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Background – Primary Development

- Primary scheme development began in 2004 under Approval No. 11060
- The Harmon Valley South (HVS) Primary field has 18 primary wells operating on 8 wellpads
- Currently there are 30 wells within 1,000m of the HVS Pilot Project, both primary producing and stratigraphic wells
<table>
<thead>
<tr>
<th>Approval 11895</th>
<th>21-Sep-12</th>
<th>Original Pilot Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approval 11895A</td>
<td>28-Nov-12</td>
<td>Revised bottomhole location for pilot wells</td>
</tr>
<tr>
<td>AUC Approval for Pilot Power Plant</td>
<td>3-Oct-12</td>
<td>AUC Approval received</td>
</tr>
<tr>
<td>Approval 11895B</td>
<td>3-Mar-14</td>
<td>Increase maximum bottomhole operating pressure from 14,500 kPag to 21,500 kPag and light hydrocarbon circulation prior to steam injection</td>
</tr>
<tr>
<td>Approval 11895C</td>
<td>11-Aug-14</td>
<td>Increase steam injection volume above 14,500 kPag from 2,500 m³ to 12,500 m³ and reduction in maximum bottomhole injection pressure from 21,500 kPag to 20,000 kPag</td>
</tr>
</tbody>
</table>
Background – Pilot Objectives

- A three well HCSS project in the Bluesky Formation
- 80% quality steam injected at the heel of the well
- Inject steam at a target rate of 500 m$^3$/d CWE
- Evaluate technology in various reservoir conditions:
  - Well 100/07-36: Tight, viscous conditions
  - Well 102/15-06: High water saturation
  - Well 103/14-06: High permeability
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Geology – Bluesky Formation Overview

- Series of north/south oriented, stacked tidal distributary channels
- Fine to medium grained litharenite
- Average depth is 675m TVD
- Thickness up to 26m
- Porosities from 24% to 30% (Avg 25%)
- Permeability from 450 to 4,200 mD
- Oil Saturation from 55% to 85% (Avg 76%)
- API Gravities of 8.7 to 9.8 API at 15.6°C
- Viscosities from 11,000 to 300,000 cSt at 20°C
Geology – Thermal Pilot Location

- **Pilot HCSS Wells**
  - 100/07-36-082-18W5
  - 102/15-06-083-17W5
  - 103/14-06-083-17W5

- **Observation Wells**
  - 100/10-06-083-17W5
  - 100/15-06-083-17W5
  - 102/14-06-083-17W5
  - 100/15-36-082-18W5
  - 100/02-06-083-17W5
  - 100/11-06-083-17W5
Geology – 3D Seismic

- 3D-HVS09 (North)
  - Shot in January 2009
  - Processed in January 2009

- 3D-HVS (South)
  - Shot in March 2008
  - Processed in March 2008
Geology – Bluesky Top Structure Map
Geology – Bluesky Base Structure Map
Geology – Net Pay Map
Geology – Structural Cross-Section
Geology – Structural Cross-Section
102/15-06-083-17W5
Geology - Cored Wells

- Cored Wells
- CSS Thermal Well
Geology – Core Photos

PENN WEST ENERGY INC.
PENN WEST WALRUS 00/10-06-083-17 W5M/0
Core #1
Top 684.09 m
Bottom 688.59 m

PENN WEST ENERGY INC.
PENN WEST WALRUS 00/15-06-083-17 W5M/0
Core #2
Top 685.96 m
Bottom 689.59 m
### Geology – Average Reservoir Properties (Pilot)

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net pay (m)</td>
<td>14.7</td>
</tr>
<tr>
<td>Area (ha)</td>
<td>184</td>
</tr>
<tr>
<td>Porosity (%)</td>
<td>27</td>
</tr>
<tr>
<td>Water Saturation (%)</td>
<td>24</td>
</tr>
<tr>
<td>Formation Temperature (°C)</td>
<td>22</td>
</tr>
<tr>
<td>Formation Pressure (kPa)</td>
<td>4,800</td>
</tr>
<tr>
<td>Viscosity (cSt at 20°C)</td>
<td>30,000</td>
</tr>
<tr>
<td>Average Hz Permeability (mD)</td>
<td>1,500</td>
</tr>
<tr>
<td>Formation Volume Factor</td>
<td>1.02</td>
</tr>
<tr>
<td>OBIP (e³m³)*</td>
<td>5,441</td>
</tr>
</tbody>
</table>

