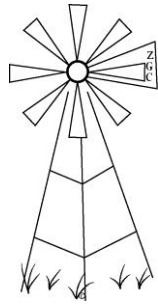


**Union County Hydrogeology Project  
Annual Progress Report  
2015-2016**



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**\*\*Please note that the information provided in this report is proprietary to the Northeast Soil and Water Conservation District, Northwest Geoinformatics and Zeigler Geologic Consulting, LLC. If you wish to use any of the data in this report, please contact the Northeast SWCD for permission.**

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## **Introduction**

This report is Zeigler Geologic Consulting, LLC's (ZGC) annual progress report for the Union County Hydrogeology Project, sponsored by the Northeastern Soil and Water Conservation District. This report builds on data and observations previously presented in Zeigler (2011, 2013), Zeigler et al. (2013, 2014, 2015) and Rawling (2013). During the 2015-2016 fiscal year, ZGC measured static water level in 55 wells in January and continued revisions of the four 1:50,000 scale quadrangles for the Dry Cimarron valley. Here we describe the progress in each of these tasks. A final report with detailed interpretations and integration of all data sets will be produced at the culmination of this project in 2018.

## **Static Water Level Measurements**

Beginning in 2007, depth to water has been measured in approximately fifty wells spread across the county in the winter to track water levels during minimum use. A 300 ft steel tape is used for most of the wells and a 500 ft steel tape for wells deeper than 300 ft. For open casing wells, we use a well level sounder (maximum length of 300 ft). The measuring point, or height of the entrance to the well above land surface, is subtracted from the total depth measurement such that the final static water level for all wells is calculated relative to the land surface. Measurements are repeated until two values that are within 0.01 ft of one another are obtained. In 2015-2016, ten wells have been added to the study: H. Brown #1 - #3 and Durrett #1 - #7. Three wells were removed from the study due to lack of access or inconclusive measurements (18N 36E 35.111, 21N 35E 01.224 and 26N 35E 13.143).

Of the wells that have been tracked since the beginning of the project and including wells added in the last three years, 22 show an overall increase in water level and 19 show a decline (numbers do not include wells dropped from the study in 2012 through 2015). Individual hydrographs for each well still being monitored are found in Appendix I. Water level trends were determined using only the January measurements in order to avoid potential issues with measurements on wells that had perhaps not fully recovered after having pumps turned off. Average increase is 0.74 feet/year and the average decline is 1.1 feet/year. Geographically, wells that show a decline are located primarily around the Sedan and Seneca Valley areas, with a

smaller area of decline east of Gladstone (Figure 1, Table 1, Appendix II). It is important to note that since the beginning of the project, the rates of decline in wells in the Sedan area has decreased from three to five feet per year in 2011 to less than a foot per year in 2016. Numerous changes in crop management practices probably contribute significantly to this change.

# Groundwater Level Changes 2008 - 2016

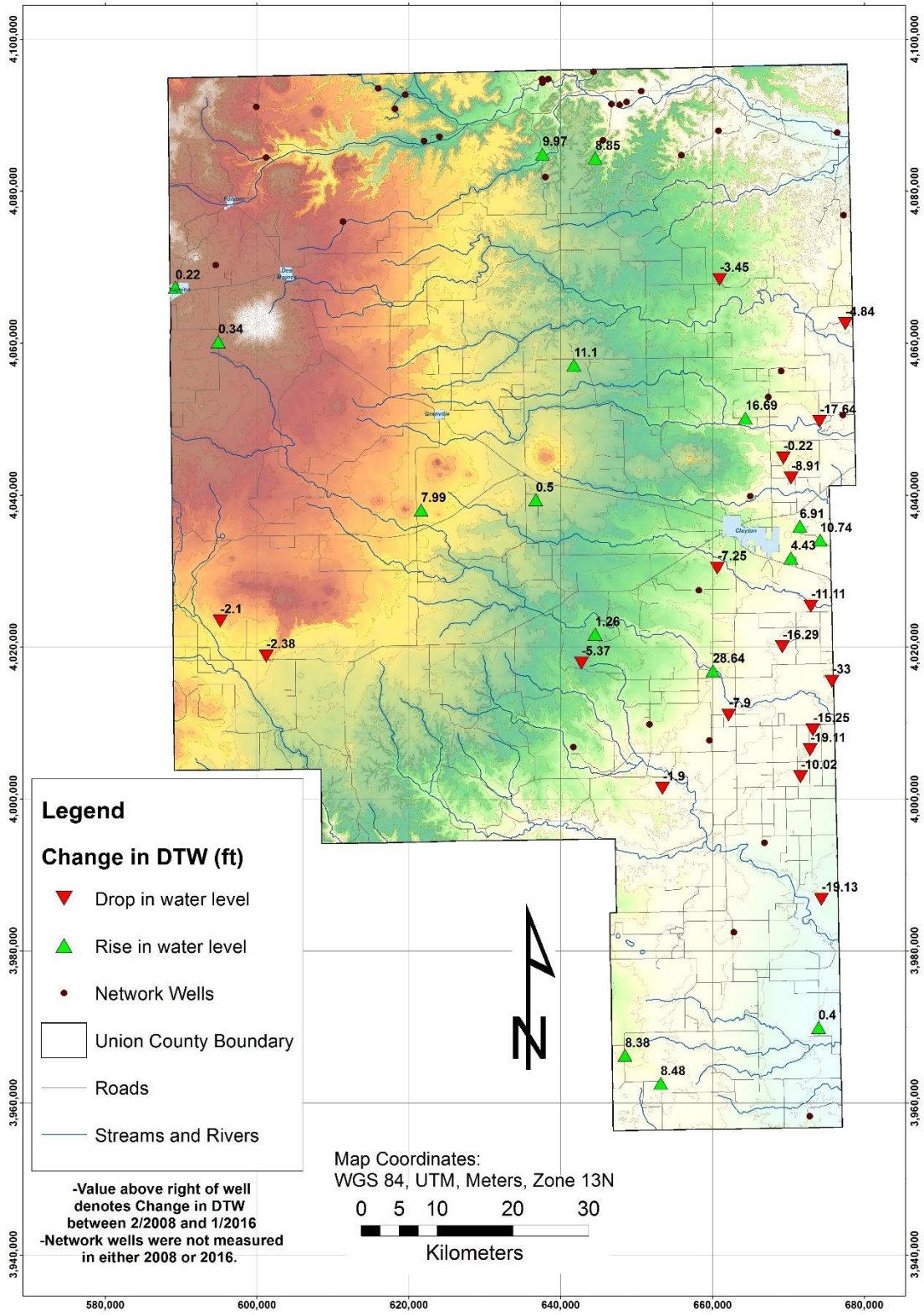


Figure 1. Changes in static water level from January 2008 to January 2016.

# Groundwater Level Changes 2015 - 2016

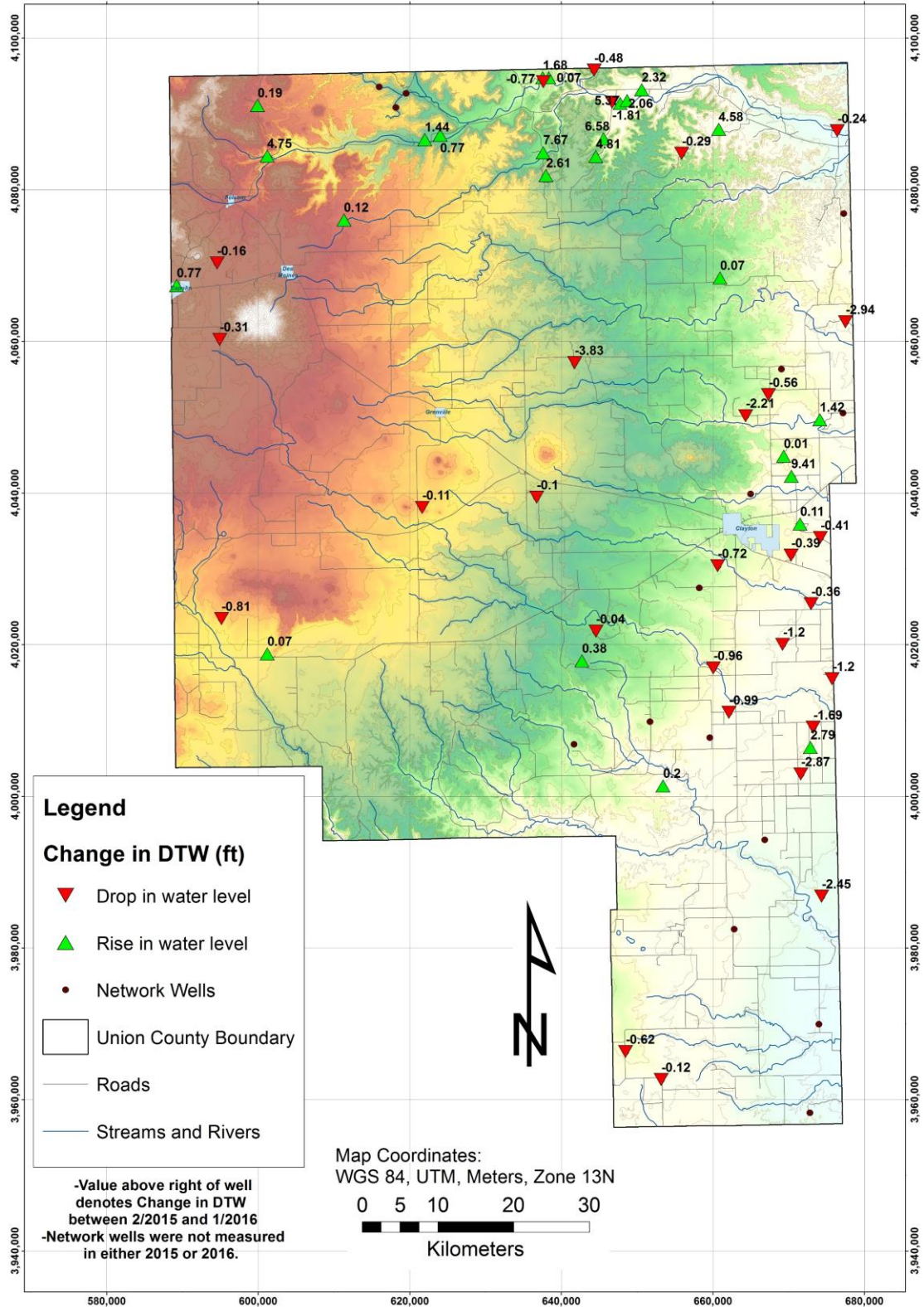


Figure 2. Changes in static water level from January 2015 to January 2016.

## **Geologic Mapping**

We are continuing to revise geologic maps of the 1:50,000 quadrangles that encompass the Dry Cimarron valley (previously published as Baldwin and Muehlberger, 1959). Maps that have had in-field revisions completed are currently being digitized. Below are draft versions of digitized maps for the western Dry Cimarron and the west-central Dry Cimarron (Figures 3 and 4). Structural features such as faults and folding in the Triassic strata will be added after initial revisions are completed. Geologic mapping of the eastern Dry Cimarron is ongoing. Further revisions will be presented in subsequent reports.



# Dry Cimmaron West

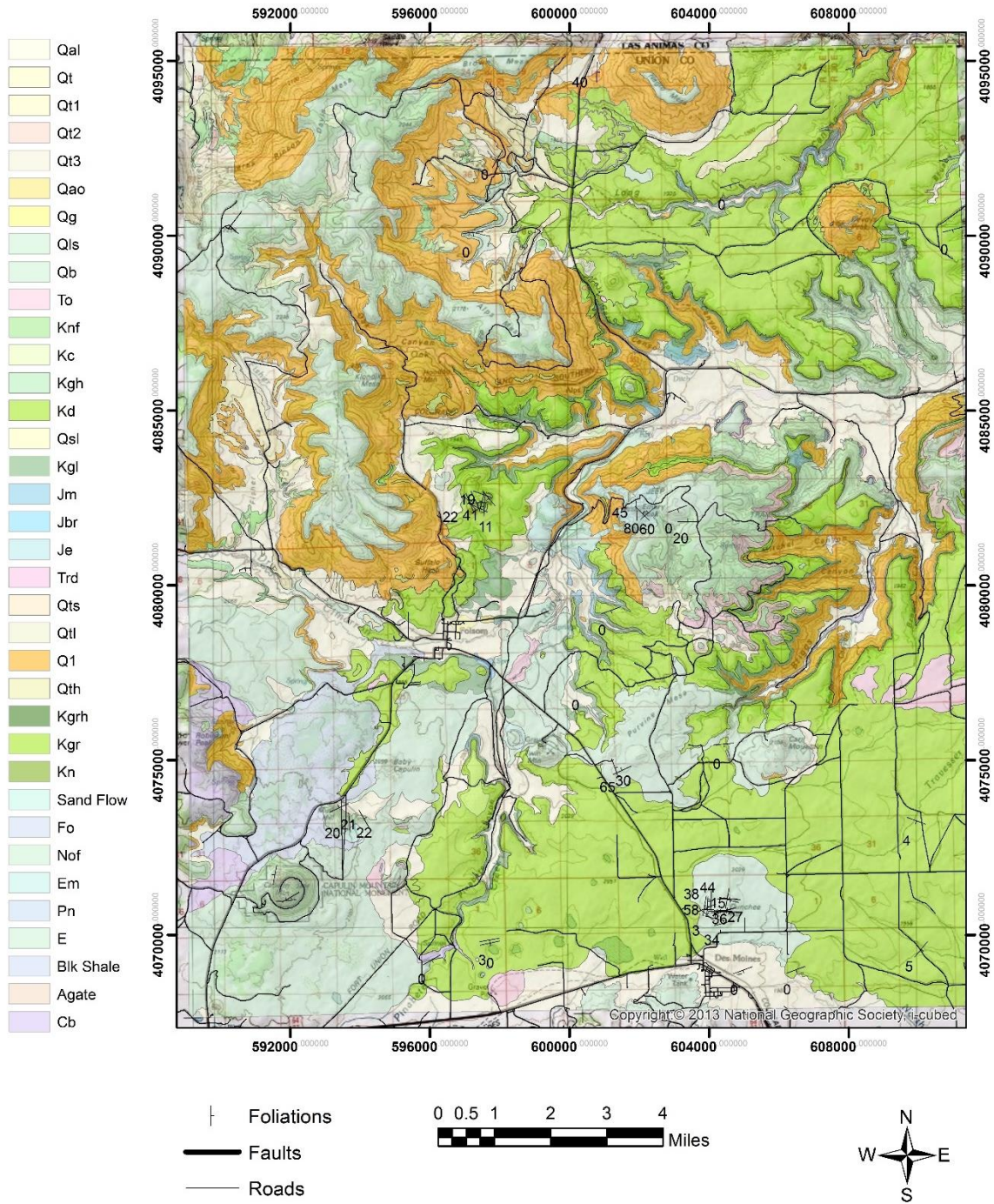


Figure 3. Draft digital version of the western 1:50,000 quadrangle of the Dry Cimarron, including the Folsom area.

