

Understanding the SWD Market in the Bakken Shale Play, North Dakota

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Abstract

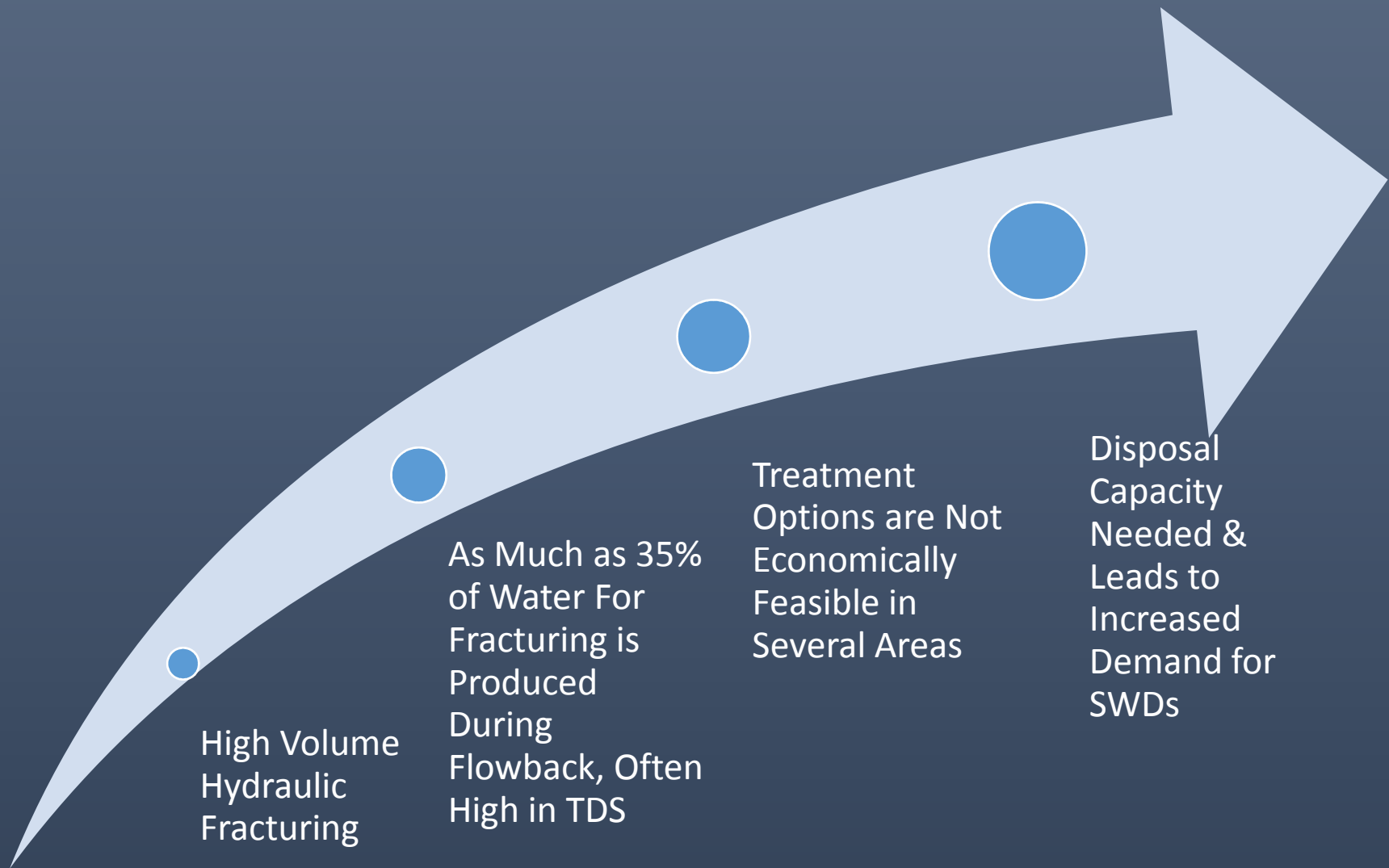
Development of the Bakken shale in North Dakota has been rapidly increasing since 2004, and challenges associated with disposing of the increasing volume of produced water has also increased. Typically, Bakken shale wells are hydraulically fractured, with water volumes ranging from 1,000,000 to 10,000,000 gallons of water per well. As much as 35 % of that volume of water is brought to the surface as produced water, and this highly saline produced water must be properly disposed. As a result, the need for Class II Salt Water Disposal (SWD) wells has become a critical link in the success of shale development in the Bakken. Challenges associated with the siting of new SWDs in North Dakota include locating the wells where high produced water volumes are being, or will be, produced, where they are accessible from a main transportation thoroughway, and where they are far enough away from competing SWD wells to prevent communication. This paper presents the current status of the SWD market and potential market opportunities for additional Class II SWDs in North Dakota.

Agenda

- Introduction
- Bakken Development
- Water Use
- Water Disposal
- Current SWD Market in ND
- Permitting SWD wells in ND



