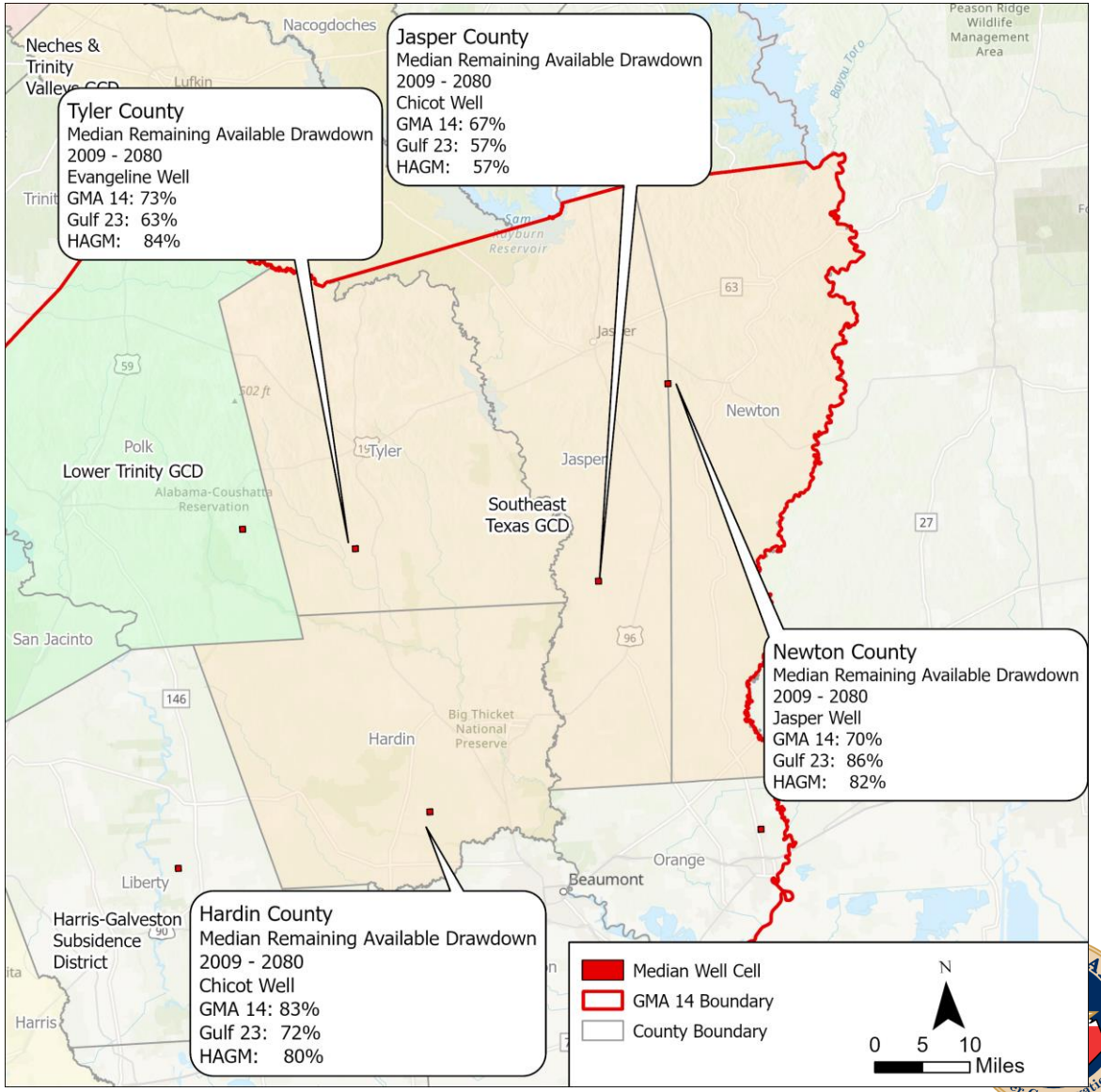
2021 Joint Planning
Median Remaining Available Drawdown



