Thermal In-Situ Scheme Progress Report for 2014
Japan Canada Oil Sands Limited Hangingstone

Approval Nos. 8788 (Demo) & 11910 (Expansion Project)

Presented on February 17, 2015
1. Background - Hangingstone
   - Demonstration
   - Expansion

2. Subsurface
   - Geosciences
   - Well Design & Instrumentation
   - Reservoir Performance

3. Surface Operations
   - Facility Design
   - Facility Performance
   - Measurement & Reporting
   - Water:
     - Source
     - Disposal
   - Other wastes
   - Sulphur emissions
   - Environmental (included but not presented)
   - Compliance Statement & Approvals
   - Future Plans

4. Discussion
Demo Scheme No. 8788 Background

**Plant 1**
- On original PCEJ CSS Site
- Startup 1999 – 2,000 bbl/day (320 m3/day)

**Plant 2**
- Phase 2 Facility, startup 2000 - 4,000 bbl/day (640 m3/day)
- Phase 3 Facility, startup in 2002 - 4,000 bbl/day (640 m3/day)

- Project located 50 km south of Fort McMurray
- Approved demonstration project area: 3.75 sections
- Approved production capacity: 11,000 bbl/day (1,760 m3/day)

**Wells & Pads**
- Pad 1: A,B (startup 1999)
- Pad 2: C,D,E (startup 2000)
- Pad 3: F,H,I (startup 2002) (F well pair abandoned in Aug 2014)
- Pad 5: T (startup 2007); R,S (2008); U startup Nov 2010; V&W drilled in 2011; (W started circulation in May 2013 and put on SAGD in August 2013)
- Pad 6: X started in May 2010 (ESP started in Dec); Y started circulation Nov/11 (Y well ESP started in Feb 2013)
- Scheme Approval: 11910 – Nov/12
- EPEA Approval: 153105 – Jan/13
- Approved Capacity – 30k bpd
- Drilling progress YE 2014 – Drilling complete on all six (Phase 1) Well Pads, ahead of schedule
- Service rig started completions work in Jun/14
- Early civil works completed in 2014
- Mechanical construction of Field Facilities started Feb/14 & CPF in Aug/14
- Mechanical completion expected Q2 2016
Subsurface
Geosciences
No New Geological Activity in 2014

30% φ
85% So
No material fluid complications
Hangingstone Demo Top Reservoir Structure
Hangingstone Demo Composite Well
Hangingstone Expansion Project Cross-Section
Hangingstone Expansion Net Pay

420 MMbbl OBIP
34% $\Phi$
77% $So$
No material fluid complications
Hangingstone Expansion
Base Reservoir Structure
No aquifers are identified in the McMurray Formation at the B1 Depletion Area.
Hangingstone Expansion
Composite Well
BE-North Area

DEPLETION AREA BE-N
1AA/04-24-84-11W4M

Wabiskaw Member
Wabiskaw Sand
MCMURRAY FM
Nonreservoir Interval
McM Ch
SAGD Reservoir Interval
WATERWAYS FM

No aquifers are identified in the McMurray Formation at the BE-North Depletion Area.
Hangingstone Expansion
Reservoir & Aquifer Monitoring

INSTRUMENTATION

- McMurray Bitumen Reservoir - T
- Upper Grand Rapids Sand - P,T
- Lower Grand Rapids Sand - P,T
- Clearwater SS - P,T
- Upper McMurray Sand - P,T
- McMurray Bitumen Reservoir - T
- Lower Grand Rapids Sand - P,T
- Clearwater SS - P,T
- McMurray Bitumen Reservoir - T

T - Thermocouple String
P,T - Piezometer

27 Well Pairs Drilled
2014 - Q1 2015
Hangingstone Expansion
Phase 1 Well Layout
Hangingstone Expansion
Phase 1 Net Pay
Hangingstone Expansion
Phase 1 Base Reservoir Structure
Hangstone Expansion
Phase 1 Scheme Cross-Section (2)
Hangingstone Expansion
Future Drilling Plans

Phase 2 Horizontal Well Pairs
Appraisal
Cap Rock Integrity

• No change in conclusions - continue to observe no cap rock integrity issues through 2014

• Initial determination of injection pressures was based on mini-fract tests in 1980s

• 2010 Mini-frac test for Hangingstone Expansion (HE) Project Cap Rock Integrity Study shows consistent results

• HE Project Cap Rock Study concluded 5 MPa to be a safe operating pressure (80% of fracture pressure)

• Ongoing sand production in some wells, but manageable through:
  – Stable operation
  – Higher subcool

• Bottom pressure is regularly measured by purging the annulus with gas;

<table>
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<th>Vert. stress</th>
<th>Stress regime</th>
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<td></td>
<td>MPa</td>
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<td>McM Sands</td>
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<td>CWTR shale</td>
<td>272.0</td>
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</table>
Network of 54 monuments

Maximum heave in 2013-2014: 40.0 mm

Cumulative Heave 1999-2014 363 mm
Max Slope: 0.072%

- Modeling predicted max heave of 400mm over 10 years with max slope of 0.12%
  - within structural design tolerances for surface facilities
- Measured heave thus far within predictions
- No concerns observed
Well Design and Instrumentation
SAGD Well Layout

- 24 active well pairs
  - “oldest” wells A/B, started up in July 1999
  - “youngest” wells V and W, started up in July 2012 and May 2013 respectively
- F-Well abandoned 2014
## SAGD Well Completions

**Approval Nos. 8788K (Demonstration)**

### Typical Injector
- 406 mm (16”) Conductor Casing
- 245 mm (9 5/8”) Intermediate Casing
- 177.8 mm (7”) Tie-Back Casing
- 177.8 mm (7”) Liner w/ Screens
- 114.3 mm (4 1/2”) Tubing

### Typical Producer
- 406 mm (16”) Conductor Casing
- 245 mm (9 5/8”) Intermediate Casing
- 177.8 mm (7”) Tie-Back Casing
- 177.8 mm (7”) Liner w/ Screens
- 114.3 mm (4 1/2”) Tubing

