Agenda
Introduction
Geoscience
Scheme Performance
Surface Operations
Compliance
Future Plans
The Orion Project - History

Daily Average Production (bbls)

- 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
- EDTA Stimulations Conducted
- First Slotted Liner Perforation
- Osum Production Corp acquires Shell Orion


Production range: 0 to 10,000 bbls
Geoscience
Well Data
Cross Section N-S
Clearwater SAGD Reservoir – Top Pay
as per Commercial Scheme Approval 10103G
Clearwater SAGD Reservoir – Base Pay
as per Commercial Scheme Approval 10103G
Clearwater SAGD Reservoir – Pay Thickness
as per Commercial Scheme Approval 10103G
Clearwater Sand Mineralogy

- Sand is angular very fine- to fine-grained feldspatic litharenite
- Clay content is less than 2% of total rock
- Clay composition is Kaolinite, Illite, Chlorite, and Smectite
Reservoir Properties

- Horizontal Permeability ~2 – 6 D
- Vertical Permeability ~1.7 - 5.1 D (Kv/Kh = 0.85)
- Viscosity ~100,000 cP
- Oil Saturation 67 – 70%
- Porosity 32 – 34%
- Thickness 14 – 23 m
- Reservoir Depth ~425 m KB
- Initial Reservoir Pressure 3.2 MPa
- Initial Reservoir Temp 15°C
- Basal water ~10 m below base pay
- Sandy heterolithic strata (SHS) facies between pay and basal water
Original Bitumen in Place (OBIP) and Recovery

- Net thickness based on maps TOP to BASE of interpreted Clearwater SAGD Reservoir
- Porosity and oil saturation from logs and core; formation volume factor (FVF) = 1

$\text{OBIP} = \text{Area} \times \text{Net Pay} \times \text{porosity} \times \text{oil saturation} \times \text{FVF}$

<table>
<thead>
<tr>
<th>Pad</th>
<th>Drainage Area, 50 m boundary $(10^3 \text{m}^2)$</th>
<th>Average Net Thickness (m)</th>
<th>Porosity (frac)</th>
<th>Oil Saturation (frac)</th>
<th>Total OBIP $(10^4 \text{m}^2)$</th>
<th>Current Recovery %</th>
<th>Estimated Recovery %</th>
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<td>0.70</td>
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<td>0.33</td>
<td>0.69</td>
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- Net thickness measured from production well to top pay
- All SAGD Pairs ~ 100 m spacing
Clearwater Shale – Caprock Thickness
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

Depth Structure of Beaverhill Lake based on 3D seismic

Seismic traverse

Unit 3: shales of Colorado Grp ~150 m
Unit 2: shales of Grand Rapids Fm ~100 m
Unit 1: primary caprock Clearwater Shale 4 ~ 5 m
Seismic Data

3D, 2D, Swath2D

- Hilda 3D
  March 2005, 1.8 km²
- 2D seismic
  Blackrock, 2005
- Orion baseline Swath 2D
  July 2007, 50 km
- Orion 3D
  April 2009, 8.4 km²
  - Orion 3D and Hilda Lake 3D merged December 2015
- Orion monitor1 Swath 2D
  November 2009, 50 km
- Orion monitor2 Swath 2D
  February 2011, 40 km
- Orion monitor3 Swath 2D
  February 2014, 66 km
Observations:

- Good thermal conformance and steam-chamber growth along most of the horizontal well bores

- Good lateral resolution allow estimates of perpendicular reach of steam chambers, to enable in-fill planning
Scheme Performance
Orion Field Production

Production/Injection (m³/d)

- Water
- Steam
- Oil
- Cum SOR
Orion Update 2015 Production

Oil Production (bbls/d)

Well Interventions
– 3 stimulation jobs in 2015
– 5 PCP conversions

Central Plant Facility
– 2015 average production 7736 bopd
– Full facility Turnaround performed in June 2015
Well Stimulation

• 3 EDTA stimulations were conducted on the following wells in 2015:
  – P105-P4: 60 m³ 10% EDTA Solution; Feb. 2015
  – P105-P4: 40 m³ 10% EDTA Solution; Oct. 2015
  – Pilot P3: 18 m³ 10% EDTA Solution April 2015

These stimulations were conducted on producer wells that had not been perforated, mainly to improve inflow by removing suspected calcium carbonate scaling.
Orion Production Performance

• 2015 production averaged 7736 bbl/d, peak monthly production of 9326 bbl/d

• Rates declined Q3/4 2015 as pressure dropped in the reservoir, and lift issues were encountered on some pads.

