

Groundwater Interpretative Report

Imperial Oil and Gas Pty Ltd

Environmental Management Plan

2021 Carpentaria 1 Work Program EP187

(15th of February 2022 to 14th of February 2023)

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Exploration Permit/Licence Number	EP187
Interest holder details	Imperial Oil & Gas Pty Limited Level 19, 20 Bond Street, Sydney NSW 2000 ABN - 92 002 699 578
Operator details	Imperial Oil & Gas Pty Limited Level 19, 20 Bond Street, Sydney NSW 2000 ABN - 92 002 699 578

Acronyms / Terms	Definition
Code	Code of Practice: Onshore Petroleum Activities in the Northern Territory
CBM	Control Monitoring Bore
DENR	Department of Environment and Natural Resources
DEPWS	Department of Environment, Parks and Water Security (NT)
EC	Electrical Conductivity
EMP	Environment Management Plan
EP	Exploration Permit
Guideline	Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-Basin
IMB	Impact Monitoring Bore
LOR / LOD	Limit of Reporting / Detection
TDS	Total Dissolved Solids

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1 Introduction

The EMP IMP3-4 – 2021 Carpentaria 1 Work Program EP187, dated 1st February 2021 was approved on the 15th February 2021.

Ministerial Condition 10 of the EMP Approval Notice requires Imperial Oil & Gas (Imperial) to provide an interpretative report of groundwater quality based on the groundwater monitoring required to be conducted at the well site.

Ministerial Condition 10 of the Approval Notice is as follows:

"In support of clause B.4.17.2 of the Code, the interest holder must provide to DEPWS, via Onshoregas.DEPWS@nt.gov.au, groundwater monitoring data and an interpretative report of groundwater quality based on the groundwater monitoring required to be conducted at the well site(s) in accordance with Table 6 of the Code. Groundwater data must be provided within one month of collection and be provided quarterly, in a format to be determined by DEPWS. The interpretative report must be provided annually within three months of the anniversary of the approval date of the EMP and include:

- *demonstration that there is no change to groundwater quality or level attributable to conduct of the regulated activity at the well site(s);*
- *interpretation of any statistical outliers observed from baseline measured values for each of the analytes;*
- *discussion of any trends observed; and*
- *a summary of the results including descriptive statistics."*

No regulated activities occurred between the 15th of February 2022 and the 14th of February 2023 under this EMP.

