Energy & Environmental Research Center (EERC)

Update on the Produced Water Assessment Report and GHCR Project

OGRC Meeting

December 16, 2020

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Outline

- Summary of produced water assessment report results.
- Introduction to GHCR approach.
- Progress update on “Produced Water Management Through Geologic Homogenization Conditioning and Reuse (GHCR)” project (G-051-101)
- Concluding remarks and next steps.

Key Project Elements and Complementary Projects

1. Legislative mandate (Sec 19, ND House Bill 1014) to conduct a study on recycling of water used in oil & gas operations. Includes a compilation of data on methods of and considerations for regulatory, scientific, technological, and feasibility considerations associated with produced water management.
2. Leveraged DOE Fossil Energy—Oil & Gas Program co-funding to provide a proof of concept of a novel approach – Geologic Homogenization Conditioning and Reuse (GHCR) – to recycling by using a geologic formation as a natural medium to homogenize and condition produced water for reuse as makeup water for hydraulic fracturing operations.

NDIC OGRP: $300,000

U.S. Department of Energy (DOE): $1,000,000

Complemented by:

BEST (DOE-funded): $21 million overall, $17 million (DOE share)

Schlumberger: $2.8 million, CMG: $1.4 million

Objectives and Deliverables

- Evaluate produced water management methods, trends, and costs.
- Evaluate economic, regulatory, and technical considerations for implementation of recycling and reuse applications of produced water in ND.
- Assess techno-economic commercial viability of the GHCR concept:
  - Evaluate GHCR concept through water sample collection at an active commercial SWD site.
  - Simulate the performance of GHCR through geologic and geochemical models.
  - Evaluate the interaction between Bakken produced water and the Inyan Kara Formation (Dakota Sandstone) through laboratory experiments.

Deliverable	Status
D1-Update of Water Management Report	*Submitted February 28, 2020*
D2-Produced Water Assessment Report	Due October 1, 2020
D3-Draft Final Report	Due November 30, 2021
D4-Final Report	Due January 31, 2022

Key Takeaways

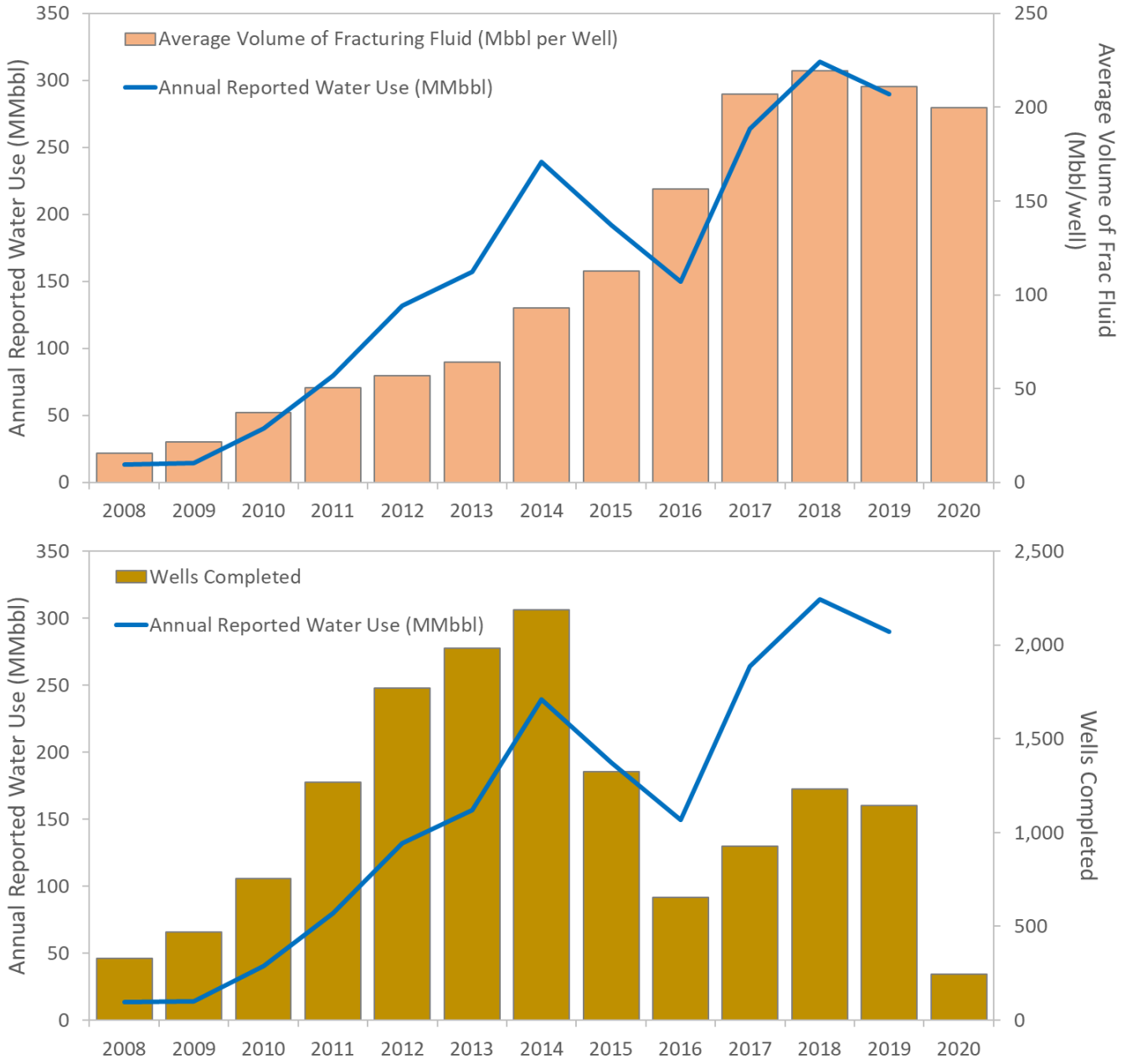
- The oil and gas industry continues to handle increasing volumes of water.
- There is an emerging need for alternative produced water handling options to supplement the Dakota Group and reduce pressurization issues and associated costs.
- High TDS Bakken produced water is a primary challenge in treatment and reuse.
- In the suppressed or low-oil-price environment, water management costs were confirmed to be driving the shut-in and restart priority of wells.
- A new subsurface technique is being evaluated as an approach to recycling/reuse.

