Western Dakota Energy Association Annual Meeting

Refracs: Completion Discussion for Bakken Generation 1 Wellbores

Originally presented to the Interim Energy Development and Transmission Committee by Pete Lewis (Completion Engineer), Jeff Parker (Region Manager), and Zac Weis (Government Relations) – August 1st, 2017

Subsequently presented at the North Dakota Petroleum Council Annual Meeting by Curtis Ryland (Regional Vice President) – September 28th, 2017.

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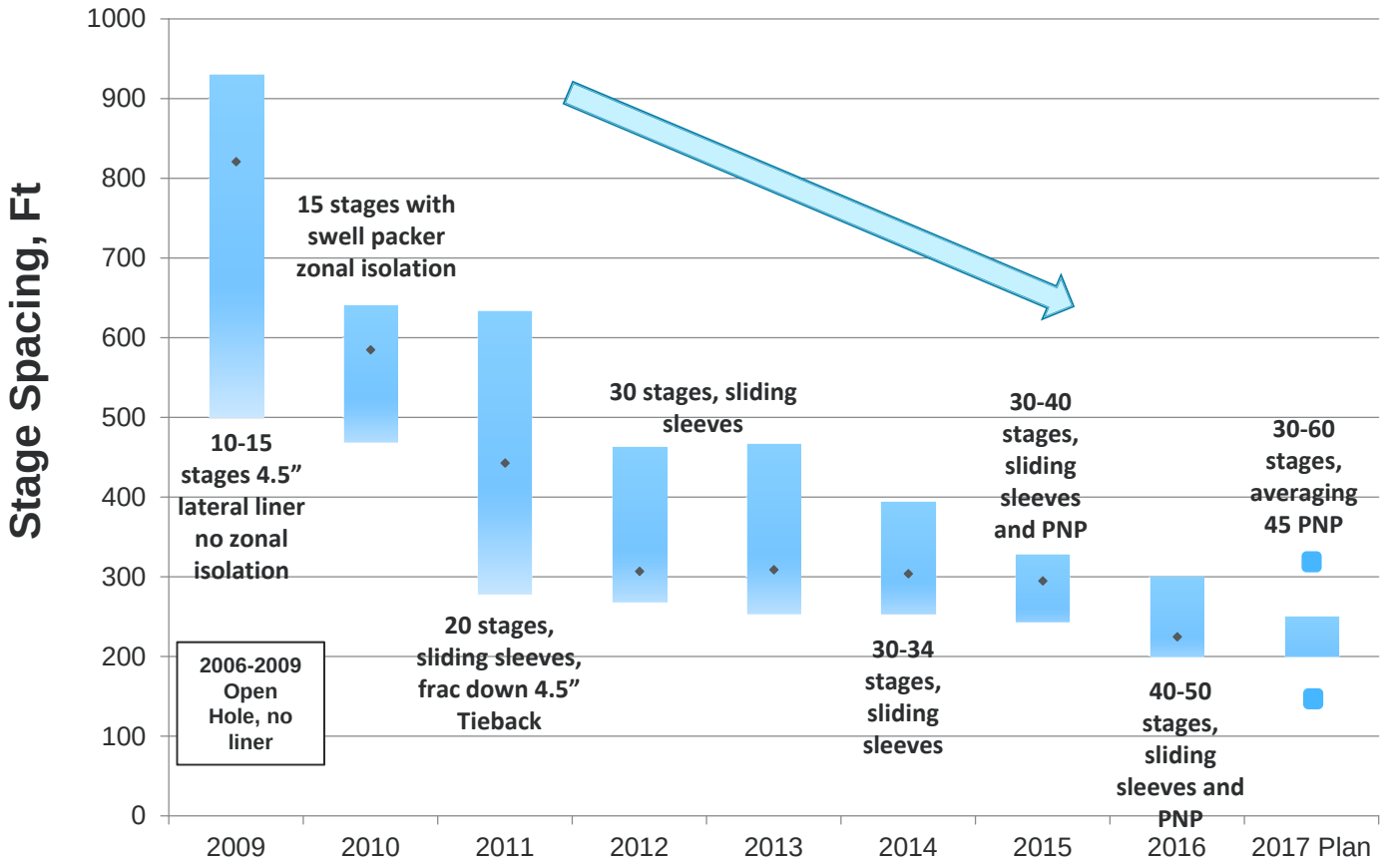
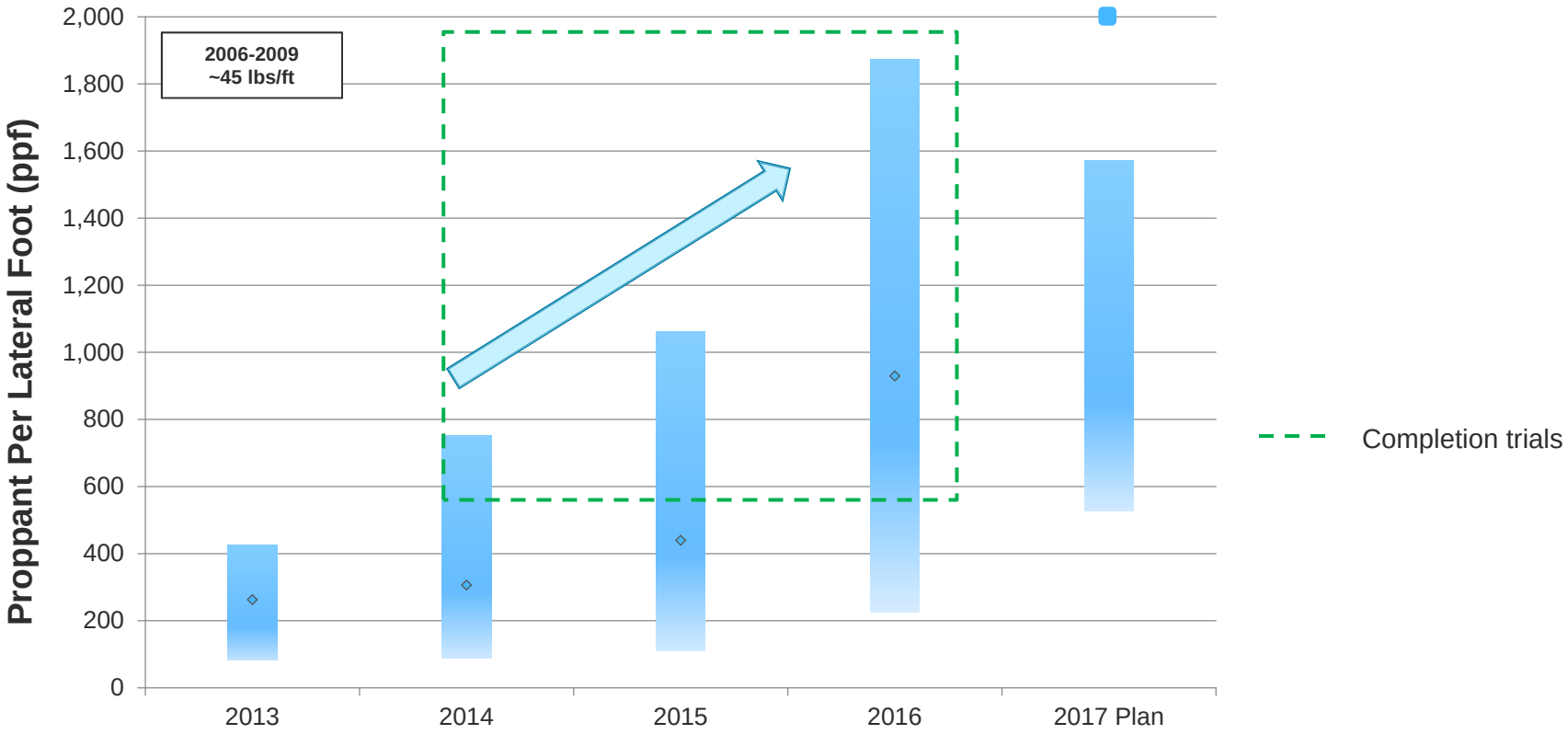
Presented by Jeff Parker, Region Manager of Bakken Asset – November 2nd, 2017

