Annual Surmont SAGD
Performance Review
Approvals 9426 and 9460

May 17, 2017
Calgary, Alberta, Canada
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Introduction, Overview and Highlights

Subsection 3.1.1 (1)
Ownership and Approvals

Ownership

- The Surmont In Situ Oil Sands Project is a 50/50 joint venture between ConocoPhillips Canada Resources Corp. and TOTAL E&P Canada Ltd; Operated by ConocoPhillips Canada.

Project History

- 1997 - First steam at pilot project
- 2007 - First steam at Phase 1
- 2010 - Construction start at Phase 2
- 2015 - Start-up of Phase 2, solvent soak on well pairs 7&8 on pad 103
- 2016 - Start-up of liquid scavenging system

Approval Update - AER Approval No. 9426

Approval 9426KK – September 15, 2016
- Application No. 1857927 - Increase of MOP at DAs 261-3 and 262-3
- Application No. 1862673 - Extension of well pair lengths at Pad 267 and cancellation of three outboard well pairs at DA 264-2

Approval 9426LL – October 19, 2016
- Application No. 1867584 – to correct MOP value for DA 267-1

Application No. 1880767 (submitted February 28)– Temporary increase of MOP at DA 262-3 to address problem wells
Surmont Overview

Currently in a “One Surmont” philosophy

Surmont combined approved capacity is 29,964 m³/cd (188,700 bbl/cd)* *(where cd is calendar day on an annual average basis)

Phase 1 is focused on the optimization of production and steam

Phase 2 is focused on the well ramp up and pressure management
2016 Highlights

- **Phase 1 production recovery**
  - Initial results from tubing deployed flow control devices at Pad 101/102 illustrate an increase in total emulsion/bitumen rates
  - Liner installed flow control devices at Pad 103 continue to outperform slotted liners (SL) wells
  - Instantaneous Steam Oil Ratio (iSOR) continues to improve and trend lower
  - Steam splitters were installed on 6 wells

- **Phase 2 continued ramp-up**
  - Tubing deployed flow control devices installed on 8 wells in 2016 and have shown an improvement in oil rates
  - Liner deployed flow control devices have shown to promote faster development of the wells compared to typical slotted liner wells
  - Some wells are still challenged with injectivity/productivity issues, which translates into a slower ramp-up or underperformance based on expectations. Evaluation of optimization opportunities continues.
  - Start up of remaining pads from circulation to SAGD except for 266-2.

- **Sustaining pads**
  - Surmont 1 infill program deferred
  - Pad 267 start-up in 2019

- **2016 Fort McMurray Wildfire Emergency Shutdown and Re-start**
Well pads 261-3, 262-2, 262-1 and 266-2 brought online before end of 2016.

Convert last 11 wells in circulation to SAGD when ready.

The well start up base plan was primarily based on a conventional circulation pre-heat period of 90 days. Actual performance has taken longer.

Futures FCD start up plans are anticipated to recover these poorer performances.
Surmont Performance

Historical Steam Injection and Bitumen Production

- 2007-2008 Unstable Ramp-Up
- 2009 Steam Gen Issues
- 2010-2012 Stable operations reaching “capacity”
- 2013 Continuous Improvement
- 2015 S2 Ramp-up begins

SOR and WOR

- SOR and WOR

Average Steam Uptime

- 2015 Key Challenges
  - OTSG fouling
  - Front-end treatment
  - Pressure drop from 2014 T/A
  - Steam constraints (PAD 103 accelerated S/U)

- 2016 Key Challenges
  - Slotted liner Ramp-up performance
  - Horizontal liner deformation
  - Increased performance on S1 base due to re-pressurization
  - Fort McMurray Wildfire Recovery

- 2017 Key Focus Items
  - ESP conversions
  - TDFCD installations
  - Steam allocation

Subsection 3.1.1 (1)
2016 Loss Production Summary

**Average Performance**

- Oil Average Production (bbl/d): 70,088
- Average Oil Loss (bbl/d): 13,666
- DOE (Excl. Wildfire): 94%
- DOE (Incl. Wildfire): 84%
- Steam Uptime (exclusive of wildfires in May 2016): 86.8%

**Well Losses**

- Artificial Lift Hydraulics: 24%
- Regulatory / Compliance / Surveillance: 2%
- Downhole Optimization: 52%
- Well Integrity: 12%
- Downhole Impairment: 10%

**Facility/Other Losses**

- Facility Maintenance/Modification: 36%
- Instrumentation and Controls: 3%
- Power/Fuel: 1%
- Mechanical Rotating Equipment: 1%
- Process Upsets: 4%
- Wildfire: 55%

Subsection 3.1.1 (1)
Subsurface Resource Evaluation and Recovery

Geology and Geophysics
Subsection 3.1.1 (2)
2016-2017 Delineation Campaign and Well Density

Delineation Wells - Surmont Lease

1485 existing wells – 46 new

46 new vertical wells (as of Mar 1, 2017)

Phase 1 and Phase 2
Development Area

Drainage Areas

Surmont leases
Focus on Surmont Phase 1 sustaining pad locations as well as delineation of Phase 3
(only wells that penetrate the McMurray)

- Existing wells
- New vertical wells (as of Mar 1, 2017)
- Phase 1 and Phase 2 Development Area
- Drainage Areas
- Surmont leases
2016-2017 Delineation Campaign and Core Density

- 1485 wells total
- 544 existing core wells
- 6 new core wells (as of Mar 1, 2017)

Phase 1 and Phase 2 Development Area

Drainage Areas

Surmont leases
2016-2017 Delineation Campaign and Core Density

Existing wells

Existing cored wells

New core wells (as of Mar 1, 2017)

Phase 1 and Phase 2 Development Area

Drainage Areas

Surmont leases
2016-2017 Delineation Campaign and FMI/CMI Logs

Subsection 3.1.1 (2f)

1485 wells total
1108 existing FMI/CMI wells
46 new FMI/CMI wells (as of Mar 1, 2017)

100% Coverage of FMI/CMI Data in 2016/2017 program
• Important for breccia identification

McMurray FMI/CMI Wells - Surmont Lease

Phase 1 and Phase 2 Development Area
Drainage Areas
Surmont leases

1: 200000

1485 wells total
1108 existing FMI/CMI wells
46 new FMI/CMI wells (as of Mar 1, 2017)
2016-2017 Delineation Campaign and FMI/CMI Logs

Subsection 3.1.1 (2f)

100% Coverage of FMI/CMI Data in 2016/2017 program
- Important for breccia identification
- Geomechanical Modeling

- Existing wells
- Existing FMI wells
- New FMI wells (as of Mar 1, 2017)
- Phase 1 and Phase 2 Development Area
- Drainage Areas
- Surmont leases
Subsection 3.1.1 (2f)

Delineation across Phases 1, 2, and 3

Delineation Well Density Map - 2016

Delineation Well Density Map - Mar 2017

Density Map Difference

2016-2017 Delineation Campaign and Well Density

McMurray penetrated wells only
Increased core density with latest drilling

Cored Wells Density Map - 2016

Cored Wells Density Map - Mar 2017

Cored Density Map Difference

McMurray penetrated wells only
Increased Formation Micro Imaging density with latest drilling

FMI Well Log Density Map – 2016

FMI Well Log Density Map – Mar 2017

FMI Density Map Difference

McMurray penetrated wells only
Phase 1 Type Log Well Pad 101

Example Log 100161408307w400

McMurray

High Sw

Continuous Bitumen

Devonian

Phase 1 Area
Phase 2 Type Log – Well Pad 264-2

Example Log 100162208306w400

---

**McMurray**

Top Gas

High Sw

Continuous Bitumen

Devonian

---

Phase 2 Area

**Type Log**
Objectives:

- Characterize vertical and lateral variance in viscosity at different temperatures.
- Model the variance in bitumen properties and its implications for bitumen production rates during SAGD.
- Characterize relationship between viscosity, density and geochemical composition.

Viscosity increases with depth in the McMurray Formation.

- 52 existing viscosity sample wells
- Delineated Wells - Surmont
Representative Structural Cross Section

- Surmont 1 Pad 102
- Surmont 1 Pad 101
- Pilot
- Surmont 2 Initial DA

- Lower Grand Rapids
- Clearwater Shale
- Clearwater Marker
- Wabiskaw / McMurray Marker
- Devonian Unconformity

10:1 vertical exaggeration

Polarity Convention

A

A'
• A well at 4-3-84-6 W4M intersected a raised bitumen/water contact, the contact is ~12 m higher than the nearest offset.

• The well also intersected a small gas pool under the bitumen.

• The presence of basal water becomes a potential impact on production performance on Well Pad 262-1.
Reservoir Characteristics

Subsection 3.1.1 (2b)

<table>
<thead>
<tr>
<th>Properties</th>
<th>Depth (masl)</th>
<th>Phi in NCB</th>
<th>So in NCB</th>
<th>KH in NCB</th>
<th>KV in NCB</th>
<th>Initial Pressure (KPa)</th>
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<td>Lease</td>
<td>~250</td>
<td>31%</td>
<td>77%</td>
<td>4090</td>
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<tr>
<td>Pilot A</td>
<td>272-208</td>
<td>31%</td>
<td>82%</td>
<td>4589</td>
<td>3836</td>
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<tr>
<td>Pilot B</td>
<td>272-212</td>
<td>31%</td>
<td>81%</td>
<td>4348</td>
<td>3625</td>
<td>1715</td>
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<tr>
<td>Pilot C</td>
<td>272-220</td>
<td>32%</td>
<td>85%</td>
<td>4700</td>
<td>3541</td>
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<tr>
<td>101N</td>
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<td>82%</td>
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<td>3616</td>
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<tr>
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<td>4515</td>
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<td>262-2</td>
<td>272-212</td>
<td>33%</td>
<td>79%</td>
<td>5257</td>
<td>4436</td>
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<td>262-3</td>
<td>271-208</td>
<td>32%</td>
<td>78%</td>
<td>4939</td>
<td>4119</td>
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<tr>
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<td>263-2</td>
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<td>78%</td>
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<tr>
<td>264-3</td>
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<td>76%</td>
<td>4470</td>
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<td>265-2</td>
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<td>32%</td>
<td>77%</td>
<td>5095</td>
<td>4252</td>
<td>1496</td>
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<tr>
<td>266-2</td>
<td>276-210</td>
<td>32%</td>
<td>80%</td>
<td>4805</td>
<td>4013</td>
<td>1337</td>
</tr>
</tbody>
</table>
McMurray Gross Isopach

2016/2017 Delineation Campaign Update

- Minor changes due to:
  - Geological picks from new Wells
  - Re-evaluated/unified geologic picks
  - Revised Seismic Interpretation
McMurray Net Gas Isopach

Net Top Gas thickness = sands have deep resistivity $\geq 10 \, \Omega \cdot m$ and Vsh $< 65$

2016/2017 Delineation Campaign Update

- Minor changes due to:
  - Geological picks from new Wells
  - Re-evaluated/unified geologic picks
  - Revised Seismic Interpretation
**McMurray Net Top Water Isopach**

**Development Area**

- Draining areas used for mapping
- Surmont leases

**Net Top Water thickness** = sands have deep resistivity

- $\Omega$-m and $V_{sh} < 45\%$

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2016/2017 Delineation Campaign Update

- Minor changes due to:
  - Geological picks from new Wells
  - Re-evaluated/unified geologic picks
  - Revised Seismic Interpretation
Top Continuous Bitumen Structure

**Subsection 3.1.1 (2d)**

- **McMurray Top Continuous Bitumen Structure**

TCB = The uppermost limit of good reservoir, bitumen-bearing sands.

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2016/2017 Delineation Campaign Update

- Minor changes due to:
  - Geological picks from new Wells
  - Re-evaluated/unified geologic picks
  - Revised Seismic Interpretation

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Development Area

Drainage Areas

3D seismic areas used for mapping

Surmont leases
McMurray Base Continuous Bitumen Structure

BCB = First occurrence of good reservoir, bitumen-bearing sands.

