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Groundwater
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Report on

Vali Gas Field Underground Water Impact Report

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Vali Gas Field Underground Water Impact Report

1 Introduction

ERIAS Group (ERIAS) is supporting Vintage Energy (Vintage) in converting Authority to Prospect (ATP) 2021 into Petroleum Lease (PL) 1125 for the Vali Gas Project. This transition necessitates compliance with the Water Act 2000, specifically the preparation and submission of an Underground Water Impact Report (UWIR).

To meet this requirement, ERIAS engaged Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) to prepare the UWIR, which was submitted to the Department of Environment, Tourism, Science and Innovation (DETSI) on 17 February 2025. On 19 May 2025, Vintage received a notice from DETSI requesting modifications to the UWIR, as summarised in Section 1.3.3.

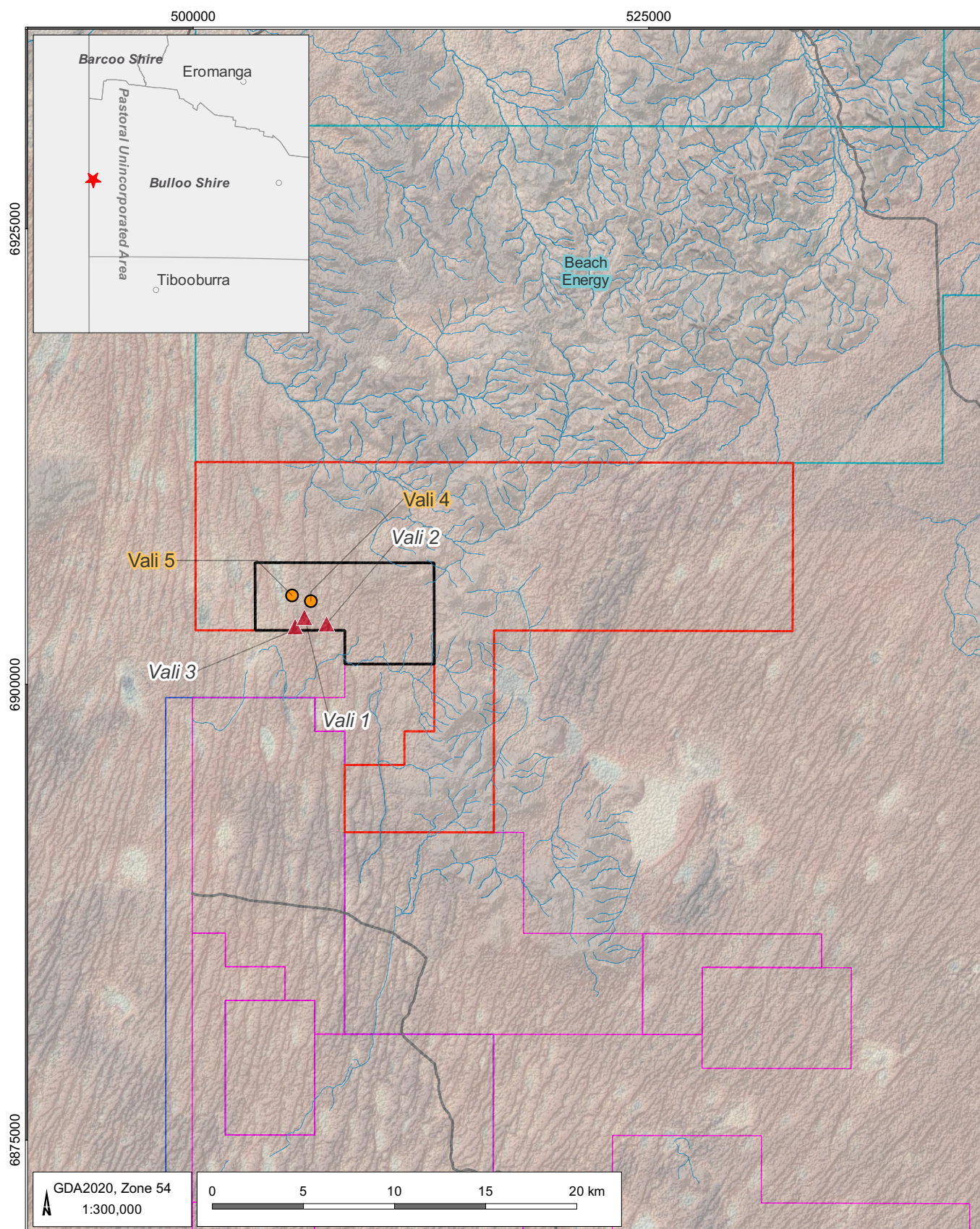
In parallel, a site-specific Environmental Authority (EA) application was submitted to DETSI. On 9 June 2025, Vintage received a response notice identifying a key issue under Item 11: the omission of Vali 4 and Vali 5 wells from the UWIR. As these wells are included in the scope of the EA application, DETSI requested either an updated UWIR incorporating these wells or a separate response addressing the requirements under section 126A(2)(c–f) of the *Environmental Protection Act 1994* (refer to Section 1.3.4).

This UWIR has been updated to address the feedback provided by DETSI in relation to both the UWIR and EA applications.

1.1 Project area

The Project is within ATP2021 in the Shire of Bulloo in Queensland. The Vali gas field comprises three production wells, Vali-1, Vali-2 and Vali-3, located on separate pads, between 700 and 1,700 metres apart. A production uplift program is currently being undertaken, including Vali-3 extracting from the Patchawarra Formation in 2026, and the development of two new production wells, Vali-4 and Vali-5, in 2027. Figure 1.1 shows the extent of the Project area, the associated PL area (PL1125) and the location of the existing and proposed production wells.

The broader Project includes a second gas field named Odin located across Queensland and South Australia. The production well Odin 1 is located approximately six kilometres west of Vali-3, in South Australia. The Odin gas field Project is excluded from this UWIR.



LEGEND

- Place names
- ▲ Vali production wells
- Vali production wells - proposed
- Watercourse
- Roads
- Authority to Prospect (ATP 2021)
- Authority to Prospect (ATPs)
- Petroleum Lease 1125
- Santos Petroleum Leases
- Santos Exploration Permits for Petroleum
- Local government region

Vali Gas Field UWIR 2025 (VGF5000.002)

Project location



AGE

DATE
14/10/2025

FIGURE No:
1.1

1.2 DETSI information requests

Table 1.1 and Table 1.2 outlines the location of the information requested by the Department of the Environment, Tourism, Science and Innovation (DETSI).

Table 1.1 Direction to modify underground water impact report – 19 May 2025

Item number	Notice description	Location of information
2	Modifications	
a)	The chief executive considers the report is inadequate in a material particular to s. 370 of the Water Act 2000 (Water Act), a responsible entity must give the chief executive an underground water impact report (UWIR) that complies with the requirements under Division 4, Requirements for underground water impact reports and final reports. The following requirements have not been sufficiently addressed within the submitted UWIR:	This report
a)i	The UWIR must describe the impacts on environmental values (EVs) that have occurred, or are likely to occur, because of any previous exercise of underground water rights as per s. 376(1)(da) of the Water Act. Section 5 provides a description of the impacts on EVs; however, it is not clear if this is relating to the previous or proposed exercise of underground water rights.	Section 5
a)ii	The UWIR must include a program for conducting an annual review of the accuracy of each map prepared under paragraph (b)(iv) (IAA) and (v) (LTAA) as per s. 376(1)(e)(i) of the Water Act.	Section 8
a)iii	The UWIR must include a program for giving the chief executive a summary of the outcome of each review, including a statement of whether there has been a material change in the information or predictions used to prepare the maps as per s. 376(1)(e)(ii) of the Water Act.	Section 6
a)iv	The UWIR must include a water monitoring strategy (WMS) as per s. 376(1)(f) of the Water Act, and the WMS must include the rationale for the WMS as per s. 378(1)(b) of the Water Act. Whilst the statement presented in section 6.2 addresses some aspects of the required rationale, it does not clearly provide direction against the rationale requirements presented in the UWIR guideline (ESR/2016/2000). The monitoring rationale should address the below (but not be restricted to): a) an assessment of changes in water levels and water quality because of the exercise of relevant underground water rights; b) supplementation of existing monitoring programs to fill any critical gaps in data; and c) an explanation about how it will improve the understanding about the impacts of underground water extractions on aquifers.	Section 6
a)v	The WMS must include a timetable for implementing the WMS strategy as per s. 378(1)(c) of the Water Act. The UWIR proposes that groundwater monitoring will be conducted on a biannual and annual basis, however the UWIR does not meet guideline requirements and include the sub-block of the tenure in which the monitoring bore(s) are located or the date(s) for the proposed monitoring	Section 6
The report must be modified as follows:		
a	Pursuant to s. 376(1)(da) of the Water Act, describe the impacts on EVs that have occurred, or are likely to occur, because of any previous exercise of underground water rights.	Section 5
b	Pursuant to s. 376(1)(e)(i) of the Water Act, provide a program for conducting an annual review of the accuracy of each map prepared under paragraph (b)(iv) (IAA) and (v) (LTAA).	Section 8
c	Pursuant to s. 376(1)(e)(ii) of the Water Act, provide a program for giving the chief executive a summary of the outcome of each review, including a statement of whether there has been a material change in the information or predictions used to prepare the maps.	Section 6

Item number	Notice description	Location of information
d	Pursuant to s. 378(1)(b) of the Water Act, include a rationale that clearly addresses the requirements presented in the UWIR guideline (ESR/2016/2000): • an assessment of changes in water levels and water quality because of the exercise of relevant underground water rights; • supplementation of existing monitoring programs to fill any critical gaps in data; and • an explanation about how it will improve the understanding about the impacts of underground water extractions on aquifers.	Section 6
e	Pursuant to s. 378(1)(c) of the Water Act, include a timetable for implementing the WMS strategy that includes the following as per the guideline Underground water impact reports and final reports (ESR/2016/2000): • a table listing: the bores to be monitored (with a unique identifier for each bore); the tenure in which the bore is located (where possible including the block and sub-block in which the bore is located); the date(s) for proposed monitoring and the parameters that will be monitored.	Table 6.1

Table 1.2 EA application notice ESR/2016/3447 - 9 June 2025

Item number	Notice description	Location of information
11	Vali 4 and Vali 5 underground water impacts <u>Issue</u> <i>The application included an Underground Water Impact Report (UWIR) as supporting information on the groundwater drawdown and groundwater quality impacts presented by the Vali gas field project. However, it is noted that Vali 4 and Vali 5 wells were not included in UWIR. As these wells are included in the scope of this site-specific environmental authority application, it is expected that the groundwater impacts of these wells are accordingly presented.</i> <u>Action required</u> <i>Provide an updated UWIR report that includes Vali 4 and Vali 5 wells. Alternatively, for the Vali 4 and Vali 5 wells, provide a response that addresses the information requirements under s126A(2)(c-f) under the Environmental Protection Act 1994."</i>	Sections 22.2, 3, 4, 5, 6, 7 and 8

1.3 Legislation and guidelines

The primary legislative requirements related to the extraction of groundwater from deep aquifers and management of produced water for Vali Gas Field activities are summarised below.

1.3.1 Petroleum and Gas (Production and Safety) Act 2004 (QLD)

Under the Petroleum and Gas (Production and Safety) Act 2004 (Qld), the petroleum tenure holder may take or interfere with underground water in the area of the tenure if this happens during the course of, or results from, the carrying out of another authorised activity for the tenure. The Act also requires tenure holders to comply with underground water obligations specified in the Water Act 2000 (Qld).

1.3.2 Water Act 2000 (QLD)

Management of underground water impacts as a result of the exercise of underground water rights by petroleum tenure holders for petroleum or CSG projects is detailed in Chapter 3 of the Water Act 2000. The Act provides a framework that requires the petroleum tenure holder to prepare an Underground Water Impact Report (UWIR) which establishes obligations for monitoring and managing impacts on aquifers and springs. More specifically it also provides for trigger levels for establishing the significance of impact on an aquifer in the event of a decline in water levels. These trigger thresholds are:

- a 5 m decline in water levels within a consolidated aquifer;
- a 2 m decline in water levels within an unconsolidated aquifer; and
- a 0.2 m decline in water levels associated with active springs.

Areas where the expected decline in groundwater levels exceeds the relevant trigger level, within the next three years are defined as Immediately Affected Areas (or IAA). Areas where the expected declines in groundwater level exceed the trigger threshold in the longer term (i.e. sometime after three years) are defined as Long-term Affected Areas (or LTAA).

1.3.3 Underground Water Impact Report (UWIR)

The overall purpose of an Underground Water Impact Report (UWIR) is to provide a summary of the predicted groundwater impacts of a Project and set out how these expected impacts are to be monitored and managed. The underground water impact report and final reports guideline (Queensland government, 2025) recommends specific methods for making predictions about the impacts of underground water extractions and for the preparation of UWIRs.

A UWIR must contain the following information:

- Part A: Information about underground water extractions resulting from the exercise of underground water rights.
- Part B: Information about aquifers affected, or likely to be affected.
- Part C: Maps showing the area of the affected aquifer(s) where underground water levels are expected to decline.
- Part D: An assessment of the impacts to the environmental values from the exercise of underground water rights.
- Part E: A water monitoring strategy.
- Part F: A spring impact management strategy.

1.3.4 Environmental Protection Act 1994 (QLD)

The Environmental Protection Act 1994 and the related Environmental Protection (Water) Policy (EPP Water) provides a framework to protect and/or enhance the suitability of Queensland waters for various beneficial uses.

Surface waters are managed under the Cooper Creek water plan which is a component of the Lake Eyre Basin. The Lake Eyre Basin extends across Queensland, South Australia, New South Wales and the Northern Territory and the governments are signatories of the Lake Eyre Basin Intergovernmental Agreement (IGA).

Groundwater resources in the Project area are managed under the Great Artesian Basin and Other Regional Aquifer (GABORA) Water Plan (Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017). The Water Plan is divided into groundwater units listed in Schedule 2 of the Water Plan and the geological formations are listed in Schedule 3 of the Water Plan. Although the geological formations of the Eromanga Basin are listed in Schedule 3 of the Water Plan, the groundwater resources from the Cooper Basin are not mentioned in the Water Plan. Therefore, there are no environmental values and water quality objectives listed in Schedule 1 of the Water Plan for the groundwater resources extracted from Vali Gas production wells.

1.4 Report structure

The structure of this UWIR is in accordance with requirements of the Environmental Protection Act 1994 (section 126A and 227AA) and Water Act 2000 (section 376) and with associated Queensland Government guidelines (Queensland Government, 2025), and includes the following sections:

- Part A: Information about underground water extractions resulting from the exercise of underground water rights (Section 2).
- Part B: Information about aquifers affected, or likely to be affected; underground water flow description (Section 3).
- Part C: Predicted changes to water levels in the affected aquifer(s) (Section 4).
- Part D: An assessment of the impacts on environmental values from the exercise of underground water rights (Section 5).
- Part E: A water monitoring strategy (Section 6).
- Part F: A spring impact management strategy (Section 7).

2 Underground water extraction (Part A)

This section presents information regarding underground water extraction carried out under existing underground water rights. Water extraction is currently or planned to occur from the following wells:

- Vali-1 (Patchawarra Formation): Predicted to remain online until 2030.
- Vali-2 (Dual Screen – Toolachee and Patchawarra Formations): Predicted to remain online until 2033.
- Vali-3 (Toolachee Formation): Predicted to extract from the Toolachee Formation until 2026.

Vintage has also indicated plans to expand production capacity with the Vali-3 well and addition of new wells Vali-4 and Vali-5 with the following schedule:

- Vali-3 (Patchawarra Formation): Scheduled to be online in 2026, with operations expected to continue until 2039.
- Vali-4 (Patchawarra Formation): Expected to come online in 2027 and remain operational until 2040.
- Vali-5 (Patchawarra Formation): Expected to come online in 2027 and remain operational until 2040.

The following sections will provide details on the volume of water already extracted (Section 2.1) and projections of future water extractions, including contributions from proposed future wells (Vali-4 and Vali-5) at the time of this UWIR (Section 2.2).

2.1 Quantity of water already extracted

There are three existing production wells located within ATP2021, which include the Vali-1 well which was completed in 2020 and the Vali-2 and Vali-3 wells which were both completed in 2021.

As summarised in Table 2.1, production testing at Vali Gas Project started in Q1 2023 from the Patchawarra and Toolachee Formations, with Vali-1 being the main testing well with 135 days of production from late February 2023 to July 2023. Information on the stratigraphic units screened by each of these three wells is provided in Table 2.1.

Table 2.1 Production wells, production dates and stratigraphy

Bore name	Start of production	Stratigraphic unit(s)	Comments
Vali-1	21 February 2023	Patchawarra Formation	135 days of testing production
Vali-2	March 2023	Toolachee and Patchawarra Formations	16 days of testing production. Well flowing from Patchawarra only from 4 May 2023
Vali-3	March 2023	Toolachee Formation	11 days of testing production

The most productive period was between 21 February and 31 July 2023 with a total 3,259 kL of water extracted from the three wells. The metred cumulated water extraction to facility and to flare/vent/blowdown is shown in Table 2.2.

Table 2.2 Water already extracted February 2023 to June 2024

Months	Water extraction ¹ (kL)				
	Vali-1 (Patchawarra)	Vali-2 ² (Patchawarra)	Vali-2 (Toolachee)	Vali-3 (Toolachee)	Total
February 2023	161.30	0.00	0.00	0.00	161.30
March 2023	379.67	0.00	96.82	211.69	688.18
April 2023	275.99	0.00	99.36	193.79	569.15
May 2023	198.39	530.38	12.08	0.00	740.85
June 2023	231.65	541.98	0.00	0.00	773.62
July 2023	263.99	62.00	0.00	0.00	325.99
August 2023 - June 2024	NA	NA	NA	NA	NA
Total	-	-	-	-	3,259.09 kL

Notes: ¹ Estimated based on metred cumulated water extraction to facility and to flare/vent/blowdown.

² Well flowing from Patchawarra only from 4 May 2023.

2.2 Quantity of water to be extracted in the next three years

Table 2.3 presents the projected total water extraction rates over the three next years (July 2024 to July 2027) for both existing production wells (Vali-1, Vali-2, Vali-3) and proposed production wells (Vali-4 and Vali-5). Groundwater extraction from the proposed wells Vali-4 and Vali-5 is predicted to commence after June 2027 and therefore does not contribute to the projected water extraction rates reported for the next three years.

Proposed water extraction activities are scheduled to continue until June 2040 (Long Term Affected Area - LTAA) and predicted water extraction for the duration of the LTAA is provided in Section 4.

Table 2.3 Total predicted water extraction rates for the next three years (July 2024-June 2027)

Year	Date	Production wells online	Vali 1 (kL/y)	Vali 2 (kL/y)	Vali 3 (kL/y)	Vali 4 (kL/y)	Vali 5 (kL/y)	Total (kL/y)
2024/2025	1 July 2024 to 30 June 2025	Vali-1, Vali-2, Vali-3 (Toolachee)	3,867	3,867	3,867	0	0	11,600
2025/2026	1 July 2025 to 30 June 2026	Vali-1, Vali-2, Vali-3 (Toolachee)	3,867	3,867	3,867	0	0	11,600
2026/2027	1 July 2026 to 30 June 2027	Vali-1, Vali-2, Vali-3 (Patchawarra)	3,867	3,867	3,867	0	0	11,600

3 Existing environment and aquifer information (Part B)

3.1 Climate

The Scientific Information for Landowners (SILO) database provides interpolated rainfall and evaporation data from available climate stations for a selected location. The monthly patched point SILO rainfall data for the Project site (longitude 141.13, latitude -28.01) were obtained from the Long Paddock website on 9 January 2024 (Queensland Government, 2024). Interpolated climatic information was obtained for the period January 2000 and December 2023.

