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EVALUATION OF CARRIZO-WILCOX GROUNDWATER ELEVATIONS AND CHANGES IN RUSK COUNTY, TEXAS

RUSK COUNTY GROUNDWATER CONSERVATION DISTRICT
JUNE 2017

PURPOSE

The primary purpose of this study was to develop Geographic Information System (GIS) models of the average annual Carrizo-Wilcox groundwater elevations within Rusk County for the years 1999 and 2009 through 2016 and then to develop GIS models of the average annual Carrizo-Wilcox groundwater elevation changes within Rusk County for the years 2009 through 2016 using the 1999 GIS groundwater elevation model as the basis for determining these changes.

SOURCES OF GROUNDWATER ELEVATION DATA INPUT INTO THE GIS MODELS

Carrizo-Wilcox groundwater elevations used to develop the 1999 GIS model were obtained from the Texas Water Development Board's (TWDB's) online Groundwater Database. Carrizo-Wilcox groundwater elevations used to develop the 2009 through 2016 GIS models were predominantly obtained from Rusk County Groundwater Conservation District (RCGCD) and supplemented with groundwater elevations obtained from the TWDB's online Groundwater Database.

METHODS

Groundwater elevation data was compiled from 215 water wells in Rusk and surrounding counties. Annual averages for Carrizo-Wilcox water levels were calculated for each well. Annual averages were calculated for 1999, and 2009 through 2016. These data were then imported into a GIS database, using the latitude and longitude coordinates associated with each well.

The annual average groundwater elevations for each year were interpolated to a raster format. Since data from outside the county were used, the raster was then clipped to the county boundary. From the raster, a surface model depicting the average Carrizo-Wilcox groundwater elevation across the county was generated for each year. These surfaces were used to map/contour the average annual Carrizo-Wilcox groundwater elevation for Rusk County for the years 1999, and 2009 through 2016. The models were also used to calculate the overall countywide average groundwater elevation for each year.

Since the Groundwater Availability Model (GAM) uses the 1999 average Carrizo-Wilcox groundwater elevation as a baseline for determining the desired future condition (DFC) of the Carrizo-Wilcox aquifer in Rusk County, the surface models for 2009 through 2016 were compared to the 1999 surface model. The 1999 surface was subtracted from each subsequent year, producing a difference model depicting the change in groundwater elevation (positive or negative) since 1999. These difference models were used to map the Carrizo-Wilcox groundwater elevation changes for the years 2009 through 2016. The models were also used to calculate the total amount of change from the 1999 baseline across Rusk County for each year.

1120 NW STALLINGS DRIVE
NACOGDOCHES, TX 75964-3428

936-568-9451
FAX 936-568-9527

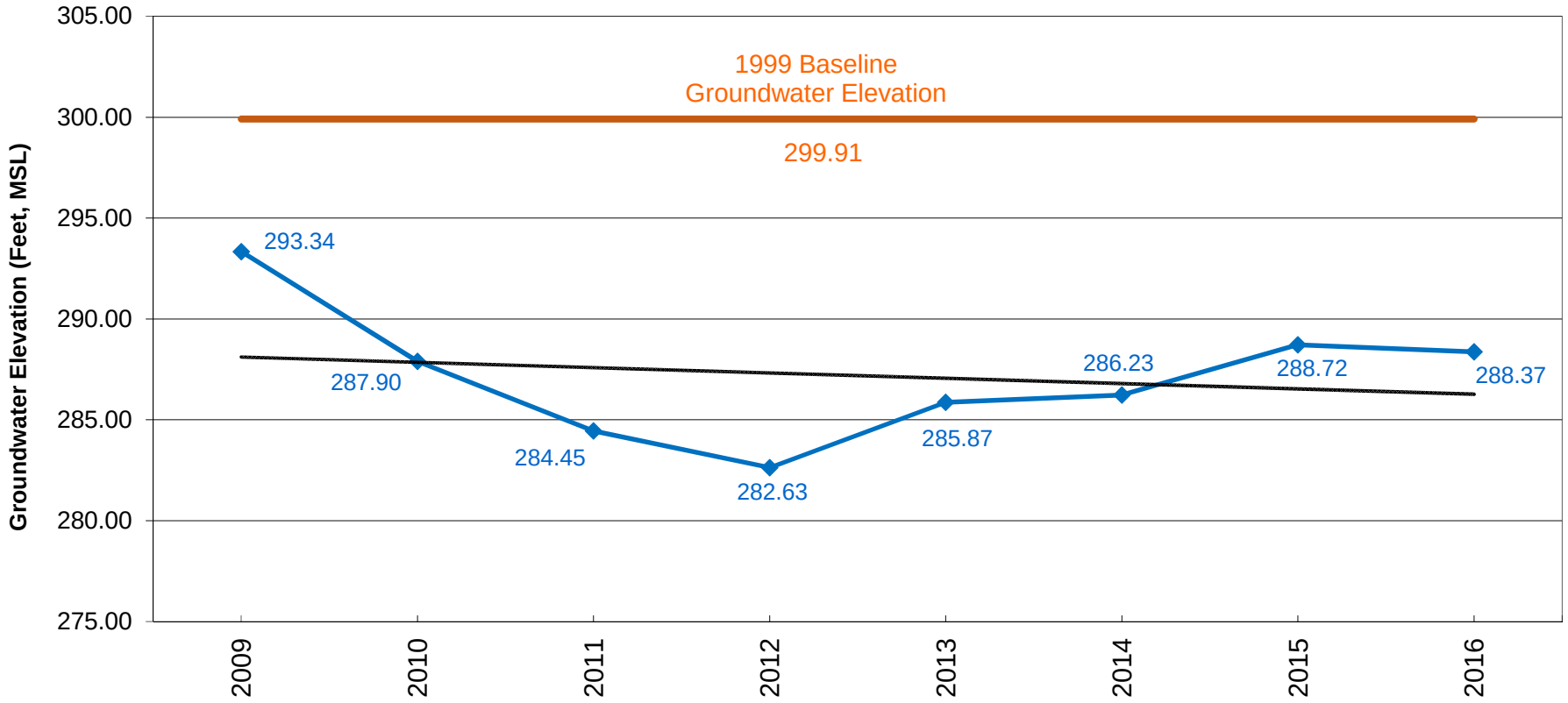
SUMMARY OF GIS MODELING RESULTS

Overall, the GIS model results for this study show a slight decreasing trend in countywide average annual Carrizo-Wilcox groundwater levels between 2009 and 2016. When comparing the average annual water levels modeled for these years to the countywide average groundwater level modeled for 1999, the year the current GAM uses as a baseline for calculating drawdown predictions, the overall average annual Carrizo-Wilcox groundwater levels (between 2009 and 2016) are shown to be consistently below the 1999 baseline level; dipping as low as 17.28 feet below the baseline in 2012 and rebounding to just over 11.5 feet below the baseline in 2016. It is worth noting that the relatively low countywide average groundwater levels modeled in 2012 appear to be related to the drought conditions observed in 2011. Additionally, it appears the 1999 average groundwater levels were historically high when compared to the levels observed and modeled between 2009 and 2016.

When reviewing the GIS Average Annual Carrizo-Wilcox Groundwater Elevation and Drawdown Maps for the years 2009 through 2016, areas of increased and decreased Carrizo-Wilcox groundwater usage may be observed. Areas of apparent increased usage (drawdown of groundwater levels since 1999) can be seen predominantly in the northeastern, central, extreme west-central, and southeastern portions of the county. Some of these areas may be attributable to increased industrial activities, specifically mining and oil and gas exploration and production, both in these parts of the county and in immediately adjoining counties. Areas of apparent decreased usage (rebound of groundwater levels since 1999) can be seen predominantly in the southwestern and extreme northwestern portions of the county and in small pockets in the central and east-central portions of the county. Overall, however, the Average Annual Carrizo-Wilcox Groundwater Elevation and Drawdown Maps produced for the years 2009 through 2016 appear to indicate groundwater usage in the county has generally increased between 2009 and 2016 with peak usage (lowest groundwater levels) likely occurring at or near the end of the drought in 2012.

Comparing the GIS model results to the GAM predictions taken from the GAM run produced for the District's newly adopted DFC, the results of the GIS models show the GAM may be under-predicting the countywide average annual drawdowns by as much as 8.58 feet between 2010 and 2016. Based on the GIS models, the highest under-prediction by the GAM is seen in 2012, the year drought conditions appear to have had an impact on the countywide average groundwater levels. By 2016, however, the GIS models indicate the GAM under-prediction of drawdown decreases to only 1.41 feet relative to the GIS drawdown models. Future GAM predictions of drawdown continue to show a slight increase to 23 feet by 2070. Interestingly, the trendline for the countywide average drawdowns shown in the GIS models for 2009 to 2016 shows a slight downward trajectory similar to the trajectory of the GAM drawdown prediction curve.

AVERAGE ANNUAL
CARRIZO-WILCOX GROUNDWATER ELEVATIONS
(Measured 2009 to 2016)



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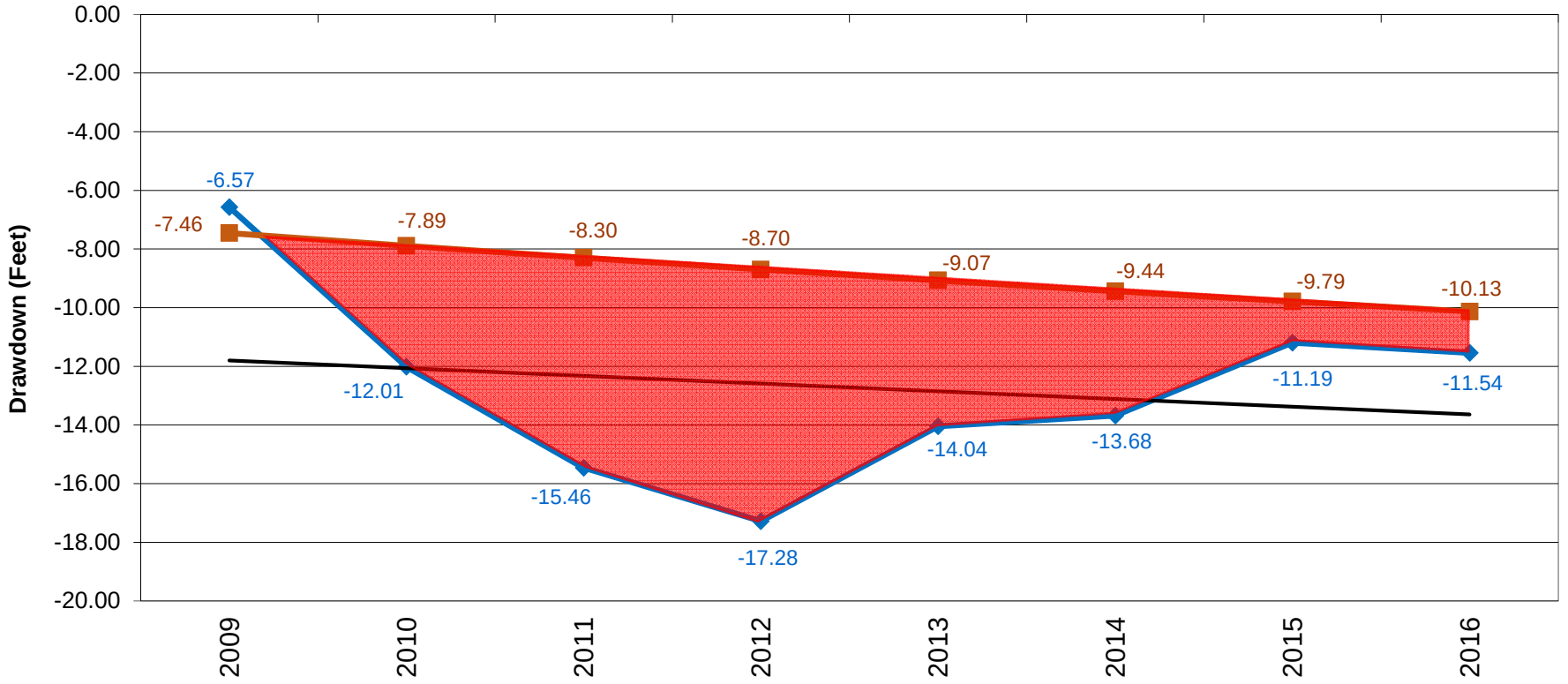
RUSK COUNTY
GROUNDWATER CONSERVATION DISTRICT

AVERAGE ANNUAL CARRIZO-WILCOX DRAWDOWN
(BASED ON 1999 GROUNDWATER ELEVATION BASELINE)
VS.
GAM PREDICTED DRAWDOWN
(2017 DFC)



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RUSK COUNTY GROUNDWATER CONSERVATION DISTRICT

Summary of the Number of Water Wells Used to Model the Average Annual Carrizo-Wilcox Groundwater Elevations in Rusk County

(By County and Year)