# Dry Cimmaron West Central

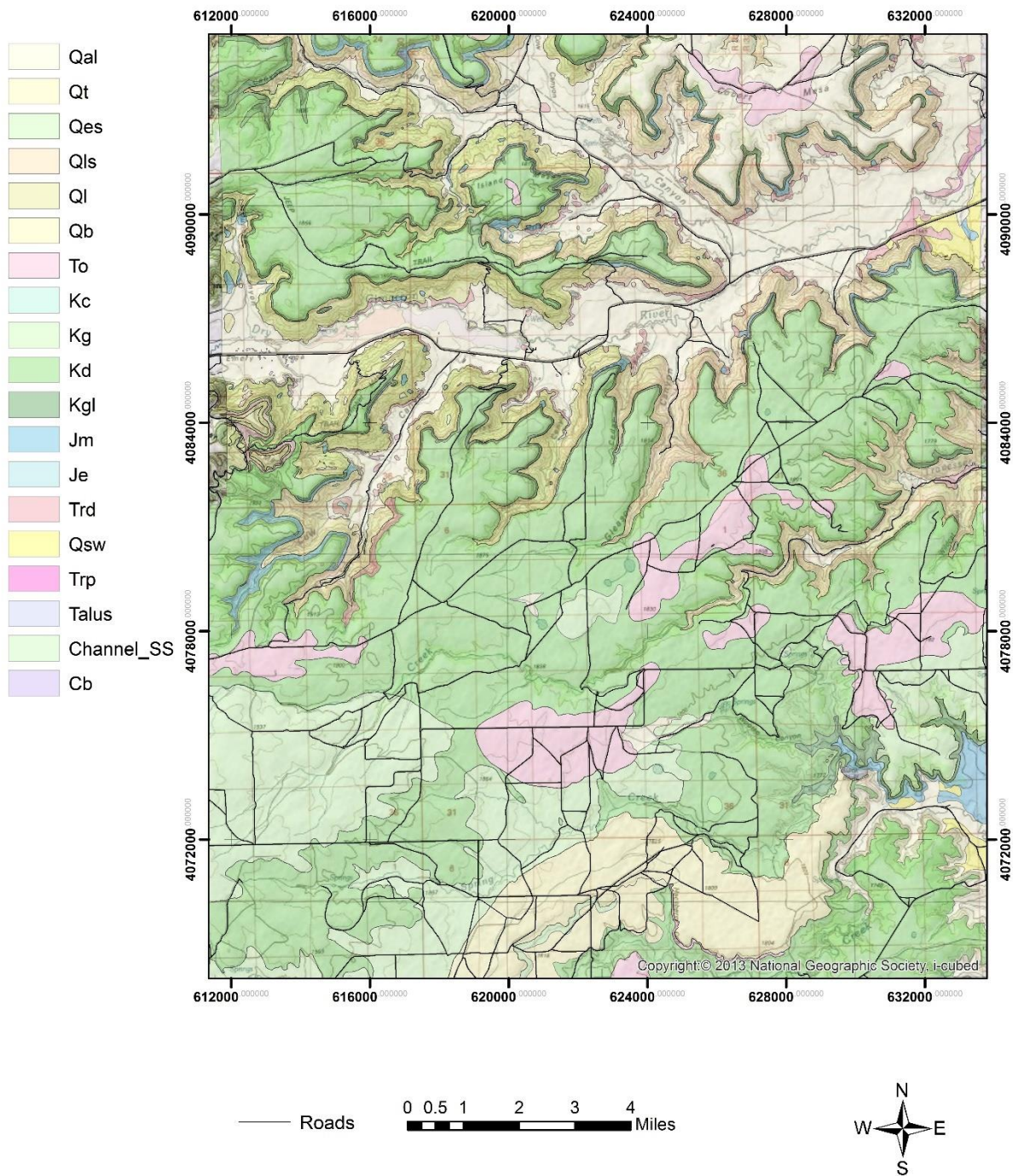
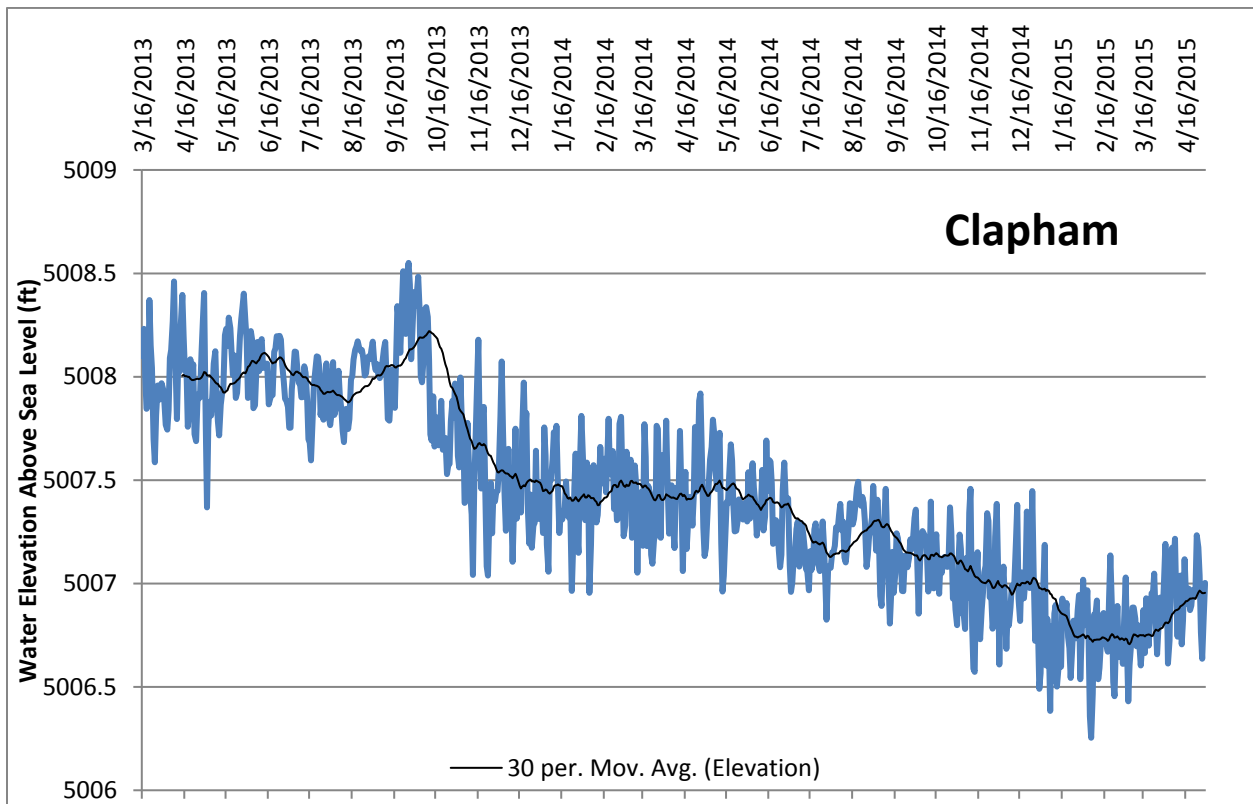
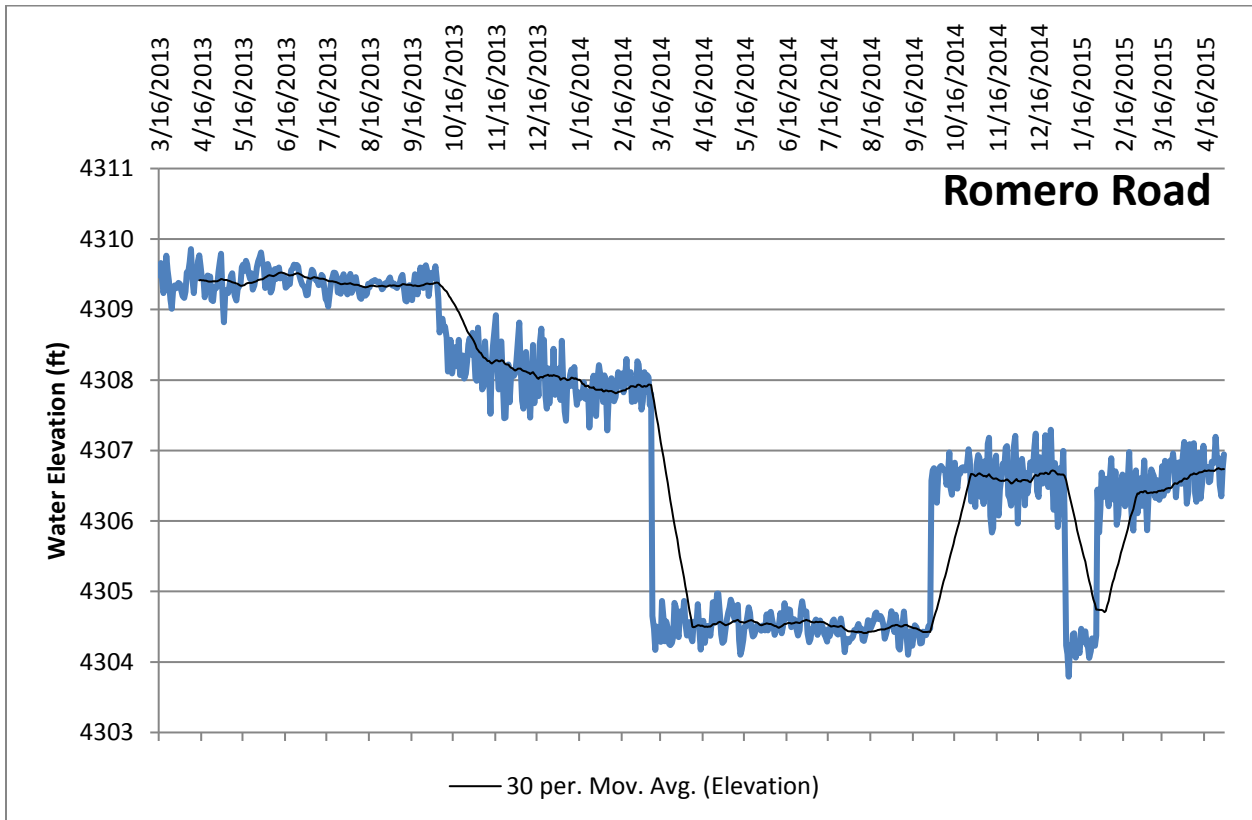
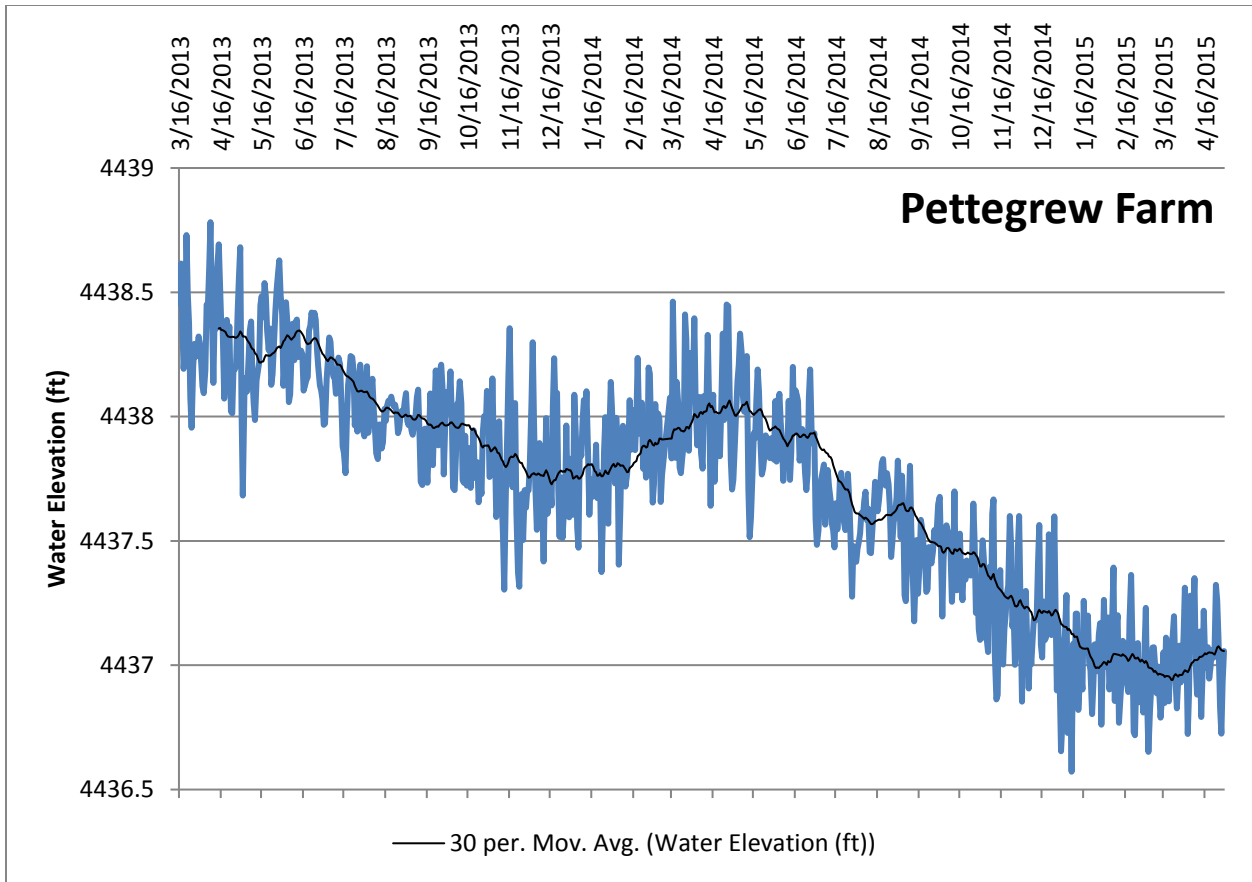


