Pelican Lake SAGD Pilot
Approval 11469B
March 2013 – March 2014 Update

AEROffices

April 2, 2014.

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Pelican Lake SAGD Pilot
Introduction and Overview

- Introduction
- Subsurface Issues Related to Resource Evaluation and Recovery
  - Directive 054, Section 3.1.1
- Surface Operations, Compliance, and Issues Not Related to Resource Evaluation and Recovery
  - Directive 054, Section 3.1.2

Pelican Lake SAGD Pilot
Subsurface Issues: Table of Contents

Brief Background

Subsurface Subsection 1

Pelican Lake SAGD Pilot
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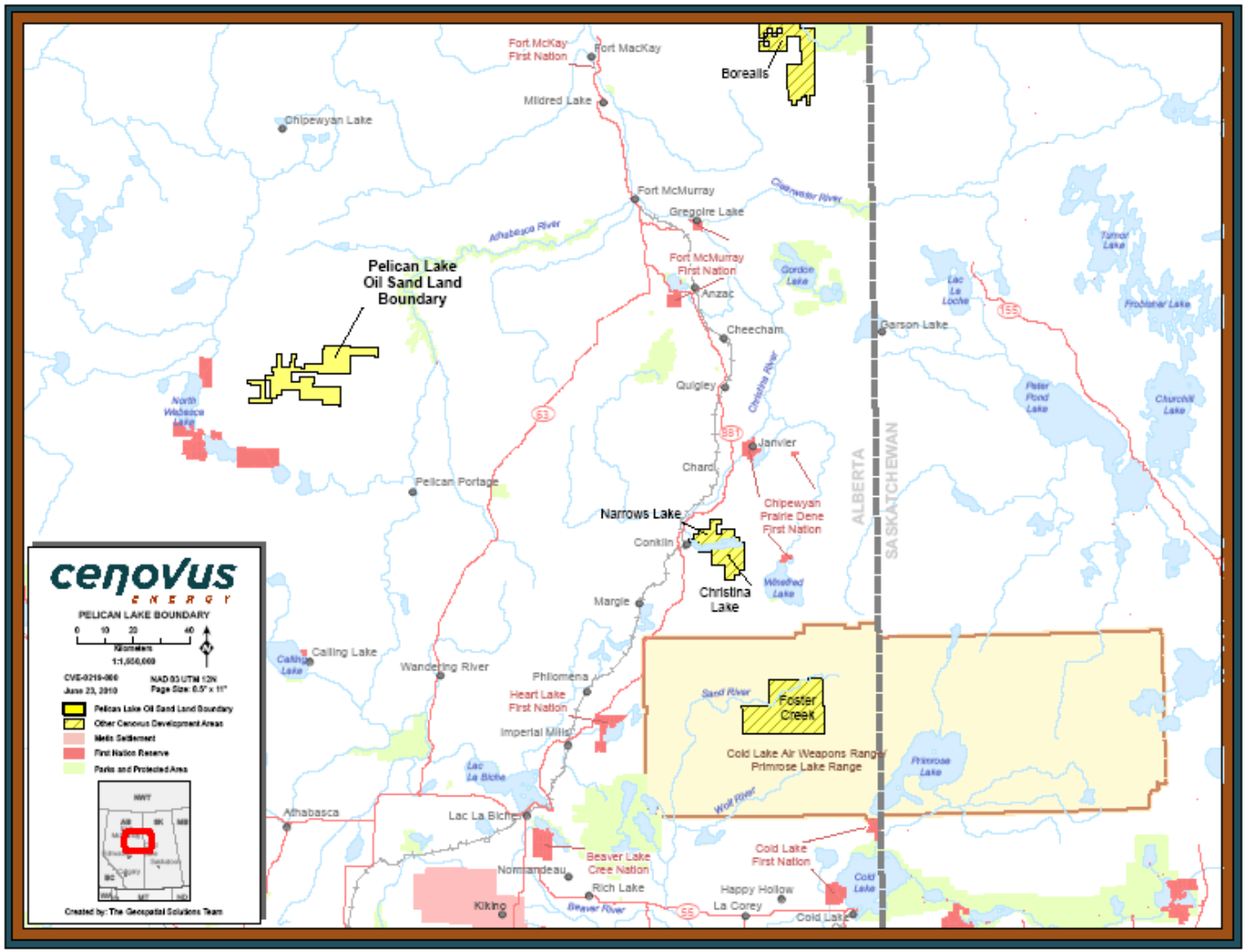
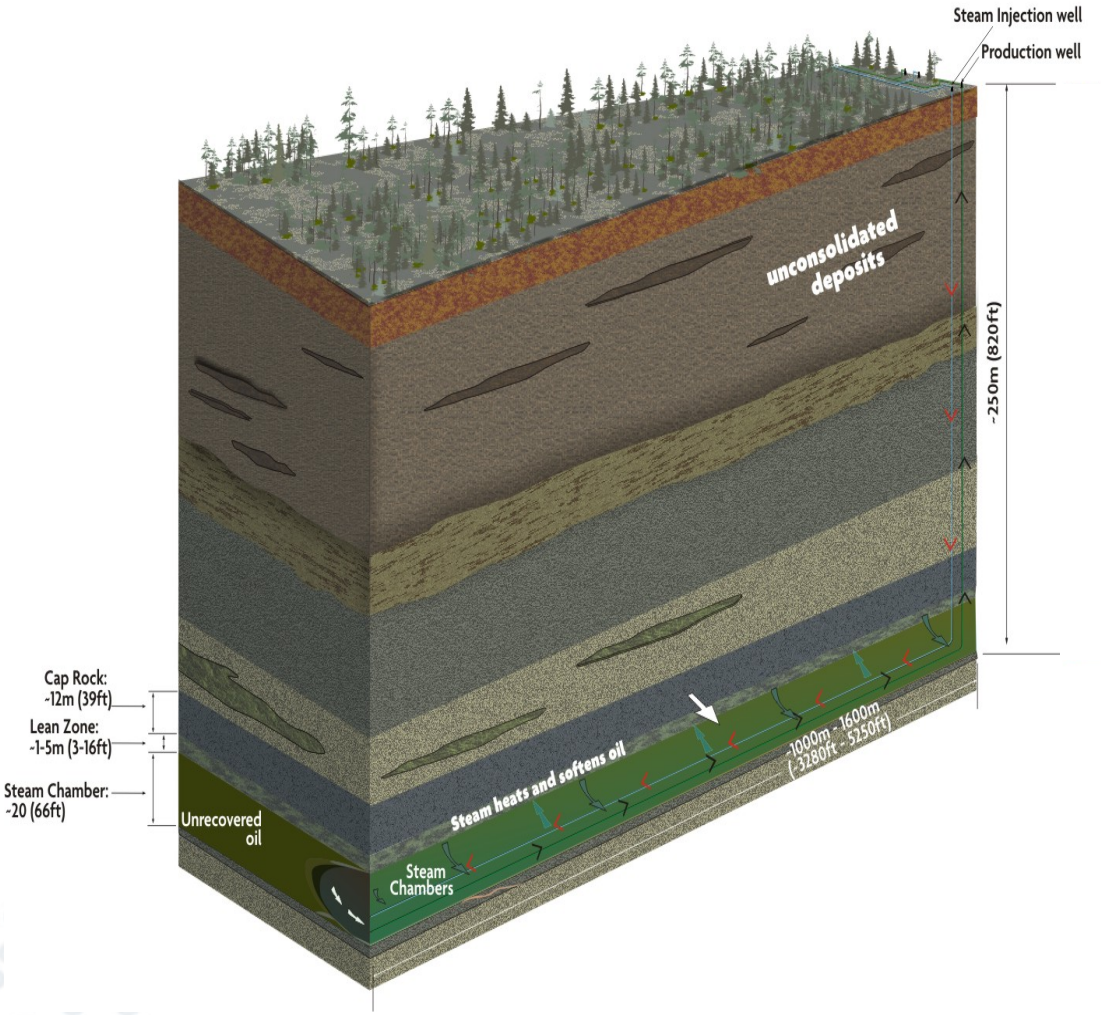
Pelican Lake SAGD Pilot
Brief Background



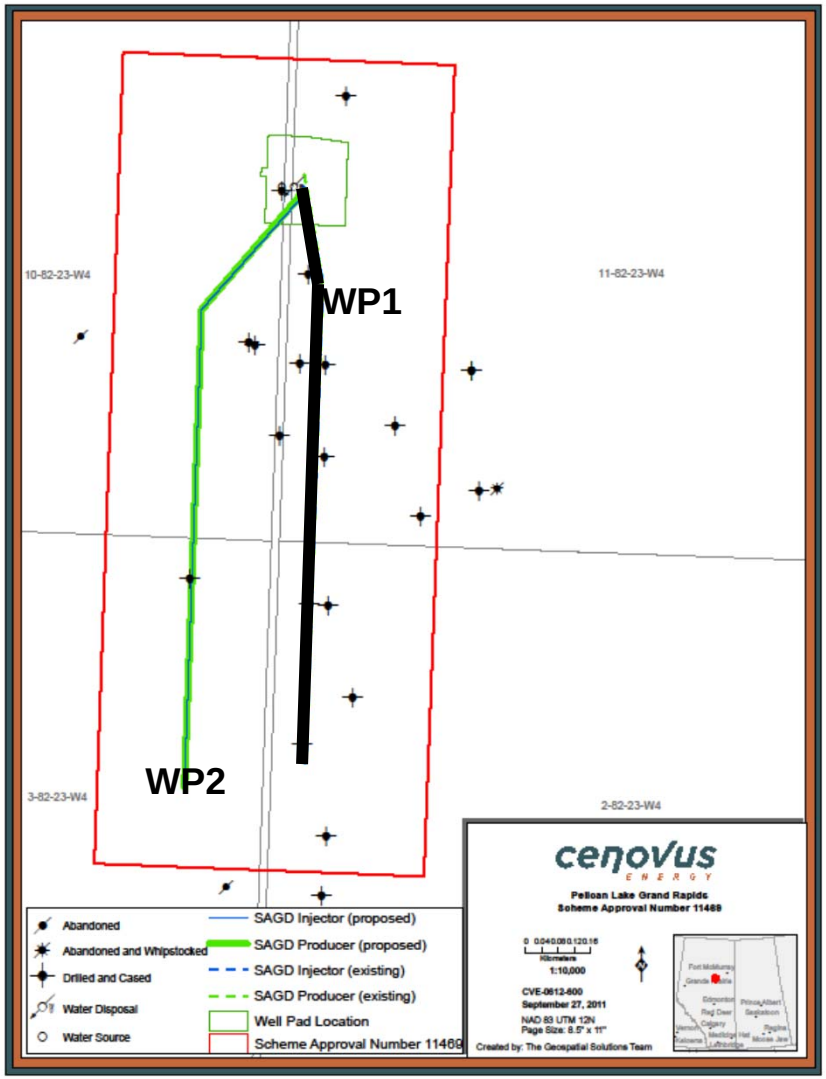
Pelican Lake SAGD Pilot
Illlustration of Recovery Process



Subsection 3.1.1 – 1)

Pelican Lake SAGD Pilot Project Overview

- SAGD Pilot to evaluate large resource base of ~ 5 Billion barrels OBIP
- 100% WI
- Other operations within the region
  - Cenovus and Canadian Natural operate enhanced recovery schemes in the Wabiskaw formation
  - Laricina commercial Demo project (CDP) 5,000 bbls/d approved Oct 2010. with Development in the Grand Rapids 'A' to the north
  - Cavalier has submitted a 10,000 bbl/d Grand Rapids 'A' In-situ scheme application in November 2012



Pelican Lake SAGD Pilot
March 1, 2013 – Febraury 28, 2014 Project Milestones

- July 2013 - Disposal well drilled
- Aug 2013 - Facility work completed to remove constraints
- Aug 2013 - P01 averaged 70 m3/d oil
- Dec 2013 - Steam chamber core drilled (analyzed January 2014)
- Jan 2014 - 4D seismic shot
- Feb 26 2014 - Disposal well approval issued

Geosciences

Subsurface Subsection 2

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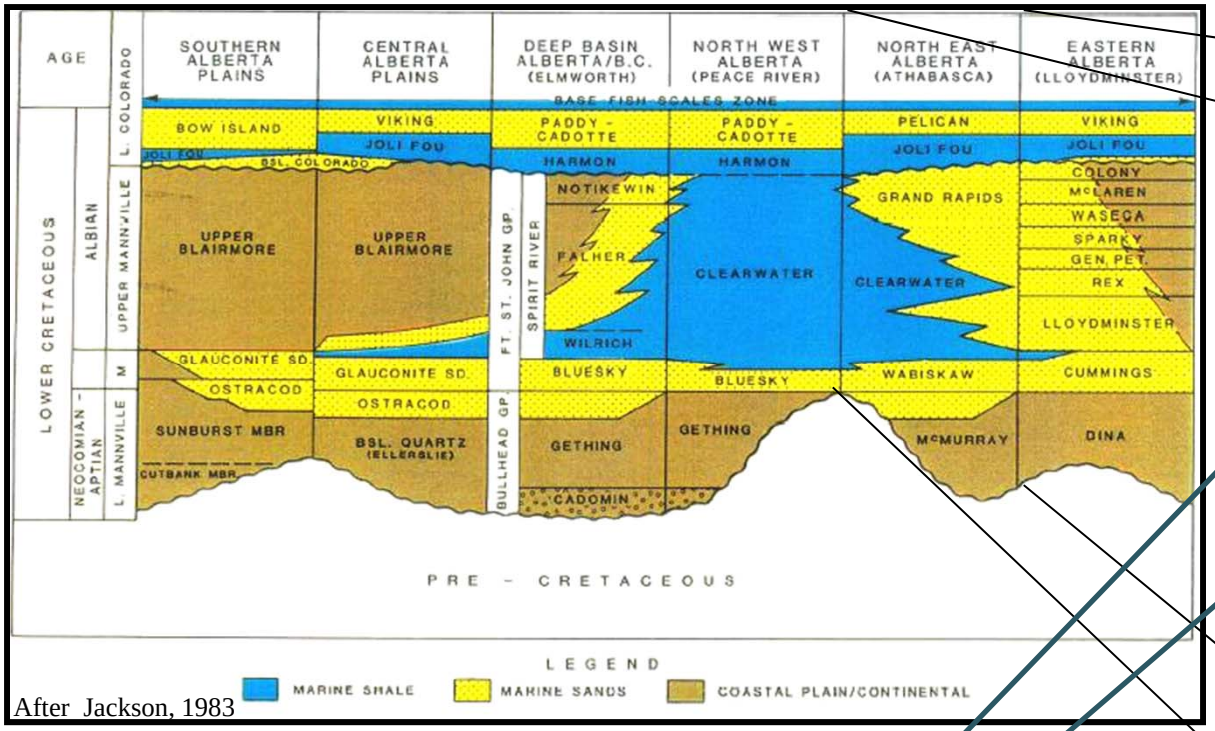
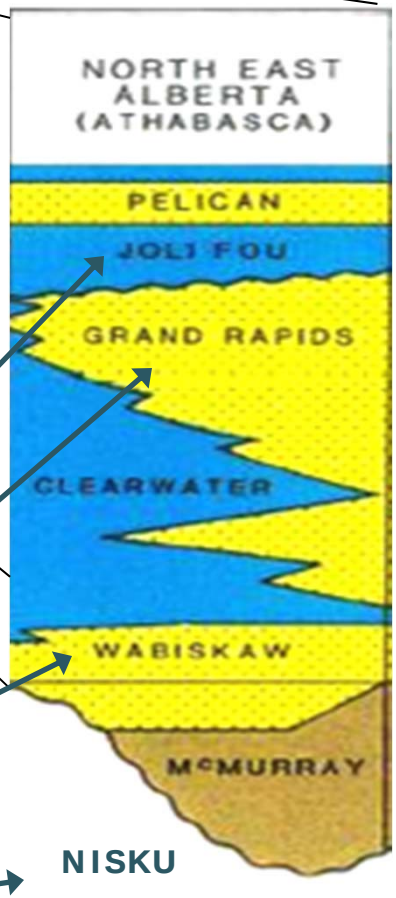
Pelican Lake SAGD Pilot
Stratigraphic Correlation



After Jackson, 1983



Cap Rock

Bitumen & Source Water

Wabiskaw Production ~23,000 bbls/day

Disposal Zone

Pelican Lake SAGD Pilot
Paleogeography - Grand Rapids 'A' member

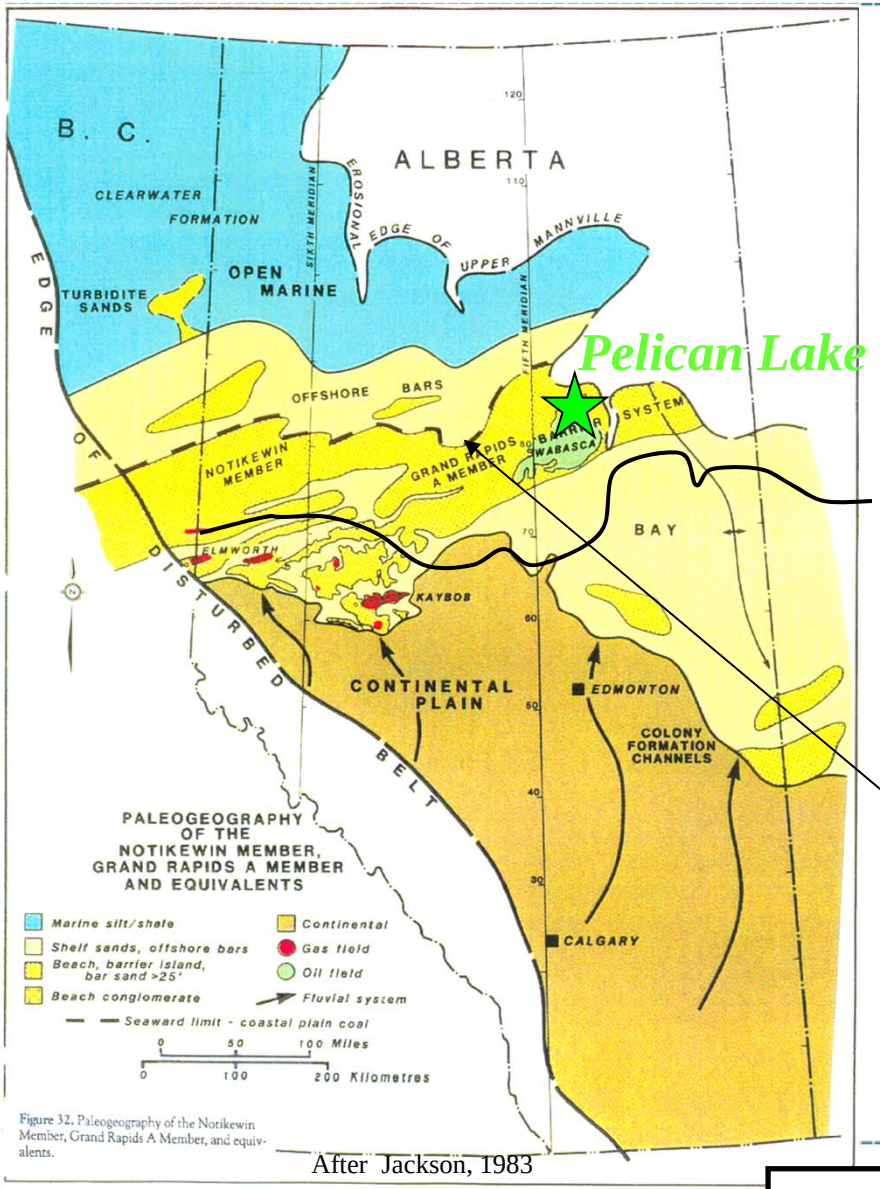


Figure 32. Paleogeography of the Notikewin Member, Grand Rapids A Member, and equivalents.

After Jackson, 1983

- Depositional environment - prograding shoreface (marine sediments forming shoreline sandstones)
- Very fine to medium grained Quartzose sand with minor feldspar, chert, muscovite and biotites
- Aerially extensive 10m+ thick bar sands

Shoreline

Subsection 3.1.1 – 2)

Pelican Lake SAGD Pilot
Summary of Reservoir Properties

Base of Grand Rapids 'A'	357-363 m Subsea
Average Gross Thickness	23 m
Average SAGD Pay Thickness	18 m
Average Porosity	35 %
Average Water Saturation	46 % (Gross)
	38 % (SAGD Pay Zone)
Average Permeability	2.9 D
OBIP	8.0 X10^6 m^3 (50.3 MMbbls)
Oil Viscosity	1,000,000 cp+
Oil Gravity	7.5-8.5 API
Initial Reservoir Pressure	1200 kPa

Pelican Lake SAGD Pilot
Grand Rapids 'A' SAGD Pay Isopach Map

SAGD Well Pairs

Grand Rapids Core Wells

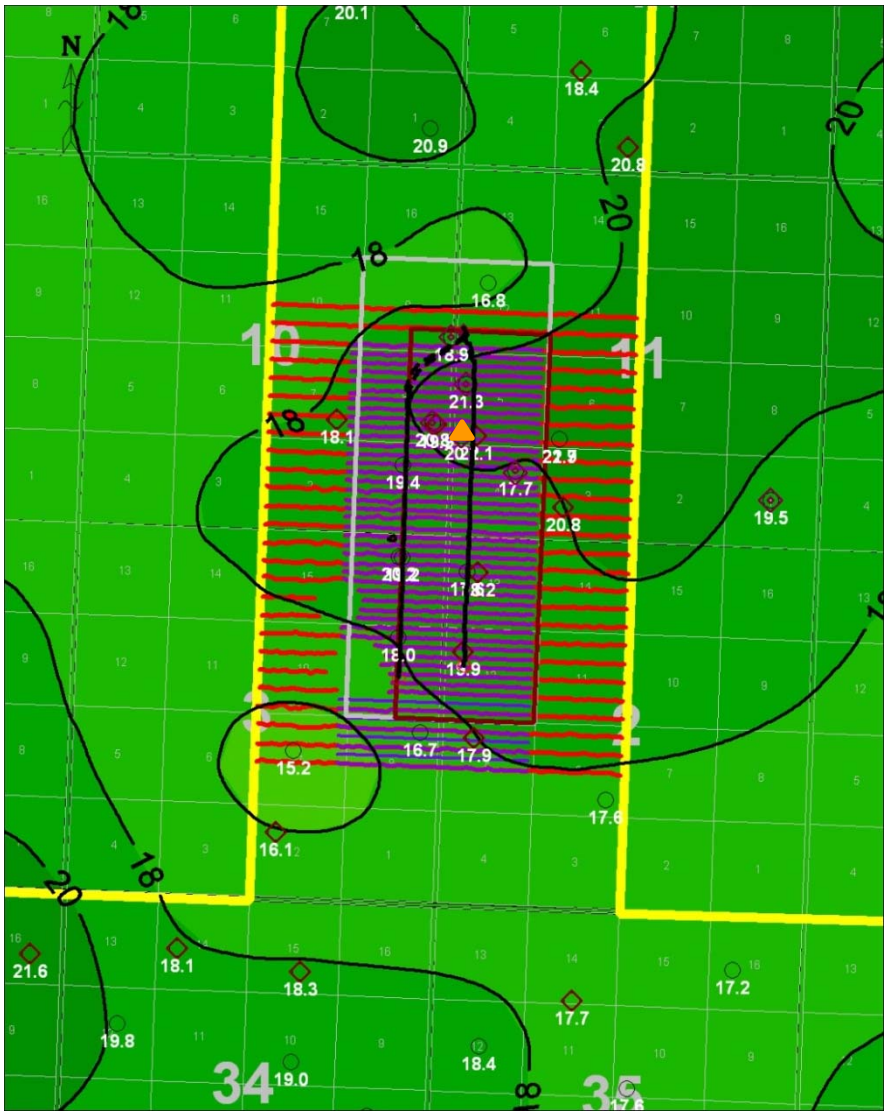
2013 & 2014 Seismic 4D Lines

2012 Seismic 4D Lines

2011 Seismic Survey Outline

Scheme Approval Area

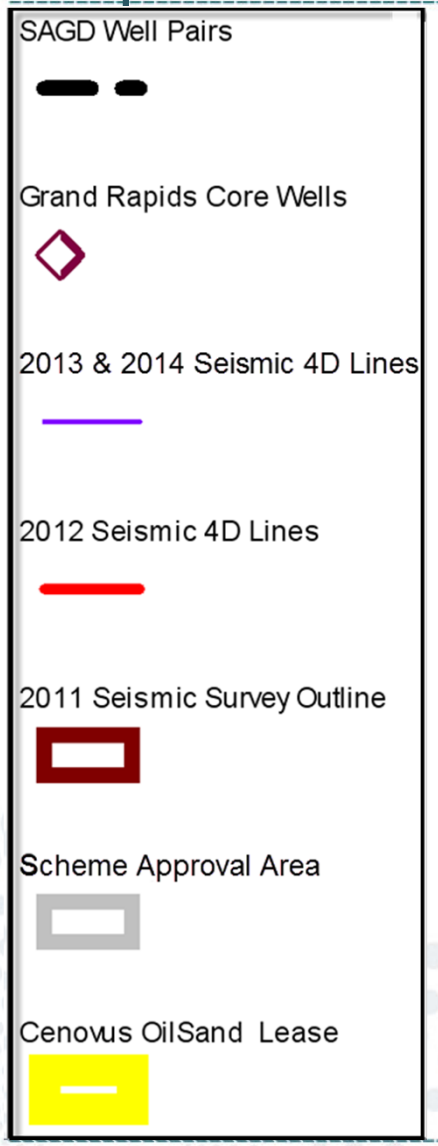
Cenovus OilSand Lease

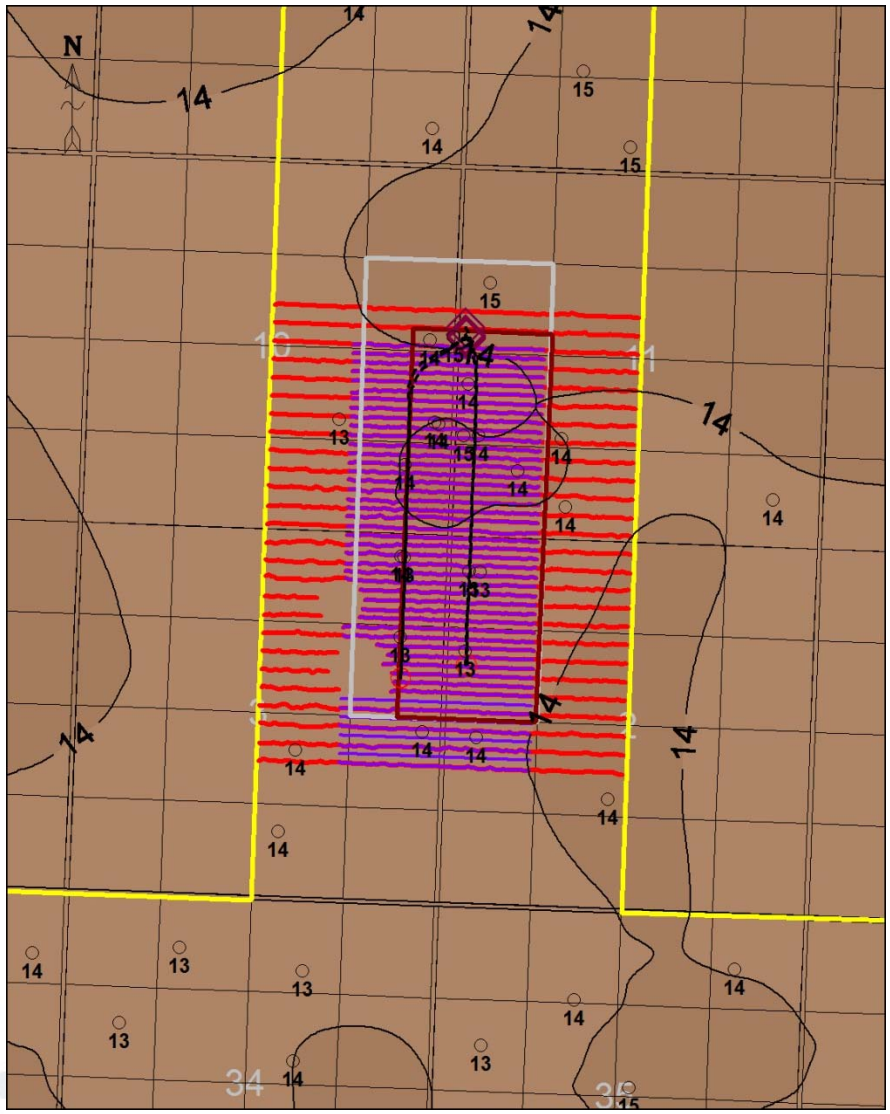


▲ = Denotes Steam Chamber core location .

