PRODUCED WATER REPORT

Regulations, Current Practices & Research Needs
Leadership Team

**Project Co-leaders**
- Shellie Chard, ODEQ | John Baza, UDOGM

**Intro. & Module 1 Leaders**
- Shellie Chard | John Baza

**Module 2 Leaders**
- Scott Kell, ODOGRM | Tom Kropatsch, WOGCC

**Module 3 Leaders**
- Ken Harris, formerly DOGGR | Nichole Saunders, EDF

**Contractors**
- Michael Dunkel, Worley
- John Veil, Veil Environmental Consulting

**GWPC Staff**
- Mike Paque | Mike Nickolaus | Erica Carr, GWPC
Study Partners
Project Timeline

GWPC Board Resolution
- April 2017

Module 1 draft to editor
- June 2017

Module 3 draft to editor
- October 2018

Module 2 & 3 final drafts to editor
- November 2018

Publication
- January 2019

Initial workgroup meeting
- February 2019

Module 2 draft to editor
- March 2019

Module 1 final draft to editor
- April 2019

Report approved at GWPC Board Meeting, pending suggested edits
- Summer 2019
Project Timeline

GWPC Board Resolution

Module 1 draft to editor

Module 3 draft to editor

Module 2 & 3 final drafts to editor

Publication

April 2017

June 2017

October 2018

November 2018

January 2019

February 2019

March 2019

April 2019

Summer 2019

Initial workgroup meeting

Module 2 draft to editor

Module 1 final draft to editor

Report approved at GWPC Board Meeting, pending suggested edits
Developing Solutions: A Modular Approach

MODULE 01

Regulatory & Legal Frameworks
This module describes the current legal and regulatory frameworks that address produced water. It also addresses changes that may need to occur to facilitate the use of produced water.

Leadership:
John Baza, Utah Division of Oil, Gas & Mining Shellie Chard: Oklahoma DEQ, Water Quality

MODULE 02

Produced Water Use in the Oilfield
This module describes the current uses and potential future uses of produced water inside the oilfield. It defines the existing constraints of use and identifies the opportunities and challenges of expanded use.

Leadership:
Tom Kropatsch: Wyoming Oil & Gas Commission Scott Keil: Ohio Department of Natural Resources

MODULE 03

Produced Water Use & Research Needs Outside the Oilfield
This module describes current and potential use of produced water outside the oilfield and identifies the research needs that will need to be addressed to facilitate expanded use.

Leadership:
Ken Harris: California Department of Conservation Nichole Saunders, Environmental Defense Fund
Report Goals

- GWPC hopes this report will be used to:
  - Educate the public
  - Encourage oil and gas industry, state and federal regulatory agencies to gather data
  - Inform new research
  - Expand the use of produced water in a manner that is protective of the environment and public health.
What is Driving the Produced Water Conversation?

• Volume of produced water
• Fresh water stress due to rising and relocating populations and regional droughts
• Induced seismicity

Source: https://myweb.rollins.edu/jsiry/Waterbasics.html
State Regulation

- Oil and gas waste stream exempt from RCRA Subtitle C
- Federal permitting programs administered by (most) states through NPDES and UIC Programs
- Authority housed in either oil and gas or environmental agencies (sometimes both)
- Regulations differ between states based on: geography, geology, hydrology, climate – weather and political, state statutory authority, state court interpretations, infrastructure, and historical practices.
<table>
<thead>
<tr>
<th>Sourcing and Ownership</th>
<th>Transportation</th>
<th>Storage</th>
<th>Hydraulic Fracturing</th>
<th>Disposition</th>
<th>Beneficial Reuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>State Water Rights &amp; Laws</td>
<td>Trucking permit/license</td>
<td>Construct &amp; Operate pits permit</td>
<td>Various State Oil &amp; Gas Regs</td>
<td>NPDES discharge</td>
<td>Inside oil &amp; gas E&amp;P no permits</td>
</tr>
<tr>
<td>Permits</td>
<td>Pipeline easements</td>
<td>Tank permit</td>
<td>Reporting Requirements</td>
<td>Pretreatment</td>
<td>Outside oil &amp; gas require permits</td>
</tr>
<tr>
<td>Contracts</td>
<td>Road, waterway, railway crossing permits</td>
<td>Secondary containment</td>
<td>FracFocus or other mandatory data systems</td>
<td>Enhance Oil Recovery/UIC</td>
<td>Local authority requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SPCC Plans</td>
<td>Transportation &amp; storage of chemicals</td>
<td>Injection Well Disposal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stormwater permit/ controls</td>
<td></td>
<td>More regs and ordinances to come</td>
</tr>
</tbody>
</table>
Module 1 Summary

Key Points

- States Regulate oil and gas activity
- Water rights and responsibilities vary from state to state
- Considering produced water during state water planning will facilitate reuse
- Regulatory frameworks may need to evolve to facilitate reuse (especially outside of oil and gas operations)
Basins Studied/Profiled in this Report