Overview of Progress to Date

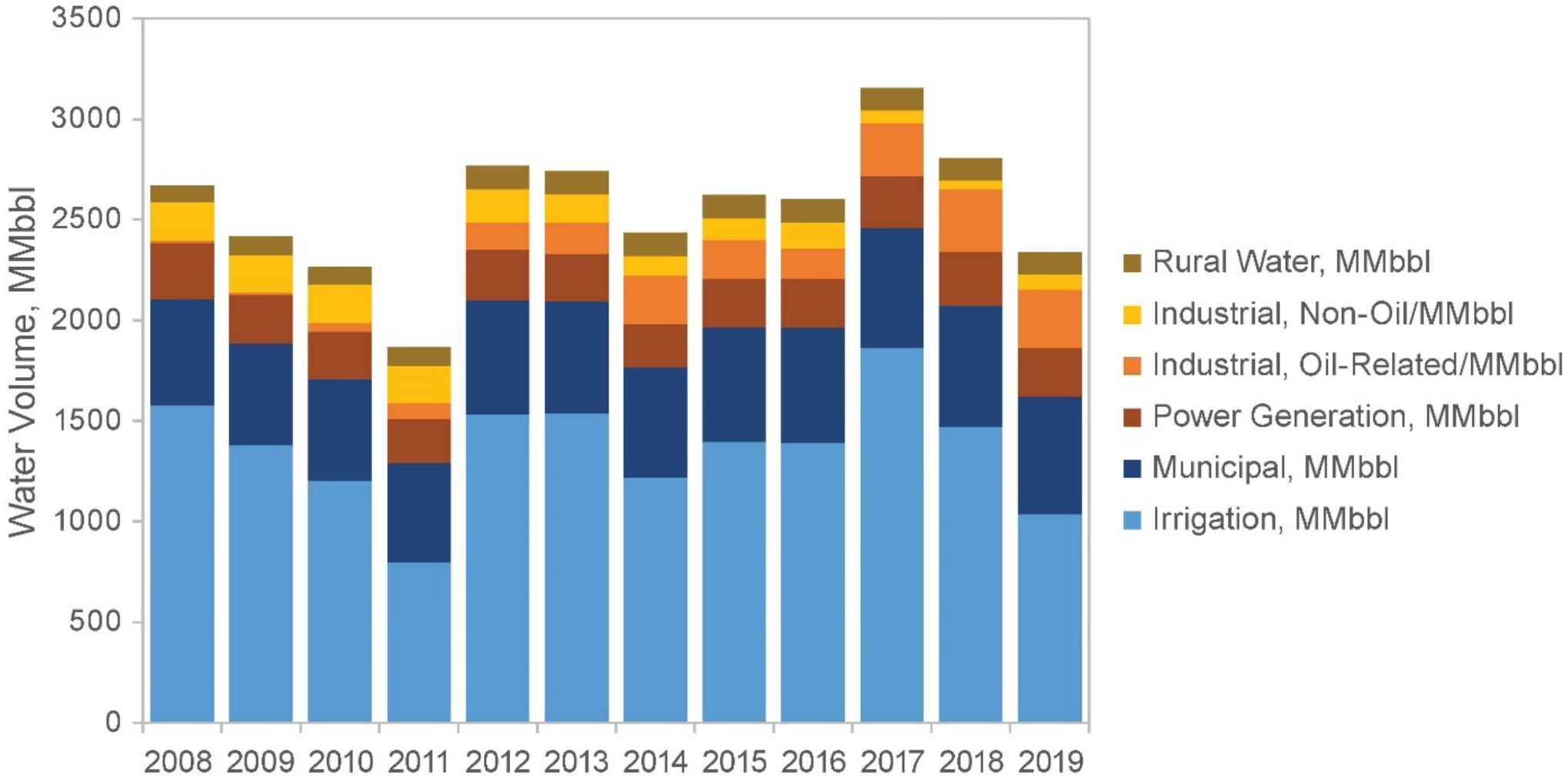
- Completed D1: Update of Water Management Report.
- D2: Produced Water Assessment Report
  - Submitted October 1st.
- Engaged operating partners via individual meetings and BPOP meeting webinar (9/2).

Fresh Water Use

- O&G industry freshwater use has increased:
  - 2008: 13.5 million bbl
  - 2019: 290 million bbl
- Fresh water used in drilling, fracturing fluid makeup, and well maintenance.
  - Fracturing fluid makeup: 87% of freshwater use for the last 5 years (based on Frac Focus reported clean water and ND SWC industrial water use)
  - Maintenance water: 15 bbl/day/well to 50 bbl/day/well.



