Agenda Item 8:
Discussion of Development of Desired Future Conditions (DFCs) in Other Groundwater Management Areas

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GMA 12 Meeting

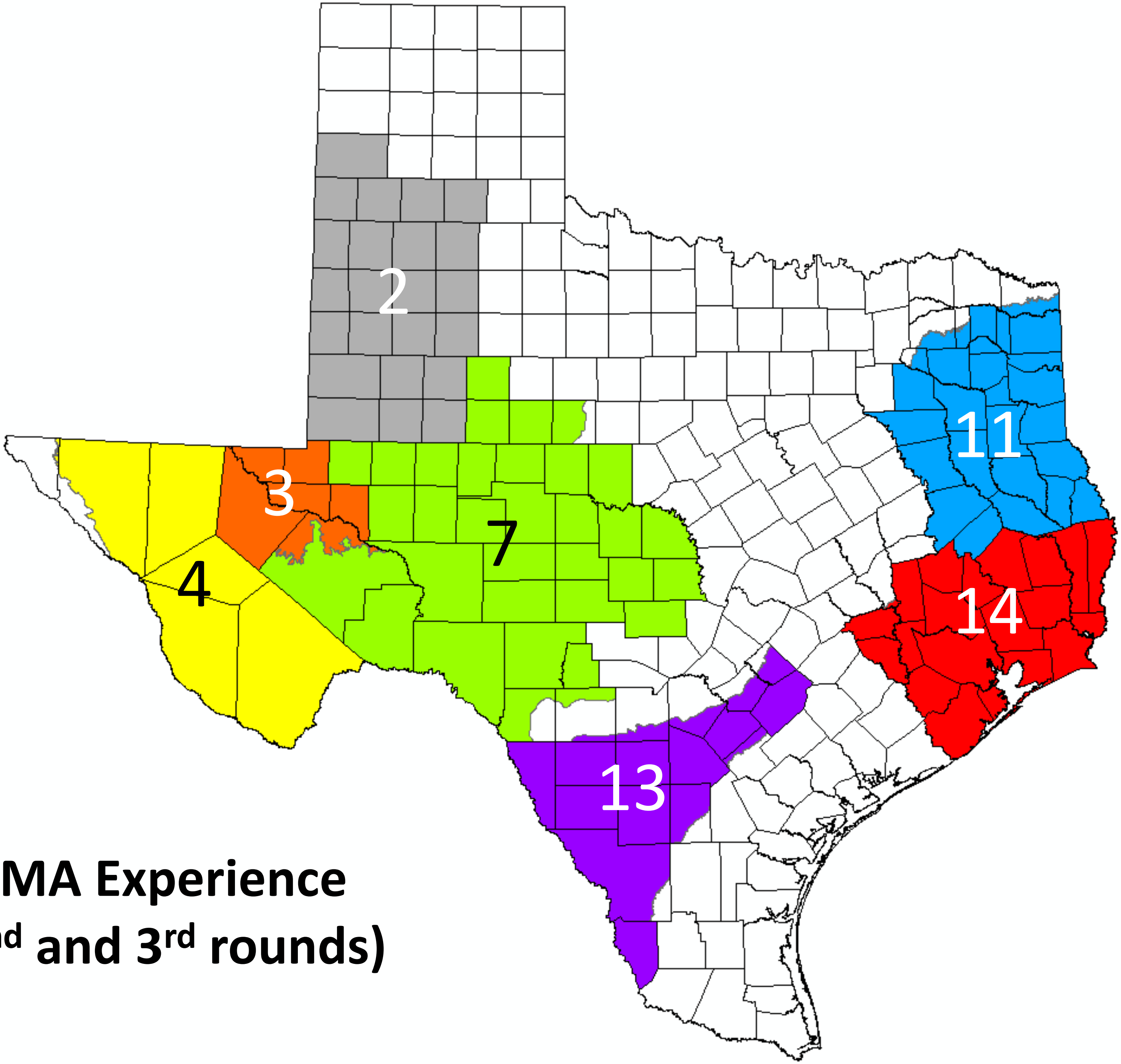
June 29, 2023

Three Basic Functions of a GCD

- Planning
  - DFCs (Joint Planning)
- Management
  - Goals and Objectives (Management Plan)
  - Includes a specific goal to “address” DFCs
    - Goal 8 of TWDB Checklist: Addressing the desired future condition established under TWC 36.108 (31 TAC 356.52(a)(1)(H); TWC 36.107(a)(8)
- Regulation
  - Implementation and Achievement of Management Plan Goals and Objectives (Rules)

Experience Background

- 2009 to 2011: Director, Texas Water Development Board Groundwater Division
  - Coordinated Technical Assistance to GCDs in initial round of joint planning
  - Lead for 9 of 15 GMAs (GMA 5 has no GCD)
- 2011 to present: Consultant to GCDs and GMAs
  - GMAs: Joint Planning (2nd and 3rd rounds)
  - GCDs: Management Plans, including evaluation of DFCs



GMA Experience (2nd and 3rd rounds)

Summary of Two GMAs

- GMA 14: Multi-metric DFC applied to entire GMA
  - Bluebonnet GCD Implementation
  - Annual DFC comparison (GMA activity)
- GMA 11: Sustainable Pumping
  - Based on current distribution of wells

GMA 14

- Multi-metric DFC (applies to entire GMA)

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.

Details of DFC Statement

- Common reservoir approach
- Multi-metric simulation
  - 70 percent median available drawdown remaining in 2080 (using 2009 as a base condition)
  - No more than 1 ft additional subsidence in 2080 (using 2009 as a base condition)
  - Pumping in a county is no more than 30,000 AF above the maximum projected water demand between 2020 and 2070 as defined in the current state water plan
  - The initial pumping distribution was taken from the 2016 modeled available groundwater simulation of the HAGM for the second round of desired future conditions

Bluebonnet GCD Implementation Approach

- Take single GMA 14-wide DFC statement
- Quantify it for use as a management goal and objective for BGCD management plan
- HAGM simulation that was the basis for DFC provides:
  - BGCD-specific drawdown and subsidence information
  - Future pumping (not specifically relevant for purposes of management plan, but useful information)
- BGCD-specific results form the basis for BGCD-specific DFC

Bluebonnet GCD-Specific DFCs

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

DFC Comparisons for Gulf Coast Aquifer in GMA 14

- Completed each year
- Example = comparison through 2021
  - 2022 comparison has not yet been completed/presented
- GMA comparison
- County comparison