2016/2017 Delineation Campaign Update

- Minor changes due to:
  - Geological picks from new Wells
  - Re-evaluated/unified geologic picks
  - Revised Seismic Interpretation
McMurray Net Continuous Bitumen Pay

Net continuous bitumen = sands have deep resistivity > 40 Ω-m and Vsh < 33%, and no shale greater than 3 m thick

Development Area

Drainage Areas

3D seismic areas used for mapping

Surmont leases

2016/2017 Delineation Campaign Update

• Minor changes due to:
  • Geological picks from new Wells
  • Re-evaluated/unified geologic picks
  • Revised Seismic Interpretation
Surmont Leases OBIP

Surmont Development Area OBIP

3D seismic areas used for mapping
Surmont leases

<table>
<thead>
<tr>
<th>Properties</th>
<th>Development Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCB Thickness</td>
<td>0 to Greater than 30 m</td>
</tr>
<tr>
<td>Range</td>
<td></td>
</tr>
<tr>
<td>Phie in NCB</td>
<td>31.86%</td>
</tr>
<tr>
<td>So in NCB</td>
<td>76.48%</td>
</tr>
<tr>
<td>OOIP in NCB &gt;</td>
<td>3509.43 MMbbls Deterministic</td>
</tr>
<tr>
<td>18m</td>
<td></td>
</tr>
</tbody>
</table>

**OBIP = Thickness x Phie x So x Area**

Subsection 3.1.1 (2a, 2b, 2c)
Surface Deformation Monitoring

- Satellite (RADARSAT-2) measurements every 24 days

- Interferometric Synthetic Aperture Radar (InSAR):
  - Corner Reflectors (CR) installed over pads and in areas to measure background deformations
  - 256 CR’s installed since monitoring program began in 2008

Phase 1 Monitoring Locations
- Satellite (RADARSAT-2) measurements every 24 days
- Corner Reflectors (CR) installed over pads and in areas to measure background deformations
- 256 CR’s installed since monitoring program began in 2008

Phase 2 Monitoring Locations
- Surface Deformation Monitoring
• Deformation currently in line with expectations

○ Corner Reflector
□ Reference Corner Reflector
◇ Corner Reflector w/quality issue
☒ Corner Reflector w/Frost Jacking
Caprock Integrity

- Caprock Core Analysis:
  - 14 caprock cores were drilled and analyzed in 2015-2017.
  - Four rock mechanics testing programs were conducted in 2015-2017.

- Diagnostic Fracture Injectivity Tests (DFITs):
  - 8 DFITs were carried out in 2015-2017
  - DFIT locations were selected based on structural and geomechanical analysis of the caprock.

- The completed analysis verified that
  - The best seals within the cap rock interval are the deeper water deposits occurring on maximum flooding surfaces.
  - The seal over the development area is continuous, consistent and laterally extensive.

Conclusions from the study:
- Best Seal: Deeper water deposits
- Muds are more than 80% clay and are correlated throughout and beyond the Surmont lease.
- The mechanical properties of the caprock allow for providing a continuous seal over the steam chamber.
ConocoPhillips Canada continues to propose a flexible tapered strategy envelope bound by the cap rock integrity study and the associated Maximum Operating Pressure (MOP) on one side and economic achievable pressures on the other side.

The DFITs are strategically placed to characterize stress changes due to structural changes while measuring the baseline stresses in the caprock.

Wellbore image log and other open-hole logs were analyzed in detail for stress analysis and natural fractures characterization.

The results suggest while the previously used value of 18.4 kPa/m is valid, the minimum horizontal stress is higher in several drainage areas.

In 2016, ConocoPhillips received approval from the AER to increase the MOP in one of the drainage areas.

ConocoPhillips Canada has submitted an application to temporarily increase MOP in one of the drainage areas at Phase 2.

In the future, select drainage areas may be investigated for potential application of higher MOP.

Conclusions from the study:
- The results suggest that in many parts of Surmont the caprock minimum horizontal stress is above the used value of 18.4 kPa/m in the MOP calculation.
- While the recommended 15 kPa/m MOP gradient is verified and valid, higher MOP gradient will be requested for select drainage areas.
Drilling and Completions

Subsection 3.1.1 (3)
## 2016 Re-Drills

- In 2016 we had a total of 5 re-drills.

<table>
<thead>
<tr>
<th>Redrill Type</th>
<th>264-2 P02</th>
<th>264-2 P03</th>
<th>266-2 P12</th>
<th>263-1 I05</th>
<th>263-1 P05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redrill Type</td>
<td>Whipstock</td>
<td>Whipstock</td>
<td>Whipstock</td>
<td>Whipstock</td>
<td>Whipstock</td>
</tr>
<tr>
<td>Reason for Redrill</td>
<td>Producer liner failure during circulation phase. Production tubing was unable to be recovered due to sand.</td>
<td>Producer liner failure during circulation phase. Production tubing was unable to be recovered due to sand.</td>
<td>Intermediate casing was found to be damaged in McMurray formation after initial drilling operation. Attempts to remedy the sand control issue was not successful.</td>
<td>Liner failure during circulation phase discovered at time of P05 Redrill. Production tubing was unable to be recovered due to sand.</td>
<td>Liner failure during circulation phase. Production tubing was unable to be recovered due to sand as well as casing damage in McMurray</td>
</tr>
<tr>
<td>Whipstock Depth (mKB)</td>
<td>481</td>
<td>423</td>
<td>734</td>
<td>408</td>
<td>364</td>
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<tr>
<td>Whipstock Depth (mTVD)</td>
<td>339</td>
<td>334</td>
<td>322</td>
<td>328</td>
<td>317</td>
</tr>
<tr>
<td>Liner Length (m)</td>
<td>1156</td>
<td>1224</td>
<td>1096</td>
<td>1557</td>
<td>1629</td>
</tr>
<tr>
<td>FCD interval Length (m)</td>
<td>952</td>
<td>1035</td>
<td>1002</td>
<td>1369</td>
<td>1402</td>
</tr>
<tr>
<td>Completion</td>
<td>7” heel, 4” toe with 5/8” TC string on outside of toe string</td>
<td>Not yet completed.</td>
<td>7” heel, 4” toe with 1.25” Fiber string ran inside toe string</td>
<td>7” heel, 4” toe with no TC’s installed</td>
<td>7” heel, 4” toe with 5/8” TC string on outside of toe string</td>
</tr>
<tr>
<td>Comments</td>
<td>Successfully drilled, completed and put on steam circulation Dec 2016</td>
<td>Successfully drilled. Completion encountered difficulty with sand incursion. Currently investigating.</td>
<td>Successfully drilled, completed and put on steam circulation Dec 2016</td>
<td>Successfully drilled and completed. Awaiting P05 completion before starting on circulation Q1 2017</td>
<td>Successfully drilled. Completion operation to be executed shortly.</td>
</tr>
</tbody>
</table>
Well Pad 101 North
Producer and Injector Vertical Offset

Subsection 3.1.1 (3a)
Well Pad 101 South
Producer and Injector Vertical Offset

Subsection 3.1.1 (3a)
Well Pad 102 North
Producer and Injector Vertical Offset

Subsection 3.1.1 (3a)
Subsection 3.1.1 (3a)
Well Pad 262-1
Producer and Injector Vertical Offset

Subsection 3.1.1 (3a)
Well Pad 262-2
Producer and Injector Vertical Offset

Subsection 3.1.1 (3a)
Well Pad 262-3
Producer and Injector Vertical Offset

Subsection 3.1.1 (3a)
Well Pad 263-1
Producer and Injector Vertical Offset

Pad 263-1

Subsection 3.1.1 (3a)
Well Pad 263-2
Producer and Injector Vertical Offset

Pad 263-2

Subsection 3.1.1 (3a)
Well Pad 264-1
Producer and Injector Vertical Offset

Subsection 3.1.1 (3a)
Well Pad 264-1-11 Fishbone
Producer and Injector Vertical Offset

Injector has 3 legs while producer has 7 legs. 3 vertical offsets.
Well Pad 264-2
Producer and Injector Vertical Offset

Subsection 3.1.1 (3a)
Pad 264-3

Well Pad 264-3
Producer and Injector Vertical Offset

Subsection 3.1.1 (3a)
Well Pad 265-2
Producer and Injector Vertical Offset

Subsection 3.1.1 (3a)
Well Pad 266-2
Producer and Injector Vertical Offset

Subsection 3.1.1 (3a)
<table>
<thead>
<tr>
<th>Well Identifier - Surface (Downhole)</th>
<th>Producer Completion</th>
<th>Injector Completion</th>
<th>Well Identifier - Surface (Downhole)</th>
<th>Producer Completion</th>
<th>Injector Completion</th>
<th>Well Identifier - Surface (Downhole)</th>
<th>Producer Completion</th>
<th>Injector Completion</th>
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<tbody>
<tr>
<td>101-01 (10DH)</td>
<td>ESP</td>
<td>Parallel</td>
<td>102-1</td>
<td>ESP</td>
<td>Parallel</td>
<td>103-1</td>
<td>Improved Gas Lift</td>
<td>Producer A</td>
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<td>101-02 (11DH)</td>
<td>ESP</td>
<td>Parallel</td>
<td>102-2</td>
<td>ESP (TDFCD)</td>
<td>Parallel</td>
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<td>Improved Gas Lift</td>
<td>Producer A</td>
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<td>101-03 (12DH)</td>
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<td>PCP</td>
<td>Parallel</td>
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### Pad 261-3 & 262-1 Well Completions

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# Pad 262-2 & 262-3 Well Completions

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## Pad 263-1 & 263-2 Well Completions

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## Pad 264-1, 264-2 & 264-3 Well Completions

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## Pad 265-2 & 266-2 Well Completions

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Typical Concentric Injector

11 ¾” Intermediate casing
7” Heel tubing String
4 ½” Toe String
8 5/8” Slotted Liner
16” Surface Casing
Liner Hanger
Typical Parallel Injector

16” Surface Casing

4 ½” Heel tubing String

11 ¾” Intermediate casing

Liner Hanger

8 5/8” Slotted Liner

2 7/8” Toe String

Subsection 3.1.1 (3c)
• Install a heel gas coil (5/8”) to lift heel production, no more blanket gas lifting

• Heel lift gas coil set 10 – 15m TVD above lateral

Subsection 3.1.1 (3c)
• Heel tubing string set 10 – 15m TVD above lateral

• 1 perforated joint on the bottom of heel tubing string with an additional 1-2 casing joints attached below.
Typical ESP Producer

13 3/8” Surface Casing

ESP Power Cable + 3/8” Bubble Tube + 2x 1/8” encapsulated F.O. P/T Instrumentation Cables (Intake/Discharge) (Clamp to outside of ESP Production Tubing)

3 ½” Production tubing String

2 1/16” Guide String

ESP (landed at Well Tangent)

P/T Sensor clamped to 2-3/8” pup joint

Liner Hanger

9 5/8” Intermediate casing

40pt Fiber Optic LxData 1 ¼” Coil (Inside of Guide Sting & FCD Tubing)

7” Slotted liner

Subsection 3.1.1 (4a)
Typical PCP Producer

- **13 3/8” Surface Casing**
- **3/8” Bubble Tube**
- **Sucker Rod/ CoRod**
- **3 ⅜” Production tubing String**
- **PCP (Progressive Cavity Pump)**
- **9 5/8” Intermediate casing**
- **Liner Hanger**
- **2 1/16” Guide String**
- **P/T Sensor clamped to 2-3/8” pup joint**
- **40pt Fiber Optic LxData 1 ⅜” Coil (Inside of Guide Sting & FCD Tubing)**
- **7” Slotted liner**
Typical Flow Control Device (FCD) Completion

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* Injector wells do not have instrumentation

Example of FCD’s

13 3/8” Surface Casing

1” Toe Lift Gas Coil Tubing
Inside Toe Tubing

5/8” Heel Lift Gas Coil Tubing
Clamped to outside of Toe Tubing

4 ½” x 3 ½” VIT L80:

