Sawn Lake Single SAGD Wellpair Demonstration Project
Peace River Oil Sands Region
Scheme Approval 11341A
Alberta Energy Regulator (AER)
Annual D54 Performance Presentation
Craig Pichach, VP Operations, October 22 2015
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   - Subsection 3.1.1 (3) Drilling and Completions
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Agenda (Surface Operations)

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  - Subsection 3.1.2 (9) Future Plans
Introduction and Overview
Sawn Lake – Land (Andora)

Andora - Working Interest in 88 sections

- Sawn Lake North
  - 10% of 51 sections (non-operated)
  - 100% of 9 sections

- Sawn Lake Central
  - 50% of 12 sections
  - Designated Operator; Approved Commercial SAGD Site

- Sawn Lake South
  - 100% of 16 sections

<table>
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<tr>
<th>(Gross 100%)</th>
<th>SAGD Contingent Resource Estimate (MMbbl)</th>
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<td>High</td>
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SAGD Project Location
Sawn Lake Single WP Pilot Overview

AER Scheme Approval: **11341A**

One (1) SAGD wellpair

Pilot Facility at 7-30-91-12W5

Target formation is the Bluesky

Traditional SAGD recovery process

Andora Energy is Operator.

Dark Green Area >20m pay

Green 15-20m pay

Light Green <15m pay
Single SAGD Wellpair Project Overview

Using Steam Assisted Gravity Drainage (SAGD) to recover bitumen from the Bluesky formation.
Sawn Lake Project Background

- Andora has working interests in 88 sections of Oil Sands Leases - all in primary term
- Andora’s Focus - Operated Leases 740307A365, 7403070363 & 7408030779
  - > 100 Legacy wells, Sawn Lake Slave Point Exploration & Development
  - 3 Andora (Signet) Horizontal Wells
  - 9 Andora (Signet) Vertical Wells
  - ~ 200km 2D seismic
  - Andora Acquired 18km² 3D Seismic over SAGD Project Location
- 2008 – 2009 Application to ERCB for SAGD Demonstration in Sawn Lake
- August 2009, ERCB Commercial Scheme Approval for SAGD demonstration project in South Sawn Lake
- 2009 – 2010 build all season access road and pipeline right of way into 15-21 site (disposal well, source water well)
Demonstration Project Applications

Single Wellpair SAGD Demonstration Project Application Timeline

- 2008 Sawn Lake SAGD Demonstration Project Application to the ERCB
- 2008 Sawn Lake SAGD Demonstration Project Supplemental Information Request #1
- 2008 Sawn Lake SAGD Demonstration Project Supplemental Information Request #2
- 2012 Sawn Lake SAGD Demonstration Project D78 Project Amendment (7-30 Application)
- 2013 Sawn Lake SAGD Demonstration Project D78 Project Amendment Supplemental Information Request
- 2013 Sawn Lake Measurement, Accounting and Reporting Plan (MARP)

Future Applications (Not Implemented)

- 2014 D78 Category 2 - 2U/2L SAGD Wellpair; Approved
- 2015 D78 Category 1 – Produced Water Boiler (PWB) Trial.; Approved
Future Applications / Approvals

Single Wellpair SAGD Demonstration Project Approvals and Licences

- AER Approval 11341A (7-30) – 2013
- AER Approval of MARP (2013)
- AER Approval for Disposal Well (D51) – 1775897; well W0420620
- AER Approval for Class II Disposal Well (D65) – 12169
- Approved Fuel Gas P/L Licence 55565
- Approved Source Well P/L Licence 55566
- Approved Disposal Well P/L Licence 55567
- Approved 1U/16-30-91-12W5 (Injector) Licence 0457964
- Approved 1L/16-30-91-12W5 (Producer) Licence 0457960
- Approved F46733 Bitumen Battery Facility Licence
- EPEA Approval 00247729-00-01
- Approved Plan 1076969MS-2013-10-08
- Water Act Approval Licence 00361158-00-00
Subsurface – Geology and Geophysics
Peace River Region – Oil Sands Deposits & Major Projects

