3.1.1. Subsurface – Table of Contents

1. Brief Background – slide 3
2. Geology / Geosciences – slide 7
3. Drilling and Completions – slide 34
4. Artificial Lift – slide 44
5. Instrumentation in Wells – slide 46
6. 4D Seismic – slide 51
7. Scheme Performance – slide 53
8. Future Plans – slide 84
1. Brief Background
Project Overview

- AER Commercial Scheme Approval No. 9835
- 30,000 BOPD SAGD Project
- Clearwater and Grand Rapids Reservoirs
- 9-10° API Bitumen
- Integrated with Husky Pipeline & Upgrader
- Project completed in 24 months
- First Steam August 20, 2006
- First Production November 29, 2006
Project Development Area

- **Approval Area:**
  - Sections 28, 29, 32 & N/2 of 21 in 064-04 W4M
  - SE ¼ Section 23, SW ¼ Section 21, Section 17 LSD 16 & Section 16 LSD 13

- **Project Life Development:**
  - ~140 well pairs; 35 year life

- **94 Horizontal Well Pairs & 7 Infill Producers**
  - 32 original well pairs (Pads A, B, C)
  - Well Pairs added:
    - Pad C East 2007 - 8 well pairs
    - Pad B Infill 2009-2010 - 3 well pairs
    - Pad A Infill & Replacements (2010/2011) - 16 well pairs
    - Pad Lower Grand Rapids (GA) 2011 - 1 well pair; 2012-2013 - 5 well pairs
    - Pad D East 2014 - 15 well pairs
    - Pad Colony (CN) 2015 - 6 well pairs & 7 infill producers
    - Pad D North 2016 - 8 well pairs
Site Overview

- 94 horizontal well pairs
- 7 infill producers

- Field Facilities – six well pads, infield pipelines & central pump station
- Central Plant:
  - Emulsion treating
  - Water Treatment – 120,000 bbl/day
  - Steam Generation – 99,000 bbl/day CWE
  - Utilities and Off sites
- Water Source & Disposal Wells
- Metering and Export Pipelines to Cold Lake Terminal
2. Geology / Geosciences
## Average Reservoir Characteristics and OBIP

<table>
<thead>
<tr>
<th>CLEARWATER</th>
<th>OBIP (X10^6 m³)</th>
<th>Thickness (m)</th>
<th>Φ</th>
<th>So</th>
<th>Original Pressure (kPa)</th>
<th>Original Temperature (°C)</th>
<th>Depth (m)</th>
<th>Vertical Permeability (mD)</th>
<th>Horizontal Permeability (mD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approval area</td>
<td>72</td>
<td>45</td>
<td>0.31</td>
<td>0.57</td>
<td>3,200</td>
<td>16</td>
<td>440</td>
<td>1,800</td>
<td>3,000</td>
</tr>
<tr>
<td>Operating portion</td>
<td>34</td>
<td>45</td>
<td>0.31</td>
<td>0.56</td>
<td>3,200</td>
<td>16</td>
<td>440</td>
<td>1,800</td>
<td>3,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOWER GRAND RAPIDS</th>
<th>OBIP (X10^6 m³)</th>
<th>Thickness (m)</th>
<th>Φ</th>
<th>So</th>
<th>Original Pressure (kPa)</th>
<th>Original Temperature (°C)</th>
<th>Depth (m)</th>
<th>Vertical Permeability (mD)</th>
<th>Horizontal Permeability (mD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA Approval Area</td>
<td>3.7</td>
<td>33</td>
<td>0.29</td>
<td>0.55</td>
<td>2,600</td>
<td>14</td>
<td>370</td>
<td>1,300</td>
<td>1,800</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COLONY</th>
<th>OBIP (X10^6 m³)</th>
<th>Thickness (m)</th>
<th>Φ</th>
<th>So</th>
<th>Original Pressure (kPa)</th>
<th>Original Temperature (°C)</th>
<th>Depth (m)</th>
<th>Vertical Permeability (mD)</th>
<th>Horizontal Permeability (mD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CN Approval Area</td>
<td>2.8</td>
<td>10</td>
<td>0.3</td>
<td>0.79</td>
<td>2,500</td>
<td>12</td>
<td>305</td>
<td>2,400</td>
<td>4,000</td>
</tr>
</tbody>
</table>

**Notes:**

*Calculation:* OBIP interval: Top of Formation → oil water contact

\[ \text{OBIP} = \text{Area} \times \text{Thickness} \times \Phi \times S_0 \]
Regional Stratigraphy

- Marginal marine deposits consisting of stacked incised valley and shoreface deposits
Isopach Map of Clearwater SAGD Net Pay

Definition of Net Pay:
Top Clearwater – Top of Transition Zone (So > 50%, Φ > 27%)
C.I. = 5 m
Structure Map of the Clearwater Top of Net Pay
Isopach Map of Lower Grand Rapids SAGD Net Pay

Definition of Net Pay:
Top Sparky – Base of Pay (So >50%, Φ >27%)
C.I. = 5m
Structure Map of the Lower Grand Rapids

- Clearwater Approval Boundary
- Lower Grand Rapids Approval Boundary
- Colony Approval Boundary
- Lease Boundary
- C.I. = 5 mASL
Structure Map of the Lower Grand Rapids Base of Net Pay

Clearwater Approval Boundary
Lower Grand Rapids Approval Boundary
Lease Boundary
C.I. = 5m
Isopach Lower Grand Rapids Transition Zone

- Clearwater Approval Boundary
- Lower Grand Rapids Approval Boundary
- Lease Boundary

C.I. = 5m
Isopach Map of Colony SAGD Net Pay

Definition of Net Pay:
Colony Top Pay– Colony Channel Base Pay (So >50%, Φ>27%)
C.I. = 2 m
Clearwater Formation Type Log

100/14-28-064-4W400
KB 619.5m

Grand Rapids sand and shale

D Valley
Dominated by tidal-fluvial channel facies

C Valley
Dominated by sand flat facies

B Valley
Dominated by sand flat facies

Bitumen Zone

Calcite cemented zones

Cored Interval

Bottom Water

0.75 m
Sparky Formation Type Log

**Correlation Table**

<table>
<thead>
<tr>
<th>Layer</th>
<th>Correlation</th>
<th>Depth (m)</th>
<th>Resistivity</th>
<th>Porosity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearwater</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colorado Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Grand Rapids</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Grand Rapids</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>103/10-32-064-04W400</td>
<td></td>
<td>326</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>325</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cored Interval**

- Bitumen saturated channel sand
- Calcite
- Water sand

**Geological Features**

- Transition
- KB = 623.7 m
Cored Wells and Special Core Analysis

- No new wells cored or analysis completed in the reporting period
Representative Structural N-S Cross-section through the Approval Area

Pad A
Pad B
Pad C
Pad D

D Valley
C Valley
Transition Zone
Bottom Water
Wabiskaw
Representative Strike Cross-section through the Sparky Channel
Representative Strike Cross-section through the Colony Channel
### Capping Shale Properties

<table>
<thead>
<tr>
<th>Well Pad</th>
<th>Issues to Date</th>
<th>Fracture Pressure Exceeded</th>
<th>Shale Depth (m)</th>
<th>Measured Fracture Gradient (kPa/m)</th>
<th>Measured Fracture Pressure (kPa)</th>
<th>Fracture Regime</th>
</tr>
</thead>
<tbody>
<tr>
<td>CN</td>
<td>No</td>
<td>No</td>
<td>305</td>
<td>17.0</td>
<td>6,100</td>
<td>Horizontal</td>
</tr>
<tr>
<td>GA</td>
<td>No</td>
<td>No</td>
<td>357</td>
<td>19.9</td>
<td>7,120</td>
<td>Horizontal</td>
</tr>
<tr>
<td>Clearwater</td>
<td>No</td>
<td>No</td>
<td>426</td>
<td>21.8</td>
<td>9,280</td>
<td>Horizontal</td>
</tr>
</tbody>
</table>

