3.1.1. Subsurface – Table of Contents

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1. Brief Background
Project Overview

- AER Commercial Scheme Approval No. 9835
- 30,000 BOPD SAGD Project
- Clearwater and Grand Rapids Reservoirs
- 9-10º 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
- **35 Year Project Life**
- **109 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
    - Pad C West Replacement 2016 – 8 injectors
    - Pad D West 2017 - 15 well pairs
Site Overview

• Field Facilities – six well pads, infield pipelines and 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>36.7</td>
<td>46</td>
<td>0.32</td>
<td>0.57</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>
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</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>
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</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>
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</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  
OBIP = Area x Thickness x Φ x So
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

Legend:
- Red: Clearwater Approval Boundary
- Green: Lower Grand Rapids Approval Boundary
- Orange: Colony Approval Boundary
- Blue: Lease Boundary
- C.I. = 5 m

Map features include topographic and geological contours, indicating variations in elevation and material properties, relevant for exploration and industrial applications.
Structure Map of the Clearwater Base of Net Pay
Isopach of Clearwater Bottom Water

C.I. = 5 m

Clearwater Approval Boundary
Lower Grand Rapids Approval Boundary
Colony Approval Boundary
Lease Boundary

C.I. = 5 m
Isopach of Clearwater Transition Zone

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

C.I. = 5 m
Isopach Map of Lower Grand Rapids SAGD Net Pay

Definition of Net Pay:
Top Sparky Pay – 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
- 2017 well
- C.I. = 5 mASL
Structure Map of the Lower Grand Rapids Base of Net Pay
Isopach Lower Grand Rapids Transition Zone

C.I. = 5m

Clearwater Approval Boundary
Lower Grand Rapids Approval Boundary
Lease Boundary
2017 well

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

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

Transition Zone

Bottom Water

McMurray Silt, Sand, Clay

Cored Interval

Calcite cemented zones

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

Top

Bottom

0.75 m

GR, TVD, Resistivity, Density
Sparky Formation Type Log

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Depth</th>
<th>Resistivity</th>
<th>Porosity</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP</td>
<td>100</td>
<td>2000</td>
<td>0.5</td>
</tr>
<tr>
<td>Clearwater</td>
<td>300</td>
<td>2000</td>
<td>0.5</td>
</tr>
<tr>
<td>Colorado</td>
<td>500</td>
<td>2000</td>
<td>0.5</td>
</tr>
<tr>
<td>Lower Grand</td>
<td>700</td>
<td>2000</td>
<td>0.5</td>
</tr>
<tr>
<td>Grand Rapids</td>
<td>900</td>
<td>2000</td>
<td>0.5</td>
</tr>
</tbody>
</table>

103/10-32-064-04W400
KB = 623.7 m

Top

0.75 m

Bottom

Cored Interval

Water sand

Calcite

Bitumen saturated channel sand
Cored Wells and Special Core Analysis

- Sparky Petrography

- Moderately well sorted sand, dominantly upper very fine grained
- Feldspar-rich (up to 28 wt % XRD) and lithic unconsolidated sandstone
- Monocrystalline quartz grains make up the majority of the detrital clasts (up to 60 wt% XRD)
- Lithic clasts: include chert, volcanics, organics, minor dolomite, and detrital clay (up to 23 wt. % XRD)

- Viscosity @ 20°C varies between 313,000 cp to more than 1,000,000 cp
Representative Structural N-S Cross-section through the Approval Area

N  

Pad A  
Pad B  
Pad C  
Pad D  

S

Pad A  
Pad B  
Pad C  
Pad D  

D Valley  
C Valley  
B Valley  
Transition Zone  
Bottom Water  
Wabiskaw  
D Marine
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>Capping Shale Issues to date</th>
<th>Capping shale 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>20.0</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>
</tr>
</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 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
- Orange: Injectors / converted to producer
- Dark Green: Producers / shut in
Pad B North Well Spacing Schematic

- 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 C West (C1 – C8 drilled 2005)

• Pad C West replacement injectors (C1R – C8R drilled 2016) are 5m directly above injectors

Legend

- Red: New Replacement Injectors
- Green: Injectors / converted to producer
- Black: Old Producers / shut in