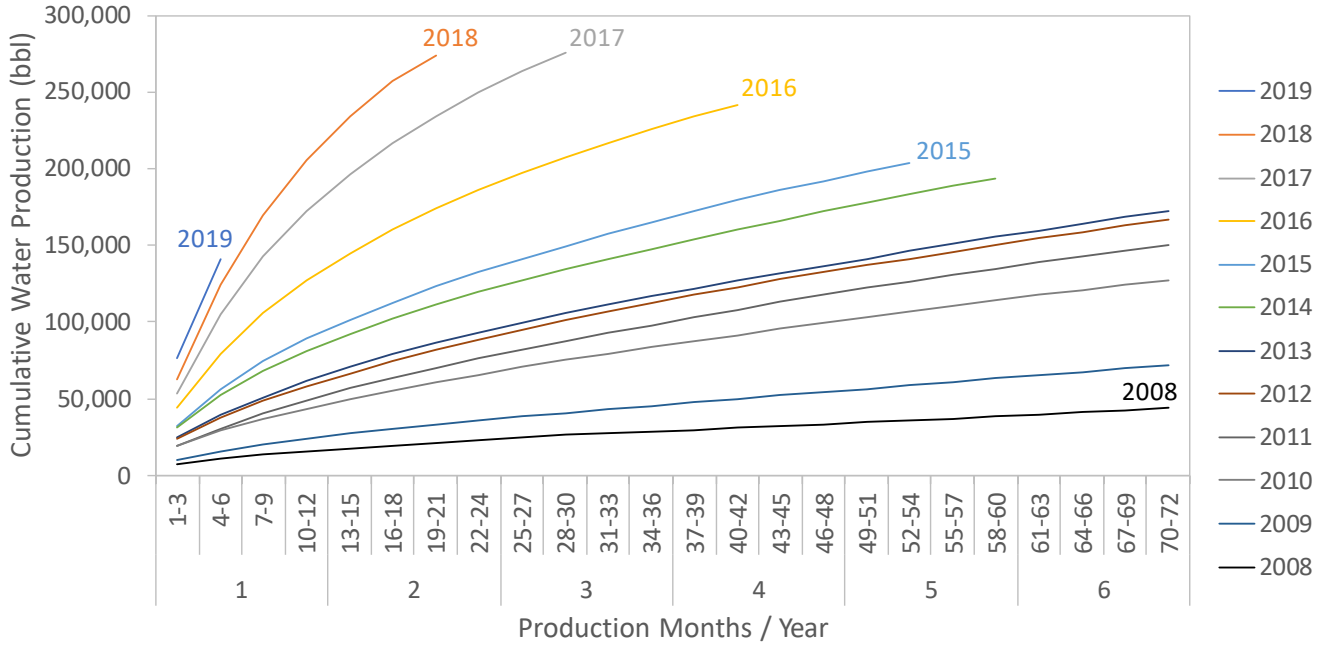
Freshwater Use Comparison

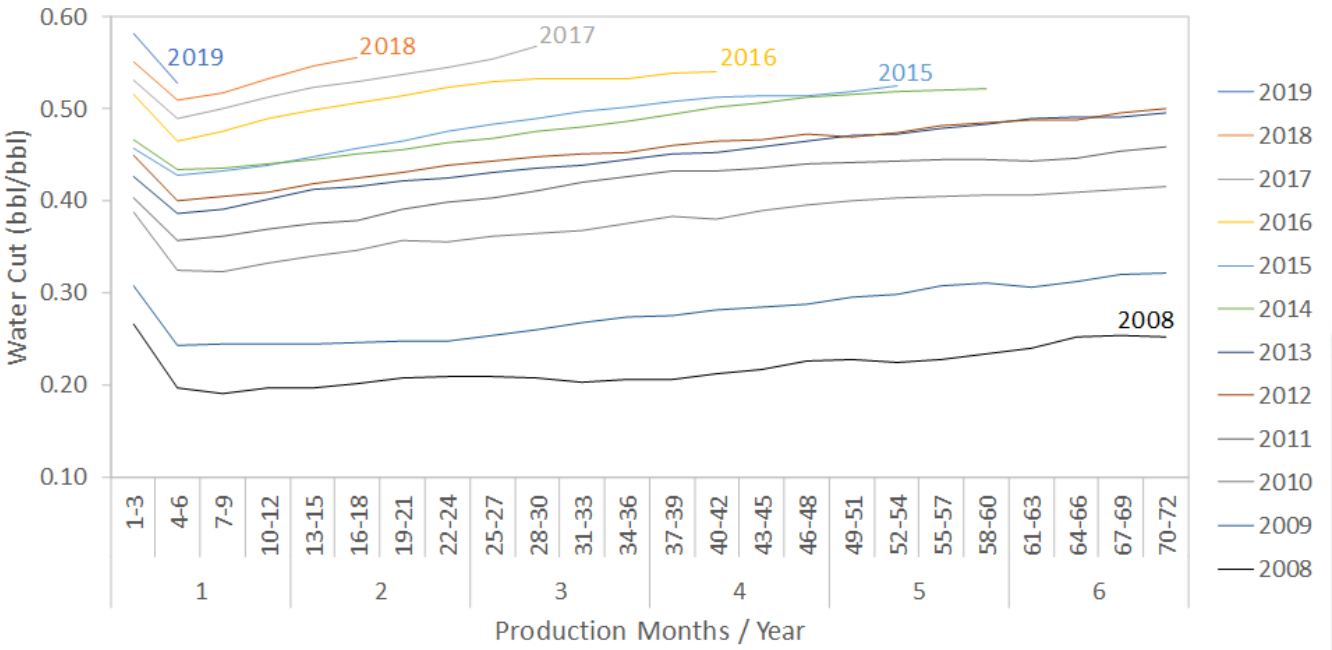


Data Source: NDSWC

Produced Water

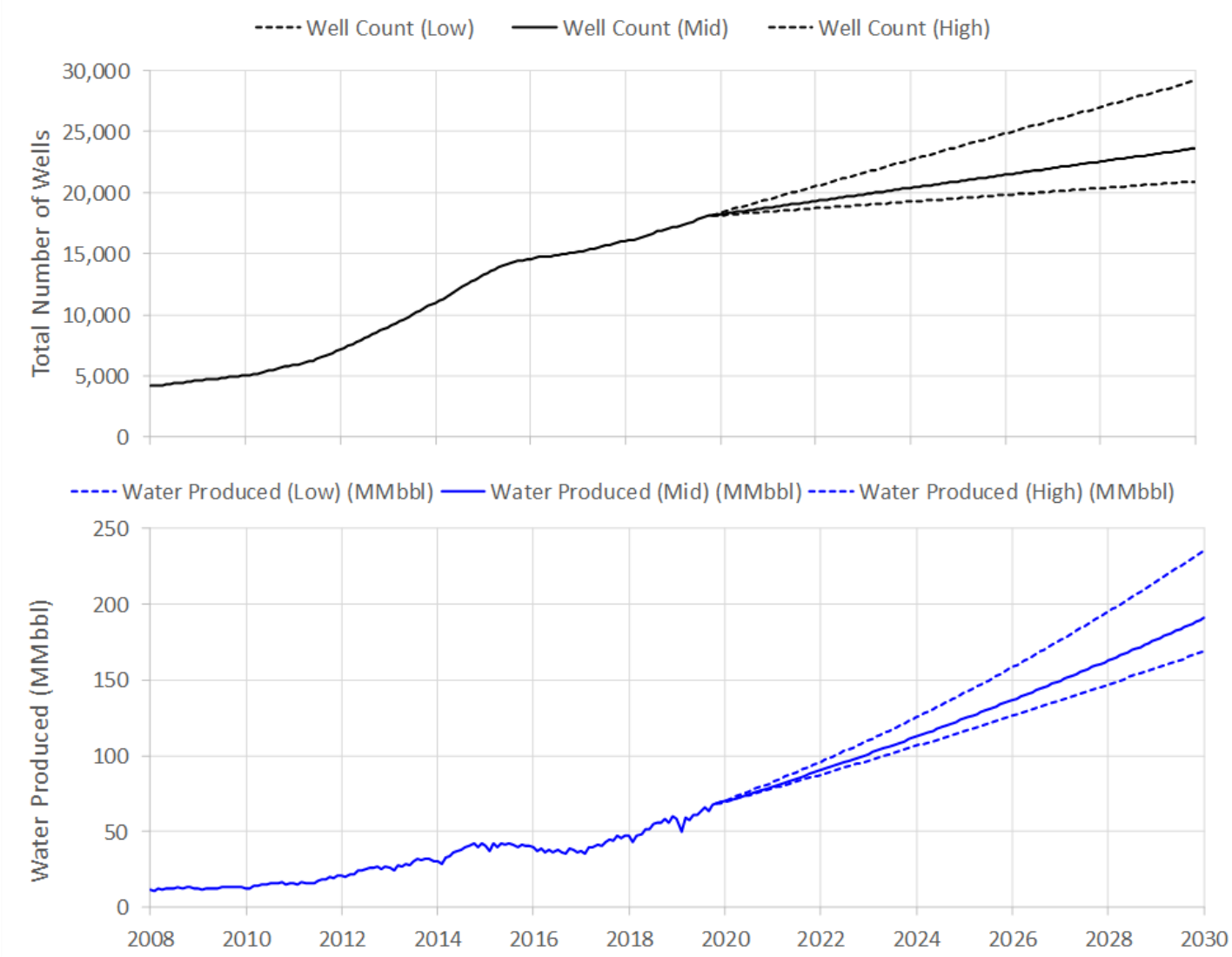
- State produced water volumes increased four-fold since 2008 to ~740 million bbl/yr.
- Increasing volumes per well and increasing water cut.
- Total dissolved solids (TDS) up to 350,000 mg/L.





