THREE MAIN POINTS

• How are new technologies implemented in the oil and gas sector?
• Which new technologies and/or new applications are the most promising?
• How can technologies best be used in Quebec?
NEW TECHNOLOGIES ARE IMPLEMENTED INCREMENTALLY

• Conventional oil and gas resources
  – Reservoir quality dominates
  – Technical improvements cannot keep up with decreases in reservoir quality
  – Overall results worsen over time
• Unconventional oil and gas resources
  – Well stimulation dominates
  – Technical improvements exceed decreases in reservoir quality
  – Overall results improve over time
• General progression: incremental everything
  – Drilling rate (bit selection, weight on bit)
  – Cost control
  – Pumping rates
  – Working fluids
  – Proppant
  – Number of fracture stages
  – Frac job sizes
Well Results Generally Decrease

Impact of Frac’ing
Well Results Still Improving
Well Results Still Improving
THE MOST PROMISING TECHNOLOGIES INCREASE COMPLETION PRECISION

- More selective fracturing
  - Openhole bullhead
  - “Plug and Trust” multi-frac
  - Individual stage sealing
- Increasing number of stages
  - Vertical (1)
  - Single-stage hz (1)
  - Multi-stage bridge plug hz (4)
  - Plug and perf (8 to 16)
  - Ball drop (12 to 24)
  - NCS (40 to 90+)
- More sensitive monitoring
  - Pressure and rate monitoring
  - Mini-frac tests
  - Micro-seismic
  - Experimental DTS and DAS
- Increasing frac job sizes
- Tighter spacing between wellbores (400 m to 300 m to 200 m)
SPIRIT RIVER COMPLETION TRENDS

Completion Trends - Gas
(GLJ Resource Play - Spirit River Horizontals (1656 Wells))

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Proprietary information of GLJ - Oct 28, 2016, 11:34 AM
VERDAZO™
ECONOMIC FACTORS

- Longer horizontal wells
  - 1 mile was common
  - 1.5 mile is now routine
  - 2+ mile has been successfully demonstrated
  - Reduced need for well pads and other surface disturbances
  - Greater offset distance from neighbours

- More wells per pad
  - 12 wells was planned
  - 24+ wells now planned

- Reduced completion time
  - Overall reduction in surface operations

- Dedicated water pipelines and centralized water handling
  - High initial cost, but expect economy of scale
  - Reduced road traffic
MONTNEY DRILLING COSTS

Drilling Cost Per Meter (percentile)

Filter: GLJ Resource Play - Montney (626 Wells 18 Hidden) - Group By: Date - Rig Release Year - WCFD - Drilling Cost per Meter ($/m)

Costs Still Decreasing
SPIRIT RIVER DRILLING COSTS

Drilling Cost Per Meter (percentile)

Filter: GLJ Resource Play - Spirit River Horizontal (1656 Wells) - Group By: Date - Rig Release Year - WCFD - Drilling Cost per Meter ($/m)

Costs Still Decreasing

Proprietary information of GLJ - Oct 28, 2016, 11:58 AM VERDAZO™
Costs Still Decreasing
SPIRIT RIVER COMPLETION COSTS

Costs Still Decreasing
TECHNOLOGIES CAN BEST BE USED IN QUEBEC BY:

• Facilitating access to data
  – Geotechnical
  – Environmental baseline
  – Production and operational results
  – Capital costs
  – Integration with existing datasets

• Transparency is critical when there’s elevated public scrutiny
Gas Type Curve (Rate vs Time)

Filter: Barnett Shale Horizontals (10930 Wells 5022 Hidden) - Group By: Date - Completion Year - CD Avg Gas (mcf/day/well)

Database Error from USA
UTICA PROPERTIES

- 40 - 200 m thick
- 2.5 to 5.0% TOC
- Mostly methane
- 300 to 500 m deep at northwest edge
- 1,800 m deep at southeast edge
- This is shallower, often thinner, than other gas resources
- Average of 60 Bcf/section
  - 85 Bcf/section for best Ohio Utica
  - 150 Bcf/section for best Marcellus
  - 250 Bcf/section for best Montney
## REPORTED PLANS FOR WELL LENGTH

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<tr>
<th>Company</th>
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## REPORTED PLANS FOR WELL SPACING

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CURRENT ANALYSIS (TECHNICAL)

- 8 wells per pad with 2,400 m horizontals at 400 m spacing
- Each well is estimated to drain 3/8 sections (square mile)
- Limited data set with very preliminary test results that are encouraging
- Four years ago, expected 3 to 4 Bcf per well
- Now expect 6.5 to 8 Bcf per well
- Recovery factors estimated between 20 and 40%
CURRENT ANALYSIS (ECONOMIC)

- Drilling cost of 8 $MM
- Premium price for gas: $0.50/Mcf to $1.50/Mcf over Henry Hub
- Expect solid economic results if development allowed
- Half cycle economics (drill, complete, tie-in) have expected development IRR of greater than 40%
- Full cycle economics (pipelines, plants, drill, complete, tie-in) have expected development IRR of greater than 20%
MOST ALBERTAN’S DON’T KNOW: QUEBEC EXPLORED FOR GAS FIRST!
QUESTIONS AND COMMENTS

Mike Morgan, PEng
Manager
Specializing in Montney
mmorgan@gljpc.com
(403) 266-9437

Chad Lemke, PEng
Manager
Specializing in Shale
clemke@gljpc.com
(403) 266-9514

Jodi Anhorn, PEng
COO
janhorn@gljpc.com
(403) 266-9479

Warren Bindon, PGeol
Specializing in Shale
wbindon@gljpc.com
(403) 266-9469