SPE-170831
Going Long - Overcoming Challenges in Completing 3600 m Laterals

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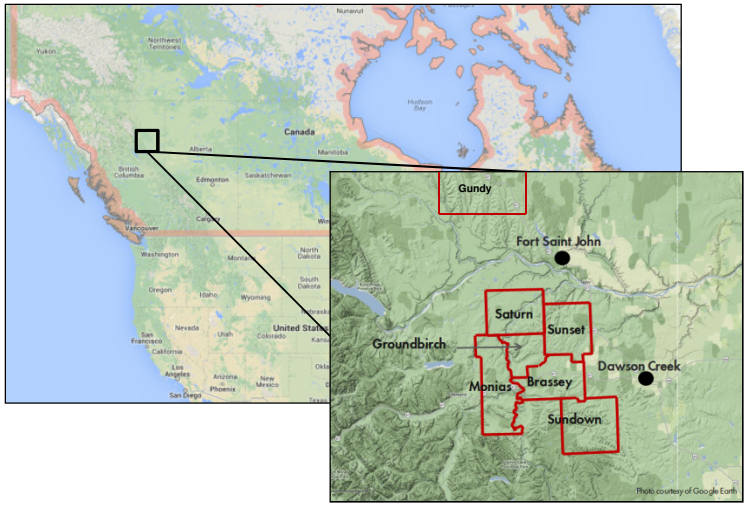
PRESENTATION OUTLINE

- Overview of the Asset
- The Benefit of Longer Wells
- Introduce the Challenge
- Completion Objectives
- Equipment Design (Coiled Tubing / BHA Design)
- Operational Summary
- Conclusions and Recommendations

GROUNDBIRCH ASSET OVERVIEW

- Location: Northeast BC, Canada
- Montney Formation (shaly siltstone)
- Horizontal Wells
  - 2,100 to 2,600 m TVD
  - 4,500 to 6,300 m MD
  - 114.3 mm or 139.7 mm casing
- Unconventional Gas Play (thousands of wells planned)
- All planned completions activities must be highly reliable and repeatable!



THE BENEFIT TO LONGER WELLS

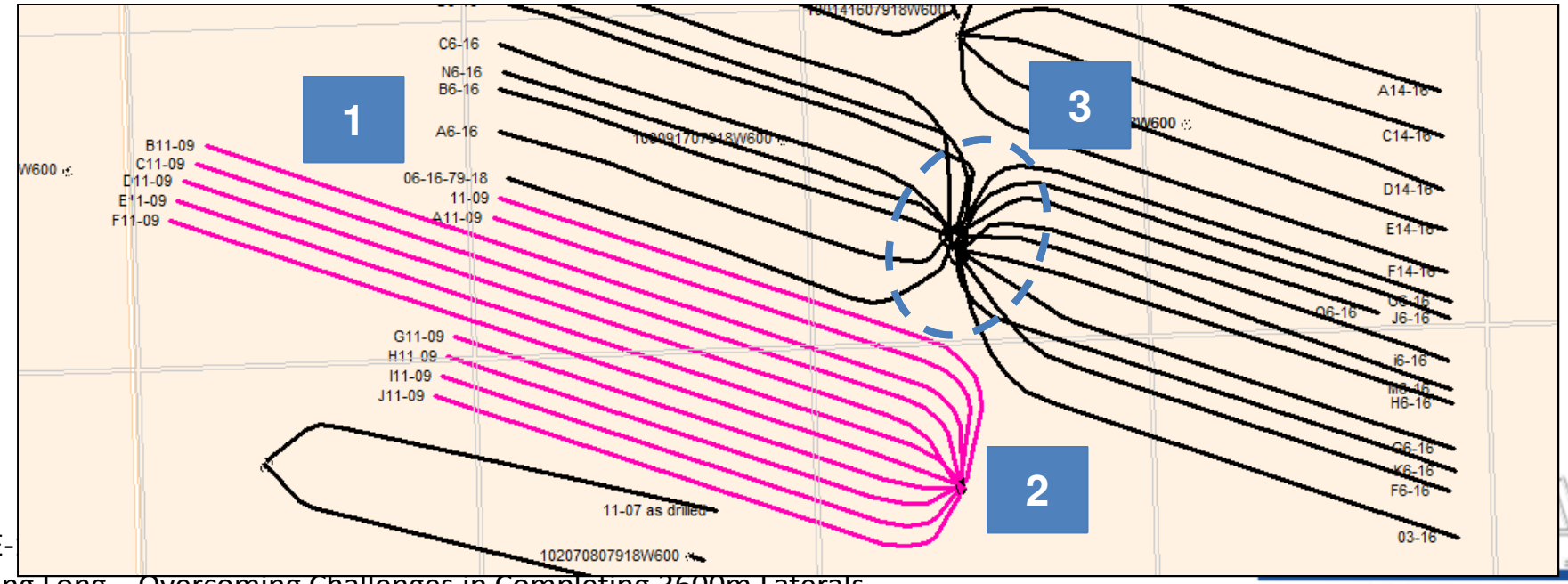
Dominance of Longer Wells in Unconventionals