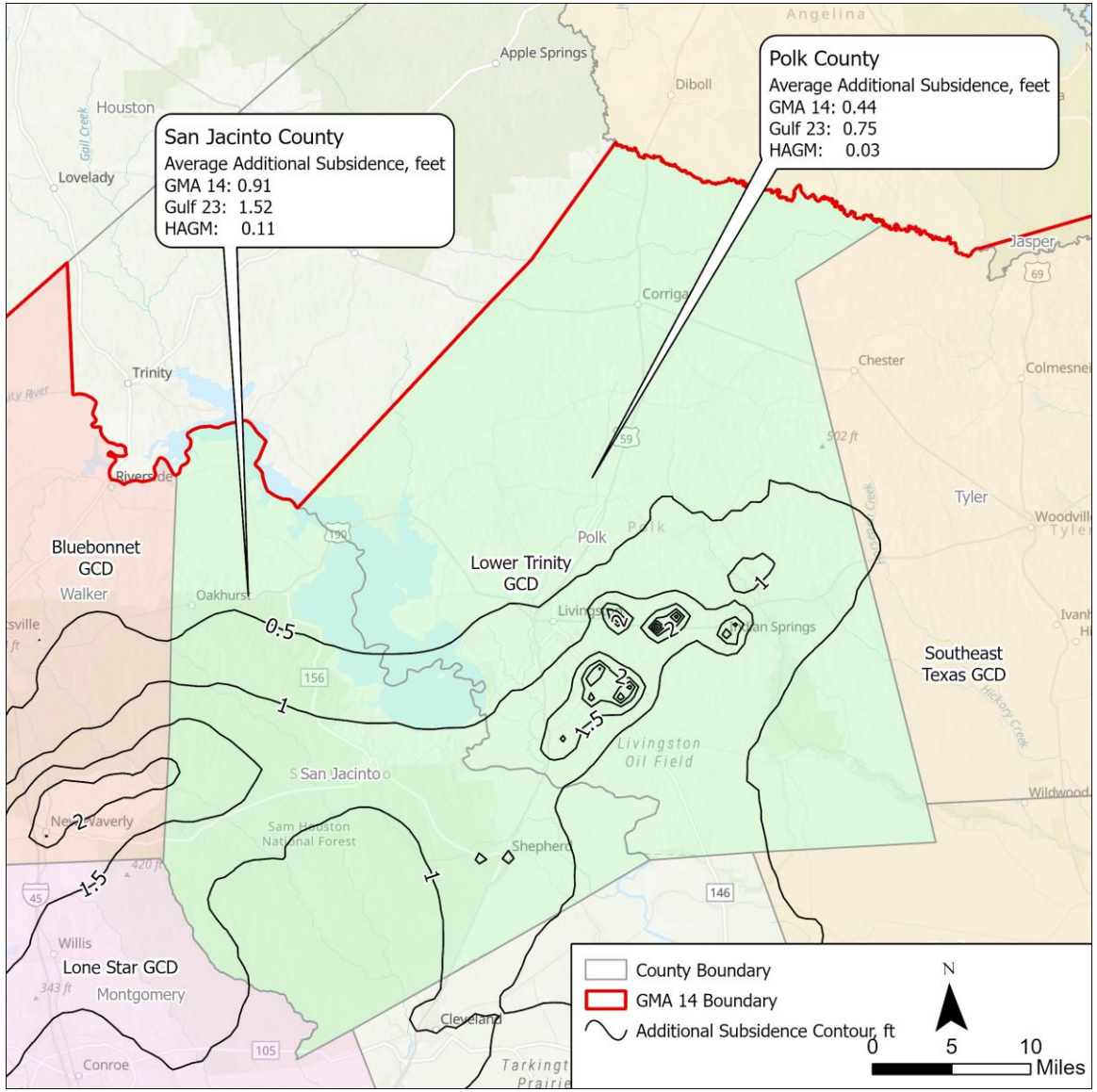


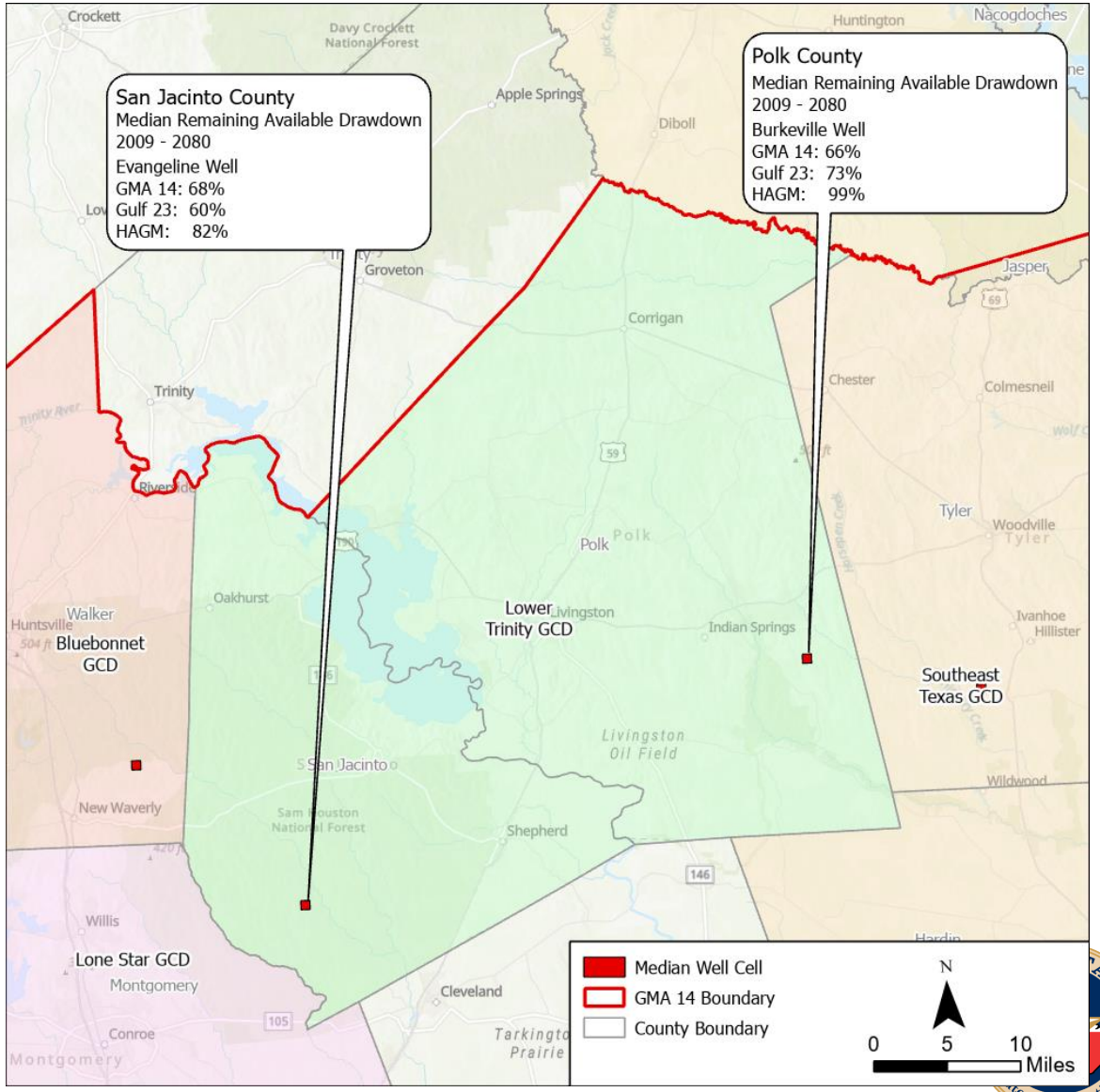
SETGCD – Results at 2021 Joint Planning MAG



