

A female worker in a blue uniform and safety gear is working on industrial machinery. She is wearing a blue hard hat, safety glasses, and heavy-duty gloves. She is looking upwards and to the right, focused on her task. The background shows a complex industrial structure with yellow metal beams and pipes.

Suncor MacKay River In Situ Project 2022 AER Scheme Performance Report Commercial Scheme Approval No. 8668

Reporting Period:
January 1, 2022 to December 31, 2022

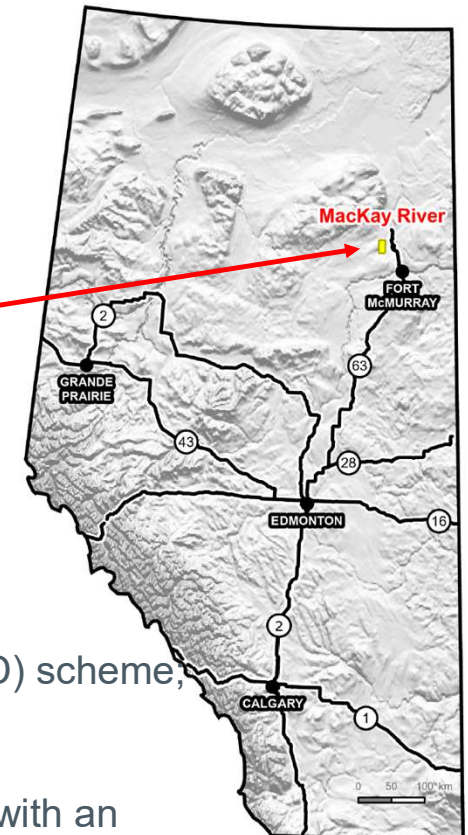
SUNCOR

Introduction

4.1



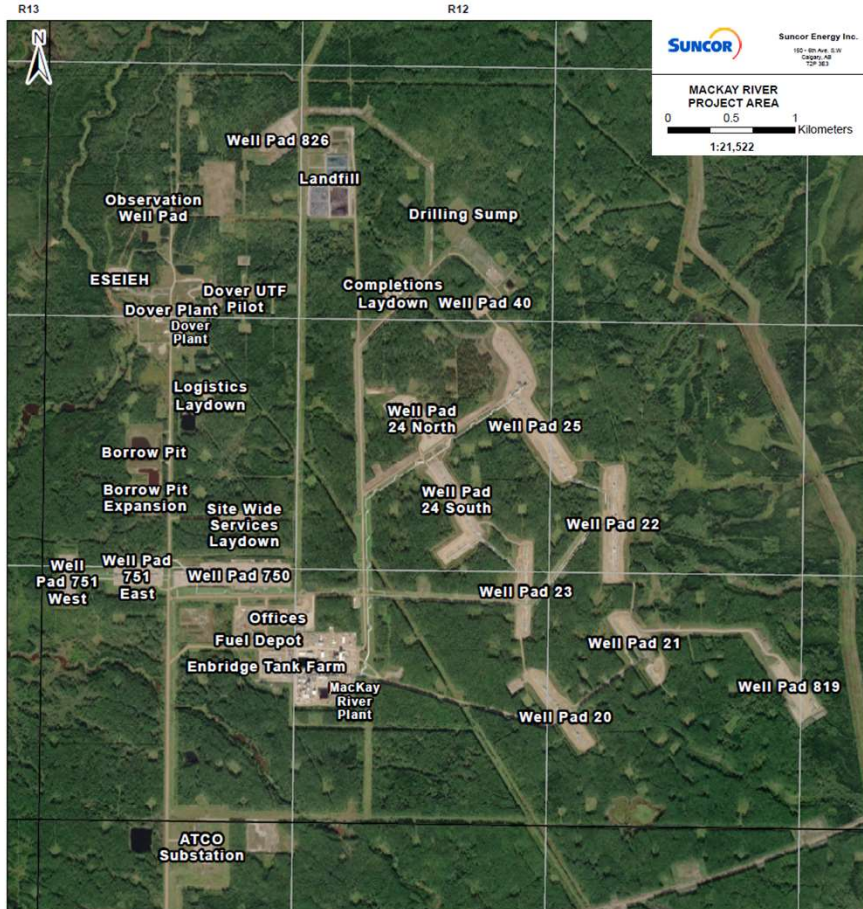
MackKay River Project Overview



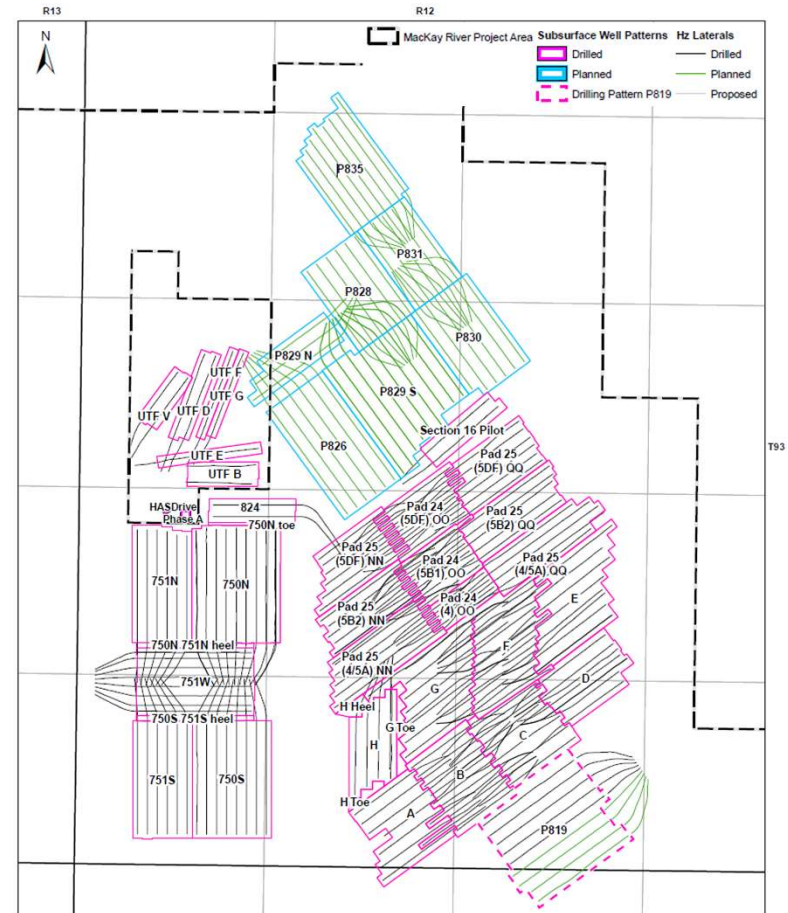
- The MackKay River Project is a commercial Steam Assisted Gravity Drainage (SAGD) scheme;
- It is the shallowest SAGD project currently in operation within Alberta;
- Average bitumen production for the reporting period was 5,137 m³/d (32,326 bbl/d) with an instantaneous steam-oil ratio (iSOR) of 2.8.
- Design rate for the MackKay River central processing facility is 6,041 m³/d (38,000 bbl/d) @ 2.8 SOR.

Project Area and Project Site

Current Project Area (PA) approximately 24 ½ sections.



