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Orion is a Steam-Assisted Gravity Drainage (SAGD) facility consisting of a central processing facility (CPF) and five well pads situated in 13-16-064-03 W4M, approximately 30 km north-west of Cold Lake, Alberta
Introduction

**History**

Daily Average Production (m$^3$/d)

- Hilda Lake Pilot 1
- Hilda Lake Pilot 3
- Commercial Development Application
- Commercial Scheme Approval
- Shell acquires Black Rock
- Phase 1 Startup
- Osum acquires Orion
- Phase 2ABC Complete

Legend:
- 1997
- 1998
- 1999
- 2001
- 2002
- 2003
- 2005
- 2006
- 2007
- 2009
- 2010
- 2011
- 2013
- 2014
- 2015
- 2017
- 2018
Introduction **Phase 2, Small Smart Steps**

- Successfully executed brownfield project doubling production through:
  - Utilizing existing plant infrastructure whenever possible
  - Reducing development cost and environmental footprint by drilling off existing pads

<table>
<thead>
<tr>
<th>Phase</th>
<th>Well Pairs</th>
<th>Facilities Scope</th>
<th>Steam Capacity (m$^3$/d)</th>
<th>Oil Capacity (m$^3$/d)</th>
<th>Expansion Completed</th>
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</thead>
<tbody>
<tr>
<td>2A</td>
<td>3</td>
<td>3$^{rd}$ Boiler, RO Package, Crystallizer #1</td>
<td>6,040</td>
<td>1,590</td>
<td>Oct 2017</td>
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<tr>
<td>2BC</td>
<td>18</td>
<td>3$^{rd}$ &amp; 4$^{th}$ Evaporators, 4$^{th}$ Boiler, De-oiling, Bitumen Treating and Utilities System</td>
<td>10,350</td>
<td>2,860</td>
<td>Oct 2018</td>
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<tr>
<td>2D</td>
<td>TBD</td>
<td>5$^{th}$ Boiler, additional Oil and Water Treating</td>
<td>12,500</td>
<td>3,815- 3,974</td>
<td>TBD</td>
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</tbody>
</table>
Introduction 2018 Scheme Amendment Approvals

2018 Amendment Approvals:

**Approval No. 8175E (Class II Disposal Well)**
Utilize 16-17 well for brackish water source and disposal (produced water storage)

**Approval No. 10103T**
Plant Expansion: Increase Bitumen Capacity to 25,000 bbl/d, additional boiler, second crystallizer, additional water treatment

**Approval No. 10103U**
Addition of 9 SAGD step out well pairs (Pads 204, 205, 206) and 8 Lower Drainage Wells (LDWs) drilled off Pad 105

**Approval No. 10103V**
Addition of 20 SAGD well pairs on two new pads (A and B) and addition to Development Area
Geoscience

Orion In Situ Oil Sands
2018 Annual Performance Report
Delineation Well Data

- Fifty-six vertical or deviated wells across lease area; 44 with full suite of logs including 8 with FMI; 28 of the wells were cored
2018 Drilling and Completion Program

- Phase 2BC; 18 SAGD well pairs; drilling began in late 2017
  - Pad 204, six well pairs
  - Pad 205, three well pairs
  - Pad 206, four well pairs
  - Pad 109, five well pairs
Clearwater Type Log

1AA/06-17-064-03W4

TOP PAY

SAGD Interval

BASE PAY

Very fine- to medium-grained sand dominated facies

Muddy sand and interbedded mud facies

Base Pay

Photos A, B, C, D
Clearwater Sand Minerology

- Sand is angular very fine- to medium-grained feldspathic litharenite
- Clay content is less than 2% of total rock
- Clay composition is kaolinite, illite, chlorite, and smectite
Structural Cross-Section
Clearwater SAGD Reservoir
Top Pay Structure
Clearwater SAGD Reservoir
Base Pay Structure
Clearwater SAGD Reservoir
Gross thickness including concretions (<3% of reservoir)
Clearwater Gas Cap Isopach
Clearwater Reservoir Basal Water Isopach
Clearwater Reservoir Caprock

- 3 units of capping shales of significant thickness
- Undisturbed basement mapped on 3D seismic
- Vertical in-situ stress gradients at the top of the Clearwater Formation for seven wells in the Orion lease range from 20.3 to 20.8 kPa/m
- Maximum Operating Pressure is 6 Mpa
Clearwater Caprock
Clearwater Shale Isopach
**Seismic Data**