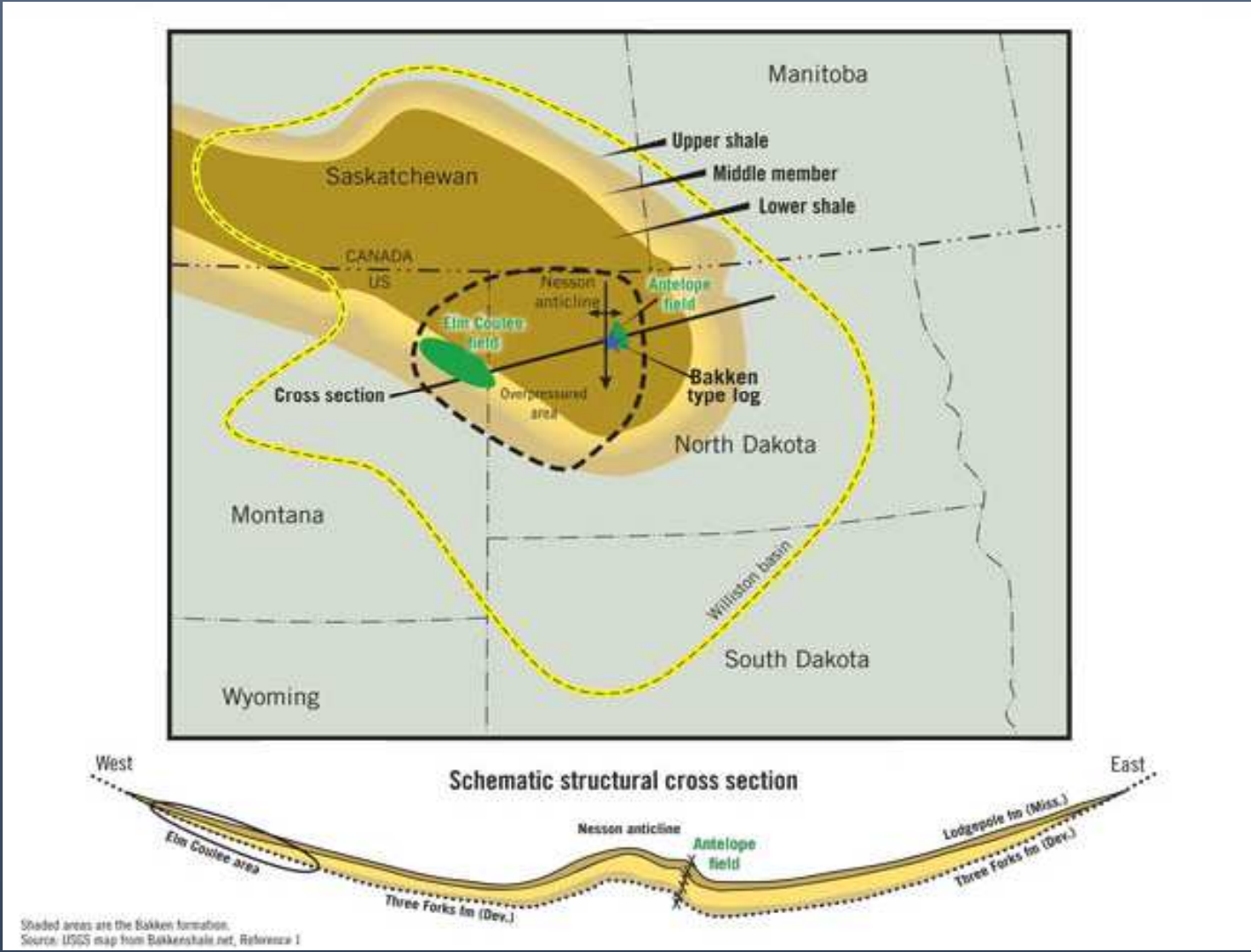
Introduction



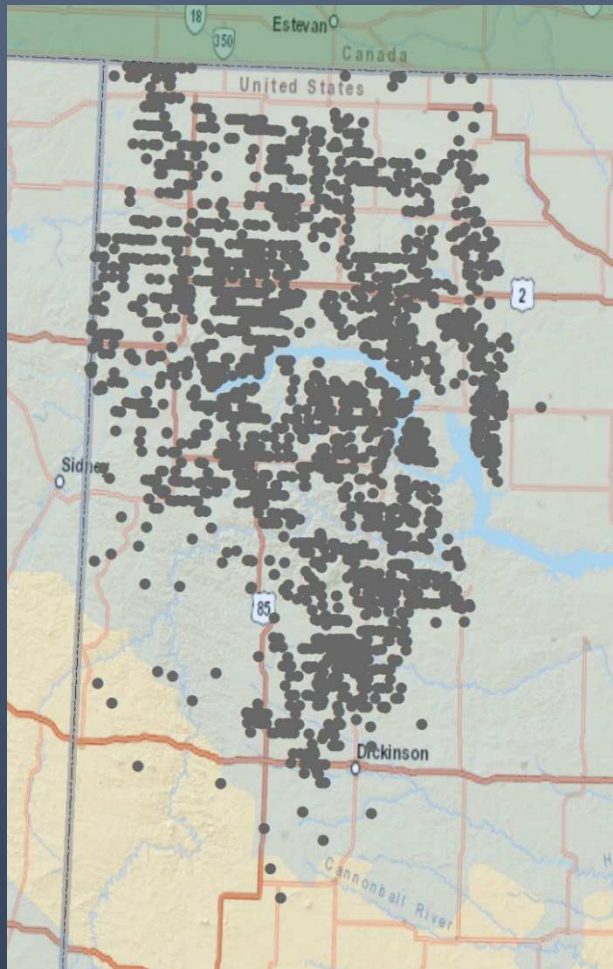
Bakken Development at a Glance

- Oil first produced from the Bakken shale in 1955
- Bakken development increased in 2004, with the implementation of horizontal drilling and hydraulic fracturing technology
- A 2013 Assessment of Undiscovered Oil Resources by the USGS estimated mean undiscovered volumes of 7.4 billion barrels of recoverable oil, 6.7 trillion cubic feet of gas, and 0.53 billion barrels of NGLs in the Bakken and Three Forks formation in Williston Basin
- Older Bakken wells are seeing an increase in water cut (more produced water) as the wells are depleted
- Newly drilled Bakken wells have a higher water cut as development moves into areas of lower oil saturation