Surface View



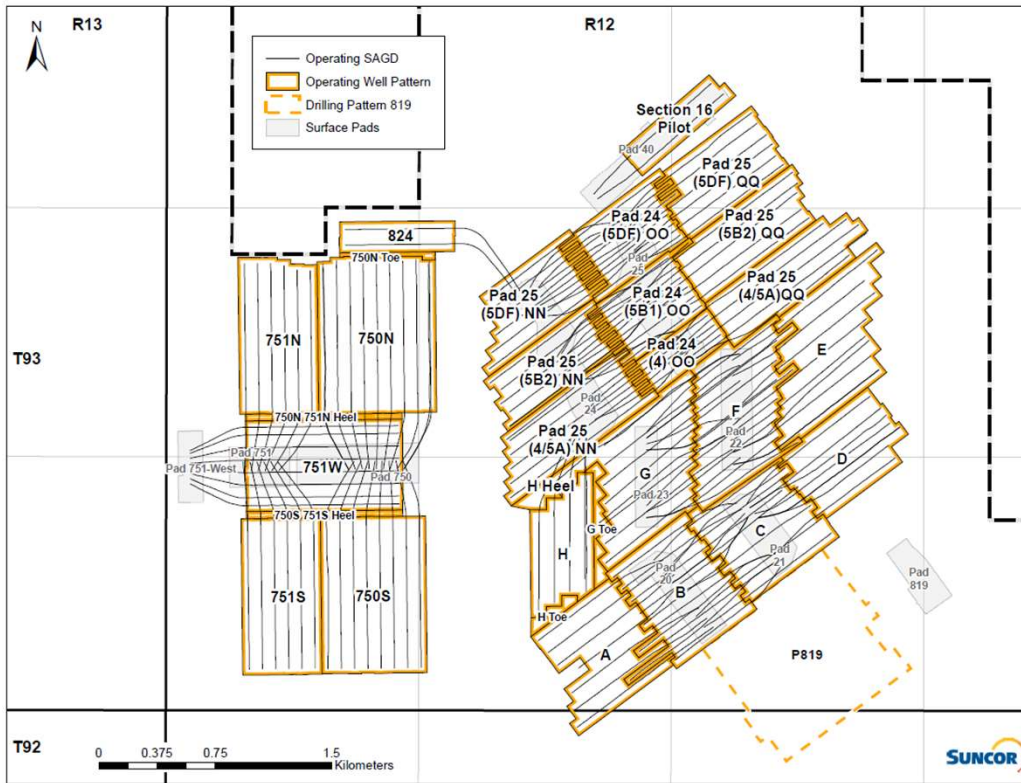
Subsurface View

Subsurface

4.2

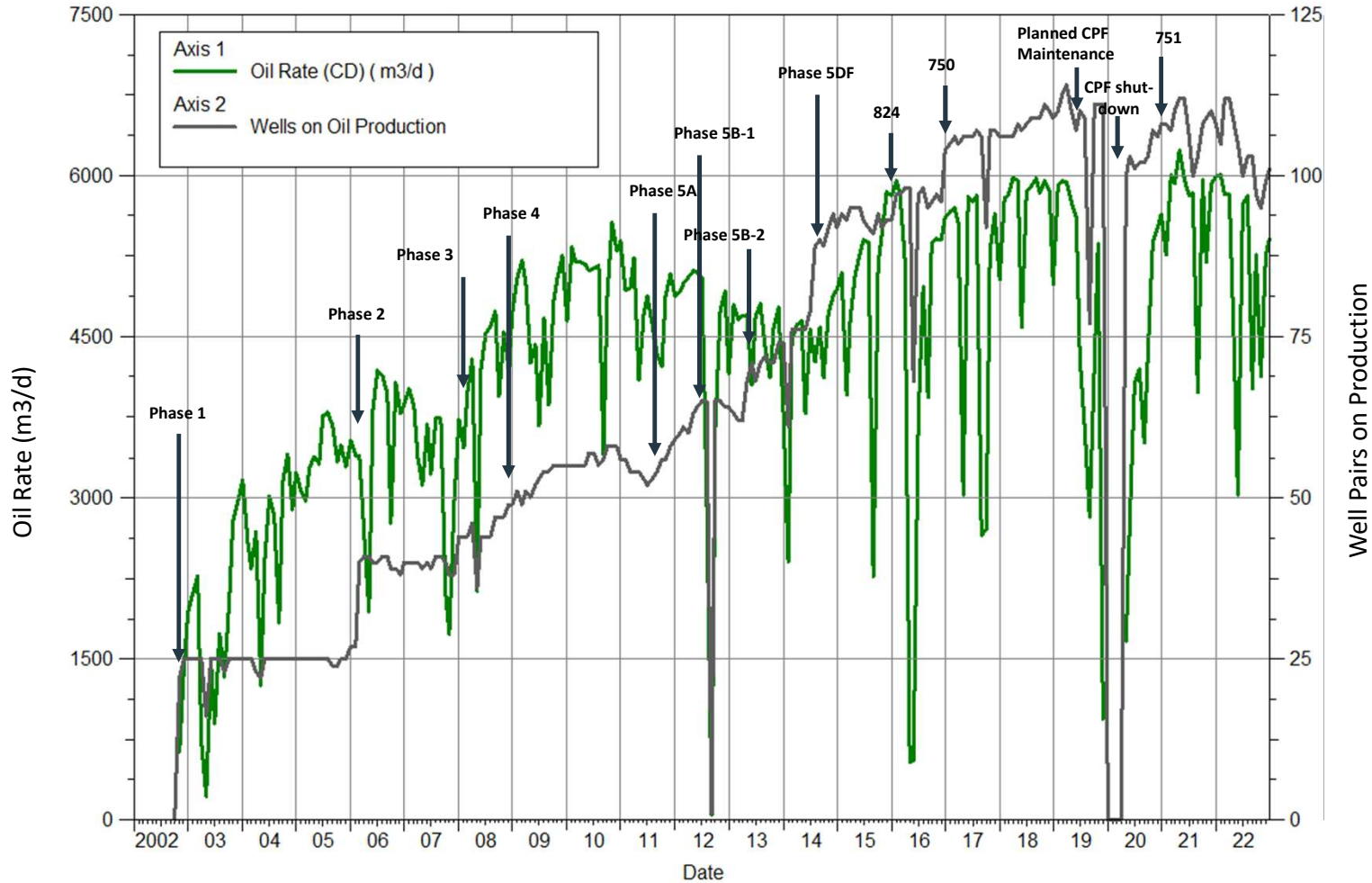


Summary of Operating Wells



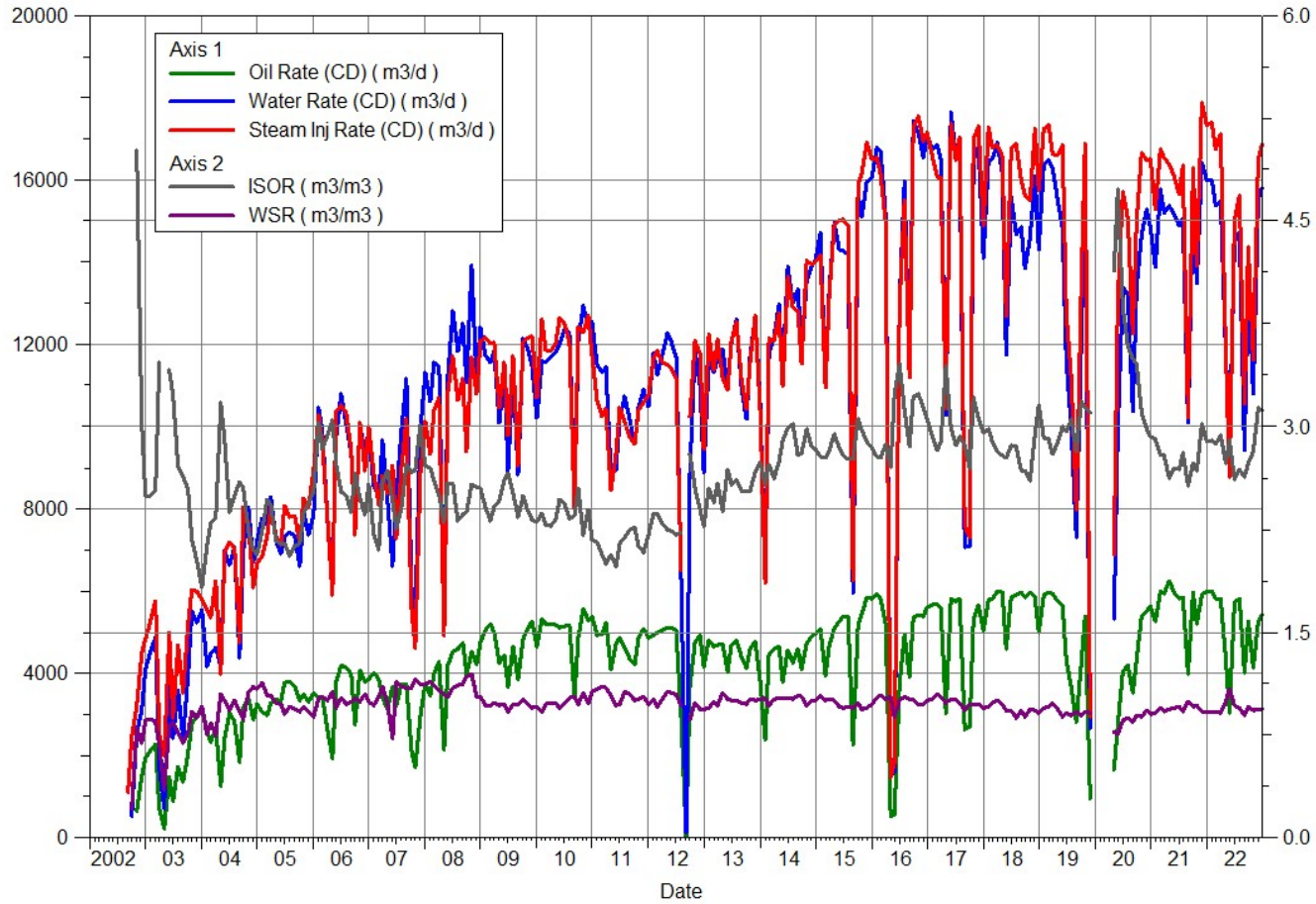
Pad	Pattern	Phase	# Well of Pairs	First Steam to Pad
20	A	1	7	2002
	C		6	
21	B	2	7	2006
	D		5	
22	E	3	7	2007
	G		7	
23	F	4	7	2008 - 2009
	OO		3	
24	OO	5B-1	6	2012
		5DF	6	2014
25	H	4	4	2009 - 2010
			2	2008
25	QQ	5A	2	2011
			5	2013
25	NN	5DF	6	2014
			4	2008
25	NN	5A	4	2011
			5	2013
25	NN	5DF	6	2014
			2	2015
24	824	6	2	2015
750	750N	7A/D	8	2016
	750S	7A/B/C	8	2016 - 2019
751	751W	8A/B	6	2020
	751N	8C	1	2020
	751S	8B/C	5	2020
	751N	8D	4	2021
	751N/751S	8E	2	2021

Scheme Performance – Well Production History



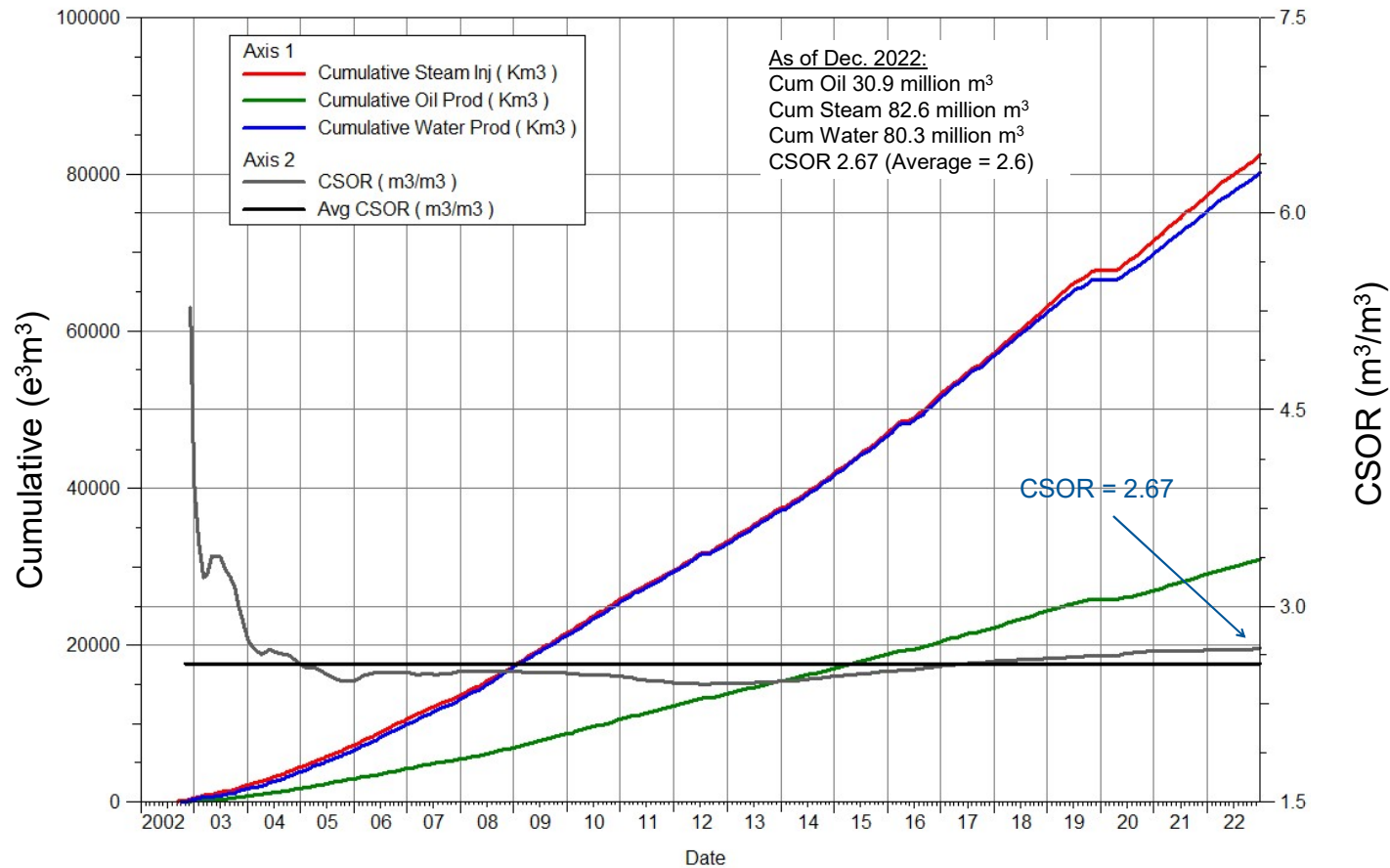
Scheme Performance – Well Production History

Historical Fluid Rates

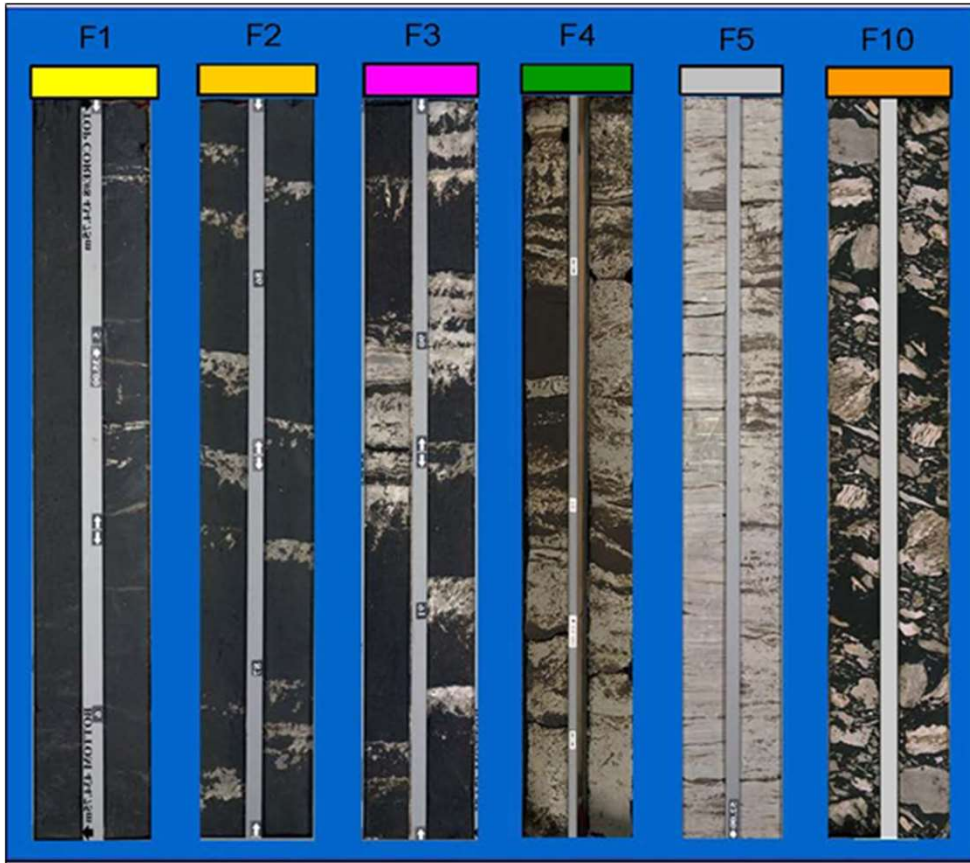


Scheme Performance – Well Production History

Historical Cumulative Fluid Volumes



Reservoir Facies



Facies:

- Defined by Visual Mud Index (VMI).