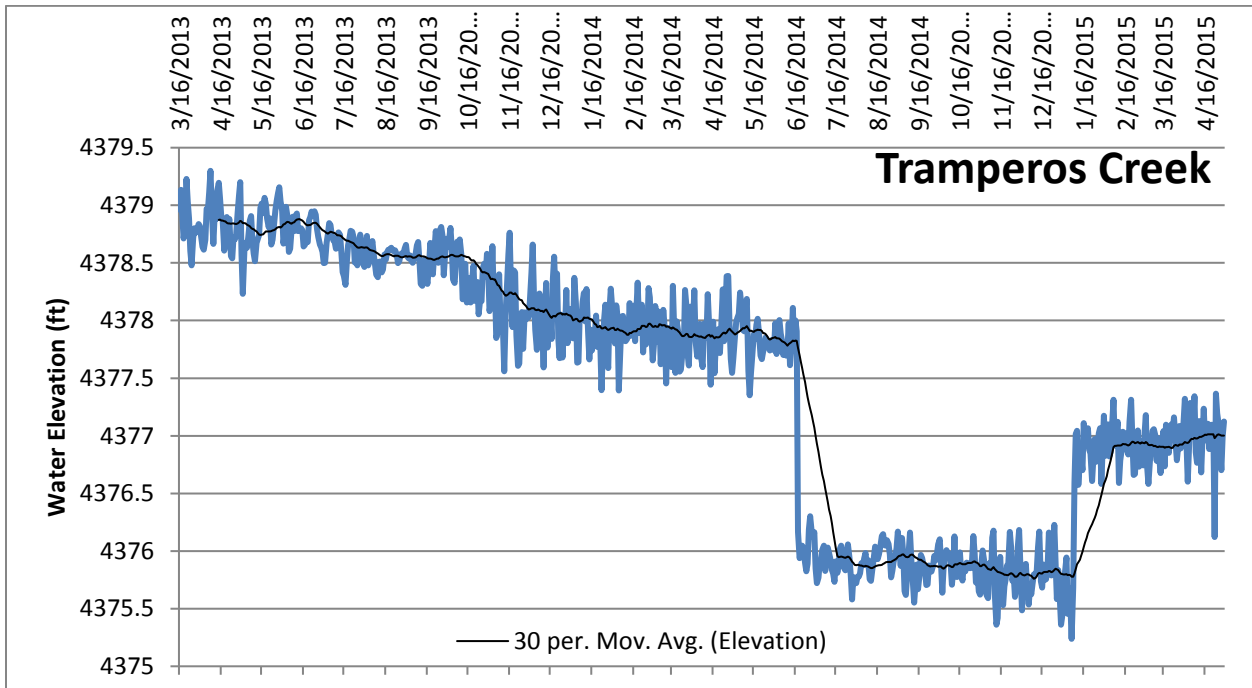
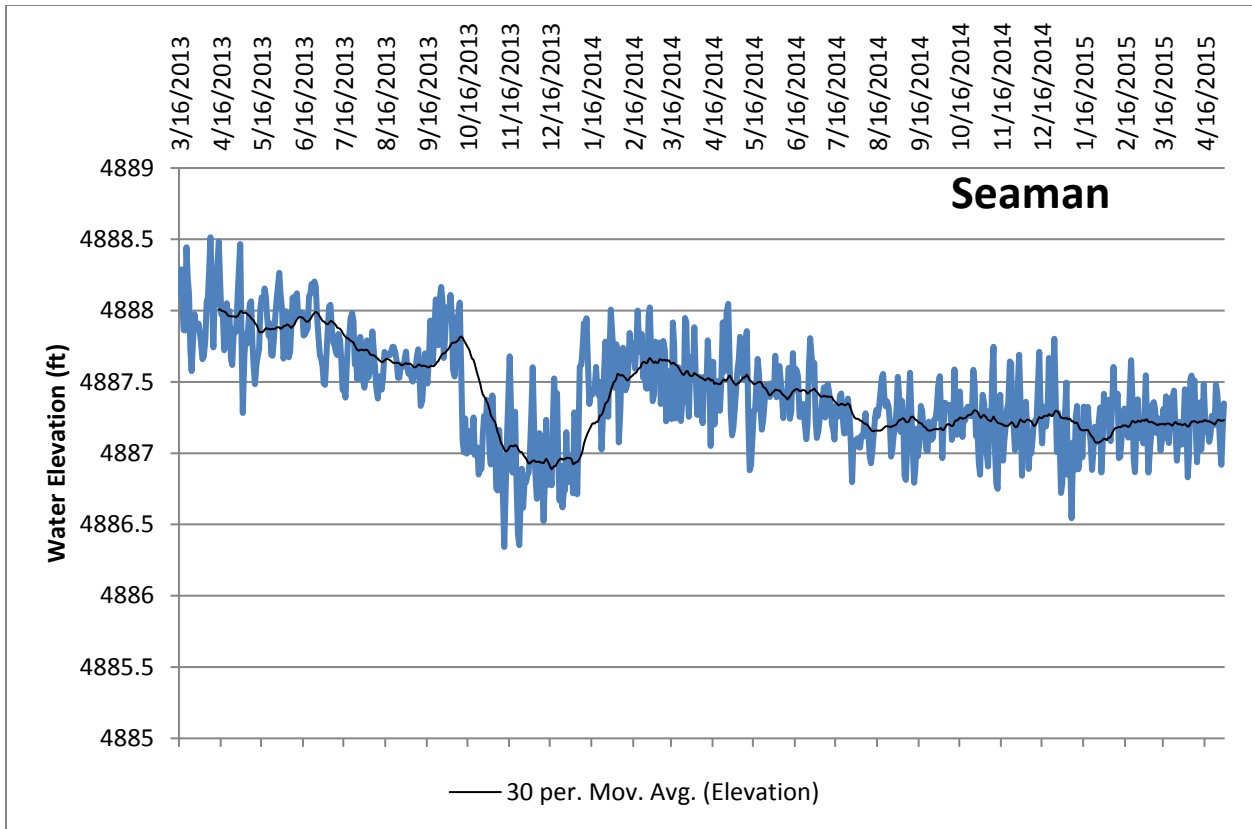
Figure 4. Draft digital version of the 1:50,000 quadrangle of the west-central Dry Cimarron.

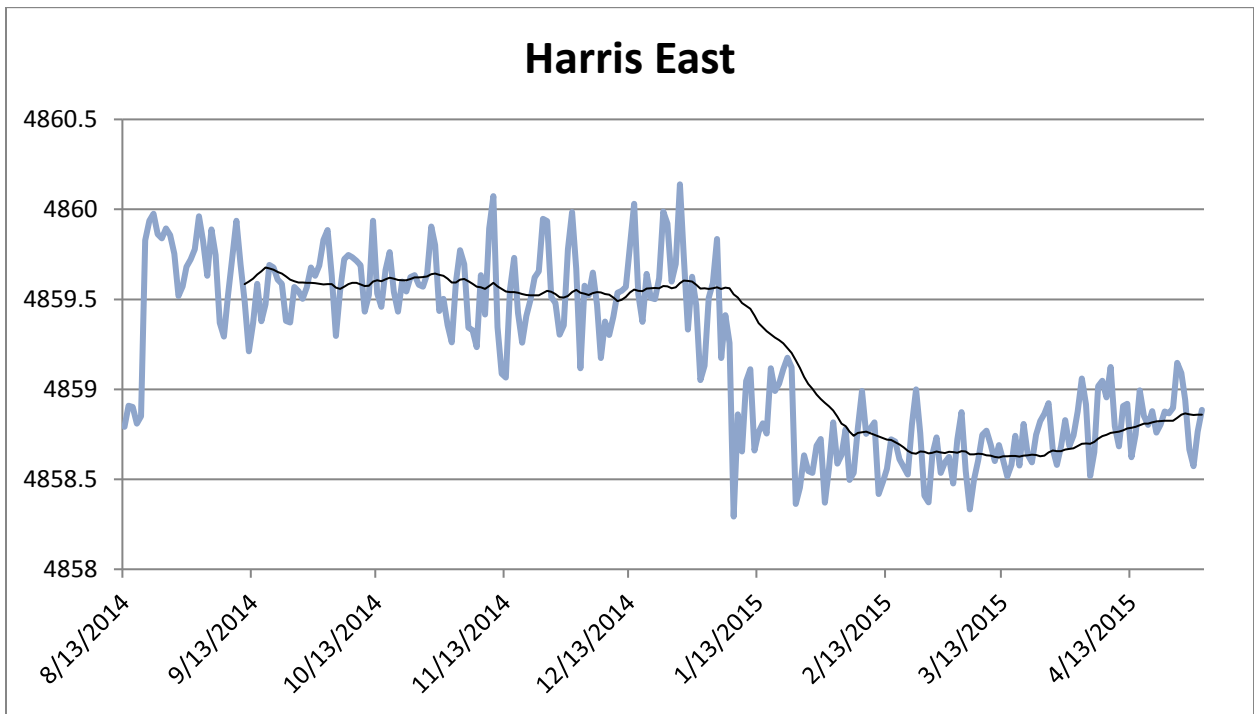
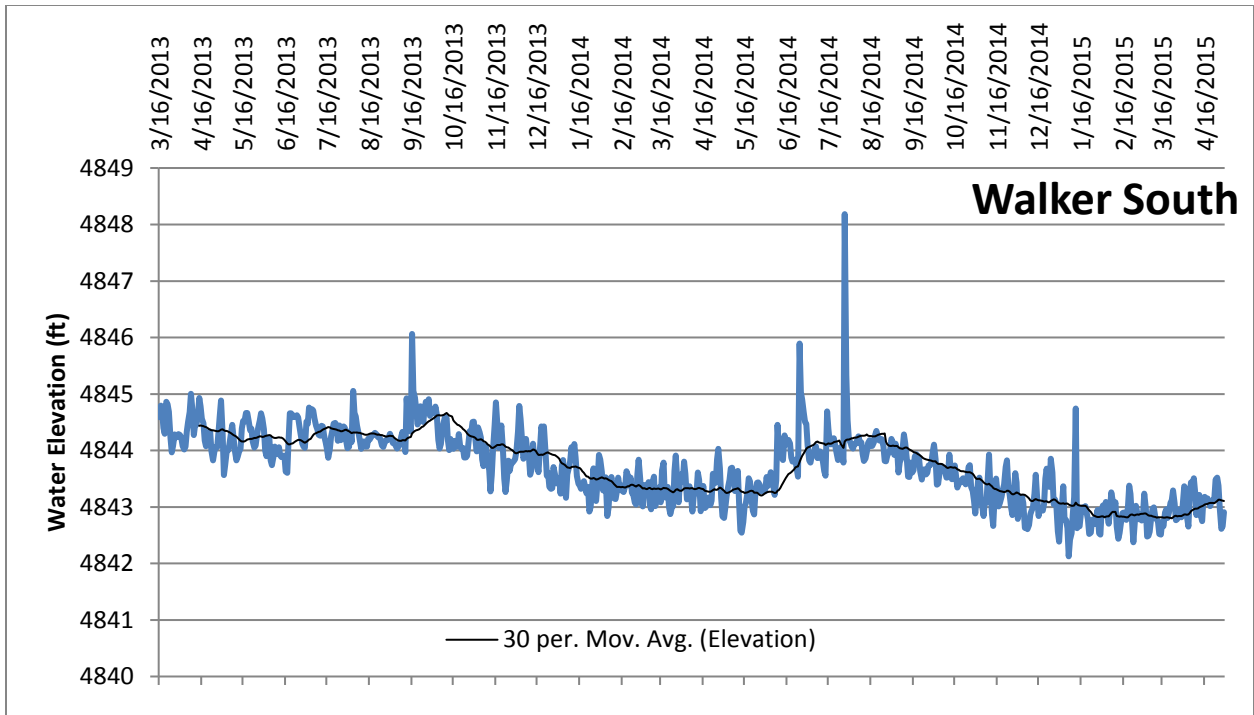
## Data Recorders

In the spring of 2013, eight data recorders were installed in wells that had been abandoned. The wells were chosen along a north-south transect that begins at the Quay County line and ends northeast of Clayton. The data recorders are programmed to record the static water level in each well twice a day (at 6 am and 6 pm). The data recorders are removed from the wells every six months so that the data can be downloaded and then are returned to the wells. Hydrographs for the data recorders through April of 2015 are shown below (Figure 5).