N

C1 C2 C3 C4 C5 C6 C7 C8

5m 100m 5m
## 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>D West</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 during the reporting period
3. Drilling and Completions
Drilling Results

Pad C West:
• 8 replacement injectors Q3 2016

Pad D West:
• 15 well pairs Q2 2017

116/05-32-064-04W40:
• 1 strat well drilled in Q1 2017
  (TD in Rex Formation)
Summary of Well Completions

Injectors (109 SAGD Injectors):
- All injectors completed with Slotted Liner: 109 (includes Pad D West)
- Injectors completed with Vacuum Insulated Tubing (VIT): 31
  - Pad C: 2
  - Pad D: 23 (does not include Pad D West yet)
  - Pad CN: 6
- Injectors completed with Steam Splitters: 36
  - Pad B: 7
  - Pad D: 23 (does not include Pad D West yet)
  - Pad CN: 6

Producers (116 Producers: 109 SAGD Producers and 7 Infill Producers):
- Producers completed with Slotted Liner: 38
  - Pad A: 8
  - Pad B: 12
  - Pad C: 18
- Producers completed with Wire Wrap Screen (WWS): 78
  - Pad A: 16
  - Pad B: 3
  - Pad C: 2
  - Pad D: 38 (includes Pad D West)
  - Pad GA: 6
  - Pad CN: 13
SAGD Well Pad CN - Injector with VIT
SAGD Well - Producer with Gas-Lift

13-3/8", J-55, 81.1 kg/m BTC Surface Casing landed at 181 mKB

9-5/8" K-55, 59.53 kg/m, Tenaris Blue Intermediate Casing landed at 719 mKB.

**Production Long String**

3-1/2" 13.83 kg/m, FJ HYDRIL 511 WEDGE Long String landed @ 1734 mKB w/ 1-1/4" Combo Coil Inside

**Gaslift / Instrumentation**

31.8mm Combo Gaslift/LX Six Instrumentation Coll. Gaslift port @ 613 mKB & Bottom landed @ 1729 mKB.

**Short String**

2-7/8" L-90, 9.52 kg/m, FJ HYDRIL 511 WEDGE SAGD Short String landed @ 643 mKB w/ Gaslift Port @ 643 mKB with 2-3/8", 6.85 kg/m, FJ HYDRIL 511 WEDGE inside 7" liner @ 725.9 mKB

0.014" x 7" K-55, 43.16 kg/m, BLUE SAGD WIRE WRAPPED SCREEN landed @ 1753 mKB

9-5/8" x 7" Liner Hanger @ 690mKB

TVD: 477.41 mKB
MD: 1765 mKB
SAGD Well Pad CN - Producer with Rod-Pump

- **Surface Casing**: 339.7 mm (13 3/8"), 81.1 kg/m, J-65 LT&C
  Landed at 155.00 mKB

- **Intermediate Casing**: 244.5 mm (9 5/8"), 60.52 kg/m, L-80, Tenara Blue
  Landed at 696.06 mKB

- **Long Injection String**
  (to remain in the hole after steam circulation)
  73.0 mm, 9.52 kg/m, J-66 Tenara BTL Tubing
  From Surface to 1,317.00 mKB MD

- **Production String**
  114.3 mm, 17.02 kg/m, J-65 Tenara BTL Tubing, Tubing clean,
  Tubing Pump 40-47% THD, 34-4-0 set on the bottom of the tubing string
  Tubing landed at 346.65 mKB MD
  Pump landed at 361.65 mKB MD

- **Rods & Pump**
  38.1 mm (1.5") stainless steel polished rod
  60.8 m of 60.8 mm (2") inner bar
  25.4 mm (1") 160K Pro rod or 46K shear pump on/off tool

- **177.8 mm (7") Wire Wrapped Screen**
  0.254 mm (0.01") slots

- **244.5 mm x 177.8 mm Import Liner Hanger**
  Top Landed at 561.38 mKB

**TVD**: 259.43 mKB
**MD**: 1,357.0 mKB
Intermittent Steam Stimulation Well Pad CN - Producer with Rod-Pump

Surface Casing
339.7 mm (13.38"), 81.1 kpsi, J-55 LT&C
Landed at 154.00 mKB

Intermediate Casing
244.5 mm (9.64"), 55.53 kpsi, L-80, Tenaris Blue
Landed at 530.89 mKB