1) Access more reserves with one wellbore [improved economics]

2) Reduced environmental footprint [HSE]

3) Reduced dead space in development

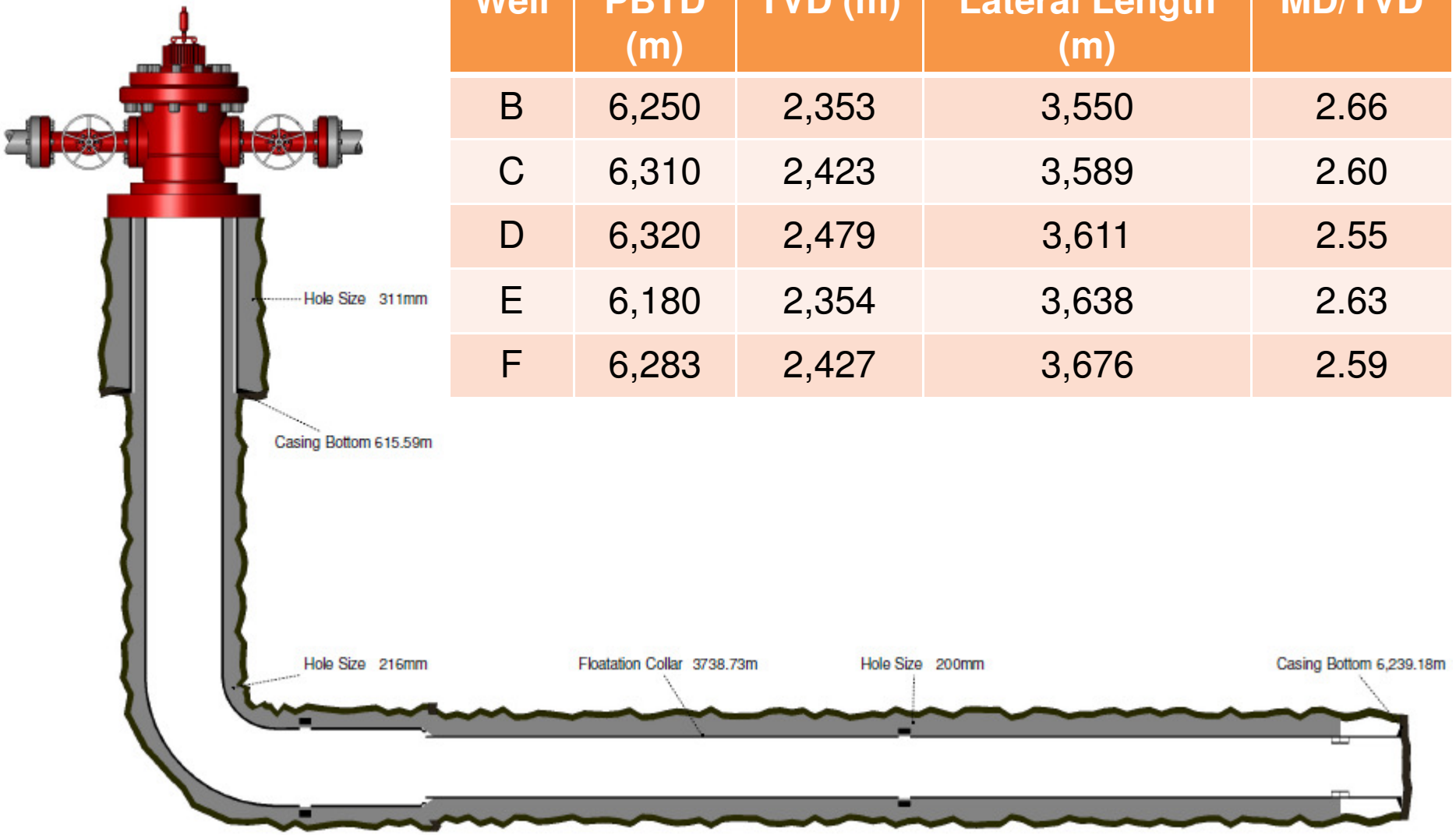
Groundbirch Conducted 5 Well Trial to Prove Technical Do-Ability



