PREDICTIVE SIMULATION REPORT: LOWER RIO GRANDE VALLEY GROUNDWATER TRANSPORT MODEL

TWDB Contract Number 1548301854

Prepared for:

Texas Water Development Board

Prepared by:

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Prepared in Association with:

GSI ENVIRONMENTAL

esi Environmental Simulations Inc.

MONTGOMERY & ASSOCIATES
Water Resource Consultants

Final Report
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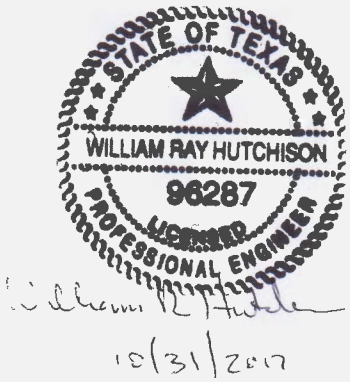
Geoscientist and Engineering Seal

This report documents the work and supervision of work of the following licensed Texas Professional Geoscientist and licensed Texas Professional Engineers:

William R. Hutchison, Ph.D., P.E. (96287), P.G. (286)

Dr. Hutchison completed the analyses and model simulations described in this report, and was the principal author of the final report.



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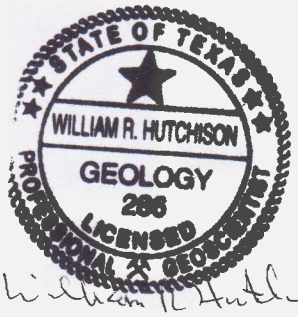

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Executive Summary

The 2016 Rio Grande Regional Water Plan (Region M Plan) included water management strategies to meet future water demands through the year 2070. Among these strategies are increases in brackish groundwater development and increases in fresh groundwater development. As stated in the RFQ for this effort, the primary objective of developing the Lower Rio Grande Groundwater Transport Model was to simulate impacts of brackish water withdrawal by the current and recommended desalination plants in the Lower Rio Grande Valley.

A total of 23 water management strategies involving groundwater were identified and recommended in the Region M Plan: 14 brackish groundwater desalination strategies and 9 fresh groundwater strategies. Total pumping in 2070 for the brackish groundwater desalination strategies is 24,160 AF/yr. Total pumping in 2070 for the fresh groundwater strategies is 9,215 AF/yr. Thus, the grand total of all groundwater strategies is 33,375 AF/yr.

This report summarizes the results of 25 separate predictive simulations from 2014 to 2070:

- A base case simulation with no increase in pumping from current conditions (pumping was set equal to 2013 amounts, the final year of the calibrated model).
- A simulation where all 23 identified Region M strategies were implemented
- 23 simulations where each identified Region M strategy is implemented individually

The simulated increases in pumping represent up to about a 100 percent increase from recent historic pumping amounts. Impacts of increased pumping include lowered groundwater levels, changes in water quality, and impacts to surface water flow. There is considerable uncertainty associated with evaluating the impacts of large pumping increases, and the results of these simulations were developed and presented with that uncertainty in mind. Specifically, the results are presented in the form of comparative analyses rather than absolute predictions. Results are presented as potential changes in groundwater elevations, potential changes in concentrations, and potential changes in water budget components as compared to a base case to illustrate what impacts might occur and provide some basis to understand the potential magnitude of those impacts.

These results suggest that large scale increases in pumping in the Lower Rio Grande Valley will result in some decrease in groundwater storage, but will have direct and significant impacts to surface water flows. These results suggest that, over the long-term, for every 2 acre-feet pumped, 1 acre-foot of surface water will supply that pumping, and could result in reduced surface water flow.

1.0 Description of Predictive Scenarios

1.1 Background

The 2016 Rio Grande Regional Water Plan (Region M Plan) included water management strategies to meet future water demands through the year 2070. Among these strategies are increases in brackish groundwater development and increases in fresh groundwater development. As stated in the RFQ for this effort, the primary objective of developing the Lower Rio Grande Groundwater Transport Model was to simulate impacts of brackish water withdrawal by the current and recommended desalination plants in the Lower Rio Grande Valley.

A total of 23 water management strategies involving groundwater were identified and recommended in the Region M Plan: 14 brackish groundwater desalination strategies and 9 fresh groundwater strategies. Total pumping in 2070 for the brackish groundwater desalination strategies is 24,160 AF/yr. Total pumping in 2070 for the fresh groundwater strategies is 9,215 AF/yr. Thus, the grand total of all groundwater strategies is 33,375 AF/yr.

1.2 Summary of Predictive Scenarios

This report summarizes the results of 25 separate predictive simulations from 2014 to 2070:

- A base case simulation with no increase in pumping from current conditions (pumping was set equal to 2013 amounts, the final year of the calibrated model).
- A simulation where all 23 identified Region M strategies were implemented
- 23 simulations where each identified Region M strategy is implemented individually

The results of these simulations can be used to evaluate the impacts of each individual strategy and the cumulative impact of all strategies. Impacts of pumping that were evaluated included changes in groundwater levels at the pumping well locations, changes in groundwater quality (total dissolved solids) at the pumping well locations, potential for subsidence at the pumping well locations, and impacts to surface water flows and groundwater evapotranspiration on a model-wide basis. Uncertainty of the estimates of groundwater levels and total dissolved solids were also evaluated.

Each of the 25 predictive simulations was run using the density dependent transport simulation as a starting point. The final year of calibration was 2013. Each predictive simulation covered the period 2014 to 2070. Calibrated model heads and concentrations from 2013 (the last stress period of the calibrated model) were used as the initial conditions for the predictive simulations. The BRACS database included estimates of current concentrations. The calibrated model concentrations for 2013 were used instead of the BRACS values since the BRACS values included many sharp interfaces that the calibrated model tended to smooth.

All predictive simulations were completed with 12 stress periods as summarized in Table 1.

Table 1. Summary of Predictive Simulation Stress Periods

Stress Period	Starting Year	Ending Year	Stress Period Length (days)
1	2014	2015	730
2	2016	2020	1,825
3	2021	2025	1,825
4	2026	2030	1,825
5	2031	2035	1,825
6	2036	2040	1,825
7	2041	2045	1,825
8	2046	2050	1,825
9	2051	2055	1,825
10	2056	2060	1,825
11	2061	2065	1,825
12	2066	2070	1,825

The simulations are planning level evaluations using a regional model to assist Region M in reporting and evaluating the impacts of the various recommended strategies in the next round of regional planning. These results cannot be viewed as a substitute for design level evaluations of specific projects where more site-specific data and more detailed models would be developed and evaluated.

1.3 Assumed Pumping for Each Scenario

The pumping for the base case for 2014 to 2070 was held constant at 2013 rates. The 2013 rates were defined by the last stress period of the calibrated model. Pumping for each of the scenarios (individual strategies and all strategies) was taken from the 2016 Region M plan, and added to the base case rates. A summary of the assumed pumping is presented in Table 2.

Table 2. Summary of Pumping for Each Scenario

Scenario	Total Pumping in 2014 (AF/yr)	Total Pumping in 2070 (AF/yr)	Number of Wells in Strategy	Strategy Pumping in 2014 (AF/yr)	Strategy Pumping in 2070 (AF/yr)
Baseline	29,420	29,422	0	0	0
All Strat	58,581	62,780	93	29,161	33,358
Strat01	30,129	30,129	1	709	707
Strat02	30,822	30,822	1	1,402	1,400
Strat03	32,219	32,222	2	2,799	2,800
Strat04	30,896	30,891	1	1,476	1,469
Strat05	30,823	30,822	1	1,403	1,400
Strat06	32,774	32,779	3	3,354	3,357
Strat07	32,780	32,786	3	3,360	3,364
Strat08	30,542	30,543	1	1,122	1,121
Strat09	30,541	30,538	1	1,121	1,116
Strat10	30,544	30,545	1	1,124	1,123
Strat11	30,120	30,121	1	700	699
Strat12	30,819	30,822	1	1,399	1,400
Strat13	29,434	32,230	2	14	2,808
Strat14	29,428	30,829	1	8	1,407
Strat15	33,925	33,933	56	4,505	4,511
Strat16	30,046	30,047	4	626	625
Strat17	30,544	30,541	2	1,124	1,119
Strat18	30,524	30,526	1	1,104	1,104
Strat19	29,925	29,923	1	505	501
Strat20	29,718	29,722	2	298	300
Strat21	29,518	29,522	1	98	100
Strat22	29,980	29,982	1	560	560
Strat23	29,827	29,830	5	407	408

1.4 Intended Audience of this Report

The intended audience of this report are the public, staff of the Texas Water Development Board, Region M members and consultants to Region M, and the groundwater conservation districts in the area and their consultants. Some of the details associated with implementing the features of Groundwater Vistas and the post-processing of the results should be useful to the technical staff of TWDB and consultants that may wish to modify, expand, or create new simulations, but may be of limited interest to Region M members and other non-technical stakeholders.

Of interest to the public and the non-technical members of Region M is the conclusions that the simulated increases in pumping represent up to about a 100 percent increase from recent historic pumping amounts. Impacts of increased pumping include lowered groundwater levels, changes in water quality, and impacts to surface water flow.

The results of the predictive simulations can be used by Region M members and consultants to make planning-level comparisons and evaluations of the strategies that were included in the 2016 Region M plan. The consultants for Region M and the Texas Water Development Board staff can use the report to understand the assumptions used in the simulations and, if needed, modify strategies and simulate them, or develop additional combinations of strategies for simulation. The report and the associated files, especially the well import tool developed as part of this project, should prove useful in the future.

Groundwater districts and their consultants can use the information from these simulations for general understanding of the potential impacts of increased pumping. However, it is emphasized that this model was not specifically constructed to be used for the development of desired future conditions. The use of this model for additional increases in pumping in support of developing desired future conditions would result in additional uncertainties, and the risk of misapplication of the results is high, especially if the pumping increases exceed the ones considered in these analyses.

There is considerable uncertainty associated with evaluating the impacts of large pumping increases, and the results of these simulations were developed and presented with that uncertainty in mind. Specifically, the results are presented in the form of comparative analyses rather than absolute predictions. Results are presented as potential changes in groundwater elevations, potential changes in concentrations, and potential changes in water budget components as compared to a base case to illustrate what impacts might occur and provide some basis to understand the potential magnitude of those impacts.

Finally, it needs to be emphasized that the results and the associated uncertainty highlight the need for site-specific data and information to further assess any new development of groundwater in the area, particularly in terms of the potential for subsidence. Subsidence impacts are presented in this report based on an analog with observed subsidence in the Houston area. The results of the subsidence analysis demonstrate the need to better understand the potential for subsidence in the Lower Rio Grande Valley by completing more detailed site-specific investigations as part of project design.

2.0 Methods

Each water management strategy is defined by the

The locations of the wells identified for the water management strategies were based on the descriptions and information contained in the 2016 Region M Plan. In many instances, assumptions were made to locate the wells for the simulations. The specific coordinates of the 93 wells and assumed pumping rates are included in Appendices A, B, and C, which also summarize the results of the simulations. Appendix A summarizes groundwater level changes. Appendix B summarizes potential subsidence. Appendix C summarizes changes in total dissolved solids.

2.1 Brackish Groundwater Strategies

The brackish wells used for the simulations are shown in Figure 1. Well locations assumed that all wells were at or near the respective desalination plant as shown in Table 4.7.2 of the Conceptual Model Report. If more than one well was listed, one well was placed at the plant location, and others were placed ½ mile to the north or east of the plant location.

Well pumping was assumed constant through time for each plant, and was estimated by dividing the total plant volume by the number of wells associated with the plant. Starting date for production was assigned based on the information from the Region M plan as outlined in Table 4.7.2 of the Conceptual Model Report.

2.2 Fresh Groundwater Strategies

The fresh wells used for the simulations are shown in Figure 2. Specifics for each strategy are provided below.

Strategy 15 – Cameron County: 56 new wells, each pumping 50 gpm for a total of 4,500 AF/yr (2,800 gpm). Well depth assumed to be 500 feet. Locations were assigned based on a Random Point Generator (ArcGIS Toolbox) with a minimum distance of ½ mile, based on a polygon for the western half of the county. East of this polygon, there are very few or no existing wells, presumably due to high salinity.

Strategy 16 – Military Highway WSC: The locations are based on Figure 5-2 of the 2016 Region M plan, and are near existing wells owned by Military Highway WSC. Assumed four wells, each 500 feet deep, each pumping 156 AF/yr (97 gpm) for a total of 625 AF/yr.

Strategy 17 – San Benito: Two new wells, each 500 feet deep, were assumed in the center of the San Benito polygon ½ mile apart. Each well assumed to pump 560 AF/yr (347 gpm) for a total of 1,120 AF/yr.

Strategy 18 – City of Alamo: One new well, 500 feet deep, was assumed 1,000 feet from existing well based on the 2016 Region M plan. Closest well is Well #3 (87-56-407). Pumping is assumed to be 1,100 AF/yr (682 gpm).

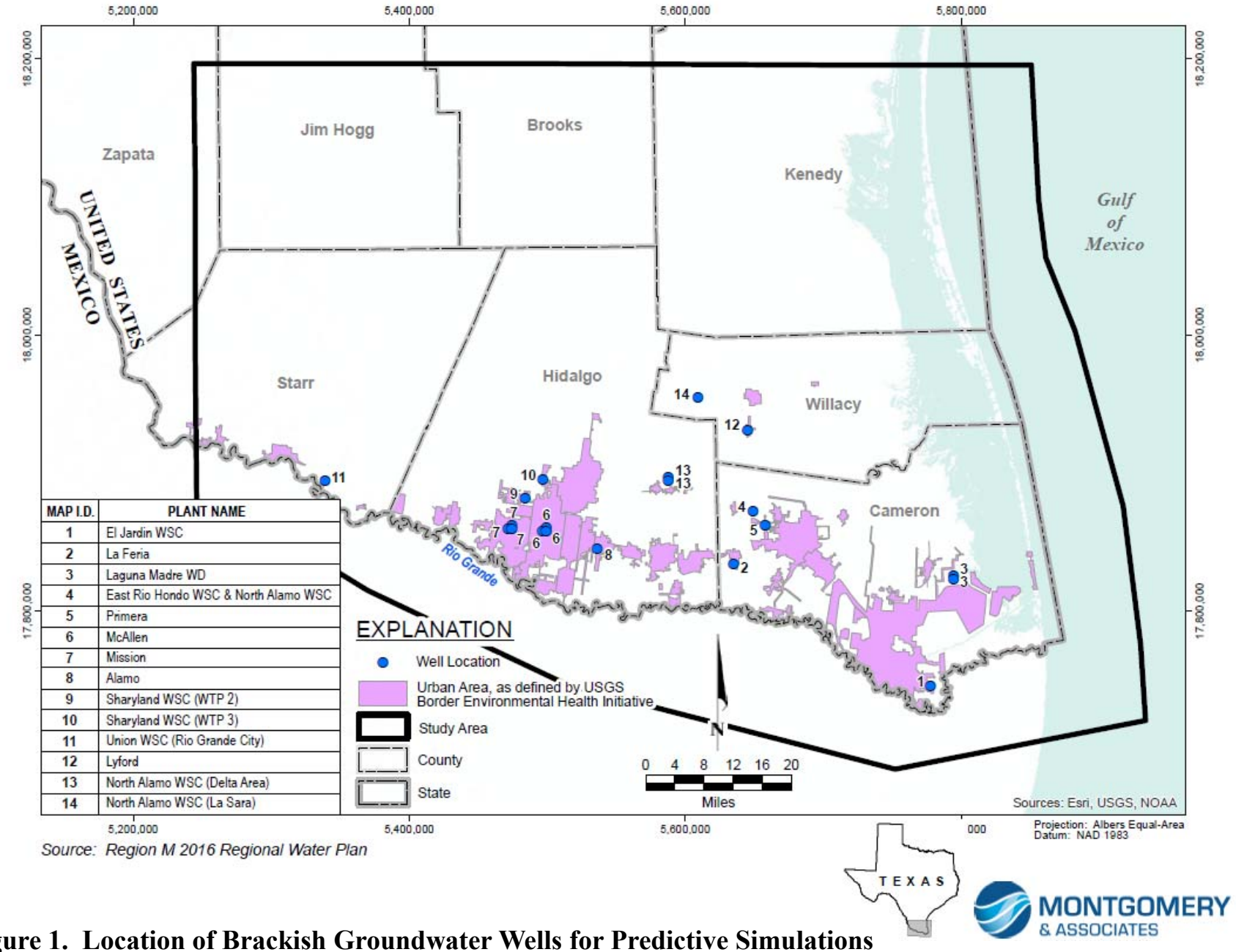
Strategy 19 – Edcouch: One new well, 500 feet deep, at the center of the Edcouch polygon. Assumed pumping is 500 AF/yr (310 gpm).

Strategy 20 – City of Hidalgo: Two new wells, 500 feet deep, ½ mile east of existing wells. Each well pumping 150 AF/yr (93 gpm) for a total of 300 AF/yr.

Strategy 21 – Hidalgo Steam Electric: The location is not specified in the 2016 Region M Plan. Assumed Duke Energy in Edinburg, located in the northern part of the county based on aerial imagery, near another electric plant (Magic Valley Generating Station). Assumed one well, 500 feet deep, pumping 100 AF/yr (62 gpm).

Strategy 22 – City of Weslaco: One new well, 500 feet deep, located at the center of the Weslaco polygon. Pumping assumed at 560 AF/yr (347 gpm).

Strategy 23 – Starr County: Five wells, each 500 feet deep, located across the county. Pumping from each well is 80.5 AF/yr (50 gpm) for a total of 400 AF/yr.



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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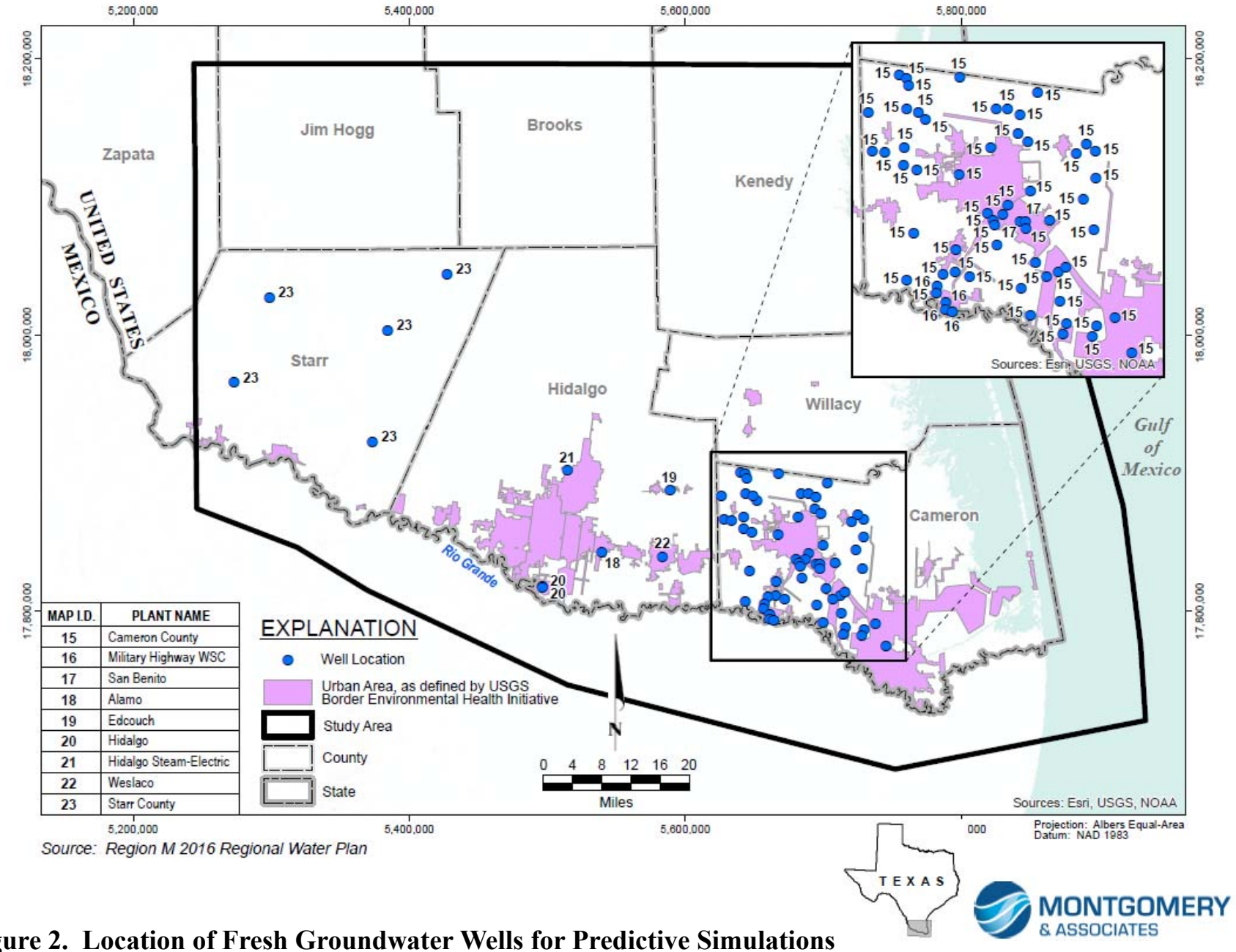
Figure 1. Location of Brackish Groundwater Wells for Predictive Simulations



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

3.0 Parameters and Assumptions

3.1 Implementation of Scenarios Using Groundwater Vistas

As requested by TWDB, the calibrated model and all predictive simulations were developed using Groundwater Vistas. This section of the report documents how each of the 25 predictive simulations were implemented in Groundwater Vistas.

The base case was developed by assuming recharge from the steady state condition of the calibrated model (Stress Period 1), and pumping from 2013 (Stress Period 30). All other time-based packages used the parameters from Stress Period 30 (2013 conditions). These other packages included the EVT (Evapotranspiration), RIV (River), GHB (General Head Boundary), CHD (Constant Head), and QRT (Return Flow). The Groundwater Vistas file for the base case is:

LRGVdenspred12sp-ESI-Baseline.gwv

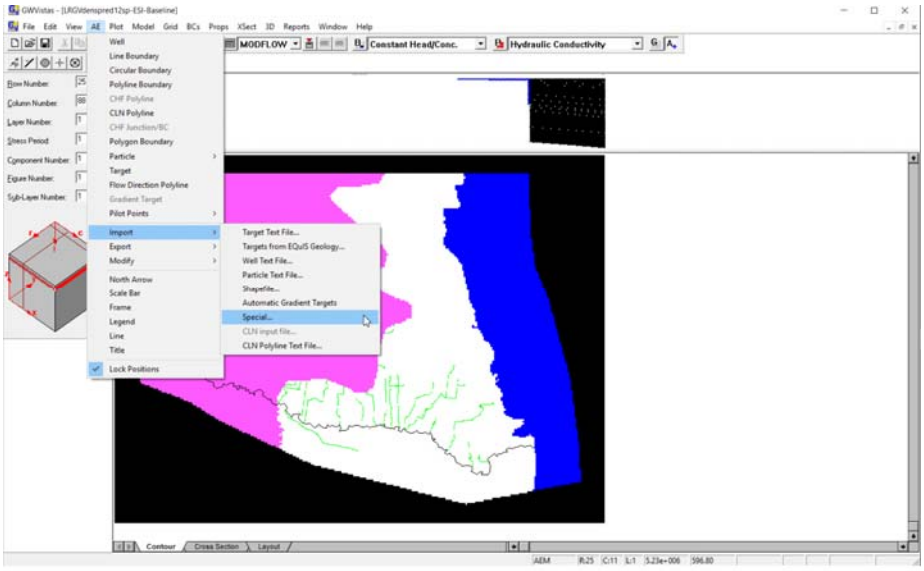
The wells locations and pumping rates for all strategies were summarized in a single csv file:

LRGVPredictiveWells_v2.csv

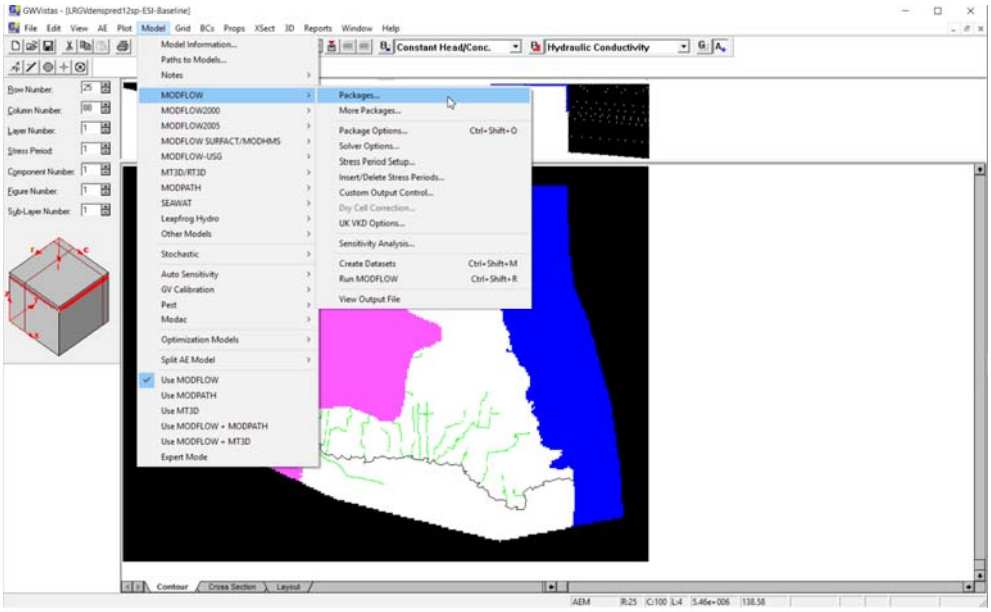
Included within the csv file are the strategy with which the well or wells are associated (ProjectID) in column C, the x and y coordinates of each well in columns D and E, the starting and ending stress period for the pumping in columns I and J, and the pumping rate of the well in acre-feet per year (column M), in cubic feet per day (column N), and in gallons per minute (column N). Details of the well ID, the entity or owner of the well, the name of the water management strategy and the well location by county are listed in columns S through V.

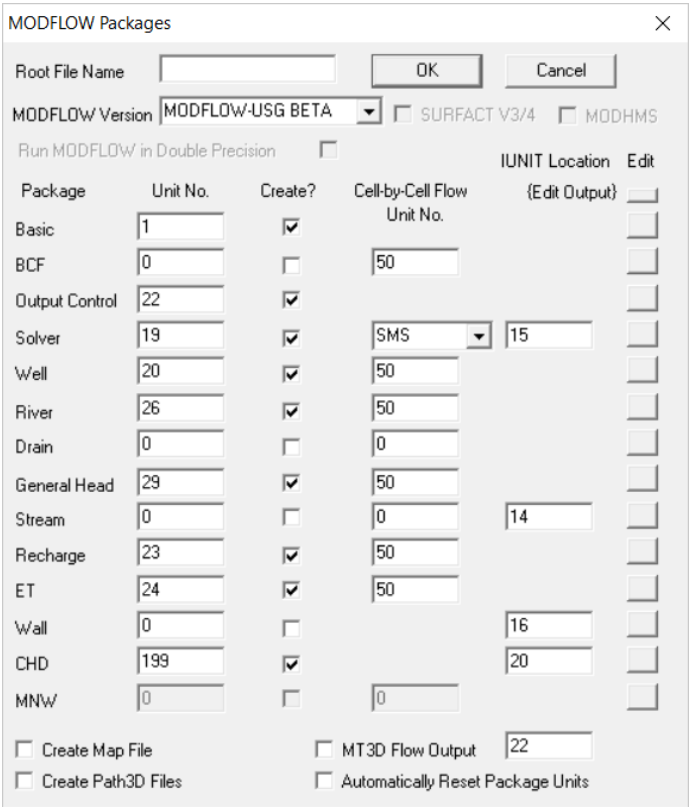
Groundwater Vistas was used to import the wells and create the model input files for each scenario. Pumping associated with the individual strategies (and for scenario that considers all strategies) added pumping to the base case, which was assumed to be equal to the 2013 pumping from the calibrated model (last stress period). Adding the pumping was completed using a special import feature developed by Jim Rumbaugh for this project, but which can be used for other simulations for other Region M projects as they are identified and developed:

1. Include the twdb.txt file in the Groundwater Vistas directory
2. Starting with the baseline file (*LRGVdenspred12sp-ESI-Baseline.gwv)* import the pumping files using AE > Import > Special

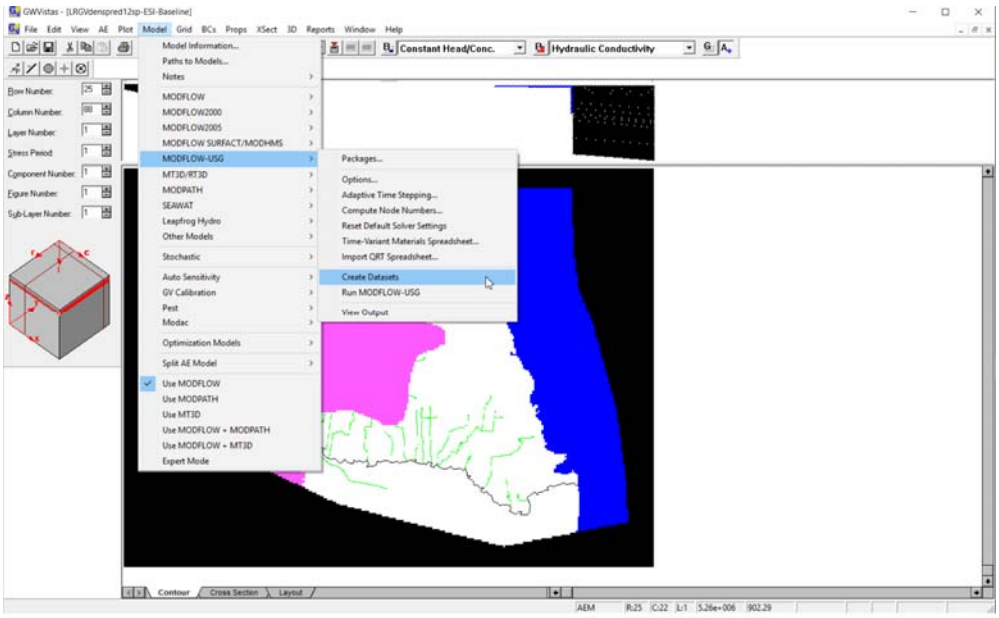


3. Select the proper directory and enter the csv filename (*LRGVPredictiveWells_v2.csv)*
4. Enter the Region M strategy number (listed as project number on the dialog which reads the ProjectID column in the csv file). To simulate all the strategies, enter 999.
5. Groundwater Vistas reports how many wells were imported (e.g. 93 for all strategies).
6. Click on Model > MODFLOW > Packages to rename the Root File Name of the input files





7. Create the input data files by clicking on Model > MODFLOW-USG > Create Datasets



8. Save the Groundwater Vistas file using a name associated with the Strategy or group of Strategies being simulated.

Please note that as part of this project, Groundwater Vistas was enhanced to include an output file named *well-info.csv* that is written when model input files are created. This file includes information on the assigned CLN node number and the groundwater grid node number for each well used in the simulation (both the existing wells used in the base case and the wells used for each simulated strategy). For this application, a well in multiple layers is assigned by assigning one CLN node per layer. Thus, there are up to 12 CLN nodes possible for each well (one per layer), and there may be up to 12 groundwater node numbers associated with each simulated well.

By editing, combining, or adding wells in the csv file, any number of combinations or new strategies can be simulated using this approach.

Groundwater Vistas and the root filename for each scenario is listed in Table 3.

Table 3. Summary of Scenarios

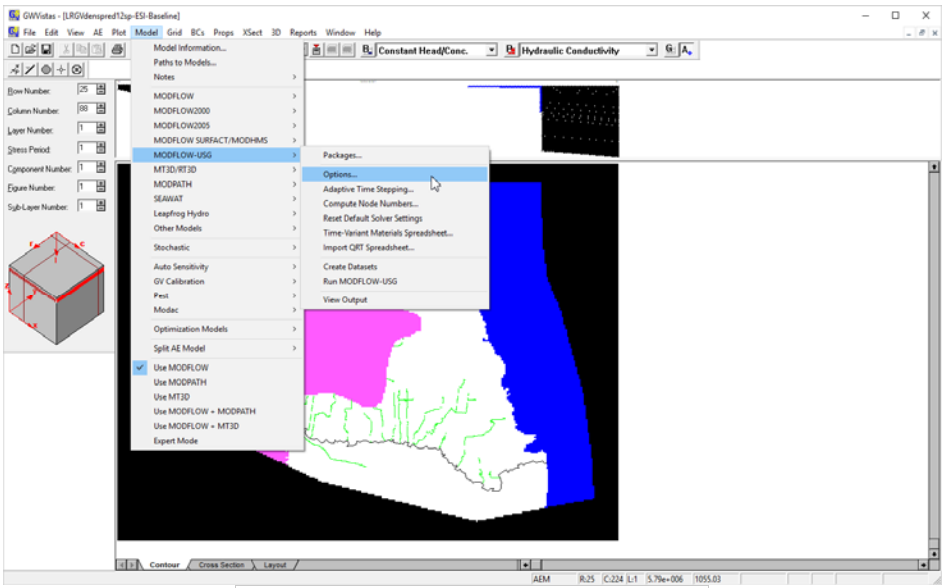
Scenario or Strategy Number	Desalination or Fresh Groundwater	Groundwater Vistas Filename	Model Input Root Filename
Base Case	N/A	*LRGVdenspred12sp-ESI-Baseline.gwv*	Baseline
All Strategies	Both	*LRGVdenspred12sp-ESI-AllStrat.gwv*	AllStrat
1	Desalination	*LRGVdenspred12sp-ESI-Strat01.gwv*	Strat01
2	Desalination	*LRGVdenspred12sp-ESI-Strat02.gwv*	Strat02
3	Desalination	*LRGVdenspred12sp-ESI-Strat03.gwv*	Strat03
4	Desalination	*LRGVdenspred12sp-ESI-Strat04.gwv*	Strat04
5	Desalination	*LRGVdenspred12sp-ESI-Strat05.gwv*	Strat05
6	Desalination	*LRGVdenspred12sp-ESI-Strat06.gwv*	Strat06
7	Desalination	*LRGVdenspred12sp-ESI-Strat07.gwv*	Strat07
8	Desalination	*LRGVdenspred12sp-ESI-Strat08.gwv*	Strat08
9	Desalination	*LRGVdenspred12sp-ESI-Strat09.gwv*	Strat09
10	Desalination	*LRGVdenspred12sp-ESI-Strat10.gwv*	Strat10
11	Desalination	*LRGVdenspred12sp-ESI-Strat11.gwv*	Strat11
12	Desalination	*LRGVdenspred12sp-ESI-Strat12.gwv*	Strat12
13	Desalination	*LRGVdenspred12sp-ESI-Strat13.gwv*	Strat13
14	Desalination	*LRGVdenspred12sp-ESI-Strat14.gwv*	Strat14
15	Fresh	*LRGVdenspred12sp-ESI-Strat15.gwv*	Strat15
16	Fresh	*LRGVdenspred12sp-ESI-Strat16.gwv*	Strat16
17	Fresh	*LRGVdenspred12sp-ESI-Strat17.gwv*	Strat17
18	Fresh	*LRGVdenspred12sp-ESI-Strat18.gwv*	Strat18
19	Fresh	*LRGVdenspred12sp-ESI-Strat19.gwv*	Strat19
20	Fresh	*LRGVdenspred12sp-ESI-Strat20.gwv*	Strat20
21	Fresh	*LRGVdenspred12sp-ESI-Strat21.gwv*	Strat21
22	Fresh	*LRGVdenspred12sp-ESI-Strat22.gwv*	Strat22
23	Fresh	*LRGVdenspred12sp-ESI-Strat23.gwv*	Strat23

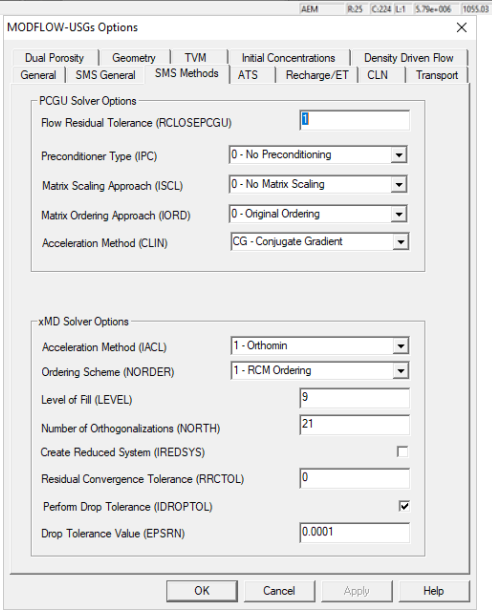
3.2 Solver Settings and Run Times

The initial set of predictive simulations used the solver parameters that were used in the final calibration run of the density dependent model. The results of the simulations were reviewed, and it was found that three of the runs crashed and the others had long simulation times (some over 12 hours). In addition, some of the simulations had a cumulative flow discrepancy that was greater than one percent.

To ensure run completion, improve run times, and improve budget discrepancies, modifications were made to the drop tolerance solver parameter. This parameter is adjusted in at the bottom of the Groundwater Vistas in the SMS Methods Tab:

Model > MODFLOW-USG > Options > SMS Methods: Drop Tolerance Value (EPSRN)





The drop tolerance of the calibration run had been set to 1E-05. All simulations were rerun with a drop tolerance of 1E-03. Run times generally improved, although some simulations crashed, and some had cumulative flow discrepancies over one percent. For simulations that crashed or had high (over one percent) flow discrepancies, the drop tolerance was changed to 1E-04. Finally, the drop tolerance was adjusted to 1E-05 if the flow discrepancy continued to be over one percent.

A final summary of the drop tolerance, run time, flow budget discrepancies, and transport budget discrepancies are presented in Table 4. For reference purposes, the run time is included, but may not be strictly comparable since the simulations were executed on two different computers.

Table 4. Summary of Drop Tolerance, Run Time, and Budget Discrepancies for Each Simulation

Scenario	Drop Tolerance	Run Time (hr:min)	Flow Discrepancy (percent)	Transport Discrepancy (percent)
Baseline	1.00E-04	1:04	0.00	1.34
AllStrat	1.00E-04	2:10	0.03	1.50
Strat01	1.00E-05	4:32	-0.28	1.35
Strat02	1.00E-03	2:08	0.03	1.34
Strat03	1.00E-03	1:30	-0.01	1.34
Strat04	1.00E-03	2:38	0.58	1.38
Strat05	1.00E-03	1:33	-0.02	1.34
Strat06	1.00E-03	1:47	0.03	1.31
Strat07	1.00E-04	2:17	-0.15	1.34
Strat08	1.00E-04	2:12	-0.15	1.57
Strat09	1.00E-05	5:40	0.20	1.55
Strat10	1.00E-03	2:09	-0.03	1.34
Strat11	1.00E-05	3:05	-0.09	1.33
Strat12	1.00E-03	2:15	-0.01	1.34
Strat13	1.00E-04	3:05	-0.09	1.33
Strat14	1.00E-04	2:15	-0.01	1.34
Strat15	1.00E-04	3:01	0.21	1.35
Strat16	1.00E-03	1:56	-0.03	1.35
Strat17	1.00E-03	4:02	0.81	1.38
Strat18	1.00E-04	2:37	-0.25	1.36
Strat19	1.00E-03	3:37	0.06	1.37
Strat20	1.00E-03	2:11	0.09	1.32
Strat21	1.00E-03	0:52	0.00	1.34
Strat22	1.00E-03	1:06	-0.02	1.34
Strat23	1.00E-03	1:30	-0.14	1.35

3.3 Post Processing of Results

Results from each simulation included the hds file (cell-by-cell groundwater elevations), the con file (cell-by-cell concentrations), and the cbb file (cell-by-cell flows). These files were post-processed with FORTRAN programs written to extract specific information for this report.

3.3.1 Head and Concentration Post Processing

The program *posthedcon.exe* reads the binary head files (saved using the suffix *hds)* and binary concentration files (saved using the suffix *con)* for all simulations, and provides summary output of groundwater elevation and concentrations for each of the 93 well locations associated with the water management strategies for each stress period. Table 5 lists the output files for each simulation.

The file written by Groundwater Vistas discussed above (*well-info.csv*), which contains data for all wells in a simulation, was edited to include only the 93 wells associated with the water management strategies, and saved as *stratwells.csv.* Wells located in more than one layer as defined by the file *stratwells.csv* were treated as a single well for purposes of the post-processing calculations. Heads and concentrations values reported for each well represent the average value over all the layers that the well is located as defined in *stratwells.csv*. The averaging calculation was completed using the groundwater nodes associated with each well as defined in *stratwells.csv*.

In addition, two files are written that summarized the results from the last stress period for all simulations. Groundwater elevations for all 93 wells for stress period 12 (the year 2070) for all simulations are summarized in *sumhedsp12.dat*. Concentrations for all 93 wells for stress period 12 (the year 2070) for all simulations are summarized in *sumconsp12.dat*. For these two files, the first column of head or concentration data is the initial value in 2012 to facilitate comparison.

Finally, two files are written that summarized change in groundwater elevation and concentration from the initial condition for the last stress period for all simulations. The changes in groundwater elevation (drawdown) are saved in *sumdhedsp12.dat*, and the changes in concentration are saved in *sumdconsp12.dat*. The first columns of head or concentration data is the initial value in 2012 to facilitate comparison.

Table 5. Individual Simulation Output Files

Simulation	Groundwater Elevation Output File	Concentration Output File
1	hedBaseline.dat	conBaseline.dat
2	hedAllStrat.dat	conAllStrat.dat
3	hedStrat01.dat	conStrat01.dat
4	hedStrat02.dat	conStrat02.dat
5	hedStrat03.dat	conStrat03.dat
6	hedStrat04.dat	conStrat04.dat
7	hedStrat05.dat	conStrat05.dat
8	hedStrat06.dat	conStrat06.dat
9	hedStrat07.dat	conStrat07.dat
10	hedStrat08.dat	conStrat08.dat
11	hedStrat09.dat	conStrat09.dat
12	hedStrat10.dat	conStrat10.dat
13	hedStrat11.dat	conStrat11.dat
14	hedStrat12.dat	conStrat12.dat
15	hedStrat13.dat	conStrat13.dat
16	hedStrat14.dat	conStrat14.dat
17	hedStrat15.dat	conStrat15.dat
18	hedStrat16.dat	conStrat16.dat
19	hedStrat17.dat	conStrat17.dat
20	hedStrat18.dat	conStrat18.dat
21	hedStrat19.dat	conStrat19.dat
22	hedStrat20.dat	conStrat20.dat
23	hedStrat21.dat	conStrat21.dat
24	hedStrat22.dat	conStrat22.dat
25	hedStrat23.dat	conStrat23.dat

3.3.2 Cell-By-Cell Post Processing

The program *postcbb.exe* reads the cbb files for all simulations, and provides summary output for each stress period of pumping (as a check on the input file), and summarizes the model-wide fluxes associated with the Rio Grande exchange with the groundwater, the canal exchanges with the groundwater, and the changes to groundwater evapotranspiration.

