# Use of Artesian Head as an Alternative DFC Metric/Evaluation Tool

Bill Hutchison

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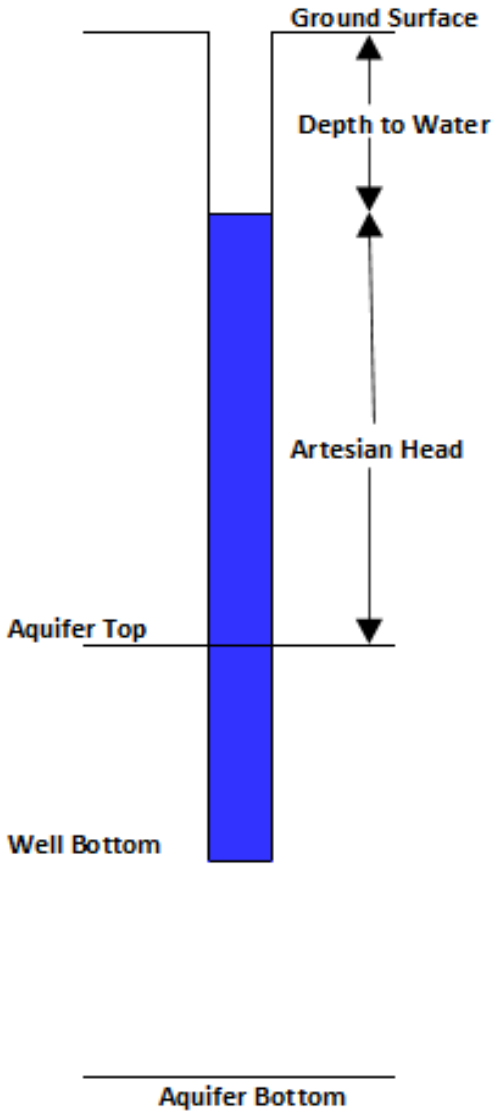
Lost Pines GCD Board Meeting

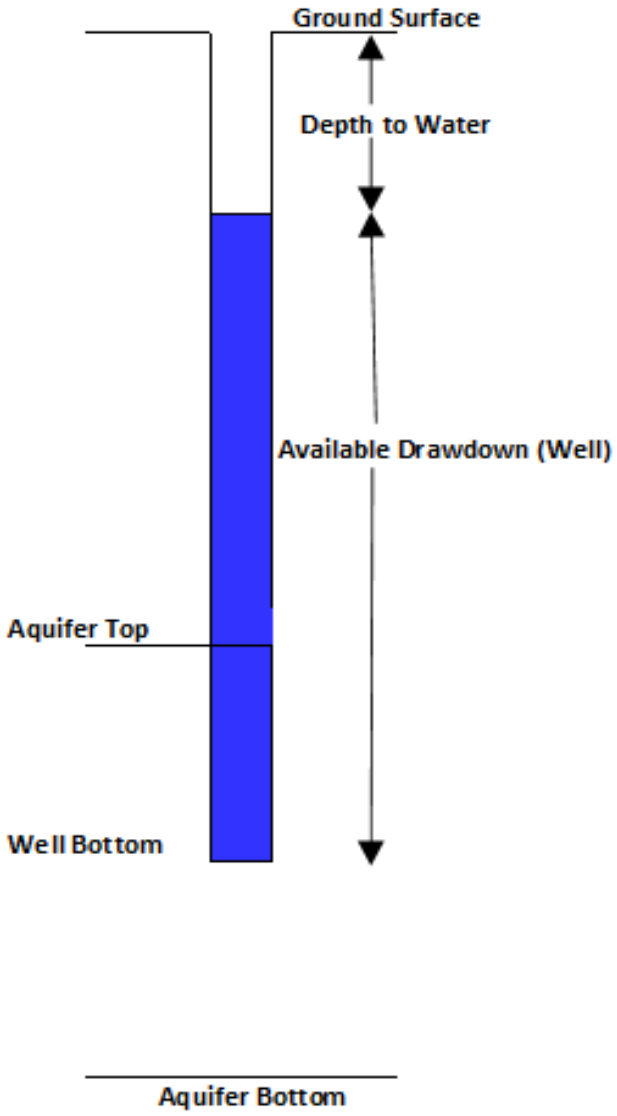
# Alternative Ways to Evaluate GAM Results

- GAM output has been processed to calculate average drawdown over each GCD-aquifer unit
  - For example: LPGCD Simsboro DFC is 240 feet of average drawdown from 2011 to 2070
- Alternative calculations include:
  - Artesian Head
  - Available Drawdown (Well)
  - Available Drawdown (Aquifer)
- Please recall that GMA 14 used a well-based “available drawdown remaining” as a DFC metric in 2021

