Blackrod SAGD Pilot Project
Athabasca Oil Sands Area
Scheme Approval No. 11522E

2016 Annual Performance Presentation
Alberta Energy Regulator

February 28, 2017
BlackPearl Resources Inc.

Blackrod Subsurface
Subsurface Agenda

1. Background
2. Geology / Geoscience
3. Drilling & Completions
4. Artificial Lift
5. Well Instrumentation
6. Scheme Performance
1. Background
Project Overview

Approved Development Area as per ERCB Scheme Approval No. 11522E

CORED WELLS
BLACKPEARL OIL SANDS
LEASE HOLDINGS
Project Summary

- AER Scheme Approval No. 11522E
- Two(2) SAGD Pilot Well Pairs
- Portage area on Oil Sands Lease 7407060158
- Pilot site located in 02-36-076-18W4
- Target formation is the Lower Grand Rapids Unit 1 (L.GR1)

- Initial reservoir data:
  - Pressure: 1700 KPA
  - Temperature: 13°C
  - Depth: 300m

- Traditional SAGD recovery process
- BlackPearl is the 100% W.I. Owner
Blackrod Pilot Site
Project Milestones – 13-25 WP1

- **Oct 2010**  
  AER Scheme Approval No. 11522

- **Dec 2010**  
  Drill 13-25 WP1

- **May 2011**  
  Commission Pilot Facility

- **Jun 2011**  
  Commence Circulation Phase

- **Sep 2011**  
  Convert to SAGD Production Phase

- **Apr 2012**  
  Achieve commercial production monthly rate of 400 bopd

- **Q1 2015**  
  “Ultra-Temp” ESP surpasses 500 days of continuous run-time

- **Aug 2015**  
  Produced 285,000 cumulative barrels of oil
Project Milestones – 10-36 WP2

- **Feb 2012**: AER Approval No. 11522C for 10-36 WP2 and facility expansion
- **Feb 2013**: Drill 10-36 WP2
- **Oct 2013**: Commission Phase 2 Pilot Facility Expansion
- **Nov 2013**: Commence Circulation Phase
- **Mar 2014**: Convert to SAGD Production Phase
- **Apr 2015**: Production surpasses commercial rate of 400 bopd
- **Dec 2016**: 21 consecutive month of +500 bopd with an iSOR of <3.0
- **Dec 2016**: Produce 470,000 cumulative barrels of oil
2. Geology / Geoscience
Original Bitumen in Place

• $\text{OBIP}_{WP1}$
  \[ = A_1 \times h_1 \times So_1 \times \phi_1 \times Bo \]
  \[ = (100 \text{ m} \times 800 \text{ m}) \times 22 \text{ m} \times 0.63 \times 0.35 \times 1.0 \]
  \[ = 388,080 \text{ m}^3 \]

• $\text{OBIP}_{WP2}$
  \[ = A_2 \times h_2 \times So_2 \times \phi_2 \times Bo \]
  \[ = (100 \text{ m} \times 1050 \text{ m}) \times 25 \text{ m} \times 0.63 \times 0.34 \times 1.0 \]
  \[ = 562,275 \text{ m}^3 \]

Where:

- OBIP = Original Bitumen In Place
- A = Drainage Area
- h = Thickness
- So = Oil Saturation
- $\phi$ = Average Porosity
- Bo = Expansion Factor
- WP1 = 1st Pilot Well Pair drilled at 13-25-076-18W4
- WP2 = 2nd Pilot Well Pair drilled at 10-36-076-18W4
• Existing lease and access selected for Pilot surface location

• Bottom hole locations for both Pilot Well Pairs selected based on offsetting well control

• L. GR is a Shoreface deposit consisting of three (3) coarsening-upward parasequences:
  – L. GR Unit 1 = upper to middle shoreface bitumen target zone
  – L. GR Unit 2 = middle to lower shoreface transition zone
  – L. GR Unit 3 = bottom H2O saturated aquifer

LOG CUTOFFS
• Gamma Ray < 75 API
• Resistivity > 20 Ohm.m
• Porosity > 33%

Total L.GR1 SAGD Net Oil Pay
L. GR Unit 3 Bottom Water Isopach Map
LOG CUTOFFS

- Gamma Ray < 75 API
- Resistivity > 20 Ohm.m
- Porosity > 33%
**L.GR1** Core Characteristics:

