



	Page
Background	4 – 5
Geology	7 – 33
Cap Rock	34 – 35
Subsurface Schematic	36
Artificial Lift	37
Instrumentation	38
Well Schematics	39 – 45
Operational Strategy	46–47
Kirby South Performance	48 – 77
Observation Well Results	78 – 80
Future Plans – Subsurface	81

#### **Outline – Surface**



	Page
Surface Facilities Overview	83 - 88
Kirby South Facility Performance	89 – 97
Measurement & Reporting	98 – 99
Future Plans – Surface	100
Kirby North Site Activities	101
Water Treatment Technology	101 – 103
Kirby South Water Usage	104 – 111
Kirby South Pressure Balancing Scheme	112 – 114
Kirby South Disposal	115
Kirby North Water Strategy	116
Kirby South Waste Disposal	117
Environmental Summary	118 – 122
Approvals	123 – 129
Compliance	130

# Background Location of Kirby Project





# Background Scheme Approval 11475N Project Area





**Recovery Process: Steam Assisted Gravity Drainage** (SAGD)

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Directive 54 Section 3.1.1 Subsurface Issues Related to Resource Evaluation and Recovery

# Geology Project Area SAGD Pay Isopach







	Average Pay Thickness (m)	Average Oil Saturation (%)	Average Porosity (%)	OBIP (e <sup>3</sup> m <sup>3</sup> )
Kirby Approved Project Area	14.8	78.4	32.7	275,864

- Volumetric calculation (for >10m contour):
  - Area above 10m of pay X Pay Thickness X Oil Sat. X Porosity

# Geology Stratigraphic Schematic





# Geology Kirby South Type Log





## Geology Kirby South Structural Cross-Section





Drainage Box 'D'

Drainage Box 'B'

Drainage Box 'E'

A 17

Drainage Box 'A'

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### Geology Kirby South Development Area





• Recovery Process: Steam Assisted Gravity Drainage (SAGD)

### Geology Kirby South SAGD Pay Isopach





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## Geology Kirby South Development Area Volumetrics



	Average Pay Thickness (m)	Average Oil Saturation (%)	Average Porosity (%)	OBIP (E³m3)
Kirby South Approved Development Area	19.7	76.3	33.2	55 <i>,</i> 000

- Volumetric calculation (for >10 m contour):
  - Area above 10 m of pay X Pay Thickness X Oil Sat. X Porosity

# Geology Kirby South Drainage Area Volumetrics



Drainage Area	Area (m²)	Oil Saturation (%)	Porosity (%)	Pay Thickness (m)	OBIP (E <sup>3</sup> m <sup>3</sup> )
А	600,017	67.9%	33.3%	28.9	3,920
В	669,345	75.4%	32.8%	23.45	3,880
С	629,989	78.3%	33.4%	25.36	4,180
D	792,398	79.5%	33.3%	26.27	5,510
E	502,828	75.5%	34.2%	23.08	3,000
F	462,018	77.6%	33.3%	21.03	2,510
G	654,516	82.9%	33.2%	25.17	4,530



	Initial Reservoir Pressure (kPa)	Initial Bottom Water Pressure (kPa)	Initial Reservoir Temperature (°C)	Average Depth of Reservoir, McMR SAGD Pay Top (mTVD)	Average Pay Thickness (m)	Average Porosity, Φ (%)
Kirby South Operating Area	~2600	~2550	10 to 15	530	21.9	33.2
Kirby Approved Project Area	~2600	~2550	12 to 13	490	14.8	32.7

	Average Oil Saturation (%)	Average Water Saturation (%)	Average Horizontal Permeability from OB plugs, Kh (mD)	Average Vertical Permeability from OB plugs, Kv (mD)	Kv/Kh Ratio
Kirby South Operating Area	74.8	25.2	6410	5260	0.82
Kirby Approved Project Area	78.4	21.6	6560	5510	0.84

### Geology Kirby South 2015 Special Core Analysis



• No additional Kirby South stratigraphic wells drilled in 2015

-No cores cut and no special core analysis performed

## Geology Kirby South SAGD Pay Top Structure





### Geology Kirby South SAGD Pay Base Structure





### Geology Kirby South Net Water Sand Isopach





# Geology Kirby North Type Log





### Geology Kirby North Structural Cross Section





# Geology Kirby North SAGD Pay Isopach





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# Geology Kirby North Development Area Volumetrics



	Average Pay Thickness (m)	Average Oil Saturation (%)	Average Porosity (%)	OBIP (e <sup>3</sup> m <sup>3</sup> )
Wabiskaw D Reservoir	15.6	77.5	32.8	43,691
McMurray Reservoir	18.2	80.0	32.3	78,237
Kirby North Approved Development Area				121,928

- Volumetric calculation (for >10m contour):
  - Area above 10m of pay **X** Pay Thickness **X** Oil Sat. **X** Porosity