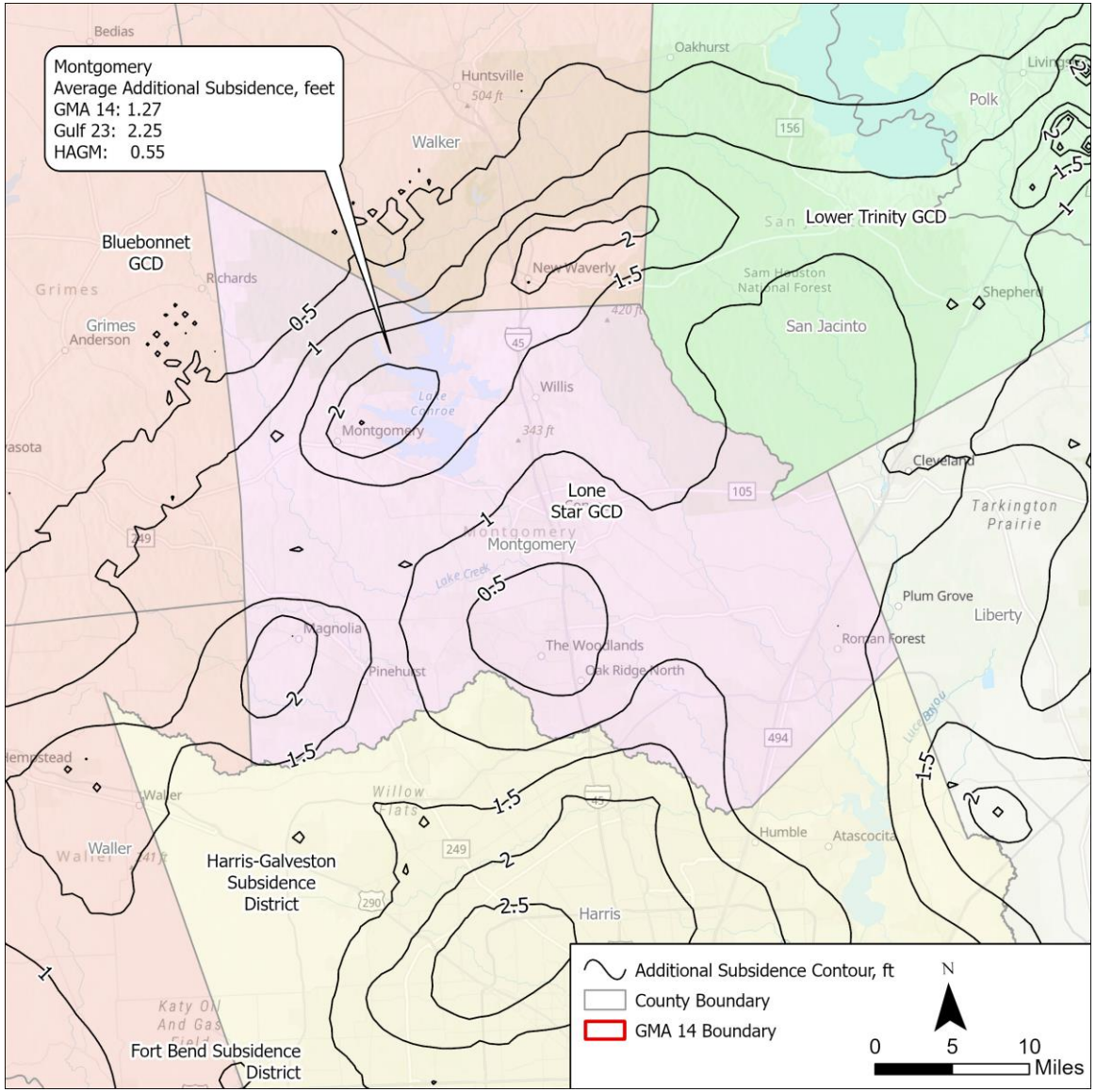


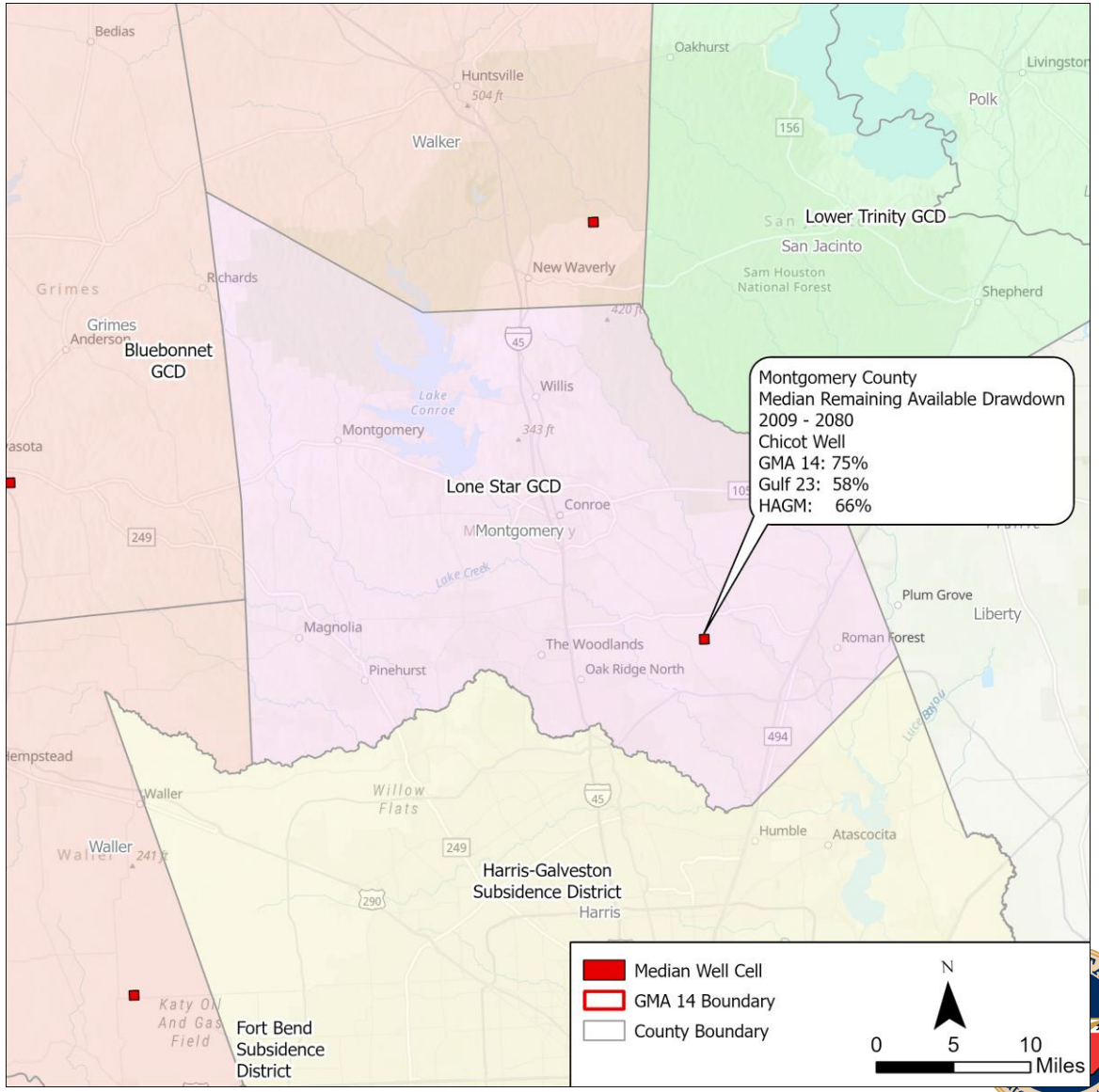
LTGCD – Results at 2021 Joint Planning MAG