Bakken Play

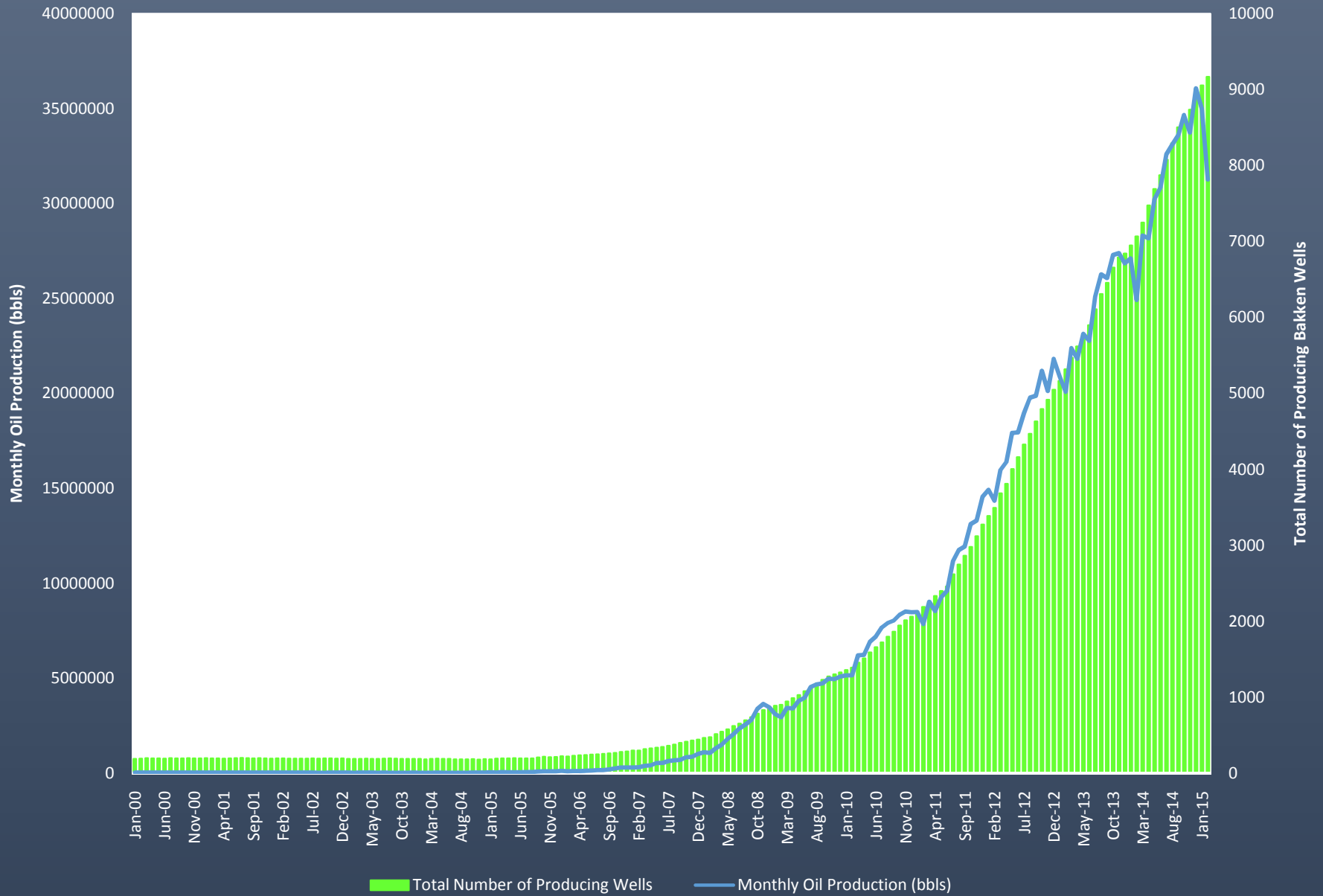


Bakken Development



- Over 2,100 Bakken wells were drilled in 2014
- As of February 2015, 9,166 wells were producing from the Bakken formation in ND
- New wells being drilled has decreased with declining oil prices but will continue
- It will take decades to fully develop the Bakken
- Roads, gathering, transportation, housing and water supply & disposal facilities are hard pressed to keep up with demand

BAKKEN MONTHLY OIL PRODUCTION (BBLs)

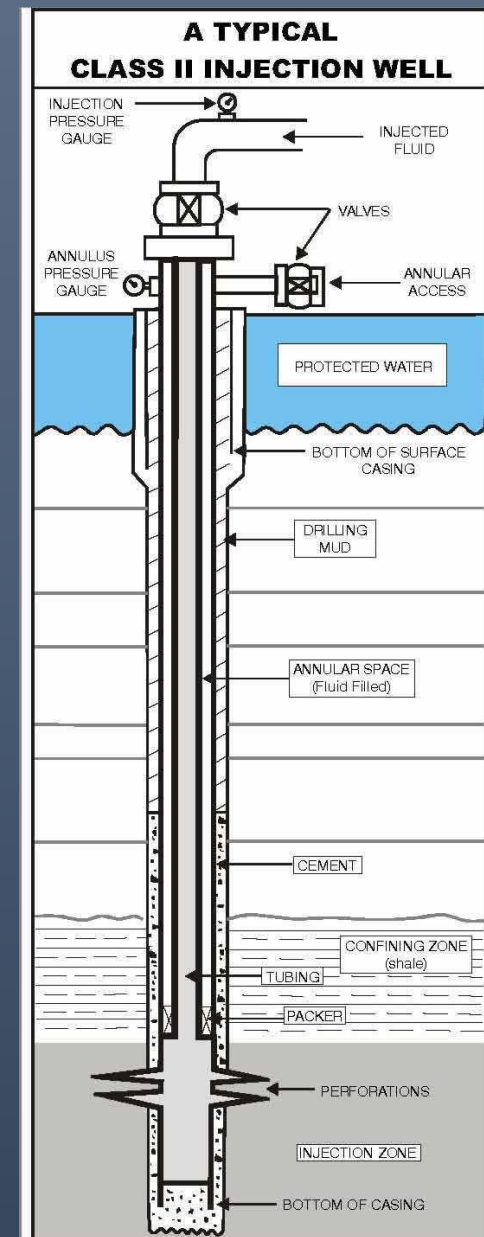


Bakken Water Use in Frac Jobs

- Average total water volume for hydraulic fracturing in the Bakken is 2,837,350 gallons per well
- Produced water TDS concentration ranges from 20,000 – 200,000 mg/L
- Percent of Fracture Fluid Volume Typically Recovered During Flowback ranges from 5% to 35%