Pre Cretaceous Unconformity

Red Earth Highlands

Figure 2.3: Bitumen pay thickness of Peace River Bluesky-Gething deposit

A

A'
Sawn Lake – Core & 3D Seismic Data

- Average of 2.8 wells per section on South & Central
- 18km² of 3D Seismic coverage over SAGD Demonstration
- 14 Bluesky Core

SAGD Project Location
Sawn Lake – 2D Seismic Data

➤ +200 km 2D seismic data

▲ SAGD Project Location
Sawn Lake – Type Well

Wilrich Shale

Bluesky Formation

Net Pay

Btm H2O

Wabamun

02/02-32-091-12W5/0

KE: 795.4 m
TD: 743.0 m [TVD]
Form TD: WBM
Mode: Abd Whip
Fluid: N/A

Gamma Density Porosity SP Resistivity
Sawn Lake - Bluesky Net Pay

Sawn Lake Reference Well

SAGD Project Location

Detail Area

T92N-R13W
T92N-R12W

T91N-R13W
T91N-R12W

Net Pay
Sawn Lake - Regional Cross Section

Regional Cross Section NW – SE through the “Tide Dominated Delta”

SAGD Demonstration Site
Thick continuous Oil Sands Reservoir within the “Paleo Valley”
Sawn Lake – Devonian Structure

Sawn Lake Reference Well

SAGD Project Location

T92N-R13W  T92N-R12W

Devonian Low

“Paleo Valley” Trend

T91N-R13W  T91N-R12W
Sawn Lake – Base Bluesky Structure
Sawn Lake – Base Bluesky Structure (Detail)

16-30 SAGD Well Pair Path

Sawn Lake Reference Well
Sawn Lake – Top Bluesky Pay Structure

T92N-R13W  T92N-R12W

T91N-R13W  T91N-R12W
Sawn Lake – Top Bluesky Structure

Sawn Lake Reference Well

SAGD Project Location
Sawn Lake – Bottom Water

Sawn Lake Reference Well

SAGD Project Location

Btm H20
Sawn Lake – SAGD Test Key Zones

**Thick Clean Heavily Oil Saturated**

**Dispersed Shale Inter-beds**

**Top Lean Zone**

* Dominant Zone Type

* Thin & aerially constrained Zone Type
1U/1L Wellpair
Sawn Lake – 1U/1L Wellpair

1U/1L wellpair

- Wellpair 50m SE of existing horizontal core well. 7-30-91-12W5 core summary shown to left.
- Producer landed at 657.5-658m (base of Z1) to avoid potential complications and give pilot best chance of success. Injector 5m higher at 652m.
- Base Temp 17degC, Base Reservoir Pressure: 2280kPag
  Average So = 0.6
  Average H = 18m
  Average $\theta_1 = 0.29$
  Average Kh = 4.3D
  Average Kv = 3.6D

Bitumen in Place (OBIP)

$$OBIP = A \times h_1 \times S_{o_1} \times \theta_1 \times B_o$$
$$= (100m \times 805m) \times 18m \times 0.6 \times 0.29 \times 1$$
$$= 252,126m^3$$
Sawn Lake - Bluesky Net Pay

- Sawn Lake Field
  - 39 contiguous sections with > 10 meters of pay and excess of 2 Billion Gross Barrels of Bitumen in Place
  - 6.5 sections with > 20 meters of pay and ~ 0.5 Billion Gross Barrels of Bitumen in Place, ~ 30% Porosity, ~70% Oil Saturation
  - Areas with no complication, bottom water, top lean zones identified; strategy is Low Pressure SAGD (LP SAGD) operating with steam chamber pressure close to base reservoir pressure
  - Base Reservoir Pressure identified as ~3200kPag at ~650m TVD.
  - Pilot Placed at 7-30-91-12W5 drilled to BH 16-30-91-12W5 (no complications)
Sawn Lake – 2-32-91-12W5 Core

2-32-91-12W5

Porosity vs. Permeability

Depth vs. Permeability

Depth vs. Oil Saturation
Sawn Lake – Petrography

- 2-32-91-12W5 (677.75 m)
- 16-20-91-12W5 (673.5 m)

XRD Analysis

<table>
<thead>
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<th>Depth Interval (m)</th>
<th>2-32-91-12W5</th>
<th>16-20-91-12W5</th>
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<tr>
<td>Total Clay</td>
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<table>
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andora
Sawn Lake – Surface Operations

Water Source Well 00/16-20-91-12W5

- Paddy / Cadotte Aquifer, 420 mKb
- Fresh Water, ~ 3600 ppm
• Disposal Well located on facility site
• Disposing to the Wabamun
Future Potential Saline Source – Bluesky

Potential source water is the Bluesky.

