OWRB Produced Water Working Group
November 2, 2016
1. Produced Water Quality Request
   A. Where to return data?
   B. Timing

2. Summary of Subcommittee Meetings and Conference Calls

3. Water treatment status

4. Produced Water and Potential User Data in Map Form

5. Economic Case Development

6. Timing for draft report

7. Next Steps

Julie Cunningham
Produced Water Quality Data

1. OWRB (JD Strong) sent letter to OIPA and OOGA in September requesting analyses

2. OIPA sent out request to companies

3. It would be best to send data back to OIPA for aggregation, but it can be sent to me directly.

4. Need for data is urgent
1. Agriculture
   A. Big water use in specific areas
   B. Seasonality for irrigation – does not match with plant output
   C. Chemical spraying volumes are small relative to PW plant
   D. Land use (hay) may compliment some scenarios

2. Water Users and Water Discharge
   A. Power, chemical plants, other
   B. Municipal – probably not a consideration
   C. Discharge to stream – permit timing – talked to EPA
   D. Aquifer Storage & Recovery – no treatment before drinking – State regulatory process is ongoing
      • Inject to marginal quality aquifer
   E. Evaporation – potential to rid water at lower cost
1. Oil and Gas
   A. Re-use requires minimal treatment
   B. Industry is working on re-use now
   C. Is there a way to compare to other economic scenarios?
   D. Incentives needed?

2. Regulatory and Challenges
   A. Commercial treatment facility designation - higher bonding
   B. NPDES permits - challenge to obtain, including the timing requirements.
   C. Produced water ownership – Value and liabilities
   D. Right-of-Way (ROW) and landowner negotiations
   E. Costs to re-use vs. disposal
   F. Legal custody of water as it relates to potential spills
Water Treatment Update

1. Six producing companies suggested treatment companies that had delivered in prior projects

2. Plan to send Request For Information (RFI) to 12 treatment companies for cost estimates for a number of treatment scenarios

3. Variables for treatment scenarios
   A. 20,000 Barrels of Water Per Day (BWPD) and 100,000 BWPD
   B. Varying TDS levels: 10,000, 30,000, 150,000 mg/l
   C. Contract term assumption: 2 years and 10 years
   D. Quality needed: “Clean brine” and TDS removal (desalination)
Summary of Data Analysis Completed to Date

1. Quantified/classified water use by county.

2. Evaluated produced water supply versus demands based on data provided by the PWWG.

3. Identified 16 matches which could be potential economic scenarios.

4. Developed screening matrix to shortlist the 16 potential scenarios down to 7 for further evaluation based on produced water quality data and treatment requirements.
Agricultural Water use by County

Data from ODEQ
Commercial Water use by County

Data from ODEQ
Industrial Water use by County

Data from ODEQ
Irrigation Water use by County

Data from ODEQ
Data from ODEQ
Power Industry’s Water use by County
Recreation, Fish & Wildlife - Water use by County
Produced Water Disposal & Water Users
Preliminary Matches of PW & Water Users

High produced water volumes in dark blue

Large water users in red and green

Data from ODEQ and OCC.
Preliminary Matches of PW & Water Users

Scenario 1a through 1.e - Reuse for Irrigation
Scenario 8.a - Aquifer Storage and Recovery (Brackish Aquifer)
Scenario 8.a - Disposal via Evaporation
Scenario 2.h - Reuse for Power
Scenario 2.a - Reuse for Power
Scenario 4.a - Reuse for Industrial
Scenario 4.b - Reuse for Industrial
Scenario 4.c - Reuse for Industrial
Scenario 3.a - Reuse for Mining
Scenario 5.a - Reuse Clean Brine by Oil and Gas
Scenario 7.a - Surface Water Discharge

Notes:
1. Aquifer Storage and Recovery alternative not shown on map at this time
2. Transfer of clean brine from Mississippi Lime to Stack play not shown on map at this time

Legend:
Average Daily Injection (2016, BFD)  
0 - 10,000  
10,001 - 54,725  
54,726 - 122,762  
122,763 - 341,257  
341,258 - 1,041,173  
County Boundary  
State Boundary  
Top 40 Water Users (BPD)  
150,001 - 300,000  
300,001 - 450,000  
450,001 - 600,000  
600,001 - 2,064,103  
Annual Average Surface Water Discharge (BPD) June 2016 to July 2016  
12,156 - 100,000  
100,001 - 450,000  
450,001 - 1,200,000  
1,200,001 - 4,000,000  
4,000,001 - 15,789,806  
OCWP Water Pur Basin  
OCWP Hot Spot Basins

FIGURE 1
Overview - Produced Water versus Water Users
Produced Water Study Oklahoma
## Screening Matrix