Looking Ahead

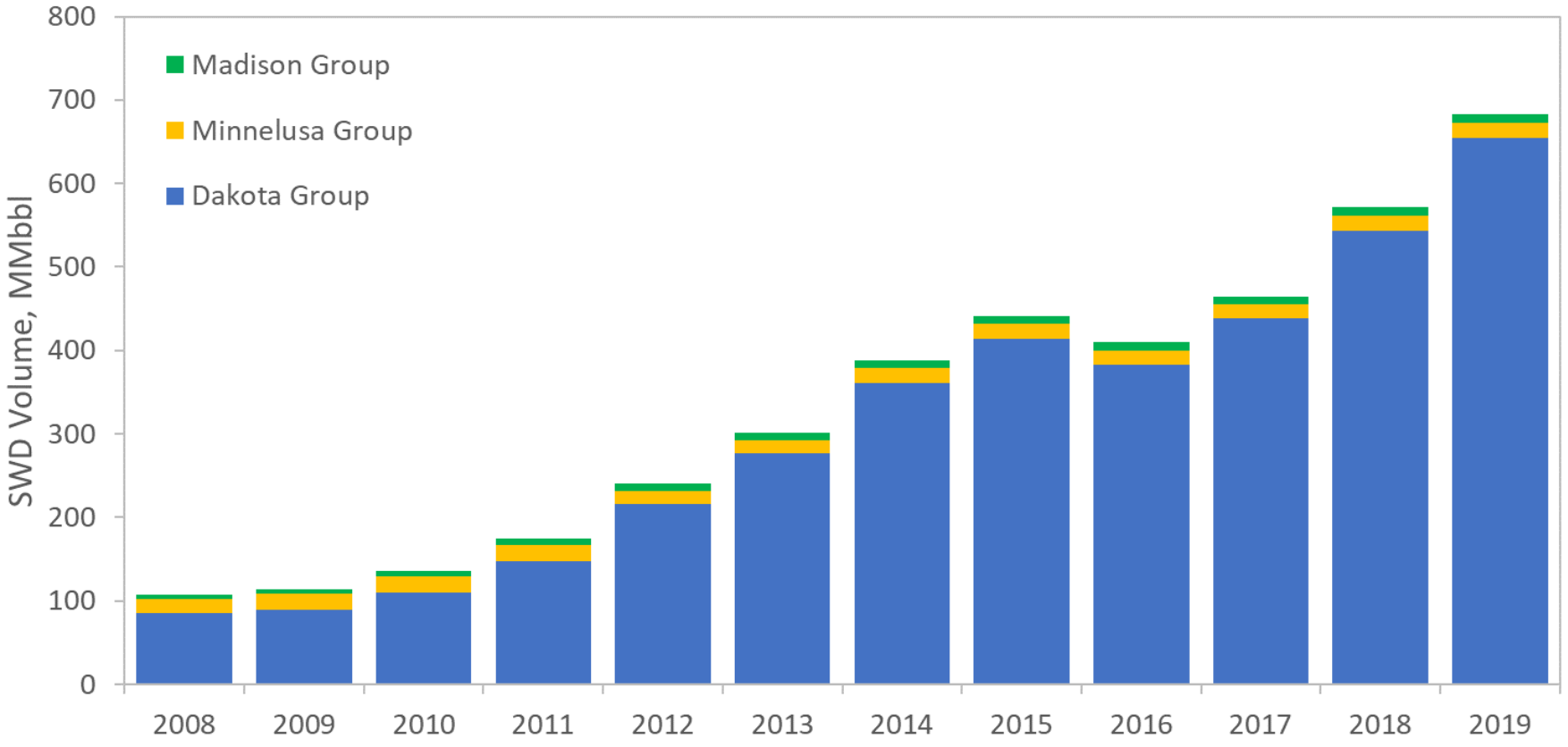
- A basic forecast suggests that volumes of produced water will more than double from 2019 to 2030.
- Based on data trends from 2017-2019.
- With 96% of current oil production, Bakken primary driver of these projections.