# Geology Kirby North Drainage Area Volumetrics



Drainage Area	Area (m2)	Oil Saturation (%)	Porosity (%)	Pay Thickness (m)	OBIP (e <sup>3</sup> m <sup>3</sup> )
KN01	763,120	79.7	32.7	23.8	4,720
KN02	757,079	82.8	32.3	22.2	4,510
KN03	763,033	84.8	33.4	22.9	4,940
KN04	763,316	83.8	33.4	23	4,900
KN05	443,723	81.6	33.5	20.8	2,530

# Geology Kirby North Core Photos







• No additional Kirby North stratigraphic wells drilled in 2015

-No cores cut and no special core analysis performed

#### **Geology** Kirby North Wabiskaw D SAGD Pay Top Structure





DETDA 0/11/2014 11-17-01 AM

#### Geology Kirby North Wabiskaw D SAGD Pay Base Structure





DETDA 0/11/2014 1-50-50 DM

# Geology Kirby North McMurray SAGD Pay Top Structure





## Geology Kirby North McMurray SAGD Pay Base Structure





#### **Geology** Kirby North McMurray Net Bottom Water Isopach





# Geology Seismic Coverage





- 4D Seismic Acquired March 2015
- Processing Completed June 2015
- Quality of data is very good
- Currently calibrating 4D observations against engineering data
- Working towards defining extent of steam chamber development
- No final interpretation to date



# Cap Rock Isopach Map





- Cap Rock interval varies in thickness from 9-22 m over development areas
- 1AA/09-06-075-08W4 Mini-Frac location (2012)
- 100/13-20-073-07W4
  Mini-Frac location (2011)

# Cap Rock Mini Frac Results





#### **Subsurface Schematic**




# Artificial Lift Summary



- Majority of wells are equipped with ESPs.
- Currently there are 5 wells on rod pump and 44 wells on ESP.
  - Range of lift capacity
    - Rod Pump: 0-300m3/d
    - ESP: 150-1000m3/d
  - Operating Temperature
    - Less than 250°C for both rod pumps and ESPs
- Completion is continually being optimized as required
  - Steam splitters 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
  - Tubing deployed inflow and outflow control devices are presently deployed as follows:
    - Steam splitters (13 wells)
    - Scab liners (27 wells)



- 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)





## Well Schematics Injection Well (Single String)





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# Well Schematics Production Well





## Well Schematics Production Well (Scab Liner)





## **Completion Optimization**



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

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

# **Completion Optimization Example**



A5 producer scab liner installation resulted in immediate increased oil production.



# **Completion Optimization Example**



A5 producer has more uniform temperature distribution in lateral after scabliner installation. Reduction in heel temperature variation and encouraging toe development



## 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





#### Well Schematics 13-20 Hz Water Disposal Well



# Operational Strategy SAGD



- Inject steam down short and long string in injector
- 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 Performance Kirby South Drilling Activity Update





# Kirby South Performance Kirby South Drilling Activity Update



Well Name	Reason for Re-drilling	Re-drill Trajectory Relative to Original	
A2 RE Well Pair	<ul> <li>Performance Concerns</li> <li>Original injector encountered breccia and I.H.S. near wellbore</li> <li>Better quality reservoir, and production rates, expected above current position</li> </ul>	<ul> <li>A2P RE and A2I RE drilled 10m above original producer and injector elevations, respectively</li> <li>A2 RE well pair drilled 12m left of original A2 trajectory</li> </ul>	
A3 RE Well Pair	<ul> <li>Performance Concerns</li> <li>Original injector encountered breccia and I.H.S. near wellbore</li> <li>Better quality reservoir, and production rates, expected above current position</li> </ul>	<ul> <li>A3P RE and A3I RE drilled 10m above original producer and injector elevations, respectively</li> <li>A3 RE well pair drilled 12m left of original A3 trajectory</li> </ul>	
A4P RE	<ul> <li>Liner Failure</li> <li>Steam breakthrough resulted in the accumulation of solids in the production liner</li> </ul>	<ul> <li>A4P RE drilled 5m right of original A4P trajectory, and at the same elevation</li> </ul>	
B2I RE	<ul> <li>Liner Failure</li> <li>Steam breakthrough due to muddy injector facies resulted in the accumulation of solids in the production liner</li> <li>Better quality reservoir, and production rates, expected above current position</li> </ul>	<ul> <li>B2I RE drilled 5m directly above the original injector elevation Original B2I converted to producer</li> </ul>	

# Kirby South SAGD Well Spacing



Pad	Number of Well Pairs	Inter well Spacing (m)	
A	6	100	
В	7	100	
С	7	100	
D	8	80	
Е	6	80	
F	7	50	
G	8	80	

