Lower Rio Grande Valley Groundwater Transport Model: Predictive Simulations

Region M Meeting

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July 12, 2017

Topics

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

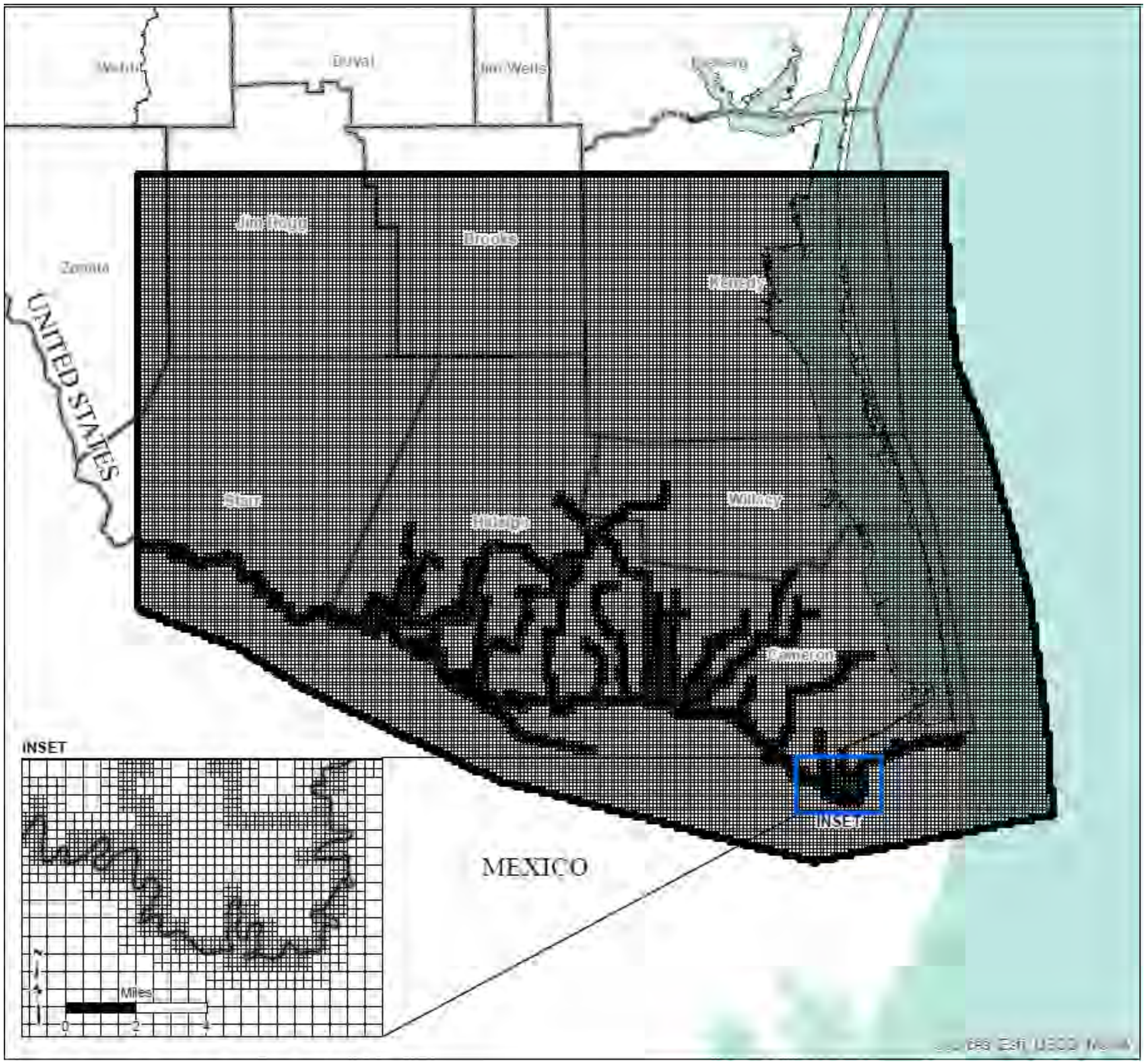
Background

- 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

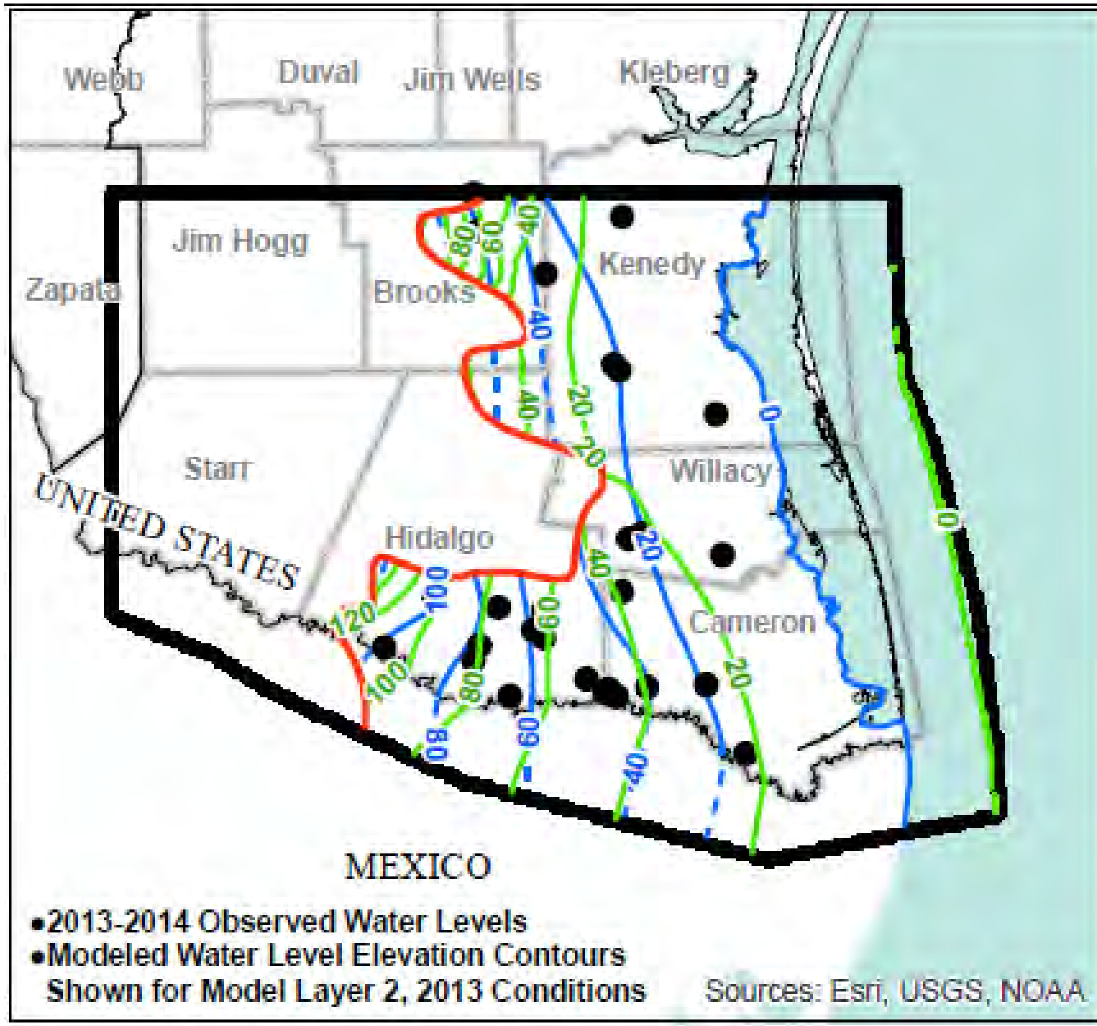
Model Domain and Grid



Model Layering

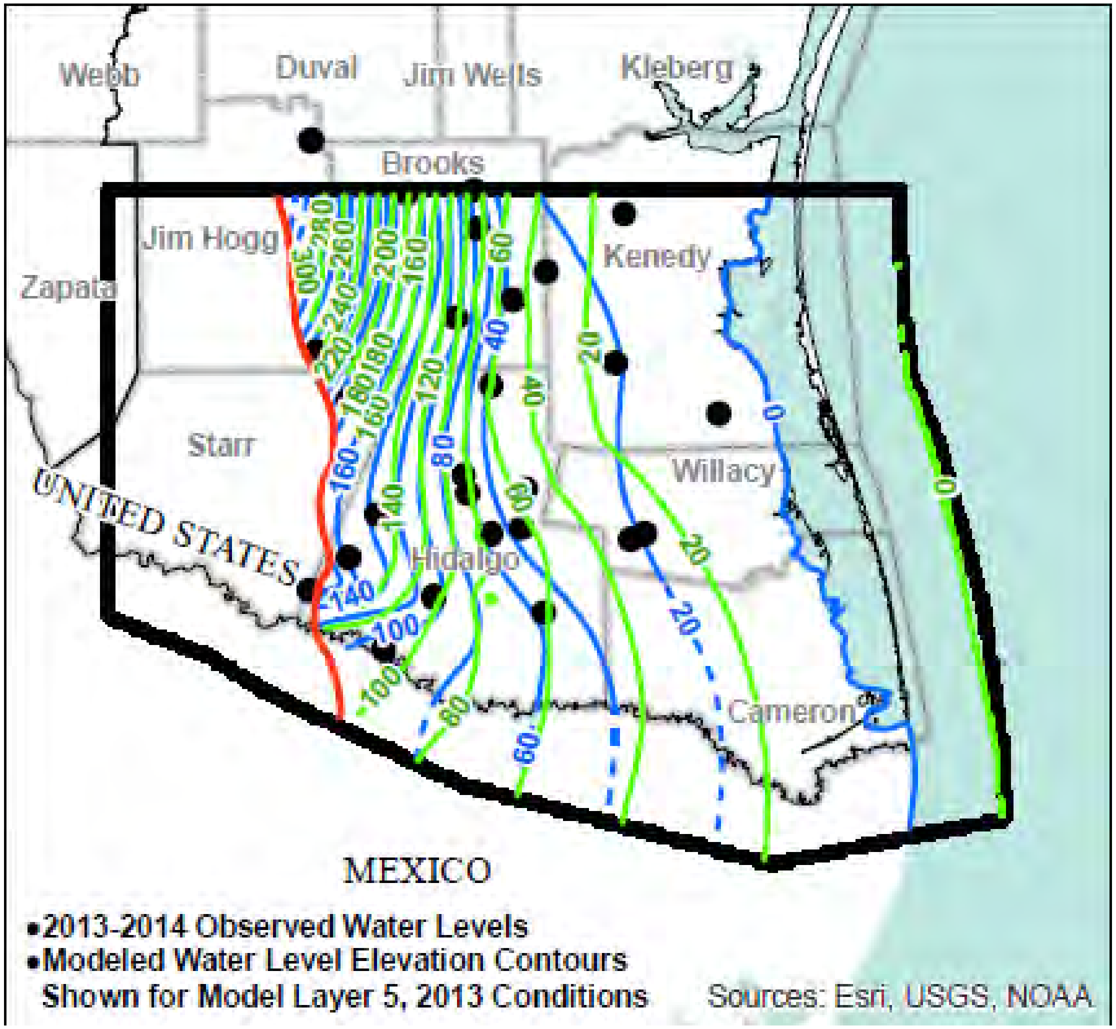
Model Layer	Geologic Formation	Hydrogeologic Unit	
Layer 1	Beaumont	Chicot Aquifer	Gulf Coast Aquifer
Layer 2	Lissie		
Layer 3	Willis		
Layer 4	Upper Goliad	Evangeline Aquifer	
Layer 5	Lower Goliad		
Layer 6	Upper Lagarto		
Layer 7	Middle Lagarto	Burkeville Confining Unit	
Layer 8	Lower Lagarto	Jasper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

