Cenovus EnCAID approval #10440K Performance presentation

Alberta Energy Regulator offices

Calgary

February 2016

cenovus ENERGY

Advisory

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Cenovus EnCAID* introduction and overview

This presentation was prepared in accordance with AER Directive 054 - Performance presentations, auditing, and surveillance of in situ oil sands schemes

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

* Canadian patent CA2594413

AER Dir 054 Section 3.1.1

Subsurface issues related to resource evaluation and recovery

Subsurface issues: Table of contents

- Scheme background
- Geology/geoscience
- Drilling and completions
- Instrumentation
- Scheme performance
- Future plans

Scheme background

Directive 54
Subsurface section 1

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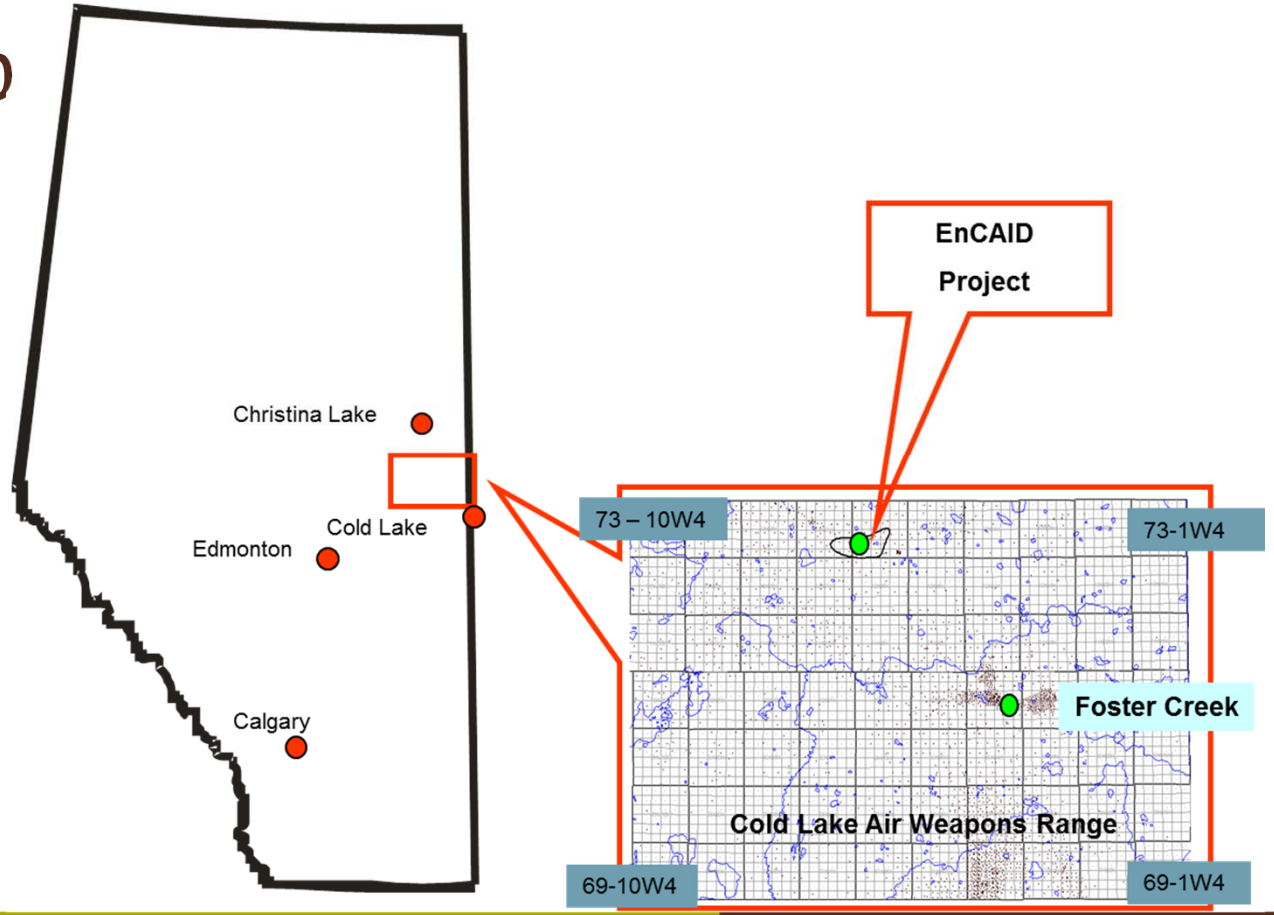
Background

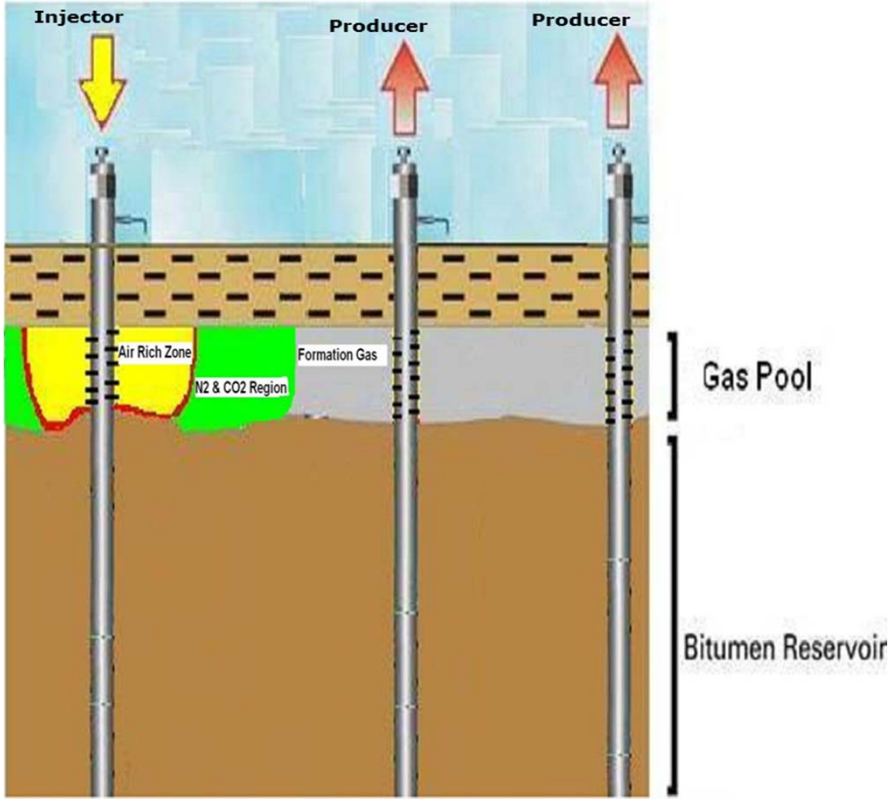
- The EnCAID project is an enhanced recovery scheme which displaces natural gas with combustion gases that are the result of combustion of residual bitumen in gas cap

Location map



Project overview

- Combustion of residual bitumen in gas cap
- Allows for displacement and re-pressurization of gas zone
- 100% Cenovus Energy Inc.



Geological/geoscience

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Subsurface section 2

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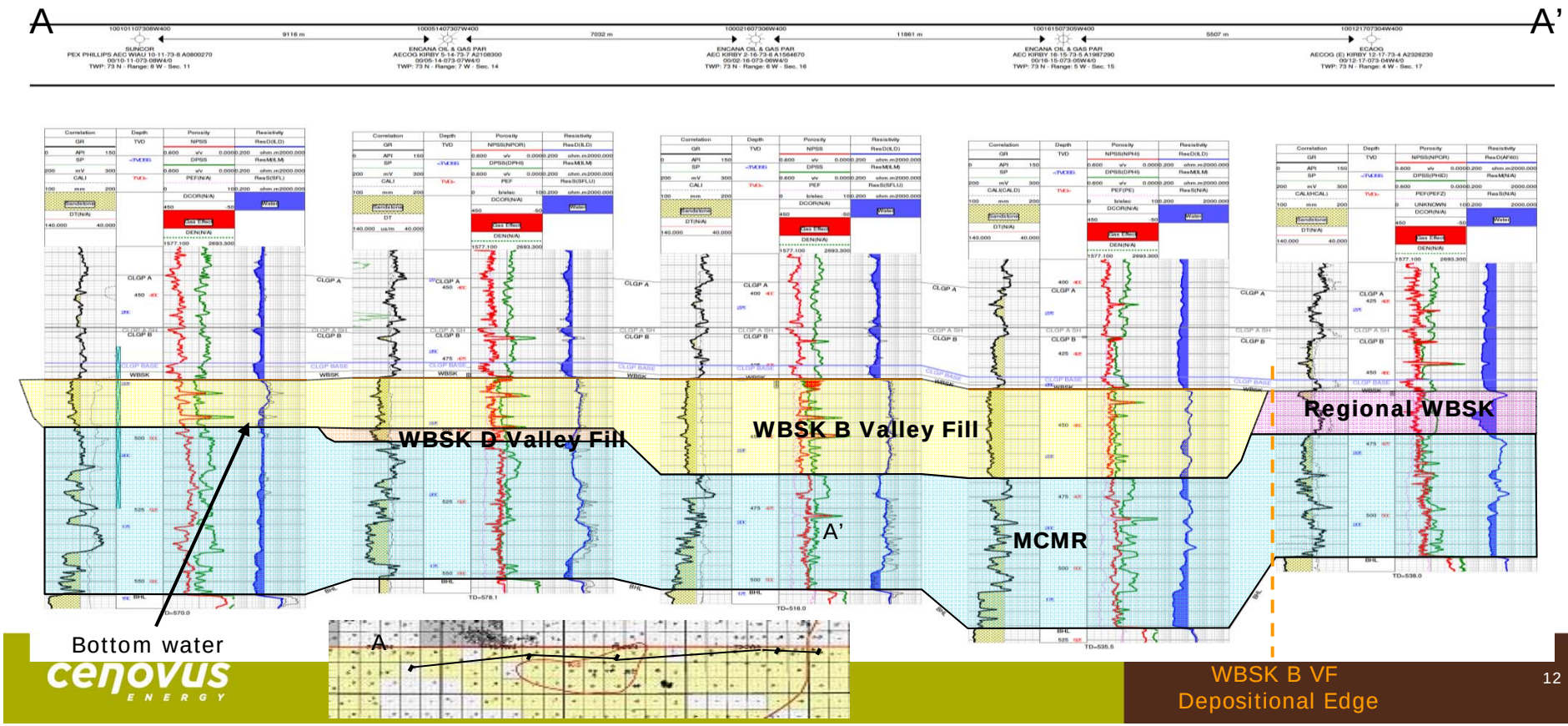
Summary of Wabiskaw gas properties

Depth	**465 TVD**
Thickness	**5 m**
Average porosity	**~36%**
Average gas saturation	**~50%**
Average water saturation	**~30%**
Average bitumen saturation	**~20%**

Wabiskaw stratigraphic cross-section



Drilling and completion

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Subsurface section 3

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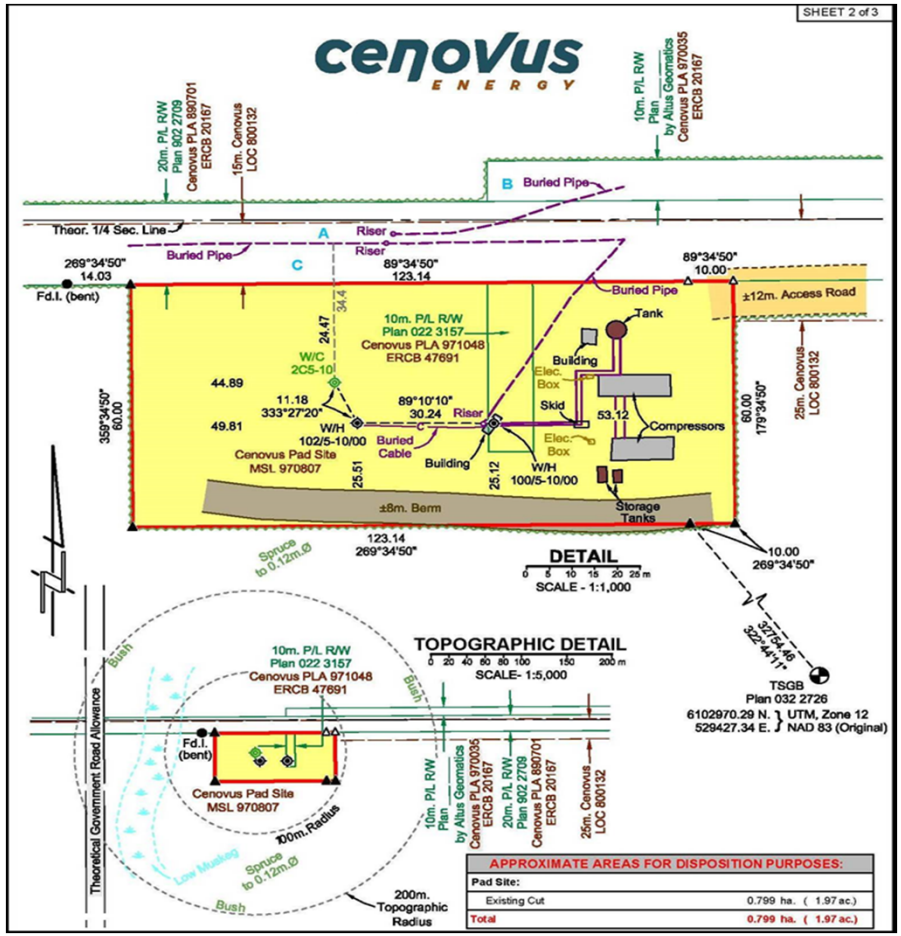
Well layout



Drilling and completion

- No new wells were drilled
- No recompletions
- No workovers

Requirements under subsection 3.1.1 3c – wellbore schematics are included in the appendix