• Pressure declined as a result of boiler reliability issues resulting in steam injection shortfalls in the latter part of 2014 and the first half of 2015.

• Following comprehensive mechanical remediation of the (two) boilers, boiler reliability and steam injection rates have significantly improved and averaged ~4600 m3/d for Q3/4 2015.

• High, consistent steam rates will be utilized to re-pressure steam chambers

• With the pressure decline in the steam chambers the following occurred:
  • Production from wells on natural flow dropped off sharply. Four of these wells were equipped with PCP pumps in December in order to improve production rates.
  • There was also a loss of thermal energy within the steam chambers leading to a temperature decline and increased viscosity of the mobilized bitumen.
Orion SAGD Pressure Scheme

• Osum would ideally have liked to maintain a constant SAGD chamber pressure of 3.0 - 3.7 MPa until late life SAGD operations. However the Q1/2 2015 boiler reliability challenges led to end-2015 pressures ranging from 2.4 – 3.2 MPa.

• Osum has significantly improved boiler reliability and overall capacity, thus increasing the overall steam injection for the latter half of 2015. Osum has stabilized reservoir pressures and is gradually building pressure in several areas of the field.
Good Well Placement – Pilot, Pad 103, Pad 105

Clearwater
Clearwater Sandstone
Top Pay

Base Pay

Wabiskaw

P105 - Pair 1

Injector
Producer
Well 105-P1 - Good Performance Well Pair

Well placed in high quality facies, high rate potential
Well Placement
Too Low – Pads 104 & 106

Clearwater
Clearwater Sandstone
Top Pay

Base Pay
Wabiskaw

Lost core

P106 - Pair 1
Well 106-P1 - Poor Performance Well Pair
*injector and producer placed in sandy heterolithic sands, impact on production

[Graph showing oil production, water production, steam inject, and cumulative SOR over time with key events labeled: Acid Wash, Workover, Perf, Turnaround]
P106-OB1 (109/09-16-064-03W400)

- Distance to Nearest Horizontal: 10m
  - (105/09-16 – P106-I1)
- Steam chamber development occurring
Moderate Well Placement – Pad 107

Clearwater
Clearwater Sandstone
Top Pay

Base Pay

Wabiskaw

P107 - Pair 1

Injector

Producer
Well 107-P1 - Medium Performance Well Pair

*Production well placed marginally too low in the sandy heterolithic sands, reasonable rates
• Distance to Nearest Horizontal: 12m
• (105/14-16 – P107-I1)
• Confirm calibration; fiber failed
Pad Recovery & Performance
Hilda Lake Pilot Injector Schematic

Typical Hilda Lake Pilot Injector

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) / 178mm (I3) slotted liner
Hilda Lake Pilot Producer Schematic

Typical Hilda Lake Pilot Producer

340 mm surface casing

245 mm Intermediate casing

Tubing string with artificial lift

Guide tubing string with fibre optic temperature instrumentation

177 mm liner - Wire Wrapped Screen

9 5/8” x 7” Liner Hanger
Typical Phase 1 Injector Completion

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

- 13 \( \frac{3}{8}'' \) 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
- 2 7/8'' J-55, 9.41 kg/m Premium or Semi-Premium Connection Tubing String to Heel String Landed at 700 m
- 3 \( \frac{1}{2}'' \) J-55, 13.69 kg/m Premium or Semi-Premium Connection Tubing String Landed at Toe (1,380 m)
- 7'' K-55, 34.29 kg/m, Semi-Premium connection Liner, Slotted to +/- 1,400m (700m liner)

