Agenda

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**AER Amendment Approvals**

- **Osum Production Corp. is currently working under Approval 10103S**
  - Production allowance of 3180 m³/d on an annual average basis
  - Approved for SAGD Recovery Process

- **Submitted Appl. #1873119;** Nov. 15th, 2016; Sustaining Well Pair Addition Amendment for Well Pair 204-05. Approval 10103P received: Jan. 30th, 2017

- **Submitted Appl. #1884644;** April 10th, 2017; Application for 24 Well Pair Additions 204 (6-11), 205(5-10), 206(6-12) and 109(1-5): April 10th, 2017. Approval 10103Q received: Aug. 28th, 2017

- **Submitted Appl. #1902870;** Nov. 20th, 2017; Amendment for Pad 204 surface well location and Pads 205/206 trajectory modification. Approval 10103R received Dec. 20th, 2017.

- **Submitted Appl. #1903727;** Dec. 7th, 2017; Amendment for Pad 109 well trajectories. Approval 10103S received Jan. 29th, 2018.
Orion Development – the path to 3,180 m³/d (20,000 bbl/d)

- Executing a plan to double production by the end of 2019. Phase 2A was executed in 2017. Phase 2BC currently being executed.
- New wells incorporate key geological and completion design lessons from Phase 1 successes.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Well Pairs</th>
<th>Facilities Scope</th>
<th>Available Steam Capacity (m³/d)</th>
<th>Installed Capacity (m³/d)</th>
<th>Expansion Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A</td>
<td>3</td>
<td>3rd Boiler, RO Package, Crystallizer #1</td>
<td>6,040</td>
<td>1,590</td>
<td>Oct 2017</td>
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</tbody>
</table>
Introduction – Project Location

Orion is a Steam-Assisted Gravity Drainage (SAGD) facility consisting of a central processing facility and five (commercial) well pads situated in 13-16-064-03 W4M, approximately 40 km north-west of Cold Lake, Alberta.
The Orion Project – History

Daily Average Production (m³/d)

- Hilda Pilot 1 first steam
- Hilda Pilot 3 first steam
- Commercial Development Application
- EUB Commercial Scheme Approval
- Construction
- Shell acquires Black Rock Ventures Inc
- Commissioning and Start Up
- Osum Production Corp acquires Shell Orion
- Phase 2A expansion complete

Osum Production Corp.
Geoscience

Orion In Situ Oil Sands
2017 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
- Fourteen wells in the Project Area are observation wells (11 existing + 3 new wells for 2BC)
2017 New Well Data

- Phase 2A SAGD Well Pairs: 108-1, 108-2, 204-5
- Two Brackish Water Wells: 1F2/15-16, 1F2/16-17
- Phase 2BC Observation Wells: 100/02-17, 112/08-16, 100/13-15
- Phase 2BC SAGD well drilling began in late 2017.
Clearwater Type Log

1AA/06-17-064-03W4

SAGD Interval

Very fine- to medium-grained sand dominated facies

Muddy sand and interbedded mud facies

TOP PAY

BASE PAY

Photo A

Photo B

Photo C

Photo D
Clearwater Sand Minerology

- Sand is angular very fine- to medium-grained feldspatic litharenite
- Clay content is less than 2% of total rock
- Clay composition is kaolinite, illite, chlorite, and smectite
Structural Cross-Section

Northwest

Hilda Pilot Obs-1
102/15-17-064-03W4

1233 m

Clearwater Shale
Clearwater Sand
TOP PAY

SAGD Interval

Base Pay

Basal Water
Wabiskaw

Pad 106
1F2/11-16-064-03W4

659 m

Facies

100/07-16-064-03W4

562 m

Facies

1AA/01-16-064-03W4

4240 m

Facies

Southwest

1AA/03-12-064-03W4

reference map

Facies from Core
- very fine- to medium-grained sand
- very fine- to medium-grained sand to muddy sand or sand with interbedded mud
- mud with interbedded sand
- carbonate concretion

Osum Production Corp.
Clearwater SAGD Reservoir
Top Pay Structure

Key
- Orion Development Area
- Orion Project Area
- 1AA/06-17-064-03W4 Reference Well
Clearwater SAGD Reservoir
Base Pay Structure
Clearwater SAGD Reservoir
Gross thickness including concretions (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

Orion Type Log
1AA/06-17-064-03W4

Base Water
Muddy sand and interbedded mud faces
TOP PAY
Very fine- to medium-grained sand dominated facies
SAGD Interval

Orion Development Area
Orion Project Area

1AA/06-17-064-03W4 Reference Well

Orion Lease Area

Thickness (m)
Contour Interval: 0.5 m

Osum Production Corp.
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
Repeat 2D Swath Seismic

Isopach maps represent an interpretation of the thermal zone from p-impedance volumes for each swath acquisition.