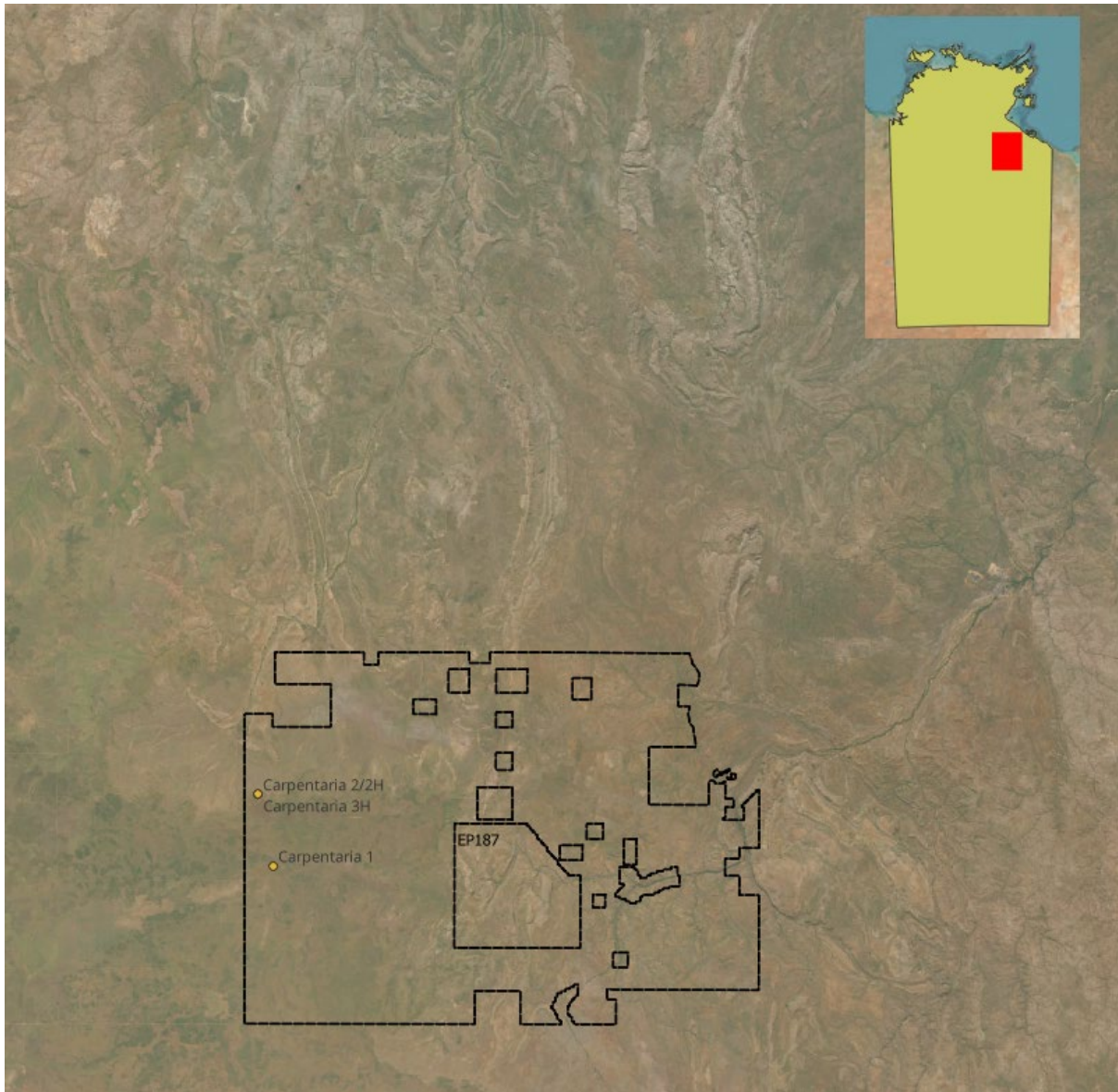


Figure 1 – Location of the Carpentaria-1 wellsite within EP187

For this well site two water monitoring bores were installed as per the Department of Environment and Natural Resources (DENR) Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-Basin (Guideline).

The following report demonstrates that the activities under the EMP have not had any impact on groundwater quality.

2 Methodology

2.1 Water Monitoring Bores

As per the Guideline a Control Monitoring Bore (CMB) is located approximately 100 metres up-gradient from the petroleum well, and an Impact Monitoring Bore (IMB) is located approximately 20 metres down-gradient from the well. Details of the monitoring bores are presented in Table 1.

Table 1 – Monitoring bores information

Well site	Carpentaria 1	
Aquifer	Gum Ridge	
Bore Number	RNo41800	RNo41678
Category	IMB	CMB
Total Depth (m)	96	96
Length of slotted liner (m)	24	22
ID of casing (mm)	158	158
Total Vol. of bore (L)	1882	1882
Production rate (L/s)	4	10
Time of produce one full volume (min)	7.8	3.1

The locations of the monitoring bores relevant to IMP3-4 are present on the Carpentaria 1 wellsite. These are visualised on Figure 2.

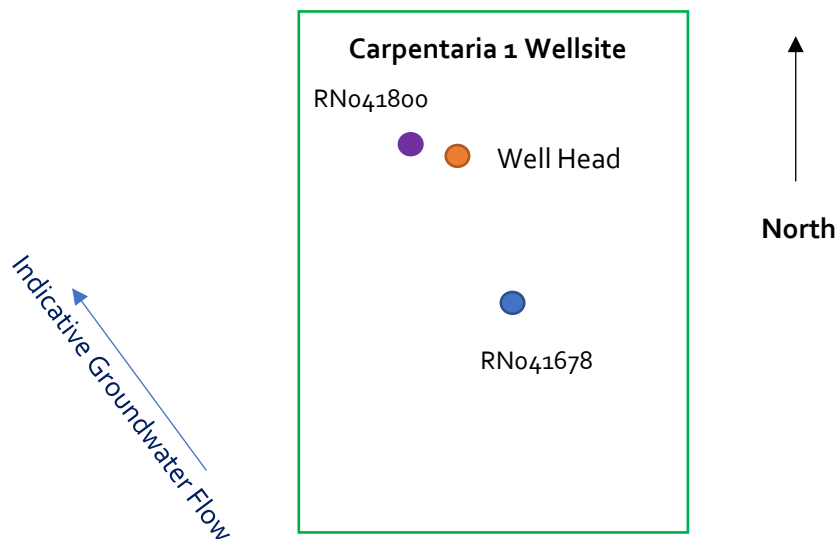


Figure 2 – Schematic of the monitoring bores locations in relation to Carpentaria-1 well

