Millennium Mine – Mavis South Extension Project

Underground Water Impact Report

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SLR Project No.: 620.031508.00001

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Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
2.0	23 November 2023	Emma Watts	Ines Epari	Ines Epari
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Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with MetRes Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

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1.0 Introduction

1.1 Overview

SLR Consulting Australia Pty Ltd (SLR) has been engaged by MetRes to undertake an Underground Water Impact Report (UWIR) for the Mavis South Underground extension area (referred to as the Project). This report details this UWIR.

The proposed Mavis South Underground operation will commence from July 2024 and based on current estimate of resource schedule, will cease operation within one year. Other approved mining at Millennium will cease by the end of 2027.

1.2 Project Description

Millennium Coal Mine is located approximately 160 kilometres (km) southwest of Mackay in Central Queensland, and some 15 km southwest of the township of Coppabella and 20 km south east of the township of Moranbah, within the Isaac Regional Council Local Government Area (LGA) in Queensland. Millennium Mine is accessed via an 8 km sealed road that branches from the Peak Downs Highway. The Goonyella Hay Point railway line crosses the Project to the south of the Mavis Downs area.

The Millennium Mine consists of two mining areas with six contiguous mining leases (ML): the Mavis Downs area (ML 70457, ML 70483, and ML 70485); and the Millennium area (ML 70313, ML 70401, ML 70344), which together form a single operational project, the Millennium Mine. Millennium Mine operates under Environmental Authority (EA) EPML00819213. The Project area is shown in **Figure 1**.

Millennium Mine commenced open cut coal mining operation in 2006, however was placed on care and maintenance by the previous owner Peabody Energy Australia Pty Ltd (Peabody), with the cessation of open-cut mining in 2018 and highwall mining in 2019. With the successful acquisition of Millennium Mine in July 2021, MetRes commenced operation in September 2021 to continue open-cut mining, utilising truck and shovel mining techniques, as well as auger miners to extract the Leichhardt seams of the Rangal Coal Measures.

On 7 December 2021, approval was received from Queensland Department of Environment and Science (DES) to commence underground mining within the Mavis Underground operation (from here on referred to as the 'Mavis Approved') from the existing Mavis Downs E Pit highwall in ML70457. The Mavis Approved comprises mining operations to extract coal from the Leichhardt Seam within the Rangal Coal Measures. Maximum depth of open cut operations ranges to 100m with the final open cut mining depth determined on economic grounds. Continuous miner methods have been selected and preferred for the Mavis Approved area given the methods flexibility, responsiveness to change in seam conditions, low capital cost and low subsidence impacts. The resource areas also lend themselves favourably toward Bord and Pillar as opposed to longwall mining methods, given the relatively narrow area widths and irregular mining lease shapes in places.

It is now requested that an additional area to the south of the Mavis Approved underground operation be approved to maximise production and provide continued utilisation of existing fleet. This area, and the subject of this EA amendment application, is referred to the Mavis South Underground Project (the Project).

The action seeking approval is to extend the Mavis Approved underground operation as shown in **Figure 1**. The Project requires an EA amendment to EPML00819213 for the extension of the Mavis Approved mine operation for approximately 854,000 tonnes Run of Mine (ROM) extracted over approximately a 12-month period, currently forecast to start July 2024.

0 0.5 1 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	620.031508
Date:	18-Jul-2023
Drawn by:	AS

Roads
Railway
Watercourses
Project Boundary
Mining Lease Boundary

MAVIS SOUTH UNDERGROUND EXTENSION UWIR

PROJECT LOCATION

SLR

FIGURE 1

H:\Projects-SLR\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Conceptualisation Report\620031508 F01 Project Location.mxd

No new surface activities are proposed as part of the Mavis Underground South operation. The surface portal for the Project utilises existing infrastructure and access via the Mavis Approved underground operation. The Project will utilise existing fleet demand and infrastructure requirements.

The underground bord and pillar mining method is proposed to extract coal targeting the Rangal Coal Measures, with the Leichardt Seam being the deepest seem mined. In consideration of concurrent mine operational activities, the proposed extension remains within EA EPML00819213 approved extraction rate of 5.5 million tonnes per annum (Mtpa).

1.3 Study Area Description

The Project is located in the Bowen Basin, a basin spanning an extent of approximately 200,000 km^2 and one of five major foreland sedimentary basins formed along the eastern side of Australia during the Permian Period. The Bowen Basin extends in a north to south direction from Townsville, Queensland at its northern extent to Moree, New South Wales at its southern extent. In the southern parts, the extent of the Bowen Basin and the Great Artesian Basin (GAB) overlap. The Bowen Basin has two north trending depocentres, the eastern Taroom Trough and western Denison Trough (Geoscience Australia, 2017). The Project lies within the Collinsville Shelf, north of the Taroom Trough depocentre.

Basin geology within the Collinsville Shelf includes the basal Permian aged Back Creek Group, which is comprised of generally fine-grained clastic sedimentary rocks deposited in a fluvial to shallow marine environment. The Back Creek Group is conformably overlain by the Blackwater Group, which includes the Rangal Coal Measures, Fort Cooper Coal Measures, and Moranbah Coal Measures. The economic seams of the Project are contained in the Late Permian Rangal Coal Measures. The Permian strata occur at outcrop on the eastern and western edges of the Basin and are unconformably overlain by the Triassic aged terrestrial sedimentary rocks of the Rewan Group. While not present at the Project, isolated pockets of remnant quartzose sandstones of the Middle Triassic Clematis Group are mapped.

The Permian and Triassic units are covered by a thin layer of unconsolidated to semi-consolidated Cainozoic sediments (Tertiary to Quaternary alluvium and colluvium). The alluvial sediments are localised along rivers and creeks (Isaac River). Volcanic intrusions and extrusions are also present within the region.

1.4 Report Structure

The main purpose of the UWIR is to describe the impacts and monitoring strategies from exercising underground water rights within the Project over a three-year period (the UWIR period). As the Project is of one year of length, this UWIR addresses this year from the commencement of operational activities (July 2024). Once the official consultation day (**Section 2.3**) is known, this report will be updated to reflect the actual timelines.

The UWIR structure is based on the framework of the Water Act (Section 376). The structure is detailed in the Guideline (Water Act 2000) Underground Water Impact Reports and Final Reports (DES, 2021). The UWIR includes the following sections:

- Part A: Information about underground water extractions resulting from the exercise of underground water rights (Section 3);
- Part B: Information about aquifers affected, or likely to be affected (Section 4);
- Part C: Maps showing the area of the affected aquifer(s) where underground water levels are expected to decline (Section 5);
- Part D: An assessment of the impacts to the environmental values from the exercise of underground water rights (Section 6);

- Part E: A water monitoring strategy (Section 7);
- Part F: A spring impact management strategy (Section 8); and
- Part G: For a Cumulative Management Area (CMA), assignment of responsibilities to resource tenure holders (Section 9).

2.0 Legislation

2.1 Queensland Water Act (2000)

The Water Act, supported by the subordinate Water Regulation 2016 (Qld) (Water Regulation), is the primary legislation regulating groundwater resources in Queensland. The purpose of the Water Act is to advance sustainable management and efficient use of water resources by establishing a system for the planning, allocation, and use of water. The Water Act is enacted under a framework of catchment specific Water Plans. Water resources within the Project are captured under the Water Plan (Fitzroy Basin) 2011 (DEHP, 2011). This plan covers the surface water associated with Isaac River (zone WQ1301), and groundwaters (zone WQ1310 – Fitzroy Basin groundwaters).

The Project is located within the Isaac Connors GMA (Zone 34) of the Fitzroy Basin defined under the Water Plan (Fitzroy Basin) 2011 made under the Water Act. The management objective of the Water Plan (Fitzroy Basin) 2011 is to maintain the 20th, 50th, and 80th percentile water quality results in order to preserve or enhance groundwater quality for its recognised uses. Groundwater units of the GMA are classified as:

- Groundwater Unit 1 - containing aquifers of the Quaternary alluvium; and
- Groundwater Unit 2 - containing all sub-artesian aquifers within the Isaac Connors groundwater management area other than the aquifers included in Groundwater Unit 1.

As part of the Project, Millennium Mine is proposing to exercise underground water rights. Chapter 3 of the Water Act details the requirements for the management of impacts from exercising underground water rights. It provides a framework that requires the tenure holder to prepare an UWIR. Trigger levels are listed in the Water Act to assess impacts on aquifers if water levels decline. The trigger levels 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.

Water levels in aquifers that exceed a trigger level, within the three-year period of the UWIR, are defined as Immediately Affected Areas (IAA). Declines in water levels in aquifers that exceed the trigger level, at any time, are defined as Long Term Affected Areas (LTAA).

The Water Act framework ensures there is sufficient monitoring, collection, and review of information to manage any impacts during the exercise of underground water rights. A summary of requirements of the UWIR under the Water Act, and the relevant sections of this report in which they are addressed, are shown at the start of Sections 3 to 8 of this report, which relate to Parts A, B, C, D, E and F of the Guideline (Water Act 2000) Underground Water Impact Reports and Final Reports DES (2021), respectively.

2.2 Project Approvals

The current Environmental Authority (EA), EPML00819213, is effective for the ML 70457, ML 70483, and ML 70485. The EA conditions for the existing approved mine relevant to groundwater are listed in Schedule D. These conditions detail monitoring and reporting requirements pertinent to groundwater level and quality.

2.3 UWIR Consultation Day

The Consultation Day of a UWIR is defined under Section 322(1) of the Water Act as 'the day a notice is first published about the proposed report'. The commencement date of the

UWIR will be the date that it is approved by the Chief Executive (Commencement Date). As this date is not set yet, this initial UWIR will report on the calendar year 2024, 2025, and 2026. Once the Commencement Date is finalised, an update of this report can be provided.

MetRes is required to provide a UWIR for its predicted take for the period of three years from the Consultation Day, and then subsequent reports within 10 days of the day which is three years after the Commencement Date. The exercise of underground water rights associated with the underground mine extension Project is expected to commence in 2024 or 2025.

3.0 Part A: Underground Water Extractions

The following section discusses the estimated underground water extraction expected to occur during the first three years of the UWIR reporting period, following the Consultation Day. The estimates are based on projected production estimates, and the methodology to make the estimates is discussed. This section addresses the requirements under Section 376 (a) of the Water Act (**Table 1**).

Table 1 Requirements under Section 376 (a) of the Water Act

Requirements under Section 376 (a) of the Water Act	Relevant UWIR Report Section	Relevant Groundwater Impact Assessment Report Section (Appendix A)
The quantity of underground water produced or taken from the area because of the exercise of underground water rights; and	**Section 3.1**	Section 6.4.5.2
An estimate of the quantity of water to be produced or taken because of the exercise of underground water rights for a three year period starting on the consultation day for the report.	**Section 3.2**	Section 6.5.2

3.1 Quantity of Water Already Produced

The quantity of water produced over the last four years is shown in **Table 2**. These quantities are inferred from annual site water balances.

Table 2 Inferred Groundwater Take from Annual Water Balance

Accounting Year	Areas	Inferred Volume (ML)
2018/19	Millennium A Pit, Millennium B Pit, Mavis D Pit, Mavis E Pit	602
2019/20	Millennium A Pit, Millennium B Pit, Mavis D Pit, Mavis E Pit	347
2020/21	Millennium A Pit, Millennium B Pit, Mavis D Pit, Mavis E Pit	149
2021/22	Mavis M Pit, Mavis D Pit, Mavis E Pit, Millennium A Pit	184

3.2 Quantity of Water to be Produced Over the Next Three Years

Predictive groundwater modelling completed by SLR in 2023 (**Appendix A**) provides an estimate of groundwater inflows over the life of the mine, including the first three years after the consultation date (**Section 2.2**). Section 6 of the above referenced Project Groundwater Impact Assessment report provides a full description of the methodology and results of the inflow modelling.

The Project intercepts Groundwater Unit 2 (sub-artesian aquifers) under the Water Plan (Fitzroy Basin) 2011. The annual groundwater take for the first three years of the UWIR period is shown in **Table 3.**

Given that the Project will utilise the existing Millennium Mine water management system, it is impractical to distinguish the underground mine inflows between the existing approved operations and the Project, and hence the combined inflows for the existing operations (Mavis Approved) and the Project (Mavis South) are listed. For completeness, the predicted inflows into the open-cut pits are listed as well.

Table 3 Predicted Volume of Groundwater Take

Year	Open Cut Inflows (ML/year)	Underground Inflows (Mavis Approved and Mavis South) (ML/year)
2023	203.71	32.89
2024	92.23	73.74
2025	51.42	119.59
2026	7.07	145.20
2027	30.33	131.38
2028	6.88	99.25
2029	24.98	0.00

4.0 Part B: Aquifer Information and Underground Water Flow

This section addresses the requirements under Section 376 (b)(1) to 376 (b)(2) of the Water Act (**Table 4**). The section includes a description of aquifers within or adjacent to the Project boundaries; groundwater flow directions; groundwater hydraulic properties; water quality; hydrographs; and structural geology to determine aquifer connectivity and water level trends. The information within this section is from the Project Groundwater Impact Assessment report provided in **Appendix A**.

Table 4 Requirements under Section 376 (b)(1) to 376 (b)(2) of the Water Act

Requirements under Section 376 (b)(1) to 376 (b)(2) of the Water Act	Relevant UWIR Report Section	Relevant Groundwater Impact Assessment Report Section (Appendix A)
For each aquifer affected, or likely to be affected, by the exercise of the relevant underground water rights, an UWIR must include:		
A description of the aquifer	**Section 4.1**	Sections 4.1 to 4.4, 5.3.1, 5.3.2, 5.3.3, 5.4.1.1, 5.4.1.2, 5.4.1.3 and 5.6
An analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers	**Section 4.2**	Sections 5.2 and 5.3
An analysis of the trends in water level change for the aquifer because of the exercise of underground water rights	**Section 4.3**	Sections 5.3.1.1, 5.3.1.2, 5.3.2 and 5.3.3.1

4.1 Aquifer Descriptions

This section describes all aquifers that occur within the Study area. The principal groundwater bearing formations in the Study area are associated with the Permian coal seams and the Quaternary alluvium. The siltstones and sandstones that make up the majority of the overburden are considered aquitards.

4.1.1 Quaternary Alluvium

A detailed description of the occurrence and quality of groundwater within the Quaternary alluvium is provided in Sections 4.2.1 and 5.4.1 of the Project Groundwater Impact Assessment report (**Appendix A**). In summary, the alluvium is associated with the Isaac River and its major tributaries and is composed of a fairly heterogenous sand lithology interspersed with clay and gravel lenses. The Isaac River deposit reaches maximum thicknesses of 20 m, however, it is does not intersect the Millennium Mine area. Predominantly recharged by rainfall and stream flow infiltration during high surface water flow events. Typically, the alluvium is a high yielding aquifer, though of limited areal extent and depth.

4.1.2 Quaternary / Tertiary Alluvial and Colluvial Deposits

Quaternary/ Tertiary alluvial and colluvial deposits are more widespread across the area, forming extensive areas of deposit approximately 8 km south of the Project extent. The nearest alluvium to the Project is a small, isolated deposit of Tertiary alluvium that is seen adjacent to the southern boundary of the Mavis Pit. A detailed description of the occurrence and quality of groundwater within the Quaternary/ Tertiary alluvium and colluvium is provided in Sections 4.2.2 and 5.4.2 of the Project Groundwater Impact Assessment report (**Appendix A**).

4.1.3 Tertiary Suttor and Duaringa Formations

A detailed description of the occurrence and quality of groundwater within the Quaternary/ Tertiary alluvium and colluvium is provided in Sections 4.2.3 and 5.4.3 of the Project Groundwater Impact Assessment report (**Appendix A**). Tertiary deposits in the vicinity of the Project comprise of both the Suttor Formation and the Duaringa Formation; these are located to the north and do not crop out within the Project extent. Both are consolidated, sedimentary formations primarily composed of mudstone, siltstone, sandstone, and conglomerate, with minor occurrences of igneous basalt. Thicknesses of these formations are variable; however, a maximum thickness of 50 m is expected in the vicinity of the Project.

4.1.4 Triassic Rewan Group

The Rewan Group overlies the Permian Coal Measures and is comprised of interbedded mudstone, sandstone, and minor conglomerate. The Rewan Group is commonly found at surface in the interfluves, where alluvial deposits are not present. Bore logs in the area suggest that the Rewan Group is dominantly composed of an interbedded siltstone and sandstone lithology.

4.1.5 Permian Rangal Coal Measures

The occurrence and quality of groundwater within the Permian Rangal Coal Measures is outlined in Sections 5.3.3 and 5.4.1.3 of the Project Groundwater Impact Assessment report (**Appendix A**). In summary, the Rangal Coal Measures comprise economic higher permeability coal seams interbedded with low permeability siltstone, sandstone, and shale. Data indicate that the coal seams within the Rangal Coal Measures contain groundwater that is generally saline with a median EC of 21,220 µS/cm and is not suitable for stock water supply or irrigation.

4.1.6 Permian Fort Cooper Coal Measures

The Fort Cooper Coal Measures underlie the Rangal Coal Measures, and crop out to the west of the Project, within Mavis open cut pit and extends along the strike of the New Chum Creek Fault that separates the Millennium pit and Mavis pit. The unit is comprised of interbedded sandstone, conglomerate, mudstone, tuff, and coal, and can be up to 70 m thick. Data indicate that the coal seams within the Fort Cooper Coal Measures contain groundwater that is generally saline with a median EC of 9,550 µS/cm and is not suitable for stock water supply or irrigation.

4.1.7 Conceptual Groundwater Model

A conceptual cross section for the Study area centred on the Millennium Mine is presented below in **Figure 2**. The Project targets the Leichardt Seam in the Rangal Coal Measures at a depth of approximately 100 m below surface. The Rewan Group separates the Isaac River flood plain and alluvium from the proposed underground working. The surface extent of the relevant hydrostratigraphic units and the solid geology is provided in Figures 10 and 11 of the Project Groundwater Impact Assessment report (**Appendix A**).

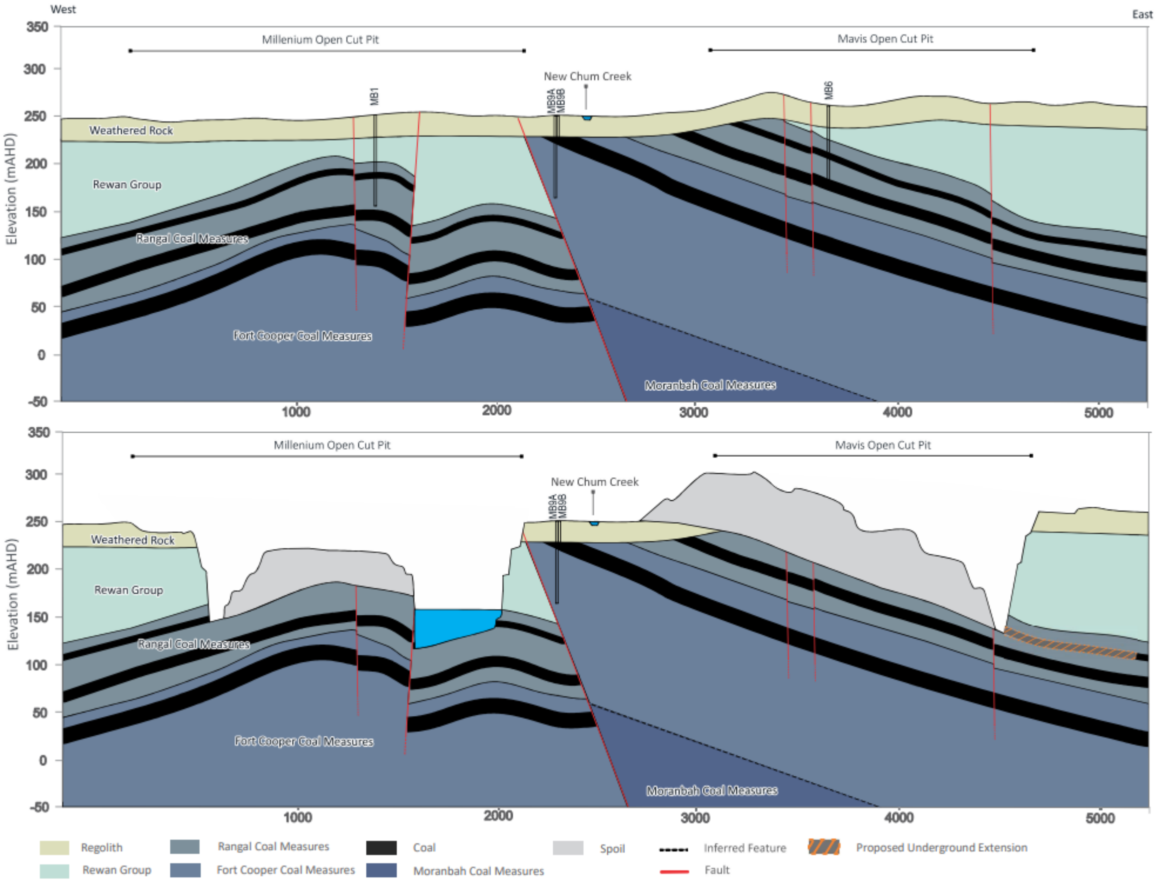


Figure 2 Conceptual Model of the Project

4.2 Underground Water Flow and Aquifer Interactions

Underground water flow and aquifer interactions are described in detail in the Project Groundwater Impact Assessment report (**Appendix A**) and are summarised below.

4.2.1 Quaternary Alluvium

The alluvium comprises a heterogeneous distribution of fine to coarse grained sands interspersed with lenses of clays and gravels. The hydraulic properties of the alluvium vary due to the variable lithologic composition, with field tests from adjacent mine sites indicating a horizontal hydraulic conductivity range between 1.4 $x10^{-2}$ and 8.7 m/day.

Regionally, groundwater flow within the alluvium is a subdued reflection of topography, with groundwater flowing in a south easterly direction consistent with the alignment of the Isaac River.

Recharge to the alluvium is predominantly from stream flow or flooding (losing streams), with direct infiltration of rainfall also occurring where there are no substantial clay barriers in the shallow sub surface. On a regional scale, discharge is via evapotranspiration from vegetation growing along creek beds and minor short duration baseflow events after significant rainfall/ flooding. Infiltration to underlying formations is limited to areas where high hydraulic conductivity coal seam aquifers directly underlie the alluvium. General downwards recharge to deeper units is limited by the low hydraulic conductivity Rewan Group and interburden sequences. Localised perched water tables are also evident where waterbodies continue to hold water throughout the dry period (pools in the Isaac River and wetlands) occurring where clay layers slow the percolation of surface water.

Further details of the recharge, flow, and hydraulic properties of groundwater within the Quaternary Alluvium is provided in Section 5.4.1 of the Project Groundwater Impact Assessment report (**Appendix A**).

4.2.2 Quaternary / Tertiary Alluvial and Colluvial Deposits

This Quaternary/ Tertiary Alluvium material comprises low hydraulic conductivity strata, which restricts rainfall recharge. This is shown by the general lack of response to climatic conditions. Groundwater discharge occurs primarily through evapotranspiration whilst vertical seepage through the regolith is limited by the underlying low hydraulic conductivity Rewan Group and interburden of the Permian Coal Measures.

Further details of the recharge, flow, and hydraulic properties of groundwater within the Quaternary/ Tertiary Alluvium is provided in Section 5.4.2 of the Project Groundwater Impact Assessment report (**Appendix A**).

4.2.3 Tertiary Suttor and Duaringa Formations

Rainfall infiltration is expected through this deposit where there are no substantial clay/ claystone barriers in the subsurface. An increase in level is observed in this unit with a weak correlation to the climatic trends and antecedent rainfall conditions, suggesting a level of confinement to this unit at the Project site. The aquifer tends to be low yielding.

Further details of the recharge, flow, and hydraulic properties of groundwater within the Suttor and Duaringa Formations is provided in Section 5.4.3 of the Project Groundwater Impact Assessment report (**Appendix A**).

4.2.4 Triassic Rewan Group

The Rewan Group is recognised to be a regional scale aquitard with a thickness of this formation of between 50 to 100 m in the Study area, providing a barrier to groundwater flow between the overlying alluvium and the underlying coal measures.

Further details of the recharge, flow, hydraulic properties, and water quality of groundwater within the Triassic Rewan Group is provided in Section 5.4.4 of the Project Groundwater Impact Assessment report (**Appendix A**).

4.2.5 Permian Rangal Coal Measures

The coal seams within the Rangal Coal Measures are typically considered the main aquifer units and may be significantly more permeable that the interburden material of interbedded mudstone, siltstone, and sandstone. Groundwater within these coal measures is considered confined and sub-artesian. When groundwater levels are locally reduced in the coal seams due to mining, these interburden units will provide a source of water by vertical leakage into the depressurised coal seams.

Recharge to these deposits will predominantly occur where the coal seams outcrop or subcrop, in the form of direct rainfall infiltration during high rainfall events when adequate saturation can occur. Additional recharge may occur to the alluvial deposits south of the Project, via leakage from the overlying Isaac River Alluvium and Tertiary deposits where it is in hydraulic connection with the Rangal Coal Measures. Discharge from this unit is dominated by evaporation and groundwater extraction from mining activities.

Regional groundwater flow is to the east down-dip along coal bedding planes, consistent with local topography and western outcrop of coal seams between faults. The flow regime in the Rangal Coal Measures across the Project has been intercepted by mining, causing local flow towards the open cut pits.

Further details of the recharge, flow, and hydraulic properties of groundwater within the Rangal Coal Measures is provided in Section 5.4.5 of the Project Groundwater Impact Assessment report (**Appendix A**).

4.2.6 Permian Fort Cooper Coal Measures

Similar to the Rangal Coal Measures, the coal seams within the Fort Cooper Coal Measures form the main aquifer-bearing units.

This geology is not currently, or will be, dewatered, though depressurisation of the above coal seams in the Rangal Coal Measures may influence some loss of water from this unit.

Further details of the recharge, flow, and hydraulic properties of groundwater within the Rangal Coal Measures is provided in Section 5.4.6 of the Project Groundwater Impact Assessment report (**Appendix A**).

4.3 Underground Water Level Trend Analysis

Underground water level trends and analyses are provided in the following sections of the Project Groundwater Impact Assessment report (**Appendix A**):

- Sections 5.4.1 and 5.4.2 provides water level trends for monitoring bores within Quaternary and Tertiary sediments (alluvium), with a water level hydrograph shown in Figure 16.
- Section 5.4.3 provides water level trends for monitoring bores within the Tertiary Suttor and Duaringa Formations, with a water level hydrograph in Figure 17.
- Section 5.4.4 provides water level trends within the regional Triassic Rewan Group.
- Section 5.4.5 and 5.4.6 provides water level trends for monitoring bores within Permian coal seam aquifers, with water level hydrographs shown in Figure 18 and Figure 19.

5.0 Part C: Predicted Water Level Declines for Affected Aquifers

This section addresses the requirements under Section 376 (b)(4) to 376 (e) of the Water Act (**Table 5**). This section considers potential impacts from water extraction on groundwater levels in aquifers. Potential impacts were assessed through a numerical groundwater model (described in Section 6 of the Project Groundwater Impact Assessment report in **Appendix A**). As defined in Section 387 of the Water Act, the model was used to identify impacts by predicting:

- Immediately Affected Area (IAA) - Water level declines, by more than the applicable bore trigger threshold, within three years following the report consultation day; and
- Long Term Affected Area (LTAA) - Water level declines, by more than the applicable bore trigger threshold, at any time.

Section 362 of the Water Act defines a bore trigger threshold for an aquifer as a decline in water levels of:

- As prescribed by regulation; or
- Five metres for consolidated aquifers; and
- Two metres for unconsolidated aquifers.

Table 5 Requirements under Section 376 (b)(4) to 376 (e) of the Water Act

Requirements under Section 376 (b)(4) to 376 (e) of the Water Act	Relevant UWIR Report Section	Relevant Groundwater Impact Assessment Report Section (Appendix A)
To meet the requirements of the Water Act, an UWIR must include the following:		
Maps showing the LTAA and IAA - sections 376 (b)(4) and 376 (b)(5);	**Section 5.2** **Figures 5**, **6**, and **7**	-
A description of the methods used to produce these maps - section 376 (c);	**Section 1.0**	Section 6.0
Information about all water bores in the IAA, including the number of bores in the area, maps showing the location of these bores and the authorised use of each bore - section 376 (d); and	**Section 5.3** **Figure 5**	Section 5.6.3 Table 15
A program for conducting an annual review of the accuracy of maps produced and giving the chief executive a summary of 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 376 (e).	**Section 5.4**	Section 7.0

5.1 Methods Used to Produce Maps

Numerical groundwater modelling was undertaken to assess the impact of the Project on the groundwater regime; to predict water level decline for the affected aquifers; and to produce maps of the IAA and LTAA as required by the Water Act. Methods and techniques used to develop the groundwater model are provided in the following sections of the Project Groundwater Impact Assessment report (**Appendix A**):

- Section 5.7 provides a conceptual model of the groundwater system;
- Section 6.2 provides details of the model code used, MODFLOW-USG; Sections 6.3 and 6.4 provide details of the model setup including geometry, model boundaries, model layers, hydraulic parameters, recharge and discharge;
- Section 6.6 provides details about the model predictions used to assess both additive and incremental impacts (e.g., mine inflows, drawdown) for a Null run, existing operations and the Project;
- Section 6.7 provides details about the model sensitivity analysis; and
- Section 6.9 provides details of the model assumptions and limitations.

The groundwater model, used to make predictions of water level impacts in the Groundwater Impact Assessment, was interrogated to fulfil the timeframes and bore trigger thresholds that are required under the Water Act and to prepare the maps of affected areas, discussed in **Section 5.2**.

5.2 Maps of Affected Area

The process of mine dewatering both directly and indirectly (through induced flow) reduces water levels in surrounding groundwater units. The extent of the zone affected by the mine dewatering (resulting in decreased water levels) is dependent on the hydraulic properties of the aquifers / aquitards and is referred to as the zone of depressurisation in a confined aquifer and zone of drawdown within the unconfined aquifer (water table). Depressurisation and drawdown of groundwater levels are largest at the mine working coal-face and reduce with distance from the mine.

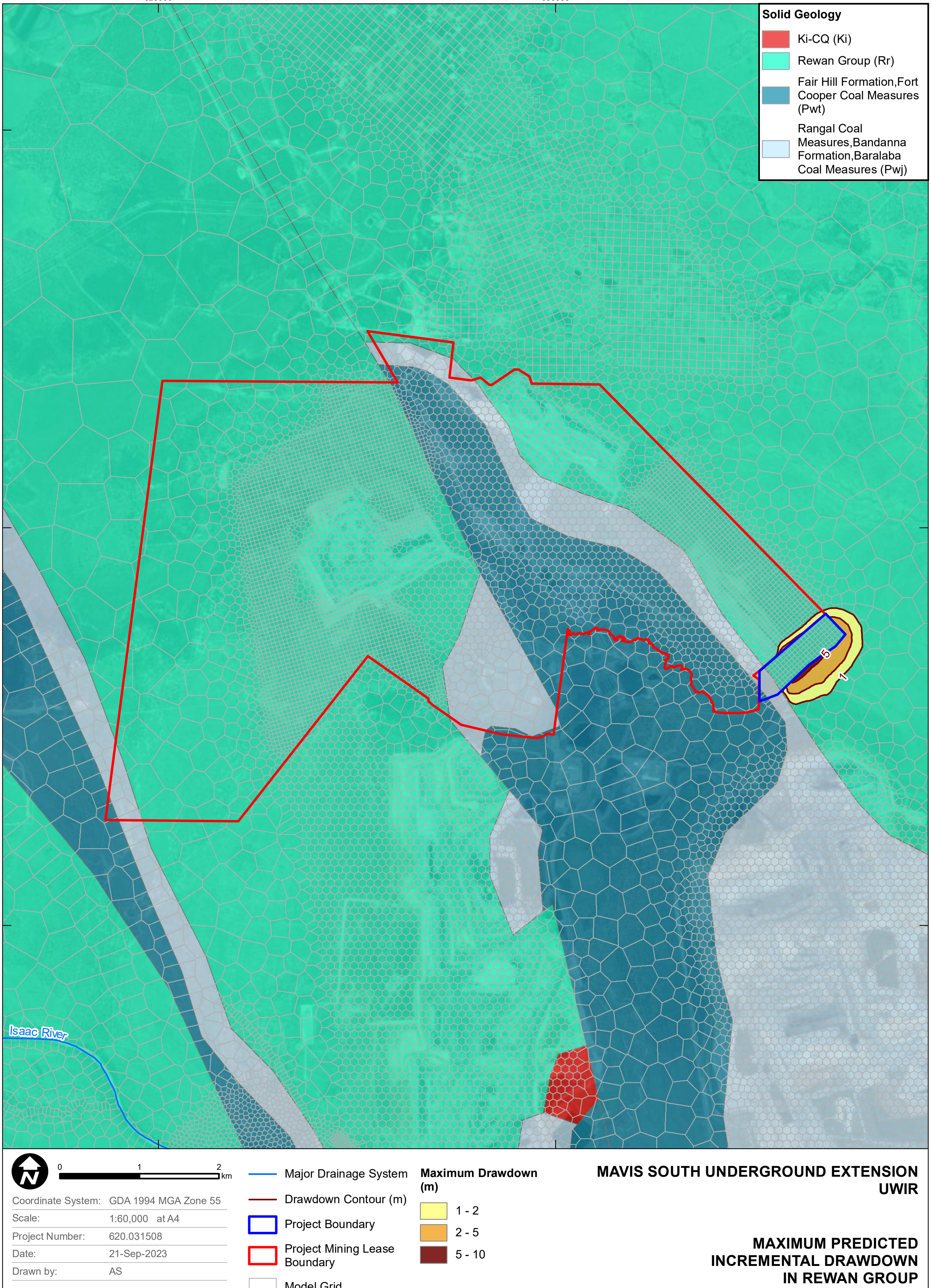
The model results were processed at the end of Year 3 (IAA) to display the difference between the existing mining and the Project at that point in time. Due to the Life of Mine being three years (till end 2027), the LTAA maximum incremental drawdown for Mavis South Underground is equivalent to that of the IAA.

5.2.1 Immediately Affected Area

As previously outlined, the extent of the IAA is defined in the Water Act as drawdown exceeding 2 m in unconsolidated aquifers and 5 m in consolidated aquifers after three years from commencement date (July 2024). For this Project, the predicted incremental drawdowns have been modelled for the Quaternary Alluvium (Layer 1), which is an unconsolidated aquifer, the Rewan Group (Layer 3), and the Leichardt Seam (Layer 5), both of which are classed as a consolidated aquifer.

No incremental drawdown is predicted in the three years of mining of this IAA UWIR reporting period within the unconsolidated aquifer of the Quaternary alluvium, due to the Project. Consequently, no map was produced.

Figure 3 and **Figure 4** show the maximum incremental drawdown of this IAA UWIR reporting period within the consolidated aquifers of the Rewan Group and Leichardt Seam (Rangal Coal Measures), due to the Project. The model predicts that 5 m of groundwater drawdown for the coal seams will extend to a maximum of 0.5 km southeast of the Project.



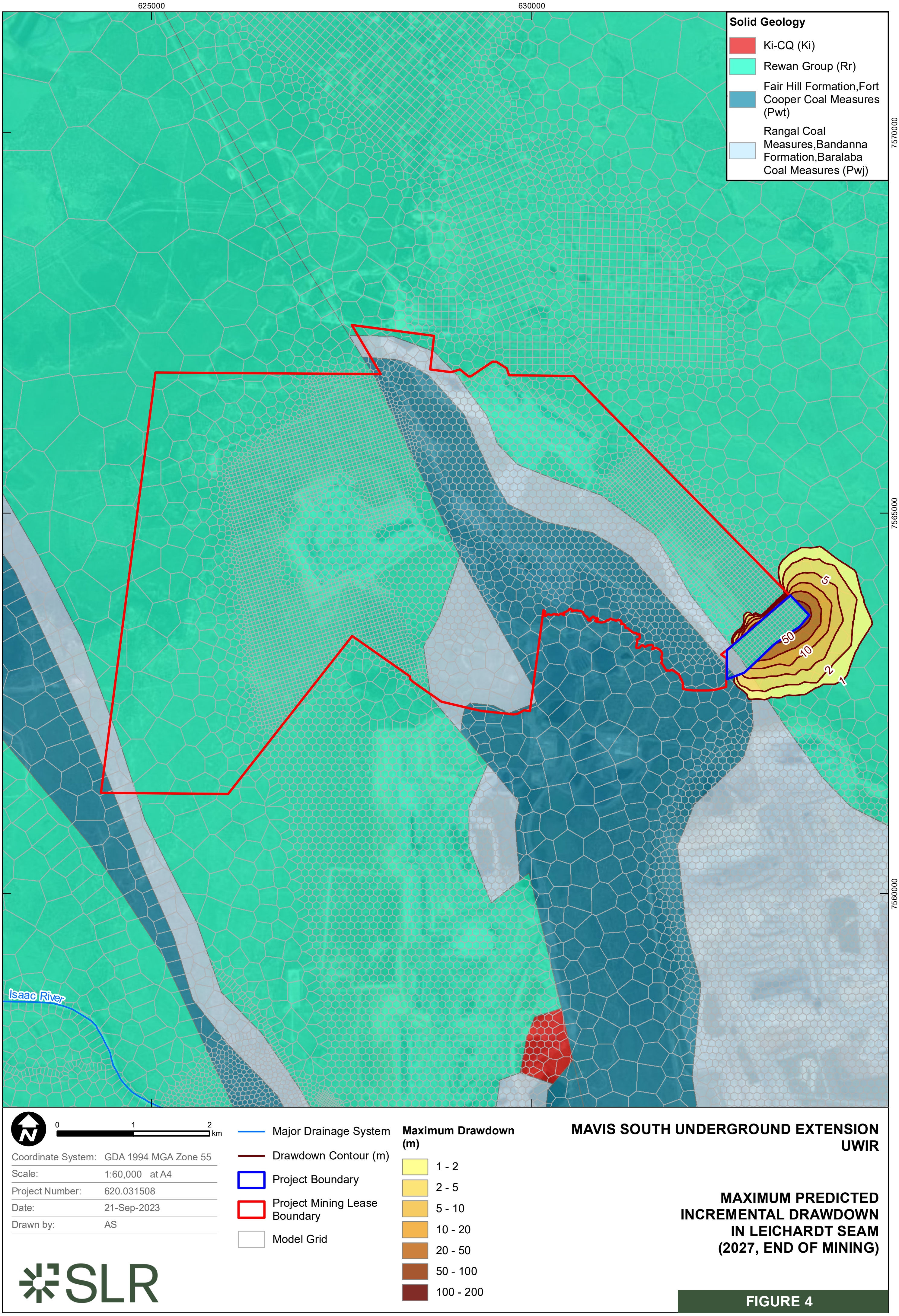
H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620031508 F31 Maximum Predicted Incremental Drawdown in Rewan Group (2027 End of Mining).mxd

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:60,000 at A4
Project Number:	620.031508
Date:	21-Sep-2023
Drawn by:	AS

MAVIS SOUTH UNDERGROUND EXTENSION UWIR

MAXIMUM PREDICTED INCREMENTAL DRAWDOWN IN REWAN GROUP (2027, END OF MINING)

FIGURE 3



Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:60,000 at A4
Project Number: 620.031508
Date: 21-Sep-2023
Drawn by: AS

SLR

MAVIS SOUTH UNDERGROUND EXTENSION UWIR

MAXIMUM PREDICTED INCREMENTAL DRAWDOWN IN LEICHARDT SEAM (2027, END OF MINING)

FIGURE 4

H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620031508 F32 Maximum Predicted Incremental Drawdown in Leichardt Seam (2027 End of Mining).mxd

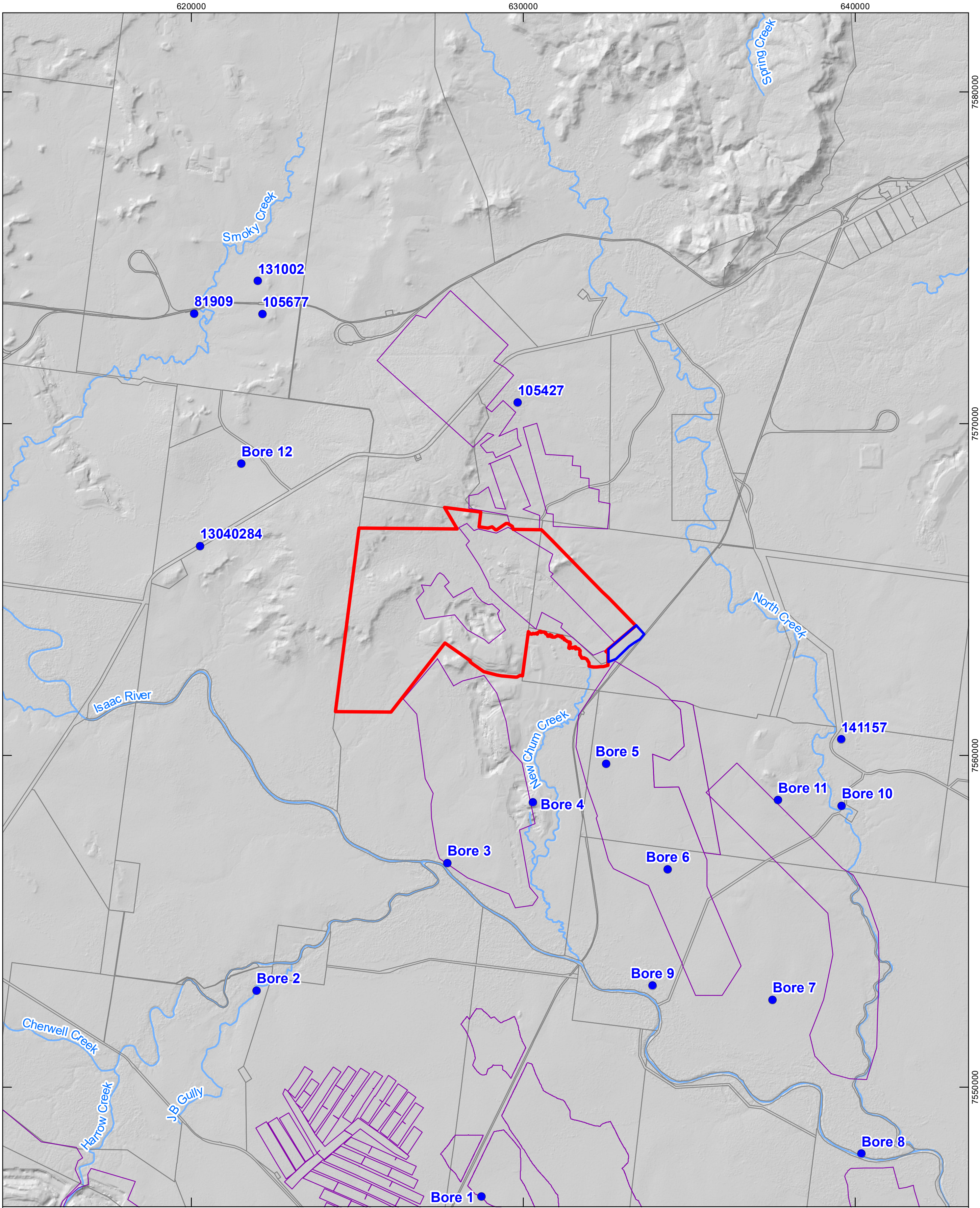
5.2.2 Long Term Affected Area

Due to the Life of Mine being end of 2027, there is no long-term affected area beyond that of the IAA.

5.3 Bores Within Immediately Affected Area

A survey of landholder bores has previously been undertaken as part of the Millennium Mine EIS (MatrixPlus, 2010) and included data from the public database run by RDMW as well as unregistered landholder bores in the vicinity of Millennium Mine, identified in the bore census undertaken for the Poitrel EIS (EPA, 2005). Details on bore construction and lithologies is limited for the unregistered landholder bores identified in the Poitrel EIS (EPA, 2005) bore census. Many of the landholder bores identified in the Millennium Mine EIS (MatrixPlus, 2010) have since been destroyed as a result of mining activity or are no longer utilised for water supply.

Due to the radius of drawdown of the Project being minimal, no bores are within the immediately affected area. A detailed bore-by-bore assessment for the incremental and cumulative drawdowns is provided in **Section 6.3.2**.



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.031508
Date:	21-Sep-2023
Drawn by:	AS

- Landholder Bores (Identified in Millennium Mine EIS, 2010)
- Watercourses
- Mining Lease Boundary
- Surrounding Mines
- Cadastre

MAVIS SOUTH UNDERGROUND EXTENSION UWIR

LANDHOLDER BORES

SLR

Data Source:
Cadastre - QLD Department of Resources DCDB Lite Aug 2021

FIGURE 5

H:\Projects-SLR\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADG\GIS\GIS\Conceptualisation Report\62003150 8 F24 Landholder Bores.mxd

5.4 Review of Maps Produced

The Groundwater Management and Monitoring Program (GMMP) has recently been updated, consistent with the EA Condition D1.1.

During the life of Millennium Mine, data collected through the GMMP will be used to review and if deemed necessary update and refine the Millennium Mine groundwater model and its impact predictions, to reflect the actual activities undertaken on site (e.g. mine development) and the results of regular groundwater monitoring.

With the current Life of Mine of Millennium Mine for a total of 4 years (latest approval included mining up to 2027), a review of the model and model predictions is not likely to be required.

6.0 Part D: Impacts on Environmental Values

This section addresses the requirements under Section 376 (da) and (db) of the Water Act (**Table 6**), with a description of predicted impacts on environmental values that result from the exercise of underground water rights. The UWIR ensures that there will be ongoing monitoring of impacts during the operational phase of the Project.

Table 6 Requirements under Section 376 (da) and (db) of the Water Act

Requirements under Section 376 (da) and (db) of the Water Act	Relevant UWIR Report Section	Relevant Groundwater Impact Assessment Report Section (Appendix A)
To meet the requirements of the Water Act, an UWIR must include the following:		
A description of the impacts on environmental values that have occurred, or likely to occur, because of any previous exercise of underground water rights (Section 376 (da) of the Water Act	N/A (no previous exercise of underground water rights as outlined in **Section 3.1**)	-
An assessment of the likely impacts on environmental values that will occur, or are likely to occur, because of the exercise of underground water rights (Section 376 (db) of the Water Act) for a three year period starting on the consultation day for the report and over the projected life of the resource tenure.	**Section 6.1** to **6.3**	

6.1 Environmental Values

Section 9 of the EP Act defines an environmental value (EV) as:

- A quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or
- Another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.

The Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water) specifies EVs and water quality objectives (WQOs) for groundwater in Queensland. The Study area is covered by the Isaac Conners Groundwater Management Area (GMA) (Zone 34) under the Fitzroy Water Plan (DEHP, 2011). Groundwater units of the GMA are classified as:

- Groundwater Unit 1 - containing aquifers of the Quaternary alluvium; and
- Groundwater Unit 2 - containing all sub-artesian aquifers within the Isaac Connors groundwater management area other than the aquifers included in Groundwater Unit 1.

Environmental Values pertinent to the Project as listed in DEHP (2011) are:

- Aquatic ecosystems;
- Irrigation;
- Farm supply/use;

- Stock watering;
- Primary recreation;
- Drinking water;
- Industrial use; and
- Cultural and spiritual values.

Primary recreation EVs apply to water reservoirs and connected waterbodies. The lack of connectivity between groundwater and surface water within the Study area means that the primary recreation EV is not relevant to groundwater for the Project. No cultural or spiritual values were identified in the vicinity of the Project.

As presented in Section 5.6.4 of the Project Groundwater Impact Assessment (**Appendix A**), the groundwater quality in the sub-artesian aquifers (Groundwater Unit 2) in the vicinity of the Study area is generally unsuitable for agriculture and irrigation as well as industrial purposes due to the high major ion and total dissolved solid concentrations.

6.2 Assessment Framework

The potential impacts of the Project on the groundwater resources have been assessed both in terms of change in groundwater levels and groundwater quality. Note that the impacts presented are incremental impacts, i.e., the additional impact of the Project compared to the existing operations. Each EV (as detailed in **Section 6.3** below) may be impacted differently by changes in groundwater levels and groundwater quality. The basis for assessing impact for each groundwater EV is presented in **Table 7**.

Table 7 Impact Assessment Framework for Each Environmental Value

EVs pertinent to Mavis South UG	Potential impact 1 – Groundwater drawdown	Impact assessment 1	Potential impact 2 – Groundwater quality degradation	Impact assessment 2
Aquatic and terrestrial ecosystems	A decrease of the groundwater table may reduce the ability for some vegetation to access groundwater. It may also affect baseflow in connected waterways as well as habitat for stygofauna.	Drawdown (m) in the alluvium, at wetlands and mapped groundwater dependent ecosystem (GDE) area	Changes in groundwater quality may affect the health of groundwater dependant ecosystems	Predicted change in quality, area affected and potential impact on GDE.
Irrigation; **farm supply / stock water, Industrial Use**	A decrease of the groundwater table may reduce bore yield or degrade groundwater quality (e.g., increase EC).	Drawdown (m) in all affected private bores	Change in groundwater quality may reduce potential use of groundwater depending on groundwater usage	Predicted change in quality, private bores affected and potential impact for each bore based on usage.

6.3 Nature and Extent of Impacts on Environmental Values

The Project Groundwater Impact Assessment (**Appendix A**) details the aquifer characteristics at the Project (Sections 5.1, 5.3, and 5.4) and groundwater quality (Section 5.5) and investigated the potential impacts that the mining activities may have on groundwater levels using a groundwater model (Section 6). Using the results of the groundwater modelling, the potential impacts to the receiving environment due to the exercise of underground water rights for the Project have been identified and described in the section below.

6.3.1 Impact on Aquatic and Terrestrial Ecosystems

The UWIR must consider the potential for groundwater to interact with surface water (e.g., baseflow to rivers and creeks) and GDEs (including any aquifers, caves, lakes, palustrine wetlands, lacustrine wetlands, rivers, and vegetation). A GDE is one in which the plant and/or animal community is dependent on the availability of groundwater to maintain its structure and function.

GDE mapping was sourced from DES (2021), with the dataset containing shapefile data which can be grouped into the three categories of GDEs:

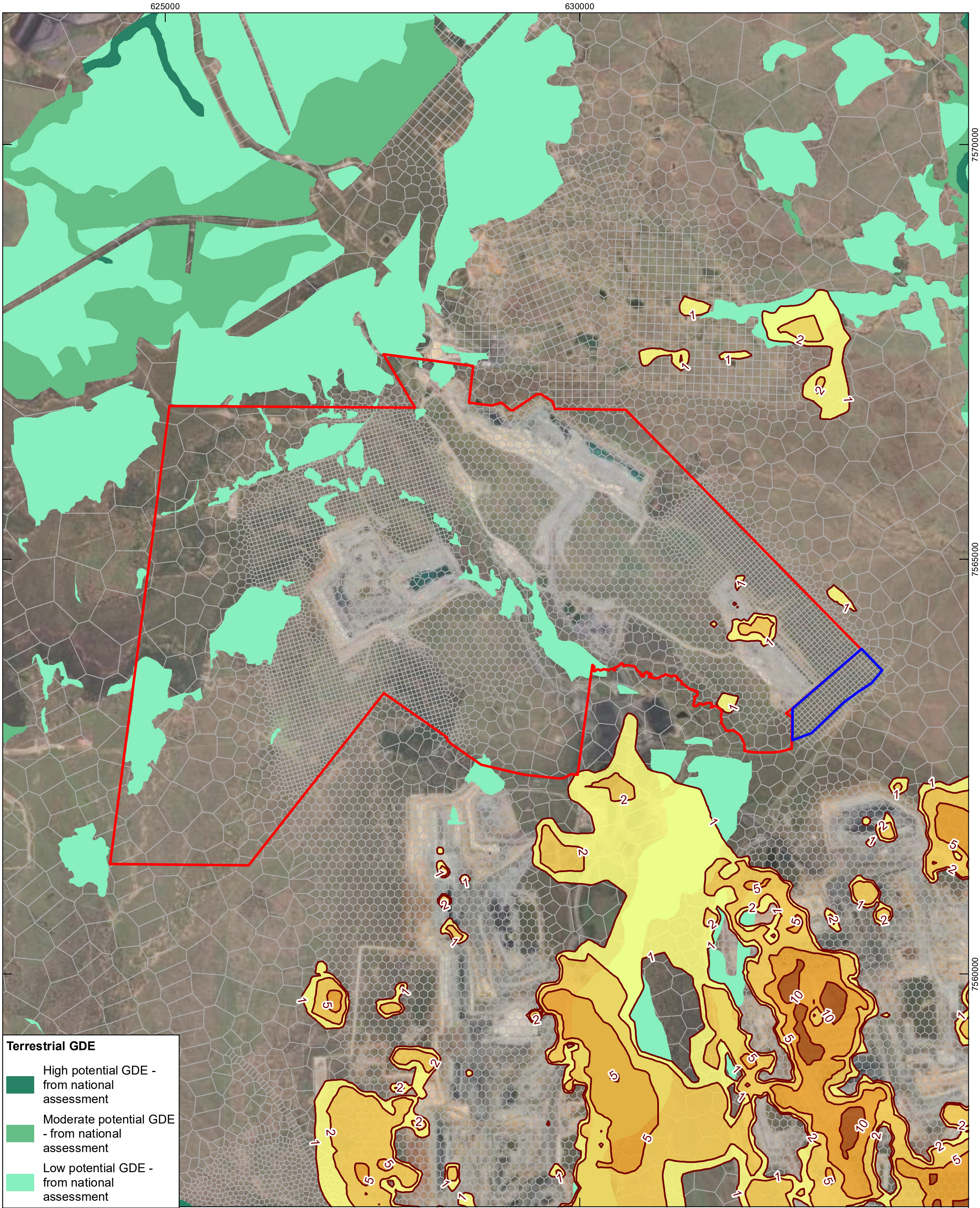
- Aquatic GDEs (and surface line expressions);
- Terrestrial GDEs; and
- Subterranean GDEs (including stygofauna).

The dataset contains information on both known and potential GDE areas, with known GDEs referring to areas that have been verified through field studies, while potential GDEs refer to areas that have been mapped at a large scale primarily through analysis of GIS data. The dataset was queried to assess the presence of GDEs within a 10 km buffer of the Project. The search showed the following:

- Terrestrial GDEs – Potential, derived with low confidence (along the Issac River and New Chum Creek and upgradient of the Project. This means that there is a low confidence that these ecosystems have some degree of groundwater dependence; and
- Aquatic GDEs – Potential, derived with low confidence (along the Isaac River, new Chum Creek, and North Creek), again this means that there is a low confidence that these ecosystems have some degree of groundwater dependence (**Figure 6**),

Terrestrial GDEs are ecosystems that are dependent on the sub-surface presence of groundwater on a permanent or intermittent basis to meet all or some of their water requirements to maintain their communities of plants and animals, ecological processes, and ecosystem services.

There is no predicted incremental drawdown to the unconsolidated deposits of the Quaternary alluvium or Tertiary regolith because of Mavis South operations. Therefore, for completeness the extent of predicted cumulative drawdown impacts (from all mining in the area) in the regolith and identified GDEs in the model domain are shown in **Figure 6**. The low potential GDEs that are 1.5 km south-west of the Project are predicted to be impacted by up to 2 m of drawdown in the regolith from cumulative mining in the area.