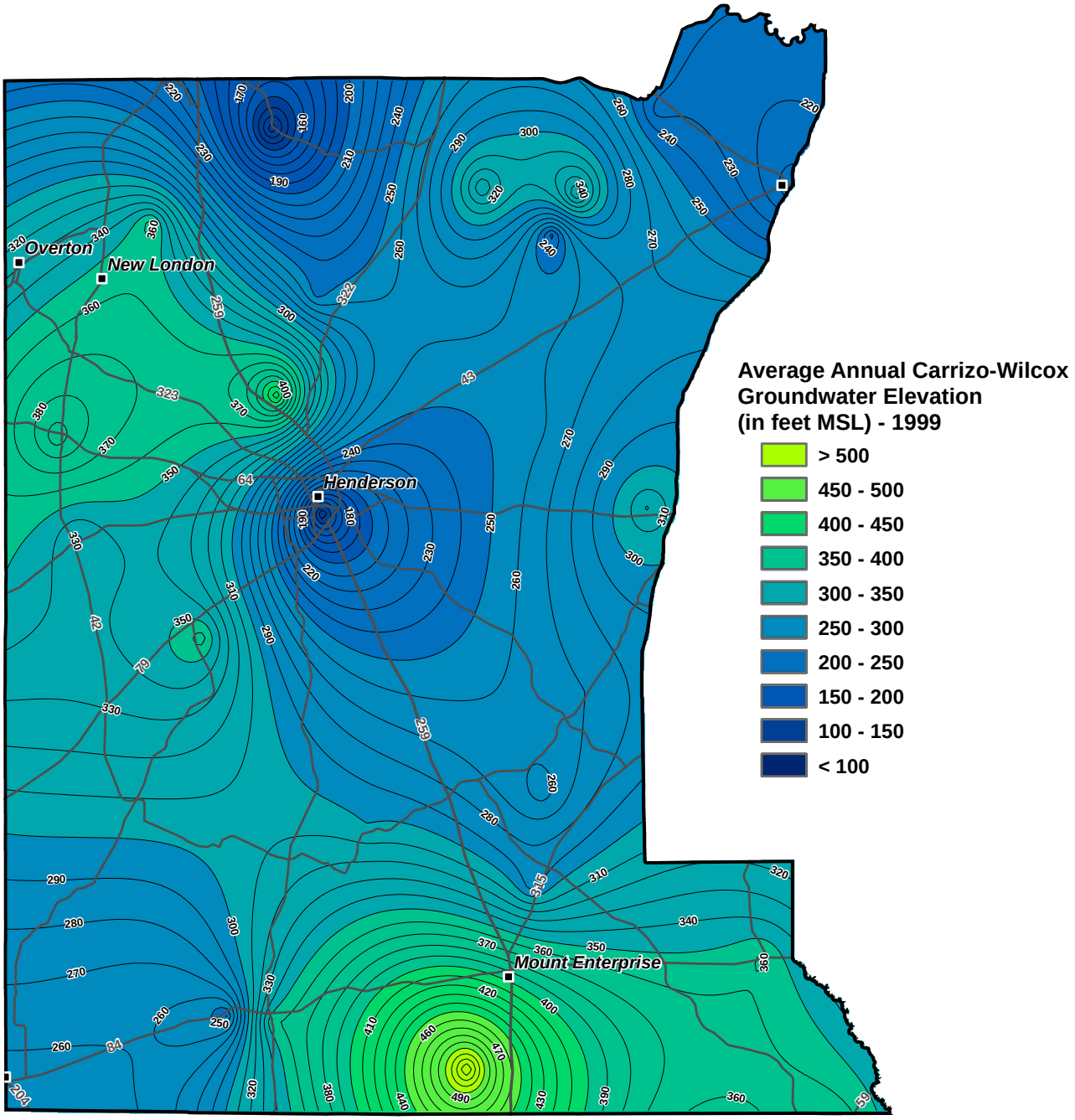
COUNTY	1999	2009	2010	2011	2012	2013	2014	2015	2016
Rusk	23	102	142	121	122	108	106	113	114
Smith	6	3	6	5	4	4	4	4	5
Cherokee	3	3	2	3	1	2	2	3	2
Nacogdoches	5	4	4	4	4	4	4	4	4
Shelby	2	2	2	2	2	2	2	2	2
Panola	6	5	4	4	5	5	5	4	5
Harrison	1	1	2	1	1	1	1	1	1
Gregg	3	2	2	1	1	0	2	2	2
TOTAL	**49**	**122**	**164**	**141**	**140**	**126**	**126**	**133**	**135**

Source of Data: RCGCD (155 Wells) and TWDB (60 Wells)