- Oil saturation: 0.60
- Bitumen weight: 11%
- Net pay thickness: 26 m
- Porosity: 36%
- Vertical permeability: 3024 mD
- Horizontal permeability: 3450 mD
- $K_v/K_h$: 0.88
- API Gravity: 9.8 (at 15.6 °C)
Cross Section Through 13-25 WP1

- 13-25 WP1 experimental well pair placed to substantiate SAGD recovery in the L.GR
Cross Section Through 10-36 WP2

- To maximize oil recoveries, 10-36 WP2 placed deeper and drilled longer than 13-25 WP1
Seismic

3D X-Line along 13-25 WP1

3D Seismic Area Coverage
Structure Map

L.GR1 TOP

L.GR1 BASE

Legend

- PILOT PROJECT STUDY AREA
- ORIGINAL SAGD PILOT WELL PAIR
- SECOND BLACKROD SAGD WELL PAIR
- BLACKPEARL OIL SANDS HOLDINGS

0 2m
Primary Cap Rock

- MFS (Maximum Flooding Shale)
- Directly overlays Lower Grand Rapids formation
- Regionally extensive
- 3 m average thickness
- Mini Frac Analysis:
  - Performed on the 13-25-076-18W4 OSE Core Hole
  - Initial Breakdown Pressure = 8500 kPa
  - Closure Pressure Gradient = 13.7 kPa/m
MFS Cap Rock Structure Map
Secondary Cap Rock

• Joli Fou formation
• 45 m above Lower Grand Rapids formation
• Regionally extensive
• 20 m average thickness
• Mini Frac Analysis:
  – Performed on the 01-36-076-18W4 OSE Core Hole
  – Initial Breakdown Pressure = 12,750 kPa
  – Closure Pressure Gradient Range = 19.4 kPa/m
Joli Fou Cap Rock Isopach Map
Joli Fou Cap Rock Structure Map
3. Drilling and Completions
13-25 WP1 - Injector
• Injector Well:
  – No modifications

• Producer Well:
  – No modifications
10-36 WP2 – Producer (Prod. Phase)
• Injector Well:
  – No modifications

• Producer Well:
  – No modifications
4. Artificial Lift
• Fluid production via “Ultra Temp” Electrical Submersible Pumps (ESP) on both 13-25 WP1 and 10-36 WP2

• ESP advantages:
  – Operate and lift fluids at controlled downhole pressures
  – Maintain continuous fluid production

• Variable Flow Drive (VFD) utilized to control pump speed and production rates

• Current ESPs meeting expectations
5. Well Instrumentation
13-25 WP1 – Obs Wells

• Toe Obs Well:
  – 103/13-25-076-18W4
  – 8.5 m North of WP1
  – RTD gauges to monitor temperature above, below, and within L.GR1
  – RTD temperature profile indicating maturing steam chamber

• Heel Obs Well:
  – 102/14-25-076-18W4
  – 17.7 m South WP1
  – RTD gauges to monitor temperature above, below, and within L.GR1
  – RTD temperature profile indicating maturing steam chamber
  – P/T gauge to monitor pressure & temperature within L.GR3 aquifer
13-25 WP1 – Instrumentation Overview
• Toe Obs Well:
  - 100/07-36-076-18W4
  - 17.5 m West of WP2
  - Thermocouples to monitor temperature above, below, and within L.GR1
  - Thermocouple profile indicating early stages of steam chamber development
  - P/T gauge to monitor pressure & temperature within L.GR3 aquifer

• Heel Obs Well:
  - 100/02-36-076-18W4
  - 16.1 m East of WP2
  - Thermocouples to monitor temperature above, below, and within L.GR1
  - Thermocouple profile indicating early stages of steam chamber development
  - P/T gauge to monitor pressure & temperature within L.GR3 aquifer
10-36 WP2 – Instrumentation Overview
Groundwater Monitoring Wells

• 100/03-36-076-18W4 GWM:
  – Directionally drilled from 14-25 lease
  – PCP to sample/analyze non-saline LGR3 H₂O
  – P/T gauge to monitor pressure & temperature within LGR3 aquifer