### Sand Properties

<table>
<thead>
<tr>
<th>Well Pad</th>
<th>Sand Depth (m)</th>
<th>Measured Fracture Gradient (kPa/m)</th>
<th>Measured Fracture Pressure (kPa)</th>
<th>Fracture Regime</th>
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</thead>
<tbody>
<tr>
<td>GA</td>
<td>375</td>
<td>17.0</td>
<td>6,360</td>
<td>Vertical</td>
</tr>
<tr>
<td>Clearwater</td>
<td>446</td>
<td>16.0</td>
<td>7,140</td>
<td>Vertical</td>
</tr>
</tbody>
</table>
Pad A Well Spacing Schematic Cross-section

- Pad A original (A1 – A8 drilled 2005) injectors were converted into producers in 2015
- Pad A replacement producers (A9 – A24 drilled 2010/2011) are 10m - 15m directly above Pad A original producers
- Pad A infill producers are 10m - 15m above and mid distance from Pad A original producers

Legend:
- Red: Infill and replacement Injectors
- Green: Infill and replacement Producers
- Green: Producers / shut in
- Red: Injectors / converted to producer

N

Legend

Location: 10m - 15m
distance

Injection and replacement Injectors

Infill and replacement Producers

Producers / shut in

Injectors / converted to producer

A24 A23 A22 A21 A20 A19 A18 A17 A16 A15 A14 A13 A12 A11 A10 A9

5m

50m

100m

A1 A2 A3 A4 A5 A6 A7 A8

10m - 15m
• Pad B North injectors (B9 – B12 drilled 2005/2006) converted into producers in 2014
• Pad B North infill producers (B9 – B11 drilled 2009/2010) are 10m - 15m above and mid distance from Pad B North

Legend
- Infill Injectors
- Infill Producers
- Injectors / converted to producer
- Producers / shut in
## Pad Inter-well Spacing

<table>
<thead>
<tr>
<th>Well Pad</th>
<th>Inter-well Spacing (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Original</td>
<td>100</td>
</tr>
<tr>
<td>A Infill and Replacements</td>
<td>50</td>
</tr>
<tr>
<td>B West</td>
<td>100</td>
</tr>
<tr>
<td>B North</td>
<td>100</td>
</tr>
<tr>
<td>B North Infill</td>
<td>100</td>
</tr>
<tr>
<td>C North</td>
<td>100</td>
</tr>
<tr>
<td>C West</td>
<td>100</td>
</tr>
<tr>
<td>C East</td>
<td>100</td>
</tr>
<tr>
<td>D East</td>
<td>50</td>
</tr>
<tr>
<td>D North</td>
<td>50</td>
</tr>
<tr>
<td>GA (LGR)</td>
<td>75</td>
</tr>
<tr>
<td>CN (SAGD)</td>
<td>75</td>
</tr>
<tr>
<td>CN Infill</td>
<td>37.5*</td>
</tr>
</tbody>
</table>

* Spacing to SAGD producer
Surface Heave Monitoring Programs

- No surface heave monitoring programs have been conducted
- Operating near reservoir pressure, therefore unlikely to be any surface heave
- Husky is committed to further investigate the possible extent of surface heave if a change in operating conditions warrant
3D Seismic Data

- No new Seismic data run or interpreted in the reporting period
3. Drilling and Completions
Drilling Results

Pad D North:
- 8 SAGD well pairs drilled in Q1 - Q2 2016
SAGD Well - Injector without VIT

Injectors completed with slotted liner: 94
- Pad A: all injectors
- Pad B: all injectors
- Pad C: all injectors
- Pad D: all injectors
- Pad Colony: all injectors
- Pad LGR: all injectors

13-3/8", 455, 81.1 kg/m Surface Casing landed at 188 mKB

9-5/8" K-55, 59.53 kg/m, Tenaris Blue Intermediate Casing landed at 733 mKB.

Injection Long String
3 1/2" L-80, 13.69 kg/m, FJ HYDRIL 511 WEDGE Long String landed @ 1144.6 mKB

Injection Short String
2-7/8" L-80, 9.52 kg/m, FJ HYDRIL 511 WEDGE SAGD Short String landed @ 660.66 mKB w/ 2-3/8" 6.85 kg/m FJ HYDRIL 511 WEDGE inside 7" liner @ 728.04 mKB

0.62" x 7" K-55, 43.16 kg/m, BLUE SAGD SLOTTED LINER landed @ 1162 mKB

9-5/8" x 7" Liner Hanger @ 709 mKB

TVD: 471.6 Mkb
MD: 1170.0 mKB
SAGD Well - Injector with VIT

Injectors completed with VIT: 22
- Pad C: C13 only
- Pad D: all D East injectors
- Pad Colony: all injectors

Injectors completed using steam splitters: 35
- Pad B: all B West (except B2)
- Pad C: all C West (except C8)
- Pad D: all D East injectors
- Pad CN: all injectors

Surface Casing
339.7 mm (13 3/8"), 81.1 kg/m, J-55 L T&C
Landed at ~170 m KB

Intermediate Casing
244.5 mm (9 5/8"), 59.53 kg/m, L-80, Tenaris Blue
Landed at +/- 620 to 770 m KB

Circulation String
73.0 mm (2 7/8"), 9.52 kg/m, J-55 Hydrill 511 Wedge
Landed above liner hanger at 8 - 15 m TVD above formation

Long Injection String
- 114.3 mm x 88.9 mm Vacuum Insulated Tubing
  Surface to the ICP point
- 114.3 mm, 17.62 kg/m, J-55 Tenaris BTL Tubing
  ICP point to the toe

177.8 mm (7") Straight Cut, Slotted Liner
0.508 mm (0.020") slots

Weatherford Shiftable GDA Sub Steam Splitters
- 114.3 mm x 114.3 mm
- 2 located in the horizontal section in long string

244.5 mm x 177.8 mm Import Liner Hanger
Top Landed at +/- 600 - 750 m KB

TVD: +/- 465 - 475 m KB
MD: +/- 970 - 1585 m KB
SAGD Well Pad CN - Injector with VIT

Surface Casing
339.7 mm (13 3/8"), 81.4 kg/m, J-55 LT&C
Landed at 155.00 mKB

Intermediate Casing
244.5 mm (9 5/8"), 59.53 kg/m, L-80, Tenaris Blue
Landed at 586.86 mKB

Circulation String
(Will not be used after steam circulation phase)
73.0 mm (2-7/8"), 9.62 kg/m, J-55 Tenaris BTL
Tubing w/ Shaved & Develled Collars Landed at 519.25 mKB MD

Long Injection String
114.3 mm x 88.9 mm Vacuum Insulated Tubing
Surface to 514.79 mKB MD
114.3 mm, 17.62 kg/m, J-55 Tenaris BTL Tubing
541.75 - 1,121.21 mKB MD
73.0 mm, 9.52 kg/m, J-55 Hydril 511 Tubing
1,122.28 - 1,284.00 mKB MD

177.8 mm (7") Wire Wrapped Screen
0.254 mm (0.010") slots

Weatherford Shiftable GDA Sub
Steam Splitters
114.3 mm x 114.3 mm
Landed at 746.12 mKB MD, 520.49 mKB MD &
1,122.28 mKB MD

244.5 mm x 177.8 mm Import Liner Hanger
Top Landed at 559.36 mKB

TVD: 316.5 mKB
MD: 1,324.0 mKB
SAGD Well - Producer with Gas-Lift

Producers completed with slotted liner: 38
Pad A: A1-A8
Pad B: B1-B12
Pad C: C1-C15 and C18-C20

