Lower Rio Grande Valley Groundwater Transport Model: Predictive Simulations

Region M Meeting

Sorab Panday, Bill Hutchison,
Jim Rumbaugh, Staffan Schorr

July 12, 2017

Topics

- Background and Project Status
  - Status of Three Reports
- Predictive Simulation Results
- Next Steps

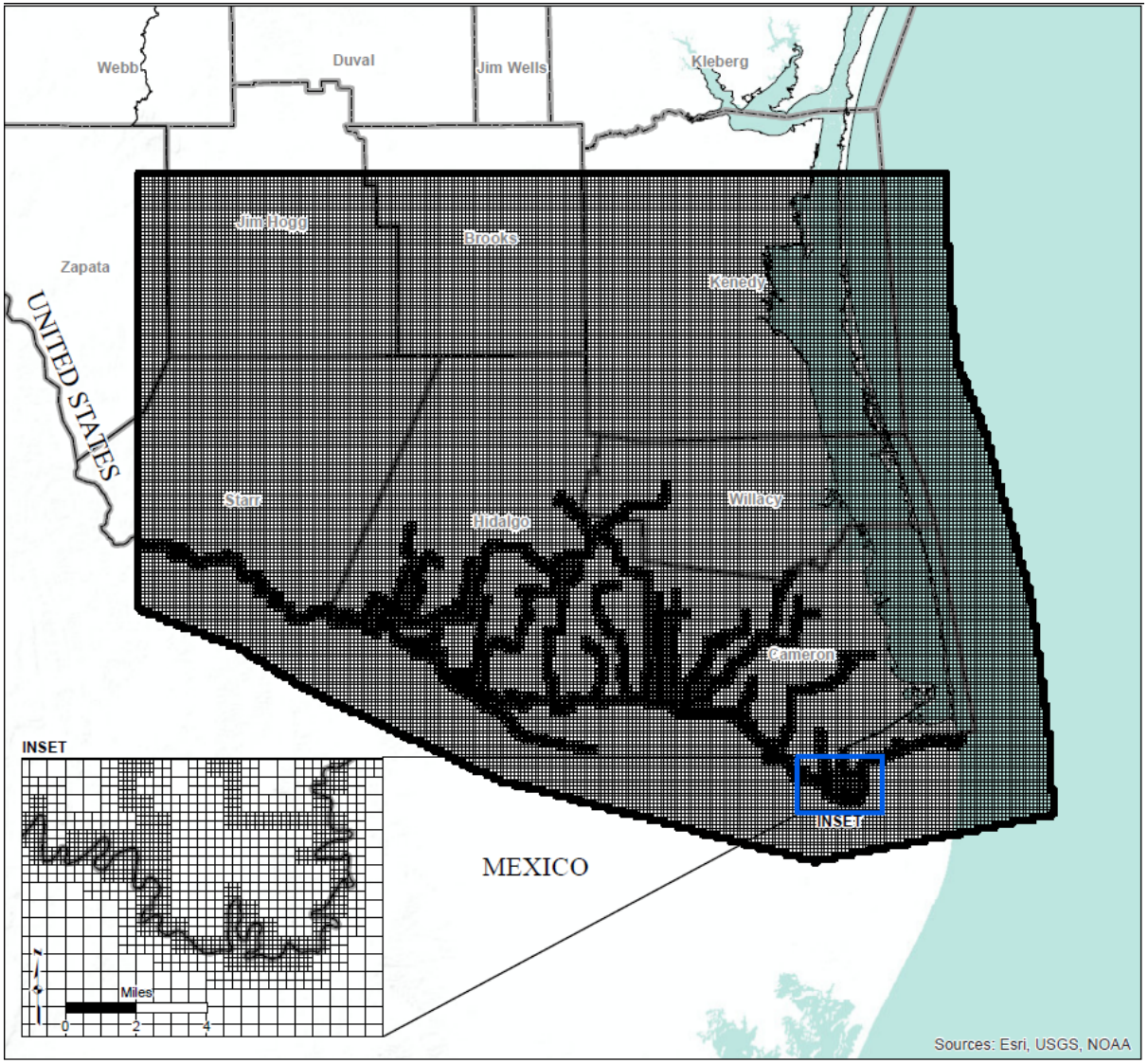
Background

- 2016 Region M plan recommends an additional 23 water management strategies involving
  - Brackish groundwater (14): 24,160 AF/yr
  - Fresh groundwater (9): 9,215 AF/yr
- Model is needed to:
  - Evaluate groundwater level changes
  - Evaluate groundwater quality changes
  - Evaluate impacts to surface water
  - Evaluate potential for subsidence

Project Status

- Conceptual model report delivered to TWDB on January 31, 2017
  - updated on June 30, 2017 based on comments to numerical report
- Numerical model report delivered on June 30, 2017
  - Responses to 100 specific comments to draft report in Appendix E
- Draft Predictive Simulations report delivered on June 30, 2017
- All reports can be found at:
  - http://www.twdb.texas.gov/groundwater/models/research/lrgv_t/lrgv_t.asp