*3D, 2D & Swath Datasets:*

- Hilda 3D – 2005, 1.8 km²
- 2D – 2005, 3 lines
- Swath – 2007, 1522 records
- Orion 3D – 2009, 6.6 km²
- Swath – 2009, 1705 records
- Swath – 2011, 1074 records
- Swath – 2014, 1708 records
- 2D – 2014, 1 lines
- Orion 3D & Hilda 3D Merged - 2015
- Swath – 2016, 1688 records

*No Seismic Data Gathered Since 2016*
## Reservoir Properties and Producible Bitumen in Place (PBIP)

<table>
<thead>
<tr>
<th>Pad</th>
<th>Start Date</th>
<th>Operating Well Pairs #</th>
<th>Well Length m</th>
<th>Well Pair Spacing (2) m</th>
<th>Total PBIP (3) $10^6$m$^3$</th>
<th>Current Recovery (4) %</th>
<th>Estimated Ultimate Recovery %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot</td>
<td>Sep 1997</td>
<td>2</td>
<td>950 m</td>
<td>100</td>
<td>1.14</td>
<td>62</td>
<td>&gt;62</td>
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<tr>
<td>Pad 103</td>
<td>Oct 2009</td>
<td>4</td>
<td>670 m</td>
<td>100</td>
<td>1.53</td>
<td>50</td>
<td>50-60</td>
</tr>
<tr>
<td>Pad 104</td>
<td>Oct 2007</td>
<td>4</td>
<td>695 m</td>
<td>100</td>
<td>1.79</td>
<td>22</td>
<td>50-60</td>
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<tr>
<td>Pad 105</td>
<td>May 2008</td>
<td>4</td>
<td>675 m</td>
<td>100</td>
<td>1.46</td>
<td>55</td>
<td>55-60</td>
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<td>Pad 106</td>
<td>Sep 2007</td>
<td>4</td>
<td>730 m</td>
<td>100</td>
<td>1.76</td>
<td>24</td>
<td>50-60</td>
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<tr>
<td>Pad 107</td>
<td>Sep 2007</td>
<td>4</td>
<td>700 m</td>
<td>100</td>
<td>1.67</td>
<td>40</td>
<td>50-60</td>
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<tr>
<td>Pad 108</td>
<td>Jun 2017</td>
<td>2</td>
<td>1,000 m</td>
<td>70</td>
<td>0.88</td>
<td>9</td>
<td>50-60</td>
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<tr>
<td>Pad 109</td>
<td>Sep 2018</td>
<td>5</td>
<td>1,000 m</td>
<td>80</td>
<td>1.74</td>
<td>&lt;1</td>
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<td>Pad 204</td>
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<td>7</td>
<td>1,000 m</td>
<td>80</td>
<td>2.76</td>
<td>4</td>
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<tr>
<td>Pad 205</td>
<td>Jul 2018</td>
<td>3</td>
<td>1,000 m</td>
<td>80</td>
<td>1.00</td>
<td>2</td>
<td>50-60</td>
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<tr>
<td>Pad 206</td>
<td>Sep 2018</td>
<td>4</td>
<td>800 m</td>
<td>80</td>
<td>1.21</td>
<td>&lt;1</td>
<td>50-60</td>
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### SAGD Reservoir Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Value</th>
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<tbody>
<tr>
<td>Depth</td>
<td>metres</td>
<td>425</td>
</tr>
<tr>
<td>Pay Thickness</td>
<td>metres</td>
<td>16-25</td>
</tr>
<tr>
<td>Average Porosity</td>
<td>%</td>
<td>35</td>
</tr>
<tr>
<td>Average Oil Saturation</td>
<td>%</td>
<td>66</td>
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<tr>
<td>Average Bitumen Weight</td>
<td>%</td>
<td>10</td>
</tr>
<tr>
<td>Horizontal Permeability</td>
<td>Darcies</td>
<td>2 to 6</td>
</tr>
<tr>
<td>Kv:Kh</td>
<td>X</td>
<td>0.8-0.9</td>
</tr>
<tr>
<td>Temperature</td>
<td>°C</td>
<td>15</td>
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<tr>
<td>Pressure</td>
<td>MPa</td>
<td>3.2</td>
</tr>
<tr>
<td>Oil Gravity</td>
<td>°API</td>
<td>10 to 11</td>
</tr>
<tr>
<td>Viscosity</td>
<td>cP</td>
<td>100,000</td>
</tr>
</tbody>
</table>