Measured/laboratory samples in T091 and T092 R13 suggest the TDS is 14,906 and 23,352 mg/L, respectively.

A DST sample in T091 R13 suggests a TDS of 19,786 mg/L.

Would require water treatment plant capable of handling saline water (such as PWB).
Future Potential Saline Source – Lower Wabamun Zones

- Lower Wabamun Zones; Middle zone (785m-803m at 15-21) and Lower Zone Wabamun lower zone (967m-977m at 15-21)
- Overall conceptual model Wabamun is saline (buried deep beneath sediment and therefore is not getting recharge from a fresh water source anywhere in close proximity)
- Based on the assumption that it is quite saline and using the remaining DST data (with outliers culled), the salinity range in the Wabamun is expected to be between 55,000 and 70,000 mg/L TDS.
- Some outlier DST data ranged from 1,000 mg/L to 22,000 mg/L.
- Future effort on mapping the middle and lower zones.
- Usage would require require water treatment plant capable of handling saline water (such as PWB).
Drilling and Completions - Injector

- **SURFACE HOLE:** 444.5 mm
  - SURFACE CASING: 210 mKB
  - SIZE: 339.7 mm, 81.10 kg/m J55 STC

- **INTERMEDIATE HOLE:** 311.0 mm
  - INTERMEDIATE CASING: 652.5 mTVD/ 819.7 mMD
  - SIZE: 244.5 mm, 59.53 kg/m L80 TENARIS BLUE
  - THERMAL 40° CEMENT

- **LONG STRING:** LANDING Ø 1537 mKB
  - SIZE: 114.3 mm, 15.63 kg/m, J55 TKC 4040 HUNTING

- **KOP:** 493 mMD
  - DLS: 7 deg/30m

- **SHORT STRING:** LANDING Ø 817.7 mKB
  - SIZE: 177.8 mm, 34.23 kg/m, L80 TENARIS BLUE LINER

- **LATERAL HOLE:** 222.0 mm
  - SLOTTED LINER: LANDING @ 1628 w/UNER HANGER @ 839 mMD
  - SIZE: 177.8 mm, 34.23 kg/m, L80 TENARIS BLUE LINER

- **TD:** 125 mASL, 652.5 mTVD/ 1638 mMD
Drilling and Completions – Producer (Circ)

**WELL NAME:**

**KOP:** 493.0 mMD
**DLS:** 7 deg/30m

**SURFACE HOLES:**
- **SURFACE HOLES:** 508 mm
- **SURFACE CASING:** 210 mKB
  - **SIZE:** 406.4 mm, 81.10 kg/m J55

**INTERMEDIATE HOLE:**
- **INTERMEDIATE HOLE:** 374.65 mm
- **INTERMEDIATE CASING:** 652.5 mTVD/819.7 mMD
  - **SIZE:** 298.4 mm, 59.53 kg/m L80

**THERMAL 40F CEMENT**

**LONG GUIDE STRING:**
- **LANDING @ 1537 mKB**
  - **SIZE:** 114.3 mm, 13.69 kg/m, L80

**SHORT String:**
- **LANDING @ 817.7 mKB**
  - **SIZE:** 114.3 mm, 13.69 kg/m, L80

**LATERAL HOLE:**
- **222.0 mm**
  - **SLOTTED LINER: LANDING @ 1626 w/LINER HANGER @ 839.0 mMD**
  - **SIZE:** 177.8 mm, 34.23 kg/m, L80

