Update of Lost Soldier/Wertz Floods
Living in a Constrained CO₂ Environment

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Agenda

- Field Background
  - Location
  - Geological Information
  - Field Development
  - Field Process Overview

- Field Performance
  - Reservoir Properties
  - Historical Production

- CO₂ Constraints
  - CO₂ Historical Purchases
  - CO₂ Allocation Process
  - New WAG Management Tools
  - Case Studies
    - Wertz Tensleep
    - Lost Soldier Cambrian

- Future Challenges
Location
Geological Information

Tensleep Contour Map

Lost Soldier Field

Wertz Field
Geological Information

- Lost Soldier and Wertz are both faulted anticlines.
- Located in Wyoming’s Great Divide Basin
Field Statistics

- Field Size: 5,500 Acres
- Productive Acres: 4300
- Reservoir Depth: 4500-7500 ft
- Pay Thickness: +/- 1000 ft
- OOIP: 660 MMBO
- Cum Recovery: 342 MMBO
Field Process Overview

Field Statistics
- Oil Production: 6200 bpd
- NGL/CND: 1250 bpd
- Water Production: 210,000 bpd
- Gas Recycle Vol: 150,000 mcfd
- Makeup CO2: 14,000 mcfd
Reservoir Background

Critical Reservoir Properties for the three main producing formations:

- Primary production was attributed to fluid expansion, water influx and gravity drainage
- All of the formations above are currently CO$_2$ flooded
- Miscibility Pressure 2,350 psi

<table>
<thead>
<tr>
<th>Field</th>
<th>Formation</th>
<th>Lithology</th>
<th>Average Depth</th>
<th>Formation Thickness</th>
<th>Average Porosity</th>
<th>Air Perm md</th>
<th>Current Spacing</th>
<th>Res Press psi</th>
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<tbody>
<tr>
<td>Lost Soldier</td>
<td>Tensleep</td>
<td>SS</td>
<td>5,000</td>
<td>535</td>
<td>9.9%</td>
<td>31.0</td>
<td>10 - 20</td>
<td>2,800</td>
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<td>Darwin</td>
<td>SS</td>
<td>5,500</td>
<td>65</td>
<td>13.0%</td>
<td>36.0</td>
<td>20 -30</td>
<td>2,650</td>
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<td>Madison</td>
<td>LS/DOL</td>
<td>5,565</td>
<td>340</td>
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<td>20 -30</td>
<td>2,650</td>
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<tr>
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<td>30.0</td>
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<tr>
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Historical CO$_2$ Purchases

Lost Soldier and Wertz CO2 Purchases

- Daily Purchases
- Cumulative Purchased

CO$_2$ Daily Purchases MMCF/Day
Cumulative Purchases BCF

Jan-86 to Jan-07
This plot considers incremental oil production calculated using the more generic economic method. A baseline decline is determined before tertiary recovery, & incremental oil then represents all production above this baseline.
CO₂ Allocation Process

Step 1: Review Historical Production/Injection by Reservoir

Step 2: Developed “Ideal CO₂ Injection” at a Pattern Level

Step 3: Combined “Ideal CO₂ Injection” at a Reservoir and Complex level to determine variance with actual constrained volume

Step 4: Revise “Ideal CO₂ Injection” based on constrained CO₂ Volumes at a reservoir and pattern level

Step 5: Finalized WAG schedule & developed WAG management tool
### WAG Management Tools

**CO₂ Set Points**

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<th>Set Point</th>
<th>Actual</th>
<th>Target</th>
<th>% Target</th>
<th>% Target</th>
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<td>0.54</td>
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**Days to Completion**

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<th>Days to Completion</th>
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**Cycle Volumes**

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<th>Cycle Volumes</th>
<th>Values</th>
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<tr>
<td>LSTP 1</td>
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<td>LSTP 2</td>
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**Zero Rates**

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**Overdue Switches**

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**MERIT ENERGY COMPANY**
Before & After WAG
Wertz Tensleep

WZTP Production History (Process Rate - Corrected)

- Oil Production, bopd
- Water Production, bwpd
- Gas Production, mcfpd
- Water Injection, bwpd
- CO2 Injection, mcfpd
- Process Rate Corrected Oil Production, bopd
Production Impact
Lost Soldier Cambrian

Monthly Averages

Oil Production, bopd
Water Production, bwpd
Gas Production, mcfpd
Water Injection, bwpd
CO2 Injection, mcfpd
Process Rate Corrected Oil Production, bopd
Original Waterflood Performance Prediction
Phased Map of Cambrian DownSpacing

Phase I
- LSCA 10 – Convert to injection
- LSTP 89 - Deepen well & convert to injection
- LSDM 156 – Deepen well & convert to injection

Phase II
- LSCA 53 – Horizontal Sidetrack & convert to injection.
- LSCA 234 – New Horizontal Producer
- LSCA 233H – New Vertical Producer

Phase III
- LSCA 120 – Convert to producer
- LSCA 49 – Convert to injector
- LSCA 108 – Horizontal Sidetrack Injector
- LSCA 235 – New Horizontal Producer
Future Challenges

• Identifying best methods to improve reservoir conformance
  – Working with Dow & reviewing polymer/gel treatments

• CO₂ Recycling Capacity
  – Installing additional compression capacity

• Water Disposal Capacity
  – Identifying reservoirs for waterflood, disposal candidates

• Maximizing CO₂ Utilization