There are 21 components in the cbb file, as summarized in Table 6.

Table 6. Summary of CBB File Components

Component Number	Component Name
1	STORAGE
2	CLN STORAGE
3	DENSITY STORAGE
4	CONSTANT HEAD
5	FLOW JA FACE
6	CLN CONST HEAD
7	FLOW CLN FACE
8	GWF TO CLN
9	WELLS
10	RIVER LEAKAGE
11	ET
12	HEAD DEP BOUNDS
13	RECHARGE
14	SINKS (QRT)
15	CNST H MASS FLUX
16	WELL MASS FLUX
17	GHB MASS FLUX
18	QRT MASS FLUX
19	RIV MASS FLUX
20	EVT MASS FLUX
21	RCH MASS FLUX

Of interest for this analysis are:

- Component 1 (Storage)
- Component 4 (Constant Head)
- Component 8 (GWF to CLN)
- Component 9 (Wells)
- Component 10 (River Leakage)
- Component 11 (ET)

Component 1 contains the storage change values for each cell. Positive numbers reflect inflow into groundwater system (storage decline), and negative numbers reflect outflow from the groundwater system (storage gain).

Component 4 contains the flux values for the interaction with the constant head boundaries (Gulf of Mexico). These flows are characteristically negative, which means that groundwater is discharging to the Gulf of Mexico.

Component 8 contains the flux values for the interaction between the groundwater system and the Rio Grande – these fluxes vary by stress period for each of the scenarios. The first 1,888 entries for the component are associated with the interaction with the Rio Grande. The entries that follow are flows from the groundwater system to the CLN cells that represent wells, and are not used in this program.

Component 9 contains the flux values for the pumping wells and the inflow into the Rio Grande at the upstream end of the model domain. The NVAL for this component is the number of cells in the model (744,325) plus the number of CLNs, which varies by scenario. The well pumping rate for the entire model is the sum of all the CLNs that are pumping wells. Inspection of the wel file for the scenarios shows that the inflow to the Rio Grande is specified in CLN number 9. Thus, the program reads and sums all the values for all CLNs (NVAL greater than 744,325), except for CLN 9.

Component 10 contains the flux values for the interaction between the canals simulated in the model and the groundwater system. Component 11 contains the flux values for groundwater evapotranspiration.

Results from the program are written in six files:

- Storage change (*storout.dat*)
- Flux to Gulf of Mexico (*chdout.dat*)
- Surface water-groundwater interaction with canals (*rivout.dat*)
- Well pumping (*welout.dat*)
- Groundwater evapotranspiration (*etout.dat*)
- Surface water-groundwater interaction with Rio Grande (*strout.dat*)

3.4 Subsidence Estimates

When groundwater is pumped from an aquifer, stored water in confined aquifers enters the well due to expansion of water, the compression of the aquifer material, and the compression of clayey beds that are within and adjacent to the aquifer. The resulting compression is considered elastic (i.e. reversible) if there is no permanent rearrangement of the skeletal structure of the sediments. Conversely, the resulting compression is considered inelastic (irreversible) if the reduction in pressure caused by the removal of water causes permanent rearrangement of the skeletal structure of the sediments. Compaction of these sediments results in a loss of storage capacity of the aquifer, and can result in land subsidence.

In general subsidence is a function of clay thickness and pumping. Areas with high pumping and thin clay sections will not experience as much subsidence as areas with high pumping and thick clay sections. Also, areas with low pumping and thick clay sections will have less subsidence than areas with high pumping and thick clay sections.

The potential for increased pumping to cause subsidence was identified by TWDB as a significant factor to be evaluated in areas where multiple groundwater desalination plants are operating. Specifically, subsidence in the Gulf Coast Aquifer has been observed in the Houston area because of years of high pumping. Recently, groundwater management in the Houston area is primarily concerned with reducing groundwater pumping to halt subsidence. Because subsidence, in general, cannot be reversed, it is important to understand the potential for subsidence and avoid it, if possible.

3.4.1 Subsidence in the Houston Area

Figure 3 presents a map of actual subsidence measurements at 474 points used by the USGS to calibrate the groundwater models of the Houston area. The original Groundwater Availability Model was developed in 2004 (Kasmarek and Robinson, 2004), and was updated in 2012 (Kasmarek, 2012). Please note that subsidence greater than three feet has occurred in Harris, Fort Bend, and Galveston counties, and has exceeded 9 feet in some areas.

Figure 4 presents a comparison of the actual subsidence at these points with estimates from the groundwater models. On the figure, points labeled GAM (the original Groundwater Availability Model) refers to Kasmarek and Robinson (2004), and points labeled HAGM (the updated Groundwater Availability Model, also known as the Houston Area Groundwater Model) refers to Kasmarek (2012).

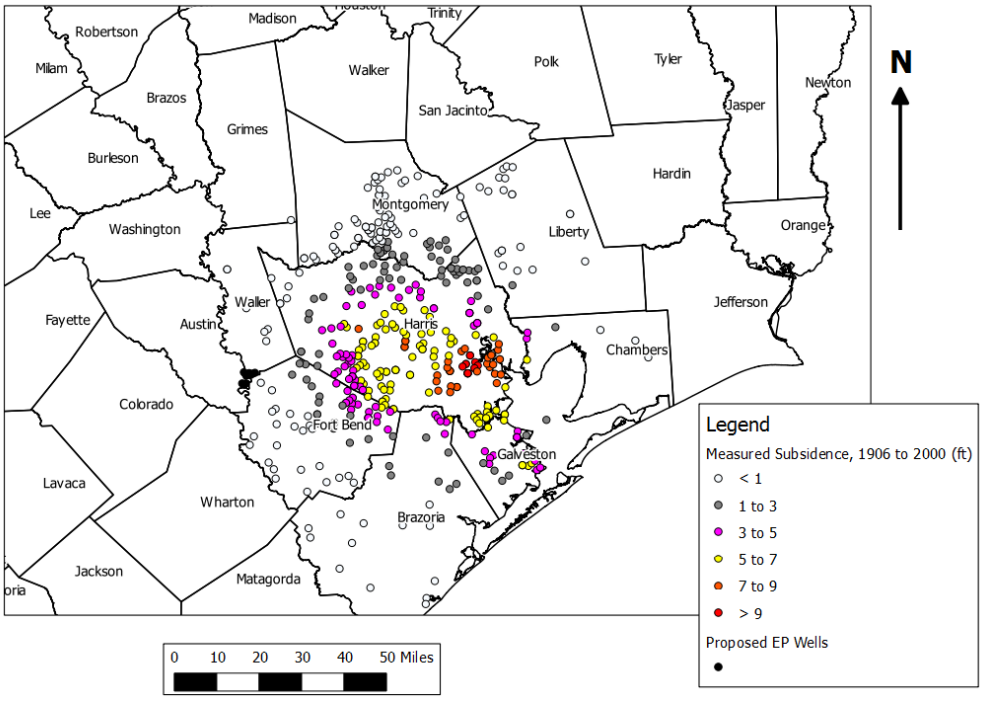


Figure 3. Map of Subsidence Measurement Locations in Houston Area

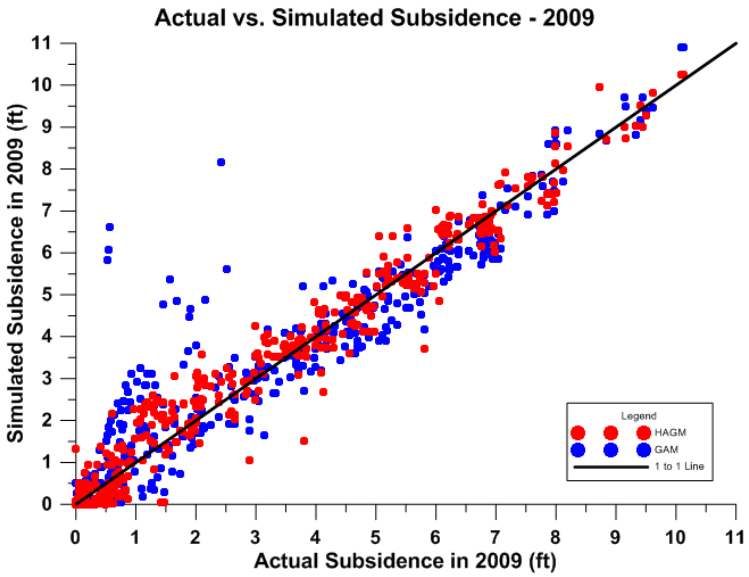


Figure 4. Comparison of Actual Subsidence from 1906 to 2000 and Estimated Subsidence from 1891 to 2009 from the GAM and HAGM

Based on the comparison in Figure 4, the HAGM represents an improvement in subsidence prediction over the GAM. The comparison also suggests that the estimated accuracy of a long-term subsidence estimate is plus or minus one foot using the model.

It is important to recognize that the Houston area has experienced high pumping for decades and a great deal of effort has been made to understand the relationship between high pumping, clay content and subsidence. The Lower Rio Grande Valley has not experienced the high degree of pumping, and it is difficult to evaluate the potential for subsidence with any accuracy since there is little in the way of calibration data to apply any analytical or numerical approach. The geologic similarity between the Houston area and the Lower Rio Grande Valley can be used to develop some conclusions as to the potential range of subsidence under assumed increased pumping conditions.

3.4.2 Application of HAGM Results to the Lower Rio Grande Valley

Figure 5 depicts the estimates of HAGM drawdown from 1891 to 2010 in both the Chicot and Evangeline aquifers versus the measured subsidence as shown previously in Figure 3. Please note that it appears that for an equal amount of drawdown, the Chicot Aquifer appears to be more susceptible to subsidence than the Evangeline Aquifer, although there are several instances where they are nearly equal.

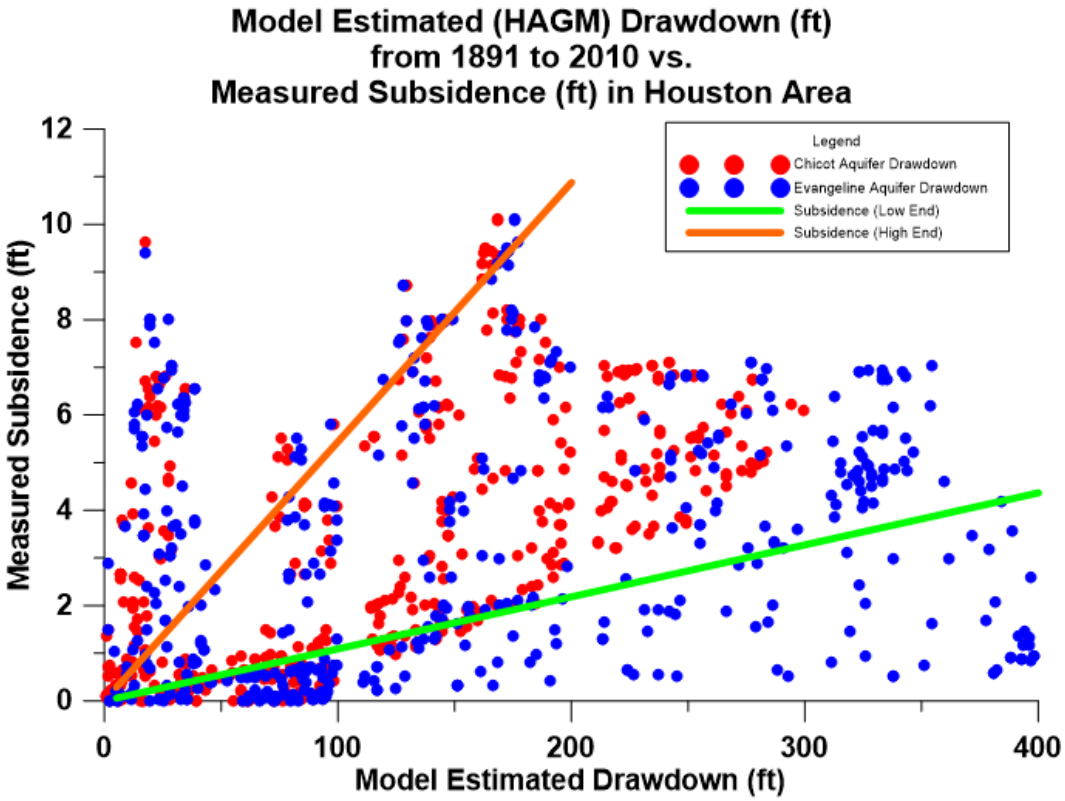


Figure 5. HAGM Drawdown vs. Measured Subsidence

The variation in the response, or scatter of the points demonstrates the complexity of the relationship that provides the ability to estimate subsidence based on pumping amounts and clay content. This complexity results in the inability to develop simple and accurate predictions of subsidence without site specific information. Absent site-specific information, only a general relationship can be developed.

Figure 5 also includes two lines that approximate a range of linear relationship between drawdown and subsidence that were drawn qualitatively to capture the potential reasonable range of subsidence given a specific drawdown. The more conservative line (green) suggests the following relationship:

Subsidence (ft) = 0.010905 * Drawdown (ft)

The higher response line (orange) suggests the following relationship:

Subsidence (ft) = 0.054361 * Drawdown (ft)

These equations were used in conjunction with the drawdown estimates to provide a range of estimates of subsidence for each of the strategies.

4.0 Results of Predictive Scenarios

4.1 Base Case Scenario Results

The base case represented continuation of pumping at 2013 amounts (stress period 30 of the calibrated model). Recharge was set equal to the steady state parameters and held constant for the entire simulation. Other time-based stresses to the system (CHD, RIV, EVT, GHB, and QRT) were set equal to 2013 parameters (stress period 30 of the calibrated model) and held constant for the entire simulation.

Because of the assumption that recharge remains constant at the steady state condition (essentially long-term average), and that the initial heads and concentrations for the simulations were set equal to 2013 conditions (stress period 30 of the calibrated model), groundwater elevations and concentrations will tend to equilibrate to these idealized conditions.

Please recall that, in the calibrated model, recharge varied by year. Steady state recharge, by definition, is has a factor of 1.00 since it is considered the long-term average recharge. In 2013, the recharge was assigned a factor value of 1.13 times the average value (i.e. 1.13 times the steady state recharge). The two prior years (2011 and 2012) had recharge multipliers that were 0.55 and 0.76. Thus, while 2013 was a slightly above year with respect to recharge, it followed two dry years. The base case results will reflect an initial response to the continued recovery from the drought of 2011 and 2012.

4.1.1 Groundwater Elevations

As described above, groundwater levels were tracked at the 93 locations of the proposed wells associated with the water management strategies. During the base case simulation from 2014 to 2070, 75 of the wells (about 81 percent) had groundwater elevation changes of -1 ft to 1 ft (negative number means a groundwater level decline, positive number means a groundwater level recovery). Eight wells (about 9 percent) had groundwater elevation declines of between 1 and 3 feet. The remaining ten wells had groundwater level recoveries of between 1 and 7 feet.

Overall, the results demonstrate that the model is a useful tool to compare alternative pumping scenarios with the base case. The base case appears to be relatively stable with respect to long term trends in groundwater elevation, and the responses are consistent given the assumptions and the specifics of the recharge estimates.

4.1.2 Total Dissolved Solids Concentrations

As described above, total dissolved solids were tracked at the 93 locations of the proposed wells associated with the water management strategies. Total dissolved solids at the 93 locations in 2070 ranged from 1,489 mg/l to 35,610 mg/l. Because of the variability in total dissolved solids

and the general lack of ability to calibrate the absolute values at any specific locations, changes in total dissolved solids were considered a more appropriate use of the results.

During the base case simulation from 2014 to 2070, 54 wells (about 58 percent) had total dissolved concentration changes of between -10 percent to 10 percent (negative numbers represented a decline in total dissolved solids, positive numbers represented an increase in total dissolved solids). 23 wells (about 25 percent) had decreases in total dissolved solids between 10 and 40 percent. The remaining 16 wells (about 17 percent) had total dissolved concentrations that increase between 10 percent and 25 percent.

4.1.3 Cell-By-Cell Flow Components

Pumping is about 29,420 AF/yr for all stress periods.

Storage declined at a rate of about 6,000 AF/yr for the first stress period (2014 and 2015) which is consistent with the change associated with the decline in recharge as compared to 2013. Subsequent stress periods show minimal changes to storage (generally less than 1,000 AF/yr) as the system equilibrates.

Recharge from the Rio Grande is about 145,000 AF/yr in 2014 and 2015, and reduces for subsequent stress periods to about 117,000 AF/yr for the years 2066 to 2070 (stress period 12). Recharge from the canals is about 53,000 AF/yr in 2014 and 2015, and reduces to about 52,000 AF/yr from 2066 to 2070. Groundwater evapotranspiration in 2014 and 2015 is about 121,000 AF/yr, and drops to about 96,000 AF/yr in later years. Again, these results demonstrate that the after the initial transient response, the system is equilibrating after the initial change in recharge.

4.2 Individual Water Management Strategy Scenario Results

The results of the simulations of the individual water management strategies are presented in this section. The focus for the analysis was the comparison of the results as changes from the baseline scenario results (as opposed to an analysis of the absolute values of the results), and the focus was on the long-term results (from 2014 to 2070) rather than on individual years. Appendix A summarizes the results in tabular form.

As reported previously in Table 3, flow discrepancies for the simulations were all below one percent, and transport discrepancies were between about 1.3 and 1.6 percent. These flow and transport discrepancies can be termed model errors in that they represent a comparison between the calculated difference between inflow and outflow and the calculated storage change. These are small, but some of the detailed results are skewed by these small differences (i.e. the non-expected results are within the reported model error), and they represent limitations of the model to do more detailed analyses.

As an example of these limitations, the base case scenario showed an initial groundwater storage decline of about 6,400 AF/yr in the first stress period, and then a reduction as the system equilibrated. However, Strategy 7 shows an initial storage gain of 587 AF/yr in the first stress period, when the expected result is at least the same amount of decline as the base case if not

slightly higher due to the increased pumping associated with the strategy. However, the flow discrepancy for the first stress period is 0.53 percent, or about 14,000 AF/yr. Subsequent stress periods for this strategy showed no other serious anomalies, and the later stress period results were considered reasonable. This identified limitation of the model and these results guided how the results are summarized in this report.

Individual strategy results are presented in the subsequent subsections. The final subsection covers the results of the simulation for all the strategies.

Individual strategy results include number of wells involved in the strategy, the change in groundwater elevation and total dissolved concentration from 2014 to 2070 under the base line (no pumping condition), and the uncertainty of that base line estimate, the pumping amount as reported by the model output (as a check on the model input) for the first and last stress periods, the change in groundwater elevation and total dissolved solids concentration at the well site from 2013 to 2070 due to the pumping associated with the strategy, the difference in groundwater elevation and total dissolved solids concentration attributable to the strategy. Where more than one well is involved in a strategy, the full range of all results for all the wells is reported.

The range in groundwater elevations and change in total dissolved solids listed in each strategy was developed from the uncertainty analysis, which is discussed in more detail in Section 5 of this report (Limitations).

The results presented in the next subsection represent a summary of important results for each of the individual strategies. The intent of the summaries is to provide a convenient summary for Region M members and consultants when summarizing the impacts of a specific strategy. The presentation follows a format that draws data and information from many places in this report. Table 7 summarizes the source of information and data for each item.

Table 7. Summary of Sources for Individual Strategy Results Summaries

Result	Source of Result
Number of Wells	Number of wells associated with the strategy please see Table 2)
Change in Groundwater Elevation under Baseline Conditions (2013 to 2070)	Calculated change of groundwater elevation from 2013 to 2070 at well location (please see Appendix A)
Range of Change (from Uncertainty Analysis)	Please see Section 5.0 and Appendix G
Change in Total Dissolved Solids under Baseline Conditions (2014 to 2070)	Calculated change of total dissolved solids from at well location (please see Appendix C)
Range of Change (from Uncertainty Analysis)	Please see Section 5.0 and Appendix G
Pumping in Stress Period 1 (2014)	Initial Pumping Rate for Strategy (Please see Table 2)
Pumping in Stress Period 12 (2070)	Final Pumping Rate for Strategy (Please see Table 2)
Change in Groundwater Elevation from 2013 to 2070 in area of pumped well	Calculated change of groundwater elevation from 2013 to 2070 at well location (please see Appendix A)
Change from Baseline Condition (attributable to strategy)	Calculated change of groundwater elevation due to strategy (please see Appendix A)
Potential Range of Subsidence	Calculated range of subsidence at well location (please see Appendix B
Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well	Calculated change of total dissolved solids from at well location (please see Appendix C)
Change from Baseline Condition (attributable to strategy)	Calculated change of total dissolved solids due to strategy (please see Appendix C)

4.2.1 Strategy 1 - El Jardin WSC

- Number of Wells: 1
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): 1.78 ft
    - Range of Change (from Uncertainty Analysis): 0.04 to 1.85 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -19 percent
    - Range of Change (from Uncertainty Analysis): -19 to -15 percent
- Pumping in Stress Period 1 (2014): 709 AF/yr
- Pumping in Stress Period 12 (2070): 707 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: 1.61 ft
    - Change from Baseline Condition (attributable to strategy): -0.17 ft
- Potential Range of Subsidence: 0 to 0.01 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -20 percent
    - Change from Baseline Condition (attributable to strategy): -1 percent

4.2.2 Strategy 2 – La Feria

- Number of Wells: 1
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -0.26 ft
    - Range of Change (from Uncertainty Analysis): -1.95 to 0.18 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -16 percent
    - Range of Change (from Uncertainty Analysis): -17 to -15 percent
- Pumping in Stress Period 1 (2014): 1,402 AF/yr
- Pumping in Stress Period 12 (2070): 1,400 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -0.41 ft
    - Change from Baseline Condition (attributable to strategy): -0.15 ft
- Potential Range of Subsidence: 0 to 0.01 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -27 percent
    - Change from Baseline Condition (attributable to strategy): -11 percent

4.2.3 Strategy 3 – Laguna Madre WD

- Number of Wells: 2
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -0.30 to -0.33 ft
    - Range of Change (from Uncertainty Analysis): -0.80 to -0.23 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): 3 to 4 percent
    - Range of Change (from Uncertainty Analysis): 3 to 5 percent
- Pumping in Stress Period 1 (2014): 2,799 AF/yr
- Pumping in Stress Period 12 (2070): 2,800 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -0.42 to -0.25 ft
    - Change from Baseline Condition (attributable to strategy): -0.12 to 0.08 ft
- Potential Range of Subsidence: 0 to 0.01 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: 4 percent (both wells)
    - Change from Baseline Condition (attributable to strategy): < 1 percent

4.2.4 Strategy 4 – East Rio Hondo WSC & North Alamo WSC

- Number of Wells: 1
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): 0.14 ft
    - Range of Change (from Uncertainty Analysis): -1.31 to 0.51 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -17 percent
    - Range of Change (from Uncertainty Analysis): -19 to -15 percent
- Pumping in Stress Period 1 (2014): 1,476 AF/yr
- Pumping in Stress Period 12 (2070): 1,469 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -1.94 ft
    - Change from Baseline Condition (attributable to strategy): -2.08
- Potential Range of Subsidence: 0.02 to 0.11 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -19 percent
    - Change from Baseline Condition (attributable to strategy): -2 percent

4.2.5 Strategy 5 – Primera

- Number of Wells: 1
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): 0.72 ft
    - Range of Change (from Uncertainty Analysis): -1.01 to 0.95 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -20 percent
    - Range of Change (from Uncertainty Analysis): -21 to -18 percent
- Pumping in Stress Period 1 (2014): 1,403 AF/yr
- Pumping in Stress Period 12 (2070): 1,400 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: 1.24 ft
    - Change from Baseline Condition (attributable to strategy): 0.52
- Potential Range of Subsidence: 0 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -30 percent
    - Change from Baseline Condition (attributable to strategy): -10 percent

4.2.6 Strategy 6 – McAllen

- Number of Wells: 3
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): 1.67 to 1.91 ft
    - Range of Change (from Uncertainty Analysis): -1.06 to 6.53 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): 9 to 10 percent
    - Range of Change (from Uncertainty Analysis): 0 to 19 percent
- Pumping in Stress Period 1 (2014): 3,354 AF/yr
- Pumping in Stress Period 12 (2070): 3,357 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -1.59 to 1.70 ft
    - Change from Baseline Condition (attributable to strategy): -3.5 to -3.2 ft
- Potential Range of Subsidence: 0.03 to 0.19 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: 11 to 12 percent
    - Change from Baseline Condition (attributable to strategy): 2 percent

4.2.7 Strategy 7 – Mission

- Number of Wells: 3
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): 3.50 to 3.91 ft
  - Range of Change (from Uncertainty Analysis): 0.21 to 9.50 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -1 to -2 percent
  - Range of Change (from Uncertainty Analysis): -4 to 0 percent
- Pumping in Stress Period 1 (2014): 3,360 AF/yr
- Pumping in Stress Period 12 (2070): 3,364 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: 2.23 to 2.78 ft
  - Change from Baseline Condition (attributable to strategy): -1.13 to -1.27 ft
- Potential Range of Subsidence: 0 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -4 to -3 percent
  - Change from Baseline Condition (attributable to strategy): -1 to -2 percent

4.2.8 Strategy 8 – Alamo

- Number of Wells: 1
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -0.70 ft
  - Range of Change (from Uncertainty Analysis): -1.80 to 1.13 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -13 percent
  - Range of Change (from Uncertainty Analysis): -15 to -11 percent
- Pumping in Stress Period 1 (2014): 1,122 AF/yr
- Pumping in Stress Period 12 (2070): 1,121 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -1.53 ft
  - Change from Baseline Condition (attributable to strategy): -0.83 ft
- Potential Range of Subsidence: 0.01 to 0.05 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -13 percent
  - Change from Baseline Condition (attributable to strategy): < 1 percent

4.2.9 Strategy 9 – Sharyland WSC (WTP 2)

- Number of Wells: 1
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): 6.54 ft
  - Range of Change (from Uncertainty Analysis): 5.3 to 14.84 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -7 percent
  - Range of Change (from Uncertainty Analysis): -9 to -6 percent
- Pumping in Stress Period 1 (2014): 1,121 AF/yr
- Pumping in Stress Period 12 (2070): 1,116 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -1.60 ft
  - Change from Baseline Condition (attributable to strategy): -8.14 ft
- Potential Range of Subsidence: 0.02 to 0.09 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: 20 percent
  - Change from Baseline Condition (attributable to strategy): 27 percent

4.2.10 Strategy 10 – Sharyland WSC (WTP 3)

- Number of Wells: 1
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): 6.44 ft
  - Range of Change (from Uncertainty Analysis): 1.97 to 15.28 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -21 percent
  - Range of Change (from Uncertainty Analysis): -25 to -19 percent
- Pumping in Stress Period 1 (2014): 1,124 AF/yr
- Pumping in Stress Period 12 (2070): 1,123 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -1.77 ft
  - Change from Baseline Condition (attributable to strategy): -4.67 ft
- Potential Range of Subsidence: 0.05 to 0.25 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -12 percent
  - Change from Baseline Condition (attributable to strategy): 9 percent

4.2.11 Strategy 11 – Union WSC (Rio Grande City)

- Number of Wells: 1
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -0.71 ft
  - Range of Change (from Uncertainty Analysis): -0.91 to -0.52 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): 1 percent
  - Range of Change (from Uncertainty Analysis): 1 percent
- Pumping in Stress Period 1 (2014): 700 AF/yr
- Pumping in Stress Period 12 (2070): 699 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -90.96 ft
  - Change from Baseline Condition (attributable to strategy): -90.25 ft
- Potential Range of Subsidence: 0.98 to 4.91 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: 7 percent
  - Change from Baseline Condition (attributable to strategy): 6 percent

4.2.12 Strategy 12 – Lyford

- Number of Wells: 1
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -0.03 ft
  - Range of Change (from Uncertainty Analysis): -1.23 to 0.42 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -20 percent
  - Range of Change (from Uncertainty Analysis): -21 to -19 percent
- Pumping in Stress Period 1 (2014): 1,399 AF/yr
- Pumping in Stress Period 12 (2070): 1,400 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -2.67 ft
  - Change from Baseline Condition (attributable to strategy): -2.64 ft
- Potential Range of Subsidence: 0.03 to 0.14 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -22 percent
  - Change from Baseline Condition (attributable to strategy): -2 percent

4.2.13 Strategy 13 – North Alamo WSC (Delta Area)

- Number of Wells: 2
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -2.16 to -2.07 ft
  - Range of Change (from Uncertainty Analysis): -3.05 to -1.47 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -5 to 2 percent
  - Range of Change (from Uncertainty Analysis): -6 to 2 percent
- Pumping in Stress Period 1 (2014): 14 AF/yr
- Pumping in Stress Period 12 (2070): 2,808 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -9.69 to -8.52 ft
  - Change from Baseline Condition (attributable to strategy): -7.62 to -6.36 ft
- Potential Range of Subsidence: 0.07 to 0.41 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -2 to 4 percent
  - Change from Baseline Condition (attributable to strategy): 2 to 3 percent

4.2.14 Strategy 14 – North Alamo WSC (La Sara)

- Number of Wells: 1
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -0.97 ft
  - Range of Change (from Uncertainty Analysis): -3.25 to -0.32 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -34 percent
  - Range of Change (from Uncertainty Analysis): -34 to -26 percent
- Pumping in Stress Period 1 (2014): 8 AF/yr
- Pumping in Stress Period 12 (2070): 1,407 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -10.22 ft
  - Change from Baseline Condition (attributable to strategy): -9.25 ft
- Potential Range of Subsidence: 0.10 to 0.50 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -39 percent
  - Change from Baseline Condition (attributable to strategy): -5 percent

4.2.15 Strategy 15 – Cameron County

- Number of Wells: 56
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -1.14 to 0.60 ft
  - Range of Change (from Uncertainty Analysis): -2.86 to 0.75 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -24 to 25 percent
  - Range of Change (from Uncertainty Analysis): -27 to 34 percent
- Pumping in Stress Period 1 (2014): 4,505 AF/yr
- Pumping in Stress Period 12 (2070): 4,511 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -1.84 to 0.16 ft
  - Change from Baseline Condition (attributable to strategy): -1.08 to 0.08 ft
- Potential Range of Subsidence: 0 to 0.06 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -28 to 25 percent
  - Change from Baseline Condition (attributable to strategy): -7 to 11 percent

4.2.16 Strategy 16 – Military Highway WSC

- Number of Wells: 4
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -0.85 to -0.46 ft
  - Range of Change (from Uncertainty Analysis): -2.25 to 0.33 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -35 to -12 percent
  - Range of Change (from Uncertainty Analysis): -39 to -11 percent
- Pumping in Stress Period 1 (2014): 626 AF/yr
- Pumping in Stress Period 12 (2070): 625 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -0.97 to -0.59 ft
  - Change from Baseline Condition (attributable to strategy): -0.14 to 0.09 ft
- Potential Range of Subsidence: 0 to 0.01 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -32 to -10 percent
  - Change from Baseline Condition (attributable to strategy): 0 to 5 percent

4.2.17 Strategy 17 – San Benito

- Number of Wells: 2
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -0.34 to -0.23 ft
  - Range of Change (from Uncertainty Analysis): -1.58 to -1.56 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): 6 to 7 percent
  - Range of Change (from Uncertainty Analysis): 6 to 10 percent
- Pumping in Stress Period 1 (2014): 1,124 AF/yr
- Pumping in Stress Period 12 (2070): 1,119 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -2.20 to -2.06 ft
  - Change from Baseline Condition (attributable to strategy): -1.86 to -1.83 ft
- Potential Range of Subsidence: 0.02 to 0.10 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: 9 to 10 percent
  - Change from Baseline Condition (attributable to strategy): 3 percent

4.2.18 Strategy 18 – Alamo

- Number of Wells: 1
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -0.86 ft
  - Range of Change (from Uncertainty Analysis): -1.87 to 0.92 ft
- Change in Total Dissolved Solids under Baseline Conditions (2014 to 2070): -19 percent
  - Range of Change (from Uncertainty Analysis): -21 to -17 percent
- Pumping in Stress Period 1 (2014): 1,104 AF/yr
- Pumping in Stress Period 12 (2070): 1,104 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -0.73 ft
  - Change from Baseline Condition (attributable to strategy): 0.13 ft
- Potential Range of Subsidence: 0 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -23 percent
  - Change from Baseline Condition (attributable to strategy): -4 percent

4.2.19 Strategy 19 – Edcouch

- Number of Wells: 1
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -2.21 ft
  - Range of Change (from Uncertainty Analysis): -4.23 to -1.71 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): 15 percent
  - Range of Change (from Uncertainty Analysis): 12 to 16 percent
- Pumping in Stress Period 1 (2014): 505 AF/yr
- Pumping in Stress Period 12 (2070): 501 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -3.94 ft
  - Change from Baseline Condition (attributable to strategy): -1.73 ft
- Potential Range of Subsidence: 0.02 to 0.09 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -15 percent
  - Change from Baseline Condition (attributable to strategy): < 1 percent

4.2.20 Strategy 20 – Hidalgo

- Number of Wells: 2
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -0.69 to -0.66 ft
  - Range of Change (from Uncertainty Analysis): -1.92 to 0.81 ft
- Change in Total Dissolved Solids under Baseline Conditions (2014 to 2070): -16 to -13 percent
  - Range of Change (from Uncertainty Analysis): -22 to 2 percent
- Pumping in Stress Period 1 (2014): 298 AF/yr
- Pumping in Stress Period 12 (2070): 300 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -0.87 to -0.84 ft
  - Change from Baseline Condition (attributable to strategy): -0.18 ft
- Potential Range of Subsidence: 0.02 to 0.01 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -19 to -14 percent
  - Change from Baseline Condition (attributable to strategy): -3 to -1 percent

4.2.21 Strategy 21 – Hidalgo Steam Electric

- Number of Wells: 1
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): 2.88 ft
  - Range of Change (from Uncertainty Analysis): 0.31 to 7.79 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -1 percent
  - Range of Change (from Uncertainty Analysis): -1 percent
- Pumping in Stress Period 1 (2014): 98 AF/yr
- Pumping in Stress Period 12 (2070): 100 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: 0.76 ft
  - Change from Baseline Condition (attributable to strategy): -2.12 ft
- Potential Range of Subsidence: 0 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -5 percent
  - Change from Baseline Condition (attributable to strategy): -4 percent

4.2.22 Strategy 22 – Weslaco

- Number of Wells: 1
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -2.17 ft
  - Range of Change (from Uncertainty Analysis): -3.56 to -1.50 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): 13 percent
  - Range of Change (from Uncertainty Analysis): 13 to 17 percent
- Pumping in Stress Period 1 (2014): 560 AF/yr
- Pumping in Stress Period 12 (2070): 560 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -2.44 ft
  - Change from Baseline Condition (attributable to strategy): -0.27 ft
- Potential Range of Subsidence: 0 to 0.01 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: 13 percent
  - Change from Baseline Condition (attributable to strategy): < 1 percent

4.2.23 Strategy 23 – Starr County

- Number of Wells: 5
- Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): -0.52 to 0.10 ft
  - Range of Change (from Uncertainty Analysis): -1.00 to 1.01 ft
- Change in Total Dissolved Solids under Baseline Conditions (2013 to 2070): -6 to 8 percent
  - Range of Change (from Uncertainty Analysis): -6 to 9 percent
- Pumping in Stress Period 1 (2014): 407 AF/yr
- Pumping in Stress Period 12 (2070): 408 AF/yr
- Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: -24.58 to -1.83 ft
  - Change from Baseline Condition (attributable to strategy): -24.06 to -1.55 ft
- Potential Range of Subsidence: 0.02 to 0.26 ft
- Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -7 to 50 percent
  - Change from Baseline Condition (attributable to strategy): -1 to 51 percent

4.3 All Water Management Strategy Scenario Results

4.3.1 Summary of Results

Details of these are provided in the results for each well in Appendices A, B, and C. Appendix A summarizes groundwater level changes. Appendix B summarizes potential subsidence. Appendix C summarizes changes in total dissolved solids. Appendix D presents contour maps of groundwater elevation and total dissolved solids for each model layer in 2070 for the AllStrat scenario.

4.3.2 Cumulative Effect of All Strategies

The simulation that assumed all strategies were implemented resulted in changes to groundwater elevation and changes to total dissolved solids that were consistent with the individual strategies in most cases. The cumulative effect of operating all wells can be summarized by considering the additional drawdown in the well (groundwater elevation at the end of the individual strategy

simulation minus the groundwater elevation at the end of the all-strategy simulation for each well), and the additional change in total dissolved solids in each well.

Figure 6 presents the additional drawdown, and Figure 7 presents the additional change in total dissolved solids.

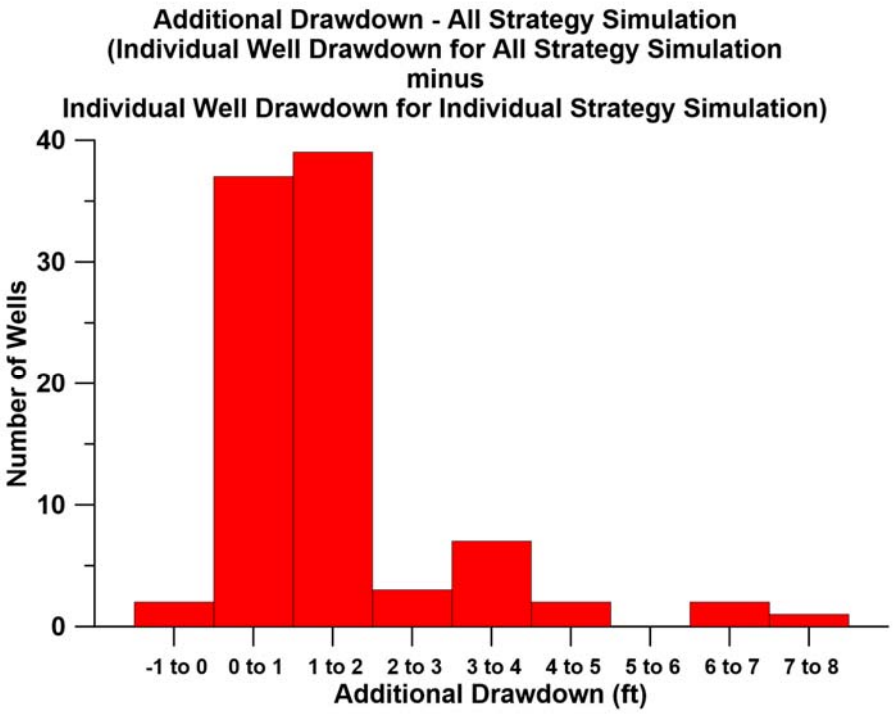


Figure 6. Additional Drawdown Histogram for All Strategy Simulation

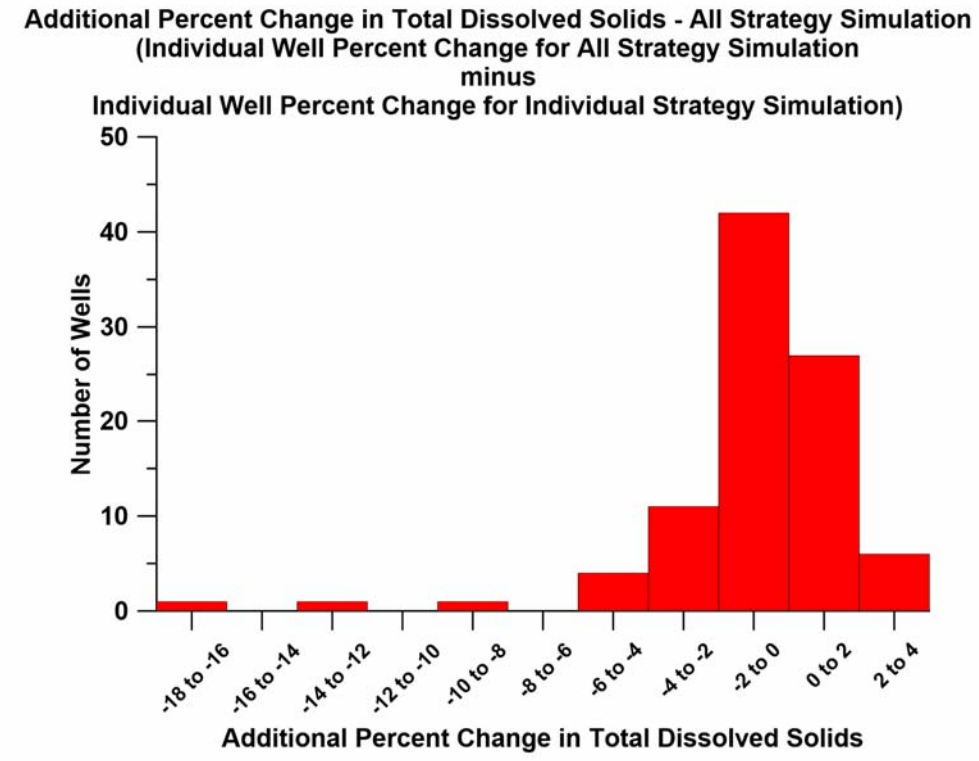


Figure 7. Additional Change in Total Dissolved Solids Histogram for All Strategy Simulation

Based on these histograms, it can be concluded that the cumulative effect of implementing all strategies is relatively small. Please note that nearly all wells showed only 1 to 2 ft increase in drawdown attributable to the cumulative effect of the implementation of all the strategies. Similarly, the change in total dissolved solids is generally small (most wells show an additional decrease in TDS of between 1 and 4 percent). There are some instances where the cumulative impacts are larger. These should be considered by Region M as they proceed with the next Regional Plan.

4.3.3 Groundwater Budget Impacts

Groundwater budget analysis is the consideration of all inflows, outflows and change in storage to the area. Changes in pumping will result in changes to other components of the groundwater budget, and the results of the all strategy simulation are discussed below.

Please note that in the first stress period (2014 to 2015), pumping increases 29,161 AF/yr over the baseline simulation. The water budget results can be used to quantify the major source of this pumping (i.e. what are the capture components of the wells):

- Decreased storage: 4,637 AF/yr (16 percent of pumping)
- Decreased flow to the Gulf of Mexico: 8,985 AF/yr (31 percent of pumping)

- Decreased groundwater evapotranspiration: 1,944 AF/yr (7 percent of pumping)
- Induced recharge from the Rio Grande: 13,846 AF/yr (47 percent of pumping)
- Induced recharge from canals: 870 AF/yr (3 percent of the pumping)

For the first two years of pumping, storage decline accounts for only 16 percent of the pumped water. Half of the pumping is derived from induced surface flows, and almost a third is captured from flow that would have gone to the Gulf of Mexico.

