Water-use requirements associated with hydraulic fracturing within the Williston Basin

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The data and interpretations within this presentation are preliminary and have not been reviewed or approved by the U.S. Geological Survey.
Water Use

Primary water use
1. Supplemental fluid in enhanced recovery
2. Drilling and completion of an oil or gas well
3. Work over or remediation (repeat completion)
4. Gas plant coolant or boiler water

Secondary water use
1. Watering down roads and pads
2. Rig wash water
3. Coolant for vehicles and other engines
4. Sanitary purposes
5. Laboratory purposes

Ancillary water use
1. Residential water use (man camps)
2. Wastewater treatment
3. Restaurants
Purpose

(1) obtain and analyze water use data at a process level,
(2) identify the primary factors (predictor variables) controlling water use, and
(3) identify the primary variables controlling water recycling and disposal.
Well development in the Bakken Formation

![Graph showing the number of wells drilled and cumulative number of wells over time in the Bakken Formation. The graph displays a sharp increase in the number of wells drilled around the year 2000, indicating a significant development effort. The cumulative number of wells also shows a steady rise, reflecting the expanding scale of the development efforts.]
Williston basin—
Oil and Gas development
Modified from Caldwell, 2015 and Haines, 2015
Water Use to Fracture Formation

2.9 million gallons (Mgal) per well (or 9 acre-ft)
Data from North Dakota Water Commission: Aug 2014

Daily use for a city of 50,000 people is 10 Mgal
Daily pumping for a center-pivot irrigator for 130 acres is 1 Mgal
Daily 400 MW Coal fire plant 365 Mgal

Data from Northern Great Plains Water Consortium Water Use Fact Sheet: Nov 2008

Future: Oil and Gas Division estimate 2500 new wells per year (15-25 yrs)
Data from North Dakota State Water Commission: Oct ,2011
## Water Use to Fracture Formation

Water use per well (hydraulic fracturing job)

<table>
<thead>
<tr>
<th>Year</th>
<th>Well Count</th>
<th>Total AcFt</th>
<th>Mean AcFt</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>30</td>
<td>31</td>
<td>1.03</td>
</tr>
<tr>
<td>2007</td>
<td>128</td>
<td>206</td>
<td>1.61</td>
</tr>
<tr>
<td>2008</td>
<td>504</td>
<td>797</td>
<td>1.58</td>
</tr>
<tr>
<td>2009</td>
<td>572</td>
<td>1,355</td>
<td>2.37</td>
</tr>
<tr>
<td>2010</td>
<td>792</td>
<td>3,632</td>
<td>4.59</td>
</tr>
<tr>
<td>2011</td>
<td>1027</td>
<td>5,960</td>
<td>5.8</td>
</tr>
<tr>
<td>2012</td>
<td>48</td>
<td>392</td>
<td>8.18</td>
</tr>
</tbody>
</table>

North Dakota Oil and Gas Division: April 5, 2012
Methods

Compilation of data and information oil and gas water usage

1. Identify Data
2. Obtain Data Resources (North Dakota Oil and Gas Division, Montana Board of Oil and Gas)
3. Develop Predictor Variables (type of proppant used, amount of proppant used, number of laterals per well, treatment type, number of fracturing instances per lateral, length of each lateral, proximity to a water source, proximity to injection wells, number of stages, etc.)
4. Database Development (put data into Access database)
Methods

Data Analysis

1. Statistical Interpretation (bootstrap random forest classification using R and error measured using Gini coefficient)

2. Develop Functions based on Primary Predictor Variables (water use based on predictor variable such as driller or location)

3. Trends Determination (changes over time and space)

4. Predict Future Water-Use Requirements for Varied Sources (projections possible for WAPR)
Laterals

Oil and Gas Development in North Dakota, 2014

EXPLANATION
- Major Cities
- Oil Well Locations
- Directional Drilling
- Limiting Access
- Highway
- Major Road
- Local Road
- Missouri River
- County Boundaries
- Federal Lands
- Hydrogeologic Units
  - Upper Fort Union
  - Middle Fort Union
  - Lower Fort Union
  - Upper Hill Creek
  - Lower Hill Creek
  - Fox Hills

For more information contact
Mark T. Anderson, director
USGS South Dakota Water Science Center
605-394-5220

Base modified from U.S. Geological Survey digital data
1:2,000,000, 1990
Albers Equal Area Projection
Standard Parallels: 20 30 N, 45 30 N
Latitude of Origin: 20 N
Central Meridian: 96 W
North American Datum of 1983
Scatterplot showing the Horizontal Distance per "Frack" verses the Amount of water water used (Acre-Feet) per "Frack"

- Bakken "Fracks" greater than 22 AcFt are highlighted in RED.
- + = Bakken
- + = Bakken
- + = 3 Forks
- x = Dakota
- o = Spearfish

Horizontal Drilling Distance, measured in Feet
Stages

**Number of "Frack" Stages versus Horizontal Drilling Distance**

- 3 Forks (117 Wells)
- Bakken (285 Wells)
- Dakota (6 Wells)
- Spearfish (6 Wells)

Horizontal Drilling Distance in Feet

Produced by Mike Hove ND State Water Commission
Scatterplot showing the Number of Stages per "Frack" versus the Amount of water used (Acre-Feet) per "Frack"

Bakken "Fracks" greater than 22 AcFt are highlighted in RED.

Produced by Mike Hove ND State Water Commission
2013 Water Use
GW – 6700 Ac-Ft
SW – 12,986 Ac-Ft
Preliminary Results: Important Predictor Variables

- Operator ID: 70%
- Number of Stages: 50%
- Distance to Williston Water Depot: 30%
- Longitude: 20%
- Latitude: 20%
- Length of Line: 10%
- Pool Number: 5%

Increase in root mean squared error, in percent
USGS UOG Water Use Focus Area Study

• Collect data on direct and ancillary processes through surveys within Bakken area – data identified previously as not typically collected
  • Assistance from operators as well as state agencies is requested
• Expand to other UOG Basins across the nation
• Develop water use relationships for USGS national water use compilation
USGS UOG Water-Use Study Team

- Kathleen Rowland, ND WSC
- Skip Veccia, ND WSC
- Janet Carter, SD WSC
- Greg Delzer, SD WSC
- Joanna Thamke, WY-MT WSC
- Roy Sando, WY-MT WSC
- Molly Maupin, ID WSC
- Seth Haines, Energy Program
Future Work
Questions