Producers completed with wire wrap screen: 63
Pad A: A9-A24
Pad B: B9E-B11E
Pad C: C16-C17
Pad D: all producers
Pad GA: all producers
Pad CN: all producers
Intermittent Steam Stimulation Well Pad CN - Producer with Rod-Pump

Surface Casing
339.7 mm (13.3/8"), 81.1 kg/m, J-55 LT&C
Landed at 154.00 mKB

Intermediate Casing
244.5 mm (9-5/8"), 55.53 kg/m, L-80, Tenaris Blue
Landed at 530.69 mKB

Long Injection String
73.0 mm, 9.62 kg/m, J-55 Tenaris BTL Tubing
from Surface to 1,490.0 mKB MD

Production String
114.3 mm, 17.62 kg/m, J-55 Tenaris BTL Tubing,
Tubing size
Tubing landed at 341.42 mKB MD
Pump Landed at 362.42 mKB MD

Rods & Pump
38.1 mm (1.5") stainless steel polish rod
56.8m of 50.8mm (2") sinker bar
26.4mm (1") 890M Pro-rod w/49k shear
Insert pump 40-328-RT6A-FR-34-4-6

177.8 mm (7") Wire Wrapped Screen
0.264mm (0.010") slots

244.5 mm x 177.8 mm Import Liner Hanger
Top Landed at 501.45 mKB

TVD: 325.22 mKB
MD: 1,530.0 mKB
Infill Well Pad CN - Producer with Rod-Pump

**Surface Casing**
244.5 mm (9.63"), 48.97 kg/m, H-40 LT&C
Landed at 152.00 mKB

**Intermediate Casing**
177.6 mm (7"), 34.2 kg/m, L-30, Tenaris Blue
Landed at 968.99 mKB

**Production String**
114.3 mm, 17.02 kg/m, J-55 Tenaris BTL Tubing,
Tubing drain & pump seating nipple
Tubing landed at 341.67 mKB MD
Pump landed at 352.97 mKB MD

**Rods & Pump**
38.1 mm (1.5") stainless steel polish rod
~ 0.8 m of 60.3 mm (2") flaker bar
25.4 mm (1") 960 M Pro-rod with 48\# shear insert pump 40-325-RWS-FR-34-40

**114.3 mm (4.5") Wire Wrapped Screen**
0.264 mm (0.010") slots

**Pump Tangent 65\(^\circ\)**

**177.8 mm x 114.3 mm Import Liner Hanger**
Top Landed at 999.83 mKB

**TVD:** +/-318.11 mKB
**MD:** +/-1,438.00 mKB
Completion - Key Learnings

- **Production - Slotted Liners vs Wire Wrap Screens:**
  - Slotted liner scaling has been a chronic problem:
    - Short term solution - Acidization
    - Long term solution - perforated liners
  - Wire-wrapped screens, which increase the open area, have been used in producers drilled since 2009:
    - No scaling issues observed in these wells
  - Current plan is to complete future producers with wire wrap screen

- **Injection - VIT (Vacuum Insulated Tubing) and Steam Splitters:**
  - VIT:
    - Improve the wellbore integrity by slowing heat transfer through tubing
    - Deliver high quality steam downhole and improve production
  - Steam Splitters:
    - Shift-able steam splitters enable proper circulation and allow steam distribution adjustments
  - VIT combined with steam splitters:
    - Improve steam quality and distribution into the reservoir
4. Artificial Lift
Artificial Lift

1. Rod-pump: Pad CN
   - 6 SAGD producers (Tubing liner pump)
   - 2 ISS producers (Insert pump)
   - 5 Infill producers (Insert pump)
   - Rod-pump operational parameters:
     - Pressure: 1,500 – 2,500 kPa
     - Bottom hole temperature: 130 – 180 ºC
     - Fluid production range: 65 – 420 m³/day

2. Gas-lift: All producers (except Pad CN)
   - 88 SAGD producers
   - Gas-lift operational parameters:
     - Pressure: 2,400 kPa – 4,000 kPa
     - Bottom hole temperature: 200 – 240 ºC
     - Gas injection rate: 1,200 – 10,800 m³/day
5. Instrumentation in Wells
Instrumentation – Observation Wells Map
Instrumentation in OBS and SAGD Wells

- 42 OBS Wells with Instrumentation:
  - 34 wells: thermocouple only
  - 8 wells: both thermocouple & piezometer

- 2 Planned OBS Wells (convert existing wells):
  - 2 wells for Pad D North: thermocouple only

- SAGD Injectors – wells use blanket gas to measure pressure and for insulation

- SAGD Producers – equipped with combo instrumentation coil (gas lift & thermocouple or fiber)
  - Combo coil installed in the long production string delivers lift-gas for the long string and provides temperature measurement in the horizontal section
  - Pressure at the heel of producers is estimated from the gas pressure of the lift-gas injected into the annulus (annulus injection provides lift-gas for the short production string)
**Thermocouple and Piezometer OBS Wells**

**Type 1 – Instrumentation Inside Tubing**

- 244.5 mm Surface Casing Landed at ~136 mKB
- 114.3 mm Production Casing Landed at ~492 mKB
- 48.26 mm Tubing String Landed at ~300 mKB
- Piezometer Mounted to Tubing and Landed at 270.0 mKB
- Viking and Clearwater Shale Perforations
- 31.75 mm Coil Tubing with 12 Thermocouples and 1 Piezometer at 469 mKB

**Type 2 – Instrumentation Outside of Casing**

- 219.1 mm Surface Casing Landed at ~485.5 mKB
- 114.3 mm Production Casing Landed at ~582 mKB
- Piezometer and Thermistor Packages Mounted to Exterior of Production Casing

~469 m TVD
~310 m TVD
~493 m TVD
~582 m TVD
~494.5 m TVD
Circulation Strategy

- Key learnings:
  - Same circulation strategy works for Colony and Clearwater
  - Colony had shorter circulation duration due to better reservoir quality and higher water mobility

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Clearwater</th>
<th>Colony</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam Rate (m³/d)</td>
<td>100-120</td>
<td>120-150</td>
</tr>
<tr>
<td>Pressure</td>
<td>Close to initial reservoir pressure</td>
<td>Close to initial reservoir pressure</td>
</tr>
<tr>
<td>Time</td>
<td>3 – 4 months</td>
<td>2 months</td>
</tr>
</tbody>
</table>
6. 4D Seismic
4D Seismic

- No 4D seismic in the reporting period
7. Scheme Performance
Scheme Performance Prediction Methodology

• Current performance prediction built on:
  • Observation of actual performance
  • Analysis of analogous SAGD projects
  • Updated geological model supplemented with simulation and analytical models
Production and Injection History

![Graph showing production and injection history with annotations for plant turnarounds and maintenance periods.]