In the last stress period of the simulation (2066 to 2070), the source of the pumped water changes as the system continues to equilibrate:

- Pumping: 33,358 AF/yr
- Decreased storage: 751 AF/yr (2 percent of pumping)
- Decreased flow to the Gulf of Mexico: 11,114 AF/yr (33 percent of pumping)
- Decreased groundwater evapotranspiration: 2,923 AF/yr (9 percent of pumping)
- Induced recharge from the Rio Grande: 16,506 AF/yr (49 percent of pumping)
- Induced recharge from canals: 1,291 AF/yr (4 percent of the pumping)

Please note that the storage contribution to the pumping has decreased and only accounts for 2 percent of the pumped water. Surface water capture is over 50 percent, and captured flow to the Gulf of Mexico remains about one-third of the pumped water.

These results suggest that large scale increases in pumping in the Lower Rio Grande Valley will result in some decrease in groundwater storage, but will have direct and significant impacts to surface water flows. These results suggest that, over the long-term, for every 2 acre-feet pumped, 1 acre-foot of surface water will supply that pumping, and could result in reduced surface water flow.

5.0 Limitations

The simulation of a base case and the simulation of individual strategies offer an opportunity to evaluate the limitations of the model and the predictive scenario results by considering the uncertainty of groundwater elevations and concentrations at the 93 well locations that were used in simulations. The base line simulation provides estimates of change in groundwater elevation and concentration with no new pumping. Individual strategy simulations provided results at the location of the pumping and at points that are far removed from the location of the new pumping. Presumably, in areas well removed from the strategy pumping, changes in groundwater elevation and concentration should be the same as the base case. However, inspection of the results shows this is not the case.

A review of the simulation of all strategies suggests that there is limited mutual interference at the 93 well sites between individual strategies. Thus, the results can be used to quantify a practical measure of uncertainty for each of the strategy sites if the effect of mutual interference is assumed to be negligible. To the extent that the effect of mutual interference is not negligible, then the uncertainty may be overstated.

For example, Strategy 1 for El Jardin WSC includes the pumping of a single well in southern Cameron County. It is isolated from wells of the other strategies. The base case (no pumping for any strategy) shows that groundwater elevations under the base case will rise 1.78 feet from 2014 to 2070. The simulations of Strategies 2 to 23 (the other individual strategies) yield groundwater elevation rises at the El Jardin WSC wellsite of between 0.04 and 1.85 ft from 2014 to 2070. If it can be assumed that, due to the distances between this site and the other pumping sites in the other strategies, the variation in groundwater elevation change predictions is due to model uncertainty, then the base case prediction increase of 1.78 feet could actually be between 0.04 and 1.85 feet. Thus, as an expression of uncertainty, the maximum change was estimated to be 1.85 ft, the minimum change was estimated to be 0.04 ft, and the maximum minus minimum is 1.81 ft.

All calculated estimates of the change in groundwater elevation and the change in total dissolved solids are presented in Appendix G.

The base case uncertainty analysis for various measures of groundwater elevation and concentration are summarized in the following figures:

- Figure 8: Groundwater Elevation in 2070
- Figure 9: Change in Groundwater Elevation from 2014 to 2070
- Figure 10: Total Dissolved Solids in 2070
- Figure 11: Change in Total Dissolved Solids from 2014 to 2070
- Figure 12: Percent Change in Total Dissolved Solids from 2014 to 2070

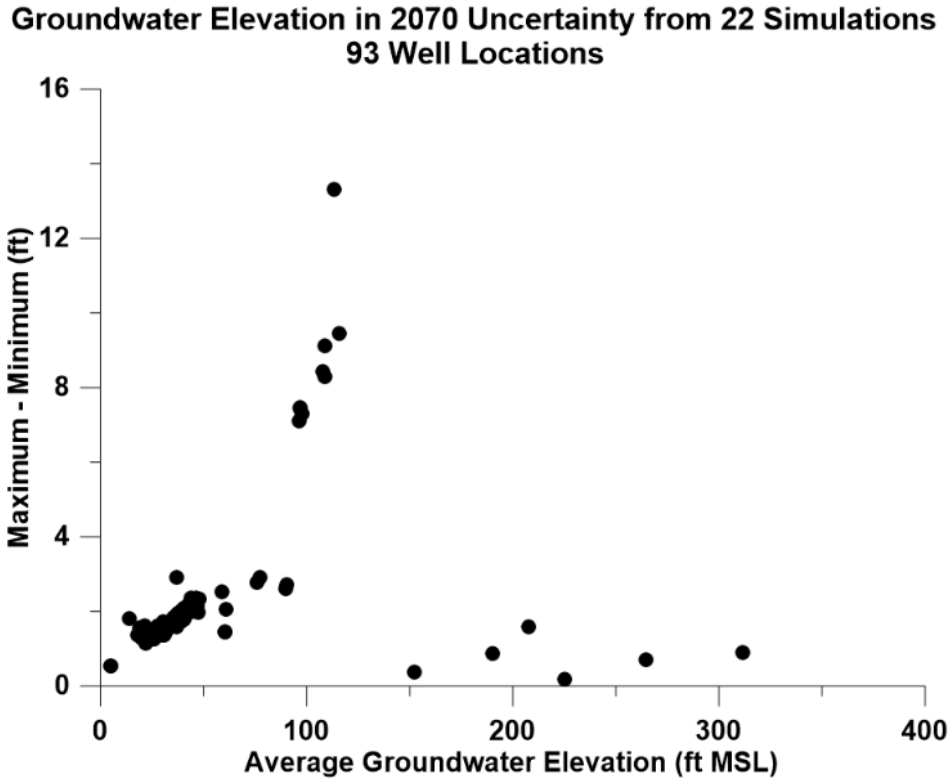


Figure 8. Uncertainty in Groundwater Elevation in 2070

In Figure 8, please note that as the average groundwater elevation increases from zero, the difference between the highest and lowest estimates (maximum – minimum) increases rapidly to where there is a range of about 14 feet when the groundwater elevation is about 100 ft MSL. This is presumably in areas where the aquifer is confined, and low storativity values result in the possibility of a relatively large range in estimated groundwater elevations. However, the difference between the highest and lower estimates (maximum – minimum) is less than 2 feet when the groundwater elevation is above 150 ft MSL, presumably because these wells are located in the upper portion of the outcrop area, and exhibit unconfined conditions.

In Figure 9, the relationship between the change in groundwater elevation and the range in uncertainty is more linear.

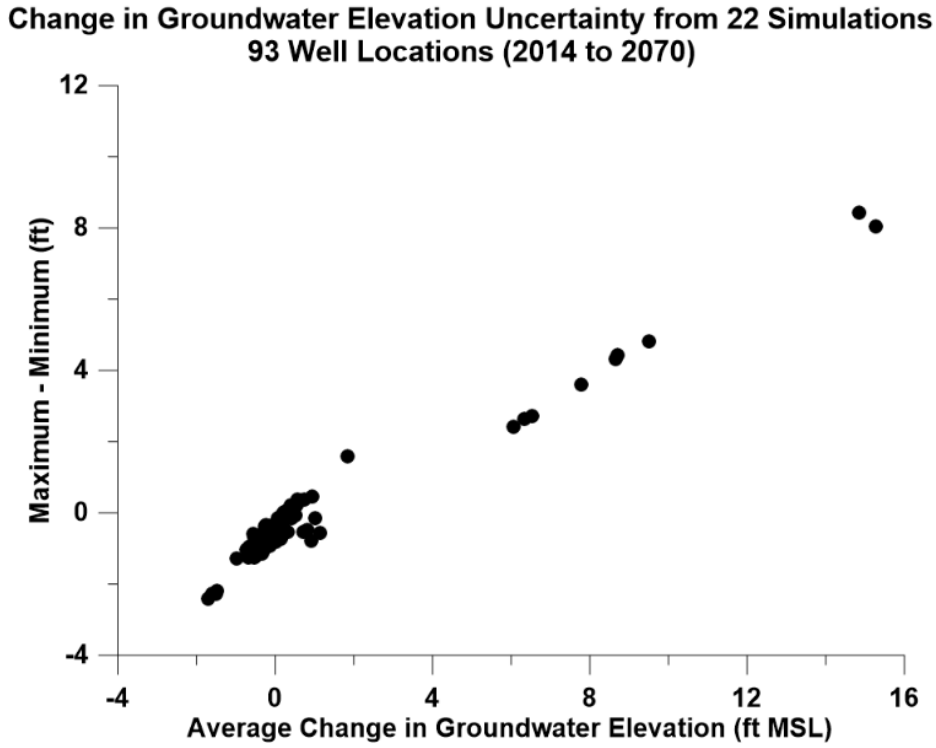


Figure 9. Uncertainty in Change in Groundwater Elevation from 2014 to 2070

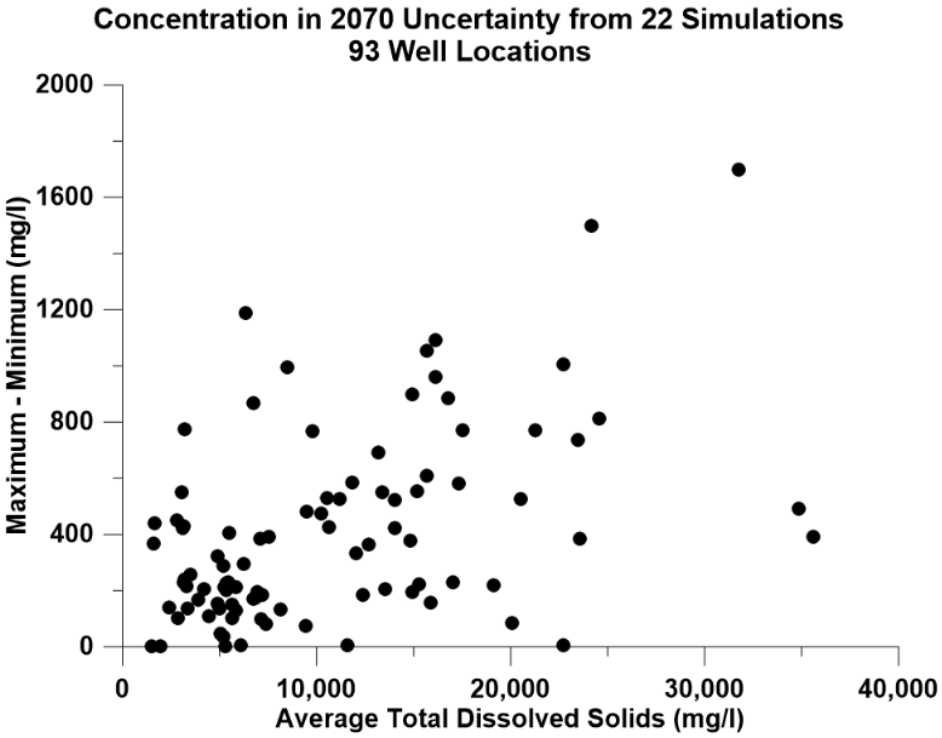


Figure 10. Uncertainty in Total Dissolved Solids in 2070

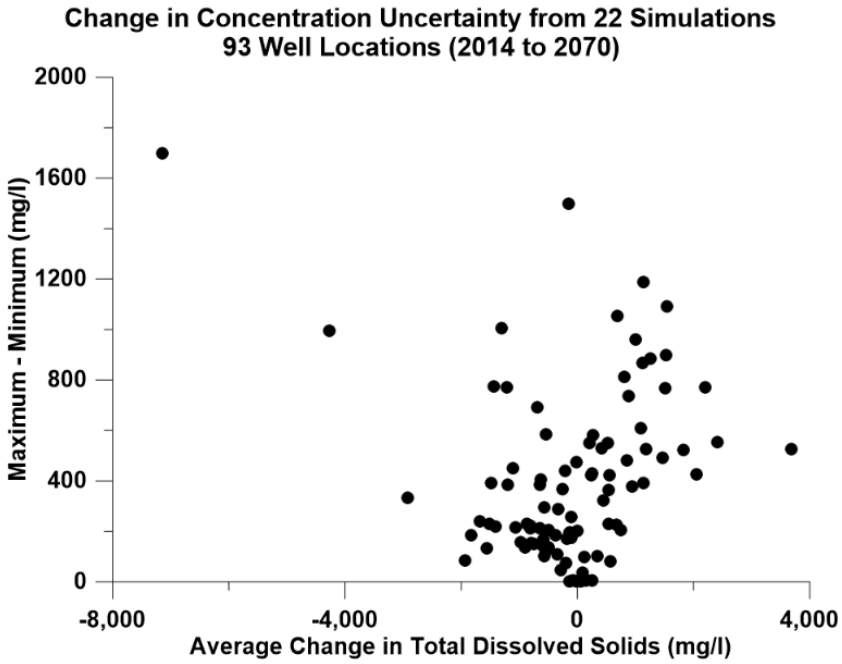


Figure 11. Uncertainty in Change in Total Dissolved Solids from 2014 to 2070

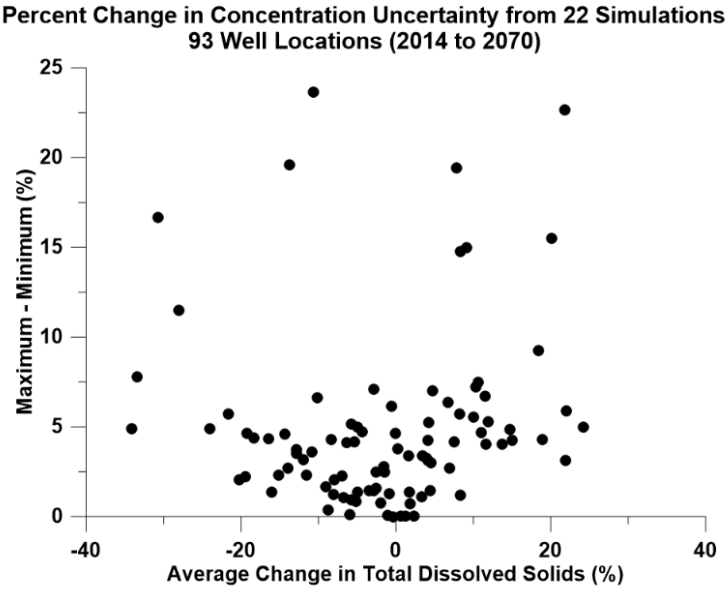


Figure 12. Uncertainty in Percent Change in Total Dissolved Solids from 2014 to 2070

The uncertainty associated with total dissolved solids (Figures 10, 11, and 12) are more complex than the groundwater elevation. In general, as salinity increases, the uncertainty in the estimate increases, and the larger the predicted change (expressed either in mg/l or as a percentage), the larger the uncertainty of the prediction.

6.0 References

Kasmarek, M.C., and Robinson, J.L., 2004, Hydrogeology and Simulation of Groundwater Flow and Land-Surface Subsidence in the Northern Part of the Gulf Coast Aquifer System, Texas: United States Geological Survey Scientific Investigations Report 2004-5102, 111 p.

Kasmarek, M.C., 2012, Hydrogeology and Simulation of Groundwater Flow and Land-Surface Subsidence in the Northern Part of the Gulf Coast Aquifer System, Texas, 1891-2009: United States Geological Survey Scientific Investigations Report 2012-5154, 55 p.

Appendix A

Summary of Groundwater Elevation Changes: Individual Strategies and Cumulative for All Strategies

Appendix A - Summary of Groundwater Elevation Changes: Individual Strategies and Cumulative for All Strategies

Well Number	Strategy Number	Well Name	X Coordinate (ft)	Y Coordinate (ft)	Well Pumping Rate		2013 Groundwater Elevation (ft MSL)	Change in Groundwater Elevation (ft) from 2013 to 2070 in Model Cell where Well is Located				
					Acre-feet per Year	Gallons per Minute		Baseline	Individual Strategy	Attributable to Individual Strategy (Individual Strategy - Baseline)	All Strategies	Attributable to All Strategies (All Strategies - Individual Strategy)
1	1	Jardin-1	5777994.48	17745494.03	700	434	12.46	1.78	1.61	-0.17	1.40	-0.21
2	2	Feria-1	5635065.11	17834288.86	1,400	868	46.48	-0.26	-0.41	-0.15	-1.87	-1.46
3	3	Laguna-Madre-2	5794527.34	17825926.43	1,400	868	5.18	-0.33	-0.25	0.08	-0.44	-0.19
4	3	Laguna-Madre-1	5794527.34	17823286.43	1,400	868	5.10	-0.3	-0.42	-0.12	-0.61	-0.19
5	4	North-Cameron-1	5649396.77	17872410.06	1,470	911	40.51	0.14	-1.94	-2.08	-2.26	-0.32
6	5	Primera-1	5657998.64	17862490.37	1,400	868	36.84	0.72	1.24	0.52	-0.56	-1.80
7	6	McAllen-3	5499346.34	17860470.80	1,120	694	94.19	1.91	-1.59	-3.50	-4.98	-3.39
8	6	McAllen-2	5496706.34	17857830.80	1,120	694	94.90	1.85	-1.35	-3.20	-4.66	-3.31
9	6	McAllen-1	5499346.34	17857830.80	1,120	694	93.65	1.67	-1.70	-3.37	-4.93	-3.23
10	7	Mission-3	5474412.78	17862543.48	1,120	694	103.97	3.91	2.78	-1.13	-4.73	-7.51
11	7	Mission-2	5471772.78	17859903.48	1,120	694	104.27	3.61	2.41	-1.20	-4.26	-6.67
12	7	Mission-1	5474412.78	17859903.48	1,120	694	103.26	3.5	2.23	-1.27	-4.69	-6.92
13	8	Alamo-1	5536327.54	17845112.44	1,120	694	77.67	-0.7	-1.53	-0.83	-4.80	-3.27
14	9	Sharyland-WTP2-1	5483868.73	17881700.02	1,125	697	107.14	6.54	-1.60	-8.14	-2.74	-1.14
15	10	Sharyland-WTP3-1	5496909.70	17895014.16	1,125	697	105.14	6.44	1.77	-4.67	-3.19	-4.96
16	11	Union-1	5339007.91	17894782.92	700	434	152.75	-0.71	-90.96	-90.25	-91.06	-0.10
17	12	Lyford-1	5645218.28	17931008.59	1,400	868	32.69	-0.03	-2.67	-2.64	-4.22	-1.55
18	13	Delta-2	5587659.95	17896889.11	1,400	868	62.65	-2.07	-9.69	-7.62	-12.05	-2.36
19	13	Delta-1	5587659.95	17894249.11	1,400	868	62.41	-2.16	-8.52	-6.36	-10.84	-2.32
20	14	La-Sara-1	5609340.46	17954869.29	1,400	868	37.69	-0.97	-10.22	-9.25	-14.12	-3.90
21	15	Cameron-County-01	5640309.65	17900747.16	81	50	40.89	-0.32	-1.29	-0.97	-2.60	-1.31
22	15	Cameron-County-02	5643720.76	17899317.38	81	50	39.05	-0.28	-1.14	-0.86	-2.46	-1.32
23	15	Cameron-County-03	5667763.95	17899730.85	81	50	31.95	-0.19	-0.62	-0.43	-1.85	-1.23
24	15	Cameron-County-04	5644681.30	17896187.91	81	50	39.60	-0.28	-1.15	-0.87	-2.45	-1.30
25	15	Cameron-County-05	5702971.24	17892595.93	81	50	21.54	0.35	0.08	-0.27	-0.69	-0.77
26	15	Cameron-County-06	5643762.09	17885553.15	81	50	41.84	-0.25	-1.16	-0.91	-2.46	-1.30
27	15	Cameron-County-07	5684216.18	17885397.44	81	50	28.17	0.17	-0.14	-0.31	-1.19	-1.05
28	15	Cameron-County-08	5689409.74	17885593.72	81	50	26.34	0.28	-0.03	-0.31	-1.00	-0.97
29	15	Cameron-County-09	5626282.79	17883921.43	81	50	47.92	-0.74	-1.82	-1.08	-3.17	-1.35
30	15	Cameron-County-10	5649025.53	17883553.78	81	50	40.56	-0.22	-1.04	-0.82	-2.37	-1.33
31	15	Cameron-County-11	5694935.15	17882503.55	81	50	25.86	0.04	-0.42	-0.46	-1.31	-0.89
32	15	Cameron-County-12	5652160.34	17880361.27	81	50	39.67	-0.14	-0.88	-0.74	-2.23	-1.35
33	15	Cameron-County-13	5694167.95	17874376.01	81	50	26.73	0.24	-0.23	-0.47	-1.12	-0.89
34	15	Cameron-County-14	5698494.06	17870310.79	81	50	25.90	0.41	-0.12	-0.53	-0.93	-0.81
35	15	Cameron-County-15	5725130.00	17869546.09	81	50	19.35	-0.45	-0.97	-0.52	-1.36	-0.39
36	15	Cameron-County-16	5642659.40	17867992.07	81	50	44.23	-0.39	-1.10	-0.71	-2.60	-1.50

Appendix A - Summary of Groundwater Elevation Changes: Individual Strategies and Cumulative for All Strategies

Well Number	Strategy Number	Well Name	X Coordinate (ft)	Y Coordinate (ft)	Well Pumping Rate		2013 Groundwater Elevation (ft MSL)	Change in Groundwater Elevation (ft) from 2013 to 2070 in Model Cell where Well is Located				
					Acre-feet per Year	Gallons per Minute		Baseline	Individual Strategy	Attributable to Individual Strategy (Individual Strategy - Baseline)	All Strategies	Attributable to All Strategies (All Strategies - Individual Strategy)
37	15	Cameron-County-17	5681782.54	17867916.28	81	50	31.50	0.07	-0.39	-0.46	-1.53	-1.14
38	15	Cameron-County-18	5628110.45	17866097.86	81	50	48.91	-1.04	-1.84	-0.80	-3.28	-1.44
39	15	Cameron-County-19	5633792.01	17865758.51	81	50	47.21	-0.73	-1.51	-0.78	-2.95	-1.44
40	15	Cameron-County-20	5720532.72	17865032.00	81	50	20.08	0.15	-0.35	-0.50	-0.87	-0.52
41	15	Cameron-County-21	5729311.21	17866405.66	81	50	18.38	-0.29	-0.76	-0.47	-1.15	-0.39
42	15	Cameron-County-22	5642294.94	17860014.79	81	50	44.63	-0.47	-1.01	-0.54	-2.52	-1.51
43	15	Cameron-County-23	5648227.30	17857513.59	81	50	42.80	-0.17	-0.64	-0.47	-2.17	-1.53
44	15	Cameron-County-24	5667370.05	17855471.01	81	50	37.09	-0.11	-0.50	-0.39	-1.86	-1.36
45	15	Cameron-County-25	5729395.25	17853762.61	81	50	18.87	0.28	-0.14	-0.42	-0.60	-0.46
46	15	Cameron-County-26	5699773.98	17848056.28	81	50	27.53	0.52	-0.02	-0.54	-0.87	-0.85
47	15	Cameron-County-27	5723765.75	17844598.28	81	50	21.11	0.6	0.10	-0.50	-0.40	-0.50
48	15	Cameron-County-28	5689496.90	17841951.09	81	50	31.88	0.13	-0.29	-0.42	-1.29	-1.00
49	15	Cameron-County-29	5680296.56	17837945.08	81	50	35.76	-0.37	-0.69	-0.32	-1.86	-1.17
50	15	Cameron-County-30	5687097.34	17837548.23	81	50	33.16	0.08	-0.34	-0.42	-1.37	-1.03
51	15	Cameron-County-31	5682757.67	17835067.06	81	50	35.29	-0.16	-0.55	-0.39	-1.64	-1.09
52	15	Cameron-County-32	5683631.94	17832558.81	81	50	34.84	-0.07	-0.41	-0.34	-1.51	-1.10
53	15	Cameron-County-33	5708604.68	17834744.59	81	50	27.42	0	-0.51	-0.51	-1.24	-0.73
54	15	Cameron-County-34	5697701.39	17830927.11	81	50	31.00	-0.35	-0.70	-0.35	-1.74	-1.04
55	15	Cameron-County-35	5728539.98	17830597.54	81	50	21.48	0.56	0.16	-0.40	-0.33	-0.49
56	15	Cameron-County-36	5646853.91	17828811.48	81	50	46.79	-1.07	-1.27	-0.20	-2.79	-1.52
57	15	Cameron-County-37	5666011.85	17821908.34	81	50	41.80	-0.78	-0.99	-0.21	-2.31	-1.32
58	15	Cameron-County-38	5684558.75	17823992.26	81	50	35.99	-0.59	-0.97	-0.38	-2.02	-1.05
59	15	Cameron-County-39	5702061.46	17816035.18	81	50	31.53	-0.5	-0.93	-0.43	-1.68	-0.75
60	15	Cameron-County-40	5665629.36	17811499.98	81	50	42.75	-0.88	-0.89	-0.01	-2.29	-1.40
61	15	Cameron-County-41	5712338.30	17811336.52	81	50	28.61	-0.56	-1.00	-0.44	-1.51	-0.51
62	15	Cameron-County-42	5715866.52	17813678.54	81	50	27.90	-0.44	-0.89	-0.45	-1.36	-0.47
63	15	Cameron-County-43	5660119.11	17810197.33	81	50	44.31	-0.98	-0.95	0.03	-2.40	-1.45
64	15	Cameron-County-44	5672162.80	17809173.81	81	50	40.94	-0.91	-0.87	0.04	-2.18	-1.31
65	15	Cameron-County-45	5707042.31	17809208.53	81	50	30.64	-0.76	-1.19	-0.43	-1.76	-0.57
66	15	Cameron-County-46	5643696.24	17807548.12	81	50	48.62	-1.14	-1.13	0.01	-2.53	-1.40
67	15	Cameron-County-47	5695447.20	17804290.68	81	50	34.90	-0.46	-0.84	-0.38	-1.65	-0.81
68	15	Cameron-County-48	5657030.86	17802080.54	81	50	45.39	-0.72	-0.64	0.08	-2.02	-1.38
69	15	Cameron-County-49	5713079.97	17798349.57	81	50	29.71	-0.37	-0.85	-0.48	-1.28	-0.43
70	15	Cameron-County-50	5699882.85	17791660.52	81	50	34.74	-0.79	-1.11	-0.32	-1.73	-0.62
71	15	Cameron-County-51	5738008.55	17790932.94	81	50	24.07	-1.06	-1.52	-0.46	-1.78	-0.26
72	15	Cameron-County-52	5716130.63	17788035.20	81	50	29.91	-0.43	-0.86	-0.43	-1.26	-0.40

Appendix A - Summary of Groundwater Elevation Changes: Individual Strategies and Cumulative for All Strategies

Well Number	Strategy Number	Well Name	X Coordinate (ft)	Y Coordinate (ft)	Well Pumping Rate		2013 Groundwater Elevation (ft MSL)	Change in Groundwater Elevation (ft) from 2013 to 2070 in Model Cell where Well is Located				
					Acre-feet per Year	Gallons per Minute		Baseline	Individual Strategy	Attributable to Individual Strategy (Individual Strategy - Baseline)	All Strategies	Attributable to All Strategies (All Strategies - Individual Strategy)
73	15	Cameron-County-53	5729855.08	17786990.44	81	50	26.49	-0.43	-1.06	-0.63	-1.24	-0.18
74	15	Cameron-County-54	5714499.15	17783140.15	81	50	30.99	-0.42	-0.92	-0.50	-1.24	-0.32
75	15	Cameron-County-55	5727800.09	17782420.29	81	50	27.30	-0.37	-0.98	-0.61	-1.16	-0.18
76	15	Cameron-County-56	5745656.90	17774810.63	81	50	22.79	-0.82	-1.35	-0.53	-1.55	-0.20
77	16	Military-Hwy-1	5657480.74	17805034.50	156	97	45.20	-0.85	-0.97	-0.12	-2.21	-1.24
78	16	Military-Hwy-2	5661468.86	17797656.08	156	97	44.35	-0.46	-0.59	-0.13	-1.71	-1.12
79	16	Military-Hwy-3	5661347.44	17794629.82	156	97	44.32	-0.56	-0.65	-0.09	-1.79	-1.14
80	16	Military-Hwy-4	5664302.12	17793177.95	156	97	43.79	-0.65	-0.79	-0.14	-1.87	-1.08
81	17	San-Benito-1	5695013.89	17834583.84	560	347	31.15	-0.23	-2.06	-1.83	-1.69	0.37
82	17	San-Benito-2	5697653.89	17834583.84	560	347	30.40	-0.34	-2.20	-1.86	-1.82	0.38
83	18	Alamo-2	5539679.13	17843005.55	1,100	682	76.69	-0.86	-0.73	0.13	-4.56	-3.83
84	19	Edcouch-1	5589219.50	17887783.07	500	310	61.38	-2.21	-3.94	-1.73	-8.09	-4.15
85	20	Hidalgo-1	5496355.06	17818318.38	150	93	90.46	-0.66	-0.84	-0.18	-2.44	-1.60
86	20	Hidalgo-2	5496556.86	17817112.08	150	93	90.17	-0.69	-0.87	-0.18	-2.42	-1.55
87	21	Hidalgo-Steam-1	5514821.40	17901851.00	100	62	93.25	2.88	0.76	-2.12	-2.90	-3.66
88	22	Weslaco-1	5583418.76	17839216.84	560	347	63.06	-2.17	-2.44	-0.27	-4.55	-2.11
89	23	Starr-County-5	5427495.78	18044303.43	81	50	207.60	-0.32	-12.29	-11.97	-13.23	-0.94
90	23	Starr-County-3	5298606.89	18027081.21	81	50	311.29	0.1	-1.83	-1.93	-2.19	-0.36
91	23	Starr-County-4	5384440.23	18003192.32	81	50	265.11	-0.52	-24.58	-24.06	-25.35	-0.77
92	23	Starr-County-2	5273051.34	17966247.88	81	50	225.80	-0.57	-2.12	-1.55	-2.27	-0.15
93	23	Starr-County-1	5373329.11	17922636.77	81	50	190.27	-0.03	-23.16	-23.13	-24.03	-0.87

Appendix B

Summary of Subsidence: Individual Strategies and Cumulative for All Strategies

Appendix B – Summary of Subsidence: Individual Strategies and Cumulative for All Strategies

Well Number	Strategy Number	Well Name	X Coordinate (ft)	Y Coordinate (ft)	Well Pumping Rate		Groundwater Elevation Change Attributable to Individual Strategy (ft) 2013 to 2070	Subsidence (ft) in 2070	
					Acre-feet per Year	Gallons per Minute		Low Estimate	High Estimate
1	1	Jardin-1	5777994.48	17745494.03	700	434	-0.17	0.00	0.01
2	2	Feria-1	5635065.11	17834288.86	1,400	868	-0.15	0.00	0.01
3	3	Laguna-Madre-2	5794527.34	17825926.43	1,400	868	0.08	0.00	0.00
4	3	Laguna-Madre-1	5794527.34	17823286.43	1,400	868	-0.12	0.00	0.01
5	4	North-Cameron-1	5649396.77	17872410.06	1,470	911	-2.08	0.02	0.11
6	5	Primera-1	5657998.64	17862490.37	1,400	868	0.52	0.00	0.00
7	6	McAllen-3	5499346.34	17860470.80	1,120	694	-3.5	0.04	0.19
8	6	McAllen-2	5496706.34	17857830.80	1,120	694	-3.2	0.03	0.17
9	6	McAllen-1	5499346.34	17857830.80	1,120	694	-3.37	0.04	0.18
10	7	Mission-3	5474412.78	17862543.48	1,120	694	-1.13	0.01	0.06
11	7	Mission-2	5471772.78	17859903.48	1,120	694	-1.2	0.01	0.07
12	7	Mission-1	5474412.78	17859903.48	1,120	694	-1.27	0.01	0.07
13	8	Alamo-1	5536327.54	17845112.44	1,120	694	-0.83	0.01	0.05
14	9	Sharyland-WTP2-1	5483868.73	17881700.02	1,125	697	-8.14	0.09	0.44
15	10	Sharyland-WTP3-1	5496909.70	17895014.16	1,125	697	-4.67	0.05	0.25
16	11	Union-1	5339007.91	17894782.92	700	434	-90.25	0.98	4.91
17	12	Lyford-1	5645218.28	17931008.59	1,400	868	-2.64	0.03	0.14
18	13	Delta-2	5587659.95	17896889.11	1,400	868	-7.62	0.08	0.41
19	13	Delta-1	5587659.95	17894249.11	1,400	868	-6.36	0.07	0.35
20	14	La-Sara-1	5609340.46	17954869.29	1,400	868	-9.25	0.10	0.50
21	15	Cameron-County-01	5640309.65	17900747.16	81	50	-0.97	0.01	0.05
22	15	Cameron-County-02	5643720.76	17899317.38	81	50	-0.86	0.01	0.05
23	15	Cameron-County-03	5667763.95	17899730.85	81	50	-0.43	0.00	0.02
24	15	Cameron-County-04	5644681.30	17896187.91	81	50	-0.87	0.01	0.05
25	15	Cameron-County-05	5702971.24	17892595.93	81	50	-0.27	0.00	0.01
26	15	Cameron-County-06	5643762.09	17885553.15	81	50	-0.91	0.01	0.05
27	15	Cameron-County-07	5684216.18	17885397.44	81	50	-0.31	0.00	0.02
28	15	Cameron-County-08	5689409.74	17885593.72	81	50	-0.31	0.00	0.02
29	15	Cameron-County-09	5626282.79	17883921.43	81	50	-1.08	0.01	0.06
30	15	Cameron-County-10	5649025.53	17883553.78	81	50	-0.82	0.01	0.04
31	15	Cameron-County-11	5694935.15	17882503.55	81	50	-0.46	0.01	0.03
32	15	Cameron-County-12	5652160.34	17880361.27	81	50	-0.74	0.01	0.04
33	15	Cameron-County-13	5694167.95	17874376.01	81	50	-0.47	0.01	0.03
34	15	Cameron-County-14	5698494.06	17870310.79	81	50	-0.53	0.01	0.03

Appendix B – Summary of Subsidence: Individual Strategies and Cumulative for All Strategies

Well Number	Strategy Number	Well Name	X Coordinate (ft)	Y Coordinate (ft)	Well Pumping Rate		Groundwater Elevation Change Attributable to Individual Strategy (ft) 2013 to 2070	Subsidence (ft) in 2070	
					Acre-feet per Year	Gallons per Minute		Low Estimate	High Estimate
35	15	Cameron-County-15	5725130.00	17869546.09	81	50	-0.52	0.01	0.03
36	15	Cameron-County-16	5642659.40	17867992.07	81	50	-0.71	0.01	0.04
37	15	Cameron-County-17	5681782.54	17867916.28	81	50	-0.46	0.01	0.03
38	15	Cameron-County-18	5628110.45	17866097.86	81	50	-0.8	0.01	0.04
39	15	Cameron-County-19	5633792.01	17865758.51	81	50	-0.78	0.01	0.04
40	15	Cameron-County-20	5720532.72	17865032.00	81	50	-0.5	0.01	0.03
41	15	Cameron-County-21	5729311.21	17866405.66	81	50	-0.47	0.01	0.03
42	15	Cameron-County-22	5642294.94	17860014.79	81	50	-0.54	0.01	0.03
43	15	Cameron-County-23	5648227.30	17857513.59	81	50	-0.47	0.01	0.03
44	15	Cameron-County-24	5667370.05	17855471.01	81	50	-0.39	0.00	0.02
45	15	Cameron-County-25	5729395.25	17853762.61	81	50	-0.42	0.00	0.02
46	15	Cameron-County-26	5699773.98	17848056.28	81	50	-0.54	0.01	0.03
47	15	Cameron-County-27	5723765.75	17844598.28	81	50	-0.5	0.01	0.03
48	15	Cameron-County-28	5689496.90	17841951.09	81	50	-0.42	0.00	0.02
49	15	Cameron-County-29	5680296.56	17837945.08	81	50	-0.32	0.00	0.02
50	15	Cameron-County-30	5687097.34	17837548.23	81	50	-0.42	0.00	0.02
51	15	Cameron-County-31	5682757.67	17835067.06	81	50	-0.39	0.00	0.02
52	15	Cameron-County-32	5683631.94	17832558.81	81	50	-0.34	0.00	0.02
53	15	Cameron-County-33	5708604.68	17834744.59	81	50	-0.51	0.01	0.03
54	15	Cameron-County-34	5697701.39	17830927.11	81	50	-0.35	0.00	0.02
55	15	Cameron-County-35	5728539.98	17830597.54	81	50	-0.4	0.00	0.02
56	15	Cameron-County-36	5646853.91	17828811.48	81	50	-0.2	0.00	0.01
57	15	Cameron-County-37	5666011.85	17821908.34	81	50	-0.21	0.00	0.01
58	15	Cameron-County-38	5684558.75	17823992.26	81	50	-0.38	0.00	0.02
59	15	Cameron-County-39	5702061.46	17816035.18	81	50	-0.43	0.00	0.02
60	15	Cameron-County-40	5665629.36	17811499.98	81	50	-0.01	0.00	0.00
61	15	Cameron-County-41	5712338.30	17811336.52	81	50	-0.44	0.00	0.02
62	15	Cameron-County-42	5715866.52	17813678.54	81	50	-0.45	0.00	0.02
63	15	Cameron-County-43	5660119.11	17810197.33	81	50	0.03	0.00	0.00
64	15	Cameron-County-44	5672162.80	17809173.81	81	50	0.04	0.00	0.00
65	15	Cameron-County-45	5707042.31	17809208.53	81	50	-0.43	0.00	0.02
66	15	Cameron-County-46	5643696.24	17807548.12	81	50	0.01	0.00	0.00
67	15	Cameron-County-47	5695447.20	17804290.68	81	50	-0.38	0.00	0.02
68	15	Cameron-County-48	5657030.86	17802080.54	81	50	0.08	0.00	0.00

Appendix B – Summary of Subsidence: Individual Strategies and Cumulative for All Strategies

Well Number	Strategy Number	Well Name	X Coordinate (ft)	Y Coordinate (ft)	Well Pumping Rate		Groundwater Elevation Change Attributable to Individual Strategy (ft) 2013 to 2070	Subsidence (ft) in 2070	
					Acre-feet per Year	Gallons per Minute		Low Estimate	High Estimate
69	15	Cameron-County-49	5713079.97	17798349.57	81	50	-0.48	0.01	0.03
70	15	Cameron-County-50	5699882.85	17791660.52	81	50	-0.32	0.00	0.02
71	15	Cameron-County-51	5738008.55	17790932.94	81	50	-0.46	0.01	0.03
72	15	Cameron-County-52	5716130.63	17788035.20	81	50	-0.43	0.00	0.02
73	15	Cameron-County-53	5729855.08	17786990.44	81	50	-0.63	0.01	0.03
74	15	Cameron-County-54	5714499.15	17783140.15	81	50	-0.5	0.01	0.03
75	15	Cameron-County-55	5727800.09	17782420.29	81	50	-0.61	0.01	0.03
76	15	Cameron-County-56	5745656.90	17774810.63	81	50	-0.53	0.01	0.03
77	16	Military-Hwy-1	5657480.74	17805034.50	156	97	-0.12	0.00	0.01
78	16	Military-Hwy-2	5661468.86	17797656.08	156	97	-0.13	0.00	0.01
79	16	Military-Hwy-3	5661347.44	17794629.82	156	97	-0.09	0.00	0.00
80	16	Military-Hwy-4	5664302.12	17793177.95	156	97	-0.14	0.00	0.01
81	17	San-Benito-1	5695013.89	17834583.84	560	347	-1.83	0.02	0.10
82	17	San-Benito-2	5697653.89	17834583.84	560	347	-1.86	0.02	0.10
83	18	Alamo-2	5539679.13	17843005.55	1,100	682	0.13	0.00	0.00
84	19	Edcouch-1	5589219.50	17887783.07	500	310	-1.73	0.02	0.09
85	20	Hidalgo-1	5496355.06	17818318.38	150	93	-0.18	0.00	0.01
86	20	Hidalgo-2	5496556.86	17817112.08	150	93	-0.18	0.00	0.01
87	21	Hidalgo-Steam-1	5514821.40	17901851.00	100	62	-2.12	0.02	0.12
88	22	Weslaco-1	5583418.76	17839216.84	560	347	-0.27	0.00	0.01
89	23	Starr-County-5	5427495.78	18044303.43	81	50	-11.97	0.13	0.65
90	23	Starr-County-3	5298606.89	18027081.21	81	50	-1.93	0.02	0.10
91	23	Starr-County-4	5384440.23	18003192.32	81	50	-24.06	0.26	1.31
92	23	Starr-County-2	5273051.34	17966247.88	81	50	-1.55	0.02	0.08
93	23	Starr-County-1	5373329.11	17922636.77	81	50	-23.13	0.25	1.26

Appendix C

Summary of Total Dissolved Solids Changes: Individual Strategies and Cumulative for All Strategies

Appendix C – Summary of Total Dissolved Solids Changes: Individual Strategies and Cumulative for All Strategies

