Northern Oklahoma Woodford Shale Overview
2014 AADE Mid-Continent Technical Conference

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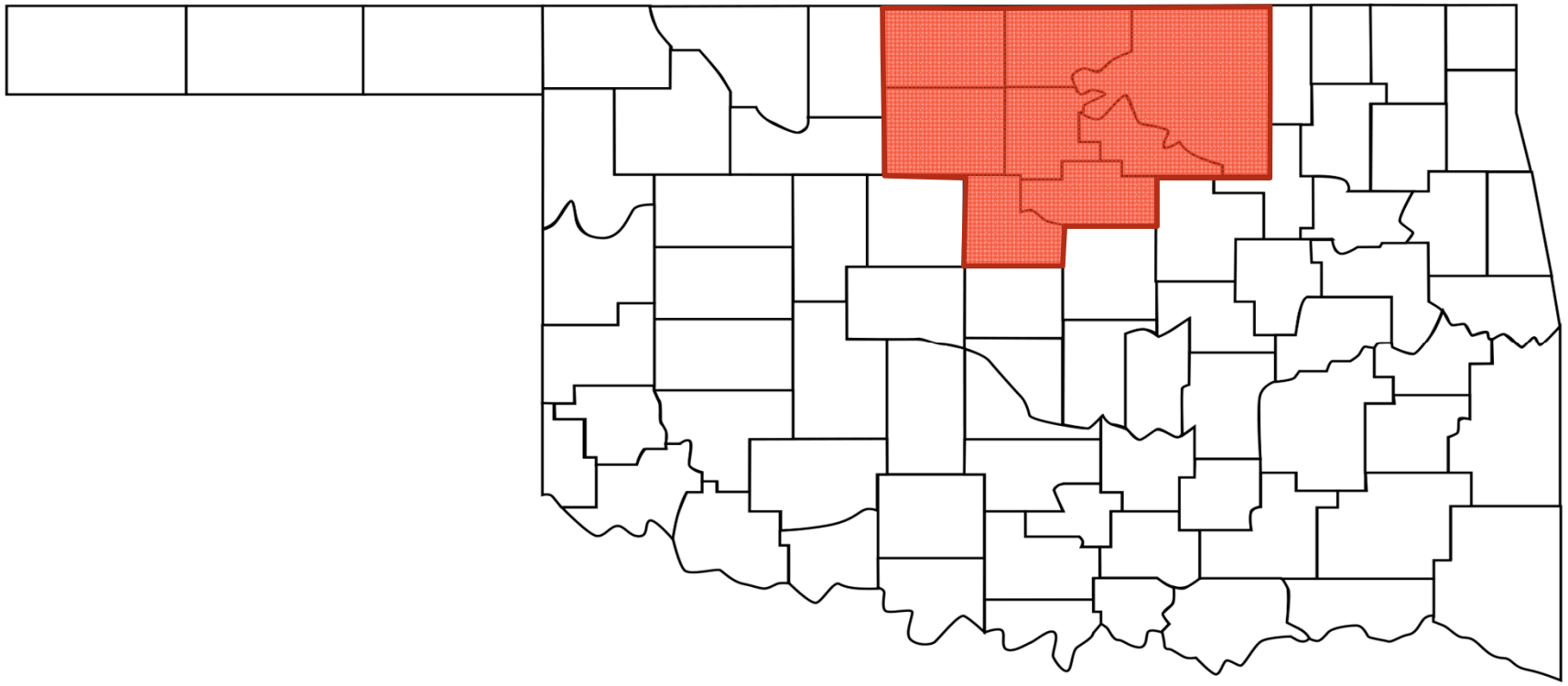
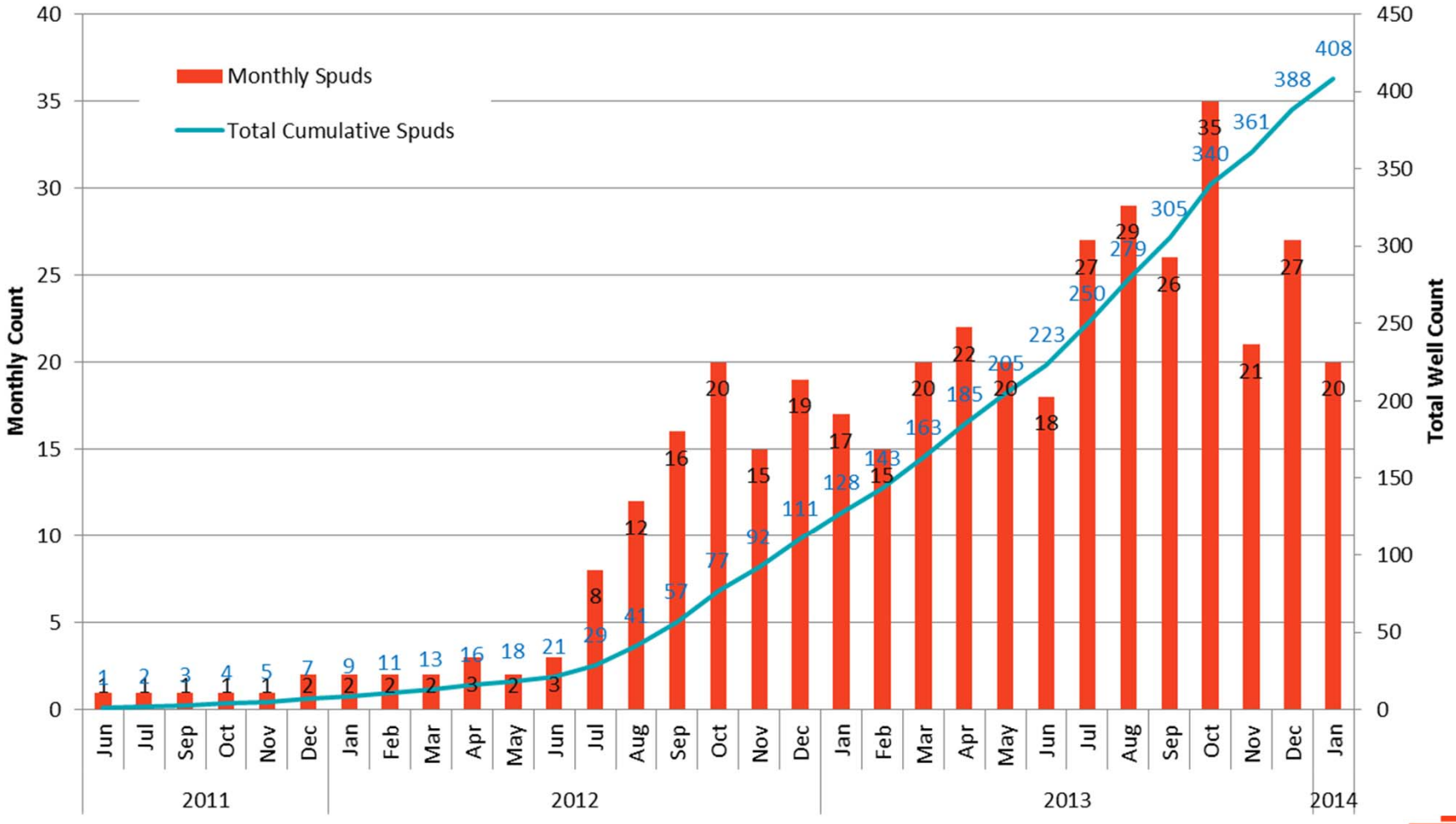
Northern Oklahoma Focus Area