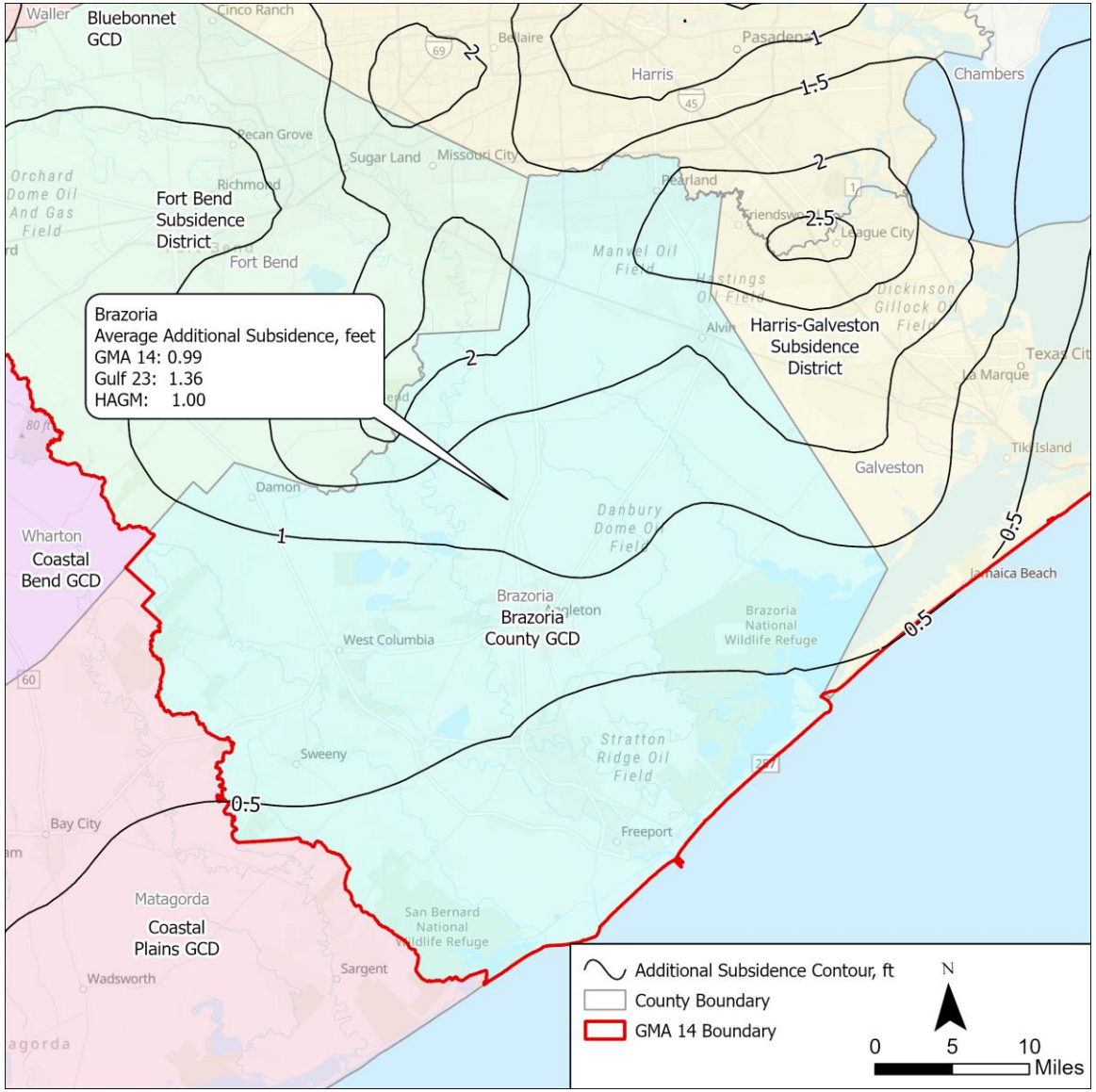


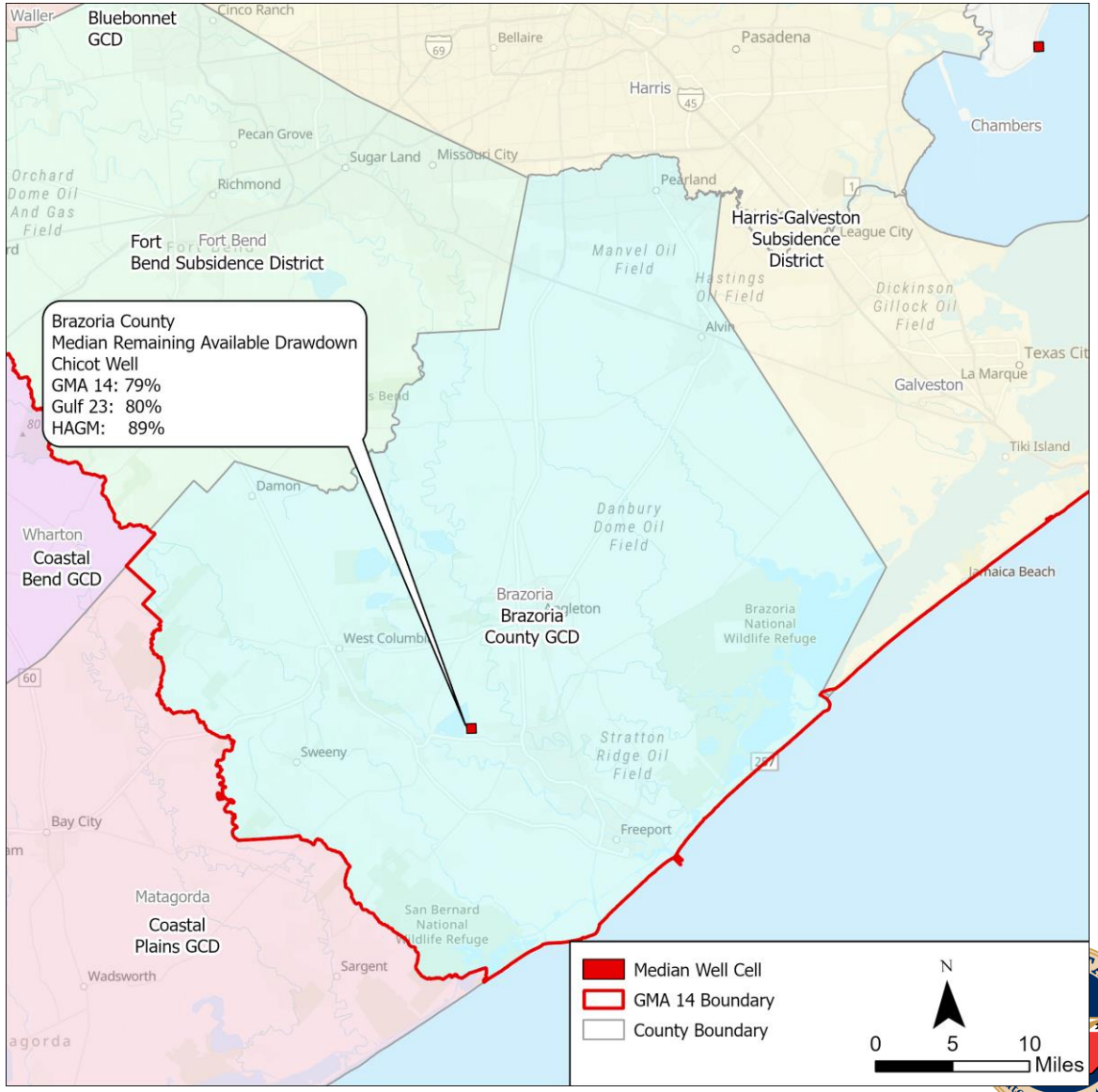
LSGCD – Results at 2021 Joint Planning MAG