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

Production String
114.3 mm, 17.67 kpsi, J-55 Tenaris BTL Tubing,
Tubing string
Tubing landed at 341.42 mKB MD
Pump landed at 362.42 mKB MD

Rods & Pump
33.1 mm (1.3") stainless steel polished rod
50.8 m of 50.8 mm (2") sinker bar
26.4 mm (1") 890M Pro-rod xw49K shear
insert pump 40-325-RWA-25-4-6

177.8 mm (7") Wire Wrapped Screen
0.254 mm (0.01") slots

Pump Tangent 60°
244.5 mm x 177.8 mm Import Liner Hanger
Top Landed at 501.48 mKB

TVD: 325.22 mKB
MD: 1,530.0 mKB
Completions - Key Learnings

Production - Slotted Liners vs Wire Wrap Screens (WWS):

- Slotted liner scaling has been a chronic problem:
  - Short term solution - Acidization
  - Long term solution - perforated liners
- WWS, which increase the open area, used in producers drilled since 2009:
  - No scaling issues observed in these wells
- Current plan is to complete future producers with WWS

Injection - Vacuum Insulated Tubing (VIT) 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

Rod-pump: 13 (Pad CN only)
- 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

Gas-lift: 88, all producers except Pad CN
- 88 SAGD producers (does not include Pad D West)
- 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 in OBS and SAGD Wells

• 44 OBS Wells with Instrumentation:
  • 36 wells: thermocouple only
  • 8 wells: both thermocouple & piezometer

• 4 Planned OBS Wells (convert existing wells):
  • 3 wells for Pad D West: thermocouple only
  • 1 well (Pad GB thermocouple and piezometers)

• 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

- Tucker Observation Well
- 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

- Tucker Observation Well
- 219.1 mm Surface Casing Landed at ~103.5 mKB
- 114.3 mm Production Casing Landed at ~583 mKB
- Piezometer and Thermistor Packages Mounted to Exterior of Production Casing
6. 4D Seismic
4D Seismic

- No new Seismic data run or interpreted during the reporting period
7. Scheme Performance
Scheme Performance Prediction Methodology

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

- Since 2008 all well pairs drilled to the base of SAGD net pay

- Revised completion of new wells
  - Dual string completions in both injector and producer
  - Injectors completed with VITs and steam splitters for Pads D East, D North 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

![Graph showing Pad C West Performance - Low Recovery Example](image-url)
Pad C West Heel Observation Well
Pad C West Mid Observation Well
Pad C West Toe Observation Well
Discussion of Pad C West Performance

- The OBS wells along C3 show non-uniform steam chamber development

- To improve production from this pad, new injectors 5 m above exiting injectors were drilled and existing injectors were converted to producers

- Pad C West performance indicators as of July 31, 2017:
  - Cum. Oil: 462,734 m³
  - Cum. Steam Injected: 4,155,958 m³
  - Cum. Water Produced: 3,232,458 m³
  - CSOR: 9.0

- Pad C West performance for the reporting period:
  - Cum. Oil: 27,601 m³
  - Oil Rate per well: 12.6 m³/day
  - SOR: 7.3
Pad A Performance - Medium Recovery Example
Pad A Wells Heel Observation Well

Tucker Observation Well
Temperature vs Depth
103/15-32-064.04W4/00

BH Temperature (deg. C)

14.5 meter North of A9 heel

Vertical Depth (m)

Clearwater Top

OWC

Clearwater Base

GAMMA RAY (API)
Pad A Wells Mid Observation Well
Discussion of Pad A Wells Performance

- The OBS wells near A9 showing minimal steam chamber development

- Pad A performance indicators as of July 31, 2017:
  - Cum. Oil: 1,227,520 m$^3$
  - Cum. Steam Injected: 7,899,493 m$^3$
  - Cum. Water Produced: 9,162,368 m$^3$
  - CSOR: 6.4

- Pad A performance for the reporting period:
  - Cum. Oil: 202,759 m$^3$
  - Oil Rate per well: 25.2 m$^3$/day
  - SOR: 4.3
Pad D East Performance – High Recovery Example

