KIRBY IN SITU OIL SANDS PROJECT
AER DIRECTIVE 54 ANNUAL PERFORMANCE PRESENTATION

November 2016
## Outline – Subsurface

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background</td>
<td>4 – 5</td>
</tr>
<tr>
<td>Geology</td>
<td>7 – 26</td>
</tr>
<tr>
<td>Cap Rock</td>
<td>27</td>
</tr>
<tr>
<td>Subsurface Schematic</td>
<td>28</td>
</tr>
<tr>
<td>Completion Summary</td>
<td>29</td>
</tr>
<tr>
<td>Instrumentation Summary</td>
<td>30</td>
</tr>
<tr>
<td>Well Schematics and Completion Optimization</td>
<td>31 – 40</td>
</tr>
<tr>
<td>Operational Strategy</td>
<td>41 – 42</td>
</tr>
<tr>
<td>Kirby South Performance</td>
<td>43 – 71</td>
</tr>
<tr>
<td>Observation Well Results</td>
<td>73</td>
</tr>
<tr>
<td>Future Plans – Subsurface</td>
<td>74</td>
</tr>
</tbody>
</table>
# Outline – Surface

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Facilities Overview</td>
<td>76 – 80</td>
</tr>
<tr>
<td>Kirby South Facility Performance</td>
<td>81 – 89</td>
</tr>
<tr>
<td>Measurement &amp; Reporting</td>
<td>90 – 92</td>
</tr>
<tr>
<td>Future Plans – Surface</td>
<td>93 – 94</td>
</tr>
<tr>
<td>Water Treatment Technology</td>
<td>95 – 96</td>
</tr>
<tr>
<td>Kirby South Water Usage</td>
<td>97 – 102</td>
</tr>
<tr>
<td>Kirby South Pressure Balancing Scheme</td>
<td>103 – 105</td>
</tr>
<tr>
<td>Kirby South Disposal</td>
<td>106</td>
</tr>
<tr>
<td>Kirby South Waste Disposal</td>
<td>107 – 108</td>
</tr>
<tr>
<td>Environmental Summary</td>
<td>109 – 114</td>
</tr>
<tr>
<td>Approvals</td>
<td>115 – 121</td>
</tr>
<tr>
<td>Compliance</td>
<td>122 – 123</td>
</tr>
</tbody>
</table>
Background

Location of Kirby Project
Background
Scheme Approval 11475O Project Area

- Recovery Process: Steam Assisted Gravity Drainage (SAGD)
AER coordinated operational assessment

- AER conducted COA of the Kirby Project May to August 2016
  - intended to confirm compliance with all requirements stipulated under the Oil Sands Conservation Act, including applicable directives, EPEA, Public Lands Act and Water Act.
- Two rounds of desktop information requests
  - Included a comprehensive review of records in relation to applications, licenses, monitoring programs, reports and previous contraventions
- AER staff on site week of June 20th
  - Focused on pipelines, facilities and C&R practices
- Overall positive feedback received from AER regarding operations of the Kirby Project.
DIRECTIVE 54 SECTION 3.1.1
SUBSURFACE ISSUES RELATED TO RESOURCE EVALUATION AND RECOVERY
Geology
Project Area SAGD Pay Isopach
Geology
Project Area Volumetrics

<table>
<thead>
<tr>
<th></th>
<th>Average Pay Thickness (m)</th>
<th>Average Oil Saturation (%)</th>
<th>Average Porosity (%)</th>
<th>OBIP (e³m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kirby Approved Project Area</td>
<td>14.8</td>
<td>78.4</td>
<td>32.7</td>
<td>275,864</td>
</tr>
</tbody>
</table>

• Volumetric calculation (for >10m contour):
  – Area above 10m of pay X Pay Thickness X Oil Sat. X Porosity
Geology
Stratigraphic Schematic

[Diagram showing stratigraphic layers and formations, including Clearwater "A" Shale, Clearwater "G" Sand & Shale, Wabiskaw "E" Valley Fill, and Devonian Limestone.]
Geology
Kirby South Structural Cross-Section

A

A'

A

A'

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Geology
Kirby South Development Area

- Recovery Process: Steam Assisted Gravity Drainage (SAGD)
Geology
Kirby South SAGD Pay Isopach

Kirby Expansion Project
Kirby South Development Area
Isopach - McMurray SAGD Pay (m)

Polygon Legend
- Kirby Expansion Project Area
- Approved Development Area(s)
- Drainage Boxes (Existing & Pending)

Drainage Boxes:
- Drainage Box 'A'
- Drainage Box 'B'
- Drainage Box 'C'
- Drainage Box 'D'
- Drainage Box 'E'
- Drainage Box 'G'
Geology
Kirby South Development Area Volumetrics

<table>
<thead>
<tr>
<th></th>
<th>Average Pay Thickness (m)</th>
<th>Average Oil Saturation (%)</th>
<th>Average Porosity (%)</th>
<th>DBIP (E3m3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kirby South Approved Development Area</td>
<td>19.7</td>
<td>76.3</td>
<td>33.2</td>
<td>55 000</td>
</tr>
</tbody>
</table>

- Volumetric calculation (for drainage boxes and >10 m contour):
  - Area above 10 m of pay $\times$ Pay Thickness $\times$ Oil Sat. $\times$ Porosity
Geology
Kirby South Drainage Area Volumetrics

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Area (m²)</th>
<th>Oil Saturation (%)</th>
<th>Porosity (%)</th>
<th>Pay Thickness (m)</th>
<th>DBIP (E³m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>600 017</td>
<td>67.9</td>
<td>33.3</td>
<td>28.9</td>
<td>3 920</td>
</tr>
<tr>
<td>B</td>
<td>669 345</td>
<td>75.4</td>
<td>32.8</td>
<td>23.45</td>
<td>3 880</td>
</tr>
<tr>
<td>C</td>
<td>629 989</td>
<td>78.3</td>
<td>33.4</td>
<td>25.36</td>
<td>4 180</td>
</tr>
<tr>
<td>D</td>
<td>792 398</td>
<td>79.5</td>
<td>33.3</td>
<td>26.27</td>
<td>5 510</td>
</tr>
<tr>
<td>E</td>
<td>502 828</td>
<td>75.5</td>
<td>34.2</td>
<td>23.08</td>
<td>3 000</td>
</tr>
<tr>
<td>F</td>
<td>462 018</td>
<td>77.6</td>
<td>33.3</td>
<td>21.03</td>
<td>2 510</td>
</tr>
<tr>
<td>G</td>
<td>654 516</td>
<td>82.9</td>
<td>33.2</td>
<td>25.17</td>
<td>4 530</td>
</tr>
</tbody>
</table>

- Volumetric calculation (for drainage boxes and >10 m contour):
  - Area above 10 m of pay × Pay Thickness × Oil Sat. × Porosity
# Geology