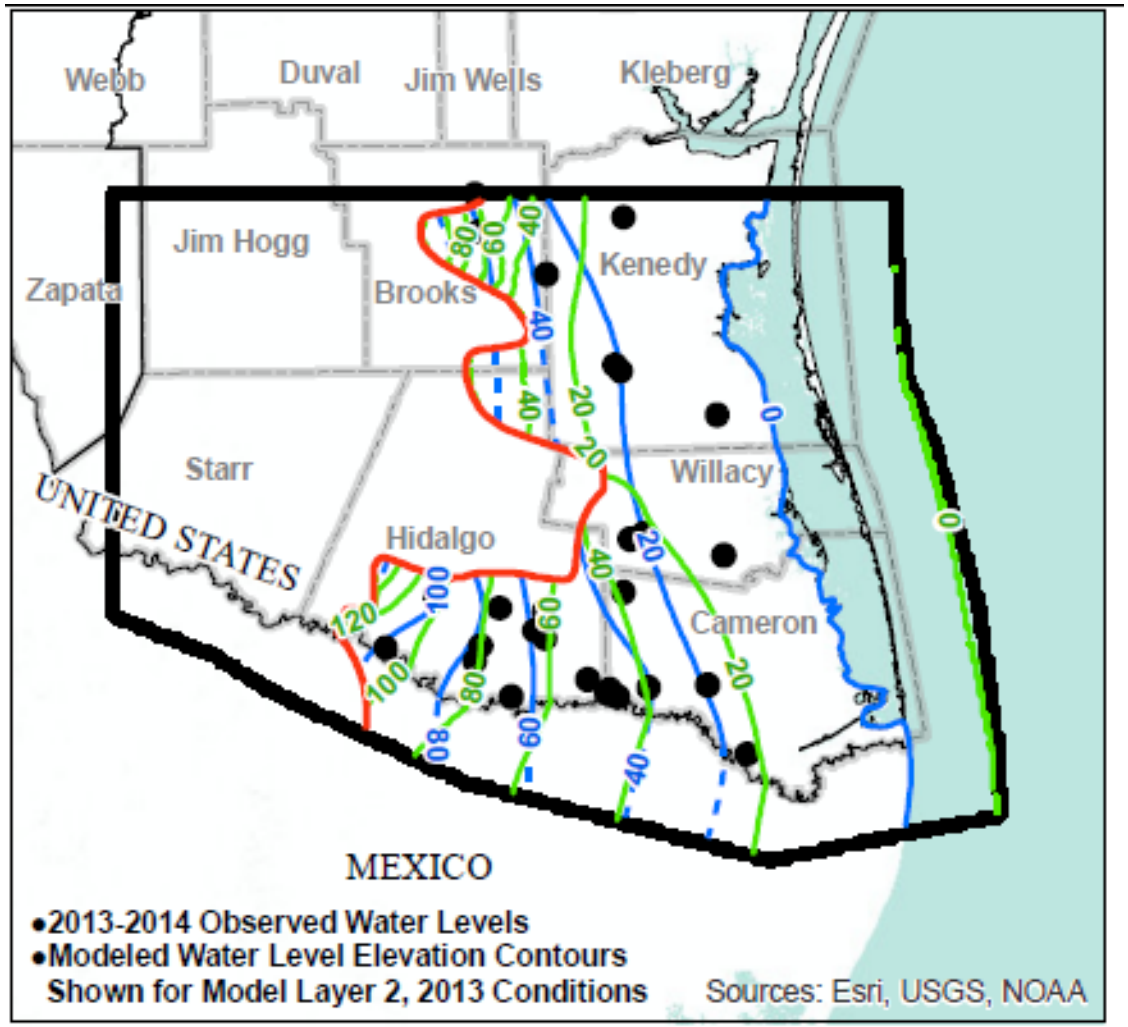
Model Domain and Grid



Model Layering

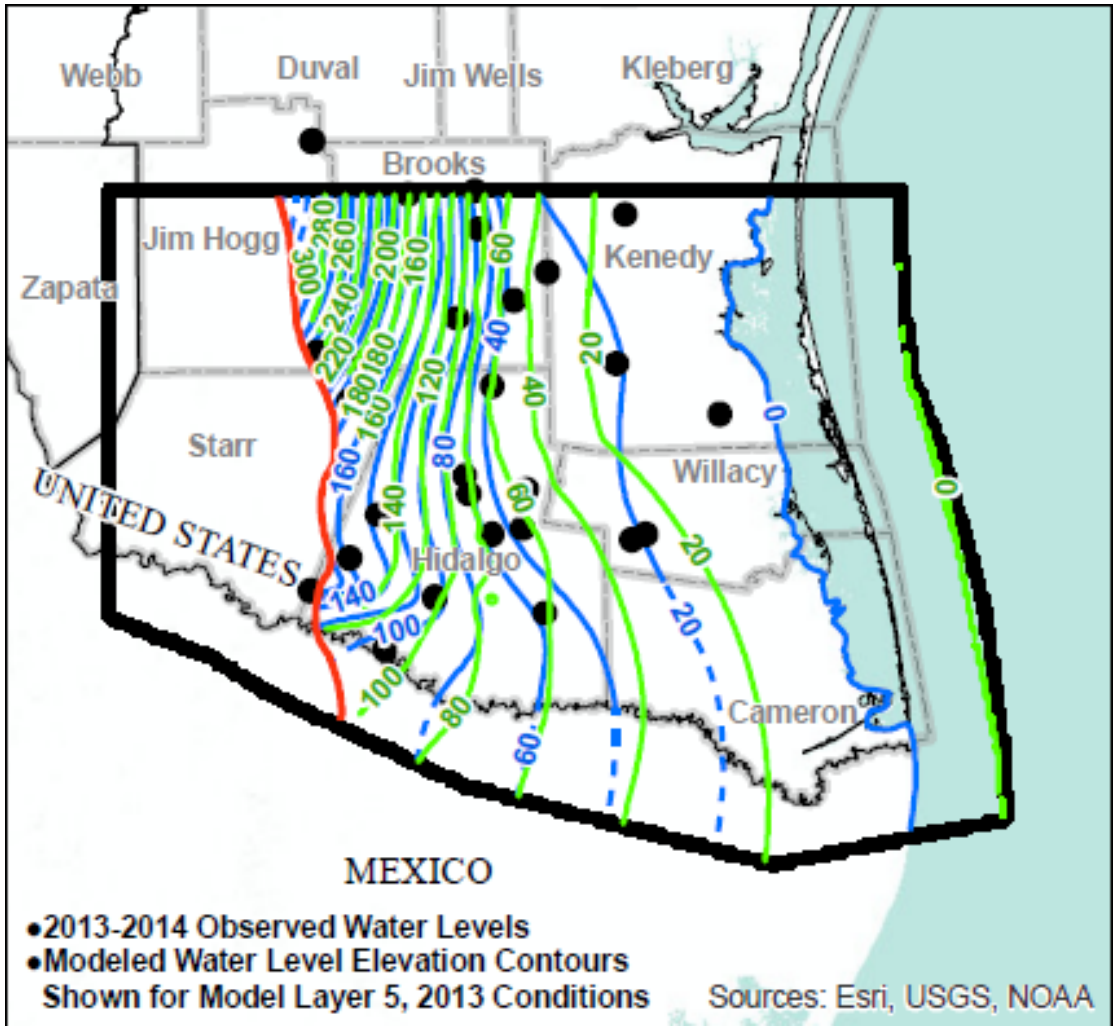
Model Layer	Geologic Formation	Hydrogeologic Unit	
Layer 1	Beaumont	Chicot Aquifer	Gulf Coast Aquifer
Layer 2	Lissie		
Layer 3	Willis		
Layer 4	Upper Goliad	Evangeline Aquifer	
Layer 5	Lower Goliad		
Layer 6	Upper Lagarto		
Layer 7	Middle Lagarto	Burkeville Confining Unit	
Layer 8	Lower Lagarto	Jasper Aquifer	
Layer 9	Oakville		
Layer 10	(Upper) Catahoula		
Layer 11	Catahoula Confining System		
Layer 12	Yegua-Jackson Aquifer		

