GAM Run 06-19

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Groundwater Availability Modeling Section
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EXECUTIVE SUMMARY:

We ran the groundwater availability model (GAM) for the central part of the Queen City-Sparta Aquifer, which includes the Carrizo-Wilcox Aquifer, for a 50-year predictive period. The results of these model runs indicate the following:

- When using the 1999 estimated pumpage for each year of the 50-year predictive model run, drawdowns are predicted to occur in all or parts of Fayette County in the Sparta, Queen City, and Carrizo aquifers. Therefore, even with zero additional pumpage, zero drawdown cannot be achieved.

- An additional 12,500 acre-feet per year of pumpage in the Carrizo Aquifer results in a maximum of 50 feet of drawdown over the 50-year predictive period in the Carrizo Aquifer. This amount of pumpage also results in additional drawdown in the overlying Sparta and Queen City aquifers.

REQUESTOR:

Ms. Linda Streicher from the Fayette County Groundwater Conservation District (the District).

DESCRIPTION OF REQUEST:

Ms. Streicher asked us to determine the amount of groundwater, produced annually over a 50-year predictive period that would result in a desired future condition of 50 feet of water level decline over a 50-year period in the Carrizo Aquifer within the District. She also requested estimates of pumpage for the other aquifers within the District with a desired future condition of zero water-level decline.

METHODS:

To determine the amount of groundwater production that resulted in the desired future conditions stated by Ms. Streicher, we used the GAM for the central part of the Queen City-Sparta Aquifer, which includes the Carrizo-Wilcox Aquifer. We ran the GAM using 1999 estimated pumpage as the basis for each year of 50-year predictive simulations. To this baseline pumpage we added pumpage to all cells present in the Carrizo Aquifer within Fayette County. Pumpage was increased until the desired future condition was reached.

PARAMETERS AND ASSUMPTIONS:

- See Kelley and others (2004) and Dutton and others (2003) for assumptions and limitations of the GAM for the central part of the Carrizo-Wilcox/ Queen City/ Sparta aquifers.

- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) in the entire GAM for the period of 1980 to 1999 ranges from 3.2 percent (Carrizo aquifer) to 7.8 percent (Sparta aquifer) of measured water levels (Kelley and others, 2004).

- We used the 1.02 version of the central part of the Carrizo-Wilcox/ Queen City/ Sparta GAM. The stream package in the central part of the Carrizo-Wilcox/ Queen City/ Sparta GAM has been updated from the original model (Kelley and others, 2004) to more accurately reflect average stream flow conditions. Updating the stream package changed heads near streams up to 20 feet compared with the original model. The overall model calibration is not affected enough to require a recalibration. In addition, slight modifications to the hydraulic properties in two cells appeared to stabilize the model and were more consistent with values used in the surrounding cells.

- The model includes eight layers representing: the Sparta Aquifer (Layer 1), Weches confining unit (Layer 2), Queen City Aquifer (Layer 3), Reklaw confining unit (Layer 4), Carrizo Aquifer (Layer 5), Calvert Bluff Formation (Layer 6), Simsboro Formation (Layer 7), and Hooper Formation (Layer 8).

- Each model run included 25 years with historic pumping representing 1975 through 1999 and a predictive period representing 2000 through 2050.

- Recharge for the predictive period (2000 through 2050) is based on average annual precipitation. The average annual precipitation is based on the average rainfall from 1961 through 1990.

- Pumping changes were uniformly distributed to the Carrizo Aquifer across Fayette County wherever the Carrizo Aquifer is present, based on the extent of the Carrizo-Wilcox Aquifer recognized by the Texas Water Development Board (TWDB) (Figure 1).

RESULTS:

For this study, it was assumed that only the Sparta, Queen City, and Carrizo aquifers were of interest for the production of groundwater. Therefore, only these aquifers are evaluated in this report. The extent of these aquifers recognized by the TWDB is shown in Figures 1 to 3. The extent of these aquifers in the GAM will be greater than what is shown in Figures 1 to 3 because the GAM includes areas of the aquifer flow system that contain poorer quality water, which are not recognized by the TWDB as part of the aquifer.

Ms. Streicher wanted to evaluate the amount of groundwater that can be produced annually with a maximum of 50 feet of drawdown in the Carrizo Aquifer over 50 years, and zero drawdown in the Queen City and Sparta aquifers. Water levels at the start of the 50-year predictive model run for the Sparta, Queen City, and Carrizo aquifers are shown in Figures 4, 5, and 6, respectively. Figure 4 indicates that groundwater flow in the Sparta is towards the Colorado River throughout the county. Figure 5 indicates that although less prominent, groundwater flow in the Queen City also appears to flow generally towards the Colorado River, even though the Queen City is not in hydraulic connection with the Colorado River in Fayette County. Figure 6 indicates that groundwater in the Carrizo Aquifer is not at all influenced by the Colorado River, and that flow is to the east/northeast.

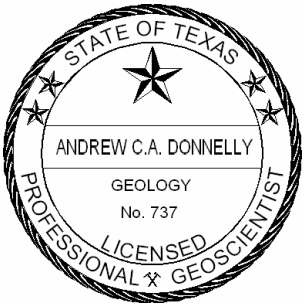
We made an initial model run to evaluate the effects of the baseline 1999 estimated pumpage on water levels in the three aquifers. Figures 7, 8, and 9 show the drawdowns (differences in water levels) after 50 years in the Sparta, Queen City, and Carrizo aquifers, respectively. Figures 7 and 8 indicate that even if the 1999 pumpage was used annually over the next 50 years, some areas of the county (shown in orange) would still show drawdown in both the Sparta and Queen City aquifers. This indicates that the concept of zero drawdown is not possible, and that some drawdown will occur even if current pumping levels remain constant for the 50-year predictive run. Figure 9 indicates that all of Fayette County will have drawdown in the Carrizo Aquifer with these pumping levels. Because the only aquifer that does not have a zero drawdown desired future condition is the Carrizo Aquifer, we only made predictive model runs with increasing pumpage in the Carrizo such that a maximum of 50 feet of drawdown over 50 years was reached.

Figures 10 through 14 show the drawdown in the Carrizo Aquifer over 10, 20, 30, 40, and 50 years when 12,500 acre-feet per year of pumpage is added to the Carrizo Aquifer in Fayette County. Drawdowns are the greatest in the middle of the area where pumpage has been added because of the additive nature of water level declines in response to pumpage. As shown in these Figures, this amount of pumpage results in increasing drawdown in the Carrizo Aquifer, with most of the drawdown occurring in the first ten years. After fifty years this amount of pumpage results in a maximum of 50 feet of drawdown, which is the requested desired future condition. Figures 15 and 16 show the effects of this amount of pumpage on the Carrizo Aquifer and on the overlying Queen City and Sparta aquifers. As shown in these figures, even though the pumpage is restricted to the Carrizo Aquifer, additional drawdown can be observed in both the Sparta (Figure 15) and Queen City (Figure 16) aquifers.

REFERENCES:

Dutton, A. R., Harden, R., Nicot, J. P., and O'Rourke, D., 2003, Groundwater availability model for the central part of the Carrizo-Wilcox aquifer in Texas: Bureau of Economic Geology, Final report prepared for the Texas Water Development Board.

Kelley, V. A., Deeds, N. E., Fryar, D. G., Nicot, J. P., Jones, T. L., Dutton, A. R., Unger-Holtz, T., and Machin J. L., 2004, Groundwater availability model for the Queen City and Sparta aquifers: Final report prepared for the Texas Water Development Board by INTERA Inc.



