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1 Introduction and Sawn Lake Single Wellpair SAGD Demonstration Project Overview

2 Geology / Geoscience
   - Subsection 3.1.1 (2) Geology and Geophysics

3 Drilling and Completions
   - Subsection 3.1.1 (3) Drilling and Completions
   - Subsection 3.1.1 (4) Artificial Lift
   - Subsection 3.1.1 (5) Instrumentation In Wells

4 Scheme Performance - Subsurface
   - Subsection 3.1.1 (7) Scheme Performance

5 Future Plans - Subsurface
   - Subsection 3.1.1 (8) Future Plans
Agenda (Surface Operations)

- **6 Facilities**
  - Subsection 3.1.2 (1) Facilities
  - Subsection 3.1.2 (2) Facility Performance

- **7 Measurement and Reporting**
  - Subsection 3.1.2 (3) Measurement and Reporting

- **8 Water Source and Disposal**
  - Subsection 3.1.2 (4) Water Production, Injection and Use

- **9 Environmental**
  - Subsection 3.1.2 (5) Sulphur Production
  - Subsection 3.1.2 (6) Environmental Issues

- **10 Compliance Statement**
  - Subsection 3.1.2 (7/8) Compliance

- **11 Future Plans - Facilities**
  - Subsection 3.1.2 (9) Future Plans
Introduction and Overview
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>SAGD Project Location</th>
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(Gross 100%)  | SAGD Contingent Resource Estimate (MMbbl) |
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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
Using Steam Assisted Gravity Drainage (SAGD) to recover bitumen from the Bluesky formation.

10 degree subcool based on the lesser of:
- Reservoir Subcool
- Toe Subcool
- Heel Subcool

Heel subcool was the dominant well control mechanism.

Future use Echo meter for additional subcool control.
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
Sawn Lake – Geological Setting

Peace River Region – Oil Sands Deposits & Major Projects

Peace River Region – Oil Sands Geological Schematic Cross Section

Pre-Cretaceous Unconformity
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 H20

Wabamun

02/02-32-091-12W5/0
KE: 795.4 m  RR: 2006.08.30
TD: 743.0 m [TVD]  FormTD: WBMN
Mode: Abb Whp  Fluid: N/A
1AL ET AL HZ SAWN LK 11-32-91-12
Sawn Lake - Bluesky Net Pay

T92N-R13W  T92N-R12W
T91N-R13W  T91N-R12W

Sawn Lake Reference Well

SAGD Project Location

Detail Area

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

SAGD Demonstration Site
Sawn Lake – Regional Cross Section NW-SE

➢ Thick continuous Oil Sands Reservoir within the “Paleo Valley”

15 Kms

NW

SE
Sawn Lake – Base Bluesky Structure

- T92N-R13W
- T92N-R12W
- T91N-R13W
- T91N-R12W

- Sawn Lake Reference Well
- SAGD Project Location

Detail Area
Sawn Lake – Base Bluesky Structure (Detail)

16-30 SAGD Well Pair Path

Sawn Lake Reference Well
Sawn Lake – Top Bluesky Pay Structure
Sawn Lake – Top Bluesky Structure
Sawn Lake - Bluesky Net Pay

- Proposed SAGD Well Pair Path
- Sawn Lake SAGD Project Cross Section

Net Pay
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 $K_h = 4.3D$
  Average $K_v = 3.6D$

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 ~2280kPag 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

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

- Paddy / Cadotte Aquifer, 420 mKb
- Fresh Water, ~ 3600 ppm
Sawn Lake – Surface Operations

- Water Disposal Well 15-21-91-12W5

- 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

- WELL NAME: UW:
  - 777.5m ASL
- SURFACE HOLE: 444.5 mm
  - SURFACE CASING: 210 mmKB
  - 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 CEMENT
- LONG STRING: LANDING @ 1537 mKB
  - SIZE: 114.3 mm, 15.63 kg/m, J55 TKC 4040 HUNTING
- KOP: 493 mMD
  - DLS: 7 deg/30m
- TD: 125 mASL, 652.5 mTVD/ 1638 mMD
  - LATERAL HOLE: 222.0 mm
  - SLOTTED LINER: LANDING @ 1628 m/UNER HANGER @ 830 mMD
  - SIZE: 177.8 mm, 34.23 kg/m, L80 TENARIS BLUE LINER
- SHORT STRING: LANDING @ 817.7 mKB
  - SIZE: 177.8 mm, 34.23 kg/m, L80 TENARIS BLUE LINER

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

- WELL HISTORY
  - DATE
  - REMARKS

- AS SHEET SCALE: 1" = 500' 07
- NTS: 1" = 500' 07
- SAWN LAKE SAGD PILOT

- JLC engineering ltd.

