# GHCR Geologic Homogenization, Conditioning, & Reuse

The Energy & Environmental Research Center (EERC), in collaboration with several key partners, has led a multiyear project to evaluate new strategies and methods of saltwater disposal (SWD) well operation and produced water management. These strategies could increase the amount of produced water recycled and reused for production, reduce freshwater intensity through less freshwater consumption, and extend the life of existing injection disposal wells.

## Addressing Challenges in Produced Water Management

Water management represents a significant technical and economic challenge for sustainable oil and gas production, as water volumes are intrinsically linked to oil production volumes. Demand for freshwater and produced water management will continue where oil and gas resources are produced. Bakken development between 2008 and 2020 resulted in a nearly fourfold increase in produced water volumes that now equate to ~640 million barrels/year and a fivefold increase in SWD volumes to ~565 million barrels/year. SWD is beginning to result in localized areas experiencing pressurization challenges in the Inyan Kara Formation, the lowermost sandstone of the Dakota Group and primary SWD target for oil and gas operators in North Dakota. These pressure limitations impact the economics of drilling new Bakken wells in these areas.

Treating produced water for reuse in North Dakota is challenged by:

- Variable chemistries and high-total dissolved solids (TDS) content of Bakken Formation water and hydraulic fracturing fluid flowback.
- Temporary storage of large volumes of produced fluids on the surface.
- Abundant and low-cost fresh water.

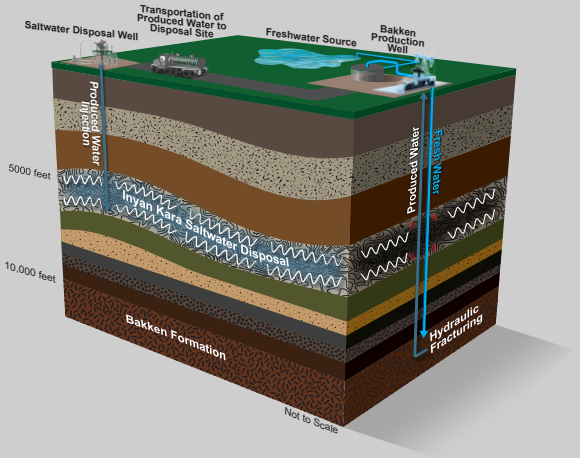
## What Is the GHCR Concept?

The geologic homogenization, conditioning, and reuse (GHCR) concept is a novel produced water management approach that uses a subsurface geologic formation as a natural medium for managing produced water recycling and reuse. The concept is to make use of the natural processes occurring in the subsurface (e.g., filtering, mixing, diluting, etc.), then extracting the water at some distance from the disposal well. The extracted water is expected to be of a more consistent and improved quality (e.g., removal of total suspended solids, reduction of TDS), suitable for hydraulic fracturing fluid makeup water, reducing industry's freshwater demand. Additionally, by extracting water from the Inyan Kara Formation, pressure can be reduced in the formation's pore space, increasing SWD capacity and extending the life of SWD wells.

## Project Results

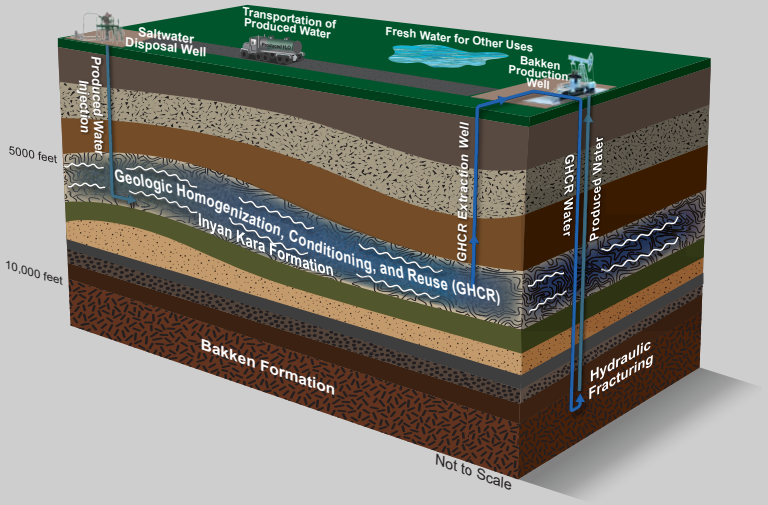
Key findings identified that the GHCR concept can be a viable approach to produced water management in North Dakota. Laboratory testing, field sample analysis, modeling, and techno-economic analysis conducted as part of this work indicate that GHCR could feasibly be implemented as a potential water management option. Field sample collection and laboratory column testing indicate that the Inyan Kara sandstone and native formation fluid are capable of homogenizing with the Bakken produced water to a point where the fluid composition stabilizes. Extracting that stabilized, homogeneous fluid could provide hydraulic fracturing fluid. Modeling results indicate that extraction of fluids from the Inyan Kara in a GHCR implementation scenario is capable of reducing localized formation pressure, which would help ease localized pressurization of the Inyan Kara and extend the capacity for nearby SWD wells.

