Peace River In Situ Oil Sands Progress Report

Commercial Scheme Approval 8143

December 8th, 2015

(revised January 28th, 2016)

TODAY'S AGENDA

Introductions and Background	Ivan Gonzalez
Subsurface Issues Related to Resource Evaluation and Recovery	
Geology/Geoscience	Victoria Walker
Geophysics	Barbara Wingate
Drilling and Completions	Dan Syrnyk
Artificial Lift	Dan Syrnyk
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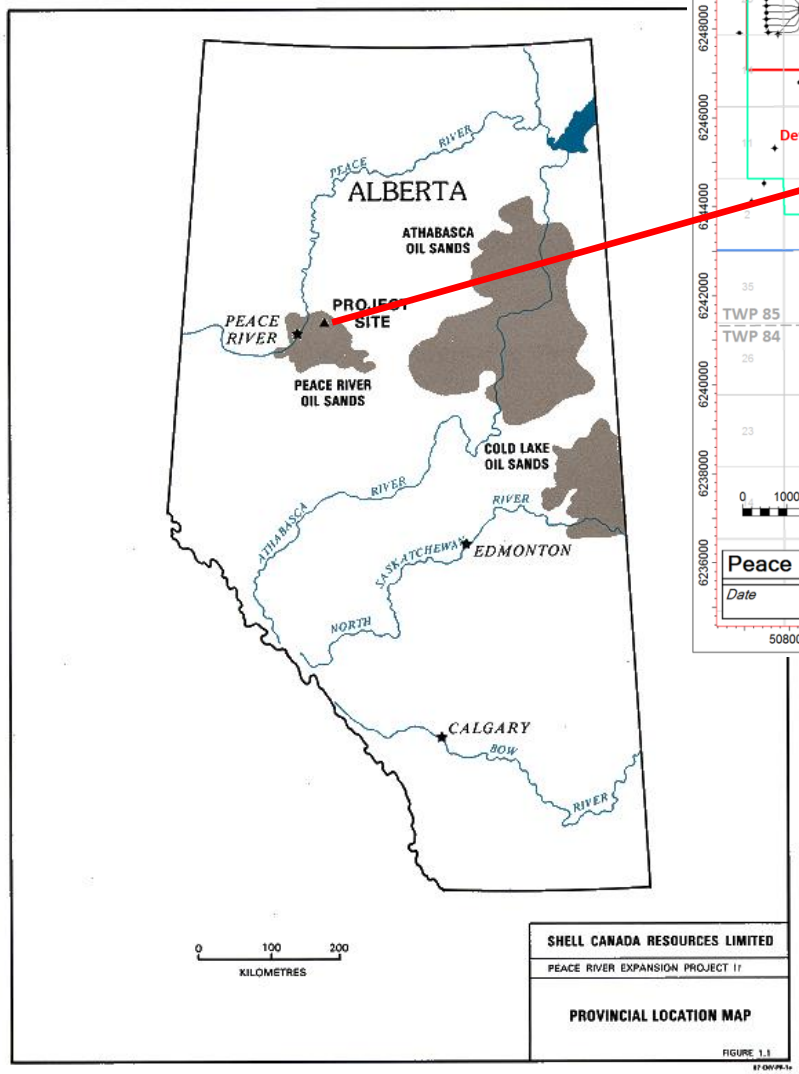
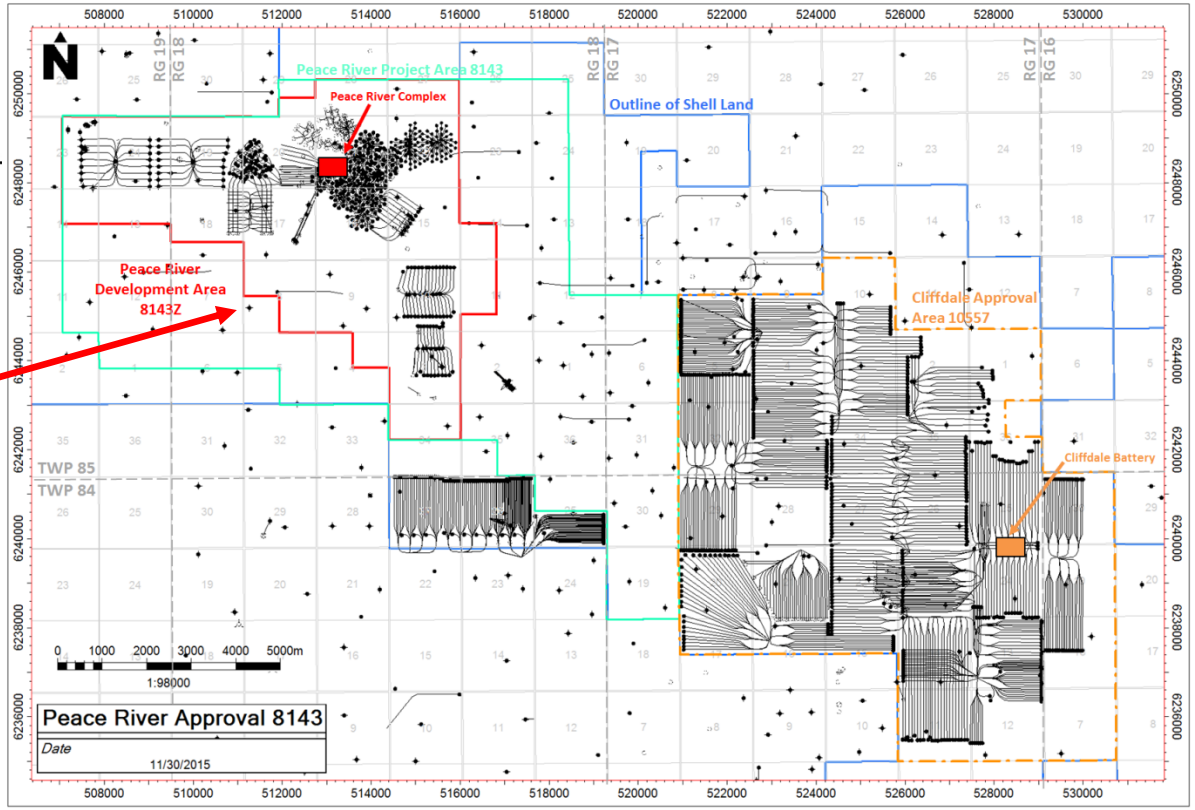
Future Plans	Pasquale Riggi
Surface Operations, Performance and Compliance	
	Darcy Forman

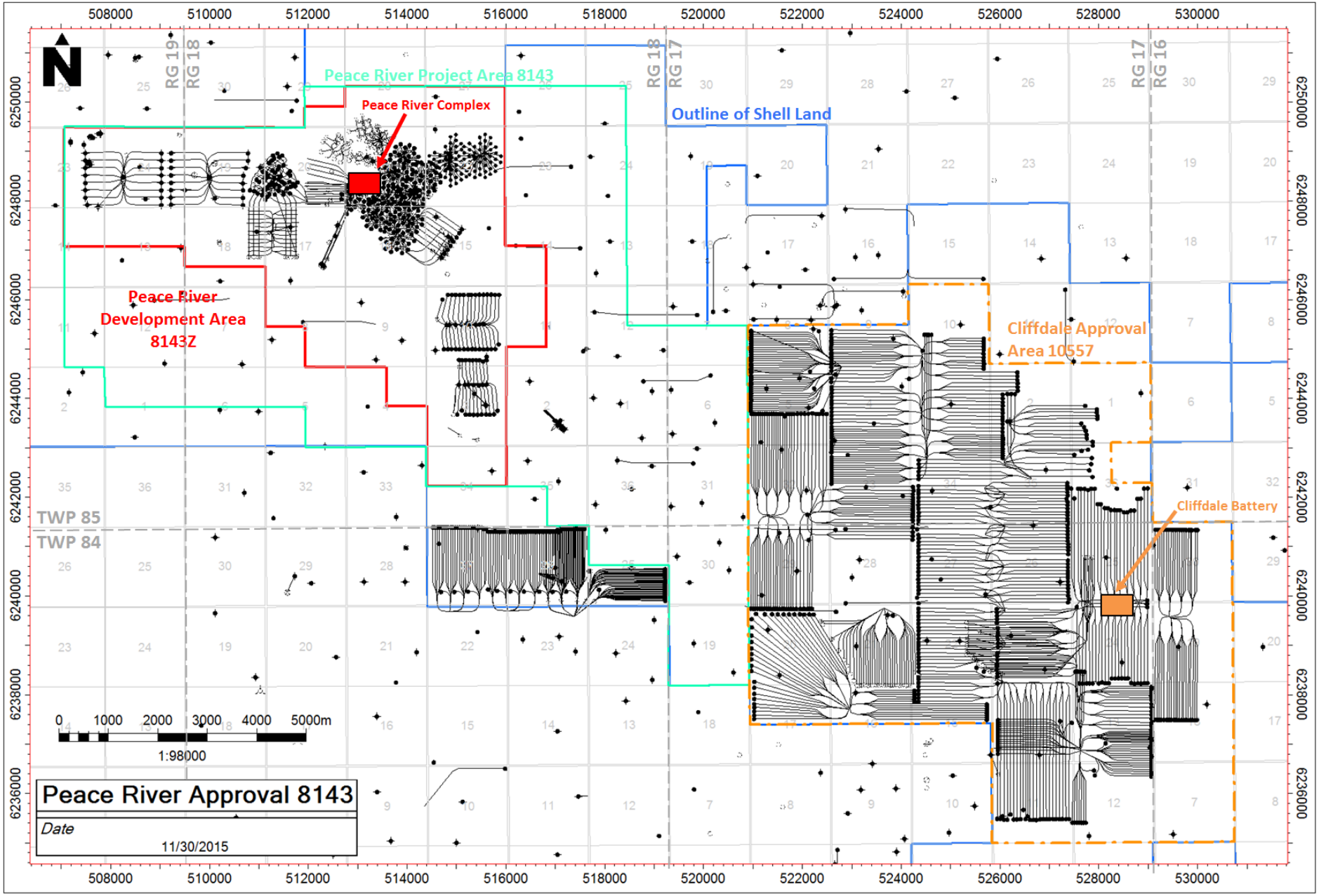
LOCATION





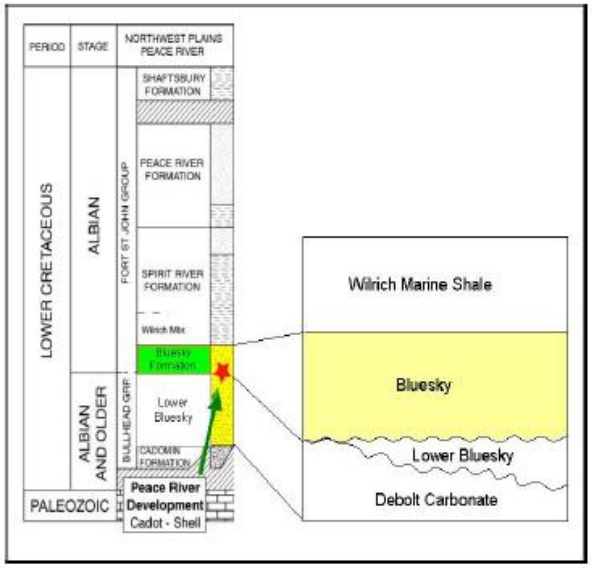
- Located in Northwestern Alberta
- 100% Shell Share
- OBIP 239 Million m^3 for the area in Approval 8143Z

APPROVAL AREAS

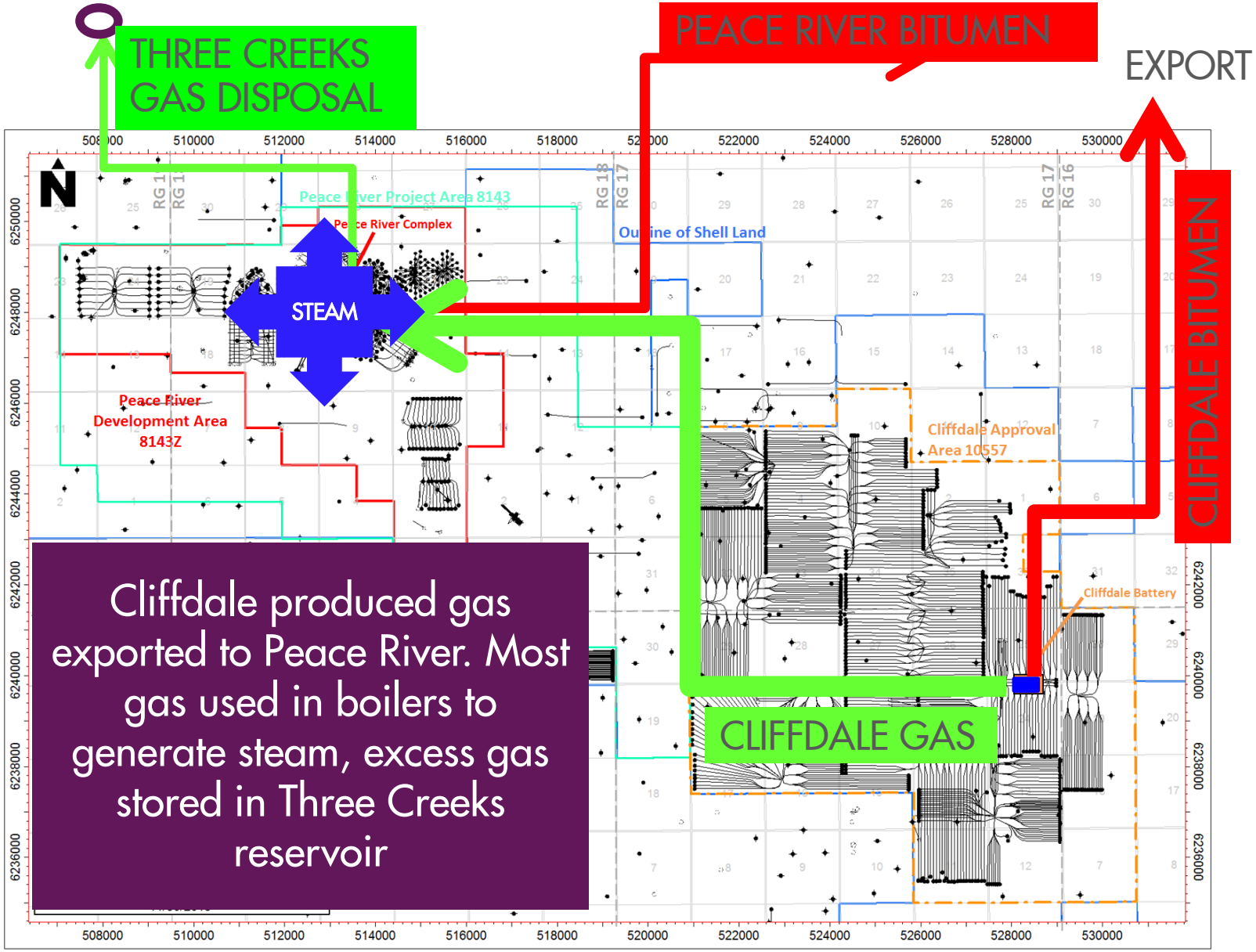


BLUESKY RESERVOIR PROPERTIES

- **Thickness**: 25-30 m
- **Depth:** 550-600 m TVD
- **NTG:** 0.8-1.0
- **API Gravity:** 6-11°
- **Porosity:** 0.25-0.30
- **Viscosity:** 10,000-1,000,000 cP (dead oil)
- **Initial pressure:** 3,800 kPa (sub-hydro)
- **Initial temperature:** 18°C
- **Horizontal permeability:** 0.1 – 10 D (air)
- **Kv/kh:** 0.3 – 0.9
- **Oil saturation (S_o):** 0.70 – 0.80

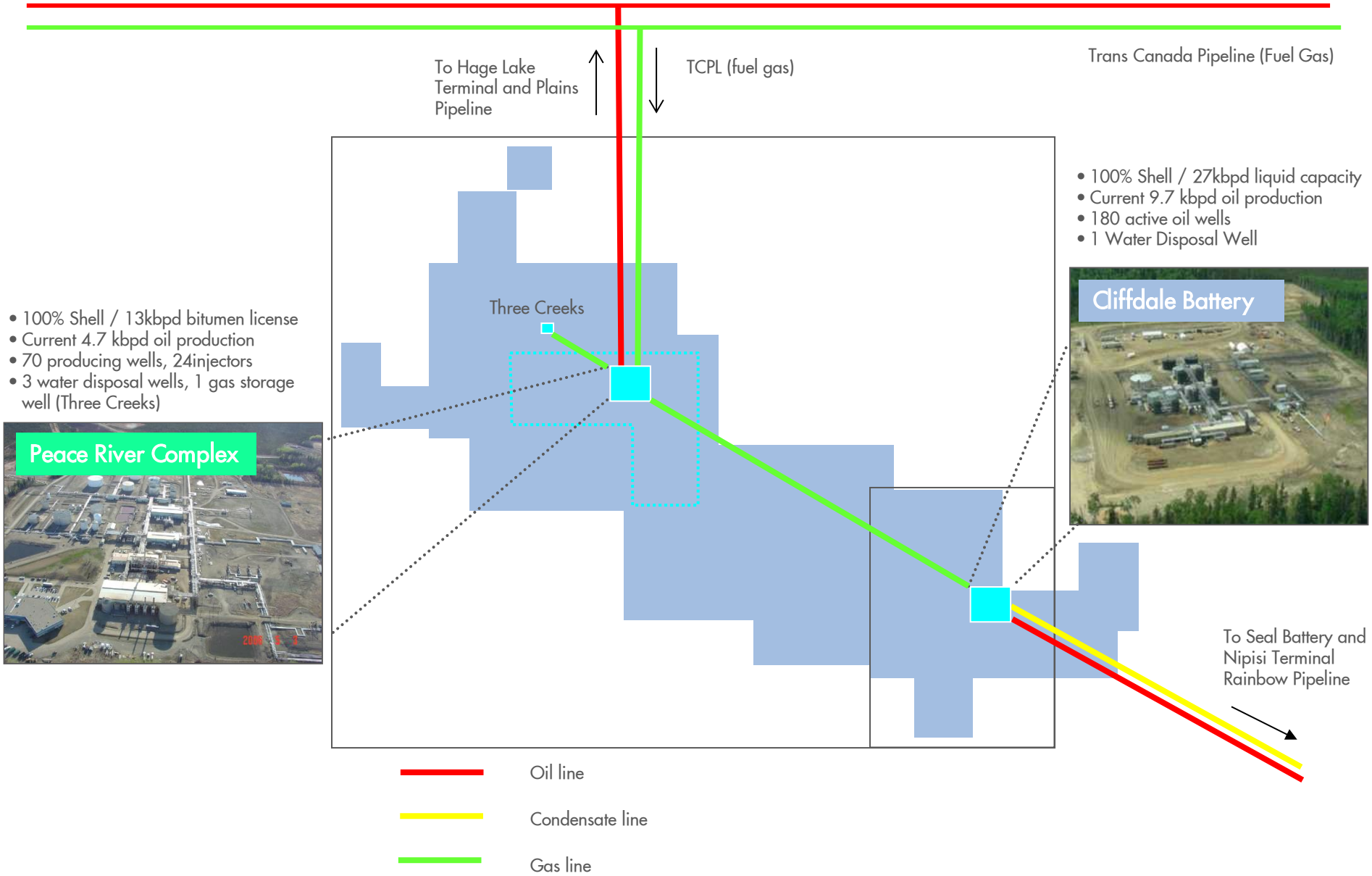


GAS INTEGRATION PEACE RIVER AND CLIFFDALE ASSETS



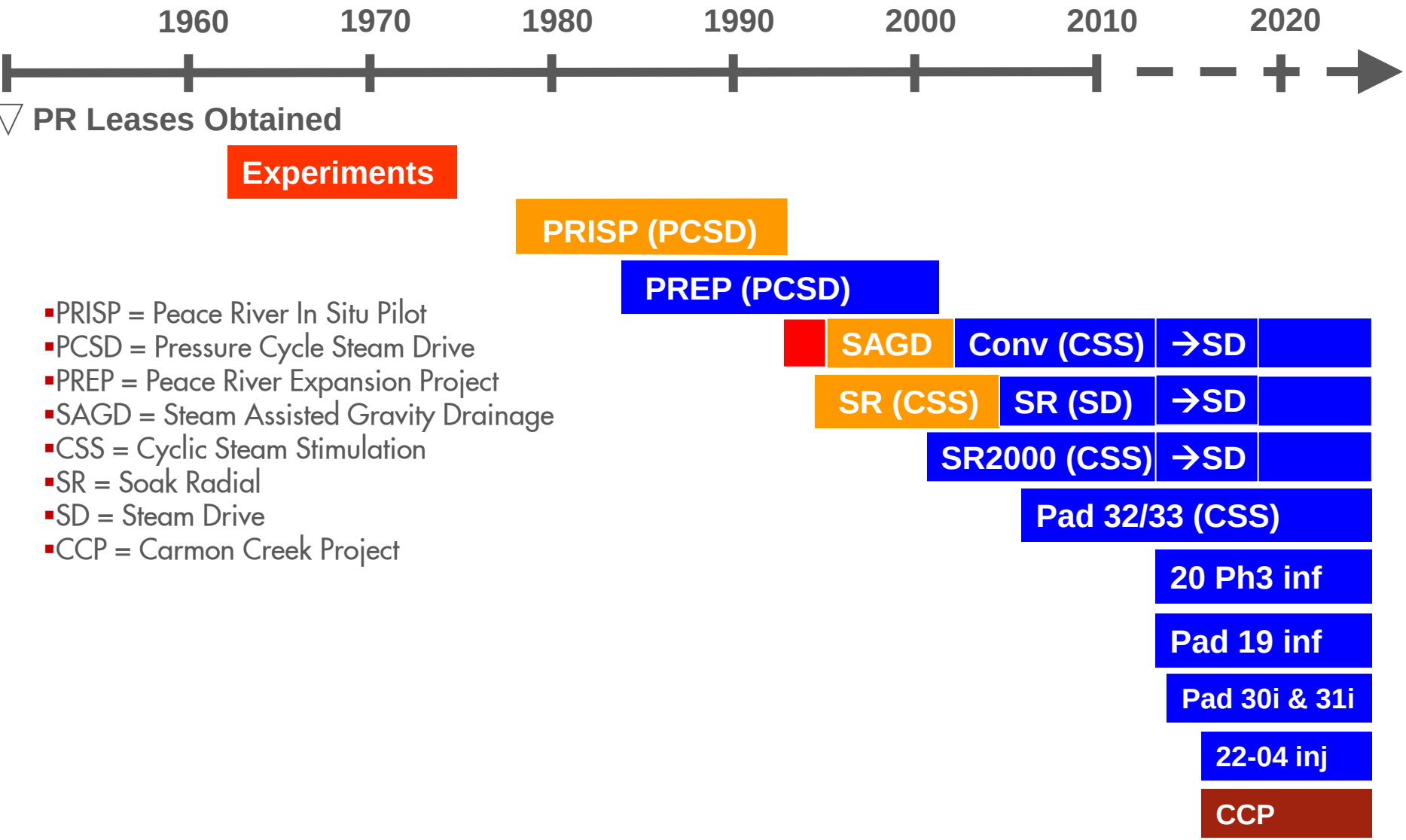
Cliffdale produced gas exported to Peace River. Most gas used in boilers to generate steam, excess gas stored in Three Creeks reservoir

GAS INTEGRATION PEACE RIVER AND CLIFFDALE ASSETS



PEACE RIVER PROJECT HISTORY

Experiment to **Pilot** to **Demonstration** to **Commercial**



- PRISP = Peace River In Situ Pilot
- PCSD = Pressure Cycle Steam Drive
- PREP = Peace River Expansion Project
- SAGD = Steam Assisted Gravity Drainage
- CSS = Cyclic Steam Stimulation
- SR = Soak Radial
- SD = Steam Drive
- CCP = Carmon Creek Project

2015 OVERVIEW

Key 2015 PRC updates:

- Abandoned 4 remaining wells on Pad 19 – Sat 3 with casing integrity issues in Q1-Q2 2015.
- Stopped solvent co-injection on Pad 19 – Sat 3 and continued monitoring solvent recovery trough the emulsion line and casing-vent system.
- Started steam injection on new Pads 30i (4 wells) and 31i (6 wells).
- Suspended wells on Pad 40 & 41 to improve field SOR and profitability.
- Drilled and completed 1 new injector on Pad 22 (over Pad 21).
- Cleaned out skim and surge tanks to remove water processing constraints.
- No government reportable spills from October 2014 to end of October 2015.
- Wildlife crossing structures on above ground pipelines-All data from past 8 years was assessed under the Comprehensive Wildlife report and submitted to the AER.
- Good progress in reclamation research projects: Airstrip Project, IPAD Borrow Pit Project, In-Situ Pad Project .

2015 OVERVIEW (cont.)

Carmon Creek Project Status – Q4 2015

- Construction at Carmon Creek has been halted. Activity stopped with 100 utility and production wells drilled.
- Shell is looking to retain and maintain the subsurface leases in the area.
- In order to maximize the value of the asset Shell is investigating a number of go forward options with regards to the infrastructure, land disturbance and regulatory approvals associated with the project.
  - Ensuring the asset remains in a safe, secure, compliant state that does not create adverse environmental impact is a priority.
- Discussions will commence shortly with all key departments of AER to seek regulatory input and guidance in order to align on forward options for the project.

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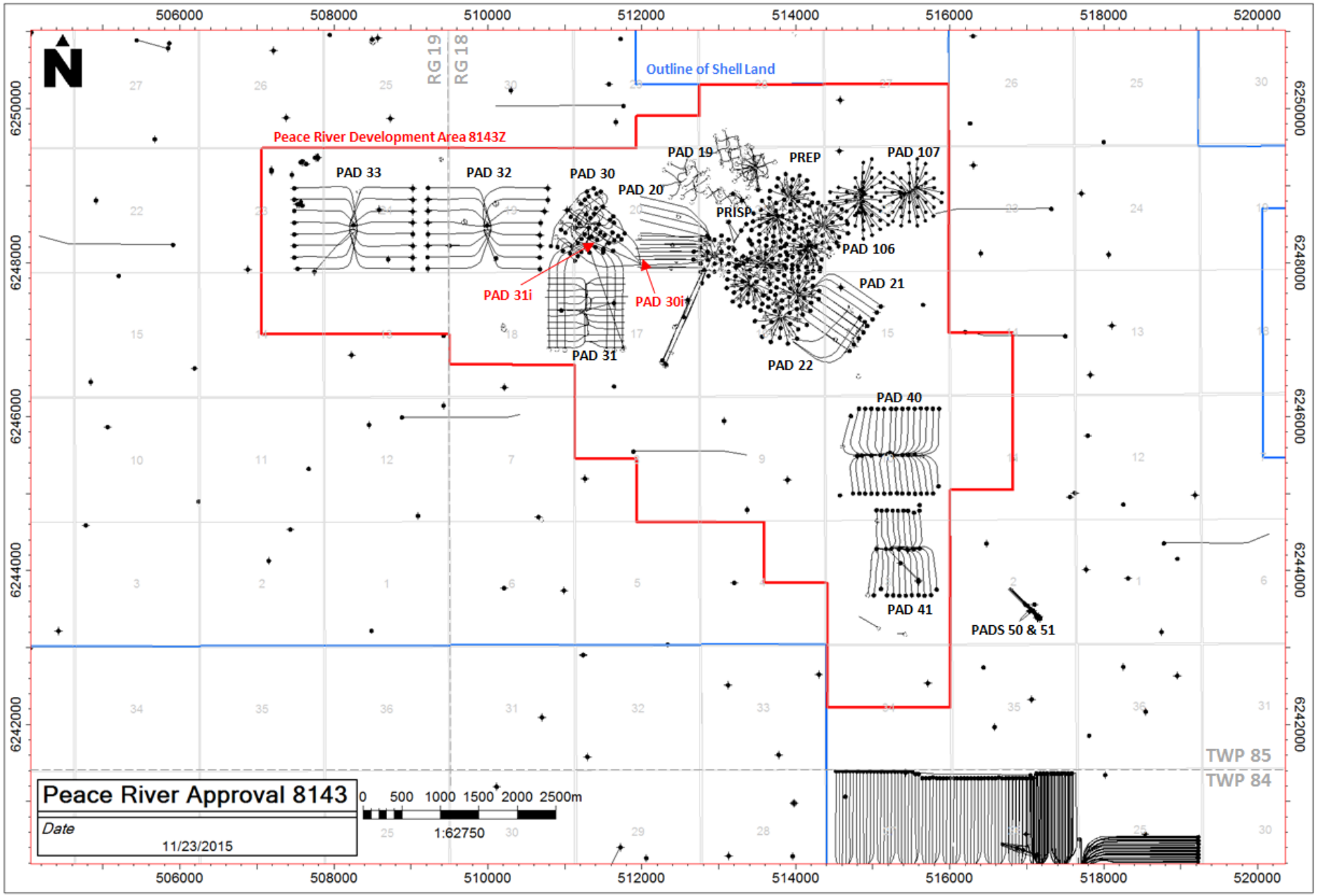
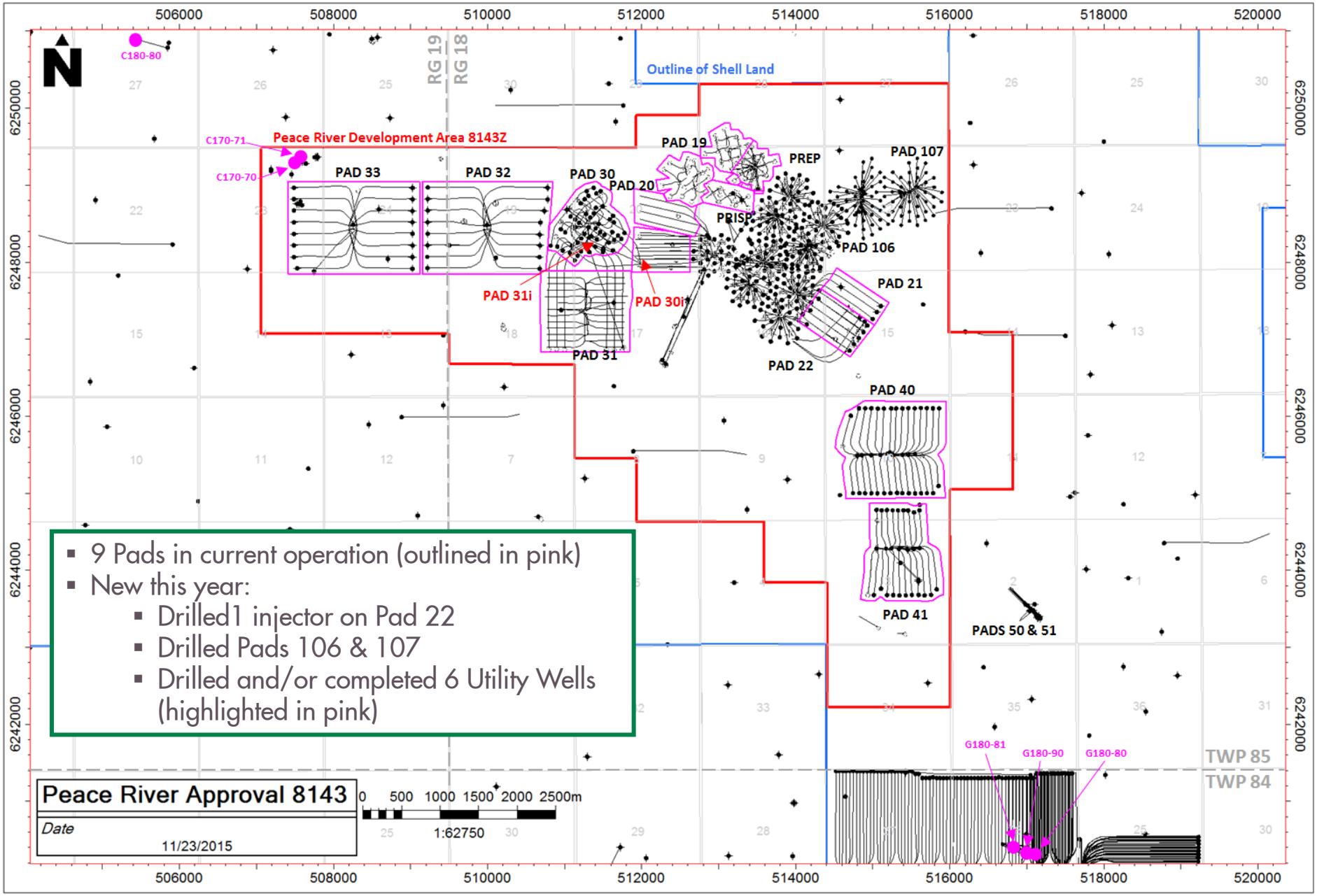
APPROVAL AREA



APPROVAL AND CURRENT OPERATING AREA

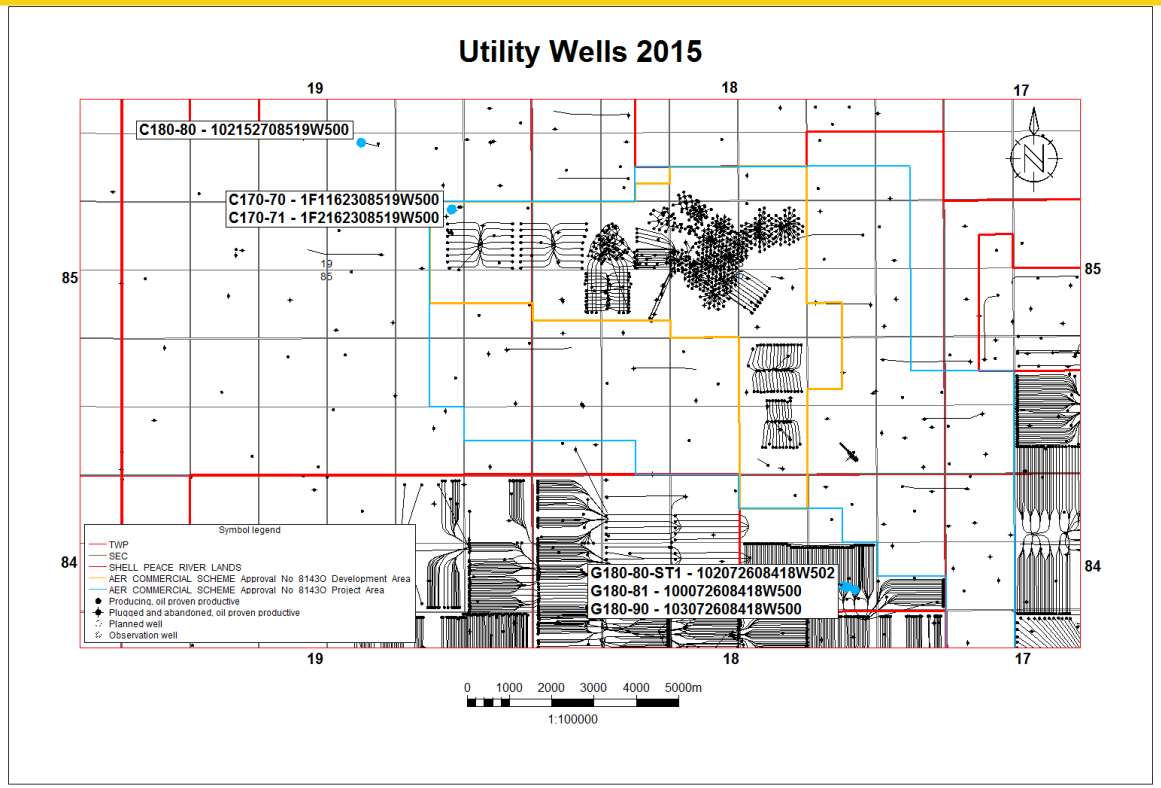


- 9 Pads in current operation (outlined in pink)
- New this year:
  - Drilled1 injector on Pad 22
  - Drilled Pads 106 & 107
  - Drilled and/or completed 6 Utility Wells (highlighted in pink)

CARMON CREEK UTILITY WELLS (LEDUC)

DATA ACQUISITION:

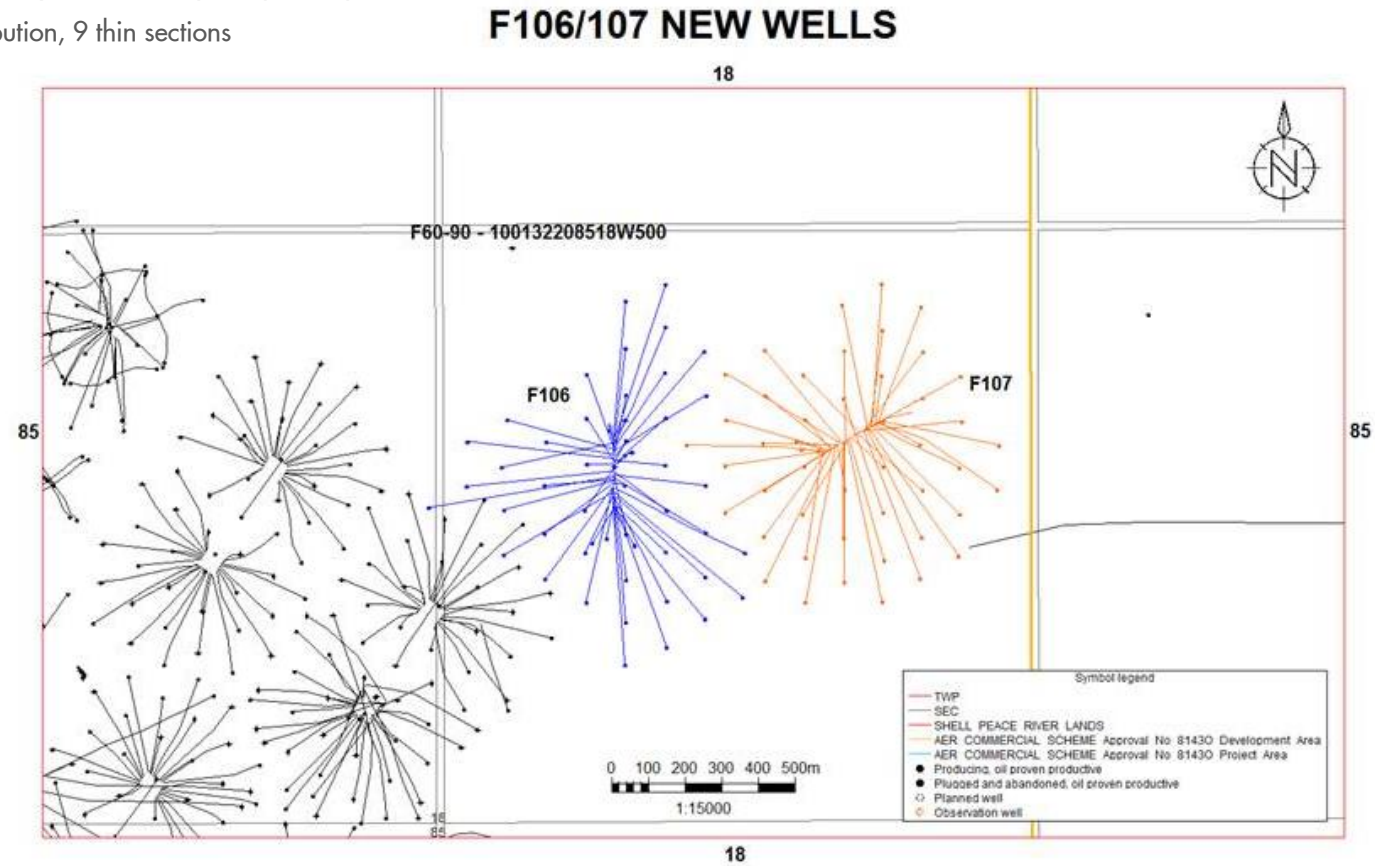
- C180-80 Well Completion
  - Failed In-situ stress test @ Ireton and Leduc
- G180-80 and G180-81
  - Core on G180-81@ Ireton and Leduc Formations
    - **Ireton** = 1591 – 1646 mMD
    - 2 Mercury Injection Capillary pressure
    - 5 thin sections
    - 3 multistage triaxle compressive strength
    - ultrasonic velocities
    - dynamic elastic parameters
    - **Leduc** = 1723.17 – 1764.15 mMD
    - 6 X-Ray Diffraction
    - 1 Mercury Injection Capillary pressure (failed)
    - 6 Thin Section
  - One successful pressure test @ Leduc, 16 failed tests
  - In-situ stress tests
    - G180-80, openhole, Nisku Formation
    - G180-81 failed attempt @ Leduc. No fracture.
    - G180-80 step rate test.