### Well Completions Table

<table>
<thead>
<tr>
<th>Wellpair</th>
<th>Tie-Back</th>
<th>Liner Size</th>
<th>Screen Type</th>
<th>4-1/2” Tubing</th>
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<td>I/P</td>
<td>I/P</td>
</tr>
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<td>J</td>
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<td>K</td>
<td>No</td>
<td>I/P</td>
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<td>I</td>
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<td>V</td>
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<td>P</td>
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<tr>
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<td>Z</td>
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<td>P</td>
<td>SCVF- 7” Cement to Surface</td>
<td>I/P</td>
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</tbody>
</table>

**Legend**
- I = Injector Well
- P = Producer Well

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*N/C from 2013 PR*
HE SAGD Well Completion Approval No. 11910

(Revised)
SAGD Well Completions

• 1999-2004 MeshRite/wire wrap – Limited technology available for “SAGD” applications
  – Isolated cases of sand production

• 2005-2010 Slotted Liner – Commercial emergence of technology, lower cost alternative
  – Good sand control
  – High pressure drops

• Hangingstone Expansion design – Straight cut slots on injectors / MeshRite and wire wrap on producers
  – Decision based on
    • Operating experience at DEMO operations
    • Thorough testing program and strength evaluations
    • Cost analysis
SAGD Well Completions – HZVP Liner Failure / Workover

- SAGD start-up in July 2012
- Liner failure (sand production / plugged well off) June 2013
- Well workover Aug – Oct 2013
- Installed one 7” casing patch, issues with casing patch setting tool
- Installed scab liner w/ 0.005” Wire-Wrapped-Screen
- Restarted SAGD in June 2014
  - Replaced instrumentation coil - mechanical failure
  - Fluid recovery of calcium chloride/nitrate heavy brine solution before commingling with produced fluid returns to CPF
  - Well running at conservative rates, BS&W sampling show intermittent traces of solids, and bitumen slowly increasing
SAGD Well Completions – Demo Workover Challenges

Contributing factors which resulted in “challenging” workovers

• JACOS DEMO operates at high injection pressures (≈4500kPa) resulting in downhole pressures higher than hydrostatic head

• Failed wells are in communication with adjacent wells making it difficult/impossible to de-pressure the reservoir

• Specialized brine (up to 1.6 density) is required to weight-up the column to preform workovers
  • Well control is difficult due to fluctuating downhole pressures; wells take kill fluids
  • Brine kill fluid returns have negative effect on plant water treatment systems; well produced fluid is trucked out until hardness/chlorides are at acceptable levels
Artificial Lift - Approval Nos. 8788K (Demonstration)

HZXP/HZYP ESP trial was initiated to test downhole pumps.

The location of the wells was chosen due to the fact the wells are relatively isolated from the adjacent high pressure wells. The adjacent well (W) was the last well to be brought on stream.

Eventually when X/Y steam chamber coalesces with W-Well, X/Y will be converted to “natural lift” SAGD wells.
Artificial Lift - Approval Nos. 8788K (Demonstration)

HZXP – Schlumberger Hotline 550 (218°C)
1st ESP pump installed Dec/10 – April/12 (Run Time 487D, Surface Connector Failure).
2nd ESP system installed May/12- June/13 (Run Time 381D, Surface Connector / Electrical Cable Failure).
3rd ESP pump installed July/13
  Operating Temperatures up to 210°C
  Intake Pump Pressure – 2000-2800kPa
  Production rate - 160-320 m³/D
  ISOR ≈ 2.5

HZYP – Schlumberger Hotline SA3 (250°C)
Pump installed Jan/13, online Feb/13
  Operating Temperatures up to 175°C
  Intake Pump Pressure – 2000-2800kPa
  Production rate - 100-150m³/D (Reduced rates due to high ΔP, temperature spikes)
  ISOR ≈ 4.3
Demo Thermocouple Placement

In this diagram, we see the placement of thermocouples in different wells. The diagram indicates which wells have thermocouples and which do not. The wells are labeled from A to J, and each well is shown with added details such as Injector and Producer sections. The diagram highlights the areas where thermocouples are placed, and it is noted that some wells do not have any thermocouples installed.

The diagram is marked with "N/C from 2013PR," indicating that the data from the year 2013 has been reflected in the current document. The diagram is a useful tool for understanding the configuration of wells with respect to thermocouple placement.
Instrumentation HZXP (ESP) - Approval Nos.
8788K (Demonstration)

HZXI – 6 Thermocouples
HZXP – 40 Point LX-Data Temperature, LX-Data Pressure
ESP – Single Point LX-Data Temperature, LX-Data Pressure
Reservoir Performance
Reservoir Performance Summary

• Currently producing 24 SAGD well pairs

• 2014 average bitumen rate ~ 5,734 bbl/day (912 m³/day)

• Cumulative bitumen produced from project startup to 12/31/2014 ~ 32.7 million bbl (5.2 million m³)

• Cumulative SOR to 12/31/2014 ~ 3.71

• OBIP for the developed area is 78 million bbl (12.6 million m³)

• Recoverable bitumen is estimated at 48 million bbl (7.6 million m³) (61% Ultimate Recovery)
Steam Injection (Temperature, Pressure, Quality)

<table>
<thead>
<tr>
<th>WELL</th>
<th>PRESSURES (kPa)</th>
<th>TEMPERATURES (°C)</th>
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<td>A-WELL</td>
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<td>259</td>
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<tr>
<td>B-WELL</td>
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<td>L-WELL</td>
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<tr>
<td>Z-WELL</td>
<td>4788</td>
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</table>

100% Steam Quality* @:
HZA, HZB, HZC, HZD, HZE
Average Steam quality for the remaining wells ~ 97%

* Steam Traps @ Phase 1&2 Wellheads
• Generic Production Curve Method for bitumen production
  – SAGD well life consists of build up period, plateau period and decline period.
  – Plateau rate is calculated as a function of effective net thickness.
Production Period (Years)

Bitumen Rate

Buildup Period

Plateau Period

End of Plateau Period
$= \frac{1}{2}$ of Reserves Recovered

Decline Period

Cumulative production $= \text{Reserves}$

Production Period (Years)
• A linear trend is adopted to describe the SOR performance.
• The initial SOR in the demo area has been evaluated as a function of effective net thickness. The initial SOR is classified into four categories of net thickness.
  – 10, 15, 20, 25m
• The increasing ratio with time is from simulation results.
  – 0.025/month
• The actual trend is close to this prediction.
Wells with History