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:60,000 at A4
Project Number:	620.031508
Date:	21-Sep-2023
Drawn by:	AS

SLR

Major Drainage System
Maximum Drawdown Contour (m)
Project Boundary
Project Mining Lease Boundary
Model Grid

Maximum Drawdown (m)

1 - 2
2 - 5
5 - 10
10 - 20

MAVIS SOUTH UNDERGROUND EXTENSION UWIR

MAXIMUM PREDICTED CUMULATIVE DRAWDOWN IMPACTS (REGOLITH) ON TERRESTRIAL GDES (2027, END OF MINING)

FIGURE 6

H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620031508 F38 Maximum Predicted Cumulative Drawdown in Regolith on GDEs_v2.mxd

6.3.2 Impact on Private Bores – Irrigation, Farm Supply / Use and Stock Water

There is no predicted incremental drawdown in the Quaternary Alluvium and in the regolith for the Mavis South Underground scenario. Maximum predicted incremental drawdowns in the Rewan Group and Leichardt Coal Seam (Rangal Coal Measures) are shown in **Figure 3** and **Figure 4** respectively.

Table 8 shows predicted incremental water table drawdown at landholder bore locations. Predicted drawdowns at bores no longer in use are not included in the table. No landholder bore is predicted to have an incremental impact as a result of mining at Mavis South Underground.

For completeness, cumulative drawdowns from regional mining are also displayed in **Table 8.** Two landholder bores were identified to be within the predicted water table drawdown extent of mining in the region. Bore 105427, screened in the Rewan Group, and Bore 8, screened in the Quaternary Alluvium, are predicted to be 11.13 and 7.59 m, respectively.

Table 8 Predicted Cumulative (Mavis South UG) Water Table Drawdown at Landholder Bore Locations

Bore	Depth mbgl	Geology	Status	Predicted Cumulative Water Table Drawdown (m)	Predicted Incremental Water Table Drawdown (m)
Bore 1	Unknown	Rangal Coal Measures	Unknown	0	0
81909	60	Rewan Group	In use	0	0
105427	100	Rewan Group	In use	11.13	0
13040284	19	Rangal Coal Measures	Unknown	0	0
Bore 8	Unknown	Quaternary Alluvium	Unknown	7.59	0
105677	67.7	Tertiary Basalt	In use	0	0
131002	63	Tertiary Basalt	Unknown	0	0

6.3.3 Impact on Alluvium

There is no predicted incremental drawdown in either the Quaternary Alluvium or the regolith as a result of the Mavis South UG project. Therefore, no significant impacts to the alluvium are anticipated from the Project.

6.3.4 Impact on Baseflow

As part of the conceptual model the surface watercourses in the vicinity of the Project are considered disconnected from the underlying aquifer systems. Therefore, no significant impacts are expected to surface watercourses, including Isaac River and New Chum Creek.

6.3.5 Post-Mining Impacts

The predicted groundwater recovery at the Millennium Mine monitoring bores is shown in **Figure 7.** The model predicts that the groundwater system at Project area is being influenced by the mining activities at the neighbour mining tenements during the recovery period. The model predicted that groundwater levels in monitoring bore CSM_MB2

(MILLCSMB2), located close to Mavis Approved area (away from other mine tenements), will reach equilibrium approximately 420 years post-mining.

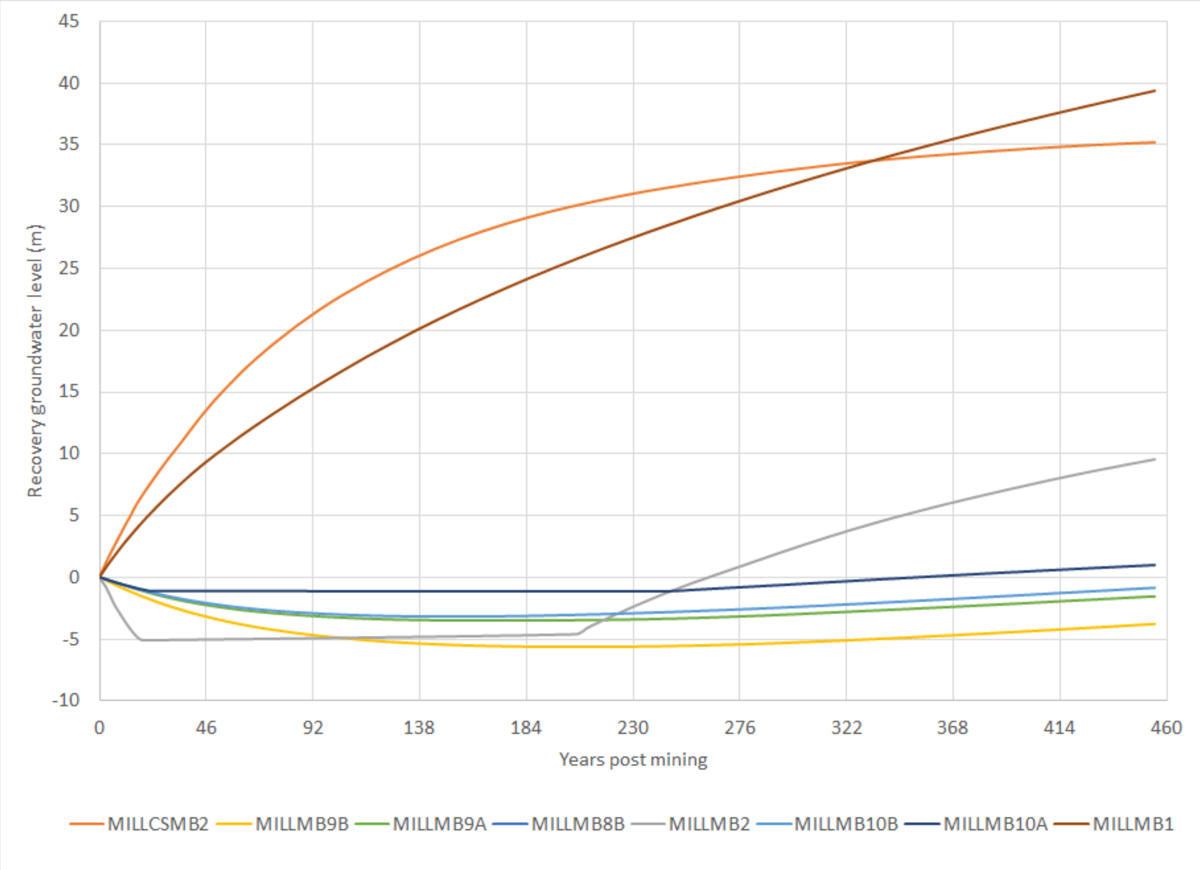
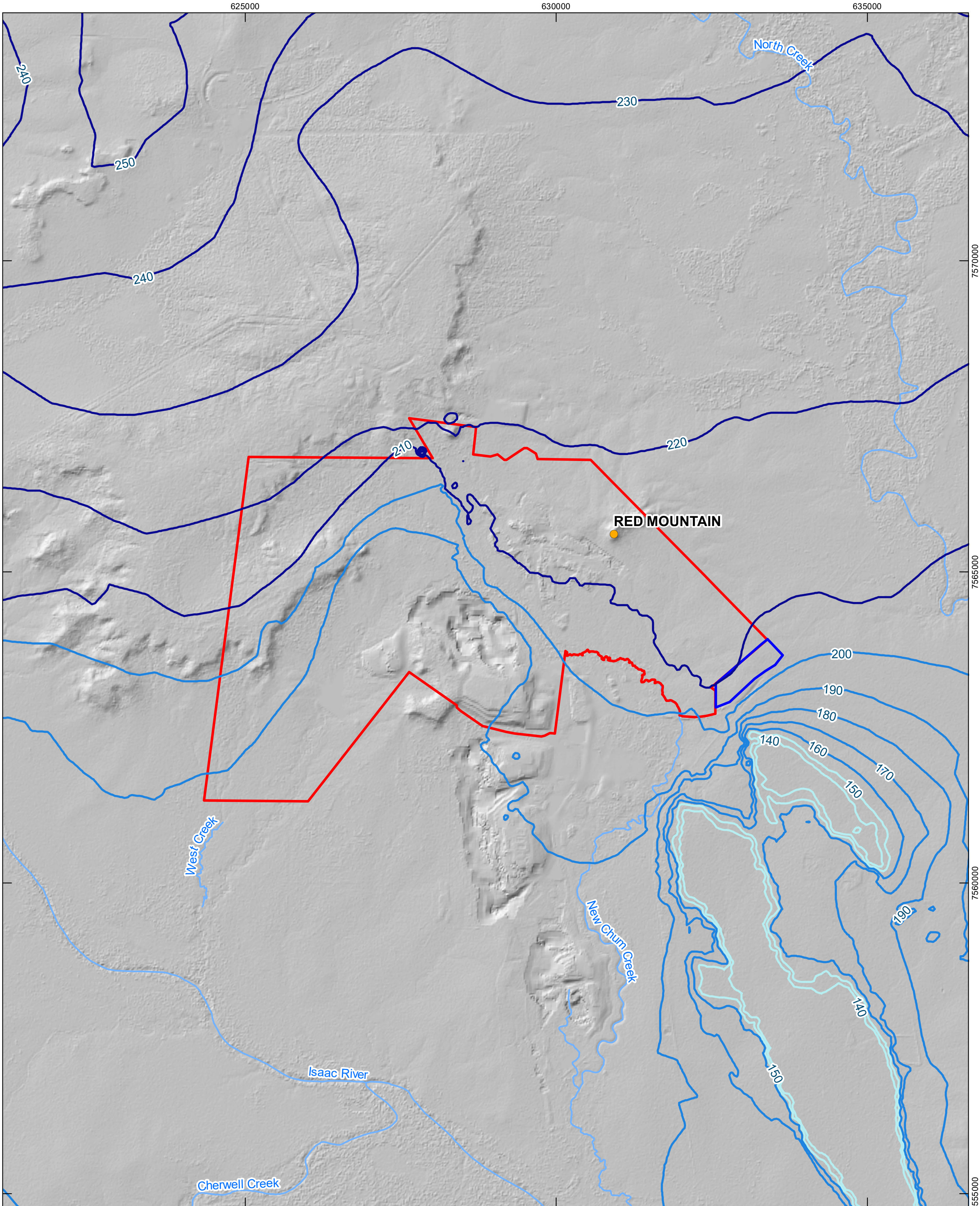


Figure 7 Predicted Groundwater Recovery within the Millennium Mine area

The recovered groundwater table in the Leichardt Seam is shown in **Figure 8**. The figure shows flat gradients around Millennium Mine and some flow towards neighbouring mines, which may be associated with their final void locations.



0 0.5 1 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	620.031508
Date:	07-Nov-2023
Drawn by:	AS

Elevation (mAHD)
- 100 - 150
- 150 - 200
- 200 - 250

- Watercourses
- Project Boundary
- Mining Lease Boundary

MAVIS SOUTH UNDERGROUND EXTENSION UWIR

GROUNDWATER TABLE AT THE END OF RECOVERY RUN

SLR

FIGURE 8

H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Modelling Report\620031508 MOD F4-2 Table at the End of Recovery Run.mxd

6.3.6 Subsidence

Due to the nature of the bord and pillar mining method and pillar design, subsidence related to the Project is predicted to be typically less than 50 mm (*pers. comm.* MetRes, 2023). To provide context, Commonwealth (2014; 2015) state that seasonal variation in surface levels can be as high as 50 mm as a result of changes in moisture content.

6.3.7 Impacts on Groundwater Quality

Table 9 lists the site activities with their associated Potential Contaminants of Concern (PCOC) and the recommended groundwater monitoring parameters to detect any potential impacts from Site activities.

Table 9 Site activities, potential contaminants of concern and recommended groundwater monitoring parameters

Site Activity	Potential Contaminant of Concern	Recommended Groundwater Monitoring Parameter	Parameters being monitored as of 2023
Storage of Coal and Waste Rock	Leachate of metals	Total and dissolved 9 metals (Al, As, Cu, Fe, Hg, Mo, Sb, Se, Zn)	Al, As, Fe, Hg, Mo, Sb, Se, Zn
Storage of raw materials	Alkaline and Saline drainage (e.g., high pH and high EC)	pH and EC	pH and EC
Storage of Solvent-based fuels and other fuels	Hydrocarbons	C6 – C9 Fraction, C10 -C40 Fraction (sum)	C6 – C9 Fraction, C10 -C40 Fraction (sum)
On site water processing and storage	Physicochemical	pH, EC, Major Ions, Total and dissolved 9 metals (Al, As, Cu, Fe, Hg, Mo, Sb, Se, Zn)	pH and EC Major Ions: bicarbonate, calcium, carbonate, chloride, magnesium, potassium, sodium, sulphate. Metals: Al, As, Fe, Hg, Mo, Sb, Se, Zn
Sewage Treatment	Nutrients, Bacteria	No interactions with groundwater expected, no monitoring parameters required	-
Use of Explosives	Release of nitrogen compounds into groundwater	No interactions with groundwater expected, no monitoring parameters required	-

In addition to the potential groundwater quality changes due to the Project related activities, groundwater quality changes may occur where groundwater level drawdown results in changes in aquifer potentiometric head gradients sufficient to cause significant alteration of groundwater flow systems that moves groundwaters of different quality into different areas of the hydrogeologic system. Furthermore, groundwater level drawdown also has the somewhat less likely potential to result in oxidation of the aquifer matrix that results in release of the matrix chemical constituents into groundwater, and this type of oxidation effect may also occur within overburden spoil dumps associated with Millennium Mine. At a single monitoring bore location, these potential groundwater quality changes may manifest as one or a combination of:

- Changes to groundwater salinity (measured as electrical conductivity (EC) or Total Dissolved Solids (TDS);
- Changes to groundwater pH;
- Modification of the ionic composition of the groundwater;
- Changes to the concentration of metal and metalloids in groundwater.

7.0 Part E: Water Monitoring Strategy

The following section describes the groundwater monitoring strategy required in section 376(f) of the Water Act for the IAA and LTAA. Ongoing underground water monitoring is required to keep track of the quantity of water produced or taken because of the exercise of relevant underground water rights and to monitor changes in underground water levels and the underground water quality.

The requirements for the monitoring strategy as outlined in section 378 of the Water Act is shown in **Table 10**.

Table 10 Requirements under Section 378 of the Water Act

Requirements under Section 378 of the Water Act	Relevant UWIR Report Section	Relevant EA Condition	Relevant Groundwater Impact Assessment Report Section (Appendix A)
To meet the requirements of the Water Act, an UWIR must include the following:			
A rationale for the strategy	**Section 7.1**	-	**-**
A timetable for the strategy	**Section 7.2**	-	Section 7.2
The parameters to be measured	**Section 7.3**	**Table D1 and Table D2**	Section 7.2
The locations for taking measurements	**Section 7.2**	**Table D1**	Section 7.1 (Table 22)
The frequency of the measurements	**Section 7.2**	**Table D1**	Section 7.1 (Table 22)
A programme for the responsible tenure holder or holders to undertake a baseline assessment for each water bore that is outside the area of a resource tenure, but within the predicted LTAA	NA	NA	NA
A program for reporting to the Office of Groundwater Impact Assessment (OGIA) about the implementation of the monitoring strategy.	NA	NA	NA

7.1 Monitoring Rationale

The objective of the groundwater monitoring network is to monitor potential groundwater impacts caused by mining, so that informed management can be undertaken. The current groundwater monitoring network established under the current EA EPML00819213 provides spatial and depth coverage to monitor potential groundwater impacts caused by the exercise of underground water rights.

The network will continue to track groundwater levels and groundwater quality over time and detect changes from baseline levels during the operational activities of the Project. In addition, trends in monitoring data that exceed trigger levels will enable action to be taken to reduce potential impacts.

7.2 Groundwater Level Monitoring Program

The groundwater monitoring bore network established under the current EA EPML00819213 allows for the compilation of groundwater data from the Rewan Group, Rangal Coal Measures, and Fort Cooper Coal Measures around the Project.

One additional bore, CS-MB2 was agreed with DES to monitor drawdown impacts at Mavis Approved; this is located to the east of the Mavis Approved footprint. Therefore, with the addition of this bore to the monitoring network, it is envisaged that this existing monitoring network at Millennium Mine is sufficient to monitor impacts from the Project. This is due to the Project being a small extension of Mavis Approved and of only one-year in length. This network is deemed suitable to assess the impacts of the Project.

The current monitoring schedule (monitoring on a quarterly basis or as defined in the EA) will be maintained for the Project as detailed in the current EA. The locations of existing monitoring bores in the current EA are presented in **Table 11**.

Table 11 Groundwater Monitoring Network

Monitoring Point	Latitude (GDA94 Z55)	Longitude (GDA94 Z55)	Ground elevation (mAHD)	Bore depth (screen interval) (mbgl)	Aquifer
MB2	22°1'50"S	148°14'18"E	262.38	90 (72-90)	Rangal Coal Measures (Coal)
MB8A	22°0'28"S	148°14'3"E	259.1	30 (22-28)	Rewan Group
MB8B	22°0'28"S	148°14'3"E	259.1	80 (62-74)	Rangal Coal Measures (Sandstone)
MB9A	22°0'34"S	148°14'43"E	251.8	30 (22-30)	Fort Cooper Coal Measures (Coal Seam)
MB9B	22°0'34"S	148°14'43"E	251.8	80 (60-74)	Fort Cooper Coal Measures (Sandstone)
MB10A	22°1'33"S	148°16'0"E	233.9	35 (27-35)	Fort Cooper Coal Measures (Sandstone)
MB10B	22°1'33"S	148°16'0"E	233.9	80 (64-76)	Fort Cooper Coal Measures (Sandstone)
CS_MB2	22°1’10”S	148°17’16”E	236.63	170 (155-158)	Rangal Coal Measures (Coal)

0 0.5 1 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	620.031508
Date:	21-Sep-2023
Drawn by:	AS

Groundwater Monitoring Network
Watercourses
Project Boundary
Mining Lease Boundary

MAVIS SOUTH UNDERGROUND EXTENSION UWIR

MONITORING BORE NETWORK

SLR

FIGURE 9

7.3 Groundwater Quality Monitoring Program

The principal contaminants of concern associated with coal mining are linked to mine-affected water. Accordingly, groundwater quality monitoring will continue to be undertaken on a quarterly basis as outlined within the current EA. As part of the full water quality monitoring programme, in addition to collecting field parameters (EC and pH), water samples will be submitted to a NATA accredited laboratory for analysis of:

- physiochemical indicators (total dissolved solids (TDS)).
- major ions (calcium, magnesium, sodium, potassium, chloride, sulphate, bicarbonate, carbonate).
- total and dissolved metals: iron, silver, arsenic, mercury, antimony, molybdenum, and selenium.
- total petroleum hydrocarbons (C6-C9, C10-C14, C15-C28 and C29-C36) with silica gel clean-up.

7.4 Groundwater Take Monitoring

Groundwater take is currently calculated using the water balance model methodology on an annual basis. This will be continued for future groundwater take reporting at the Mavis South Project.

7.5 Impact Assessment Criteria

Groundwater monitoring criteria (trigger levels) to monitor predicted impacts on both environmental values and predicted changes in groundwater levels and quality are defined in the current EA and apply for the Project for the existing monitoring bores outlined in **Table 11**.

7.6 Baseline Assessment Plan

A program to undertake a baseline assessment for the Project is not required, because:

- Mavis South Underground is a minor extension of an approved and operating mine (Mavis Underground and Millennium open cut), that has an established baseline assessment plan that can be utilised for the new underground works; and
- As shown in Sections **6.3.1** and **6.3.2**, there are no groundwater dependent ecosystems or registered groundwater bores within the predicted incremental drawdown radius for Mavis South Underground.

7.7 Data Management and Reporting

Ongoing from the existing reporting requirements outlined in EA EPML00819213, the following processes will be adhered to:

- The groundwater monitoring at all bores will be conducted on a quarterly basis.
- Data will be stored within the existing consolidated groundwater database.
- Quality assurance and quality control procedures, such as field sampling procedures and the use of NATA accredited laboratories, will continue to be in place to assess the accuracy of data entered into the database.

In accordance with the current EA, findings from the quarterly monitoring events will continue to be documented:

- The quarterly review will include identification of any groundwater quality trigger exceedances.
- Where a trigger exceedance is identified, the regulator will be notified within 28 days and an investigation into the potential for environmental harm will be completed. The groundwater database and factual quarterly documentation will be available for provision to the regulator upon request.
- Each year an annual review of groundwater level and quality trends will be conducted by a suitably qualified person and provided to the regulator. The review will assess the change in groundwater level and quality over the year, compared to historical trends and impact assessment predictions. The annual review will discuss any groundwater trigger exceedances or where trends show potential for environmental harm.

7.8 Future Modelling

During the life of Millennium Mine, data collected through the GMMP will be used to review and if deemed necessary update and refine the Millennium Mine groundwater model and its impact predictions, to reflect the actual activities undertaken on site (e.g. mine development) and the results of regular groundwater monitoring.

With the current Life of Mine of 4 years (latest approval included mining up to 2027), a review of the model is not likely to be required.

8.0 Part F: Spring Impact Management Strategy

A spring impact management strategy is required under Section 376 (g) of the Water Act, with the contents of the strategy provided in Section 379 of the Water Act. This section addresses the requirements under Section 379 of the Water Act as shown in **Table 12**.

Table 12 Requirements under Section 379 of the Water Act

Requirements under Section 379 of the Water Act	Relevant UWIR Report Section	Relevant Groundwater Impact Assessment Report Section (Appendix A)
To meet the requirements of the Water Act, a UWIR must include the following:		
Details of the spring, including its location	**Section 8.1**	Section 5.6.2
An assessment of the connectivity between the spring and the aquifer(s) over which the springs is located	N/A	-
The predicted risk to, and likely impact on, the ecosystem and cultural and spiritual values of the spring because of the decline in water levels of the aquifer over which the spring is located	N/A	-
A strategy for preventing or mitigating the predicted impacts outlined above, or if a strategy for preventing or mitigating the predicted impacts is not included, the reason for not including the strategy	N/A	-
A timetable for implementing the strategy	N/A	-
A program for reporting to OGIA about the implementation of the strategy.	N/A	-

8.1 Spring Inventory

As outlined in Section 5.6.2 of the Project Groundwater Impact Assessment in **Appendix A**, a desktop search showed that there were no active springs within a 50 km of the Project.

A search of the EPBC Act 'Protected Matters' database (DEE, 2019) found that there are no Internationally or Nationally Important Wetlands within the Project Area. The closest wetlands of international importance are located approximately 190 km south-east of the Project and include those of the Shoalwater and Corio Bays Area. Lake Elphinstone is the closest nationally important wetland, located 50 km north (upstream) of the Project. Due to their distance from site, no internationally and nationally important wetlands will be impacted by the Project.

8.2 Management of Springs

The Project incremental maximum drawdown does not intersect any active springs, and as such the Project will have no impacts on springs. Therefore, it is concluded that there is no requirement for a Spring Management Strategy for the Project.

9.0 Part G: For a Cumulative Management Area Assign Responsibilities to Resource Tenure Holders

Under the Water Act, a cumulative management area (CMA) can be declared if an area contains two or more resource tenures, including tenures on which coal seam gas (CSG) and mining activities operate, and where there may be cumulative impacts on groundwater resulting from water extraction by the tenure holders.

The Surat CMA, which covers part of the Bowen Basin was declared in 2011 for CSG activities and has since been managed by the Office of Groundwater Impact Assessment (OGIA).

In December 2016, the underground water management framework in the Water Act was expanded to include mining tenures. The OGIA advised that coal mining and CSG developments target the same coal formation in the Surat and Clarence Moreton basins, and impacts are likely to overlap. In January 2020, the Surat CMA was amended to include coal mining tenures located within the Surat and Clarence Moreton basins. The amendment did not extend the Surat CMA to include coal mining tenures within the Bowen Basin and therefore is not applicable to the Millennium Mine (and hence the Project).

10.0 References

Commonwealth of Australia (2014). *Subsidence from coal mining activities, background review*, prepared by Sinclair Knight Merz Pty Ltd for the Department of the Environment, Commonwealth of Australia, Canberra.

Commonwealth of Australia (2015). *Management and monitoring of subsidence induced by longwall coal mining activity*, prepared by Jacobs Group (Australia) for the Department of the Environment, Commonwealth of Australia, Canberra.

Department of the Environment and Energy (DEE) (2019). *Environment Protection and Biodiversity Conservation Act 1999 Protected Matters Database*. Available at: https://www.environment.gov.au/epbc/protected-matters-search-tool

Department of Environment and Heritage Protection (DEHP) (2011). Environmental Protection (Water) Policy 2009. Fitzroy River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Fitzroy River Sub-basin. September 2011

Department of Environment and Science (DES) (2021). *Underground water impact reports and final reports guideline.*

Environmental Protection Agency (EPA), 2005. *EIS Assessment Report – Poitrel Coal Mine Project*.

Geoscience Australia (2017). *Bowen Basin*. Available at: http://www.ga.gov.au/scientific-topics/energy/province-sedimentary-basin-geology/petroleum/onshore-australia/bowen-basin

MatrixPlus, 2010. *Millennium Expansion Project: Environmental Impact Statement, Appendix F4 - Groundwater*. Report prepared for Peabody Energy Ltd. Report No: PEA801

Appendix A Groundwater Impact Assessment Report

Millennium Mine – Mavis South Extension Project

Underground Water Impact Report

MetRes Pty Ltd

SLR Project No.: 620.031508.00001

23 November 2023

Executive Summary

SLR Consulting Australia Pty Ltd (SLR) has been engaged by MetRes Pty Ltd (MetRes) to undertake a Groundwater Impact Assessment for the Mavis South underground extension area (referred to as the Project) in support of an EA amendment. Open-cut mining was approved in the proposed Mavis Area via 2011 Environmental Impact Statement and subsequent approvals of the mining leases and environmental authority with a recent amendment to include underground mining at Mavis. The impacts of the proposed underground development of Mavis South Area on the groundwater environment will be assessed. The proposed operation will commence from July 2024 and based on current estimate of resource schedule, will cease operation within one year (by June 2025).

The main sources of information were the Groundwater Impact Assessment prepared for the Millennium Expansion Project Environmental Impact Statement, which was prepared in 2011, alongside the Groundwater Impact Assessment prepared for Mavis Approved underground in 2021. The conceptualisation of the groundwater assessment was updated with newly available data gathered since then. The key aquifers in the Project area are the Quaternary and Tertiary Alluvium/Colluvium, the Permian Rangal Coal Measures, and the Permian Fort Cooper Coal Measures. The water quality in those formations is generally brackish to saline and the groundwater is not widely used in the area.

A regional groundwater model was constructed. The model was then used to quantify the incremental and cumulative impacts of the underground mining at Mavis South on the groundwater. From this assessment, the following conclusions were drawn:

- The impact assessment was carried out as incremental (difference between all active and foreseeable mining excluding Mavis South against all active and foreseeable mining including Mavis South) and cumulative (difference between a no mining scenario and all active and foreseeable mining including Mavis South).
- Underground mining at Mavis South has a negligible incremental impact on the shallow groundwater system. No landholder bores or GDEs are impacted by the mining at Mavis South, on top of the cumulative impacts predicted by regional mining.

The Mavis South extension is not adding to the Mavis Approved impacts and hence the groundwater monitoring network designed for Mavis approved is deemed adequate. Reporting requirements will be kept the same as for the Mavis approved.

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Appendices

1.0 Introduction

1.1 Scope and Objectives

SLR Consulting Australia Pty Ltd (SLR) has been engaged by MetRes to undertake a Groundwater Impact Assessment for the Mavis South Underground extension area (referred to as the Project). The impacts of the proposed underground development of Mavis South Underground Area on the groundwater environment will be assessed in support of an EA amendment.

The proposed Mavis South Underground operation will commence from July 2024 and based on current estimate of resource schedule, will cease operation within one year.

1.2 Existing Operations

Millennium Coal Mine is located approximately 160 kilometres (km) southwest of Mackay in Central Queensland, and some 15 km southwest of the township of Coppabella and 20 km south-east of the township of Moranbah, within the Isaac Regional Council Local Government Area (LGA) in Queensland. Millennium Mine is accessed via an 8 km sealed road that branches from the Peak Downs Highway. The Goonyella Hay Point railway line crosses the Project to the south of the Mavis Downs area.

The Millennium Mine consists of two mining areas with six contiguous mining leases (ML): the Mavis Downs area (ML 70457, ML 70483, and ML 70485); and the Millennium area (ML 70313, ML 70401, ML 70344), which together form a single operational project, the Millennium Mine. Millennium Mine operates under Environmental Authority (EA) EPML00819213. The Project area is shown in **Figure 1**.

At Millennium Mine, the coal is processed and loaded for transport by rail at the facility of the Red Mountain Infrastructure Coal Handling and Preparation Plant (RMI CHPP) operated by Red Mountain Infrastructure Pty Ltd (RMI). MetRes has agreements with RMI and/or BHP Billiton Mitsui Coal Pty for access to the BHP RMI CHPP and associated infrastructure, to process and load Millennium's coal.

Millennium Mine commenced open cut coal mining operation in 2006, however was placed on care and maintenance by the previous owner Peabody Energy Australia Pty Ltd (Peabody), with the cessation of open-cut mining in 2018 and highwall mining in 2019. With the successful acquisition of Millennium Mine in July 2021, MetRes commenced operation in September 2021 to continue open-cut mining, utilising truck and shovel mining techniques, as well as auger miners to extract the Leichhardt seams of the Rangal Coal Measures.

On 7 December 2021, approval was received from Queensland Department of Environment and Science (DES) to commence underground mining within the Mavis Underground operation (from here on referred to as the 'Mavis Approved') from the existing Mavis Downs E Pit highwall in ML70457. Mavis Approved comprises mining operations to extract coal from the Leichhardt Seam within the Rangal Coal Measures. Maximum depth of open cut operations ranges to 100m with the final open cut mining depth determined on economic grounds. Continuous miner methods have been selected and preferred for the Mavis Approved area given the methods flexibility, responsiveness to change in seam conditions, low capital cost and low subsidence impacts. The resource areas also lend themselves favourably toward bord and pillar as opposed to longwall mining methods, given the relatively narrow area widths and irregular mining lease shapes in places.

N

0 0.5 1 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	620.031508
Date:	18-Jul-2023
Drawn by:	AS

SLR

Roads
Railway
Watercourses
Project Boundary
Mining Lease Boundary

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

PROJECT LOCATION

FIGURE 1

H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Conceptualisation Report\620031508 F01 Project Location.mxd

In line with current requirements of the EA, the following activities are currently authorised operations:

- Handling and use of explosives for blasting activities associated with operational mining and testing (signature holes);
- Mine Industrial Area (MIA) – Administration, Mavis Workshop, Warehouse, Sewage Treatment Plan, water tanks, washbay, Emergency Response Team;
- Storage, handling and use of chemicals and flammable or combustible liquids;
- Potable water supply – treated water from the Isaac Regional Council's standpipe supplied to site; and
- Both coarse and fine (tailings) rejects will be disposed of in Mavis Pit waste dumps.
- Maintenance of existing power lines and associated fire breaks;
- Maintenance of hardstand/laydown areas, access tracks and roads that may utilise coarse reject material from the RMI CHPP;
- Waste management - Onsite disposal of tyres;
- Dust suppression;
- Storage of explosives at explosives magazine on ML70313;
- Maintenance of water management infrastructure including sediment and erosion control dams; stormwater runoff drainage; dewatering infrastructure network (pipelines and pumps) and the levee;
- Reshaping of spoil dumps, replacement of topsoil and revegetation of the mined out and backfilled areas;
- Review designs and conditions of various water drains;
- Construction of drains in rehabilitated areas;
- Maintaining a nature conservation corridor – New Chum Creek buffer;
- Rehabilitation of exploration boreholes;
- Ongoing monitoring required for dust, water storage, mine affected water releases, saline drainage, groundwater, receiving environment, rehabilitation and other such as noise, odour, airblast on request from the administrating authority;
- Land management activities, including but not limited to, fire breaks, weed and feral animal control;
- Rehabilitation maintenance activities such as weed management and erosion control;
- Maintenance of existing groundwater monitoring bores and all other monitoring infrastructure and equipment; and
- Ongoing stakeholder engagement with the landowner's Property Manager, landowner and State Government regarding rehabilitation and future transition to a Progressive Rehabilitation Closure Plan.

In relation to off lease activities, the following is current authorised:

- Management and monitoring activities associated with the Wotonga Offset Area;

- Waste management - off lease disposal of general and regulated waste through a licensed waste management company;
- Processing of Run off Mine (ROM) coal through the RMI CHPP to produce coking coal and a PCI (Pulverised Coal Injection) coal; and
- Transporting the product coal by rail to the Dalrymple Bay Coal terminal for export.

1.3 The Project

It is now requested that an additional area to the south of the Mavis Approved underground operation be approved to maximise production and provide continued utilisation of existing fleet. This area, and the subject of this EA amendment application, is referred to the Mavis South Underground Project (the Project).

The action seeking approval is to extend the Mavis Approved underground operation as shown in **Figure 1**. The Project requires an EA amendment to EPML00819213 for the extension of the Mavis Approved mine operation for approximately 854,000 tonnes Run of Mine (ROM) extracted over approximately a 12-month period, currently forecast to start July 2024.

No new surface activities are proposed as part of this extension to the Mavis Underground South operation. The surface portal for the Project utilises existing infrastructure and access via the Mavis Approved operation. The Project will utilise existing fleet demand and infrastructure requirements.

The underground bord and pillar mining method is proposed to extract coal targeting the Rangal Coal Measures, with the Leichardt Seam being the deepest seem mined. In consideration of concurrent mine operational activities, the proposed extension remains within EA EPML00819213 approved extraction rate of 5.5 million tonnes per annum (Mtpa).

The proposed underground extension is currently within a portion of Mine Lease Development (MDL) 3046 (Lot 3 on SP190266). A mine lease application for the area will be lodged with the Department of Resources (DoR) at the same time as the EA amendment application.

1.4 Objectives

For an EA amendment change in mining method to underground operation, a Groundwater Assessment will need to be carried out. The groundwater assessment comprises two parts;

(i) A description of the existing hydrogeological environment; and

(ii) A quantitative assessment of the potential impacts of mining on that environment with a numerical groundwater model where the term ‘Study area’ means the boundary of the groundwater model.

For this assessment, the following scope of work has been carried out:

- A review of relevant hydrogeological, geotechnical, and environmental reports to characterise the geological and hydrogeological setting in the Study area, including:
    - Publicly available hydrogeological data such as the Queensland Government’s spatial data system (Queensland Globe) and the Bureau of

Meteorology's (BoM) National Groundwater Information System (NGIS) (BoM, 2023).

- On-site monitoring from the Millennium Mine bore network including groundwater level and quality monitoring.
- Existing census of groundwater supply bores in the vicinity of the Project to confirm locations, usage, and groundwater quality.

- Characterisation of the existing groundwater resources, including properties and general water quality.
- Conceptualisation of the groundwater regime surrounding the Project, including assessment of the influence of faults on this groundwater regime.
- Assessment of the potential interaction between the Isaac River and associated alluvium and the Project.
- Construction and calibration of a numerical groundwater flow model suitable for the assessment of potential impacts of the Project, in accordance with the Australian Groundwater Modelling Guidelines (Barnett *et al*., 2012).
- Perform predictive modelling for the scale and extent of mining impacts upon groundwater levels, groundwater quality and groundwater users, and comparing the impact from the approved open cut method to the underground method.
- Predictive modelling of the cumulative impacts of Project, surrounding mines, and other relevant developments (e.g., Bowen Gas Project).
- Assess the extent of groundwater impacts as a result of the Project, including long-term impacts on regional groundwater levels and water quality impacts on environmental flows and baseflows.
- Assess potential impacts on groundwater dependant ecosystems (GDEs) resulting from short and/or long-term changes in the quantity and quality of groundwater.
- Assess the potential third party impacts (i.e., privately-owned bores) as a result of changes to the regional groundwater system.
- Develop reasonable and practicable mitigation and management strategies where potential adverse impacts are identified.
- Propose a suitable groundwater monitoring program and management measures.

This groundwater assessment will be undertaken in accordance with the Queensland government requirements to support an amendment of the current Environmental Authority to obtain approval for mining in the new mine lease.

1.5 Information Sources

The main sources of information were the Groundwater Impact Assessment (MatrixPlus, 2010) prepared for the Millennium Expansion Project (MEP) EIS (Peabody, 2010) as well as the Groundwater Impact Assessment for the Millennium Mine Mavis Underground operation (SLR, 2021).

The conceptualisation of the groundwater system has used the work done by SLR (2021) and has been updated with newly available data acquired at the Project since the time of that report.

In addition to publicly available and Project specific information and data, this groundwater assessment has been prepared utilising information and data collected and collated as part of recent groundwater assessments for the nearby Winchester South Project (SLR, 2020), Moorvale South Project (SLR, 2019a), Eagle Downs Mine (SLR, 2019b), and Olive Downs Project (HydroSimulations, 2018). MetRes has established groundwater data sharing agreements with the owners of each of these projects/mines, which allows for the sharing of groundwater data, models, and documentation. Under these agreements, data utilised as part of each mine's groundwater assessment has been incorporated into this groundwater assessment where relevant.

The following information sources have been relied upon for the development of this groundwater assessment.

- MetRes provided information:
    - Indicative Project footprint and mine plan information;
    - Site geological model for the Project;
    - Geology logs and information for site monitoring bores and drill holes;
    - Historical to current groundwater monitoring database for the Project;
    - Previous Environmental Impact Assessment to support the initial Expansion Project approval (Peabody, 2011; MatrixPlus, 2010); and
    - Geological study reports conducted at or near the Project site.
- Publicly available information:
    - Bureau of Meteorology (BoM) climate data;
    - BoM Groundwater Dependent Ecosystems (GDE) Atlas;
    - Registered bore information and hydrogeological data from the registered bore database;
    - Publicly available geological maps;
    - Publicly available reports; and
    - Federal and Queensland State Government legislation.

2.0 Legislative Requirements and Relevant Guidelines

This section summarises the relevant groundwater legislation and policy relevant to the Project, inclusive of the following;

- Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act);
- Queensland *Water Act 2000* (Water Act).
  - *Water Resource (Fitzroy Basin) Plan 2011.*
  - *Environmental Protection (Underground Water Management) and Other Legislation Amendment Act 2016.*
- *Queensland Environmental Protection Act 1994* (EP Act).
  - *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water).

2.1 Environment Protection and Biodiversity Conservation Act 1999

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is administered by the Commonwealth Department of the Agriculture, Water and Environment (DAWE). The EPBC Act is designed to protect national environmental assets, known as Matters of National Environmental Significance (MNES).

This assessment was carried out under State legislation. Commonwealth considerations were not included.

2.2 Queensland Water Act 2000

The *Queensland Water Act 2000* (Water Act), supported by the subordinate Queensland Water Regulation 2002, is the primary legislation regulating groundwater resources in Queensland. The purpose of the Water Act is to advance sustainable management and efficient use of water resources by establishing a system for planning, allocation, and use of water.

The taking of water from an aquifer within the area is regulated by the Water Act. Where operations such as coal mining activities intersect aquifers, the Department of Regional Development, Manufacturing and Water (DRDMW) assess the need for water licencing of groundwater inflow to coal mine pit voids. In cases where groundwater inflow to a mine pit void is sourced from an identified aquifer, and/or where this resource is utilised by others, a licence to take water may be required. A water licence is required to facilitate the management of the resource in terms of monitoring and mitigation requirements. Further, it will provide security, via make good clauses, to other parties (environmental or anthropogenic) potentially affected by the removal of groundwater from the specified aquifers by mining activities.

It is understood that Millennium Mine exercise its statutory right under Mineral Resources Act 1989 (MRA) to take associated water and does not hold an Associated Water Licence. Millennium Mine undertakes regular reporting under section 334ZP of the MRA. It is assumed that this process will continue as the change from open cut to underground mining was not deemed to be a change to exercise of underground water rights as defined in the Water Act.

The development and implementation of a groundwater monitoring program was stipulated under Millennium's Environmental Authority (EA) EPML00819213. The monitoring program was required to be sufficient to detect significant changes to groundwater levels and quality.

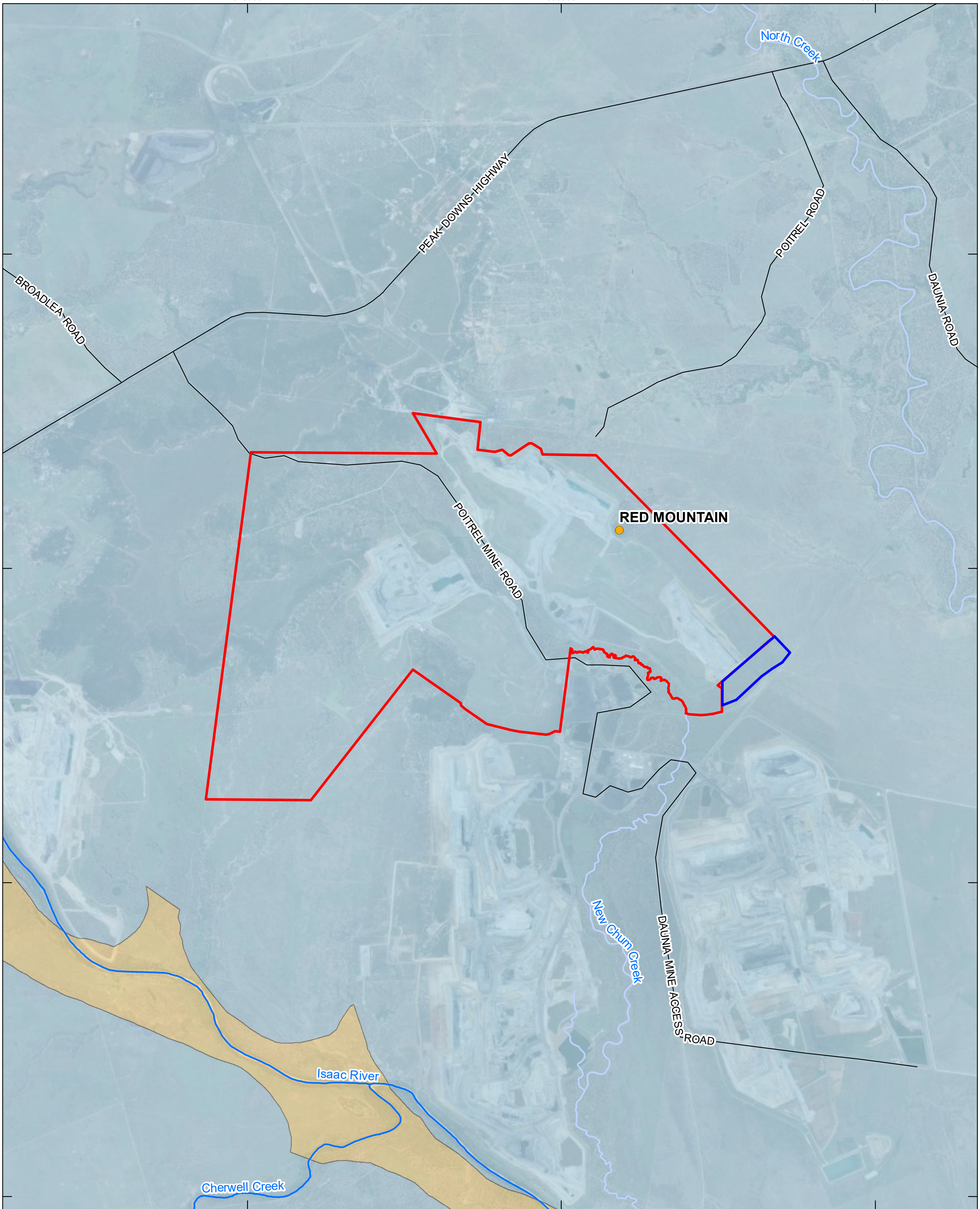
A Water Management Plan (WMP) for Millennium Coal Mine was developed in early 2016, updated in 2017 and current version updated in December 2020 (Peabody, 2020). Groundwater quality trigger levels are in place and exceedance for two consecutive monitoring periods must be reported to the administering authorities. The Millennium Mine Groundwater Monitoring Program (July 2023) stipulates that the Permian Coal Measures is the only hydrogeological feature that will be impacted by mining operations in relation to the Millennium Mine.

2.2.1 Water Resource (Fitzroy Basin) Plan 2011

The Water Act is enacted under a framework of catchment specific Water Resource Plans (WRPs). A WRP provides a management framework for water resources in a plan area, and includes outcomes, objectives, and strategies for maintaining balanced and sustainable water use in that area. **Figure 2** shows the applicable WRP in the area. Resource Operations Plans (ROPs) implement the outcomes and strategies of WRPs. Groundwater Management Areas (GMAs) and their component groundwater units are defined under WRPs. Authorisation is required to take non-associated groundwater from a regulated GMA or groundwater unit for specified purposes. The specified purposes are defined under a WRP, the Water Regulation 2016, or a local water management policy.

Groundwater units of the GMA are classified as:

- Groundwater Unit 1 - containing aquifers of the Quaternary alluvium; and
- Groundwater Unit 2 - containing all sub-artesian aquifers within the Isaac Connors groundwater management area other than the aquifers included in Groundwater Unit 1.



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Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	620.031508
Date:	18-Jul-2023
Drawn by:	AS

SLR

Roads

Major Drainage

Minor Drainage

Project Boundary

Mining Lease Boundary

Groundwater Management Area

Isaac Connors Alluvium Groundwater Sub-Area

Isaac Connors Groundwater Management Area

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

WATER RESOURCE PLANS AND GROUNDWATER MANAGEMENT AREAS

FIGURE 2

H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Conceptualisation Report\620031508 F03 Water Resource Plans and Groundwater Management Areas.mxd

2.2.2 Water Act Declared Watercourses and Drainage

The Water Act includes criteria for determining watercourses that require authorisation to take water, interfere with the flow of water, take quarry material, or excavate and place fill in a watercourse. The Water Act also includes criteria for drainage features that may require authorisation to take or interfere with overland flow. The Isaac River in the vicinity of the Project is defined as a watercourse under the Water Act criteria, and several small tributaries of the Isaac River that traverse the Project Area are defined as drainage features.

These declared watercourses and drainage features may be relevant to the groundwater assessment for the Project if there is a component of surface water-groundwater interaction associated with them.

2.3 Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act), supported by the subordinate *Environmental Protection Regulation 2019*, is the primary legislation regulating environmental protection in Queensland. The EP Act's objective is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains ecological processes.

The *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP) aims to achieve objectives set out by the EP Act and applies to all waters of Queensland. The EPP provides a framework to protect and/ or enhance the suitability of Queensland waters for various beneficial uses by:

- Identifying environmental values (EVs) and management goals for Queensland waters;
- Establishing water quality guidelines and water quality objectives (WQO) to enhance or protect the EVs;
- Providing a framework for making consistent, equitable and informed decisions; and
- Monitoring and reporting on the condition of Queensland waters.

The management objective of the Water Plan (Fitzroy Basin) 2011 is to maintain the 20th, 50th, and 80th percentile water quality results in order to preserve or enhance groundwater quality for its recognised uses.

Groundwater resources within the vicinity of the Project are scheduled under the EPP as of the Fitzroy Basin water plan (WQ1310). The EPP also provides limited water quality objectives for underground aquatic ecosystem protection in Fitzroy Basin groundwaters. These WQOs provided in the EPP are classified by groundwater depth and the regional chemistry zone (Zone 34).

Surface water resources within the vicinity of the Project are scheduled under the EPP Water and Wetland Biodiversity as:

- Surface Waters of the Isaac northern tributaries of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1301); and
- Surface Waters of the Isaac and lower Connors River main channel of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1301).

The legislated EVs for groundwater and surface waters near Millennium Mine are listed in **Table 1**.

The surface water WQOs for both the Isaac northern tributaries and lower Connors River main channel of the Isaac River sub-basin of the Fitzroy Basin water plan may be relevant to the groundwater assessment for the Project if there is a component of surface water-groundwater interaction associated with them.

Table 1 Applicable Environmental Values

Environmental Value	Fitzroy Basin Water Plan (WQ1310)	
	Groundwater	Surface Water
Aquatic Ecosystems	✓	✓
Irrigation	✓	✓
Farm water supply	✓	✓
Stock watering	✓	✓
Aquaculture	×	×
Human consumption	×	✓
Primary recreation	✓	✓
Secondary recreation	×	✓
Visual recreation	×	✓
Drinking water	✓	✓
Industrial use	✓	✓
Cultural and Spiritual Values	✓	✓

2.3.1 Environmental Authority

Under the EP Act, an environmental assessment is required as part of the application for an EA, or the application for an amendment to an existing EA, to undertake an environmentally relevant activity (ERA). This process assesses the potential environmental impact of the Project, and how impacts should be avoided, minimised, and managed. DES is responsible for the administration and delivery of applications for an EA, and amendment applications.

The mine currently operates under EA EPML00819213. The groundwater related conditions are listed in Schedule D of the EA.

2.4 Relevant Guidelines

There are several available guidelines designed to assist project proponents meet the relevant legislative requirements complete a groundwater assessment for coal mining proposals such as the Project. These guidelines are:

- DES (2016) - *Requirements for site-specific and amendment applications—underground water rights* - EP Act;
- DES (2017) - *Underground water impact reports and final reports* - Water Act;
- DES (2021) - *Using monitoring data to assess groundwater quality and potential environmental impacts* - EP Act;
- IESC (2018) - *Information guidelines for proponents preparing coal seam gas and large coal mining development proposals* – EPBC Act;
- IESC (2023) - *Information Guidelines explanatory note. Uncertainty analysis—Guidance for groundwater modelling within a risk management framework* – EPBC Act;

- Doody *et al.* (2019) - *Information Guidelines Explanatory Note. Assessing groundwater-dependent ecosystems* – EPBC Act; and
- Barnett *et al*. (2012) - *Australian Groundwater Modelling Guidelines. Waterlines report. National Water Commission, Canberra*, 2012.

3.0 Existing Conditions

This section documents the existing conditions at the Project, including climate (both historical and present), topography and drainage, and the current land use.

3.1 Climate

Regional climatic conditions at the Project are that of a sub-tropical nature, with higher temperatures, higher rainfall, and higher evaporation occurring in the summer months (December through February).

The closest BoM weather station to the Project is located at Moranbah Airport (station 34035), approximately 20 km to the south-west of the Project. The record is continuous with only minor gaps in the monitoring record; however, this weather station has only been in operation since 2012. A nearby station at Iffley (station 34100, 30 km south-east of the Project) has been open since 1998 but the monitoring record has a poor continuity.

Carfax weather station (station 34016) is located approximately 62 km south-east of the Project and has been in operation since 1962. This station has a continuous record with only a few occasional months of missing data. **Table 2** provides the details of the nearby operational weather stations.

Table 2 Operational BoM Weather Stations near the Project

Name	Site Number	Data Period	Easting⁺	Northing⁺	Elevation (mAHD*)	Operational Status	Distance from Project
Moranbah Airport	34035	2012-Present	610999	7559653	232	Open	20 km south-west
Iffley	34100	1998-Present	647356	7539801	173	Open	30 km south-east
Carfax	34016	1962-2021	673063	7515595	128	Open	62 km south-east
⁺GDA 94, Zone 55 *mAHD = metres Australian Height Datum							

For the purposes of this assessment, SILO Grid point data at latitude: -22.00, longitude: 148.25 (Queensland Government, 2023) was used to assess long-term climate trends in the vicinity of the Project. This dataset is interpolated from observational timeseries data collected at nearby BoM climate stations.

Data spanning January 1970 until June 2023 was used for assessing the long-term trends in the vicinity of the Project. Based on this data, the average annual site rainfall is 600 millimetres (mm). The two highest annual rainfalls were recorded for the years 1998 and 2010, with annual rainfalls of 968 mm and 1,133 mm, respectively. The minimum annual rainfall occurred in 1982 with 261 mm. Monthly averages for the three BoM stations as well as the SILO grid point are listed in **Table 3**.

Table 3 Average Monthly Rainfall

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Moranbah Airport	99.3	81.8	81.1	27.3	32.8	16.8	38.5	13.3	15.7	24.8	62.6	62.8	**562.8**
Iffley	97.4	83.5	57.8	37.3	16.9	37.3	22.1	36.3	15.4	33.6	56.5	87.4	**554.5**
Carfax	109.8	93.6	62.2	31.3	35.8	27.5	22.1	22.4	18.5	35.7	55.0	95.6	**614.5**
SILO Data	103.9	94.0	68.4	30.4	27.8	28.8	23.2	18.6	14.1	29.3	54	83.6	**576.3**

Long-term rainfall trends, based on the SILO grid point data, are indicated by analysis of the cumulative rainfall deficit/ deviation from the mean cumulative rainfall deficit (CRD). Positive gradients on this curve (rising limbs) confirm wetter conditions than normal, while negative gradients (falling limbs) indicate drier conditions than normal. Average rainfall conditions are inferred during periods of a stable trend in the CRD. **Figure 3** shows that, over the past 22 years, above average rainfall has occurred at the beginning of 2008 and in 2011 to 2012. Below rainfall conditions were observed between 2002 and 2008 as well as between 2017 and 2021. Over the last 2 years, the Project has experiences wetter than average conditions, as shown by the inclining trend in the CRD.

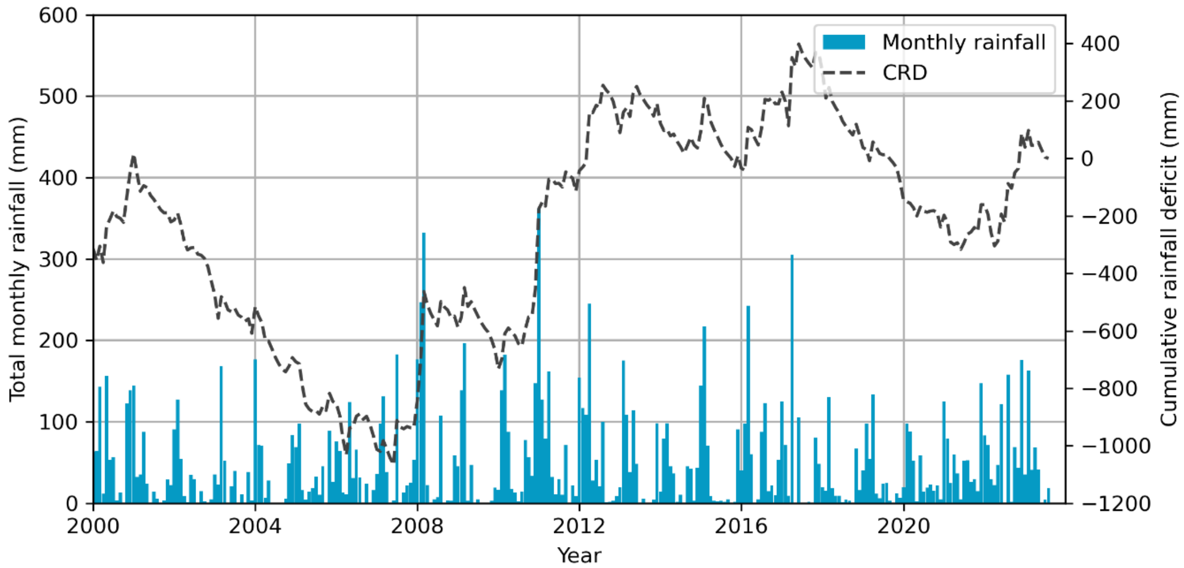


Figure 3 Long-term Monthly Rainfall and Cumulative Rainfall Deficit Curve at the Study Area (SILO Grid point -22.00, 148.25).