Well Number	Strategy Number	Well Name	X Coordinate (ft)	Y Coordinate (ft)	Well Pumping Rate		2013 Total Dissolved Solids (mg/l)	Change in Total Dissolved Solids (%)				
					Acre-feet per Year	Gallons per Minute		Baseline	Individual Strategy	Attributable to Individual Strategy (Individual Strategy - Baseline)	All Strategies	Attributable to All Strategies (All Strategies - Individual Strategy)
1	1	Jardin-1	5777994.48	17745494.03	700	434	38,891	-18.85	-20.47	-1.62	-21.05	-0.58
2	2	Feria-1	5635065.11	17834288.86	1,400	868	9,704	-16.38	-27.08	-10.70	-27.24	-0.16
3	3	Laguna-Madre-2	5794527.34	17825926.43	1,400	868	33,400	4.4	4.03	-0.37	4.17	0.14
4	3	Laguna-Madre-1	5794527.34	17823286.43	1,400	868	34,460	3.34	3.89	0.55	4.04	0.15
5	4	North-Cameron-1	5649396.77	17872410.06	1,470	911	9,014	-16.7	-19.30	-2.60	-20.60	-1.30
6	5	Primera-1	5657998.64	17862490.37	1,400	868	14,955	-19.62	-29.77	-10.15	-28.68	1.09
7	6	McAllen-3	5499346.34	17860470.80	1,120	694	2,821	9.15	10.94	1.79	11.80	0.86
8	6	McAllen-2	5496706.34	17857830.80	1,120	694	2,857	9.16	10.96	1.80	11.58	0.62
9	6	McAllen-1	5499346.34	17857830.80	1,120	694	2,865	9.97	12.10	2.13	12.61	0.51
10	7	Mission-3	5474412.78	17862543.48	1,120	694	6,912	-2.29	-3.57	-1.28	-0.16	3.41
11	7	Mission-2	5471772.78	17859903.48	1,120	694	6,961	-1.24	-2.87	-1.63	-0.59	2.28
12	7	Mission-1	5474412.78	17859903.48	1,120	694	7,049	-1.29	-3.34	-2.05	0.35	3.69
13	8	Alamo-1	5536327.54	17845112.44	1,120	694	3,844	-12.88	-13.41	-0.53	-12.72	0.69
14	9	Sharyland-WTP2-1	5483868.73	17881700.02	1,125	697	4,806	-6.59	19.77	26.36	20.46	0.69
15	10	Sharyland-WTP3-1	5496909.70	17895014.16	1,125	697	4,017	-20.92	-11.57	9.35	-9.34	2.23
16	11	Union-1	5339007.91	17894782.92	700	434	22,567	0.65	6.59	5.94	6.57	-0.02
17	12	Lyford-1	5645218.28	17931008.59	1,400	868	8,996	-20.41	-22.32	-1.91	-21.57	0.75
18	13	Delta-2	5587659.95	17896889.11	1,400	868	5,329	-5.3	-2.47	2.83	-2.76	-0.29
19	13	Delta-1	5587659.95	17894249.11	1,400	868	5,099	1.75	4.07	2.32	4.46	0.39
20	14	La-Sara-1	5609340.46	17954869.29	1,400	868	12,747	-33.88	-39.12	-5.24	-35.81	3.31
21	15	Cameron-County-01	5640309.65	17900747.16	81	50	6,390	-11.95	-10.31	1.64	-11.74	-1.43
22	15	Cameron-County-02	5643720.76	17899317.38	81	50	6,351	-8.29	-7.78	0.51	-8.35	-0.57
23	15	Cameron-County-03	5667763.95	17899730.85	81	50	7,025	1.59	2.20	0.61	2.09	-0.11
24	15	Cameron-County-04	5644681.30	17896187.91	81	50	6,220	-9.32	-8.88	0.44	-9.43	-0.55
25	15	Cameron-County-05	5702971.24	17892595.93	81	50	20,514	-6.85	-4.28	2.57	-4.44	-0.16
26	15	Cameron-County-06	5643762.09	17885553.15	81	50	5,675	-14.19	-12.51	1.68	-14.18	-1.67
27	15	Cameron-County-07	5684216.18	17885397.44	81	50	14,003	-3.51	-2.45	1.06	-2.21	0.24
28	15	Cameron-County-08	5689409.74	17885593.72	81	50	16,070	-5.02	-2.86	2.16	-2.68	0.18
29	15	Cameron-County-09	5626282.79	17883921.43	81	50	5,906	-15.41	-11.97	3.44	-15.29	-3.32
30	15	Cameron-County-10	5649025.53	17883553.78	81	50	5,876	-11.19	-9.61	1.58	-11.46	-1.85
31	15	Cameron-County-11	5694935.15	17882503.55	81	50	15,081	-0.89	0.86	1.75	0.74	-0.12
32	15	Cameron-County-12	5652160.34	17880361.27	81	50	6,667	-12.32	-11.58	0.74	-12.83	-1.25
33	15	Cameron-County-13	5694167.95	17874376.01	81	50	16,845	-5.78	-5.14	0.64	-5.25	-0.11
34	15	Cameron-County-14	5698494.06	17870310.79	81	50	18,521	-8.37	-6.47	1.90	-7.45	-0.98
35	15	Cameron-County-15	5725130.00	17869546.09	81	50	22,568	3.77	6.33	2.56	4.17	-2.16
36	15	Cameron-County-16	5642659.40	17867992.07	81	50	6,141	-10.62	-13.10	-2.48	-13.01	0.09
37	15	Cameron-County-17	5681782.54	17867916.28	81	50	12,759	-3.05	-2.60	0.45	-1.50	1.10
38	15	Cameron-County-18	5628110.45	17866097.86	81	50	5,319	-0.11	1.94	2.05	0.36	-1.58
39	15	Cameron-County-19	5633792.01	17865758.51	81	50	5,519	-6.13	-7.23	-1.10	-8.10	-0.87

Appendix C – Summary of Total Dissolved Solids Changes: Individual Strategies and Cumulative for All Strategies

Well Number	Strategy Number	Well Name	X Coordinate (ft)	Y Coordinate (ft)	Well Pumping Rate		2013 Total Dissolved Solids (mg/l)	Change in Total Dissolved Solids (%)				
					Acre-feet per Year	Gallons per Minute		Baseline	Individual Strategy	Attributable to Individual Strategy (Individual Strategy - Baseline)	All Strategies	Attributable to All Strategies (All Strategies - Individual Strategy)
40	15	Cameron-County-20	5720532.72	17865032.00	81	50	24,199	-2.97	-1.85	1.12	-2.47	-0.62
41	15	Cameron-County-21	5729311.21	17866405.66	81	50	23,774	3.26	4.96	1.70	3.37	-1.59
42	15	Cameron-County-22	5642294.94	17860014.79	81	50	6,819	-8.58	-10.62	-2.04	-10.27	0.35
43	15	Cameron-County-23	5648227.30	17857513.59	81	50	8,301	-14.57	-21.52	-6.95	-20.75	0.77
44	15	Cameron-County-24	5667370.05	17855471.01	81	50	9,626	-2.05	-1.96	0.09	-1.91	0.05
45	15	Cameron-County-25	5729395.25	17853762.61	81	50	24,314	-0.93	-0.71	0.22	-1.12	-0.41
46	15	Cameron-County-26	5699773.98	17848056.28	81	50	18,724	-7.17	-5.20	1.97	-5.01	0.19
47	15	Cameron-County-27	5723765.75	17844598.28	81	50	24,010	-6.81	-3.77	3.04	-5.25	-1.48
48	15	Cameron-County-28	5689496.90	17841951.09	81	50	13,872	-4.29	-2.68	1.61	-4.04	-1.36
49	15	Cameron-County-29	5680296.56	17837945.08	81	50	9,981	11.13	12.92	1.79	10.34	-2.58
50	15	Cameron-County-30	5687097.34	17837548.23	81	50	12,355	-4.3	-1.92	2.38	-4.02	-2.10
51	15	Cameron-County-31	5682757.67	17835067.06	81	50	10,095	1.96	7.05	5.09	2.02	-5.03
52	15	Cameron-County-32	5683631.94	17832558.81	81	50	10,234	0.22	0.73	0.51	0.12	-0.61
53	15	Cameron-County-33	5708604.68	17834744.59	81	50	17,054	0.83	2.92	2.09	2.24	-0.68
54	15	Cameron-County-34	5697701.39	17830927.11	81	50	13,390	12.25	11.64	-0.61	9.96	-1.68
55	15	Cameron-County-35	5728539.98	17830597.54	81	50	22,011	-8.82	-8.42	0.40	-8.70	-0.28
56	15	Cameron-County-36	5646853.91	17828811.48	81	50	3,456	21.46	22.17	0.71	21.76	-0.41
57	15	Cameron-County-37	5666011.85	17821908.34	81	50	5,230	12.61	23.18	10.57	14.47	-8.71
58	15	Cameron-County-38	5684558.75	17823992.26	81	50	8,547	24.65	25.27	0.62	23.62	-1.65
59	15	Cameron-County-39	5702061.46	17816035.18	81	50	12,206	14.64	14.65	0.01	18.00	3.35
60	15	Cameron-County-40	5665629.36	17811499.98	81	50	4,921	10.8	11.55	0.75	12.05	0.50
61	15	Cameron-County-41	5712338.30	17811336.52	81	50	14,584	10.37	11.49	1.12	8.84	-2.65
62	15	Cameron-County-42	5715866.52	17813678.54	81	50	15,102	6.27	7.87	1.60	4.84	-3.03
63	15	Cameron-County-43	5660119.11	17810197.33	81	50	4,445	10.01	9.35	-0.66	9.39	0.04
64	15	Cameron-County-44	5672162.80	17809173.81	81	50	5,603	18.24	12.13	-6.11	13.28	1.15
65	15	Cameron-County-45	5707042.31	17809208.53	81	50	12,785	17.59	18.87	1.28	18.23	-0.64
66	15	Cameron-County-46	5643696.24	17807548.12	81	50	3,595	-2.12	-4.36	-2.24	-5.85	-1.49
67	15	Cameron-County-47	5695447.20	17804290.68	81	50	8,638	8.7	9.08	0.38	10.96	1.88
68	15	Cameron-County-48	5657030.86	17802080.54	81	50	4,375	-23.88	-28.38	-4.50	-27.93	0.45
69	15	Cameron-County-49	5713079.97	17798349.57	81	50	13,491	3.51	5.23	1.72	3.16	-2.07
70	15	Cameron-County-50	5699882.85	17791660.52	81	50	8,285	20.15	24.04	3.89	19.69	-4.35
71	15	Cameron-County-51	5738008.55	17790932.94	81	50	16,855	21.07	22.22	1.15	21.30	-0.92
72	15	Cameron-County-52	5716130.63	17788035.20	81	50	12,870	4.05	3.55	-0.50	3.70	0.15
73	15	Cameron-County-53	5729855.08	17786990.44	81	50	15,507	7.78	11.52	3.74	9.23	-2.29
74	15	Cameron-County-54	5714499.15	17783140.15	81	50	12,160	4.14	5.13	0.99	3.96	-1.17
75	15	Cameron-County-55	5727800.09	17782420.29	81	50	14,998	5.65	8.01	2.36	6.44	-1.57
76	15	Cameron-County-56	5745656.90	17774810.63	81	50	19,045	11.58	15.39	3.81	14.25	-1.14
77	16	Military-Hwy-1	5657480.74	17805034.50	156	97	4,457	-11.66	-10.21	1.45	-13.48	-3.27
78	16	Military-Hwy-2	5661468.86	17797656.08	156	97	4,884	-32.18	-31.99	0.19	-33.91	-1.92

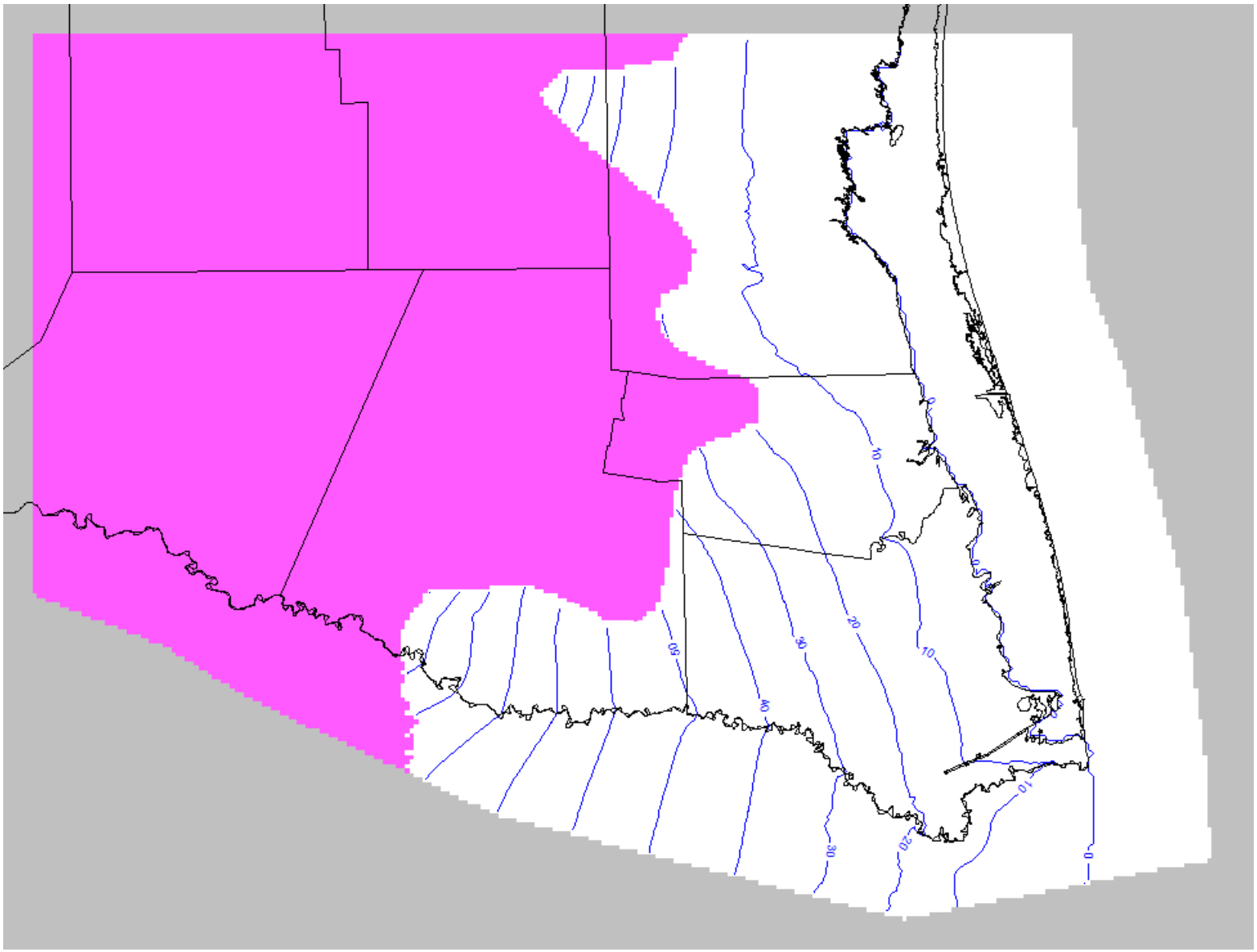
Appendix C – Summary of Total Dissolved Solids Changes: Individual Strategies and Cumulative for All Strategies

Well Number	Strategy Number	Well Name	X Coordinate (ft)	Y Coordinate (ft)	Well Pumping Rate		2013 Total Dissolved Solids (mg/l)	Change in Total Dissolved Solids (%)				
					Acre-feet per Year	Gallons per Minute		Baseline	Individual Strategy	Attributable to Individual Strategy (Individual Strategy - Baseline)	All Strategies	Attributable to All Strategies (All Strategies - Individual Strategy)
79	16	Military-Hwy-3	5661347.44	17794629.82	156	97	4,641	-35.33	-29.90	5.43	-35.78	-5.88
80	16	Military-Hwy-4	5664302.12	17793177.95	156	97	3,925	-27.23	-26.54	0.69	-32.48	-5.94
81	17	San-Benito-1	5695013.89	17834583.84	560	347	13,866	5.88	9.35	3.47	7.41	-1.94
82	17	San-Benito-2	5697653.89	17834583.84	560	347	14,588	7.33	10.22	2.89	7.97	-2.25
83	18	Alamo-2	5539679.13	17843005.55	1,100	682	2,990	-19.22	-22.72	-3.50	-21.41	1.31
84	19	Edcouch-1	5589219.50	17887783.07	500	310	4,648	14.72	14.55	-0.17	12.85	-1.70
85	20	Hidalgo-1	5496355.06	17818318.38	150	93	1,854	-12.98	-14.16	-1.18	-31.11	-16.95
86	20	Hidalgo-2	5496556.86	17817112.08	150	93	1,864	-15.72	-18.91	-3.19	-31.74	-12.83
87	21	Hidalgo-Steam-1	5514821.40	17901851.00	100	62	6,174	-1.08	-4.85	-3.77	-4.91	-0.06
88	22	Weslaco-1	5583418.76	17839216.84	560	347	2,506	13.38	13.44	0.06	11.09	-2.35
89	23	Starr-County-5	5427495.78	18044303.43	81	50	2,054	-6.04	-7.22	-1.18	-7.26	-0.04
90	23	Starr-County-3	5298606.89	18027081.21	81	50	5,236	1.2	2.21	1.01	2.23	0.02
91	23	Starr-County-4	5384440.23	18003192.32	81	50	1,494	-0.37	50.22	50.59	50.28	0.06
92	23	Starr-County-2	5273051.34	17966247.88	81	50	6,828	8.26	17.91	9.65	17.28	-0.63
93	23	Starr-County-1	5373329.11	17922636.77	81	50	11,309	2.29	6.23	3.94	6.02	-0.21

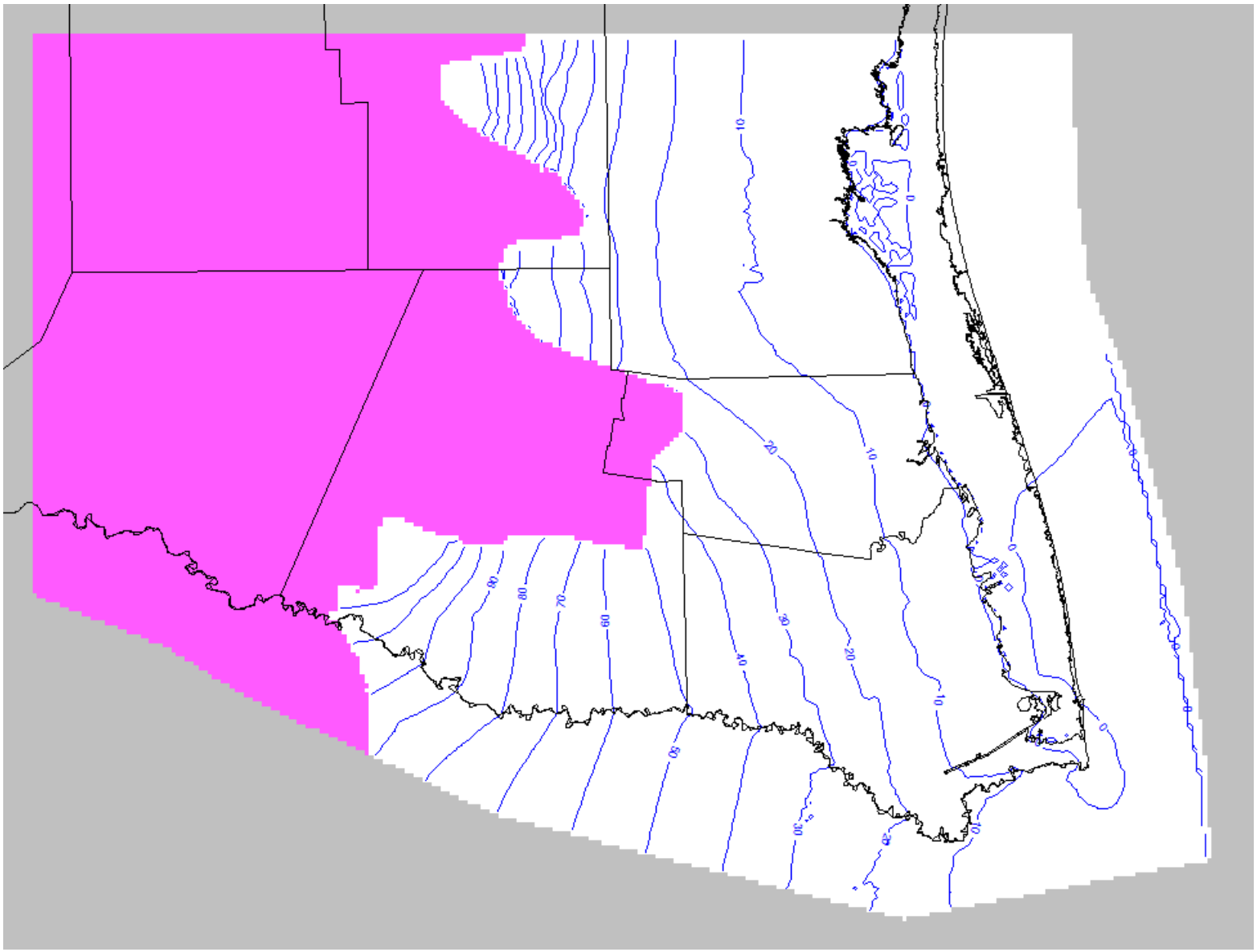
Appendix D

Example Contour Maps of Groundwater Elevation and Total Dissolved Solids

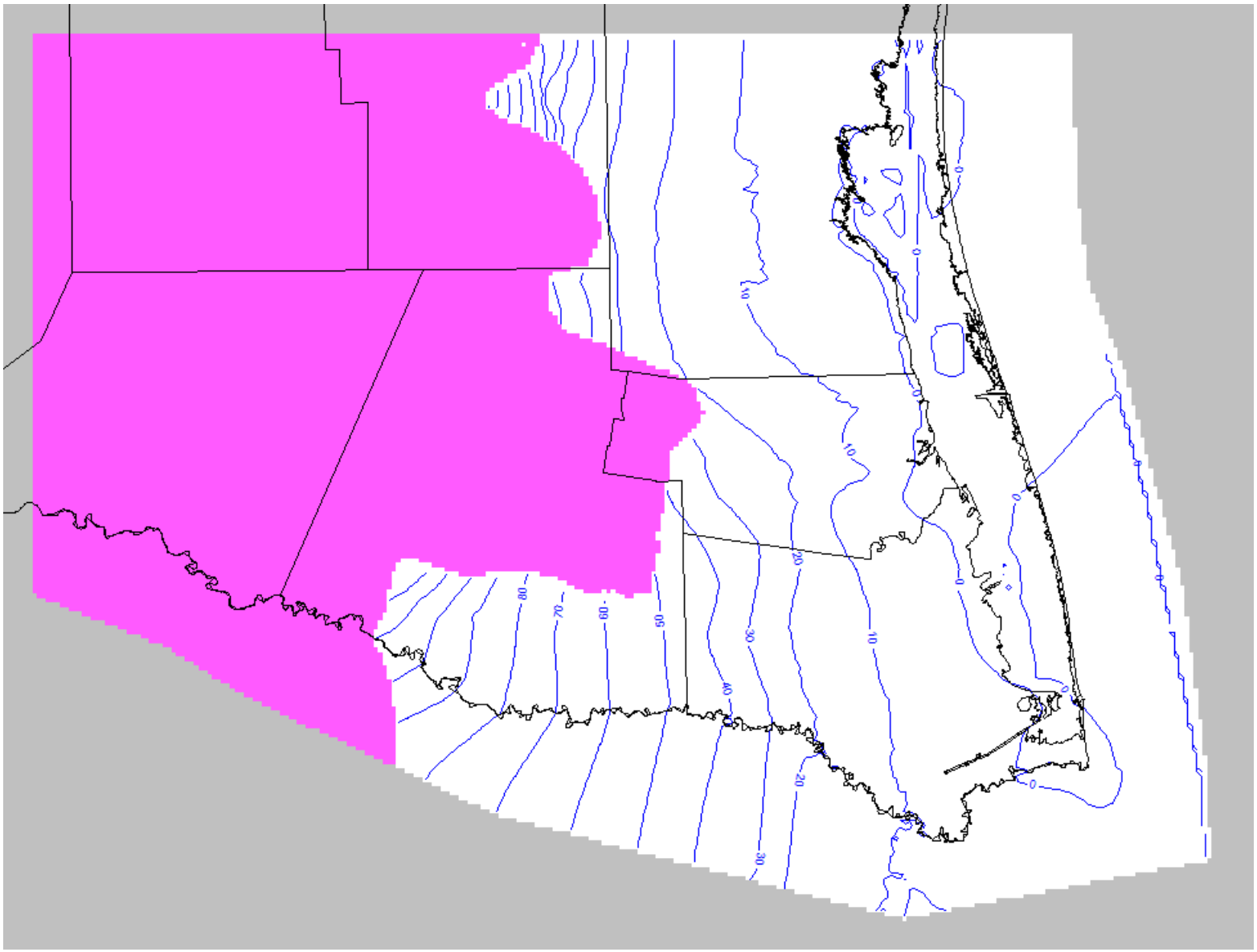
Contours of Groundwater Elevations (ft MSL) - All Strategy Scenario – Model Layer 1 (Beaumont)



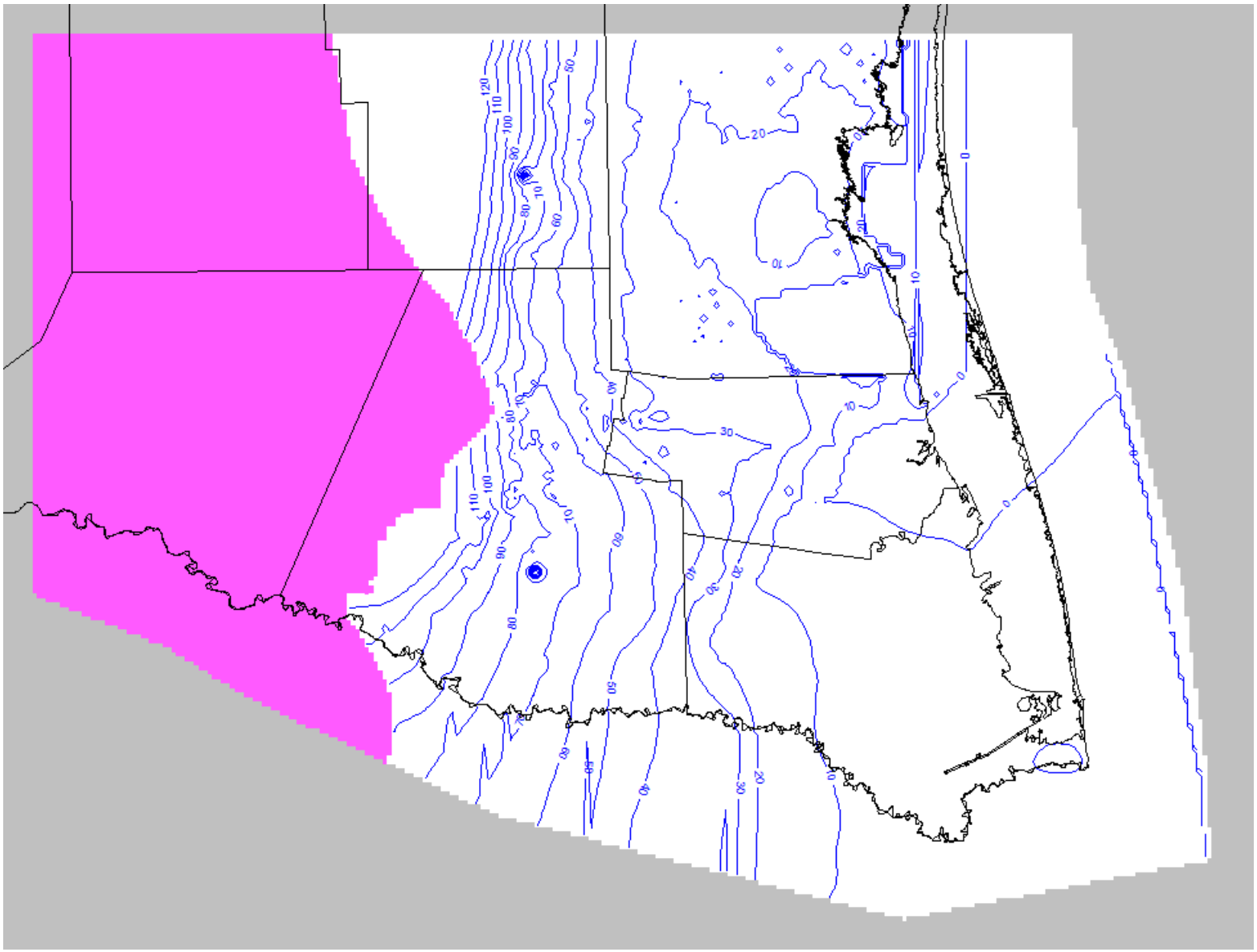
Contours of Groundwater Elevations (ft MSL) - All Strategy Scenario – Model Layer 2 (Lissie)



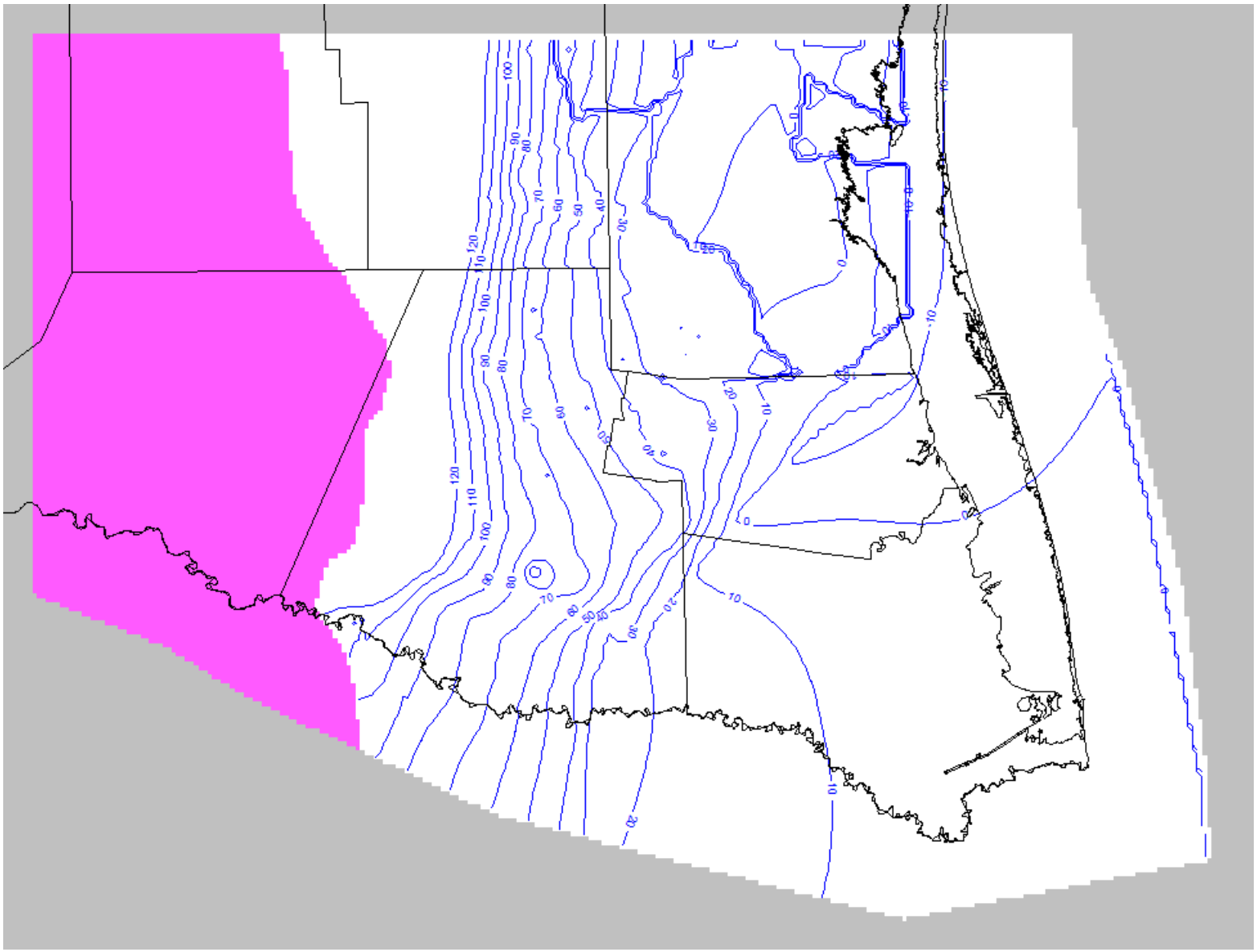
Contours of Groundwater Elevations (ft MSL) - All Strategy Scenario – Model Layer 3 (Willis)



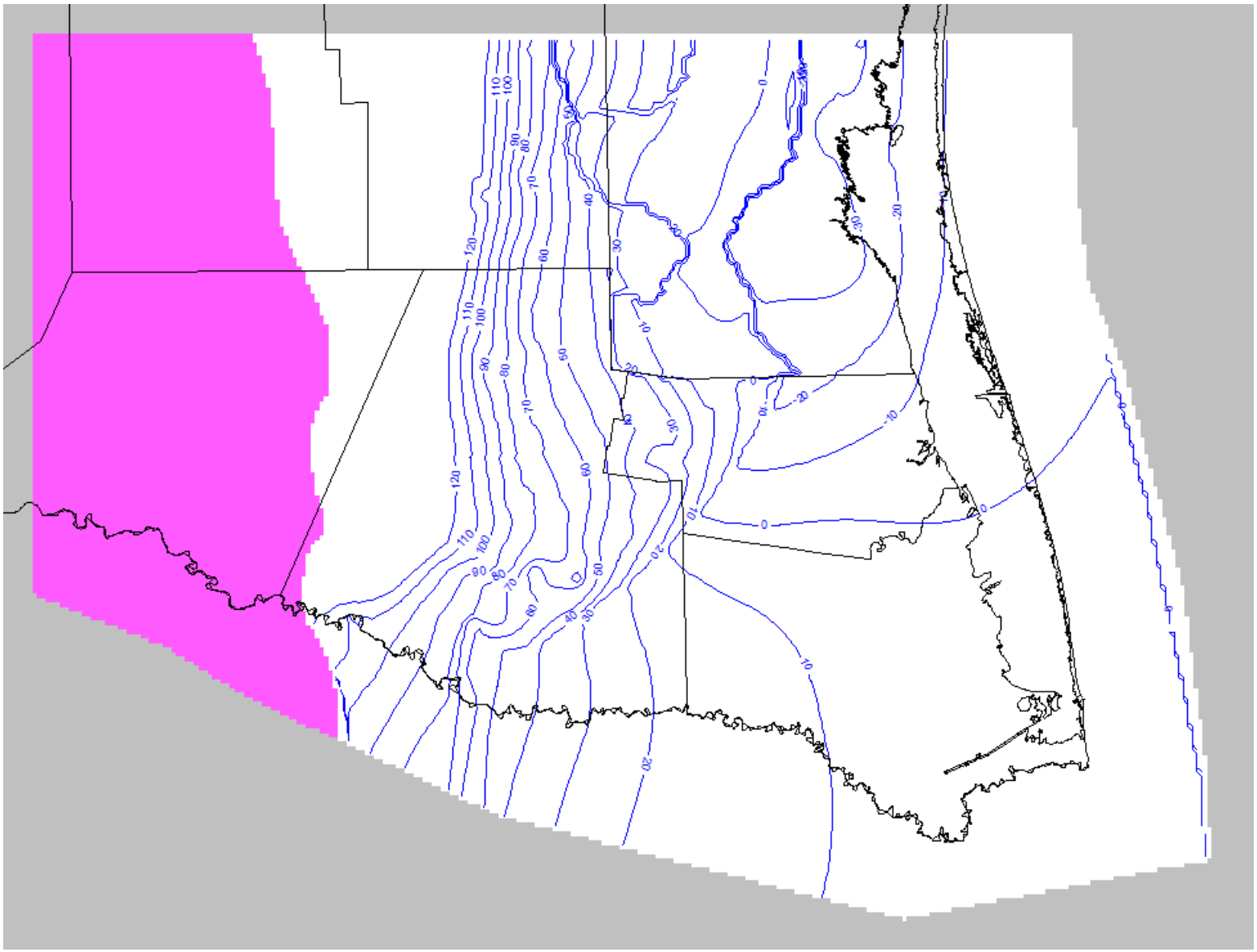
Contours of Groundwater Elevations (ft MSL) - All Strategy Scenario – Model Layer 4 (Upper Goliad)



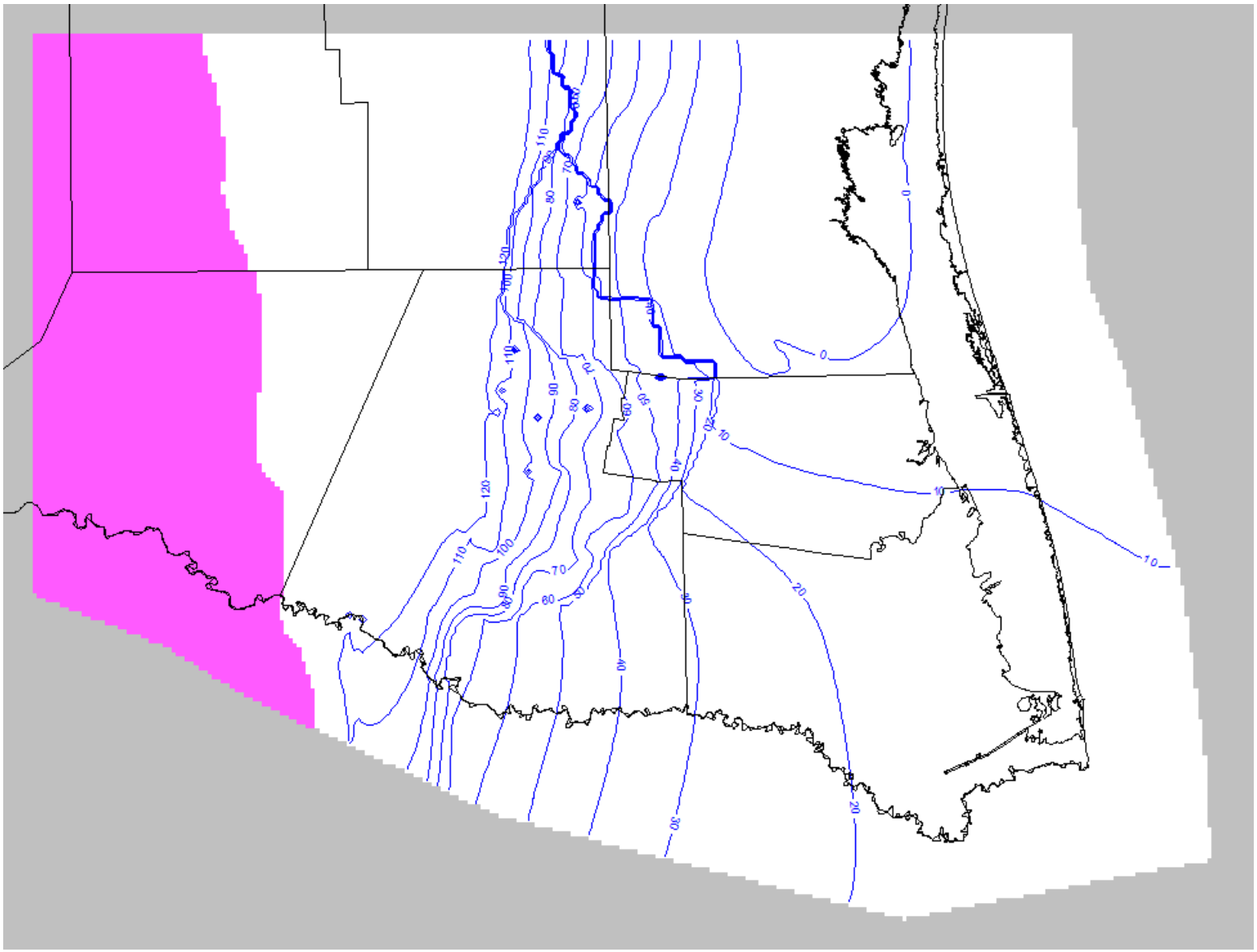
Contours of Groundwater Elevations (ft MSL) - All Strategy Scenario – Model Layer 5 (Lower Goliad)



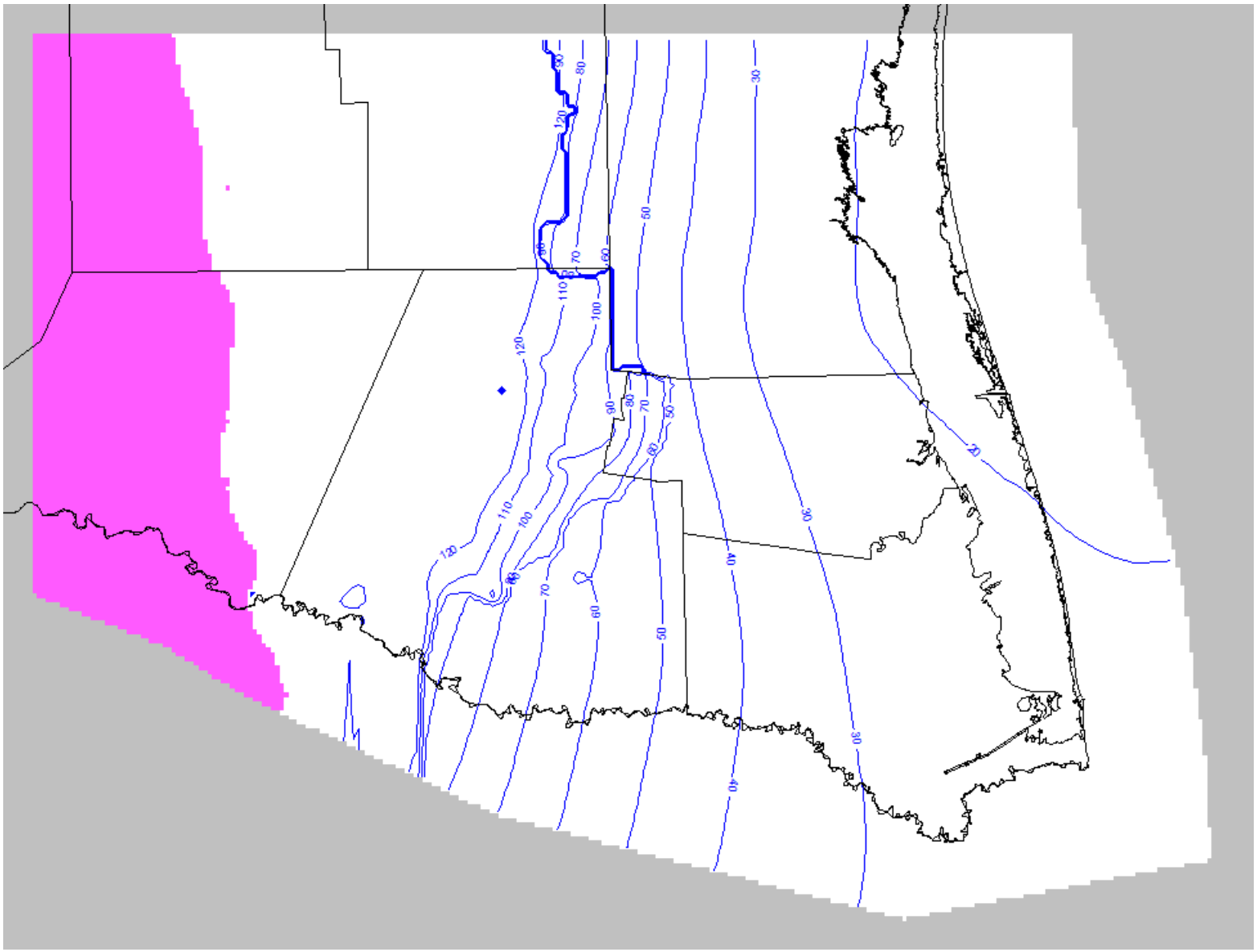
Contours of Groundwater Elevations (ft MSL) - All Strategy Scenario – Model Layer 6 (Upper Lagarto)