Slide 4

AO13 if this gets blurry when its blown up on the projector, you will not be able to read it. and the two squares in the left corner should either be photo shopped out or not cut off, looks messy.
Anna Ostrom, 10/7/2014

Well	PBTD (m)	TVD (m)	Lateral Length (m)	MD/TVD
B	6,250	2,353	3,550	2.66
C	6,310	2,423	3,589	2.60
D	6,320	2,479	3,611	2.55
E	6,180	2,354	3,638	2.63
F	6,283	2,427	3,676	2.59



THE CHALLENGE – "GOING LONG"

- Increase lateral length 60% to 3600 m
- Key Design Considerations:
  - Drilling (SPE-170888-MS) – 177.8mm x 139.7mm ← **Modified design**
  - Effective stimulation of complete lateral ← **Plug & Perf**
  - Effective cleanout of wellbore post-stimulation ← **Limiting factor**

Address the limitations:

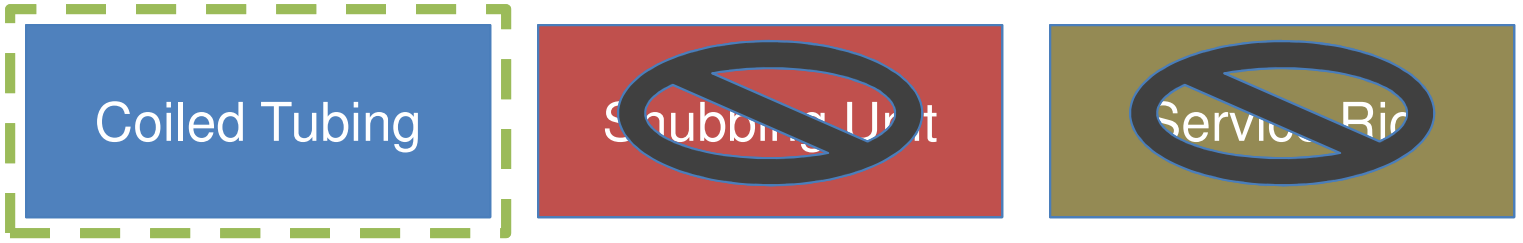
Completion Objectives	Design Optimization	Execution

Slide 6

AO15 the arrow in the first line needs to be fixed.
this is also a fairly boring slide.
Anna Ostrom, 10/7/2014

