Trends in Water Use for Hydraulic Fracturing

Shareholder, Lender & Operator Guide to Water Sourcing

Monika Freyman, Water Program, Ceres
October 21 2014

www.ceres.org/shalemaps
Ceres works with NGO partners, investors and companies to build a thriving and sustainable global economy

Milestones:
- Catalyzed the corporate sustainability reporting movement
- Introduced climate and water risk as key investment considerations
- Mitigate water impacts from company and investor activities and play productive role in water resource protection.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ESG Disclosure Score</strong></td>
<td>58.51</td>
<td>57.26</td>
<td>56.43</td>
<td>53.11</td>
<td>53.11</td>
<td>50.62</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Disclosure Score</td>
<td>57.02</td>
<td>54.55</td>
<td>52.89</td>
<td>46.28</td>
<td>46.28</td>
<td>41.32</td>
</tr>
<tr>
<td>Total GHG Emissions</td>
<td>143,000.00</td>
<td>140,000.00</td>
<td>139,000.00</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>NOx Emissions</td>
<td>140.00</td>
<td>120.00</td>
<td>130.00</td>
<td>150.00</td>
<td>160.00</td>
<td>161.00</td>
</tr>
<tr>
<td>SO2 Emissions</td>
<td>130.00</td>
<td>140.00</td>
<td>160.00</td>
<td>190.00</td>
<td>210.00</td>
<td>236.00</td>
</tr>
<tr>
<td>Total Energy Consumption</td>
<td>430,555.54</td>
<td>408,777.77</td>
<td>405,638.89</td>
<td>416,666.66</td>
<td>430,555.54</td>
<td>433,649.99</td>
</tr>
<tr>
<td>Water Consumption</td>
<td>372,348.24</td>
<td>340,392.00</td>
<td>347,386.99</td>
<td>352,316.01</td>
<td>323,000.00</td>
<td>309,000.00</td>
</tr>
<tr>
<td>Hazardous Waste</td>
<td>190.00</td>
<td>130.00</td>
<td>80.00</td>
<td>40.00</td>
<td>168.00</td>
<td>246.00</td>
</tr>
<tr>
<td>Environmental Fines #</td>
<td>65</td>
<td>83</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Environmental Fines $</td>
<td>1.30</td>
<td>11.00</td>
<td>5.10</td>
<td>13.00</td>
<td>3.80</td>
<td>12.80</td>
</tr>
<tr>
<td><strong>Social</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Disclosure Score</td>
<td>53.13</td>
<td>53.13</td>
<td>53.13</td>
<td>53.13</td>
<td>53.13</td>
<td>53.13</td>
</tr>
<tr>
<td>Number of Employees</td>
<td>82,100</td>
<td>83,600</td>
<td>80,700</td>
<td>79,900</td>
<td>80,800</td>
<td>82,000</td>
</tr>
<tr>
<td>% Women in Workforce</td>
<td>26.00</td>
<td>26.00</td>
<td>26.00</td>
<td>25.00</td>
<td>25.00</td>
<td>24.00</td>
</tr>
<tr>
<td>% Women in Management</td>
<td>14.00</td>
<td>14.00</td>
<td>13.00</td>
<td>12.00</td>
<td>12.00</td>
<td>12.00</td>
</tr>
</tbody>
</table>
Shareholder and Lender Concerns

- U.S. and Canada over 40 shareholder resolutions filed with companies primarily requesting greater transparency and data reporting on environmental and social impacts and policies to mitigate risks. Many more backroom conversations.

- U.S. Security and Exchange Commission sent over 70 letters to companies to improve disclosure related to environmental risks related to use of hydraulic fracturing and horizontal drilling technologies.

- Globally one of the most active investor issues with United Nations Principals for Responsible Investors coordinating corporate engagement.

- Transparency and disclosure the biggest investor requests.

- Loss of social license to operate.
Well Locations + Water Stress Maps...

WRI Aqueduct Water Risk Atlas*

Drought & Groundwater Data**


** Konikow Groundwater Depletion Study USGS Study, Report 2013-5079
United States

Water Use Trends for Hydraulic Fracturing

U.S. Data Summary (January 1, 2011 - May 31, 2013) as reported by FracFocus

**WATER USE TRENDS**

Number of Wells Used to Calculate Water Volume Data: 39,294

Total Water Use (gallons): 97.5 billion

Average Water Use (gallons/well): 2.5 million

**EXPOSURE TO WATER RISKS**

Proportion of Wells in High or Extreme Water Stress: 48%

Proportion of Wells in Medium or Higher Water Stress: 73%

Proportion of Wells in Drought Regions (as of Jan. 7, 2014): 56%

**LOCAL WATER USE IMPACTS**

Water Use in Top 10 Counties as Proportion of Water Use Nationally

Number of Counties with Hydraulic Fracturing Activity: 402

Highest Water Use by a County (gallons): Dimmit County, Texas

4 billion

**OPERATING TRENDS**

Type of Wells Reported:

- Oil: 53%
- Gas: 47%

Number of Operators Reporting to FracFocus (1st Quarter 2013)

- 253

**OPERATORS**

Top Three in U.S. by Water Use:

- Chesapeake
- EOG
- XTO

**SERVICE PROVIDERS**

Top Three in U.S. by Water Use:

- Halliburton
- Schlumberger
- Baker Hughes

www.ceres.org/shalemaps
State Trends

Figure 6: States with most reported hydraulic fracturing activity by water stress category.

