The Evolution of CT Fracturing Techniques in Western Canada

SPE ICOTA Roundtable
October 20, 2011

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Outline

- Industry Trends
- Overview of Different Techniques (with a focus on doing more with less)
  - Sandjet Perforating & Packer
  - Frac Sleeves
  - Straddle Systems
  - The Half Straddle™

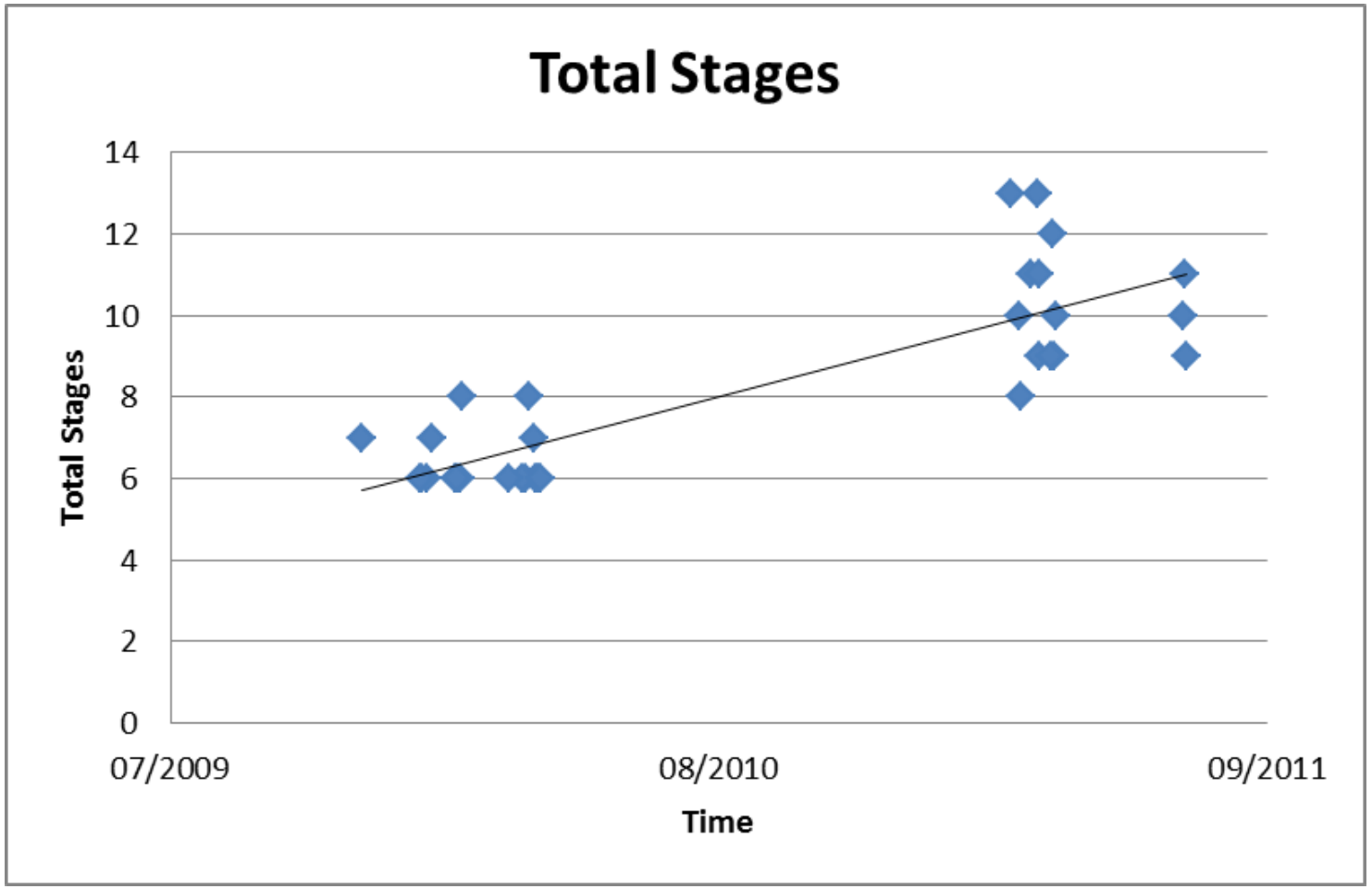
Outline

- Process Efficiency
  - Reduce fluid consumption
  - More done in less time

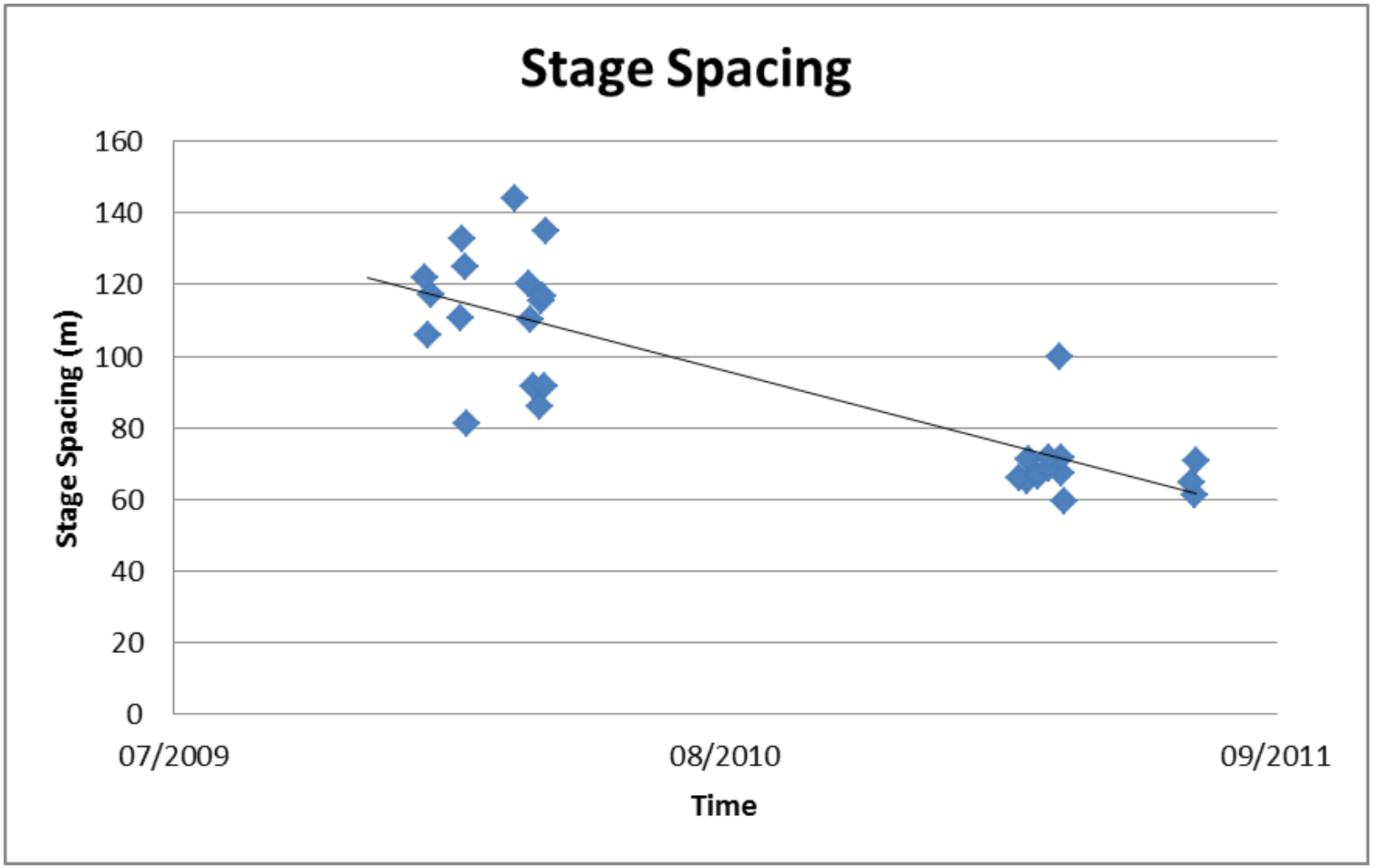
Intervention & Coiled Tubing Association