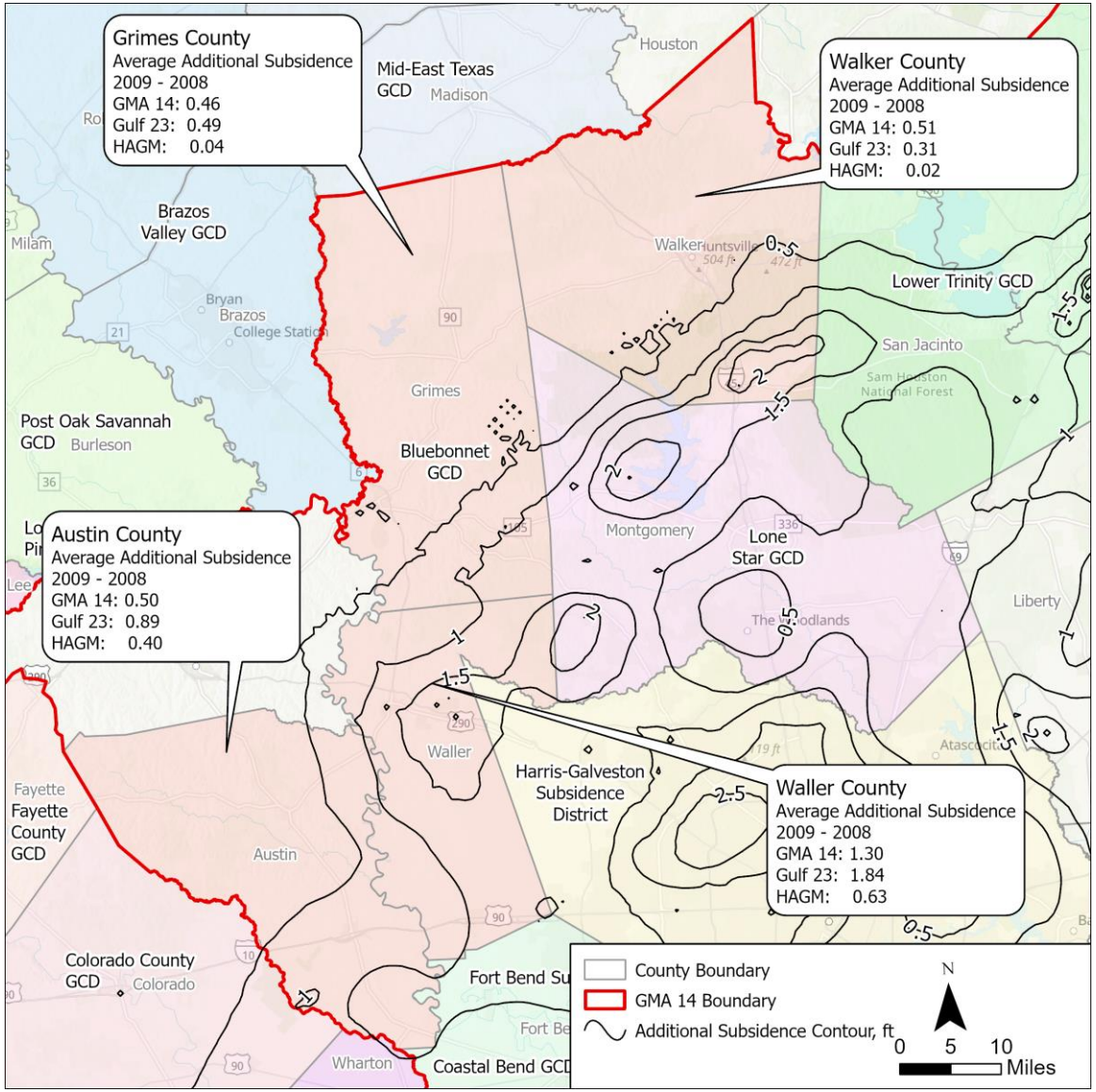


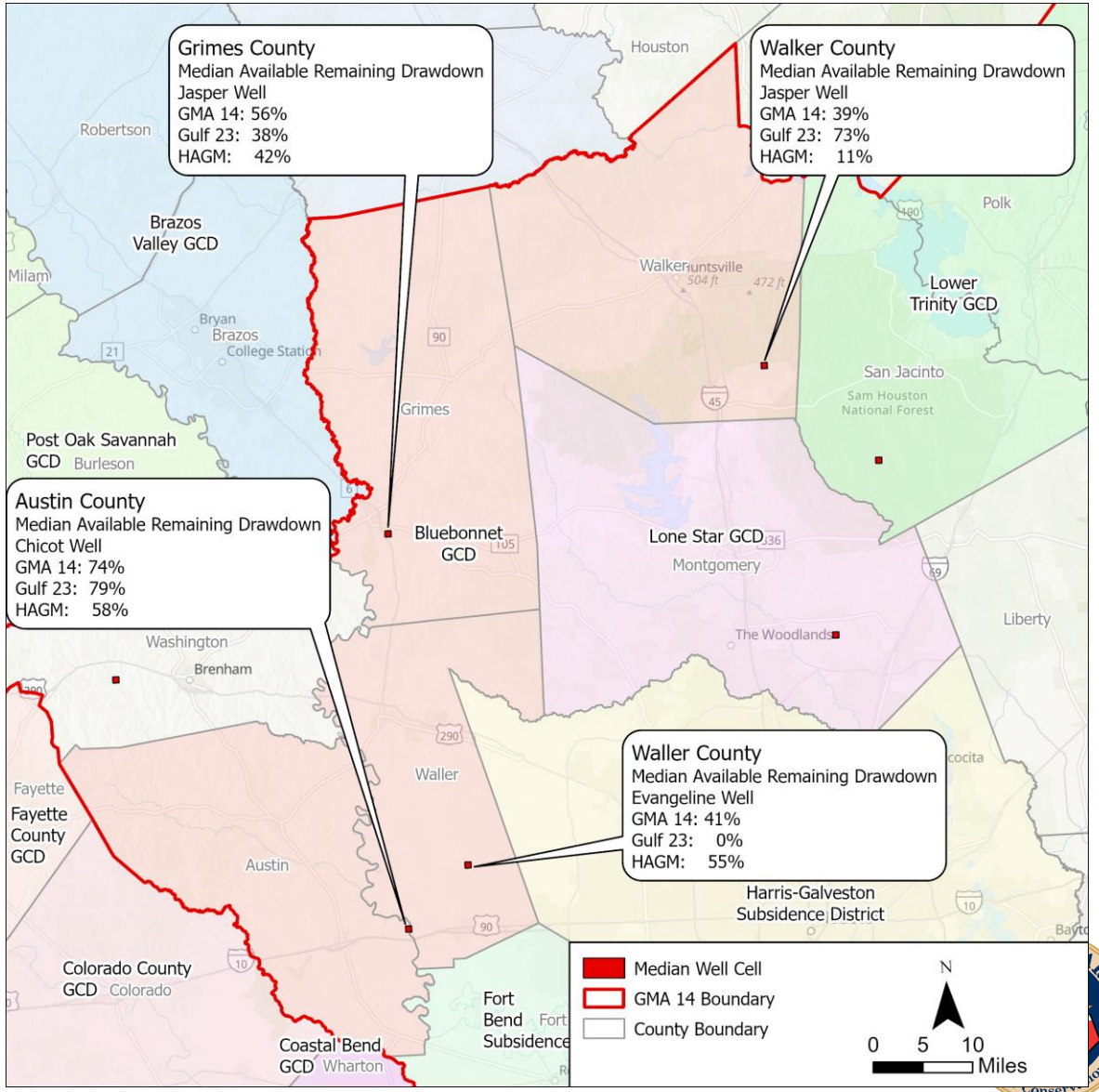
BCGCD – Results at 2021 Joint Planning MAG