(1AA/05-11-82-23W4)

Pelican Lake SAGD Pilot
Cap Rock Isopach Map (Joli Fou Formation)





Pelican Lake SAGD Pilot
Grand Rapids 'A' Lean Zone Isopach Map

SAGD Well Pairs

Grand Rapids Core Wells

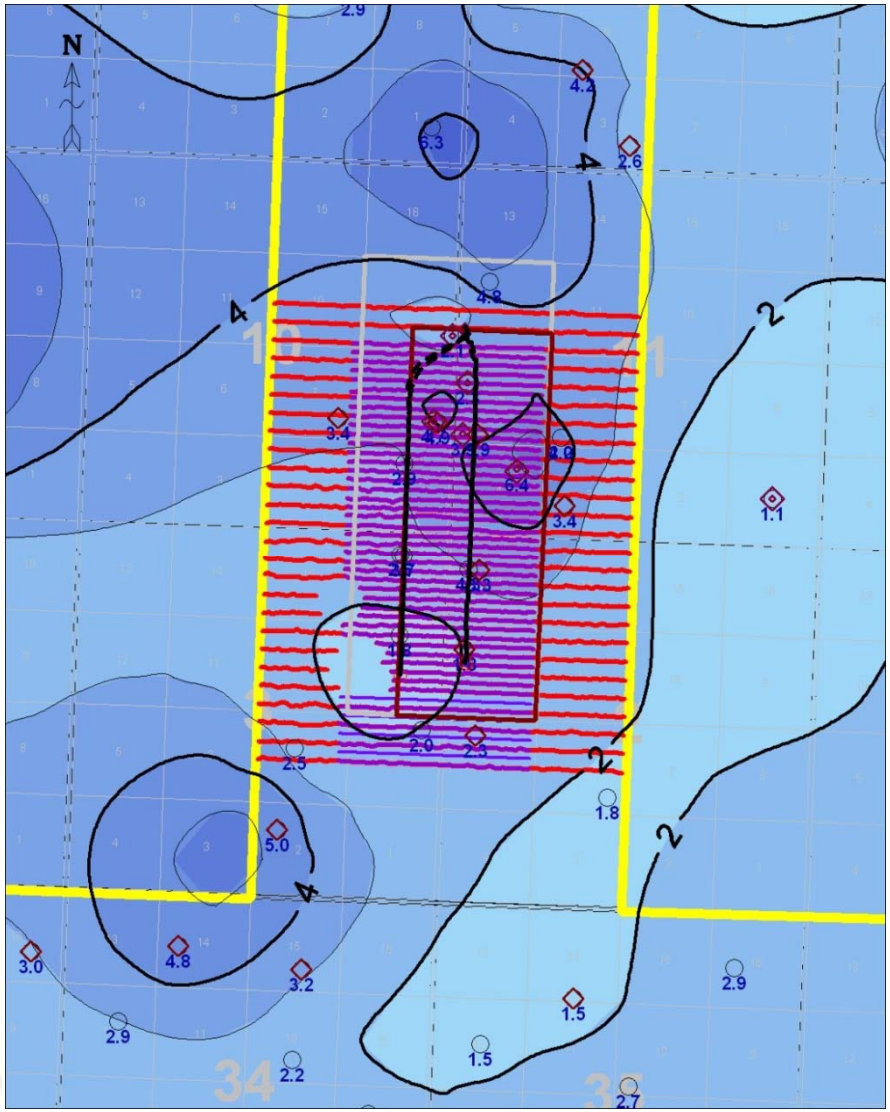
2013 & 2014 Seismic 4D Lines

2012 Seismic 4D Lines

2011 Seismic Survey Outline

Scheme Approval Area

Cenovus OilSand Lease



Pelican Lake SAGD Pilot
Grand Rapids 'A' Top Structure Map

SAGD Well Pairs

Grand Rapids Core Wells

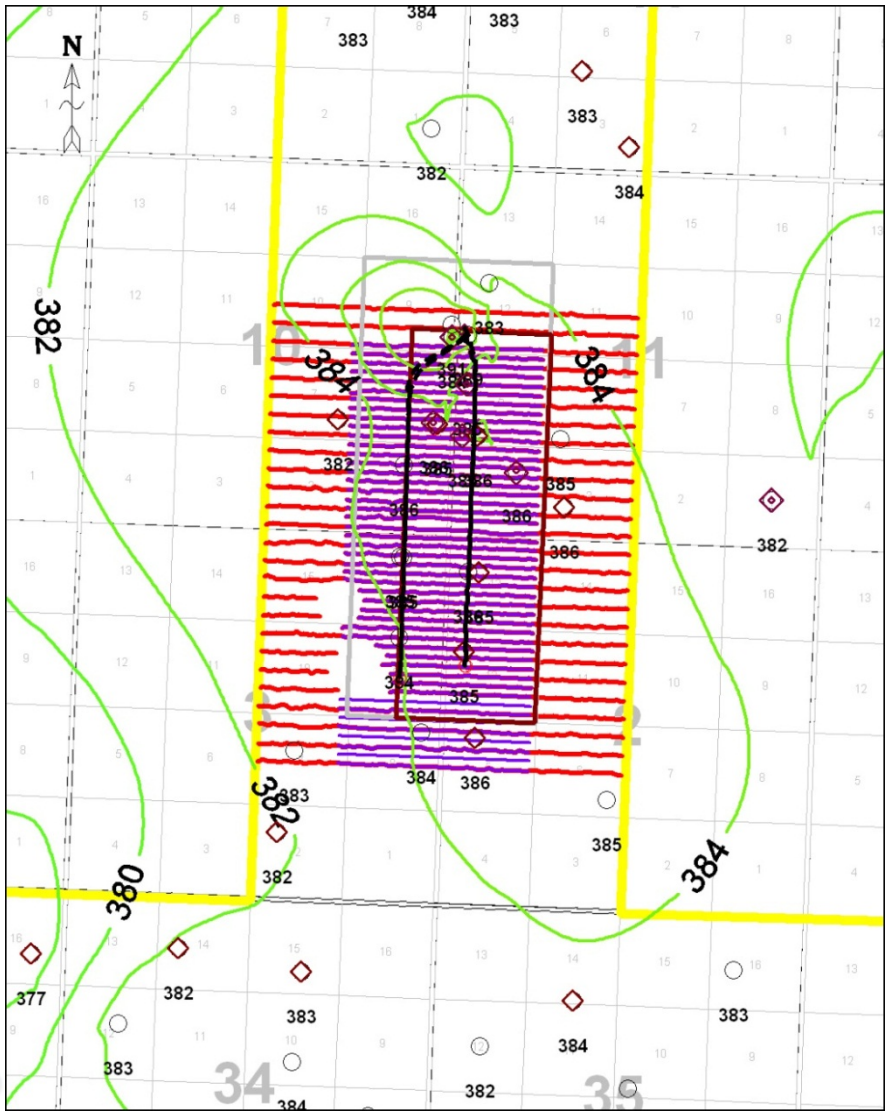
2013 & 2014 Seismic 4D Lines

2012 Seismic 4D Lines

2011 Seismic Survey Outline

Scheme Approval Area

Cenovus OilSand Lease



Subsection 3.1.1 – 2) d)

Pelican Lake SAGD Pilot
Grand Rapids 'B' Top Structure Map

SAGD Well Pairs

Grand Rapids Core Wells

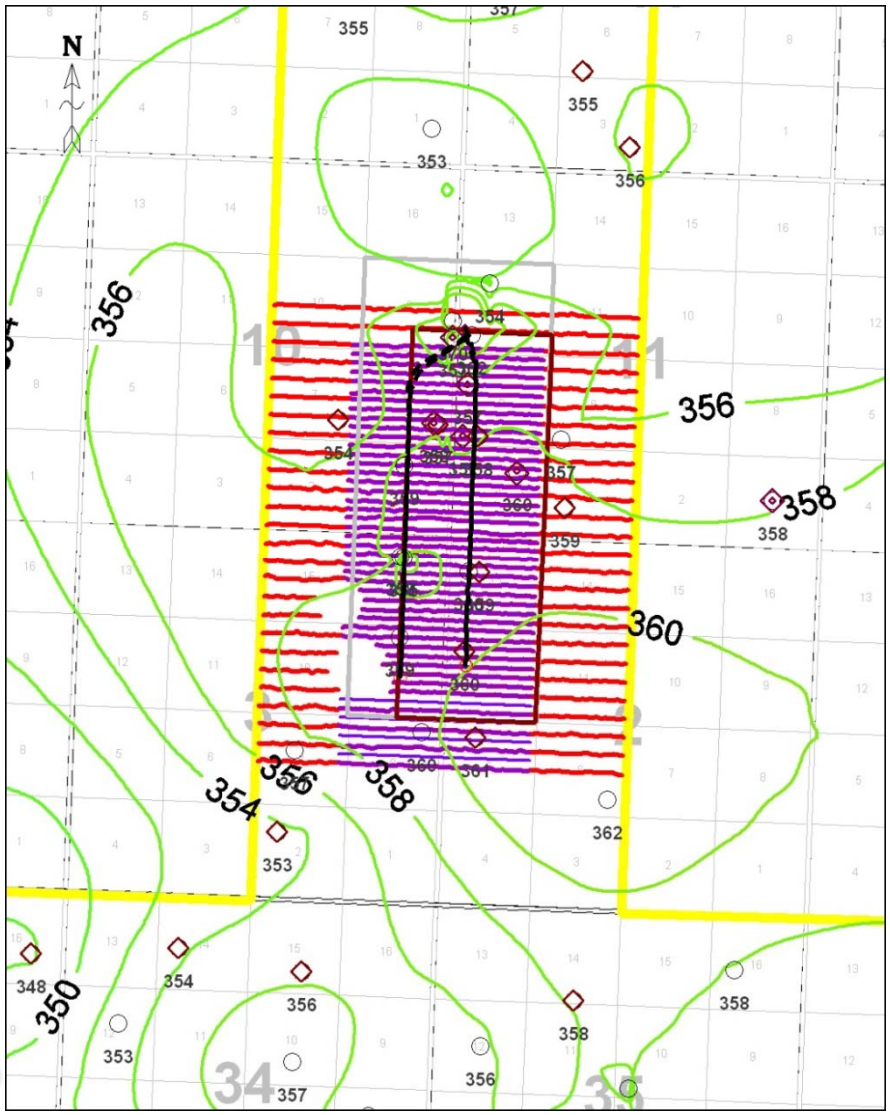
2013 & 2014 Seismic 4D Lines

2012 Seismic 4D Lines

2011 Seismic Survey Outline

Scheme Approval Area

Cenovus OilSand Lease



Subsection 3.1.1 – 2) d)

Pelican Lake SAGD Pilot
SAGD Base Structure Map

SAGD Well Pairs

Grand Rapids Core Wells

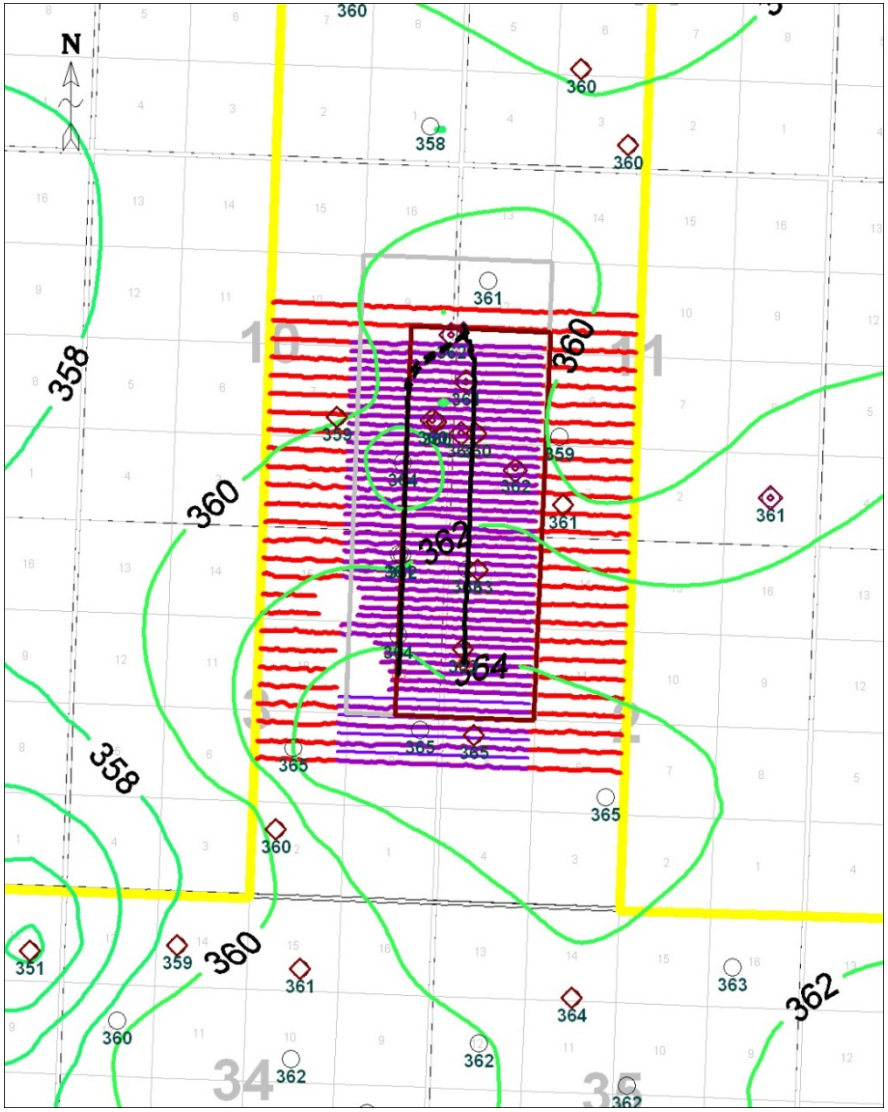
2013 & 2014 Seismic 4D Lines

2012 Seismic 4D Lines

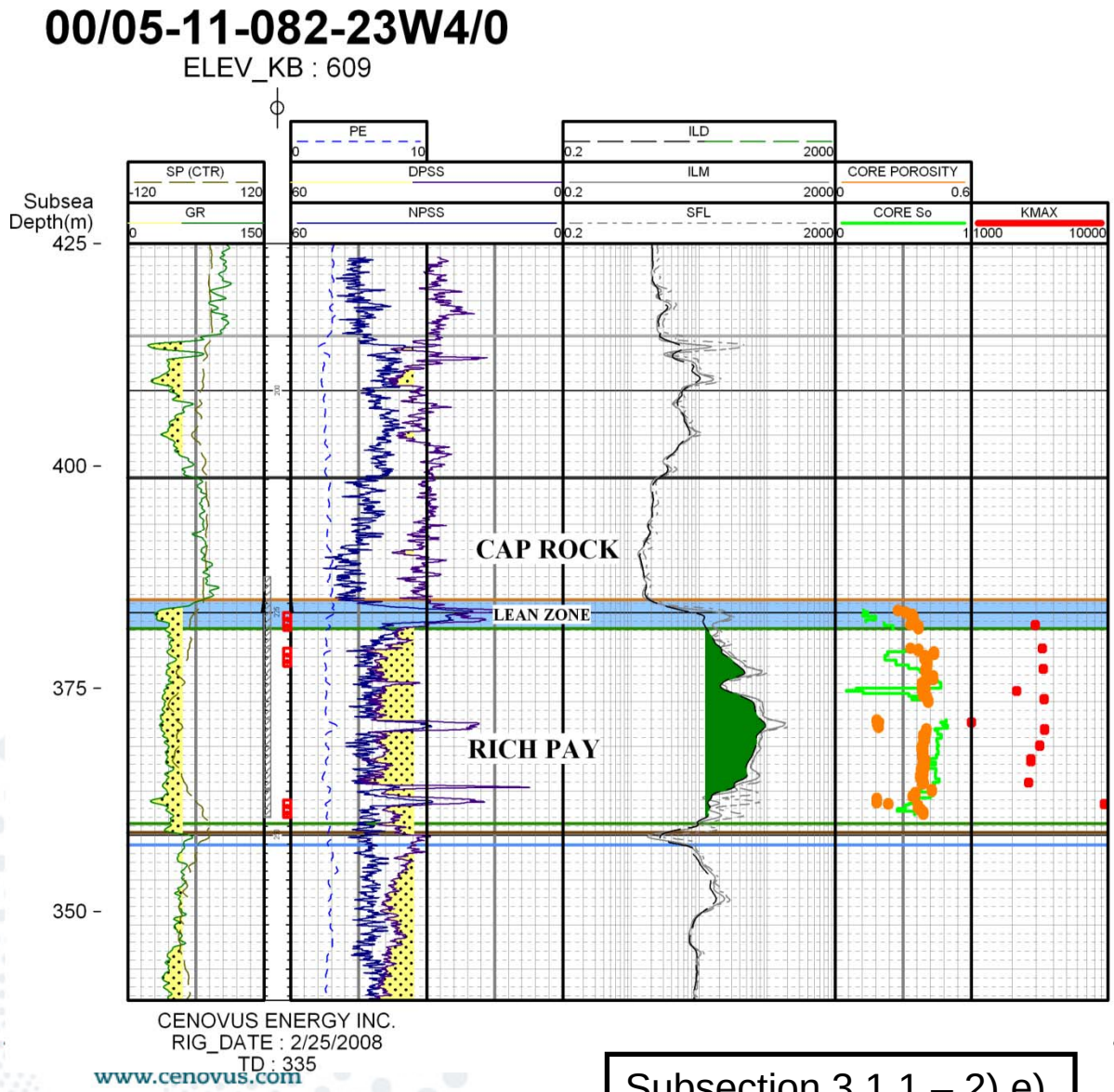
2011 Seismic Survey Outline

Scheme Approval Area

Cenovus OilSand Lease



Pelican Lake SAGD Pilot
Type Log



VIKING

JOLI FOU

GRAND RAPIDS 'A'

GRAND RAPIDS 'B'

Subsection 3.1.1 – 2) e)

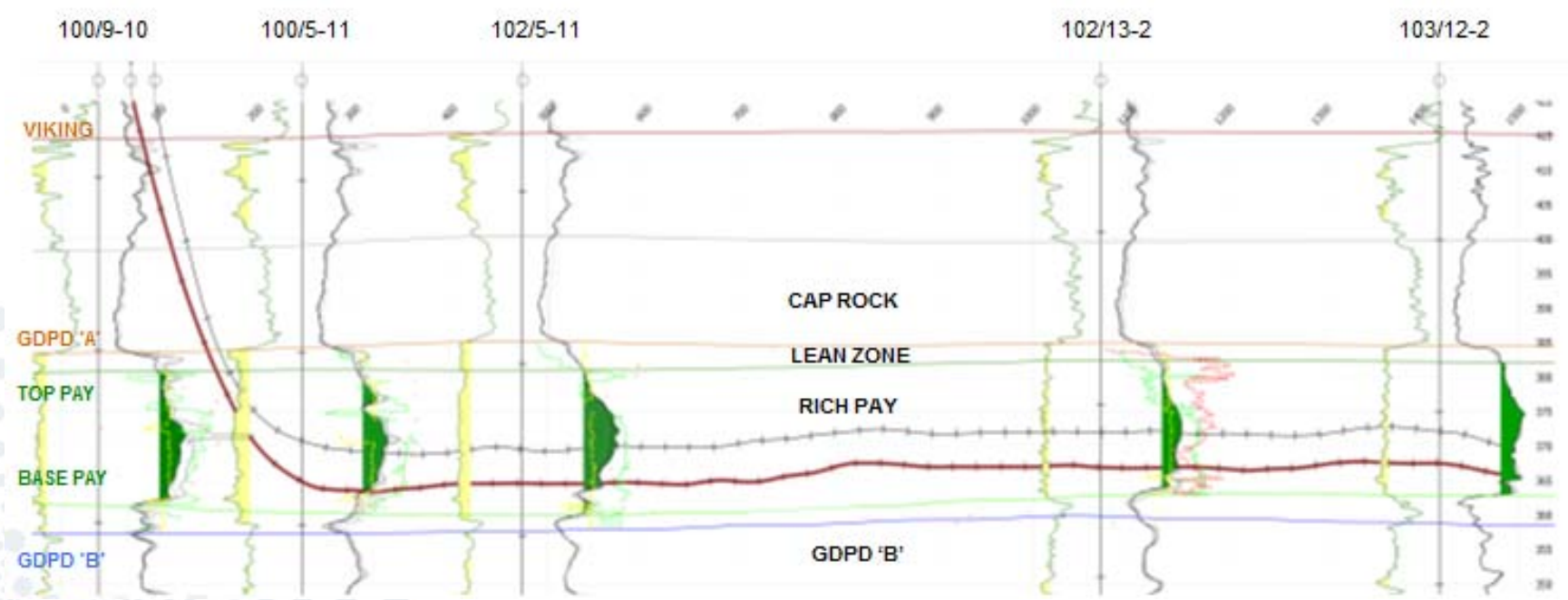
Pelican Lake SAGD Pilot
26P01/I01 horizontal well paths

Shore-face Deposit

- Depositional environment is ideal for SAGD. Sands are laterally and vertically continuous and predictable.

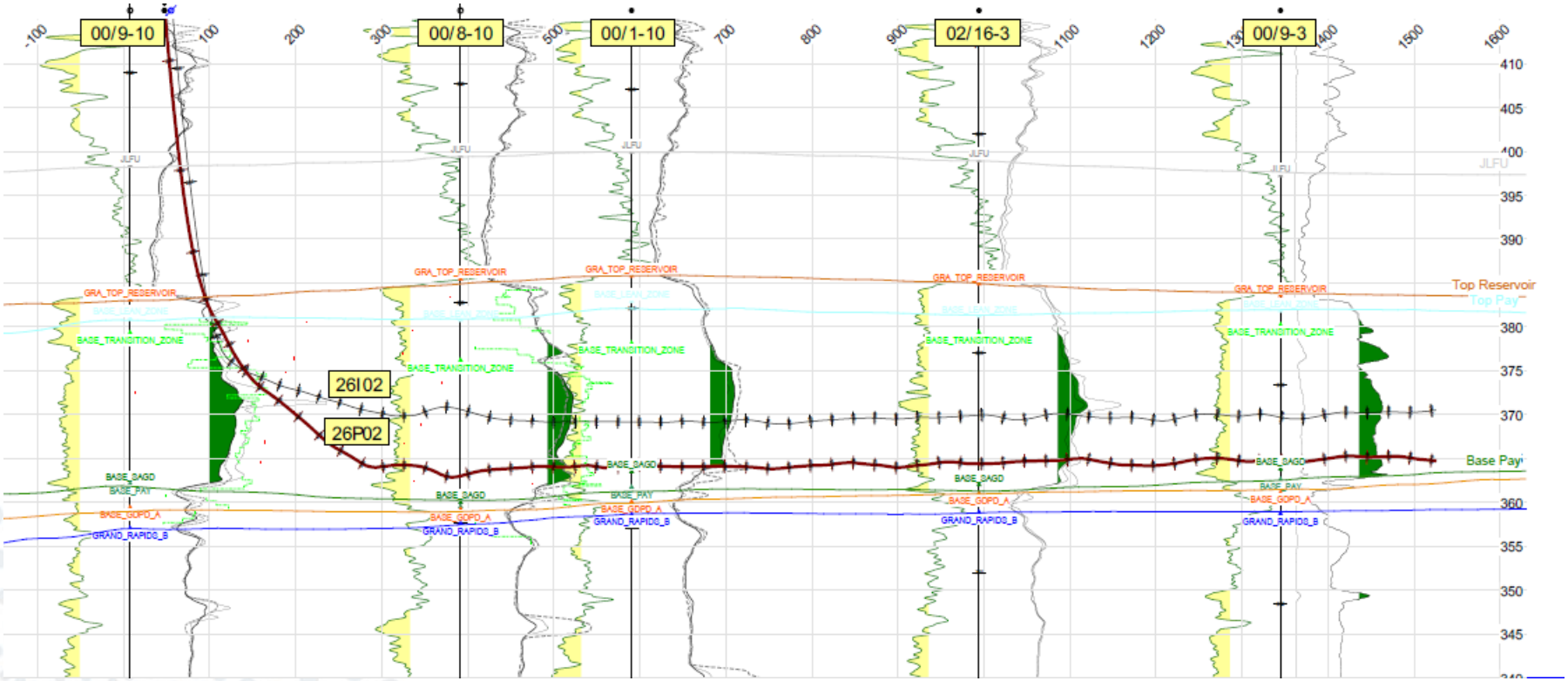
Bitumen deposit within Regional Grand Rapids 'A' Aquifer

- Non saline ground water
- Variability in water saturations within the resource



Pelican Lake SAGD Pilot
26P02/I02 horizontal well paths

Wells 26P02, 26I02



Pelican Lake SAGD Pilot
Surface Heave Monitoring (InSAR)

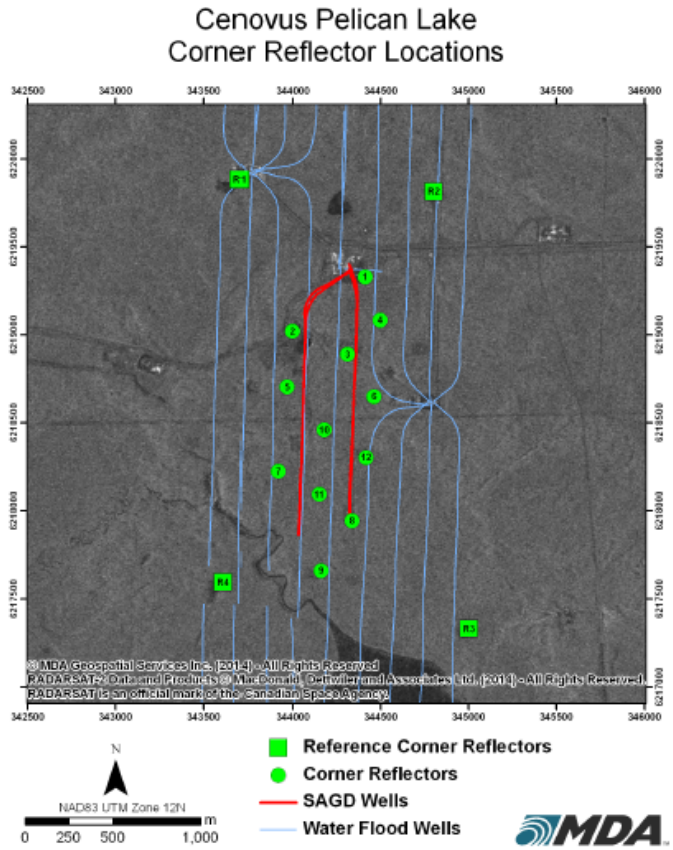


Figure 1: Corner Reflector Locations at Cenovus Pelican Lake, Alberta. Well layouts provided by Cenovus in 2012 and 2013.

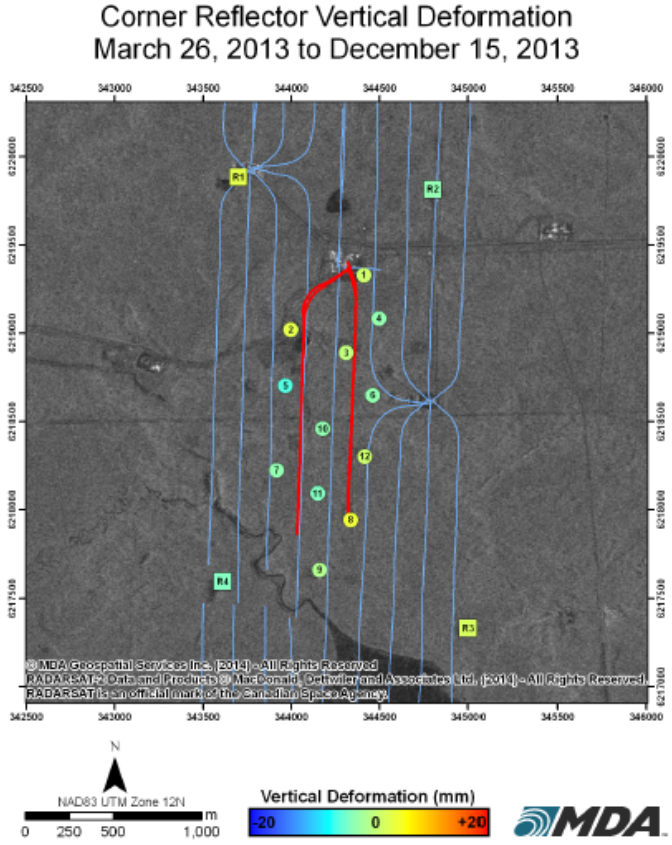
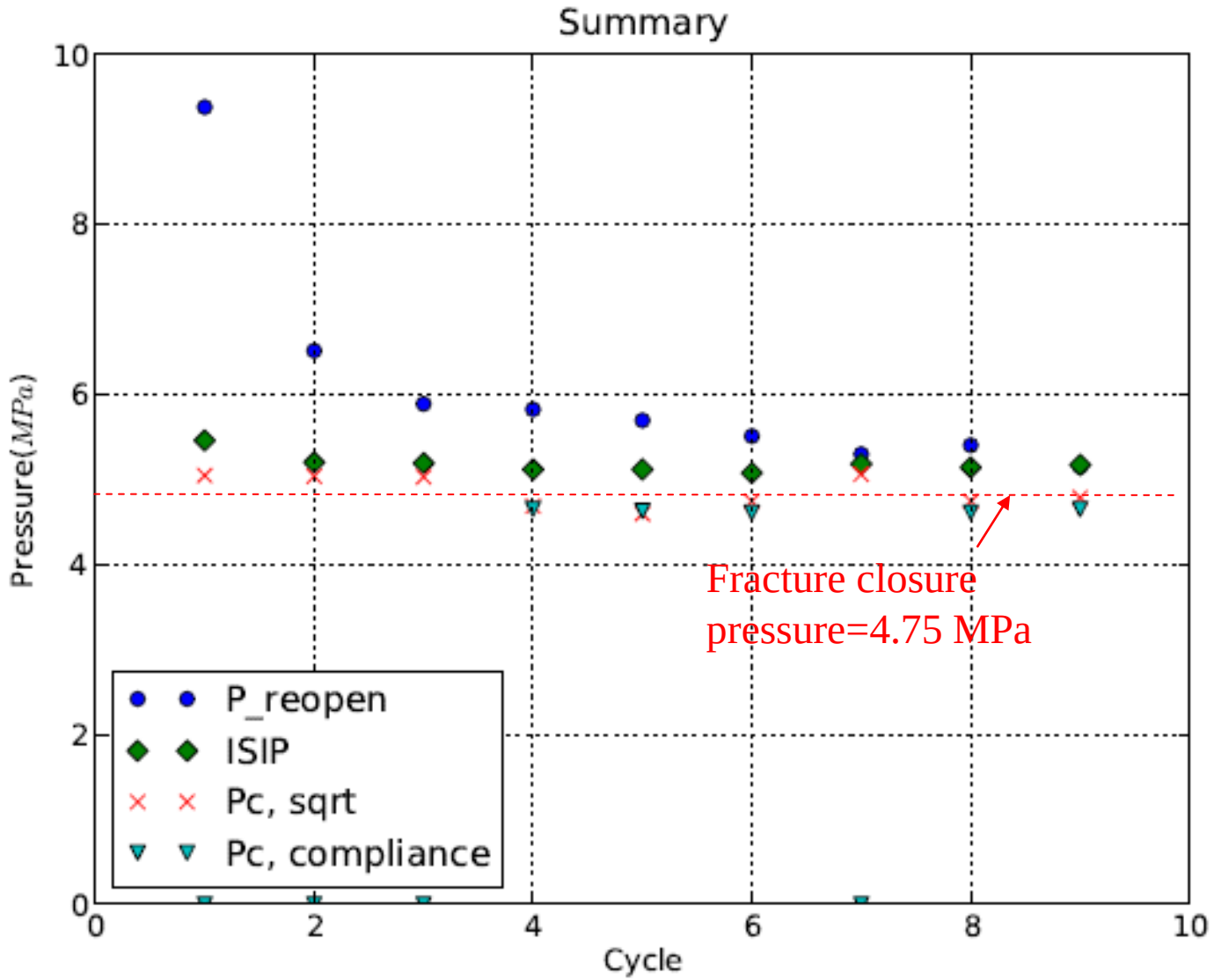


Figure 3: Cumulative corner reflector vertical deformation: March 26, 2013 to December 15, 2013.