The CRD performs an additional service: if rainfall recharge is a significant source of groundwater, the temporal variability in recorded groundwater levels can be expected to mimic the pattern of the CRD curve. That is, natural fluctuations in the groundwater table result from temporal changes in rainfall recharge to groundwater systems. Typically, changes in groundwater elevation reflect the deviation between the long-term monthly (or yearly) average rainfall, and the actual rainfall, illustrated by the rainfall CRD. Groundwater hydrographs showing the relationship between rainfall and groundwater levels are assessed in **Section 5.0**.

Potential evapotranspiration taken from SILO Grid point data has been generated using the FAO Penman-Monteith formula, which uses local temperature, radiation, wind speed, and vapour pressure data to calculate potential evapotranspiration. Evapotranspiration takes place where the water table is close to ground surface and/ or within root zone depths (typically 1 to 2 m away from creek lines). Pan evaporation taken from SILO Grid point data showed that for each month, evaporation is approximately two to three times greater than the average monthly rainfall (**Figure 4**). The EVT and EVAP in the district are about 1,600 mm/year and 2,000 mm/year respectively, according to long-term averages calculated using SILO Grid point data for the Project.

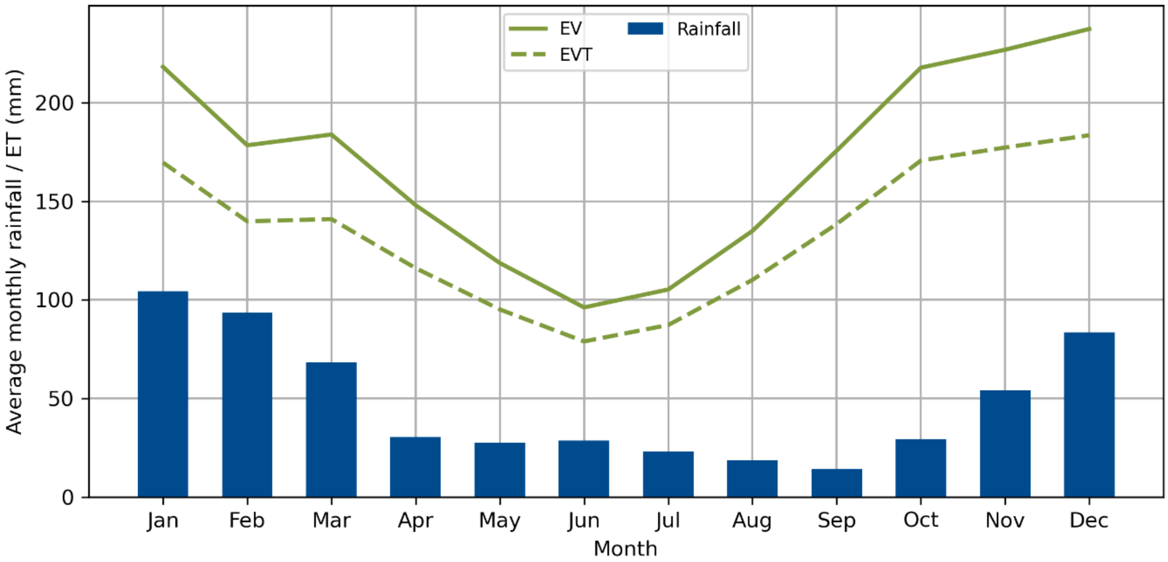


Figure 4 Average Monthly Rainfall, Evaporation (EV) and Pan Evapotranspiration (EVT) at SILO Grid Point – 22.00, 148.25

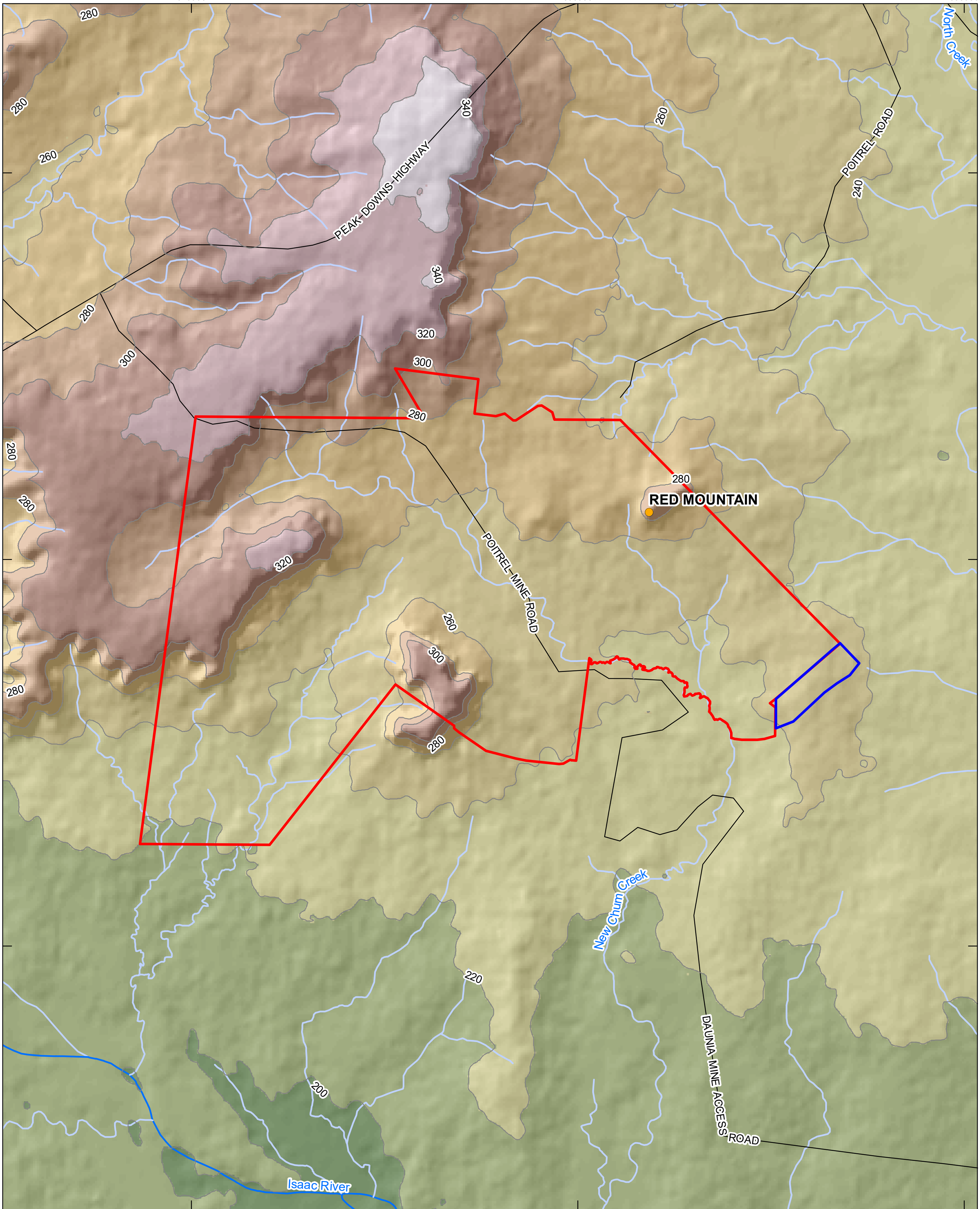
3.2 Topography and Drainage

3.2.1 Topography

The topography of the Project extent is relatively flat with gentle undulation with an overall gradient to the south, towards the Isaac River. Regionally the Project sits on the Isaac River valley slope, with high elevations to 340 mAHD to the north and north-east of the ML boundary sloping down to approximately 220 mAHD along the eastern and southern ML boundaries (**Figure 5**).

3.2.2 Surface Watercourses

The Project is located in the Isaac River drainage basin sub-area of the wider Fitzroy Drainage Basin. The Isaac River, to the south-west of the Project, is the major drainage feature of the region and flows in a south-easterly direction. New Chum Creek runs between the existing Millennium and Mavis open cut pits and is a tributary of the Isaac River. New Chum Creek and Isaac River are classified as third order and sixth order streams respectively, and both are ephemeral, experiencing short periods of flow following high rainfall events over the summer months.



Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:65,000 at A4
Project Number: 620.031508
Date: 18-Jul-2023
Drawn by: AS

0 0.5 1 km

Roads
Major Drainage
Minor Drainage
Project Boundary
Mining Lease Boundary

Elevation (m)
- < 200
- 200 - 220
- 220 - 240
- 240 - 260
- 260 - 280
- 280 - 300
- 300 - 320
- 320 - 340
- > 340

SLR

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

TOPOGRAPHY AND DRAINAGE

FIGURE 5

H:\Projects-SLR\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Conceptualisation Report\62003150 8 F08 Topography and Drainage.mxd

A DRDMW gauging station is located along Isaac River at Deverill (station 130410A). This station is located approximately 19 km from the Project and approximately 16 km downstream of the confluence with New Chum Creek. **Figure 6** presents daily the maximum stream discharge at the Isaac River at Deverill station from 2000 to June 2023, compared against monthly daily rainfall at the SILO data point at latitude: -22.00, longitude: 148.25 as discussed in **Section 3.1**. The cyclic nature of the graph confirms ephemeral flows in the Isaac River occurring during the summer months.

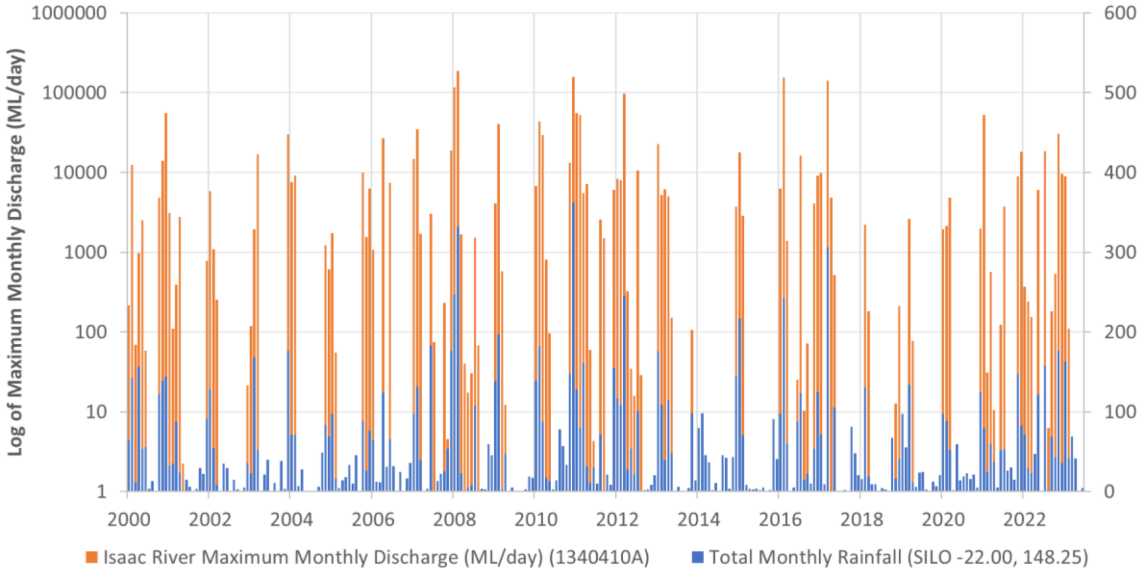


Figure 6 Isaac River (Station 130410A) Stream Flow and Monthly Rainfall (SILO data point)

Based on daily flow data from 1968 to 2019 (**Figure 7**), Isaac River flows only 27% of the time, with less than a 11% probability of flows exceeding 100 ML/day. Less than 1% of readings exceed 10,000 ML/day, which includes high flow/flood events in 2008 (January and February), 2010 (December), 2012 (March), 2016 (February) and 2017 (March).

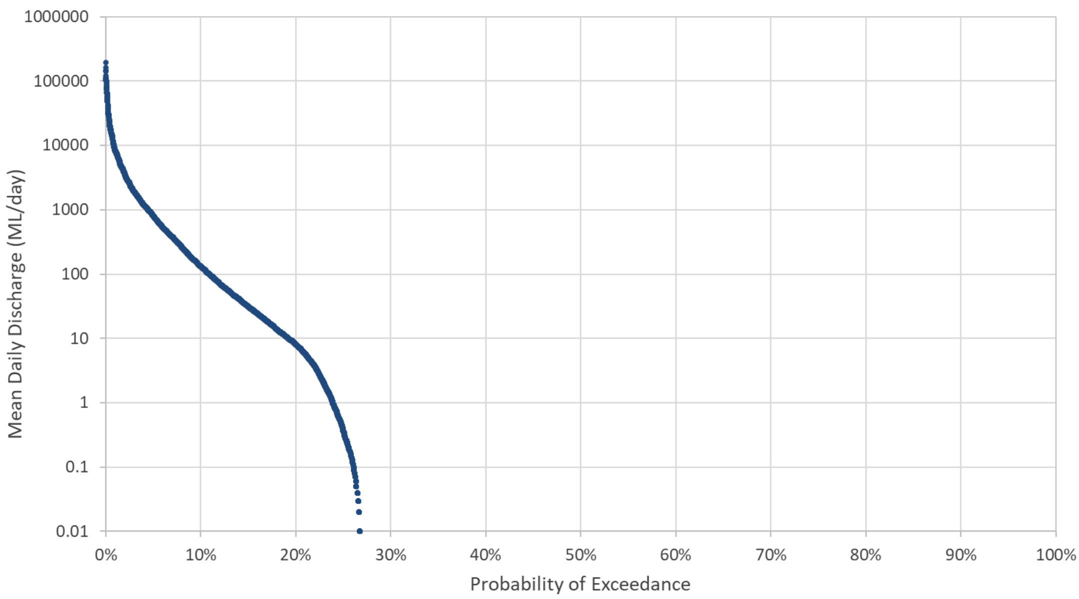


Figure 7 Isaac River (Station 130410A) Mean Daily Flow Duration Curve (1968 – 2019 data)

The catchment area of New Chum Creek is approximately 51 km^2, with the Millennium Miene, as well as Poitrel and Daunia Mines, located within the catchment. The main channel of New Chum Creek typically has a base width of approximately 3 m and a depth of up to 2 m. Although minor waterholes can persist in the channel for several weeks following high rainfall events, there is little to no aquatic vegetation due to the stream being ephemeral, with streamflow expected to occur less than 30% of the time (Peabody, 2020).

Figure 8 shows the most recent site daily flow data for the flow gauge at New Chum Creek downstream, together with daily rainfall. The creek flows after significant rain events with periods of no flow in between, which confirms the ephemeral nature of this creek.

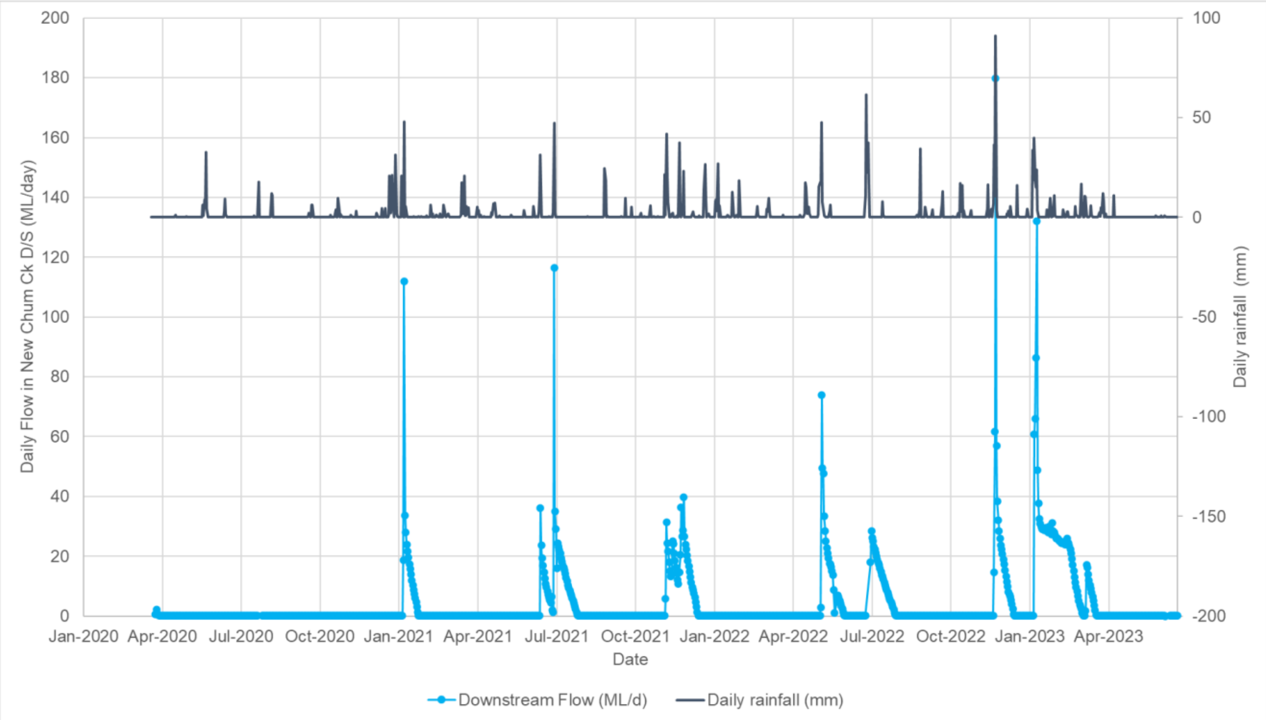


Figure 8 Daily flow in New Chum Creek (Downstream) with daily rain

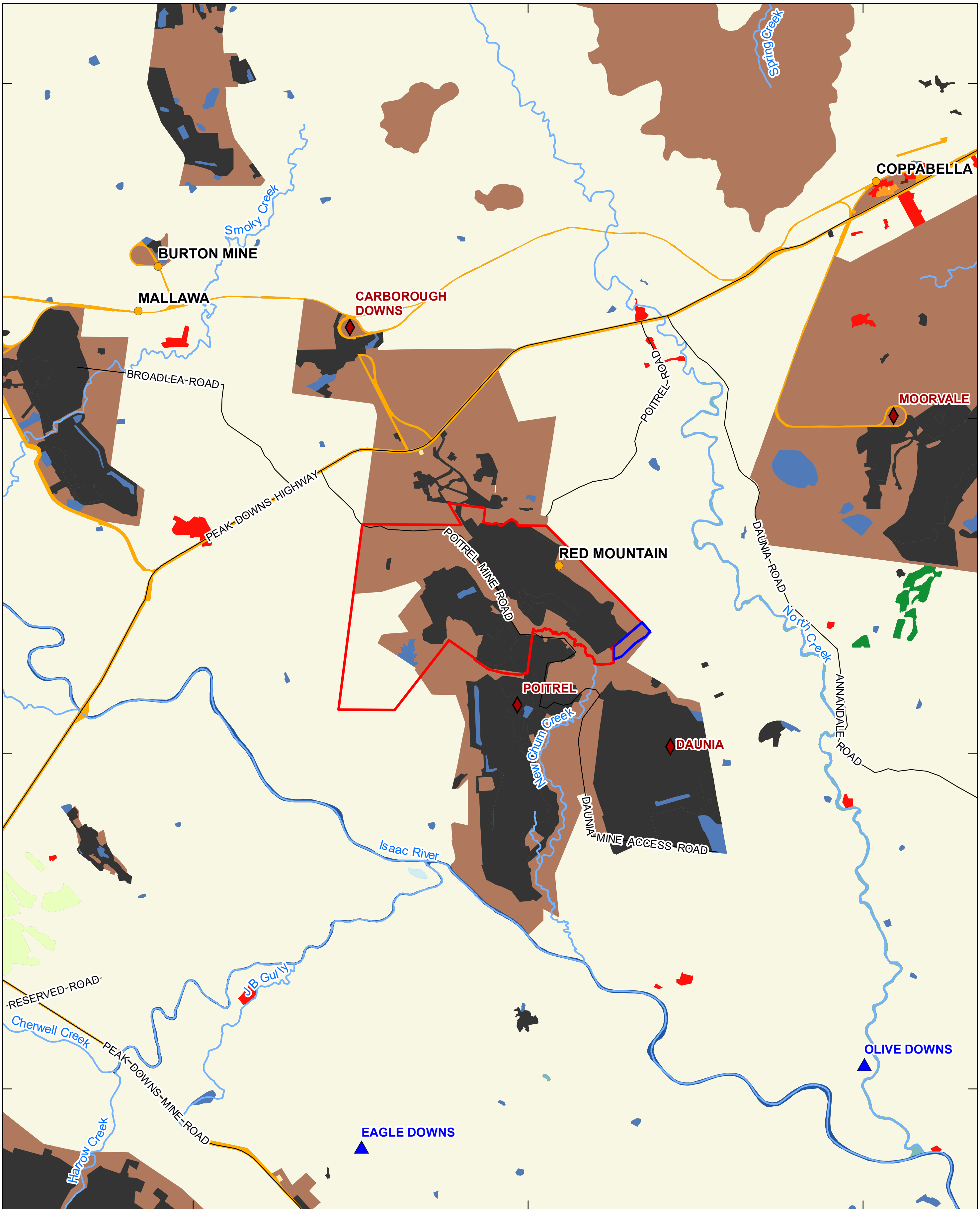
Flood modelling undertaken by WRM Water and Environment Pty Ltd (2010) confirmed that the existing Millennium Mine operations were outside the 100-year average recurrence interval (ARI) flood extend from New Chum Creek. New Chum Creek is crossed by two road culverts within the ML boundary and a railway culvert crossing at the downstream boundary (Peabody, 2020). New Chum Creek has been diverted downstream as part of a neighbouring mining operation at Poitrel Mine.

3.3 Land Use and Mining

The Project area covers approximately 0.42 km^2 of land 6 km to the north-east of Isaac River. The land outside of mining activities is dominated by native pasture used for grazing, with some proximal areas of land classified under other minimal use (**Figure 9**). There are no nature conservation areas, including National or State Parks in or nearby the Project. There is no Strategic Cropping Land mapped within the Project area.

Overall, the two predominant land uses are mining and agriculture (grazing). There are several proposed and active coal mining operations near to the Project. There are also proposed wellfields for extraction of coal seam gas (CSG) associated with the Bowen Gas Project. **Table 4** summarises the nearby resource extraction operations.

A summary of the closest surrounding mines and the Bowen Gas Project is provided in the sub-sections below. **Figure 9** shows the locations of the developments. The potential for cumulative impacts due to all neighbouring mining and gas developments included in the cumulative assessment is discussed in Section **6.6.2.2**.



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.031508
Date:	18-Jul-2023
Drawn by:	AS

- Roads
- Watercourses
- Coal Mine
- Avanced Coal Project
- Project Boundary
- Mining Lease Boundary

Land Use

- Other minimal use
- Grazing native vegetation
- Grazing modified pastures
- Cropping
- Residential and farm infrastructure
- Services
- Utilities
- Transport and communication
- Mining
- Waste treatment and disposal
- Lake
- Reservoir/dam
- River
- Marsh/wetland

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

LAND USE

FIGURE 9

Table 4 Proposed and Current Mining and CSG Operations

Operation	Status	Type	Planned Start	Planned End	Distance from Project	Target Resource
Carborough Downs Mine[1]	Operating	Underground	2005	2035	Adjacent, north	Rangal Coal Measures
Poitrel[1]	Operating	Open cut	2006	2026	Adjacent, south	Rangal Coal Measures
Daunia[1]	Operating	Open cut	2011	2034	Adjacent, south	Rangal Coal Measures
Moorvale	Operating	Open cut	2003	2017+	3.4 km east	Rangal Coal Measures
Moorvale South Project[1]	Proposed	Open cut	2021	2031	4.4 km south-east	Rangal Coal Measures, Fort Cooper Coal Measures
Olive Downs Project[1]	Proposed	Open cut	2020	2099	8.5 km south	Rangal Coal Measures
Isaac Plains	Operating	Open cut	2006	2070	9 km north-west	Rangal Coal Measures
Winchester South Project[1]	Proposed	Open cut	2023	2053	10 km south	Rangal Coal Measures, Fort Cooper Coal Measures
Bowen Gas Project[1]	Proposed[2]	Coal Seam Gas	~2017[2]	2055	Proposed wells approximately 10 km south	Rangal Coal Measures, Moranbah Coal Measures
Eagle Downs Mine[1]	Care & Maintenance	Underground - Longwall	~2017[2]	2064	11 km south-east	Moranbah Coal Measures
Peak Downs[1]	Operating	Open cut	1972	2075	21 km south-west	Moranbah Coal Measures
Coppabella	Operating	Open cut	1998	2035	23 km north-east	Rangal Coal Measures, Fort Cooper Coal Measures
Caval Ridge[1]	Operating	Open cut	2013	2043	24 km south-west	Moranbah Coal Measures
Moranbah South	Proposed	Underground – Longwall and Bord and Pillar	2017[2]	2060	25 km west	Moranbah Coal Measures
Saraji[1]	Operating	Open cut	1974	2040	45 km south-west	Moranbah Coal Measures
Saraji East[1]	Proposed	Underground - Longwall	TBD	TBD	45 km south-west	Moranbah Coal Measures
Lake Vermont[1]	Operating	Open cut	2014	2045	45 km south	Rangal Coal Measures

Operation	Status	Type	Planned Start	Planned End	Distance from Project	Target Resource
Norwich Park	Care & Maintenance	Open cut	1979	2012	50 km south	German Creek Formation
1. Cumulative impacts assessed as part of this groundwater assessment						

3.3.1 Poitrel Mine

The Poitrel Mine owned by Stanmore Coal is located 25 km east south-east of Moranbah, and adjacent to the Project. The Poitrel Mine is an open cut mine targeting the Leichhardt and Vermont Seams within the Rangal Coal Measures, which consists of 79 million tonnes (Mt) of resources. The Poitrel Mine is projected to produce up to 5 Mtpa of ROM coal for at least 20 years (Environmental Protection Agency [EPA], 2005).

3.3.2 Daunia Mine

Daunia Mine is located approximated 30 km south-east of Moranbah, and adjacent to the Project. Daunia Mine is an open cut mine targeting the Leichhardt and Vermont Seams within the Rangal Coal Measures. The Daunia Mine is located on the eastern limb of an anticline that separates it from adjacent Poitrel Mine. The Daunia Mine has a production rate of 4 Mtpa with a mine life of 21 years.

3.3.3 Carborough Downs

Carborough Downs is an underground coal mine owned by the Fitzroy Australia Resources Pty Ltd, located adjacent to the north of the Project, approximately 21 km east of Moranbah. The Carborough Downs mine commenced in 2009. The mine extracts coal from the Leichhardt Seam which ranges between 4.5 – 5.7m in thickness. The expected mine life is currently 10 year (approximately 2033) (Fitzroy, 2023).

3.3.4 Moorvale South Project

Moorvale South Project operated by Peabody Energy Australia PCI (C & M Management) Pty Ltd and owned by the Coppabella and Moorvale Joint Venture is located 4.4 km south-easts of the Project. The Moorvale South Project initially targets the Leichhardt and Vermont Seams, and where economically viable also the Fort Cooper Coal Measures using conventional open cut mining and strip-mining methods. The Moorvale South Project is projected to extract between 1.5 and 2 Mtpa with a mine life of 10 years.

3.3.5 Isaac Plains and Isaac Downs

The Isaac Plains Mine is located approximately 6km to the west of the Project. The mine extracts coal from the Leichardt Seam (Rangal Coal Measures) with open-cut methods. An underground extension is planned to commence in 2037.

The Isaac Downs mine will extract approximately 3.2 Mtpa ROM coal over the first nine years, and then approximately 1 Mtpa over the next seven years. Construction activities were planned in early 2021, subject to obtaining all required approvals, with mining operations commencing in 2022 and completed in 2037 (AGE, 2020).

The Isaac Plains and Isaac Downs mines were not included in the cumulative assessment. Even though these mines are targeting or will target the same coal seams as the Project, a review of the geological setting (AGE, 2020) concluded that there are multiple faults between these mines and the Project and that there is no connection between the coal seams that would require a cumulative assessment.

3.3.6 Bowen Gas Project

The Bowen Gas Project is a CSG development by Arrow Energy Pty Ltd (Arrow), targeting gas within coal seams of the Rangal Coal Measures and Moranbah Coal Measures. The Bowen Gas Project proposes to extract approximately 270 gigalitres (GL) of associated water with the gas over a period of 55 years from 6,000+ extraction wells covering and area of 9,500 square kilometres (km^2). Arrow has identified an extraction wellfield targeting the Rangal Coal Measures and Moranbah Coal Measures in the vicinity of the Project. While the final well locations and relative timing of these activities are yet to be finalised, gas extraction has been considered for the purposes of cumulative assessment of the Project (Section **6.6.2**).

4.0 Geology

As per the State (Queensland Government) Detailed Surface Geology (SDSG) mapping, the geology surrounding the Project is typically Quaternary deposits overlying Tertiary, Permian, and Triassic Age sedimentary and igneous bedrock.

4.1 Regional Geology

The Project is located in the Bowen Basin, a basin spanning an extent of approximately 200,000 km^2 and one of five major foreland sedimentary basins formed along the eastern side of Australia during the Permian Period. The Bowen Basin extends in a north to south direction from Townsville, Queensland at its northern extent to Moree, New South Wales at its southern extent. In the southern parts, the extent of the Bowen Basin and the Great Artesian Basin (GAB) overlap. The Bowen Basin has two north trending depocentres, the eastern Taroom Trough and western Denison Trough (Geoscience Australia, 2017). The Project lies within the Collinsville Shelf, north of the Taroom Trough depocentre.

Basin geology within the Collinsville Shelf includes the basal Permian aged Back Creek Group, which is comprised of generally fine-grained clastic sedimentary rocks deposited in a fluvial to shallow marine environment. The Back Creek Group is conformably overlain by the Blackwater Group, which includes the Rangal Coal Measures, Fort Cooper Coal Measures, and Moranbah Coal Measures. The economic seams of the Project are contained in the Late Permian Rangal Coal Measures. The Permian strata occur at outcrop on the eastern and western edges of the Basin and are unconformably overlain by the Triassic aged terrestrial sedimentary rocks of the Rewan Group. While not present at the Project, isolated pockets of remnant quartzose sandstones of the Middle Triassic Clematis Group are mapped.

The Permian and Triassic units are covered by a thin layer of unconsolidated to semi-consolidated Cainozoic sediments (Tertiary to Quaternary alluvium and colluvium). The alluvial sediments are localised along rivers and creeks (Isaac River). Volcanic intrusions and extrusions are also present within the region.

The major lithological units found in the vicinity of the Project are shown in **Table 5**.

Table 5 General Stratigraphic Sequence

Period	Stratigraphic Unit	Map code	Lithological Description	Thickness (m)*	Location to Project
Quaternary	Isaac River alluvium	Qa	Clay, silt, sand and gravel; flood-plain alluvium	0 to 20	Surficial cover localised along Isaac River and North Creek.
	Colluvial deposits	Qr	Clay, silt, sand, gravel and soil; colluvial and residual deposits	0 to 20	Surficial cover localised along Isaac River and downstream portions of New Chum Creek where it joins the Isaac River.

Period	Stratigraphic Unit		Map code	Lithological Description	Thickness (m)*	Location to Project
Quaternary/ Tertiary	Regolith - alluvium, colluvium and other sediments in floodplains, alluvial fans, and high terraces		TQa	Locally red-brown mottled, poorly consolidated sand, silt, clay, minor gravel; high-level alluvial deposits (generally related to present stream valleys but commonly dissected)	0 to 20	Proximal to the Project as isolated deposits occurring along New Chum Creek.
Tertiary	Suttor Formation		Tu	Quartz sandstone, clayey sandstone, mudstone and conglomerate; fluvial and lacustrine sediments; minor interbedded basalt.	0 to 50	Crops out to the north-west of the Project, associated with the high topography areas. Small outcrops to west and north of the Project.
	Duaringa Formation		Tb	Mudstone, sandstone, conglomerate, siltstone, oil shale, lignite & basalt	0 to 50	No outcrop in proximity to the Project.
Cretaceous	Undifferentiated igneous intrusives		Ki	Gabbro, leuco-diorite, quartz hornblende diorite, biotite-hornblende granodiorite, microgranite, rhyolite, trachyte	Unknown	To the south of the Project.
Triassic	Mimosa Group	Clematis Group	Re	Cross-bedded quartz sandstone, some quartz conglomerate and minor red-brown mudstone.		No outcrop in proximity to the Project.
		Rewan Group	Rr	Lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanilithic pebble conglomerate (at base). Sandstone mudstone & minor conglomerate (at base).	5 to 70 >600 m regionally	Crops out at surface at the Project location.

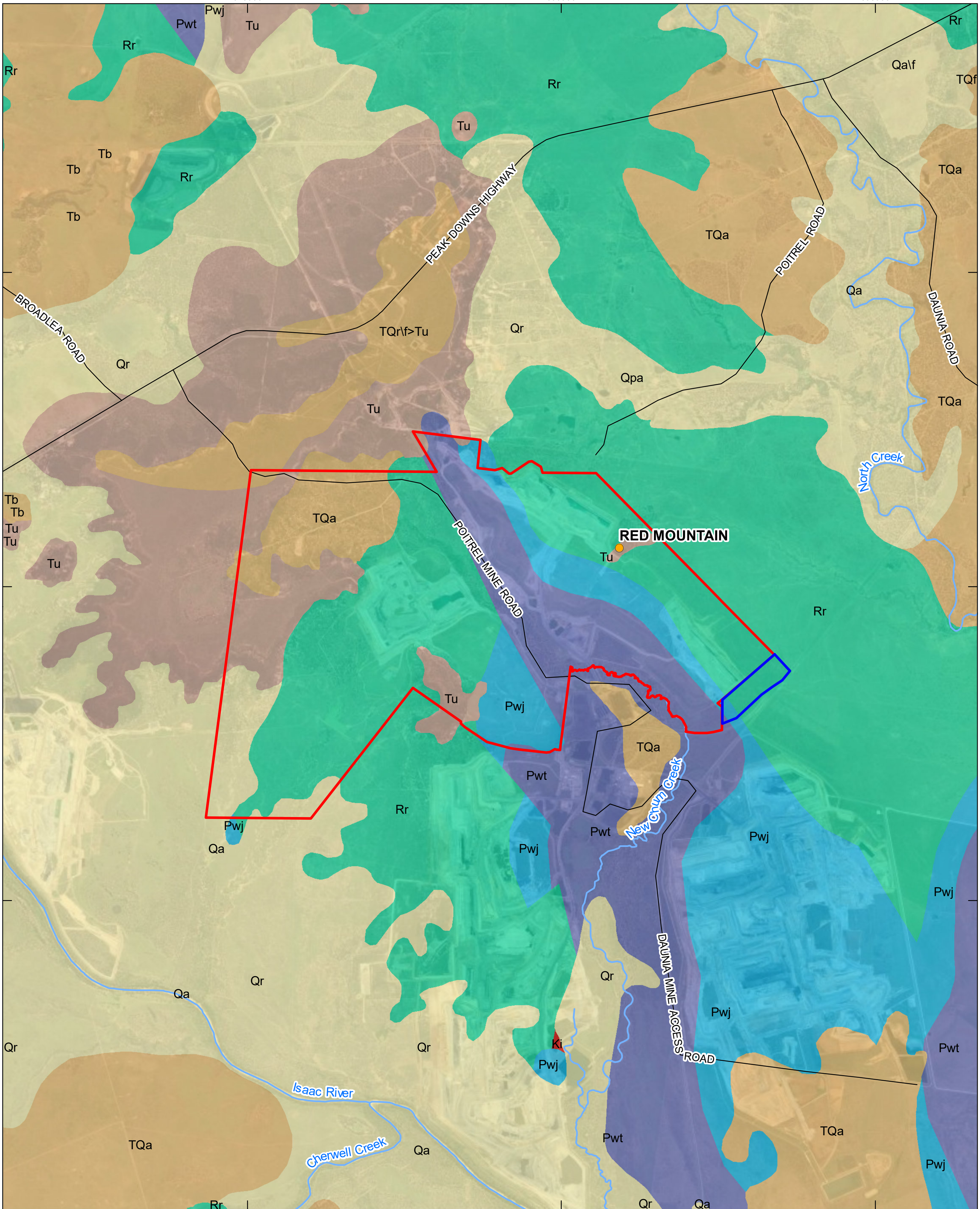
Period	Stratigraphic Unit		Map code	Lithological Description	Thickness (m)*	Location to Project
Permian	Blackwater Group	Rangal Coal Measures	Pwj	Calcareous sandstone, calcareous shale, mudstone, and concretionary limestone including the following coal seams: • Leichardt; • Millennium; and • Vermont.	20 to 70 Leichardt (4 to 10) Millennium (1) Vermont (4 to 10)	At depth at the Project location, underlying the Rewan Group.
		Fort Cooper Coal Measures	Pwt	Lithic sandstone, conglomerate, mudstone, carbonaceous shale, coal, tuff, tuffaceous (cherty) mudstone.	30 to 60	At depth at the Project location, underlying the Rangal Coal Measures.
		Moranbah Coal Measures	Pwb	Labile sandstone, siltstone, mudstone, coal, conglomerate in the east		At depth at the Project, crops out to the east.
	Back Creek Group		Pb	Quartzose to lithic sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite		At depth at the Project, crops out to the west.
*MatrixPlus (2010) and SLR (2021)						

4.2 Local Geology

The bedrock stratigraphy at the Project typically comprises of Triassic aged deposits, namely the Rewan Formation, which unconformably overlie Permian Coal Measures, inclusive of the Rangal Coal Measures and Fort Cooper Coal Measures. Proposed operations at the Project will extract from the Leichhardt Coal Seam in the Rangal Coal Measures Formation, whereas Millennium and Vermont Coal Seams (also within the Rangal Coal Measures) are not targeted by the Project.

Superficial deposits include alluvial and weathered colluvial bedrock, formed during the Tertiary and Quaternary Periods. The Quaternary alluvial deposits are localised along creeks and rivers; in the area surrounding the Project these are associated with the Isaac River to the south and south-west. The Tertiary-aged alluvium is more widespread across the area and is likely associated with historical palaeo-watercourses.

The area surrounding the Project is heavily influenced by regional-scale faulting, including the Daunia and New Chum Thrusts, and the Daunian Graben bounding faults, which are north-south trending faults that form vertical displacements of over 30 m (*Babaahmadi et al.,* 2020).The surficial geology surrounding the Project is shown in **Figure 10**, whilst the solid geology is displayed in **Figure 11**.



Coordinate System:	GDA 1994 MGA Zone 55
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Project Number:	620.031508
Date:	18-Jul-2023
Drawn by:	AS

0 0.5 1 km

Roads
Watercourses
Project Boundary
Mining Lease Boundary

Surface Geology

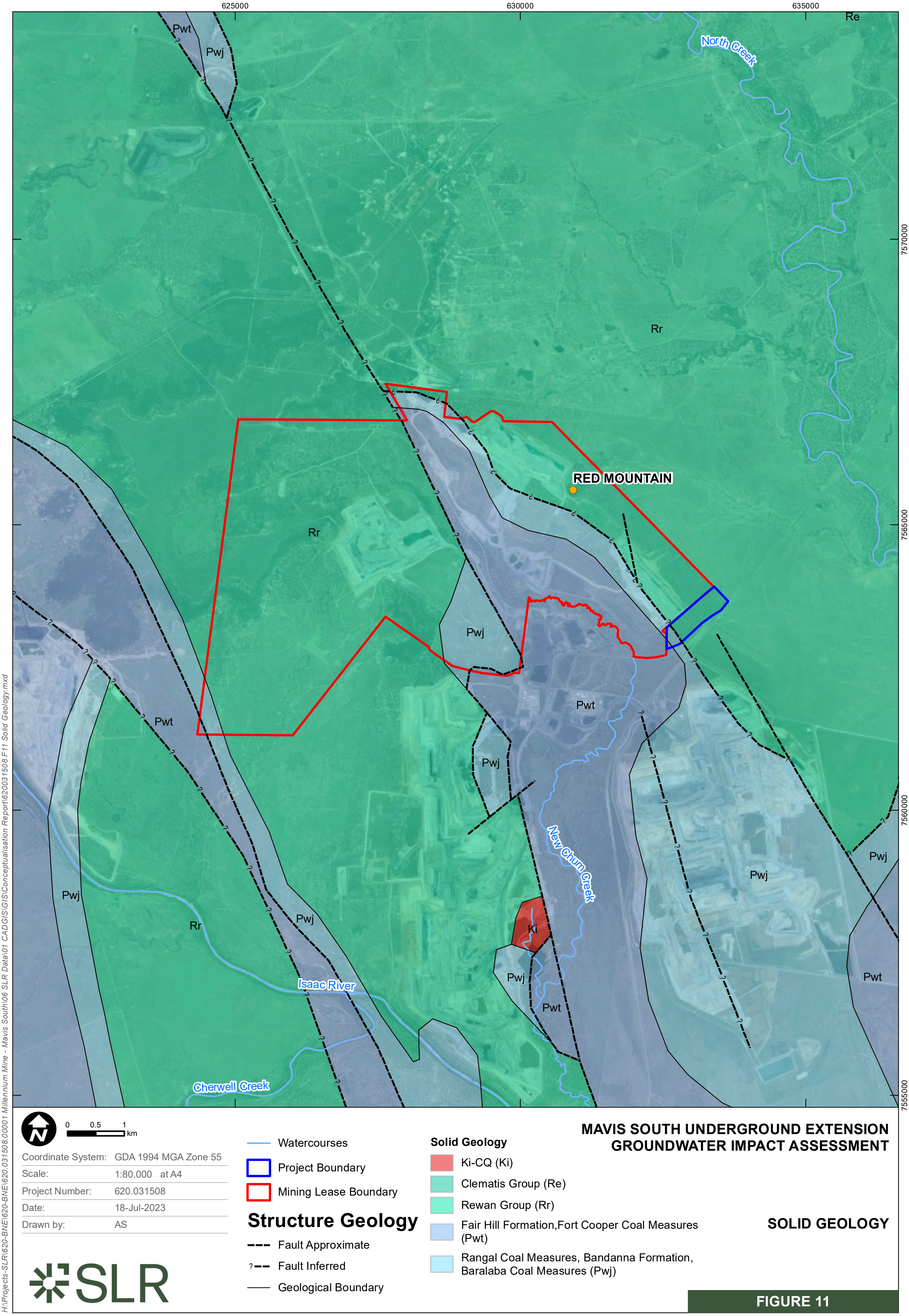
- Tertiary Sandstone (TQ)
- Alluvium (Qa)
- Suttor Formation (Tu)
- Fort Cooper Coal Measures (Pwt)
- Rewan Group (Rr)
- Rangal Coal Measures (Pwj)
- Ki-CQ

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

SURFACE GEOLOGY

FIGURE 10

H:\Projects-SLR\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Conceptualisation Report\620031508 F10 Surface Geology.mxd



MAVIS SOUTH UNDERGROUND EXTENSION
GROUNDWATER IMPACT ASSESSMENT

SOLID GEOLOGY

FIGURE 11

4.2.1 Quaternary Alluvial Deposits

The Quaternary alluvial deposits surrounding the Project are associated with floodplain deposits along Isaac River and its two major tributaries, New Chum Creek and West Creek, approximately 5 km south-west of the Project extent.

Alluvial deposits unconformably overlie the Triassic and Permian deposits with a weathered surface apparent at the contact. There has been no ground investigation carried out by MetRes into this deposit, though the last EIS completed by MatrixPlus (2010) stated that the thickness of the alluvium is highly variable to the west of the Project, though exists as a relatively thin deposit with maximum thicknesses of 20 m recorded. Studies indicate the alluvium is composed of a heterogeneous distribution of fine to coarse grained sand, interspersed with clay and gravel lenses (MatrixPlus, 2010).

Drill holes and Agricultural Transient Electromagnetic (AgTEM) surveys have been carried out for nearby projects, to determine the extent and depth of Quaternary deposits along the Isaac River. These include Winchester South Project (SLR, 2020), Moorvale South Project (SLR, 2019a), and Olive Downs Project (SLR, 2021), all located to the south and downgradient of the Project. General stratigraphy from these studies, while spatially variable, generally comprised of four main stratigraphic sequences of the alluvial deposits:

- Upper soil and clay layer (0 m – 13 m thick);
- Sand and sandy clay unit (0 m – 24 m thick);
- Sand and gravel unit (0 m – 8 m thick); and
- Basal clay unit (0 m – 10 m thick).

4.2.2 Quaternary / Tertiary Alluvial and Colluvial deposits

Quaternary/ Tertiary alluvial deposits are more widespread across the area, forming extensive areas of deposit approximately 8 km south of the Project extent. The nearest alluvium to the Project is a small, isolated deposit of Tertiary alluvium that is seen adjacent to the southern boundary of the Mavis open cut pit.

Colluvial deposits are also present to the west of the Project, commonly found close to the Isaac River. These are associated with weathered bedrock material.

No ground investigation has been carried out by MetRes into these deposits, though MatrixPlus (2010) predicted the thickness of these deposits around the Project to be approximately 20 m.

4.2.3 Tertiary Suttor and Duaringa Formations

Tertiary deposits in the vicinity of the Project comprise of both the Suttor Formation and the Duaringa Formation; these are located to the north and do not crop out within the Project extent. Both are consolidated, sedimentary formations primarily composed of mudstone, siltstone, sandstone, and conglomerate, with minor occurrences of igneous basalt. Thicknesses of these formations are variable; however, a maximum thickness of 50 m is expected in the vicinity of the Project (MatrixPlus, 2010). These formations are associated with the topographic high points to the north of the Project, reaching spot height elevations of up to 350 mAHD.

4.2.4 Triassic Rewan Group

The Rewan Group overlies the Permian Coal Measures and is comprised of interbedded mudstone, sandstone, and minor conglomerate. The Rewan Group is commonly found at surface in the interfluves, where alluvial deposits are not present. Near the Project this deposit crops out within the location of the Millennium pit and surrounds the Mavis pit. Regionally, the Rewan Group can reach thicknesses of greater than 600 m. Based on work completed by MatrixPlus (2010) and SLR (2021), where the Rewan Group is present in the Project Area it is less than 100 m thick.

Bore logs in the area suggest that the Rewan Group is dominantly composed of an interbedded siltstone and sandstone lithology. The exact boundary between this unit and the underlying Rangal Coal Measures cannot be determined in the logs due to the similar lithology of the two, though the first coal seam of the Rangal Coal Measures is commonly found at depths between 60 to 150 mbgl.

The upper zone of this Group has been weathered in places; this weathered zone is associated with the colluvial deposits described in **Section 4.2.2**.

4.2.5 Permian Coal Measures

As detailed in **Table 5**, the Permian Coal Measures within the regional setting are the Rangal Coal Measures, Fort Cooper Coal Measures, and the Moranbah Coal Measures, where the Rangal Coal Measures and Fort Cooper Coal Measures underly the Project area and are described further in this section.

4.2.5.1 Rangal Coal Measures

The Rangal Coal Measures Formation consists of interbedded sandstone, siltstone, mudstone, and coal with basal tuff and is up to 70 m thick in vicinity of the Project (MatrixPlus, 2010). The unit is extensive across the Project and are exposed at surface in the vicinity of the Project by thrust faults in the region. The targeted seams for the Project, the Leichardt Seam, the Millennium Seam, and the Vermont Seam, lie within this Formation.

The upper zone of this Formation has been weathered in places; this weathered zone is associated with the colluvial deposits described in **Section 4.2.2**.

4.2.5.2 Fort Cooper Coal Measures

The Fort Cooper Coal Measures underlie the Rangal Coal Measures, and crop out to the west of the Project, within Mavis open cut pit and extends along the strike of the New Chum Creek Fault that separates the Millennium pit and Mavis pit. The unit is comprised of interbedded sandstone, conglomerate, mudstone, tuff, and coal, and can be up to 70 m thick (MatrixPlus, 2010).

The upper zone of this Formation has been weathered in places; this weathered zone is associated with the colluvial deposits described in **Section 4.2.2**.

4.2.6 Structural Geology

The Project is located in the Bowen Basin on the western margins of the Taroom Trough, within a heavily faulted and folded Permian sub-crop. A series of northwest aligned faults displaying throws of up to 80 m disjoint the sedimentary assemblage, with the Fort Cooper and Rangal Coal measures outcropping centrally.

A three-dimensional (3D) seismic survey conducted in 2016 found a major structure present in the Millennium Pit area is the thrust fault in the northern section, with a maximum vertical displacement of 17 m. Associated with this thrust fault are a series of smaller accommodation structures with vertical displacements ranging up to 9 metres (**Figure 11**). Comparatively, in the Mavis north-west area, relatively few structures were identified. In general, the seismic surveys are consistent with the general understanding of the area, with most of the reverse structure strike north-west to south-east, indicating a broadly compressional environment.

5.0 Hydrogeology

This section discusses the hydrogeological units local to the Project, including, where available, groundwater occurrence, recharge and discharge processes, and hydraulic properties. Also provided in this section is a discussion regarding groundwater quality, groundwater use and management, and groundwater monitoring.

5.1 Key Aquifers

The three main hydrostratigraphic units in the vicinity of the Project are:

- The Quaternary alluvial sand of the Isaac River Alluvium, located along Isaac River and New Chum Creek. These are predominantly recharged by rainfall and stream flow infiltration during high streamflow events. Typically, they are high-yielding aquifers (albeit of limited areal extent and depth).
- Quaternary/ Tertiary alluvial and colluvial sediments, an unconfined perched aquifer that is predominantly recharged by rainfall.
- Rangal Coal Measures and Fort Cooper Coal Measures - a semi-confined to confined aquifer with most groundwater flow occurring through the higher permeability coal seam layers. Predominantly recharged through rainfall where the deposit outcrops at surface, or by leakage from alluvium. The siltstones and sandstones that make up the majority of the interburden are considered to act as confining layers, due to their low permeabilities. This unit has historically been mined and will continue to be mined as part of the proposed underground mine.

5.2 Current Groundwater Monitoring at Millennium Mine

The groundwater monitoring network at the Project focuses on the adjacent Tertiary and Permian lithologies to identify changes and potential impacts from mining activity to these aquifers. Groundwater monitoring at the site commenced in 2011 with the installation of the initial suite of monitoring bores, which was extended in 2014 with further monitoring sites appended to the program. A summary of current monitoring bores is provided in **Table 6**, including provision of the monitoring data captured. Previous historical monitoring at bores at the Project site are shown in **Table 7**The locations of each of the bores are shown in **Figure 12**.

Table 6 EA Monitoring Bore Network

Bore Name	Coordinates		Aquifer	Depth	Screen	WL data from:	WL Data to:	WQ data from:	WQ Data to:	Notes	Inclusion GW Monitoring Plan 2023
	Latitude	Longitude		mbgl~							
MB2	-22.03	148.24	RCM# (Coal)	90	72 - 90	Jan 2011	May 2023	Jan 2011	May 2023	Limited data prior 2013, SWL* only after 2013	Quarterly SWL
MB8A	-22.01	148.23	Rewan Group	30	22 - 28	NA^	NA^	NA^	NA^	Bore dry	Quarterly SWL & Quality
MB8B	-22.01	148.23	RCM (Sandstone)	80	62 - 74	Jan 2014	May 2023	Jan 2014	May 2023	WQ 10/2020 only includes pH, EC, Temp, Desc	Quarterly SWL & Quality
MB9A	-22.01	148.24	FCCM+ (Coal)	30	22 - 30	Jan 2014	May 2023	Jan 2014	May 2023	WQ 10/2020 only includes pH, EC, Temp, Desc	Quarterly SWL & Quality
MB9B	-22.01	148.24	FCCM (Sandstone)	80	60 - 74	Jan 2014	May 2023	Jan 2014	May 2023	WQ 10/2020 only includes pH, EC, Temp, Desc	Quarterly SWL & Quality
MB10A	-22.03	148.27	FCCM (Sandstone)	35	27 - 35	Jan 2014	May 2023	Jan 2014	May 2023	WQ 10/2020 only includes pH, EC, Temp, Desc	Quarterly SWL & Quality
MB10B	-22.03	148.27	FCCM - Sandstone	80	64 - 76	Jan 2014	May 2023	Jan 2011	May 2023	WQ 10/2020 only includes pH, EC, Temp, Desc	Quarterly SWL & Quality
CS_MB2	-22.02	148.29	RCM (Coal)	170	161-164	May 2020	May 2023	NA^	NA^	No water quality measurements required.	Quarterly SWL

~ metres below ground level
*SWL=Standing water level
#Rangal Coal Measures
+ Fort Cooper Coal Measures
^ Not Available

Table 7 Historical Monitoring Bore Network

Bore Name	Coordinates		Aquifer	Depth	Screen	WL data from:	WL Data to:	WQ data from:	WQ Data to:	Notes
	Latitude	Longitude		mbgl~						
MB1	-22.02	148.24	Permian Rangal	96	78 - 96	Jan 2011	May 2020	Jan 2011	Apr 2014	Lost to mining end 2014
MB3A	-22.04	148.26	Tertiary Sandstone	30	22 - 30	Jan 2011	Nov 2017	Jan 2011	Nov 2017	Monitoring ceased in 2017
MB3B	-22.04	148.26	Tertiary Sandstone	63	54 - 63	Jan 2011	Nov 2017	Jan 2011	Nov 2017	Monitoring ceased in 2017
MB4	-22.03	148.26	Tertiary Sandstone	35	29 - 35	Jan 2011	Nov 2017	Jan 2011	Nov 2017	Monitoring ceased in 2017
MB5	NA^	NA^	NA^	NA^	NA^	NA^	NA^	NA^	NA^	No monitoring bore infrastructure installed
MB6	-22.01	148.26	Permian Rangal	78	66 - 78	NA^	NA^	NA^	NA^	Only one data point 04/2011
MB7	-22.00	148.25	Unknown	78	60-78	Jan 2011	Apr 2014	Jan 2011	Apr 2014	3 data points only, 2011 & 2014
MB11A	-22.04	148.28	Tertiary Sandstone	0	30 - 35	Jan-14	Nov 2017	Jan 2011	Nov 2017	None
MB11B	-22.04	148.28	Tertiary Sandstone	0	Unknown	Jan-14	Nov 2017	Jan 2011	Nov 2017	None

~ metres below ground level
*SWL=Standing water level
#Rangal Coal Measures
+ Fort Cooper Coal Measures
^ Not Available

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	620.031508
Date:	21-Sep-2023
Drawn by:	AS

Groundwater Monitoring Network
Watercourses
Project Boundary
Mining Lease Boundary

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

MONITORING BORE NETWORK

SLR

FIGURE 12

H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Conceptualisation Report\62003150 8 F12 Monitoring Bore Network.mxd

5.3 Hydraulic Properties

No field testing has been undertaken in the vicinity of the Project, and therefore no site-specific hydraulic data to the Project is available. However, as part of the Moorvale South Project, 4.4 km south-east of Millennium Mine, slug and injection tests were conducted on the major geological units. In addition, two pumping tests were carried out for Moorvale to establish characteristics of the Isaac River alluvial aquifers and the coal seam aquifers of the Rangal Coal Measures (Golder Associates, 2019). This information contributes to the understanding of the connectivity between the deep and shallow aquifers, the interaction between the shallow aquifer and the Isaac River, and the flow dynamics within the aquifers.

Hydraulic testing was also conducted in 2017 for the Olive Downs South groundwater assessment, 8.5 km south of the Project, in the form of core samples for vertical and horizontal hydraulic conductivity (anisotropy), slug testing and packer testing for horizontal hydraulic conductivity, as well as documented airlift yields (SLR, 2019a). Further hydraulic testing was conducted recently for the Winchester South groundwater assessment, 10 km south of the Project (SLR, 2020).