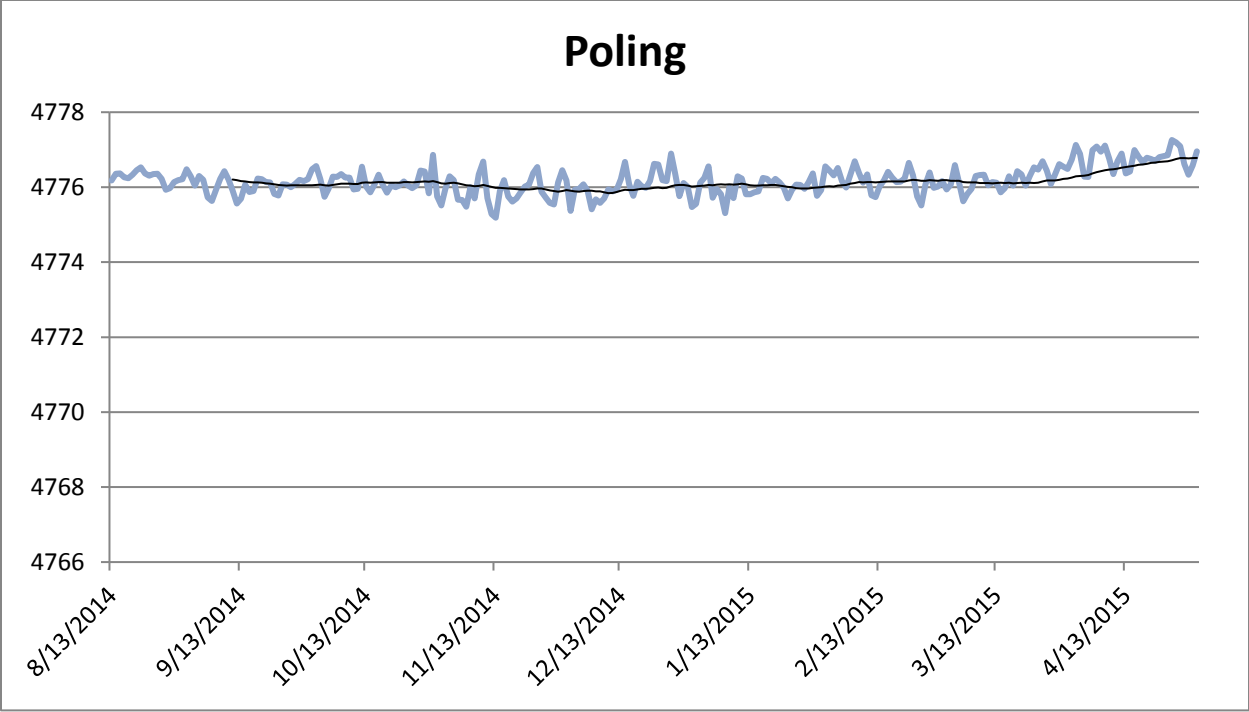


Figure 5. Hydrographs for data loggers installed in eastern Union County from March 2013 to June 2014.

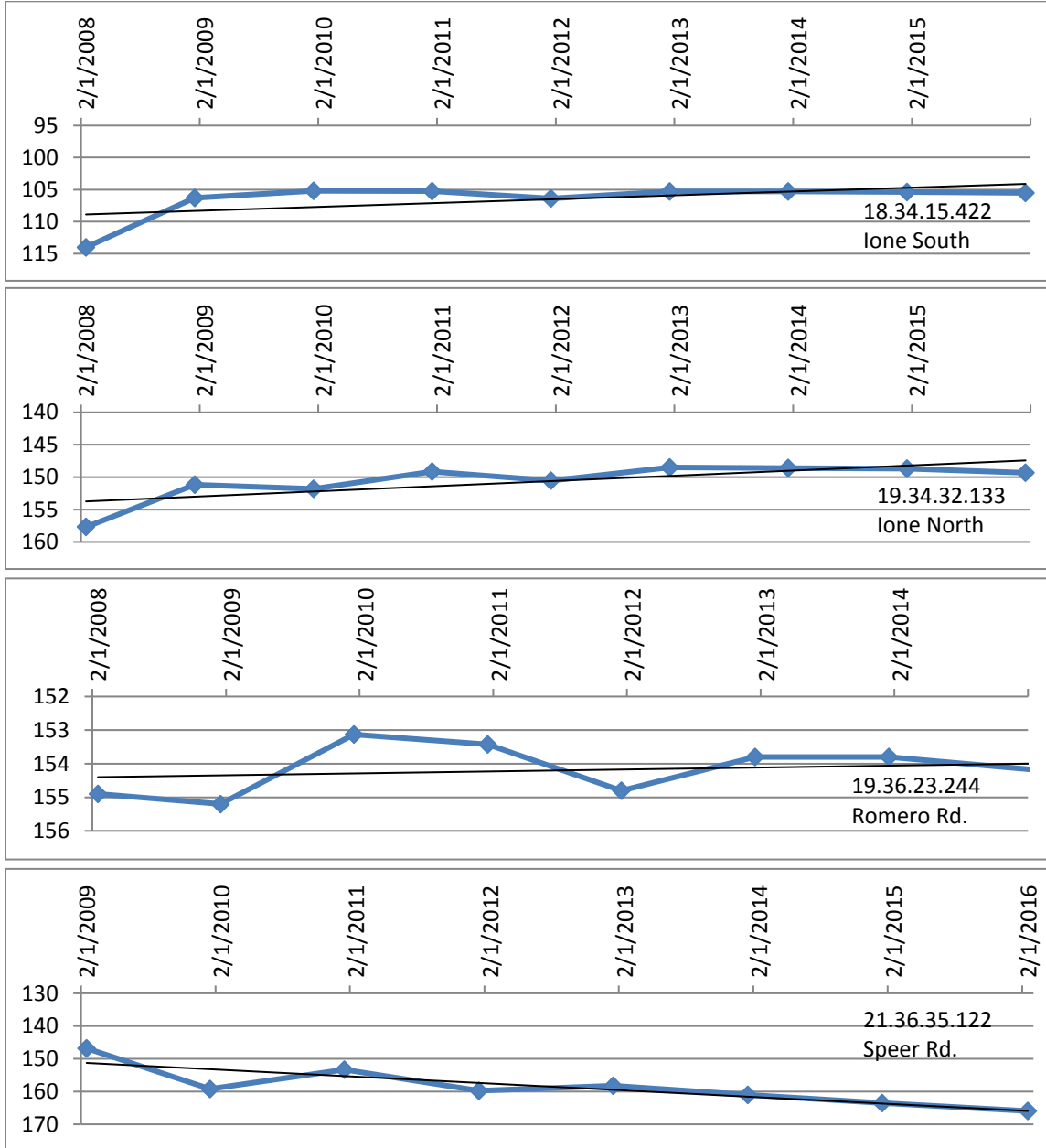
## References

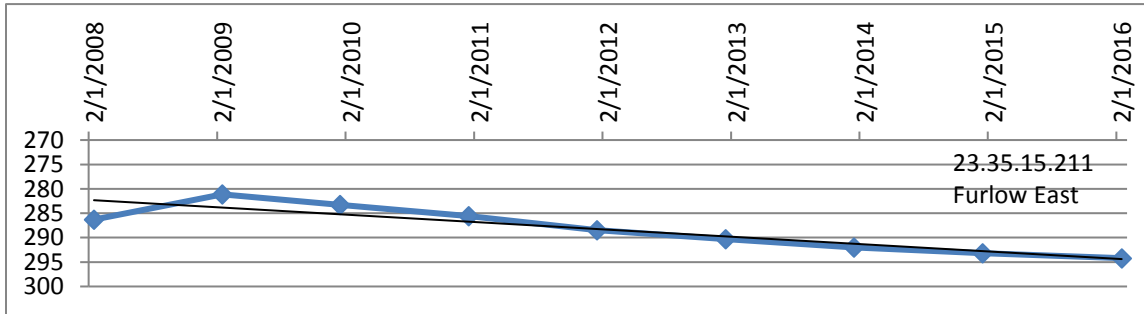
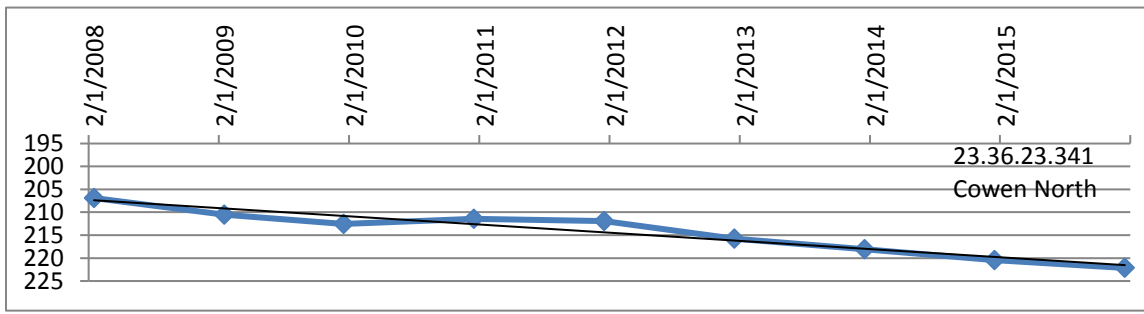
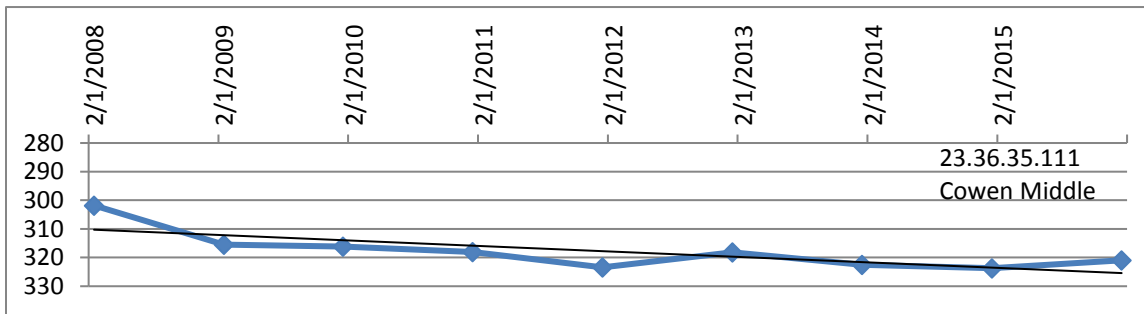
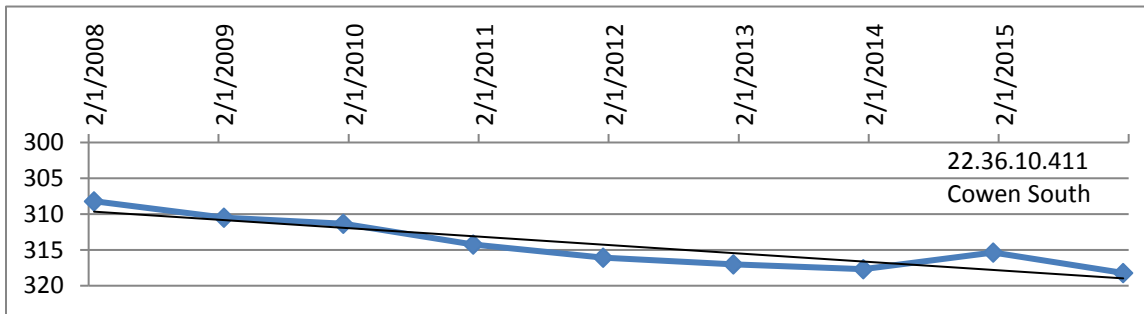
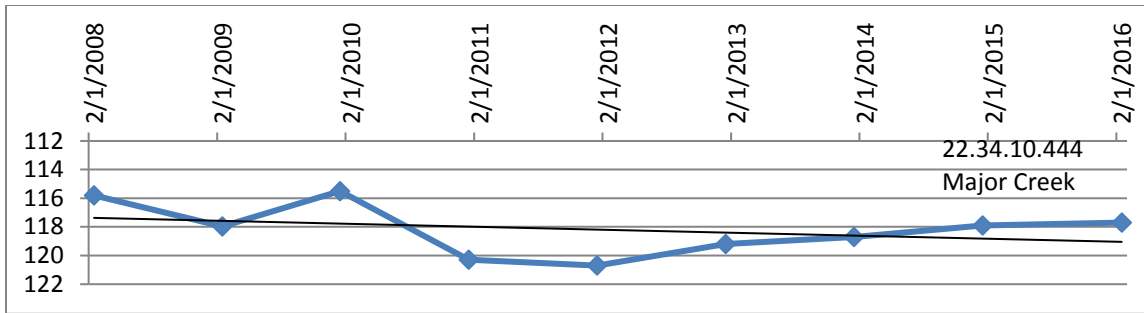
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- Zeigler, K.E., Peacock, G., Williams, S., Yuhas, E. and Yuhas, A., 2013, Union County Hydrogeology Project: Annual progress report 2012-2013, 55 p.
- Zeigler, K.E., Peacock, G., Williams, S., Yuhas, A. and Yuhas, E., 2014, Union County Hydrogeology Project: Annual progress report 2013-2014, 64 p.
- Zeigler, K.E., Mann, R., Lynch, J., Williams, S. and Yuhas, A., 2015, Union County Hydrogeology Project: Annual progress report 2014-2015, 51 p.