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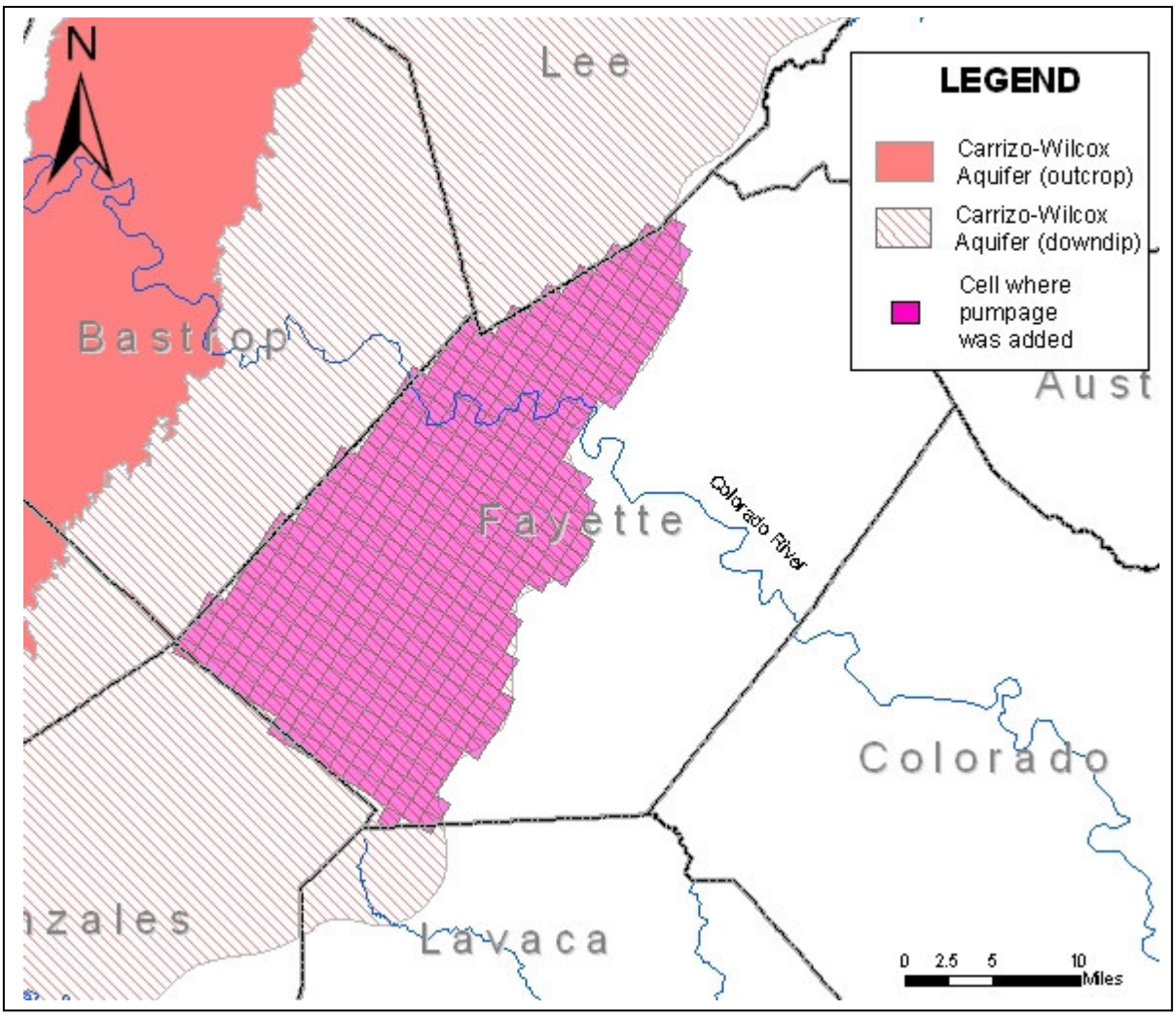

Figure 1. Extent of the Carrizo Aquifer in Fayette County and cells where pumpage was added in the predictive model runs.

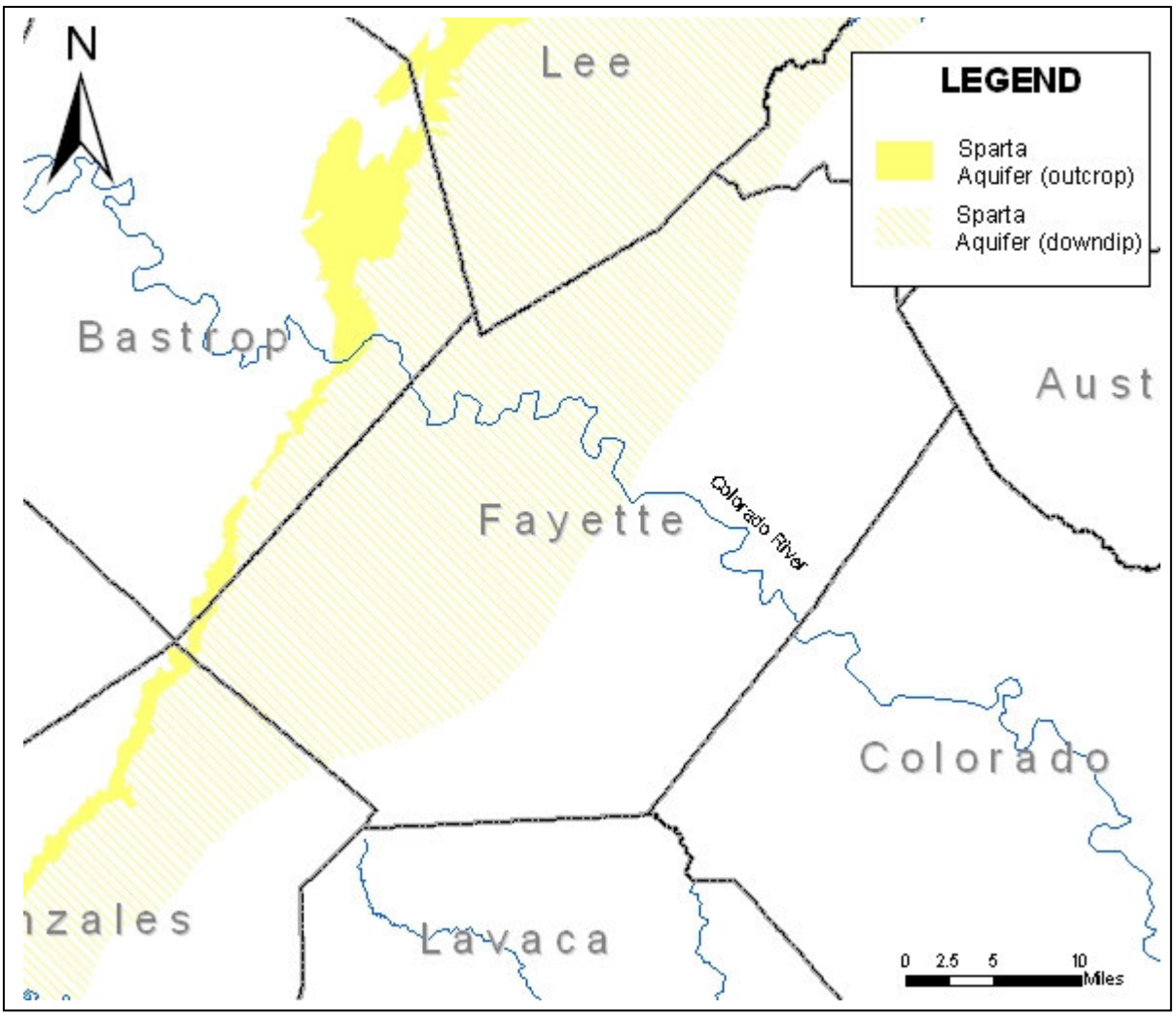

Figure 2. Extent of the Sparta Aquifer in Fayette County.

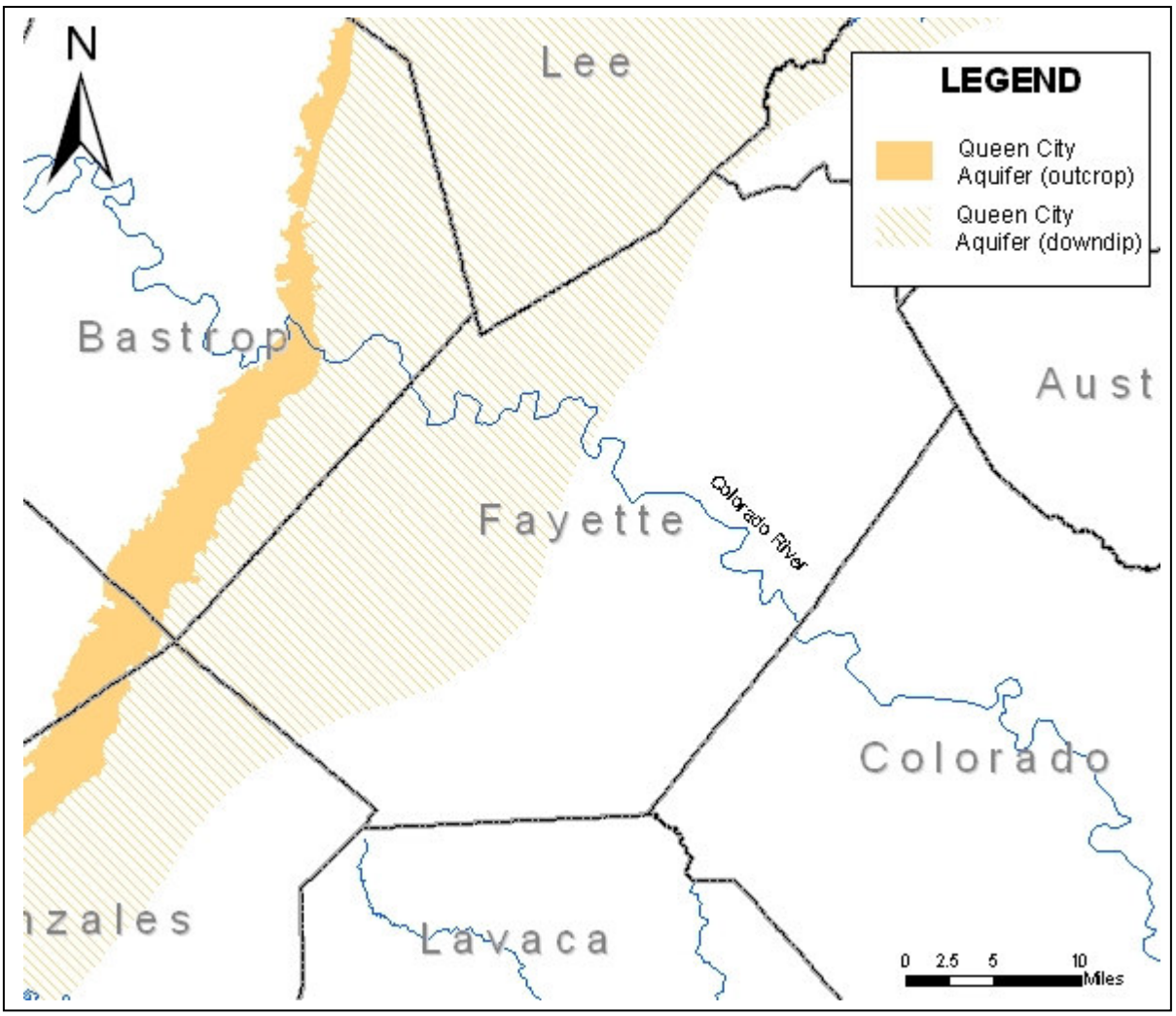

Figure 3. Extent of the Queen City Aquifer in Fayette County.