According to the Köppen major classification system (BOM, 2005) the Project area experiences a desert climate. Figure 3.1 summarises observed monthly average temperature ranges and precipitation between 2000 and 2023. As shown monthly precipitation is limited, typically less than 10 mm/month in winter rising slightly in the summer to up to 26 mm on average in January. Average annual rainfall over the period analysed was 174 mm. Average maximum temperature in January is 39°C falling to 20°C on average in July.

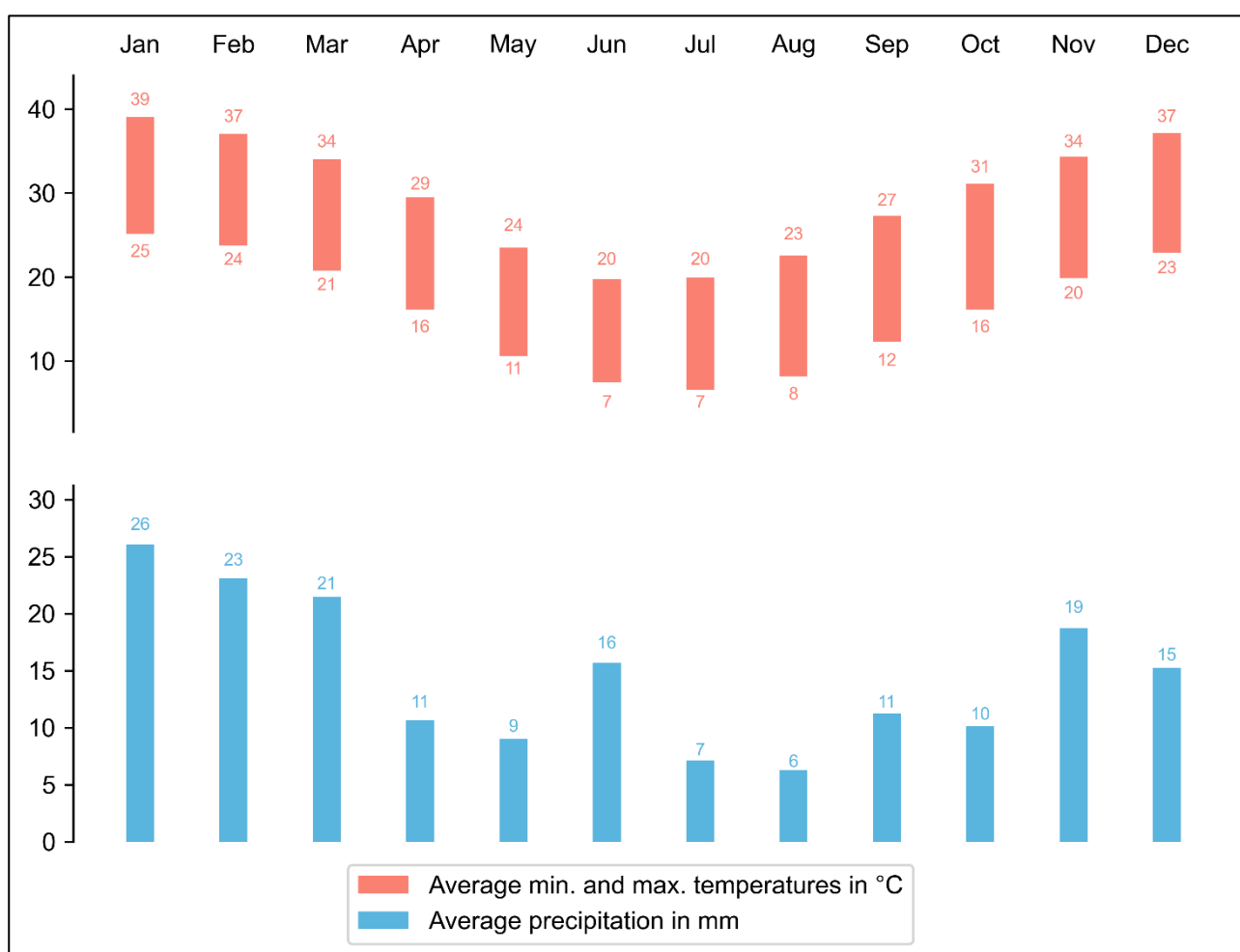


Figure 3.1 Average temperatures and precipitations between 2000 and 2023

The monthly Cumulative Rainfall Departure (CRD) was calculated for the period January 2000 to January 2024 and shows the area has experienced distinct cycles of above and below-average rainfall (Figure 3.2). The CRD method (Weber and Stewart, 2004) represents a summation of the monthly departure of rainfall from the long-term average monthly rainfall. A rising trend in the CRD plot therefore indicates periods of above-average rainfall, whilst a negative slope indicates periods of below-average rainfall.

The first part of the graph shows the millennium drought until 2010, then a wet period between 2010 and 2012. Between 2013 and 2020 rainfall totals were below average for the most part, with relatively short periods of above average rainfall. Since 2020 rainfall has been close to average.

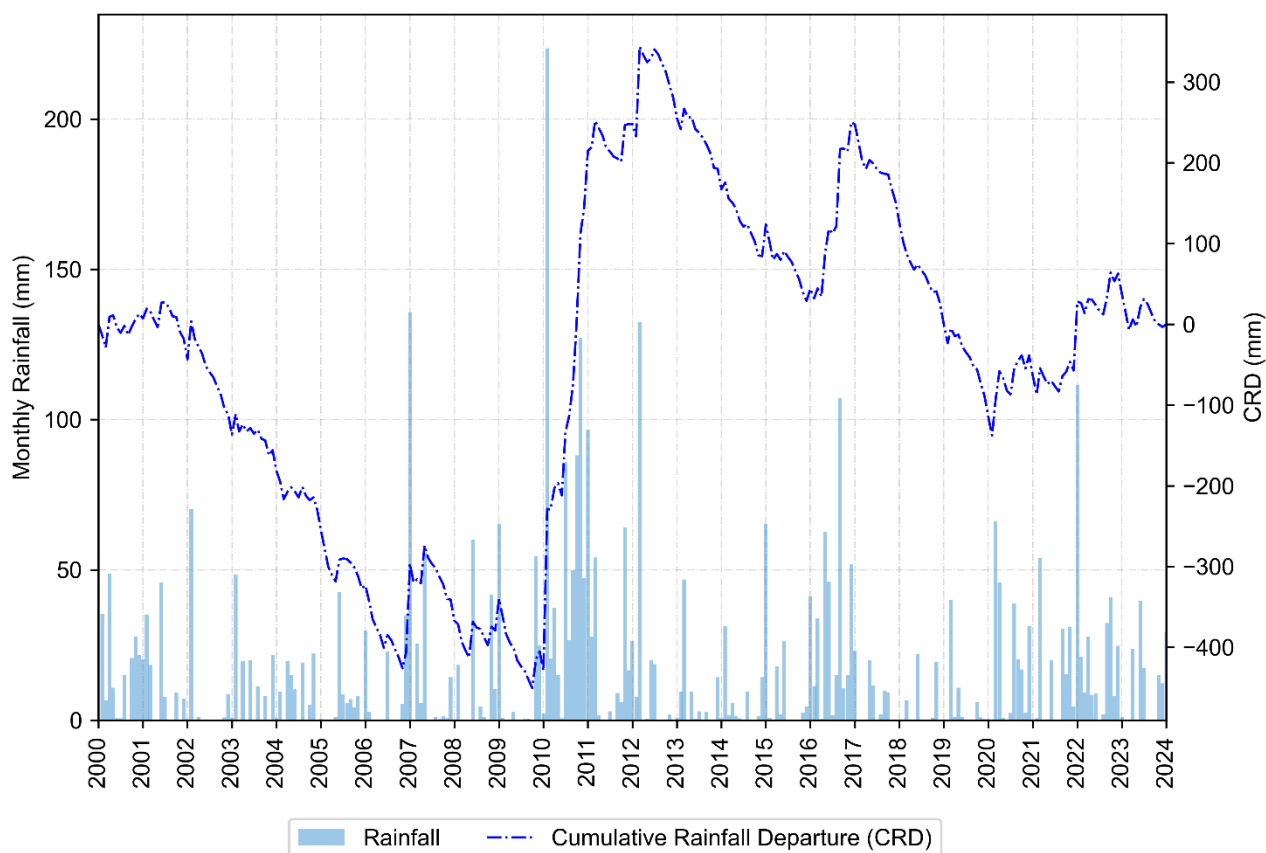


Figure 3.2 Monthly SILO rainfall and CRD (2000-2024)

3.2 Topography and drainage

Figure 3.3 shows the topography and drainage of the Project area.

3.2.1 Topography

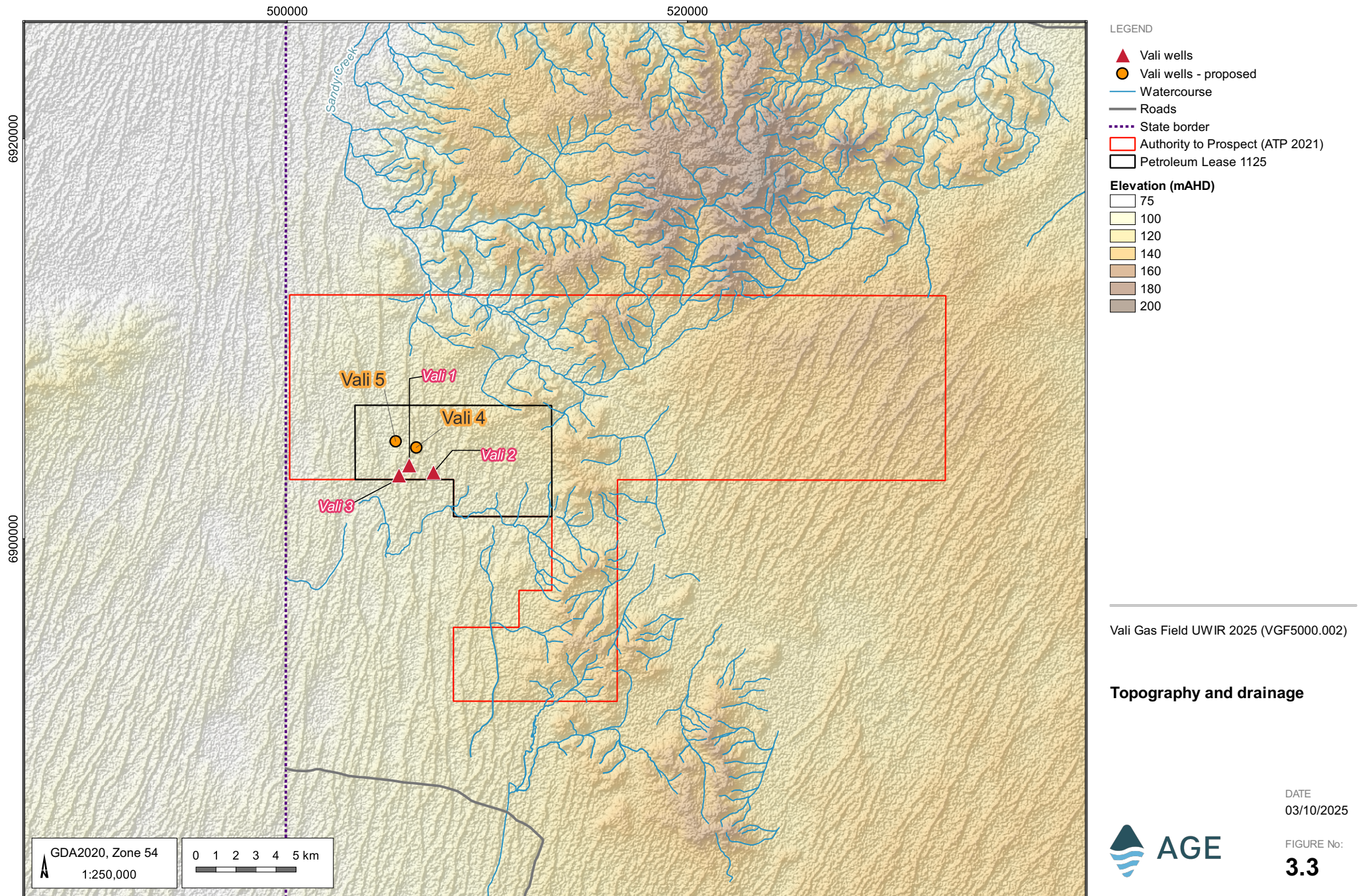
The Vali gas field site is located between the Simpson, Strzelecki and Sturt Stony deserts. The terrain in the area is dominated by undulating dune fields. It also comprises flat gibber plains, sand plains and flood plains.

Ground elevation at the Vali-1 well site is between 102 and 105 metres Australian Height Datum (mAHD). It is adjacent to a clay depression and a dune. Ground elevation at the Vali-2 pad is approximately 107 mAHD and 103 mAHD at the Vali-3 well pad. Since Vali-4 and Vali-5 have not yet been drilled, ground elevation data is currently unavailable for these wells.

3.2.2 Drainage

The site is located in a sub-basin of the Cooper Creek. Local drainage lines flow towards Lake Eyre, which is located approximately 370 km to the west of the Project area.

There are no springs from the Queensland Springs Database mapped within or near the Project area. The nearest mapped spring is approximately 300 km to the east of the Project area. The closest Great Artesian Basin springs in South Australia are approximately 100 km south west of the Project area.



3.3 Geology

A review of the geological and hydrogeological features that occur beneath ATP2021 are described below and have been used to develop the hydrogeological conceptualisation of the groundwater regime beneath the Project area and surrounds. This understanding forms the basis for the analytical groundwater flow model. As mentioned previously the targets for gas production at PL1125 comprise the Toolachee and the Patchawarra Formations within the Cooper Basin. There are no regional faults mapped in the Project area.

Figure 3.4 summarises the stratigraphy of the project area.

3.3.1 Surface deposits

Figure 3.5 shows the surface geology at the Vali Gas field which is dominated by Quaternary sands. The older Tertiary age Glendower Formation outcrops to the east of the PL1125 and the Winton Formation (Cretaceous) outcrops to the northeast of ATP2021. The Glendower Formation is a fluvial deposit comprising sandstone, siltstone, conglomerate and mudstone. The Winton formation comprises interbedded, fine to coarse sandstone, siltstone, shale and coal seams deposited in fluvio-lacustrine environments. The total average thickness of the surface deposits (Quaternary, Tertiary and Cretaceous) is 850 metres.

3.3.2 Eromanga Basin

The Winton Formation is underlain by a series of sedimentary deposits with comprise the Eromanga Basin which represents the largest sub-basin within the Great Artesian Basin (GAB). The total sedimentary thickness of the Eromanga Basin at the site is approximately 1,050 metres. It comprises several stacked formations. The Hutton Sandstone is one of the major sandstone formations of the GAB and is present at the base of the Eromanga Basin in the Project area with a thickness averaging 105 metres. The base of the Eromanga Basin is approximately 2,000 metres below ground level (mbgl) at the Project area. A major unconformity at the base of the Eromanga Basin separates it from the underlying Cooper Basin.

3.3.3 Cooper Basin

The Eromanga Basin unconformably overlies the Cooper Basin. The Cooper Basin is a non-marine sedimentary pile and can be subdivided into three major geological groups:

- Triassic Nappamerri Group: which comprises the Tinchoo Formation (interbedded siltstone and sandstone, minor coal seams and intraclast conglomerate) and the Arraburry Formation (mudstone, siltstone and fine-grained sandstone). The total thickness of the Nappamerri Group is approximately 350 metres in the Project area.
- Permian Gilgealpa Group: which includes the two target formations for the Vali gas field (i.e. the Toolachee and the Patchawarra Formations).
 - The Toolachee Formation comprises interbedded fine to coarse-grained sandstone, siltstone and carbonaceous shale. It is approximately 160 metres thick in the Project area (between 2,400 and 2,550 metres below ground level) and unconformably overlies the mudstones and siltstones of the Daralingie Formation.
 - The Daralingie Formation, The Roseneath Shale, Epsilon Formation and Murteree Shale overlie the Patchawarra Formation. The cumulative thickness of these deposits in the Project area is around 350 metres which predominantly comprises interbedded mudstone, siltstone and shale.
 - The Patchawarra Formation predominantly comprises interbedded sandstone, siltstone, shale and coal. It is approximately 310 metres thick at the three existing production wells. Depths are approximately between 2,800 and 3,110 metres below ground level.
 - The underlying Tirrawarra Sandstone predominantly comprises fine to coarse-grained sandstone interbedded with conglomerate and minor carbonaceous siltstone, shale and coal.
- Late Carboniferous Group: which includes the Merrimelia Formation, it is of glacial origin.