2.2 Water Sampling

Water sampling has been ongoing at Carpentaria 1 since April 2021 and a total of 26 samples from both bores have been analysed in accordance with the suite of analytes presented in Table 6: Minimum suite of analytes for groundwater monitoring from the Code of Practice: Onshore Petroleum Activities in the Northern Territory (the Code). Hydraulic fracturing (HF) of the Carpentaria 1 well occurred on the 4th of June 2021 and finished on the 8th of June 2021. Below is a breakdown of dates the samples were taken:

- 16 samples were taken from both bores prior to initiating the HF activity to provide site-specific data baseline groundwater data between the dates of:
 - 18/04/2021 – 25/05/2021
- 10 samples were taken after HF activities were conducted:
 - 16/06/2021- 17/01/2023

Raw data tables are provided in Appendix A – Data Tables.

3 Results and Discussions

As per the Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin:

"Analytes of particular interest include Total Dissolved Solids, Chloride, and Electrical Conductivity (E.C.) as a proxy, because drilling fluids, hydraulic fracturing fluids, well suspension fluids and produced formation fluids may have orders of magnitude (100s-1000s) higher concentrations of Chloride than background values in potable waters. In addition, Strontium and Barium are typically elevated in produced water from unconventional shale gas reservoirs and serve among others as additional useful tracers. Dissolved methane is important to monitor as a baseline and over the longer term."

As such these analytes have been discussed in detail below. All other analytes did not show any notable change to groundwater quality between the Control Monitoring and Impact Monitoring Bores, all raw data can be found in **Appendix A**.

3.1 Gum Ridge Aquifer

3.1.1 Electrical Conductivity

The results of monitoring for Electrical Conductivity in Gum Ridge aquifer are presented in Figure 3.