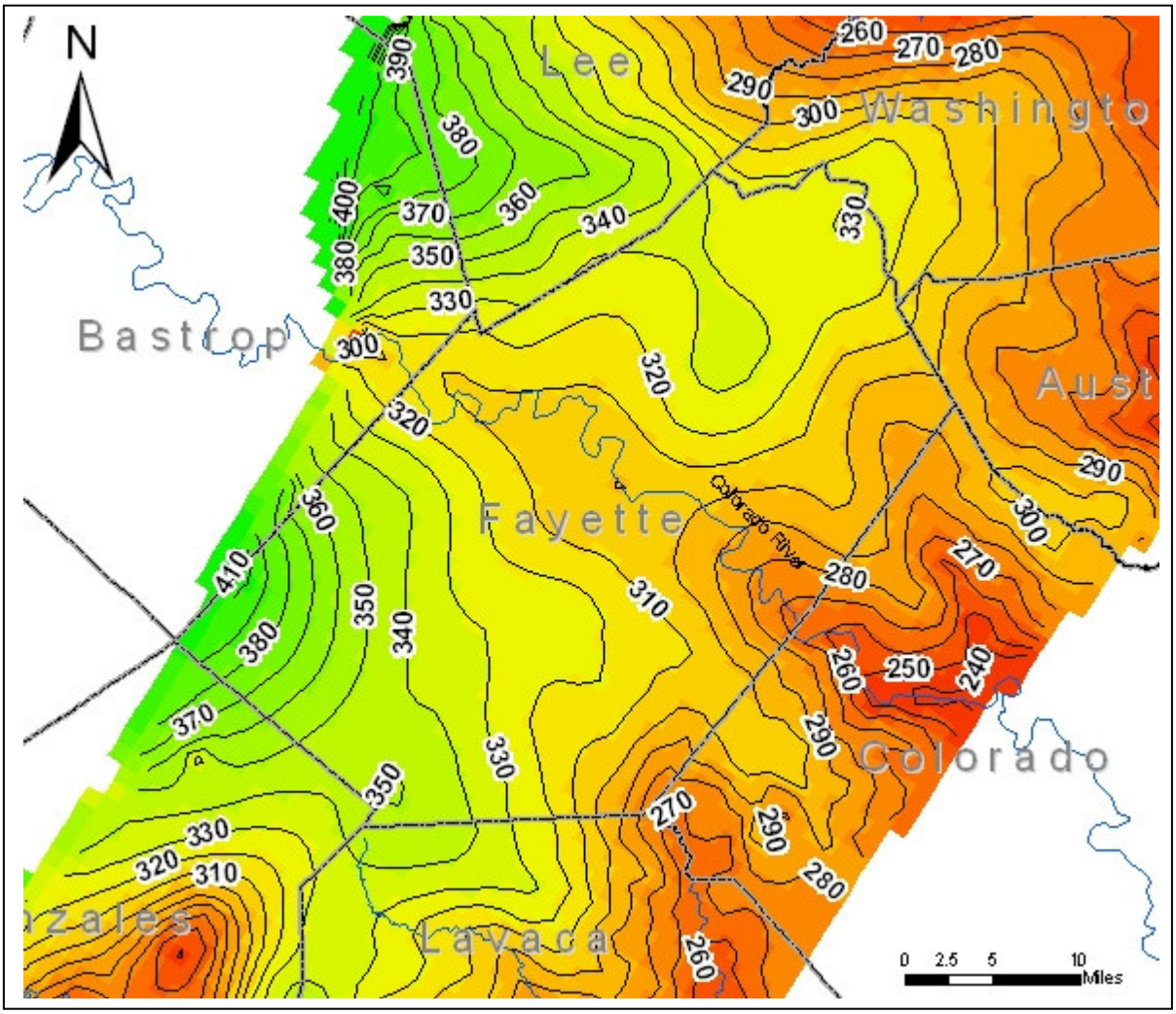

Figure 4. Water levels at the start of the predictive model run (1999) in Layer 1 (Sparta Aquifer). The water level contour interval is 10 feet.

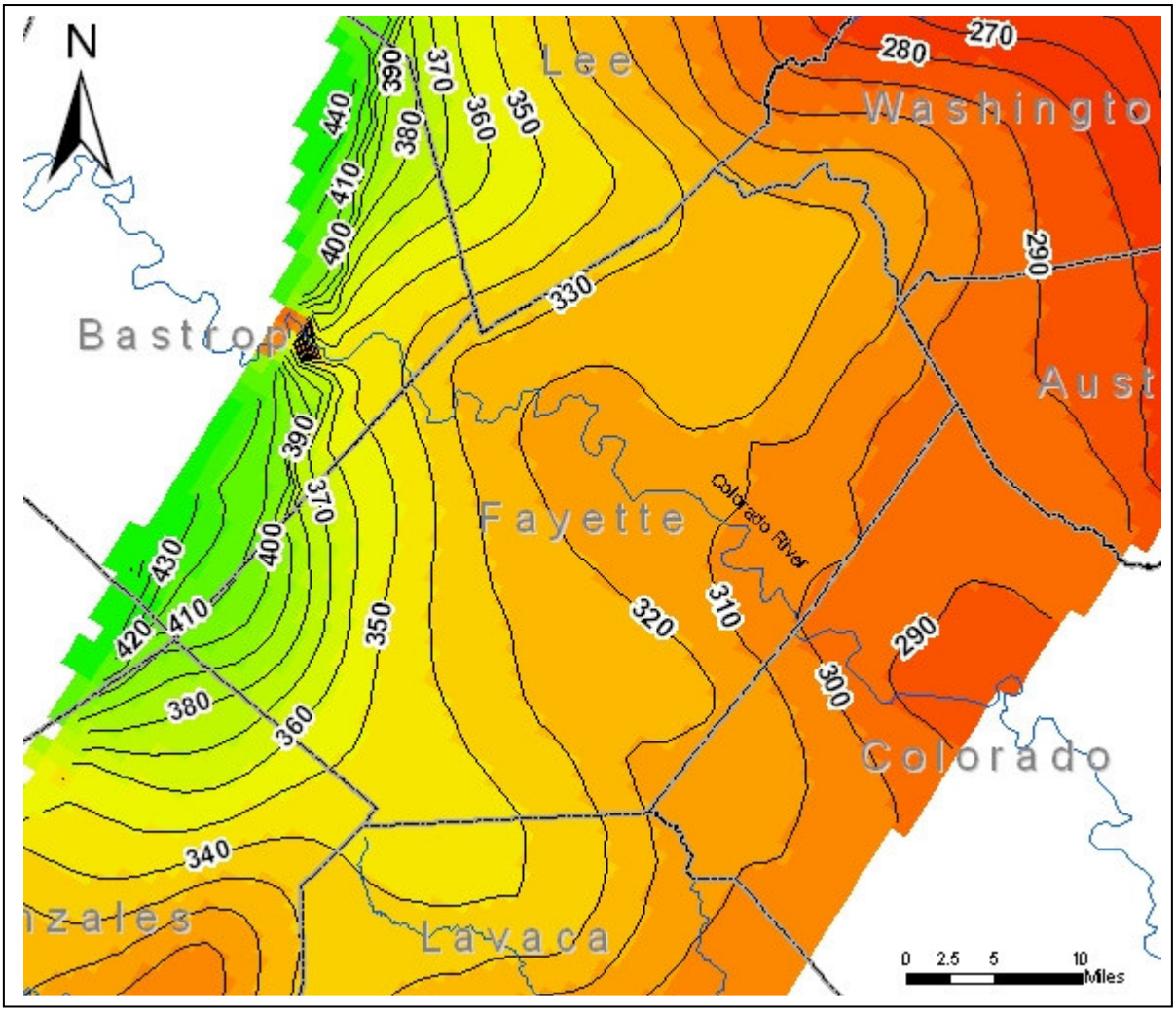

Figure 5. Water levels at the start of the predictive model run (1999) in Layer 3 (Queen City Aquifer). The water level contour interval is 10 feet.