BGCD – Results at 2021 Joint Planning MAG





Summary of Model Comparisons

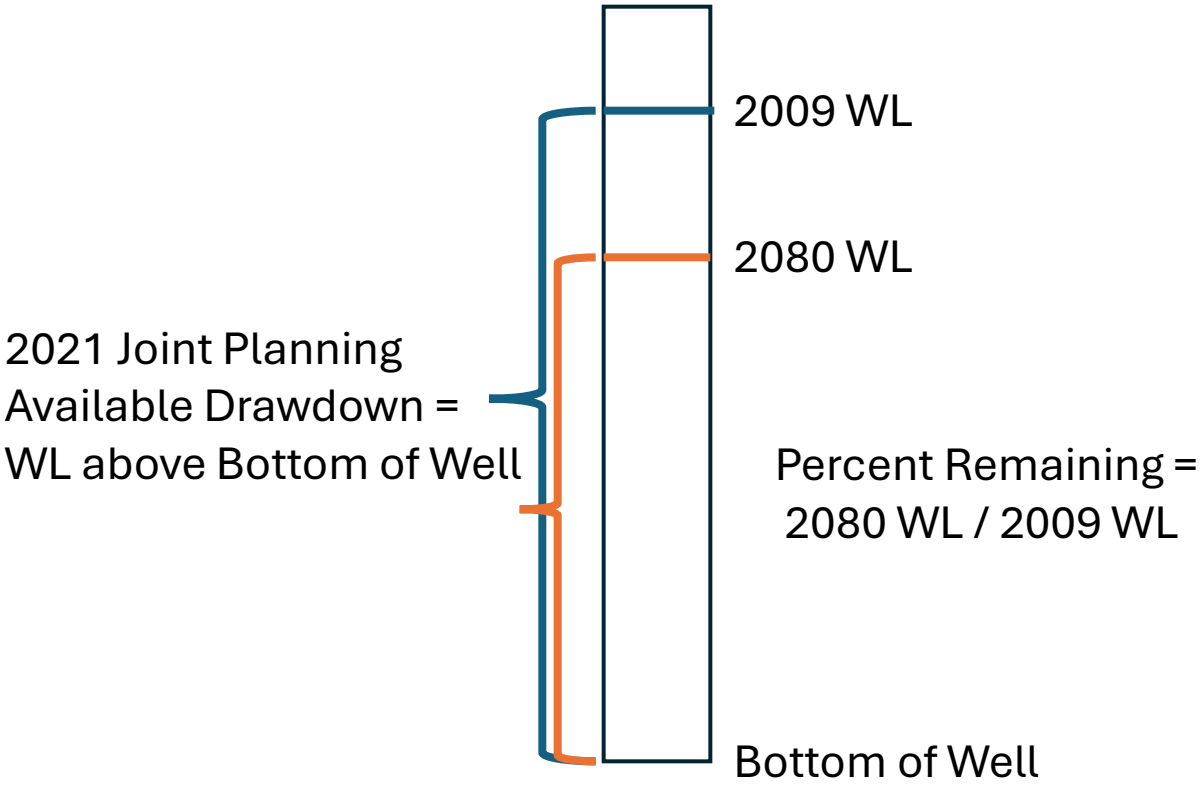
- Changes to the aquifer conceptual model (e.g., outcrop area) affect DFC considerations
- The GMA 14 Model shows generally higher amounts of additional compaction during the predictive period
- With current DFCs, the MAG would decrease in several counties with the GMA 14 Model
- Median percent remaining available drawdown metric may not reasonably reflect District monitoring