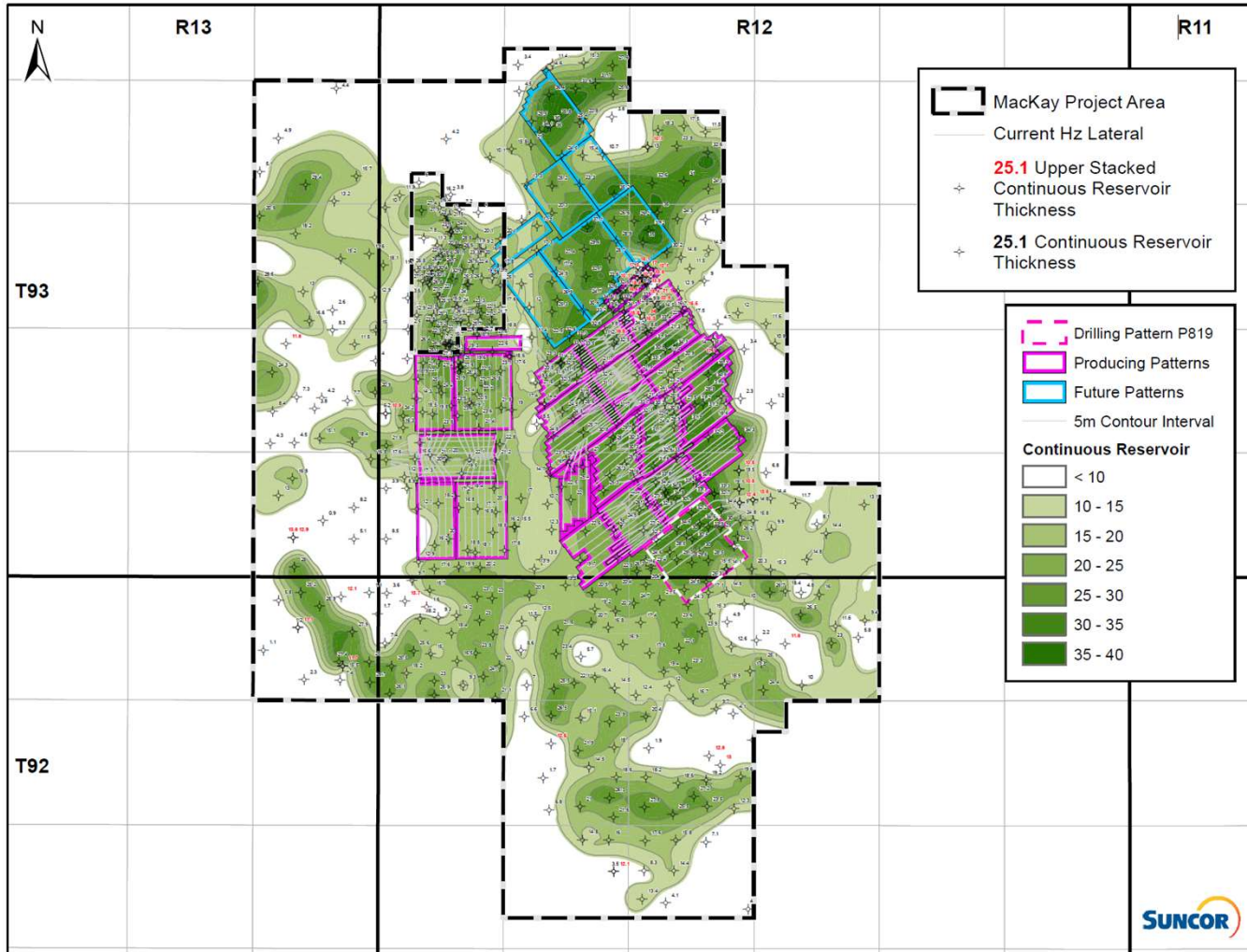
Cutoffs:

- F1 (Sandstone) <5% VMI;
- F2 (Sandy HIS*) 5-15% VMI;
- F3 (IHS*) 15-30% VMI;
- F4 (Muddy IHS) 30-70% VMI;
- F5 (Mudstone) 70-100% VMI;
- F10 (Breccia) Variable.

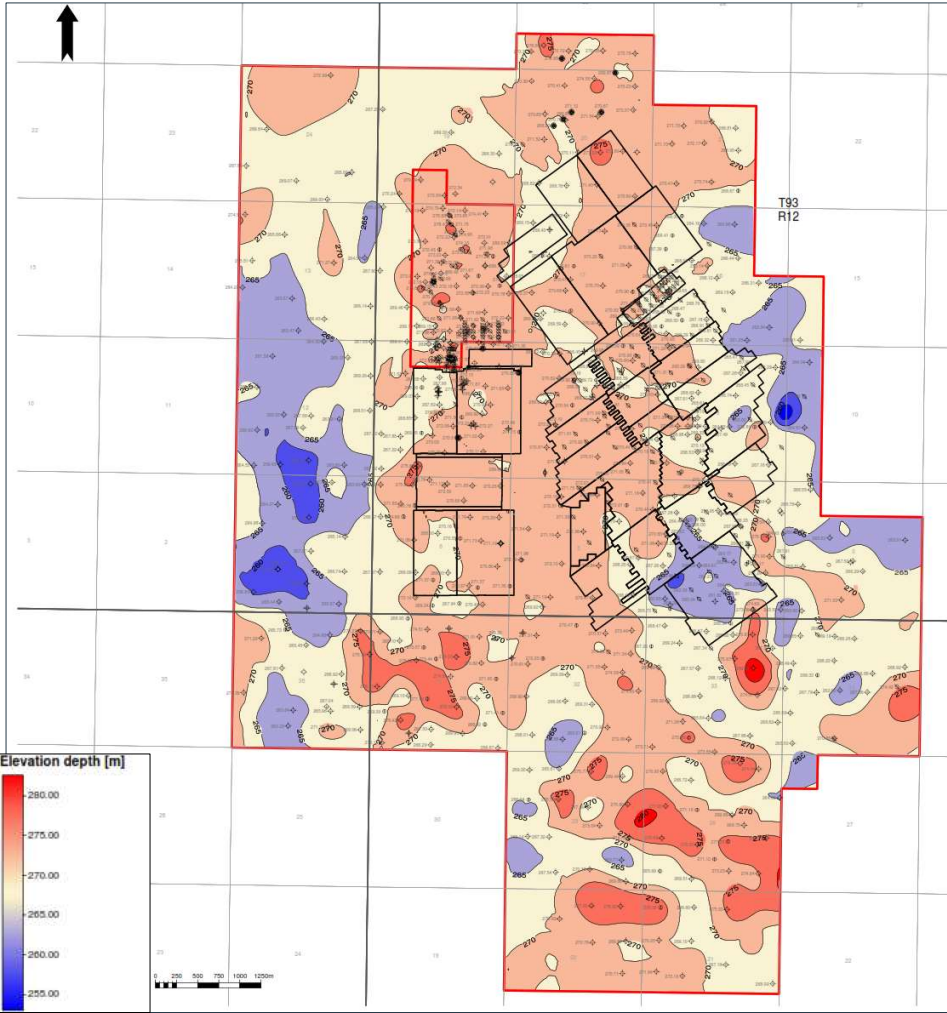
*IHS – Inclined Heterolithic Strata

- Reservoir includes Facies F1, F2, and F10, but can include F3-F5, if < 2m thick.
- Weight percent bitumen > 6%;
- Porosity (generally) > 30%;
- Continuous reservoir thickness >10m for OBIP volumetric calculation.

Continuous Reservoir Isopach



Base of Reservoir Structure Map



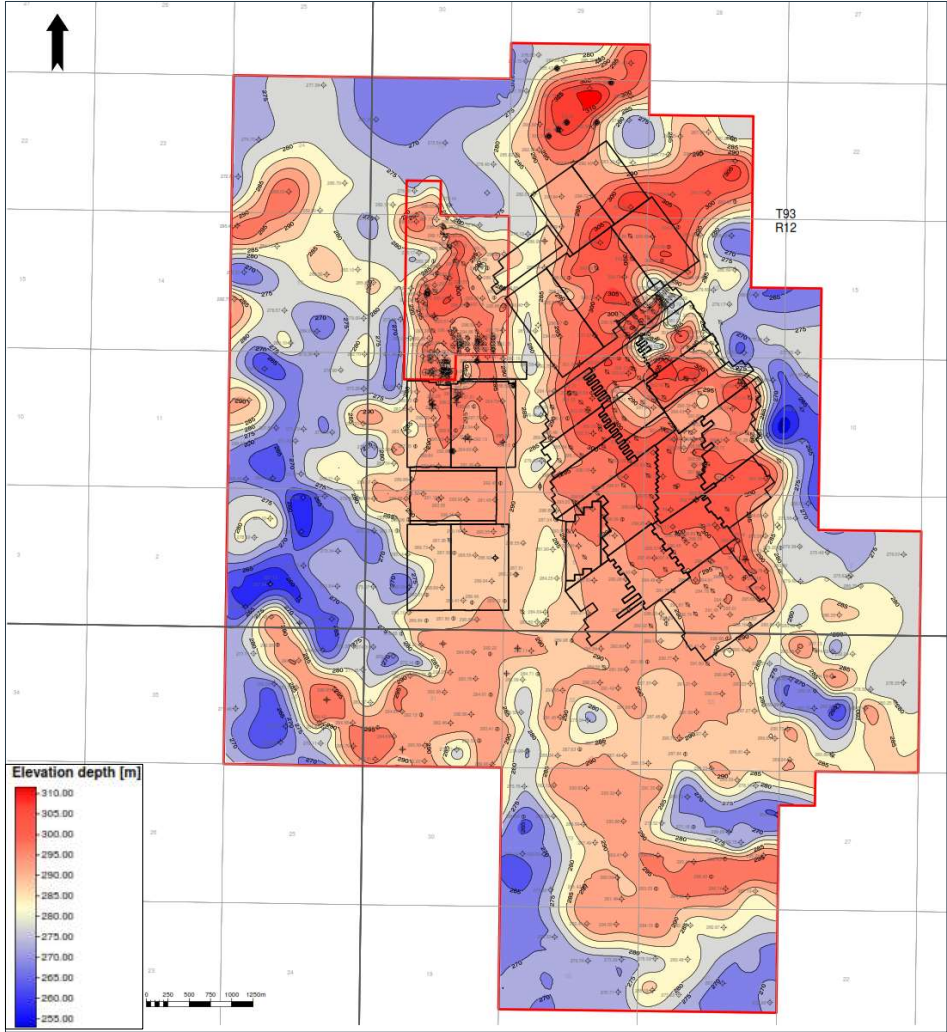
Legend

- Approved PA Boundary
- Contour Interval = 5m


2022 MacKay Base of Reservoir

- Contour Interval = 5m

Top of Reservoir Structure Map



Legend

 Approved PA Boundary

- Contour Interval = 5m

2022 MacKay Top of Reservoir

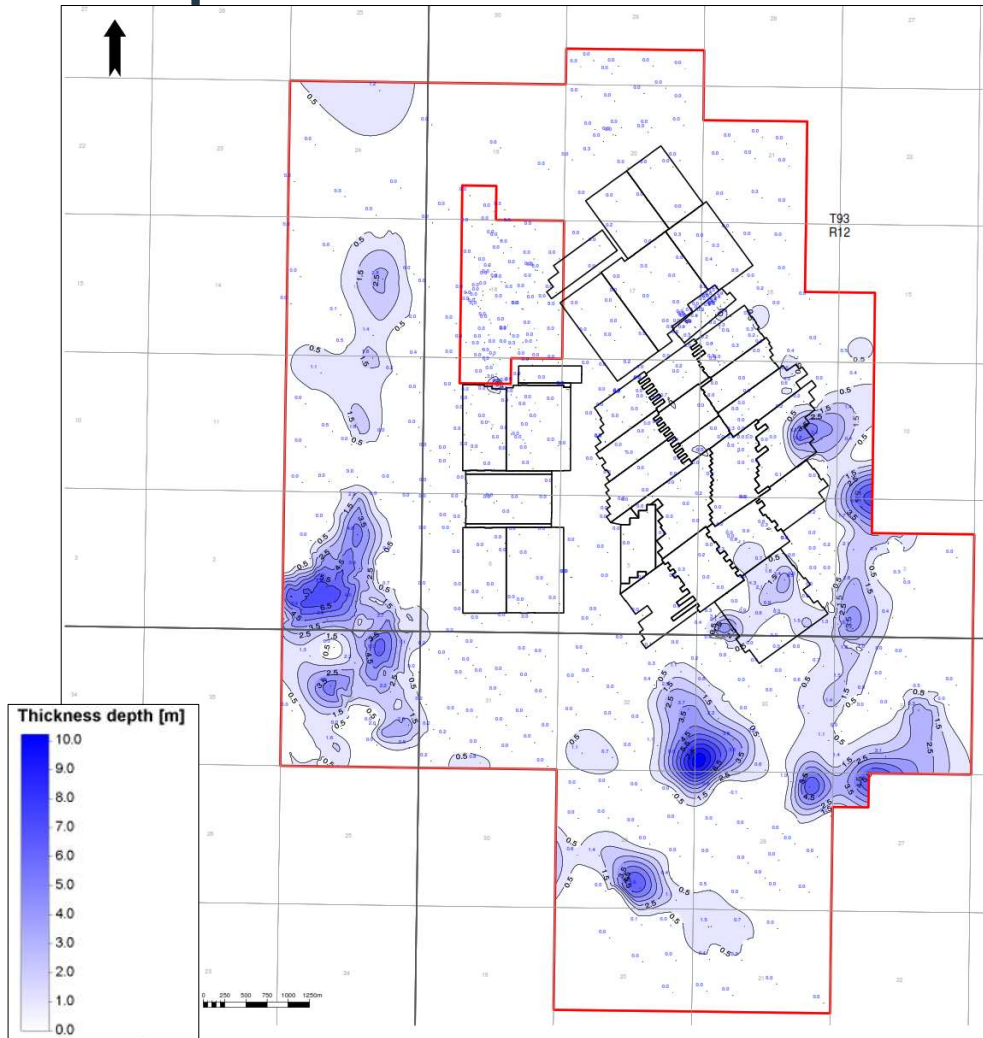
- Contour Interval = 5m

Reservoir Gas Isopach



Gas zones shown above are inconsequential to SAGD operations at Mackay River but are included for reference