7” Heel tubing String

9 5/8” Intermediate casing

Liner Hanger

FCD’s with Screens

7” Non Slotted liner

1.25” Thermocouples (8pt)
Clamped to outside of Toe Tubing

4 ½” Toe String

10 – 15m TVD

Emulsion
Typical Tubing Deployed FCD (TDFCD) Completion – ESP

**Subsection 3.1.1 (3c)**

- **13 3/8” Surface Casing**
- **3 ½” Production tubing String**
- **ESP Power Cable + 3/8” Bubble Tube + 2x ¼” encapsulated F.O. P/T Instrumentation Cables (Intake/Discharge) (Clamp to outside of ESP Production Tubing)**
- **FCD Liner Hanger**
- **Production Liner Hanger**
- **Swell Packers**
- **40pt Fiber Optic LxData 1 ⅜” Coil (Inside of Guide Sting & FCD Tubing)**
- **4.5” Tubing Deployed Flow Control Device (TDFCD)**
- **2 1/16” Guide String**
- **4.5” Liner Joints**
- **7” Production liner**

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**10 – 15m TVD**
Typical Tubing Deployed FCD (TDFCD) Completion – ESP

- **13 3/8” Surface Casing**
- **3 1/2” Production tubing String**
- **10 – 15m TVD**
- **2 1/16” Guide String**
- **40pt Fiber Optic LxData 1 3/8” Coil** (Inside of Guide Sting & FCD Tubing)
- **4.5” Tubing Deployed Flow Control Device (TDFCD)**
- **9 5/8” Intermediate casing**
- **Swell Packers**
- **4.5” Liner Joints**
- **7” Production liner**
- **ESP Power Cable + 3/8” Bubble Tube + 2x 1/8” encapsulated F.O. P/T Instrumentation Cables (Intake/Discharge) (Clamp to outside of ESP Production Tubing)**

**Table: Total Wells with TDFCDs**

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Subsection 3.1.1 (3c)
Current Surmont 2 Steam Splitter Design

- Steam Splitter design used for top water zone risk reduction.
- Splitter open/closed position to be assessed on a well by well basis.
102-P21 (INF)
- Restarted warmup operations with steam bullheading in Q1 and Q3 2016
- Workover September 2016 to identify previous source of challenges with pump operation
- New PCP pump installed October 2016 and well restarted with steam assist to keep rod torque at manageable levels
- Consistent production from October to present, including improvement in lateral temperatures
- Expecting to remove steam assist as temperatures continue to improve

102-P22 (INF)
- Short warmup cycle ran for 2 weeks in Q3 2016. Well has been on standby to use learnings from 102-21
- Downhole temps were showing some improvement along with good injectivity
- Back on warmup Q1 2017 with intention of startup of production with steam assist before Q2 2017
102 P21 Fishbone Completion

13 3/8” Surface Casing

3/8” Bubble Tube & P/T gauge (clamped to outside)

Sucker Rod/ CoRod

3 ½” Production tubing String

PCP (Progressive Cavity Pump)

Liner Hanger

9 5/8” Intermediate casing

2 3/8” & 3.5” Guide String

6 5/8” FCD Liner with sand Screens

40pt Fiber Optic LxData ” Coil (Inside of Guide Sting & FCD Tubing)

P/T Instrumentation

Subsection 3.1.1 (4a)
Artificial Lift

Subsection 3.1.1 (4)
## Artificial Lift Current Pad Overview

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### Subsection 3.1.1 (4a)

85
Artificial Lift Types

• **Gas Lift**
  - Gas lift is effective with bottom hole flowing pressures >2,700 kPa with pressure of well head (Pwh) approx. 1,000 kPa
  - Lifting from heel and toe with gas assist at start of vertical section
  - Current production rates range from 100 m³/d to 700 m³/d of emulsion targeting 3,500 kPa

• **Electric Submersible Pump (ESP)**
  - ESP for thermal SAGD applications can be sized to meet the specific deliverability of the well.
  - Operating temperatures typically below 215°C
  - Typically Series 500 installed, and Series 400 pumps installed due to casing restrictions

• **Progressive Cavity Pumps (PCP)**
  - Generally PCPs have been used for low deliverability wells and where potential solids may be produced.*
  - Installation of metal to metal pumps

* ConocoPhillips Canada initial strategy for PCPs was to use them on low deliverability wells where the current ESP designs were deemed less appropriate. However, installation of larger PCP are being considered for wells that may produce relatively “cold” viscous fluid for some time.
**ESP Run Life Definitions**

- **MTTF:** This run-life measure is calculated as the total exposure time of all systems (running, pulled and failed) divided by the number of failed systems.

- **Average Runtime:** This run-life measure is calculated as the total exposure time of all systems (running, pulled and failed) divided by the number of systems (running, pulled and failed).

- **Average run life running ESP:** This run-life measure is calculated as the total exposure time of running systems divided by the number of running systems.

- **Window:** Window time allows for changes in average run-life to be more apparent, as they are less obscured by previous data.
ESP Performance

KPIs

- **Population:** 52 ESP’s
- **Cumulative MTTF:** 29.1 months
- **Windowed* MTTF:** 31.4 months
- **Average Runtime:** 15.4 months
- **Windowed Runtime:** 18.8 months
- **Average run life running ESP:** 10.6 months

2016: 16 ESP failures

2017: 5 ESP failures

*(730 day window)
• The artificial lift mode selection is reliant on the pressure strategy for any given well, or drainage area (DA).
  • Phase 2 wells currently utilize Gas Lift (GL) and then will be converted to ESP when the flowing bottom hole pressure is below the effective GL operating point.
  • Four wells in Pad 103 will be ESP day 1. Which means following the circulation time the well will be converted directly to ESP. 266-2 is an ESP Day 1 pad as well.
Instrumentation in Wells

Subsection 3.1.1 (5)
• All wells on Phase 1 pads contain 40 point fiber optic strings in the producers unless otherwise noted.
Phase 2 SAGD Well Instrumentation

- 9 of the 11 pads currently online contain 8 thermocouples in the producers.
- The other remaining pads contain 40 instrumentation points as per the image.
- Pads not online as of Feb 2017:
  - Pad 267
All 12 producer wells on Pad 261-3 were installed with Fiber Optics DTS (Distributed Temperature Sensing) instrument strings.

8 out of the 12 wells, the DTS strings are clamped to the outside of toe tubing; 4 of the 12 wells are installed with DTS strings in 1-1/4" coil tubing, installed inside the toe tubing as a gas lift and instrument combo string.

All 12 WP are on SAGD as of December 2016

Temperature data collected are sent to both DCS and Data Historian.
• DAS was piloted at Surmont to understand if it can be used to reduce the frequency of 4D seismic monitors
  • Similar to a VSP it uses a receiver within the well along with a source at surface
  • Additionally it can passively record within the well to complement seismic

• The DAS trial aimed to utilize the DAS technology on producer wells completed with FCD’s

• Initial flow rate from DAS data analysis shows DAS data has potential for production profiling at Surmont

• The same capillary tube as LxData or DTS can be used to perform the DAS survey
Typical Observation Well Measurement

- Example thermocouple and piezometer (101-07-OBA)
- Typically 40 TC (2m spacing)
- 0-10 piezometers placed at varying intervals

Soft cable Thermocouple (TC) strings were replaced by hard cable TC strings for improved well integrity
Typical Injector Well Configuration

- **16” Surface Casing**
- **11 3/4” Intermediate casing**
- **Liner Hanger**
- **7” Slotted liner**
- **7” Heel tubing String**
- **Toe String**
Typical ESP Well Configuration

13 3/8” Surface Casing

ESP Power Cable + 3/8” Bubble Tube + 2x 1/8” encapsulated F.O. P/T Instrumentation Cables (Intake/Discharge) (Clamp to outside of ESP Production Tubing)

3 3/8” Production tubing String

ESP (landed at Well Tangent)

Liner Hanger

9 5/8” Intermediate casing

2 1/16” Guide String

P/T Sensor clamped to 2 3/8” pup joint

7” Slotted liner or 6 5/8” Equalizer Liner

40pt Fiber Optic LxData (S1) 8pt Thermocouple Instrumentation (S2)

Subsection 3.1.1 (5b)
Improved Gas Lift Producer A: All Pads Excluding 263-1, 263-2 & 264-2

- Install a heel gas coil (5/8”) to lift heel production, no more blanket gas lifting
- Heel lift gas coil set 10 – 15m TVD above lateral

Subsection 3.1.1 (3c)
Improved Gas Lift Producer B: 263-1, 263-2 & 264-2

- Heel tubing string set 10 – 15m TVD above lateral
- 1 perforated joint on the bottom of heel tubing string with an additional 1-2 casing joints attached below.

- 13 3/8” Surface Casing
- 9 5/8” Intermediate casing
- 4 ½” x 3 ½” VIT L80: Blanket gas
- Bubble Tube Clamped to outside of Toe Tubing
- 1” Toe Lift Gas Coil Tubing Inside Toe Tubing
- 7” Slotted liner
- 4 ½” Toe String
- 1.25” Thermocouples (8pt) Clamped to outside of Toe Tubing
- 1” Toe Lift Gas Coil Tubing
4D Seismic

Subsection 3.1.1 (6)
4D Seismic Location Map – Phase 1

Phase 1 Area

Pilot
- Buried analog single component geophones
- Cased dynamite shots (1/4 Kg) @ 9 m
- 14th monitor acquired in September 2015

Pad 101N
- Buried analog single component geophones
- Cased dynamite shots (1/8 Kg) @ 6 m
- 8th monitor acquired in March 2015

Pad 101S
- Buried analog single component geophones
- Cased dynamite shots (1/8 Kg) @ 6 m
- 9th monitor acquired in March 2015

Pad 102N
- Buried analog single component geophones
- Cased dynamite shots (1/8 Kg) @ 6 m
- 9th monitor acquired in April 2015

Pad 102S
- Buried analog single component geophones
- Cased dynamite shots (1/8 Kg) @ 6 m
- 6th monitor acquired in October 2016

Pads 103 and 104
- Buried analog single component geophones
- Cased dynamite shots (1/8 Kg) @ 6 m
- 2nd monitor acquired in October 2016
Phase 2

- Buried analog single component geophones
- Cased dynamite shots (1/8 Kg) @ 6 m
- Acquired in three stages:
  - Initial 11 DA’s: 2010-11
  - South extension: 2013-14
- First Monitor acquired in Spring 2016: 263-2
# Phase 1 4D Seismic Program

<table>
<thead>
<tr>
<th>PAD</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spring</td>
<td>Fall</td>
<td>Spring</td>
<td>Fall</td>
</tr>
<tr>
<td>101N</td>
<td>B</td>
<td>M</td>
<td>M</td>
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<td>101S</td>
<td>B</td>
<td>M</td>
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<td>M</td>
</tr>
<tr>
<td>102N</td>
<td>B</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>102S</td>
<td></td>
<td>M</td>
<td></td>
<td>M</td>
</tr>
<tr>
<td>Pilot</td>
<td></td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>103</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>104</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- B: Baseline
- M: Monitor
# Phase 2 4D Seismic Program

<table>
<thead>
<tr>
<th>PAD</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spring</td>
</tr>
<tr>
<td>263-1</td>
<td></td>
</tr>
<tr>
<td>264-1</td>
<td></td>
</tr>
<tr>
<td>265-2</td>
<td></td>
</tr>
<tr>
<td>264-3</td>
<td></td>
</tr>
<tr>
<td>262-1</td>
<td></td>
</tr>
<tr>
<td>266-2</td>
<td></td>
</tr>
<tr>
<td>262-3</td>
<td></td>
</tr>
<tr>
<td>263-2</td>
<td></td>
</tr>
<tr>
<td>264-2</td>
<td></td>
</tr>
<tr>
<td>262-2</td>
<td></td>
</tr>
<tr>
<td>261-3</td>
<td></td>
</tr>
</tbody>
</table>

- **B**: Baseline
- **M**: Monitor
2015 4D Seismic Results Pad 101

- Well Pair 07/08/09, without a true baseline.
- 4D anomaly volume have increased for the remaining well pairs.
- Good conformance, especially at the heel.