Calibrated Model Results for 2013



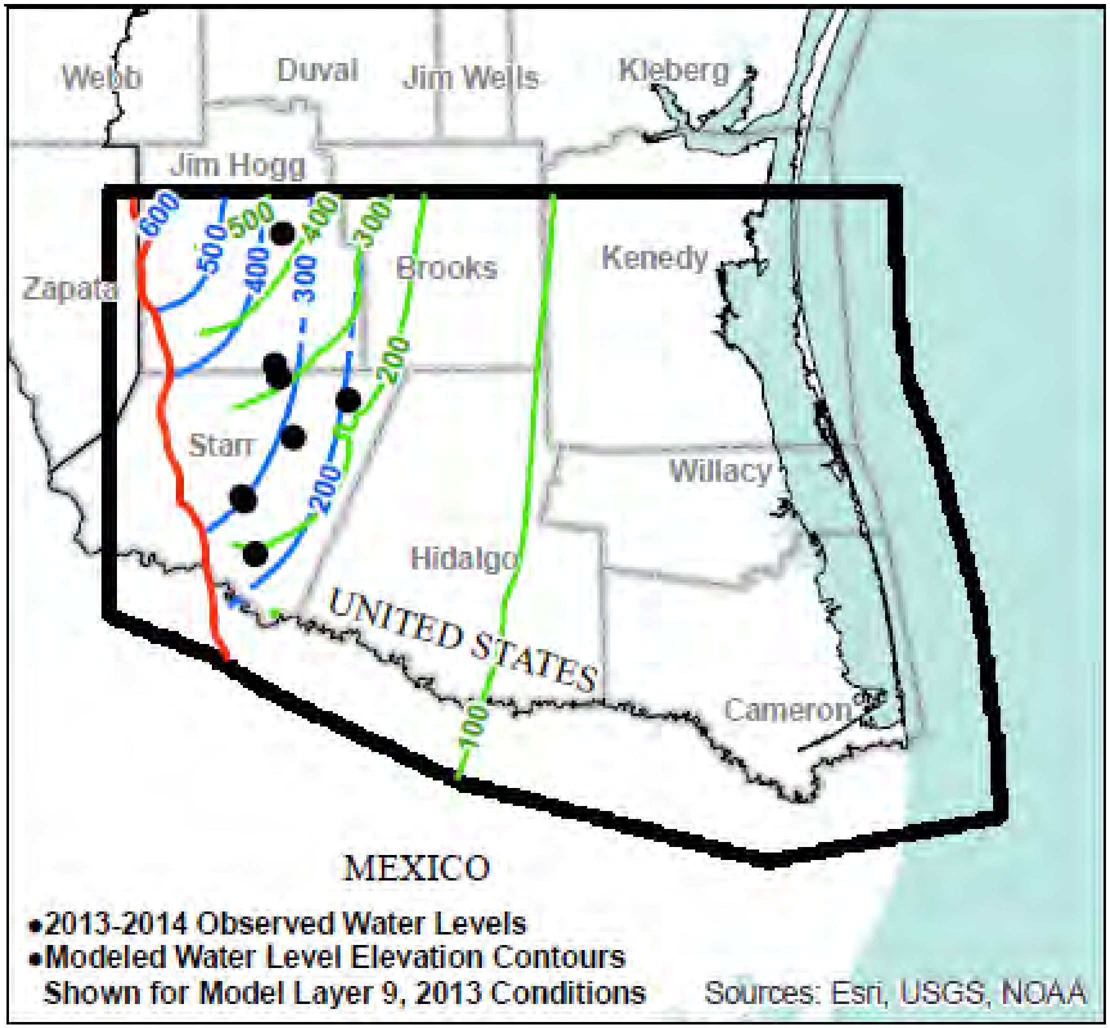
Chicot Aquifer

Calibrated Model Results for 2013



Evangeline Aquifer

Calibrated Model Results for 2013



Jasper Aquifer

Predictive Simulations

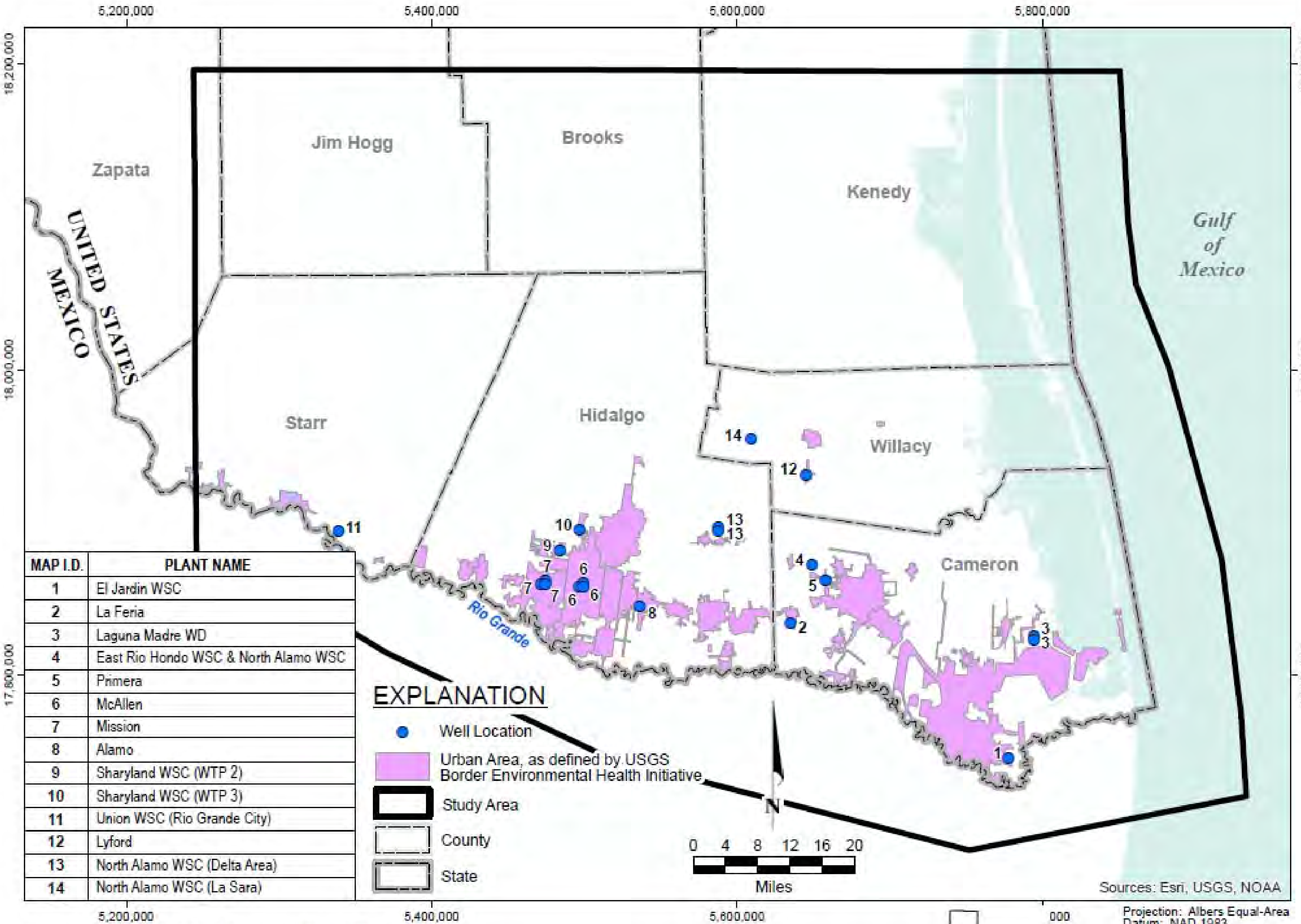
- Evaluate the potential impacts of each individual water management strategy individually and the cumulative impact of all strategies
- 25 Simulations of Flow and Transport from 2014 to 2070
  - Base case (2013 pumping)
  - All water management strategies implemented
  - 23 simulations where each strategy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

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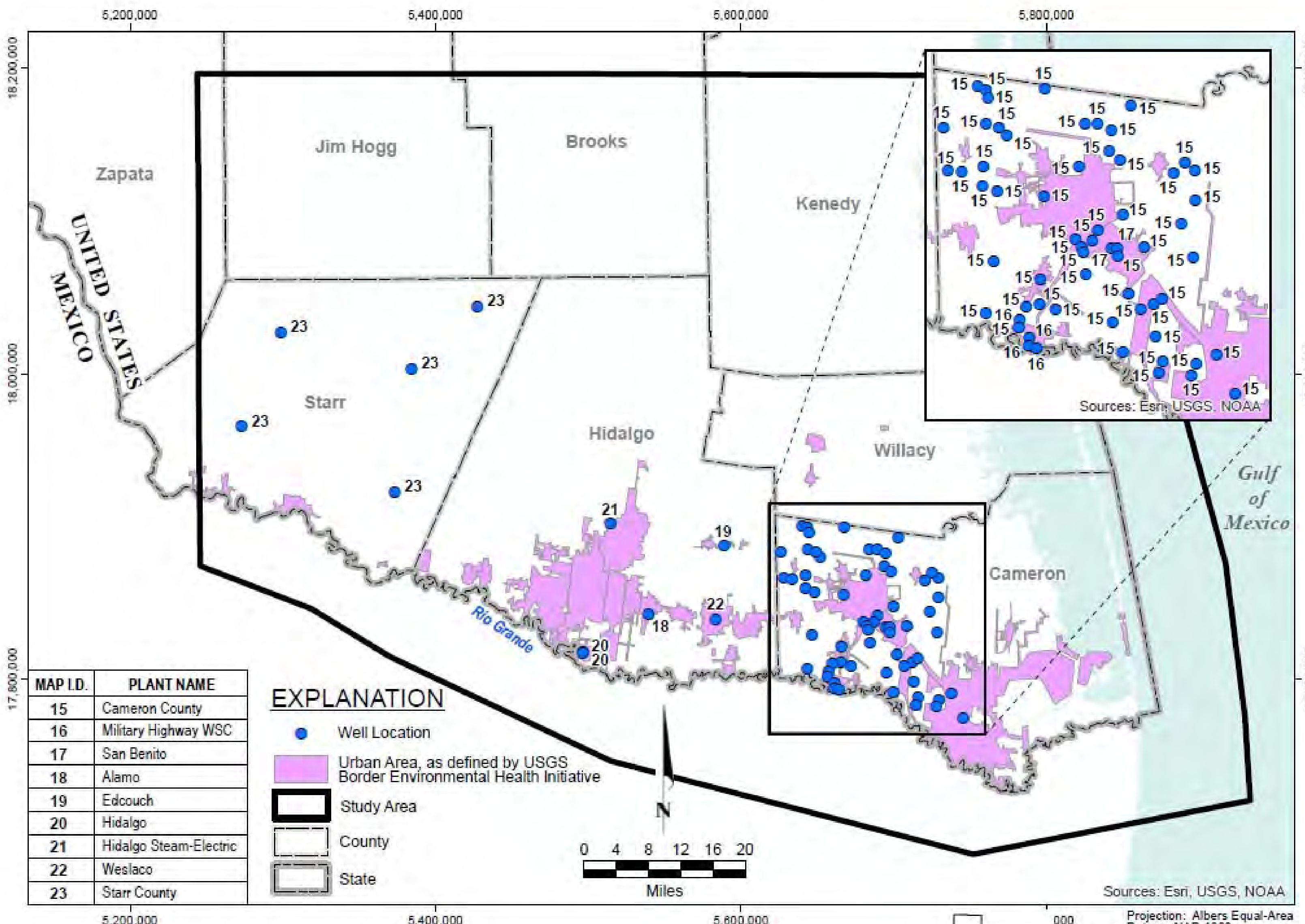
Figure 1. Location of Brackish Groundwater Wells for Predictive Simulations