Canadian Chapter

WCSB Industry Trends



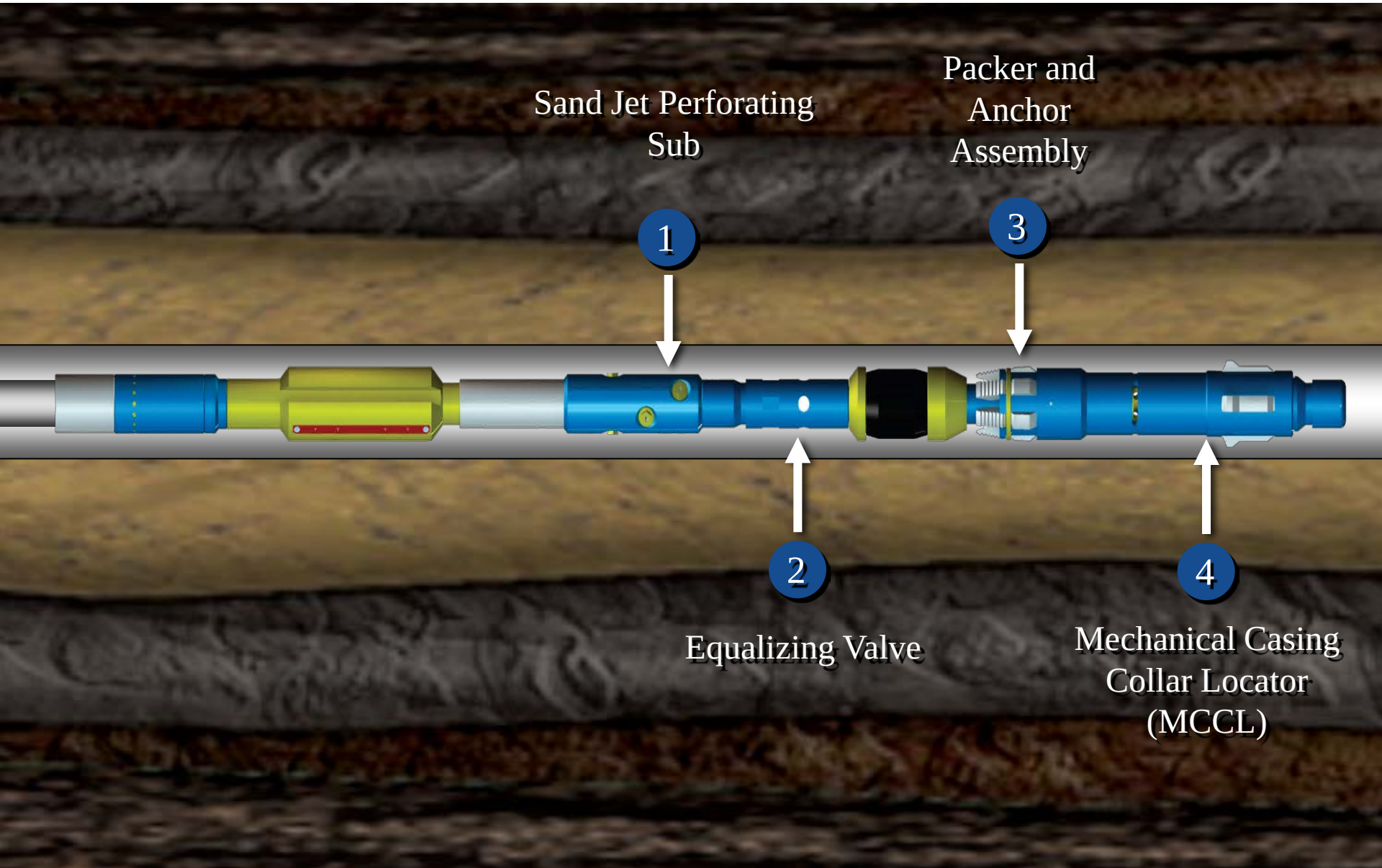
WCSB Industry Trends



Packer & Sand Jet Perforating

- Broad market application since 2009
  - >1000 wells & 10,000 zones in WCSB
- Expanding into new markets
  - Deeper Wells @ higher pressures
- "The most successful people are those who are good at Plan B" *James Yorke (1941-)*
  - Process contingency for Screen Outs
  - Feedback to adapt on the fly

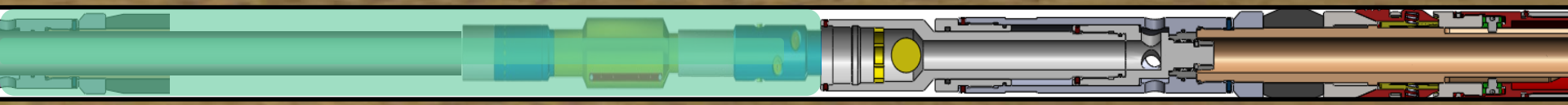
Sand Jet Perforating & Packer



Packer & Perforating System

Run in hole, locate collars with Mechanical Casing Collar Locater (MCCL)