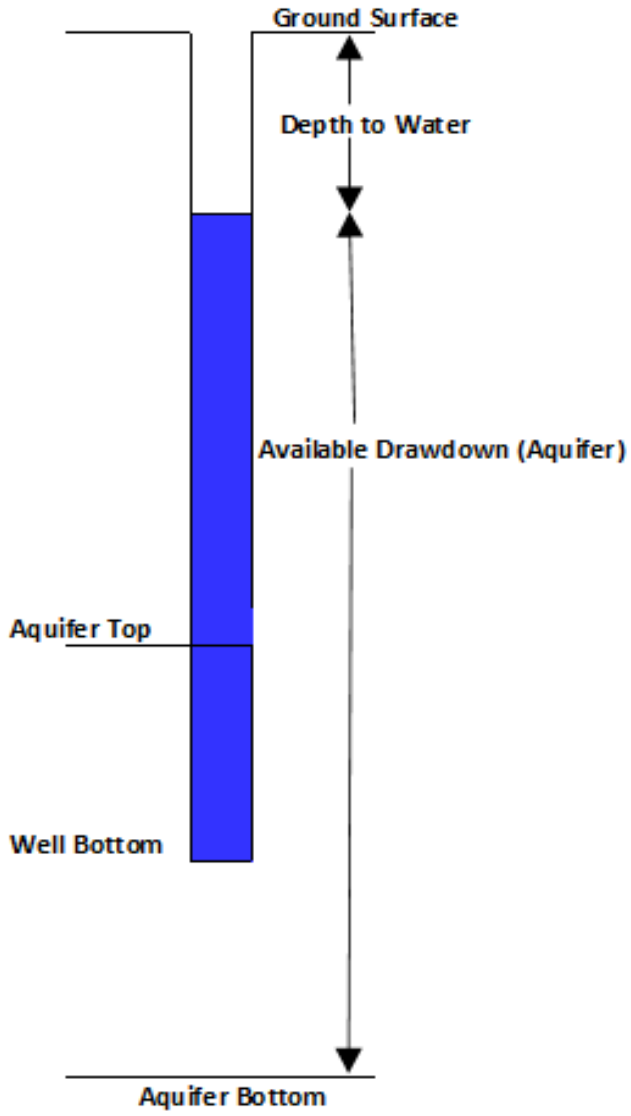
## Artesian Head




## Available Drawdown (Well)




## Available Drawdown (Aquifer)



# Available Drawdown (Well)

- Requires a database of wells with locations and depths to apply
  - LPGCD database was used to evaluate BVGCD permit simulation results
  - Good for LPGCD evaluation

# Alternative Way to Express DFC (GMA 14)

- Second round of joint planning:
  - Example of “reverse-engineering” to develop DFCs
    - Single model runs with specific pumping amounts
  - Petition filed against Lone Star GCD
- Third round of joint planning
  - Goals:
    - Avoid criticism of “reverse engineering”
    - Avoid “project-based” GAM simulations
  - Develop a GMA-wide DFC approach that was more focused on aquifer capabilities and variability
  - Resulted in a GMA-wide DFC statement:
    - “In each county in GMA 14, no less than 70 percent median available drawdown remaining in 2080 or no more than an average of 1.0 additional foot of subsidence between 2009 and 2080”

# Bluebonnet GCD Adoption of GMA 14 DFC

**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**

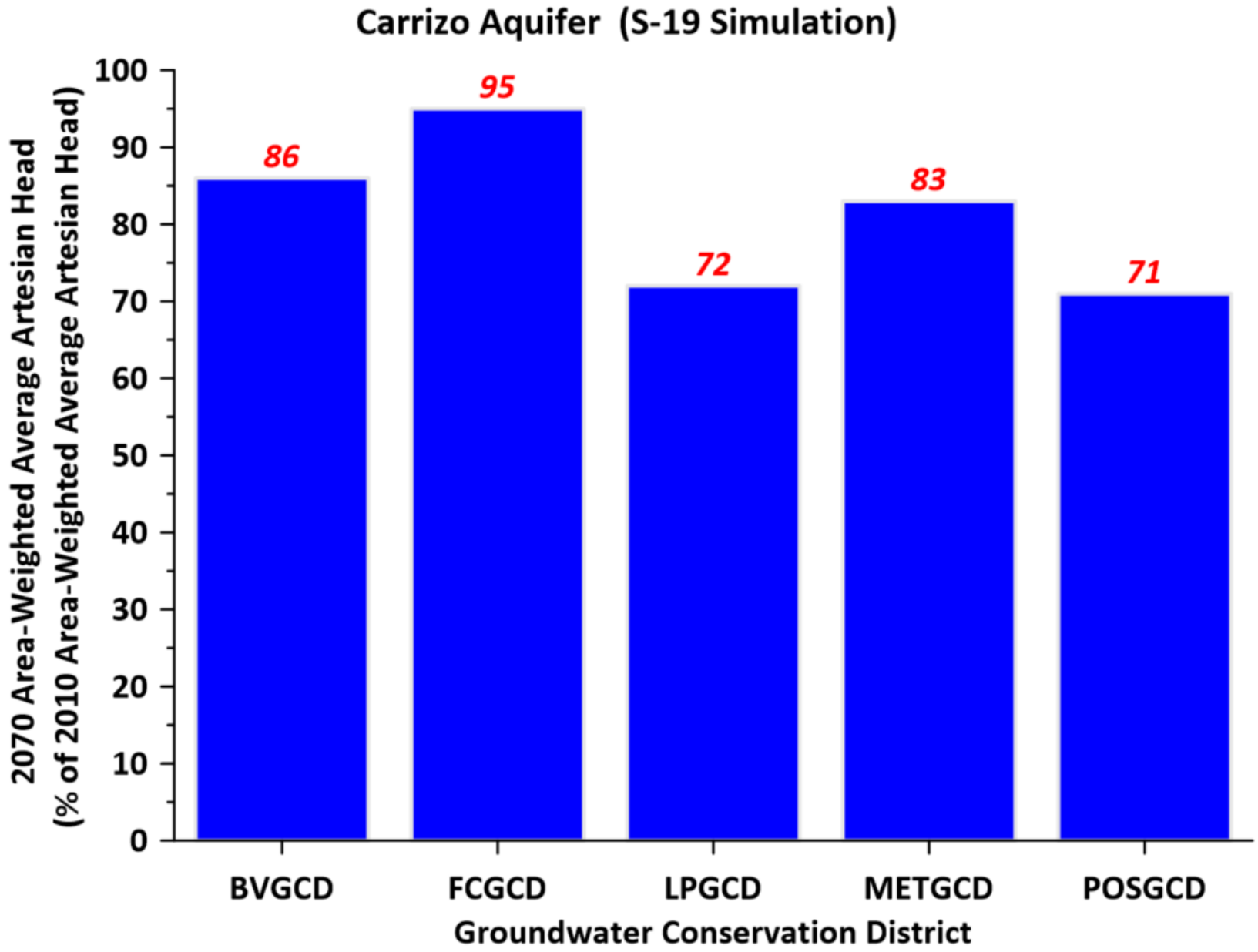
| County | Aquifer | Recommended BGCD-Specific Desired Future Conditions | | Expected Modeled Available Groundwater (Pumping in AF/yr from 2010 to 2080) |
|---|---|---|---|---|
| | | Average Drawdown in ft from 2009 to 2080 | Maximum Subsidence in ft from 1890 to 2080 | |
| Austin | Chicot | 54 | 3.39 | 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 |