Good lateral resolution allows estimates of steam chamber growth

Thermal chambers have grown vertically, as well as laterally through the years

November 2016 seismic acquisition reveals good thermal conformance along all thermal well pairs

Gas cap affects seismic resolution. The thickest portion of the gas cap overlies Pad 103 and impacts seismic imaging of the thermal chamber below.

2016 repeat seismic provides baseline for 2ABC well pairs.
## Reservoir Properties and Producible Bitumen in Place (PBIP)

### PBIP and Recovery to Date

<table>
<thead>
<tr>
<th>Pad Name</th>
<th>Date</th>
<th>Well Pair Spacing</th>
<th>Total PBIP</th>
<th>Current Recovery</th>
<th>Ultimate Recovery Estimate</th>
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<tbody>
<tr>
<td>Pilot</td>
<td>Sep-1997</td>
<td>2</td>
<td>1.14 m³</td>
<td>58%</td>
<td>&gt;60%</td>
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<tr>
<td>Pad 103</td>
<td>Oct-2009</td>
<td>4</td>
<td>1.53 m³</td>
<td>43%</td>
<td>50-60%</td>
</tr>
<tr>
<td>Pad 104</td>
<td>Oct-2007</td>
<td>4</td>
<td>1.79 m³</td>
<td>19%</td>
<td>50-60%</td>
</tr>
<tr>
<td>Pad 105</td>
<td>May-2008</td>
<td>4</td>
<td>1.46 m³</td>
<td>48%</td>
<td>50-60%</td>
</tr>
<tr>
<td>Pad 106</td>
<td>Sep-2007</td>
<td>4</td>
<td>1.76 m³</td>
<td>20%</td>
<td>50-60%</td>
</tr>
<tr>
<td>Pad 107</td>
<td>Sep-2007</td>
<td>4</td>
<td>1.67 m³</td>
<td>36%</td>
<td>50-60%</td>
</tr>
<tr>
<td>Pad 108</td>
<td>Jun-2017</td>
<td>2</td>
<td>0.88 m³</td>
<td>2%</td>
<td>50-60%</td>
</tr>
<tr>
<td>Pad 204</td>
<td>Jun-2017</td>
<td>1</td>
<td>2.76 m³</td>
<td>&lt;1%</td>
<td>50-60%</td>
</tr>
</tbody>
</table>

### SAGD Reservoir Properties

- **Depth**: 425 metres
- **Pay Thickness**: 16-25 metres
- **Average Porosity**: 35%
- **Average Oil Saturation**: 66%
- **Average Bitumen Weight**: 10%
- **Horizontal Permeability**: 2 to 6 Darcies
- **Kv/Kh**: X, 0.8-0.9
- **Temperature**: 15 °C
- **Pressure**: 3.2 MPa
- **Oil Gravity**: 10 to 11 °API
- **Viscosity**: 100,000 cP

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(1) As of December 2017
(2) Approximate Well Pair Spacing, m
(3) PBIP=Area x Thickness Above Producer x Porosity x Oil Saturation
(4) Recovery as of December 2017, on PBIP basis
(5) Pad 204 PBIP is for 7 Well Pairs; 6 of the Well Pairs to be started in 2018
Scheme Performance
Orion In Situ Oil Sands
2017 Annual Performance Report
Orion Field Production – Since Inception

Production/Injection (m³/d)
- Water
- Steam
- Oil
- Cum SOR

Cumulative SOR
• 2017 production averaged 1,287 m$^3$/d (8,100 bbl/d) with peak monthly production of 1,581 m$^3$/d (9,945 bbl/d) in November
• Maintained stable production levels from Phase 1 base (averaged 1,188 m$^3$/d)
• Incremental volumes from Phase 2A expansion well pairs resulted in higher exit rate