Calibrated Model Results for 2013



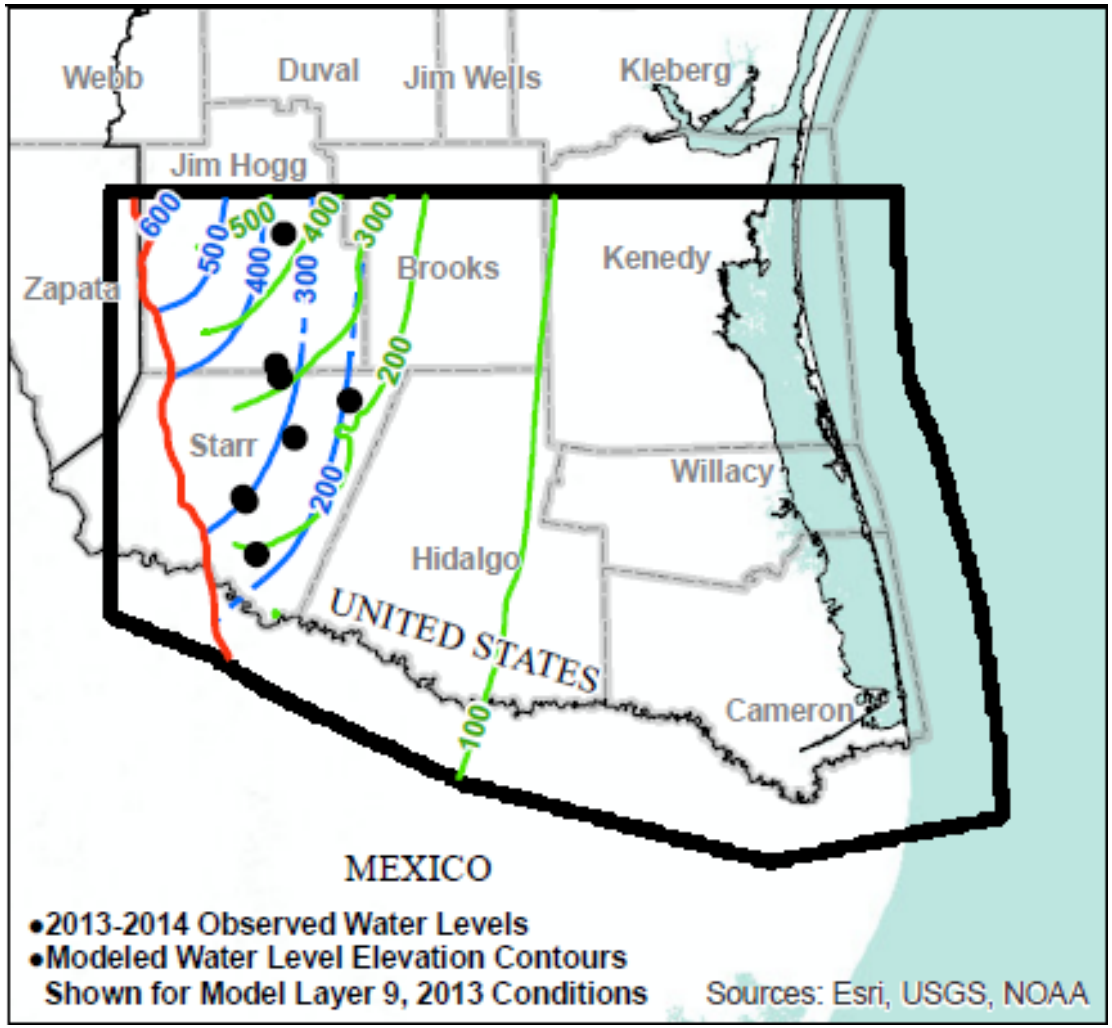
Chicot Aquifer

Calibrated Model Results for 2013



Evangeline Aquifer

Calibrated Model Results for 2013



Jasper Aquifer

Predictive Simulations

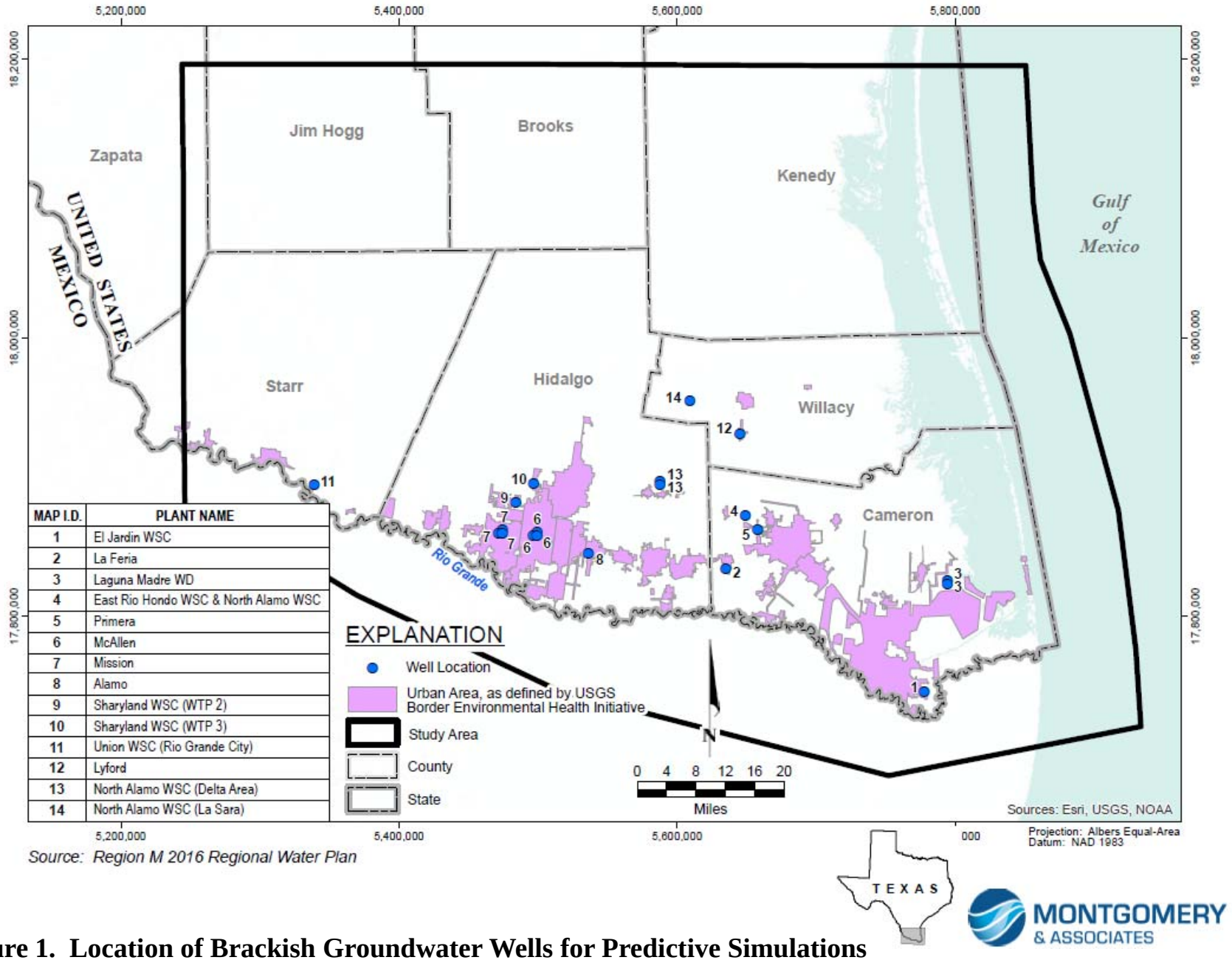
- Evaluate the potential impacts of each individual water management strategy individually and the cumulative impact of all strategies
- 25 Simulations of Flow and Transport from 2014 to 2070
  - Base case (2013 pumping)
  - All water management strategies implemented
  - 23 simulations where each strategy is implemented individually

Impacts of Pumping

- Changes in groundwater levels
- Changes in groundwater quality (TDS)
- Potential for subsidence
- Impacts to surface water flows

Summary of Predictive Simulation Report

- Section 2 documents how wells were located for the simulation
- Section 3 documents how the simulations were developed in Groundwater Vistas
- Section 4 provides an overview of the simulations
- Section 5 documents the post-processors used for the simulation results, including how subsidence was estimated
- Section 6 presents the results of the base case, including uncertainty
- Section 7 presents results of individual strategies simulations and simulation of all strategies