**TD:** 777.5 m ASL
**TD:** 125 m ASL, 652.5 mTVD/1636 mMD

**WELL PURPOSES:**
- SAGD INJECTOR WELL - CIRCULATION/WARM-UP & PRODUCTION PHASE

**WELL HISTORY**

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<th>DATE</th>
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**ENGINEERING AND PERMIT STAMPS**

**CUSTOMER**

**JLC engineering ltd.**

**SAWN LAKE SAGD PILOT**
**LSD. 07-30-91-12-W5M**

**STANDARD**
**SAGD PILOT INJECTOR WELL**
**SAGD CIRCULATION & PRODUCTION PHASE**

**DRG No**
**AN1051**

**AN1051-4-STD-050-00**

39
Drilling and Completions - Producer (SAGD)

WELL NAME:
UK

777.5m ASL

SURFACE HOLE: 444.5 mm
SURFACE CASING: 210 mkB
SIZE: 339.7mm, 81.10 kg/m J55 STC

INTERMEDIATE HOLE: 311.0 mm
INTERMEDIATE CASING: 849.5 mMD/ 657.5 mTD
SIZE: 244.5 mm, 59.53 kg/m L80 TENARIS BLUE

THERMAL 40F CEMENT

GUIDE STRING: 1580 mm, 4.84 kg/m J55 850 mkB HUNTING U TUBING LANDING @ 1580 mkB

ANNULUS PT GAUGE

FIBRE OPTIC DTS LANDED DEPTH 1532 mkB

KOP: 407.8 mMD
DLS: 7 deg/30m

TARGET: 85.0 deg INC
TANGENT FROM 778.0 mMD
TO 798.7 mMD

LATERAL HOLE: 222.0 mm
SLOTTED LINER: LANDING @ 1839.5 w/LINER HANGER @ 825 mMD
SIZE: 177.8 mm, 34.23 kg/m, L80 TENARIS BLUE LINER

ESP STRING: LANDING @ 822 mMD WITH PT GAUGE @ INTAKE & MOTOR
SIZE: 88.9 mm, 13.84 kg/m, J55 WITH HUNTING FJ150

TO: 120 mASL 657.5 mTD/1580 mMD

SAWN LAKE SAGD PILOT

JLC engineering ltd.

STANDARD
SAGD PILOT PRODUCER WELL
SAGD PRODUCTION PHASE

DRG No
AN1051-4-STD-051-00

REV
1

40
Drilling and Completions – Well Survey

Project: Sawm Lake (Nad 63)
Site: 30-91-12W6M
Well: Andora 1L Sawm Lake 7-30/16-30-91-12W6M
16-30(1L) Final Survey

Vertical Section at 36.69° (30 m)

Surface Capacity

LCL

End of 8 Degrees

10,000 m (30 ft)

6,000 m (200 ft)

3,000 m (100 ft)

0 m (0 ft)

Vertical Section at 36.69° (30 m)

LCL

End of 8 Degrees

10,000 m (30 ft)

6,000 m (200 ft)

3,000 m (100 ft)

0 m (0 ft)
Instrumentation

Injector
- Blanket gas for downhole pressure measurement

Producer
- Fiberoptic DTS temperature profile
- X2 P/T Gauge on ESP Suction (heel)
- P/T Gauge on ESP Motor
- X 1 Pressure gauge at Toe
- Casing Gas pressure at surface

Discussion
- Toe Pressure gauge reading lower (~400kPa+) than heel pressure gauges; and has trended down below base reservoir pressure; believed to have failed.
- DTS fiberoptic temperatures were trending with surface temperatures; surface compensation corrected
- Primary subcool on heel pressure, temperature and DTS Avg/High at heel pressure.
Artificial Lift provided by Electric Submersible Pump (ESP) due to depth (650m TVD) with low base reservoir pressure (3200kPag)
First ESP lasted from Sept 2015 to May 2016; (9 months); motor failure due to manufacturing fault. Pump showed no sign of sand, well integrity good. Some sign of up-thrust damage from low start up rates (on edge of pump curve).
New ESP downsized to avoid future upthrust potential.
Scheme Performance
May 19, 2014
First Sustained OTSG firing