CARMON CREEK PAD WELLS

DATA ACQUISITION:

- **Pad 106-90 Observation well**
  - Open hole logs
  - Two external pressure gauges @ 324 and 509 mMD
  - Cored BLSK
  - Core analysis: 9 viscosity samples, 9 particle size distribution, 9 thin sections
- **Pad 107-90 Observation well**
  - Open hole logs
  - Two external pressure gauges @ 310 and 510 mMD
  - Cored BLSK
  - Core analysis: 10 viscosity samples, 10 particle size distribution, 10 thin sections



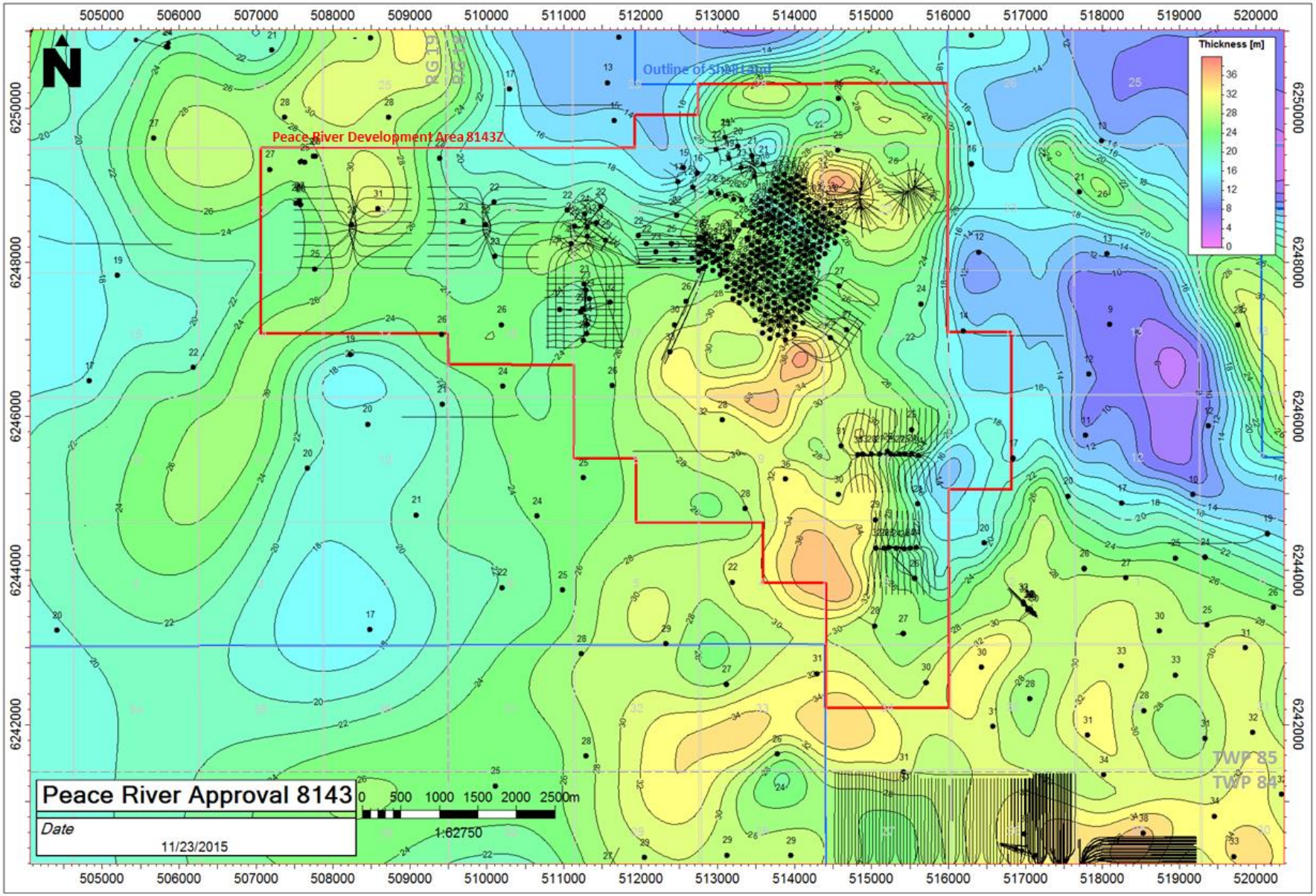
VOLUMETRICS

- **Methodology:** Well tops, 3D seismic surfaces (where available) and properties modeled in a 3D cellular static reservoir model (cell size: 50x50x1m)

	Units	Development Area*	Operating Area
Original Bitumen In Place	**$10^6 m^3$**	**239**	**55.6**
Area	$10^6 m^2$	42.6	10.5
Average Net Pay	m	27	24
Average Porosity	1/1	0.27	0.28
Average Oil Saturation	1/1	0.81	0.81
Bo	1/1	1.004	1.004

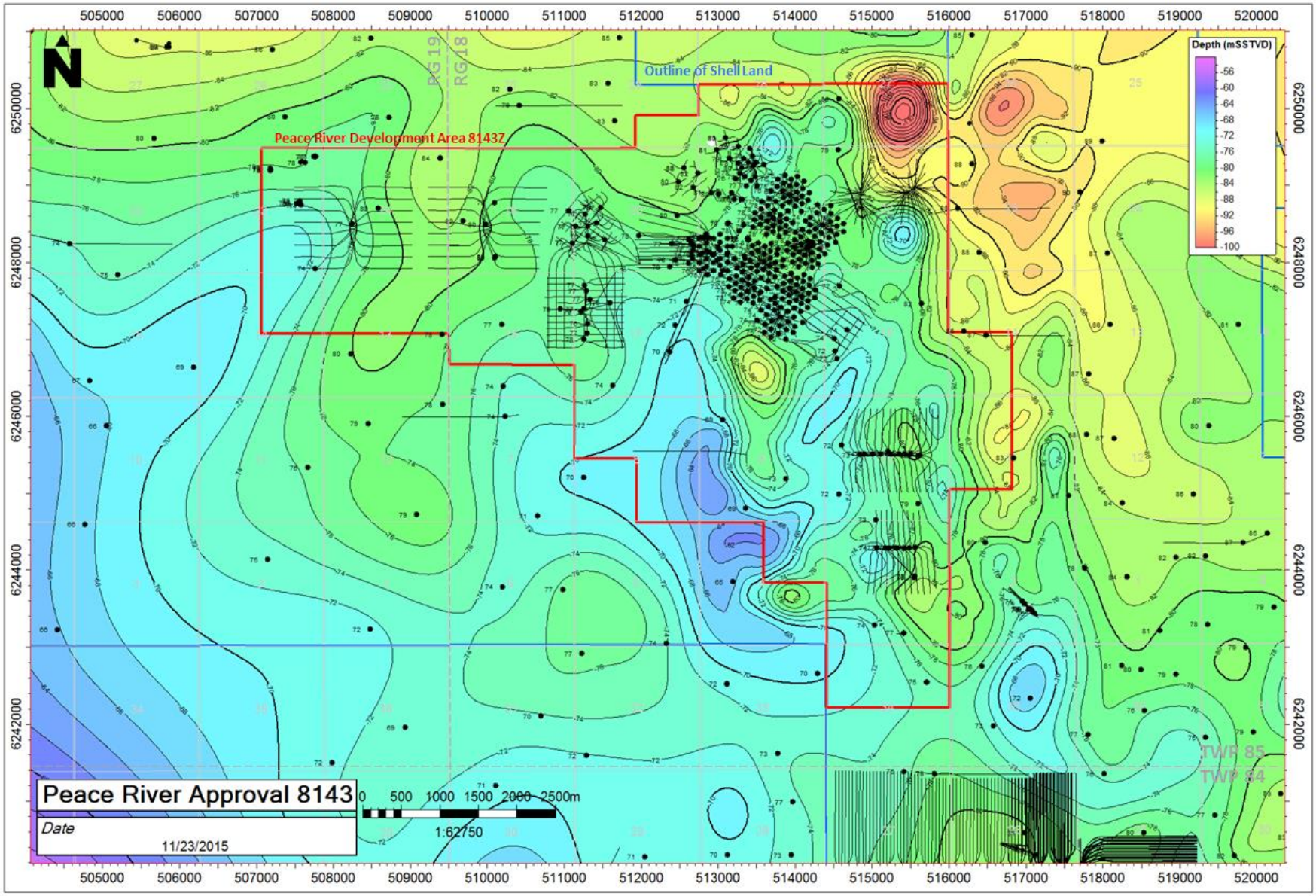
*Calculations are based on the 8143Z development scheme approval area

BLUESKY NET PAY



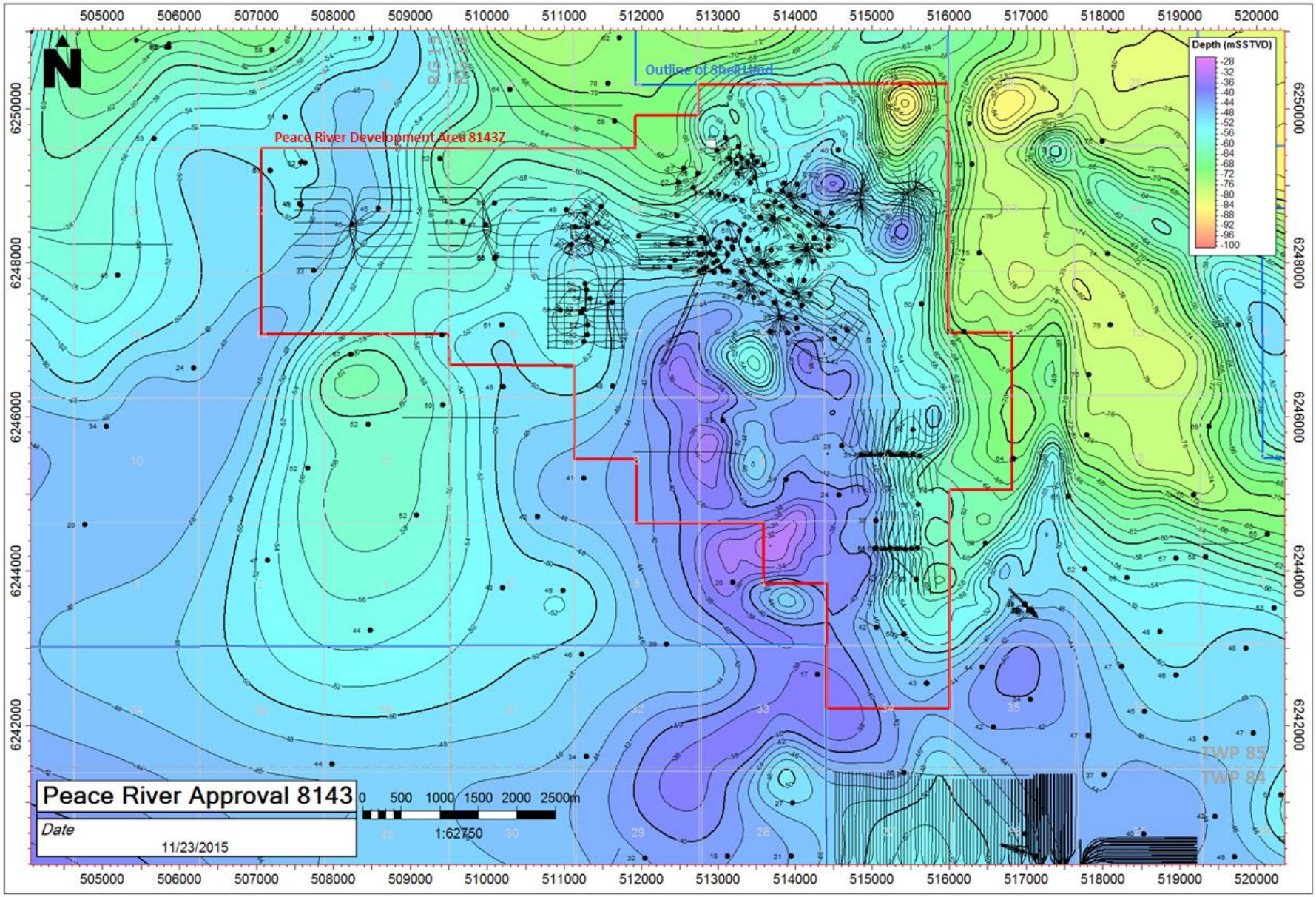
- Ranges from 14-38m in the approved area

TOP BLUESKY STRUCTURE



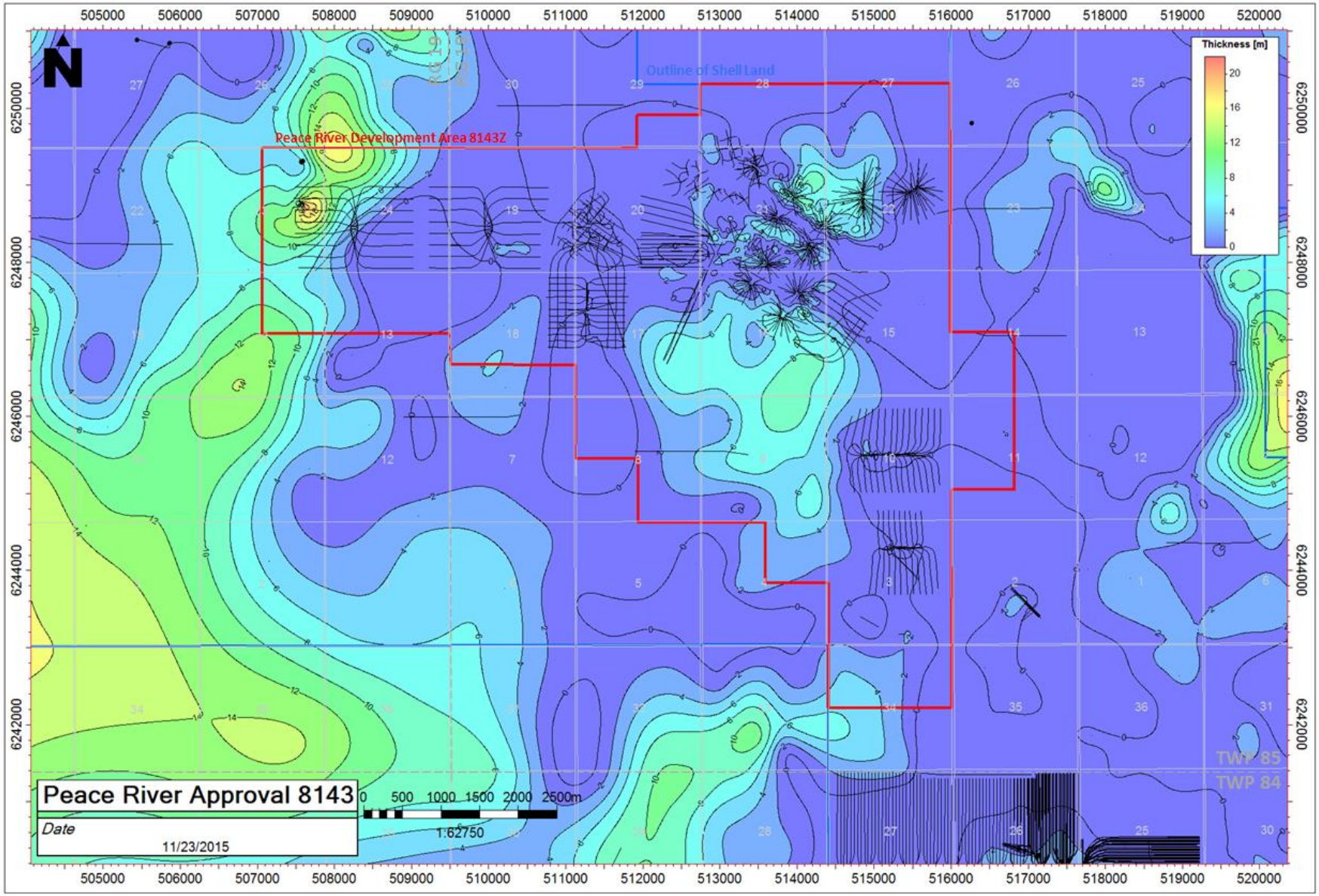
- Ranges from 70-86 m SS in the approved area

BASE BLUESKY STRUCTURE



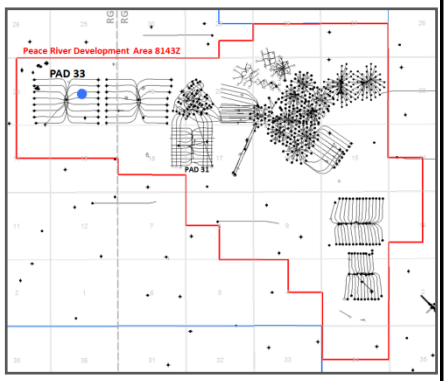
- Ranges from 36-68 m SSTVD in approval area

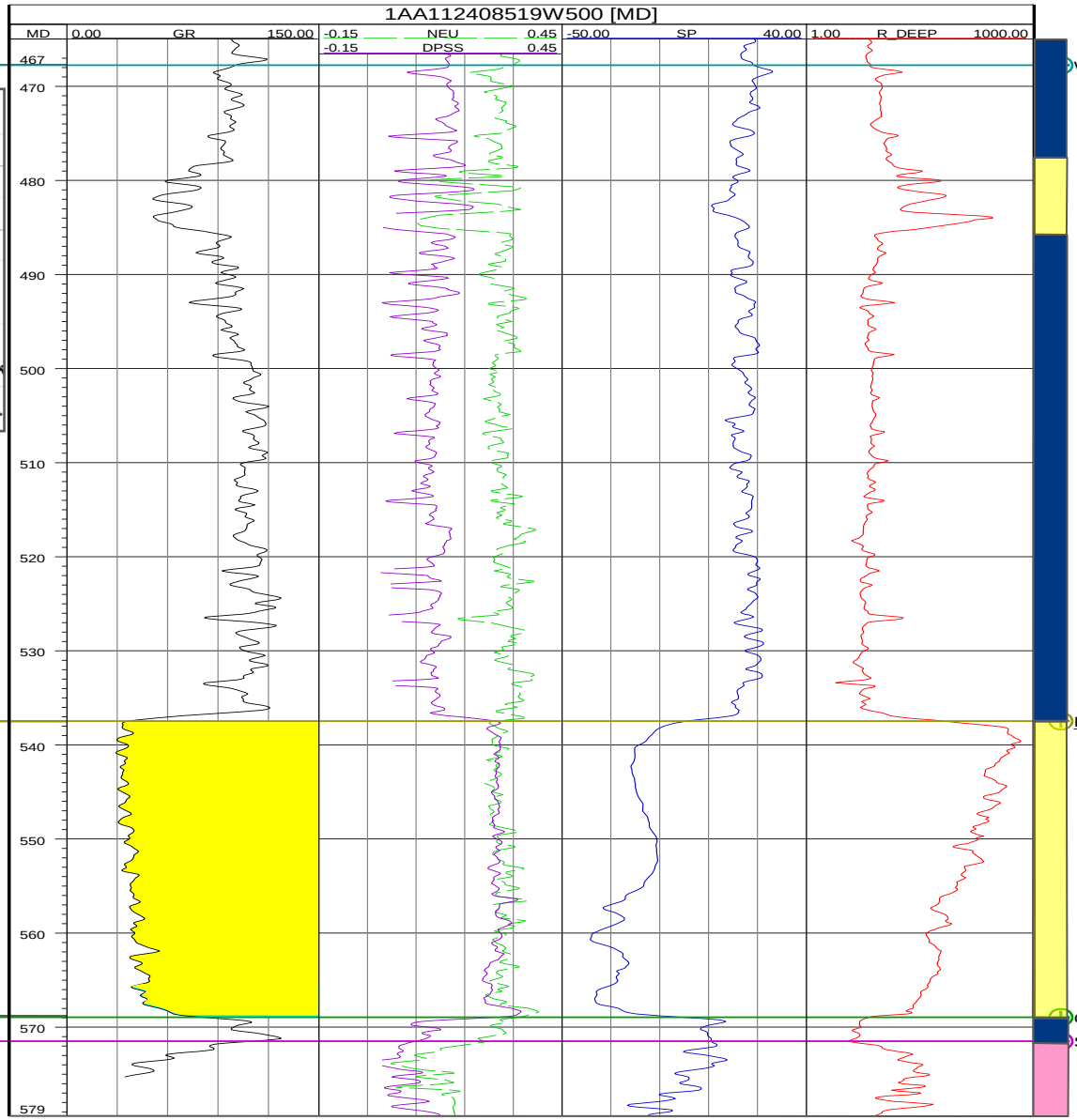
BASAL WATER ISOCHORE



- Basal Water is a transitional zone of increasing water saturations in the Bluesky that is defined by a Sw > 0.31.

COMPOSITE WELL LOG 1AA/11-24-085-19W5/00





Legend:

Well Logs

- Gamma Ray
- Neutron porosity
- Density porosity
- Spontaneous potential
- Resistivity

Fluids

- Bitumen

Rock framework

- Shales
- Sands
- Carbonate

INTERPRETED BREAKDOWN PRESSURES AND CAP ROCK INTEGRITY

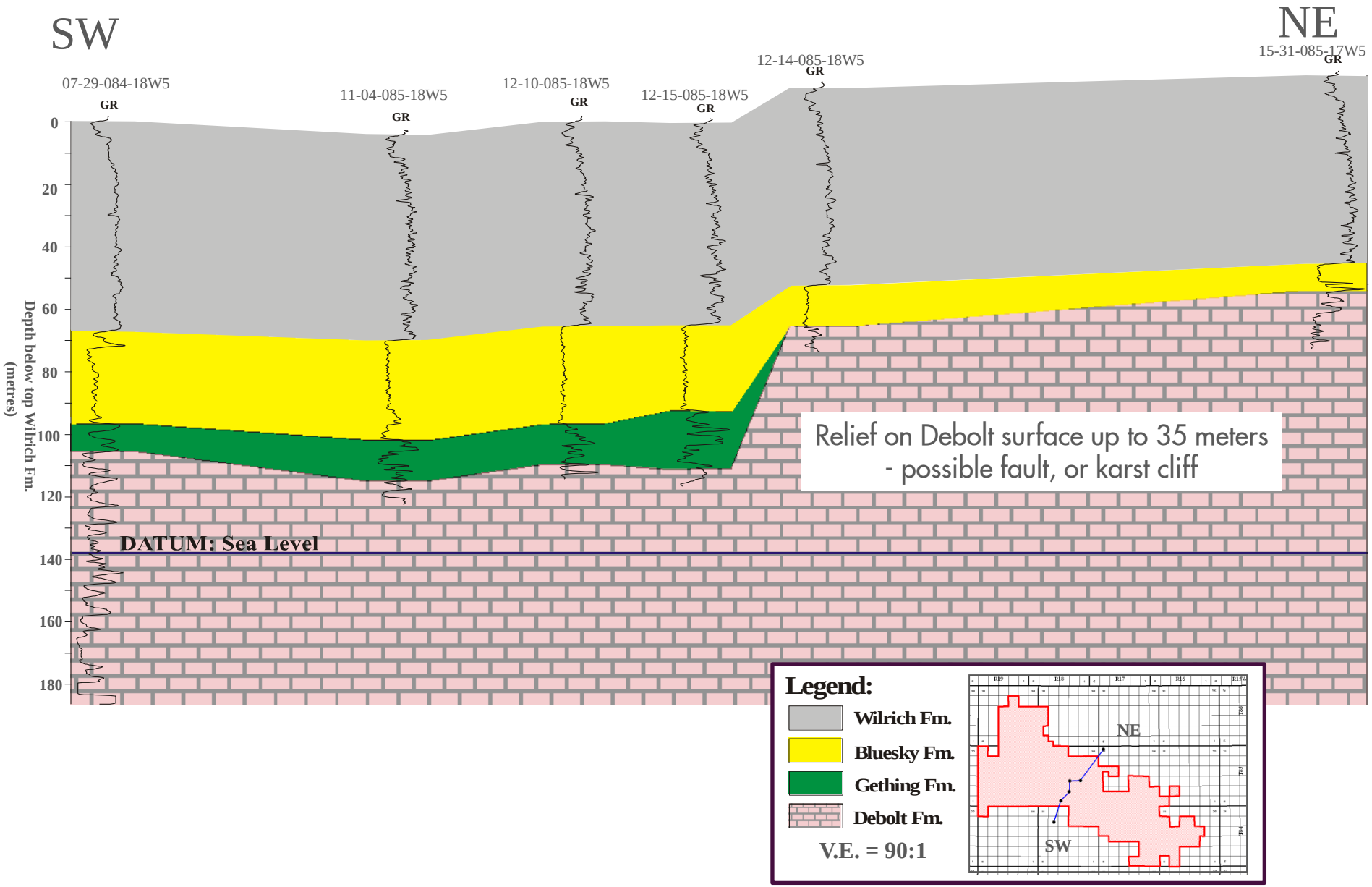
- Cap rock: consists of the highly continuous Spirit River Formation (Wilrich/Falher/ Notikewin) which has a minimum thickness of 240m over the approval area.

- 2012 Stress Testing:
  - 12 in-situ cap rock stress tests, 3 wells @ 3 different depths in Wilrich, 1 depth top Bluesky
    - Measured Minimum Stress Wilrich = 19.6-22.7 kPa/m, avg 20.9 kPa/m
    - Calculated Minimum Stress Wilrich = 21.6-22.2 kPa/m
    - Measured Minimum Stress Bluesky = 14.7-20.2 kPa/m, avg 16.6 kPa/m
  - 2 additional in-situ stress tests in 1 well in Notikewin and Fahler formations
    - Fahler Measured Breakdown Stress = 28.7 kPa/m
    - Fahler Measured Minimum Stress = 20.0 kPa/m
    - Fahler Calculated Minimum Stress = 21.3 kPa/m
    - Notikewin Measured Breakdown Stress = 29.1 kPa/m
    - Notikewin Measured Minimum Stress = 19.0 kPa/m
    - Notikewin Calculated Minimum Stress = 21.0 kPa/m

STRESS TESTING IN DEEP FORMATIONS

- Q4 2014 Stress Testing:
  - 3 tests were conducted on 3 of the Carmon Creek Utility Wells:
    - Nisku Formation In-situ stress test @ G180-80 (102/07-26-084-18W5/02)
      - Openhole test with 1.7m straddle packer used to obtain minimum horizontal stress (28.3MPa), Vertical stress (38.4MPa), Breakdown pressure (40.1MPa) at 1573m TVD
    - Leduc Formation In-situ stress test @ G180-81 (100/07-26-084-18W5/00)
      - Cased hole with 50m perforated zone (1694.9 -1744.3m TVD) didn't achieve fracture. Pressures reached 30.4MPa.
    - Leduc Formation Step rate test on G180-80 (102/07-26-084-18W5/02)
      - Cased hole with 50m perforated zone (1684.6 – 1734.4m TVD). Initial breakdown of 39MPa.

DIP STRUCTURAL CROSS SECTION



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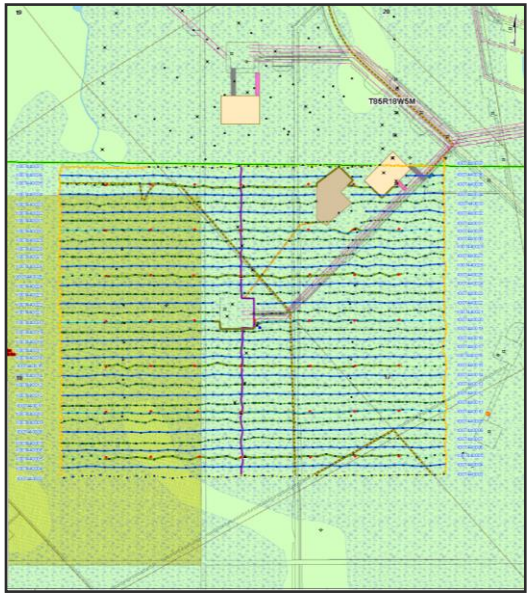
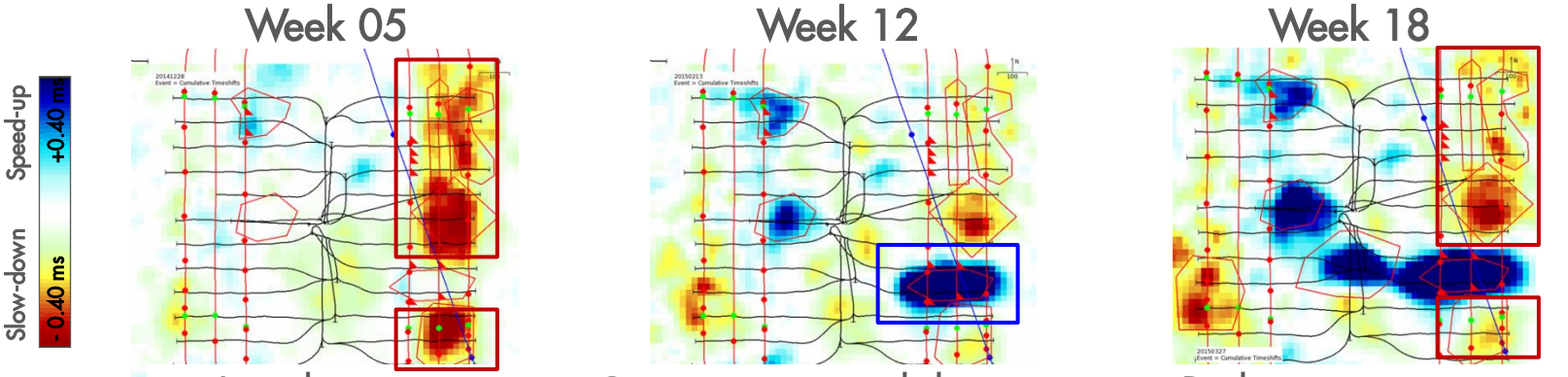
CONTINUOUS REFLECTION MONITORING AT PAD 31



- Recording May 2014 – May 2016
- First steam on infill wells @ Nov 2014
- Time shifts are measurable
- Working to relate time shifts to production effects



Initial steam conformance

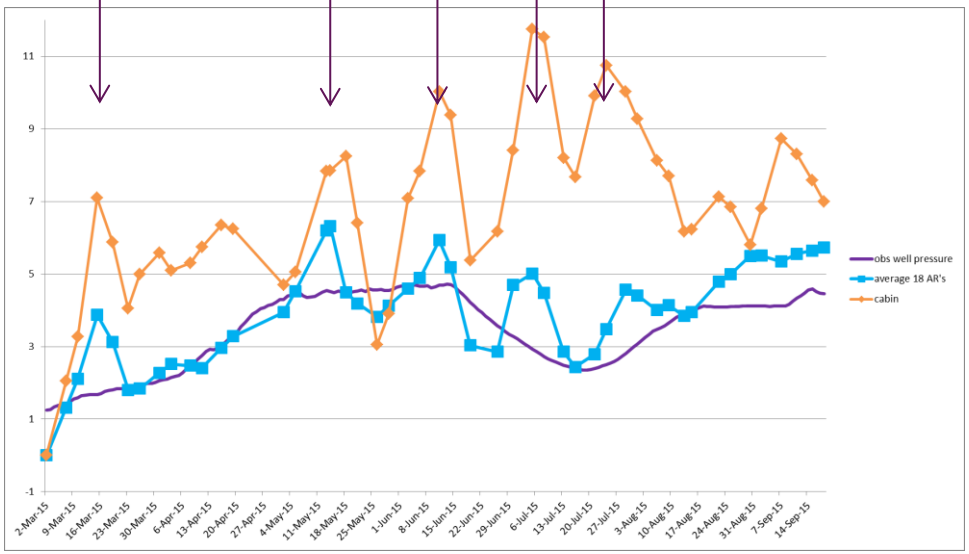
Connection to mobile zone ➔ conformance suffers

Reduce pump rate ➔ conformance improves

INSAR AT PAD 31

- Cemented corner reflectors installation Feb 2015
- Surface deformations (measured with InSAR) correlate well with reservoir pressure changes

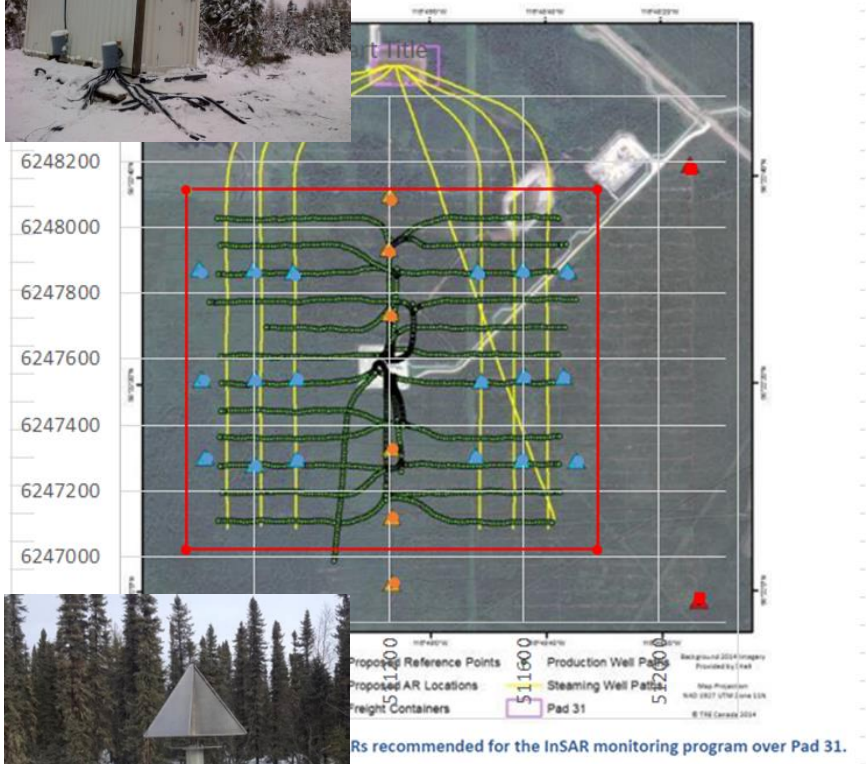
Near surface disturbances (thawing, precipitation)



March '15 Calendar Time → September '15

cabin attached

- Less stable

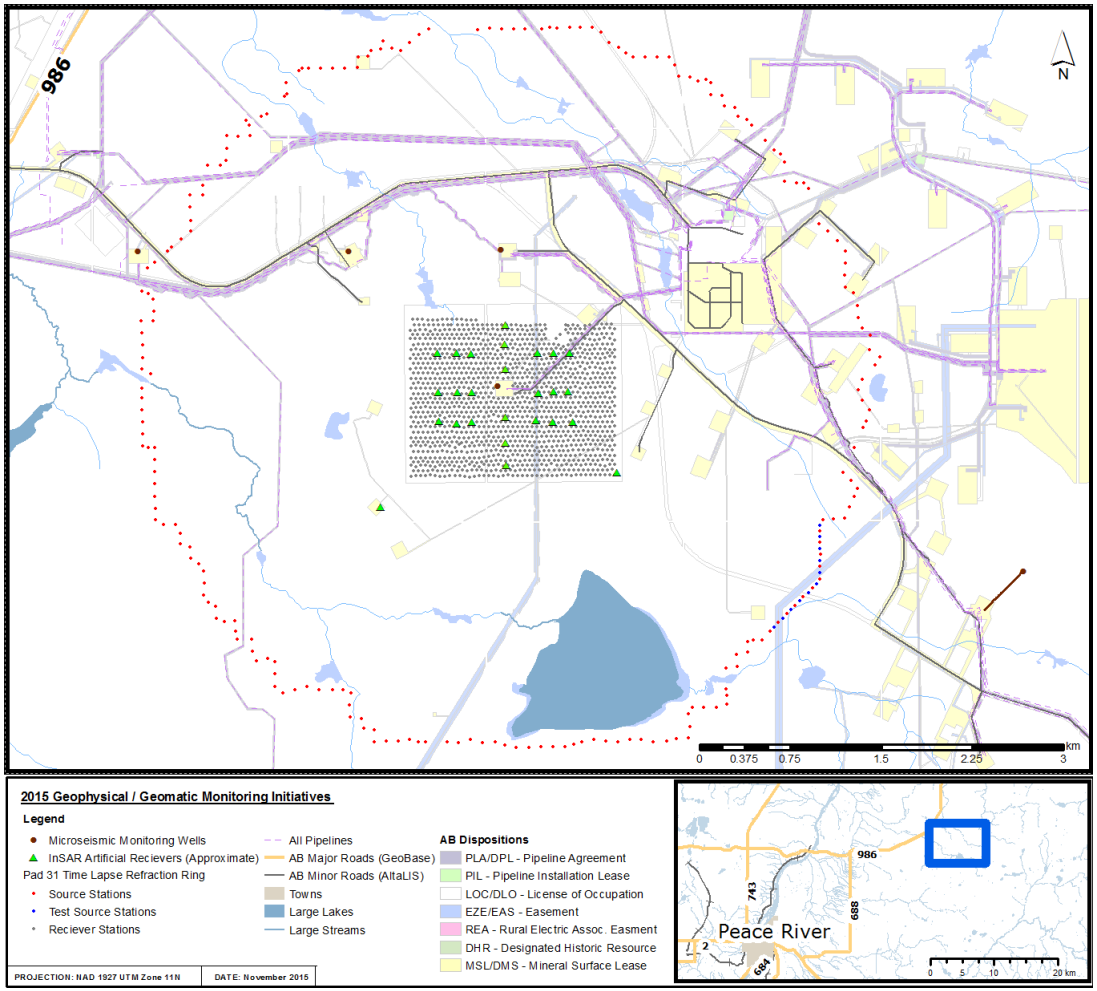


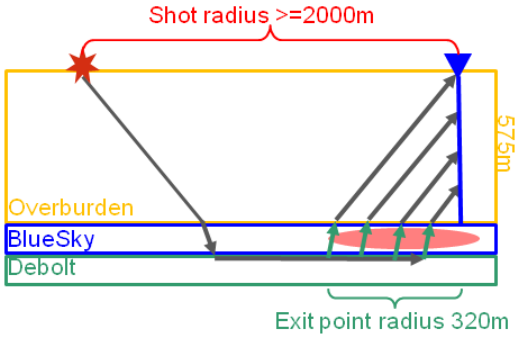
- More stable

cemented into ground

REFRACTION TRIAL AT PAD 31

- Repeat refraction surveys on Pad 31- seven acquisitions to date
- Data is currently being processed and analyzed

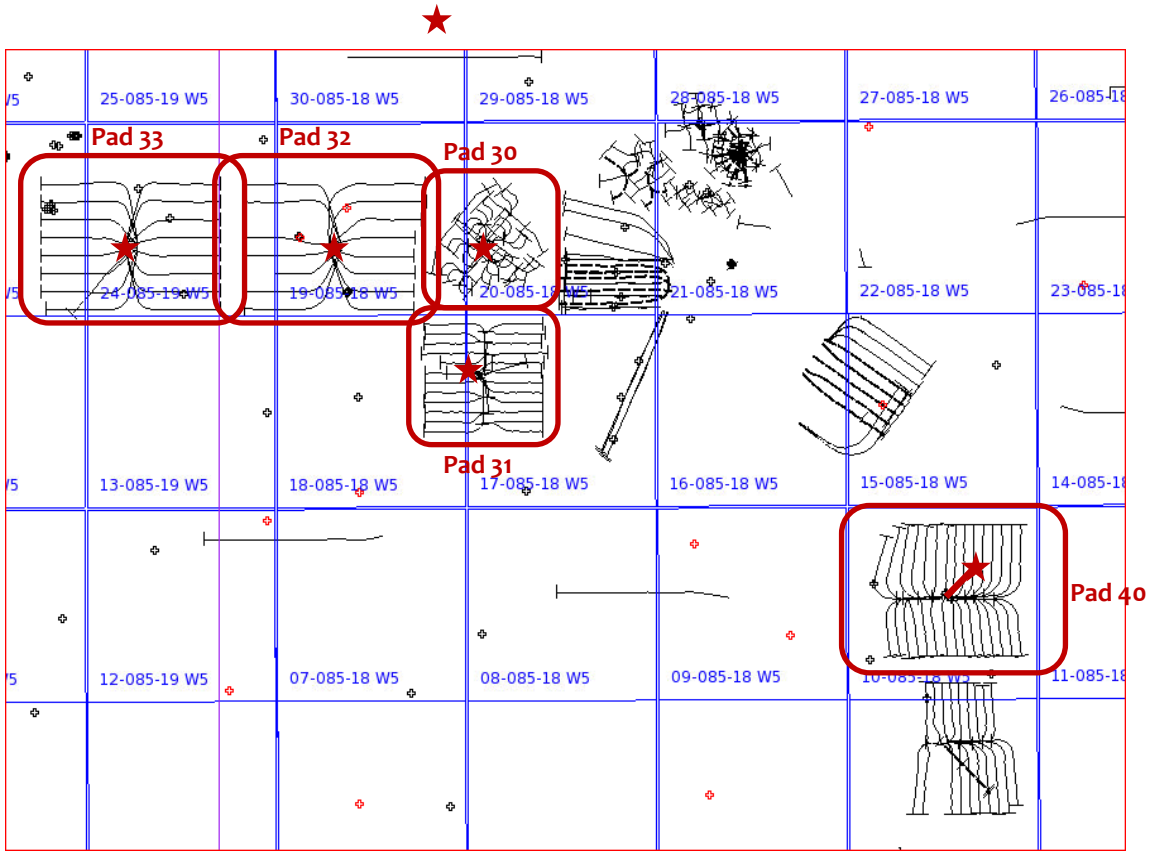




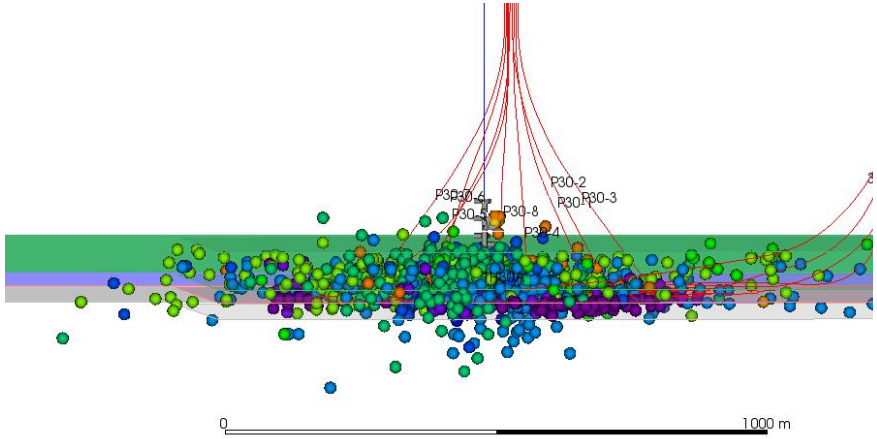
Acquisition	
Baseline ✓	Feb17-18, 2015
First Repeat ✓	Mar 16-17, 2015
Second Repeat ✓	Apr 14-15,2015
Third Repeat ✓	May 13-14, 2015
Forth Repeat ✓	June 9-10, 2015
Fifth Repeat ✓	July 7-8, 2015
Sixth Repeat ✓	Aug 25-26, 2015
Seventh Repeat ✓	Sept 22-23, 2015

MICROSEISMIC MONITORING CONTINUES

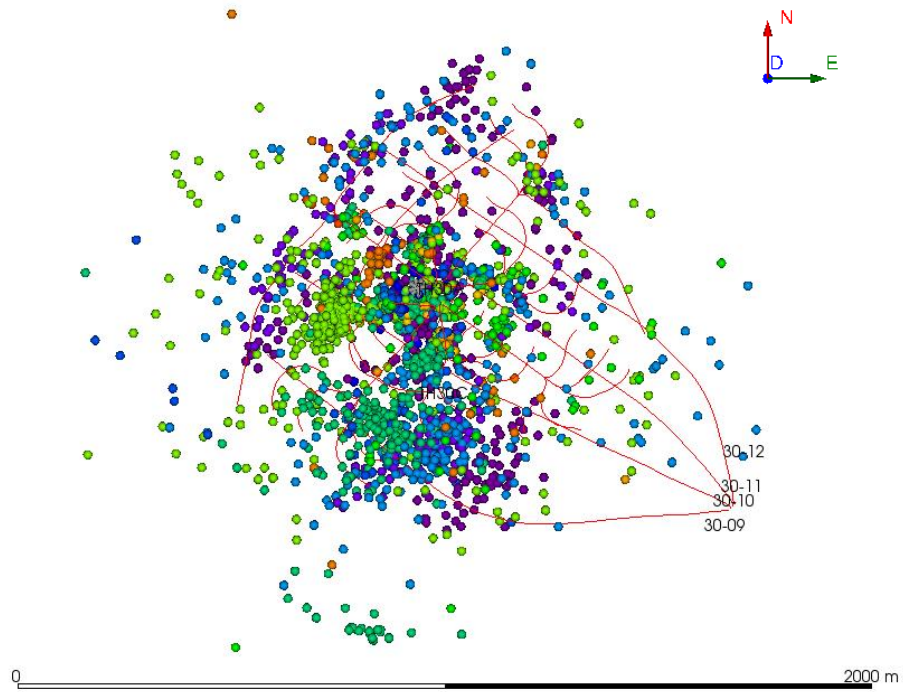
- Microseismic monitoring is ongoing at Pad 30,31,32, 33 and 40 to monitor caprock and wellbore integrity, as well for out of zone injection.
- Microseismic receiver arrays installed in the Observation wells
- Microseismic monitoring provides an early alert/detection of event activities which might correspond to possible casing failures and/or out of zone injection
- Any such event data is reported by the vendor and analyzed in-house
  to determine its significance for further
  follow-up action
- Follow- up actions can range from data
  gathering through to well interventions



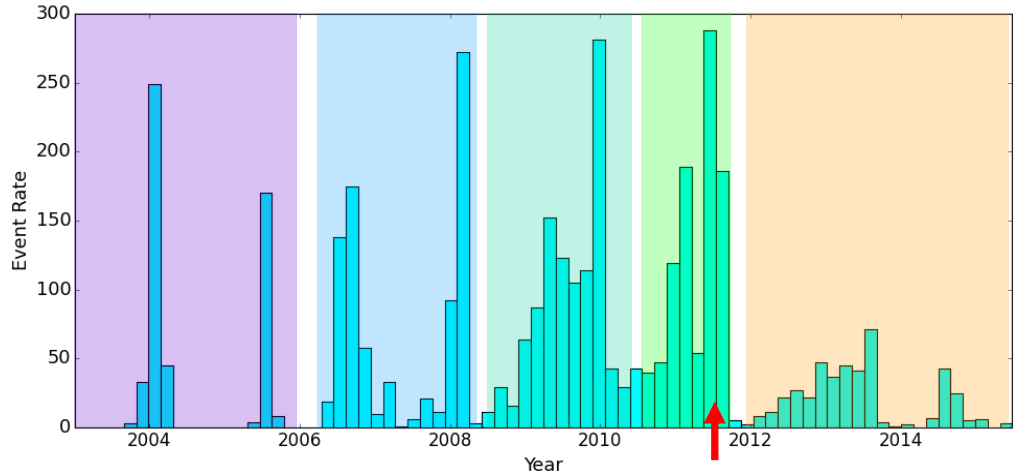
HISTORIC MICROSEISMIC AT PAD 30



Events are colored by:
Year



- Microseismic events from 2003 to 2015
- Increased number of events correspond to steam cycle timing
- Arrow indicates last CSS cycle started in April 2011
- Very few events recorded in 2014/2015
- Magnitude typically in -1.5 to - 3.5 range



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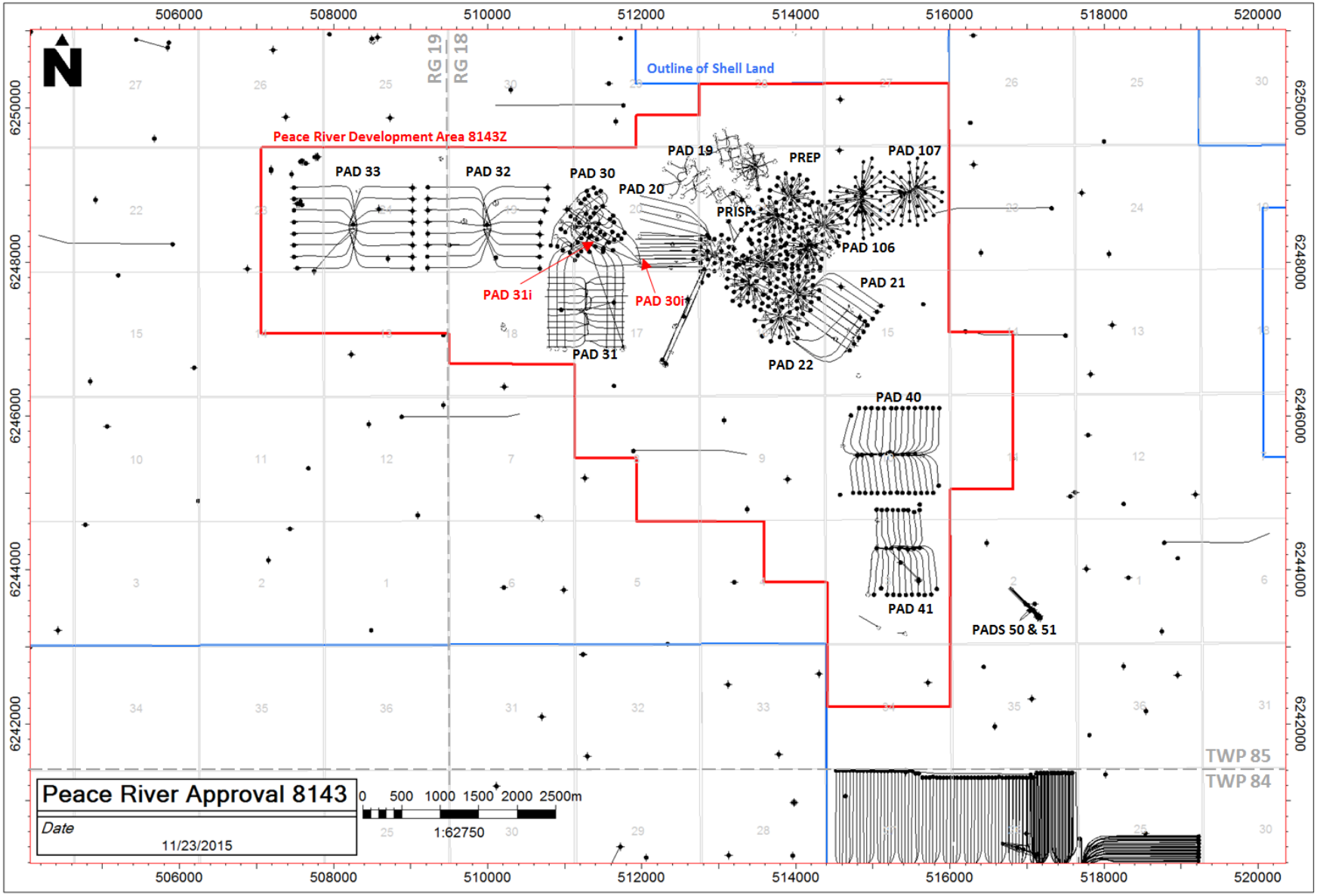
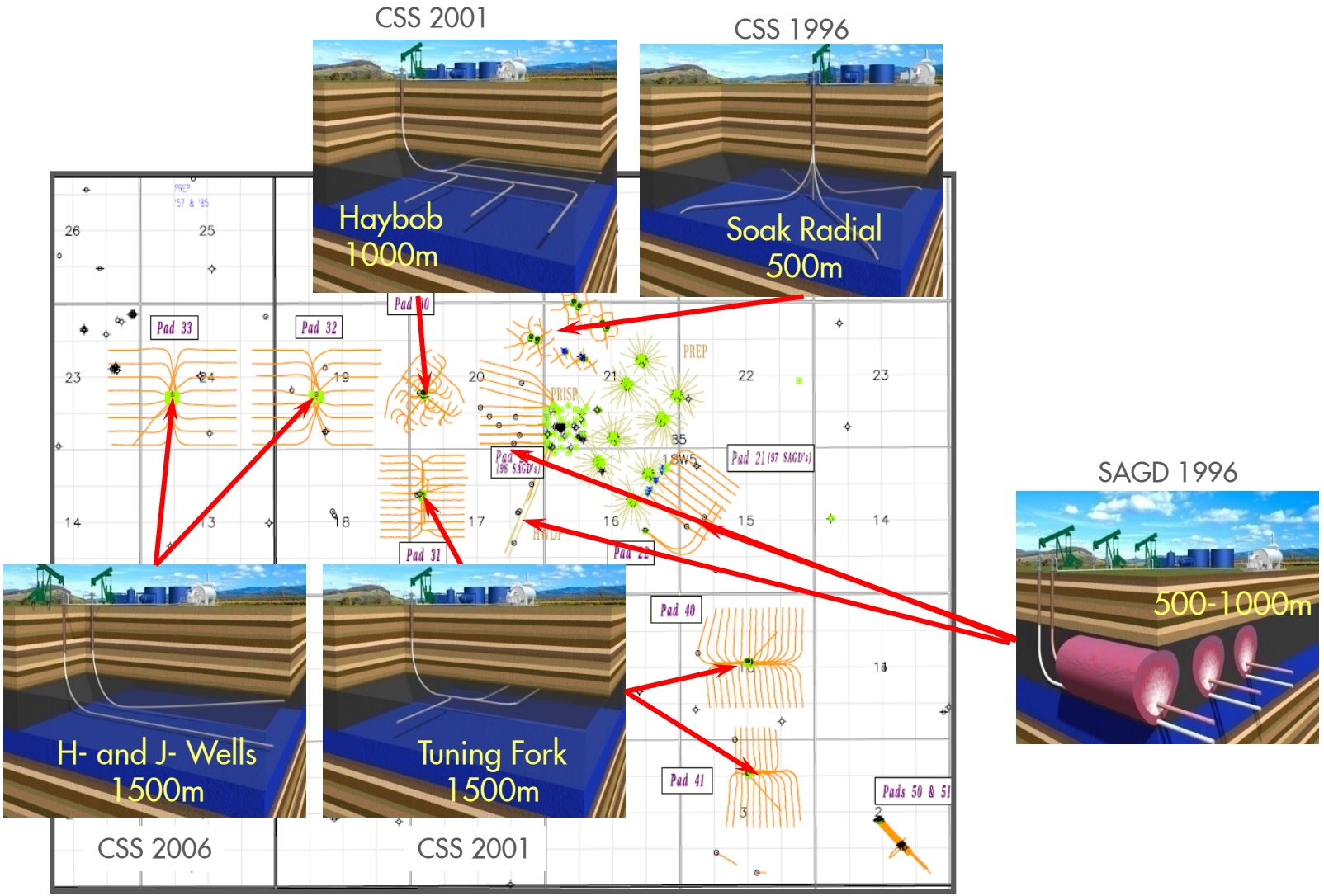
DRILLING AND COMPLETION OVERVIEW