- 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



Pad	OBIP (E3m3)	Ult. Recovery (E3m3)	Cum Oil (E3m3)	RF
Α	3,920	2,352	152	4%
В	3,880	2,328	301	8%
С	4,180	2,508	361	9%
D	5,510	3,306	251	5%
E	3,000	1,800	365	12%
F	2,510	1,506	178	7%
G	4,530	2,718	202	5%
Total	27,530	16,518	1,809	7%

Recovery as of August 20, 2015

## **Kirby South Performance Kirby Field Production**





# Kirby South Performance Summary



- Reservoir performance is similar to expectations, currently optimizing well-pair conformance.
- Facility performance more steady than 2013-2014.
- Record oil production to date ~6000 m<sup>3</sup>/d
- 4 wells re-drilled due to liner failures (A4, B2, D3, D7, D8)
- 2 wells re-drilled due to performance concerns (A2, A3)
- All 49 wells, including re-drills, have been converted to SAGD operation as of July 2015

## Kirby South Performance 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: 4%

#### Kirby South Performance Pad A Production





## Kirby South Performance High Recovery Pad A Well Pair





## Kirby South Performance Low Recovery Pad A Well Pair





## Kirby South Performance Pad A Obs Well – 26 metres from A4





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#### Kirby South Performance Pad A Obs Well Pressures





#### A 9-21 - 104/09-21-073-07W4

BW pressure changes as pad pressures are increased / decreased

McMurray pressure beginning to be 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



- To date, Pad A has performed below reservoir expectations
- Re-drilled A2 and A3 Pairs as well as A4 producer
  - First well Spudded: January 27, 2015
  - Last well Rig Released: March 4, 2015
  - Circulated A2 and A3 Re-drill Pairs from April 2015 until July 2015
  - Circulated A4 from April 2015 until Mid-May 2015
- Re-drilled pairs are performing as expected.
- Evaluating the economic potential to re-drill A1 in 2016.
- A1, A4, A5, and A6 producers communicate with bottom water -Balance pressures with bottom water
  - -To date bottom water does not seem to be influencing performance

#### Kirby South Performance 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: 5%

#### Kirby South Performance Pad D Production





## Kirby South Performance High Recovery Pad D Well Pair





## Kirby South Performance Low Recovery Pad D Well Pair





# Kirby South Performance Horizontal Observation Well







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## Kirby South Performance Pad D Obs Well Pressures





#### Kirby South Performance Pad D Obs Well – 5 m From D2





#### Kirby South Performance Pad D Obs Well – 5.5 m From D2





# Kirby South Performance Pad D Key Learnings



- Reservoir performance is meeting expectations
- D3, D7, & D8 re-drills commenced circulation Oct 2014
- 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
- Scab liners have been installed on D1 & D2 to improve temperature conformance
- Evaluating the economics of re-drilling D5 in 2016 (suspect liner failure).
#### 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: 9%

#### Kirby South Performance Pad C Production





#### Kirby South Performance High Recovery Pad C Well Pair





#### Kirby South Performance Low Recovery Pad C Well Pair





#### Kirby South Performance Pad C Obs Well – 36 m From C2





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#### Kirby South Performance Pad C Obs Well – 27 m From C2





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# Kirby South Performance Pad C Key Learnings



- Reservoir performance is meeting expectations
- Producers communicate with transition zone
  - -To date no performance issues due to bottom water
  - -Balance pressures with bottom water

# 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
- There is some evidence that certain pads and wells have experienced slightly lower quality during start-up
  - -This is not expected to have an impact on recovery
- No other fluids are injected with the steam

# Kirby South Observation Well Results 100/10-28-073-07W4 – 4 m From G3





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# Kirby South Observation Well Results 100/10-21-073-07W4





- Seeing temperatures heat up in the Wabiskaw formation due to proximity to A5P build section (~5 m).
- Very localized and isolated temperature increase.

# Kirby South Observation Well Results Overall Performance



- 103/10-20-073-07W4/00 Hz Obs Well
  - Data was not being transmitted to surface. Pulled gauges, repaired and re-ran. All problems resolved.
- 102/10-20-073-07W4/00 Obs Well
  - Suspicious thermocouple readings. Blew well dry, and re-ran string. All problems resolved.
- 100/03-29-073-07W4/00 Obs Well
  - Perforated McMurray bottom water and re-ran thermocouple string with pressure gauge.
- 102/12-20-073-07W4/00 Obs Well
  - Perforated McMurray bottom water and re-ran thermocouple string with pressure gauge.
- 100/15-28-073-08W4/00 New water observation well
- Potential repairs for next winter season
  - 102/12-20-073-07W4/00 Pressure data not transmitting
  - 100/09-28-073-07W4/00 Pressure and temperature data appears erroneous
  - 100/10-28-073-07W4/00 1 TC is showing a cooling effect.
- Annual preventative maintenance program for all observation wells.