May 21, 2014
Commenced steam injection on injector and producer (First Steam) at 25-30tpd/wellpair

May 23, 2014
Offloading of liquids in producer and injector

May 23 – Aug 29 2014
SAGD Circulation

Aug 29, 2014
Plant Shut down / Cool down

Sept 9 – 11 2014
Service Rig for ESP and fiberoptic install

Sept 12 2014
Plant Start Up on SAGD mode
Performance Data (Month Cal. Day Avg)

To Sept 30 2015

OTSG Inspection/
MARP calibration

ESP Replacement

ESP Install/
SAGD Mode
Performance Data (Weekly Averages) - SAGD

Sawn Lake 2014/2015 Steam Inj and Production Rate (Weekly Averages)

- Average of Steam Injection to Wells
- Average of Water Production from Wells
- Average of Total Fluid Production
- Average of Well Bitumen Production

- Bitumen on secondary (right) axis

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<th>Time</th>
<th>Weekly Average Flow (m³/d)</th>
<th>Bitumen Production (bopd)</th>
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<tr>
<td>60</td>
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</tbody>
</table>

- Steam Ramp Up: 376 bopd
- OTSG Inspection/MARP calibration: 376 bopd
- ESP Replacement: 440 bopd
Performance Data (Recovery) - SAGD

Simulated Ultimate Recovery expected to be ~60% (LP-SAGD).
Performance Data (cSOR / iSOR) - SAGD
Sawn Lake 1U/1L Gas Production Performance (Weekly Averages)
Circulation mode slugging due to tests to confirm steam throughout well.

SAGD mode declines in injection pressure at constant steam rate believed to be due to steam chamber volume expansion and condensation surface area increase (caprock).

Increases in steam injection pressure due to increased steam injection.
Sproule (Andora) Expectations Dec31-2014

- Exceeding Sproule “LOW” case [121 bopd @ SOR 8 for 2015; 242 bopd @ SOR 5.7 for 2016 & 2017]
- Exceeding Sproule “BEST” case [173 bopd @ SOR 5.6 for 2015; 345 bopd @ SOR 4 for 2016 & 2017]
- Aiming to exceed “HIGH” case of [224 bopd @ SOR 4.3 for 2015; 449 bopd @ SOR 3.1 for 2016 & 2017]
- Can inject more steam than predicted by Sproule [>380 tpd actual vs. 208 tpd Sproule] which could mean more production.

16-30-091-12W5 Pilot Well Forecasts
Sawn Lake – 1U/1L Wellpair

1U/1L wellpair

- Production stagnation prior to caprock evidence of penetration to lean zone above Z1.
- Steam injection at 400tpd with injector pressure at 2750kPag further indication of low base reservoir pressure ~2300kPag and good permeability's.
- Further trialing to determine if steam is productive.
SAWN LAKE ANALYTICALS

Bitumen
Last Analysis September 2015 – 1021kg/m³ density; 7.0API; generally 7.8API. Sawn Lake bitumen is consistent with a McMurray formation bitumen 7-8API.

Produced Gas
Typical SAGD casing gas; small production; 54% methane, 40% CO2, 2% Hydrogen, 1.4% H2S remainder C2+ hydrocarbons.

Produced Water
TDS: 2100mg/L by evaporation, 352mg/L calculated
P-Alkalinity 0ppm, M Alkalinity 287ppm, Total Alkalinity 287mg/L
Total Hardness: 5mg/L as CaCO3
Silica: 125-141mg/L

Non-Saline Make Up Water
TDS: 3530mg/L by evaporation
P-Alkalinity 0ppm, M Alkalinity 1648mg/L, Total 1648mg/L
Total Hardness: 49mg/L
Silica: 3-8mg/L
Project Overview– Facility, Wells, Pipeline

- Facility and SAGD Wellpair
- Source Water Well
- Disposal Well
- Pipeline Route
- TCPL Natural Gas Tie-in (Nova P/L)
Sawn Lake SAGD Facility
Project Overview– Facility (Equipment)
Facility Performance

**Equipment**
- Oil/Water Separation facility built upon AOSTRA/Devon/Suncor Dover project equipment; equipment refurbishment went well. Vessels have passed inspections. Some issues with gasket leaks, have been eliminated through use of modern gaskets.
- New OTSG has passed 1 year run time inspection; no issues.