(1) As of December 2018  
(2) Approximate Well Pair Spacing, m  
(3) PBIP = Area x Thickness Above Producer x Porosity x Oil Saturation  
(4) Recovery as of December 2018, on PBIP basis
Scheme Performance

Orion In Situ Oil Sands
2018 Annual Performance Report
Orion Field Production Since Inception

[Graph showing production data over time, with key metrics including Fluid (m³/d) and SOR. The graph includes data points for Produced Crude Oil_Bitumen, Produced Water, Injected Steam, ISOR, and CSOR.]
Lessons Learned Well Placement

Placement of Phase 2BC well pairs were positioned at the same stratigraphic level as Phase 2A well pairs. This was based on lessons learned from the placement of wells, relative to Base Pay in Phase 1.

Well pairs from Pads 104 and 106 have less recovery per pore volume steam injected than other well pairs. Lower $K_v$ impacts SAGD performance.
Lessons Learned Liner Design

Clearwater sands are reactive under thermal conditions. Phase 1 performance was impaired by scale in the producer slotted liners. This was mitigated with liner perforations resulting in enhanced production and no sand production issues due to reservoir consolidation.

Phase 2 was completed with wire wrapped screen (WWS) liners which has resulted in:

- Increased open flow area
- Less scaling tendencies
- Lower SAGD Injector-Producer differential pressures
- No sand production issues
Lessons Learned **Orion SAGD Pressure Strategy**

**Pressure Strategy:**
- Circulate at high pressure (~4.5 MPa) to maximize conduction
- Operate early-life SAGD at high pressure (4 - 4.5 MPa)
  - Enhanced chamber growth, lower viscosity
  - Wells utilize natural lift without needing downhole pumps
- Reduced pressure in mature wells to reduce SOR

**2018 Year-end Status:**
- Phase 1
  - 21 of 22 well pairs operating on artificial lift facilitating operation at lower pressures (2.4 – 2.8 MPa)
- Phase 2
  - 9 well pairs circulating at 4 – 4.5 MPa
  - 11 well pairs operating on natural lift at 4 - 4.5 MPa
  - Well pair 204-5 in communication with Phase 1, initially requiring additional steam prior to artificial lift. Currently operating at 2.8 MPa
Lessons Learned **SAGD Startup Strategy**

- Circulation is utilized to startup all SAGD well pairs
  - Circulation time frame 3 - 4 months
  - Both injectors and producers are tested and monitored
    - Downhole temperature measurement in producers to ensure consistent temperature along full liner length
  - Initially well pairs operated with balanced pressure between injector and producer
  - Moderate differential pressure applied after 60 days
  - Transition to Semi-SAGD prior to SAGD operation

- Circulation Lessons from Phase 2
  - Good oil ramp up
  - Low SAGD differential pressures
  - No scale indications
  - Adequate circulation heating
  - Successful liner design
Orion Field Production 2018

Year Highlights:

- 70% increase in production through the year despite challenging Q4 market environment
- Reliable plant operation post expansion
- Phase 1 - Low oil decline at improved SOR (3.2 avg.)
- Phase 2 - 18 Phase 2BC well pairs initiated circulation in 2018
  - 2018 Q4 - 9 well pairs converted to SAGD
  - 2019 Q1 - 9 remaining well pairs converted to SAGD
High Recovery **Hilda Lake Pilot** (2 well pairs)

- 62% recovery with no decline
- High recovery potential, CSOR improving
- Placed near base pay
- Completed with wire wrap liners
- Startup sub-optimal
- Frequent steam shortages early in life
Medium Recovery Pad 107 (4 well pairs)

- 40% recovery with no decline
- High recovery potential, CSOR improving
- Placed 2m below base pay
- Completed with slotted liners
- Performance significantly improved post perforations (2013 and 2016)
Low Recovery Pad 204 (7 well pairs)

- Single well pair (204-5) startup in 2017 as part of Phase 2A
- Early communication between 204-5 and Phase 1
  - Initially required higher steam rates
  - ESP installed August 2018
  - Water/Steam back in balance
- Six additional Phase 2BC well pairs began circulation June 2018
- Placed 1-2m above base pay
- Completed with wire wrap liners
- No issues completing, circulating, or operating >2,000m MD wells
- Rate and SOR (~3) meeting performance expectations
Typical Orion Injector Completion

17-1/2” surface hole to +/- 180 m, 13 3/8” J-55 81.1 Kg/m, BTC Connection Surface Casing, landed at +/- 180 m