5.3.1 Field Hydraulic Parameters

5.3.1.1 Hydraulic conductivity

Field results for hydraulic conductivity are presented in **Figure 13** and separated by test method given that results can vary based on the analysis undertaken. The results show that the hydraulic conductivity of the alluvium is variable, which reflects the heterogeneous nature of the alluvial sediments. Pumping tests conducted in 2019 as part of the Moorvale South Project assessment (SLR, 2019a) reported hydraulic conductivity values in the range of 2.1 to 2.7 m/day which is in the range of values provided by slug testing previously conducted.

The Rewan Group sediments exhibit a low hydraulic conductivity, typically less than 10^{-4} m/day, similar to the interburden/ overburden material of the Rangal Coal Measures. Two interburden slug tests conducted for the Winchester South Project in 2012 identified bores in the Rewan Group with an unusually elevated hydraulic conductivity of just under 1 m/day, which is thought to be associated with faulting and fracturing in the vicinity of these bores.

The coal seams of the Permian Coal Measures generally record higher hydraulic conductivity than the interburden/ overburden. This is due to the dual porosity of the coal seams, with a primary matrix porosity and a second (dominant) porosity provided by fractures (joints and cleats) and supports the concept of the coal seams themselves forming the dominant groundwater zones of the Permian units.

Moorvale South Project site pumping tests in 2019, performed on the Leichhardt and Vermont Seams, reported hydraulic conductivity ranges between 0.5 to 1.5 m/day, and 0.5 to 1.2 m/day, respectively. These values generally align with previous testing of the Permian coal measures across the Study Area.

Figure 13 shows available field hydraulic conductivity data, summarised for the Winchester South Project (SLR, 2020), including hydraulic test data obtained for the Winchester South Project as well as externally reported hydraulic properties for reference. As evident in **Figure 13**, the hydraulic conductivity of the Rewan Group sediments as well as the Permian Coal Measures, declines with depth. This is due to increasing overburden pressure reducing the aperture of fractures and cleats.

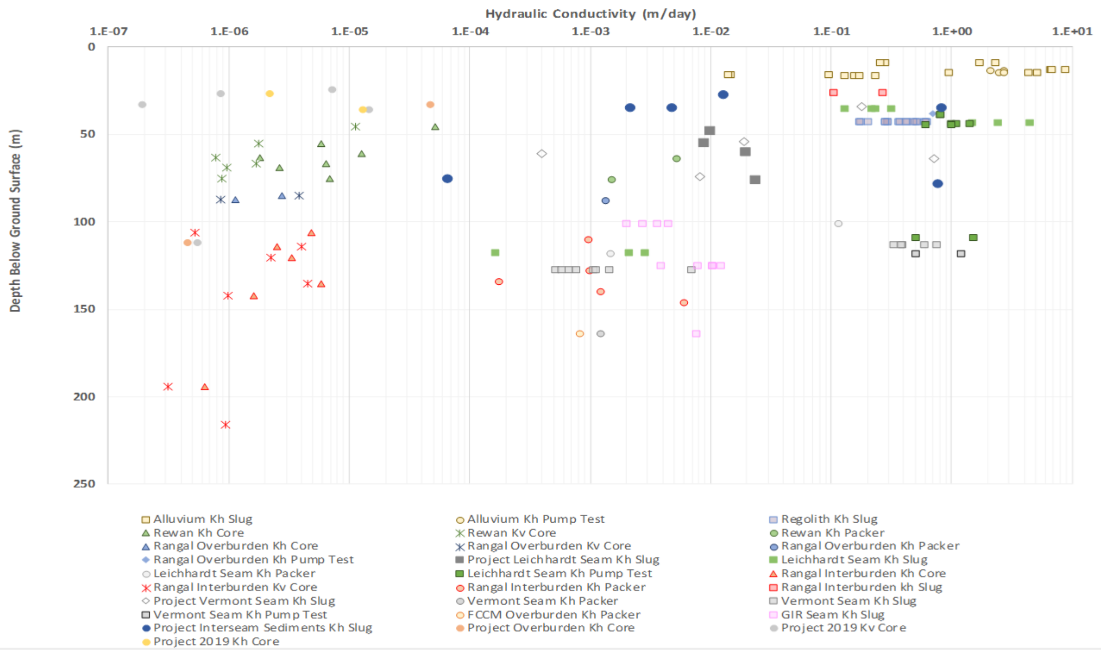


Figure 13 Summary of Hydraulic Testing Results for the Winchester South project (SLR, 2020)

A summary of hydraulic conductivity data from field testing at Caval Ridge Mine, Winchester South Project, Olive Downs Project, and Moorvale South Project, prepared for the Caval Ridge Mine Horse Pit Extension Project (SLR, 2021a), is presented in **Figure 14**. The field results are compared to the range of documented values for the various units in literature.

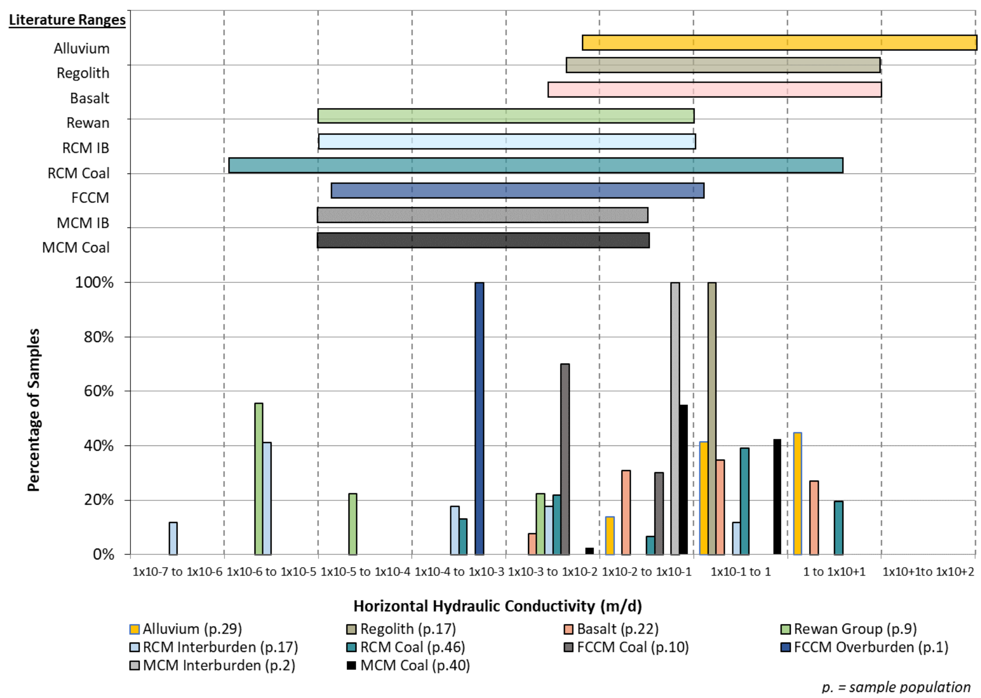


Figure 14 Histogram of Horizontal Hydraulic Conductivity Distribution (from SLR, 2021)

The comparison shows that the field results for alluvium, colluvium, Rangal Coal Measures, and Fort Cooper Coal Measures within the Study area fall within the range of field data collected through other studies across the Bowen Basin. Results from the Moorvale South Project site recorded some lower readings for the Rewan Group than previously identified in literature. A broader range of hydraulic conductivity for the Rangal Coal Measures coal was also observed at the Project area and at the adjacent Moorvale South Project and Olive Downs Project sites than is observed in literature, with values of up to 1.5 m/day (Winchester South Project area) and 4.4 m/day (Moorvale South Project area) reported.

5.3.1.2 Anisotropy

Comparison of horizontal hydraulic conductivity (Kh) and vertical hydraulic conductivity (Kv) indicates that within the Rewan Group the Kv is around 10 to 40 % of Kh. Anisotropy for the Rangal Coal Measures interburden material was more variable, with Kv ranging between 11 and 76 % of Kh. During the Olive Downs Project groundwater assessment, core samples were collected within the coal seam roof/floor material and proximal to fault zones, where practicable (i.e., for competent samples). Results for these samples indicated a Kv of between 50 to 160 % of Kh.

5.3.1.3 Fault zones

To help understand the hydraulic properties of fault zones, analysis of coal seam roof/ floor core samples collected proximal to a fault zone was undertaken for the Moorvale South Project. The samples recorded vertical hydraulic conductivity of around 50 to 160 % of horizontal conductivity. This indicates the faulting may provide either conduits or barriers to vertical flow. It is also noted that areas of increased Kv are limited vertically, with samples collected from the same drill hole at different horizons (interburden and Rewan Group) returning a lower Kv of between 11 and 76 % of Kh. In addition, for the Winchester South Project packer testing was also carried out by on two drill holes that were identified as intersecting fault lines. Reported hydraulic conductivity ranged between 6.93×10^{-5} and 2.07×10^{-3} m/day. These properties indicate that the faulting zones intercepted and tested within the Project Area are ‘healed’ and not pathways for preferential flow.

The impact of faults on groundwater flow within the Study area was also assessed as part of the Bowen Gas Project. Kinnon (2010) assessed the movement of water and gas across a series of faults in the Bowen Basin using stable isotope and water quality analysis to assess zones of potential recharge, water mixing and flow pathways. Higher gas production rates were also observed on either side of a major fault, with differences in isotopic compositions of produced water for wells north and south of the major fault line at similar depths, implying little communication across the fault boundary, and suggesting that the fault acts as a permeability barrier to water and gas flow. The results of the study showed that compartmentalisation was evident and that this was due to the structural geology (faulting) in the basin.

Based on a detailed literature review of the effect of faulting on groundwater flow, Coffey (2014) has developed a conceptual model for fault zone hydraulic characterisation in the Bowen Basin (**Figure 15**), largely based on Jourde *et al.* (2002) and Flodin *et al.* (2001). This conceptualisation provides a means of inferring hydraulic conductivities of the fault core and the fault damage zone from regional hydraulic conductivity, with the fault core typically one to three orders of magnitude lower conductivity.

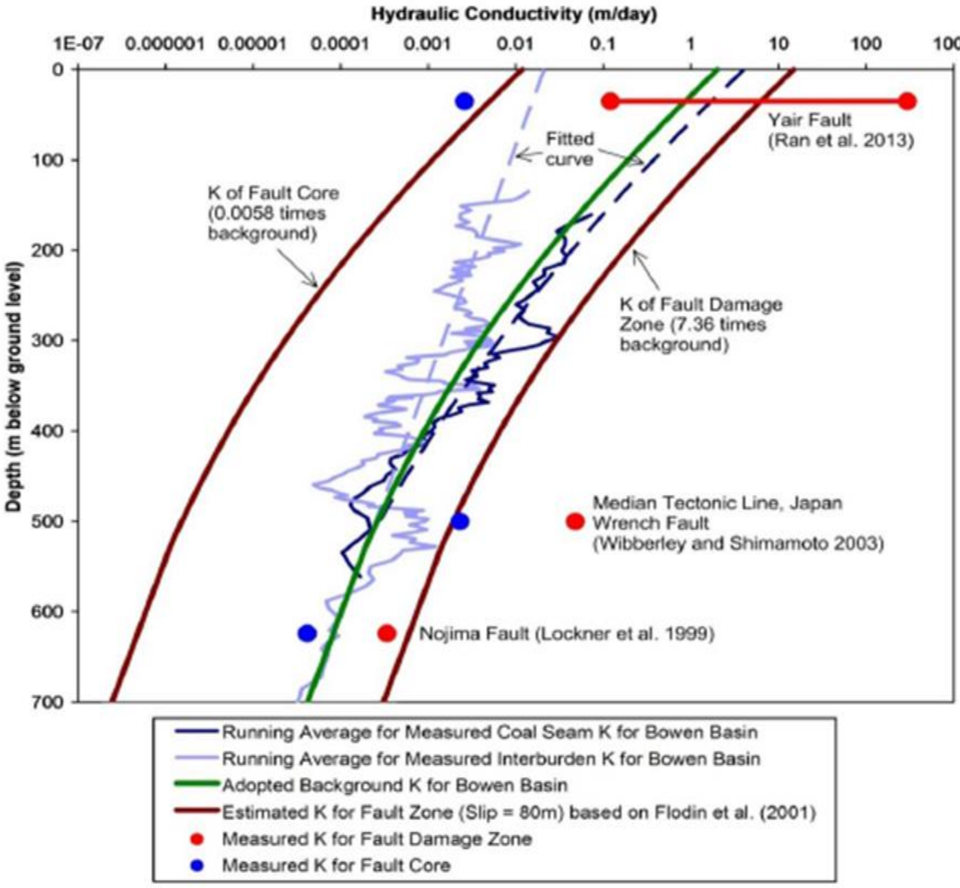


Figure 15 Faulting Conceptual Model Developed by Coffey (2014)

5.3.2 Previously Modelled Hydraulic Parameters

5.3.2.1 Hydraulic conductivity

The final calibrated modelled parameters used in the numerical model for the 2010 groundwater assessment (MatrixPlus, 2010) and subsequent assessments are shown in **Table 8**. The calibrated model parameters for the most recent 2021 groundwater assessment (SLR, 2021) are shown in **Table 9**.

Table 8 Calibrated Hydraulic Conductivity Values (MatrixPlus, 2010)

Model Layer	Final Modelled Parameters (m/d)		Reference
	Horizontal conductivity (Kx = Ky)	Vertical conductivity (Kz)	
Alluvium	10	1	MatrixPlus (2010)
Weathered Tertiary/ Permian	0.3	0.075	JBT Consulting (2015)
Rangal Coal Measures	0.001 to 0.9	N/A	MatrixPlus (2010)
Rangal Coal Measures - Coal Seams	0.2	0.02	JBT Consulting (2015)
Rangal Coal Measures - Interburden	0.02	0.005	JBT Consulting (2015)

Model Layer	Final Modelled Parameters (m/d)		Reference
	Horizontal conductivity (Kx = Ky)	Vertical conductivity (Kz)	
Rangal Coal Measures - Sandstone bands	0.5	0.125	JBT Consulting (2015)
Fair Hill Formation	0.02	0.005	JBT Consulting (2015)

Table 9 Calibrated Hydraulic Conductivity Values (SLR, 2021)

Formation	Unit	Horizontal Hydraulic Conductivity (m/day)	Anisotropy Kz/Kx
Alluvium	Surface cover	12.0	0.2
Regolith	Surface cover	1.0	0.03 to 0.1*
Weathered Permian	Surface cover	0.6	0.06
Duaringa Formation	Surface cover	0.5	0.05
Tertiary Basalt	Tertiary basalt	3.2	0.1
Rewan Group	Triassic	2.0×10^{-3}	0.07
Rangal Coal Measures	Leichhardt overburden	1.0×10^{-5} to 6.0×10^{-3}	0.09
	Leichhardt seam	1.0×10^{-4} to 9.0×10^{-2}	0.002
	Interburden	5.0×10^{-5} to 1.0×10^{-3}	0.1
	Vermont seam	1.0×10^{-4} to 1.0×10^{-2}	0.03
	Vermont underburden	5.0×10^{-5} to 1.0×10^{-3}	0.002
Fort Cooper Coal Measures	Fort Cooper overburden	5.0×10^{-5} to 1.0×10^{-3}	0.1
	Fort Cooper seam	1.0×10^{-4} to 1.0×10^{-3}	0.1
	Fort Cooper underburden	5.0×10^{-5} to 4.0×10^{-1}	0.005
Moranbah Coal Measures	Q Seam	1.0×10^{-4} to 1.0×10^{-1}	0.2
	Interburden	5.0×10^{-5} to 5.0	0.2
	P Seam	1.0×10^{-4} to 5.0	0.05
	Interburden	5.0×10^{-5} to 3.0×10^{-1}	0.04
	H Seam	1.0×10^{-4} to 1.0×10^{-1}	0.007
	Interburden	5.0×10^{-5} to 2.0×10^{-1}	0.06
	D Seam	1.0×10^{-4} to 1.0×10^{-1}	0.03
	Interburden	1.0×10^{-5} to 2.0×10^{-1}	0.005
Faults		5.0×10^{-5} to 1.0×10^{-2}	0.1
Spoil		3.0×10^{-1}	0.2

*Dependent on layer

5.3.2.2 Storage

The final calibrated modelled parameters used in the numerical model for the 2010 groundwater assessment (MatrixPlus, 2010) to support EIS approvals are shown in **Table 10**. Storage values for the alluvium were taken from literature values due to the lack of test data in these deposits. In comparison, the storage values for the Rangal Coal Measures are taken from proximal pumping tests. Note, these pumping tests are not presented in the groundwater assessment, and it is unknown the location or particulars of these.

Table 10 Calibrated storage values from 2010 numerical model (MatrixPlus, 2010)

Model Layer	Final Modelled Parameters	
	Specific Yield (unitless)	Storage Coefficient (unitless)
Alluvium	0.2	1×10^{-4}
Rangal Coal Measures	0.08	4×10^{-4}

5.4 Groundwater Levels, Flow, Recharge, and Discharge

Groundwater monitoring data from the bores listed in **Table 6** and **Table 7** have been reviewed for this study.

Groundwater levels within the alluvial deposits associated with the Isaac River tend to mimic topography and surface water flow. Where sporadic deposits of alluvium/ colluvium are present, the discontinuity of deposits results in perched aquifer systems, with flow within these likely to be controlled by topography.

Bedrock groundwater levels are typically highest where coal seams crop out at surface, and groundwater generally flows down-dip along bedding planes towards the east. The natural groundwater table and flow has been influenced by the depressurisation at the current Millennium Mine and surrounding mines.

5.4.1 Quaternary Isaac River Alluvium

The Quaternary Isaac River Alluvium consists of a heterogeneous distribution of fine to coarse grained sand, interspersed with clay and gravel lenses. These Quaternary sediments are not present over the Project extent, but instead are associated with Isaac River, 4 km to the south-west and North Creek tributary, 2.5 km to the west.

Limited information is available in terms of the unconsolidated, surficial aquifers in the region surrounding the Project. Currently no monitoring bores are installed directly into the Quaternary Alluvium at Millennium Mine. Based on work done by SLR (2019a) for the Moorvale South Project, groundwater elevations along the Isaac River to the south-west of the Project, range between 162 mAHD and 167 mAHD, equating to around 10 to 17 mbgl and follow the south-easterly flow direction of the Isaac River. Higher groundwater elevations closer to ground surface, are recorded in bores positioned closest to the surface watercourses of Isaac River and New Chum Creek. Groundwater levels are beneath the elevation of the Isaac River, when flowing, indicating a losing river system.

It is noted in SLR (2019a) that there is a general lack of response of groundwater levels to rainfall trends in the Quaternary Alluvium, which may either relate to the presence of surficial clays restricting groundwater recharge, or that the amount of rainfall is generally not sufficient to wet the unsaturated zone and provide infiltration of water towards the water table. Groundwater monitoring also suggests limited rainfall recharge to the alluvium, with groundwater levels only responding slightly to the above average rainfall conditions in 2021. In comparison, water levels monitored for the Caval Ridge Mine Horse Pit Extension (SLR, 2021) and Winchester South (SLR, 2020) groundwater assessments suggest that the alluvial levels show a stronger correlation to rainfall; this may indicate the absence or reduction of clay in the shallow subsurface at these downgradient locations.

The alluvium is considered to behave as an unconfined aquifer, with recharge to the alluvial sediments predominantly occurring from leakage from the ephemeral Isaac River and New Chum Creeks during high rainfall and streamflow events. Direct rainfall recharge is likely to be heterogeneous over the areal extent of the alluvium, with limited recharge occurring where low permeability clay sediments are found at surface.

Geological logs indicate the alluvium is underlain by low hydraulic conductivity stratigraphy (i.e., claystone, siltstone, and sandstone), which likely restricts the rate of downward leakage to underlying formations. Localised perched water tables within the alluvium are evident where waterbodies continue to hold water throughout the dry period (pools in the Isaac River and floodplain wetlands) occurring where clay layers slow the percolation of surface water. Where the Isaac River Alluvium is in direct contact with coal seams of the underlying Rangal Coal Measures, a level of hydraulic connection is expected between the two aquifers, with the alluvium likely discharging to the bedrock.

Although limited, available bore yield data suggest flows are highly variable within the alluvial deposits with maximum yields of 4 L/sec observed (MatrixPlus, 2010). However, the Isaac River Alluvium is not laterally or vertically extensive, and therefore, although high yielding, does not form a regionally significant aquifer in the area surrounding the Project. Prolonged, intensive groundwater extraction from this aquifer is unlikely to be sustainable, and excessive pumping is likely to impact significantly on groundwater drawdown across the aquifer.

5.4.2 Quaternary / Tertiary Alluvial and Colluvial Deposits

Quaternary/ Tertiary Alluvium is present close to the Project extent, associated with watercourses. No MetRes monitoring bores are installed directly into the Quaternary/ Tertiary alluvium. One third-party registered number (RN) bore 162550, is registered as monitoring “Quaternary Sediments” of a clayey silt to clayey sand composition and has time series water level data dating back to early 2016. This registered bore is located to the south of New Chum Creek and is approximately 40 m south of MetRes monitoring bores MB10A and MB10B (RN 162248 and RN 162249 respectively). The groundwater level in RN 162550 is approximately 10 mbgl. A comparison of groundwater levels to the CRD plot is shown in **Figure 16**.

The geological map associates RN 162550 with an isolated Tertiary/ Quaternary alluvial deposit, though it is currently unknown if this bore is screening true alluvium or weathered bedrock colluvium (of the underlying Fort Cooper Coal Measures). Either way, the bore indicates the presence of persistent groundwater in the shallow geology within the vicinity of the Project.

MB10A and MB10B both screen the Fort Cooper Coal Measures at depths of between 27 to 35 mbgl and 64 to 76 mbgl respectively, groundwater hydrographs for both are presented in **Figure 16** to compare with the shallow groundwater table at the site with the CRD. Given the apparent lack of impact from mining operations the groundwater occurrence in RN 162550 is likely a localised, perched system that is not in hydraulic connection with the deeper Fort Cooper Coal Measures aquifer. These deposits are not expected to form a significant aquifer in relation to the Project.

This Quaternary/ Tertiary Alluvium material comprises low hydraulic conductivity strata, which restricts rainfall recharge. This is shown by the general lack of response to climatic conditions in RN 162550. This is consistent with observations within colluvial monitoring bores in the nearby Moorvale South and Winchester South project areas, where groundwater levels have remained relatively stable between June 2017 and February 2019, despite above average rainfall (although not substantial) from October to December 2017 and over February 2018. Like the Quaternary Alluvium, mentioned in **Section 5.4.1**, the lack of response in monitoring bores may also be due to rainfall being insufficient to wet the unsaturated zone above the water table as well as providing vertical groundwater flow towards the water table.

Groundwater discharge occurs primarily through evapotranspiration whilst vertical seepage through the regolith is limited by the underlying low hydraulic conductivity Rewan Group and interburden of the Permian Coal Measures.

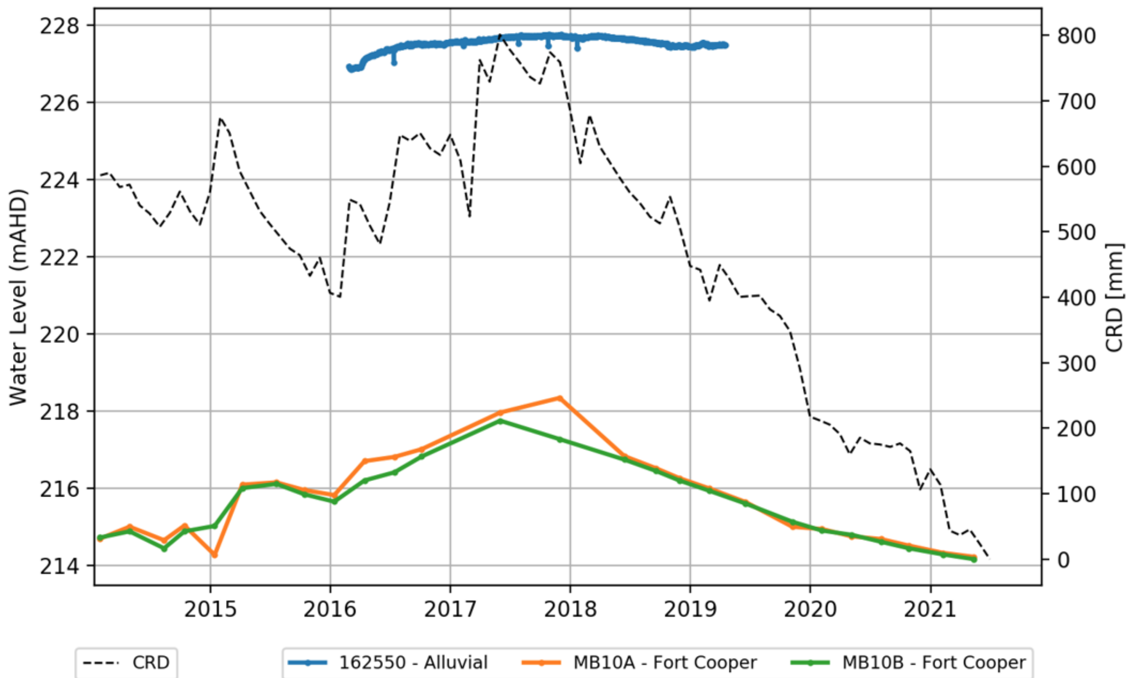


Figure 16 RN 162250, MB10A and MB10B Groundwater Level Hydrographs

5.4.3 Tertiary Suttor and Duaringa Formations

The Suttor Formation and the Duaringa Formation form the local Tertiary sediments, occurring to the north of the Project. These Formations are associated with the topographic high points to the north of the Project, reaching elevations of up to 350 mAHD. Small outcrops of this deposit are encountered to the west and adjacent north of the Project. Rainfall infiltration is expected through this deposit where there are no substantial clay/ claystone barriers in the subsurface.

Five monitoring bores are in this Formation, the hydrographs are shown in **Figure 17**. All five bores ceased monitoring at the end of 2017 with the sale and transfer of the Red Mountain Infrastructure mining lease to BHP. They show a variety of groundwater levels and responses. In the bores monitored since 2011 (MB3A, MB3B, and MB4) an increase in level is observed over the monitoring period with a weak correlation to the CRD and antecedent rainfall conditions, suggesting a level of confinement to this unit.

There are a limited number of registered bores within this hydrostratigraphic unit and therefore it is expected to be low yielding. Where bores exist, they are associated with the upper weathered zone where unconsolidated deposits are present at surface.

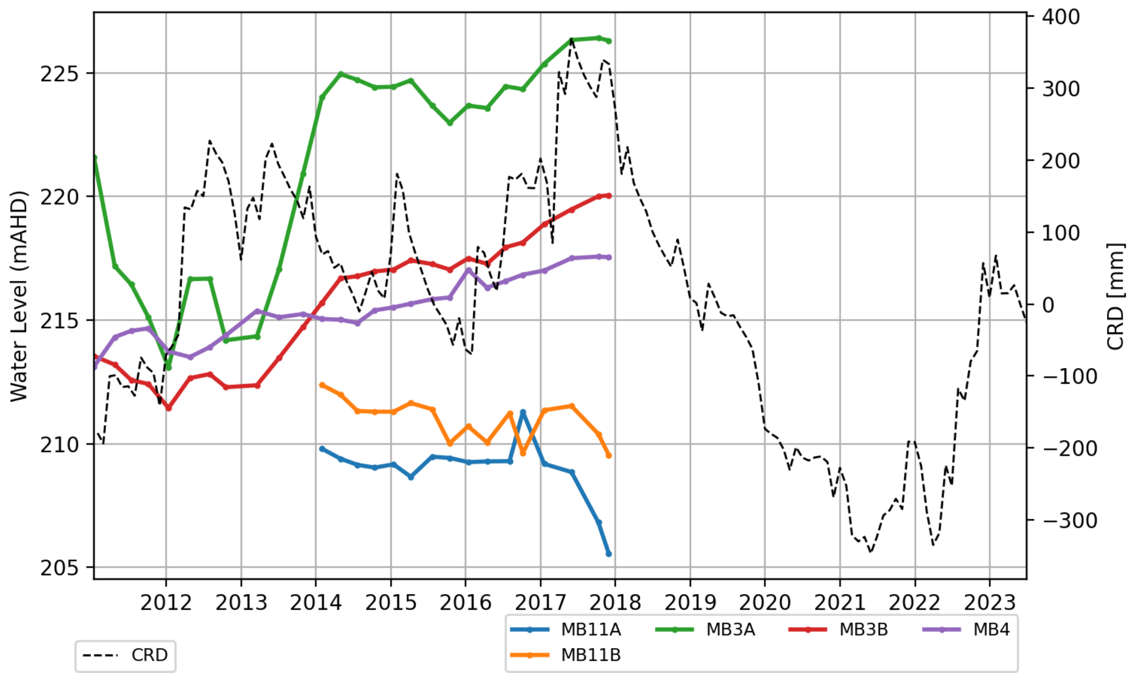


Figure 17 Groundwater Level for Tertiary Sandstone Bores

5.4.4 Triassic Rewan Group

The Rewan Group unit typically has a low permeability due to the abundance of mudstone and is likely to act as confining layer to the underlying Permian Coal Measures, though permeability may increase in areas where sandstone and conglomerate dominate the lithology. Due to the dominance of siltstone and sandstone in the vicinity of the Project, the permeability of the sediment may allow some recharge through the substrate.

MB8A is located within this unit, this bore has shown as historically dry and therefore the hydrogeology of this unit at the Project is unknown. From monitoring of this unit at the nearby Olive Downs Project (8.5 km south of the Project), groundwater elevations in this Group are shown be to relatively stable with increases observed after heavy antecedent rainfall conditions (HydroSimulations, 2018). Groundwater elevations within the Rewan Group are above those recorded within the deeper Permian Coal Measures, indicating a downward hydraulic gradient from the Rewan Group, possibly a result of the depressurisation in the lower unit. The alluvial/ colluvial groundwater levels are above the groundwater levels in the Rewan Group, indicating downward migration of groundwater, restricted by the local permeability of the Rewan Group.

5.4.5 Permian Rangal Coal Measures

The coal seams within the Rangal Coal Measures are typically considered the main aquifer units and may be significantly more permeable that the interburden material of interbedded mudstone, siltstone, and sandstone. Groundwater within these coal measures is considered confined and sub-artesian. The Permian coal seams are classified as a dual-porosity, dual-permeability medium with water stored and transmitted through both the primary matrix porosity and secondary fracture porosity. The hydraulic gradient within the Permian coal measures is primarily downward, however this gradient might reverse with increased depth of cover and pressure, coinciding with the observed decrease in hydraulic conductivity with depth as discussed in **Section 5.3.1**. When groundwater levels are locally reduced in the coal seams due to mining, these interburden units will provide a source of water by vertical leakage into the depressurised coal seams.

Due to folding and faulting in the vicinity of the Project, the Rangal Coal Measures are found either cropping out at surface, at subcrop beneath alluvial deposits, or confined at depth by the Rewan Group. Recharge to these deposits will predominantly occur where the coal seams outcrop or subcrop, in the form of direct rainfall infiltration during high rainfall events when adequate saturation can occur (MatrixPlus, 2010). Additional recharge may occur to the alluvial deposits south of the Project, via leakage from the overlying Isaac River Alluvium and Tertiary deposits where it is in hydraulic connection with the Rangal Coal Measures. Discharge from this unit is dominated by evaporation and groundwater extraction from mining activities.

Groundwater monitoring is currently taking place within this unit at MB1, MB2, MB7, MB8B, and CS_MB2. **Figure 18** presents the reduced water level (RL) for these bores screened in the Rangal Coal Measures, alongside the CRD. Since commencement of the water level record in 2011, a decline in water level is apparent in both MB2 and MB8B bores, attributable to local mining activity within the Rangal Coal Measures. The decline in MB1, located in the Millennium Pit, is not observed to the same extent in MB2, which lies outside of the open cut pit. CS_MB2 has observed a gradual rise and fall in water level from mid 2020 to mid 2023.

Based on regional studies, regional groundwater flow is to the east down-dip along coal bedding planes, consistent with local topography and western outcrop of coal seams between faults. Differences in piezometric heads within the confined coal seam aquifers of the Moranbah Coal Measures drive groundwater flow eastwards across the Bowen Basin, from the slightly more elevated subcrop areas on the western flank of the Basin to the less elevated subcrop areas on the eastern flank (GHD, 2017). The flow regime in the Rangal Coal Measures across the Project has been intercepted by mining, causing local flow towards the open cut pits.

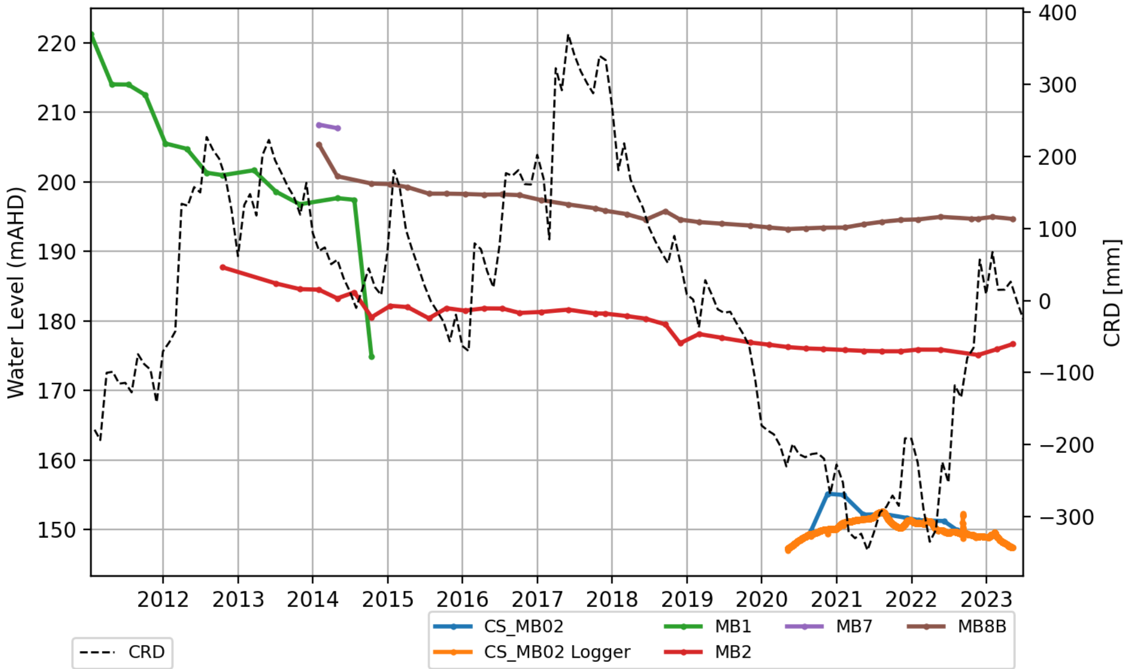


Figure 18 Groundwater level for Permian Rangal Coal Measures bores

The surrounding Permian overburden and interburden sequences typically comprise of low permeability claystones, mudstones, siltstones, and shales that are often confining in nature. Regionally, within the Bowen Basin the overburden/interburden is considered essentially impervious and acts as an aquitard, with exceptions occurring where significant faulting or jointing has occurred and are acting as conduits to flow (AGE, 2014). These lithologies can often provide localised supplies of variable, but typically low yielding and poor-quality, groundwater.

During mining activities at the Mavis Open Cut Pit, interception of 'unexpected' groundwater was noted when an excess of water was found to be impacting on blasting operations, even though groundwater mapping as well as regional and local bore drilling suggests the absence of groundwater at this location. Two reports authored by AGE (2014) and JBT Consulting (2015) were commissioned to determine the origin of this groundwater and the future impacts this groundwater may have on mining activities. These reports and their results are described individually in more detail below.

5.4.5.1 Millennium Mine, Mavis Pit – Groundwater Review (AGE, 2014)

This study was commissioned due to encounters with groundwater in the overburden above the Leichardt Seam along the highwall of the Mavis Pit interfering with the efficiency of blasting. The purpose of the investigation was to identify the likely cause for the high groundwater levels and to identify possible options to mitigate their continued presence in this area.

Where possible, groundwater levels were measured in existing boreholes and at blast holes. Groundwater levels ranged between 200 mAHD and 215.6 mAHD, with pit floor levels between 200 to 202 mAHD. Drilling within the Mavis Pit had indicated no groundwater was intersected above the Leichardt Seam and that the seam itself was dry.

Fourteen holes were drilled to approximately 70 mbgl to investigate further. All but one of these holes was found to be dry during drilling. Subsequent monitoring saw a stabilisation of groundwater levels in some bores. Water levels indicated the presence of a groundwater mound approximately midway along the highwall of the existing Mavis Pit. The groundwater mound is 20 to 30 m higher than the groundwater levels previously measured in the in-pit blast holes.

The source of the groundwater resulting in the identified groundwater mound is not clear, although is potentially attributed to localised faulting (extensive faulting known in this area) and recent high rainfall facilitating recharge. Alternatively, it was proposed that it could be a result of infiltration of surface water runoff from topographically elevated areas into ‘more permeable’ sediments that make up and/ or underlie these areas.

5.4.5.2 Mavis Pit E30a Extension Groundwater Seepage Assessment (JBT Consulting, 2015)

This study was commissioned to undertake a detailed groundwater seepage assessment from the Southern Void, prior to extension mining of the ‘E30a and E30 Future Mining Area’ beyond the existing Mavis Pit to the south-west (located within the defined Southern Void Mining Exclusion Zone).

Initial evaluations considered the Southern Void “as built” to be acting as a water storage structure. Therefore, the purpose of this assessment was to calculate a predicted rate of seepage from this structure, to define appropriate monitoring, and determine seepage mitigation measures to reduce likelihood of mine affected water entering sensitive areas (i.e., New Chum Creek). The following were undertaken as part of this seepage assessment:

- Two cross-sectional models were constructed in Seep/W software to undertake a detailed groundwater seepage assessment within the known hydrogeological systems that occur at the Project (Quaternary Alluvial, Tertiary, Triassic, and Permian aquifers). Calculation of the rates (L/sec) of seepage based on numerous scenarios to correlate with variation in mining progress and relative levels of voids. A water level range of 190 mAHD to 230 mAHD at increments of 10 m was assessed.
- Determination if the full storage volume level of the Southern Void would be impacted upon due to the proximity of the proposed mining blocks, and a calculation of the likely seepage during mining.

A summary of the two cross-sectional models is provided in **Table 11**.

Table 11 Summary of Groundwater Models in JBT Consulting (2015)

Model	Locality	Purpose	Summary of Findings
Model 1	Oriented southeast-northwest, extending from the Southern Void to the Mavis Pit through the deepest area of the E30a extension	Investigate the change in seepage rate to the Mavis Pit endwall due to changes in the water level within the Southern Pit	Predicted inflow rates from each proposed scenario (i.e., if water level in Southern Void = RL 210 mAHD the development of the E30a mining block will result in an increase in seepage rate to the Mavis Pit from 0.9 L/sec to 1.1 L/sec. RL = 220 mAHD, seepage 1.5L/sec, etc) Majority of seepage occurs through the coal seam (generally accounting for 80%)

Model	Locality	Purpose	Summary of Findings
			At high water levels in the Southern Void, significant seepage is noted through the weathered zone.
Model 2	Oriented northeast-southwest, extending from the Southern Void in a southwest direction towards New Chum Creek	Investigate changes in groundwater level beneath New Chum Creek due to changes in water level in the Southern Void	No scenario modelled resulted in discharge of seepage water to New Chum Creek.

Seep/W software represents the water content and drainage properties of different geological materials. However, this only considers the total drainable volume (specific yield), and the rate at which drainage is allowed to occur. Site-specific hydraulic data was not available for this assessment, as such the study used estimates and regional Bowen Basin coal mine data to provide hydraulic conductivity and specific yield for the lithologies. A sensitivity analysis was undertaken to account for these literature values.

Review of the model results reveals that majority of the seepage occurs through the coal seam (Leichhardt Seam) that extends from the base of the Southern Void to the base of the Mavis Pit, with seepage via the coal seam accounting for more than 80 % of the total seepage through the face. At high water levels in the Southern Void, significant seepage is noted through the weathered zone. This supports the conceptual model of the Rangal Coal Measures suggesting the majority of groundwater flow is encountered in the permeable coal seams and upper weathered portion at surface.

5.4.6 Permian Fort Cooper Coal Measures

Recharge to the Fort Cooper Coal Measures is predominantly through permeation of direct rainfall and stream flow infiltration from the ephemeral New Chum Creek during periods of high rainfall events where it outcrops at surface to the west of the Project.

Figure 19 show the hydrographs for monitoring bores screening the Fort Cooper Coal Measures, compared with the CRD. Water levels in all bores, except MB9B, are showing slight long-term decline post 2018, which is likely commensurate with below average annual rainfall (downward sloping CRD trend) and in response to active mining and associated dewatering. This is followed by a rise corresponding to an upward trend in CRD from late 2022. This geology is not currently, or will be, dewatered, though depressurisation of the above coal seams in the Rangal Coal Measures may influence some loss of water from this unit. In contrast to other bores, MB9B shows a unique water level trend with an overall steady rise in water level over time. Bore MB9B shows a groundwater level recovery since observations stared, including over the last five years, with the rate of increase slowing down over the last three years, and tending towards a plateau around 221 mAHD. A mining impact is likely; however, it relates to water level recovery rather than water level drawdown (SLR, 2023b).

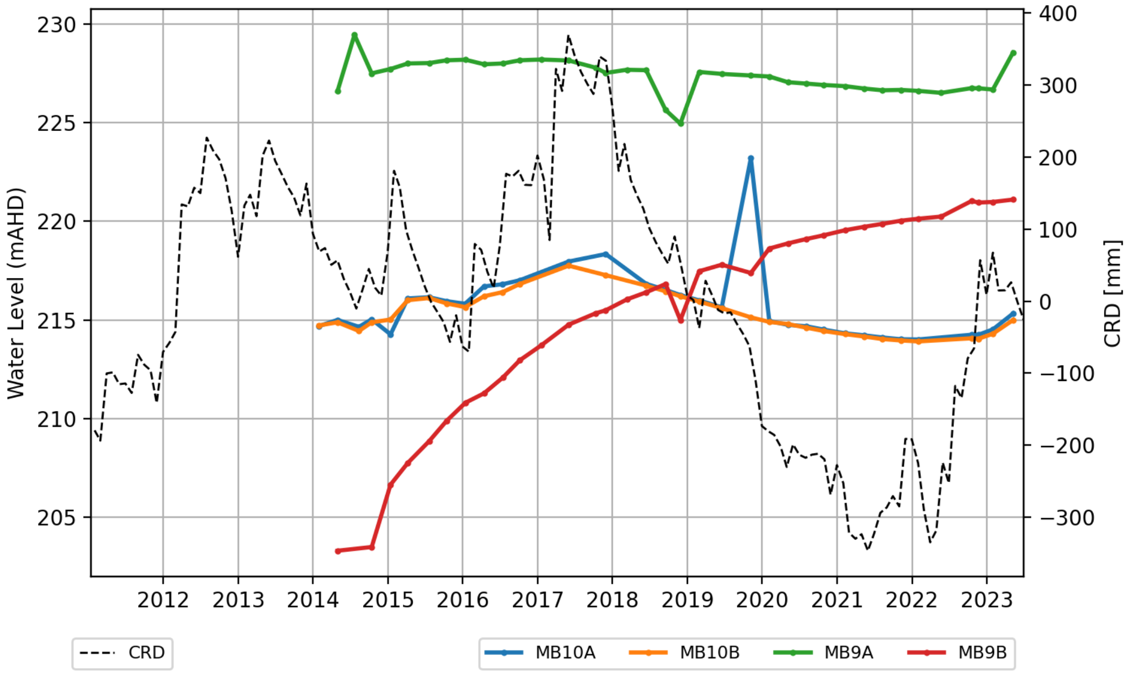


Figure 19 Groundwater Level for Fort Cooper Coal Measures bores and CRD

5.4.7 Groundwater – Surface Water Interaction

In central Queensland, highly seasonal rainfall results in intermittent stream flow, limited groundwater recharge, and deep groundwater tables. In this environment, the most appropriate way to assess surface water and groundwater interaction is by comparing stream stage elevation data to the underlying groundwater elevation in a nearby monitoring bore.

At Millennium Mine, the key surface water drainage feature is New Chum Creek. Stream flow monitoring is shown in **Figure 8**, **Section 3.2.2**, no stream level is recorded in this Creek. Limited alluvial sediments are associated with New Chum Creek; where these do exist, they form small, isolated pockets of deposit. A shallow groundwater table is observed within these deposits of approximately 10 mbgl, far below the base of the channel indicating limited hydraulic connection between groundwater and surface water of the New Chum Creek. In peak rainfall events when the channel flows some leakage of water to the underlying sediments to the water table is expected. In addition, scenario modelling completed by JBT Consulting (2015, see **Section 5.4.5.2** for more details), to investigate changes in groundwater level beneath New Chum Creek due to changes in water level in the Southern Void, found that no scenario modelled resulted in interaction between the mine and New Chum Creek.

The Isaac River is the predominant surface water feature regionally; however, it is not considered local to the Project. Studies conducted on the Isaac River indicate that is functions as a losing system, with stream-stage above that of the local groundwater. Occasional periods of baseflow to the Isaac River from the underlying alluvium may occur after prolonged rainfall events or following flood events. Under these conditions, recharged alluvial sediments will drain to the Isaac River as the hydraulic gradient reverses and sustains streamflow for a short period after the rainfall event.

5.5 Groundwater Quality

This section reports on the chemical characteristics and resulting possible beneficial uses of groundwater within the various geological units across the wider Project area. The main units include alluvium, colluvium, interburden (sandstone/siltstone) and coal of the Permian aged coal measures. Historical water quality monitoring for monitored parameters are presented in **Appendix A**.

5.5.1 Data Availability

The available MetRes groundwater quality data is variable across the hydrogeological units. A summary of the water quality record is as follows:

- Quaternary Alluvium: there are no water quality data available for this formation.
- Tertiary Sandstone: there are no water quality data available for the bores monitoring the Tertiary Sediments post-2017. Prior to this, data is available from five bores (MB3A, MB3B, MB4, MB11A, and MB11B) since 2011.
- Rangal Coal Measures: three bores (MB2, MB8B, and CS_MB2) monitor the Rangal Coal Measures, however, quality data is extremely limited. Three water quality measurements are available for MB2 between 2011 and 2017. Data for MB8B is available from 2014.
- Fort Cooper Coal Measures: quarterly monitoring for four bores (MB9A, MB9B, MB10A, and MB10B) for water quality from early 2014 to present day.

5.5.2 EA Water Quality Triggers

The DES (2021) guideline '*Using monitoring data to assess groundwater quality and potential environmental impacts*', the water quality triggers presented in EA EPML00819213 have been reviewed in consideration of the Water Plan (Fitzroy Basin) 2011 Water Quality Objectives (DEHP, 2013), ANZECC (2000) criteria (ANZG, 2018), and site-specific conditions.

MB8A has been found dry since installation and no water level or quality data is available. MB2 is only recording water level data. For the five remaining existing bores with a sufficiently long data set (MB8B, MB9A/B and MB10A/B), the 95th percentile for the relevant parameters has been selected as the compliance trigger. A full set of water quality timeseries with the 95th percentile, together with the WQO and ANZG, 2018 guideline values is presented in **Appendix B**. For most parameters and bores, the 95th percentile is either significantly above or below the guideline values. In either case, the guideline value would not be able to capture the trend of the data, which is why the statistical approach has been chosen.

An exception to the statistical approach are:

- pH, for which a uniform trigger range of 6.0 to 7.5 pH units (as per current EA) was adopted.
- Hydrocarbons: TPH limits for two fractions (C6-C9 and C10-C36) were taken from the Guideline Model water conditions for coal mines in the Fitzroy basin (DES, 2013).

An investigation would be required when three consecutive exceedances of the proposed bore specific trigger are recorded.

The Project is located in the Isaac Groundwaters area of the Fitzroy Basin, specifically in Groundwater Quality Zone 34. The management objective of the Water Plan (Fitzroy Basin) 2011 is to maintain the 20th, 50th, and 80th percentile water quality results in order to preserve or enhance groundwater quality for its recognised uses. The 80th percentile for each parameter provides a suitable trigger value to assess significant change in that parameter.

For the parameters which are not included in the Fitzroy Basin WQO (DEHP, 2013), guideline values for the relevant groundwater uses from the Australian and New Zealand Fresh and Marine Water Quality Guidelines (ANZG, 2018) were adopted. The relevant groundwater uses for the Project, identified below in **Section 5.6.4**, include ecosystems, irrigation, and stock water supply, therefore the most conservative value for each water quality indicator (Slightly-Moderately Disturbed Aquatic Ecosystem) has been recommended as a trigger. Remaining parameters for which a necessary trigger update was not identified were assigned the currently approved (EA EPML00819213) trigger value.

The 80th percentile will be used as an internal trigger limit to detect any potential trends before the compliance limit is reached.

Table 12 EA compliance triggers for the existing bores

<table>
<tr><th>Group</th><th>Parameter and unit</th><th>MB8A</th><th>MB8B</th><th>MB9A</th><th>MB9B</th><th>MB10A</th><th>MB10B</th></tr>
<tr><td rowspan="3">Field parameters</td><td>EC (µS/cm)</td><td>8,910</td><td>24,240</td><td>20,329</td><td>16,000</td><td>3,998</td><td>10,265</td></tr>
<tr><td>pH (pH units)</td><td colspan="6">6.0 to 7.5</td></tr>
<tr><td>Cl (mg/L)</td><td>3,185</td><td>8,520</td><td>6,785</td><td>5,905</td><td>789</td><td>5,905</td></tr>
<tr><td rowspan="9">Metals</td><td>Ag (mg/L)</td><td colspan="6">Below LOR</td></tr>
<tr><td>Al (mg/L)</td><td colspan="6">0.055</td></tr>
<tr><td>As (mg/L)</td><td colspan="6">0.013</td></tr>
<tr><td>Cu (mg/L)</td><td colspan="2">0.0014</td><td>0.0002</td><td colspan="3">0.0014</td></tr>
<tr><td>Hg (mg/L)</td><td colspan="6">0.0006</td></tr>
<tr><td>Mo (mg/L)</td><td colspan="6">0.034</td></tr>
<tr><td>Sb (mg/L)</td><td colspan="6">0.009</td></tr>
<tr><td>Se (mg/L)</td><td colspan="6">0.011</td></tr>
<tr><td>Zn (mg/L)</td><td>0.008</td><td>0.317</td><td>0.06</td><td>0.008</td><td>0.06</td><td>0.008</td></tr>
<tr><td rowspan="2">TPH</td><td>C6-C9 (mg/L)</td><td colspan="6">0.02</td></tr>
<tr><td>C10-C36 (mg/L)</td><td colspan="6">0.1</td></tr>
</table>

5.5.2.1 pH

Table 13 presents the minimum, 20th percentile, median, 80th percentile, and maximum of the field pH for groundwater in the Tertiary Sediments, the Rangal Coal Measures, and the Fort Cooper Coal Measures. The field pH is considered the more accurate measurement, as pH has a short holding time for laboratory analysis. The groundwater from all units is typically neutral to weakly alkaline, with median pH values of 6.97 to 7.56 for all units.

Table 13 Statistical Summary of pH Observations

Unit	Number of Observations	Minimum	20th percentile	Median	80th percentile	Maximum
Tertiary Formations	113	6.68	7.07	7.56	8.06	8.83
Rangal Coal Measures	61	6.34	6.81	6.97	7.35	8.50
Fort Cooper Coal Measures	140	6.11	6.82	7.02	7.50	8.12

5.5.2.2 Electrical Conductivity

Electrical conductivity (EC) isa measure of the salinity level in water. **Table 14** presents the minimum, 20th percentile, median, 80th percentile, and maximum values of the field EC for groundwater in the Tertiary (Suttor and Duaringa Formations), the Rangal Coal Measures, and the Fort Cooper Coal Measures.

Table 14 Statistical Summary of the EC (µS/cm) Observations

Unit	Number of Observations	Minimum	20th percentile	Median	80th percentile	Maximum
Tertiary Formations	113	2,020	3,012	3,390	5,234	9,750
Rangal Coal Measures	41	1,560	9,655	21,220	22,600	24,400
Fort Cooper Coal Measures	135	3,140	3,804	9,550	17,356	20,600

Long-term time series plots of EC, shown in **Figure 20**, **Figure 21**, and **Figure 22**, show an overall relatively stable tend over time for all units. A few outliers are observed and are considered to be unrepresentative; these may be the result of an erroneous measurement or a human database error. Bore MB9B shows a significant jump in EC in early 2018 (**Figure 22**). This bore also showed unique water level data with an overall steady rise in water level over time compared to steady decline in all other Fort Cooper Coal bores (**Figure 19**). MB10B has shown a gradual increase in EC over the history of monitoring, with the last four measurements being above the EA trigger level (shown against EA EC trigger in **Appendix A**), indicting an exceedance.