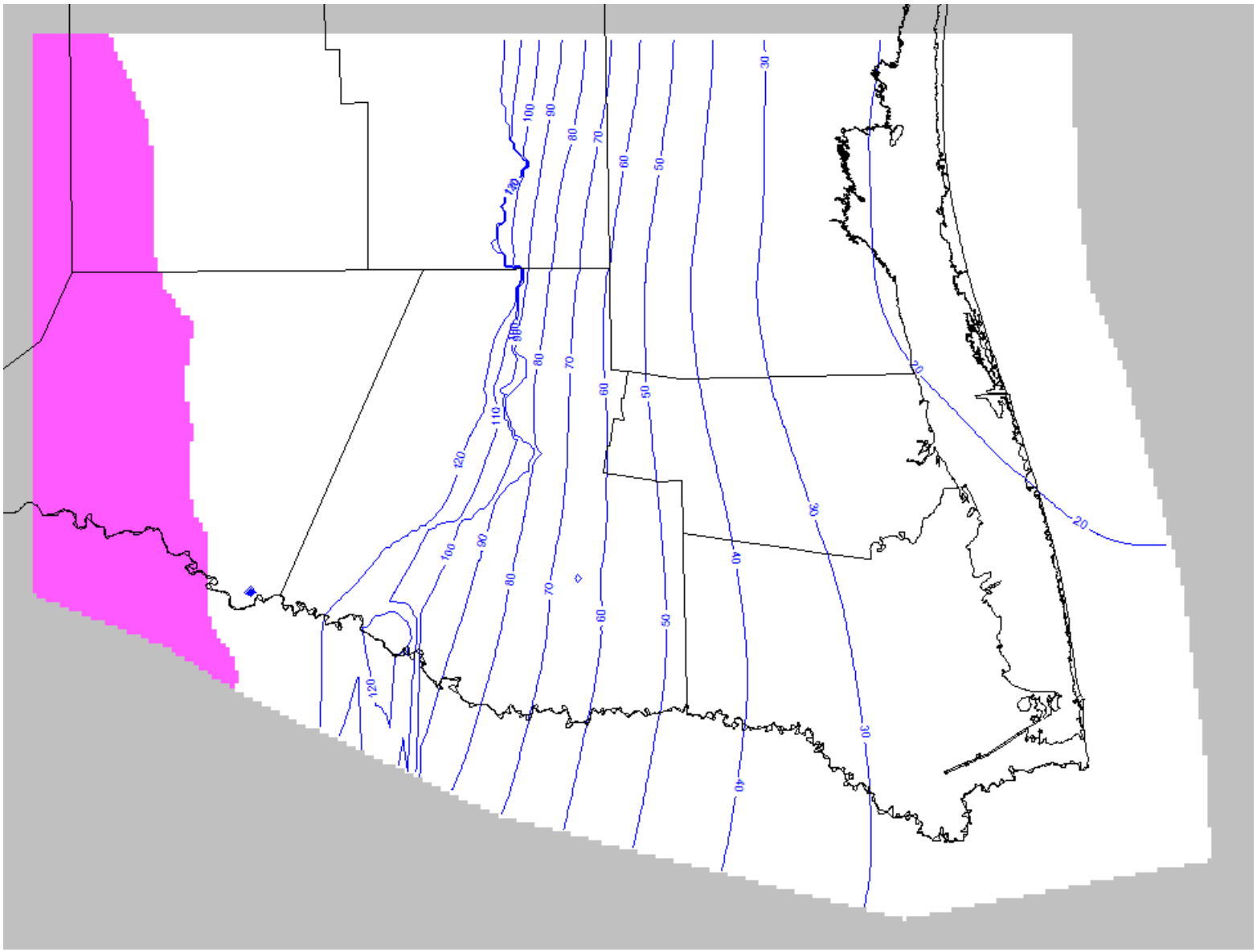
Contours of Groundwater Elevations (ft MSL) - All Strategy Scenario – Model Layer 7 (Middle Lagarto)



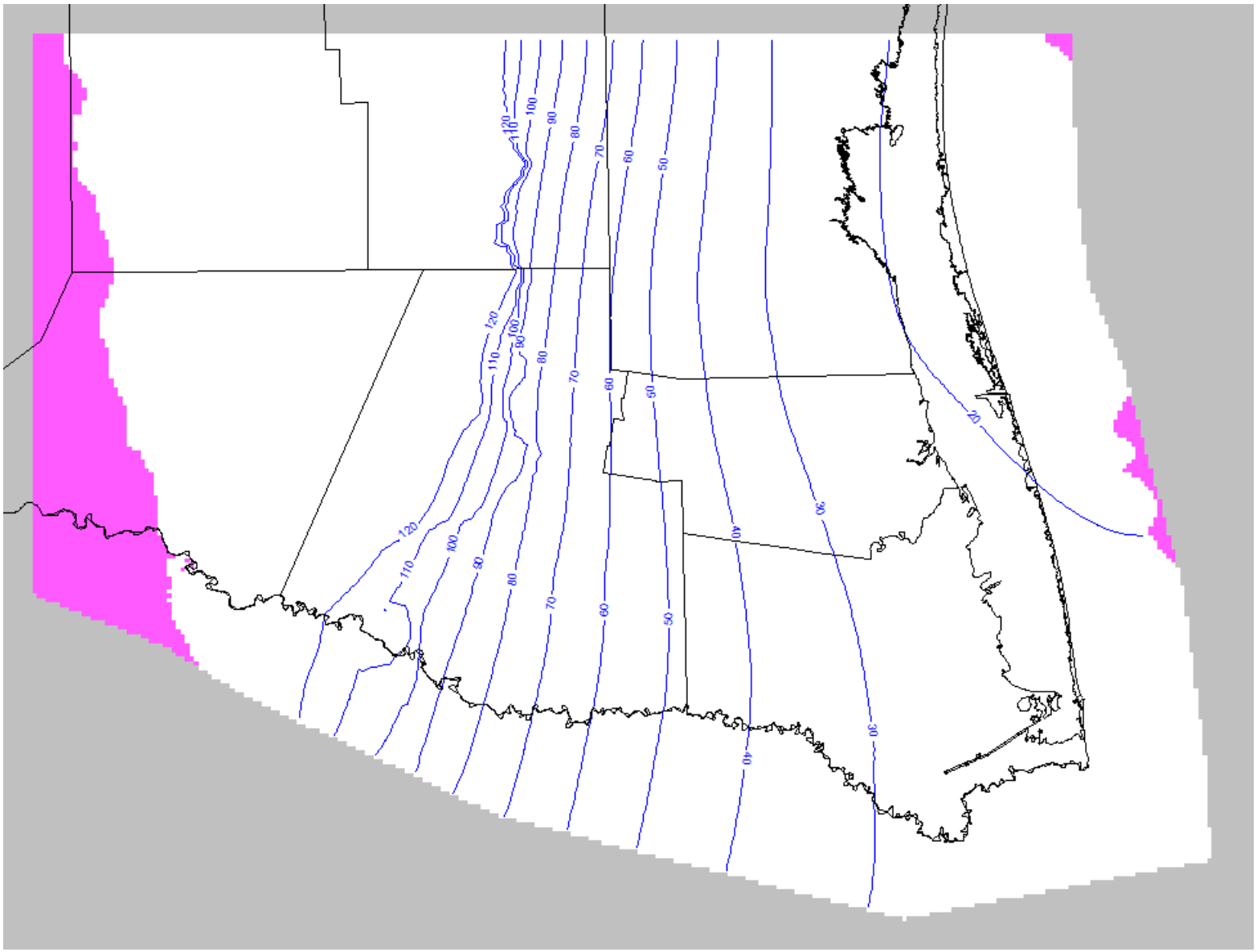
Contours of Groundwater Elevations (ft MSL) - All Strategy Scenario – Model Layer 8 (Lower Lagarto)



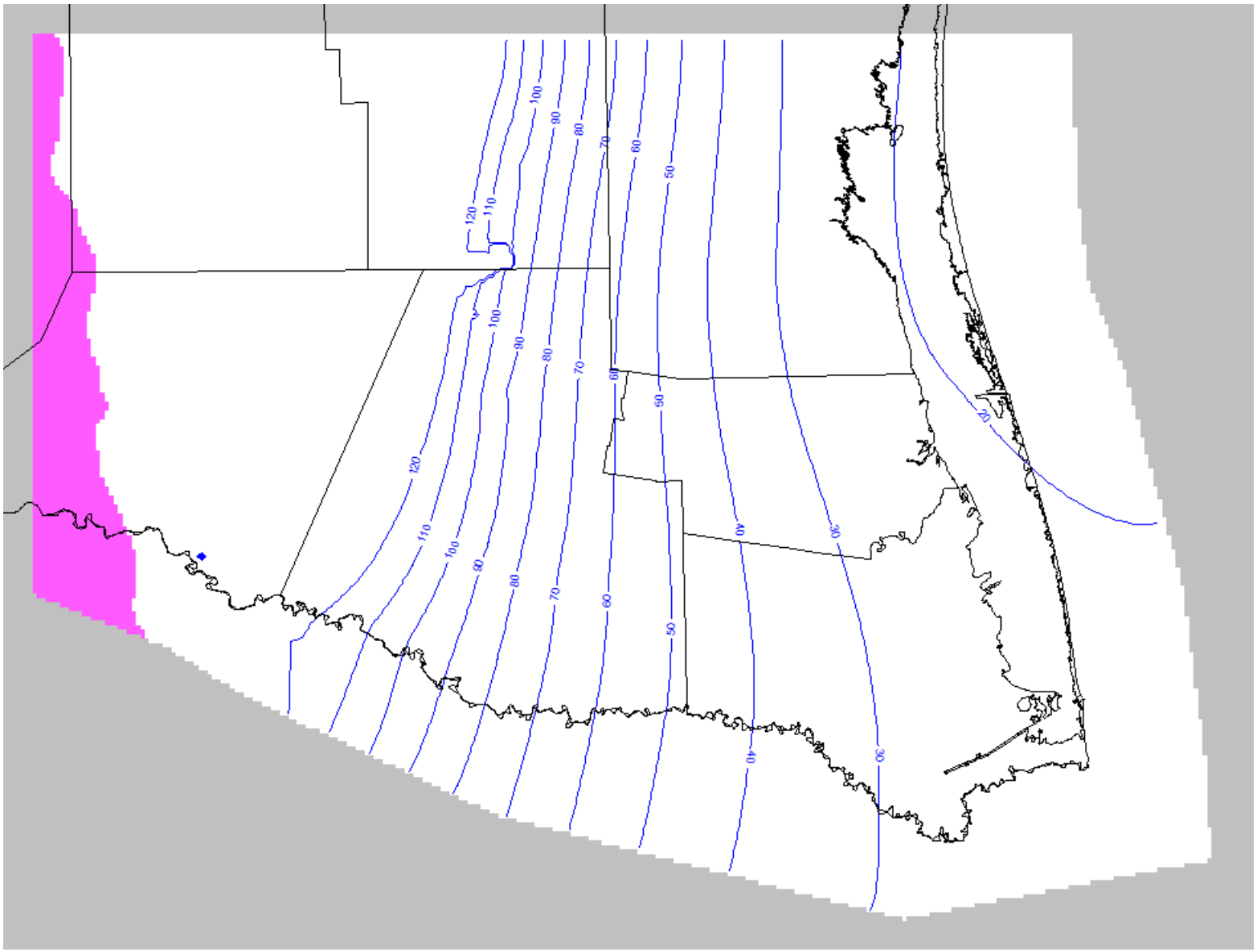
Contours of Groundwater Elevations (ft MSL) - All Strategy Scenario – Model Layer 9 (Oakville)



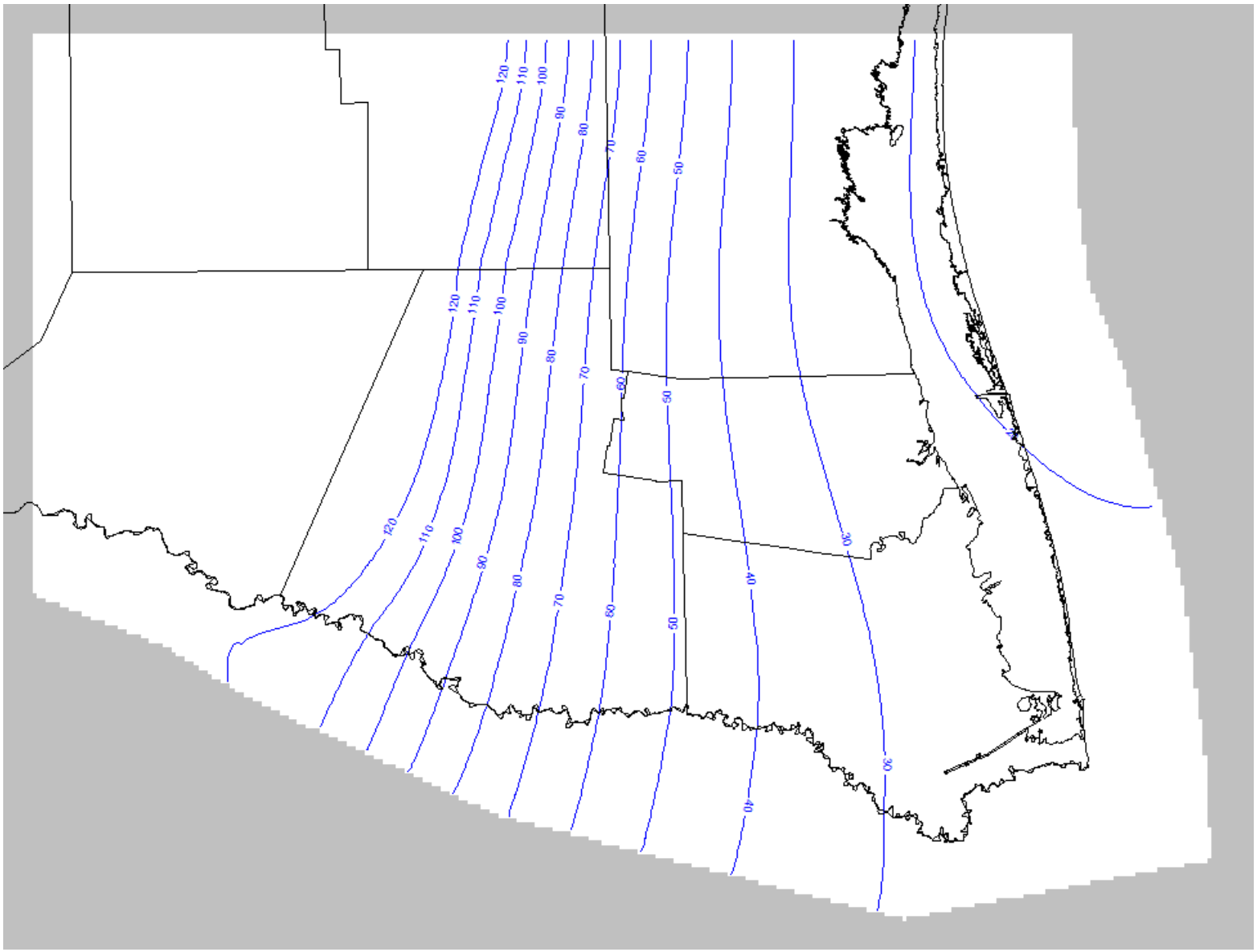
Contours of Groundwater Elevations (ft MSL) - All Strategy Scenario – Model Layer 10 (Upper Catahoula)



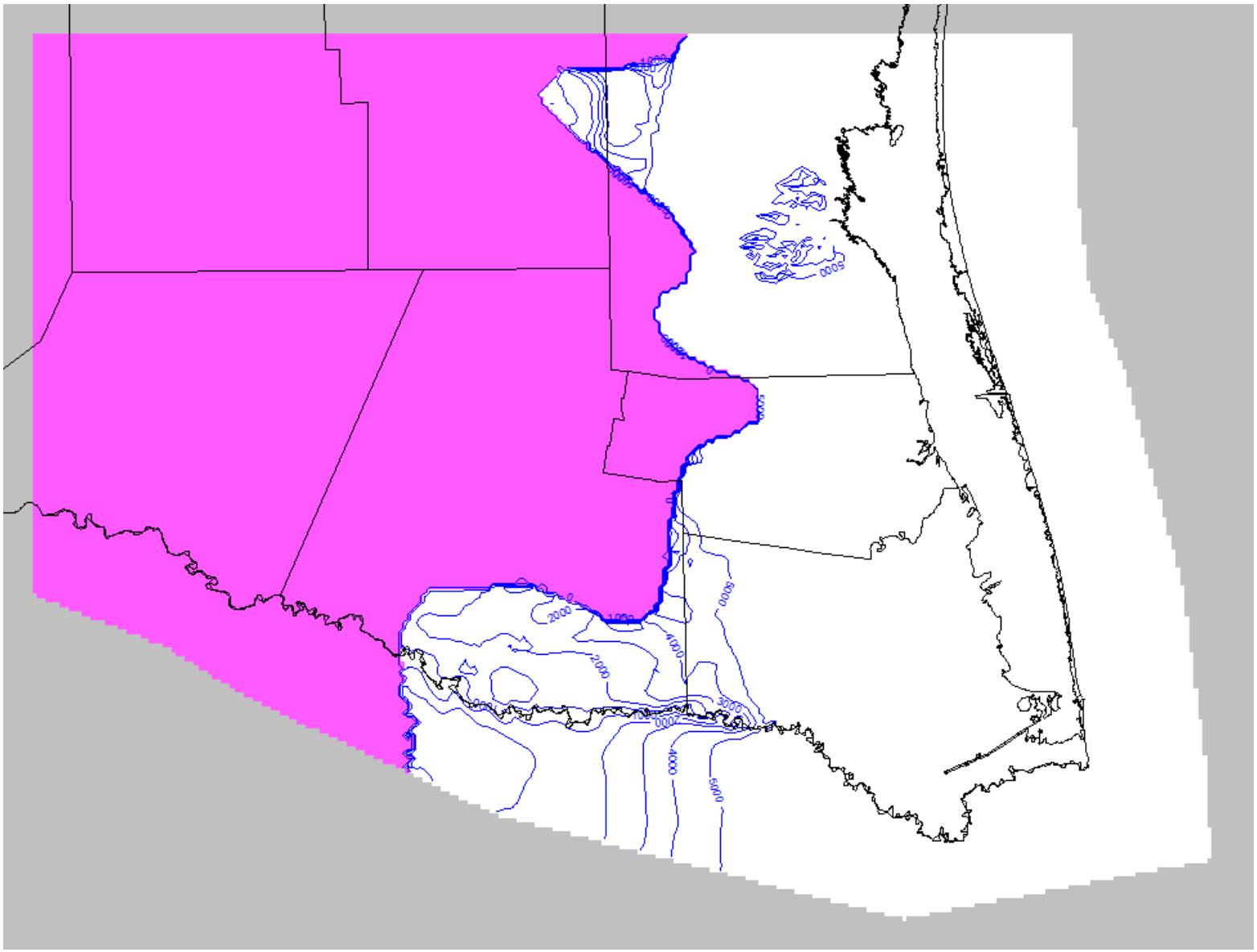
Contours of Groundwater Elevations (ft MSL) - All Strategy Scenario – Model Layer 10 (Catahoula Confining System)



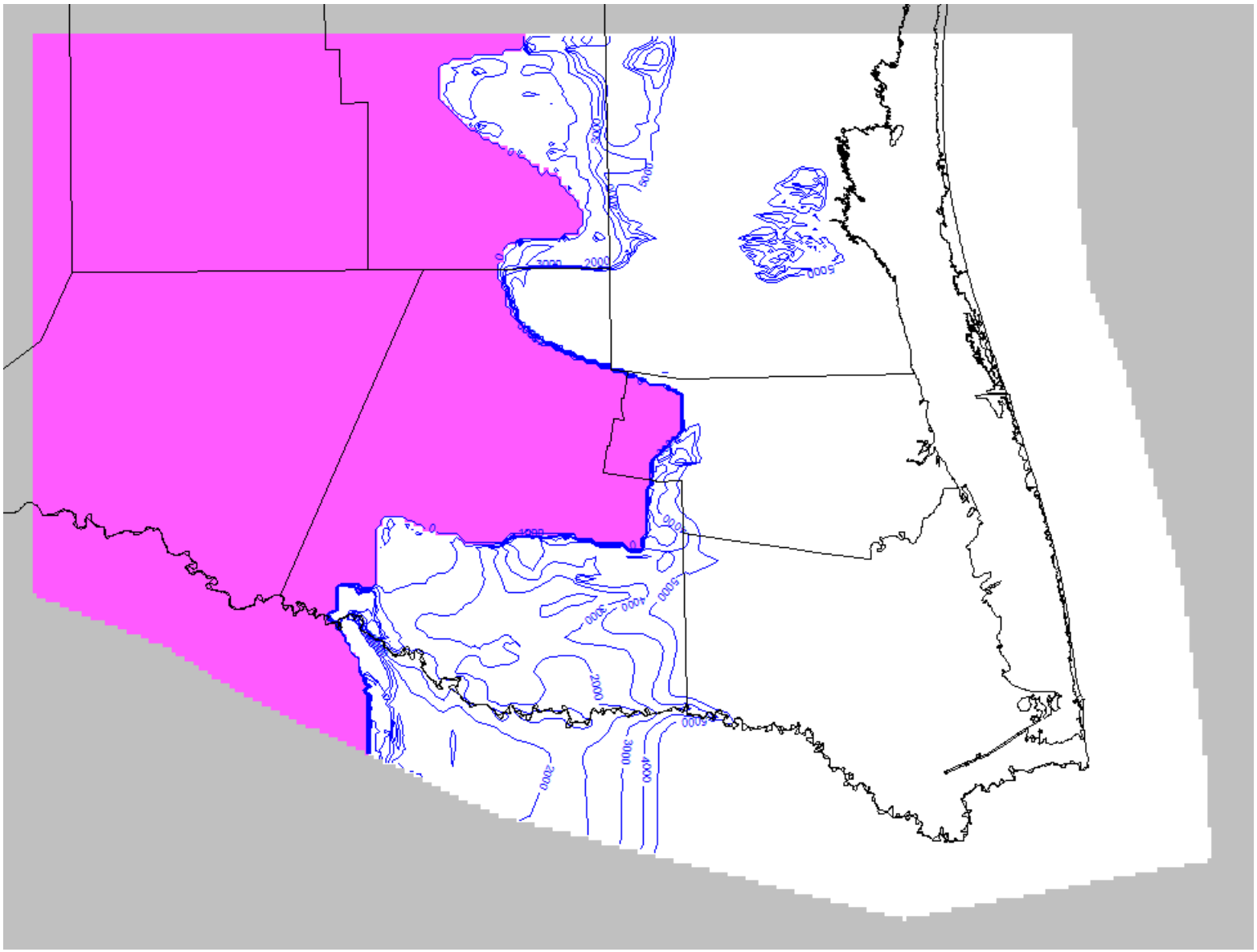
Contours of Groundwater Elevations (ft MSL) - All Strategy Scenario – Model Layer 10 (Yegua-Jackson Aquifer)



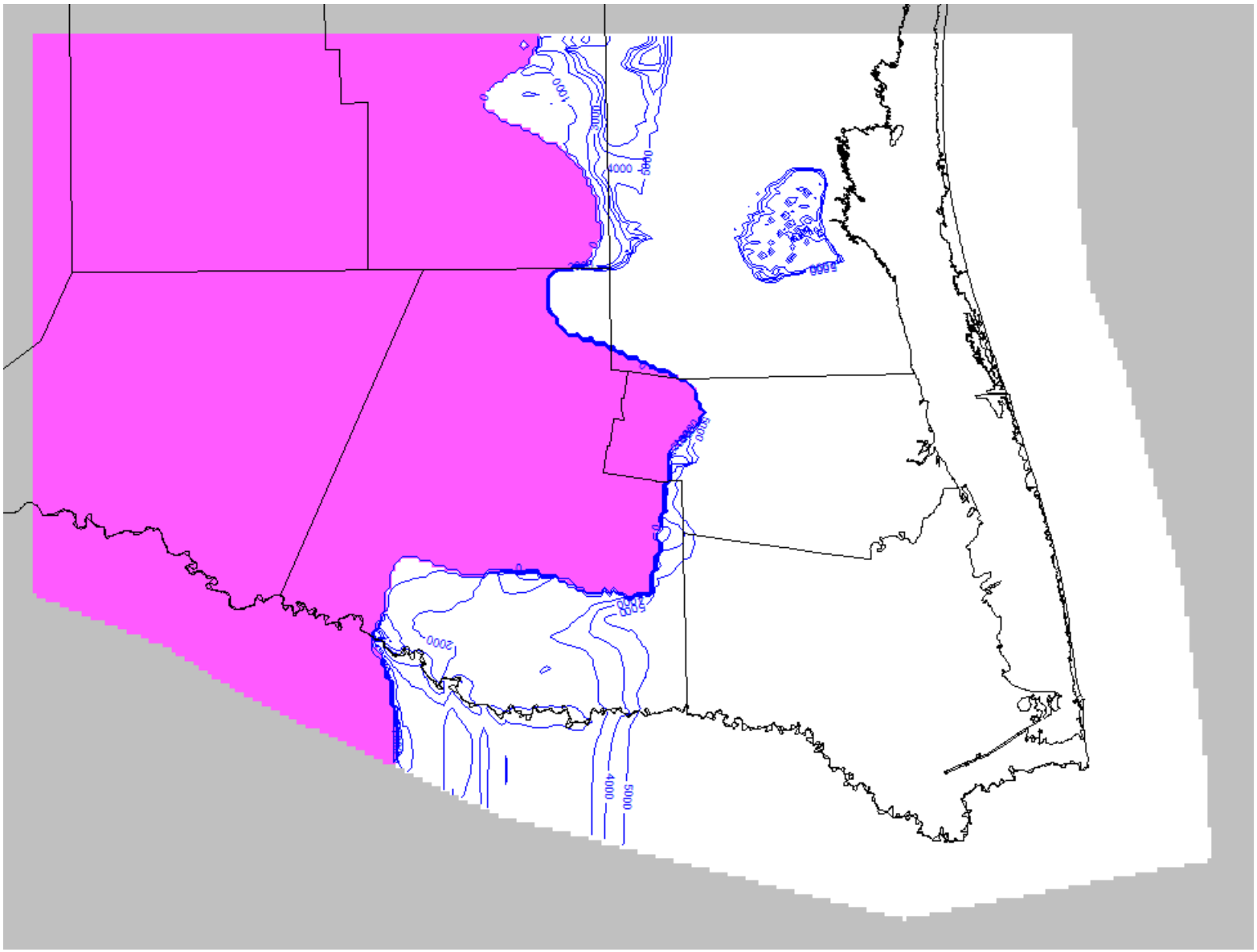
Contours of Total Dissolved Solids (mg/l) - All Strategy Scenario – Model Layer 1 (Beaumont)
Note: Contours Limited to 0 to 5,000 mg/l)



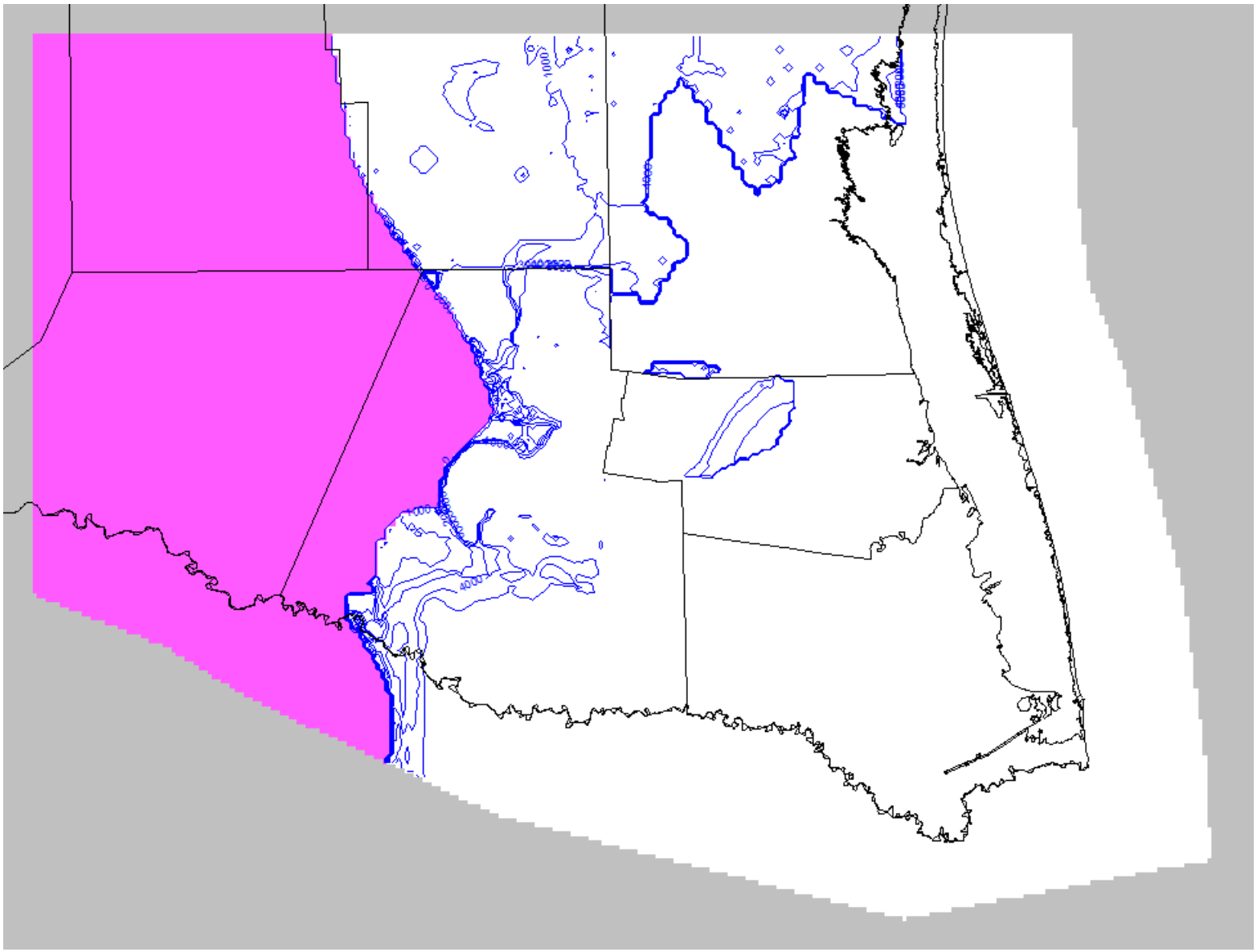
Contours of Total Dissolved Solids (mg/l) - All Strategy Scenario – Model Layer 2 (Lissie)
Note: Contours Limited to 0 to 5,000 mg/l)



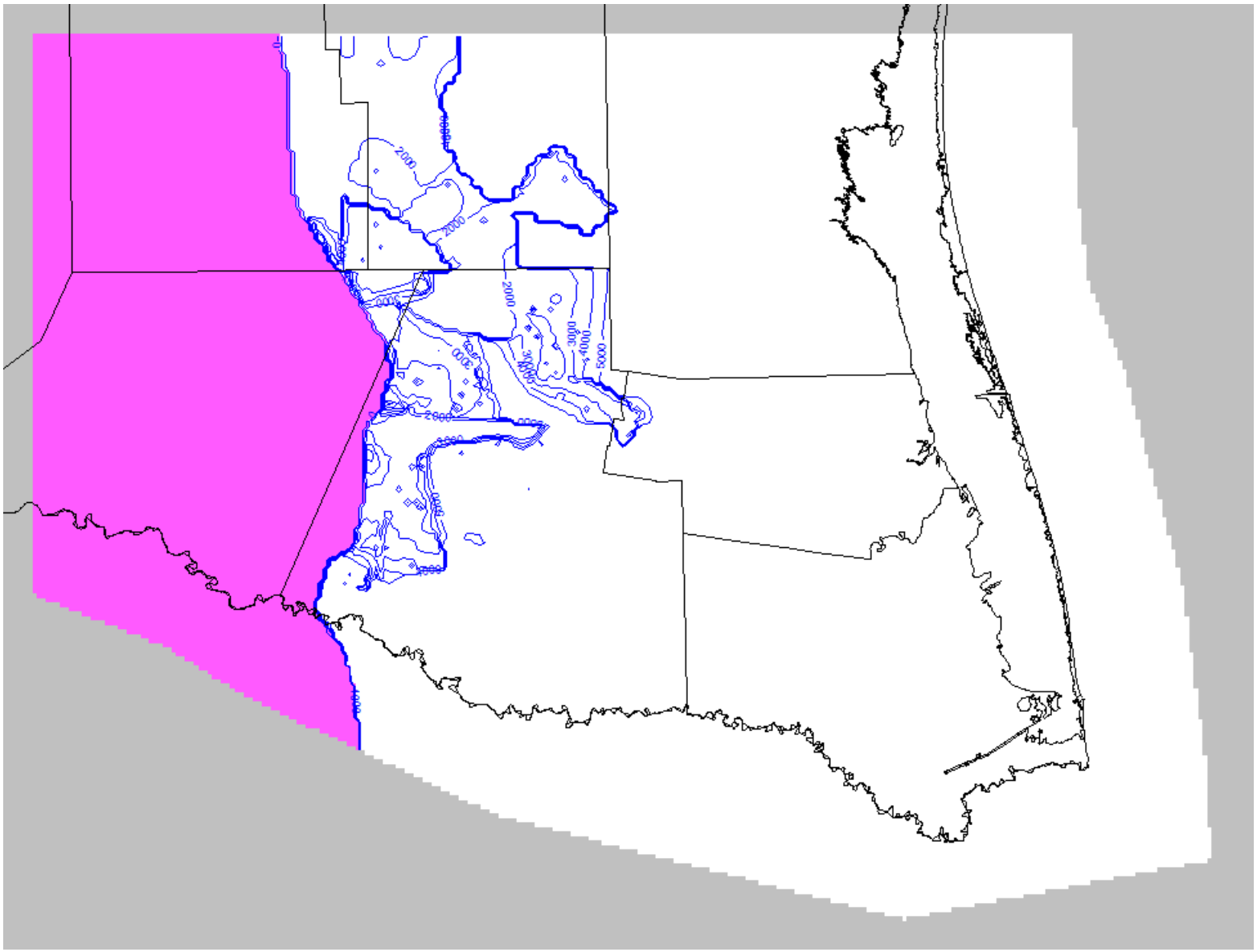
Contours of Total Dissolved Solids (mg/l) - All Strategy Scenario – Model Layer 3 (Willis)
Note: Contours Limited to 0 to 5,000 mg/l)



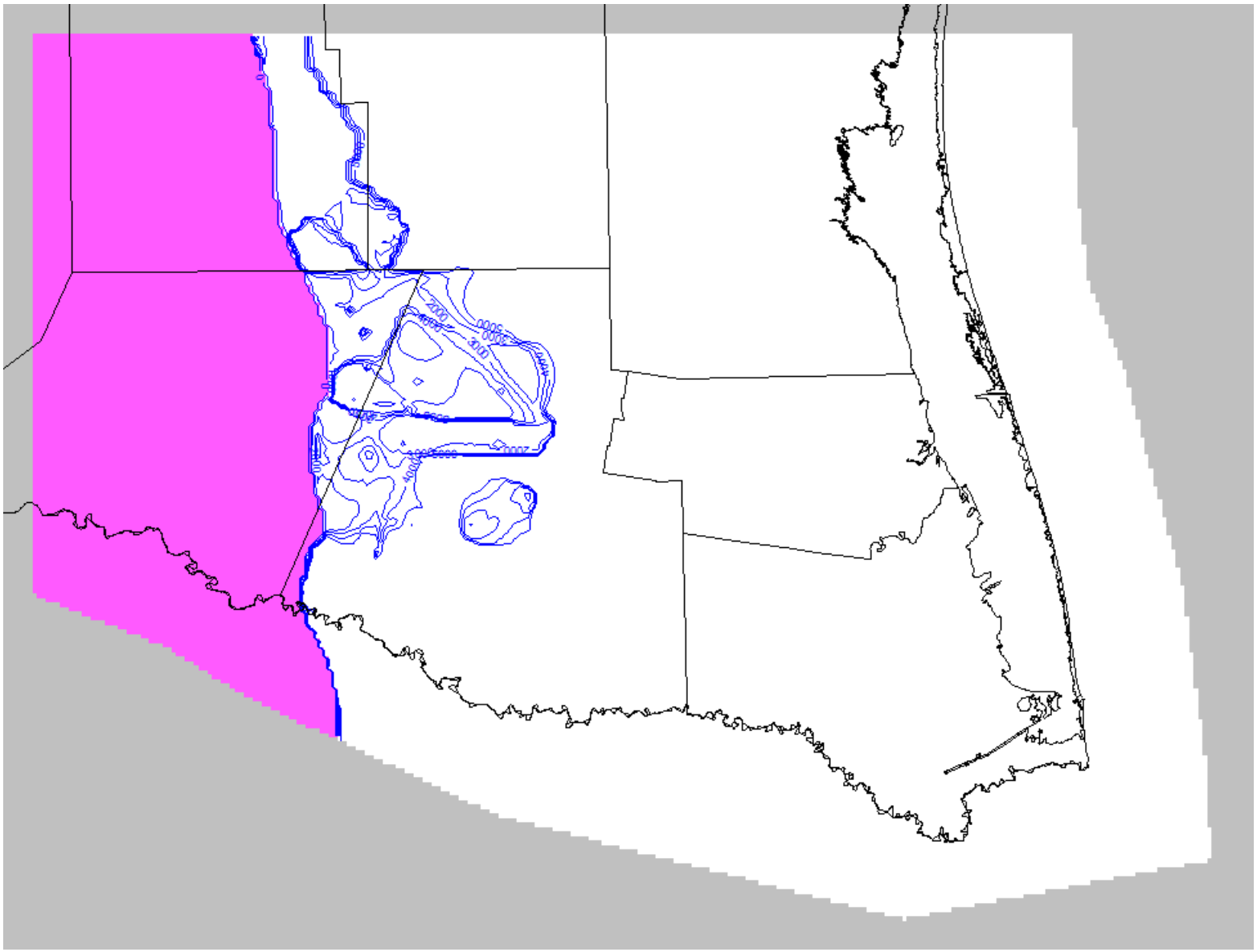
Contours of Total Dissolved Solids (mg/l) - All Strategy Scenario – Model Layer 4 (Upper Goliad)
Note: Contours Limited to 0 to 5,000 mg/l)



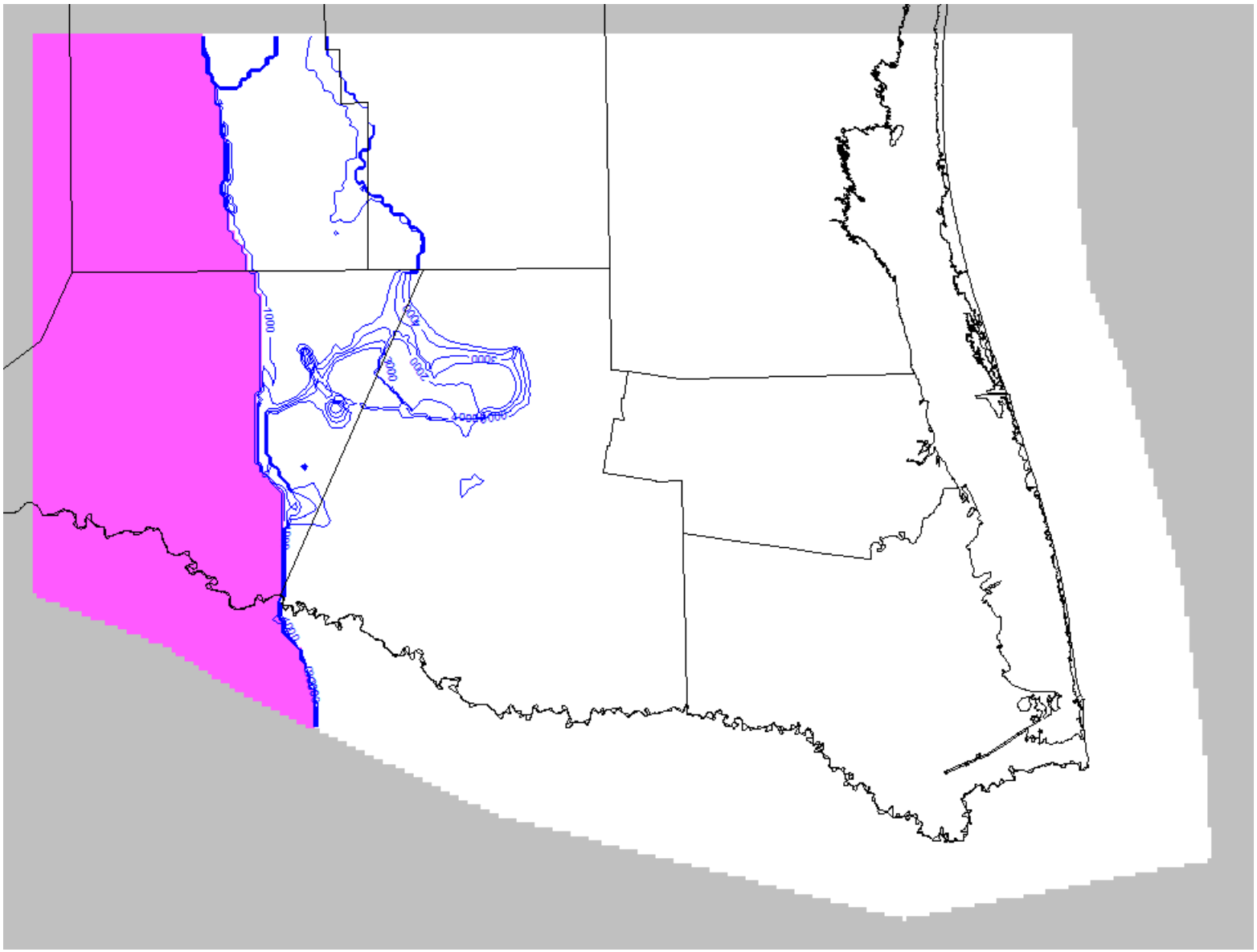
Contours of Total Dissolved Solids (mg/l) - All Strategy Scenario – Model Layer 5 (Lower Goliad)
Note: Contours Limited to 0 to 5,000 mg/l)