12-1/4” hole to 800 - 1130 m, 9-5/8” L-80 59.53 Kg/m Blue Connection Casing, Thermally Cemented to Surface

2-7/8” J-55 9.52 Kg/m Hydril Connection Tubing String to Heel Landed above Liner Hanger

4-1/2” J-55 17.26 Kg/m BTC XP Tubing String Landed at Toe

9-5/8” x 7” Liner Hanger

7” K-55, 34.29 Kg/m, Semi-Premium Connection Slotted to Toe, w/OCD’s on some wells
Typical Orion Producer Completion **Steam Lift**

- 17-1/2” surface hole to +/- 180 m, 13 3/8” J-55 81.1 Kg/m, BTC Connection Surface Casing, landed at +/- 180 m
- 12-1/4” hole to 800 - 1130 m, 9-5/8” L-80 59.53 Kg/m Blue Connection Casing, Thermally Cemented to Surface
- 2-7/8” J-55 9.52 Kg/m Hydril Connection Tubing String to Heel Landed above Liner Hanger
- 4-1/2” J-55 17.26 Kg/m BTC XP Tubing String Landed at Toe
  - 1.5” Instrumentation Coil inside tubing landed at toe
- 9-5/8” x 7” Liner Hanger
- 7” K-55, 34.29 Kg/m, Semi-Premium Connection Liner, Wire-Wrapped Screen or Slotted Liner to Toe
Typical Orion Producer Completion PCP

13-3/8” J-55 or H-40, 81.1 kg/m, non-premium connection surface casing
Landed at 160 m, thermally cemented to surface

9-5/8” L-80 or K-55, 59.53 kg/m, premium connection casing
Landed at 700 m, thermally cemented to surface

4-1/2” J-55, 22.8 kg/m, premium or semi-premium connection tubing
string to heel. Landed at +/- 680 m with PCP

2-1/16” J-55, 4.84 kg/m IJ string with 1-1/4” coil to toe for instrumentation.
DTS fibre in coil in the majority of producers for temperature monitoring.
Pressure is measured during N2 purges.

9-5/8” x 7” Liner Hanger

7” K-55, 34.29 Kg/m, Semi-Premium Connection Liner, Wire-Wrapped Screen or Slotted Liner to Toe
Artificial Lift

• Phase 1
  • 21 of 22 well pairs utilize artificial lift, installed to enable lower pressure operation
  • Majority of wells utilize metal-to-metal progressive cavity pumps (PCP)
    – Good performance and reduced cost over operating range

• Phase 2
  • Higher bottom hole pressure should allow lift to be achieved without any pumps in most cases for the first 3-5 years of production
  • As wells reach mid/late life (or communicate with Phase 1) artificial lift will be installed
    – Electrical submersible pumps (ESP) will be utilized on higher rate potential wells

• Osum continues to work collaboratively with PCP and ESP vendors to improve performance and run time.
• Phase 1 Observation (OBS) wells
  • Installed repaired OBS well DTS interrogator February 2018
  • Temperatures began to drift shortly after installation, and interrogator sent for repair.
  • Currently no representative OBS well data for 2018

• Phase 2 Observation (OBS) wells
  • Will begin gathering data in 2019.
Hilda Lake and Phase 1 Observation Wells

Hilda Lake Observation Well

- 219.1 mm surface casing
- 139.7 mm production casing
- 38 mm tubing string with fibre string

Phase 1 and 2 Observation Well

- 219.1 mm surface casing
- 139.7 mm production casing
- 4.25 mm fibre string suspended with sinker bar
Wellbore Integrity

• All newly drilled eighteen SAGD well pairs had cement to surface, and surface casing vents installed.
• Osum has not experienced liner failures on existing wells.
• Osum is currently updating the Well Integrity Management Plan which addresses design, integrity risks, corrosion mitigation, along with monitoring and detection.
• Osum has both an Emergency Response Program and a Well Intervention Plan in place to mitigate the environmental impact of a near surface casing failure.
Future Plans

Orion In Situ Oil Sands
2018 Annual Performance Report
Future Amendments **Upper Grand Rapids Channel**

- Program planned to further delineate Upper Grand Rapids Channel for AER amendment.
  - Delineated northern edge of a southwest to northeast trending channel in the Upper Grand Rapids with build sections of Pad 206 horizontal wells. This included core and wireline logs from a sidetrack of 206-9 injector (103/06-16).
  - Quartzose sub-arenite with excellent reservoir quality (34% porosity, 6000 mD Kh, 70% oil saturation with 60,000 cp viscosity @ 16ºC) and pay thickness (18.75 m TVD in cored well).