• 100/14-25-076-18W4 GWM:
  – Directionally drilled from 14-25 lease
  – PCP to sample/analyze non-saline LGR3 H₂O
  – P/T gauge to monitor pressure & temperature within LGR3 aquifer

• 100/15-25-076-18W4 GWM:
  – PCP to sample/analyze non-saline Viking H₂O
  – P/T gauge to monitor pressure & temperature within Viking aquifer

* Annual Groundwater Monitoring Summary Report Submitted to the AER in Q1 2016
6. Scheme Performance
• Four (4) years of SAGD Production Phase

• ESP failed Aug 2015 and well is currently shut in
13-25 WP1 Summary

• Objective(s):
  • Prove SAGD recovery works in the Lower Grand Rapids reservoir
  • Test production techniques to establish best operating practices

• Well Placement:
  • “Ultra-conservative” placement above L. GR Unit 3 Bottom Water
13-25 WP1 Key Learnings

- Consistent up-time is critical for optimal steam chamber development and productivity
- Fines & clays can be mobile, reactive plugging mechanisms
- Heat conformance can be achieved across 700+ m HZ section
13-25 WP1 Oil Production as of Aug 31, 2015

• Cumulative Production = 45,500 m³

• Recovery to Date = 11.7%

• Ultimate Recovery = 20 - 25% (lower due to 13-25 WP1 well placement)

• CSOR including Circ. Phase = 5.4

• CSOR during Prod. Phase only = 5.2

• Average Rate during Prod. Phase = 31.6 m³/day

• Max Rate during Prod. Phase = 96 m³/day
• Average Steam Chamber Pressure = 2400 kPa
• Average Surface Steam Temperature = 265 °C
• Wellhead Steam Quality = 95 – 100%
13-25 WP1 Performance Plot

Blackrod 13-25 WP1 - Performance Plot

- Fluid Rate (m³/d)
- Perforated Liner

- Produced Crude Oil/Bitumen
- Produced Water
- Injected Steam
- ISOR
- CSOR

Perforated Liner

Timeline from June 11 to August 15:
- 2011
- 2012
- 2013
- 2014
- 2015

SOR (Stirred Occupancy Ratio)
10-36 WP2 Performance as of Dec 31, 2016

• 34 months of SAGD Production Phase
• Maturing steam chamber / flat-lined oil production
• Oil production currently averaging 83 m³/d
10-36 WP2 Summary

• Applied Learnings:
  • Improved well design (i.e. longer HZ section and WWS for sand control)

• Objective(s):
  • Evaluate SAGD performance from a commercial well pair prototype
  • Target 100% up-time

• Well Placement:
  • “Cautious” placement above L. GR Unit 3 Bottom Water
10-36 WP2 Key Learnings

• Longer ramp-up periods now expected at Blackrod
• WWS favorable to the Blackrod L. GR reservoir
• Scab liner effective in protecting ESP and facilitating heat conformance across HZ section
• Heat conformance can be achieved across 950+ m HZ section
10-36 WP2 Oil Production as of Dec 31, 2016

- Cumulative Production = 75,000 m³
- Recovery = 13.3%
- Ultimate Recovery = 55 - 60%
- CSOR including Circ. Phase = 3.25
- CSOR during Prod. Phase only = 3.03
- Average Rate during Prod. Phase = 70.4 m³/day (442.75 bopd)
- Current Rate = 83.4 m³/day (525 bopd)
• Average Steam Chamber Pressure = 2328 kPa
• Average Surface Steam Temperature = 265 °C
• Wellhead Steam Quality = 95 – 100%
Surface Operations Agenda

1. Facilities
2. Measurement & Reporting
3. Water Source
4. Disposal
5. Environmental
6. Compliance Statement
1. Facilities
Pilot Facility Overview
Pilot Facility Plot Plan
Pilot Facility Plot Plan (cont.)
Pilot Facility Performance

• No issues with bitumen treatment, water treatment, or steam generation

• Pilot Facility uptime 99.7% in 2016 – only downtime associated with scheduled shut-downs

• Generated steam, produced bitumen, produced water, and produced gas volumes reported to Petrinex

• Purchased gas volumes reported to Petrinex

• Flared gas volumes reported to AER and Petrinex

• SO\textsubscript{2} & No\textsubscript{x} emissions and ambient air quality data submitted to AER both monthly and annually as per terms of EPEA Approval 00264736-00-00