Bottom Water Isopach



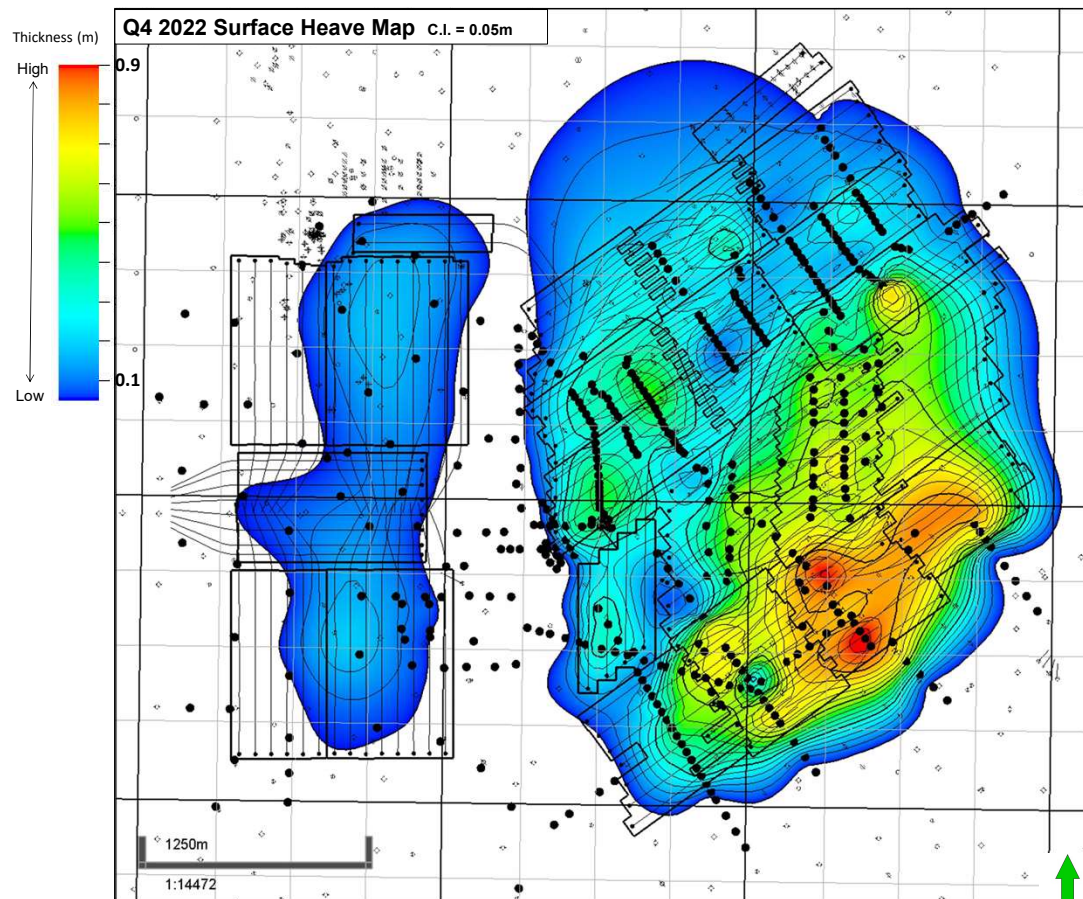
Legend

- Approved PA Boundary
- Contour Interval = 1m

2022 Mackay Bottom Water Isopach

- Cutoff = BMFO < 0.02 & GR < 60 API
- Contour Interval = 1m

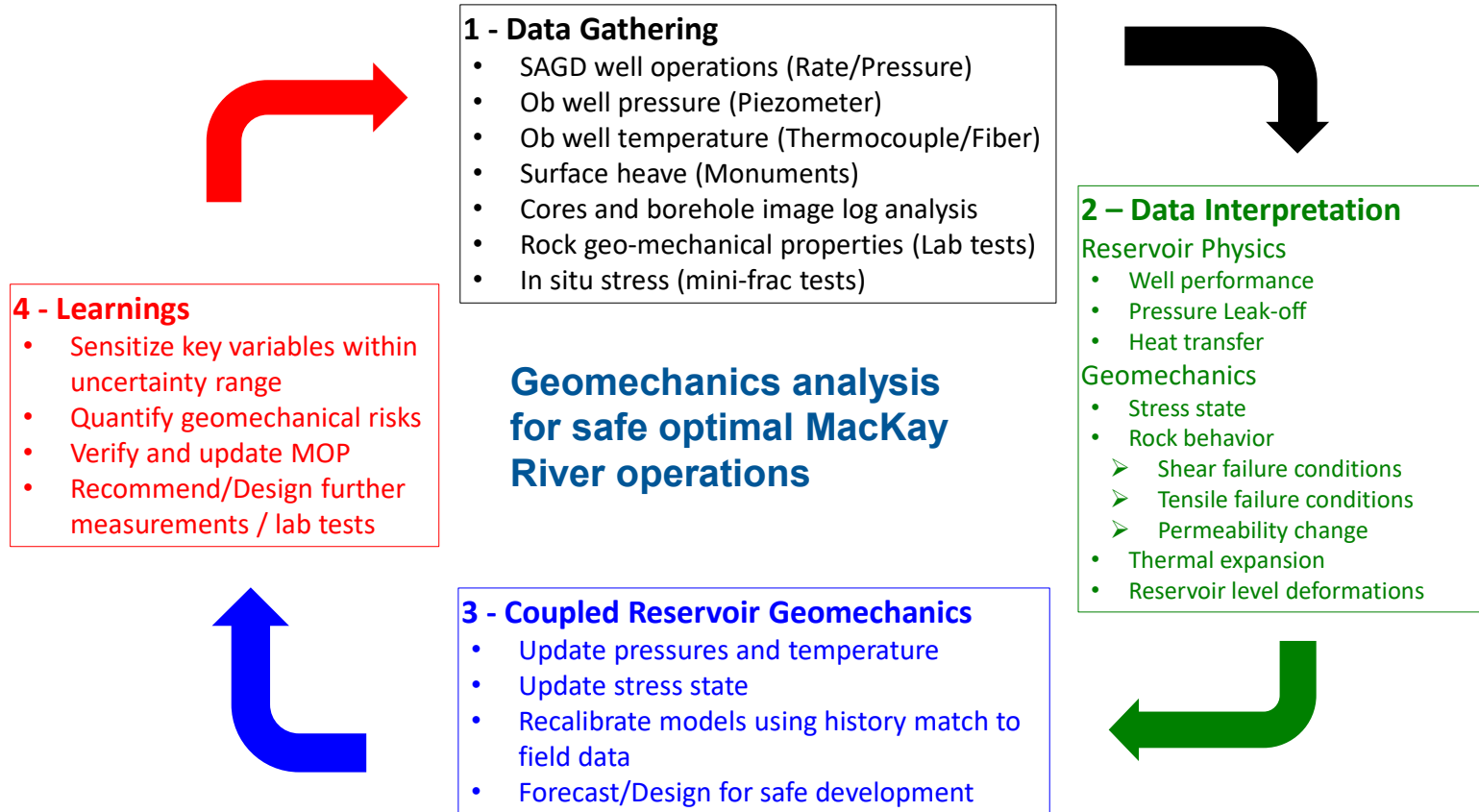
Cumulative Heave: From 2002 - 2022



- Maximum heave of ~92 cm observed over C Pattern / Pad 21 (this relates to an increase of ~2 cm from survey in 2021):
 - Mature area of the field
- Monitor subsurface safety and investigate areas which appear anomalous,
 - There are no geomechanical anomalies in the producing area
- Heave data is used to calibrate geomechanical models

Note: 2022 heave mapping covered all the producing area of MacKay River.

MacKay River Coupled Geomechanics / Reservoir Workflow



Reservoir Fracture Closure Gradients

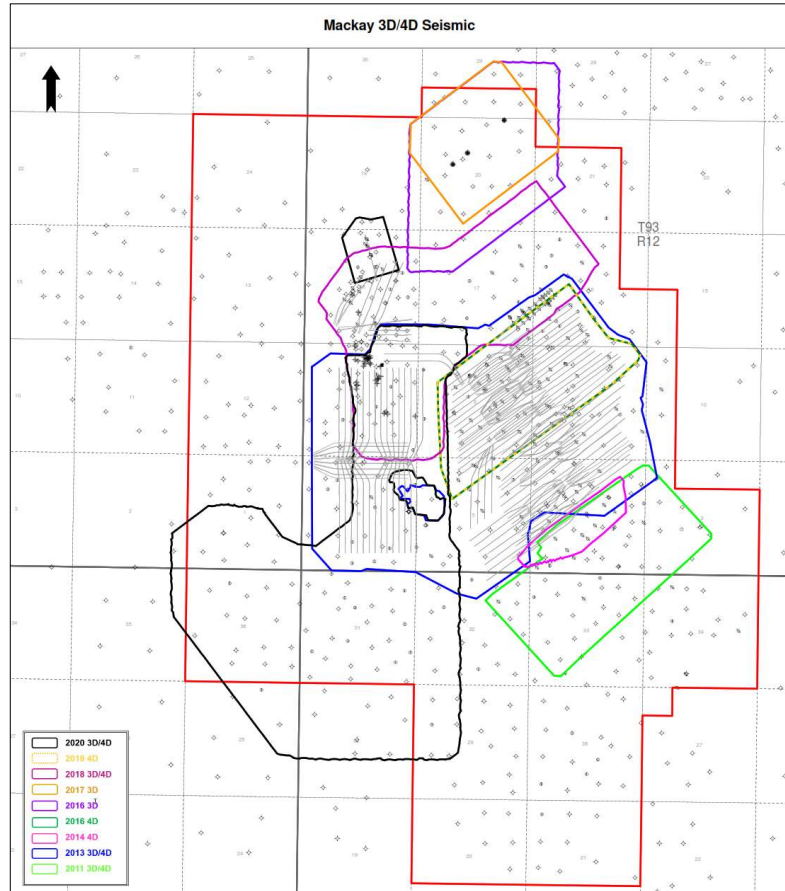
No Mini-Frac wells in 2022.

No changes recommended to the MacKay River bottomhole maximum operating pressures (MOPs) currently approved; using the following methodology:

- Fracture gradient of 21 kPa/m X based of the caprock (Wab D) in pattern X 80% (20% safety factor).