• 2017 steam injection averaged 5,643 m$^3$/d vs. 4,975 m$^3$/d in 2016 (full year with 3rd boiler)
• Operational issues in late December resulted in lower exit rate (planned production reductions)
Orion SAGD Pressure Scheme

- Steam injection volume increased with additional boiler in November 2016
- Higher 2017 steam rates allowed some pressure increase to be achieved in Phase 1 wells prior to 2A startup
- Stable pressures in Phase 1
  - Pad Pressures: 2200-3000kPa
- 2A well startup in June utilized incremental steam
- 2A chamber pressures initially 4000-4500kPa
  - Production lift is achieved with higher reservoir pressure
Orion SAGD Startup Strategy

- Circulation is utilized to startup all SAGD well pairs (similar to Orion Phase1)
  - Circulation time frame 3-4 months
  - Both injectors and producers are tested and monitored
    - Producers monitor liner temperatures
- Chamber pressures initially 4000-4500kPa
  - Production lift is achieved with higher reservoir pressure
  - Balanced circulation pressures initially, small differentials induced nearing completion
**Well Interventions – 2017**

**Perforations:**

- Short sections – saw continued benefit with short heel section previously not perforated (eg. 50-150m)
  - P105-2, P105-4, P103-1, P103-4

- Larger sections – wells previously unperforated
  - P106-5 – full liner length perforated
  - Pilot 1 and Pilot 3 – approximately 1/3 of liner lengths were perforated

- Continued success noted in all perforated wells
  - Majority of all Phase 1 slotted liners are now perforated full length
  - Pilot wells showed improvement
High Recovery Well Example, Good Well Placement Pilot, Pad 103, Pad 105

Pilot and Pads 103, 105

- 100/15-17 location
- 103-P1

- Producer wells generally above SHS - Sandy Facies interface
- Slotted liner design, later perforated
Well 103-P1 – High Recovery, Good Performance

Well placed in high quality facies, high rate potential

Incremental steam due to communication with Pilot

Perforation

Steam inj  Oil Prod  Water prod  Cum SOR

Volume (m³/d)  Cum SOR
Low Recovery Example, Low Well Placement
Pads 104 & 106

Pads 104 and 106

- 1F1/15-16 location
- 104-P1

- Producer wells placed beneath SHS - Sandy Facies interface
- Slotted liner design, later perforated

1F1/15-16-064-03W4
Well 104-P1 – Low Recovery, Low Performance

Injector producer placed in sandy heterolithic sands, impact on production

Perforation

Volume (m³/d)

Cum SOR


Steam inj  Oil Prod  Water prod  Cum SOR
Moderate Recovery Well Example - Pad 107

- Producer wells placed close to SHS - Sandy Facies interface
- Slotted liner design, later perforated
Well 107-P1 – Medium Recovery, Medium Performance

Production well placed marginally low in the sandy heterolithic sands, reasonable rates
2A Expansion – Typical Well Placement

Phase 2A

100/15-17 location

P108-2

- Producer wells placed in Sandy Facies
- Wire-wrapped liner design to minimize pressure drop
Phase 2A Expansion Well Pairs

Typical expansion well performance, well pair P108-2

Volume, m³/d

Jan-17  Feb-17  Apr-17  May-17  Jul-17  Sep-17  Oct-17  Dec-17

Steam  Oil  Water  iSOR
Pad Recovery and Performance

Orion RF vs. Pore Volume of Steam Injection

- Pilot
- Pad 103
- Pad 104
- Pad 105
- Pad 106
- Pad 107
- Pad 108
- Pad 204

RF (%) vs. Pore Volume of Steam Injection
**Hilda Lake Pilot Injector Schematic**

- 406 mm (I1) / 340 mm (I3) Surface Casing
- 298.5 mm (I1) / 245 mm (I3) Intermediate Casing
- 89 mm (I1) / 82.6 mm (I3) Short string
- 89 mm (I1) / 82.6 mm (I3) Long string
- 219.1 mm (I1) / 178 mm (I3) slotted liner
- 9½” x 7” liner hanger
Hilda Lake Producer Schematic

- 340 mm Surface Casing
- 245 mm Intermediate Casing
- Tubing string with artificial lift
- Guide tubing string with fibre-optic temperature instrumentation
- 177 mm wire-wrapped screen liner
- 9 5/8" x 7" liner hanger
Typical Phase 1 Injector Completion

Downhole pressure is measured continuously via casing annulus pressure gauge at surface including N2 purges. Downhole temperature is not measured on injectors.