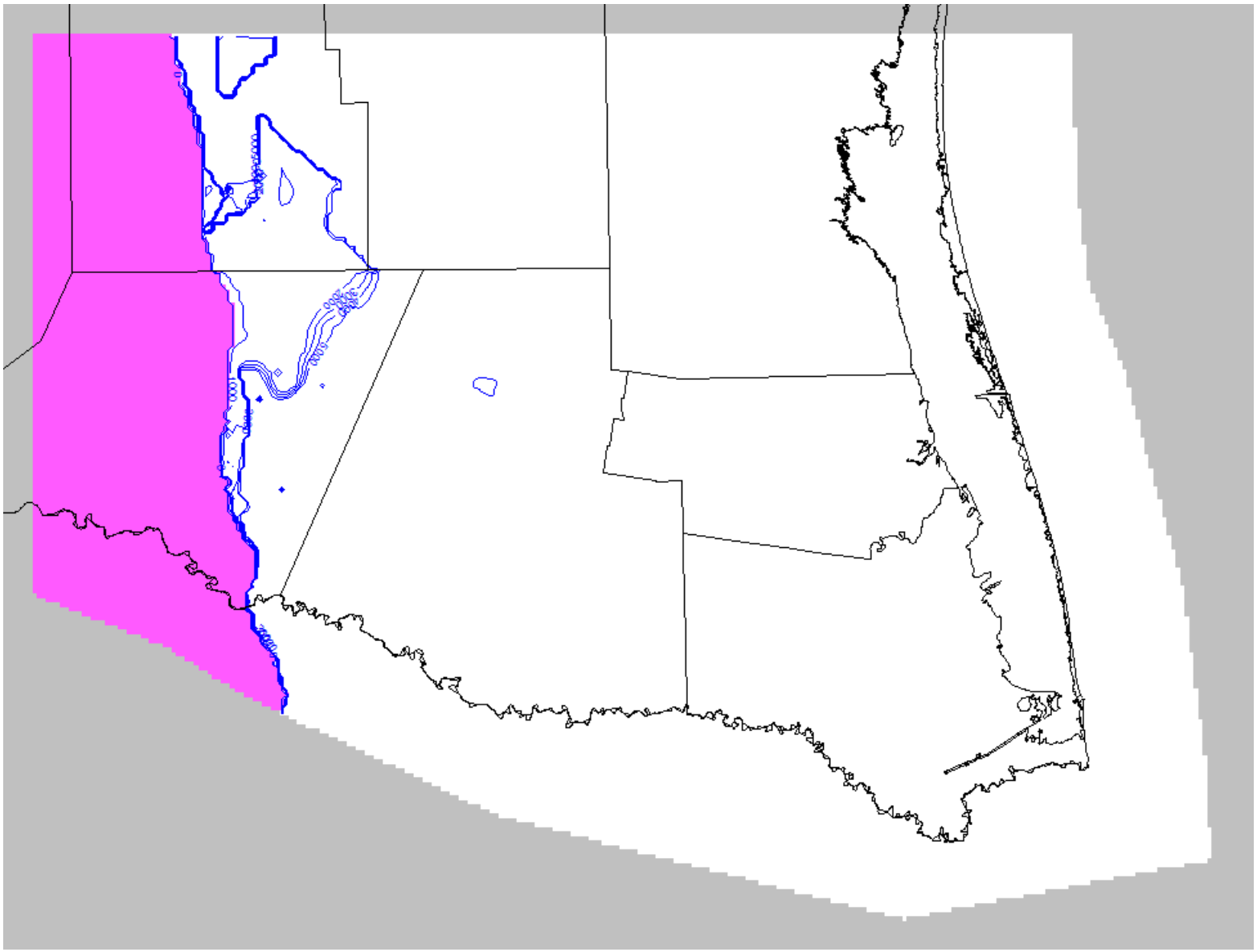
Contours of Total Dissolved Solids (mg/l) - All Strategy Scenario – Model Layer 6 (Upper Lagarto)
Note: Contours Limited to 0 to 5,000 mg/l)



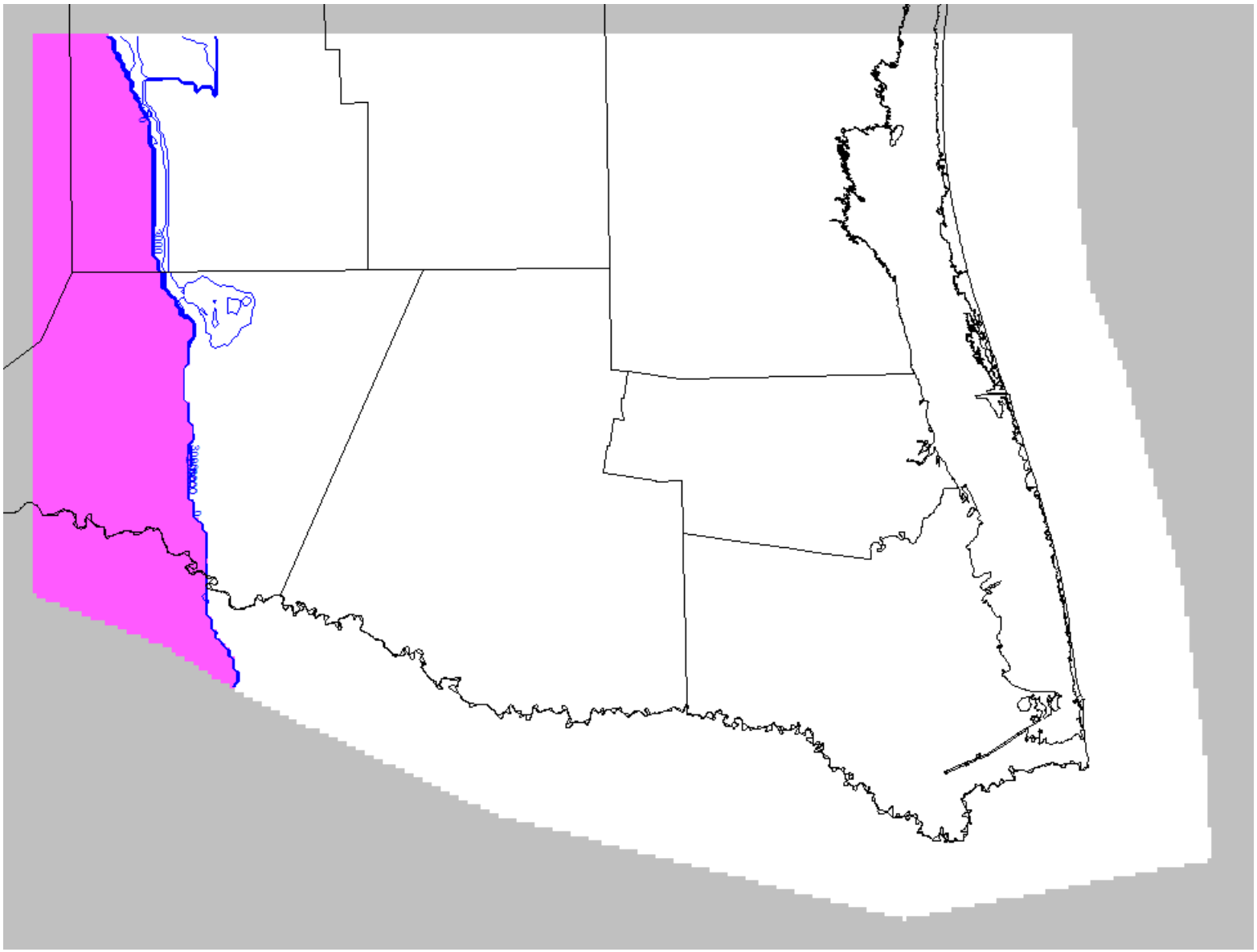
Contours of Total Dissolved Solids (mg/l) - All Strategy Scenario – Model Layer 7 (Middle Lagarto)
Note: Contours Limited to 0 to 5,000 mg/l)



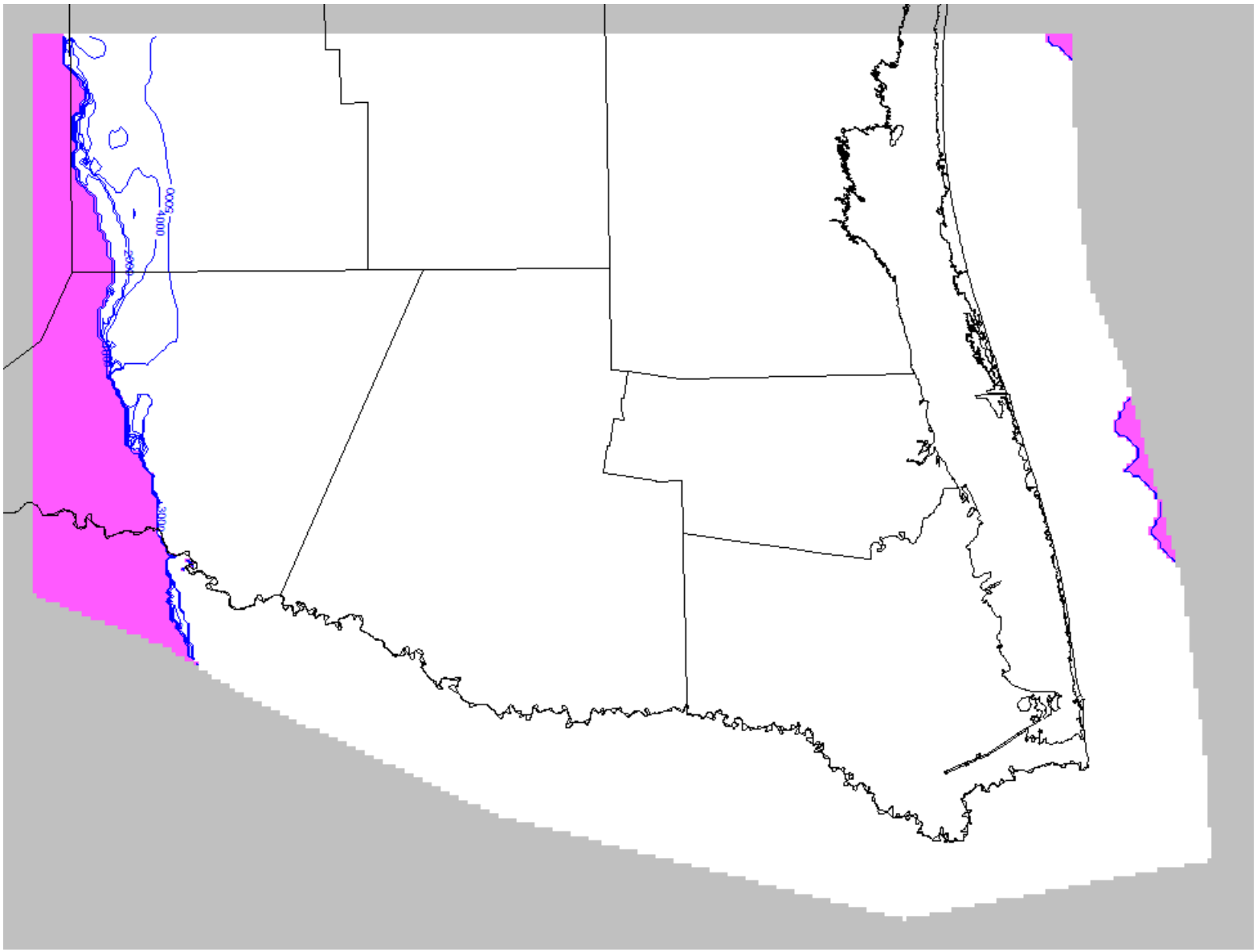
Contours of Total Dissolved Solids (mg/l) - All Strategy Scenario – Model Layer 8 (Lower Lagarto)
Note: Contours Limited to 0 to 5,000 mg/l)



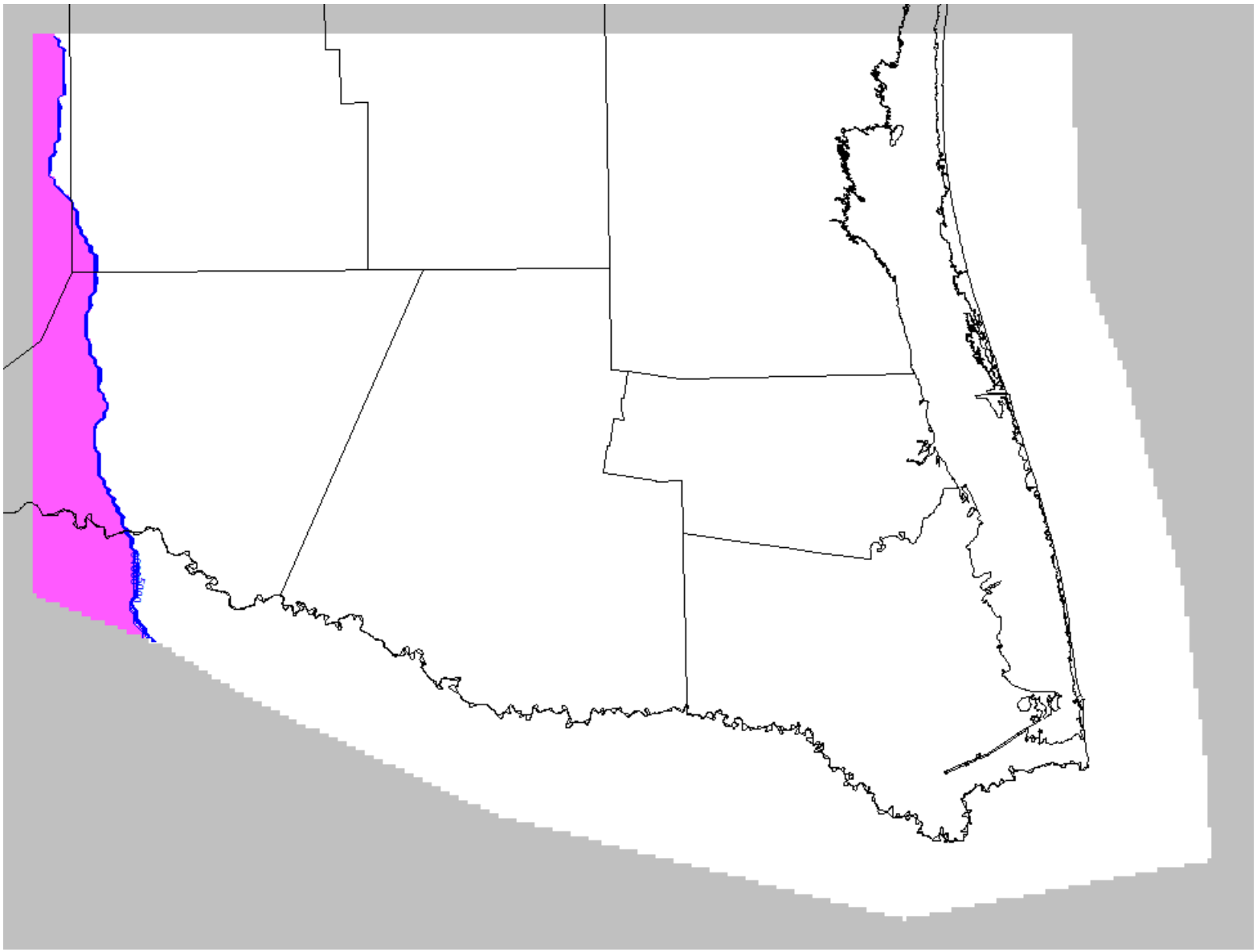
Contours of Total Dissolved Solids (mg/l) - All Strategy Scenario – Model Layer 9 (Oakville)
Note: Contours Limited to 0 to 5,000 mg/l)



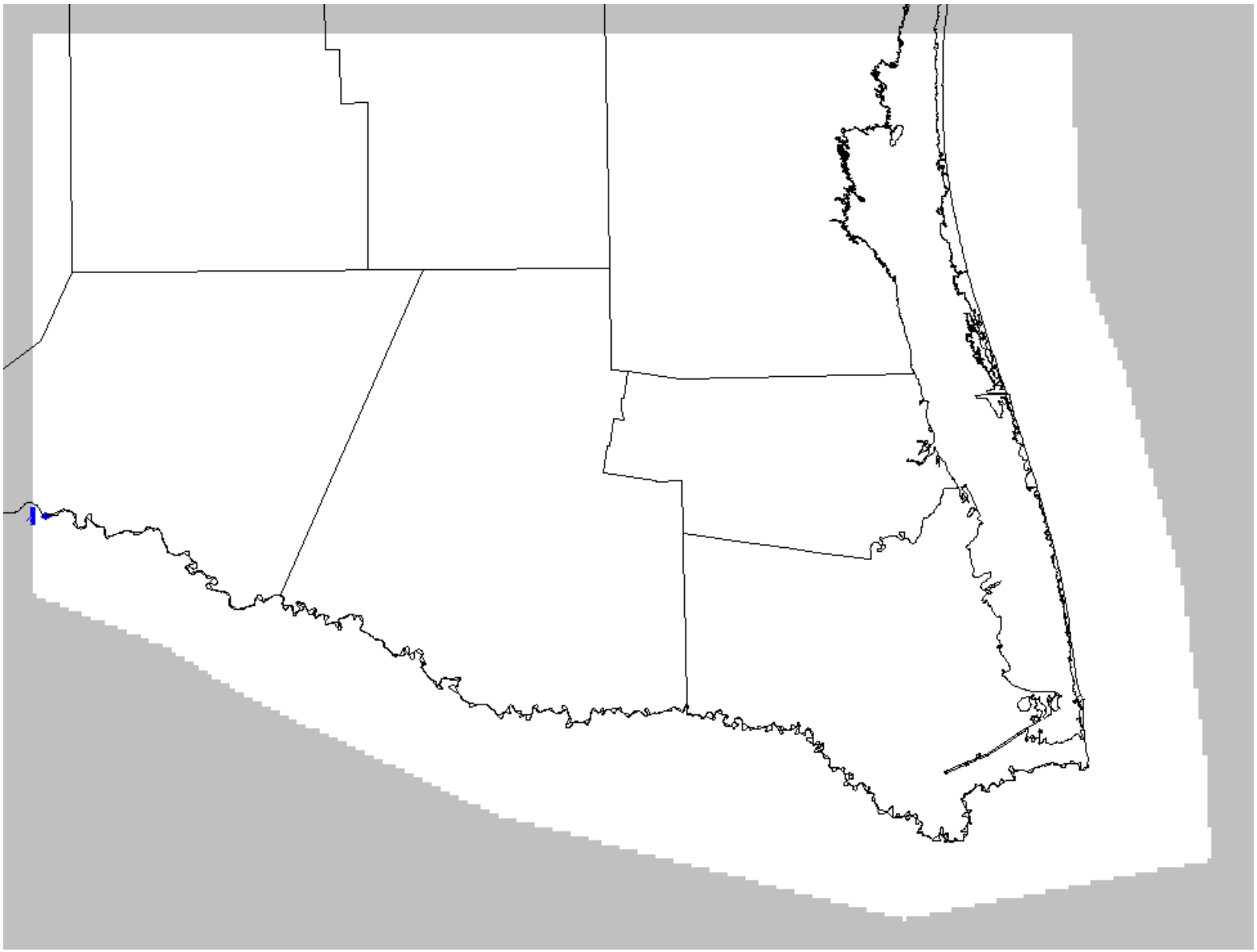
Contours of Total Dissolved Solids (mg/l) - All Strategy Scenario – Model Layer 10 (Upper Catahoula)
Note: Contours Limited to 0 to 5,000 mg/l)



Contours of Total Dissolved Solids (mg/l) - All Strategy Scenario – Model Layer 10 (Catahoula Confining System)
Note: Contours Limited to 0 to 5,000 mg/l)



Contours of Total Dissolved Solids (mg/l) - All Strategy Scenario – Model Layer 10 (Yegua-Jackson Aquifer)
Note: Contours Limited to 0 to 5,000 mg/l)



Appendix E

Post Processor Output for AllStrat Scenario Groundwater Elevations

Appendix E - Post Processor Output for AllStrat Scenario - Groundwater Elevations

Well Number	Scenario Name	Scenario Number	Groundwater Elevation (ft MSL)												
			2013 (Initial Condition)	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
1	Jardin-1	1	12.46	9.36	11.49	11.60	11.87	11.82	12.31	13.08	12.86	13.78	13.42	14.26	13.86
2	Feria-1	2	46.48	42.41	44.18	43.91	44.35	44.24	44.48	44.49	44.67	44.62	44.60	44.46	44.62
3	Laguna-Madre-2	3	5.18	3.89	4.98	5.07	5.04	5.01	4.91	4.90	4.80	4.85	4.78	4.78	4.74
4	Laguna-Madre-1	3	5.10	3.75	4.66	4.76	4.72	4.68	4.58	4.59	4.49	4.55	4.49	4.51	4.48
5	North-Cameron-1	4	40.51	37.13	38.09	38.12	38.17	38.20	38.26	38.39	38.42	38.46	38.31	38.20	38.25
6	Primera-1	5	36.84	32.94	35.25	35.39	35.90	35.70	36.09	35.93	36.29	36.07	36.27	35.96	36.28
7	McAllen-3	6	94.19	89.20	89.30	89.25	89.13	89.25	89.25	89.24	89.24	89.16	89.22	89.06	89.21
8	McAllen-2	6	94.90	90.16	90.30	90.23	90.12	90.24	90.24	90.22	90.23	90.13	90.24	90.06	90.24
9	McAllen-1	6	93.65	88.70	88.81	88.75	88.65	88.76	88.75	88.76	88.74	88.67	88.73	88.57	88.72
10	Mission-3	7	103.97	98.41	98.97	99.07	99.02	99.11	99.17	99.08	99.10	99.02	99.10	99.08	99.23
11	Mission-2	7	104.27	99.07	99.75	99.86	99.81	99.90	99.96	99.90	99.91	99.84	99.91	99.90	100.02
12	Mission-1	7	103.26	97.69	98.31	98.40	98.36	98.44	98.51	98.43	98.45	98.38	98.46	98.42	98.56
13	Alamo-1	8	77.67	73.15	73.25	73.30	73.13	73.21	73.15	73.20	73.09	73.16	72.93	72.92	72.88
14	Sharyland-WTP2-1	9	107.14	104.84	105.17	105.01	104.88	104.77	104.73	104.62	104.57	104.48	104.45	104.39	104.40
15	Sharyland-WTP3-1	10	105.14	101.83	102.34	102.26	102.08	102.20	102.17	102.23	102.00	102.14	102.00	101.94	101.94
16	Union-1	11	152.75	67.74	63.59	62.86	62.54	62.40	62.33	62.21	62.07	61.97	61.89	61.72	61.69
17	Lyford-1	12	32.69	27.89	29.10	29.05	29.05	29.06	29.02	29.11	29.03	29.00	28.86	28.55	28.47
18	Delta-2	13	62.65	57.46	57.85	58.00	57.57	57.89	57.87	58.11	57.81	58.07	50.94	50.73	50.60
19	Delta-1	13	62.41	56.99	57.43	57.58	57.21	57.50	57.46	57.68	57.43	57.64	51.86	51.70	51.57
20	La-Sara-1	14	37.69	36.27	34.93	34.92	35.42	35.24	35.18	35.57	35.39	35.51	35.37	24.43	23.57
21	Cameron-County-2	15	40.89	38.50	38.53	38.68	38.63	38.67	38.62	38.78	38.72	38.74	38.45	38.33	38.29
22	Cameron-County-1	15	39.05	36.69	36.79	36.95	36.89	36.93	36.88	37.03	36.97	37.00	36.74	36.62	36.59
23	Cameron-County-3	15	31.95	30.36	30.16	30.32	30.29	30.33	30.29	30.39	30.35	30.40	30.22	30.14	30.10
24	Cameron-County-3	15	39.60	37.22	37.33	37.49	37.42	37.47	37.43	37.57	37.52	37.54	37.29	37.16	37.15
25	Cameron-County-5	15	21.54	20.49	19.87	20.51	20.61	20.77	20.74	20.90	20.84	21.01	20.86	20.92	20.85
26	Cameron-County-3	15	41.84	39.72	39.48	39.67	39.58	39.66	39.61	39.79	39.72	39.78	39.50	39.41	39.38
27	Cameron-County-4	15	28.17	26.70	26.34	26.87	26.92	27.02	26.99	27.13	27.08	27.20	27.03	27.04	26.99
28	Cameron-County-3	15	26.34	24.95	24.59	25.11	25.17	25.30	25.28	25.42	25.39	25.52	25.37	25.39	25.35
29	Cameron-County-2	15	47.92	45.07	45.11	45.21	45.15	45.21	45.16	45.33	45.28	45.29	44.88	44.76	44.75
30	Cameron-County-2	15	40.56	38.46	38.25	38.45	38.36	38.44	38.39	38.56	38.49	38.56	38.31	38.22	38.19
31	Cameron-County-1	15	25.86	24.57	24.46	24.57	24.53	24.55	24.56	24.63	24.62	24.70	24.59	24.57	24.55
32	Cameron-County-2	15	39.67	37.60	37.38	37.60	37.53	37.63	37.59	37.76	37.70	37.77	37.54	37.46	37.44
33	Cameron-County-9	15	26.73	25.37	25.28	25.43	25.45	25.49	25.52	25.62	25.63	25.72	25.62	25.62	25.61
34	Cameron-County-6	15	25.90	24.56	24.49	24.66	24.69	24.75	24.79	24.90	24.92	25.03	24.94	24.97	24.97
35	Cameron-County-1	15	19.35	18.41	18.28	18.28	18.19	18.15	18.11	18.10	18.06	18.11	18.01	18.01	17.98
36	Cameron-County-4	15	44.23	41.88	41.64	41.99	41.78	41.98	41.82	42.11	41.93	42.10	41.73	41.76	41.63
37	Cameron-County-1	15	31.50	29.89	29.76	29.91	29.89	29.93	29.94	30.04	30.03	30.11	29.99	29.98	29.97

Appendix E - Post Processor Output for AllStrat Scenario - Groundwater Elevations

Well Number	Scenario Name	Scenario Number	Groundwater Elevation (ft MSL)												
			2013 (Initial Condition)	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
38	Cameron-County-3	15	48.91	46.29	45.98	46.16	46.05	46.14	46.04	46.23	46.11	46.18	45.77	45.71	45.63
39	Cameron-County-5	15	47.21	44.72	44.44	44.73	44.56	44.73	44.57	44.84	44.66	44.81	44.39	44.39	44.25
40	Cameron-County-2	15	20.08	19.04	18.95	18.99	18.95	18.94	18.96	19.01	19.04	19.14	19.11	19.17	19.21
41	Cameron-County-3	15	18.38	17.48	17.41	17.44	17.39	17.35	17.33	17.33	17.30	17.35	17.26	17.25	17.23
42	Cameron-County-4	15	44.63	42.25	41.96	42.39	42.22	42.41	42.26	42.53	42.37	42.54	42.19	42.22	42.11
43	Cameron-County-3	15	42.80	40.44	40.31	40.96	40.56	41.04	40.67	41.16	40.80	41.19	40.69	40.93	40.63
44	Cameron-County-1	15	37.09	35.18	35.05	35.18	35.16	35.21	35.21	35.33	35.31	35.39	35.26	35.25	35.23
45	Cameron-County-1	15	18.87	17.92	17.88	17.98	18.00	18.01	18.06	18.12	18.15	18.25	18.22	18.25	18.27
46	Cameron-County-4	15	27.53	26.09	26.04	26.26	26.32	26.41	26.54	26.53	26.71	26.48	26.63	26.49	26.66
47	Cameron-County-2	15	21.11	20.03	20.01	20.19	20.26	20.33	20.42	20.52	20.61	20.61	20.64	20.62	20.71
48	Cameron-County-4	15	31.88	30.23	30.17	30.35	30.41	30.48	30.54	30.67	30.69	30.74	30.63	30.62	30.59
49	Cameron-County-4	15	35.76	33.96	33.88	34.02	34.06	34.11	34.13	34.21	34.18	34.13	34.00	33.94	33.90
50	Cameron-County-3	15	33.16	31.46	31.39	31.56	31.61	31.67	31.72	31.85	31.86	31.93	31.83	31.83	31.79
51	Cameron-County-8	15	35.29	33.52	33.44	33.58	33.62	33.66	33.69	33.80	33.79	33.84	33.72	33.71	33.65
52	Cameron-County-4	15	34.84	33.09	33.02	33.17	33.21	33.24	33.28	33.38	33.39	33.43	33.38	33.33	33.33
53	Cameron-County-4	15	27.42	26.03	25.99	26.15	26.18	26.21	26.27	26.36	26.35	26.35	26.23	26.20	26.17
54	Cameron-County-3	15	31.00	29.39	29.32	29.50	29.48	29.61	29.54	29.81	29.18	29.36	29.14	29.30	29.26
55	Cameron-County-5	15	21.48	20.43	20.42	20.60	20.66	20.71	20.80	20.92	20.97	21.06	21.07	21.12	21.15
56	Cameron-County-5	15	46.79	44.50	44.31	44.37	44.32	44.31	44.26	44.34	44.26	44.29	44.10	44.06	44.00
57	Cameron-County-7	15	41.80	39.81	39.68	39.74	39.72	39.72	39.69	39.76	39.70	39.75	39.59	39.60	39.49
58	Cameron-County-4	15	35.99	34.26	34.17	34.30	34.27	34.31	34.09	34.26	33.95	34.02	33.91	33.95	33.97
59	Cameron-County-1	15	31.53	30.02	29.95	30.10	30.11	30.13	30.13	30.20	30.26	29.82	29.97	29.68	29.85
60	Cameron-County-5	15	42.75	40.76	40.64	40.67	40.65	40.63	40.60	40.66	40.61	40.63	40.52	40.51	40.46
61	Cameron-County-1	15	28.61	27.25	27.19	27.29	27.29	27.27	27.29	27.39	27.36	27.35	27.23	27.20	27.11
62	Cameron-County-4	15	27.90	26.57	26.51	26.60	26.59	26.56	26.58	26.68	26.68	26.70	26.62	26.61	26.53
63	Cameron-County-1	15	44.31	42.24	42.11	42.15	42.11	42.09	42.06	42.12	42.06	42.08	41.97	41.96	41.91
64	Cameron-County-5	15	40.94	39.04	38.92	38.98	38.94	38.94	38.88	38.99	38.91	38.97	38.84	38.89	38.76
65	Cameron-County-3	15	30.64	29.19	29.13	29.27	29.27	29.29	29.23	29.38	29.18	29.11	29.00	28.89	28.88
66	Cameron-County-2	15	48.62	46.38	46.23	46.27	46.21	46.22	46.19	46.27	46.20	46.26	46.13	46.14	46.09
67	Cameron-County-1	15	34.90	33.30	33.23	33.35	33.37	33.35	33.33	33.47	33.39	33.46	33.30	33.37	33.26
68	Cameron-County-5	15	45.39	43.29	43.20	43.27	43.26	43.29	43.31	43.41	43.39	43.45	43.37	43.39	43.37
69	Cameron-County-2	15	29.71	28.32	28.29	28.42	28.42	28.42	28.39	28.56	28.46	28.56	28.43	28.51	28.43
70	Cameron-County-1	15	34.74	33.18	33.15	33.35	33.35	33.43	33.10	33.06	32.98	33.01	32.93	33.12	33.01
71	Cameron-County-2	15	24.07	22.93	22.91	23.01	22.83	22.88	21.98	22.26	22.01	22.19	22.17	22.30	22.29
72	Cameron-County-4	15	29.91	28.53	28.50	28.60	28.63	28.61	28.64	28.83	28.74	28.88	28.67	28.82	28.65
73	Cameron-County-3	15	26.49	25.25	25.25	25.34	25.33	25.30	25.25	25.39	25.33	25.34	25.27	25.31	25.25
74	Cameron-County-5	15	30.99	29.58	29.57	29.71	29.77	29.79	29.77	29.94	29.79	29.86	29.71	29.80	29.75

Appendix E - Post Processor Output for AllStrat Scenario - Groundwater Elevations

Well Number	Scenario Name	Scenario Number	Groundwater Elevation (ft MSL)												
			2013 (Initial Condition)	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
75	Cameron-County-2	15	27.30	26.03	26.02	26.13	26.13	26.12	26.02	26.24	26.08	26.18	26.09	26.19	26.14
76	Cameron-County-2	15	22.79	21.68	21.71	21.81	21.81	21.78	21.50	21.72	21.10	21.31	21.17	21.29	21.24
77	Military-Hwy-1	16	45.20	43.09	42.97	43.01	42.97	42.99	42.98	43.07	43.03	43.08	43.00	43.01	42.98
78	Military-Hwy-2	16	44.35	42.30	42.22	42.36	42.42	42.50	42.55	42.67	42.67	42.69	42.68	42.62	42.64
79	Military-Hwy-3	16	44.32	42.28	42.22	42.36	42.38	42.45	42.47	42.61	42.57	42.67	42.57	42.62	42.53
80	Military-Hwy-4	16	43.79	41.80	41.70	41.80	41.79	41.84	41.85	41.99	41.96	42.04	41.97	42.03	41.92
81	San-Benito-1	17	31.15	29.45	29.30	29.50	29.49	29.61	29.55	29.72	29.66	29.54	29.52	29.41	29.47
82	San-Benito-2	17	30.40	28.70	28.50	28.73	28.65	28.76	28.34	28.56	28.25	28.58	28.42	28.63	28.58
83	Alamo-2	18	76.69	72.63	72.44	72.52	72.35	72.45	72.38	72.46	72.34	72.44	72.18	72.19	72.13
84	Edcouch-1	19	61.38	55.27	55.45	55.64	55.52	55.79	55.59	55.86	55.70	55.85	53.41	53.42	53.30
85	Hidalgo-1	20	90.46	88.07	88.09	88.09	88.08	88.00	88.05	88.02	88.07	87.99	88.04	87.97	88.03
86	Hidalgo-2	20	90.17	87.79	87.82	87.82	87.81	87.72	87.77	87.74	87.80	87.71	87.77	87.70	87.75
87	Hidalgo-Steam-1	21	93.25	89.49	90.39	90.11	90.66	90.62	90.54	90.49	90.64	90.51	90.42	90.17	90.35
88	Weslaco-1	22	63.06	59.36	59.03	59.08	58.97	59.02	58.95	59.04	58.95	59.02	58.61	58.60	58.51
89	Starr-County-5	23	207.60	196.10	194.75	194.43	194.39	194.48	194.55	194.50	194.51	194.49	194.42	194.37	194.37
90	Starr-County-3	23	311.29	309.10	307.99	308.39	308.67	308.75	308.84	308.87	308.95	308.98	309.07	309.08	309.10
91	Starr-County-4	23	265.11	242.05	238.63	239.12	239.44	239.58	239.67	239.69	239.74	239.75	239.78	239.75	239.75
92	Starr-County-2	23	225.80	224.03	223.78	224.00	224.01	223.96	223.91	223.84	223.78	223.72	223.67	223.59	223.53
93	Starr-County-1	23	190.27	169.45	166.22	165.70	165.92	166.27	166.28	166.32	166.34	166.31	166.26	166.21	166.24

Appendix F

Post Processor Output for AllStrat Scenario
Total Dissolved Solids

Appendix F - Post Processor Output for AllStrat Scenario - Total Dissolved Solids

Well Number	Scenario Name	Scenario Number	Total Dissolved Solids (mg/l)												
			2013 (Initial Condition)	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
1	Jardin-1	1	38,891	39,132	38,607	37,850	37,179	36,591	34,671	35,075	33,156	33,578	31,846	32,346	30,704
2	Feria-1	2	9,704	9,383	8,419	8,451	7,931	8,063	7,643	7,764	7,415	7,517	7,230	7,276	7,060
3	Laguna-Madre-2	3	33,400	34,491	34,105	34,248	34,180	34,522	34,441	34,753	34,656	34,887	34,766	34,921	34,793
4	Laguna-Madre-1	3	34,460	35,811	35,444	35,488	35,509	35,769	35,740	35,954	35,897	36,026	35,933	35,974	35,852
5	North-Cameron-1	4	9,014	9,036	8,464	8,213	8,139	7,961	7,876	7,706	7,617	7,462	7,375	7,238	7,157
6	Primera-1	5	14,955	15,308	13,501	12,854	12,446	12,114	11,940	11,602	11,509	11,171	11,079	10,771	10,666
7	McAllen-3	6	2,821	2,841	2,887	2,930	2,984	3,025	3,070	3,100	3,119	3,154	3,150	3,170	3,153
8	McAllen-2	6	2,857	2,878	2,917	2,968	3,019	3,051	3,090	3,119	3,145	3,174	3,168	3,198	3,188
9	McAllen-1	6	2,865	2,879	2,912	2,959	2,999	3,037	3,078	3,096	3,138	3,169	3,186	3,228	3,227
10	Mission-3	7	6,912	6,914	6,944	6,948	6,953	6,966	6,961	6,971	6,964	6,965	6,944	6,935	6,901
11	Mission-2	7	6,961	6,957	6,976	6,984	6,988	6,998	6,994	6,994	6,981	6,978	6,958	6,947	6,919
12	Mission-1	7	7,049	7,045	7,068	7,081	7,089	7,101	7,105	7,115	7,115	7,115	7,105	7,099	7,074
13	Alamo-1	8	3,844	3,812	3,756	3,703	3,652	3,605	3,558	3,516	3,477	3,442	3,410	3,381	3,355
14	Sharyland-WTP2-1	9	4,806	4,917	5,123	5,280	5,407	5,510	5,589	5,649	5,694	5,729	5,754	5,773	5,789
15	Sharyland-WTP3-1	10	4,017	4,008	3,984	3,959	3,934	3,895	3,857	3,817	3,789	3,742	3,698	3,673	3,642
16	Union-1	11	22,567	22,613	22,764	22,927	23,086	23,238	23,378	23,510	23,631	23,745	23,852	23,954	24,049
17	Lyford-1	12	8,996	8,894	8,447	8,155	7,951	7,784	7,645	7,514	7,401	7,304	7,223	7,131	7,056
18	Delta-2	13	5,329	5,332	5,312	5,292	5,278	5,253	5,225	5,195	5,172	5,142	5,177	5,186	5,183
19	Delta-1	13	5,099	5,172	5,265	5,313	5,338	5,339	5,331	5,313	5,297	5,275	5,312	5,326	5,327
20	La-Sara-1	14	12,747	11,556	10,503	10,232	9,886	9,573	9,450	9,093	8,972	8,665	8,570	8,462	8,182
21	Cameron-County-2	15	6,390	6,403	6,348	6,292	6,234	6,172	6,107	6,034	5,959	5,881	5,804	5,722	5,640
22	Cameron-County-1	15	6,351	6,388	6,352	6,316	6,277	6,236	6,191	6,137	6,081	6,017	5,957	5,887	5,821
23	Cameron-County-3	15	7,025	7,286	7,219	7,196	7,198	7,206	7,215	7,218	7,217	7,212	7,202	7,190	7,172
24	Cameron-County-3	15	6,220	6,261	6,213	6,169	6,131	6,083	6,033	5,971	5,911	5,840	5,777	5,702	5,634
25	Cameron-County-5	15	20,514	23,532	21,414	21,133	20,600	20,672	20,289	20,393	20,055	20,141	19,830	19,902	19,603
26	Cameron-County-3	15	5,675	5,804	5,648	5,530	5,458	5,381	5,304	5,221	5,145	5,079	4,999	4,942	4,870
27	Cameron-County-4	15	14,003	16,570	14,774	14,629	14,291	14,379	14,135	14,228	14,004	14,074	13,860	13,907	13,693
28	Cameron-County-3	15	16,070	18,806	17,152	16,925	16,543	16,559	16,271	16,310	16,052	16,086	15,847	15,871	15,640
29	Cameron-County-2	15	5,906	6,040	5,769	5,695	5,603	5,540	5,455	5,391	5,300	5,240	5,145	5,088	5,003
30	Cameron-County-2	15	5,876	6,054	5,856	5,747	5,680	5,632	5,566	5,506	5,436	5,388	5,314	5,273	5,203
31	Cameron-County-1	15	15,081	15,119	15,284	15,424	15,474	15,470	15,453	15,418	15,383	15,336	15,296	15,244	15,192
32	Cameron-County-2	15	6,667	7,024	6,736	6,556	6,426	6,341	6,250	6,178	6,093	6,029	5,947	5,889	5,812
33	Cameron-County-9	15	16,845	16,810	16,732	16,655	16,582	16,512	16,439	16,366	16,292	16,214	16,135	16,050	15,961
34	Cameron-County-6	15	18,521	18,467	18,335	18,212	18,083	17,972	17,854	17,743	17,637	17,521	17,403	17,268	17,141
35	Cameron-County-1	15	22,568	22,730	22,895	23,112	23,188	23,318	23,397	23,521	23,574	23,593	23,593	23,549	23,510
36	Cameron-County-4	15	6,141	6,905	5,962	6,321	5,780	6,202	5,666	6,042	5,549	5,909	5,433	5,776	5,342
37	Cameron-County-1	15	12,759	12,787	12,829	12,862	12,885	12,894	12,890	12,871	12,837	12,788	12,727	12,653	12,568

Appendix F - Post Processor Output for AllStrat Scenario - Total Dissolved Solids

Well Number	Scenario Name	Scenario Number	Total Dissolved Solids (mg/l)												
			2013 (Initial Condition)	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
38	Cameron-County-3	15	5,319	5,724	5,372	5,347	5,260	5,324	5,268	5,332	5,284	5,354	5,311	5,381	5,338
39	Cameron-County-5	15	5,519	6,138	5,362	5,608	5,180	5,511	5,112	5,434	5,072	5,392	5,058	5,376	5,072
40	Cameron-County-2	15	24,199	24,304	24,508	24,664	24,747	24,774	24,730	24,646	24,501	24,320	24,105	23,859	23,602
41	Cameron-County-3	15	23,774	23,832	23,949	24,070	24,189	24,306	24,412	24,508	24,578	24,623	24,638	24,622	24,574
42	Cameron-County-4	15	6,819	8,078	6,851	7,086	6,603	6,938	6,463	6,770	6,338	6,616	6,220	6,474	6,119
43	Cameron-County-3	15	8,301	9,671	7,664	8,738	7,261	8,407	7,117	8,118	6,929	7,863	6,737	7,643	6,578
44	Cameron-County-1	15	9,626	9,659	9,727	9,776	9,808	9,819	9,812	9,787	9,745	9,687	9,616	9,533	9,442
45	Cameron-County-1	15	24,314	24,357	24,431	24,483	24,502	24,504	24,477	24,432	24,365	24,291	24,211	24,132	24,042
46	Cameron-County-4	15	18,724	18,661	18,374	18,158	17,900	17,645	17,977	17,576	18,718	18,010	18,448	17,781	17,786
47	Cameron-County-2	15	24,010	23,985	23,842	23,666	23,443	23,342	23,260	23,081	23,330	23,191	23,299	22,957	22,749
48	Cameron-County-4	15	13,872	13,807	13,621	13,440	13,261	13,113	12,985	12,949	13,039	13,175	13,281	13,324	13,311
49	Cameron-County-4	15	9,981	9,937	9,832	9,750	9,702	9,685	9,803	10,004	10,467	10,702	10,957	11,021	11,014
50	Cameron-County-3	15	12,355	12,310	12,158	12,011	11,866	11,783	11,653	11,618	11,603	11,700	11,781	11,858	11,858
51	Cameron-County-8	15	10,095	10,079	9,983	9,906	9,834	9,801	9,771	9,794	9,861	9,975	10,096	10,212	10,299
52	Cameron-County-4	15	10,234	10,209	10,112	10,030	9,961	9,907	9,878	9,840	9,906	9,888	10,105	10,067	10,247
53	Cameron-County-4	15	17,054	17,021	16,893	16,764	16,643	16,542	16,532	16,652	16,925	17,223	17,443	17,483	17,436
54	Cameron-County-3	15	13,390	13,444	13,243	13,368	12,883	13,345	13,027	15,879	15,558	16,064	15,403	15,335	14,724
55	Cameron-County-5	15	22,011	21,944	21,758	21,566	21,392	21,216	21,052	20,882	20,720	20,553	20,405	20,238	20,096
56	Cameron-County-5	15	3,456	3,567	3,679	3,773	3,850	3,891	3,989	3,982	4,099	4,056	4,171	4,115	4,208
57	Cameron-County-7	15	5,230	5,358	5,445	5,571	5,607	5,691	5,740	5,799	5,782	5,919	5,852	6,107	5,986
58	Cameron-County-4	15	8,547	8,589	8,574	8,790	8,782	9,785	9,855	11,186	11,135	11,280	11,052	10,787	10,565
59	Cameron-County-1	15	12,206	12,258	12,160	12,183	12,098	12,199	12,453	12,552	14,374	13,933	14,996	14,328	14,403
60	Cameron-County-5	15	4,921	5,017	5,139	5,243	5,328	5,397	5,456	5,493	5,526	5,535	5,543	5,531	5,514
61	Cameron-County-1	15	14,584	14,634	14,684	14,692	14,671	14,636	14,641	14,749	14,981	15,260	15,535	15,738	15,873
62	Cameron-County-4	15	15,102	15,163	15,243	15,276	15,276	15,245	15,220	15,212	15,269	15,384	15,536	15,692	15,834
63	Cameron-County-1	15	4,445	4,527	4,635	4,722	4,805	4,851	4,893	4,917	4,928	4,926	4,917	4,894	4,862
64	Cameron-County-5	15	5,603	5,728	5,825	6,011	6,042	6,252	6,224	6,408	6,314	6,503	6,328	6,667	6,346
65	Cameron-County-3	15	12,785	12,848	12,754	12,781	12,644	12,969	13,051	13,972	14,503	14,777	15,351	15,156	15,115
66	Cameron-County-2	15	3,595	3,655	3,734	3,784	3,812	3,814	3,797	3,763	3,711	3,648	3,568	3,478	3,384
67	Cameron-County-1	15	8,638	8,663	8,669	8,682	8,694	8,820	8,836	9,090	9,157	9,481	9,483	9,693	9,584
68	Cameron-County-5	15	4,375	4,385	4,316	4,216	4,103	3,971	3,841	3,693	3,573	3,448	3,349	3,238	3,153
69	Cameron-County-2	15	13,491	13,509	13,483	13,521	13,444	13,605	13,515	13,813	13,733	13,992	13,928	13,991	13,917
70	Cameron-County-1	15	8,285	8,245	7,930	8,022	7,826	9,507	10,528	10,855	10,876	10,877	10,348	10,483	9,916
71	Cameron-County-2	15	16,855	16,953	16,979	17,683	17,700	21,394	21,093	21,933	21,502	21,349	21,010	20,760	20,446
72	Cameron-County-4	15	12,870	12,924	12,945	12,918	12,855	12,804	12,694	12,960	12,812	13,343	13,187	13,535	13,345
73	Cameron-County-3	15	15,507	15,536	15,586	15,657	15,700	16,044	16,276	16,538	16,806	17,017	17,050	17,046	16,939
74	Cameron-County-5	15	12,160	12,136	12,021	11,866	11,696	11,820	11,858	12,392	12,498	12,800	12,776	12,729	12,641