## Average Reservoir Properties

<table>
<thead>
<tr>
<th></th>
<th>Initial Reservoir Pressure (kPa)</th>
<th>Initial Bottom Water Pressure (kPa)</th>
<th>Initial Reservoir Temperature (°C)</th>
<th>Average Depth of Reservoir, McMR SAGD Pay Top (mTVD)</th>
<th>Average Pay Thickness (m)</th>
<th>Average Porosity, Φ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kirby South Operating Area</td>
<td>~2600</td>
<td>~2550</td>
<td>13</td>
<td>530</td>
<td>21.9</td>
<td>33.2</td>
</tr>
<tr>
<td>Kirby Approved Project Area</td>
<td>~2600</td>
<td>~2550</td>
<td>13</td>
<td>490</td>
<td>14.8</td>
<td>32.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Average Oil Saturation (%)</th>
<th>Average Water Saturation (%)</th>
<th>Average Horizontal Permeability from OB plugs, Kh (mD)</th>
<th>Average Vertical Permeability from OB plugs, Kv (mD)</th>
<th>Kv/Kh Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kirby South Operating Area</td>
<td>74.8</td>
<td>25.2</td>
<td>6410</td>
<td>5260</td>
<td>0.82</td>
</tr>
<tr>
<td>Kirby Approved Project Area</td>
<td>78.4</td>
<td>21.6</td>
<td>6560</td>
<td>5510</td>
<td>0.84</td>
</tr>
</tbody>
</table>
• No additional Kirby South stratigraphic wells drilled in 2016
  – No cores cut and no special core analysis performed
Geology
Kirby South SAGD Pay Top Structure
Geology
Kirby South SAGD Pay Base Structure

Drainage Box 'F'
Drainage Box 'C'
Drainage Box 'G'
Drainage Box 'B'
Drainage Box 'A'
Drainage Box 'D'
Drainage Box 'E'
Geology
Kirby South Net Water Sand Isopach

Canadian Natural
Kirby Expansion Project
Kirby South Development Area
Isopach - McMurray Net Water Sand (m)

Polygon Legend:
- Kirby Expansion Project Area
- Approved Development Area(s)
- Drainage Boxes
  (Existing & Pending)
## Geology

### Kirby North Development Area Volumetrics

<table>
<thead>
<tr>
<th>Reservoir Type</th>
<th>Average Pay Thickness (m)</th>
<th>Average Oil Saturation (%)</th>
<th>Average Porosity (%)</th>
<th>OBIP ($m^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wabiskaw D Reservoir</td>
<td>15.6</td>
<td>77.5</td>
<td>32.8</td>
<td>43,691</td>
</tr>
<tr>
<td>McMurray Reservoir</td>
<td>18.2</td>
<td>80.0</td>
<td>32.3</td>
<td>78,237</td>
</tr>
<tr>
<td>Kirby North Approved Development Area</td>
<td></td>
<td></td>
<td></td>
<td>121,928</td>
</tr>
</tbody>
</table>

• Volumetric calculation (for >10m contour):
  – Area above 10m of pay $\times$ Pay Thickness $\times$ Oil Sat. $\times$ Porosity
Geology
Seismic Coverage

- 4D Seismic acquired March 2015
- Calibrated 4D observations against engineering data (TFO, produced volumes)
- Measured extent of steam chamber based on amplitude difference mapping
- Results impacted by location of CPF, re-drills and steam injection downtime
Kirby South 4D Seismic - March 2015

- Steam chamber growth depicted at 18 months past initial steam date
- 4D amplitude anomaly with amplitude cutoff (1750) calibrated to produced volumes by pad
- Irregularities attributed to facies heterogeneity
- Some well pairs do not show steam chamber growth due to non-steaming events such as downtime and re-drill startups
Kirby South Formation and Well Placement Overview
Some OCDs and ICDs are shiftable tools in the closed position.

- Production: majority of wells are equipped with ESPs.

<table>
<thead>
<tr>
<th>AL Type</th>
<th>Well Count</th>
<th>Lift Capacity (m3/d)</th>
<th>Operating Temperature (DegC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESP</td>
<td>47</td>
<td>150-1000</td>
<td>&lt;250</td>
</tr>
<tr>
<td>Rod Pump</td>
<td>2</td>
<td>0-300</td>
<td>&lt;250</td>
</tr>
</tbody>
</table>

- Injection: majority of wells are completed with a heel and toe string

- Completions are continually optimized as required by well behavior
  - Outflow control devices are installed to improve steam distribution in the injector
  - Scab liners are installed to enhance toe production in the producer and reduce heel hot spots
  - Inflow control devices are installed to limit single point breakthrough and/or to control to wellbore hydraulics
    - Well pairs with ICD: B2, D6, D7, F5 and F6
    - Well pairs with OCD: B4, C2, C3, D1, D4, E1, E2, E5, E6, F1, F2 and F4

<table>
<thead>
<tr>
<th>Completion Tool</th>
<th>OCD</th>
<th>Scab Liner</th>
<th>ICD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well Count</td>
<td>12</td>
<td>22</td>
<td>5</td>
</tr>
</tbody>
</table>
Instrumentation Summary

- Blanket gas pressures are used to monitor bottom hole pressures for SAGD injection wells.

- SAGD producers are equipped with fiber optic temperature monitoring (DTS) along the lateral and bubble tubes with surface measurement for heel or toe pressure.

- Observation wells gather multiple temperatures and pressures at various elevations.
Well Schematics
Injection Well (Dual String)

- 339.7 mm (13 3/8”) Surface Casing set @ ~ 200.0 mKB
- 244.5 mm (9 5/8”) Casing set @ ~ 750.0 mKB
- 88.9 mm (3 1/2”) short tubing (Heel) @ ~ 750.0 mKB
- 88.9 mm (3 1/2”) Long Tubing (Toe) @ ~ 1700.0 mKB
- Liner Hanger ~20 m behind ICP
- Slotted Liner 177.8 mm (7”)
- 600-1000 m Hz sections
Well Schematics
Injection Well (Single String)

339.7 mm (13 3/8") Surface Casing set @ ~ 200.0 mKB

244.5 mm (9 5/8") Casing set @ ~ 750.0 mKB

114.3 mm (4 1/2") Long Tubing @ ~ 1700.0 mKB

Liner Hanger ~20 m behind ICP

2 - 114.3 (4 1/2") Steam Splitters

Slotted Liner 177.8 mm (7"")

600-1000 m Hz sections
Well Schematics
Production Well

339.7 mm (13 3/8") Surface Casing set @ ~ 200.0 mKB

244.5 mm (9 5/8") Casing set @ ~ 750.0 mKB

88.9mm (3 ½") tubing to Pump landed ~50 m behind Liner Hanger

48 mm (1.9") guide string with DTS fibre instrumentation

600-1000 m Hz sections

Liner Hanger ~20 m behind ICP

Pump

Slotted Liner 177.8 mm (7")
Well Schematics
Production Well (Scab Liner)

339.7 mm (13 3/8") Surface Casing set @ ~ 200.0 mKB

244.5 mm (9 5/8") Casing set @ ~ 750.0 mKB

88.9mm (3 1/2”) tubing to Pump landed ~50 m behind Liner Hanger

Liner Hanger ~20 m behind ICP

600-1000 m Hz sections

Pump

Production Port if Required

Scab Liner 127 mm (5”)

Slotted Liner 177.8 mm (7”)

48 mm (1.9”) guide string with DTS fibre instrumentation
Well Schematics
Production Well (Swellable Packers and ICDs)

339.7 mm (13 3/8") Surface Casing set @ ~ 200.0 mKB

244.5 mm (9 5/8") Casing set @ ~ 750.0 mKB

88.9mm (3 ½") tubing to Pump landed ~50 m behind Liner Hanger

48 mm (1.9") guide string with DTS fibre instrumentation

Liner Hanger ~20 m behind ICP

600-1000 m Hz sections

Slotted Liner 177.8 mm (7"")

Closed Toe
Completion Optimization

- Steam splitter and scab liner installations/removals were selected based on specific opportunities for each well.
  - Steam splitters to target a specific stream distribution in the injector
  - Scab liner installs to encourage toe development and minimize heel temperature variations
  - Scab liner removals to promote heel development after toe fluids are mobile