Water Disposal

- Wastewater can be categorized
 - Miscellaneous wastewater from drilling operations
 - Water produced during flowback operations
 - Produced water
 - Concentrate from treatment operations
 - Other Miscellaneous (from completion, operations)
- Disposal Options
 - Private Class II SWDs
 - Commercial Class II SWDs
 - Reuse/recycling for drilling/completion activities



Current SWD Market in ND

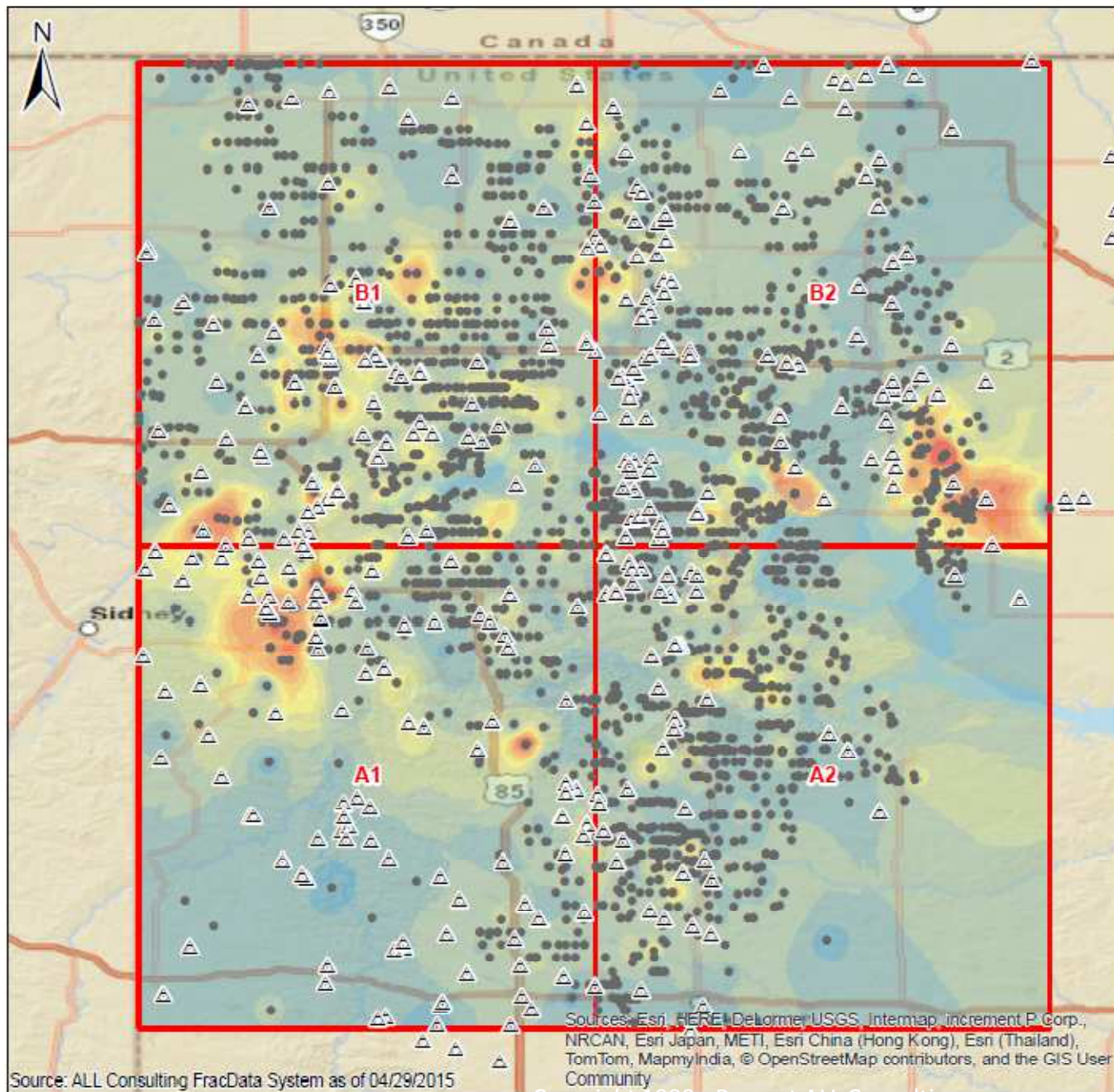
- There are currently 430 Active SWD wells in North Dakota
- There are currently 133 Commercial SWD wells in North Dakota
- There are currently 10 Approved SWD wells that have not been drilled
- There are currently 16 SWDs that have Confidential Status
- There are currently 25 Permits Pending Approval

SWD Capacity Considerations

- As development activities progressed, commercial SWD capacity has been an issue.
- Permitting and development of new SWDs has occurred at a rapid pace.
- The need for additional SWDs will arise as new wells are drilled and older wells see increased water production.