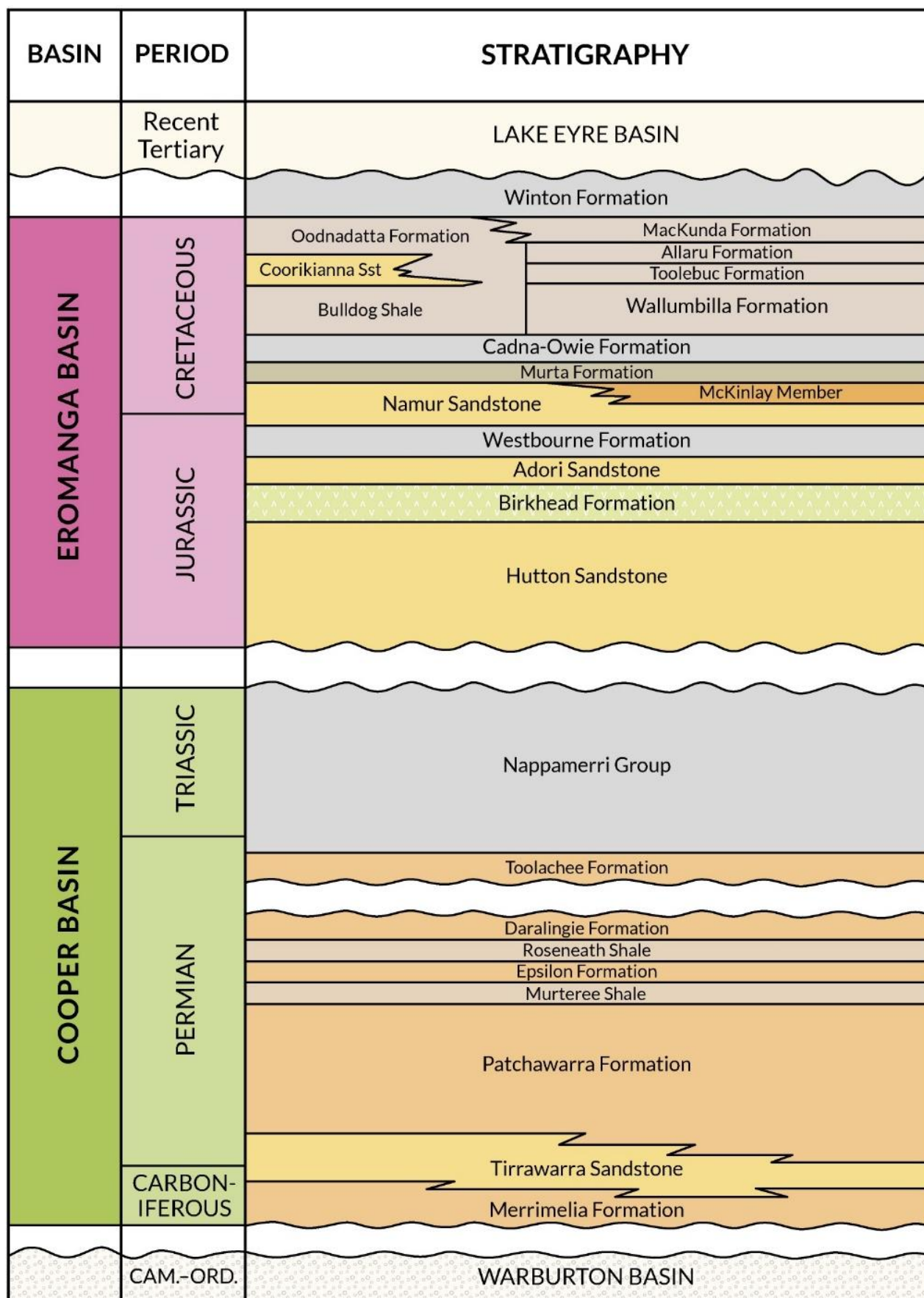
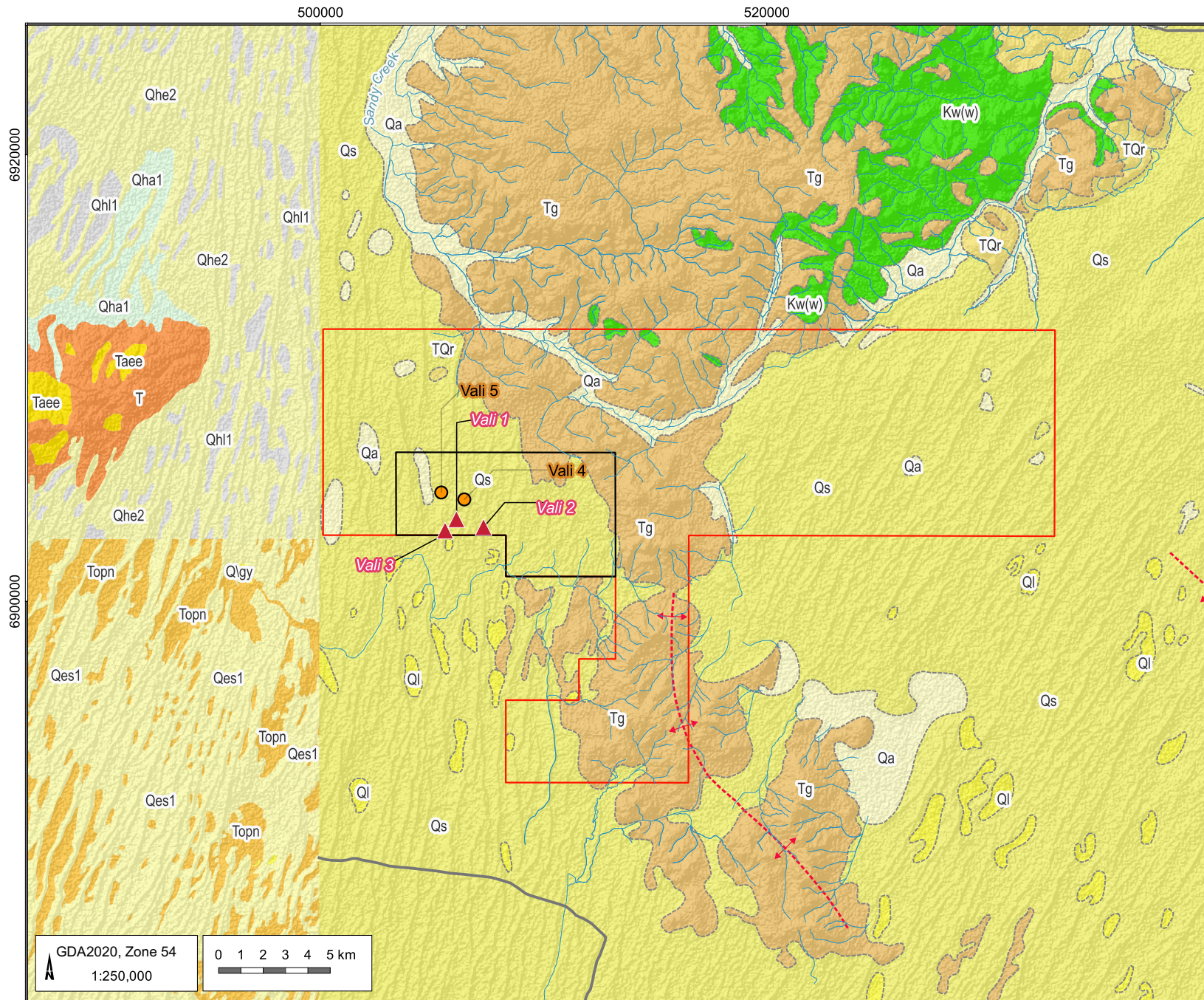


Figure 3.4 Stratigraphy of the Eromanga and Cooper basins



LEGEND

- ▲ Vali wells
 - Vali wells - proposed
 - Watercourse
 - Roads
 - - - Detailed Folds
 - - - Detailed Geological Boundaries
 - Authority to Prospect (ATP 2021)
 - Petroleum Lease 1125
- QLD Detailed surface geology (100k)**
- Quaternary alluvium (Qa)
 - Quaternary mud (Ql)
 - Quaternary sand (Qs)
 - Colluvium (TQr)
 - Glendower Formation (Tg)
 - Winton Formation(w) (Kw(w))
- South Australia Surface geology (100k)**
- Quaternary gypcrete (Qgy)
 - Holocene alluvial/fluviol unit 1 (Qha1)
 - Holocene lacustrine/playa unit 1 (Qh11)
 - Holocene aeolian unit 2 (Qhe2)
 - Eyre Formation (Tae)
 - Simpson Sand unit 1 (Qes1)
 - Namba Formation (Topn)
 - Namba Formation (Topn)
 - Tertiary rocks (T)

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Surface geology

DATE
03/10/2025

FIGURE No:
3.5



3.4 Hydrogeology

As would be expected significant groundwater resources are generally only consistently intersected in those stratigraphic units which are sandstone dominated. Other units which are dominated by siltstone, mudstone and shale formations tend to act as aquitards. The main aquifers for water extraction include the following:

- Shallow Quaternary and Tertiary sediments.
- The Winton Formation.
- The Great Artesian Basin (GAB) aquifers of the Eromanga Basin which include: Mackunda Formation, Wallumbilla Formation, Cadna-Owie Formation, Hooray and Hutton Sandstones.
- Other Cooper Basin aquifers including: Toolachee Formation, Epsilon Formation, Patchawarra Formation and Tirrawarra Sandstone.

The Winton and Mackunda aquifers are the primary targets for groundwater extraction in the project area because they are relatively shallow. Groundwater from Cadna-Owie, Hooray systems and other Eromanga Basin aquifers are rarely targeted for extraction locally due to drilling depths exceeding 1,000 metres. Petroleum exploration bores that intersect these deeper aquifers are sometimes repurposed for water supply purposes, however as discussed in Section 5.1, the deepest existing water supply bore within 15 km of the Project Area is less than 300 m deep. The aquifers of the Cooper Basin are present at ever greater depth (base of the Toolachee is approximately 2,550 mbgl and base of the Patchawarra is 3,110 mbgl) and only accessed for gas production.

It is considered unlikely that the impact of water extraction in the Cooper Basin could extend far beyond the top of the Cooper Basin into the overlying Eromanga Basin due to the geological discontinuity between the two basins, the thickness and the anticipated low permeability of the Tinchoo Formation, which sits immediately below the base of the Eromanga Basin. Based on this conceptualisation, the aquifers which could be impacted by the three Vali project production wells include:

- Hutton Sandstone: typically, comprises fine to coarse-grained quartzose porous sandstones interbedded with minor finer-grained siltstones. It lies unconformably over the Cooper Basin. Thickness is approximately 105 metres (between 1,900 and 2,000 mbgl). Estimated hydraulic conductivities are between 9.8×10^{-3} and 3.5×10^{-1} m/d (Santos, 2019) and storativity is estimated at 1×10^{-4} .
- Toolachee Formation: typically comprises porous sandstones interbedded with finer-grained siltstones, mudstones and shales with thin coal seams and some conglomerates. It unconformably overlies older formations across the whole Cooper Basin. Thickness is around 160 metres (between 2,380 and 2,540 mbgl in Vali-1). Estimated hydraulic conductivities are between 2×10^{-3} and 4.3×10^{-3} m/d (Santos, 2019) and storativity is 5.5×10^{-5} .
- Epsilon Formation: predominantly siltstone with minor coal and sandstones. The thickness averages 50 metres. There are no hydraulic properties estimated in the surrounding existing UWIR (Beach Energy, 2020 and Santos, 2019).
- Patchawarra Formation: consisting of variable porous sandstone interbedded with siltstone, mudstone and shale with thin coal seams. The thickness is 310 m at the project area (between 2,805 and 3,115 mbgl at Vali-1). Estimated hydraulic conductivities are between 3.3×10^{-4} and 3.5×10^{-3} m/d (Santos, 2019) and storativity is 1.1×10^{-4} .
- The Tirrawarra Sandstone: consisting of fine to coarse-grained and pebbly sandstone interbedded with conglomerate, minor carbonaceous siltstone, shale and coal. The Tirrawarra Sandstone thickness is on average approximately 80 metres. No estimated hydraulic conductivities were provided in other UWIR reports (Beach Energy, 2020 and Santos, 2019).

3.5 Groundwater quality

Single groundwater results are available for four locations within the project area: two mixed samples from Vali-1, Vali-2 and Vali-3 production bores (taken from two different locations within the gas/water collection network) and samples from two landowner bores (the Watties and Christmas bores) collected during baseline assessment data collation activities. Table 3.1 summaries the formations screen in each bore as well as sampling dates.

Table 3.1 Water sample information

Sample name	Date	Lithology
Top Pond (mixed sample from Vali-1, 2 and 3)	22/09/2023	Toolachee and Patchawarra Formations
Overflow Pond (mixed sample from Vali-1, 2 and 3)	22/09/2023	Toolachee and Patchawarra Formations
Watties Bore	05/04/2022	Glendower or Winton Formations
Christmas Bore	05/04/2022	Glendower or Winton Formations

Salinity can be described by total dissolved solid (TDS) concentrations or electrical conductivity (EC¹). TDS concentrations are commonly classified on a scale ranging from fresh to extremely saline. The Queensland Government released Science Note – Measuring Salinity (Queensland Government, 2018) provides an overview of the typical salinity characteristics of water (Table 3.2).

Table 3.2 Guide to typical salinity limits for waters (Queensland Government, science notes L137)

Type	EC (µS/cm)	TDS (mg/l)
Distilled water	1	0.67
Rainfall	30	20
Freshwater	0 to 1500	0 to 1000
Great Artesian Basin Water	700 to 1000	470 to 670
Brackish water	1500 to 15000	1000 to 10050
Upper limit recommended for drinking	1600	1070
Seawater	55000	36850
Tolerances of livestock to salinity in drinking water (at these values, animals may have an initial reluctance to drink, but stock should adapt without loss of production)		
• Beef cattle	5970 to 7460	4000 to 5000
• Dairy cattle	3730 to 5970	2500 to 4000
• Sheep	7460 to 14925	5000 to 10000
• Horses	5970 to 8955	4000 to 6000
• Poultry	2985 to 4475	2000 to 3000
General limits for irrigation		
• Salt sensitive crops	650	435
• Moderately salt sensitive crops	1300	870
• Salt tolerant crops	5200	3485
• Generally, too saline for crops	8100	5430

¹ Electrical conductivity is a measure of the saltiness of the water and is measured on a scale from 0 to 50,000 µS/cm. Electrical conductivity is measured in micro siemens per centimetre (µS/cm).

The samples taken from the Watties and Christmas bores suggest that groundwater is brackish with electrical conductivity ranging between 2,220 and 7,560 $\mu\text{S}/\text{cm}$ (i.e. towards the upper end of the limits for stock watering and irrigation uses (Table 3.2). Given the depth of the Toolachee and Patchawarra units in the Project area, data for the gas production bores points are highly saline conditions with EC ranging between 10,000 and 19,000 $\mu\text{S}/\text{cm}$ and well above the upper limits for drinking, stock watering or irrigation (Table 3.2).

A piper plot (Figure 3.6) and a Durov diagram (Figure 3.7) were generated for the four water samples collected. As shown in Figure 3.6, all boreholes can be classified as a sodium-chloride water type. As would be expected, given the higher salinity values discussed above water drawn from the production bores is characterised by substantially higher chloride concentrations (between 3,300 and 7,200 mg/L) than the groundwater drawn from the local water supply bores (between 810 and 1,800 mg/L).

The pH is close to neutral for three samples, ranging between 6.8 and 7.5 (Figure 3.7) while water sampled from the overflow pond is basic with a pH of 8.5. This may be related to chemical changes occurring within the pond.

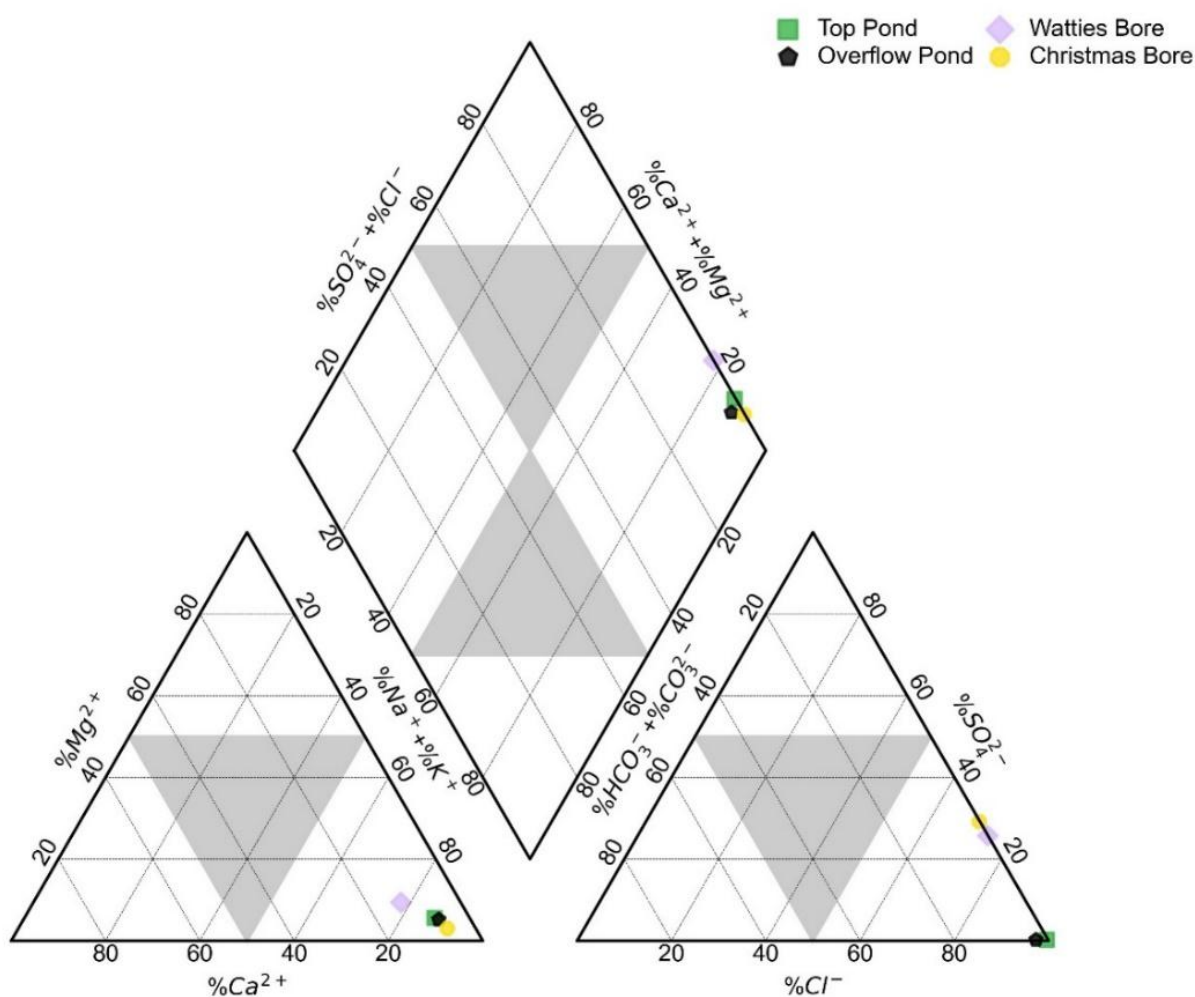


Figure 3.6 Piper plot

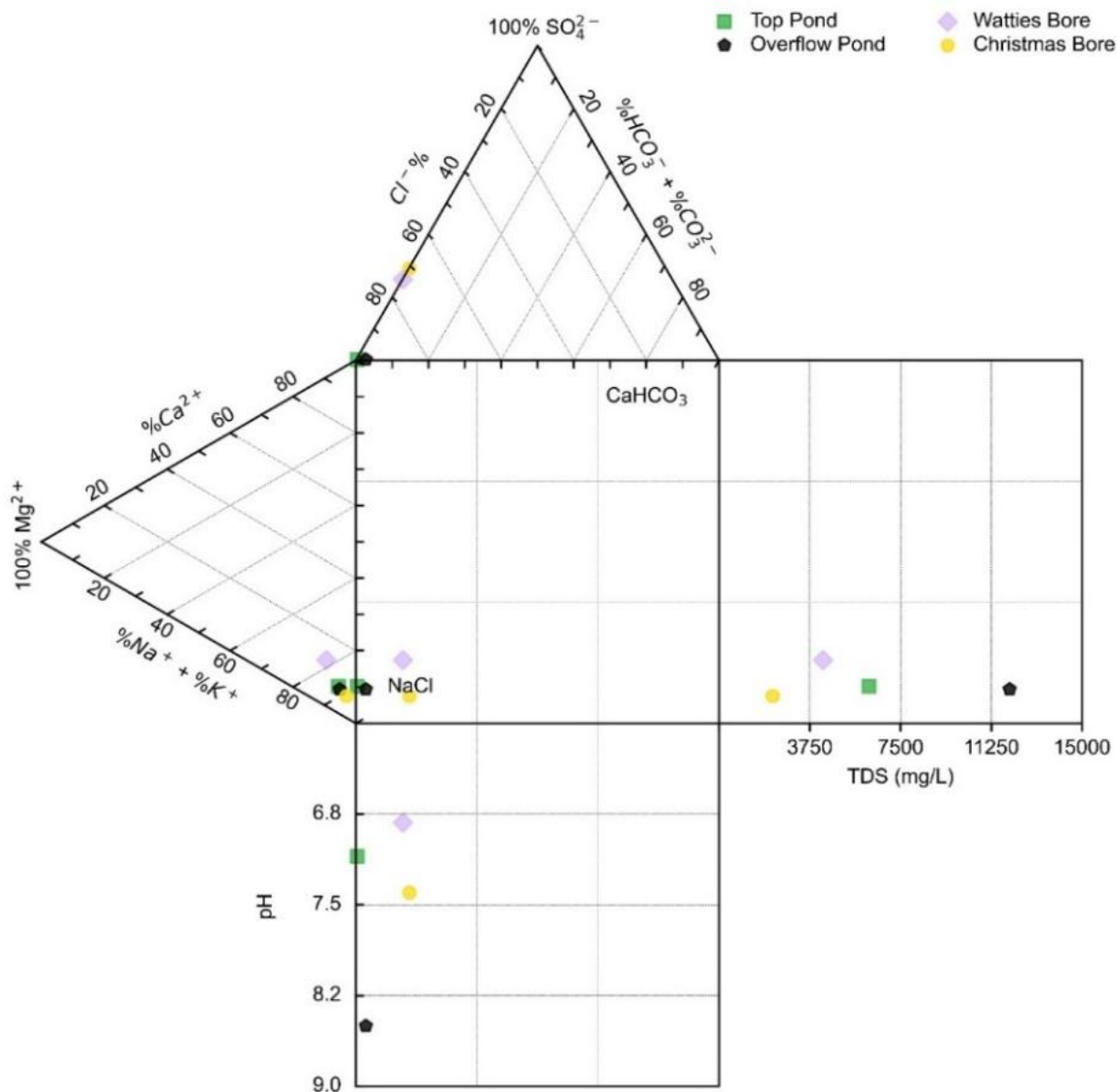


Figure 3.7 Durov diagram

3.6 Hydrogeological conceptual model

Figure 3.8 presents a hydrogeological conceptual model of Vali gas field based on the data available. Other local water supply bores in the Project area extend to less than 300 metres below ground level and are therefore thought to be extracting from the Winton or Glendower Formations. The Eromanga Basin unconformably overlies the Cooper Basin where the three active production bores, Vali-1, Vali-2 and Vali-3 are extracting water from between 2,380 and 3,110 m below ground level. This places the production zone more than 2,080 metres below the depth of local groundwater extraction.