SERVICE EQUIPMENT OPTIONS CONSIDERED

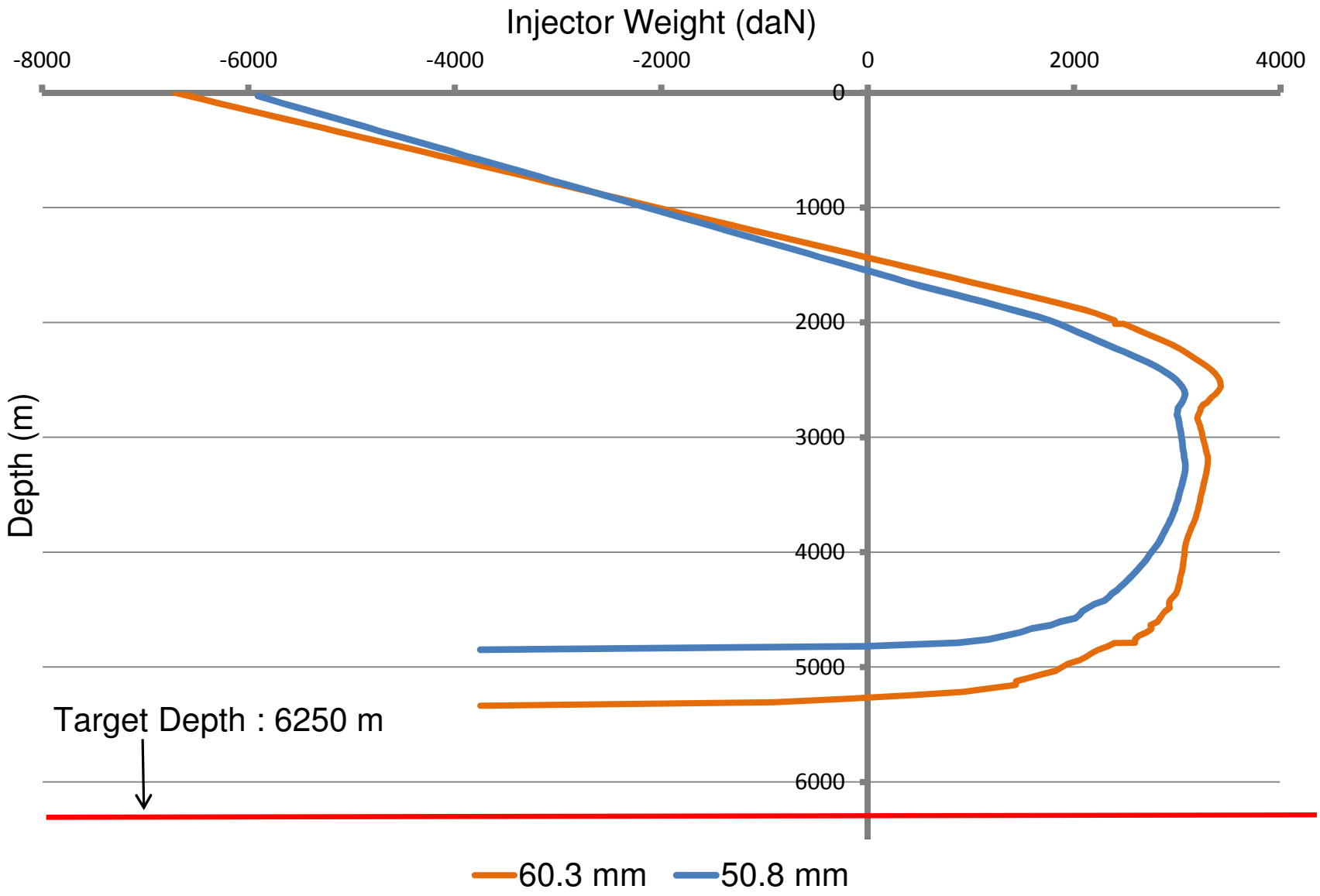
- Specific Requirements:
  1. **Depth:** Achieve 6250 m w/ 250 daN to mill out deepest plug.
  2. **Annular Velocity:** >40 m/min in vertical 177.8 mm Casing
  3. **Cost:** Avoid increasing completion cost / meter of well in development scenario
- Options considered:



Slide 7

BL2 again this slide needs something to keep the audience. Creat boxes for options considered - possibly bought up with animation
Ben Layton, 10/8/2014