MAP I.D.	PLANT NAME
15	Cameron County
16	Military Highway WSC
17	San Benito
18	Alamo
19	Edcouch
20	Hidalgo
21	Hidalgo Steam-Electric
22	Weslaco
23	Starr County

Source: Region M 2016 Regional Water Plan

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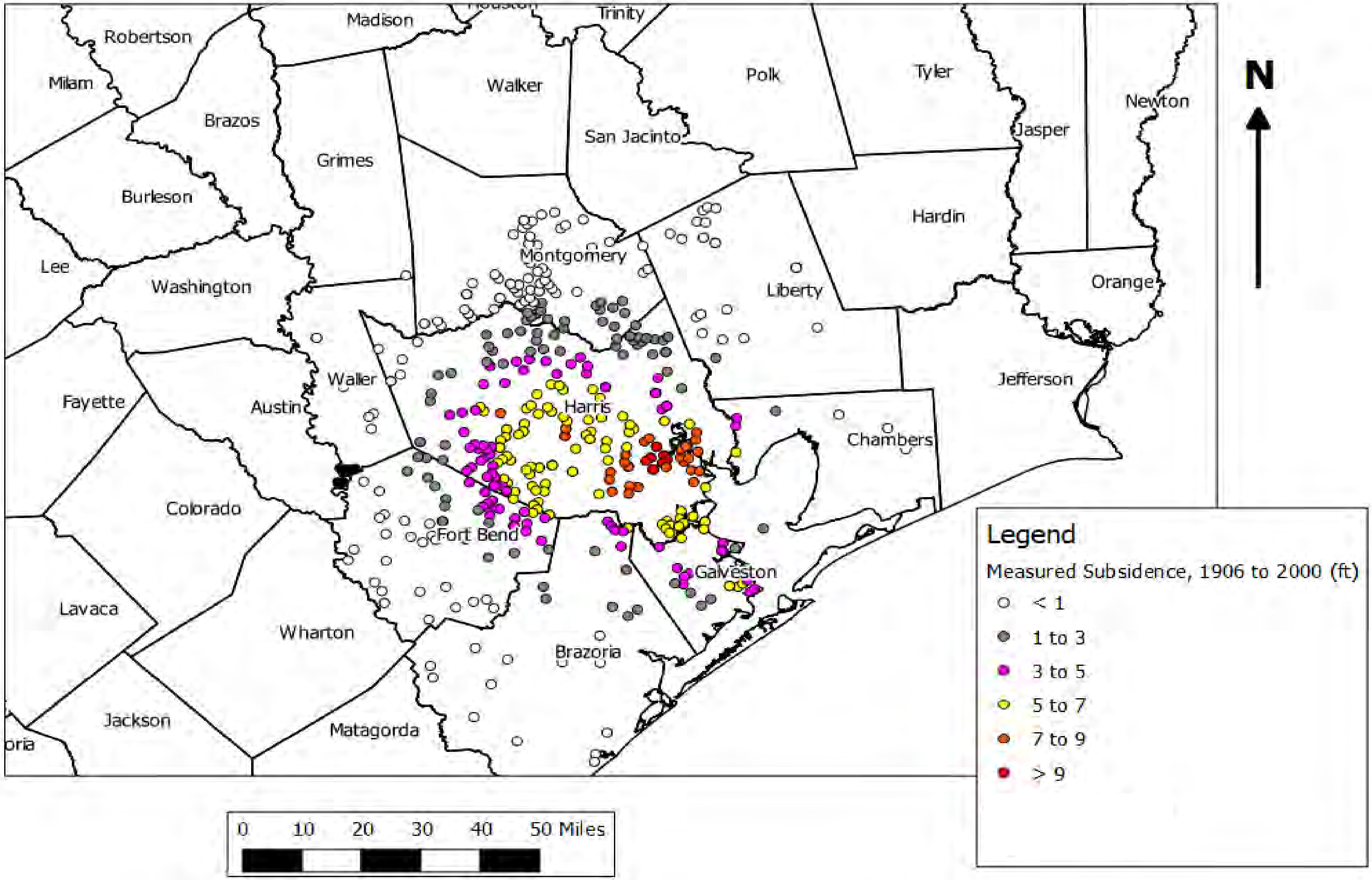
Figure 2. Location of Fresh Groundwater Wells for Predictive Simulations