- ICDs and swellable packers strings were used to limit single point breakthrough and/or to control to wellbore hydraulics

- Impact on well performance has been well pair specific
  - In general, the results of completion optimization workovers have been encouraging.
Completion Optimization Example

D1I was injecting out of the toe only on its single string, shiftable splitter design. After the toe was developed, the splitter was opened to allow for steam to access and mobilize more of the reservoir.
Completion Optimization Example

G7I was injecting out of the heel and toe string. To increase the quality of steam, the long string was pulled back to heel, but the performance of the well has not changed from the expected ramp up of the well.
Well Schematics
Observation Well

Note: Shows a plan for 2011-2013 drilled observation wells, as previous wells don’t have external casing transmitters
Well Schematics
Disposal Well

244.5 mm SURFACE CASING, SET BETWEEN 25 m & 150 m CEMENTED FULL LENGTH

177.8 mm PRODUCTION CASING THERMALLY CEMENTED TO SURFACE

88.9 mm TUBING

ANNULUS FILLED WITH INHIBITED WATER

McMURRAY TOP

INJECTION ISOLATION PACKER

PERFORATIONS OR SCREEN

McMURRAY BASAL AUQUIFER (at 550 m)

WGC
Well Schematics
13-20 Hz Water Disposal Well

339.7 mm (13 3/8") Surface Casing set @ ~ 182.0 mKB

244.5 mm (9 5/8") Casing set @ ~ 730.0 mKB

114.3 mm (4 1/2") Tubing @ ~ 692.0 mKB with isolation packer set at 690.0

Liner Hanger 20 m behind ICP

Slotted Liner
177.8 mm (7") Slotted Liner w/perfs

525m Hz section
Operational Strategy
SAGD

• Injection Strategies
  • Steam down heel and toe string in dual string completion
  • Steam down single long string with steam splitters

• Pump fluid from producer using artificial lift

• Operate wells based on a target steam chamber pressure and target subcool

• Steam chamber pressure is measured by blanket gas pressure in the injector and is controlled by the steam injection rate
  • Target pressure chosen to balance bottom water where it exists, typically 2.5 MPa to 3.5 MPa (Pads A to F)
  • For pads without bottom water influence, pressures may increase up to 5 MPa (Pad G)
Operational Strategy
SAGD Continued

• Subcool is the difference between saturated temperature at producer pressure and the highest temperature along the producer lateral
  • Target chosen to maximize production and minimize live steam production

• To optimize pressure and subcool target, a combination of parameters are monitored including:
  • Water retention in reservoir
  • Chlorides concentration in produced water
  • SOR
  • Bottom hole pressures
Kirby South Drilling Activity Update

- No drilling at Kirby South between August 20, 2015 and August 17, 2016
Kirby South
SAGD Well Spacing

<table>
<thead>
<tr>
<th>Pad</th>
<th>Number of Well Pairs</th>
<th>Inter well Spacing (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td>B</td>
<td>7</td>
<td>100</td>
</tr>
<tr>
<td>C</td>
<td>7</td>
<td>100</td>
</tr>
<tr>
<td>D</td>
<td>8</td>
<td>80</td>
</tr>
<tr>
<td>E</td>
<td>6</td>
<td>80</td>
</tr>
<tr>
<td>F</td>
<td>7</td>
<td>50</td>
</tr>
<tr>
<td>G</td>
<td>8</td>
<td>80</td>
</tr>
</tbody>
</table>

• Infill wells are being considered for wider SAGD pads.

• Original well spacing on Pads A, B, & C were 100 m.

• Well spacing was optimized from 100 m to 80 m to achieve improved CDOR, SOR and recovery factors for wells with less bottom water influence.

• F Pad spacing was decreased to 50 m where thicker bottom water exists to lessen the slumping of oil and therefore improve CDOR, SOR and recovery factor.
# Kirby South Performance
## Pad Recoveries

**Recovery as of August 17, 2016**

<table>
<thead>
<tr>
<th>Pad</th>
<th>OBIP (E3m3)</th>
<th>Ult. Recovery (E3m3)</th>
<th>Cum Oil (E3m3)</th>
<th>RF (%)</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>3,920</td>
<td>2,352</td>
<td>375</td>
<td>10</td>
</tr>
<tr>
<td>B</td>
<td>3,880</td>
<td>2,328</td>
<td>602</td>
<td>16</td>
</tr>
<tr>
<td>C</td>
<td>4,180</td>
<td>2,508</td>
<td>830</td>
<td>20</td>
</tr>
<tr>
<td>D</td>
<td>5,510</td>
<td>3,306</td>
<td>613</td>
<td>11</td>
</tr>
<tr>
<td>E</td>
<td>3,000</td>
<td>1,800</td>
<td>634</td>
<td>21</td>
</tr>
<tr>
<td>F</td>
<td>2,510</td>
<td>1,506</td>
<td>335</td>
<td>13</td>
</tr>
<tr>
<td>G</td>
<td>4,530</td>
<td>2,718</td>
<td>562</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>27,530</strong></td>
<td><strong>16,518</strong></td>
<td><strong>3952</strong></td>
<td><strong>14</strong></td>
</tr>
</tbody>
</table>
Kirby South Performance Summary

- Reservoir performance is similar to expectations, currently optimizing well-pair conformance.

- Plant turnarounds:
  - Oct 2015: Evap cleanings and Boiler 2 inspection
  - Jan/Feb 2016: Evap 3 cleaning and Boiler 5 regulatory inspection/TA
  - Feb/Mar 2016: Boiler 3 and 4 regulatory inspection/TA and Evap 2 cleaning
  - Aug 2016: Boiler 1 regulatory inspection/TA and Evap 1 cleaning

- Record oil production to date ~6850 m³/d (43 100 bbl/d)

- 9 wells lost sand control, 7 wells remediated
  - Installed ICDs on 4 well pairs
  - Installed bridge plugs on 3 well pairs

- Pad G being operated at an increased pressure target of 3.5 MPa
Kirby South Performance – Low Recovery Pad A

- SAGD well pair: 6
- First steam: Oct. 2013
- Inter-well pair spacing: 100 m
- Avg. net pay: 29 m
- Avg. So: 68%
- Avg. porosity: 33%
- Current RF: 10%
Kirby South Performance Pad A Production

Re-drills successfully targeted better reservoir.
Best performer of A pad ramped up to the expected performance
Kirby South Performance
Low Recovery Pad A Well Pair

Kirby South A4 Production

- Oil Production
- Water Production
- Steam Injection
- iSOR
- cSOR

Original Producer Well Fails
Circulating Re-Drill

Re-drill successful, ramping to targeted performance
Kirby South Performance
Pad A Obs Well – 26 metres from A4

Chamber has intersected the obs well.
Kirby South Performance
Pad A Obs Well Pressures

- BW pressure changes as pad pressures are increased / decreased
- McMurray pressure is being influenced by SAGD pressure (26m from A4)
- Clearwater gauge landed in impermeable shale
- Clearwater declining pressure result of gauge effects and does not indicate change in cap rock properties
Kirby South Performance
Pad A Key Learnings

• Pad A has performed at reservoir expectations through this year.