End of Plateau Period
= ½ of Reserves Recovered

Cumulative production = Reserves
Wells with History

History ↔ Forecast

Update decline based on actual trend

Cumulative production = Reserves
Wells with History

Well Life is based on the Performance of Bitumen Rate

Instantaneous SOR

Production Period (Years)

History

Forecast

Linear Trend
• Decline method
  – Adopted to well groups (A to Q pairs) that have enough production history to estimate the decline
  – The steam chambers from the well pairs in this group have merged or will merge in the future (Steam chamber between J well and O well have a communication since 2011.)
  – A trend that reflects the stable operating period in both bitumen production and SOR is picked for the forecast with assumption that reservoir pressure will be relatively constant (fluctuation in pressure may exist due to marketing of bitumen and gas supply)
Decline predicted from A – Q well pair production history
Estimated date for commencing NCG CO-injection with Plant 1 turn down.
<table>
<thead>
<tr>
<th>Start Year</th>
<th>Well Pair</th>
<th>Original Bitumen in Place (Mm³)</th>
<th>Cum Produced Bitumen (Mm³)</th>
<th>Current Recovery (%)</th>
<th>Ultimate Recovery (%)</th>
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<tbody>
<tr>
<td>1999</td>
<td>A, B, C D and E</td>
<td>3,113</td>
<td>1818</td>
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<td>585</td>
<td>16</td>
<td>3</td>
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</table>

Total 12,584 5,205 41 61
Recovery factor at the end of 2014: 65.2%
• These wells have approximately 14 years history and still maintain economic performance.

• These two wells produced ~ 5.6 MMbbl (0.89 million m$^3$) of bitumen and CSOR ~ 3.8

• The steam chambers for the A and B wells have been communicating since late 2001.

• The injection pressure of B is slightly higher than A, thereby sweeping bitumen from B to A. B well is a steam donor

• Drainage west of A pair is beyond 50m. Most of the bitumen in this area is expected to be recovered through the sweep between M and A wells. (M at higher pressure)

• NCG co-injection on A and B well pairs was conducted in parts of 2012 and 2013. No NCG in 2014
Recovery factor at the end of 2014: 49%
• J pair has maintained good performance over the past year.
• The bitumen production profile appears to be following the typical build up, plateau, and decline periods.
• Well produced ~ 2.2 MMBBL and CSOR ~ 3.0
• The decline rate has moderated in the last 1-3 years.
• The J pair is in communication with the I pair to the south.
• The J pair started communication with the O pair in 2011 to the north and some steam is provided to the O well from J.
Recovery factor at the end of 2014: 37%
• Actual bitumen production is lower than expected (150m$^3$/d).
• Well produced ~ 0.8 MMBBL and CSOR ~ 3.9
• Potential reasons for this low productivity are:
  
  – The reservoir along the HZ well contains clast facie and these slow down the steam chamber growth. Thermocouple data in the producer indicate that steam chamber growth at the toe is poor; likely due to the previously mentioned clast facie.
  
  – Steam coning induced sand production. This well has been controlled by production rate which prevents sand influx. This option enables the N well to produce steadily without sand issues.
Recovery factor at the end of 2014: 14.2%
‘X’ WELL

• First well with ESP test in the field.
• Well produced ~ 0.5 MMBBL & cSOR ~ 2.8
• X pair has maintained good performance since an ESP was installed to operate at low pressure (in December, 2010).
  – Maintained bitumen production
  – Reduced steam rate, which was free to be redeployed into other wells to maximize the total bitumen production from the facility.
  – Reduced SOR
• The second ESP failed in June 2013 (398 days in service) due to control line failure resulting in a short. The third ESP has been installed and running since July 2013. (Ref. : First ESP life : 487 days)
• X well was shut-in since November 2014 due to hot toe
• **SAGD start-up in Feb 2012**
• Sand production observed early in production life
• **Liner failure (sand production / plugged well off) Nov 2012, well workover**
• Rate control to minimize sand production
• Slowly ramping up production from the well considering past experiences with hot toe

Recovery factor at the end of 2014: **8%**
NCG Co-injection

- Received AER approval to co-inject NCG in H-Q
  - No NCG co-injection happened in 2014
  - A-Q NCG Co-Injection
    - Date to start co-injection still to be determined
- Long Term Plan
  - Target NCG rate for Phases 1&2 is
  - Target NCG rate for Phases 3 & 4 is ~26,000sm$^3$/d

<table>
<thead>
<tr>
<th>Well Pair</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>P</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Rate (sm$^3$/d)</td>
<td>5,600</td>
<td>4,650</td>
<td>2,400</td>
<td>2,730</td>
<td>4,000</td>
<td>2,270</td>
<td>2,200</td>
<td>2,200</td>
</tr>
</tbody>
</table>
Fluid Communication

• A & B in December 2001
• D & E in April 2005
• H & I in May 2004
• H & K in January 2005
• J & O in March 2011
• S & T in January 2012
• P & O in April 2012
Fluid Communication

- Phases 3 & 4 are thermally mature
  - Production from phase 3 wells started in December 2001
  - Production from the last wells in phase 4 started in August 2005
  - Temperature observation wells show full steam chamber development in the clean sand
  - Fluid communication between the wells observed between the phases 3 & 4 and presented below.
Future Development Options

- Lower pressure operation
- NCG Co-injection for the next group of thermally mature well pads
- Blowdown
Surface Operations
Facility Design
Plant Schematic – PLANT 1

N/C from 2013 PR
Plant Schematic – PLANT 2

N/C from 2013 PR
Facility Performance
Facility Performance – 2014 Service Factor

2014 Service Factor – 93%

Operations interruptions are described in two categories

Planned Plant Turnarounds
- Major – April/May & June 2014
  - Vessel inspections, PSV maintenance, process equipment cleaning, meter calibration/checks, boiler pigging, various repairs
- Minor – October 2014
  - Boiler pigging, HTS cleaning, corrosion coupon installation