Instrumentation

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Subsurface section 5

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Instrumentation in wells

Observation Well: 102/05-10-73-6W4

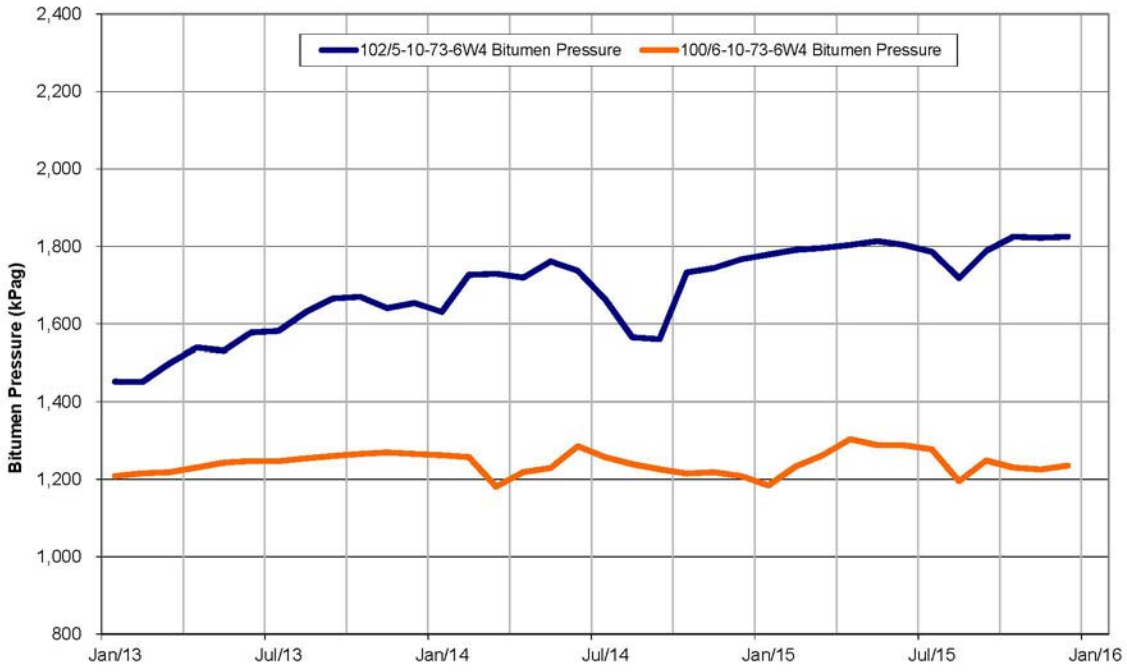
- Equipped with three piezometers
- Equipped with 10 thermocouples

Observation Well: 100/6-10-73-6W4

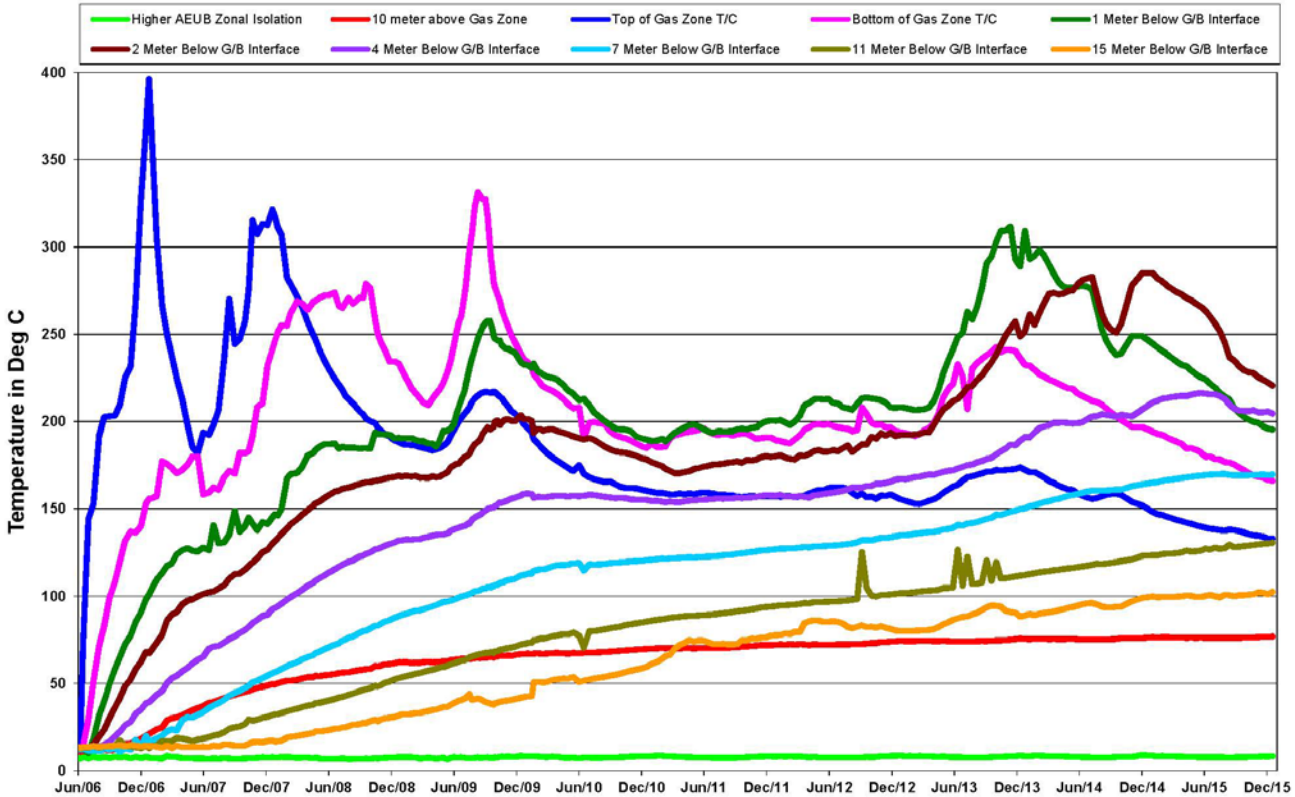
- Equipped with one piezometer
- Equipped with 10 thermocouples

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

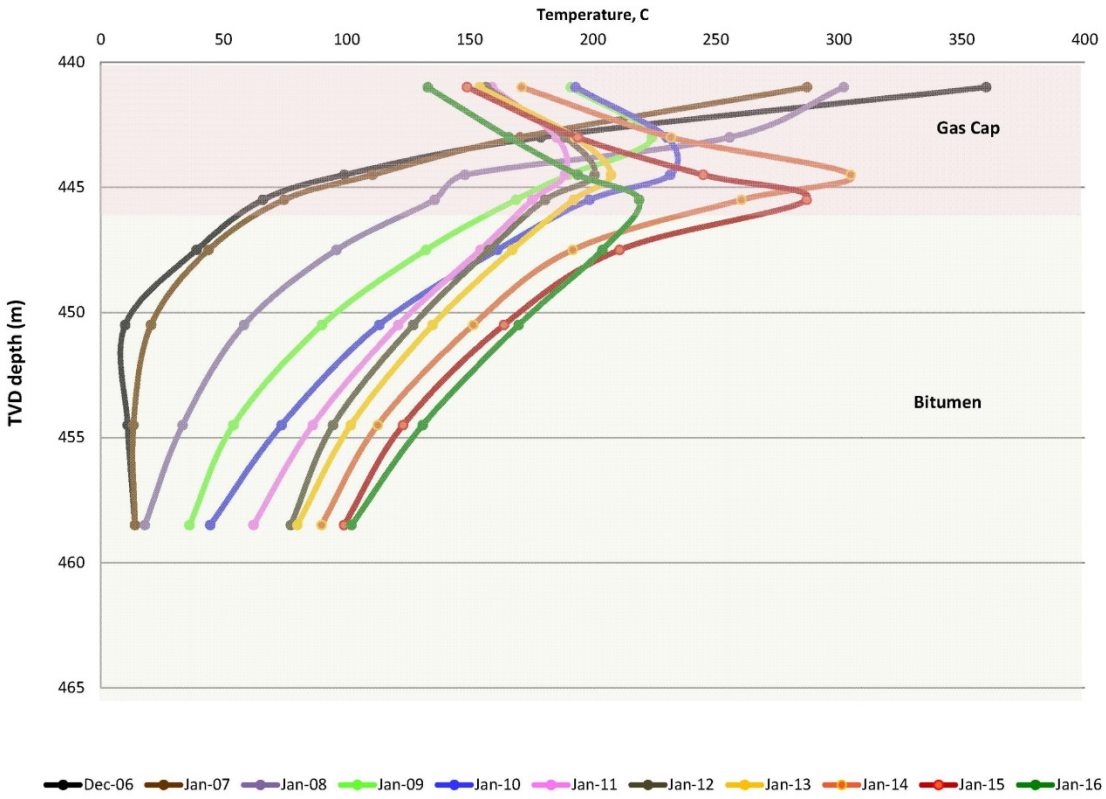
Observation wells bitumen pressure



102/05-10-073-06W4 – Temp history



Observation well temperature



Scheme performance

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Subsurface section 7

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Project performance history

Year	Activity
2006	June - Ignition and start-up
2007	Q1 – Nitrogen response at 00/14-9-73-6W4/00 Q2 – Nitrogen response at 00/2-16-73-6W4/00, 00/11-15-73-6W4/00, shut-in 00/14-9-73-6W4/00
2008	May – Nitrogen response at 00/1-17-73-6W4/00
2009	Jan – Gas production shut-in due to 00/6-18-73-6W4/00 segregation repair Jun – Nitrogen response at 00/7-8-73-6W4/00 Oct – Injectivity decrease observed
2010	Q1– 00/5-10-73-6W4/00 injector stimulation treatment Q4 – Shut-in 00/1-17-73-6W4/00, 00/2-16-73-6W4/00, 00/11-15-73-6W4/00. Removal of 00/5-10-73-6W4/00 thermocouple string and perform pressure fall off tests
2011	Q1 - 00/5-10-73-6W4/00 injector stimulation treatment Mar/Apr – 00/11-15-73-6W4/00 flowed N_2 85%
2012	Jul – Startup of 00/6-7-76-6W4/00 Oct – Primrose sales volumes flowing to Caribou gas facility
2013	Feb - Startup of 00/6-6-73-6W4/00 Mar- Shut-in 00/7-8-73-6W4/00
2014	Dec – Startup 00/10-12-73-7W4/00
2015	Jul– Startup 00/10-11-73-7W4/00

Production/injection summary

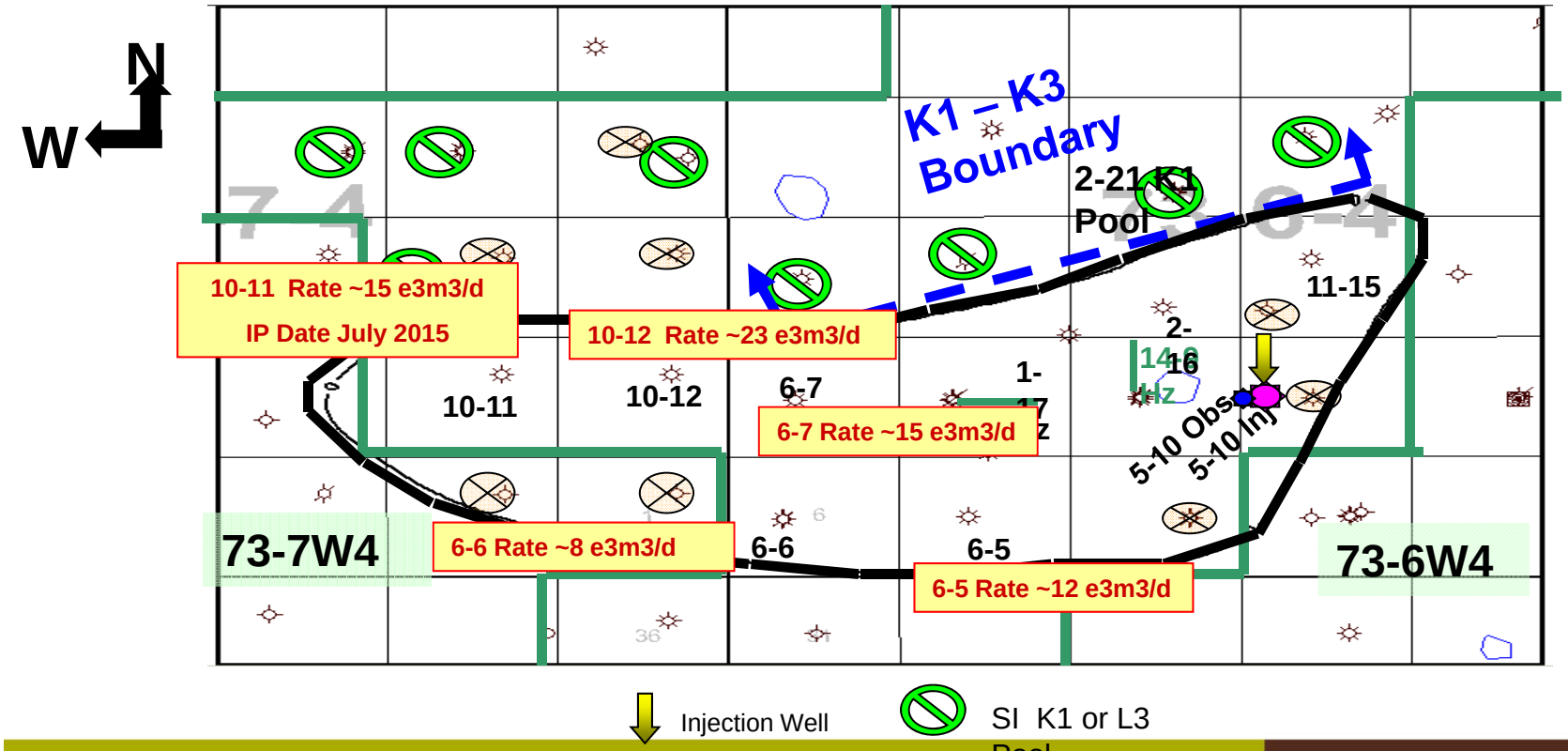
Production operations

Operating for	Air injected	Bulk gas recovered	Formation gas recovered
>nine years	~ 240 e^6m^3	~ 165 e^6m^3	~ 144 e^6m^3