- PRISP & PREP (1979)
  - 31 wells and 212 wells, 7 spot pattern
- Disposal Wells (1978 & 2008)
  - 3 brine disposal, 2 water disposal
- Pad 19 (1996 and infills drilled in 2011)
  - 1 test hole and 15 producers, "soak radial" design
  - Pad 19 infill wells: 10 new producers and 8 new injectors (vertical wells)
- Pad 20/21 SAGD (1997 and phase 3 infills drilled in 2011)
  - 5 well pairs, 5 dual wellbores, 9 observation wells
  - Pad 20 phase 3 injectors (4 new horizontal wells)
- Pad 30/31/40/41 Multi Laterals (2000)
  - 8 "haybob", 25 "tuning fork", 6 observation wells
- Pad 20/21 Conversions, Infills, 19 SD (2004)
  - Converted SAGD well to CCS, drilled 7 single lateral infills, 2 steam wells on pad 19
- Pad 32/33 Horizontals (2005)
  - 16 wells per pad, 3 obs wells
- Pad 22 Steam Injectors (2006)
  - 2 steam injectors running over pad 21 conversions, acting as steam drive
- Pad 30 & 31 Steam Injectors (2014)
  - 10 steam injectors 4 over Pad 30 & 6 over Pad 31
- 2 Carmon Creek Wells (2014)
  - Brine disposal well (02/15-27-85-19W5)
  - Delineation well (AA/04-26-85-18W5, D&A)
- Pad 22 Steam Injector (2015)
  - Top down Steam Drive injector 22-04
- Carmon Creek Wells 2015
  - Pad F106
    - 46 wells + 1 Observation well
  - Pad F107
    - 46 wells + 1 Observation well
  - 2 Acid gas injection well & 1 monitoring well
  - 2 water back producers

FIELD MAP


Outline of Shell Land
Peace River Development Area 8143Z
PAD 33
PAD 32
PAD 30
PAD 20
PAD 19
PREP
PAD 107
PRISP
PAD 106
PAD 21
PAD 22
PAD 31i
PAD 30i
PAD 31
PAD 40
PAD 41
PADS 50 & 51
RG 19
RG 18
TWP 85
TWP 84
Peace River Approval 8143
Date
11/23/2015
0 500 1000 1500 2000 2500m
1:62750
506000
508000
510000
512000
514000
516000
518000
520000
6250000
6248000
6246000
6244000
6242000

WELL TYPE OVERVIEW



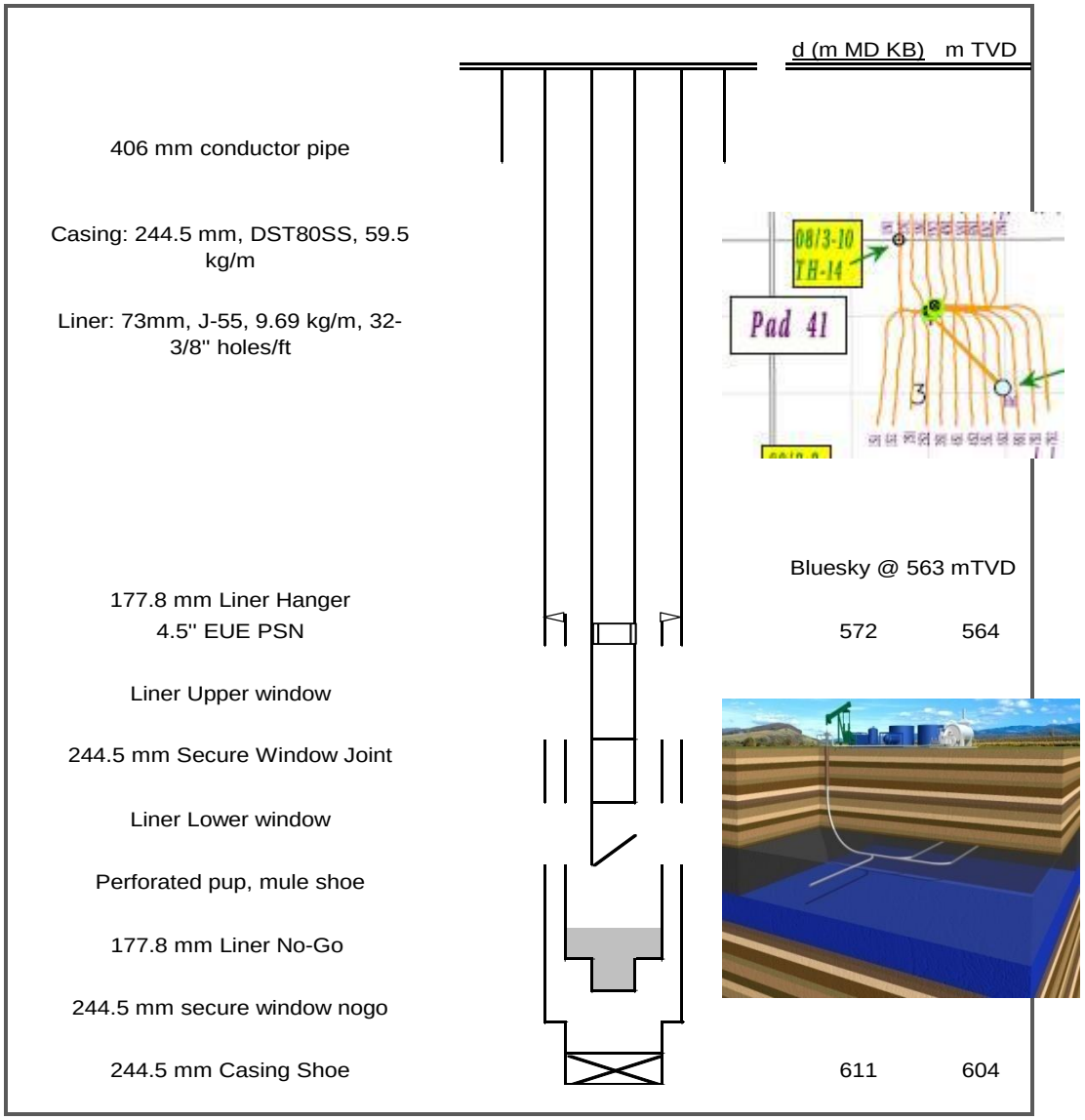
REPRESENTATIVE WELL SPACING FOR INDIVIDUAL PADS

- Pad 19
  - 100 m horizontal separation between injector and producer vertical wellbores
  - 150 m horizontal separation between producer vertical wellbores
  - Subsurface spacing variable due to soak radial geometry
- Pad 20
  - 5m vertical separation between SAGD injectors and producers
  - 100m horizontal separation between SAGD pairs and J-wells
  - 100m horizontal separation between new phase 3 infill injectors
  - 50m horizontal separation between a phase 3 injector and an original SAGD well pair
  - Vertical separation between a phase 3 injector and an original SAGD well pair is 3m to 15m
- Pad 21/22
  - 5m vertical separation between SAGD injectors and producers

  100m horizontal separation between SAGD pairs and J-wells
- Pad 21/22 (continued)
  - 90m horizontal spacing between pad 22 injectors
  - Pad 22 injectors are 10m to 17m above original SAGD producers
- Pad 30
  - Highly variable due to Haybob geometry
  - 2014 injector spacing – 150 – 250m
- Pad 31
  - 80 m horizontal separation between laterals
  - 2014 injector spacing 100m
- Pad 32
  - 150 m horizontal separation between horizontal wells
- Pad 33
  - 150 m horizontal separation between horizontal wells
- Pad 40
  - 80 m horizontal separation between laterals
- Pad 41
  - 80 m horizontal separation between laterals

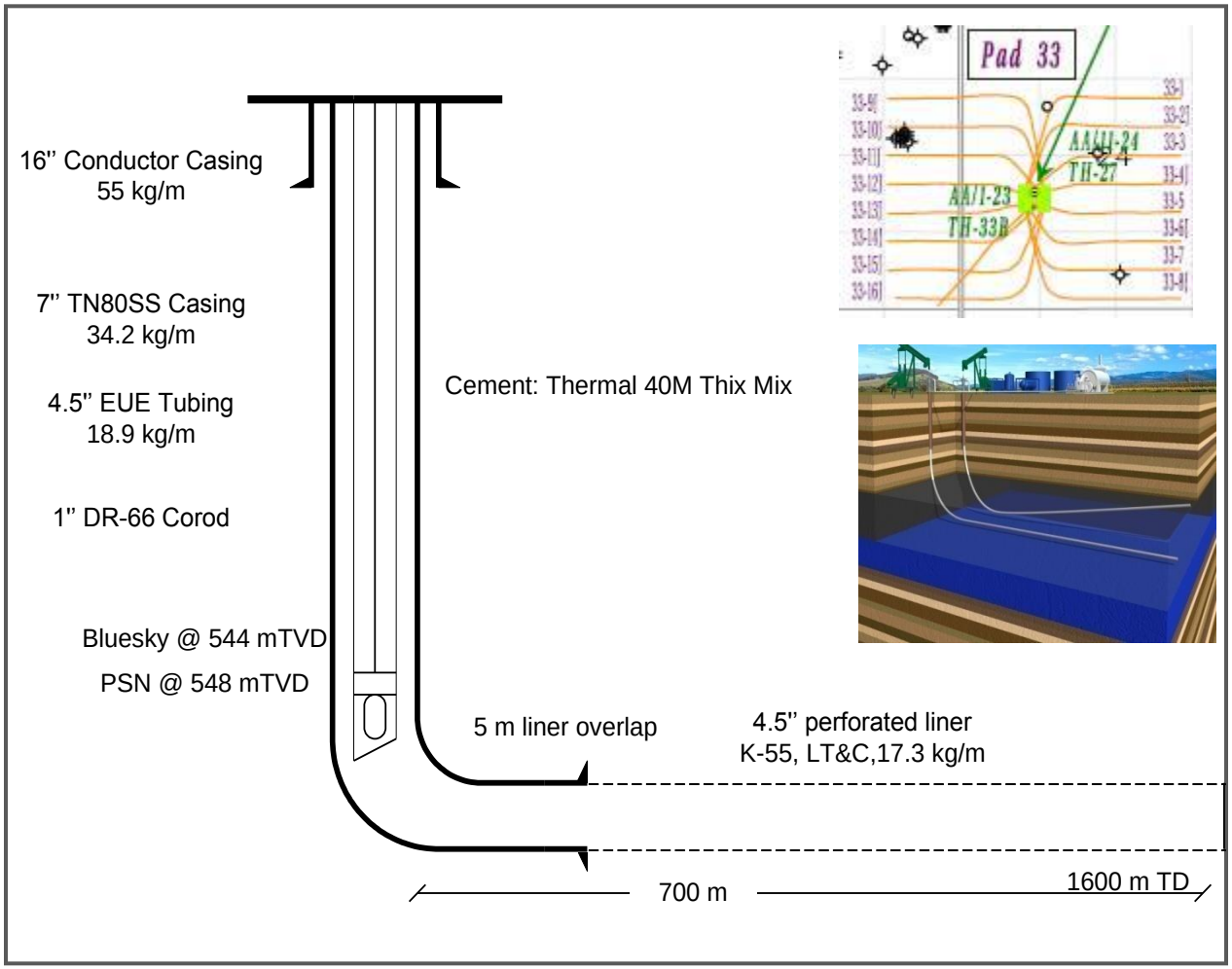
TYPICAL MULTI LATERAL PRODUCER COMPLETION

- Pads 30, 31, 40 &41
- 9 5/8'' Casing
- 7'' Window sleeve
- 2 7/8'' Liner
- Thermal 40F cement
- 4.5'' tubing
- Insert pumps
- 550-700m laterals
- During full steam cycles, the pump is removed and steam is injected down the tubing of the well.
- For mini soaks (steam injection volumes 500-2000 t) the pump is unseated and steam is injected down the casing.



TYPICAL SINGLE LATERAL COMPLETION

- Pads 32 & 33
- 7'' Casing
- 4.5'' perforated liner
- 4.5'' Tubing
- Insert pumps
- Thermal 40M cement
- 500-700 m lateral



PAD 19 SAT 3 – WELL SCHEMATIC – START-UP 2013

Producer Well Design

General Data:

Surface hole size: : 374mm (14-3/4”), depth 250m – 310m

Inclination in surface section 0º - 20º

Main hole size: 273 mm (10-3/4”), TD 590m – 688m MD (~585m TVD)

Inclination at TD 13º – 47º

Casing Data:

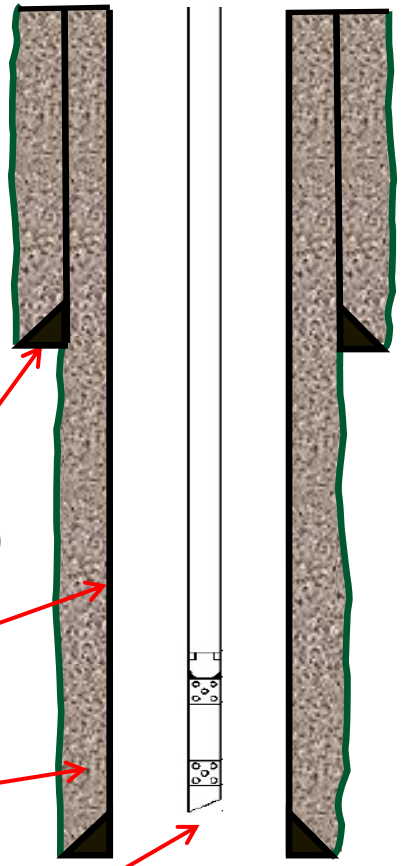
- Surface casing: 298.5mm (11-3/4”) 62.5 kg/m (42 lb) H40 STC
- Production Casing: 219.1mm (8-5/8”) 47.6 kg/m (32 lb) L80IRP TS3SB

Cement:

Both strings cemented to surface with RFC Thermal (thixotropic, ~40% silica, 1740 kg/m3)

Tubing:

88.9mm, 13.84kg/m, J55 EUE



Injector Well Design

General Data:

Surface hole size: 311mm (12-1/4”), depth 250m – 310m

Inclination in surface section 0º - 21º

Main hole size: 216mm (8-1/2”), TD 599m – 646m MD (~585m TVD)

Inclination at TD 29º – 45º

Casing Data:

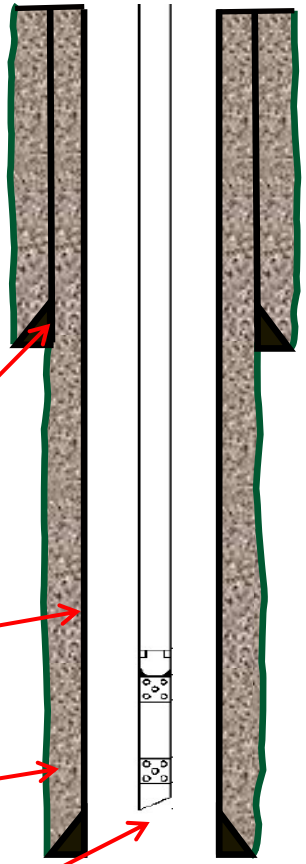
- Surface casing: 244.5mm (9-5/8”) 47.6 kg/m (32 lb) K55 TBlue
- Production Casing: 177.8mm (7”) 34.2 kg/m (23 lb) L80IRP TBlue

Cement:

Both strings cemented to surface with RFC Thermal (thixotropic, ~40% silica, 1740 kg/m3)

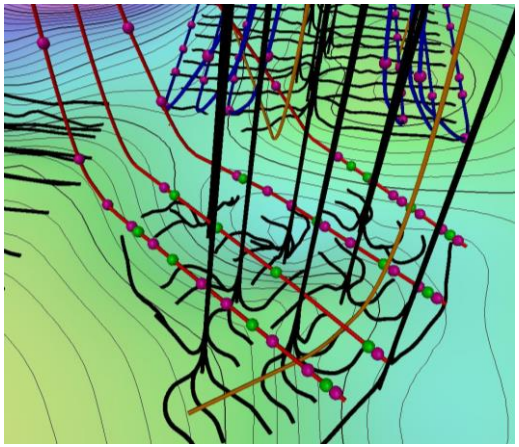
Tubing:

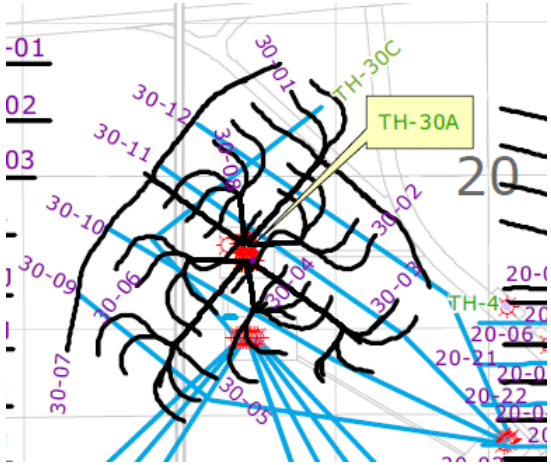
73mm, 9.67kg/m, J55 EUE

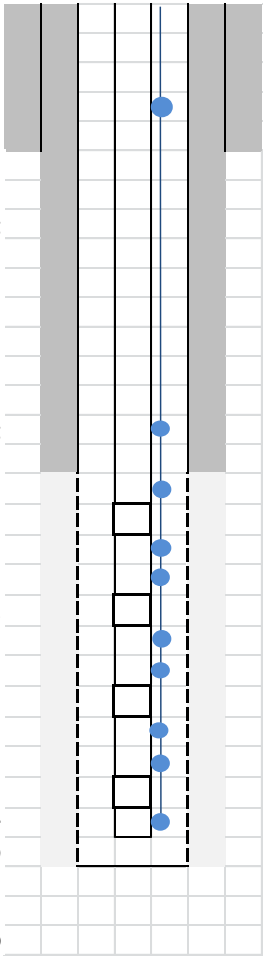


PAD 30I INJECTOR COMPLETION – START UP JAN 2015

- Pads 30i
- 4 Single Laterals
- Instrumented coil tubing with thermocouples
- 30 -11 has DTS
- 8 $^{5}/_{8}$" Casing
- 2 $^{7}/_{8}$" tubing with 4 x ½" steam subs
- 5 ½" wire wrap liner
- 400-800 m lateral







Conductor Casing 20"

Surface Casing (13 3/8" H40 81.1 STC)

Tubing
2 7/8" L80 9.67 kg/m EUE w/bullnose
4 x 4 1/4" OD steam subs x 0.25" hole per sub @ 100 m spacing
5 x 1/8" Duplex MI cable, Type K thermocouples inside 5/8" sensor tube
Cannon clamped at each collar and mid joint

Liner Top
Production Casing
10 5/8" hole x 8 5/8" L80IRP Blue 47.62 kg/m

Steam Sub 1

Steam Sub 2

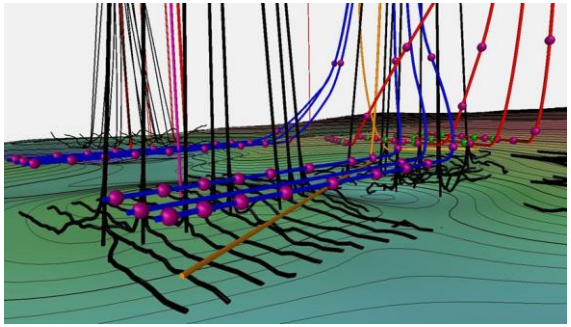
Steam Sub 3

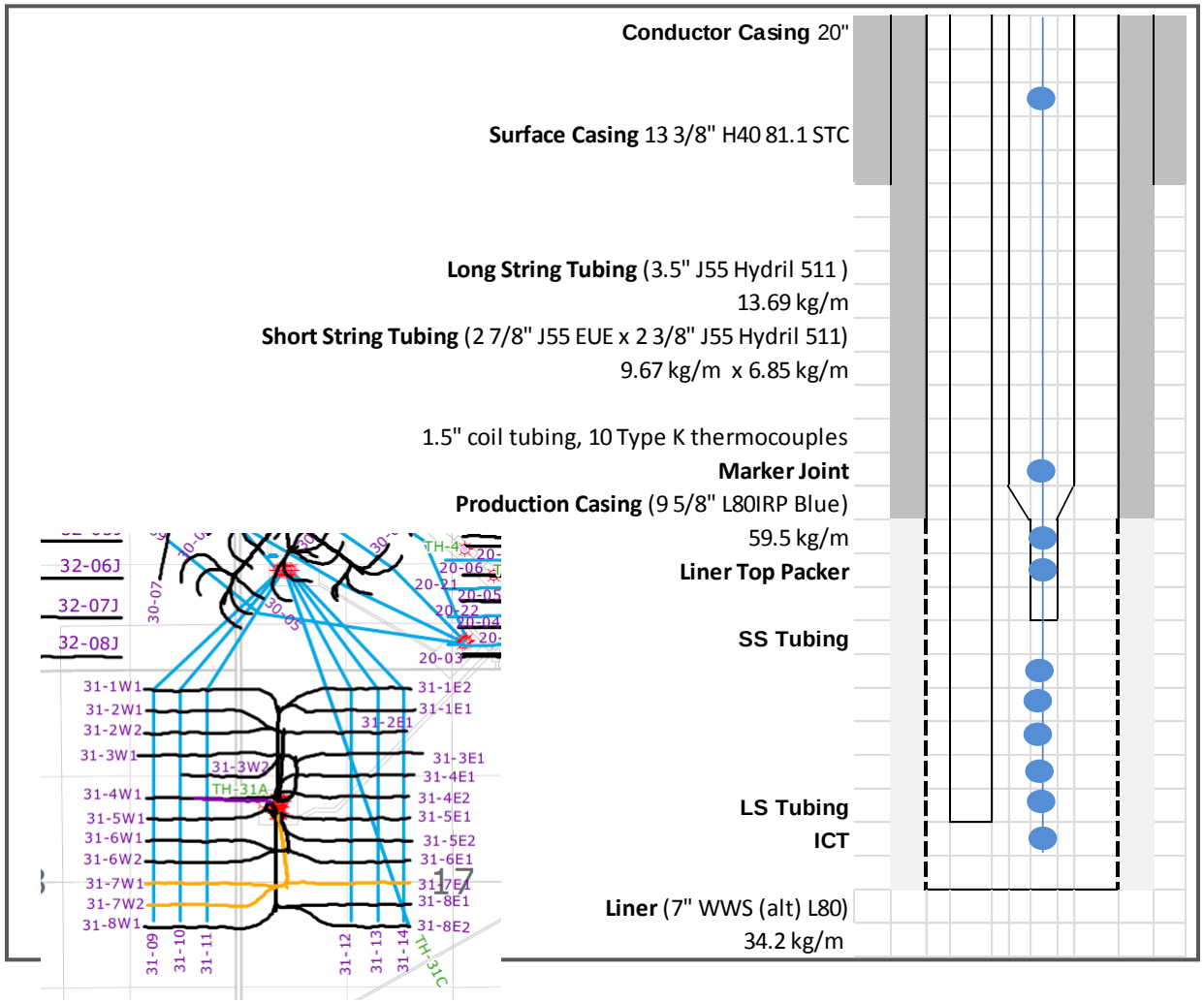
Steam Sub 4

Tubing - 10m back from liner
Liner - 10m back from TD
7 5/8" hole x 5.5" WWS (alt) L80 25.3 kg/m premium threads
Drift ID 4.767"
TD

PAD 31I INJECTOR COMPLETION – START UP NOV 2014

- Pads 31i
- 6 Single Laterals
- Instrumented coil tubing with thermocouples
- 31-10 & 31-13 have DTS
- 9 $^{5}/_{8}$'' Casing
- 3 $^{1}/_{2}$'' long string tubing
- 2 $^{7}/_{8}$'' short string
- 7" wire wrap screen liner
- 950 m lateral

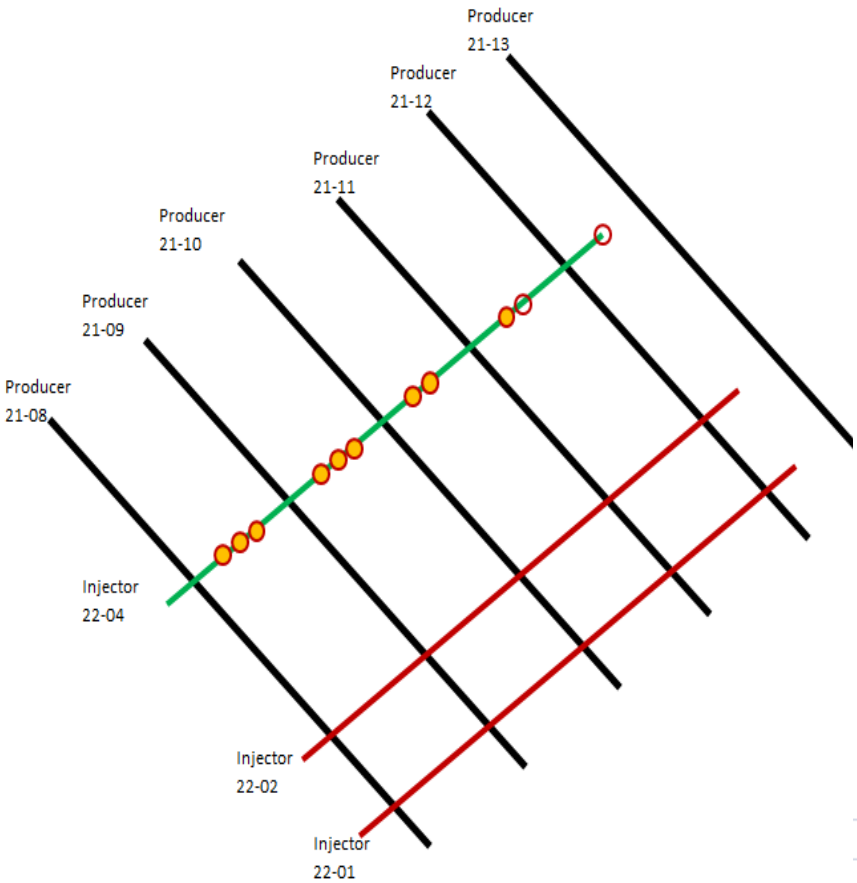




PAD 22 (22-04) – WELL SCHEMATIC – START UP NOV 2015

Well equipped with

- VIT from surface to 300 mKB
- 10 ICD subs at 4 Intervals
- 10 Type K thermocouples

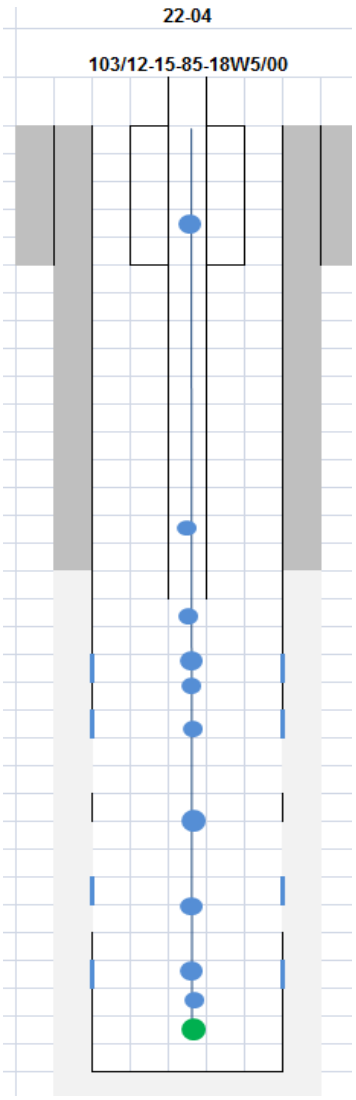


Surface Casing	
Size	339 mm
Weight	81.1 kg/m
Grade	J55 STC
mKB	301
SC Cement Top	Surface

Production Casing	
Size	244 mm
Weight	59.53 kg/m
Grade	L80 IRP T-Blue
mKB	859
PC Cement Top	Surface

Tubing	
Size	88.9 mm
Weight	9.67 kg/m
Grade	J55
mKB	830

Liner	
Size	177 mm
Weight	34.23 kg/m
Grade	L80 DWC/C
Liner, mKB	1305
Open hole TD, mKB	1314

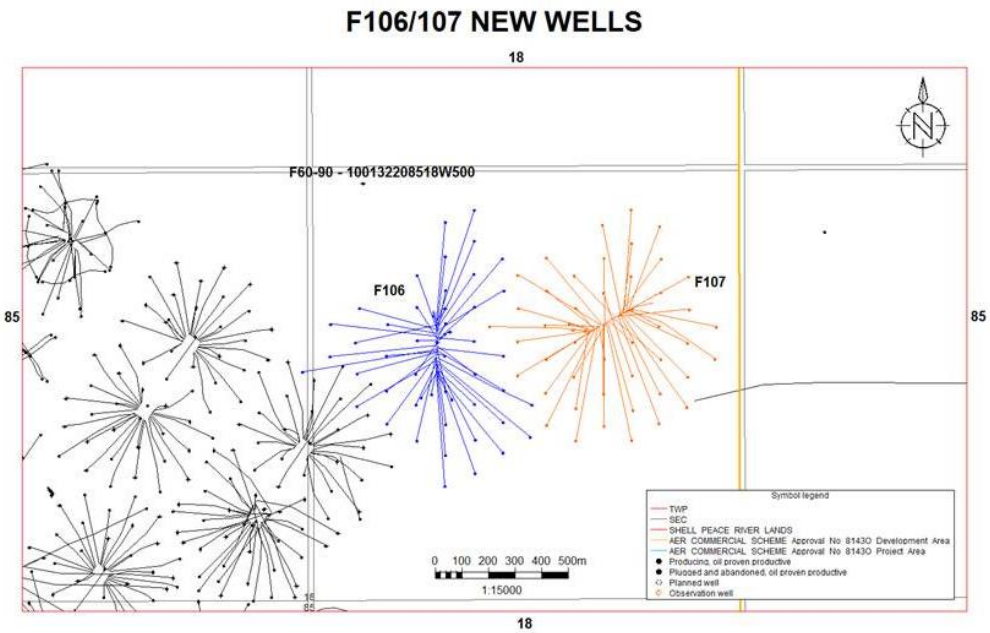


CARMON CREEK PAD WELLS

Two key findings led to the decision to proceed to recover bitumen in the resource development area using VSD, complemented by CSS:

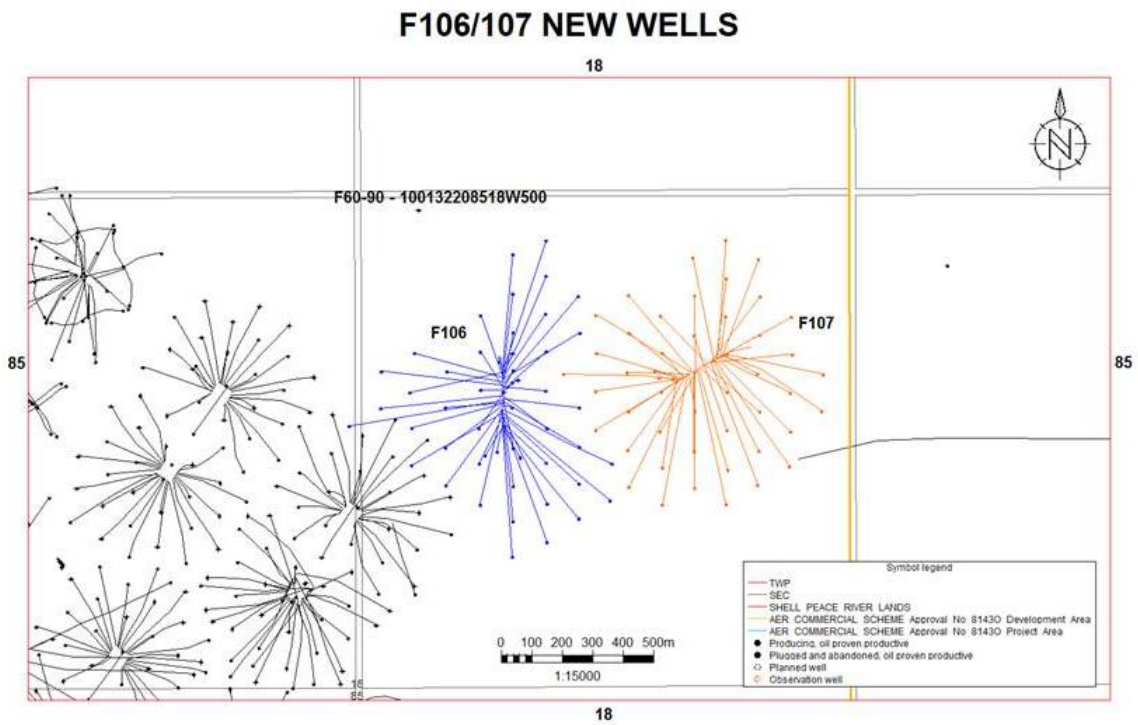
- Vertical permeability in the Bluesky is much lower than expected based on results from core analyses and logs. This low permeability is created by small-scale shale barriers that prevent vertical gravitational flow (rising steam, sinking bitumen), and eliminate any recovery technique that relies on gravity drainage
- Steam injectivity with vertical wells is high enough to allow bitumen recovery within the Bluesky because of initial water mobility in the formation, even above the bottom water zone

Further details can be found in application #1637869 Volume 1, Section 4.2 - the Application for Approval of the Carmon Creek Project (AER approval #8143O)



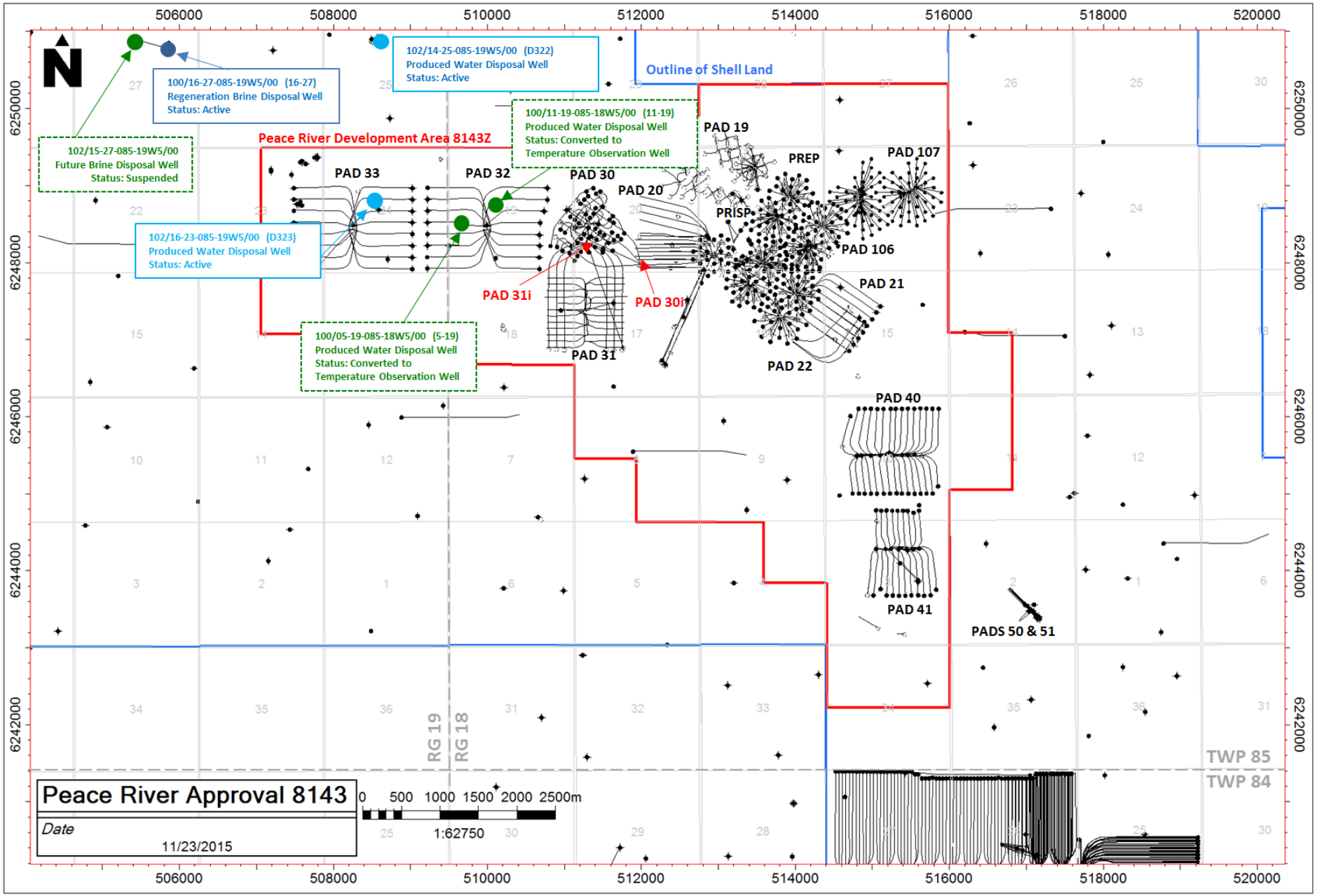
CARMON CREEK PAD WELLS

- **Pad 106** production wells
  - 43 production wells, 3 surface holes
  - Drilled Sept 2014-Oct 2015
  - No completion
  - Standing, to be suspended
- **Pad 106-90 Observation well**
  - Drilled Sept 2014-Sept 2015
  - Two external pressure gauges @ 324 and 509 mMD
  - No completion
  - Standing, to be suspended
- **Pad 107** production wells
  - 46 production wells
  - Drilled Apr – Aug 2015
  - No completion
  - Standing, to be suspended
- **Pad 107-90 Observation well**
  - Drilled Apr 2015
  - Two external pressure gauges @ 310 and 510 mMD
  - No completion
  - Standing, to be suspended



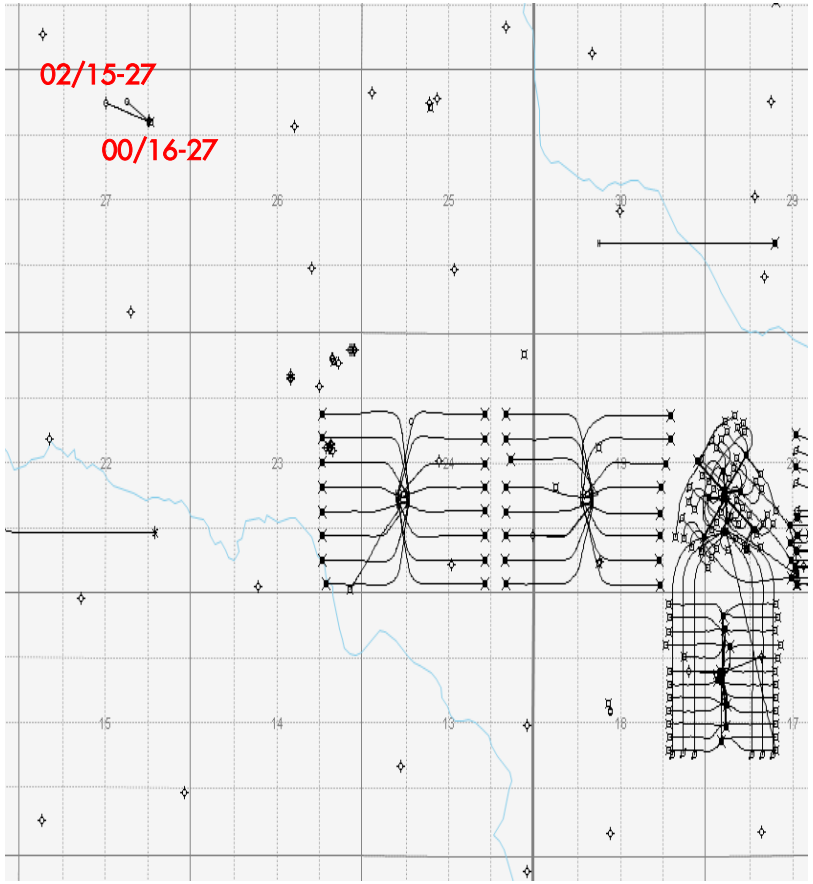
- **Pad 101, 104, and 105**
  - Civil earthworks complete
  - Conductors installed
- **Pad 102 and 103**
  - Civil earthworks completed
- **Pad 108, 109 and 110**
  - Licensed, no field work executed

DISPOSAL WELL LOCATIONS

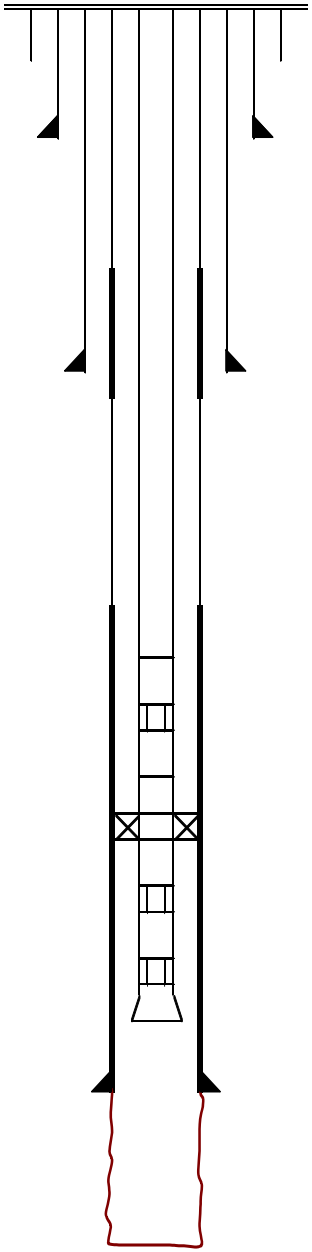


TYPICAL BRINE DISPOSAL WELL COMPLETION- 15 &16 - 27

Softener regeneration waste water is currently disposed into the 16-27 well. 02/15-27 Standing back up brine disposal well.

