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

2018 Annual Performance Presentation
Alberta Energy Regulator

March 13, 2019
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. 11522G

- CORED WELLS
- BLACKPEARL OIL SANDS LEASE HOLDINGS
Project Summary

• AER Scheme Approval No. 11522G
• One (1) Operating SAGD 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
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 2012</td>
<td>AER Approval No. 11522C for 10-36 WP2 and facility expansion</td>
</tr>
<tr>
<td>Feb 2013</td>
<td>Drill 10-36 WP2</td>
</tr>
<tr>
<td>Oct 2013</td>
<td>Commission Phase 2 Pilot Facility Expansion</td>
</tr>
<tr>
<td>Nov 2013</td>
<td>Commence Circulation Phase</td>
</tr>
<tr>
<td>Mar 2014</td>
<td>Convert to SAGD Production Phase</td>
</tr>
<tr>
<td>Apr 2015</td>
<td>Production surpasses commercial rate of 400 bopd</td>
</tr>
<tr>
<td>Dec 2016</td>
<td>21 consecutive month of +500 bopd with an iSOR of &lt;3.0</td>
</tr>
<tr>
<td>Dec 2017</td>
<td>Produce 645,000 cumulative barrels of oil</td>
</tr>
<tr>
<td>Dec 2018</td>
<td>Produced 800,000 cumulative barrels of oil</td>
</tr>
</tbody>
</table>
2. Geology / Geoscience
Original Bitumen in Place

• \( OBIP_{WP2} \)

\[
= A_2 \times h_2 \times So_2 \times \phi_2 \times Bo
\]

\[
= (100 \text{ m} \times 1050 \text{ m}) \times 25 \text{ m} \times 0.63 \times 0.34 \times 1.0
\]

\[
= 562,275 \text{ m}^3
\]

Where:

OBIP  =  Original Bitumen In Place
A  =  Drainage Area
h  =  Thickness
So  =  Oil Saturation
\( \phi \)  =  Average Porosity
Bo  =  Expansion Factor
WP2  =  2^{nd} Pilot Well Pair drilled at 10-36-076-18W4
Lower Grand Rapids (L. GR) Net Pay Map

- 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 LGR1 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
- Kv/Kh: 0.88
- API Gravity: 9.8 (at 15.6 °C)
• 10-36 producer well was drilled with a minimum 5m standoff from LGR2 transition zone

• LGR2 transitions from 30% oil saturation to 100% water
Seismic

3D X-Line along 13-25 WP1

3D Seismic Area Coverage
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
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 Base Depth Map
3. Drilling and Completions
• Injector Well:
  – No modifications

• Producer Well:
  – No modifications
4. Artificial Lift
Electrical Submersible Pump

- Fluid production via “Ultra Temp” Electrical Submersible Pumps (ESP)
- 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 ESP has +1400 days of runtime
5. Well Instrumentation
10-36 WP2 – Obs Wells

• Toe Obs Well:
  - 100/07-36-076-18W4
  - 17.5 m West of WP2
  - Thermocouples to monitor temperature above, below, and within L.GR1
  - 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
  - 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 L.GR3 H₂O
  – P/T gauge to monitor pressure & temperature within L.GR3 aquifer

• 100/14-25-076-18W4 GWM:
  – Directionally drilled from 14-25 lease
  – PCP to sample/analyze non-saline L.GR3 H₂O
  – P/T gauge to monitor pressure & temperature within L.GR3 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
6. Scheme Performance
• 59 months of SAGD Production Phase

• Maturing steam chamber / Oil production in decline

• Oil production currently averaging 68 m³/d
• **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, 2018

• Cumulative Production = 127,000 m³
• Recovery = 22.6%
• Ultimate Recovery = 55 - 60%
• CSOR including Circ. Phase = 3.60
• CSOR during Prod. Phase only = 3.4
• Average Rate during Prod. Phase = 70.82 m³/day (445.40 bopd)
• Current Rate = 68 m³/day (427.6 bopd)
• Average Steam Chamber Pressure = 2160 kPa
• Average Surface Steam Temperature = 265 °C
• Wellhead Steam Quality = 95 – 100%
10-36 WP2 Performance Plot

Blackrod 10-36 WP2 - Performance Plot

Fluid rate (m³/d)

Produced Crude Oil/Bitumen
Produced Water
Injected Steam
ISOR
CSOR

Pulled Scab Liner
Facility Turn Around
Surface Operations Agenda

1. Facilities
2. Measurement & Reporting
3. Water Source
4. Disposal
5. Environmental
6. Compliance Statement
1. Facilities
Pilot Facility Performance

- No issues with bitumen treatment, water treatment, or steam generation
- Pilot Facility uptime 98.5% in 2018
- 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
- \( \text{SO}_2 \) & \( \text{NO}_x \) emissions and ambient air quality data submitted to AER both monthly and annually as per terms of EPEA Approval 00264736-00-02
- GHG emissions reporting not required for Blackrod Pilot Facility as per terms of EPEA Approval 00264736-00-02
### Pilot Facility Monthly Volumes