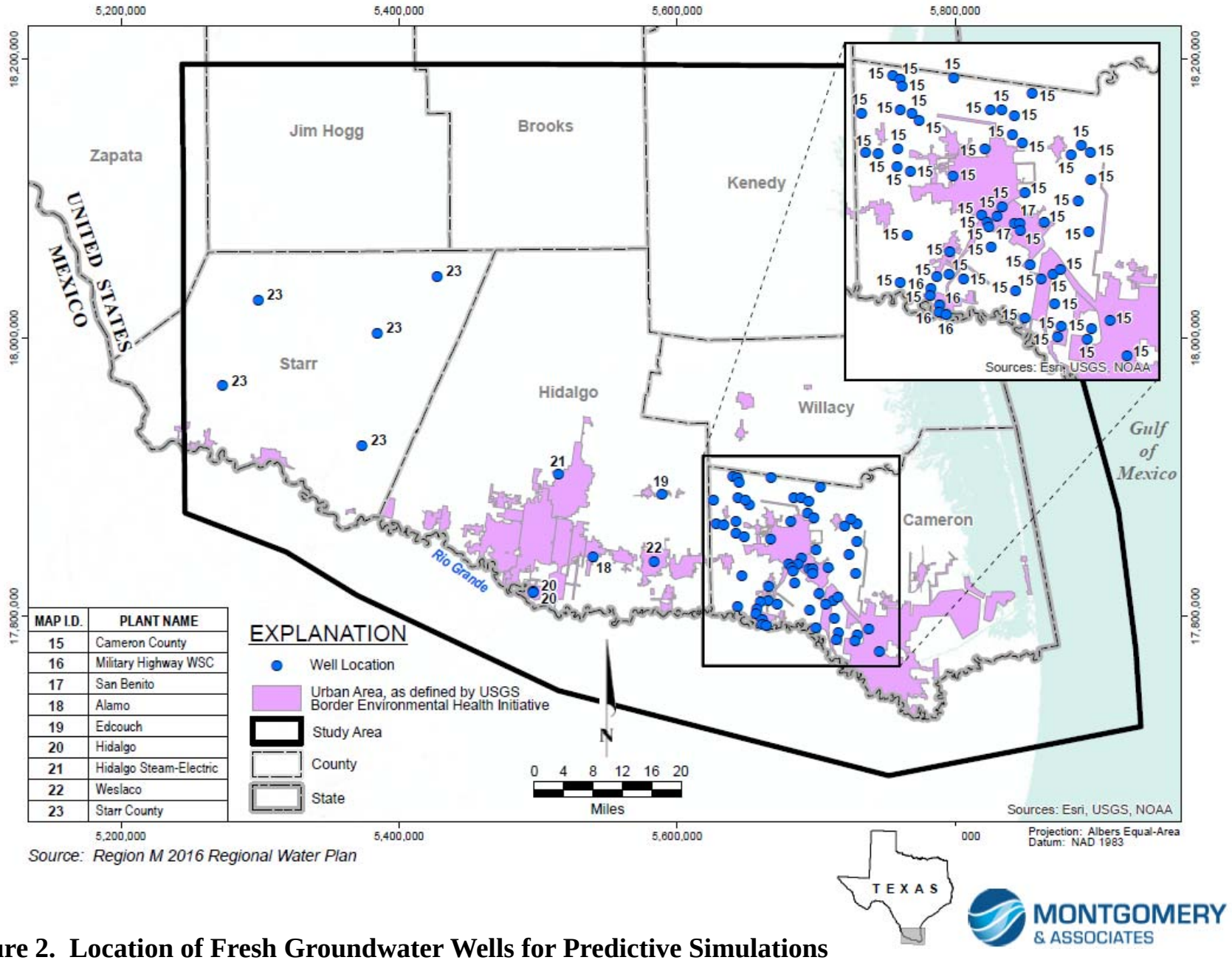


MAP I.D.	PLANT NAME
1	El Jardin WSC
2	La Feria
3	Laguna Madre WD
4	East Rio Hondo WSC & North Alamo WSC
5	Primera
6	McAllen
7	Mission
8	Alamo
9	Sharyland WSC (WTP 2)
10	Sharyland WSC (WTP 3)
11	Union WSC (Rio Grande City)
12	Lyford
13	North Alamo WSC (Delta Area)
14	North Alamo WSC (La Sara)

Source: Region M 2016 Regional Water Plan

MONTGOMERY & ASSOCIATES

Figure 1. Location of Brackish Groundwater Wells for Predictive Simulations



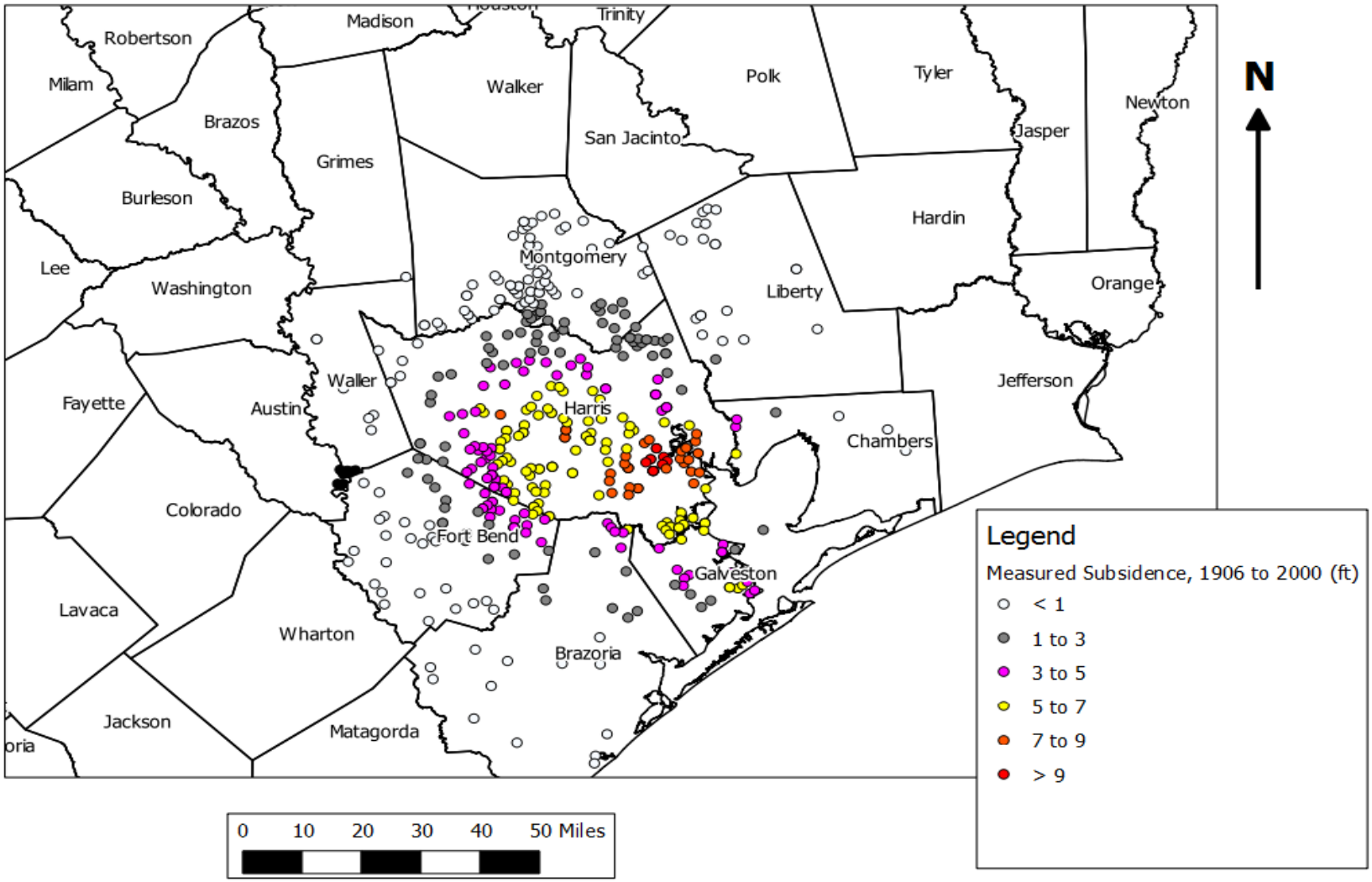
Source: Region M 2016 Regional Water Plan

