

**THE STATE CORPORATION COMMISSION  
OF THE STATE OF KANSAS**

Before Commissioners: Pat Apple, Chairman  
Shari Feist Albrecht  
Jay Scott Emler

In the Matter of an Order Reducing Saltwater ) Docket No.: 15-CONS-770-CMSC  
Injection Rates into the Arbuckle Formation, )  
Applicable to Wells in Defined Areas of ) CONSERVATION DIVISION  
Increased Seismic Activity in Harper and )  
Sumner Counties. )

**COMMISSION STAFF'S REPORT AND RECOMMENDATION**

The Commission's August 9, 2016, Order in this docket directed Staff to continue monitoring seismic activity and to document its finding in a report and recommendation due on or before April 1, 2017. Staff hereby complies with that request via the attached document.

Respectfully submitted,

  
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**REPORT AND RECOMMENDATION  
CONSERVATION DIVISION**

**To:** Chairman Pat Apple  
Commissioner Shari Feist Albrecht  
Commissioner Jay Scott Emler

**From:** Ryan A. Hoffman, Director, Conservation Division

**Date:** 3/31/17

**Re:** Staff Recommendation Docket No. 15-CONS-770-CMSC

**SUBJECT:**

15-CONS-770-CMSC: In the Matter of an Order Reducing Saltwater Injection Rates into the Arbuckle Formation, Applicable to Wells in Defined Areas of Increased Seismic Activity in Harper and Sumner Counties.

**EXECUTIVE SUMMARY:**

Staff recommends continuing the injection limitations currently implemented for both the 2015 and 2016 Specified Areas. Staff further recommends maintaining the minimum ¼ mile spacing for all new large volume Arbuckle injection wells in the 2015 and 2016 Specified Areas. Staff requests more time to research whether wells in closer proximity than ¼ mile should be treated as a single wellbore for purposes of limiting daily maximum injection rates.

**BACKGROUND:**

On March 10, 2015, the Commission issued the original Order in this docket: 1) establishing maximum injection volume limitations for large volume Arbuckle injection wells in Harper and Sumner Counties; 2) initializing a monthly procedure for reporting daily injection volumes; 3) verifying the true vertical depth of certain wells; 4) defining the class of large volume Arbuckle injection wells; and 4) instituting a ¼ mile spacing requirement for all new large volume Arbuckle injection wells. The Commission ordered Staff to make a report and recommendation 180 days after issuance of the original Order.

The Commission extended the provisions of the original Order on October 29, 2015, and ordered Staff to again report back after 180 days.

On August 9, 2016, the Commission issued its Second Order Reducing Saltwater Injection Rates, establishing the 2016 Specified Area, covering parts of Barber, Harper, Sumner, Kingman, and Sedgwick Counties. All large volume Arbuckle injection wells within this new area were assigned a maximum daily injection limitation of 16,000 barrels per well per day and were subject to the monthly reporting of daily injection information. The maximum injection limitation in the areas of Harper and Sumner County not included in the 2016 Specified Area remained at 25,000 barrels per well per day. The wells inside of the 2015 Areas of Seismic Concern were still subject to a 8,000 barrels per well per day injection limitation. The

Commission ordered Staff to continue monitoring seismic activity in the 2016 Specified Area, and to the extent possible, outside of the area. The Commission directed Staff to specifically address the issue of large volume Arbuckle injection wells located less than ¼ mile from other large volume Arbuckle injection wells, and ascertain whether those wells should be treated as a single wellbore for the purpose of assigning a maximum daily injection limitation.

**ANALYSIS:**

K.S.A. 2014 Supp. 77-536(a) gives the agency the authority to act when there is “an immediate danger to the public health, safety or welfare requiring immediate state agency action” or “as otherwise provided by law.”

K.S.A. 55-162(b) gives the Commission the authority to issue orders “[i]f it appears to the commission that damage may result if immediate remedial action is not taken.”

Paragraph E of the original Order and Paragraphs 31 and H of the Second Order Reducing Saltwater Injection Rates provide the Commission with the authority to enter additional Orders in this docket as deemed appropriate.