- 4D anomaly volumes have increased.
- Continued conformance improvement along Well Pad 10, 11, 16, 17.
- Infill wells drilled between Well Pads 10, 11, 12, 16, 17 and 18 to optimize production in a geological more complex zone.

= 4D anomaly 
~60 deg C Isotherm
2016 4D Seismic Results Pad 102 (102S)

- 4D anomaly volumes have increased. Improved conformance along well pairs 1 to 9.

- 4D anomaly volumes have increased. Improved conformance along well pairs 10 to 18.

= 4D anomaly ~60 deg C Isotherm
• Relative good conformance in most of well pair.
• 4D indications of coalescence with thermal chamber of Pad 101N (103-11 and 103-12)
2016 4D Seismic Results Phase 2

- **Spring Monitor:**
  - 263-2

- **Fall Monitors:**
  - 263-1
  - 264-1
  - 265-2
  - 264-3

- Relative good conformance in most well pairs (except 263-2 – First Monitor few months after SAGD conversion)

- 4D indications of coalescence between 263-1 and 264-1

= 4D anomaly
~60 deg C Isotherm
Seismic Examples: 101-P16 Conformance (Toe)

Problem:
• Well pair 101-P16 lacking good conformance along well pair.

Action:
• Increase pressure of steam injection at toe.

Results:
• Conformance improved at toe.
Seismic Examples: 102-04 OBA Baffle Breakthrough (Heel)

- 2009 RST and 4D surveys confirmed recovery above mudstone.
- Operating pressure reduced to manage thief zone interactions.
• 4D seismic has proven very useful in monitoring and optimizing conformance and pressure strategy.

• 4D correlates with observation well data.

• Continuing to optimize heel/toe production/injection splits using 4D results.

• Ongoing efforts to history match reservoir models using 4D seismic.
Scheme Performance

Subsection 3.1.1 (7)
Surmont: Pilot Performance Plot

Pilot ceased operations after the Fort McMurray Wildfire Emergency Shutdown on May 5, 2016.

Ratios—SOR: 5.4; WOR: 9.9
Late life Pilot performance was impacted by thief zone (top water) interaction.
OBIP = (BV)(Φ)(So)

- **OBIP**: 597 – 1215 E3M3
- **Current RF**: 7% - 48%

- **Porosity**: 33%
- **Oil saturation**: 82% - 84%

**Surmont: Pilot – OBIP and RF**

**Surmont: Average Porosity and Oil Saturation**

- **Pilot A**: Avg. Porosity: 33%
- **Pilot B**: Avg. Porosity: 33%
- **Pilot C**: Avg. Porosity: 33%

- **Pilot A**: Avg. Oil Saturation: 82%
- **Pilot B**: Avg. Oil Saturation: 84%
- **Pilot C**: Avg. Oil Saturation: 83%

**Subsection 3.1.1 (7c i & ii)**
Surmont: Pad 101 Performance Plots

**Well Count**
- Prod. Well Pairs: 17
- Prod. Infill Well Pairs: 2
- Prod. Infill Well: 2
- On Circulation: 1
- Standing Well Pairs: 3
- Total: 25

**Surmont Phase 1: Pad 101: Volumes**
- Bitumen: 826 E3M3
- Steam: 2162 E3M3
- Water: 2085 E3M3

**Surmont Phase 1: Pad 101 SOR**
- iSOR: ~18 months of circulation
- cSOR: Slim hole completion
- Installed tubing deployed flow control devices on 3 producers
  - 101-06 (17): increased total emulsion rate
  - 101-11 (04): installed Feb 14, 2017
  - 101-20: increased total emulsion rate

**Ratio**
- SOR: 2.62
- WOR: 2.52

Subsection 3.1.1 (7a i)
Surmont: Pad 102 Performance Plots

- **Well Count**
  - Prod. Well Pairs: 18
  - Prod FB Infill Wells: 1
  - Std FB Infill Well: 1
  - Total: 20

- **Surmont Phase 1: Pad 102 Volumes**
  - Volumes (E3M3) – Bitumen: 702; Steam: 2424; Water: 2277

- **SURMONT PHASE 1: Pad 102 SOR**
  - SOR: 3.5; WOR: 3.2

- **Subsection 3.1.1 (7a i)**

- **Findings**
  - Sustained production from P21 FB infill well
    - Learnings are being applied to P22 FB infill well
  - NCG pilot commenced Jan, 2017 on WP 102-10/11/12
  - Installed tubing deployed flow control devices on 2 producers
    - 102-02: ESP failure; performance is TBD
    - 102-09: Increased total emulsion rate
  - Lower steam injection has resulted in a lower iSOR but higher reservoir pressures have contributed to sustaining a flat bitumen production rate.
**Surmont: Pad 103 Performance Plots**

- **WP: 103-01**
- **WP: 103-12**

**Well Count**

<table>
<thead>
<tr>
<th>Prod. Well Pairs</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>12</td>
</tr>
</tbody>
</table>

**Surmont Phase 1: Pad 103 Volumes**

- **Volumes (E3M3)** – Bitumen: 688; Steam: 1734; Water: 1794

**SURMONT PHASE 1: Pad 103 SOR**

- Initial production performance in line with forecasted expectations.
- ISOR continues to decline as expected with a new pad startup.

**Ratio – SOR: 2.5; WOR: 2.6**
Focus remains on sustaining our maturing base production at Pad 101 and 102 and optimizing Pad 103 performance.

Phase 1 iSOR remains within expectations.
Surmont: Production vs. Scheme Approval

SURMONT SCHEME APPROVAL = S1 + S2 + S2DB

Subsection 3.1.1 (7a iii)
• Temperature and pressure development; No significant changes.

Subsection 3.1.1 (7b)
Surmont: Obs Wells Temp & GR – 101-P07-OBA, 101-P08-OBC

- Temperature and pressure development; No significant changes.
Surmont: Obs Wells Temp & GR – 101-P15-OBD, 101-P15-OBB

- Temperature and pressure development; No significant changes.

Subsection 3.1.1 (7b)
• Temperature and pressure development; No significant changes.
Temperature and pressure development; No significant changes.
Surmont: Phase 1 - OBIP and RF

- OBIP: 6,998 – 10,176 E3M3
- Current RF: 7.5% - 49%

- Porosity: 31% - 33%
- Oil saturation: 74% - 84%

Cumulative volumes and recoveries align with internal forecasts. Blowdown timing will determine final EUR/RF.
Surmont: Pad 101 Low, Medium, High Recovery Examples

- Low Recovery: 101-13(06)
- Medium Recovery: 101-11(04)
- High Recovery 101-02(11)

101 North 8th monitor - March 2015

101 South 9th monitor - March 2015

101-13(06)

- Low ceiling in the middle.
- Low quality geology a driver behind overall well performance.
- Injector toe tubing landed in the middle.

101-11(04)

- Low quality at the producer toe.
- Good steam chamber development along wellbore.

101-02(11)

- Very good steam chamber development along wellbore.
- Clean I/P.

Subsection 3.1.1 (7c iii)
Surmont: Pad 101 Low, Medium, High Recovery Examples

- Low Recovery: 101-13(06)
- Medium Recovery: 101-11(04)
- High Recovery: 101-02(11)

**Subsection 3.1.1 (7c iii)**

- **Sustained / increased bitumen production from subject wells.**
- **Effective steam management improved performance of 101-06.**
Surmont: Pad 102 Low, Medium, High Recovery Examples

- Low Recovery: 102-03
  - Limited steam chamber development
  - Poor geology a significant driver behind overall well performance
  - I/P landed in muddy sands

- Medium Recovery: 102-08
  - Significant steam chamber development
  - I/P landed in marginal geology

- High Recovery: 102-11
  - Significant steam chamber development
  - I/P landed in good geology
  - Toe impacted by low muddy ceiling

Subsection 3.1.1 (7c iii)
Surmont: Pad 102 Low, Medium, High Recovery Examples

- Low Recovery (102-03)
- Medium Recovery (102-08)
- High Recovery (102-11)

- Sustained / increased bitumen production from subject wells.
- Optimized steam injection to maximize bitumen production from 102-11.

Pad 102: Production Performance

Pad 102: Steam Injection
Surmont: Pad 103 Low, Medium, High Recovery Examples

Pad 103 2nd Monitor – October, 2016

103-11
- Interaction will low pressure chamber of 101N
- Short well (790m)
- Fish in hole

103-05
- SL completion
- Good geology

103-08
- FCD completion
- Good geology
- Early ESP conversion
Surmont: Pad 103 Low, Medium, High Recovery Examples

- **Low Recovery (103-11)**
- **Medium Recovery (103-05)**
- **High Recovery (103-08)**

**Pad 103: Production Performance**

- FCD completion continues to outperform SL

**Pad 103: Steam Injection**

Subsection 3.1.1 (7c iii)
Surmont 1 – Recovery Examples – Normalized Well Life Production Data

- Low Recovery
- Medium Recovery
- High Recovery

Subsection 3.1.1 (7c iii)
Surmont: Post Fort McMurray Wildfire Performance Plots

- Reservoir performance on trend with pre-Fort McMurray Wildfire baseline.
Phase 1 – Key Learnings

• At pad 101/102, incremental steam injected during 2015/2016 increased the reservoir chamber pressure which attributed to a flat bitumen production profile during the subject timeframe
  • Even during Q4, 2016 when steam injection rates were considerably curtailed, bitumen production rates have held constant.
  • iSOR continues to improve and trend lower

• Liner installed flow control devices at Pad 103 continue to outperform SL wells.

• Initial results from tubing deployed flow control devices at Pad 101/102 continue to be assessed however, early days are illustrating a net increase in total emulsion/bitumen rates.

• Optimization continues to improve performance of mature wells:
  • NCG pilot commenced January, 2017 on 3 wells at Pad 102
  • Fishbone infill well 102-22 expected to be onstream in Q2, 2017
  • Steam injection optimization
  • Subcool management
  • Well stimulations
  • Changes in injector tubing landing depths
  • Additional tubing deployed flow control devices
  • Investigating possible BP drill outs to recover lost sections of laterals
Surmont: Phase 1 Well Pad Rates and SOR

Subsection 3.1.1 (7h)
Pilot focused on co-injection of fuel gas with steam in order to reduce steam requirements – ultimately reducing water usage, fuel consumption and lower greenhouse gas emissions.

Pilot on 102 South is located on the western side of the well pad. Subject pilot wells are:
- 102-WP10
- 102-WP11
- 102-WP12

Injection concentrations are up to a maximum of 2 mol% methane or 10 E3m³/d per well pair.
All eleven pads started as of February 28, 2017.
Steam/Water trends diverting result of thief zone interactions in Pads 264-1, 263-1, 265-2, 262-2
Three well pairs re-drilled due to downhole failures
Surmont 2 ramp-up ongoing.
264-1 has been operating at a target pressure of 3,675 kPa
• 11/12 wells converted to SAGD. 1 well circulating
• Good development on West side of DA, however challenging performance on Eastern area
• Top water interaction has been identified in three wells
• Coalescence with Pad to the North on West side
Performance / Chamber Development Challenges – Pad 264-1

264-1-P04-OBD. 17 meters from well pair

- Top Water interaction observed from Obs Well data and WSR
Performance / Chamber Development Challenges – Pad 262-2

- Started circulation after Fort McMurray Wildfire Emergency Shutdown & Re-start
- Close proximity to Bottom Water NE of Surmont
- Some wells encountered low resistivity zones while drilling, blanked liners in these zones

Subsection 3.1.1 (7b)
• Bottom Water pressurization noticed early after circulation start
• Wells 05/07 direct contact with BW reducing circulation effectiveness
Performance / Chamber Development Challenges – Pad 262-2

- Steam leak noticed early after circulation start by reduction of WSR (steam/water trends diverting)
- Pressure reduction mitigation to ~2000 kPa however this is too low for Gas Lift hence needing ESPs
### SOIP & Recovery Per Pad