# Kirby South Observation Well Results Overall Performance



#### • 1AB/11-20-073-07W4/00 OB1C

Well is cased to 498.0 mKB and has an estimated cement top within the casing of 475.0 mKB. A 10 point thermocouple string is landed from 446.0 – 473.0 mKB across the Clearwater cap rock. There are no plans to enter this well.

#### • 100/06-21-073-07W4/00

– In March 2014, the thermocouple string was pulled and the McMurray bottom water was perforated because the external pressure gauge was not providing accurate data. An internal pressure gauge was run and the thermocouple string was **not** re-run. There are no plans to enter this well.

# Future Plans – Subsurface Summary



- Continue to optimize SAGD pairs
- Pending favorable economic conditions, the following future plans are contemplated:
  - -Potentially re-drill D5 (failed producer liner) and A1 (performance).
  - F pad: drill remaining approved wells (F8, F9, F10)
  - Scheme Amendment applications (H & I Pads Section 23)
- Kirby North Development
  - Received scheme approval for revised pads KN01-KN05 in Nov, 2014.
  - 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.



Directive 54 Section 3.1.2 Surface Operations, Compliance and Issues Not Related to Resource Evaluation and Recovery

#### Surface Facilities Overview Plot Plans

Canadian Natural

- 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
  - -Kirby North Central Plant Plot Plan
    - Dwg No. KNP-100-210-0001 R1
- Simplified Schematic:
  - -Kirby In-Situ Oil Sands Project Simplified Schematic

# Surface Facilities Overview Kirby South SAGD Production Pad Plot Plan



Canadian Natural

#### Surface Facilities Overview Kirby South Central Plant Plot Plan





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### Surface Facilities Overview Kirby North Central Plant Plot Plan





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#### Surface Facilities Overview Kirby Simplified Schematic





## Surface Facilities Overview Kirby South Modifications



- Summary of Modifications since August 2014
  - Slop oil recycle re-integration (enhanced integration to process train)
  - Piping modifications in the Evaporators to facilitate cleaning and vessel draining
  - Disposal fluid treatment upgrade and anti-scale addition
  - Boiler floor refractory installation/optimization and burner tuning
  - Metering changes made to improve measurement of utility gas injection
  - New maintenance office building completion

# Kirby South Facility Performance Oil Treating/Produced Water De-oiling Area



- Overall water quality and oil treating targets have been generally met
  - Experienced some treating challenges due to higher rates and below par skim tank performance
  - Continued dealing with periodic oil treating upsets during the ramp up phase as production rates hit new highs
    - Continued optimizations to the chemical treating program, vessel operation, and instrumentation have been made to resolve the issues
    - Plans in place to remove issues as rates increase to full design
  - Several PW de-oiling upsets have led to short-term restrictions for evaporator cleaning and protection
    - Several changes to operating parameters and chemical treating program have been made to resolve the issues
    - Plans in place to continue optimizing/removing issues as rates increase to full capacity
  - Challenges in keeping up with slop generation
    - Improvements made to slop handling flexibility (recycle, trucking)

# Kirby South Facility Performance Water Treatment Area



- In general good performance in the evaporators meeting design expectations
- Water upsets have affected evaporator performance periodically due to excess oil being sent to the evaporators. This has affected steam availability
  - Oil-in-water excursion response protocol updated based on operating data
  - Chemical / Mechanical cleaning procedures in place and optimized to address the issue and quickly restore evaporator capacity after an upset
  - Plans in place to further streamline upset response and cleaning procedures

# 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 fully meeting 2015 steam demand
    - Tubes were replaced and refractory was installed on the furnace floor in all boilers to eliminate future failures
    - Burners were tuned to shift heat away from furnace
    - Since its installation, refractory has been modified and burners re-tuned
  - Plans in place to further optimize the solution based on inspection/performance of the repaired / upgraded boilers to meet increasing well steam demand into 2016

# Kirby South Facility Performance Salt Caverns



- Salt caverns continue to manage evaporator blowdown solids
- Some optimization ongoing to cavern return filtration
- 2015 Sonar Logging
  - Cavern 1 complete
  - Cavern 2 scheduled for this fall
- Both salt caverns have passed their MIT
  - -MIT will be performed on a five year cycle.

