ALTERNATIVE PRODUCED WATER MANAGEMENT STRATEGIES IN A SEISMICALLY RESTRICTED WORLD: ISSUES & OPPORTUNITIES

Presented by:
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Presented at:
2022 CSTS Annual Meeting
August 3, 2022
Conway, KS
Oil Price and NM Production Trends

- **NM Produced Water Generation**
- **New Mexico Oil Production**
- **Average Monthly Oil Price ($/bbl)**

Data Source: EIA 2022
UPPER CONFINEMENT

- Protection of USDW
- Confine Injectate to Injection Interval
  - Faults
  - Outcrops
  - Penetrating “Problem Wells” (Purge)

Source: Power & James 1986

Source: ALL Consulting 2022
2019 “Purge” in Oklahoma

Issue: Saltwater Flowing to Surface

Response: OCC Issues directives
- Required specific SWDs to shut-in or reduce injection pressure.
- Prohibited new SWDs in the Permian with Permian Restriction Zone
- Limits for injection in the Pennsylvanian.
  - 10,000 BPD Commercial
  - 5,000 BPD Non-commercial

Data Source: OCC 2022

Permian Restricted Zone
LOWER CONFINEMENT/CORRELATIVE RIGHTS

• Concerns of lack of competent lower confinement

• Mitigation: Limit DMG Disposal to top of DMG
  • Numerous competent confining layers
  • 1,000’s ft separation from underlying production

Source: NMOCD SWD-2378

Source: ALL 2021
PERMIAN SHALLOW PRESSURE TRENDS

- **Texas Midland Basin Shallow Injection Well Trends**
  - AVG Volume: 1,500 BPD > 2,200 BPD
  - Source: EnergyMakers Advisory Group 2021 Permain Formation Pressure Studies

- **Texas Delaware Basin Shallow Injection Well Trends**
  - AVG Volume: 4,800 BPD > 9,000 BPD

- **New Mexico Shallow Wells**
  - AVG Volume: ~1,200 + BPD
  - Source: EnergyMakers Advisory Group 2021 Permain Formation Pressure Studies

NEW SHALLOW WELLS RESTRICTED
### Oklahoma - Bottomhole Pressures (psi/ft)

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<th>Injection Depth Range (ft)</th>
<th>County A</th>
<th>County B</th>
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### Midland Basin Texas - Bottomhole Pressures (psi/ft)

*Source: ©EnergyMakers 2017 Permian Bottomhole Pressure Report*
- Ancient shallow sea reef complex.
- High quality ground water at greater depths.
- 4-String Area
- Confirmation Water Sampling
OPTIONALITY FOR CLASS I IN KANSAS

• KS Class I Shallow Disposal options limited by requirement for “gravity injection” (KAR 28-46-28).

• Switching to a shallower injection interval takes time and money and may or may not be an option based on geology.

• KDHE prohibits injection into the Cedar Hills (Glorietta) formation due to lack of vertical confinement and concerns about water protection (KDHE 1990).

Source: ALL 2021
Source: NMOC 2022
RECYCLING APPROVALS

• States Encouraging Non-Commercial Recycling
• Commercial Recycling Requires a Permit
• Detailed Designs & Plans
T25S R30E — Feb 21, 2019
7 Active Water Pits
894,556 sf Surface Area
≈2,000 bbls evap/day

Source: SourcEnergy 2022
Enhanced Evaporation

- Mechanical sprayer
- Increase liquid/air contact area
- Land-Based or Floating

400’ x 400’ Produced Water Impoundment

- Passive Evaporation: ≈400 bpd
- Enhanced Evaporation: ≈1,200 bpd

Source: RWI
Daily Evaporation (bbls per evaporation unit)

- Wyoming (50k ppm TDS)
- Wyoming (100k ppm TDS)
- Wyoming (200k ppm TDS)
- Texas (50k ppm TDS)
- Texas (100k ppm TDS)
- Texas (200k ppm TDS)

Data Source: RWI
• Regulations
  • Pit or Waste Facility Permit
  • Setbacks
  • Hydrogeology Evaluation
  • Operating Plans (O&M, Contingency, Closure)

• Design Considerations
  • Sufficient Capacity for Inbound Water
  • Evaporation Rate Variability
  • Droplet Drift
  • Depth to Groundwater, etc.,

• In line with KDHE waste minimization guidance.
TRANSPORT OUT OF SENSITIVE AREA
PRODUCED WATER PIPELINE NETWORK

Map showing the produced water pipeline network with highlighted seismic response areas and pipeline midstream data.
DISPOSAL LOCATION CHANGES OVER TIME

2020
SRA Volume: 2.5M bbls
Deep SWDs w/i SRA: 4

2021
SRA Volume: 1.4M bbls
Deep SWDs w/i SRA: 2

2022
SRA Volume: 192k bbls
Deep SWDs w/i SRA: 0
DISPOSAL RESTRICTION IN ACTION

M3.4  M4.0

6-10 mi

3-6 mi

0-3 mi

PW Generation

PW Disposal

Bureau of Land Management, Texas

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SUMMARY

• Seismic-based disposal restrictions are demonstrably changing the landscape of water disposal across the country.

• Various options exist for managing water/waste where deep disposal is restricted (shallow disposal, evaporation, transportation)- each with its own regulatory, operational, and economic considerations.

• States are trying to encourage alternatives to deep disposal, but regulatory barriers still exist which make other options less feasible or economic.
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