<table>
<thead>
<tr>
<th>DA</th>
<th>SOIP* (E3M3)</th>
<th>CUM OIL (E3M3)</th>
<th>Recovery Factor</th>
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<tbody>
<tr>
<td>261-3</td>
<td>9,755</td>
<td>148.0</td>
<td>1.5%</td>
</tr>
<tr>
<td>262-1</td>
<td>8,755</td>
<td>221.9</td>
<td>2.5%</td>
</tr>
<tr>
<td>262-2</td>
<td>8,461</td>
<td>97.1</td>
<td>1.1%</td>
</tr>
<tr>
<td>262-3</td>
<td>9,552</td>
<td>140.5</td>
<td>1.5%</td>
</tr>
<tr>
<td>263-1</td>
<td>9,146</td>
<td>583.5</td>
<td>6.4%</td>
</tr>
<tr>
<td>263-2</td>
<td>8,954</td>
<td>359.0</td>
<td>4.0%</td>
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<tr>
<td>264-1</td>
<td>7,573</td>
<td>251.2</td>
<td>3.3%</td>
</tr>
<tr>
<td>264-2</td>
<td>9,845</td>
<td>194.7</td>
<td>2.0%</td>
</tr>
<tr>
<td>264-3</td>
<td>10,122</td>
<td>460.5</td>
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<tr>
<td>265-2</td>
<td>6,839</td>
<td>365.5</td>
<td>5.3%</td>
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<tr>
<td>266-2</td>
<td>9,383</td>
<td>44.9</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

*SOIP: SAGDable Oil in Place

---

**Cumulative Bitumen Production by Subsurface Pad (m³)**

Pads ramping-up. Oil allocated during circulation accounted for RF.
Good Performance – WP 263-1-07

- Well Performance exceeds expectations.
- Very good injectivity translating into fast ramp-up and good production rate.
- Falloff data (confirmed with 4D) shows mainly first half of well contributing to production.
• Well Performance meets expectations.
• Very good injectivity translating into fast ramp-up and good production rate.
• Falloff data (confirmed with 4D) shows two main sections contributing to production
Poor Performance – WP 262-3-08

- Well Performance below expectations despite good geology. Large circulation period (~5 months) indicated poor communication between injector/producer wells.
- Pad MOP increased to 4300kPa in SAGD which helped increase injectivity in the formation.
- Flowing temperature data indicates poor development in middle section of the well.
Surmont 2 – Operating Pressure Strategy

- Surmont 2 base case Operating Strategy follows a declining pressure profile, which is influenced by the efficiency of artificial lift, SOR, thief zone (TZ) interaction, etc.
- Certain DAs have been identified at risk for top and bottom water TZ interaction, which has already been observed in some wells.
- Strategy for these DA’s account for a more aggressive pressure drop to minimize steam loss into the TZ, but still keeping an overbalanced condition to avoid water influx into the chambers.
- Timing of pressure drop is dependent on each DA’s condition. This has already been implemented in some individual wells where interaction has occurred.
- ESP conversions will help implement a lower pressure strategy where required.

Example of wells in Pad 264-1 where pressure has been decreased to mitigate TZ interaction
Phase 2 - Key Learnings

• Some wells are still challenged with injectivity/productivity issues, which translates into a slower ramp-up or underperformance based on expectations. Evaluation of optimization opportunities is work in progress.

• Liner deployed Flow Control Devices have showed to promote faster development of the wells compared to typical slotted liner wells, mainly due to the operational benefit they provide.

• Proper risk ranking and identification of thief zone areas, combined with close monitoring of chamber development is of great importance for timely execution of operating strategy.

• Optimization projects still under evaluation include:
  • Tubing Deployed FCDs
  • Injector steam splitters
  • Well stimulations
Subsection 3.1.1 (7h)

Surmont 2 – 262-1 Pad

Graphs showing rates (m3/d) and ISOR/cSOR (sm3/sm3) over time from 5/1/2016 to 2/1/2017.
Surmont 2 – 262-2 Pad

Rates (m³/d)

- Steam Rate
- Oil Rate
- Water Rate

iSOR / cSOR (sm³/sm³)

- iSOR
- cSOR

Subsection 3.1.1 (7h)
Surmont 2 – 263-1 Pad

Rates (m3/d)

iSOR / cSOR (sm3/sm3)

Subsection 3.1.1 (7h)
Surmont 2 – 264-1 Pad

Rates (m³/d)

Steam Rate
Oil Rate
Water Rate

iSOR / cSOR (sm³/sm³)

iSOR
cSOR

Subsection 3.1.1 (7h)
Surmont 2 – 264-2 Pad

Rates (m³/d)

ISOR / cSOR (sm³/sm³)
Surmont 2 – 265-2 Pad

Rates (m3/d)

- Steam Rate
- Oil Rate
- Water Rate

ISOR / cSOR (sm3/sm3)

- ISOR
- cSOR

Subsection 3.1.1 (7h)
Future Plans

Subsection 3.1.1 (8)
Future Plans – Surmont

Surmont 1
• Fishbone infill well 102-22 expected to be onstream in Q2, 2017
• NCG pilot commenced January, 2017 on 3 wells at Pad 102
• Well stimulations are being investigated
• Additional tubing deployed flow control devices will be looked at for install
• Investigating possible BP drill outs to recover lost sections of laterals

Surmont 2
• Start-up remaining 11 wells in Q1 2017
• Start ESP conversions for 5 different pads
• Continue tubing deployed flow control device installations
• Continue more steam splitter installations
• Evaluate well stimulations and redrill opportunities for under performing pads
Surface Operations and Compliance
Surmont Project
Approval 9426

Facilities
Subsection 3.1.2 (1)
• Steam Generator (installed but never tied in) was removed from Phase 1
Phase 1 Plot Plan: Pad 102

- Non-Condensable Gas (NCG) Co-Injection trial required piping modifications on wellpairs 10, 11, and 12 to tie lift gas lines into heel steam injection lines.
• No ESP Conversions or Major Modifications at Pad 101.
Phase 1 Plot Plan: Pad 103

- Pad 103 ESP Conversions: Added 3 ESPs in Feb 2016, 1 in Apr 2016, and 1 in Aug 2016

Subsection
Installation of one additional OTSG at Surmont 2, construction work is on-going. No changes in other areas of the plant.
• No ESP Conversions or Major Modifications at Pad 261-3
Phase 2 Plot Plan: Pad 262-1

- No ESP Conversions or Major Modifications at Pad 262-1
Pad 262-2 ESP Conversions: Added 3 ESPs in Feb 2017
Phase 2 Plot Plan: Pad 262-3

• No ESP Conversions or Major Modifications at Pad 262-3
Phase 2 Plot Plan: Pad 263-1

- No ESP Conversions or Major Modifications at Pad 263-1
Phase 2 Plot Plan: Pad 263-2

- No ESP Conversions or Major Modifications at Pad 263-2
• No ESP Conversions or Major Modifications at Pad 264-1
No ESP Conversions or Major Modifications at Pad 264-2
Phase 2 Plot Plan: Pad 264-3

- No ESP Conversions or Major Modifications at Pad 264-3

Subsection
Phase 2 Plot Plan: Pad 265-2

- P06 ESP
- P07 ESP
- P08 ESP

• Pad 265-2 ESP Conversions: Added 3 ESPs in Feb 2017
Phase 2 Plot Plan: Pad 266-2

- Pad 266-2 ESP Conversions: Added 8 ESPs in Feb 2017
- Produced Gas interconnect from Phase 1 to Phase 2 operational in 2016
• Produced Gas interconnect from Phase 1 to Phase 2 operational in 2016
2016 Surmont Operations

• **Phase 1:**
  - Installed new Economizer box on one steam gen with upgraded materials and additional monitoring capabilities.
  - Steam control valves upgraded to increase steam production to Pads.
  - Installation of forced draft fans on steam generators to maximize air flow, improve combustion and maximize steam production.

• **Phase 2**
  - Train 2 and train 3 commissioned and started up.
  - Commissioned and started up remaining well pads and prepared for 2017 ESP conversions.
  - Low fin thermocouples installation, for monitoring fouling and pigging initiated.
Facility Performance

Subsection 3.1.2 (2)
Facility Performance: Bitumen Treatment by CPF

Subsection 3.1.2 (2a)
Facility Performance: Bitumen Treatment by Train

- CPF 1 Train 1
- CPF 1 Train 2
- CPF 2 Train 1
- CPF 2 Train 2
- CPF 2 Train 3

Fort McMurray Wildfire Emergency Shutdown & Re-Start

Measured Emulsion Flow [AM3/hr]

- 2/1/16 - 2/25/17

Graph showing measured emulsion flow over time with various colors representing different trains.
Facility Performance: Phase 1 Water Treatment

• Phase 1 water treatment plant continues to operate as per design.
• Chemical trials conducted in 2016 have improved water treatment performance.
• Successful ramp-up from the Fort McMurray Wildfire Emergency Shutdown & Re-start.

Boiler Feed Water Quality (Feb 1, 2016 to Feb 28, 2017)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BFW Specification</th>
<th>Avg. Value</th>
<th>% of time on Spec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness (Total), mg/L</td>
<td>&lt;0.5</td>
<td>0.31</td>
<td>92.9</td>
</tr>
<tr>
<td>Silica, as SiO2, mg/L</td>
<td>&lt;50</td>
<td>19.6</td>
<td>99.6</td>
</tr>
<tr>
<td>Bitumen in Water, ppm</td>
<td>&lt;0.5</td>
<td>0.24</td>
<td>99.7</td>
</tr>
<tr>
<td>Turbidity, NTU</td>
<td>&lt;3.5</td>
<td>1.05</td>
<td>99.5</td>
</tr>
</tbody>
</table>
Continued successful ramp up of Phase 2 water treatment plant. Water plant is operating at approximately 80% of nameplate design.

New well start-ups created deoiling challenges, however the well count has stabilized.

Successful ramp-up from the Fort McMurray Wildfire Emergency Shutdown & Re-start.

**Boiler Feed Water Quality (Feb 1, 2016 to Feb 28, 2017)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BFW Specification</th>
<th>Avg. Value</th>
<th>% of time on Spec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness (Total), mg/L</td>
<td>&lt;0.5</td>
<td>0.38</td>
<td>83.7</td>
</tr>
<tr>
<td>Silica, as SiO2, mg/L</td>
<td>&lt;50</td>
<td>21.4</td>
<td>100</td>
</tr>
<tr>
<td>Bitumen in Water, ppm</td>
<td>&lt;0.5</td>
<td>0.41</td>
<td>82.4</td>
</tr>
<tr>
<td>Turbidity, NTU</td>
<td>&lt;3.5</td>
<td>1.63</td>
<td>89.9</td>
</tr>
</tbody>
</table>
Facility Performance: Water Treatment

Phase 1 and Phase 2 Water Treatment Flowrates

Fort McMurray Wildfire Plant Evacuation and Re-Start

Warm Lime Softener Inlet Flowrate (m³/hr)

- Phase 2
- Phase 1

Surmont Project: Steam Generation Performance

- S1 531 D economizer replaced
- Surmont phase 2 online
- S1 531 B economizer replaced

Shutdown due to Wildfires

Steam injection (cwe bpd)

Steam output

Steam quality

1-Jan-15
1-Feb-15
1-Mar-15
1-Apr-15
1-May-15
1-Jun-15
1-Jul-15
1-Aug-15
1-Sep-15
1-Oct-15
1-Nov-15
1-Dec-15
1-Jan-16
1-Feb-16
1-Mar-16
1-Apr-16
1-May-16
1-Jun-16
1-Jul-16
1-Aug-16
1-Sep-16
1-Oct-16
1-Nov-16
1-Dec-16
1-Jan-17
1-Feb-17

Quality (%)
Surmont Phase 2: Steam Generation Performance

- Phase 2 steam generators were commissioned in 2015 and 2016.
- SG-531 B and SG-531 D economizers were replaced (upgraded) on November 2016, allowing for higher steam qualities (83-85%).
- Steam interconnect between Phase 2 and Phase 1 was commissioned in 2015. Excess of steam from Phase 2 is directed to Phase 1 wellpads.
- Average steam rates through interconnect:
  - 2015: ~11,786 bpd.
  - 2016: ~40,021 bpd.
- Phase 2 continued ramp up in 2016.
- Implementing optimization opportunities like steam enhancement trial
• The number of pigging events at Phase 1 decreased in 2016 compared with 2015 (15 vs 28 pigging events).