Approved producers

UWI	Status	UWI	Status
00/06-05-073-06W4/0	Flowing ~ 42% N_2	00/02-16-073-06W4/0	Shut-in ~ 83% N_2
00/06-06-073-06W4/2	Flowing <1% N_2	00/01-17-073-06W4/0	Shut-in ~ 85% N_2
00/06-07-073-06W4/2	Flowing ~ 2% N_2	00/10-11-073-07W4/0	Flowing <1% N_2
00/07-08-073-06W4/0	Shut-in ~ 93% N_2	00/10-12-073-07W4/0	Flowing <1%
00/11-15-073-06W4/0	Shut-in ~ 82% N_2		

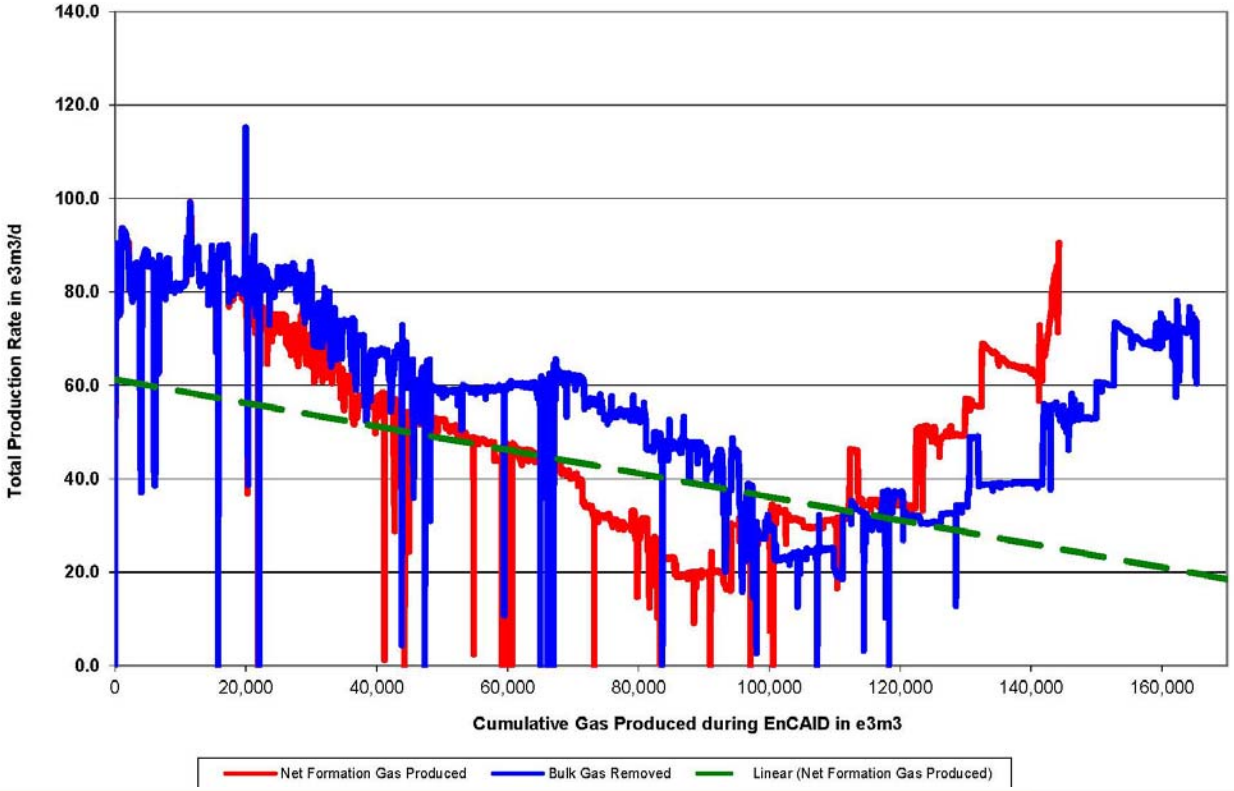
K3 pool production



Injection Well

SI K1 or L3 Pool

History production



Voidage replacement ratio (VRR) - 2015

January and early August

- Steady air injection rates
- Minor downtime due to weather related events

Early August to late August

- Reduce air injection due to mechanical issues on a compressor

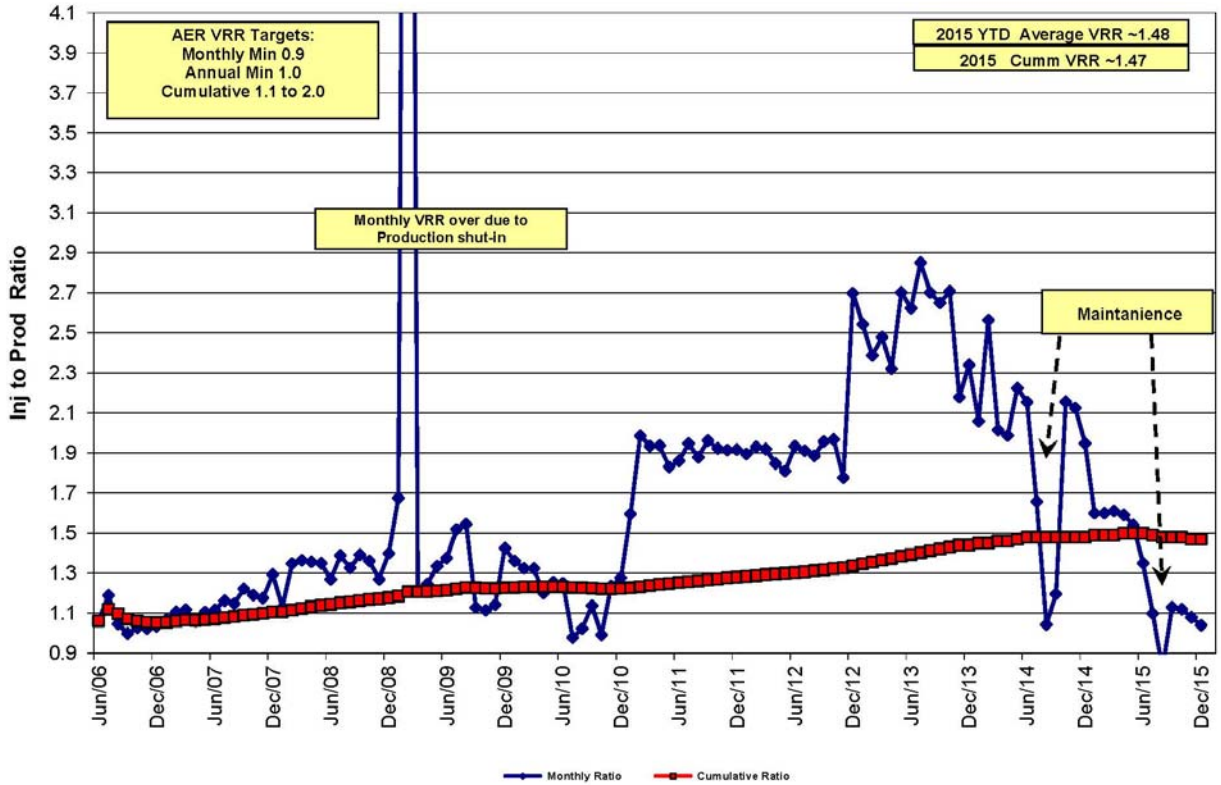
Late August to December

- Reduce air injection due to mechanical issues

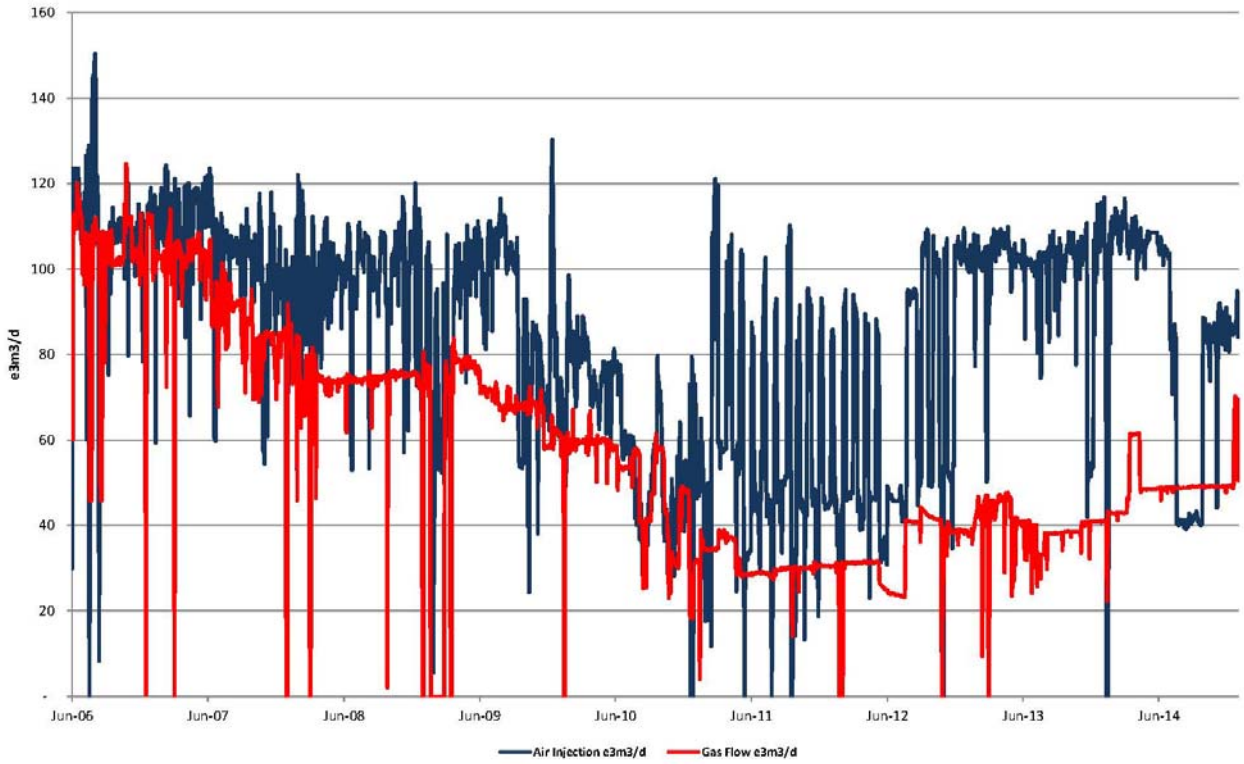
Voidage replacement ratio (VRR)

	Monthly VRR	Cumulative VRR	VRR regulatory approved limit (Min monthly)
January	1.6	1.49	0.90
February	1.6	1.49	0.90
March	1.61	1.49	0.90
April	1.59	1.5	0.90
May	1.54	1.5	0.90
June	1.35	1.5	0.90
July	1.1	1.49	0.90
August	0.82	1.48	0.90
September	1.13	1.48	0.90
October	1.12	1.48	0.90
November	1.08	1.47	0.90
December	1.04	1.47	0.90