9\( \frac{5}{8}'' \) x 7'' Liner Hanger
Typical Phase 1 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 Semi-Premium Connection Tubing String to Heel Landed at 680 m with PCP
- 2 1/16” J-55, 4.84 kg/m IJ String Landed at 720 m with 1-1/4” QT-70, 1.98 kg/m Coil to Toe for Instrumentation. DTS fiber 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 Landed at +/- 1,400m (700m Liner)
- 9 5/8” x 7” Liner Hanger
Typical Phase 1 Producer Completion – Steam Lift

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

2 7/8” J-55, 9.67 kg/m Premium or Semi-Premium Connection Tubing String to Heel Landed at ± 700 m / Some Well has Instrument Coil to toe

3 1/2” J-55, 13.84 kg/m Premium or Semi-Premium Connection Tubing String Landed at ± 1,350m. DTS fiber 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 Landed at ± 1,400m (700m Liner)

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

<table>
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<th>Criteria</th>
<th>All Metal PCP</th>
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<td>Operating Temperature Range</td>
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<tr>
<td>Rate</td>
<td>100 - 370 m³/d</td>
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<tr>
<td></td>
<td>100 - 350 RPM</td>
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2015 Conversions

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<th>ESP to MTM</th>
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<td>103P1</td>
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<td>103P3</td>
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<tr>
<td>103P4</td>
<td>Natural Lift to MTM</td>
</tr>
<tr>
<td>105P2</td>
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</table>

PCP SAGD 15 Wells
Natural Lift SAGD 7 Wells
Redrilled 1 Well

Pilot 1
107-WP1
Pilot 3
107-WP2
107-WP3
107-WP4
103-WP1
104-WP1
104-WP2
104-WP3
104-WP4
103-WP2
103-WP3
103-WP4
105-WP1
105-WP2
105-WP3
105-WP4
106-WP1
106-WP2
106-WP3
106-WP4
106-WP5
Ground Uplift Monitoring

- Ground deformation measured with InSAR since March, 2010
- 53 corner reflectors; 938 coherent targets
- Ground uplift is normal and expected with thermal operations
- Osum Orion SAGD operations coincides with < 1.5 cm/yr uplift
- Imperial Oil Ltd CSS operations coincides with < 45 cm/cycle uplift
- No detrimental cap-rock, production or HSE impact reported, or expected
- Five years of monitoring have confirmed SAGD operations result in minimal, < 9 cm, uplift
- As a result, InSAR acquisition was suspended June 20, 2015
- Monitoring equipment is still in place and data can be collected if deemed necessary

Source
InSAR Deformation Monitoring Osum Orion and Boundary 2015, Quarter 2, MDA Geospatial Services, June 20, 2015
Hilda Lake Pilot Observation Wells

Typical Hilda Lake OB Well

- 219.1 mm surface casing
- 139.7 mm production casing
- 38 mm Tubing string with fiber string
Typical Phase 1 Observation Well

Typical Orion OB Well

219.1 mm surface casing

139.7 mm production casing

4.25 mm fiber string suspended with sinker bar
Surface Operations
Plant & Facilities Summary

• Osum has focused on maintaining:
  – A safe operating environment
  – Increasing asset reliability
  – Maintaining/Improving production performance
  – Meeting or exceeding regulatory license requirements

• Increasing the reliability of the two steam generation boilers was a primary focus in 2015
A Reverse Osmosis water treatment unit was added to treat brackish water.
Orion Water Usage and Treatment
Orion Central Processing Facilities (CPF)

- Two 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 FWKO 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 allowing it to be re-used to generate steam. The process allows us to reuse almost all of the produced water (95.5%).

- Brackish water is drawn from two McMurray formation source wells to supply required make-up water.

- The waste produced in the evaporative water treatment process is trucked offsite to an AER approved waste disposal facility.
De-Oiling

- Produced water from the production treating train is de-oiled using the following equipment:
  - Skim Tank – Designed to maximize retention time.
  - Induced Gas Flotation Vessel – Micro-Bubble Flotation (Hydrocarbon Content < 10ppm oil/water)
  - Oil Removal Filters – walnut shell Deep Bed Filtration.
Water Treatment

- Evaporator technology is utilized to produce Boiler Feed water (BFW)
- The evaporators at Orion:
  - Produce BFW that meets or exceeds the water criteria set out by ASME
  - Generate a concentrated brine waste stream that is disposed of at an AER approved facility
  - Have a 95% design conversion rate of feed to distillate (BFW)
Steam Generation

• Conventional Boilers generate 100% quality steam at 6,000 kPag for injection at the Well Pads.

