Update on the Bakken Water Opportunities Assessment: Phase 1 and 2

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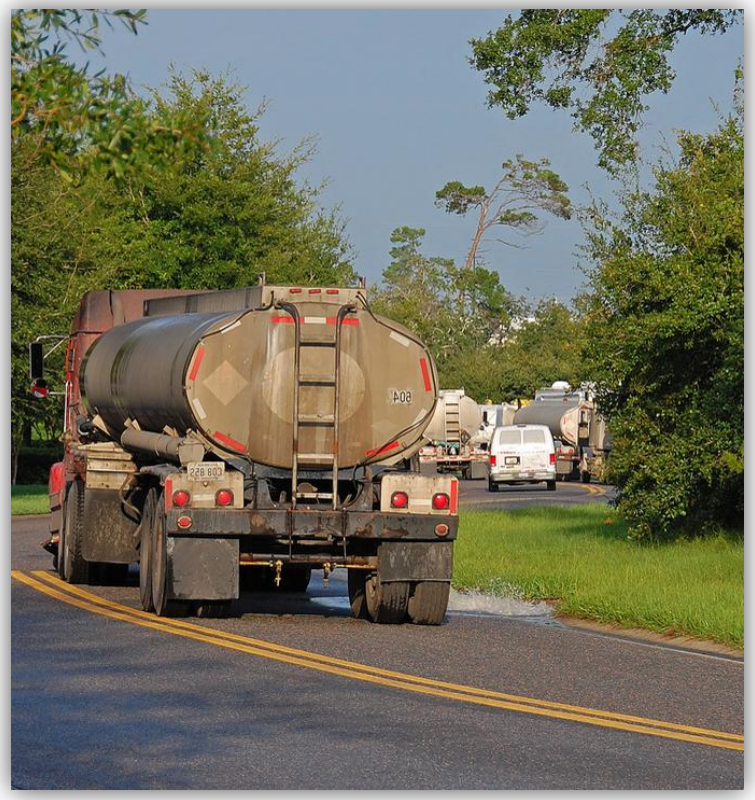
Bakken Water Opportunities: Phase I

- Project goal: To assess the technical and economic potential to recycle frac flowback water in the Bakken play.
- Project sponsors
  - North Dakota Industrial Commission (NDIC) Oil and Gas Research Council (OGRC)
  - U.S. Department of Energy (DOE)
  - North Dakota Petroleum Council (NDPC)



Bakken Water Opportunities: Phase 2

- Project goal: To evaluate the technical and economic feasibility of brackish groundwater treatment for use in hydraulic fracturing.
- Project sponsors
  - OGRC
  - DOE
  - Hess Corporation

Total Project Expenditures

Sponsor	Contribution	% of Total
North Dakota Industrial Commission	$110,000	2.9
U.S. Department of Energy	$155,000	4.0
North Dakota Petroleum Council (Phase 1)	$10,000	0.3
Hess Corporation (Phase 2)	$3,554,133	92.8
Total for Phase 1 and 2	$3,829,133	

Time Line

Phase 1: Evaluation of frac flowback water treatment feasibility: June 2009 – March 2010

Phase 2: Membrane treatment technology assessment, vendor selection, and site preparation: January–June 2010

Phase 2: Pilot project demonstration: July 2010 – April 2011

Phase 2: System performance evaluation, economic assessment, and final report preparation: May–December 2011

Industrial Partners

Phase 1

Data and information provided by five major oil producers

Phase 2

Hess Corporation

GE Water and Process Technologies

Phase 1 Conclusions

- Bakken frac flowback water is characterized by extremely high salinity and low recovery rates.
- Treatment would be very challenging, even with the most robust recycling/reuse technologies.
- Treatment likely not cost-effective in most cases.
- While frac flowback recycling does not appear feasible, water acquisition costs are high enough to warrant an evaluation of nontraditional water supplies.

Phase 2 Overview

- The EERC partnered with Hess Corporation to conduct a pilot project using reverse osmosis (RO) to treat brackish groundwater (~10,000 mg/L total dissolved solids [TDS]) from the Dakota Aquifer.
- Site located near Tioga at an existing water production well and waterflood site.
- GE Water Process and Technologies (GE) was contracted to supply a mobile RO treatment system.

Phase 2 Project Highlights

- Over 14.4 million gallons of high-quality water was produced and used for fracking.
- An on-site water-hauling station allowed four trucks to fill simultaneously in about 20 minutes.
- The waste heat of the feedwater was used to partially heat the treated water, thereby reducing costs to heat the water prior to use in fracking.
- Hess and GE are partnering to build a full-scale RO plant.

Phase 2 Conclusions

- RO treatment of brackish groundwater appears to be an economically viable water supply option for some operators given the current demand for water in the Bakken play.
- Highly dependent on:
  - Disposal costs (commercial vs. dedicated injection wells) and TRANSPORTATION.
  - Reduced heating costs achieved by partial heating of the treated water.

Cost Comparison (per barrel)

Source	Acquisition Cost	Overall Costs (with Trucking and Heating)
RO Plant (estimated)	$1.28–$2.95	$5–$8
Municipal	$0.63–$1.26	$8–$10
Western Area Water Supply Pipeline	$0.63–$1.26	$4–$6

Deliverables

- Interim reports as contractually required.
- Presentations at various regional meetings, including the Williston Basin Petroleum Conference, the 2011 PERF Annual Meeting in Bartlesville, and the 2011 International Water Conference in Orlando.
- Two final reports detailing the Phase 1 and 2 project approach, data, results and conclusions.

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