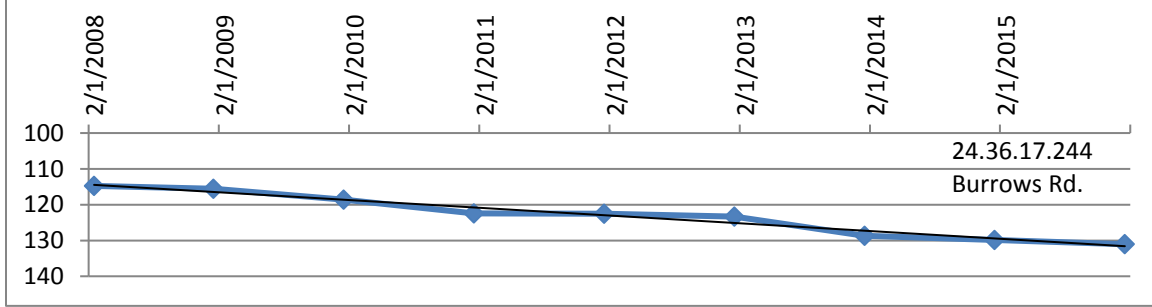
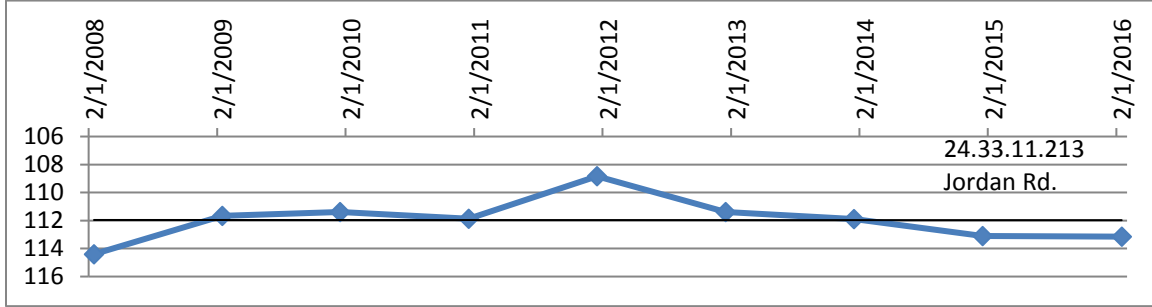
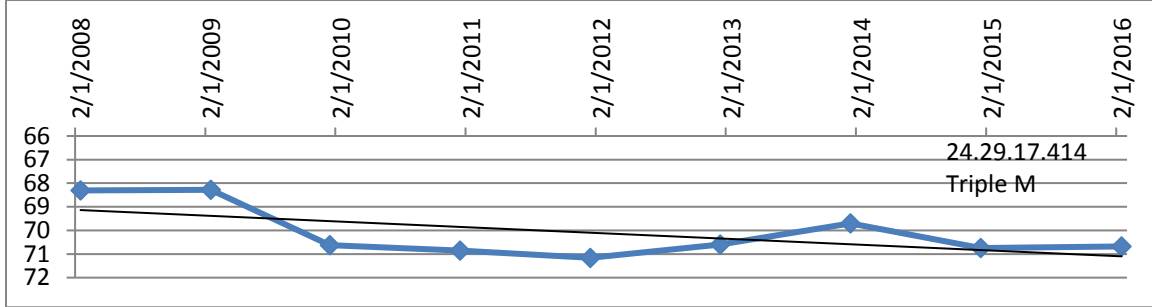
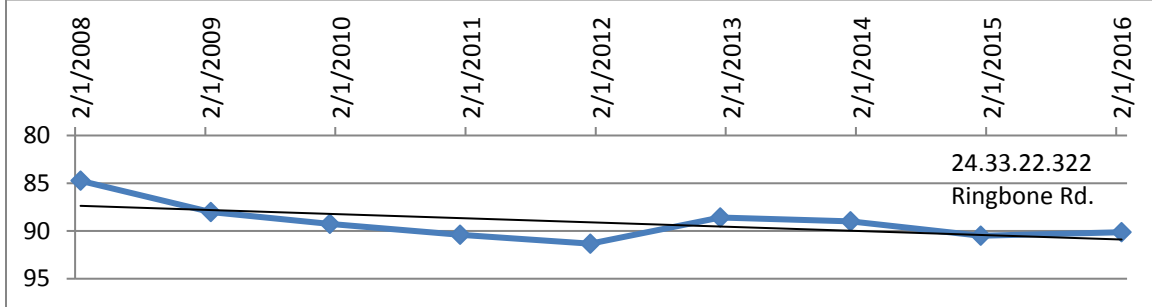
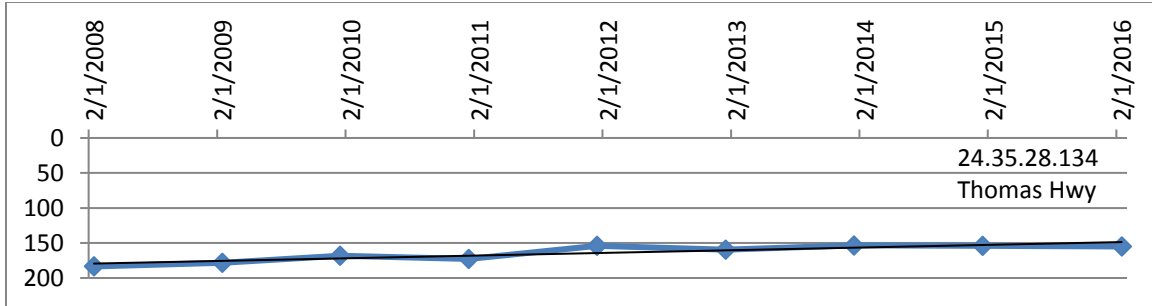


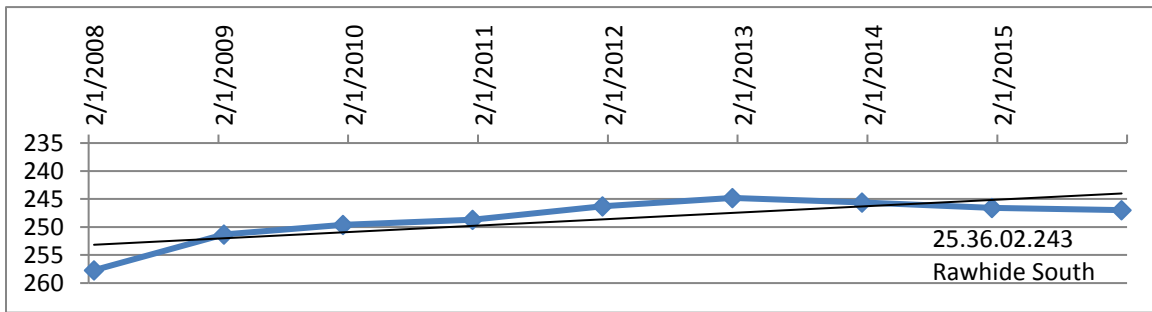
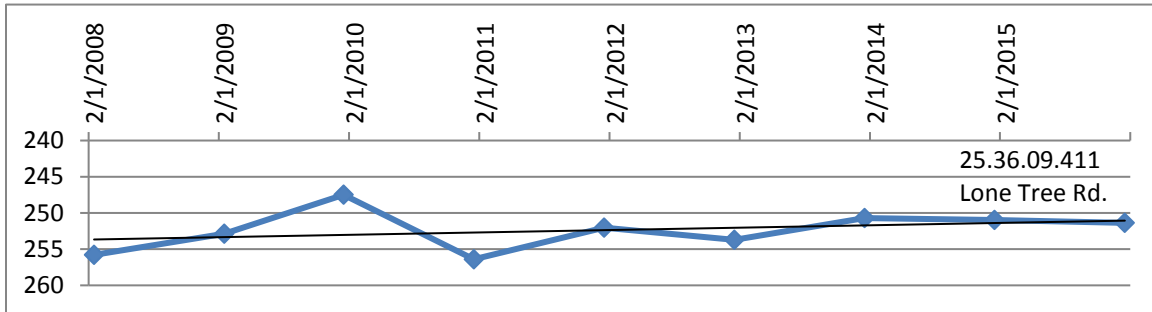
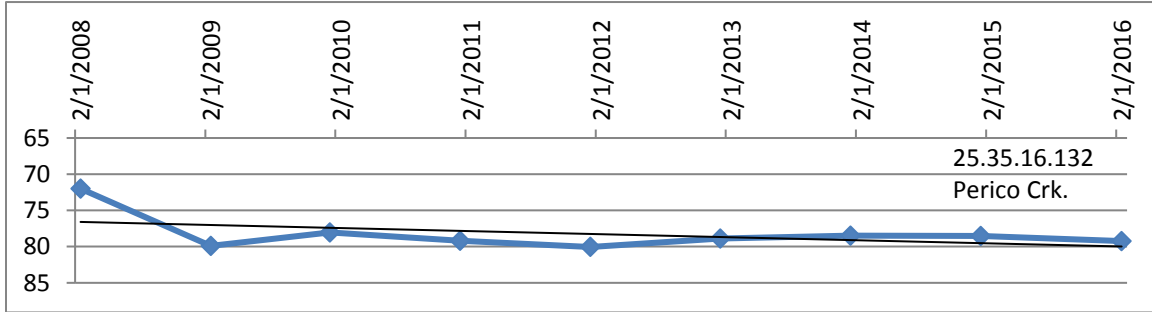
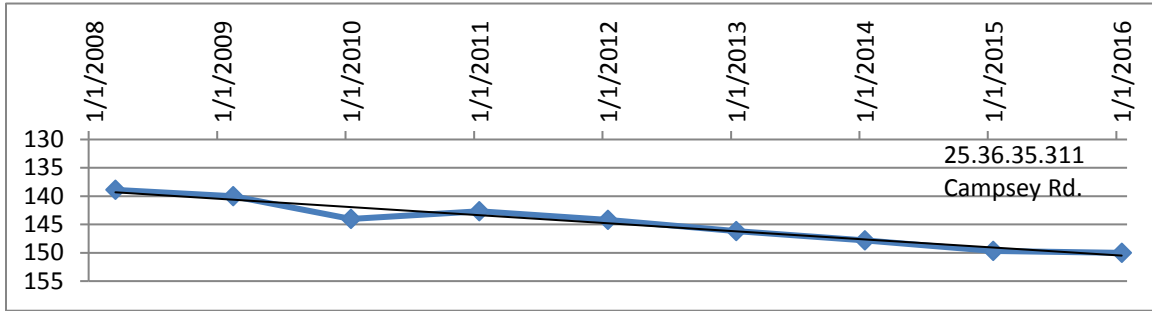
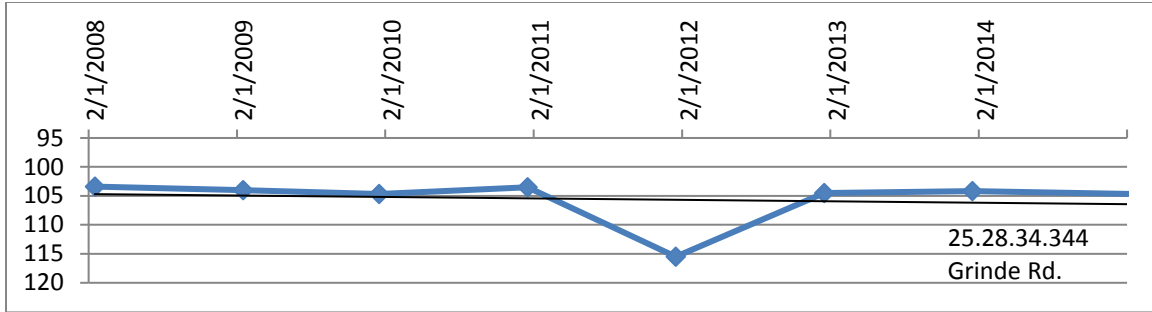
## Appendices