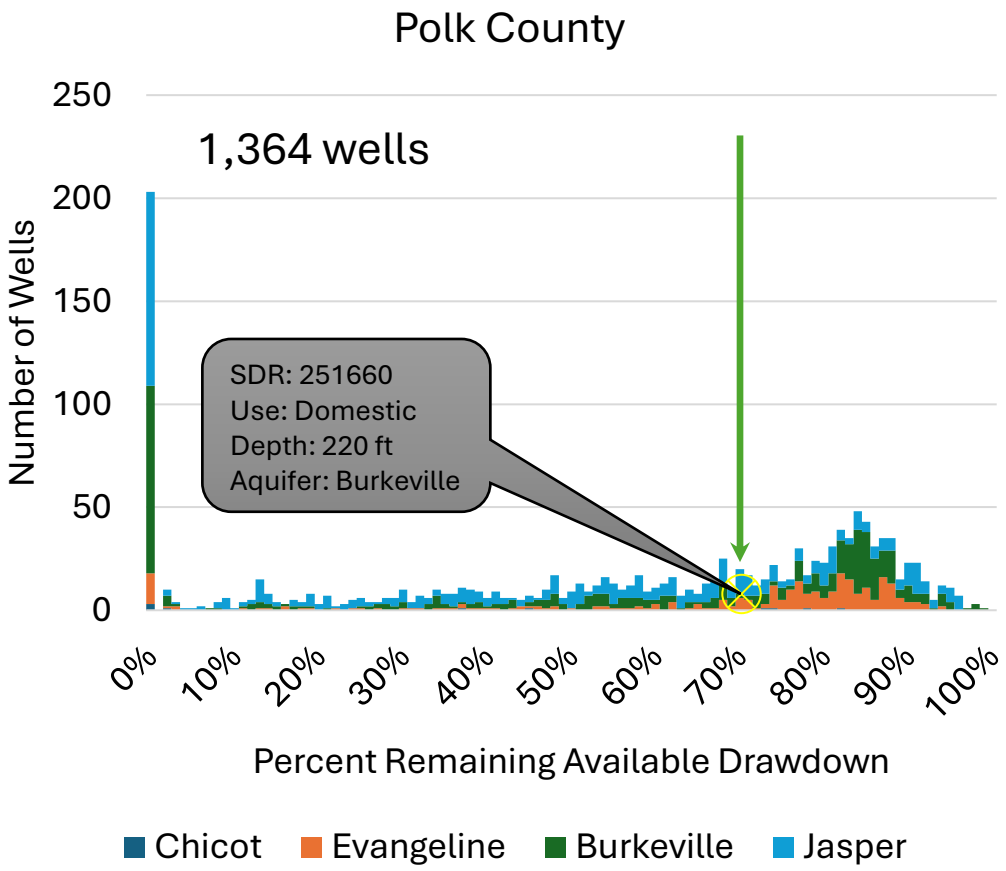
2026 Joint Planning Path Forward

Evaluation Metrics

- 2021 Joint Planning
  - Median remaining available drawdown based on well locations
  - Average additional subsidence
- Average drawdown (approach used prior to 2021 Joint Planning)
- Remaining available drawdown based on aquifer structure
- Results at monitoring locations
- Other options?
  - Ensemble modeling

2021 Joint Planning
Median Remaining Available Drawdown





Average Drawdown

$$\bar{s} = \frac{\sum_{i=1}^{n} s_i}{n}$$

$$\bar{s} = \frac{21 + 35 + 39 + 27 + 36 + 27 + 46 + 39 + 47}{9}$$

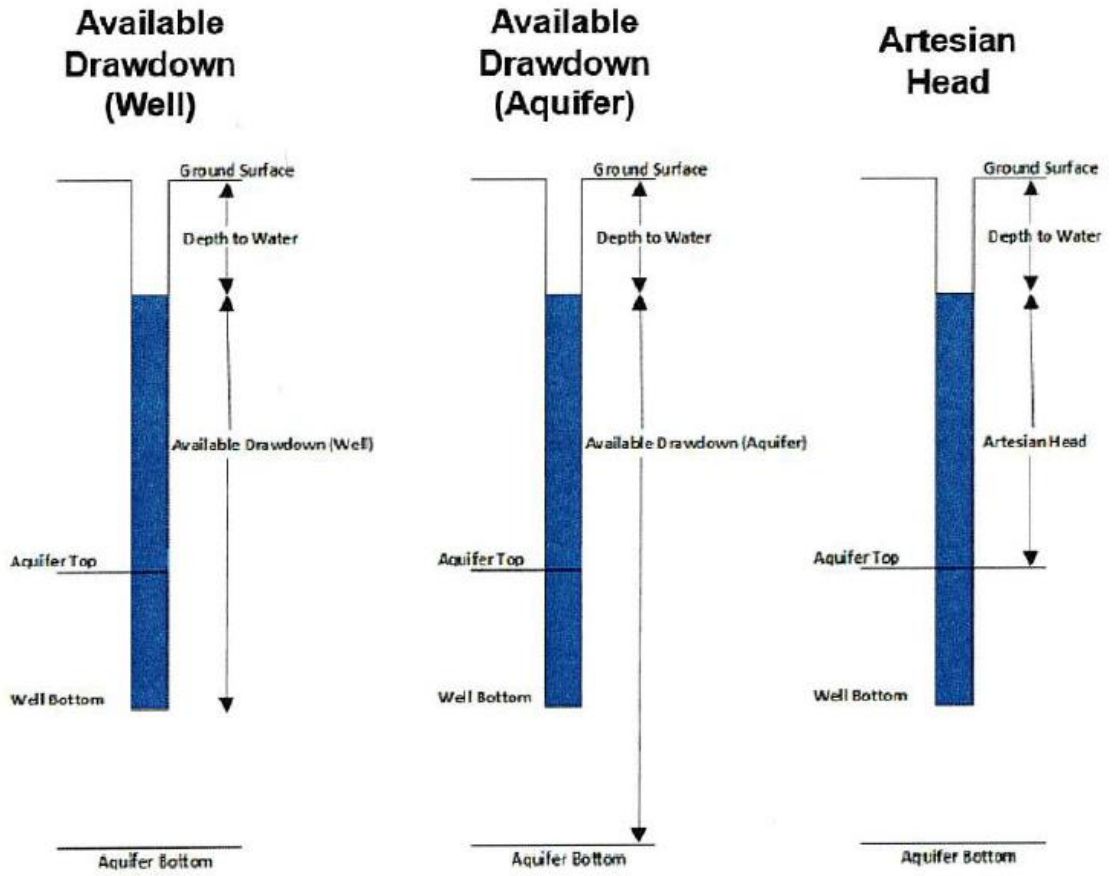
$$\bar{s} = 35$$

Predicted Drawdown

21	35	39
27	36	27
46	39	47

Available Drawdown Options Presented to GMA 12

- Using the bottom of the well
  - 2021 Joint Planning
  - Physically impractical
- Using the bottom of the aquifer
  - Physically impossible
  - Applicable to all aquifer areas
- Using the top of the aquifer
  - Limited to artesian head
  - Does not consider unconfined