• A small concentrated blowdown of 3-5% of the inlet mass flow is recycled back to the Evaporator Feed Tank for re-use.

• Boiler Reliability was a key focus for Orion in 2015.
  • Mud drum (tube-end to drum joints) fully welded out in both boilers.
  • Re-configured Fuel Gas Control philosophy, to incorporate produced gas heating value.
  • Tuning of boilers to address vibration issues at start up conditions and low firing rates.
  • Boiler stress reduction improvements.
Orion Vapour Recovery System

• The vapour recovery system allows for collection, compression and utilization of produced vapours. All recovered vapour is used as fuel in the steam generation system. The sources of vapour are:
  – Evaporator vent recovery
  – Ten storage tanks
  – Diluent recovery system
  – Induced Gas Flotation system

• The vapour recovery system is integrated with the Low Pressure (LP) flare system. If the vapour recovery system is not available the recovered vapour is diverted to the LP flare system
Orion Well Pad Facilities

- The facility has 6 well pads with a total of 22 SAGD well pairs
- Typical well pad configuration is 4 SAGD well pairs, which consists of 4 injector and 4 producer wells
Plant & Facilities Summary

• Boiler reliability improvement and maximizing Boiler Feed Water (BFW) supply in 2015 was a major focus:
  – Increased boiler and overall plant reliability to target measures mainly after the turnaround in June 2015
  – Installed an Reverse Osmosis (RO) unit to increase BFW and steam supply
  – Utilization of pH and Silica carrier chemical for Evaporator fouling reduction and increase in BFW supply

• Facility performance and site condition improvements:
  – Well pad berm rebuild for improved containment capability
  – Site grounds grading for better run-off management
  – Improved Well pad maintenance program
  – Improvements to boiler control parameters yielding higher steam production rates
Plant Reliability Downtime due to:
June Turnaround – 2.9%
Boiler Outages – 2.2%
Power Outages – 0.3%
Others – 0.4%
Brackish Water Modifications

- June 2015 - 16-17 brackish water well was tied into production line, increasing brackish water capacity.
- Sept 2015 - rental RO package installed to support boiler feed water demand.
Brackish Water Usage - 2015

Total brackish water usage 209,495 m³
Produced Water - 2015

Total brackish water usage 209,495 m³
• Effective September 1st, 2015 water disposal limit calculation changed to the Directive 81 formula from a 90% produced water recycle rate:
  – In early December our cumulative disposal was within acceptable limits.
On-Site Water Disposal – 2015

• 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 (AER License # 0192346)
  – Normal Operating Pressure Range: 11100 - 12500 KPa
  – 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 (AER License # 0196880)
  – Suspended Nov. 2011
Measurement, Accounting & Reporting Plan (MARP)
Enhanced Production Audit Program (EPAP)

MARP

• Annual MARP revision prepared in conjunction with third-party specialist April 2015
• Accounting meters calibrated / verified on an annual basis

EPAP

• EPAP initial declaration for reporting facilities (treating, injection and water disposal) effective March 2016
• Utilized third-party controls specialist to complete initial controls documentation, evaluation and testing
• Remediation of identified deficiencies is underway
Orion Well Integrity

• Wellhead Integrity Maintenance
  – Include wellhead integrity checks as part of all completions activities
  – Yearly wellhead integrity maintenance completed June, 2015. All thermal wellheads and components visually inspected and re-torqued to specification
  – Wellhead components inventory and tracking system components specifications, up-to-date pictures, scheduled maintenance information will be available online through service provider’s website

• During 2015
  - Conducted Multi-finger Caliper and/or Vertilog on five wells – well casings on all five wells checked out satisfactory
Monthly Energy Intensity – 2015