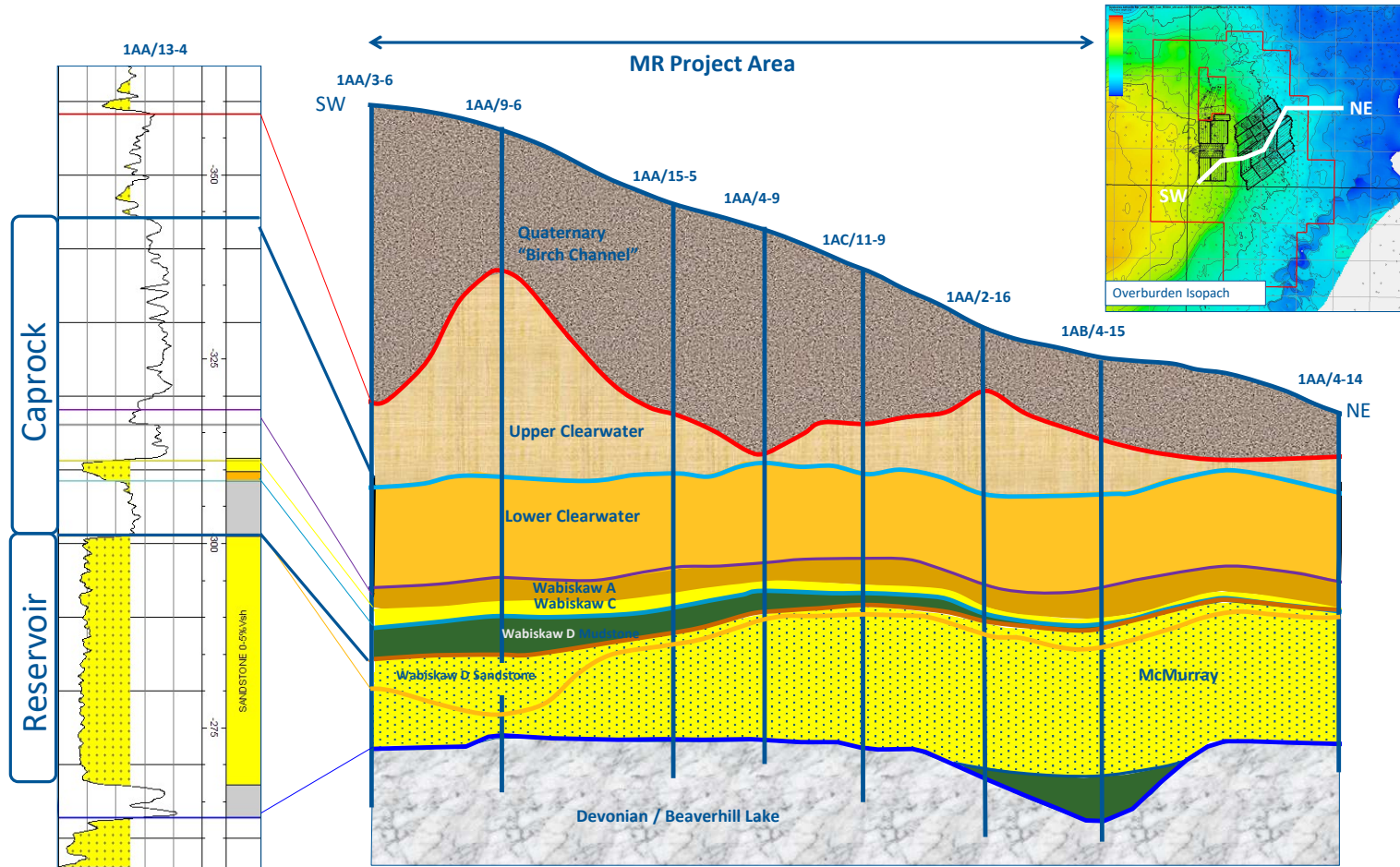
Well Date Collected	Formation			
	Clearwater	Wabiskaw D	Wabiskaw C	McMurray
Dover 7-36 AB/07-36-092-13W4 2020	22.8	23.1	23.7	19.8
Dover 6-17 AB/06-17-093-12W4 2020	22.2	22.8	24.2	21.5
OB23 100/11-20-093-12W4 2017	20.4	19.5	-	19.0
JK-9 1AA/16-04-093-12W4 2014	22.3	21.1	22.1	-
LQ2 100/05-34-092-12W4 2011	21.3	21.2	22.6	21.1
SST3 100/09-06-093-12W4 2008	24.1	-	24.3	19.9
kPa/m: unit of fracture gradient				

MacKay River – 3D / 4D Seismic Activity



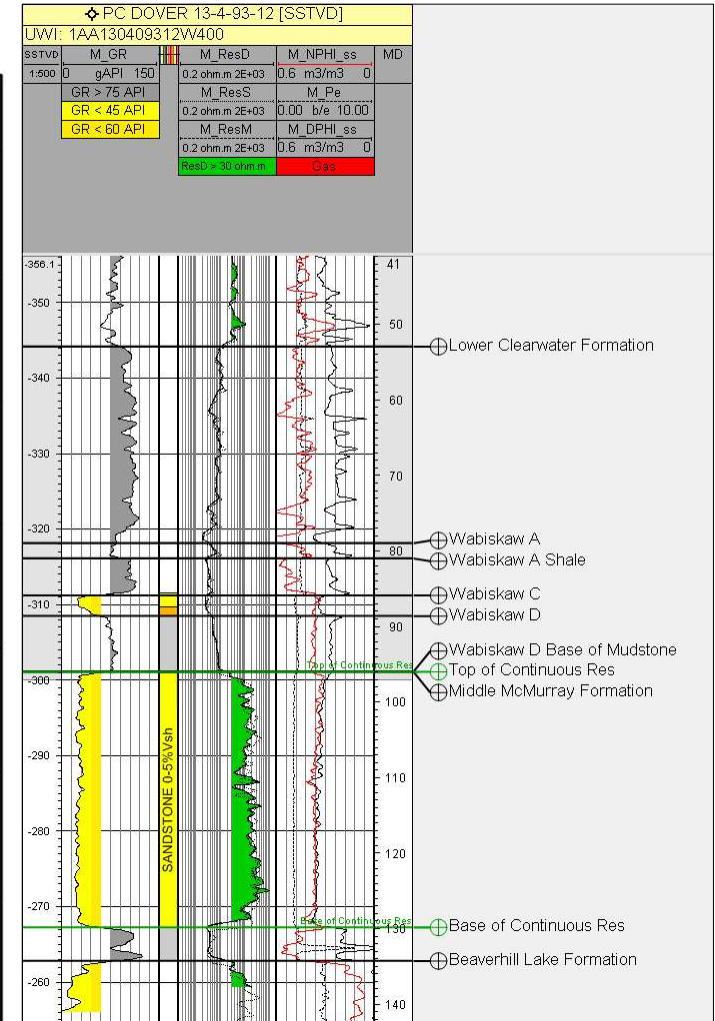
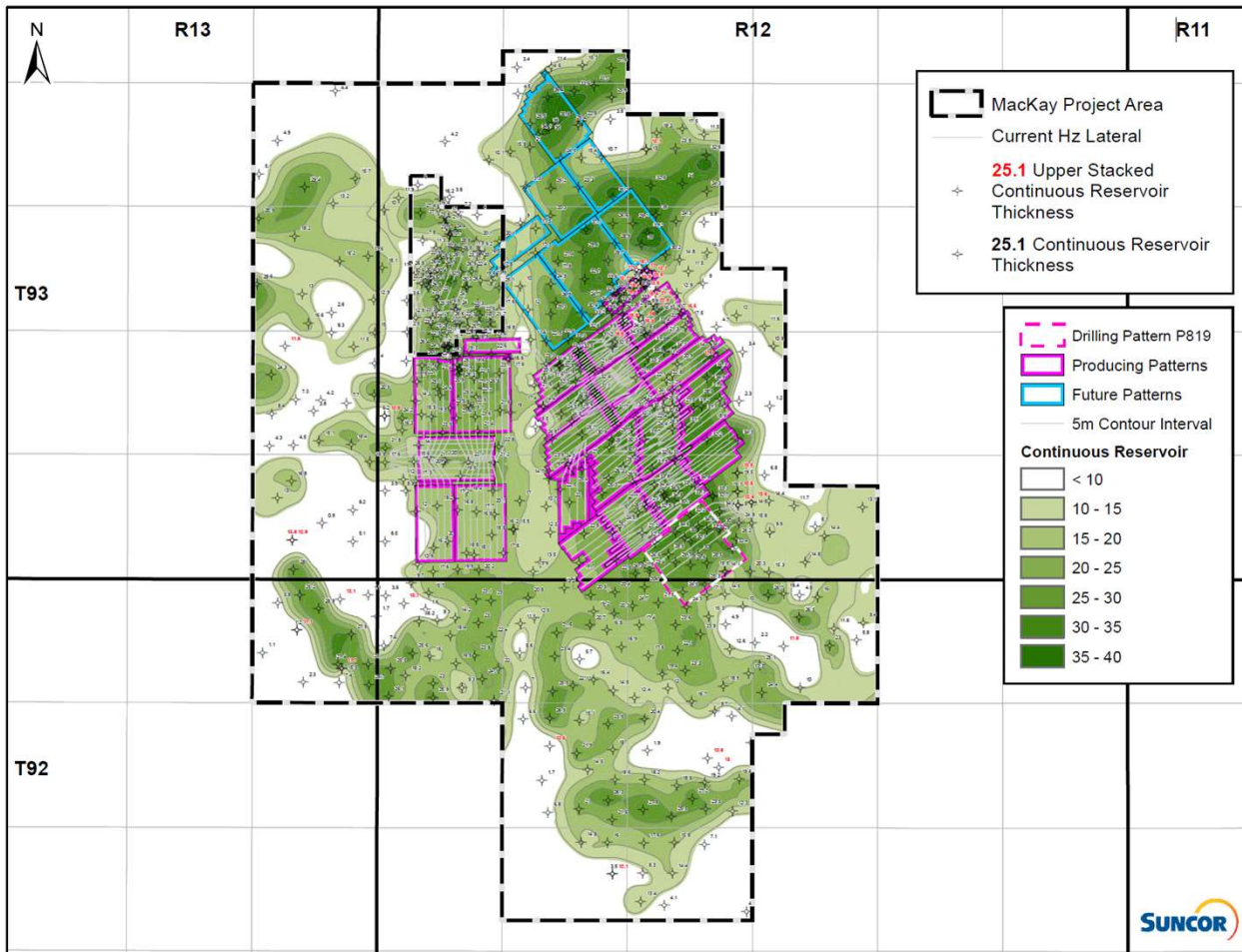
- No seismic activity in 2022.

MacKay River Regional Structure



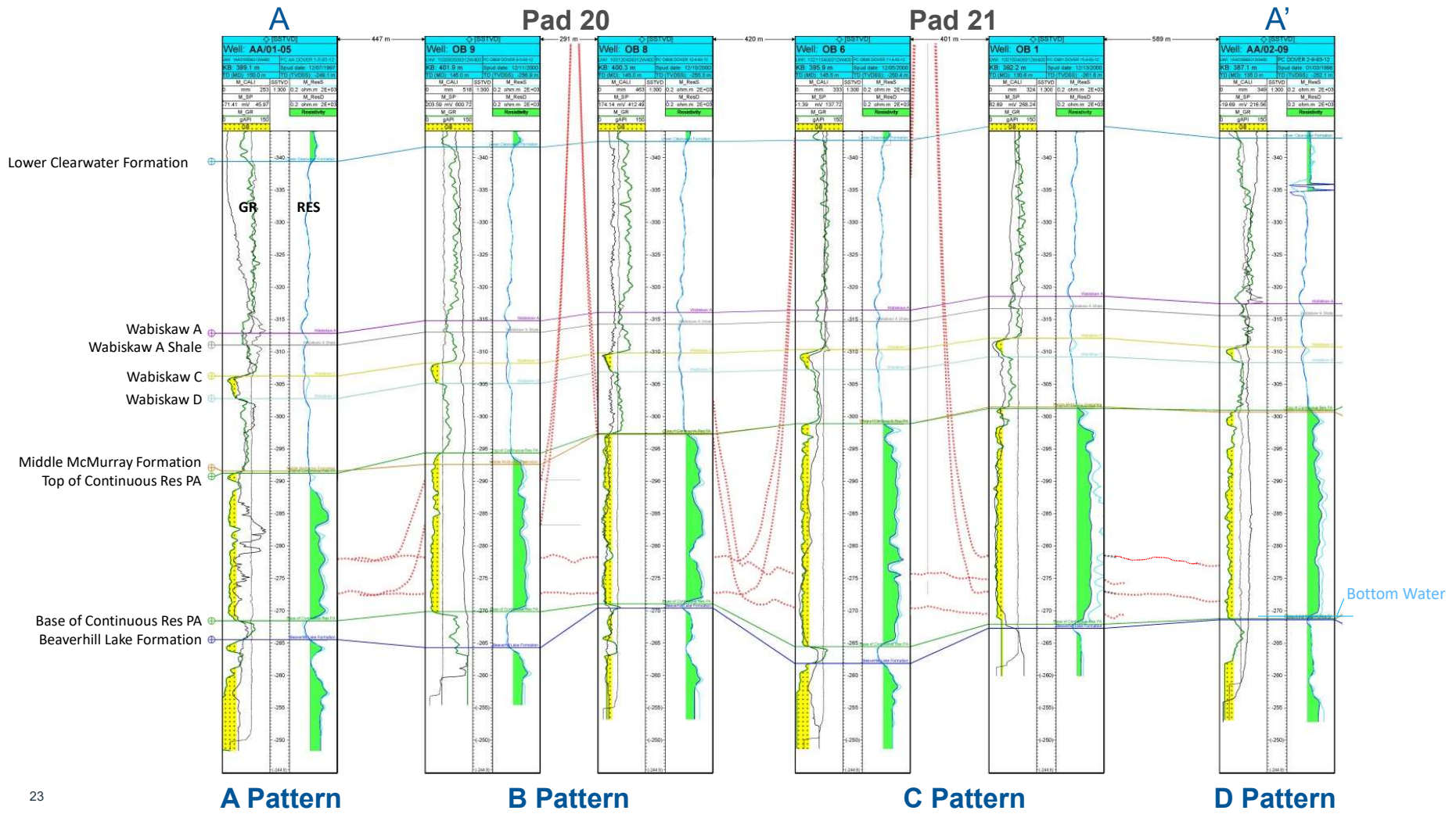
MackKay River Stratigraphy

4.2.4
a) b)