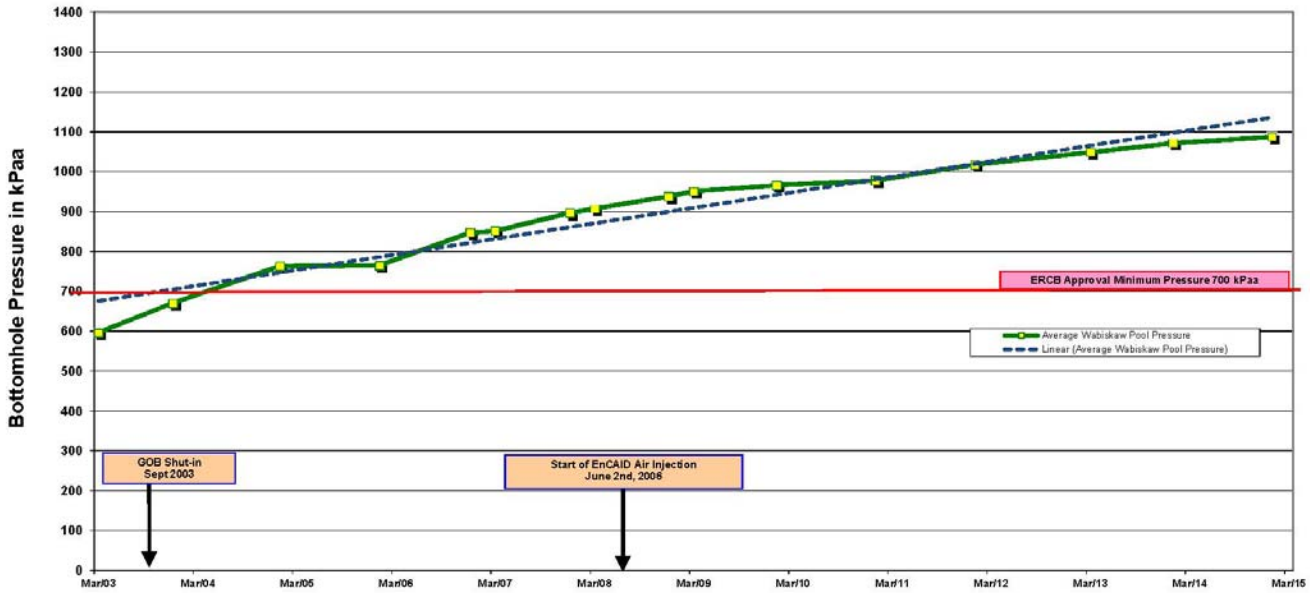
VRR performance



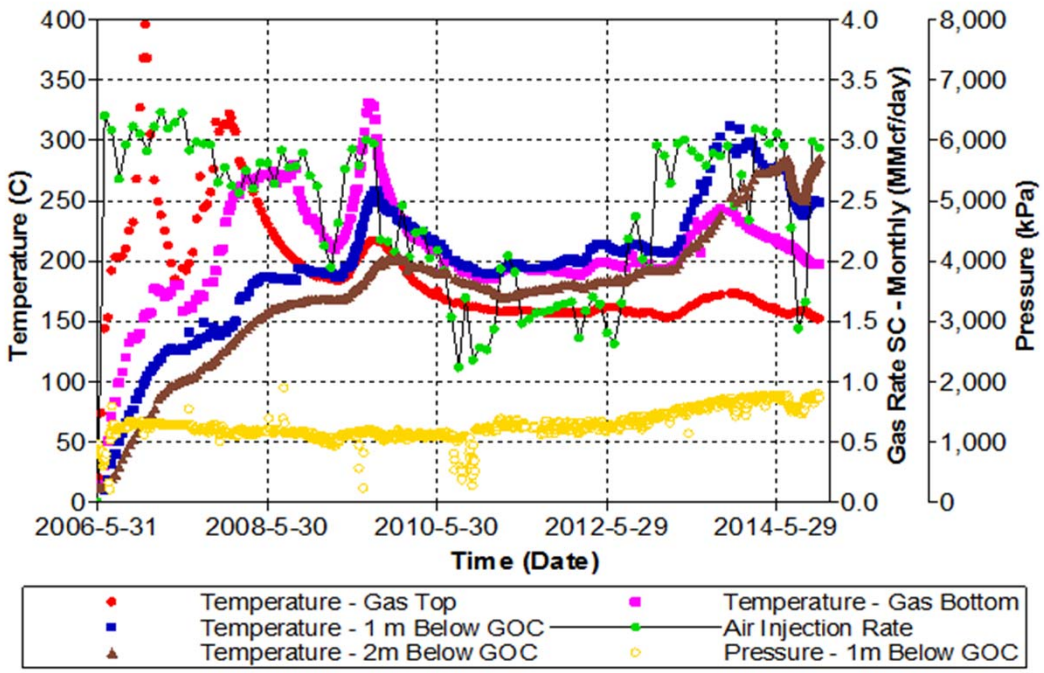
VRR history



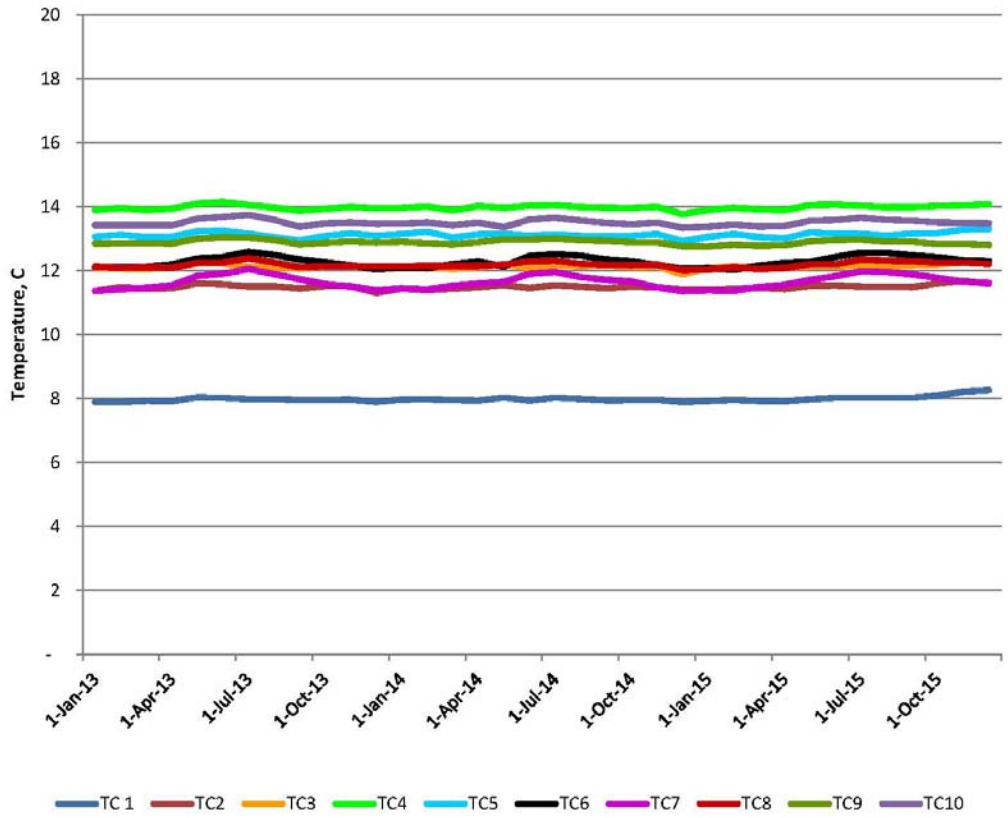
K3 pool pressure



Historical: Temperature vs. Air Injection



Observation 6-10 well temperature

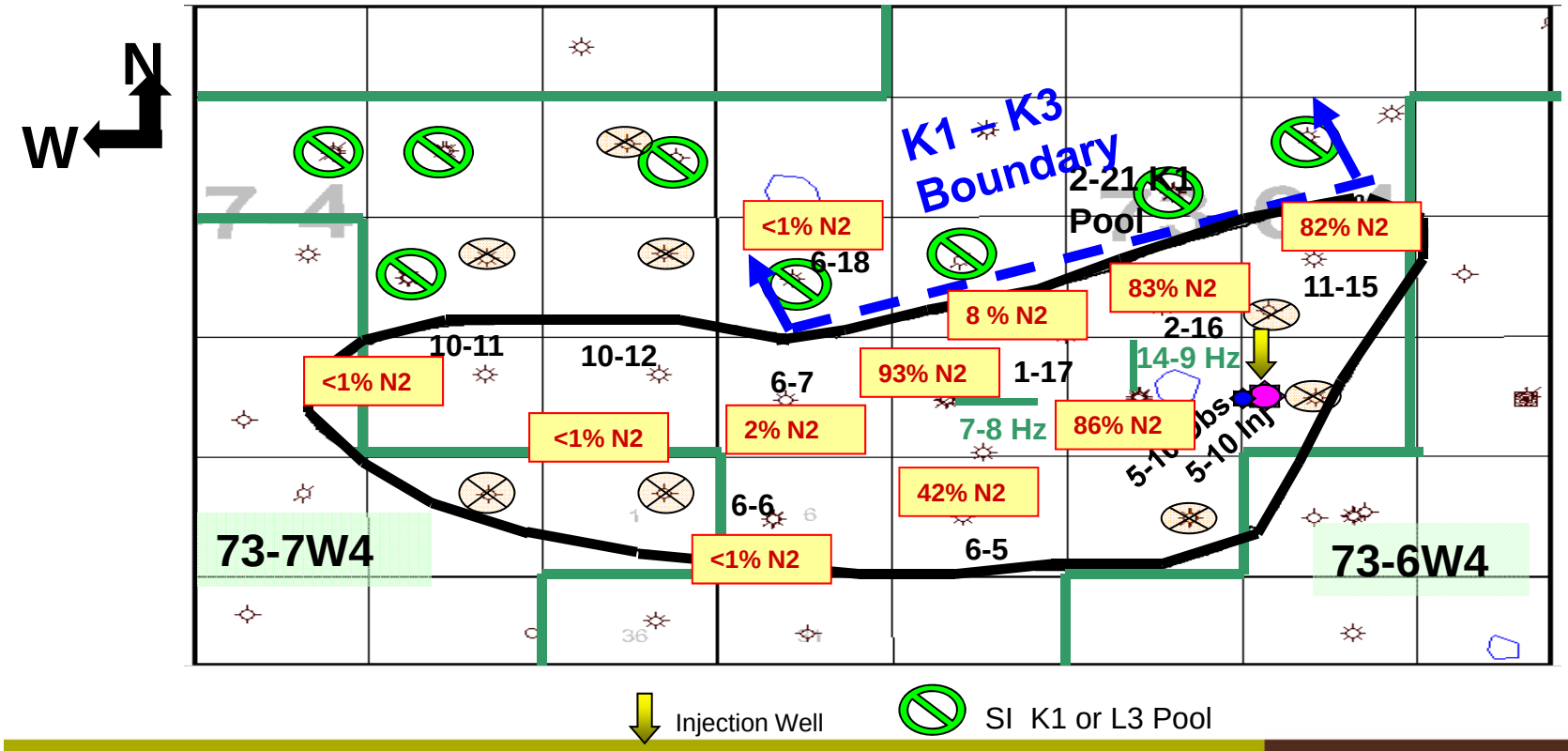


Composition of injected/produced fluids

- EnCAID does not currently sample air injected
- EnCAID captures gas samples for analysis on the schedule located to the right and monitors compositional changes for each well
- Cenovus samples selective wells on more frequent basis then required under Approval 10440K

Location	Min Approval Sampling Frequency
00/6-10-73-6W4/2	Semi- annual
00/6-5-73-6W4/0	Semi- annual
00/6-6-73-6W4/2	Semi- annual
00/6-7-73-6W4/2	Semi- annual
00/7-8-73-6W4/0	Semi- annual
00/11-15-73-6W4/0	Semi- annual
00/2-16-73-6W4/0	Semi- annual
00/1-17-73-6W4/0	Semi- annual
00/10-11-73-7W4/0	Semi- annual
00/10-12-73-7W4/0	Semi- annual
00/6-18-73-6w4/0	Annual
00/10-36-72-7W4/2	Annual
00/11-17-73-6W4/0	Annual
00/14-9-73-6W4/0	Annual

Nitrogen response



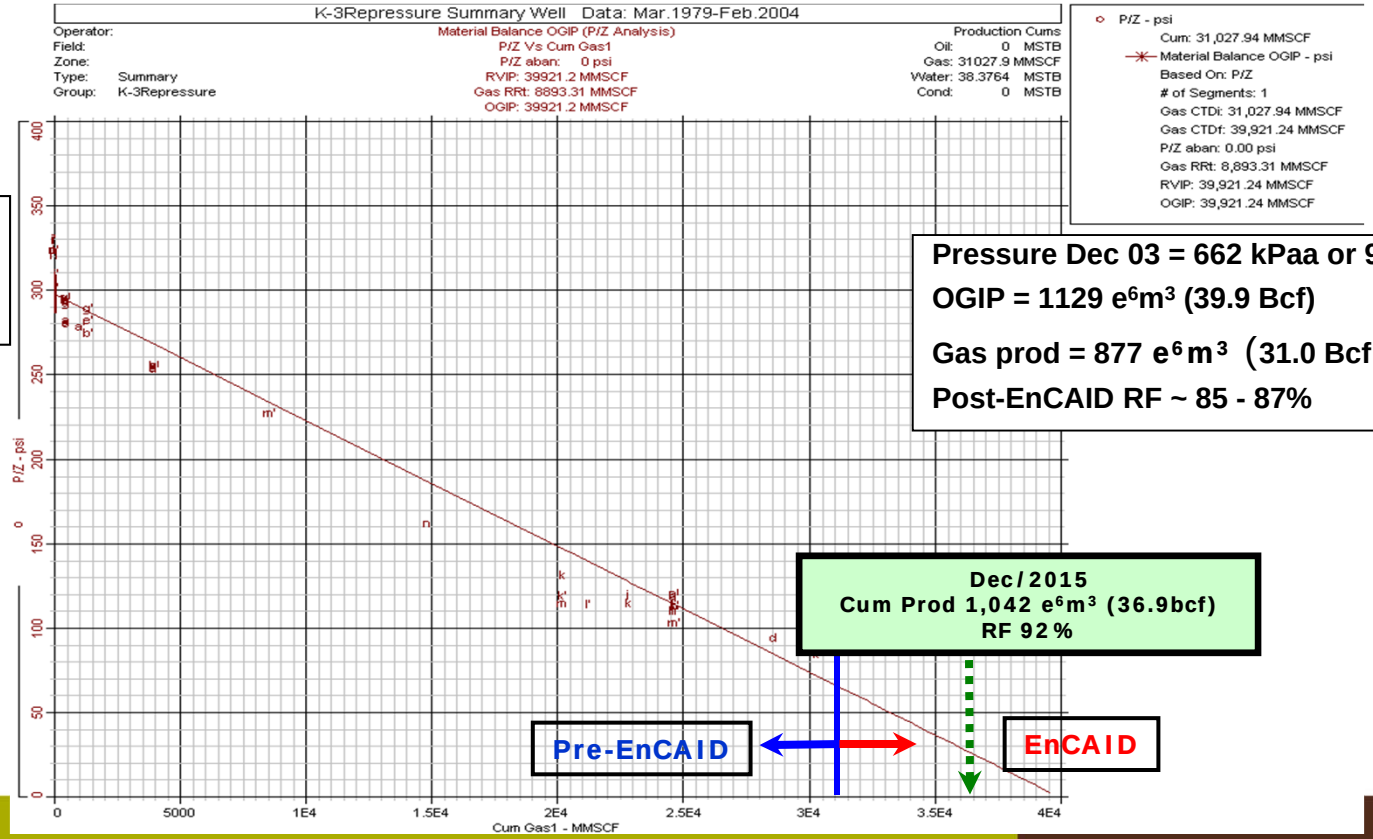
Injection Well

SI K1 or L3 Pool

Wabiskaw K-3 Pool material balance

Original Pressure – 2050 kPaa

(300 psia)



Pressure Dec 03 = 662 kPaa or 96 psia

OGIP = 1129 e^6m^3 (39.9 Bcf)

Gas prod = 877 e^6m^3 (31.0 Bcf 77% RF)

Post-EnCAID RF ~ 85 - 87%

Dec/2015
Cum Prod 1,042 e^6m^3 (36.9bcf)
RF 92%

Pre-EnCAID

EnCAID

Subsurface key learnings

- Presence of more than one oxidation front indicates that there is fuel remaining in the region swept by the combustion front
  - fuel remaining in the region swept by the combustion front
  - could be either residual oil left behind first oxidation front, or re-saturation with oil from adjacent rock or, possibly from flammable vapor produced from the oxidation and cracking reactions
- Strong correlations between air-injection rate and temperature changes
  - first oxidation zone at the bottom of the gas cap was truncated by a reduction in injection rate
  - increase in injection rate performed in early 2013 resulted in ignition and combustion of the top of the bitumen