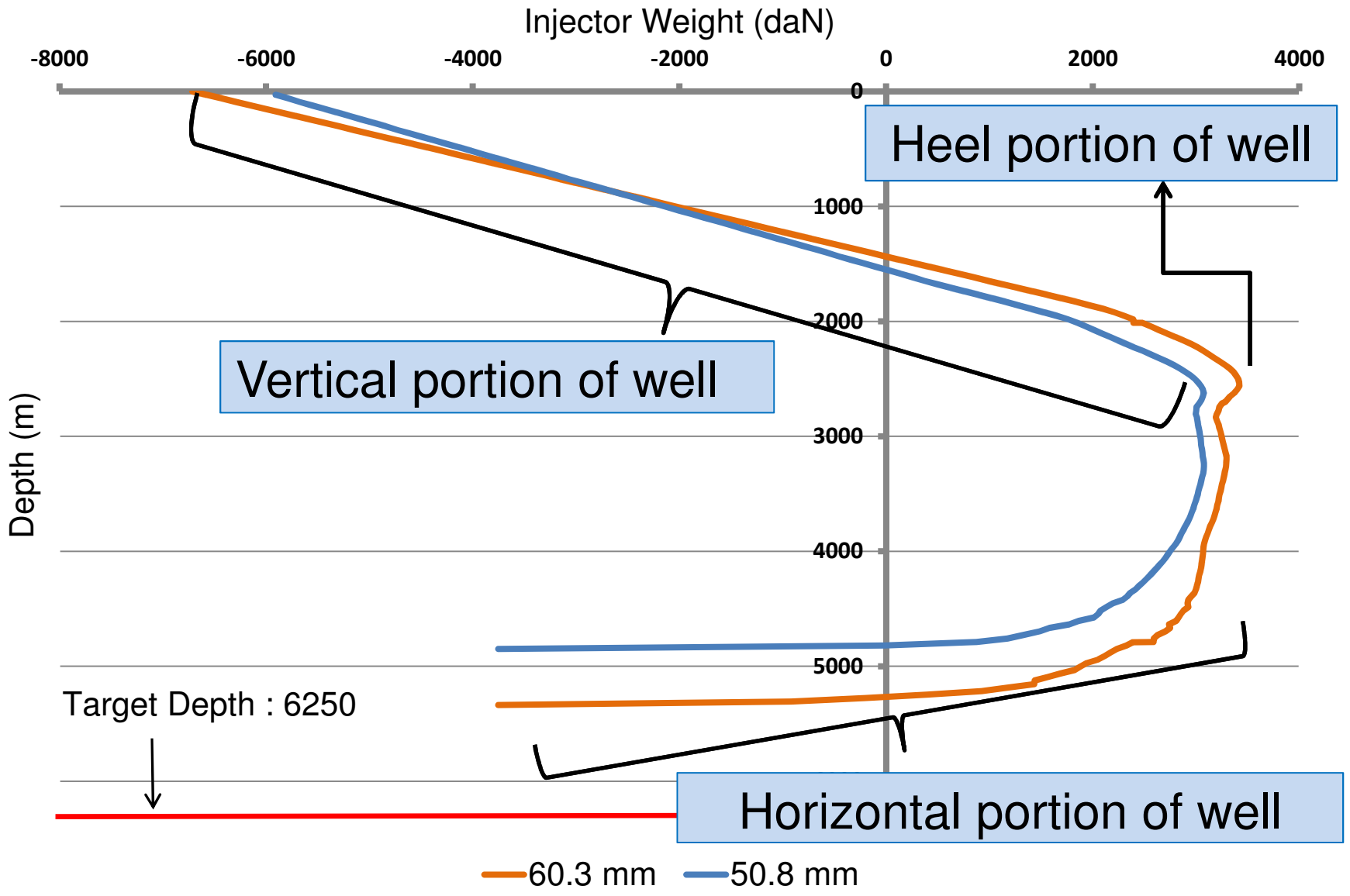
Force Limitation Utilizing 50.8 mm / 60.3 mm Coiled Tubing



Slide 8

AO12 youve cut off the "slide 10" in the right corner. either make them all smaller or takethem out.
Anna Ostrom, 10/7/2014