• Well stimulation during October 2015 impacted water quality and pigging frequency during the first quarter of 2016.

• Overall, Phase 2 steam generators have better run time than Phase 1.
2017 Goal: Step 3 started on January 12, 2017 and data is currently being collected and analyzed.
Phase 2 Steam Quality Enhancement Trial

2017 Path forward:

• Steam trials expected to be complete by end of June, 2017.
• Steam gens equipped with additional thermocouples will be fired at 80 – 83% steam quality.
• Install additional thermocouples on remaining Phase 2 gens in 2017.
• Maximize Phase 2 steam production based on learnings from Trial.
Phase 1 is at a steady state of production and electrical consumption, however the Fort McMurray Wildfire Emergency Shutdown and Re-start resulted in a variance.
• Effect of Fort McMurray Wildfire Emergency Shutdown and Re-start created variance – plant moving towards steady state
## Surmont Facility Performance: Gas Usage

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>TCPL Gas Imports (10^3 m^3)</td>
<td>42,999</td>
<td>160,095</td>
<td>183,933</td>
<td>223,447</td>
<td>228,344</td>
<td>250,412</td>
<td>230,339</td>
<td>240,496</td>
<td>433,138</td>
<td>962,313</td>
<td>218,242</td>
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<tr>
<td>Solution Gas (10^3 m^3)</td>
<td>2,755</td>
<td>4,155</td>
<td>10,073</td>
<td>12,703</td>
<td>13,869</td>
<td>15,193</td>
<td>17,005</td>
<td>14,246</td>
<td>19,301</td>
<td>33,636</td>
<td>9,337</td>
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<tr>
<td>Flared Gas (10^3 m^3)</td>
<td>4,641</td>
<td>6,439</td>
<td>3,962</td>
<td>705</td>
<td>625</td>
<td>218</td>
<td>117</td>
<td>271</td>
<td>475</td>
<td>371</td>
<td>50</td>
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<tr>
<td>% of Solution Gas Recovery</td>
<td>60.67%</td>
<td>94.45%</td>
<td>95.49%</td>
<td>98.57%</td>
<td>99.31%</td>
<td>98.10%</td>
<td>97.54%</td>
<td>98.90%</td>
<td>99.46%</td>
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<td></td>
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Subsection 3.1.2(2e)
Facility Performance: Gas Consumption

Subsection 3.1.2 (2e)
Facility Performance: Gas Consumption by Location

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<tr>
<th>Month</th>
<th>Flared Gas</th>
<th>Camp</th>
<th>Battery</th>
<th>OTSGs</th>
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<td>84</td>
<td>214</td>
<td>3,422</td>
<td>70,427</td>
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<tr>
<td>Feb-16</td>
<td>-</td>
<td>182</td>
<td>3,146</td>
<td>68,334</td>
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<tr>
<td>Mar-16</td>
<td>-</td>
<td>161</td>
<td>3,451</td>
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<tr>
<td>Apr-16</td>
<td>-</td>
<td>120</td>
<td>2,668</td>
<td>80,698</td>
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<tr>
<td>May-16</td>
<td>-</td>
<td>25</td>
<td>660</td>
<td>9,786</td>
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<tr>
<td>Jun-16</td>
<td>84</td>
<td>70</td>
<td>2,941</td>
<td>52,118</td>
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<tr>
<td>Jul-16</td>
<td>133</td>
<td>70</td>
<td>1,332</td>
<td>95,162</td>
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<tr>
<td>Aug-16</td>
<td>46</td>
<td>73</td>
<td>379</td>
<td>96,188</td>
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<tr>
<td>Sep-16</td>
<td>-</td>
<td>88</td>
<td>774</td>
<td>97,834</td>
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<tr>
<td>Oct-16</td>
<td>-</td>
<td>156</td>
<td>2,230</td>
<td>106,739</td>
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<td>Nov-16</td>
<td>18</td>
<td>156</td>
<td>1,788</td>
<td>105,121</td>
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<td>Dec-16</td>
<td>6</td>
<td>238</td>
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<tr>
<td>Jan-17</td>
<td>8</td>
<td>214</td>
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<td>114,769</td>
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<tr>
<td>Feb-17</td>
<td>43</td>
<td>190</td>
<td>2,674</td>
<td>106,777</td>
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Subsection 3.1.2 (2e)
Surmont Facility Performance: 2016 Gas Usage

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<th>Feb-16</th>
<th>Mar-16</th>
<th>Apr-16</th>
<th>May-16</th>
<th>Jun-16</th>
<th>Jul-16</th>
<th>Aug-16</th>
<th>Sep-16</th>
<th>Oct-16</th>
<th>Nov-16</th>
<th>Dec-16</th>
<th>Jan-17</th>
<th>Feb-17</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flared Gas</strong></td>
<td>84</td>
<td>-</td>
<td>211</td>
<td>2,566</td>
<td>1,952</td>
<td>2,655</td>
<td>150</td>
<td>804</td>
<td>3,017</td>
<td>3,695</td>
<td>3,592</td>
<td>4,579</td>
<td>4,358</td>
<td>4,156</td>
</tr>
<tr>
<td><strong>Solution Gas</strong></td>
<td>72,035</td>
<td>69,095</td>
<td>75,501</td>
<td>80,831</td>
<td>10,404</td>
<td>10,404</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td><strong>Imports (TCPL)</strong></td>
<td>104,931</td>
<td>113,312</td>
<td>110,819</td>
<td>102,482</td>
<td>94,861</td>
<td>92,694</td>
<td>93,342</td>
<td>55,955</td>
<td>3,695</td>
<td>3,592</td>
<td>4,579</td>
<td>4,358</td>
<td>4,156</td>
<td>4,586</td>
</tr>
</tbody>
</table>
• Amount of flared gas was influenced by the following events in 2016:
  • Start-up of Surmont 2 Trains 2 and 3
  • Start-up of six Surmont 2 Well Pads
  • Well Operation shifting from Circulation to Gas Lift and/or ESP
  • May Fort McMurray Wildfire Emergency Shutdown and June re-start
Facility Performance: Greenhouse Gas

Agreement with AER to continue reporting Phase 2 CO2e emission, through its rampup, separately from Phase 1.

2016 Phase 1 SGER intensity reduction target of 15% was not achieved.

2016 GHG Emission intensity has been completed, verified and payment submitted.

2014 Turn-Around: Flaring emissions over very minimal production create a brief high intensity moment, when data is aggregated monthly.

May 2016: Fort McMurray Wildfire Emergency Shutdown & Re-start
Measurement and Reporting

Subsection 3.1.2 (3)
Well Testing

• Surmont Well Pads are configured to, automatically and sequentially, align each production well into the Test Separator.

• Well Test Duration, Total Produced Emulsion, Average Water Cut and Total Produced Water Vapors are recorded for each Well Test.

• Well Test Results are reviewed to “Approve”, if representative of the wells production, or “Reject.”

• Well Test Durations range from 5 to 10 hours, with up to 4 hours purge, based on the wells previous liquid production rates.
Well Estimated Monthly Production

Each well’s estimated monthly production is calculated using only “approved” Well Test Results. Daily estimated volumes are used to calculate the wells monthly estimated volume from the time of an approved well test, until its next approved well test.

**Well Monthly Estimated Oil Production =**

\[
\text{Well Estimated Daily Oil Production} \times \text{Hours per Days in Operation}
\]

- **Well Estimated Daily Oil Production =**
  
  \[
  \frac{\text{Test Produced Emulsion Volume} \times (1 - \text{WC\%})}{\text{Test Duration (hours)}} \times 24\text{ hours}
  \]

**Well Monthly Estimated Water Production =**

\[
\text{Well Estimated Daily Water Production} \times \text{Hours per Days in Operation}
\]

- **Well Estimated Daily Water Production =**
  
  \[
  \frac{\text{Test Produced Emulsion Volume} \times \text{WC\%} + \text{Water Vapor}}{\text{Test Duration (hours)}} \times 24\text{ hours}
  \]
Well Allocated Oil Production

*Well Estimated Monthly Oil Production* × *Oil Proration Factor*

- **Oil Proration Factor** =
  
  \[
  \frac{\text{Battery Produced Oil}}{\text{Total Estimated Monthly Oil Production}}
  \]

- **Battery Produced Oil** =
  
  \[\text{Oil Dispositions + Battery Tank Inventory + Shrinkage – Receipts + Well Load Oil}\]

- **Total Estimated Monthly Oil Production** =
  
  \[
  \sum_{n=1}^{x} \text{Well}_n \text{ Estimated Monthly Oil Production}
  \]

  where \(x\) is the total number of production wells for the reporting period.

- **Oil Dispositions** =
  
  \(Sales \ CTM^1 + Enbridge \ Tank \ Inventory + TruckOut\)

- **Oil in Battery’s Tank Inventory** =
  
  \(Sales \ Oil \ Tanks + OffSpec \ Tanks + Slop \ Oil \ Tanks + Skim \ Oil \ Tanks\)

- **Receipt** =
  
  \(Diluent \ CTM^1 + Diluent \ Tank \ Inventory + Diluent \ TruckIn\)
Well Allocated Water Production

**Well Estimated Monthly Water Production × Water Proration Factor**

- **Water Proration Factor =**
  \[
  \frac{\text{Battery Produced Water}}{\text{Total Estimated Monthly Water Production}}
  \]

- **Battery Produced Water =**
  \[
  \text{Water Dispositions} + \text{Battery Tank Inventory} - \text{Receipts} + \text{Well Load Water}
  \]

- **Total Estimated Monthly Water Production =**
  \[
  \sum_{n=1}^{x} \text{Well}_n \text{ Estimated Monthly Water Production}
  \]
  where \( x \) is the total number of production wells for the reporting period.

- **Water Dispositions =**
  \[
  \text{Dispositions to Injection Facility} + \text{Truck–Out}
  \]

- **Water in Battery’s Tank Inventory =**
  \[
  \text{Skim Oil Tanks} + \text{Slop Oil Tanks} + \text{DeSand/BackWash/ORF Tanks} + \text{Sales/OffSpec/Diluent Tanks}
  \]

- **Receipt =**
  \[
  \text{IF Condensate Returns} + \text{Water in Diluent} + \text{Truck–In}
  \]
2016 Well Oil and Water Production Highlights and Changes

• After May 2016 Pilot Plant ceased operations, Diluent, Produced Oil and Water receipt/dispositions between Surmont and the Pilot Plant no longer exist.

• At the Test Separator, include the accounting of Water Produced as Vapour, to better estimate water returns during Steam Circulation.

• Large number of wells shifting operating mode, from start-up Circulation to SAGD Production, Gas Lift and/or ESP.

• Considerable effort implemented to achieve water cut meter’s performance under shifting well operating conditions.
Well Allocated Gas Production

**Well Allocated Oil Production × GOR**

- **Gas to Oil Ration (GOR) =**
  \[
  \frac{\text{Battery Produced Gas}}{\text{Battery Produced Oil}}
  \]

- **Battery Produced Gas =**
  \[
  \text{Gas Dispositions} - \text{Receipts}
  \]

- **Gas Dispositions =**
  \[
  \text{Battery Utility FG} + \text{Steam Generators FG} + \text{Flare Purge} + \text{NCG CoInjection} + \text{Flared Gas}
  \]

- **Receipt =**
  \[
  \text{TCPL Fuel Gas CTM}^1
  \]

---

1 CTM: Custody Transfer Meter
• Non Condensable Gas (NCG) Co-Injection Trial initiated November 2016. Co-Injected volumes are measured and added to the Battery’s gas dispositions.

• Plant Control System (DCS) shutdown during Fort McMurray Wildfire Emergency Shutdown & Re-start. Flare volumes were accounted for until DCS shutdown.