Contributed 6% of downtime

Transportation/Utility Restrictions
- Limitations in the following
  - Markets
  - Road access
  - Natural gas supply

Contributed 1% of downtime
Steam Generation (Revised)

- Plant 1
  - B-201A/B – 50 MMBtu/h Boilers
- Plant 2
  - B510/520 – 180 MMBtu/h Boilers
  - B540 – 50 MMBtu/h Boiler

<table>
<thead>
<tr>
<th></th>
<th>Steam Volume (m³)</th>
<th>Steam Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plant 1</td>
<td>Plant 2</td>
</tr>
<tr>
<td>January</td>
<td>27,450</td>
<td>99,244</td>
</tr>
<tr>
<td>February</td>
<td>24,463</td>
<td>97,007</td>
</tr>
<tr>
<td>March</td>
<td>25,820</td>
<td>114,177</td>
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<td>April</td>
<td>21,355</td>
<td>82,653</td>
</tr>
<tr>
<td>May</td>
<td>23,487</td>
<td>87,293</td>
</tr>
<tr>
<td>June</td>
<td>16,698</td>
<td>117,365</td>
</tr>
<tr>
<td>July</td>
<td>27,180</td>
<td>121,357</td>
</tr>
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<td>August</td>
<td>27,917</td>
<td>117,420</td>
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<td>September</td>
<td>27,454</td>
<td>120,815</td>
</tr>
<tr>
<td>October</td>
<td>28,903</td>
<td>114,788</td>
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<td>27,379</td>
<td>114,550</td>
</tr>
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<td>December</td>
<td>26,696</td>
<td>117,669</td>
</tr>
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<td>Total</td>
<td>304,803</td>
<td>1,304,337</td>
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<tr>
<td>Daily Average</td>
<td>833</td>
<td>3,564</td>
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<td>Design Capacity</td>
<td>1,206</td>
<td>6,009</td>
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</table>
Power & Energy Intensity

Power (kWh&MW) & Intensity [Natural Gas (m³ & GJ)/Bitumen (m³)]

<table>
<thead>
<tr>
<th>Year</th>
<th>Power (kWh)</th>
<th>Power (MW)</th>
<th>Natural Gas* (e³m³)</th>
<th>Bitumen (m³)</th>
<th>Intensity (m³/m³)</th>
<th>Nat gas heating value (GJ/e³m³)</th>
<th>Intensity** (GJ/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>2,694,904</td>
<td>3.6</td>
<td>8,654</td>
<td>28,320</td>
<td>306</td>
<td>39.39</td>
<td>12.0</td>
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<tr>
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<td>2,431,689</td>
<td>3.6</td>
<td>8,224</td>
<td>25,755</td>
<td>319</td>
<td>39.14</td>
<td>12.5</td>
</tr>
<tr>
<td>Mar</td>
<td>2,593,331</td>
<td>3.5</td>
<td>9,604</td>
<td>29,600</td>
<td>324</td>
<td>40.04</td>
<td>13.0</td>
</tr>
<tr>
<td>Apr</td>
<td>2,152,011</td>
<td>3.0</td>
<td>7,156</td>
<td>21,591</td>
<td>331</td>
<td>39.72</td>
<td>13.2</td>
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<td>2,196,687</td>
<td>3.0</td>
<td>7,935</td>
<td>21,082</td>
<td>376</td>
<td>39.05</td>
<td>14.7</td>
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<td>2,061,747</td>
<td>2.9</td>
<td>9,157</td>
<td>25,957</td>
<td>353</td>
<td>38.89</td>
<td>13.7</td>
</tr>
<tr>
<td>Jul</td>
<td>2,249,298</td>
<td>3.0</td>
<td>9,956</td>
<td>31,238</td>
<td>319</td>
<td>38.90</td>
<td>12.4</td>
</tr>
<tr>
<td>Aug</td>
<td>2,254,009</td>
<td>3.0</td>
<td>9,635</td>
<td>30,695</td>
<td>314</td>
<td>39.04</td>
<td>12.3</td>
</tr>
<tr>
<td>Sep</td>
<td>2,253,553</td>
<td>3.1</td>
<td>9,905</td>
<td>30,378</td>
<td>326</td>
<td>40.16</td>
<td>13.1</td>
</tr>
<tr>
<td>Oct</td>
<td>2,405,888</td>
<td>3.2</td>
<td>9,667</td>
<td>29,338</td>
<td>330</td>
<td>40.00</td>
<td>13.2</td>
</tr>
<tr>
<td>Nov</td>
<td>2,438,218</td>
<td>3.4</td>
<td>9,382</td>
<td>29,423</td>
<td>319</td>
<td>40.04</td>
<td>12.8</td>
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<td>Dec</td>
<td>2,512,952</td>
<td>3.4</td>
<td>9,586</td>
<td>29,380</td>
<td>326</td>
<td>40.18</td>
<td>13.1</td>
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<tr>
<td>TOTAL</td>
<td>28,244,287</td>
<td>3.2</td>
<td>108,860</td>
<td>332,757</td>
<td>327</td>
<td></td>
<td>12.3</td>
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</tbody>
</table>

* - Total natural gas to plant
** - Using monthly nat gas heating values
### Natural/Produced Gas Summary - 2014

<table>
<thead>
<tr>
<th>(e³m³)</th>
<th>Purchased Gas</th>
<th>Produced Gas</th>
<th>Flared Gas</th>
<th>Produced Gas Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>8,654</td>
<td>279</td>
<td>31</td>
<td>88.9%</td>
</tr>
<tr>
<td>February</td>
<td>8,224</td>
<td>246</td>
<td>26</td>
<td>89.4%</td>
</tr>
<tr>
<td>March</td>
<td>9,604</td>
<td>286</td>
<td>28</td>
<td>90.4%</td>
</tr>
<tr>
<td>April</td>
<td>7,156</td>
<td>223</td>
<td>35</td>
<td>84.2%</td>
</tr>
<tr>
<td>May</td>
<td>7,935</td>
<td>205</td>
<td>30</td>
<td>85.3%</td>
</tr>
<tr>
<td>June</td>
<td>9,157</td>
<td>283</td>
<td>23</td>
<td>91.9%</td>
</tr>
<tr>
<td>July</td>
<td>9,956</td>
<td>317</td>
<td>27</td>
<td>91.6%</td>
</tr>
<tr>
<td>August</td>
<td>9,635</td>
<td>314</td>
<td>30</td>
<td>90.4%</td>
</tr>
<tr>
<td>September</td>
<td>9,905</td>
<td>324</td>
<td>25</td>
<td>92.4%</td>
</tr>
<tr>
<td>October</td>
<td>9,667</td>
<td>298</td>
<td>25</td>
<td>91.6%</td>
</tr>
<tr>
<td>November</td>
<td>9,382</td>
<td>296</td>
<td>24</td>
<td>91.9%</td>
</tr>
<tr>
<td>December</td>
<td>9,586</td>
<td>346</td>
<td>26</td>
<td>92.5%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>108,860</td>
<td>3,417</td>
<td>330</td>
<td>90.4%</td>
</tr>
</tbody>
</table>
Measurement & Reporting
Production / Injection