- Acquired 15 RADARSAT-2 scenes in 2013 the first sign of change – March 26, 2013
- Less than 4 mm of heave throughout 2013

Pelican Lake SAGD Pilot

Cap Rock Integrity - Joli Fou Fm 103/06-11-082-23 W4M (221 mKB)



Drilling and Completions

Subsurface Subsection 3

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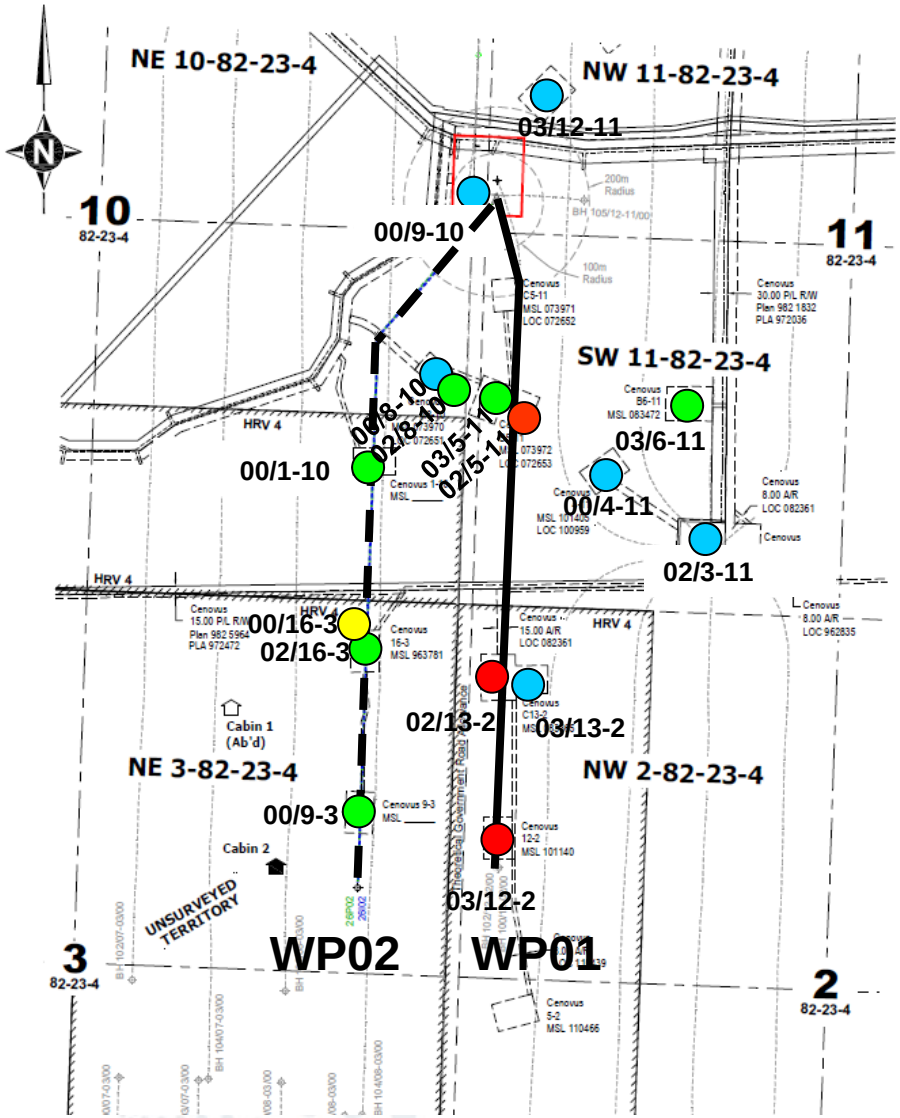
Pelican Lake SAGD Pilot
Well Layout / Location Map



- Temperature
- Temperature & Pressure
- Ground Water observation
- Thermal compliancy observation

Ground water observation wells

not illustrated on map

100/04-27-82-22

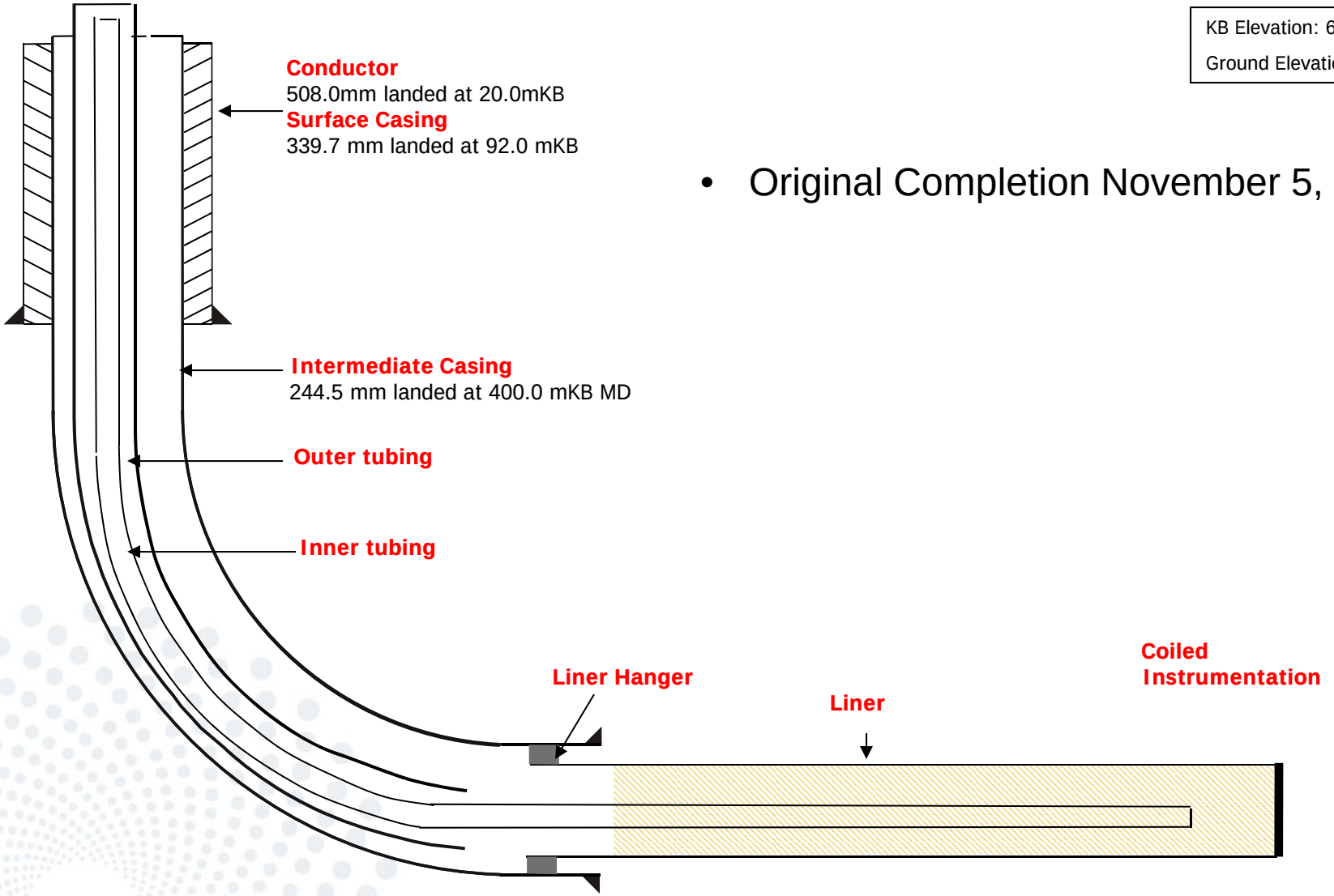
1F1/13-07-82-22

16-07-82-22 (camp 1 water source well)

26I01 Completion

KB Elevation: 609.03 m

Ground Elevation: 604.36 m



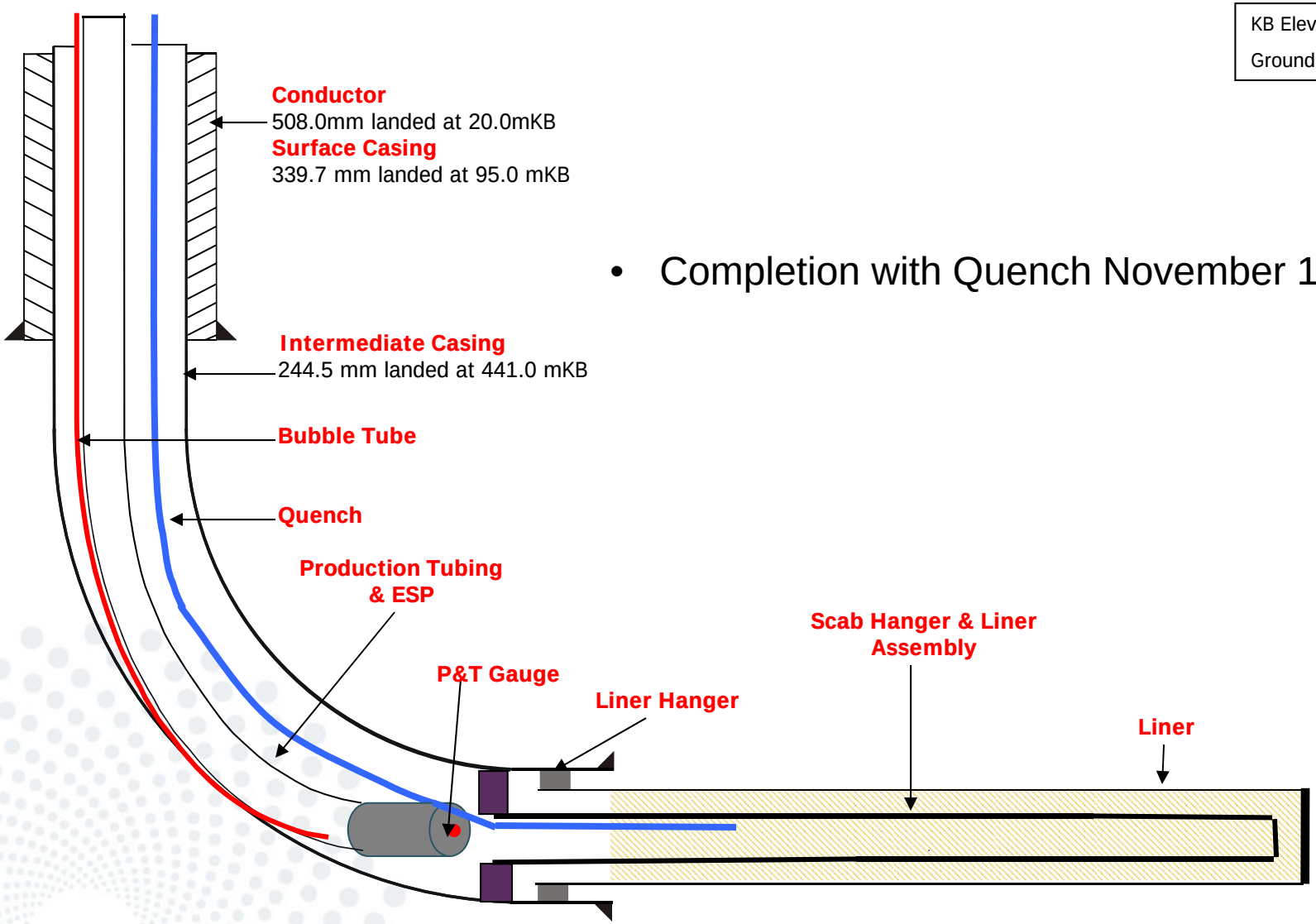
- Original Completion November 5, 2010

Subsection 3.1.1 – 3) b)

26P01 Completion with Downhole Quench (February 2013 – March 2014)

KB Elevation: 609.95 m

Ground Elevation: 604.95m



- Completion with Quench November 11, 2012

26P01 Downhole Quench (February 2013 – March 2014)

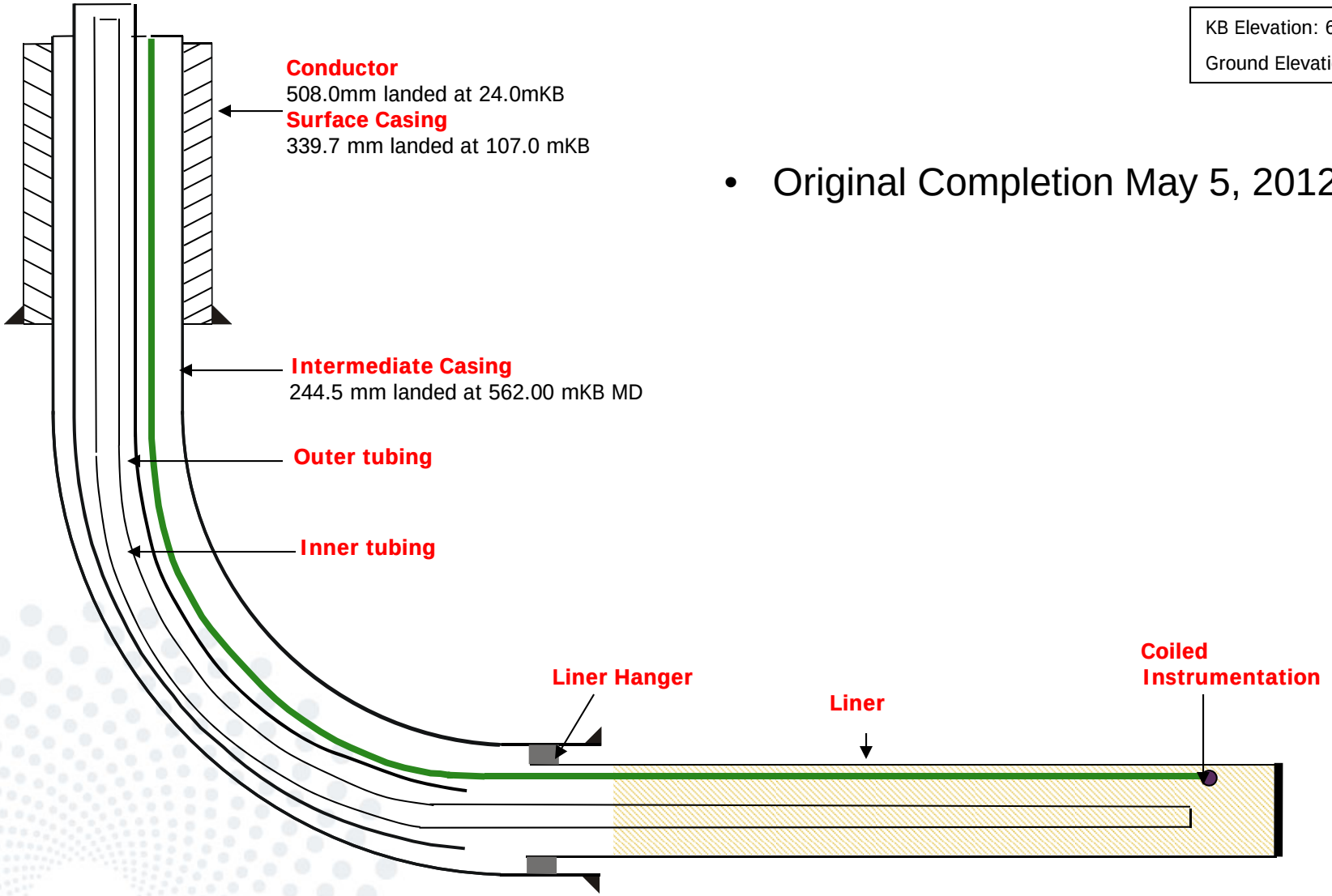
P01 Downhole Quench

- Quench line installed Nov 11, 2012
- Quench line 1 ¼" coil landed ~ 200 m past the pump intake
- The theory is that by injecting cold fluid past the pump it helps pump efficiency by reducing the saturation conditions at the pump reducing the amount of steam at pump intake
- The quench was used intermittently throughout the year based on pump behavior
- The injection of quench fluid downhole increased pump stability and efficiency by allowing for increase in production

26I02 Completion

KB Elevation: 609.03 m

Ground Elevation: 604.36 m



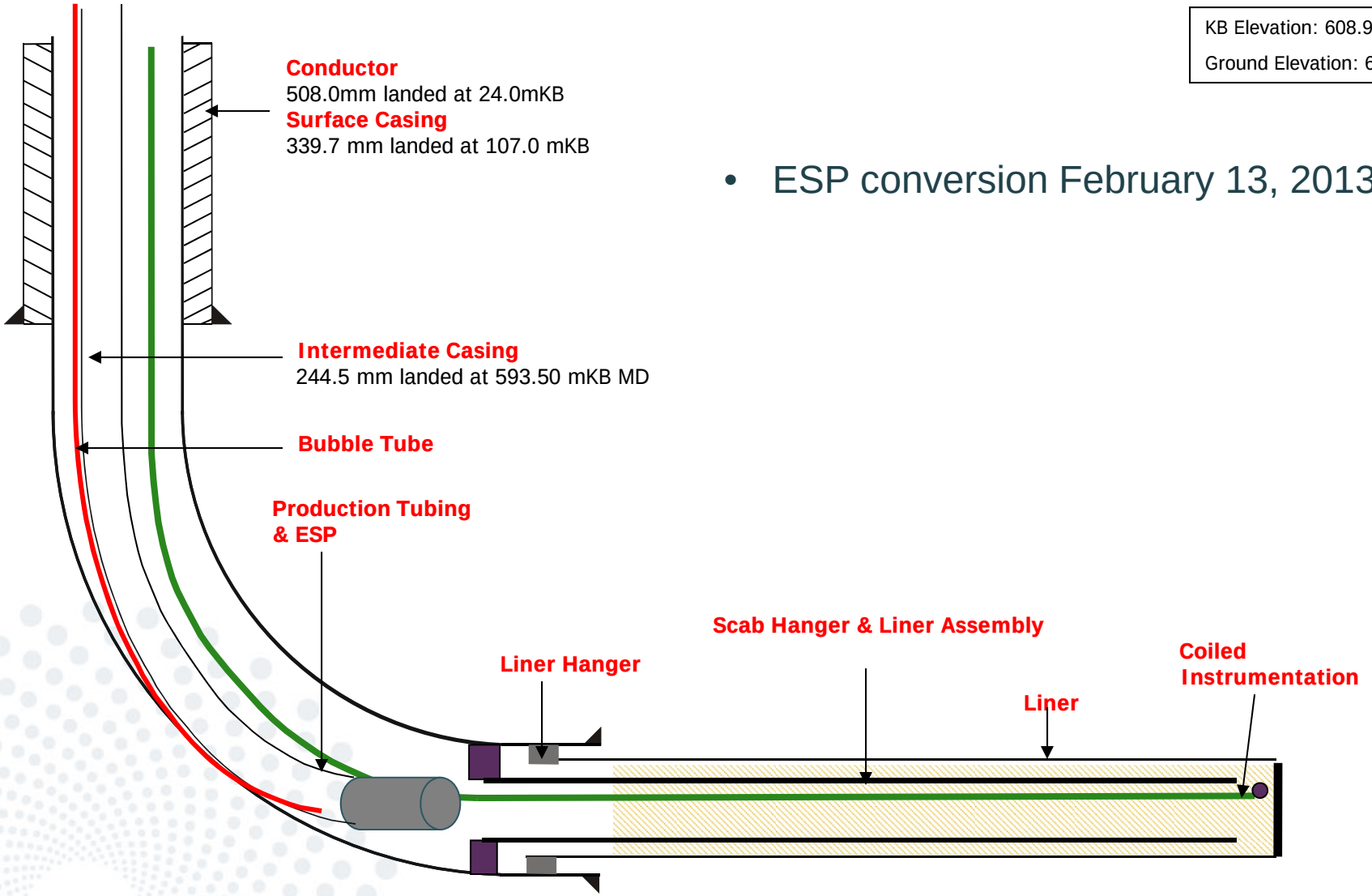
- Original Completion May 5, 2012

Subsection 3.1.1 – 3) b)

26P02 SAGD Completion (February 2013 – January 2014)

KB Elevation: 608.93 m

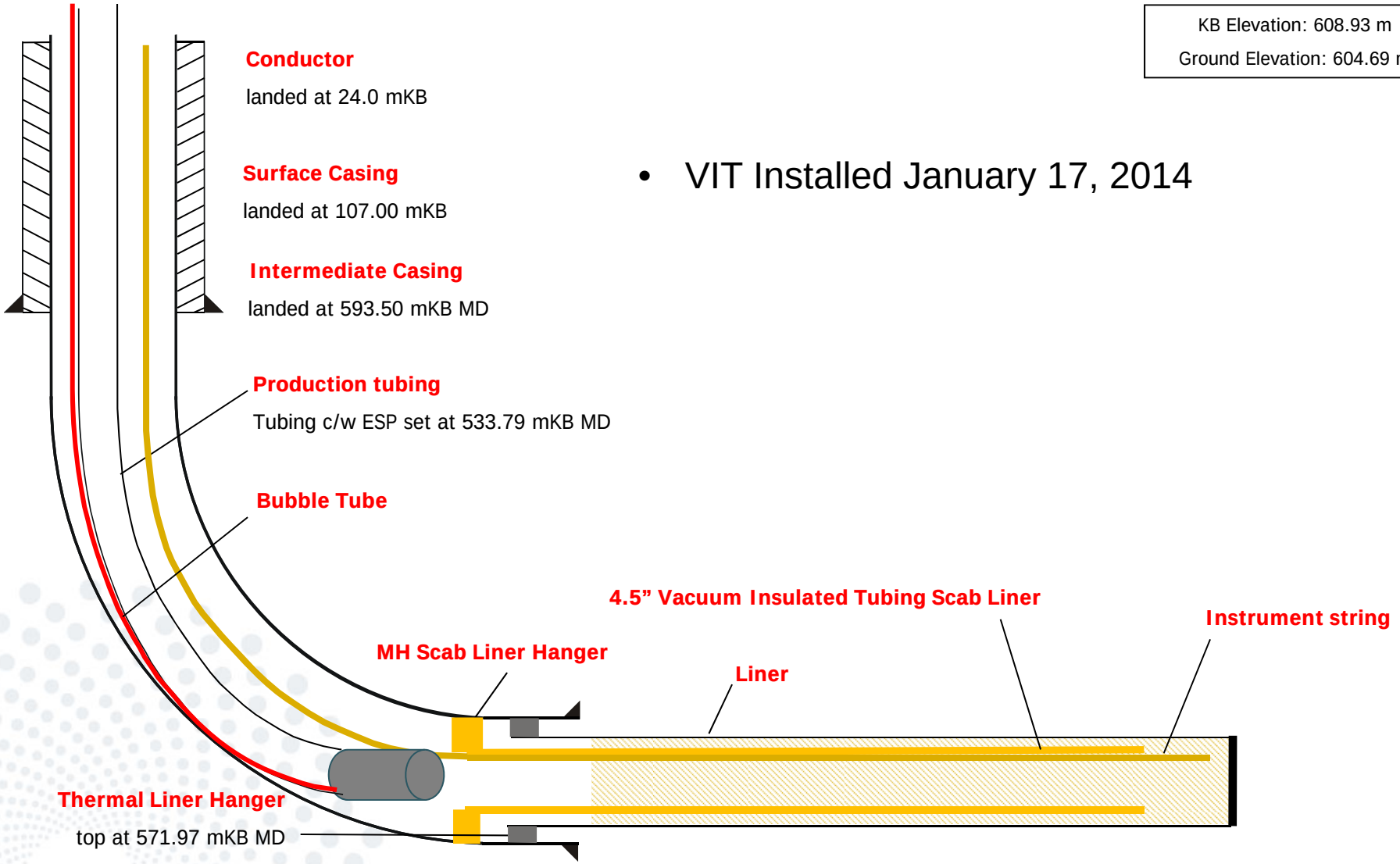
Ground Elevation: 604.69 m



- ESP conversion February 13, 2013

26P02 Producer Completion – January 2014

KB Elevation: 608.93 m
Ground Elevation: 604.69 m



- VIT Installed January 17, 2014

Artificial Lift

Subsurface Subsection 4

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Pelican Lake SAGD Pilot
Artificial Lift

The artificial lift used for the Grand Rapids 'A' SAGD Pilot producers are Electric Submersible Pumps (ESP)

- Intake pump pressure 500 – 1,150 kPaa.
- Lift capacity per pump 60-600 m3/d.
- Pump operating temperature limit of 218°C.

Instrumentation in Wells

Subsurface Subsection 5

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Pelican Lake SAGD Pilot Instrumentation In Wells

SAGD Well Pair 1 Instrumentation

- I01: Gas blanket for injector bottomhole pressures. No downhole temperature measurements
- P01: Bubble tube for producer bottomhole pressure measurements. Installed 40-point temperature fiber and pressure sensor at the toe in producer in 2014

SAGD Well Pair 2 Instrumentation

- I02: Gas blanket in annulus for injector bottomhole pressures. Equipped with 40-point temperature fiber and pressure sensor at toe.
- P02: Bubble tube for producer bottomhole pressure measurements. Removed 40-point temperature fiber and pressure sensor at toe. Replaced with 6 thermocouple temperature point string in 2014.

Requirements under subsection 3.1.1 5a – wellbore schematics, 5c and 5d are included in the Appendix.

Pelican Lake SAGD Pilot
Instrumentation In Observation Wells

Formation of Observation (Number of Wells)	Temperature only	Pressure Only	Pressure & Temperature	Sampling
Quaternary/Tertiary (3)			**3**	**2**
Viking (1)			**1**	**1**
GDPD 'A' (11)	**3**	**1**	**7**	**1**
GR"B" (4)			**4**	**3**

19 water monitoring/observation wells for Pelican Lake SAGD Pilot

Failures in 2013:

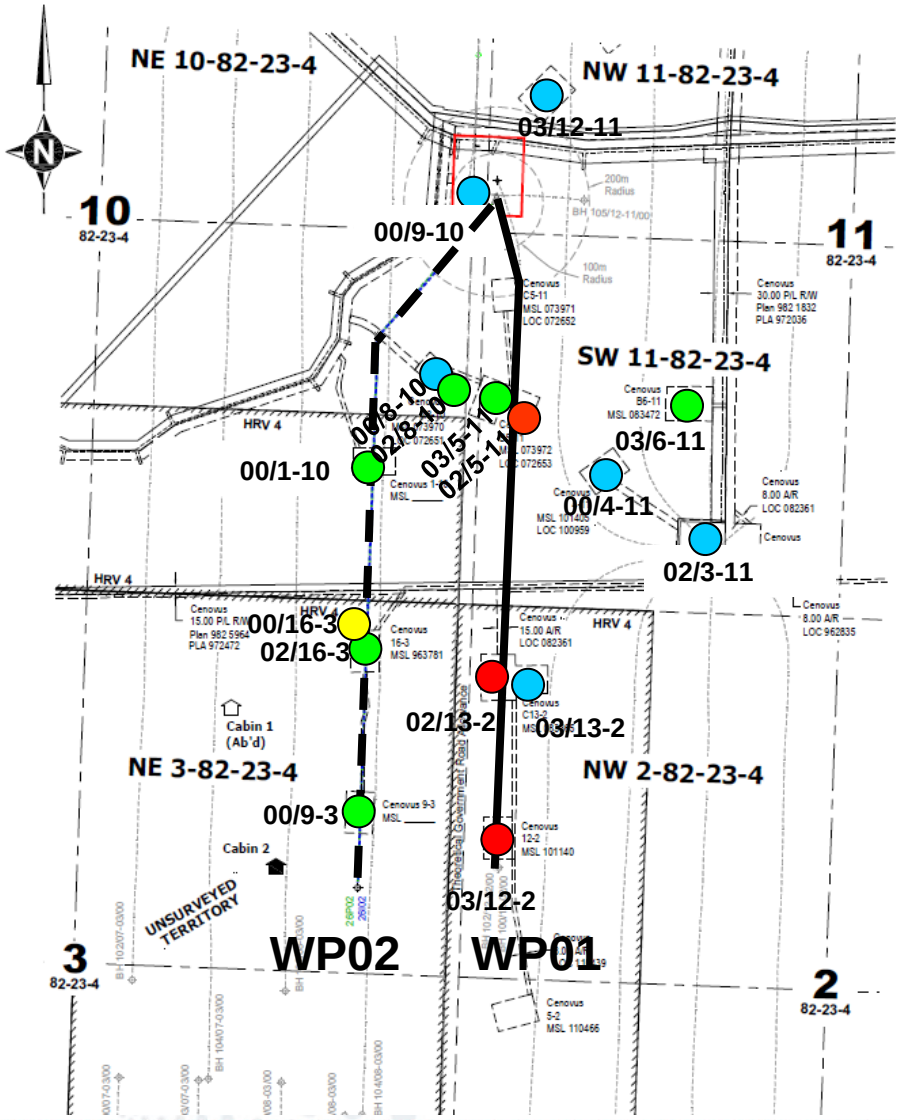
- Thermocouples
  - WP01 – 103/5-11-82-23W4 at depths: 246mKB, 242.9 mKB
  - WP02 - 100/16-3-82-23W4
  - WP01 - 102/5-11-82-23W4 Aug 2013 –Feb 2014 surface equipment issues
- Piezometers:
  - WP01 - 103/5-11-82-23W4 at depths: 242.9 mKB, 233.4 mKB, 227.1 mKB, 224 mKB

Resolution:

- February 2014 - Surface Equipment fixed on 102/5-11-82-23W4
- March 2014 - Add thermocouple strings to 103/5-11-82-23W4 & 100/16-3-82-23W4

Requirements under subsection 3.1.1 5a – wellbore schematics, 5c and 5d are included in the Appendix.