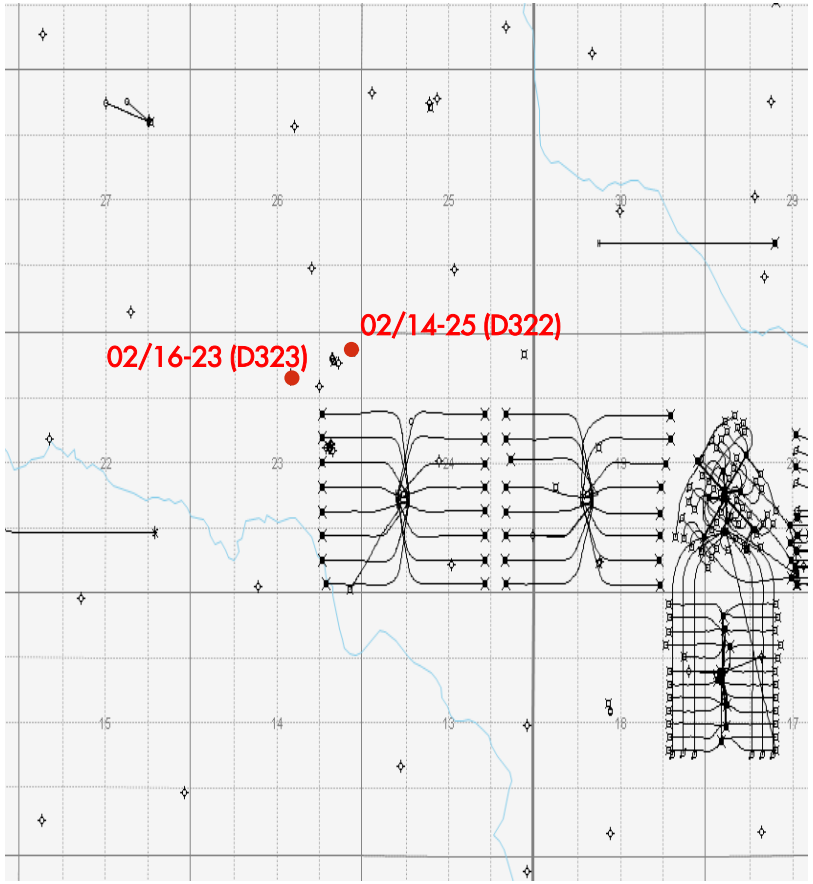


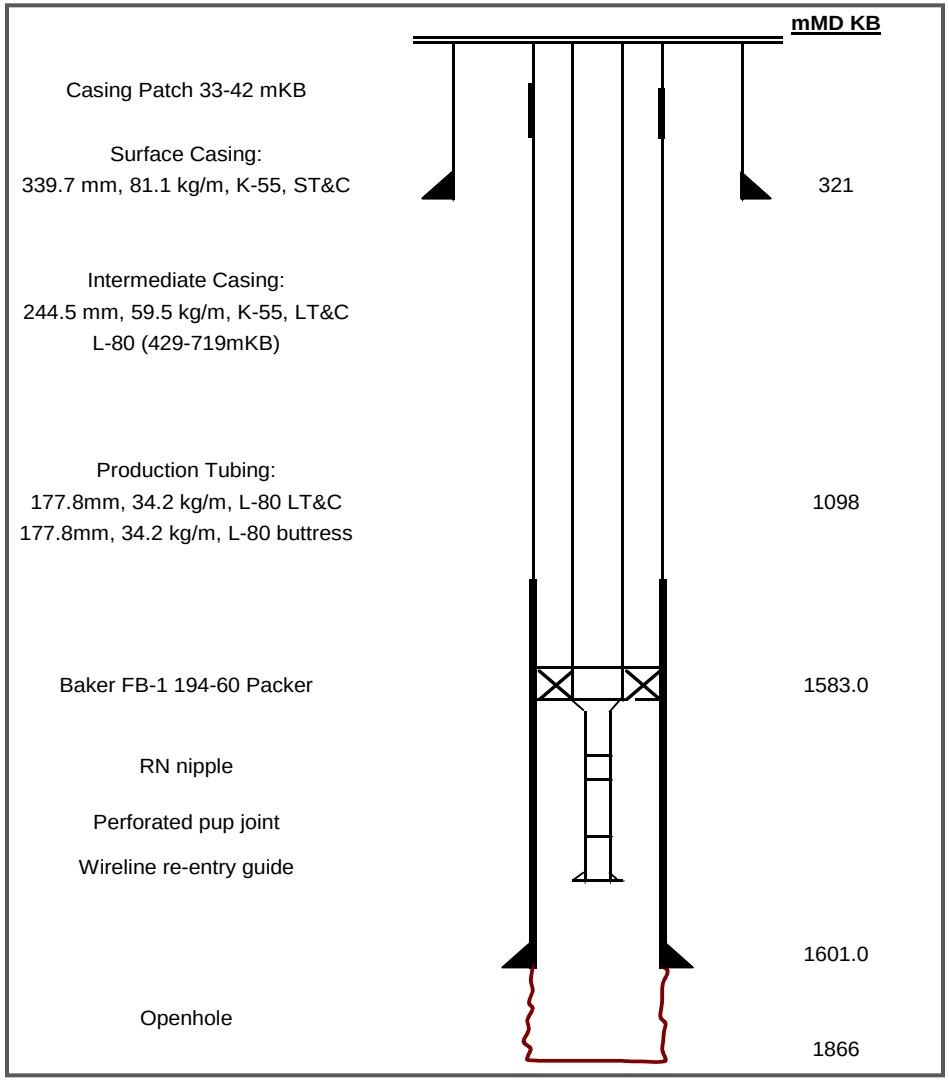
	mMD KB
Conductor 508 mm	~20
Surface Casing 339.7 mm, 81.1 kg/m, J-55, ST&C	261
Base Groundwater Protection	381
Intermediate Casing 244.5 mm, 53.4 kg/m, J-55, LT&C	680
Production Tubing 88.9 mm, 13.8 kg/m, L-80, Hydril 553 to 1557 m *Internally coated w/ TK-69 (5.3 - 8.8 mil thick)*	1547.8
OTIS X nipple (89 mm, Hydril 553, ID - 69.85 mm)	1554.3
Baker Model K22 Anchor Seal (89 mm, Hydril 553)	1560.8
Baker Model SAB-3 Production Packer (89 mm, Hydril 553)	1562.2
OTIS X nipple (89 mm, Hydril 553, ID - 69.85 mm)	1565.6
OTIS XN nipple (89 mm, Hydril 553 x EUE, ID - 69.85 x 66.93 mm)	1569.0
Baker Wireline Re-Entry Guide (140 mm x 89 mm, EUE)	1569.2
Production Casing 177.8 mm, 34.2 kg/m, L-80, NSCC-M & LT&C **NSCC-M Casing: 472 - 722 m & 1519 - 1577m**	1576.8
Openhole 158.8 mm	1777



TYPICAL PRODUCED WATER DISPOSAL WELL COMPLETION

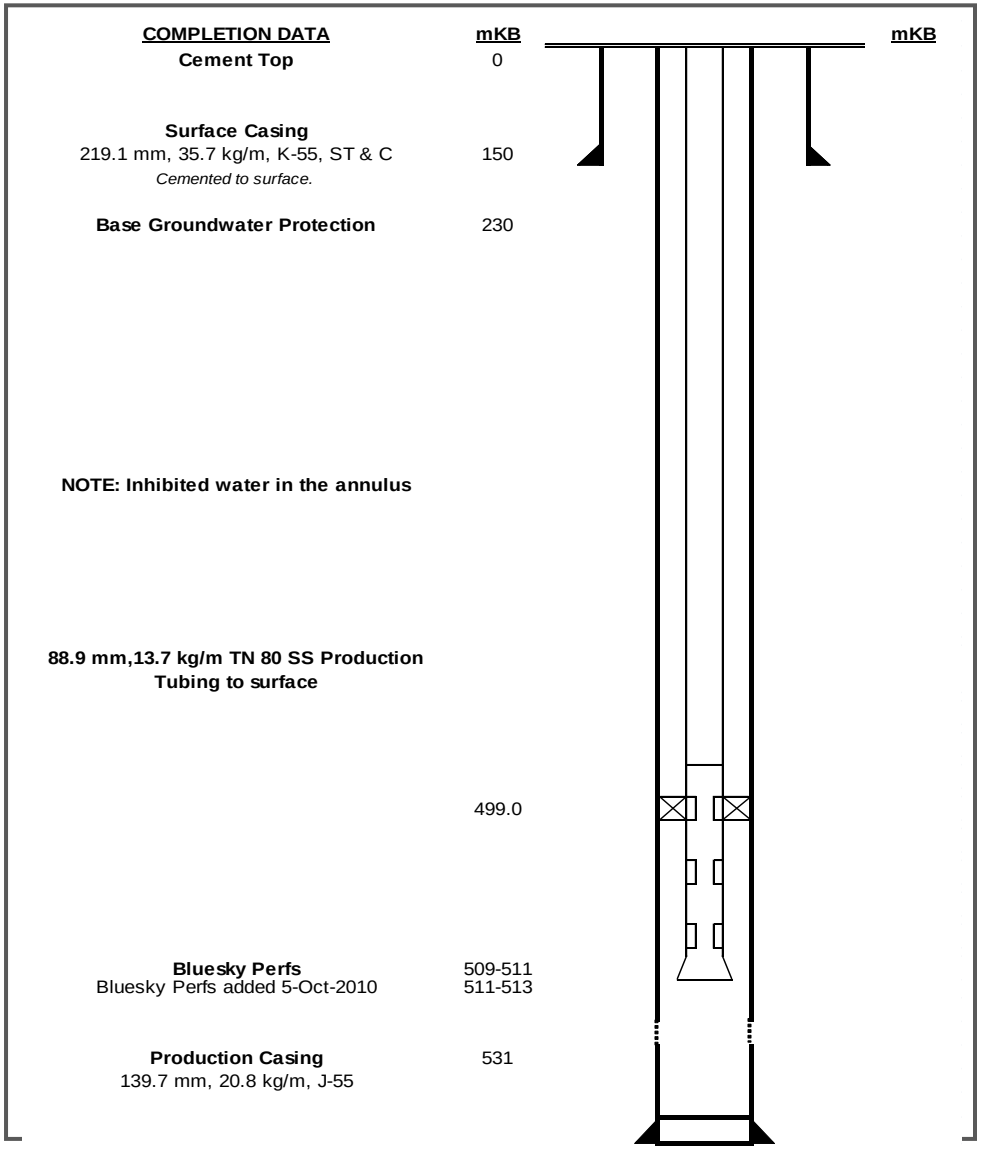
02/16-23 & 02/14-25 dispose of produced water and boiler blowdown into the Leduc formation.





SOUR GAS INJECTION WELL COMPLETION

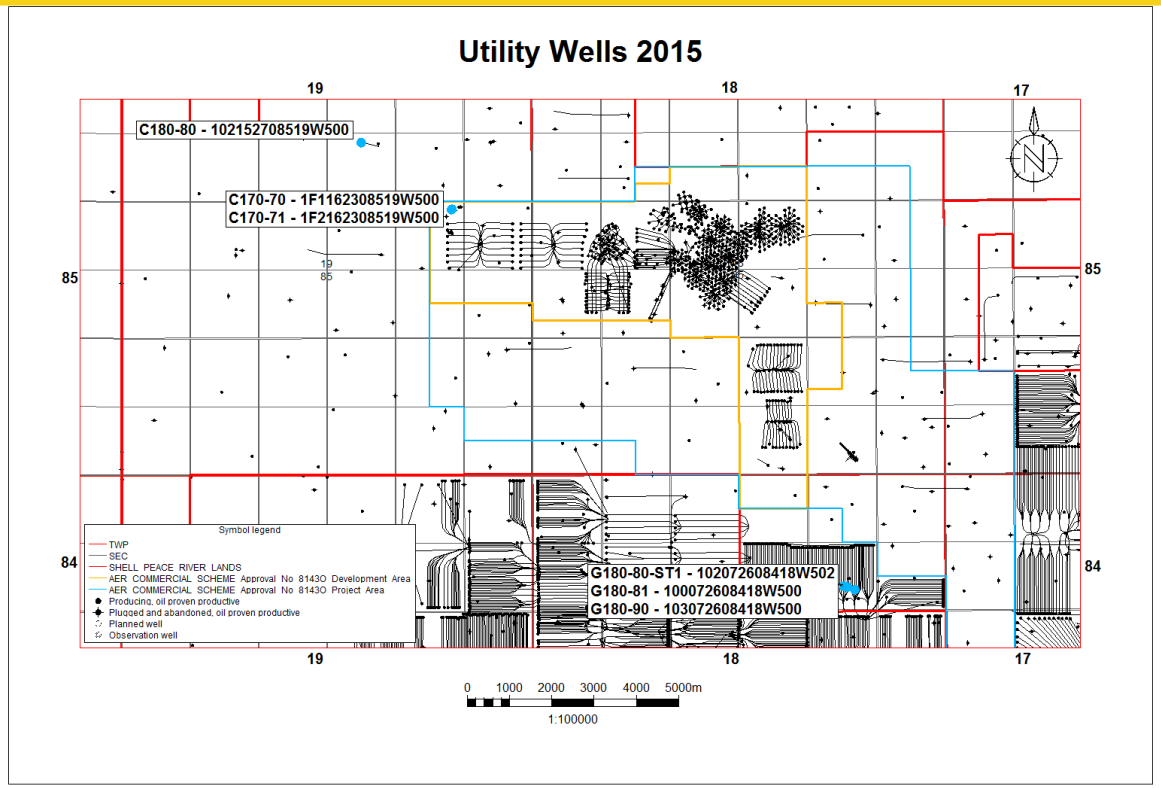
- The 8-11 sour gas injector was completed Nov 2009 as part of the Three Creeks Sour Gas Storage project.
- Injection started Aug 2010.



CARMON CREEK UTILITY WELLS (LEDUC)

Oct 2014 – Oct 2015:

- C180-80 Brine Injection Well Completion
  - Drilled Mar/Apr 2014
  - Completed
  - Suspended
- G180-80 and G180-81, Two injectors
  - Drilled Sept-Dec 2014
  - G180-80 required acid wash, step rate test OK
  - Perforated (50m) liner across Middle Leduc
  - No completion hardware installed
  - Suspended
- G180-90, One monitor well
  - Drilled Sept-Dec 2014
  - TD in Winterburn Formation
  - No completion
  - Suspended
- C170-70 and C170-71, Water back producers
  - Drilled Dec 2014 – Jan 2015
  - Did not reach target depth on either well
    - C170-70 cemented intermediate casing @ 1603 mKB, called TD
    - C170-71 int casing @ 1610 mKB, drilled and open to TD @ 1776 mKB
  - No completion
  - Suspended



TODAY'S AGENDA

Introductions and Background	Ivan Gonzalez
Subsurface Issues Related to Resource Evaluation and Recovery	
Geology/Geoscience	Victoria Walker
Geophysics	Barbara Wingate
Drilling and Completions	Dan Syrnyk
Artificial Lift	Dan Syrnyk
Instrumentation in Wells	Dan Syrnyk
Well Integrity	Dan Syrnyk
Scheme Performance	Laura Mislan
Future Plans	Pasquale Riggi
Surface Operations, Performance and Compliance	
	Darcy Forman

ARTIFICIAL LIFT – ROD PUMPING EQUIPMENT

Pumping Units: Max.Capacity:

- Pumpjacks:144″ – 260″ stroke
  - Lufkin/Legrand Pump Jacks 280 m3/d
  - Rotaflex: 288″ stroke 250 m3/d

Automation:

- Pump Off Controllers(POC): load cells, motor sensor, crank sensor, VFD
- XSPOC: Real-time pump cards
- LOWIS: Pilot deployed in August 2015

Pumps:

- Insert rod pumps, 2.0 – 3.25″ barrel, 1″ continuous rod, rod string designs
- Continuous improvement initiatives ongoing (improved rod-string designs, POC pump checks, dynagraph verification, fluid shots, etc.), POC fluid level verification

Stuffing Boxes:

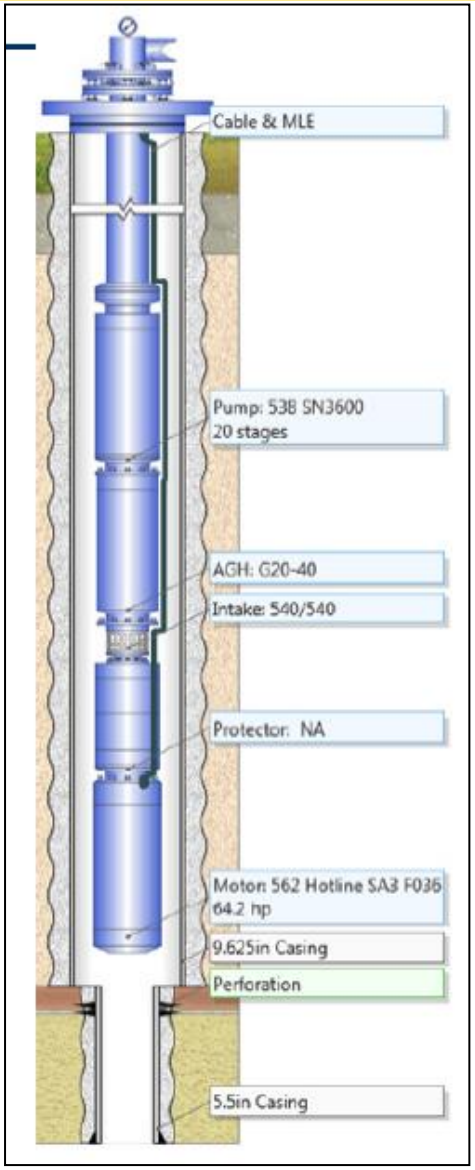
- High temperature stuffing boxes are installed on every pumping well. The cone packing is used while pumping and it has rubber elements with brass supports.
- Packing Leak Containment devices (complete with high-level- shut-down switches) have been installed on all wells.
- There have been no offsite emulsion releases in 2015

ARTIFICIAL LIFT – ESP WELLS

Pumping Units:	Max.Capacity:
▪Schlumberger ESP D2400N SA-3	360 m3/d
▪ Schlumberger ESP D1800N SA-3	280 m3/d

Automation:

- Downhole pressure and temperature monitoring to optimize subcool
- ESP's equipped with VSD



ESP Completion

TODAY'S AGENDA

Introductions and Background	Ivan Gonzalez
Subsurface Issues Related to Resource Evaluation and Recovery	
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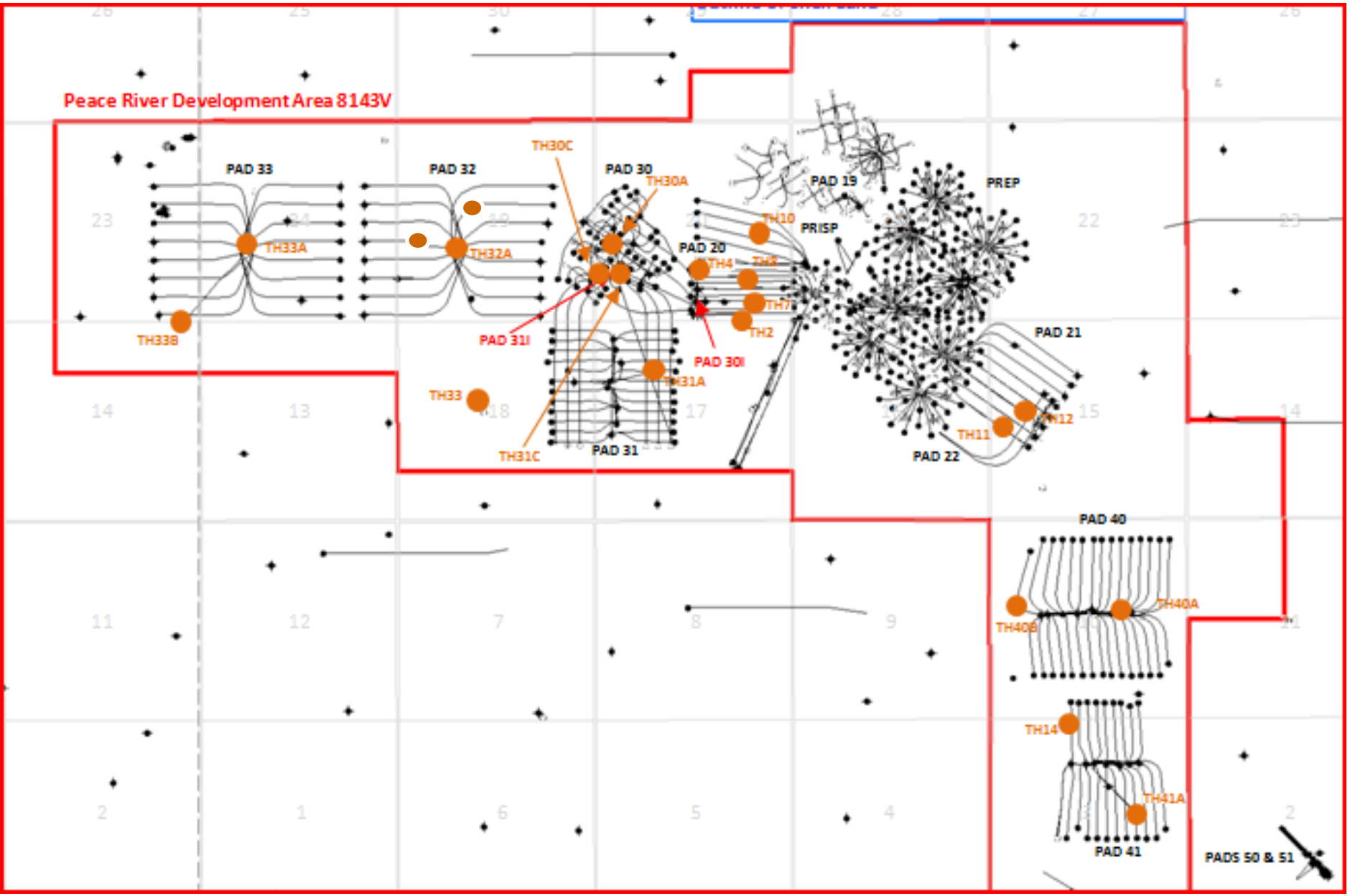
OBSERVATION WELLS - 19 Wells Over Existing Pads



ACTIVE OBSERVATION WELLS

Well Name	Type of observation well
TH33	Pressure and temperature
TH33A	Temperature and micro seismic
TH33B	Temperature
TH32A	Temperature and micro seismic
TH30A	Temperature and micro seismic
TH31A	Temperature and micro seismic
TH6	Temperature
TH7	Temperature
TH8	Temperature
TH9	Temperature
TH10	Temperature
TH11	Temperature
TH12	Temperature
TH40A	Temperature and micro seismic
TH40B	Temperature
TH14	Temperature
TH41A	Temperature
D320 (5-19)	Temperature via DTS
D321 (11-19)	Temperature – DTS install to be Q4 2014
12-35	Pressure

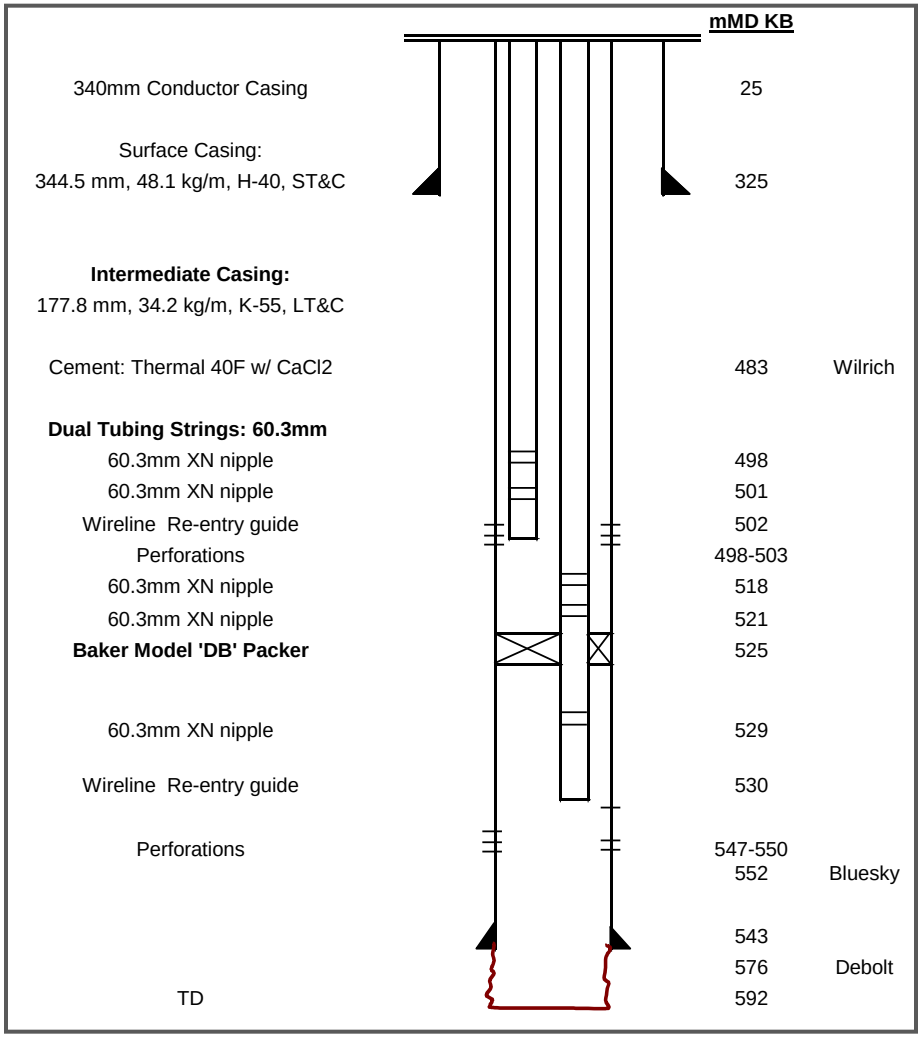
TEMPERATURE OBSERVATION WELLS

Well	Pad	Current Max Temp (°C)	Current Avg Temp (°C)	Temp trend (last 7 d)
TH-6	P20	39	33	↑
TH-7	P20	73	38	↓
TH-8	P20	148	79	↓
TH-9	P20	99	82	↑
TH-10	P20 I	87	71	→
TH-11	P21	47	44	→
TH-12	P21	208	187	→
TH-30A	P30	57	52	→
TH-31A	P31	57	52	↓
TH-32A	P32	20	19	↑
TH-33A	P33	20	19	↓
TH-33B	P33	80	55	↑
TH-40A	P40	43	36	↓
TH-40B	P40	134	106	→
TH-41A	P41	45	34	↓
TH-14	P41	26	25	↓

THREE CREEKS

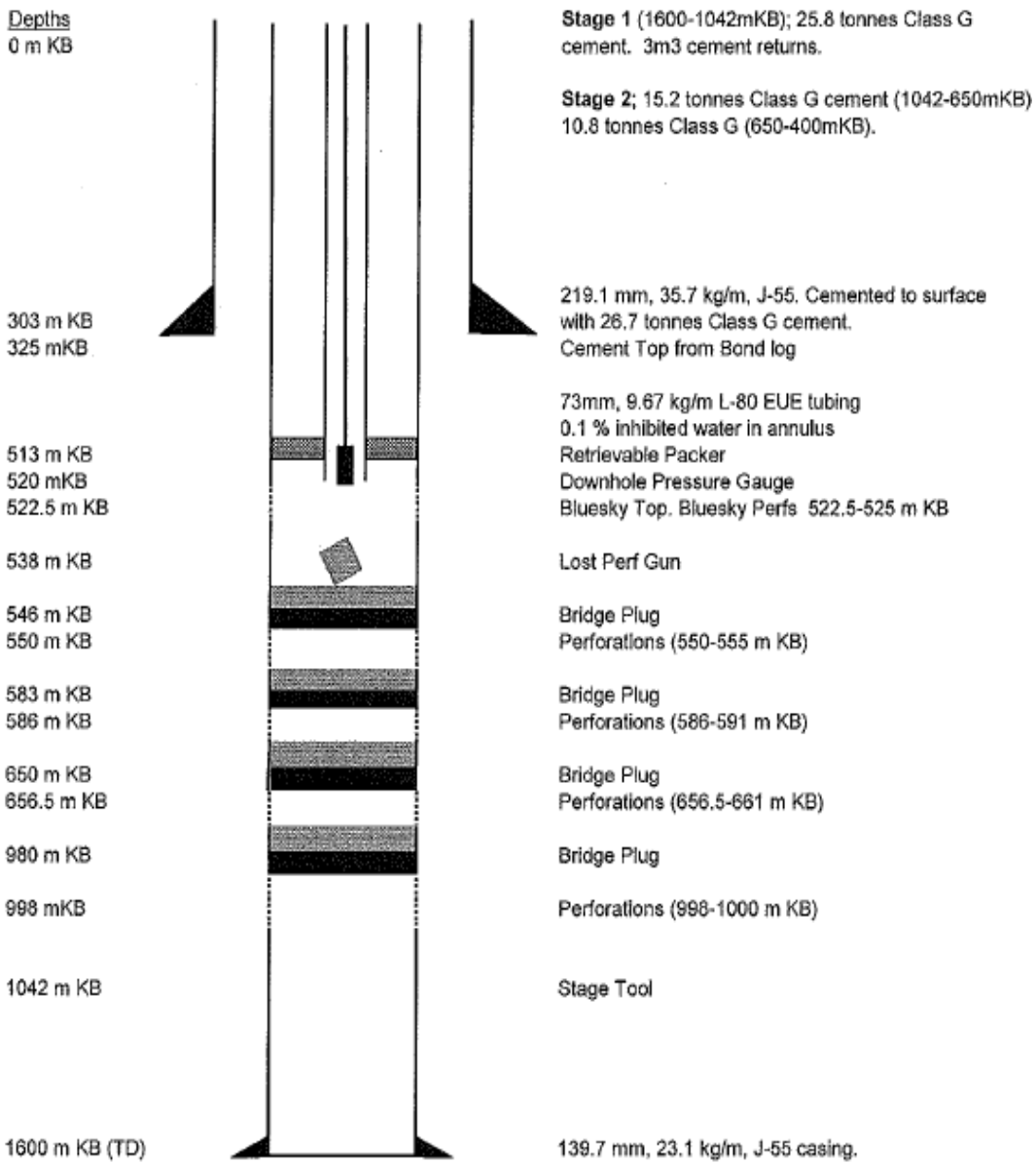
	Current P (kPa)	P trend (last 7 d)
12-35	2633	↑

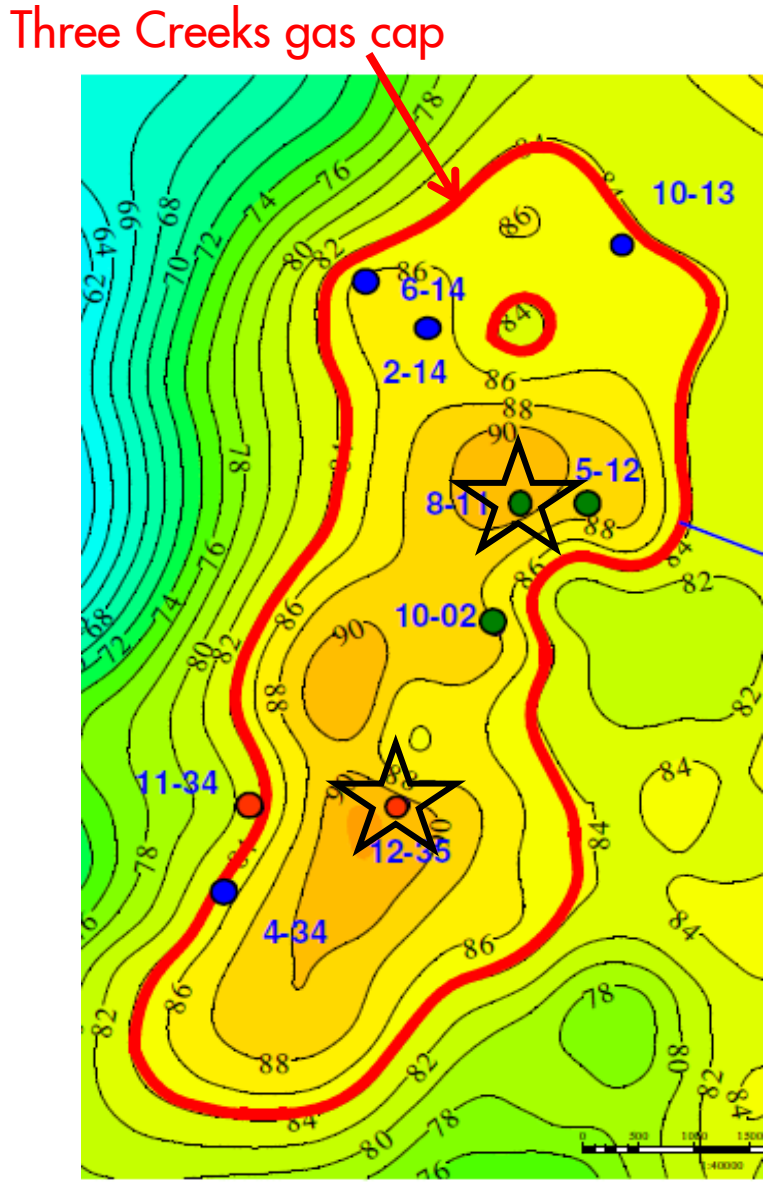
PRESSURE MONITORING OF WILRICH –WELL TH33



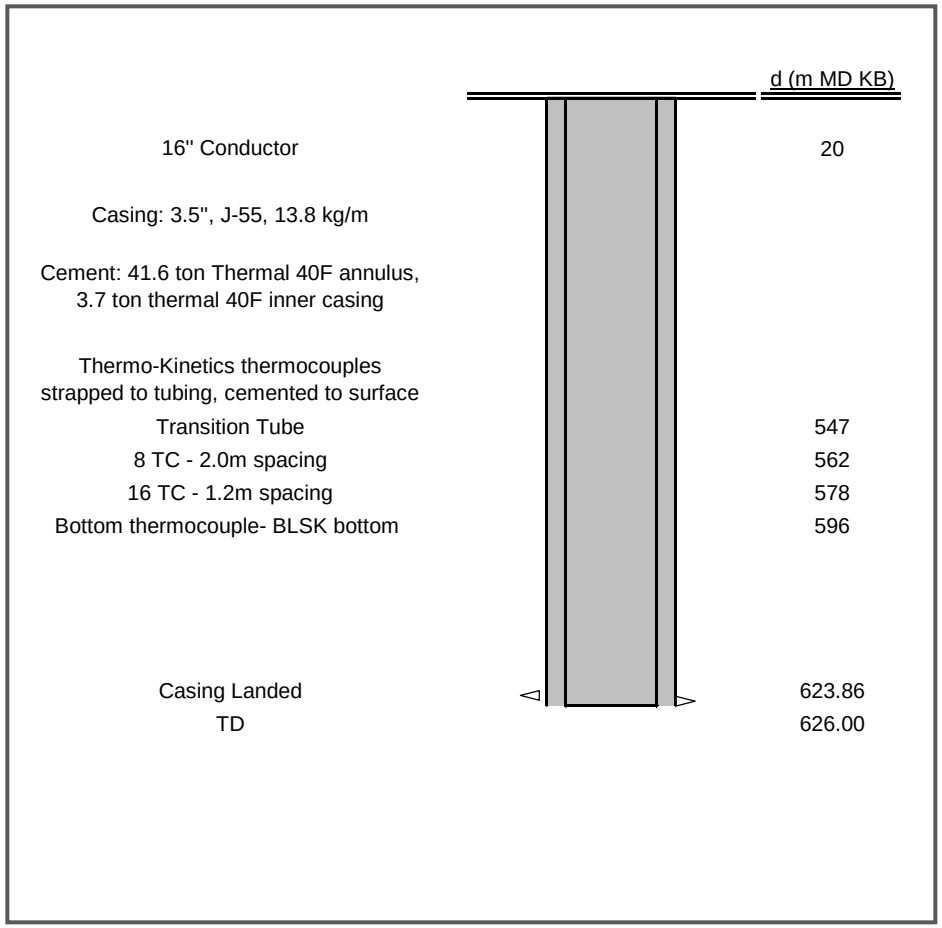
- Wilrich shale pressure and temperature are monitored. The Bluesky gauge failed in 2007.

THREE CREEKS PRESSURE OBSERVATION WELL 12-35



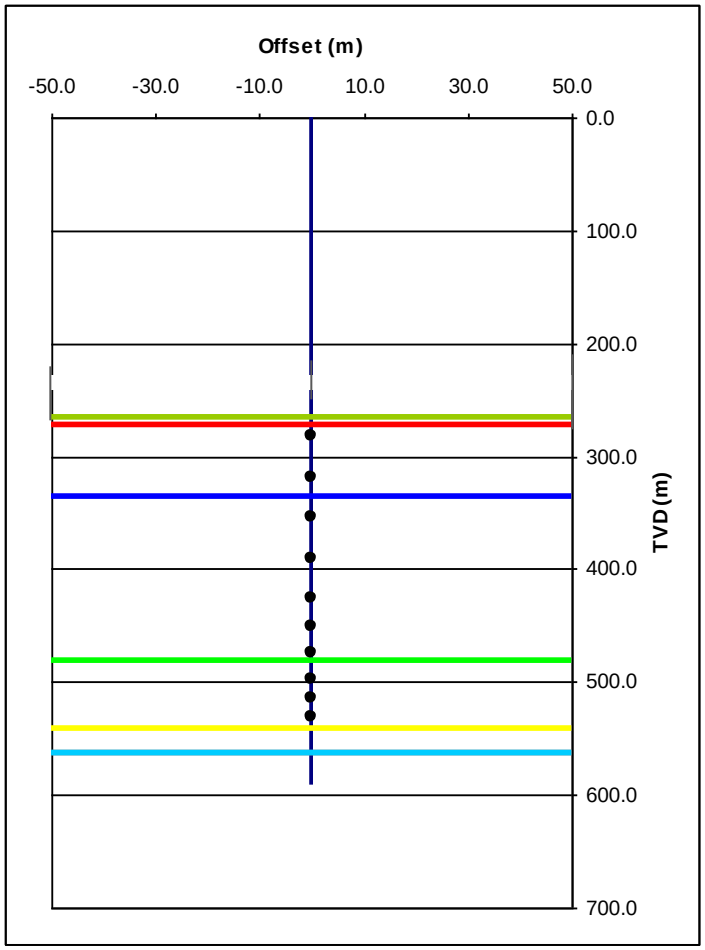


TEMPERATURE OBSERVATION WELL COMPLETION – TH40-B



- Thermocouples situated from the Wilrich to the Debolt formations to monitor steam chamber rise and temperature variations over cycle(s). The thermocouples are cemented in the well to surface.

OBSERVATION WELL – GEOPHONE LOCATIONS



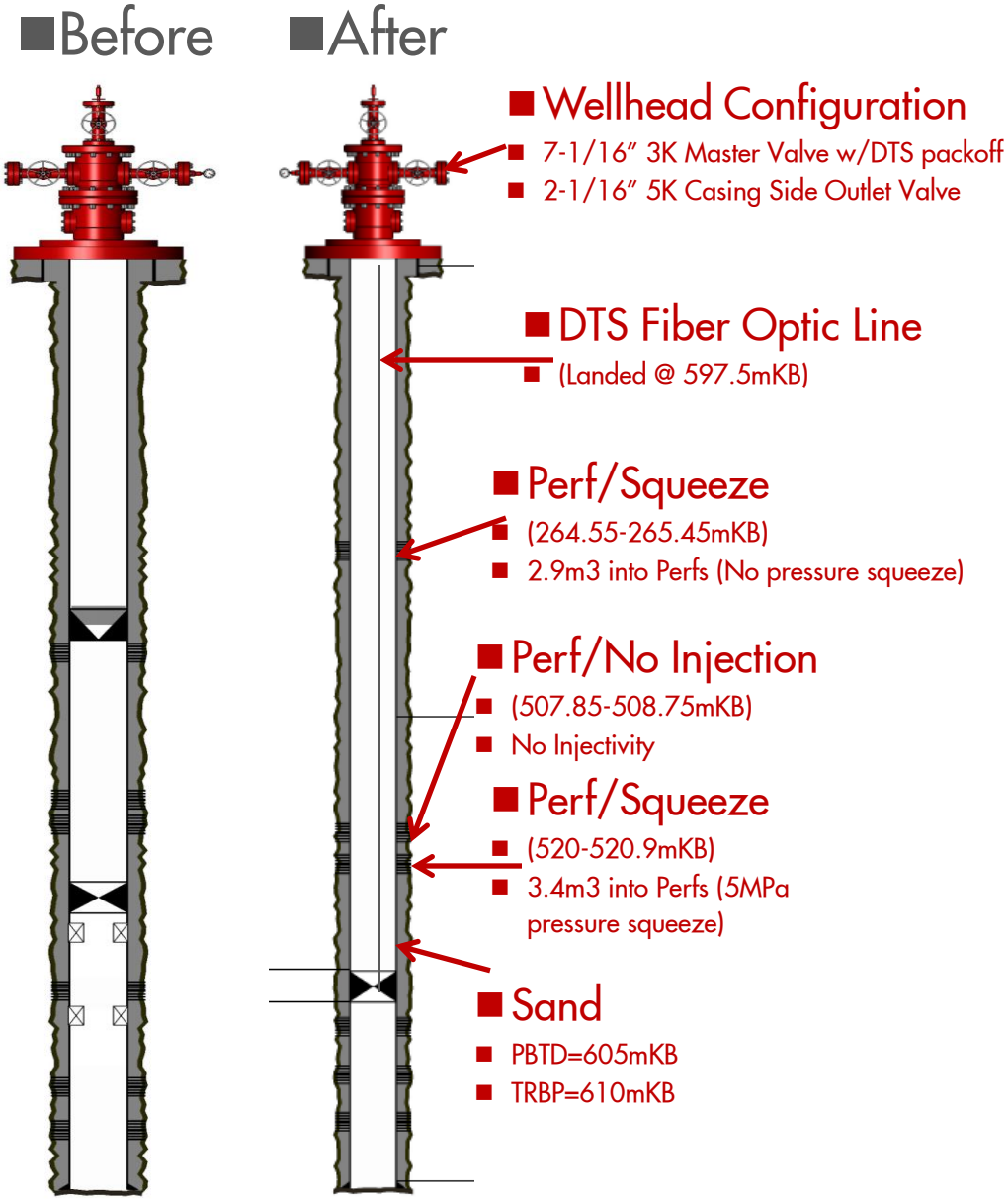
Geophones located in Obs wells:

TH40A, TH30A, TH31A, TH32A, TH33A

Geophones placement

Paddy/Cadotte	
Harmon Shale	
Notikewan	
Falher	
Wilrich	
Bluesky	
Detrital	
Debolt	

2014 DTS INSTALLATION AT 00/05-19-85-18W5 (D320)



- The 5-19 water disposal well was drilled and completed with the 11-19 well in 1978 as part of the PRISP (Peace River In Situ Pilot) disposal scheme
- The well injected produced water until 1986, and then water softener backwash brine, until 2009, into the Debolt formation.
- Observed casing head pressures of around 16MPa, though a hydraulic pressure test later confirmed casing and bridge-plug integrity.
- Obtained cement, behind-casing fluid, and integrity data by means of caliper, ultrasonic, and saturation logs on the 5-19 well.
- Well perforated in the Wilrich (520 – 520.9 mKB) and cement squeezed with T-Mix thermal cement.
- Drilled out cement and logged to evaluate isolation – Confirmed isolation to the Bluesky however wanted to ensure we had better isolation above.
- Re-perfed 507.85 – 508.75 – obtained no injectivity – confirmed pressure integrity to 10 Mpa at perf face.
- As per the AER requirements we perfed 264.55 – 265.45 mKB and performed a cement squeeze (to isolate the Paddy Cadotte)
- Isolation was confirmed - Installed DTS Fiber

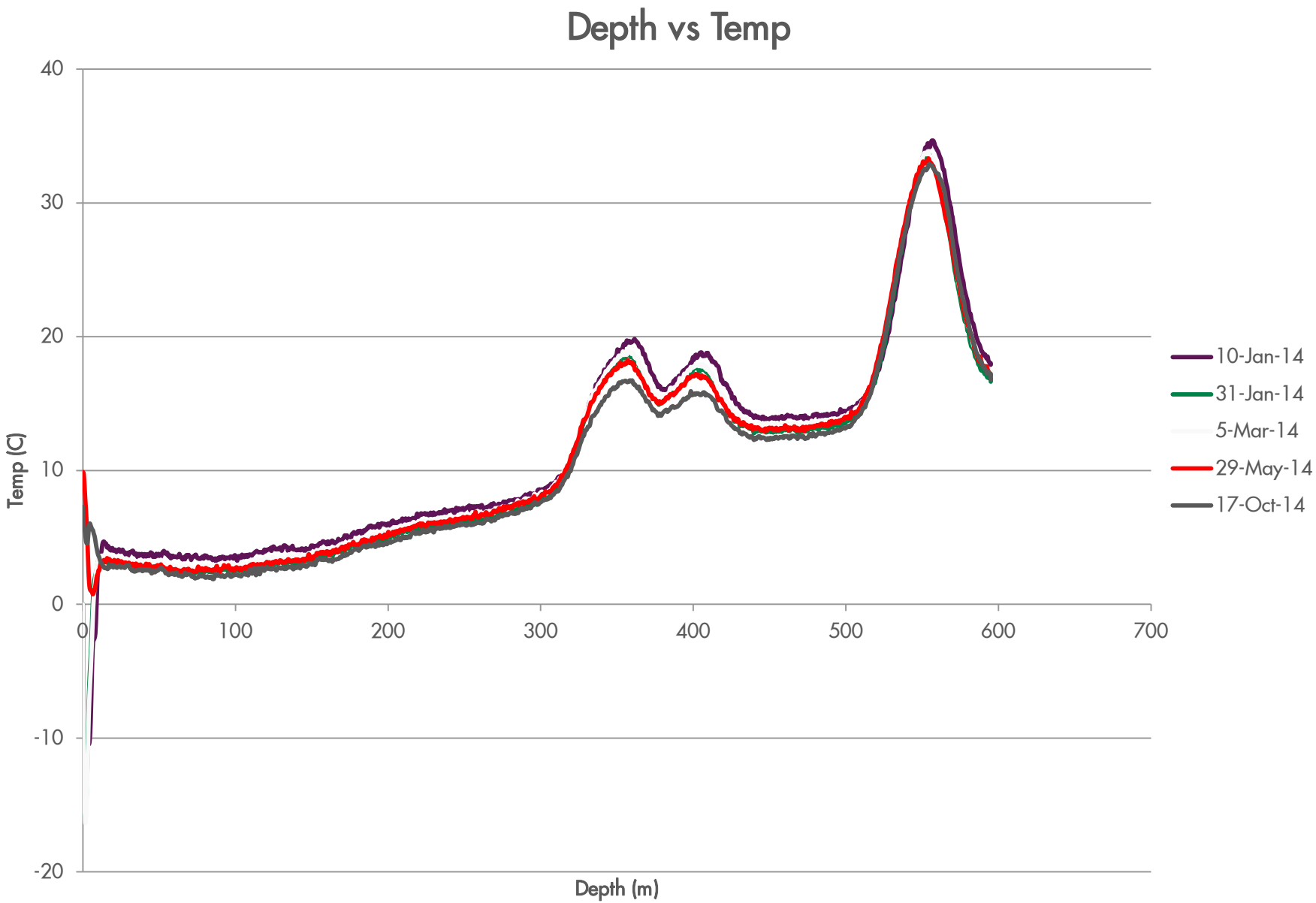
WELLHEAD CONFIGURATION

- Before

- After

- 7-1/16″ 3K Valve, ½″ termination port for DTS Line
- 2-1/16″ 5K Valve, 2″LP crossover to ½″ NPT needle and Pressure Gauge
- Junction Box

5-19 2014 DTS RESULTS



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Well Integrity	Dan Syrnyk
Scheme Performance	Laura Mislan
Future Plans	Pasquale Riggi
Surface Operations, Performance and Compliance	
	Darcy Forman

WELL INTEGRITY: MONITORING PROGRAM

- All pads part of Shell's well integrity management program (WIMS)
- Risk based program that schedules preventative maintenance and associated repair times to the severity of the failure and AER regulations.
- All well histories being updated in eWIMS repository.
- Wellhead Integrity Tests (WITS) carried out on cycle basis:
  - Majority of surface components (casing heads, trees, stuffing boxes, valves, BOPs etc are pressure tested before steam injection)
- Subsurface Integrity Tests (SITS)
  - Production casing (deformation, wall thinning, corrosion logging, hydraulic integrity, packer isolation tests)
  - SCVFs conducted on yearly basis
    - 17 non-serious SCVF being monitored at present as per ID2003-01 (includes wells drilled for Carmon Creek (see Table 1)
  - SITs begin on a sample of CSS wells (1 well per pad/10% wells) beginning at their 5th CSS cycle. Addition logs (CEL, Caliper, Pressure test etc) run on ad-hoc basis based on non-invasive triggers (eg passive seismic, opportunity)

WELL INTEGRITY: SCVF Wells

Table 1 :

UWI	LIC NUM	STATUS	COMMENT	WELL NAME/ALIAS	Date Checked	Results/Obsevations	24 Hour Build Up
104/11-15-085-18W5/00	0310826	Open	Non Serious	SHELL P13 CADOT 11-15-85-18 (21-13)	22-Oct-15	No LEL/H2S, No vent flow observed - Could Close out - will monitor 1 more year	0 kPa
106/11-15-085-18W5/00	0361194	Open	Non Serious	SCL 22-01 CADOTTE 11-15-85-18	21-Oct-15	No LEL/H2S, Observed 60 bubbles/10 min	72 kPa
1F2/01-21-085-18W5/00	0411266	Open	Non Serious	SCL 547-D CADOTTE 1-21-85-18	16-Oct-15	Water Obs well, Observed 21 bubbles/10 mins	42 kpa
100/16-27-085-19W5/00	0389349	Open	Non Serious	SCL C89-01 CADOTTE 16-27-85-19	22-Oct-15	No LEL/H2S, Observed 60 bubbles/10 mins	64 kPa
104/06-20-085-18W5/00	0432193	Open	Non Serious	SCL HZ 20-20 CADOTTE 3-20-85-18	21-Oct-15	No LEL/H2S, Observed 100 bubbles/10 mins	71 kPa
105/03-20-085-18W5/00	0432195	Open	Non Serious	SCL HZ 20-22 CADOTTE 3-20-85-18	21-Oct-15	No LEL/H2S, No vent flow observed - Could Close out - will monitor 1 more year	0 kPa
106/03-20-085-18W5/00	0432196	Open	Non Serious	SCL HZ 20-23 CADOTTE 3-20-85-18	21-Oct-15	No LEL/H2S, Observed 6 bubble/10 mins	21 kPa
104/06-17-085-18W5/00	0464726	Open	Non Serious	SCL 31-13 CADOTTE 6-17-85-18	15-Jun-15	Installed dead weight tester to SCV - no pressure or flow observed	0 kPa
105/06-17-085-18W5/00	0464727	Open	Non Serious	SCL 31-14 CADOTTE 6-17-85-18	22-Oct-15	No LEL/H2S, No vent flow observed - Could Close out - will monitor 1 more year	0 kPa
105/12-20-085-18W5/00	0464729	Open	Non Serious	SCL TH30C CADOTTE 12-20-85-18	22-Oct-15	No LEL/H2S, No vent flow observed - Could Close out - will monitor 1 more year	0 kPa
104/09-19-085-18W5/00	0464733	Open	Non Serious	SCL 30-11 CADOTTE 9-19-85-18	22-Oct-15	No LEL/H2S, Observed 6 bubbles/10 mins	23 kPa
117/11-22-085-18W5/00	0459072	Open	Non Serious	F107-16	20-Oct-15	No LEL/H2S, 45 bubbles/10 mins	90 kPa
106/07-22-085-18W5/00	0465846	Open	Non Serious	F107-18	20-Oct-15	No LEL/H2S, 26 bubbles/10 mins	64 kPa
112/07-22-085-18W5/00	0459075	Open	Non Serious	F107-24	20-Oct-15	No LEL/H2S, 46 bubbles/10 mins	117 kPa
100/08-22-085-18W5/00	0459081	Open	Non Serious	F107-36	20-Oct-15	No LEL/H2S, 24 bubbles/10 mins	69 kPa
103/15-22-085-18W5/00	0459082	Open	Non Serious	F107-39	20-Oct-15	No LEL/H2S, 55 bubbles/10 mins	90 kPa
104/09-22-085-18W5/00	0459087	Open	Non Serious	F107-47	20-Oct-15	No LEL/H2S, 286 bubbles/10 mins	172 kPa

WELL INTEGRITY: ONGOING REMEDIATION/INVESTIGATION

- D320 (5-19) Suspended water disposal well
  - Remediation plan (casing-cuts & cement squeezes) completed. AER engagement on 29th Oct 2012 and 19th Nov 2012 & Oct 2013.
  - Converted to temperature monitoring well via DTS installation.