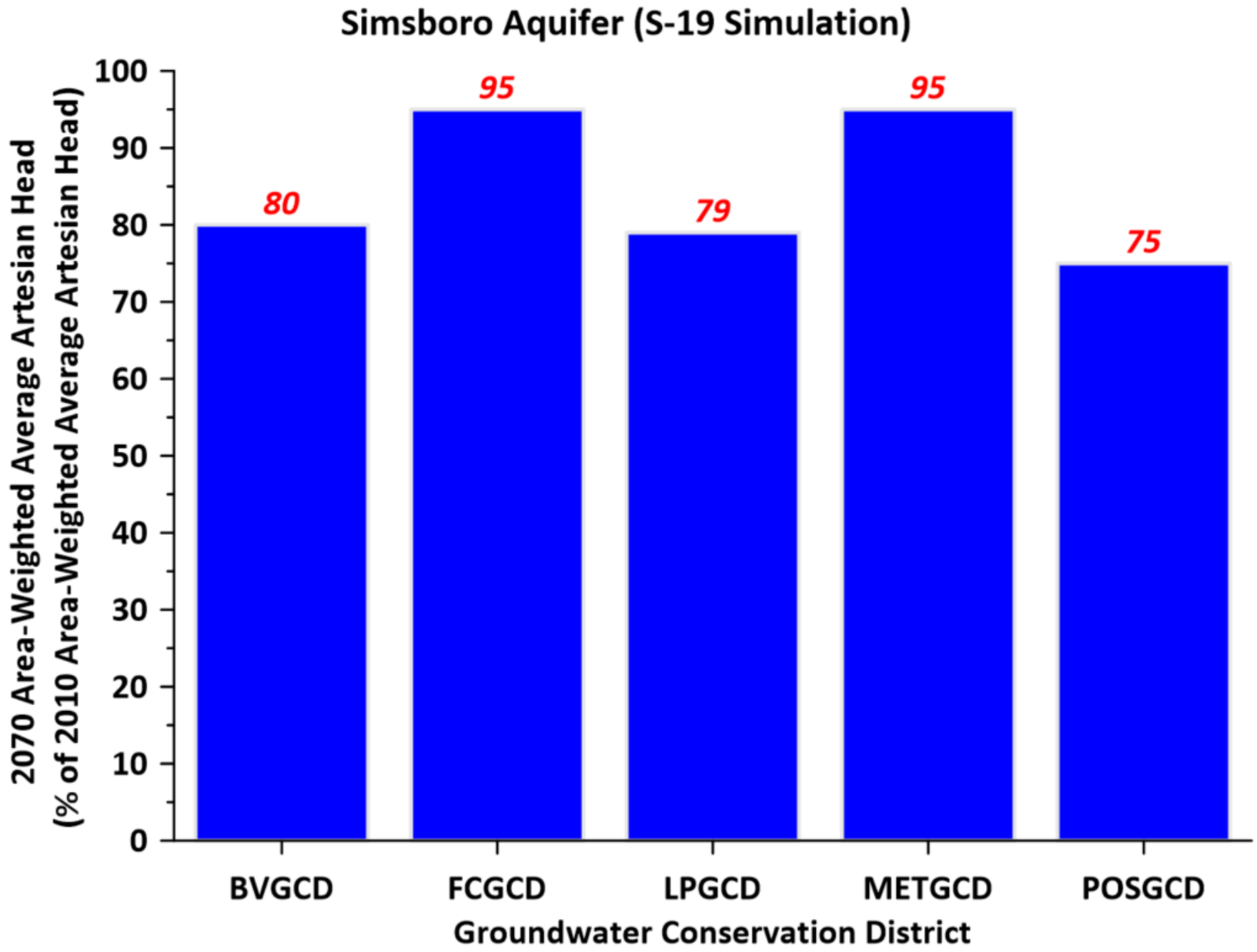
# Available Drawdown (Aquifer)