MRO Completion and Stage Spacing Evolution

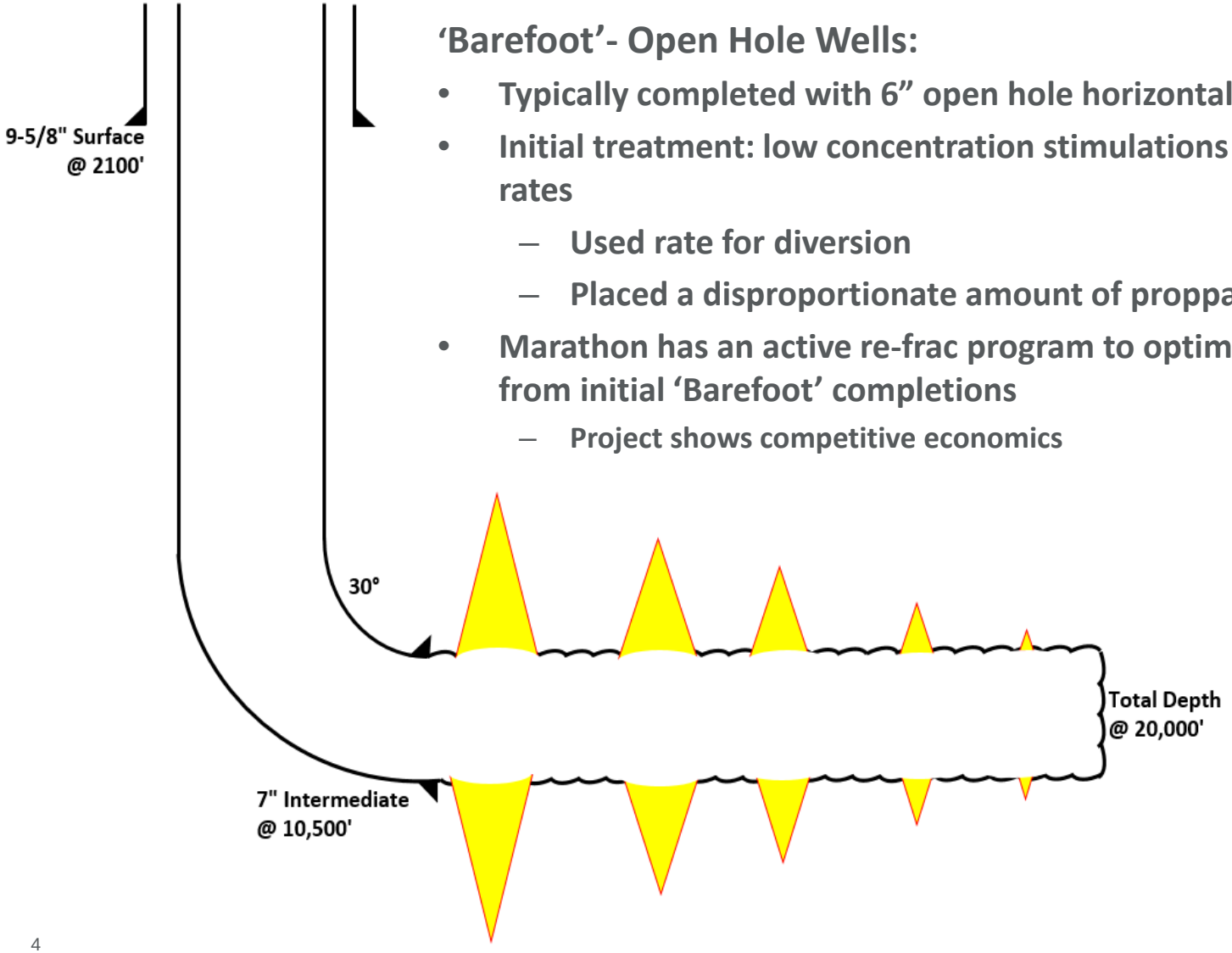


MRO Proppant Loading Evolution



Well Type of Current Re-frac Program

Open-hole or 'Barefoot' Completions (2006-2009)



'Barefoot'- Open Hole Wells:

- Typically completed with 6" open hole horizontal laterals
- Initial treatment: low concentration stimulations pumped at high rates
  - Used rate for diversion
  - Placed a disproportionate amount of proppant near heal
- Marathon has an active re-frac program to optimize recovery from initial 'Barefoot' completions
  - Project shows competitive economics

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What does it take to Refrac an Open Hole Lateral?