• Re-drills have been successful in improving pad performance
  – Continuing to evaluate the economic potential to re-drill A1.
Kirby South Performance – Mid Recovery Pad D

- SAGD well pair: 8
- First steam: Oct. 2013
- Inter-well pair spacing: 80 m
- Avg. net pay: 26 m
- Avg. So: 80%
- Avg. porosity: 33%
- Current RF: 11%
Kirby South Performance
Pad D Production

Re-drills are successfully ramping to the expected peak rate.
Kirby South Performance
High Recovery Pad D Well Pair

Kirby South D4 Production

- Oil Production
- Water Production
- Steam Injection
- iSOR
- cSOR

Best performer of D pad
D6 successfully ramping to the peak rate
Kirby South Performance
Pad D Obs Well Pressures

- Pad D Obs wells show good pressure sensitivities to changes in SAGD operations.
Kirby South Performance
Pad D Obs Well – 5 m From D2
Kirby South Performance
Pad D Key Learnings

• Reservoir performance is meeting expectations
• All re-drills on SAGD operation as of Q2 2015
• Known communication through old RAX SAGD pilot
  – To date no performance issues due to RAX pilot to date
  – Long term strategy to balance pressures between C & D pad
  – Continually monitor RAX pressure and temperatures
• Steam splitters reconfigured on D1 to improve temperature conformance
Kirby South Performance
Pad C – High Recovery Pad

- SAGD well pair: 7
- First steam: Sept. 2013
- Inter-well pair spacing: 100 m
- Avg. net pay: 25 m
- Avg. So: 78%
- Avg. porosity: 33%
- Current RF: 20%
Pad C is one of the best performers among KBS pads with 20% RF so far.
Kirby South Performance
High Recovery Pad C Well Pair

Kirby South C2 Production

- Oil Production
- Water Production
- Steam Injection
- iSOR
- cSOR

C2 is the best performer on C pad with ramp up to 300 m³/d
C7 is an example of a low performer on pad C
Kirby South Performance
Pad C Obs Well – 27 m From C2

Chamber has intersected the obs well.
Kirby South Performance
Pad C Key Learnings

• Reservoir performance is meeting expectations
• Known communication through old RAX SAGD pilot
  – No impact on production
Kirby South Performance
5 Year Outlook – Pad Abandonments

• No expected pad abandonments in the next 5 years
Kirby South Performance
Wellhead Steam Quality

• During steady operations, wellhead quality should be 95% or greater

• No other fluids are injected with the steam
Kirby South Observation Well Results
100/10-28-073-07W4 – 4 m From G3

Colony gas well to evaluate the ability of non-thermal cement to maintain hydraulic isolation in a thermal environment.
Future Plans – Subsurface Summary

• Continue to optimize SAGD pairs

• Pending favorable economic conditions, the following future plans are contemplated:
  – Potential resumption of B2 (failed producer liner) and A1 (performance).
  – F Pad: Drill remaining approved wells (F8, F9, F10)
  – D Pad: Drill D9 and D10
  – G Pad: Drill G9 and G10
  – Drill strat wells to evaluate the above drilling
  – Scheme Amendment applications (additional pads)

• Disposal: adding disposal well to one of the existing pads

• Kirby North Development
  – Canadian Natural announced in 2015 that the Kirby North Project would be deferred due to several external factors including commodity prices
  – Construction suspended August 2015
DIRECTIVE 54 SECTION 3.1.2
SURFACE OPERATIONS, COMPLIANCE AND ISSUES
NOT RELATED TO RESOURCE EVALUATION AND RECOVERY
Surface Facilities Overview
Plot Plans

• Detailed Site Plot Plans:
  – Kirby SAGD Production Pad Plot Plan
    ▪ Dwg No. KBF-G-210-0001
  – Kirby South Central Plant Plot Plan
    ▪ Dwg No. KBP-00-210-0002

• Simplified Schematic:
  – Kirby In-Situ Oil Sands Project Simplified Schematic
Surface Facilities Overview
Kirby South SAGD Production Pad Plot Plan
Summary of Modifications since August 2015

- A second ISF was added to further prevent oil fouling in the Evaporators
- A mist eliminator hood trial was added to the vapor suction in Evaporator 1
- Two additional decanting tanks were added for further handling of off spec streams
- Additional disposal water filtration was added to improve performance of the disposal wells
• Overall water quality and oil treating targets have been met

– Oil treating is running very stable, short term upsets from well ramp ups during maintenance activities is still experienced, but are decreasing in frequency
  ▪ The addition of the additional ISF has helped to maintain on spec produced water
  ▪ Optimization work continues on the chemical program
– PW de-oiling upsets leading to evaporator fouling and additional cleanings has been greatly reduced
– New production record reached November 7th, of 43,100 BPD.

– Challenges in keeping up with slop generation
  ▪ Improvements have been made in reducing the slop generated on site, through process and chemical program optimization
  ▪ The flexibility of recycle locations has been increased to allow high water and oil streams to be recycled separately
Kirby South Facility Performance
Water Treatment Area

- In general good performance in the evaporators - meeting design expectations
- Water upsets affecting evaporator performance has greatly decreased, increasing steam availability
- Disposal well injectivity decreases have lead to steam limitations
  - Additional filtration and water flushes of the disposal wells has slowed the injectivity decreases
  - The disposal lines are being pigged to remove any solids build up
Kirby South Facility Performance
Boilers

• Boiler failures

  – Tube header failures discovered in April 2014 and Furnace tube failures discovered in July 2014 causing steam limitation

  – Engineering solution implemented to protect boilers in 2015
    ▪ Tubes were replaced, refractory was installed on the furnace, burners were tuned to shift heat away from furnace, refractory has been modified and burners re-tuned

  – In 2016 the above mention solutions were implemented on all the boilers, all boilers were inspected and optimization work has continued

  – In 2017 the boilers will be monitored and the next regulatory inspection is in 2018
• Salt caverns continue to manage evaporator blowdown solids

• Some optimization ongoing to cavern return filtration

• 2016 Sonar Logging
  – Cavern 1 scheduled for this fall
  – Cavern 2 complete

• Both salt caverns have passed their MIT
  – MIT will be performed on a five year cycle.
### Kirby South Facility Performance

#### Power Consumption on a monthly basis

<table>
<thead>
<tr>
<th>Month</th>
<th>Total Power Consumption (kWh)</th>
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Kirby South Facility Performance
Gas Usage

- Gas Usage on a monthly basis

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<th>Month</th>
<th>Total Purchased Gas e3m3</th>
<th>Total Gas Produced e3m3</th>
<th>Total Gas Vented e3m3</th>
<th>Total Solution Gas to Flare e3m3</th>
<th>Solution Gas Recovered %</th>
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<td>-</td>
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<td>512</td>
<td>-</td>
<td>0.0</td>
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Recovering greater than 99% solution gas
Kirby South Facility Performance

Emissions

• Kirby Greenhouse Gas Emissions
  – Currently establishing baseline in accordance with the Specified Gas Emitters Regulation (SGER).

• Kirby Sulphur Emissions
  – No exceedance of the EPEA daily SO2 emissions limit of 2.0 t/d
  – No exceedance of the AER D56 calendar quarterly sulphur limit of 0.99 t/d
  – No plans for sulphur recovery installation at this time
  – Contingency plan is to reduce production if the sulphur emission rate approaches the EPEA or D56 limit
Kirby South Facility Performance
Sulphur Emissions

Sulphur Emissions (t/d)


- Blue: Sulphur Rate Quarterly Avg.
- Green: Sulphur Daily Rate
- Red: EPEA Limit Quarterly Basis
- Red: D56 Limit Quarterly Basis
Kirby South Facility Performance
Ambient Air Quality Results

• During the monitoring periods, there were no ambient SO2 or NO2 readings above the Alberta Ambient Air Quality Objective (AAAQO).