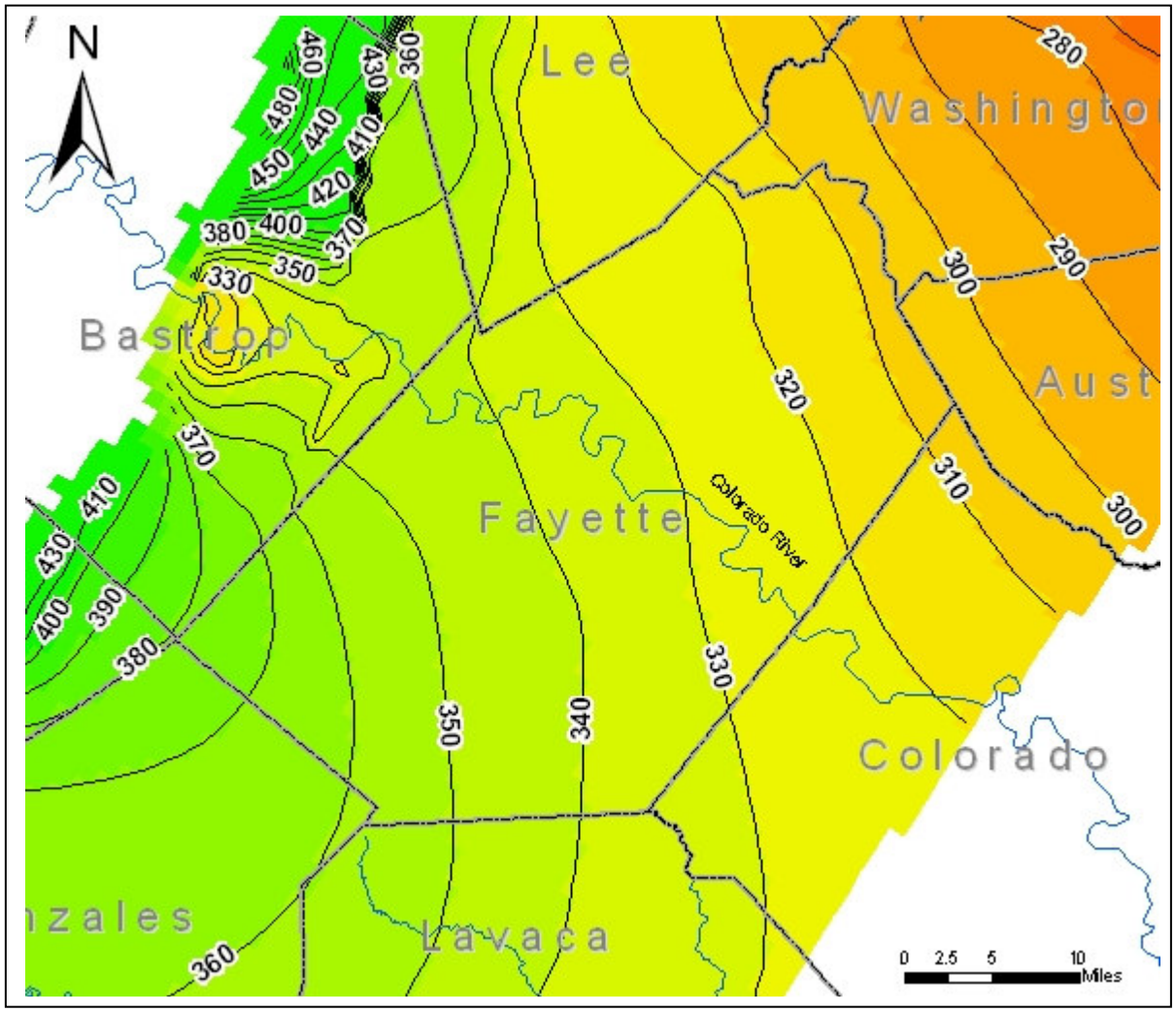

Figure 6. Water levels at the start of the predictive model run (1999) in Layer 5 (Carrizo Aquifer). The water level contour interval is 10 feet.

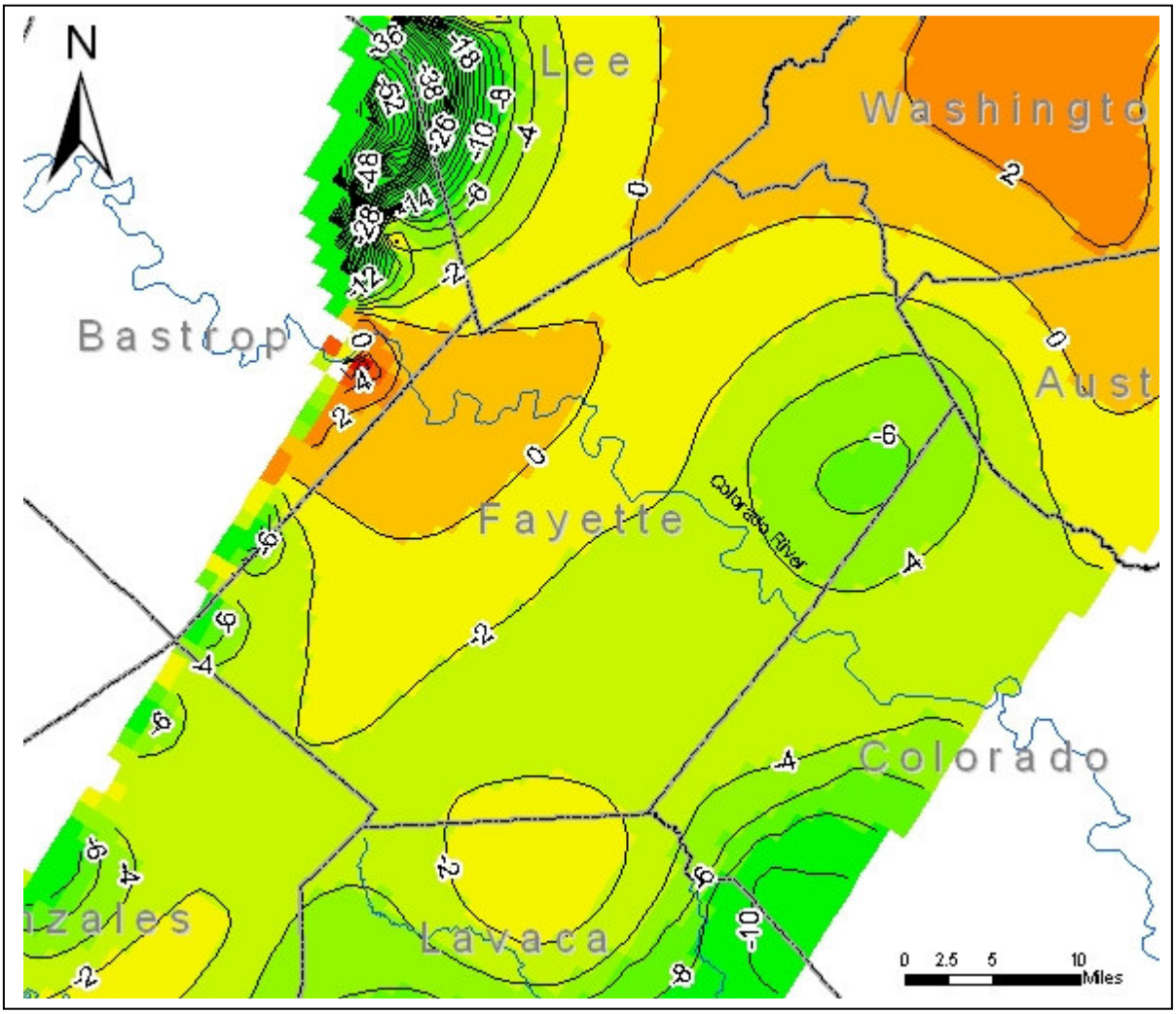

Figure 7. Drawdowns (in feet) in Layer 1 (Sparta Aquifer) after 50 years using the baseline (1999) pumpage for each year of the 50-year predictive model run. Orange and red areas (positive values) are where water levels have declined (drawdown has occurred), yellow and green areas (negative values) are where water levels have increased (recovered). Contour interval is 2 feet.