- Refrac Candidate Selection
  - Thorough well history review to identify operational risk
    - Squeeze perforations, sidetracks, or any mechanical constraint
- Pre-investment Approvals
- Well preparation
  - Decompletion
    - Completed by a workover rig
      - Remove the existing production equipment (surface + downhole)
      - Test the casing and securing the well for large (drilling) rig mobilization
  - Downhole Equipment Installation
    - Clean-out run to TD
    - 4-1/2” lateral liner installation (cemented in-place)
    - Run 4-1/2” tieback string
- Stimulation execution
  - 5.5 MMlbs proppant
  - 110 Mbbls water
- Coiled tubing clean out (mill up frac plugs)
- Flowback
- Production

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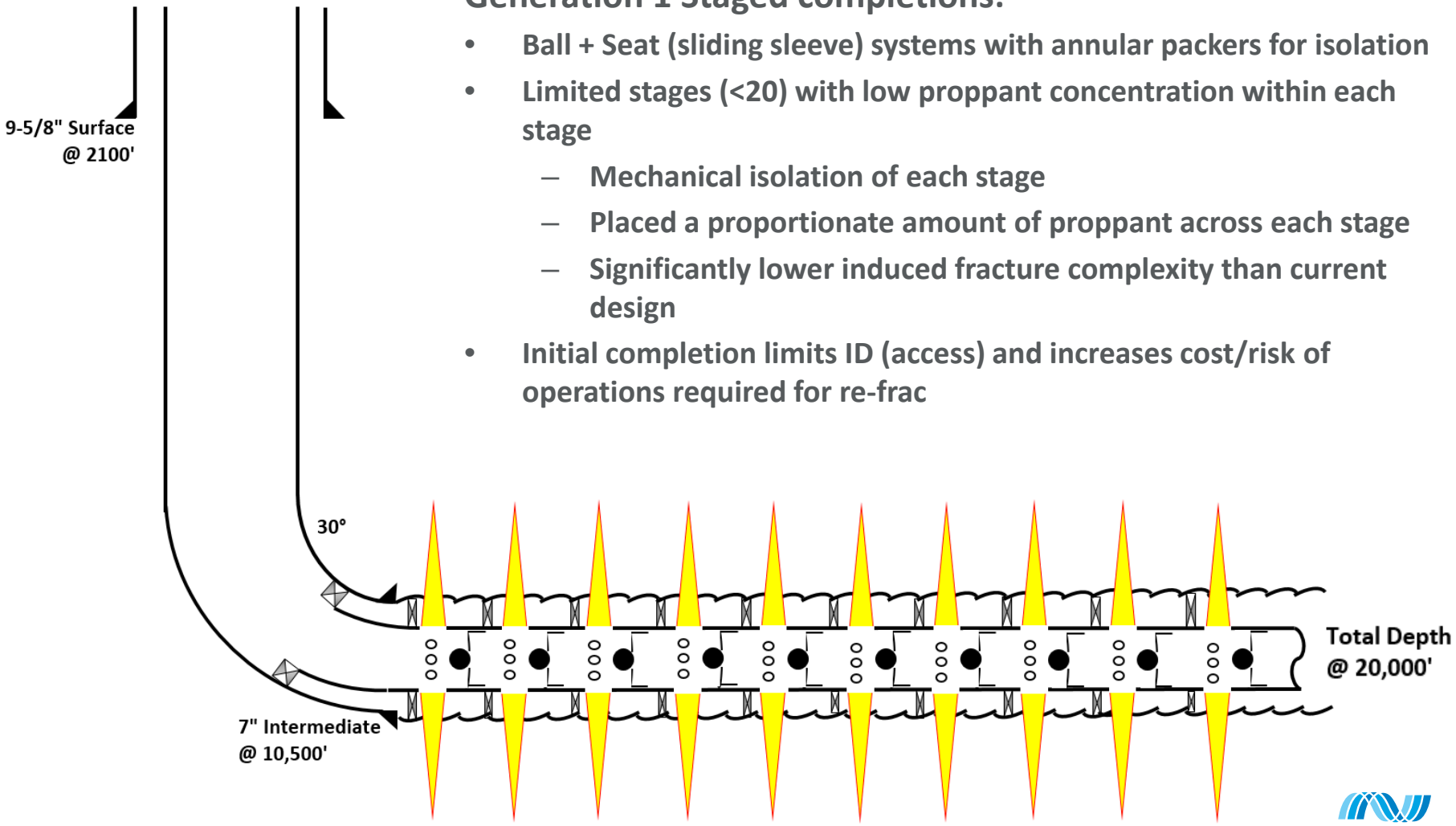
Overview of Existing Horizontal Well Types

