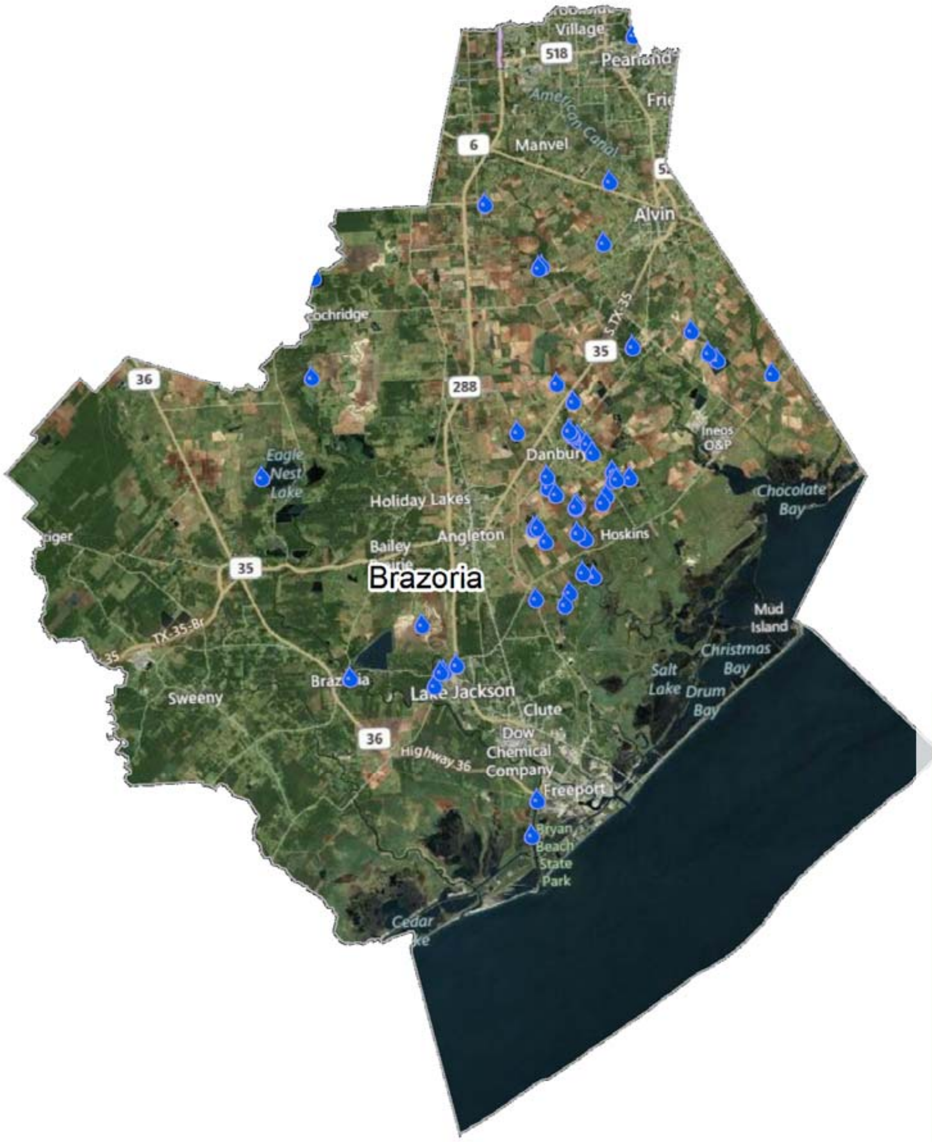
APPENDIX H

Predictions of Potential Impacts on Water Levels and Land Subsidence in Brazoria County Report

November 2013

CDM Smith

Predictions of Potential Impacts on Water Levels and Land Subsidence caused by Well Fields near Brazosport Water Authority Plant in Brazoria County



Final Report

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Executive Summary

This study was conducted to evaluate the impacts of future groundwater production near the Brazos River Water Authority's (BWA) water treatment plant (WTP) on groundwater drawdown and land subsidence. The Houston Area Groundwater Model (HAGM) (Kasmarek, 2012) and the Lower-Colorado River Basin (LCRB) model (Young and others, 2009) were used to simulate the impacts of pumping on water level and subsidence surrounding the proposed well fields. The pumping scenarios simulated by the HAGM are:

- **Pumping Scenario 1:** Two wells pumping 1,000 GPM of slightly saline water in the lower Chicot Aquifer. The wells are located on the current property boundary for the BWA WTP.

- **Pumping Scenario 2:** Four wells pumping 1,000 GPM of slightly saline water from the lower Chicot Aquifer. All four wells are located on the current property boundary for BWA WTP.

- **Pumping Scenario 3:** Four wells pumping 1,000 GPM of slightly saline water from the lower Chicot Aquifer. The two well pumping the from the lower Chicot located on the current property boundary BWA WTP and two well pumping the lower Chicot located across the Brazos River from the BWA WTP.

Modeling results from the HAGM indicate that the impacts for all three pumping scenarios are acceptable and will not adversely impact current well owners or land owners. For all three scenarios, the predicted drawdown was less than 12 beyond a five-mile radius from the wells and the predicted land subsidence was less than 0.1 ft beyond a five-mile radius from the wells. The comparison of results between the HAGM and the LCRB model indicate that the HAGM model may be over predicting both drawdown and land subsidence.

1.0 Background

The purpose of this study is to evaluate the potential for pumping in the vicinity of the Brazosport Water Authority (BWA) Water Treatment Plant (WTP) to cause groundwater drawdowns and land subsidence. **Figure 1** shows the proposed well field in Brazoria County, Texas. The well field scenarios pump water at rates between 2,000 gallons per minute (GPM and 4,000 GPM from the Chicot Aquifer.

The Chicot aquifer is part of the Gulf Coast Aquifer System. Currently, Groundwater Management Area 14 (GMA 14) is using the Houston Area Groundwater Model (HAGM) (Kasmarek, 2012) for predicting regional changes to water levels caused by projected pumping in the northern gulf coast aquifer system. To help check of the reasonableness of the HAGM predictions, predictions from the Lower-Colorado River Basin (LCRB) model (Young and others, 2009) are also performed for two of the pumping scenarios.

The HAGM is used to simulate three pumping scenarios from proposed wells near the Brazosport Water Authority. The three simulations are:

- **Pumping Scenario 1:** Two wells pumping 1,000 GPM of slightly saline water in the lower Chicot Aquifer. The wells are located on the current property boundary for the Brazosport Water Treatment Plant.
- **Pumping Scenario 2:** Four wells pumping 1,000 GPM of slightly saline water from the lower Chicot Aquifer. All four wells are located on the current property boundary for BWA WTP.
- **Pumping Scenario 3:** Four wells pumping 1,000 GPM of slightly saline water from the lower Chicot Aquifer - two wells pumping the from the lower Chicot located on the current property boundary for BWA WTP and two wells pumping the lower Chicot located across the Brazos River from the BWAWTP.

The HAGM is a MODFLOW-2000 (Harbaugh and others, 1996) groundwater flow model that was developed by the United States Geologic Survey (Kasmarek, 2012) for the Northern Gulf Coast Aquifer System. The HAGM model calibration period begins in 1900 and ends in 2009. The model has four model layers that represent the Chicot Aquifer, Evangeline Aquifer, the Burkeville Confining Layer, and the Jasper Aquifer. The grid cells are uniformly one square mile. The HAGM was developed by revising the current GAM for GMA 14 (Kasmarek and Robinson, 2004).

The LCRB model is a MODFLOW-SURFACT (HGL, 2005) groundwater flow model that was developed by URS and INTERA for the Lower Colorado River Authority. The LCRB model calibration period begins in 1900 and ends in 2006. The model has six model layers that represent a shallow flow zone, the Beaumont Formation in the Chicot Aquifer, the Lissie Formation in the Chicot Aquifer, the Willis Formation in the Chicot Aquifer, the Upper Goliad Formation in the Evangeline Aquifer, and the Lower Goliad Formation in the Evangeline Aquifer. The grid cells are non-uniform with dimensions varying between 0.25 miles and one mile.

Figure 2 shows the model domain for the HAGM and the LCRB model. The two models overlap coverage in Brazoria County. The development of the HAGM focused on the model calibration on a five-county area that included Brazoria County. The development of the LCRB Model focused on the model calibration on Colorado, Wharton, and Matagorda Counties.

In a previous analyses of the Gulf Coast Aquifer in the vicinity of the Brazosport well field (INTERA, 2012) the analysis of geophysical logs indicated that the upper Chicot and lower Chicot contain fresh water and slightly saline water, respectively. INTERA (2012) defined fresh water to have a Total Dissolved Solids (TDS) less than 1,000 parts per million (ppm) and defined slightly saline water to have a TDS between 1,000 ppm and 3,000 ppm. Because the HAGM model represents the Chicot Aquifer as one model layer and the HAGM assumes a well fully penetrates the entire aquifer, the HAGM cannot differentiate between pumping the upper and lower Chicot Aquifer. However, the LCRB model represents the Chicot as four different model layers and therefore can be used to differentiate pumping between the upper and lower Chicot Aquifer.

2.0 Simulation of Historical Groundwater Level and Land Subsidence in the HAGM

Figure 3 shows the historical pumping in Brazoria County in the HAGM model. In Brazoria County, pumping only occurs in the Chicot Aquifer and Evangeline Aquifer. Figure 4 presents the historical water level and subsidence in Chicot Aquifer simulated by the HAGM model at the proposed well field in the Chicot Aquifer from 1920 to 2006.

The HAGM was calibrated to measured water level and land subsidence from predevelop conditions (~1900) to 2009. Figure 5 shows the drawdown and land subsidence the HAGM simulated for 2005 relative to predevelopment conditions. Two potentially important measures of a groundwater model's ability to predict pumping impacts are an accurate representation of the aquifer hydraulic properties and the ability to predict historical water levels given that there is an accurate representation of historical pumping. To help evaluate the HAGM, an assessment was made of how well the HAGM simulated water levels matched the measured water levels within a 20 mile radius of the proposed well fields (see Figure 6). The measured water levels were obtained from the Texas Water Development Board (TWDB) groundwater database. The simulated water levels were extracted from the HAGM at the locations of the TWDB wells that had more than four water level measurements (a total of 59 wells). Table 1 shows the calculated mean error and the root mean squared errors (RMSE) for the 59 wells. The considerable spread in both set of numbers is attributed to simplifications in the model structure, inaccuracies with representing the aquifer hydraulic properties, and inaccuracies in the historical pumping. The average RMSE represents an estimate of the average error in the simulating the water level. For the HAGM, the RMSE for the 59 wells is about 34 feet. This amount of error has been considered acceptable by the TWDB (Wade and others, 2013).

3.0 Potential Impacts of Future Groundwater Pumping on Water Levels and Land Subsidence Predicted by the HAGM

Four model runs were conducted using the HAGM to predict impacts of future groundwater pumping on water levels and subsidence. The model runs are described below:

> **Baseline Pumping Scenario:** Baseline predictive run (1900-2050). The HAGM model was temporally extended to 2050. The boundary conditions (including pumping locations and rates) from the beginning of 2006 to the end of the simulation are identical to those in year 2005. This run provides a baseline prediction assuming all the conditions continue without variation.
>
> **Pumping Scenario 1:** Baseline predictive run with two additional wells pumping slightly saline water at 1,000 GPM each (2,000 GPM total), starting at the beginning of 2006 and continuing until 2050. These two wells, represented by wells 1 and 2 in Figure 7, are added into model layer 1 (Chicot).
>
> **Pumping Scenario 2.** Baseline predictive run with the four wells (wells 1 through 4 in Figure 7) pumping slightly saline water at 1,000 GPM each (4,000 GPM total), starting at the beginning of 2006 and continuing until 2050. All of these four additional wells are located in model layer 1 (Chicot).
>
> **Pumping Scenario 3.** Baseline predictive run with two brackish freshwater wells across the Brazos River (wells 1 and 2 in Figure 8) and two brackish water wells (wells 3 and 4 in Figures 7 and 8) pumping at 1,000 GPM each (4,000 GPM total), starting at the beginning of 2006 and continuing until the end of the model. All of these four additional wells are located in model layer 1 (Chicot).

Figures 9 through 12 show the simulated water level and subsidence at the well field over time (2006-2050) for the baseline and three pumping scenarios. Contours of drawdown from 2005 to 2050 in model layer 1 are plotted in Figure 13 for the Baseline Pumping Scenario.

For Pumping Scenarios 1, 2, and 3, the difference of the simulation results (water level and subsidence) and those from the Baseline Pumping Scenario shows the effect of production at the well field. Figures 14 through 22 show the contours of net water level change and subsidence caused by the well field pumping as simulated by the HAGM in years 2020, 2035 and 2050, for the three pumping scenarios.

4.0 Simulation of Historical and Future Groundwater Levels and Land Subsidence using the LCRB Model

Figures 23 and 24 show the simulated water level and subsidence for the historical period (before 2005) in the LCRB model. For the convenience of comparison, the simulated values of the HAGM model were plotted in the same figures as well. Table 1 shows how well the LCRB matches the historical measurements of the measured water levels compared to the HAGM model. The RMSE for the LCRB model and the HAGM are about 36 ft and 34 ft respectively. Thus, the HAGM has a slightly better fit than the LCRB model. However, the LCRB was calibrated to also match hydraulic conductivity values (Young and others, 2006) where the calibration criteria listed by Kasmarek (2012, pg. 12) does not indicate that matching hydraulic conductivity or any other measured aquifer hydraulic parameter was a part of the objective function used to drive the calibration. The lack of objective constraints on the aquifer parameters can lead to unrepresentative and even unrealistic hydraulic conductivity values. During its calibration, the LCRB model was also constrained to develop aquifer parameters that are developed from empirically based relationship between the measured physical properties of the aquifer such as percent sand, depth of burial and depositional setting to constraint hydraulic conductivity, and other aquifer parameters during model calibration. For these reasons, the LCRB Model was used to simulate pumping scenarios so that results could be compared to those produced by the HAGM. Descriptions of the three pumping scenarios simulated by the LCRB model are as follows:

Baseline Pumping Scenario: (1900-2050). From the beginning of 2006, the recharge rate at each grid cell was set to the average recharge rate from 1900 through 2000; and the pumping rate at each well was set as the average pumping in 2005. This run provides a baseline prediction assuming all the conditions continue as an average condition.

Pumping Scenario 4: Baseline predictive run with two additional wells pumping fresh water at 1,000 GPM each (2,000 GPM total), starting at the beginning of 2006 and continuing until 2050. These two wells, represented by wells 1 and 2 in Figure 7, are added into model layer 2 (Beaumont).

Pumping Scenario 5: Baseline predictive run with two additional freshwater wells (wells 1 and 2 in Figure 7) and two brackish water wells (wells 3 and 4 in Figure 7) pumping at 1,000 GPM each (4,000 GPM total), starting at the beginning of 2006 and continuing until 2050. The two freshwater wells are located in Model Layer 2 (Beaumont) and the two brackish water wells are located in Model Layer 3 (Lissie).

Figures 25 through 30 show the simulated water level and subsidence at the well field over time in the predictive period for the pumping scenarios. Figures 31 and 32 shows the net water level and subsidence caused by the additional water production simulated by the LCRB predictive runs in 2050.

5.0 Comparison Between Clay Thicknesses and Aquifer Parameters in the HAGM that Affect Predicted Subsidence

The two aquifer parameters in groundwater models that affect the amount of subsidence predicted from drawdown are preconsolidation head and the non-elastic storage coefficient. Subsidence is calculated by multiplying the drawdown either by the elastic storage coefficient or the non-elastic storage coefficient. the storage coefficient. Typically, the elastic storage coefficient is 10 to 100 times lower than the non-elastic coefficient. Preconsolidation head determines the drawdown at which the subsidence is determined by the non-elastic storage coefficient instead of the elastic storage coefficient. Thus, subsidence does not typically become an issue of concern until after drawdown exceeds the preconsolidation head. Lower predictions of subsidence will thus occur from higher preconsolidation heads and lower non-elastic storage coefficients.