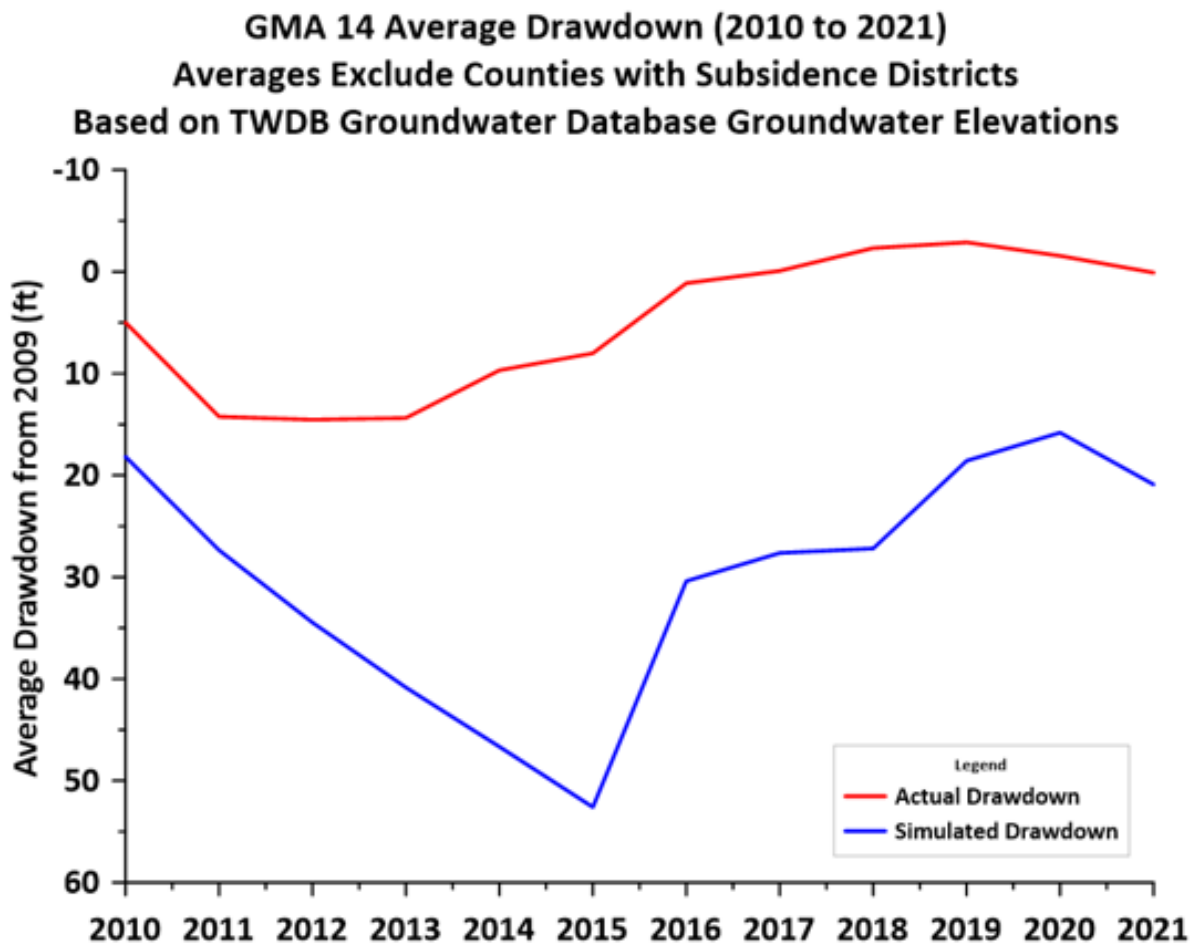


Figure 6. Average Drawdown (Actual and Simulated) - GMA 14 Counties without Subsidence District