Pelican Lake SAGD Pilot Instrumentation in Wells



- Temperature
- Temperature & Pressure
- Ground Water observation
- Thermal compliancy observation

WP01 Equipped with fiber-optic string for temperature monitoring

WP02 Equipped with 6-point thermocouple string for temperatures

Ground water observation wells

not illustrated on map

100/04-27-82-22

1F1/13-07-82-22

16-07-82-22 (camp 1 water source well)

Seismic

Subsurface Subsection 6

Pelican Lake SAGD Pilot
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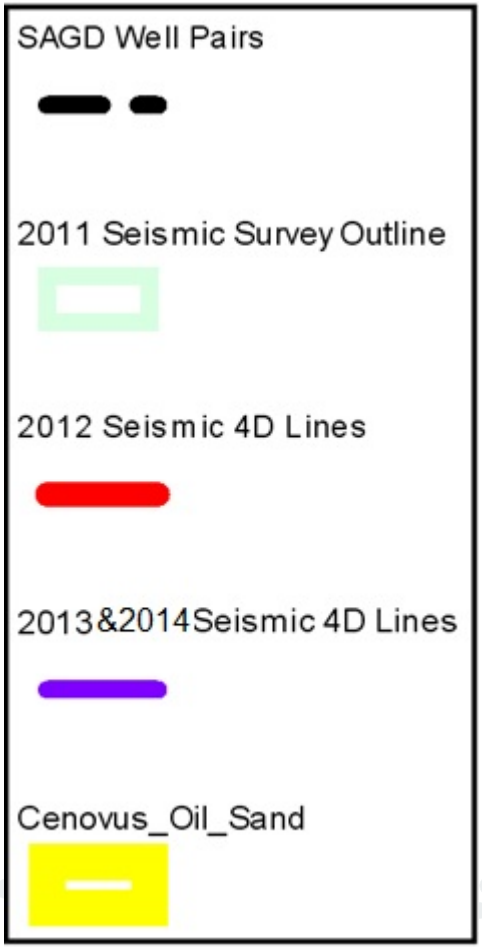
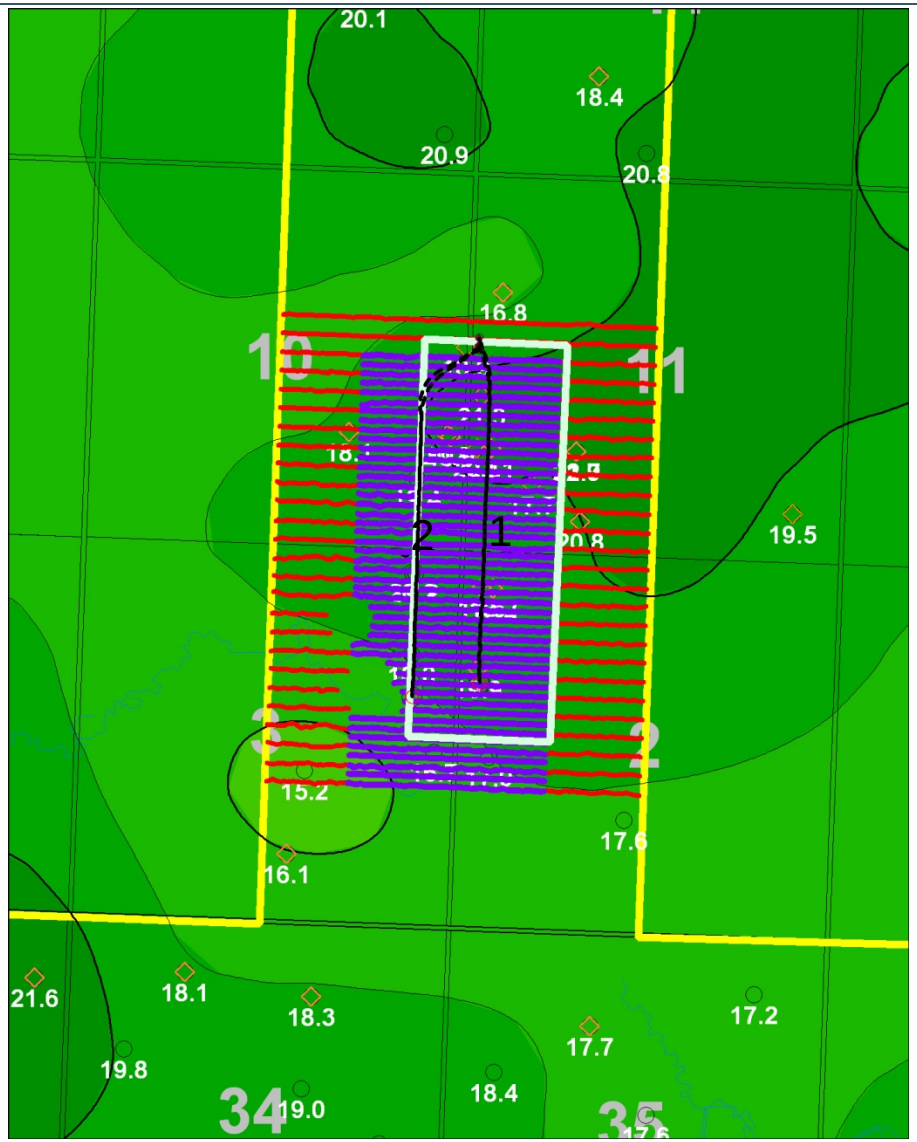
Pelican Lake SAGD Pilot Seismic Coverage

Purpose: monitor steam chamber growth

- Bin size: 10 m by 10 m
- Baseline 3D was shot on January 2nd, 2011
- First 4D was shot on January 3rd, 2012
- Second 4D was shot in March 2013
- Third 4D was shot in January 2014
- 4D seismic show the areas of steam chamber development and connection to the lean zone
- 2014 being processed

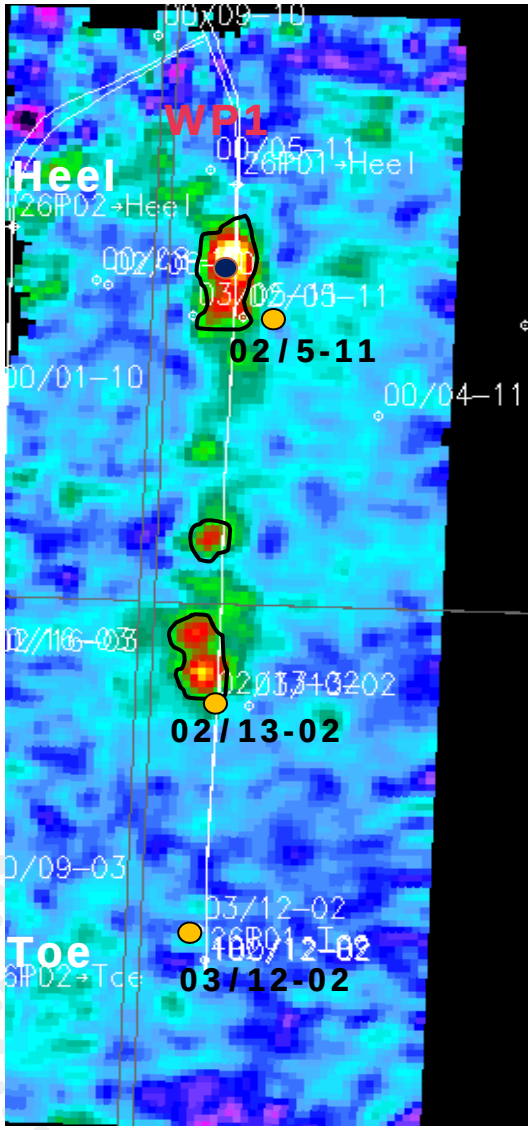
4D Seismic Coverage





Subsection 3.1.1 – 6)

26P01 4D Seismic Interpretation

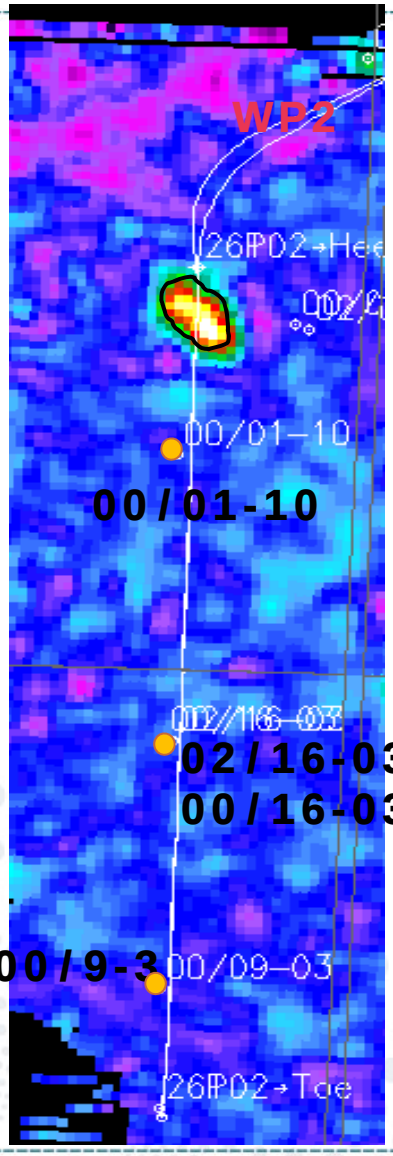


4D seismic between 2013 and 2011 show steam at heel and middle of WP01

Steam chamber core

Temp. OB Well

26P02 4D Seismic Interpretation



4D seismic between 2013 and 2012 shows steam at heel of WP02

- Steam chamber at heel is interpreted to be connected to the overlying lean zone
  - 2013 4D seismic analysis shows seismic amplitude throughout the bitumen, transition, and lean zone
- Lean zone pressure (measured in offsetting observation wells) increased several months after WP2 start-up
- Injector pressure is balanced with the overlying lean zone pressure
- Temperature logs in both the Producer and Injector show elevated temperature coinciding with the 4D seismic

Subsection 3.1.1 – 6)

Scheme Performance

Subsurface Subsection 7

Pelican Lake SAGD Pilot

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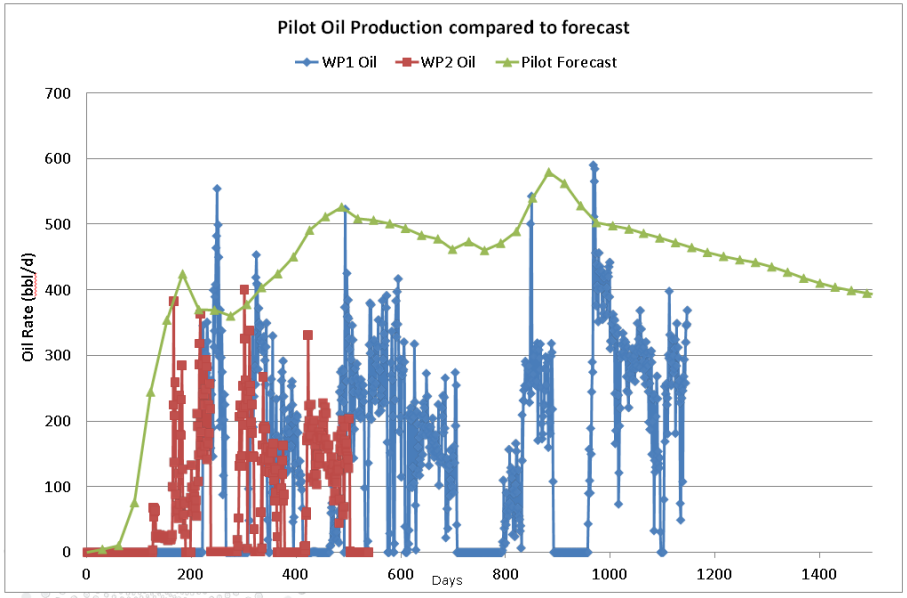
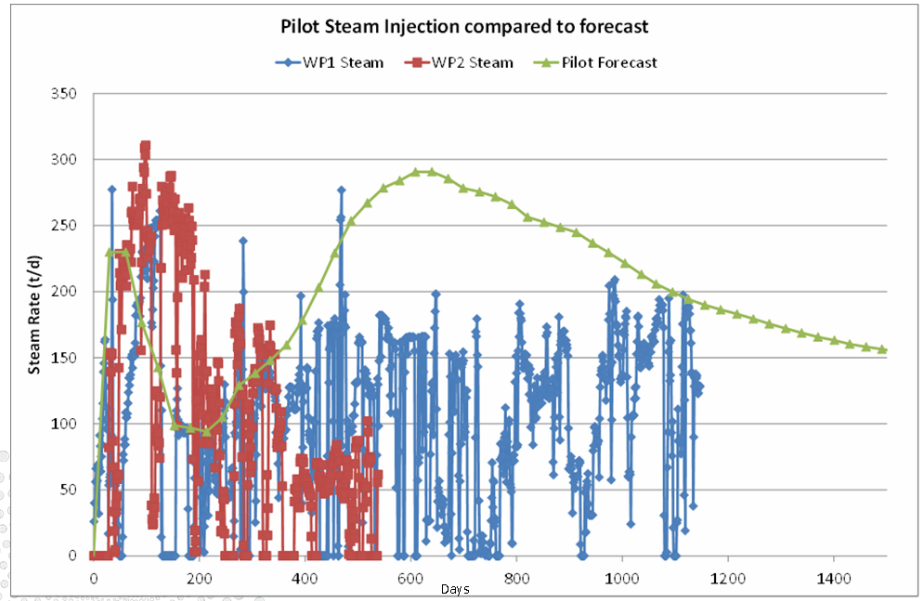
Pelican Lake SAGD Historical Production & Injection (July 2011 – March 2014)

Actual Pilot performance versus forecasted performance of an equivalent commercial well pair

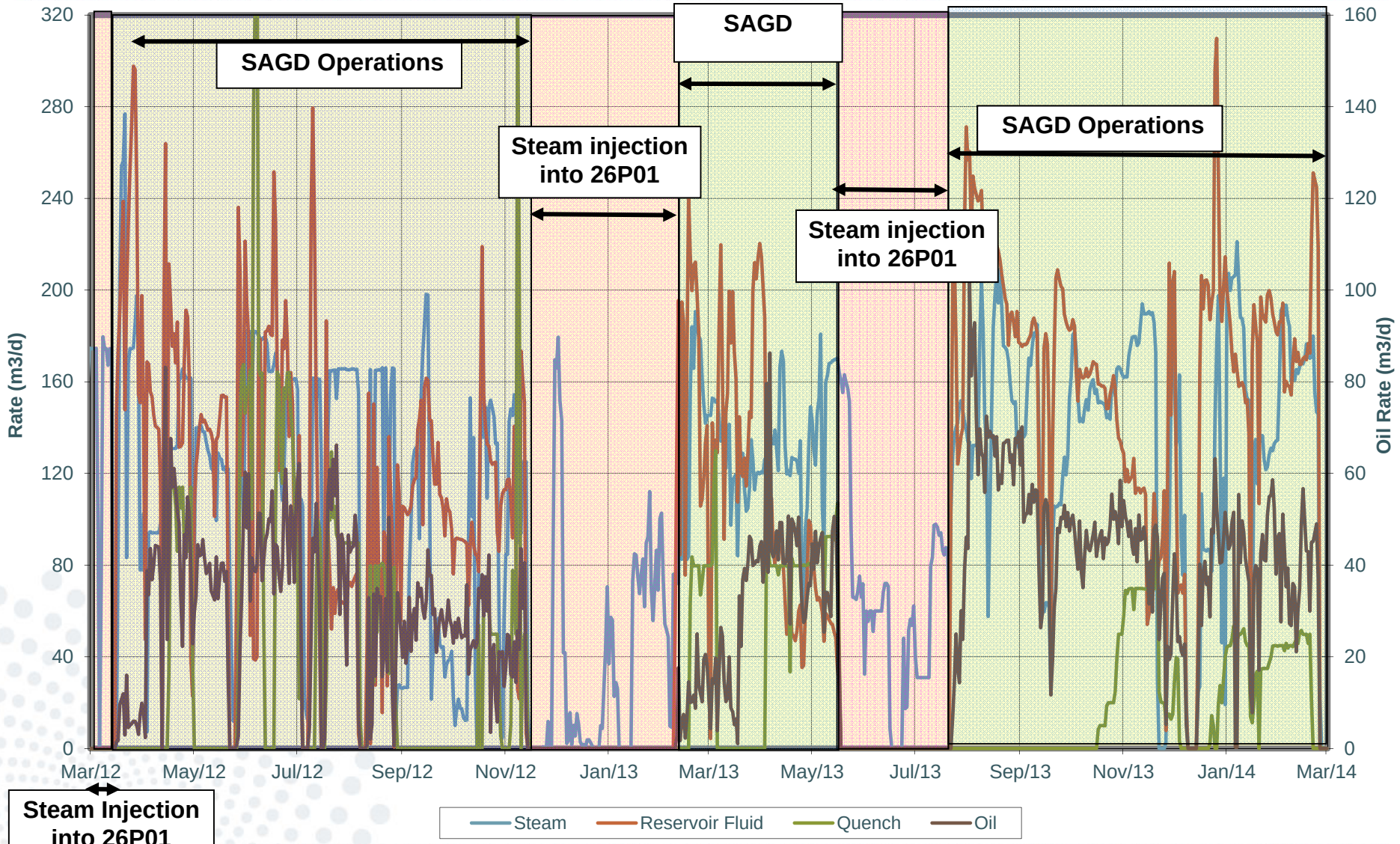




- Hot spot development in both Wellpair producers
- Poor conformance
- Damaged scab liner

Well Pair #1

Pelican Lake SAGD Pilot
March 2012 – February 28, 2014 WP01 Performance



Pelican Lake SAGD Pilot
March 1, 2013 – February 28, 2014 WP01 SAGD Performance

Maximum sustained reservoir fluid rate ~ 230m³/d

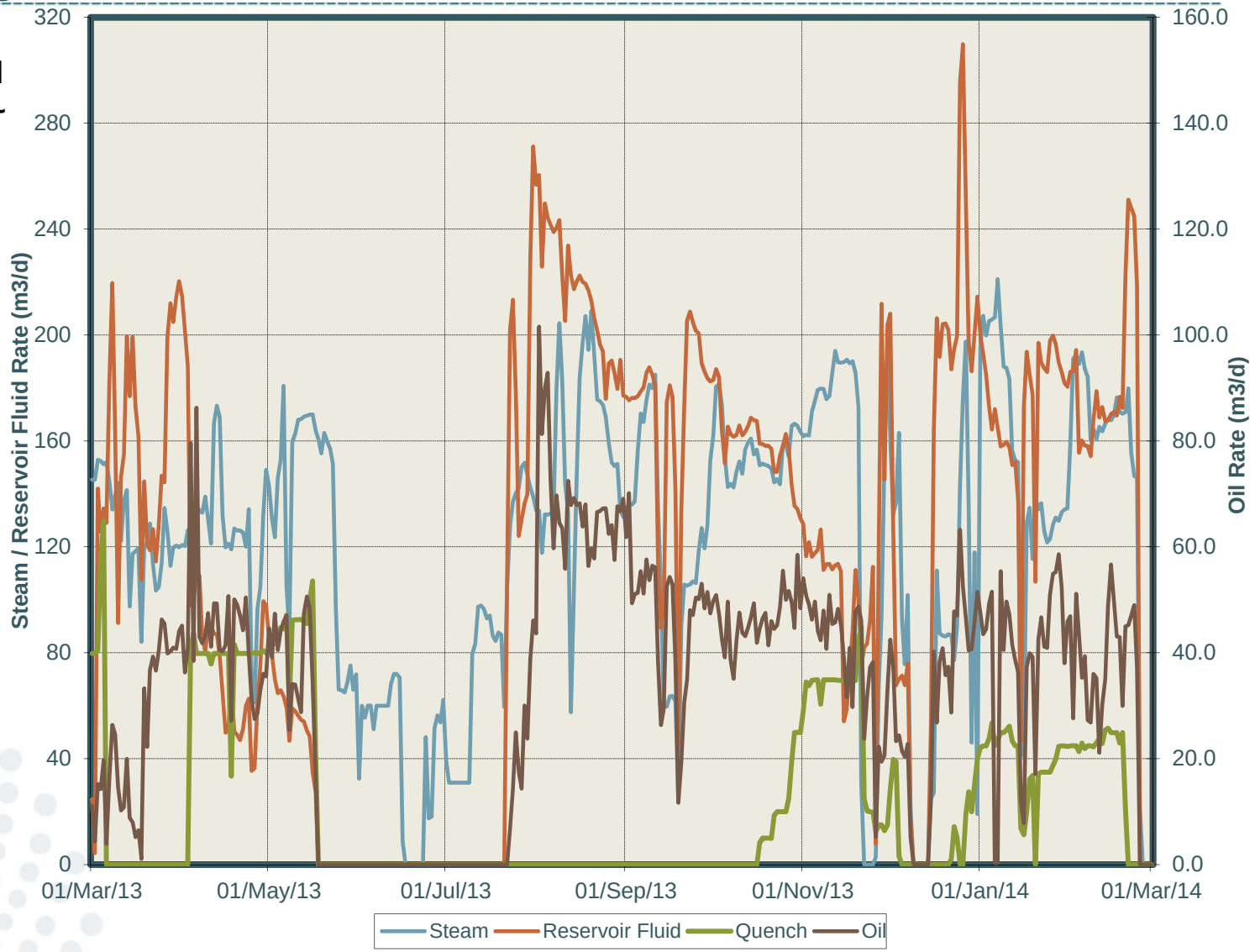
254 days on production

Ave. oil rate = 35m³/d

Ave. reservoir fluid rate = 160m³/d

SOR = 4.0

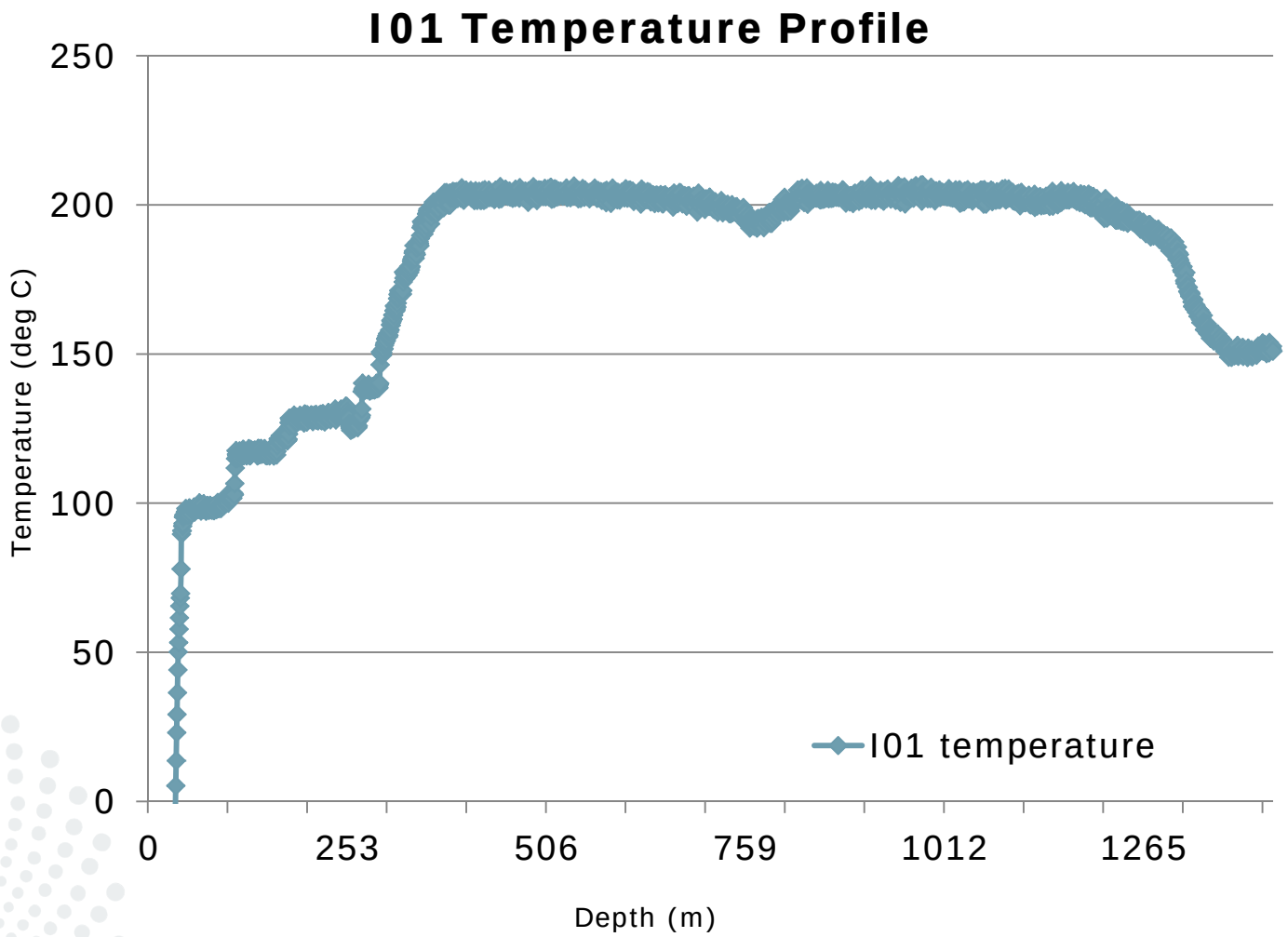
WOR = 3.3



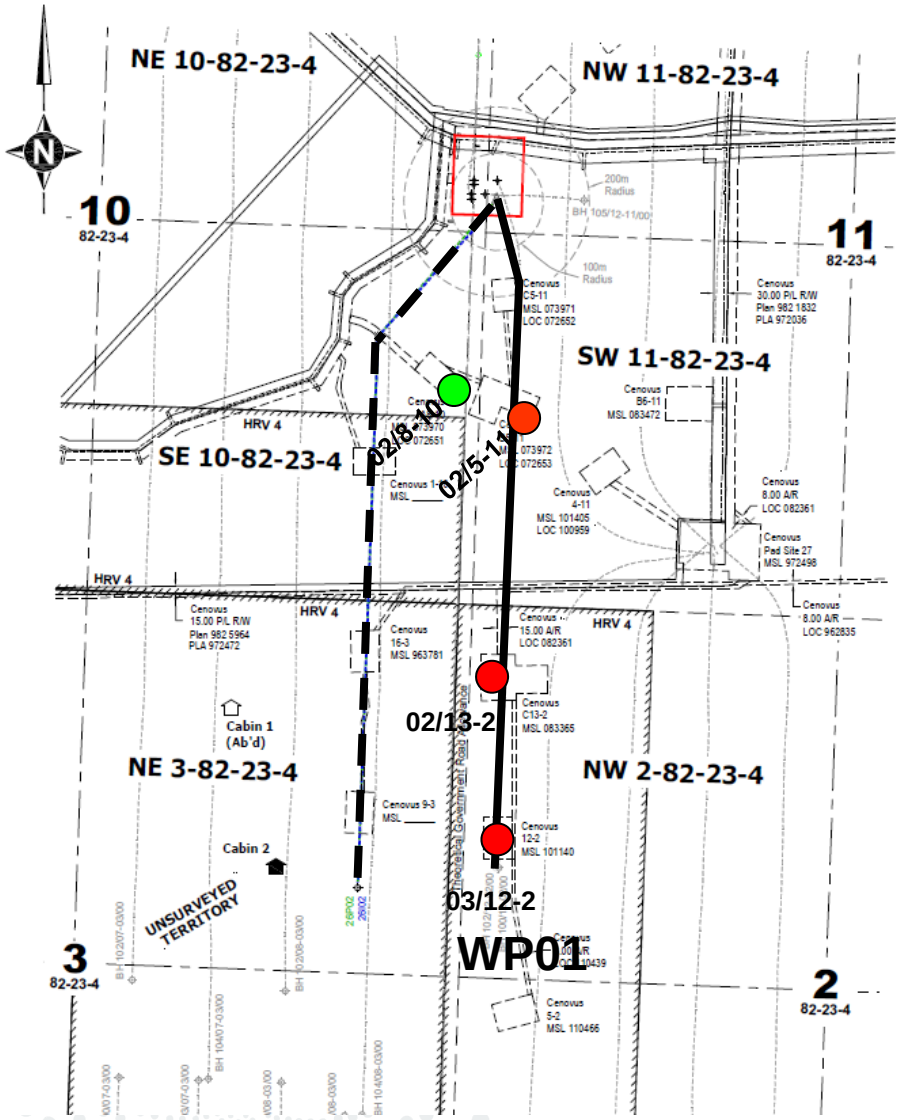
Subsection 3.1.1 – 7)

Pelican Lake SAGD Pilot
I01 Temperature Survey

- **Target to improve conformance by increasing drawdown capability of mid-section to toe section of well**
- **Survey was conducted on December 11, 2013. Injector was shut-in for 2 days**