- D321 (11-19) Suspended water disposal well:
  - During CEL assessment (Flexural Attenuation), a small hole/puncture was discovered in the casing joint at approximately 527-528m MDKB
  - AER DDS submission (ID: 1328497) was entered on 13/7/12
  - Remediation matured. AER engagement on 29th Oct 2012
  - Conversion to permanent temperature monitoring well via DTS installation.

- 40-08 Suspended thermal well on steam-drive (Pad 40):
  - MFC investigation and SIT revealed casing leak at 609m MDKB across the Wilrich shale. Well suspended with TRBP at 620 mMDKB
  - AER DDS submission was entered November 2012.
  - Approval granted for low pressure (<6 Mpa) use.

WELL INTEGRITY: ONGOING REMEDIATION/INVESTIGATION

- 100/03-28-85-18W5 (SR -12) Soak Radial – Pad 19 Satellite 4:
  - Parted casing detected at 120 mKB depth via a calliper log. Appears to be a pin-box (straight tensile) pull.
  - Retrievable bridge plug was installed (top of BP at 556 mKB) with 20 m of Thermal cement for subsurface isolation.
  - AER DDS submission (ID: 1410655) entered on June 11, 2013. Repair extension approval granted Dec. 10, 2013.
  - Abandonment planned in 2016

- 107/15-21-85-18W5 (19-3-PH{15}) and 103/03-28-85-18W5 (19-3-PK{17}) Pad 19 Satellite 3:
  - A collapsed/buckled casing section was detected via a downhole camera run performed on October, 2013. Failure depth is ≈ 276mKB on19-3-PH{15} and 190.3 mKB on 19-3-PK{17}.
  - AER DDS submission (ID: 1456424 & ID: 1441050) made in Oct, 2013.
  - Both wells abandoned Jan 2014 as per Directive 20

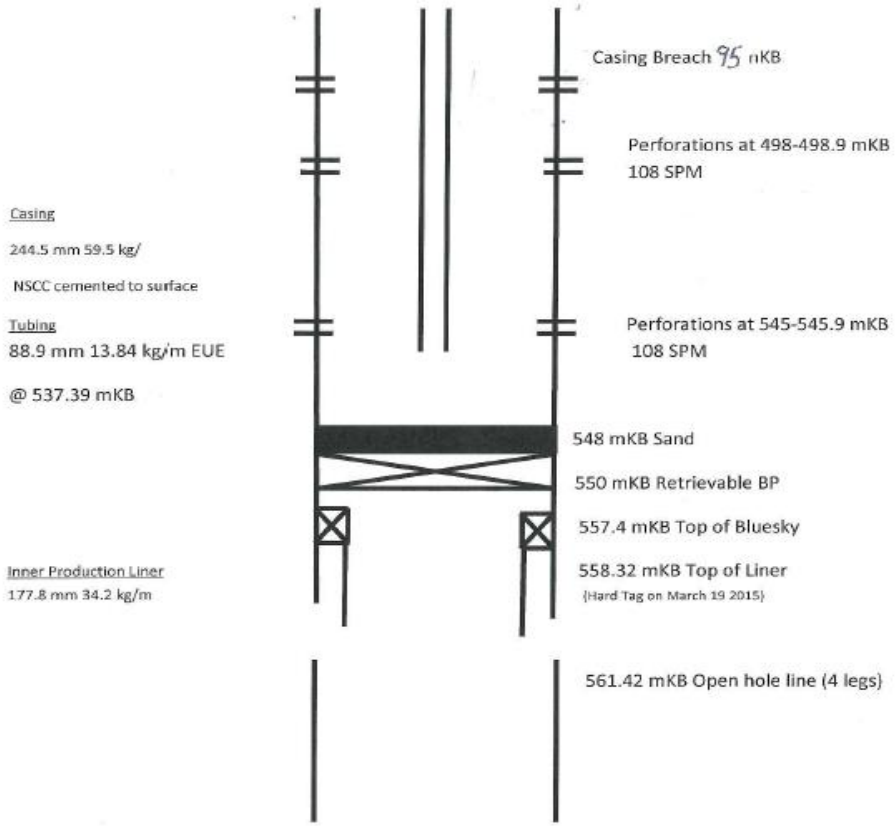
- Pad 19 Satellite 3: Injectors (4) with casing collapse
  - A collapsed/buckled casing section was detected via a downhole camera runs performed Nov 2013. AER DDS submissions Dec 2013.
  - All 4 wells successfully abandoned Q-1 2015. Cut and cap completed 2015.

WELL INTEGRITY: ONGOING REMEDIATION – (SR -3) 02/12-21-85-18W5 - Licence # 0186658

- Well shut in on January 15, 2015 for production optimization reasons. January 30th the wellbore was N2 purged to suspend the location
- On February 25, 2015 gas emission detected with an an infrared camera during routine monthly inspection . Gas is intermittent (flares up and dies off). Readings of 50 to 75 PPM of H2S have been recorded around the wellhead. No H2S can be detected outside of a radius of 2 ft from the wellhead.
- On March 14, 2015 we commenced an investigative workover program to inspect the production casing. We detected a pin-collar straight tensile failure had occurred at ~94m
- Shell continued to observe trace amounts of gas migration immediately around the production casing, and a decision was made to perform further logging to determine the source of the gas migration
- On May 14, 2015 we ran noise-temperature and CHAT tools to further investigate the potential source of gas.
- On July 12, 2015 Perforate and attempt to squeeze 545 – 545.9mKB. Perfs would not take any fluid. July 13, 2015 perforate/acidize and attempt to squeeze 498 – 498.9 mKB - very limited injectivity (6-8 liters/min).
- Swab wellbore down to 191.5 mKB – continue to shoot fluid levels, monitor bubbles around base of the wellbore, and observe H2S and pressure reading
- On August 20, 2015 install vent nanny on casing annulus.

SR-03 CURRENT WELLBORE SCHEMATIC / PICTURE

- GM appears to be bleeding off, as build-up is much lower than previously measured
- Shell recently gathered gas samples for analysis
- Plan is to swab well down once again and perform flow-rate and build-up pressure tests. These will be compared to previous flow-rate and build-up tests to confirm the wellbore is bleeding off. Additionally, Compare gas analysis to typical Bluesky composition

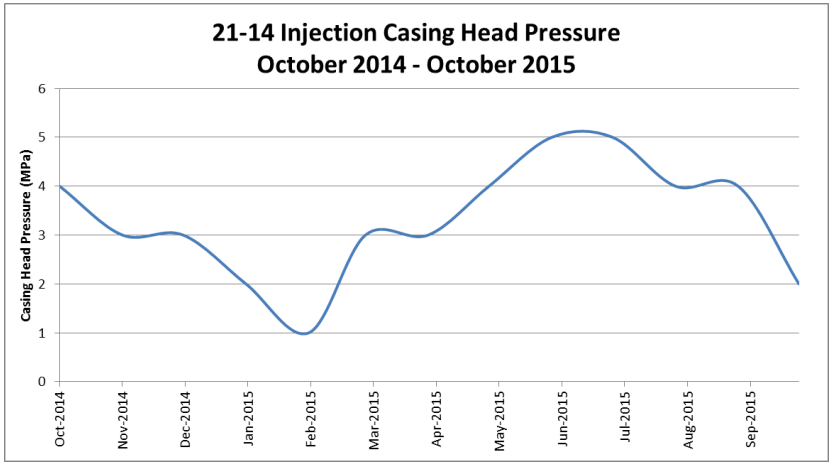


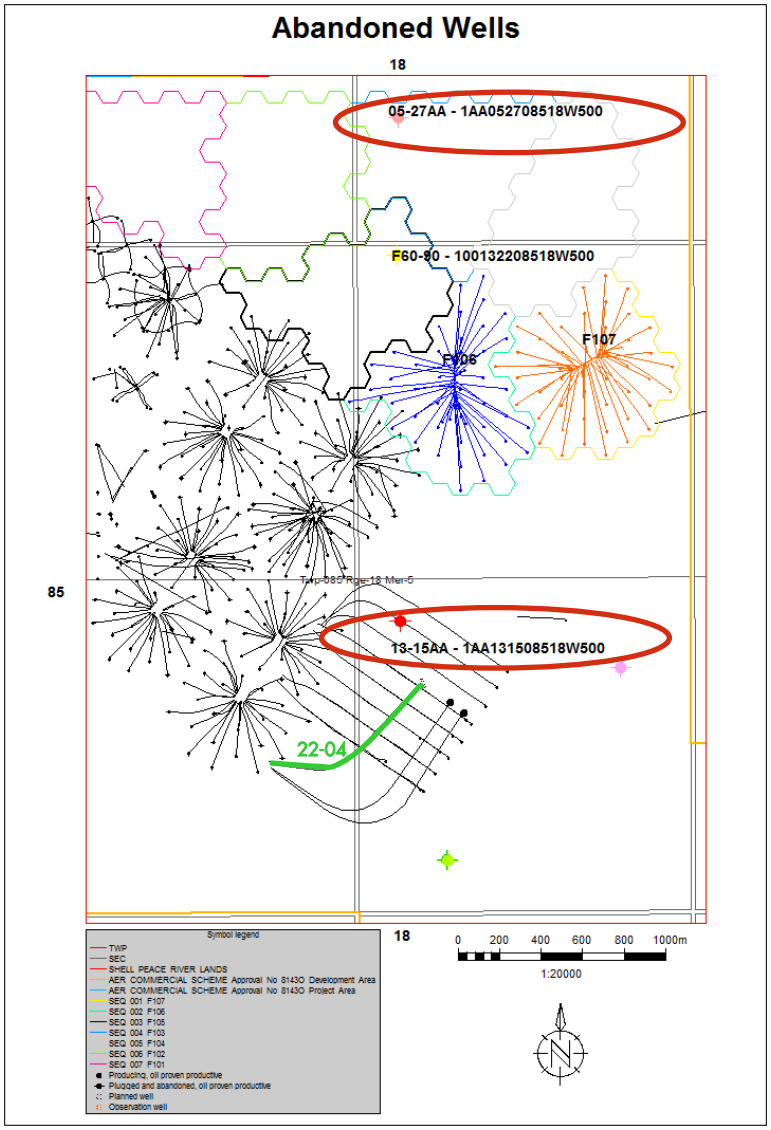
PREVIOUSLY ABANDONED WELLS

Update required as per AER approval no. 8143W

Oct 2014 – Oct 2015:

- 1AA052708518W500
  - Pad 106 wells drilled 400m to south – no production
  - Closest production wells on Pad 19 > 1000m
- 1AA131508518W500
  - Low pressure injection on Pad 21/22
  - New steam injector well 22-04 (green) drilled
  - No changes observed





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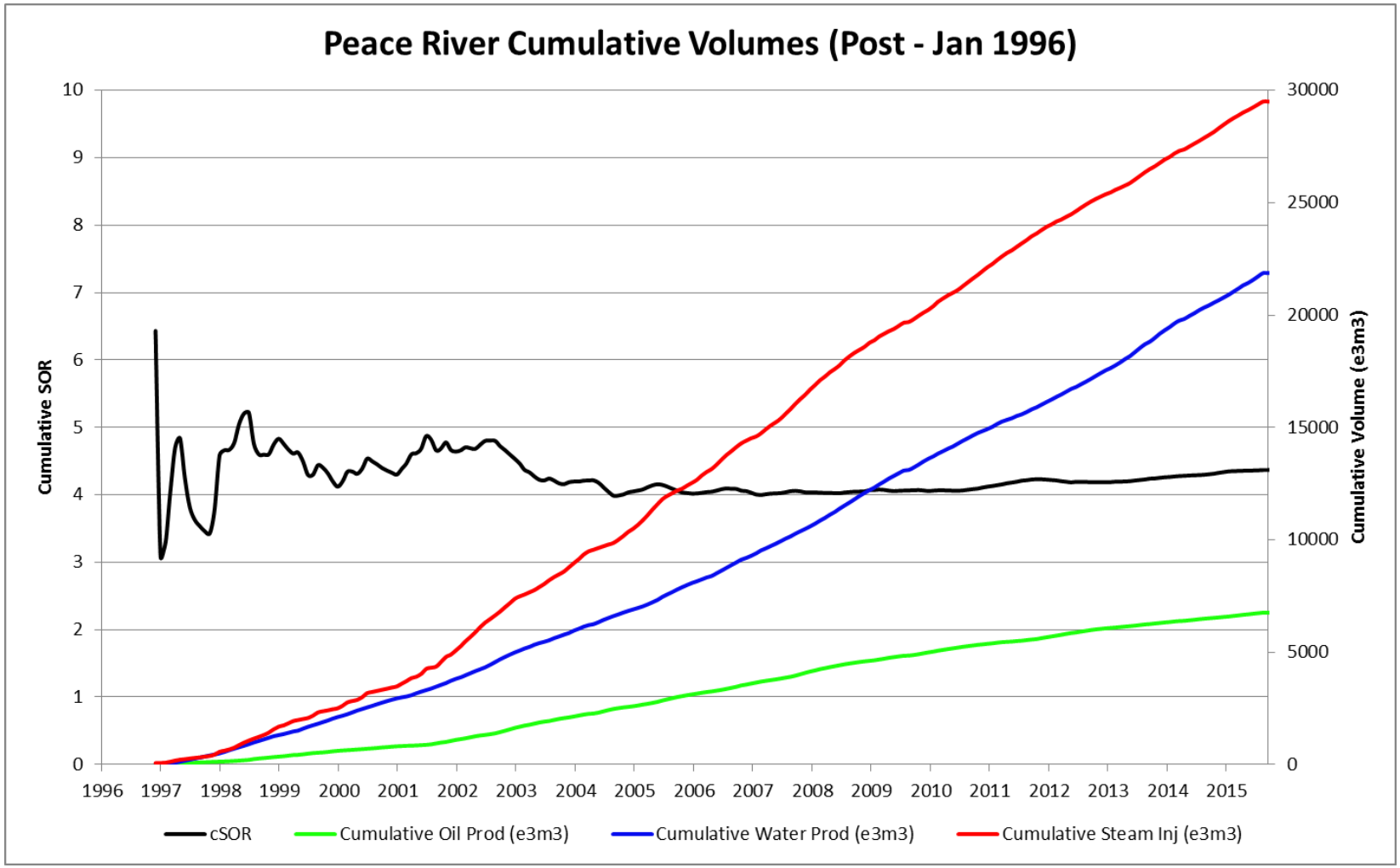
SCHEME PERFORMANCE PREDICTION

- The basis for Scheme performance prediction estimation based on historical cOSR decline for steam drive pads, and water cut increase with recovery factor for blow down pads.

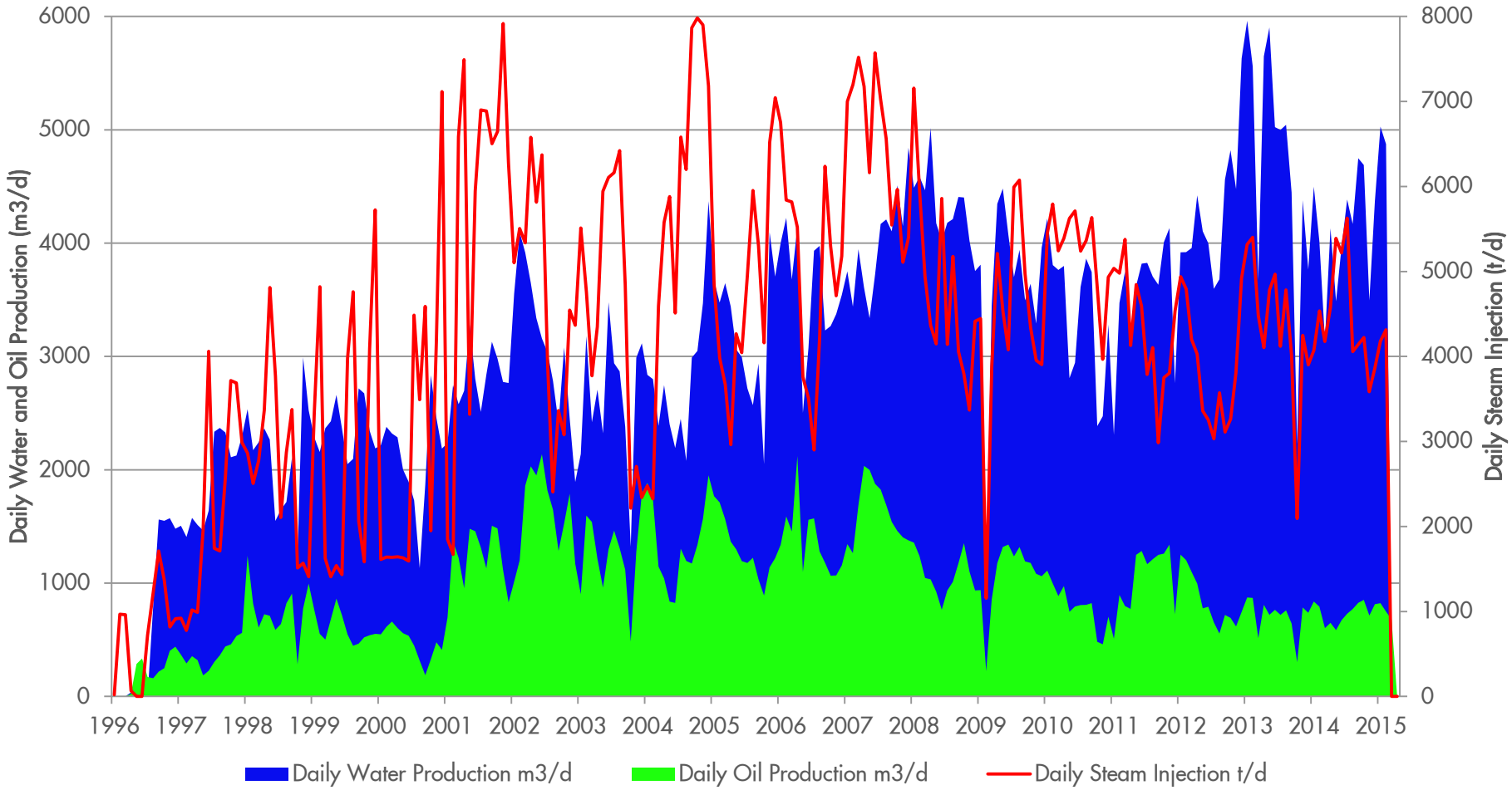
Pad	Recovery Process	Date of Conversion
19 Sat 1 and 2	Lateral Steam Drive	Oct 2012
19 Infills	Vertical Well Steam Drive	July 2013
20 Conv	Top-Down Steam Drive	July 2012
20 Infills	Lateral Steam Drive	June 2012
21 Conv	Top-Down Steam Drive	Jan 2009
21 Infills	Lateral Steam Drive	Nov 2011
30	Top-Down Steam Drive	Dec 2014
31	Top-Down Steam Drive	Nov 2014
40	*Suspended*	*Converted to LSD June 2012* *Blowdown June 2014* *Suspended October 2015*
41	*Suspended*	*Converted to LSD June 2012* *Blowdown June 2014* *Suspended October 2015*
32/33	Cyclic Steam Stimulation (CSS)	*Converted to LSD December 2012* *Converted to CSS August 2014*

PEACE RIVER PRODUCTION HISTORY



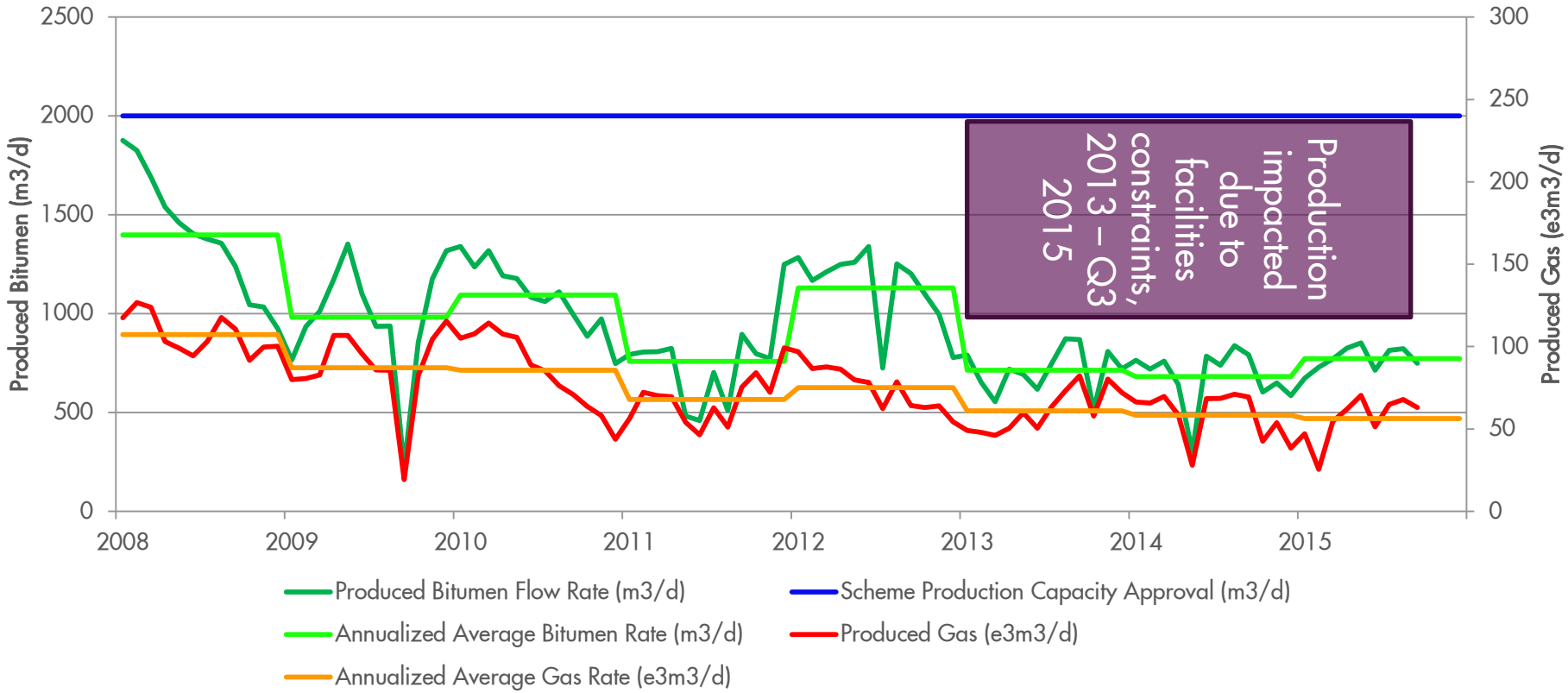
- All data current as of Oct 2015
  - Cumulative SOR = 4.37
  - Cumulative WSR = 0.74
- All data current as of Oct 2015
  - Cum Oil: 6,756 Mm3
  - Cum Wtr: 21,869 Mm3
  - Cum Stm: 29,505 Mm3

PEACE RIVER PRODUCTION HISTORY



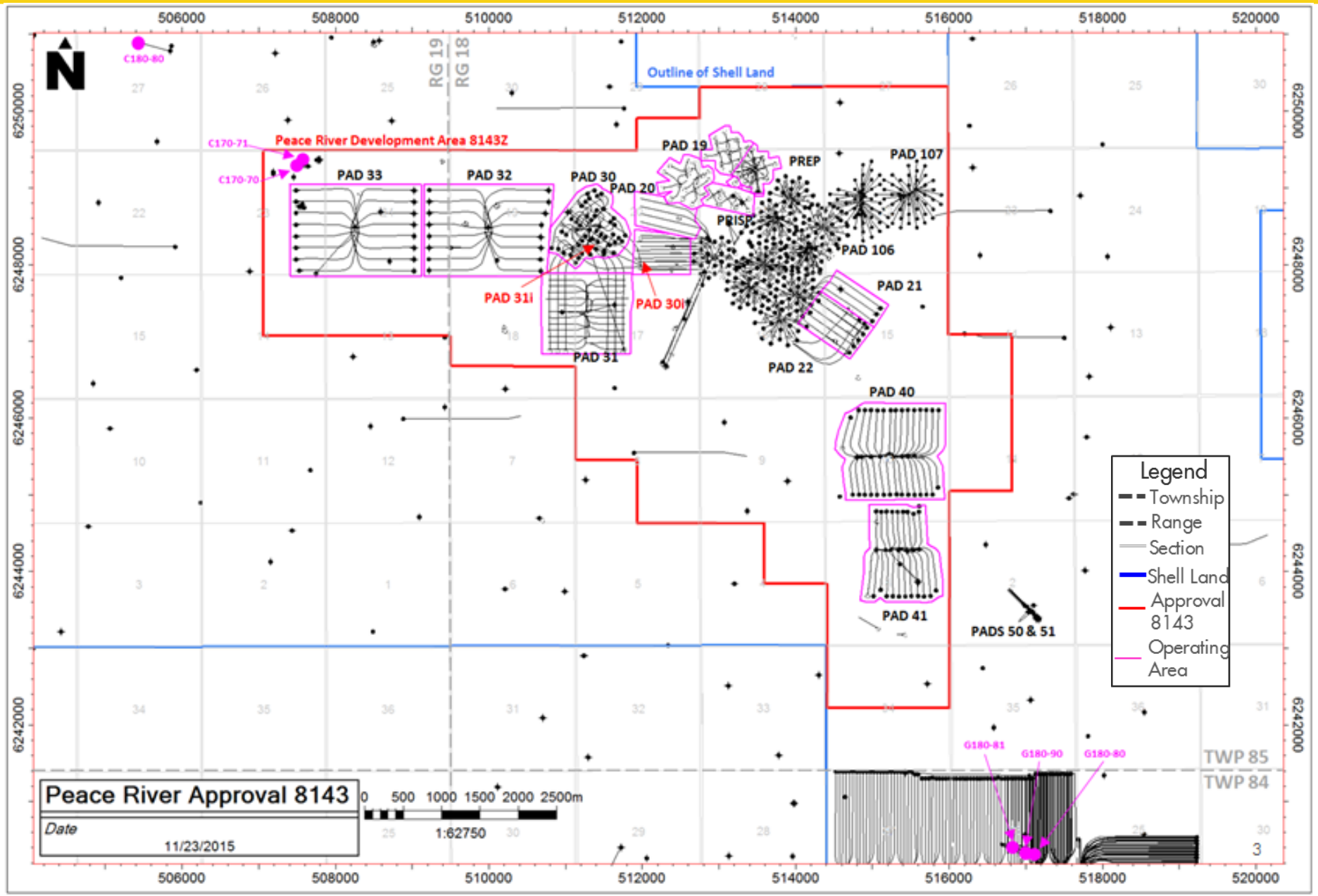
- 2015 YTD average
  - Oil rate = 763 m^3/d
  - Injection rate = 4584 t/d

ACTUAL PRODUCTION VS. APPROVAL CAPACITY



- Production capacity limit raised to 2000 m^3/d (from 1900 m^3/d) annualized average on April 30, 2002 as part of Amendment F to 8143 approval.
- Bitumen production has decreased from peak rates in Nov/Dec 2007 due to maturing pads.
- Cycle 4 steaming on Pad 32/33 commenced in April 2011. Low production from these wells in 2011 due to cycle 4 steaming, most wells having cycle 4 peak production in 2012, and low end of cycle production in 2013 – 2015.
- 2013 - 2015 production has been impacted by produced water scaling issues, gas injection compressor issues and multiphase pump reliability issues. Excessive scaling in water processing side of facilities impacted water handling capacity from late 2012 until June 2013 when all lines where mechanically cleaned. Skim and surge tank cleanings undertaken in 2015 in order to increase emulsion processing capacity.

AREA FOR VOLUMETRICS



PAD OBIP VALUES

Pad	Area (m2)	Height (m)	NTG (frac)	Porosity (frac)	So (frac)	Bo (m3/m3)	PV (m3)	OBIP (m3)
SR 1-3	199,482	23	1.00	0.290	0.83	1.01	1,330,545	1,093,418
SR 4-7	359,361	16	1.00	0.290	0.83	1.01	1,667,435	1,370,268
SR 8-11	256,081	22	1.00	0.290	0.83	1.01	1,612,254	1,306,774
SR 12-15	249,546	19	1.00	0.290	0.83	1.01	1,374,998	1,129,949
Pad 20 Infills	373,386	21	1.00	0.280	0.82	1.01	2,195,510	1,782,493
Pad 20 Conv	410,545	22	1.00	0.280	0.82	1.01	2,528,957	2,053,213
Pad 21 Infills	279,163	25	1.00	0.280	0.82	1.01	1,954,141	1,586,530
Pad 21 Conv	427,746	25	1.00	0.280	0.82	1.01	2,994,222	2,430,953
Pad30	758,773	24	1.00	0.290	0.82	1.01	5,281,060	4,287,593
Pad31	1,239,870	23	1.00	0.285	0.82	1.01	8,127,348	6,598,441
Pad40	1,626,190	25	1.00	0.265	0.80	1.01	10,773,509	8,533,472
Pad41	1,077,660	24	1.00	0.265	0.80	1.01	6,853,918	5,428,846
Pad 32	1,725,020	24	1.00	0.275	0.78	1.01	11,385,133	8,792,479
Pad 33	1,805,980	24	1.00	0.275	0.78	1.01	11,919,467	9,205,133
Total								**55,599,562**

- Net pay calculated based on the net pay map (shown in the Geology section)
- Area and OBIP for Pad 19 Sat 3 (SR8-11) have been modified to reflect new Pad 19 Infill wells

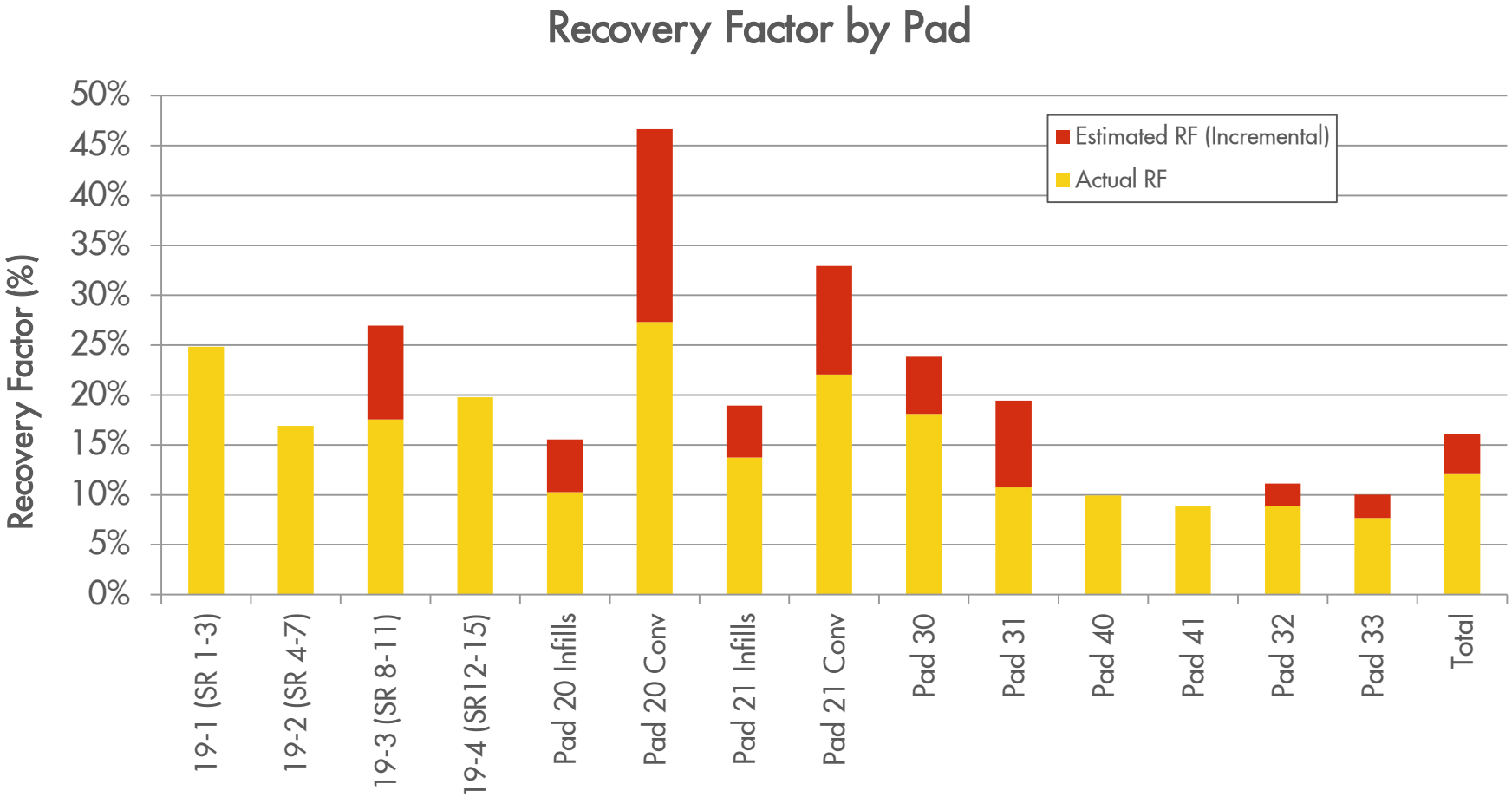
PAD RECOVERY FACTORS

Pad	OBIP (e3m3)	Cum Produced 30.09.2015 (e3m3)	Expected Ultimate Recovery (e3m3)	Actual RF at 30.09.2015 (%)	Estimated RF* (%)
SR 1-3[1,4]	1,093	272	272	25%	25%
SR 4-7[4]	1,370	232	232	17%	17%
SR 8-11[4]	1,307	230	352	18%	27%
SR 12-15[4]	1,130	223	223	20%	20%
Pad 20 Infills	1,782	183	277	10%	16%
Pad 20 Conv[2]	2,053	561	958	27%	47%
Pad 21 Infills	1,587	218	301	14%	19%
Pad 21 Conv[3]	2,431	536	801	22%	33%
Pad30[5]	4,288	776	1,022	18%	24%
Pad31[5]	6,598	709	1,284	11%	19%
Pad40[6]	8,533	847	847	10%	10%
Pad41[6]	5,429	483	483	9%	9%
Pad 32	8,792	779	979	9%	11%
Pad 33	9,205	706	922	8%	10%
Total	55,598	6,756	8,953	12%	16%

NOTES:

1. SR 1-3: 17% recovery from CSS, additional recovery from steam drive from wells SR-16+17
2. Pad 20 Conv wells : 14% recovery from SAGD operations, additional recovery from CSS, expected RF from phase 3 infills Top down Steam Drive
3. Pad 21 Conv wells: 6% recovery from SAGD operations, 4% recovery from CSS, additional recovery from top-down steam drive
4. Pad 19 SR 1-3 are operating in steam drive, SR 6,7 are producing, SR 8-10 are part of the Pad 19 Infills and SR 12-15 are currently being re-started
5. Pad 30 and 31 had injectors added in 2014, will see remaining RF recovered via Top down Steam Drive.
6. Pad 40 and 41 to be ramped down starting in 2015 and remaining OBIP recovered through Carmon Creek

PAD RECOVERY FACTORS



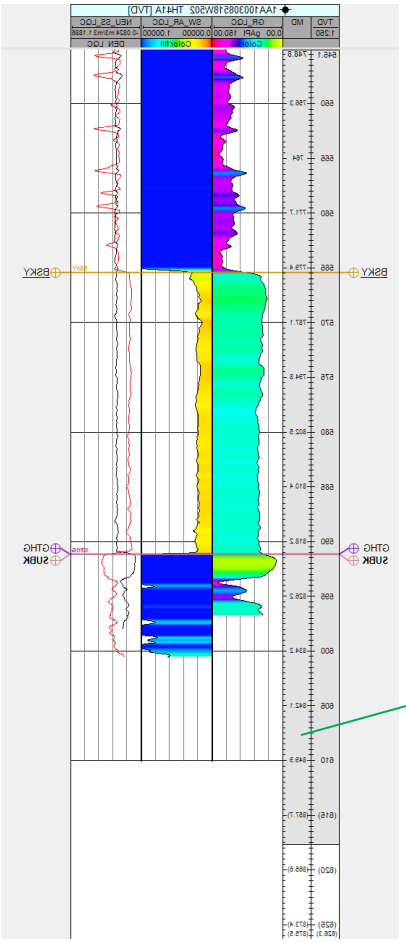
- Pads 40/41 – Low performing CSS / lateral steam drive pads, suspended Oct 2015
- Pad 19 – Overall medium recovery with CSS and vertical steam drive
- Pads 20, 21/22 – High performing TDSD pads
- Pad 20/21 infills – Medium-performing LSD pads

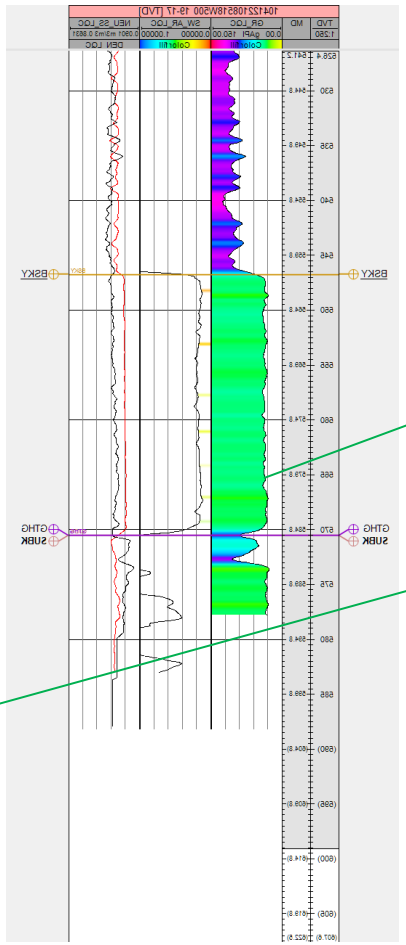
RECOVERY EXAMPLES

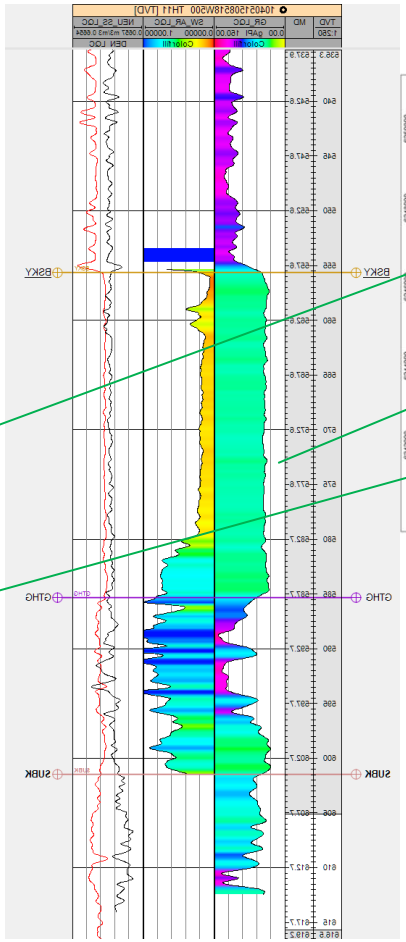
Low
Pad 41

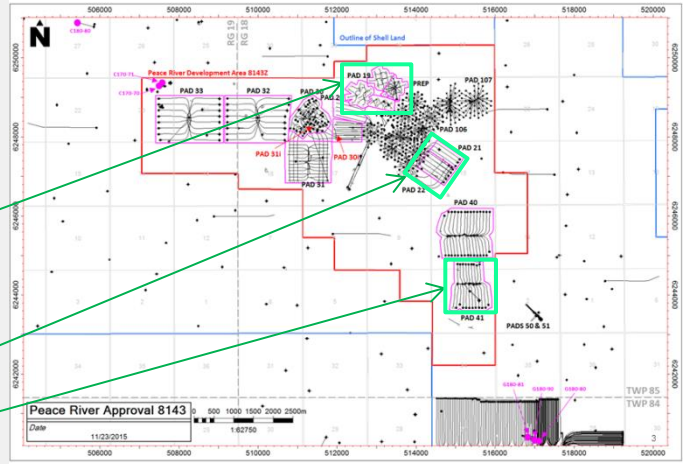
Medium
Pad19

High
Pad21





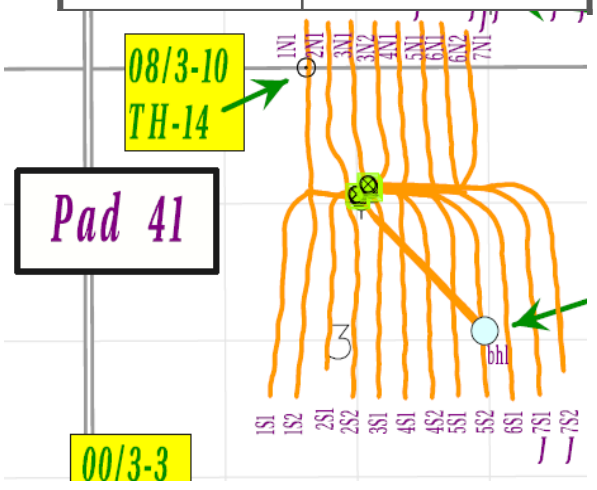


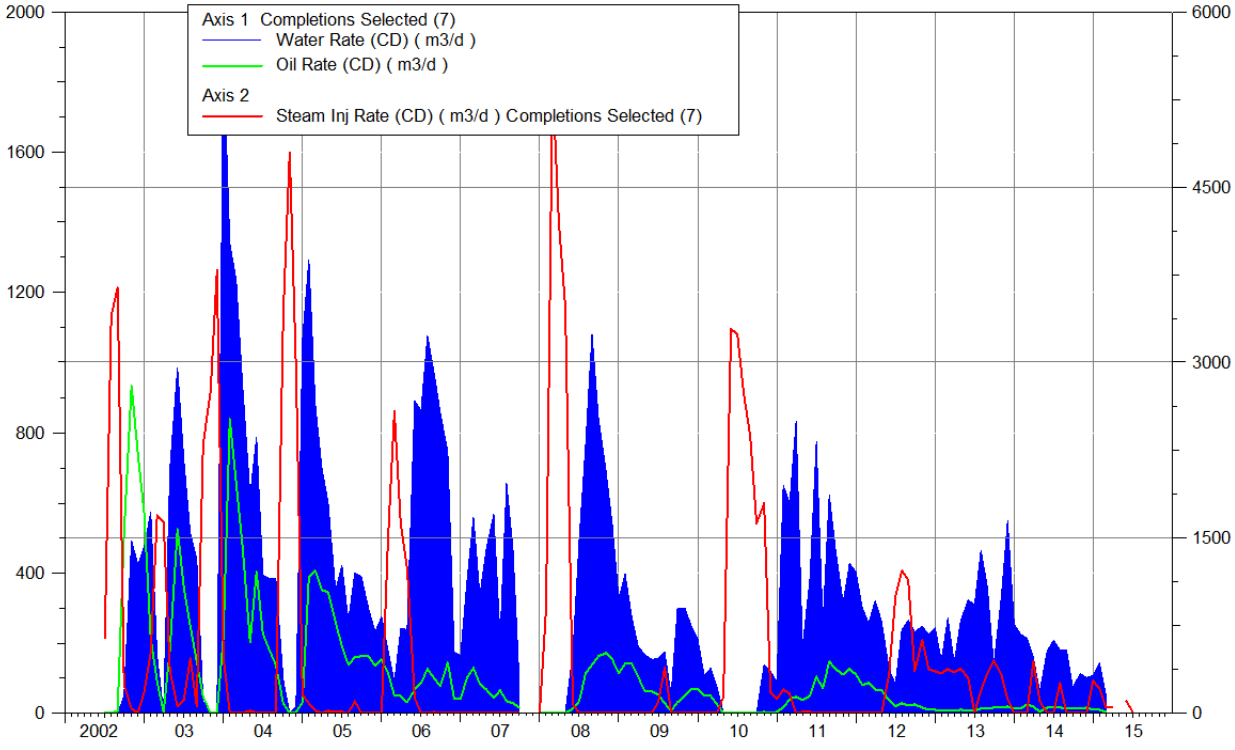


LOW RECOVERY EXAMPLE – PAD 41 CSS/SD

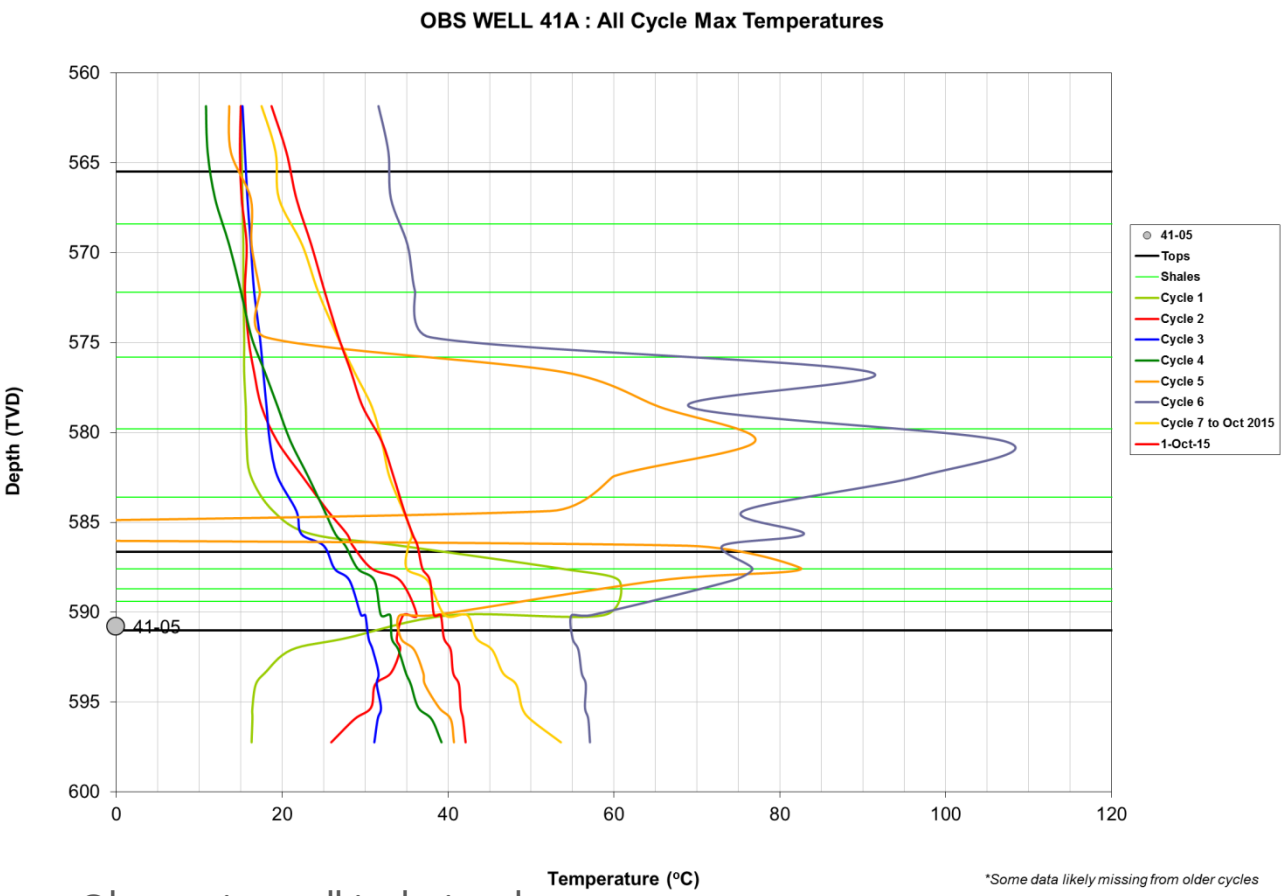
- 7 CSS cycles completed
  - Low pressure cycle 2 → lower cycle recovery
  - Poorer overall performance attributed to reservoir quality, steam injection volumes/cycle, and/or steam quality at the pad
- Converted to steam drive June 2012, poor lateral steam drive performance to date due to operational constraints – unable to produce pad at max rates or provide continuous steam. Wellbore configuration also plays a factor – multilaterals are more connected at the heels of the wells than the toes.