**Upper GR Channel Isopach Map (Seismic)**
Surface Operations

Orion In Situ Oil Sands

2018 Annual Performance Report
Facility Highlights

• **Improved steam generation capacity and boiler reliability:**
  - H-4500 was installed as part of 2BC expansion
  - Maintained consistent boiler reliability (minimal downtime)
  - Boilers were tuned and internal inspections were completed

• **Produced Gas & VRU:**
  - Additional Produced Gas Cooler & Produced Gas Trim Cooler were installed as part of 2BC
  - VRU compressors were repaired

• **Water treatment and delivery:**
  - Free Water Knock Out (FWKO), Treater, Skim Tank, Induced Gas Flotation (IGF), Oil Removal Filter (ORF), Evaporators 3 and 4 were added during 2BC expansion
  - Crystallizer unit helps process additional distillate to boiler feed and decreases evaporator blowdown waste disposal (200 m³/d reduction)
  - 16-17 brackish well has been completed enabling utilization as a produced water disposal well or as a source water well depending on water balance needs.
Orion Central Processing Facilities (CPF)

General process description:

- Four conventional drum boilers are used to generate steam, which is sent via steam pipelines to the field for injection into the reservoir

- Emulsion returns to the CPF by pipeline, produced gas is separated at the well pad and separately piped to the CPF where it is mixed with purchased natural gas for boiler fuel

- Oil separation occurs in the free-water knockout and treater vessels, produced water is cooled and sent to de-oiling while oil is transferred to product storage

- The water treatment facilities treat produced water in order to be re-used to generate steam. The process results in reuse of over 90% of the produced water

- Brackish water is drawn from two McMurray formation source wells to supply required make-up water. Brackish water is processed through RO units prior to feeding the boilers. In 2018, 80% of produced brackish water was used to generate steam (RO reject water is injected into on-site water disposal well)

- The waste produced in the evaporative water treatment process is fed to the Crystallizer unit which recovers distillate water to feed the boilers

- Waste produced in the Crystallizer unit is sent offsite to an AER approved waste disposal facility
Produced water is recovered from emulsion utilizing:

1. Skim tank – designed to maximize retention time for adequate separation

2. Induced gas flotation vessel – micro-bubbles of fuel gas are introduced into the produced water to remove residual hydrocarbon content to <10ppm oil/water

3. Oil removal filters – walnut shell deep bed filtration
Water Treatment **Evaporators**

- Evaporator technology is utilized to produce boiler feed water (BFW)
  - Evaporators 3 and 4 were added – 2BC
  - Produce BFW that meets or exceeds water treatment criteria

- Orion evaporators generate a brine waste stream that is further concentrated in the Crystallizer, residual waste brine is disposed of at an AER approved facility

- 95% design conversion rate of feed to distillate for BFW
In October 2017 Osum commissioned a Forced Circulation Crystallizer Unit which converts approximately 69% of evaporator blowdown waste to boiler feed water quality distillate.

The unit has significantly reduced the volume of off-site waste disposal and increased the water recycle ratio of the facility.
Steam Generation

Description

Conventional drum boilers generate 100% quality steam at 6,000 kPag for injection at the well pads.

A concentrated blowdown of 3-5% of the inlet mass flow to the boilers is sent to the de-oiled tank and can also be routed to the reverse osmosis units.

2018 Focus

Boiler reliability from existing equipment and the safe and successful commissioning of a fourth boiler installed in September 2018 were key steam generation related focus points in 2018.

1. Minimal downtime in 2018 – consistent steam generation averaging 6,820 m³/d
2. Internal inspection and tuning was completed on four boilers (H-4100/4200/4300/4500)
Orion Vapor Recovery System

General process description:

• The vapour recovery (VRU) system collects and compresses produced gas vapours from:
  • Evaporator vent recovery
  • Ten storage tanks
  • Diluent recovery system
  • Induced gas flotation system

• All recovered gas vapours are utilized in the steam generation fuel gas system

• VRU system is 2 times 100% redundant compressors

• The vapour recovery system is routed to the low pressure (LP) flare system during upset conditions
Orion Well Pad Facilities

- Five surface well pads with a total of 43 SAGD well pairs.
- Eighteen Phase 2BC well pairs were drilled from existing Phase 1 surface pads in 2018.
Orion Steam/Produced Water Performance