Force Limitation Utilizing 50.8 mm / 60.3 mm Coiled Tubing

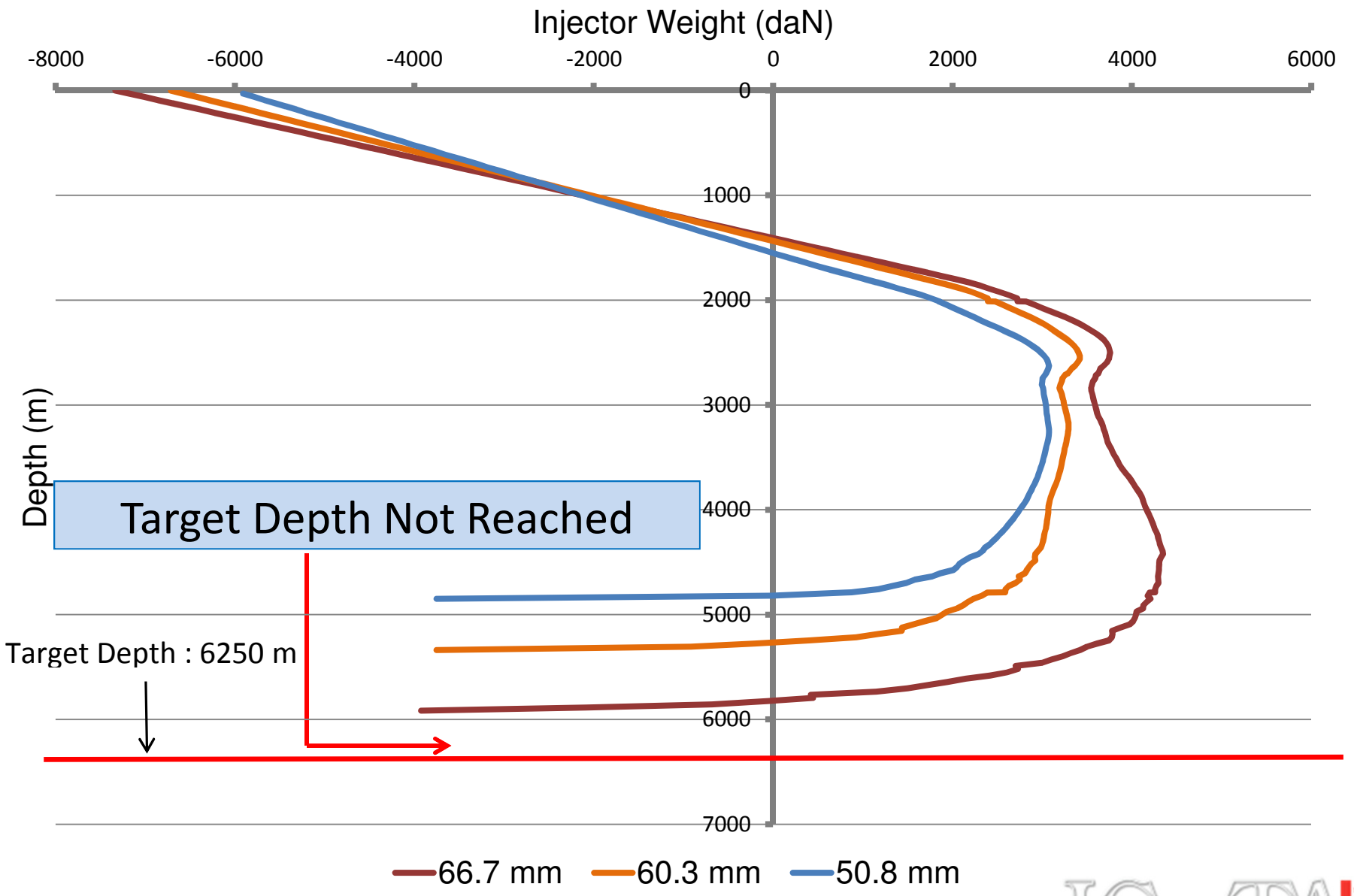


Slide 9

AO9 change the referance lines to black. having the red may cause confusion.
Anna Ostrom, 10/7/2014

AO11

Force Limitation Utilizing 66.7 mm Coiled Tubing



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Slide 10

AO11 same with this change the large arrow to black.
Anna Ostrom, 10/7/2014

CT SELECTION CRITERIA SUMMARY

CT Size	Specific Requirements			Meets Objectives
	Depth: 6250 m required	**Annular Velocity:** >40 m/min required	**Cost:** Complete all wells with 1 string (CT Fatigue)	
60.3 mm	5400 m	33.6 m/min	No Concern	**No**
66.7 mm	6000 m	38.6 m/min	Concern	**No**

Slide 11

BL4 Watch that the green is still legible when used with the projector.
Change Slide to black - make meet objectives Dark bolded red
Ben Layton, 10/8/2014

EXTENDED REACH TECHNIQUES CONSIDERED

Options Considered:

Coiled Tubing Tractor

Hydraulically activated downhole pulling effect – up to 7000 lbs of additional force

Pipe Straightener

- Risk of becoming stuck in hole from debris-laden column.
- Cost of losing the tool downhole. Availability at time of operation.

