Energy Water Initiative (EWI)
Water Management Case Studies, Water Reuse & the Future

Oklahoma Governor's Water Conference
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“Coming together is the Beginning. Keeping together is Progress. Working together is SUCCESS.”

- Henry Ford
EWI Case Study Participants
Energy Water Initiative (EWI)

• Collaborative effort among oil and natural gas companies to study, communicate and improve lifecycle water use in onshore Ops

• Recognize the importance of water management and conservation, and the role technology and knowledge-sharing can play in continuous improvement

• Develop recommended management practices and technologies to efficiently use and conserve water resources

• Provides fact-based information to regulators, NGOs, and other stakeholders
Case Study Project Objectives

- Illustrate the diverse, regional water resource challenges the industry faces
- Share innovative strategies and lessons learned:
  - Continually evolving water stewardship practices
- Educate stakeholders
- Share advancements in industry
Typical Water Use and Management
Typical Water Production by Well

- Eventually produced water production decline
- Water, oil and gas are separated
- Water is reused or properly disposed of according to regulations

1000 gallons = 31.75 barrels
1000 barrels = 31,500 gallons
Trend 1: Improvement in Chemistry

• Enables industry to use non-freshwater

• Water quality and quantity varies
  – Crosslink: higher quality, less volumes
  – Slickwater: lesser quality, higher volumes
Case Example: Apache

- Apache is conducting slickwater stimulation without fresh water
- Recycling 100% of produced water
Trend 2: Treatment Tech. Innovation

• Increased viability of use of produced water

• Due to technological improvements, operators are better able to use lower quality water

• Treatment of produced water is an option in certain circumstances

Pioneer partnered with a startup company with a new carrier gas extraction (CGE) process that desalinates produced water with less energy and lower operating costs than comparable commercial technology. The first-of-its-kind plant …
Trend 2: Treatment Tech. Innovation

• Innovations in water treatment applications
• Goal is low cost and environmentally safe
• Limited disposal options: making reuse more viable
• Disposal include:
  – Injection wells
  – Treatment to discharge
Case Example: QEP Recycling

- Liquids gathering system (LGS) facilitates an increased use of water recycling
- The LGS is used by multiple operators and water is treated to different standards depending on necessary requirements
- Recycling water reduces fresh water use and air emissions

QEP Wyoming Green River Basin

QEP Recycled Water Use

<table>
<thead>
<tr>
<th>Year</th>
<th>Recycled Water Use (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>65</td>
</tr>
<tr>
<td>2009</td>
<td>88</td>
</tr>
<tr>
<td>2010</td>
<td>95.5</td>
</tr>
<tr>
<td>2011</td>
<td>99.5</td>
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<tr>
<td>2012</td>
<td>99.5</td>
</tr>
<tr>
<td>2013</td>
<td>99.5</td>
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</tbody>
</table>
Case Example: Newfield Exploration

- Recycling over 98% of all produced water in Utah operations
- Separate treatment facilities for each completion and waterflood operation
Case Example: Southwestern Energy

• Developed centralized waste treatment facility
• Achieved near-zero disposal of produced water
• Clean, treated water can either be used for operational needs or discharged via NPDES permit
Trend 3: Water Conveyance Improvements

• Companies are increasingly using pipelines

• Decreasing truck traffic, road impact, and safety issues

• Temporary lines can be used for short term needs

• Systems need to be flexible

• Layflat hose provides compact, large capacity pipe
Case Example: Pioneer Natural Res.

• Construction through 2019
• 20 subsystem networks
• 125+ water storage ponds connected
• Non-fresh source water from Odessa and potentially Midland’s effluent water
• $100 million in 2015 on water infrastructure
Case Example: Anadarko Petroleum

- Constructed a pipeline network for water in Marcellus
- Treats flowback and produced water for reuse onsite
- Eliminated more than 80,000 truck trips in 2014
Case Example: BP

- Co-location production and disposal facilities reduce truck traffic by 14,810 trips in 2013
Trend 4: New Water Storage Designs

• Steel fracturing tanks and impoundments used to store water

• New designs provide flexibility for quantity stored

• Type of storage unit can be influenced by surface owner, regulations and topography
Trend 4: New Water Storage Designs

- Regulations and industry practices prevent leaks, protect groundwater, and safeguard the environment.

- Advances in the design of large storage systems address variables such as slopes, soil composition, moisture control, dual liners, sump, liner thickness, covers and monitoring wells.
Case Example: Devon Energy

• Store brackish water in in-ground impoundments
• Constructed with felt and 40-mil HDPE liners
• Equipped with water level transducers connected to SCADA system
Trend 5: Transparency with Stakeholders

• Increased data gathering and public disclosure
• EWI is an example of industry collaboration
• FracFocus is a national registry managed by Ground Water Protection Council (GWPC)
• 85,000 disclosures to FracFocus (2011-2014)
Trend 6: Dedicated Water Staff

• Dedicated teams to facilitate water management
  – Separate entity (LLC)
  – Corp. experts
  – Asset-based water teams

• Improve water management planning, technical support, and performance

• Companies are centralizing lessons learned, establishing standards, identify subject matter experts
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Six Trends for Progressive Water Management

• Improved Chemistry
• Treatment Technology Innovations
• Water Conveyance Improvements
• New Water Storage Designs
• Transparency with Stakeholders
• Dedicated Water Staff
Future: Water Infrastructure Reduces Costs & Promotes Reuse

• Trucking can be a large component in water costs

• Pipelines and storage can reduce trucking

• Infrastructure allows more volume processing and lower treatment costs for reuse
Challenges of Water Infrastructure

• Changing rig schedules and strategic plans
• Costs are front loaded
• Fractionated ownership of mineral interests
• Right-of-way access
• Medium to longer term time horizon required
• Not the traditional “core business” for oil companies
Benefits to Everyone

• Lower costs

• Easier to recycle and have multiple water supply options

• Lower community impacts
  – Fewer trucks on the road
  – Easier to substitute brackish for fresh water
Thank You