- 15 out 24 SAGD well pairs have individual metered wellhead separators; produced fluid rates are continuously measured and recorded

- Two Group/Test separators
  - P / Q / Z Wells
  - R / S / T / U / V / W Wells

- Bitumen cut determined as follows
  - Phase 5 Wells (R→W) – Online Cut Meter (Phase Dynamics)
  - All other wells – Manual bitumen cut measurement (twice a month)

- Steam injection rates are continuously measured at each and every wellhead and prorated to high-pressure steam meters
Proration Factor Method

- Total daily bitumen production is determined with metered truck-out volumes and inventory levels in sales tanks. The trucked volume is prorated to the custody transfer meter from the receivers trucking terminals.

- $\sum$ Individual wellhead bitumen is measured/calculated and prorated to the plant production.

- Produced water from each well is calculated with the following formula
  - $PW = \text{Produced Fluid} - \text{Bitumen}$
  - Produced water from all the wells is then prorated to the total metered de-oiled produced water (This volume includes all condensed produced steam which is not measured off the liquid leg of the well head separators)
Proration Factors (Revised)

- The average 2014 proration factor for bitumen was 1.091, steam was 1.059, and water was 1.107.
Measurement and Reporting – Water Balance

The chart below summarizes the water balance for 2014

<table>
<thead>
<tr>
<th></th>
<th>IN</th>
<th></th>
<th>OUT</th>
<th></th>
<th>(ABS) Δ(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Produced</td>
<td>Raw</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>January</td>
<td>120,964</td>
<td>17,692</td>
<td>138,656</td>
<td>126,414</td>
<td>2,648</td>
</tr>
<tr>
<td>February</td>
<td>115,170</td>
<td>17,261</td>
<td>132,431</td>
<td>121,216</td>
<td>2,212</td>
</tr>
<tr>
<td>March</td>
<td>132,216</td>
<td>17,740</td>
<td>149,956</td>
<td>139,715</td>
<td>2,300</td>
</tr>
<tr>
<td>April</td>
<td>99,313</td>
<td>13,318</td>
<td>112,631</td>
<td>103,739</td>
<td>2,656</td>
</tr>
<tr>
<td>May</td>
<td>102,291</td>
<td>20,762</td>
<td>123,053</td>
<td>110,508</td>
<td>3,215</td>
</tr>
<tr>
<td>June</td>
<td>123,906</td>
<td>20,002</td>
<td>143,908</td>
<td>133,797</td>
<td>2,022</td>
</tr>
<tr>
<td>July</td>
<td>136,513</td>
<td>24,405</td>
<td>160,918</td>
<td>148,261</td>
<td>2,458</td>
</tr>
<tr>
<td>August</td>
<td>132,815</td>
<td>24,431</td>
<td>157,245</td>
<td>145,060</td>
<td>2,233</td>
</tr>
<tr>
<td>September</td>
<td>137,683</td>
<td>22,154</td>
<td>159,837</td>
<td>148,002</td>
<td>2,595</td>
</tr>
<tr>
<td>October</td>
<td>132,214</td>
<td>21,495</td>
<td>153,709</td>
<td>143,414</td>
<td>2,868</td>
</tr>
<tr>
<td>November</td>
<td>136,719</td>
<td>18,627</td>
<td>155,346</td>
<td>141,663</td>
<td>2,598</td>
</tr>
<tr>
<td>December</td>
<td>135,917</td>
<td>21,904</td>
<td>157,820</td>
<td>144,091</td>
<td>2,651</td>
</tr>
<tr>
<td>Total</td>
<td>1,505,723</td>
<td>239,789</td>
<td>1,745,512</td>
<td>1,605,879</td>
<td>30,455</td>
</tr>
</tbody>
</table>

- Evaporation from multiple sources is calculated (details in MARP). Sources include tanks, the hot lime softener, and the crystallizer
- Hangingstone Expansion (HE) water is used for construction and drilling at the expansion project
Optimization of test duration

- Optimization of test duration
  - Achieve the minimum test period and frequency for each well
  - Maximize time & frequency for wells with weak returning pressure and/or unstable operation

- Minimum test period: 2 days per month
- Minimum test frequency: Target 1 per month
- Minimum BS&W tests: 2 cuts per month
2014 MARP Submission

New to JACOS 2014 MARP

- Water/Steam Primary and Secondary Measurement
  - Additional meter details added
  - Calculation/flow diagram details

- Addition of new gas co-injection wells
  - Originally Phase 1&2 approved for co-injection (5 wells)
    - Application No. 1635331
  - 2014 additional Phase 3&4 co-injection was approved (8 wells)
    - Application No. 1764015
    - Note, co-injection for Phase 3&4 has not yet commenced

- Revision/clarification of raw water reporting method for Hangingstone Expansion (construction & drilling)
  - All source water from wells DQ-02-2 and DQ06-7 is REC at demo
  - Expansion construction/drilling usage will be DISP from demo
Directive 081 – Water Disposal Limits and Reporting Requirements for Thermal In Situ Oil Sands Schemes

JACOS Hangingstone DEMO Monthly Water Balance

JACOS Hangingstone DEMO Monthly Disposal

- Actual Disposal
- Disposal Limit
Water
Raw, Produced, Injection, Disposal
Water Sources & Uses

Wells - DQ02-2 & DQ06-7
SE 11-084-11W4M

Water Source – fresh groundwater; both wells withdraw from the Muriel Lake formation (Leismer Channel). There is no brackish water and no surface water use.