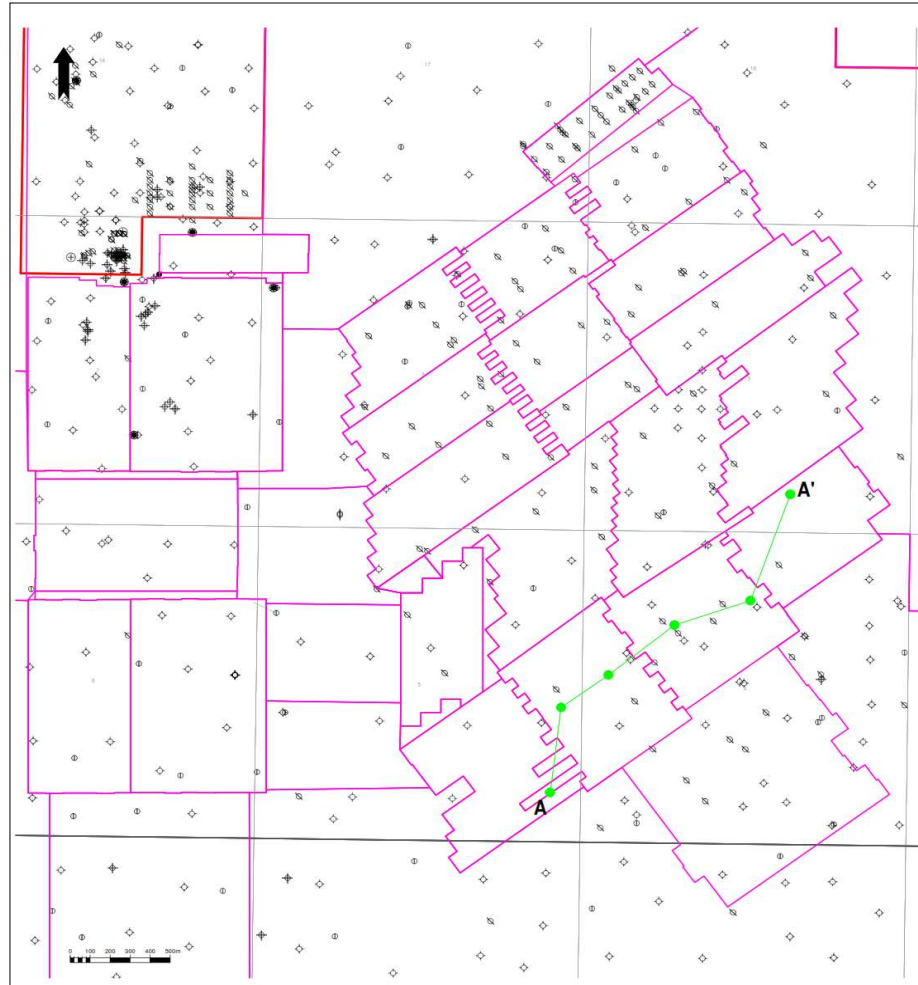
Representative well cross-section (Phase 1)

4.2.4
a) b) c)

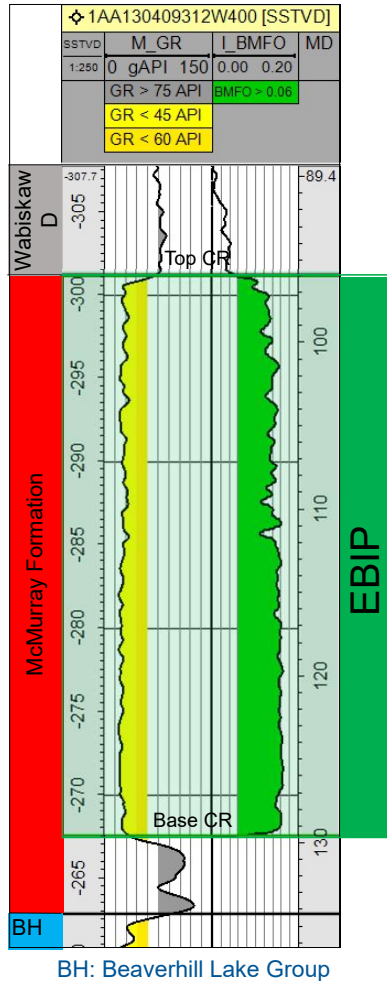


Representative well top-down view (Phase 1)

Wells that defined the representative cross section (slide 24)



Exploitable Bitumen in Place (EBIP)



Exploitable Bitumen in Place (EBIP) is defined in each well by the top and base of Continuous Reservoir; It is selected at the base of a continuous sand unit either developed or most likely to be developed.

- Continuous Reservoir base: lowest portion of the continuous reservoir sandstone with Bulk Mass Fraction of Oil (BMFO) cut-off of 6%, <3m of >50% mud/breccia in the lower portion.
- Continuous Reservoir top: 2m of mudstone, no BMFO or porosity cut offs.

Upper Lean, Middle Lean, and Gas Zones that are in pressure communication with the continuous reservoir are included with no thickness cutoffs.

Observation wells and 4D seismic will take precedence over pre-operations core and log-based picks.

Note: EBIP at Mackay River is the same as Original Bitumen in Place (OBIP). EBIP is the preferred term used on site.

Exploitable Bitumen in Place & Average Reservoir Properties

Pattern	HC area (m ²)	Continuous Reservoir Thickness (m)	Porosity	Horizontal Permeability (mD)	Vertical Permeability (mD)	Oil Saturation	EBIP (e ³ m ³)	EBIP (MMbbls)
A	438,699	21.7	0.33	6000	1000	0.72	2,245	14.12
B	495,385	26.6	0.34	7000	1000	0.82	3,701	23.28
C	460,137	33.1	0.34	7000	1000	0.83	4,283	26.94
D	375,189	30.7	0.33	6000	1000	0.79	3,037	19.10
E	541,970	29.9	0.33	6000	1000	0.8	4,345	27.33
F	532,340	30.0	0.34	7000	1000	0.82	4,466	28.09
G	617,808	27.9	0.34	6000	1000	0.78	4,548	28.60
H	351,723	21.8	0.34	6000	1000	0.78	2,022	12.72
NN	1,039,756	26.4	0.34	6000	1000	0.78	7,247	45.58
OO	749,567	27.5	0.34	6000	1000	0.77	5,302	33.35
QQ	1,011,974	25.6	0.34	6000	1000	0.76	6,621	41.64
824	130,443	19.7	0.32	6000	1000	0.81	679	4.27
750N	782,650	22.7	0.33	6000	1000	0.79	4,617	29.04
750S	684,498	18.0	0.34	6000	1000	0.74	3,069	19.30
751W	676,067	20.2	0.34	6000	1000	0.77	3,547	22.31
751N	507,153	22.2	0.33	5000	1000	0.76	2,851	17.94
751S	423,807	17.0	0.34	6000	1000	0.75	1,840	11.57
Combined Active Well Pattern Area	9,819,166	25.0	0.34	N/A	N/A	0.78	64,420	405
* Project Development Area	42,295,107	20.7	0.33	N/A	N/A	0.73	212,962	1,340

EBIP: Exploitable Bitumen In Place. Without modification this generally stands for SAGD EBIP or producible bitumen in place.

EBIP = OBIP

HC: Hydrocarbon

- Project area and Development area are the same.

Performance Summary by Pattern

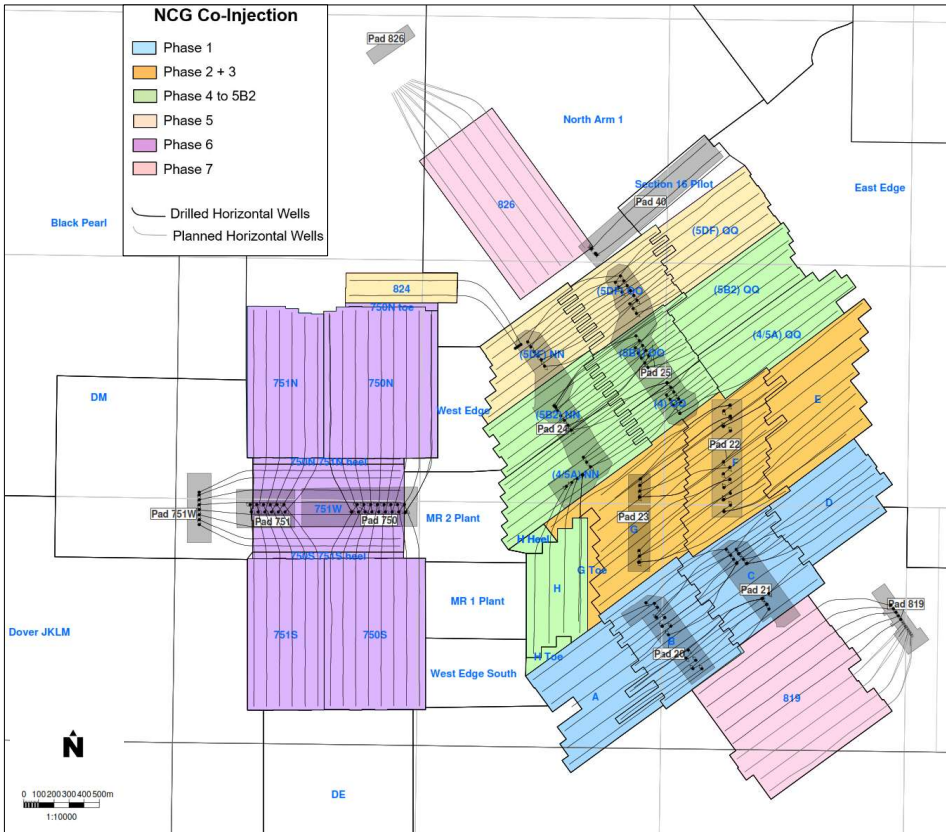
Pattern	EBIP (e ³ m ³)	Cum. Oil (e ³ m ³)	Recovery (%)	CSOR (m ³ /m ³)	iSOR (m ³ /m ³)	Ultimate Recovery (%)
A	2,245	1214	54%	4.3	1.4	60%
B	3,701	2949	80%	2.7	1.4	84%
C	4,283	2994	70%	3.1	0.6	77%
D	3,037	2167	71%	2.6	1.8	75%
E	4,345	2827	65%	2.3	1.7	72%
F	4,466	2921	65%	2.7	2.8	77%
G	4,548	2328	51%	2.5	2.1	59%
H	2,022	834	41%	3.2	3.4	61%
NN	7,247	3747	52%	2.8	3.8	74%
OO	5,302	1742	33%	2.9	3.0	52%
QQ	6,621	2306	35%	2.5	3.2	50%
824	679	233	34%	3.2	8.9	52%
750	7,686	2358	31%	2.7	2.4	72%
751	8,238	892	11%	3.1	3.1	68%
Combined Active Well Pattern Area	64,420	29,512	46%	2.8	2.8	67%

Average Reservoir Properties

Average reservoir properties for the operating portion of the scheme:

- Initial reservoir pressure: 400kPa
- Initial reservoir temperature: 6°C
- Average reservoir thickness: 25.0 m
- Average porosity: 0.337
- Average oil saturation: 0.78
- Horizontal permeability: 2 to 8 D
- Vertical permeability: 1 to 4 D
- Viscosity: ~ 1,000,000 cp @ 15°C

SAGD NCG Co-Injection Strategy



Pilot

- NCG (non-condensable gas) co-injection into B pattern – 2011
- Injection was based on steam availability

Phase 1

- NCG co-injection to A, B, C and D patterns – 2016

Phase 2 + 3

- NCG co-injection to E, F and G patterns – 2018

Phase 4

- NCG co-injection to H Pattern, NN1 to NN10, OO1 to OO9 and QQ2 to QQ10 – Mar 2021

Phase 5

- NCG co-injection to Pad 824, NN11 to NN16, OO10 to OO15 and QQ11 to QQ16 – 2023

Phase 6:

- NCG co-injection to Pad 750 and 751 – 2025

NCG Co-Injection Strategy

At MacKay, NCG (i.e. methane fuel gas) is co-injected with steam:

- The primary purpose is to maintain production and chamber pressures while reducing steam usage.