- Bitumen Production (m3)
- GJ/Bitumen Production
Monthly Gas Usage – 2015

Total Fuel Gas Consumption: 110,338 E3M3
Monthly Power Consumption – 2015

Total Annual Power Consumption: 58,891 MW-hr

- 2015/01
- 2015/02
- 2015/03
- 2015/04
- 2015/05
- 2015/06
- 2015/07
- 2015/08
- 2015/09
- 2015/10
- 2015/11
- 2015/12
Water Proration Factors – 2015

Range - 0.881 to 1.005
Oil Proration Factors – 2015

Range 0.868 to 1.131
### Fresh Non-Potable Water Usage – 2015

**Water drawn from WSW well**
- Situated at 13-16-064-03W4M
- Under Water Act Approval 242090-00-00
- Water levels have steadily increased since monitoring began in 2006 even though water production increased from 2013 – 2015.
- TDS concentration is 750 mg/l
- Dissolved iron concentration is 2.4 mg/l
- All concentrations exceed Drinking Water Guidelines
- Water is therefore used for domestic needs

**Cumulative Fresh Water Usage**

**Monthly Fresh Water Usage**

**Total 2015 Fresh Water Usage = 4,577 m³**

**Max Annual Allowable Volume = 23,725 m³**
## 2015 Cumulative Water Balance

### Source Water Wells
Brackish Water-Make-Up
- 16-17-064-03 W4M-0196880
- 15-16-064-03 W4M-0327690

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

### Septic

### Injection Wells
Produced Water

### Water Treatment and Steam Generation

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<th>Volume</th>
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<tr>
<td>Brackish</td>
<td>209,495 m³</td>
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<tr>
<td>Fresh</td>
<td>4,577 m³</td>
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<td>Diluent Pipeline Water</td>
<td>38 m³</td>
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<td>TOTAL</td>
<td>1,506,892 m³</td>
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<table>
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<th>OUT</th>
<th>Volume</th>
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<tbody>
<tr>
<td>Steam</td>
<td>1,364,998 m³</td>
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<tr>
<td>Disposal</td>
<td>157,690 m³</td>
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<tr>
<td>Fresh water usage</td>
<td>4,577 m³</td>
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<td>IPF Pipeline Water</td>
<td>2,087 m³</td>
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<tr>
<td>TOTAL</td>
<td>1,529,352 m³</td>
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### Difference (as a percentage of total in's)
- 22,460 m³ (1.5%)

### Disposal Limit
- 13 %

### Actual Disposal
- 12 %

### Disposal
Evaporator Blowdown/Excess Produced Water
Disposal Well 16-17-064-03 W4M
Tervita 05-26-056-05 W4M
Off-Site Waste Disposal

• Tervita-Lindbergh – Class 1b – 05-26-056-05W4M
  – Evaporator Blowdown – 83,591 m³
  – Turnaround Volumes from Vessel Cleaning- Sludge 520 m³

• RBW Waste Management
  – Contaminated soil from housekeeping and hydro-vac activities 50 m³
  – Recycle-Glycol, Lube oil, Filters, Oily rags, Aerosols, Methanol 33.6 m³
  – Recycle-Scrap metal 0.2 m³
  – NORM from refractory brick 2.3 m³
Domestic Waste Disposal

• Domestic waste water from the administrative offices washrooms and kitchens are 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 1297 m³.

• Domestic waste is hauled to municipal landfills in either Cold Lake or Bonnyville. Approximately 262 kilograms was disposed.

• Paper, cardboard and steel recycling program processed 1077 kg of material.
Air Monitoring Programs

- Monthly air contaminant concentrations for SO$_2$/NOx, annual manual stack survey results, fugitive emissions, greenhouse gas emission and summarized monthly emission reporting is submitted in accordance with EPEA Approval requirements.

- Sulphur emissions at the facility peaked at 0.45 t/d in May 2015 and averages 0.34 t/d. This trend is not anticipated to change in the near term.

- Sulphur dioxide emissions peaked at 0.9 t/d in May which prompted a request to raise the facility EPEA limit from 0.9 t/d to 1.61 t/d based on modelling results the average daily emission rate for SO$_2$ is 0.67 t/d.