- Can be applied for all areas of GMA 12 with GAM
- Implicitly assumes that portions of the aquifer below existing wells have the same characteristics (transmissivity and water quality)

# Artesian Head

- Can be applied to all areas of GMA 12 with GAM
- Potential approach to evaluate DFCs and apply balancing test
- Calculated area-weighted artesian head for each cell organized by GCD-aquifer units
  - S-19 simulation (basis for 2021 DFC)
  - S-19 simulation plus Brazos Valley GCD permit approvals
  - Impact of turning off permitted pumping in LPGCD
- Summarized by Aquifer and GCD
  - Report = Complete Set
  - Presentation = Selected


Carrizo Aquifer (S-19 Simulation)
2070 Area-Weighted Average Artesian Head
(% of 2010 Area-Weighted Average Artesian Head)
100
90
80
70
60
50
40
30
20
10
0
86
95
72
83
71
BVGCD
FCGCD
LPGCD
METGCD
POSGCD
Groundwater Conservation District


Simsboro Aquifer (S-19 Simulation)
2070 Area-Weighted Average Artesian Head
(% of 2010 Area-Weighted Average Artesian Head)
100
90
80
70
60
50
40
30
20
10
0
80
95
79
95
75
BVGCD
FCGCD
LPGCD
METGCD
POSGCD
Groundwater Conservation District

# Compare to Registered-Well Based Artesian Head

- Carrizo (Layer 7):
  - 158 registered downdip wells
  - 11 wells with negative artesian head in 2010
  - 23 well with positive artesian head in 2010, negative artesian head in 2070
  - Average artesian head in 2070 in 147 wells with positive artesian head in 2010 = 50% of 2010 artesian head (compare to 72% of all LPGCD Carrizo cells in GAM)
- Simsboro (Layer 9):
  - 208 registered downdip wells
  - 5 wells with negative artesian head in 2010
  - 38 well with positive artesian head in 2010, negative artesian head in 2070
  - Average artesian head in 2070 in 203 wells with positive artesian head in 2010 = 58% of 2010 artesian head (compare to 79% of all LPGCD Simsboro cells in GAM)