Monthly Steam Production

Produced Water

Osum Production Corp.
Brackish Water Usage (80% of production)

Brackish production (m$^3$/month)

Cumulative production

Monthly production

Jan18  Feb18  Mar18  Apr18  May18  Jun18  Jul18  Aug18  Sep18  Oct18  Nov18  Dec18

Cumulative m$^3$
Water Disposal vs. Limits (33% under limit)

Cumulative Disposal Volumes

Monthly Disposal Volumes
On-site Water Disposal (Approval #8175E)

- License permits produced water and recovered steam condensate to be disposed into the Granite Wash formation. Granite Wash water disposal well 102/16-17-064-03W4M (Well License #192346)
  - Normal operating pressure range: 11100 - 12500 KPa (surface pressure)
  - Protected by a high pressure shutdown limit of 12600 KPa
  - Normal disposal temperature range: 60 - 80 deg C
- McMurray water disposal well 105/16-17-064-03W4M (Well License # 0487069)
  - 105/16-17-064-03W4M was approved for use as disposal or brackish water supply in May 2018.
  - As a result 73,439 m³ produced water was disposed in this well and will subsequently be produced as source water when needed
  - Maximum wellhead injection pressure: 3200 Kpa
- Total disposal volumes were reduced by 40% in 2018 with the addition of Phase 2BC
**Fresh (Non-Potable) Water Usage (Well ID 1420481)**

Water drawn from water source well situated at 13-16-064-03W4M under Water Act Approval 242090-00-00

- Water is used for domestic needs/utility water
- Water levels have steadily increased since monitoring began in 2006 even though water production increased from 2013 – 2018
- Water quality does not meet drinking water criteria:
  - TDS concentration is 760 mg/l
  - Dissolved iron concentration is 2.2 mg/l
Cumulative Water Balance

Source Water Wells
Brackish Water-Make-Up
1F2/16-17-064-03W4M 0487069
1F1/16-17-064-03W4M 0196880*
1F2/15-16-064-03W4M 0486697
1F1/15-16-064-03W4M 0327690*

Fresh Water Well
13-16-064-03 W4M
Water Act Approval 242090-00-00

SAGD Wells
Produced Water

Disposal
Evaporator & Crystallizer
Blowdown / Excess
Produced Water
Disposal Well 16-17-064-03W4M
Tervita 05-26-056-05W4M

Water Treatment and Steam Generation

### IN

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<thead>
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<th>Volume</th>
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<td>Produced</td>
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<tr>
<td>Brackish</td>
</tr>
<tr>
<td>Fresh</td>
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<tr>
<td>Diluent Pipeline Water</td>
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<td>TOTAL</td>
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### OUT

<table>
<thead>
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<th>Volume</th>
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<tbody>
<tr>
<td>Steam</td>
</tr>
<tr>
<td>Disposal</td>
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<tr>
<td>Fresh water usage</td>
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<tr>
<td>IPF Pipeline Water</td>
</tr>
<tr>
<td>TOTAL</td>
</tr>
</tbody>
</table>

| Difference (as a percentage of total in’s) | 53,926 m³ (1.9%) |
| Disposal Limit | 15% |
| Actual Disposal | 10% |

* Abandoned Wells
Monthly Natural Gas Intensity

Purchased fuel per m³ of steam injection

Purchased fuel per m³ of bitumen production
Monthly Gas Usage

Total steam generation (injection) consumption 163,515 m³

Gas volume (m³)

Jan18  Feb18  Mar18  Apr18  May18  Jun18  Jul18  Aug18  Sep18  Oct18  Nov18  Dec18

Purchased  Produced  Fuel  Flare
Monthly Flaring and Venting

Flaring

Gas volume (e^3 m^3)

Jan18 - 78 e^3 m^3 N2 purging (wells), exchanger and PG cooler maintenance
Aug18 - 112 e^3 m^3 Commissioning of Boiler H4500
Boiler H4300 repairs
Sep18 - 410 e^3 m^3 Commissioning, tuning and repairs (boilers)

Venting

Gas volume (e^3 m^3)