Vali-1 is screened within the deepest unit, the Patchawarra Formation. The production well Vali-3 is currently screened within the Toolachee Formation, while Vali-2 extracts gas from both the Toolachee and Patchawarra Formations. In 2026, Vali-3 will be reconfigured to target the Patchawarra Formation, which will also be the target formation for the upcoming Vali-4 and Vali-5 wells.

Adopted hydraulic conductivity and storativity values are based predominantly on values available for adjacent lease areas (Santos 2019; Beach Energy, 2020) which are shown in Figure 3.8. Sections 3.6.1 and 3.6.2 below describe the estimated water levels and potential groundwater flow and recharge mechanisms within the Cooper Basin.

3.6.1 Underground water flow and aquifer interactions

As would be expected given the depth of the target formations in the Project area, information on groundwater levels and flow directions in the Toolachee and Patchawarra formations and the Cooper Basin in general are limited. Groundwater movement even within coarse sandstone units present at such depths is likely to be limited by its reduced capacity to transmit water as permeability tends to decrease with increasing depth. Similarly, groundwater recharge through the overlying 2,400 m thick sedimentary pile which includes significant thicknesses of aquitard material is likely to be negligible. Hence consistent with the water quality data described above (Section 3.5) Toolachee and Patchawarra formations are saline and likely to be relatively old, when compared to waters from the overlying GAB aquifers in the Eromanga Basin. The implication here is that the recharge of the Cooper Basin aquifers may be considered minimal to none (Keppel et al., 2016). In general groundwater flow, if it occurs at all given the expected low permeability, generally follows the sedimentary bedding, towards lower-lying areas.

Evidence gathered from drill stem testing (DST) during drilling showed “over-pressuring” in the Toolachee, Daralingie and Patchawarra Formations (i.e. pressures which increase with depth and are above the hydrostatic pressure line), which suggests the existence of highly effective seals (i.e. aquitards) within the Nappamerri Group (Lech et al., 2020). Movement of groundwater into and out of the Cooper Basin formations via the overlying Eromanga Basin aquifers is therefore only likely to occur where a connected pathway through the Nappamerri group exists or is subsequently established. Hypothesized pathways include locations where the unit abuts basement highs which could, in combination with localised faulting, create preferential pathways for vertical fluid migration.

3.6.2 Underground water level trend analysis

There is limited groundwater level information in the Cooper Basin within the Vali gas field. Short post-production and production shut-in pressure tests were provided for two production wells, Vali-1 and Vali-2, in August 2023. The estimated water levels at Vali-1 from the pressure tests vary between 190 and 1,500 metres (not stabilised) below ground level. The shut-in pressure test at Vali-2 was not stabilised and the pressure measured was equivalent to 1,140 metres below ground level at the time of the test. It is likely there is a depressurisation in the production wells above 1,500 metres of water depletion however it is unlikely the depressurisation extends to the overlaying Eromanga Basin. The Winton Formation is likely locally depressurised from the water users' bores.

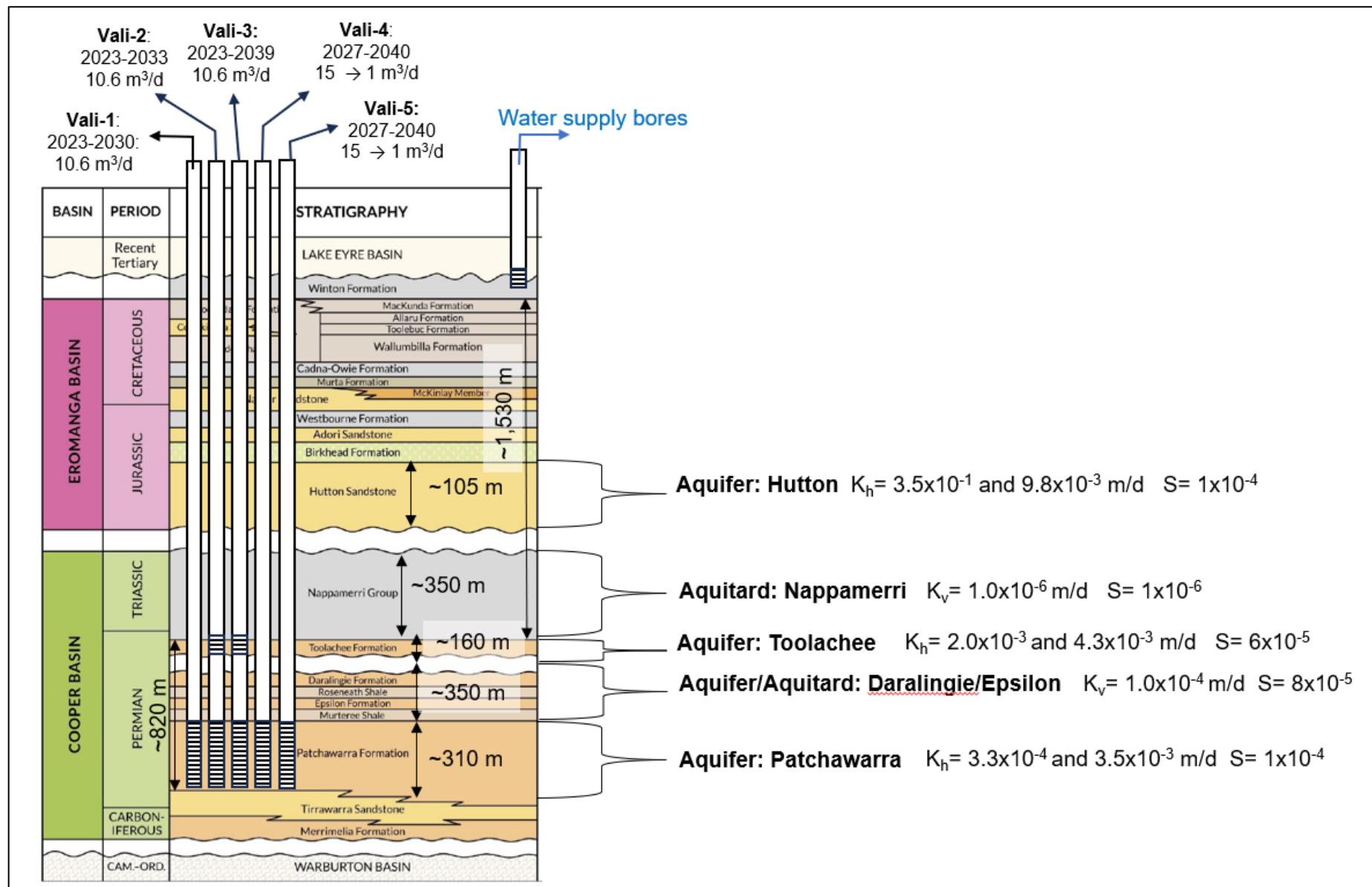


Figure 3.8 Hydrogeological conceptual model

4 Predictions of groundwater impacts (Part C)

For the purposes of this UWIR, the affected area in the Cooper Basin and the Hutton Sandstone is considered to be the area where observed or predicted groundwater level drawdown, caused by the removal of water to allow efficient gas extraction, exceeds five metres (Section 1.3.2). The drawdown threshold for potential impact on springs and groundwater dependent ecosystems (GDEs) is 0.2 m.

As mentioned in Section 2, during IAA frame time 2023-2026, water extraction is currently supported by the following three wells:

- Vali-1: Predicted to remain online until 2030.
- Vali-2: Predicted to remain online until 2033.
- Vali-3 (Toolachee Formation): Predicted to extract from this formation until 2026.

Vintage has also indicated plans to expand production capacity by adding two new wells (Vali-4 and Vali-5), with Vali-3 extracting from the Patchawarra Formation:

- Vali-3 (Patchawarra Formation): Scheduled to come online in 2026, with operations expected to continue through to 2039.
- Vali-4: Expected to come online in 2027 and remain operational until 2040.
- Vali-5: Expected to come online in 2027 and remain operational until 2040.

Vali-3 (Patchawarra Formation), along with the new wells Vali-4 and Vali-5, has been considered in relation to long-term declines in groundwater levels (LTAA).

The description of the method used to predict groundwater impacts is provided in Section 4.1, while the predicted groundwater level drawdown outcomes for the IAA and LTAA areas are presented in Section 4.2 and shown in Figure 4.3 and Figure 4.4. See Section 8 for the annual review program.

4.1 Model approach

An analytical modelling approach has been adopted for the study on the basis that the risk to existing water users and GDEs are expected to be low, since:

- There is a significant (1,530 m) vertical separation of the target formations (the Toolachee and Patchawarra formations) from potential receptors (existing water supply bores screened into the Winton Formation and terrestrial GDEs potentially partially sourced by near surface aquifer units).
- The existence of a number of regional scale aquitards in the zone between the target formations and potential receptors, including in particular the Nappamerri Group (approximately 350m thick) which is known to form a highly effective seal at the top of the Cooper Basin in the area (Lech et al., 2020).
- There are no mapped major faults which might form vertical impact propagation pathways or mound springs which might provide evidence of actual pathways, within 100 km of the Project area.

Predictive modelling was undertaken using the MLU software (version 2.25.78). This is a relatively sophisticated quasi 3D analytical modelling tool which unlike other analytical tools allows simulation of multiple aquifer systems and intervening aquitards and can easily be set up to provide predictions in each aquifer based on ongoing extraction from a number of extraction wells.

The primary objective of the predictive modelling was to provide estimates of the decline in water level in response to the ongoing removal of water from the Toolachee and Patchawarra formations over a three-year period (i.e. identify the IAA area) and in the long-term (i.e. the LTAA area). Given the large distances between the target formation and the receptors this primarily involved assessing the degree to which extraction impacts propagate vertically through the overlying material.

Due to the existence of a geological discontinuity between the Eromanga and the Cooper Basins and the thickness of the Nappamerri Group aquitard above the Toolachee Formation, it is considered highly unlikely that the impact of water extraction in the Cooper Basin will propagate into the overlying Eromanga Basin.

Nevertheless, the Hutton Sandstone has been simulated to quantify potential drawdown at the base of the Eromanga Basin from the Vali gas field.

The proposed development involves groundwater extraction from a defined set of wells over two assessment periods:

- IAA: Groundwater extraction is limited to continued use of three existing wells (Vali-1, Vali-2, and Vali-3) throughout the IAA timeframe.
- LTAA: Groundwater extraction will include the continued use of Vali-3, along with two additional wells (Vali-4 and Vali-5) for the duration of the LTAA period.

4.1.1 Model construction

For analytical modelling purposes, as summarised in Table 4.1, the conceptual model shown in Figure 3.8 was slightly simplified by representing the interval between the Toolachee and Patchawarra Formations, including the Epsilon Formation aquifer and adjacent aquitards (Daralingie Formation, Roseneath Shale, and Murteree Shale) as a single layer. As shown each of the three remaining aquifers (i.e. the Hutton Sandstone and the Toolachee and the Patchawarra Formations) were simulated using dedicated layers and consistent with the conceptual model were modelled as being separated by significant thicknesses of intervening aquitard material.

Adopted hydraulic parameters used for modelling purposes are also provided in Table 4.1 and were sourced from existing UWIR surrounding the Project area.

Table 4.1 Initial scenario - hydrogeological parameters

Layer	Thickness (m)	K (m/d)	S	Lithology	Aquifer
1	105	3.5×10^{-1}	1.0×10^{-4}	Hutton Sandstone	Aquifer
2	350	$*1.0 \times 10^{-6}$	1.0×10^{-6}	Nappamerri Group	Aquitard
3	160	2.0×10^{-3}	5.5×10^{-5}	Toolachee Formation	Aquifer
4	350	$*2.0 \times 10^{-4}$	8.0×10^{-5}	Daralingie Formation/Roseneath Shale/Epsilon Formation/Murteree Shale	Aquifer/Aquitard
5	310	3.3×10^{-4}	1.1×10^{-4}	Patchawarra Formation	Aquifer

Note: *Vertical hydraulic conductivity.

Location and modelled layer attributions for each of the simulated extraction wells are summarised in Table 4.2. Additionally, Table 4.3 presents the average groundwater extraction rates applied in the analytical modelling to assess potential impacts on the regional groundwater system during both the IAA and LTAA phases.

Table 4.2 Existing and proposed production wells

Well name	Easting	Northing	Modelling layer	IAA	LTAA
Vali 1	506107.8	6903682.8	5	3 years	Until 2030
Vali 2 (dual screen)	507322.8	6903329.1	3,5	3 years	Until 2033
Vali 3 (Toolachee)	505599.3	6903174.4	3	3 years	Until 2026
Vali 3 (Patchawarra)	505599.3	6903174.4	5	-	Until 2039
Vali 4	506450.9	6904568.3	5	-	Until 2040
Vali 5	505418.5	6904879.0	5	-	Until 2040

Note: Coordinates system: GDA 2020.

Table 4.3 Average groundwater extraction rates used in analytical modelling for IAA and LTAA periods

Year	Date	Extraction wells online	Vali 1 (kL/y)	Vali 2 (kL/y)	Vali 3 (kL/y)	Vali 4 (kL/y)	Vali 5 (kL/y)	Total water extraction (kL/y)
2023/2024	1 July 2023 to 30 June 2024	Vali-1, Vali-2, Vali-3	2,300	2,300	2,300	0	0	6,900
2024/2025	1 July 2024 to 30 June 2025	Vali-1, Vali-2, Vali-3	3,867	3,867	3,867	0	0	11,600
2025/2026	1 July 2025 to 30 June 2026	Vali-1, Vali-2, Vali-3	3,867	3,867	3,867	0	0	11,600
2026/2027	1 July 2026 to 30 June 2027	Vali-1, Vali-2, Vali-3 ^a ,	3,867	3,867	3,867	0	0	11,600
2027/2028	1 July 2027 to 30 June 2028	Vali-1, Vali-2, Vali-3 ^a , Vali-4, Vali-5	3,867	3,867	3,867	4,558	4,558	20,717
2028/2029	1 July 2028 to 30 June 2029	Vali-1, Vali-2, Vali-3 ^a , Vali-4, Vali-5	3,867	3,867	3,867	3,106	3,106	17,812
2029/2030	1 July 2029 to 30 June 2030	Vali-1, Vali-2, Vali-3 ^a , Vali-4, Vali-5	3,867	3,867	3,867	2,252	2,252	16,104
2030/2031	1 July 2030 to 30 June 2031	Vali-2, Vali-3 ^a , Vali-4, Vali-5	0	3,867	3,867	1,708	1,708	11,149
2031/2032	1 July 2031 to 30 June 2032	Vali-2, Vali-3 ^a , Vali-4, Vali-5	0	3,867	3,867	1,340	1,340	10,413
2032/2033	1 July 2032 to 30 June 2033	Vali-2, Vali-3 ^a , Vali-4, Vali-5	0	3,867	3,867	1,079	1,079	9,891
2033/2034	1 July 2033 to 30 June 2034	, Vali-3 ^a , Vali-4, Vali-5	0	0	3,867	888	888	5,642
2034/2035	1 July 2034 to 30 June 2035	Vali-3 ^a , Vali-4, Vali-5	0	0	3,867	743	743	5,353
2035/2036	1 July 2035 to 30 June 2036	Vali-3 ^a , Vali-4, Vali-5	0	0	3,867	631	631	5,129
2036/2037	1 July 2036 to 30 June 2037	Vali-3 ^a , Vali-4, Vali-5	0	0	3,867	543	543	4,952
2037/2038	1 July 2037 to 30 June 2038	Vali-3 ^a , Vali-4, Vali-5	0	0	3,867	472	472	4,810
2038/2039	1 July 2038 to 30 June 2039	Vali-3 ^a , Vali-4, Vali-5	0	0	3,867	414	414	4,694
2039/2040	1 July 2039 to 30 June 2040	Vali-4, Vali-5	0	0	0	233	233	467

Note: ^a Gas extraction from the Patchawarra Formation commencing July 2026.

4.1.2 Assumptions and limitations

The assumptions and limitations of the analytical modelling include:

- Predictive production rates provided by Vintage were equally divided between the Vali-1, Vali-2 and Vali-3 bores while the current production rates are mainly from Vali-1.
- Estimated aquifer parameters (hydraulic conductivity and storativity) are based on literature review and based on UWIRs for adjacent production leases (Santos, 2019; Beach Energy 2020). No hydrogeological parameter measurements were available for the Vali gas field.
- Project life of Vali gas field is estimated at 17 years.
- Like other similar tools MLU neglects the effects of the storage term within aquitard units and hence does not predict any lag between stresses applied to the target formations (Toolachee and Patchawarra formations). As such the predicted impacts are expected to be conservative especially with regard to the timing of any impacts in the Hutton Sandstone. In practice, impacts would likely take hundreds if not thousands of years to migrate through the underlying 350 m thick aquitard and would therefore be significantly delayed.

4.2 Model results

Figure 4.1 and Figure 4.2 present the predicted drawdown for the initial scenario in the production wells Vali-1, Vali-2, Vali-3, Vali-4 and Vali-5 in the Cooper Basin and the Hutton Sandstone. Table 4.4 resents the maximum drawdown, the IAA and LTAA, with five-metre drawdown contours in both Toolachee and Patchawarra aquifer.