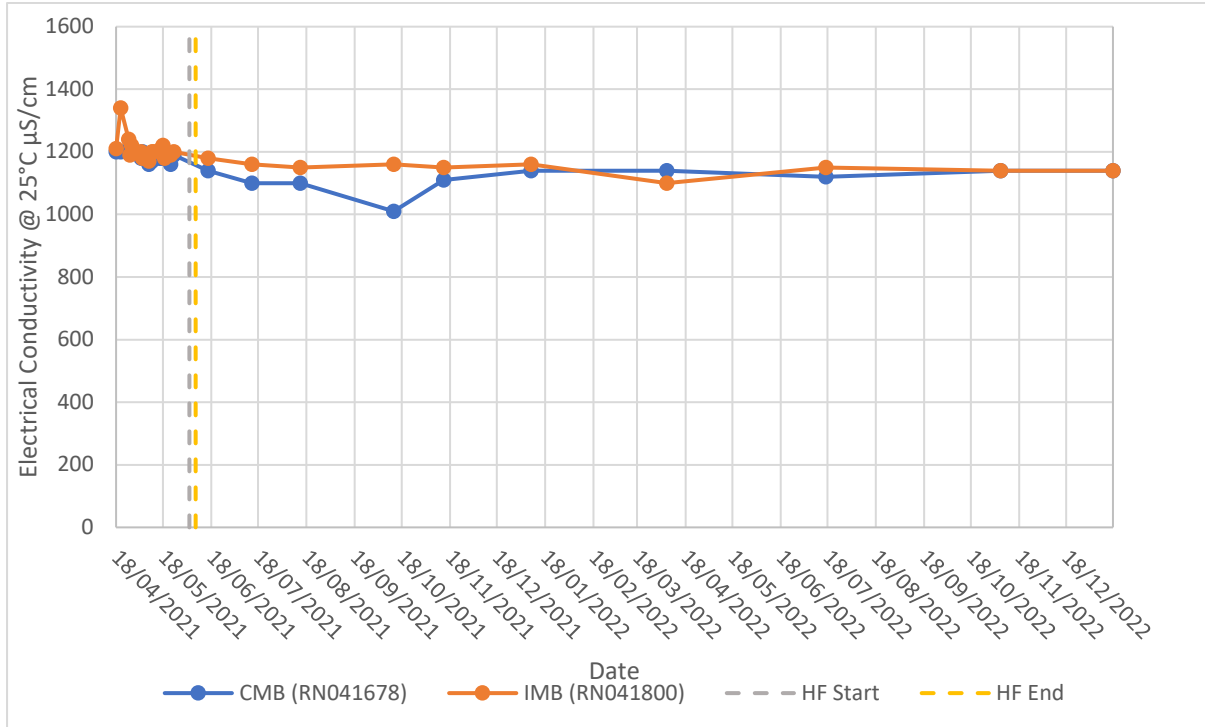


Figure 3 – Electrical Conductivity measurements in Gum Ridge aquifer

The data shows consistent trends between the IMB and CMB measurements. Both sets of data display a relatively stable trend throughout the reporting period, which aligns with historic concentration levels. No statistical outliers were observed in the Electrical Conductivity measurements sampled within the reporting period.

Table 2 – Summary statistics of the Electrical Conductivity measurements in Gum Ridge aquifer

Electrical Conductivity @ 25°C µS/cm	CMB (RN041678)	IMB (RN041800)
Minimum	1010	1100
Maximum	1210	1340
Average	1158	1186
20th percentile	1128	1150
80th percentile	1200	1210
Limit of detection	1	1
STD	45	44

3.1.2 Total Dissolved Solids

The results of monitoring for Total Dissolved Solids in Gum Ridge aquifer are presented in Figure 4.