# Kirby South Facility Performance Power Consumption



• Power Consumption on a monthly basis

Month	Total Power Consumption (kWh)			
Sep -14	12,800,171			
Oct -14	12,593,742			
Nov -14	13,601,048			
Dec -14	13,974,570			
Jan -15	14,705,705			
Feb -15	14,835,522			
Mar -15	13,350,334			
Apr -15	14,247,749			
May -15	14,388,195			
Jun -15	14,076,847			
Jul -15	14,401,652			
Aug-15	15,823,554			

# Kirby South Facility Performance Gas Usage



• Gas Usage on a monthly basis

Month	Total Purchased Gas e3m3	Total Gas Produced e3m3	Total Gas Vented e3m3	Total Solution Gas to Flare e3m3	Solution Gas Recovered %
Sep -14	15,385	279	-	0	100.0
Oct -14	18,725	296	-	0	100.0
Nov -14	20,052	380	-	2	99.6
Dec -14	20,536	307	-	0.3	99.9
Jan -15	21,467	252	-	7.1	97.0
Feb -15	19,201	313	-	17.1	95.0
Mar -15	20,284	216	-	1.2	99.0
Apr -15	21,218	357	-	0	100.0
May -15	20,044	549	-	0.6	99.9
Jun -15	21,477	233	-	13.3	94.3
Jul -15	23,213	700	-	7.6	98.9
Aug-15	21,639	1,004	-	0	100

# 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 0.9 t/d
  - No plans for sulphur recovery installation at this time, as Canadian Natural anticipates sulphur emissions to be less than 1 t/d sulphur
  - Contingency plan is to reduce production if the sulphur emission rate approaches the EPEA or D56 limit

#### Kirby South Facility Performance Sulphur Emissions





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# Kirby South Facility Performance Ambient Air Quality Results



 During the monitoring periods, there were no ambient SO2, H2S or NO2 readings above the Alberta Ambient Air Quality Objective (AAAQO).

## Measurement and Reporting Summary



- MARP approved in October 2011 and last updated in February 2015
  - Most were minor changes (typos on drawings, inconsistencies between information on the drawings and measurement list)
  - A couple of meters added on flare system and incorporation of a few sample points
- 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 our operating experience, wells are currently being tested for a period of anywhere between 1 to 6 hours/day, each depending on their unique conditions and maturity

#### Measurement and Reporting KS Battery & Injection Reporting Codes



#### 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)
- Some spikes and fall offs caused due to shutdowns and/or very low rates
- Continuing to improve calibration techniques to further improve profacs



# Future Plans – Surface Kirby South Planned 2015 – 2016 Activities



- Central Plant
  - Optimize the Oil train process and improve overall de-oiling performance, including
    - New ISF installation in series with existing ISF vessel
      - Un-satisfactory skim tank performance
      - ISF technology has worked well for our Bitumen-Water mixture separation
    - Diluent to bitumen optimization (continuous improvement)
    - Separation chemical testing to optimize rates and location (continuous improvement).
  - Slop oil recycle modifications
  - Evaporator performance optimization by modification to vapor washer spray reducing carryover fluids into the vapor washer
  - Boiler 1, 3, 4, 5 floor refractory installation/optimization and burner tuning
  - Piping additions/modifications to accommodate potential new disposal well
- Pads
  - Piping modifications on F-pad step outs (pending budget approval)
  - Piping modifications on two well re-drills (pending budget approval)

## 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.

# Water Treatment Technology Summary



- 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
### Water Treatment Technology Schematic



#### Mechanical Vapor Compression Evaporator:



# Kirby South Produced and Make-up Water Usage







# Kirby South Produced and Make-up Water Usage



Month	Non-saline Volume	Saline Volume	Non Saline Make-Up Percentage	Injection	Produced	PWR
	m <sup>3</sup>	m <sup>3</sup>	%	m³	m <sup>3</sup>	%
Sep-14	14,986	36,679	29	21,526	214,046	90
Oct-14	6,843	26,655	20	21,826	279,968	92
Nov-14	11,637	31,536	27	18,971	298,406	94
Dec-14	6,649	34,548	16	20,525	297,629	93
Jan-15	6,064	34,933	15	22,820	316,655	93
Feb-15	14,436	24,111	37	17,108	283,221	94
Mar-15	22,671	19,118	54	19,453	306,218	94
Apr-15	15,991	20,785	43	20,910	340,453	94
May-15	15,193	28,556	35	22,375	327,370	93
Jun-15	25,746	27,016	49	18,818	327,117	94
Jul-15	17,030	15,956	52	24,194	418,640	94
Aug-15	17,025	23,281	42	30,001	403,345	93
2014-2015 Totals	174,272	323,175	35	258,527	3,813,068	93

- Water Act Diversion License renewed in August, 2015
- Non-saline volumes declined and saline volumes increased vs 2013-2014
- Directive 81 Disposal Limit = 12%, Actual Disposal = 6% for 2014-2015
- Also used a total of 45837 m3 of non-saline/potable water to supply camps and office complex during first year of operations

#### **Kirby South Source and Disposal Well Map**







Well Name	Use	Unique Well Identifier	
McMurray Source Wells			
CNRL WSW01 Kirby 14-30-73-7	Make-up Source (not used)	1F1/14-30-73-7W4M	
CNRL WSW MC01 Kirby 10-33-73-8	Make-up Source	1F1/10-33-73-8 W4M	
CNRL WSW MC02 Kirby 10-33-73-8	Make-up Source	1F2/10-33-73-8 W4M	
McMurray Off-Lease Saline Source Evaluation Well			
CNRL WSW MC03 Kirby 11-13-73-6	Make-up Source	1F1/11-13-73-06W4M	
Grand Rapids Source Well			
CNRL WSW GR01 Kirby 13-21-73-7	Make-up Source	1F3/13-21-073-07W4M	