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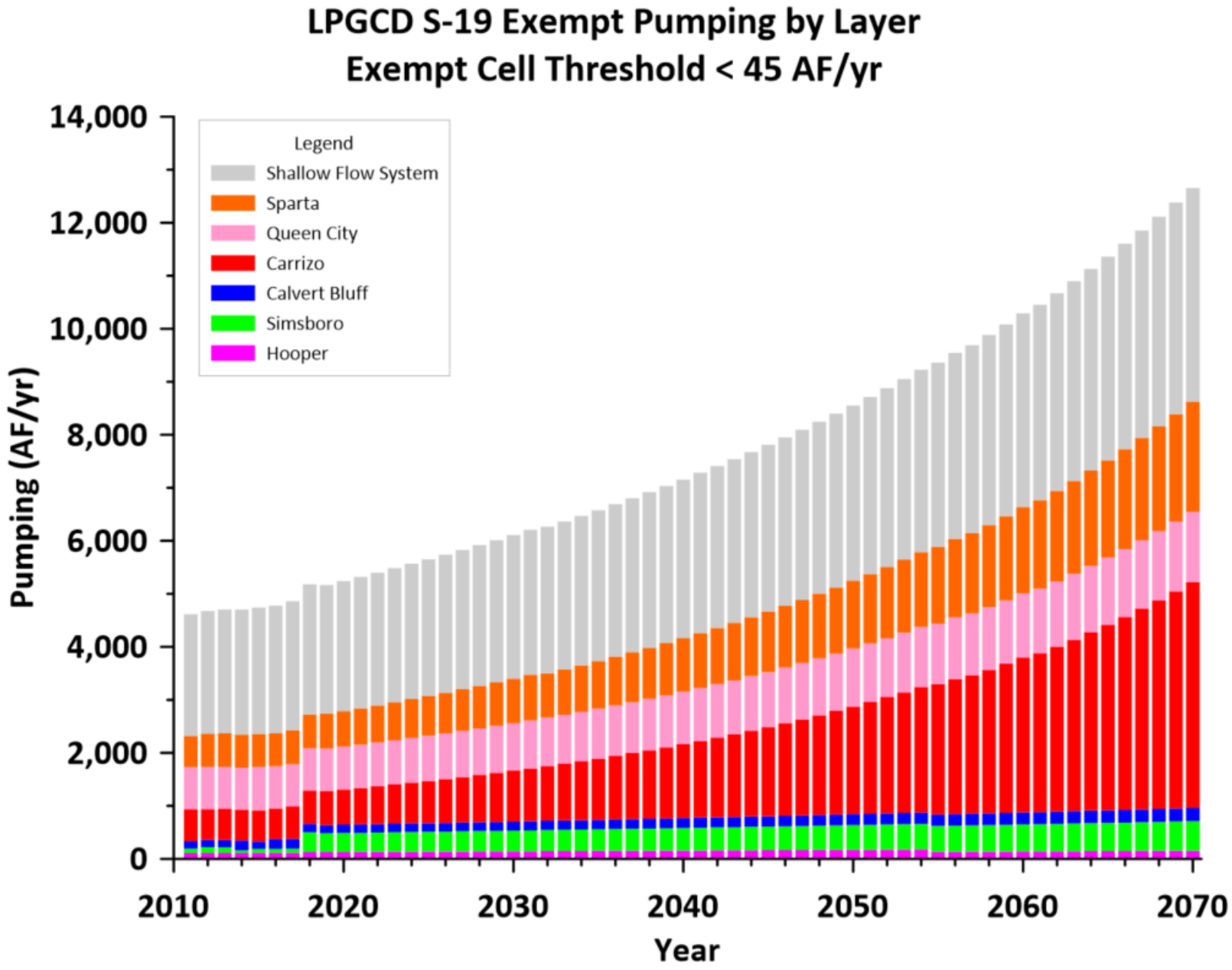
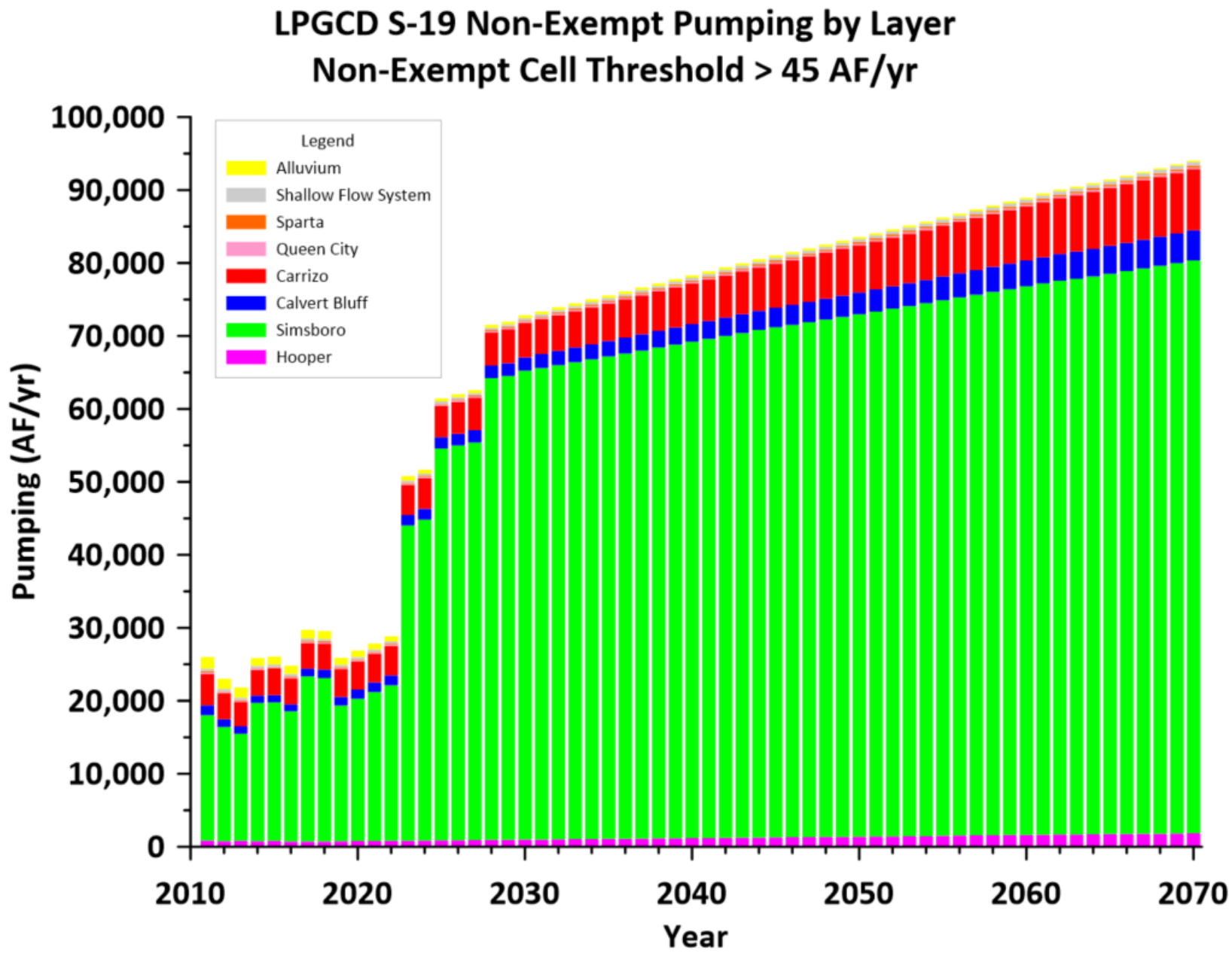
# Sensitivity Simulations