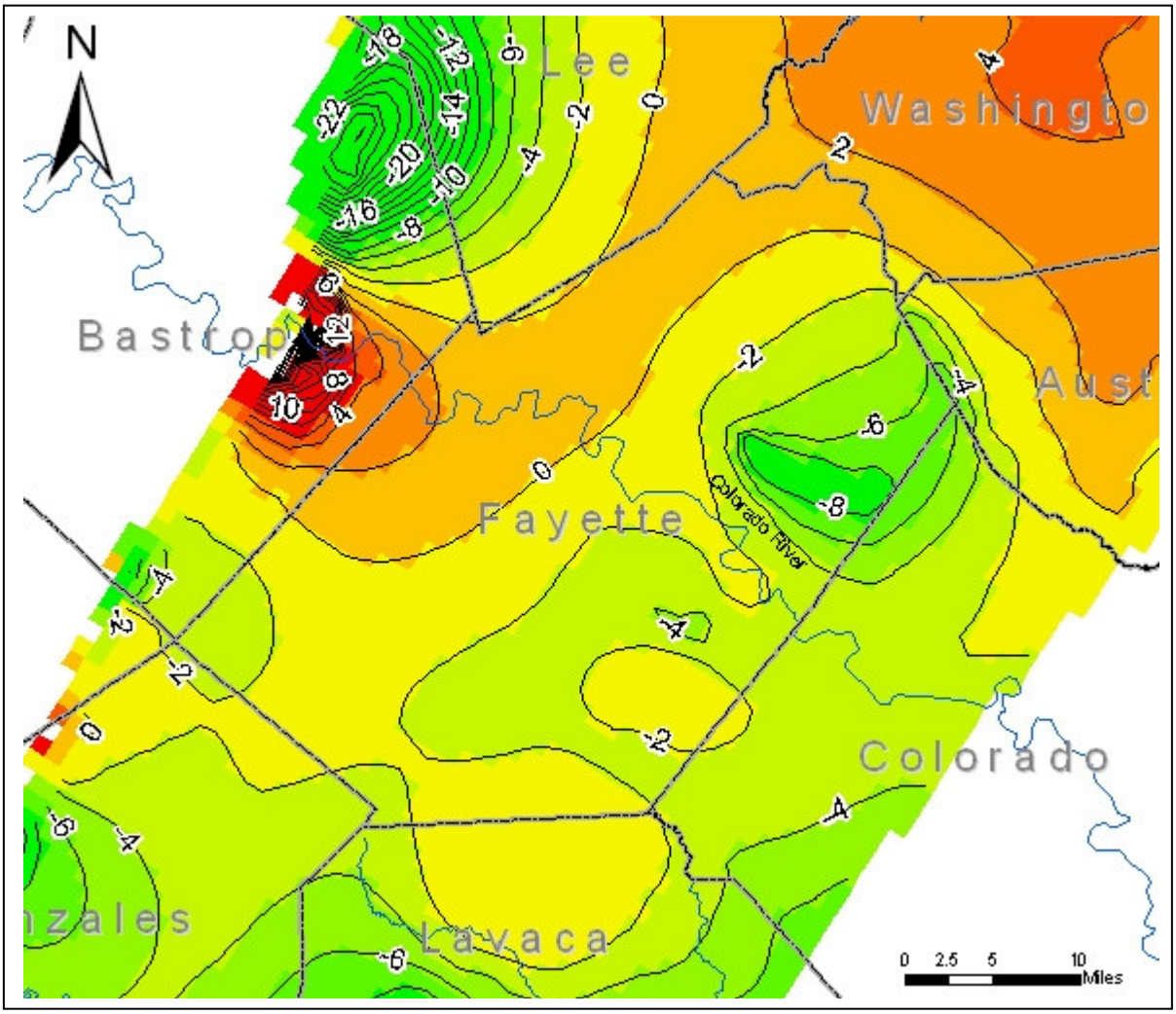

Figure 8. Drawdowns (in feet) in Layer 3 (Queen City Aquifer) after 50 years using the baseline (1999) pumpage for each year of the 50-year predictive model run. Orange and red areas (positive values) are where water levels have declined (drawdown has occurred), yellow and green areas (negative values) are where water levels have increased (recovered). Contour interval is 2 feet.

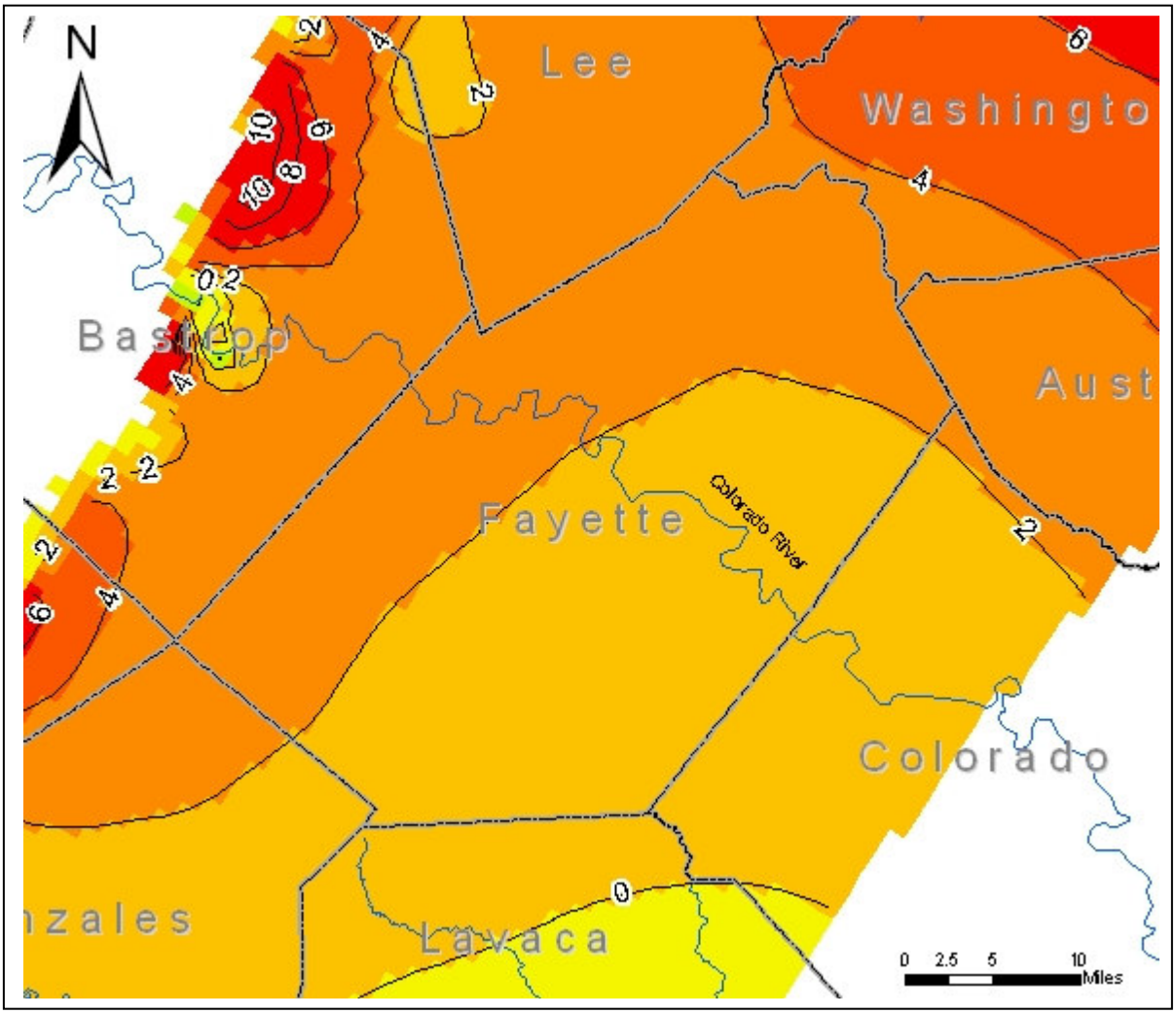

Figure 9. Drawdowns (in feet) in Layer 5 (Carrizo Aquifer) after 50 years using the baseline (1999) pumpage for each year of the 50-year predictive model run. Orange and red areas (positive values) are where water levels have declined (drawdown has occurred), yellow and green areas (negative values) are where water levels have increased (recovered). Contour interval is 2 feet.