- 13⅜" J-55 or H-40, 81.1 kg/m, non-premium connection surface casing. Landed at 160 m; thermally cemented to surface.
- 9⅝" L-80 or K-55, 59.53 kg/m, premium connection casing landed at 700 m, thermally cemented to surface.
- 2⅞" J-55, 9.41 kg/m, premium or semi-premium connection tubing string to heel string, landed at 700 m.
- 3½" J-55, 13.69 kg/m premium or semi-premium connection tubing string landed at toe at 1380 m.

7" K-55, 34.29 kg/m, semi-premium connection liner. 700 m liner slotted to ≈1400 m.

9¾" x 7" liner hanger.
**Typical Phase 1 Producer Completion – Steam Lift**

13⅜" J-55 or H-40, 81.1 kg/m, non-premium connection surface casing. Landed at 160 m, thermally cemented to surface

9⅜" L-80 or K-55, 59.53 kg/m, premium connection casing. Landed at 700 m. Thermally cemented to surface

2⅞" J-55, 9.67 kg/m, premium or semi-premium connection tubing string to heel landed at ≈700 m. Some wells have instrument coil to toe

3½" J-55, 13.84 kg/m premium or semi-premium connection tubing string landed at ≈1350 m. DTS fibre in coil in the majority of producers for temperature. Pressure is measured during N2 purges

7" K-55, 34.29 kg/m, semi-premium connection liner. Wire-wrapped screen or perforated slotted liner. 700 m liner landed at ≈1400 m

9½" x 7" liner hanger
Typical Phase 1 Producer Completion – PCP

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

9⅝” L-80 or K-55, 59.53 kg/m, premium connection casing landed at 700 m, thermally cemented to surface

4½” J-55, 22.8 kg/m, premium or semi-premium connection tubing string to heel string, landed at 680 m with PCP

21/16” J-55, 4.84 kg/m IJ-string landed at 720 m with 1¼” QT-70, 1.98 kg/m coil to toe for instrumentation. DTS fibre in coil in the majority of producers for temperature. Pressure is measured during N2 purges

7” K-55, 34.29 kg/m, semi-premium connection liner. Wire-wrapped screen or perforated slotted liner. 700 m liner landed at ≈1400 m

9⅝” x 7” liner hanger
Typical Phase 2A Injector Completion (108-1, 108-2 + 204-5)

Phase 2A Injector Profile

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

12-1/4” hole to 800m - 1130m, 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

7” K-55, 34.29 kg/m, Semi-Premium Connection Slotted Liner to Toe

9 5/8” x 7” Liner Hanger
**Typical Phase 2A Producer Completion – Steam Lift**

**Phase 2A Producer Profile**

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

- 12-1/4” hole to 800m - 1130m, 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 this tubing landed at toe

- 7” K-55, 34.29 kg/m, Semi-Premium Connection Liner, Sand Control Screen to Toe

- 9 5/8” x 7” Liner Hanger
Artificial Lift – Orion Wells

<table>
<thead>
<tr>
<th>Criteria</th>
<th>All Metal PCP</th>
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<tbody>
<tr>
<td>Maximum Operating Temperature</td>
<td>350 °C</td>
</tr>
<tr>
<td>Rate</td>
<td>100 -370 m³/d</td>
</tr>
<tr>
<td></td>
<td>100 -350 RPM</td>
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</table>

PCP SAGD  14 Wells
Natural Lift SAGD  10 Wells
ESP SAGD  1 Well
Orion Observation Wells Location Map

Number of Observation Wells per Pad

<table>
<thead>
<tr>
<th>Pad</th>
<th>Number of Wells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hilda Pilot</td>
<td>4</td>
</tr>
<tr>
<td>Pad 103</td>
<td>3</td>
</tr>
<tr>
<td>Pad 106</td>
<td>2</td>
</tr>
<tr>
<td>Pad 107</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11</strong></td>
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</table>
Orion Observation Wells Remediation