Devon Activity



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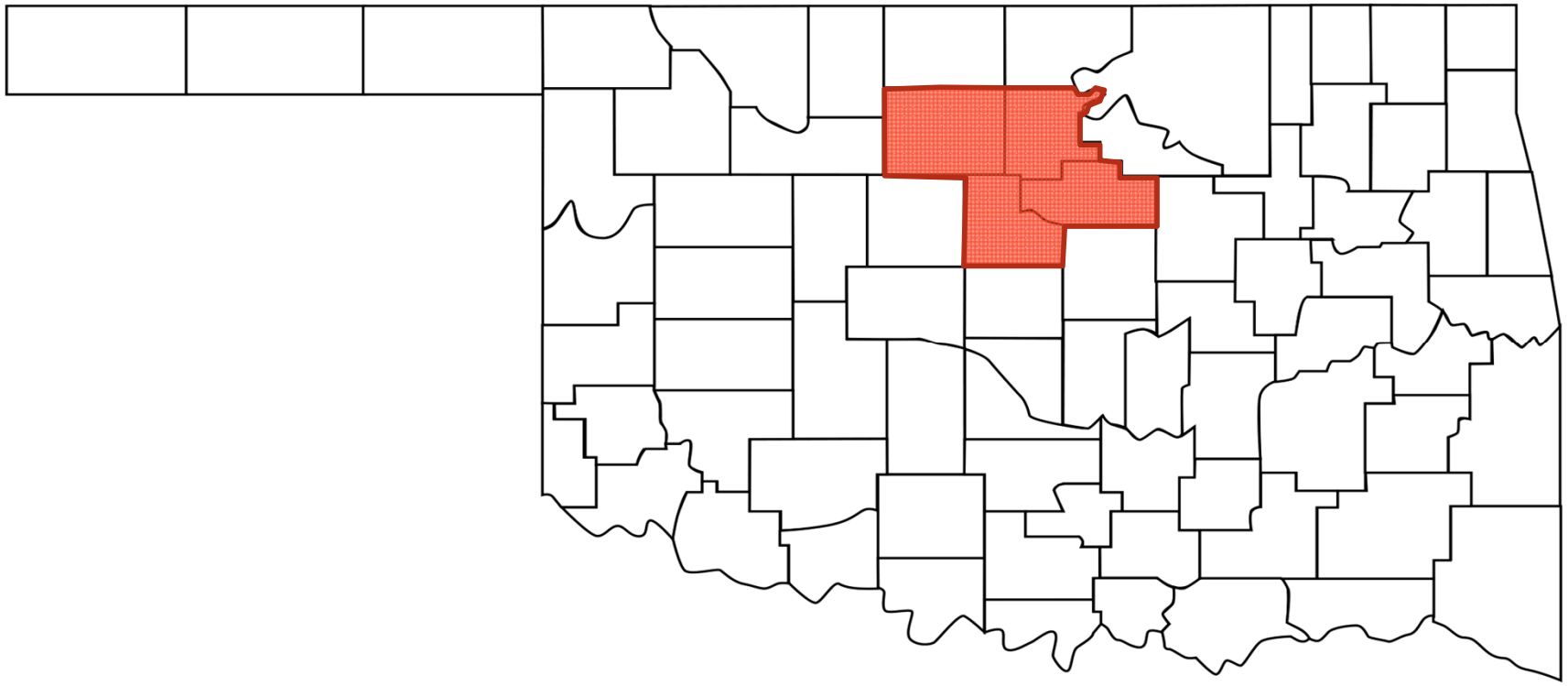
Woodford Shale Focus Area