• There were four H2S readings above the hourly and daily AAAQO in December 2015 and January 2016.
  – Determined to be due to a gas leak on the annulus gas line at a flange at G8 production well.
Measurement and Reporting Summary

- MARP approved in October 2011 and last updated in August 2016
  - Mainly minor updates and corrections
  - Disposal well 00/09-19-073-08W4 was added to the document
  - A few of the out of service meters were removed from the document, and the potable water meters as these are part of the camp.

- Methods for estimating well production and injection volumes:
  - Produced emulsion from the scheme is commingled at the battery. Bitumen and water production from the battery will be prorated to each well using monthly proration test data and proration factors
    - Total Battery Oil (Water) / Total Test Oil (Water) at Wells = Oil (Water) Proration Factor
    - Oil (Water) Proration Factor * Each Well Test Oil (Water) Volume = Oil (Water) Allocated to Each Well
  - Gas is allocated to each well using a battery GOR
    - Total Solution Gas Produced / Total Battery Oil = Gas Oil Ratio
    - Gas Oil Ratio * Oil Allocated to Each Well = Gas Allocated to Each Well
  - Injected steam volumes will be continuously measured at the wellhead and prorated to the total steam leaving the injection facility

- Test Durations
  - Based on operating experience to date, well test duration has been optimized at 1 hour and each well is tested 3 to 4 times per day.
Kirby South Battery
  Location: 14-21-73-07W4M
  Registry Code: ABBT0116017
  Registry Sub Type: 344 – Crude Bitumen Multi-Well Proration Battery

Kirby South Steam Plant
  Location: 14-21-73-07W4M
  Registry Code: ABIF0116018
  Registry Sub Type: 506 - In Situ Oil Sands

Kirby South Disposal Wells
  Location: Various
  Registry Code: ABIF0117173
  Registry Sub Type: 503 - Disposal

Kirby South Salt Cavern #1
  Location: 14-21-73-07W4M
  Registry Code: ABWP0116019
  Registry Sub Type: 702 – Cavern Waste

Kirby South Salt Cavern #2
  Location: 14-21-73-07W4M
  Registry Code: ABWP0117526
  Registry Sub Type: 702 – Cavern Waste
Measurement and Reporting Proration Factors

- 100% compliance with D17 (3-month avg. range 0.85-1.15)
- The spike in October 2015 is due to a plant maintenance outage
Future Plans – Surface
Kirby South Planned 2016 – 2017 Activities

• Central Plant
  – Boiler burner optimization.
  – Disposal filtration optimization.

• Pads
  – Piping modifications on step outs and re-drills
  – Disposal well tie-in
Kirby North Site Activities Summary

- Canadian Natural announced in January 2015 that the Kirby North project would be deferred due to several external factors including commodity prices.

- Construction suspended August 2015.
Mechanical Vapor Compression (MVC) evaporators selected for BFW treatment

- Treatment of both recycled produced water and makeup water
- Evaporator blow down solids disposal to on-site salt cavern
- Silica Sorption process selected vs. high pH process from application
Mechanical Vapor Compression Evaporator:
Kirby South Produced and Make-up Water Usage

Water Sources

Saline
- McMurray Fm
  - TDS = 14,500 ppm
  - Pressure balancing and make-up water
- Grand Rapids
  - TDS 4,500 ppm (tested frequently)
  - Make-up water

Non-Saline
- Grand Rapids
  - TDS 2,450 ppm
  - Make-up water
- Empress Fm
  - TDS = 550 ppm
  - Make-up and utility water
Kirby South Produced and Make-up Water Usage

<table>
<thead>
<tr>
<th>Month</th>
<th>Non-saline Volume</th>
<th>Saline Volume</th>
<th>Non Saline Make-Up Percentage</th>
<th>Injection</th>
<th>Produced</th>
<th>PWR</th>
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<tbody>
<tr>
<td></td>
<td>m³</td>
<td>m³</td>
<td>%</td>
<td>m³</td>
<td>m³</td>
<td>%</td>
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<tr>
<td>Sep-15</td>
<td>15,997</td>
<td>41,414</td>
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<td>26,120</td>
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<td>Mar-16</td>
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<td>2015-2016 Totals</td>
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<td>34</td>
<td>289,996</td>
<td>5,048,952</td>
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</table>

- Water Act Diversion License renewed in August, 2015
- Directive 81 Disposal Limit = 11%, Actual Disposal = 5% for 2015-2016
- Also used a total of 14,655 m³ of non-saline/potable water to supply camps and office complex
Kirby South Source and Disposal Well Map

- Disposal Well
- Saline Source Well
- Off-Lease Saline Evaluation Well
- Non-Saline Source Well (Make-Up)
- Non-Saline Source Well (Domestic)
- Salt Cavern Disposal Well
## Kirby South Source Wells - Saline

<table>
<thead>
<tr>
<th>Well Name</th>
<th>Use</th>
<th>Unique Well Identifier</th>
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</thead>
<tbody>
<tr>
<td><strong>McMurray Source Wells</strong></td>
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</tr>
<tr>
<td>CNRL WSW01 Kirby 14-30-73-7</td>
<td>Make-up Source</td>
<td>1F1/14-30-73-7W4M</td>
</tr>
<tr>
<td>CNRL WSW MC01 Kirby 10-33-73-8</td>
<td>Make-up Source</td>
<td>1F1/10-33-73-8 W4M</td>
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<tr>
<td>CNRL WSW MC02 Kirby 10-33-73-8</td>
<td>Make-up Source</td>
<td>1F2/10-33-73-8 W4M</td>
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<tr>
<td><strong>Grand Rapids Source Well</strong></td>
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<tr>
<td>CNRL WSW GR01 Kirby 13-21-73-7</td>
<td>Make-up Source</td>
<td>1F3/13-21-073-07W4M</td>
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</table>
# Kirby South Source Wells – Non-Saline

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<th>Well Name</th>
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<td><strong>GRAND RAPIDS Formation</strong></td>
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<tr>
<td>Grand Rapids Source Wells</td>
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<tr>
<td>CNRL WSW02 Kirby 14-30-73-7</td>
<td>Make-up Source</td>
<td>1F2/14-30-73-8W4M</td>
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<td><strong>EMPRESS Formation Source Wells</strong></td>
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<tr>
<td>CNRL WSW Kirby 13-21-73-7</td>
<td>Utility Source</td>
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<tr>
<td>CNRL WSW EMP03 12-21-73-7</td>
<td>Utility Source</td>
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<td><strong>MURIEL LAKE Formation - Source Wells</strong></td>
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<td>Domestic Source</td>
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<td><strong>ETHEL LAKE Formation - Source and Standby Wells</strong></td>
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# Kirby South Disposal Wells

## McMurray Disposal Wells

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<td>Disposal</td>
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## Salt Cavern Wells

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<td>Prairie Evaporate</td>
<td>02/04-28-073-07W4M</td>
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Kirby South Pressure Balance Scheme Update
Kirby South Pressure Balance Scheme Update

- After initial declines, pressure in Basal McMurray Aquifer now almost equal to initial pressure in all observation wells in South sourcing/disposal area
  - High pressure spikes in 9-34 due to produced water disposal in 9-34
Kirby South Pressure Balance Scheme Update

- McMurray Fm Basal Aquifer pressure near 10-17-74-8 disposal area
  - Pressure increased in aquifer early on during cavern washing, but has now decreased to ~ 3,000 kPa and holding
  - Obtained chemistry sample at 1-17 obs well in March, 2014, TDS ~12,500, which is background concentration
Kirby South Disposal