2015 plant shut down for maintenance

<table>
<thead>
<tr>
<th>Date</th>
<th>Cal Dly Oil</th>
<th>Cal Dly Water</th>
<th>Cal Inj Steam</th>
<th>ISOR</th>
<th>Well Count</th>
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<tbody>
<tr>
<td>Jan-2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Jan-2016</td>
<td></td>
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<tr>
<td>Jan-2017</td>
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</tr>
<tr>
<td>Jan-2018</td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>
Pad D East Mid Observation Well
Pad D East Toe Observation Well
Discussion of Pad D East Performance

• Since steam commenced in Q2 2015, high temperature has not been observed at the OBS wells

• Pad D East performance indicators as of July 31, 2017:
  • Cum. Oil: 696,316 m³
  • Cum. Steam Injected: 1,919,170 m³
  • Cum. Water Produced: 1,916,785 m³
  • CSOR: 2.8

• Pad D East performance for the reporting period:
  • Cum. Oil: 367,935 m³
  • Oil Rate per well: 67.2 m³/day
  • SOR: 2.6
Pad B North Performance
Pad C North Performance
Pad C East Performance
Pad D North Performance
Pad Lower Grand Rapids (GA) Performance

- Water-steam-ratio is high due to the presence of bottom water and high water mobility in the reservoir
- Operating pressure at or slightly below the bottom water pressure to optimize steam efficiency
- Steam injection rates are optimized on a weekly basis based on well performance and total water produced from each well pair
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, 2017:
  - Cum. Oil: 353,744 m³
  - Cum. Steam Injected: 1,725,549 m³
  - Cum. Water Produced: 2,311,070 m³
  - CSOR: 4.9

- Pad GA performance for the reporting period:
  - Cum. Oil: 77,847 m³
  - Oil Rate per well: 35.5 m³/day
  - SOR: 4.4
Pad Colony (CN) Performance
Discussion of Pad CN Performance

- First steam in February 2016
- 6 SAGD pairs and 7 infill wells

- Pad CN performance indicators as of July 31, 2017:
  - Cum. Oil: 291,311 m³
  - Cum. Steam Injected: 682,217 m³
  - Cum. Water Produced: 638,727 m³
  - CSOR: 2.3

- Pad CN performance for the reporting period:
  - Cum. Oil: 219,439 m³
  - Oil Rate per well: 98.8 m³/day
  - SOR: 2.1
New Development: Pad D West

- Pad D West (15 SAGD well pairs):
  - 8 injectors will be equipped with VIT and steam splitters
  - 7 injectors will be equipped with bare tubing and steam splitters
  - All producers will be completed with dual string
  - Drilling completed Q2 2017
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)
## OBIP and Recoveries by Well Pad

<table>
<thead>
<tr>
<th>Well PAD</th>
<th>Thickness (m)</th>
<th>Area (10² m²)</th>
<th>Pad Volume¹ (10⁶ m³)</th>
<th>So</th>
<th>PhiE</th>
<th>OBIP (10² m³)</th>
<th>Recovery to Date 7/31/2017 (10³ m³)</th>
<th>Recovery Factor to Date (%)</th>
<th>Estimated Ultimate Recovery (10⁴ m³)</th>
<th>Ultimate Recovery Factor (%)</th>
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<tbody>
<tr>
<td>A Pad</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>A Infills and Replacement (16 well pairs)</td>
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<tr>
<td>A original (8 well pairs)</td>
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<td>640</td>
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<td></td>
<td></td>
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<tr>
<td>B Pad</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>B West (8 well pairs)</td>
<td>37</td>
<td>640</td>
<td>39.8</td>
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<td>7.3</td>
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<td>13</td>
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<tr>
<td>B North (4 well pairs)</td>
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<td>320</td>
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<tr>
<td>B North Infills (3 well pairs)</td>
<td>40</td>
<td>345</td>
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<tr>
<td>C Pad</td>
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<tr>
<td>C West (8 well pairs)</td>
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<td>5.1</td>
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<tr>
<td>C North (4 well pairs)</td>
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<td>320</td>
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</tr>
<tr>
<td>C East (8 well pairs)</td>
<td>43</td>
<td>640</td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>D East (15 well pairs)</td>
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<tr>
<td>D North (8 well pairs)</td>
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<td>0.61</td>
<td>0.33</td>
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<td>2</td>
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<td>GA Pad (6 well pairs)</td>
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<td>18</td>
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<tr>
<td>CN Pad (6 well pairs + 7 infill)</td>
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<td>6.5</td>
<td>0.82</td>
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<td>1.5</td>
<td>292</td>
<td>18</td>
<td>1</td>
<td>60</td>
</tr>
</tbody>
</table>