NCG injection targets are determined by:

- Desired operating pressures;
- Field wide strategies for steam reallocation;
- Steam chamber maturity and current oil recovery;
- NCG retention within the reservoir.

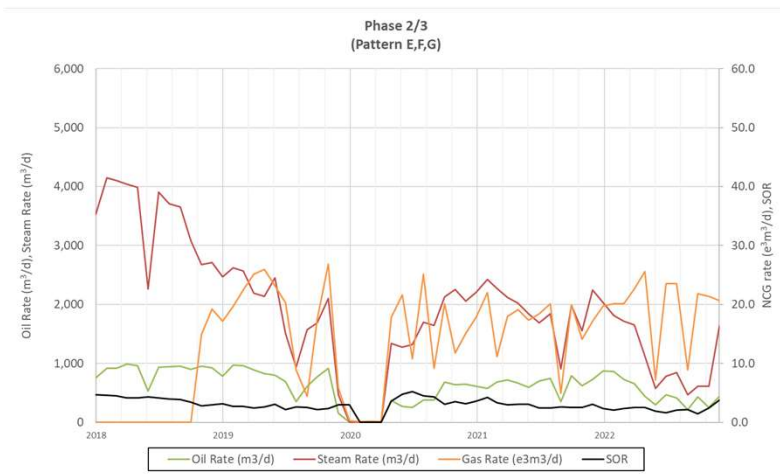
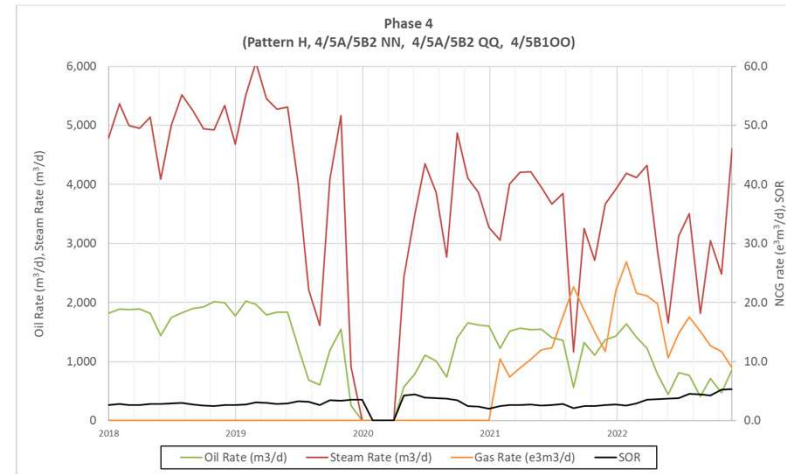
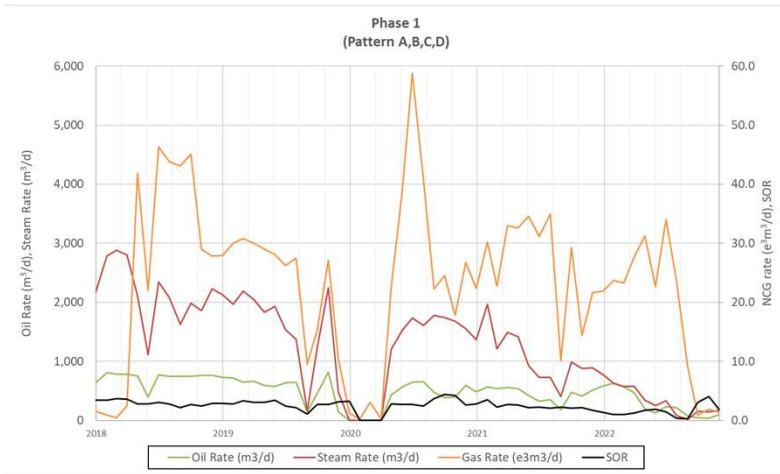
Typical NCG to gas replacement ratios range between 15 – 40 Sm³/m³ CWE;

Injected NCG does not exceed a maximum of 18 e³m³/d per well on a quarter year average basis;

NCG returns have been challenging to measure precisely due to produced gas from gas lift usage.

NCG returns have been challenging to measure precisely due to produced gas from the gas lift usage. The percentage of NCG recovered is estimated to be in the range of 6 – 10%.

Key Learnings



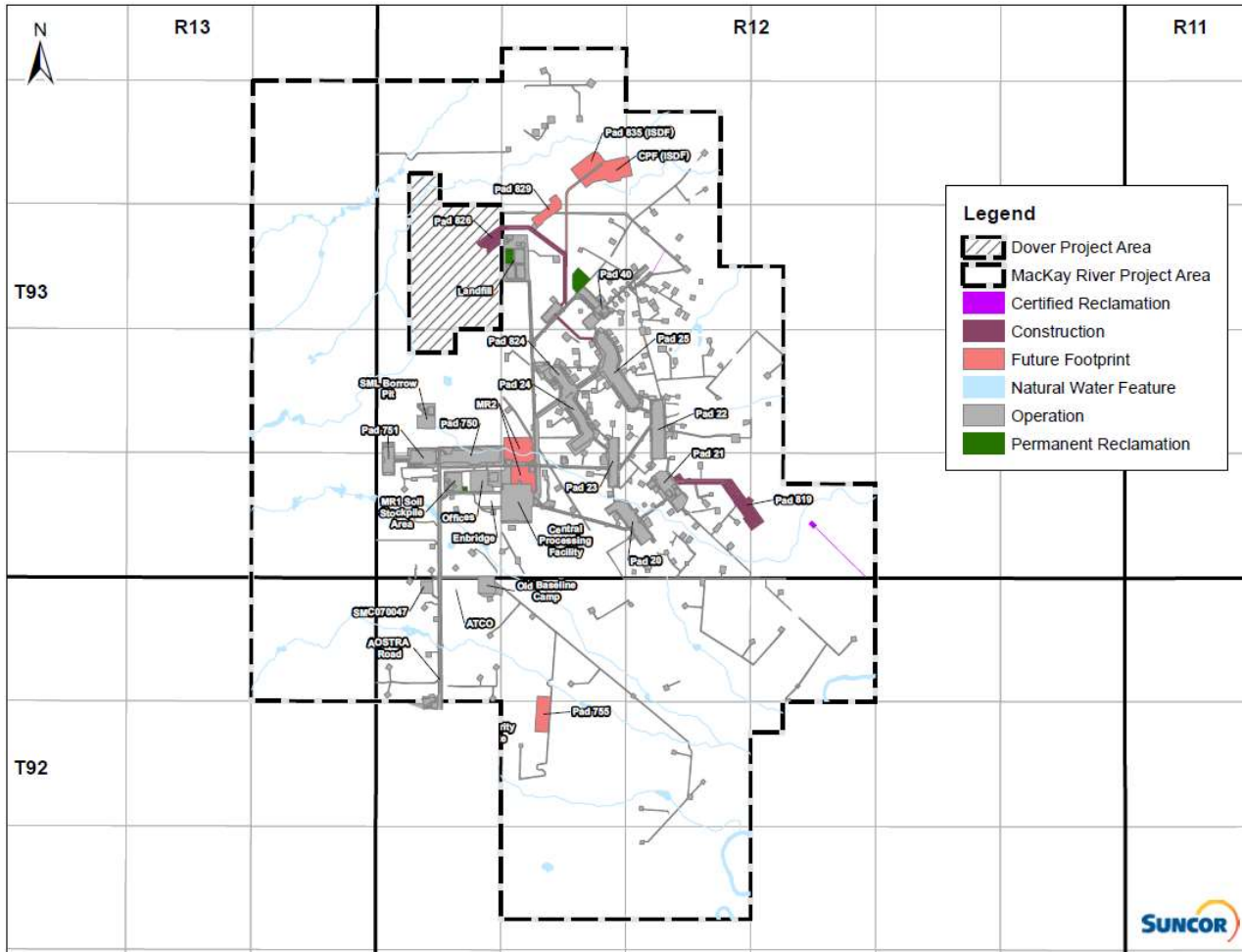
- NCG was used successfully after the outages to help rebuild pressures and optimize steam allocation to younger, more impacted patterns,
- Phase 4 NCG co-injection was started March 2021
- Steam cuts were made while co-injecting less NCG than anticipated to sustain target chamber pressures,
- Overall, NCG has helped reduce SOR where it has been applied,
- No negative impacts to oil rates, wellbore integrity, or ultimate recovery have been observed,
- Future NCG phases have been considered for acceleration to further optimize steam allocation.

Surface

4.3



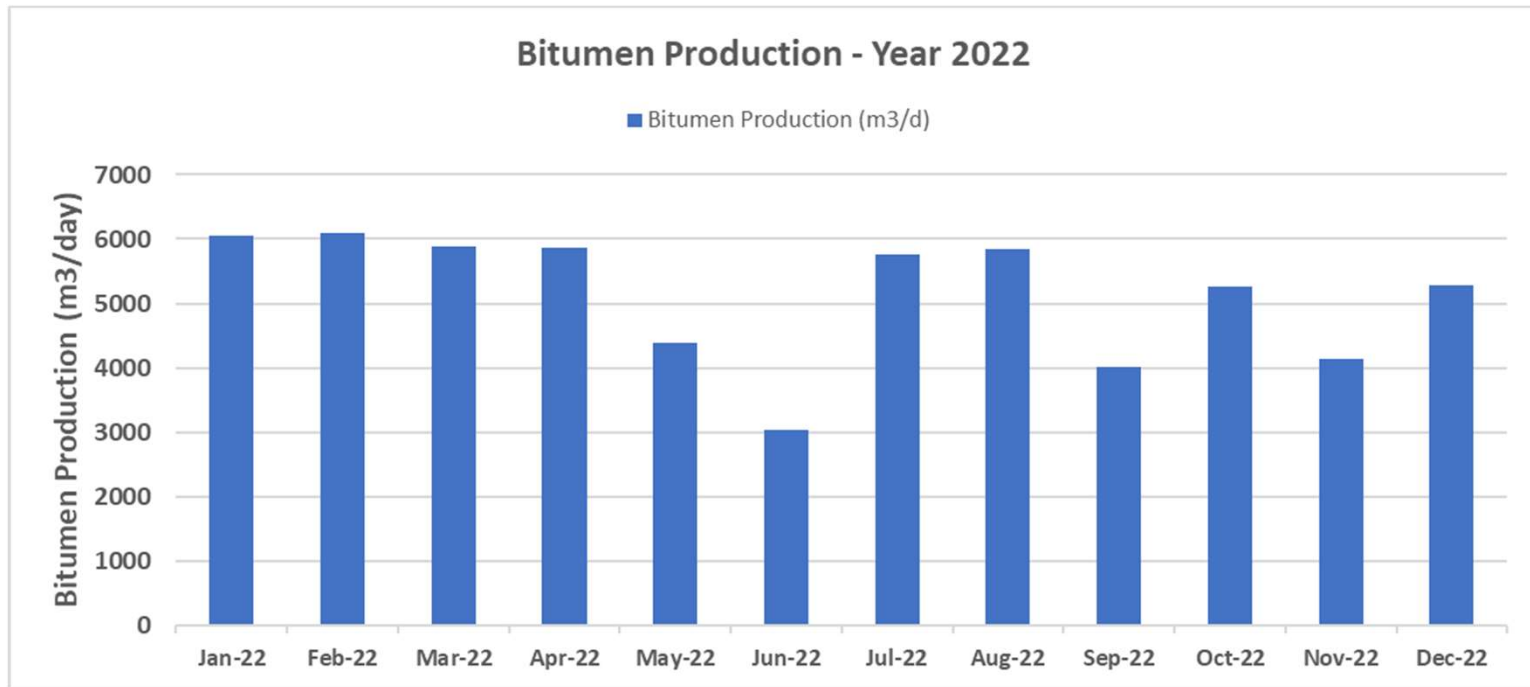
Overview of Built and Planned Surface Infrastructure



There have been no modifications to the Central Processing Plant (CPF) during the reporting period that have required an Alberta Energy Regulator (AER) application approval.