- Scenario 1 = S-19 (base case)
- Scenario 2 = all non-exempt pumping in LPGCD = 0 (only exempt pumping included), all other pumping = S-19
- Scenario 3 to 8 = all non-exempt pumping in LPGCD ***layer*** = 0 (only exempt pumping included), all other pumping = S-19
  - Scenario 3 = ***Sparta***
  - Scenario 4 = ***Queen City***
  - Scenario 5 = ***Carrizo***
  - Scenario 6 = ***Calvert Bluff***
  - Scenario 7 = ***Simsboro***
  - Scenario 8 = ***Hooper***

# Non-Exempt or Permitted Pumping

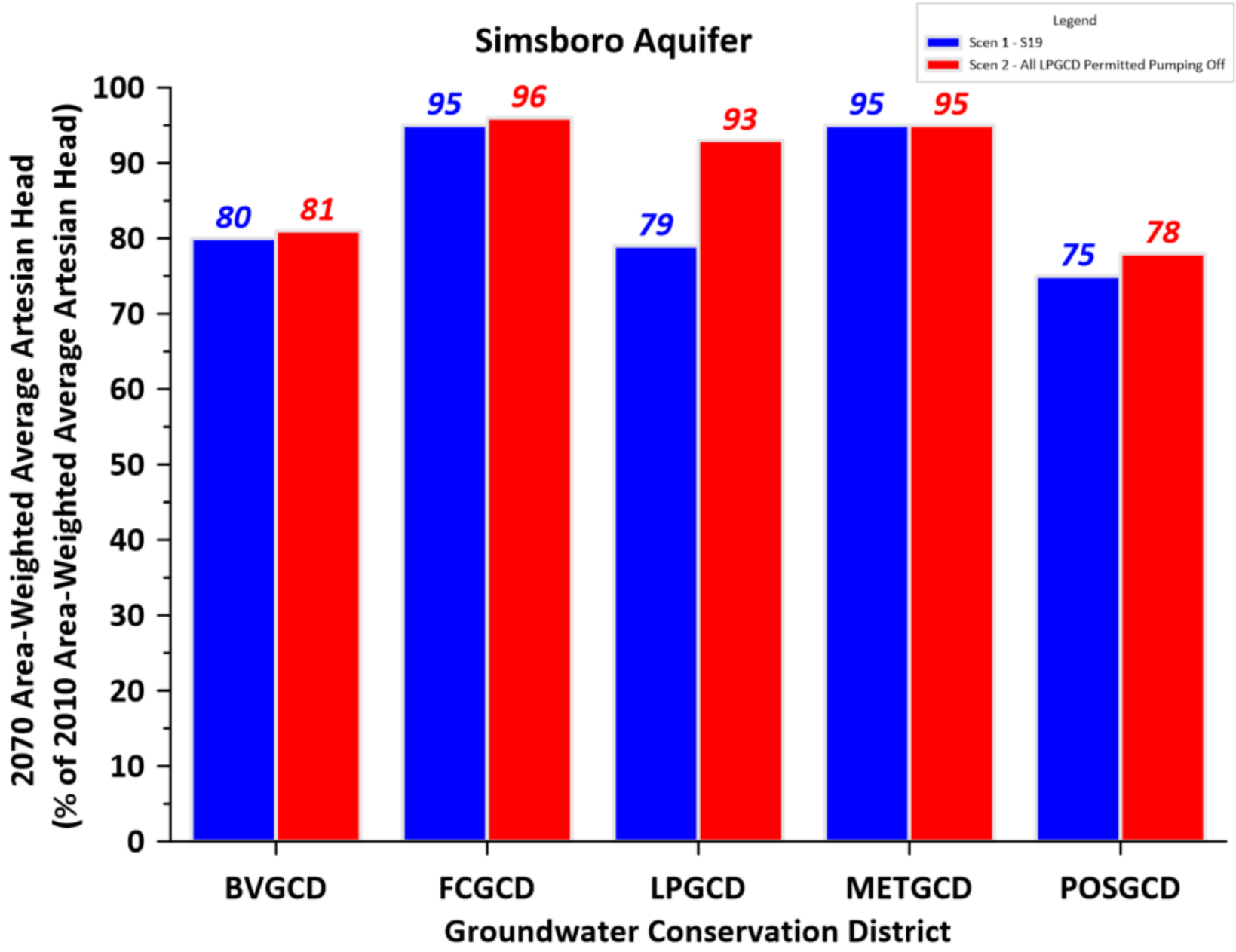
- LPGCD database of registered wells
- Non-exempt well locations were matched with S-19 pumping locations
  - Assumed that Total Pumping – Non-Exempt Pumping would equal exempt pumping
  - Unsatisfactory results (too much exempt pumping relative to total pumping for nearly all layers)
  - Need to address with an updated S-19 (separate task)
- Alternative approach:
  - If pumping in a cell > 45 AF/yr, assume non-exempt
  - If pumping in a cell < 45 AF/yr, assume exempt
  - Layer by layer results in report


LPGCD S-19 Exempt Pumping by Layer
Exempt Cell Threshold < 45 AF/yr
Legend
Shallow Flow System
Sparta
Queen City
Carrizo
Calvert Bluff
Simsboro
Hooper
Pumping (AF/yr)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
2010
2020
2030
2040
2050
2060
2070
Year