The magnitude of the elastic and non-elastic storage coefficients across an aquifer is primarily determined by the thickness of clay. As a result, an aquifer storage coefficient should increase with an increase in the total thickness of the clay in the aquifer. Figure 33 shows the estimates of clay thicknesses in the Chicot and Evangeline Aquifers. These estimates are from Young and others (2010, 2012) and were determined as part of a stratigraphic analysis of the Gulf Coast. Several attempts were made to obtain the clay thickness measurements from the USGS from a Freedom of Information Act request sent to the Fort Bend Subsidence District, who funded the development of the HAGM. However, neither the Fort Bend Subsidence District nor the USGS provided any data. Thus, the values from Young (2010, 2012) are used for this discussion. The clay thickness values in Figure 33 suggest that clay thicknesses vary by a factor of within about a 20 mile radius of the well field and that the total clay thicknesses tend to increase toward the east. The spatial distribution of the HAGM non-elastic storage values in Figure 34 appear to be consistent with the clay thicknesses values.

6.0 Summary

Predicted drawdowns and subsidence values for three pumping scenarios were simulated using the HAGM from 2005 to 2045. The three pumping scenarios are:

- **Pumping Scenario 1:** Two wells pumping 1,000 GPM of slightly saline water in the lower Chicot Aquifer. The wells are located on the current property boundary for the BWA WTP.
- **Pumping Scenario 2:** Four wells pumping 1,000 GPM of slightly saline water from the lower Chicot Aquifer. All four wells are located on the current property boundary for BWA WTP.
- **Pumping Scenario 3:** Four wells pumping 1,000 GPM of slightly saline water from the lower Chicot Aquifer. The two well pumping the from the lower Chicot located on the current property boundary BWA WTP and two well pumping the lower Chicot located across the Brazos River from the BWA WTP.

Beyond a five-mile radius from the well fields in the pumping scenarios, the predicted drawdowns and land subsidence is less than 0.1 ft and less than 12 ft, respectively, for any of the three pumping scenarios. To help check the credibility of the HAGM predictions, the HAGM predictions were compared to those from the LCRB model. The comparison between the HAGM and LCRB models are not straightforward because the two models have different representation of the Chicot Aquifer. Nonetheless, based on the comparisons, HAGM does provide higher estimates of land subsidence than does the LCRB model. Given that the LCRB model was calibrated with a much higher emphasis to match measured aquifer properties, the HAGM predictions of land subsidence are considered to be biased toward being too high.

7.0 References

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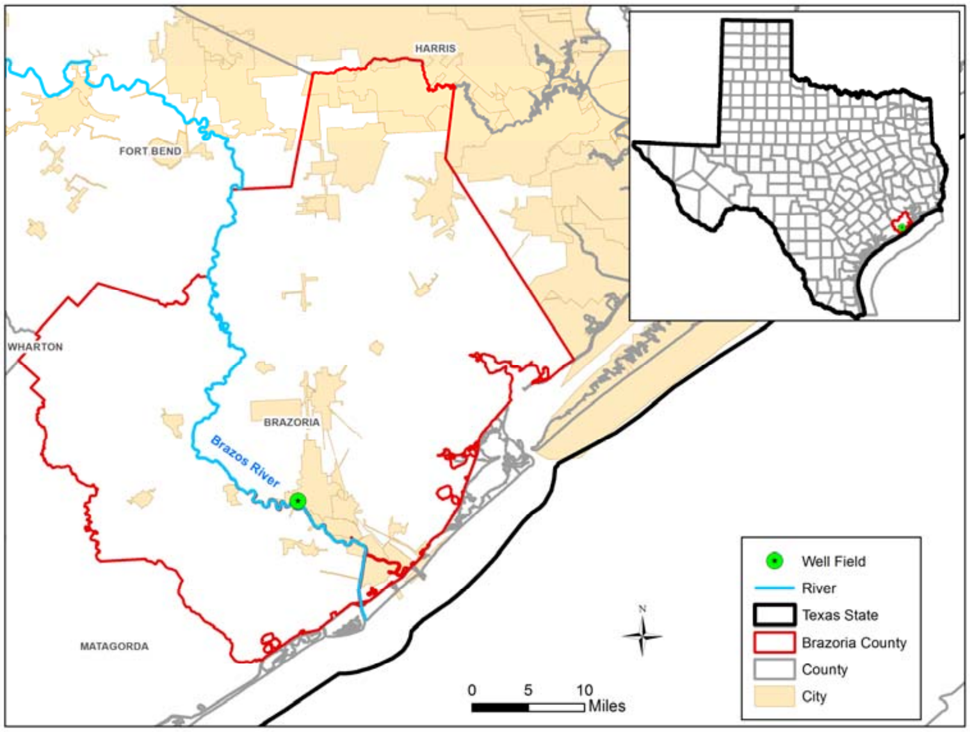

Figure 1. Location of the proposed well field in Brazoria County, Texas.

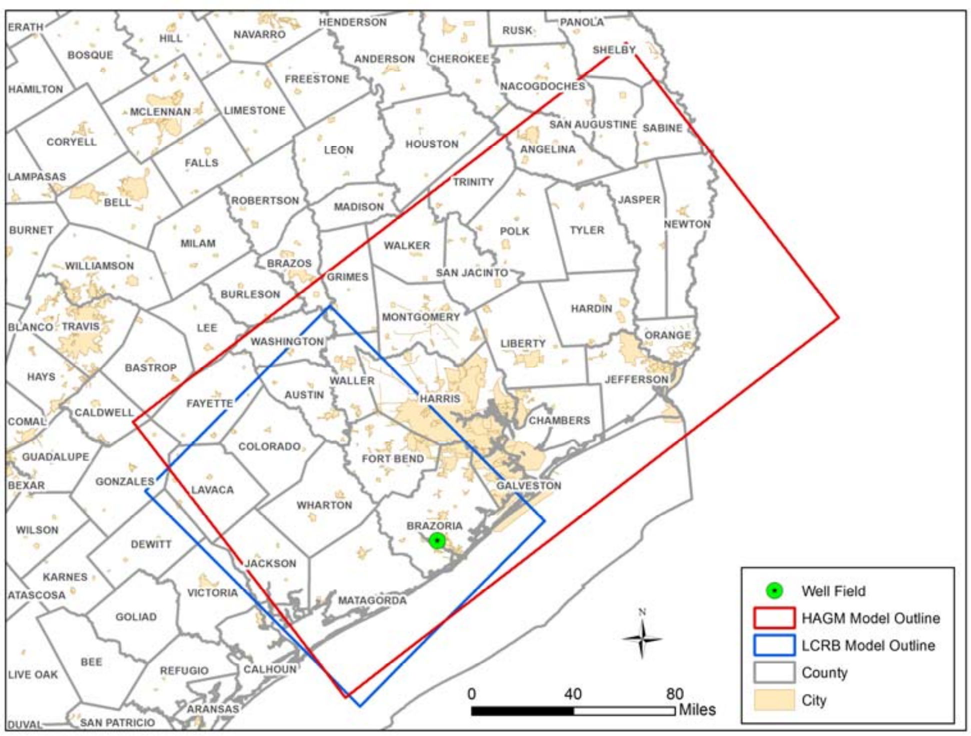

Figure 2. Model extents of the HAGM model and the LCRB model and the proposed well field.

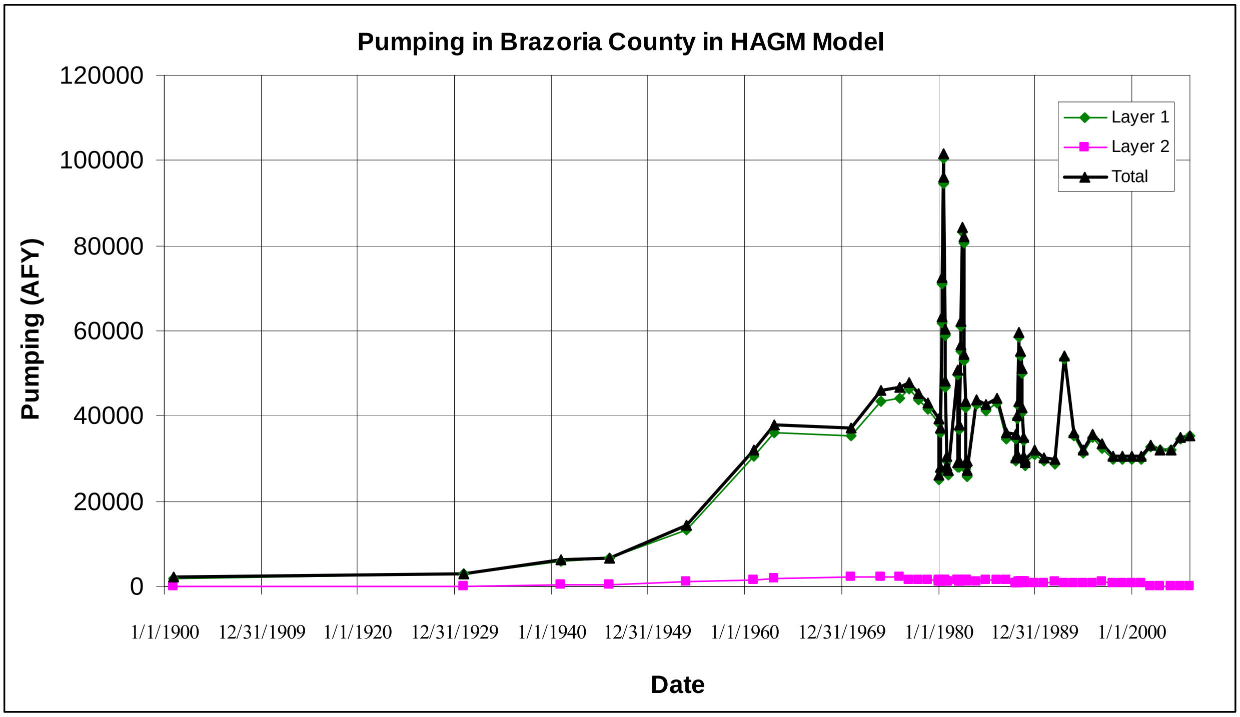

Figure 3. Pumping in Brazoria County in the HAGM.

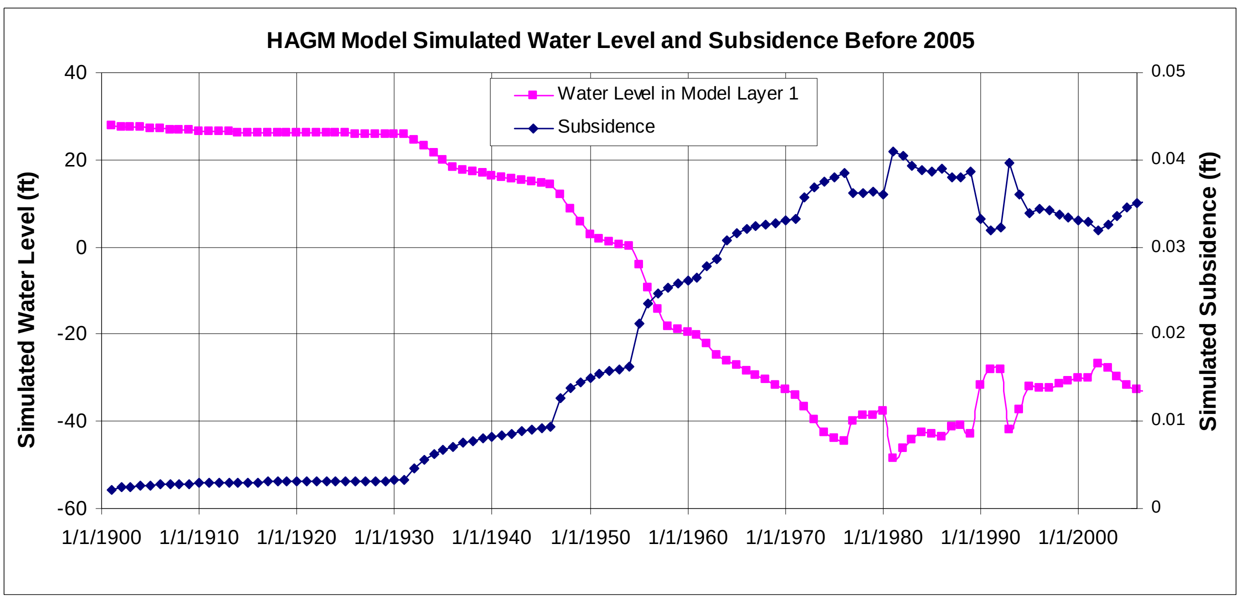

Figure 4. Historical water level and land subsidence in Chicot Aquifer simulated by the HAGM at the proposed well field.

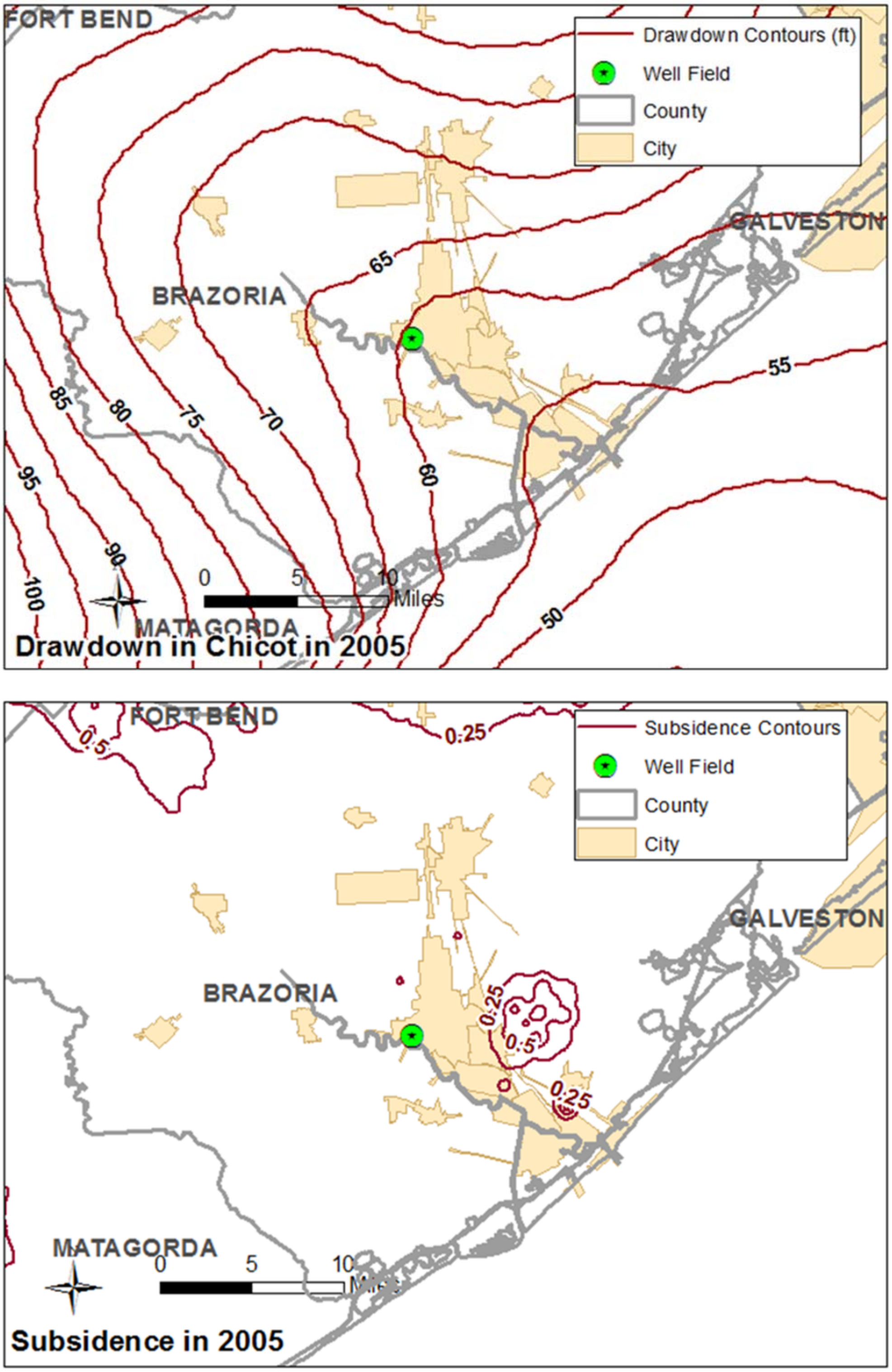

Figure 5. Drawdown and subsidence simulated by the HAGM for 2005.