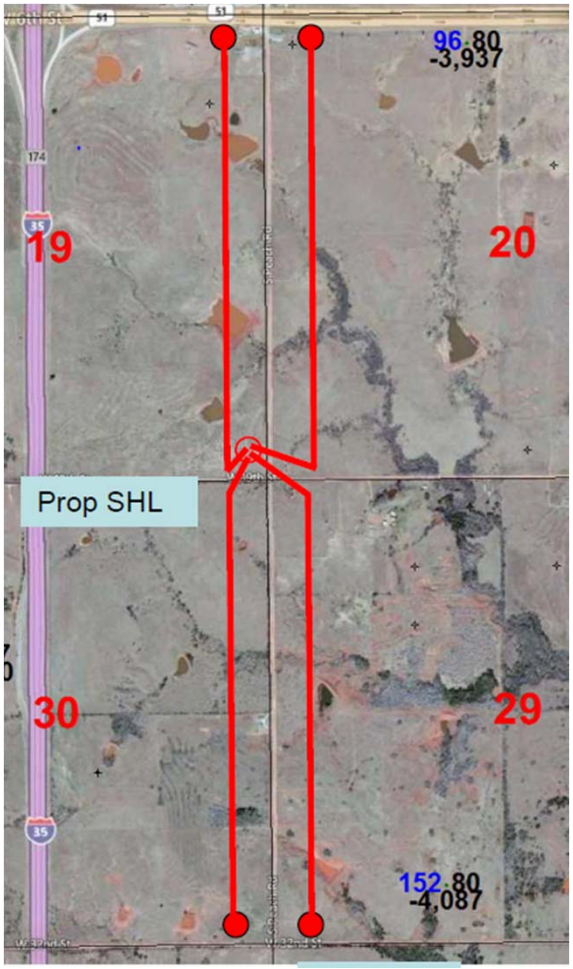
Woodford Shale Horizontals
Challenges & Best Practices

- Multiple well pads
  - Shallow directional work, increased torque & drag
- Curve design
  - Smooth tangent for ESP placement
- Well design
  - What is the optimum design?
- Lateral performance
  - Best practices for optimum performance
- Lost circulation
  - What is the driving mechanism?
- Liner cementing
  - Best practices for successful jobs

Multiple Well Pads

- 4-5 wells per pad – 20 ft. spacing
  - 3-4 producers & 1 disposal

- Benefits
  - Cost savings, reduction of surface footprint and facilities
- Challenges
  - Directional work required on every well out from under surface
  - Significant nudge inclinations
  - Increased torque and drag
  - Limited artificial lift options



Curve Design

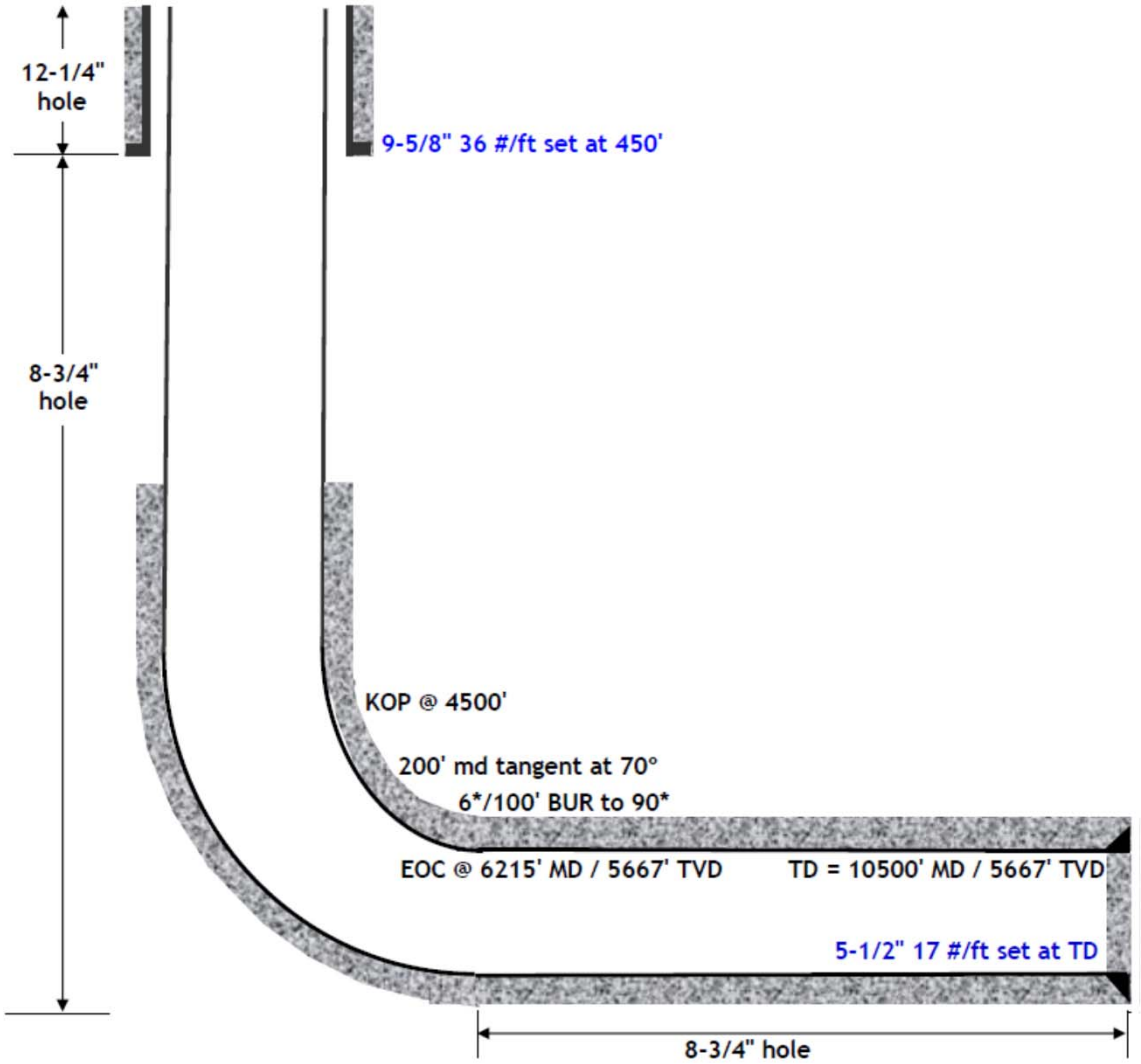
- All wells require 200’ md smooth tangent for ESP placement