Table 4.4 Predicted maximum drawdown – initial scenario

Aquifer	IAA (year 3)		LTAA	
	Drawdown (m)	5 m Drawdown Extent radius (km)	Maximum Drawdown (m)	5 m Drawdown extent radius (km)
Hutton	0.003	NA	0.02	NA
Toolachee	55	1.5	55	2.5
Patchawarra	153	1.5	183	3

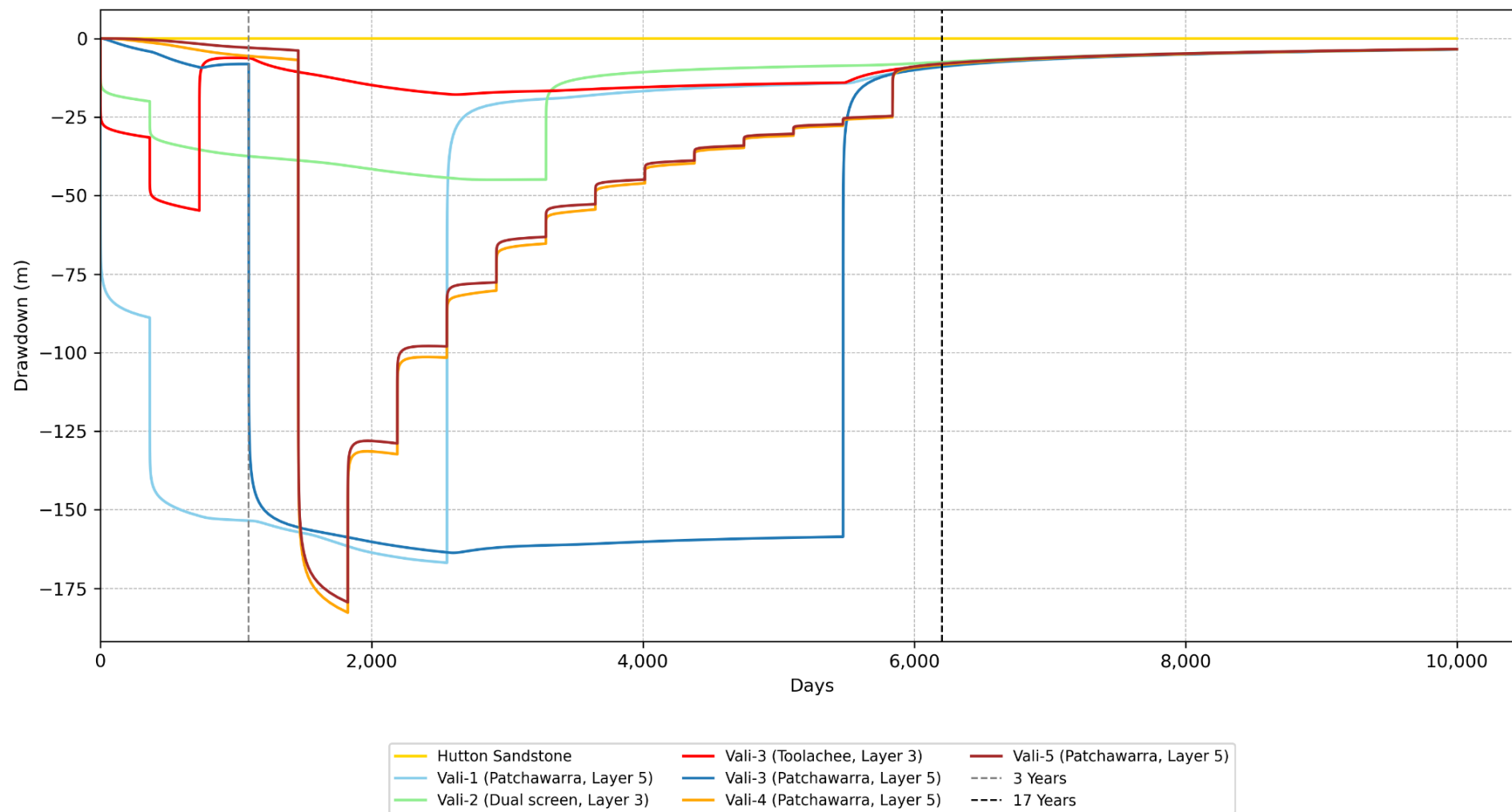


Figure 4.1 Predicted drawdown – initial scenario

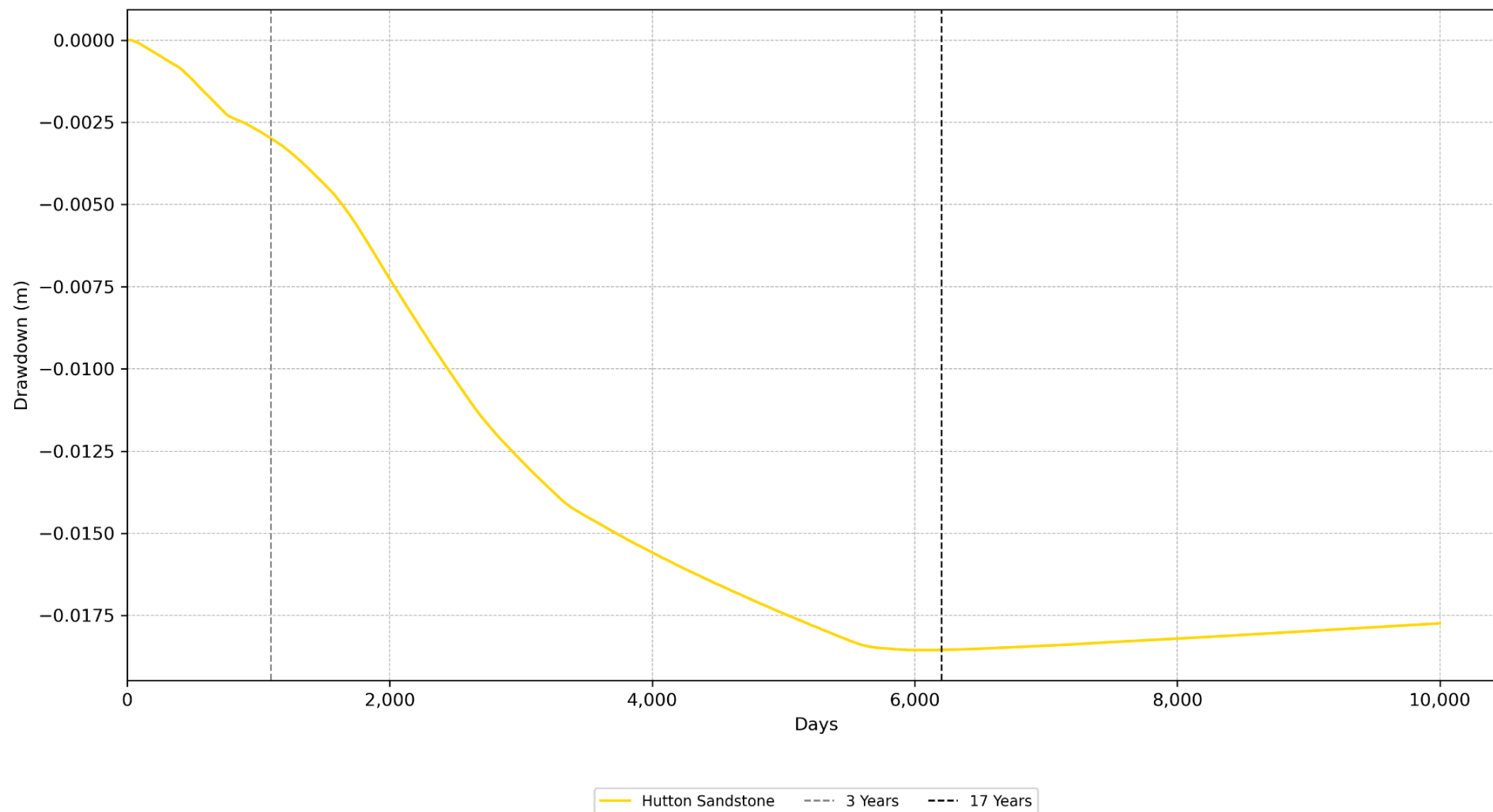
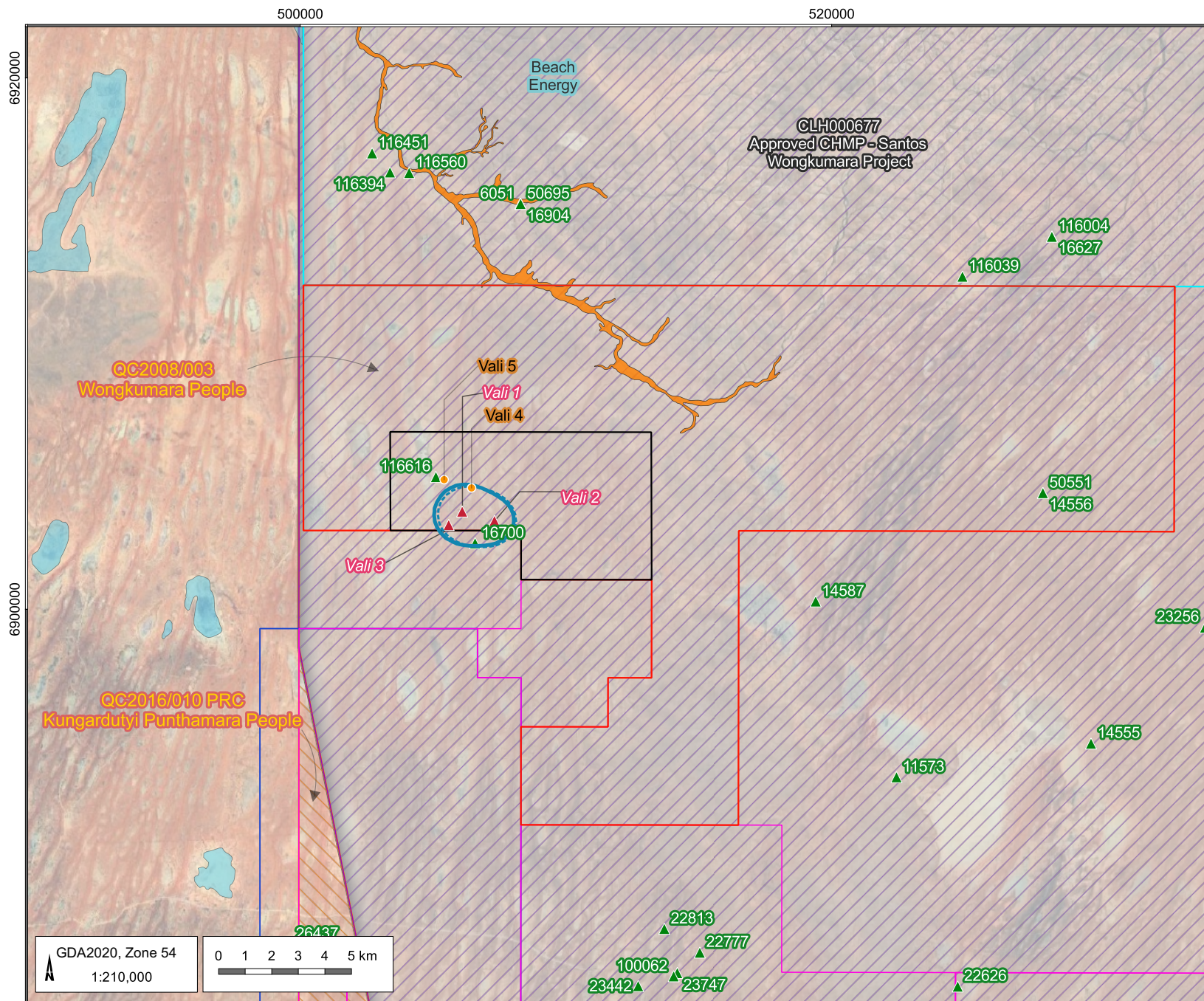


Figure 4.2 Predicted drawdown – initial scenario - Hutton Sandstone



LEGEND

- Place names
 - ▲ Vali wells
 - Vali wells - proposed
 - ▲ Registered bores
 - 5m drawdown contour (m) - Toolachee
 - 5m drawdown contour (m) - Patchawarra
 - Authority to Prospect (ATP 2021)
- Authority to Prospect (ATPs)**
- Petroleum Lease 1125
 - Santos Petroleum Leases
 - Santos Exploration Permits for Petroleum
 - Santos Cooper Basin
 - Cultural Heritage Management Plan boundary
- Cultural Heritage Party boundaries**
- Kungardutyi Punthamara People
 - Wongkumara People
- Aquatic GDEs**
- Low potential GDE - from national assessment
- Terrestrial GDEs**
- Moderate potential GDE - from regional studies

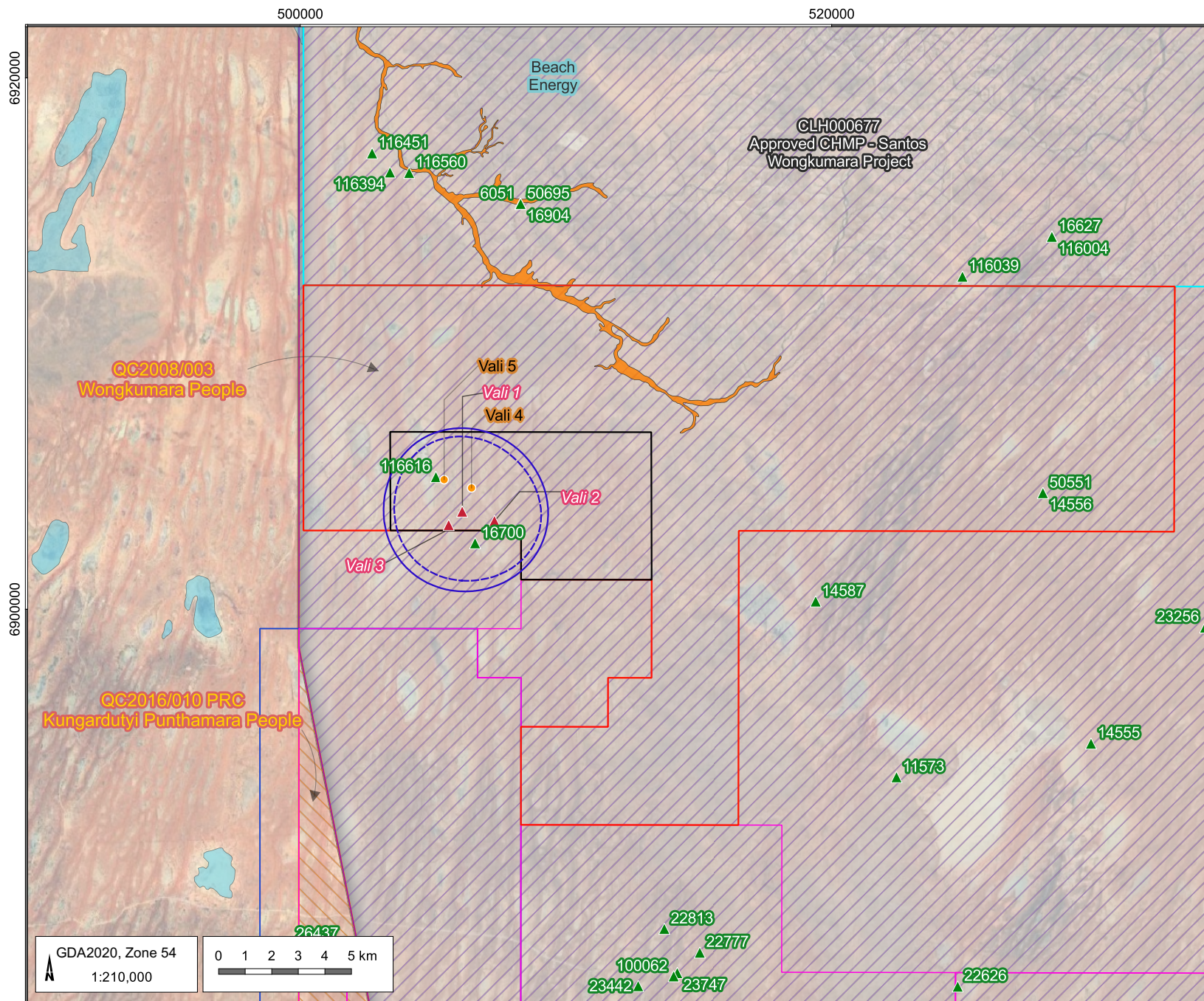
Vali Gas Field UWIR 2025 (VGF5000.002)

IAA - Predicted groundwater impact drawdown – Toolachee and Patchawarra formations



DATE
14/10/2025

FIGURE No:
4.3



LEGEND

- Place names
- ▲ Vali wells
- Vali wells - proposed
- ▲ Registered bores
- - - 5m drawdown contour (m) - Toolachee
- - - 5m drawdown contour (m) - Patchawarra
- Authority to Prospect (ATP 2021)
- Authority to Prospect (ATPs)**
 - Petroleum Lease 1125
 - Santos Petroleum Leases
 - Santos Exploration Permits for Petroleum
 - Santos Cooper Basin
 - Cultural Heritage Management Plan boundary
- Cultural Heritage Party boundaries**
 - Kungardutyi Punthamara People
 - Wongkumara People
- Aquatic GDEs**
 - Low potential GDE - from national assessment
- Terrestrial GDEs**
 - Moderate potential GDE - from regional studies

Vali Gas Field UWIR 2025 (VGF5000.002)

LTAA - Predicted groundwater impact drawdown – Toolachee and Patchawarra formations

DATE
14/10/2025

FIGURE No:
4.4



4.2.1 Immediately affected area (IAA)

The predicted IAA area, i.e. the area where more than 5 m of drawdown is predicted during the 2023 to 2026 UWIR reporting period for the Toolachee and the Patchawarra formations (Layers 3 and 5) is presented in Figure 4.3. The maximum drawdown predicted in the Hutton Sandstone during this period (Figure 4.2) is 0.003 m and hence there is no IAA for this aquifer. No drawdown impacts are therefore predicted in any units overlying the Hutton Sandstone. The maximum predicted drawdown is 183 m at Vali-4 within the Patchawarra Formation.

As shown in Figure 4.3 and Table 4.4 the predicted IAA for the Toolachee and the Patchawarra formations are very similar (since the Vali-2 bore is screened in both formations and hence provides a location connection between the two units) and extend approximately 3km from the production wells Vali-1, Vali-2 and Vali-3.

4.2.2 Long-term affected area (LTAA)

The predicted LTAA area, i.e. the area where more than 5 m of drawdown is predicted at any time in the future for the Toolachee and the Patchawarra formations (Layers 3 and 5) is presented in Figure 4.4. Maximum predicted drawdown in the Hutton Sandstone at the end of the production period (Figure 4.2) is 0.02 m and hence there is no LTAA for this aquifer. No drawdown impacts are therefore predicted in any units overlying the Hutton Sandstone, including the Glendower and Winton Formations. The maximum predicted drawdown is 183 m in Vali-4 within the Patchawarra Formation (Figure 4.10).