**Note:**

¹ Due to rounding of values, the calculated values may not equal the individual values presented in the 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 (2017/2018)

- Pad D West Development:
  - Finish construction, commission & start-up facilities (Q4 2017/Q1 2018)
  - Complete 15 SAGD well pairs, circulate/start-up SAGD operations (Q4 2017/ Q1 2018)

- Pad B West Replacement Wells:
  - Based upon performance of Pad C West Replacement wells (2018)

- Pad C North Future Development:
  - Evaluate and propose a development strategy for optimizing the resource recovery
3.1.2. Surface - Table of Contents

1. Facilities – slide 90
2. Facilities Performance – slide 100
3. Measurement, Accounting and Reporting – slide 110
4. Water Production, Injection and Uses – slide 124
5. Sulphur Production – slide 138
6. Environmental Issues – slide 144
7. Compliance Statement – slide 154
8. Non-Compliance Events – slide 157
1. Facilities
Layout (Looking Southeast)
Central Processing Facility (CPF)
Central Field Facility (CFF - Located at Pad B)
Facility Modifications

• Pad C West Replacement Well Commissioning:
  • Commissioned new injectors and original injectors converted to producers in Q4 2016

• Pad D North Commissioning:
  • Surface facility construction & commissioning completed in Q4 2016

• Pad D West Drilling and Construction:
  • Drilling completed Q2 2017
  • Surface facility construction on-going with completion expected in Q4 2017/Q1 2018
Pad C West Replacement Wells

- Pad C East
- Pad C North
- Pad C West (including Replacement Wells)
Pads D North and D West

Pad D North

Pad D East

Pad D West
2. Facilities Performance
Operating Issues

Operating issues:

- The de-oiled storage tank had the roof replaced due to corrosion under insulation (CUI)

- Warm Lime Softener (WLS):
  - The WLS scrapper rake failed due to a broken shaft; repaired
  - Found holes in the floor of the WLS while repairing the broken shaft; repaired
  - Root cause analysis is currently ongoing
Operating Limitations

- The WLS rake shaft failure resulted in one month of reduced production (~12k bbl/day)
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 307 ppm)
  • IGF Inlet – 100 ppm (average 129 ppm)
  • IGF Out – 40 ppm (average 90 ppm)
  • ORF Outlet – 20 ppm (average 40 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 – 25 ppm (average 9 ppm)
  • Silica – 50 ppm (average 45 ppm)
  • Turbidity – 20 NTU (average 17 NTU)
Power Consumption

![Graph showing monthly power consumption from Aug-16 to Jul-17. The graph indicates fluctuations in power consumption with a peak in Jan-17 and a significant decrease in Jun-17.]
Gas Usage

The chart above shows the volume of gas usage from August 2016 to July 2017. The blue bars represent the total purchased volume, while the red bars represent the total produced volume. The volume is measured in cubic meters (m³).
Flaring and Venting

- There were 5 flaring events that were either over 4 hours in duration or over a volume of 30,000 m³
- One venting notification March 21, 2017 at well, 1F1/11-30-064-04 W4M (brackish)

<table>
<thead>
<tr>
<th>Date</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Aug-16</td>
<td>2.89</td>
</tr>
<tr>
<td>Sep-16</td>
<td>8.59</td>
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<tr>
<td>Oct-16</td>
<td>4.70</td>
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<tr>
<td>Nov-16</td>
<td>87.90</td>
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<td>Dec-16</td>
<td>95.66</td>
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<tr>
<td>Jan-17</td>
<td>36.73</td>
</tr>
<tr>
<td>Feb-17</td>
<td>70.45</td>
</tr>
<tr>
<td>Mar-17</td>
<td>5.02</td>
</tr>
<tr>
<td>Apr-17</td>
<td>15.01</td>
</tr>
<tr>
<td>May-17</td>
<td>0.86</td>
</tr>
<tr>
<td>Jun-17</td>
<td>87.03</td>
</tr>
<tr>
<td>Jul-17</td>
<td>279.05</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
- 660,886.38 tonnes of Carbon Dioxide Equivalent were emitted in 2016 (information taken from the Tucker Thermal 2016 Compliance report submitted under the Specified Gas Emitters Regulation)
- 252,241 emission performance credits generated
3. Measurement, Accounting and Reporting
Measurement and Reporting – Oil