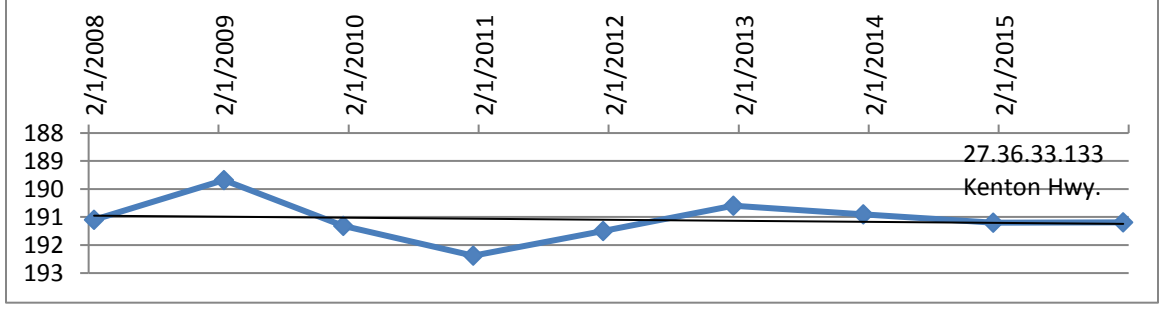
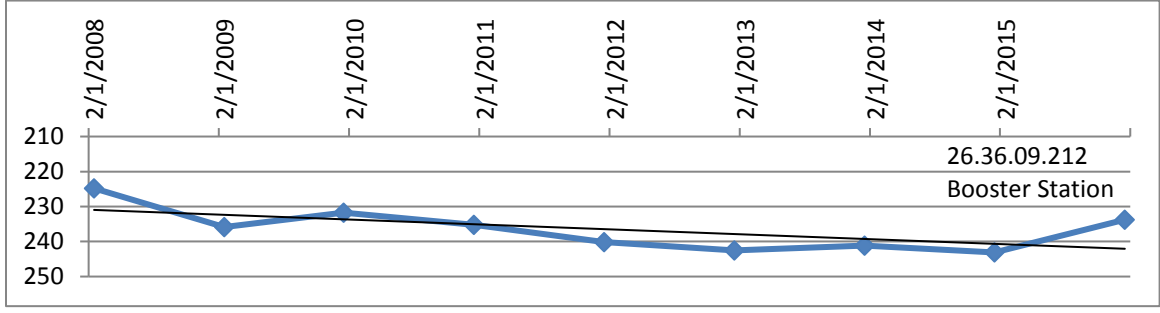
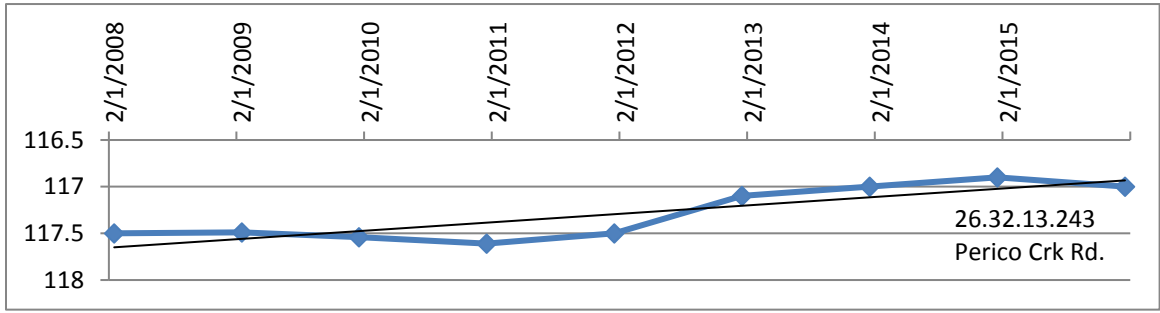
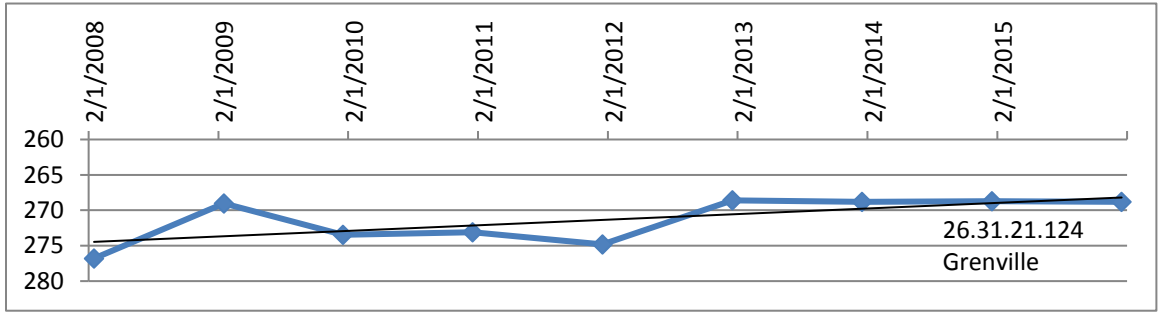
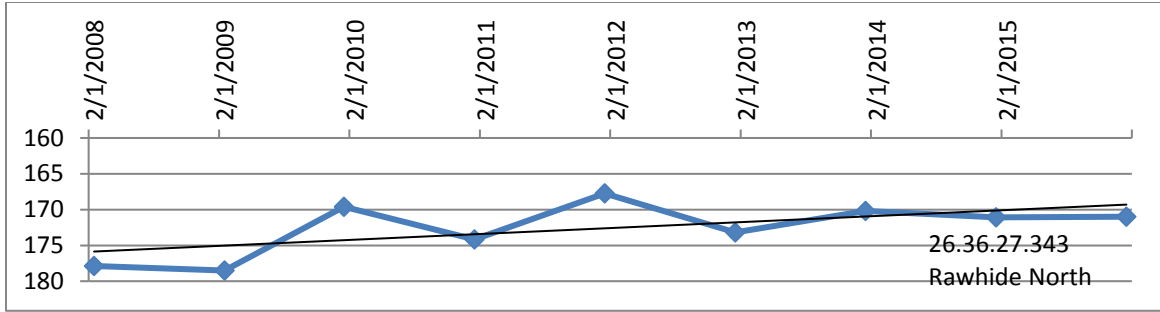
**Appendix I: January Static Water Level Hydrographs 2008-2016**  
 (does not include wells removed from study in 2012 or 2014 - 2016).

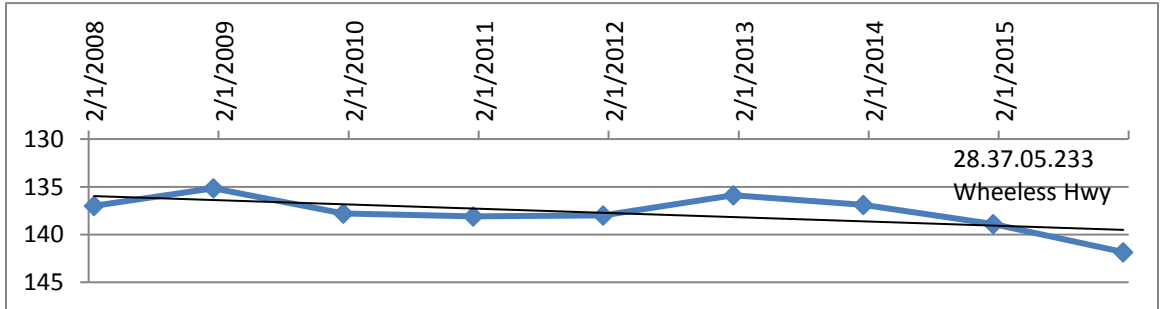
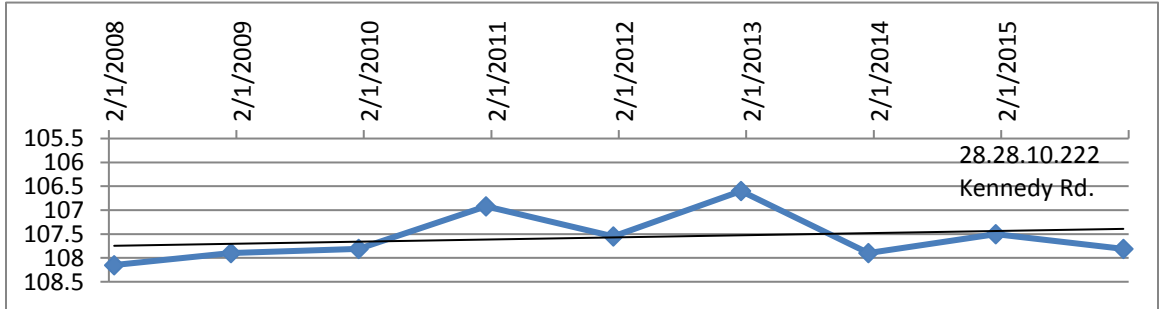
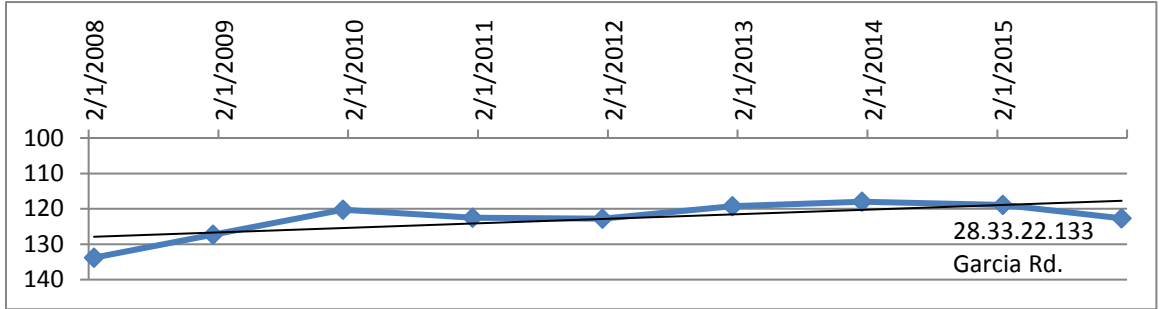
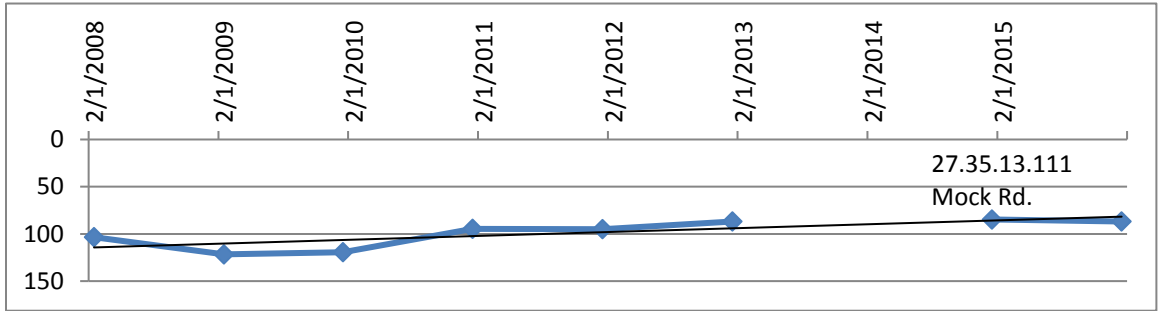
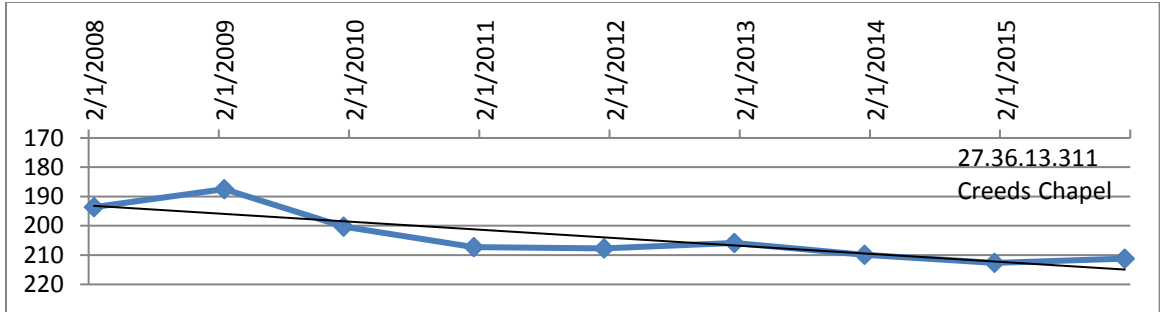