**STAFF’S ANALYSIS:**

For the purpose of this recommendation, Staff has separated the available data into four approximately six-month long timeframes and will discuss each area or well type separately. These timeframes are:

- March 1, 2015 through August 31, 2015;
- September 1, 2015 through February 29, 2016;
- March 1, 2016 through August 31, 2016; and
- September 1, 2016 through February 28, 2017.

2016 Specified Area: Staff has compiled the available seismic data provided by the Kansas Geological Survey and the volume data provided by the operators for the 2016 Specified Area summarized in Table 1 below.

<b>Table 1: 2016 Specified Area Volumes and Earthquakes</b>		
<b>Timeframe</b>	<b>Volume (barrels)</b>	<b>Earthquakes</b>
March 2015 through August 2015	56,744,031	1,967
September 2015 through February 2016	49,792,036	2,263
March 2016 through August 2016	46,604,867	1,438
September 2016 through February 2017	40,292,032	668

As demonstrated by the Table 1 above, injection activity within the 2016 Specified Area has decreased from over 56 million barrels during the first six-month timeframe to approximately 42 million barrels. After seeing an initial spike in earthquake activity, the number of earthquakes has decreased from 1,967 during the first six-month timeframe to 668 during the most recent six-month timeframe. This data is also displayed on the maps attached as Exhibits A1 through A4.

Staff would note there are several areas on the periphery of the 2016 Specified Area where seismicity is increasing, but there do not appear to be corresponding injection or disposal trends.

2015 Areas of Seismic Concern: Staff has also compiled the available seismic data as it pertains to the 2015 Areas of Seismic Concern, as summarized in Table 2 below.

<b>Table 2: 2015 Areas of Seismic Concern Volumes and Earthquakes</b>				
<b>Timeframe</b>	<b>Volume (barrels)</b>	<b>Earthquakes</b>	<b>M 2.5-2.9</b>	<b>M 3.0+</b>
March 2015 through August 2015	16,610,546	1,177	41	6
September 2015 through February 2016	11,765,864	936	15	4
March 2016 through August 2016	12,502,959	588	12	0
September 2016 through February 2017	10,886,874	211	12	1

\*M = magnitude

As demonstrated by the Table 2, there has been a decrease in the volume of fluid being injected and the number of earthquakes occurring within the 2015 Areas of Seismic Concern. Staff would note the percentage of overall earthquakes occurring in the 2016 Specified Area occurring within the 2015 Areas of Seismic Concern decreased from 60% to 32%. Also of importance, both the number of earthquakes and the magnitude of the earthquakes are decreasing. When comparing the timeframes, the reduction of potentially-felt earthquakes within the Areas of Seismic Concern is noticeable. There were ten magnitude 3.0 or larger earthquakes from March 2015 to February 2016 within the 2015 Areas of Seismic Concern; however, from March 2016 through February 2017, there was only one magnitude 3.0 or larger earthquake. During these same timeframes, the number of magnitude 2.5-2.9 earthquakes reduced from 56 to 24.

Large Volume Arbuckle Injection (LVAI) wells nearer than ¼ mile to another LVAI:

Staff identified four sets of “twin” LVAI wells, i.e. LVAI wells nearer than ¼ mile to each other. The distance between the twin wells in each set was 67 feet, 100 feet, 146 feet, and 152 feet, respectively. The wells are identified on Exhibit B. Staff has compiled the relevant volumes and earthquake data within a six-mile radius of each set. It is important to note that only three sets are within the 2015 Areas of Seismic Concern. One set is to the southwest, near the Oklahoma border. Table 3 below demonstrates the trend of an overall decrease in both injection volumes and earthquakes within a six-mile radius of the three sets of twin LVAI wells within the 2015 Areas of Seismic Concern. Table 4 below provides more detail regarding the four sets of twin LVAI wells. It shows: the percentage of total fluid injected in the 2015 Areas of Seismic Concern by the three sets of twin LVAI, the percentage of total fluid injected in the 2016 Specified Area that are attributable to all four sets of twin LVAI wells, the percentage of earthquakes in the 2015 Areas of Seismic Concern that occurred within a six-mile radius of the three sets of twin LVAI, and the percentage of earthquakes that occurred in the 2016 Specified Area that occurred within a six-mile radius of the four sets of twin LVAI wells.