174 e^3 m^3 -5 instances VRU constriction remediation

Osum Production Corp.
Monthly Power Consumption

Total power consumption 92,204 MW-h
**Measurement & Reporting**

**MARP**

- April 2018; AER approval to convert Brackish source well 1F2/16-17-064-03W4/0 to disposal well
- August 2018; AER site visit/audit ORION MARP – minor findings have been addressed via response to AER
- November 2018; reported deviation from MARP related to trucking in condensate (Inter-Pipeline- pipeline lateral maintenance outage)
- November 2018; reported deviation from MARP related to produced water calculation due to a hydraulic restriction
- Annual MARP revision prepared December 2018
  - Changes included the addition of metering associated with the 18 new SAGD well pairs and metering associated with the central plant facility additions; H4500 boiler
- Accounting meters calibrated / verified on an annual basis

**EPAP**

- Declaration deadline May 31, 2019 for 2018 reporting period
- Controls documentation, evaluation and testing completed by third party
- Continued focus on the quality, accuracy and internal visibility of measurement data
Oil & Water Proration Factors

85-115% AER Requirement

Osum Production Corp.
Compliance

Orion In Situ Oil Sands
2018 Annual Performance Report
2018 Compliance Status

Osum Production Corp. believes existing Orion operations are in compliance with all approval conditions and regulatory requirements.

- Compliance is maintained through:
  - Incident Management System
  - Velocity EHS database for compliance commitments and approval condition management
  - Dedicated on-site professionally accredited environmental personnel
  - Embedded assurance (routine inspections, audits and preventative maintenance)
## 2018 Compliance Summary

<table>
<thead>
<tr>
<th>Approval Number</th>
<th>Amendments</th>
<th>Compliance Reporting</th>
<th>Corrective Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPEA 01141258</td>
<td>141258-01-03</td>
<td>CIC 339147-NOx limit exceedance 0.08kg/hr</td>
<td>• Optimized boilers to enable amendment of EPEA conditions.</td>
</tr>
<tr>
<td></td>
<td>Modification of NOx emission limit to 12.1 kg/hr for all boiler units from 10.5 kg/hr on H4300/H4500 and 11.6 kg/hr on H4100/4200</td>
<td>CIC 343366-NOx limit exceedance 0.3kg/hr</td>
<td>• Amend EPEA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CIC 346983-NOx limit exceedance 0.02kg/hr</td>
<td>• Installed alarms based off of CEMS performance for non-CEMS boilers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CIC 347180-NOx limit exceedance 0.02 kg/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CIC 347717-NOx limit exceedance 0.2kg/hr</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CIC 348048-NOx limit exceedances max 0.28kg/hr</td>
<td></td>
</tr>
<tr>
<td>Water Act License 00242090</td>
<td>-</td>
<td>Compliant with all conditions of approval</td>
<td>-</td>
</tr>
<tr>
<td>Reportable Release</td>
<td>-</td>
<td>CIC 339373-De-oiled bellows rupture within containment</td>
<td>Replace bellows and implement program to replace all within facility.</td>
</tr>
<tr>
<td>Directive 13/IWCP Program</td>
<td>-</td>
<td>Year 4 compliant</td>
<td>Completed all required suspensions and abandonments</td>
</tr>
</tbody>
</table>
## Monitoring Programs