LPGCD S-19 Non-Exempt Pumping by Layer
Non-Exempt Cell Threshold > 45 AF/yr
Legend
Alluvium
Shallow Flow System
Sparta
Queen City
Carrizo
Calvert Bluff
Simsboro
Hooper
Pumping (AF/yr)
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
2010
2020
2030
2040
2050
2060
2070
Year

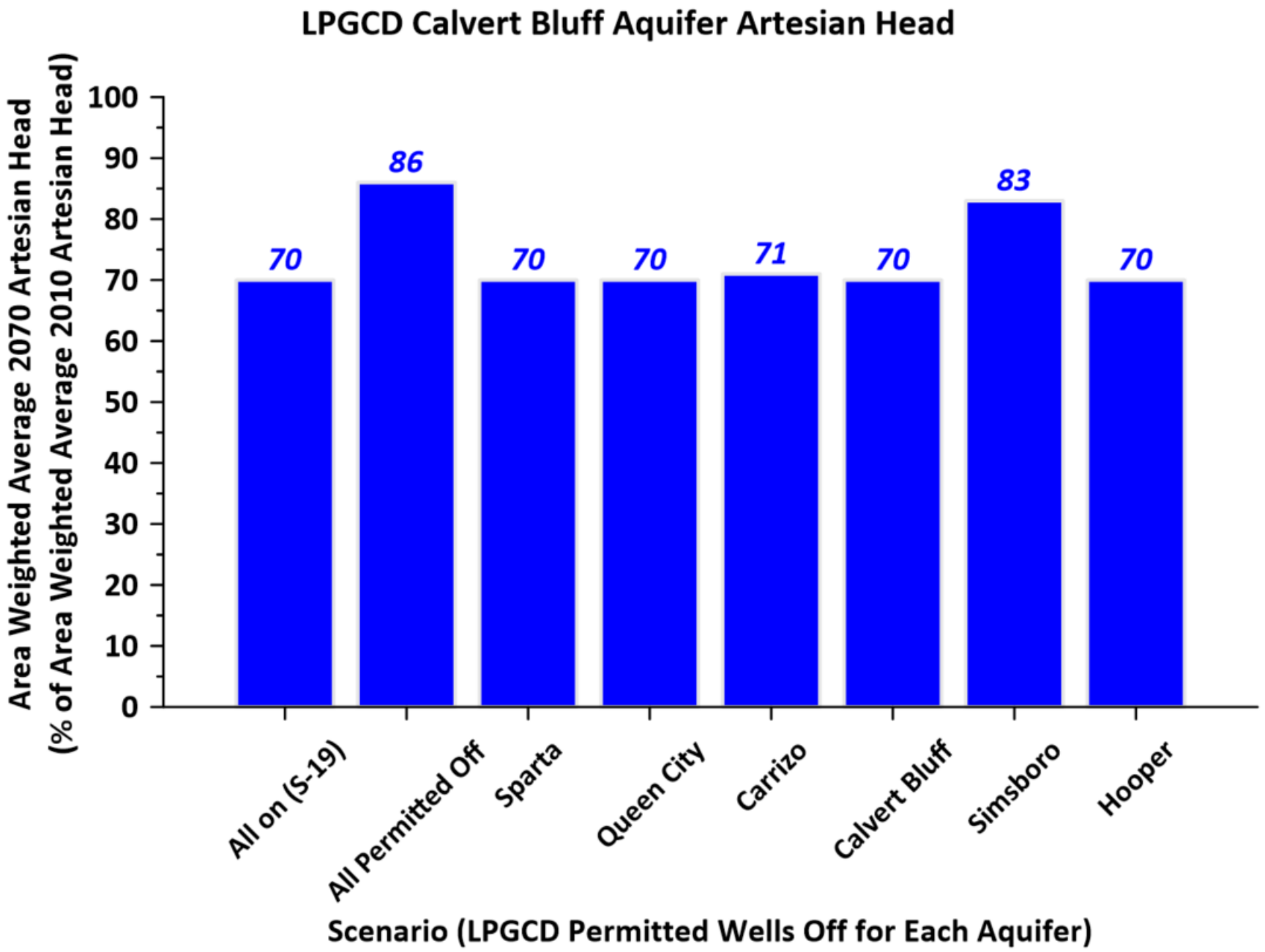
# Compare 2070 Artesian Head for Scenarios 1 and 2