Licensed withdrawal - 438,000 m³/yr
2014 withdrawal - 239,789 m³/yr

Max pumping rate - 1200 m³/day
2014 max day - 1022 m³/day
2014 average - 657 m³/day

Source water is required to makeup for reservoir loss, evaporation & disposal at the demo.

All makeup used for steam generation – introduced at wellheads and plant as “quench” water

Additionally, source water is used for construction & drilling of expansion project
Disposal Limit & Actual

\[
\text{Disposal Limit (\%)} = \left(\frac{\text{Produced Water} \times \text{Produced Factor}}{\text{Produced Water} + \text{Fresh Water}}\right) \times 100\%
\]

\[
\text{Disposal Actual (\%)} = \left(\frac{\text{Well Disposal} + \text{Brine Trucking}}{\text{Produced Water} + \text{Fresh Water}}\right) \times 100\%
\]

<table>
<thead>
<tr>
<th></th>
<th>Produced Water (m³)</th>
<th>Fresh Water (m³)</th>
<th>Disposal Limit, %</th>
<th>Disposal (m³)</th>
<th>Brine Trucked (m³)</th>
<th>Disposal Actual, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-14</td>
<td>120964</td>
<td>17692</td>
<td>9.11%</td>
<td>2648</td>
<td>195</td>
<td>2.05%</td>
</tr>
<tr>
<td>Feb-14</td>
<td>115170</td>
<td>17261</td>
<td>9.09%</td>
<td>2212</td>
<td>235</td>
<td>1.85%</td>
</tr>
<tr>
<td>Mar-14</td>
<td>132216</td>
<td>17740</td>
<td>9.17%</td>
<td>2300</td>
<td>0</td>
<td>1.53%</td>
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<td>99313</td>
<td>13318</td>
<td>9.17%</td>
<td>2656</td>
<td>155</td>
<td>2.50%</td>
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<td>102291</td>
<td>20762</td>
<td>8.82%</td>
<td>3215</td>
<td>360</td>
<td>2.91%</td>
</tr>
<tr>
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<td>123906</td>
<td>20002</td>
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<td>2022</td>
<td>76</td>
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<td>2458</td>
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<td>1.55%</td>
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<td>1.49%</td>
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<tr>
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<td>9.03%</td>
<td>2595</td>
<td>148</td>
<td>1.72%</td>
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<tr>
<td>Oct-14</td>
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<td>21495</td>
<td>9.02%</td>
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<td>1.96%</td>
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<td>2598</td>
<td>39</td>
<td>1.70%</td>
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<td>Dec-14</td>
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<td>9.03%</td>
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<tr>
<td>Average</td>
<td>125477</td>
<td>19982</td>
<td>9.04%</td>
<td>2538</td>
<td>125</td>
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<td>Total</td>
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<td>239789</td>
<td>9.04%</td>
<td>30455</td>
<td>1504</td>
<td>1.83%</td>
</tr>
</tbody>
</table>

*Produced water factor: 0.1 ; Fresh water factor: 0.03
Produced Water

- Produced Water Recycle = (Steam Injection – Fresh Water) / Produced Water
- Reservoir Loss = 1 – (Produced Water / Steam Injection)

<table>
<thead>
<tr>
<th>Month</th>
<th>Fresh Water to Demo (m³)</th>
<th>Produced Water Volume (m³)</th>
<th>Steam Injection Volume (m³)</th>
<th>Produced Water Recycle (%)</th>
<th>Reservoir Loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>14,929</td>
<td>120,964</td>
<td>126,414</td>
<td>92</td>
<td>4.3</td>
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<tr>
<td>February</td>
<td>15,062</td>
<td>115,170</td>
<td>121,216</td>
<td>92</td>
<td>5.0</td>
</tr>
<tr>
<td>March</td>
<td>15,723</td>
<td>132,216</td>
<td>139,715</td>
<td>94</td>
<td>5.4</td>
</tr>
<tr>
<td>April</td>
<td>11,528</td>
<td>99,313</td>
<td>103,739</td>
<td>93</td>
<td>4.3</td>
</tr>
<tr>
<td>May</td>
<td>17,315</td>
<td>102,291</td>
<td>110,508</td>
<td>91</td>
<td>7.4</td>
</tr>
<tr>
<td>June</td>
<td>18,373</td>
<td>123,906</td>
<td>133,797</td>
<td>93</td>
<td>7.4</td>
</tr>
<tr>
<td>July</td>
<td>21,151</td>
<td>136,513</td>
<td>148,261</td>
<td>93</td>
<td>7.9</td>
</tr>
<tr>
<td>August</td>
<td>20,728</td>
<td>132,815</td>
<td>145,060</td>
<td>94</td>
<td>8.4</td>
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<tr>
<td>September</td>
<td>19,664</td>
<td>137,683</td>
<td>148,002</td>
<td>93</td>
<td>7.0</td>
</tr>
<tr>
<td>October</td>
<td>19,018</td>
<td>132,214</td>
<td>143,414</td>
<td>94</td>
<td>7.8</td>
</tr>
<tr>
<td>November</td>
<td>15,918</td>
<td>136,719</td>
<td>141,663</td>
<td>92</td>
<td>3.5</td>
</tr>
<tr>
<td>December</td>
<td>20,056</td>
<td>135,917</td>
<td>144,091</td>
<td>91</td>
<td>5.7</td>
</tr>
<tr>
<td>Total</td>
<td>209,464</td>
<td>1,505,723</td>
<td>1,605,879</td>
<td>93</td>
<td>6.2</td>
</tr>
</tbody>
</table>
2014 Waste Water Disposal

JACOS CLASS 1b WELLs
- WS2-23 F1/02-23-084-11W4/0
- WD-3 00/15-14-084-11W4/0
- WD-4 00/01-23-084-11W4/0 (abandoned 2009)
- WD-5 00/16-14-084-11W4/0 (abandoned 2009)