	As of 30.09.2015
Cumulative Oil	483 e^3m^3
Current RF	9%
SOR	N/A (Pad Suspended)

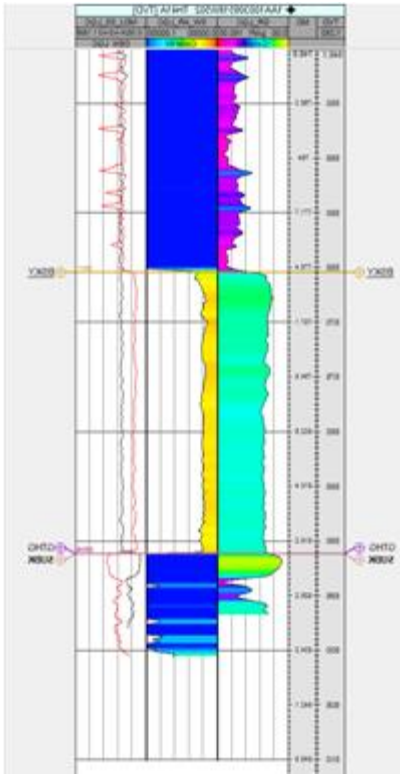


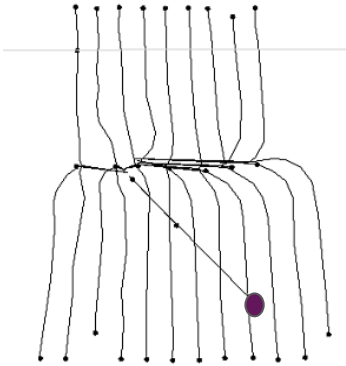


PAD 41 – CSS/SD PERFORMANCE



*Some data likely missing from older cycles



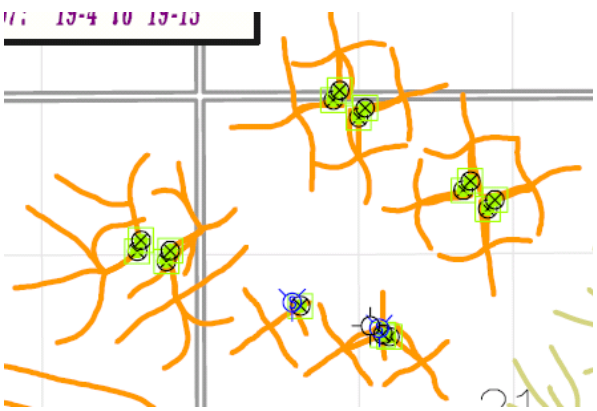


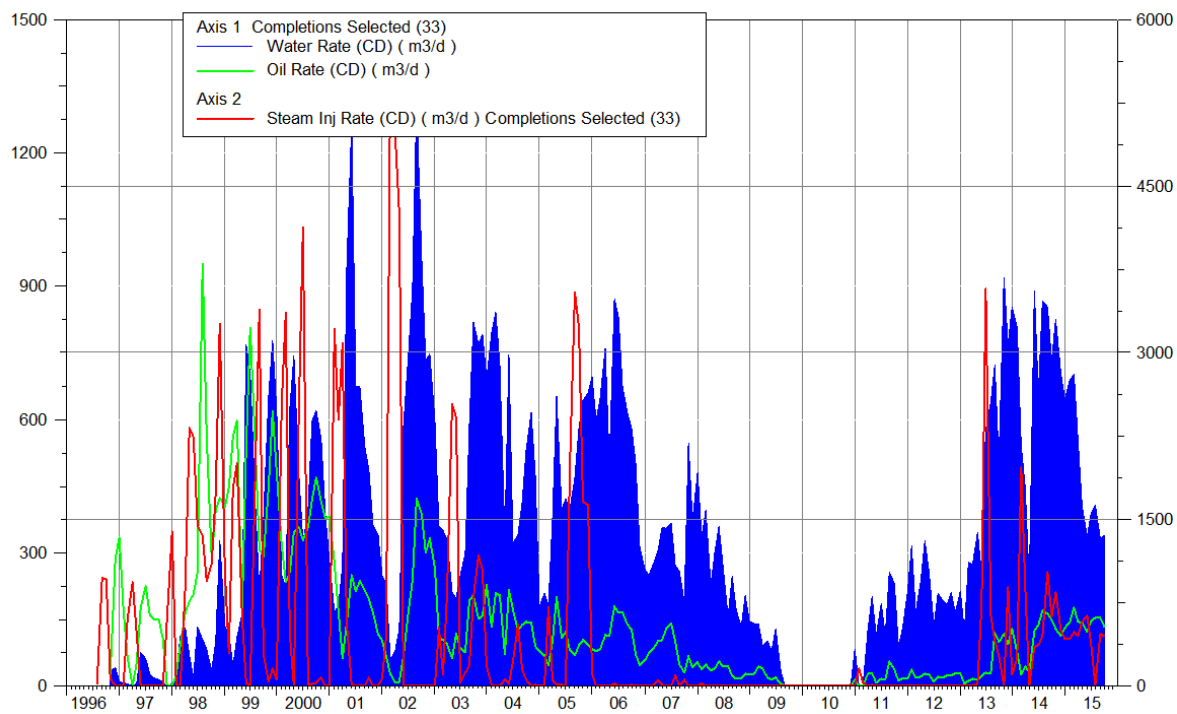
- Observation well is deviated
- Highest temperatures observed in cycles 5 & 6
- Cycle 7 and current temperatures cooling, as steam injection has been limited and pad is now suspended
- Lateral Steam Drive was chosen as the recovery process for Pads 40 & 41 based on their poor reservoir quality (low permeability, low Kv/Kh)

MEDIUM RECOVERY EXAMPLE – PAD 19 CSS

- 15 Soak radial wells, 2 vertical injectors
- 8 CSS cycles completed on SR1-3; converted to steam drive Feb 2003
- 6 CSS cycles completed on SR 4-7
- 8 CSS cycles completed on SR 8-15
- SR 6 restarted – steam support from adjacent pad
- SR 14-15 restarted – steam support from Pad 19 Infills
- CSS cycles ongoing on select wells in order to improve steam drive recovery
- Steam solvent trial underway in 2014/2015, solvent injection completed in 2014
  - Estimation of solvent recovery was aided significantly by frequent sampling campaigns on Pad 19; 70-80% of solvent was recovered

	As of 30.09.2015
Cumulative Oil	956 e^3m^3
Current RF	20%
SOR	3.03



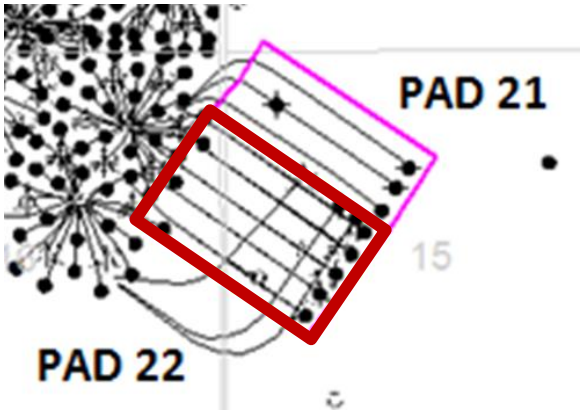


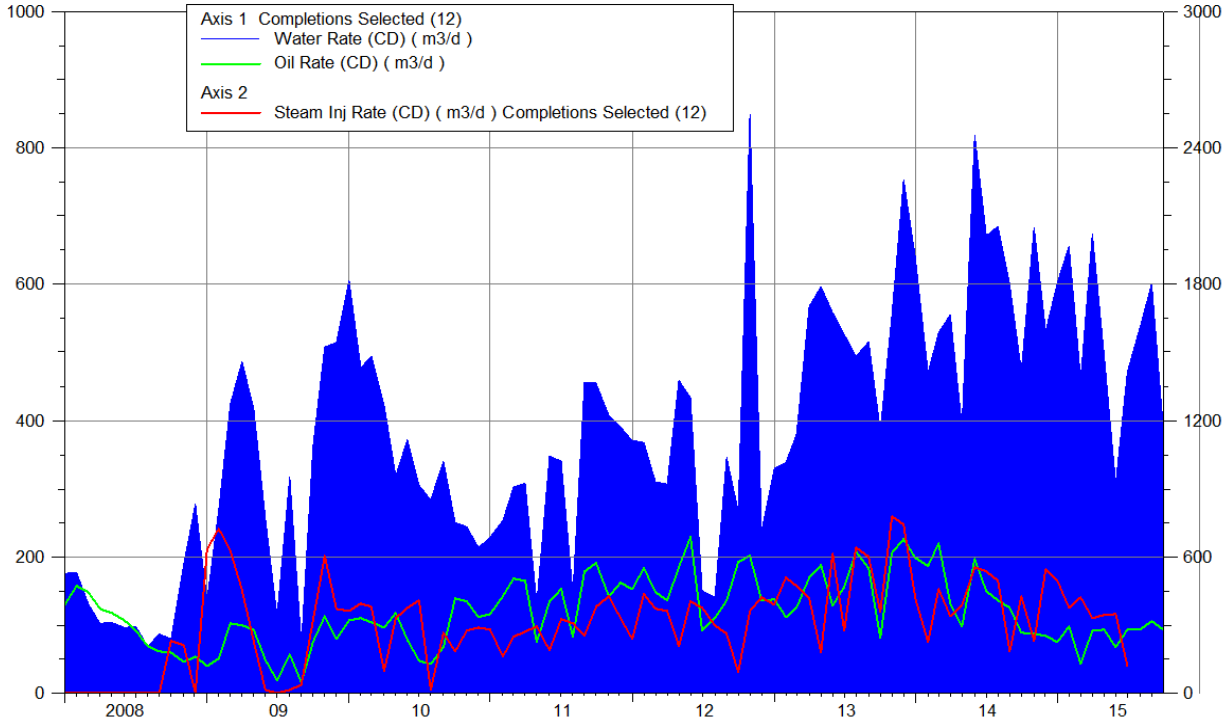
PAD 21/22 HIGH RECOVERY EXAMPLE TDSD

- Pad 21 SAGD pairs [21-08 to 21-12]
  - Injector legs 5 m above producer legs
  - SAGD operation from 1997 - 2003
  - CSS operation from 2003 -2008
    - Steam injection through injection legs
    - Production from production legs
  - Steam drive from 2008 onwards
    - Steam injection through pad 22 injectors
    - Production from 21.8-12 production legs

- Pad 22 wells [22-01, 22-02]
  - Two single laterals drilled perpendicular to existing wells higher in the reservoir
  - Initial cold production test in February 2007
  - Cold produced October 2007 to August 2008
  - Steam drive to Pad 21 conversion wells below since November 2008
    - Top-down steam drive was pursued for Pads 20 and 21 as a follow-up process to CSS, as CSS performance was worsening in subsequent cycles
    - Well configuration on Pads 20 and 21 was appropriate for TDSD as these wells were drilled as SAGD well pairs

SD performance	As of 30.09.2015
Cumulative Oil	304e3m3
Cumulative Steam	848 e3m3
Cumulative SOR	2.79

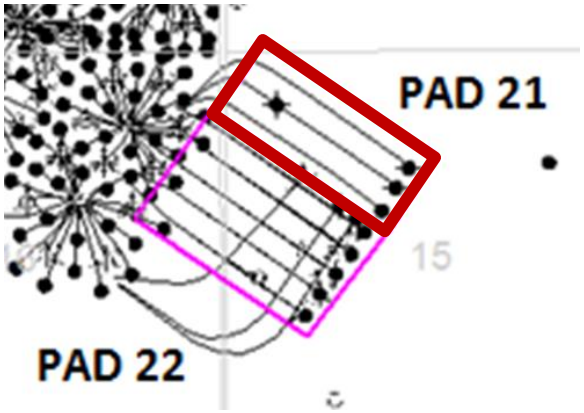


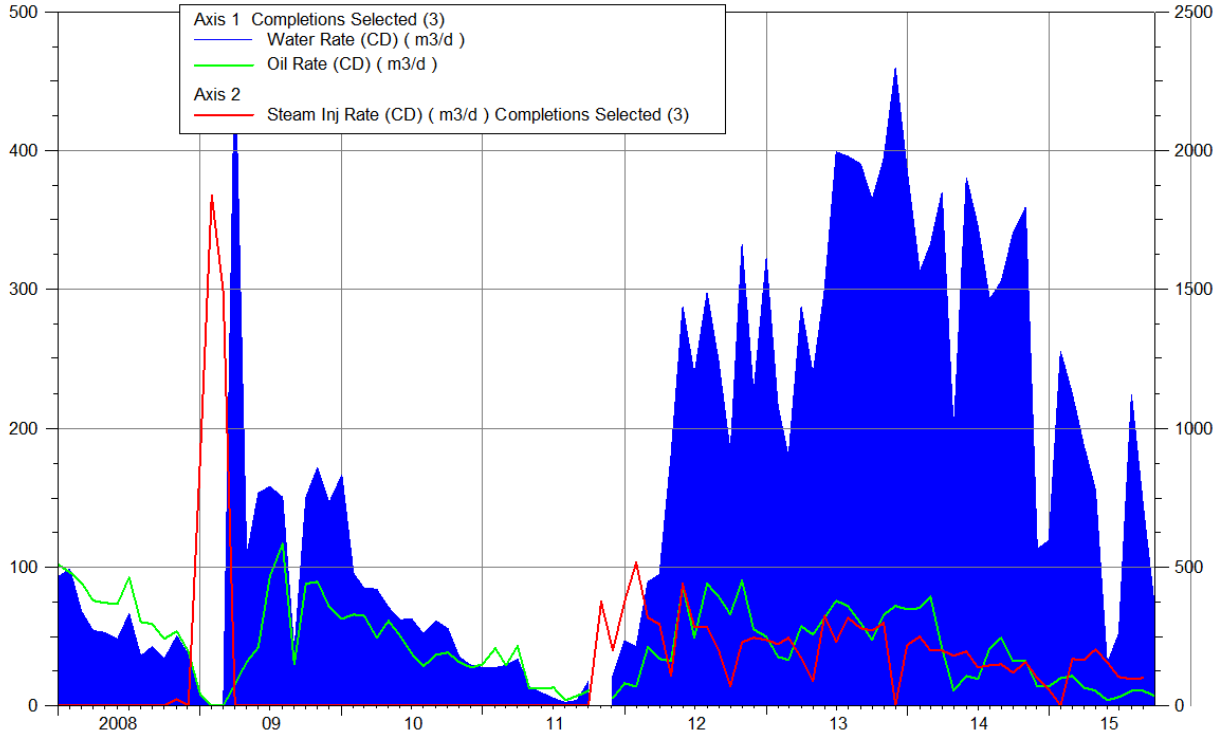


PAD 21 INFILLS LATERAL STEAM DRIVE PERFORMANCE

- Pad 21 Infills [21-13, 21-14, 21-15]
  - 3 J-wells, drilled 2004
  - CSS operation, 4 cycles completed
  - Converted to lateral SD in November 2011
    - 21-14 converted to dedicated injector
    - TDSD was not pursued on Pad 20 Infills or Pad 21 Infills due to the J-well producer configuration (vertical spacing of infill injectors and producers is suboptimal)
  - Significant improvement in SOR performance once communication between injector and producer established

SD performance	As of 30.09.2015
Cumulative Oil	218 e3m3
Cumulative Steam	701 e3m3
Cumulative SOR	3.22





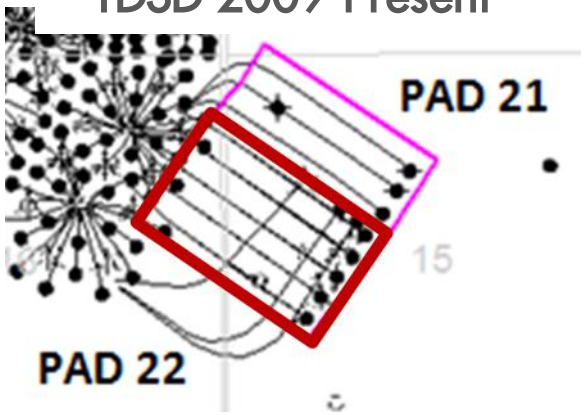
KEY LEARNINGS OF RECOVERY MECHANISMS IN PR

- **Pressure Cycle Steam Drive (PCSD)** *1979-2001*
  - Approximate reservoir pressure range: 1-12 MPa
  - Need steam to rise and gravity to drain oil
  - Performance hindered if pressure interference exists
  - Demonstrated vertical well steam drive to be feasible
- **Steam Assisted Gravity Drainage (SAGD)** *1997-2003*
  - Approximate reservoir pressure range: 2-6 MPa
  - Uneconomic due to low kv/kh in the Bluesky
- **Cyclic Steam Stimulation (CSS)** *1997 - present*
  - Approximate reservoir pressure range: 1-12 MPa
  - Steam growth limited by low kv/kh with horizontal wells
  - Works well with vertical wells if reservoir is conditioned properly
  - Need higher pressure injection *(~14+MPa surface)* – demonstrated by Pad 41 cycle 2
- **Horizontal Well Steam Drive (SD)** *2005 - present*
  - Approximate reservoir pressure range: 2-6 MPa
  - Need established fluid pathways
  - Maintain low pressure operation
  - Horizontal well steam drive demonstrated feasible in mature areas.

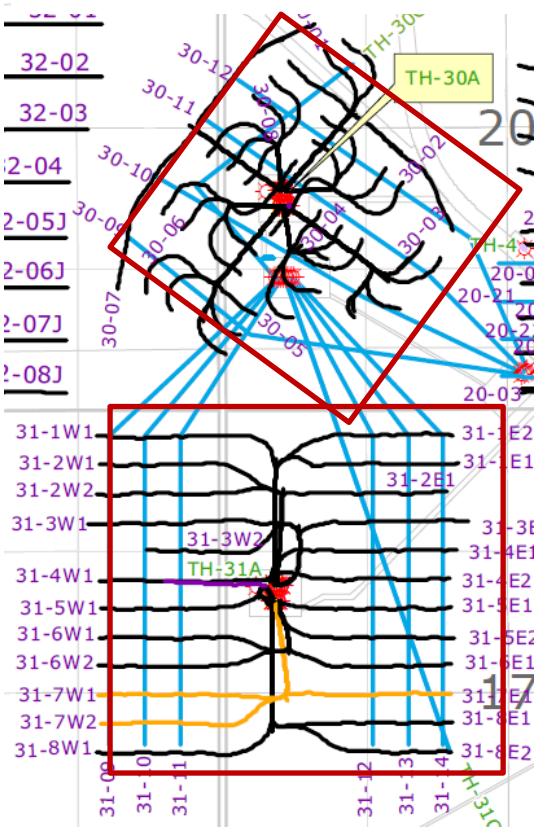
KEY LEARNINGS OF TOP-DOWN STEAM DRIVE IN PR

- Top-Down Steam Drive (TDSD) *2009-Present*
  - Approximate reservoir pressure range: 1.5 – 6 MPa
  - Dedicated injectors effectively target unswept oil and reduce SOR and WC
  - Performance hindered if production offtake rates are not consistent across the pad or if there is not consistent steam delivery
  - Demonstrated to be feasible (Pads 20 and 21/22, 30/31 TDSD)

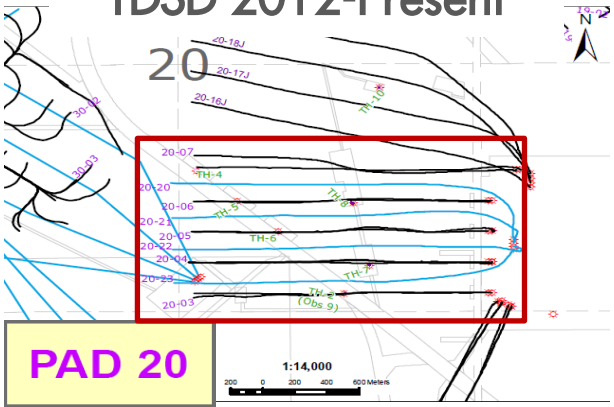
TDSD 2009-Present



TDSD 2014-Present



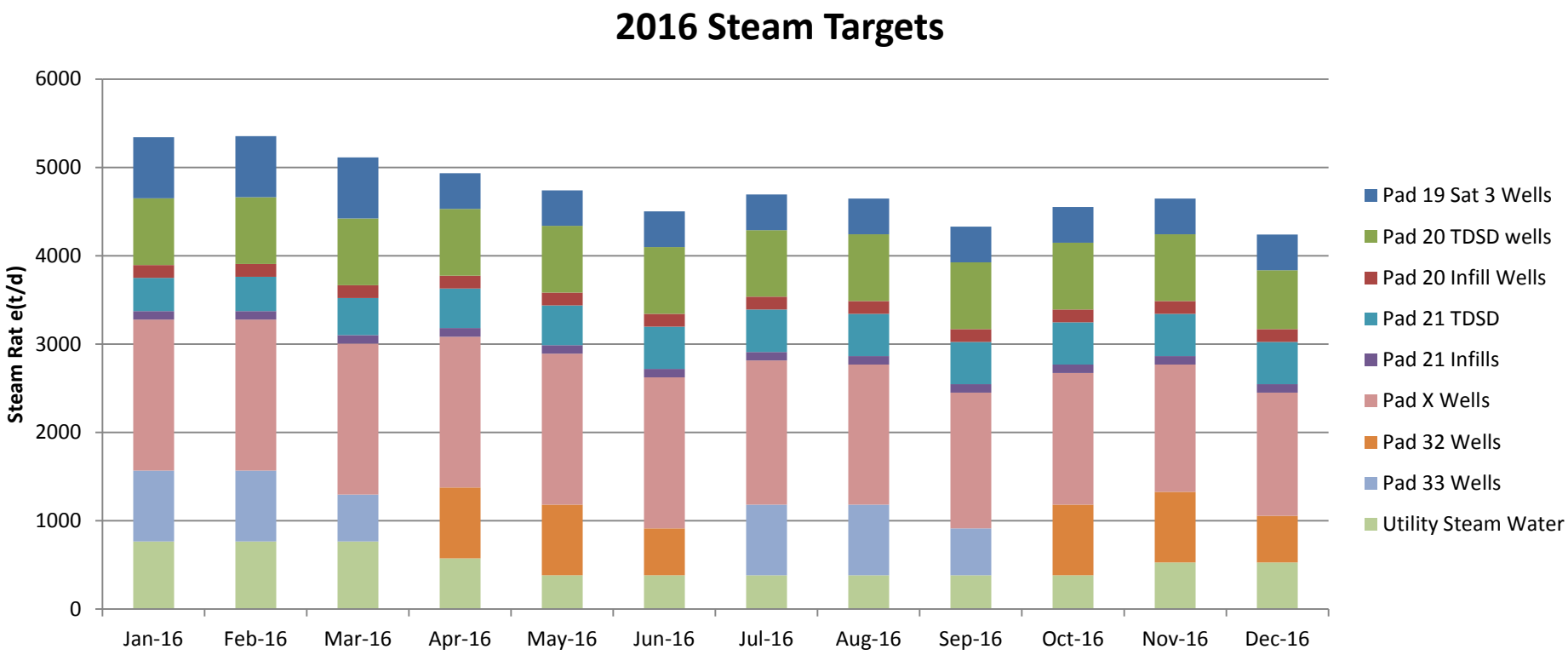
TDSD 2012-Present



FACTORS IMPACTING RECOVERY

- Well design
  - Multi and single lateral J wells have no clear performance advantage
  - Difficult to control subsurface steam movement in multilaterals
- Inter-well or Inter-pad Communication
  - Examples include: pad 40-41, pad 32-30, pad 32-33, pad 20 infills-conv, pad 21 infills-conv)
  - If evidence of well established communication exists:
    - Temporarily shut in well adjacent to steaming if necessary
    - Production may not require additional steam
  - If not well established
    - Monitor pressure and temperatures
- Steam Drive
  - Optimize within injection and production constraints
- Geology
  - The presence of shale layers is variable across the leasehold and shows some impact to injector / producer communication. However, good communication has been established in top-down steam drive pads which suggests that these shales act as baffles not barriers.

STEAM SCHEDULE



- Pad 19 SAT1 : Blowdown (No further steam injection)
- Pad 19 Infills: CSS / Steam Drive
- Pad 20 Phase 3: Top-Down Steam Drive
- Pad 20 Infills: Lateral Steam Drive
- Pad 21 Conv/Pad22 : Top-Down Steam Drive
- Pad 21 Infills: Lateral Steam Drive
- Pad 30: Top-Down Steam Drive
- Pads 31: Top-Down Steam Drive
- Pad 32/33: CSS
- Pads 40: Blowdown (No further steam injection)
- Pads 41: Blowdown (No further steam injection)

5-YEAR OUTLOOK OF PAD ABANDONMENT

- Plan to abandon 14 wells in 2016
- Any future uneconomic wells will be suspended as per Directive 13

	Well Abandonment – 5-Year Outlook				
Year	2016	2017	2018	2019	2020
# Wells Abandoned	14	10	10	10	10

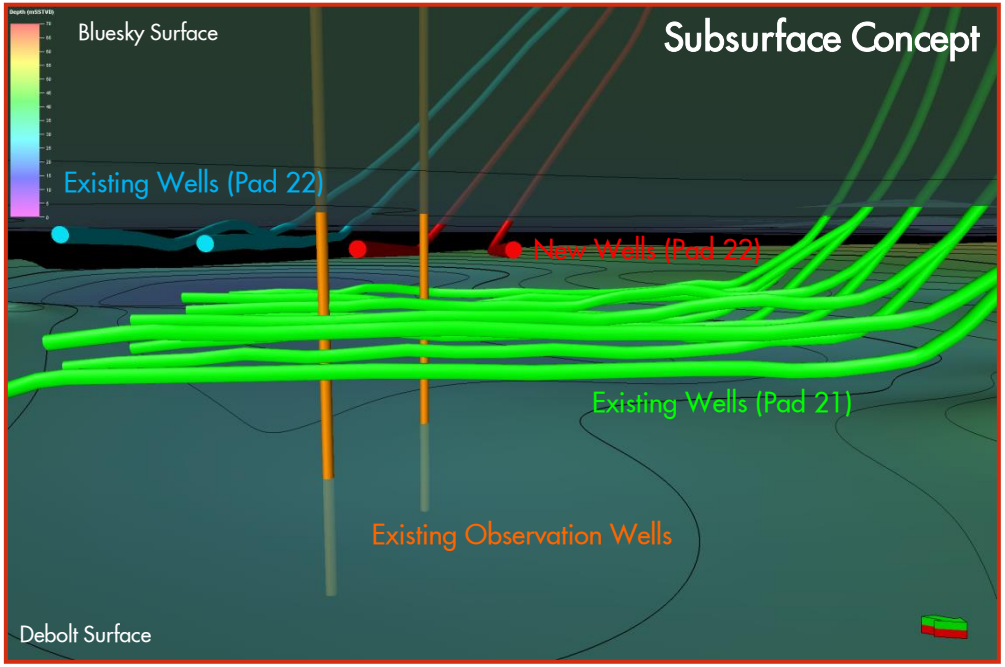
TODAY'S AGENDA

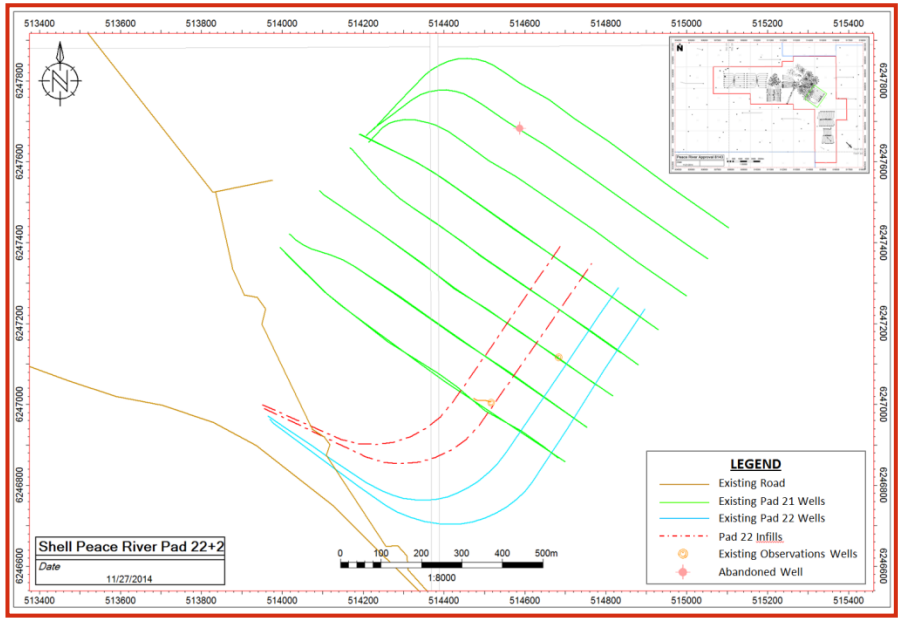
Introductions and Background	Ivan Gonzalez
Subsurface Issues Related to Resource Evaluation and Recovery	
Geology/Geoscience	Victoria Walker
Geophysics	Barbara Wingate
Drilling and Completions	Dan Syrnyk
Artificial Lift	Dan Syrnyk
Instrumentation in Wells	Dan Syrnyk
Well Integrity	Dan Syrnyk
Scheme Performance	Laura Mislan
Future Plans	Pasquale Riggi
Surface Operations, Performance and Compliance	
	Darcy Forman

PAD 22+2 (Pad 21) INFILLS

Purpose:

- To utilize PRC's steam and production capacity and increase ultimate recovery from Pad 21 existing horizontal producing wells, located in the lower portion of Bluesky Formation. Two additional horizontal injection wells (to be placed in the upper part of Bluesky Formation) are proposed from existing surface location on Pad 22, expanding current TDSD process.





PAD 22+2 INFILL PROJECT

Scope:

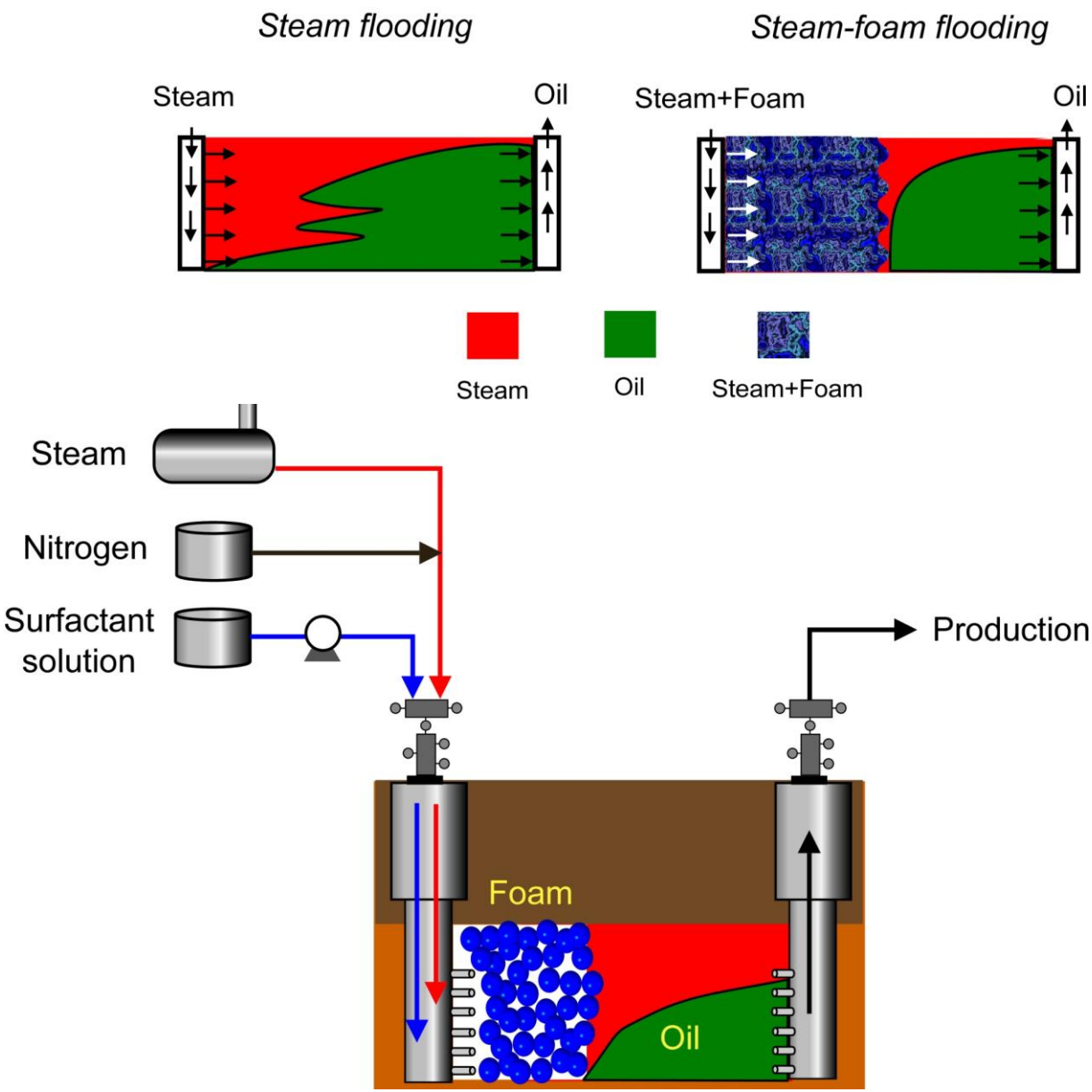
- Drill 2 additional horizontal TDSD injection wells from existing Pad 22
- Tie in to existing steam lines and construct new steam lines to the new wells on Pad 22

Schedule:

- Scheme amendment approval received November 2014
- Drilling: September 2015
- Optimized our steam injection to the pad and decided to only drill one well (22-4)
- Steam Start-up: November 2015

Shell Peace River PAD 19-3 Steam-Foam Proof of Concept

- Shell is planning to perform a Steam Foam Proof of Concept (PoC) injection trial into two wells (111/14-21-85-18W5/00 and 112/14-21-85-18W5/00) within the existing Pad 19 Satellite 3 in summer 2016.
- Surfactant injection will take place for up to 1 year
- The Steam-Foam technology is being trialed to determine if the technology can improve the sweep efficiency by overcoming gravity override, viscous fingering and channelling



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Future Plans	Pasquale Riggi
Surface Operations, Performance and Compliance	
	Darcy Forman

Area 730: Cogen 3
- Piling Complete

Area 720: Cogen 2
- Piling + Foundations complete
- Equipment install and set up (GT, GTG, Electrical building,, GSU TX….)
- Cogen divert stack partially installed
- BU-37 : high bay 35% complete

Area 710: Cogen 1
- Piling + Foundations complete
- Equipment install and set up (GT, GTG, Lube oil unit, Electrical building, Glycol cooler, GSU TX….)
- Cogen divert stack partially installed
- BU-20 low bay completed, high bay 80% completed

Area 700 : Substations
- Piling Complete
- Substation 240 KV, 34.5KV, 4160V install
- Transformer 240KV/34.5KV, 34.5 KV/4160 install

North Sediment pond : complete
South sediment pond : Complete

ALL Other Areas (outside blue boxes) – earthworks and grading only

Area 900 : Blow down pond rough excavated only (2/3 of final dimension)
Area 910 : Sewage lagoon rough excavated

Area 470 : Water Tank
- Tank pad complete

Area 630 : Product Tank
- BFW tank Excavation and ring wall complete
- Diluent Tank : Excavation and engineering fill complete

Area 500: ACM Building
- Piling Complete
- Foundation complete (80%)
- ACM pound excavate

AREA	NAME	AREA	NAME
100	CVG COMPRESSOR PHASE 1 & 2	620	TANK FARM – PHASE 2
110	OIL & GAS TREATING – PHASE 1	630	PRODUCTION TANK FARM
120	OIL & GAS TREATING – PHASE 2	700	SUBSTATION
210	WATER TREATING – PHASE 1	710	COGEN #1
220	WATER TREATING – PHASE 2	720	COGEN #2
300	ACID GAS COMPRESSOR PHASE 1 & 2	730	COGEN #3
310	AMINE UNIT PHASE 1	740	OTSG'S
320	AMINE UNIT PHASE 2	800	MAIN PIPERACK
[illegible]	[illegible]	810	PIPERACK PHASE 1
460	FLARE	820	PIPERACK PHASE 2
470	RIVER WATER TANK	900	RUNOFF/BLOWDOWN POND
500	ADMIN/CONTROL AND MAINTENANCE BUILDINGS	910	SEWAGE LAGOON
610	TANK FARM – PHASE 1		

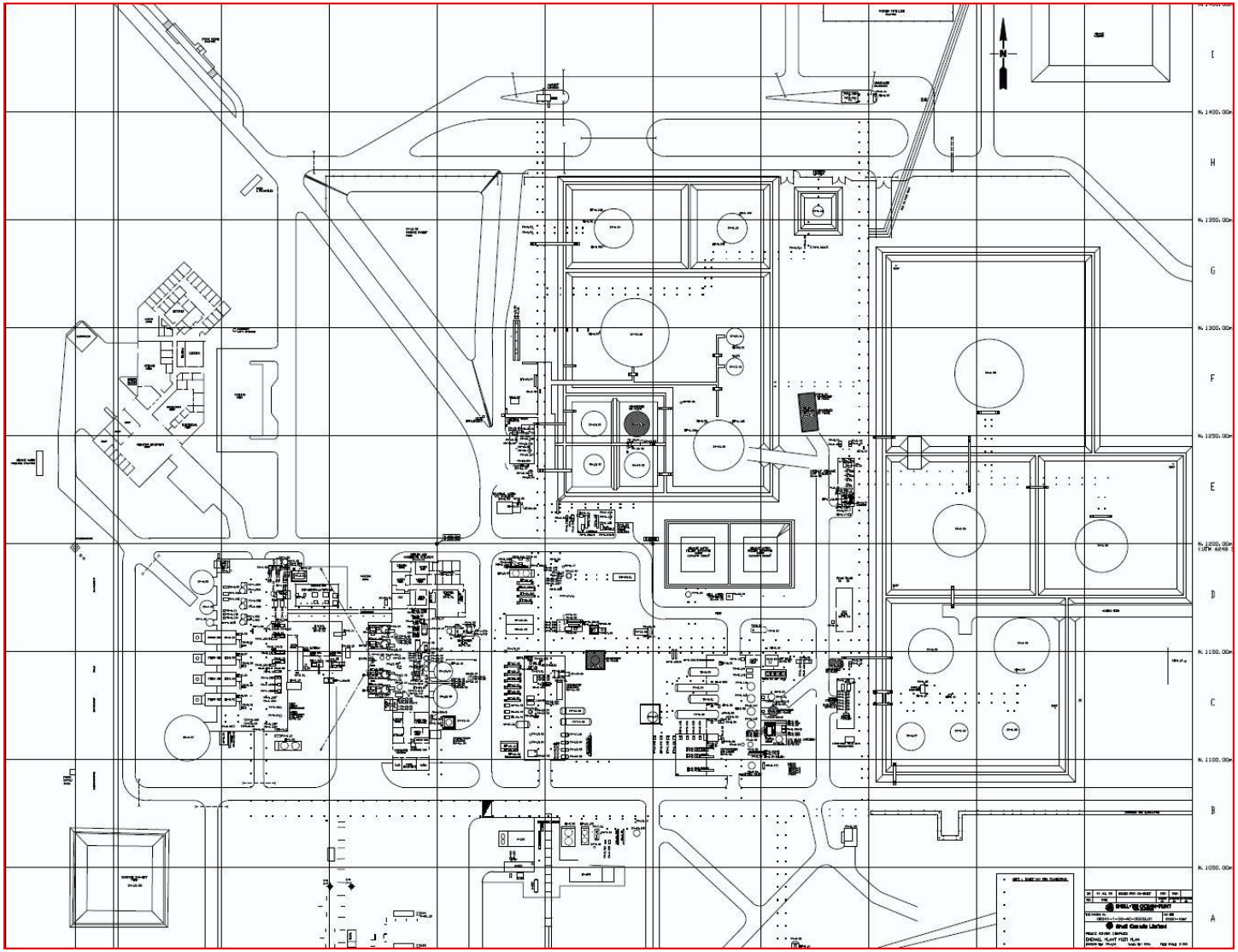
CARMON CREEK CPF CONSTRUCTION

CENTRAL PROCESSING FACILITY
SCALE: 1:2500

CARMON CREEK PROJECT
CENTRAL PROCESSING FACILITY
PHASE 1 & 2
CONSTRUCTION AREA PLAN

DRG No. CCK-0000-BA-2404-009-00003-001

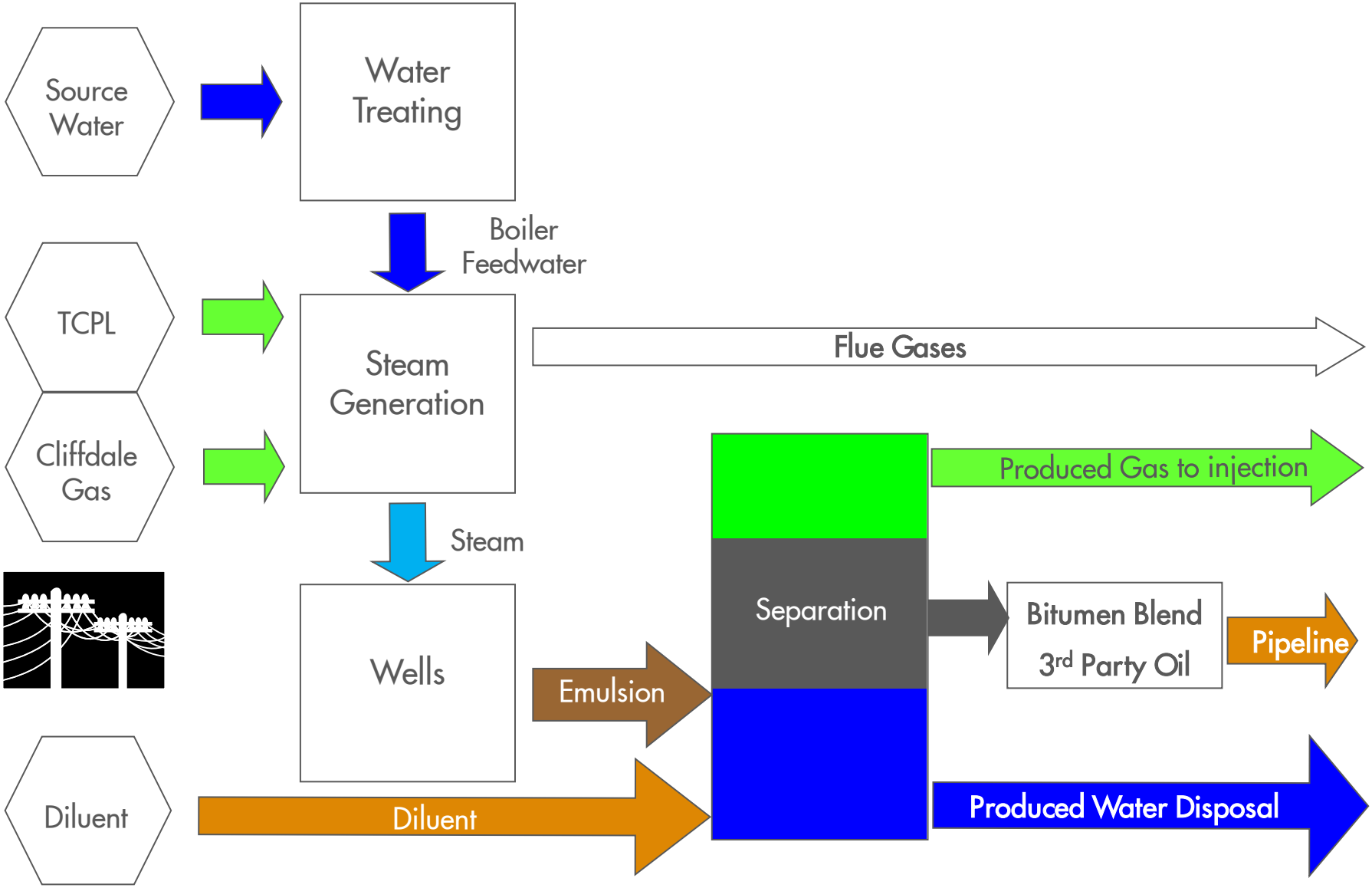
PLOT PLAN WITH 2013 MODIFICATIONS



No modifications in 2015

PEACE RIVER PLANT

THERMAL PRODUCTION TREATING: PROCESS FLOW DIAGRAM



FACILITY OVERVIEW

- PR is a thermal facility
- Recovery mechanism is a combination of steam drive and cyclical steaming.
  - In cyclical steaming, the wells are left shut-in for a period of time to soak. Subsequently the wells are flowed back until they reach flowline pressure (1,300 kPa) at which point pumps are installed.
  - In steam drive steam is injected through dedicated injectors and water and bitumen are produced through dedicated producers at some distance from the injectors
- Production is pumped into the production pipeline. The casings are vented into a casing vent line that runs on plant line pack (250 kPa). Pad 32/33 have multiphase pumps that compress the gas back into the production line.
- Emulsion enters the plant for oil, water, and gas separation.
- Bitumen treating consists of degassing, separating & treating. The separation process is enhanced by controlled heat exchange and addition of demulsifier & diluent.
- The produced gas is compressed and injected into a formation for future usage
- Production averages around 40% of 2,000 m^3/day licensed capacity.