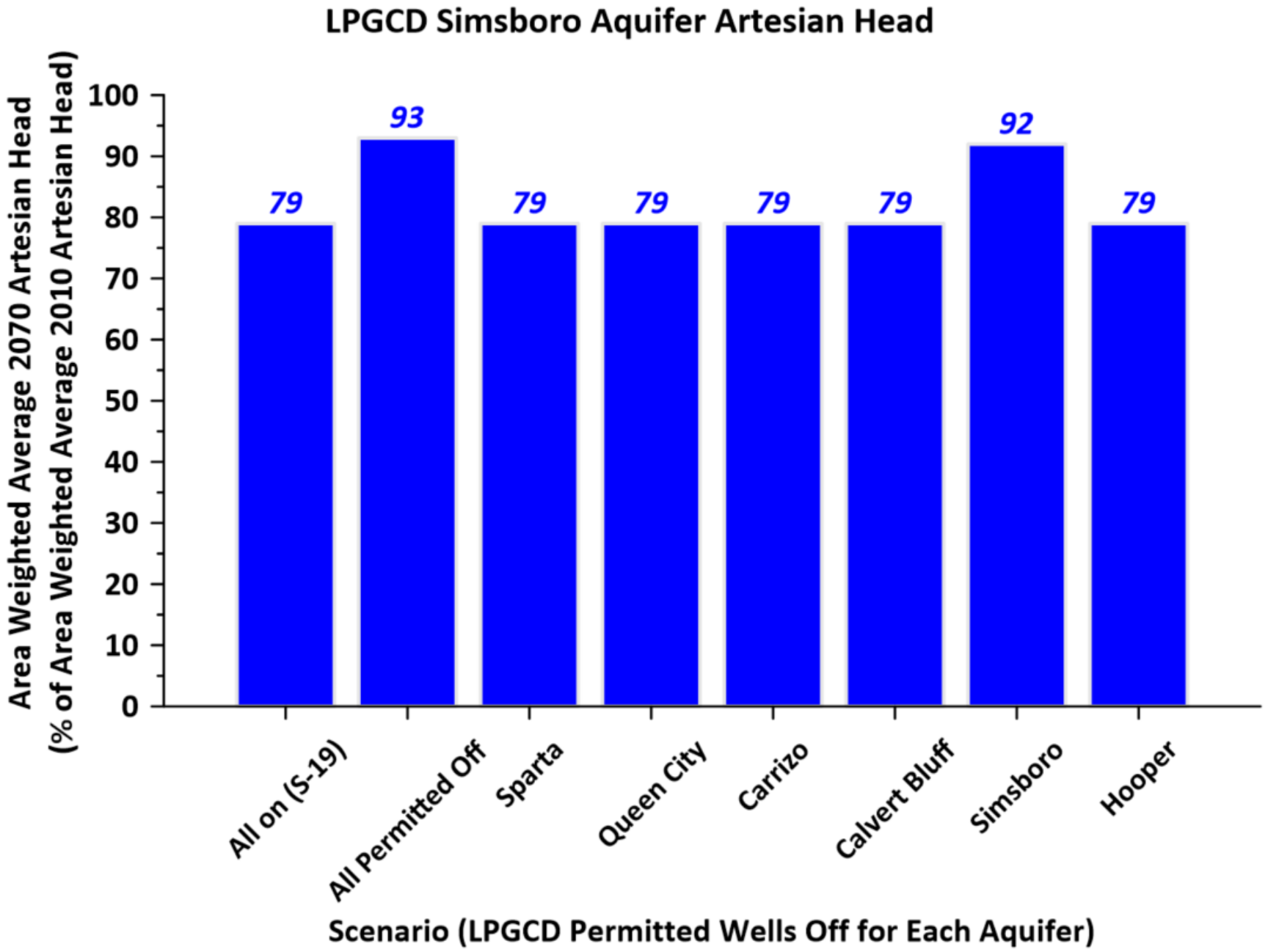
- Scenario 1 = S-19
  - 2070 LPGCD simulation pumping = 106,694 AF/yr
- Scenario 2 = All LPGCD non-exempt pumping =0
  - 2070 LPGCD simulation pumping = 12,656 AF/yr


Simsboro Aquifer
Legend
Scen 1 - S19
Scen 2 - All LPGCD Permitted Pumping Off
2070 Area-Weighted Average Artesian Head
(% of 2010 Area-Weighted Average Artesian Head)
100
90
80
70
60
50
40
30
20
10
0
80
81
95
96
79
93
95
95
75
78
BVGCD
FCGCD
LPGCD
METGCD
POSGCD
Groundwater Conservation District

# LPGCD Results for Each Aquifer for All Scenarios

- Evaluate impact of reducing LPGCD pumping in one layer on artesian head in overlying and/or underlying layers


LPGCD Calvert Bluff Aquifer Artesian Head
Area Weighted Average 2070 Artesian Head
(% of Area Weighted Average 2010 Artesian Head)
100
90
80
70
60
50
40
30
20
10
0
70
86
70
70
71
70
83
70
All on (S-19)
All Permitted Off
Sparta
Queen City
Carrizo
Calvert Bluff
Simsboro
Hooper
Scenario (LPGCD Permitted Wells Off for Each Aquifer)


LPGCD Simsboro Aquifer Artesian Head
Area Weighted Average 2070 Artesian Head
(% of Area Weighted Average 2010 Artesian Head)
100
90
80
70
60
50
40
30
20
10
0
79
93
79
79
79
79
92
79
All on (S-19)
All Permitted Off
Sparta
Queen City
Carrizo
Calvert Bluff
Simsboro
Hooper
Scenario (LPGCD Permitted Wells Off for Each Aquifer)

# Observations

- Highlights connection of components of Wilcox Aquifer
  - Calvert Bluff
  - Simsboro
  - Hooper
- Provides a baseline of LPGCD impacts vs impacts from other GCDs