- 2007 plant turnaround
- 2011 plant shut down for maintenance
- Begin perforation program
- 2012 plant shut down for maintenance
- 2013 plant shut down for maintenance
- 2015 plant shut down for maintenance
Production vs. Approval Capacity Variance

• 32 Original well pairs had poor performance due to:
  • Placement in the transition zone where oil saturation is low
  • Poor start-up strategy (bull-heading); currently circulating
  • Variable steam chamber development

• All new well pairs drilled to the base of SAGD net pay
  • Pad C East
  • Pad B North Infill
  • Pad A Infill and Replacement Wells
  • Pad GA
  • Pad D East
  • Pad CN
  • Pad D North

• Revised completion of new wells
  • Dual string completions in both injector and producer
  • Injectors completed with VITs and steam splitters for Pads D East and CN
  • Wire-wrapped screens for all new producers to increase open area
  • Blanket gas installed on all wells to provide
    • Insulation
    • Casing protection
    • Down hole pressure measurement
Pad C West Performance - Low Recovery Example
Pad C West Heel Observation Well

Tucker Observation Well Temperature vs Depth
100/10-29-064-04W4/06

BH Temperature (deg. C)

Clearwater Top

Clearwater Base

OWC

GAMMA RAY (API)
Pad C West Mid Observation Well
Discussion of Pad C West Performance

• The OBS well 22 m south of C3 Heel showing good steam chamber development

• Pad C West performance indicators as of July 31, 2016:
  • Cum. Oil: 436,027 m³
  • Cum. Steam Injected: 3,962,865 m³
  • Cum. Water Produced: 3,095,590 m³
  • CSOR: 9.1

• Pad C West performance for the reported period:
  • Cum. Oil: 38,015 m³
  • Oil Rate per well: 14.2 m³/day
  • SOR: 8.4
Pad A Performance - Medium Recovery Example
Pad A Wells Heel Observation Well
Pad A Wells Mid Observation Well
Discussion of Pad A Wells Performance

- The OBS well 14.5 m north of A9 heel showing minimal steam chamber development

- Pad A performance indicators as of July 31, 2016:
  - Cum. Oil: 966,984 m³
  - Cum. Steam Injected: 6,143,312 m³
  - Cum. Water Produced: 7,057,765 m³
  - CSOR: 6.4

- Pad A performance for the reported period:
  - Cum. Oil: 192,720 m³
  - Oil Rate per well: 23.3 m³/day
  - SOR: 4.9
Pad C East Mid-Section Observation Well

![Graph showing BH Temperature (deg. C) and other geological layers.](Image)
Pad C East Toe Observation Well
Discussion of Pad C East Performance

- The OBS well 11 m north of C13 toe is showing very good steam chamber development in both horizontal and vertical directions

- Pad C East performance indicators as of July 31, 2016:
  - Cum. Oil: 1,188,189 m$^3$
  - Cum. Steam Injected: 5,733,349 m$^3$
  - Cum. Water Produced: 6,103,733 m$^3$
  - CSOR: 4.8

- Pad C East performance for the reported period:
  - Cum. Oil: 152,085 m$^3$
  - Oil Rate per well: 52.1 m$^3$/day
  - SOR: 4.5

- The well placement was mainly above the transition zone

- Circulation start-up strategy was successfully implemented
Pad Lower Grand Rapids (GA) Performance
Discussion of Pad GA Performance

- Pilot well started in September 2011
- Remaining 5 Well Pairs started by September 2013

- Pad GA performance indicators as of July 31, 2016:
  - Cum. Oil: 276,470 m³
  - Cum. Steam Injected: 1,389,878 m³
  - Cum. Water Produced: 1,894,738 m³
  - CSOR: 5.0

- Pad GA performance for the reported period:
  - Cum. Oil: 77,644 m³
  - Oil Rate per well: 35.5 m³/day
  - SOR: 4.5
Pad B North Performance
Pad B West Performance
Pad D East Performance

2015 plant shut down for maintenance

Graph showing Daily Rates (m³/d) and ISOR, Well Count from Jan-2015 to Jan-2017.
Pad Colony (CN) Performance
New Developments: Pads D North and C West

- Pad D North (8 SAGD well pairs):
  - All injectors will be equipped with VIT and steam splitters
  - All producers will be completed with dual string
  - Drilling completed Q2 2016

- Pad C West (8 Replacement wells):
  - AER Scheme Approval (9835N) received August 18, 2014
  - Drilling started in late July 2016
  - Scheduled for start-up in Q4 2016
OBIP and Recoveries by Pad

• OBIP for each pad is calculated from the formula:

\[
OBIP = L \times W \times H \times (1 - S_w) \times \Phi \times 1/B_o
\]

Where

- \( L \) = Effective Average Length of wells
- \( W \) = Lateral Width covered by the wells
- \( H \) = Thickness from the top of pay to the producer elevation
- \( \Phi \) = Average Porosity in the Pay zone
- \( S_w \) = Average Water Saturation in the Pay zone
- \( B_o \) = Oil Volume factor/Shrinkage factor (taken as 1)
<table>
<thead>
<tr>
<th>Well PAD</th>
<th>OBIP (10^6 m³)</th>
<th>Recovery to Date July 31, 2016 (10^3 m³)</th>
<th>Recovery Factor to Date (%)</th>
<th>Estimated Ultimate Recovery (10^6 m³)</th>
<th>Ultimate Recovery Factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (24 well pairs)</td>
<td>5.4</td>
<td>1,025</td>
<td>19</td>
<td>3.1</td>
<td>59</td>
</tr>
<tr>
<td>B (15 well pairs)</td>
<td>7.2</td>
<td>820</td>
<td>11</td>
<td>3.0</td>
<td>42</td>
</tr>
<tr>
<td>C (20 well pairs)</td>
<td>10.2</td>
<td>1,682</td>
<td>17</td>
<td>5.1</td>
<td>50</td>
</tr>
<tr>
<td>GA (6 well pairs)</td>
<td>2.0</td>
<td>276</td>
<td>14</td>
<td>1.2</td>
<td>59</td>
</tr>
<tr>
<td>D East (15 pairs)</td>
<td>5.4</td>
<td>329</td>
<td>6</td>
<td>3.2</td>
<td>60</td>
</tr>
<tr>
<td>CN (6 well pairs + 7 infill)</td>
<td>1.6</td>
<td>72</td>
<td>5</td>
<td>1.0</td>
<td>60</td>
</tr>
<tr>
<td>Total</td>
<td>31.7</td>
<td>4,204</td>
<td>13</td>
<td>16.5</td>
<td>52</td>
</tr>
</tbody>
</table>
5-Year Outlook of Expected Pad Abandonment

- No pad abandonment anticipated in the next 5 years
Temperature, Pressure and Quality of Steam

• High pressure steam separator delivers steam at a 100% quality

• Steam quality losses are experienced during transportation to the pads

• Steam quality at the wellhead is estimated to be 95%
Composition of Other Injected/Produced Fluids

- Not applicable
Summary of Key Learnings

• Well placement is a critical factor for well performance

• Circulation is the optimum startup procedure for establishing thermal communication in a SAGD process

• Wire-wrapped screens are better for avoiding scaling problem of the production liner

• Steady operating conditions are key to obtaining good steam chamber conformance

• To maintain steady operations and prevent water inflow the operating pressure needs to be constant and close to bottom water pressure
8. Future Plans
Future Plans (2016/2017)

• Pad D North Development:
  • Finish construction, commission & start-up facilities (Q4 2016)
  • Complete 8 SAGD well pairs, circulate/start-up SAGD operations (Q4 2016)

• Pad C West Replacement Wells:
  • Drill & complete 8 replacement injectors and tie-in to existing facilities (Q4 2016)
  • Start-up and commence SAGD operations (Q4 2016)

• Pad D West Development:
  • AER Scheme Approval (9835T) received August 9, 2016
  • Drill & Complete 15 SAGD well pairs (Q1 - Q3 2017)
  • Construct facilities (2017/2018)

• Pad C North Future Development:
  • Based on performance at Pads A infill and replacement wells, B North infill wells, B West and C West replacement wells
  • Evaluate and propose a development strategy for optimizing the resource recovery
3.1.2. Surface - Table of Contents

1. Facilities – slide 87
2. Facilities Performance – slide 99
3. Measurement and Reporting – slide 109
4. Water Production, Injection and Uses – slide 125
5. Sulphur Production – slide 139
7. Compliance Statement – slide 155
8. Non-Compliance Events – slide 158
1. Facilities
Layout (Looking Southeast)