FACILITY PERFORMANCE: PRODUCED WATER TREATMENT

- Produced water is treated & disposed into two injection wells completed in the Leduc Zone
- Produced water is:
  - Taken off the separators and treaters
  - Cooled using exchangers with boiler feedwater as the cooling medium
  - Sent to the skim tank and surge tank for additional retention time and oil separation
  - Passed through the sand filters
  - Sent to disposal tank
  - Sent to Leduc injection wells
- Produced water recycle percent = 0%
- Typical water quality:
  - Produced water TSS 30 mg/L, Oil and Grease 75 ppm, Total Hardness 374 mg/L
- Solids are periodically disposed of through approved waste stream treating companies
- This year we took the produced water skim tank and surge tank off line for internal cleanings. Removed 40% volume in solids.
- Designed produced water handling and injection capacity is 7977 m3/day.

FACILITY PERFORMANCE: SOURCE WATER TREATMENT

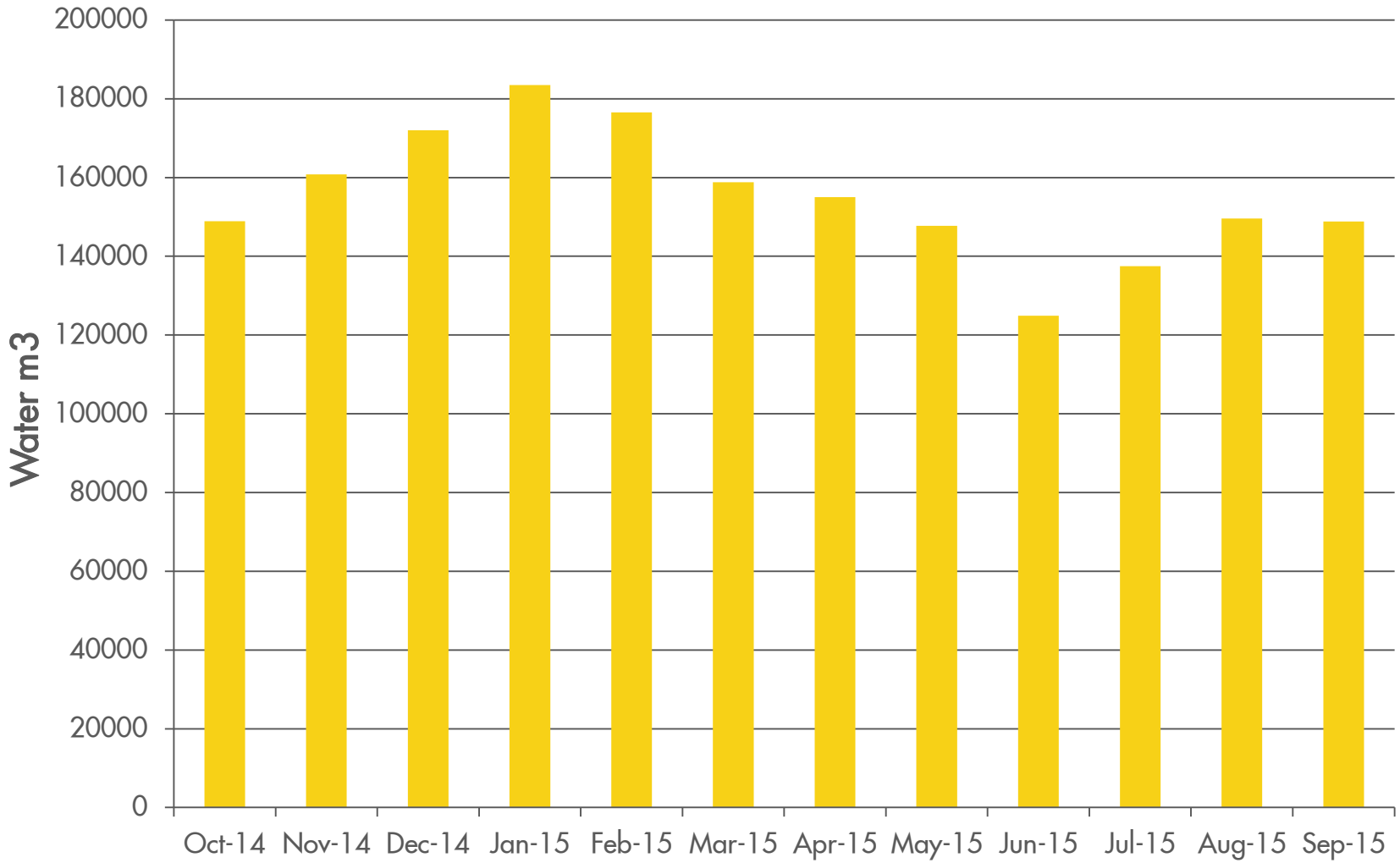
- PRC pulls water from the Peace River on a continuous basis. Shell has a source water treatment facility located on the east bank of the Peace River
- PRC is licensed to withdraw 4.3 e^6m^3 of water from the Peace River per year (11,813 m3/day)
- Historical water usage range is 5,000 m^3/day to 11,000 m^3/day
  - YTD fresh water withdrawal (as of Sep 30th) is 1.8 e^6m^3 or an average of 4,925 m^3/day
- Before being sent to the main complex, fresh water from source water is treated to:
  - less than 5 ntu, and less than 0 ppm oxygen
- Water is clarified in a reaction clarifier. After passing through gravity sand filters, the water is vacuum deaerated.
- The water is pumped to the main complex through a 20 km pipeline
- Main PRC water treatment consists of water softening using the sodium zeolite resin exchange process to remove calcium and magnesium
- 2015 working on a project that will use shallow shell resin technology in the softeners.
- Waste brine is disposed down a disposal well (16-27) in the Leduc formation

FACILITY WATER SOURCE:

- Peace River Complex pulls water from the Peace River through our source water facility
- The removal of water is covered under three Water Act Licences:
  - 00030033-00-00
  - 00030034-00-00
  - 00030035-00-00

  Each of the licences have been amended three times

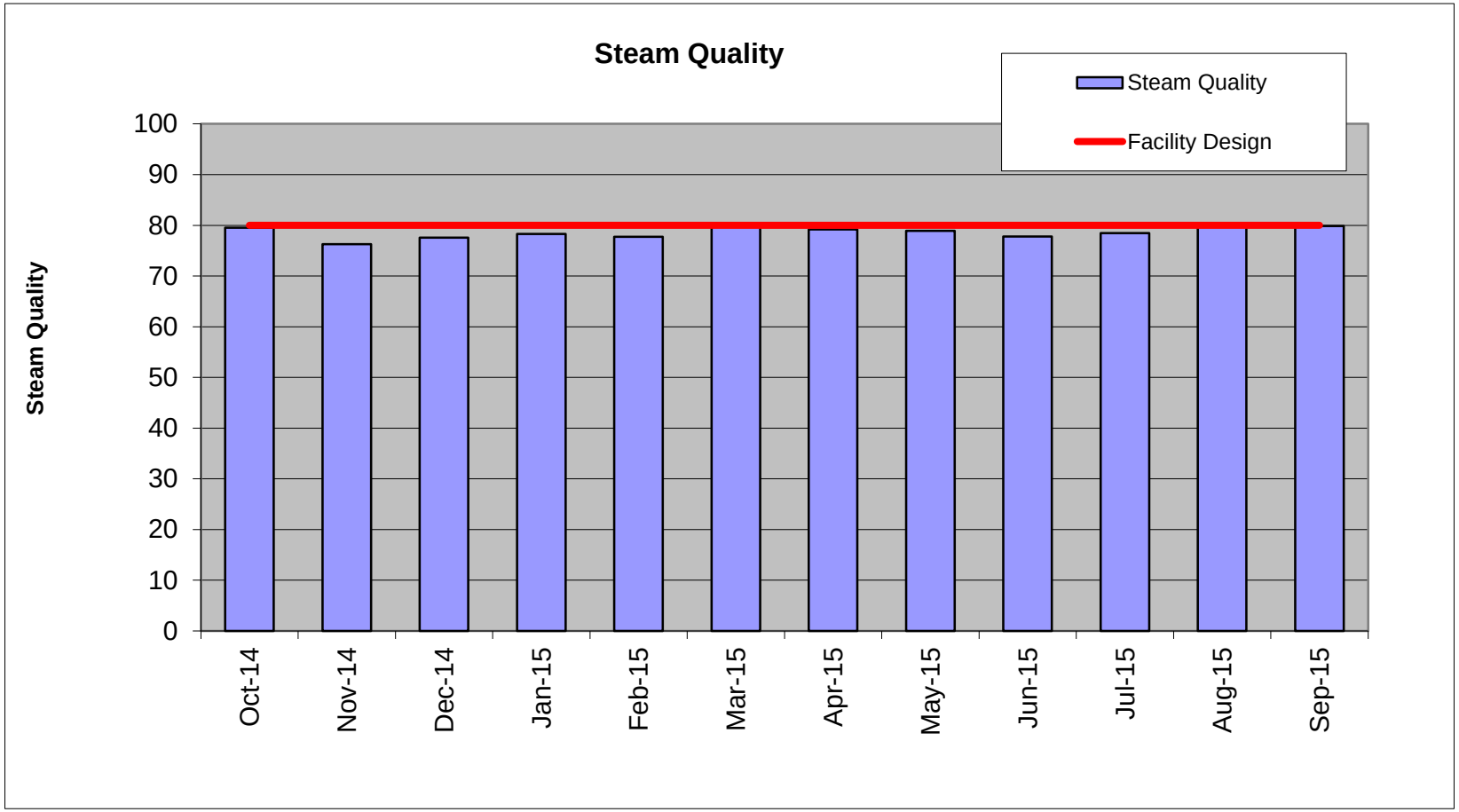
FACILITY PERFORMANCE: WATER WITHDRAWAL



FACILITY PERFORMANCE: STEAM GENERATION

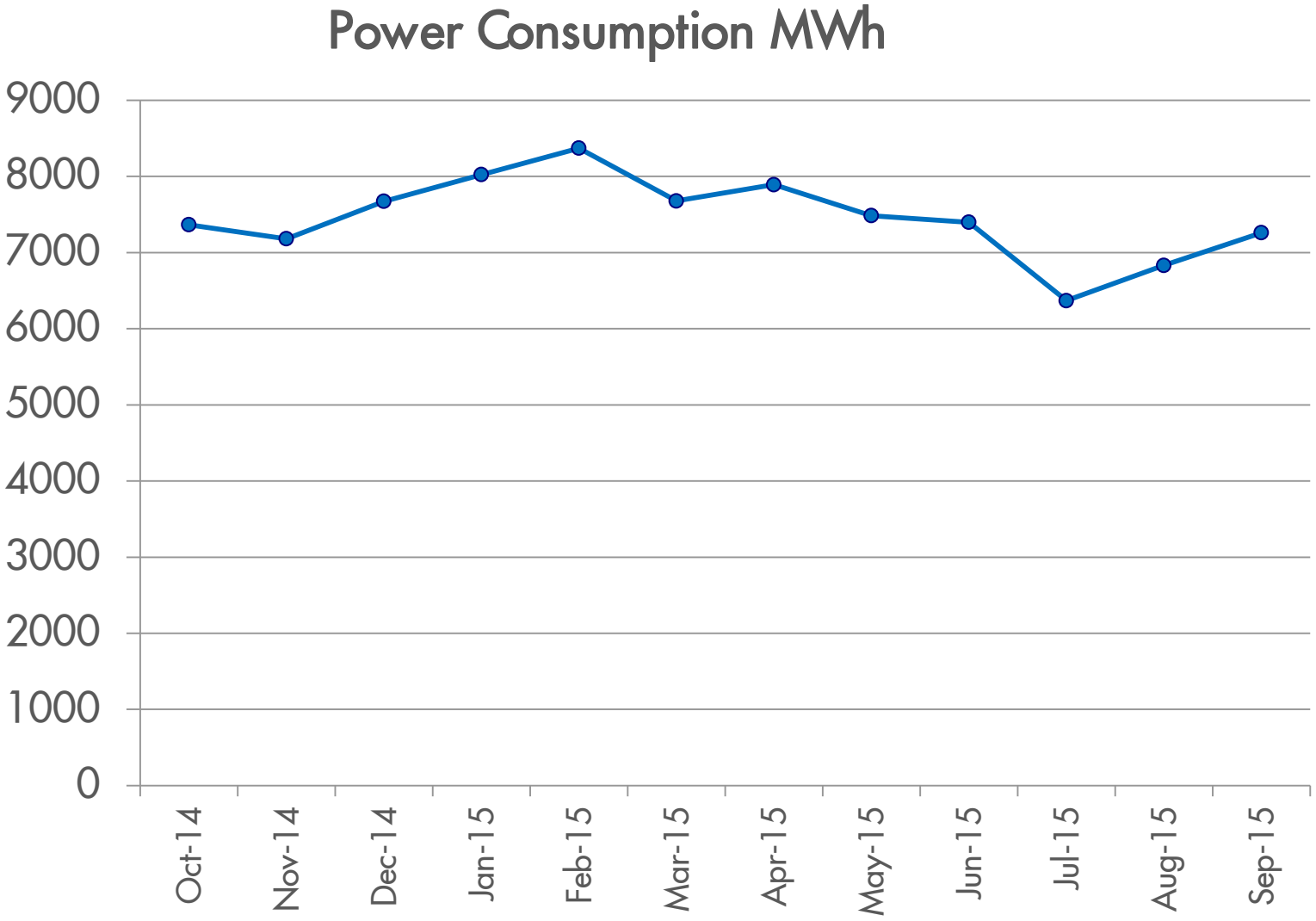
- PRC generates 80% steam quality from four once through steam generators.
- The four steam generators have a total capacity of approximately 8,000 tons of 80% quality per day. Steam pressures of 14 MPa and 335 °C.
- The main complex takes formation steam off the high pressure injection line and utilizes it in the utility steam system. The utility steam uses 700 to 1,500 t/d based on seasonal requirements.
- PRC has a100% utility steam system blowdown recycle back in to the plant steam condensate recovery system.
- All Steam Generators are now using a mixture of 60% Cliffdale and 40% Natural Gas by volume as their fuel source.
- Currently doing detailed engineering work to convert the Peace River steam system back to 100% steam quality to the field. Targeting an implementation date of mid 2016.

FACILITY PERFORMANCE: STEAM GENERATED

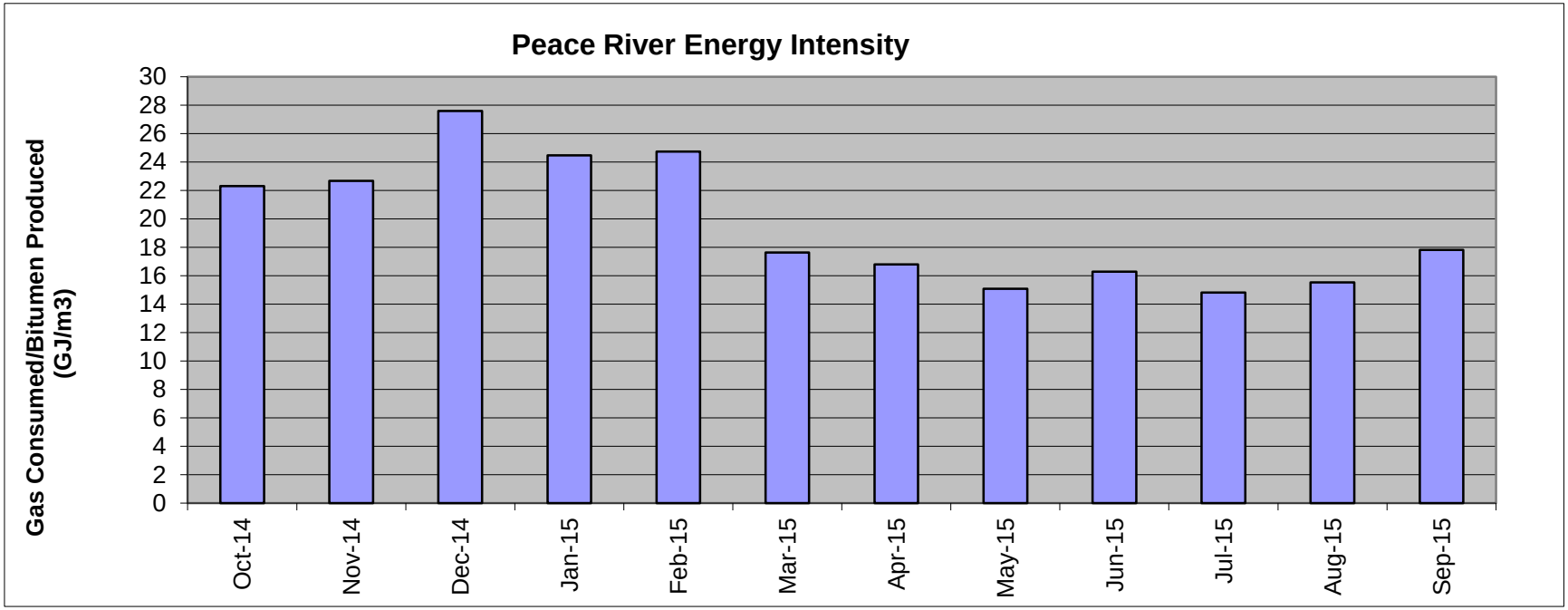


- Four PREP boilers at 2000 tons/d capacity each

FACILITY PERFORMANCE: POWER USAGE



FACILITY PERFORMANCE: ENERGY INTENSITY



- Gas Consumed = Steam Generated x Boiler Efficiency
- Delay from steaming to production on any given well lag behind up to 6 months

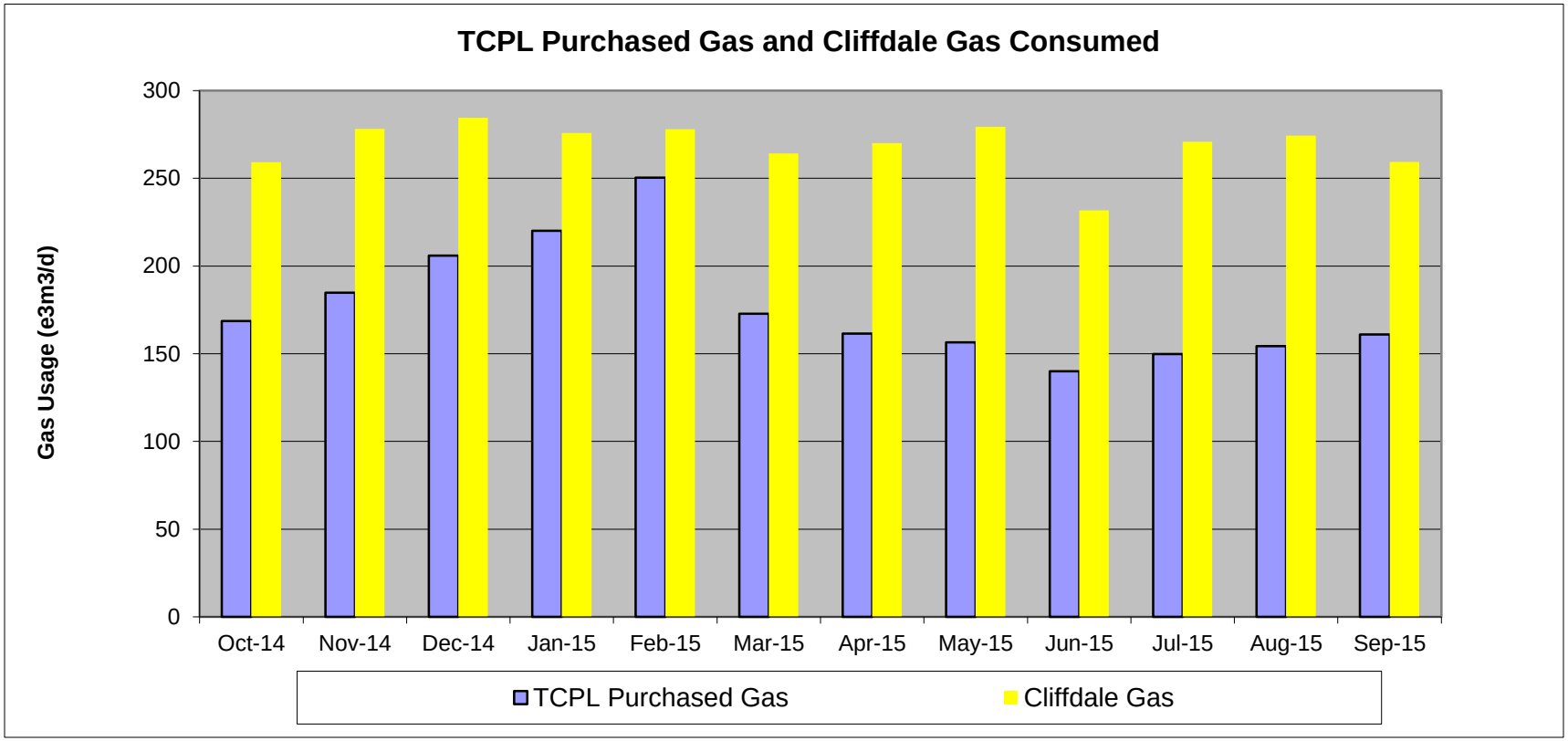
FACILITY PERFORMANCE: GAS USAGE

- Natural gas is purchased from TransCanada for use as fuel.
- Since June 2010, CVG from the Cliffdale field is being imported to PRC as a fuel source to the boilers
- EPEA licence restrictions limit using sour fuel in the boilers to events less than 72 hours in duration. While Peace River has the capability to burn sour mixed gas it has not been done since 2010.

FACILITY PERFORMANCE: Three Creeks Compressor

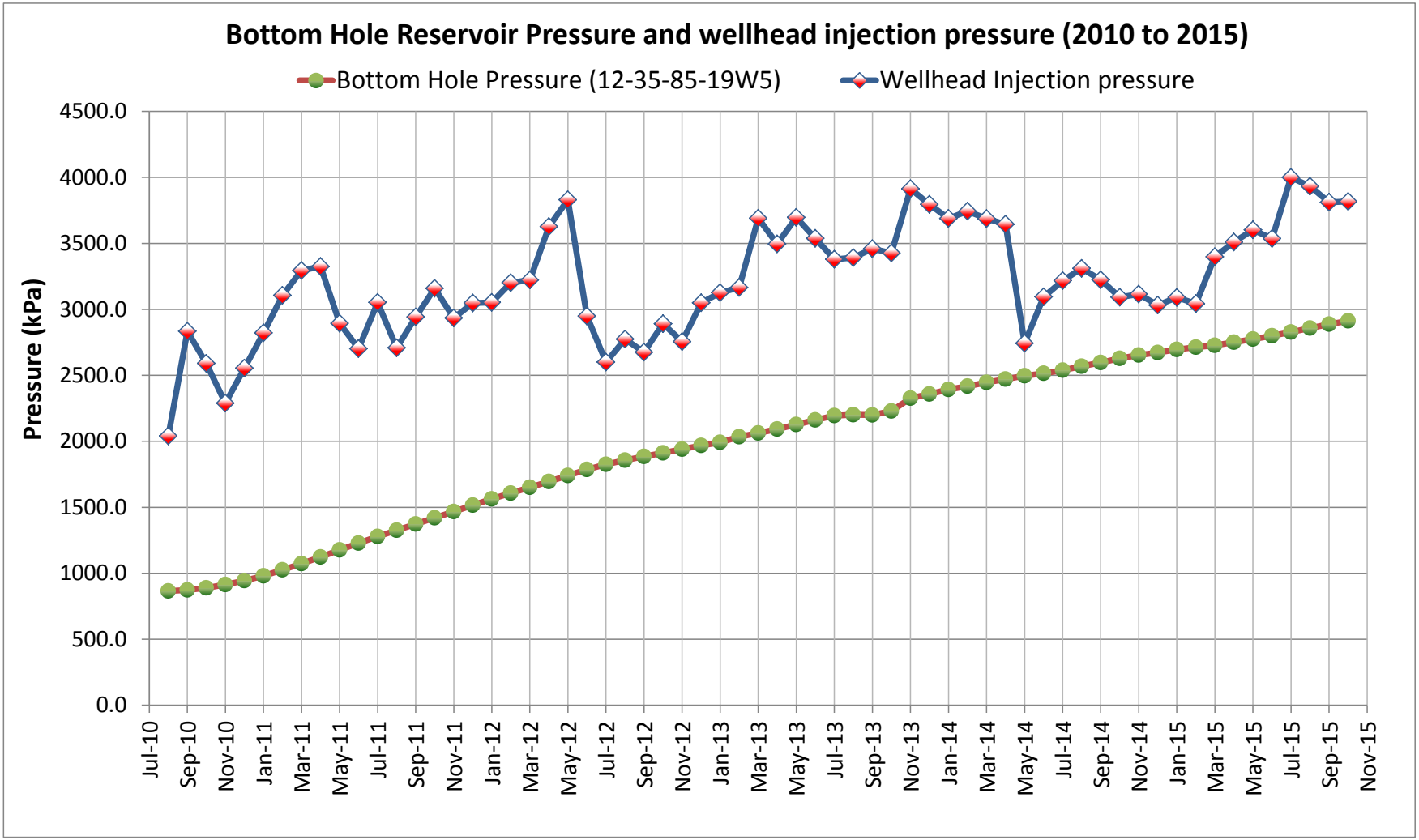
- Three Creeks Gas injection facility has been operational for five years.
- Gas is currently analyzed once per month at the Three Creeks dehydration outlet to the Three Creeks gas injection pipeline. Analysis done by a outside lab.
- Well acid stimulation completed October 3, 2015
- Compressor turnaround completed June 2015
- 2015 Injection facility reliability is currently 99 %. This includes planned maintenance shutdowns.

FACILITY PERFORMANCE: GAS USAGE



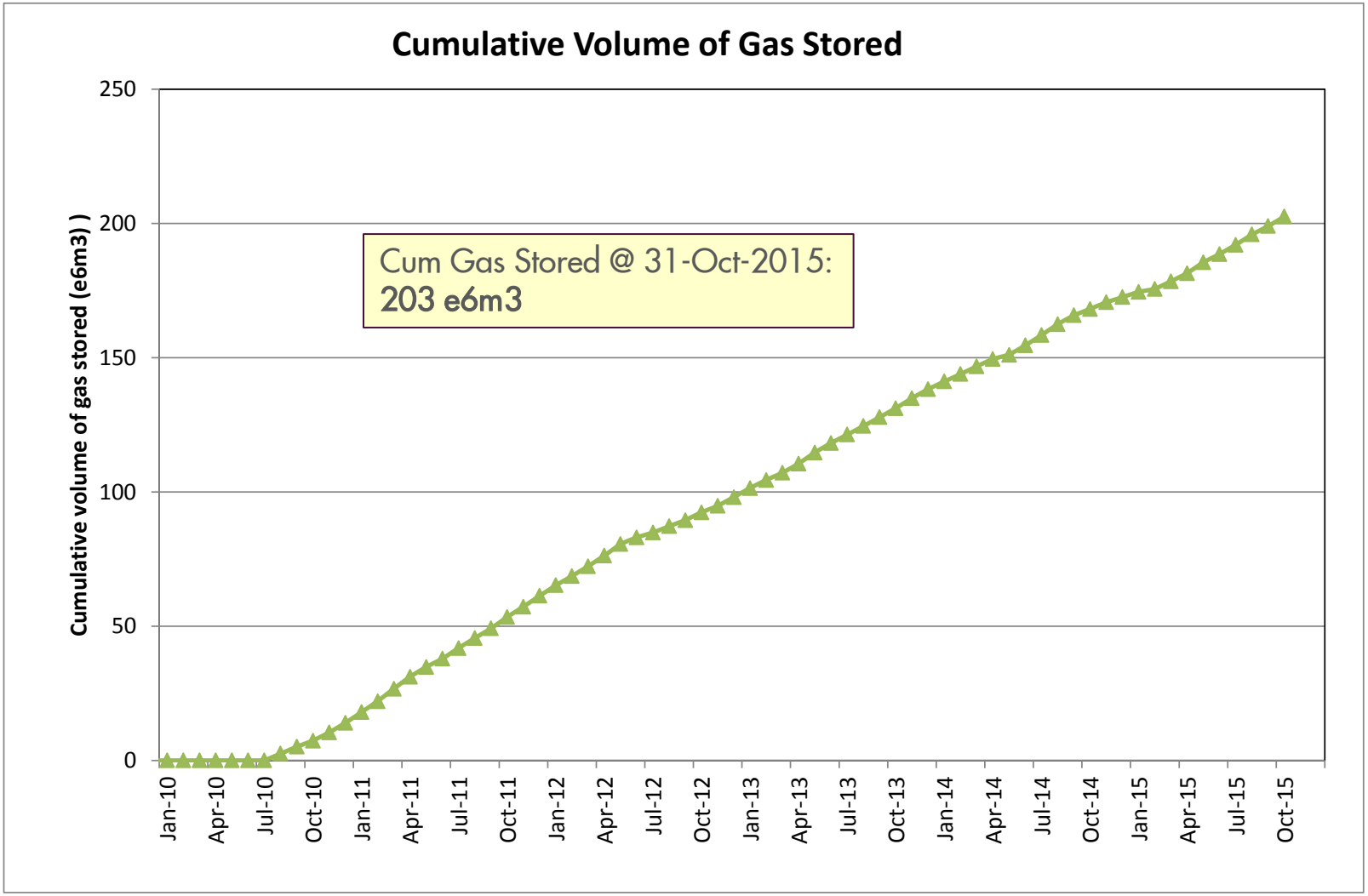
- PRC produced gas is no longer consumed in boilers but injected into the Three Creeks reservoir since September 2010

THREE CREEKS SUBSURFACE INFORMATION



- Data as per Three Creeks annual progress report submitted in Oct 2015

THREE CREEKS SUBSURFACE INFORMATION



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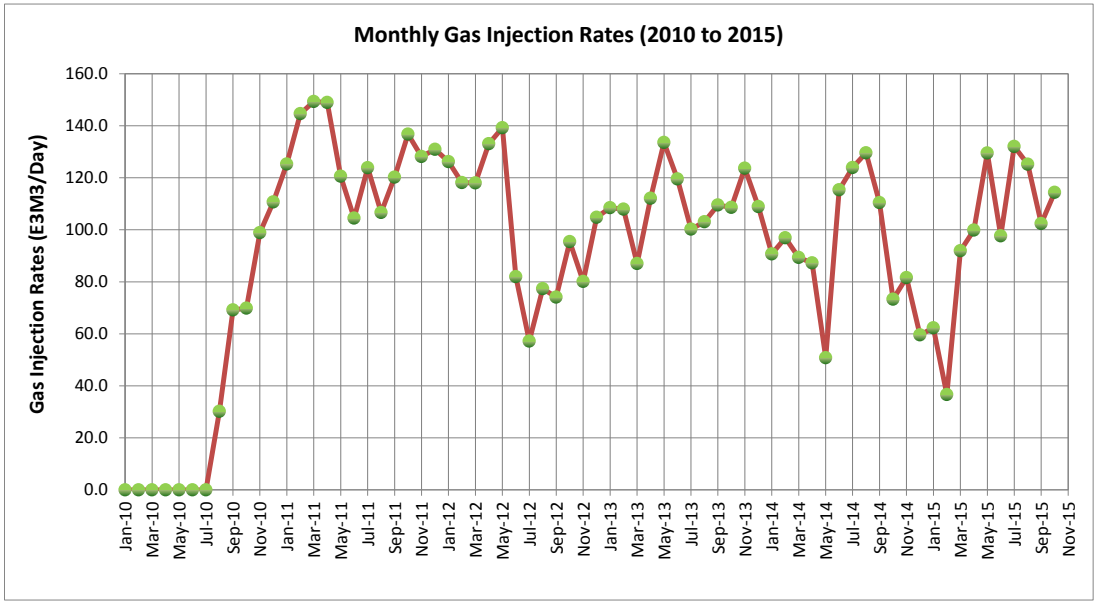


- Remaining Three Creeks storage capacity (in million sm^3 as of Q3 2015) to initial reservoir pressure (3564 kPa)

Empirical Method	67
Numerical Reservoir Simulation	121

- Asset life span matrix (forecasted as of Nov.1 2015)

The asset is forecasted to maintain a gas injection rate between 100 and 150 e3m3/d in the future. The table below provides fill up dates (up to initial reservoir pressure) for different average gas injection rates:

Injection Rate (e3m3/d)	Empirical Method Fill-up date	Numerical Simulation Fill-up date
100	Aug-2017	Aug-2019
120	May-2017	Oct-2018
150	Jan-2017	Dec-2017

There is a chance that the initial reservoir pressure will be reached before the expiry of the current D81 waiver (Nov-2017).
A D65 amendment will be submitted to increase maximum reservoir pressure in the Three Creeks gas cap.

THREE CREEKS SUBSURFACE INFORMATION

- Injected gas stream is analyzed once every month. The table below presents the gas analysis for July, August and September 2015.

Component	July 2015	August 2015	September 2015
	Mole Fraction (As Received)		
Hydrogen	0.00606	0.00727	0.00585
Helium	0.00009	0.00008	0.00009
Nitrogen	0.00280	0.00361	0.00215
Carbon Dioxide	0.31813	0.34520	0.36354
Hydrogen Sulfide	0.00750	0.00740	0.00850
Methane	0.64438	0.60577	0.59934
Ethane	0.00797	0.00911	0.00791
Propane	0.00530	0.00536	0.00491
Isobutane	0.00147	0.00238	0.00097
n-Butane	0.00213	0.00400	0.00162
Isopentane	0.00166	0.00481	0.00224
n-Pentane	0.00130	0.00340	0.00173
Hexanes	0.00078	0.00112	0.00085
Heptanes+	0.00043	0.00049	0.00030
TOTAL	**1.00000**	**1.00000**	**1.00000**

MEASUREMENT, ACCOUNTING & REPORTING PLAN (MARP)

- A MARP was approved in July 2009. Most recent MARP update was submitted on February 27, 2015.

- No significant changes to the Measurement, Accounting and Reporting Plan since the last submission.

PRODUCTION WELL TESTING

- Each well is directed to a test vessel near the pad, except pad 19 sat 1,2,4 & 20
- Well test duration/frequency largely dependent on purge time & number of wells tied into each test separator:

Pad	Separator	Purge time**	Duration	Frequency
21	2 phase	~3-8 hrs	~24 hrs	3-4x/month
19 sat 1-2-4 & 20	3 phase	~ 1 to 8 hrs	~ 10 hrs	3-4x/month*
19 sat 3	2 phase	~0.5 hrs	~ 24 hrs	3-4x/month
30, 31	2 phase	~ 0.5 hrs	~ 10 hrs	4-5x/month
32, 33	2 phase	~ 0.5 hr	~ 10 hrs	4-5x/month

*Pad 20 tests for ESP wells average 1-2/month, due to operational changes required for chemical injection/decreasing production

** Purge time varies for each test, as it is dependent on the production rate of the well. A pre-determined purge volume is applied to each vessel

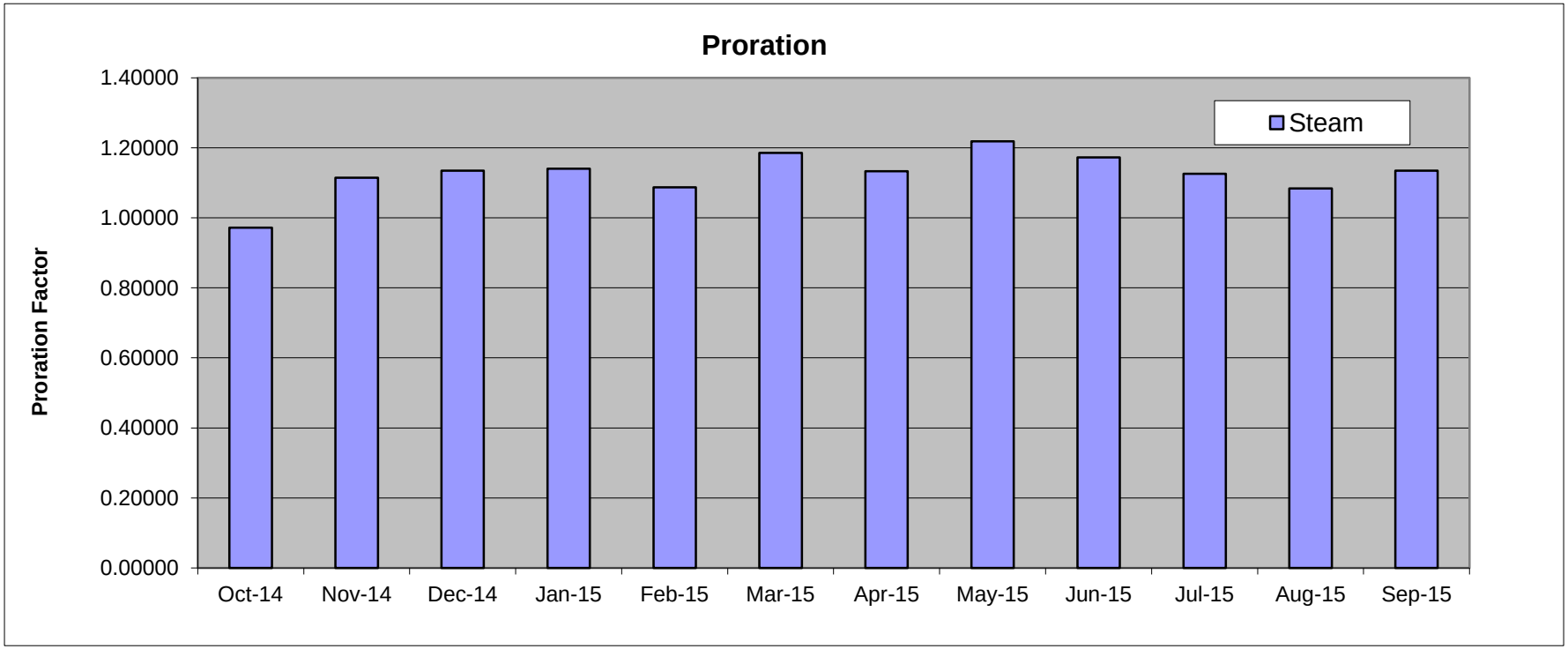
- Flow rates are measured by a Coriolis meter
- Water/bitumen cuts are determined by inline BS&W analyser
- Reported volumes are prorated based on measured total volumes at the plant
- Details of measurement and reporting procedures can be found in the Peace River MARP

WELL TESTING

- Reliability
  - 100% compliance was not achieved for the year. April, July, Sept and October 2015 are compliant.
  - Made use of Application No. 1812468 (Directive 17 Section 12.3 Waiver for testing Pad 20 ESP wells) until August 2015, after which point upgrades were made to test separator PV 17.03 which allowed for testing of ESP wells in accordance with Directive 17
  - Test compliance issues:
    - January 2015 - Repaired steam control valve(no pressure control for test separator, Pad 19)
    - January – March, May 2015 -AGAR meters issues, showing unacceptable test results on Pad 32, Level control issues on Pad 31, switched devices and tests are acceptable (DP transmitter to radar probe)
    - June 2015 – MPP down for maintenance on Pad 32, not able to keep pressure on test separator, insufficient well test data.
    - August 2015 – Steam outage on Pad 19 lasted longer than expected, no pressure support for test separator
- Improvement Plans
  - Field wide AGAR calibration campaign to be executed. Samples to be obtained prior, to implement new curves. (Health check completed for the software/hardware)
  - Natural gas adaptation for pressure management of the vessels to commence in 2016 (to begin with 19sat3)
  - Ongoing troubleshooting of pad 31 test separator (replaced leaky ESD, to troubleshoot leaking rotary valve, to implement an in-line check valve upstream of the original check valves for a producer, and possible natural gas adaptation instead of make-up steam for pressure management)

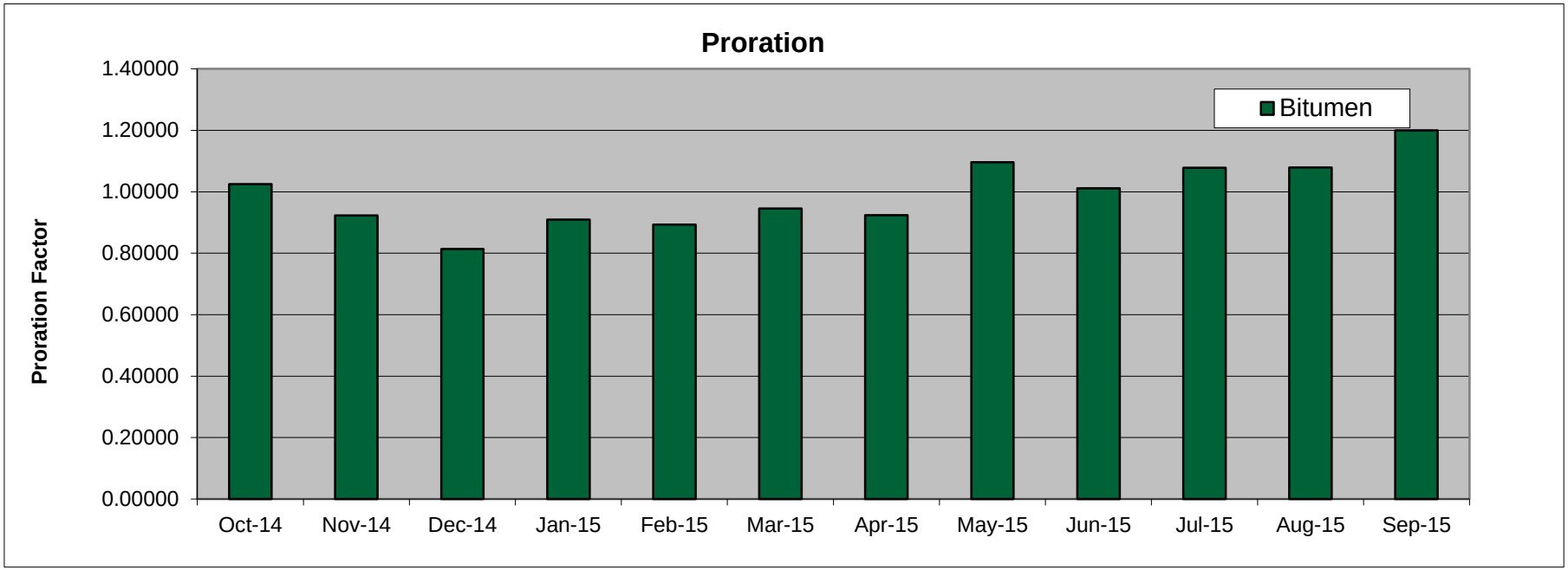
STEAM PRORATION

Proration	Oct 2014 – Oct 2015 Range	Oct 2014 - Oct 2015 Average
Steam	0.97 – 1.22	1.13



BITUMEN PRORATION

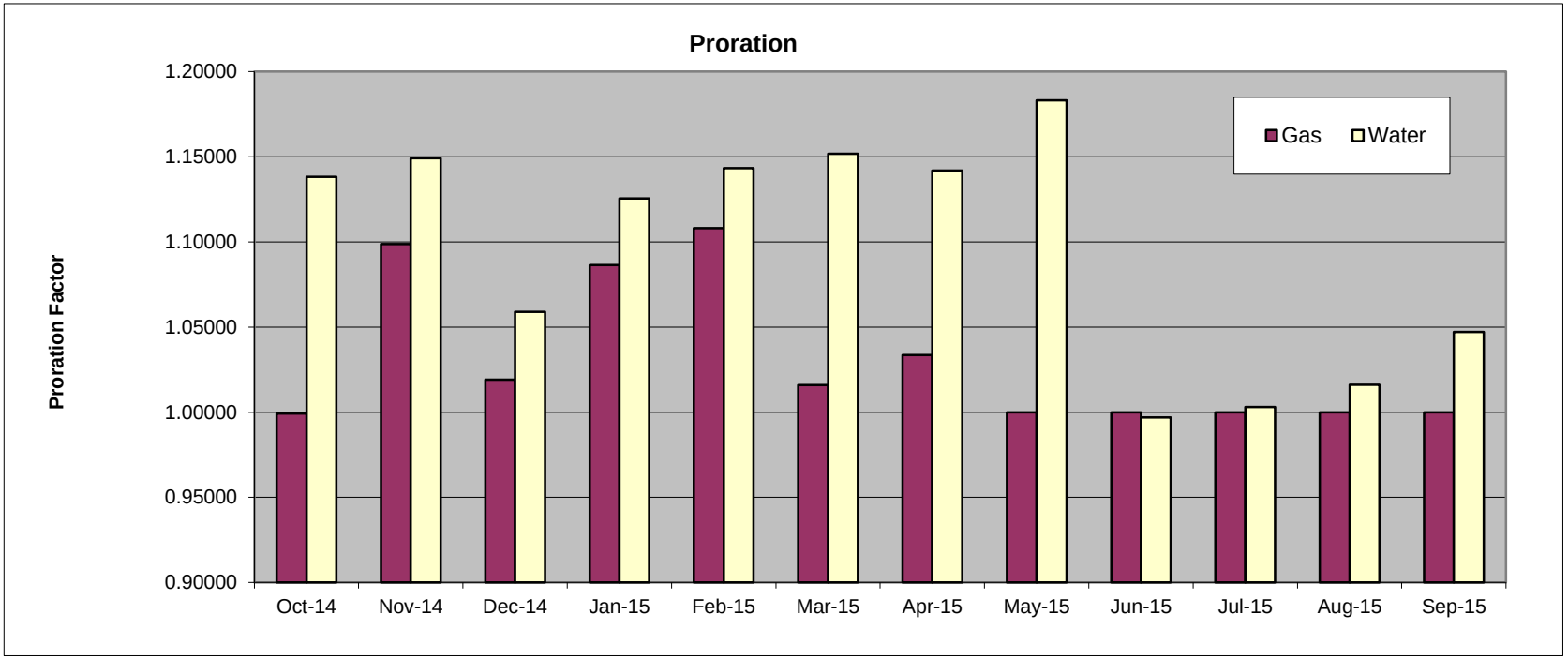
Proration	Oct 2014 – Oct 2015 Range	Oct 2014 - Oct 2015 Average
Bitumen	0.81 – 1.20	0.99



- In November 2015 we did a field wide well sampling and AGAR meter calibration program.