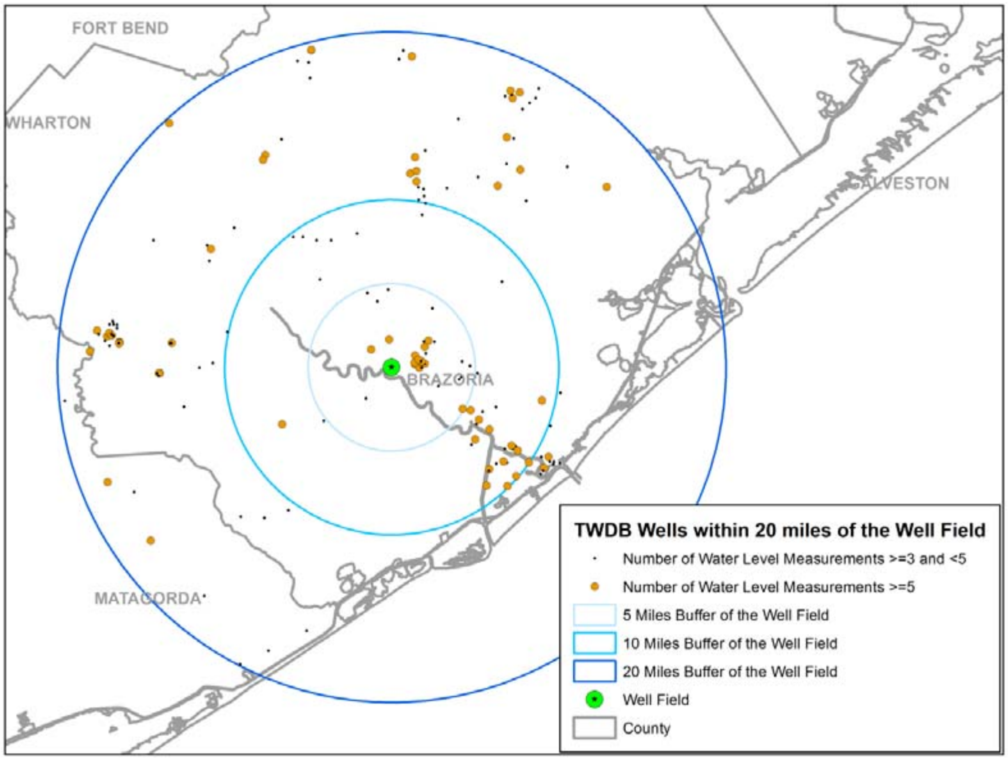

Figure 6. TWDB wells used for RMSE calculation (orange circles) around the well field.

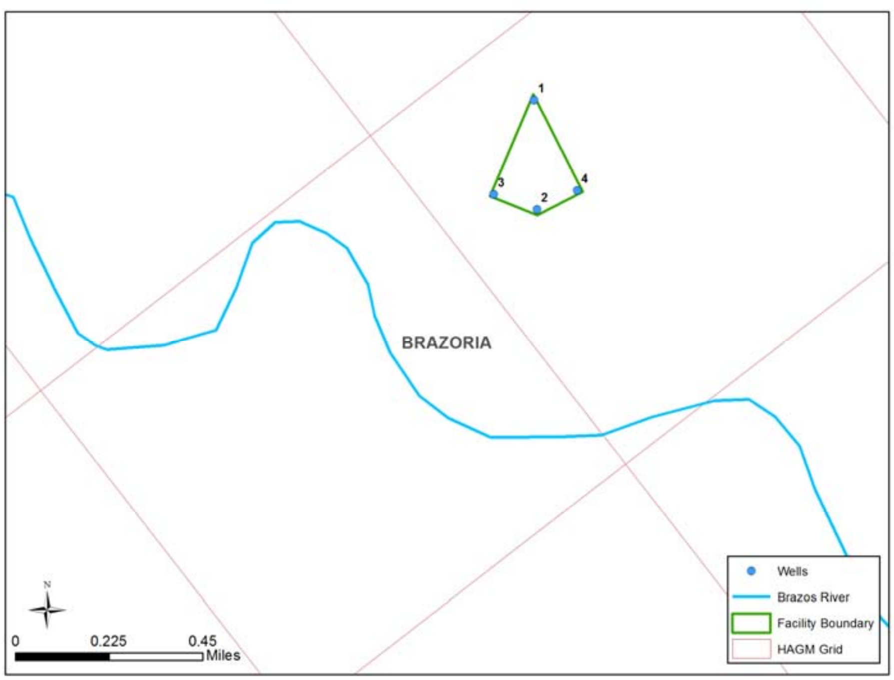

Figure 7. Locations of the additional water production wells in the HAGM model grid for pumping scenario 1 and pumping scenario 2: wells 1 and 2 are freshwater wells and wells 3 and 4 are brackish water wells.

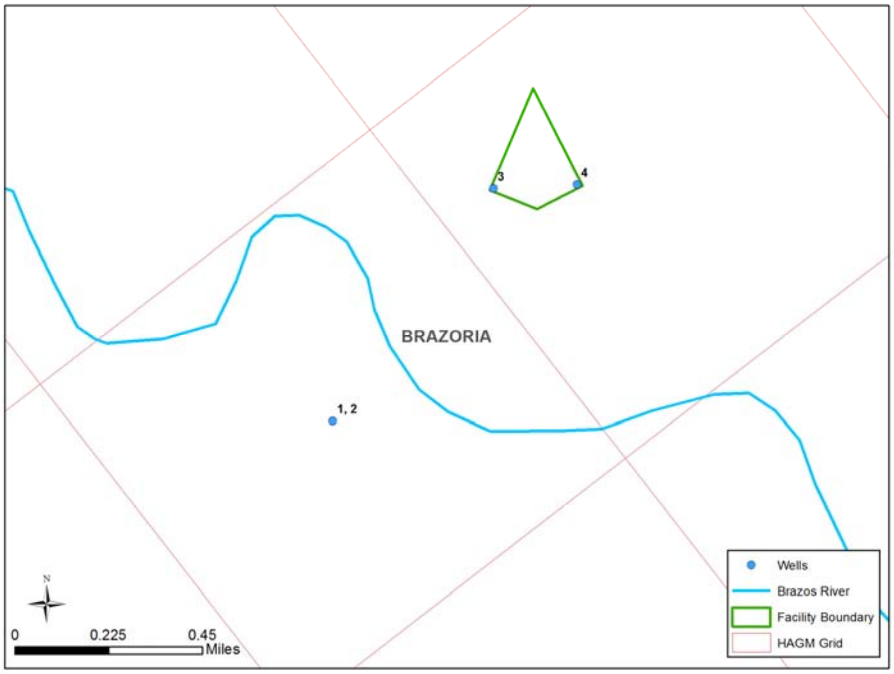

Figure 8. Locations of the additional water production wells in the HAGM model grid for pumping scenario 3: wells 1 and 2 are freshwater wells and wells 3 and 4 are brackish water wells.

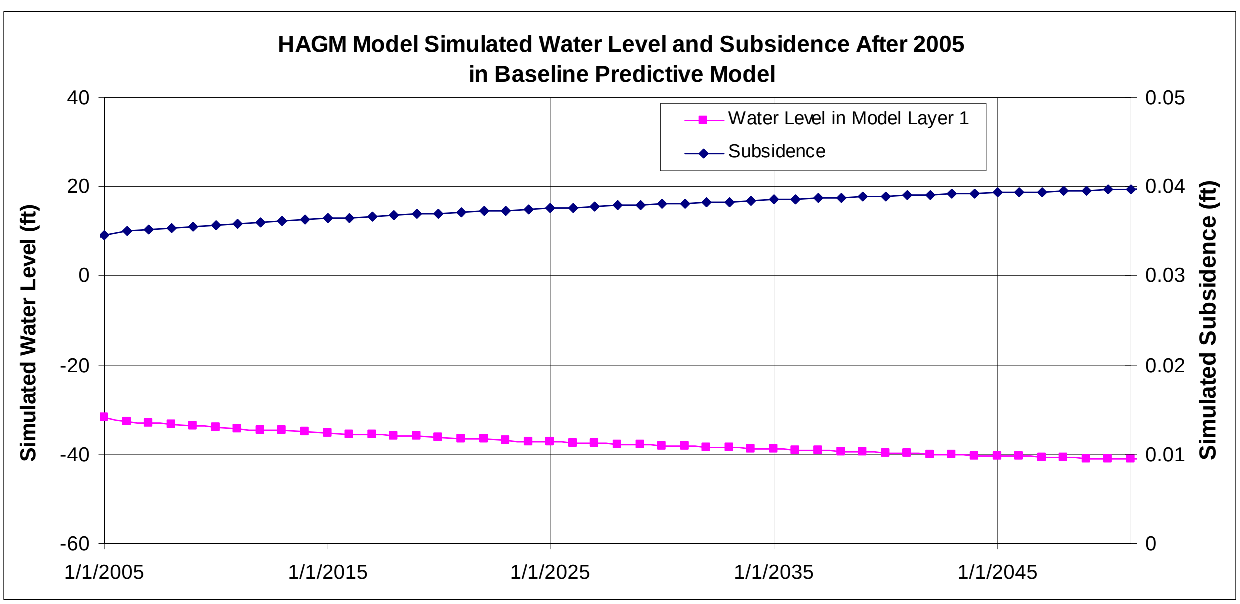

Figure 9. Simulated water level (in layer 1) and land subsidence in HAGM model baseline predictive model (baseline pumping scenario) at the well field.

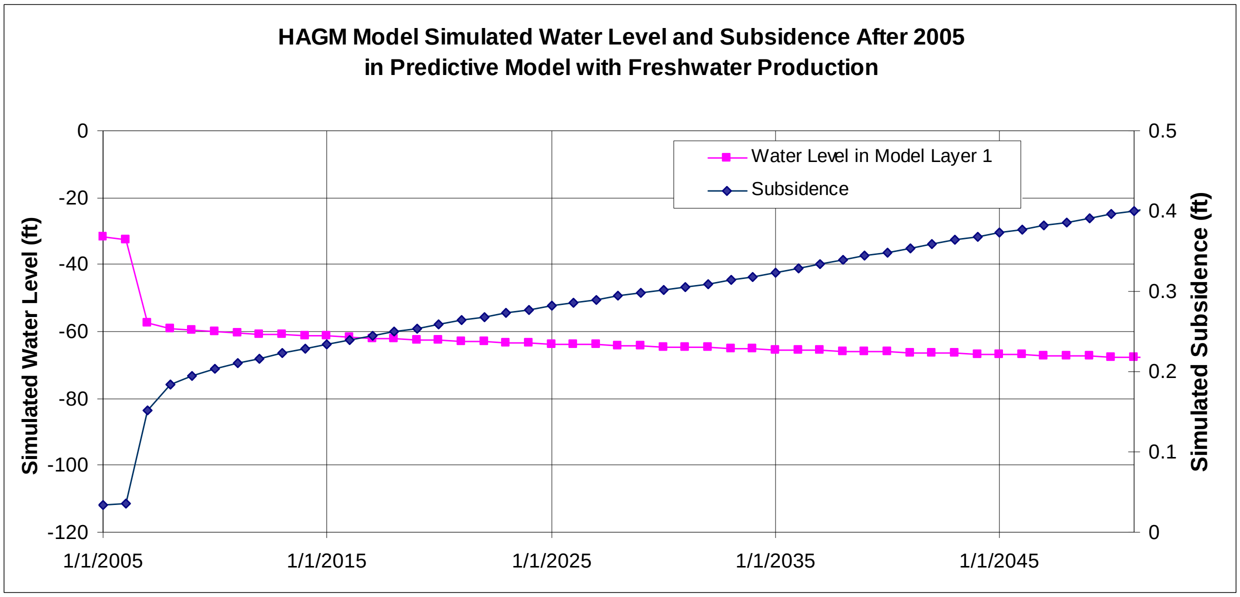

Figure 10. Simulated water level (in layer 1) and land subsidence in HAGM model predictive model with two fresh water wells (2,000 GPM) at the well field (pumping scenario 1).

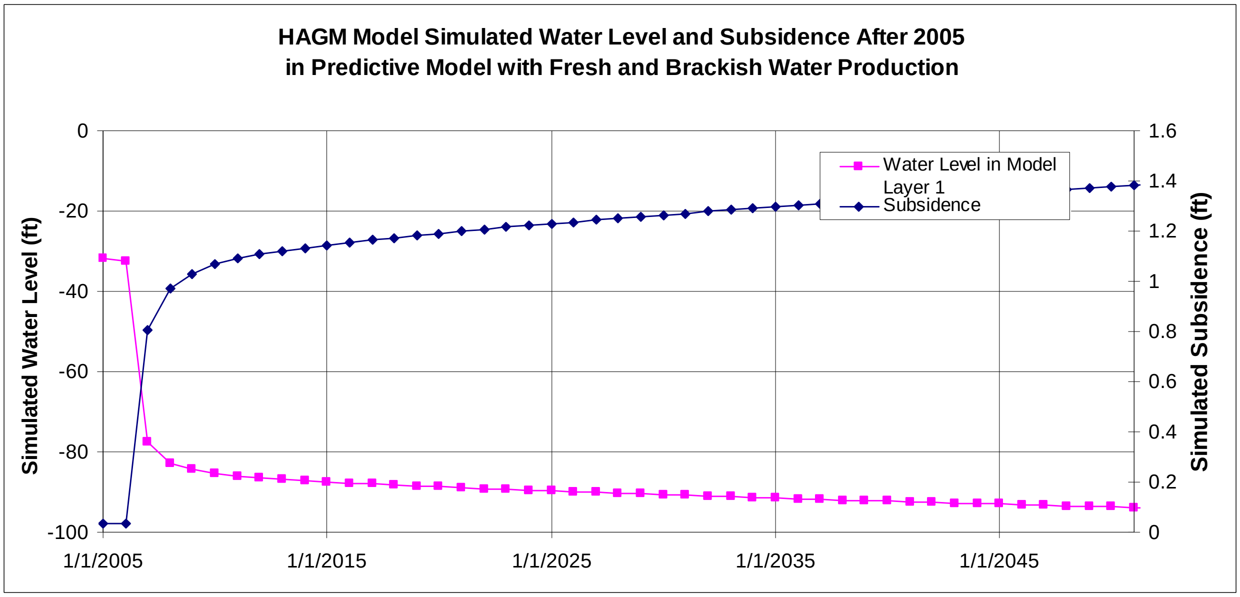

Figure 11. Simulated water level (in layer 1) and land subsidence in HAGM model predictive model with two fresh water wells and two brackish water wells (4,000 GPM) at the well field (pumping scenario 2).

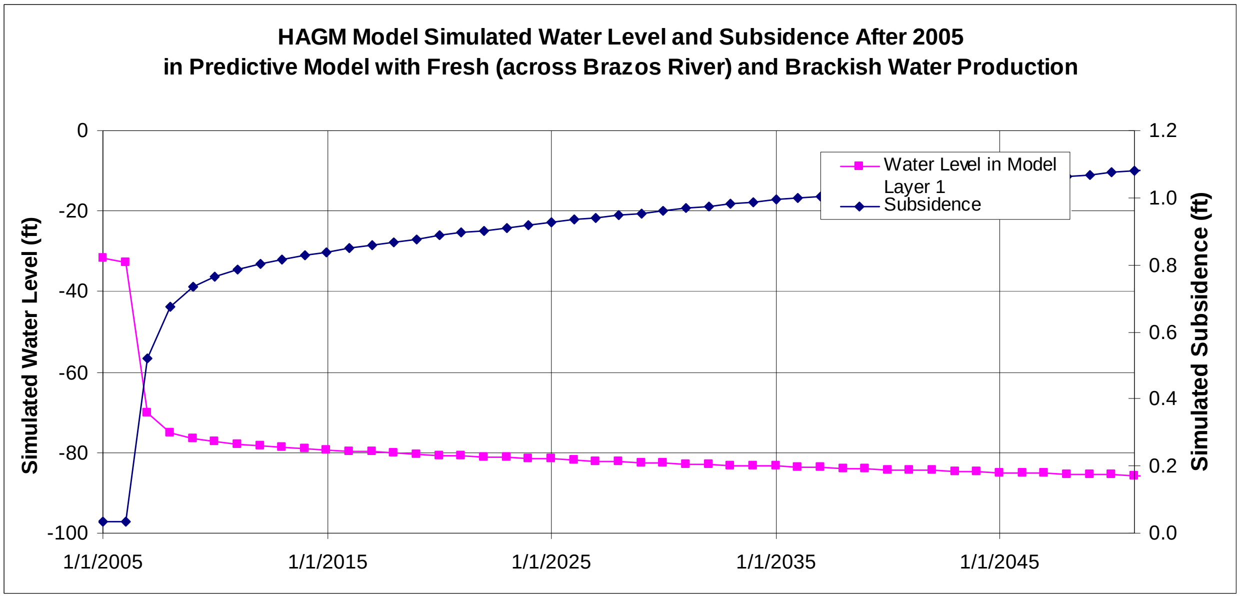

Figure 12 Simulated water level (in layer 1) and land subsidence in HAGM model predictive model with two fresh water wells (across Brazos River) and two brackish water wells (4,000 GPM) at the well field (pumping scenario 3).