2017 was a significant year for remediation and improvement of the observation wells and data gathering

• Installed new DTS interrogator November 2016. Temperatures started to drift May 2017, interrogator was recalibrated, reinstalled, and operating properly by February 2018

• Ran new or re-ran thermal fiber capillary line in Hilda OB1, Hilda OB2, 103-OB1, 103-OB2, 106-OB2 and 107-OB2

• Reconfigured tubing for pressure monitoring: Hilda OB3

• Abandoned wellbores: 104-OB1 and 105-OB1
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 Observation Well

- 219.1 mm surface casing
- 139.7 mm production casing
- 4.25 mm fibre string suspended with sinker bar
Hilda OB1

- Flat temperature profile of ~100 deg C observed above the Clearwater formation
- The height of this effect reduced early 2017 and no longer noticeable late May 2017
Hilda OB2

- Minimal change in height or temperature from 2016.
Hilda OB4

- Steam chamber growth has reached the top of Clearwater Reservoir
- Increased temperature through 2017.
**103 OB1**

- Steam Chamber has not intersected wellbore to date
- Investigating completion to determine if fluid present in wellbore
- Previous data poor for comparison
103 OB2

- Workover completed May 2017 to remove fluid from wellbore
- Good chamber development near mid section of 103 WP1 and 103 WP2
- Previous data poor for comparison
103 OB3

- Thermal-couple data, truncated dataset.
- Good steam chamber development at the mid section of 103 WP4 area
- Minimal change in height or temperature from 2016.
106 OB1

- Good chamber development near the toe of 106 WP1 area
- Minimal change in height or temperature from 2016.
106 OB2

- Workover completed May 2017 to remove fluid from wellbore
- Chamber development near the toe of 106 WP2 area
- Previous data poor for comparison
107 OB1

- Good chamber development at the heel of 107 WP1 area
**107 OB2**

- Workover completed May 2017 to remove fluid from wellbore
- Good chamber development at the toe of 107 WP2 area
Wellbore Integrity

Surface Casing and Liner Integrity

• In 2016/ 2017 Osum conducted a complete inspection of all Phase 1 and Hilda Lake pilot SAGD well pairs for surface casing corrosion.
  • Nine wells had external near surface casing corrosion which required repairs.
  • No significant corrosion was observed on any production casings.
  • Corrosion issues were mainly caused by low cement tops or degradation at surface over time in the presence of a saturated water layer.
  • None of the wells with surface casing waivers had significant casing corrosion at surface.

• In future surface casing corrosion checks will be conducted every second year on a single well on each of our pads. If significant corrosion is found then additional wells will be examined.

• New wells will be checked for cement to surface. Bentonite top ups will be done if required.

• Osum has not experienced liner failures on any Phase 1 or Hilda Lake Pilot wells.

• Osum is currently updating the Well Integrity Management Plan which addresses design, integrity risks, corrosion mitigation, and monitoring and detection.

• Osum has both an Emergency Response Program and a Well intervention Plan in place which would mitigate the environmental impact of a near surface casing failure.
Surface Operations

Orion In Situ Oil Sands

2017 Annual Performance Report
Plant & Facilities Summary

- Boiler reliability and steam generation capacity:
  - Maintained consistent boiler reliability (minimal downtime)
  - Boilers were tuned and internal inspections were completed

- Produced Gas & VRU:
  - Produced Gas Trim Cooler: ruptured tubes in January, frozen tubes in December
  - VRUs were repaired
  - Evaporator vent odor control vessels were replaced

- Water treatment and delivery:
  - Installed a Crystallizer (commissioned in October) to increase distillate to boiler feed and decrease evaporator blowdown disposal (200 m³/d reduction)
Orion Central Processing Facility – Plot Plan

- RO's
- Crystallizer
- Evaporators
- De-oiling
- FVKO and Treater
- Sales tanks
- Blend to IPL
- Diluent from IPL
- Steam out to field
- Commodities in from field

Commodities in from field
Steam out to field
Diluent from IPL
Blend to IPL
FWKO and Treater
De-oiling
Evaporators
Crystallizer
RO's
Orion Water Usage and Treatment

[Flowchart diagram of water usage and treatment process]