*Based on the pilot project area*
Geology – Fracture Pressure

- In 2011, a mini-frac test was conducted in 100/03-06-083-17W5
- Penn West performed two new MDT mini-frac tests to determine the closure stress in the Wilrich and Bluesky Formations:
  - Wilrich Fm depth of 672m MD
  - Bluesky Fm depth of 698m MD
- After processing the data, the following gradients are calculated:

<table>
<thead>
<tr>
<th>Zone</th>
<th>Depth (m) (MD)</th>
<th>Min Stress (kPa)</th>
<th>Gradient (kPa/m)</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wilrich</td>
<td>672</td>
<td>16,000</td>
<td>23.8</td>
<td>horizontal</td>
</tr>
<tr>
<td>Bluesky</td>
<td>698</td>
<td>12,600</td>
<td>18.1</td>
<td>vertical</td>
</tr>
</tbody>
</table>

- The MOP granted by the AER for the pilot is 20MPa (29.8 kPa / m)
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- 60.3mm guide string to the toe
- 38.1mm coil tubing thermocouple instrumentation line inside the guide string
- 114.3mm injection and production string landed at the heel
- Bubble tube strapped to the guide string

**Drilling and Completions – Wellbore Design**

**Surface Casing:**
339.7 mm, 81.10 kg/m, J-55, ST&C

**Injection/Production String:**
114.3 mm, 18.97 kg/m, L-80 Hydril 503

**Guide String:**
60.3 mm, 6.99 kg/m, L-80 Hydril 503

**Production Casing:**
244.5 mm, 59.53 kg/m, L-80, Hydril 563

**Bubble tube** strapped to guide string.

**CT Instrumentation String:**
38.1 mm coil tubing

**Liner Hanger:**

**Reciprocating Rod Pump:**

**Slotted Liner:**
177.8 mm, 34.23 kg/m, L-80 Hydril 563

**Cement to surface**

**Thermal cement to surface**

**ICP**
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Artificial Lift

- 3.25” insert rod pumps run on all three wells initially
- Due to low reservoir temperatures in Well 103/14-06 following steam cycle 1, pump could not produce the viscous oil
  - Weatherford 56-1500 Insert PCP run in May 2014 to enable continued production
  - Intend to return to rod pump following second steam cycle on Well 103/14-06
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Well Instrumentation – HCSS Wells

- Multiple thermocouples to monitor temperature from wellhead to the toe of the well (1,600 – 1,800m MD)
- Heel pressure measurement via bubble tube strapped to the 60.3mm guide string
- Toe pressure measurement via bubble tube in instrumentation coil
- Ability to perform N₂ purge from surface
Well Instrumentation – Observation Wells

- Five observation wells to measure reservoir response at various locations along the horizontal lengths of the wells
- Real-time pressure and temperature monitoring via thermocouples and single point pressure gauges spaced in the reservoir
- Permanent passive micro-seismic monitoring from 2 observation wells to monitor casing and caprock integrity
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4D Seismic

- No current plans to conduct 4D Seismic at HVS
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Scheme Performance – Well 100/07-36

Produced Oil
Produced Water
Total Steam
Total cSOR

Well shut-in due to rod hang-up. Awaiting next steam cycle.
Scheme Performance – Well 100/07-36

Wellhead Pressure, kPa
Heel Pressure, kPa
Toe Pressure, kPa
Scheme Performance – Well 100/07-36

Temperature, degC

- 489mKB
- 944mKB
- 1047mKB
- 1092mKB

01-Jun-14 11-Jun-14 21-Jun-14 01-Jul-14 11-Jul-14 21-Jul-14
Scheme Performance – Well 100/07-36

100/02-06-083-17W5

100/15-36-082-18W5

Formation Depth, mKB

Temperature, degC

685
690
695
700
705
710
715

20 22 24 26 28 30

3-Jun 10-Jun 14-Jun 30-Jun

3-Jun 10-Jun 14-Jun 30-Jun
Well shut-in due to rod hang-up.
Repairs completed on steam plant prior to commencing next steam cycle.
Scheme Performance – Well 102/15-06
Bottomhole Conditions