Well Name	Use	Unique Well Identifier	
GRAND RAPIDS Formation			
Grand Rapids Source Wells			
CNRL WSW02 Kirby 14-30-73-7	Make-up Source	1F2/14-30-73-8W4M	
EMPRESS Formation Source Wells			
CNRL WSW Kirby 13-21-73-7	Utility Source	1F2/13-21-73-07W4M	
CNRL WSW EMP03 12-21-73-7	Utility Source	1F1/12-21-73-07W4M	
MURIEL LAKE Formation - Source Wells			
CNRL WSW ML03 Kirby 13-21-73-7	Domestic Source	1F4/13-21-73-7W4M	
ETHEL LAKE Formation - Source and Standby Wells			
CNRL WSW EL01 Kirby 16-29-73-7	Domestic Source	1F1/16-29-73-7W4M	
CNRL WSW EL02 Kirby 15-29-73-7	Domestic Source	No UWI No license required	



Well Name	Use	Unique Well Identifier	
McMurray Disposal Wells			
RAX Kirby 9-34-73-8	Disposal (not currently used)	00/09-34-073-08W4M	
CNRL WDW01 Kirby 8-17-74-8	Disposal	00/08-17-074-08W4M	
CNRL WDW02 Kirby 10-17-74-8	Disposal	02/10-17-074-08W4M	
CNRL WDW03 Kirby 15-17-74-8	Disposal	00/15-17-074-08W4M	
CNRL WDW HZ MCM05 Kirby 13-20-73-8	Disposal	00/13-20-073-08W4M	
Salt Cavern Wells			
CNRL CAVERN VERT KIRBY 13-21-73-7	Lotsburg	00/13-21-073-07W4M	
CNRL CAVERN DD KIRBY 4-28-73-7	Prairie Evaporate	02/04-28-073-07W4M	

#### 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



### 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**

![](_page_118_Picture_1.jpeg)

#### Disposal issues

- Seeing decreasing injectivity over time.
  - Plugging
  - Oil Carryover
  - Scale buildup in pipelines
- Operating close to MWHIP
- -Acid stimulations showing diminishing returns.
- Potential future work
  - Hydraulic fracture Stimulation
  - Evaluating need for additional disposal well
  - Upgrade filter system at the plant

# **Kirby North Source and Disposal Strategy**

 $\otimes$ 

Cavern Well

**Empress WSW** 

Clearwater WSW

#### Water Sources and Wastewater Disposal

•Salt caverns to treat water and drop out particulates in the Prairie Evaporite and the Lotsburg Formation

•McMurray Formation Basal Aquifer – Primary Wastewater Disposal Zone

-Pressure balanced with source wells, water used for cavern wash and make-up

Used learnings from Kirby South to locate wells

•Clearwater Formation B Aquifer -Saline water source

-Cavern wash and make-up water

•Empress Formation Terrace Aquifer -Non-Saline water source

-Cavern wash, peak make-up, and utility

McMurray WSW

McMurray WDW

![](_page_119_Figure_14.jpeg)

![](_page_119_Picture_15.jpeg)

## Kirby South Waste Disposal Summary

![](_page_120_Picture_1.jpeg)

Beaver Regional Municipal Landfill	4,745 kg debris	Recycle Systems	21.6 kg gas
Blue Plant Recycling	3,713 kg plastic	Secure Pembina Landfill	13.6 kg solids/flammable liquid
Clean Harbors Ryley Landfill	56,991 kg leachable solids	Sunset Recycle & Sales Ltd.	26,660 kg metal
Custom Environmental	146.2 kg aerosols	Tervita Janvier Landfill	91,690 kg soils & debris
General Scrap Edmonton	2,366 kg scrap metal	Van Brabant Oil	1,900 kg oil/glycol
GFL Edmonton Oil	12,000 kg leachable oil	Wood Buffalo Landfill	96,030 kg domestic waste
MCL Waste Systems Environmental	15,870 kg solids		

![](_page_121_Picture_1.jpeg)

- 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 black bear, Canada lynx, coyote, fisher, grey wolf, moose, muskrat, red fox, red squirrel, river otter, snowshoe hare, whitetailed deer, woodland caribou
  - Marsh bird survey conducted
    - 43 species heard or observed, including Western toad and common nighthawk. No occurrences of yellow rail.
  - Comprehensive report to be completed in 2017
  - Updated Wildlife Mitigation Plan and Monitoring Program submitted December 2014.