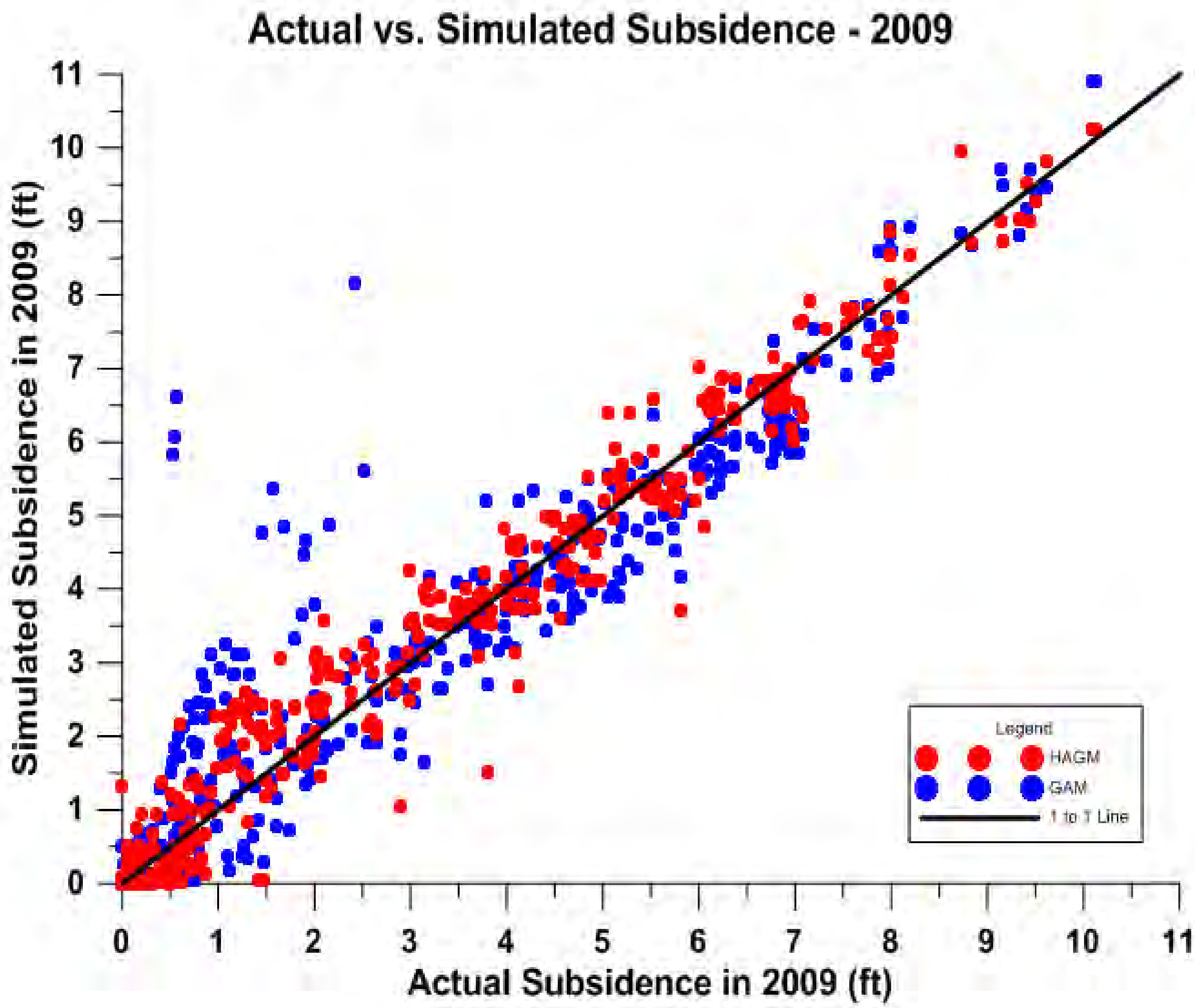
Subsidence

- 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

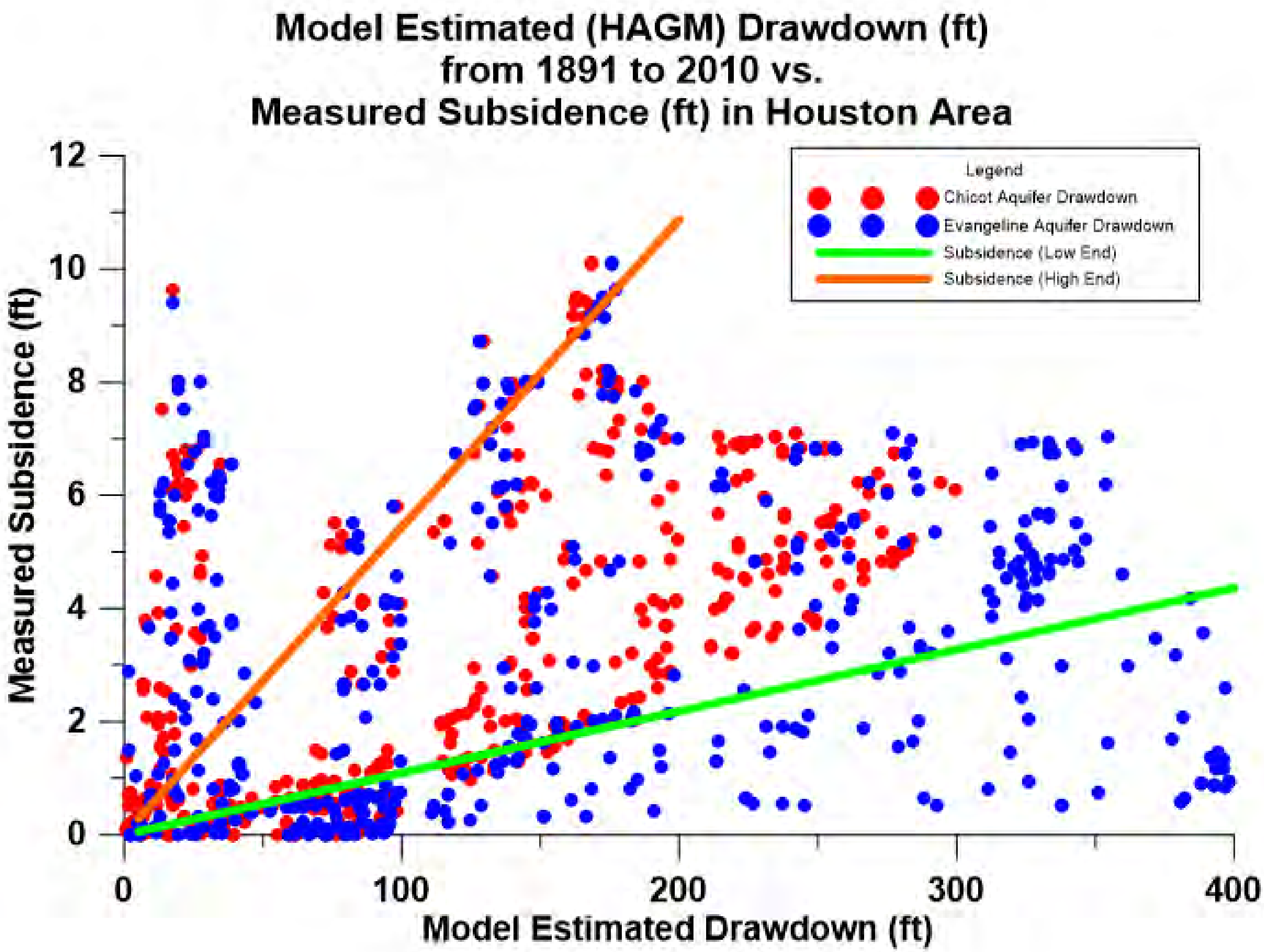

Robertson
Madison
Trinity
Milam
Walker
Polk
Tyler
Newton
Brazos
San Jacinto
Jasper
Grimes
Burleson
Hardin
Lee
Washington
Montgomery
Liberty
Orange
Waller
Fayette
Austin
Harris
Jefferson
Chambers
Colorado
Fort Bend
Galveston
Lavaca