Wellhead Pressure, kPa
Heel Pressure, kPa
Toe Pressure, kPa

01-May-14 20-Jun-14 09-Aug-14 28-Sep-14 17-Nov-14
Scheme Performance – Well 102/15-06
Bottomhole Conditions

Temperature, degC

Temperature, degC vs Time

- 450mKB
- 752mKB
- 785mKB
- 832mKB
- 879mKB
- 923mKB
- 973mKB
- 1,020mKB
- 1,068mKB
- 1,115mKB
- 1,162mKB
- 1,209mKB
- 1,256mKB
- 1,293mKB
- 1,350mKB
- 1,397mKB
- 1,444mKB
- 1,491mKB
- 1,538mKB
- 1,585mKB

Time:
- 18-Sep-14
- 28-Sep-14
- 08-Oct-14
- 18-Oct-14
- 28-Oct-14
- 07-Nov-14
- 17-Nov-14
Scheme Performance – Well 102/15-06
Bottomhole Conditions

Temperature, degC vs. Measured Depth of Thermocouple, mKB

- Cycle 1
- Cycle 2
Scheme Performance – Well 102/15-06

**100/10-06-083-17W5**

- 5-May
- 18-May
- 26-Aug
- 18-Sep
- 23-Nov
- 31-Dec

**Formation Depth, mKB**

- 670
- 680
- 690
- 700
- 710

**Temperature, degC**

- 20
- 25
- 30
- 35
- 40
- 45
- 50

**100/15-06-083-17W5**

- 5-May
- 18-May
- 26-Aug
- 18-Sep
- 23-Nov
- 31-Dec

**Formation Depth, mKB**

- 670
- 680
- 690
- 700
- 710

**Temperature, degC**

- 0
- 20
- 40
- 60
- 80
- 100
- 120
Scheme Performance – Well 103/14-06

Produced Oil
Produced Water
Total Steam
Total cSOR

Well shut-in awaiting next steam cycle.
Scheme Performance – Well 103/14-06

**100/11-06-083-17W5**
- 3-Mar
- 15-Mar
- 30-Mar
- 8-Apr
- 1-Sep
- 14-Dec
- 31-Dec

**102/14-06-083-17W5**
- 3-Mar
- 15-Mar
- 30-Mar
- 8-Apr
- 1-Sep
- 14-Dec
- 31-Dec
Scheme Performance – Steam Injection

- Steam Pressure, MPa
- Steam Quality, %
- Steam Rate, m3/d
- Steam Temperature, degC

Graph shows variations in steam pressure, quality, rate, and temperature from 01-Dec-13 to 16-Nov-14.
- Offsetting primary wells are thermally compatible.
- To date, Penn West has not identified any communication between the thermal wells and the offsetting primary wells.
- Temperature of the produced fluids is monitored to identify any potential steam migration, and will be shut in if temperatures show a significant increase.
### Scheme Performance – Recovery Factor

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cycle 1 Production, m³</strong></td>
<td>2,067</td>
</tr>
<tr>
<td><strong>Cycle 2 Production to Date, m³</strong></td>
<td>1,335</td>
</tr>
<tr>
<td><strong>Total Production to Date, m³</strong></td>
<td>3,402</td>
</tr>
<tr>
<td><strong>OBIP, m³</strong></td>
<td>5,441,000</td>
</tr>
<tr>
<td><strong>Current Recovery, %</strong></td>
<td>0.1%</td>
</tr>
<tr>
<td><em><em>Estimated Ultimate Recovery</em>, %</em>*</td>
<td>3%</td>
</tr>
</tbody>
</table>

*Estimated Ultimate Recovery is low due to the large project area defined. Typical primary recovery in this area is 5%.
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Future Plans

- Complete second steam cycle on Well 103/14-06 in Q1 2014
- Begin second steam cycle on Well 100/07-36
- Evaluate second production cycles on all three pilot wells to determine third steam cycle schedule
- With the increased injection volumes, Penn West is still early in the evaluation phase of pilot results and the technology’s application in the specific reservoir conditions
- Continuously evaluating project economics in light of current market conditions
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Facilities – Pilot Plot Plan
Facilities - Modifications