**Emulsion Treating**
- Facility on circulation/SAGD start up was unable to meet water content requirement. Following ramp up good success with chemical treatment and high temperature separator. Meeting Tervita/Pembina sales spec 0.5% BS&W and Shell Peace River complex sales spec of 0.35% BS&W. Also exporting to Murphy 1-26. Early start up issues with HTS resulted in excess produced water trucking especially on start up steam circulation required trucking to Custom Treating stations (Gibsons Valleyview, NewAlta Peace River, Secure Judy Creek).
- Plains Midstream Nipisi terminal has been unable to blend (too heavy at 7-8API). Currently exporting to Shell Peace River Complex, Murphy 1-26, Tervita High Prairie.
- Able to meet spec with single High Temperature Separator (HTS) train. Flash Treater in building, not yet hooked up.
- Decision made to proceed with Recycle pumps; should allow for off-spec bitumen from off-spec tank to be recycled through the high temp separator to be brought on-spec.
Facility Performance

Steam Requirements / Plant Pressure Rating
- If 400tpd steam per well is productive than OTSG undersized for x 2 wellpairs; need additional 30-50MMBTU/hr steam generator for 1U/1L. 2U/2L will need to be revisited for additional steam requirements following start up steam circulation if steam injection is shown to be productive. Less than 3000kPag bottom hole pressures, plant could be designed for #600ANSI

Road / Geomembrane Trial
- Issues with truck turn around required improvement project with geomembrane/gravel appears to be a success; trouble free since road improvement project.

ESP Sizing/Scaling
- No sand generation; liner slot size strategy seems to have been successful
- During ESP replacement silica scaling on the production tubing at liquid/steam interface.
- New wells should have a start up ESP as opposed to full-rate ESP to avoid up-thrust damage or use 6 month run-time for first ESP.

Power Generators
- Gensets (x 3 270kW gensets) have issues with respect to switchgear / load shedding causing plant trips. Continuing to work on issues.

Natural Gas
Hydrate issues at nat gas let down; methanol injection commenced.
Facility Performance - Gas

**Gas Volumes E3m³**

- Note – Most Produced Gas is recovered and consumed in the OTSG
- Tank vapors to LP Flare

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<th>Purchased Gas</th>
<th>Produced Gas</th>
<th>Flared Gas</th>
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## Facility Performance – Greenhouse Gas Emissions

### GREENHOUSE GAS EMISSIONS - SAWN LAKE (May 2014 to Sept 2015)

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MARP Approved – October 23, 2013

MARP Calibrations ongoing; complete account meter recalibrations for 2015 completed

Reporting Codes:

SAGD Production Facility
ABBT 0132513

SAGD injection Facility
ABIF 0132513

Water source is 16-20-91-12W5 100162009112W500

Water injection (disposal) is 15-21-091-12W5/100 100042809112W500

SAGD Wellpair Injector: BH 103/16-30-091-12W5/0

SAGD Wellpair Producer: BH 102/16-30-091-12W5/0
MARP Approved – October 23, 2013
MARP Calibrations on-going; complete account meter recalibrations for 2015 completed
Bitumen Production = Truck receipts (Std Conditions) + Daily delta LT-2511 (T-251) + Daily delta LT-2521 (T-252)

Required adjustment on water cut on start up until chemical program produced on-spec bitumen.
Gas Production (Battery Facility) = FIT-2314+ FIT-2316 + Estimated solution gas vapors (See Section 6.4). Use of Hysys is permitted in CAPP guide “Estimation of Venting Volumes from Upstream Oil and Gas Facilities”. For initial operation of the plant Andora will report low pressure flaring of 2 Sm3 per m3 of bitumen produced.
Water Production = FIT-2684 (Disposal Meter) + Daily Delta LT-2611 (T-261) + Daily Delta LT-2621 (T-262) – FIT-5553 (Blowdown)