ALTERNATIVE EXTENDED REACH TECHNIQUES

Options Considered:

Coiled Tubing Tractor

Pipe Straightener

Straightens pipe to reduce residual bend and friction

- Additional mechanical bend increases fatigue
- Time constraints to design and develop for large OD CT

UNDERSTANDING CT LIMITATIONS – LITERATURE REVIEW

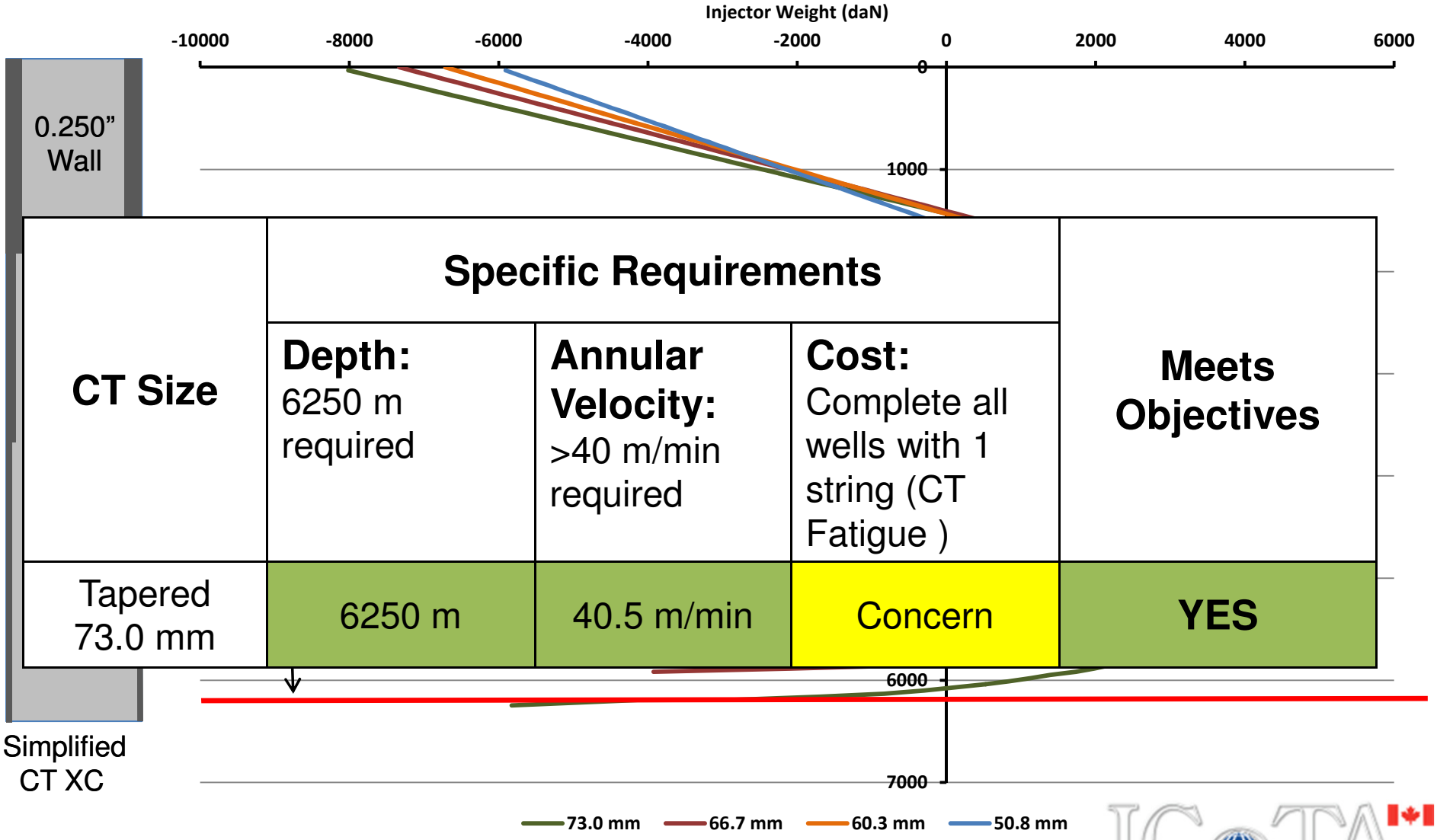
Reference (SPE#)	Region	Category	CT Total Depth (md-m)	CT Lateral Reach (m)	MD/ TVD
94208 (Moore et al., 2005)	Sakhalin, Russia	with Tractor	9,373	6,760	3.59
164237 (Arukhe et al., 2013)	Saudi Arabia		9,113	6,217	3.15
170831 (Liston et al., 2014)	W. Canada	without Tractor	6,198	3,612	2.57
159574 (Griffin and Nichols, 2012)	Bakken Shale, US		5,520	2,939	2.14
127399 (Al-Buali et al., 2009)	Saudi Arabia		3,694	2,390	1.99
168250 (Burke et al., 2014)	Alaska	CT Drilling	4,077	1,309	1.47
106874 (Tongs et al., 2007)	W. Canada		6,370	1,908	1.43
84162 (Patrick et al., 2003)	W. Canada		6,605	1,025	1.21