- Pilot plant facility construction completed in Q4 2013 with the following major equipment:
  - 14.65 MW OTSG
  - Water Treatment Package
  - Water Tank Farm
  - Produced Fluids Tank Farm
  - MCC / Instrument Air Building
  - Diesel and Natural Gas Generators
  - Glycol System
  - HP/LP Flare
  - Three HCSS wells with electrically powered pump jacks
Facilities - Modifications

- Drilled one horizontal source water well (14-25-082-18W5) and one vertical source water well (16-36-082-18W5) and connected to the facility via pipeline in Q3 2013

- Constructed 8” 23.4km fuel gas pipeline from TransCanada 05-09-085-17W5 to pilot facility

- Constructed telecommunications infrastructure in Q3 2013 including tower, microwave and radio equipment and UPS
Facility Performance

- **Bitumen Treatment:**
  - Successfully produced sales spec oil with existing facility
  - Each production well is tied into common header/production system

- **Steam Generation:**
  - OTSG capacity 14.65MW and 80% steam quality
  - Design to steam one well at a time
  - Have not run the OTSG consistently at full capacity and steam quality due to injectivity constraints caused by the reservoir conditions
Other Equipment:

- Genset Packages: installed diesel and natural gas generators. Downtime for various reasons, such as overcurrent trips, cooked wires, detonation problems, fan failure, VFD faults.

- Glycol Heaters: Downtime caused by variety of reasons, such as overloads, coolant leaks, cooked VFD, VFD faults.

- The fuel gas lines were mostly installed without insulation or heat tracing – moisture in lines caused variety of problems and equipment trips.
Facility Performance

- Radar level transmitters in produced fluids tanks failed to provide correct tank level feedback. Tank level gauges installed instead.

- Significant work required to swing well from steaming to production service. In future, use spectacle blinds instead of removable spools in places where possible.

- The flare knock-out drum was not fitted with separate liquid transfer pump. The vacuum truck is used as a solution. Operating costs should be considered when looking into decisions aimed at capital savings.
Harmon Valley South Thermal Pilot operates using an natural gas generator with a diesel generator as back-up.
## Facility Performance – Fuel Use

<table>
<thead>
<tr>
<th>Month</th>
<th>Purchased Gas</th>
<th>Vent Gas</th>
<th>Flare Gas</th>
<th>Produced Gas</th>
<th>Produced Gas Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>e³m³</td>
<td>e³m³</td>
<td>e³m³</td>
<td>e³m³</td>
<td>%</td>
</tr>
<tr>
<td>Jul-13</td>
<td>22.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Aug-13</td>
<td>206.4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Sep-13</td>
<td>186.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Oct-13</td>
<td>239.9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Nov-13</td>
<td>304.7</td>
<td>0</td>
<td>18.1</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Dec-13</td>
<td>639.5</td>
<td>0</td>
<td>6.2</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Jan-14</td>
<td>389.6</td>
<td>0</td>
<td>6.2</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Feb-14</td>
<td>277.3</td>
<td>0</td>
<td>6.2</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Mar-14</td>
<td>280.6</td>
<td>0</td>
<td>6.2</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Apr-14</td>
<td>210.9</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>May-14</td>
<td>261.2</td>
<td>0</td>
<td>6.9</td>
<td>0.1</td>
<td>0%</td>
</tr>
<tr>
<td>Jun-14</td>
<td>293.7</td>
<td>0</td>
<td>11.5</td>
<td>0.3</td>
<td>0%</td>
</tr>
<tr>
<td>Jul-14</td>
<td>73.5</td>
<td>0</td>
<td>6.9</td>
<td>0.3</td>
<td>0%</td>
</tr>
<tr>
<td>Aug-14</td>
<td>92.4</td>
<td>0</td>
<td>6.7</td>
<td>0.2</td>
<td>0%</td>
</tr>
<tr>
<td>Sep-14</td>
<td>256.2</td>
<td>0</td>
<td>3.6</td>
<td>0.2</td>
<td>0%</td>
</tr>
<tr>
<td>Oct-14</td>
<td>527.2</td>
<td>0</td>
<td>10.6</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Nov-14</td>
<td>419.7</td>
<td>0</td>
<td>18.1</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Dec-14</td>
<td>435.7</td>
<td>0</td>
<td>17.1</td>
<td>0.1</td>
<td>0%</td>
</tr>
</tbody>
</table>
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Measurement and Reporting

• Updated MARP submitted in August 2014 - Revision 6

• Oil production volumes are estimated on lease by tank gauge and measured at the sales point by coriolis meter

• Gas produced with emulsion and casing gas flows directly to HP Flare and is measured by annubar meter. Solution gas from the produced fluid tanks is directed to LP Flare and measured by ultrasonic meter. Both meters to be updated on new MARP revision.