As illustrated in Figure 4.4 the predicted LTAA for both the Toolachee and Patchawarra Formations is largely similar. This is primarily due to the Vali-2 production well being screened across both formations, providing a hydraulic connection between the two units. The LTAA extends approximately 8 kilometres from the production wells, Vali-1, Vali-2, Vali-3, Vali-4, and Vali-5.

However, the LTAA is slightly larger in the Patchawarra Formation compared to the Toolachee Formation. This difference is attributed to the planned cessation of water extraction from the Toolachee Formation and the expansion of production activities targeting the Patchawarra Formation.

4.2.3 Sensitivity

Nine scenarios were run for sensitivity analysis with hydraulic conductivities and storativity of one order of magnitude higher and lower than the initial scenario (scenario 5). Table 4.5 and Table 4.6 present the hydraulic parameters for the nine scenarios.

Figure 4.5, Figure 4.6, Figure 4.7 and Figure 4.8 present the predicted drawdown in each production well and the Hutton Sandstone for the nine sensitivity scenarios. The maximum predicted drawdown in the Hutton Sandstone is 3.91 m (Scenario 10) after approximately 7 years of production (Figure 4.5). The maximum predicted drawdown after three years is 1,531 m and 1,657 m after 7 years in the well Vali-1 (Scenario 9).

Figure 4.12 and Figure 4.13 present the IAA and LTAA. The groundwater depletion in scenario 1 is lower than five metres in any of the analytical model layers except for Vali-1, therefore there are no IAA and LTAA identified for those sensitivity scenarios. The groundwater depletion in scenarios 3, 4 and 8 is lower than five metres within 3 years for Vali-4 and Vali-5. Scenarios 2, 3, 6, 7, 8, 9 and 10 show a predicted drawdown exceeding 5 metres within 3 years and at the end of life of the project for all the other wells. The largest predicted IAA in the Patchawarra and Toolachee is approximately 5 km radius and 10 km radius for the LTAA (scenario 6).

There is no groundwater drawdown greater than five metres predicted in the Eromanga Basin (Hutton Sandstone) in any sensitivity scenarios. There is no impact to registered water bores screened in the Cooper Basin and no environmental receptors identified within the IAA and LTAA.

Existing petroleum wells Kappa 1, Kappa 3, Kappa 4 and Chef 1 from Santos's Petroleum Lease are within the LTAA of sensitivity scenarios 6 and 9, within a radius of eight kilometres.

Table 4.5 Sensitivity scenarios 1 to 4

Scenarios #	1		2		3		4	
Layer	K (m/d)	S	K (m/d)	S	K (m/d)	S	K (m/d)	S
1	3.5×10^{-1}	1.0×10^{-3}	3.5×10^{-1}	1.0×10^{-4}	3.5×10^{-1}	1.0×10^{-5}	3.5×10^{-1}	1.0×10^{-3}
2	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}
3	2.0×10^{-2}	5.5×10^{-4}	2.0×10^{-2}	5.5×10^{-5}	2.0×10^{-2}	5.5×10^{-6}	2.0×10^{-3}	5.5×10^{-4}
4	2×10^{-4}	8.0×10^{-4}	2.0×10^{-4}	8.0×10^{-5}	2.0×10^{-4}	8.0×10^{-6}	2.0×10^{-4}	8.0×10^{-4}
5	3.3×10^{-3}	1.1×10^{-3}	3.3×10^{-3}	1.1×10^{-4}	3.3×10^{-3}	1.1×10^{-5}	3.3×10^{-4}	1.1×10^{-3}

Table 4.6 Sensitivity scenarios 6 to 10

Scenarios #	6		7		8		9		10	
Layer	K (m/d)	S	K (m/d)	S	K (m/d)	S	K (m/d)	S	K (m/d)	S
1	3.5×10^{-1}	1.0×10^{-5}	3.5×10^{-2}	1.0×10^{-3}	3.5×10^{-2}	1.0×10^{-4}	3.5×10^{-2}	1.0×10^{-5}	3.5×10^{-2}	1.0×10^{-5}
2	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-5}	1.0×10^{-6}
3	2.0×10^{-3}	5.5×10^{-6}	2.0×10^{-4}	5.5×10^{-4}	2.0×10^{-4}	5.5×10^{-5}	2.0×10^{-4}	5.5×10^{-6}	2.0×10^{-4}	5.5×10^{-6}
4	2.0×10^{-4}	8.0×10^{-6}	2.0×10^{-5}	8.0×10^{-4}	2.0×10^{-5}	8.0×10^{-5}	2.0×10^{-5}	8.0×10^{-6}	2.0×10^{-5}	8.0×10^{-6}
5	3.3×10^{-4}	1.1×10^{-5}	3.3×10^{-5}	1.1×10^{-3}	3.3×10^{-5}	1.1×10^{-4}	3.3×10^{-5}	1.1×10^{-5}	3.3×10^{-5}	1.1×10^{-5}

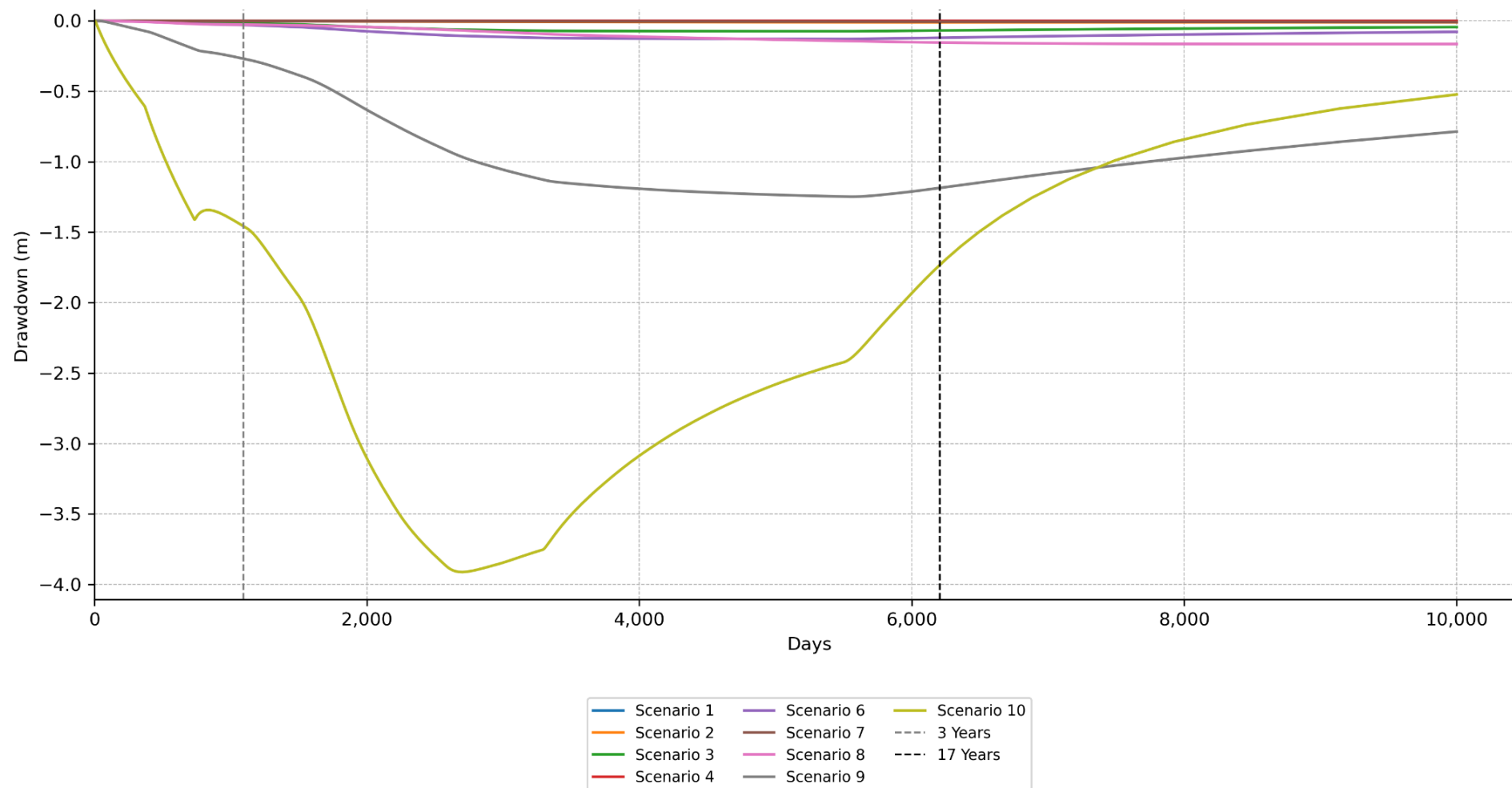


Figure 4.5 Sensitivity analysis – predicted drawdown – Hutton Sandstone

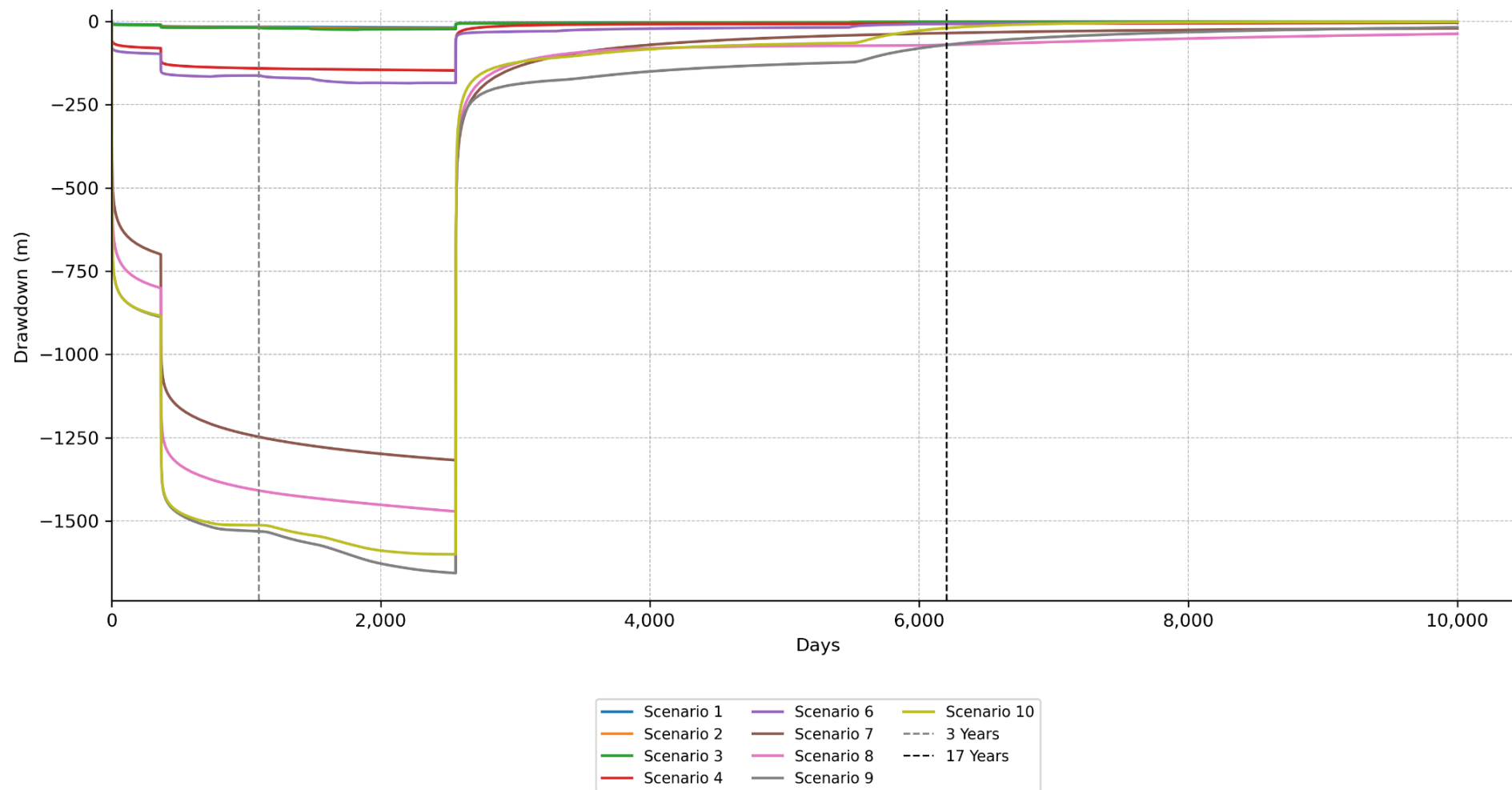


Figure 4.6 Sensitivity analysis – predicted drawdown – Vali-1

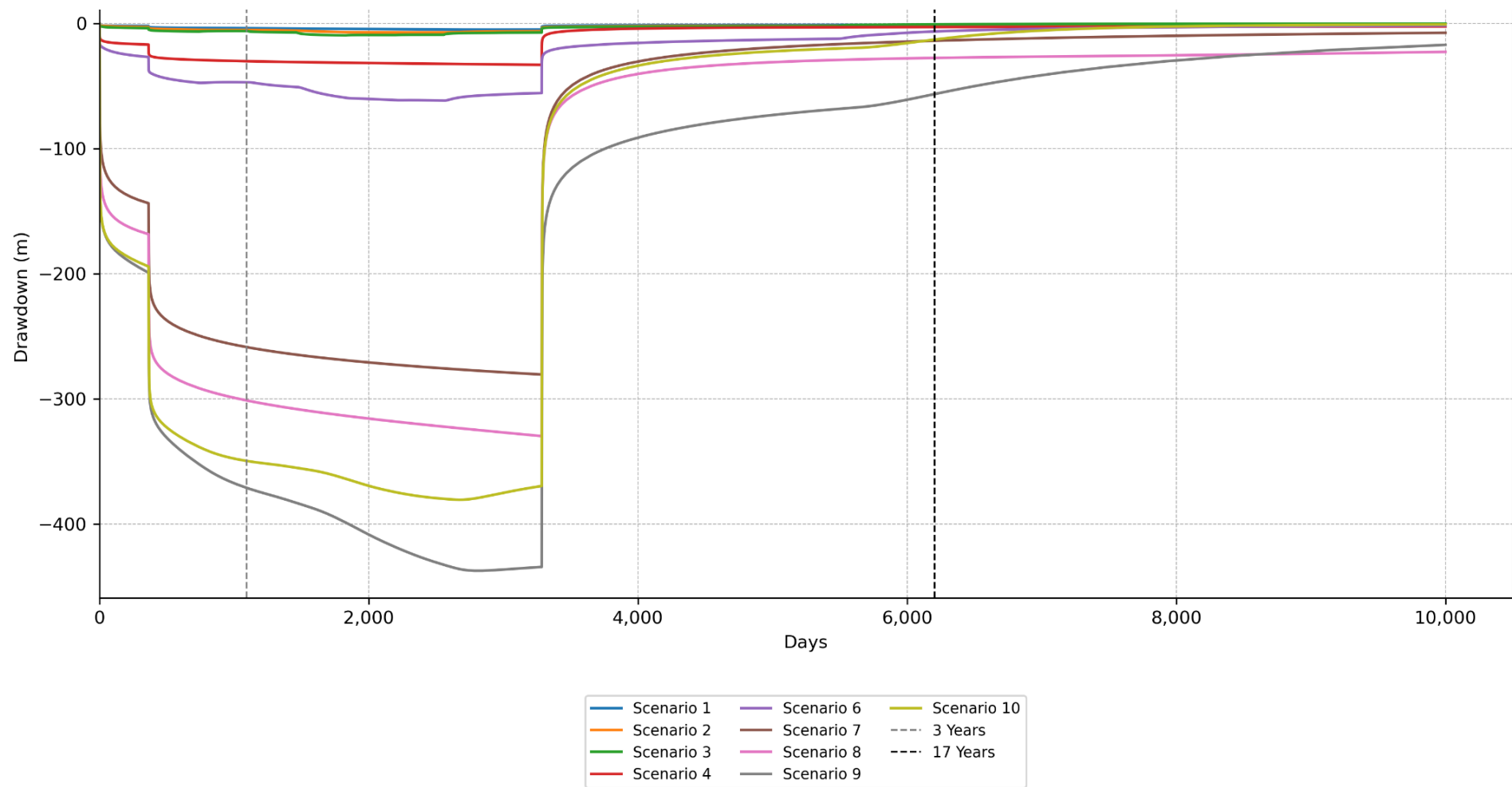
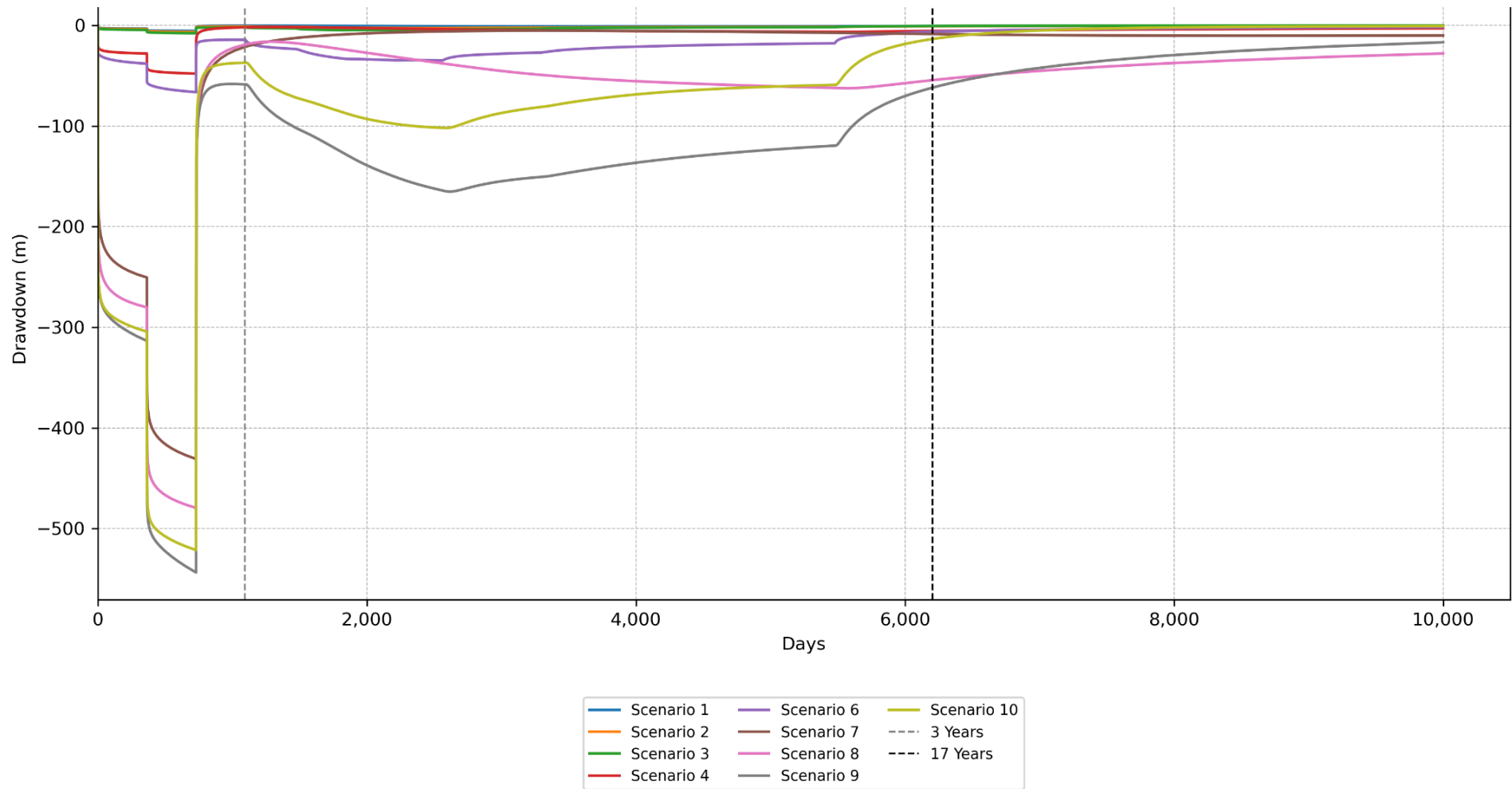