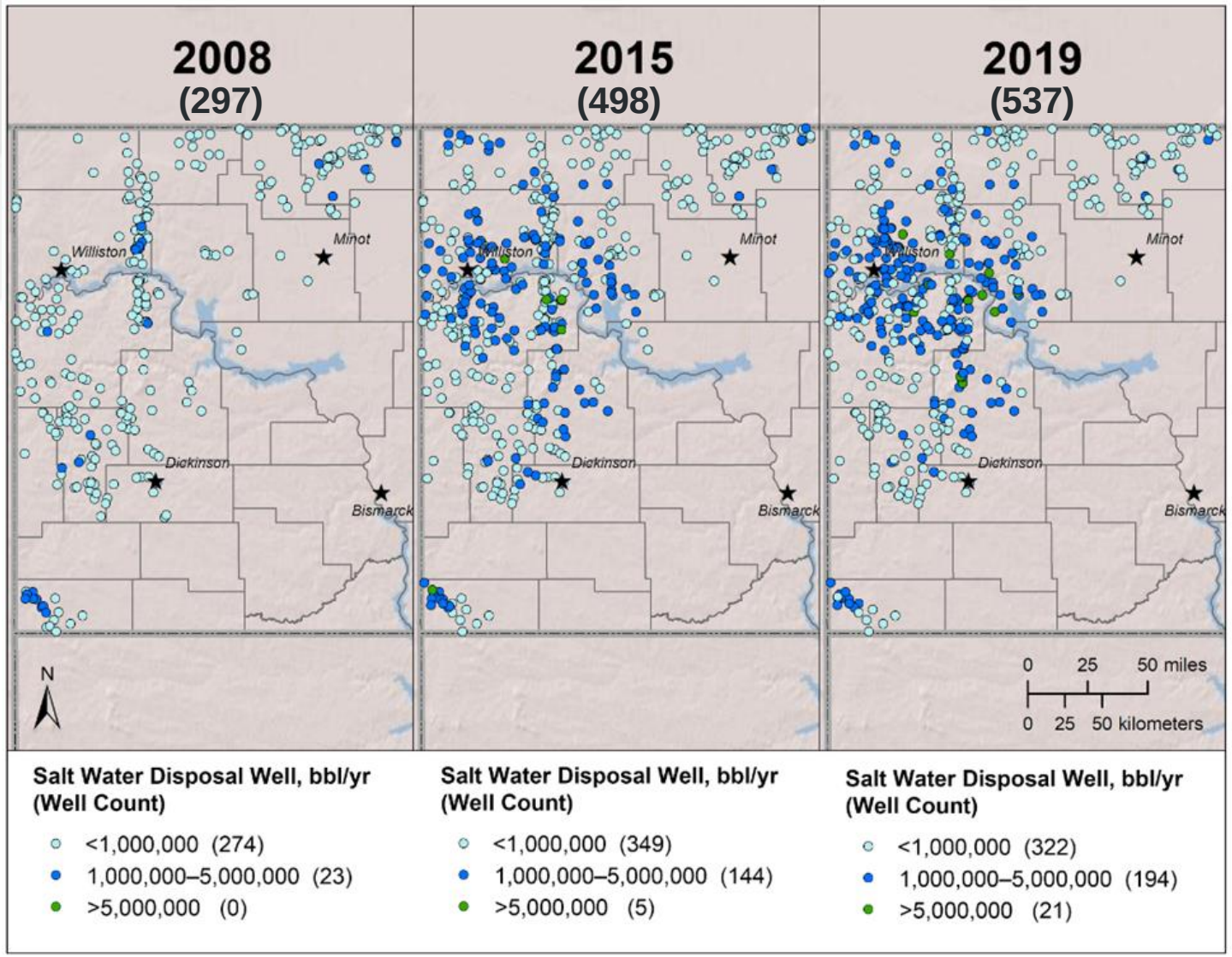
Actual (2008-2019) and projected (2020-2030) well counts under three different growth assumptions (top) and the associated monthly produced water volumes (bottom).

Produced Water Disposal

- Disposal volumes five-fold increase since 2008 to ~680 million bbl/yr.
- Over 95% of saltwater disposal (SWD) targets the Dakota Group (Inyan Kara Formation).
- Primarily transported by pipeline.

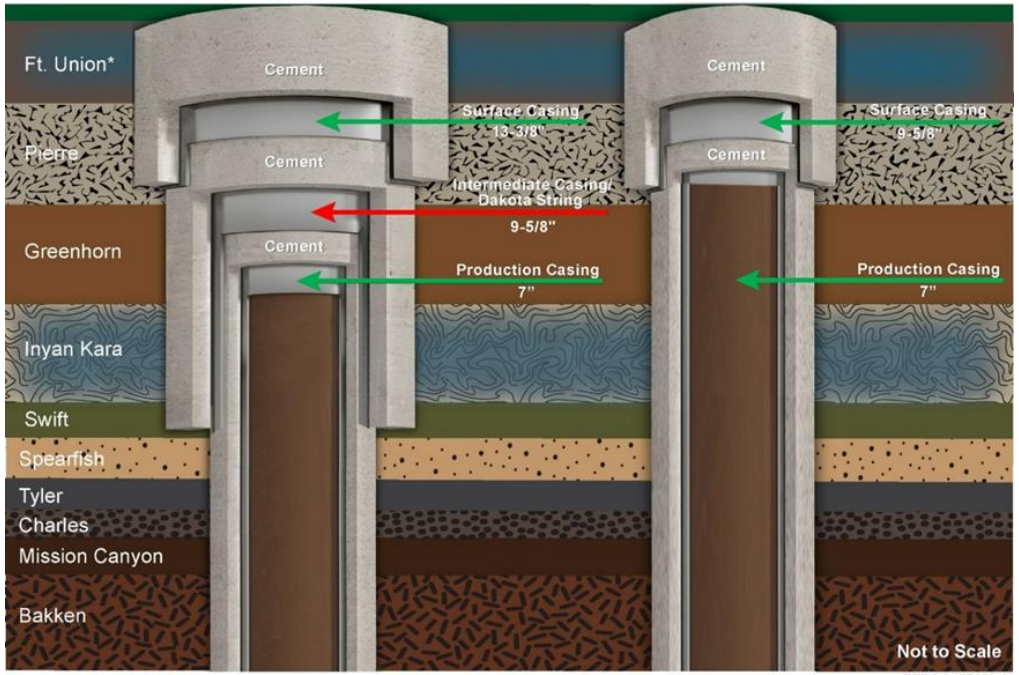


Produced Water Disposal



Pressure increases in the Inyan Kara (Dakota Group) have resulted in changes to drilling operations in the Bakken, costing ~$0.5 million/well.

- Affects operator decisions.
- Identified ~200 wells thus far with additional casing string.



