Produced Water Accounting and Characteristics: the Case of Hydraulic Fracturing in Texas

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2013 GSA Annual Meeting & Convention
Denver, CO – October 30, 2013
Hydraulic fracturing (HF) of a well requires large amounts of water
but only some of it flows back to the surface
From Nicot, Scanlon, Reedy, and Costley, Source and Fate of Hydraulic Fracturing Water in the Barnett Shale: A Historical Perspective, in review ES&T
Hydraulic Fracturing Water Use

2011: 81.5 kAF
~0.5% of state water use
2013: >100 kAF

Source of raw data: IHS Enerdeq database

IHS, FracFocus, Skytruth
Water use in other states

• Large volumes, 10’s of thousands of HF wells in the US, generally small % of total water use (~2013)
  • ND (Bakken): ~22 kAF (27 Mm$^3$)
  • PA (Marcellus): >20 kAF (>25 Mm$^3$)
  • CO: ~20 kAF (25 Mm$^3$)
  • OK: ~15 kAF (18 Mm$^3$)
  • TX: ~100 kAF (123 Mm$^3$)

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- 600 million bbl/yr oil
- 650 bcf/yr gas
- ~25% of U.S. production
- ~500 kAF O&G
- 7220 million bbl/yr salt water
- ~930 kAF

Approximate values for ~2012-2013

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Based on ~30% of water use

**Fraction from recycling / reuse and brackish water**

- **Anadarko:**
  - R/R: 20%
  - BK: 30%

- **Midland:**
  - R/R: 2%
  - BK: 30%

- **Delaware:**
  - R/R: 0%
  - BK: 80%

- **Barnett:**
  - R/R: 5%
  - BK: 3%

- **East Texas:**
  - R/R: 5%
  - BK: ~0%

- **Eagle Ford:**
  - R/R: ~0%
  - BK: 20%

- **Fresh water**
- **R/R Brackish**
Flowback at end of Year 1

- Anadarko: ~100%
- Barnett: ~60%
- Midland: ~75%
- Haynesville: ~15%
- Delaware: ~80%
- Cotton Valley: ~60%
- Eagle Ford: ~20%

Based on ~30% of water use
Monthly produced water percentiles – Barnett Shale

Number of wells having produced that many months

90th percentile

Median

5th percentile

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Cumulative produced water percentiles – Barnett Shale

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Time variability of produced water fraction

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County-level produced water fraction
Barnett Shale: County-level produced water fraction from well completion

- 1 month
- 2 months
- 3 months
- 6 months
- 1 year
- 2 years
- 3 years

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Cumulative produced water percentiles – Eagle Ford

Number of wells

- 70th percentile
- Median
- 30th percentile
- 5th percentile
Barnett Shale: Annual injection well volumes through time (Ellenburger Fm.)

- 2000
- 2001
- 2002
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
- 2011

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Summary

• Amount of flowback / produced (FP) water is very variable; higher for tight formations
• Water production decline is similar to that of oil and gas
• Only a small and early fraction of the FP water is recycled
• Deep-well injection of FP water is the norm in Texas but overall FP volumes are small relative to other sources
• Amount of FP water is negatively correlated with well productivity (shales)