Future plans

Subsurface section 8

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Future plans

- No changes in overall recovery strategy are planned at this time

AER Dir 54 Section 3.1.2

Surface operations, compliance and issues not related to resource evaluation and recovery

Surface operations: Table of contents

1. Facility overview/modifications
2. Measurement and reporting
3. Environmental issues
4. Compliance statement
5. Future plans

Facility overview/modifications

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Subsurface Operations section 1

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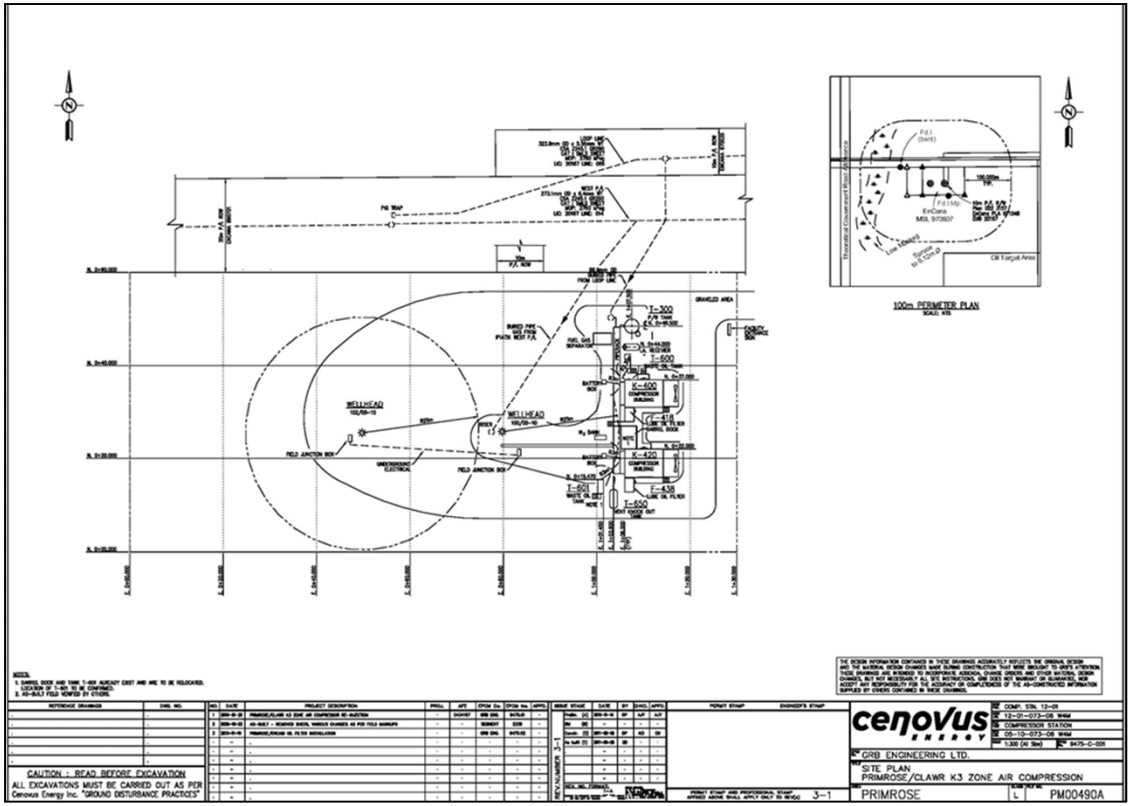
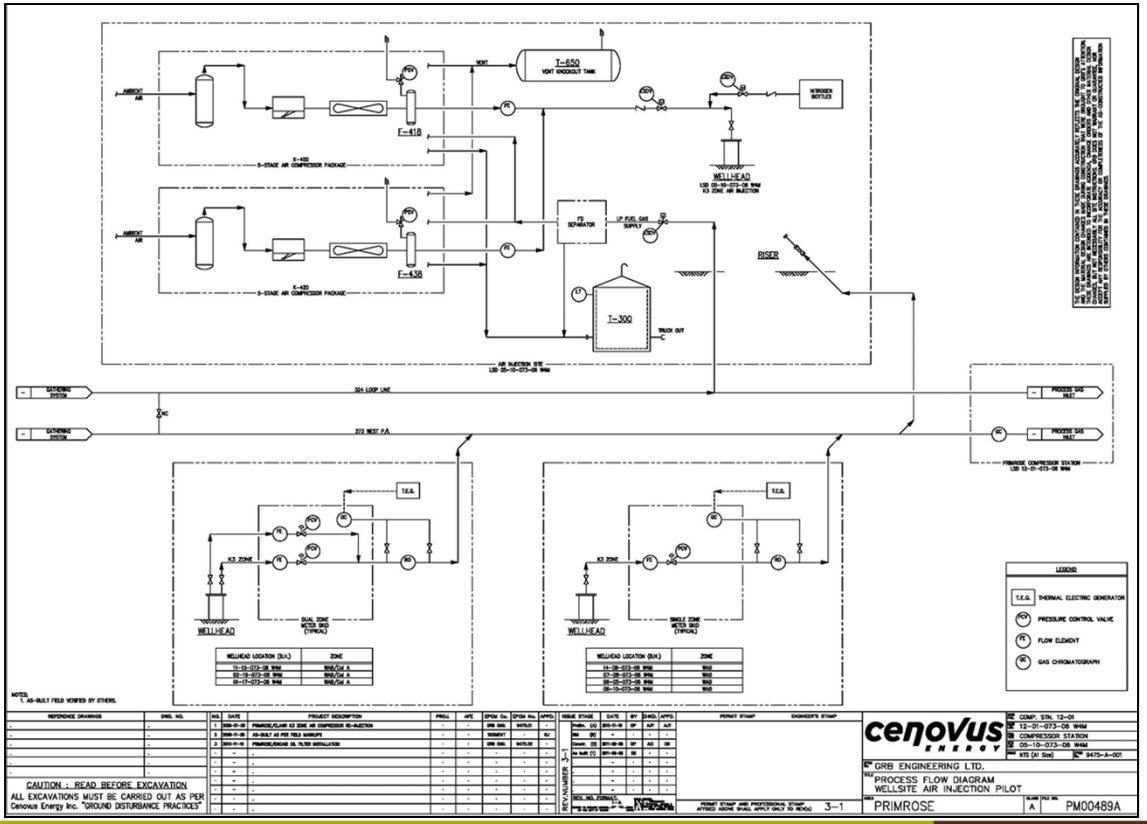
Site Layout



Process flow schematic



Plant performance - 2015

January to early August

- Steady air injections
- Some weather related reductions

August 5 to August 22 , 2015

- Reduced air injection rate

August to year end

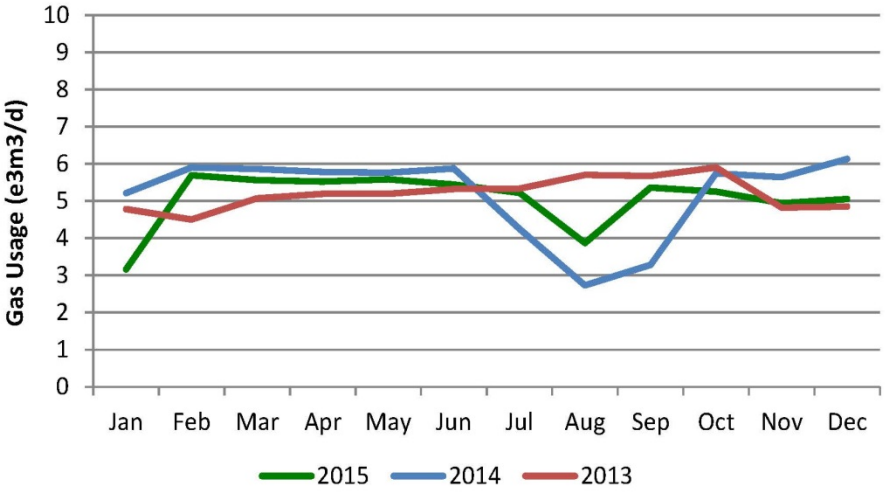
- Resumption of steady air injections

Facility is operating as expected

Gas usage

Usage is as fuel gas for air compressor operations

- Gas source Primrose plant fuel gas
- Total 2015 usage 1,907 e^3m^3



Green house gas emissions

	2015 (tonnes)	2014 (tonnes)
January	522	477
February	439	472
March	478	519
April	461	498
May	482	521
June	456	504
July	455	405
August	335	300
September	437	326
October	457	511
November	413	484
December	431	538

Surface gas migration

Year	Observations
2005	No development yet at EnCAID site, set base line.
2006	LEL disappeared when went to "Methane elimination mode" which is standard practice for these tests.
2007	LEL detection in "Full Gas Detection Mode" disappeared in "Methane Elimination Mode" suggesting swamp gas, the report noted clay cap over most of the sites could be trapping methane from organic peat decomposition.
2008	Collected low pressure gas samples for analysis at 5-10 & 11-15. Additional testing confirmed biogenic gas.
2009	SDS concluded that in their opinion it is a biogenic gas/swamp gas problem. Single Sample showed above 100% LEL came from wet, sloppy and drilling mud type of soil west of well center
2010	SDS opinion it is a biogenic gas/swamp gas problem. 2010 LEL readings less then 2009 LEL readings. No samples taken.
2011	SDS opinion is that gas detected through field screening is swamp gas from the organic material beneath the well site. The gas sample collected contained insufficient hydrocarbons for carbon isotope analysis.
2012	No testing undertaken.
2013	SDS considered two samples to be inconclusive as soil around the well center were highly saturated and swampy. No sample was submitted for isotope analysis.
2014	SDS considered it was a biogenic gas/swamp gas problem.
2015	No gas migration, with detected gas being biogenic gas/swamp gas .

Surface facility key learnings

- Safe operation of production and injection wells
- Geographical location provides challenges for instrumentation operations utilizing solar panels during the winter season
- Purity of injection gases plays key role in maintaining injectivity
- Marginal economics to operate in today's pricing environment

Measurement and reporting

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Surface Operations section 2

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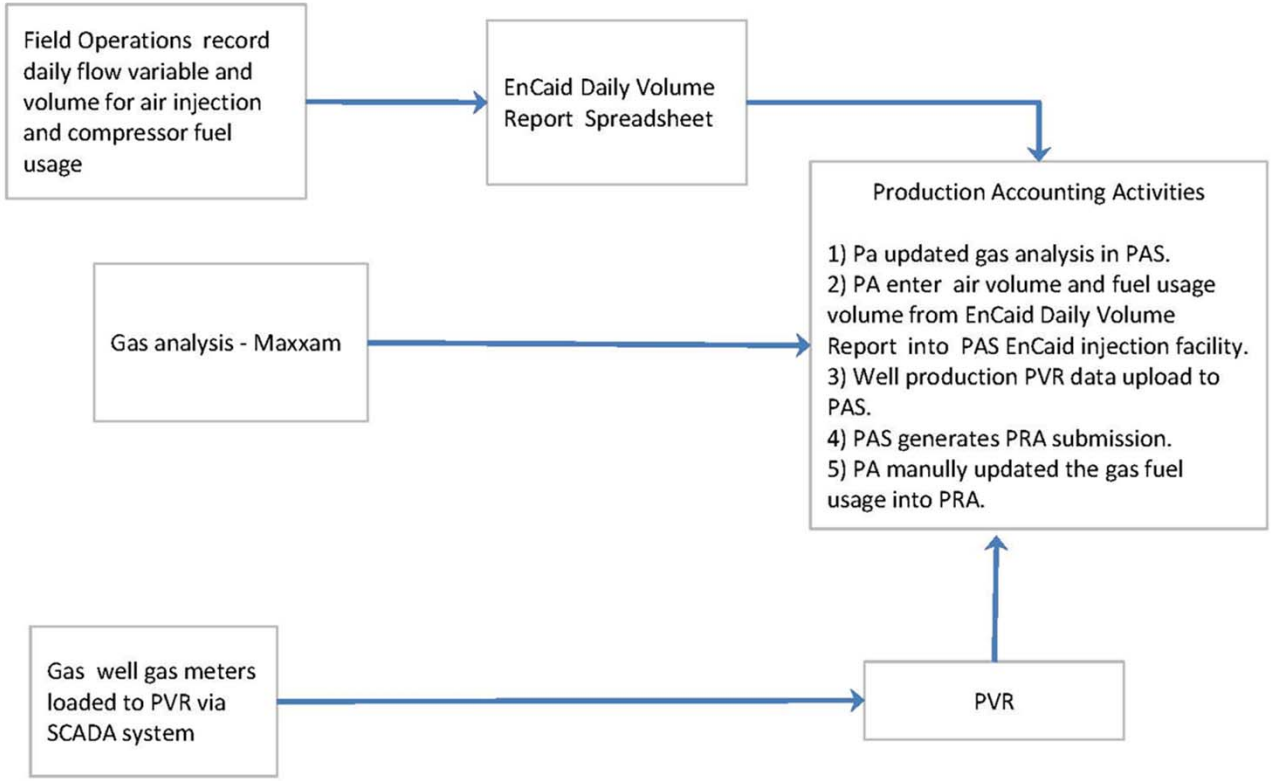
Measurement reporting



Environmental issues

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Subsurface Operations section 7

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Environmental compliance

- No environmental non-compliance events occurred since the last performance review

Compliance statement

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Subsurface Operations section 8

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Compliance confirmation

- August 26, 2015 notice sent to AER that Cenovus may not meet the VRR of 0.9 for August as per condition 12 of Approval# 10440J
  - AER response acknowledging receipt received August 26, 2015
  - no further action required from AER on this matter
- No other non-compliance events occurred since the last performance review