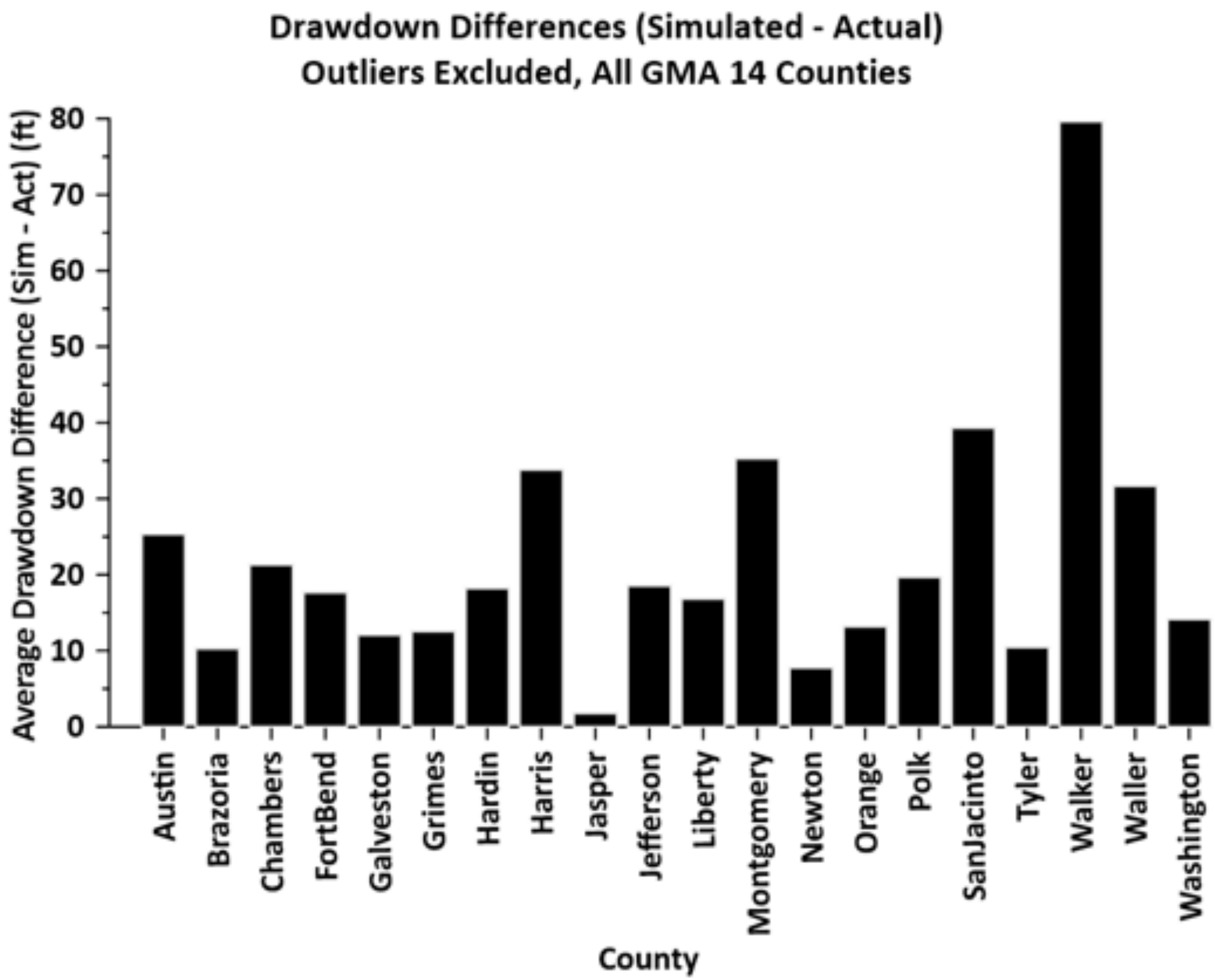


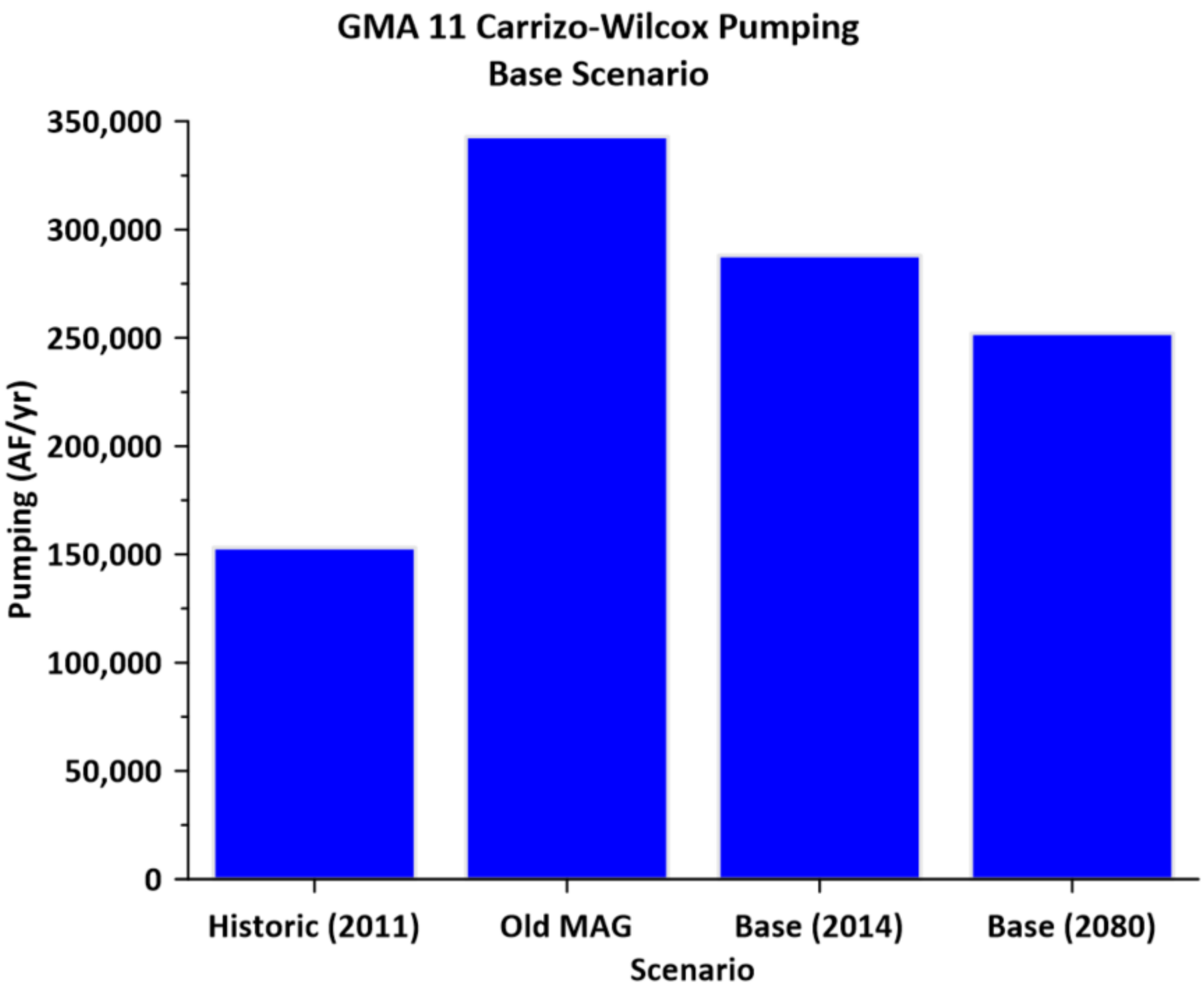
Figure 5. Average Drawdown Differences by County (Outliers Excluded)