Pad A
Pad B
CPF
Pad C
Pad D
Pad CN
Pad GA
Layout (Looking North)
Central Processing Facility (CPF)
Central Field Facility (CFF - Located at Pad B)
Facility Plot Plan, Central Process Facility (CPF)
Facility Modifications

• Pad CN Commissioning:
  • Commissioned in February 2016 with first steam February 14, 2016

• Pad D North Drilling:
  • Drilling completed Q2 2016
  • Surface facility construction on-going with completion expected in Q4 2016

• Pad C West Replacement Wells:
  • Drilling new injectors and original injectors converted to producers in progress
  • Minor piping modifications

• Commissioning of a 6th OTSG:
  • Construction, commissioning and start-up completed Q4 2015
Pad C and CPF
Facility Modifications – 6th OTSG Addition
2. Facilities Performance
Operating issues:

- Several tube repairs necessary in one of the Once Through Steam Generators (OTSGs). Root cause has been determined as improper long term lay-up procedure, allowing water to lay in sections of the tubes.
- The de-oiled storage tank had severe corrosion under insulation (CUI) on the roof. Plans being developed to repair and reduce the risk of re-occurrence.
- On-going leaking problems with the original dilbit coolers (plate and frame); purchased a new set.
- Erosion damage was found on the inlet emulsion pump and flow control valve.
- The Continuous Emissions Monitoring System (CEMS) unit on the new OTSG failed after 7 months.
Operating Limitations

- No limitations in the reporting period.
Process Water De-Oiling

- The de-oiling process consists of 2 Skim Tanks (in series), IGF and 2 Oil Removal Filters

- The performance of the de-oiling equipment has been close to specifications; performing well

- De-Oiling KPI’s are:
  - FWKO – 1,000 ppm (average 459 ppm)
  - IGF Inlet – 100 ppm (average 112 ppm)
  - IGF Out – 40 ppm (average 93 ppm)
  - ORF Outlet – 20 ppm (average 42 ppm)
Warm Lime Softener (WLS)

- Primary water treatment to produce boiler feedwater
- Feed sources:
  1. De-oiled produced water
  2. Brackish water make-up
  3. Sludge pond water
- Reduces water contaminants:
  1. Hardness - primarily Calcium and Magnesium
  2. Silica - main contaminant due to thermal recovery process
  3. Turbidity - suspended solids
- Produces sludge as waste product - stored in ponds
- Mechanical turbine, rake drives
- Main zones: Mixing, Reaction, Settling
- Produces water effluent with hardness ~20 ppm and silica ~50 ppm
WLS Chemistry / Performance

• Chemistry:
  • Lime – primary hardness control
  • Magnesium Oxide (MagOx) – primary silica reduction
  • Caustic – water pH control, aids softening
  • Sodium Carbonate (soda ash) – permanent hardness removal
  • Polymer – coagulants and flocculants establish sludge bed control

• Performance:
  • The WLS has performed very well to date

• Key KPIs:
  • Soluble Hardness – 30 ppm (average 7 ppm)
  • Silica – 50 ppm (average 41 ppm)
  • Turbidity – 20 NTU (average 17 NTU)
Power Consumption

![Power Consumption Graph]

The graph shows the monthly power consumption in kWh from August 2015 to July 2016. The consumption generally fluctuates with a peak in March 2016 and a trough in October 2015.
Gas Usage

![Bar chart showing gas usage from August 2015 to July 2016. The bars indicate the volume in cubic meters per month, with separate colors for total purchased and total produced.]
Flaring and Venting

- No flaring events over 4 hours in duration or 30,000m³
- No Venting

<table>
<thead>
<tr>
<th>Date</th>
<th>Gas flare (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug-15</td>
<td>0.70</td>
</tr>
<tr>
<td>Sep-15</td>
<td>0.71</td>
</tr>
<tr>
<td>Oct-15</td>
<td>0.34</td>
</tr>
<tr>
<td>Nov-15</td>
<td>1.16</td>
</tr>
<tr>
<td>Dec-15</td>
<td>1.62</td>
</tr>
<tr>
<td>Jan-16</td>
<td>0.32</td>
</tr>
<tr>
<td>Feb-16</td>
<td>11.44</td>
</tr>
<tr>
<td>Mar-16</td>
<td>0.11</td>
</tr>
<tr>
<td>Apr-16</td>
<td>0.46</td>
</tr>
<tr>
<td>May-16</td>
<td>10.91</td>
</tr>
<tr>
<td>Jun-16</td>
<td>5.07</td>
</tr>
<tr>
<td>Jul-16</td>
<td>0.36</td>
</tr>
</tbody>
</table>
Green House Gas (GHG)

- Emission sources considered include stationary combustion associated with steam generators and glycol heaters, flaring, venting and fugitive emissions
- 560,670.19 tonnes of Carbon Dioxide Equivalent were emitted in 2015 (information taken from the Tucker Thermal 2015 report submitted under the Specified Gas Emitters Regulation)
- 4,936 emission performance credits generated

![Quarterly Greenhouse Gas Emissions Graph]
3. Measurement and Reporting
Battery Schematic - AB BT 0089133-344
OIL & DILUENT METERING

<table>
<thead>
<tr>
<th>LABEL</th>
<th>TAG</th>
<th>P&amp;ID#</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1P</td>
<td>FQ032</td>
<td></td>
<td>LACT DILBIT SALES FLOW TOTALIZER</td>
</tr>
<tr>
<td>2P</td>
<td>L3130S</td>
<td>30MF02</td>
<td>DILBIT STORAGE TANK VOLUME</td>
</tr>
<tr>
<td>3P</td>
<td>L3131S</td>
<td>30MF03</td>
<td>DILBIT STORAGE TANK VOLUME</td>
</tr>
<tr>
<td>1D</td>
<td>FQ031</td>
<td>30MF01</td>
<td>DILUENT TO PLANT FLOW TOTALIZER</td>
</tr>
<tr>
<td>2D</td>
<td></td>
<td></td>
<td>DILUENT FLASH VOLUME LOSS (CALCULATED)</td>
</tr>
<tr>
<td>3D</td>
<td></td>
<td></td>
<td>DILUENT SHRINKAGE VOLUME (CALCULATED)</td>
</tr>
</tbody>
</table>

OIL PRODUCTION TOTAL = (PIPELINE METER ± INVENTORY CHANGE) - NET DILUENT VOLUME ADDED + (SHRINKAGE AND FLASH VOLUME LOSS)

(1P + (1 - (AI-095/100))) + (1 + (2P + 3P) - 10 + (2D + 3D))

NOTE: OIL VOLUMES REPORTED TO THE AER ARE CORRECTED FOR SHRINKAGE AND FLASH IN ACCORDANCE WITH Directive 17 Section 14.3
BY PRODUCTION ACCOUNTING

NOTE: AI-095 MEASURES SALES BS&W
Measurement and Reporting – Produced Gas

**GAS METERING**

**LABEL**  | **TAG**  | **PAS#**  | **DESCRIPTION**  
---|---|---|---  
10 | PB0100 | B00116 | TOTAL PURCHASED GAS FLOW TOTALIZER  
30 | PB0310A | B00118 | FWI/TREATERS/STVR GAS FLOW TOTALIZER  
40 | PB0820 | B00117 | GAS TO FIELD MANIFOLD, LIFT GAS, TEST SEPARATOR) FLOW TOTALIZER  
50 | PB0300 | B00120 | TANKAGE BLANKET GAS, VESSEL FUEL GAS, FLOW TOTALIZER  
60 | PB0305 | B00119 | LP FLAME WATER FLOW TOTALIZER  
70 | PB0400 | B00121 | HP PLANE WATER FLOW TOTALIZER  
100 | PB0840 | B00122 | PURGE GAS TO FLARE SYSTEM MEASURED BY GG AND T6  