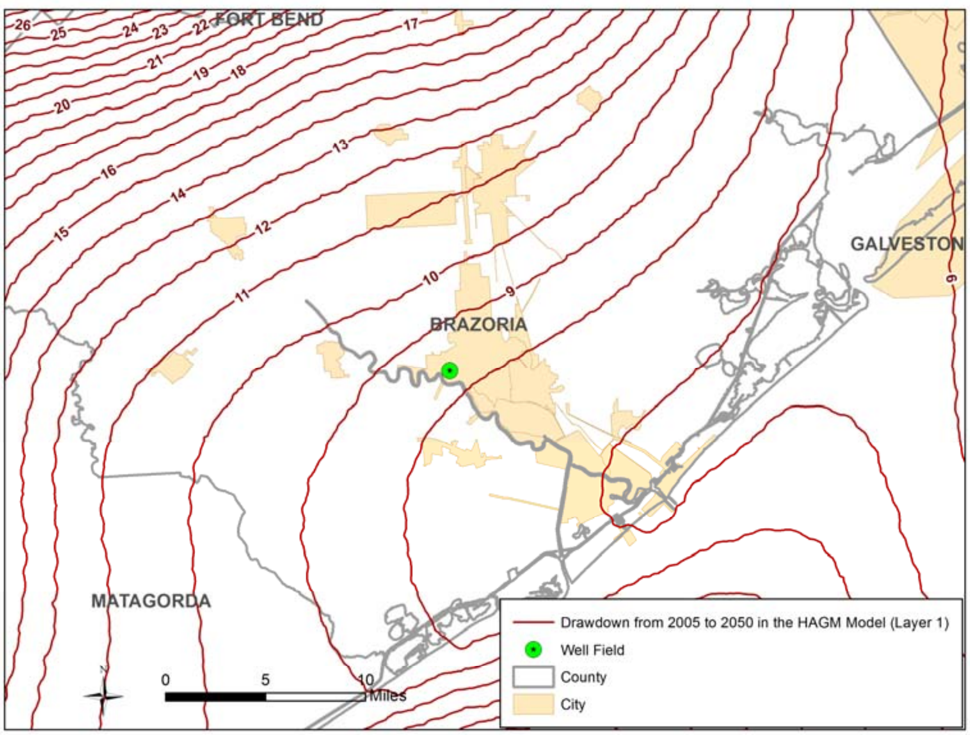

Figure 13. Drawdown (feet) from 2005 to 2050 in layer 1 of the baseline HAGM pumping scenario.

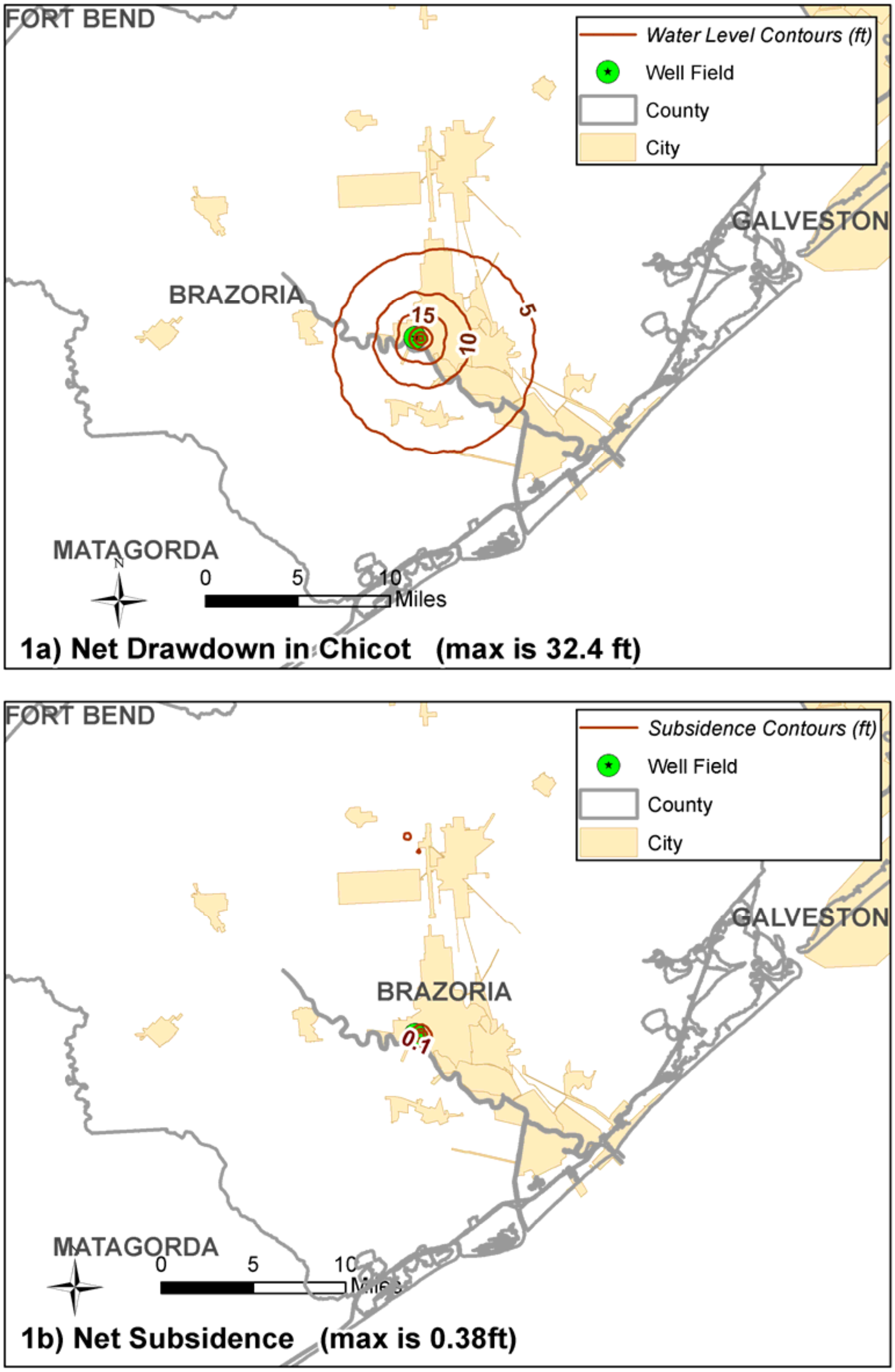

Figure 14. Impacts of freshwater production from 2005 to 2020 (2,000 GPM) simulated by the HAGM for pumping scenario 1.

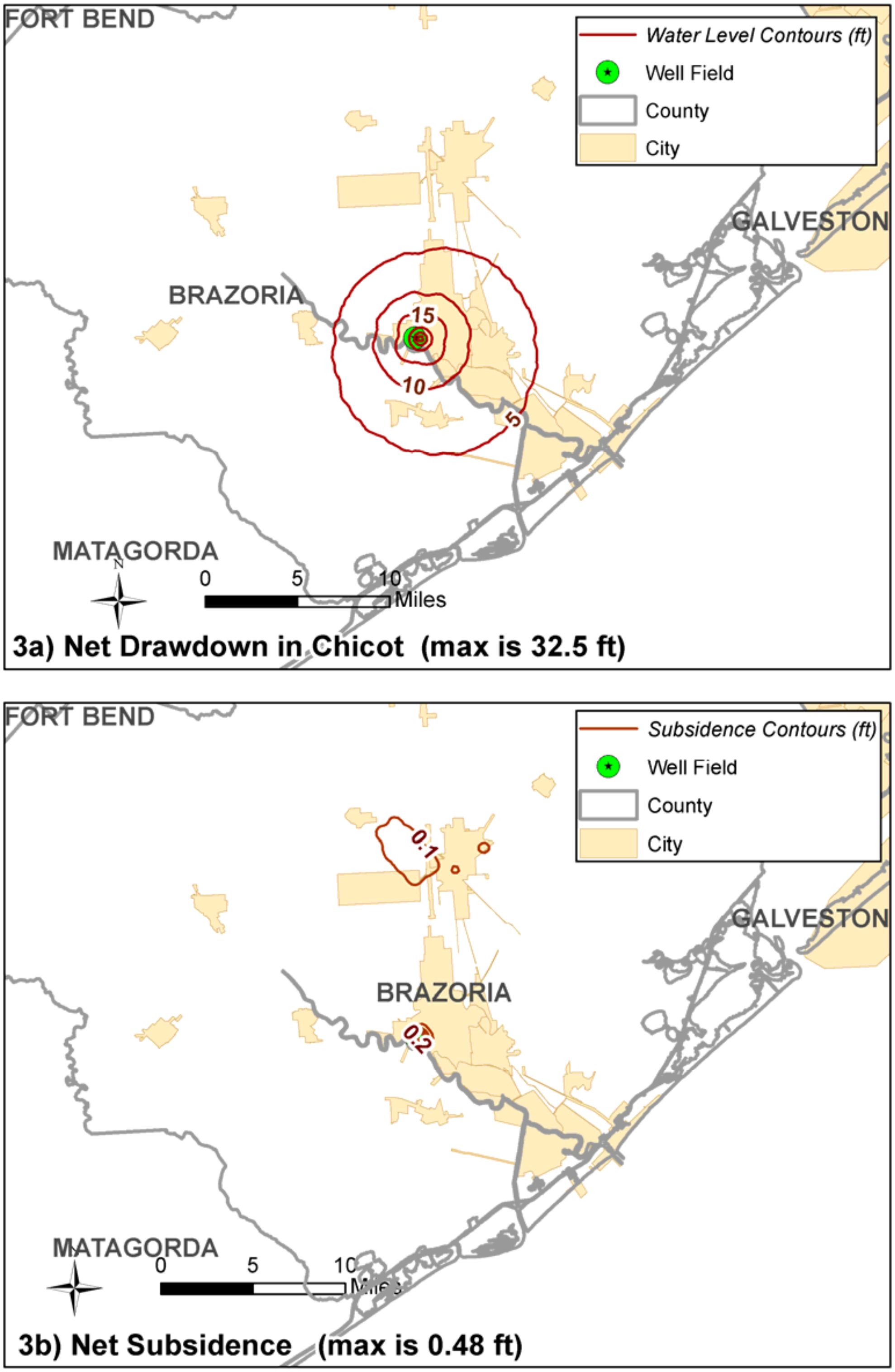

Figure 15. Impacts of freshwater production from 2005 to 2035(2,000 GPM) simulated by the HAGM for pumping scenario 1.

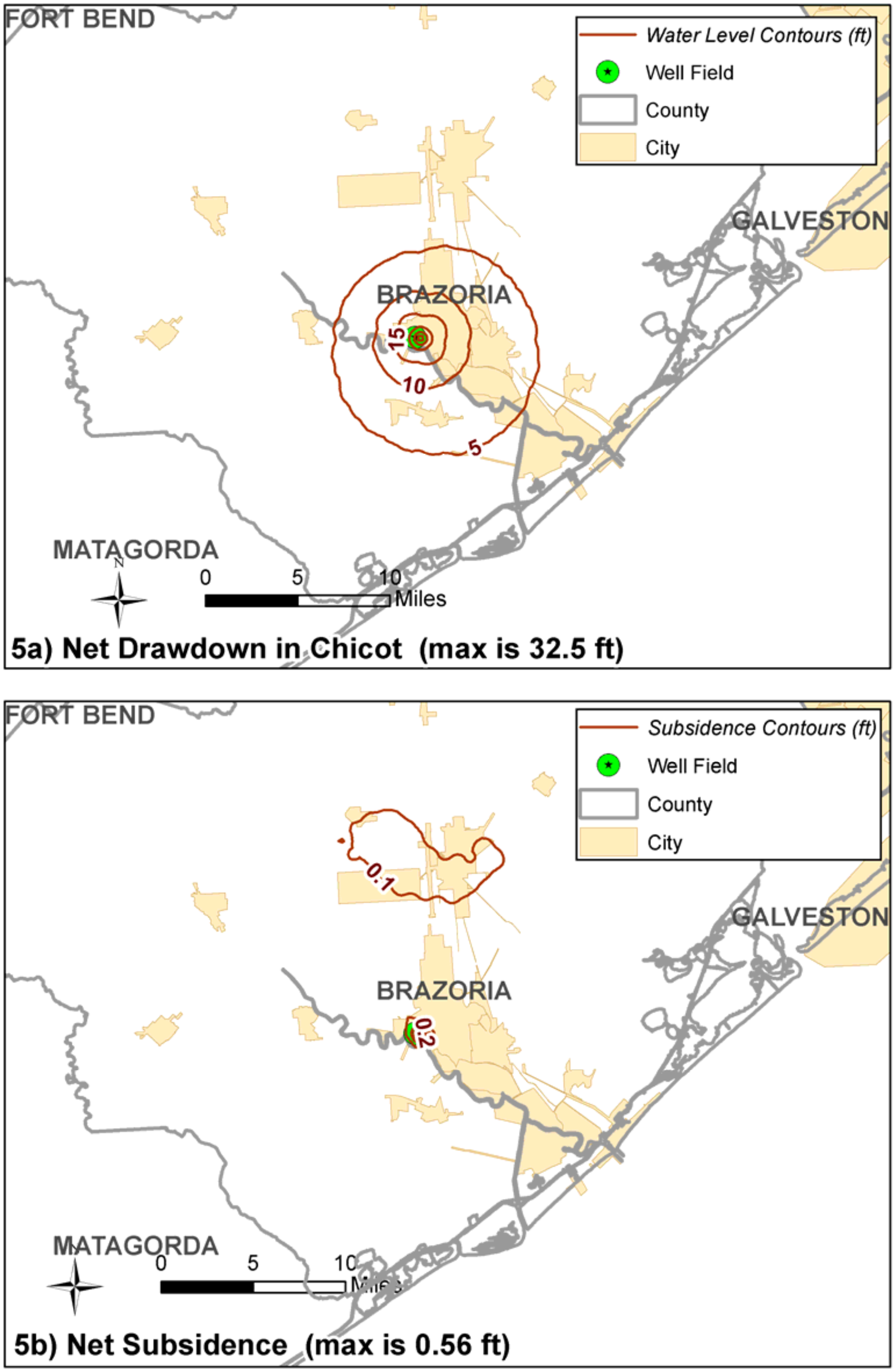

Figure 16. Impacts of freshwater production from 2005 to 2050 (2,000 GPM) simulated by the HAGM for pumping scenario 1.