OIL & DILUENT METERING

<table>
<thead>
<tr>
<th>LABEL</th>
<th>TAG</th>
<th>P&amp;ID#</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>1P</td>
<td>FQ032</td>
<td></td>
<td>LACT DILBIT SALES FLOW TOTALIZER</td>
</tr>
<tr>
<td>2P</td>
<td>LQ313S</td>
<td>30MF02</td>
<td>DILBIT STORAGE TANK VOLUME</td>
</tr>
<tr>
<td>3P</td>
<td>LQ313S</td>
<td>30MF03</td>
<td>DILBIT STORAGE TANK VOLUME</td>
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<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))(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 – Water and Steam
### AB IF 008451

#### WELL PAD GRAND RAPIDS

<table>
<thead>
<tr>
<th>WELL NAME</th>
<th>LW</th>
<th>LID</th>
<th>LIC/OPER</th>
<th>DETAIL</th>
<th>STATUS</th>
<th>FUEL</th>
<th>TIDE</th>
<th>MEAS.</th>
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</thead>
<tbody>
<tr>
<td>G01555</td>
<td>107/15-33-064-504N/00</td>
<td>05-21-004-0404</td>
<td>HUSKY</td>
<td>STEAM</td>
<td>7</td>
<td>PRODUCING</td>
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<td>G04565</td>
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<td>STEAM</td>
<td>7</td>
<td>PRODUCING</td>
<td>-</td>
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<td>HUSKY</td>
<td>STEAM</td>
<td>7</td>
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<td>-</td>
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<td>05-21-004-0404</td>
<td>HUSKY</td>
<td>STEAM</td>
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<tr>
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#### WELL PAD COLONY

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#### WELL PAD D NORTH

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<th>STATUS</th>
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<th>TIDE</th>
<th>MEAS.</th>
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<td>12</td>
<td>CIRCULATING</td>
<td>-</td>
<td>PC-432H</td>
</tr>
</tbody>
</table>
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

- Three Test Separator Designs (well tests):
  1. Blow-Case (Pads A Original, B, C East, C West):
     - Load-cell or level
     - Vortex for steam + natural gas
     - AGAR water-cut analyzer
  2. Conventional (Pads B North, A Infill & Replacement Wells, GA, D East, D North):
     - 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, 2016 to July 31, 2017 = 43.3 m$^3$/m$^3$
Water Balance

- **Steam Injection:**
  - Vortex meters on each well toe and heel
  - Total steam to field measured at the battery
  - Steam Proration = 0.993 $\text{m}^3/\text{m}^3$

- **Water Proration Factors (see next slide):**
  - Average 12-Month Rolling Proration Factors
    - Water = 1.098
    - Oil = 1.059

- **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
## 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>
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</tr>
<tr>
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<td>C1-9</td>
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<td>17.8</td>
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<td>D24-33</td>
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<td>V-450</td>
<td>D34-38</td>
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<td>14.0</td>
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<td>V-630</td>
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<td>7.1</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, 2017

• No technical issues identified with measurement equipment

• Implemented improvements:
  • Detailed review of measurement schematics to include Pad D North test separator and steam injection

• Future opportunities:
  • Pad CN Phase Dynamics individual well characteristics set-up
  • Test separators overhead gas meter sizing verification
  • Detailed review of measurement schematics to include Pads D West and D East test separator and steam injection
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 process
Brackish Water Consumption
Fresh Water

- Water Diversion License No. 00194427-00-01
  - Location well: 12-28-064-04-W4, on the Tucker CPF site
  - Bonnyville Aquifer
  - Domestic use only:
    - Safety showers / eye-wash stations
    - Cleaning water
    - Washroom / kitchen use