MONTGOMERY & ASSOCIATES

Figure 2. Location of Fresh Groundwater Wells for Predictive Simulations

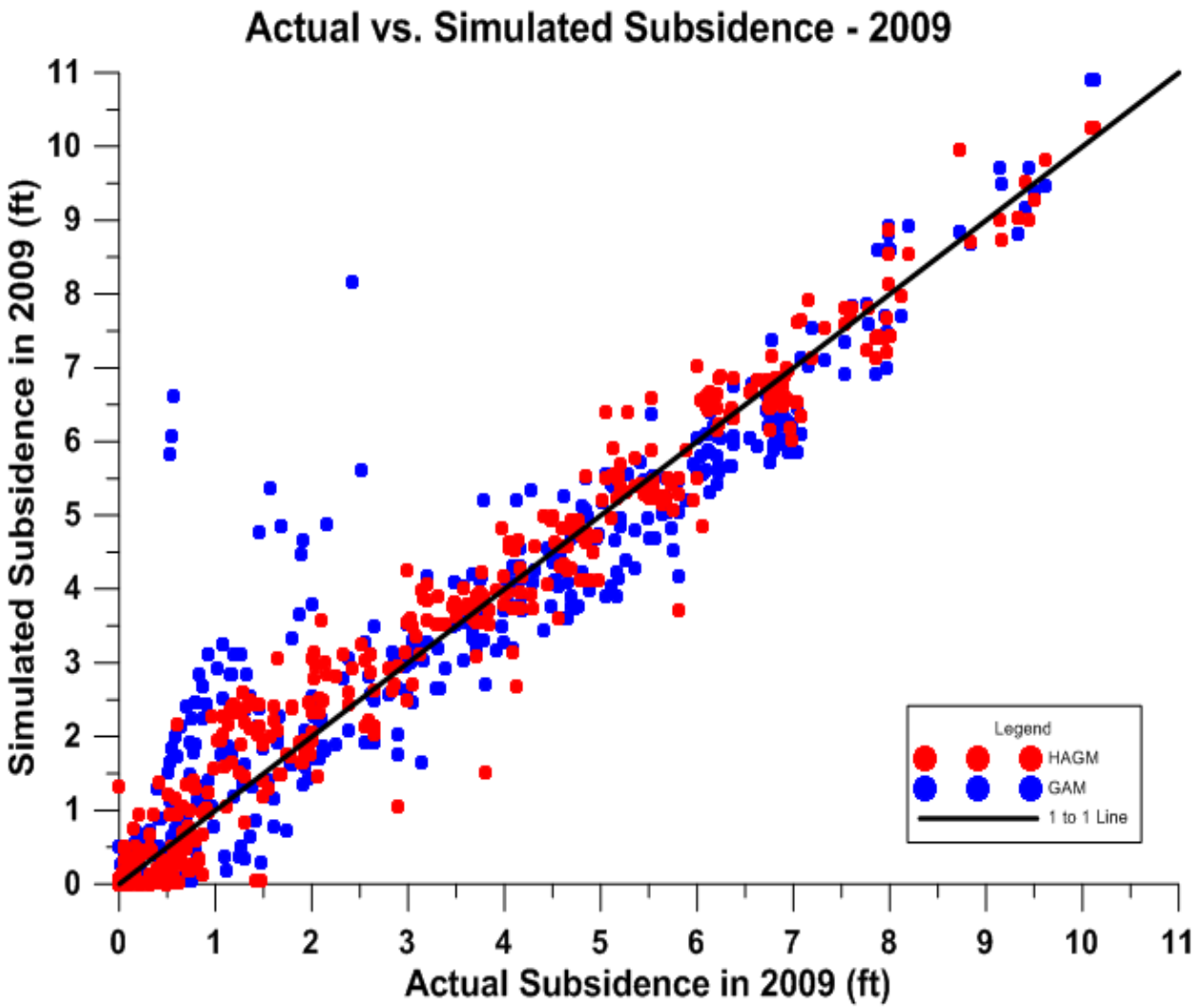
Subsidence

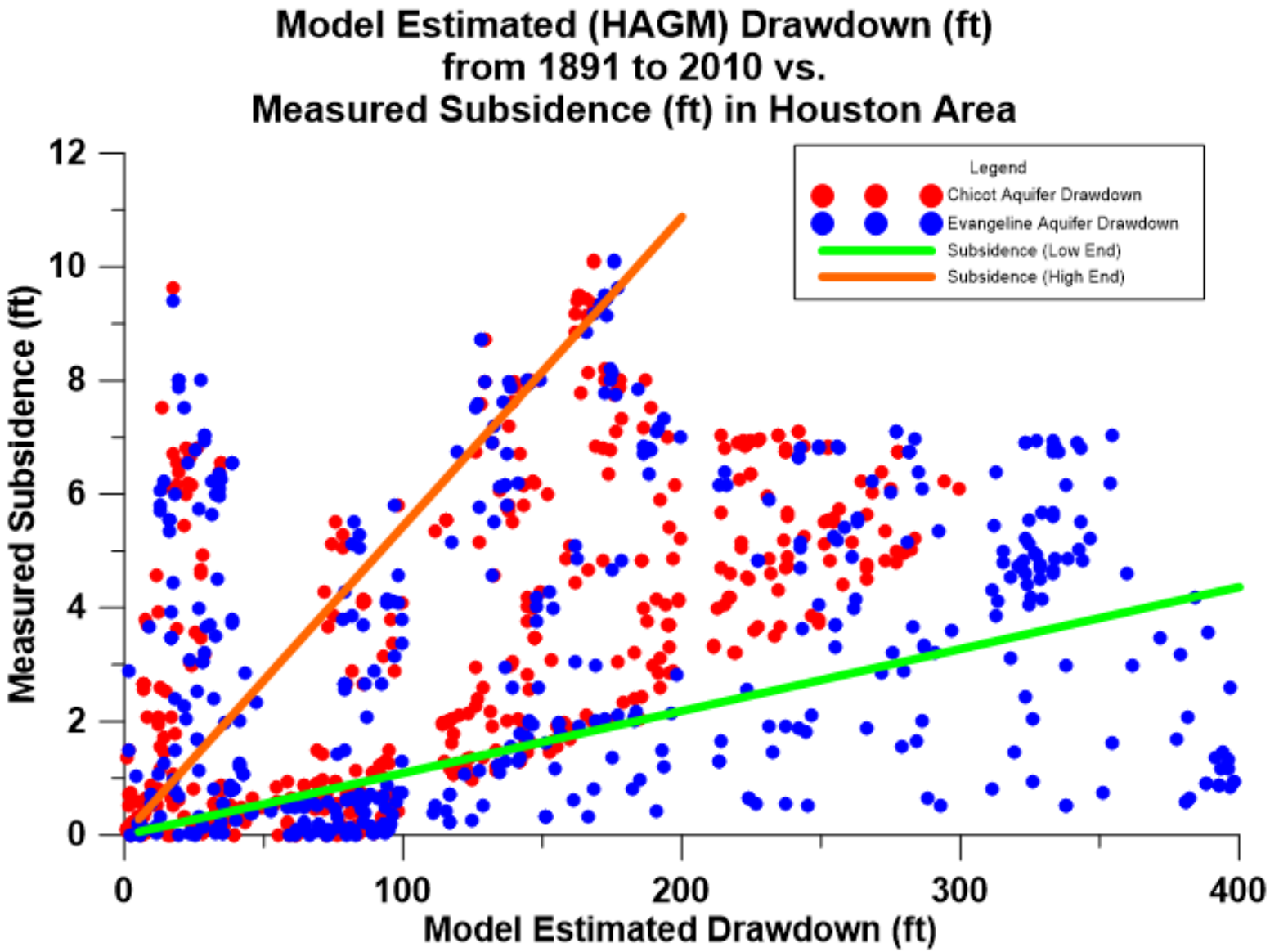
- Subsidence can result in some areas due to pumping of groundwater
  - Function of drawdown and clay content
- LRGV has not experienced a high level of pumping
  - Difficult to estimate subsidence with any accuracy with no ability to calibrate analytical or numerical models
  - Geologically similar to other areas of the Gulf Coast Aquifer
- Subsidence has been observed in the Gulf Coast Aquifer in the Houston area
  - Recent groundwater management is concerned with reducing groundwater pumping to halt subsidence


Robertson
Madison
Trinity
Milam
Walker
Polk
Tyler
Newton
Brazos
San Jacinto
Jasper
Grimes
Burleson
Hardin
Montgomery
Lee
Liberty
Orange
Washington
Waller
Jefferson
Fayette
Austin
Harris
Chambers
Colorado
Fort Bend
Galveston
Lavaca
Wharton
Brazoria
Jackson
Matagorda
oria
N
Legend
Measured Subsidence, 1906 to 2000 (ft)
< 1
1 to 3
3 to 5
5 to 7
7 to 9
> 9
0 10 20 30 40 50 Miles