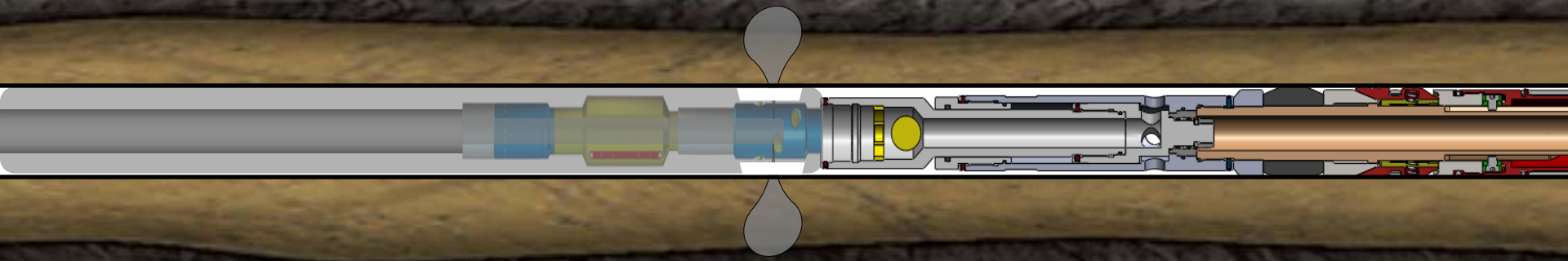
Set BHA in the toe of the well



Packer and Perforating System

Circulate abrasive slurry through perforator (Fluid Volume = 4 m^3)

Circulate to slurry up the well away from perforations (Fluid Volume = 2 m^3)



Packer and Perforating System

Pump fracture stimulation fluids down the annulus

- Deadleg for Real Time Bottom Hole Pressure
- Annulus flow supports large Flow Rates

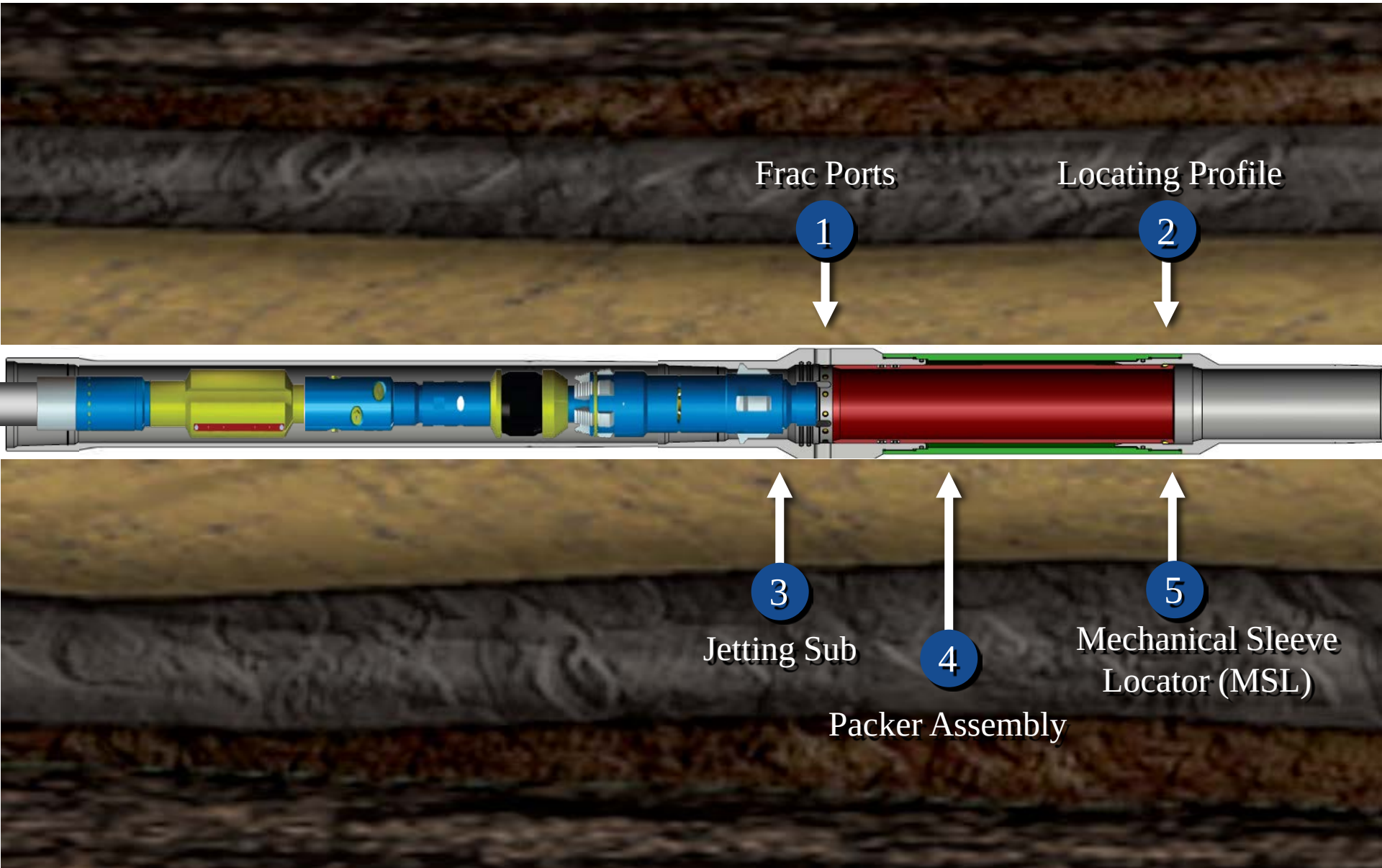
Fluid Volumes (typical Bakken well)