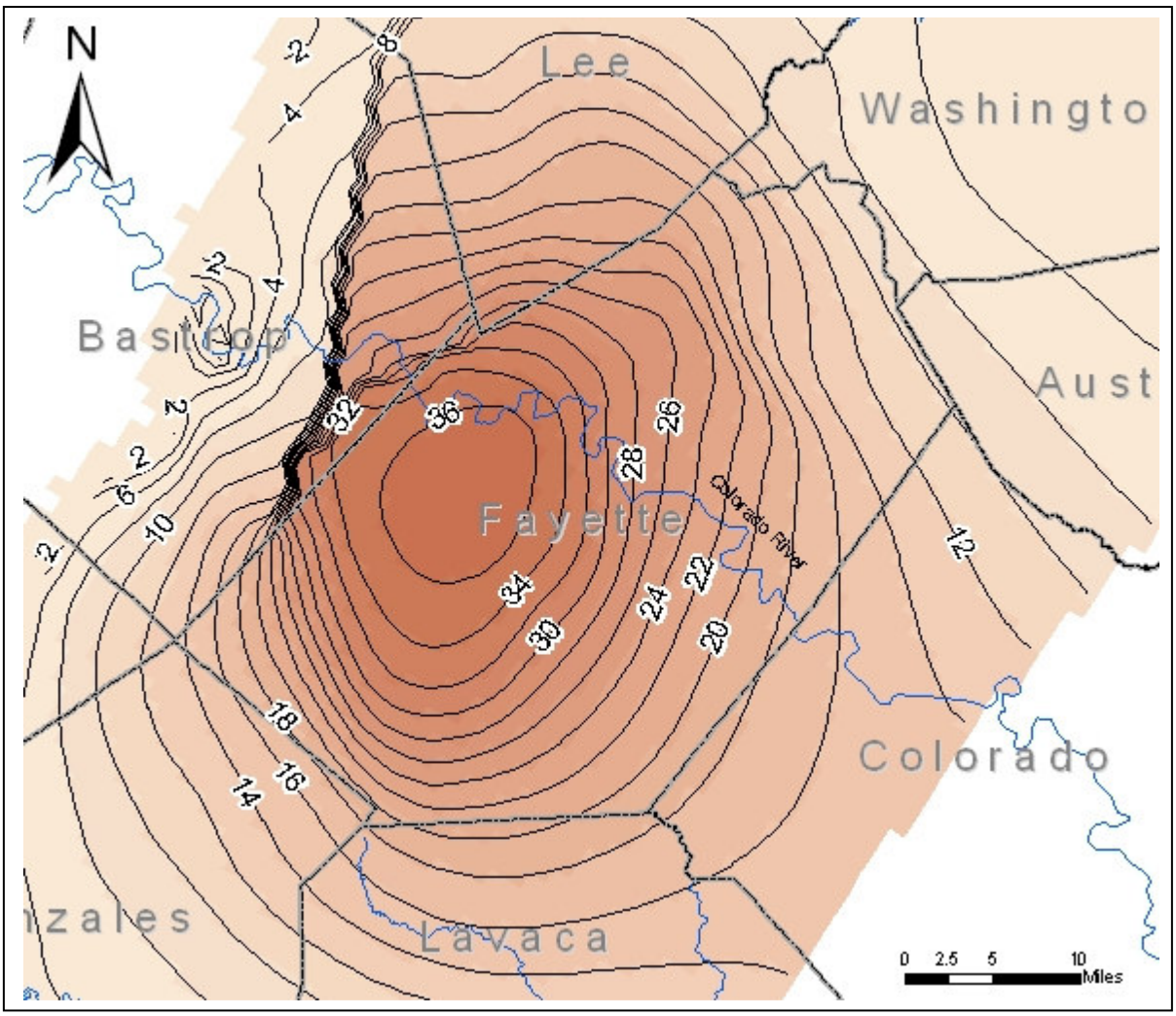

Figure 10. Drawdowns (in feet) in Layer 5 (Carrizo Aquifer) after 10 years using the baseline (1999) pumpage plus 12,500 acre-feet per year in the Carrizo Aquifer for each year of the 50-year predictive model run. Greater drawdowns are darker red. Contour interval is 2 feet.

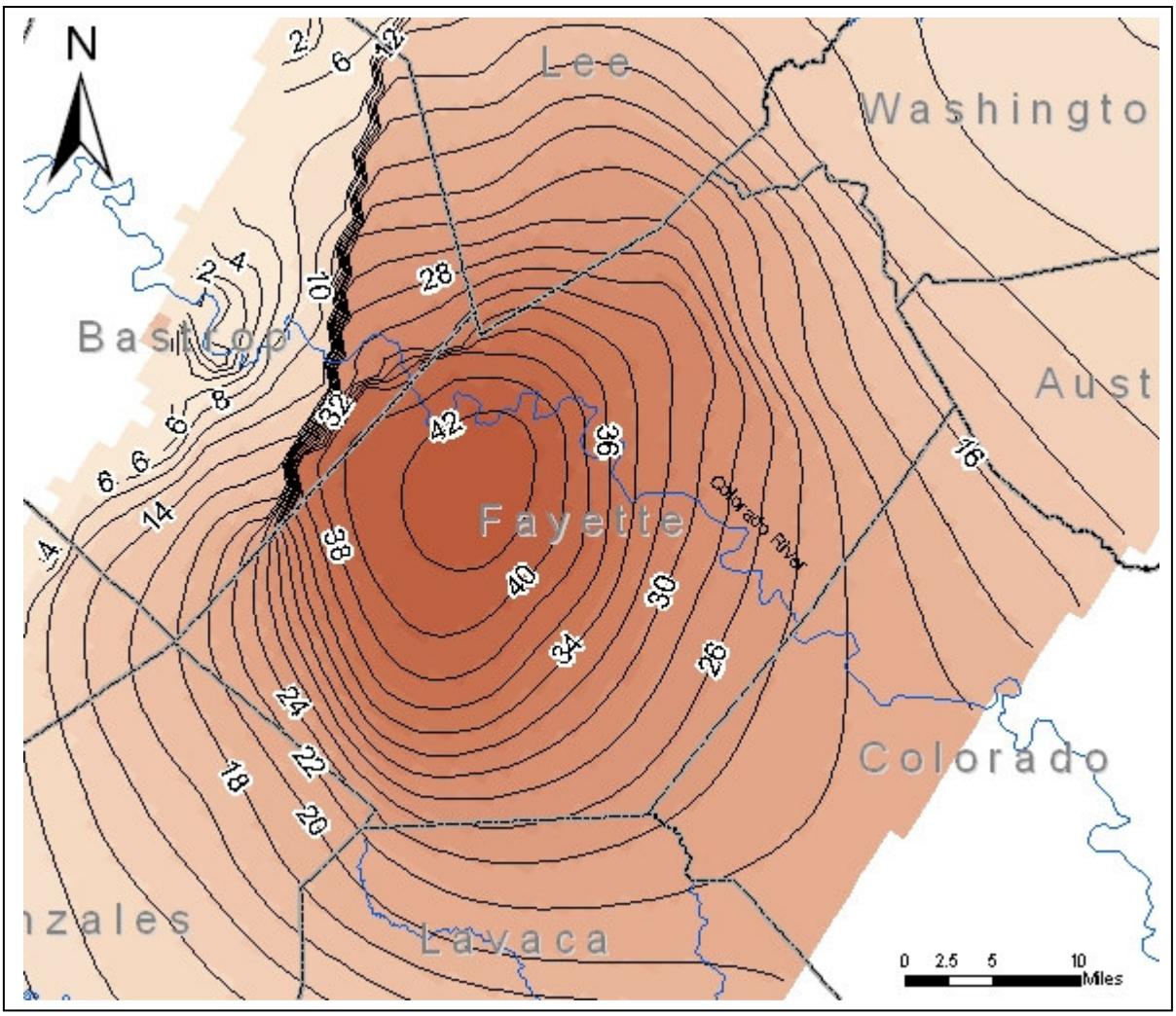

Figure 11. Drawdowns (in feet) in Layer 5 (Carrizo Aquifer) after 20 years using the baseline (1999) pumpage plus 12,500 acre-feet per year in the Carrizo Aquifer for each year of the 50-year predictive model run. Greater drawdowns are darker red. Contour interval is 2 feet.