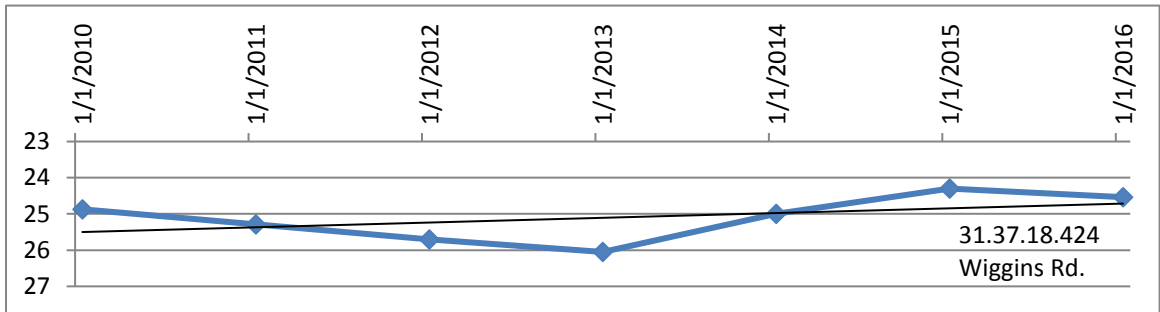
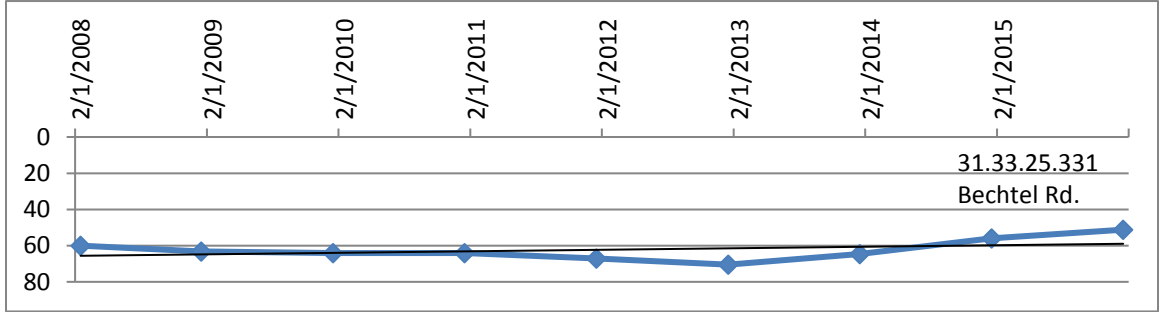
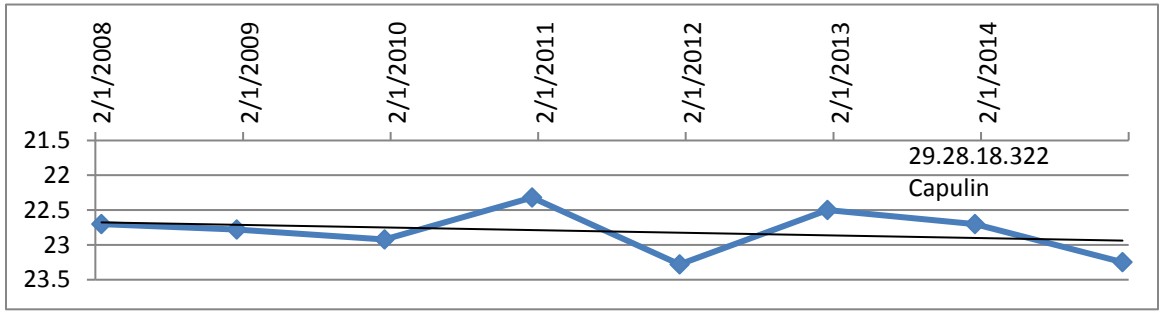
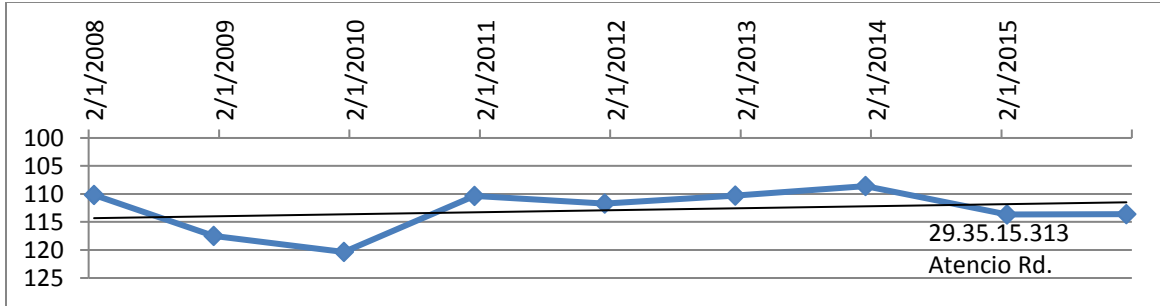


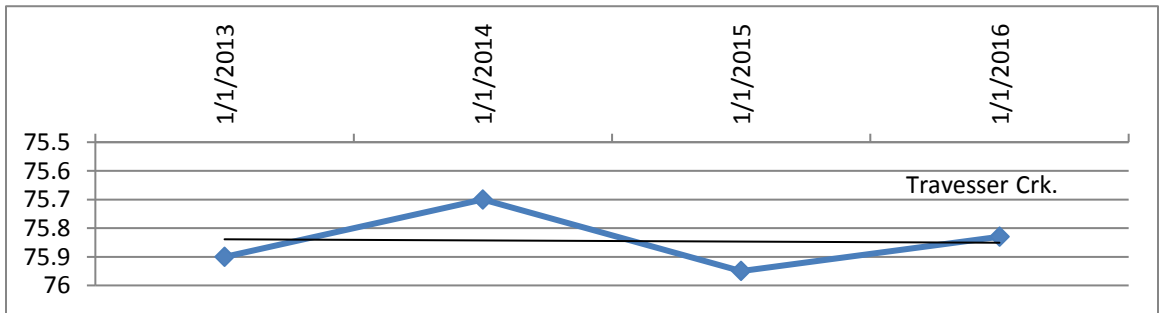
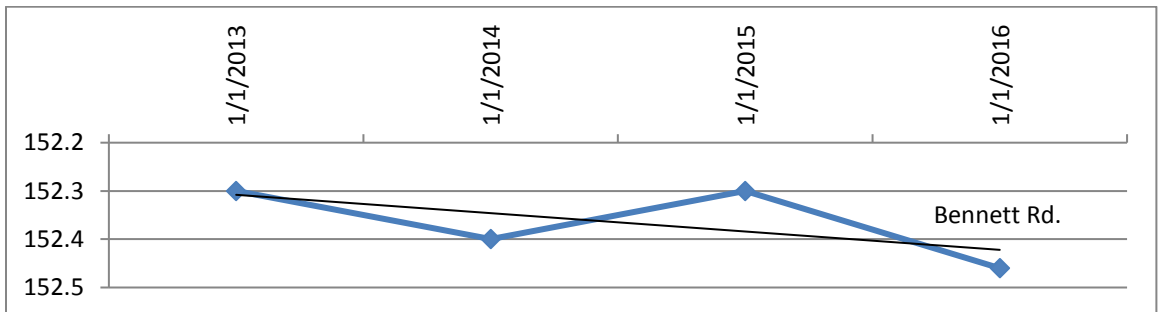
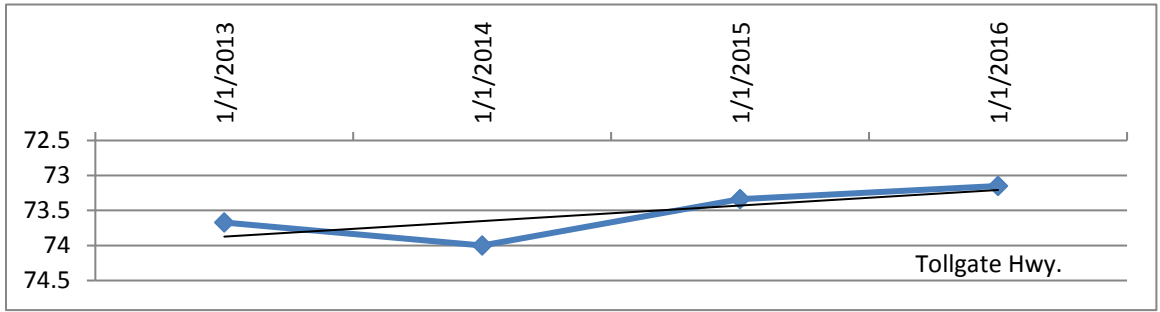
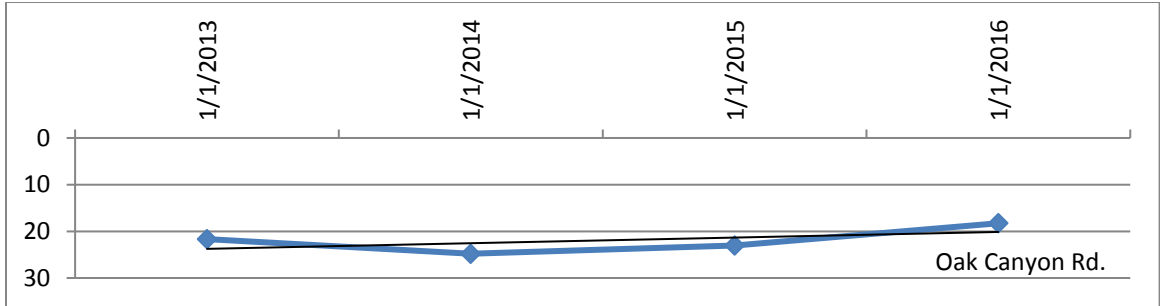














## Appendix II: January Static Water Level Measurements

Individual well static water level measurements from January 2008 through January 2016. Highlighted wells are those currently being monitored.

LOCAL ID & ELEVATION	DATE	DEPTH TO WATER	Delta Depth	Years	Rate
18N36E35.111	2/18/2008	270.6	10.45	8	1.31
4465'	1/30/2009	273.3			
Centerville	1/5/2010	270.8			
	1/1/2011	275.99			
	1/3/2012	273.95			
	1/6/2013	269.2			
	1/3/2014	259.2			
	1/8/2015	260.15			
18N34E15.422	2/18/2008	114	8.48	9	0.94
4764'	1/30/2009	106.3			
Ione South	1/6/2010	105.2			
	1/7/2011	105.25			
	1/3/2012	106.38			
	1/6/2013	105.3			
	1/3/2014	105.3			
	1/8/2015	105.4			
	1/25/2016	105.52			
19N34E32.133	2/18/2008	157.7	8.38	9	0.93
4883'	1/30/2009	151.2			
Ione North	1/1/2010	151.8			
	1/1/2011	149.14			
	1/3/2012	150.54			
	1/6/2013	148.5			
	1/3/2014	148.6			
	1/8/2015	148.7			
	1/25/2016	149.32			
19N36E23.244	2/6/2008	154.9	1.1	7	0.16
4360'	1/30/2009	155.2			
Romero	1/1/2010	153.13			
*data recorder	1/1/2011	153.43			
	1/3/2012	154.8			

	1/6/2013	153.8			
	1/3/2014	153.8			
	1/25/2016	154.5			
20N35E11.333	2/18/2008	85.9	-23.4	6	-3.90
4558'	2/24/2009	81			
Nara Visa Hwy	1/10/2010	80.35			
	1/1/2011	103.91			
	1/7/2012	83.17			
	1/6/2013	109.3			
20N35E01.211	2/18/2008	92.4	1.61	5	0.32
Tompkins Rd	1/30/2009	90.3			
	1/20/2010	91.1			
	1/13/2011	94.55			
	1/3/2012	90.79			
21N36E35.122	2/24/2009	146.82	-19.13	8	-2.39
4450'	1/12/2010	159.24			
Speer Rd	1/14/2011	153.29			
	1/7/2012	159.74			
	1/6/2013	158.2			
	1/4/2014	161			
	1/4/2015	163.5			
	2/12/2016	165.95			
21N35E01.224	2/18/2008	219	-11.61	8	-1.45
4570'	2/16/2009				
Proffitt Rd	1/11/2010	222.22			
	1/14/2011	229.05			
	1/2/2012	232.04			
	1/6/2013	228.5			
	1/4/2014	229.7			
	1/3/2015	230.61			
22N34E10.444	2/26/2008	115.8	-1.9	9	-0.21
4765'	2/16/2009	117.96			
Major Creek Rd.	1/11/2010	115.5			
	1/11/2011	120.3			
	1/3/2012	120.7			
	1/6/2013	119.2			
	1/5/2014	118.7			
	1/8/2015	117.9			

	2/12/2016	117.7			
22N36E04.121	3/4/2008	192	-16.68	5	-3.34
4611'	2/9/2009	205.5			
Vandiver Rd	1/13/2010	189.04			
	1/13/2011	203.16			
	1/2/2012	208.68			
22N36E10.411	2/19/2008	308.2	-10.02	9	-1.11
4558'	2/9/2009	310.51			
Cowen South	1/13/2010	311.35			
	1/13/2011	314.23			
	1/2/2012	316.08			
	1/6/2013	317			
	1/4/2014	317.7			
	1/3/2015	315.35			
	1/25/2016	318.22			
23N36E35.111	2/19/2008	301.8	-19.11	9	-2.12
4611'	2/9/2009	315.44			
Cowen Middle	1/11/2010	316.1			
	1/12/2011	318.1			
	1/2/2012	323.42			
	1/6/2013	318.2			
	1/4/2014	322.5			
	1/11/2015	323.7			
	1/25/2016	320.91			
23N33E28.432	2/26/2008	71.8	-1.2	7	-0.17
5020'	2/16/2009	71.84			
Clapham	1/12/2010	72.77			
*data recorder	1/15/2011	72.63			
	1/3/2012	73.2			
	1/6/2013	72.91			
	1/5/2014	73			
23N35E29.122	2/26/2008	184.5	-7.2	7	-1.03
4794'	2/24/2009	192.24			
Anderson Rd	1/13/2010	189.32			
	1/15/2011	189.79			
	1/3/2012	188.1			
	1/6/2013	183.8			
	1/4/2014	191.7			