• GHG emissions reporting not required for Blackrod Pilot Facility as per terms of EPEA Approval 00264736-00-00
Pilot Facility Modifications

• No modifications in 2016
2. Measurement & Reporting
• BlackPearl remains compliant with AER Directive 017 as well as Directive 042 as per the terms of our approved MARP (Measurement, Accounting, and Reporting Plan)

• To validate compliance with Directive 017 and Directive 042, BlackPearl performs a detailed EPAP (Enhanced Production Audit Program) review annually as per Directive 076 with an independent consulting group
Process Flow Diagram
Individual Well Testing

• Production volumes from both pilot well pairs are determined using the test-to-test method as per the terms of our approved MARP:

  – Both the 13-25 and 10-36 Producer wells are tested individually through the flash separator for 36 hours cumulative every month

  – Bitumen and water production rates are measured through a mass flow (coriolis) meter downstream the flash separator with BS&W cuts determined through a proportional fluid sampler

  – Total battery gas production is measured through the flare gas meter and is prorated to the 13-25 and 10-36 Producer wells based on the production volumes determined using the test-to-test method

  – As of Sep-2015, 10-36 Producer has been on continuous test since 13-25 WP1 has been shut-in

• In August-2016, 13-25 WP1 was suspended and the facility was switched back to a single well battery
Proration Factors

Blackrod Prorations

Proration Factor

- Nov-13
- Dec-13
- Jan-14
- Feb-14
- Mar-14
- Apr-14
- May-14
- Jun-14
- Jul-14
- Aug-14
- Sep-14
- Oct-14
- Nov-14
- Dec-14
- Jan-15
- Feb-15
- Mar-15
- Apr-15
- May-15
- Jun-15
- Jul-15
- Aug-15
3. Water Source
Blackrod Water Source(s)

- **1F1/14-24-076-18W4 L.GR3 WSW:**
  - Non-saline (~3700 TDS)
  - AER Water Act Licence No. 00308617-01-00 valid until Jun 2019
  - Approved for 109,500 m³ annually
  - Production volumes reported to AER and Petrinex
  - 100/14-24-076-18W4 monitoring well 20 m North of 1F1/14-24 WSW
  - No issues with water softening process

- **1F1/15-25-076-18W4 Grosmont Member D WSW:**
  - Saline (~12,800 TDS)
  - No issues with saline treatment process
Blackrod Water Source(s)

Monthly Source Water Volumes
4. Disposal
Blackrod Disposal

• Produced Water:
  – 100/02-25-076-18W4 Class 1b Disposal Well
  – AER Scheme Approval No. 11703A
  – Disposal into Grosmont Members B, A
  – Maximum wellhead injection pressure of 6300 kPa
  – This well continues to operate on vacuum with no pressure at the wellhead
  – All disposal volumes reported to Petrinex

• Waste:
  – Waste fluids (i.e. sewage, sludge, etc.) trucked out to third party disposal facilities.
Blackrod Disposal

100/02-25-076-18W4 Disposal Well

* 02-25 Disposal Well continues to operate on vacuum
5. Environmental Issues
Blackrod Environmental

• No environmental issues to date

• BlackPearl remains compliant with the terms of AER Approval No. 264736-00-00:
  – CPP (Caribou Protection Plan)
  – Air Monitoring
  – Groundwater Monitoring
  – Soil Monitoring
  – Etc.
6. Compliance
• To the best of BlackPearl’s knowledge, the Blackrod SAGD Pilot Project is currently in full compliance with all conditions and regulatory requirements related to AER Scheme Approval No. 11522E
1. Ongoing Pilot Objectives
Ongoing Pilot Objectives

- Continue to produce 10-36 WP2
- Trial new water treatment technology
2. SAGD Commercial Development
SAGD Commercial Development

- 80,000 bbl/d (12,720 m³/d) to be developed in phases, with the first phase planned for 20,000 bbl/d; two additional phases of 30,000 bbl/d each to follow

- Commercial SAGD Application No. 1728831 submitted in Q2 2012 was approved by the AER in Q3 of 2016
Appendices

1. Pressure & Temperature Data
   • 13-25 WP1
   • 10-36 WP2
   • Heel & Toe Observation Wells