Water Use In the Eagle Ford Shale Play: A Systems Dynamics Approach

Jeanne Eckhart

Virtual Policy Fellow, American Water Works Association

Masters Candidate Energy and Earth Resources, The University of Texas at Austin
Objectives of Study:
- Assess localized water use impacts from Eagle Ford shale play
- Utilize a Systems Dynamics approach
  - Input from different stakeholders
  - Output: policy recommendations
- Accessing data only made publicly available
  - FracFocus
- Timeline of Study
  - Approximately 5 months

Federal vs. State vs. more localized
- Federal Level
  - Different shale plays have different attributes that are not uniform across the nation
- State Level Water Usage (TWDB State Water Plan, 2012)
  - Mining (includes O&G development) uses approximately 1.6% of the water used in the state
  - Use from mining expected to decrease by 2060
  - Shale play development significantly different in each region of Texas
- Local Level
Water Use Difficult to Track

Nicot, 2013
State of the Eagle Ford Area: GROWTH

- Tremendous growth since 2008
- Texas experiencing drought conditions through this extreme growth period

**Eagle Ford Task Force Report, 2013**

<table>
<thead>
<tr>
<th>Year</th>
<th>OIL PRODUCTION</th>
<th>Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>358</td>
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<tr>
<td>2009</td>
<td>844</td>
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<tr>
<td>2010</td>
<td>11,986</td>
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<tr>
<td>2011</td>
<td>126,459</td>
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<td>2012</td>
<td>338,911</td>
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<table>
<thead>
<tr>
<th>Year</th>
<th>GAS PRODUCTION</th>
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<tr>
<td>2008</td>
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<tr>
<td>2009</td>
<td>47</td>
<td>487%</td>
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<tr>
<td>2010</td>
<td>216</td>
<td>360%</td>
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<tr>
<td>2011</td>
<td>959</td>
<td>344%</td>
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<td>2012</td>
<td>964</td>
<td>0.5%</td>
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<table>
<thead>
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<th>Year</th>
<th>CONDENSATE PRODUCTION</th>
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<tr>
<td>2009</td>
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<tr>
<td>2010</td>
<td>13,708</td>
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<tr>
<td>2011</td>
<td>70,934</td>
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<td>2012</td>
<td>72,126</td>
<td>1.6%</td>
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<table>
<thead>
<tr>
<th>Year</th>
<th>DRILLING PERMITS</th>
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<tr>
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<td>26</td>
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<tr>
<td>2009</td>
<td>94</td>
<td>261%</td>
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<tr>
<td>2010</td>
<td>1,010</td>
<td>974%</td>
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<tr>
<td>2011</td>
<td>2,826</td>
<td>180%</td>
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<tr>
<td>2012</td>
<td>4,145</td>
<td>46%</td>
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<table>
<thead>
<tr>
<th>Year</th>
<th>PRODUCING OIL WELLS</th>
<th>Growth</th>
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<tbody>
<tr>
<td>2009</td>
<td>40</td>
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<tr>
<td>2010</td>
<td>72</td>
<td>80%</td>
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<tr>
<td>2011</td>
<td>368</td>
<td>41%</td>
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<td>2012</td>
<td>1,262</td>
<td>243%</td>
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<table>
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<tr>
<th>Year</th>
<th>PRODUCING GAS WELLS</th>
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<tr>
<td>2008</td>
<td>67</td>
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<tr>
<td>2009</td>
<td>158</td>
<td>136%</td>
</tr>
<tr>
<td>2010</td>
<td>550</td>
<td>248%</td>
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<tr>
<td>2011</td>
<td>855</td>
<td>55%</td>
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Wells and County Locations
Region L

Regional Water Planning Area - Region L

Map Legend
- All Regions
- Major River
- Existing Reservoir
- River Basin
- Interstate Highway
- U.S. Highway
- State Highway
- City
- County
- Major Aquifer
  - Gulf Coast
  - Edwards, Aquifer (subzone)
  - Edwards-Trinity, Edwards (subzone)
  - Edwards-Trinity/Edwards (subzone)
  - Trinity (subzone)
  - Edwards (subzone)