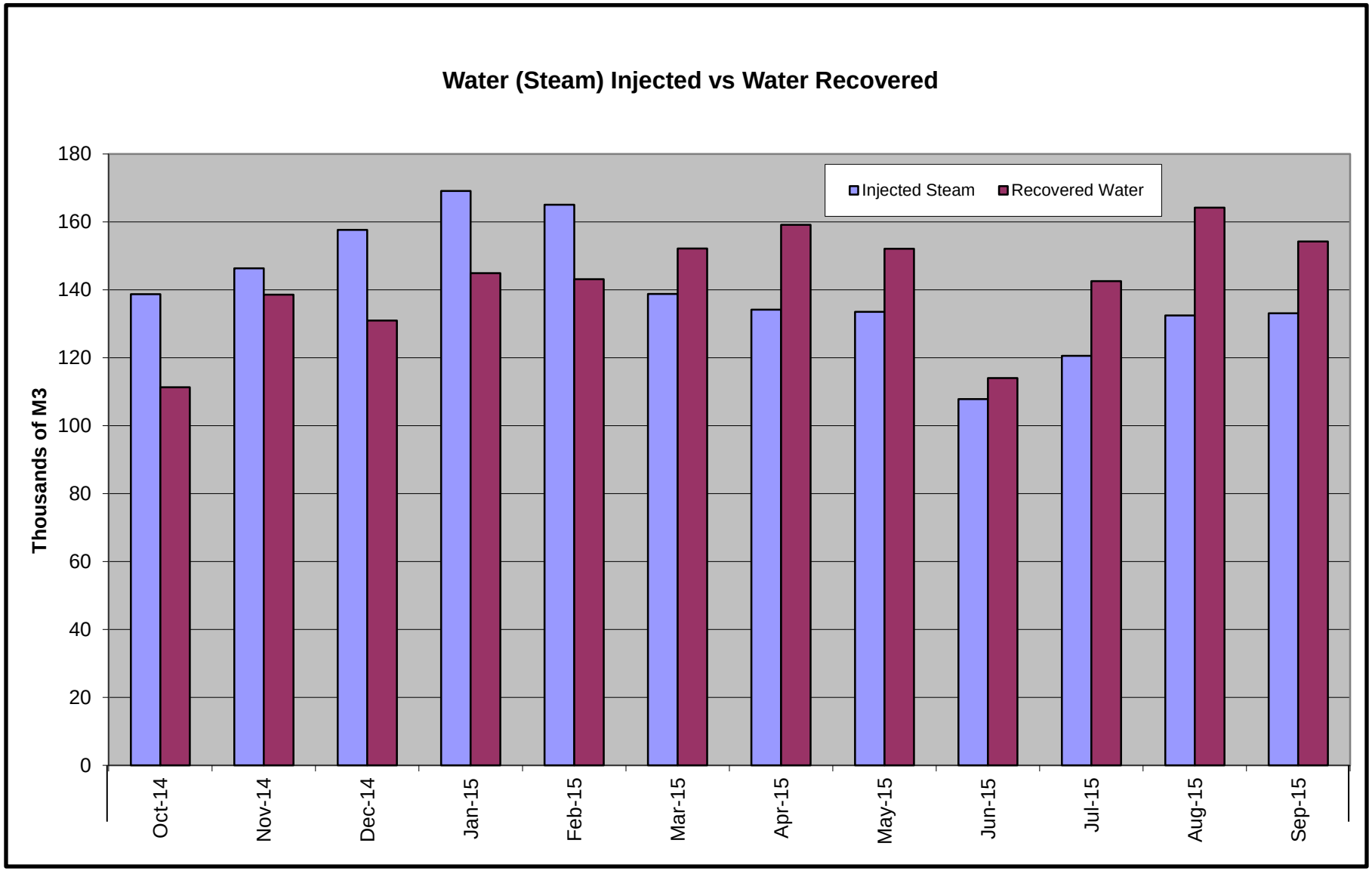
WATER & GAS PRORATION

Proration	Oct 2014- Oct 2015 Range	Oct 2014- Oct 2015 Average
Gas	1.00 – 1.11	1.03
Water	1.00 – 1.18	1.10

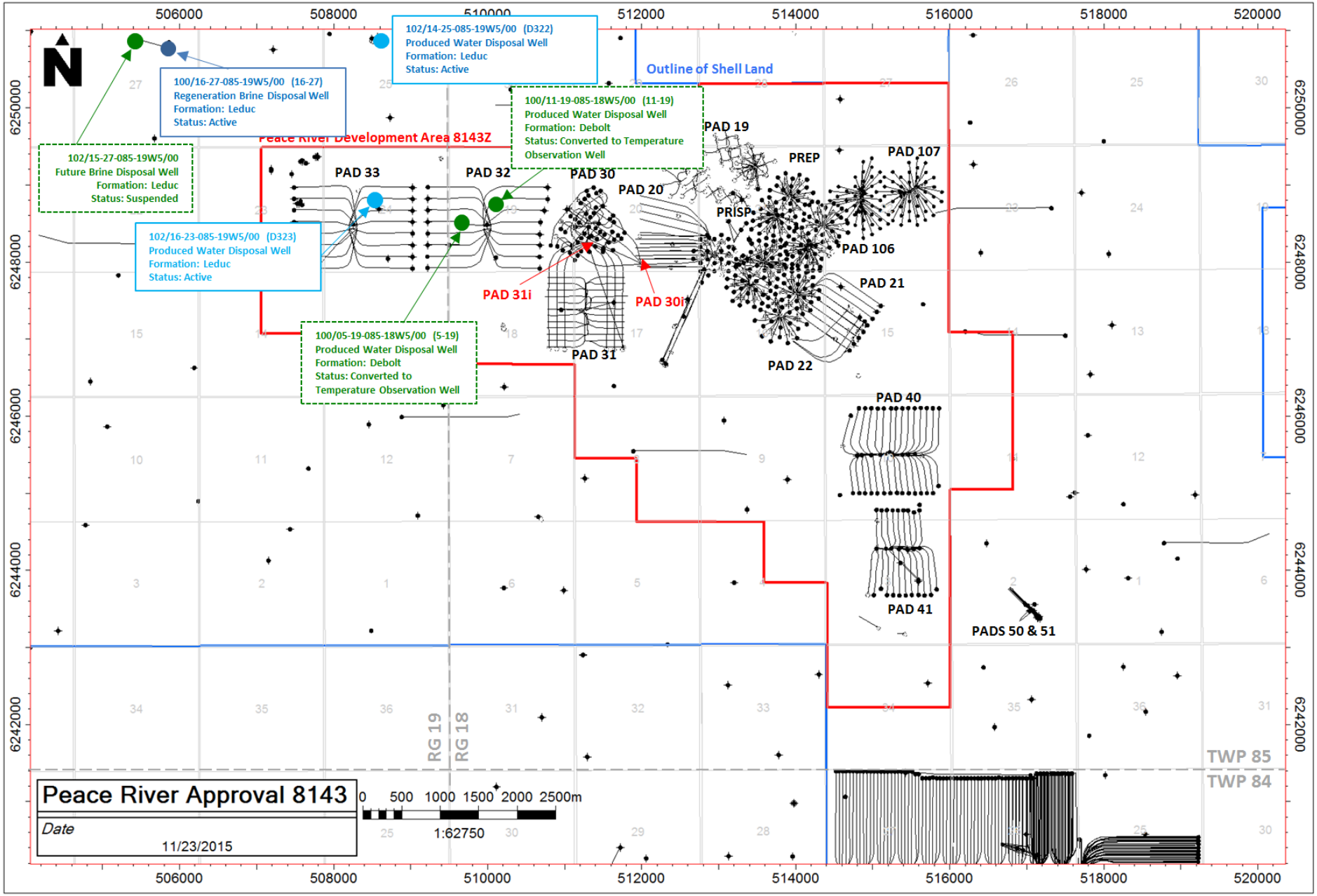


- Battery Level GOR x Prorated Well Oil Volume used for reporting PRC Produced Well Gas Volumes (May 2015 forward). Implemented the steam volumes used for winterization and test separator pressure into the water recycle calculation to correct the produced water volume.

STEAM INJECTED & PRODUCED WATER



WATER DISPOSAL WELLS



WATER DISPOSAL

- **Brine Water Disposal Well** (100/16-27-85-19W5)
  - Disposing into the Leduc formation
  - Used for boiler feed water softener regeneration waste
  - Average Disposal Volume/Day = 111 m^3/d
  - Average Upstream Pressure = 2,780 kPa
  - Max Wellhead Pressure = 3385 kPa* (Approved pressure = 4,500 kPa)
  - Typical Total Dissolved Solids (TDS) is 9000 g/m^3
  - Approval up to 4500 kPag wellhead injection pressure (as per approval no. 9953A)

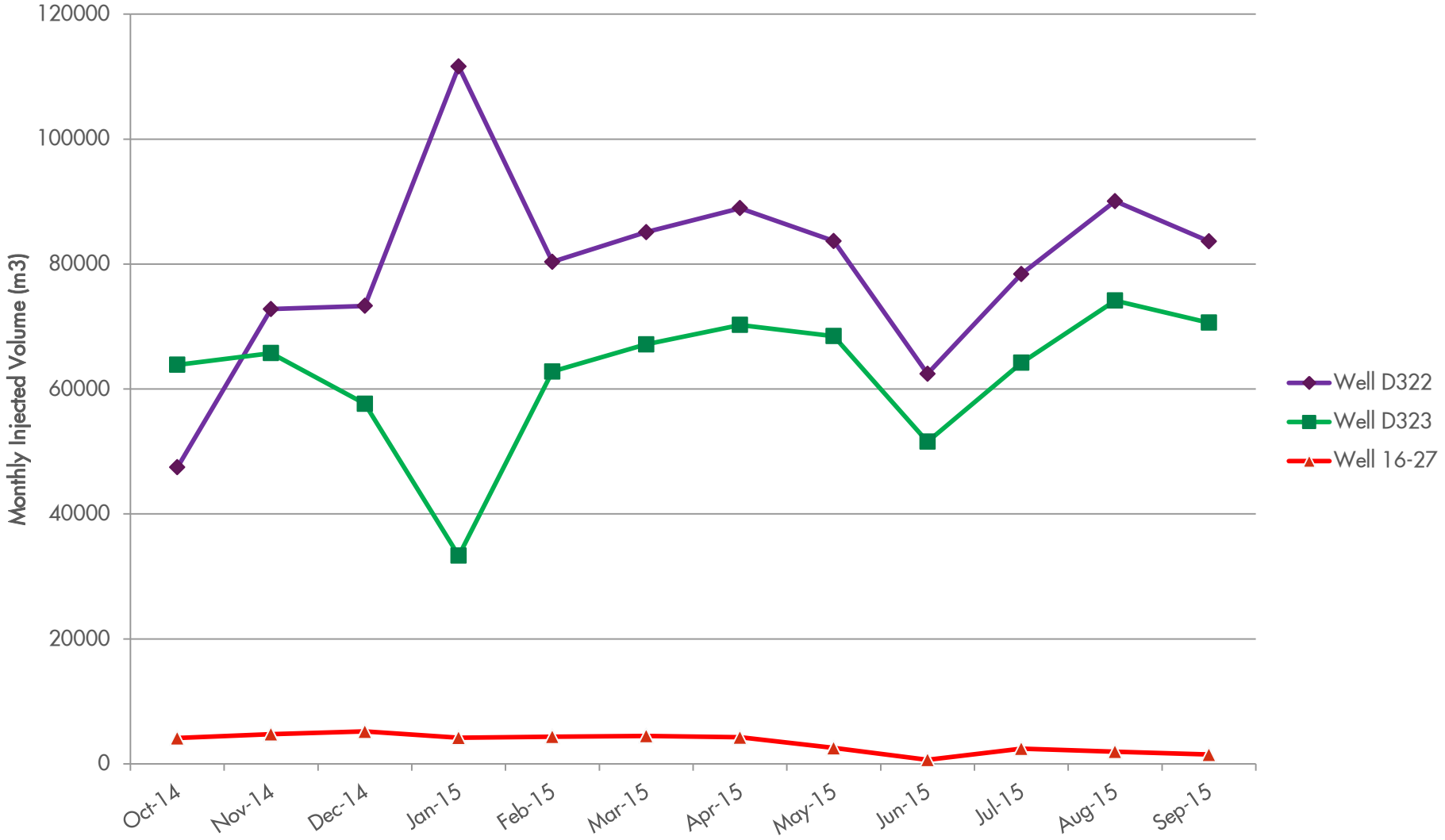
*Note that third-party data issues do not allow data analysis between Sept 23, 2014 - Nov 11, 2014 for Well 16-27.

WATER DISPOSAL

- **Produced Water Disposal Well 322** (102/14-25-85-19W5)
  - Disposing into the Leduc formation
  - Used as produced water disposal well
  - Average Disposal Volume/Day = 2,624 m^3/d
  - Average Pressure = 5,507 kPa
  - Max Pressure = 8341 kPa (Approved pressure = 18,000 kPa)
  - Average Temperature = 61 °C
  - Typical Total Dissolved Solids (TDS) is 5300 g/m^3
  - Approval up to 18,000 kPag (as per approval no. 6308)

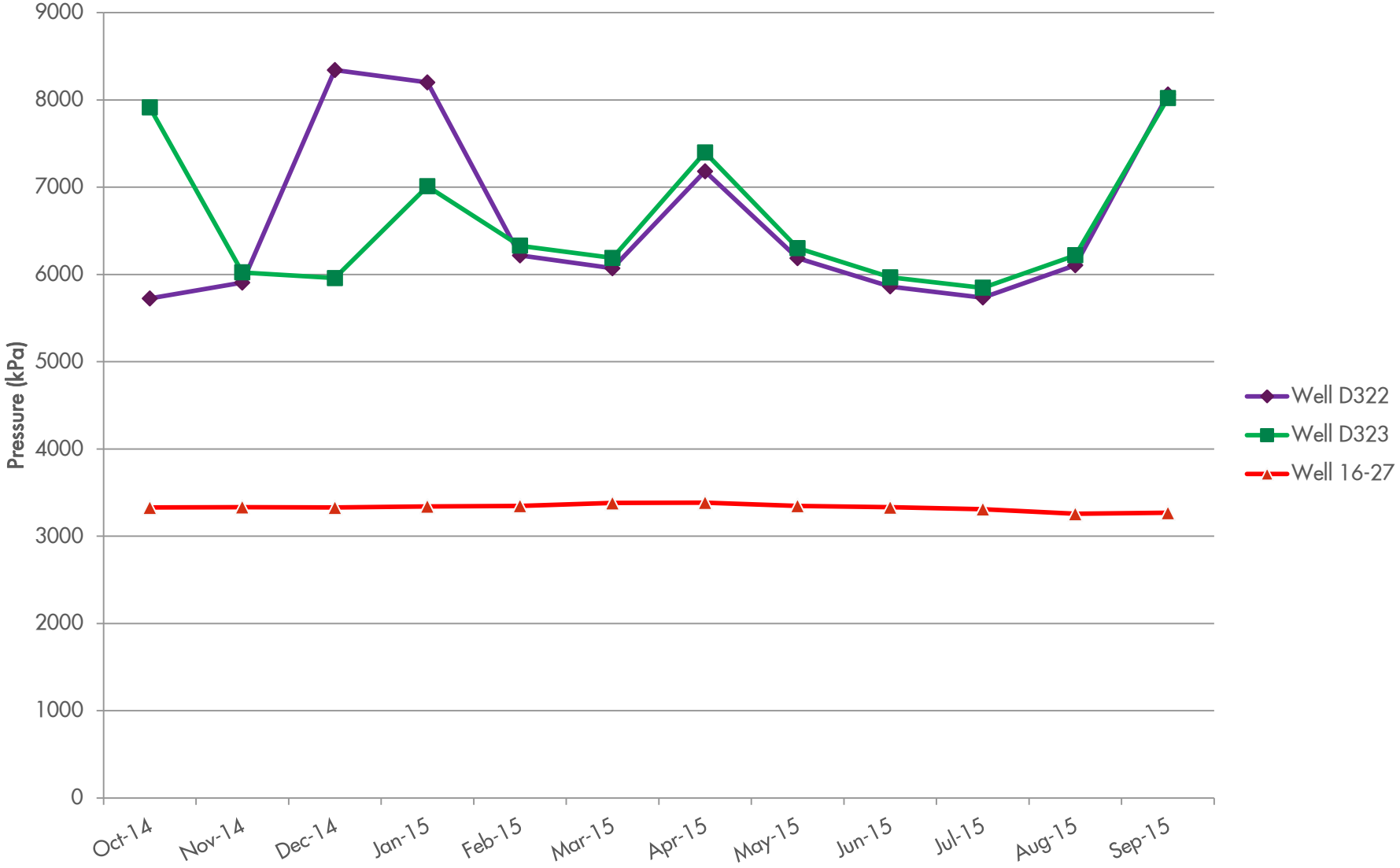
- **Produced Water Disposal Well 323** (102/16-23-85-19W5)
  - Disposing into the Leduc formation
  - Used as produced water disposal well
  - Average Disposal Volume/Day = 2,054 m^3 /d
  - Average Pressure = 5,307 kPa
  - Max Pressure = 8019 kPa (Approved pressure = 18,000 kPa)
  - Average Temperature = 62 °C
  - Typical Total Dissolved Solids (TDS) is 5300 g/m^3
  - Approval up to 18,000 kPag (as per approval no. 6308)

WATER DISPOSAL MONTHLY VOLUMES



Disposal Volumes injected into D323 decreased in January 2015 due to the drilling of the Carmon Creek Disposal Wells.

WATER DISPOSAL MAX MONTHLY INJECTION PRESSURES



*Note that third-party data issues do not allow data analysis between Sept 23, 2014 - Nov 11, 2014 for Well 16-27.

WASTE DISPOSAL

- Newalta-Red Earth (12-13-87-9W5)
  - Treatment, Recovery & Disposal (TRD) Facility
  - 208 m3 to October 2015
  - COEMUL and SLGHYD

- Newalta Seal Lake (11-07-82-15W5)
  - Treatment, Recovery & Disposal (TRD) Facility
  - COEMUL and SLGHYD
  - 561.3 m3 to October 2015

- RBW Waste Management
  - To Edmonton Facility for disposal 3907-69 Ave.
  - 1.6 m3 of waste solids (SOILCO) to October 2015

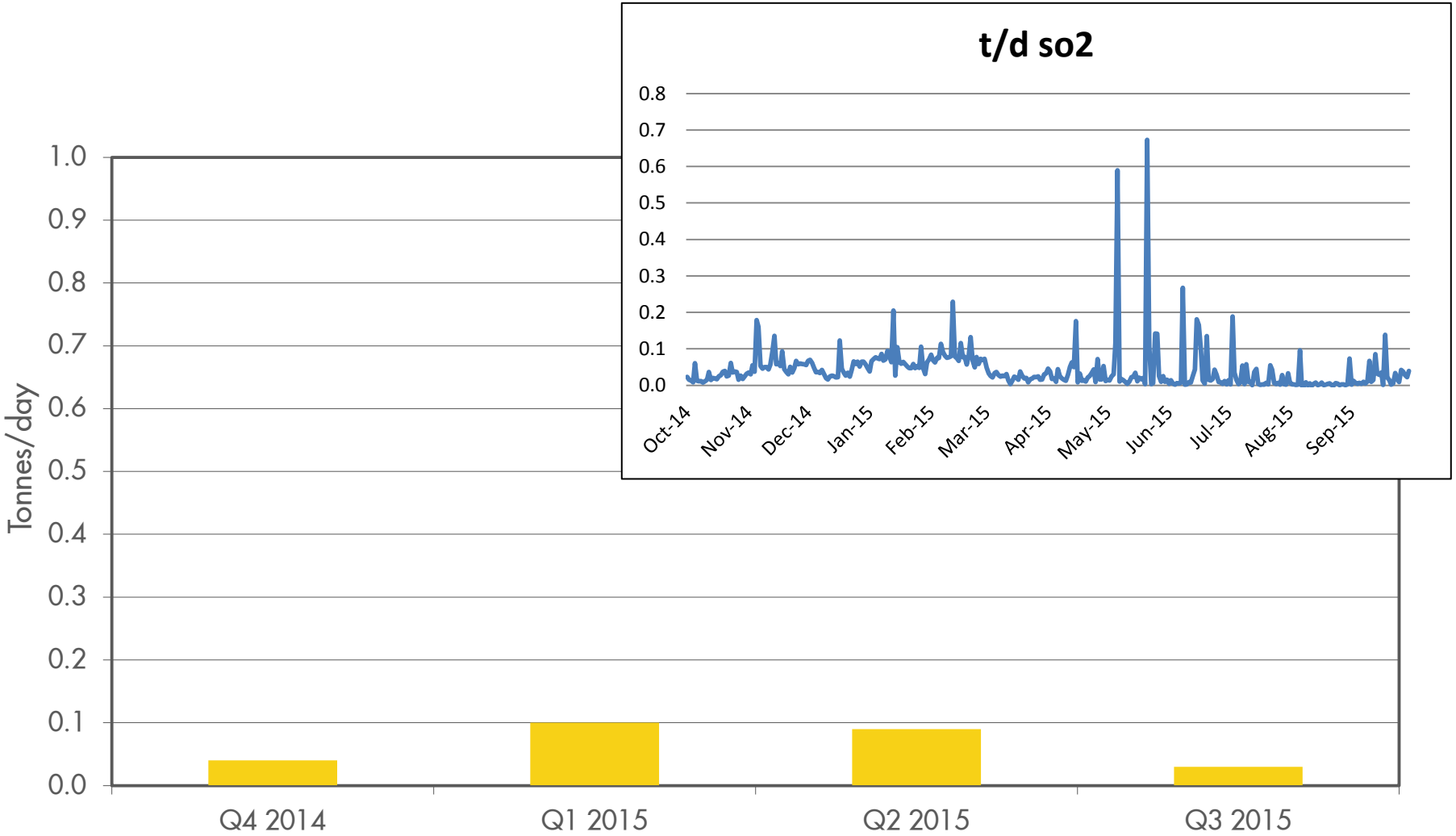
WASTE DISPOSAL

- Tervita Corporation– Peace River (12-24-85-19-W5)
  - Treatment, Recovery & Disposal (TRD) Facility
  - Primarily hydrocarbon sludge (NON-DOW, SLGHYD, COEMUL, SOILCO, WSHWTR)
  - 7238.1 m3 to October 2015

- Tervita (Hazco) Environmental (1/4-03-25-22W4)
  - Tervita Waste Management (TWM)
  - SOILRO and FILOTH
  - 13.17 m3 to October 2015

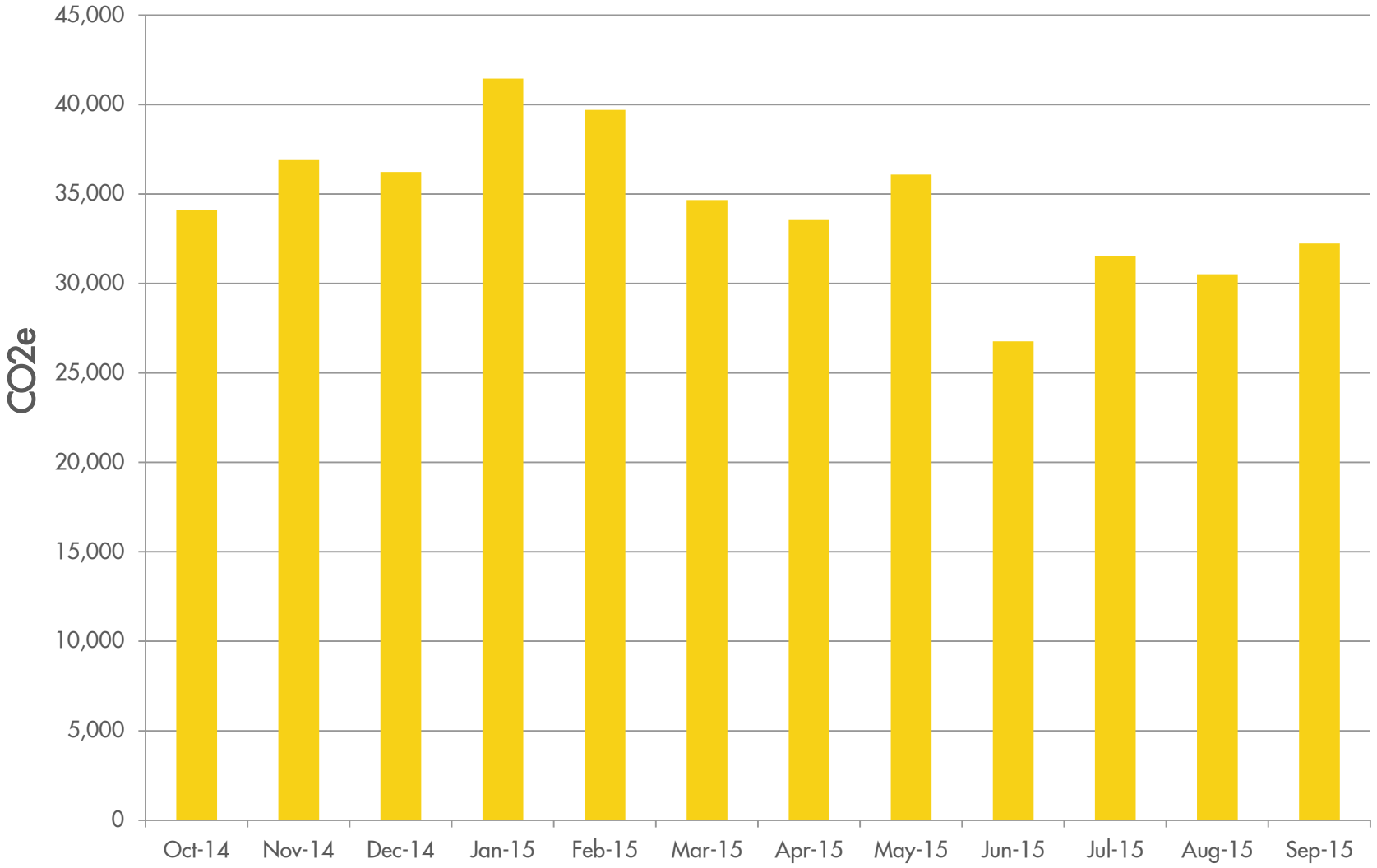
- Tervita Corporation– Spirit River (12-31-77-5W6)
  - Tervita Waste Management (TWM)
  - Activated Carbon ACTCRB
  - 16.9 m3 to October 2015

SULPHUR EMISSIONS (< 1T/DAY)

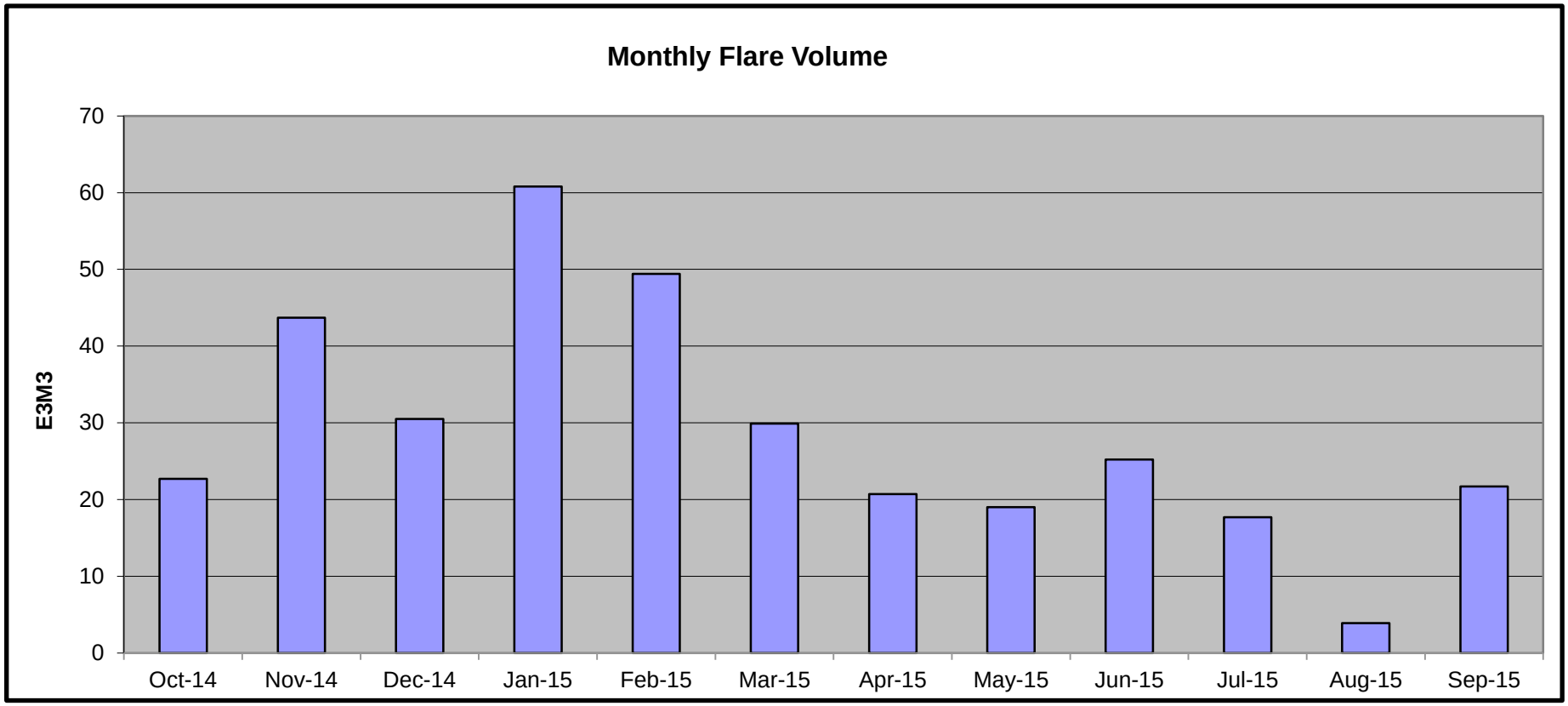


New AER Operating License has 0.99 T/Day continuous SO2
Sulphur emissions have reduced since 2010 due to PRC produced gas injection into Three Creeks.

GREEN HOUSE GAS EMISSIONS



FLARE VOLUMES



- Jan and Feb high mostly due to increased filter backwashes. Second reason was blanket gas eductor during SV-606 cleaning.

AMBIENT AIR MONITORING

Static/Passive Air Monitoring

- Twelve passive stations
- Gathers data on Sulphur Dioxide and Hydrogen sulphide
- 2014/2015 monitoring and reporting satisfactory

Continuous Ambient Monitoring data

- **Continuous Monitoring** - Monitored parameters: sulphur dioxide, hydrogen sulphide, wind speed and direction, Methane and Non-Methane

ENVIRONMENTAL COMPLIANCE

- There were no Ambient Air Exceedences at the PRC Environmental Trailer (EPEA Approval 1642-02-07) from October 2014-October 2015. The air trailer maintained over 90% uptime each month as per license requirements.

- Government (AER and/or AESRD) reportable spills and releases at PRC
  - No government reportable spills from October 2014 to end of October 2015
  - 3 releases to atmosphere from tanks (venting) October to December 2014
  - Total volume vented for this period was 0.0076 e3m3
  - 6 releases to atmosphere from tanks (venting) January to October 2015
  - Total volume vented for this period was 0.8693 e3m3

COMPLIANCE

To the best of Shell's knowledge, operations at Peace River are consistent with all conditions of the 8143 approval

Amendment	Approval Date	Description
N, O	October 2, 2012, April 26, 2013	Carmon Creek Phases 1 and 2 Project, Carmon Creek changes to CPF designs and adding third separator to all well pads.
P	Oct. 4, 2013	Carmon Creek changes to CPF designs and adding a third separator to all well pads.
Q	Dec 9, 2013	Peace River Project X-two injection pads for Pads 30 and 31
R	Dec 12, 2013	Carmon Creek conversion of well pads from injection to CSS producers
S	March 6, 2014	Carmon Creek updates to the CPF
T	April 15, 2014	Directive 81 variance application for PRC
U	Oct 10, 2014	Peace River Pad 20 AGAR meter installation
V	Nov 7, 2014	Peace River Pad 22 addition of 2 infill wells
W	4 May 2015	Carmon Creek application- Removing condition to re-abandon, re-enter two wells in our original approval.
X	6 Apr 2015	Carmon Creek – 7 pressure monitoring wells –variance application to not drill these wells.
Y	14 Apr 2015	Peace River Pad 19-Sat 2 -6 additional wells application
Z	21 May 2015	Carmon Creek Development area expansion and additional 13 pads application.

ENVIRONMENTAL: AMENDMENTS TO APPROVALS

EPEA Operating Approval 1642-02-03 had 2 amendments during 2014/2015.

1642-02-06 amendment outlined adjustments to the Carmon Creek air emissions limits.

1642-02-07 amendment granted the option for PRC to send domestic wastewater to any domestic wastewater facility with its own registration under the Act.

2 amendments were made to each of PRC's EPEA Water Diversion permits in 2014. (30033-00-02, 30034-00-02, and 30035-00-02). These amendments provided detailed point of use locations as well as added the additional purpose for withdrawal to support oil and gas drilling. (Sept 2014)

Shell's Surface Lands department deals with many amendments to leases as a part of day to day business

ENVIRONMENTAl: MONITORING PROGRAMS RESULTS

Soil Monitoring Program

Drilling program for soil monitoring and sampling was executed in October 2014. Reports were submitted March 2015.

2015 soil monitoring program is ongoing.

Results to be reported in annual report.

Groundwater Program

Per EPEA 1642-02-07, PRC has requirements for both groundwater and deep well water testing. Testing and reporting are both required on an annual basis.

Testing was completed in November 2015.

Results will be reported in the 2015 annual report.

ENVIRONMENTAl: MONITORING PROGRAMS RESULTS

Shallow groundwater monitoring program

Groundwater testing occurred in November 2015 on plant piezometers.
Final results will be received by PRC in late 2015.
Continued groundwater monitoring per EPEA approval.

Shallow groundwater wells around reclaimed PSDS (Produced Solids Disposal Site)

PSDS has been reclaimed and well Pad 32 was built on the location.
Piezometers remain around perimeter of well pad
No contamination seen in these wells with little variation at a majority of the monitoring locations
Monitoring continues per Alberta Environment Approval
Sampling occurred November 2015.

Deep Regional Wells

2004 drilling program (50 and 105 meter depth)
2005 drilling program (70 meter depth)
2009 drilling program (3 wells (each approximately 60, 120 and 270 meters deep)
Tested and monitoring continues per EPEA Approval

ENVIRONMENTAL STUDIES PROGRAM

- Wildlife crossing structures on above ground pipelines-All data from past 8 years was assessed under the Comprehensive Wildlife report and submitted to the AER in 2015.
- Multiple wildlife studies including bird surveys, winter mammal study and owl surveys and continental trumpeter swan survey with Fish and Wildlife departments
- Partnered with the Miistakis Institute in their Wildwatch Program.
- EDNA partnered with the Alberta Conservation Association on a 3 year amphibian study beginning in 2014.
- Peatland Reclamation Research with NAIT and the Boreal Research Institute
- Airstrip Reclamation in progress (15 ha)

TAR STORAGE AREA REMEDIAL STRATEGY

- Two separate former storage areas were identified at E ½-23-85-19W5
- Worley Parsons was contracted to perform a remedial option analysis which included soil and groundwater sampling as part of an environmental site assessment

RECLAMATION RESEARCH

NAIT Boreal Research Institute (nBRI) in Peace River, Alberta, is to receive $2.2 million over five years from the Natural Sciences and Engineering Research Council of Canada (NSERC) to support boreal forest reclamation research

Shell is a partner in the research, contributing over $500,000

Initial commitment for a 3 year program, at $70,000 per year

Agreement for additional 5 years of funding, at $75,000 per year

Shell has allocated five well pads and one sump site and the airstrip at its Peace River Complex for applied research

Results so far:

- To date there has been some success establishing various moss families using the fragmentation technique developed by Dr. Line Rochefort at Laval University.

2015 Research:

- Seed collection of native boreal plant species
- Continued restoration of Inversion Pad Trail #1
  - Studying vegetation performance, hydrology, and substrate chemistry on restored site.

RECLAMATION RESEARCH cont…

- 2015 Research Cont…
- Inversion Trials #2 and #3 new well pad locations were identified in the spring, planning in progress
- Linear Features
- NBRI is conducting a small trial to restore a stretch of winter access road near inversion pad trial 1
- Goal of program is to promote tree growth canopy and reduce the line of site
- Airstrip Project 2015
- The research objectives are as follows:
  - Compare different soil adjustment techniques that will restore physical soil properties and hydrological function and create a variety of microsites for plant establishment.
  - Compare sequences and combinations of vegetation management to reduce the time required to successfully establish appropriate woody and herbaceous vegetation.
  - Examine the potential for using improved 'super' aspen seedlings for reclamation.
  - Evaluate the suitability of various woody boreal species against tested reclamation methods.

RECLAMATION RESEARCH cont…

Airstrip Project Con't

- Wetland portion (4 ha)
  - Site was recontoured and graded to the natural surrounding wetland level
  - The culvert on one site was removed and vegetation and subsoil were salvaged and redistributed onsite which will enhance soil organic content and aid in water holding capacity and provide additional seeds/propagules.
  - Re-vegetation was completed in 2015 including direct seeding, transplanting, cuttings and planting of stock plants.
- Upland portion (14 ha)
  - Re-plowing on four 120x30 meter wide strips in order to compare the impact of surface soil adjustment on native plant establishment and weed management was completed.
  - Two organic amendments were deployed including DMI biosolids and Humalites. This was conducted in partnership with Alberta Innovates Technology Futures.
  - Production of tree and shrub seedlings complete. Planting occurred May 2015. Approximately 40, 000 seedlings planted on this site along with grasses, shrubs and willows.

RECLAMATION RESEARCH cont…

2015 Research Cont…

IPAD Borrow Pit

- Research objectives:
- Compare growth and survival of three woody shrubs and three tree species.
- Monitor short-medium term recruitment/natural ingress of forest vegetation.
- Seedlings were planted spring of 2014 for white spruce, aspen, buffaloberry and western dogwood, growing well in 2015
- The cover crop trial portion of the study was assessed and results are being compiled. Initial observations indicated good establishment with some native grasses and indian paintbrush.

IN-SITU PAD RESEARCH

- Objectives of the research are as follows:
  - Restore surface hydrologic connectivity with the surrounding peatland;
  - Create a stable saturated-but not inundated-peat surface; and
  - Establish plant community similar to the surrounding natural peatland.

- Three main methods were applied to adjust the site:
  - Complete pad removal and peat fluffing;
  - Complete pad removal and peat inversion; and
  - Partial pad removal and peat inversion.

Pad material was returned to the borrow pit where it was taken from; the borrow pit was then added to the upland reclamation research program to test decompaction methods.

IN-SITU PAD RESEARCH cont…..

- Peat from nearby donor sites was spread on the surface using the fragmentation method once it was confirmed that subsurface flow was reconnected with the surrounding poor fen. Straw was applied to increase humidity.

Vegetation

- The vegetation restoration on the Inversion Pad is being monitored through the NBRI peatland program.
- Hydrology, water flows
- Water table fluctuations and connectivity with natural peatland were monitored for a fourth growing season in 2015.
- The data from monitoring programs will be used to compare key ecological parameters on the restored site to the surrounding natural peatlands to evaluate prograssion towards a functional peatland over time.
- NBRI is currently conducting surveys of natural peatlands in the boreal region to establish a series of reference peatland sites to provide baseline information in setting reasonable restoration targets and progress goals.

IN-SITU PAD RESEARCH cont…..

Water chemistry

- Basic water chemistry was collected regularly in monitoring wells on the Inversion Pad itself and in the surrounding natural peatlands.

Surface topography

- Surface topography has fluctuated following the pad removal. In an effort to understand how the peat profile is impacted by the removal of pad, the topography was intensively surveyed for a second season last year. A last data set was collected in October 2013.

Donor site monitoring

- The peatland area where donor material was collected was surveyed . Vegetation recovery and peat physio- and chemical properties were assessed. The same surveys will be performed every summer in next two years to document the natural recovery of these locations.

ENVIRONMENTAL - RECLAMATION PROGRAMS

- NAIT Boreal Research Institute using existing airstrip for their peatlands work for the next 4 years.
- Various sites assessed for reclamation certificates in 2015 – consultant currently working on reports.
- 10-2-86-19 W5 reclaimed road and lease with trees planted 2015
- 11-34-85-19W5 reclamation complete. Asessed and applied for reclamation certificate from AER.
- 2-26-85-19W5 Airstrip reclamation in progress. Site is within airstrip project boundaries and will be applied for within airstrip project.
- 15-26-85-19 cut and capped one well due to access being through airstrip. Will assess status in 2016.
- Pad removal in the muskeg 2015 fall 8-22 removing pad and filling in borrow pit (location directly north of Carmon Creek CPF)