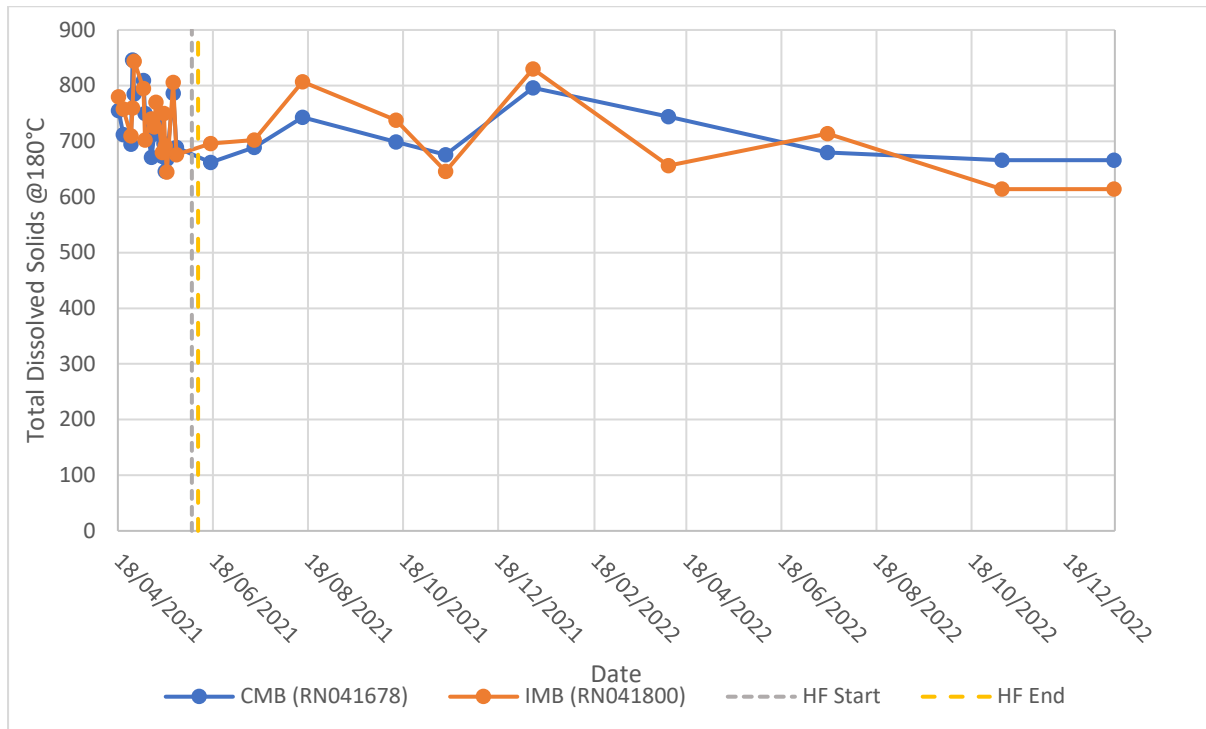


Figure 4 – Total Dissolved Solids measurement in Gum Ridge aquifer

The data shows consistent trends between the IMB and CMB measurements. Both sets of data display a relatively stable trend throughout the reporting period, which aligns with historic concentration levels. No statistical outliers were observed in Total Dissolved Solid measurements sampled within the reporting period.

Table 3 – Summary statistics of the Total Dissolved Solids measurements in Gum Ridge aquifer

Total Dissolved Solids @180°C mg/L	CMB (RN041678)	IMB (RN041800)
Minimum	646	614
Maximum	846	844
Average	717	725
20th percentile	669	664
80th percentile	773	789
Limit of detection	10	10
STD	53	64

3.1.3 Chloride

The results of monitoring for Chloride in Gum Ridge aquifer are presented in Figure 5.

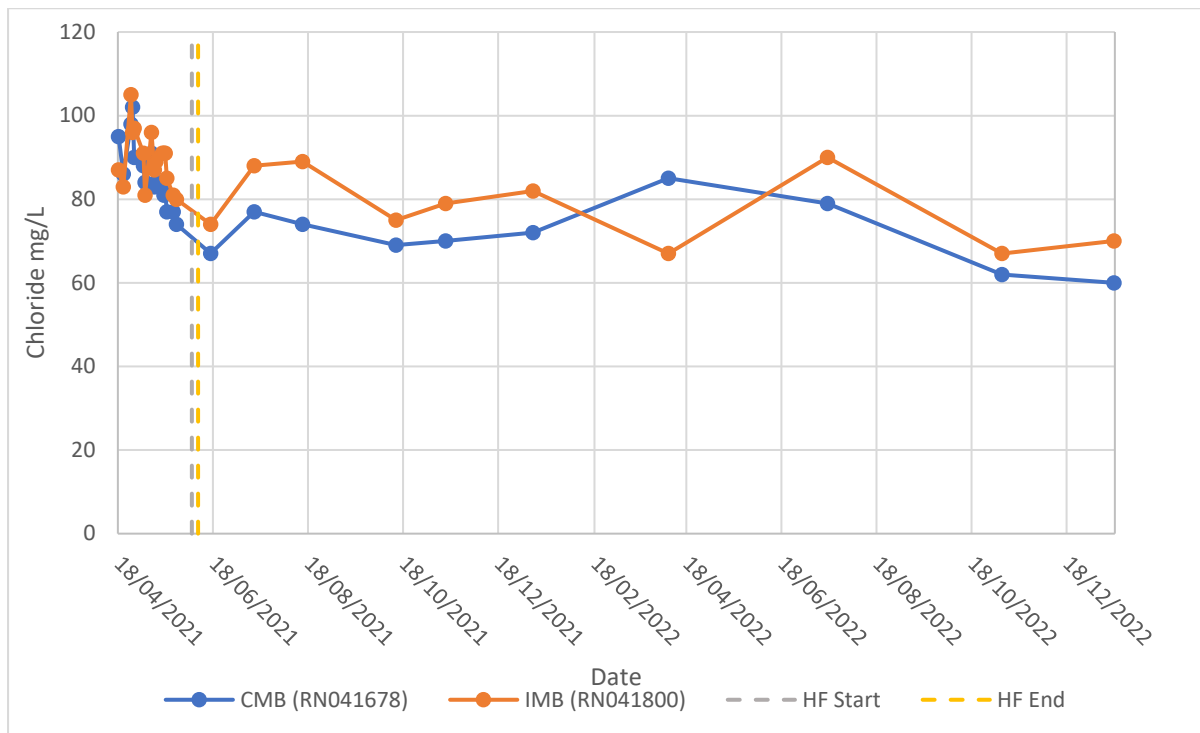


Figure 5 – Chloride measurements in Gum Ridge aquifer

The data shows consistent trends between the IMB and CMB measurements. Both sets of data display a relatively stable trend throughout the reporting period, which is slightly lower than historic concentration levels. No statistical outliers were observed in the Chloride measurements sampled within the reporting period.