Produced Water Recycling Challenges and Opportunities

Challenges

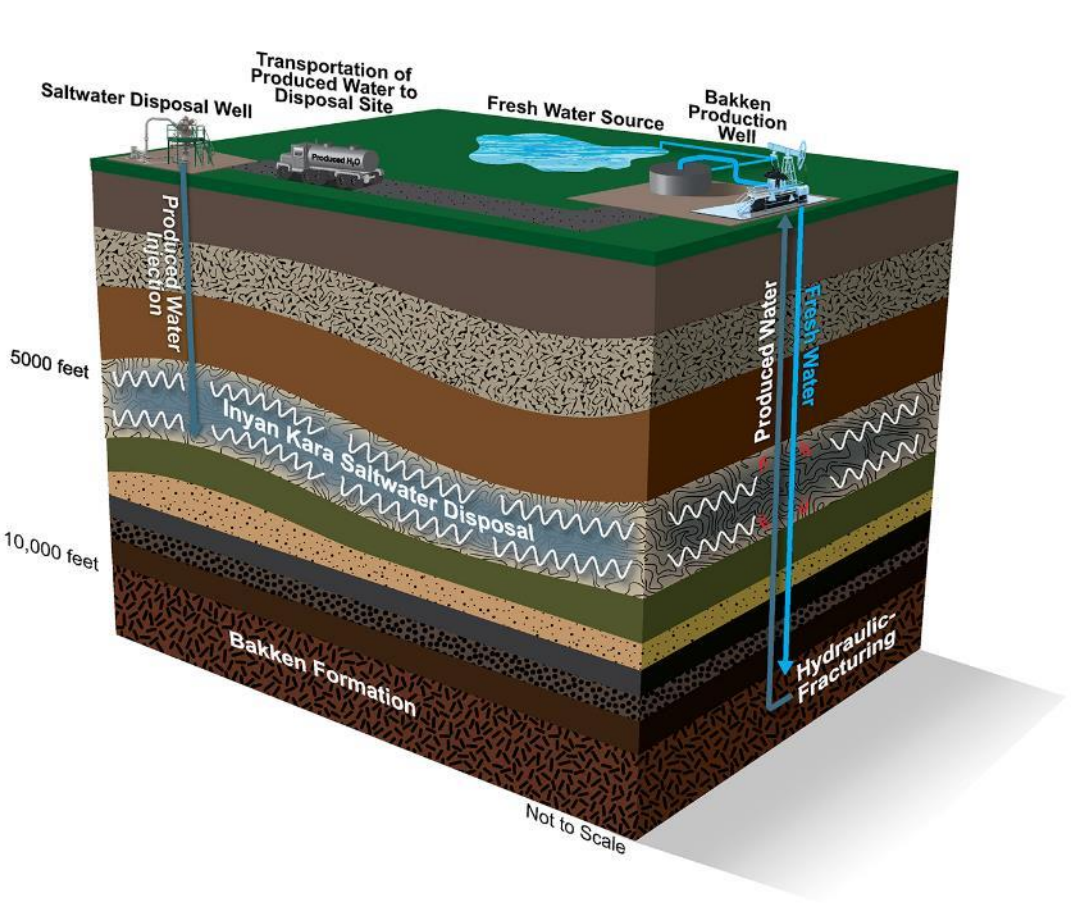
- High TDS
- Economics need to work
- Spill prevention
- Waste handling
- Centralized infrastructure
- Surface storage

Opportunities

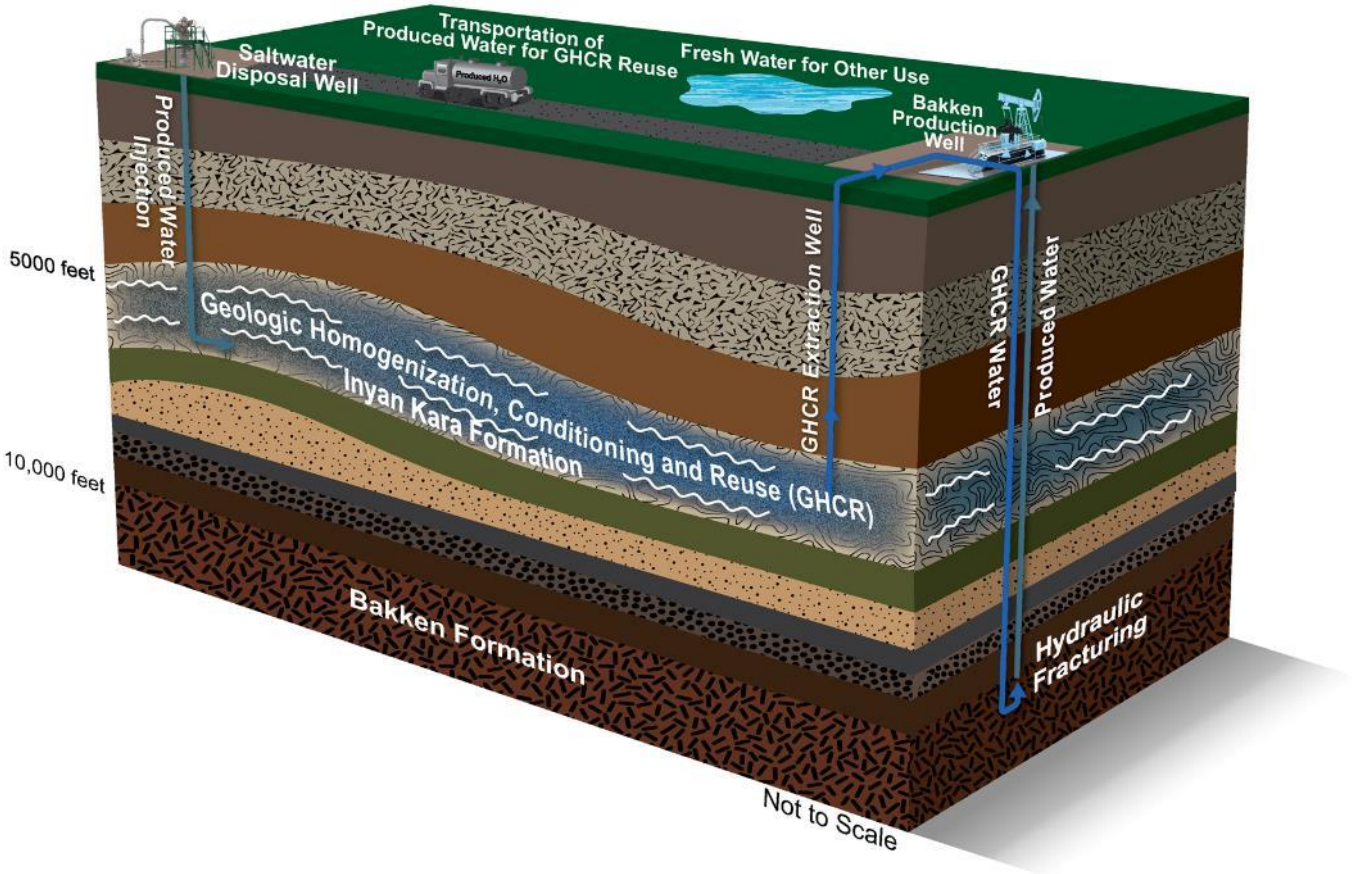
- Relieve capacity constraints in the Dakota sandstone
- Reduce localized pressurization issues and associated Bakken well drilling costs.
- Reduce freshwater consumption.
- Value-add product: turning produced water from waste to a valued product.