Wharton
Brazoria
Jackson
Matagorda
oria
N
0 10 20 30 40 50 Miles
Legend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

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



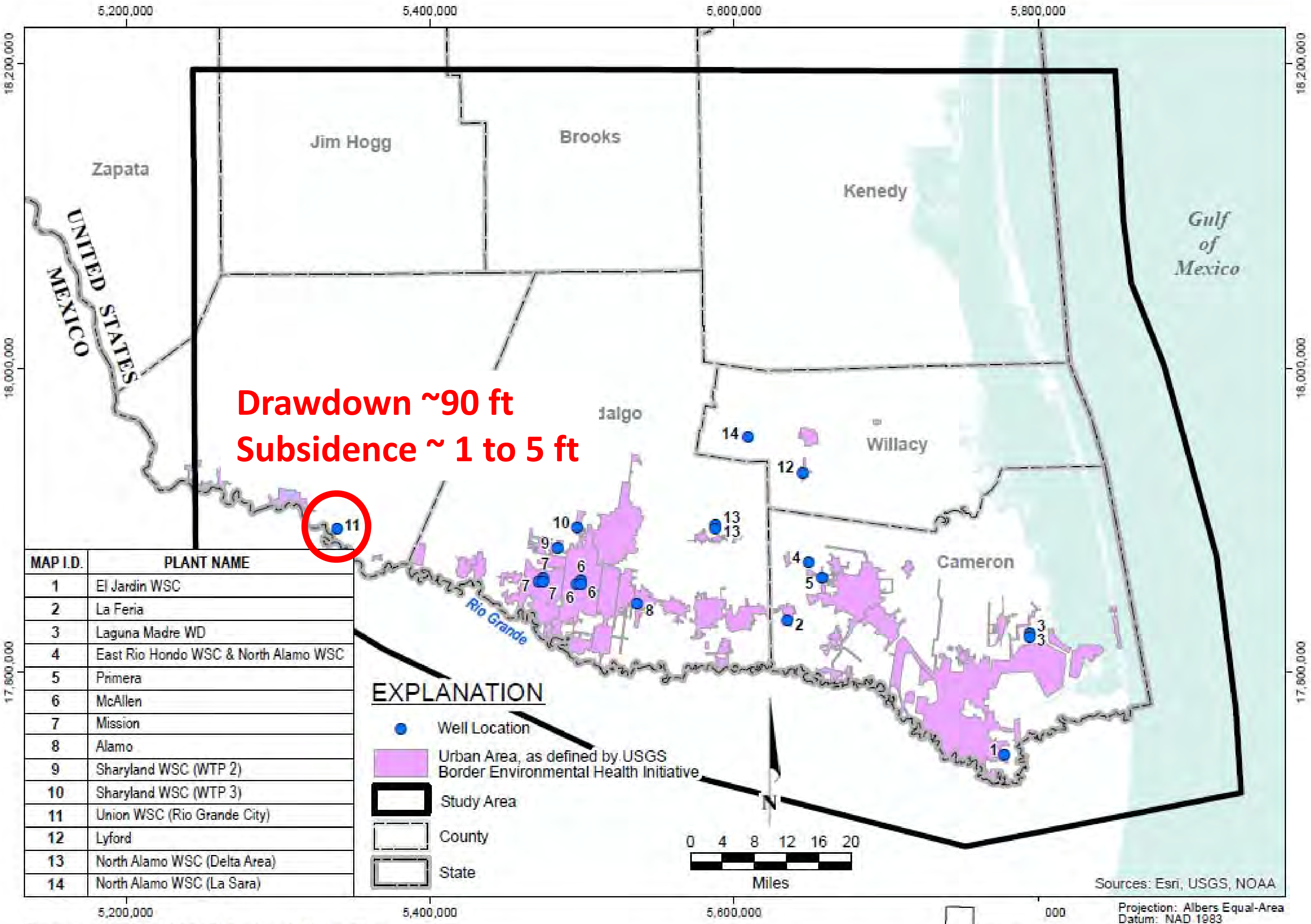
Actual vs. Simulated Subsidence - 2009
Simulated Subsidence in 2009 (ft)
Actual Subsidence in 2009 (ft)
0
1
2
3
4
5
6
7
8
9
10
11
Legend
HAGM
GAM
1 to 1 Line