Future plans

Directive 54
Subsurface Operations section 10

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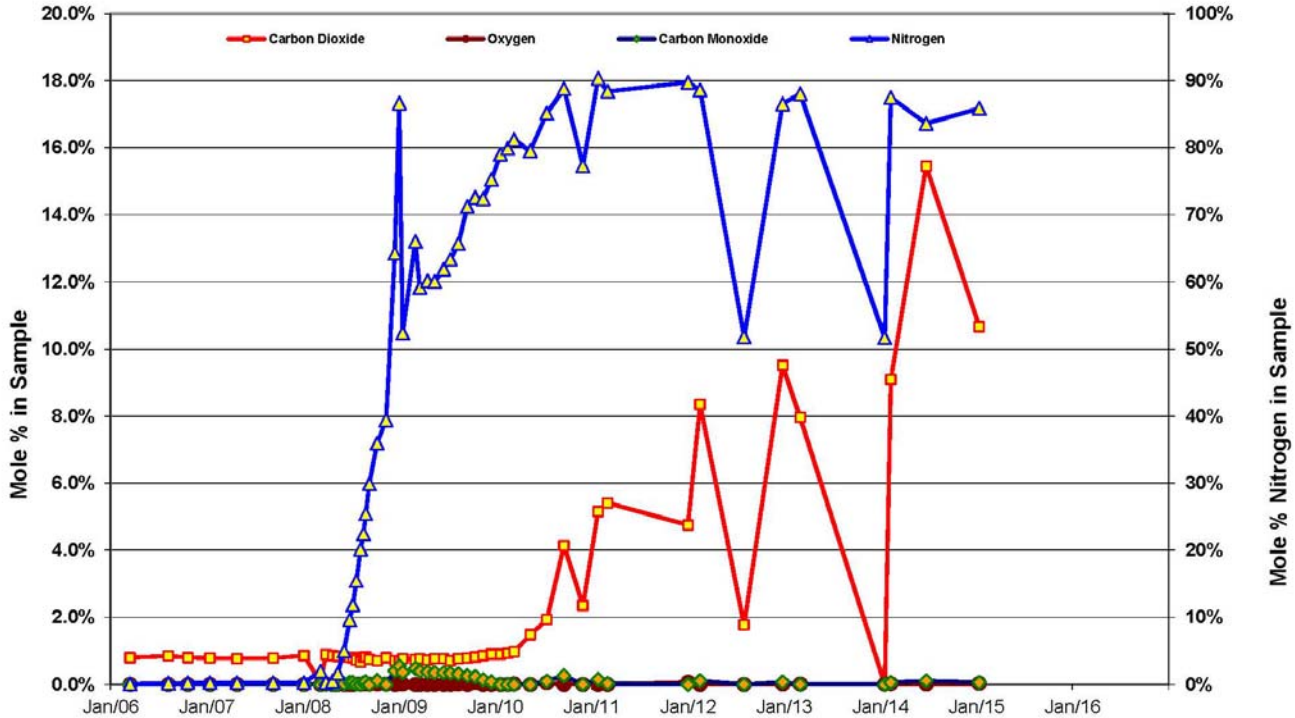
Future plans

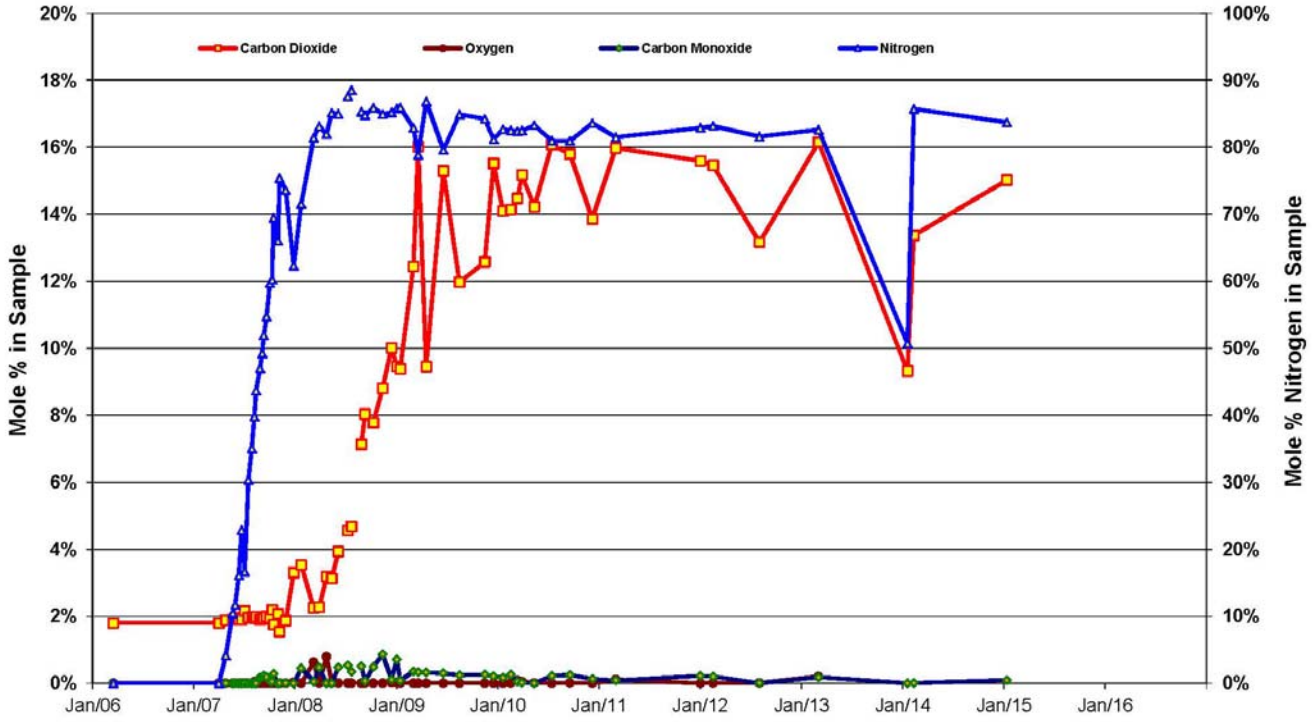
- No major initiatives or plans that may require submission of an application are being contemplated at this time
- No changes to overall plant design or amendments are anticipated at this time
- Operate the project until it is economic