OFFSITE BRINE DISPOSAL
- Absolute 10-17-053-23W4
- Worthington Business Park, Edmonton

Rate Summary

<table>
<thead>
<tr>
<th>Well</th>
<th>2014 Avg Rate (m$^3$/D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WD-3</td>
<td>8</td>
</tr>
<tr>
<td>WS2-23</td>
<td>76</td>
</tr>
<tr>
<td>Total disposal to JACOS wells</td>
<td>84</td>
</tr>
<tr>
<td>Brine to offsite disposal well</td>
<td>4</td>
</tr>
<tr>
<td>TOTAL DISPOSAL</td>
<td>88</td>
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</tbody>
</table>
2014 Waste Water Disposal Volumes

Monthly Disposal Volumes

<table>
<thead>
<tr>
<th>Disposal Volumes (m³)</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trucked Out</td>
<td>195</td>
<td>235</td>
<td>0</td>
<td>155</td>
<td>360</td>
<td>76</td>
<td>37</td>
<td>111</td>
<td>148</td>
<td>149</td>
<td>39</td>
<td>0</td>
</tr>
<tr>
<td>WD-3</td>
<td>420</td>
<td>206</td>
<td>0</td>
<td>47</td>
<td>384</td>
<td>118</td>
<td>0</td>
<td>0</td>
<td>368</td>
<td>412</td>
<td>392</td>
<td>422</td>
</tr>
<tr>
<td>WS2-23</td>
<td>2,218</td>
<td>1,924</td>
<td>2,306</td>
<td>2,649</td>
<td>2,769</td>
<td>1,835</td>
<td>2,480</td>
<td>2,274</td>
<td>2,241</td>
<td>2,539</td>
<td>2,260</td>
<td>2,293</td>
</tr>
</tbody>
</table>
Solid Waste Disposal

Types of Solid Waste
- Lime Sludge
- Sand
- Spent filter media

SOLID WASTE DISPOSAL
16.6 tonne/day
Class II Oilfield Landfills:
Tervita Janvier SE-03-081-06W4M
Sulphur Dioxide Emissions

2014 Sulphur Dioxide Emissions

SO2 (tonnes/day)

Jan-14 | Feb-14 | Mar-14 | Apr-14 | May-14 | Jun-14 | Jul-14 | Aug-14 | Sep-14 | Oct-14 | Nov-14 | Dec-14

Approval Limit

SO2 Emissions
Sulphur Inlet Rate

- Sulphur inlet rates are under the 1 t/day criteria from ID 2001-3 for sulphur recovery.
- Gas samples (flare inlets & recovered gas) are collected and analyzed monthly.
- Recovered gas sampling increased to weekly during NCG co-injection.
• **Active Ambient air monitoring program:**
  - Data collected from July 1\textsuperscript{st} to December 31, 2014 (6 months in 2014) as per approval; in compliance with all AAAQO.

• **Routine Annual monitoring programs:**
  - Six passive ambient air monitoring stations collected SO\textsubscript{2} and H\textsubscript{2}S data during 2014 – no exceedances noted.
  - Groundwater - spring/fall sampling results were largely comparable to previous years. Increasing trends in parameters were still noted at ENV98-1A. A soil excavation program planned for 2015 to address the exceedance.
  - Fugitive emission survey (LDAR) results in compliance with CCME guidelines. Select minor repairs to be made during spring of 2015.
  - Water Use - report in draft; updates to AESRD Water Use Reporting registry ongoing.
  - Soil Management – From the previous Soil Monitoring Program, mitigation measures to be developed as part of the Management Program by Q1 of 2015.
  - Stack survey results were in alignment with previous years and in compliance with approved limits.
  - All other annual compliance initiatives competed were comparable with findings from previous years.
Facility Repairs and Upgrades:

• **Surface Run-off Modifications & Repairs:**
  - Surface re-contouring work was carried out at Plant 2 to improve run-off water drainage to the licensed pond.
  - JACOS issued a self-disclosure letter to the AER regarding corrective actions required at Plant 2 sumps and trenches.
  - Detailed design for repairs developed for deficient sumps, tanks and trenches.
  - Repairs included re-grading the Plant 2 run-off pond.

• **Secondary Containment Repair:**
  - Secondary containment repair and replacement work to conclude in 2015.
Demo Scheme No. 8788

2014 Ambient Air Quality from Passive Monitoring Stations
Total Sulphur Dioxide

Limit = 11 ppb (30-day average)
Demo Scheme No. 8788

2014 Ambient Air Quality from Passive Monitoring Stations
Hydrogen Sulphide

Limit = 3 ppb (24-hour average)
Demo Scheme No. 8788

2014 Ambient Air Quality from Active Monitoring Station
Sulphur Dioxide (SO2)

Limit = 172 ppb (1-hour average)

Limit = 48 ppb (24-hour average)

+----------------+----------------+----------------+----------------+----------------+----------------+----------------+
| Month          | Max Hourly Ave | Max Hourly Ave AAAQO | Max 24hr Ave | Max 24hr Ave AAAQO |
| Jul-14         |                |                      |              |                    |
| Aug-14         |                |                      |              |                    |
| Sep-14         |                |                      |              |                    |
| Oct-14         |                |                      |              |                    |
| Nov-14         |                |                      |              |                    |
| Dec-14         |                |                      |              |                    |
+----------------+----------------+----------------+----------------+----------------+----------------+
2014 Ambient Air Quality from Active Monitoring Station
Hydrogen Sulphide (H2S)

- Limit = 10 ppb (1-hour average)
- Limit = 3 ppb (24-hour average)
- Minimum reporting threshold (1 ppb)
• **Environmental monitoring programs:**

  – Groundwater monitoring – drilling of groundwater monitoring wells commenced Dec/14

  – Wildlife mitigation & monitoring program – data collection & review underway

  – Woodland caribou monitoring & mitigation plan – program execution underway

  – Wetland monitoring program proposal – approved; program implementation underway

  – Soil monitoring program proposal – due Jan 31/15; draft currently under review

  – Wetland reclamation trial program proposal – filed on Dec 31/14

  – Reclamation monitoring program proposal – filed on Dec 31/14
• Regional Initiative Involvement:

