Are Vertical Wells Impacted by Horizontal Drilling?

A study of Kingfisher County

September 14, 2017
Illustration of Vertical and Horizontal Well

Horizontal Surface Position
Qtr/Qtr, Sec Town. Range

Horizontal Toe Position
Qtr/Qtr, Sec Town. Range

Vertical Well Position
Qtr/Qtr, Sec Town. Range

Stage Frac Detail

Horizontal Well Frac

Vertical Well

Pilot Hole
Vertical Well to Horizontal Well

Example: 5000 foot horizontals on 320 acre

Example: 5000 foot horizontals on 640 acre

Example 10,000 foot horizontals on 1280 acre

Legend:
- Distance between vertical and horizontal
- Horizontal Lateral
- 1 mile
- 1 Section (640 Acres)
- Vertical Well
- Horizontal Toe
- Horizontal Surface
Need for Independent Report

Industry Challenges

- Known damage to OEPA member wells
- Increasing number of horizontal wells create more opportunity to impact more vertical wells
- Increasingly bigger fracks create greater opportunity to damage more vertical wells
- Significant Anecdotal Evidence – Reports of Vertical Wells Damaged
  - Changed operational conditions
  - Circulating wells to remove sand influx
  - Swabbing wells to remove sudden fluid increase
  - Shutting in wells in attempt to minimize impact
- Denials of damage by major horizontal drillers
Horizontal Wells Kingfisher County
Overlaid by Vertical Wells
OEPA Criteria for Independence

| Independence from OEPA                              | • No prior knowledge of OEPA  
|                                                   | • No prior relationships with founding members  |
| Degreed Petroleum Engineer                         | • BSPE University of Tulsa  |
| Operational Experience                             | • Managed operations for many wells  
|                                                   | • Different production lift methods and reservoir drive mechanisms  |
| Ability to develop solution                        | • Brought potential solution method  |
| Experienced in art of the possible                 | • MBA with extensive problem solving experience  
|                                                   | • Energy regulatory background, assisting with assessment to support successful regulatory change  
|                                                   | • Past management consultant  |
Objective: Identify Vertical Wells Impacted by Horizontal Drilling in Kingfisher County

Identify number of vertical wells:
• Within 2 miles of a horizontal well
• With average long term production changes of +/- 25% after horizontal well fracked
• With month-to-month short term production changes +/-50% after horizontal well fracked
• Investigation period March 2014 to January 2017

Sources of Information
• Oklahoma Tax Commission production records
• Oklahoma Corporation Commission well records
### Findings: 451 Potentially Impacted Vertical Wells

<table>
<thead>
<tr>
<th>Findings</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>360 (80%) impacted vertical wells outside horizontal well unit boundaries</td>
<td></td>
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<tr>
<td>91 (20%) impacted vertical wells within horizontal well unit boundaries</td>
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<tr>
<td>371 (82%) impacted vertical wells operated by vertical well only operators</td>
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<tr>
<td>80 (18%) impacted vertical wells operated by horizontal well operators</td>
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IMPACTED WELL ADDITIONAL OPERATIONAL COSTS

• COST TO CLEAN OUT SAND AND WATER FROM WELLBORE

• COST TO REPLACE DAMAGED EQUIPMENT, SURFACE AND SUBSURFACE

• COST TO CONTINUALLY REBALANCE PRODUCTION SYSTEM AND VESSELS

• COST TO DISPOSE OF IMPACTION WATER AND SAND

• COST TO ADDRESS ENVIRONMENTAL DAMAGE

• COST OF INCREASED GENERAL ONGOING OPERATIONAL EXPENSES

• THE ULTIMATE DISASTER: COLLAPSED CASING FROM FRAC PRESSURES
Environmental Damage
### Horizontal Well Operators in Kingfisher County

<table>
<thead>
<tr>
<th>Operator</th>
<th>Horizontals Wells Drilled March 2014 to June 2017</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newfield Exploration</td>
<td>117</td>
<td>28%</td>
</tr>
<tr>
<td>Oklahoma Energy Acquisitions</td>
<td>81</td>
<td>19%</td>
</tr>
<tr>
<td>Chaparral Energy</td>
<td>41</td>
<td>10%</td>
</tr>
<tr>
<td>Devon Energy</td>
<td>36</td>
<td>9%</td>
</tr>
<tr>
<td>Gastar Exploration</td>
<td>36</td>
<td>9%</td>
</tr>
<tr>
<td>Chesapeake</td>
<td>33</td>
<td>8%</td>
</tr>
<tr>
<td>Marathon Oil</td>
<td>24</td>
<td>6%</td>
</tr>
<tr>
<td>Hinkle Oil &amp; Gas</td>
<td>11</td>
<td>3%</td>
</tr>
<tr>
<td>Chisholm Oil &amp; Gas Operating</td>
<td>10</td>
<td>2%</td>
</tr>
<tr>
<td>Longfellow Energy</td>
<td>8</td>
<td>2%</td>
</tr>
<tr>
<td>Blake Production Company</td>
<td>6</td>
<td>1%</td>
</tr>
<tr>
<td>Cimarex Energy</td>
<td>5</td>
<td>1%</td>
</tr>
<tr>
<td>Payne Exploration</td>
<td>3</td>
<td>1%</td>
</tr>
<tr>
<td>Husky Ventures</td>
<td>3</td>
<td>1%</td>
</tr>
<tr>
<td>Sandridge</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>Gulf Exploration</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>416</strong></td>
<td><strong>100%</strong></td>
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**Total Horizontal Well Count in Kingfisher County: 633**
**WELL IMPACT REPORT**

**Date:**

**Operator:** Oper. #

**Well Name:** Well #

**API Number:** (10-DIGIT API# - FOR EXAMPLE, 3500321606)

**Country:**

**Latitude:**

**Longitude:**

**Datum used:**

**Formation being hydraulically fractured:**

**Perforated Interval:**

**TD (MD):**

**TD (TVD):**

**Date of impact or when impact consequence was observed:**

**Producing formation1:**

**Producing formation2:** (if applicable)

**Producing formation3:** (if applicable)

**Was frac notice received?** (Y/N)  
If "yes", date received:

**Was well flowing or on artificial lift prior to impact?** (Gas lift, Plunger Lift, Rod pump, Flowing)

**Distance to well being hydraulically fractured:** (ft)

**Offset well being hydraulically fractured:**

**Well Name:**

**Operator:** Oper. #

**API Number:** (10-DIGIT API# - FOR EXAMPLE, 3500321606)

**County:**

**Latitude:**

**Longitude:**

**Datum used:**

**Formation being hydraulically fractured:**

**Perforated Interval:**

**TD (MD):**

**TD (TVD):**

**Was incident reported to District office?** (Y/N)  
If "yes", date received:

**Was a 1085 filed by the District?** (Y/N)

**Report filed by:**

**Phone:**

**Email:**

**RULE: 165-10-3-10(b)(4) effective date 9/11/17**

(4) If an operator believes there is evidence that hydraulic fracturing operations have impacted its well(s), the operator may report the occurrence either by facsimile or electronic mail to the appropriate Conservation District Office with 24 hours of discovery.

**PRODUCTION INFORMATION**

Report 12 months production prior to impact and all production after impact to current date.

<table>
<thead>
<tr>
<th>DATE (MM/yyyy)</th>
<th>OIL (bbls)</th>
<th>GAS (mcf)</th>
<th>WATER (bbls)</th>
<th>CASING (psi)</th>
<th>TUBING (psi)</th>
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QUESTIONS?
THANK YOU