1999

Average Annual Carrizo-Wilcox Groundwater Elevation

299.91 feet MSL



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0 2 4 6 12 18 24

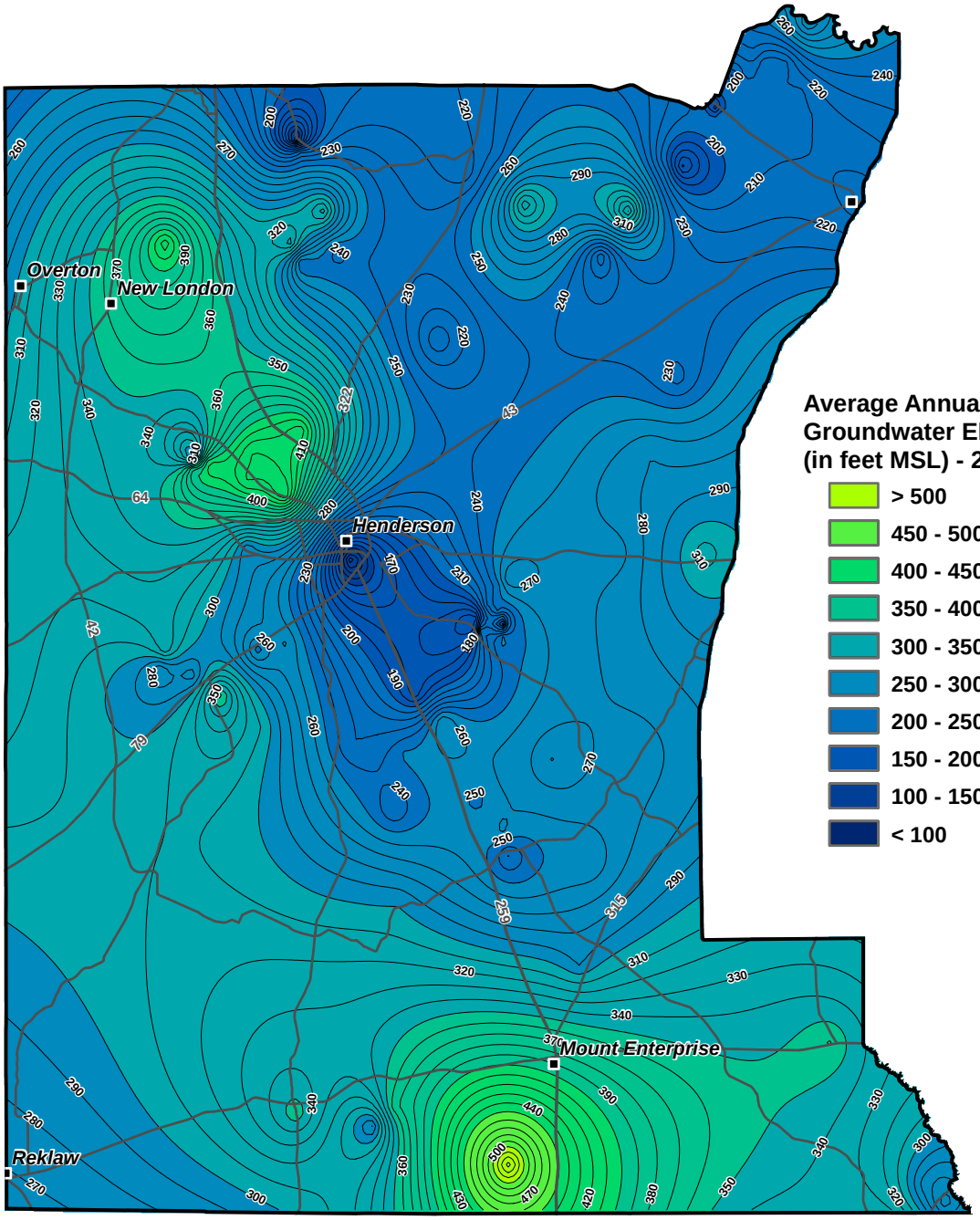
Miles

Rusk County Groundwater Conservation District

2009

Average Annual Carrizo-Wilcox Groundwater Elevation

293.34 feet MSL



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0 2 4 6 12 18 24

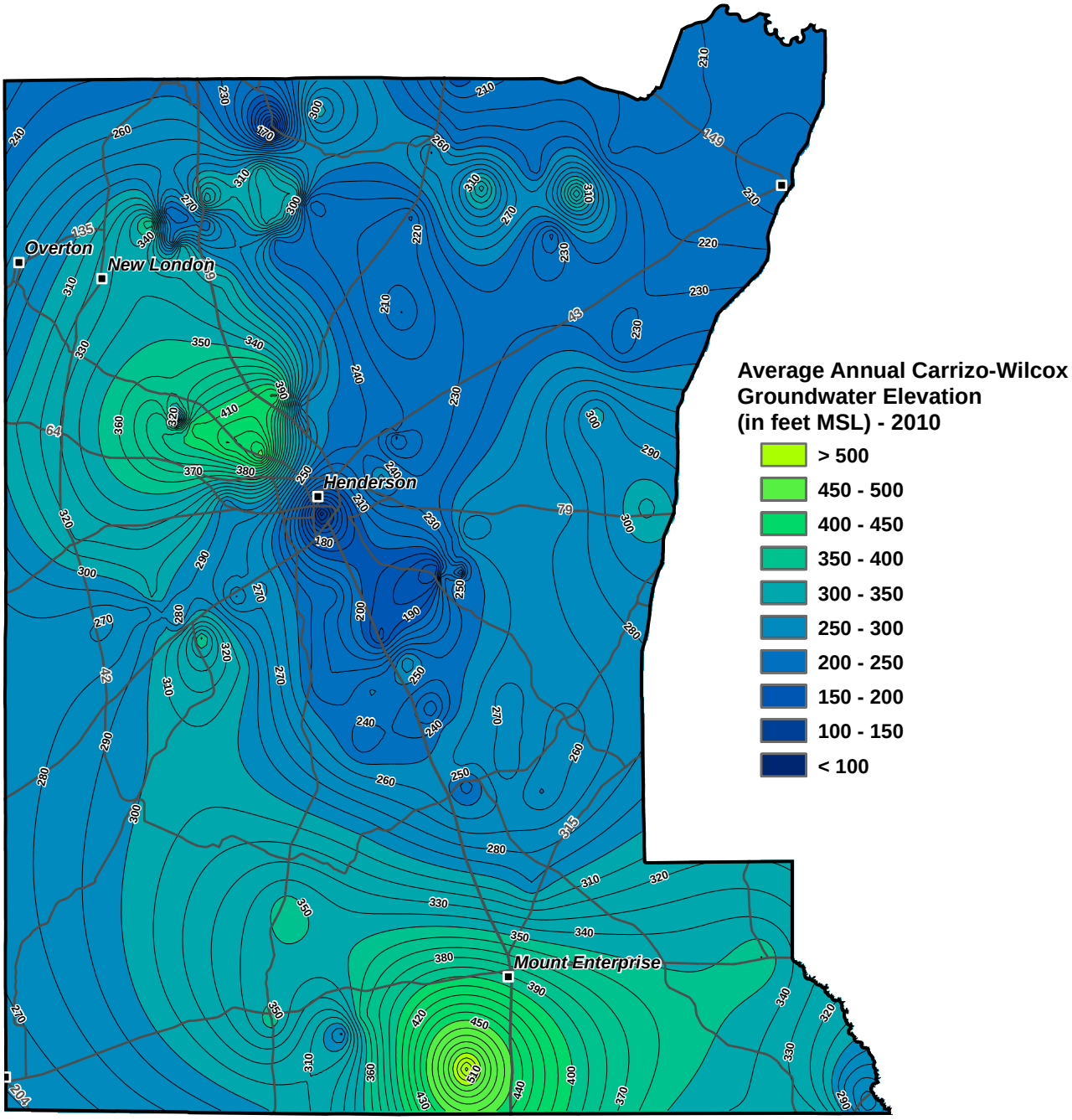
Miles

Rusk County Groundwater Conservation District

2010

Average Annual Carrizo-Wilcox Groundwater Elevation

287.90 feet MSL



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0 2 4 6 12 18 24

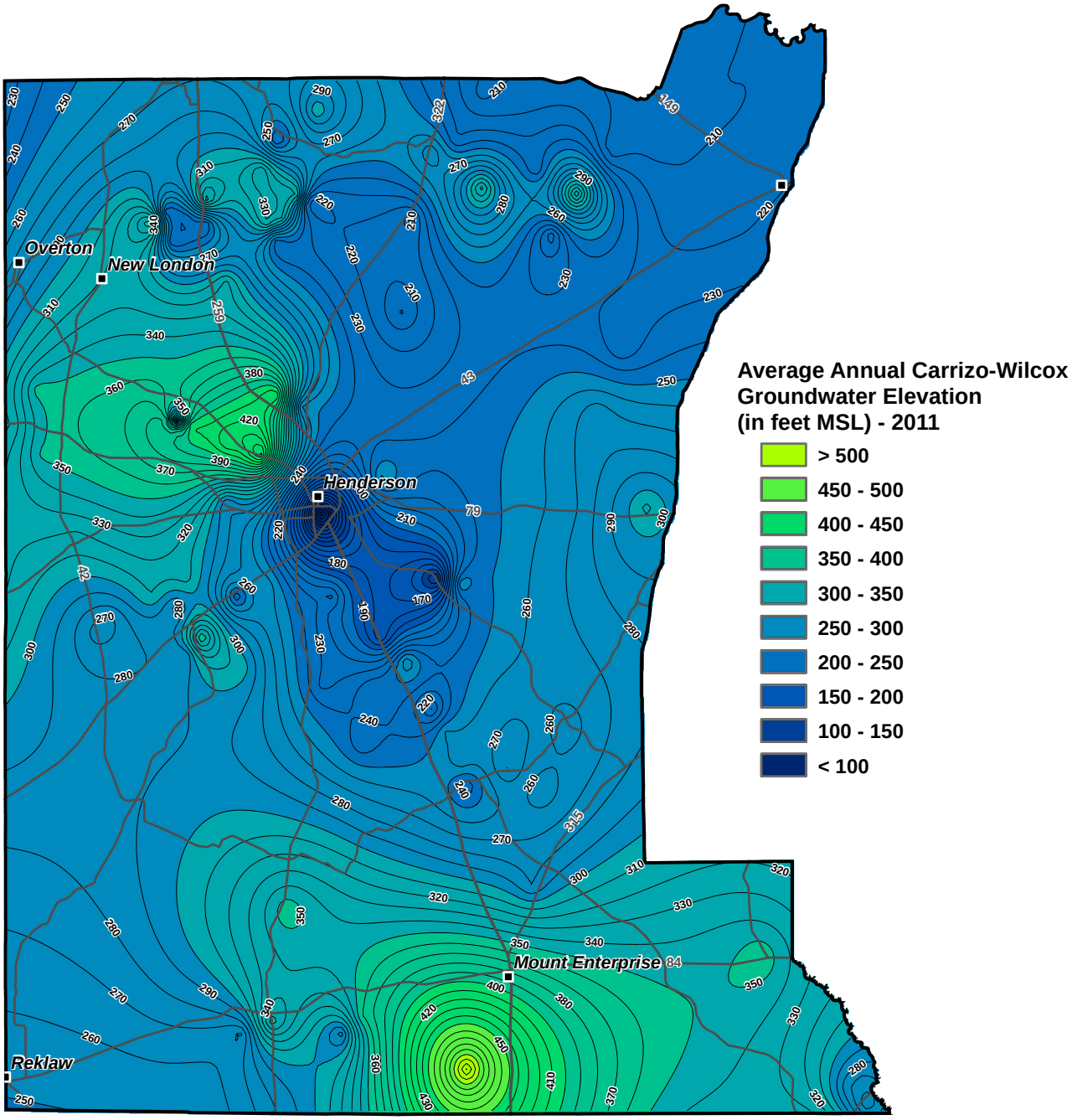
Miles

Rusk County Groundwater Conservation District

2011

Average Annual Carrizo-Wilcox Groundwater Elevation

284.45 feet MSL



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0 2 4 6 12 18 24

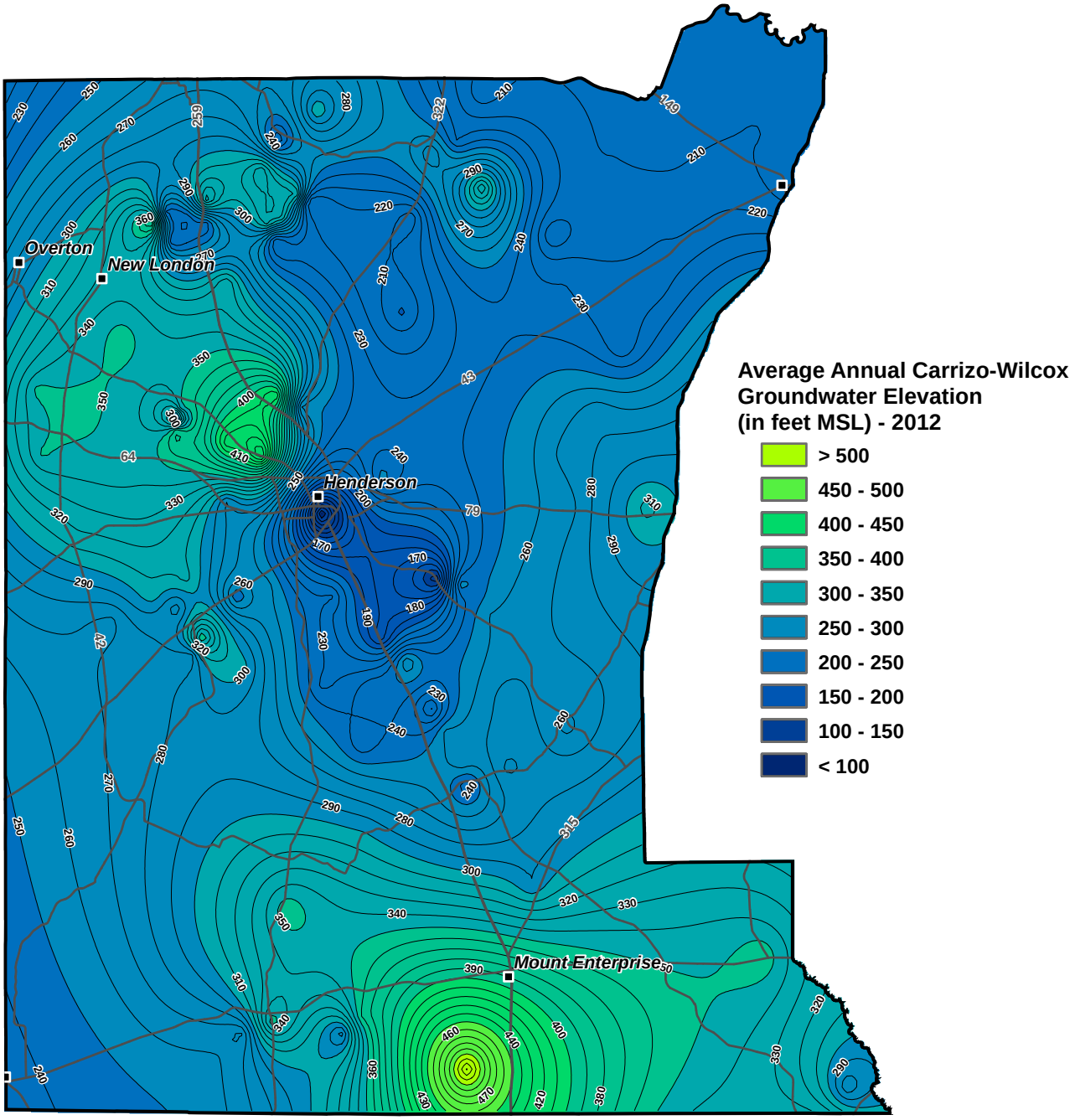
Miles

Rusk County Groundwater Conservation District

2012

Average Annual Carrizo-Wilcox Groundwater Elevation

282.63 feet MSL