<table>
<thead>
<tr>
<th></th>
<th>Steam Generated (m³)</th>
<th>Bitumen Volumes (m³)</th>
<th>Produced Water Volumes (m³)</th>
<th>Purchased Gas (e³m³)</th>
<th>Produced Gas (e³m³)</th>
<th>Fuel Gas to Flare Volume (e³m³)</th>
<th>Flared Gas Volume (e³m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>10318</td>
<td>2166</td>
<td>7440</td>
<td>887</td>
<td>24</td>
<td>28</td>
<td>52</td>
</tr>
<tr>
<td>February</td>
<td>9365</td>
<td>1948</td>
<td>8054</td>
<td>807</td>
<td>22</td>
<td>28</td>
<td>50</td>
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<tr>
<td>March</td>
<td>10389</td>
<td>2182</td>
<td>8611</td>
<td>884</td>
<td>24</td>
<td>24</td>
<td>48</td>
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<tr>
<td>April</td>
<td>10142</td>
<td>1935</td>
<td>8457</td>
<td>842</td>
<td>23</td>
<td>14</td>
<td>37</td>
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<tr>
<td>May</td>
<td>10604</td>
<td>2007</td>
<td>8625</td>
<td>857</td>
<td>24</td>
<td>13</td>
<td>36</td>
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<tr>
<td>June</td>
<td>10259</td>
<td>1933</td>
<td>8272</td>
<td>832</td>
<td>23</td>
<td>15</td>
<td>38</td>
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<tr>
<td>July</td>
<td>10774</td>
<td>2032</td>
<td>8743</td>
<td>860</td>
<td>28</td>
<td>13</td>
<td>41</td>
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<tr>
<td>August</td>
<td>9372</td>
<td>2006</td>
<td>8568</td>
<td>850</td>
<td>29</td>
<td>14</td>
<td>43</td>
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<tr>
<td>September</td>
<td>9776</td>
<td>1975</td>
<td>8131</td>
<td>796</td>
<td>27</td>
<td>15</td>
<td>42</td>
</tr>
<tr>
<td>October</td>
<td>10673</td>
<td>2054</td>
<td>8963</td>
<td>891</td>
<td>33</td>
<td>15</td>
<td>48</td>
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<tr>
<td>November</td>
<td>9729</td>
<td>2143</td>
<td>8181</td>
<td>827</td>
<td>30</td>
<td>14</td>
<td>44</td>
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<tr>
<td>December</td>
<td>10306</td>
<td>2122</td>
<td>8867</td>
<td>875</td>
<td>29</td>
<td>16</td>
<td>45</td>
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<tr>
<td>Total</td>
<td>121706.5</td>
<td>24501.4</td>
<td>100911.2</td>
<td>10206.9</td>
<td>314.2</td>
<td>209</td>
<td>523.53</td>
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</table>

- Fuel gas is combined with produced gas upstream of flare to maintain a minimum lower heating value of 12MJ/m³
## Blackrod NOx Emissions

<table>
<thead>
<tr>
<th>Year</th>
<th>Run Time (hours)</th>
<th>NOx (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>744</td>
<td>0.21</td>
</tr>
<tr>
<td>February</td>
<td>672</td>
<td>0.19</td>
</tr>
<tr>
<td>March</td>
<td>744</td>
<td>0.21</td>
</tr>
<tr>
<td>April</td>
<td>720</td>
<td>0.20</td>
</tr>
<tr>
<td>May</td>
<td>744</td>
<td>0.21</td>
</tr>
<tr>
<td>June</td>
<td>720</td>
<td>0.2</td>
</tr>
<tr>
<td>July</td>
<td>744</td>
<td>0.21</td>
</tr>
<tr>
<td>August</td>
<td>744</td>
<td>0.21</td>
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<tr>
<td>September</td>
<td>684</td>
<td>0.19</td>
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<tr>
<td>October</td>
<td>744</td>
<td>0.21</td>
</tr>
<tr>
<td>November</td>
<td>720</td>
<td>0.20</td>
</tr>
<tr>
<td>December</td>
<td>744</td>
<td>0.21</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>2.45</td>
</tr>
</tbody>
</table>

- Under Section 4.1.17 and 4.1.18 of the EPEA approval, BlackPearl is required to conduct a manual stack survey on the 15 MW steam generator once within six months of commissioning.

- A manual stack survey was conducted which gave an average mass flow rate of 0.28 kg/h which is below the 1.4 kg/hr limit for NOx in the approval

- Monthly NOx is calculated by using the hourly emissions rate and knowing the monthly run time hours
Pilot Facility Modifications

• No modifications in 2018
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
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 m$^3$ 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 (~13,800 TDS)
  – No issues with saline treatment process
Blackrod Water Source(s)

Monthly Source Water Volumes

Volume (M3)


- LGR (14-24-76-18W4)
- Grosmont (15-25-76-18W4)
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.
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
Blackrod 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. 11522G
Blackrod Future Plans
Blackrod Future Plans

- BlackPearl Resources was acquired by International Petroleum Corporation (IPC) at the end of Q4 2018
- As of January 2019 IPC will be operating the Blackrod project
1. Ongoing Pilot Objectives
Drill and complete a 3\textsuperscript{rd} well pair

- The well will be drilled with a longer lateral and completed with flow control devices (FCD). Learnings from the 3\textsuperscript{rd} well pair will be used to further develop a commercial well pair prototype.

Trial new water treatment technology

- BlackPearl is planning on completing a 1 year trial, to test a new produced water treatment technology. Learnings from the trial will be applied to the commercial facility design.
Blackrod Future Plans

2. SAGD Commercial Development
• Commercial SAGD Application No. 1728831- Approved

• 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
Appendices
Appendices

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