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

- AN1051

- DRG No
  - AN1051-4-STD-050-00

- REV
Drilling and Completions – Producer (Circ)

WELL NAME:

Surface Hole: 508 mm
Surface Casing: 210 mkB
Size: 406.4mm, 81.10 kg/m J55

Intermediate Hole: 374.65 mm
Intermediate Casing: 652.5 mTVD/819.7mMD
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

KOP: 493 mMD
DLS: 7 deg/30m

777.5m ASL

TD: 125 mASL, 652.5 mTVD/1636 mMD

Lateral Hole: 222.0 mm
Slotted Liner: Landing @ 1526 w/ Liner Hanger @ 839.0 mMD
Size: 177.8 mm, 34.23 kg/m, L80

Short String: Landing @ 817.7 mkB
Size: 114.3 mm, 13.69 kg/m, L80
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.
- Future consideration; using Echometer to see fluid level for more aggressive subcool operation
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
Operations Timeline (Continued)

May 11 – May 29 2015
Loss of ESP; ESP replacement

August 11 – August 15 2015
Boiler Inspection

September – December 2015
Avg steam for 209tpd
Avg Production 615bopd
Avg SOR 2.13

March 1, 2016
Steam to SAGD wellpair discontinued; ESP shut down.

March 1 – April 1, 2016
Plant and P/Ls under nitrogen purge;
Heat to MCC
HMI/PLCs removed

April 1, 2016
Site suspended and dark.
Performance Data (Month Cal. Day Avg)

To Sept 30 2015

- Low Steam Optimization
- High Steam Optimization
- OTSG Inspection/MARP calibration
- ESP Replacement
- ESP Install/SAGD Mode
Pilot Production; Steam (Wk Avg)
BH Pressures – Step Changes

Estimated Caprock plateau
Reservoir stabilizes than slight depressurization at constant steam

High Steam Trial
Operations attempts to re-pressurize; able to reach 400tpd steam injection without exceeding 2800kPag. Ops Holds for a month to determine if steam is productive.

Low Steam Trials
Operations lowers steam injection in step changes until producer at base reservoir pressure and experiences production boost

Operation of well within 500kPa of base reservoir pressure at all steam injection rates.
Pilot Production; Steam (Daily)
GOR low 2-4 vs. expected 8.
Production, iSOR, cSOR
Sawn Lake Steam Injection and Production - SAGD mode

Cumulative Production m³

Recovered Bitumen (%)
Conformance

September 2014

March 2015
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**
Wellpair 1U/1L performed as expected until reaching plateau where three dissonances with early models were evident:

- The upper reservoir is somehow more permeable than believed that operations was able to inject 400tpd steam without pressuring up the reservoir and that this team somehow displaces bitumen and water production.
- When the producer is at base reservoir pressure (at 210tpd steam injection) production is boosted and the iSOR lowers to 2.2.
- For some reason after shut downs the displaced emulsion does not all flow to the producer (i.e. the displaced bitumen did not flow back on shut downs).

History matching to model for accounting of these three production trends has been best done through adding a highly permeable thief zone near the caprock at the paleogas cap with high compressibility. When downhole pressure is above base reservoir dilation occurs and emulsion is displaced. When downhole pressure is at base reservoir pressure dialation does not occur and displaced emulsion does not flow to the producer. Modelling on-going, currently showing High recovery (70-75%) expected with lower pressures, cSOR of 2.7 at 2030.
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
Surface and Facilities
Sawn Lake SAGD Facility
Project Overview – Facility Plot Plan
Block Flow Diagram
Facility Performance

**Facility Overview:**

- Oil/Water Separation train 3200bopd AOSTRA/Devon/Suncor facility relocated to Sawn. No condensate on site.
- New Conventional SAC/OTSG
- Refurbished natgas gensets for power

**Key Learnings:**

- High Temperature Separator; effective with proper chemical program; making on-spec (less than 0.5% BS&W oil).
- Pressure; Only need 3000kPag steam for injector; 600ANSI design at wellhead.
- Hot Bitumen Trucking; effective up to 6 hours. Facility exporting to Bitutainers could extend range
- Roads – gravel ineffective without geoweb.
- Operations – Multi disciplined team.; 10 operators 14 on/14 off [3 days, 2 nights]; Alpha and Omega shift. Effective; could operate larger battery. No condensate reduced environmental and safety risks.
Learnings – Bitumen Export

**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 was exporting to Murphy 1-26; battery shut down early 2016.

- 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
- 50MMBTU/hr OTSG is good for x 2 SAGD wellpairs.
- 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. Issues resolved in Jan 2016.