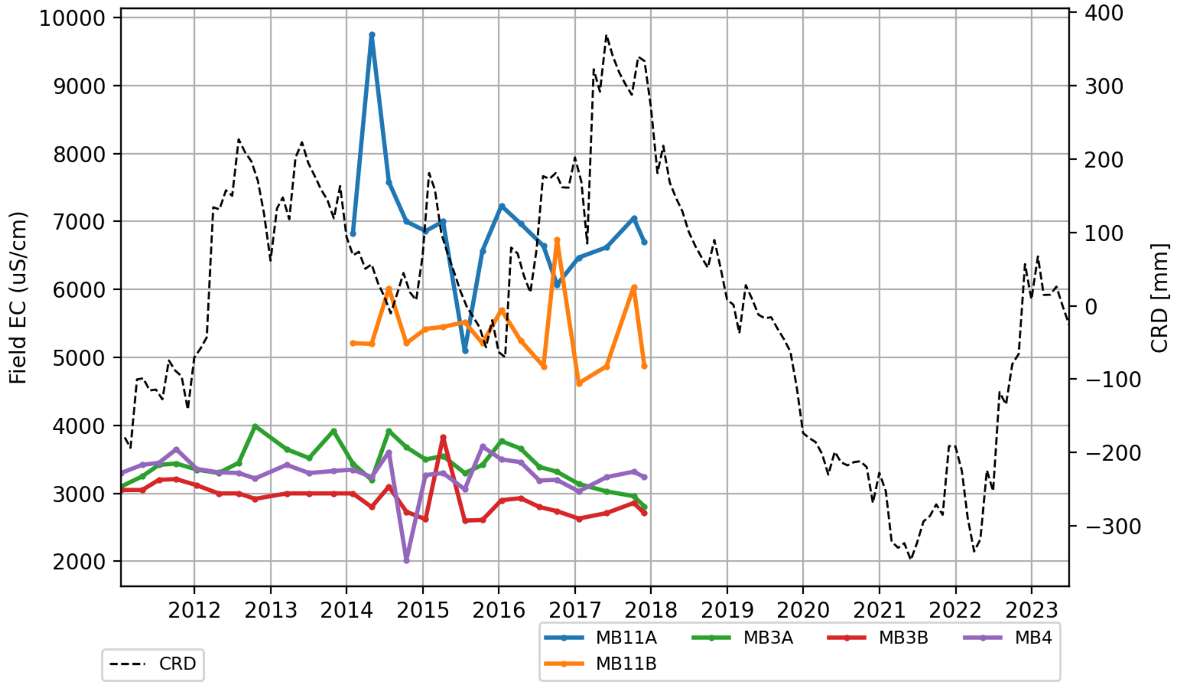


Figure 20 Timeseries EC for Tertiary monitoring bores, with CRD

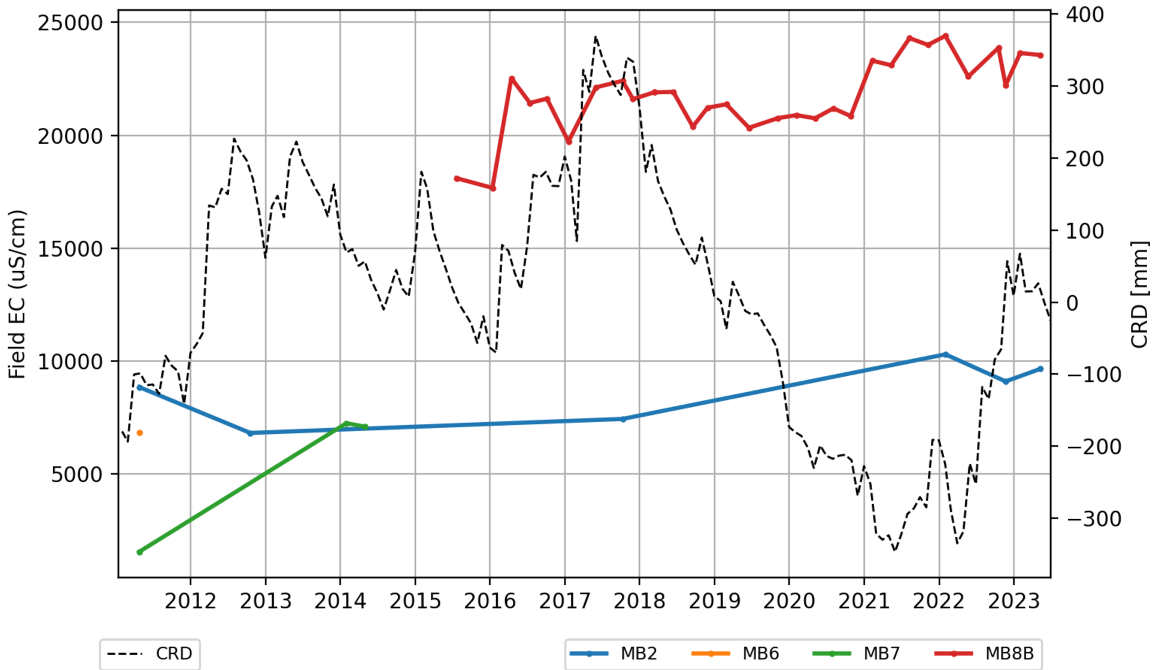


Figure 21 Timeseries EC for Rangal Coal Measures monitoring bores with CRD

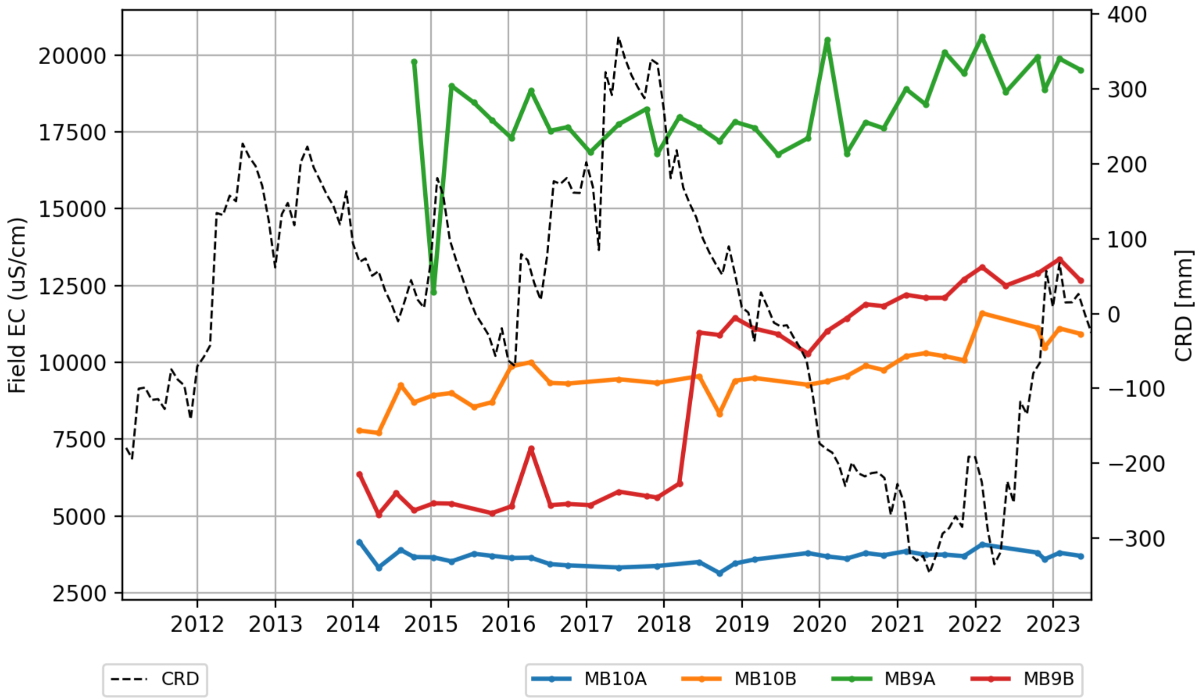


Figure 22 Timeseries EC for Fort Cooper Coal Measures monitoring bores, with CRD

5.5.2.3 Metals and metalloids

Since the implementation of the new EA water quality limits in March 2023 no exceedances have been observed. However, the historical dataset suggests that the following bores display spike concentrations above the EA trigger limits, including:

- Dissolved aluminium in bores MB8B (in 2020), MB9A, MB9B, and MB10A (latter three in 2022); and
- Dissolved antimony in MB8B (in 2016).

5.5.2.4 Hydrocarbons

Analysis of hydrocarbons can indicate the presence, source and extent of organic contamination based on concentrations of different carbon fractions.

In order to assess the condition of the groundwater, the hydrocarbon data has been compared to the EA limits. Hydrocarbon data is presented as minimum, 20th percentile, median, 80th percentile, and maximum values for the Tertiary Formations, Rangal Coal Measures, and Fort Cooper Coal Measures in **Appendix B**.

Maximum values recorded have exceeded EA limits since 2023 for:

- C6 – C10 Fraction in MB8B, MB9B, and MB10B. The deeper bores (B series) tend to have higher concentrations of the C6 – C10 fraction.
- C10 – C40 Fraction in MB8B, MB9A, MB9B. This correlated to a spike in all three bores in late 2022. Spikes are often seen in all bores (excluding MB10B).

5.5.3 Water Type

The ionic composition on a bore-by-bore basis is presented in the Piper diagrams (**Figure 23**). Monitoring bores are visualised based on the aquifer type – (a) Fort Cooper, (b) Rangal and (c) Tertiary. For the Fort Cooper and Rangal seams, the majority of the bores are of sodium (Na) and potassium (K) cation dominance with proportionally higher concentrations of chloride type anions (Cl). Monitoring bores with screened intervals in the Tertiary show lower concentrations of Na cations and Cl anions and is dominated by a 'mixed type' water signature. Temporally, the data points for bore are relatively stable in position on the plot indicating no significant changes in water type identified in the bores over the monitoring history.

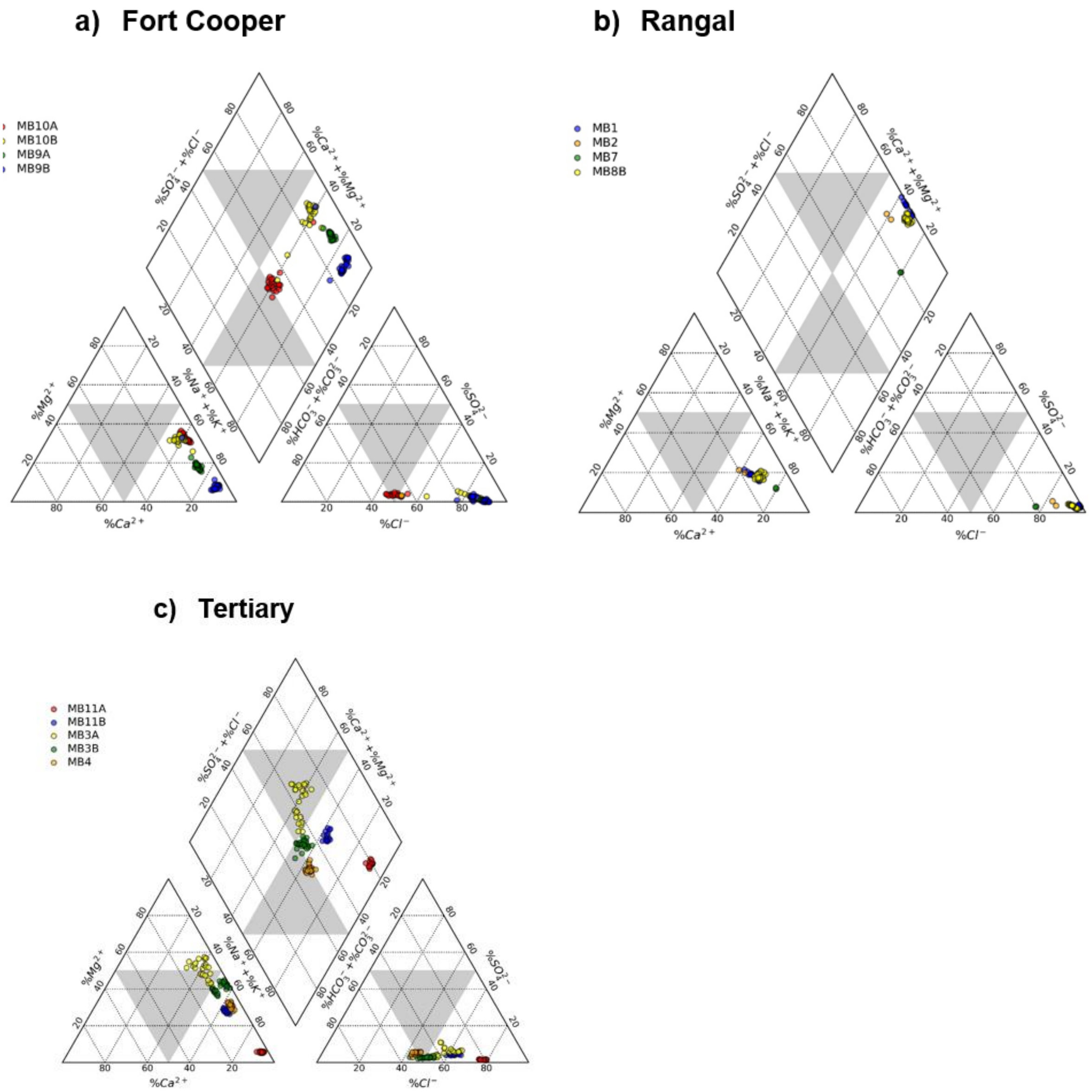


Figure 23 Piper Diagrams by Geology

5.6 Groundwater Users

5.6.1 Groundwater Dependent Ecosystems

Ecosystems that rely on groundwater to maintain their structure and function are classified as Groundwater Dependent Ecosystems (GDEs). The GDE Atlas developed BoM provides high level mapping for surface and sub-surface GDEs, based on national-scale analysis and regional studies. The Atlas contains information about three types of ecosystems:

- Terrestrial GDEs are ecosystems dependent on the sub-surface presence of groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their vegetation communities.
- Aquatic GDEs are ecosystems that rely on the surface expression of groundwater. This includes surface water ecosystems which may have a groundwater component, such as rivers, wetlands, and springs. Marine and estuarine ecosystems can also be groundwater dependent, however these are not mapped in the BoM Atlas.
- Subterranean ecosystems, includes cave and aquifer ecosystems (stygofauna).

The first two categories may overlap in riparian zones where vegetation may access groundwater in the subsurface but also via its surface expression during overbank flooding of streamflow sourced from baseflow.

A review of the Atlas has been undertaken and the findings relevant to the Project described in the following sections.

5.6.1.1 Terrestrial GDEs

Potential terrestrial GDE's have been identified both regionally and locally to the Project from national assessment, as shown on **Figure 24**. This data is not based on focused studies in the region and consequently comes with an inherent level of uncertainty.

For vegetation to access groundwater in the subsurface, the roots must be able to reach the capillary zone above the water table at some time during the plant's life cycle. A widely adopted rule of thumb is that vegetation use of groundwater is likely where depth-to-water (DTW) is 0 to 10 mbgl, possible at depths of 10 to 20 mbgl, and unlikely at depths of >20 mbgl (Doody, 2019). However, vegetation use of groundwater from greater depths should not be ruled out. Vegetation communities that are solely reliant on shallow soil moisture are not terrestrial GDEs. Those that access perched groundwater are terrestrial GDEs but may not be priority terrestrial GDEs for the purpose of this method if the perched groundwater is not connected to groundwater in the target formation(s).

Due to the combination of the saline nature and depth to groundwater in the local aquifers (Rangal Coal Measures and Fort Cooper Coal Measures) it is not thought likely that these aquifers are valuable resources for GDEs. Temporary perched aquifers present after high rainfall events (i.e., when flow is observed in the ephemeral waterways) in the surficial sediments may be responsible for servicing the water needs of terrestrial vegetation communities over a short period of time, consequently rendering them GDEs. However, given the lack of connection between these perched temporary groundwater systems and mining operations it is unlikely that any impact to GDEs would be incurred because of mining.

5.6.1.2 Aquatic Ecosystems

Potential aquatic GDEs based on the BoM GDE Atlas are presented in **Figure 24**. High potential aquatic GDEs are associated with higher order streams, such as the Isaac River to the south-west of the Project. Given the disconnect between the Projects mining activities and these larger watercourses, the regional potential aquatic GDEs are not considered dependent on or related to mining activities.

Wetlands of high ecological significance within a 50 km radius of the Project. Minor wetlands are evident to the south-east of the Project (**Figure 24**).

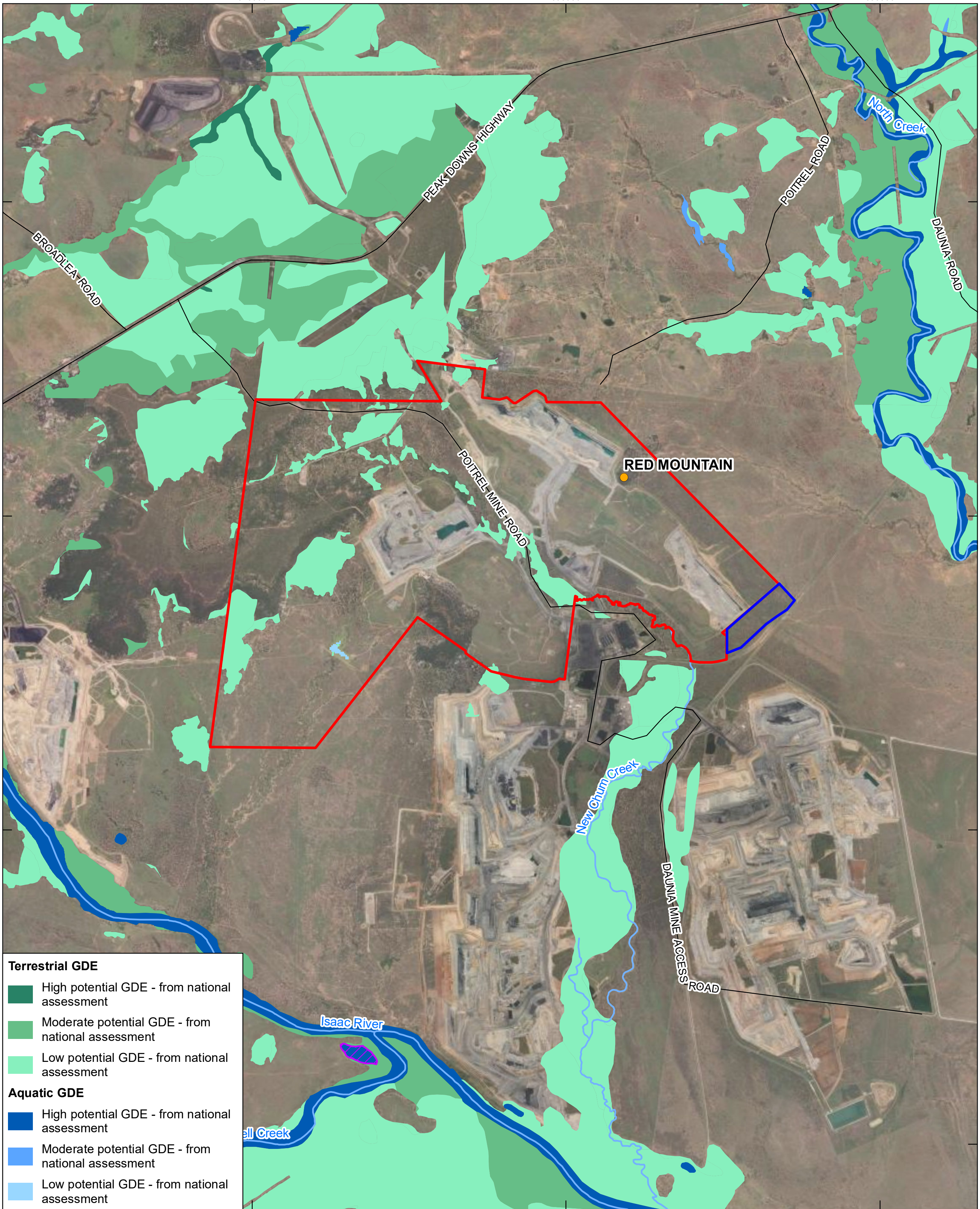
5.6.1.3 Subterranean GDEs

GDE aquifers have the potential to support subterranean fauna (stygofauna). It is expected that the potential for aquifers in the Project Area to support high stygofauna diversity are low. This is due to salinity levels in the vicinity of the Project being high, shown be elevated EC values above 5,000 µS/cm. According to Hancock and Boulton (2008), most stygofauna collected from alluvial aquifers in New South Wales and Queensland prefer salinities less than 5,000 µS/cm. Hose et al. (2015) reported that the salinity range for aquifers in the Bowen Basin that yielded stygofauna was 342 µS/cm to 9,975 µS/cm (Hose et al., 2015). The GDE atlas indicates no occurrence of potential subterranean GDEs in or around the Project site.

5.6.2 Springs

A spring vent is a point where there is a surface expression of groundwater, with groundwater flow occurring intermittently or continuously. The Queensland Government maintains an inventory of identified springs in the Queensland Springs Database (DES, 2019). No springs have been identified within the Project Area within a 50 km radius of the Project.

A search of the EPBC Act ‘Protected Matters’ database (DEE, 2019) found that there are no Internationally or Nationally Important Wetlands within the Project Area. The closest wetlands of international importance are located approximately 190 km south-east of the Project and include those of the Shoalwater and Corio Bays Area. Lake Elphinstone is the closest nationally important wetland, located 50 km north (upstream) of the Project. Due to their distance from site, no internationally and nationally important wetlands will be impacted by the Project.



0 0.5 1 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	620.031508
Date:	18-Jul-2023
Drawn by:	AS

Roads
Watercourses
Wetlands of High Ecological Significance
Project Boundary
Mining Lease Boundary

MAVIS SOUTH UNDERGROUND EXTENSION
GROUNDWATER IMPACT ASSESSMENT

GROUNDWATER DEPENDENT ECOSYSTEMS

SLR

FIGURE 24

H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Conceptualisation Report\620031508 F23 Groundwater Dependent Ecosystems.mxd

5.6.3 Landholder Bores

A survey of landholder bores has previously been undertaken as part of the Millennium Mine EIS (MatrixPlus, 2010) and included data from the public database run by RDMW as well as unregistered landholder bores in the vicinity of Millennium Mine, identified in the bore census undertaken for the Poitrel EIS (EPA, 2005). Details on bore construction and lithologies is limited for the unregistered landholder bores identified in the Poitrel EIS (EPA, 2005) bore census. Many of the landholder bores identified in the Millennium Mine EIS (MatrixPlus, 2010) have since been destroyed as a result of mining activity or are no longer utilised for water supply.

A summary of private bores identified in the Millennium Mine EIS (Matrix Plus, 2010) and their updated use status is provided in **Table 15**. The spatial distribution of landholder bores is shown in **Figure 25**. The updated landholder bore data suggests there is minimal use of groundwater surrounding the Project.

Table 15 Landholder Bores

RN	Drill Date	Eastings (GDA94)	Northings (GDA94)	Depth (m)	Screened Aquifer	Use Status
81909	17/12/1994	620090	7573318	60	Rewan Group	In use
105427	22/04/2004	629841	7570637	100	Rewan Group	In use
13040284	02/09/2004	620264	7566309	19	Rangal Coal Measures	Unknown
105677	13/06/2005	622136	7573306	67.7	Tertiary Basalt	In-use
131002	18/11/2005	621997	7574302	63	Tertiary Basalt	Unknown
141157	27/04/2007	639587	7560479	66	Rangal Coal Measures	No longer used
Bore 1	Unknown	628740	7546688	Unknown	Rangal Coal Measures	Unknown
Bore 2	Unknown	621970	7552907	Unknown	Rangal Coal Measures	No longer used
Bore 3	Unknown	627714	7556752	Unknown	Quaternary Alluvium	No longer used
Bore 4	Unknown	630297	7558574	Unknown	Rangal Coal Measures	No longer used
Bore 5	Unknown	632495	7559750	Unknown	Rangal Coal Measures	No longer used
Bore 6	Unknown	634350	7556563	Unknown	Rangal Coal Measures	No longer used
Bore 7	Unknown	637519	7552624	Unknown	Rangal Coal Measures	No longer used
Bore 8	Unknown	640189	7547989	Unknown	Quaternary Alluvium	Unknown
Bore 9	Unknown	633898	7553055	Unknown	Quaternary Alluvium	No longer used
Bore 10	Unknown	639594	7558477	Unknown	Rangal Coal Measures	No longer used
Bore 11	Unknown	637684	7558650	Unknown	Fort Cooper Coal Measures	No longer used

RN	Drill Date	Eastings (GDA94)	Northings (GDA94)	Depth (m)	Screened Aquifer	Use Status
Bore 12	Unknown	621511	7568791	Unknown	Rangal Coal Measures	No longer used

5.6.4 Beneficial Groundwater Uses

The Project falls within Isaac Connors Groundwater Management Area (GMA – Zone 34) of the Fitzroy Basin under the Water Plan (Fitzroy Basin) 2011. Groundwater at the Project includes Quaternary alluvium under GMA Groundwater Unit 1 and water within the hard rock aquifers in GMA Groundwater Unit 2 (sub-artesian aquifers). The management objective of the Water Plan (Fitzroy Basin) 2011 is to maintain the 20th, 50th and 80th percentiles water quality results in order to preserve or enhance groundwater quality for its recognised uses. In the case of Isaac groundwaters, these values include aquatic ecosystems, irrigation, farm supply/use, stock watering, primary recreation, drinking water, industrial use, as well as being of cultural and spiritual value.

In order to understand the groundwater resources within the Study area, available water quality data has been compared to the:

- Fitzroy Basin Zone 34 groundwater quality objectives for deep water;
- Australian Drinking Water Guidelines (ADWG) (NHMRC, 2011); and
- ANZECC (2000) guidelines for aquatic ecosystems, irrigation (long term and short term) and stock water supply.

Although groundwater in the vicinity of the Project area may have some cultural and spiritual values, none were identified in the literature reviewed. In addition, primary recreation EVs apply to water reservoirs and connected waterbodies. The lack of connectivity between groundwater and surface water within the study area means that the primary recreation EV is not relevant to groundwater for the Project and were therefore not considered. Consequently, the EVs pertinent to groundwater in the vicinity of the Project are:

- Aquatic ecosystems;
- Irrigation;
- Industrial use; and
- Stock water supply.

Applicable maximum guideline values for these EVs are presented in **Appendix B**.

5.6.4.1 Major ions

Major ion data has been reviewed and the minimum, 20th percentile, median, 80th percentile, and maximum has been calculated for groundwater in the Tertiary Formations, Rangal Coal Measures, and Fort Cooper Coal Measures. These statistics are provided in further detail in **Appendix B**.

Comparing the data to all relevant guideline levels, the results indicate that the Tertiary bedrock is generally suitable for agriculture and irrigation practices, as well as industrial activities. However, the groundwater within this deposit is generally high in sodium and chloride meaning that it exceeds the guidelines for these ions and select areas around the Project may not be suitable for these uses. The Tertiary groundwater also records concentrations of bicarbonate above the Fitzroy Plan Water WQO for Zone 34 (deep).

All major ion data within the Rangal and Fort Cooper Coal Measures exceeds the observed 20^{th}, 50^{th}, and 80^{th} percentiles exceed the Fitzroy Plan Water WQO (Zone 34 - deep) for all measured major ions, indicating a high percentage of total dissolved solids (TDS).

5.6.4.2 Metals and metalloids

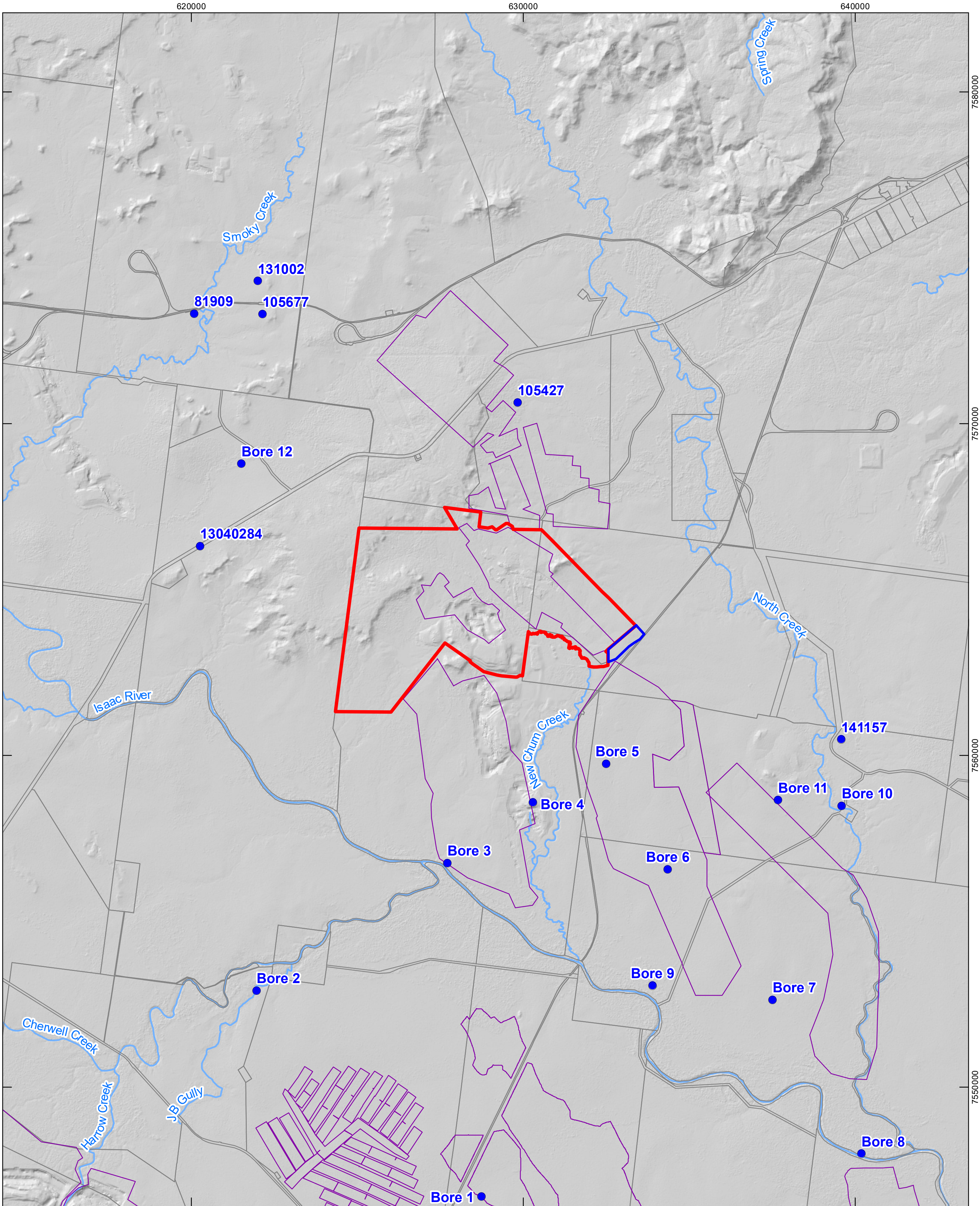
Analysis of metals and metalloids can indicate the potential groundwater uses based on toxicity levels of individual constituents. Temporal monitoring around mining operations is used to indicate changes to water composition over time, potentially resulting from contamination or other induced impacts on groundwater.

In order to assess the condition of the groundwater the metal and metalloid data has been compared to the ANZECC (2000) Water Quality Guidelines for livestock drinking water, as well as for long- and short-term use as irrigation water. These guideline limits are presented in **Appendix B**.

Metal and metalloid data is provided as the minimum, 20^{th} percentile, median, 80^{th} percentile, and maximum values for groundwater in the Tertiary Formations, Rangal Coal Measures, and Fort Cooper Coal Measures in **Appendix B**. The data shows that groundwater does not exceed WQOs for livestock drinking water or for short-term irrigation.

However, when considering trigger values for long-term irrigation multiple exceedances were identified including:

- Median values exceed the manganese guideline for long-term irrigation in both the Rangal Coal Measures and Fort Cooper Coal Measures. All the observed 20^{th}, 50^{th}, and 80^{th} percentiles for manganese in both formations exceed the Fitzroy Plan Water WQO (Zone 34 - deep);
- The maximum value recorded exceeded the guideline for long term irrigation for:
  - Tertiary Formations: Beryllium, boron, and iron.
  - Rangal Coal Measures: Beryllium, manganese, and iron.
  - Fort Cooper Coal Measures: Manganese, molybdenum, uranium, iron, boron, and mercury.



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Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.031508
Date:	21-Sep-2023
Drawn by:	AS

SLR

- Landholder Bores (Identified in Millennium Mine EIS, 2010)
- Watercourses
- Mining Lease Boundary
- Surrounding Mines
- Cadastre

Data Source:
Cadastre - QLD Department of Resources DCDB Lite Aug 2021

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

LANDHOLDER BORES

FIGURE 25

H:\Projects-SLR\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Conceptualisation Report\62003150 8 F24 Landholder Bores.mxd

5.7 Conceptual Groundwater Model

A conceptual model of the groundwater regime has been developed based on review of the available hydrogeological data for the Project and surrounds.

The Project is located approximately 20 km south-east of the township of Moranbah. Geologically it is located within the Collinsville Shelf, part of the wider Bowen Basin, a foreland sedimentary basin formed along the eastern side of Australia during the Permian Period. The geology is comprised of Permian-aged Rewan Group overlying the Rangal Coal Measures, and Fort Cooper Coal Measures. Both formations are comprised of interbedded sequences of siltstone, sandstone, shale, and coal. Younger Cretaceous intrusive volcanics are also locally mapped in the region.

The Isaac River, an ephemeral sixth order stream located to the south-west of the Project, is the major drainage feature of the region and flows in a south-easterly direction. New Chum Creek, an ephemeral third order stream, runs parallel to the Project, between the existing Millennium and Mavis open cut pits, and is a tributary of the Isaac River. Sporadic alluvial and colluvial deposits of limited extent are associated with New Chum Creek.

The main hydrogeological features at the Project include:

- Quaternary alluvial sand of the Isaac River Alluvium, located along Isaac River and New Chum Creek. These are predominantly recharged by rainfall and stream flow infiltration during high streamflow events. Typically, they are high-yielding aquifers (albeit of limited areal extent and depth).
- Quaternary/ Tertiary alluvial and colluvial deposits - an unconfined perched aquifer occurring in sporadic deposits across the Project area comprised of surficial clays and silts that is predominantly recharged by rainfall. Groundwater within this unit is around 10 m below surface and is not connected to New Chum Creek.
- Permian Coal Measures including the Rangal Coal Measures and Fort Cooper Coal Measures. Both exhibit an interbedded nature with hydrogeologically 'tight' interburden units and water bearing coal sequences with groundwater associated with secondary porosity through cracks and fissures. Both formations are at depth and confined to semi-confined under the Rewan Group at the Project location. These formations are dominantly recharged by rainfall where they outcrop or sub-crop beneath overlying permeable strata (alluvium, regolith, and thinner, or more permeable deposits of the Rewan Group).

The alluvium comprises a heterogeneous distribution of fine to coarse grained sands interspersed with lenses of clays and gravels. The hydraulic properties of the alluvium vary due to the variable lithologic composition, with field tests from the Moorvale South Project and Olive Downs Project groundwater assessments indicating horizontal hydraulic conductivity can range between 1.4 $\times10^{-2}$ and 8.7 m/day. According to data acquired for the Moorvale South Project, groundwater elevations along the Isaac River to the south-west of the Project, range between 162 mAHD and 167 mAHD, equating to around 10 to 17 mbgl. Regionally, groundwater flow within the alluvium is a subdued reflection of topography, with groundwater flowing in a south easterly direction consistent with the alignment of the Isaac River. Higher groundwater elevations closer to ground surface, are recorded in bores positioned closest to the surface watercourses of Isaac River and New Chum Creek. Groundwater levels are beneath the elevation of the Isaac River, when flowing, indicating a losing river system.

Recharge to the alluvium is predominantly from stream flow or flooding (losing streams), with direct infiltration of rainfall also occurring where there are no substantial clay barriers in the shallow sub surface. On a regional scale, discharge is via evapotranspiration from vegetation growing along creek beds and minor short duration baseflow events after significant rainfall/ flooding. Infiltration to underlying formations is limited to areas where high hydraulic conductivity coal seam aquifers directly underlie the alluvium. General downwards recharge to deeper units is limited by the low hydraulic conductivity Rewan Group and interburden sequences. Localised perched water tables are also evident where waterbodies continue to hold water throughout the dry period (pools in the Isaac River and wetlands) occurring where clay layers slow the percolation of surface water.

Direct rainfall recharge to the coal measures will occur where they outcrop at surface or where they subcrop beneath the Quaternary/ Tertiary deposits. The Rewan Group is typically thought of as an aquitard, due to its mudstone and shale dominance. In the Project Area, review of registered bore logs suggest that the Rewan Group is predominantly composed of sandstone and siltstone lithology with minor shale and may allow rainfall recharge to the underlying Permian deposits. The amount of recharge to underlying Permian is expected to be heterogenous across the area, dependent on the composition and thickness of the Rewan Group. Groundwater discharge occurs primarily through evapotranspiration; vertical seepage through the regolith is limited by the underlying low hydraulic conductivity Rewan Group and interburden of the Permian Coal Measures.

Tertiary-Quaternary aged sediments (alluvial and colluvial) are present and forms the base of the unconfined shallow groundwater system. The groundwater flow processes are like those of the alluvium; however, the fluxes are expected to be significantly lower due to the dominance of clay within these sediments. The groundwater level in the colluvial deposits proximal to the Project is recorded at approximately 10 mbgl, indicating the presence of persistent groundwater in the shallow geology within the vicinity of the Project. These deposits are not expected to form a significant aquifer in relation to the Project. Groundwater discharge occurs primarily through evapotranspiration; vertical seepage through the regolith is limited by the underlying low hydraulic conductivity Rewan Group and interburden of the Permian Coal Measures.

In the Permian strata, groundwater is encountered in the coal seams and in the interburden units of lower hydraulic conductivity. As with the rest of the Bowen Basin, the coal seams are the main groundwater bearing units within the Permian sequences; with low hydraulic conductivity interburden generally confining the individual seams. The coal seams are dual porosity in nature with a primary matrix porosity and a secondary (dominant) porosity provided by fractures (joints and cleats). Hydraulic conductivity of the coal decreases with depth due to increasing overburden pressure reducing the aperture of fractures. Vertical movement of groundwater (including recharge) is limited by the confining interburden layers, meaning that groundwater flow is primarily horizontal through the seams with recharge only occurring at outcrop or subcrop.

Review of fault behaviour has identified that faults can increase vertical hydraulic conductivity parallel to the fault trace and reduce it perpendicular to the fault trace. However, any increases in vertical hydraulic conductivity is limited to small vertical horizons (<20 m) and is variable between faults dependent on localised hydrothermal activity and mineralisation in-filling pore spaces. A conceptualisation by Peabody (2017) is provided in **Figure 26**. It shows the significant responsibility of faults for partially or fully isolating stratigraphic units via displacement along multiple local faults.

Regionally, groundwater within the Permian Coal Measures flows in an easterly direction across the Project. Review of water quality data indicates water within the Permian Coal Measures is generally saline at the Project.

A conceptual cross-section of the hydrogeological system, made from a west-east section through the Project, is presented in **Figure 27** illustrating the conceptual model of the area prior to and after mining.

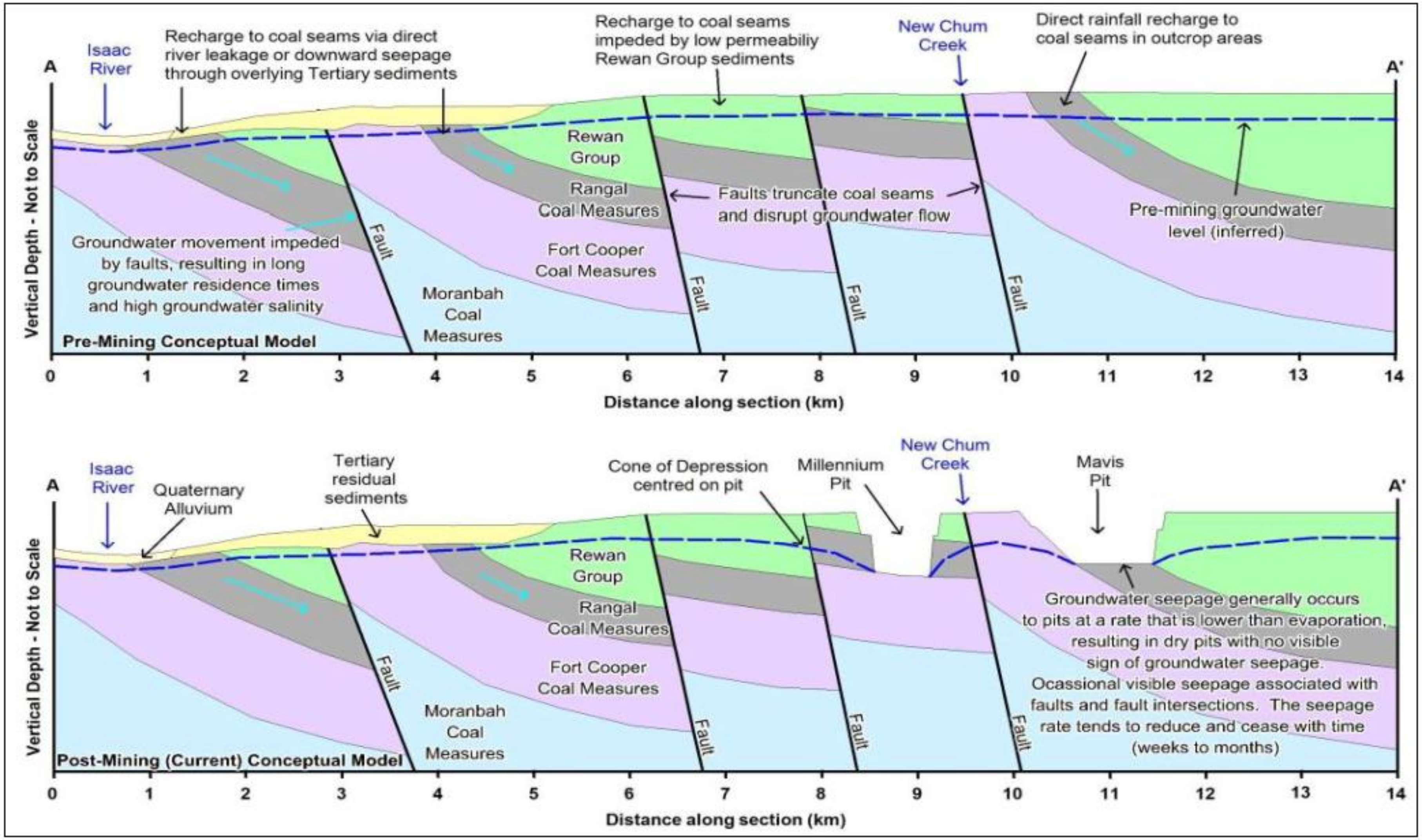


Figure 26 **Conceptual Model showing extensive local faulting and displacement (from Peabody 2017)**

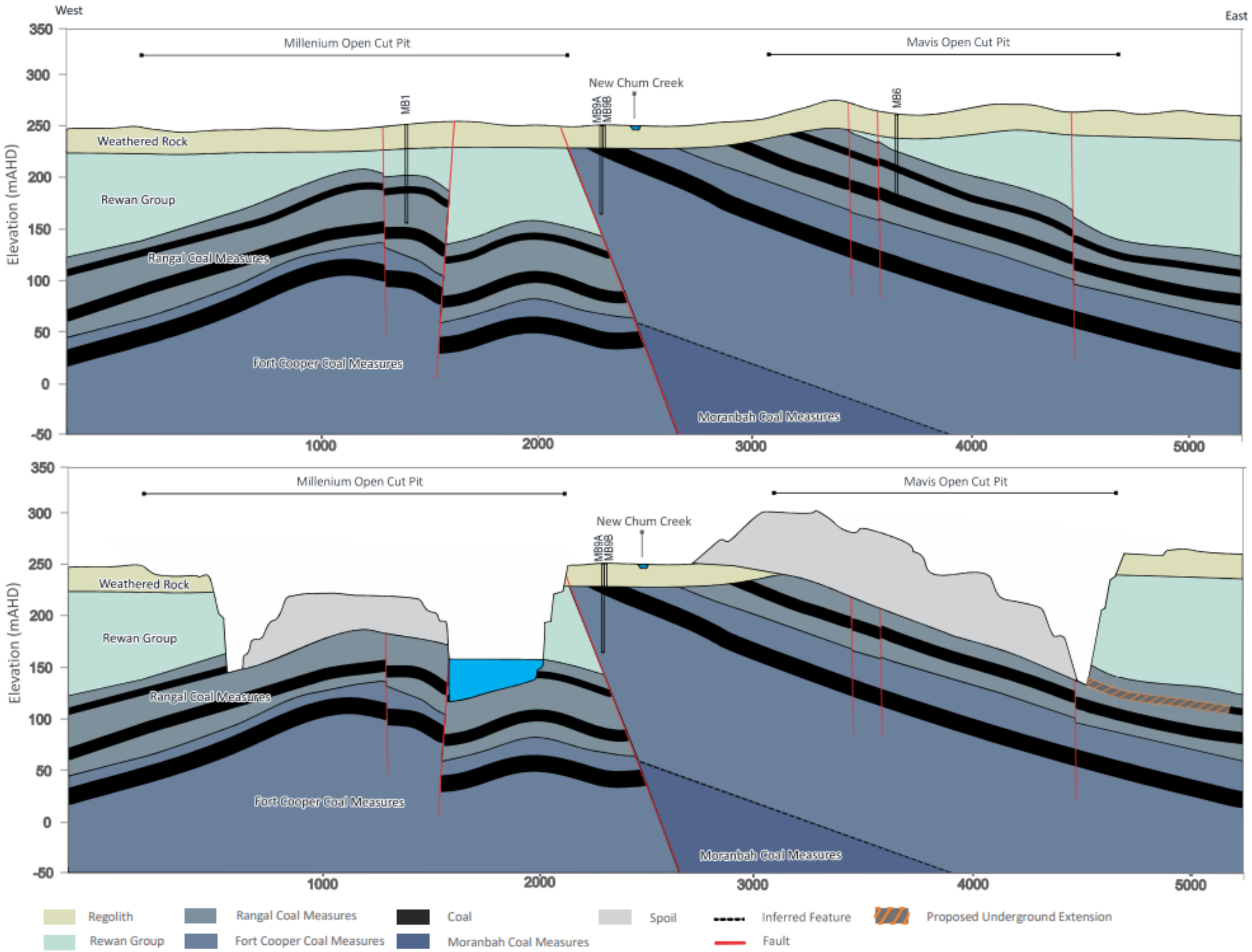


Figure 27 Conceptual Model of the Project

6.0 Groundwater Numerical Model

6.1 Model Objectives

Numerical modelling was undertaken to assess the impact of the Project on the groundwater regime. The key objectives of the predictive modelling were to:

- estimate the groundwater inflow to the mine workings as a function of mine position and timing.
- simulate and predict the extent and area of influence of dewatering and the level and rate of drawdown at specific locations (groundwater users, **Section 5.6**).
- identify areas, where groundwater impact mitigation / control measures may be necessary.

For the purposes of the EA amendment, this assessment has predicted the impacts for the proposed extension to underground mining at Mavis South Underground operation.

6.2 Modelling Code

MODFLOW-USG Transport was used as the model code (Panday *et al*. 2013). MODFLOW-USG is the latest version of the industry standard MODFLOW code and was identified to be the most suitable modelling code for accomplishing the model objectives. To allow stable numerical modelling of the large spatial area of the model domain, an unstructured grid with varying Voronoi cell sizes was designed using Algomesh (HydroAlgorithmics, 2014). Fortran code and a MODFLOW-USG edition of the Groundwater Data Utilities (Watermark Numerical Computing) were used to construct the MODFLOW-USG input files.

6.3 Model Construction

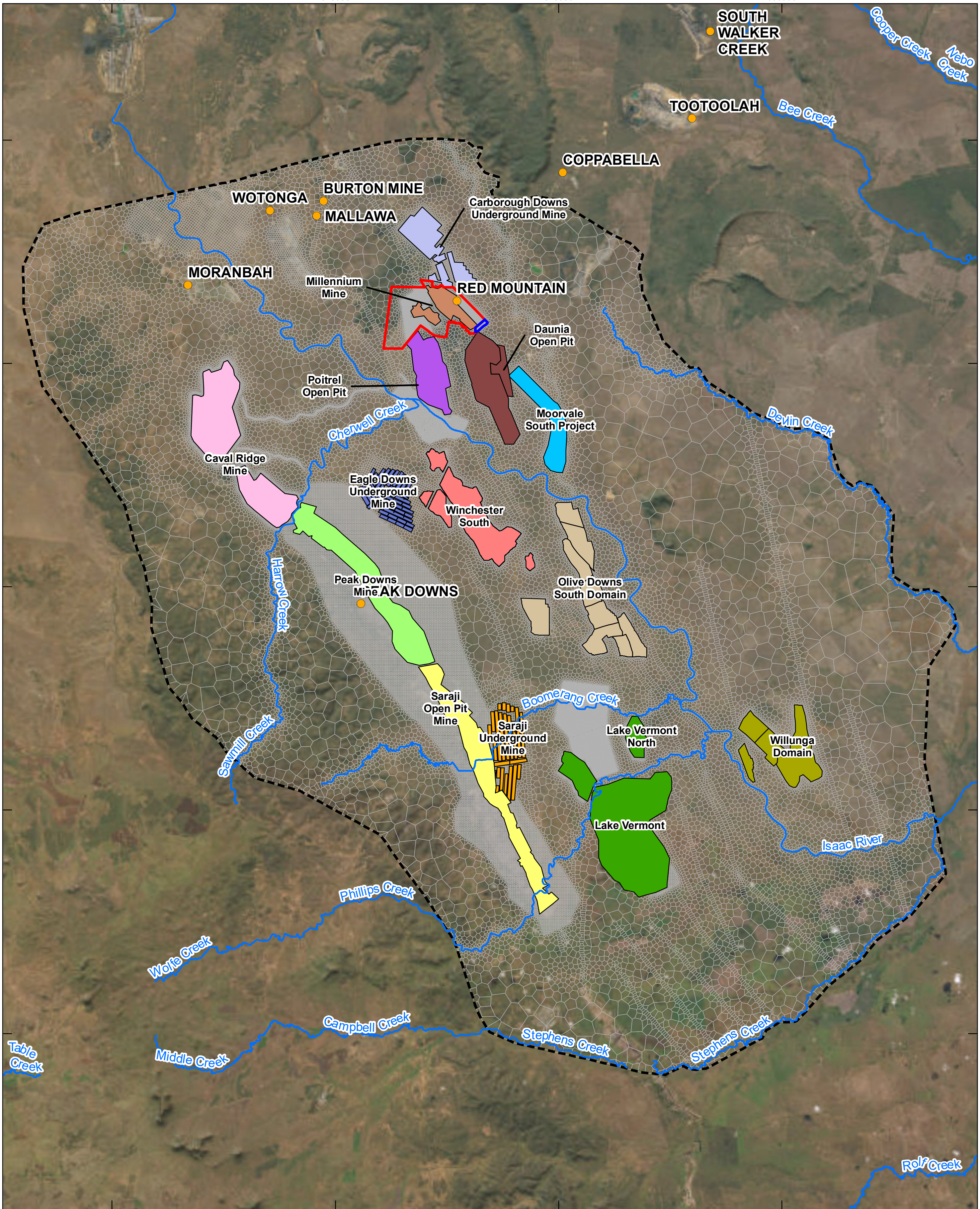
6.3.1 Model Extent and Design

The model extent was kept as per that of the SLR (2021) model. The model encompasses the Project and Millennium Mine with adjacent regional mining. Model elongation is in the direction of geological strike (northwest to southeast). At its widest extents, the model is approximately 62 km west-east by 95 km north-south.

The model domain is intended to place boundary conditions sufficiently distant from Millennium and surrounding mines to allow the extent of potential impacts from mining activities on the groundwater system to be assessed. The model extent and grid discretisation are shown in **Figure 28**. The model grid discretisation has been updated from the SLR (2021) model to provide greater resolution in the vicinity of the Mavis South UG Project.

LiDAR data, provided by MetRes, was used to define local surface elevation within the Project area. Surface elevation for the surrounding model domain was defined using LiDAR data from the Daunia, Poitrel, Moorvale South, Winchester South, Olive Downs, and CVM sites, outside the extents of which public domain 25 m DEM data sourced from Geoscience Australia was used to define topography.

The model domain was vertically discretised into 19 layers, each layer comprising a cell count up to 121,439. The total number of cells in the model is 1,610,515. This is after pinching out areas in layers 3 to 19 where a layer is not present based on the structural geology. Model layers are listed in **Table 16**.



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Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:450,000 at A4
Project Number:	620.031508
Date:	21-Sep-2023
Drawn by:	AS

SLR

- Place Name
- Major Drainage System
- Project Boundary
- Project Mining Lease Boundary
- Model Boundary
- Model Grid

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

GROUNDWATER MODEL DOMAIN

FIGURE 28

H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620031508 F28 Groundwater Model Domain.mxd

Model layer extents (lateral and vertical) have been defined using the site geological models from Millennium, Daunia, Poitrel, CVM, Lake Vermont North and Winchester South, in addition to data from the CSIRO Regolith depth survey and Queensland Globe surface geology, basement geology and bore hole log data.

Table 16 Model Layers and Thicknesses

Model Layer	Formation	Unit	Average Thickness (m)
1	Alluvium, colluvium, Tertiary basalt	Surface cover	6.5
2	Tertiary sediments, Tertiary basalt	Tertiary and minor Triassic Clematis, weathered Permian, Tertiary basalt	16.5
3	Rewan Group	Triassic	139.0
4	Rangal Coal Measures	Leichhardt overburden	36.0
5		Leichhardt seam (Target coal seam)	4.9
6		Interburden	36.5
7		Vermont seam	4.0
8		Vermont underburden	26.5
9	Fort Cooper Coal Measures	Fort Cooper overburden	61.5
10		Fort Cooper seams (combined)	61.5
11		Fort Cooper underburden	60.0
12	Moranbah Coal Measures	Q Seam	1.5
13		Interburden	17.0
14		P Seam	2.5
15		Interburden	41.0
16		H Seam	4.5
17		Interburden	65.5
18		D Seam	8.5
19		Interburden	100.0

6.3.2 Boundary Conditions and Stresses

6.3.2.1 Surface water

General Head Boundaries (GHB) have been specified along the eastern, southern, and part of the northern model boundaries. A no flow boundary was applied to the western boundary and a section of the eastern boundary of the model that represents the outcrop of the Back Creek Group. A Drain Boundary (DRN) condition was used along the northern model boundary to simulate the mining at the Grosvenor Mine.

Major rivers, including Isaac River, as well as minor creeks were built into the model using MODFLOW-USG River (RIV) package. The rivers within and around the Project that were included in the RIV package are presented in **Table 17**.

Table 17 River and Surface Water Features in the Millennium Model

Boundary	River Stage (m)	River Bed Kz (m/day)
Isaac River	Warm Up Simulation - Long term Average (2008-2021) Calibration simulation - Historical Quarterly Averages Prediction simulation- Fixed Stage Height- Long term Average (2008-2021)	1.0×10^{-2}
New Chum Creek	0	1.0×10^{-2}
Other Minor Creeks	0	1.0×10^{-3} to 1.0×10^{-2}

6.3.2.2 Recharge and evaporation

The dominant mechanism for recharge to the groundwater system is through diffuse infiltration of rainfall through the soil profile and subsequent deep drainage to underlying groundwater systems. Diffuse rainfall recharge to the model was represented using the MODFLOW-USG Recharge package (RCH). Rainfall recharge was imposed as a percentage of actual rainfall data from the SILO Grid Point at Millennium (-22.00, 148.25), summarised in **Table 18**. Long-term average rainfall (1970 to 2021) was used for the steady-state model. For the transient calibration model, quarterly averages of the historical rainfall data were used (2008 to 2021). For the prediction model, the annual average of 1990-2021 rainfall data was used.

Table 18 Long-term Average Rainfall at Millennium

SILO Grid Point	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
(-22.00, 148.25)	103.3	94.6	66.9	32.9	33.4	23.9	20.9	23.8	10.0	33.4	63.3	93.9	595.7

The model included seven recharge zones with recharge, as a percentage of rainfall, defined as listed in **Table 19**.

Table 19 Recharge Zones and Recharge Rainfall Factors

Model Geology Zone	% Rainfall
Isaac River Channel Alluvium	0.53
Isaac River Flood Plain Alluvium	0.23
Other Alluvium	0.23

Model Geology Zone	% Rainfall
Duaringa Formation	0.01
Tertiary basalts	0.32
Weathered Permian	0.06
Regolith	0.01

An enhanced recharge of 100 % is applied to the final voids in the prediction model. The recharge to the spoil is set to 1 % of actual rainfall.

The MODFLOW Evapotranspiration (EVT) package was used to simulate evapotranspiration from the groundwater system. Extinction depths were set to 2 m below ground across the model domain. Maximum potential rates were set using actual evapotranspiration values (from the Bureau of Meteorology), with the average value (600 millimetres per year [mm/year]) used as the transient calibration evapotranspiration rate. An EVT rate of 0 mm/year was assigned to the model cells representing the rivers.

6.3.2.3 Simulation of Mining

The MODFLOW Drain (DRN) package is used to simulate mine dewatering in the model for the Project and surrounding mines. To simulate the project in the model, drain cells are applied to all active layers from the surface to the base of the lowermost mined seam. In the Mavis Pit (Pit E), historical open cut mining is simulated through drain cells applied from Layer 1 to Layer 7 (Vermont seam) as per MatrixPlus (2010).