- The 2015 fugitive emissions survey noted 22 leaks - all were repaired within a week of determination.
Sulphur Emissions (Tonnes)

Monthly Limit 24.15 - 24.95 tonnes/month

Quarterly Emissions

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<td>Q2</td>
<td>33.27 t</td>
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<td>Q4</td>
<td>35.99 t</td>
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<td>Jun-15</td>
<td>7.54</td>
</tr>
<tr>
<td>Jul-15</td>
<td>11.51</td>
</tr>
<tr>
<td>Aug-15</td>
<td>11.96</td>
</tr>
<tr>
<td>Sep-15</td>
<td>12.65</td>
</tr>
<tr>
<td>Oct-15</td>
<td>14.05</td>
</tr>
<tr>
<td>Nov-15</td>
<td>12.38</td>
</tr>
<tr>
<td>Dec-15</td>
<td>9.56</td>
</tr>
</tbody>
</table>
SO2 Volumes Monthly/Quarterly (Tonnes)

Monthly Limit 48.3-49.91 tonnes/month

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Flare</td>
<td>2.82</td>
<td>2.09</td>
<td>2.84</td>
<td>1.34</td>
<td>2.89</td>
<td>2.72</td>
<td>1.67</td>
<td>1.64</td>
<td>0.49</td>
<td>0.80</td>
<td>1.53</td>
<td>1.22</td>
</tr>
<tr>
<td>Stack</td>
<td>9.90</td>
<td>18.10</td>
<td>20.18</td>
<td>22.49</td>
<td>24.74</td>
<td>12.36</td>
<td>21.35</td>
<td>22.27</td>
<td>24.81</td>
<td>27.30</td>
<td>23.22</td>
<td>17.90</td>
</tr>
</tbody>
</table>

Quarterly Emissions
- Q1: 55.93 t
- Q2: 66.54 t
- Q3: 72.23 t
- Q4: 71.97 t
- Limit: 144.9 t
Monthly NOx Emissions Per Boiler

Limit 7.56 - 7.81 tonnes/month/boiler

<table>
<thead>
<tr>
<th>Month</th>
<th>Boiler 4100</th>
<th>Boiler 4200</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>3.21</td>
<td>2.39</td>
</tr>
<tr>
<td>February</td>
<td>1.89</td>
<td>3.27</td>
</tr>
<tr>
<td>March</td>
<td>3.13</td>
<td>3.61</td>
</tr>
<tr>
<td>April</td>
<td>3.60</td>
<td>3.50</td>
</tr>
<tr>
<td>May</td>
<td>3.97</td>
<td>3.73</td>
</tr>
<tr>
<td>June</td>
<td>1.98</td>
<td>1.98</td>
</tr>
<tr>
<td>July</td>
<td>3.96</td>
<td>3.82</td>
</tr>
<tr>
<td>August</td>
<td>4.43</td>
<td>3.48</td>
</tr>
<tr>
<td>September</td>
<td>4.38</td>
<td>4.08</td>
</tr>
<tr>
<td>October</td>
<td>4.60</td>
<td>4.29</td>
</tr>
<tr>
<td>November</td>
<td>4.49</td>
<td>4.24</td>
</tr>
<tr>
<td>December</td>
<td>4.71</td>
<td>4.37</td>
</tr>
</tbody>
</table>
• Ambient air monitoring is fulfilled by supporting the LICA Airshed and participating on the Airshed steering committee. Osum continues to operate 5 passive monitoring stations- 4 fence-line and one at landowners request.
Monthly Greenhouse Gas Emissions (Tonnes of CO2E)

Compliance Emission Rate 0.5911 CO$_2$eq/m$^3$
Actual 0.4419 CO$_2$eq/m$^3$

<table>
<thead>
<tr>
<th>Month</th>
<th>Emissions Tonnes of CO2E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-15</td>
<td>12,185.533</td>
</tr>
<tr>
<td>Feb-15</td>
<td>12,342.724</td>
</tr>
<tr>
<td>Mar-15</td>
<td>15,953.197</td>
</tr>
<tr>
<td>Apr-15</td>
<td>16,542.425</td>
</tr>
<tr>
<td>May-15</td>
<td>16,110.283</td>
</tr>
<tr>
<td>Jun-15</td>
<td>9,217.921</td>
</tr>
<tr>
<td>Jul-15</td>
<td>17,771.326</td>
</tr>
<tr>
<td>Aug-15</td>
<td>17,671.557</td>
</tr>
<tr>
<td>Sep-15</td>
<td>18,439.065</td>
</tr>
<tr>
<td>Oct-15</td>
<td>20,319.969</td>
</tr>
<tr>
<td>Nov-15</td>
<td>18,871.675</td>
</tr>
<tr>
<td>Dec-15</td>
<td>19,743.856</td>
</tr>
</tbody>
</table>