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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<td>6.4</td>
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<tr>
<td>Mar-16</td>
<td>77.5</td>
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### Facility Performance – Greenhouse Gas Emissions

#### GREENHOUSE GAS EMISSIONS - SAWN LAKE (May 2014 to March 2016)

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<tr>
<th>Month</th>
<th>CO2 (tonnes)</th>
<th>N2O (tonnes)</th>
<th>CO2e (tonnes)</th>
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Measurement and Reporting
MARP Approved – October 23, 2013

MARP Calibrations on-going; 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 16-20-91-12W5
  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
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
SO2 Production

Sawn Lake Daily SO2 Production (tpd); Monthly Average

SO2 Emissions: no exceedances of EPEA Approval Limit.
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
Ground Water Monitoring Program

- The groundwater monitoring program has been designed to monitor for potential impacts to groundwater 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.
IWCP – Low Risk Non-Compliance

- 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. 02/15-21 core was to be suspended per D13 however 01/15-21 came up on the list (old well, converted to source). Andora is in communication with AER through Crest Consultants to fix this list and then will suspend 02/15-21 in 2016. Also 07/30 on the IWCP list is an observation well, attempting to have removed from list.

- Wish to suspend wells with service rig to do late 2016/early 2017 core well to north.
2015 Site Inspection

Detailed site inspection Dec 10, 2015 which went through the entire Sawn Lake operation. Action items noted as follows:

**P/L Corrosion Monitoring and Mitigation – High Risk Non Compliance**

**Concern:** Field did not have copies of pipeline cathodic assays required within 1 year of operating P/L per CSA. Disposal line is Fiberspar (no cathodic protection required), fresh water and natural gas lines however are protected by anodes. NG line also set up to receive cathodic protection from TCPL station.

**Mitigation:** The Andora P/L Operations manual requires annual corrosion reviews. Andora has scheduled corrosion assays to occur Jan of every year. Jan 2016 assay found additional anodes on fresh water line required; these were installed Feb 2016. NG line shown to be protected. Copies of the cathodic protection assays are to be available on-side when the plant is in operation.

**Outstanding:** AER inspectors wish for Andora to confirm anodes can provide good protection in lieu of TCPL CA system; Andora to install isolation kit for next testing and confirm anode adequacy. Andora wishes to then remove the isolation kit to ensure double protection is provided.

**Ground Water Pump-Off Tests**

**Concern:** Rain water pump off testing done by ops on-site lab with Baker, not third party ISO accredited lab. ISO laboratory must be used,

**Mitigation:** All samples now sent to third party (Corelab) for analysis; validating on-site lab.
P/L Right of Way Surveillance – High Risk Non Compliance

**Concern:** No formal documentation regarding P/L RoW inspections in field.

**Mitigation:** Andora P/L operations manual mandates a pipeline patrol per CSA every 14 days (shift) and a formal annual inspection. These pipeline patrols however had no documentation noting that the RoW patrol had taken place. Andora now has added a formal sign off that a P/L RoW patrol has taken place every shift with the operators name and time of inspection noted on the operator round sheets.

Source/Disposal Water Casing Vent within Shed – Low Risk Non Compliance

**Concern:** 15-21 disposal and 16-20 source well casing vents open but within shed; casing vents must be open to atmosphere.

**Mitigation:** In January 2016 Andora added extensions to the casing vents that they now vent outside of the well sheds.

Source/Disposal Signage at entrance of well pad – Low Risk Non Compliance

**Concern:** 15-21 disposal and 16-20 source well had a sign on the road to the wells but not at the wellpads

**Mitigation:** Signs placed at entrance to wellpads.
Future Plans
### Regulatory

| Year | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
|------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 2015 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 2016 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 2017 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 2018 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 2019 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 2020 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

**2U/2LWELLPAIR ADDITION TO EXISTING SITE**

[+400bopd to 800bopd]

- AER Approval

**PRODUCED WATER BOIL PILOT AND TRIAL**

- AER approval
  - AER submission

**ADD x2 WELLPAIR TO EXISTING SITE**

[+800bopd to 1600bopd]

**ADD x 4 WELLPAIRS AT NEW 8-30 LEASE**

[+1600bopd to 3200bopd]

- FEED
- Approval Period
- AER submission
- AER approval
490m3/d Regulatory Application

Application Includes:

- Use of existing oil/water production facility (3200bopd), natural gas line, disposal well and in field well.

- Three (3) additional wellpairs for a total of five (5) operating SAGD wellpairs. Design work for up to 8 SAGD wellpairs is presented (was prepared prior to pilot results); 6U/6L backup for 1U/1L; 7 and 8 moved to sustaining wellpairs.

