Water Management Trends & The Eagle Ford

EFCREO Shale Oil & Gas Development Workshop:
Management of Water Resources, Air Resources and Oilfield Waste

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Maximize hydrocarbons, minimize water

November 18, 2014
Water Use to Develop Energy Becoming Critical Tipping Point

Source: World Resources Institute: Global Shale Gas Development, 2014
How Much Does Water Cost?

- Fresh Water Sourcing: $0.30 – 0.80/bbl, 3%
- Fresh Water Transport: $1.00 – 4.00/bbl, 19%
- Fresh Water Storage: $1.00 – 4.00/bbl, 9%
- Fresh Water Treatment: $0.10 – 0.50/bbl, 4%
- Fresh Water Transfer: $0.60 – 1.00/bbl, 4%
- Fracture Treatment: $1.00 – 2.00/bbl, 7%
- Flow back / Produced Water Storage: $2.00 – 6.00/bbl, 25%
- Flow back / Produced Water Transport: $1.00 – 10.00/bbl, 29%

**$400K - $1,700K PER WELL**

**$7.46 - $9.23 PER BBL OF OIL PRODUCED**
Oilfield Water is Complex

Key Contaminants

- TSS
- Oil
- Heavy Metals
- Hardness
- Sulfides
- Boron

Interferes with cross link performance

- Sours wells, corrosion, reduces production
- Interferes with breakers
- Dangerous to personnel
- Inhibits proper hydration of polymers
- Causes pre-mature cross linking

Damages formation, reduces permeability

Sours wells, corrosion, reduces production

Interferes with cross link performance

Dangerous to personnel

Inhibits proper hydration of polymers

Causes pre-mature cross linking
There is no “silver bullet” for water treatment solutions
Today's Water Management Focus Areas

**Decrease Costs**
- Simple, low-cost, reliable, serviceable technologies
- High volume treatment
- Integrated approach for optimized operations

**Increase Reliability**
- Consistent, reliable water sources
- Water has to travel with you
- Robust, proven technology

**Innovate**
- Fracture fluid chemistry for high TDS waters
- Real time measuring and monitoring
- Data collection and management software
- Turn produced water waste into an asset

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Safety & Reservoir Optimization
Water Reuse/Recycling is Expected to Grow

2014F Produced & Flowback Water (25.5 Billion barrels)

- **Re-Injection**:  58%
- **E&P Saltwater Disposal**: 24%
- **Third-Party Disposal**: 17%
- **Recycle/Reuse**: 2%

Growth in Water Recycled and Treatment Market

- **Reuse/Recycle Volume**: CAGR 35%
- **Water Treatment Spend**: CAGR 26%

Source: PacWest
# Water Services Spend Will Move from Logistics to Treatment

## Where the market is concentrated today

<table>
<thead>
<tr>
<th>% of Spend</th>
<th>Anadarko</th>
<th>Bakken</th>
<th>DJ Basin</th>
<th>Eagle Ford</th>
<th>Marcellus</th>
<th>Permian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sourcing</td>
<td>3%</td>
<td>3%</td>
<td>2%</td>
<td>11%</td>
<td>3%</td>
<td>7%</td>
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<td>Pre-Treatment</td>
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<td>Flowback Services</td>
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<td>Hauling</td>
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<td>Transfer</td>
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<td>Storage</td>
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<td>24%</td>
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## Where the market is growing tomorrow

<table>
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<tr>
<th>'14 - '16 CAGR</th>
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*Source: PacWest*
Eagle Ford: Highest Water Use, 3rd Largest Water Production

Fracture Water Use by Basin

- Eagle Ford: 9.9% CAGR, 19.6%
- Permian: 14.0%
- Marcellus: 12.5%
- Anadarko*: 10.5%
- Bakken: 21.0%
- DJ Basin: 11.0%

Flowback & Produced Water by Basin

- Permian: 5.4% CAGR
- Anadarko*: 2.2%
- Eagle Ford: 23.6%
- Bakken: 16.0%
- DJ Basin: 17.1%
- Marcellus: 9.4%