Table 4 – Summary statistics of the Chloride measurements in Gum Ridge aquifer

Chloride mg/L	CMB (RN041678)	IMB (RN041800)
Minimum	60	67
Maximum	102	105
Average	80	85
20th percentile	70.8	77
80th percentile	89.2	91
Limit of detection	1	1
STD	10	9

3.1.4 Barium

The results of monitoring for Barium in Gum Ridge aquifer are presented in Figure 6.

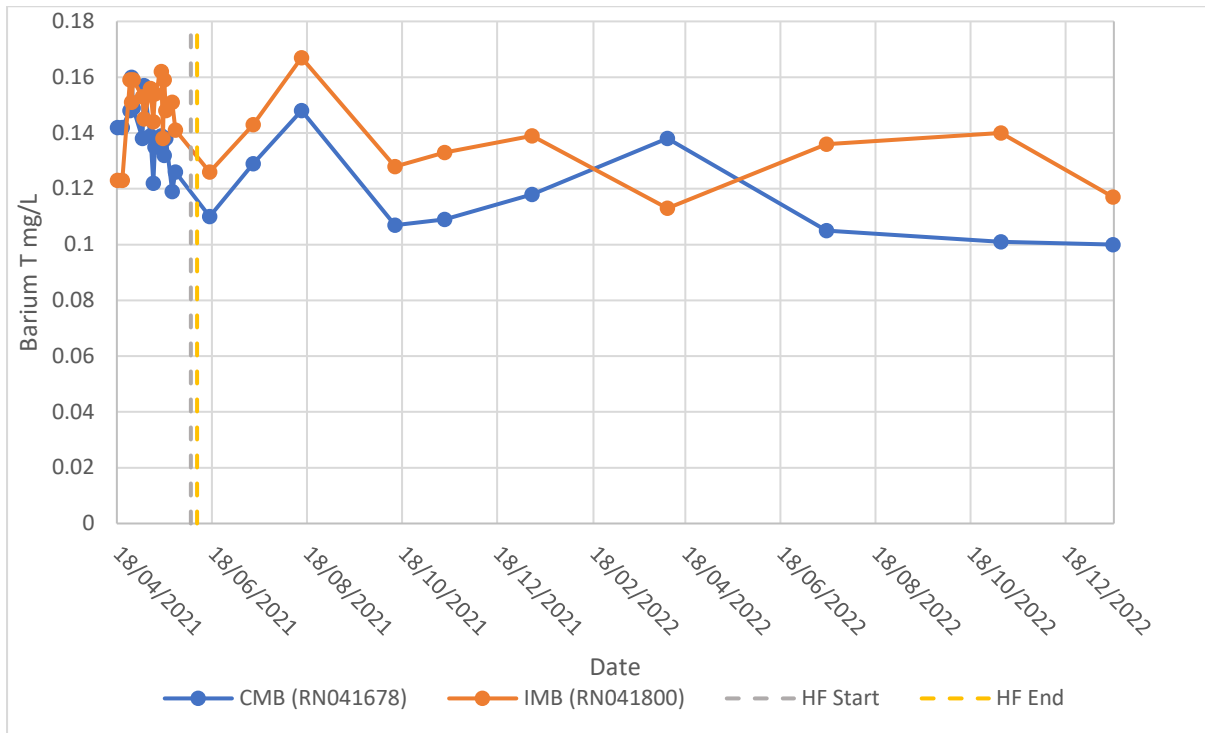


Figure 6 – Total Barium measurements in Gum Ridge aquifer

The data shows consistent trends between the IMB and CMB measurements. Both sets of data display a relatively stable trend throughout the reporting period, which aligns with historic concentration levels. The Total Barium measurements sampled during the reporting period showed no statistical outliers and had a standard deviation of less than 1.