Generation 1 Staged Completions (2009-2011)



Generation 1 Staged completions:

- Ball + Seat (sliding sleeve) systems with annular packers for isolation
- Limited stages (<20) with low proppant concentration within each stage
  - Mechanical isolation of each stage
  - Placed a proportionate amount of proppant across each stage
  - Significantly lower induced fracture complexity than current design
- Initial completion limits ID (access) and increases cost/risk of operations required for re-frac

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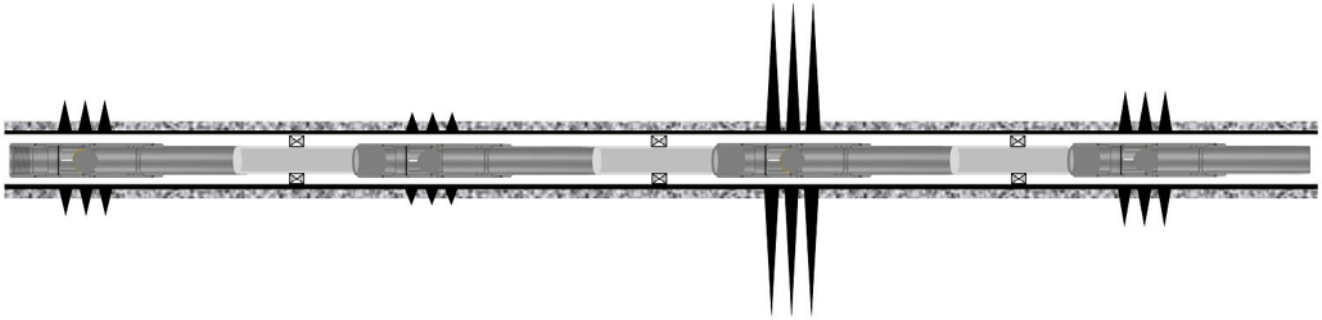
Available Refrac Completion Options

Existing Generation #1: Ball + Seat Systems Refrac Option #1

- **Option #1: Particulate Diverters**
  - Existing Ball + Seat installations can be refrac'd using the existing 4-1/2" liner assembly
    - Requires a lateral liner cleanout before and after treatment
      - Also, a 4-1/2" tieback string installation
    - Least expensive option
    - Multiple stages of proppant and particulate diverter pills are 'bull headed' from surface
    - Concept is predicated on treating path of least resistance
      - Generating enough 'net' pressure to divert flow to another sleeve



Challenges:

- Least effective option. There is no reliable way to divert to different sleeves other than pumping particulates.
- Difficult to add effective perforations and additional zones

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Available Refrac Completion Options

Existing Generation #1: Ball + Seat Systems Refrac Option #2

- **Option #2: Inner String Installation (with sleeves)**
  - Install a 3-1/2” Flush Joint (FJ) lateral liner with a slim-hole ball + seat system (using swell packers for zonal isolation)
    - Ball + Seat Sliding Sleeve system (27 Stages possible, but not practical due to ID)
    - Annular isolation accommodated by swell packers
    - A 2-7/8” system cut for 3-1/2” Flush Joint tubing to minimize friction pressure
    - **If more stages are required, the lateral liner must be perforated prior to running the internal assembly**

Challenges:

- The 2-7/8” ball and seat systems leave a small ID which limits any remedial workover capability. (2.1” max)
  - An operationally difficult completion to install and maintain. Small tools limit options to clean out sand/debris.
  - Not practical for longer laterals - measured depth limitation of 2.0” tools
  - Difficult to add perforations (more zones)