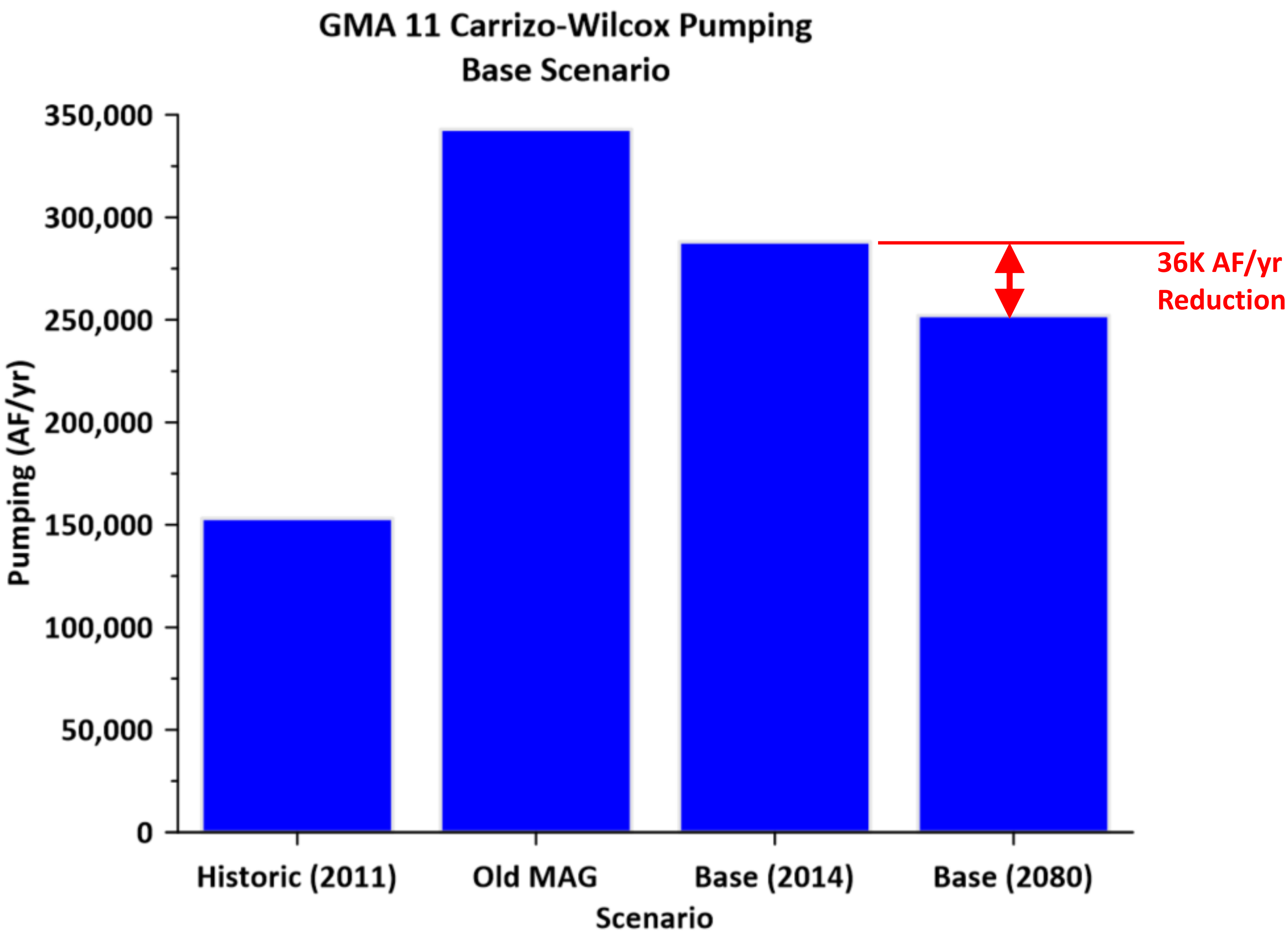
GMA 11

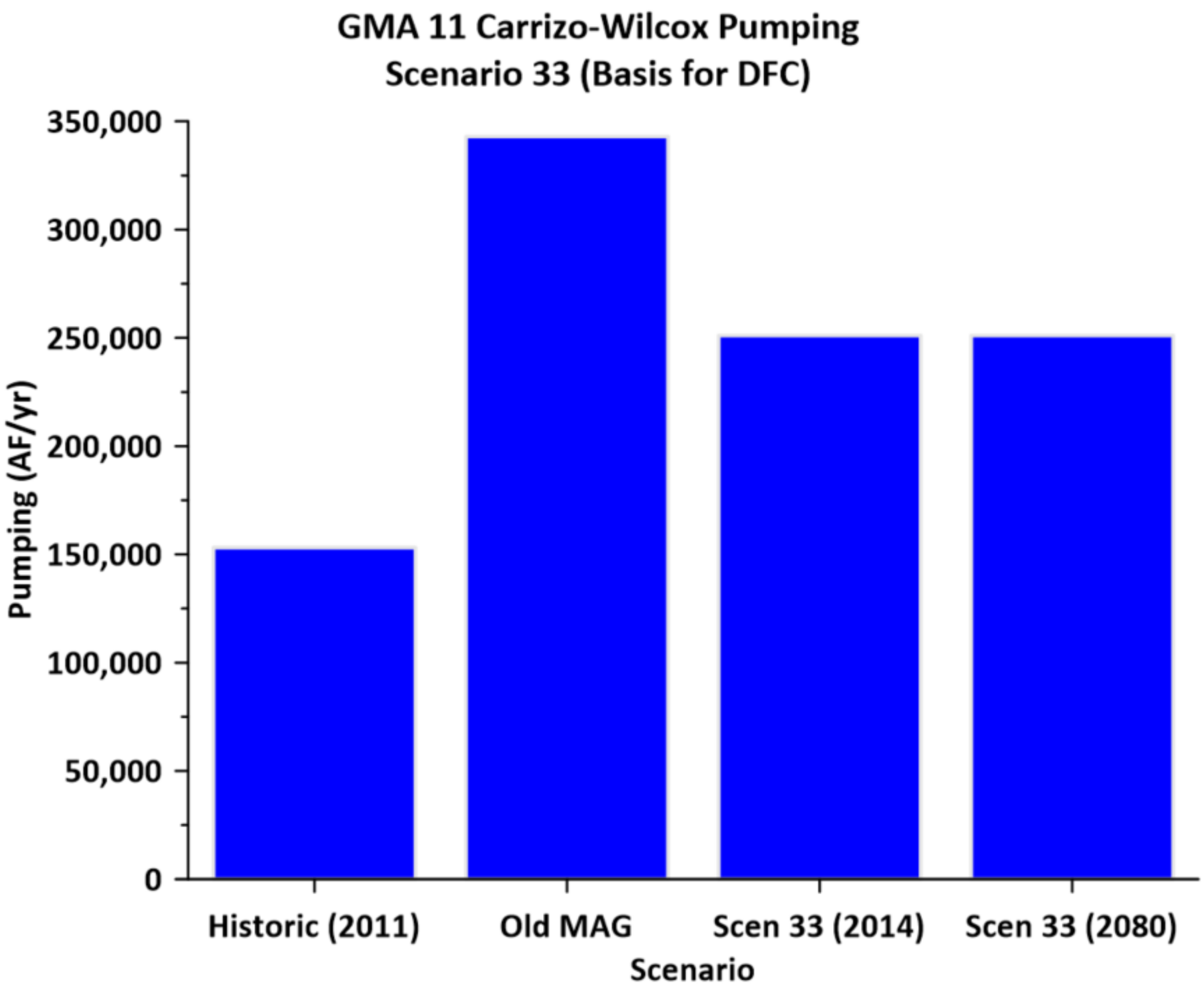
- 2016 DFC placed high emphasis on meeting Regional Water Plan (RWP) needs
  - One of the nine factors in 36.108
- GAM limitations resulted in underestimated drawdowns
  - Documented in GMA 11 Tech Memo 16-02
- New GAM resulted in re-evaluation for 2021 DFC
  - Some RWP needs not realistic
  - Focused on sustainable levels of pumping
- Simulations focused on defining equal pumping for entire predictive period (2014 to 2080)
  - Tested by county/river basin units for each aquifer

Summary of New (2020) GAM Simulations

- Sensitivity simulations
  - Drawdown under different pumping amounts
  - Drawdown under different recharge amounts
- Simulate drawdown with 2016 MAGs
  - Pumping reductions (could not be maintained due to high drawdown)
- Continued to reduce pumping until no reductions from 2014 to 2080
  - 33 iterations


GMA 11 Carrizo-Wilcox Pumping
Base Scenario
Pumping (AF/yr)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Historic (2011)
Old MAG
Base (2014)
Base (2080)
Scenario


GMA 11 Carrizo-Wilcox Pumping
Base Scenario
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Pumping (AF/yr)
36K AF/yr
Reduction
Historic (2011)
Old MAG
Base (2014)
Base (2080)
Scenario


GMA 11 Carrizo-Wilcox Pumping
Scenario 33 (Basis for DFC)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Pumping (AF/yr)
Historic (2011)
Old MAG
Scen 33 (2014)
Scen 33 (2080)
Scenario

Groundwater Budgets

- Groundwater budgets are an accounting of:
  - Inflows
  - Outflows
  - Storage Change
- Concept in the literature dates to at least 1930s (Meinzer, 1932)
- Tolman (1937) noted that methods to develop groundwater budgets had not reached the accuracy to be acceptable
  - Extensive data requirements
  - Lengthy time needed to observe a sufficient range of hydrologic conditions

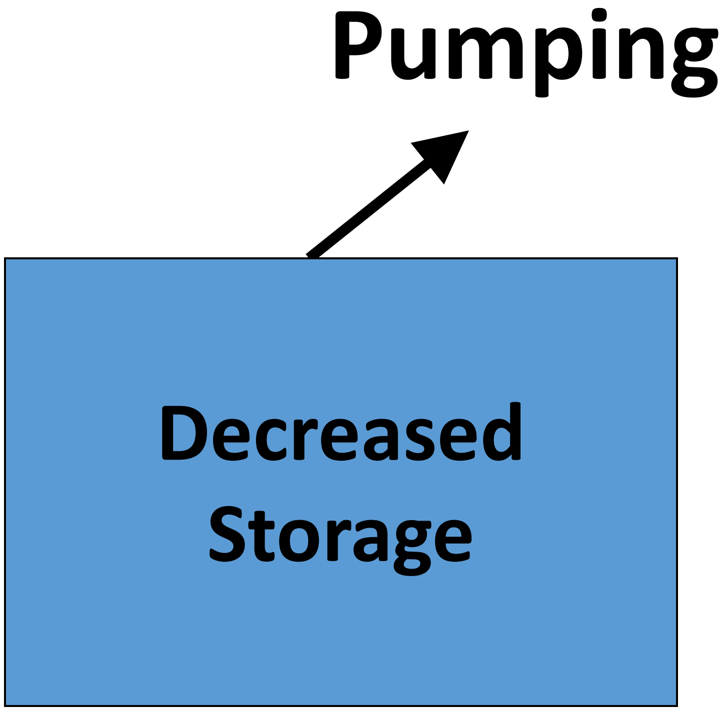
Capture (from Bredehoeft, 2002)

- Capture is a dynamic process
- Principles of capture first presented in 1940 (Theis)
- With constant pumping, a groundwater system will tend towards a new equilibrium after an initial decline in storage
  - Increased inflow
  - Decreased natural outflow

  } ***"Capture"***
- Groundwater Model: analytic tool to study the dynamic process of capture
  - "Extend" observed data
  - Consider alternative pumping scenarios
  - Consider alternative hydrologic conditions