- Two designs
  - Curve with tangent
    - 6-8°/100’ BUR curve with tangent at 60-70°
  - Tight radius curve
    - 16-20°/100’ BUR curve with tangent above KOP

- Both designs have challenges, still testing both designs…

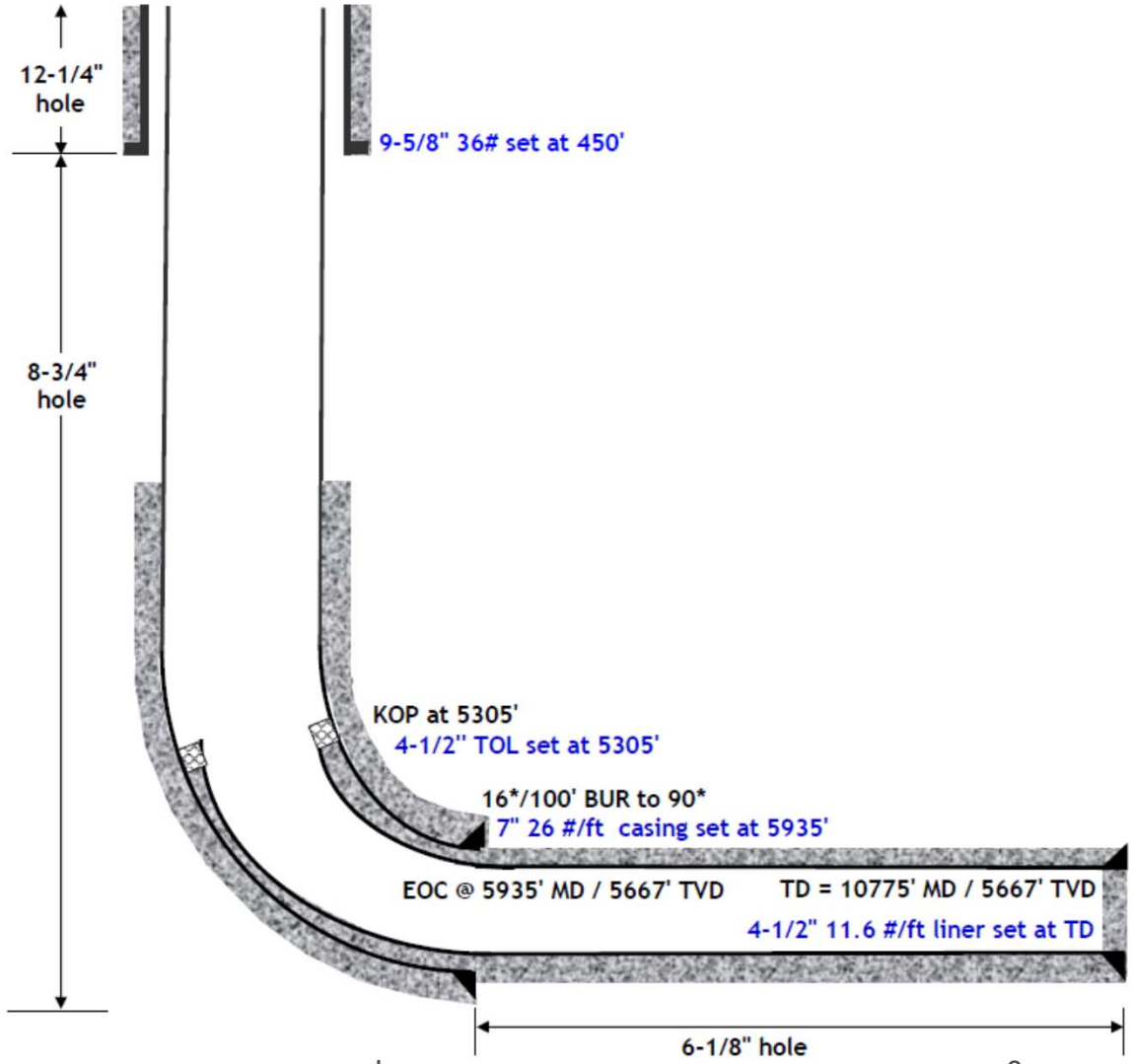
Initial Well Design

No intermediate casing – Curve with tangent

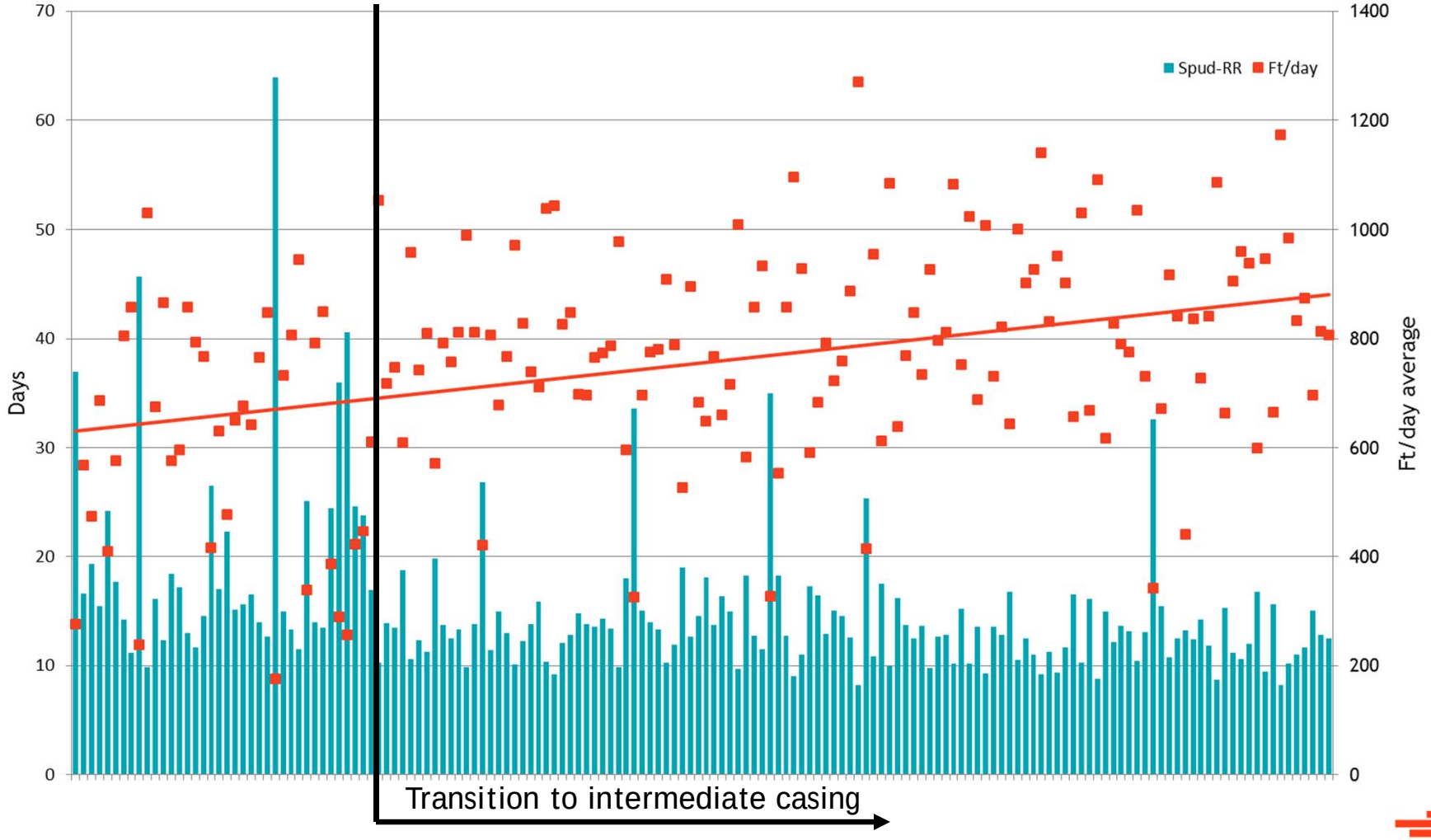


Current Well Design