Osum Production Corp.
Orion Central Processing Facilities (CPF)

General process description:

• Three 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 sales storage

• The water treatment facilities treat produced water in order to be re-used to generate steam. The process results in reuse of about 90% of the produced water (2017 produced water recycle ratio averaged 90%)

• 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 2017, 67% of produced brackish water was used to generate steam (RO reject water is sent to Osum’s approved water disposal well)

• The waste produced in the evaporative water treatment process is fed to the Crystallizer unit (commissioned in October) which is converted into distillate to feed the boilers

• Waste produced in the Crystallizer unit is trucked offsite to an AER approved waste disposal facility (Tervita Lindbergh)
De-oiling Facilities

Produced water using:

1. Skim tank – designed to maximize retention time for adequate separation
2. Induced gas flotation vessel – micro-bubble from the production treating train is de-oiled flotation (hydrocarbon content <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)

The evaporators at Orion:

- Produce BFW that meets or exceeds water treatment criteria
- Generate a concentrated brine waste stream that is disposed of at an AER approved facility (Tervita Lindbergh)
- Have a 95% design conversion rate of feed to distillate (BFW)
In October 2017 Osum commissioned a Forced Circulation Crystallizer Unit which converts approximately 73% of evaporator blowdown waste to BFW quality distillate.

This has significantly reduced the volume of off-site waste disposal to Tervita 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 RO units.

2017 Focus
Boiler reliability from existing equipment and the safe and successful commissioning of a third boiler installed in late 2016 were key steam generation related focus points in 2017.

Both were achieved:

1. Minimal downtime in 2017 – the boilers were able to consistently generate steam averaging 5,643 m³/d
2. Internal inspection & tuning was completed on all boilers
Orion Vapor Recovery System

General process description

- The vapour recovery system collects and compresses produced gas vapours
- All recovered gas vapours are utilized in the steam generation fuel gas system
- VRU system is 2X100% redundant compressors
- The sources of gas vapour are:
  - Evaporator vent recovery
  - Ten storage tanks
  - Diluent recovery system
  - Induced gas flotation system
- The vapour recovery system feeds the low pressure (LP) flare system in upset conditions

2017 operational issues: The VRU compressors were repaired
**Orion Well Pad Facilities**

- The Facility has 5 well pads (in addition to the Hilda Lake Pilot) with a total of 25 SAGD well pairs.
- 3 new well pairs (P108-1, P108-2, P204-5) were added, 108 wells were drilled from the surface of Pad 107 and 204-5 well was drilled from surface Pad 104 in order to minimize cost and surface disturbance.
- Typical Phase 1 well pad configuration is four SAGD well pairs, which consists of 4 injector and 4 producer wells.
Plant Reliability – 98%

- Plant Trip
- PG Cooler Freezing
- H-4300 Leak Repair
- Power Outage
- H-4200 Annual Inspection
- AltaGas Inlet Pressure Issues
- H-4100 Annual Inspection
- Plant Trip
- PG Cooler Freezing

Total Steam Generated m³/day

January  February  March  April  May  June  July  August  September  October  November  December

H-4300 Annual Inspection
Monthly Steam Production

- **Steam injection (total m³)**
- **Steam injection (m³/d)**

- **Jan-17**
- **Feb-17**
- **Mar-17**
- **Apr-17**
- **May-17**
- **Jun-17**
- **Jul-17**
- **Aug-17**
- **Sep-17**
- **Oct-17**
- **Nov-17**
- **Dec-17**

- **Monthly**
- **Daily**
- **Annual avg. m³/d**
Produced Water

Produced water (m³)

Recycle ratio

Produced water (volume)  Produced-Water Recycle %  Avg.
Brackish Water Usage (67% of production)

- Brackish used
- RO Reject

Usage 67%

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

Cumulative m³/month

275,827 m³

Cumulative m³
**Water Disposal vs. Limits (3% under limit)**

### Cumulative Disposal Volumes

- **Cumulative limit**: Blue line
- **Cumulative disposal**: Light blue line

### Monthly Disposal Volumes

- **Disposal limit**: Blue bar
- **Water disposal**: Light blue bar

**Note**: 9,400 m$^3$ (3% under)
On-site Water Disposal

- License permits produced water and recovered steam condensate to be disposed into the Granite Wash formation. Disposal Approval #8175
- Granite Wash water disposal well 02/16-17-064-03W4M (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 03/16-17-064-03W4M (Well License # 0196880)
  - Suspended as a disposal well Nov. 2011 and converted to a brackish water source well May 2013
  - Well was abandoned Dec. 2017. A new replacement disposal well application for 1F2/16-17-64-03W4M has been submitted which is currently being used as a brackish water well.
- Integration of Phase 2BC water treatment facilities will reduce future annual disposal volumes.