GHCR Approach

Traditional Approach



GHCR Approach

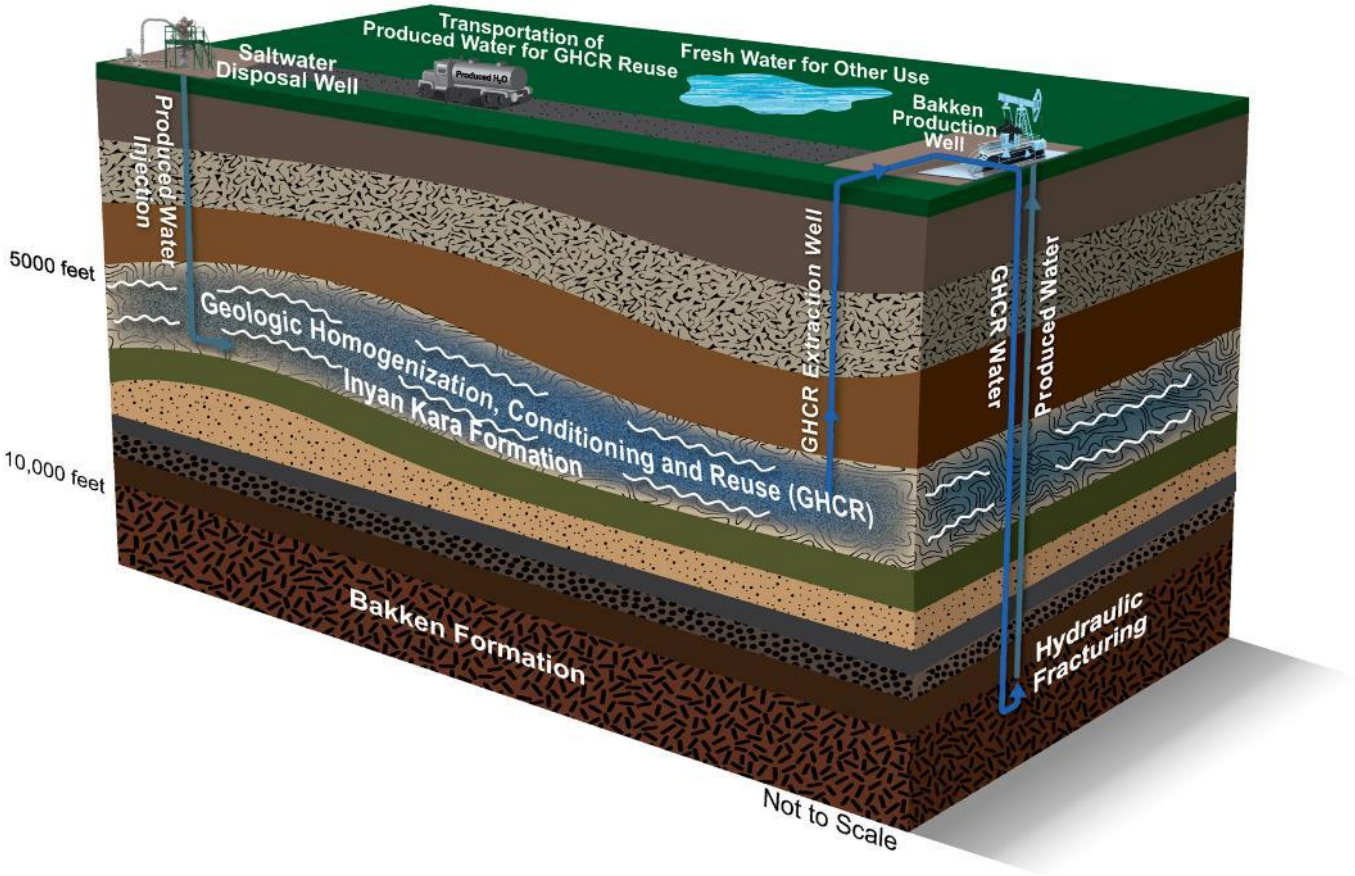


GHCR Approach

Potential Benefits

- Use of existing infrastructure and industry techniques.
- Formation as a storage container.
- Sand filtration can help reduce total suspended solids and other constituents of concern for reuse.
- Potential homogenization of the water for reuse.
- Reduction in freshwater demand.