PRODUCED GAS = GAS FROM FIELD-GAS TO FIELD+ FWI/TREATERS/STVR GAS+ TANKAGE BLANKET GAS, VESSEL FUEL GAS+ LP FLARE GAS  
FLARED GAS = FLARE STACK WATER TOTAL-FLARE SYSTEM PURGE GAS  
FUEL GAS = PURCHASED GAS+PRODUCED GAS-FLARED GAS  
VISIT GAS = THE TANKER FACILITY WAS DESIGNED TO CAPTURE ALL GAS SOURCES FOR USE AS FUEL IN THE EVENT GAS IS VENTED TO ATMOSPHERE THE VOLUME WILL BE ESTIMATED USING GENERALLY ACCEPTED ENGINEERING PRACTICE  
NOTE: IF THE STVR COMPRESSOR IS NOT OPERATIONAL, TANKAGE PRODUCED GAS IS MEASURED BY GG.
Measurement and Reporting – Primary and Secondary Produced Water

- On August 31, 2014 MARP was approved for primary and secondary produced water meters (unable to meet 5% difference)
- 2015 MARP submission detailed a proposed new primary and secondary water measurement:
  - Disposition to injection facility (primary) = produced water at FWKO + Oil Treaters - water pipelined out
  - Secondary produced water measurement method = produced water to ORF ± change in produced water inventory - water pipelined out -100
  - AER indicated deficiencies would be identified and communicated
    - No deficiencies were communicated
    - New water measurement was implemented February 2016
- Significant maintenance required for ultrasonic (USM) meter with limited improvement
- Oil content in FWKO and Treater produced water remains low (less than 500ppm)

<table>
<thead>
<tr>
<th>Date</th>
<th>Unit of Measure</th>
<th>ORF’s Meters</th>
<th>Primary Meter</th>
<th>Secondary Meter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>FWKO+Treater Meters</td>
<td>WLS U/S Meter (USM)</td>
<td>WLS U/S Meter (Orifice Plate)</td>
</tr>
<tr>
<td>2015 Jan 1 – April 30</td>
<td>m³/day</td>
<td>11,224</td>
<td>11,396</td>
<td>12,146</td>
</tr>
<tr>
<td></td>
<td>% Diff</td>
<td>1.52% *</td>
<td>7.89% *</td>
<td>-9.44% *</td>
</tr>
<tr>
<td>2015 June 1 – Dec 31</td>
<td>m³/day</td>
<td>10,852</td>
<td>10,843</td>
<td>11,934</td>
</tr>
<tr>
<td></td>
<td>% Diff</td>
<td>-0.28% *</td>
<td>19.95% *</td>
<td>-11.02% *</td>
</tr>
<tr>
<td>2016 Jan 1 – Sept 30</td>
<td>m³/day</td>
<td>11,615</td>
<td>11,647</td>
<td>13,003</td>
</tr>
<tr>
<td></td>
<td>% Diff</td>
<td>0.28% *</td>
<td>23.91% *</td>
<td>-10.55%*</td>
</tr>
</tbody>
</table>

* % Difference = (Secondary – Primary) / [(Secondary + Primary) / 2] x 100%
Measurement and Reporting – Pad CN Testing
Measurement and Reporting – Steam Injection
Estimating Well Production

- **Oil and Water Estimated by Well Test:**
  - Battery level measurement prorated to wells based on the estimates
  - Correction factor applied to calculated well steam fraction volume
  - No testing completed during circulation on Pad CN

- **Three Test Separator Designs (Well Tests):**
  1. **Blow-Case (Pads A Original, B, C East, C West):**
     - Loadcell or level
     - Vortex for steam + natural gas
     - AGAR water-cut analyzer
  2. **Conventional (Pads B North, A Infill & Replacement Wells, GA, D East):**
     - Coriolis meter for liquid
     - Vortex for steam + natural gas
     - AGAR water-cut analyzer
  3. **Horizontal (Pad CN):**
     - Coriolis meter for liquid
     - Orifice plate for steam + natural gas
     - Phase Dynamics water-cut analyzer

- **Steam fraction calculated** (from \( \frac{P_{\text{sat}}}{P_{\text{meas}}} \)) for all three designs

- **Gas Measured at the Battery (proration = 1):**
  - GOR for August 1, 2015 to July 31, 2016 = 45.1 m³/m³
Water Balance

- **Steam Injection:**
  - Vortex meters on each well toe and heel
  - Total steam to field measured at the battery
  - Steam Proration = 1.005 m³/m³

- **Water Proration Factors (see next slide):**
  - Average 12-Month Rolling Proration Factors
    - Water = 1.208
    - Oil = 1.11

- **Water / Steam Meter Calibrations:**
  - Metering equipment inspected / calibrated annually
  - Annual well steam injection meters inspection as per Directive 017
  - AGAR water cut analyzer calibration program as per Directive 017
  - MARP updated to include all new measurement meters and changes

- **Metering Accuracy:**
  - Accounting meters meets requirements as per Directive 017 single point measurement accuracy
Estimating Well Production – Proration Factors

![Graph showing proration factors for different months and production types, with lines for oil, water, steam, adjusted oil, and adjusted water, indicating trends over time.]
## Well Test Averages

<table>
<thead>
<tr>
<th>Test Separator</th>
<th>Well Group</th>
<th>Average Test Duration (hours/test/month)</th>
<th>Average Test Frequency (well/month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V-151/2</td>
<td>A1-8</td>
<td>3.9</td>
<td>15.5</td>
</tr>
<tr>
<td>V-251/2</td>
<td>B1-12</td>
<td>4.5</td>
<td>9.7</td>
</tr>
<tr>
<td>V-351/2</td>
<td>C1-9</td>
<td>3.7</td>
<td>11.8</td>
</tr>
<tr>
<td>V-391/2</td>
<td>C13-20</td>
<td>4.1</td>
<td>16.4</td>
</tr>
<tr>
<td>V-170</td>
<td>A9-20</td>
<td>4.3</td>
<td>12.2</td>
</tr>
<tr>
<td>V-171</td>
<td>A21-24</td>
<td>7.2</td>
<td>17.8</td>
</tr>
<tr>
<td>V-213A</td>
<td>B9EP</td>
<td>22.3</td>
<td>28.9</td>
</tr>
<tr>
<td>V-214A</td>
<td>B10EP</td>
<td>22.8</td>
<td>28.8</td>
</tr>
<tr>
<td>V-540</td>
<td>GR01-06</td>
<td>5.1</td>
<td>21.6</td>
</tr>
<tr>
<td>V-440</td>
<td>D24-33</td>
<td>4.4</td>
<td>14.6</td>
</tr>
<tr>
<td>V-450</td>
<td>D34-38</td>
<td>5.8</td>
<td>15.9</td>
</tr>
<tr>
<td>V-630</td>
<td>CN2,4,6,8,10,12</td>
<td>18.3</td>
<td>4.7</td>
</tr>
<tr>
<td>V-640</td>
<td>CN7,9</td>
<td>Circulating</td>
<td>Circulating</td>
</tr>
</tbody>
</table>
Solvents and Condensable Gas

- Bitumen production accounts for diluent flash and volumetric shrinkage
- No solvent injection to reservoir
- There is no non-condensable gas injection
Measurement Initiatives – Continuous Improvement

- MARP updated February 28, 2016

- Technical issues identified with measurement equipment:
  - Lift gas meter transmitter range increased

- Husky Enhanced Production Audit Program (EPAP) completed

- Implemented improvements:
  - Detailed review of measurement schematics to include:
    - Pad CN test separator and steam injection
  - Correction factor for estimated produced water steam fraction volume portion
  - Operational procedure for on-line BS&W analyzer troubleshooting

- Future opportunities:
  - Pad CN Phase Dynamics individual well characteristics set-up
  - Test separators overhead gas meter sizing verification
4. Water Production, Injection and Uses
Brackish Water

- Make-up water for steam generation
- McMurray Formation
- 3 Source Wells:
  - 1F1/11-30-064-04 W4M
  - 1F1/12-30-064-04 W4M
  - 1F1/08-25-064-04 W4M
Water Usage

- Using brackish water ~20,000 ppm Total Dissolved Solids (TDS) for steam generation (when required)

- Normally no fresh water is used in our process
Brackish Water Consumption

The diagram illustrates the consumption of brackish water from August 2015 to July 2016. The x-axis represents the months from August 2015 to July 2016, and the y-axis represents volumes in cubic meters per month, ranging from 0 to 50,000 m³.