Appendix

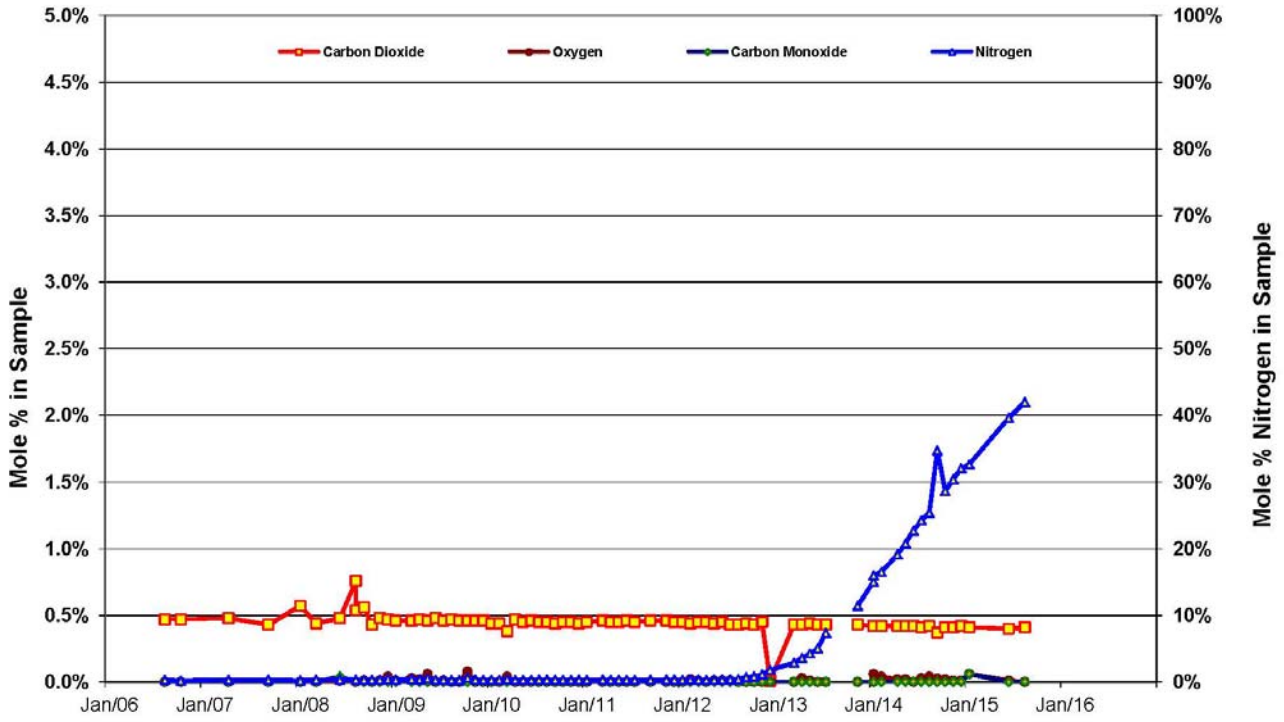
Gas composition 00/1-17-73-6W4/0



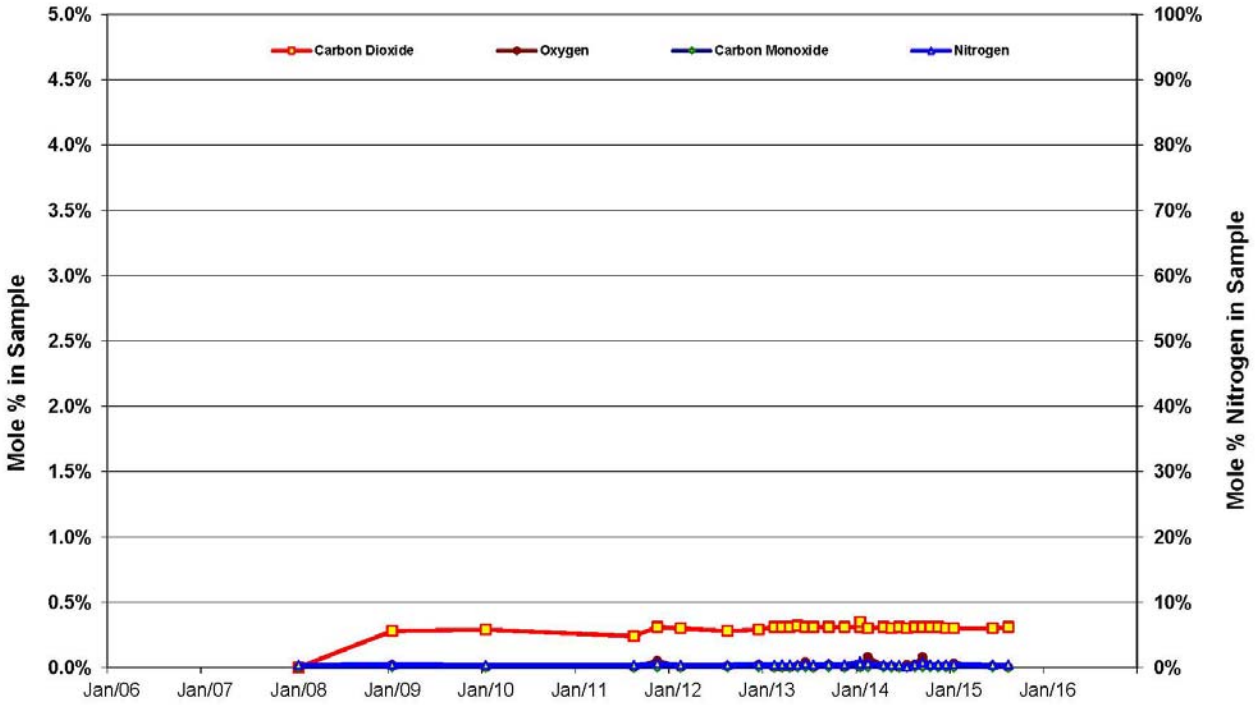
Gas composition 00/2-16-73-6W4/0



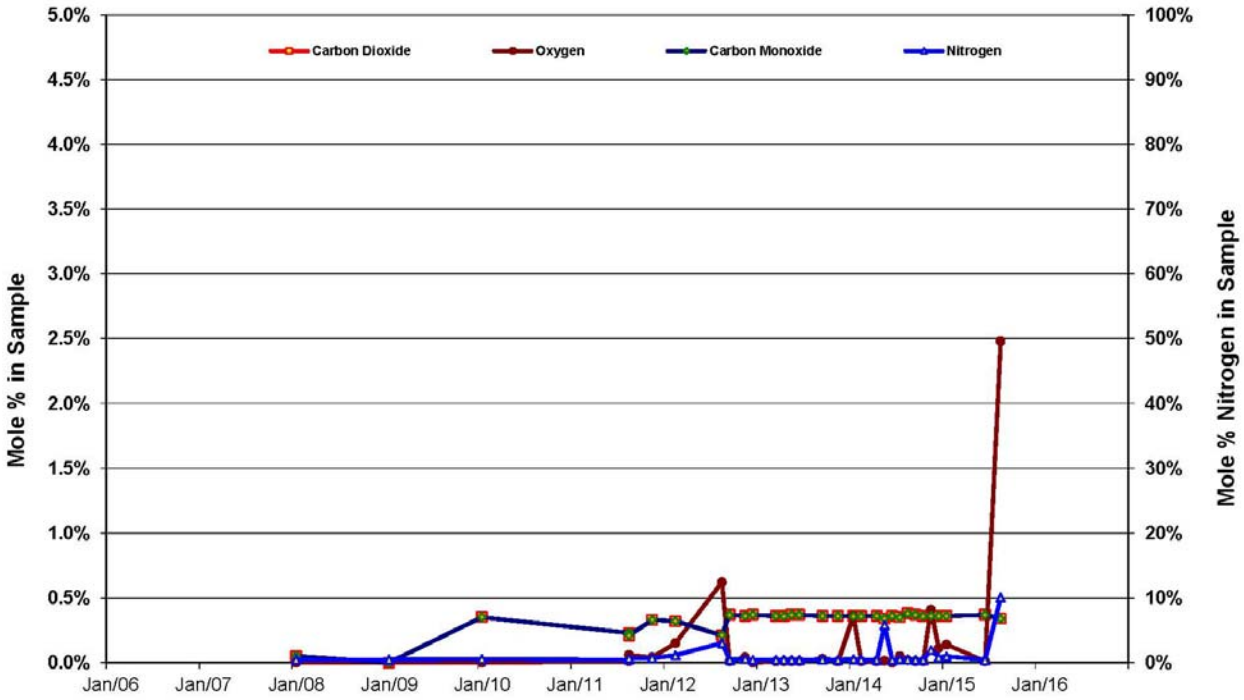
Gas composition 00/6-5-73-6W4/0



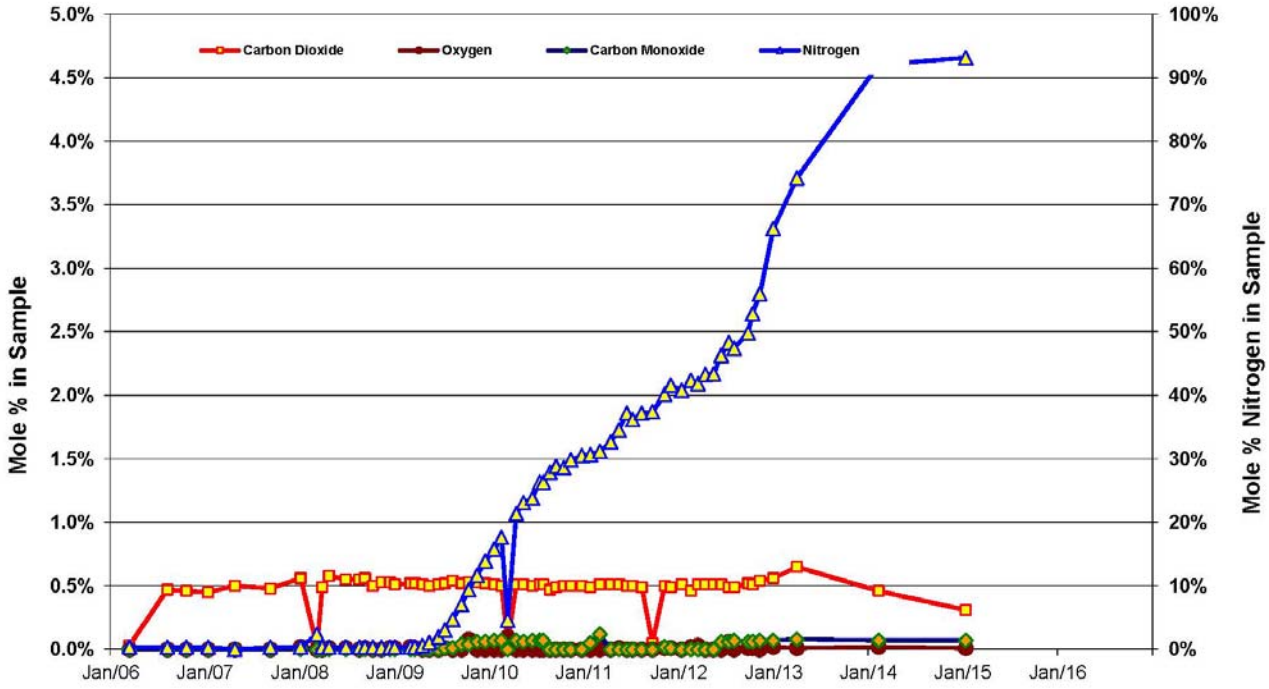
Gas composition 00/6-6-73-6W4/0



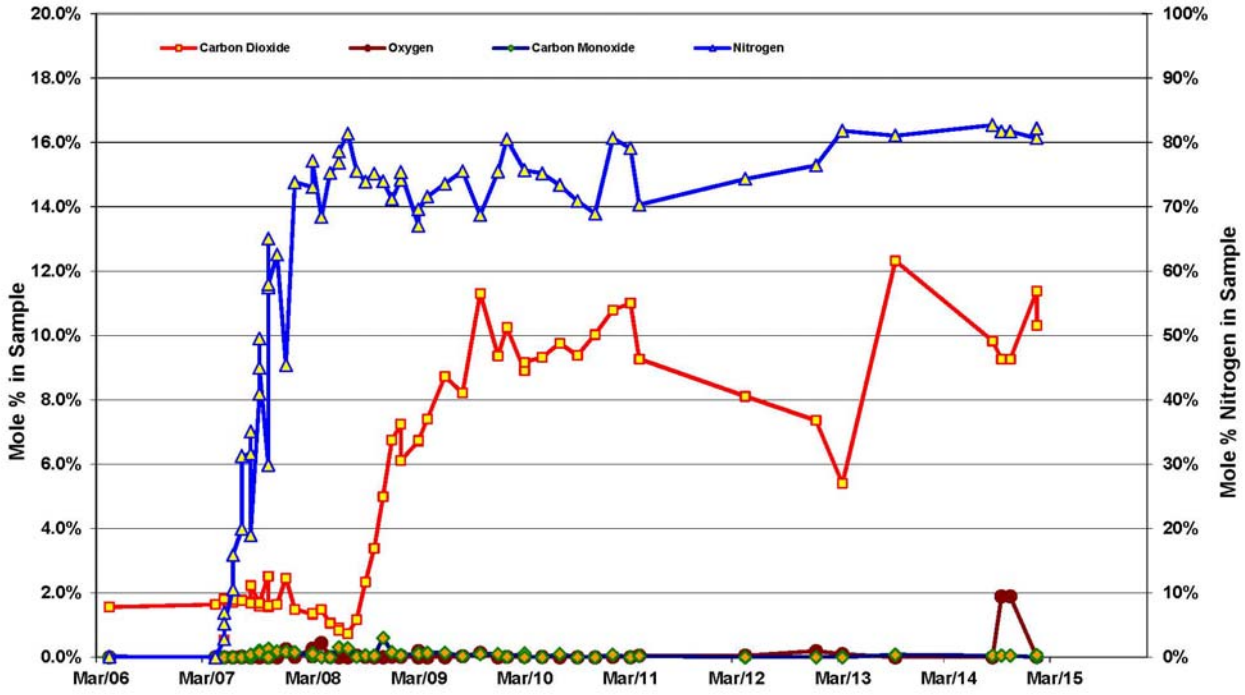
Gas composition 00/6-7-73-6W4/0



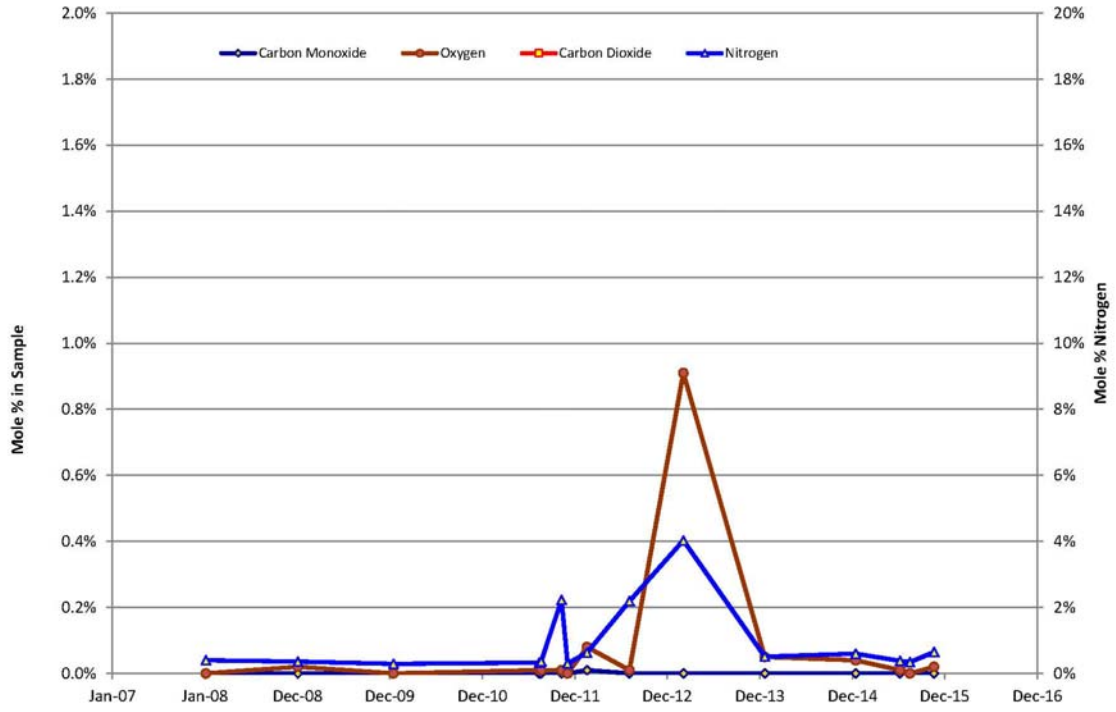
Gas composition 00/7-8-73-6W4/0



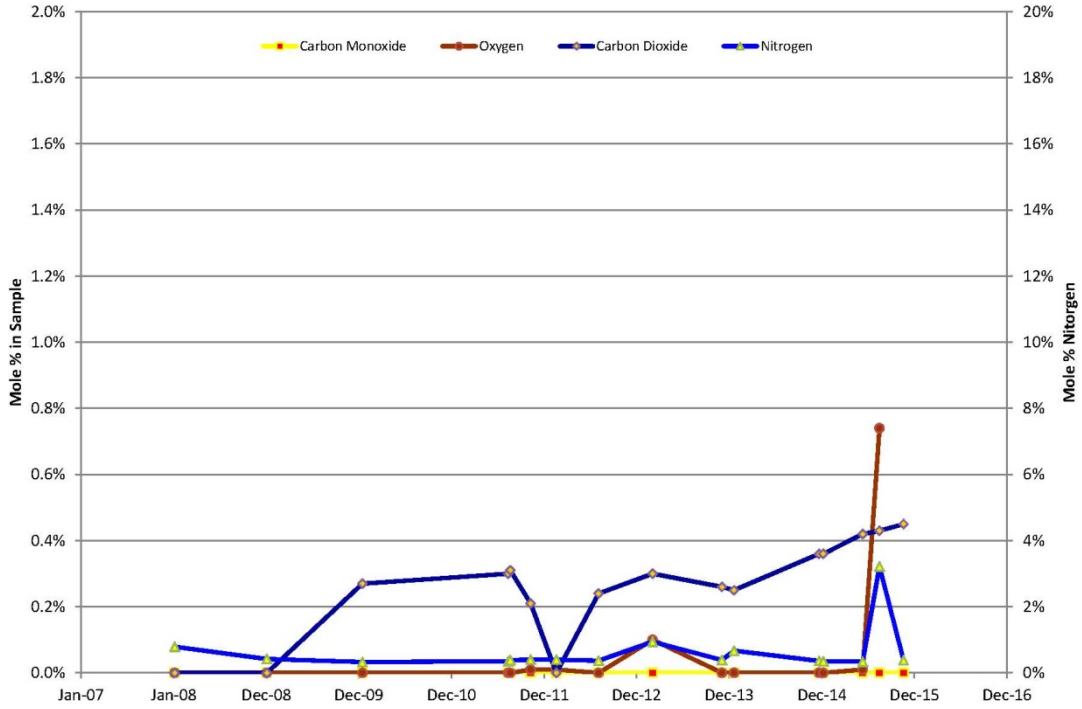
Gas composition 00/11-15-73-6W4/0