Use of Houston Area Data and Models

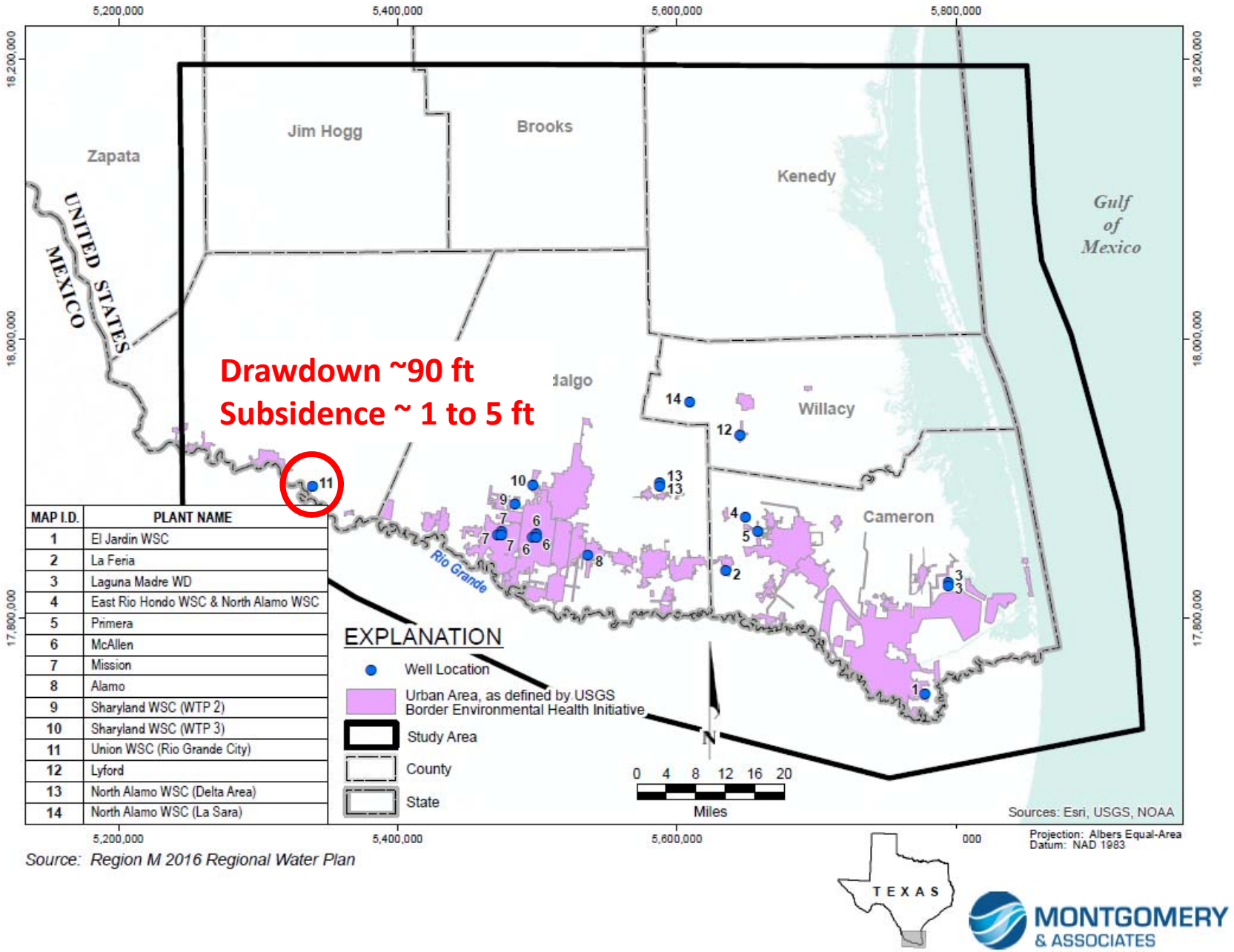
- HAGM: Houston Area Groundwater Model
- HAGM is calibrated to estimate subsidence over long periods of time
- Developed a relationship between drawdown and subsidence from HAGM to estimate range of potential subsidence in LRGV


Actual vs. Simulated Subsidence - 2009
Simulated Subsidence in 2009 (ft)
Actual Subsidence in 2009 (ft)
0
1
2
3
4
5
6
7
8
9
10
11
Legend
HAGM
GAM
1 to 1 Line


Model Estimated (HAGM) Drawdown (ft)
from 1891 to 2010 vs.
Measured Subsidence (ft) in Houston Area
Legend
Chicot Aquifer Drawdown
Evangeline Aquifer Drawdown
Subsidence (Low End)
Subsidence (High End)
Measured Subsidence (ft)
0
2
4
6
8
10
12
0
100
200
300
400
Model Estimated Drawdown (ft)

Individual Strategy Results

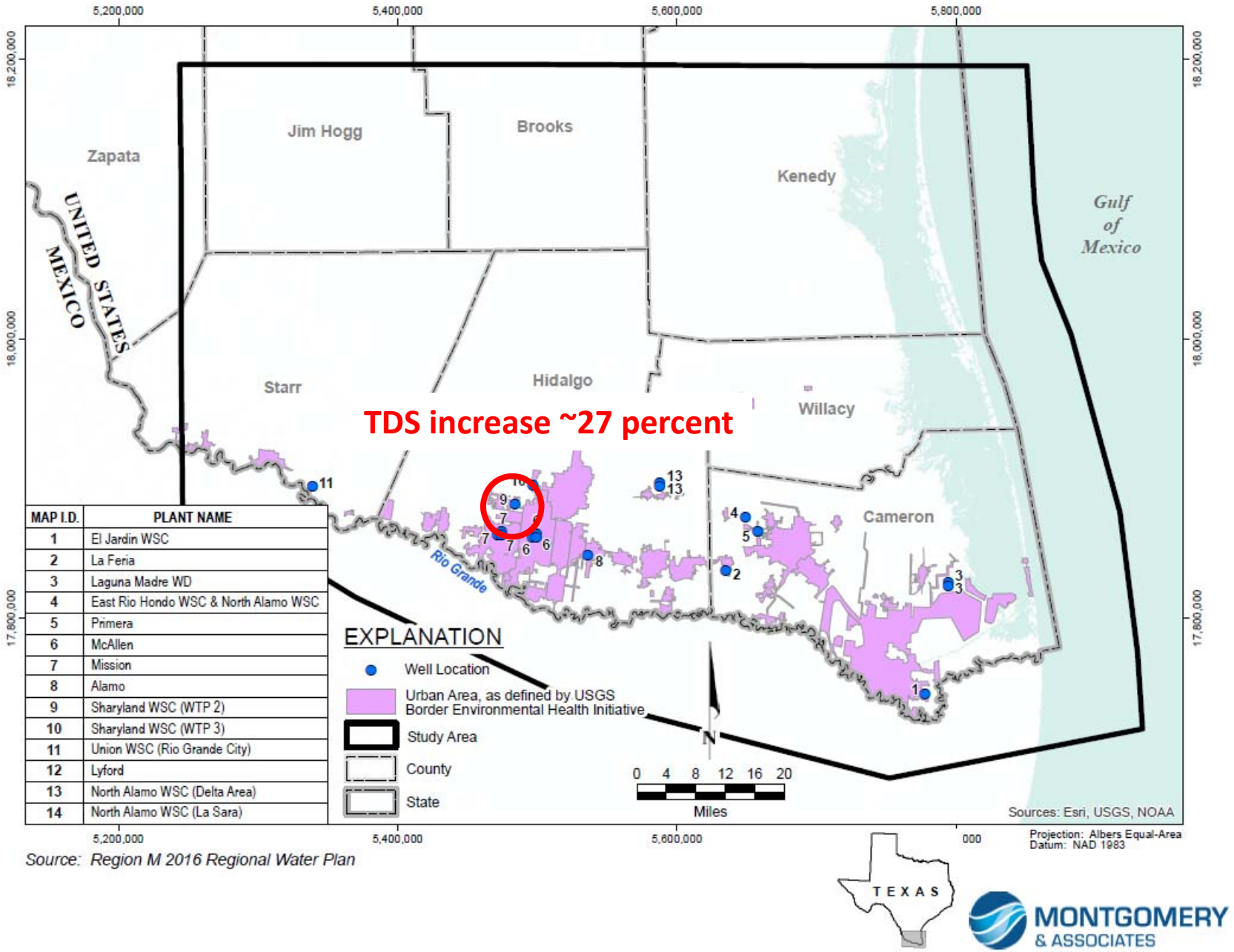
- Details in Section 7 of report
- For each strategy:
  - Number of wells
  - Pumping amount
  - Change in groundwater elevation and TDS
    - Baseline
    - 2013 to 2070
    - Attributable to strategy
- Results highlight the importance of design level investigations to understand clay content and water quality of surrounding area