Intermediate casing – Tight radius curve



Performance
Woodford Horizontals

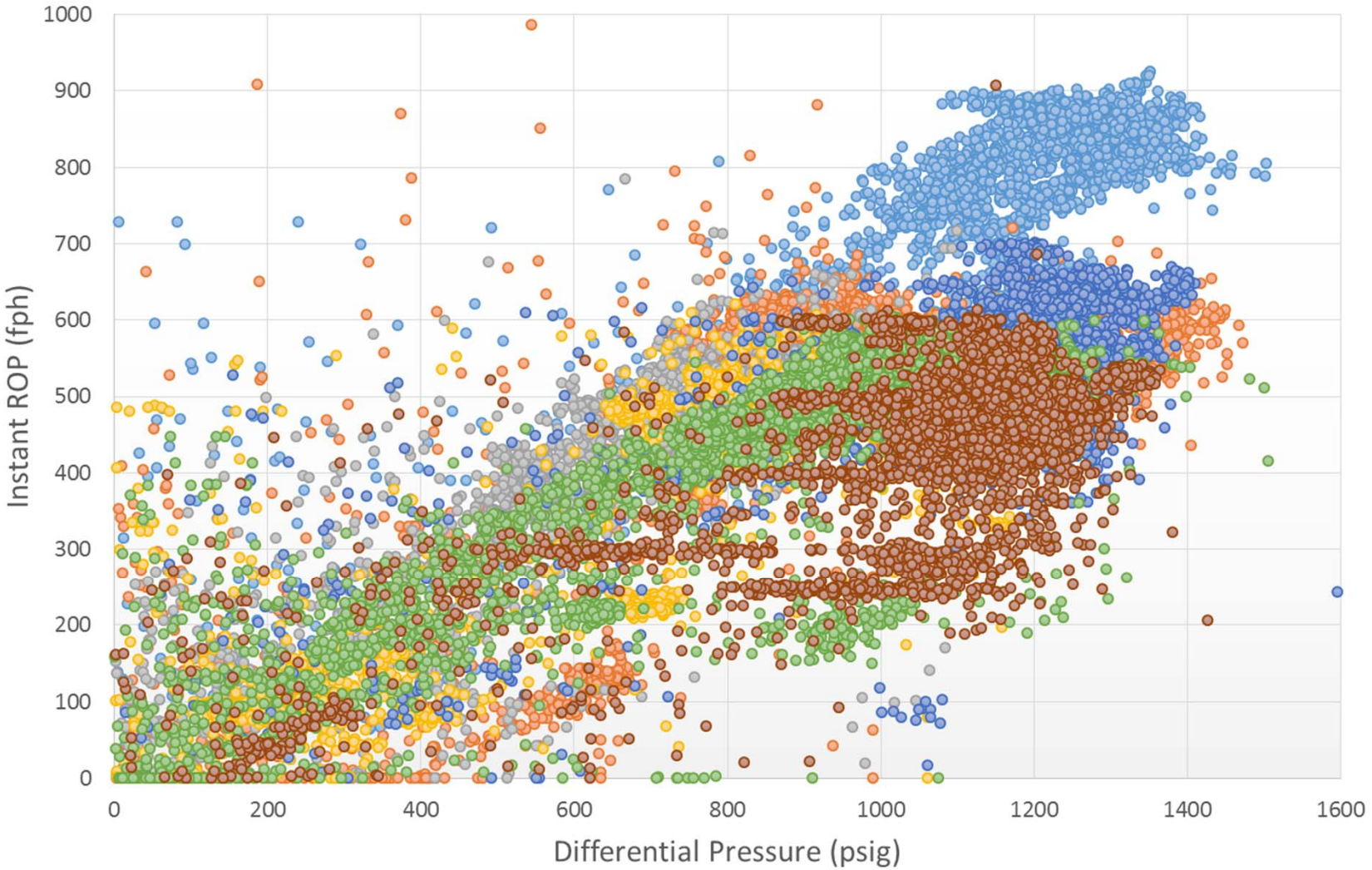


Lateral Performance

- High performance, high speed, stabilized motors on 4” drill pipe
- Differential Pressure vs. ROP
- Reduced connection times
- Planned clean-up cycles
- Reduction of agitator usage
- Frequent communication with geologists and geosteerers