Annual Rates – Bitumen; January 1, 2022 to December 31, 2022

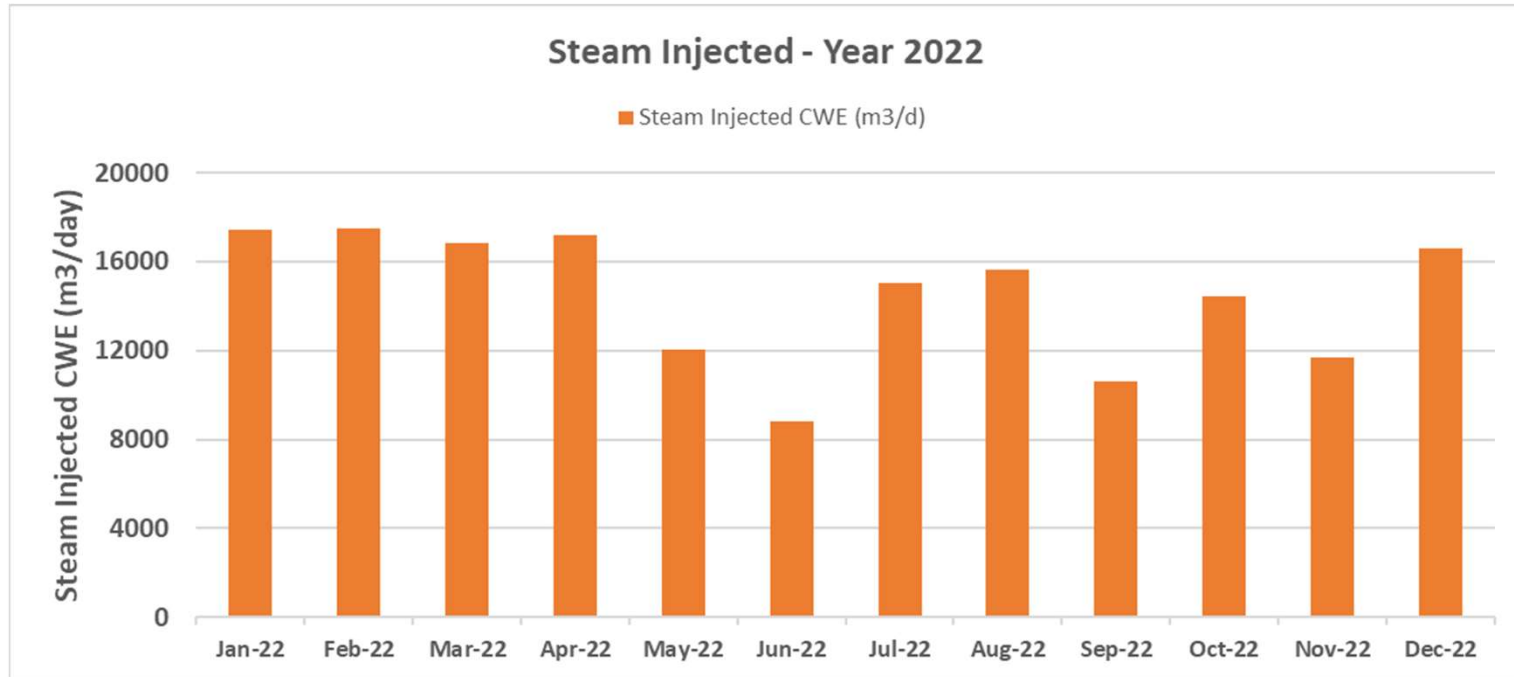
From January 2022 to December 2022 MacKay River averaged 5,137 m³/day (32,326 bbl/d) of bitumen production. The Design rate for the MacKay River CPF is 6,041 m³/day (38,000 bbl/d) @ 2.8 SOR.



Annual Rates – Steam; January 1, 2022 to December 31, 2022

From January 2022 to December 2022 MacKay River injected on average 14,485 m³/day (91,143 bbl/d) of steam into the wells.

The steam injection design rate for the MacKay River CPF is 18,432 standard m³/d (115,937 bbl/d).



Historical and Upcoming Activity

4.4



Suspension and Abandonment Activity

Well Abandonment:

- For the reporting period from January 1, 2022 to December 31, 2022, no producing wells were abandoned in the MacKay River project.
- One observation well was abandoned.

Pad Abandonment:

- For the reporting period from January 1, 2022 to December 31, 2022, no pads were abandoned in the MacKay River project.

Regulatory Applications; January 1, 2022, to December 31, 2022

Approved Applications:

Application #	Description	Registration Date	Approval Date	Application Type
1935674	Logging waiver request at Pad 819	31-Jan-22	1-Feb-22	OS Drill/Log Waivers
1935675	Drilling waiver request at Pad 819	31-Jan-22	1-Feb-22	OS Drill/Log Waivers
014-00048408	EPEA Approval Renewal Application	31-Mar-22	24-Nov-22	EPEA Renewal
001-483595	Water Act License	29-Apr-22	13-Jun-22	Water Act License
1937616	Heavy Oil Late Life Energy Recovery Pilot	3-May-22	18-Jul-22	Comm Amend Category 2
1938278	Logging waiver request for horizontal wells	9-Jun-22	13-Jun-22	OS Drill/Log Waivers
1938277	Drilling waiver request for horizontal wells	9-Jun-22	13-Jun-22	OS Drill/Log Waivers
1938610	Request to Conduct Multiple Interval Commingled Injection Test	11-Jul-22	3-Aug-22	Injectivity Test
1938917	Commingled Injectivity Test	8-Aug-22	15-Aug-22	Injectivity Test
1939217	In Situ Demonstration Facility Approval Rescinded	6-Sep-22	3-Oct-22	OSCA Amendment
1939643	Disposal Scheme Application for two disposal wells (DW1 and OB63)	12-Oct-22	31-Jan-23	Class I Disp: New
1941088	Heavy Oil Late Life Energy Renewal Pilot Amendment	18-Nov-22	15-Dec-22	Comm Amend Category 2
1941521	Base deposit waiver for winter drilling program	20-Dec-22	21-Dec-22	OS Drill/Log Waivers

Future Applications:

- For the reporting period of January 1, 2023, to December 31, 2023:
 - Suncor to submit 3 Water Act Applications.

Summary of Events

No significant changes were made in 2022 that materially affected scheme performance or energy or material balances.

Pad 751 Start-Up Continued into 2022

- There are 18 well pairs and 2 single well producers on Pad 751
 - Pad 751 start up had a staggered of well pairs, to support CPF capacity demand;
 - Circulation commenced in 2020 and continued through 2022, with the remaining wells starting up in 2023

Pad 826 Well Head Spacing

- Well heads were moved 24.1 meters. No change to drainage patterns and no significant changes.

Summary of Key Learnings

Piping Release at Steam Generator 04-SG-401D leading to unplanned plant outage:

- Conducted corrosion hazard assessment, updated regional and enterprise standards relating to adherence of industry practice, reviewed facility layout and areas with high fluid turbulence to implement changes. Also increased inspection frequency to catch early signs of issues.

Completion of the CPF emulsion line capital project:

- Demonstrated an engineered solution against accelerated erosion of piping wall thickness.

Completion of the pH trial in water treatment circuit:

- Permanent reduction of the boiler feed water pH is under review.

Pilots / Technical Innovations – New Technology Update

Heavy Oil Late Life Energy Recovery (HOLLER):

- Application submitted in Q2 2022;
- Applying to use well on MacKay River's Pad 20 to pilot the HOLLER technology.
- Amended HOLLER Approval in Q4 2022 to allow Mackay River produced water use and extension of project expiry date.

In Situ Demonstration Facility (ISDF):

- OSCA Approval rescinded.

Compliance History

Date Incident	AER - Edge#	Type of Incident	Title & Description	Remediation or compliance efforts
Jan 26-2022	387391	Spill	Hydrochloric acid release from the HCL tanks at Plant 300 CPF	The total volume release was 12 m3. Approximately 9m3 remained within the berm and 3m3 went through the 2nd containment system and was released onto the soil. No water bodies were impacted. All the acid was neutralized with soda ash and the area affected was cleaned up. Investigation was completed and actions were created to prevent reoccurrence
May 12-2022	390504	Spill	Cogen - Tripped following for steam condensate water spill	Upon discovery of the release, operations placed containments in the area. The fluids released on the ground of the CPF footprint were clean up by hydro vacuum trucks
May 25 -2022	390929 & 391013	Spill	Mackay River-steam release from a significant damage in the high pressure steam pipe in Plant 400	The plant was shutdown and plant was evacuated. The condensate of the steam release was cleaned up as well any other released caused by the emergency shutdown. A full investigation was completed and corrective actions were implemented such as the increase of inspections frequency and conduct a corrosion hazard assessment for MR.
Jun 24-2022	400617	Flaring > 4hrs	Flaring due to 04-P-401B Tripped on M04TAHH430 causing Cogen duct burners and steam generators to trip	This tripped caused some upsets in the plant operations and once it was stabilized the flaring ceased.
Aug 20-2022	402966	Spill	Uncontrolled steam release from a production well 25NN3P LT GL Wing Valve Bonnet	Operations called for completions support and they were able to close the wing valve and reduced the steam release to a minimum until have the valve replacement.
Sep 12-2022	404275	Fire Flaring > 4hrs	While operations was bringing down Co-gen facility for a planned outage a fire was noted coming from the duct burners dog house in the co-gen plant. There was a Flaring due to the excess fuel gas caused by the Cogen fire.	A full investigation was completed and corrective actions has been adopted to avoid reoccurrence of this event. This flaring was caused due to the excess fuel because the fire at Cogen. The flaring stopped once the plant started coming back .
Oct 16-2022	405675	Spill	Small amount of HCl release from the gasket of 03-LIT-381 (Level Transmitter)	This was a small leak (<1L) and it was all contained withing the containment berm . Spill was cleaned up and the gasket replaced.
Nov 08-2011	526977	Non-conformance	AER inspection found non conformance with D55 at the MR- tank farm	Repairs has been scheduled to bring the tank farm containment system back in compliance
Nov 27-2022	407150	Flaring > 4hrs	LP flaring due to - 02-PCV-501 failure	The valve was isolated and operations managed to adjust the sweep gas to stop the flaring.
Dec 03-2022	407400	Flaring > 4hrs	Flaring was caused due to a PSV that was passing	The valve was replaced and the flaring stopped
Dec 16-2022	407810	Flaring > 4hrs	Flaring due to the VRU tripped caused by the seal water flow	Once the VRU returned to operations, flaring stopped.
Dec 21-2022	407916	Flaring > 4hrs	Flaring due to trip of 04-SG-401A cause by the high fuel gas pressure 04-PI-1179	After several attempts to restart, operations were able to bring the steam generator back on line and stopped the flaring

January to December 2022

Surface Casing Vent Flow; Reporting and Deferral

ID Submission 2073143

PC NN(I) - 07 DOVER 03-08-93-12W4M; UWI 102/03-08-093-12W4/0;
Reported VIA DDS on November 27, 2020;
Deferral request approved to April 30, 2024.

ID Submission 2073151

PC NN(I) - 09 DOVER 06-08-93-12W4M; UWI: (107/06-08-093-12W4/0);
Reported via DDS on November 27, 2020;
Deferral request approved to April 30, 2024.

ID Submission 2125382

PC NN(I) - 08 DOVER 03-08-93-12W4M; UWI: (111/03-08-093-12W4/0);
Reported via DDS on October 12, 2021;
Deferral request approved to April 30, 2024.

ID Submission 2125384

PC NN(I) - 10 DOVER 06-08-93-12W4M; UWI: (108/06-08-093-12W4/0);
Reported via DDS on October 12, 2021;
Deferral request approved to April 30, 2024.

ID Submission 2125385

PC QQ(I) - 09 DOVER 03-16-93-12W4M; UWI: (109/03-16-093-12W4/0);
Reported via DDS on October 12, 2021;
Deferral request approved to April 30, 2024.

Future Plans

The following horizontal drilling activities are expected to commence within the next five years:

- Brownfield Programs
 - 2023: 5 sidetrack wells
 - 2024: # of sidetrack wells TBD
- Pad 819 – 9 well pairs: 2023
- Pad 826 – 6 well pairs: 2023
- Pad 829 – 12 well pairs: 2024

The following first steam dates are planned to occur within the next five years:

- Pad 819 – Q2 2024
- Pad 826 – Q4 2024
- Pad 829 – Q2 2026

Coreholes and observation wells will be drilled as necessary to:

- Adequately delineate the resource
- Monitor SAGD operations
- Further caprock integrity analysis
- Allow land retention

Note: Development plans are evaluated annually and are subject to change

Future Plans

First steam dates planned to occur within the next five years:

- Pad 819 – Q2 2024
- Pad 826 – Q4 2024
- Pad 829 – Q2 2026

(Regulatory approval in place for these pads)

Other planned pads in the figure to be developed beyond the five year mark.

Brownfield sidetracks are evaluated as needed to capture additional cellar resource (if present) and/or restore production to existing areas.

Development plans evaluated annually and are subject to change.