Pelican Lake WP01
Thermocouples in Wells

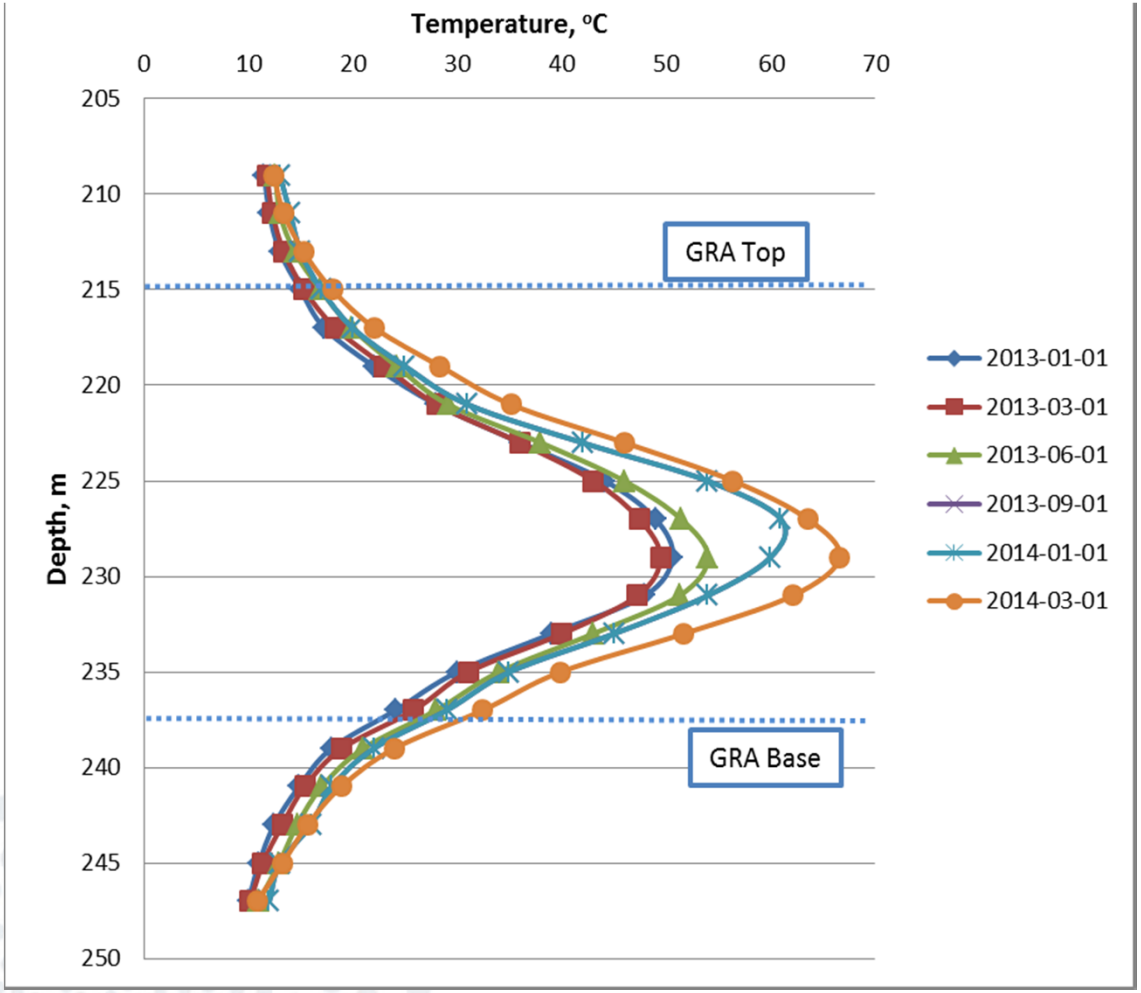


Temperature

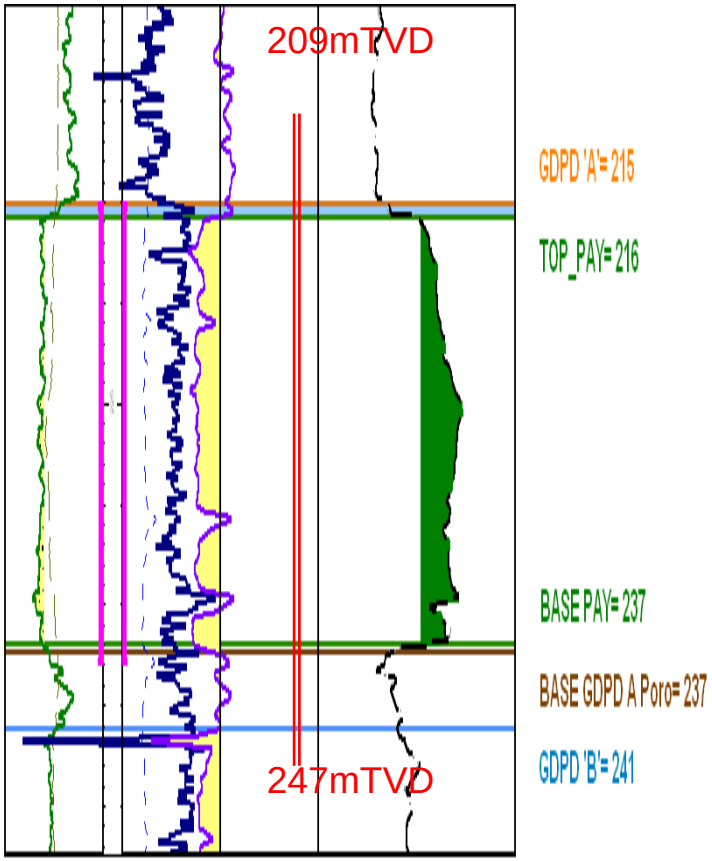
Temperature & Pressure

WP01 Equipped with fiber-optic string for temperature monitoring

Pelican Lake SAGD Pilot
Thermocouple Response 103/12-02

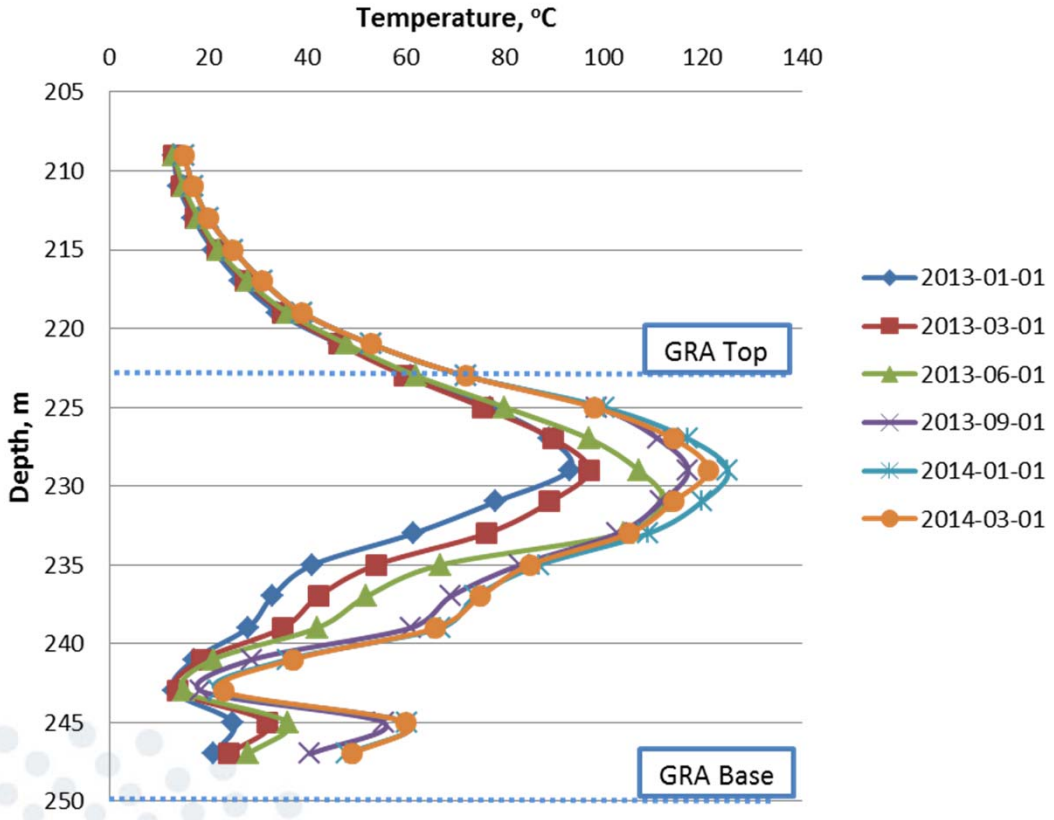


Thermocouple – located at toe

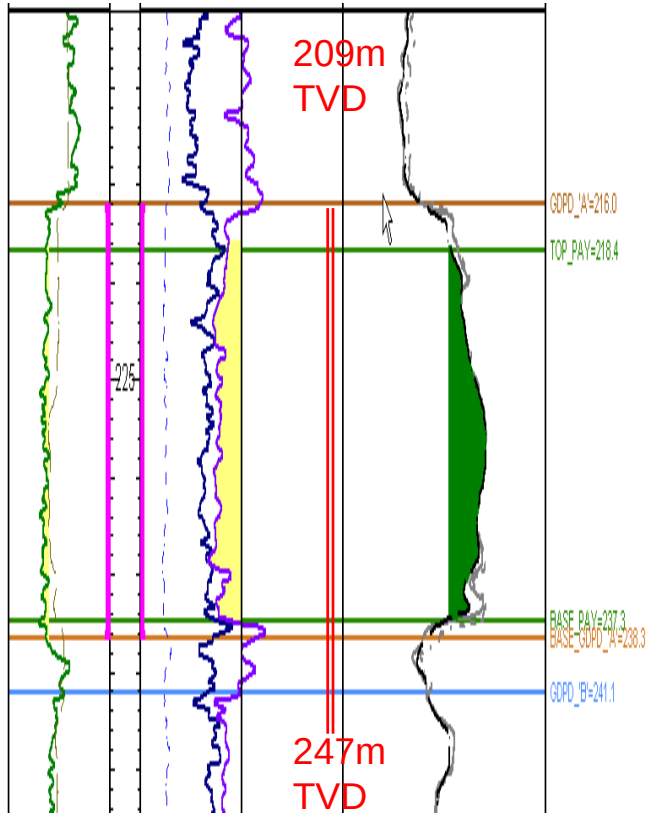


Lateral distance from Observation well to the well pair = 4.0 m

Pelican Lake SAGD Pilot
Thermocouple Response 102/13-02



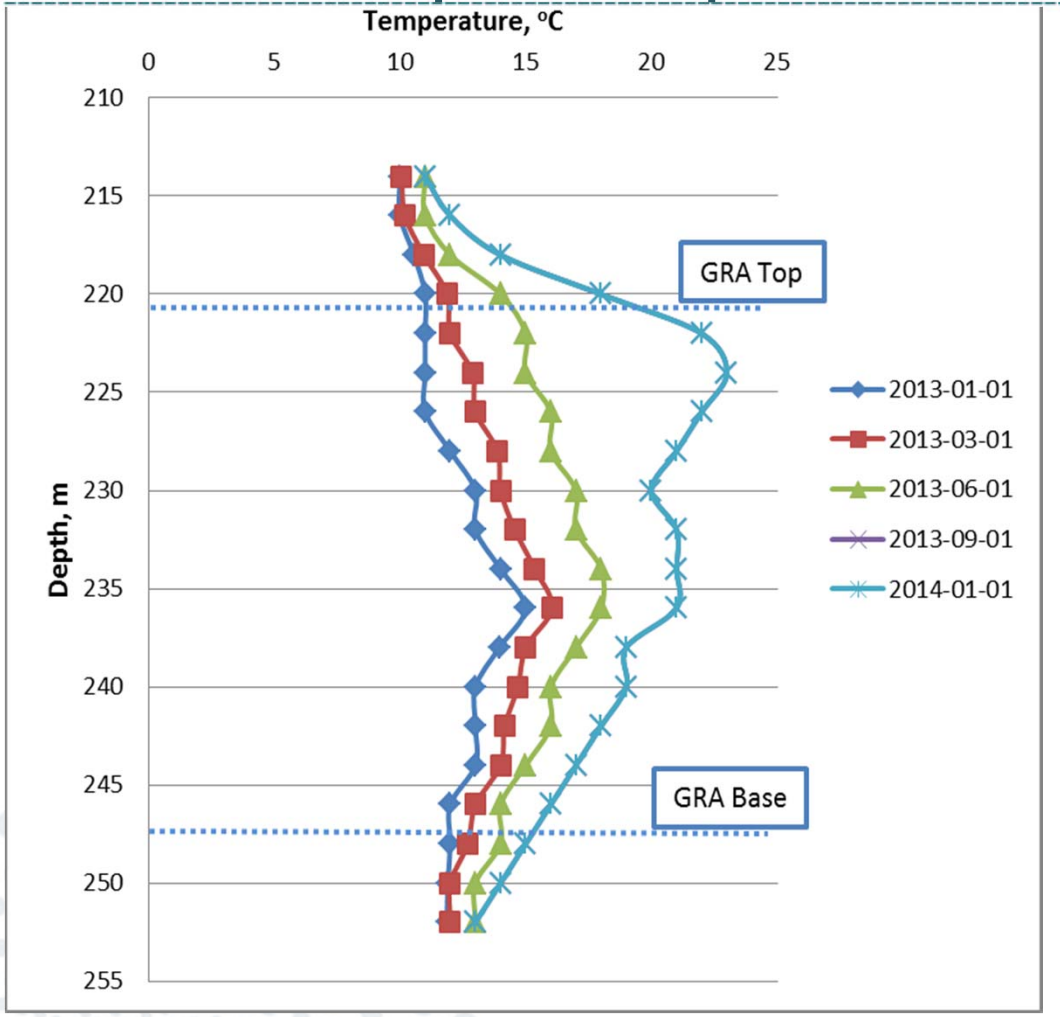
Thermocouple – 400m from toe toward heel



- Temperature spike at 245m is due to steam injection at producer conductively heating bottom of the pay zone.

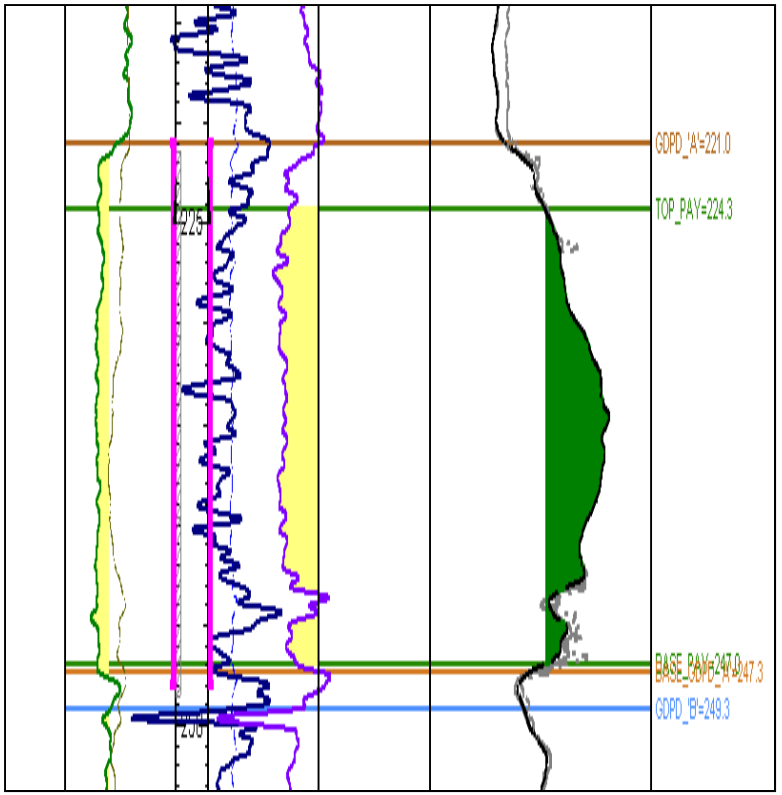
Lateral distance from Observation well to the well pair = 4.2 m

Pelican Lake SAGD Pilot
Thermocouple Response 102/05-11



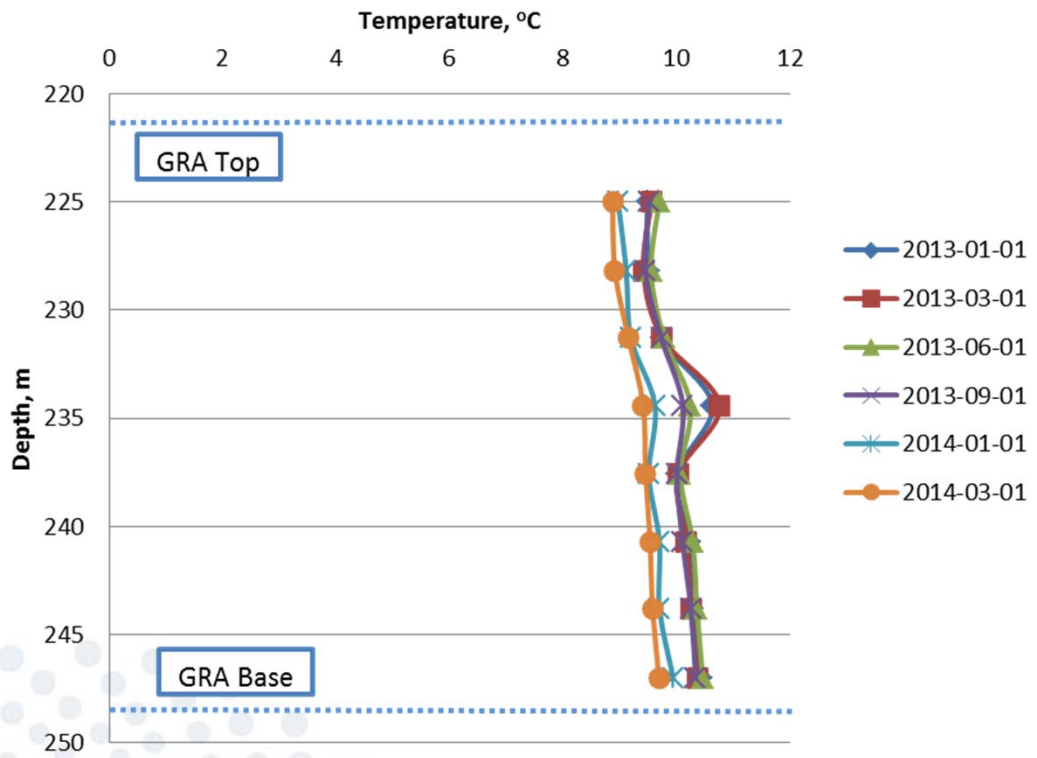
Not working Aug 2013 –Feb 2014 surface equipment issues

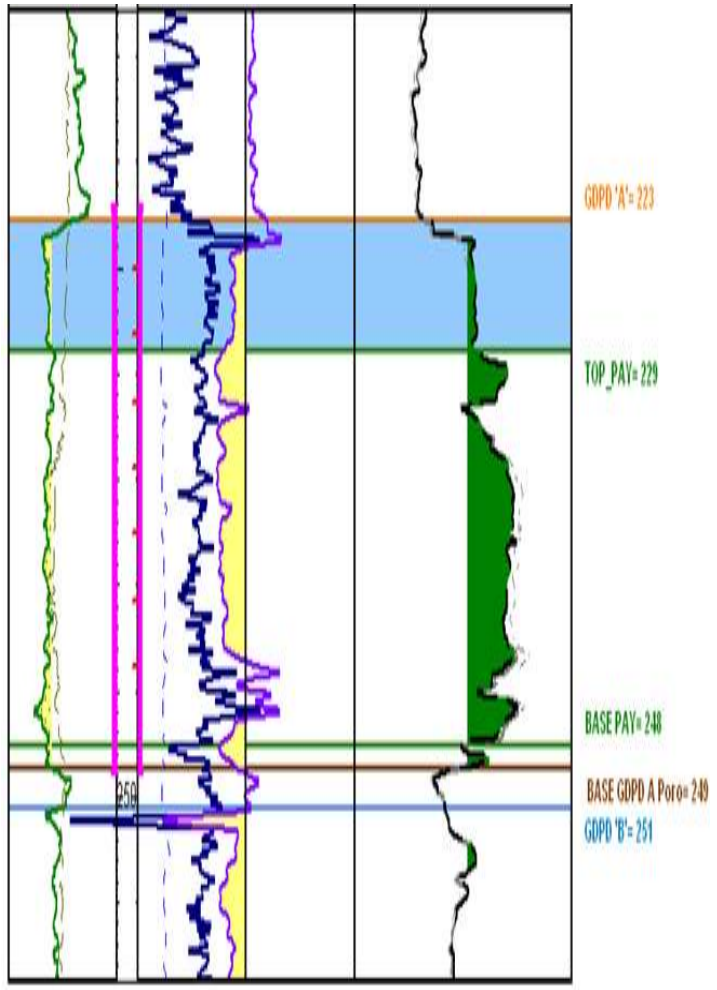
Thermocouple – Located at heel



Lateral distance from Observation well to the well pair = 21.4 m

Pelican Lake SAGD Pilot
Thermocouple Response 102/08-10





Lateral distance from Observation well to the well pair = 174 m

Pelican Lake WP01
March 1, 2013 – February 28, 2014 Milestones

- August 2013 - P01 averaged 70 m3/d oil
- Dec 2013 - HCl job on P01
- March 2014 - Removed quench line, installed ICD/scab liner in P01 with DTS
- January 2014 - P01 recompletion (hole in scab liner)

Pelican Lake SAGD WP01
Key Learnings

- High steam injection pressures combined with high drawdown created steam jetting conditions resulting in a hole in both slotted and scab liner
- Drawdowns should be maintained below 500 kPa to minimize risk of steam jetting holes in tubing
- Measurement audit showed small discrepancies in production and injection data. These are currently being resolved.
- P1 downhole quench completion showed positive results. Casing steam production was eliminated and production tubing steam was reduced.
- Temperature limitation of Pelican Lake oil infrastructure was improved from 2012, however full resolution was not achieved due to downhole issues.

Well Pair #2

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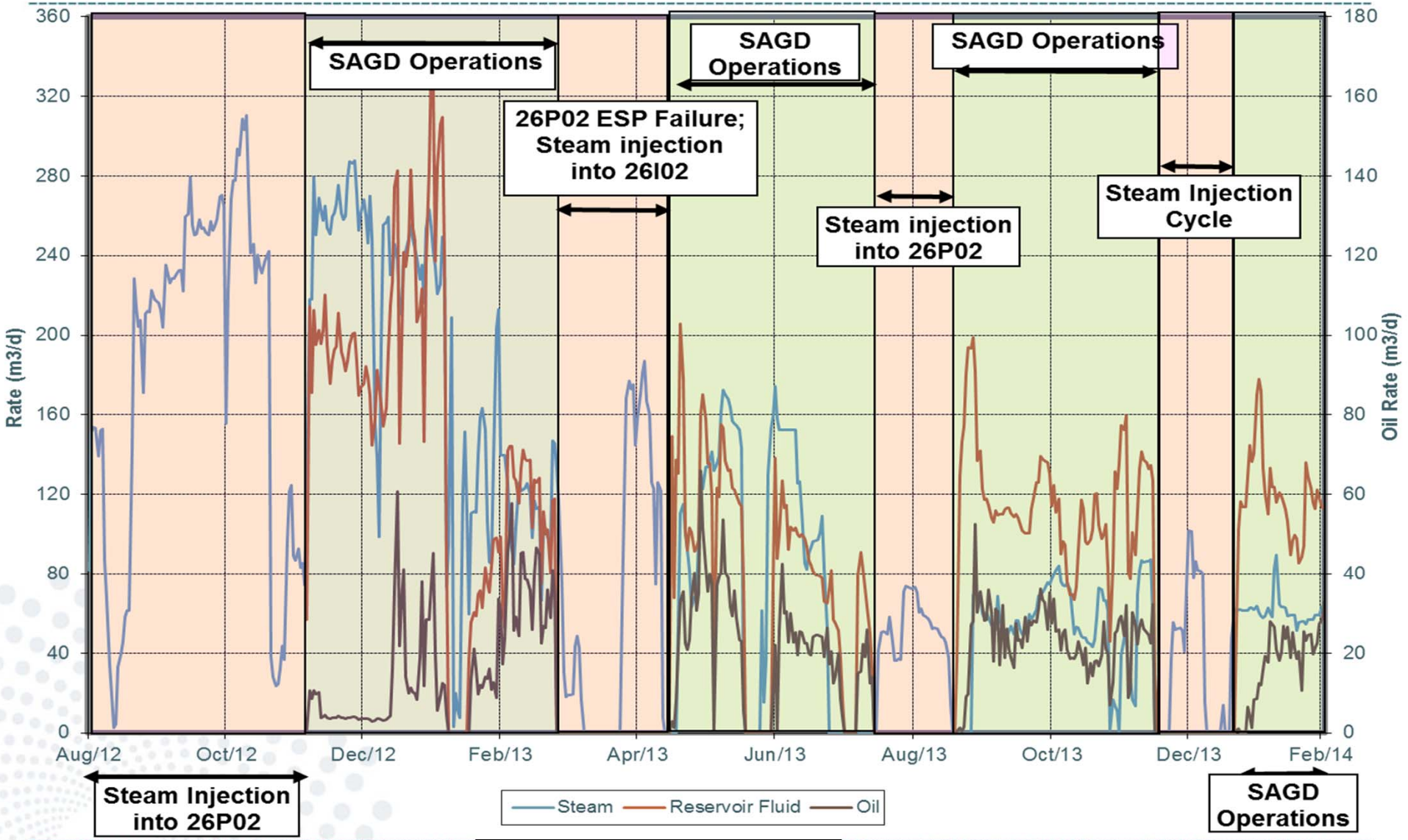
Pelican Lake SAGD Pilot
August 2012 – February 28, 2014 WP2 Performance