Lateral Performance

Differential Pressure vs. ROP



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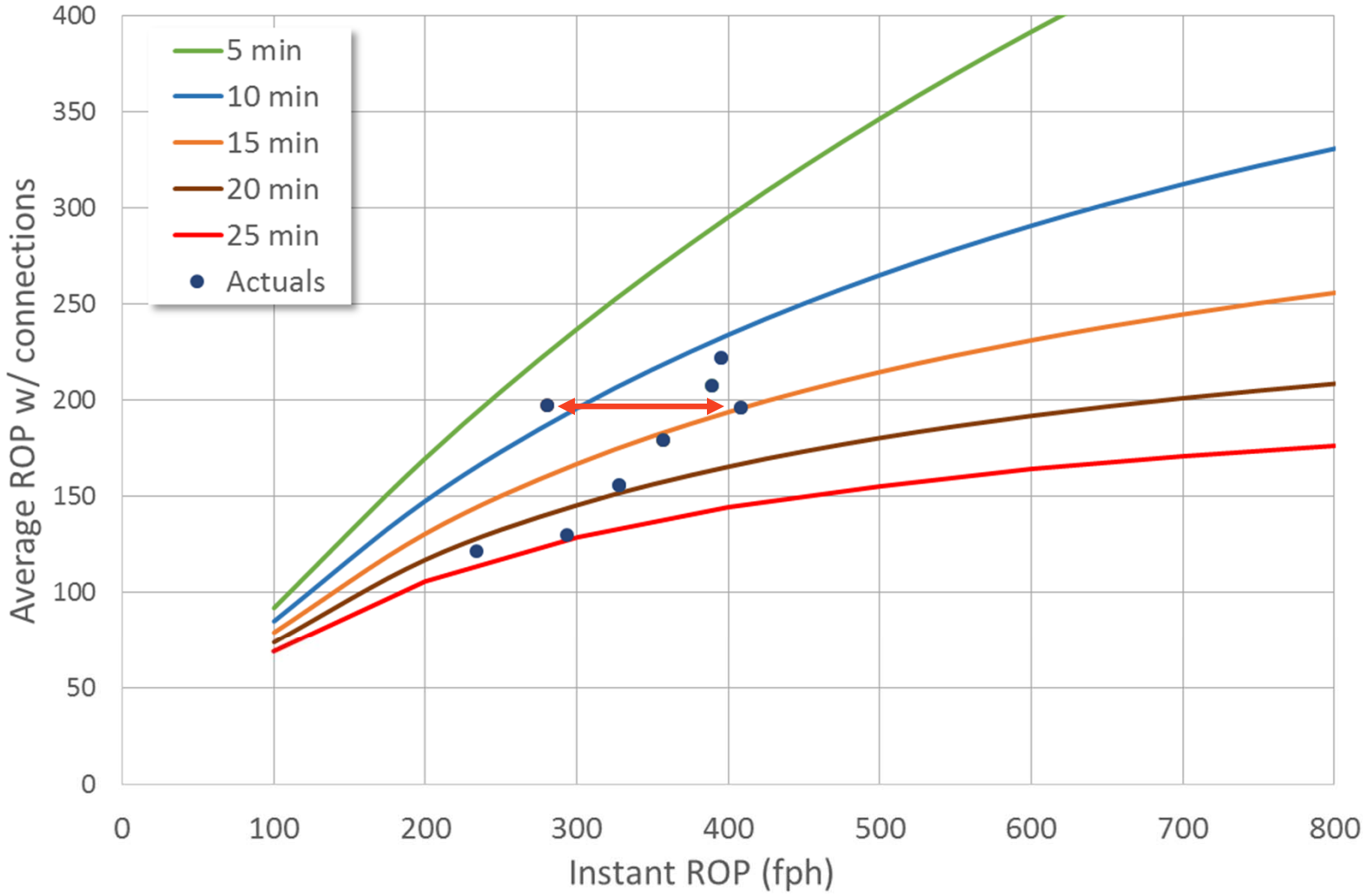
Lateral Performance
Connection times