![](_page_122_Picture_1.jpeg)

- Wetland and Waterbody Monitoring Program
  - Culvert inspection program identified corrective action required on culverts.
  - Overall, effects on wetlands are due to culvert functionality. Mitigation measures implemented on culverts.
  - Surface water withdrawal monitoring yielded changes in water elevation at one site. Further monitoring required to investigate causal factors.
  - Water quality monitoring yielded no substantial changes from previous reporting period.
  - Updated Wetland and Waterbody Monitoring Program submitted December 2014 and February 2015

![](_page_123_Picture_1.jpeg)

- Groundwater Monitoring Program
  - Well pad monitoring program to monitor potential effect of steam injection on mineral solubility and mobilization of trace elements
    - I monitoring well on each Pad B, Pad D, Pad F
    - No impacts to groundwater quality identified
  - Central Plant monitoring program monitors groundwater conditions within shallow sediments
    - 20 groundwater monitoring wells at CPF
    - Groundwater elevations in two wells increased from dry, likely due to seasonal variability with slow recharge in winter months
  - Groundwater chemistry monitoring: Parameters that were identified above comparative guidelines were not considered impacts to the groundwater quality as the parameters were most likely naturally occurring.
  - Updated Groundwater Monitoring Program approved July 2015.

![](_page_124_Picture_1.jpeg)

- Air Monitoring
  - Source Monitoring
    - Two manual stack surveys reported with RATAs in 2014
    - CEMS at steam generator measures SO2 and NO2
    - Two cylinder gas audits conducted in 2014
      - Results show CEMS code is met
    - Increase in SO2 emissions consistent with increase in production
  - -Ambient Air Monitoring
    - Continuous ambient air monitoring station located 0.7 km from plant site
      - No significant air quality issues related to 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

#### **Environmental Summary Reclamation Activities**

![](_page_125_Picture_1.jpeg)

- Reclamation Activities
  - Four borrow areas have been revegetated
  - Two borrow areas have reclamation soils placed
  - -28.8 ha undergoing land reclamation
- Reclamation Monitoring
  - Objectives are to ensure:
    - Iand is reclaimed to an equivalent land capability
    - appropriate replacement of all salvaged topsoil on recontoured 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
  - Updated reclamation monitoring program proposal due June 2016.

### Environmental Summary Provincial/Federal Programs

![](_page_126_Picture_1.jpeg)

- Canadian Oil Sands Innovation Alliance (COSIA)
- 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. Technical information and site access provided as necessary.
- Provincial and Federal Woodland Caribou Policies
  - Participating in the implementation of habitat restoration work on Canadian Natural project lands as part of the Regional Industry Caribou Collaboration
  - Participating in the upcoming GOA process to develop and implement range-level restoration plans
- Base Level Industrial Emissions Requirements (BLIERs)
  - Providing feedback through CAPP on Multi-sector Air Pollutants Regulations (MSAPR) which includes BLIERs for Reciprocating Engines and Boilers & Heaters

#### Approvals Commercial Oil Sands Scheme

![](_page_127_Picture_1.jpeg)

Commercial Oil Sands Scheme			
11475	September 2010	Commercial Oil Sands Scheme Approval	
11475A	November 2010	Revise initial development Pads A to G	
11475B	November 2011	Change inter-well spacing Drainage Area D	
11475C	December 2011	Change inter-well spacing in Drainage Area B	
11475D	May 2012	Change inter-well spacing in Drainage Area E	
11475E	June 2012	Evaluation of on-lease McMurray brackish water	
11475F	August 2012	Change inter-well spacing in Drainage Area G	
11475G	September 2012	Change inter-well spacing in Drainage Area F Addition to Drainage Area D	
11475H	April 2013	Evaluation of off-lease Clearwater brackish water	

#### Approvals Commercial Oil Sands Scheme

![](_page_128_Picture_1.jpeg)

Commercial Oil Sands Scheme			
114751	January 2014	Operational Strategy amendment	
11475J	March 2014	Trajectory and lateral length modifications in Drainage Area G	
11475K	May 2014	Approval of Kirby In Situ Oil Sands Expansion Project	
11475L	November 2014	Revise initial Kirby North development Pads KN01-KN05	
11475M	December 2014	Redrill well pairs A1, A2, A3	
11475N	May 2015	Additional Kirby South and Kirby North disposal wells	
		In Compliance	

## Approvals Disposal

![](_page_129_Picture_1.jpeg)

		Class 1b Cavern Disposal
11716	November 2011	Cavern Solution Mining
11716A	July 2013	<ul> <li>Class 1b Cavern Disposal</li> <li>Prairie Evaporites formation through well 00/13-21-073- 07W4</li> <li>Lotsberg formation through well 00/04-28-073-07W4</li> </ul>
11716B	June 2015	Modify testing requirements. Approval modified to reference CSA Z341.4
In Compliance		

# Approvals Disposal

![](_page_130_Picture_1.jpeg)