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Water Use</th>
<th>County</th>
<th>Potential User(s)</th>
<th>Volume Needed (BPD)</th>
<th>Volume Produced in County (BPD)</th>
<th>Match</th>
<th>Supply and Demand</th>
<th>Located in OCWP Hot Spot Basin</th>
<th>Year Around User</th>
<th>Treatment Required</th>
<th>Regulatory Challenges</th>
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<tbody>
<tr>
<td>1.a</td>
<td>Irrigation</td>
<td>Texas</td>
<td>Heimsoth Partners</td>
<td>217,739</td>
<td>149,403</td>
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<td></td>
<td></td>
<td>X</td>
<td>X</td>
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<tr>
<td>1.b</td>
<td></td>
<td>Texas</td>
<td>Russell Family Partnership</td>
<td>449,499</td>
<td>149,403</td>
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<tr>
<td>1.c</td>
<td></td>
<td>Texas</td>
<td>Fischer Family Farms LP</td>
<td>227,681</td>
<td>149,403</td>
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<tr>
<td>1.d</td>
<td></td>
<td>Texas</td>
<td>Stephens Land &amp; Cattle Co Inc</td>
<td>195,477</td>
<td>149,403</td>
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<td>X</td>
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<tr>
<td>1.e</td>
<td></td>
<td>Texas</td>
<td>Chemical Spray for Agriculture/Irrigation</td>
<td>&lt;10,000²</td>
<td>149,403</td>
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<td></td>
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<td>2.a</td>
<td>Power</td>
<td>Pawnee</td>
<td>Oklahoma Gas and Electric Company</td>
<td>1,550,729</td>
<td>93,787</td>
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<td>2.b</td>
<td></td>
<td>Oklahoma</td>
<td>Oklahoma Gas and Electric Company</td>
<td>203,617</td>
<td>191,323</td>
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<tr>
<td>2.c</td>
<td></td>
<td>Seminole</td>
<td>Oklahoma Gas and Electric Company</td>
<td>743,499</td>
<td>329,065</td>
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<tr>
<td>3.a</td>
<td>Mining</td>
<td>Dewey</td>
<td>Kauk Mike and LaDena</td>
<td>223,199</td>
<td>122,762</td>
<td>X</td>
<td></td>
<td>TBD</td>
<td></td>
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<tr>
<td>4.a</td>
<td>Industrial</td>
<td>Muskogee</td>
<td>Georgia-Pacific Consumer Products</td>
<td>752,741</td>
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<td>4.b</td>
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<td>Kay</td>
<td>Phillips Refinery</td>
<td>131,748</td>
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<td>4.c</td>
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<td>Garfield</td>
<td>Koch (Chemical Manufacturing)³</td>
<td>10,000,000</td>
<td>146,793</td>
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<td>5.a</td>
<td>Oil and Gas</td>
<td>Alfalfa to Blaine</td>
<td>Transfer Produced Water</td>
<td>250,000</td>
<td>600,560</td>
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<td>6.a</td>
<td>Oil and Gas or Other?</td>
<td>Alfalfa</td>
<td>Aquifer Storage and Recovery - in Saline Aquifer</td>
<td>TBD</td>
<td>600,560</td>
<td>X</td>
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<td></td>
<td></td>
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<td>7.a</td>
<td>Surface Water Discharge</td>
<td>Beckham</td>
<td>Irrigation - Lugert-Altus Irrigation District</td>
<td>1,819,025</td>
<td>22,323</td>
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<tr>
<td>8.a</td>
<td>Evaporation</td>
<td>Alfalfa</td>
<td>None</td>
<td>NA</td>
<td>600,560</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

*Uses highlighted have been shortlisted for further evaluation; assume one from “Power” and one from “Industrial” will be selected based on water quality.
Scenario 1: Irrigation and Chemical Spray

- Not feasible due to seasonal demands for irrigation and small volume of water required for chemical spraying.
Scenario 2.a: Power (Coal Power Plant)

- One alternative match between power plant water demands and an area of high produced water.
Scenario 2.b: Power (Coal Power Plant)

- Second alternative match between power plant water demands and an area of high produced water.
Scenario 2.c: Power (Coal Power Plant)

- Third alternative match between power plant water demands and an area of high produced water.
- Assume one of the three power plant alternatives will be further evaluated based on produced water quality data, etc.
Scenario 3.a: Mining

- Further evaluation is required to determine seasonality of water demands, water quality requirements, etc.
Scenario 4.a: Industrial (Consumer Products)

- One alternative match between an Industrial user who manufactures consumer products such as tissues and an area of high produced water.
- Further evaluation is required to determine seasonality of water demands, water quality requirements, etc.
Scenario 4.b and 4.c: Industrial (Refinery and Chemical Manufacturing)

- Two additional alternative matches between an Industrial user – refinery and a chemical manufacturing plant.
- Further evaluation is required to determine seasonality of water demands, water quality requirements, etc.
Scenario 5.a: Transfer Clean Brine for O/G

- Transfer clean brine from Mississippi Lime to Stack play for oil and gas use.
Scenario 6.a: Aquifer Storage and Recovery

- Aquifer storage and recovery into a brackish aquifer.
- Higher chloride concentrations around Great Salt Plains Reservoir.
- May be a potential to improve native water quality and provide incentive for ASR.
- Target shallow depth to brackish water.
Scenario 7.a: Surface Water Discharge

- Target hot spot basin.
- Discharge into North Fork of the Red River in Beckham County due to higher produced water volumes.
- North Fork of the Red River supplies the Lugert-Altus Irrigation District Reservoir.
Scenario 8.a: Evaporation

- Evaporation ponds in Alfalfa County due to high volume of produced water and vicinity to oil and gas activity.
- Current produced water estimates 600,560 BPD.
Next Steps - Timing

1. Produced water quality is crucial
2. Water treatment cost estimates
3. Cost estimates of economic scenarios
4. Review of economic conclusions
   A. Next meeting in mid-December or January?
   B. Phone meeting?
5. Review of draft report (February?)
Thank You