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0 2 4 6 12 18 24

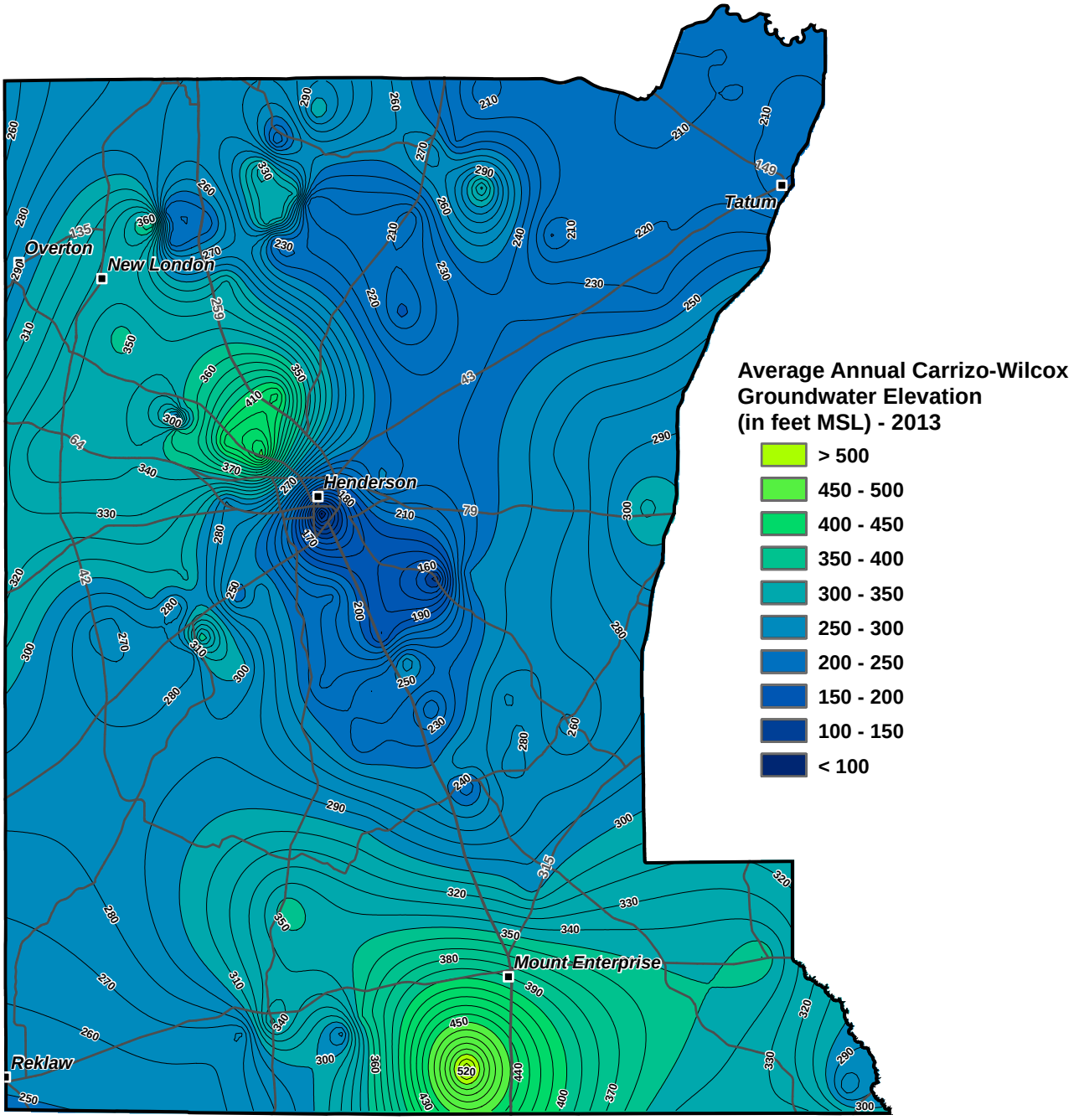
Miles

Rusk County Groundwater Conservation District

2013

Average Annual Carrizo-Wilcox Groundwater Elevation

285.87 feet MSL



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0 2 4 6 12 18 24

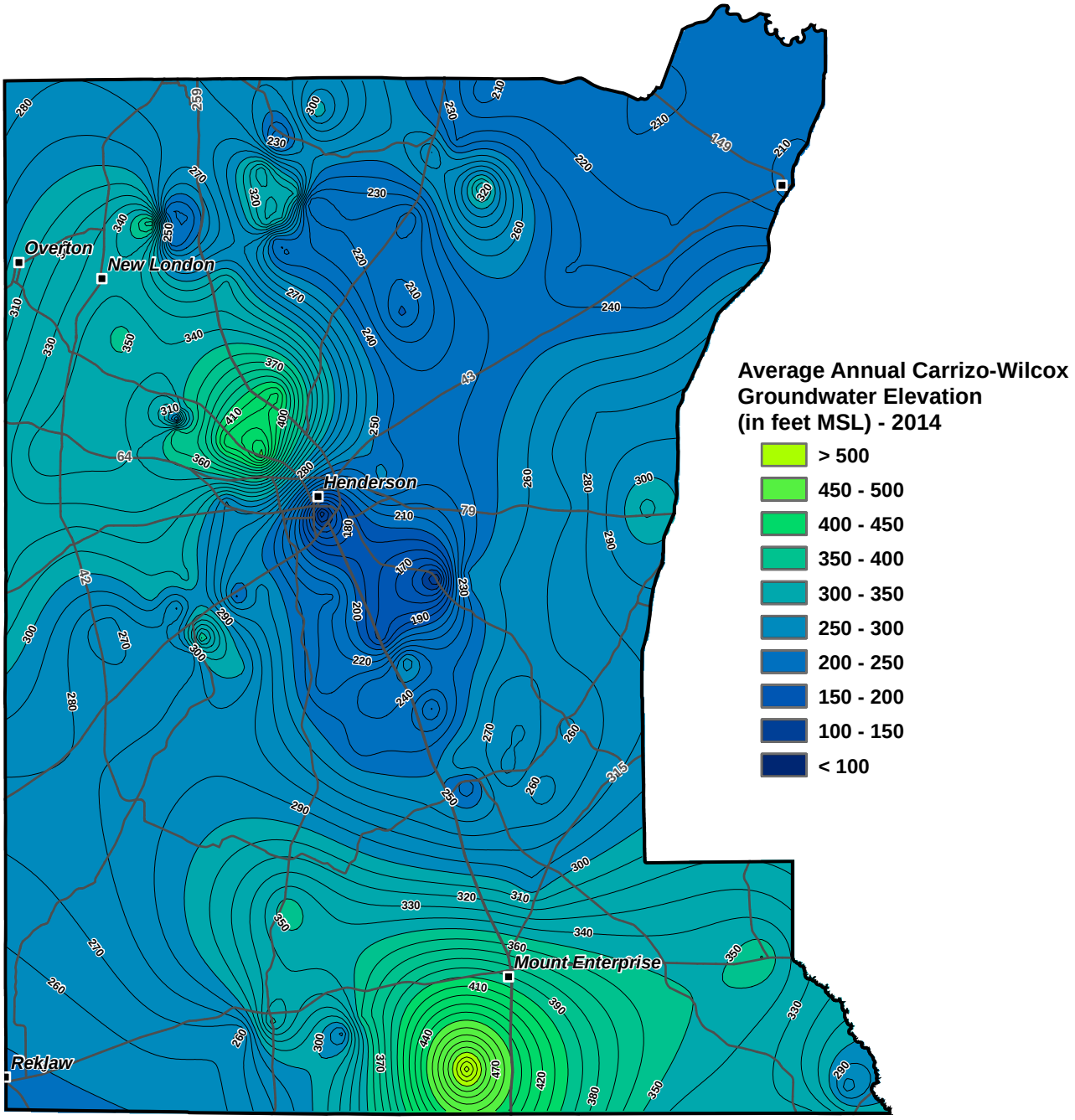
Miles

Rusk County Groundwater Conservation District

2014

Average Annual Carrizo-Wilcox Groundwater Elevation

286.23 feet MSL



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0 2 4 6 12 18 24

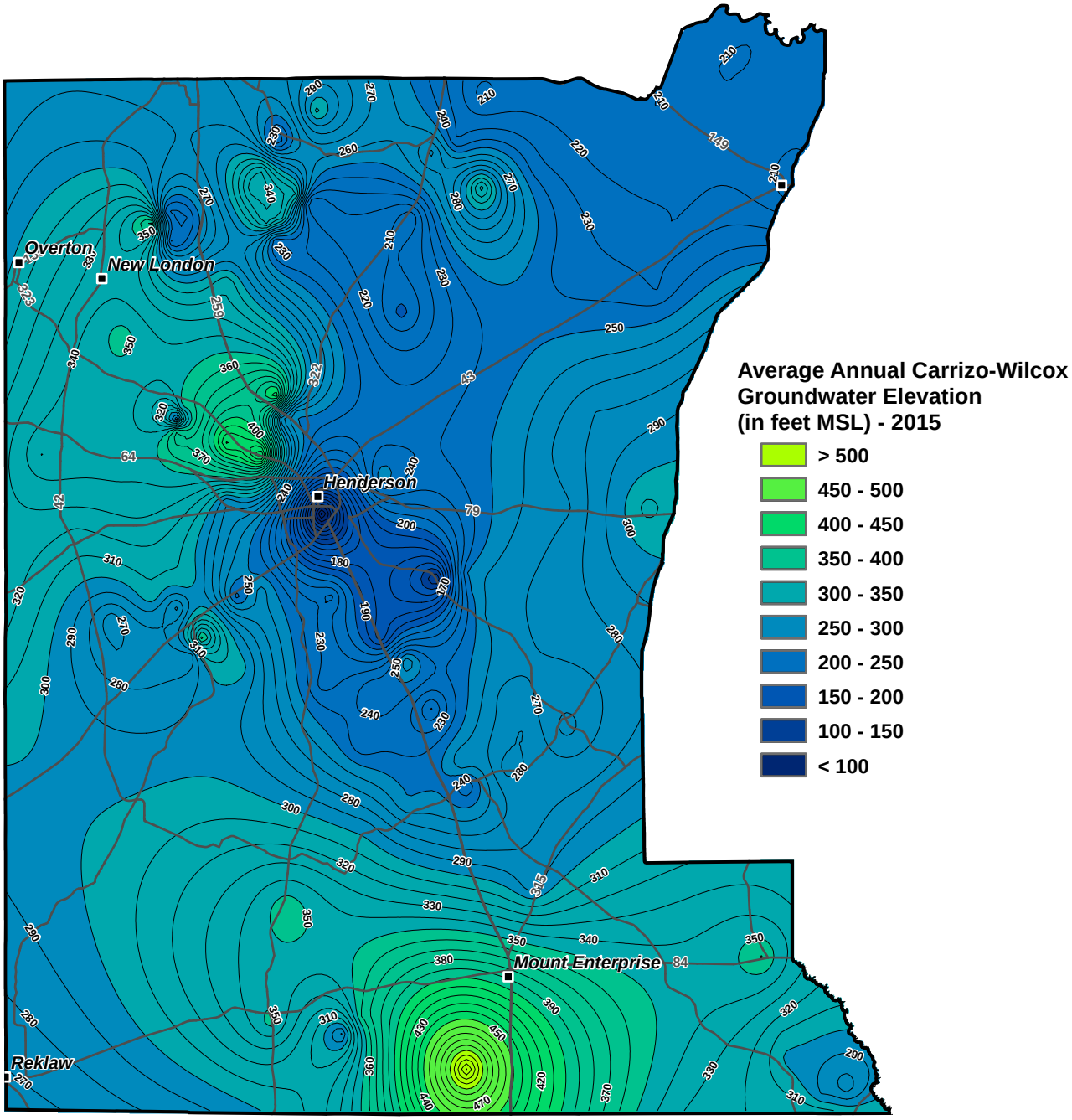
Miles

Rusk County Groundwater Conservation District

2015

Average Annual Carrizo-Wilcox Groundwater Elevation

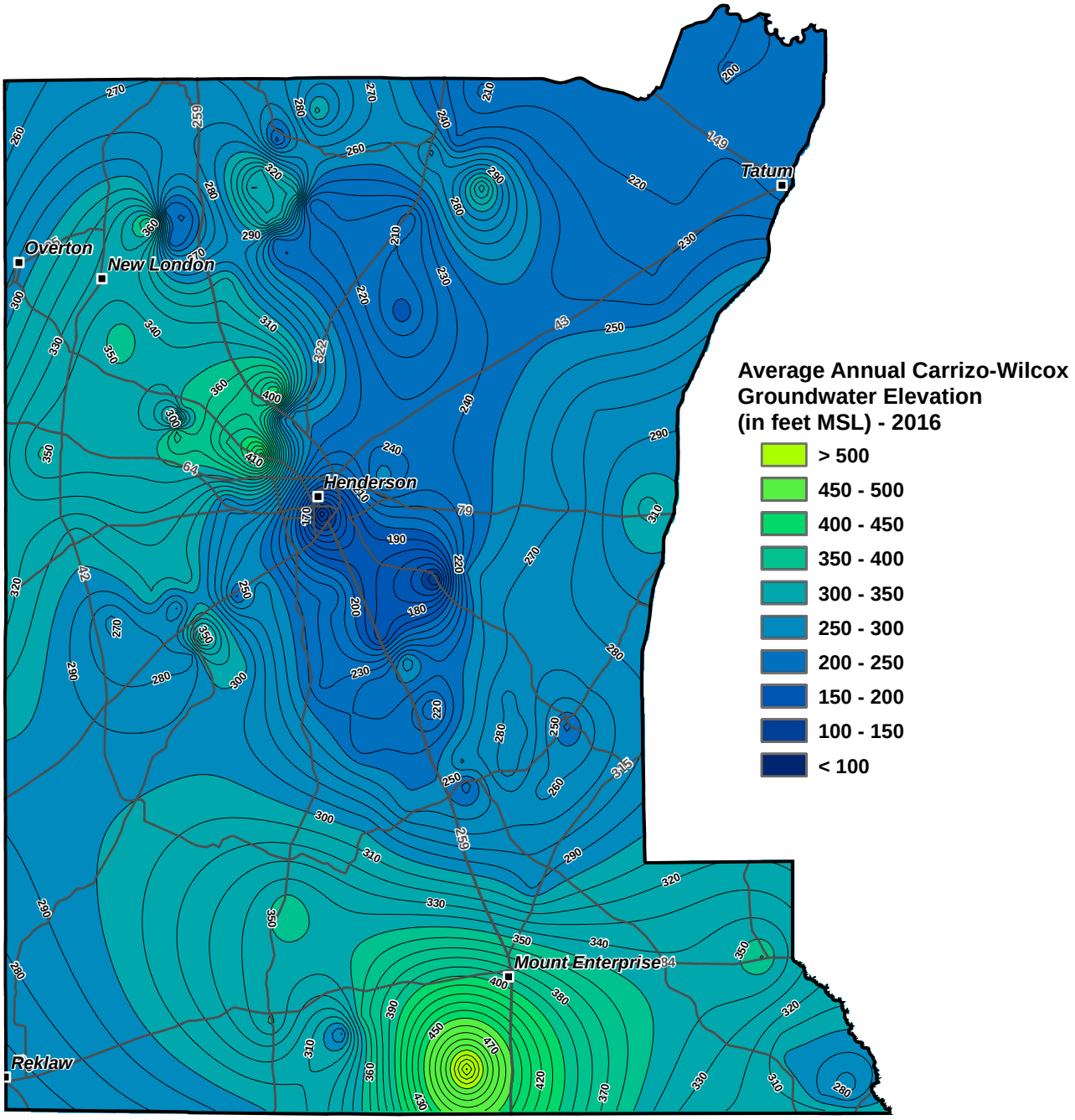
288.72 feet MSL



2016

Average Annual Carrizo-Wilcox Groundwater Elevation

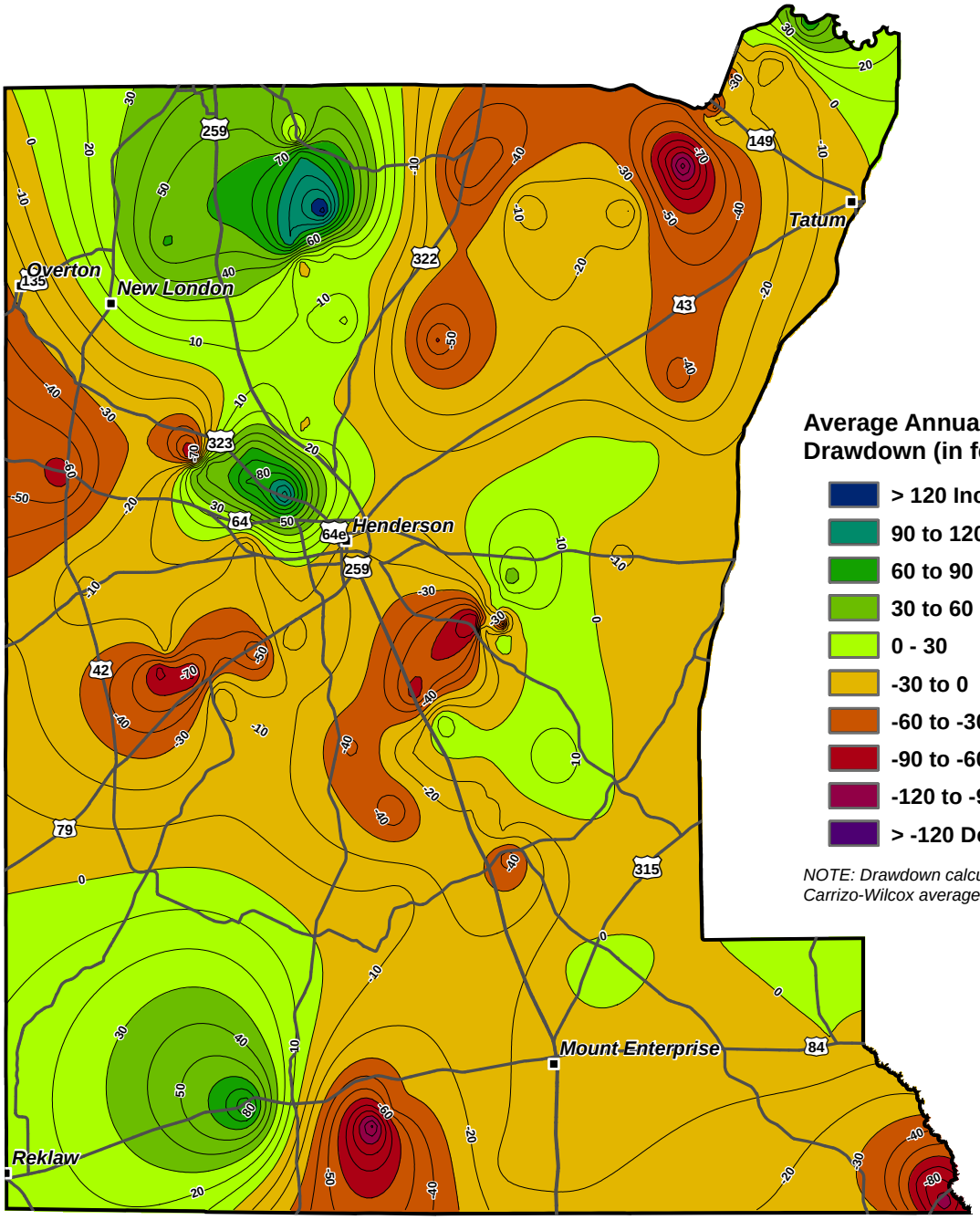
288.37 feet MSL



2009

Average Annual Carrizo-Wilcox Drawdown

-6.57 feet



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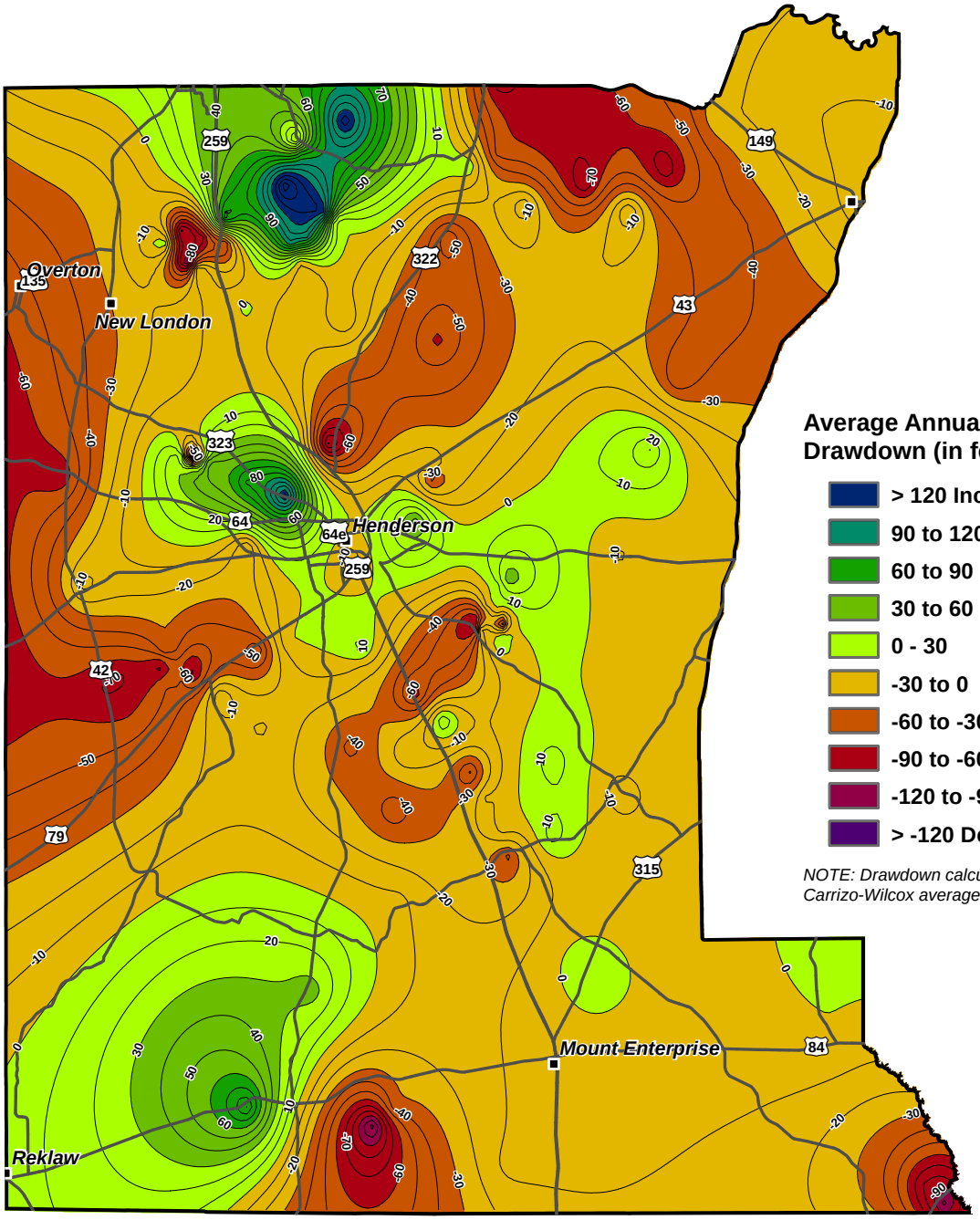
Miles