23N36E23.341	2/19/2008	206.9	-15.25	9	-1.69
4761'	2/9/2009	210.56			
Cowen North	1/15/2010	212.52			
	1/20/2011	211.4			
	1/2/2012	211.91			
	1/6/2013	215.74			
	1/4/2014	218.1			
	1/3/2015	220.46			
	1/25/2016	222.15			
23N34E16.442	2/26/2008	169.1	5.6	8	0.70
4925'	2/16/2009	176.74			
Thomas South	1/14/2010	171.35			
	1/20/2011	170.1			
	1/3/2012	175.82			
	1/6/2013	167			
	1/5/2014	165.6			
	1/8/2015	163.5			
23N35E15.211	2/26/2008	286.3	-7.9	9	-0.88
4797'	2/24/2009	281.13			
Furrow East	1/25/2010	283.29			
	1/15/2011	285.58			
	1/3/2012	288.47			
	1/6/2013	290.3			
	1/4/2014	292			
	1/8/2015	293.21			
	2/9/2016	294.2			
23N35E16.121	2/26/2008	295.7	-1.9	-6	0.32
4812'	2/3/2009	314.9			
Furrow West	1/12/2010	295.62			
	1/14/2011	289.52			
	1/3/2012	292.83			
	1/6/2013	297.6			
24N36E36.422	2/19/2008	174.2	-33	9	-3.67
4720'	2/13/2009	205.1			
Dixon Rd	1/15/2010	205.48			
	1/13/2011	196.99			
	1/6/2012	200.42			
	1/6/2013	197.9			

	1/4/2014	202			
	1/9/2015	206			
	1/26/2016	207.2			
24N35E28.134	2/27/2008	183.5	28.64	9	3.18
4643'	2/16/2009	178.17			
Thomas Hwy	1/15/2010	168.25			
	1/16/2011	172.79			
	1/3/2012	154.19			
	1/6/2013	159.5			
	1/5/2014	153.4			
	1/8/2015	153.9			
	2/9/2016	154.86			
24N33E22.322	2/27/2008	84.75	-5.37	9	-0.60
5410'	2/11/2009	88.03			
Ringbone Rd	1/15/2010	89.25			
	1/15/2011	90.39			
	1/4/2012	91.33			
	1/6/2013	88.6			
	1/7/2014	89			
	1/8/2015	90.5			
	2/9/2016	90.12			
24N29E17.414	2/28/2008	68.3	-2.38	9	-0.26
5760'	2/4/2009	68.28			
Triple M	1/16/2010	70.62			
Springer Hwy	1/12/2011	70.85			
	1/4/2012	71.16			
	1/6/2013	70.6			
	1/7/2014	69.7			
	1/2/2015	70.75			
	2/9/2016	70.68			
24N33E11.213	2/27/2008	114.4	1.26	9	0.14
5675'	2/4/2009	111.66			
Jordan Rd	1/16/2010	111.38			
	1/15/2011	111.88			
	1/6/2012	108.84			
	1/6/2013	111.4			
	1/7/2014	111.9			
	1/2/2015	113.1			
	2/9/2016	113.14			

24N36E17.244	2/16/2008	114.76	-16.29	9	-1.81
4707'	1/17/2009	115.57			
Burrows Rd	1/15/2010	118.6			
	1/23/2011	122.41			
	1/6/2012	122.5			
	1/6/2013	123.3			
	1/5/2014	128.7			
	1/9/2015	129.85			
	1/26/2016	131.05			
25N28E34.344	2/28/2008	103.4	-2.1	9	-0.23
5960'	2/4/2009	104			
Grinde Rd	1/14/2010	104.65			
	1/13/2011	103.5			
	1/6/2012	115.5			
	1/6/2013	104.5			
	1/7/2014	104.2			
	2/11/2015	104.69			
	1/26/2016	105.5			
25N36E.35.311	3/5/2008	138.9	-11.11	9	-1.23
4682'	2/13/2009	140.01			
Campsey Rd	1/14/2010	144.04			
	1/15/2011	142.68			
	1/6/2012	144.21			
	1/6/2013	146.2			
	1/5/2014	147.8			
	1/9/2015	149.65			
	1/26/2016	150.01			
25N35E30.222	2/27/2008	93.7	0.6	5	0.12
5007'	2/13/2009	93.04			
Leavitt Rd	1/13/2010	91.98			
	1/23/2011	93			
	1/6/2012	93.1			
25N31E20.222	2/4/2009	205.65	5.36	4	1.34
	1/13/2010	198.52			
Snyder Rd	1/13/2011	196.72			
	1/4/2012	200.29			
25N35E16.132	2/27/2008	72	-7.25	9	-0.81

5045'	2/26/2009	79.9			
Nara Visa Hwy N	1/14/2010	78.04			
	1/12/2011	79.19			
	1/6/2012	80.05			
	1/6/2013	78.9			
	1/5/2014	78.5			
	1/11/2015	78.53			
	2/9/2016	79.25			
25N36E09.411	2/27/2008	255.8	4.43	9	0.49
4850'	2/11/2009	252.86			
Texline Hwy	1/14/2010	247.5			
Lone Tree	1/13/2011	256.4			
	1/6/2012	252.05			
	1/6/2013	253.7			
	1/8/2014	250.7			
	1/11/2015	250.98			
	1/26/2016	251.37			
25N36E.02.243	2/27/2008	257.7	10.74	9	1.19
4810'	2/11/2009	251.29			
Rawhide South	1/15/2010	249.58			
	1/14/2011	248.68			
	1/6/2012	246.31			
	1/6/2013	244.8			
	1/8/2014	245.6			
	1/11/2015	246.55			
	1/26/2016	246.96			
26N36E.27.343	2/27/2008	177.9	6.91	9	0.77
4810'	2/11/2009	178.51			
Rawhide North	1/15/2010	169.6			
	1/13/2011	174.17			
	1/6/2012	167.75			
	1/6/2013	173.2			
	1/8/2014	170.2			
	1/11/2015	171.1			
	1/26/2016	170.99			
26N31E.21.124	2/28/2008	276.8	7.99	9	0.89
6010'	2/4/2009	269.04			
Grenville	1/21/2010	273.45			
	1/14/2011	273.1			

	1/4/2012	274.8			
	1/6/2013	268.6			
	1/7/2014	268.8			
	1/10/2015	268.7			
	1/28/2016	268.81			
26N32E.13.243	2/28/2008	117.5	1	9	0.06
5600'	2/4/2009	117.49			
Perico Creek Rd	1/23/2010	117.54			
	1/12/2011	117.61			
	1/4/2012	117.5			
	1/6/2013	117.1			
	1/7/2014	117			
	1/10/2015	116.9			
	1/28/2016	117			
26N35E.13.143	2/2/2008	239.4	31.58	8	3.95
4850'	2/4/2009	230.38			
Apache Valley	1/21/2010	202.1			
	1/12/2011	203.34			
	1/6/2012	212.38			
	1/6/2013	215.2			
	1/10/2014	208.1			
	1/10/2015	207.82			
26N36E.09.212	2/2/2008	224.8	-8.91	9	-0.99
4792'	2/11/2009	235.9			
Booster Station	1/12/2010	231.76			
	1/12/2011	235.2			
	1/6/2012	240.16			
	1/6/2013	242.5			
	1/8/2014	241.2			
	1/6/2015	243.12			
	1/26/2016	233.71			
27N36E.33.133	2/28/2008	191.1	-0.09	9	-0.01
4892'	2/11/2009	189.68			
Kenton Hwy	1/12/2010	191.32			
Feedlot	1/11/2011	192.38			
	1/6/2012	191.5			
	1/6/2013	190.6			
	1/8/2014	190.9			
	1/6/2015	191.2			



	1/26/2016	191.19			
27N36E13.311	2/29/2008	193.6	-17.64	9	-1.96
4776'	2/11/2009	187.47			
Creeds Chapel	1/8/2010	200.29			
	1/2/2011	207.3			
	1/6/2012	207.66			
	1/6/2013	205.9			
	1/8/2014	209.9			
	1/6/2015	212.66			
	1/26/2016	211.24			
27N35E.13.111	2/2/2008	103.6	16.69	9	1.85
4963'	2/28/2009	121.66			
Mock Rd	1/5/2010	119.54			
	1/14/2011	94.8			
	1/5/2012	95.02			
	1/6/2013	86.9			
	1/8/2014	nm			
	1/6/2015	84.7			
	1/26/2016	86.91			
27N37E.18.222	2/9/2009	128.5	-13.7	5	-2.74
4718'	1/9/2010	129.08			
Seneca Valley	1/15/2011	141			
	1/6/2012	147.52			
	1/6/2013	140.7			
	1/8/2014	142.2			
28N36E28.131	2/2/2008	213.1	-5.5	6	-0.92
4905'	1/31/2009	222.83			
Kenton Hwy	1/12/2010	217.49			
	1/3/2011	223.2			
	1/5/2012	224.23			
	1/6/2013	218.6			
28N33E.22.133	2/10/2008	133.8	11.1	9	1.23
5546'	1/21/2009	127.3			
Garcia Rd	1/6/2010	120.22			
	1/7/2011	122.55			
	1/4/2012	122.83			
	1/6/2013	119.3			
	1/9/2014	118			

	2/11/2015	118.87			
	1/27/2016	122.7			
28N28E.10.222	2/28/2008	108.15	0.34	9	0.04
6814'	1/31/2009	107.9			
Kennedy Rd	1/6/2010	107.81			
	1/20/2011	106.92			
	1/4/2012	107.55			
	1/6/2013	106.6			
	1/6/2014	107.9			
	1/10/2015	107.5			
	1/28/2016	107.81			
28N37E.05.233	2/2/2008	137	-4.84	9	-0.54
4811'	1/30/2009	135.16			
Wheless Hwy	1/7/2010	137.8			
	1/8/2011	138.1			
	1/5/2012	137.98			
	1/6/2013	135.9			
	1/6/2014	136.9			
	1/6/2015	138.9			
	1/27/2016	141.84			
29N35E.15.313	2/10/2008	110.15	-3.45	9	-0.38
5180'	1/31/2009	117.48			
Atencio Rd	1/7/2010	120.36			
	1/8/2011	110.36			
	1/4/2012	111.69			
	1/6/2013	110.3			
	1/9/2014	108.6			
	2/11/2015	113.67			
	1/27/2016	113.6			
29N28E.18.322	2/28/2008	22.7	0.22	9	0.02
6890'	1/31/2009	22.78			
Capulin	1/9/2010	22.92			
	1/6/2011	22.32			
	1/4/2012	23.28			
	1/6/2013	22.5			
	1/6/2014	22.7			
	1/10/2015	23.25			
	1/28/2016	22.48			

30N37E20.321	2/2/2008	59.42	-14.08	7	-2.01
4720'	2/3/2009	65.82			
Stone house	1/7/2010	67.2			
	1/8/2011	73.53			
	1/5/2012	73.17			
	1/6/2013	73.5			
	1/6/2014	73.5			
31N33E25.331	2/10/2008	60.05	8.85	9	0.98
5372'	1/31/2009	63.18			
Bechtel	1/8/2010	64.05			
	1/9/2011	64.18			
	1/5/2012	67.12			
	1/6/2013	70.5			
	1/6/2014	64.6			
	1/5/2015	56.01			
	1/28/2016	51.2			
31N33E.30.212	2/10/2008	38.1	9.97	9	1.11
5120'	1/31/2009	40.4			
Lake Hwy	1/8/2010	34.68			
	1/8/2011	35.36			
	1/5/2012	35.48			
	1/6/2013	35.3			
	1/6/2014	35			
	1/5/2015	35.8			
	1/28/2015	28.13			
31N37E.18.424	1/6/2010	24.87	0.33	7	0.05
4356'	1/5/2011	25.29			
Wiggins Rd	1/5/2012	25.7			
	1/6/2013	26.05			
	1/6/2014	25			
	1/5/2015	24.3			
	1/28/2016	24.54			
Bannon Oak Canyon	1/6/2013	21.7	3.43	4	0.86
	1/6/2014	24.8			
	1/5/2015	23.02			
	1/28/2016	18.27			
Bannon Tollgate	1/6/2013	73.67	0.52	4	0.13

	1/6/2014	74			
	1/5/2015	73.34			
	1/28/2016	73.15			
Bennett #1	1/8/2013	152.3	-0.16	4	-0.04
	1/9/2014	152.4			
	1/10/2015	152.3			
	2/10/2016	152.46			
Bennett #3	1/8/2013	75.9	0.07	4	0.02
Travesser Crk	1/9/2014	75.7			
	2/11/2015	75.95			
	2/10/2016	75.83			
Harris West	1/8/2014	104.4	0.44	3	0.15
	1/6/2015	103.4			
	2/16/2016	103.96			
Burchard #1	3/12/2014	19.78	0.13	3	0.04
	6/23/2014	20.2			
	1/5/2015	21.09			
	2/10/2016	19.65			
Burchard #2	1/5/2015	16.85			
	2/10/2016	16.08			
Bennefield #3	6/27/2014	20.05	3.75	3	1.25
	1/5/2015	18.91			
	2/11/2016	16.3			
H. Brown #1	6/9/2015	36.88			
	2/10/2016	32.11			
H. Brown #2	6/9/2015	32.74			
	2/10/2016	31.3			
H. Brown #3	6/9/2015	33.04			
	2/10/2016	36.69			
Durrett #1	6/16/2015	90.57			
	2/11/2016	83.99			
Durrett #2	6/16/2015	41.39			

	2/11/2016	43.2			
Durrett #3	6/16/2015	33.52			
	2/11/2016	31.46			
Durrett #4	6/16/2015	28.39			
	2/11/2016	23.02			
Durrett #5	6/16/2015	52.44			
	2/11/2016	47.86			
Durrett #6	6/16/2015	49.76			
	2/11/2016	50.05			
Durrett #7	6/16/2015	36.21			
	2/11/2016	33.89			