Commercial Disposal

- 133 Commercial Disposal Wells
- Total permitted Capacity of 939,275 barrels per day (28,553,960 barrels per month)
- 14,825,216 barrels of water disposed of in commercial SWD wells in March 2015
- Current disposal in commercial SWD wells is at 52% of permitted capacity



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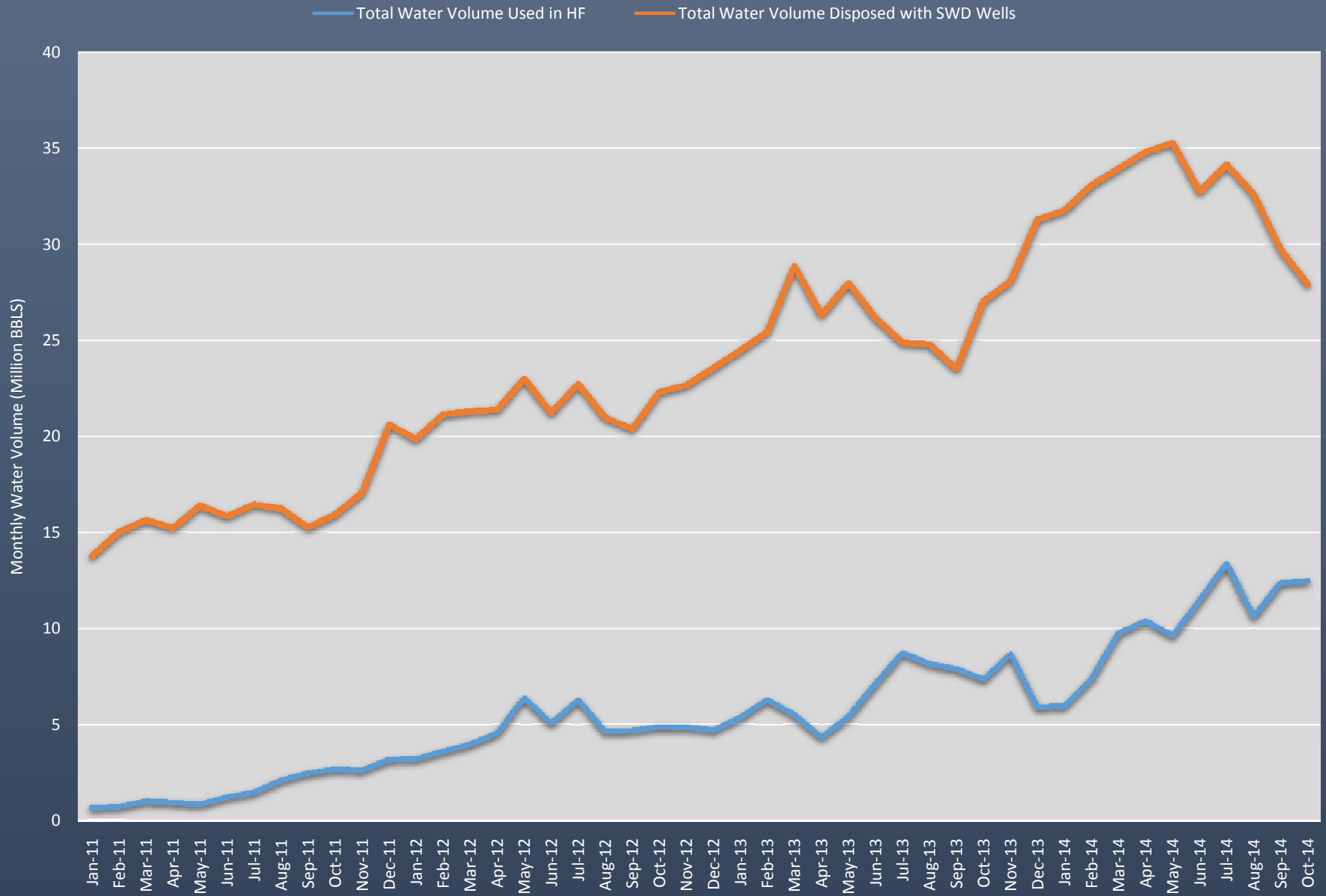
- △ Active SWD Well
- FracFocus Well

Area Water Use for Fracking

- < 1,000,000 gal
- 1M - 2M gal
- 2M - 3M gal
- 3M - 4M gal
- 4M - 5M gal
- 5M - 6M gal
- 6M - 7M gal
- 7M - 8M gal
- 8M - 9M gal
- 9M - 10M gal
- > 10,000,000 gal