Three different categories are represented by different colored bars:
- 1F1/12-30-064-04W4/00 (blue)
- 1F1/11-30-064-04W4/00 (red)
- 1F1/08-25-064-04W4/00 (green)

The highest consumption is observed in May 2016, with volumes over 45,000 m³, while the lowest consumption is in October 2015, with volumes below 5,000 m³.
Fresh Water

- Water Diversion Licence Amendment No. 00194427-00-01

- Domestic use only:
  - Safety showers / eye-wash stations
  - Cleaning water
  - Washroom / kitchen uses

- Bonnyville Aquifer

- 12-28-064-04-W4
Fresh Water Consumption

Volume (m$^3$) / Month

- Aug-15
- Sep-15
- Oct-15
- Nov-15
- Dec-15
- Jan-16
- Feb-16
- Mar-16
- Apr-16
- May-16
- Jun-16
- Jul-16

Data: 10/21/2016 0
Produced Water & Steam Injected
Water Disposal Limits
Monthly Injection Water Balance

Imbalance: \[
\frac{(\text{Total Water IN} - \text{Total Water OUT})}{\text{Total Water IN}} \times 100
\]
OTSG Blow-down Recycle

- OTSG blow-down is recycled to the Warm Lime Softener (WLS) at a percentage that allows the total dissolved solids, out of the OTSG, to remain below 50,000 uS/cm
- Brackish water make-up has a very high TDS and affects OTSG blow-down recycle
- Recycle approximately 40.4% of our blow-down back to the WLS
Disposal Wells

• AER Class 1 Wastewater Disposal Wells

• Boiler blow-down disposal:
  • 1AA/12-21-064-04 W4M (AER Approval 10591)
  • 1F1/11-28-064-04 W4M (AER Approval 10591)
  • 00/04-28-064-04W4/0 (AER Approval 10591A) – licensed

• Water treatment process disposal:
  • 00/14-29-064-04 W4M (AER Approval 10591)
Disposal Wellhead Injection Pressures & Volumes

Average Monthly Injected Pressures (kPa)

Injected Volumes (m³) / Month

1AA/12-21-064-04W4
1F1/11-28-064-04W4
100/14-29-064-04W4
1AA/12-21-064-04W4
1F1/11-28-064-04W4
100/14-29-064-04W4
Landfill Waste Handling

• No landfill within facility
• All landfill waste streams disposed offsite at licensed facilities
<table>
<thead>
<tr>
<th>AER Waste Code</th>
<th>Waste Description</th>
<th>Location Sent To</th>
<th>Final Handling Method</th>
<th>Total</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACID</td>
<td>Acid Solutions Unneutralized</td>
<td>Rbw Waste Management Ltd.</td>
<td>Other (specify)</td>
<td>0.113</td>
<td>m3</td>
</tr>
<tr>
<td>CAUS</td>
<td>Caustic Solutions Unneutralized, Spent</td>
<td>Rbw Waste Management Ltd.</td>
<td>Recycling Facility (excluding used oil)</td>
<td>0.2</td>
<td>m3</td>
</tr>
<tr>
<td>CLNRAG</td>
<td>Clean Rags</td>
<td>Rbw Waste Management Ltd.</td>
<td>Recycling Facility (excluding used oil)</td>
<td>0.205</td>
<td>m3</td>
</tr>
<tr>
<td>COEMUL</td>
<td>Interphase &gt; 20%, Oil &lt;= 30%</td>
<td>Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>13</td>
<td>m3</td>
</tr>
<tr>
<td></td>
<td>Interphase 0 - 10%, Oil &lt;= 30%</td>
<td>Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>36</td>
<td>m3</td>
</tr>
<tr>
<td></td>
<td>Interphase 10.1 - 20.0%, Oil &lt;= 30%</td>
<td>Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>64</td>
<td>m3</td>
</tr>
<tr>
<td></td>
<td>Cavern Waste Oil - Solids</td>
<td>Tervita - Lindbergh</td>
<td>Cavern</td>
<td>1648.08</td>
<td>m3</td>
</tr>
<tr>
<td>DOMWST</td>
<td>Garbage Domestic Waste</td>
<td>Rbw Waste Management Ltd.</td>
<td>Recycling Facility (excluding used oil)</td>
<td>67.06</td>
<td>m3</td>
</tr>
<tr>
<td>EMTCON</td>
<td>Empty Container (rbw Container)</td>
<td>Rbw Waste Management Ltd.</td>
<td>Recycling Facility (excluding used oil)</td>
<td>3.35</td>
<td>m3</td>
</tr>
<tr>
<td>FILWTT</td>
<td>Cavern Filter (Media) Water Treatment</td>
<td>Tervita - Lindbergh</td>
<td>Cavern</td>
<td>124.7</td>
<td>m3</td>
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<tr>
<td>GLYCHM</td>
<td>Glycol Solutions Containing Lead or Other Heavy Metals</td>
<td>Rbw Waste Management Ltd.</td>
<td>Recycling Facility (excluding used oil)</td>
<td>0.205</td>
<td>m3</td>
</tr>
<tr>
<td>INOCHM</td>
<td>Chemicals Inorganic</td>
<td>Rbw Waste Management Ltd.</td>
<td>Recycling Facility (excluding used oil)</td>
<td>1.4</td>
<td>m3</td>
</tr>
<tr>
<td>OILABS</td>
<td>Absorbents</td>
<td>Rbw Waste Management Ltd.</td>
<td>Recycling Facility (excluding used oil)</td>
<td>1.045</td>
<td>m3</td>
</tr>
<tr>
<td>OILRAG</td>
<td>Oily Rags</td>
<td>Rbw Waste Management Ltd.</td>
<td>Recycling Facility (excluding used oil)</td>
<td>1.1</td>
<td>m3</td>
</tr>
<tr>
<td>SLGHYD</td>
<td>Sludge Hydrocarbon</td>
<td>Tervita - Lindbergh</td>
<td>Cavern</td>
<td>16.48</td>
<td>m3</td>
</tr>
<tr>
<td>SMETAL</td>
<td>Metal Scrap</td>
<td>Rbw Waste Management Ltd.</td>
<td>Recycling Facility (excluding used oil)</td>
<td>4.76</td>
<td>m3</td>
</tr>
<tr>
<td>SOILCO</td>
<td>Contaminated Debris and Soil Crude Oil Condensate</td>
<td>Clean Harbors - Ryley Class Ia</td>
<td>Class Ia Landfill</td>
<td>7</td>
<td>m3</td>
</tr>
<tr>
<td>WSTMIS</td>
<td>Waste Miscellaneous</td>
<td>Rbw Waste Management Ltd.</td>
<td>Recycling Facility (excluding used oil)</td>
<td>11.2</td>
<td>m3</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td></td>
<td></td>
<td>1999.90</td>
<td>m3</td>
</tr>
</tbody>
</table>
5. Sulphur Production
Sulphur Dioxide (SO\textsubscript{2}) Sources