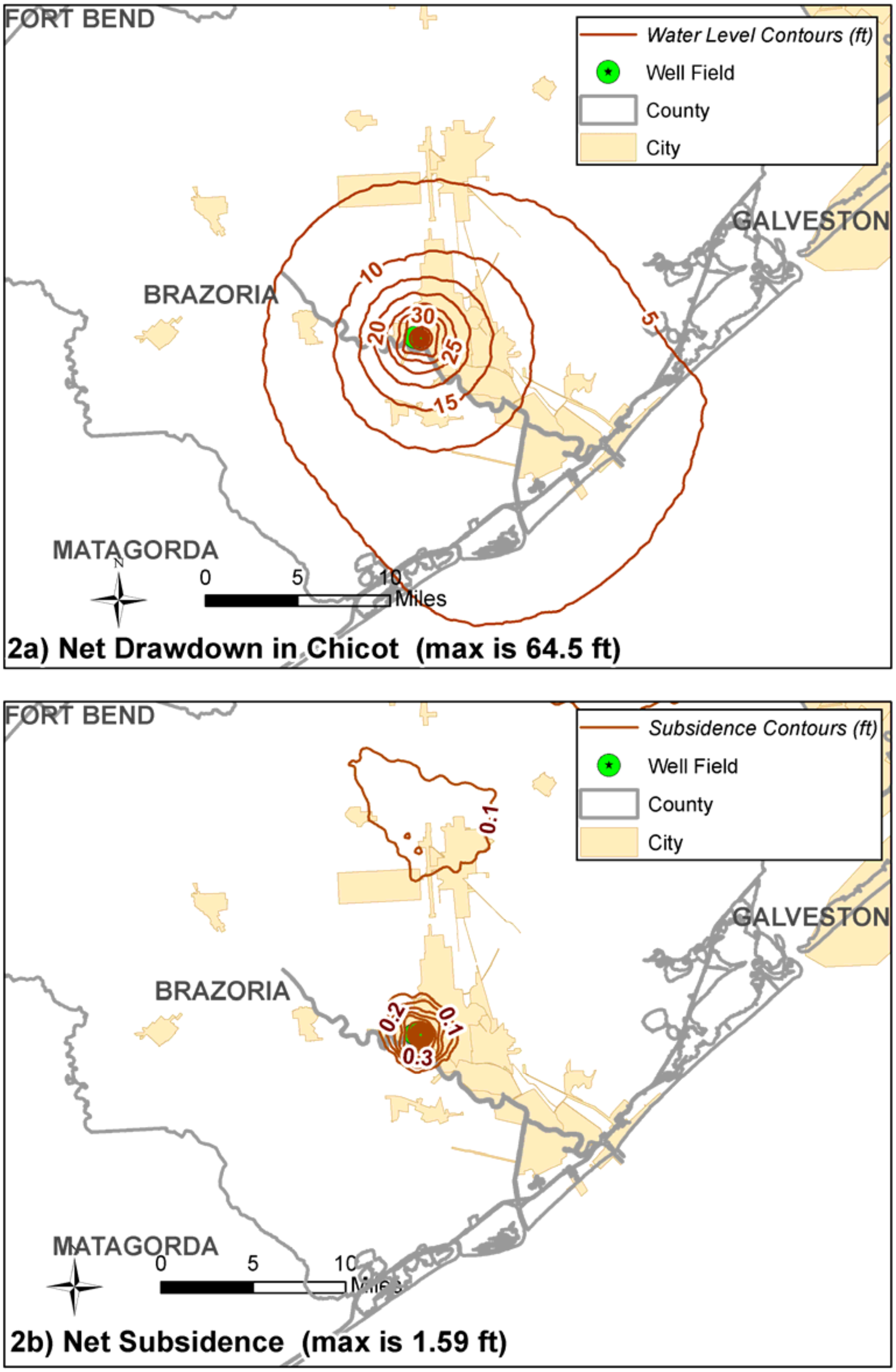

Figure 17. Impacts of fresh and brackish water production from 2005 to 2020 (4,000 GPM) simulated by the HAGM for pumping scenario 2.

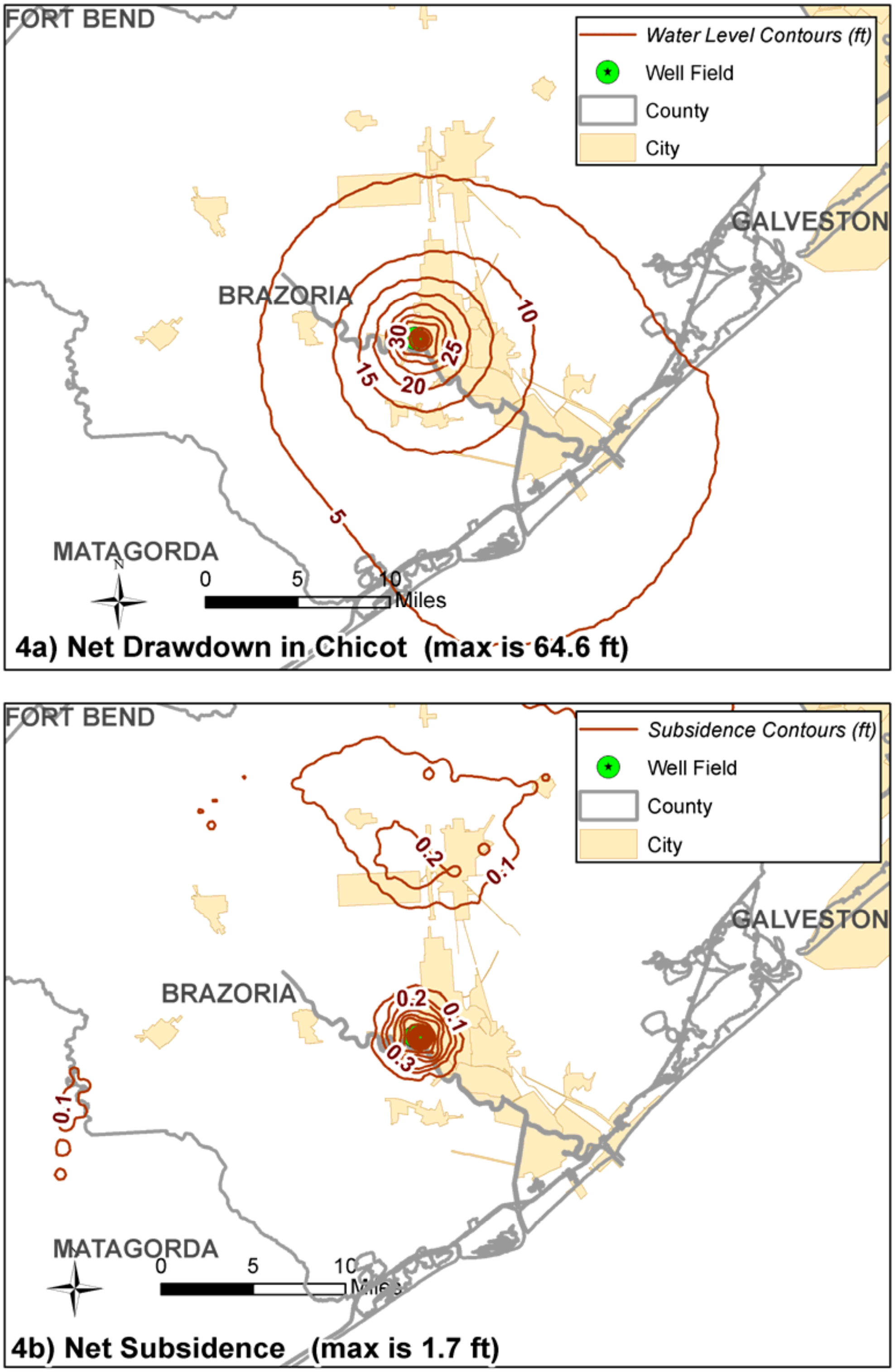

Figure 18. Impacts of fresh and brackish water production from 2005 to 2035 (4,000 GPM) simulated by the HAGM for pumping scenario 2.

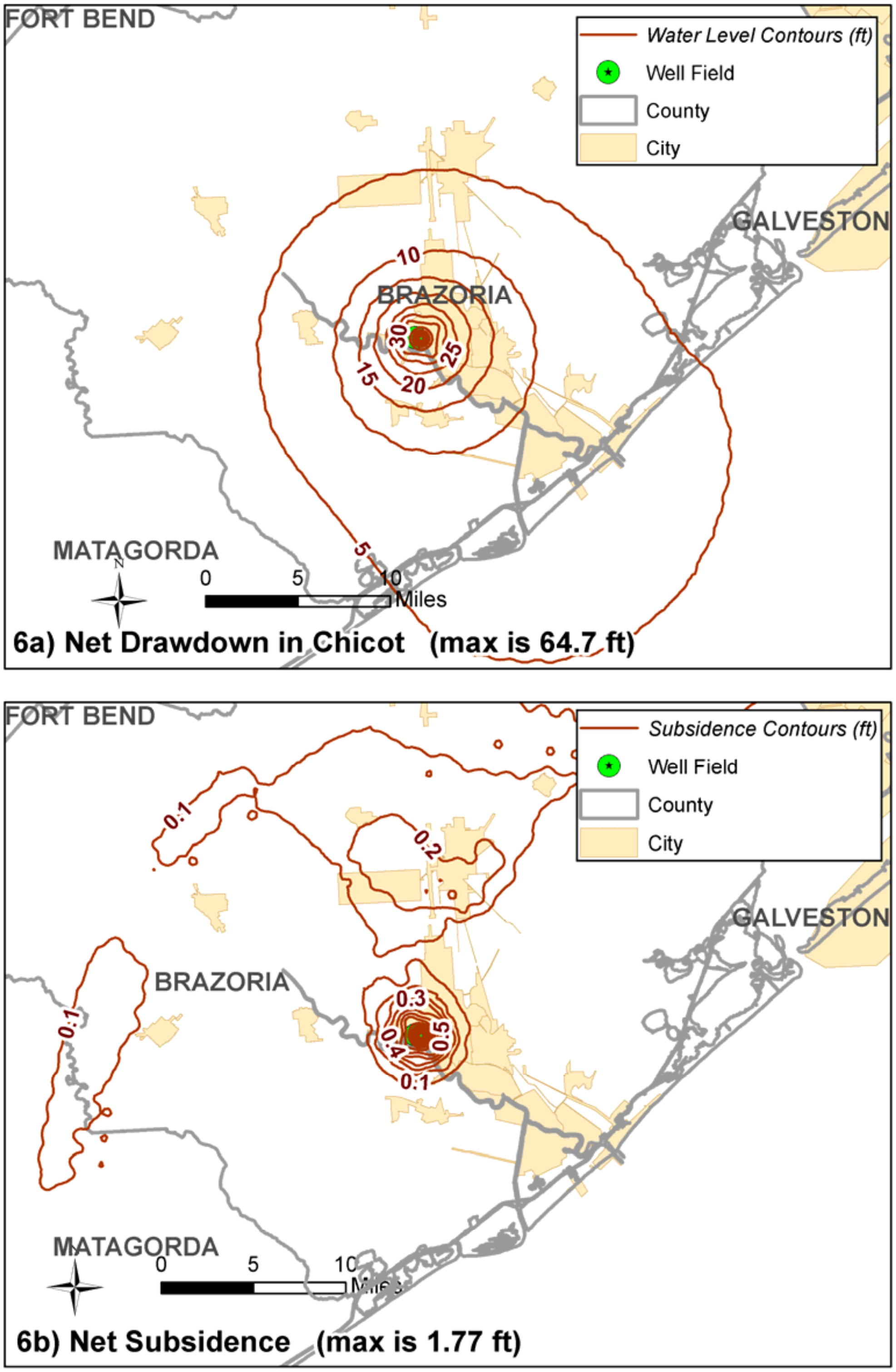

Figure 19. Impacts of fresh and brackish water production from 2005 to 2050 (4,000 GPM) simulated by the HAGM for pumping scenario 2.

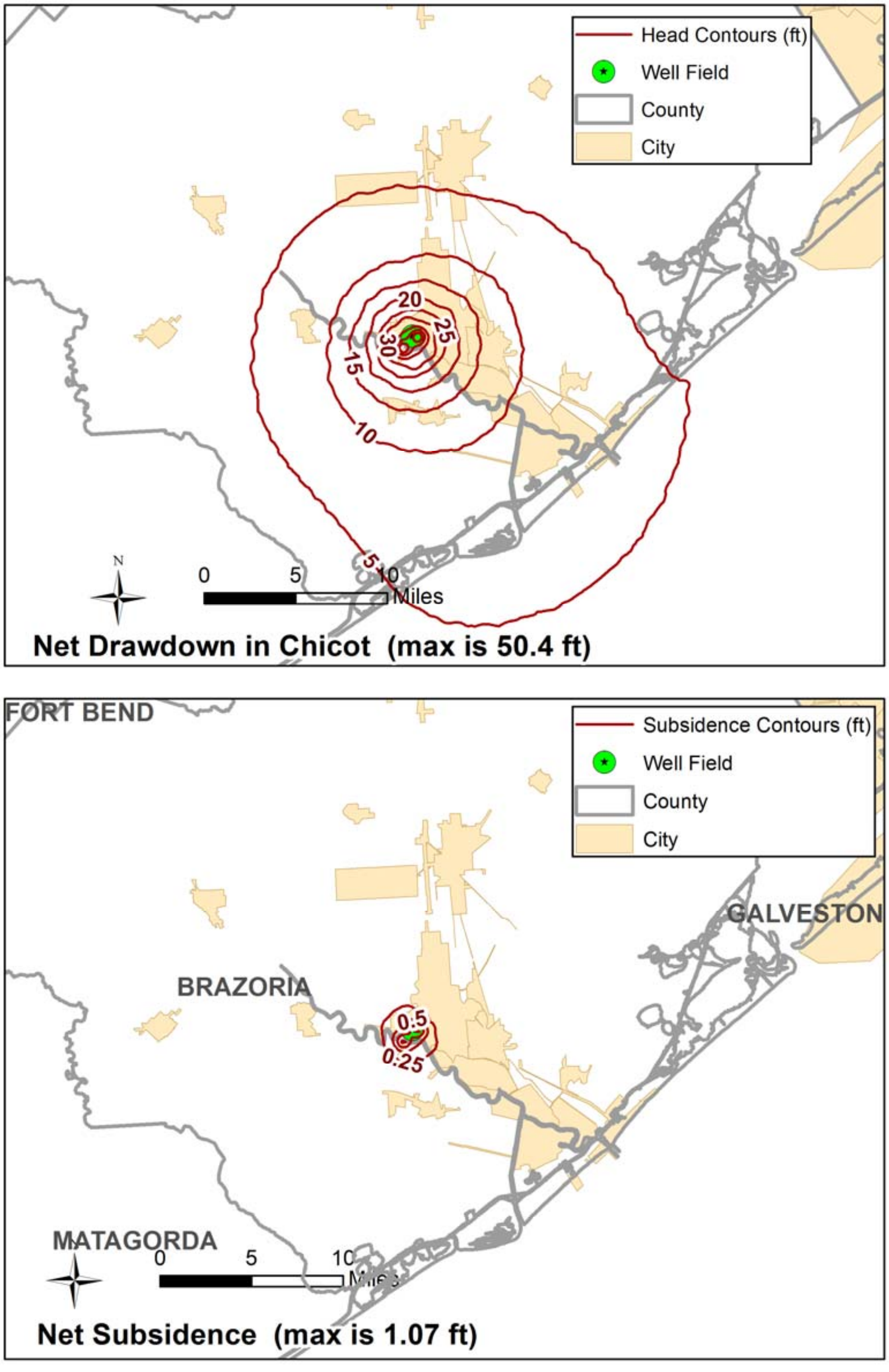

Figure 20. Impacts of freshwater (wells located across Brazos River) and brackish water production from 2005 to 2020 (4,000 GPM) simulated by the HAGM for pumping scenario 3.

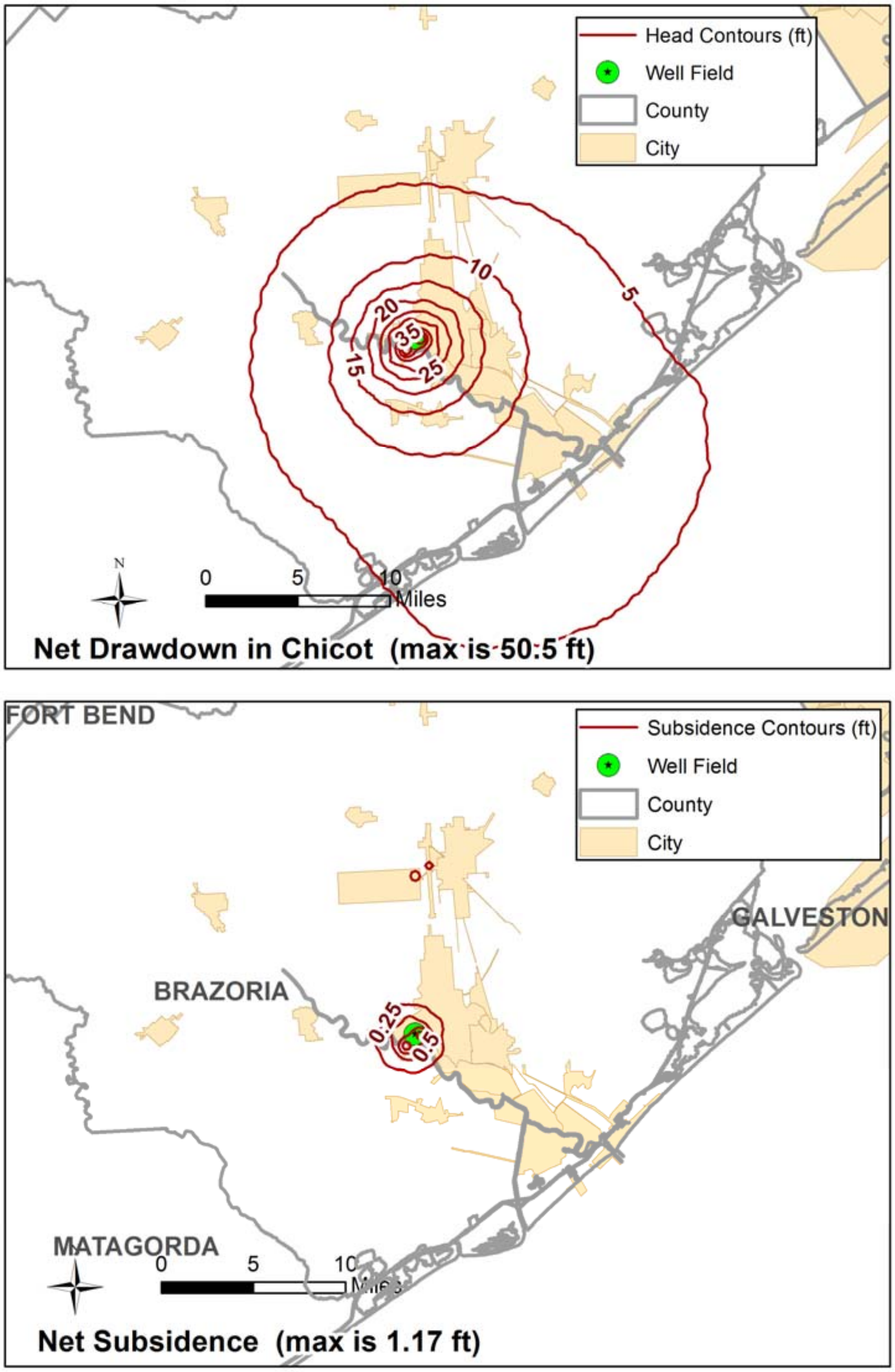

Figure 21. Impacts of freshwater (wells located across Brazos River) and brackish water production from 2005 to 2035 (4,000 GPM) simulated by the HAGM for pumping scenario 3.

