Drilling and Completions Changes from Conventional to Unconventional Developments – Part One

Presented at the 26th International Petroleum Environmental Conference, San Antonio, TX, October 7-9, 2019
Part One – Conventional Well Design
• Targets permeable reservoirs with technologies of the day
• Within a traditional mineral leasing structure
• To develop a conventional field, vertically or directionally

Part Two – Unconventional Well Design
• Targets very low permeability rock with new technologies
• Within a relatively new mineral leasing structure
• To develop an unconventional field, horizontally

Part Three – Regulatory Response to Unconventionals
• Increased focus on protection of workers, public health, the environment
• Maintain protection of mineral ownership and prevents waste
• Adapting or replacing older paradigms to embrace new technology
All drone pics were taken during one of the wettest periods in recent Oklahoma history.
Conventional Leasing Framework

Drilling Units

Vertical Wells
Conventional Vertical Development

Trapping Formation Has Relatively High Permeability

Source Formation Has Relatively Low Permeability
Conventional Vertical Development
All drone pics were taken during one of the wettest periods in recent Oklahoma history.

Conventional Drilling

- Fully Constructed (Drilled and Completed) Producing Well
  - 2 strings
  - 3 strings
  - 3 strings

Protected zone
Trouble zone
Pay zone
Conventional Drilling

Geology, Geophysics, Reservoir, Leasing, Engineering, Planning, Permits

protected zone  protected zone

trouble zone  trouble zone

pay zone  pay zone
**Conventional Drilling**

<table>
<thead>
<tr>
<th>Build the Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2 strings</strong></td>
</tr>
<tr>
<td><strong>3 strings</strong></td>
</tr>
<tr>
<td><strong>3 strings</strong></td>
</tr>
</tbody>
</table>

- **protected zone**
- **protected zone**
- **trouble zone**
- **trouble zone**
- **pay zone**
- **pay zone**
All drone pics were taken during one of the wettest periods in recent Oklahoma history.

Conventional Drilling

Set the Conductor Pipe

- 2 strings
- 3 strings
- 3 strings

- protected zone
- protected zone

- trouble zone
- trouble zone

- pay zone
- pay zone
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### Conventional Drilling

#### Drill the Surface Hole

<table>
<thead>
<tr>
<th>2 strings</th>
<th>3 strings</th>
<th>3 strings</th>
</tr>
</thead>
<tbody>
<tr>
<td>protected zone</td>
<td>protected zone</td>
<td>protected zone</td>
</tr>
<tr>
<td>trouble zone</td>
<td>trouble zone</td>
<td>trouble zone</td>
</tr>
<tr>
<td>pay zone</td>
<td>pay zone</td>
<td>pay zone</td>
</tr>
</tbody>
</table>
Conventional Drilling

Run and Cement the Surface Casing String

- 2 strings
- 3 strings
- 3 strings

protected zone
protected zone

trouble zone
trouble zone

pay zone
pay zone
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Conventional Drilling

Drill the Intermediate Hole

2 strings

3 strings

3 strings

protected zone

protected zone

trouble zone

trouble zone

pay zone

pay zone
Conventional Drilling

<table>
<thead>
<tr>
<th>Run and Cement the Intermediate Casing String</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 strings</td>
</tr>
</tbody>
</table>

- **protected zone**
- **trouble zone**
- **pay zone**
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Conventional Drilling

Drill the Production Hole (aka Drill to TD)

2 strings
3 strings
3 strings

protected zone
protected zone

trouble zone
trouble zone

pay zone
pay zone
All drone pics were taken during one of the wettest periods in recent Oklahoma history.

Run and Cement the Production Casing String (aka Long String)

- 2 strings
- 3 strings
- 3 strings

- protected zone
- protected zone
- trouble zone
- trouble zone
- pay zone
- pay zone
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Conventional Drilling

Move Drilling Rig off Location, Move in Completions Spread

2 strings 3 strings 3 strings
Conventional Completions

Perforate the Production Casing

<table>
<thead>
<tr>
<th>Strings</th>
<th>Diagram 1</th>
<th>Diagram 2</th>
<th>Diagram 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 strings</td>
<td>![Diagram 1](protected zone, trouble zone)</td>
<td>![Diagram 2](protected zone, trouble zone)</td>
<td>![Diagram 3](protected zone, trouble zone)</td>
</tr>
<tr>
<td>3 strings</td>
<td>![Diagram 1](protected zone, trouble zone)</td>
<td>![Diagram 2](protected zone, trouble zone)</td>
<td>![Diagram 3](protected zone, trouble zone)</td>
</tr>
<tr>
<td>3 strings</td>
<td>![Diagram 1](protected zone, trouble zone)</td>
<td>![Diagram 2](protected zone, trouble zone)</td>
<td>![Diagram 3](protected zone, trouble zone)</td>
</tr>
</tbody>
</table>

Pay zone
Conventional Completions

Stimulate (Hydraulic Fracture, aka HF) the Target Zone

- **2 strings**
- **3 strings**
- **3 strings**
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Conventional Completions

Move Frac Spread off Location, Hook up to Production

- 2 strings
- 3 strings
- 3 strings
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