Pelican Lake SAGD Pilot
March 1, 2013 – February 28, 2014 WP2 Performance

Maximum sustained reservoir fluid rate ~ 110m³/d

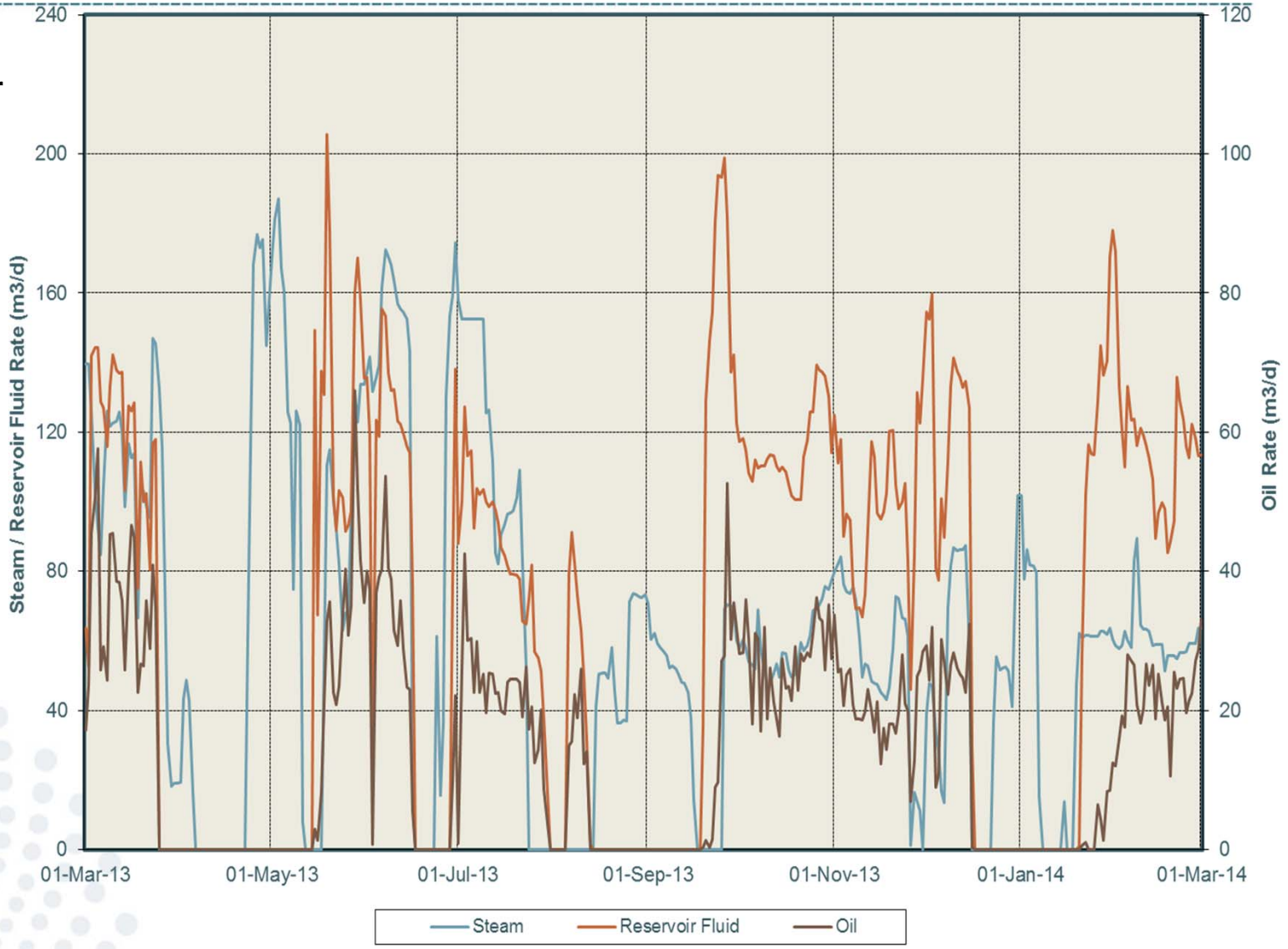
226 days on production

Ave. oil rate = 24m³/d

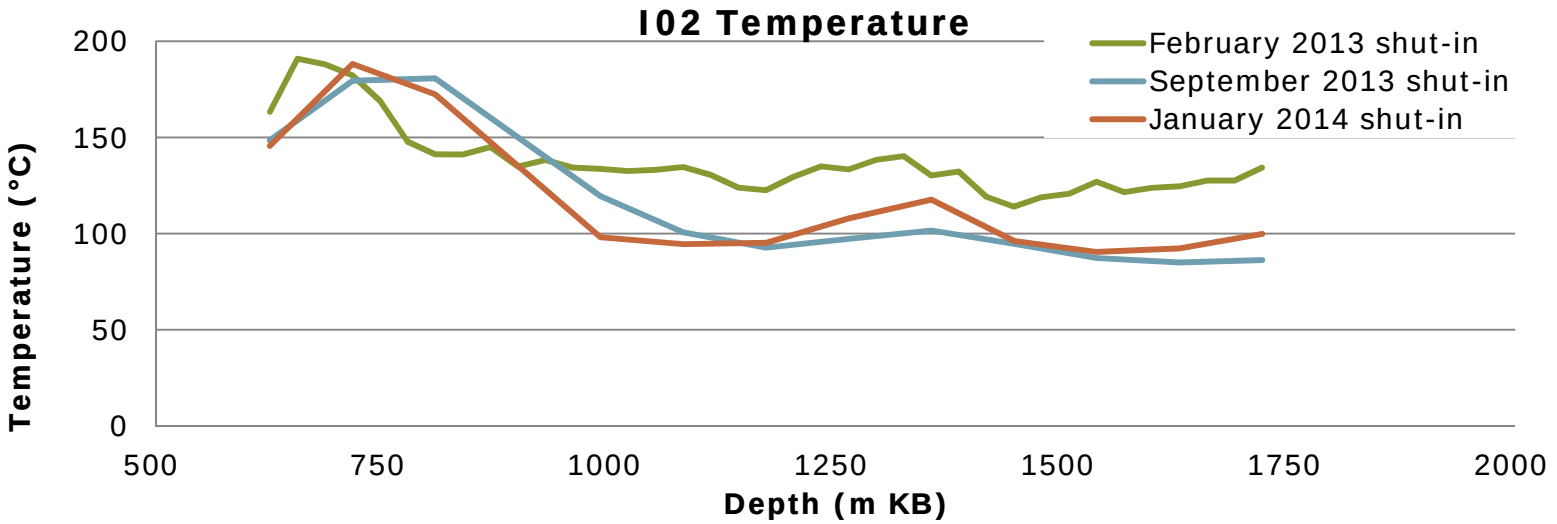
Ave. reservoir fluid rate = 110m³/d

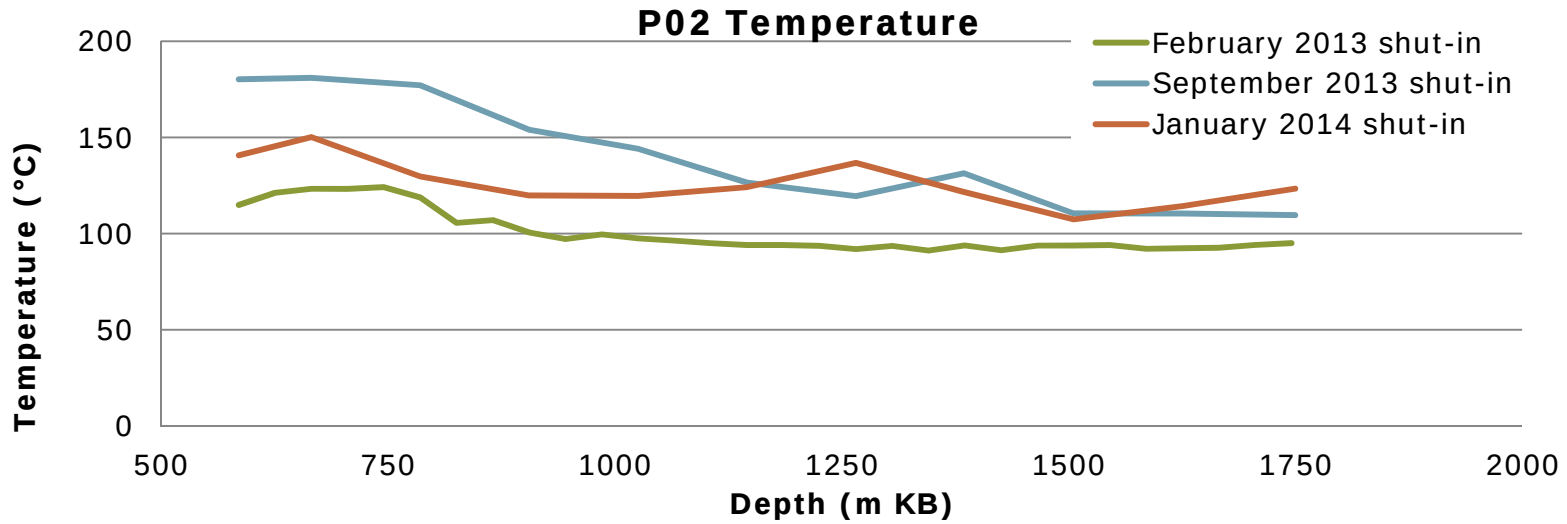
SOR = 5.0

WOR = 3.6

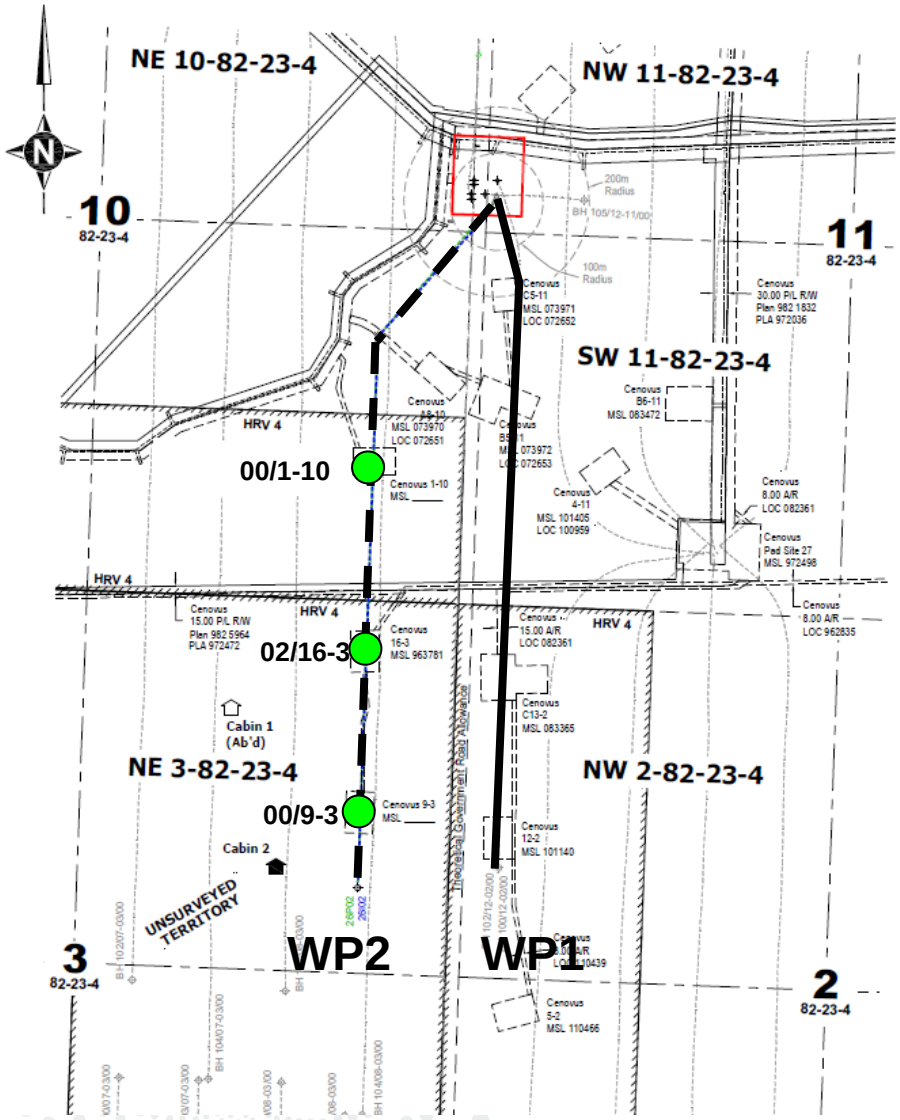


Pelican Lake SAGD Pilot
26I02 & 26P02 Fiber Temperatures





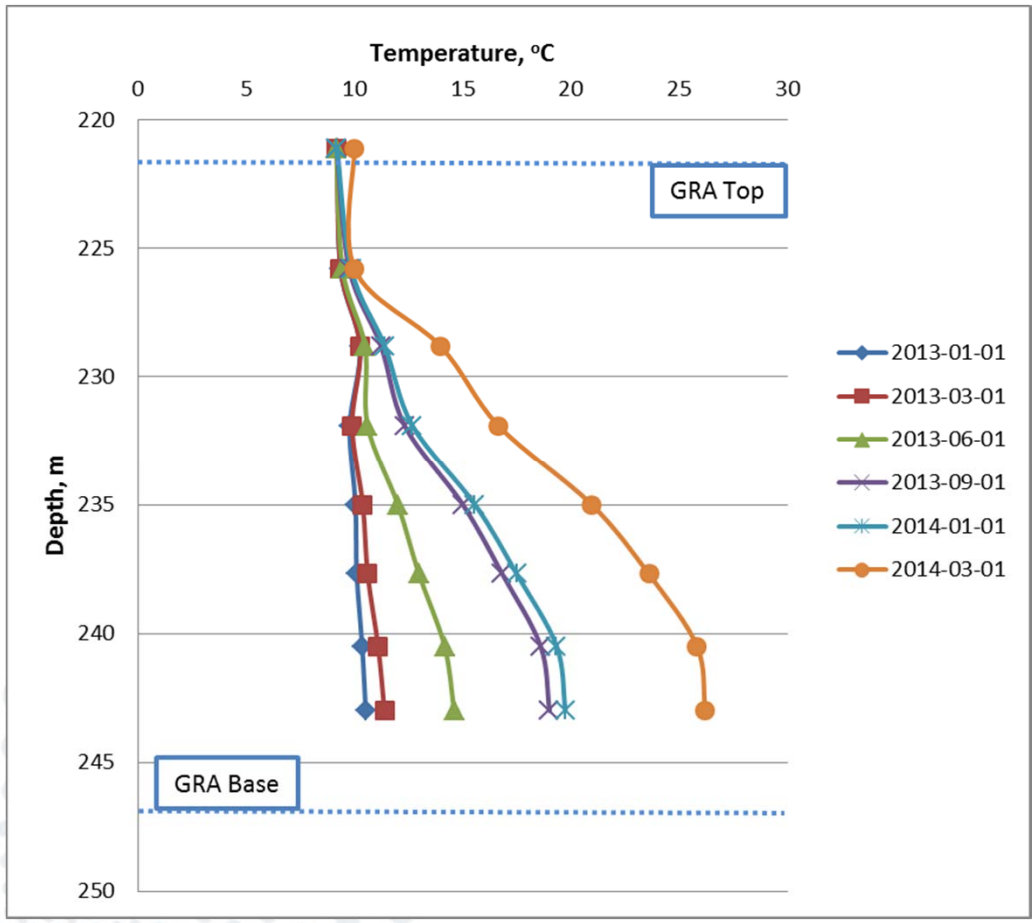
Pelican Lake WP02
Thermocouples in Wells

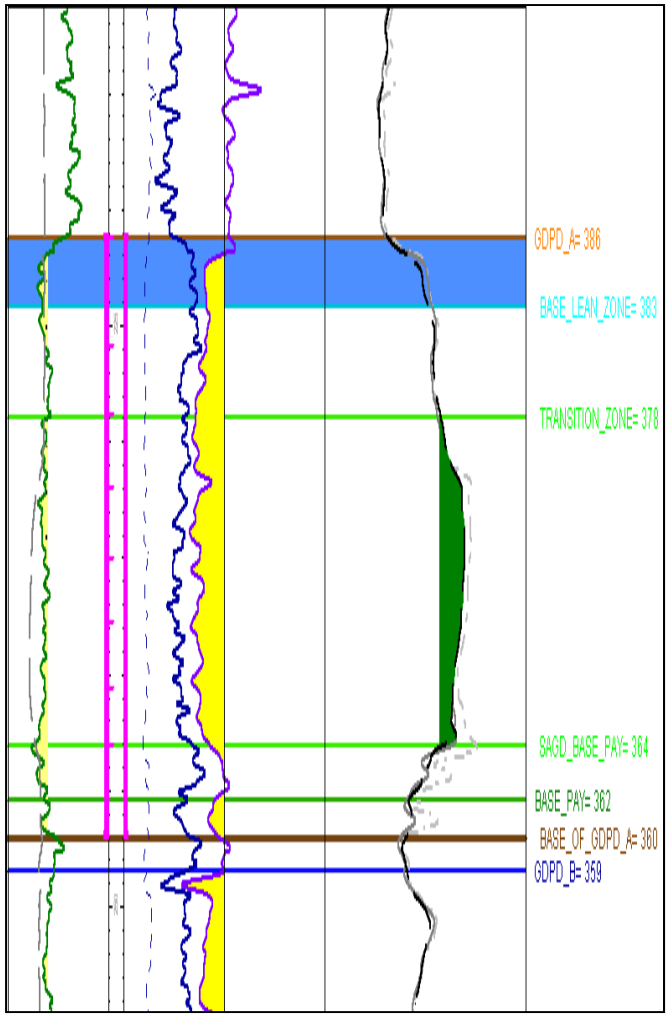


Temperature & Pressure

WP2 Equipped with 6-point thermocouple string for temperatures

Pelican Lake SAGD Pilot
Thermocouple Response 100/01-10

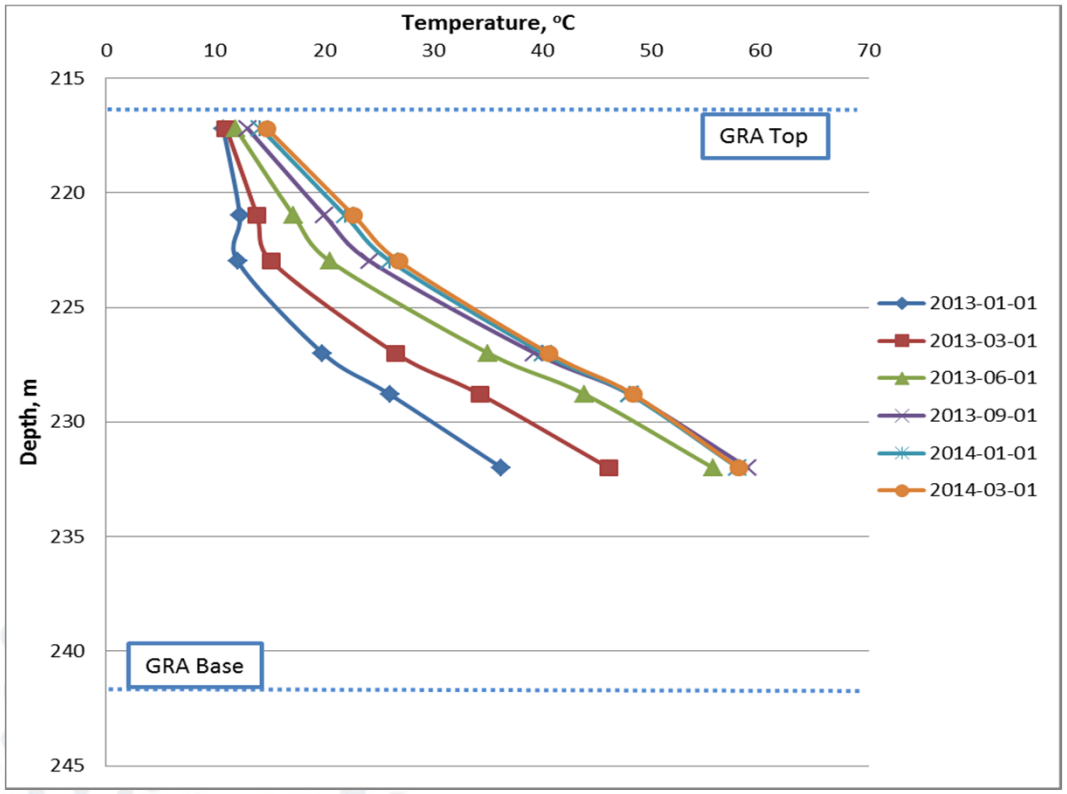


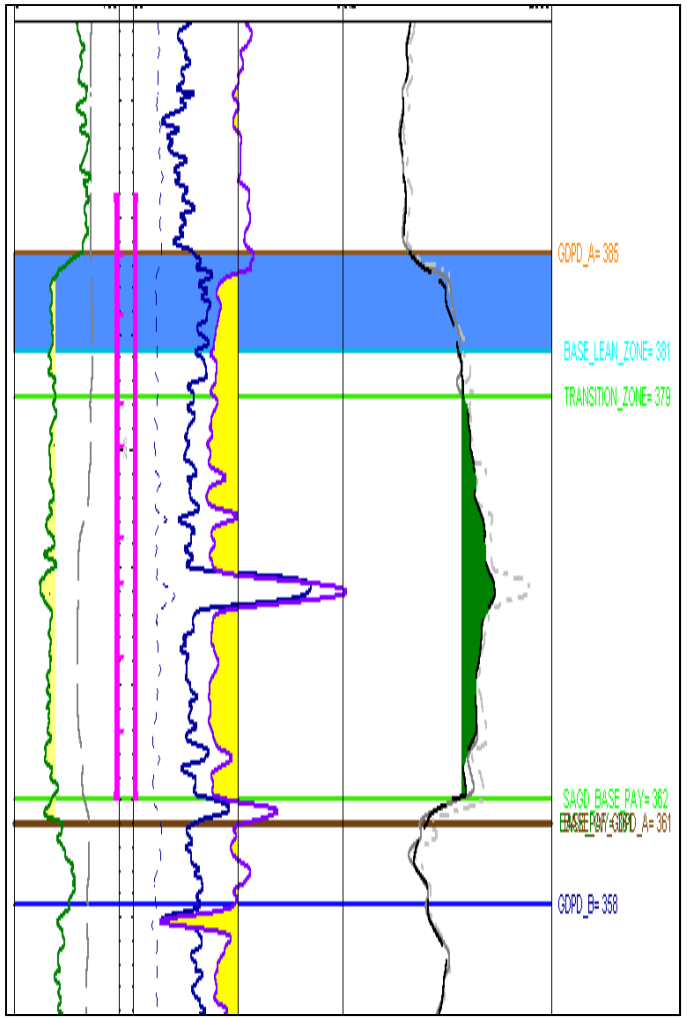


Distance from Observation well to the well pair = 12m

Subsection 3.1.1 – 7)

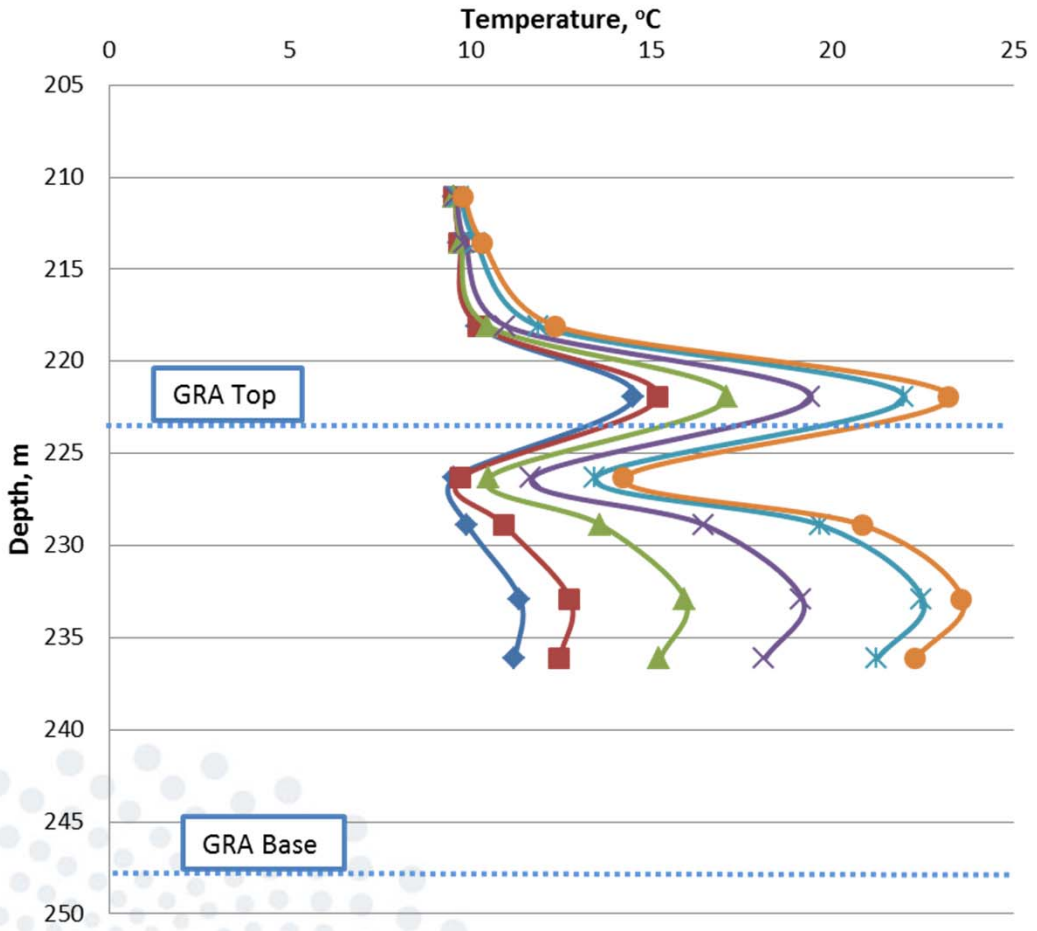
Pelican Lake SAGD Pilot
Thermocouple Response 102/16-03

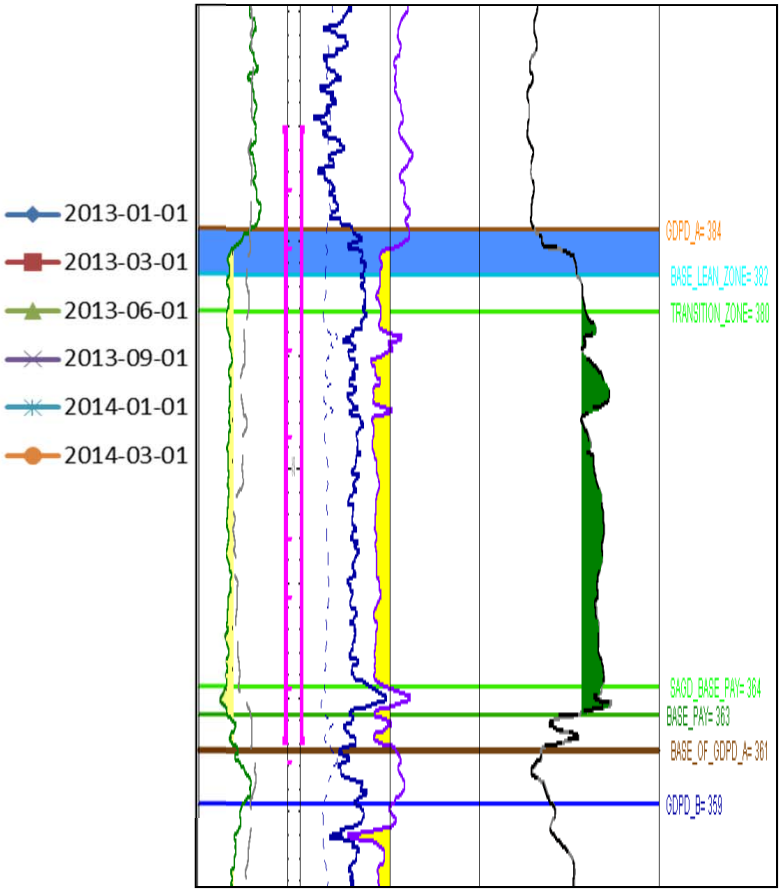




Distance from Observation well to the well pair = 2.4m

Pelican Lake SAGD Pilot
Thermocouple Response 100/09-03





- At 223m natural temperature of lean zone.

Distance from Observation well to the well pair = 9.8m

Pelican Lake WP02
March 1, 2013 – February 28, 2014 Milestones

- August 2013 - P02 HCl cleanout
- January 2014 - Installed insulated tubing in P02
- March 2014 - P02 recompletion (hole in scab liner)

Pelican Lake SAGD WP02
Key Learnings

- Circulation start-up resulted in hot spot formation at the heel of the wellpair
- High steam injection pressures combined with high drawdown failed to improve conformance. Additionally, these conditions created steam jetting resulting in a hole in both slotted and scab liner.
- Drawdowns should be maintained below 500 kPa to minimize risk of steam jetting holes in tubing
- Recompletion to install insulated tubing Jan 2014 to aid in start-up of P2 toe and improve conformance.
- Temperature limitation of Pelican Lake oil infrastructure constrained emulsion rates.

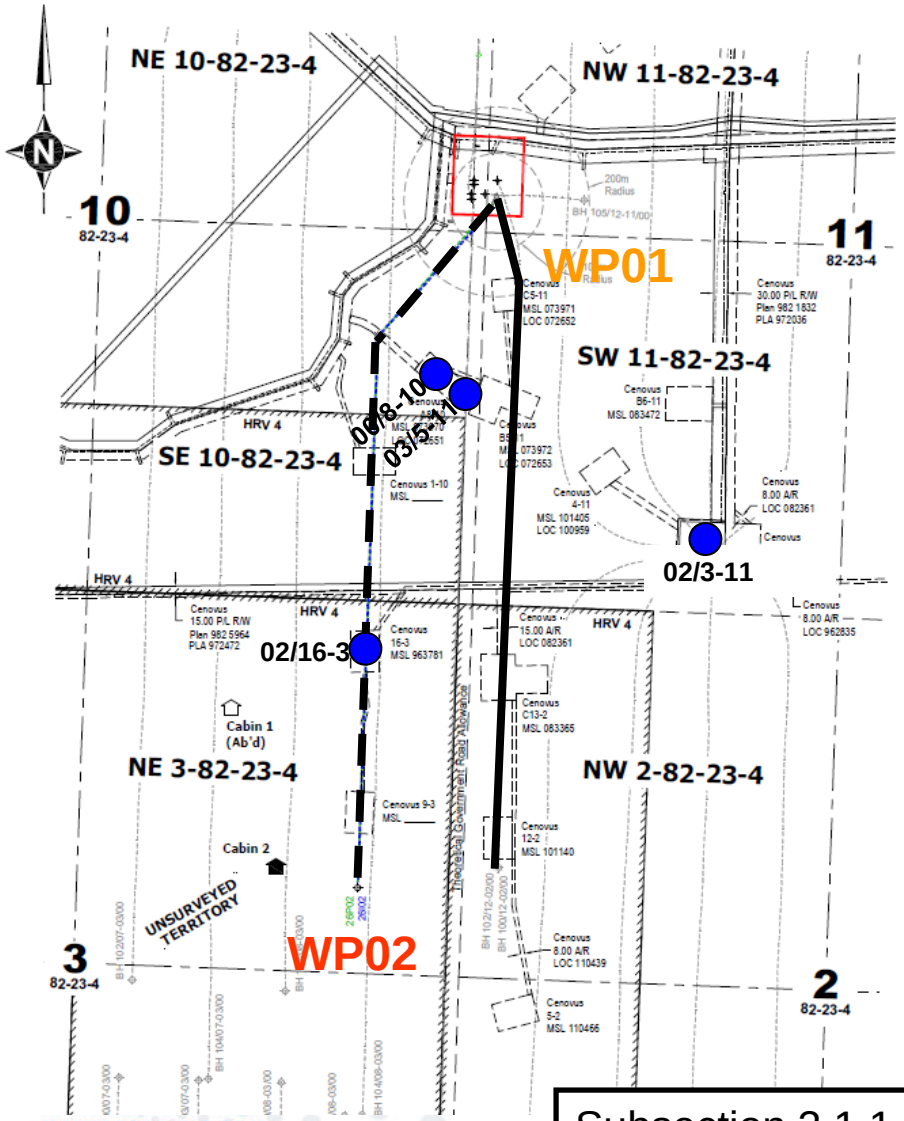
Pelican Lake SAGD Pilot
Production Summary

WP01	Cumulative	March 1, 2013 to February 28, 2014
Oil (m^3)	24,405	12,099
Water (m^3)	78,353	39,856
WOR (m^3/m^3)	2.85	3.3
Steam Injection (m^3)	128,000	48,981
SOR (m^3/m^3)	5.0	4.0
WSR (m^3/m^3)	0.62	0.82
WP02 **	**Cumulative**	**March 1, 2013 to February 28, 2014**
Oil (m^3)	6,226	5,454
Water (m^3)	33,269	19,769
WOR (m^3/m^3)	5.34	3.6
Steam Injection (m^3)	62,308	27,572
SOR (m^3/m^3)	10.0	5.0
WSR (m^3/m^3)	0.53	0.72

- Significant steam losses to lean zone to maintain pressure.
- WP01 steam injection volumes include steam injected into P01
- WP01 water doesn't includes quench