- Three (3) Produced Water Boilers (PWB), Vapor-Recovery-Unit (VRU)

- Additional back up source water well at 8-30-91-12W5.
490m³/d Regulatory Application Wellpairs

- Existing 1U/1L Wellpair
- Approved 2U/2L Wellpair
- Applied for 3U/3L, 4U/4L, 5U/5L
- 6U/6L Sustaining 1U1L Replacement
- Future Sustaining 7U/7L; 8U/8L
- 0/7-30; Obs Well

Well Spacing – 100m
490m3/d Regulatory Application Wellpairs

D56 Survey Wellpairs 3U/3L and 4U/4L

D56 Survey Wellpairs 5U/5L, 6U/6L, 7U/7L, 8U/8L
490m³/d Project Overview

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

Wellpairs #5 (Future #6-#8),
1000kW power
8-30 Backup Water Well
x 4 PWB

Source Water Well

TCPL Nat Gas Meter Station

Disposal Well
490m³/d Battery Expansion

Minimized Footprint using existing 7-30-91-12W5 and 8-30-91-12W5 Site
Conceptual Battery Expansion

Wellpairs #5-#8 Note Welpairs #6-#8 are future/sustaining

Tank Farm

Steam Generation OTSG, x 1PWB

3200bopd oil/water Battery c/w Power, VRU

X2 Produced Water Boilers + Power

Back Up Water Well

Wellpairs #3-#4

Wellpairs #1-#2
Battery Expansion

Dev MSL
(Not on C-8-3)
Andora PWB Technology

- Produced Water Boiler a patented improvement on the an older boiler process. Unit can fire on oilfield produced water, brackish water, sea water or fresh water greatly simplifying SAGD plant strategies while meeting AER D81 water recycle requirements. Allows D81 PW recycle at small scale; combines boiler function with water treatment function in a single 30 or 50 MMBTU/hr package.

- Lower pressure steam at the wellheads; eliminate steam transmission lines/pressures.

- Based on commercially available units in 60-70s; patented improvements by Andora for sustained operation based on lessons learned and current technologies.

### TYPICAL RANGE OF FEEDWATERS *

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<th>Constituent</th>
<th>Parts per Million (mg/L)</th>
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<td>Total Oil</td>
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<tr>
<td>Total Dissolved Solids (TDS)</td>
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<td>Total Hardness (Ca+Mg)</td>
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<td>Silica (SiO2)</td>
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<td>Sulfate (SO4)</td>
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<tr>
<td>Suspended Matter (Turbidity)</td>
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* Figures used are not necessarily the maximum values that the PWB can handle

- Lower capital intensity
- Lower footprint and better energy efficiency
- No Tube Ruptures
- Smaller scale; can target better pay
- Risk Mitigation
Water Balance and MARP Notes:

- The Expansion Project will utilize high efficiency water treating technology described previously, which will convert more than 92% of the fed produced water to 100% quality steam.

- All cases where the WSR is less than 1.1 the existing facility meets D81.

- In the event the WSR is greater than 1.1 even if 100% of the produced water was converted to 100% quality steam D-81 calculated allowed limits cannot be achieved as excess produced water would need to be disposed of. A WSR of 1.2 was achieved by the Sawn Lake 1U/1L wellpair in January and February 2016. This case is noted in the application to ensure the AER is aware and approves of facility operation with WSR above 1.1 given that 93%+ of the produced water is converted to 100% quality steam, no make up water would be required and the existing SAC/OTSG steam generation train would be shut down (all steam would be from the PWBs).

- Preliminary MARP diagrams included; wellhead emulsion proration based on flows and water cut test heater, produced gas proration based on orifice meters at wellheads. Export volumes and accumulation used for ultimate production values.
Battery Expansion
Pre-invested Emulsion Treating Equipment

- 3200bopd Production Building Dover AOSTRA/Devon/Suncor inlet facility equipment. Flash Treater in building; requires hookup.
- Water Treatment/Steam Generation
- Injector 1U
- Producer 1L
- BFW/PW Exchangers in place, ready for installation
- MCC
- PWB Boiler Test Plot Space
- IGF Ready to Be Refurbished and Installed
- 3200bopd Production Building Dover AOSTRA/Devon/Suncor inlet facility equipment. Flash Treater in building; requires hookup.
- HP/LP Flare
• Current plans to export by truck to Shell Peace River and Murphy batteries along Rainbow Pipeline (Plains Nipisi unable to blend)

• Exploring utilizing Keyera crude / Mount Bastion Oil and Gas facilities to blend closer to facility and at less cost.

• Andora Sawn Lake is “bitutainer” export ready; ISO rated containers capable of transporting on-spec (less than 0.05%BS&W); bitumen can be re-heated with internal coils at destination (steam or thermal oil).
Andora Energy Corporation
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Calgary Alberta
T2P 3E6

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