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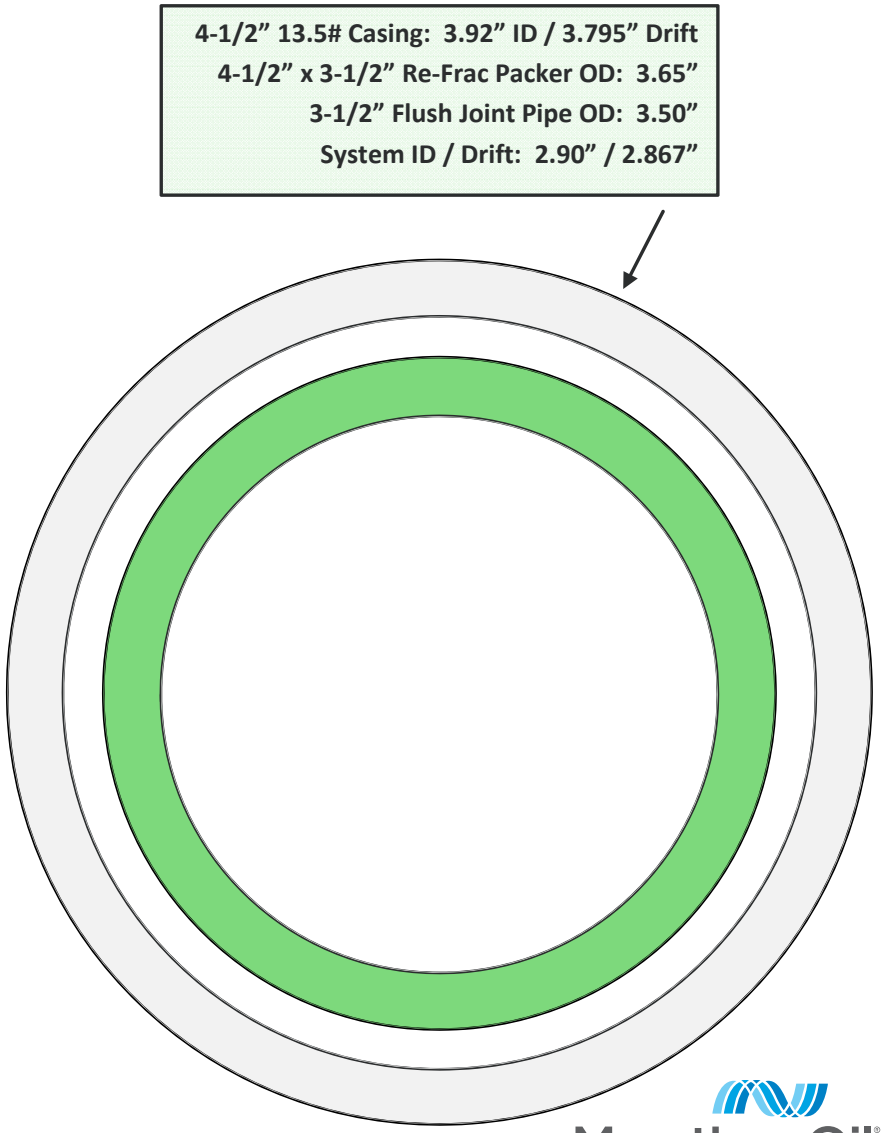
Available Refrac Completion Options

Existing Generation #1: Ball + Seat Systems Refrac Option #3

- **Option #3: Inner String Installation**
  - Install a Flush Joint (FJ) lateral liner (inner string) to accommodate Plug and Perforation stimulation techniques.
    - Annular isolation can be accommodated with either:
      - #1: Expandable packers (for zonal isolation)
      - #2: Can be cemented in place despite tight clearances
    - Designed for plug and perforation re-stimulation activity
    - More versatile than available ball + seat systems due to a larger ID.
      - **Accommodates increasing the stage count and the use of particulate diverter**

Challenges:
- Very tight tolerances to deploy especially in depleted conditions
- Cement isolation very difficult due to low circulation rates
- Expensive specialty pipe required for 3-1/2" installation



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What does it take to Refrac a Generation 1: Ball + Seat Installation?