Source: PacWest
Note: “Anadarko Basin” includes Anadarko Woodford, SCOOP, STACK, Cleveland; Tonkawa, Granite Wash, Cana Woodford and Mississippian
Eagle Ford: Disposal is King, Water Treatment Growing

Eagle Ford Water Volumes & End Use

Water Treatment as a % of Volume by Play

Source: PacWest
Note: “Anadarko Basin” includes Anadarko Woodford, SCOOP, STACK, Cleveland; Tonkawa, Granite Wash, Cana Woodford and Mississippian
High Volumes of Produced Water Far from Disposal Wells

Source: Digital H2O
Challenges in Disposal

- Managed by EPA under Safe Water Drinking Act

- Current issues
  - Reported Earthquakes
    - Typically less than 2.9, but some >5.0 in Barnett and Arkansas
    - Ban on disposal wells in western Arkansas
  - Transportation
    - $40k lane/mile for repairs
      (Denton County, TX)
  - Accidents
    - Eagle Ford shale – La Salle County >400% increase since 2008
    - Eagle Ford shale – McMullen County >1000% increase
Texas: Model for Water Management?

- Over 100 technical and complex oil and gas regulations, active inspection program
- P&A abandoned wells to prevent groundwater contamination (2011)
  - Oil & Gas Regulation and Cleanup Fund (Senate Bill 1, 82nd Legislature)
- Improved transparency and communication with industry and communities (2011)
- Requires mandatory reporting of chemicals used in frac fluid (2012)
  - Hydraulic Fracturing Disclosure (Statewide Rule 29, Texas Administrative Code, Title 16, Part 1, §3.29)
- Established stringent well-integrity, well-construction rules (2013)
  - Casing, Cementing, Drilling, Well Control, and Completion Requirements (Statewide Rule 13, Texas Administrative Code, Title 16, Part 1, §3.13)
- Encouraged water recycling and conservation in the oilfield (2013)
  - Water Protection (Statewide Rule 8, Texas Administrative Code, Title 16, Part 1, §3.8), Texas HB 2767 (83rd Legislature), Texas Water Recycling Association
- Amends disposal well rules to address operations in areas of historic or future seismicity (2014)
  - Disposal Wells (Statewide Rule 9 & 46, Texas Administrative Code, Title 16, Part 1, §3.9 and §3.46)
- Coordinate among energy producing states to share best practices, challenges
  - Membership in Interstate Oil and Gas Compact Commission (IOGCC), “States First” initiative, State Oil & Gas Regulatory Exchange (SOGRE), State Review of Oil & Gas Environmental Regulations (STRAWER), Independent Petroleum Association of America (IPAA)

Source: TRRC; Sustainable Water Management in the Texas Oil & Gas Industry, Atlantic Council, 2014
Water Management in an $80/bbl Oil Market

Oil Economics – Price Required for a 10% ATROR*

Source: TudorPickering Holt & Co, Company Filings and Presentations, RigData
Note: Price Required for 10% ATROR – economics assumes $3.75/mcf NYMEX
CMT Refers to the Cleveland, Tonkawa, Marmaton

TPHe ~ 150-160 hz rigs at risk
TPHe ~ 30 vt rigs at risk
Key Takeaways

- Water scarcity is leading to *increased scrutiny and regulation*
- Water costs include *direct costs, indirect costs, and financial risks*
- There is *no silver bullet* for water treatment
- Today *water* is viewed as a commodity, what will be its *true value* tomorrow?
- The goal is to *decrease costs, increase reliability, continue innovation*
- Water *recycling is* predicted to *grow* rapidly
- Declining oil prices will *shift focus to subsurface*
New State Rules

  - Chapter 4 reorganized to cover solid and fluid recycling separately
  - Rule 3.8 clarifies that an operator does not need permits to recycle fluids on their own leases

- New California Statute SB4 (2013)
  - Applies to all well stimulation, not just HF
  - Includes full HF fluid disclosure requirements

- Proposed Rules in Wyoming (2014)
  - Would require baseline water testing before drilling starts
  - Challenges from industry on nitrate testing (agricultural sources)
  - Environmental groups want broader tests and to include methane