MAP I.D.	PLANT NAME
1	El Jardin WSC
2	La Feria
3	Laguna Madre WD
4	East Rio Hondo WSC & North Alamo WSC
5	Primera
6	McAllen
7	Mission
8	Alamo
9	Sharyland WSC (WTP 2)
10	Sharyland WSC (WTP 3)
11	Union WSC (Rio Grande City)
12	Lyford
13	North Alamo WSC (Delta Area)
14	North Alamo WSC (La Sara)

Source: Region M 2016 Regional Water Plan

MONTGOMERY & ASSOCIATES



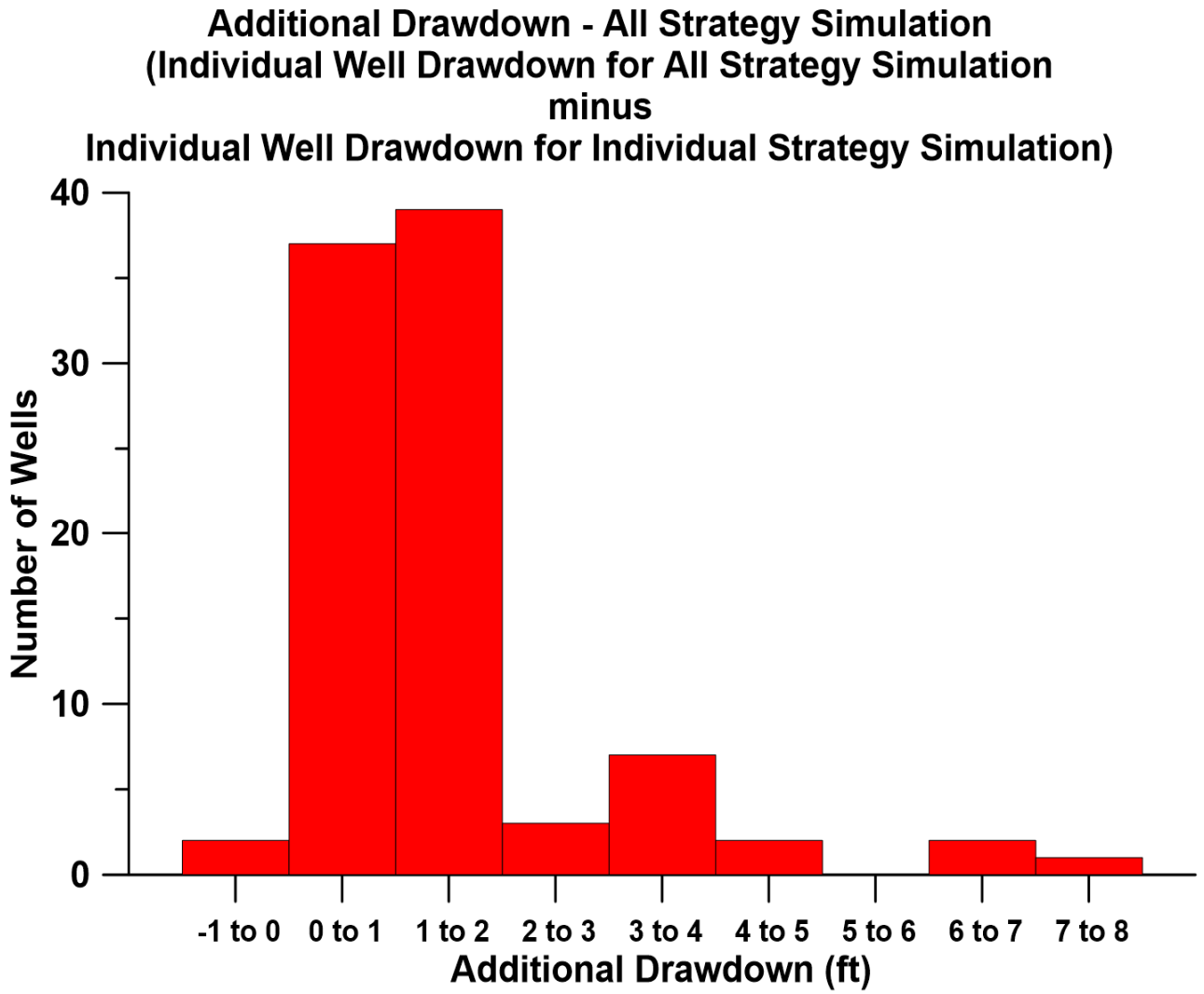
MAP I.D.	PLANT NAME
1	El Jardin WSC
2	La Feria
3	Laguna Madre WD
4	East Rio Hondo WSC & North Alamo WSC
5	Primera
6	McAllen
7	Mission
8	Alamo
9	Sharyland WSC (WTP 2)
10	Sharyland WSC (WTP 3)
11	Union WSC (Rio Grande City)
12	Lyford
13	North Alamo WSC (Delta Area)
14	North Alamo WSC (La Sara)