Seven basins profiled

- Appalachia
- Bakken
- Eagle Ford
- Haynesville
- Niobrara/ DJ
- Oklahoma
- Permian
Opportunities for Beneficial Reuse

Within Oil & Gas Industry
• Increase beneficial reuse in enhanced recovery (conventional) and in drilling/hydraulic fracturing (unconventional)

Benefits of Reuse
• Minimize produced water disposal (costly/capacity limitations)
• Lessen potential for induced seismicity in some areas
• Reduce costs/risks associated with transportation
• Reduce fresh water usage benefitting local water needs
Challenges of Produced Water Management

- Adapting to State Regulatory Frameworks
- Transport
- Storage
- Underground Injection
- Treatment/Fit for Purpose
- Spill Management & Mitigation
- Treatment Residual Management
- Air Emissions
- Wildlife Protection
Areas for Additional Research

• Leak detection
• Addressing specific water treatment challenges
• Improvement in enhanced evaporation or desalination
• Automation in treatment systems
• Separation of saleable products during treatment
• Water treatment research needs
• Regulatory changes needed to facilitate discharge
Policy Initiatives to Facilitate Reuse

- Tracking water transfers
- Commercial designation
- Storage
- Temporary layflat lines
- Right of way on county roads
- Clarity of regulations
- Incentives
- Produced water ownership
Module 2 Summary

Key Points

 Produced water Midstream is emerging as a water management strategy

 Research needs and policy initiatives need to be addressed to expand produced water reuse in oil and gas operations.

 Challenges and opportunities affect reuse in oil and gas

 Cost is THE key driver of reuse

 Reuse varies by region/area
Module 3: The Road Ahead

- The most complicated and forward looking challenge
- Some small scale efforts exist
- Moving with caution
- Research needs on all fronts – environmental impact
Current reuse outside of oil and gas operations is minimal but many opportunities exist.
Expanded Opportunities for Reuse

Outside Oil & Gas Industry

• Possibilities for further reuse with additional research
  • Land Application (e.g., irrigation)
  • Discharges to Surface or Ground Water
  • Industrial Use (e.g., cooling water)

WAY Down the Road
Potable Reuse
Potential risks must be well understood and appropriately managed in order to prevent unintended consequences.
Phase I: Preliminary Assessment of Proposed Program

- Define proposed reuse program
- Desktop screening for basic feasibility
- Initial evaluation: Practical Considerations (e.g., public perception, legal and regulatory, logistics, economics, benefits)
- Does the preliminary assessment suggest a feasible program?
- Consider alternative uses or approaches for produced water

Phase I: Preliminary assessment of proposed program
Phase II: Identify Stressors of Interest (constituents of concern) for Risk Assessment

Adequate tools to identify/quantify potential stressors of concern?

Yes

Proposed treatment scheme expected to reduce/remove known stressors of concern?

Yes

Pilot Testing & Effluent Characterization

Modify, Develop, Apply Additional Tools/Methods

Select/Develop/Refine Technologies

Feedback

Feedback

No / Unknown

Yes

No / Unknown
Phase III: Risk Assessment - Treated Produced Water

Exposure Assessment

Hazard Identification & Dose Response Assessment

Risk Characterization
Phase IV: Risk Management & Decision Making

Is risk expected to be manageable?

- Yes: Establish Practices & Policies for Further Risk Reduction
  (e.g., standards & monitoring tools; best practices)
  Proceed with Reuse Program

- No / Uncertain: Consider advanced or additional treatment options

Feedback

Ongoing assessment and incorporation of new knowledge
Fit for Purpose Treatment

- This module includes an extensive discussion and review of treatment technologies – both current availabilities and research needs.

- Treatment should be designed specifically to address a certain type of produced water and certain level of quality goals for reuse.
Fit for Purpose Research

- Not all produced water end uses will require the same analysis.
- Benefits, risks, and costs associated with reuse scenarios will differ based on quality and circumstances of the end use.
- Not all questions will be appropriate or necessary for all end uses.
Other Practical Considerations

- Benefits
- Logistics
- Public Perception
- Legal & Regulatory
- Economics

[Diagram showing interconnections between benefits, logistics, public perception, legal & regulatory, and economics]
Published literature on produced water exists and is growing but more is needed.
Module 3 Summary

- Contains a decision-making framework to evaluate and manage reuse risks
- Level of treatment and research depends on intended use
- Must consider public perception, economics, logistics, regulation and benefits
- Potential risks must be understood and managed to prevent unintended consequences
- Public literature on produced water exists and is growing
- More research is needed for expanded safe reuse
- Current reuse is small but opportunities exist
Conclusions

• Reuse is possible and may be cost effective in the right situations
• Oil & gas companies and end users must work together
• Regulators can look for ways to allow reuse projects but must ensure environmental and public health protection
• Expanding reuse opportunities may require regulatory or legislative solutions
  • Ownership of produced water
  • Transfer of ownership
  • Determination of liability
  • Human health and safety concerns
  • Environmental risk and mitigation concerns
Produced water reuse has local potential but requires careful thought.
Questions