- Temporary Diversion License, TDL License No. 00395372
  - Required due to WLS shut-down and repair
  - Valid from June 16, 2017 to July 31, 2017
  - Approved for a maximum volume of 79,200 m³
  - Actual volume used was 36,019 m³
Fresh Water Consumption

Volume (m$^3$/Month)

<table>
<thead>
<tr>
<th>Month</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug-16</td>
<td>90</td>
</tr>
<tr>
<td>Sep-16</td>
<td>80</td>
</tr>
<tr>
<td>Oct-16</td>
<td>70</td>
</tr>
<tr>
<td>Nov-16</td>
<td>70</td>
</tr>
<tr>
<td>Dec-16</td>
<td>70</td>
</tr>
<tr>
<td>Jan-17</td>
<td>80</td>
</tr>
<tr>
<td>Feb-17</td>
<td>60</td>
</tr>
<tr>
<td>Mar-17</td>
<td>90</td>
</tr>
<tr>
<td>Apr-17</td>
<td>100</td>
</tr>
<tr>
<td>May-17</td>
<td>120</td>
</tr>
<tr>
<td>Jun-17</td>
<td>150</td>
</tr>
<tr>
<td>Jul-17</td>
<td>170</td>
</tr>
</tbody>
</table>

Fresh Water Consumption
Produced Water & Steam Injected

![Bar chart showing monthly produced water and steam injection volumes from August 2016 to July 2017, along with cumulative reservoir water retention. The chart includes bars for produced water and injected steam, and a line graph for cumulative reservoir water retention.](chart.png)
Water Disposal Limits

![Chart showing water disposal limits for different months, with blue representing allowable disposal and red representing actual disposal. The chart highlights variations in disposal percentages across the months.]
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 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 34% of 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)
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>Quantity</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAUS</td>
<td>Caustic Solutions Unneutralized, Spent</td>
<td>Rbw Waste Management Ltd</td>
<td>Other (specify)</td>
<td>0.06</td>
<td>m3</td>
</tr>
<tr>
<td>COEMUL</td>
<td>Condensate/Crude Oil Emulsions</td>
<td>Tervita Lindbergh Cavern</td>
<td>Oilfield Waste Processing Facility</td>
<td>1317.46</td>
<td>m3</td>
</tr>
<tr>
<td></td>
<td>High Solids: Solids &gt;40%</td>
<td>NewAlta Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>314</td>
<td>m3</td>
</tr>
<tr>
<td></td>
<td>Interphase &gt; 20%, Oil &lt;= 30%</td>
<td>NewAlta Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>974.5</td>
<td>m3</td>
</tr>
<tr>
<td></td>
<td>Interphase 0 - 10%, Oil &lt;= 30%</td>
<td>NewAlta Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>2813</td>
<td>m3</td>
</tr>
<tr>
<td></td>
<td>Interphase 0 - 10%, Oil &gt; 30%</td>
<td>NewAlta Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>17.5</td>
<td>m3</td>
</tr>
<tr>
<td></td>
<td>Interphase 10.1 - 20.0%, Oil &lt;= 30%</td>
<td>NewAlta Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>897</td>
<td>m3</td>
</tr>
<tr>
<td></td>
<td>Interphase 10.1 - 20.0%, Oil &gt; 30%</td>
<td>NewAlta Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>20.5</td>
<td>m3</td>
</tr>
<tr>
<td>DOMWST</td>
<td>Domestic Waste</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>124.44</td>
<td>m3</td>
</tr>
<tr>
<td>EMTCON</td>
<td>Empty Containers</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>3.06</td>
<td>m3</td>
</tr>
<tr>
<td>FILOTH</td>
<td>Filters - Other (Raw Fuel Gas, NGL's)</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>10.08</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>2.8</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>1.96</td>
<td>m3</td>
</tr>
<tr>
<td>OILRAG</td>
<td>Rags Oil</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>1.4</td>
<td>m3</td>
</tr>
<tr>
<td>ORGCHM</td>
<td>Chemicals Organic</td>
<td>Rbw Waste Management Ltd</td>
<td>Other (specify)</td>
<td>0.02</td>
<td>m3</td>
</tr>
<tr>
<td>SAND</td>
<td>Stung Sand Wet</td>
<td>Tervita Bonnyville</td>
<td>Class II Landfill</td>
<td>18738.43</td>
<td>Tonnes</td>
</tr>
<tr>
<td>SLGHYD</td>
<td>Cav Sludge Hydrocarbon</td>
<td>Tervita Lindbergh Cavern</td>
<td>Oilfield Waste Processing Facility</td>
<td>12.5</td>
<td>m3</td>
</tr>
<tr>
<td>SLGLIM</td>
<td>Lime Sludge</td>
<td>Tervita Bonnyville</td>
<td>Class II Landfill</td>
<td>43</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>6.3</td>
<td>m3</td>
</tr>
<tr>
<td>SOILCO</td>
<td>Hydrovac Material</td>
<td>Tervita Lindbergh Cavern</td>
<td>Class I Landfill</td>
<td>21</td>
<td>m3</td>
</tr>
<tr>
<td></td>
<td>Contaminated Debris and Soil</td>
<td>Clean Harbors Ryley</td>
<td>Class I Landfill</td>
<td>5</td>
<td>m3</td>
</tr>
<tr>
<td></td>
<td>Crude Oil Condensate</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>16.5</td>
<td>m3</td>
</tr>
<tr>
<td>WATER</td>
<td>Cav Waste Produced Water</td>
<td>Tervita Lindbergh Cavern</td>
<td>Class I Landfill</td>
<td>8.13</td>
<td>m3</td>
</tr>
<tr>
<td>WPAINT</td>
<td>Waste Paint</td>
<td>Rbw Waste Management Ltd</td>
<td>Other (specify)</td>
<td>0.02</td>
<td>m3</td>
</tr>
<tr>
<td>WSTMIS-R</td>
<td>Waste Hydraulic Hoses</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>0.7</td>
<td>m3</td>
</tr>
</tbody>
</table>
5. Sulphur Production
Sulphur Dioxide (SO₂) Sources