• After wildfires, fuel gas was injected into the injection wall (semi-SAGD operation) to restart some S2 wells. The fuel gas injected did not immediately return to the Battery; therefore, the calculated Battery’s Produced Gas resulted into “negative volumes” for June 2016 reporting period.
Well Measured Steam $\times$ Steam Proration Factor

- Well Measured Steam =
  $\text{Steam Injected @Heel} + \text{Steam Injected @Toe}$

- Steam Proration Factor =
  $\frac{\text{Steam Produced}}{\text{Total Measured Steam}}$

- Steam Produced =
  $\text{Steam Generated (CPF)} - \text{Steam Condensate Returns}$

- Total Measured Steam =
  $\sum_{n=1}^{x} \text{Well}_n \text{ Measured Steam}$

  where $x$ is the total number of injection wells during the reporting period.
Oil and Water Production Proration Factors

Subsection 3.1.2 (3b)

2016: Maintained Regulatory Compliance all Year

Regulatory Compliance Limits
0.85 - 1.15

Pad 101/102, 38 Wells in SAGD
Pad 101, 1 Well in CIRC

Pad 103, 8 Wells in SAGD
Pad 103, 4 Wells in CIRC

S2, 31 Wells in SAGD
S2, 45 Wells in CIRC

124 Wells in SAGD at end of February 2017
Steam Injection Proration Factor

2016 Average Steam Proration Factor: 0.984
Always within ±5%

Regulatory Compliance Limits
0.85 - 1.15
Water Production, Injection, and Uses

Subsection 3.1.2 (4)
Surmont Phase 1 Non-Saline Water Source Wells

<table>
<thead>
<tr>
<th>Source Well</th>
<th>Observation Well</th>
<th>Formation</th>
</tr>
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<tbody>
<tr>
<td>1F1021808306W400</td>
<td>1F2021808306W400</td>
<td>Lower Grand Rapids</td>
</tr>
<tr>
<td>1F1041808306W400</td>
<td>102041808306W400</td>
<td>Lower Grand Rapids</td>
</tr>
<tr>
<td>1F1011908306W400</td>
<td>100011908306W400</td>
<td>Lower Grand Rapids</td>
</tr>
<tr>
<td>1F1032308307W400</td>
<td>100032308307W400</td>
<td>Lower Grand Rapids</td>
</tr>
</tbody>
</table>
Surmont Phase 2 Non-Saline Water Source Wells

<table>
<thead>
<tr>
<th>Source Well</th>
<th>Observation Well</th>
<th>Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1F1022108306W400</td>
<td>100022108306W400</td>
<td>Lower Grand Rapids</td>
</tr>
<tr>
<td>1F1022608306W400</td>
<td>100022608306W400</td>
<td>Lower Grand Rapids</td>
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<tr>
<td>1F1052808306W400</td>
<td>100052808306W400</td>
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</tr>
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<td>1F1070308306W400</td>
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<td>1F1153408307W400</td>
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<td>Lower Grand Rapids</td>
</tr>
</tbody>
</table>

NAD83 UTM Zone 12

Lower Grand Rapids
Clearwater
McMurray
Keg River
Non-Saline Source Water Well
Disposal Well
Surmont Pilot
Surmont 1
Surmont 2

Subsection 3.1.2 (4a)
### Surmont Phase 2 Saline Water Source Wells

<table>
<thead>
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<th>Source Well</th>
<th>Formation</th>
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<td>1F1020608404W400</td>
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<td>1F1033008304W400</td>
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<td>1F1042208305W400</td>
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<td>1F1071308305W400</td>
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<td>1F1081008305W400</td>
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<td>1F1160908404W400</td>
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<td>1F2091708404W400</td>
<td>Lower Grand Rapids</td>
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<tr>
<td>1F2141108404W400</td>
<td>Lower Grand Rapids</td>
</tr>
</tbody>
</table>

Subsection 3.1.2 (4a)
Surmont Non-Saline and Saline Water Source Wells Production Volumes

- Surmont Phase 2 Saline [4 Lower Grand Rapids, 6 Clearwater Wells]
- Surmont Phase 2 Non-Saline [7 Lower Grand Rapids Wells]
- Surmont Phase 1 Non-Saline [4 Lower Grand Rapids Wells]
Water Production and Steam Injection Volumes

![Graph showing water production and steam injection volumes over time with key events marked: Fort McMurray Wildfire Emergency Shutdown & Re-start, Phase 2 First steam.]
Directive 81: Injection Facility Water Imbalance

- Surmont in compliance with *Directive 81* Injection Facility Water Imbalance since June 2014
- Challenging to keep metering imbalance within 5% when performing large projects (Phase 2 CPF mega-flush Nov 2014 - Mar 2015) or unplanned events (Fort McMurray Wildfire Emergency Shutdown and Re-start May 2016)
- Maintained compliance during Phase 2 ramp up

![Graph showing water imbalance over time](image-url)
Surmont anticipates *Directive 81* disposal limit compliance in 2017 as per current trend (6.0% actual vs. 10.3% disposal limit)

Surmont accomplished *D-81* compliance in 2016 (7.6% actual vs. 10.6% disposal limit) after commissioning brackish water system and blowdown evaporators at Phase 2 CPF

Excess disposal in 2015 due to:
- Phase 2 ramp-up (Testing 12 out of 18 OTSGs)
- Performed Phase 2 CPF mega-flush (started in Nov 2014 and disposed in Mar 2015)
- Significant repair work on Phase 1 OTSG-D
- Well caustic work causing significant water plant upset
### Surmont Phase 1 Water Disposal Wells

<table>
<thead>
<tr>
<th>Well</th>
<th>Zone Approved for Disposal</th>
<th>Maximum Wellhead Injection Pressure (kPa)</th>
<th>Well Status</th>
<th>AER Disposal Approval No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>100/01-16-083-05W4/0</td>
<td>McMurray</td>
<td>2700</td>
<td>Water Disposal</td>
<td>10044H</td>
</tr>
<tr>
<td>100/07-22-083-05W4/0</td>
<td>McMurray</td>
<td>2500</td>
<td>Water Disposal</td>
<td>10044H</td>
</tr>
<tr>
<td>100/08-10-083-05W4/0</td>
<td>McMurray</td>
<td>2300</td>
<td>Water Disposal</td>
<td>10044H</td>
</tr>
<tr>
<td>100/04-21-083-05W4/0</td>
<td>McMurray</td>
<td>2500</td>
<td>Water Disposal</td>
<td>10044H</td>
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<tr>
<td>100/01-11-083-05W4/0</td>
<td>McMurray</td>
<td>2500</td>
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## Surmont Phase 2 Water Disposal Wells

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<th>Maximum Wellhead Injection Pressure (kPa)</th>
<th>Well Status</th>
<th>AER Disposal Approval No.</th>
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</thead>
<tbody>
<tr>
<td>100/01-09-083-05W4/0</td>
<td>McMurray</td>
<td>3400</td>
<td>Water Disposal</td>
<td>10044H</td>
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<tr>
<td>100/01-04-083-05W4/0</td>
<td>McMurray</td>
<td>2500</td>
<td>Water Disposal</td>
<td>10044H</td>
</tr>
<tr>
<td>102/08-21-083-05W4/0</td>
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<td>Water Disposal</td>
<td>10044H</td>
</tr>
<tr>
<td>102/15-15-083-05W4/0</td>
<td>McMurray</td>
<td>3400</td>
<td>Water Disposal</td>
<td>10044H</td>
</tr>
<tr>
<td>100/08-27-083-05W4/0</td>
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<tr>
<td>100/08-23-083-05W4/0</td>
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<td>3400</td>
<td>Water Disposal</td>
<td>10044H</td>
</tr>
<tr>
<td>100/16-24-083-05W4/0</td>
<td>McMurray</td>
<td>3400</td>
<td>Water Disposal</td>
<td>10044H</td>
</tr>
</tbody>
</table>
Surmont Phase 1 Water Disposal Wells Well Head Pressure (McMurray)

Approval Max. WHP for 100/01-16: 2700 kPa

Approval Max. WHP for 100/07-22, 100/04-21, and 100/01-11: 2700 kPa

Approval Max. WHP for 100/08-10: 2300 kPa

- 100/01-16-083-05 W4M
- 100/07-22-083-05 W4M
- 100/08-10-083-05 W4M
- 100/04-21-083-05 W4M
- 100/01-11-083-05 W4M

Subsection 3.1.2 (4h)
Water Disposal Well 100/01-16-083-05 W4M Observation Well Pressure (McMurray)

- 102/01-16 Piezo 3 [McMurray Gas, 238 mKB]
- 102/01-16 Piezo 2 [McMurray Water, 263 mKB]
- 102/01-16 Piezo 1 [McMurray Water, 289 mKB]
Subsection 3.1.2 (4h)

- 102/08-10 Piezo 3 [McMurray Gas, 203 mKB]
- 102/08-10 Piezo 2 [McMurray Water, 228 mKB]
- 102/08-10 Piezo 1 [McMurray Water, 253 mKB]
## Waste Disposal

<table>
<thead>
<tr>
<th>Waste Description</th>
<th>Disposal Weight (Tonnes)</th>
<th>Disposal Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dangerous Oilfield Waste</td>
<td>63,855</td>
<td></td>
</tr>
<tr>
<td>Hydrocarbon/Emulsion Sludge</td>
<td>4,167</td>
<td>Oilfield Waste Processing Facility</td>
</tr>
<tr>
<td>Crude Oil/Condensate Emulsions</td>
<td>58,463</td>
<td>Oilfield Waste Processing Facility</td>
</tr>
<tr>
<td>Various</td>
<td>1,224</td>
<td>Landfill</td>
</tr>
<tr>
<td><strong>Non-Dangerous Oilfield Waste</strong></td>
<td>27,918</td>
<td></td>
</tr>
<tr>
<td>Lime Sludge</td>
<td>17,633</td>
<td>Landfill</td>
</tr>
<tr>
<td>Various</td>
<td>9,486</td>
<td>Landfill</td>
</tr>
<tr>
<td>Well Fluids</td>
<td>799</td>
<td>Cavern</td>
</tr>
</tbody>
</table>
## Waste Recycling

<table>
<thead>
<tr>
<th>Waste Description</th>
<th>Disposal Weight (Tonnes)</th>
<th>Disposal Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil</td>
<td>17</td>
<td>Used Oil Recycler</td>
</tr>
<tr>
<td>Empty Containers</td>
<td>4</td>
<td>Recycling Facility</td>
</tr>
<tr>
<td>Fluorescent Light Tubes</td>
<td>1</td>
<td>Recycling Facility</td>
</tr>
<tr>
<td>Batteries</td>
<td>3</td>
<td>Recycling Facility</td>
</tr>
</tbody>
</table>
## Typical Water Analysis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Non-Saline Makeup Water (mg/L)</th>
<th>Saline Makeup Water (mg/L)</th>
<th>Produced Water (mg/L)</th>
<th>Disposal Water (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>8.5</td>
<td>8.2</td>
<td>7.5</td>
<td>11.8</td>
</tr>
<tr>
<td>Total Dissolved Solids (TDS)</td>
<td>1,400</td>
<td>8,000</td>
<td>1,800</td>
<td>23,000</td>
</tr>
<tr>
<td>Chloride</td>
<td>200</td>
<td>2,800</td>
<td>650</td>
<td>9,500</td>
</tr>
<tr>
<td>Hardness as CaCO₃</td>
<td>&lt;0.5</td>
<td>225</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Alkalinity as CaCO₃</td>
<td>900</td>
<td>350</td>
<td>250</td>
<td>2,700</td>
</tr>
<tr>
<td>Silica</td>
<td>8</td>
<td>7</td>
<td>190</td>
<td>225</td>
</tr>
<tr>
<td>Total Boron</td>
<td>6</td>
<td>3.3</td>
<td>40</td>
<td>260</td>
</tr>
<tr>
<td>Total Organic Carbon</td>
<td>15</td>
<td>4</td>
<td>500</td>
<td>2,150</td>
</tr>
<tr>
<td>Oil Content</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>65</td>
<td>30</td>
</tr>
</tbody>
</table>
Sulphur Production

Subsection 3.1.2 (5)
Daily $SO_2$ Emissions

Subsection 3.1.2 (5c)
• Sulphur recovery unit commissioned in Q1 and restarted in Q2
• Sulphur recovery unit met or exceeded 69.7% recovery limit during Q3 and Q4.
Continuous ambient air monitoring: all Alberta Ambient Air Quality Objectives were met in 2016.
Continuous ambient air monitoring: all Alberta Ambient Air Quality Objectives were met in 2016.
Environmental Compliance

Subsection 3.1.2 (6)
Environmental Monitoring

- **Groundwater Monitoring Program**
  - Management triggers introduced as per EPEA approval 48263-01-00.
  - 2016 monitoring results are being analyzed in 2017
  - New monitoring well northeast of the Surmont Phase 1 Storm Pond.