Equilibrium: Inflow = Outflow

Modified from Alley and others, 1999



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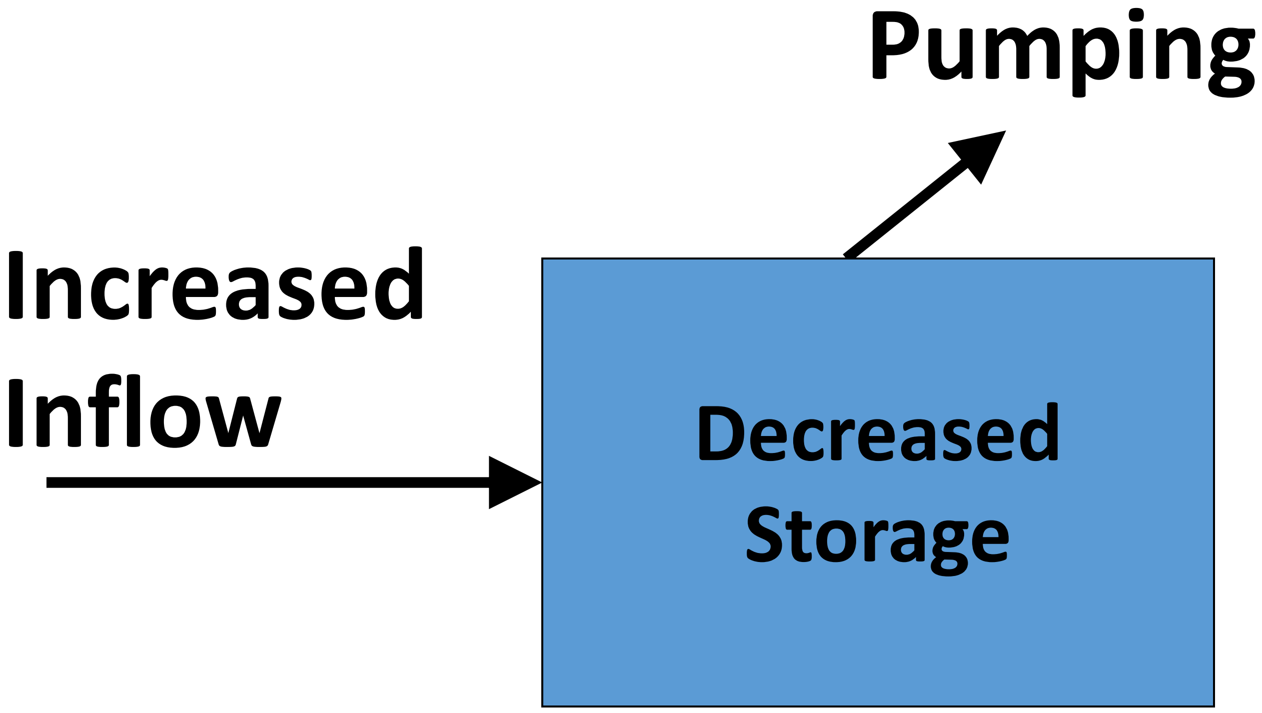

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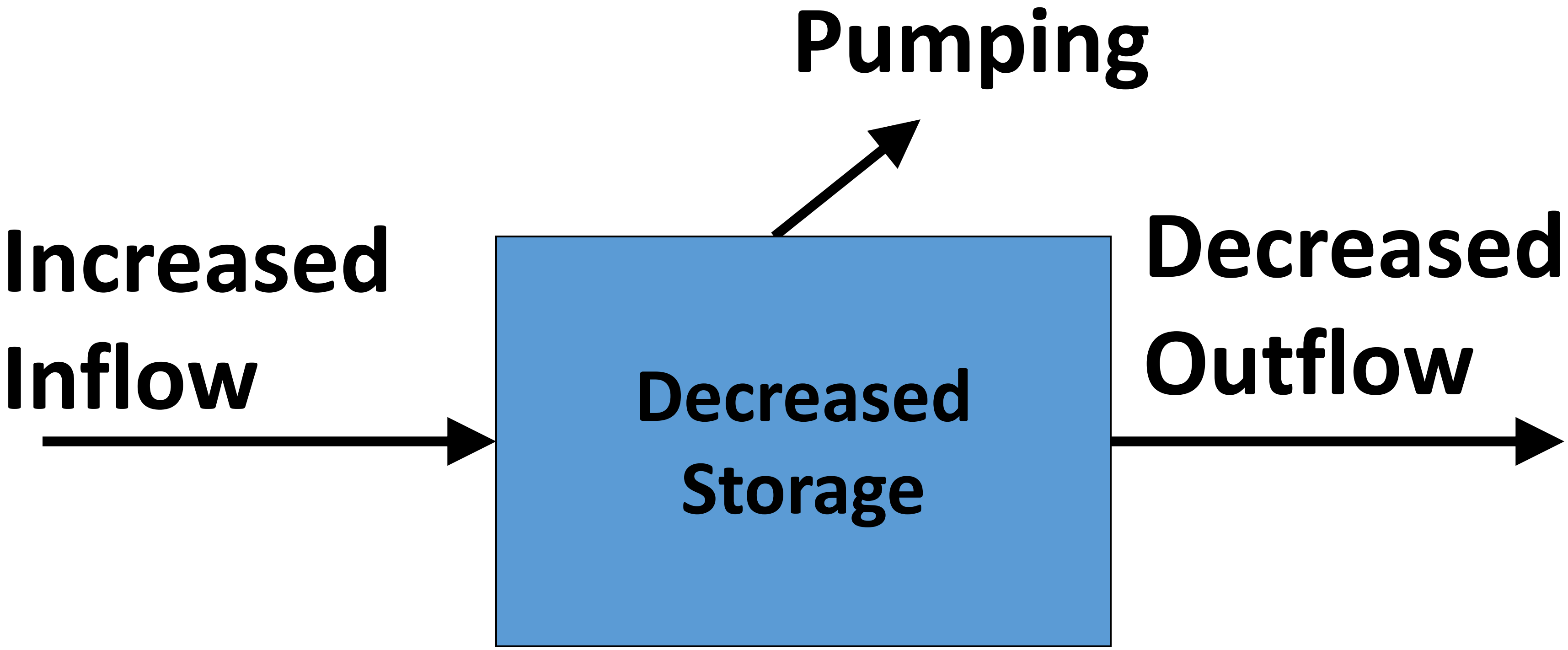

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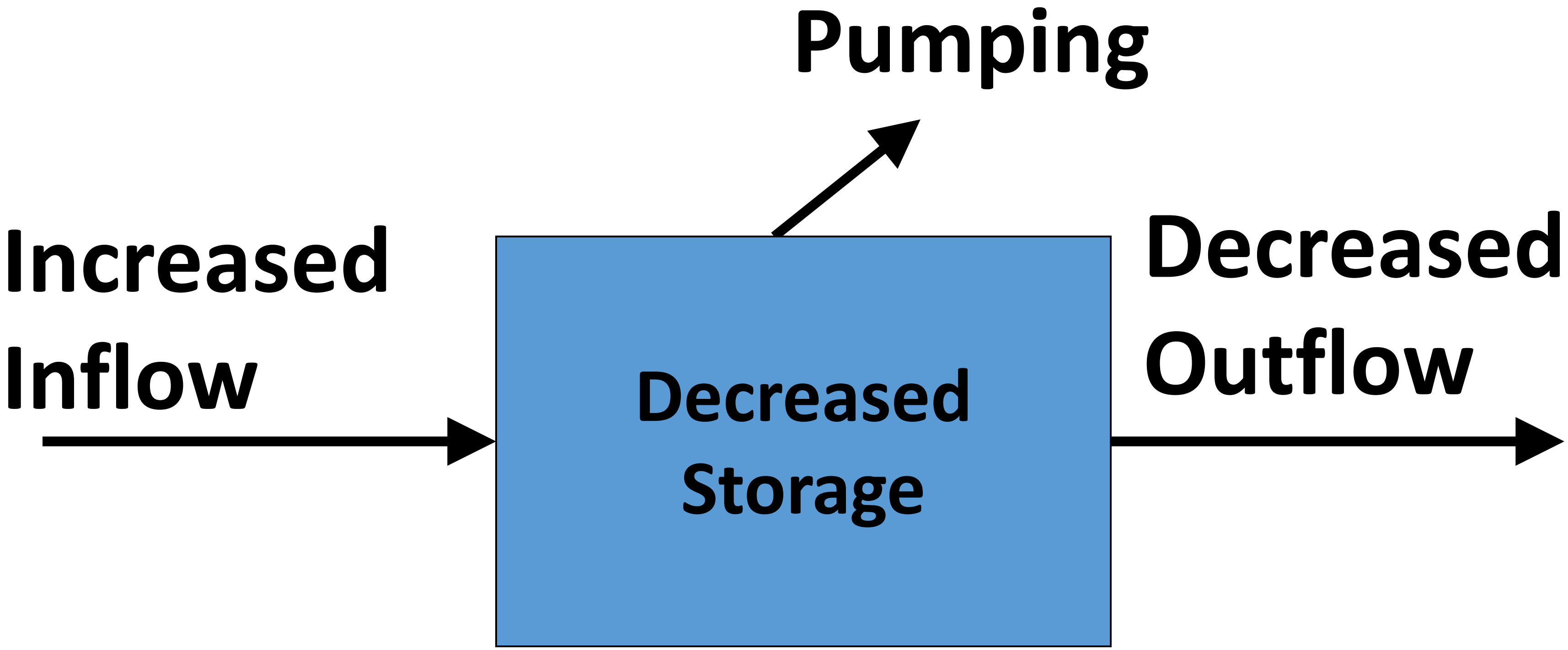