For open cut mining, Hawkins (1998) and Mackie (2009) indicate that spoil and waste rock are more permeable than the undisturbed strata. Completed open cut mining areas will be backfilled with waste overburden as the extraction proceeds. Backfilling of open cut mine areas with spoil was also modelled using the Time-variant materials (TVM) package. The model cell properties were updated to spoil properties guided by operational mine plans. Horizontal hydraulic conductivity of 0.3 m/day and vertical hydraulic conductivity of 0.1 m/day is applied to the spoil. The storage parameters used for the spoil were a specific yield of 0.05 and a storage coefficient of 1.0×10^{-5} m^{-1}.

Underground mining was simulated as follows, based on the mining method employed:

- **Bord and pillar mining** at Mavis and Mavis South Underground area has been simulated using drain cells applied to Layer 5, which remain active and dewater the area for two years. Following active mining, resultant voids are represented by altered material properties of the area using the TVM package. The specific yield for the underground workings after coal removal was set to 0.5 (i.e., 50% of coal left in place and 50% of void space created).

- **Longwall extraction** at Carborough Downs Mine, Grosvenor Mine, Eagle Downs Mine and Saraji East are represented as drain cells in the model layer representing the target seam for each mine, with the fracture zone extended through up to 8 overlying layers.

The drain cell conductance was selected as 100 m^2/d in accordance with previous models (SLR, 2021).

During the recovery period, all drain cells representing the Millennium open cut and Mavis Underground (Approved and the Project) mining were removed at the start of the recovery period to allow groundwater levels in the underground workings and the overlying water-bearing strata to recover. The MODFLOW Transient Variable Materials (TVM) package

- In open cut pits, the TVM package was used to represent backfill (excluding E Pit that will be left as open cut) with properties of: horizontal hydraulic conductivity of 0.3 m/day and vertical hydraulic conductivity of 0.1 m/day. The storage parameters used for the spoil were a specific yield of 0.1 and a specific storage of 1.0 x 10^{-5} m^{-1}.
- Underground mines were assigned high horizontal and vertical hydraulic conductivities (1,000 m/day) and storage parameters based on the compressibility of water (specific yield of 1.0, storage coefficient of 5.0 x 10^{-6} m^{-1}), to simulate free water movement within the cells.

6.4 Model Calibration

The SLR (2021) numerical model was not recalibrated under this scope of works. SLR (2021) previously calibrated this model using a data set of 5,157 measured groundwater levels collated for 424 sites, dating to July 2021.

The model for this scope of works has been updated with data from additional bores and groundwater measurements up until June 2023 and the model has undergone validation. The validation data set includes a further 3,782 measured groundwater levels for 283 bores across the model domain.

6.4.1 Calibrated Parameters

The hydraulic properties (i.e., horizontal, vertical conductivity, specific yield, and specific storage) and recharge rates were adjusted during the calibration of the Project model (SLR, 2021) to provide best match between the measurements and model simulated heads.

Table 20 provides a summary of the calibrated values for horizontal and vertical hydraulic conductivity used in the model. The hydraulic parameter zones in all the model layers are presented spatially in **Appendix C**.

Table 20 Calibrated Hydraulic Parameters

Model Layer	Formation	Unit	Horizontal Hydraulic Conductivity (m/day)	Anisotropy Kz/Kx
1	Alluvium	Surface cover	12.0	0.2
1	Regolith	Surface cover	1.0	0.1
1	Weathered Permian	Surface cover	0.6	0.06
1	Duaringa Formation	Surface cover	0.5	0.05
1 & 2	Tertiary Basalt	Tertiary basalt	3.2	0.1
2	Regolith	Surface cover	1.0	0.03
3	Rewan Group	Triassic	2.0 x 10^{-3}	0.07
4	Rangal Coal Measures	Leichhardt overburden	1.0 x 10^{-5} to 6.0 x 10^{-3}	0.09
5		Leichhardt seam	1.0 x 10^{-4} to 9.0 x 10^{-2}	0.002
6		Interburden	5.0 x 10^{-5} to 1.0 x 10^{-3}	0.1

Model Layer	Formation	Unit	Horizontal Hydraulic Conductivity (m/day)	Anisotropy Kz/Kx
7		Vermont seam	1.0×10^{-4} to 1.0×10^{-2}	0.03
8		Vermont underburden	5.0×10^{-5} to 1.0×10^{-3}	0.002
9	Fort Cooper Coal Measures	Fort Cooper overburden	5.0×10^{-5} to 1.0×10^{-3}	0.1
10		Fort Cooper seam	1.0×10^{-4} to 1.0×10^{-3}	0.1
11		Fort Cooper underburden	5.0×10^{-5} to 4.0×10^{-1}	0.005
12	Moranbah Coal Measures	Q Seam	1.0×10^{-4} to 1.0×10^{-1}	0.2
13		Interburden	5.0×10^{-5} to 5.0	0.2
14		P Seam	1.0×10^{-4} to 5.0	0.05
15		Interburden	5.0×10^{-5} to 3.0×10^{-1}	0.04
16		H Seam	1.0×10^{-4} to 1.0×10^{-1}	0.007
17		Interburden	5.0×10^{-5} to 2.0×10^{-1}	0.06
18		D Seam	1.0×10^{-4} to 1.0×10^{-1}	0.03
19		Interburden	1.0×10^{-5} to 2.0×10^{-1}	0.005
	Faults		5.0×10^{-5} to 1.0×10^{-2}	0.1
-	Spoil		3.0×10^{-1}	0.2

The hydraulic conductivity of the Permian interburden material in the Rangal Coal Measures, Fort Cooper Coal Measures and Moranbah Coal Measures reduces with depth to reflect field observations, as detailed in **Section 5.3.1**. As the decrease of Kx within the interburden rock units is driven by an increase in overburden pressure, the relationship between Kx and depth is different from that of coal seams. The hydraulic conductivity for the interburden material is capped at a minimum of 5.0×10^{-5} m/day and the hydraulic conductivity of the coal seams is capped at a minimum of 1.0×10^{-4} m/day. The Kx vs depth relationships applied for the Leichhardt and the Vermont Seam in the model were calibrated for the model (SLR, 2021).

6.4.2 Calibration Fit (Hydrographs)

This section provides discussion on the modelled to observed water level trends (calibration hydrographs) for select monitoring bores across the Millennium site.

The calibration hydrographs for Millennium site bores MILLMB1, MILLMB4, MILLMB8B, and MILLMB10A are shown in **Figure 29**.

- The hydrograph for MILLMB1, located in the Rangal Coal Measures overburden, near the centre of the Millennium Mine area, shows the model closely matches observed water levels at this location. No water levels were recorded at bore MILLMB1 after October 2014 due to the bore being lost to mining.
- Modelled water levels in MILLMB4, located in the Tertiary Sandstone sediments with variable thickness, about 2 km to the northwest of the Mavis South Project area, provide a similar trend to the observed water levels at this location. However, there is approximately four metres difference between the observed and modelled water level at the location of this bore, with the model underpredicting groundwater heads at this location.

- The hydrograph for MILLMB8B, located in the Rangal Coal Measures overburden toward the north of the Millennium Mine area, shows the model overpredicts water levels at this location by approximately 20 m. The overprediction may be a result of structural features present at this location that are not currently represented in the model. The Millennium geological model indicates a 4 km fault runs to the south-southeast, between bore MILLMB8B and bore MILLMB1, along which permeability may be higher. However, the modelled water level trend matches the observed trend, which is deemed acceptable.
- The hydrograph for MILLMB10A, located in the Fort Cooper Coal Measures-Interburden close to the MILLMB4 bore at the northeastern part of the Mavis South underground project area, doesn't show as much discrepancy as bore MILLMB4, which reports a good model prediction at the depth of this bore. Modelled water level matches closely with measured water level at the beginning and the end of the monitoring period which has been ongoing since 2014 to the present time. However, the model does not manage to replicate seasonal groundwater level variation and underpredicts the maximum levels observed.

Calibration hydrographs for the full calibration dataset are presented in **Appendix D**. While water levels at some Millennium site bores are not well matched by the model (i.e., 20 m discrepancy), the observed water level trends for these bores are reflected well in modelled water level trends. The Australian Groundwater Modelling Guidelines (Barnett et al. 2012) suggest that model outputs obtained by calculating the difference between a stressed and unstressed or 'null mining' scenario can minimise the predictive uncertainty associated with model outcomes.

As drawdown predictions are obtained by calculating the difference in predicted aquifer groundwater levels between two model scenarios, the absolute error associated with predicted groundwater levels is negated and the model is considered fit for the purpose of this assessment.

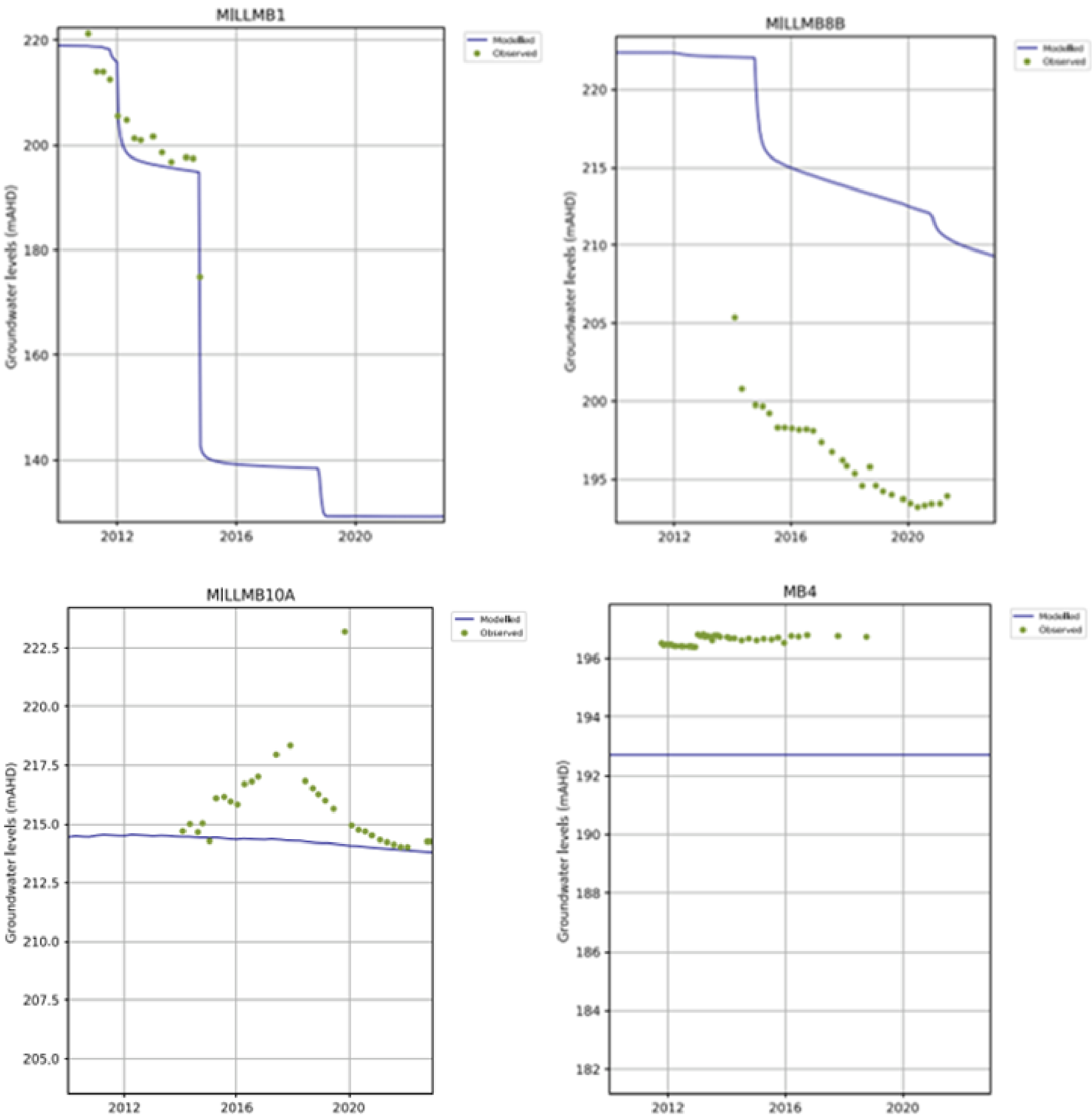


Figure 29 Calibration Fit for Millennium Site Bores MB1, MB4, MB8B, and MB10A

6.4.3 Calibration Statistics

One of the industry standard methods to evaluate the calibration of the model is to examine the statistical parameters associated with the calibration. This is done by assessing the error between the modelled and observed (measured) water levels in terms of the root mean square (RMS). The RMS error calculated for the validated model is 11.22 m, compared with 11.98 m for the Millennium site observation bores. This equates to a scaled RMS (ratio of RMS to the total head change, SRMS) of 7.19% across the model domain, with 21.95% for the Millennium bores being due to the narrower range of groundwater measurements at site.

Details on each of the observation points and their residuals are presented in **Appendix E**.

6.5 Model Timing & Scenario

6.5.1 Calibration Period Setup

A combined transient warm up and transient calibration model was developed, as follows:

- A transient warm-up model from January 1988 to December 2007 conditions with 20 yearly time interval.
- Transient calibration model from December 2007 to June 2021 with quarterly time intervals to replicate influence of historical mining.

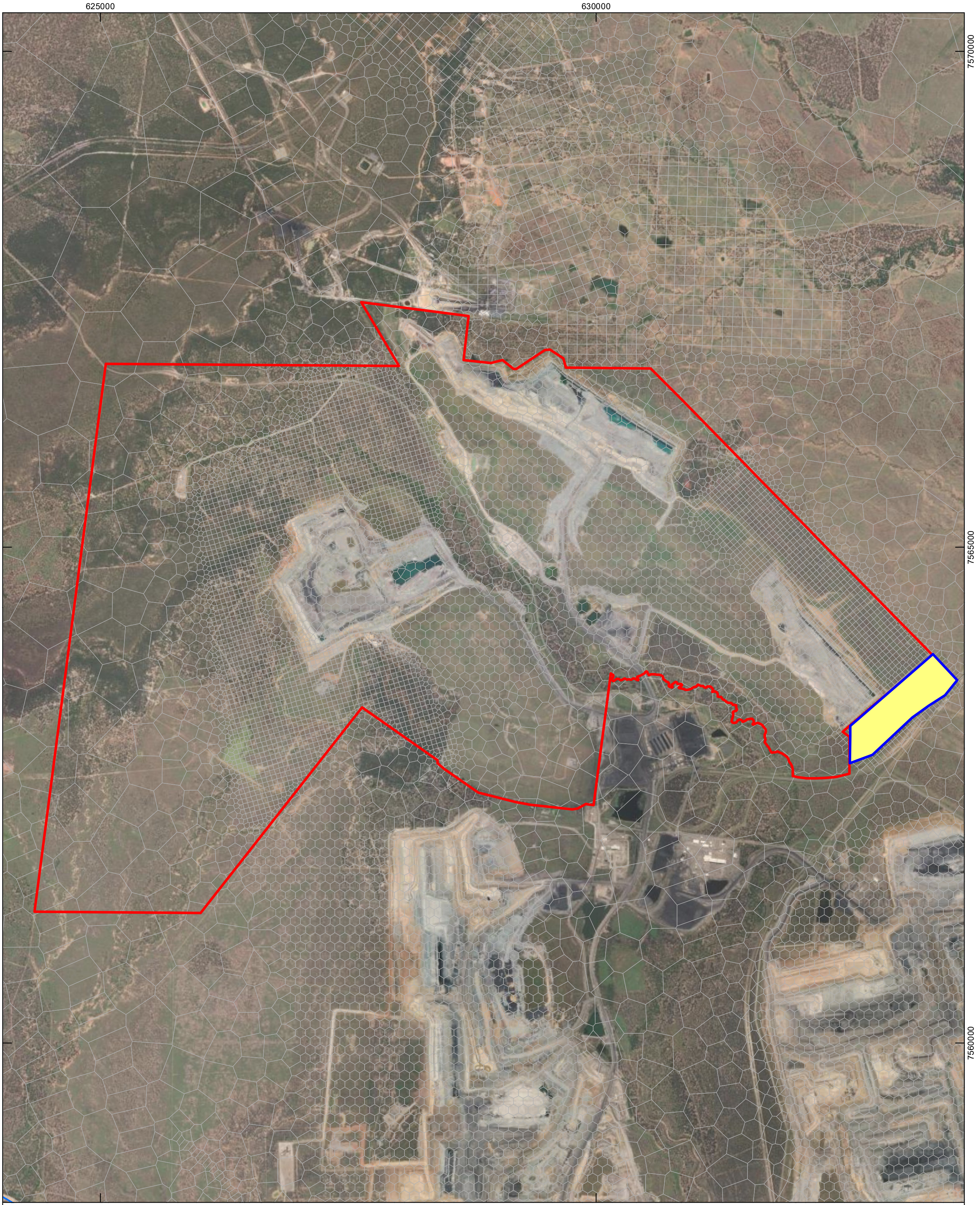
The first stress period of the warm-up model was steady-state and did not include any mining. This was to simulate the pre-mining conditions within the model domain.

6.5.2 Predictive Period Setup

Transient predictive models have been developed for three model scenarios, from July 2021 to December 2021 with quarterly time intervals followed by bi-annual time intervals from January 2022 to December 2042:

- Null Run – no mining within region from January 2008 (end of transient warmup).
- Approved (Base Case) – all approved and foreseeable mining in region excluding underground mining at Mavis South.
- Project (Cumulative)– all approved and foreseeable mining in region with the proposed UG mining at Mavis South.

The simulated predictive mine progression for the Project is presented in **Figure 30**. This assumes mining at Mavis South Underground from June 2024.



Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:50,000 at A4
Project Number: 620.031508
Date: 21-Sep-2023
Drawn by: AS

- Major Drainage System
- Project Boundary
- Project Mining Lease Boundary
- Model Boundary
- Model Grid

Mine Progression

- FY2024/25 (July 24-June 25)

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

MINE PROGRESSION FOR THE MAVIS SOUTH

FIGURE 30

H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620031508 F30 Mine Progression for the Mavis South.mxd

6.5.3 Recovery Period

The post-mining recovery modelling included simulation of groundwater level recovery in the Mavis South Underground workings as well as the Millennium open cuts. A 456-year transient model was created to ascertain post-mining recovery.

6.6 Model Predictions

6.6.1 Assessment of Impacts

The predicted impacts presented will include:

- **Incremental** – impacts due to underground (UG) mining at Mavis South only, obtained by comparing the difference between the cumulative project and approved basecase scenarios.
- **Cumulative** – impacts due to all approved mining plus UG mining at Mavis South Pit, obtained by comparing the difference between the Cumulative and Null Run scenarios.

6.6.2 Maximum Predicted Drawdown Impacts

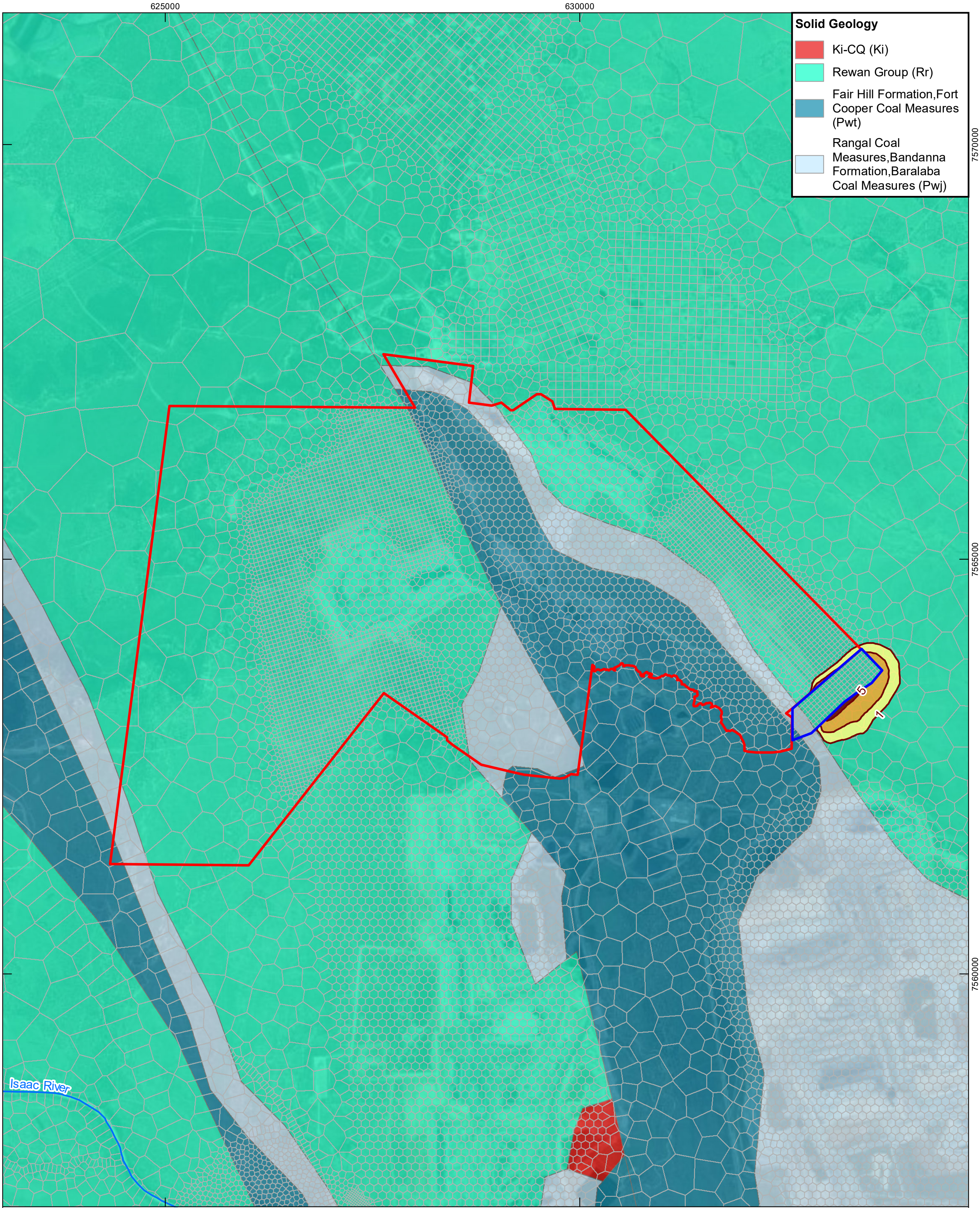
Maximum predicted drawdowns have been calculated for the Quaternary alluvium, regolith, Rewan Group, and Leichardt Seam as described in **Section 6.6.1**. The maximum drawdown represents the maximum drawdown values recorded at each model cell at any time over the model duration. Predicted drawdown figures (**Figure 31** to **Figure 35**) show where maximum drawdown impacts are predicted to exceed 1 m.

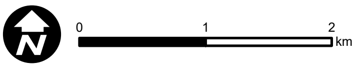
6.6.2.1 Maximum Predicted Incremental Drawdown

There is no predicted incremental drawdown in the Quaternary Alluvium and in the regolith for the Mavis South UG scenario. Maximum predicted incremental drawdowns in the Rewan Group and Leichardt Coal Seam are shown in **Figure 31** and **Figure 32**, respectively.

Figure 31 shows maximum predicted drawdown in the Rewan Group due to simulated Project is up to 10 m at the working coal face. The predicted incremental drawdown in the Rewan Group extends 400 m to the south-east of the Mavis South mining scenario.

Figure 32 shows the predicted incremental drawdown in the Leichardt Seam for the Project. The Leichardt Seam is the target coal seam at the Project and maximum predicted drawdown reaches to 95 m in this layer. As depicted in the **Figure 32**, it is predicted that the drawdown surrounding the Mavis South underground operation is predominantly from north-east to the south-west direction with the maximum extent of approximately 950 m towards the southeastern part of the Mavis South project boundary.





Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:60,000 at A4
Project Number:	620.031508
Date:	21-Sep-2023
Drawn by:	AS

Major Drainage System
Drawdown Contour (m)
Project Boundary
Project Mining Lease Boundary
Model Grid

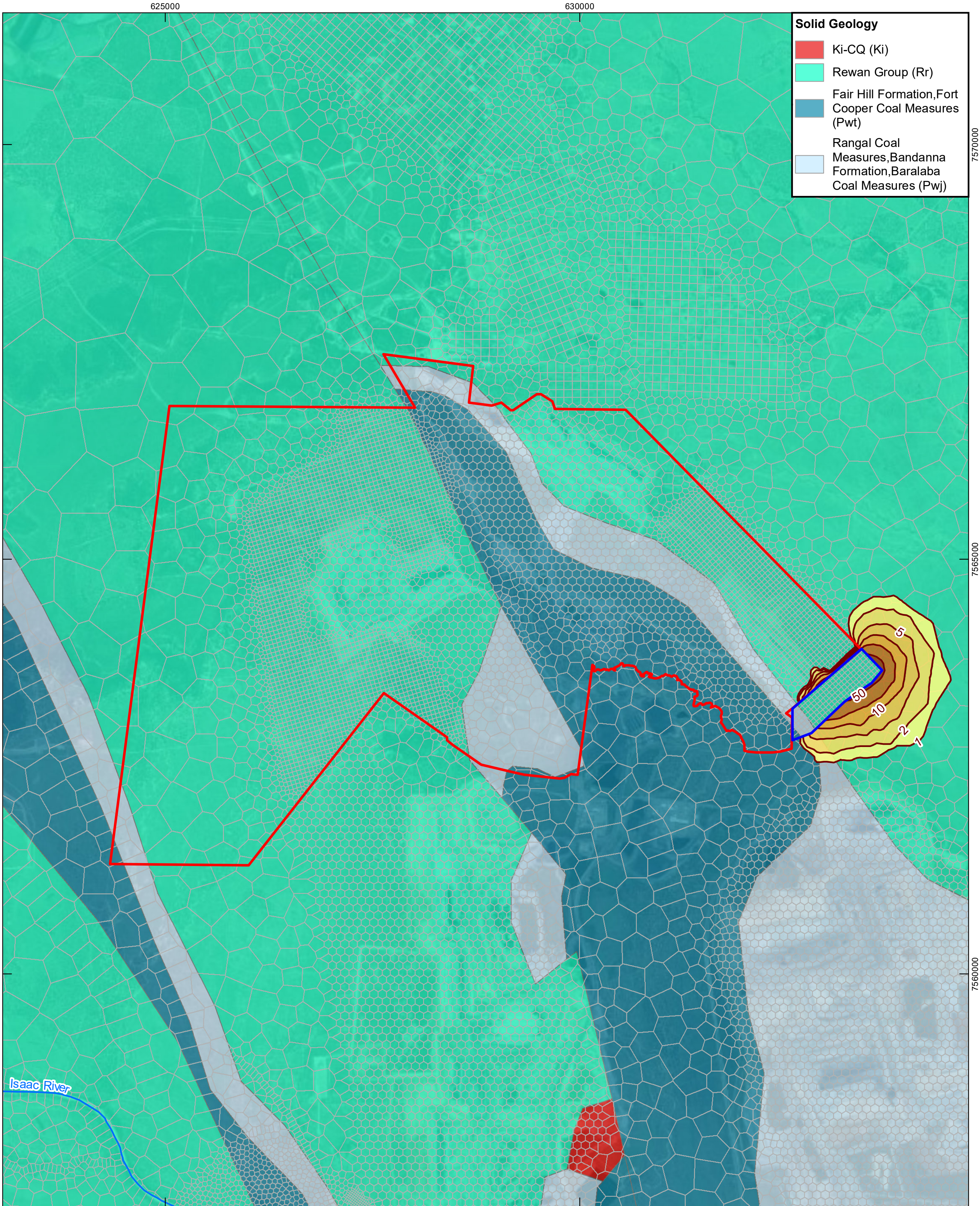
Maximum Drawdown (m)
1 - 2
2 - 5
5 - 10

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

MAXIMUM PREDICTED INCREMENTAL DRAWDOWN IN REWAN GROUP (2027, END OF MINING)

FIGURE 31

H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620031508 F31 Maximum Predicted Incremental Drawdown in Rewan Group (2027 End of Mining).mxd



H:\Projects-SLR\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620031508 F32 Maximum Predicted Incremental Drawdown in Leichardt Seam (2027 End of Mining).mxd

0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:60,000 at A4
Project Number:	620.031508
Date:	21-Sep-2023
Drawn by:	AS

- Major Drainage System
- Drawdown Contour (m)
- Project Boundary
- Project Mining Lease Boundary
- Model Grid

Maximum Drawdown (m)

- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200

SLR

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

MAXIMUM PREDICTED INCREMENTAL DRAWDOWN IN LEICHARDT SEAM (2027, END OF MINING)

FIGURE 32

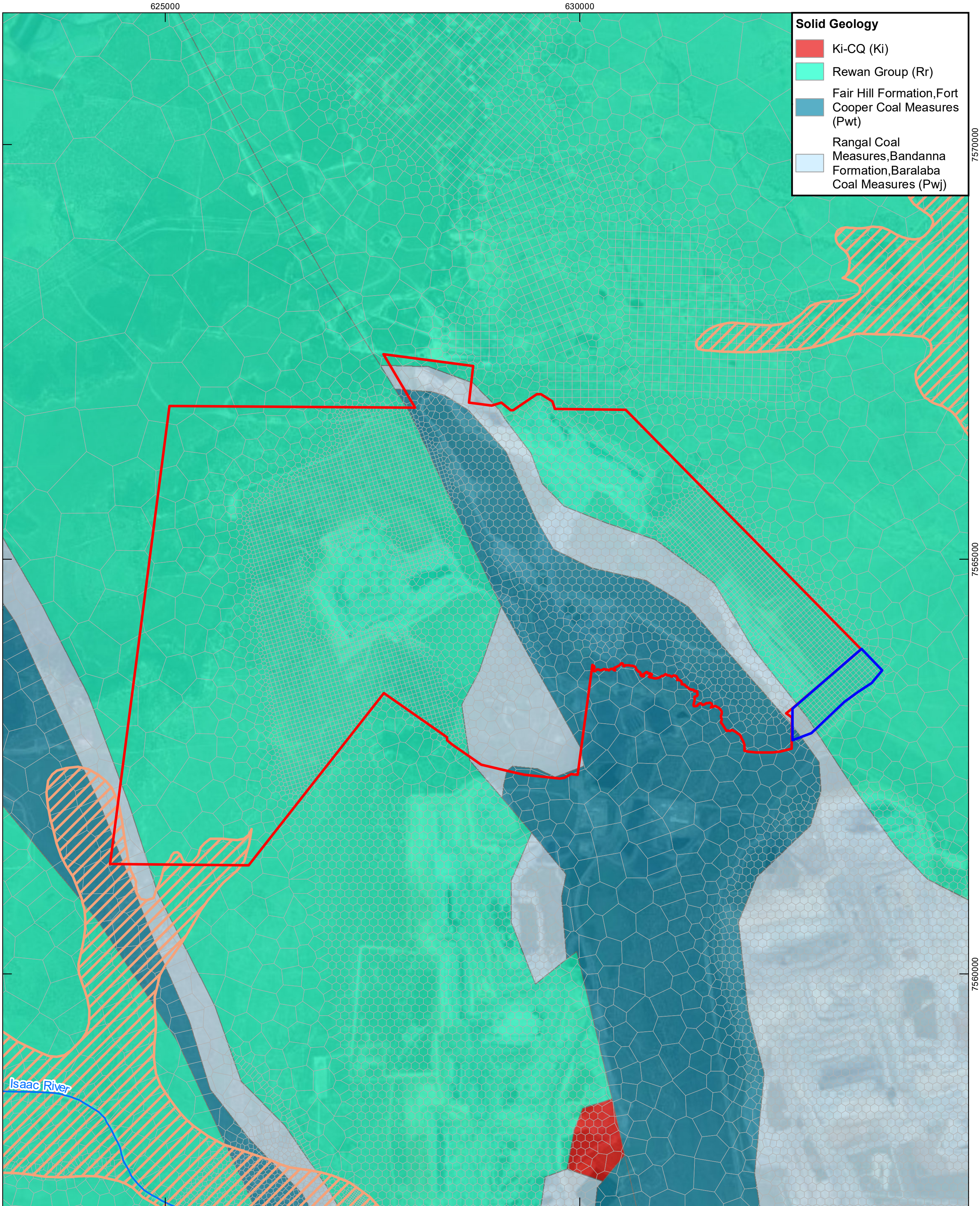
6.6.2.2 Maximum Predicted Cumulative Drawdown

Maximum predicted cumulative drawdowns in the Quaternary alluvium, Tertiary regolith, Rewan Group, and Leichardt Coal Seam are shown in **Figure 33** to **Figure 36**. These drawdowns represent the total impact of mining by all current mining in addition to the Project. They show the difference in the groundwater levels between the cumulative and the theoretical "no-mining" or null run scenario.

There is no predicted incremental drawdown impacts in the Quaternary alluvium or the Tertiary regolith sediments as a result of the Mavis South UG (**Figure 33** and **Figure 34**). However, as shown in **Figure 33**, the cumulative predicted drawdown impact within the regolith is associated with surrounding mines while showing a minimal apparent impact of up to 5 m in a small region between Mavis underground and Mavis Pit open cut boundary in the Mavis Approved area.

Maximum predicted cumulative drawdown in the Rewan Group is mainly between 10 to 20 m which covers the significant part of the project site except the northeastern part that shows less drawdown ranging 5 to 10 m (**Figure 35**). Cumulative drawdown in the surrounding mines is mostly around 20 to 50 m range with a very small region that drawdown reaches to 100 m in this layer.

Maximum predicted cumulative drawdown in Leichardt Seam increases from south-west to the north-east direction ranging from 20 to 50 m drawdown up to 200 m in the Mavis South project area. **Figure 36** presents the drawdown within the project site and the surrounding mines in Leichardt Seam unit.



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:60,000 at A4
Project Number:	620.031508
Date:	21-Sep-2023
Drawn by:	AS

- Major Drainage System
- Project Boundary
- Project Mining Lease Boundary
- Model Grid
- Alluvium Extent

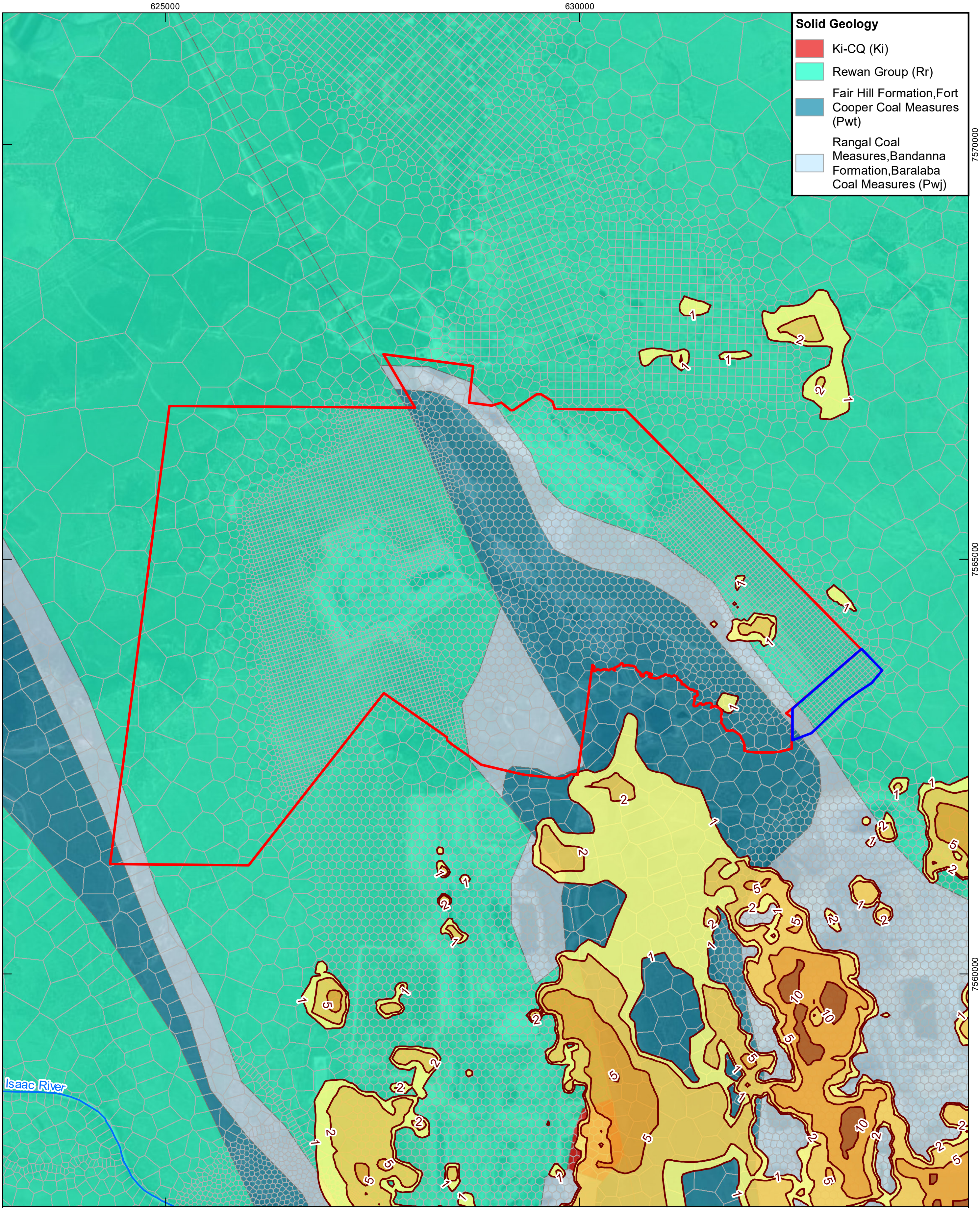
SLR

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

MAXIMUM PREDICTED CUMULATIVE DRAWDOW IN QUATERNARY ALLUVIUM (2027, END OF MINING)

FIGURE 33

H:\Projects-SLR\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620031508 F33 Maximum Predicted Cumulative Drawdown in Quaternary Alluvium (2027 End of Mining).mxd



H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620031508 F34 Maximum Predicted Cumulative Drawdown in Regolith(2027 End of Mining).mxd

0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:60,000 at A4
Project Number:	620.031508
Date:	21-Sep-2023
Drawn by:	AS

SLR

- Major Drainage System
- Maximum Drawdown Contour (m)
- Project Boundary
- Project Mining Lease Boundary
- Model Grid

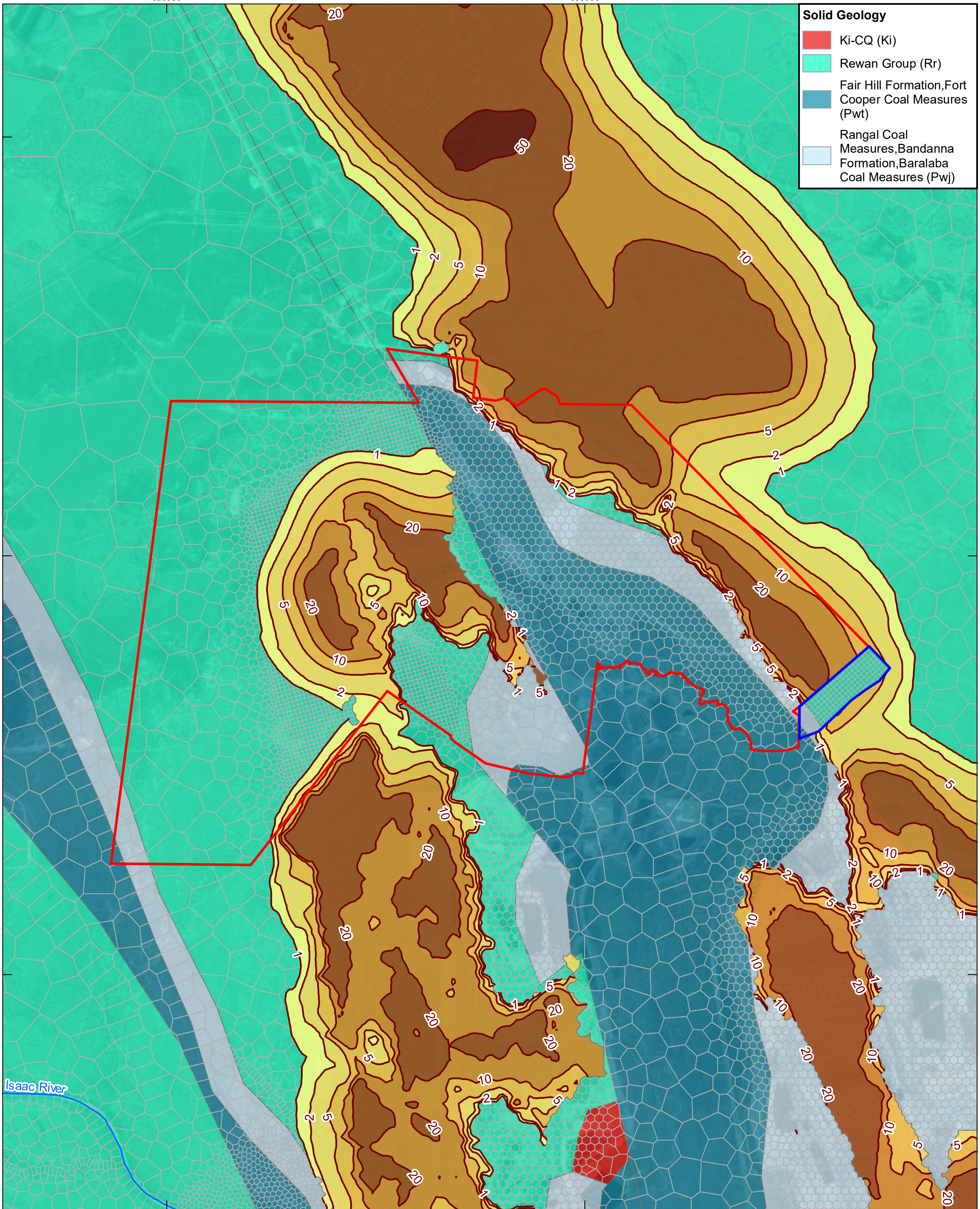
Maximum Drawdown (m)

- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

MAXIMUM PREDICTED CUMULATIVE DRAWDOW IN REGOLITH (2027, END OF MINING)

FIGURE 34



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:60,000 at A4
Project Number:	620.031508
Date:	21-Sep-2023
Drawn by:	AS

SLR

Major Drainage System

Maximum Drawdown Contour (m)

Project Boundary

Project Mining Lease Boundary

Model Grid

Maximum Drawdown (m)

1 - 2

2 - 5

5 - 10

10 - 20

20 - 50

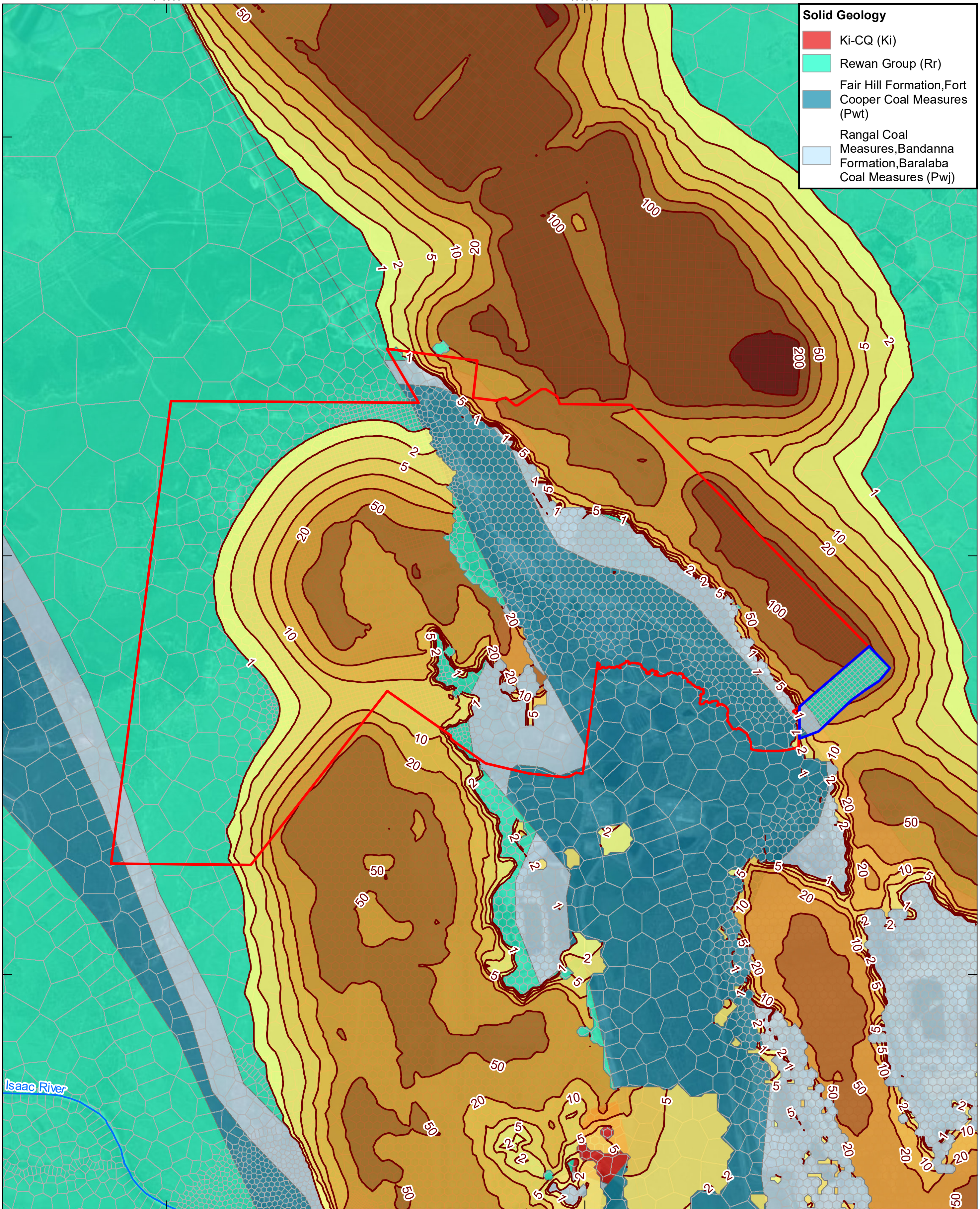
50 - 100

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

MAXIMUM PREDICTED CUMULATIVE DRAWDOW IN REWAN GROUP (2027, END OF MINING)

FIGURE 35

H:\Projects-SLR\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620031508 F35 Maximum Predicted Cumulative Drawdown in Rewan Group (2027 End of Mining).mxd



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:60,000 at A4
Project Number:	620.031508
Date:	21-Sep-2023
Drawn by:	AS

SLR

Major Drainage System

Maximum Drawdown Contour (m)

Project Boundary

Project Mining Lease Boundary

Model Grid

Maximum Drawdown (m)

- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- 200 - 500

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

MAXIMUM PREDICTED CUMULATIVE DRAWDOW IN LEICHARDT SEAM (2027, END OF MINING)

FIGURE 36

H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620031508 F36 Maximum Predicted Cumulative Drawdown in Leichardt Seam (2027 End of Mining).mxd

6.6.3 Predicted Mine Inflows

Mine inflow volumes for Millennium Mine have been calculated as time weighted averages of the outflow reported by ZoneBudget software for Millennium drain cells. The predicted groundwater inflows to Mavis South Pit from 2023 to the end of mining are presented in **Figure 37**.

The inflow due to the proposed Mavis South Underground is predicted to occur in 2025 and 2026. The maximum predicted inflow in this period is 71.5 ML/year for year 2026. The inflow due to the Mavis Approved underground mining fluctuates throughout these years with an overall increase from 32.9 ML/year in 2023 to 131.4 ML/year in 2027. **Figure 37** also shows the totals for both the Mavis Approved and Mavis South underground mines, which has a maximum in 2026 with approximately 150 ML/year.

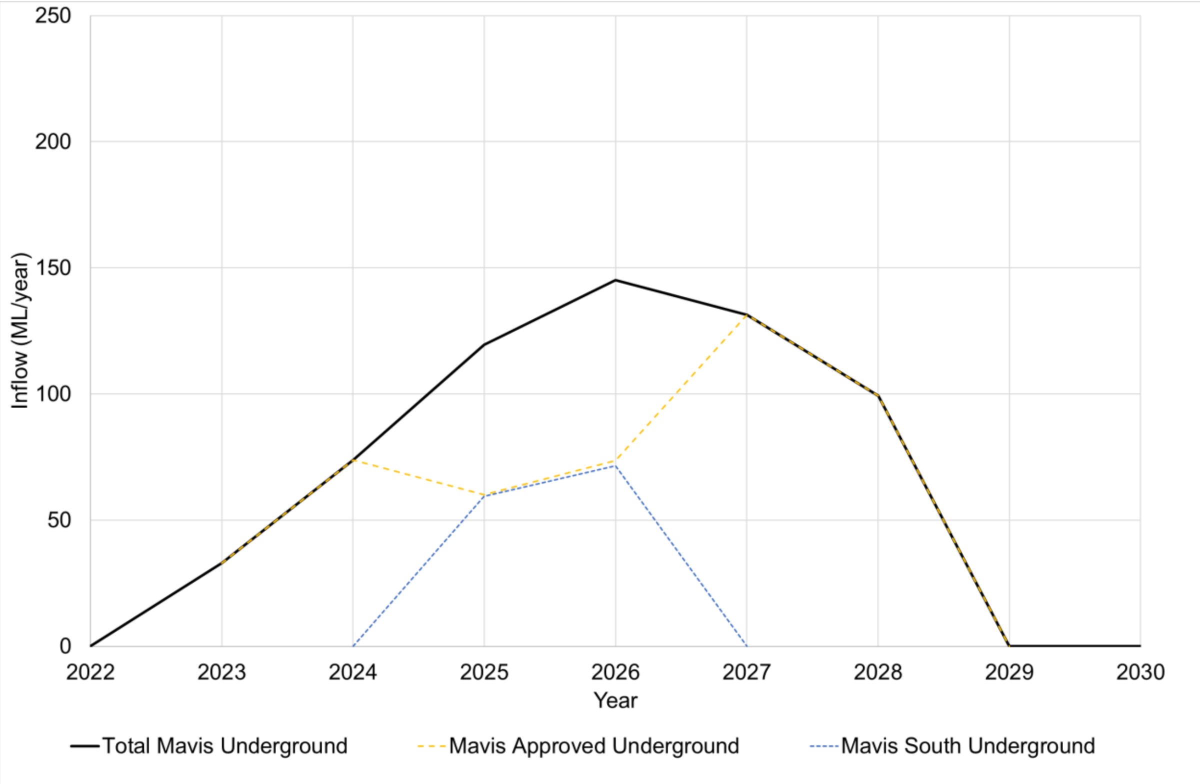
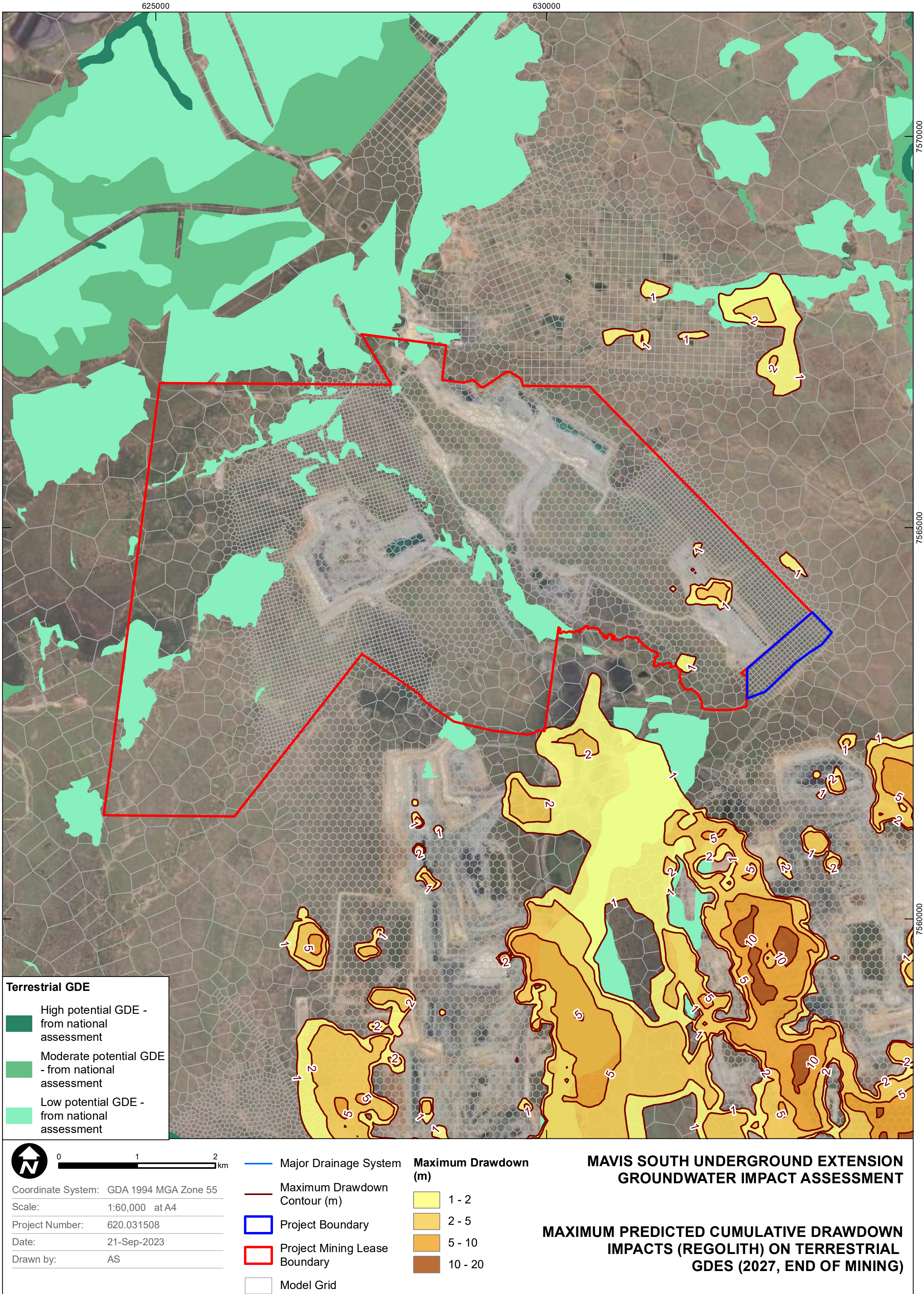


Figure 37 Predicted Groundwater Inflows (2023 to End of Mining)

6.6.4 Predicted Impacts on GDEs and Landholder Bores

The extent of predicted cumulative drawdown impacts in the regolith and identified GDEs in the model domain are shown in **Figure 38**. Low potential GDEs 1.5 km south-west of the Project are predicted to be impacted by up to 2 m of drawdown in the regolith.

As the incremental drawdowns associated with underground mining at Mavis South have predicted extents less than 1 km from the pit, the cumulative drawdowns shown in **Figure 38**, predicted to impact the low potential GDEs, are likely a result of simulated surrounding and historical mining.



MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

MAXIMUM PREDICTED CUMULATIVE DRAWDOWN IMPACTS (REGOLITH) ON TERRESTRIAL GDES (2027, END OF MINING)

FIGURE 38

H:\Projects-SLR\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620031508 F38 Maximum Predicted Cumulative Drawdown in Regolith on GDEs_v2.mxd

Table 21 shows predicted cumulative water table drawdown at landholder bore locations. Predicted drawdowns at bores no longer in use are not included in the table. Two landholder bores were identified to be within the predicted water table drawdown extent. Cumulative (all mining) drawdowns at bore 105427, screened in the Rewan Group, and at Bore 8, screened in the Quaternary Alluvium, are predicted to be 11.13 and 7.59 m, respectively.