Note – Due to flashing across FIT-5553 / scaling; better calc blowdown

Blowdown = FIT-3911 – FIT-1014 – FIT-1012
Pipeline Gas Into Battery Facility = FIT-2411
Fuel Gas Consumed by Battery Facility = FIT-2411+ FIT-2314 - FE-5110
Fuel Gas Disposition from Battery to Injector Facility (Consumed by Injector Facility) = FE-5110
Water Production and Usage
Source Water Well

- Water Act Approval Licence 00361158-00-00
- Non Saline Source Water Well at 16-30-91-12W5
  TDS: 3530mg/L by evaporation
  P-alkalinity 0ppm, M Alkalinity 1648mg/L, Total 1648mg/L
  Total Hardness: 49mg/L Silica: 3-8mg/L
- Water from the Paddy/Cadotte

Water Recycle

- Andora pilot uses less than 500,000m3 per year of make up water and does not recycle the produced water as per allowance in Directive 081, Section 5.
Produced Water Disposal Well

- AER Approval for Disposal Well (D51) – 1775897; well W0420620
- AER Approval for Class II Disposal Well (D65) – 12169
- Disposal into Upper Wabamum zone at 15-21-91-12W5
- Well remains near vacuum; injection pressure less than 500kPag

Other

- Tervita High Prairie – ABWP0093970
- Tervita Peace River – ABWP0090327
- Gibsons Mayerthorpe - ABWP0000556;
- NewAlta Peace River (11-07-082-W5M) – AB WP 0097804
- NewAlta Red Earth AB WP 0000663
- Secure Fox 11-36 - ABWL0730091
Sawn Lake Source / Disposal Rates

Regulatory Limits

Withdrawal
620m³

Disposal
700m³
Sawn Lake Monthly Water / Steam Totals

[Bar chart showing monthly totals for Fresh Wtr, Disposal, and Steam from May 14 to Sept 15]
Disposal Well approved (D51) for Maximum Wellhead Injection Pressure of 7000kPag; no issues with wellhead injection pressures typically less than 500kPag.
Sulphur Production and Environmental
Sulphur Production

Sawn Lake Daily Sulphur Production (tpd); Monthly Average

Subsection 3.1.2(5a)
SO2 Production

SO2 Emissions: no exceedances of EPEA Approval Limit.
Regulatory Summary

**Emissions**
- No exceedances on NO₂, SO₂, H₂S

**Soil and Groundwater Monitoring**
- Soil monitoring program on-going; samples taken 2015.

**Spills and Clean Up**
- October 5, 2015: Andora reported an onsite disposal (produced) water spill – 5m³. Area remediated and confirmed via third party; berm reinforced as requested.

**Reclamation Programs**
- No reclamation programs in 2014/2015
The groundwater monitoring program has been designed to monitor for potential impacts to roundwater quality due to operations at the central processing facility (CPF) and thermal-related effects to non-saline potential domestic use aquifers. The program was developed in consideration of the existing draft Alberta Environment and Sustainable Resource Development Groundwater Monitoring Directive (ESRD 2012).

On March 9, 2015 a deficiency letter was received by Andora Energy from the AER noting that “The thermal effects groundwater monitoring program must include groundwater monitoring wells completed within the deeper non-saline aquifers beneath the site. There are nearby water wells completed within sand and gravel aquifers at approximately 25 mbgl and 150 mbgl that must be protected. Confirm that Andora Energy will install groundwater monitoring wells within these aquifers and provide proposed locations and completion intervals on maps and cross-sections.”

Letter sent to AER April 2015 that nearby wellcores show no deeper intervals; May 28, 2015 AER noted that they wanted confirmation no Dunvegan or Wapiti at 7-30-91-12W5.

September/October 2015 – Andora Drilled ground water test hole to 149.5m and drilled and completed 11 proposed shallow ground water wells at 7-30-91-12W5. Shallow Wells complete.

Hole drilled; no apparent aquifers within the bedrock from cuttings return and drilling response; confirmed by geophysical logging; there are no apparent deep aquifers, just the shallow sand already noted above bedrock roughly around the 17-20m mark.