<b>Table 3: Large Volume Injection Wells Nearer than ¼ Mile but within 2015 Areas of Seismic Concern</b>		
<b>Timeframe</b>	<b>Volume (barrels)</b>	<b>Earthquakes</b>
March 2015 thru August 2015	9,941,888	800
September 2015 thru February 2016	5,907,527	668
March 2016 thru August 2016	7,413,630	275
September 2016 thru February 2017	6,937,935	123

<b>Table 4: Less Than ¼ Mile LVAI Percentage of Total Volume and Earthquakes</b>				
<b>Timeframe</b>	<b>Volume</b>		<b>Earthquakes</b>	
	<b>% of 2016 Specified Area</b>	<b>% of 2015 ASC</b>	<b>% of 2016 Specified Area</b>	<b>% of 2015 ASC</b>
March 2015 through August 2015	19%	60%	42%	68%
September 2015 through February 2016	14%	50%	30%	71%
March 2016 through August 2016	17%	59%	20%	47%
September 2016 through February 2017	19%	64%	20%	58%

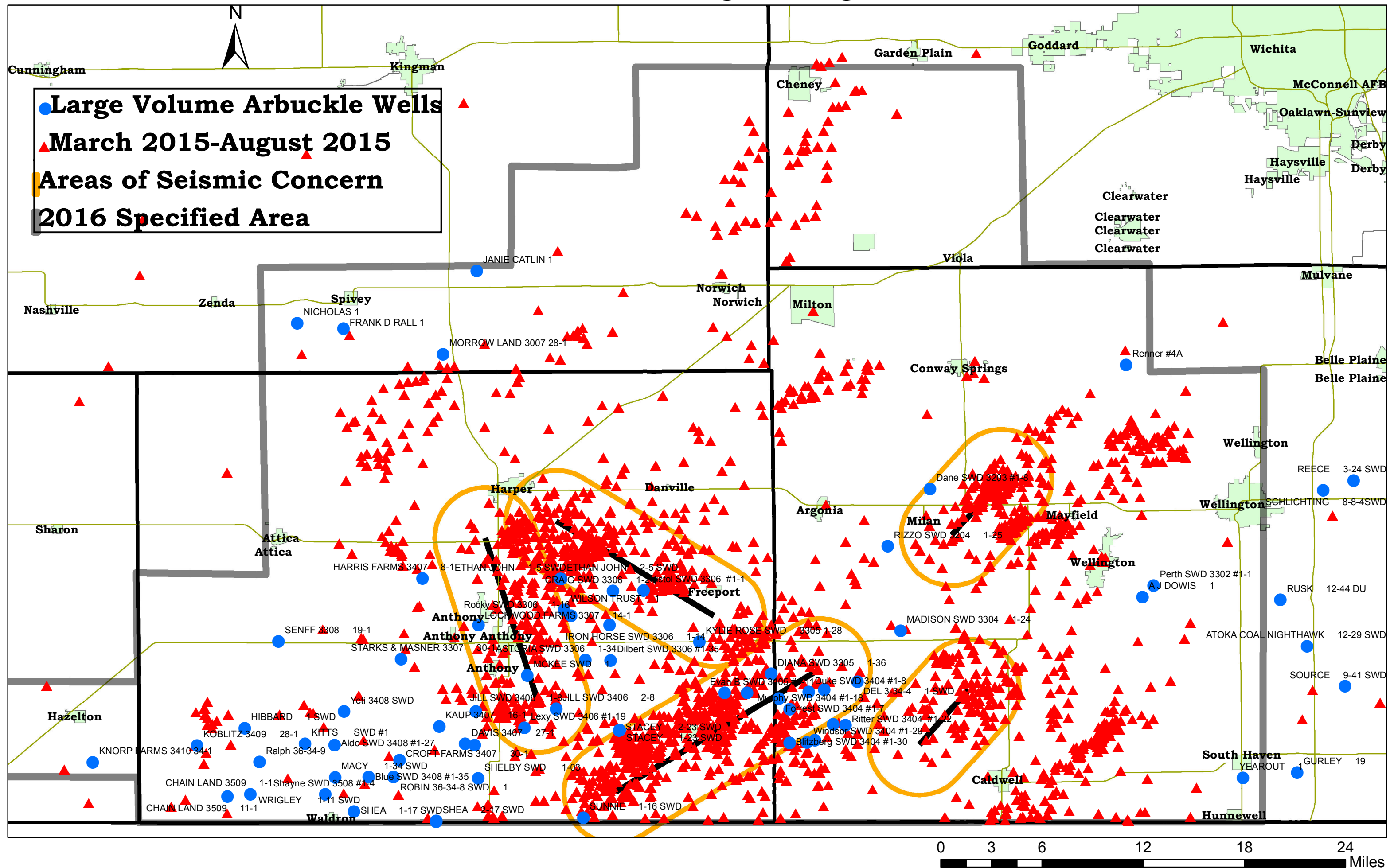
\*ASC means Areas of Seismic Concern

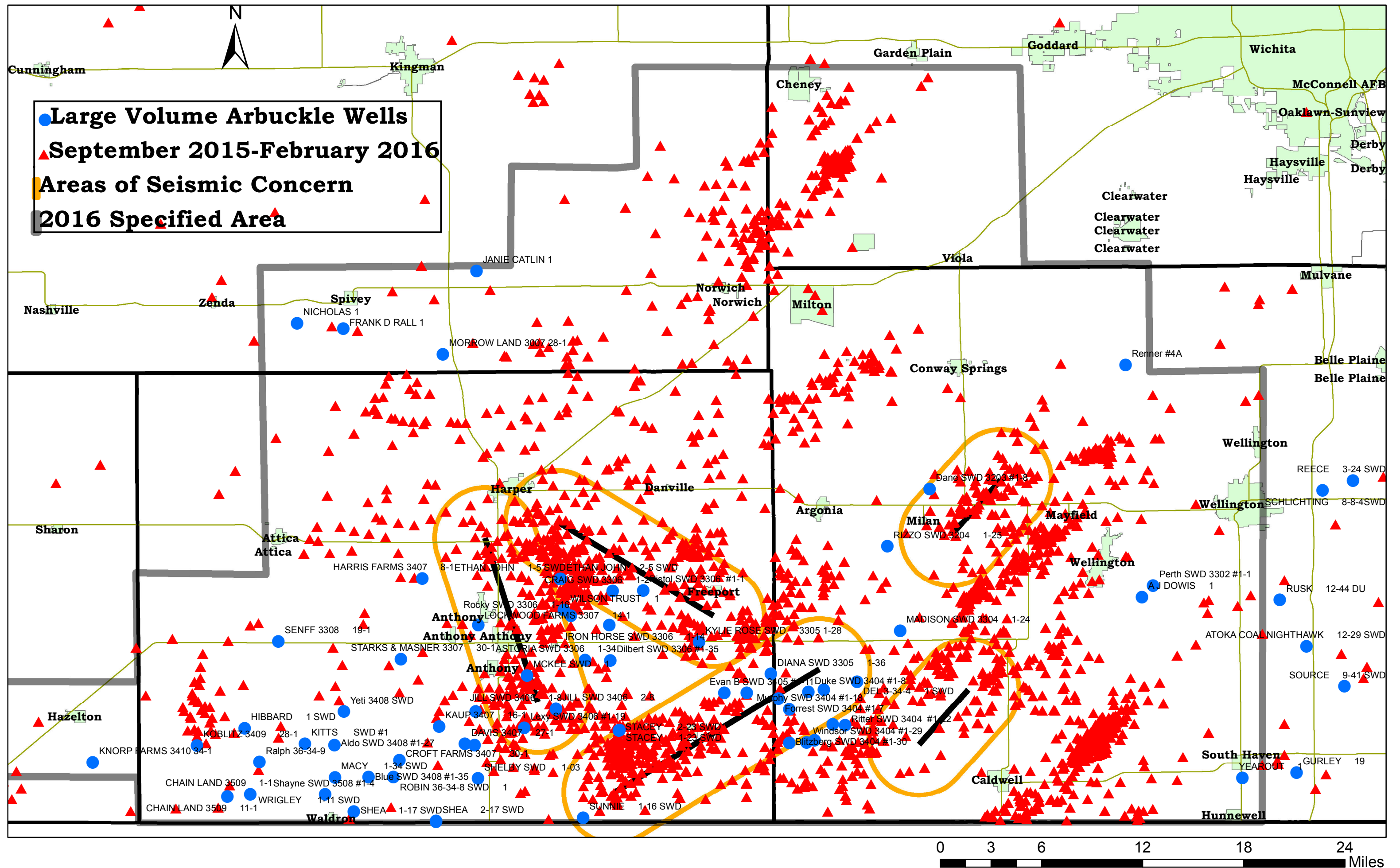
Based on this data, Staff believes there appears to be a correlation between increased seismicity and the injection activities of large volume Arbuckle injection wells in close proximity to each other. The overall percentage of total earthquakes occurring within a six-mile radius of these twin wells compared to the 2016 Specified area has decreased from 42% to 20%; however, the percentage of total earthquakes within the 2015 Areas of Seismic Concern has only decreased from 68% to 58% from the six wells within the 2015 Areas of Seismic Concern.