## Water Use in Select Counties

<table>
<thead>
<tr>
<th></th>
<th>De Witt County</th>
<th>Dimmit County</th>
<th>Gonzales County</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>2010</strong></td>
<td><strong>2011</strong></td>
<td><strong>2011</strong></td>
</tr>
<tr>
<td>Municipal</td>
<td>998,407,464 59.38%</td>
<td>1,328,494,527 42.04%</td>
<td>1,574,837,883 23.66%</td>
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<tr>
<td>Manufacturing</td>
<td>59,956,584 3.57%</td>
<td>78,855,942 2.50%</td>
<td>691,781,673 10.39%</td>
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<tr>
<td>Mining</td>
<td>20,854,464 1.24%</td>
<td>709,377,627 22.45%</td>
<td>9,123,828 0.21%</td>
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<tr>
<td>Livestock</td>
<td>550,362,339 32.73%</td>
<td>847,212,600 26.81%</td>
<td>1,776,865,503 41.02%</td>
</tr>
<tr>
<td>Irrigation</td>
<td>51,810,309 3.08%</td>
<td>195,836,451 6.20%</td>
<td>424,909,704 9.81%</td>
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<tr>
<td><strong>De Witt County Total</strong></td>
<td>1,681,391,160</td>
<td>3,159,777,147</td>
<td>4,331,537,343</td>
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<tr>
<td></td>
<td><strong>Dimmit County Total</strong></td>
<td></td>
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</tr>
<tr>
<td>Municipal</td>
<td>834,504,411 17.39%</td>
<td>782,042,400 19.68%</td>
<td>1,574,837,883 23.66%</td>
</tr>
<tr>
<td>Mining</td>
<td>326,828,553 6.81%</td>
<td>1,208,255,508 30.41%</td>
<td>9,123,828 0.21%</td>
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<tr>
<td>Livestock</td>
<td>179,869,752 3.75%</td>
<td>151,520,715 3.81%</td>
<td>1,776,865,503 41.02%</td>
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<tr>
<td>Irrigation</td>
<td>3,457,604,961 72.05%</td>
<td>1,831,934,322 46.10%</td>
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<tr>
<td><strong>Dimmit County Total</strong></td>
<td>4,798,807,677</td>
<td>3,973,752,945</td>
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<tr>
<td></td>
<td><strong>Gonzales County Total</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Municipal</td>
<td>1,338,595,908 30.90%</td>
<td>1,574,837,883 23.66%</td>
<td>691,781,673 10.39%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>782,042,400 18.05%</td>
<td>9,123,828 0.21%</td>
<td>1,776,865,503 41.02%</td>
</tr>
<tr>
<td>Mining</td>
<td>9,123,828 0.21%</td>
<td>732,187,197 11.00%</td>
<td>424,909,704 9.81%</td>
</tr>
<tr>
<td>Livestock</td>
<td>1,776,865,503 41.02%</td>
<td>1,438,306,314 21.61%</td>
<td>2,219,697,012 33.34%</td>
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<tr>
<td>Irrigation</td>
<td>424,909,704 9.81%</td>
<td>2,219,697,012 33.34%</td>
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<tr>
<td><strong>Gonzales County Total</strong></td>
<td>4,331,537,343</td>
<td>6,656,810,079</td>
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</tbody>
</table>

(Source: TWDB, 2013)
Region L: Water Stresses

- Drought
- Unmet irrigation needs
- Increasing needs for more water through 2060 projections
- Increasing population

County Level Water Usage
- Reliance on GMA’s & GCD’s to implement some regulation on GW usage in region
  - Evergreen GCD
  - Wintergarden GCD
Major Studies Recap

- **Eagle Ford Task Force Report (RRC, 2013)**
  - Trend to gel fracs
  - 850 gallons of water/ft of fracture
  - ~5 million gallons of water/well
  - Carrizo-Wilcox Aquifer = 80% of EF
    - Likely able to handle load
    - “Water Market” created in EF
    - Produced water - future source

- **UT study (Nicot, 2012)**
  - Data set for EF less certain
  - ~90% of water initially injected in EF is GW
  - ~20% brackish water
  - ~0% recycling/reuse water
  - Future trend: Freshwater use decrease; Brackish water use increase