Compiling and will submit information to the AER and document baseline measurements.
**Low Risk Noncompliance**

- Inactive IWCP (core wells) suspended without downhole isolation per D13
- **Remedial Action:** Will bring 1 noncompliant inactive well into compliance per year; wells to be used as future in-field and/or observation wells.

Outside of the above to the best of our knowledge, the Andora Sawn Lake Single Wellpair SAGD Project is currently in compliance with all conditions of its approvals and associated regulatory requirements.
Future Plans
## Regulatory

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### 2U/2LWELLPAIR
Addition to Existing Site

- **ADD x 4 WELLPAIRS AT NEW 8-30 LEASE**
  - **[+1600bopd to 3200bopd]**

  - **Approach:** Feed
  - **Approval Period:**
  - **AER Approval**
  - **AER Submission**

### PRODUCED WATER BOIL PILOT AND TRIAL

- **ADD x 2 WELLPAIR TO EXISTING SITE**
  - **[+800bopd to 1600bopd]**

  - **AER Approval**
  - **AER Submission**

### 87
Patent

- Canadian patent issued (2015-06-16) for Produced Water Boiler (PWB) technology enabling steam generation from SAGD produced water meeting regulatory water recycle requirements on a per well pair scale enabling lower capital SAGD project expansions with mitigated capital requirements and risk.

Background

- Economics of scale surrounding traditional SAGD water recycle technologies have generally required large capital investments to achieve adequate capital intensities. These large scale projects are inflexible once initiated and are susceptible to severe cost overruns.

Application

- Produced Water Boiler (PWB) technology allows for low capital intensities at a smaller scale (1000bopd+, $70MM+) Well pair scaled expansions allow for conversion of pilot facilities to commercial pods that meet regulatory requirements, enable modularization of facilities to reduce costs and optimise well pair placement.

- Under development project agreement Andora could test Andora technology at Sawn Lake Demonstration Project.

- Elimination of steam/emulsion transmission lines, heat efficiencies when coupled with High Temperature Separation, mitigation of OTSG tube rupture risks result in increased environmental and energy performance on a smaller footprint.
Conceptual Regulatory Application

Application Includes:

- Use of existing oil/water production facility (3200bopd), natural gas line, disposal well and in field well.
- Six (6) additional wellpairs for a total of eight (8) SAGD wellpairs
- Six (6) Produced Water Boilers (PWB), Vapor-Recovery-Unit (VRU)
- Additional back up source water well at 8-30-91-12W5.
Conceptual Project Overview

3200bopd Battery with Bitumen O/W Separation
Wellpairs #1-#4, 700kW power, VRU, Tank Farm x 3 PWB/OTSG

Wellpairs #5-#8, 700kW power
8-30 Backup Water Well x 4 PWB

Source Water Well

TCPL Nat Gas Meter Station

Disposal Well
Conceptual Battery Expansion

- Wellpairs #5-#8
- Produced Water Boilers + Power
- Back Up Water Well
- Wellpairs #1-#2
- Wellpairs #3-#4
- 3200bopd oil/water Battery c/w Power, VRU
- Steam Generation OTSG, PWBs
- Tank Farm
Pre-invested Emulsion Treating Equipment

3200bopd Production Building
Dover AOSTRA/Devon/Suncor inlet facility equipment. Flash Treater in building; requires hookup.

Injector 1U
Producer 1L
MCC

BFW/PW Exchangers in place, ready for installation

Water Treatment/Steam Generation
PWB Boiler Test Plot Space

IGF Ready to Be Refurbished and Installed

HP/LP Flare
• Current plans to export by truck to Shell Peace River and Murphy batteries along Rainbow Pipeline (Plains Nipisi unable to blend)

• At 3200bopd can existing Keyera crude / Penn West facilities be used to blend closer to facility and at less cost?

• Synergies with respect to power / diluent / fuel gas still to be investigated.
Andora Energy Corporation
Suite 1505, 505 -3rd Street S.W
Calgary Alberta
T2P 3E6

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Vice President, Operations
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p: 4032941770 ext230