Appendix F - Post Processor Output for AllStrat Scenario - Total Dissolved Solids

Well Number	Scenario Name	Scenario Number	Total Dissolved Solids (mg/l)												
			2013 (Initial Condition)	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
75	Cameron-County-2	15	14,998	15,019	15,050	15,110	15,095	15,563	15,591	16,188	16,192	16,371	16,243	16,131	15,965
76	Cameron-County-2	15	19,045	19,014	18,898	18,969	18,883	20,019	20,089	22,179	22,102	22,342	22,167	21,974	21,759
77	Military-Hwy-1	16	4,457	4,529	4,593	4,597	4,562	4,503	4,427	4,339	4,247	4,148	4,052	3,948	3,856
78	Military-Hwy-2	16	4,884	4,901	4,571	4,205	3,891	3,604	3,426	3,196	3,257	3,029	3,317	3,093	3,228
79	Military-Hwy-3	16	4,641	4,545	4,222	3,969	3,730	3,548	3,309	3,215	2,955	3,103	2,907	3,193	2,980
80	Military-Hwy-4	16	3,925	4,012	3,843	3,750	3,565	3,449	3,260	3,119	2,960	2,952	2,703	3,037	2,650
81	San-Benito-1	17	13,866	14,221	13,904	14,018	13,624	14,048	13,926	14,291	15,020	14,980	15,423	15,054	14,893
82	San-Benito-2	17	14,588	15,209	14,728	15,163	14,941	17,078	16,756	18,047	16,982	17,204	16,398	16,384	15,751
83	Alamo-2	18	2,990	2,959	2,880	2,807	2,740	2,679	2,620	2,565	2,514	2,467	2,424	2,385	2,350
84	Edcouch-1	19	4,648	4,722	4,863	4,988	5,087	5,167	5,226	5,269	5,296	5,313	5,279	5,259	5,245
85	Hidalgo-1	20	1,854	1,849	1,763	1,663	1,584	1,516	1,468	1,417	1,384	1,345	1,322	1,293	1,277
86	Hidalgo-2	20	1,864	1,869	1,805	1,712	1,632	1,557	1,505	1,442	1,404	1,355	1,329	1,291	1,273
87	Hidalgo-Steam-1	21	6,174	6,161	6,130	6,101	6,072	6,044	6,017	5,991	5,965	5,940	5,917	5,894	5,871
88	Weslaco-1	22	2,506	2,719	2,626	2,569	2,653	2,636	2,714	2,695	2,761	2,738	2,786	2,769	2,784
89	Starr-County-5	23	2,054	2,048	2,032	2,017	2,002	1,988	1,975	1,962	1,949	1,938	1,926	1,915	1,905
90	Starr-County-3	23	5,236	5,241	5,253	5,263	5,274	5,284	5,294	5,304	5,314	5,324	5,333	5,343	5,352
91	Starr-County-4	23	1,494	1,524	1,598	1,671	1,741	1,810	1,877	1,943	2,006	2,069	2,129	2,188	2,245
92	Starr-County-2	23	6,828	6,878	6,989	7,101	7,211	7,319	7,425	7,528	7,629	7,727	7,823	7,917	8,008
93	Starr-County-1	23	11,309	11,334	11,408	11,485	11,554	11,614	11,672	11,728	11,782	11,835	11,888	11,940	11,990

Appendix G

Uncertainty Analysis Results: Change in Groundwater Elevation and Change in Total Dissolved Solids

Appendix G - Uncertainty Analysis Results: Change in Groundwater Elevation

Well Number	1	2	3	4	5	6	7	8	9	10	11	12
Well Name	Jardin-1	Feria-1	Laguna-Madre-2	Laguna-Madre-1	North-Cameron-1	Primera-1	McAllen-3	McAllen-2	McAllen-1	Mission-3	Mission-2	Mission-1
Associated Strategy Number	1	2	3	3	4	5	6	6	6	7	7	7
Strat01		0.18	-0.49	-0.46	0.51	0.95	6.22	6.1	5.79	9.5	8.71	8.66
Strat02	1.68		-0.34	-0.31	-0.18	0.4	2.23	2.18	1.98	4.41	4.08	3.97
Strat03	1.76	-0.31			0.08	0.66	1.85	1.79	1.62	3.77	3.48	3.37
Strat04	1.28	-1.95	-0.44	-0.42		-1.01	2.59	2.59	2.3	5.41	4.95	4.87
Strat05	1.77	-0.37	-0.35	-0.31	-0.06		1.89	1.83	1.65	3.89	3.59	3.47
Strat06	1.75	-0.35	-0.35	-0.32	0.05	0.64				2.87	2.66	2.48
Strat07	1.67	-0.17	-0.25	-0.23	0.2	0.78	3.44	3.35	3.11			
Strat08	1.85	-0.28	-0.32	-0.29	0.21	0.76	2.62	2.57	2.34	4.97	4.57	4.46
Strat09	1.49	-0.54	-0.27	-0.26	0.03	0.56	-0.91	-0.98	-1.06	0.38	0.4	0.21
Strat10	1.75	-0.3	-0.33	-0.29	0.1	0.68	1.39	1.37	1.2	3.36	3.11	2.99
Strat11	1.68	-0.21	-0.37	-0.34	0.2	0.75	2.8	2.74	2.53	5.03	4.65	4.54
Strat12	1.8	-0.33	-0.34	-0.31	0.01	0.6	1.88	1.83	1.65	3.83	3.54	3.43
Strat13	0.04	-0.81	-0.8	-0.78	-0.82	-0.21	6.53	6.33	6.05	8.07	7.29	7.36
Strat14	1.67	-0.26	-0.44	-0.4	-0.22	0.46	4.14	4.07	3.82	6.61	6.08	6.01
Strat15	1.56	-0.59	-0.31	-0.29	-0.58	0.21	1.75	1.53	1.35	4.92	4.49	4.21
Strat16	1.78	-0.3	-0.33	-0.3	0.11	0.69	1.89	1.83	1.65	3.88	3.58	3.47
Strat17	0.83	-1.66	-0.62	-0.62	-1.31	-0.77	2.3	2.24	2.02	4.89	4.55	4.39
Strat18	1.45	-0.28	-0.48	-0.45	-0.22	0.39	4.58	4.5	4.25	7.14	6.56	6.48
Strat19	1.73	-0.44	-0.34	-0.31	-0.07	0.53	2.17	2.12	1.92	4.34	4.02	3.9
Strat20	1.78	-0.25	-0.35	-0.31	0.14	0.72	1.91	1.85	1.67	3.91	3.61	3.5
Strat21	1.78	-0.26	-0.34	-0.3	0.13	0.71	1.86	1.8	1.62	3.83	3.53	3.42
Strat22	1.79	-0.32	-0.33	-0.3	0.08	0.67	1.86	1.8	1.63	3.83	3.54	3.43
Strat23	1.73	-0.32	-0.29	-0.28	0.05	0.61	4.35	4.28	3.99	6.99	6.41	6.37

Minimum	0.04	-1.95	-0.8	-0.78	-1.31	-1.01	-0.91	-0.98	-1.06	0.38	0.4	0.21
Maximum	1.85	0.18	-0.25	-0.23	0.51	0.95	6.53	6.33	6.05	9.5	8.71	8.66
Average	1.57	-0.46	-0.39	-0.36	-0.07	0.44	2.70	2.62	2.41	4.81	4.43	4.32
Range	1.81	2.13	0.55	0.55	1.82	1.96	7.44	7.31	7.11	9.12	8.31	8.45

Appendix G - Uncertainty Analysis Results: Change in Groundwater Elevation

Well Number	13	14	15	16	17	18	19	20	21	22	23
Well Name	Alamo-1	Sharyland-WTP2-1	Sharyland-WTP3-1	Union-1	Lyford-1	Delta-2	Delta-1	La-Sara-1	Cameron-County-2	Cameron-County-1	Cameron-County-3
Associated Strategy Number	8	9	10	11	12	13	13	14	15	15	15
Strat01	1.13	14.84	13.78	-0.52	-0.8	-1.83	-1.84	-3.25	-0.22	-0.19	-0.21
Strat02	-0.73	7.37	7.05	-0.78	-0.22	-2.42	-2.49	-1.27	-0.59	-0.55	-0.43
Strat03	-0.75	6.29	6.27	-0.73	-0.08	-2.1	-2.19	-1.05	-0.37	-0.33	-0.22
Strat04	-1.4	8.97	8.57	-0.77	-1.23	-2.77	-2.89	-1.85	-2	-1.93	-1.61
Strat05	-0.74	6.5	6.4	-0.68	-0.12	-2.16	-2.26	-1.02	-0.47	-0.42	-0.31
Strat06	-1.31	5.38	5.4	-0.67	-0.09	-2.28	-2.38	-0.99	-0.41	-0.36	-0.24
Strat07	-0.21	10.27	9.64	-0.66	0.18	-1.97	-2.06	-0.61	-0.25	-0.21	-0.16
Strat08		8.16	7.87	-0.72	-0.07	-2.02	-2.11	-1.12	-0.23	-0.2	-0.14
Strat09	-1.8		1.97	-0.58	0.15	-2.72	-2.84	-0.61	-0.24	-0.23	-0.17
Strat10	-0.91	5.39		-0.7	-0.06	-2.11	-2.2	-1.01	-0.36	-0.32	-0.21
Strat11	-0.41	8.1	7.74		0.1	-2.44	-2.53	-0.86	-0.24	-0.2	-0.12
Strat12	-0.74	6.37	6.32	-0.71		-2.16	-2.25	-1.37	-0.57	-0.52	-0.37
Strat13	0.79	14.78	15.28	-0.85	-0.15			-1.58	-1.16	-1.07	-0.85
Strat14	0.33	10.54	10.15	-0.7	0.42	-1.47	-1.6		-0.51	-0.45	-0.29
Strat15	-1.42	9.1	8.82	-0.8	-0.07	-2.18	-2.29	-0.32			
Strat16	-0.72	6.5	6.4	-0.7	-0.05	-2.1	-2.19	-0.97	-0.35	-0.31	-0.21
Strat17	-0.86	7.89	7.42	-0.91	-0.93	-2.94	-3.05	-1.89	-1.61	-1.53	-1.35
Strat18	-0.22	11.29	10.71	-0.71	0.36	-2.11	-2.2	-0.36	-0.57	-0.5	-0.3
Strat19	-0.72	7.18	6.93	-0.71	-0.16	-2.46	-2.62	-1.06	-0.54	-0.49	-0.36
Strat20	-0.71	6.55	6.45	-0.66	-0.04	-2.07	-2.17	-0.98	-0.32	-0.28	-0.19
Strat21	-0.72	6.38	6.27	-0.73	-0.04	-2.07	-2.16	-0.97	-0.33	-0.29	-0.19
Strat22	-0.76	6.41	6.35	-0.7	-0.07	-2.09	-2.19	-1.04	-0.37	-0.33	-0.22
Strat23	0.07	11.13	10.72	-0.81	-0.24	-1.89	-1.97	-0.95	-0.43	-0.41	-0.37

Minimum	-1.8	5.38	1.97	-0.91	-1.23	-2.94	-3.05	-3.25	-2	-1.93	-1.61
Maximum	1.13	14.84	15.28	-0.52	0.42	-1.47	-1.6	-0.32	-0.22	-0.19	-0.12
Average	-0.58	8.43	8.02	-0.72	-0.15	-2.20	-2.29	-1.14	-0.55	-0.51	-0.39
Range	2.93	9.46	13.31	0.39	1.65	1.47	1.45	2.93	1.78	1.74	1.49

Appendix G - Uncertainty Analysis Results: Change in Groundwater Elevation

Well Number	24	25	26	27	28	29	30	31	32	33	34	35
Well Name	Cameron-County-3	Cameron-County-5	Cameron-County-3	Cameron-County-4	Cameron-County-3	Cameron-County-2	Cameron-County-2	Cameron-County-1	Cameron-County-2	Cameron-County-9	Cameron-County-6	Cameron-County-1
Associated Strategy Number	15	15	15	15	15	15	15	15	15	15	15	15
Strat01	-0.15	0.26	0.04	0.1	0.19	-0.35	0.05	-0.07	0.1	0.07	0.18	-0.49
Strat02	-0.55	0.2	-0.55	-0.06	0.07	-1.03	-0.53	-0.16	-0.45	0.02	0.18	-0.59
Strat03	-0.32	0.32	-0.31	0.13	0.25	-0.8	-0.28	0.01	-0.2	0.21	0.37	-0.49
Strat04	-1.95	-0.71	-2.03	-1.18	-1.01	-2.49	-2.02	-1.18	-1.92	-1.04	-0.88	-1.35
Strat05	-0.43	0.28	-0.42	0.05	0.17	-0.89	-0.4	-0.06	-0.33	0.14	0.31	-0.5
Strat06	-0.36	0.32	-0.34	0.12	0.24	-0.86	-0.3	0	-0.22	0.2	0.37	-0.47
Strat07	-0.21	0.36	-0.18	0.18	0.28	-0.65	-0.16	0.04	-0.09	0.22	0.37	-0.44
Strat08	-0.19	0.38	-0.16	0.2	0.31	-0.63	-0.14	0.06	-0.07	0.26	0.43	-0.42
Strat09	-0.24	0.39	-0.27	0.14	0.26	-0.67	-0.27	0.03	-0.21	0.18	0.34	-0.29
Strat10	-0.31	0.35	-0.29	0.16	0.27	-0.79	-0.26	0.03	-0.18	0.23	0.4	-0.46
Strat11	-0.2	0.4	-0.17	0.21	0.32	-0.68	-0.15	0.08	-0.08	0.25	0.41	-0.38
Strat12	-0.5	0.26	-0.42	0.05	0.17	-0.9	-0.38	-0.06	-0.29	0.15	0.32	-0.5
Strat13	-1.09	-0.41	-1.15	-0.64	-0.54	-1.65	-1.13	-0.82	-1.05	-0.76	-0.67	-1.69
Strat14	-0.48	0.28	-0.57	0.04	0.16	-1.04	-0.55	-0.08	-0.46	0.08	0.22	-0.65
Strat15												
Strat16	-0.3	0.34	-0.28	0.15	0.26	-0.77	-0.25	0.02	-0.17	0.22	0.39	-0.46
Strat17	-1.56	-0.74	-1.62	-1.09	-0.96	-2.17	-1.6	-1.18	-1.53	-1.1	-0.99	-1.55
Strat18	-0.52	0.32	-0.58	0.02	0.15	-1.14	-0.55	-0.09	-0.46	0.03	0.16	-0.53
Strat19	-0.49	0.24	-0.47	0.02	0.14	-0.99	-0.44	-0.09	-0.35	0.11	0.27	-0.57
Strat20	-0.28	0.35	-0.25	0.17	0.28	-0.74	-0.22	0.04	-0.14	0.24	0.4	-0.45
Strat21	-0.29	0.35	-0.26	0.17	0.28	-0.75	-0.23	0.04	-0.15	0.25	0.41	-0.45
Strat22	-0.32	0.33	-0.31	0.14	0.26	-0.81	-0.28	0.02	-0.2	0.22	0.38	-0.47
Strat23	-0.4	0.27	-0.34	0	0.12	-0.75	-0.33	-0.1	-0.26	0.06	0.2	-0.41

Minimum	-1.95	-0.74	-2.03	-1.18	-1.01	-2.49	-2.02	-1.18	-1.92	-1.1	-0.99	-1.69
Maximum	-0.15	0.4	0.04	0.21	0.32	-0.35	0.05	0.08	0.1	0.26	0.43	-0.29
Average	-0.51	0.19	-0.50	-0.04	0.08	-0.98	-0.47	-0.16	-0.40	0.01	0.16	-0.62
Range	1.8	1.14	2.07	1.39	1.33	2.14	2.07	1.26	2.02	1.36	1.42	1.4

Appendix G - Uncertainty Analysis Results: Change in Groundwater Elevation

Well Number	36	37	38	39	40	41	42	43	44	45	46	47
Well Name	Cameron-County-4	Cameron-County-1	Cameron-County-3	Cameron-County-5	Cameron-County-2	Cameron-County-3	Cameron-County-4	Cameron-County-3	Cameron-County-1	Cameron-County-1	Cameron-County-4	Cameron-County-2
Associated Strategy Number	15	15	15	15	15	15	15	15	15	15	15	15
Strat01	0.09	-0.05	-0.54	-0.23	-0.05	-0.33	-0.01	0.23	-0.13	-0.02	-0.08	0.3
Strat02	-0.72	-0.18	-1.38	-1.07	-0.03	-0.42	-0.81	-0.51	-0.39	0.15	0.3	0.51
Strat03	-0.45	0.03	-1.1	-0.79	0.1	-0.33	-0.53	-0.23	-0.16	0.26	0.45	0.66
Strat04	-2.28	-1.37	-2.86	-2.59	-0.88	-1.14	-2.28	-1.95	-1.66	-0.62	-0.76	-0.34
Strat05	-0.58	-0.09	-1.19	-0.9	0.08	-0.33	-0.65	-0.37	-0.29	0.22	0.4	0.51
Strat06	-0.48	0.02	-1.15	-0.84	0.11	-0.31	-0.56	-0.26	-0.17	0.23	0.45	0.52
Strat07	-0.31	0.07	-0.93	-0.63	0.12	-0.28	-0.37	-0.08	-0.07	0.19	0.49	0.53
Strat08	-0.3	0.1	-0.95	-0.64	0.16	-0.25	-0.4	-0.12	-0.09	0.29	0.48	0.59
Strat09	-0.49	-0.04	-1.07	-0.79	0.16	-0.17	-0.61	-0.34	-0.29	0.27	0.33	0.51
Strat10	-0.43	0.06	-1.09	-0.78	0.14	-0.29	-0.51	-0.21	-0.13	0.29	0.55	0.55
Strat11	-0.31	0.07	-0.96	-0.65	0.16	-0.24	-0.4	-0.12	-0.13	0.31	0.39	0.57
Strat12	-0.51	-0.03	-1.15	-0.84	0.09	-0.33	-0.57	-0.28	-0.21	0.28	0.42	0.66
Strat13	-1.34	-0.93	-1.78	-1.55	-1.13	-1.55	-1.37	-1.1	-1.08	-1.25	-0.96	-0.87
Strat14	-0.76	-0.11	-1.33	-1.07	-0.06	-0.51	-0.77	-0.44	-0.27	0	0.35	0.38
Strat15												
Strat16	-0.42	0.05	-1.07	-0.76	0.13	-0.3	-0.5	-0.2	-0.14	0.31	0.5	0.71
Strat17	-1.86	-1.37	-2.48	-2.2	-1.1	-1.35	-1.94	-1.67	-1.65	-0.9	-1.06	-0.82
Strat18	-0.76	-0.21	-1.4	-1.1	-0.04	-0.4	-0.79	-0.49	-0.46	0.06	0.06	0.35
Strat19	-0.61	-0.08	-1.27	-0.96	0.01	-0.4	-0.68	-0.37	-0.28	0.18	0.41	0.54
Strat20	-0.39	0.07	-1.04	-0.73	0.14	-0.28	-0.46	-0.17	-0.1	0.28	0.46	0.52
Strat21	-0.39	0.08	-1.04	-0.74	0.15	-0.29	-0.47	-0.17	-0.11	0.32	0.5	0.69
Strat22	-0.45	0.04	-1.11	-0.8	0.13	-0.31	-0.52	-0.22	-0.15	0.3	0.5	0.75
Strat23	-0.42	-0.13	-1.03	-0.72	0.07	-0.26	-0.5	-0.23	-0.28	0.24	0.22	0.37

Minimum	-2.28	-1.37	-2.86	-2.59	-1.13	-1.55	-2.28	-1.95	-1.66	-1.25	-1.06	-0.87
Maximum	0.09	0.1	-0.54	-0.23	0.16	-0.17	-0.01	0.23	-0.07	0.32	0.55	0.75
Average	-0.64	-0.18	-1.27	-0.97	-0.07	-0.46	-0.71	-0.42	-0.37	0.06	0.20	0.37
Range	2.37	1.47	2.32	2.36	1.29	1.38	2.27	2.18	1.59	1.57	1.61	1.62

Appendix G - Uncertainty Analysis Results: Change in Groundwater Elevation

Well Number	48	49	50	51	52	53	54	55	56	57	58	59
Well Name	Cameron-County-4	Cameron-County-4	Cameron-County-3	Cameron-County-8	Cameron-County-4	Cameron-County-4	Cameron-County-3	Cameron-County-5	Cameron-County-5	Cameron-County-7	Cameron-County-4	Cameron-County-1
Associated Strategy Number	15	15	15	15	15	15	15	15	15	15	15	15
Strat01	-0.21	-0.63	-0.22	-0.38	-0.22	-0.27	-0.7	0.37	-0.67	-0.58	-0.61	-0.6
Strat02	-0.12	-0.65	-0.18	-0.48	-0.35	-0.25	-0.56	0.42	-1.4	-1.22	-0.92	-0.81
Strat03	0.14	-0.39	0.07	-0.21	-0.11	-0.04	-0.34	0.49	-1.13	-0.84	-0.74	-0.62
Strat04	-1.24	-1.84	-1.34	-1.65	-1.51	-1.16	-1.66	-0.33	-2.68	-2.27	-2.07	-1.83
Strat05	0.13	-0.49	0	-0.34	-0.2	-0.15	-0.4	0.52	-1.19	-1.01	-0.8	-0.67
Strat06	0.11	-0.42	0.06	-0.23	-0.11	-0.13	-0.41	0.53	-1.17	-0.86	-0.74	-0.63
Strat07	0.23	-0.35	0.12	-0.15	-0.01	-0.05	-0.4	0.57	-0.94	-0.58	-0.49	-0.48
Strat08	0.11	-0.44	0.02	-0.27	-0.15	-0.06	-0.34	0.57	-1.11	-1	-0.72	-0.57
Strat09	0.01	-0.57	-0.07	-0.4	-0.29	-0.17	-0.58	0.51	-1.35	-1.15	-0.94	-0.72
Strat10	0.2	-0.41	0.11	-0.24	-0.1	-0.09	-0.34	0.55	-1.11	-0.82	-0.72	-0.56
Strat11	0.06	-0.47	-0.01	-0.25	-0.14	-0.1	-0.39	0.53	-1.06	-0.91	-0.6	-0.57
Strat12	0.11	-0.41	0.04	-0.23	-0.13	0	-0.42	0.52	-1.15	-0.83	-0.74	-0.63
Strat13	-1.01	-1.43	-1.01	-1.22	-1.09	-1.29	-1.55	-0.53	-1.55	-1.4	-1.51	-1.48
Strat14	0.04	-0.45	0.01	-0.21	-0.13	-0.14	-0.43	0.45	-0.96	-0.62	-0.65	-0.55
Strat15												
Strat16	0.2	-0.36	0.12	-0.19	-0.1	-0.01	-0.42	0.54	-1.12	-0.83	-0.76	-0.61
Strat17	-1.48	-2.05	-1.57	-1.87	-1.74	-1.57	-2.02	-0.61	-2.55	-2.42	-2.32	-2.06
Strat18	-0.34	-0.89	-0.41	-0.68	-0.55	-0.46	-0.83	0.24	-1.16	-1.2	-1.19	-0.97
Strat19	0	-0.57	-0.07	-0.38	-0.24	-0.23	-0.44	0.47	-1.26	-1.05	-0.86	-0.69
Strat20	0.14	-0.41	0.07	-0.2	-0.1	-0.03	-0.29	0.57	-1.08	-0.8	-0.61	-0.58
Strat21	0.19	-0.32	0.13	-0.15	-0.06	0.04	-0.38	0.56	-1.08	-0.76	-0.69	-0.5
Strat22	0.19	-0.35	0.12	-0.18	-0.09	-0.04	-0.38	0.54	-1.13	-0.82	-0.73	-0.48
Strat23	-0.13	-0.63	-0.21	-0.46	-0.32	-0.28	-0.72	0.43	-1.09	-0.9	-0.84	-0.78

Minimum	-1.48	-2.05	-1.57	-1.87	-1.74	-1.57	-2.02	-0.61	-2.68	-2.42	-2.32	-2.06
Maximum	0.23	-0.32	0.13	-0.15	-0.01	0.04	-0.29	0.57	-0.67	-0.58	-0.49	-0.48
Average	-0.12	-0.66	-0.19	-0.47	-0.35	-0.29	-0.64	0.36	-1.27	-1.04	-0.92	-0.79
Range	1.71	1.73	1.7	1.72	1.73	1.61	1.73	1.18	2.01	1.84	1.83	1.58

Appendix G - Uncertainty Analysis Results: Change in Groundwater Elevation

Well Number	60	61	62	63	64	65	66	67	68	69	70	71
Well Name	Cameron-County-5	Cameron-County-1	Cameron-County-4	Cameron-County-1	Cameron-County-5	Cameron-County-3	Cameron-County-2	Cameron-County-1	Cameron-County-5	Cameron-County-2	Cameron-County-1	Cameron-County-2
Associated Strategy Number	15	15	15	15	15	15	15	15	15	15	15	15
Strat01	-0.35	-0.79	-0.64	-0.35	-0.35	-0.89	-0.5	-0.35	0.01	-0.32	-0.42	-1.31
Strat02	-1.09	-0.76	-0.63	-1.21	-1.02	-1.02	-1.39	-0.72	-0.92	-0.54	-0.92	-1.18
Strat03	-0.94	-0.51	-0.41	-1.04	-1.02	-0.85	-1.19	-0.5	-0.78	-0.42	-0.82	-1.15
Strat04	-2.17	-1.68	-1.52	-2.28	-2.1	-2.06	-2.5	-1.82	-1.95	-1.55	-1.93	-2.04
Strat05	-0.95	-0.59	-0.47	-1.06	-0.88	-0.83	-1.21	-0.56	-0.8	-0.42	-0.84	-1.1
Strat06	-0.94	-0.65	-0.53	-1.05	-0.86	-0.82	-1.22	-0.57	-0.8	-0.47	-0.84	-1.05
Strat07	-0.62	-0.61	-0.48	-0.7	-0.57	-0.79	-0.96	-0.42	-0.43	-0.37	-0.76	-1.21
Strat08	-0.93	-0.66	-0.53	-1.01	-0.89	-0.83	-1.16	-0.47	-0.76	-0.39	-0.76	-0.99
Strat09	-1.14	-0.78	-0.63	-1.24	-1.11	-1	-1.34	-0.65	-0.95	-0.52	-0.93	-1.13
Strat10	-0.91	-0.55	-0.43	-1.02	-0.87	-0.81	-1.17	-0.59	-0.75	-0.36	-0.69	-1.07
Strat11	-0.91	-0.65	-0.52	-1.01	-0.98	-0.82	-1.12	-0.49	-0.72	-0.4	-0.76	-1.07
Strat12	-0.94	-0.48	-0.38	-1.04	-1	-0.83	-1.19	-0.5	-0.78	-0.39	-0.81	-1.09
Strat13	-1.27	-1.6	-1.5	-1.25	-1.32	-1.65	-1.14	-1.22	-0.94	-1.2	-1.27	-2.16
Strat14	-0.54	-0.61	-0.49	-0.59	-0.51	-0.74	-0.73	-0.36	-0.29	-0.31	-0.52	-1.17
Strat15												
Strat16	-0.95	-0.52	-0.4	-1.05	-1.01	-0.85	-1.19	-0.5	-0.81	-0.39	-0.8	-1.09
Strat17	-2.36	-1.89	-1.74	-2.46	-2.32	-2.25	-2.5	-1.95	-2.11	-1.79	-2.1	-2.37
Strat18	-1.03	-1.06	-0.93	-1.02	-1.2	-1.23	-0.93	-0.92	-0.68	-0.82	-1.24	-1.52
Strat19	-1.02	-0.67	-0.55	-1.14	-1	-0.92	-1.29	-0.69	-0.86	-0.46	-0.8	-1.14
Strat20	-0.87	-0.56	-0.44	-0.98	-0.86	-0.75	-1.13	-0.48	-0.73	-0.42	-0.79	-1.02
Strat21	-0.89	-0.46	-0.36	-0.99	-0.95	-0.81	-1.14	-0.46	-0.73	-0.36	-0.77	-1.08
Strat22	-0.92	-0.49	-0.39	-1.03	-0.96	-0.82	-1.18	-0.52	-0.77	-0.37	-0.79	-1.08
Strat23	-0.82	-0.8	-0.67	-0.88	-0.87	-1.1	-1.11	-0.65	-0.64	-0.59	-0.87	-1.23

Minimum	-2.36	-1.89	-1.74	-2.46	-2.32	-2.25	-2.5	-1.95	-2.11	-1.79	-2.1	-2.37
Maximum	-0.35	-0.46	-0.36	-0.35	-0.35	-0.74	-0.5	-0.35	0.01	-0.31	-0.42	-0.99
Average	-1.03	-0.79	-0.67	-1.11	-1.03	-1.03	-1.24	-0.70	-0.83	-0.58	-0.93	-1.28
Range	2.01	1.43	1.38	2.11	1.97	1.51	2	1.6	2.12	1.48	1.68	1.38

Appendix G - Uncertainty Analysis Results: Change in Groundwater Elevation

Well Number	72	73	74	75	76	77	78	79	80	81	82	83
Well Name	Cameron-County-4	Cameron-County-3	Cameron-County-5	Cameron-County-2	Cameron-County-2	Military-Hwy-1	Military-Hwy-2	Military-Hwy-3	Military-Hwy-4	San-Benito-1	San-Benito-2	Alamo-2
Associated Strategy Number	15	15	15	15	15	16	16	16	16	17	17	18
Strat01	-0.3	-0.54	-0.27	-0.39	-1.03	-0.12	0.33	0.19	0.15	-0.55	-0.66	0.92
Strat02	-0.64	-0.56	-0.6	-0.44	-0.85	-1.06	-0.64	-0.82	-0.79	-0.47	-0.48	-0.87
Strat03	-0.49	-0.51	-0.48	-0.28	-0.88	-0.91	-0.51	-0.56	-0.68	-0.29	-0.39	-0.93
Strat04	-1.45	-1.3	-1.55	-1.36	-1.48	-2.08	-1.66	-1.79	-1.8	-1.56	-1.58	-1.71
Strat05	-0.47	-0.46	-0.48	-0.39	-0.82	-0.92	-0.53	-0.58	-0.7	-0.3	-0.29	-0.9
Strat06	-0.48	-0.44	-0.44	-0.34	-0.88	-0.92	-0.49	-0.56	-0.72	-0.26	-0.32	-1.43
Strat07	-0.47	-0.55	-0.43	-0.43	-0.91	-0.56	-0.15	-0.21	-0.34	-0.21	-0.27	-0.41
Strat08	-0.41	-0.4	-0.44	-0.41	-0.65	-0.88	-0.47	-0.63	-0.64	-0.28	-0.29	-1.21
Strat09	-0.55	-0.5	-0.52	-0.41	-0.91	-1.07	-0.65	-0.76	-0.84	-0.46	-0.54	-1.87
Strat10	-0.42	-0.41	-0.47	-0.33	-0.74	-0.88	-0.49	-0.53	-0.65	-0.23	-0.24	-1.08
Strat11	-0.4	-0.43	-0.39	-0.28	-0.81	-0.85	-0.43	-0.48	-0.63	-0.33	-0.41	-0.58
Strat12	-0.46	-0.47	-0.45	-0.24	-0.83	-0.9	-0.5	-0.55	-0.68	-0.32	-0.41	-0.91
Strat13	-1.15	-1.28	-1.14	-1.36	-1.87	-1.05	-0.7	-0.9	-0.98	-1.38	-1.48	0.52
Strat14	-0.23	-0.46	-0.31	-0.38	-0.71	-0.41	-0.01	-0.16	-0.2	-0.28	-0.4	0.08
Strat15						-0.76	-0.37	-0.5	-0.56	-0.53	-0.66	-1.57
Strat16	-0.45	-0.48	-0.45	-0.25	-0.85					-0.31	-0.37	-0.88
Strat17	-1.72	-1.72	-1.78	-1.65	-1.91	-2.25	-1.84	-1.96	-1.97			-1.05
Strat18	-0.82	-0.89	-0.87	-0.81	-1	-0.8	-0.45	-0.56	-0.61	-0.73	-0.8	
Strat19	-0.52	-0.44	-0.58	-0.46	-0.76	-0.99	-0.62	-0.66	-0.74	-0.36	-0.35	-0.89
Strat20	-0.42	-0.31	-0.4	-0.32	-0.87	-0.84	-0.44	-0.49	-0.68	-0.2	-0.21	-0.86
Strat21	-0.43	-0.45	-0.42	-0.22	-0.82	-0.86	-0.46	-0.52	-0.64	-0.26	-0.34	-0.89
Strat22	-0.45	-0.48	-0.44	-0.28	-0.85	-0.89	-0.5	-0.54	-0.67	-0.23	-0.36	-0.95
Strat23	-0.63	-0.57	-0.67	-0.57	-0.75	-0.75	-0.39	-0.46	-0.58	-0.58	-0.69	-0.1

Minimum	-1.72	-1.72	-1.78	-1.65	-1.91	-2.25	-1.84	-1.96	-1.97	-1.56	-1.58	-1.87
Maximum	-0.23	-0.31	-0.27	-0.22	-0.65	-0.12	0.33	0.19	0.15	-0.2	-0.21	0.92
Average	-0.61	-0.62	-0.62	-0.53	-0.96	-0.94	-0.54	-0.64	-0.73	-0.46	-0.52	-0.80
Range	1.49	1.41	1.51	1.43	1.26	2.13	2.17	2.15	2.12	1.36	1.37	2.79

Appendix G - Uncertainty Analysis Results: Change in Groundwater Elevation

Well Number	84	85	86	87	88	89	90	91	92	93
Well Name	Edcouch-1	Hidalgo-1	Hidalgo-2	Hidalgo-Steam-1	Weslaco-1	Starr-County-5	Starr-County-3	Starr-County-4	Starr-County-2	Starr-County-1
Associated Strategy Number	19	20	20	21	22	23	23	23	23	23
Strat01	-1.82	0.3	0.19	5.91	-1.5	0.11	-0.67	-0.91	-0.73	0.18
Strat02	-2.51	-0.61	-0.65	2.92	-2.36	-0.29	0.08	-0.56	-0.58	-0.1
Strat03	-2.24	-0.7	-0.73	2.85	-2.23	-0.32	0.12	-0.49	-0.57	-0.03
Strat04	-2.97	-0.85	-0.9	3.89	-3.56	0.21	0.23	-0.3	-0.55	0.06
Strat05	-2.31	-0.68	-0.71	2.85	-2.24	-0.31	0.11	-0.5	-0.57	-0.01
Strat06	-2.43	-1.1	-1.11	2.17	-2.4	-0.35	0.08	-0.55	-0.58	-0.06
Strat07	-2.09	-0.5	-0.55	4.43	-1.91	0.19	0.17	-0.29	-0.56	0.2
Strat08	-2.17	-0.45	-0.5	3.57	-2.19	-0.18	0.13	-0.44	-0.57	0
Strat09	-2.82	-1.92	-1.91	0.31	-2.43	-0.47	0.05	-0.28	-0.57	0.14
Strat10	-2.25	-0.79	-0.82	2.14	-2.27	-0.34	0.11	-0.52	-0.57	-0.03
Strat11	-2.55	-0.29	-0.34	3.28	-2.05	-0.43	-0.23	-0.99	-0.7	-0.67
Strat12	-2.3	-0.7	-0.73	2.85	-2.23	-0.32	0.1	-0.52	-0.57	-0.03
Strat13	-4.23	0.81	0.71	7.79	-2.2	0.53	-0.19	-0.53	-0.63	0
Strat14	-1.71	0.34	0.27	4.96	-1.95	-0.41	-0.1	-0.86	-0.65	-0.38
Strat15	-2.32	-1.15	-1.19	4.48	-2.53	1.01	-0.19	-0.65	-0.75	0.06
Strat16	-2.24	-0.67	-0.7	2.85	-2.2	-0.32	0.1	-0.52	-0.58	-0.03
Strat17	-3.14	-0.57	-0.6	3.02	-3	0.03	-0.23	-1	-0.7	-0.42
Strat18	-2.24	0.51	0.43	4.77	-2.06	-0.57	-0.05	-0.75	-0.62	-0.24
Strat19		-0.62	-0.65	3.07	-2.32	-0.35	0.07	-0.56	-0.58	-0.08
Strat20	-2.21			2.88	-2.16	-0.31	0.11	-0.5	-0.57	0
Strat21	-2.21	-0.68	-0.71		-2.18	-0.32	0.11	-0.52	-0.57	-0.04
Strat22	-2.24	-0.7	-0.73	2.89		-0.31	0.12	-0.5	-0.57	-0.02
Strat23	-2.01	0.03	-0.03	5.18	-2					

Minimum	-4.23	-1.92	-1.91	0.31	-3.56	-0.57	-0.67	-1	-0.75	-0.67
Maximum	-1.71	0.81	0.71	7.79	-1.5	1.01	0.23	-0.28	-0.55	0.2
Average	-2.41	-0.50	-0.54	3.59	-2.27	-0.16	0.00	-0.58	-0.61	-0.07
Range	2.52	2.73	2.62	7.48	2.06	1.58	0.9	0.72	0.2	0.87

Appendix G - Uncertainty Analysis Results: Change in Total Dissolved Solids (percent)

Well Number	1	2	3	4	5	6	7	8	9	10	11	12
Well Name	Jardin-1	Feria-1	Laguna-Madre-2	Laguna-Madre-1	North-Cameron-1	Primera-1	McAllen-3	McAllen-2	McAllen-1	Mission-3	Mission-2	Mission-1
Associated Strategy Number	1	2	3	3	4	5	6	6	6	7	7	7
Strat01		-15.75	5.1	3.91	-19.07	-20.71	0.9	4.49	4.43	-3.89	-2.85	-2.98
Strat02	-18.48		4.35	3.28	-16.35	-19.42	8.37	8.86	9.68	-2.51	-1.5	-1.58
Strat03	-18.91	-16.3			-16.66	-19.61	9.15	9.19	9.95	-2.25	-1.17	-1.21
Strat04	-18.15	-15.72	4.15	3.16		-18.49	7.14	6.23	7.54	-3.02	-1.75	-2.05
Strat05	-18.72	-16.48	4.45	3.36	-16.9		9.2	9.24	10.03	-2.34	-1.28	-1.3
Strat06	-18.81	-16.06	4.53	3.41	-16.59	-19.51				-2.15	-1.07	-1.1
Strat07	-18.68	-15.96	4.02	3.06	-16.15	-19.47	6.7	6.01	7.6			
Strat08	-19.06	-16.08	4.47	3.36	-16.48	-19.5	7.76	8.65	9.31	-2.59	-1.42	-1.52
Strat09	-17.61	-15.28	3.89	2.95	-16.28	-19.43	13.04	12.32	12.6	-1.42	-0.36	-0.21
Strat10	-18.67	-16.43	4.4	3.33	-16.78	-19.63	9.2	9.22	9.97	-2.2	-1.15	-1.19
Strat11	-18.18	-16.12	4.5	3.41	-16.8	-19.64	6.78	8.03	8.7	-2.59	-1.5	-1.61
Strat12	-18.92	-16.31	4.41	3.35	-16.56	-19.55	9.16	9.21	9.94	-2.31	-1.24	-1.26
Strat13	-14.69	-16.21	4.96	3.79	-15.06	-19.24	-0.26	1.9	3.22	-3.41	-2.22	-2.74
Strat14	-18.43	-15.44	4.77	3.6	-14.72	-19.04	6.25	7.65	8.17	-3.19	-2.01	-2.13
Strat15	-17.73	-16.32	3.63	2.78	-15.99	-19.24	19.18	16.66	18.19	-2.14	-0.4	-0.26
Strat16	-18.9	-16.35	4.31	3.27	-16.74	-19.65	9.12	9.19	9.98	-2.3	-1.24	-1.28
Strat17	-17.88	-15.97	4.05	3.14	-14.85	-18.74	7.33	8.63	9.22	-2.73	-1.63	-1.73
Strat18	-18.62	-15.76	4.75	3.56	-15.8	-19.35	3.31	5.77	6.14	-3.27	-2.14	-2.26
Strat19	-18.36	-16.64	4.48	3.39	-16.64	-19.57	8.47	8.65	9.43	-2.4	-1.37	-1.43
Strat20	-18.79	-15.96	4.63	3.47	-16.52	-19.49	9.32	9.29	10.14	-2.27	-1.24	-1.27
Strat21	-18.9	-16.22	4.4	3.34	-16.74	-19.63	9.1	9.29	10.04	-2.27	-1.18	-1.2
Strat22	-18.92	-16.28	4.34	3.29	-16.68	-19.6	9.17	9.22	10	-2.27	-1.22	-1.26
Strat23	-18.69	-16.16	3.97	3.04	-17.3	-19.88	3.68	4.62	5.55	-3.55	-2.18	-2.56