Table 5 – Summary statistics of the Total Barium measurements in Gum Ridge aquifer

Barium T mg/L	CMB (RN041678)	IMB (RN041800)
Minimum	0.100	0.113
Maximum	0.160	0.167
Average	0.130	0.143
20th percentile	0.109	0.127
80th percentile	0.146	0.158
Limit of detection	0.001	0.001
STD	0.017	0.015

3.1.5 Strontium

The results of monitoring for Strontium in Gum Ridge aquifer are presented in Figure 7.

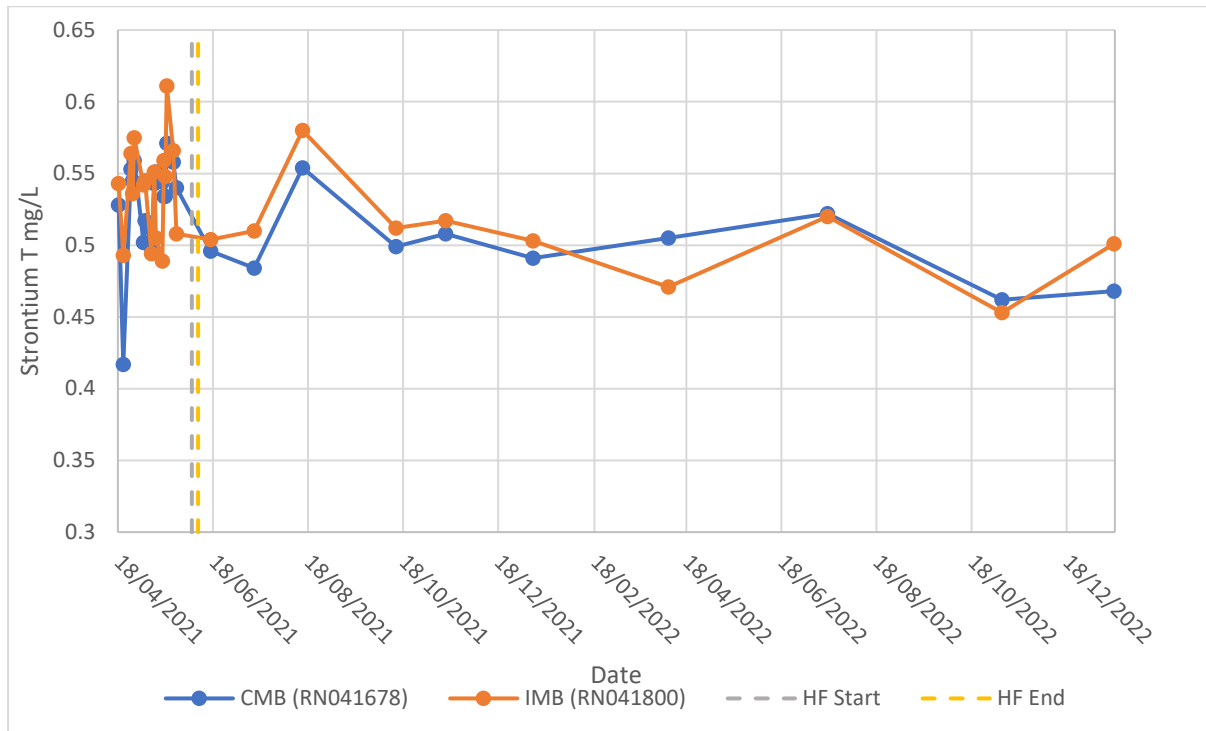


Figure 7 – Total Strontium measurements in Gum Ridge aquifer

The data shows consistent trends between the IMB and CMB measurements. Both sets of data display a relatively stable trend throughout the reporting period, which aligns with historic concentration levels. The Total Strontium measurements sampled during the reporting period showed no statistical outliers and had a standard deviation of less than 1.

Table 6 – Summary statistics of the Total Strontium measurements in Gum Ridge aquifer

Strontium T mg/L	CMB (RN041678)	IMB (RN041800)
Minimum	0.417	0.453
Maximum	0.571	0.611
Average	0.519	0.527
20th percentile	0.493	0.497
80th percentile	0.552	0.562
Limit of detection	0.001	0.001
STD	0.036	0.037

3.1.6 Methane

The results of monitoring for Methane in Gum Ridge aquifer are presented in Figure 8. Measurements with values below the Limit of Detection (LOD) of 0.01 mg/L were assumed to be equal to 0.01 mg/L.