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)
Model Estimated Drawdown (ft)
0
2
4
6
8
10
12
0
100
200
300
400

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



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Source: Region M 2016 Regional Water Plan

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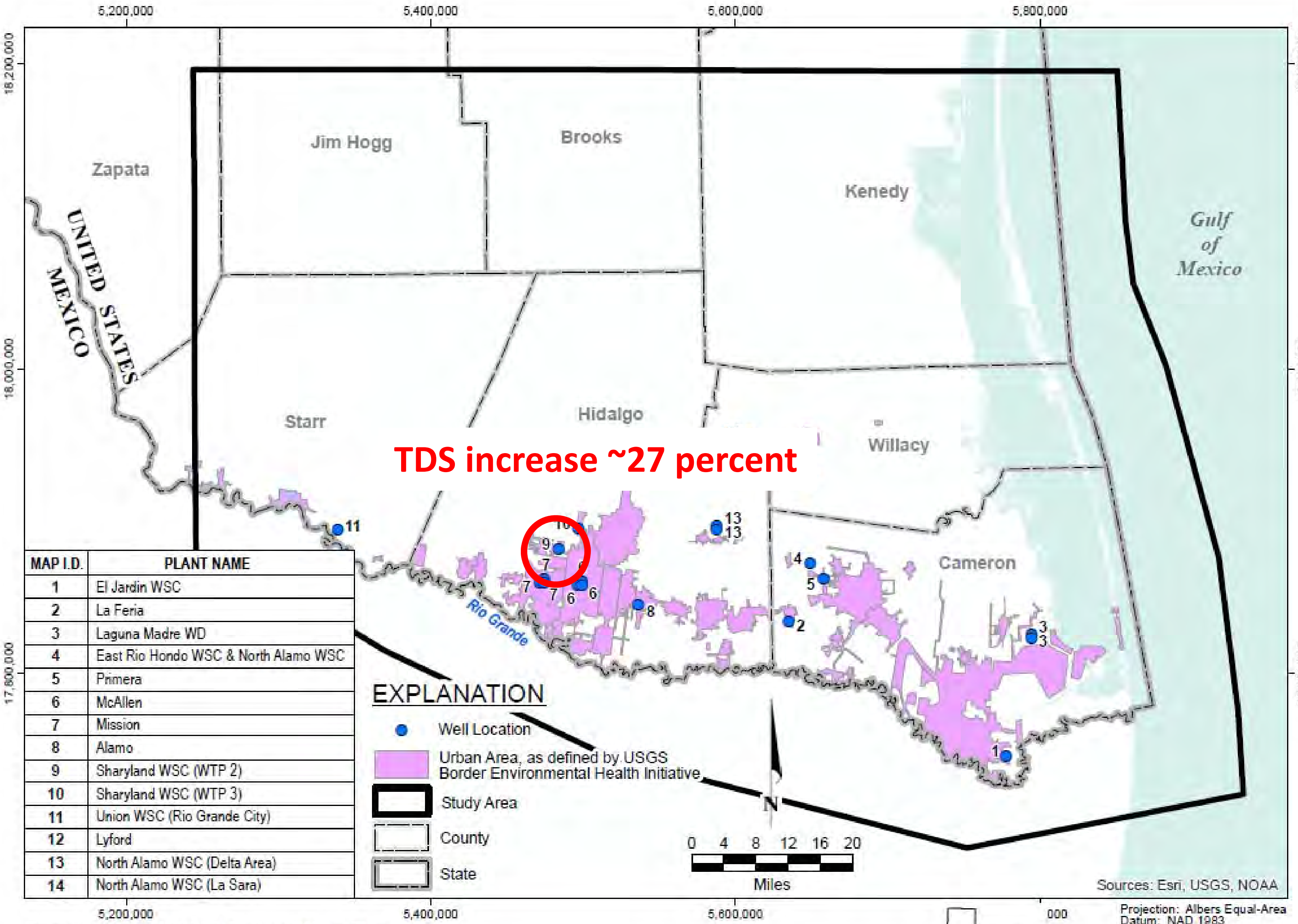