- **Ceres Study (Freyman, 2013)**
  - 51% of TX wells = high water stress areas

- **Texas House Natural Resources Committee Interim Report (2013)**
  - Projected O&G water demand in EF ~ 5.5
    - 6.7% of total water demand in that region
  - ~1500 wells drilled using ~6.1 million gal/well
  - Over next 20 yrs. ~25,000 new wells will be drilled in EF
  - Difficult to predict and manage GW availability
  - Wintergarden GCD – impact to water supply should be assessed by local scale
    - 1/3 of avg. annual recharge in Carrizo-Wilcox Aquifer required to develop EF
    - Recharge rates slower than pumping rates in historical past of aquifer
Major Assumptions for this Study

• Most water use quantities reported on FracFocus are for entire life cycle of well
  – Hydraulic fracturing makes a large component of that amount
• Water is consumed, not just withdrawn
• Most wells in region are horizontal, not vertical
Stakeholder Input:
- Oil and Gas Industry
- Policymakers and advisors (both state and federal)
- Local and other public representatives
- Water users, planners, and regulators
- Academia
- Environmental Entities
- Landowners

Methods: Systems Dynamics Approach

Pierce, 2008
Methods: Trends

- “Trend” method – 5% off the top and the bottom of the data to create an average without outliers
- FracFocus
  - DeWitt, Dimmit, and Gonzales county analyses
- SkyTruth
  - 27 county analysis of average water trends for Eagle Ford
- Sky Truth vs. FracFocus
  - Difference between these two on a large scale not significant when assessing just average water use trends from the FracFocus header data
  - *Note: More in-depth analysis will be needed to if assessing beyond average trends*
Eagle Ford Region Findings

- Approximately 5 million gallons of water used per a well in region

- Although increasing average trend of water use can be seen, this is most likely due to large growth in region

- Major companies in region have variable average water use trends

<table>
<thead>
<tr>
<th>Year</th>
<th>Average Water Use in Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1,000,000</td>
</tr>
<tr>
<td>2012</td>
<td>2,000,000</td>
</tr>
<tr>
<td>2013</td>
<td>4,000,000</td>
</tr>
</tbody>
</table>

Eagle Ford Average Water Use Per Well Over Time

Average Water Use in Gallons

- Overall Average
County Findings

De Witt County Per Well Averages

Gonzales County Per Well Averages

Dimmit County Per Well Averages
Challenges to Research

- Talking to industry – variable input
- Collaboration
- Accessing information
  - Quality control of data & data validation
- FracFocus database:
  - Prior to June 2013, database validity checks not as strong as current version implements
  - Voluntary input in 2011, 2012, and part of 2013 within Texas
- Data consistency lacking due to structural database changes, voluntary submission, and ease of database maneuverability to gather research in a timely manner
Visible Trends & Other Considerations

- Most operators source the water themselves (not the service companies)
  - Usually means groundwater wells
- Disconnect between what water planners are planning for and actual mining use
  - Need to further assess
- A relatively slow industry trend towards brackish water use in area
  - Brackish water use highly variable by company

- Other things to consider in further analysis:
  - Population growth from EF eco. development
  - Changing water use demands of O&G because of recycling/reuse, market fluxes, and other factors (scenarios)
  - Other water stresses and competition (i.e. irrigation in region and GW recharge)
Policy Recommendations

- Promote tracking of sources of water used for O&G operations
- Promote transparency and ease of access to information
- Promote water plans that:
  - Account for O&G operations during drought planning, especially for water stressed localities
  - Considered scenarios of changes of water demand by O&G industry over projection time periods
  - Although mining is a small portion on a large scale, localized affects should be assessed in water stressed regions
- Promote O&G industry to have effective water management plans for every well site
  - Plans that include an assessment of water use in that area
- Promote policymakers and regulators to have more inclusive definitions in regulations and laws
Questions?

Jeanne Eckhart

Virtual Policy Fellow, American Water Works Association

Masters Candidate, The University of Texas at Austin

jeanne.eckhart@gmail.com

Adam Carpenter

Regulatory Analyst

1300 Eye St. NW; Suite 701W, Washington, DC 20005

202-628-8303

acarpenter@awwa.org
Texas Overview

- State & Local Regulators:
  - Texas Railroad Commission
  - Texas Commission on Environmental Quality
  - Groundwater Management Areas
  - Groundwater Conservation Districts

- Recent regulations:
  - RRC: Hydraulic Fracturing Disclosure Rule - O&G required to submit to Fracfocus.org (since Feb. 2013)
  - RRC: Amendment to recycling/reuse rules to make these technologies easier to utilize