- Well preparation
  - Decompletion
    - Completed by a workover rig
      - Remove the existing production equipment (surface + downhole)
      - Mill up the existing ball seats to accommodate an inner string deployment
      - Install a 4-1/2” tieback string (likely)
  - Downhole equipment installation
    - Deploy an inner string (2-7/8” or 3-1/2”) inside the existing 4-1/2” lateral liner
      - Zonal isolation achieved by either cement or mechanical (expandable packers) 4-1/2” lateral liner installation (cemented in-place)
- Stimulation
  - Plug and perforation techniques
- Coiled tubing clean out (mill up frac plugs if Plug and Perforation Techniques are used)
- Flowback
- Production

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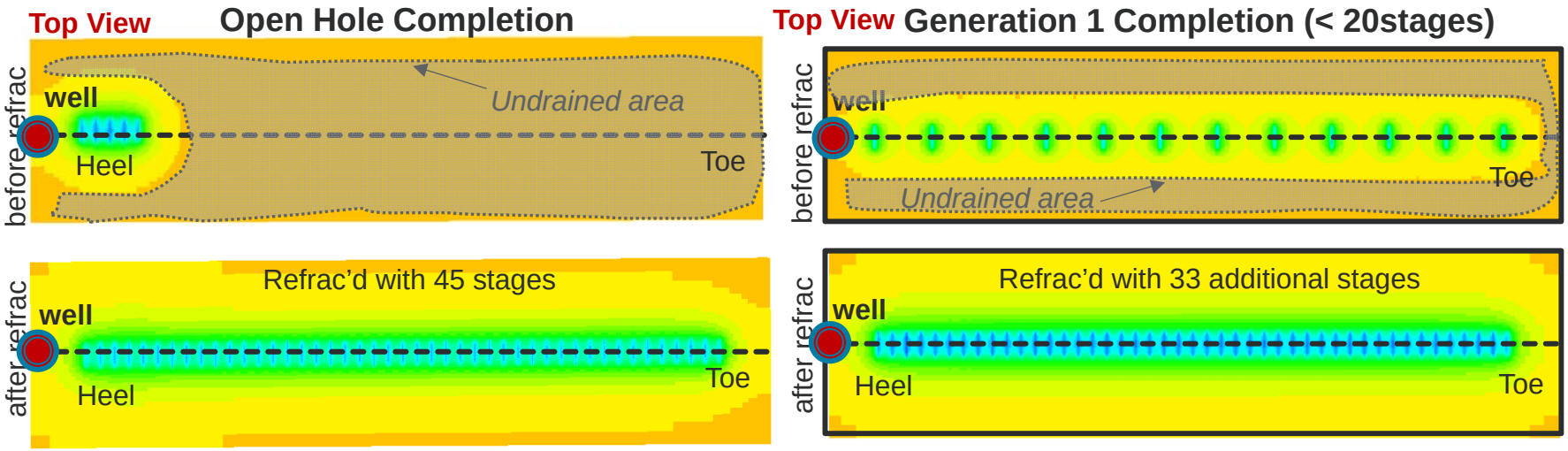
Initial Completion and Remaining Hydrocarbon

Reservoir Pressure Maps



- Significant **un-depleted area** before refrac with original open hole completion
- Generation 1 completions refrac'd by **adding stages** to the original completion

- **Open hole** completions has greater undrained area resulting in **larger remaining hydrocarbon** volume