- Six Once-Through Steam Generators (OTSG)
- One High Pressure Flare Stack
- One Low Pressure Flare Stack
### Quarterly SO\textsubscript{2} Emissions

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Period</th>
<th>Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q3 2016</td>
<td>(August 2016 – October 2016)</td>
<td>68.46 tonnes</td>
</tr>
<tr>
<td>Q4 2016</td>
<td>(November 2016 – January 2017)</td>
<td>78.76 tonnes</td>
</tr>
<tr>
<td>Q1 2017</td>
<td>(February 2017 – April 2017)</td>
<td>119.36 tonnes</td>
</tr>
<tr>
<td>Q2 2017</td>
<td>(May 2017 – July 2017)</td>
<td>101.81 tonnes</td>
</tr>
</tbody>
</table>
SO$_2$ Emissions Trends

SO2 Emission Limit - 1.96 t / d

![Bar chart showing SO$_2$ emissions trends from August 2016 to July 2017](chart.png)
Peak and Average SO\textsubscript{2} Emissions

- August 1, 2016 to July 31, 2017:

<table>
<thead>
<tr>
<th>SO\textsubscript{2} Emissions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Daily (highest)</td>
<td>1.01</td>
</tr>
<tr>
<td>Maximum Daily (highest)</td>
<td>1.48</td>
</tr>
</tbody>
</table>

- Limit under EPEA Approval is 1.96 tonnes/day

- No exceedances
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/)

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
  • 382,710.2 m³ 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 2016 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 58,710 m³ 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
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 during this reporting period
8. Non-Compliance Events
Non-Compliance Events

- AER Contravention report, CIC # 320177, Jan 19, 2017. CEMS Code violation (<90% uptime) B7800 CEMS failure.
- AER Contravention report, FIS # 20172174, Jul 5, 2017. WLS release due to floor corrosion.
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 H₂S 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 H₂S since December 23, 2013
  - Update presentation to AER on May 29, 2014

- Husky commitment:
  - Quarterly monitoring of H₂S, SCVF and temperature
  - Update in annual performance presentation
Status:
- Currently, no SCVF at C13S
- Multiple temperature deviations along tubing
  - Maximum temperature of approximately 187 °C at 392 m depth
  - 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 (December 2017)
- Husky will notify AER of any changes to SCVF
9. Future Plans
Future Plans (2017/2018)

- Construct, commission & start-up Pad D West SAGD development
- Pad B West Replacement Well development