### Traditional Approach to Produced Water Management




Above: Illustration of standard produced water management in North Dakota. Produced water is transported, typically via truck or pipeline, to an injection well for disposal. The Inyan Kara Formation, located at a depth of approximately 5000 feet, is the most common geologic formation target for SWD. While this traditional method is still the preferred approach, future challenges in water management (e.g., increasing volumes of produced water, increasing formation pressures, etc.) may necessitate new approaches to water management in the oil and gas industry.

### GHCR Approach to Produced Water Management




Above: Illustration of the GHCR approach to produced water management. Instead of relying exclusively on fresh water for hydraulic fracturing, the GHCR concept uses an extraction well that is placed some distance away from the SWD well to extract the previously injected produced water. This water is then used during the hydraulic fracturing process, freeing up fresh water to be used for other uses.

## Advancing the GHCR Concept

The GHCR approach may be commercially adopted and applied at wellsites in North Dakota and beyond. GHCR addresses key challenges associated with the recycling of produced water, including large-scale storage of produced water and treatment of highly variable, high-TDS Bakken Formation waters.

GHCR addresses localized formation pressurization challenges and may extend the life of existing SWD wells and reduce oil and gas development costs. The findings from this work may provide the requisite information and confidence for project partners to progress the GHCR concept to a pilot demonstration of beneficial end use of GHCR water. A pilot demonstration of the GHCR concept would provide additional techno-economic data and regulatory knowledge.

Economic analysis indicates that there are scenarios where GHCR implementation can be a competitive or even lower-cost option than a conventional water management approach. Site-specific conditions will dictate the economic potential of GHCR, but potentially attractive sites for GHCR implementation will be those that are located above a pressurized zone of the Inyan Kara, need several Bakken infill wells, and face high costs for conventional SWD and/or fresh water. Based on the regulatory review, drilling into the Inyan Kara for SWD and, potentially, to harness as a source water for industrial use has precedent in North Dakota, and a workable regulatory solution for GHCR seems likely. However, restrictions regarding surface storage and transport of produced fluids may influence project economics and how GHCR could be implemented.

A detailed evaluation of constituents of concern into produced water (e.g., sulfate, iron, naturally occurring radioactive material [NORM], etc.) would help inform 1) impacts of produced water chemistries on produced water reuse as hydraulic fracturing makeup water and 2) impacts on the production well (e.g., trace elements, NORM, well souring, etc.) where recycled produced water is used for stimulation. Additonal investigation is needed into high-value material (HVM), the extraction of which could benefit the economics of GHCR, e.g., rare-earth elements and lithium, to understand the content and variability across the Bakken play. More data are needed to determine if this is an economically viable option and, if so, the spatial distribution of favorable HVM conditions and how it could be inserted into the GHCR concept.

With the continued development of the Bakken and increasing interest from producers to increase water-recycling rates (water recycle rate [%] = recycled water [bbl]/total water consumed [bbl]) and reduce freshwater intensity (barrels of water used in completions per barrels of oil equivalent produced), implementing a practice such as GHCR is a potential option to reach these goals.

## Who Is Involved in the Project?

The project was conducted by the EERC in partnership with Nuverra Environmental Solutions, the North Dakota Industrial Commission Oil and Gas Program, and the U.S. Department of Energy Oil and Gas Program. The EERC, at the University of North Dakota, is an organization dedicated to providing practical, pioneering solutions to the world's energy and environmental challenges. This project is being conducted at the Nuverra-operated Johnsons Corner site, which was established in 2008 as a commercial SWD facility and is home to the Brine Extraction and Storage Facility (BEST) project.

## BEST Site Map


## For More Information, Contact:


- **Kyle Glazewski**
  Principal Analyst
  (701) 777-5421
  kglazewski@undeerc.org
- **John Hamling**
  Director for Subsurface Initiatives
  (701) 777-5472
  jhamling@undeerc.org
- **Bethany Kurz**
  Director for Analytical Solutions
  (701) 777-5050
  bkurz@undeerc.org

EERC
UND UNIVERSITY OF NORTH DAKOTA

**Energy & Environmental Research Center**
University of North Dakota
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018
www.undeerc.org