• Steam injection volumes are measured by differential pressure meter across the flow nozzle

• Water to injection facility from source water wells is measured at each well by turbine meters

• Fuel gas supply from TransCanada Pipeline is measured at facility by vortex meters
Measurement and Reporting

- Test separator equipped with watercut analyzer used to prorate oil volumes to each well
- Wells put into test on rotation
- Reporting as per Directive 017 requirements
Multiple wells producing Jun-14 through Sep-14

Harmon Valley South Proration Factors

- Oil Proration Factor
- Water Proration Factor
- Wells Online

Graph showing proration factors and number of wells online from Jun-14 to Sep-14.
## Measurement and Reporting – Water Balance

### INJECTION FACILITY AB IF 0128299

<table>
<thead>
<tr>
<th>Month</th>
<th>TOTAL IN</th>
<th>TOTAL OUT</th>
<th>INVENTORY ADJUSTMENT</th>
<th>BALANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m³</td>
<td>m³</td>
<td>m³</td>
<td>m³</td>
</tr>
<tr>
<td>Nov-13</td>
<td>2,808</td>
<td>2,463</td>
<td>315</td>
<td>-29</td>
</tr>
<tr>
<td>Dec-13</td>
<td>5,420</td>
<td>5,428</td>
<td>-8</td>
<td>0</td>
</tr>
<tr>
<td>Jan-14</td>
<td>2,749</td>
<td>2,807</td>
<td>26</td>
<td>85</td>
</tr>
<tr>
<td>Feb-14</td>
<td>717</td>
<td>908</td>
<td>-51</td>
<td>140</td>
</tr>
<tr>
<td>Mar-14</td>
<td>3,231</td>
<td>3,157</td>
<td>71</td>
<td>-3</td>
</tr>
<tr>
<td>Apr-14</td>
<td>1,601</td>
<td>1,598</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>May-14</td>
<td>2,969</td>
<td>2,849</td>
<td>-43</td>
<td>-164</td>
</tr>
<tr>
<td>Jun-14</td>
<td>2,515</td>
<td>2,544</td>
<td>-104</td>
<td>-74</td>
</tr>
<tr>
<td>Jul-14</td>
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<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>Aug-14</td>
<td>43</td>
<td>0</td>
<td>41</td>
<td>-2</td>
</tr>
<tr>
<td>Sep-14</td>
<td>3,077</td>
<td>2,992</td>
<td>85</td>
<td>0</td>
</tr>
<tr>
<td>Oct-14</td>
<td>6,081</td>
<td>6,117</td>
<td>-36</td>
<td>0</td>
</tr>
<tr>
<td>Nov-14</td>
<td>4,368</td>
<td>4,368</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dec-14</td>
<td>3,566</td>
<td>3,512</td>
<td>54</td>
<td>0</td>
</tr>
</tbody>
</table>
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Water Use

- Water source wells: 1F1/16-36-082-18W5 and 100/14-25-082-18W5
- A Water Act Application was not required as water is sourced from the Paddy-Cadotte Aquifer of the Peace River Formation, which is approximately 4,700 ppm TDS in this area

<table>
<thead>
<tr>
<th></th>
<th>Brackish Water, m³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1F1/16-36-082-18W5</td>
</tr>
<tr>
<td>Nov-13</td>
<td>461</td>
</tr>
<tr>
<td>Dec-13</td>
<td>4,272</td>
</tr>
<tr>
<td>Jan-14</td>
<td>2,578</td>
</tr>
<tr>
<td>Feb-14</td>
<td>592</td>
</tr>
<tr>
<td>Mar-14</td>
<td>1,554</td>
</tr>
<tr>
<td>Apr-14</td>
<td>63</td>
</tr>
<tr>
<td>May-14</td>
<td>1,347</td>
</tr>
<tr>
<td>Jun-14</td>
<td>413</td>
</tr>
<tr>
<td>Jul-14</td>
<td>0</td>
</tr>
<tr>
<td>Aug-14</td>
<td>23</td>
</tr>
<tr>
<td>Sep-14</td>
<td>1,887</td>
</tr>
<tr>
<td>Oct-14</td>
<td>6,063</td>
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<tr>
<td>Nov-14</td>
<td>4,313</td>
</tr>
<tr>
<td>Dec-14</td>
<td>2,637</td>
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</tbody>
</table>
Surface Agenda