**All data current to February 28, 2014

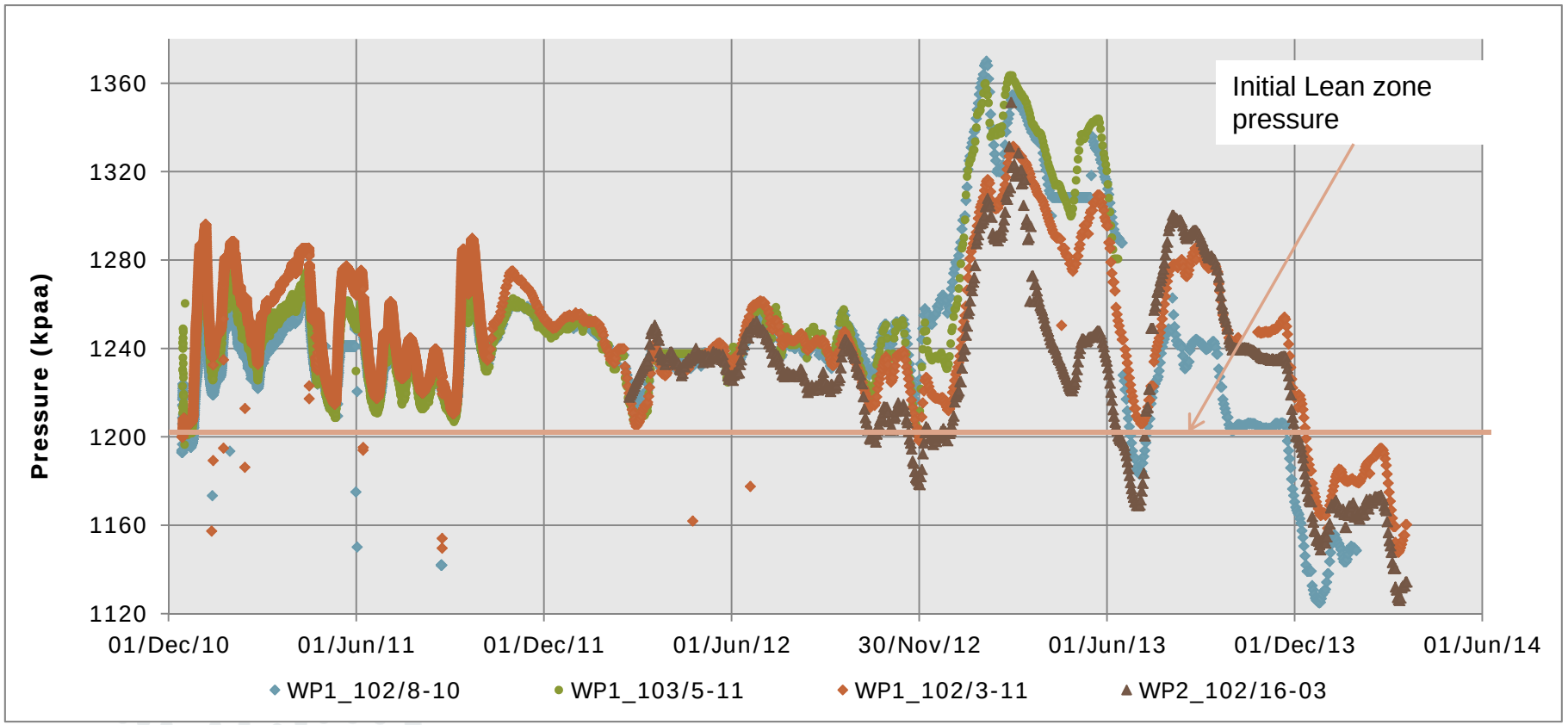
Pelican Lake SAGD Pilot
Lean Zone Observation Wells



- Lean Zone Observation Wells

Subsection 3.1.1 – 7)

Pelican Lake SAGD Pilot
Lean Zone Pressure History



•Lean zone pressure below expected reservoir pressure in 2014

Future Plans

Subsurface Subsection 8

Pelican Lake SAGD Pilot

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Pelican Lake SAGD Pilot
Future Plans

- March 2014: install ICDs in P01 to restrict hot-spot steam production
- Possible recompletions for I01 and I02 to improve conformance
- 3rd well pair being considered for 2015 to evaluate improved SAGD start-up, completion and facility integration

3.1.2 Surface Operations, Compliance and Issues Not related to Resource Evaluation and Recovery

Pelican Lake SAGD Pilot
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Pelican Lake SAGD Pilot
Surface Operations: Table of Contents

1. Facilities
2. Facilities Performance
3. Measurement and Reporting
4. Water production, injection and Uses
5. Sulphur Production
6. Environmental Issues
7. Compliance Confirmation
8. Future Plans

Facilities

Surface Subsection 1

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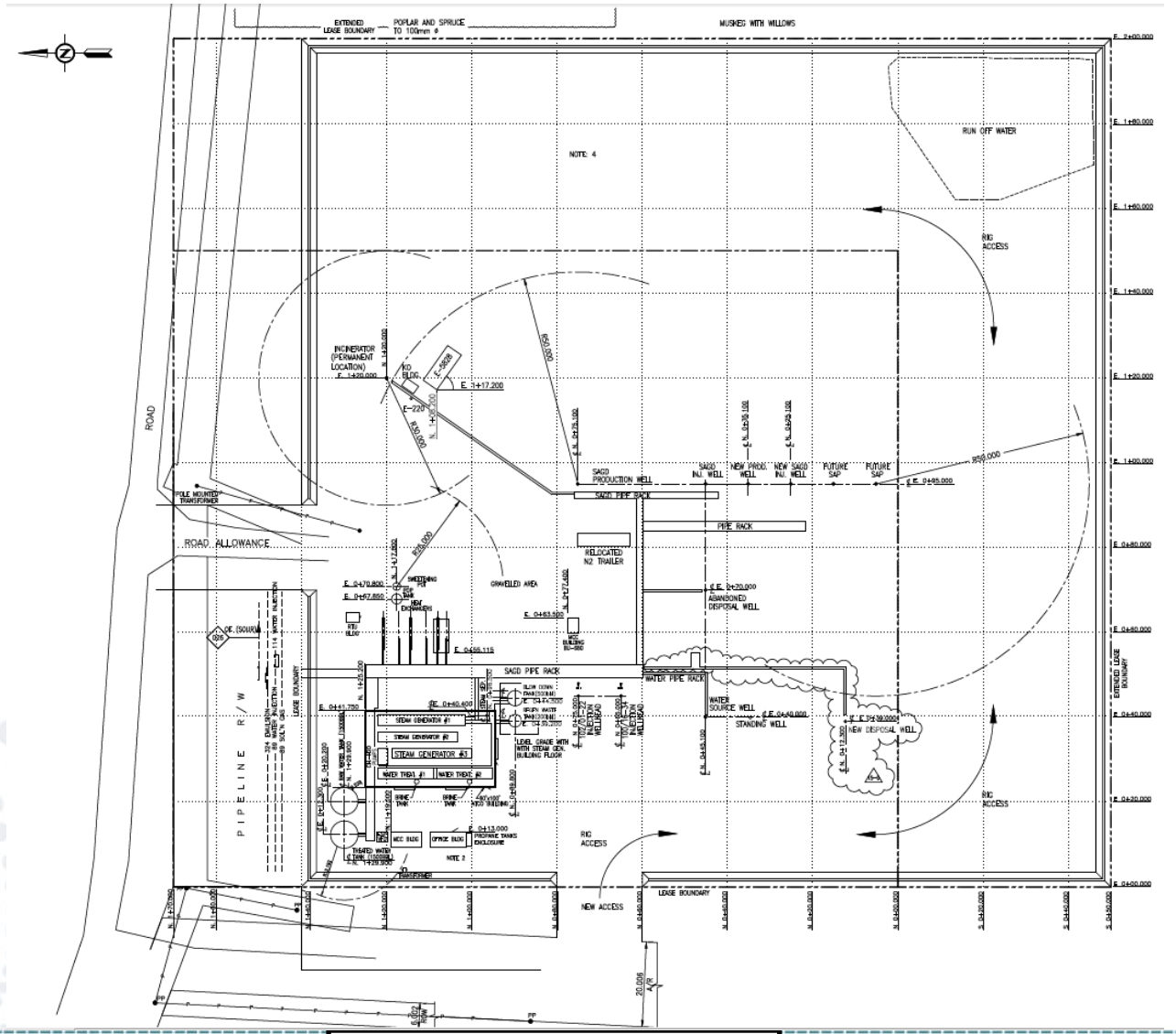
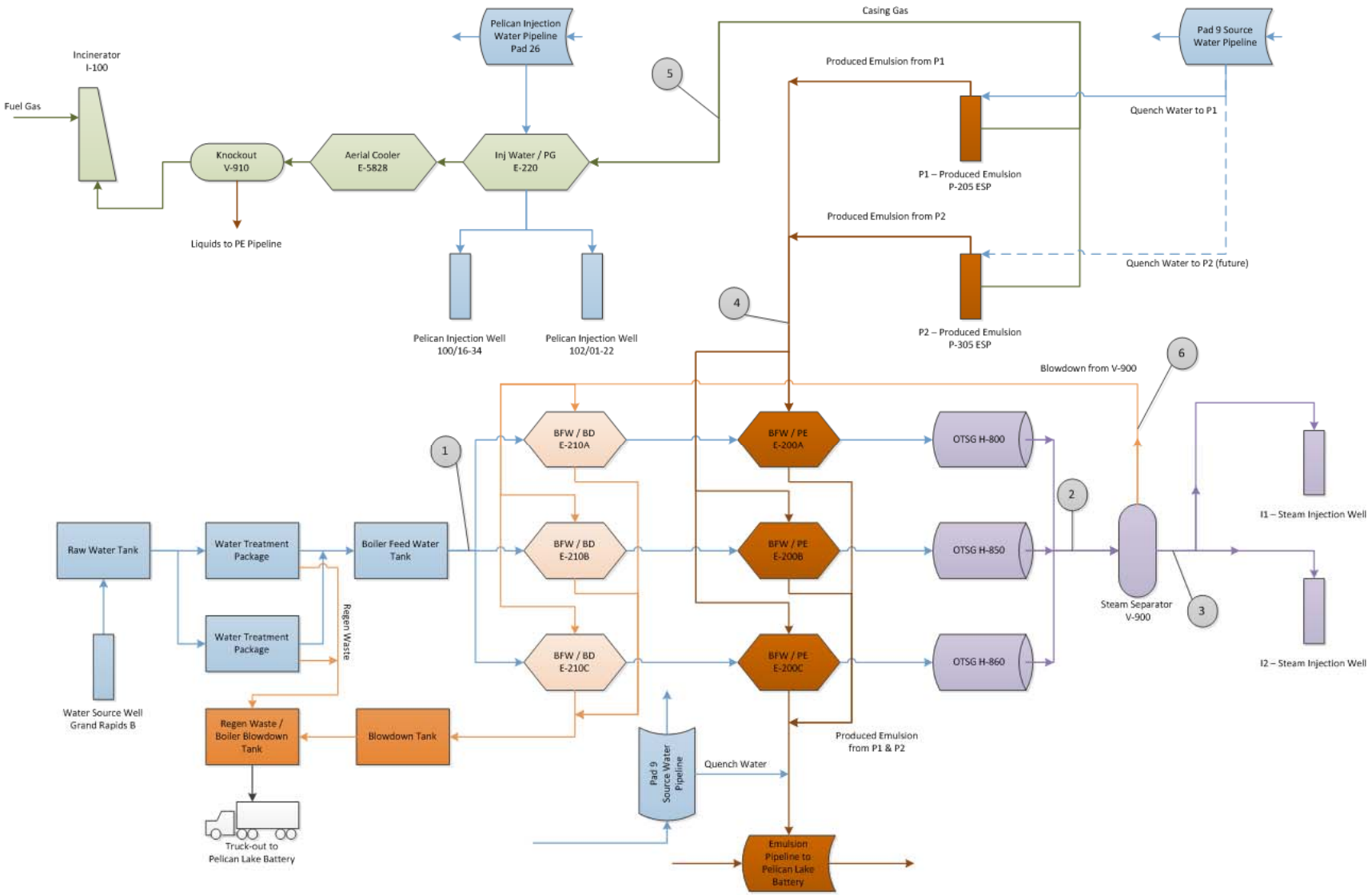
Pelican Lake SAGD Pilot – Current Site Plan



Subsection 3.1.2 – 1)

Pelican Lake SAGD Pilot Block Diagram



Pelican Lake SAGD Pilot - Facilities Modifications

- Casing gas heat exchanger installed and commissioned
- Added emulsion quench line water tie in and Pad 9 water tie in for cooling, to lift production constraints
- ESP Harmonics improved pump/motor performance (avoided shutdowns)
- Water Disposal Well/Water Source Well Tie-in
- Service change to the Heat Exchanger Shell & Tube
- Added in aerial cooler to increase cooling ability for casing gas produced prior to knockout tank
- Added building louver to allow venting, replaced emergency shutdown valve to allow gas flow to pilot (safety improvement & reduced shutdowns)
- Increased P300AB discharge line & heat traced
- Quench water to 26P01 annulus removed

Facilities Performance

Surface Subsection 2

Pelican Lake SAGD Pilot
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Pelican Lake SAGD Pilot
Plant Performance

- Emulsion pipeline to battery temperature limit
  - Limited to 55°C.
  - Wabiskaw produced water used to lower Pad 26 emulsion temperatures. Produced water temperature has increased from 20 to 40°C over the past 2 years.
  - Service change to the Heat Exchanger Shell & Tube – Reverse emulsion and BFW to test improved efficiency and aid in emulsion out pipeline cooling
  - Production from both WP01 and WP02 constraint reduced by installing pad 9 quench to emulsion line out

Measurement and Reporting

Surface Subsection 2

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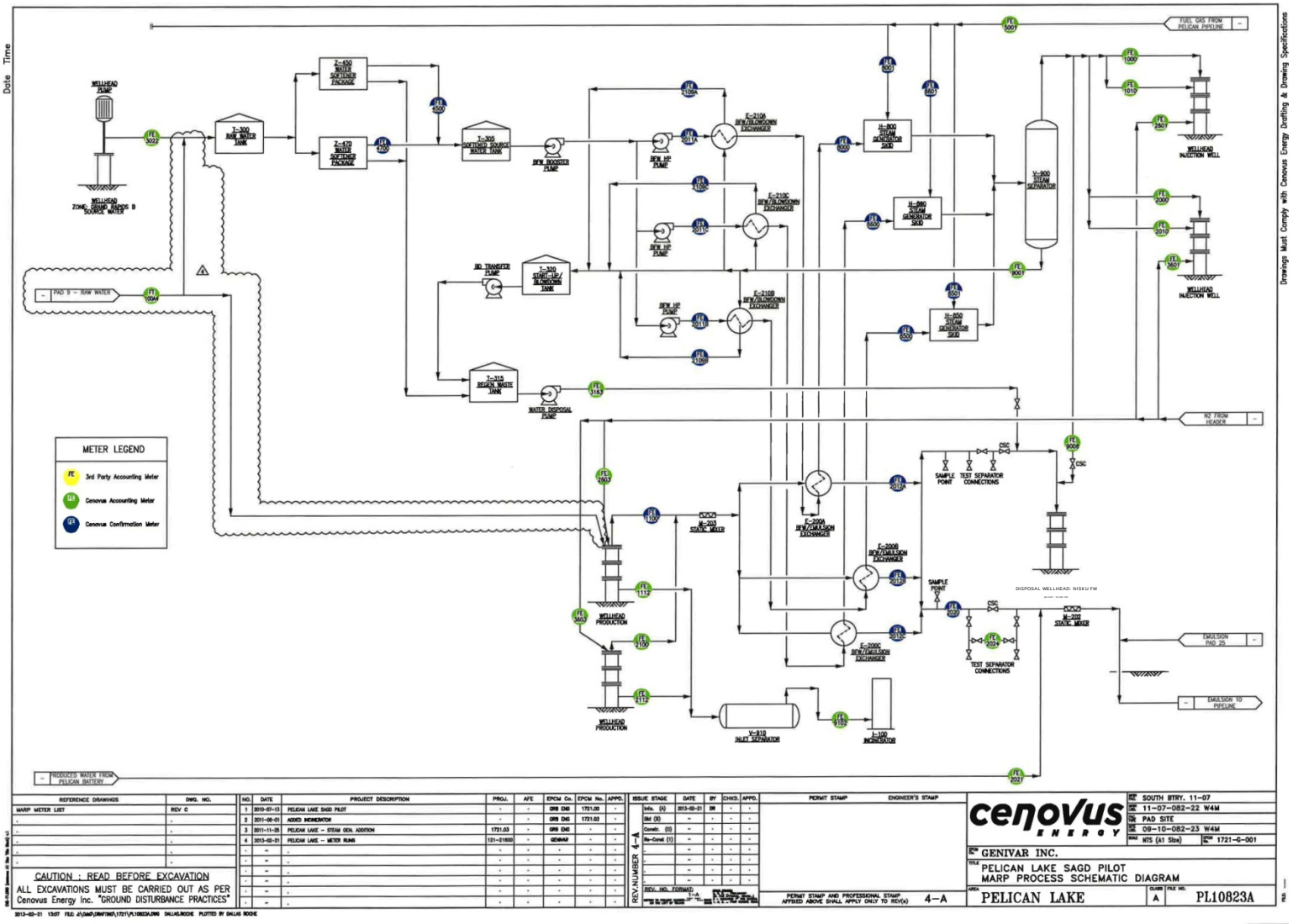
Pelican Lake SAGD Pilot
MARP

Updated MARP submitted February 28th, 2014

- 2013 Amendments
  - Updated Casing gas meter calculations to reflect current standard SAGD gas metering by using temperature and pressure from casing gas meters. The partial pressure theory is used to calculate steam and gas being produced from each well.
- Auditing MARP results

Pelican Lake SAGD Pilot
MARP Schematic



Subsection 3.1.2 – 3)

Water Production, Injection and uses

Surface Subsection 3

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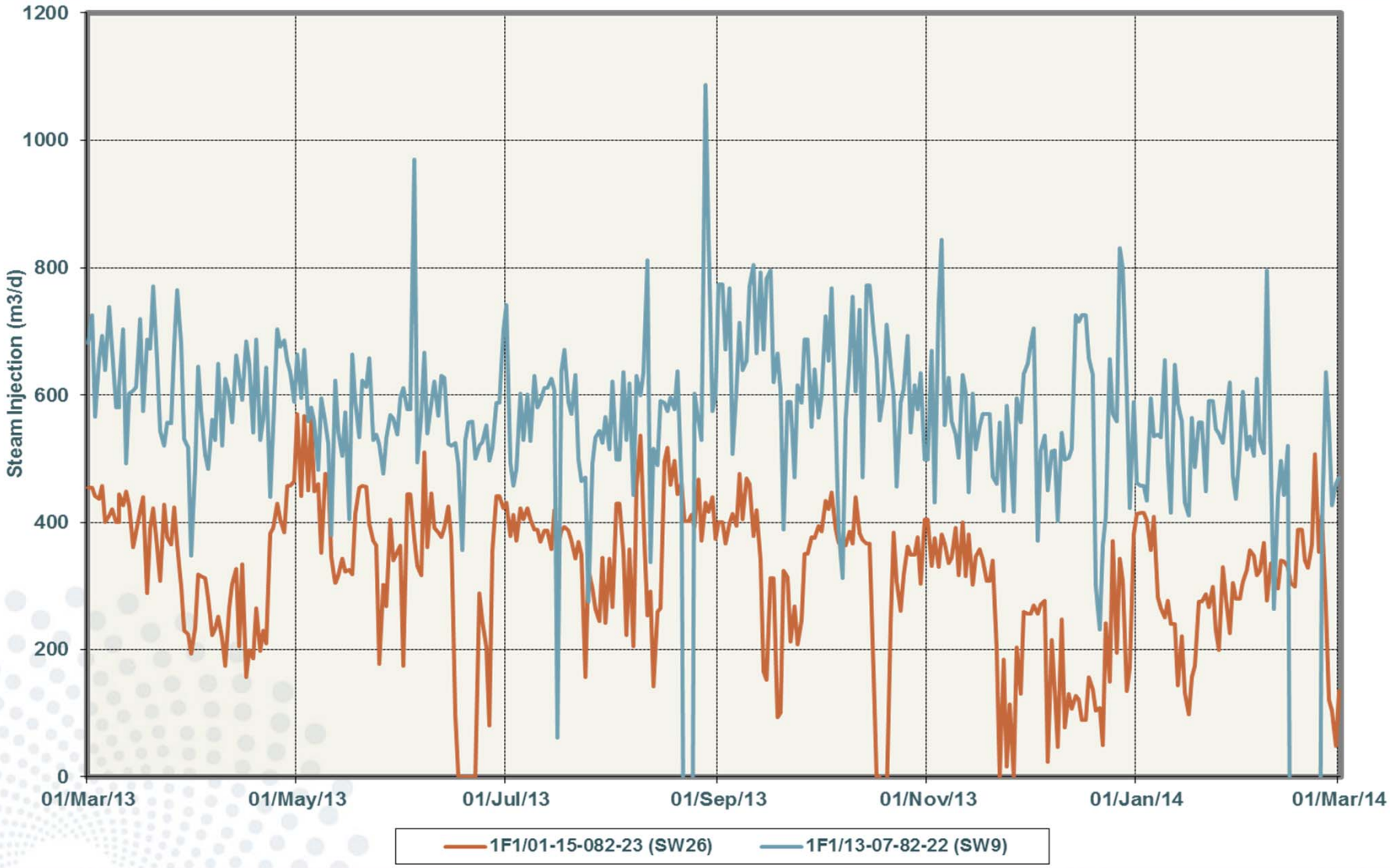
Pelican Lake SAGD Pilot
Water Source Wells

- Two source water wells
  1. 1F1/01-15-082-23W4 in the Grand Rapids ‘B’ formation
  2. 1F1/13-07-082-22W4 in the Grand Rapids ‘B’ formation

- No Brackish water wells

Pelican Lake SAGD Pilot
Source Water Well Rates



Subsection 3.1.2 – 4)

Water Treatment Technology

Surface Subsection 4

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Pelican Lake SAGD Pilot
Water Treatment Technology

- Media Filtering
- Primary Strong Acid Cation (SAC)
- Secondary SAC polisher
- Source water for brine regeneration

Water, Landfill waste and waste disposal wells

Surface Subsection 5

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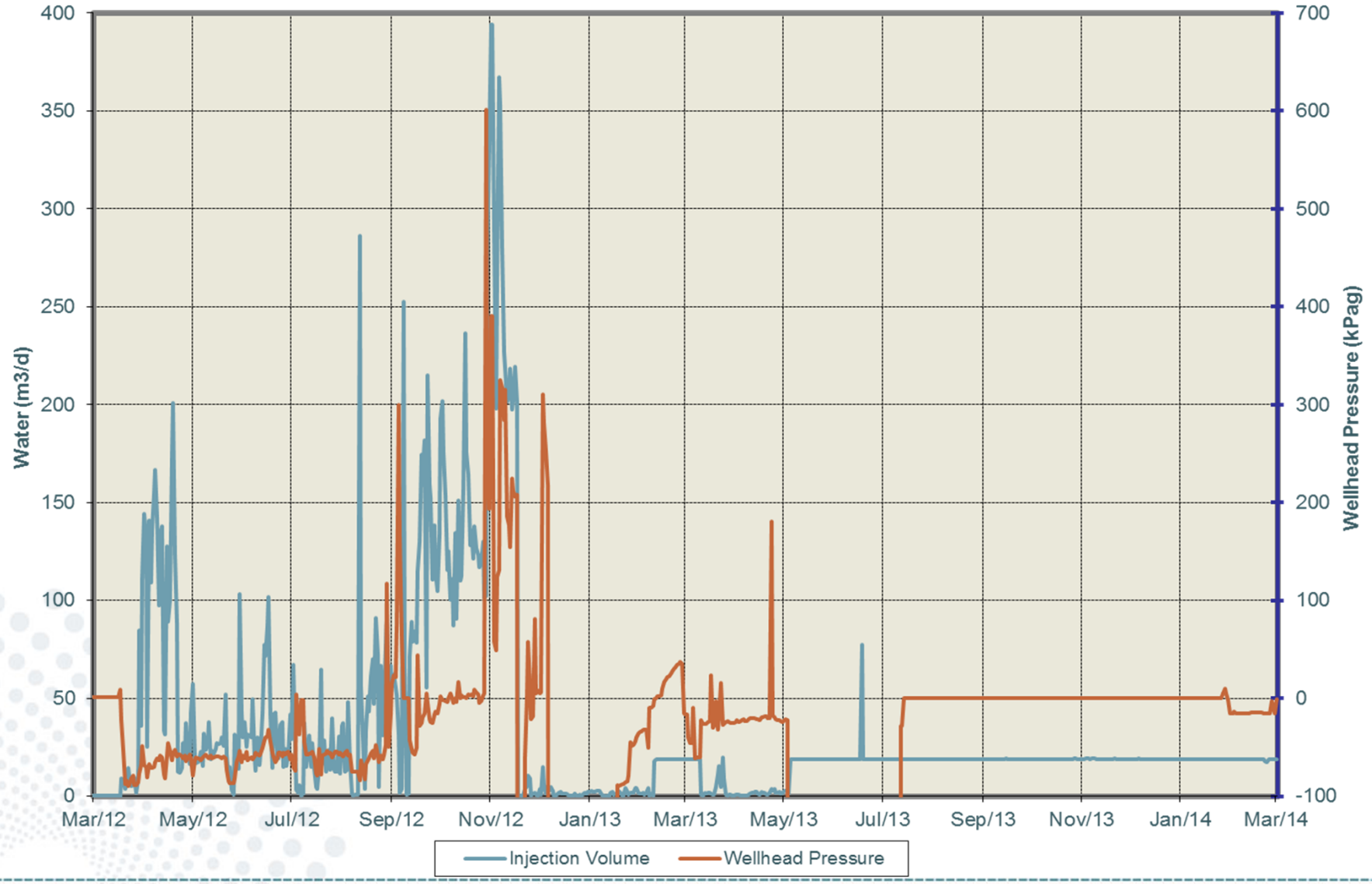
Pelican Lake SAGD Pilot
Disposal Well

- Disposal well 105/12-11-082-23W4 located at Pad 26 – Abandoned July 2013
- New Disposal well 102/9-10-82-23W4 drilled and cased to Nisku Fm, July 2013
- Fluids trucked from site during 2013 until new Disposal approval received February 26,2014

Pelican Lake SAGD Pilot
Disposal Well Rates



Sulphur Production

Surface Subsection 5

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Sulphur production

Quarterly sulphur emissions and facility monthly sulphur balance not generated due to following:

- Casing gas samples before the V-910 (knock-out drum) show 181ppm tested in late March 2013, however samples after March have shown less then 10ppm.
- Casing gas samples after V-910 have 10ppm or less.