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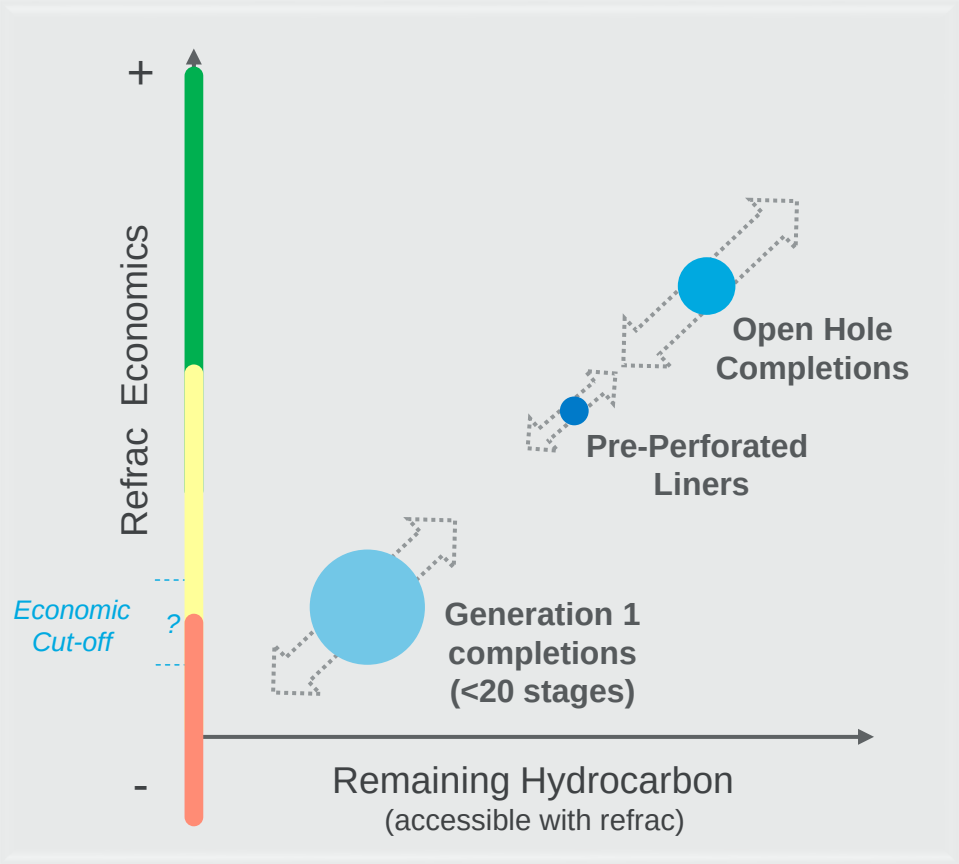
Re-frac Project Value

Economics driven by remaining hydrocarbon

Refrac Project Value Plot



- performance uncertainty

** Bubble size represents remaining refrac inventory*

- Project economics grossly depends on **remaining hydrocarbon** volume accessible with a refrac
- Largest remaining refrac inventory is **Generation 1** completions (10-20 stages)
- Variation in reservoir properties, well production and completion history generate **uncertainty** around refrac performance

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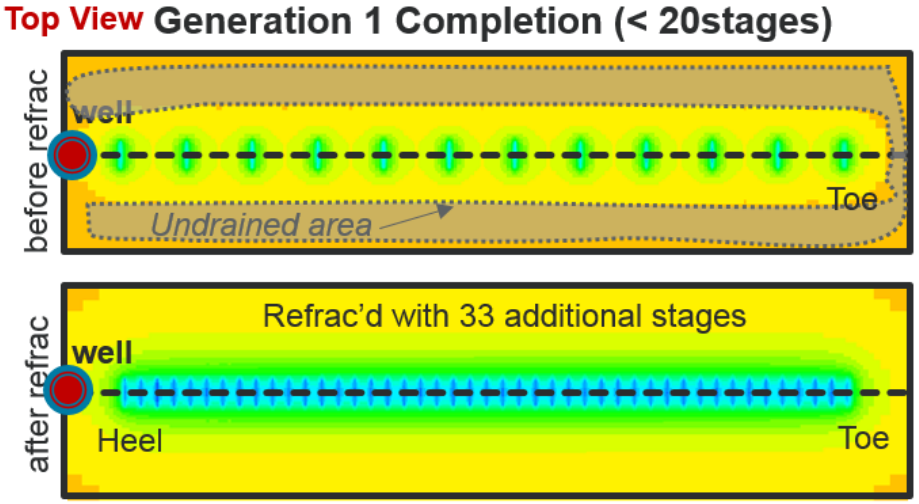
Staged Completion Re-frac Considerations

How do we reduce economic uncertainty to better understand potential value?



Reserves / Resources

- Incremental benefit uncertainty
- Dependent on:
  - DSU remaining hydrocarbon volume
  - Re-frac completion effectiveness
  - Geologic uncertainty

Completion

- Cost of technology
- Risk of execution
- Operational risk of future well work activities due to reduced ID requiring small tools in tight clearance

Investment Decisions

- Deferred production / risk of lost production from existing well
- Partner approval requirements
- Confidence in technology
- Economic competitiveness within opportunity portfolio