• Disposal issues
  – Experiencing decreasing injectivity over time.
    ▪ Plugging
    ▪ Oil Carryover
    ▪ Scale buildup in pipelines
  – Operating close to MWHIP
  – Acid stimulations showing diminishing returns
  – Produced water flushes of the disposal well have been successful in short term returns of injectivity
  – Additional filtering of the disposal water before injection has slowed the injectivity decrease of the wells
  – Pipeline solids accumulation – ongoing pigging

• Potential future work
  – Filter optimization.
  – Drilling new disposal wells
  – Produced water flush and stimulation work as required
Kirby South Waste Disposal

Top 10 Waste Streams (Kgs)

- Filters - Leachable: 59,857
- Oil - Leachable: 2,555
- Rags - Leachable: 8,646
- Soil & Debris NR HC Refined: 10,473
- Scrap Metal: 44,660
- Domestic Garbage: 46,474
- Soil & Debris NR Chemicals: 16,040
- Cardboard: 4,310
- Wood Waste: 16,990
- NR Solids Soil C/W Oil: 8,530

Total
Kirby South Waste Disposal

Top 10 Disposal Facilities (Kgs)

- Beaver Regional Municipal Landfill: 20,330
- Blue Planet Recycling: 743
- General Scrap Edmonton: 808
- GFL Edmonton Metals: 110
- Miller Environmental: 2,555
- Tervita Janvier Landfill: 1,460
- Tervita Red Deer Metals Recycling: 24,570
- (blank): 44,740
- Wood Buffalo Landfill: 50,950
- Cloverbar Landfill Edmonton: 8,670
- Cascades Recovery - Edmonton: 570
- Pnewko Trucking: 40

Total: 57,920
Wildlife Mitigation Plan and Monitoring Program

- Monitoring mitigation efficacy (above ground pipelines, barriers to wildlife movement, effects of human presence)
- 21 remote cameras deployed throughout the project
  - 13 species detected, including three provincially sensitive species and one federally threatened species (woodland caribou)
  - Frequent caribou sightings near Kirby South Plant reported by onsite staff
- 23 camera stations monitoring linear deactivation, initiated in Feb 2015
  - 10 mammal species recorded
  - Noted correlation between low carnivore detections along treated lines
- 22 species of concern (17 bird species, 5 mammals) observed in the Kirby Project area in 2015
- Comprehensive wildlife report to be completed in 2017
• Wetland and Waterbody Monitoring Program
  – Two monitoring stations showed water level response is sensitive to discharges of industrial waste water from nearby pads or the Kirby South CPF.
  – Two culvert surveys completed at Kirby South and Kirby North in 2015.
    ▪ Mitigation measures applied to most problematic culverts following the surveys.
    ▪ Additional mitigation measures being applied throughout the year to meet target of repairing all damaged culverts within one year from time of assessment.
  – Overall indication that project infrastructure has some effect on wetlands in Kirby South.
    ▪ Corrective measures include improvements to road and culvert design in problematic areas to alleviate water impoundment
• Groundwater Monitoring Program

– Well pad monitoring program to monitor potential effect of steam injection on mineral solubility and mobilization of trace elements
  ▪ 1 monitoring well on each Pad B, Pad D, Pad F
  ▪ No impacts to groundwater quality identified
  ▪ Sub-regional groundwater monitoring program focusing on deeper, Quaternary- and Tertiary-aged aquifers.

– Central Plant monitoring program monitors groundwater conditions within shallow sediments
  ▪ 20 groundwater monitoring wells at CPF
  ▪ Increase in chloride concentration in monitoring well P12-06.
    ▪ Action plan submitted to AER July 20, 2016
Environmental Summary
Monitoring Programs

• Air Monitoring
  – Source Monitoring
    ▪ Two RATAs conducted on Generator 1 in 2015
    ▪ CEMS at steam generator measures SO2 and NO2
    ▪ Two cylinder gas audits conducted in 2015
      ▪ Results show CEMS code is met
    ▪ One manual stack survey conducted on Glycol Heater Exhaust Stack in 2015
    ▪ No significant trends in emissions data
  – Ambient Air Monitoring
    ▪ Continuous ambient air monitoring station located 0.7 km from plant site
      ▪ Measured exceedances of AAAQOs did not indicate a significant issue with plant operations
    ▪ Five passive monitoring stations located around the plant site
      ▪ All passive exposure monitoring results for SO2, H2S, NO2 and O3 were low for the monitoring period
Reclamation Activities

- No reclamation activities August 2015 to August 2016.

Reclamation Monitoring

- Objectives are to ensure:
  - land is reclaimed to an equivalent land capability
  - appropriate replacement of all salvaged topsoil on re-contoured areas
  - sustainable, diverse vegetation growth on all disturbed areas
  - pre-disturbance wildlife carrying capacities are obtained
- Regular site monitoring throughout reclaimed areas within the Project Area
Environmental Summary
Provincial/Federal Programs

• Lower Athabasca Regional Plan (LARP)
  – Participation in the South Athabasca Oil Sands (SAOS) area for Groundwater Management

• Joint Canada/Alberta Implementation Plan for Oil Sands Environmental Monitoring
  – Participation in the implementation of the program until June 2016 when AEMERA was cancelled
  – Working directly with researchers on environmental monitoring

• Provincial and Federal Woodland Caribou Recovery Policies
  – Participating in GOA processes to develop and implement range-level caribou recovery plans and province-wide action plan (CAPP).
  – Participating in caribou research (COSIA, RICC, FLMF)
  – Engaging with the GOA and Government of Canada to understand opportunities for knowledge transfer and to address data gaps (COSIA and CAPP).

• Alberta Wetland Policy
  – Participating in discussions with AEP and the AER regarding implementation of the policy in the Green Area of Alberta (CAPP)

• Alberta’s Climate Leadership Plan (CLP)
  – Working with AER and GOA on development of various aspects of the CLP including the oil sands emission limit and performance standards
## Approvals
### Commercial Oil Sands Scheme

<table>
<thead>
<tr>
<th>Approval Code</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11475</td>
<td>September 2010</td>
<td>Commercial Oil Sands Scheme Approval</td>
</tr>
<tr>
<td>11475A</td>
<td>November 2010</td>
<td>Revise initial development Pads A to G</td>
</tr>
<tr>
<td>11475B</td>
<td>November 2011</td>
<td>Change inter-well spacing Drainage Area D</td>
</tr>
<tr>
<td>11475C</td>
<td>December 2011</td>
<td>Change inter-well spacing in Drainage Area B</td>
</tr>
<tr>
<td>11475D</td>
<td>May 2012</td>
<td>Change inter-well spacing in Drainage Area E</td>
</tr>
<tr>
<td>11475E</td>
<td>June 2012</td>
<td>Evaluation of on-lease McMurray brackish water</td>
</tr>
<tr>
<td>11475F</td>
<td>August 2012</td>
<td>Change inter-well spacing in Drainage Area G</td>
</tr>
<tr>
<td>11475G</td>
<td>September 2012</td>
<td>Change inter-well spacing in Drainage Area F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Addition to Drainage Area D</td>
</tr>
<tr>
<td>11475H</td>
<td>April 2013</td>
<td>Evaluation of off-lease Clearwater brackish water</td>
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## Approvals