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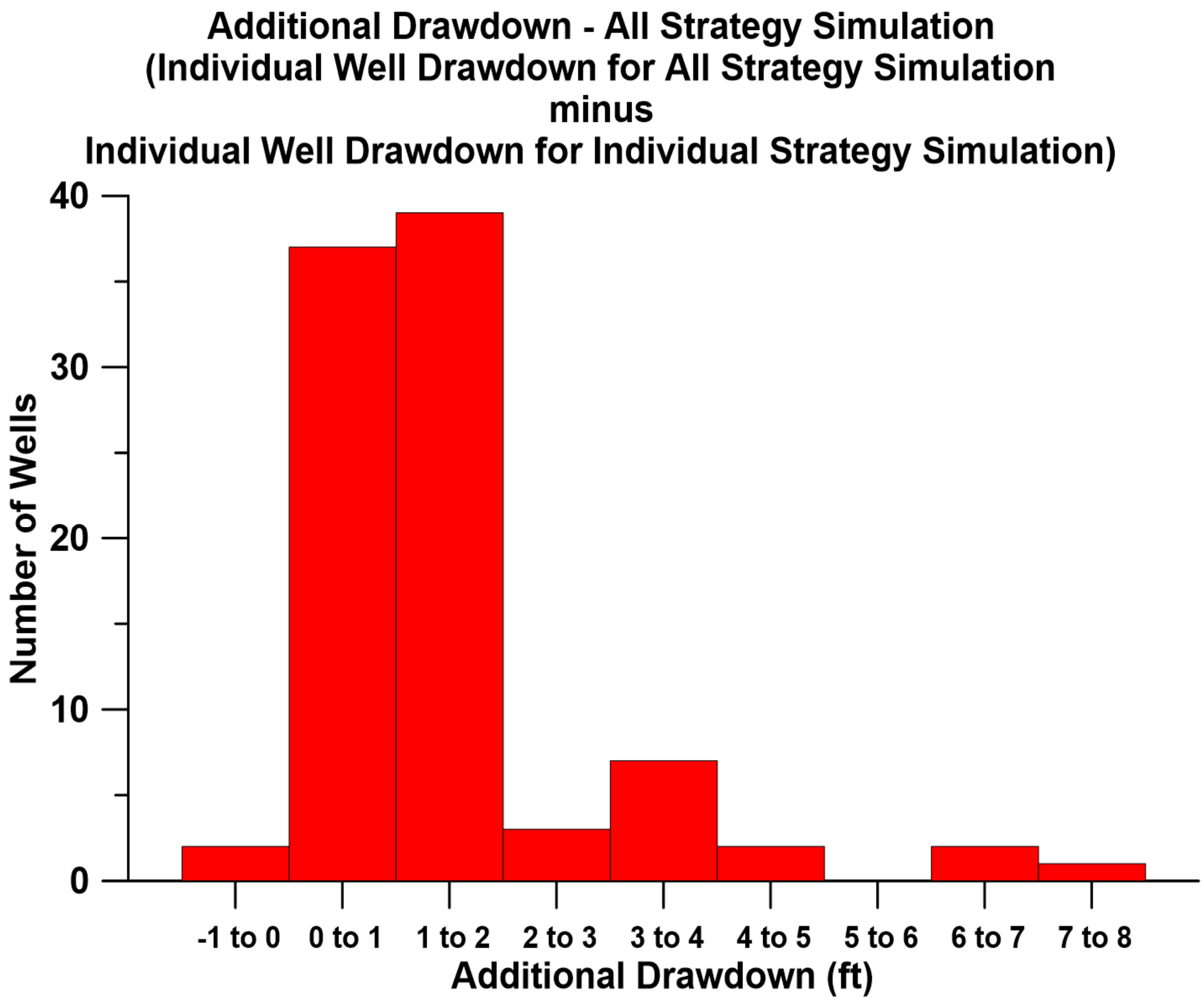
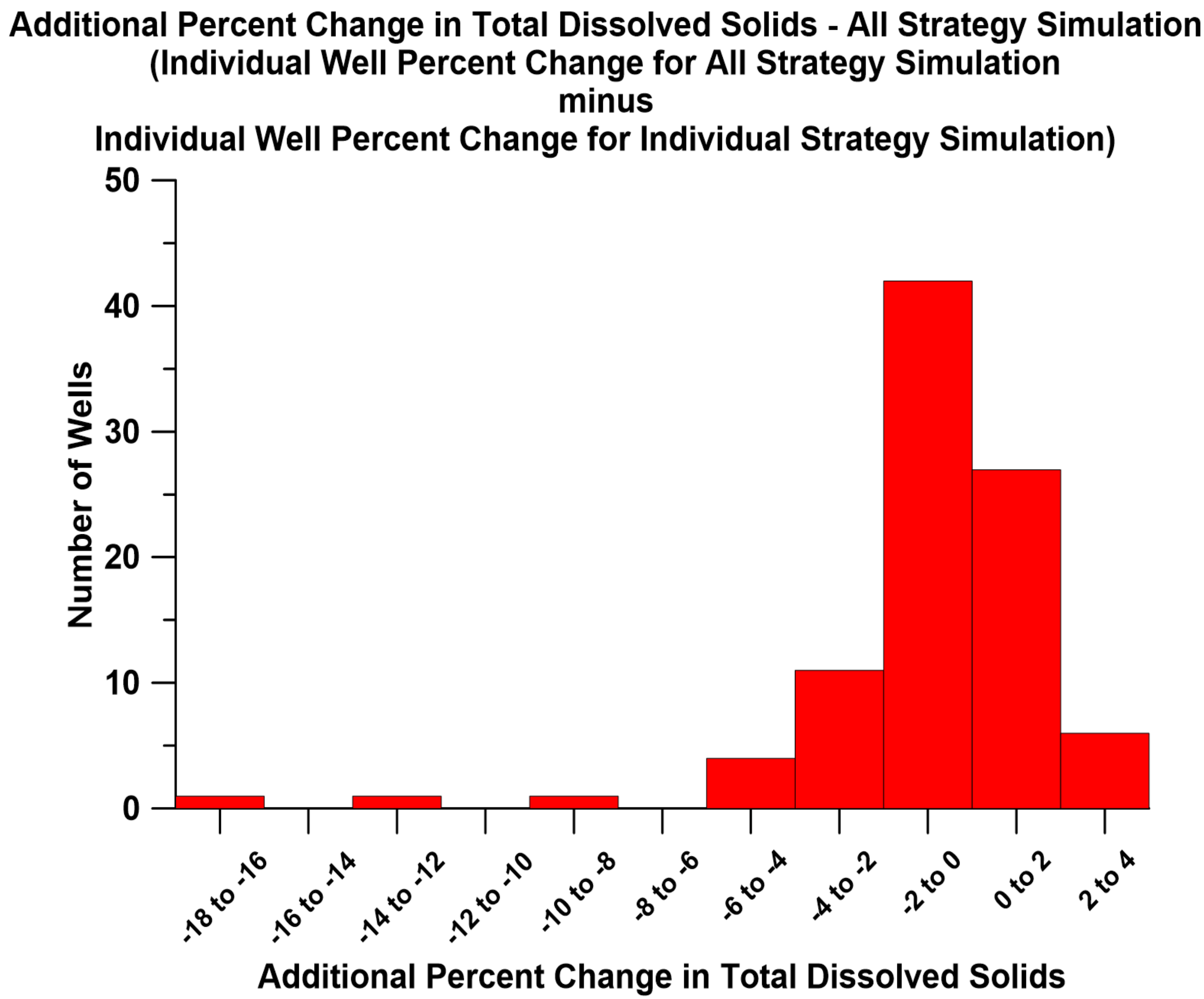
Source: Region M 2016 Regional Water Plan

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
0
10
20
30
40
50
-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

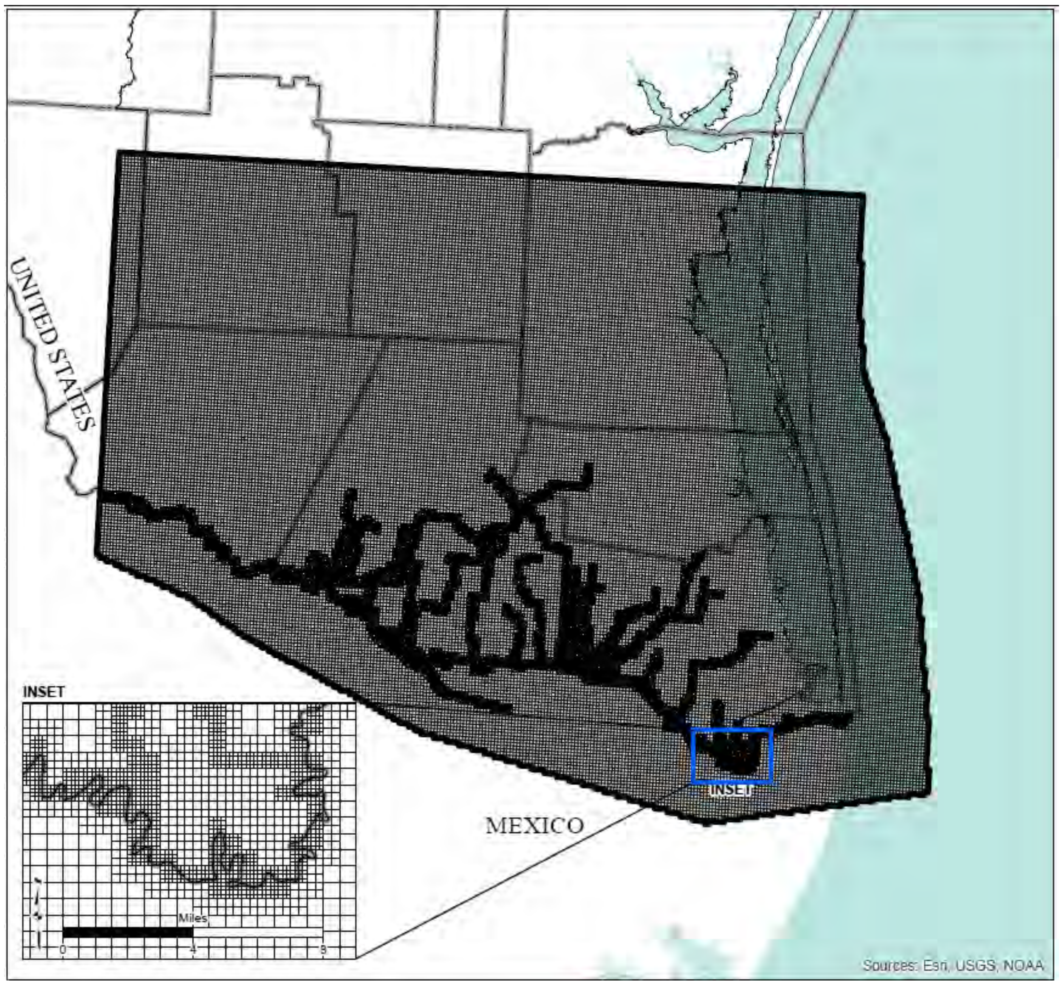
Component	**2 Years of Pumping**	**57 Years of Pumping**
Decreased Storage	16%	2%
Captured flow (Gulf)	31%	33%
Captured flow (ET)	7%	9%
Induced recharge (Rio Grande)	47%	49%
Induced recharge (canals)	3%	4%

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

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GSI ENVIRONMENTAL

MEMORANDUM

TO: Rohit Goswami, TWDB

CC: Cindy Ridgeway, TWDB

Larry French, TWDB

FROM: Julie Spencer, GSI Environmental Inc.