- **Wetlands**
  - Management triggers introduced as per EPEA approval 48263-01-00.
  - Program revised to focus monitoring on early change detection.
  - 2016 results are within background concentrations.

- **Wildlife Monitoring Program**
  - Management triggers introduced as per EPEA approval 48263-01-00.
  - Program revised to focus monitoring on early change detection.
  - One vehicle – animal collision.
  - No serious nuisance wildlife or human-bear interactions.

- **Reclamation Work**
  - No final reclamation completed in 2016.
  - A density trial was conducted by planting 44,710 vegetation seedlings at soil stockpile near the Surmont Regional Residence
Environmental Compliance

- Update to the Reclamation Monitoring Program Proposal
  - Per Schedule IX of EPEA Approval number 48263-01-00, as amended, a update to the Reclamation Monitoring Program proposal was due to AEP on or before December 31, 2016.
  - An extension to February 28, 2017 was granted and the updated proposal was submitted.
Compliance Confirmation and Non Compliances

Subsection 3.1.2 (7) + (8)
ConocoPhillips Canada is in regulatory compliance for 2016 with the exception of the following:

264-2 I09 Overpressure Event
• Bottomhole pressure exceeded by 100 kPa for 7.5 hours.

Surmont Phase 1 Pond Primary Liner Leak
• A corrective action plan was submitted in 2015 and the action items were completed.
• CPC will be submitting an update to the AER during Q2 2017.

Surmont Phase 2 Storm Pond Certificate of Completion Submitted March 22, 2016
• Certificate of Completion was not submitted within 60 days of completion.

Remote Sump Non-Compliance (33-081-06W4)
• The site entrance was missing a sign, and it has been corrected.
AER Investigation into Master Well Valve Failure (264-1 I05, January 7, 2017)
• AER investigation is still on-going.
• No non-compliances were identified during clean-up inspections to date.

Air Monitoring Frequency
• Continuous Emissions Monitoring System (CEMS) and air monitoring trailer downtime exceedance.
Future Plans

Subsection 3.1.2 (9)
Future Plans – Surmont

**Phase 1**
- Turn around planned for September 2017
- Upgrade of economizer box on remaining Phase 1 steam generator (OTSG A) to improve steam quality
- Continued monitoring of leaking Pond Primary Liner

**Phase 2**
- Completion of construction of relocated steam generator and high pressure steam separator, commissioning is targeting Q4 2017
- Design work is ongoing for the installation of an additional steam generator
- Mechanical cleaning of select Boiler Feed Water Pre-heat exchangers for improved heat integration
- Continued work on steam quality enhancement
- Continued ramp-up of Phase 2 production towards plant capacity
- Trial for alternative diluent supply scheduled for Q2 2017
• 267 is the next pad in the queue.
• 268 is on hold pending further review.
• 104 is second in the queue.
• Third pad in queue: Looking at near-CPF options.
Surface Operations and Compliance
Pilot Project Approval 9460

Facilities
Subsection 3.1.2 (1)
Site Survey Plan & Facility Modifications

Subsection 3.1.2 (1a)

All equipment was cleaned, purged and left in a safe state.
Facility Performance

Subsection 3.1.2 (2)
Thief zone interaction limiting production

Cease of production on May 5th

2015 Production = ~352 bbls/day
2016 Production = ~163.5 bbls/day
Production Jan – May 2016 = 375.4 bbls/d

Subsection 3.1.2 (2a)
Pilot Plant Performance Produced Water

Produced Water (m³/day)

Produced Water

Steam injection ceased on March 17th, 2016
Blowdown monitoring began
Facility Performance: Electricity Consumption Surmont Pilot

Pilot ceased operations in May due to Fort McMurray Wildfire.

Electrical Consumption (MWh/month)

Electrical Intensity (kWh/BBL Bitumen)
## Pilot Plant Performance: Gas Usage

<table>
<thead>
<tr>
<th></th>
<th>TCPL Gas Imports ($10^3 m^3$)</th>
<th>Produced Gas ($10^3 m^3$)</th>
<th>Flared Gas ($10^3 m^3$)</th>
<th>% of Produced Gas Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>8,068.6</td>
<td>1,339.2</td>
<td>2.4</td>
<td>99.8%</td>
</tr>
<tr>
<td>2012</td>
<td>9,727.7</td>
<td>2,947.5</td>
<td>2.5</td>
<td>99.9%</td>
</tr>
<tr>
<td>2013</td>
<td>11,828.3</td>
<td>3,229.2</td>
<td>85.4</td>
<td>97.4%</td>
</tr>
<tr>
<td>2014</td>
<td>10,511.0</td>
<td>1,152.0</td>
<td>31.7</td>
<td>97.2%</td>
</tr>
<tr>
<td>2015</td>
<td>9,228.8</td>
<td>697.4</td>
<td>7.3</td>
<td>99.0%</td>
</tr>
<tr>
<td>2016</td>
<td>2,421.6</td>
<td>438.4</td>
<td>204.3</td>
<td>53.4%</td>
</tr>
<tr>
<td>2017</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Pilot Plant ceased operations in May 2016. Volume displacement due to decommissioning of the Plant extended to December 2016.
Pilot Plant Performance: Greenhouse Gas

May 2016: Ceased operations during Fort McMurray Wildfire Emergency Shutdown and was not re-started.
Measurement and Reporting

Subsection 3.1.2 (3)
Battery Actual Bitumen Production:
[Closing Inventories – Opening Inventories (Oil portion of Sales and Slop)]/Shrinkage Factor – Diluent Received + [Closing Inventories – Opening Inventories (Diluent)] + [Closing – Opening (Injected Fluids into Producers)] + Sales Shipped to S1 and Trucked

Battery Estimated Bitumen Production:
Well bitumen production is calculated from well tests (pro-rated battery)

No changes to accounting formula
Water Production:
[Closing inventories – Opening Inventories (Water portion of Sales, Slop, Flash, Skim and Produced Water)] – Water Content of Received Diluent or Oil + [Closing – Opening (Injected Fluids into Producers)] + Produced Water + Produced Water Truck Tickets + Water Content of Sales Oil

Battery Estimated Water Production:
Well water production is calculated from well tests (pro-rated battery)

No changes to accounting formula
Measurement and Reporting Methods

Production Gas

- Total battery gas production estimated from inlet of FKOD, Scrubber and P3 usage.
- Well gas production calculated from well oil production and GOR.
- GOR = battery gas production / battery bitumen production.
- Gas proration factor = total battery gas production / well test gas production.

Steam

- Steam injection metered individually at each well and allocated using the group steam injection meter.

Well Testing

- One well on test at a time.
- Target a minimum of two tests per well per month (24 hours in length).
- All well pairs tests regularly tested to meet minimum monthly target.

No changes to accounting formula
• Surmont Pilot Plant was operating until the Fort McMurray Wildfire Emergency Shutdown in May 2016.

• In June 2016, a decision was made not to restart the Plant.

• Pilot production volumes displaced continued to be reported until December 2016.
Water Production, Injection, and Uses

Subsection 3.1.2 (4)
Surmont Pilot Non-Saline Water Source Wells

<table>
<thead>
<tr>
<th>Source Well</th>
<th>Observation Well</th>
<th>Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1F1082508307W400</td>
<td>1AJ082508307W400</td>
<td>Lower Grand Rapids</td>
</tr>
<tr>
<td>1F1072508307W400</td>
<td>100072508307W400</td>
<td>Clearwater</td>
</tr>
</tbody>
</table>

Subsection 3.1.2 (4a)
Pilot Water Source Wells Production Volumes

Subsection 3.1.2 (4b)
## Surmont Pilot Water Disposal Well

<table>
<thead>
<tr>
<th>Well</th>
<th>Zone Approved for Disposal</th>
<th>Maximum Wellhead Injection Pressure (kPa)</th>
<th>Well Status</th>
<th>AER Disposal Approval No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>100/09-25-083-07W4/0</td>
<td>Keg River</td>
<td>6000</td>
<td>Water Disposal</td>
<td>9573C</td>
</tr>
</tbody>
</table>

Subsection 3.1.2 (4g)
Pilot Water Disposal Well 100/09-25-083-07 W4M Well Head Pressure (Keg River)

Approval Max. WHP for 100/09-25: 6,000 kPa

Subsection 3.1.2 (4h)
## Waste Disposal & Recycling

### Solid Waste

<table>
<thead>
<tr>
<th>Waste Description</th>
<th>Disposal Weight (kg)</th>
<th>Disposal Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycled Materials</td>
<td>25</td>
<td>Recycled</td>
</tr>
<tr>
<td>Dangerous Oilfield Waste</td>
<td>4</td>
<td>Landfill</td>
</tr>
<tr>
<td>Non-Dangerous Oilfield Waste</td>
<td>25</td>
<td>Landfill</td>
</tr>
</tbody>
</table>

### Fluid Waste

<table>
<thead>
<tr>
<th>Waste Description</th>
<th>Disposal Volumes (m³)</th>
<th>Disposal Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dangerous Oilfield Waste</td>
<td>208</td>
<td>Cavern</td>
</tr>
<tr>
<td>Non-Dangerous Oilfield Waste</td>
<td>1,039</td>
<td>Cavern</td>
</tr>
</tbody>
</table>
Sulphur Production

Subsection 3.1.2 (5)
Daily Sulphur Emissions

Subsection 3.1.2 (5bi)
Monthly Sulphur Emissions

Subsection 3.1.2 (5bii)

Sulphur Emissions (tonnes/month)

- 01/2016
- 02/2016
- 03/2016
- 04/2016
- 05/2016
- 06/2016
- 07/2016
- 08/2016
- 09/2016
- 10/2016
- 11/2016
- 12/2016
- 01/2017

Emissions increase significantly in April 2016.
Daily SO₂ Emissions

Subsection 3.1.2 (5c)
Ambient Air Quality Monitoring

Passive Ambient Air Quality Results - H$_2$S

- Peak Reading
- Average
- Limit (ppb)

Passive Ambient Air Quality Results - SO$_2$

- Peak Reading
- Average
- Limit (ppb)
Environmental Compliance

Subsection 3.1.2 (6)
Environmental Compliance

Groundwater Monitoring

- 2016 results have changed from background in some wells. No changes have been observed in downstream surface water chemistry.

Soil Monitoring

- 2016 results within historical/background concentrations.

Reclamation Programs

- No reclamation in 2016
Compliance Confirmation and Non Compliances

Subsection 3.1.2 (7) + (8)
ConocoPhillips Canada is in compliance in all areas of the regulations for 2016.

**Flaring during Blowdown Phase**
- D60 flaring variance application was submitted in March 2016.
- AER responded that an approval letter was not required to flare during blowdown phase.

**Notification of Shut-in**
- Originally we submitted a notification letter stating a June 15\textsuperscript{th} shut-in.
- Following the wildfires in May, we submitted an update informing that the pilot would not start up post fire.
Future Plans

Subsection 3.1.2 (9)
Future Plans

• Suspension of the Pilot Plant was completed in November 2016 leaving the facility in a safe and secure state.
  • All pipelines were discontinued and have been purged, cleaned and blinded.
  • All 6 wells were downhole suspended.

• A Decommissioning and Land Reclamation Plan was submitted to the AER in December 2016 and approval is pending.

• Logging data will continue to be collected up to 2020.

• Decommissioning and Land Reclamation activities at the Pilot Plant are scheduled to begin in 2020.