### Commercial Oil Sands Scheme

<table>
<thead>
<tr>
<th>Code</th>
<th>Date</th>
<th>Description</th>
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<tbody>
<tr>
<td>11475I</td>
<td>January 2014</td>
<td>Operational Strategy amendment</td>
</tr>
<tr>
<td>11475J</td>
<td>March 2014</td>
<td>Trajectory and lateral length modifications in Drainage Area G</td>
</tr>
<tr>
<td>11475K</td>
<td>May 2014</td>
<td>Approval of Kirby In Situ Oil Sands Expansion Project</td>
</tr>
<tr>
<td>11475L</td>
<td>November 2014</td>
<td>Revise initial Kirby North development Pads KN01-KN05</td>
</tr>
<tr>
<td>11475M</td>
<td>December 2014</td>
<td>Redrill well pairs A1, A2, A3</td>
</tr>
<tr>
<td>11475N</td>
<td>May 2015</td>
<td>Additional Kirby South and Kirby North disposal wells</td>
</tr>
<tr>
<td>11475O</td>
<td>July 2016</td>
<td>Conversion of existing Kirby South observation well to disposal well</td>
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In Compliance
## Approvals Disposal

<table>
<thead>
<tr>
<th>Approval</th>
<th>Date</th>
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<tbody>
<tr>
<td>11716</td>
<td>November 2011</td>
<td>Cavern Solution Mining</td>
</tr>
</tbody>
</table>
| 11716A   | July 2013   | Class 1b Cavern Disposal  
• Prairie Evaporites formation through well 00/13-21-073-07W4  
• Lotsberg formation through well 00/04-28-073-07W4 |
| 11716B   | June 2015   | Modify testing requirements. Approval modified to reference CSA Z341.4                                                                   |

**In Compliance**
## Approvals Disposal

<table>
<thead>
<tr>
<th>Number</th>
<th>Date</th>
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<tbody>
<tr>
<td>11761</td>
<td>December 2011</td>
<td>Class Ib Disposal</td>
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<tr>
<td></td>
<td></td>
<td>• 00/08-17-74-08W4</td>
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<tr>
<td></td>
<td></td>
<td>• 02/10-17-74-08W4</td>
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<tr>
<td></td>
<td></td>
<td>• 00/15-17-74-08W4</td>
</tr>
<tr>
<td>11761A</td>
<td>April 2013</td>
<td>Modify pH requirements</td>
</tr>
<tr>
<td>11761B</td>
<td>March 2014</td>
<td>Amend MWHIP</td>
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<tr>
<td>11761C</td>
<td>May 2015</td>
<td>Additional Kirby South disposal well</td>
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<tr>
<td></td>
<td></td>
<td>• 100/13-21-73-08W4</td>
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<tr>
<td></td>
<td></td>
<td>Additional Kirby North disposal well</td>
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<tr>
<td></td>
<td></td>
<td>• 02/08-22-74-10W4</td>
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<tr>
<td>11761D</td>
<td>July 2016</td>
<td>Conversion of existing observation well to disposal well</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 100/09-19-73-8W4</td>
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**In Compliance**
## Approvals Disposal (continued)

<table>
<thead>
<tr>
<th>Approval Code</th>
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<tbody>
<tr>
<td>9113</td>
<td>June 2002</td>
<td>Class II Disposal</td>
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<tr>
<td></td>
<td></td>
<td>• 00/08-22-074-10W4/0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 00/09-34-073-08W4/0</td>
</tr>
<tr>
<td>9594</td>
<td>September 2003</td>
<td>Transferred to Canadian Natural from Rio Alto Exploration</td>
</tr>
<tr>
<td>9594A</td>
<td>December 2011</td>
<td>Approval of Kirby In Situ Oil Sands Project</td>
</tr>
<tr>
<td>9594B</td>
<td>May 2014</td>
<td>Approval of Kirby In Situ Oil Sands Expansion Project</td>
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</tbody>
</table>

In Compliance
## Approvals
### Facility License

<table>
<thead>
<tr>
<th>License Number</th>
<th>Date</th>
<th>Description</th>
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<tbody>
<tr>
<td>F42290</td>
<td>October 2010</td>
<td>Kirby South Phase 1 Central Processing Facility</td>
</tr>
<tr>
<td>F42290 amended</td>
<td>July 2013</td>
<td>Amended for KS1 CPF to reflect stream day rates and number of compressors and pumps</td>
</tr>
<tr>
<td>F44051</td>
<td>July 2014</td>
<td>Kirby North Phase 1 Central Processing Facility</td>
</tr>
</tbody>
</table>

**In Compliance**
## Approvals
### EPEA and Water Act

<table>
<thead>
<tr>
<th>Approval Number</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>237382-00-00</td>
<td>April 2011</td>
<td>Approval of Kirby In Situ Oil Sands Project</td>
</tr>
<tr>
<td>237382-00-01</td>
<td>July 2014</td>
<td>Approval of Kirby In Situ Oil Sands Expansion Project</td>
</tr>
<tr>
<td>237382-00-02</td>
<td>February 2015</td>
<td>Amend Kirby South steam generator NOx limit to include efficiency credit</td>
</tr>
<tr>
<td>00334375-00-00</td>
<td>August 2013</td>
<td>Groundwater diversion license, Empress Unit 1 and Grand Rapids Formation</td>
</tr>
<tr>
<td>00337375-01-00</td>
<td>August 2015</td>
<td>Renewal of Groundwater diversion license</td>
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<tr>
<td>00288494-00-00</td>
<td>April 2011</td>
<td>Groundwater diversion license, Ethel Lake Formation</td>
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<tr>
<td>00327156-00-00</td>
<td>August 2013</td>
<td>Industrial surface runoff diversion license</td>
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<tr>
<td>00303825-00-00</td>
<td>July 2014</td>
<td>Preliminary Certificate groundwater diversion, Empress Terrace Formation</td>
</tr>
<tr>
<td>00303820-00-00</td>
<td>September 2014</td>
<td>Industrial surface runoff diversion license</td>
</tr>
</tbody>
</table>

**In Compliance**
Compliance Summary

• Reportable Spills
  – 2 reportable spills: 10 m³ produced water (Aug 2015), 5 m³ brackish water (March 2016)

• EPEA Contraventions
  – Three NOx mass emission rate hourly exceedances, Dec 2015 and Feb 2016
  – Four exceedances of H2S AAAQO, Dec 2015 and Jan 2016
  – CEMS failure to meet 90% uptime, Dec 2015
  – pH limit exceedance for industrial runoff, March 2016
  – Capping subsoil stockpiles with topsoil*.

• Water Act
  – Water Act License No. 00150748 data not reported to WURS. This license has since been cancelled*.
  – Water Act License No. 00303820 data not reported to WURS*.

*Identified through the COA and resolved.
Compliance Summary

• Pipelines
  – Steel risers on poly fresh water pipeline system are not cathodically protected and require sacrificial anodes to be installed*.
  – Pipeline Operation and Maintenance Manual to be updated March 2017*.

• Other
  – Failure to keep flaring, incinerating and venting logs*.
  – Need to update calculation for flared gas volumes (MARP)*.
  – Salt Cavern surface casing vent needs to be directed outside wellhead building*.