Figure 4.7 Sensitivity analysis – predicted drawdown – Vali-2 Toolachee and Patchawarra



c

Figure 4.8 Sensitivity analysis – predicted drawdown – Vali-3 (Toolachee)

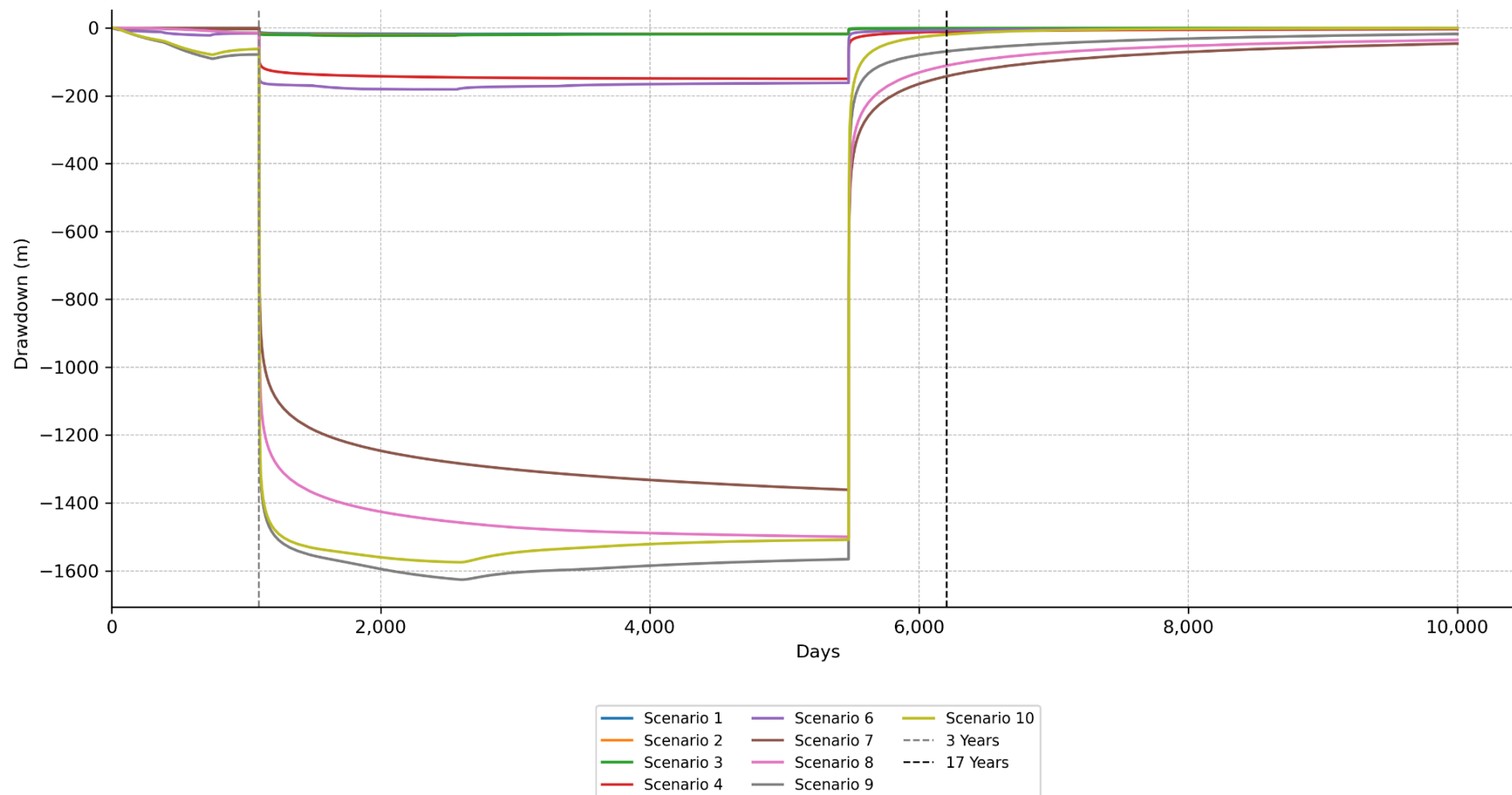


Figure 4.9 Sensitivity analysis – predicted drawdown – Vali-3 (Patchawarra)

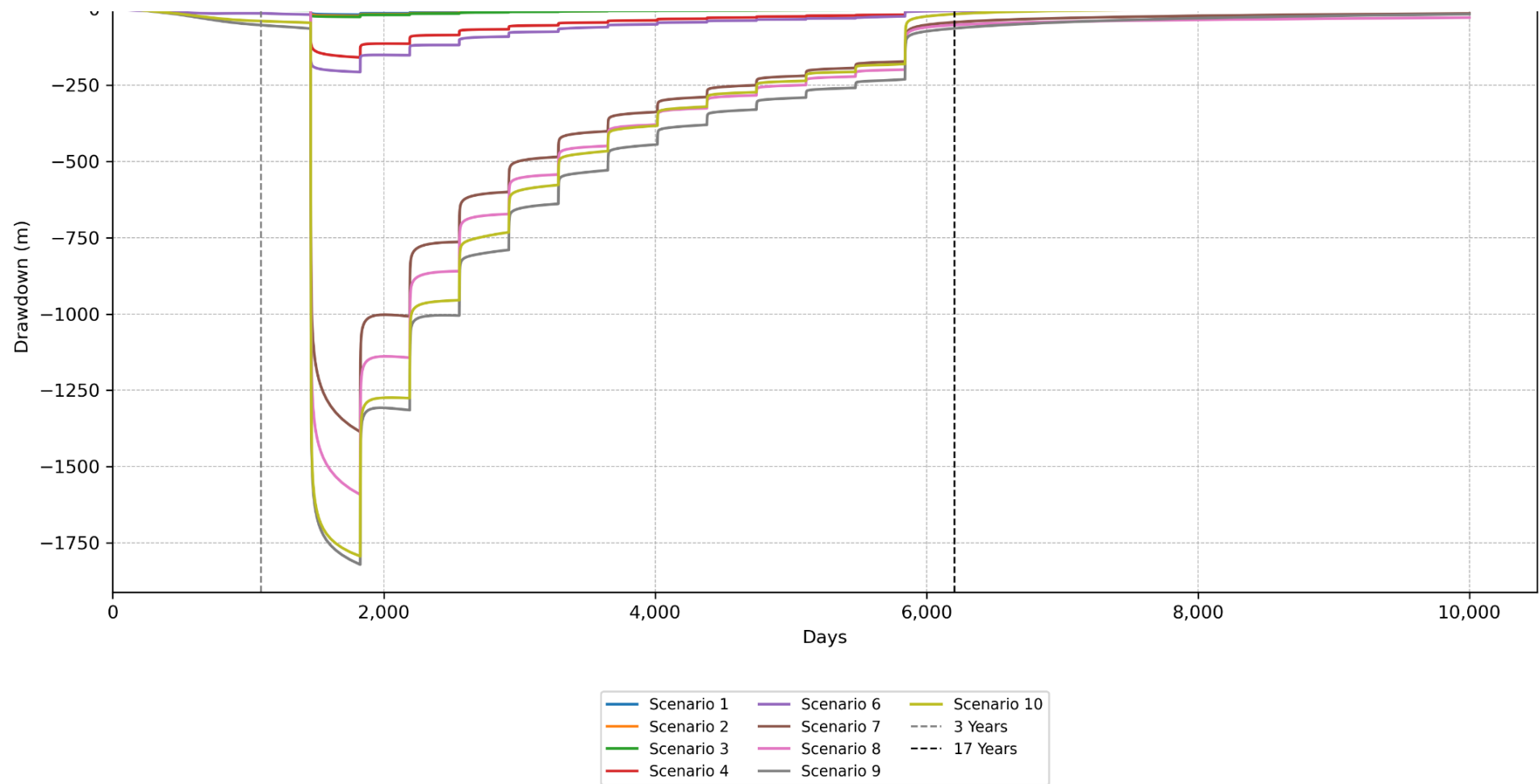


Figure 4.10 Sensitivity analysis – predicted drawdown – Vali-4

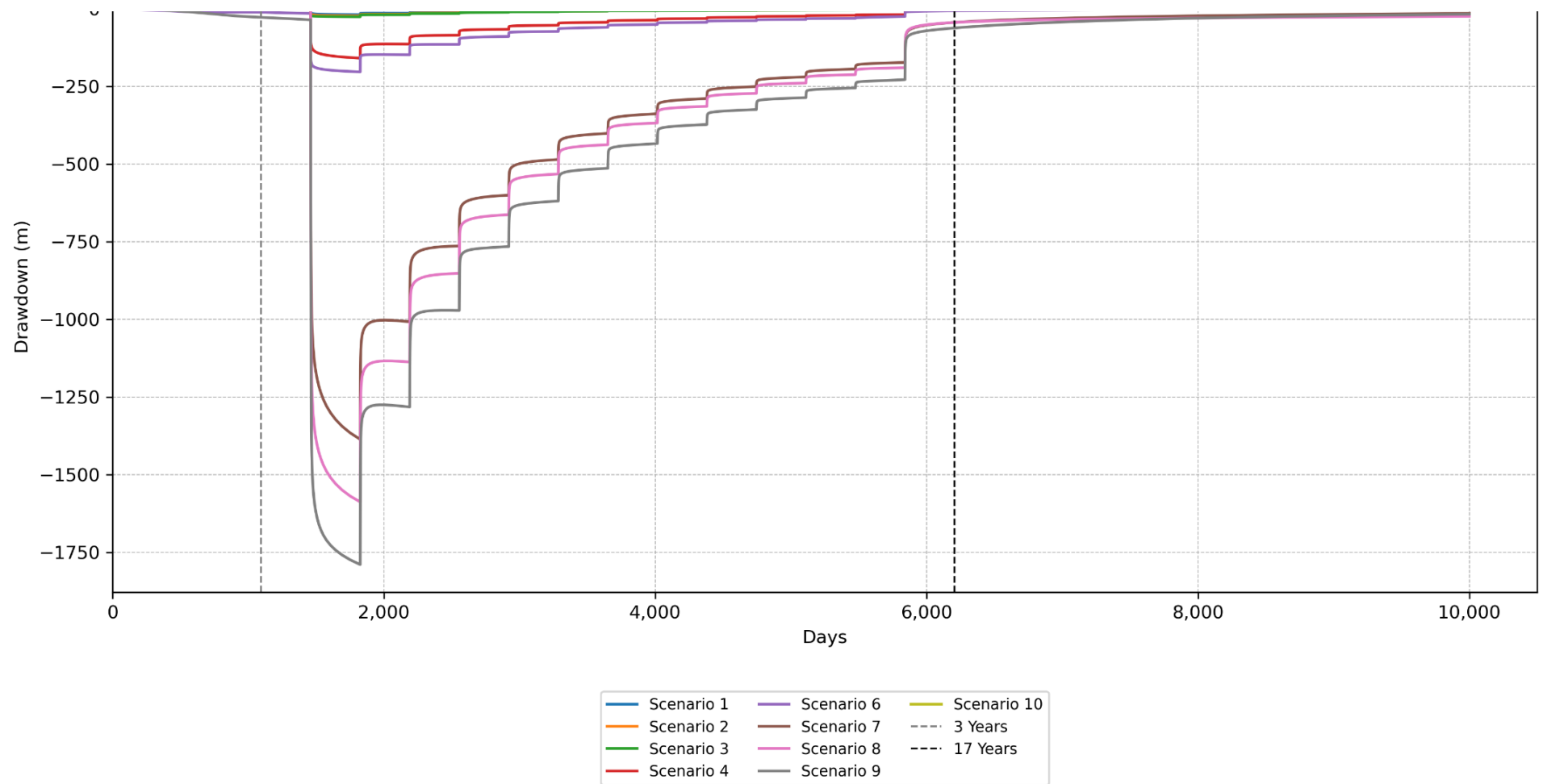
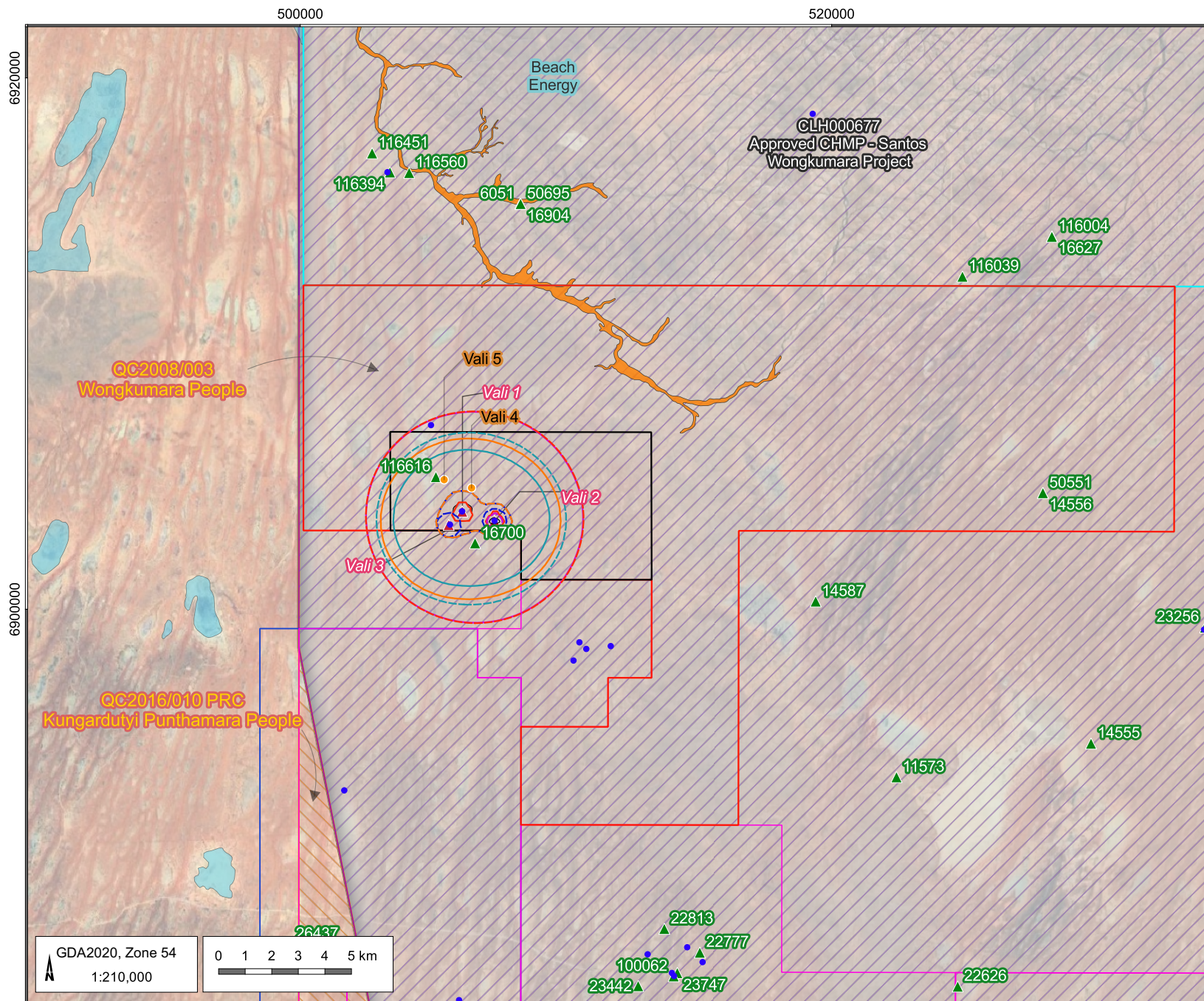
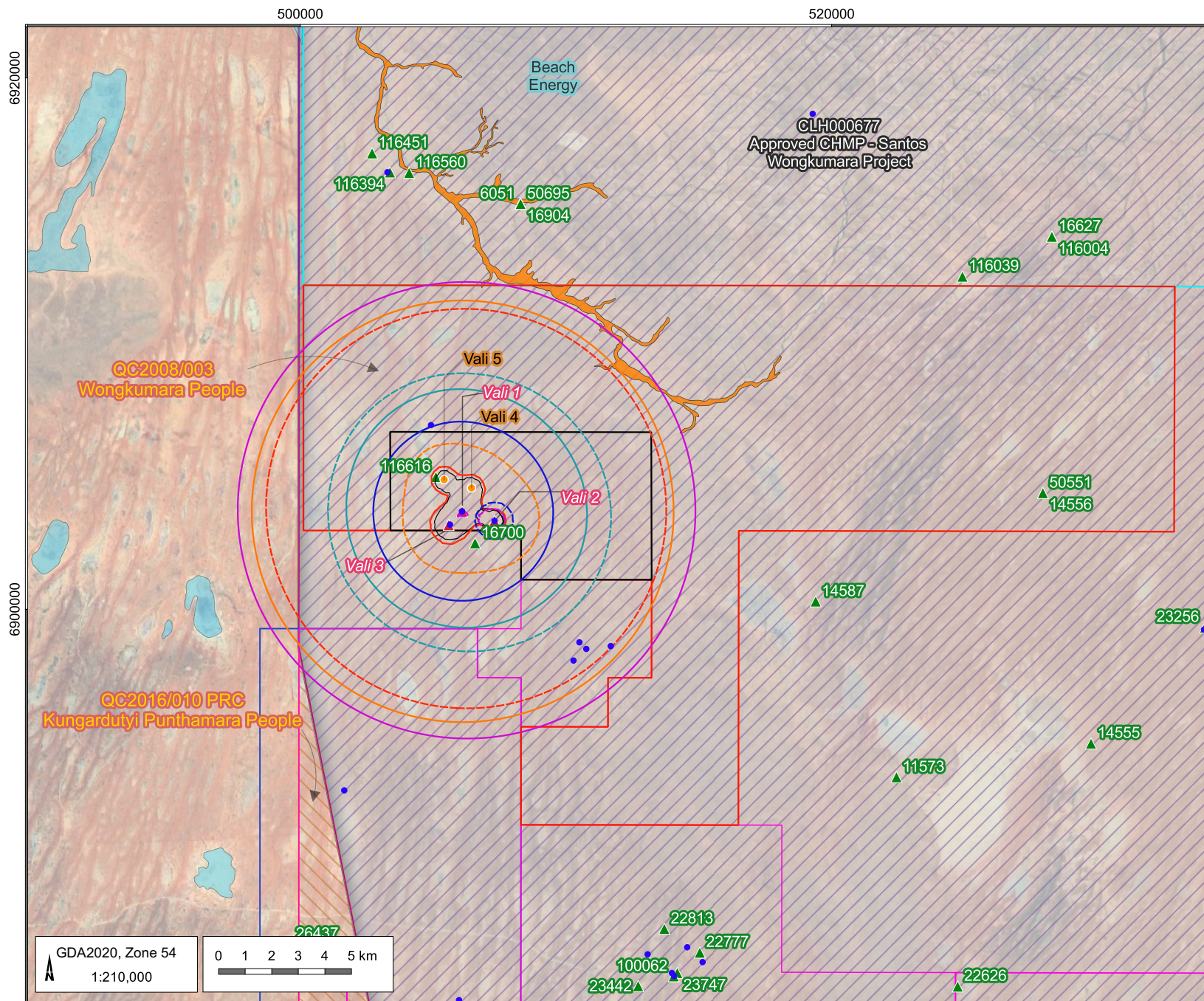


Figure 4.11 Sensitivity analysis – predicted drawdown – Vali-5



DATE
14/10/2025

FIGURE No:
4.12



- LEGEND**
- Place names
 - ▲ Vali wells
 - Vali wells - proposed
 - ▲ Registered bores
 - Petroleum wells
 - Authority to Prospect (ATP 2021)
 - Petroleum Lease 1125
 - Cultural Heritage Management Plan boundary

Cultural Heritage Party boundaries

- Kungardutyi Punthamara People
- Wongkumara People

Aquatic GDEs

- Low potential GDE - from national assessment

Terrestrial GDEs

- Moderate potential GDE - from regional studies

5m drawdown contours (Toolachee)

- Sc. 4 Base K High S
- Sc. 6 Base K Low S
- Sc. 7 Low K High S
- Sc. 8 Low K Base S
- Sc. 9 Low K Low S
- Sc. 10

5m drawdown contours (Patchawarra)

- Sc. 4 Base K High S
- Sc. 6 Base K Low S
- Sc. 7 Low K High S
- Sc. 8 Low K Base S
- Sc. 9 Low K Low S
- Sc. 10

Vali Gas Field UWIR 2025 (VGF5000.002)

LTAA – sensitivity analysis - Toolachee and Patchawarra

DATE
14/10/2025

FIGURE No:
4.13



5 Impact on environmental values (Part D)

According to the Water Act 2000 Guideline (Queensland Government, 2021), by default the environmental values may include (Section 1.3.4):

- aquaculture uses and human consumption of aquatic food;
- irrigation, farm supply/use, stock water uses;
- drinking water uses;
- aquatic ecosystems;
- recreational uses;
- industrial uses; and
- cultural and spiritual values.