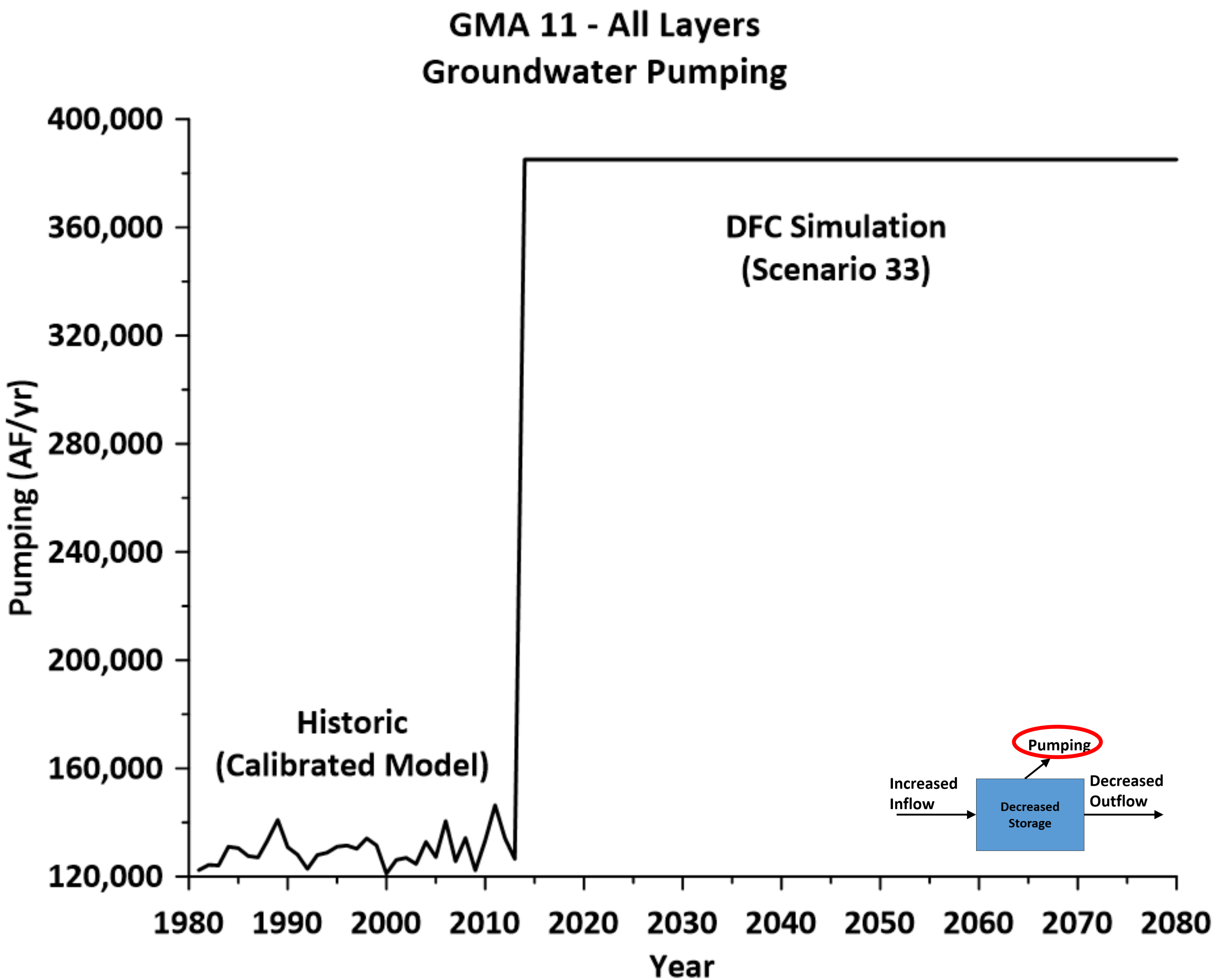
"Capture" = Increased Inflow + Decreased Outflow