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Water Treatment

- Water Treatment Package designed to treat saline water and produce BFW quality suitable for OTSG

- The source water is treated by a softening system consisting of multimedia filter, primary and secondary WAC softeners, neutralization, regen and dosing systems

- Water Treatment Package designed with condensed equipment and piping spacing, resulting in limited maintenance access

- Separate heated storage for chemicals currently being constructed

- Harmon Valley South Pilot facility does not recycle produced water due to make up water requirements of less than 500 000 m³/year
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Water and Waste Disposal

- Produced water from the facility is sent for disposal to the Class II Disposal facility at 14-18-082-17W5
- Class II Disposal Scheme Approval No. 11913 for disposal in the Leduc Formation
Includes all disposal water injected at 100/14-18-082-17W5
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## Sulphur Balance

<table>
<thead>
<tr>
<th>Month</th>
<th>Sulphur Production</th>
<th>Sulphur in Flared Gas</th>
<th>Sulphur in Recovered Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-14</td>
<td>0.000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Feb-14</td>
<td>0.000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Mar-14</td>
<td>0.000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Apr-14</td>
<td>0.000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>May-14</td>
<td>0.000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Jun-14</td>
<td>0.000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Jul-14</td>
<td>0.000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Aug-14</td>
<td>0.000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Sep-14</td>
<td>0.000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Oct-14</td>
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</tr>
<tr>
<td>Nov-14</td>
<td>0.000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Dec-14</td>
<td>0.000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

2014 Total Sulphur Production = 0 tonne
SO$_2$ Production

- EPEA Approval for Harmon Valley South Pilot facility does not require real-time Sulphur Dioxide (SO$_2$) emission monitoring
- Site is equipped with passive air monitoring for SO$_2$, nitrogen dioxide (NO$_2$) and hydrogen sulphide (H$_2$S) emissions
- Reports submitted monthly
## SO₂ Emissions

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<thead>
<tr>
<th>Month</th>
<th>Peak Reading (ppb)</th>
<th>Average Reading (ppb)</th>
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<tbody>
<tr>
<td>Aug-13</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Sep-13</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Oct-13</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Nov-13</td>
<td>0.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Dec-13</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Jan-14</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Feb-14</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Mar-14</td>
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<td>Apr-14</td>
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<td>0.2</td>
</tr>
<tr>
<td>May-14</td>
<td>2.8</td>
<td>1.9</td>
</tr>
<tr>
<td>Jun-14</td>
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<td>0.2</td>
</tr>
<tr>
<td>Jul-14</td>
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<td>Sep-14</td>
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<tr>
<td>Oct-14</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Nov-14</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Dec-14</td>
<td>0.5</td>
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</tr>
</tbody>
</table>
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Penn West received EPEA Approval No. 303255-00-00 on October 23, 2012

- Additional burners on new emulsion tanks added Q2 2014 operating under Director’s Authorization

Monitoring ongoing as per EPEA Approval conditions:

- Air Emissions
- Industrial Wastewater and Industrial Runoff
- Groundwater
- Soil Monitoring
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Statement of Compliance

- To the best of our knowledge, Penn West is in compliance with all the requirements and conditions of Commercial Scheme Approval No. 11895C and all other approvals related to the Harmon Valley South HCSS Pilot.
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Non-Compliance – Voluntary Self-Declarations

- Jan 2013: High Risk Enforcement due to application for Directive 056 Facility License prior to Directive 042 MARP Approval

- April 2014: Exceeded steam injection volume to 103/14-06-083-17W5 during steam cycle 1
  - Injected 3,569 m³ above 14.5MPa due to faulty cumulative steam calculated tag
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Future Plans

- Evaluating project success with increased injection volumes
- Evaluating project economics in light of current market conditions