Total disposal 289,941 m$^3$
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 – 2017
- TDS concentration is 760 mg/l
- Dissolved iron concentration is 2.2 mg/l
- All concentrations exceed drinking water guidelines
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

Water Treatment and Steam Generation

IN | Volume
---|---
Produced | 2,026,868 m³
Brackish | 275,827 m³
Fresh | 3,543 m³
Diluent Pipeline Water | 350 m³
TOTAL | 2,306,588 m³

OUT | Volume
---|---
Steam | 2,059,798 m³
Disposal | 289,941 m³
Fresh water usage | 3,543 m³
IPF Pipeline Water | 2,578 m³
TOTAL | 2,355,860 m³

Difference (as a percentage of total in’s) | 49,272 m³
2.1%

Disposal Limit | 15%
Actual Disposal | 14%

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

DILUENT PIPELINE WATER
IPF PIPELINE WATER
Monthly Gas Usage

Total steam generation (injection) consumption 136,010 e³m³

Gas volume (e³m³)

- 0
- 2,000
- 4,000
- 6,000
- 8,000
- 10,000
- 12,000
- 14,000

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

Purchased
Produced
Fuel
Flare gas

Osum Production Corp.
**Flaring**

- 115 e$^3$m$^3$ Jan $\rightarrow$ PGTC tube rupture
- 72 e$^3$m$^3$ Jun $\rightarrow$ Boiler tuning (H-4200/4300)
- 337 e$^3$m$^3$ Dec $\rightarrow$ VRU vibration + PGTC tube leak

**Venting**

- 7.4 e$^3$m$^3$ July (3 Instances) $\rightarrow$ Evaporators over-heating
Monthly Power Consumption

Total power consumption 79,917 MW-h
Measurement & Reporting

MARP

- May 2017 reported deviation from MARP related to trucking in condensate (IPL lateral pipeline maintenance outage)
- Annual MARP revision prepared September 2017
- Changes included the addition of metering associated with the completion of three new well pairs: WP108-1, WP108-2 and WP204-5
- Accounting meters calibrated / verified on an annual basis

EPAP

- Declaration deadline May 31, 2018 for 2017 reporting period
- Controls documentation, evaluation and testing being completed in-house
- Continued focus on the quality, accuracy and internal visibility of measurement data
Oil & Water Proration Factors

Proration Factor

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

85-115% AER requirement

Oil  Water
Compliance

Orion In Situ Oil Sands
2017 Annual Performance Report
**Offsite Waste Disposal and Recycling Program**

- Tervita-Lindbergh – Class 1b – 05-26-056-05W4M
  - Evaporator Blowdown – 102,955 m³

- RBW Waste Management
  - Contaminated soil from housekeeping and hydro-vac activities 35 m³
  - Well workover fluids 5,811 m³
  - Recycle-Glycol, lube oil, filters, oily rags, aerosols, methanol 77 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 1196 m³

- Domestic waste is hauled to municipal landfills in either Cold Lake or Bonnyville, 160 m³

- Paper, cardboard and steel recycling program processed 91 m³

- Wood recycling 69 m³

- Metal recycling 46 m³
Daily Sulphur (Tonnes)

Peak 0.83 t/d
Average 0.46 t/d

Quarterly Sulphur Balance (tonnes/qtr)

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Sulphur Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>43.94</td>
</tr>
<tr>
<td>Q2</td>
<td>42.18</td>
</tr>
<tr>
<td>Q3</td>
<td>40.69</td>
</tr>
<tr>
<td>Q4</td>
<td>41.23</td>
</tr>
</tbody>
</table>
SO₂ Volumes (Tonnes) – Daily

Peak 1.66 t/d

Average 0.93 t/d

Volume (tonnes/day)