Rusk County Groundwater Conservation District

2010

Average Annual Carrizo-Wilcox Drawdown

-12.01 feet



Average Annual Carrizo-Wilcox Drawdown (in feet) - 2010

- > 120 Increase
- 90 to 120
- 60 to 90
- 30 to 60
- 0 - 30
- -30 to 0
- -60 to -30
- -90 to -60
- -120 to -90
- > -120 Decrease

NOTE: Drawdown calculated based on 1999 Carrizo-Wilcox average groundwater elevation

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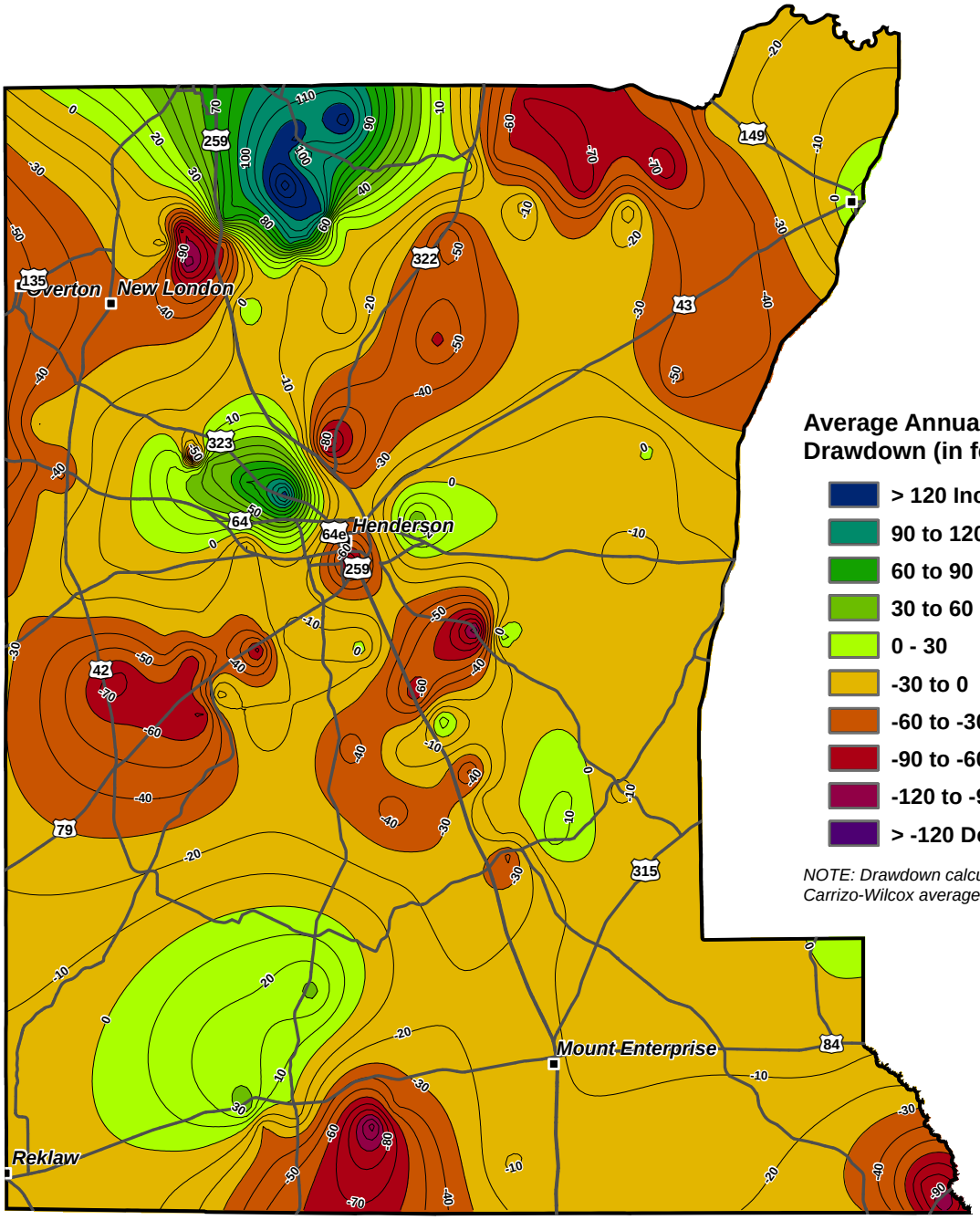
Miles

Rusk County Groundwater Conservation District

2011

Average Annual Carrizo-Wilcox Drawdown

-15.46 feet



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0 2 4 6 12 18 24

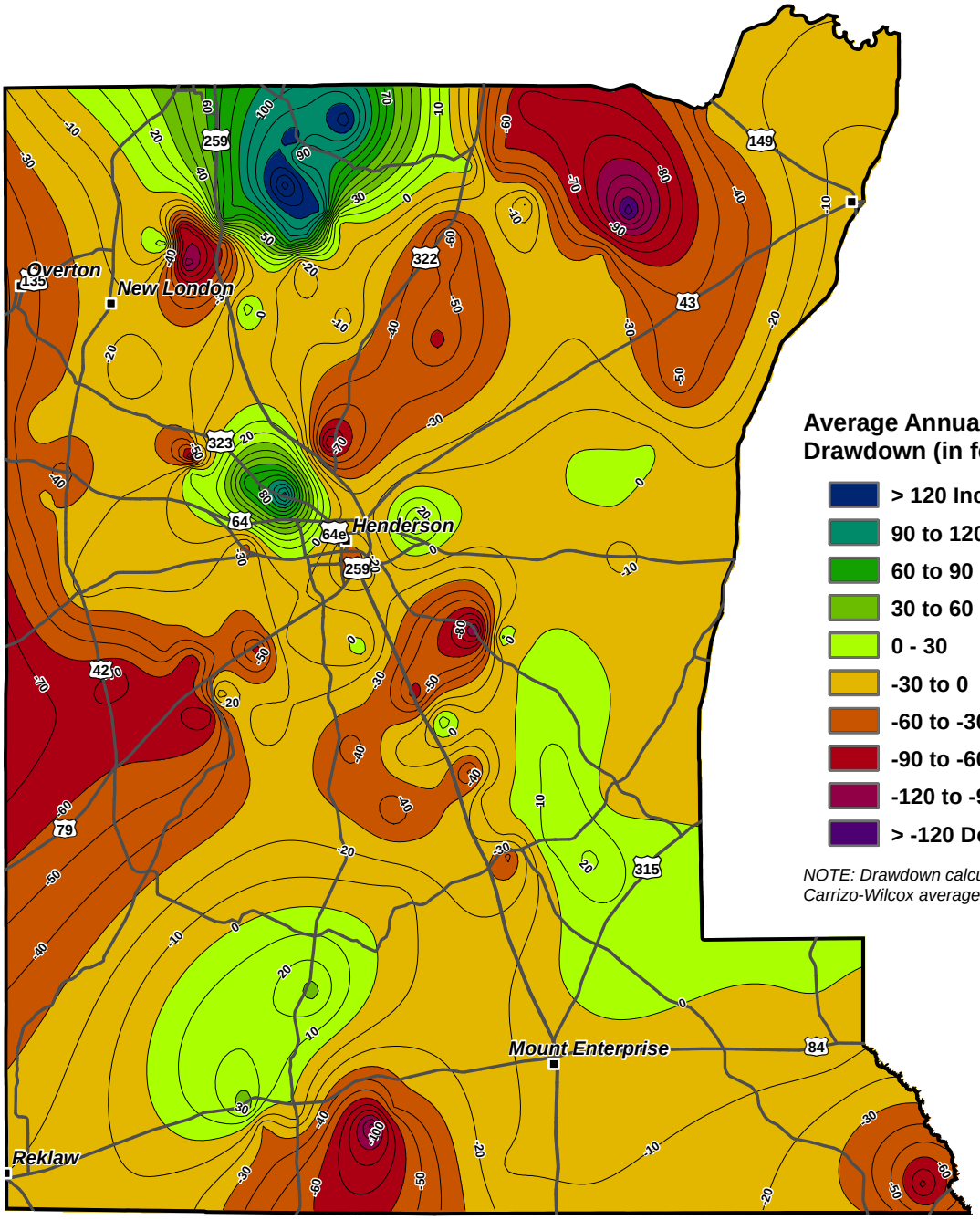
Miles

Rusk County Groundwater Conservation District

2012

Average Annual Carrizo-Wilcox Drawdown

-17.28 feet



Average Annual Carrizo-Wilcox Drawdown (in feet) - 2012

- > 120 Increase
- 90 to 120
- 60 to 90
- 30 to 60
- 0 - 30
- -30 to 0
- -60 to -30
- -90 to -60
- -120 to -90
- > -120 Decrease

NOTE: Drawdown calculated based on 1999 Carrizo-Wilcox average groundwater elevation

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0 2 4 6 12 18 24

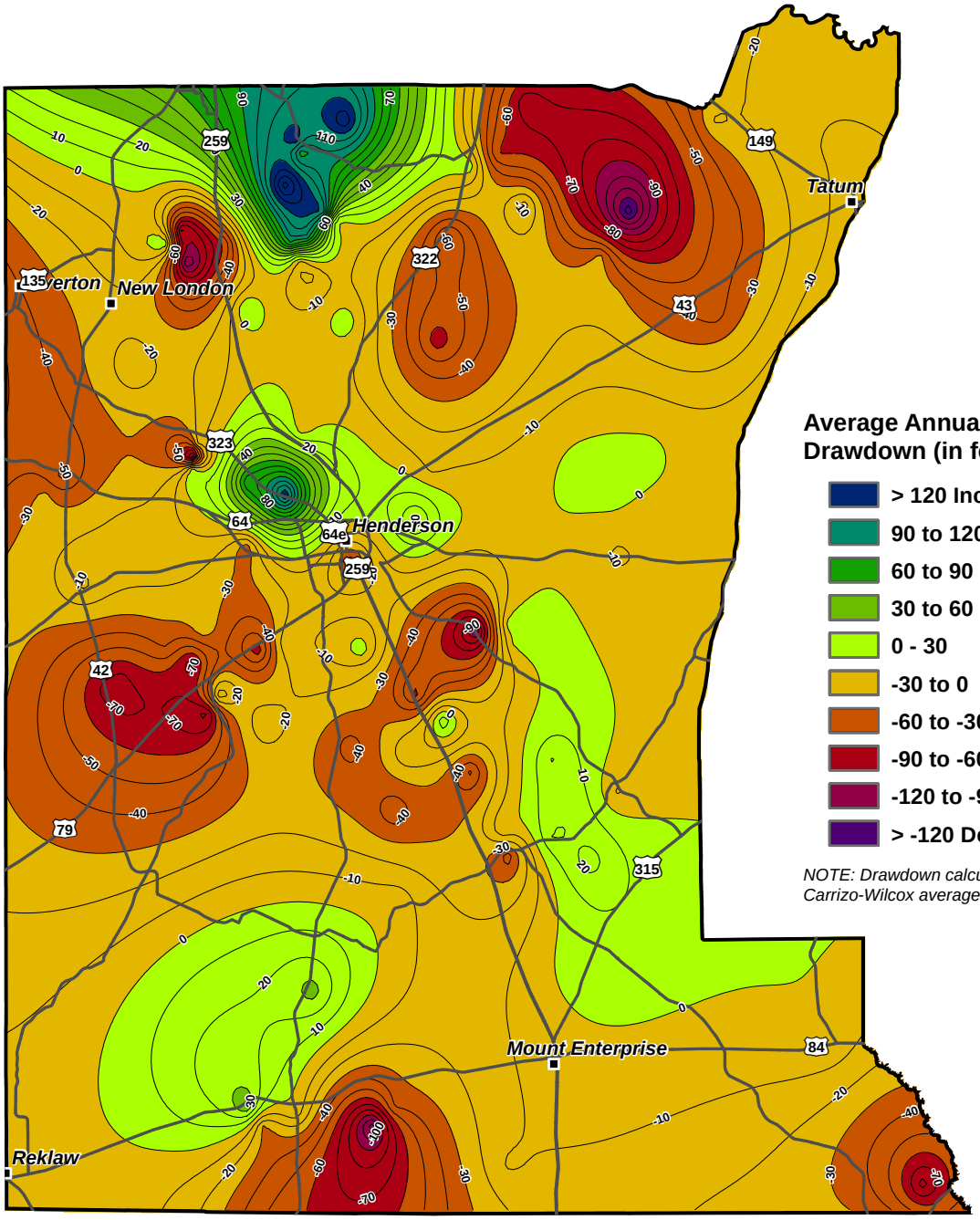
Miles

Rusk County Groundwater Conservation District

2013

Average Annual Carrizo-Wilcox Drawdown

-14.04 feet



Average Annual Carrizo-Wilcox Drawdown (in feet) - 2013

- > 120 Increase
- 90 to 120
- 60 to 90
- 30 to 60
- 0 - 30
- -30 to 0
- -60 to -30
- -90 to -60
- -120 to -90
- > -120 Decrease

NOTE: Drawdown calculated based on 1999 Carrizo-Wilcox average groundwater elevation