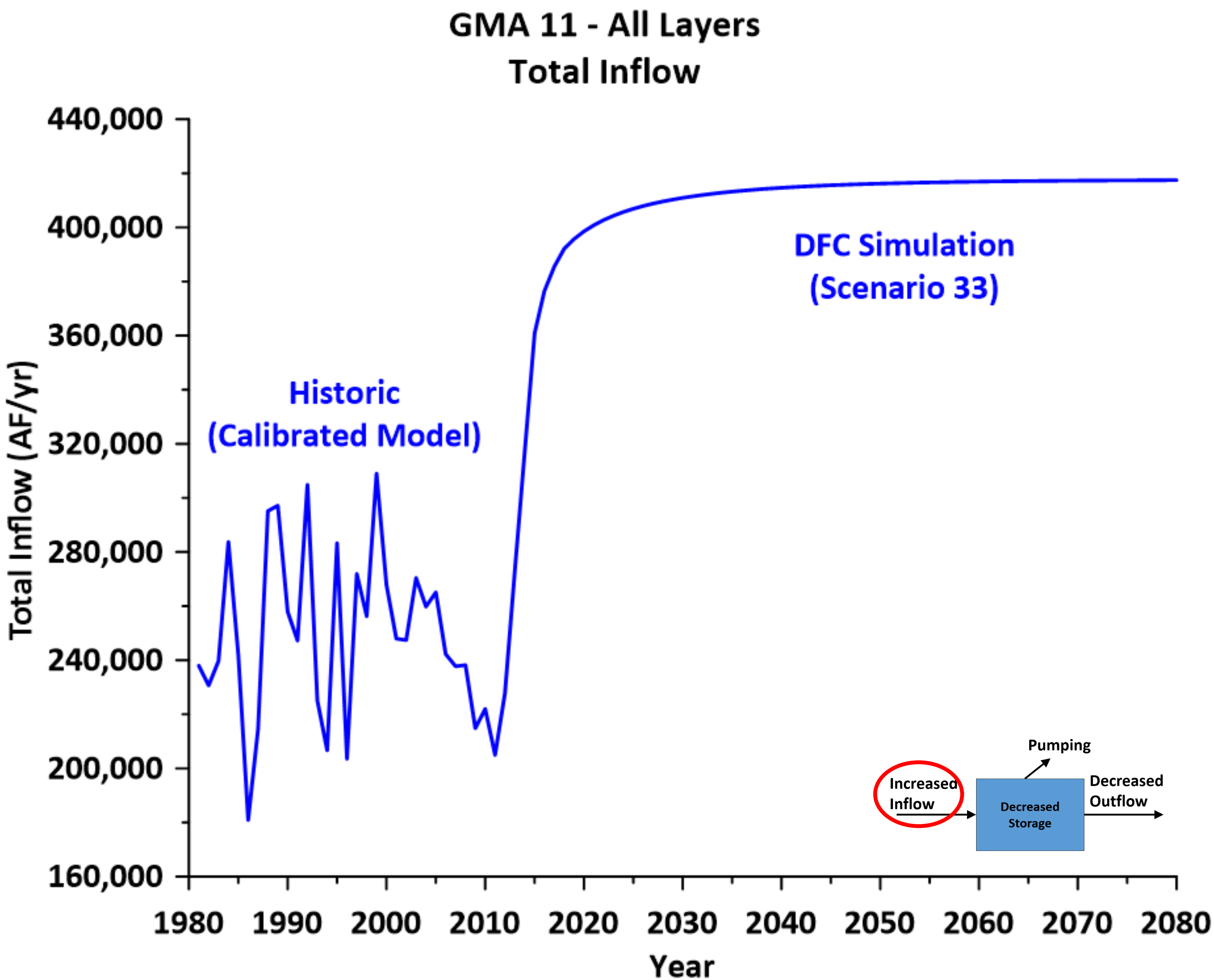
Pumping = Capture + Decreased Storage

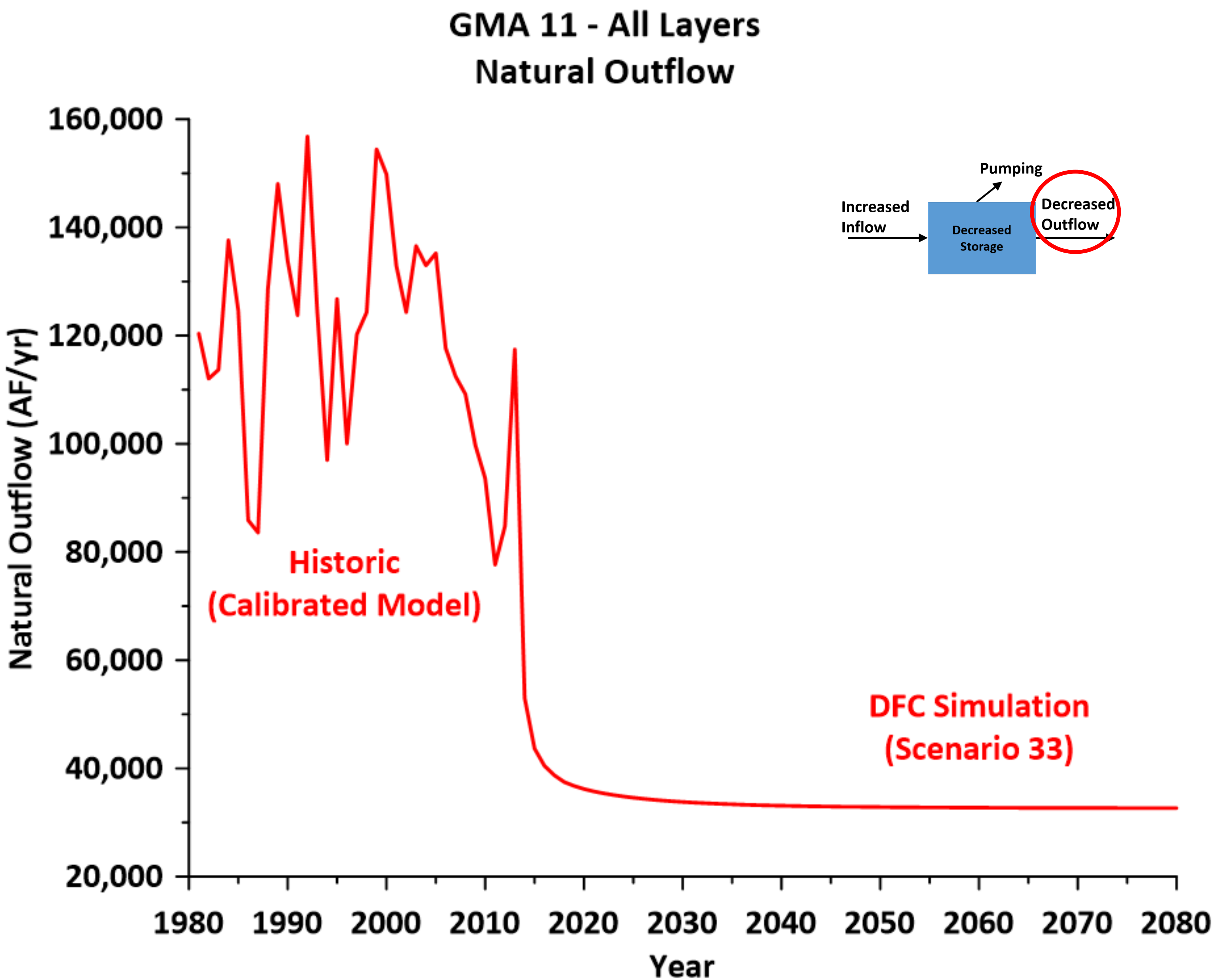
Modified from Alley and others, 1999

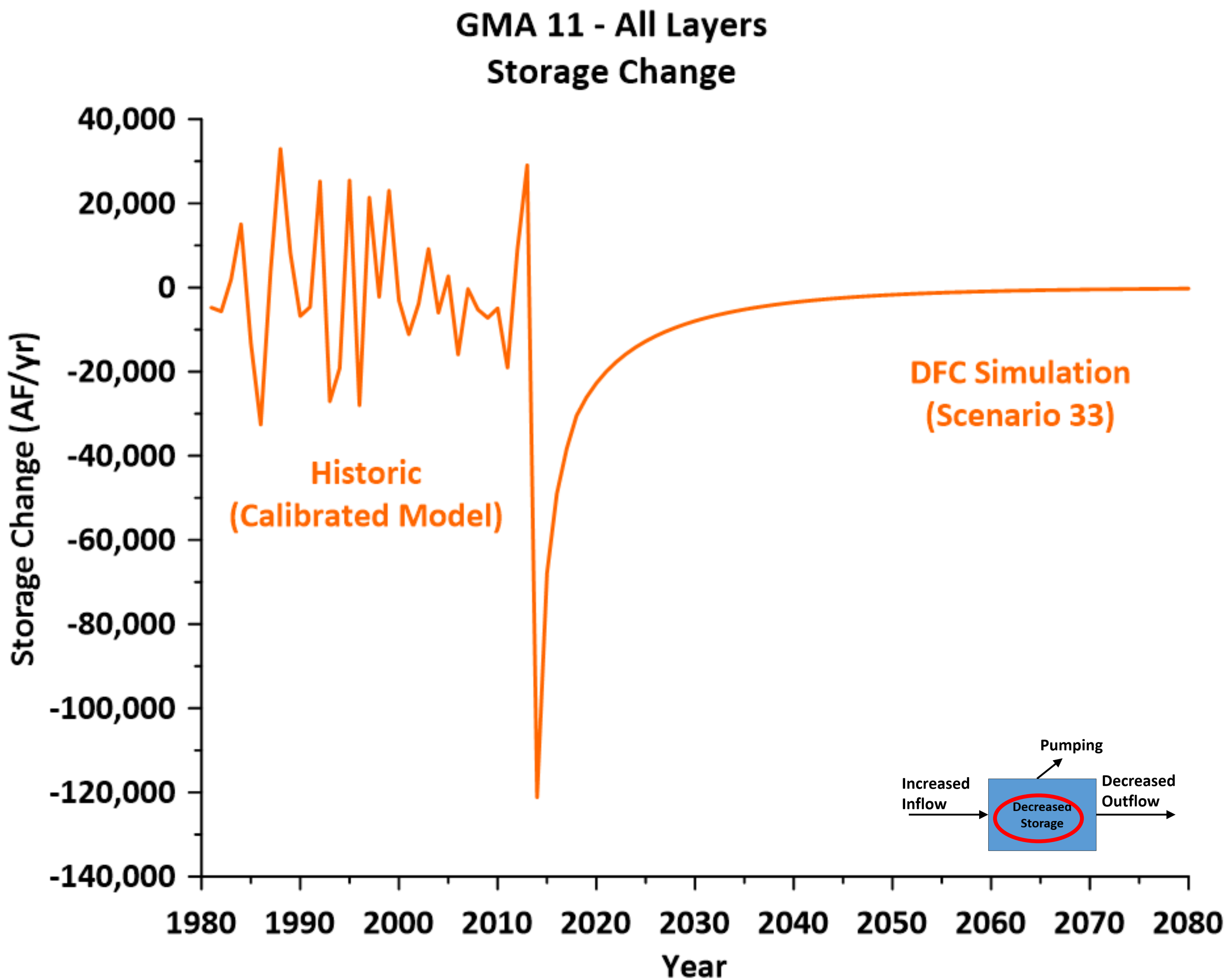
Simulations with New GAM

- Calibrated Model (1981 to 2013)
- Scenario 33 (2014 to 2080)
  - Basis for new DFC
  - Assumed significant increase in pumping in GMA 11
    - About 130,000 AF/yr to about 385,000 AF/yr
  - Assumed average recharge and streamflow conditions
  - Simulation results provide basis to understand dynamic changes associated with increased pumping