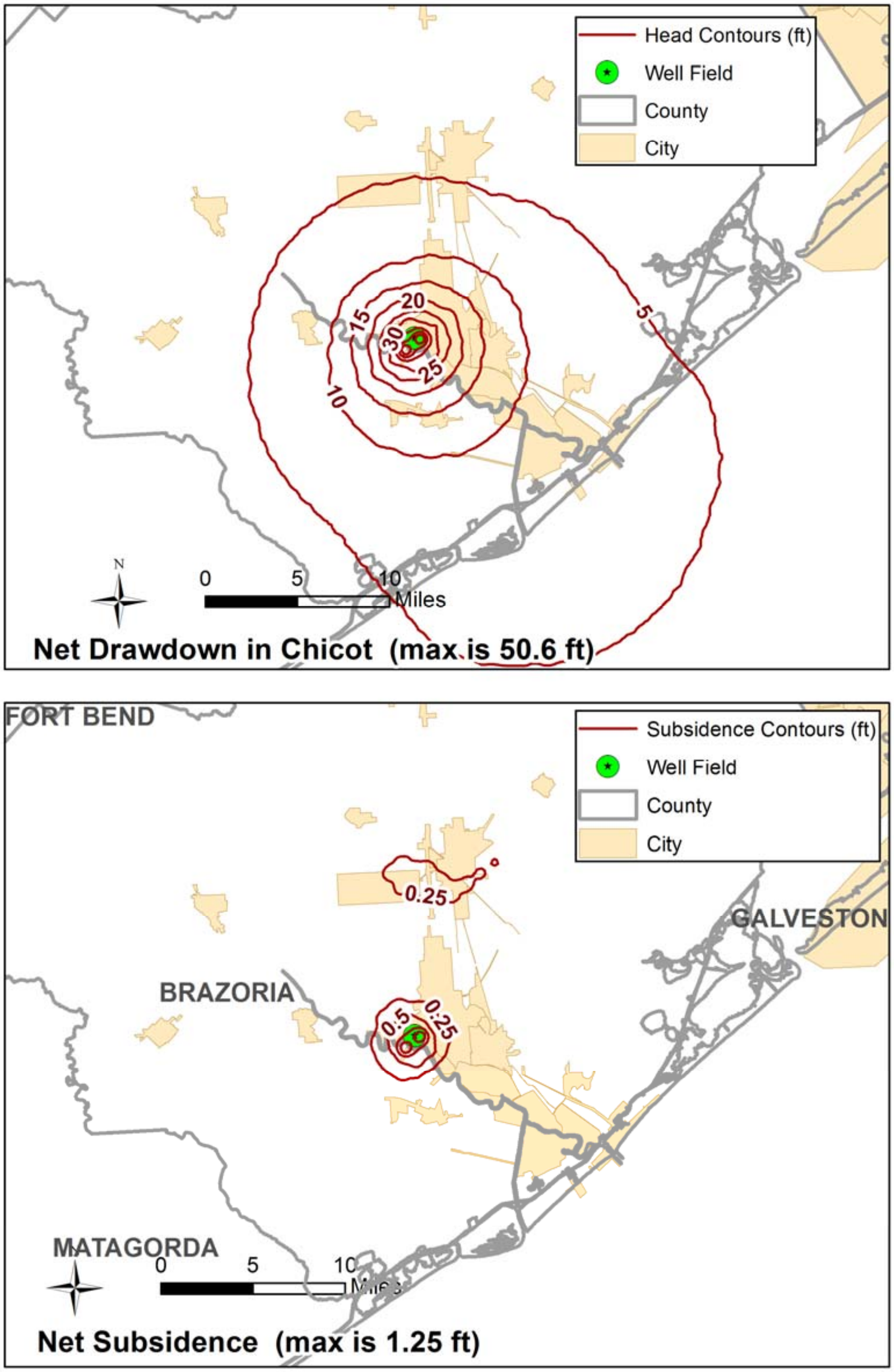

Figure 22. Impacts of freshwater (wells located across Brazos River) and brackish water production from 2005 to 2050 (4,000 GPM) simulated by the HAGM for pumping scenario 3.

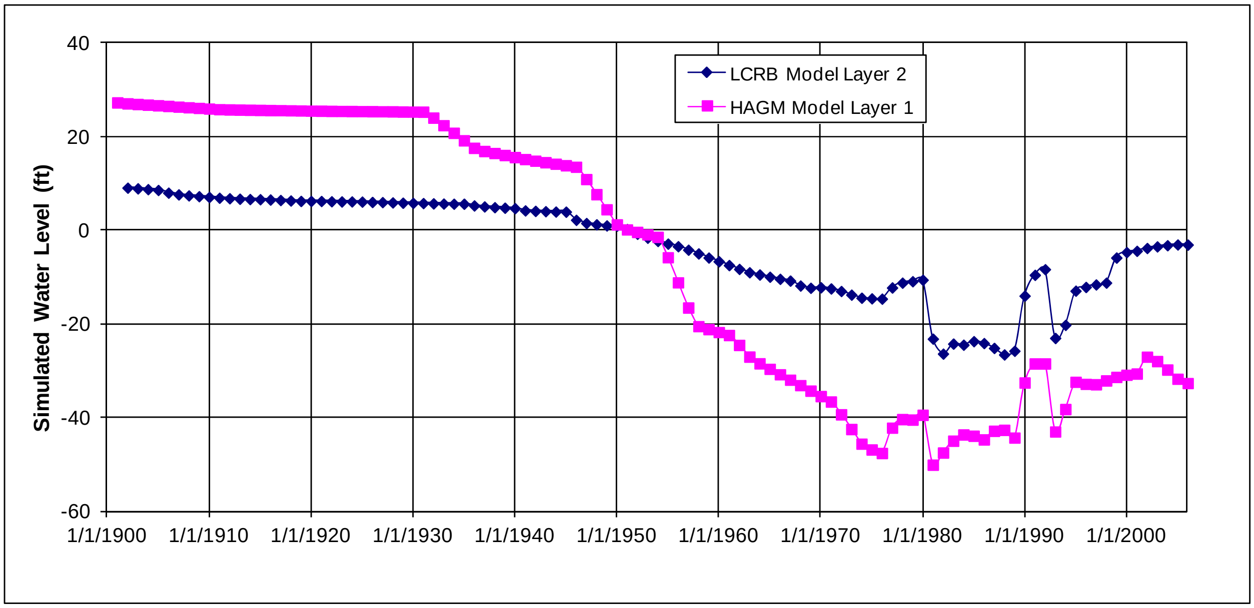

Figure 23. Simulated water level at the well field in the HAGM and the LCRB model before 2005.

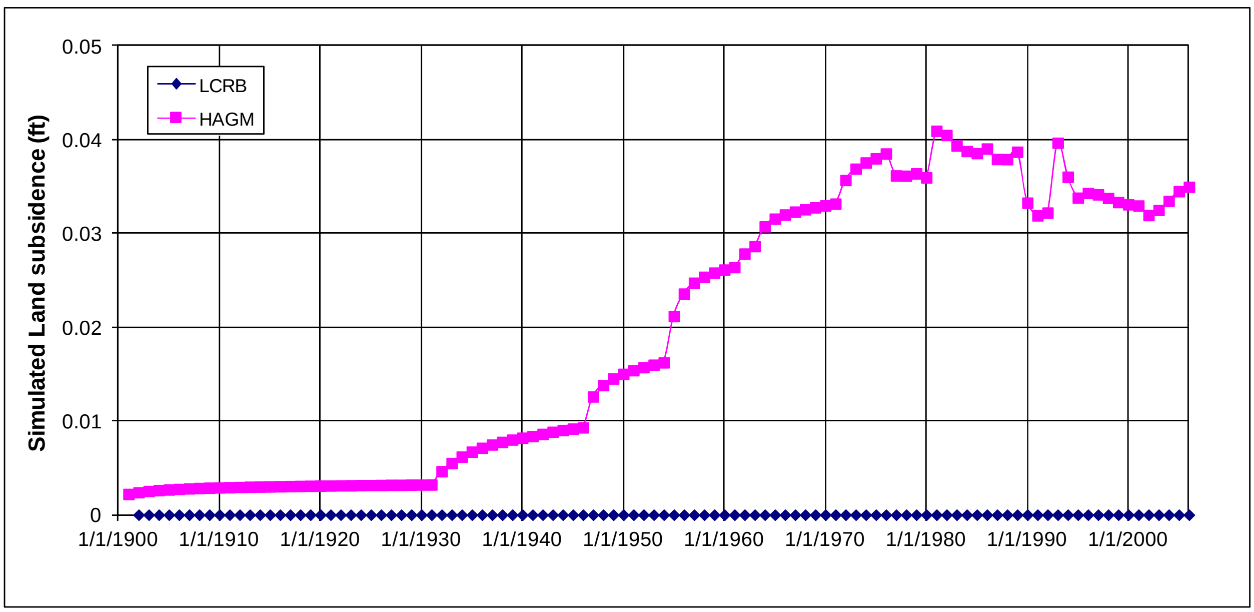

Figure 24. Simulated land subsidence at the well field in the HAGM and the LCRB model before 2005.

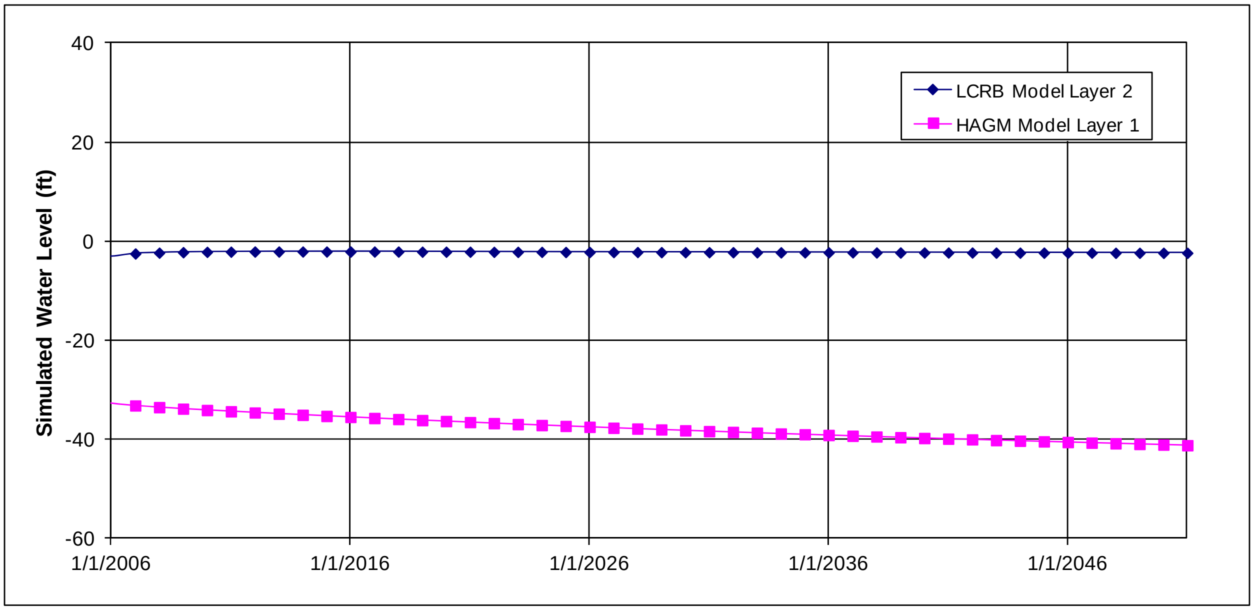

Figure 25. Simulated water level at the well field in the baseline predictive runs based on HAGM and the LCRB model after 2005.

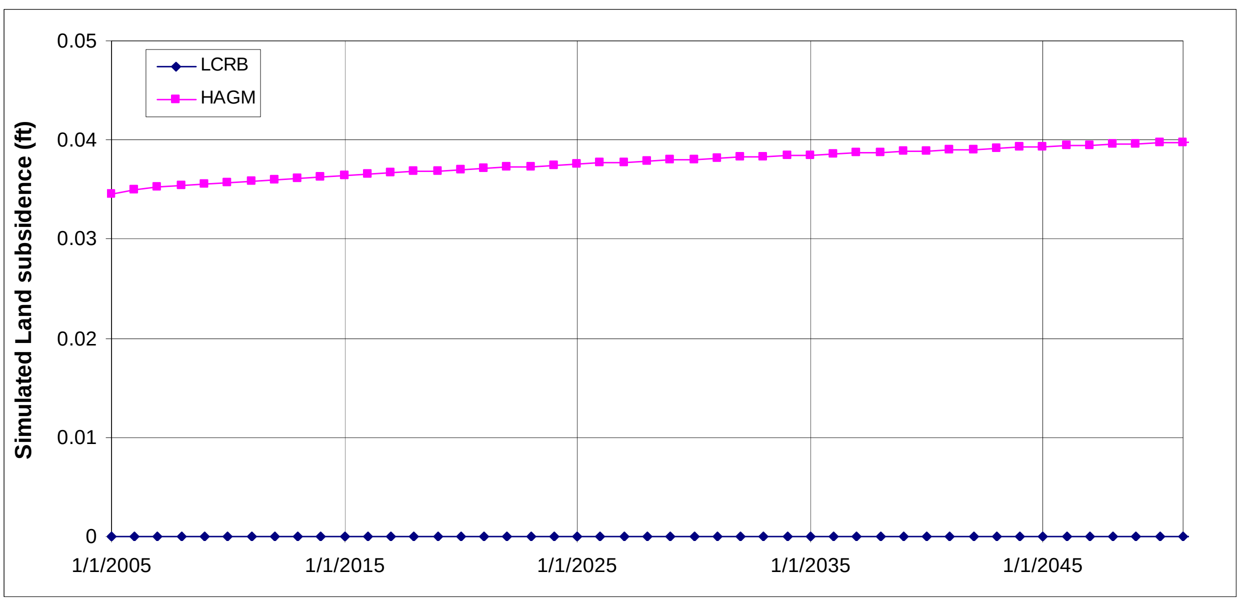

Figure 26. Simulated land subsidence at the well field in the baseline predictive runs based on HAGM and the LCRB model for baseline pumping scenario after 2005.