<table>
<thead>
<tr>
<th>Monitoring Aspect</th>
<th>Monitoring Programs</th>
<th>Progress and Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air Quality</strong></td>
<td>• Continuous monitoring on boiler emissions</td>
<td>• 98.6% compliant NOx, 100% compliant SOx</td>
</tr>
<tr>
<td></td>
<td>• Ambient air quality is monitored through the LICA Airshed</td>
<td>• Exceedances associated with H2S from Jessie Lake and particulate matter from BC fires</td>
</tr>
<tr>
<td></td>
<td>• Fugitive emissions survey conducted annually</td>
<td>• Deficiencies addressed</td>
</tr>
<tr>
<td><strong>Groundwater Monitoring</strong></td>
<td>• Monitoring of potential contaminants, thermally liberated minerals, physical and chemical parameters</td>
<td>• 9 new wells installed associated with expansion.</td>
</tr>
<tr>
<td></td>
<td>• 3 wells abandoned due to lack of effectiveness or casing issues.</td>
<td>• Results reflective of historical trends</td>
</tr>
<tr>
<td><strong>Soils management and monitoring program</strong></td>
<td>• Soil investigation of fluid transfer areas, spill locations and historical impacts for residual contaminants</td>
<td>Monitoring program conducted Q3 2018</td>
</tr>
<tr>
<td></td>
<td>• 9 new wells installed associated with expansion.</td>
<td>• Zero surficial soil impacts due to diligent fluid handling practices</td>
</tr>
<tr>
<td></td>
<td>• 3 wells abandoned due to lack of effectiveness or casing issues.</td>
<td>• Historical impacts remain unchanged</td>
</tr>
<tr>
<td><strong>Wetland and Water Bodies Monitoring Program</strong></td>
<td>• Investigation of wetlands in proximity to facility roads and infrastructure</td>
<td>Proximity to roads does not have an impact on vegetative community or environmental condition</td>
</tr>
<tr>
<td></td>
<td>• Proximity to roads does not have an impact on vegetative community or environmental condition</td>
<td>• Dewatering events have an observable and short-lived influence on wetland hydrology</td>
</tr>
<tr>
<td><strong>Wildlife Monitoring and Mitigation Program</strong></td>
<td>• Passive monitoring of wildlife in and around facility for species diversity and richness</td>
<td>Comprehensive report submitted 2018</td>
</tr>
<tr>
<td></td>
<td>• A total of 11 mammal, 72 bird, 3 amphibian and 5 bat species were observed; 22 of which are listed as sensitive</td>
<td>• Increase in tree density required, all other factors are representative of pre-disturbance conditions.</td>
</tr>
<tr>
<td></td>
<td>• Supplementation planting will occur in 2019</td>
<td>• Supplemental planting will occur in 2019</td>
</tr>
<tr>
<td><strong>Reclamation Monitoring</strong></td>
<td>• Assessment of reclaimed areas for soil replacement and vegetation establishment and planted species health</td>
<td>Submitted October 31&lt;sup&gt;st&lt;/sup&gt;, authorized February 7&lt;sup&gt;th&lt;/sup&gt; 2019</td>
</tr>
<tr>
<td><strong>Project Level Conservation and Closure Plan</strong></td>
<td>• Conservation plan for the next ten years of development activity.</td>
<td>Submitted October 31&lt;sup&gt;st&lt;/sup&gt;, authorized February 7&lt;sup&gt;th&lt;/sup&gt; 2019</td>
</tr>
</tbody>
</table>
Annual Surface Water Release

All water associated with annual precipitation (65,721 m³) was released back into the environment.
Daily Sulphur (Tonnes)

Peaks Value 0.76 t/d

Daily Average 0.43 t/d

Quarterly Sulphur Balance (tonnes/qtr)

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>31.46</td>
</tr>
<tr>
<td>Q2</td>
<td>30.76</td>
</tr>
<tr>
<td>Q3</td>
<td>43.24</td>
</tr>
<tr>
<td>Q4</td>
<td>50.75</td>
</tr>
</tbody>
</table>
Daily $\text{SO}_2$ Volumes (Tonnes)

- **EPEA Limit**: 3.0 t/d
- **Peak Value**: 1.51 t/d
- **Daily Average**: 0.86 t/d

The graph shows the daily $\text{SO}_2$ volumes from January 2018 to December 2018, indicating fluctuations around the peak and average values.
Daily NOx Emissions Per Boiler

EPEA limit amended to 12.1 kg/hr
Offsite Waste Disposal and Recycling Program

- Tervita-Lindbergh – Class 1b – 05-26-056-05W4M
  - Evaporator waste water – 61,476 m³ – 40% reduction over previous year

- RBW Waste Management
  - Contaminated soil from housekeeping and hydro-vac activities 46 m³
  - Well drilling and completion fluids 28,203 m³
  - Recycle-Glycol, lube oil, filters, oily rags, aerosols, methanol 345 m³

- Domestic waste water from the administrative offices washrooms and kitchens is collected in holding tanks and disposed of weekly by a commercial septic service. Total volume disposed of at a Town of Bonnyville Waste Facility was 1282 m³

- Domestic waste is hauled to municipal landfills in either Cold Lake or Bonnyville, 675 m³

- Paper, cardboard and steel recycling program processed 267 m³

- Wood recycling 632 m³

- Metal recycling 225 m³
Environmental:

- Membership with Lakeland Industry and Community Association (LICA)
- Specifically, representation on:
  - LICA Governance Committee
  - LICA Education and Information Committee
  - LICA Oil Sands Industry Members Committee

Community:

- Annual Lakeland Town Hall – November 28, 2018
- Well-established community investment program that annually supports initiatives targeting education, promoting student interest in science and innovation and sport.
- Annual Osum Spark Award – three recipients from the Cold Lake area in 2018
- Annual Osum Leader of Tomorrow Award – six recipients from the Cold Lake area in 2018.