- Perforating = 6 m^3
- Pad = 5.5 m^3
- Place Proppant = 11 m^3
- Flush = 5 m^3
- Total/Stage = 27.5 m^3

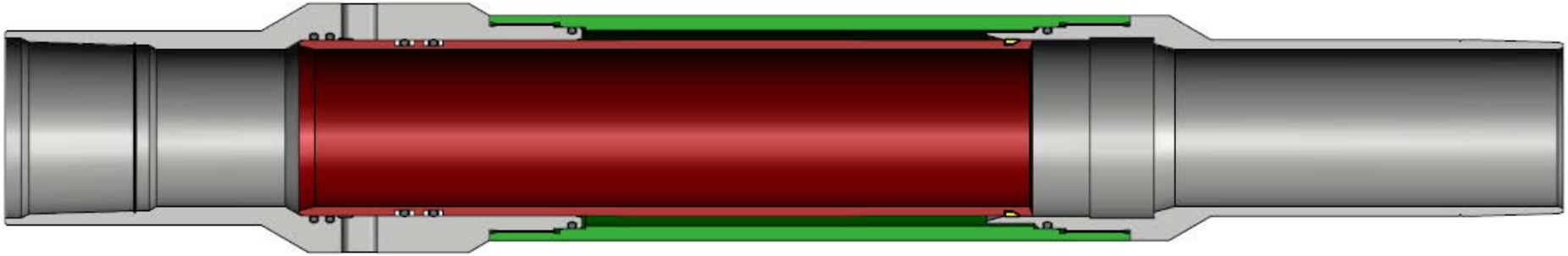
CT Frac Sleeves

- Broad Market Application since 2010
  - More than 5000 Stages in over 300 wells
- Refinement of the Packer and Sand Jet Perforating Technique
- Sand jet perforation tunnels replaced by the CT Frac Sleeves

CT Frac Sleeve



CT Frac Sleeve



Fluid Volumes (same typical Bakken well)

- Perforating = 0 m^3
- Pad = 5.5 m^3
- Proppant = 11 m^3
- Flush = 5 m^3
- Total/Stage = 21.5 m^3

Straddle System

- Market Application
  - Refrac existing wells
  - Add stages between existing stages
  - New well construction
    - Explosive Perforating, Burst Ports, Frac Sleeves
- Benefits
  - Complete zonal isolation
- Limitations
  - Pump frac down CT
  - Limited circulation capabilities (limited Plan Bs even for MacGyver)