There is no predicted incremental from the Project (Mavis South UG) water table drawdown at bore 105427 or Bore 8, as the maximum predicted incremental water table drawdown extends only 1 km from Mavis South Pit. As bore 105427 is located within the Carborough Downs Mine area, predicted cumulative drawdown impacts at this location are likely to be caused by simulated mining at Carborough Downs Mine. The water table drawdown predicted in the cumulative (Mavis South UG) scenario at Bore 8 is likely to be associated with simulated surrounding or historical mining.

Table 21 Predicted Cumulative (Mavis South UG) Water Table Drawdown at Landholder Bore Locations

Bore	Depth mbgl	Geology	Status	Predicted Cumulative Water Table Drawdown (m)	Predicted Incremental Water Table Drawdown (m)
Bore 1	Unknown	Rangal Coal Measures	Unknown	0	0
81909	60	Rewan Group	In use	0	0
105427	100	Rewan Group	In use	11.13	0
13040284	19	Rangal Coal Measures	Unknown	0	0
Bore 8	Unknown	Quaternary Alluvium	Unknown	7.59	0
105677	67.7	Tertiary Basalt	In use	0	0
131002	63	Tertiary Basalt	Unknown	0	0

6.6.5 Recovery Period

The predicted groundwater recovery at the Millennium Mine monitoring bores is shown in **Figure 39.** The model predicts that the groundwater system at Project area is being influenced by the mining activities at the neighbour mining tenements during the recovery period. The model predicted that groundwater levels in monitoring bore MILLCSMB2, located close to Mavis Approved area will reach equilibrium approximately 420 years post-mining.

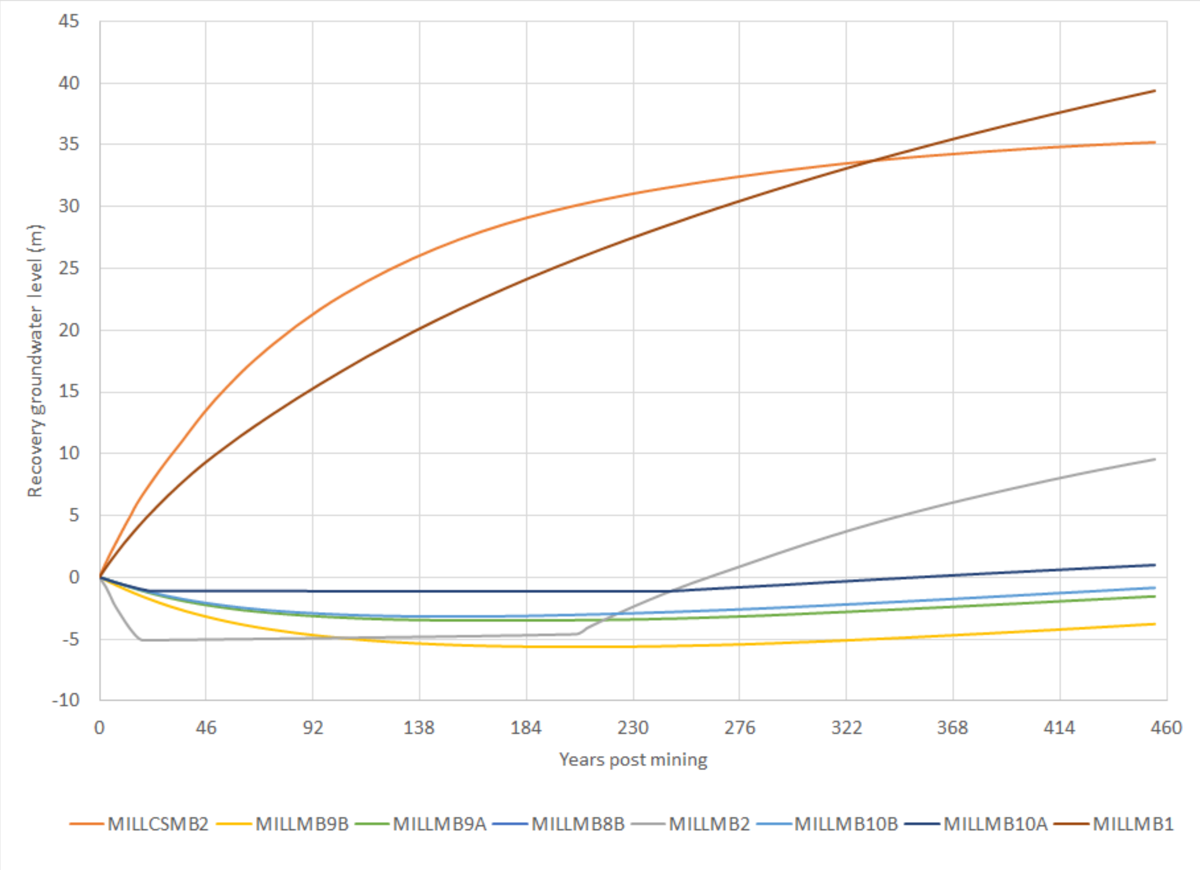


Figure 39 Predicted Groundwater Recovery within the Millennium Mine area

6.7 Sensitivity Analysis Results

The PEST utility GENLINPRED was used to provide an estimate of parameter identifiability for each of the model parameters (see SLR, 2023b for further information about identifiability).

Figure 40 presents the relationship between the identifiability of the Mavis South mine inflows and the identifiability of the calibration. Sensitivity classifications for the sensitivity types have been assigned using judgement based on the range of the identifiability. The results show that the key parameter that require further work to reduce their influence on predictive uncertainty in relation to groundwater inflows include the vertical hydraulic conductivity of the H seam (Layer 16).

Figure 41 presents the relationship between identifiability of the maximum predicted drawdown and the identifiability of the calibration. Sensitivity classifications for the sensitivity types have been assigned using judgement based on the range of the posterior predictions. The results show that the key parameter that requires further work to reduce its influence on predictive uncertainty in relation to the maximum drawdown extent is vertical hydraulic conductivity of the RCM interburden (Layer 6).

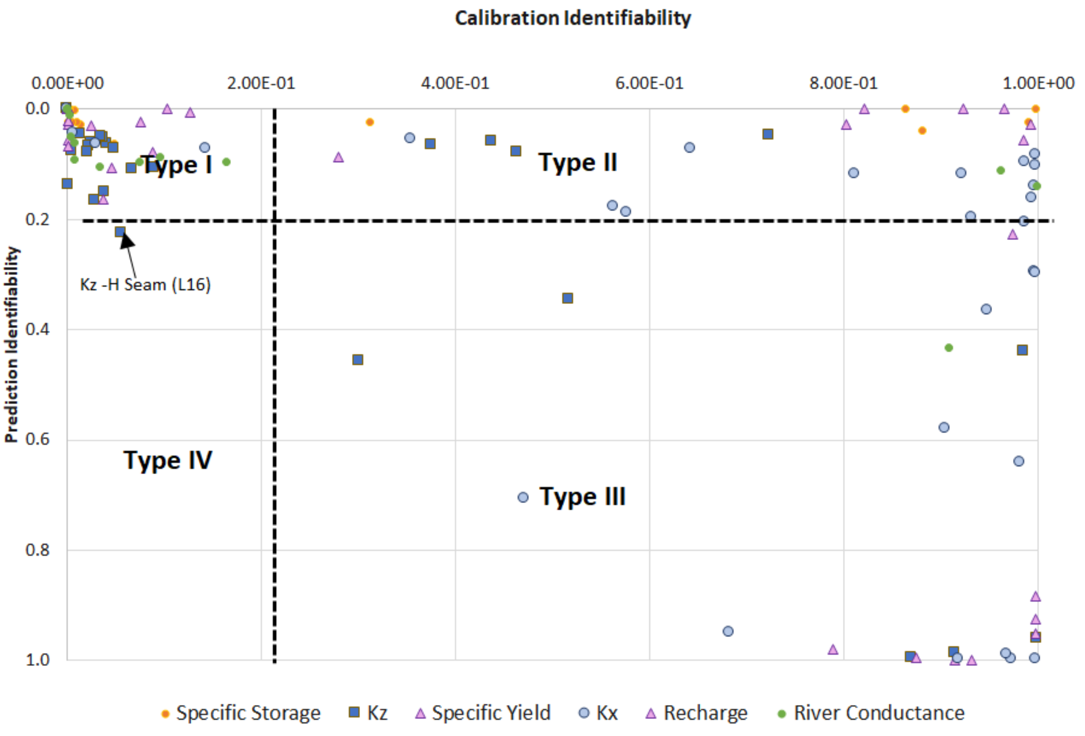


Figure 40 Uncertainty Contribution (Predicted Mine Inflow) versus Identifiability

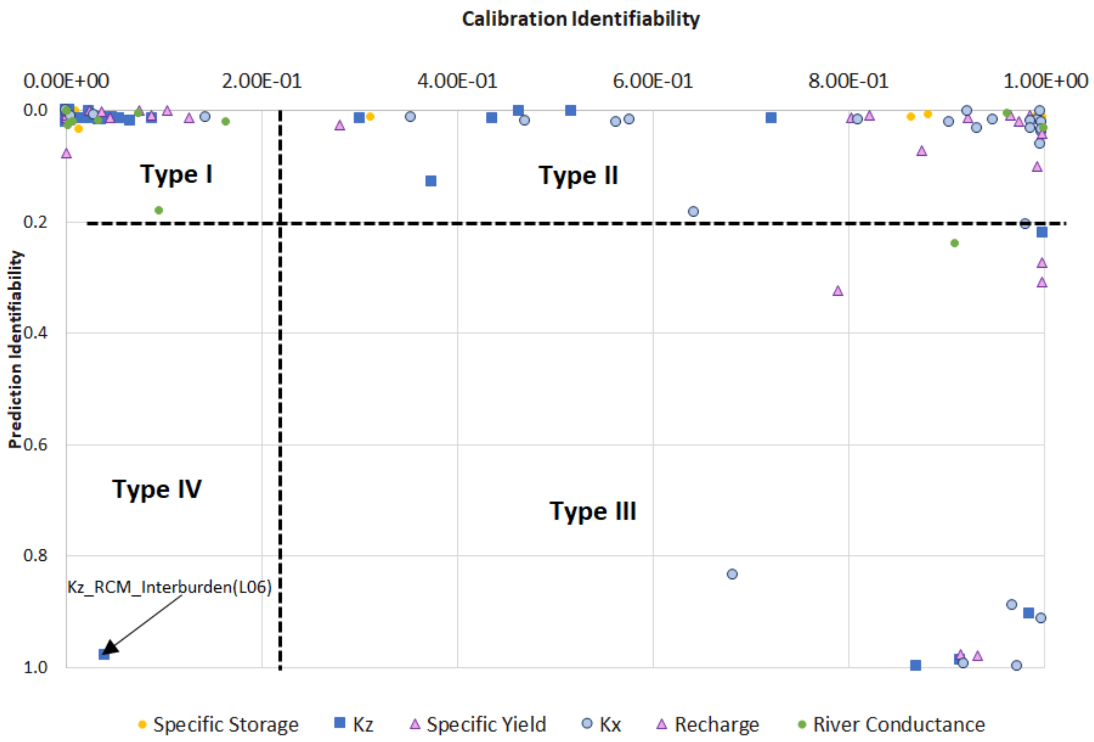


Figure 41 Uncertainty Contribution (Maximum Incremental Drawdown) versus Identifiability

6.8 Uncertainty Analysis Results

A Type 3 Monte Carlo uncertainty analysis was undertaken to estimate the uncertainty in the future impacts predicted by the model. 73 realisations were selected as calibrated realisations and used for uncertainty analysis. The predictive model was run using the 139 parameters sets. The results from the predictive model were used to conduct statistical analyses to assess if additional realisations were likely to provide results that would significantly change the reported predictive results. The 95 % confidence interval was calculated for the mine inflows and the maximum drawdown.

The uncertainty analysis has demonstrated no impact on alluvial water levels for the Project, with Project related drawdown primarily contained within the Project area.

6.8.1 Mine Inflows

Figure 42 shows the predicted inflows for the combined Mavis Approved and Mavis South Underground Mine and different percentiles including 10th, 33rd, 50th, 67th, and 90th prediction bounds. Based on the IESC (2018) guidelines these percentiles represent:

- 10th percentile indicates it is very likely the outcome is larger than this value,
- 10th – 33rd indicates it is likely that the outcome is larger than this value,
- 33rd - 67th indicate it is as likely as not that the outcome is larger or smaller than this value,
- 67th - 90th indicates it is unlikely that the outcome is larger than this value, and
- 90th percentile indicates it is very unlikely the outcome is larger than this value.

The bounds in the figure demonstrate the uncertainty within the predicted inflow rate. The bounds show that the calibrated model generally match the 50th percentile.

As shown in **Figure 42,** the maximum mine inflow in the uncertainty analysis was 638 ML/year (1.75 ML/d) (i.e., very unlikely that the outcome is larger than this value). The average inflows for the 10th to 90th percentiles are 15.5 ML/year (0.04 ML/d) and 127.1 ML/year (0.35 ML/day) respectively. The estimated inflows from the calibrated prediction model are following the 67th percentile lines, which means that the best calibrated model is slightly overpredicting the groundwater inflows.

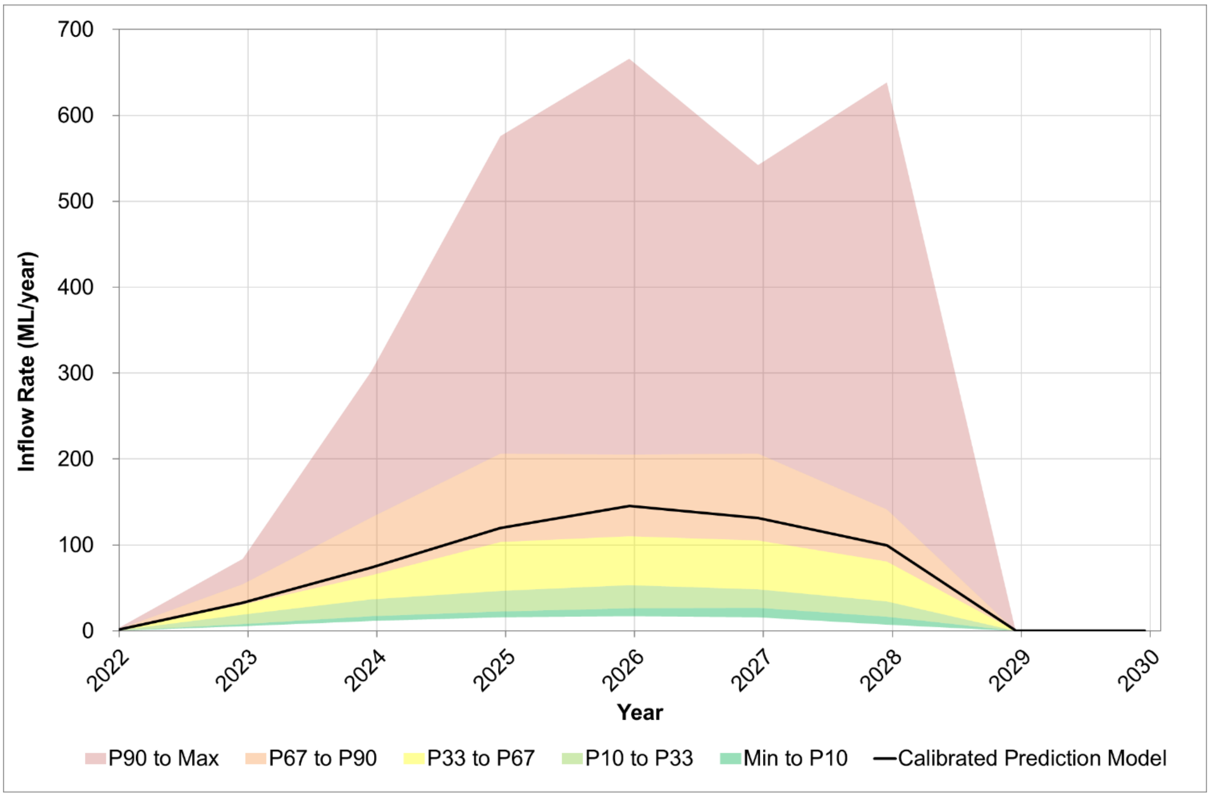


Figure 42 Mine Inflow Uncertainty

6.8.2 Groundwater Drawdowns Uncertainty

To illustrate the level of uncertainty in the extent of predicted maximum incremental drawdown, the 1 m drawdown due to the Project is compared to 5th, 50th and 95th percentiles maximum drawdown from the uncertainty analysis.

The 95th percentile lines show the predicted maximum drawdown extent exceeded by 5% of tested realisations. Therefore, drawdown extent greater than the 95th percentile area is an unlikely outcome. The 5th percentile lines in the figures show the predicted maximum drawdown extent exceeded by 95% of tested realisations. Therefore, it is highly likely that the actual extent will be greater than that shown for the 5th percentile. The 50th percentile lines show the predicted maximum drawdown extent exceeded 50% of tested realisations. Therefore, these predictions are considered as likely outcomes.

The uncertainty results for the 95th percentile indicate that it is highly unlikely the Mavis South Underground project will result in additional impacts on the alluvium and regolith, and hence no maps are shown for those two layers.

Figure 43 shows the uncertainty in the extent of predicted 1 m maximum incremental drawdown in Rewan formation. As shown in this figure, the 95th percentile maximum drawdowns in the Rewan extends approximately between 0.8 km to the east and 10 km to the south of the Project area.

Figure 44 shows the uncertainty in the extent of predicted 1 m maximum incremental drawdown in the Leichhardt Seam. The figures show that the 95th percentile drawdown in Leichhardt Seam extends between 2.6 and 2.1 km to the northeast and southeast of the Project area, whereas, the calibrated prediction model extends approximately between 0.84 and 0.92 km to the northeast and southeast of the Project area.

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Drawn by:	AS

MAVIS SOUTH UNDERGROUND EXTENSION
GROUNDWATER IMPACT ASSESSMENT

UNCERTAINTY IN PREDICTED
1 M MAXIMUM INCREMENTAL
DRAWDOWN IN REWAN GROUP (LAYER 3)

FIGURE 43

H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Modelling Report\620031508 MOD F6-05 Uncertainty in Predicted 1 m Maximum Incremental Drawdown in Rewan Group.mxd

H:\Projects-SLR\620-BNE\620-BNE\620.031508.00001 Millennium Mine - Mavis South\06 SLR Data\01 CADGIS\GIS\Modelling Report\620031508 MOD F6-06 Uncertainty in Predicted 1 m Maximum Incremental Drawdown in Leichardt Seam.mxd

0 0.5 1 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	620.031508
Date:	07-Nov-2023
Drawn by:	AS

Watercourses
Project Boundary
Mining Lease Boundary

1m Drawdown
5th Percentile
50th Percentile
95th Percentile
Basecase

MAVIS SOUTH UNDERGROUND EXTENSION GROUNDWATER IMPACT ASSESSMENT

UNCERTAINTY IN PREDICTED 1 M MAXIMUM INCREMENTAL DRAWDOWN IN LEICHARDT SEAM (LAYER 5)

SLR

FIGURE 44

6.9 Model Limitations

The groundwater modelling was conducted in accordance with the Australian Groundwater Modelling Guidelines (Barnett *et al*. 2012), the MDBC Groundwater Flow Modelling Guideline (MDBC, 2001) and the released IESC Explanatory Note for Uncertainty Analysis (Peeters and Middlemis, 2023).

Overall, the model captures depressurisation due to active mining. The model is numerically stable with no mass balance error. The model shows a good fit between observed and modelled groundwater levels. Overall, the model is considered fit for purpose to achieve the model objectives based on the data provided and the Project timeframe. Updates could be conducted in future to further refine the model, but this would be dependent on the purpose of the modelling and availability of data to inform future changes.

The model sensitivity was explored for an array of parameters. This showed that these parameters were generally well constrained by the calibration. For the predictions, two parameters fell into the type 4 error, which has low identifiability, but high predictive uncertainty.

The uncertainty analysis was undertaken to add a likelihood estimate to the prediction for the main two quantities of interest, the groundwater inflows and predicted drawdowns in a multitude of relevant geological formations.

7.0 Monitoring Program

The current monitoring requirements as presented in EA EPML00819213 for approved mining at Millennium Mine were reviewed to assess the suitability for future monitoring of impacts due to the proposed underground mining at the Project.

7.1 Monitoring Locations and Aquifers

The groundwater monitoring bore network as per the current EA EPML00819213 allows for the compilation of groundwater monitoring data from the Rangal Coal Measures and Fort Cooper Coal Measures for the currently approved operations at Millennium. **Table 22** lists the groundwater monitoring bores specified in this EA with their location, depth, and monitored horizon.

One additional bore, CS-MB2 was agreed with DES to monitor drawdown impacts at Mavis Approved; this is located to the east of the Mavis Approved footprint. Therefore, with the addition of this bore to the monitoring network, it is envisaged that this existing monitoring network at Millennium Mine is sufficient to monitor impacts from the Project. This is due to the Project being a small extension of Mavis Approved and of only one-year in length. Therefore, no additional bores are recommended. It is recommended that groundwater monitoring according to the current EA EPML00819213 should continue for the duration of the Project.

Table 22 Groundwater Monitoring Program

Monitoring Site	Latitude (GDA94 Z55	Longitude (GDA94 Z55)	Bore Depth (mbgl)	Proposed Aquifer for amended EA	Monitoring Frequency	SWL	Water quality
MB2	22°1'50"S	148°14'18"E	90	Rangal Coal Measures (Coal)	Quarterly	yes	no
MB8A	22°0'28"S	148°14'3"E	30	Rewan Group	Quarterly	yes	yes
MB8B	22°0'28"S	148°14'3"E	80	Rangal Coal Measures (Sandstone)	Quarterly	yes	yes
MB9A	22°0'34"S	148°14'43"E	30	FCCM (Coal Seam)	Quarterly	yes	yes
MB9B	22°0'34"S	148°14'43"E	80	FCCM (Sandstone)	Quarterly	yes	yes
MB10A	22°1'33"S	148°16'0"E	35	FCCM (Sandstone)	Quarterly	yes	yes
MB10B	22°1'33"S	148°16'0"E	80	FCCM (Sandstone)	Quarterly	yes	yes
CS_MB2	22°1’10”S	148°17’16”E	170	Rangal Coal Measures (Coal)	Quarterly	yes	no

7.2 Monitoring Parameters and Frequency

The proposed monitoring parameters and frequency are listed in **Table 22**.

The principal contaminants of concern associated with coal mining are linked to mine-impacted water. It includes potential change to salinity and pH, modification of the ionic composition of water and introduction of potential toxic levels of metal, metalloids, and hydrocarbons.

The existing EA for mining leases adjacent to the Project include stressors that are directly toxic to biota (pH, salinity, heavy metals, and petroleum hydrocarbon). As part of the full water quality monitoring, in addition to collecting field parameters (EC and pH), water samples will be submitted to a NATA accredited laboratory for analysis of:

- physiochemical indicators (total dissolved solids (TDS)).
- major ions (calcium, magnesium, sodium, potassium, chloride, sulphate, bicarbonate, carbonate).
- total and dissolved metals: iron, silver, arsenic, mercury, antimony, molybdenum, and selenium.
- total petroleum hydrocarbons (C6-C9, C10-C14, C15-C28, and C29-C36) with silica gel clean-up.

7.3 Reporting Requirements

Ongoing from the existing reporting requirements outlined in EA EPML00819213, the following processes will be adhered to:

- The groundwater monitoring at all bores will be conducted on a quarterly basis.
- Data will be stored within the existing consolidated groundwater database.
- Quality assurance and quality control procedures, such as field sampling procedures and the use of NATA accredited laboratories, will continue to be in place to assess the accuracy of data entered into the database.

In accordance with the current EA, findings from the quarterly monitoring events will continue to be documented:

- The quarterly review will include identification of any groundwater quality trigger exceedances.
- Where a trigger exceedance is identified, the regulator will be notified within 28 days and an investigation into the potential for environmental harm will be completed. The groundwater database and factual quarterly documentation will be available for provision to the regulator upon request.
- Each year an annual review of groundwater level and quality trends will be conducted by a suitably qualified person and provided to the regulator. The review will assess the change in groundwater level and quality over the year, compared to historical trends and impact assessment predictions. The annual review will discuss any groundwater trigger exceedances or where trends show potential for environmental harm.

MetRes (Millennium Mine), under the Mineral Resources Act 1989 (section 334ZP) as the holder of the ML is entitled to take or interfere with underground water (i.e., associated water) covered by the holder’s ‘underground water rights’ if the taking is part of or results from carrying out the authorised activity. Under Section 31 of the Mineral Resources Regulation 2013, Millennium Mine must measure and report on the taking of associated water on an annual basis.

For the Project approval, a new mining lease is required. Reporting requirements will be updated if deemed necessary from the Underground Water Impact Reporting (UWIR) framework under the Water Act, Section 3.

8.0 Conclusions and Recommendations

The groundwater assessment undertaken for the EA amendment for continued underground mining at Mavis South has shown:

- The regional land use is dominated by mining and grazing.
- Surface water in the area is ephemeral and does not have a significant groundwater baseflow component.
- The water quality in the coal measures is generally saline and not widely used.
- The impact assessment was carried out as incremental (difference between all active and foreseeable mining excluding Mavis South against all active and foreseeable mining including Mavis South) and cumulative (difference between a no mining scenario and all active and foreseeable mining including Mavis South).
- Underground mining at Mavis South has a negligible incremental impact on the shallow groundwater system. No landholder bores or GDEs are impacted by the mining at Mavis South, on top of the cumulative impacts predicted by regional mining.

The Mavis South extension is not adding to the Mavis Approved impacts and hence the network designed for Mavis approved is deemed adequate. Reporting requirements will be kept the same as for the Mavis approved.

9.0 References

AGE (2014). *MILLENNIUM MINE, MAVIS PIT – GROUNDWATER REVIEW*, Letter report, dated 10 February 2014.

AGE (2020). *Isaac Downs Groundwater Impact Assessment.* Prepared for Stanmore, IP South Pty Ltd. Project No. G1803D, November 2020

A. Babaahmadi, P. Brooks & M. Grant (2020). *Postorogenic structural style and reactivation in the northern Bowen Basin,* Eastern Australia, Australian Journal of Earth Sciences

ANZG (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments*, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines

Barnett, B, Townley, L.R., Post, V., Evans, R.E., Hunt, R.J., Peeters, L., Richardson, S., Werner, A.D., Knapton, A. and Boronkay, A (2012). *Australian Groundwater Modelling Guidelines.* Waterlines report 82, National Water Commission, Canberra

Coffey (2014). *Appendix E - Supplementary Groundwater Assessment, Arrow Energy Bowen Gas Project*. Supplementary Report to the EIS. 17 April 2014.

Department of the Environment and Energy (DEE) (2019). *Environment Protection and Biodiversity Conservation Act 1999 Protected Matters Database*. Available at: https://www.environment.gov.au/epbc/protected-matters-search-tool

Department of Environment and Science (DES) (2013). *Guideline Resource activity – mining Model water conditions for coal mines in the Fitzroy basin*, ESR/2015/1561

DES (2016). *Requirements for site-specific and amendment applications—underground water rights - EP Act*.

DES (2017). *Underground water impact reports and final reports - Water Act*.

Department of Environment and Science (DES) (2019). *Queensland Springs Database*.

Department of Environment and Science (DES) (2021). *Using monitoring data to assess groundwater quality and potential environmental impacts.*

Department of Environment and Heritage Protection (DEHP) (2011). *Environmental Protection (Water) Policy 2009. Fitzroy River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Fitzroy River Sub-basin*. September 2011

Doody TM, Hancock PJ, Pritchard JL (2019). *Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems*. Report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2019.

Environmental Protection Agency (EPA) (2005). *EIS Assessment Report – Poitrel Coal Mine Project*.

Fitzroy, 2023: https://fitzroyoz.com.au/operations/, accessed 03 October 2023

Flodin, E.A., Aydin, A., Durlofsky, L.J. and Yeten, B. (2001). *Representation of Fault Zone Permeability in Reservoir Flow Models*. SPE Annual Technical Conference and Exhibition, New Orleans, Louisiana.

Geoscience Australia (2017). *Bowen Basin*. Available at: http://www.ga.gov.au/scientific-topics/energy/province-sedimentary-basin-geology/petroleum/onshore-australia/bowen-basin

GHD (2017). *Caval Ridge Mine Numerical Groundwater Model*, Prepared for BHP, Project number 31/34006/03, December 2017

Golder Associates (2019). *Olive Downs North Stage 2 ODN Hydrogeological Factual Report*. Report for Peabody Energy Australia Coal Pty Ltd, May 2019.

Hancock PJ and Boulton AJ (2008). Stygofauna biodiversity and endemism in four alluvial aquifers in easternAustralia. Invertebrate Systematics, 22: 117–126.Hawkins, 1998

Hose, G.; Janardhanan, S.; Barron, O.; Pollino, Carmel (2015). *Stygofauna in Australian groundwater systems: Extent of knowledge.* Australia: CSIRO; 2015. CSIRO:EP158350. https://doi.org/10.4225/08/58518bb3e6222

HydroSimulations (2018). *Olive Downs Groundwater Impact Assessment.*

IESC (2018a). *Information guidelines for proponents preparing coal seam gas and large coal mining development proposals – EPBC Act*

IESC (2018b). *Information Guidelines explanatory note. Uncertainty analysis—Guidance for groundwater modelling within a risk management framework – EPBC Act*

JBT Consulting (2015). *Mavis Pit E30A Extension Groundwater Seepage Assessment.* Report prepared for Peabody Energy Ltd. Report No: JBT01-064-001

Flodin, E.A., Aydin, A., Durlofsky, L.J. and Yeten, B. (2001). *Representation of Fault Zone Permeability in Reservoir Flow Models*. SPE Annual Technical Conference and Exhibition, New Orleans, Louisiana.

Jourde *et al*. (2002). *Computing permeability of fault zones in eolian sandstone from outcrop measurements*. AAPG Bulletin, v. 86, no. 7, p. 1187–1200

Kinnon, E. C. (2010). *Analysis of Gas and Water Production Pathways in Coal Seams*. Masters of Philosophy thesis, University of Queensland

MatrixPlus (2010). *Millennium Expansion Project: Environmental Impact Statement, Appendix F4 - Groundwater*. Report prepared for Peabody Energy Ltd. Report No: PEA801

MDBC (Middlemis, H., Merrick, N., and Ross, J.), (2000). *Murray-Darling Basin Commission – Groundwater Flow Modelling Guideline*. Report for MDBC.

Panday, S, Langevin, CD, Niswonger, RG, Ibaraki, Motomu, & Hughes, JD, (2013), *MODFLOW– USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation*: U.S. Geological Survey Techniques and Methods, book 6, chap. A45, 66 p. < https://pubs.usgs.gov/tm/06/a45>

Peeters LJM and Middlemis H (2023). *Information Guidelines Explanatory Note: Uncertainty analysis for groundwater modelling*, A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of Climate Change, Energy, the Environment and Water, Commonwealth of Australia, 2023

Peabody (2010). *Millennium Expansion Project. Environmental Impact Statement*.

Peabody (2020). *MILLENNIUM COAL MINE WATER MANAGEMENT PLAN*. Version dated December 2020

QLD Government SILO (2023). *Australian climate data from 1889 to yesterday*. Available at: https://www.longpaddock.qld.gov.au/silo/

SLR (2019a). *MOORVALE SOUTH PROJECT Groundwater Assessment*. Prepared for Peabody Energy. Report Ref: 620.13122.10000-R01-v3.0

SLR (2019b). *Eagle Downs Groundwater Monitoring 2018 Annual Review*. Report prepared for South32, July 2019

SLR (2020). *Winchester South Project EIS. Groundwater Impact Assessment Baseline Report*. Report for Whitehaven Coal. 2020.

SLR (2021) *MILLENNIUM MINE, Supporting documentation to the Environmental Authority (EPML00819213) amendment application. Mavis Underground operations - Groundwater Impact Assessment*. State considerations, report no SLR Ref: 620.30404.00000-R01, Version No: -v3.0, October 2021

SLR (2021a). *CAVAL RIDGE MINE Horse Pit Extension Project Groundwater Impact Assessment.* Prepared for BHP. Report Ref: 620.13593.00005-R01-v1.0

SLR (2023a). Millennium Mine: *Groundwater Network Review and Trigger Assessment*. Report No: 620.30802.00000-R02-v3.0. February 2023.

SLR (2023b). *Millennium Mine: Groundwater Technical Modelling report for the Mavis South Extension, prepared for MetRes*, No: 620.031508.00001-R03, in preparation.

SLR (2023c). *Millennium Mine: Underground Water Impact Report for the Mavis South Extension*, prepared for MetRes, No: 620.031508.00001-R04, in preparation.

WRM Water and Environment (2010). *MILLENNIUM EXPANSION PROJECT SURFACE WATER ASSESSMENT,* Report 0570-02-A[Rev3]

Appendix A Monitoring Bore Water Quality Plots

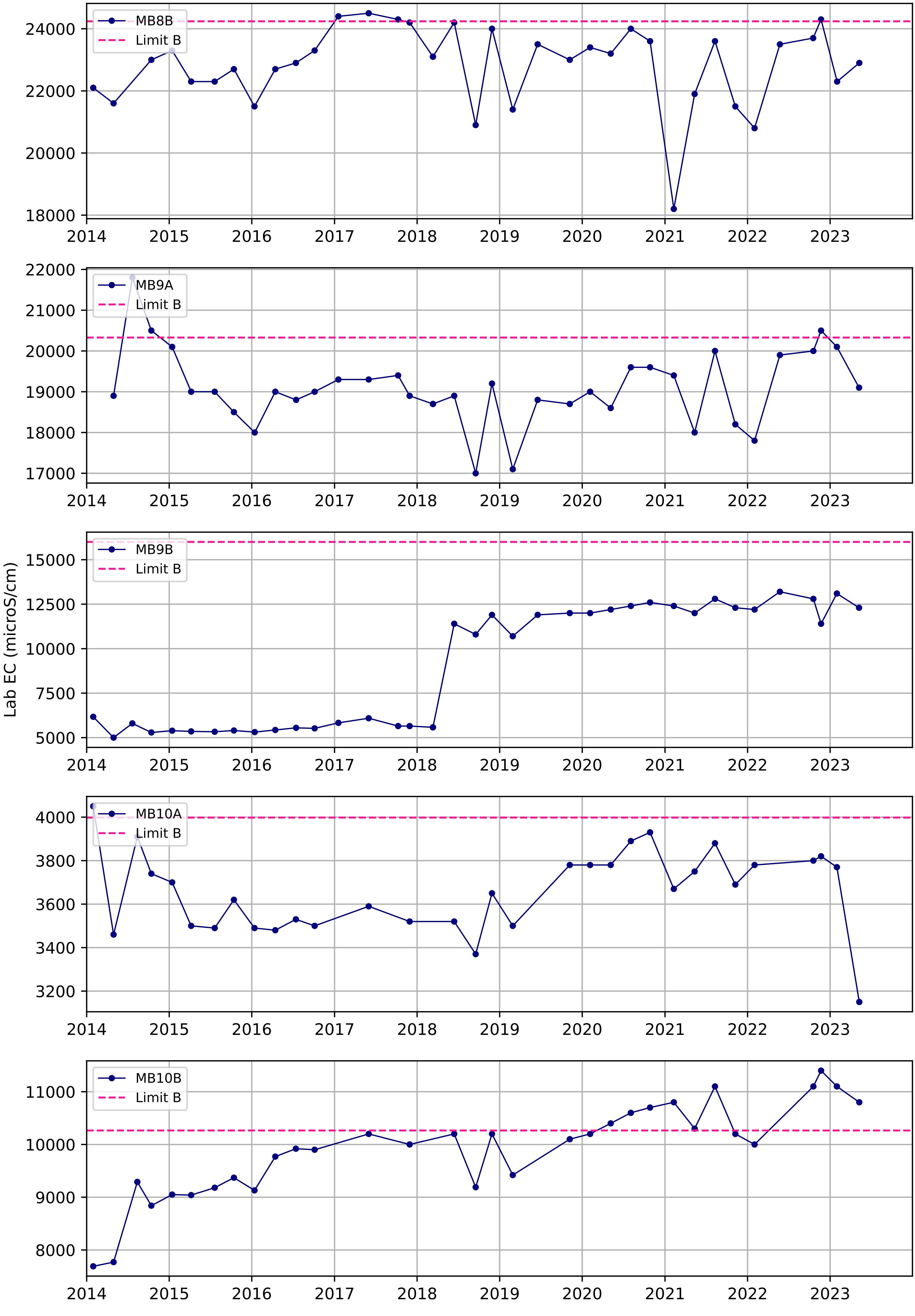
Millennium Mine – Mavis South Extension Project

Supporting documentation to the Environmental Authority (EPML00819213) amendment application Mavis South Underground operations – Groundwater Impact Assessment: State considerations

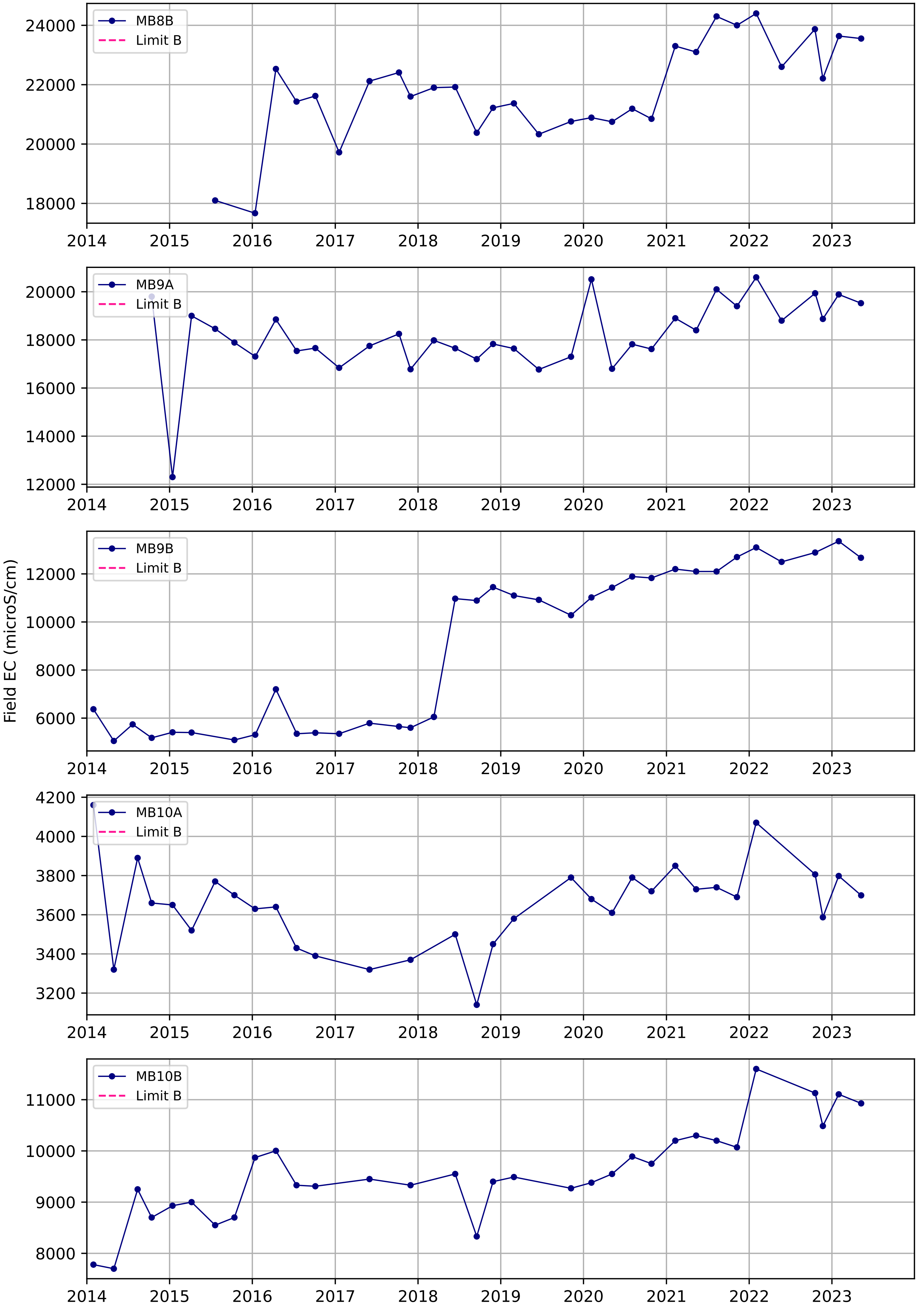
MetRes Pty Ltd

SLR Project No.: 620.031508.00001

23 November 2023



MB8B
Limit B
MB9A
Limit B
MB9B
Limit B
MB10A
Limit B
MB10B
Limit B
Lab EC (microS/cm)
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023



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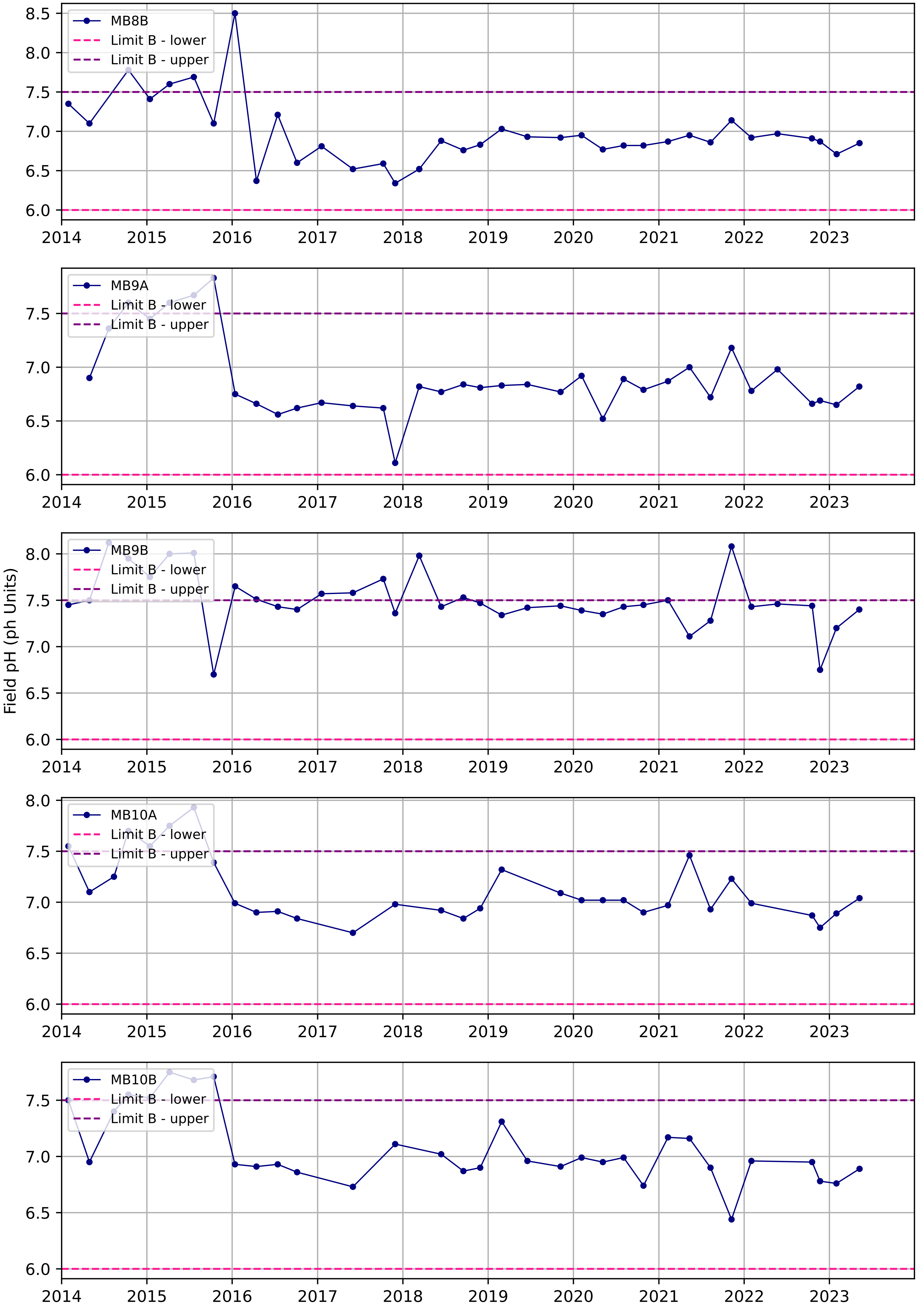
Limit B
MB9A
Limit B
MB9B
Limit B
MB10A
Limit B
MB10B
Limit B
Field EC (microS/cm)
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023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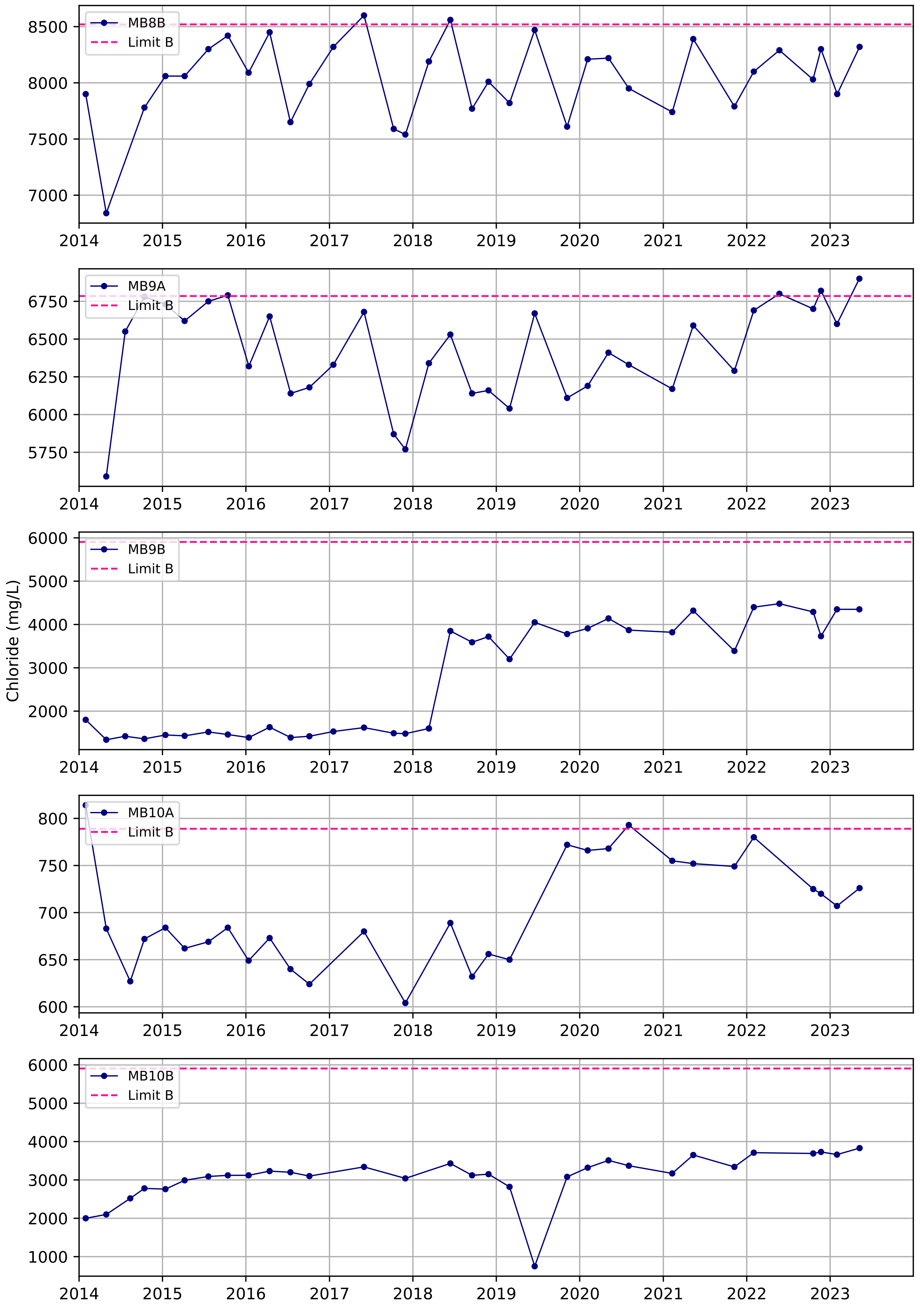
Limit B - lower
Limit B - upper
MB9A
MB9B
MB10A
MB10B
Field pH (ph Units)
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
6.0
6.5
7.0
7.5
8.0
8.5