GHCR Approach

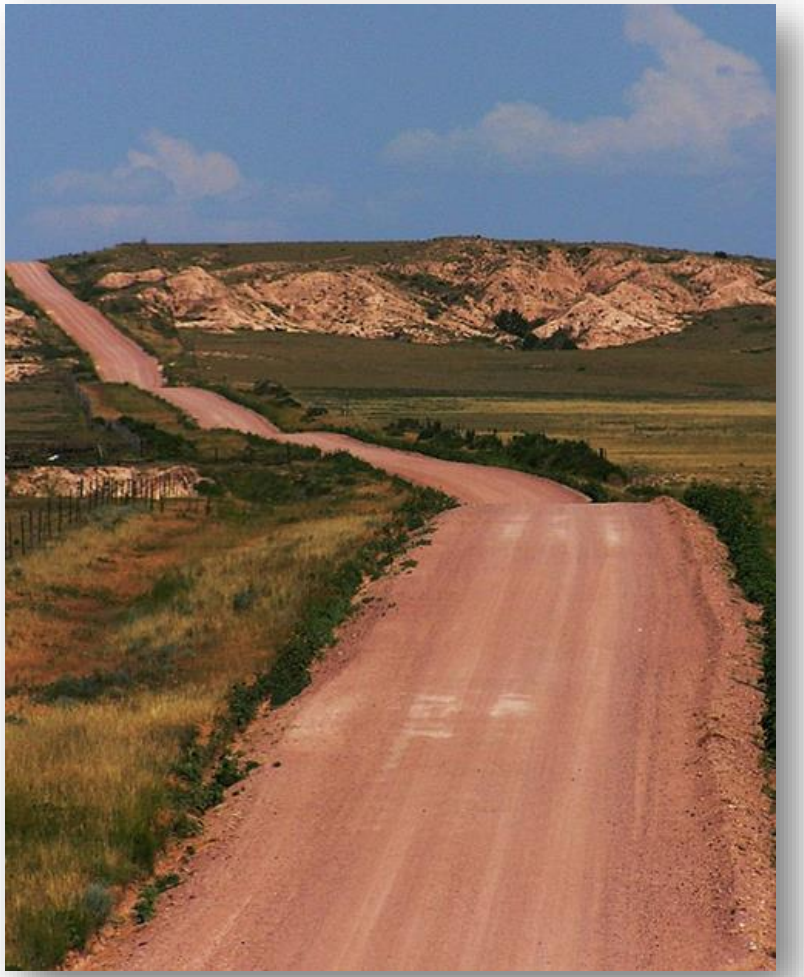


Key Takeaways

- The oil and gas industry continues to handle increasing volumes of water.
- There is an emerging need for alternative produced water handling options to supplement the Dakota Group and reduce pressurization issues and associated costs.
- High TDS Bakken produced water is a primary challenge in treatment and reuse.
- In the suppressed or low-oil-price environment, water management costs were confirmed to be driving the shut-in and restart priority of wells.
- The GHCR approach is being evaluated as a potential option to facilitate recycling/reuse.

Next Steps

- Should we achieve proof of concept on the GHCR, we recommend proceeding to a field pilot to demonstrate the use of GHCR water for use in hydraulic fracturing.
- Other potential areas of future work:
  - Further geologic characterization of alternative SWD targets such as the Minnelusa or Madison.
  - Integrated produced water pipeline systems to transport to more suitable SWD locations.
  - Surface storage alternatives to reduce cost and risk for recycling.



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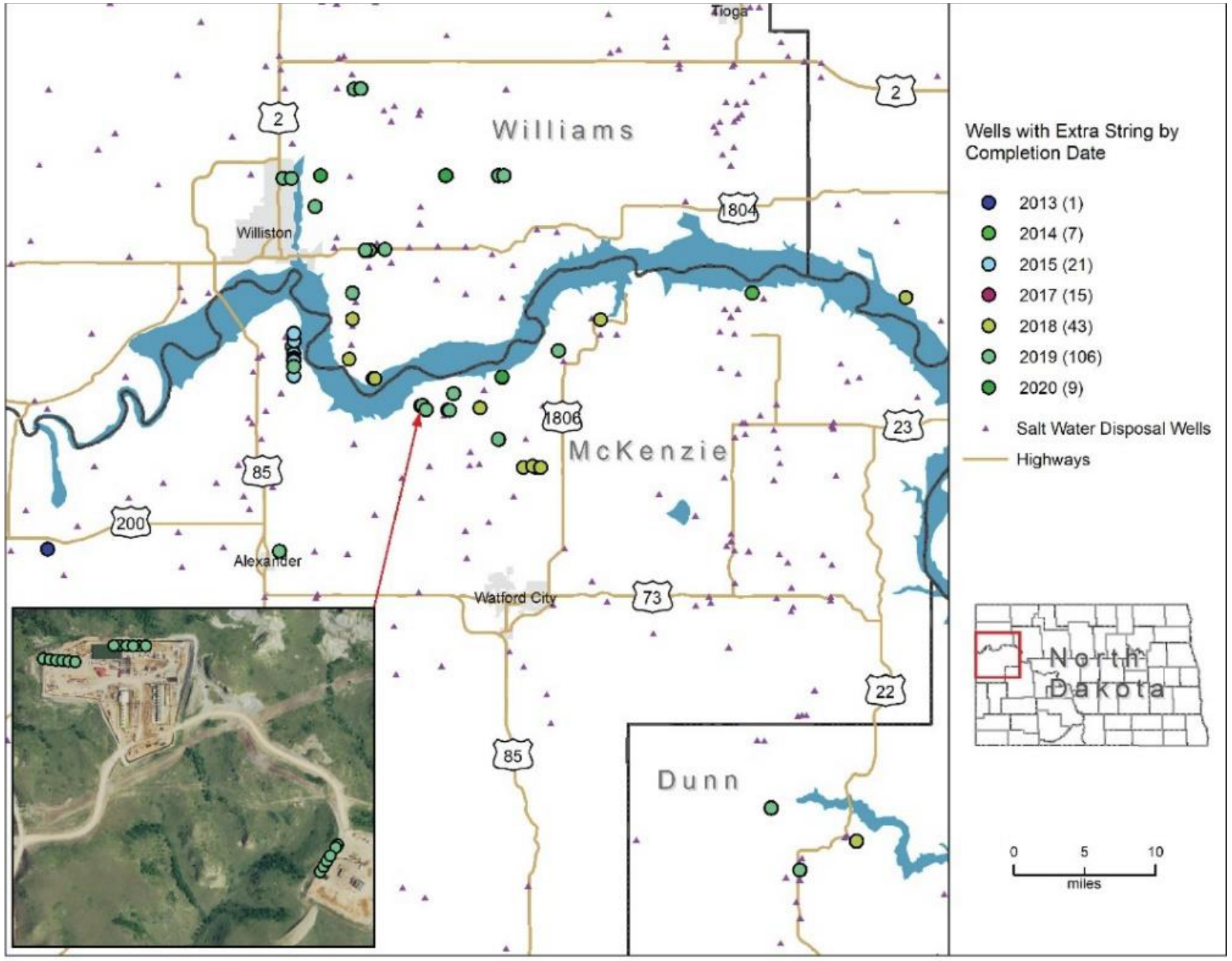
THANK YOU

Critical Challenges. Practical Solutions.


Tioga
Williams
Williston
2
1804
1806
23
85
200
Alexander
McKenzie
Watford City
73
22
85
Dunn
Wells with Extra String by Completion Date
2013 (1)
2014 (7)
2015 (21)
2017 (15)
2018 (43)
2019 (106)
2020 (9)
Salt Water Disposal Wells
Highways
North Dakota
0
5
10
miles