GMA 11 - All Layers
Groundwater Pumping
400,000
360,000
320,000
280,000
240,000
200,000
160,000
120,000
Pumping (AF/yr)
DFC Simulation
(Scenario 33)
Historic
(Calibrated Model)
Pumping
Increased
Inflow
Decreased
Storage
Decreased
Outflow
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
Year


GMA 11 - All Layers
Total Inflow
440,000
400,000
360,000
320,000
280,000
240,000
200,000
160,000
Total Inflow (AF/yr)
Historic
(Calibrated Model)
DFC Simulation
(Scenario 33)
Pumping
Increased
Inflow
Decreased
Storage
Decreased
Outflow
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
Year


GMA 11 - All Layers
Natural Outflow
Natural Outflow (AF/yr)
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
Year
Historic
(Calibrated Model)
DFC Simulation
(Scenario 33)
Pumping
Increased
Inflow
Decreased
Storage
Decreased
Outflow


GMA 11 - All Layers
Storage Change
Storage Change (AF/yr)
40,000
20,000
0
-20,000
-40,000
-60,000
-80,000
-100,000
-120,000
-140,000
Historic
(Calibrated Model)
DFC Simulation
(Scenario 33)
Pumping
Increased
Inflow
Decreased
Storage
Decreased
Outflow
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
Year

Connection to TERS Interpretation

- Total Estimated Recoverable Storage (TERS)
  - 25% to 75% of Total Groundwater Storage
  - Three components:
    - Outcrop
    - Downdip-Artesian
    - Downdip-Saturated
- Old GAM Estimate of Total Storage in GMA 11
  - Sparta: 55.3 MAF
  - Queen City: 142.0 MAF
  - Carrizo-Wilcox: 2,070.6 MAF

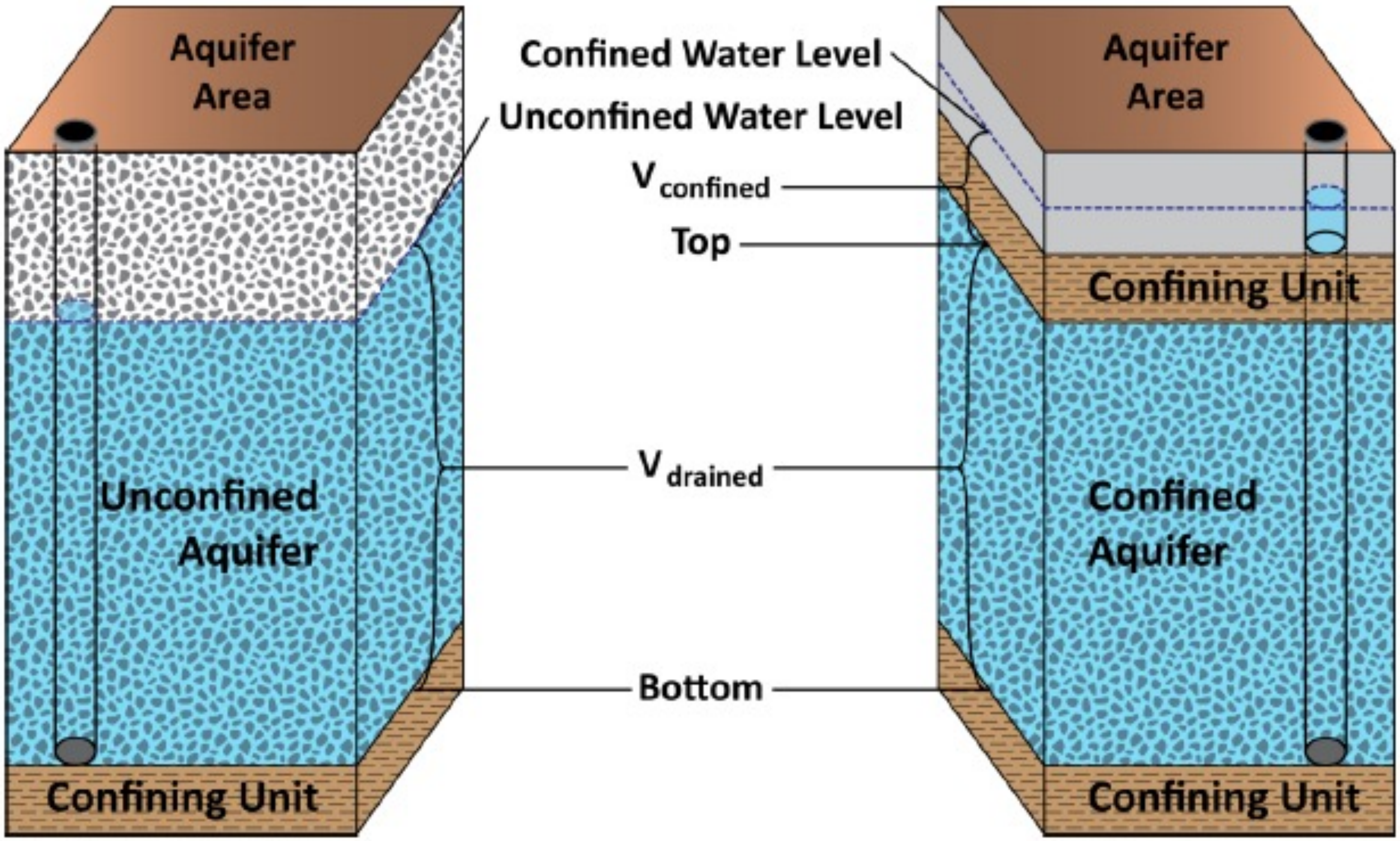


FIGURE 1. SCHEMATIC GRAPH SHOWING THE DIFFERENCE BETWEEN UNCONFINED AND CONFINED AQUIFERS.

From TWDB Report
GAM Task 13-034 (GMA 11)

Updated GAM Estimates in GMA 11

- Updated Estimate: Total Storage
  - Sparta: 0.499 MAF (0.90% of old GAM)
  - Queen City: 0.756 MAF (0.53% of old GAM)
  - Carrizo-Wilcox: 13.032 MAF (0.63% of old GAM)
- Updated Estimate: Carrizo-Wilcox Components
  - Outcrop: 0.537 MAF (4.12% of total)
  - Downdip-Artesian: 1.073 MAF (8.23% of total)
  - Downdip-Saturated: 11.422 MAF (87.64% of total)

Implications

- Over 85% of the total storage is in downdip-saturated portion of the aquifer
- Cannot “program” a well to reduce storage in downdip-saturated of the aquifer
- Pumping creates hydraulic gradients that result in “capture”
  - Induced inflow
  - Reduced natural outflow
- Understanding the “source” of increased pumping is critical to planning, management, and regulation

Questions and Discussion

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