<table>
<thead>
<tr>
<th>ABMI</th>
<th>CAPP</th>
<th>CEMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAMP</td>
<td>iFROG – COSIA JIP (wetland monitoring research group)</td>
<td>JOSM/AEMERA</td>
</tr>
</tbody>
</table>

• Remediation and Reclamation Progress:

  • In 2014, 95 reclaimed OSE sites were assessed, and 35 were planted/transplanted
  • Black spruce were planted at the former 16-14 remote sump
  • A Detailed Site Assessment and Reclamation Application was filed for 5&6-34
  • The 2009 and 2010 OSE programs received reclamation certificates (34.77 ha)
  • Phase 2 ESAs: 100/16-14, 13-13, and 3&4-27
  • Detailed Site Assessments: 14-21, 15-34, 12-27. Results indicated further work required to meet surface and vegetation requirements, no reclamation applications were submitted.
“Removing the Wellsite Footprint” (iFROG Program) – Partial Road Removal Project

- **Work completed:**
  - The partial removal of the road fill material in winter 2011.
  - Three excavations along the road as re-vegetation treatment plots.
  - Re-vegetation and hydrologic communication assessed in 2014.

- **Work planned:**
  - Final reporting and project closure set for 2014. Continuation of work through COSIA JIP.
Compliance Statement & Approvals
JACOS is in compliance with conditions of their approval and regulatory requirements, subject to the following:

- **Secondary Containment Self-Disclosure – May 26/14**
  - Sump, trench, and tank secondary containment systems repair in progress
  - Engineering study in progress to recommend repairs for certain systems (HLS sump)
  - Mitigation and Monitoring plan developed for non-compliant sumps and tanks at Plant 1.

- **Ongoing reclamation of various historical sites - prioritized by environmental risk**
HZII Wellhead Leak & Repair Status – (FIS No. 291042)

- On October 19, 2014 a small volume of steam was observed leaking from the bolted flange of the HZII Injector Well casing.
- Release could not immediately be controlled so it was reported to the AER (FIS No. 291042)
- Steam injection to the well was immediately shut in to control the leak.
- No adverse impact to the environment as most of the release was steam; about 25 litres of condensed steam dripped into the well’s cellar and contained.
- Daily monitoring is ongoing; all subsurface tubulars are currently gas blanketed and well leak is controlled
- Repair was planned for November 2014 but delayed due to discontinuation of wellhead replacement components
- Re-engineering and manufacturing of components was required.
- Components have now been sourced and repair is scheduled during plant turnaround in May 2015.
• Greenhouse Gas Emissions:
  – SGER Compliance Report for 2013 – submitted in Mar/14
  – Material error in fuel gas emission factor calculation, resulting in overestimate of emissions, found through course of 2013 report verification. Error present in all past reports including baseline.
    • Baseline Application restated and approved by ESRD
    • 2010 – 2013 compliance reports re-stated and currently waiting for approval.
    • Total direct GHG emissions for 2014 – 225,347 T CO\textsubscript{2}e.
    • Approved baseline emission intensity was revised to 0.4662 tonne CO\textsubscript{2}-e/m\textsuperscript{3}

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Requirement</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution Gas Recovery</td>
<td>&gt; 90%</td>
<td>90.4%</td>
</tr>
<tr>
<td>SO\textsubscript{2} Emissions</td>
<td>&lt; 1.63 T/d</td>
<td>0.46 T/d</td>
</tr>
<tr>
<td>D81 Disposal Limit</td>
<td>&lt;9.04%</td>
<td>1.83%</td>
</tr>
<tr>
<td>Plant 2 B-520 NO\textsubscript{x}</td>
<td>&lt; 7.60 kg/hr</td>
<td>3.15 kg/hr</td>
</tr>
</tbody>
</table>
• Amendments to Scheme Approval 8788 in 2014:
  – Amendment ‘J’ - NCG co-injection on Well Pairs H – Q received on Mar 21/14
  – Amendment ‘K’ – rescind minimum recycle rate of 90% and, in place, comply with Directive 081 received on May 28/14
  – Category 1 D78 approval for MVR installation received on Mar 6/14
  – Formal abandonment of ‘F’ well pair in Aug/14
• MARP: 2014 update submitted on Feb 28/14
• EPAP: Filed 2014 Declaration on Nov 28/14
• JACOS is in compliance with conditions of their approval and regulatory requirements, subject to the following:

• Self-Disclosure, Mar 10/14: Trespass of 100/07-22-084-11W4/00 (W04-P04) into Devonian where JACOS does not have mineral rights – drilling halted immediately and well plugged back; no adverse impact as Devonian is non-hydrocarbon bearing at this location; corrective actions were taken to prevent reoccurrence.

• Self-Disclosure, Jun 26/14: WA Approval No. 00322883 (DQ12-18 well drilled for Expansion Project) – Note: no water being withdrawn from this well - failure to report water levels in 2 obs wells; level transmitters installed and data collection commenced; one transmitter has failed; wellheads will be modified to standard water well design and transmitter reinstalled; WUR account for this approval being set up.

• Self-Disclosure, Oct 17/14: Runoff water release caused erosion & sedimentation issues – pumping stopped immediately; silt fence installed to prevent silt from leaving site; ditch upgrades will be made before spring runoff; monitor spring runoff closely to ensure compliance.
• Amendment ‘B’ to Scheme Approval 11910:
  – Approval to install Highway 63 box culvert crossing

• Scheme Approval Variance:
  – Clause 7 of Approval No. 11910B to allow the SAGD wells on Pad 5 to be drilled before the 00/01-22-084-11W4/2 well is completed or abandoned

• D78 Category 1 Information Updates:
  – Well Pair 1 and 3 on Well Pad 06 updates
  – Well Pad 05 trajectory updates
  – Well Pair 3 on Well Pad 06 ICP modification

• EPEA Approval Amendment 153105-00-02:
  – Noise and air quality monitoring update

• Process pond design clarification letter:
  – 2nd SIR response submitted Dec 15/14; waiting for response
Demo:
- Closure of Secondary Containment Self-Disclosure Items
- Timing of Plant 1 decommissioning under evaluation

Expansion:
- Seeking response on process pond design SIR 2 submission