Minimum	-19.06	-16.64	3.63	2.78	-19.07	-20.71	-0.26	1.9	3.22	-3.89	-2.85	-2.98
Maximum	-14.69	-15.28	5.1	3.91	-14.72	-18.49	19.18	16.66	18.19	-1.42	-0.36	-0.21
Average	-18.37	-16.08	4.39	3.33	-16.44	-19.47	7.82	8.29	9.08	-2.59	-1.46	-1.55
Range	4.37	1.36	1.47	1.13	4.35	2.22	19.44	14.76	14.97	2.47	2.49	2.77

Appendix G - Uncertainty Analysis Results: Change in Total Dissolved Solids (percent)

Well Number	13	14	15	16	17	18	19	20	21	22	23
Well Name	Alamo-1	Sharyland-WTP2-1	Sharyland-WTP3-1	Union-1	Lyford-1	Delta-2	Delta-1	La-Sara-1	Cameron-County-2	Cameron-County-1	Cameron-County-3
Associated Strategy Number	8	9	10	11	12	13	13	14	15	15	15
Strat01	-13.75	-8.08	-24.2	0.65	-20.31	-5.01	1.41	-33.35	-12.54	-8.81	1.59
Strat02	-12.71	-6.91	-21.13	0.65	-20.33	-5.27	1.76	-33.69	-11.59	-7.91	1.78
Strat03	-12.82	-6.53	-20.84	0.65	-20.35	-5.29	1.77	-33.87	-11.91	-8.26	1.59
Strat04	-12.06	-7.21	-21.69	0.65	-19.22	-5.03	1.94	-33.15	-10.2	-6.76	2.68
Strat05	-12.83	-6.63	-21	0.65	-20.35	-5.29	1.76	-33.83	-11.88	-8.21	1.53
Strat06	-12.68	-6.63	-20.83	0.65	-20.27	-5.39	1.7	-33.83	-11.79	-8.18	1.65
Strat07	-13.01	-7.51	-22.67	0.66	-20.6	-5.27	1.83	-34.08	-11.7	-8.09	1.78
Strat08		-6.86	-21.54	0.65	-20.29	-5.27	1.82	-33.82	-11.44	-7.97	1.64
Strat09	-12.01		-19.13	0.66	-20.18	-5.71	1.61	-33.74	-11.84	-8.16	1.73
Strat10	-12.87	-6.43		0.65	-20.47	-5.34	1.72	-33.89	-11.92	-8.27	1.61
Strat11	-13.37	-6.89	-21.62		-20.41	-5.39	1.78	-33.99	-11.99	-8.33	1.57
Strat12	-12.74	-6.53	-20.84	0.65		-5.28	1.78	-33.63	-12.07	-8.46	1.96
Strat13	-13.8	-8.69	-24.84	0.65	-20.51			-26.41	-10.32	-7.39	1.3
Strat14	-14.32	-7.3	-22.29	0.65	-21.15	-4.87	2.05		-11.07	-7.61	1.59
Strat15	-11.61	-7.27	-22.79	0.65	-19.11	-5.09	1.92	-34.21			
Strat16	-12.84	-6.56	-20.87	0.65	-20.43	-5.3	1.75	-33.87	-11.92	-8.27	1.59
Strat17	-12.92	-7.07	-21.62	0.64	-19.71	-4.99	2.12	-33.09	-10.6	-7.24	1.92
Strat18	-14.59	-7.57	-22.72	0.65	-20.31	-4.93	2.1	-34.11	-10.88	-7.55	1.54
Strat19	-13.01	-6.82	-21.16	0.65	-20.36	-5.08	1.89	-33.66	-11.64	-8.08	1.63
Strat20	-12.83	-6.73	-21.11	0.65	-20.12	-5.28	1.77	-33.78	-11.94	-8.26	1.67
Strat21	-12.79	-6.52	-20.87	0.65	-20.46	-5.28	1.77	-33.9	-11.77	-8.19	1.6
Strat22	-12.83	-6.56	-20.88	0.65	-20.43	-5.3	1.75	-33.87	-11.93	-8.26	1.63
Strat23	-11.08	-7.45	-22.27	0.64	-19.85	-5.14	1.83	-33.94	-11.96	-8.38	1.64

Minimum	-14.59	-8.69	-24.84	0.64	-21.15	-5.71	1.41	-34.21	-12.54	-8.81	1.3
Maximum	-11.08	-6.43	-19.13	0.66	-19.11	-4.87	2.12	-26.41	-10.2	-6.76	2.68
Average	-12.89	-7.03	-21.68	0.65	-20.24	-5.22	1.81	-33.44	-11.59	-8.03	1.69
Range	3.51	2.26	5.71	0.02	2.04	0.84	0.71	7.8	2.34	2.05	1.38

Appendix G - Uncertainty Analysis Results: Change in Total Dissolved Solids (percent)

Well Number	24	25	26	27	28	29	30	31	32	33	34	35
Well Name	Cameron-County-3	Cameron-County-5	Cameron-County-3	Cameron-County-4	Cameron-County-3	Cameron-County-2	Cameron-County-2	Cameron-County-1	Cameron-County-2	Cameron-County-9	Cameron-County-6	Cameron-County-1
Associated Strategy Number	15	15	15	15	15	15	15	15	15	15	15	15
Strat01	-9.8	-7.02	-15.21	-3.82	-5.3	-15.99	-12.51	-1.22	-13.49	-6.11	-8.07	2.88
Strat02	-9.05	-6.81	-14.04	-3.38	-4.9	-15.59	-10.73	-0.8	-11.99	-5.7	-8.1	3.95
Strat03	-9.3	-6.87	-14.18	-3.52	-5.03	-15.37	-11.15	-0.91	-12.27	-5.8	-8.41	3.76
Strat04	-8.15	-6.09	-12.91	-2.46	-4.07	-14.61	-8.89	-0.07	-11.18	-5.19	-7.21	4.71
Strat05	-9.24	-6.8	-14.16	-3.45	-4.95	-15.52	-11.17	-0.86	-12.4	-5.64	-8.2	3.79
Strat06	-9.23	-6.81	-14.14	-3.46	-4.97	-15.36	-11.13	-0.87	-12.22	-5.75	-8.32	3.82
Strat07	-9.13	-6.8	-13.84	-3.48	-5	-14.96	-10.73	-0.88	-11.77	-5.67	-7.96	4.06
Strat08	-9.03	-6.92	-13.92	-3.52	-5.05	-15.29	-10.98	-0.94	-12.02	-5.82	-8.41	3.61
Strat09	-9.18	-6.75	-13.92	-3.37	-4.89	-16.08	-10.77	-0.81	-11.78	-5.69	-8.11	2.91
Strat10	-9.32	-6.87	-14.24	-3.5	-5.01	-15.47	-11.23	-0.89	-12.34	-5.79	-8.41	3.83
Strat11	-9.35	-6.89	-14.3	-3.57	-5.07	-15.4	-11.34	-0.98	-12.4	-5.86	-8.41	3.35
Strat12	-9.46	-6.74	-14.16	-3.28	-4.83	-15.32	-11.11	-0.74	-12.16	-5.69	-8.32	3.76
Strat13	-8.45	-7.15	-12.9	-3.93	-5.44	-13.78	-10.15	-1.35	-11.68	-5.99	-7.96	6.15
Strat14	-8.61	-6.98	-12.49	-3.57	-5.11	-13.85	-8.95	-0.98	-10.31	-5.69	-8.07	4.56
Strat15												
Strat16	-9.3	-6.88	-14.21	-3.53	-5.04	-15.42	-11.2	-0.92	-12.3	-5.82	-8.43	3.76
Strat17	-8.35	-6.28	-13.04	-3.09	-4.55	-13.9	-9.89	-0.65	-11.01	-5.5	-7.39	4.87
Strat18	-8.63	-7.16	-13.38	-3.71	-5.24	-13.93	-10.26	-1.2	-11.51	-5.93	-8.28	3.3
Strat19	-9.19	-6.85	-14.18	-3.51	-5.02	-15.24	-10.96	-0.9	-12.19	-5.76	-8.14	4.16
Strat20	-9.29	-6.75	-14.07	-3.41	-4.91	-15.32	-11.05	-0.79	-12.17	-5.68	-8.17	3.89
Strat21	-9.26	-6.87	-14.17	-3.51	-5.03	-15.4	-11.23	-0.91	-12.32	-5.81	-8.44	3.78
Strat22	-9.3	-6.86	-14.2	-3.5	-5.01	-15.54	-11.1	-0.89	-12.21	-5.79	-8.39	3.84
Strat23	-9.58	-6.73	-15.01	-3.32	-4.79	-16.08	-11.98	-0.65	-12.97	-5.68	-7.89	3.27

Minimum	-9.8	-7.16	-15.21	-3.93	-5.44	-16.08	-12.51	-1.35	-13.49	-6.11	-8.44	2.88
Maximum	-8.15	-6.09	-12.49	-2.46	-4.07	-13.78	-8.89	-0.07	-10.31	-5.19	-7.21	6.15
Average	-9.10	-6.81	-13.94	-3.45	-4.96	-15.16	-10.84	-0.87	-12.03	-5.74	-8.14	3.91
Range	1.65	1.07	2.72	1.47	1.37	2.3	3.62	1.28	3.18	0.92	1.23	3.27

Appendix G - Uncertainty Analysis Results: Change in Total Dissolved Solids (percent)

Well Number	36	37	38	39	40	41	42	43	44	45	46	47
Well Name	Cameron-County-4	Cameron-County-1	Cameron-County-3	Cameron-County-5	Cameron-County-2	Cameron-County-3	Cameron-County-4	Cameron-County-3	Cameron-County-1	Cameron-County-1	Cameron-County-4	Cameron-County-2
Associated Strategy Number	15	15	15	15	15	15	15	15	15	15	15	15
Strat01	-13.96	-3.53	-0.95	-7.97	-2.62	2.28	-10.66	-16.95	-2.22	1	-5.05	-5.74
Strat02	-10.09	-2.91	0.22	-5.68	-2.63	3.47	-8.2	-14.2	-1.96	-1.07	-9.17	-5.89
Strat03	-10.59	-3.05	-0.22	-6.26	-3.01	3.21	-8.63	-14.54	-2.03	-1.97	-5.82	-5.69
Strat04	-7.66	-2.21	2.31	-3.14	-1.64	4.22	-7	-12.96	-1.57	0.03	-6.8	-4.98
Strat05	-10.63	-2.08	-0.02	-6	-2.88	3.27	-8.58	-14.7	-2.14	-0.85	-8.72	-4.85
Strat06	-10.6	-2.99	-0.2	-6.21	-2.76	3.33	-8.56	-14.52	-1.99	-0.59	-8.33	-4.47
Strat07	-10.04	-3	0.12	-5.75	-2.48	3.68	-8.4	-14.44	-2.02	0.77	-7.5	-5.87
Strat08	-10.62	-3.03	-0.22	-6.25	-2.97	2.93	-8.53	-14.51	-1.97	-0.95	-6.09	-5.64
Strat09	-10.43	-2.96	-0.71	-6.74	-2.61	2.54	-8.49	-14.02	-1.98	-0.35	-5.95	-5.71
Strat10	-10.82	-3.04	-0.25	-6.33	-2.96	3.31	-8.72	-14.65	-2.04	-1.34	-6.17	-5.83
Strat11	-10.88	-3.1	-0.2	-6.33	-2.92	2.8	-8.7	-14.68	-1.98	-1.56	-5.09	-5.37
Strat12	-10.54	-2.93	-0.16	-6.18	-3.01	3.22	-8.54	-14.52	-2.04	-2.04	-5.84	-5.6
Strat13	-7.34	-3.14	1.02	-4.29	-1.45	5.69	-6.37	-12.33	-1.9	4.12	-5.84	-3.1
Strat14	-7.84	-2.89	1.9	-3.46	-2.54	4.22	-6.82	-13.06	-1.99	0.52	-6.64	-5.27
Strat15												
Strat16	-10.81	-3.08	-0.23	-6.33	-3.04	3.25	-8.73	-14.66	-2.06	-2.01	-6.06	-6.28
Strat17	-7.72	-2.63	2.49	-2.99	-1.52	4.39	-6.75	-13.1	-1.46	0.6	-6.19	-3.58
Strat18	-9.34	-3.13	1.4	-4.49	-2.77	2.94	-7.79	-13.83	-1.92	-0.77	-5.24	-6.9
Strat19	-10.32	-3.01	0.17	-5.86	-2.59	3.69	-8.56	-14.55	-1.94	-0.76	-8.12	-7.28
Strat20	-10.41	-2.95	0.03	-5.94	-2.71	3.33	-8.44	-14.45	-1.95	-0.86	-5.56	-5.45
Strat21	-10.7	-3.04	-0.35	-6.34	-3.03	3.24	-8.65	-14.63	-2.05	-1.88	-5.88	-5.11
Strat22	-10.78	-3.05	-0.18	-6.31	-3	3.31	-8.72	-14.62	-2.04	-2.01	-5.95	-6.14
Strat23	-12.12	-2.94	-1.3	-8.16	-2.49	3.27	-9.58	-15.32	-1.98	-0.95	-5.57	-4.96

Minimum	-13.96	-3.53	-1.3	-8.16	-3.04	2.28	-10.66	-16.95	-2.22	-2.04	-9.17	-7.28
Maximum	-7.34	-2.08	2.49	-2.99	-1.45	5.69	-6.37	-12.33	-1.46	4.12	-5.05	-3.1
Average	-10.19	-2.94	0.21	-5.77	-2.62	3.44	-8.34	-14.33	-1.97	-0.59	-6.44	-5.44
Range	6.62	1.45	3.79	5.17	1.59	3.41	4.29	4.62	0.76	6.16	4.12	4.18

Appendix G - Uncertainty Analysis Results: Change in Total Dissolved Solids (percent)

Well Number	48	49	50	51	52	53	54	55	56	57	58	59
Well Name	Cameron-County-4	Cameron-County-4	Cameron-County-3	Cameron-County-8	Cameron-County-4	Cameron-County-4	Cameron-County-3	Cameron-County-5	Cameron-County-5	Cameron-County-7	Cameron-County-4	Cameron-County-1
Associated Strategy Number	15	15	15	15	15	15	15	15	15	15	15	15
Strat01	-2.58	14.26	-2.28	5.74	1.9	1.39	15.27	-8.56	22.99	22.75	23.01	15.42
Strat02	-3.92	12.32	-3.23	5.38	1.11	1.71	12.2	-8.75	19.63	27.06	24	14.69
Strat03	-5.37	9.99	-5.33	2.28	-1.66	0.52	11.54	-8.81	23.16	10.85	22.34	13.34
Strat04	-3.17	13.63	-1.93	6.68	1.9	1.19	14.5	-8.58	22.31	31.86	26.6	16.7
Strat05	-7.34	11.7	-5.12	5.43	-0.05	2.38	12.1	-8.79	22.45	33.53	24.55	14.6
Strat06	-4.98	11.08	-5.11	2.81	-0.85	2.44	8.56	-8.62	25.09	14.1	23.56	14.24
Strat07	-7.55	11.8	-5.93	3.67	-1.87	0.97	9.27	-8.81	20.32	12.43	21.99	14.23
Strat08	-3.42	13.16	-2.54	6.42	2.77	1.81	12.14	-8.74	23.88	26.76	26.21	15.33
Strat09	-6.49	10.29	-6.67	3.2	-1.45	1.13	9.7	-8.71	23.45	20.1	23.54	14.8
Strat10	-6.94	11.75	-6.34	4.46	-1	2.31	12.24	-8.95	21.72	25.84	23.65	16.52
Strat11	-3.89	12.35	-3.62	3.1	0.96	1.84	11.54	-8.75	20.41	19.21	23.73	15.19
Strat12	-5.37	9.82	-5.27	1.91	-1.75	-0.29	9.42	-8.81	22.84	12.39	22.28	13.75
Strat13	-4.13	13.05	-4.2	4.99	0.68	2.98	13.93	-8.86	19.42	16.28	22.24	13.36
Strat14	-4.84	11.17	-4.6	2.04	-0.94	1.52	8.92	-8.88	19.74	25.85	24.2	13.84
Strat15												
Strat16	-7.32	9.58	-6.67	2.22	-1.57	0.77	8.9	-8.83	22.12	22.06	24.24	13.24
Strat17	-3.79	13.47	-2.59	6.23	0.86	2.63	14.12	-8.61	20.32	33	26.23	17.23
Strat18	-2.89	14.19	-2.47	6.19	0.62	2.02	10.6	-8.87	20.39	23.13	26.96	13.99
Strat19	-4.38	13.03	-3.79	5.67	-0.2	3.02	12.03	-8.69	21.05	33.39	25.4	15.81
Strat20	-4.21	12.87	-3.73	4.22	1.39	1.69	11.18	-8.7	25.32	14.73	25.28	14.31
Strat21	-5.73	9.13	-5.79	1.53	-1.7	-0.38	9.07	-8.8	23.21	13.45	22.7	17.51
Strat22	-6.92	8.98	-6.6	1.43	-1.73	1.06	13.3	-8.83	22.68	20.91	23.45	16.9
Strat23	-3.92	13.01	-2.51	6.14	1.38	1.63	11.4	-8.81	20.92	18.79	24.78	15.41

Minimum	-7.55	8.98	-6.67	1.43	-1.87	-0.38	8.56	-8.95	19.42	10.85	21.99	13.24
Maximum	-2.58	14.26	-1.93	6.68	2.77	3.02	15.27	-8.56	25.32	33.53	26.96	17.51
Average	-4.96	11.85	-4.38	4.17	-0.05	1.56	11.45	-8.76	21.97	21.75	24.13	15.02
Range	4.97	5.28	4.74	5.25	4.64	3.4	6.71	0.39	5.9	22.68	4.97	4.27

Appendix G - Uncertainty Analysis Results: Change in Total Dissolved Solids (percent)

Well Number	60	61	62	63	64	65	66	67	68	69	70	71
Well Name	Cameron-County-5	Cameron-County-1	Cameron-County-4	Cameron-County-1	Cameron-County-5	Cameron-County-3	Cameron-County-2	Cameron-County-1	Cameron-County-5	Cameron-County-2	Cameron-County-1	Cameron-County-2
Associated Strategy Number	15	15	15	15	15	15	15	15	15	15	15	15
Strat01	12.32	14.55	9.96	8.83	12.97	20.44	-4.47	11.87	-25.15	3.25	14.48	22.85
Strat02	11.83	10.47	6.46	12.69	23.91	18.32	-2.87	11.59	-26.57	3.29	18.52	21.1
Strat03	11	7.32	3.83	10.46	20.41	18.92	-2.16	7.6	-23.34	3.38	18.16	21.67
Strat04	11.66	10.46	6	12.15	23.64	21.26	-3.74	13.09	-25.67	5.51	22.17	23.56
Strat05	10.67	9.75	5.81	9.9	21.61	17.74	-1.61	9.66	-22.97	3.61	18.18	21.31
Strat06	10.86	11.68	7.64	10.19	13.73	17.62	-1.79	11.81	-22.6	5.19	20.76	20.63
Strat07	9.97	11.69	7.41	8.76	11.91	18.82	-2.11	11.77	-24.73	3.51	18.61	22.7
Strat08	13	13.23	9.51	10.51	22.97	18.84	-2.73	9.79	-22.26	5.97	17.65	21.06
Strat09	11.87	12.72	8.28	10.69	15.9	19.89	-2.94	8.18	-23.25	4.4	20.67	21.48
Strat10	10.95	9.48	5.78	11.67	27.31	17.87	-2.19	11.86	-24.88	3.22	17.05	21.2
Strat11	11.8	11.99	7.78	10.95	20.23	18.64	-1.93	8.61	-22.98	4.38	19.81	21.43
Strat12	10.85	7.08	3.61	9.78	19.4	18.95	-2.36	7.52	-23.42	3.25	18.06	21.67
Strat13	9.12	12.29	8.87	6.8	22.85	16.94	-8.35	9.88	-24.61	3.86	12.91	22.99
Strat14	9.38	11.61	7.45	7.9	21.07	18.44	-4.3	12.23	-24.66	3.46	17.71	22.46
Strat15												
Strat16	11.19	8.56	4.57	11.06	20.47	19.59	-2.2	7.94	-23.69	3.07	18.22	21.58
Strat17	12.43	9.86	5.93	14.05	25.84	20.35	-2.1	9.6	-25.54	5.91	20.43	23.67
Strat18	10.68	12.91	8.94	8.68	20.85	18.87	-5.8	10.82	-25.02	5.33	19.93	22.23
Strat19	11.12	10.16	6.45	12.3	27.4	17.98	-2	11.71	-25.25	3.48	18.98	21.1
Strat20	11.17	10.56	6.55	11.35	15.92	17.29	-1.23	9.83	-21.65	4.95	19.09	20.55
Strat21	10.93	7.5	4.02	10.02	19.67	19.01	-2.17	7.56	-23.14	3.22	17.01	21.72
Strat22	11.04	7.81	4.23	10.78	18.89	18.48	-2.33	8.66	-23.78	2.83	19.04	21.34
Strat23	8.33	11.24	7.42	7.21	14.69	20.3	-3.01	8.35	-25.13	4.99	17.08	22.32

Minimum	8.33	7.08	3.61	6.8	11.91	16.94	-8.35	7.52	-26.57	2.83	12.91	20.55
Maximum	13	14.55	9.96	14.05	27.4	21.26	-1.23	13.09	-21.65	5.97	22.17	23.67
Average	11.01	10.59	6.66	10.31	20.07	18.84	-2.93	10.00	-24.10	4.09	18.39	21.85
Range	4.67	7.47	6.35	7.25	15.49	4.32	7.12	5.57	4.92	3.14	9.26	3.12

Appendix G - Uncertainty Analysis Results: Change in Total Dissolved Solids (percent)

Well Number	72	73	74	75	76	77	78	79	80	81	82	83
Well Name	Cameron-County-4	Cameron-County-3	Cameron-County-5	Cameron-County-2	Cameron-County-2	Military-Hwy-1	Military-Hwy-2	Military-Hwy-3	Military-Hwy-4	San-Benito-1	San-Benito-2	Alamo-2
Associated Strategy Number	15	15	15	15	15	16	16	16	16	17	17	18
Strat01	2.57	8.8	3.62	5.74	12.85	-14.81	-36.64	-33.42	-31.69	7.99	9.73	-20.53
Strat02	5.41	7.48	4.6	2.87	10.67	-12.62	-35.31	-31.1	-29.7	7.1	6.33	-18.91
Strat03	3.98	8.5	3.96	0.91	11.77	-11.59	-33.09	-28.23	-29.45	6.32	7.6	-19.17
Strat04	4.92	6.09	5.69	6.65	10.66	-14.88	-35.24	-34.14	-31.81	8.34	7.84	-18.07
Strat05	4.02	8.61	4.65	5.09	11.42	-11.68	-32	-34.97	-31.21	6.73	5.62	-19.18
Strat06	4.22	7.2	3.52	4.57	12.02	-11.64	-35.52	-27.47	-29.02	6.16	6.93	-18.96
Strat07	4.45	10.37	4.04	6.69	12.79	-13.24	-33.78	-37.29	-31.77	5.7	6.87	-19.44
Strat08	5.9	9.2	6.32	7.93	12.15	-11.3	-33.21	-30.2	-23.85	7.5	7.26	-20.98
Strat09	4.62	8.53	4.23	4.46	12.51	-12.57	-34.56	-22.03	-20.31	7.09	8.65	-18.05
Strat10	3.75	7.73	4.58	4.92	10.31	-11.76	-31.75	-30.4	-27.29	6.41	5.56	-19.24
Strat11	3.96	8.43	4.26	3.7	12.1	-11.73	-33.11	-29.92	-24.47	6.8	8.02	-19.91
Strat12	4.03	8.77	4.04	1.66	11.81	-11.78	-33.17	-30.07	-30.26	6.43	7.85	-19
Strat13	2.61	6.61	3.69	6.61	12.43	-14.9	-36.58	-32.13	-26.85	6.86	8.36	-20.88
Strat14	1.64	8.9	4.22	6.01	9.55	-14.47	-34.59	-33.2	-24.03	5.64	7.59	-21.29
Strat15						-15.05	-36.39	-25.94	-28.04	5.97	6.44	-17.28
Strat16	3.73	9.14	3.67	1.66	12.1					7.22	7.94	-19.18
Strat17	4.88	10.07	5.1	5.47	12.25	-13.71	-34.95	-34.58	-28.1			-19.35
Strat18	4.6	9.13	6.47	6.69	8.8	-13.93	-34.6	-25.19	-25.7	8.16	9.34	
Strat19	3.83	6.1	4.94	5.77	11.43	-12.46	-31.81	-24.85	-26.46	6.9	5.83	-19.48
Strat20	3.62	4.67	3.48	3.43	12.6	-11.3	-34.06	-35.35	-31.74	6.98	6.35	-19.13
Strat21	3.96	8.72	4.02	1.71	11.77	-11.54	-32.95	-29.82	-29.88	6.63	7.77	-19.11
Strat22	3.96	9.36	4.05	2.85	12.04	-11.69	-32.84	-28.21	-28.83	5.99	6.99	-19.16
Strat23	5.63	7.67	6.38	6.74	10.45	-14.46	-35.72	-38.69	-27.84	8.18	9.61	-16.64

Minimum	1.64	4.67	3.48	0.91	8.8	-15.05	-36.64	-38.69	-31.81	5.64	5.56	-21.29
Maximum	5.9	10.37	6.47	7.93	12.85	-11.3	-31.75	-22.03	-20.31	8.34	9.73	-16.64
Average	4.10	8.19	4.52	4.64	11.57	-12.87	-34.18	-30.78	-28.10	6.87	7.48	-19.22
Range	4.26	5.7	2.99	7.02	4.05	3.75	4.89	16.66	11.5	2.7	4.17	4.65

Appendix G - Uncertainty Analysis Results: Change in Total Dissolved Solids (percent)

Well Number	84	85	86	87	88	89	90	91	92	93
Well Name	Edcouch-1	Hidalgo-1	Hidalgo-2	Hidalgo-Steam-1	Weslaco-1	Starr-County-5	Starr-County-3	Starr-County-4	Starr-County-2	Starr-County-1
Associated Strategy Number	19	20	20	21	22	23	23	23	23	23
Strat01	11.58	2.37	-2.29	-1.11	16.57	-6.02	1.21	-0.37	8.13	2.26
Strat02	14.67	-11.73	-14.67	-1.1	13.52	-6.02	1.2	-0.36	8.24	2.28
Strat03	14.77	-13.09	-15.79	-1.08	13.42	-6.03	1.2	-0.36	8.34	2.29
Strat04	14.25	-11.51	-14.69	-1.14	14.89	-6.03	1.2	-0.37	8.53	2.31
Strat05	14.74	-12.81	-15.54	-1.08	13.43	-6.04	1.2	-0.36	8.3	2.29
Strat06	14.74	-18.63	-20.23	-1.09	12.9	-6.04	1.21	-0.37	8.37	2.27
Strat07	14.01	-9.48	-13.09	-1.11	13.4	-6.03	1.2	-0.36	8.41	2.28
Strat08	14.7	-10.76	-13.89	-1.1	13.28	-6.02	1.2	-0.37	8.46	2.29
Strat09	14.91	-21.29	-21.88	-1.07	12.74	-6.02	1.19	-0.37	8.81	2.3
Strat10	14.66	-14.35	-16.85	-1.08	13.2	-6.04	1.2	-0.36	8.34	2.29
Strat11	15.23	-9.26	-12.74	-1.09	13.42	-6.03	1.2	-0.37	8.09	2.3
Strat12	14.75	-13.06	-15.79	-1.08	13.31	-6.04	1.2	-0.36	8.36	2.29
Strat13	14.29	1.77	-2.93	-1.13	15.44	-6.03	1.21	-0.37	7.61	2.26
Strat14	15.52	-5.58	-9.65	-1.1	14.36	-6.04	1.21	-0.36	8.55	2.31
Strat15	15.55	-11.74	-14.61	-1.14	12.55	-6.11	1.21	-0.37	8.08	2.26
Strat16	14.74	-12.97	-15.71	-1.08	13.36	-6.04	1.2	-0.36	8.33	2.29
Strat17	15.14	-12.45	-15.51	-1.1	14	-6.07	1.23	-0.36	8.24	2.28
Strat18	16.46	-5.51	-9.75	-1.1	13.66	-6	1.19	-0.37	8.36	2.29
Strat19		-11.74	-14.66	-1.09	13.49	-6.02	1.2	-0.36	8.29	2.28
Strat20	14.8			-1.09	13.38	-6.06	1.21	-0.37	8.36	2.27
Strat21	14.76	-13.34	-16.03		13.37	-6.03	1.2	-0.36	8.33	2.29
Strat22	14.68	-13.19	-15.9	-1.08		-6.04	1.2	-0.36	8.34	2.29
Strat23	14.57	-7.02	-11.17	-1.12	13.25					

Minimum	11.58	-21.29	-21.88	-1.14	12.55	-6.11	1.19	-0.37	7.61	2.26
Maximum	16.46	2.37	-2.29	-1.07	16.57	-6	1.23	-0.36	8.81	2.31
Average	14.71	-10.70	-13.79	-1.10	13.68	-6.04	1.20	-0.36	8.31	2.29
Range	4.88	23.66	19.59	0.07	4.02	0.11	0.04	0.01	1.2	0.05

Appendix H

Responses to Comments (Letter of August 22, 2017)

Appendix H – Responses to Comments (Letter of August 22, 2017)

General Comments:

1. **For all documents the title pages and page headers should reference TWDB Contract Number 1548301854. Please remove references to TWDB Report#.**

Header (with TWDB Contract Number) has been added.

2. **When not applicable, please remove references to ESRI, USGS, and NOAA on the Figures in each report.**

Not applicable to this report.

3. **Please be informed that source code and documentation of the MODFLOW-USG version used during the project would be due with the final project deliverables.**

Not applicable to this report.

Draft Predictive Model Report comments:

General comments to be addressed:

4. **Per TWDB Contract No. 1548301854, please make the predictive model report accessible for people with disabilities.**

Final report will be made accessible for people with disabilities

5. **Please include an executive summary in the predictive model report, per TWDB Contract No. 1548301854 Exhibit B; Attachment 1, page 33.**

Executive Summary has been added

6. **Per TWDB Contract No. 1548301854 Exhibit B, Attachment 1, page 33, please follow the guidelines in constructing the sections of the predictive model report and designing it with the general public as the audience. We recommend that the information provided in current sections 2.0 through 7.0 be rearranged per the guidelines referenced above. Any additional information that would be helpful for more technically inclined audience should be provided in Appendices.**

Report has been reorganized with the specified section titles

7. **Please include maps as outlined on TWDB Contract No. 1548301854 Exhibit B, Attachment 1, page 33, under "4.0 Results of Predictive Scenarios". These maps include but are not limited to water level and water quality (total dissolved solids) for each hydrostratigraphic unit for the years 2020, 2030, 2040, and 2050; possible impacts of seawater intrusion, such as a total dissolved solids contour of 35,000 milligrams per liter near the coast; possible upcoming of higher-salinity groundwater near a desalination pumping center. If such maps cannot be included, please provide equivalent replacement and/or justification for the same.**

This comment correctly identifies that the standard contract language calls for maps of water level and water quality (total dissolved solids) for each hydrostratigraphic unit for the years 2020, 2030, 2040, and 2050. Because this is standard language, it does not reflect the specifics of this effort.

Region M had identified 23 separate groundwater-related strategies and the model was used to consider them individually and as a group, as well as a base case on which the results could be compared. Moreover, the predictive simulations were run through the year 2070 to match up with current Regional Water Planning practice. Thus, under the specific language of the contract, the simulations should have been run only through the year 2050. Also, the preparing a report in accordance with specific language would have resulted in 2,400 maps (two parameters, four time periods, 12 model layers, and 25 scenarios). If the years 2060 and 2070 were also included, an additional 1,200 maps would need to be included, for a total of 3,600 maps.

Given the objective of the simulations (evaluating the potential impacts of Region M groundwater strategies), the reported results focused on items of interest to advancing the regional planning process. The maps would be of secondary value to the results presented (changes in groundwater elevation at each well site, potential subsidence at each well site, changes in groundwater quality at each well site, and overall impacts to the groundwater budget).

Most of the results presented were focused on the individual well sites, which is useful to understand the potential impacts of the strategies, individually and collectively. The larger regional results were summarized in the context of the groundwater budget impacts. The groundwater budget results are not required in the standard contract language, but are far more useful in documenting the regional impacts of the proposed strategies than a collection of maps.

One of the advantages of TWDB using Groundwater Vistas as a pre- and post-processor is that these types of results can be viewed as a simulation is completed. The deliverables include 25 individual Groundwater Vistas files (one for each scenario) that can be used to generate any or all of the maps. Examples of these maps have been included in Appendix D, and the text has been updated to reflect the inclusion of these examples.

Finally, it should be noted that one of the objectives of this effort was to deliver a tool that could be used in the future. It is reasonable to assume that some of the strategies may be dropped from consideration and some may be added. As documented in the report, the deliverables can be used

to modify or create new strategies as the next round of regional planning develops. The Regional Planning consultants (or groundwater conservation district consultants) can use this developed tool to evaluate new strategies as necessary to advance their objectives as they develop.

8. **Please discuss all the limitations of the model as a separate section titled, "5.0 Limitations", per TWDB Contract No. 1548301854 Exhibit B, Attachment 1, page 34.**

This is essentially a repeat of Comment 6 above. Section 5 is now titled "Limitations".

Draft Predictive Model Report comments:

Specific comments to be addressed:

9. **Please consider including results of subsidence analysis for the year(s) 2020, 2030, 2040, and 2050 in the individual strategy results along with other major results such as drawdowns, to present summary of pertinent information to the general audience in one section such as the current section 7.1 to 7.23.**

The comment mirrors the contract language by specifying years (2020, 2030, 2040, and 2050) even though the simulations were completed through the year 2070 so that the simulations results would be useful to the Regional Planning Group.

As noted in the report, the post-processing of the results included output files of groundwater elevation and total dissolved solids concentration for all stress periods and for all wells for each of the scenarios. These output files are included in the project deliverables. In response to the comment, two appendices have been added for the scenario that includes all strategies (Scenario "AllStrat"). Appendix E presents the results from the output file with groundwater elevations. Appendix F presents the results from the output file with total dissolved solids. Subsidence estimates, as explained in the report, are based on a relationship between long-term drawdown and long-term drawdown. Although possible mathematically possible, the calculation was not completed for the intermediate results because the relationship is specifically for long-term subsidence.

10. **Please consider adding pumpage information as well as subsidence results in the table provided in Appendix A.**

Appendix A has been split into Appendix A (change in groundwater elevation), Appendix B (subsidence), and Appendix C (change in total dissolved solids). Pumping amounts for each simulated well has been added to each of these tables.

11. **The representative spatial scale of estimated subsidence values is unclear from the description in the report. Please describe the spatial scale at which**

subsidence values were estimated from drawdown data and at which they are deemed representative. For e.g. were the subsidence values estimated from average drawdown values at the CLN element (simulating the well) or in the cell containing the well and are representative of subsidence estimates only in the vicinity of the well; or perhaps the subsidence values were estimated for drawdown values from all the cells within two-three miles (or some other distance) of the well and are therefore representative

As described in the report, subsidence is calculated from drawdown based on a relationship from the Houston Area Groundwater Model (HAGM). Also, as described in the report, drawdown is calculated in the post-processor included in the deliverables (*posthedcon.exe*). As described in Section 3.3.1 of the report, Groundwater Vistas creates a file named *well-info.csv*, which contains data for all wells in a particular simulation. The file was edited to include only the 93 wells associated with the water management strategies, and named *stratwells.csv*. Wells located in more than one layer as defined by the file *stratwells.csv* were treated as a single well for purposes of the post-processing calculations. Heads and concentrations values reported for each well represent the average value over all the layers that the well is located as defined in *stratwells.csv*. The averaging calculation was completed using the groundwater nodes associated with each well as defined in *stratwells.csv*. The text in the report has been revised to clarify the averaging approach in response to this comment.

Appendix I

Responses to Comments (Email of October 31, 2017)

Appendix I – Responses to Comments (Email of October 31, 2017)

1. **Please clarify the baseline year for the predictive simulations and please be consistent throughout the report. For example, the Executive Summary and Section 1.2 states the models were from 2013 through 2070; however, Table 1 suggests the model runs were from 2014 to 2070. Please update the report as needed for consistency.**

To be clear, the calibrated model ends in 2013 and the predictive runs cover the period 2014 to 2070. Errors in the text have been corrected.

2. **Please clarify the basis for pumping for the base case model. For example, Section 1.2, states the base case model used pumping from the last stress period of the calibrated model (2013); however, in Section 3.1 the text suggests the pumping was from 2012. Please update the report as needed for consistency.**

To be clear, the calibrated model ends in 2013 and the predictive runs cover the period 2014 to 2070. Baseline pumping used model estimates for 2013. Errors in the text have been corrected.

3. **Please clearly state in the text of the report that the initial head and other boundary conditions, such as rivers, drains, and so on, were from the last stress period of the calibrated model--2013. In addition, please discuss assumptions for the recharge used in the predictive simulations; for example, was the recharge biased toward dry or wet conditions.**

The text in Section 3.1 has been updated to reflect the following assumptions used for the predictive simulations: The base case was developed by assuming recharge from the steady state condition of the calibrated model (Stress Period 1), and pumping from 2013 (Stress Period 30). All other time-based packages used the parameters from Stress Period 30 (2013 conditions). These other packages included the EVT (Evapotranspiration), RIV (River), GHB (General Head Boundary), CHD (Constant Head), and QRT (Return Flow).

Please note that Section 4.1 included a discussion of the use of steady state recharge and its impact on results. The text has been modified slightly in response to this comment.

4. **Please clearly state in the text of the report that the other predictive scenarios add pumping to the base case model, which were based on 23 Region M planning strategies.**

The text in Section 3.1 has been updated to clearly state that each of the predictive scenarios result in pumping that is added to the base case. Also, a new section and table has been added (Section 1.3 and Table 2) that presents the total pumping and scenario.

5. **Table 3: please review Table 3 and please clarify if the last two columns should be percentages. Please update the table, as needed.**

The table has been updated (and is now Table 4).

6. **Page 24 and Figure 5: please clarify in the text of the report if the lower and higher bounds were qualitatively determined or if another approach was used. In the text of the report, please concisely summarize the approach used to model subsidence including any limitations in the approach used considering the assumptions, and please provide any recommendations that would result in a more accurate prediction of subsidence and possibly a more correlated scatter plot in Figure 5.**

The text has been updated in response to this comment. The most important emphasis is that site-specific data are needed at the design level to better understand the potential for subsidence.

7. **Please include maps as outlined on TWDB Contract No. 1548301854 Exhibit B, Attachment 1, page 33, under "4.0 Results of Predictive Scenarios". These maps include but are not limited to water level and water quality (total dissolved solids) for each hydrostratigraphic unit for the years 2020, 2030, 2040, and 2050; possible impacts of seawater intrusion, such as a total dissolved solids contour of 35,000 milligrams per liter near the coast; possible upconing of higher-salinity groundwater near a desalination pumping center. If such maps cannot be included, please provide equivalent replacement and/or justification for the same.**

This is a repeat of the Comment 7 from the letter of August 22, 2017. The response to this comment was included in the draft final report (now Appendix H), and is repeated below:

This comment correctly identifies that the standard contract language calls for maps of water level and water quality (total dissolved solids) for each hydrostratigraphic unit for the years 2020, 2030, 2040, and 2050. Because this is standard language, it does not reflect the specifics of this effort.

Region M had identified 23 separate groundwater-related strategies and the model was used to consider them individually and as a group, as well as a base case on which the results could be compared. Moreover, the predictive simulations were run through the year 2070 to match up with current Regional Water Planning practice. Thus, under the specific language of the contract, the simulations should have been run only through the year 2050. Also, the preparing a report in accordance with specific language would have resulted in 2,400 maps (two parameters, four time periods, 12 model layers, and 25 scenarios). If the years 2060 and 2070 were also included, an additional 1,200 maps would need to be included, for a total of 3,600 maps.

Given the objective of the simulations (evaluating the potential impacts of Region M groundwater strategies), the reported results focused on items of interest to advancing the regional planning process. The maps would be of secondary value to the results presented (changes in groundwater elevation at each well site, potential subsidence at each well site, changes in groundwater quality at each well site, and overall impacts to the groundwater budget).

Most of the results presented were focused on the individual well sites, which is useful to understand the potential impacts of the strategies, individually and collectively. The larger regional results were summarized in the context of the groundwater budget impacts. The groundwater budget results are not required in the standard contract language, but are far more useful in documenting the regional impacts of the proposed strategies than a collection of maps.

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Finally, it should be noted that one of the objectives of this effort was to deliver a tool that could be used in the future. It is reasonable to assume that some of the strategies may be dropped from consideration and some may be added. As documented in the report, the deliverables can be used to modify or create new strategies as the next round of regional planning develops. The Regional Planning consultants (or groundwater conservation district consultants) can use this developed tool to evaluate new strategies as necessary to advance their objectives as they develop.

8. **Please expand Section 4.2 to discuss how to interpret model results and uncertainty results. For example, it may be insightful to take a strategy such as Strategy 7 and discuss the results (please see italicized comments below):**

Strategy 7--Mission

- **Number of Wells: 3**
- **Change in Groundwater Elevation under Baseline Conditions (2013 to 2070): 3.50 to 3.91 ft.** ***Please explain how this was calculated and please refer to Appendix A, if applicable.***
    - **Range of Change (from Uncertainty Analysis): 0.21 to 9.50 ft** ***Please explain how this was calculated and how it relates to values noted above.***
- **Change in Total Dissolved Solids under Baseline Conditions (2014 to 2070): -1 to -2 percent** ***Please explain how this was calculated and please refer to Appendix C, if applicable.***
    - **Range of Change (from Uncertainty Analysis): -4 to 0 percent** ***Please explain how this was calculated and how it relates to values noted above.***
- **Pumping in Stress Period 1 (2014): 3,360 AF/yr**
- **Pumping in Stress Period 12 (2070): 3,364 AF/yr** ***Please clarify if the increase in pumping is due to the strategy. It would be good to comment out the differences. Please clarify if the values are from the well file or water budget.***
- **Change in Groundwater Elevation from 2013 to 2070 in area of pumped well: 2.23 to 2.78 ft** ***Please explain how this was calculated and how it relates to values noted above***
- **Change from Baseline Condition (attributable to strategy): -1.13 to -1.27 ft** ***Please explain how this was calculated and how it relates to values noted above and baseline values.***
- **Potential Range of Subsidence: 0 ft**

- **Change in Total Dissolved Solids from 2013 to 2070 in area of pumped well: -4 to -3 percent** ***Please explain how this was calculated and please refer to Appendix B, if applicable.***
    - **Change from Baseline Condition (attributable to strategy): -1 to -2 percent** ***Please explain how this was calculated and how it relates to values noted above and the baseline values.***

In response to this comment, clarifying text has been added to Section 4.2 and a new table (Table 7) has been added that lists each of the results and the source of the information and data used in the summaries.

Additionally, in response to the blue italicized comments, a new Appendix has been added (Appendix G) that provides detailed results of the uncertainty analysis on a scenario by scenario and well by well basis.