Lost Circulation

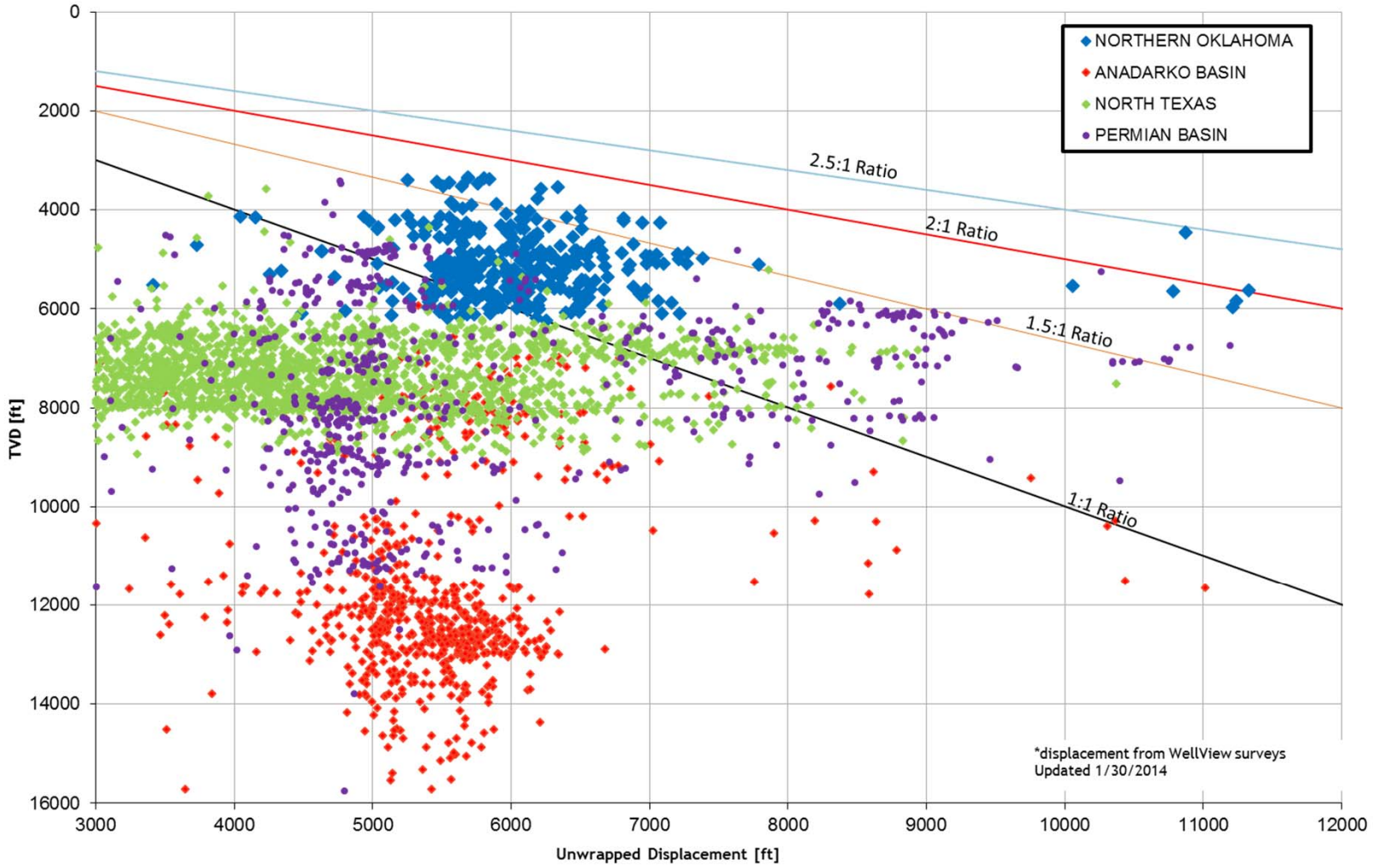
- Lose at least 100 bbl.. WBM on 75% of all WDFD laterals
- What is driving mechanism of lost circulation/seepage?
  - Faulting/natural fractures
  - ECDs > fracture gradient
- Lost circulation mitigation/treatment
  - Nitrogen units
  - Planned cleanup cycles
  - Minimize LCM treatments
  - “Dry” drill

Liner Cementing

- Liner hanger/packer selection
  - "Wash/ream to bottom" and/or "float"
- Centralization
  - 1 centralizer per joint
- Nitrified mud ahead of cement job
  - 1 gpm:1scfm ratio
- Increased excess from 20% to 30-50%
  - Relatively small additional volume
- Rotate liner while cementing
  - 15 to 25 rpms

Extended Reach Drilling (ERD)

Devon drilled horizontals



Extended Laterals
Challenges

- Provide twice the length of lateral for less than twice the cost of a standard length lateral

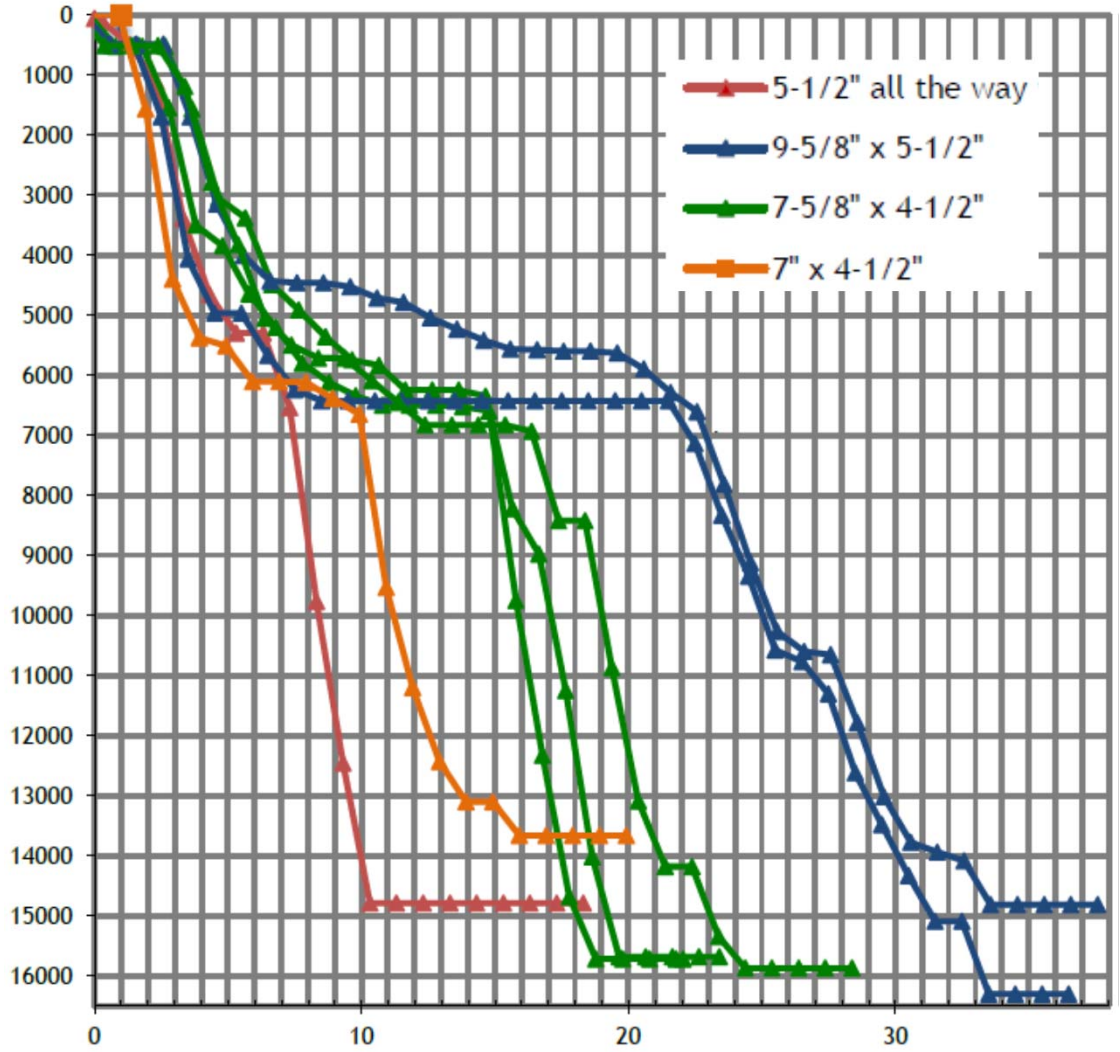
- Optimum well design
  - What is the optimum design?
- Hole cleaning
  - Lost circulation reduces efficiency
- Tool availability
  - Limited supply of specialty tools
- Torque and Drag
  - Conventional vs. Rotary Steerable
  - Getting casing to bottom