Daily SO₂

Monthly Average
Daily NOx Emissions Per Boiler 2017

EPEA Approval Limits
Boilers 4100, 4200
Limit 11.6 kg/hr
Boiler 4300
Limit 10.5 kg/hr

NOx Emissions (kg/hr)

Boiler 4100
Boiler 4200
Boiler 4300
## Monitoring Programs

<table>
<thead>
<tr>
<th>Monitoring Program</th>
<th>Progress and Results</th>
</tr>
</thead>
</table>
| Air Quality                                                  | • Ambient air quality is monitored through the LICA Airshed  
  • 5 passive monitors are situated at the Orion facility,  
    maximum SO$_2$ 2.70 ppb, H$_2$S 0.42 ppb                  |
| Groundwater Monitoring                                        | • Implementation of renewed program  
  • Results reflective of historical trends                      |
| Soils management and monitoring program                      | • Surficial management areas addressed  
  • Monitoring program scheduled for Q3 2018                     |
| Wetland and Water Bodies Monitoring Program                  | • First year of program  
  • Proximity to roads does not have an impact on vegetative community or environmental condition  
  • Dewatering events have an observable and short-lived influence on wetland hydrology |
| Wildlife Monitoring and Mitigation Program                    | • Comprehensive report submitted May 2018  
  • Mitigation objectives met  
  • Listed species observed:  
    2- may be risk, 15- sensitive, 2- threatened  
  • Total number of species detected-74                          |
| Reclamation Monitoring                                        | • Renewed reclamation monitoring program initiated in 2018.                                                                                           |
| Project Level Conservation and Closure Plan                  | • To be submitted October 2018.                                                                                                                       |
## 2017 Compliance Summary

<table>
<thead>
<tr>
<th>Approval Number</th>
<th>Amendments</th>
<th>Compliance</th>
<th>Corrective Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPEA 01141258</td>
<td>None</td>
<td>CIC 322418-late reporting</td>
<td>• Redundant reminder</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CIC 323952-venting</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>CIC 326556-venting</td>
<td></td>
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<tr>
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<td></td>
<td>CIC 327046-venting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CIC 327807-venting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CIC 326039-NOx exceedence-1 h</td>
<td>• Osum has identified the root cause for venting incidents and has implemented control logic to alleviate future occurrence.</td>
</tr>
<tr>
<td>Water Act License 00242090</td>
<td>03- Amended June 26 to add purpose</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Change from automatic to manual control during boiler upset</td>
</tr>
<tr>
<td>Directive 13/IWCP Program</td>
<td></td>
<td>Year 3 Compliant</td>
<td>Completed all required suspensions and abandonments for Osum Production Corp.</td>
</tr>
</tbody>
</table>
Regional Initiatives

Environmental

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

Community

• Annual Lakeland Town Hall – November 30, 2017
• Annual Scholarships: Spark Award and Leader of Tomorrow Award
  • 9 Lakeland Recipients
2017 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)
Future Plans

Orion In Situ Oil Sands
2017 Annual Performance Report
## 2BC Project Scope – Complete Q4 2018

<table>
<thead>
<tr>
<th>Unit Area</th>
<th>Installed Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaporator</td>
<td>10,800 m³/d (stream day)</td>
</tr>
<tr>
<td>Steam Generation</td>
<td>10,350 m³/day CWE (stream day)</td>
</tr>
<tr>
<td>De-oiling</td>
<td>20,000+ bopd (equivalent)</td>
</tr>
<tr>
<td>Oil Processing</td>
<td>~18,000 bopd (equivalent)</td>
</tr>
<tr>
<td>Utilities &amp; Heat Integration</td>
<td>~18,000 bopd (equivalent)</td>
</tr>
</tbody>
</table>

Three Observation wells
Eighteen new Horizontal SAGD Well Pairs:
- 5 Well Pairs on Pad 109 (01 to 05)
- 3 Well Pairs on Pad 205 (05 to 07)
- 4 Well Pairs on Pad 206 (06 to 09)
- 6 Well Pairs on Pad 204 (06 to 11)
Future Planned Amendment Applications

• Orion Oil Capacity Increase (including a fifth Boiler and second Crystallizer)
• Orion Pad Additions
• Orion Co-Injection Pilot
Osum Production Corp

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