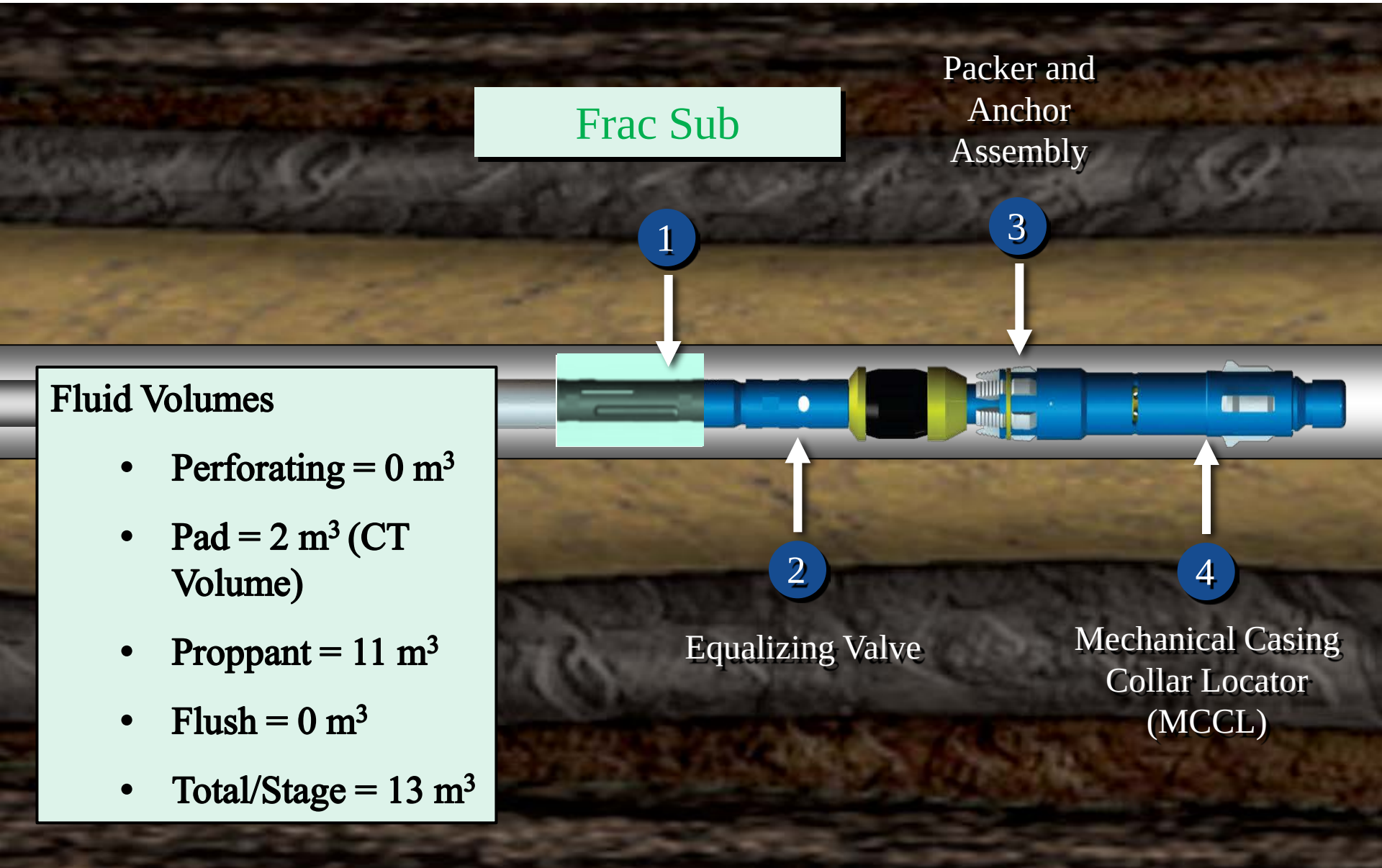
Straddle System

- Fluid Volumes
  - Perforating = 0 m^3
  - Pad = 8 m^3 (CT Volume)
  - Proppant = 11 m^3
  - Flush = 0 m^3
  - Total/Stage = 19 m^3

Half Straddle™

- Modification of Packer & Sand Jet Perforating Technique
- Frac Stimulation Fluid pumped down the CT
- Sand Jet Perforator replaced with frac sub
- Use with Frac Sleeves (perforating not required)
- Similar to Straddle BHA technique without the top cup

Half Straddle™ Technique



Fluid Volumes

- Perforating = 0 m^3
- Pad = 2 m^3 (CT Volume)
- Proppant = 11 m^3
- Flush = 0 m^3
- Total/Stage = 13 m^3

Fluid Volume Comparison Summary

Frac Technique	Fluid Savings Stage Volume m^3	Fluid Savings x 25 Stages m^3	Fluid Reduction %	% Time per Stage *
Half Straddle™ vs. Packer & Sand Jet Perforating	14.5	363	47%	44%
Half Straddle™ vs. CT Frac Sleeves	8.5	213	39%	72%
Half Straddle™ vs. Conventional Straddle	6	150	31%	79%

* No unplanned events

Conclusions

- CT is having a significant impact on creating new and improving processes for multi-stage fracturing techniques
  - Time savings and fluid reductions
  - Improving productivity

Questions?

- ICOTA
- NCS Oilfield Services
- Geo Webworks Inc.

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NCS OILFIELD SERVICES

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