Reduced Emissions Completions
Jonah Case Study

Bonnie Ellwood
Environmental Engineer
EnCana Oil & Gas (USA) Inc. | Denver, CO | October 20, 2009
Outline

• Hydraulic fracturing review
• Traditional surface setup
• Reduced Emission Completions (REC) surface setup
• Applicability
• Case study
Completion Operations

- Casing perforated with jet charge based on geologic correlation
- Penetrates casing and cement
- Connects the reservoir to the wellbore
Fracturing Operations

- Sand in gel (guar) and water
- Pressure initiates fracture
- Sand pumped into fracture
- Fluid flowed back
- Sand stays in formation
- Some fluid recovered during completion
- Remainder produced over time or stays in the reservoir
- Fracture creates conductive path
- Very controlled system during fracturing
Fracturing Operations

- After flow back a composite plug set
- Isolates previous stage
- Next Stages is perforated
- Another fracture treatment is performed
- Repeated every 200’ to 250’ as needed
Fracturing Operations

- Composite plugs drilled out
- Tubing string run in hole
- Well put on production through tubing
- Gas will follow path of least resistance into wellbore and to surface through tubing
- Pressure gradient allows gas to move only up tubing
Down Hole Frac Fluids

- **Water Fracs**
  - Cross Linked Gel – increases viscosity
  - Breaker – breaks viscosity

- **Energized Systems**
  - $\text{N}_2$, $\text{CO}_2$
  - Foams or assist
Proppant Types

- **Low Strength**
  - Sand

- **Resin Coated**
  - Use various substrate

- **Intermediate Strength**
  - Man-made proppants
  - Aluminum silicate

- **High Strength**
  - Bauxite
Usually not hooked up to permanent sales line until well is completed and tubing landed.
Previously installed sales line

Temporary meter

Valve

Flare

Well head

Flow back slurry

Liquid

Water Tank
Less Than 100% Captured

Rate

Volume of gas flared

Minimum P to enter sales line

Pressure

Time

Water

Gas

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Energized Fluids

Minimum percent of energized fluid for sales composition

Volume of gas flared

N2, CO2

Rate

Water

Gas

Time

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Volume of gas flared does not warrant feasible time for REC
Non applicable scenarios

- No permanent sales line
  - Step out wells, exploratory, wild cat
- Gas pressure relative to the sales line
- Energized fluids
  - N2 and CO2 limits for sales gas
- Distinctive liquid to gas interface with no sand
  - Time
  - Volume of gas
  - Gas pressure for level controller pneumatics
## Estimated Flared Volume

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Gas thru Unit</th>
<th>% Flared</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MMCF/YR</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>2002</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>2003</td>
<td>459</td>
<td>3.70%</td>
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<tr>
<td>2004</td>
<td>6,237</td>
<td>1.01%</td>
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<tr>
<td>2005</td>
<td>17,985</td>
<td>0.61%</td>
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<tr>
<td>2006*</td>
<td>9,461</td>
<td>1.46%</td>
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<tr>
<td>2007</td>
<td>8,492</td>
<td>0.87%</td>
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<tr>
<td>2008</td>
<td>14,832</td>
<td>0.45%</td>
</tr>
<tr>
<td>2009YTD</td>
<td>2,848</td>
<td>0.10%</td>
</tr>
</tbody>
</table>
Cost of REC

• Daily rate * number of days in completions
  – Flow back unit
  – Crew
  – Iron rentals
  – Temporary meter skid

• Cost to install pipeline to well head after completions
## Economics of Captured Gas

<table>
<thead>
<tr>
<th>Year</th>
<th>Gas to Sales MMCF/YR</th>
<th>Price NWP $/MCF</th>
<th>Cost of Flow Back ($/MCF)</th>
<th>Gas Sale Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>442</td>
<td>4.62</td>
<td>($3,036,200)</td>
<td>$2,040,973</td>
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<tr>
<td>2004</td>
<td>6,174</td>
<td>5.87</td>
<td>($8,857,800)</td>
<td>$36,260,555</td>
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<tr>
<td>2005</td>
<td>17,876</td>
<td>7.80</td>
<td>($9,112,400)</td>
<td>$139,454,713</td>
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<tr>
<td>2006*</td>
<td>9,323</td>
<td>6.34</td>
<td>($16,800,000)</td>
<td>$59,151,099</td>
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<tr>
<td>2007</td>
<td>8,418</td>
<td>4.43</td>
<td>($37,728,000)</td>
<td>$37,268,080</td>
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<tr>
<td>2008</td>
<td>14,766</td>
<td>7.01</td>
<td>($40,425,000)</td>
<td>$103,438,462</td>
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<tr>
<td>2009YTD</td>
<td>2,845</td>
<td>3.19</td>
<td>($9,075,000)</td>
<td>$9,063,281</td>
</tr>
</tbody>
</table>

NPV 2003: US$190,070,000
Conclusions

- Fits well into resource play development
- Economical
- Environmental benefit
- Not always viable
- Improves our social license to operate