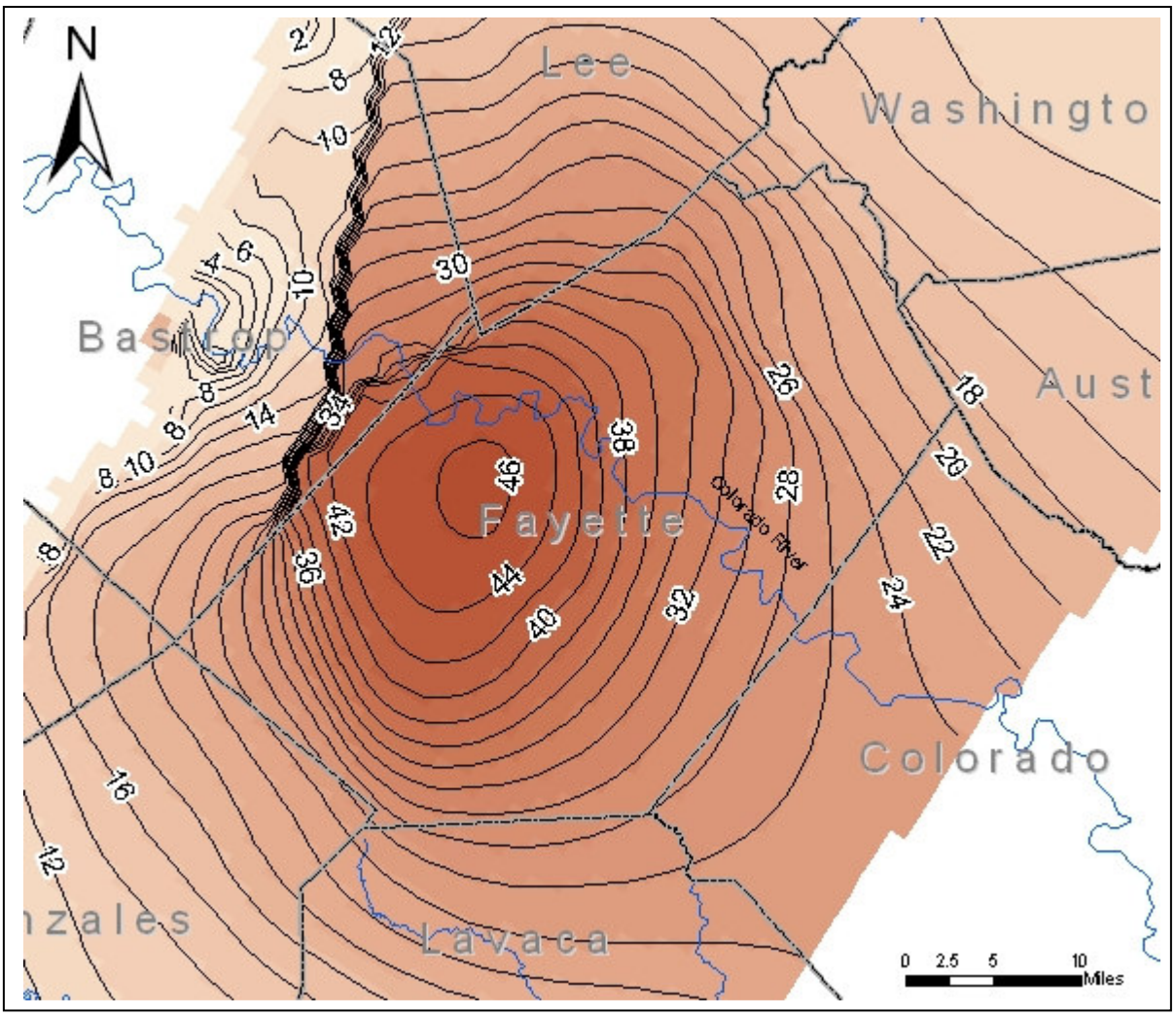

Figure 12. Drawdowns (in feet) in Layer 5 (Carrizo Aquifer) after 30 years using the baseline (1999) pumpage plus 12,500 acre-feet per year in the Carrizo Aquifer for each year of the 50-year predictive model run. Greater drawdowns are darker red. Contour interval is 2 feet.

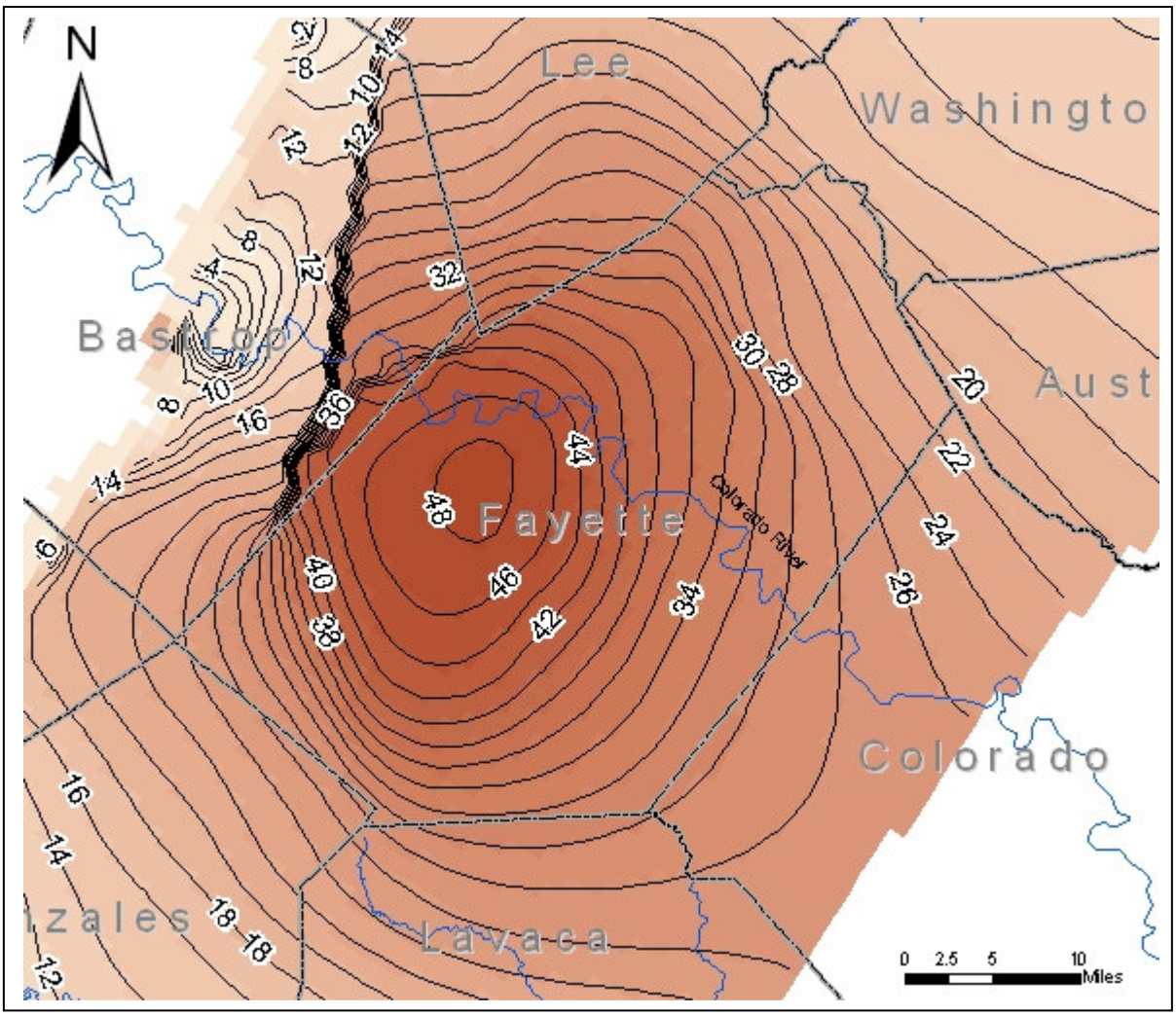

Figure 13. Drawdowns (in feet) in Layer 5 (Carrizo Aquifer) after 40 years using the baseline (1999) pumpage plus 12,500 acre-feet per year in the Carrizo Aquifer for each year of the 50-year predictive model run. Greater drawdowns are darker red. Contour interval is 2 feet.

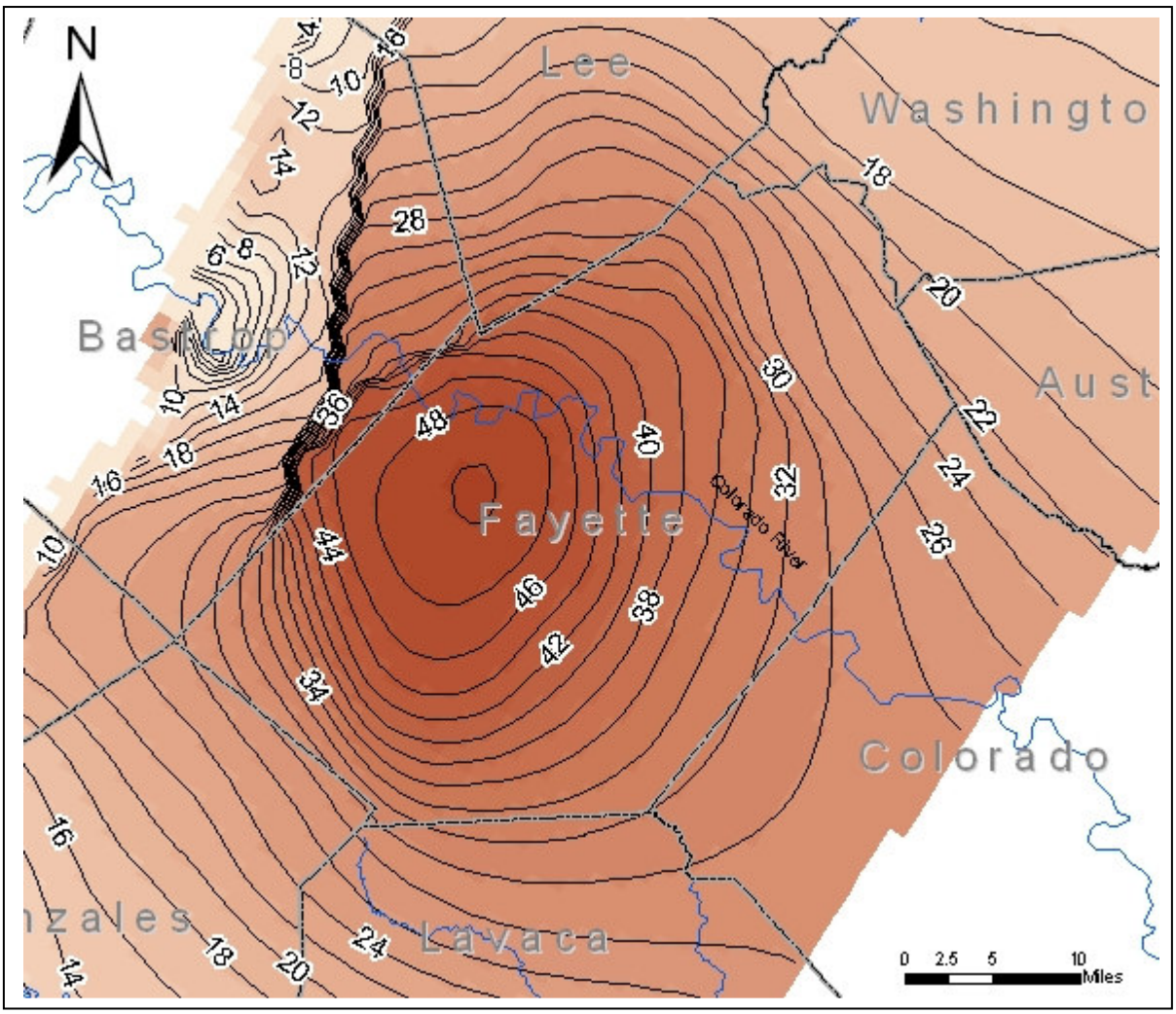

Figure 14. Drawdowns (in feet) in Layer 5 (Carrizo Aquifer) after 50 years using the baseline (1999) pumpage plus 12,500 acre-feet per year in the Carrizo Aquifer for each year of the 50-year predictive model run. Greater drawdowns are darker red. Contour interval is 2 feet.