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0 2 4 6 12 18 24

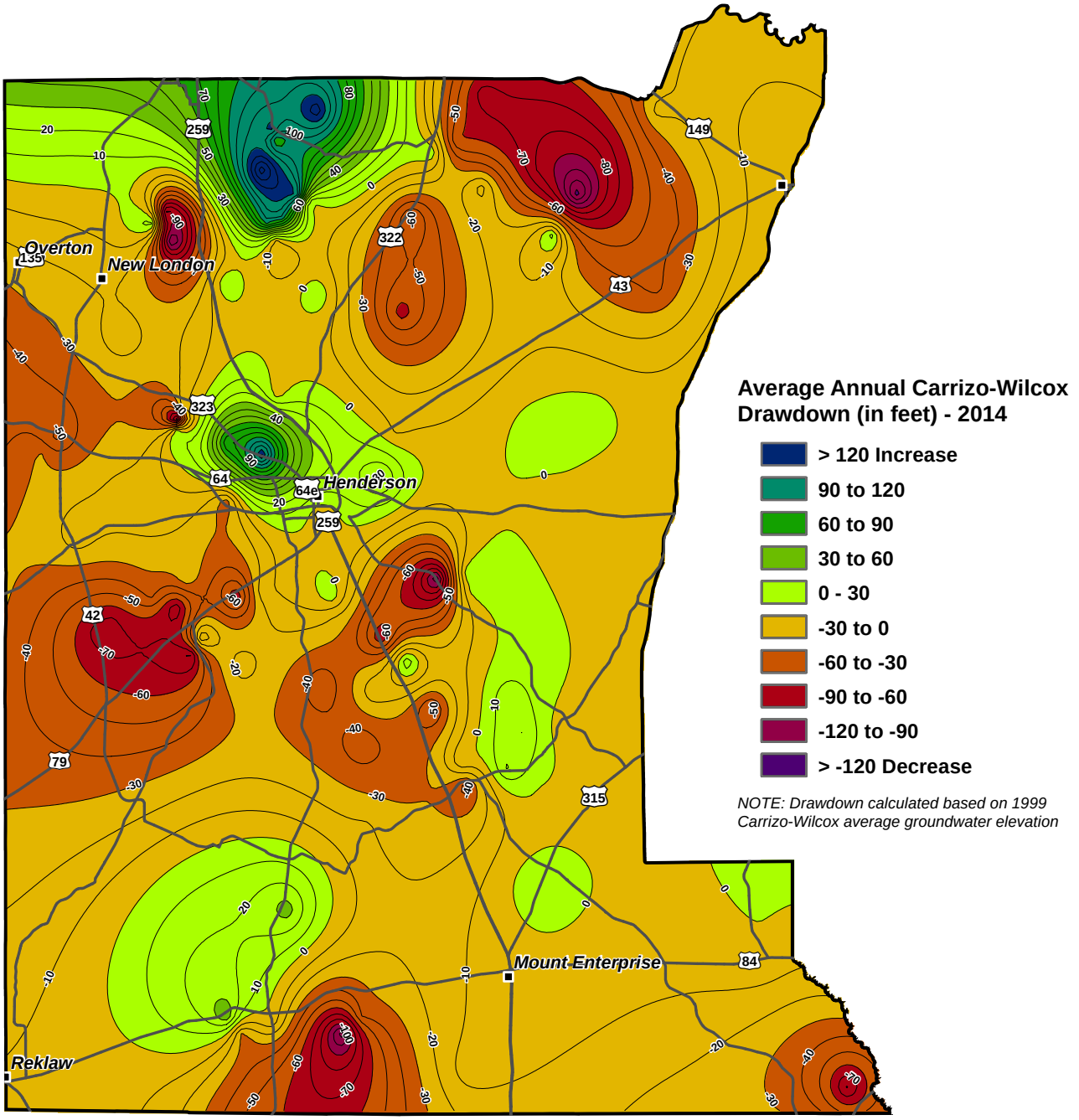
Miles

Rusk County Groundwater Conservation District

2014

Average Annual Carrizo-Wilcox Drawdown

-13.68 feet



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0 2 4 6 12 18 24

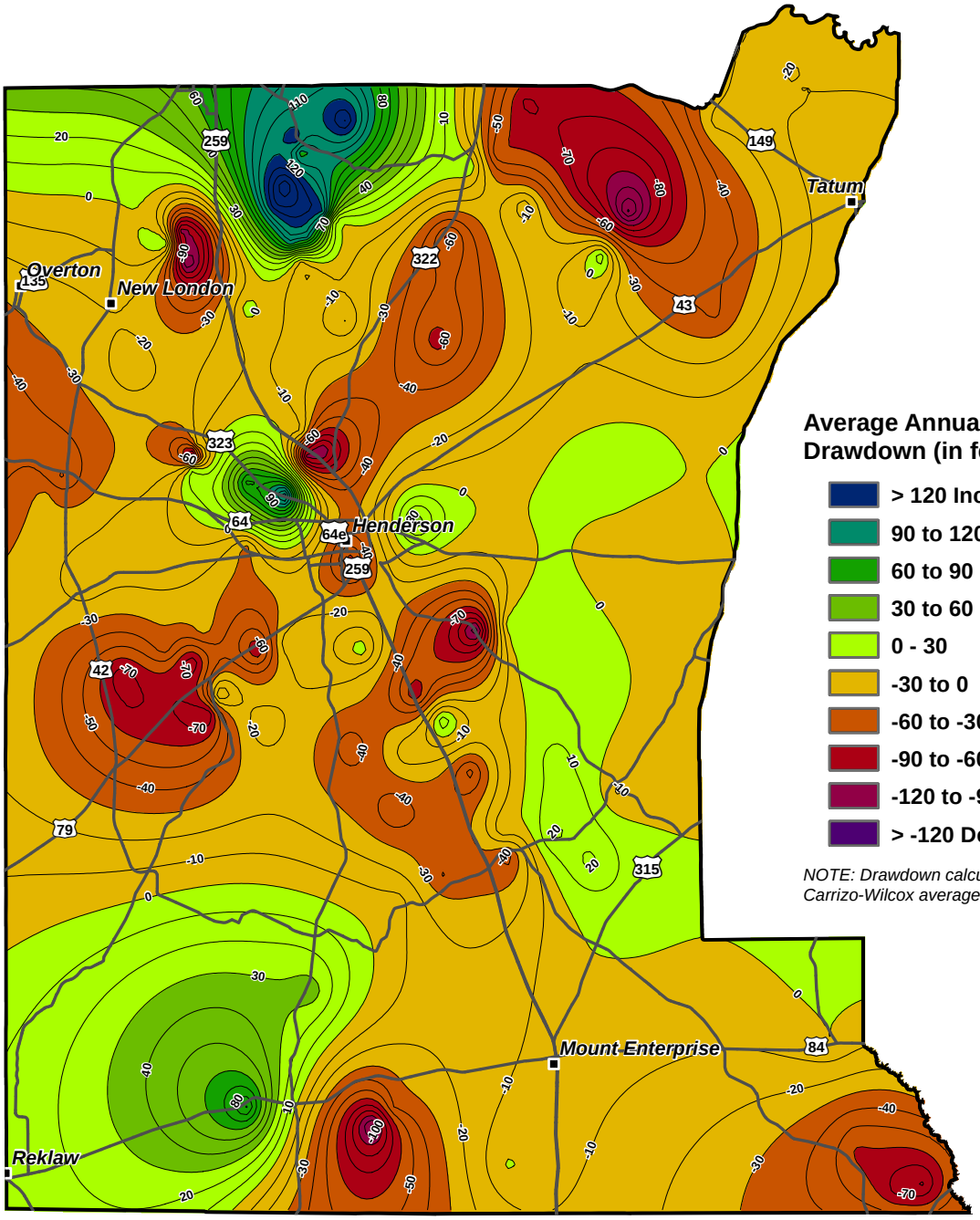
Miles

Rusk County Groundwater Conservation District

2015

Average Annual Carrizo-Wilcox Drawdown

-11.19 feet



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0 2 4 6 12 18 24

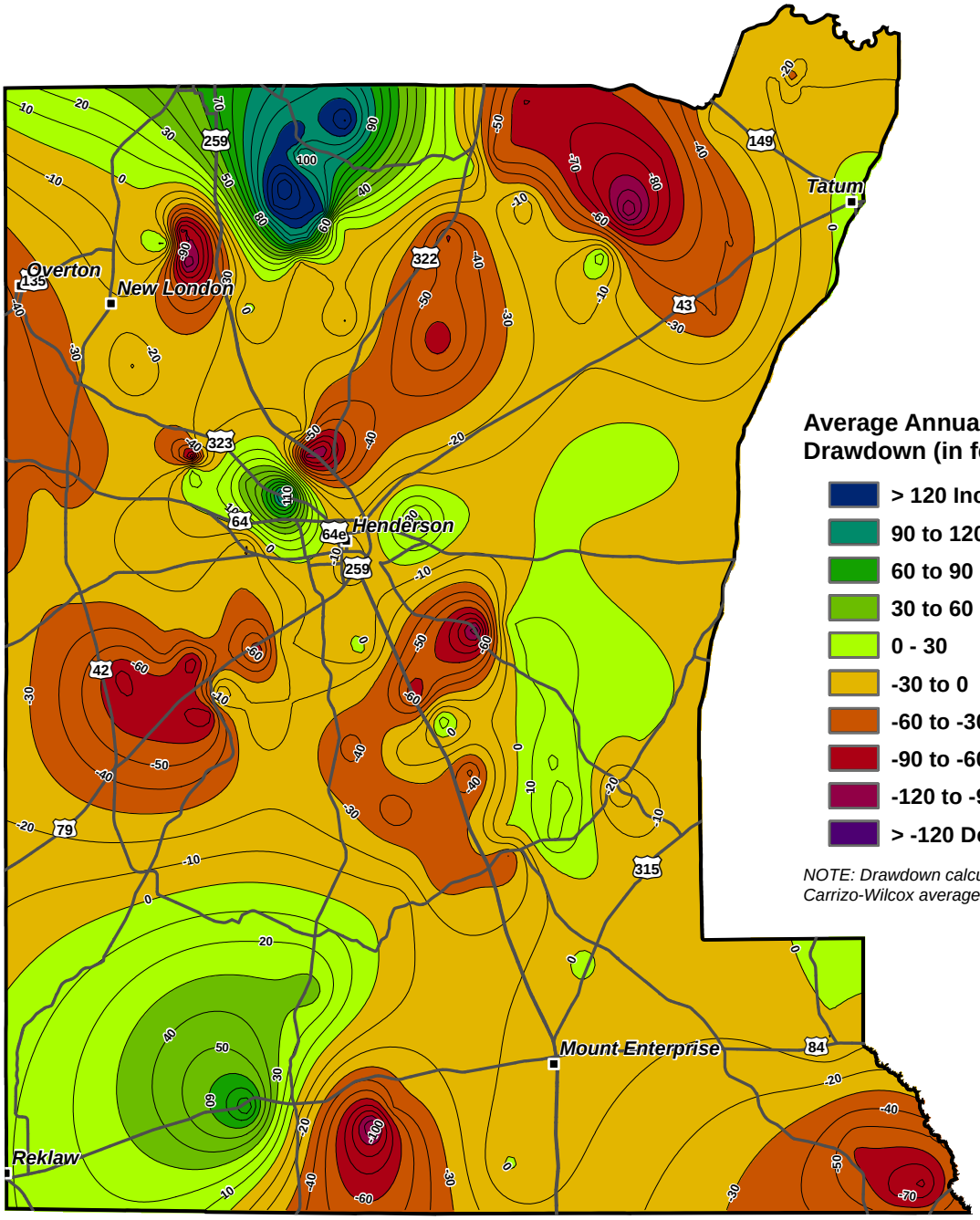
Miles

Rusk County Groundwater Conservation District

2016

Average Annual Carrizo-Wilcox Drawdown

-11.54 feet



Average Annual Carrizo-Wilcox Drawdown (in feet) - 2016

- > 120 Increase
- 90 to 120
- 60 to 90
- 30 to 60
- 0 - 30
- -30 to 0
- -60 to -30
- -90 to -60
- -120 to -90
- > -120 Decrease

NOTE: Drawdown calculated based on 1999 Carrizo-Wilcox average groundwater elevation

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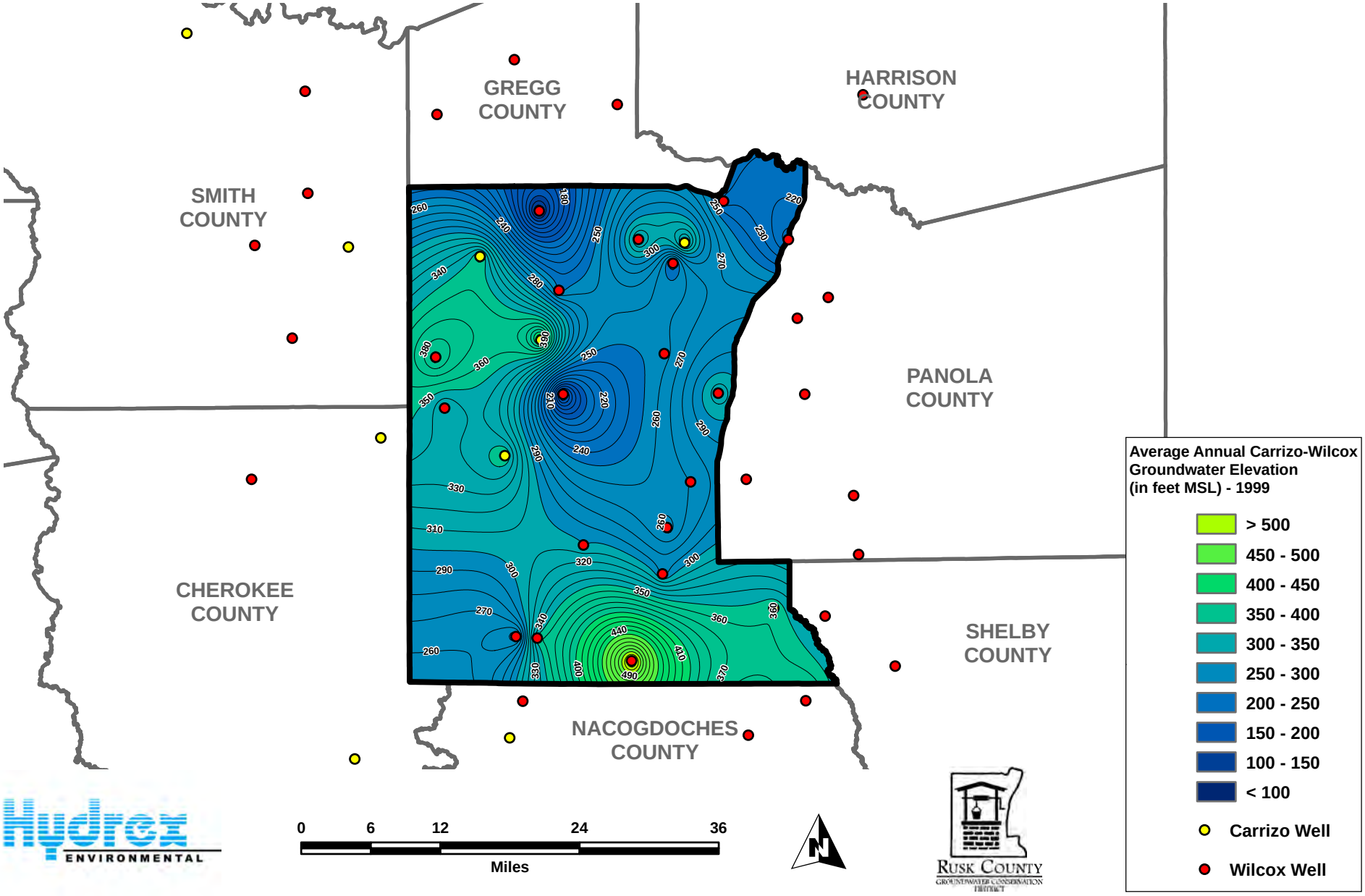
0 2 4 6 12 18 24