Source: Dr. Bill Hutchison

Available Drawdown based on Aquifer Structure

Considerations

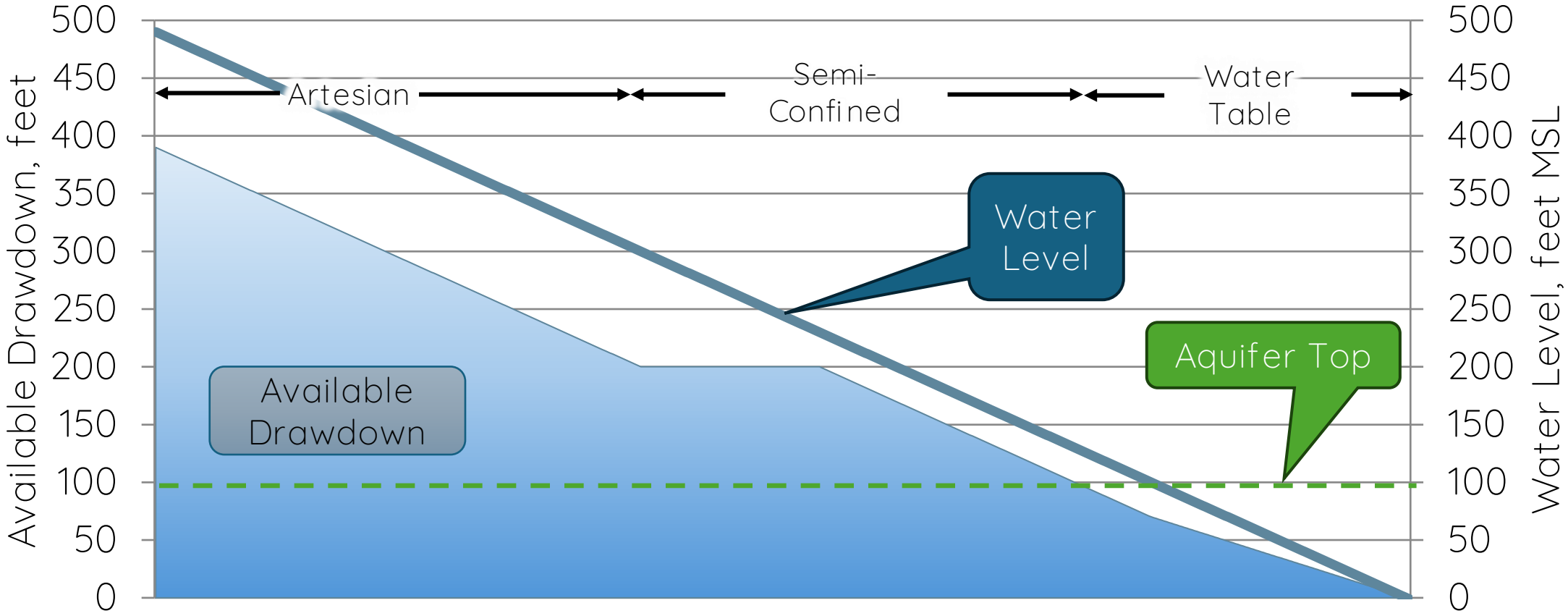
- All aquifer conditions
- Be measurable
- Be aquifer based, not well based
- Include policy and physical considerations

Example Criteria

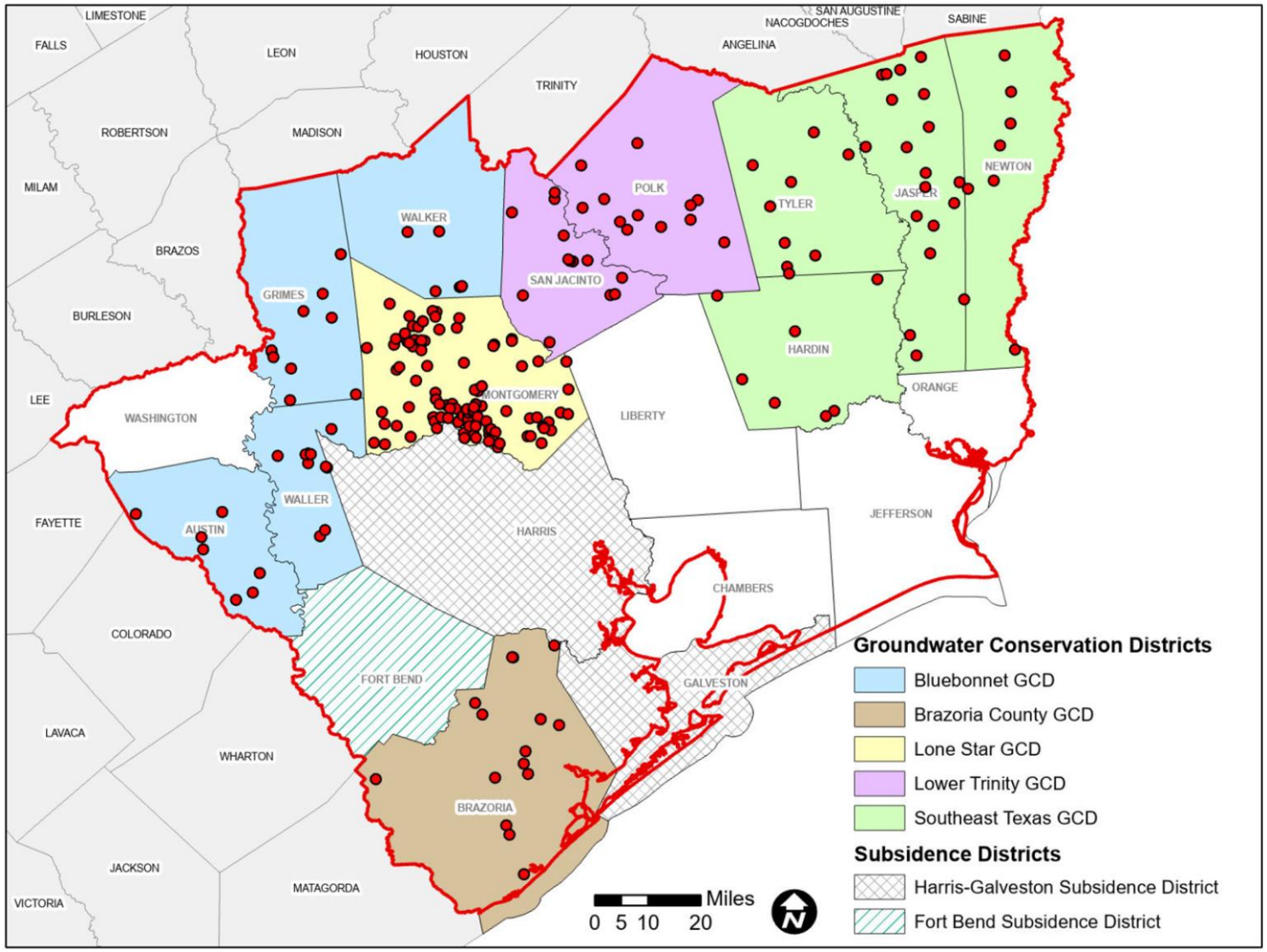
Condition	Available Drawdown	Description
Aquifer Top ≥ *1,500* feet BGL	Water Level – *1,500*	Deep Artesian
Water Level ≥ *200* feet above Aquifer Top	Water Level – Aquifer Top	Artesian
Water Level ≥ Aquifer Top AND Water Level < *200* feet above Aquifer Top	Water Level – *0.3* * Aquifer Thickness (maximum of *200* feet)	Semi-Confined
Water Level < Aquifer Top	Water Level – *0.3* * Saturated Thickness (maximum of *200* feet)	Water Table

Italicized values are policy decision numbers

Available Drawdown based on Aquifer Structure Example



Monitored Wells



Desired Future Conditions (“DFCs”) TWC 36.108(d-2)

Highest Practicable Level
of Groundwater Production

Conservation,
Preservation, Protection,
Recharging, and Prevention
of Waste of Groundwater
and Control of Subsidence

Next Simulation(s)

- Projected groundwater demand
- Timing, location, and volumes
- Informed by regional water planning
- How to evaluate simulation results?

Additional Discussion

GMA 14 Model Update Predictive Scenarios

April 30, 2025