Total Monthly Water Volme Used in HF



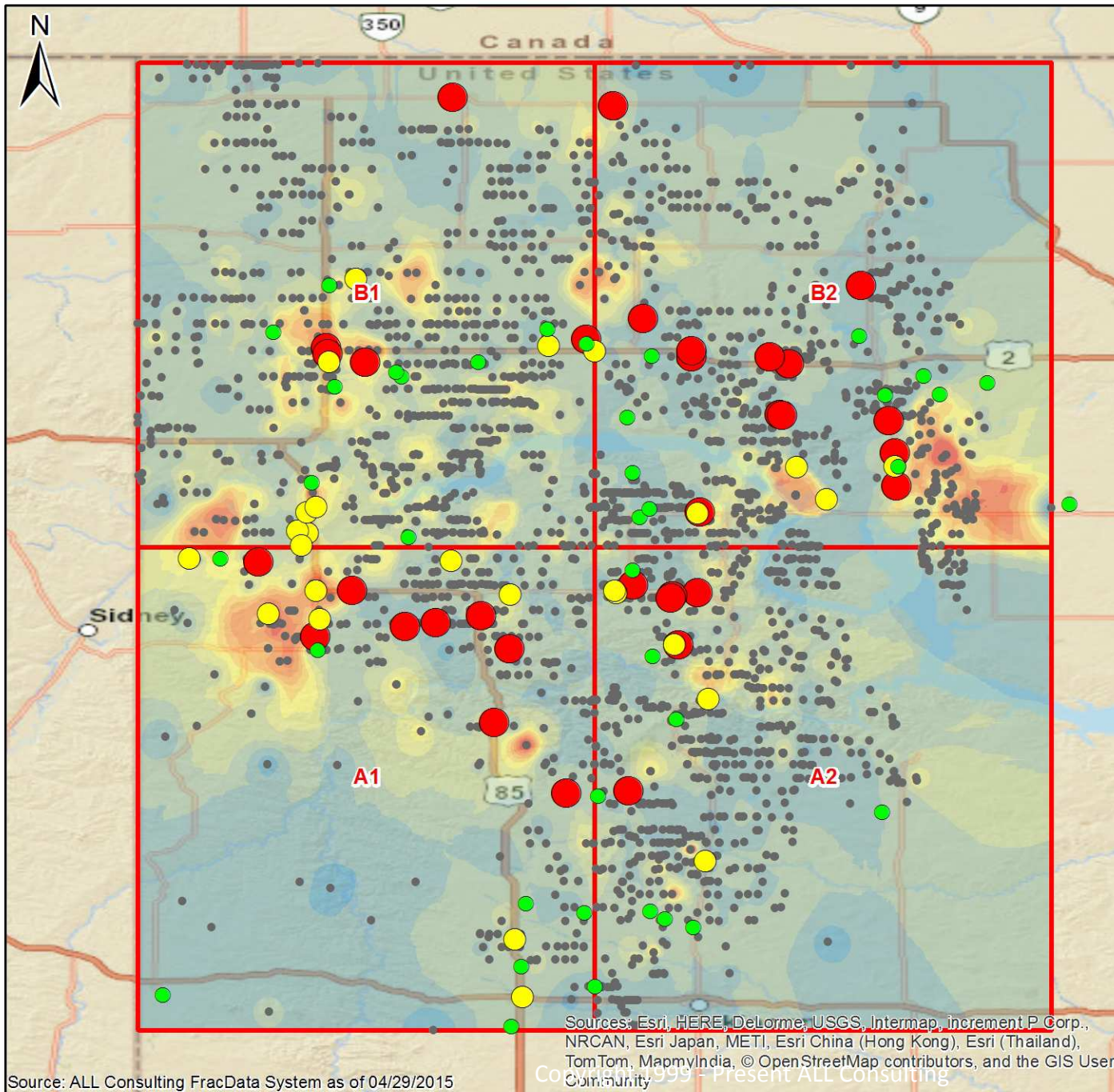
Well Siting Considerations

- Identify geologic formations with adequate disposal capacity.
- Evaluate structural geology of the area for potential faulting.
- Avoid locations where disposal will “water out” surrounding production and clustering that leads to well interference and reduced injection capacity.
- Avoid residential areas if at all possible.
- Locate well in areas with high water production.
- Locate well in areas with adequate road network.



Pre-construction planning with multiple disciplines is essential.

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Legend

● FracFocus Wells

Commercial SWD Wells

Permitted Disposal Volume
(bbls / mo.)