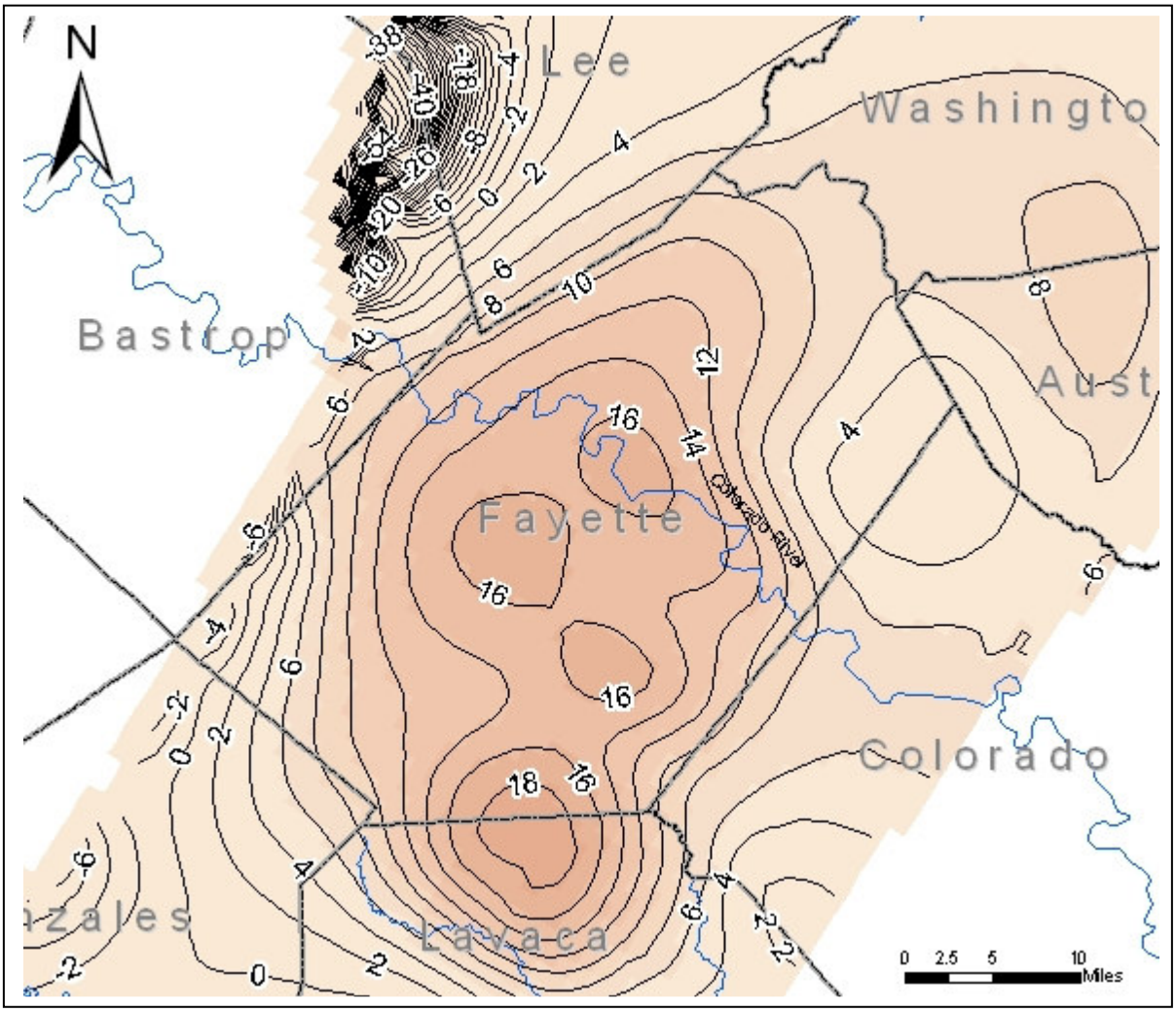

Figure 15. Drawdowns (in feet) in Layer 1 (Sparta Aquifer) after 50 years using the baseline (1999) pumpage plus 12,500 acre-feet per year in the Carrizo Aquifer for each year of the 50-year predictive model run. Greater drawdowns are darker red. Contour interval is 2 feet.

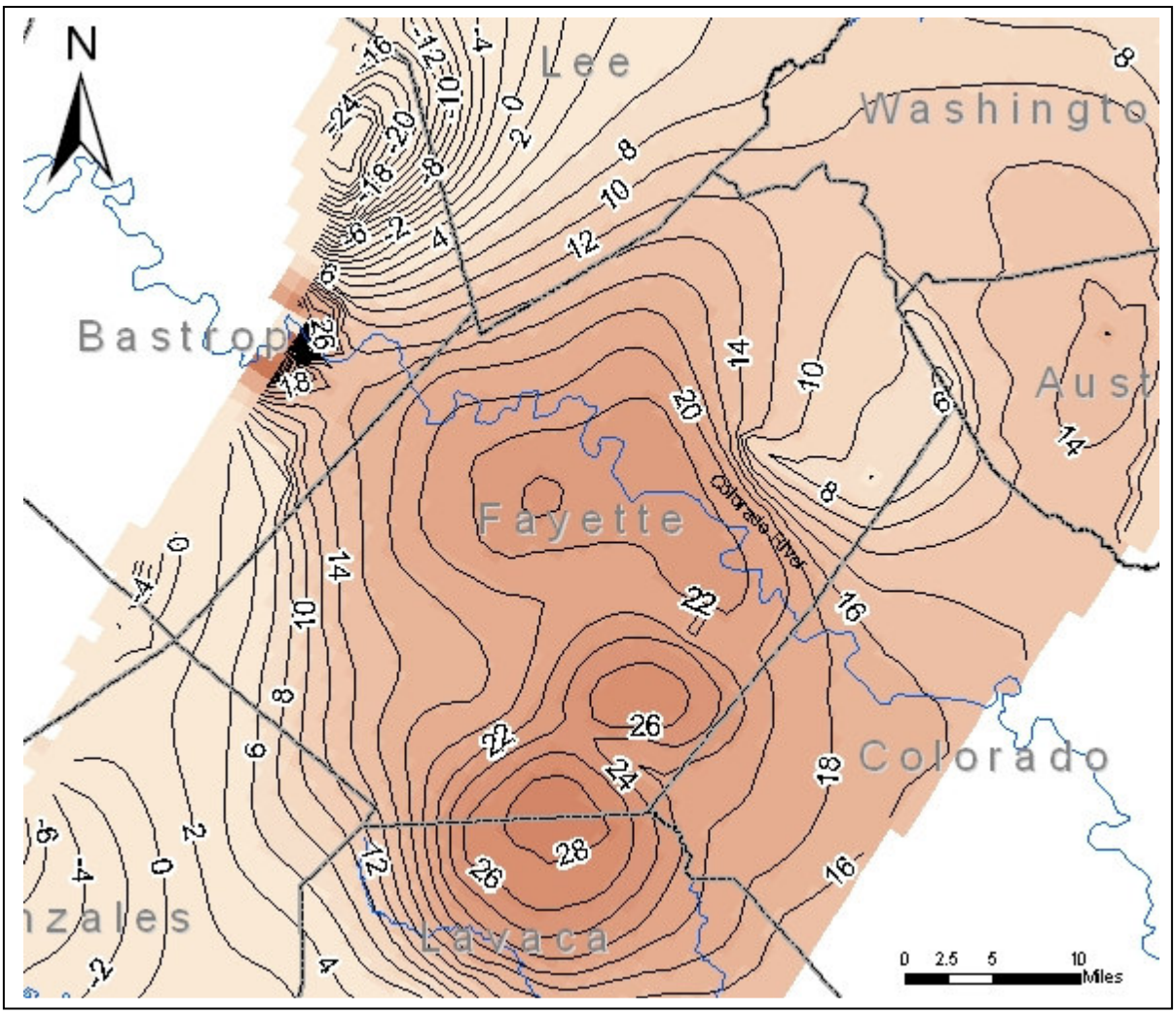

Figure 16. Drawdowns (in feet) in Layer 3 (Queen City Aquifer) after 50 years using the baseline (1999) pumpage plus 12,500 acre-feet per year in the Carrizo Aquifer for each year of the 50-year predictive model run. Greater drawdowns are darker red. Contour interval is 2 feet.