- Six Once-Through Steam Generators (OTSG)
- One High Pressure Flare Stack
- One Low Pressure Flare Stack
<table>
<thead>
<tr>
<th>Quarter</th>
<th>Period</th>
<th>Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q3 2015</td>
<td>(August 2015 – October 2015)</td>
<td>33.91 tonnes</td>
</tr>
<tr>
<td>Q4 2015</td>
<td>(November 2015 – January 2016)</td>
<td>34.18 tonnes</td>
</tr>
<tr>
<td>Q1 2016</td>
<td>(February 2016 – April 2016)</td>
<td>38.61 tonnes</td>
</tr>
<tr>
<td>Q2 2016</td>
<td>(May 2016 – July 2016)</td>
<td>56.38 tonnes</td>
</tr>
</tbody>
</table>
SO₂ Emissions Trends

SO₂ Emissions Daily Average Per Month

SO₂ Emission Limit - 1.96 t / d
Peak and Average SO$_2$ Emissions

- August 1, 2015 to July 31, 2016:
  
<table>
<thead>
<tr>
<th>SO$_2$ Emissions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Daily (highest)</td>
<td>0.75</td>
</tr>
<tr>
<td>Maximum Daily (highest)</td>
<td>0.96</td>
</tr>
</tbody>
</table>

- Limit under EPEA Approval is 1.96 tonnes/day

- No exceedences
Ambient Air Monitoring

- Ambient air quality is currently monitored by the Lakeland Industry and Community Association (LICA) - Air Shed committee. LICA is under contract from Alberta Environmental Monitoring and Science Division (EMSD) of Alberta Environment and Parks (AEP) to provide these services.

- No exceedences were recorded during the last reporting period.

- Airshed quality results available on LICA website or Clean Air Strategic Alliance (CASA) Data Warehouse.

  - [http://www.lica.ca/](http://www.lica.ca/)
  - [http://www.casadata.org/](http://www.casadata.org/)
6. Environmental Issues
Environmental – Compliance to Approvals

• EPEA Approval:
  • No compliance issues during this reporting period

• AER:
  • No compliance issues during this reporting period

• DFO:
  • No compliance issues during this reporting period
Environmental - Amendments to EPEA Approval

- No amendments to EPEA approval 147753-01-00 during the reporting period
Environmental – Wildlife

• As part of the regulatory approval, Husky has developed and implemented a Wildlife Monitoring Program (WMP) for:
  • Canadian toad distribution, abundance and population status
  • Above Ground Pipeline (AGP) monitoring to ensure wildlife can cross under the lines
  • Wildlife Habitat Enhancement Program (WHEP)

• Annual WMP report describes the observations and results collected during the previous year
Environmental - Industrial Wastewater

• Disposal Locations:
  • Boiler blow-down disposal 12-21-064-04W4M and 11-28-064-04W4M
  • Water treatment process disposal 14-29-064-04W4M
  • 366,971.6 m$^3$ was disposed

• Domestic Wastewater:
  • Domestic waste sludge is disposed of at the Cold Lake Municipal Treatment Facility or the Bonnyville Municipal Treatment Facility

• Industrial Run-off (from 2015 Annual Waste Water Report):
  • Total of six discharge locations (Well Pads: A, B, C, GA, CN and the run-off retention pond located on CPF)
  • A total of 33,441 m$^3$ surface water was discharged due to a very wet year
  • All discharges were in compliance with EPEA approval
Environmental - Soils

- No soil monitoring activities were conducted during the reporting period
Environmental – Air

- Air related monitoring, reporting and studies are conducted by Lakeland Industry and Community Association (LICA) under contract from Alberta Environmental Monitoring and Science Division (EMSD)

- The LICA airshed monitoring network consists of:
  - 4 continuous monitoring stations
  - 26 passive monitoring stations
  - 2 volatile organic compound and polycyclic aromatic hydrocarbon samplers, and
  - 2 soil acidification monitoring plots
Environmental – Ground Water

• Groundwater monitoring program includes:
  • CPF Groundwater: monitors shallow groundwater quality beneath the CPF
  • Pad-specific Groundwater: monitors possible impacts to groundwater quality
  • Regional Groundwater: monitors possible effects on regional groundwater quality between
    the project areas and the local lakes and streams

• Expansion to Groundwater Monitoring Program:
  • No additional expansion to the monitoring network occurred during this reporting period
Environmental – Initiatives

• Alberta Environmental Monitoring and Science Division (EMSD)

• Participation in the Lakeland Industry and Community Association (LICA)
  • Board of Directors
  • Beaver River Watershed Alliance
  • Airshed

• Participation in Alberta Biodiversity Monitoring Institute (ABMI)
Environmental – Reclamation

- Objectives of the Annual Report (demonstrate and document):
  - Compliance with the development and reclamation approval
  - Site conditions and successful reclamation
  - General project development (surface disturbances) and reclamation activities
  - Problem areas and resolution

- Site Clearing and Timber Salvage:
  - No site clearing or timber salvage occurred during this reporting period

- Vegetation Monitoring:
  - Annual weed monitoring and control as per Husky’s best practices

- Reclamation Activities:
  - No permanent reclamation activities were completed during the reporting period
7. Compliance Statement
Compliance

- AER
  - All conditions of AER License F-32143 as well as all scheme approvals for the project were met during the reporting period
  - All conditions of the EPEA approval 147753-01-00 were met during the reporting period
Self Declarations

• No self declaration in this reporting period
8. Non-Compliance Events
Non-Compliance Issues

- Reportable Pipeline incident – Above ground pipeline release due to pin hole in control valve during start-up steaming of Pad CN:
  - Reported March 14, 2015
  - Release contained on pad-site
  - Replaced failed valve with new valve and changed steam start-up operation
  - AER closure letter received July 26, 2016

- Berm breach – Pad C:
  - Reported March 30, 2016

- Alberta CEMS code – B7300 CEMS unit failure
  - Reported July 7, 2016
  - CEMS unit failed and sent to manufacturer (SICK) in Ontario for repairs

- Alberta CEMS code – B7800 CEMS unit failure
  - Reported August 23, 2016
  - After trouble shooting with manufacturer replacement parts shipped
SCVF/GM Update – Summary

• On-going, yearly monitoring of existing, non-serious vent flows in accordance with AER ID 2003-01

• SCVF testing procedure ensures test accuracy & repeatability:
  • If vent flow exists, condenser used to separate and allow measurement of non-condensable flow

• Key learnings:
  • Dual-string completions used to inject steam to the heel and toe of wells
  • C13S SCVF issues mitigated with VIT installation
SCVF/GM Update – C13S

• C13S SCVF Update:
  • Currently, no SCVF
  • Quarterly of $H_2S$ and SCVF
  • Quarterly monitoring of temperature
  • Temperature log trend deviation commenced in June 2015

• Background Information:
  • Installation of VIT and temp monitoring, December 20, 2013
  • Resumed steaming to test remediation, December 24, 2013
  • Results: No SCVF or $H_2S$ since December 23, 2013
  • Update presentation to AER on May 29, 2014

• Husky commitment:
  • Quarterly monitoring of $H_2S$, SCVF and temperature
  • Update in annual performance presentation
SCVF/GM Update – C13S Cont’d

Status:
• Currently, no SCVF at C13S
• Multiple temperature deviations along tubing
  – Maximum temperature of approximately 174 °C between 90-100 m interval
  – Increased temperature due to loss-of-insulating properties in the Vacuum Insulated Tubing (VIT)

Plan:
• Continue quarterly monitoring of temperature, SCVF and H₂S
• Next temperature log (September 2016)
• Husky will notify AER of any changes
8. Future Plans
Future Plans (2016/2017)

• Construct, commission & start-up Pad D North SAGD development
• Construct, commission & start-up Pad C West Replacement wells
• Start construction of Pad D West SAGD development