● 800 - 5,000

● 5,001 - 10,000

● 10,001 - 25,000

Area Water Use for Fracking

■ < 1,000,000 gal

■ 1M - 2M gal

■ 2M - 3M gal

■ 3M - 4M gal

■ 4M - 5M gal

■ 5M - 6M gal

■ 6M - 7M gal

■ 7M - 8M gal

■ 8M - 9M gal

■ 9M - 10M gal

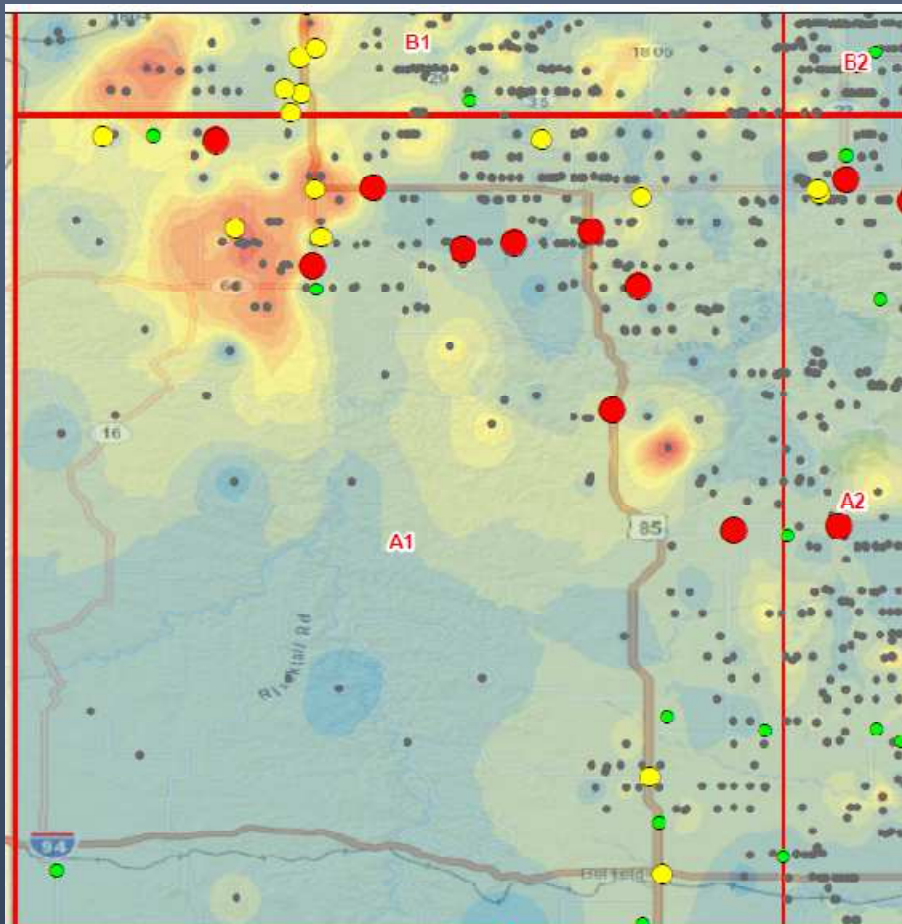
■ > 10,000,000 gal

0 10 20 40



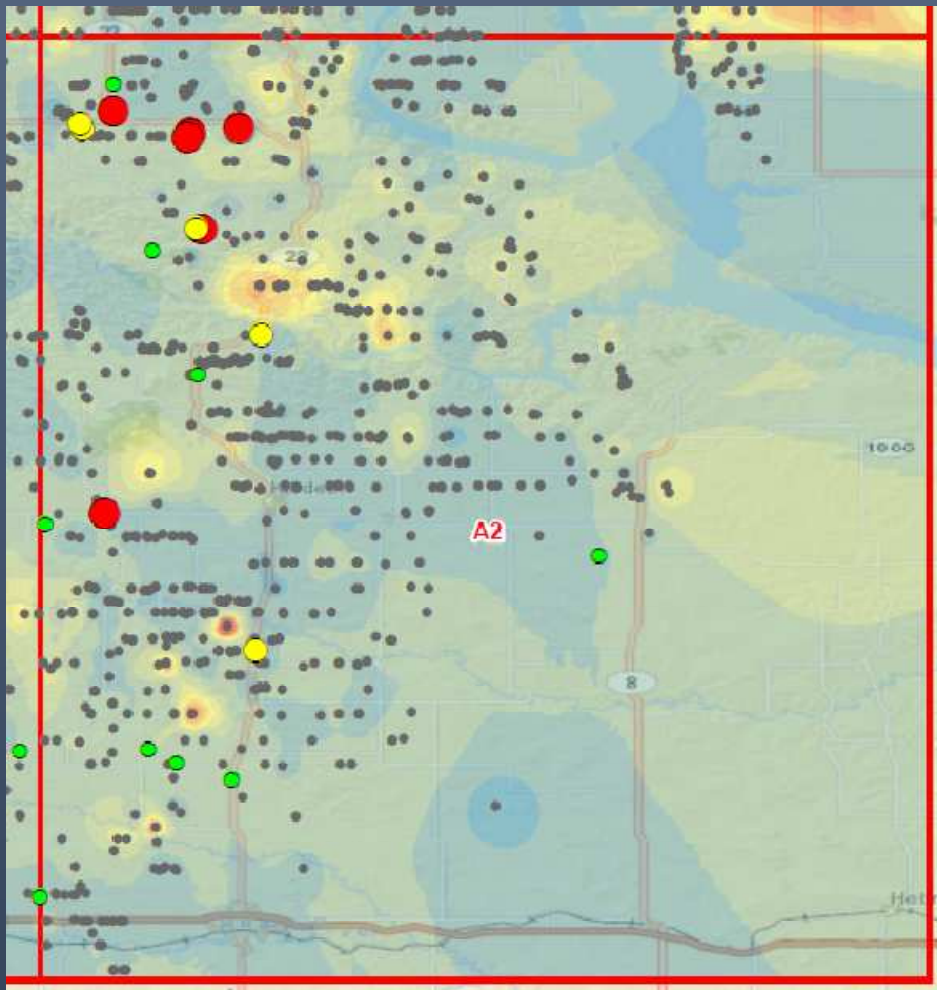
Miles

Quadrant A1



- 27 Commercial SWD wells operated by 19 different operators
- 225,000 bpd disposal capacity
- 454 Producing Bakken Wells
- Opportunities for additional SWD wells in NW portion of Quadrant (High water production)