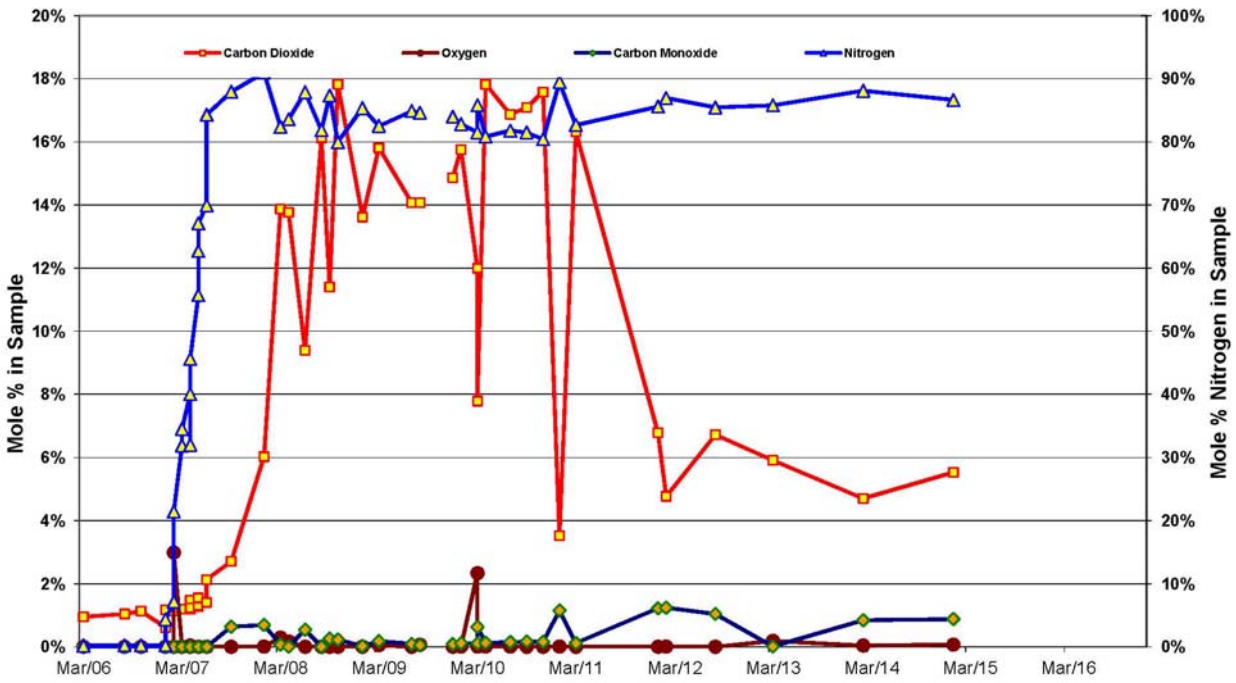
Gas composition 00/10-11-73-7W4/0



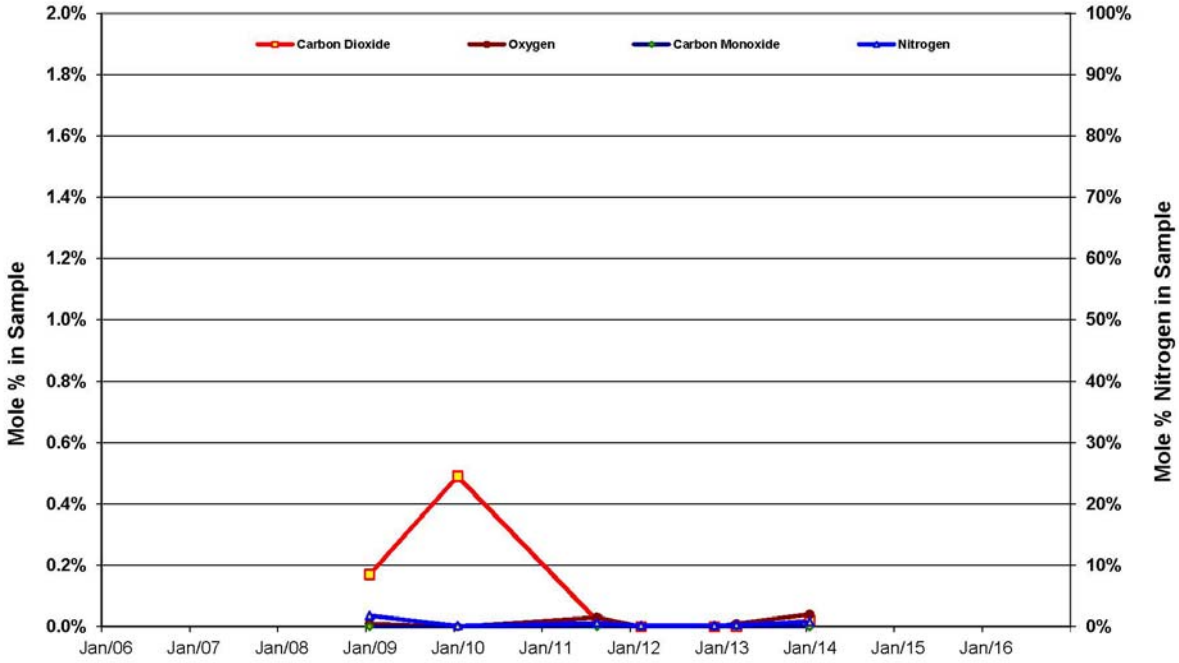
Gas composition 00/10-12-73-7W4/0



Gas composition 00/14-9-73-6W4/0

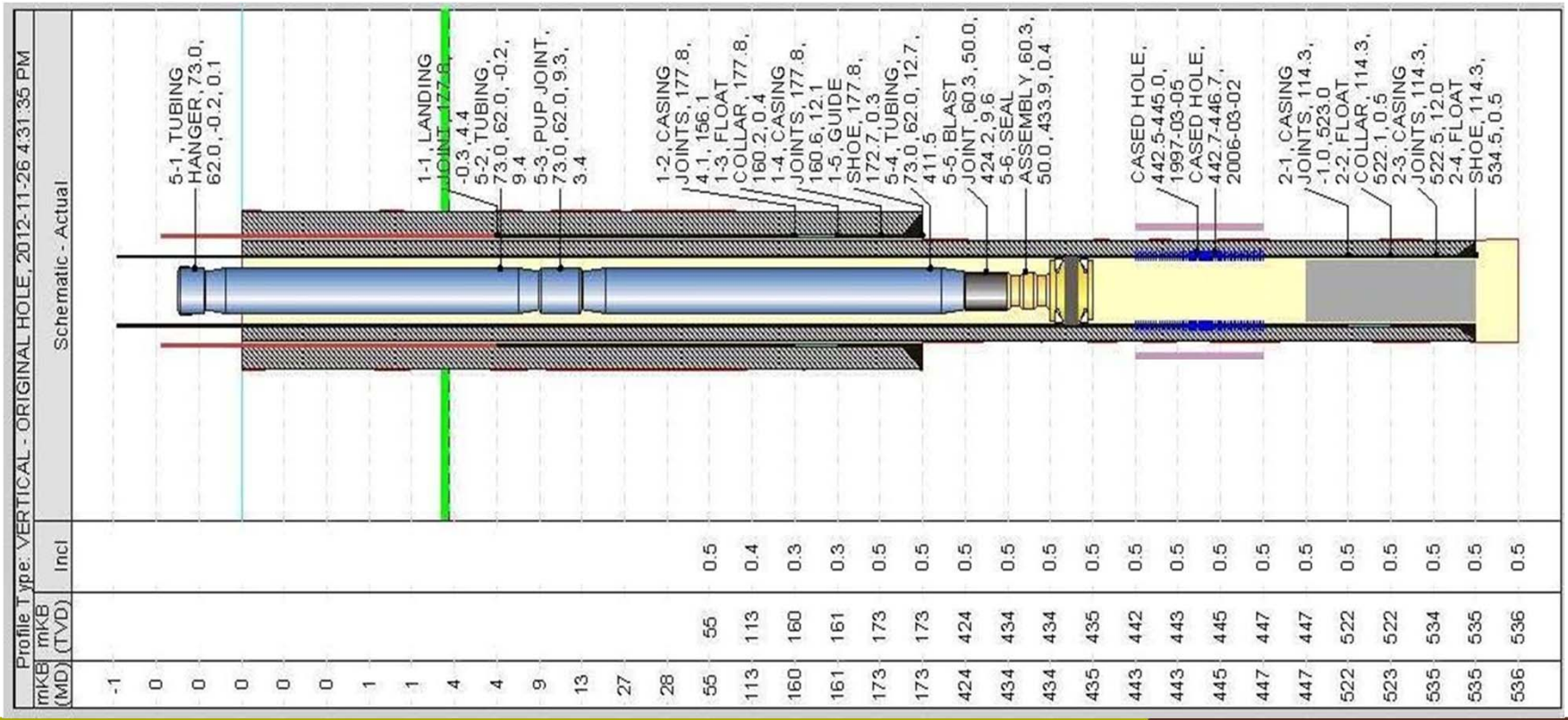


Gas composition 00/6-18-73-6W4/0

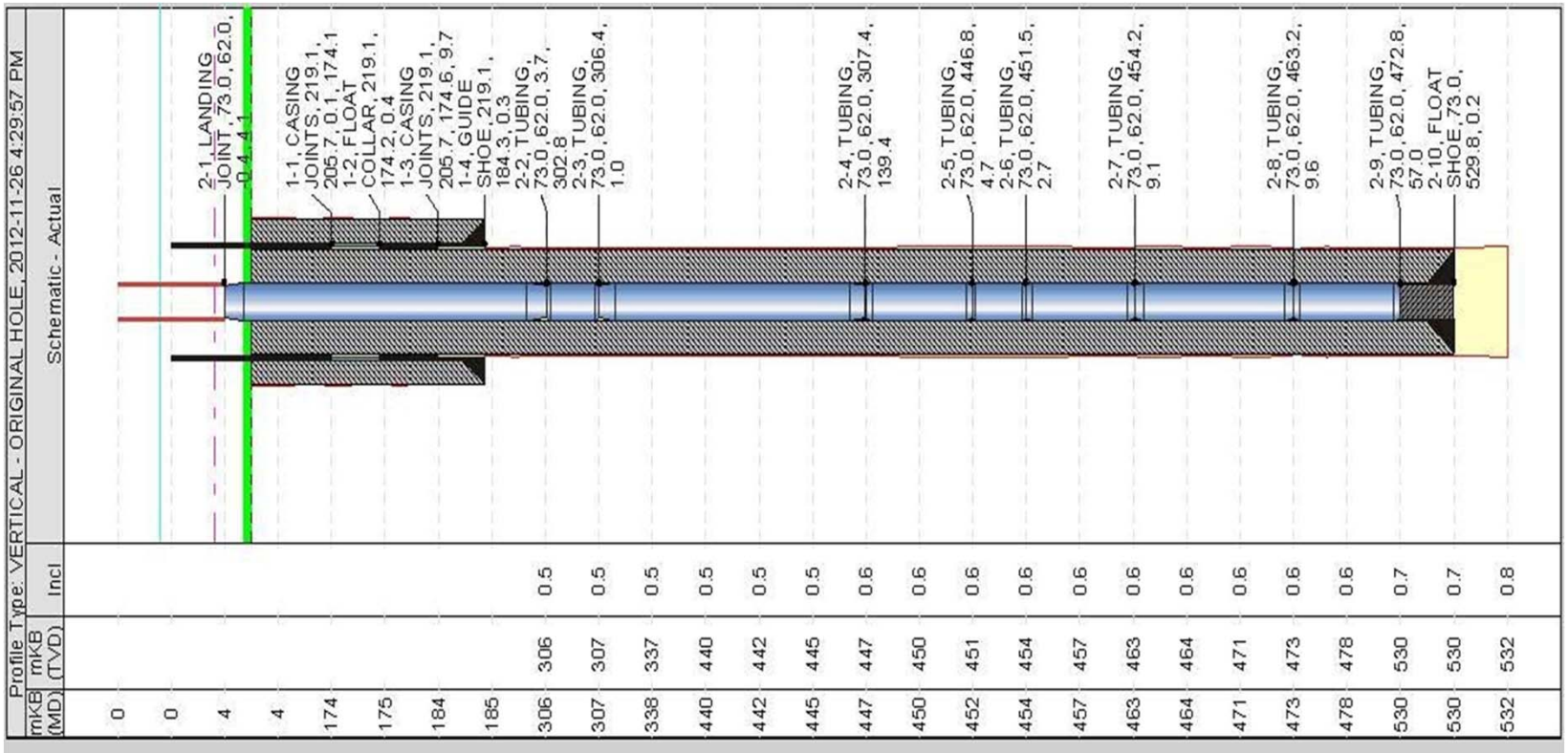


Downhole instrumentation layout

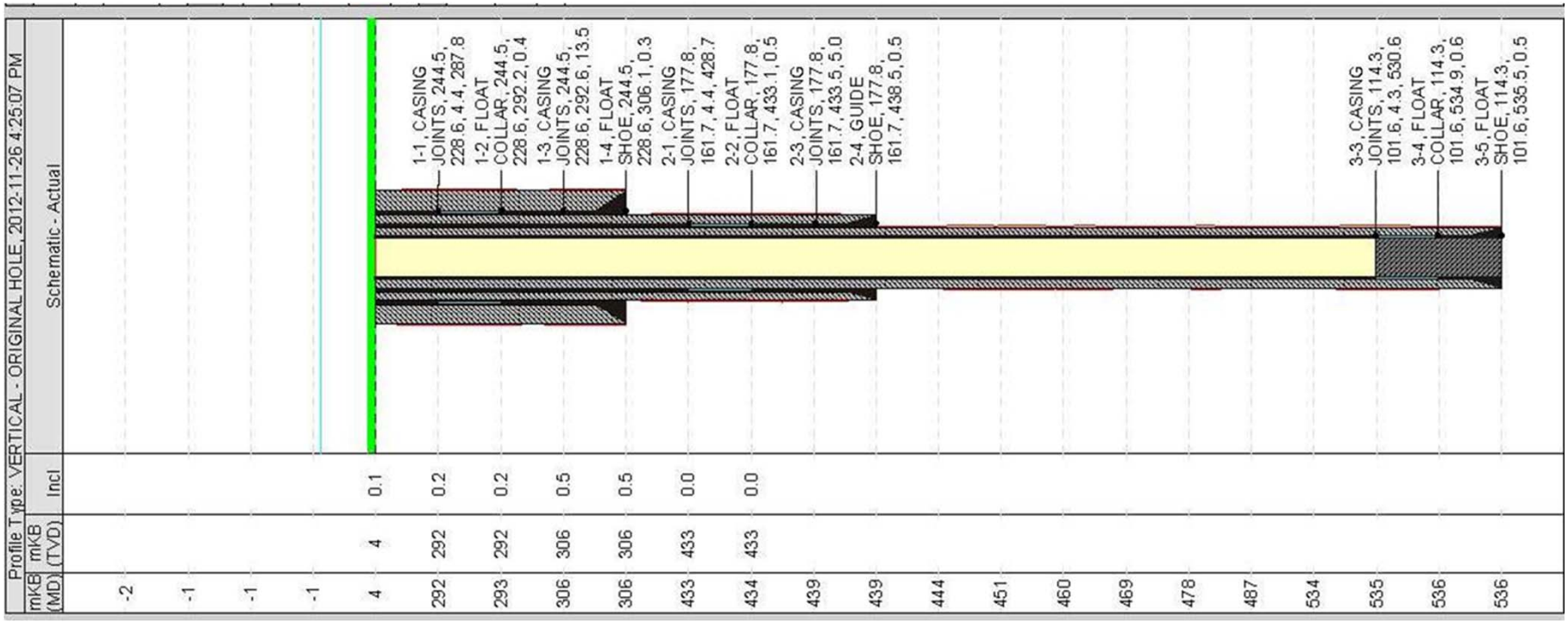
100/05-10-073-06W4 wellbore schematic



102/05-10-073-06W4 wellbore schematic



103/05-10-073-06W4 wellbore schematic



Thank you