Figure 5.1 presents the environmental values and existing registered groundwater bores identified within 15 km radius of the Vali gas field.

5.1 Irrigation, farm supply/use and drinking water

There are eight existing registered water bores within fifteen kilometres of Vali production wells. Further details relating to each of these existing bores is provided in Table 5.1. As shown, the majority of the bores are screened into the Winton Formation at depths of up to 294 m below ground and at least 1,600 m above the top of the Hutton Sandstone and hence based on the model results presented above (Section 4.2) are not expected to experience any drawdown due to previous or proposed underground water extraction activities associated with the Project. Therefore, there are no expected changes in water quality in the registered bores listed in Table 5.1 resulting from the decline of groundwater levels due to the project.

Table 5.1 Queensland registered water bores within 15 km radius

RN	Bore name	Easting*	Northing*	Ground elevation (mAHD)	Year drilled	Formation	Top Screen (mbgl)	Bottom Screen (mbgl)	Bore depth (mbgl)
14556	Watties bore	527944	6904365	80.5	1960	Glendower Formation or Winton Formation	NA	81.1	NA
16700	Christmas Yard bore	506583	6902489	96.3	1966	Winton formation	125	154.2	NA
50551	Watties No 2	527944	6904365	NA	1980	Winton formation	NA	81.1	NA
116616	Kudnari	505108	6904981	NA	2023	Winton formation	145.9	148.2	150.2
116394	NA	503380	6916450	NA	2013	-	NA	76	77
116560	Anakin Bore	504101	6916428	NA	2013	Winton formation?	260	272	294
50695	NA	508297	6915261	122	1990	Winton formation	NA	NA	125
14587	Roundhill Bore	519404	6900298	76.5	1961	Winton formation	NA	168.6	168.6

Notes: Coordinate system GDA 2020.

NA: Not Available.

5.2 Groundwater dependent ecosystems (incl. springs)

5.2.1 Springs

There are no springs mapped within 15 km of the Project area. The nearest known GAB springs are located around 100 km to the southwest in South Australia. In Queensland, the nearest springs are 300 km to the east of the area, outside the Cooper Basin. No information is currently available on the source aquifer for these springs in Queensland. Since the nearest springs are located far away from areas of predicted drawdown impacts in the gas reservoir targeted by the Project, no springs are impacted due to previous or proposed underground water extraction activities associated with the Vali Gas Project.

5.2.2 Groundwater Dependent Ecosystems (GDEs)

No GDEs have been identified within PL1125 according to the GDE Atlas. The only GDE present within PL1125 is a vegetation community classified as RE 5.3.22, belonging to the ephemeral wetland group. Additionally, a moderate potential terrestrial GDE has been identified by the Bureau of Meteorology (BOM) along the ephemeral Sandy Creek to the north of the Project area. Hence any groundwater support to this area will be provided by aquifers at or close to the ground surface. Therefore, potentially significant drawdown impacts of more than 0.2 m drawdown are not expected to extend beyond the top of the Cooper Basin at more than 2,000 m below ground. No qualitative and quantitative impacts of this or any other terrestrial GDEs present in the area are therefore predicted as a result of previous or proposed groundwater extraction activities associated with the Project.

5.3 Aquatic ecosystem

Several lacustrine and palustrine intermittent wetlands are present within the project area, with claypans adjacent to the well sites observed on aerial photographs. Low potential for aquatic GDEs associated with lacustrine wetland are mapped in South Australia, to the west of the project area (Aquatic GDEs). The closest aquatic GDE is more than 10 km from the Vali gas field. As no groundwater level impacts are expected above the top of the Cooper Basin which is around 2000 m below ground, no impacts on quality, water levels and flows are anticipated on any surficial aquatic ecosystems due to previous or proposed Project groundwater extraction activities.

5.4 Aquaculture

There is no known use of groundwater for aquaculture purposes within 15 km radius of the Project area. Therefore, no impacts on primary or secondary recreational waters are predicted due to previous or proposed underground water extraction activities associated with the Project.

5.5 Recreational waters

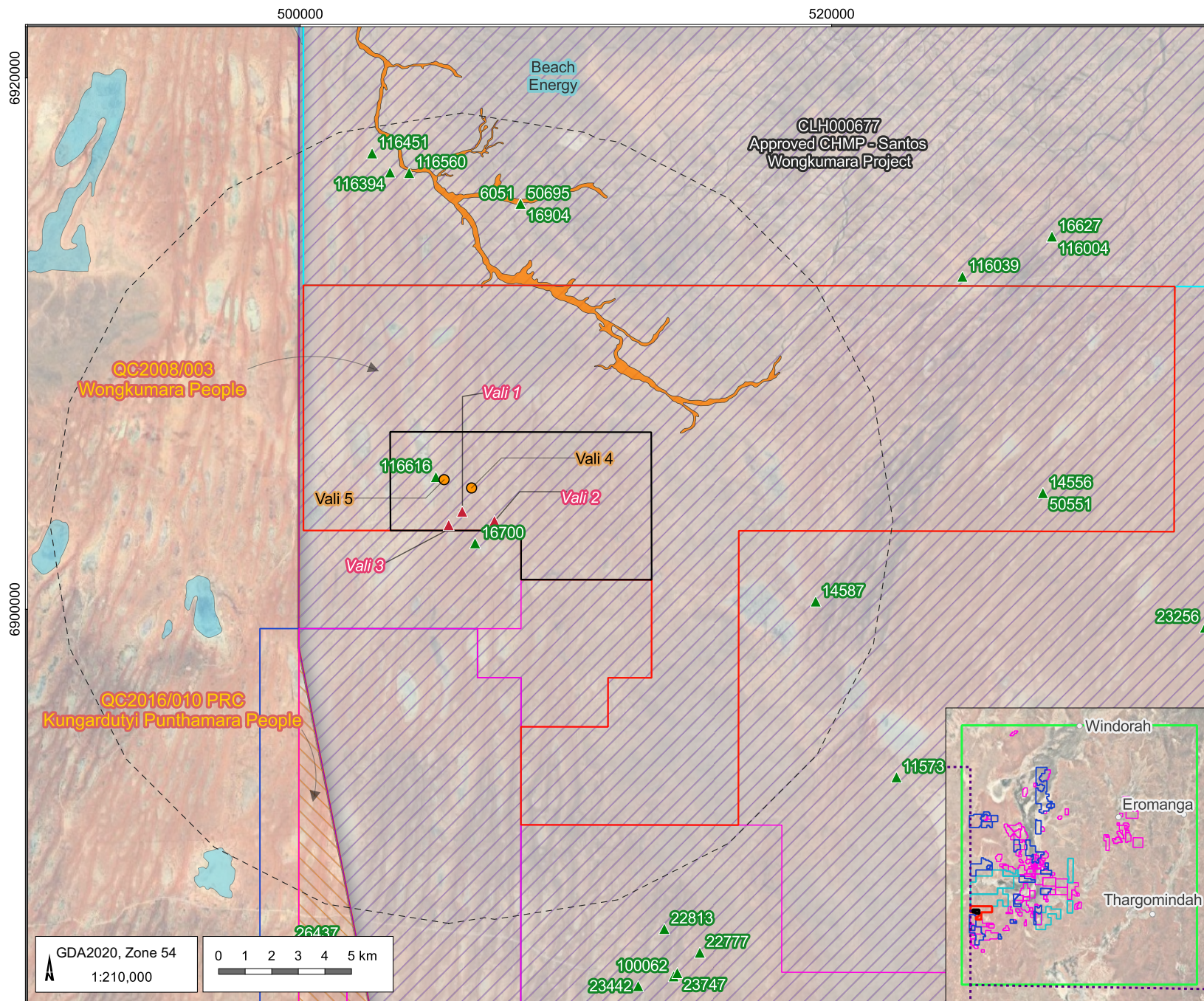
There are no known primary or secondary recreational waters within 15 km radius of the Project area. A such no impacts on primary or secondary recreational waters are predicted due to previous or proposed underground water extraction activities associated with the Vali Gas Project.

5.6 Industrial

Figure 1.1 shows the petroleum leases and exploration leases adjacent to Vali Gas Project. Santos Petroleum leases are directly adjacent to the south of the Project area. However, no existing Santos production bores are within 15 km radius of the Project area (Figure 4.13). No qualitative and quantitative impacts are anticipated on industrial users due to previous or proposed underground water extraction activities associated with the Vali Gas Project.

5.7 Cultural and spiritual values

The three production wells are within the cultural heritage area of the Wongkumara People. In the absence of any known mound springs or other similar features within 300 km of the Project area and no predicted impact on groundwater levels above the top Cooper Basin, no qualitative and quantitative impacts are anticipated on any water dependent cultural or spiritual features as a result of proposed or existing underground water extraction activities associated with the Project.



LEGEND

- Place names
- ▲ Vali wells
- Vali wells - proposed
- ▲ Registered bores
- State Borders
- Authority to Prospect (ATP 2021)
- Authority to Prospect (ATPs)
- Petroleum Lease 1125
- Santos Petroleum Leases
- Santos Exploration Permits for Petroleum
- Santos Cooper Basin
- Cultural Heritage Management Plan boundary
- Vli wells 15km radius
- Cultural Heritage Party boundaries**
 - ▨ Kungardutyi Punthamara People
 - ▨ Wongkumara People
- Aquatic GDEs**
 - Low potential GDE - from national assessment
- Terrestrial GDEs**
 - Moderate potential GDE - from regional studies

Vali Gas Field UWIR 2025 (VGF5000.002)

Environmental values



DATE
03/10/2025

FIGURE No:
5.1

6 Water monitoring strategy (Part E)

Under section 376(f) of the Water Act, responsible tenure holders are required to develop an appropriate underground water monitoring strategy (WMS) to keep track of the quantity of water produced or taken because of the exercise of relevant underground water rights. Responsible tenure holders are also required to monitor any changes in underground water levels and the underground water quality.

6.1 Monitoring rationale

The monitoring rationale should include (but not be restricted to):

- an assessment of changes in water levels and water quality because of the exercise of relevant underground water rights;
- supplementation of existing monitoring programs to fill any critical gaps in data; and
- an explanation about how it will improve the understanding about the impacts of underground water extractions on aquifers.

Details on how the WMS aligns with the monitoring rationale are further described in Section 6.2 below.

6.2 Monitoring strategy

Based on the hydrogeological conceptualisation and the findings of the groundwater impact assessment for both IAA and the LTAA outlined in Section 4.2, the groundwater resources potentially impacted from Vali's operations are the gas reservoir formations, namely, the Toolachee, Epsilon, and Patchawarra Formations. These aquifers are located at depths of at least 2,080 metres below the shallow groundwater extraction zones, such as the Glendower and Winton Formations used by pastoralists.

Although no adverse impacts on environmental values within either the IAA or LTAA (Part D) are anticipated, a groundwater monitoring program is proposed to validate these predictions. In addition to the ongoing monitoring of the three gas production wells (Vali-1, Vali-2, and Vali-3), it is proposed that two nearby registered bores (RN 16700 and RN 116616) also be included in the monitoring network to confirm that no impacts are occurring at these existing groundwater users (Winton Formation). When the two additional wells Vali-4 and Vali-5 come online, they will be part of the monitoring program.

As the water supply bore RN16700 (Christmas Yard Bore) is outside of PL1125, an agreement between the landowner and Vintage will be necessary prior to including this bore in the monitoring program. Registered bore RN116616 (Kudnari bore) is located within PL1125 and is occasionally used for water supply by Vintage.

A monitoring program is recommended to record the following parameters for both the production wells and the two water supply bores:

- Total extraction volumes of the targeted gas reservoir (Toolachee and Patchawarra Formations) and the water supply aquifer (Winton Formation).
- Pressure of the targeted gas reservoir and water levels in the Winton Formation.
- Water quality of the gas reservoir and in the Winton Formation.

Table 6.1 outlines the monitoring parameters, schedule, frequency, and rationale for seven monitoring points, which include three existing production wells and two proposed monitoring locations at registered bores RN116616 and RN16700. For each site, the table details the monitoring period and the specific parameters to be measured, including those planned for the proposed bore monitoring activities.

Vintage Energy will maintain the current monthly monitoring of the water production rates for each gas production well (i.e. Vali-1, Vali-2 and Vali-3). The quality of combined water drawn from the production wells will be monitored biannually from the separator to identify any changes in groundwater chemistry which might be indicative of water being drawn from different sources. In addition, a minimum of one shut-in test will be recorded annually to estimate the reservoir pressure in the Toolachee and Patchawarra Formations to assess the change in gas reservoir pressure during the Project.

The monitoring of groundwater levels, groundwater quality and total extraction volumes will be undertaken biannually at Kudnari bore (RN 116616). Following an agreement with the landowner, the Christmas Yard Bore (RN 16700) might also be included in the monitoring program with proposed groundwater quality, total extraction volume and groundwater level² monitored biannually.

An annual review of monitoring data will be undertaken to determine whether there are any material changes in groundwater conditions or changes to the existing conceptual model. Results of the annual monitoring data review and WMS implementation will be reported per regulatory requirements (see Section 8).

² Pending on the access – submerged pump might prohibit the installation of a data logger or taking manual water level measurements.

Table 6.1 UWIR monitoring points - groundwater monitoring parameters and frequency

Unique Bore ID	Bore name	RN (QLD Globe)	Type	Tenure	Sub-block	Easting ¹	Northing ¹	Status	Monitoring period	Water level	Volume extracted	Water quality		Monitoring rationale
										Frequency	Frequency	Parameters	Frequency	
Vali1	Vali-1	-	Gas production well	PL1125	COOP 3421 Y	506107.8	6903682.8	Existing	August-2024 onwards	Annually ⁴	Monthly	pH, EC, TRH, cations and anions	Biannual	A, C
Vali2	Vali-2	-	Gas production well	PL1125	COOP 3421 Z	507322.8	6903329.1	Existing	August-2024 onwards	Annually ⁴	Monthly	pH, EC, TRH, cations and anions	Biannual	A, C
Vali3	Vali-3	-	Gas production well	PL1125	COOP 3421 Y	505599.3	6903174.4	Existing	August-2024 onwards	Annually ⁴	Monthly	pH, EC, TRH, cations and anions	Biannual	A, C
Vali4	Vali-4	-	Gas production well	PL1125	COOP 3421 Y	506450.9	6904568.3	Scheduled for 2027	2027 onwards	Annually ⁴	Monthly	pH, EC, TRH, cations and anions	Biannual	A, C
Vali5	Vali-5	-	Gas production well	PL1125	COOP 3421 Y	505418.5	6904879	Scheduled for 2027	2027 onwards	Annually ⁴	Monthly	pH, EC, TRH, cations and anions	Biannual	A, C
RN116616	Kudnari	RN116616	Registered bore	PL1125	COOP 3421 Y	505108	6904981	Proposed	March-2026 onwards	Biannual	Biannual	pH, EC, TRH, cations and anions	Biannual	A, B, C
RN16700	Christmas Yard bore	RN16700	Registered bore	-	BROK 37 D	506583	6902489	Proposed ²	March 2026 onwards	Biannual ³	Biannual	pH, EC, TRH, cations and anions	Biannual	A, B, C

Notes: ¹ Coordinate system GDA2020.

² Awaiting agreement between Vintage and the landowner to be included in the monitoring program.

³ Pending on the access – submerged pump might prohibit the installation of a data logger or taking manual water level measurements.

⁴ One pressure test annually.

Monitoring rationale: A: an assessment of changes in water levels and water quality because of the exercise of relevant underground water rights.

B: supplementation of existing monitoring programs to fill any critical gaps in data.

C: an explanation about how it will improve the understanding about the impacts of underground water extractions on aquifers.

7 Spring impact management strategy (Part F)

As discussed in Section 5.2.1 the nearest mapped GAB spring is more than 100 km away from the Project area, in South Australia. The nearest springs in Queensland are 300 km east outside the Cooper Basin boundaries. No impacts are predicted to extend beyond the Cooper Basin due to previous or proposed underground water extraction activities associated with the Vali Gas Project. As such a spring monitoring program is not required for this UWIR.

8 Annual review and UWIR reporting

Per Section 376(1)(e)(i) of the Water Act, this UWIR report will be reviewed annually, which will consider the following:

- new hydrogeological data that significantly alter the conceptual model;
- whether new production testing or production has been undertaken or is planned; and
- whether the predictions made in Section 4 have materially changed.

The outcome of this annual review will be reported to the Department of the Environment, Tourism, Science and Innovation (DETSI) as required per Section 376(1)(e)(ii) of the Water Act, including a statement of whether there has been a material change in the information or predictions presented in this UWIR. The program for the implementation of the WMS will also be reported to the Office of Groundwater Impact Assessment (OGIA) every six months.

In addition to the annual review, the UWIR will be updated every three years. However, if any material changes occur in the assumptions underpinning the UWIR or the annual review, a reassessment and potential revision of the UWIR will be triggered.

9 References

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