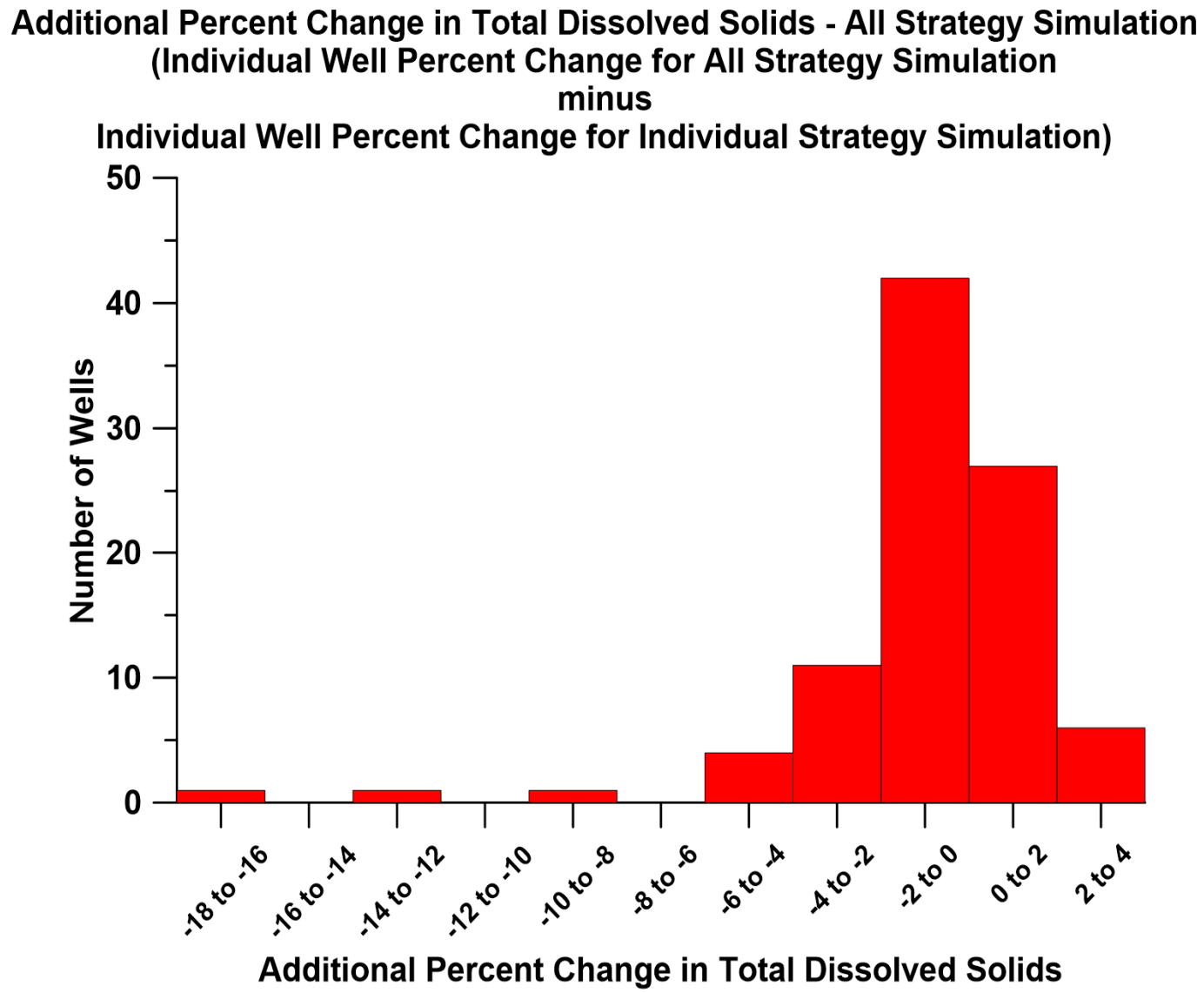
Source: Region M 2016 Regional Water Plan

MONTGOMERY & ASSOCIATES

All Strategy Results

- Tabular data (Appendix A)
- Figures to show limited cumulative effects
  - Drawdown and TDS impacts are generally localized
- Cumulative impacts:
  - Drawdown increase with all strategies generally about 1 to 2 feet of additional drawdown
  - TDS impacts is generally about 4 percent (increase or decrease)


Additional Drawdown - All Strategy Simulation
(Individual Well Drawdown for All Strategy Simulation
minus
Individual Well Drawdown for Individual Strategy Simulation)
Number of Wells
40
30
20
10
0
-1 to 0
0 to 1
1 to 2
2 to 3
3 to 4
4 to 5
5 to 6
6 to 7
7 to 8
Additional Drawdown (ft)


Additional Percent Change in Total Dissolved Solids - All Strategy Simulation
(Individual Well Percent Change for All Strategy Simulation
minus
Individual Well Percent Change for Individual Strategy Simulation)
Number of Wells
50
40
30
20
10
0
-18 to -16
-16 to -14
-14 to -12
-12 to -10
-10 to -8
-8 to -6
-6 to -4
-4 to -2
-2 to 0
0 to 2
2 to 4
Additional Percent Change in Total Dissolved Solids

Water Budget Analysis

- Initial response to pumping is decreased storage
- Over time, pumping “captures” other flow

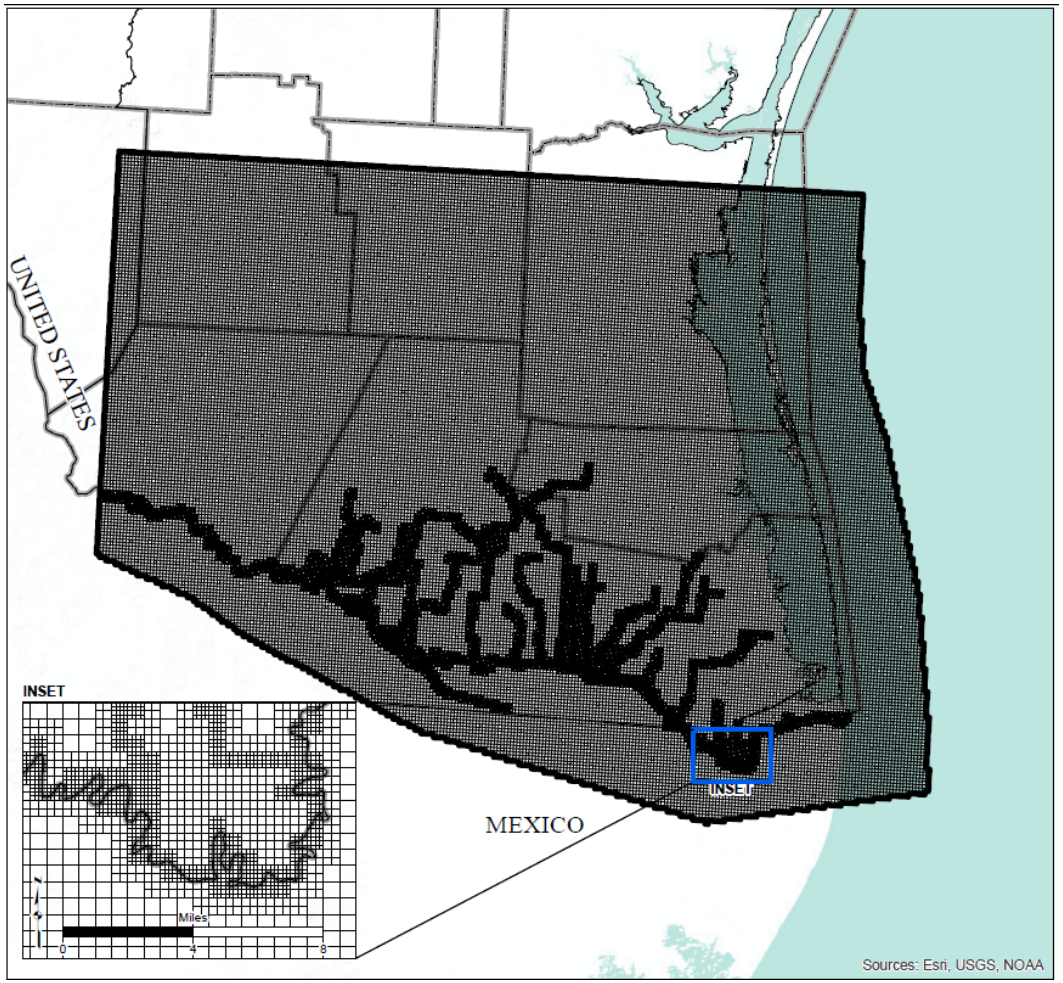
Component	2 Years of Pumping	57 Years of Pumping
Decreased Storage	16%	2%
Captured flow (Gulf)	31%	33%
Captured flow (ET)	7%	9%
Induced recharge (Rio Grande)	47%	49%
Induced recharge (canals)	3%	4%

Takeaways

- Historic groundwater pumping in LRGV has been low
  - Region M strategies represent a large increase
- Increased Groundwater pumping:
  - Lowers groundwater levels (potential for subsidence)
  - Induces flow from surrounding areas (potential for groundwater quality improvement or degradation)
  - Reduces surface water flow – about a 2 to 1 ratio (2 AF/yr of pumping means 1 AF/yr less surface flow)

Next Steps

- Predictive Simulation Report open for comment until August 4, 2017
- Project completion date is October 31, 2017



Questions and Discussion

billhutch@texasgw.com
sp@gsi-net.com
jrumbaugh@groundwatermodels.com
sschorr@elmontgomery.com