The decreasing trend in earthquakes within the 2015 Areas of Seismic Concern in proximity to the LVAI wells located nearer than ¼ mile is less pronounced and therefore is concerning to staff. Staff believes the data above could support a decision to treat the twin wells as one well for the purposes of establishing maximum daily injection limits; however, there is not enough data to establish what the appropriate spacing should be for large volume injection wells as requested by the Commission. Further, Staff notes the frequency and intensity of the earthquakes continues to decline. Given this trend, Staff does not believe there is an immediate need to take further action regarding these twin wells.

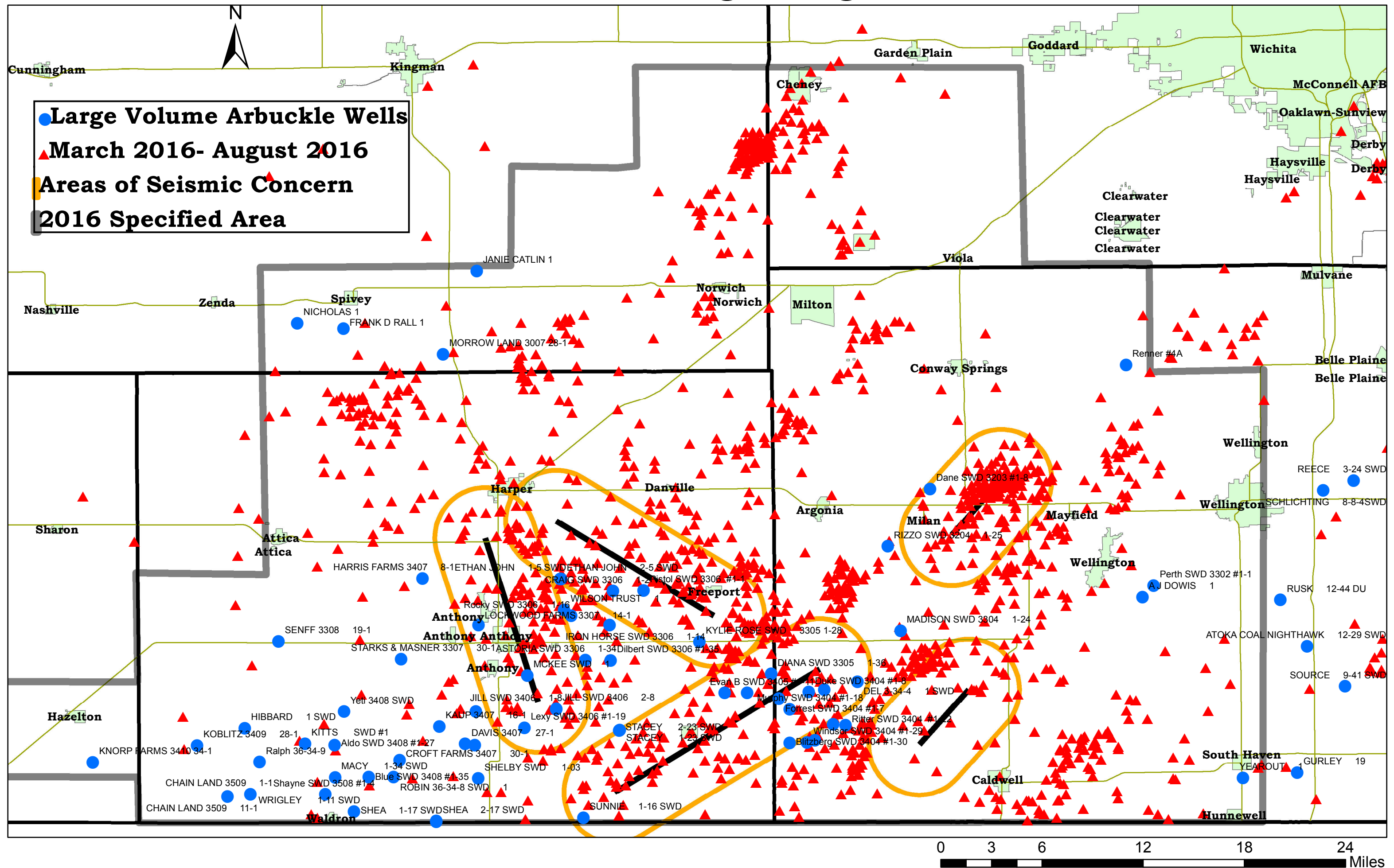
### **RECOMMENDATION:**

- 1) All of the current volume limitations should remain in effect for large volume Arbuckle injection wells, both the 8,000 daily limit per well inside the 2015 Areas of Seismic Concern and the 16,000 daily limitation per well in the 2016 Specified Area.
- 2) The provisions for monthly reporting of daily data should remain in effect for all large volume Arbuckle injection well in Harper and Sumner County and the 2016 Specified Area.
- 3) Staff should continue to monitor seismic activity in conjunction with KGS and KDHE and make any further recommendations as they arise.
- 4) Staff should further evaluate the evidence to determine what proper spacing should be for Large Volume Arbuckle Injection wells.
- 5) Staff recommends keeping the current boundaries of the 2016 Specified Areas, but Staff should monitor the peripheral areas with increasing seismicity trends to determine if any future expansion of the boundaries is necessary.