Baseline Water Stress:
- Extremely High (>80%)
- High (40-80%)
- Medium to High (20-40%)
- Low to Medium (10-20%)
- Low (<10%)
- Arid & Low Water Use

States with less than 100 wells excluded.
Eagle Ford Data Summary (January 1, 2011 - May 31, 2013)

**WATER USE TRENDS**
- Total Water Use (gallons): 19.2 billion
- Average Water Use (gallons/well): 4.5 million

**EXPOSURE TO WATER RISKS**
- Proportion of Wells in *High or Extreme Water Stress*: 28%
- Proportion of Wells in *Medium or Higher Water Stress*: 98%
- Drought Region as of January 7, 2014 (yes or no): Yes
- Groundwater Challenges (yes or no): Yes

**LOCAL WATER USE IMPACTS**
- Concentration of Water Use: Top Three Water Use Counties as a Proportion of Total Water Use in Play
  - Top Three by Water Use: Chesapeake, Anadarko, EOG
  - Top Three by Water Use: Halliburton, Schlumberger, C&J

---

Alberta Data Summary (January 1, 2011 - May 31, 2013)

**EXPOSURE TO WATER RISKS**
- Proportion of Wells in *High or Extreme Water Stress*: 14%
- Proportion of Wells in *Medium or Higher Water Stress*: 20%

**OPERATING TRENDS**
- Number of Operators in Region: 88
- Top Three by Water Use: Encana, Apache, Peyto
- Top Three by Water Use: Not available

---

*Note: The maps and data presented are indicative and have been manipulated for illustrative purposes.*
Average water use for major plays/basins from the first quarter of 2011 to end of the first quarter of 2013. Average water use can increase due to technical or geologic factors, movement from vertical to horizontal drilling or increasing length of pipes used in horizontal drilling.

Source: Ceres analysis using PacWest FracDB from FracFocus.org.
Average Water Use per Well

**Figure 3: Average Water Use per Well by Type of Production**

- **Horizontal Gas**: 4.8 M Gallons
- **Horizontal Oil**: 3.2 M Gallons
- **Vertical Gas**: 0.7 M Gallons
- **Vertical Oil**: 0.5 M Gallons

Source: Ceres analysis using PacWest FracDB from FracFocus data from wells drilled January 2011-May 2013.
Corporate Exposure: Operators

Figure ES4: Top Ten Operators by Number of Wells & Exposure to Water Stress

- Number of Wells on the y-axis
- Percent of Wells in Medium or Higher Water Stress Regions on the x-axis
- Area of circles represents total water use by operator

Companies represented:
- Chesapeake
- Anadarko
- XTO
- EOG
- Southwestern
- Devon
- Pioneer
- Apache
- Encana
- Oxy
Corporate Exposure: Service Providers

FIGURE ES5: TOP TEN SERVICE PROVIDERS BY WATER USE & WATER STRESS CATEGORY

- Halliburton
- Baker Hughes
- Schlumberger
- FTS
- Calfrac
- Weatherford
- Nabors
- Trican
- Universal
- Pioneer

Number of Wells

Percent of Wells in Medium or Higher Water Stress Regions

Area of circles represents total water use by service provider.
Development and Water Use
Very Localized

PERCENTAGE OF WELLS IN TOP THREE MOST ACTIVE COUNTIES PER PLAY

Permian (Andrews, Glassock, Midland)
Marcellus (Bradford, Susquehanna, Lycoming)
Eagle Ford (Karnes, La Salle, Dimmit)
Barnett (Tarrant, Montague, Wise)
Haynesville (DeSoto, Panola, Red River)
Bakken (McKenzie, Mountrail, Williams)
Fayetteville (Van Buren, White, Conway)
DJ Basin (Weld, Laramie, Larimer)
Piceance (Garfield, Rio Blanco, Mesa)
Uinta (Uintah, Duchesne, Carbon)

Proportion of wells developed in top three counties by activity versus all wells developed for entire play/basin.

www.ceres.org/shalemaps
Wastewater Management and Disposal Wells

Barnett Disposal Volumes

Earthquakes and Disposal Wells


Water Sourcing and Governance

- **Transparency** in current AND FUTURE regional water requirements in context of local needs (amounts and sources)
- **Transparency** in current AND FUTURE regional wastewater disposal requirements (amounts and fate)
- **Proactive** stakeholder engagement
- **Recycling and beneficial reuse** – careful management
- **Better Groundwater** management
- **Brackish groundwater use risks**
- **Stakeholder issues** consult versus consent
- **Wastewater management** and deep well injection issues.
- **Water Allocation and Better Management**: groundwater, surface water, cumulative impacts, population growth, climate change.

**Apache’s Water Network**

Ground water change in California, Nasa’s GRACE

**USGS National Brackish Groundwater Assessment**
Thank you

Monika Freyman, Ceres’ Water Program
freyman@ceres.org

www.ceres.org/shalemaps