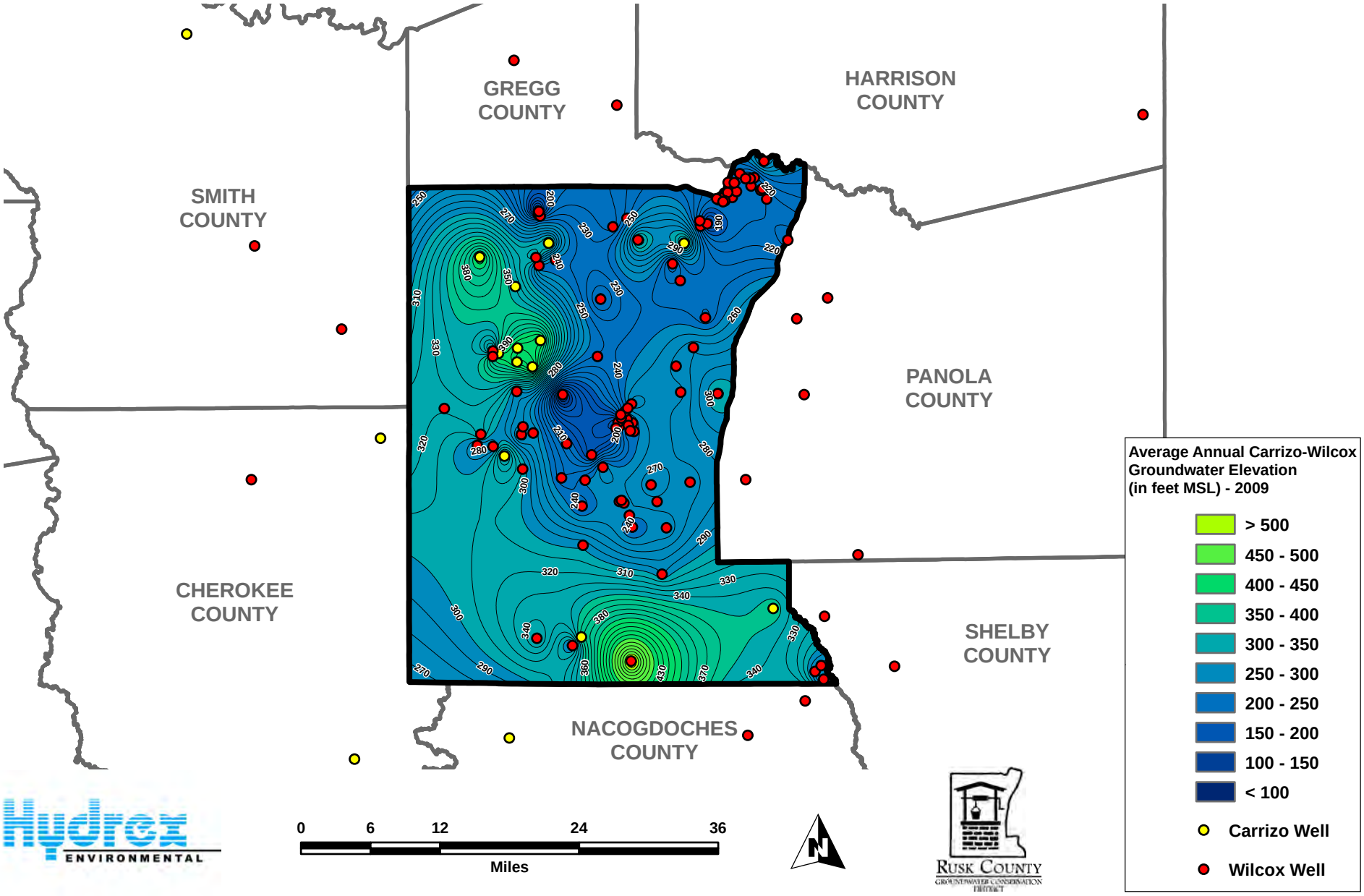
Miles

Rusk County Groundwater Conservation District

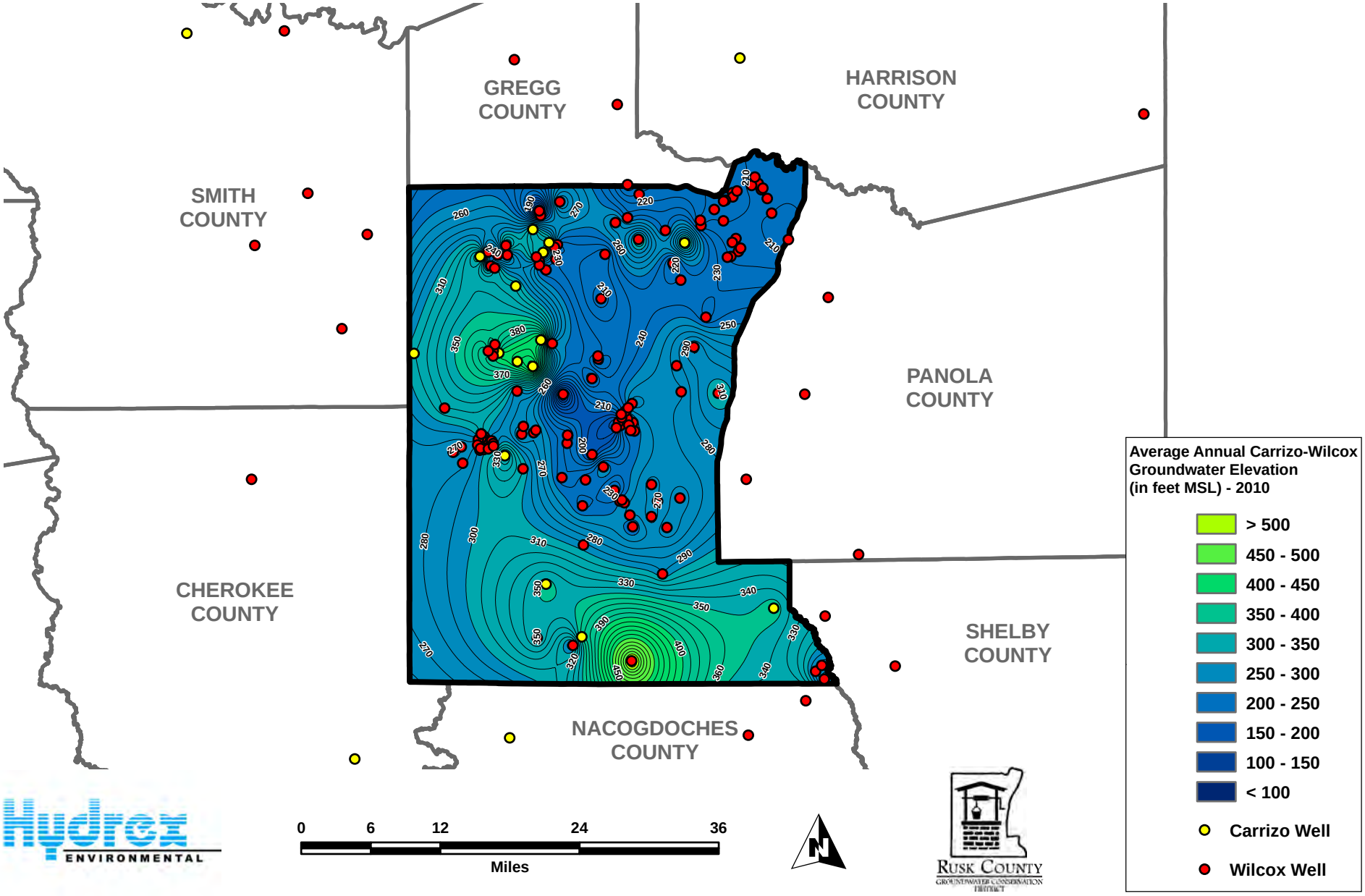
Water Level Measurement
Well Location Map
- 1999 -



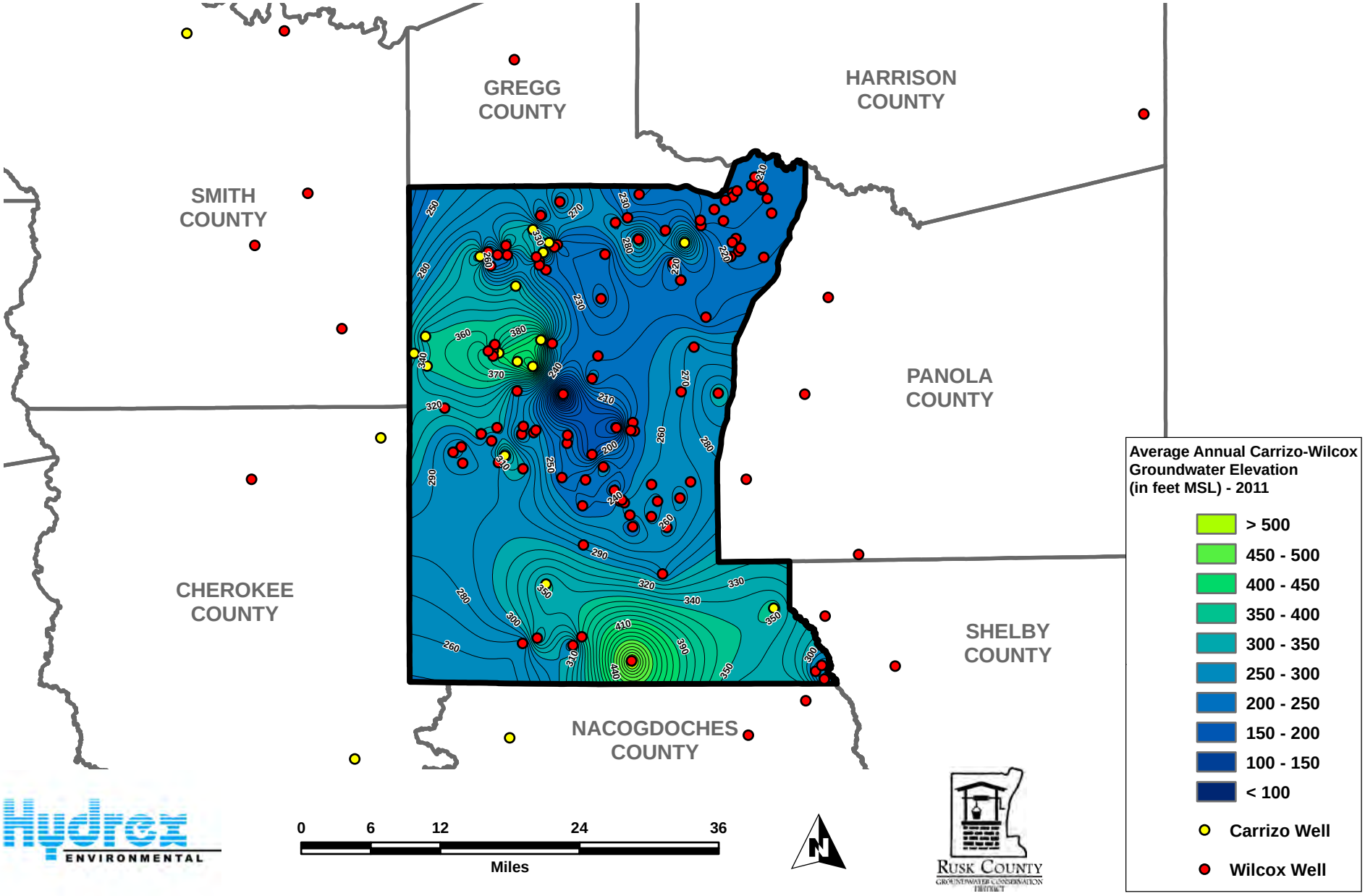
Water Level Measurement
Well Location Map
- 2009 -