RE: Notes from a progress report of the Lower Rio Grande Valley Groundwater Transport Model project at the Region M meeting of July 12, 2017

A progress report on the Lower Rio Grande Valley (LRGV) Groundwater Transport Model was made at the Rio Grande Regional Water Planning Group (RGRWPG) – Region "M" meeting on July 12, 2017. The meeting was held in the Lower Rio Grande Valley Development Council Main Campus Ken Jones Executive Board Room located at 301 West Railroad Street, in Weslaco, Texas. The portion of the RGRWPG related to the LRGV Transport Model was item 4 on the agenda, and began at approximately 09:35 AM and was concluded at approximately 10:00 AM. The meeting was kept brief at the request of the Region M Chairman. The presentation was given by Bill Hutchison, Ph.D., P.E., P.G., a member of the LRGV Groundwater Transport Model team.

The objective of the presentation was to give an overview of the final numerical model report and the draft simulation report that is currently under review by the TWDB. A summary of the questions asked and answers provided during the presentation, and a list of attendees is provided below.

Q1: Can you clarify that your model predicts that an increase in groundwater pumpage will decrease surface water flows?

A1: Yes. As you begin pumping the groundwater, you will decrease the water levels. In the beginning, this water will come from storage. However, as you continue to pump, that water will also come from other sources. In this area, those other sources include surface water in the Rio Grande and the canals. This is true for the entire Rio Grande Valley. The impacts of groundwater pumpage on surface water is significant.

Q2: It is my understanding that groundwater flows away from the Rio Grande, particularly in certain areas. Would this decrease in surface water flows affect these areas as well?

A2: That is true under unstressed conditions, meaning in areas where there has not been a lot of pumping. However, if groundwater pumping is increased in a particular area, the groundwater direction will change to flow toward where the groundwater is being pumped. The flow dynamics will change.

Q3: At what depth would groundwater extraction result in subsidence?

A3: Using Houston as an example, typically pumping groundwater at shallow depths has the greatest impact on subsidence. It is a function of where the clay layers are.

Q4: When you pump a lot of groundwater in one area and it starts to affect surface water flows, what will happen? For example, if you pull out a lot of water in Hidalgo County, will the Rio Grande go dry in Cameron County?

A4: In these model scenarios, we are talking about pumping about 30,000 acre-feet. With that pumping rate, there is the potential for 15,000 acre-feet of surface water to be affected. However, with the amount of surface water flow in the Rio Grande, that is a relatively small amount. So, we are not talking about completely drying out the Rio Grande. However, if you start talking about pumping two, three, four hundred thousand acre-feet, you may begin to see some serious effects. But at the levels we are dealing with here, the significance may not be that important, but it is something that should be recognized as you move forward.

Q5: What historic pumping rates did you include in your model?

A5: I don't have the exact number in front of me, but it can be found in our report which is available on the TWDB website.

Q6: Is it in addition to the 30,000 acre-feet you are talking about here?

A6: Yes. The 30,000 acre-feet is in addition to the amounts that were reported by the Region in 2012. This additional pumping was included in our simulations.

Q7: But where did you get the historical information? I don't believe the TWDB historical pumping numbers are accurate. I think they are extremely low and there is a lot of water use that is not being reported. I would like to see an accurate study to determine what the real pumping rates are.

A7: After much discussion between the board members and TWDB representatives, it was determined that the 30,000 acre-feet of fresh and brackish water estimation came from the recommended projects in the 2016 Regional Water Plan. If that number needs to be revised, it can be input in the model and revised predictions will be made. That is what the groundwater model is for and the TWDB can assist with that process. It is a tool that can be used to make predictions based on changes in the Region's strategies. Those numbers can be changed at any time to look at differing effects and determine what to implement.

Q8: What would you recommend to reduce the effects of subsidence? In this area, floodplain management is a critical issue. How do we combine your information and floodplain management? These have financial impacts on the development of land in the area.

A8: Due to the lack of actual subsidence data from the LRGV, we have bracketed the subsidence numbers in the model based on effects seen in the Houston area. With these numbers you can get an idea on what the effects in the LRGV may be. In the model simulations, most areas saw less than 0.5 feet of subsidence. I would suggest that if you were to start seeing one to two feet of subsidence occurring in your model predictions, you may want to conduct an actual detailed field study to find out the clay content of the soil in your particular area to assess potential effects of subsidence. The model can be used as an "early-warning device" with regard to subsidence and let you know potential areas that may need further assessment.

Q9: So, in some cases, the effects of subsidence may offset the benefits of pumping the groundwater?

A9: Possibly. That is something that would be best to verify with a detailed study of the area of interest.

A list of attendees is provided below:

Name	Affiliation
Tomas Rodriguez	RGRWPC Executive Committee Member
Sonny Hinojosa	RGRWPC Executive Committee Member
Donald K. McGhee	RGRWPC Executive Committee Member
Frank Schuster	RGRWPC Executive Committee Member
Nick Benavides	RGRWPC Executive Committee Member
Glenn Jarvis	RGRWPC Voting Member
John Bruciak	RGRWPC Voting Member/Brownsville PUB
Sonia Lambert	RGRWPC Voting Member
Carlos Garza	RGRWPC Voting Member
Dennis Goldsberry	RGRWPC Voting Member
Armando Vela	RGRWPC Voting Member/Red Sands Groundwater Conservation District
Raizul Mia	RGRWPC Voting Member/City of Laredo
Dale Murden	RGRWPC Voting Member
Connie Townsend	TWDB
William Alfaro	TWDB
Robert Bradley	TWDB
Ricardo Chapa	Texas State Soil and Water Conservation Board
Luis Pena	Duval County Groundwater Conservation District
Dennis Gucisarda	Duval County Groundwater Conservation District
Jacob Reyes	Duval County Groundwater Conservation District
Shania Zapata	Duval County Groundwater Conservation District
Makayla Hinojosa	Duval County Groundwater Conservation District
Sara Eatman	Black & Veatch
Eileen Mattei	Freelance Writer/Texas Master Naturalist
Andy Garza	Kenedy County GCD
Felix Saenz	Brush Country GCD
Javier Mendez	City of Primera
Marco Vega	McAllen Public Utility
Kevin Spencer	R.W. Harden & Associates

Nelda L. Barrera	Texas Department of Agriculture
Ron Lacewell	Texas A&M AgriLife
Kristina Leal	Halff Associates
Venki Uddameri	Texas Tech University
Carlos Colina-Vargas	CC-V & Associates - Austin
Felipe J. Zamora	East Rio Hondo Water Supply Corporation
Bill Hutchison	Independent Consultant/LRGV Modeling Team
Sorab Panday	GSI Environmental Inc./LRGV Modeling Team
Julie Spencer	GSI Environmental Inc./LRGV Modeling Team
Debby Morales	Lower Rio Grande Valley Development Council