Emissions Tonnes of CO2E
Groundwater Monitoring Program

• The groundwater monitoring program was consistent with previous years, no negative trends were detected

• No new wells were added

• Arsenic well program sampling events were increased to quarterly and a solute transport model was commissioned
Wildlife Monitoring Program

• The wildlife monitoring program included a breeding bird, yellow rail and amphibian survey and a winter tracking event;

• A comprehensive report summarizing the last 7 years of monitoring was submitted in 2016; and

• The 2015 monitoring program was augmented with the addition of remote cameras for above ground pipeline crossing utilization and acoustical recorders in addition to the approved program. The additions increased the species richness captured over previous years.
Environmental Monitoring Program

• In accordance with Conditions outlined in EPEA Approval 141258-00-00 and Water Act Approval 242090-00-00 the remaining annual reports were prepared and submitted for:
  – Industrial Waste Water and Surface Water
  – Surface Water Quality-Ethel and Hilda Lake
  – Conservation and Reclamation
  – Domestic Water Use

• Conditions were reflective of previous years for these reports.
Amendments to Existing Approvals

- EPEA Approval 141258-00-04 was issued in response to increasing sulphur dioxide daily emissions from 0.9 t/d to 1.61 t/d.

- An extension of the existing approval was issued on July 21 to move expiry of current approvals to July 31, 2016 or upon issuance of EPEA Approval 141258-01-00.

- Changes to Scheme Approval for 2015
  - 10103 J/M- Phase 2 development (Pads 301,302,403,404) and amendment to well layout and addition of 103 wells.
  - 10103 K- Installation of Reverse Osmosis Unit
  - 10103 L- Rescinding of Condition 8-Regarding Long-Term Supply Pumping Test
Compliance

• Sulphur dioxide emissions were exceeded on May 18\textsuperscript{th}. This prompted both the investigation into the source of the increased volume of produced gas entering the facility and applying to increase the limit to reflect modelled tolerances.

• Osum requested a joint audit of the facility by the AER to ensure continued compliance efforts and identify any gaps requiring correction. This was conducted on March 8 and 9\textsuperscript{th}, 2016.
Future Plans
Future Plans – Field Development for Orion Phase 2

- AER Category 2 Amendment Application for Orion Phase 2 was submitted November 2015 and approved Jan 6th 2016. Included the full development plan as submitted previously (for Pads 301, 302, 403 and 404) but with the following changes:
  - Pad 302: Changed from 8 SAGD well pairs with 100 m spacing to 12 SAGD well pairs with 67 m spacing and 990m well length
  - Pad 103 Infill wells: 3 Producer wells drilled between existing Pad 103 and the toe end of Pad 105 SAGD well pairs; total well length 980 m
- The timing of executing this development is under review
Future Plans – CPF Debottlenecking

• Debottlenecking projects under consideration for near term implementation. Objectives include:
  o Reduce time to build reservoir pressure across the field back into the target range
  o Provide incremental production
  o Reduce OPEX through on-site treatment of evaporator blowdown waste stream which will:
    o Reduce off-site disposal volumes
    o Increase water recycle rates to be used for additional steam generation

Within Existing AER Scheme Approvals from Orion Phase 2 Expansion:
• Installation of 3rd Boiler (H-4300)
• Installation of new underground brackish water pipeline from well 16-17 to CPF

AER Scheme Amendment Approval Required (D78 submission ~ July 2016):
• Crystallizer addition to treat evaporator blowdown waste
• Additional Reverse Osmosis (RO) unit for brackish well 16-17 feed
• Polisher addition for boiler continuous blowdown to remove loading on evaporators for additional steam generation
Thank you