Summary of Environmental Issues

Surface Subsection 6

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Pelican Lake SAGD Pilot
Environment Update

- November 2013:
  - Incinerator temperatures dropped below 500 ^{o}C
  - Less than 24 hours

- February 12, 2014:
  - Self-Disclosed Emulsion spill from E-200B exchanger
  - Found gate valve gasket leaking
  - 5 m3 of emulsion spilled on ground
  - 4 days to clean-up

Compliance Confirmation

Surface Subsection 7

Pelican Lake SAGD Pilot
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Pelican Lake SAGD Pilot
Compliance Confirmation

- No regulatory compliance issues

Future Plans

Surface Subsection 9

Pelican Lake SAGD Pilot
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Pelican Lake SAGD Pilot
Future Plans

2014

- New oil cut shack to be constructed and installed in 2014
  - Audit improved data analysis/ measurement

2015

- Considering 3rd wellpair will require no additional surface disturbance

Appendix

Pelican Lake SAGD Pilot
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Pelican Lake SAGD Pilot
Instrumentation In Observation Wells

Formation of Observation (Number of Wells)	Temperature only	Pressure Only	Pressure & Temperature	Sampling
Quaternary/Tertiary (3)			3	2
Viking (1)			1	1
GR"A" (11)	3	1	7	1
GR"B" (4)			4	3

19 water monitoring/observation wells for Pelican Lake SAGD Pilot

Pelican Lake SAGD Pilot
SAGD Observation Wells

WELL PAIR 1 OBSERVATION WELLS				
UWI	Temperature	Pressure	Distance to WP1 Toe (m)	Lateral Distance to WP1 (m)
102/05-11-082-23W4/00	X		1200	21.4
102/13-02-082-23W4/00	X		400	4.2
103/12-02-082-23W4/00	X		10	4.0
102/08-10-082-23W4/00		X	1200	174
103/05-11-082-23W4/00	X	X	1200	52
103/06-11-082-23W4/00	X	X	1200	374

WELL PAIR 2 OBSERVATION WELLS (Temperature and Pressure)		
UWI	Distance to WP2 Toe (m)	Lateral Distance to WP2 (m)
100/01-10-082-23W4/00	940	12.0
102/16-03-082-23W4/00	530	2.4
100/09-03-082-23W4/00	175	9.8

Pelican Lake SAGD Pilot
Groundwater Observation Wells

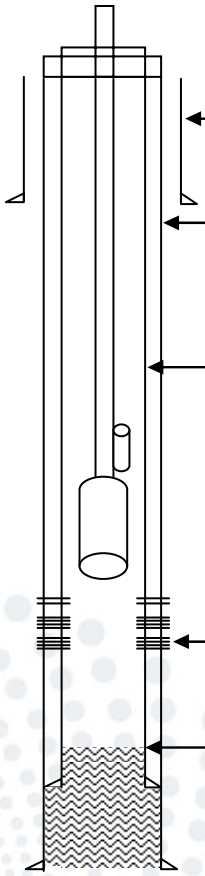
UWI	Perf. Interval TVD (m)	Zone	Lateral Difference from well pair (m)
102/03-11-082-23W4/00	228-230	GR A	408 E
103/12-11-082-23W4/00	196-198	VIKING	468 N
100/09-10-082-23W4/00	257-259 266-270 276-280	GR B	252 N
100/08-10-082-23W4/00	254-256 263-267 276-280	GR B	179 W
103/13-02-082-23W4/00	246-248 256-258 273-277	GR B	~40 E
100/04-11-082-23W4/00	253-255 263-267 277-281	GR B	~190 E
100/04-27-082-22W4/00	197-202	Tertiary	~9825 NE to the toe
100/16-03-82-23W4/00	NA	GR A	2.4 W
1F2/13-07-082-22W4/00	140.7 – 183.0	Quat/Tert	~3940 NE to the toe
16-07-082-22W4	112.2 – 116.7	Quat	~4890 NE to the toe

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

ECA ECOG A8 BRINT 8-10-82-23

100/08-10-082-23W4 LSD 8-10-82-23W4M

KB= 607.7 mKB
GRD= 603.9 mKB
PBTD = 326.9 mKB



Conductor:
Landed at 20 m KB / 244.5mm

Intermediate Casing:
139.7 mm , 25.30 kg/m , K-55
Landed at 342.5 mKB
Cemented to surface with Thermal Cement 2.0m3 of returns

Secondary Intermediate Casing:
88.9 mm , 13.84 kg/m , J-55
Landed at 327.26 mKB
Cemented to surface with Thermal Cement 6.1m3 of returns

Tubing String:
31.8mm, 1.697kg/m, Galvonized Steel
Landed at 193.21mKB
ESP Pump - 193.21-194.21mKB (Pressure/Temperature sensor for fluid level calculation @ 193.75mKB)

Perforations:
254-256mKB
263-267 mKB
276-280 mKB

PBTD Cement Top in Secondary Intermediate Casing @ 326.9 mKB

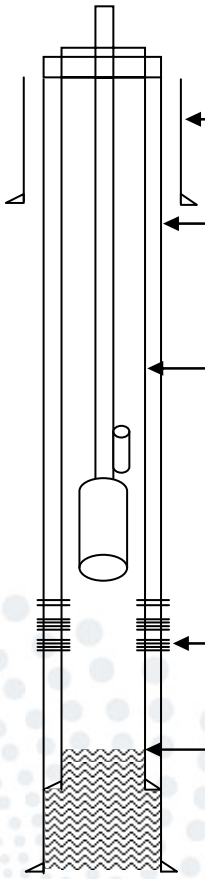
Intended Purpose:
Pressure (Fluid Level), Temperature, Water quality monitoring of Grand Rapids B aquifer

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

ECA ECOG A9 BRINT 9-10-82-23

100/09-10-082-23W4 LSD 9-10-82-23W4M

KB= 608.9 mKB
GRD= 605.1 mKB
PBTD = 308.4 mKB



Conductor:
Landed at 20 m KB / 244.5mm

Intermediate Casing:
139.7 mm , 25.30 kg/m , K-55
Landed at 337.0 mKB
Cemented to surface with Thermal Cement 2.0m3 of returns

Secondary Intermediate Casing:
88.9 mm , 13.84 kg/m , J-55
Landed at 321.30 mKB
Cemented to surface with Thermal Cement 2.0m3 of returns

Tubing String:
31.8mm, 1.697kg/m, Galvonized Steel
Landed at 193.21mKB
ESP Pump - 193.21-196.78mKB (Pressure/Temperature sensor for fluid level calculation @ 196.32mKB)

Perforations:
257-259mKB
266-270 mKB
276-280 mKB

PBTD Cement Top in Secondary Intermediate Casing @ 308.4 mKB

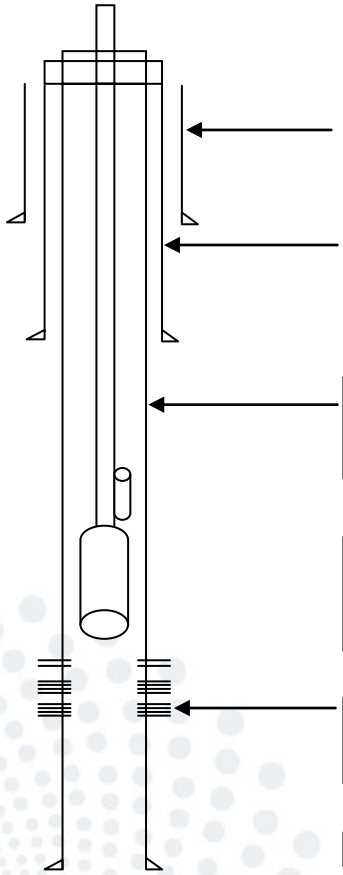
Intended Purpose:
Pressure (Fluid Level), Temperature, Water quality monitoring of Grand Rapids B aquifer

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

CVE BRINT 4-11-82-23

100/04-11-082-23W4 LSD 4-11-82-23W4M

KB= 608.5 mKB
GRD= 604.3 mKB
PBTD = 336.0 mKB



Conductor:

Landed at 20 m KB / 406.4mm

Surface Casing:

177.8 mm , 25.30 kg/m , H-40
Landed at 99.5 mKB
Cemented to surface with Thermal Cement 1.0m3 of returns

Intermediate Casing:

114.3 mm , 17.26 kg/m , L-80
Landed at 335.9 mKB
Cemented to surface with Thermal Cement 4.0m3 of returns

Tubing String:

31.8mm, 1.697kg/m, Galvonized Steel
Landed at 194.35mKB
ESP Pump - 194.35 - 195.35mKB (Pressure/Temperature sensor for fluid level calculation @ 193.89mKB)

Perforations:

253-255 mKB
263-267 mKB
277-281 mKB

Intended Purpose:

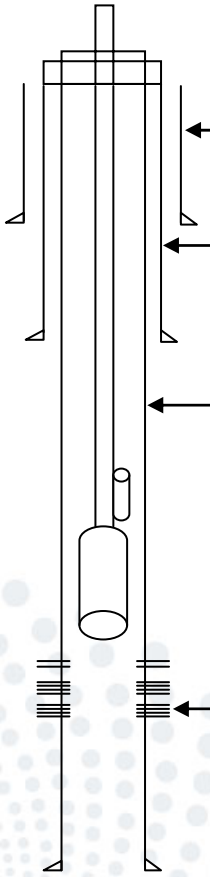
Pressure (Fluid Level), Temperature, Water quality monitoring of Grand Rapids B aquifer

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

CVE 2C13 BRINT 13-2-82-23

103/13-02-082-23W4 LSD 13-2-82-23W4M

KB=	601.2 mKB
GRD=	596.9 mKB
PBTD =	328.0 mKB



Conductor:

Landed at 20 m KB / 406.4mm

Surface Casing:

177.8 mm , 25.30 kg/m , H-40
Landed at 86.25 mKB
Cemented to surface with Thermal Cement 1.5m3 of returns

Intermediate Casing:

114.3 mm , 17.26 kg/m , L-80
Landed at 328.0 mKB
Cemented to surface with Thermal Cement 4.0m3 of returns

Tubing String:

31.8mm, 1.697kg/m, Galvonized Steel
Landed at 194.05mKB
ESP Pump - 194.05 - 195.05mKB (Pressure/Temperature sensor for fluid level calculation @ 193.77mKB)

Perforations:

246-248 mKB
256-258 mKB
273-277 mKB

Intended Purpose:

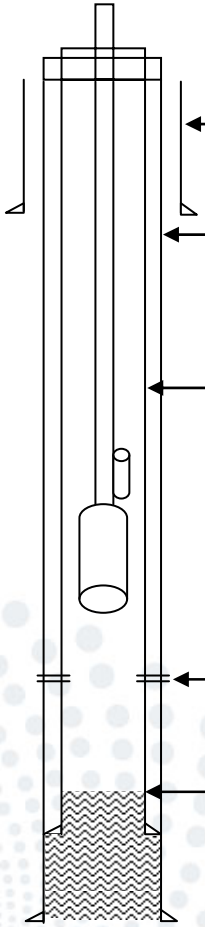
Pressure (Fluid Level), Temperature, Water quality monitoring of Grand Rapids B aquifer

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

ECA ECOG B3 BRINT 3-11-82-23

102/03-11-082-23W4 LSD 3-11-82-23W4M

KB= 611.7 mKB
GRD= 607.9 mKB
PBTD = 326.0 mKB



Conductor:

Landed at 20 m KB / 244.5mm

Intermediate Casing:

139.7 mm , 25.30 kg/m , K-55
Landed at 345.0 mKB
Cemented to surface with Thermal Cement 2.0m3 of returns

Secondary Intermediate Casing:

88.9 mm , 13.84 kg/m , J-55
Landed at 329.66 mKB
Cemented to surface with Thermal Cement 2.0m3 of returns

Tubing String:

31.8mm, 1.697kg/m, Galvonized Steel
Landed at 149.1mKB
ESP Pump - 149.1-150.0mKB (Pressure/Temperature sensor for fluid level calculation @ 149.5mKB)

Perforations:

228-230mKB

PBTD Cement Top in Secondary Intermediate Casing @ 326.0 mKB

Intended Purpose:

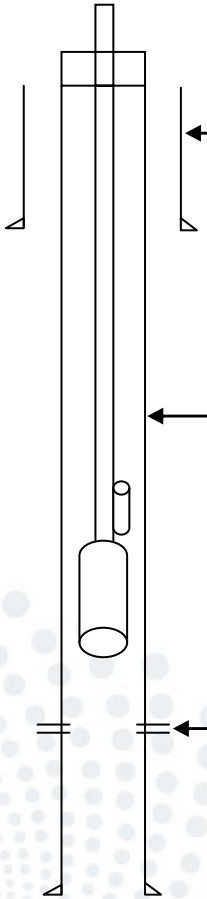
Pressure (Fluid Level), Temperature, Water quality monitoring of Grand Rapids A aquifer

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

CVE C12 BRINT 12-11-82-23

103/12-11-082-23W4 LSD 12-11-82-23W4M

KB= 606.3 mKB
GRD= 602.3 mKB
PBTD = 335.0 mKB



Conductor:

Landed at 22 m KB / 244.5mm

Intermediate Casing:

114.3 mm , 17.26 kg/m , L-80
Landed at 335.0 mKB
Cemented to surface with Thermal Cement 2.0m3 of returns

Tubing String:

31.8mm, 1.697kg/m, Galvonized Steel
Landed at 150.0mKB
ESP Pump - 150.0 - 151.0mKB (Pressure/Temperature sensor for fluid level calculation @ 150.4mKB)

Perforations:

196-198 mKB

Intended Purpose:

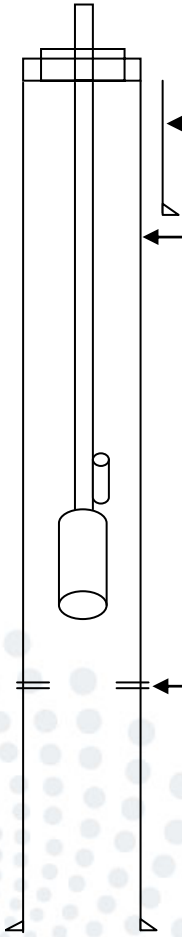
Pressure (Fluid Level), Temperature, Water quality monitoring of Viking aquifer

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

ECA ECOG B3 BRINT 4-27-82-22

100/04-27-082-22W4 LSD 4-27-82-22W4M

KB=	627.00 mKB
GRD=	622.9 mKB
TD =	341.0 mKB



Surface Casing:

177.8 mm , 25.30 kg/m , H-40
Landed at 166.0 mKB

Intermediate Casing:

114.3 mm , 22,471 kg/m , L-80
Landed at 341.0 mKB
Cemented to surface with Thermal Cement 2.0m3 of returns

Tubing String:

33.4mm, 2.53kg/m, C-75 Galvonized Steel
Landed at 172.5mKB
ESP Pump - 173.5mKB (Pressure/Temperature sensor for fluid level calculation @ 172.5mKB)

Perforations:

197.0-202.0 mKB

Intended Purpose:

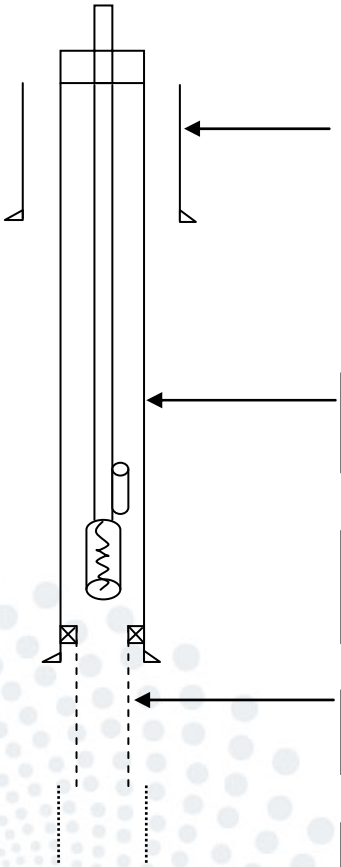
Pressure (Fluid Level), Temperature, Water quality monitoring of Tertiary aquifer

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

CVE WS2 BRINT 13-7-82-22

1F2/13-07-082-22W4 LSD 13-7-82-22W4M

KB= 623.9 mKB
GRD= 620.4 mKB
PBTD = 191.0 mKB



Conductor:

Landed at 20 m KB / 406.4mm

Intermediate Casing:

219.1 mm , 35.72 kg/m , J-55
Landed at 152.0mKB
Cemented to surface with Thermal Cement 2.0m3 of returns

Tubing String:

88.9mm, 13.84kg/m, J-55
Landed at 140.0mKB
PCP landed @ 126.4mKB (Pressure/Temperature sensor for fluid level calculation @ 97.0mKB)

Liner:

139.7mm, 29.48kg/m, J-55
0.381mm slot size (15 thou)
Set depth 140.69 - 183 mKB (open hole from 183 - 191 mKB)

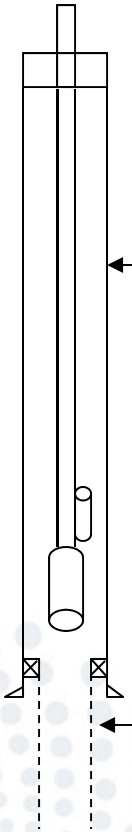
Intended Purpose:

Pressure (Fluid Level), Temperature, Water quality monitoring of Quaternary/Tertiary aquifer (well pumping consistantly as it provides fresh water for current Wabiskaw polymer flood in the area)

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

2003 Camp Water Supply Well No. 16-07

NE-07-082-22W4 LSD 16-7-82-22W4M



PBTD = 117.0 mKB

Intermediate Casing:

152.4 mm, Plastic (PVC)
Landed at 112.2mKB
Bentonite Chips/Tablets to 106.68mKB

Tubing String:

31.75mm, Plastic (PVC)
Landed at 140.0mKB
ESP landed @ 100.6mKB (Pressure/Temperature sensor for fluid level calculation @ 95.0mKB)

Liner:

152.4mm, Stainless Steel
0.381mm slot size (15 thou)
Set depth 112.2 - 116.7mKB

Intended Purpose:

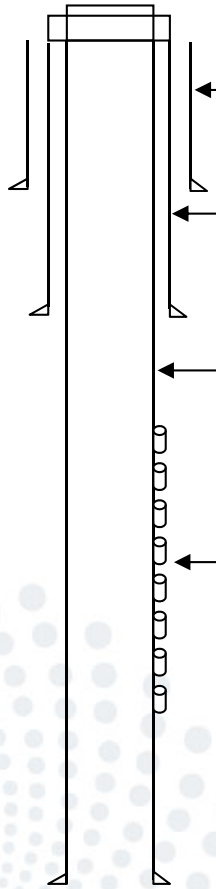
Pressure (Fluid Level), Temperature, Water quality monitoring of Quaternary aquifer (well pumping consistantly as it provides fresh water Pelican Lake Camp)

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

CVE BRINT 8-10-82-23

102/08-10-082-23W4 LSD 8-10-82-23W4M

KB= 607.8 mKB
GRD= 603.6 mKB
PBTD = 334.0 mKB



Conductor:

Landed at 22 m KB / 406.4mm

Surface Casing:

219.1 mm , 35.72 kg/m , J-55
Landed at 69.5 mKB
Cemented to surface with Thermal Cement 2.0m3 of returns

Intermediate Casing:

114.3 mm , 17.26 kg/m , L-80
Landed at 333.85 mKB
Cemented to surface with Thermal Cement 4.5m3 of returns

Sensors:

8 Piezometers Cemented to Casing
Pressure/Temperature Sensor Set Depths:
225.0 mKB
228.2 mKB
231.3 mKB
234.4 mKB(Pressure sensor failed)
237.6 mKB(Pressure sensor failed)
240.7 mKB
243.8 mKB
247.0 mKB

Intended Purpose:

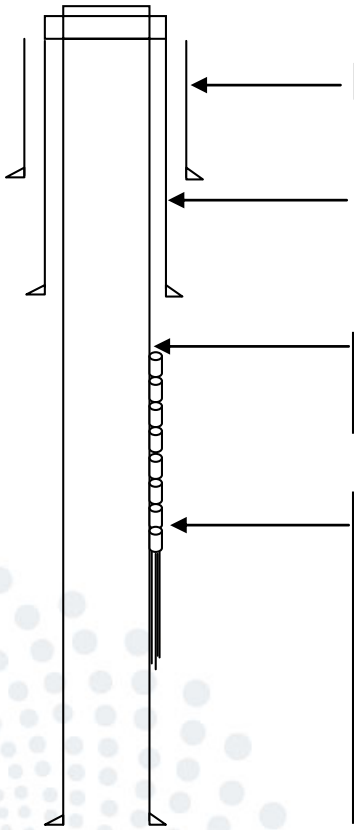
Pressure and Temperature through Grand Rapids A steam chamber

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

CVE 2B BRINT 5-11-82-23

103/05-11-082-23W4 LSD 5-11-82-23W4M

KB= 606.4 mKB
GRD= 602.4 mKB
PBTD = 333.0 mKB



Conductor:

Landed at 20 mKB / 406.4mm

Surface Casing:

219.1 mm , 35.72 kg/m , J-55
Landed at 98.70 mKB
Cemented to surface with Thermal Cement 3.0m3 of returns

Intermediate Casing:

114.3 mm , 17.26 kg/m , L-80
Landed at 332.15 mKB
Cemented to surface with Thermal Cement 4.0m3 of returns

Sensors:

8 Piezometers (Pressure) Cemented to Casing

Pressure Measurement Depths:
224.0 mKB(Pressure sensor failed)
227.1 mKB(Pressure sensor failed)
230.3 mKB
233.4 mKB
236.6 mKB
239.7 mKB
242.9 mKB
246.0 mKB(Pressure sensor failed)

Intended Purpose:

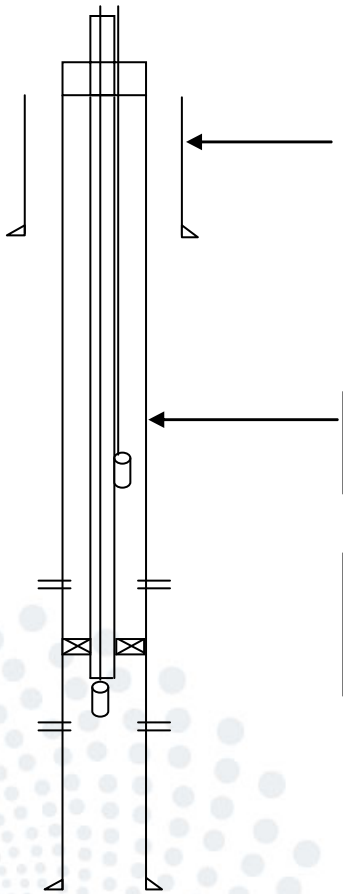
Pressure and Temperature through Grand Rapids A steam chamber

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

CVE B6 BRINT 6-11-82-23

103/06-11-082-23W4 LSD 6-11-82-23W4M

KB= 611.3 mKB
GRD= 607.3 mKB
PBTD = 339.5 mKB



Conductor:

Landed at 25 m KB / 244.5mm

Intermediate Casing:

177.8 mm , 38.69 kg/m , L-80
Landed at 339.5 mKB
Cemented to surface with Thermal Cement 2.0m3 of returns

Tubing String:

73.0 mm, 9.67kg/m, J-55
Landed at 241.92mKB
Packer to isolate zones landed at 236.49mKB
Pressure/Temperature Sensor banded to tubing at 208.2mKB (above packer)
Pressure/Temperature Sensor deployed through tubing landed at 241.6mKB (below packer)

Perforations:

228-230 mKB
244-246 mKB

Intended Purpose:

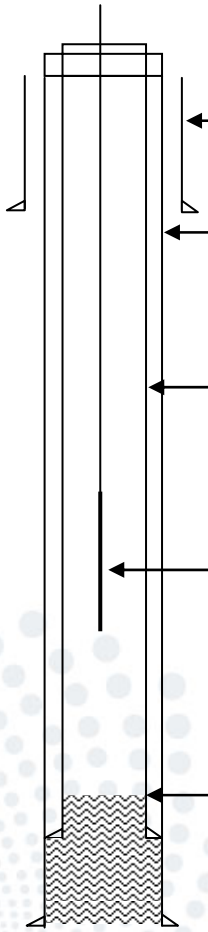
Pressure (Fluid Level) and Temperature monitoring of Grand Rapids A zone

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

ECA ECOG B5 BRINT 5-11-82-23

102/05-11-082-23W4 LSD 5-11-82-23W4M

KB= 606.9 mKB
GRD= 603.1 mKB
PBTD = 312.7 mKB



Conductor:
Landed at 20 mKB / 244.5mm

Intermediate Casing:
139.7 mm , 25.30 kg/m , K-55
Landed at 339.5 mKB
Cemented to surface with Thermal Cement 2.0m3 of returns

Secondary Intermediate Casing:
88.9 mm , 13.84 kg/m , J-55
Landed at 317.9 mKB
Cemented to surface with Thermal Cement 1.5m3 of returns

Thermocouple String:
WIKA 20 Point Thermocouple
Landed 214.0 - 252.0 mKB
Each Thermocouple is 2 m apart along the landing depth length

PBTD Cement Top in Secondary Intermediate Casing @ 312.7 mKB

Intended Purpose:
Temperature monitoring of Grand Rapids A steam chamber

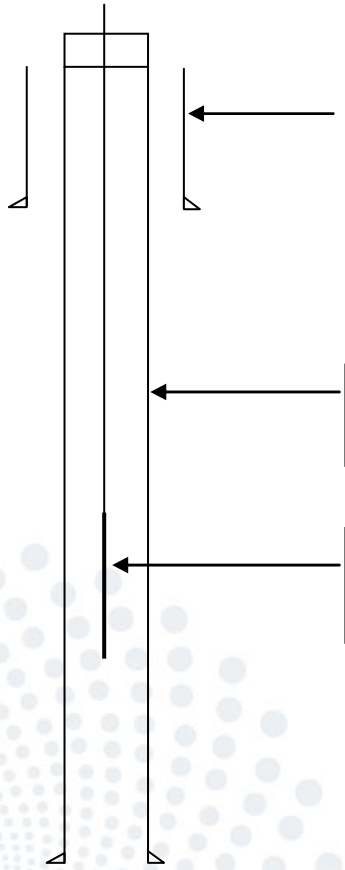
- **Note**: Thermocouples failed August 2013 to February 2014

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

ECA ECOG C13 BRINT 13-2-82-23

102/13-02-082-23W4 LSD 13-2-82-23W4M

KB= 601.0 mKB
GRD= 596.9 mKB
PBTD = 328.0 mKB



Conductor:

Landed at 23 mKB / 244.5mm

Intermediate Casing:

177.8 mm , 38.69 kg/m , L-80
Landed at 328.0 mKB
Cemented to surface with Thermal Cement 2.0m3 of returns

Thermocouple String:

WIKA 20 Point Thermocouple
Landed 209.0 - 247.0 mKB
Each Thermocouple is 2 m apart along the landing depth length

Intended Purpose:

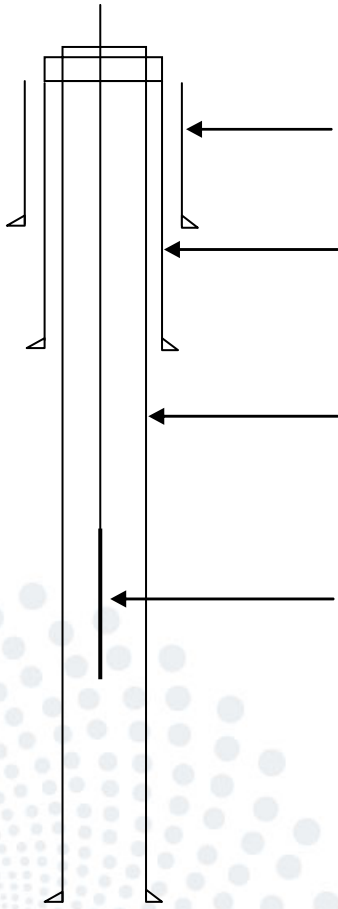
Temperature monitoring of Grand Rapids A steam chamber

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

CVE BRINTNELL 12-2-82-23

103/12-02-082-23W4 LSD 12-2-82-23W4M

KB= 599.9 mKB
GRD= 595.7 mKB
PBTD = 325.0 mKB



Conductor:

Landed at 24.2 m KB / 406.4mm

Surface Casing:

177.8 mm , 25.30 kg/m , H-40
Landed at 86.25 mKB
Cemented to surface with Thermal Cement 2.0m3 of returns

Intermediate Casing:

114.3 mm , 17.26 kg/m , L-80
Landed at 324.0 mKB
Cemented to surface with Thermal Cement 1.0m3 of returns

Thermocouple String:

WIKA 20 Point Thermocouple
Landed 209.0 - 247.0 mKB
Each Thermocouple is 2 m apart along the landing depth length

Intended Purpose:

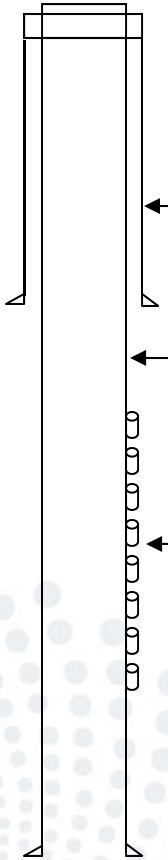
Temperature monitoring of Grand Rapids A steam chamber

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

CVE BRINT 1-10-82-23

100/01-10-082-23W4 LSD 1-10-82-23W4M

KB= 607.1 mKB
GRD= 603.0 mKB
PBTD = 334.0 mKB



Surface Casing:

219.1 mm , 35.72 kg/m , J-55
Landed at 117 mKB
Cemented to surface with Thermal Cement 4.0m3 of returns

Intermediate Casing:

114.3 mm , 17.26 kg/m , L-80
Landed at 334 mKB
Cemented to surface with Thermal Cement 3.0m3 of returns

Sensors:

8 Piezometers Cemented to Casing
Pressure/Temperature Sensor Set Depths:
221.1.0 mKB
225.8 mKB
228.8 mKB
231.9 mKB
235.0 mKB
237.7 mKB
240.5 mKB
243.0 mKB

Intended Purpose:

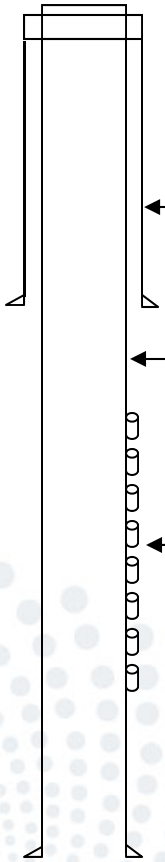
Pressure and Temperature through Grand Rapids A steam chamber

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

CVE BRINT 16-3-82-23

102/16-03-082-23W4 LSD 16-3-82-23W4M

KB= 602.0 mKB
GRD= 597.9 mKB
PBTD = 329.0 mKB



Surface Casing:

219.1 mm , 35.72 kg/m , J-55
Landed at 117 mKB
Cemented to surface with Thermal Cement 3.0m3 of returns

Intermediate Casing:

114.3 mm , 17.26 kg/m , L-80
Landed at 329.0 mKB
Cemented to surface with Thermal Cement 3.0m3 of returns

Sensors:

8 Piezometers Cemented to Casing
Pressure/Temperature Sensor Set Depths:
214.6 mKB
217.2 mKB
221.0 mKB
223.0 mKB
227.0 mKB
228.8 mKB
232.0 mKB
235.2 mKB

Intended Purpose:

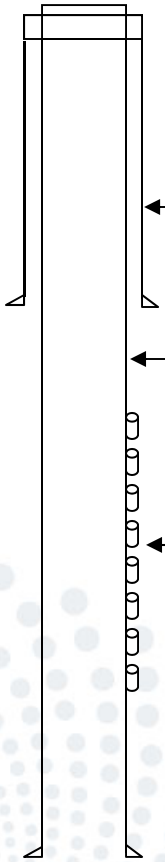
Pressure and Temperature through Grand Rapids A steam chamber

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

CVE BRINT 9-3-82-23

100/09-03-082-23W4 LSD 9-3-82-23W4M

KB= 598.5 mKB
GRD= 594.4 mKB
PBTD = 325.0 mKB



Surface Casing:

219.1 mm , 35.72 kg/m , J-55
Landed at 119.0 mKB
Cemented to surface with Thermal Cement 3.0m3 of returns

Intermediate Casing:

114.3 mm , 17.26 kg/m , L-80
Landed at 325.0 mKB
Cemented to surface with Thermal Cement 3.0m3 of returns

Sensors:

8 Piezometers Cemented to Casing
Pressure/Temperature Sensor Set Depths:
211.1 mKB
213.6 mKB
218.1 mKB
221.9 mKB
226.3 mKB
228.9 mKB
232.9 mKB
236.1 mKB

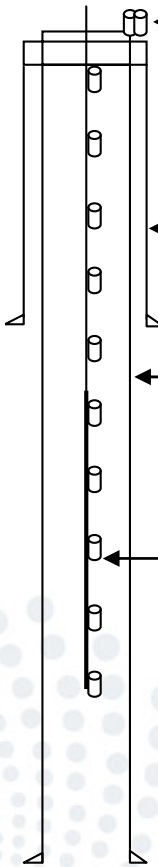
Intended Purpose:

Pressure and Temperature through Grand Rapids A steam chamber

Appendix: Pelican Lake SAGD Pilot Observation Wellbore Schematic

CVE BRINT 16-3-82-23

100/16-03-082-23W4 LSD 16-3-82-23W4M



Real Time Pressure & Temperature gauge at Wellhead

KB= 602.0 mKB
GRD= 598.1 mKB
PBTD = 432.2 mKB

Surface Casing:

219.1 mm , 35.72 kg/m , J-55
Landed at 105 mKB
Cemented to surface with Thermal Cement

Intermediate Casing:

139.7mm , 23.067 kg/m , J-55
Landed at 432.2 mKB
Cemented to surface with Thermal Cement 3.0m3 of returns

Sensors:

10 points Acoustic fibre and 34 Thermocouples (Temperature) Hang off
Temperature Sensor Set Depths:
217.0 mKB - 250 mKB (Temperature every meter)
Acoustic Fibre Sensor Set Depths:
0.0 mKB - 250 mKB (Acoustic point every 25 meter)

Intended Purpose:

Acoustic Fibre through out wellbore to measure noise and Temperature through Grand Rapids A steam chamber - Non thermal casing with thermal cement monitoring wellbore