- Greater reaches obtained with tractors → non viable for application
- Project exceeded conventional limitations w/o tractors (2.57 MD/TVD)

Slide 14

AO8 This chart may be too busy, some may have an issue reading this from the back of the room.
Anna Ostrom, 10/7/2014

The Answer: Benefits of an Engineered 73.0 mm Tapered String



CT Size	Specific Requirements			Meets Objectives
	Depth: 6250 m required	**Annular Velocity:** >40 m/min required	**Cost:** Complete all wells with 1 string (CT Fatigue)	
Tapered 73.0 mm	6250 m	40.5 m/min	Concern	**YES**

Slide 15

BL5 again watch this green
Remove 7 inch casing, enlarge font, make green text either more green or black with green shading in background. - make colors more pronoucned and legible.
Ben Layton, 10/8/2014

TOOL DESIGN – MAXIMIZE RATE AND MINIMIZE FATIGUE

Objectives:

Control Fatigue	Maximize Velocity	Minimize Stalls / Circ. Pressure	Increase Torque

Requirement: Improved BHA design

Motor Performance	Standard 2-7/8" Design	New 3-1/8" Design	% Improvement
Flow Range (L/Min)	190-650	380-800	25 %
Operating Pressure (kPa)	7,310	5,450	26 %
Stall Torque (Nm)	1,790	2,200	23 %

Slide 16

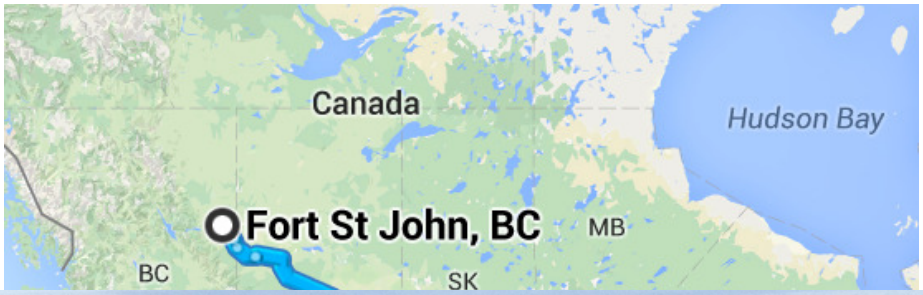
BL6 may want to make this chart a little bigger
Create boxes for objectives
Percent improvement over previous design
Ben Layton, 10/8/2014

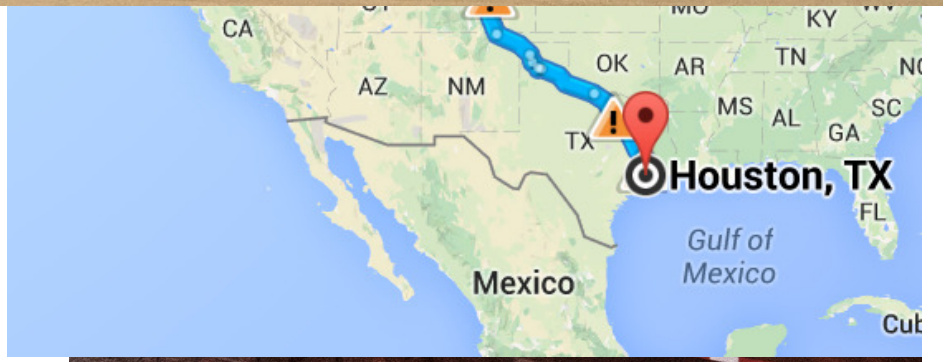
COILED TUBING EQUIPMENT DESIGN

BL7

New trailer construction enabled:

1) Additional pipe capacity
2) Overcome transport limitations from Houston to Site (4,400 kms)





Slide 17

BL7 eliminate 60.3 and 66.7mm
alude to transportation issues that forced the construction of new equipment
Ben Layton, 10/8/2014

OPERATIONAL SUMMARY

Slide 18

AO3 Same comment as slide 7
Anna Ostrom, 10/7/2014