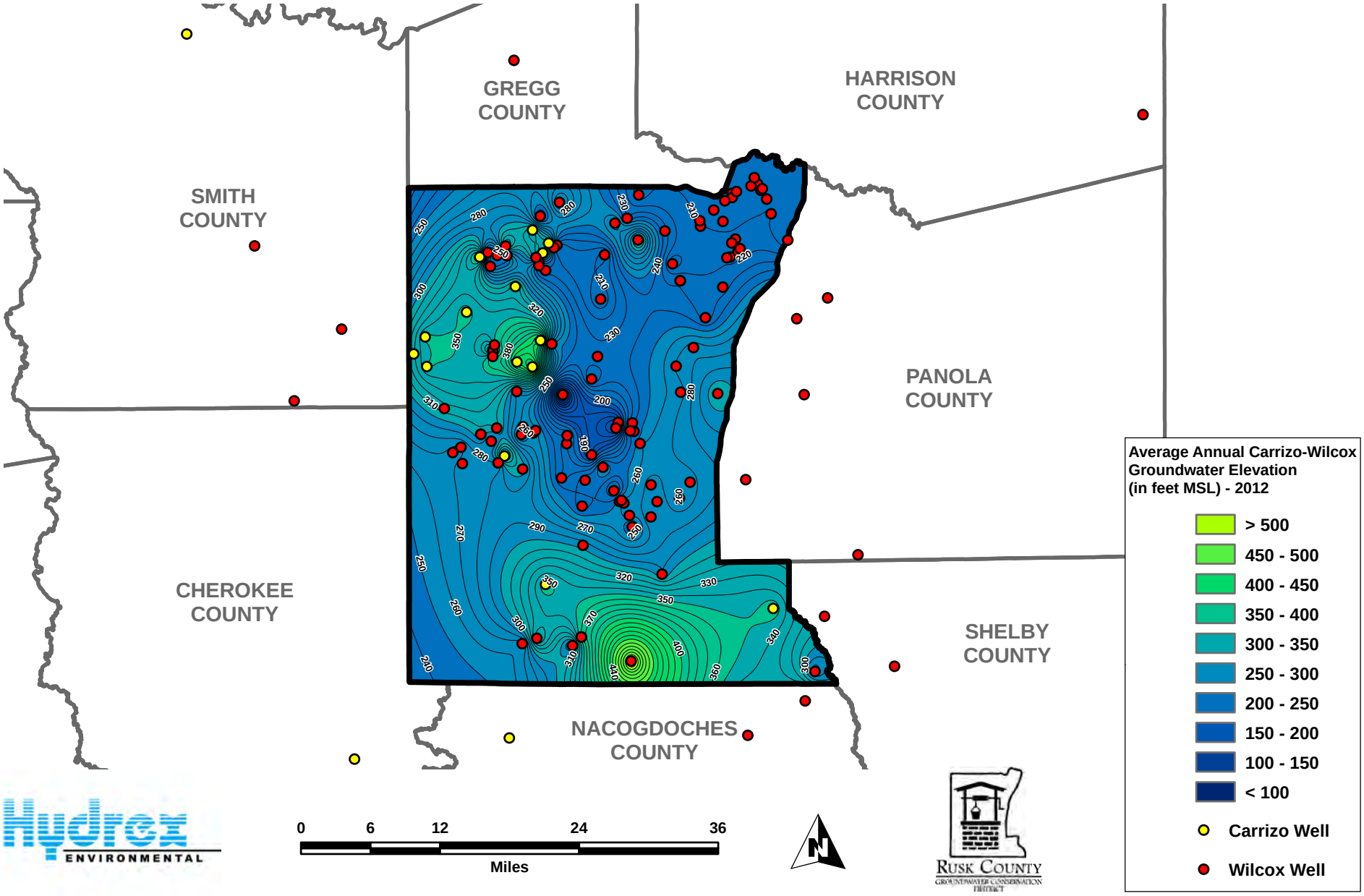
Water Level Measurement
Well Location Map
- 2010 -



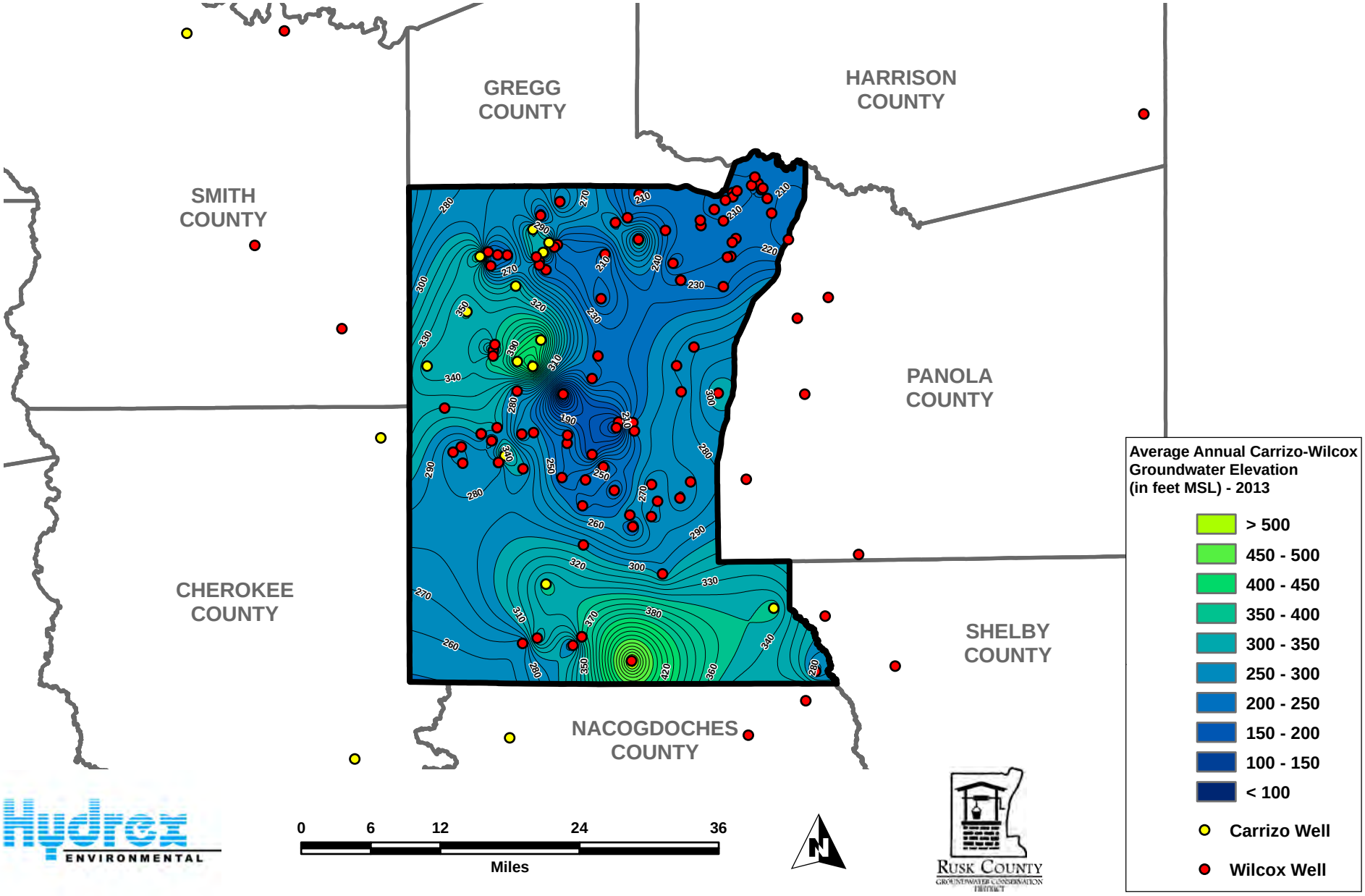
Water Level Measurement
Well Location Map
- 2011 -



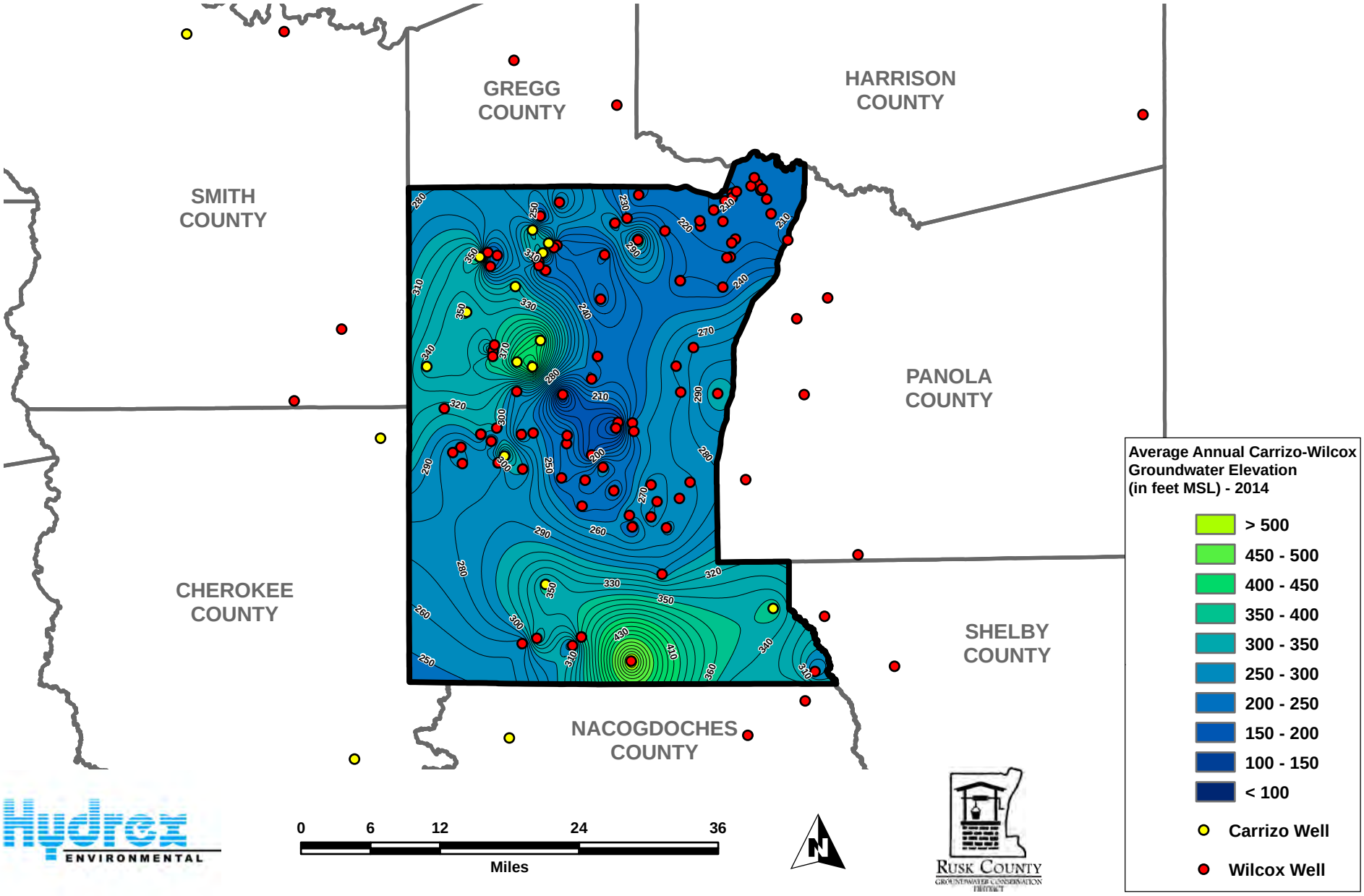
Water Level Measurement
Well Location Map
- 2012 -



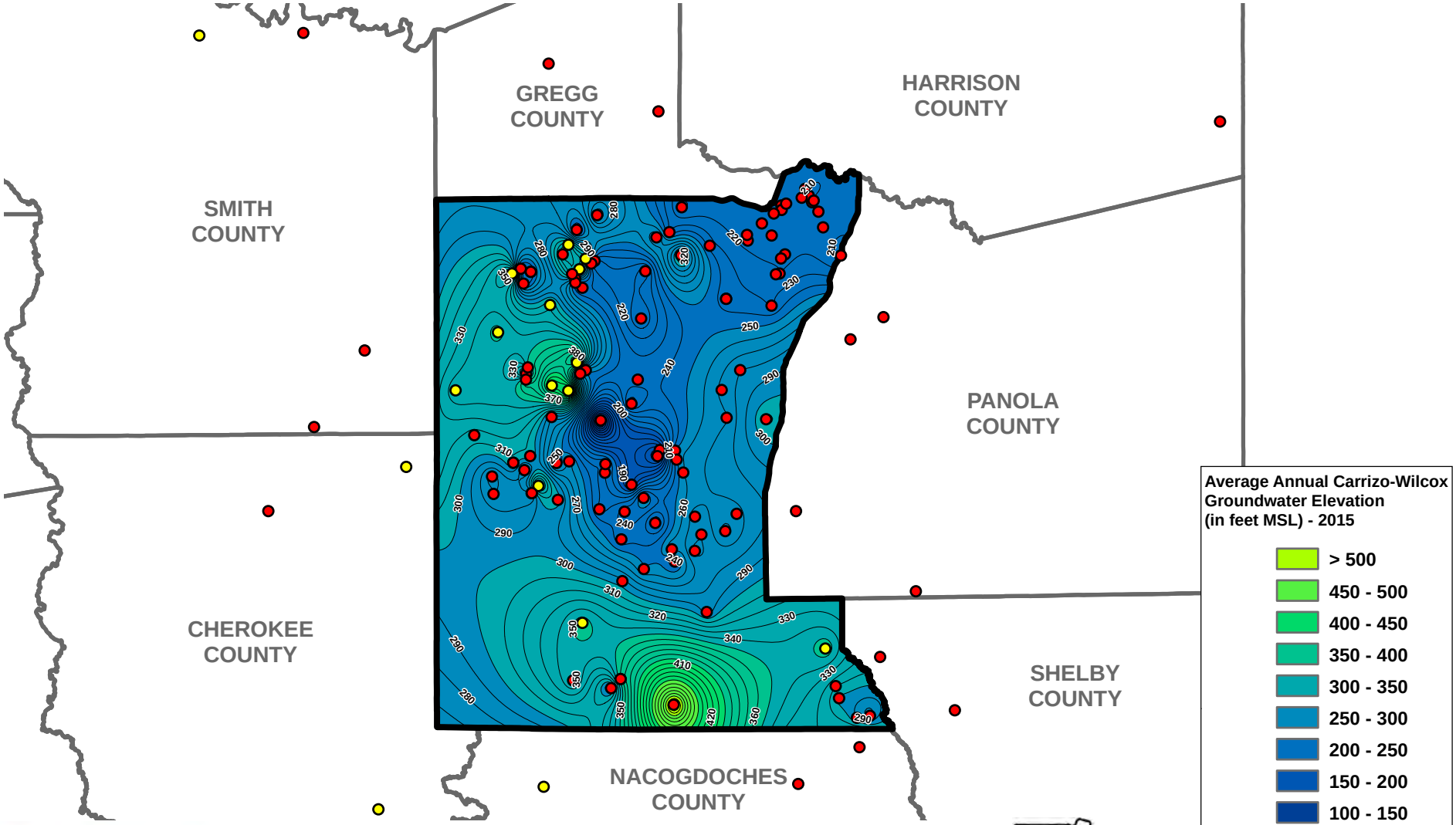
Water Level Measurement
Well Location Map
- 2013 -



Water Level Measurement
Well Location Map
- 2014 -



Water Level Measurement
Well Location Map
- 2015 -



Water Level Measurement
Well Location Map
- 2016 -