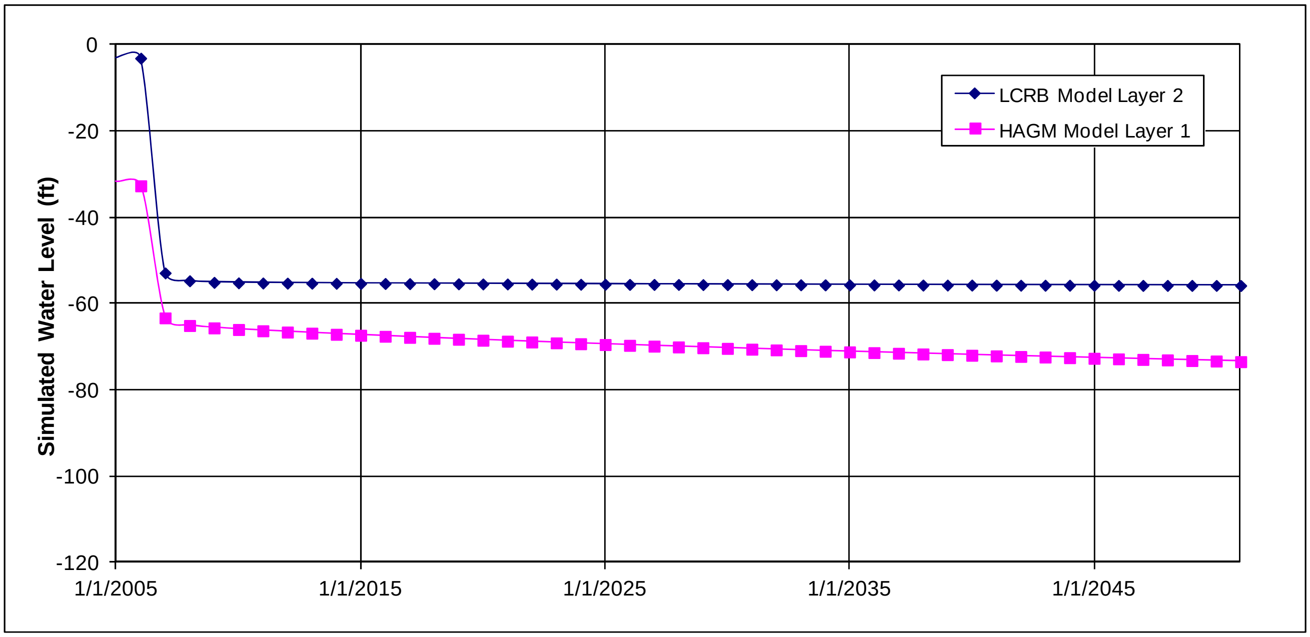

Figure 27. Simulated water level after 2005 by the HAGM in the well field pumping slightly saline water at two wells at 1,000 GPM (pumping scenario 1) and by the LCRB model in the well field pumping freshwater wells at two wells at 1,000 GPM (pumping scenario 4).

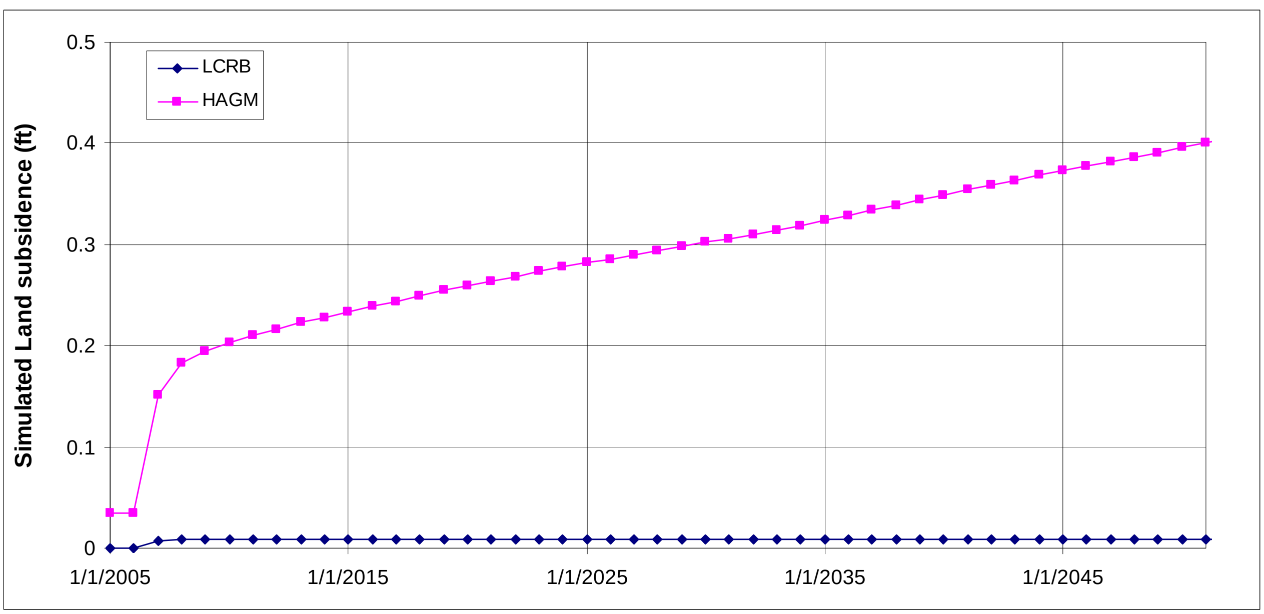

Figure 28. Simulated land subsidence after 2005 by the HAGM in the well field pumping slightly saline water at two wells at 1,000 GPM each (pumping scenario 1) and by the LCRB model in the well field pumping freshwater wells at two wells at 1,000 GPM each (pumping scenario 4).

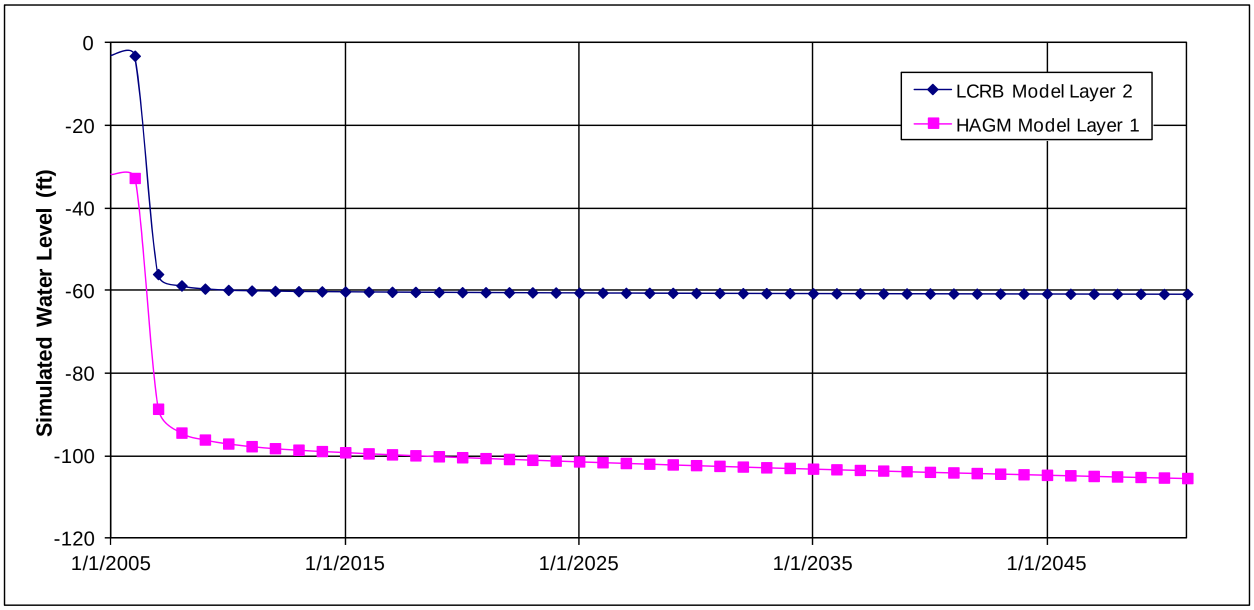

Figure 29. Simulated water level after 2005 by the HAGM well field pumping slightly saline water at four wells at 1,000 GPM each (pumping scenario 2) and by the LCRB model in the well field pumping freshwater at two wells 1,000 GPM each and slightly saline water at two wells 1,000 GPM each (pumping scenario 5).

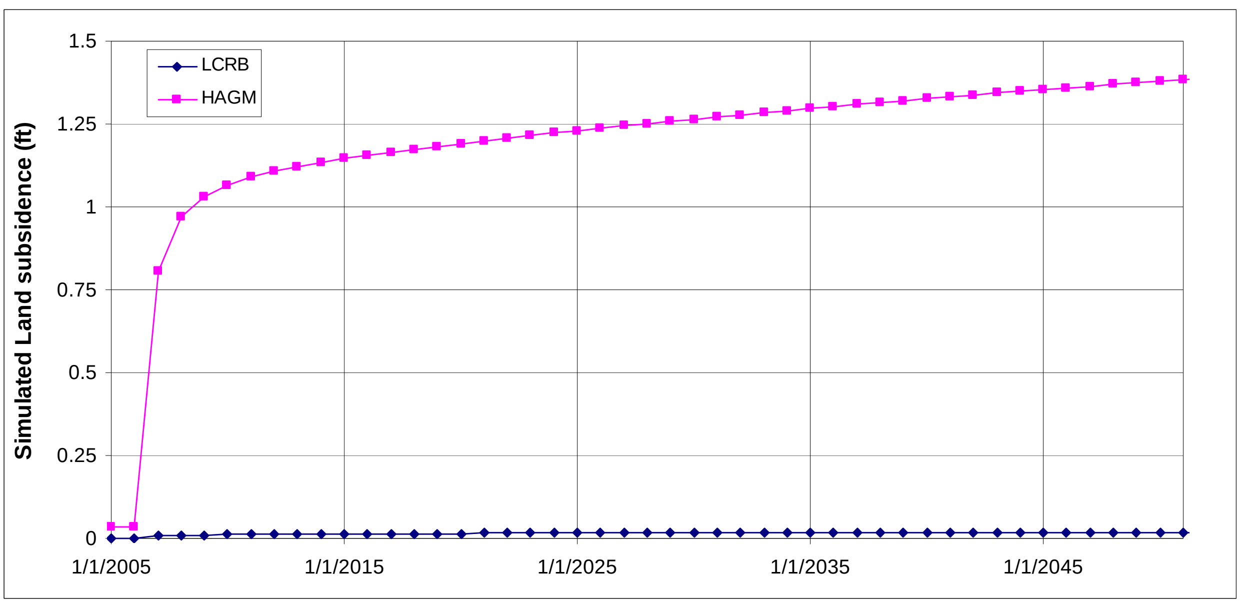

Figure 30. Simulated subsidence by the HAGM well field pumping slightly saline water at four wells at 1,000 GPM each (pumping scenario 2) and by the LCRB model in the well field pumping freshwater at two wells 1,000 GPM each and slightly saline water at two wells 1,000 GPM each (pumping scenario 5).

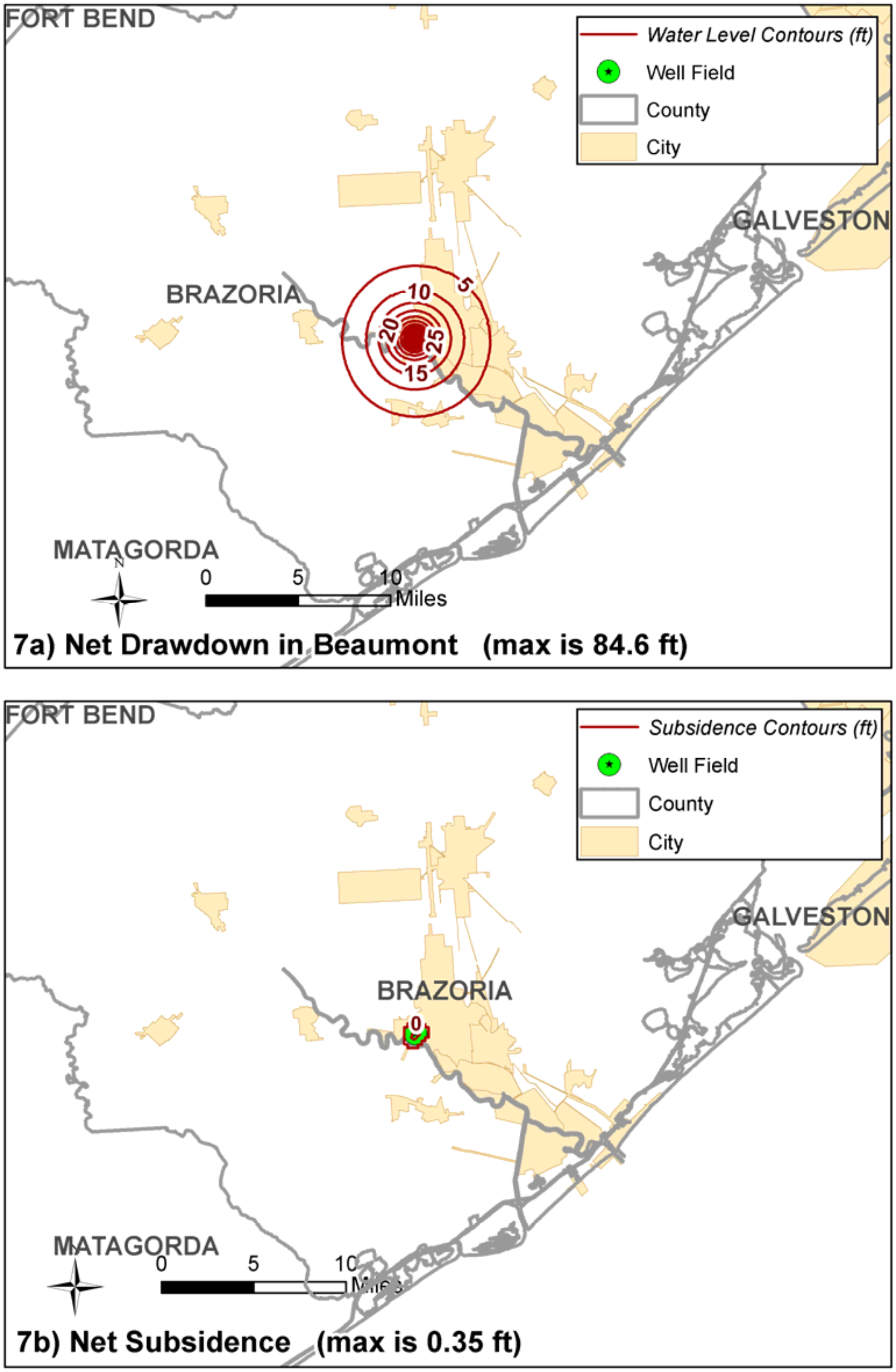

Figure 31. Impacts on drawdown and subsidence simulated by the LCRB model (pumping scenario 4) caused by pumping fresh from 2005 to 2050 (2,000 GPM).