Extended Laterals
Optimum well design

- Tested designs
  - 8-3/4” all the way = 5-1/2” long string
  - 8-3/4” curve, 6-1/8” lateral = 7” x 4-1/2” liner
  - 12-1/4” curve, 8-3/4” lateral = 9-5/8” x 5-1/2” long string
  - 9-7/8” to KOP, 8-3/4” curve, 6-1/2” lateral = 7-5/8” x 4-1/2” liner
  - There are a number of additional designs also worth considering…
- Challenges
  - Risk vs. Reward
  - ECDs in slim hole, accurate ECD modeling
  - What zones can be exposed? How long?
  - Additional drilling time for larger hole = additional days and cost

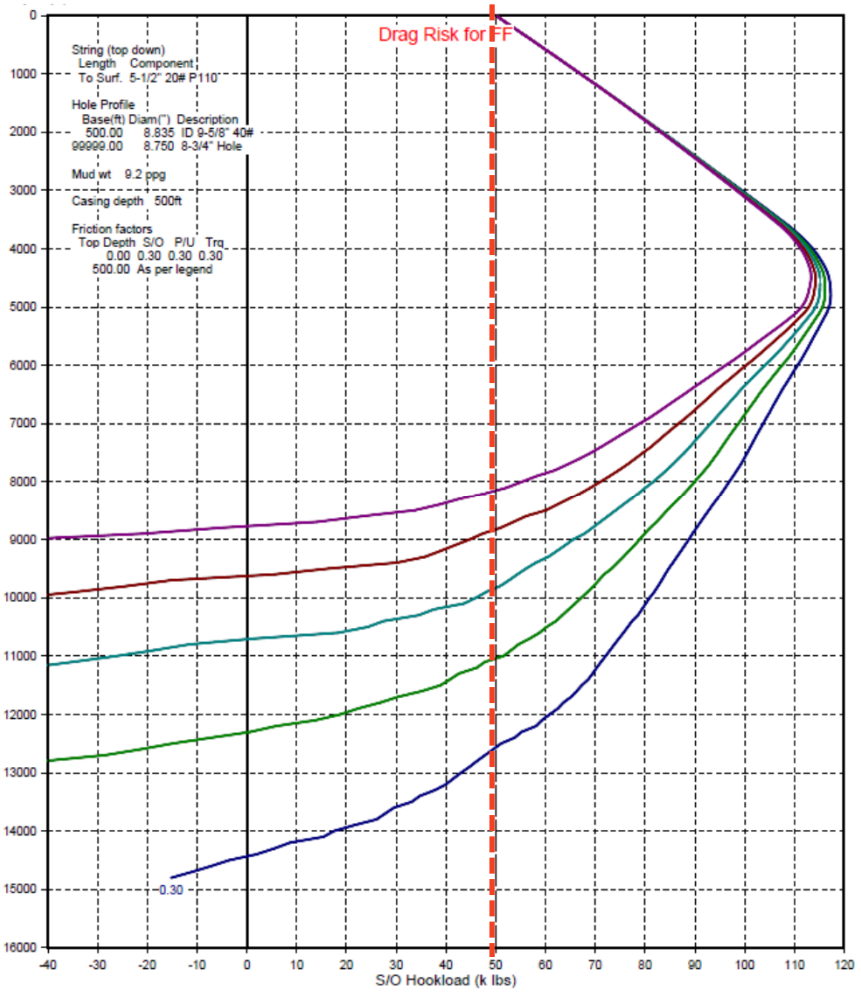
Extended Laterals

Days vs. Depth



Extended Laterals
Torque & Drag

- Relatively high FFs
- Conventional vs. RSS
  - What is the limit?
- Running Casing
  - Long strings
    - Conventional
    - Rotate to bottom
    - Floating
  - Liner
    - Conventional
    - Rotate to bottom
    - Floating
- Lubricants
  - Cost vs. Benefit



Moving Forward

- Continuous improvement of current practices
- Define the boundaries of the play
  - Continue testing well design concepts for standard length laterals throughout the entire play
  - Utilize key learnings from standard length laterals and apply to extended laterals
- WellCon – Decision Support Center
  - 24/7 real-time monitoring center

Thank You

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