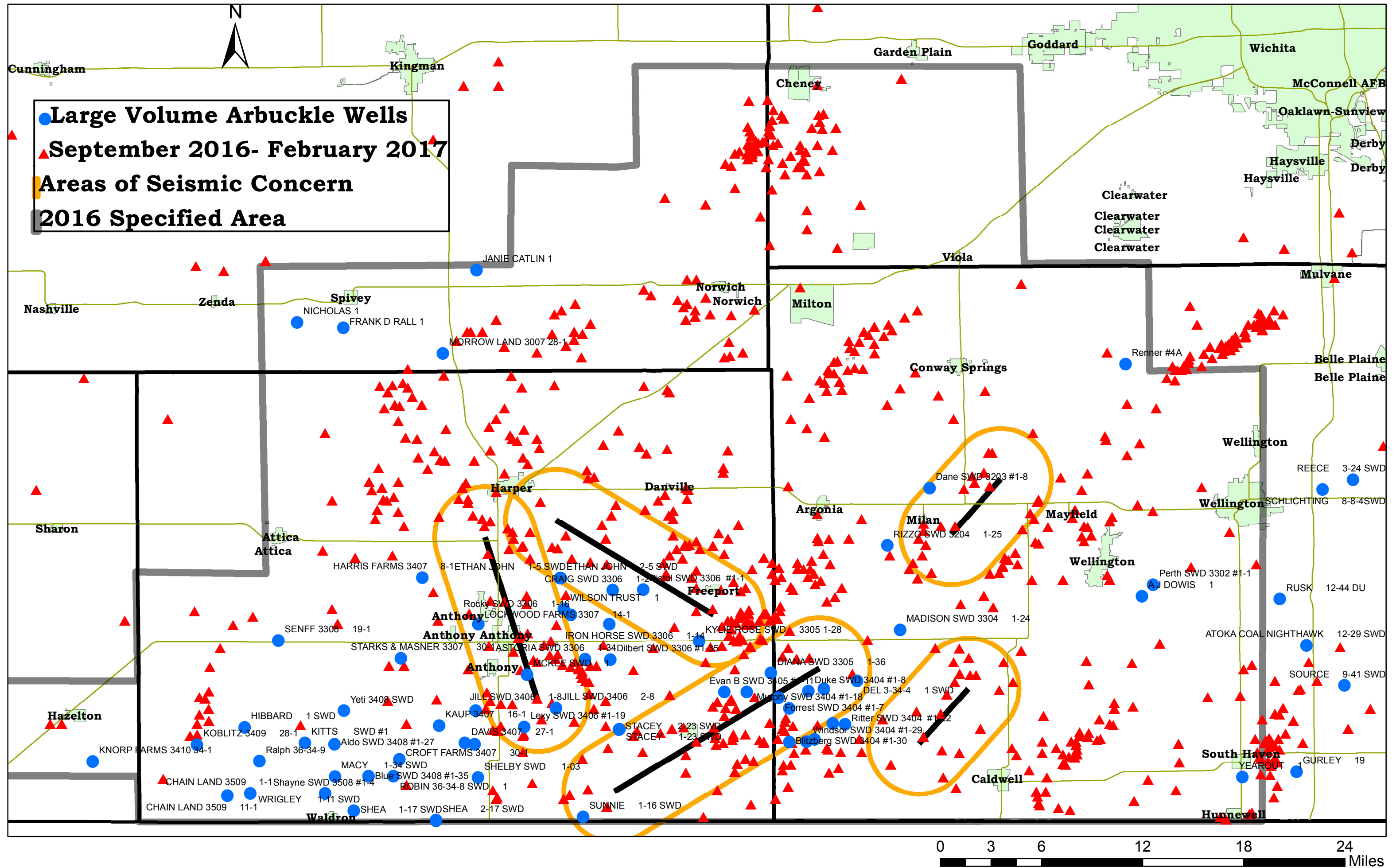












## Less Than 1/4 Mile Arbuckle Injection Wells

Well Name	Sec	Twp	Rng	Operator	WH_LAT	WH_LONG	Distance (feet)
ETHAN JOHN 1-5 SWD	5	33	6	SandRidge Exploration and Production LLC	37.207183	-97.985532	
ETHAN JOHN 2-5 SWD	5	33	6	SandRidge Exploration and Production LLC	37.207185	-97.986047	152
JILL SWD 3406 1-8	8	34	6	SandRidge Exploration and Production LLC	37.095334	-97.989562	
JILL SWD 3406 2-8	8	34	6	SandRidge Exploration and Production LLC	37.095746	-97.989558	146
STACEY 1-23 SWD	23	34	6	SandRidge Exploration and Production LLC	37.077425	-97.934962	
STACEY 2-23 SWD	23	34	6	SandRidge Exploration and Production LLC	37.069282	-97.942587	67
SHEA 1-17 SWD	17	35	7	SandRidge Exploration and Production LLC	36.998828	-98.092543	
SHEA 2-17 SWD	17	35	7	SandRidge Exploration and Production LLC	36.999172	-98.092547	100

## **CERTIFICATE OF SERVICE**

I certify that on March 31, 2017, I caused a complete and accurate copy of Commission Staff's Report and Recommendation to be served via United States mail, with the postage prepaid and properly addressed to the following:

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