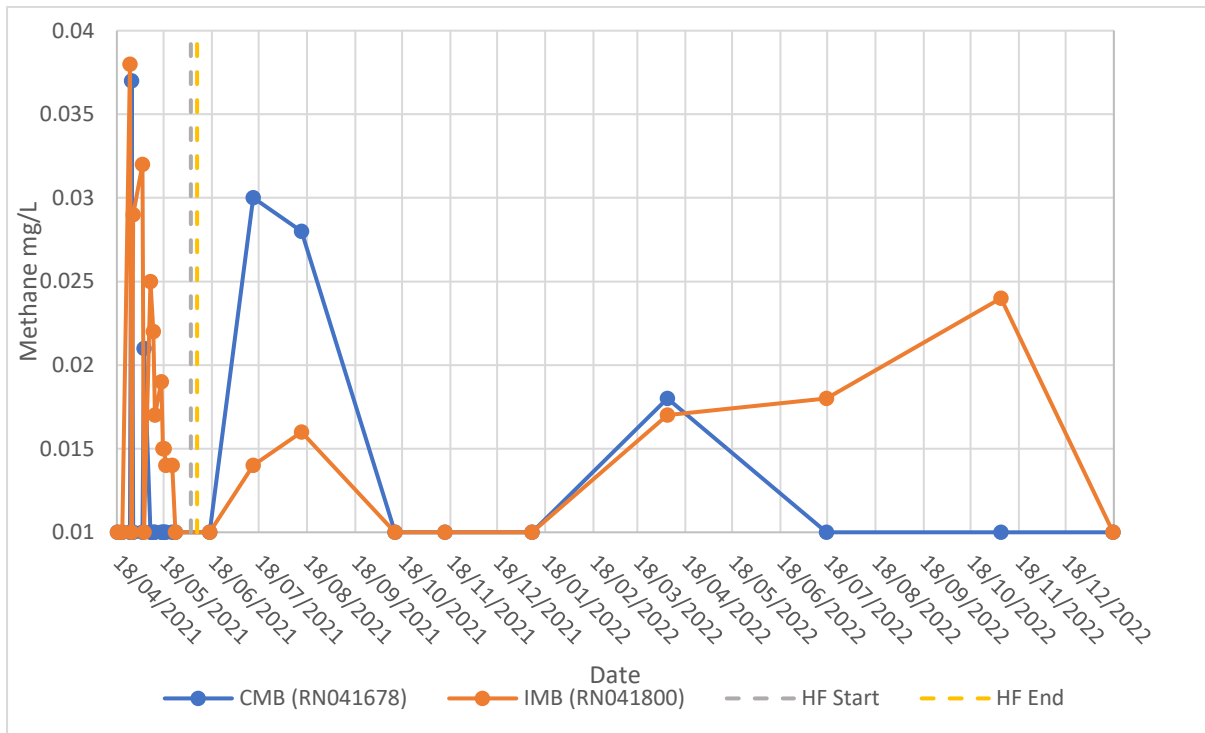


Figure 8 – Methane measurements in Gum Ridge aquifer

The data shows consistent trends between the IMB and CMB measurements. For most of the methane samples collected, the methane concentration is below the detection limit. Although there was a minor increase in concentration within the IMB during the reporting period, it is consistent with historical concentration levels. The Methane measurements sampled during the reporting period showed no statistical outliers and had a standard deviation of less than 1.

Table 7 – Summary statistics of the Methane measurements in Gum Ridge aquifer

Methane µg/L	CMB (RN041678)	IMB (RN041800)
Minimum	0.010	0.010
Maximum	0.037	0.038
Average	0.013	0.017
20th percentile	0.010	0.010
80th percentile	0.015	0.023
Limit of detection	0.010	0.010
STD	0.007	0.008

4 Conclusion

In conclusion, the analysis of the IMBs and CMBs showed consistent trends and comparable concentration levels to historical sampling during the reporting period. This confirms that there have been no significant changes in groundwater quality due to activities at the well site. Imperial will continue ongoing groundwater sampling, as mandated by Ministerial Condition 10, to further ensure the groundwater condition at the Carpentaria 1 well site.

Appendix A – Data Tables