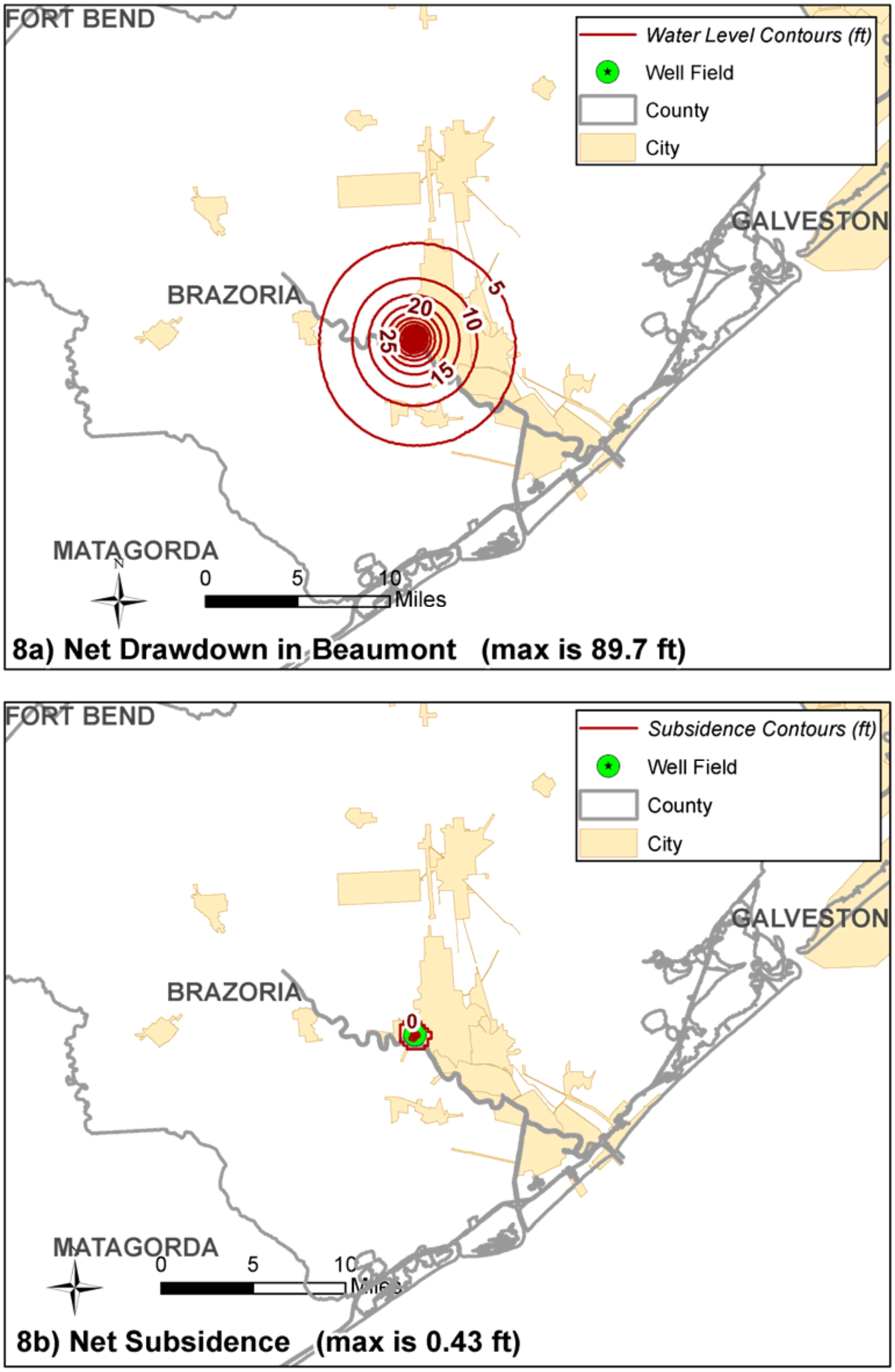

Figure 32. Impacts on drawdown and subsidence simulated by the LCRB model (pumping scenario 5) caused by pumping fresh and slightly saline water production from 2005 to 2050 (4,000 GPM).

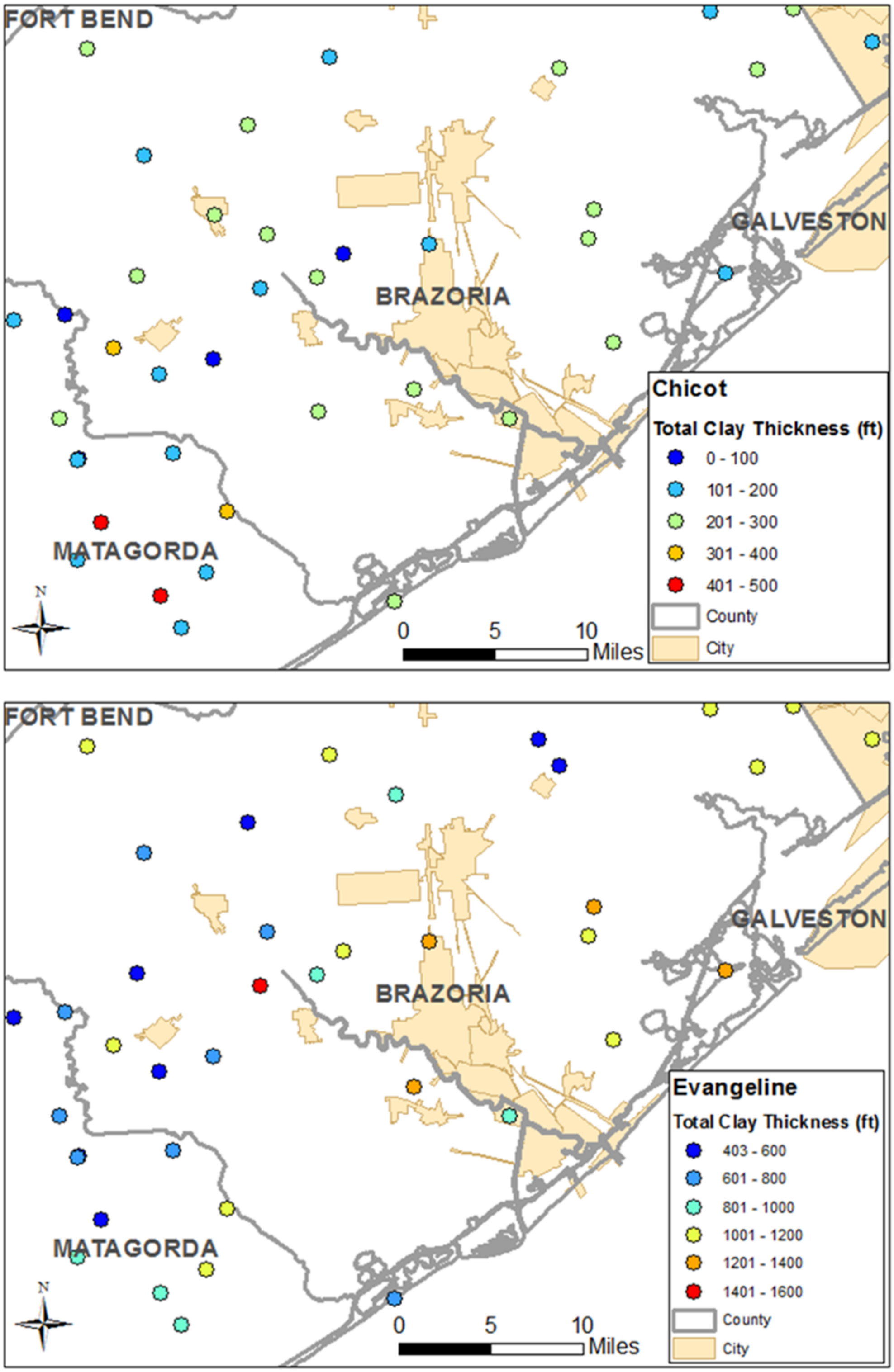

Figure 33. Total clay thicknesses based on analysis of geophysical logs using the analyses presented and discussed by Young and others (2010, 2012).

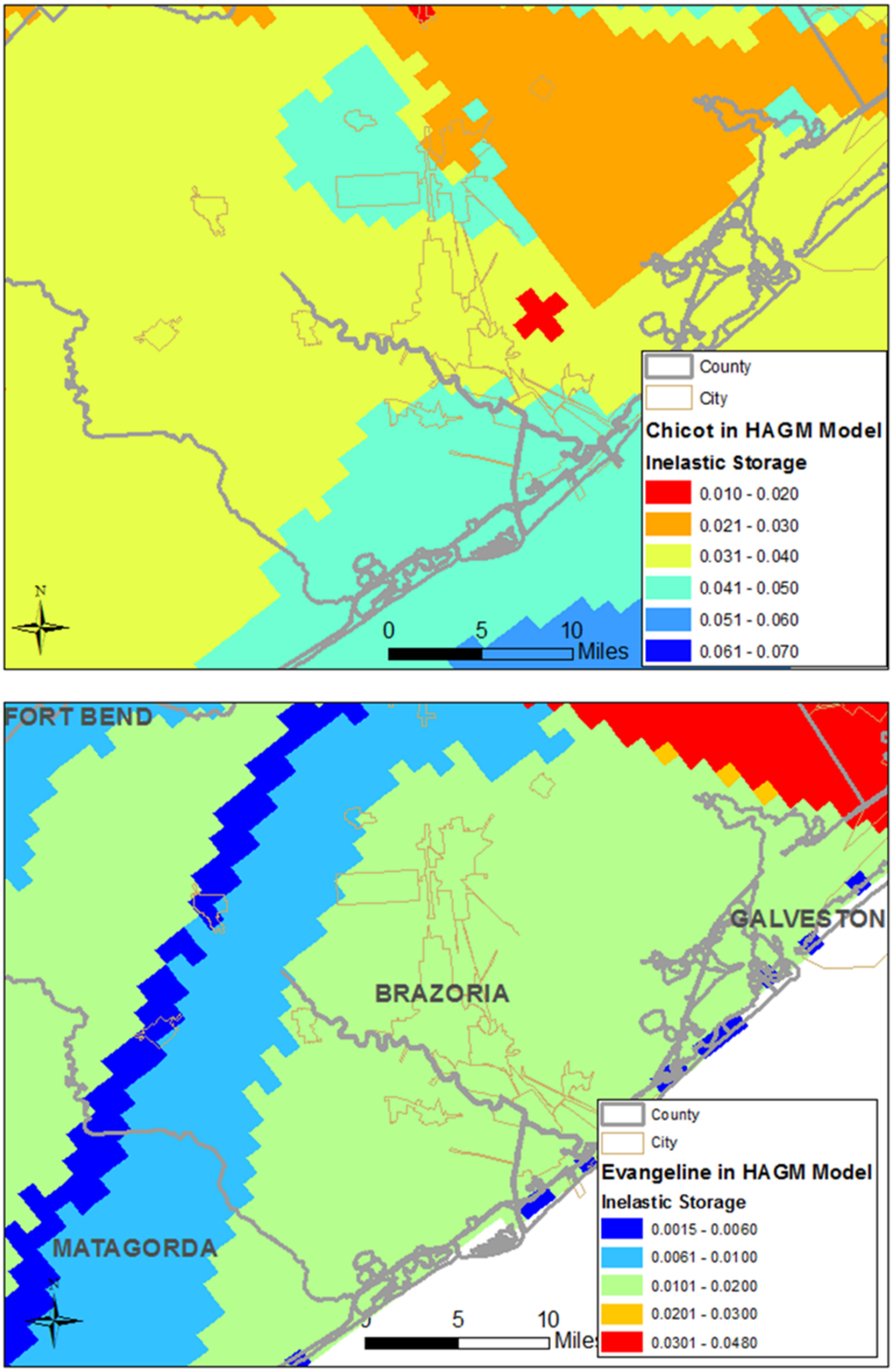

Figure 34. Non-elastic storage coefficients from the HAGM for the Chicot and Evangeline Aquifers.

Table 1. Calculated RMS for the HAGM and LCRB model from 1920 through the end of 2006.

Well Name	Latitude	Longitude	Distant to Well Field (miles)	Number of Observations	HAGM Model			LCRB Model		
					Model Layer	Mean Error (ft)	RMSE (ft)	Model Layer	Mean Error (ft)	RMSE (ft)
6561805	29.037499	-95.448333	1.4	16	1	-19.01	22.69	3	-21.86	23.98
6561801	29.036110	-95.447777	1.4	93	1	37.11	42.49	3	39.43	45.73
6561508	29.043888	-95.447221	1.6	84	1	34.41	39.51	3	35.23	41.58
6561404	29.050555	-95.490555	1.6	16	1	-9.95	11.18	4	-10.87	11.88
6561804	29.033054	-95.443610	1.7	15	1	-17.81	19.28	3	-19.97	21.27
6561810	29.040277	-95.444166	1.7	67	1	47.19	49.84	3	50.52	53.55
6561402	29.058611	-95.472221	1.7	196	1	-23.59	24.20	3	-23.23	23.65
6561806	29.038055	-95.441666	1.8	224	1	-11.39	16.47	3	-11.62	16.15
6561809	29.038333	-95.441110	1.8	65	1	46.17	49.24	3	50.26	53.62
6561802	29.036388	-95.438055	2.0	91	1	34.81	41.53	3	37.40	45.21
6561504	29.050833	-95.437499	2.3	15	1	58.51	63.80	3	67.75	72.31
6561509	29.056111	-95.433610	2.7	62	1	32.31	37.16	3	39.65	44.17
8105305	28.995833	-95.402500	4.9	182	1	4.39	7.80	3	9.70	12.50
8105306	28.994166	-95.394721	5.4	191	1	5.54	8.40	3	12.03	14.76
8105304	28.985833	-95.386944	6.1	109	1	2.01	4.57	3	6.32	7.25
8105303	28.968888	-95.391388	6.6	197	1	0.94	4.47	3	6.45	9.36
8105320	28.976943	-95.376943	6.9	27	1	2.35	22.41	3	10.90	23.60
8104202	28.988888	-95.581388	7.4	41	1	5.21	8.06	4	12.60	17.45
8105602	28.942777	-95.378888	8.4	286	1	82.74	85.16	3	88.79	90.63
8106107	28.962222	-95.355833	8.6	7	1	90.90	95.25	3	97.54	101.38
8106406	28.948888	-95.364444	8.7	58	1	75.13	87.06	3	81.37	89.33
8106413	28.957777	-95.349721	9.0	202	1	65.82	67.75	3	76.49	77.75
8105601	28.928332	-95.381943	9.1	202	1	77.04	79.16	3	84.90	86.23
8106214	29.000000	-95.323888	9.2	13	1	3.16	4.76	3	21.18	22.69
8106407	28.935555	-95.352222	9.9	191	1	75.42	77.07	3	86.39	87.43
8106408	28.927221	-95.361388	9.9	125	1	73.15	77.50	3	83.04	86.12
8106405	28.946944	-95.339444	10.0	35	1	72.48	81.11	3	79.08	85.24
8106505	28.951111	-95.319721	10.8	157	1	68.79	70.16	3	82.81	83.75
8106506	28.941666	-95.324721	10.9	215	1	60.88	62.94	3	76.16	77.49
6553513	29.194166	-95.438888	11.2	13	1	14.15	36.61	4	32.23	44.03
6553504	29.201388	-95.444721	11.6	75	1	10.02	17.47	4	14.59	22.98
6553505	29.203333	-95.438333	11.8	13	1	26.45	27.53	4	30.41	32.02
6554403	29.187499	-95.358611	12.6	45	1	-45.08	45.62	3	-32.19	32.83
6553201	29.215277	-95.439166	12.6	11	1	15.89	17.09	4	19.06	20.94
6551901	29.143055	-95.644999	12.9	48	1	12.85	13.91	4	17.99	23.48
6559501	29.063055	-95.687221	13.2	71	1	-14.91	26.56	3	-16.76	20.04
6559803	29.037499	-95.700277	13.9	39	1	-0.28	15.14	3	2.15	10.11
6559804	29.037499	-95.701111	13.9	15	1	11.06	17.01	3	2.13	11.33
6554407	29.200555	-95.335555	14.1	79	1	11.86	15.41	4	19.59	20.27
6552103	29.218332	-95.589721	14.6	15	1	10.62	11.08	4	28.46	28.79
6552102	29.222499	-95.587499	14.8	13	1	-2.99	6.38	4	13.20	15.86
6554101	29.229166	-95.347499	15.4	20	1	-33.41	34.04	3	-12.29	16.78
6559413	29.065277	-95.738888	16.3	55	1	8.39	28.13	3	0.80	19.97
6559406	29.065555	-95.738888	16.3	28	1	-2.94	27.81	3	-7.79	20.43
6559414	29.064444	-95.739444	16.4	71	1	-10.34	28.52	3	-15.31	21.89
6554602	29.182499	-95.250833	16.8	12	1	-32.83	33.00	4	-26.72	26.81
6559411	29.071666	-95.746110	16.8	111	1	23.09	26.76	3	6.63	13.77
6559410	29.073888	-95.748610	17.0	28	1	17.51	21.05	3	1.85	11.66
6558607	29.071110	-95.750833	17.1	18	1	7.16	10.53	3	-7.76	10.73
6546702	29.262777	-95.340277	17.6	64	1	-17.11	20.02	4	-13.29	14.92
8103701	28.892499	-95.715555	17.7	18	1	-25.63	28.91	4	-12.56	12.85
6558606	29.076388	-95.760555	17.7	16	1	13.62	14.25	3	0.61	3.72
6546701	29.269166	-95.341944	18.0	9	1	-46.39	47.62	3	-38.44	38.93
6558601	29.058611	-95.768332	18.1	39	1	-14.56	26.79	3	-13.83	18.06
6546801	29.267499	-95.333054	18.1	9	1	-48.78	49.97	3	-41.18	41.64
6545501	29.302500	-95.438333	18.6	74	2	-11.17	25.12	5	-4.73	19.06
6544601	29.311388	-95.537777	19.5	7	2	19.46	20.45	4	37.67	39.66
6544607	29.311666	-95.537777	19.5	10	2	17.73	30.44	4	44.88	49.54
6543803	29.253055	-95.681388	19.7	17	2	4.83	14.04	4	30.44	31.01
Average RMSE							33.87			35.94