		Class Ib Disposal	
11761	December 2011	Class Ib Disposal • 00/08-17-74-08W4 • 02/10-17-74-08W4 • 00/15-17-74-08W4	
11761A	April 2013	Modify pH requirements	
11761B	March 2014	Amend MWHIP	
11761C	May 2015	Additional Kirby South disposal well • 100/13-21-73-08W4 Additional Kirby North disposal well • 02/08-22-74-10W4	
		In Compliance	

### Approvals Disposal (continued)

![](_page_131_Picture_1.jpeg)

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

#### Approvals Facility License

![](_page_132_Picture_1.jpeg)

Facility License			
F42290	October 2010	Kirby South Phase 1 Central Processing Facility	
F42290 amended	July 2013	Amended for KS1 CPF to reflect stream day rates and number of compressors and pumps	
F44051	July 2014	Kirby North Phase 1 Central Processing Facility	
In Compliance			

#### Approvals EPEA and Water Act

![](_page_133_Picture_1.jpeg)

Environmental Protection and Enhancement Act			
237382-00-00	April 2011	Approval of Kirby In Situ Oil Sands Project	
237382-00-01	July 2014	Approval of Kirby In Situ Oil Sands Expansion Project	
237382-00-02	February 2015	Amend Kirby South steam generator NOx limit to include efficiency credit	
		Water Act	
00334375-00-00 (Kirby South)	August 2013	Groundwater diversion license, Empress Unit 1 and Grand Rapids Formation	
00337375-01-00 (Kirby South)	August 2015	Renewal of Groundwater diversion license	
00288494-00-00 (Kirby South)	April 2011	Groundwater diversion license, Ethel Lake Formation	
00327156-00-00 (Kirby South)	August 2013	Industrial surface runoff diversion license	
00303825-00-00 (Kirby North)	July 2014	Preliminary Certificate groundwater diversion, Empress Terrace Formation	
00303820-00-00 (Kirby North)	September 2014	Industrial surface runoff diversion license	
		In Compliance	

## Compliance Summary

![](_page_134_Picture_1.jpeg)

- Reportable Spills
  - 5 reportable spills: 2 produced water, 1 acid + produced water, 2 fresh water. All sites remediated.
- EPEA Contraventions
  - -CEMS malfunction, less than 90% total run time December 2014 and April 2015
  - Exceedances of NOx emission limit of 16.4 kg/hr between Dec 19 25, 2014
    - I exceedance of 17.5 kg/hr NOx
  - NOx emission limit was corrected to 17.5 kg/hr to account for allowable efficiency credit.
- Scheme Approval
  - Lapse in data acquisition at groundwater monitoring well 100/04-30-74-8W4, March 2015.
- Water Act
  - Pressure data logger breakdown Bonnyville OBS2006-02 at 13-21-73-7W4.
  - Missed groundwater chemistry sample at 1F1/12-21-73-7W4.
- All compliance items reported to ESRD/AEP/AER as required.

#### **Forward Looking Statements**

![](_page_135_Picture_1.jpeg)

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 can be identified by the words "believe", "anticipate", "expect", "plan", "estimate", "target", "continue", "could", "intend", "may", "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 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, Primirose thermal projects, Pelican Lake water and polymer flood project, the Kirby Thermal Oil Sands Project, 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 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 time horizons. These statements as there can be used throughout the year statements as there can be assured to construction on the proposed Keystone XL Pipeline formation is based on annual budgets and multi-year forecasts, and is reviewed and revised throughout the year as necessary in the context of targeted fi

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 of the Company is products; volatility of and assumptions regarding crude oil and natural gas prices, fluctuations in currency and interest rates; assumptions on which the Company's products; volatility of and assumptions are development activities; impact of competitors, the Company's defenses; political uncertainty, including actions of or against terrorists, insurgent groups or other conflict including conflict between states; industry capacity; ability of the Company to implement its business trategy, including exploration and development activities; impact of competition of the mining, extracting or upgrading of the Company's betmens products; volatility of the Company to attract the necessary labour required to build there and oil sands mining projects; operating hazards and of dif difficulties inherent in the exploration of and development activities and the company; bitumen products; availability and cost of financing; the Company's and its subsidiaries and evelopment activities and the ability to replace and expand crude oil and natural gas and no mining, extracting or upgrading the difficulties inherent in the develoration and alvelopment activities and the ability to replace and expand crude oil and natural gas eveloration and development activities and replace and expand crude oil and the exploration for and products or instance. The business of exploration and development activities and the elements of recoverable quantities inderent in the econtrol addities of crude oil and natural gas and no mini

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, or the foregoing factors affecting this information, should circumstances or Management's estimates or opinions change.

#### **Reporting Disclosures**

![](_page_136_Picture_1.jpeg)

#### 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.

![](_page_137_Picture_0.jpeg)