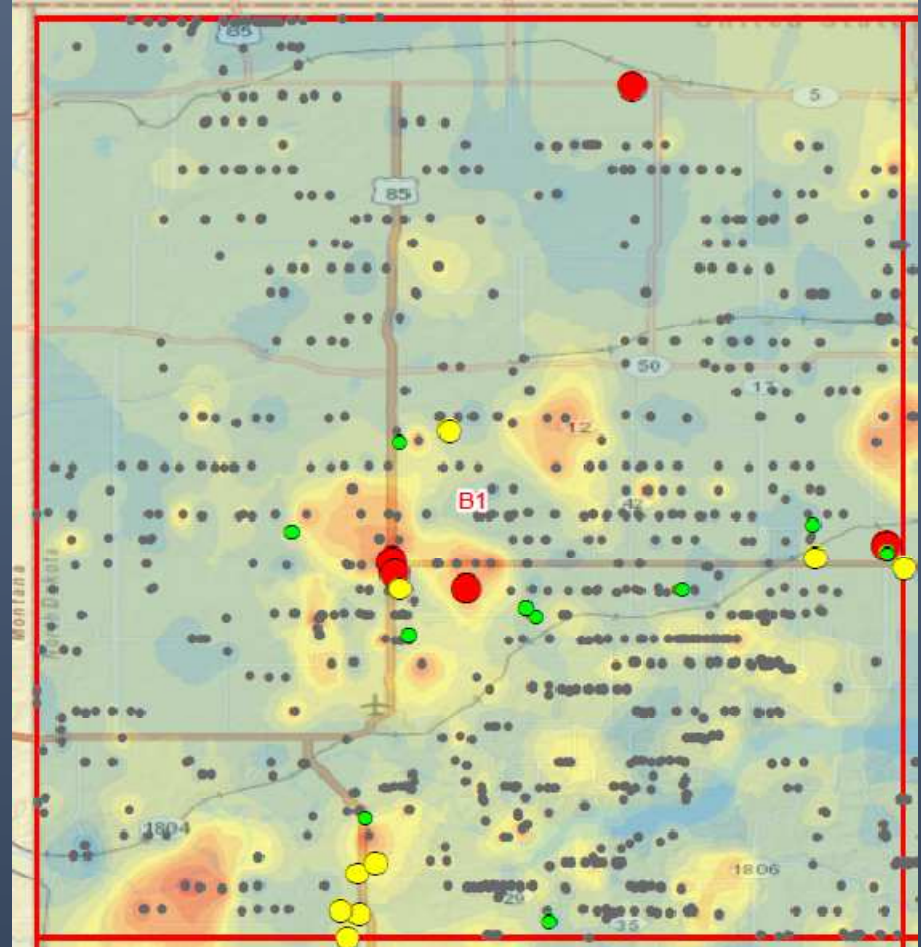
Quadrant A2



- 21 Commercial SWD wells operated by 14 different operators
- 161,725 bpd disposal capacity
- 1,049 Producing Bakken Wells
- Opportunities for additional SWD wells in eastern portion of quadrant (Low ratio of disposal wells to producing wells)

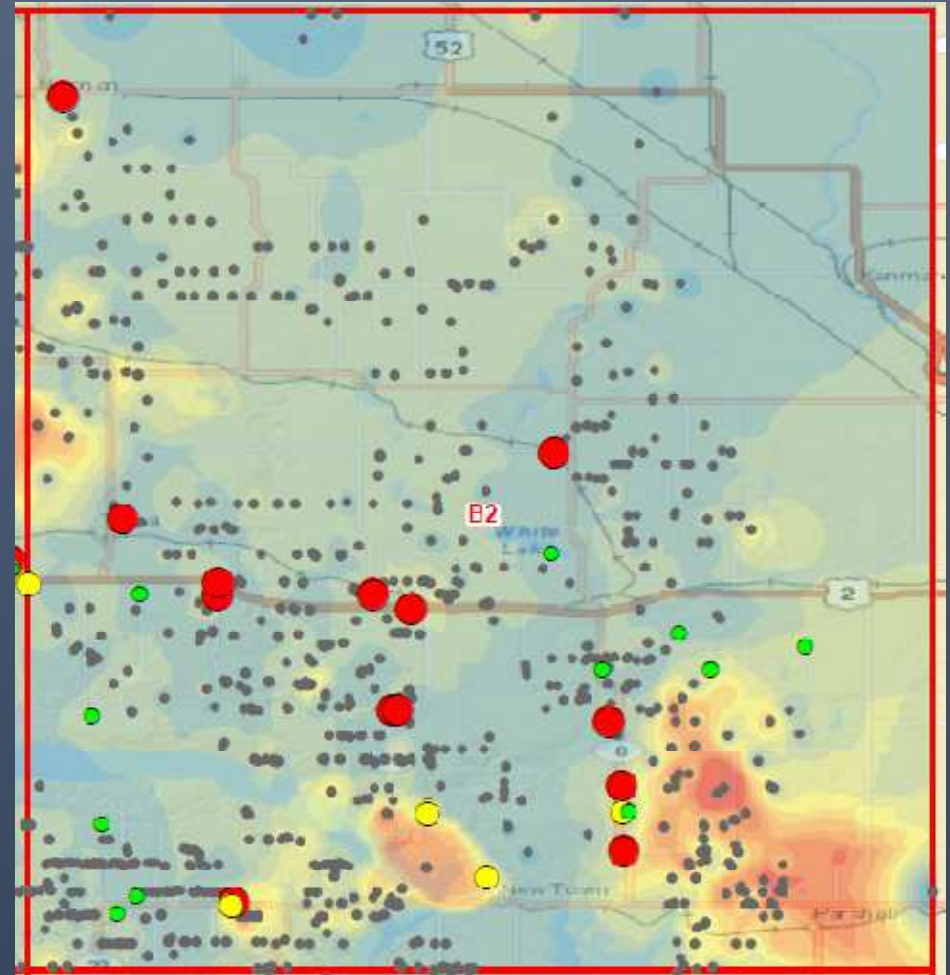
Quadrant B1

- 26 Commercial SWD wells operated by 16 different operators
- 163,500 bpd disposal capacity
- 1,259 Producing Bakken Wells
- Opportunities for additional SWD wells in northern portion of quadrant along Highway 85 and Highway 50 (High water production areas and low ratio of disposal wells to producing wells)



Quadrant B2

- 34 Commercial SWD wells operated by 16 different operators
- 266,550 bpd disposal capacity
- 1,367 Producing Bakken Wells
- Opportunities for additional SWD wells SE portion of quadrant (High water volumes) and in the North half of quadrant (Low ratio of disposal wells to producing wells)



Permitting SWD in North Dakota

- 75 wells were drilled or converted to SWD and began disposing water in 2012, 40 wells in 2013, and 18 wells in 2014
- Current backlog of approximately 25 SWD applications
- Permitting process for SWD takes approximately 3-4 Months
 - 1 Month for notification period
 - 2-3 months for docketing

Summary

- Well planned and properly constructed Class II disposal wells will continue to be the best practice for managing flowback and produced water in the Bakken shale
- The rate of development in the Bakken shale has created extremely high activity with waste handling and management, including the need for many new Class II disposal wells
- Disposal demands vary throughout the state, with some areas having plentiful disposal capacity while others are limited

Questions?

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(ODNR 1993)

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