*Identified through the COA and resolved.
Forward Looking Statements

Certain statements relating to Canadian Natural Resources Limited (the "Company") in this document or documents incorporated herein by reference constitute forward-looking statements or information (collectively referred to herein as "forward-looking statements") within the meaning of applicable securities legislation. Forward-looking statements include, without limitation, any statements that use the words "believe", "anticipate", "plan", "project", "estimate", "continue", "could", "intend", "may", "likely", "will", "potential", "predict", "should", "will", "objective", "project", "forecast", "goal", "guidance", "outlook", "effort", "seeks", schedule "proposed" or expressions of a similar nature suggesting future outcome or statements regarding an outlook. Disclosure related to expected future commodity pricing, forecast or anticipated production volumes, royalties, operating costs, capital expenditures, income tax expenses, and other guidance provided throughout this presentation constitute forward-looking statements. Disclosure of plans relating to and expected results of existing and future developments, including but not limited to the Horizon Oil Sands operations and future expansion, Septimus, Primrose thermal projects, Pelican Lake water and polymer flood project, the construction of the proposed Keystone XL Pipeline from Hardisty, Alberta to the US Gulf coast, the proposed Kinder Morgan Trans Mountain pipeline expansion from Edmonton, Alberta to Vancouver, British Columbia, the proposed Energy East pipeline from Hardisty to Eastern Canada, the construction and future operations of the North West Redwater bitumen upgrader and refinery and disclosures relating to the Devon Canada Asset acquisition also constitute forward-looking statements. This forward-looking information is based on annual budgets and multi-year forecasts, and is reviewed and revised throughout the year as necessary in the context of targeted financial ratios, project returns, product pricing expectations and balance in project risk and timing. These forward-looking statements are not guarantees of future performance and are subject to certain risks and the reader should not place undue reliance on these forward-looking statements as there can be no assurances that the plans, initiatives or expectations upon which they are based will occur.

In addition, statements relating to "reserves" are deemed to be forward-looking statements as they involve the implied assessment based on certain estimates and assumptions that the reserves described can be profitably produced in the future. There are numerous uncertainties inherent in estimating quantities of proved and proved plus probable crude oil and natural gas and natural gas liquids (NGLs”) reserves and in projecting future rates of production and the timing of development expenditures. The total amount or timing of actual future production may vary significantly from reserve and production estimates.

The forward-looking statements are based on current expectations, estimates and projections about the Company and the industry in which the Company operates, which speak only as of the date such statements were made or as of the date of the report or document in which they are contained, and are subject to known and unknown risks and uncertainties that could cause the actual results, performance or achievements of the Company to be materially different from any future results, performance or achievements expressed or implied by such forward-looking statements. Such risks and uncertainties include, among others: general economic and business conditions which will, among other things, impact demand for and market prices of the Company’s products; volatility of and assumptions regarding crude oil and natural gas prices; fluctuations in currency and interest rates; assumptions on which the Company’s current guidance is based; national, provincial and local regulation and environmental protection regulations. Should one or more of these risks or uncertainties materialize, or should any of the Company’s assumptions prove incorrect, actual results may vary in material respects from those projected in the forward-looking statements. The impact of any one factor on a particular forward-looking statement is not determinable with certainty as such factors are dependent upon other factors, and the Company’s course of action would depend upon its assessment of the future considering all information then available. For additional information refer to the “Risks Factors” section of the AIF.

Although the Company believes that the expectations conveyed by the forward-looking statements are reasonable based on information available to it on the date such forward-looking statements are made, no assurances can be given as to future results, levels of activity and achievements. All subsequent forward-looking statements, whether written or oral, attributable to the Company or persons acting on its behalf are expressly qualified in their entirety by these cautionary statements. Except as required by law, the Company assumes no obligation to update forward-looking statements, whether as a result of new information, future events or other factors, of the foregoing factors affecting this information, should circumstances or Management’s estimates or opinions change.
Reporting Disclosures

Special Note Regarding Currency, Production and Reserves

In this document, all references to dollars refer to Canadian dollars unless otherwise stated. Reserves and production data are presented on a before royalties basis unless otherwise stated. In addition, reference is made to crude oil and natural gas in common units called barrel of oil equivalent ("BOE"). A BOE is derived by converting six thousand cubic feet of natural gas to one barrel of crude oil (6Mcf:1bbl). This conversion may be misleading, particularly if used in isolation, since the 6Mcf:1bbl ratio is based on an energy equivalency conversion method primarily applicable at the burner tip and does not represent a value equivalency at the wellhead. In comparing the value ratio using current crude oil prices relative to natural gas prices, the 6Mcf:1bbl conversion ratio may be misleading as an indication of value.

This document, herein incorporated by reference, have been prepared in accordance with IFRS, as issued by the International Accounting Standards Board. For the year ended December 31, 2013 the Company retained Independent Qualified Reserves Evaluators ("Evaluators"), Sproule Associates Limited and Sproule International Limited (together as “Sproule”) and GLJ Petroleum Consultants Ltd. ("GLJ"), to evaluate and review all of the Company's proved and proved plus probable reserves with an effective date of December 31, 2013 and a preparation date of February 3, 2014. Sproule evaluated the North America and International light and medium crude oil, primary heavy crude oil, Pelican Lake heavy crude oil, bitumen (thermal oil), natural gas and NGLs reserves, GLJ evaluated the Horizon SCO reserves. The evaluation and review was conducted in accordance with the standards contained in the Canadian Oil and Gas Evaluation Handbook ("COGE Handbook") and disclosed in accordance with National Instrument 51-101 – Standards of Disclosure for Oil and Gas Activities ("NI 51-101") requirements. In previous years, Canadian Natural had been granted an exemption order from the securities regulators in Canada that allowed substitution of U.S. Securities Exchange Commission ("SEC") requirements for certain NI 51-101 reserves disclosures. This exemption expired on December 31, 2010. As a result, the 2011 and 2012 reserves disclosure is presented in accordance with Canadian reporting requirements using forecast prices and escalated costs.

The Company annually discloses net proved reserves and the standardized measure of discounted future net cash flows using 12-month average prices and current costs in accordance with United States Financial Accounting Standards Board Topic 932 “Extractive Activities - Oil and Gas” in the Company's Form 40-F filed with the SEC in the “Supplementary Oil and Gas Information” section of the Company’s Annual Report targeted to be released in late March 2013.

Resources Other Than Reserves

The contingent resources other than reserves (“resources") estimates provided in this presentation are internally evaluated by qualified reserves evaluators in accordance with the COGE Handbook as directed by NI 51-101. No independent third party evaluation or audit was completed. Resources provided are best estimates as of December 31, 2012. The resources are evaluated using deterministic methods which represent the expected outcome with no optimism or conservatism.

Resources, as per the COGE Handbook definition, are those quantities of petroleum estimated, as of a given date, to be potentially recoverable from known accumulations using established technology or technology under development, but are not currently considered commercially viable due to one or more contingencies. There is no certainty that it will be commercially viable to produce any portion of these resources.

Due to the inherent differences in standards and requirements employed in the evaluation of reserves and contingent resources, the total volumes of reserves or resources are not to be considered indicative of total volumes that may actually be recovered and are provided for illustrative purposes only.

Crude oil, bitumen or natural gas initially-in-place volumes provided are discovered resources which include production, reserves, contingent resources and unrecoverable volumes.

Special Note Regarding non-GAAP Financial Measures

This document includes references to financial measures commonly used in the crude oil and natural gas industry, such as adjusted net earnings from operations, cash flow from operations, cash production costs and net asset value. These financial measures are not defined by International Financial Reporting Standards ("IFRS") and therefore are referred to as non-GAAP measures. The non-GAAP measures used by the Company may not be comparable to similar measures presented by other companies. The Company uses these non-GAAP measures to evaluate its performance. The non-GAAP measures should not be considered an alternative to or more meaningful than net earnings, as determined in accordance with IFRS, as an indication of the Company’s performance. The non-GAAP measures adjusted net earnings from operations and cash flow from operations are reconciled to net earnings, as determined in accordance with IFRS, in the “Financial Highlights” section of the Company’s MD&A. The derivation of cash production costs is included in the “Operating Highlights – Oil Sands Mining and Upgrading” section of the Company's MD&A. The Company also presents certain non-GAAP financial ratios and their derivation in the “Liquidity and Capital Resources” section of the Company’s MD&A.

Volumes shown are Company share before royalties unless otherwise stated.