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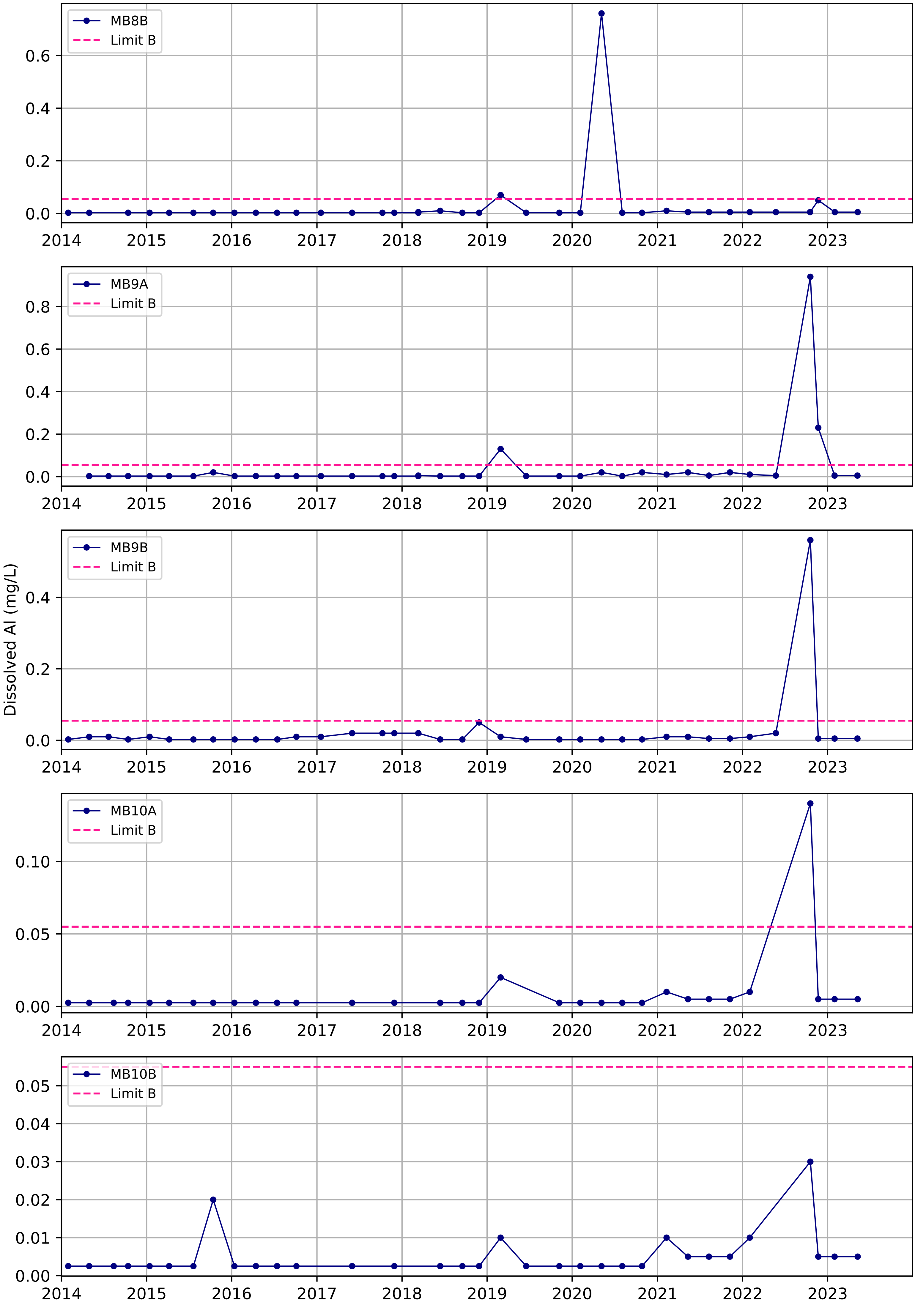
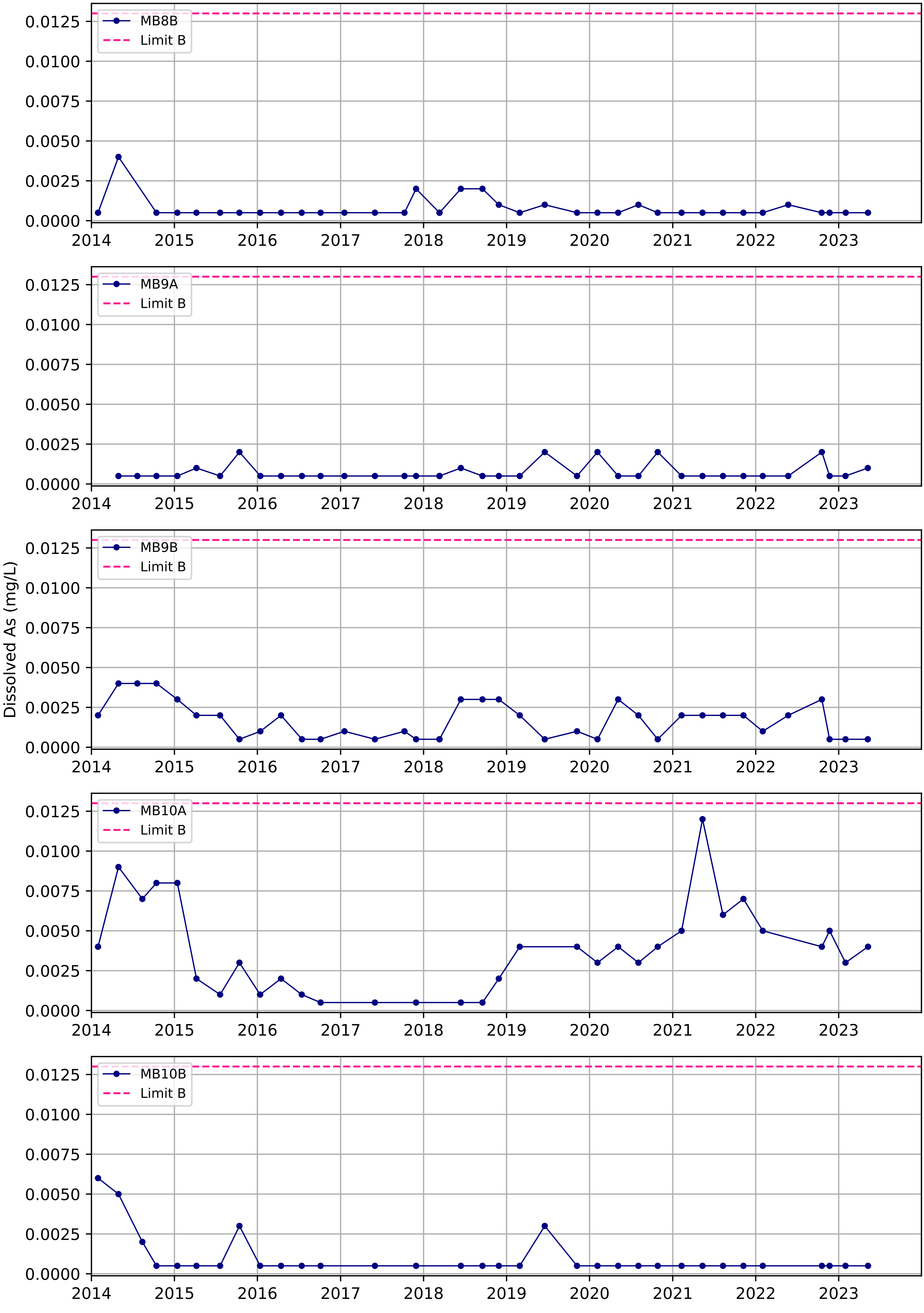
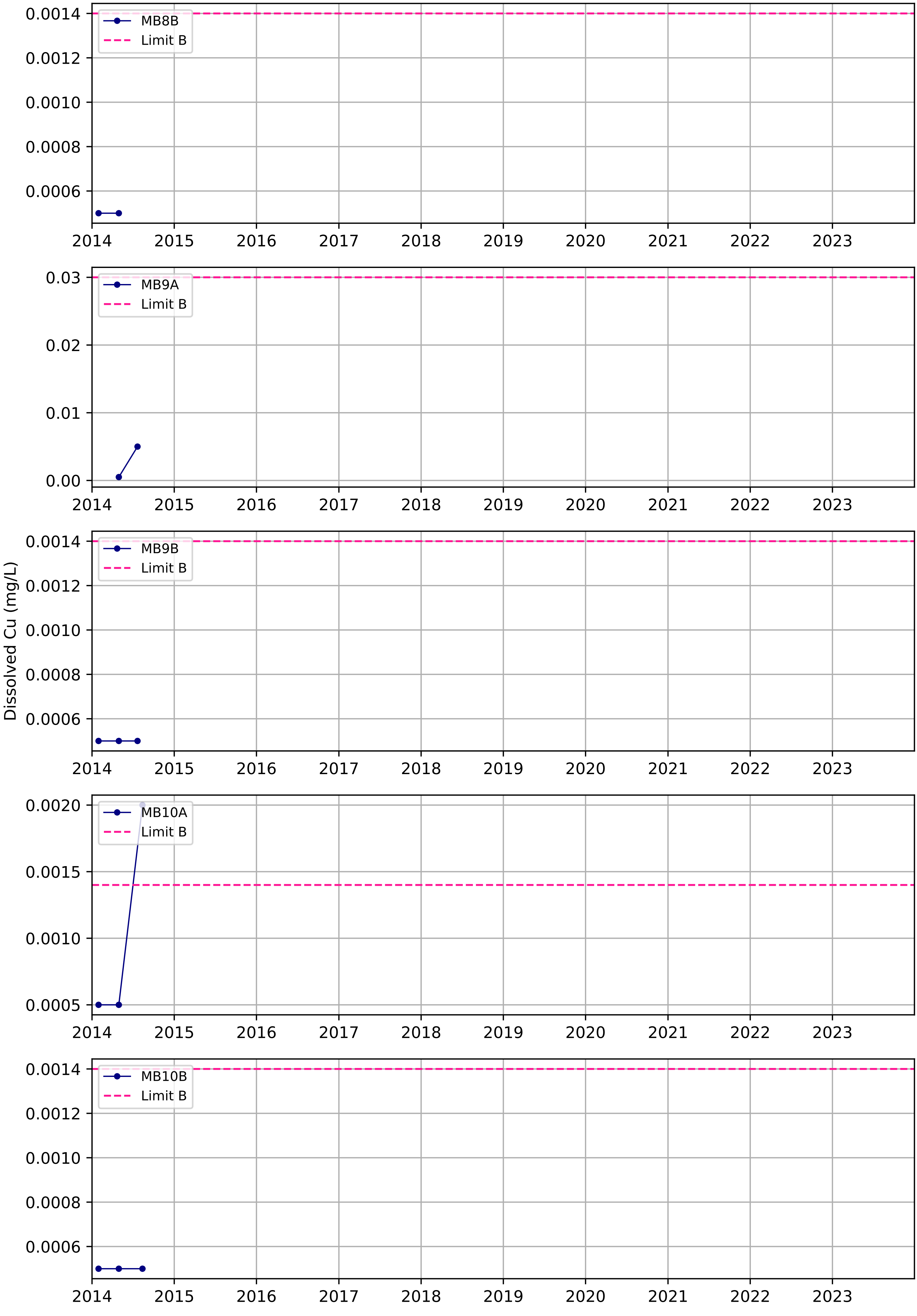
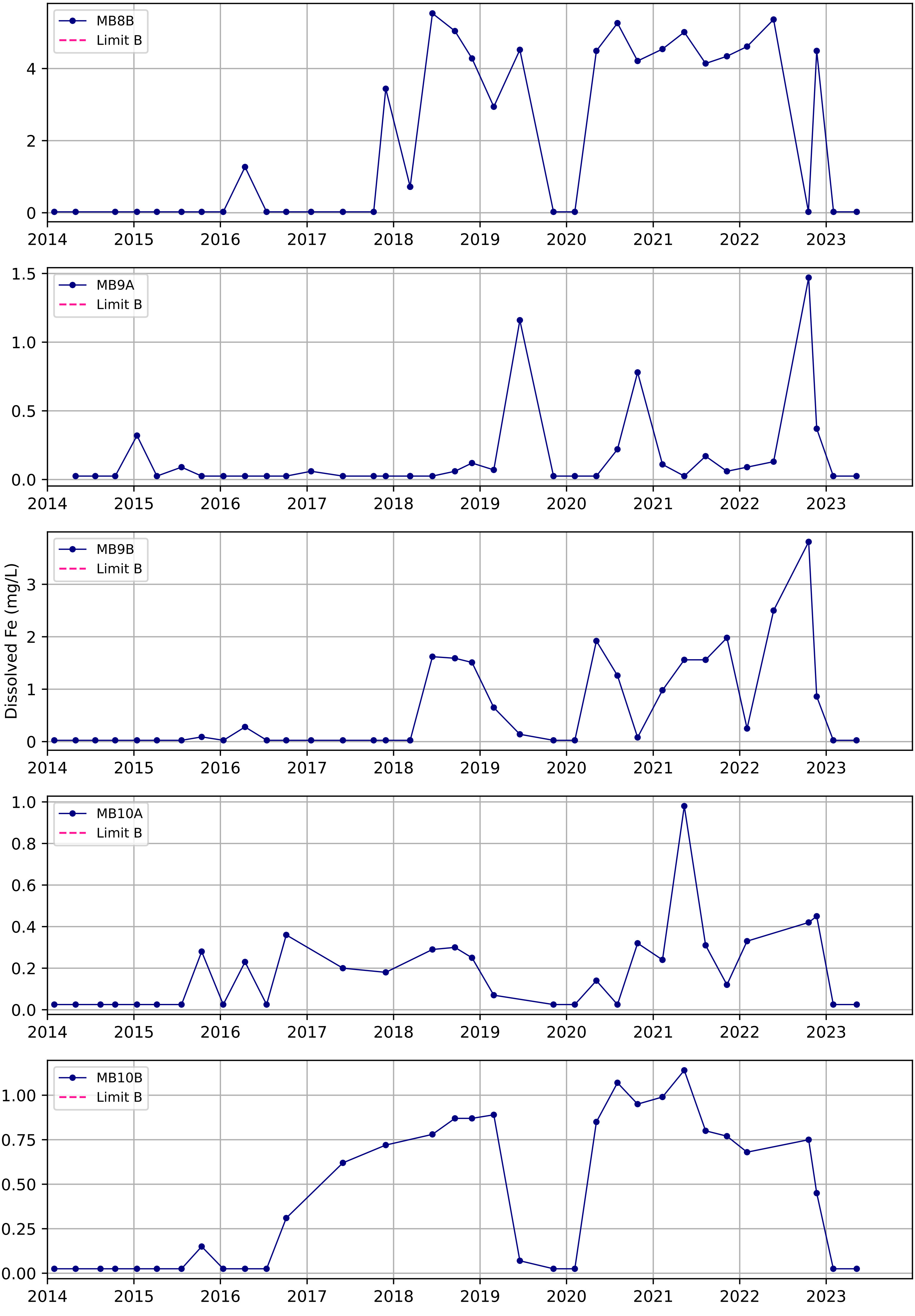
Limit B
MB9A
Limit B
MB9B
Limit B
Chloride (mg/L)
MB10A
Limit B
MB10B
Limit B
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

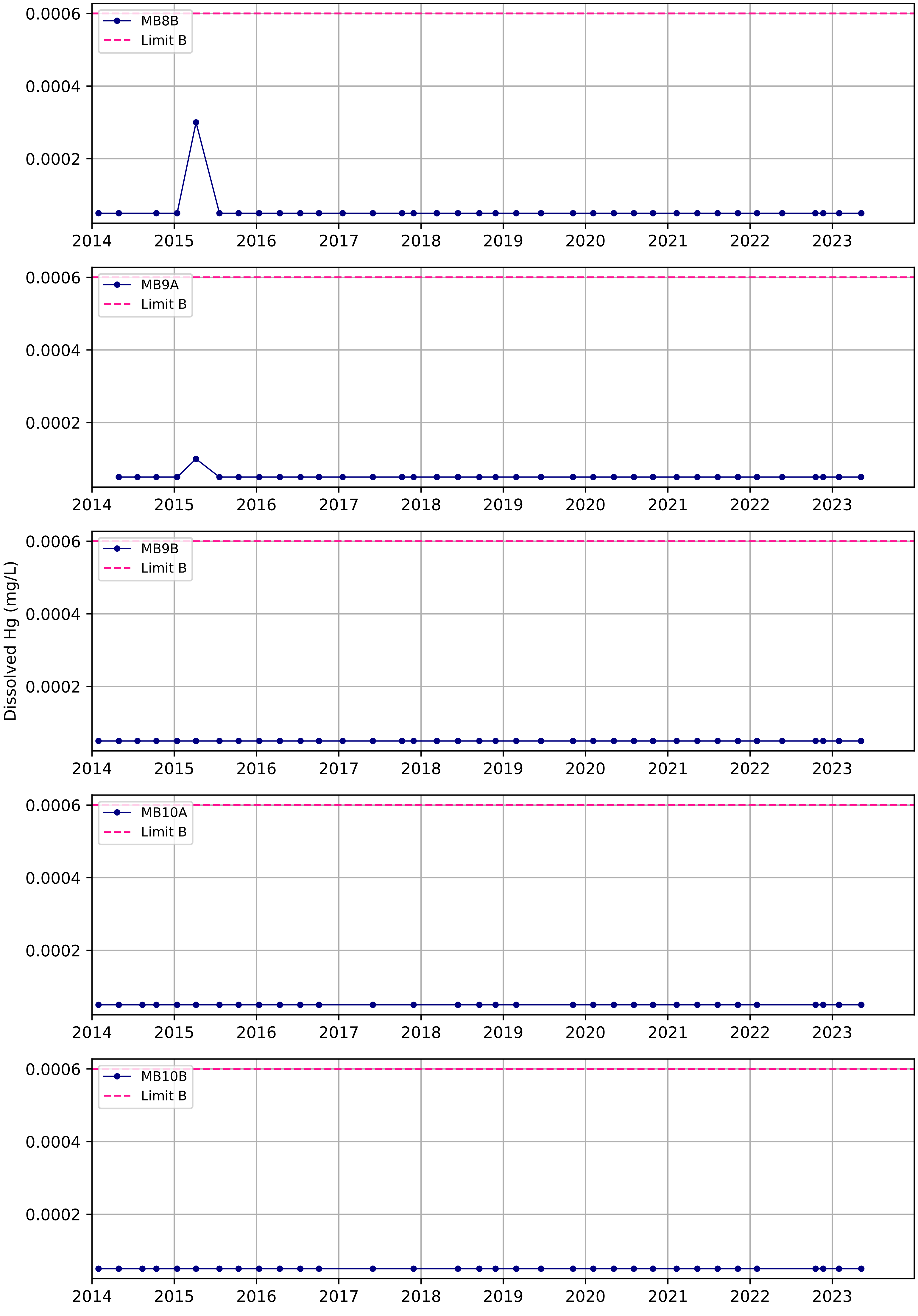


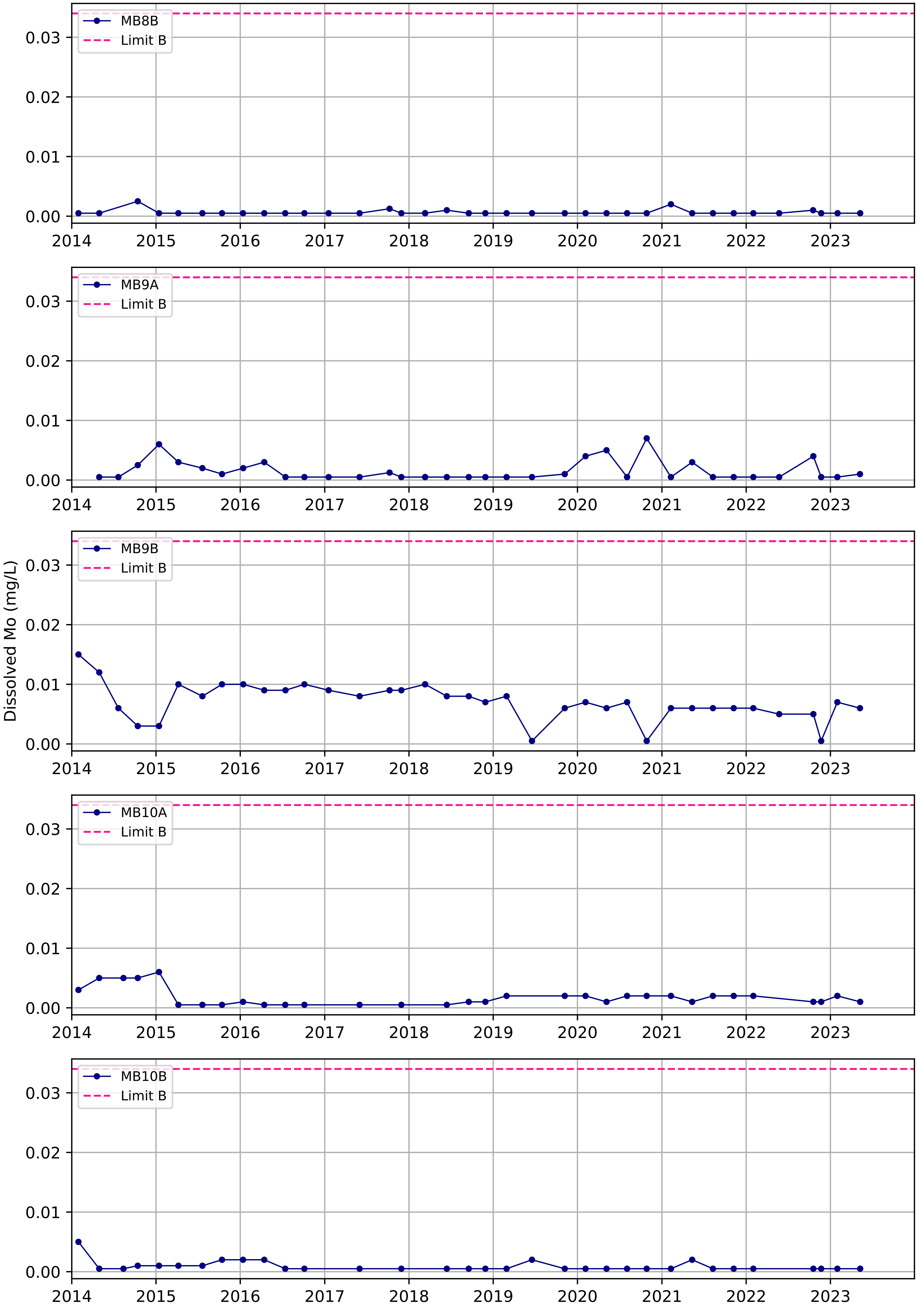
MB8B
Limit B
MB9A
Limit B
MB9B
Limit B
MB10A
Limit B
MB10B
Limit B
Dissolved Al (mg/L)
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023


MB8B
MB9A
MB9B
MB10A
MB10B
Limit B
Dissolved As (mg/L)
0.0000
0.0025
0.0050
0.0075
0.0100
0.0125
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

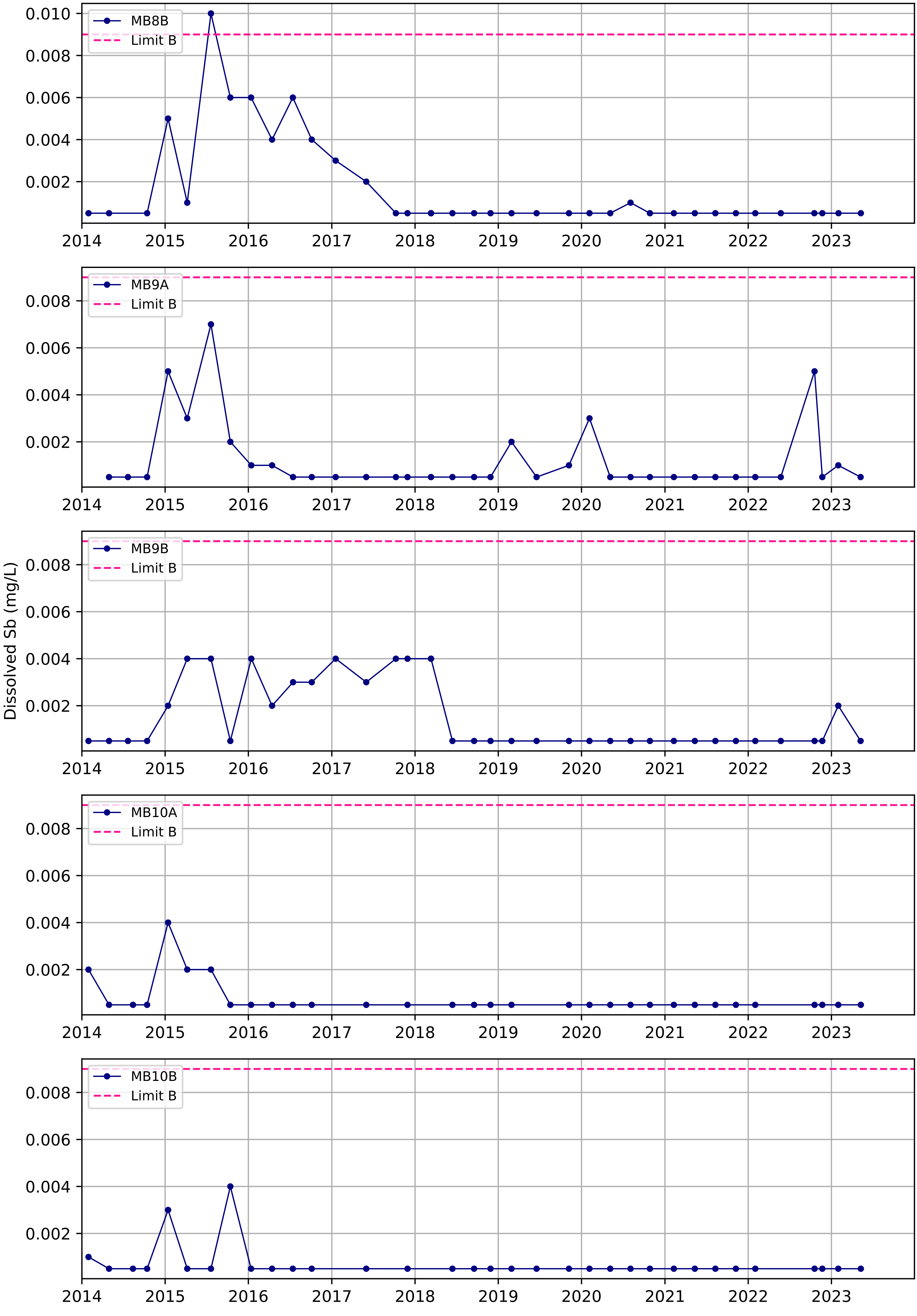

Dissolved Cu (mg/L)
MB8B
Limit B
MB9A
Limit B
MB9B
Limit B
MB10A
Limit B
MB10B
Limit B
0.0014
0.0012
0.0010
0.0008
0.0006
0.03
0.02
0.01
0.00
0.0020
0.0015
0.0005
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023


MB8B
Limit B
MB9A
Limit B
MB9B
Limit B
MB10A
Limit B
MB10B
Limit B
Dissolved Fe (mg/L)


Dissolved Hg (mg/L)
MB8B
Limit B
MB9A
Limit B
MB9B
Limit B
MB10A
Limit B
MB10B
Limit B
0.0006
0.0004
0.0002
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

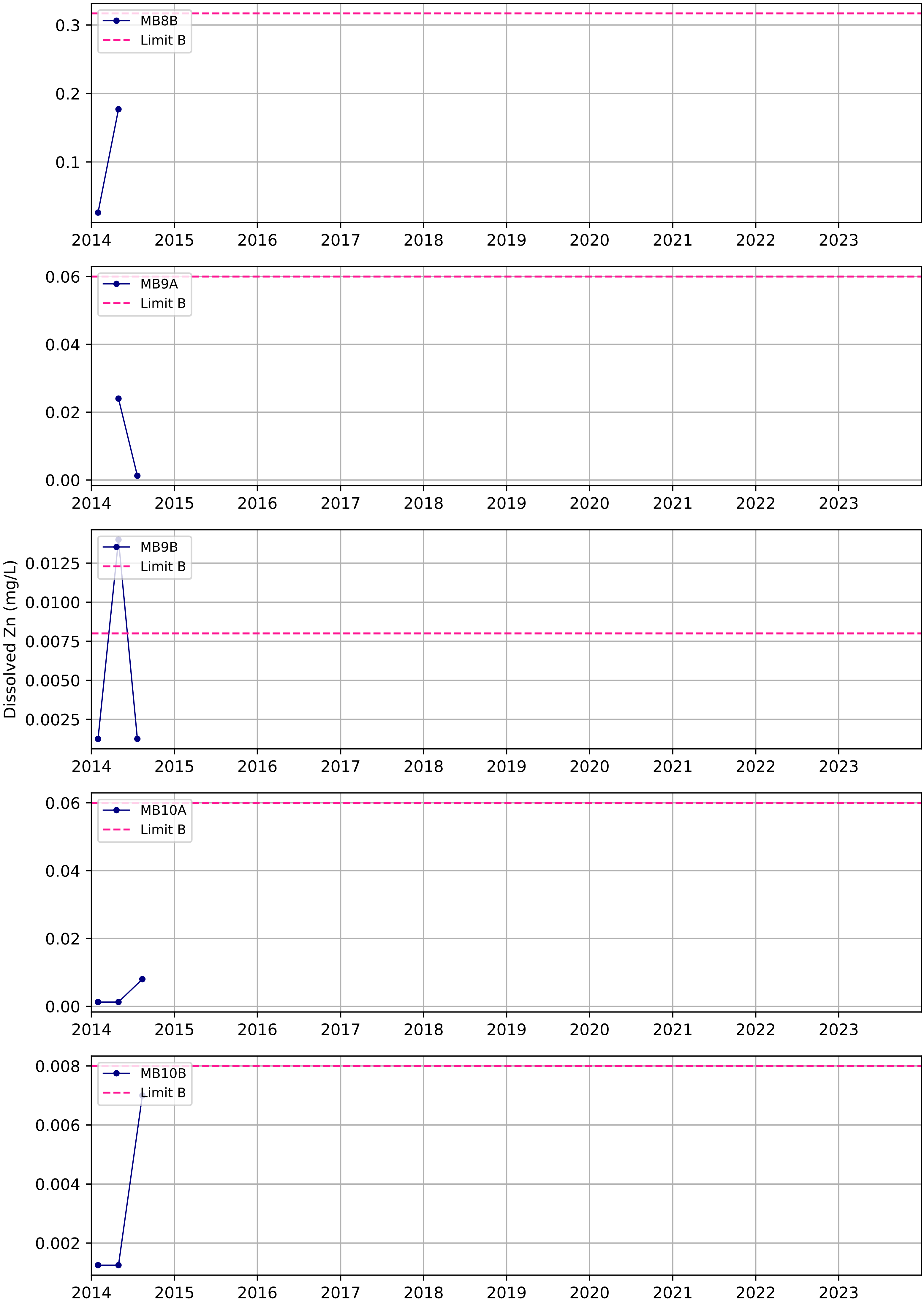


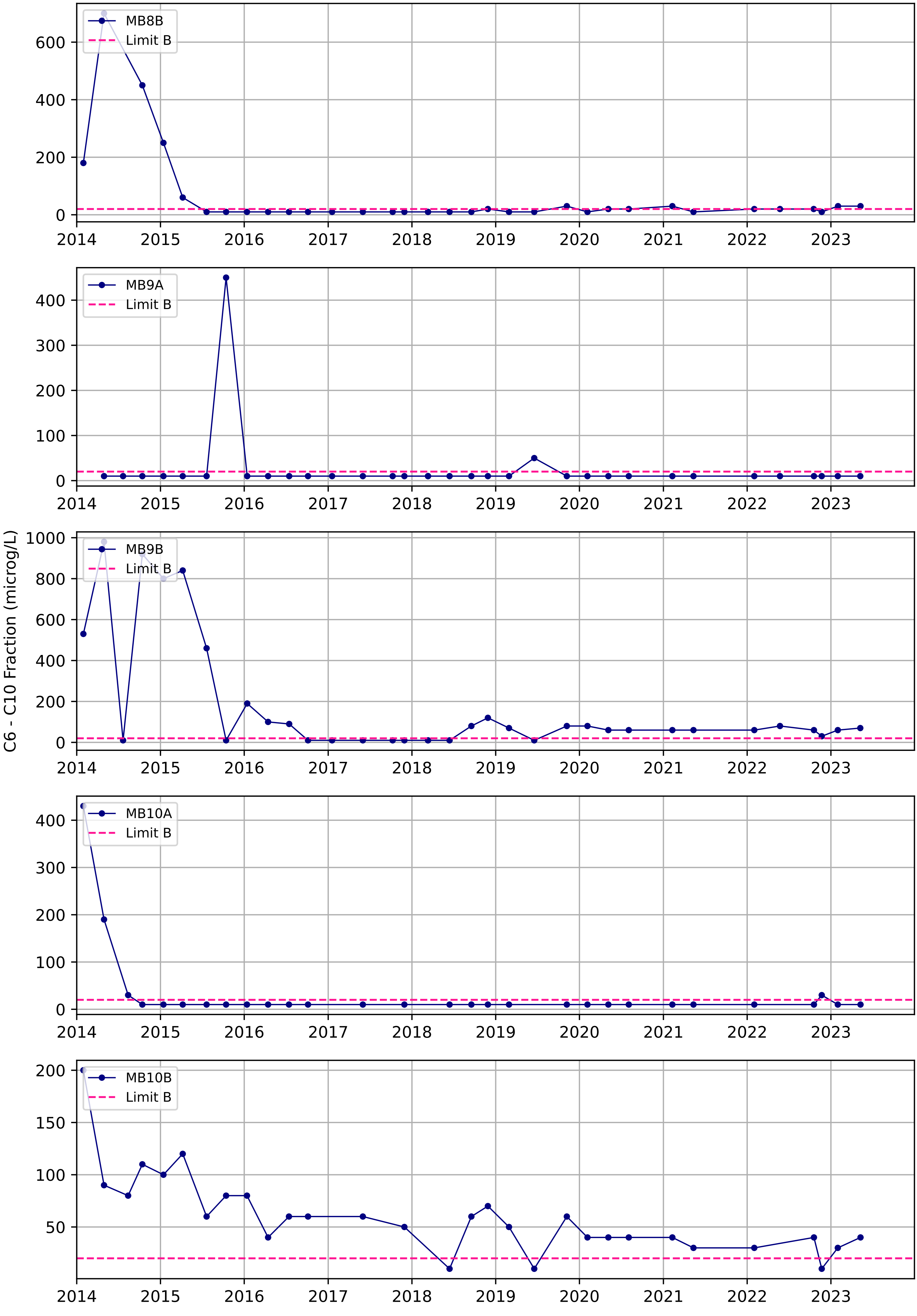
Dissolved Mo (mg/L)
MB8B
MB9A
MB9B
MB10A
MB10B
Limit B
0.00
0.01
0.02
0.03
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023



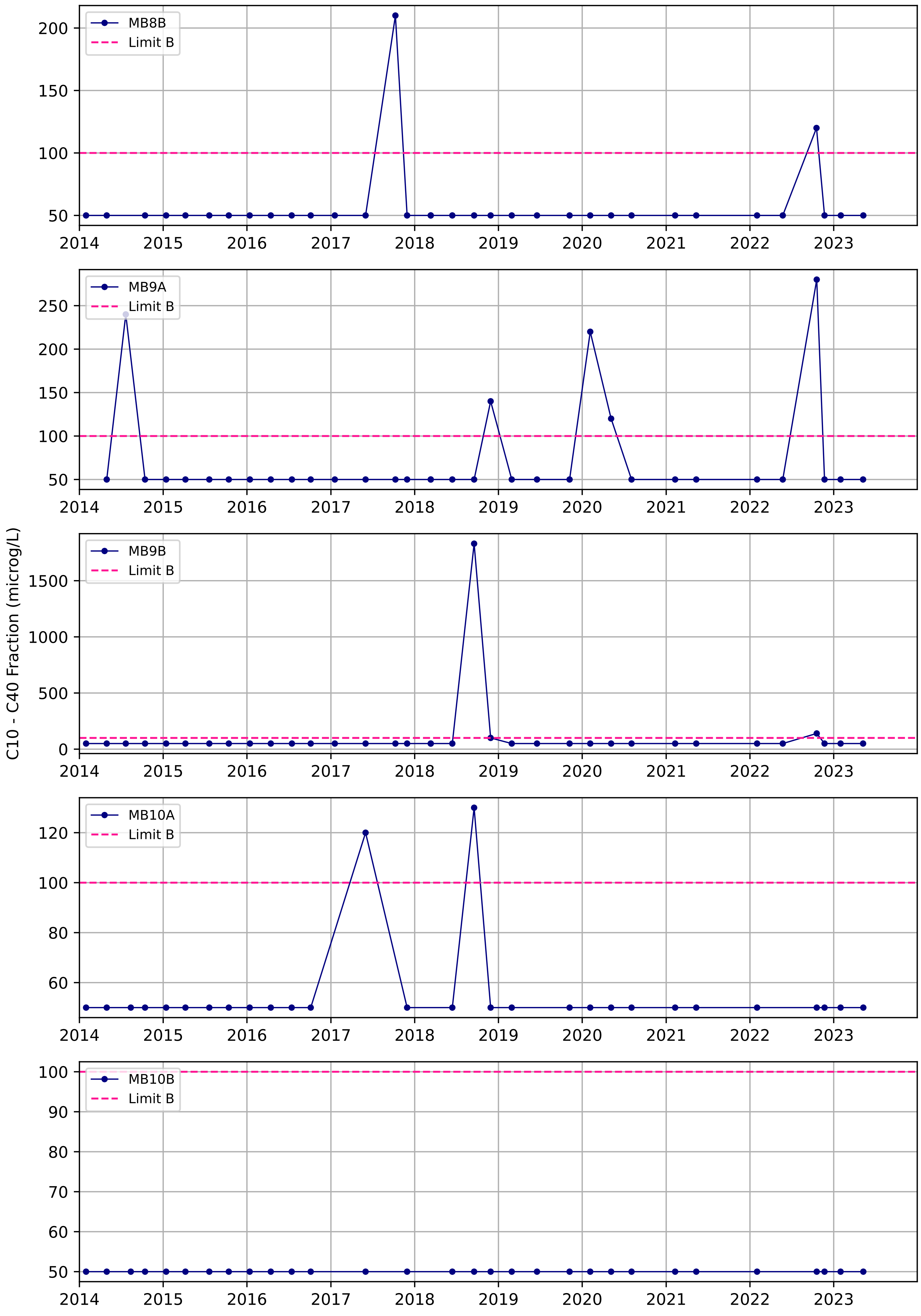
Dissolved Sb (mg/L)
MB8B
Limit B
MB9A
Limit B
MB9B
Limit B
MB10A
Limit B
MB10B
Limit B
0.010
0.008
0.006
0.004
0.002
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023


MB8B
Limit B
MB9A
Limit B
MB9B
Limit B
MB10A
Limit B
MB10B
Limit B
Dissolved Se (mg/L)
0.010
0.008
0.006
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

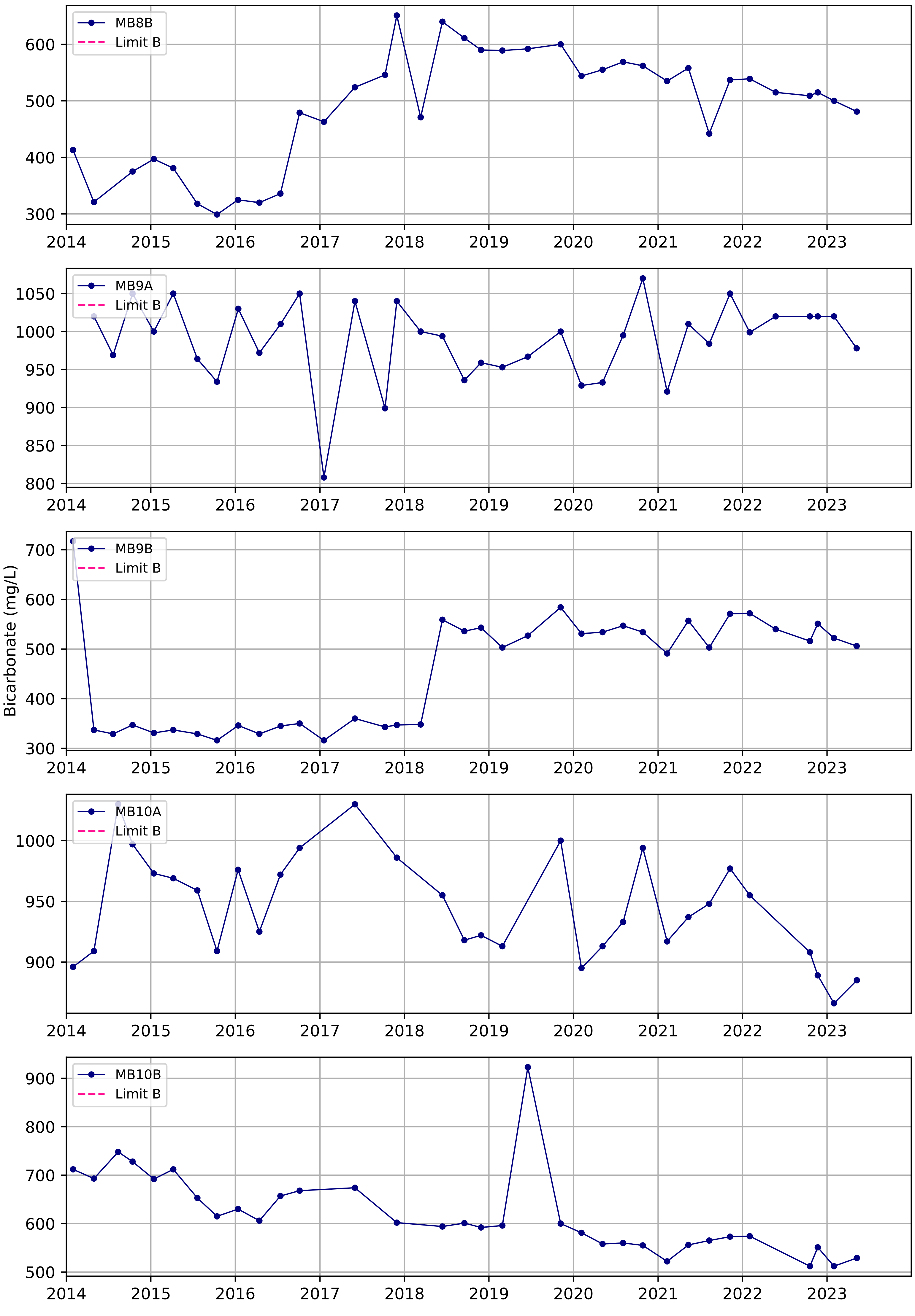

MB8B
Limit B
MB9A
Limit B
MB9B
Limit B
MB10A
Limit B
MB10B
Limit B
Dissolved Zn (mg/L)
0.3
0.2
0.1
0.06
0.04
0.02
0.00
0.0125
0.0100
0.0075
0.0050
0.0025
0.008
0.006
0.004
0.002
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023



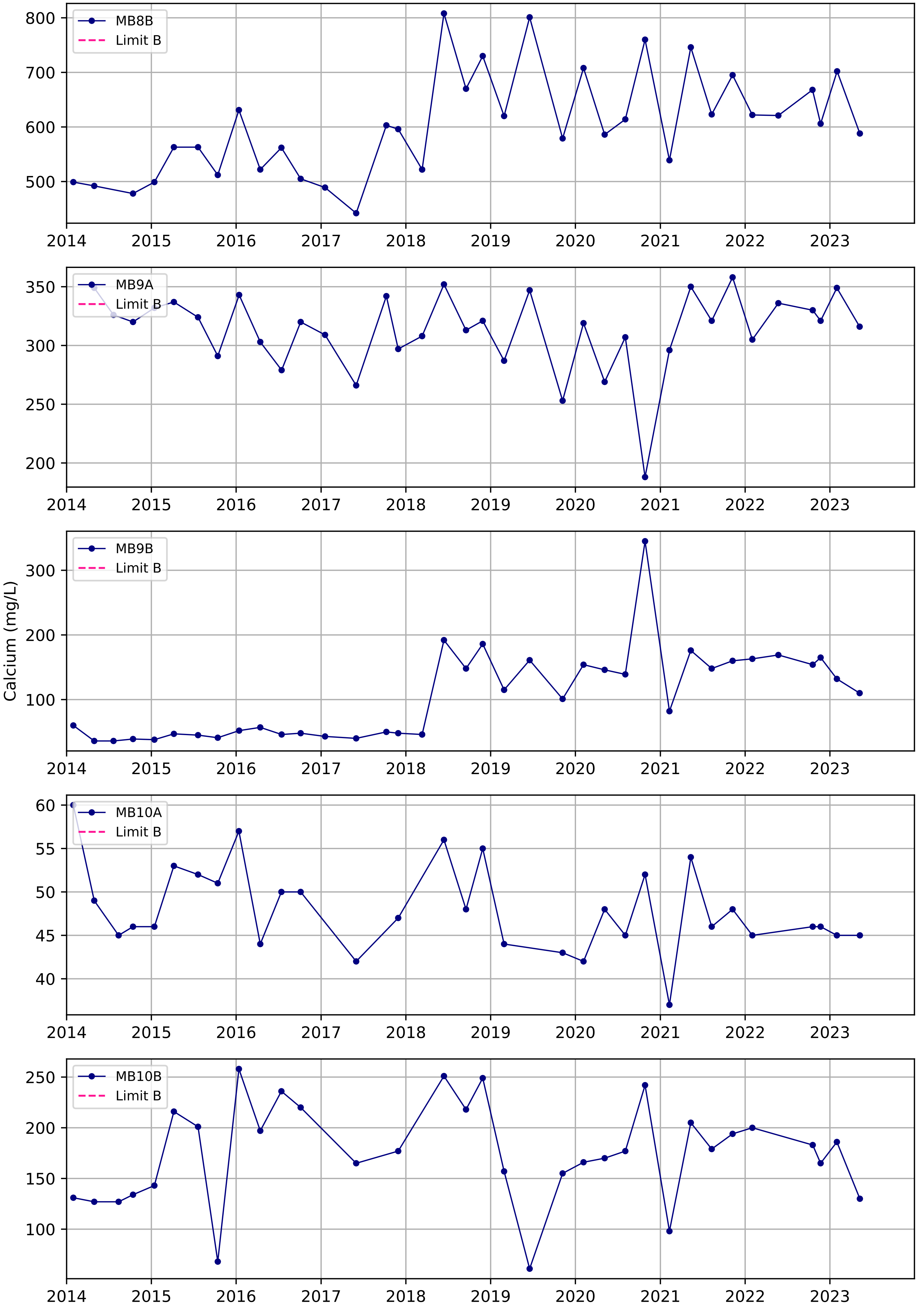
MB8B
Limit B
MB9A
Limit B
MB9B
Limit B
MB10A
Limit B
MB10B
Limit B
C6 - C10 Fraction (microg/L)
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

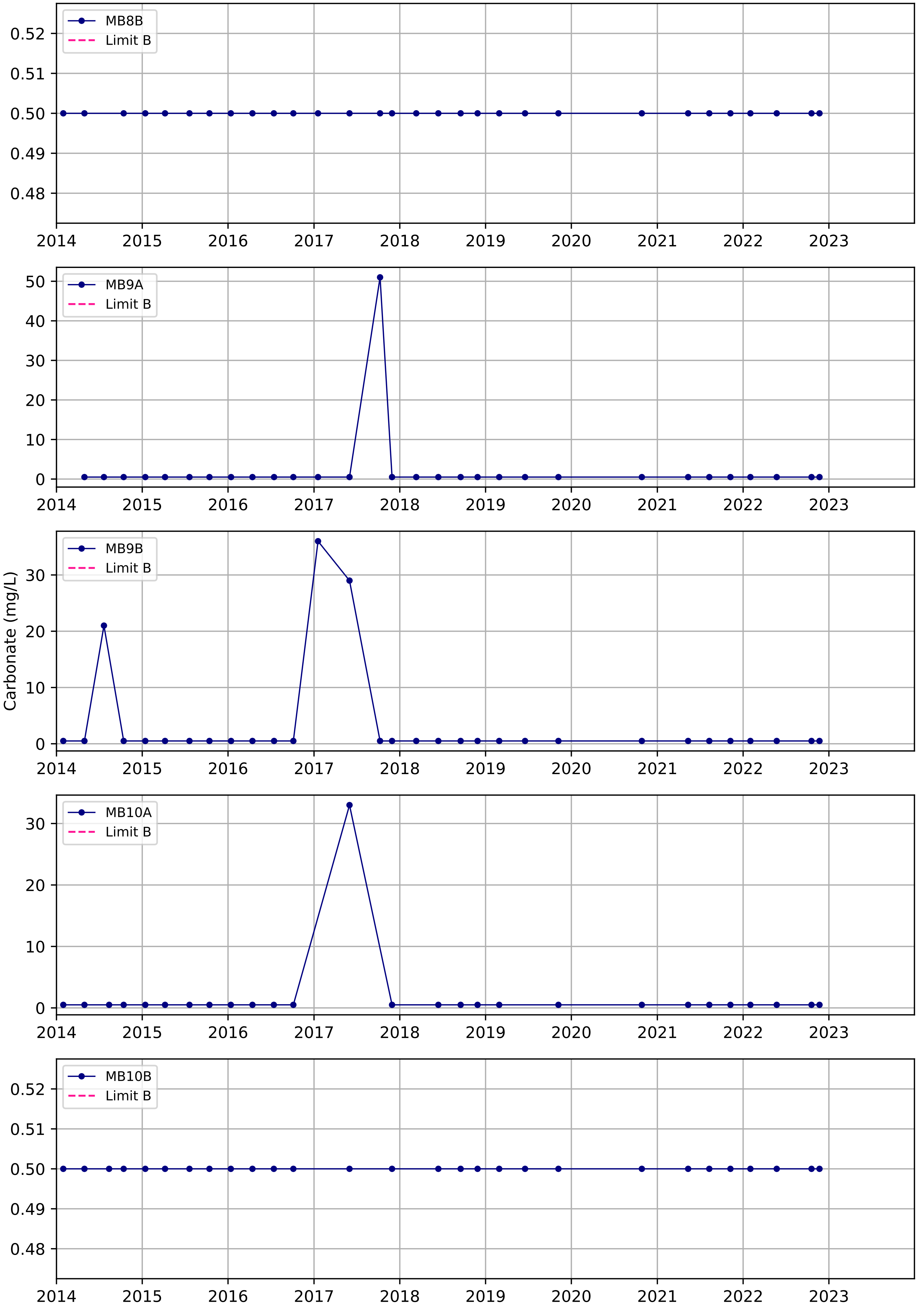


MB8B
Limit B
MB9A
Limit B
MB9B
Limit B
MB10A
Limit B
MB10B
Limit B
C10 - C40 Fraction (microg/L)
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023



MB8B
Limit B
MB9A
Limit B
MB9B
Limit B
MB10A
Limit B
MB10B
Limit B
Bicarbonate (mg/L)
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023


MB8B
Limit B
MB9A
Limit B
MB9B
Limit B
MB10A
Limit B
MB10B
Limit B
Calcium (mg/L)
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023


MB8B
Limit B
MB9A
Limit B
MB9B
Limit B
MB10A
Limit B
MB10B
Limit B
Carbonate (mg/L)
0.48
0.49
0.50
0.51
0.52
0
10
20
30
40
50
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

Appendix B Summary Statistics with Water Quality Objectives and Guideline Values

Millennium Mine – Mavis South Extension Project

Supporting documentation to the Environmental Authority (EPML00819213) amendment application Mavis South Underground operations – Groundwater Impact Assessment: State considerations

MetRes Pty Ltd

SLR Project No.: 620.031508.00001

23 November 2023

Table B-1: Water Quality Guideline Values

Element	Unit	NHRMC	ANZECC, 2000				EPP Fitzroy River Sub-basin EC and WQO - Zone 34					
		Drinking Water Quality	Livestock Drinking Water	Irrigation Water		Slightly-Moderately Disturbed Ecosystems	Shallow			Deep		
				Long-term (up to 100 years)	Short-term (up to 20 years)		20th	50th	80th	20th	50th	80th
pH		6.5 to 8.5	6.0 to 8.0	6.0 to 8.5	6.0 to 8.5	ND	7.10	7.75	8.10	7.40	7.80	8.03
EC	uS/cm	ND	ND	Various	Various	ND	498	2150	8910	3419	6100	16000
Aluminium	mg/L	0.2	5	5	20	0.055	-	-	-	-	-	-
Arsenic	mg/L	0.003	0.5	0.1	2	0.013	-	-	-	-	-	-
Beryllium	mg/L	0.06	ND	0.1	0.5	ND	-	-	-	-	-	-
Bicarbonate	mg/L	ND	ND	ND	ND	ND	187	536	878	188	330	650
Boron	mg/L	4	0.5	0.5	5	0.37	-	-	-	-	-	-
Cadmium	mg/L	0.002	0.01	0.01	0.05	0.0002	-	-	-	-	-	-
Calcium	mg/L	0.002	1000	ND	ND	ND	18	84	215	46	145	442
Chloride	mg/L	250	ND	175	175	ND	171	1309	3185	753	1900	5905
Chromium	mg/L	0.05	1	0.1	1	0.0274	-	-	-	-	-	-
Cobalt	mg/L	ND	1	0.05	0.1	0.001	-	-	-	-	-	-
Copper	mg/L	1	0.4 (sheep) 1 (cattle) 5 (pigs & poultry)	0.2	5	0.0014	0	0.01	0.03	0.017	0.03	0.03
Fluoride	mg/L	1.5	2	1	2	ND	0.1	0.28	0.5	0.02	0.155	0.4

Element	Unit	NHRMC	ANZECC, 2000				EPP Fitzroy River Sub-basin EC and WQO - Zone 34					
		Drinking Water Quality	Livestock Drinking Water	Irrigation Water		Slightly-Moderately Disturbed Ecosystems	Shallow			Deep		
				Long-term (up to 100 years)	Short-term (up to 20 years)		20th	50th	80th	20th	50th	80th
Iron	mg/L	ND	not sufficiently toxic	0.2	10	ND	0	0.03	0.14	0	0.05	0.246
Lead	mg/L	0.01	0.1	2	5	0.0034	-	-	-	-	-	-
Lithium	mg/L	ND	ND	2.5	2.5	ND	-	-	-	-	-	-
Manganese	mg/L	0.1	not sufficiently toxic	0.2	10	1.9	0	0.01	0.16	0	0.05	0.291
Magnesium	mg/L	ND	2000	ND	ND	ND	27	108	389	35	115	491
Mercury	mg/L	0.001	0.002	0.002	0.002	0.00006	-	-	-	-	-	-
Molybdenum	mg/L	0.05	0.15	0.01	0.05	ND	-	-	-	-	-	-
Nickel	mg/L	0.02	1	0.2	2	0.007	-	-	-	-	-	-
Nitrate	mg/L	50	400	ND	ND	0.7	0	0.95	5.3	0.01	2.15	14.92
Sodium	mg/L	180	ND	115	115	ND	135	747	1500	480	1100	2565
Selenium	mg/L	0.01	0.02	0.02	0.05	0.005	-	-	-	-	-	-
Sulphate	mg/L	250	1000	ND	ND	ND	12	140	318	25	138	398
Uranium	mg/L		0.2	0.01	0.1	ND	-	-	-	-	-	-
Vanadium	mg/L	0.006	ND	0.1	0.5	0.1	-	-	-	-	-	-
Zinc	mg/L	3	20	2	5	0.008	0	0.015	0.06	0.01	0.025	0.317

Table B-2 Statistical Summary table - Tertiary Sediment Major Ions, Metal, and Metalloid data

Element	Unit	Number of Observations	Minimum	20th percentile	Median	80th percentile	Maximum
Major Ions							
Bicarbonate Alkalinity as CaCO3	mg/L	113	492	648	782	919.6	998
Sulfate as SO4 - Turbidimetric	mg/L	113	32	42	77	106	163
Chloride	mg/L	110	464	570.6	634	1220	1970
Calcium	mg/L	113	4	29.4	44	76.2	169
Magnesium	mg/L	113	40	126.4	152	206.4	317
Sodium	mg/L	110	69	361.6	473.5	844	1490
Potassium	mg/L	113	0.5	4	5	6	9
Metals							
Aluminium	mg/L	113	0.0025	0.0025	0.0025	0.0025	0.03
Antimony	mg/L	113	0.0005	0.0005	0.0005	0.0005	0.012
Arsenic	mg/L	113	0.0005	0.0005	0.0005	0.002	0.01
Barium	mg/L	45	0.0005	0.085	0.152	0.2116	4.76
Beryllium	mg/L	45	0.0005	0.0005	0.0005	0.0005	0.255
Cadmium	mg/L	45	5.00E-05	5.00E-05	5.00E-05	5.00E-05	5.00E-05
Cobalt	mg/L	45	0.0005	0.0005	0.0005	0.001	0.001
Chromium	mg/L	45	0.0005	0.0005	0.0005	0.00125	0.005
Copper	mg/L	45	0.0005	0.0005	0.0005	0.0005	0.002
Manganese	mg/L	45	0.0005	0.0154	0.026	0.0322	0.16
Nickel	mg/L	45	0.0005	0.0018	0.003	0.0052	0.014
Lead	mg/L	45	0.0005	0.0005	0.0005	0.0005	0.0005
Vanadium	mg/L	45	0.0025	0.0025	0.0025	0.0025	0.02
Zinc	mg/L	45	0.00125	0.00125	0.007	0.0168	0.035

Element	Unit	Number of Observations	Minimum	20th percentile	Median	80th percentile	Maximum
Molybdenum	mg/L	113	0.0005	0.0005	0.002	0.002	0.006
Selenium	mg/L	113	0.0025	0.0025	0.0025	0.0025	0.01
Silver	mg/L	113	0.0005	0.0005	0.0005	0.0005	0.003
Uranium	mg/L	45	0.0005	0.0005	0.0005	0.0005	0.003
Boron	mg/L	45	0.025	0.23	0.26	0.3	0.78
Iron	mg/L	113	0.013	0.025	0.025	0.056	0.95
Mercury	mg/L	110	5.00E-05	5.00E-05	5.00E-05	5.00E-05	0.0002

Table B-3 Statistical Summary table - Rangal Coal Measures Metal and Metalloid Data

Element	Unit	Number of Observations	Minimum	20th percentile	Median	80th percentile	Maximum
Major Ions							
Bicarbonate Alkalinity as CaCO3	mg/l	61	77	138	413	555	681
Sulphate as SO4 - Turbidimetric	mg/l	61	1.5	248	402	469	510
Chloride	mg/L	55	1810	7580	8090	8602	10400
Calcium	mg/L	61	119	442	596	801	1100
Magnesium	mg/L	61	68	436	528	605	712
Sodium	mg/L	59	940	3282	3740	4122	5130
Potassium	mg/L	61	9.3	30	38	42	63
Metals							
Aluminium	mg/L	61	0.0025	0.0025	0.0025	0.005	0.76
Antimony	mg/L	61	0.0005	0.0005	0.0005	0.0005	0.01
Arsenic	mg/L	61	0.0005	0.0005	0.0005	0.0005	0.004
Barium	mg/L	12	0.0005	0.0005	0.2844	0.3785	0.3928

Element	Unit	Number of Observations	Minimum	20th percentile	Median	80th percentile	Maximum
Beryllium	mg/L	12	0.0005	0.0005	0.0005	0.0005	0.0005
Cadmium	mg/L	12	$5x10^{-05}$	$5x10^{-05}$	$5x10^{-05}$	$5x10^{-05}$	$5x10^{-05}$
Cobalt	mg/L	12	0.0005	0.0005	0.0005	0.0005	0.0009
Chromium	mg/L	12	0.0005	0.0005	0.0005	0.0005	0.0005
Copper	mg/L	12	0.0005	0.0005	0.0005	0.0005	0.002
Manganese	mg/L	12	0.113	0.113	1.322	1.415	1.484
Nickel	mg/L	12	0.0005	0.0005	0.0005	0.0005	0.0084
Lead	mg/L	12	0.0005	0.0005	0.0005	0.0005	0.0005
Vanadium	mg/L	12	0.0025	0.0025	0.0025	0.0025	0.0025
Zinc	mg/L	16	0.00125	0.00125	0.0105	0.033	0.219
Molybdenum	mg/L	61	0.0005	0.0005	0.0005	0.0005	0.004
Selenium	mg/L	61	0.005	0.005	0.005	0.005	0.005
Silver	mg/L	16	0.0005	0.0005	0.0005	0.0005	0.0005
Uranium	mg/L	12	0.0005	0.0005	0.0005	0.0025	0.0025
Boron	mg/L	12	0.025	0.025	0.025	0.205	0.25
Iron	mg/L	61	0.025	0.025	0.025	4.49	5.53
Mercury	mg/L	57	$5x10^{-05}$	$5x10^{-05}$	$5x10^{-05}$	$5x10^{-05}$	0.0003

Table B-4: Statistical Summary table - Fort Cooper Coal Measures Metal and Metalloid Data

Element	Unit	Number of Observations	Minimum	20th percentile	Median	80th percentile	Maximum
Major Ions							
Bicarbonate Alkalinity as CaCO3	mg/L	140	316	530.6	778	987.6	1070
Sulfate as SO4 - Turbidimetric	mg/L	140	0.5	45.6	67	96	196

Element	Unit	Number of Observations	Minimum	20th percentile	Median	80th percentile	Maximum
Chloride	mg/L	132	604	768.8	3200	6168	6900
Calcium	mg/L	140	36	47	154.5	303.4	358
Magnesium	mg/L	140	45	97.8	184	417.2	545
Sodium	mg/L	140	444	614.8	1365	3132	3900
Potassium	mg/L	140	4	5	10	38	54
Metals							
Aluminium	mg/L	140	0.0025	0.0025	0.0025	0.01	0.94
Antimony	mg/L	140	0.0005	0.0005	0.0005	0.001	0.007
Arsenic	mg/L	140	0.0005	0.0005	0.0005	0.003	0.012
Barium	mg/L	13	0.14	0.2434	0.762	1.422	3.07
Beryllium	mg/L	13	0.0005	0.0005	0.0005	0.0005	0.0005
Cadmium	mg/L	13	$5x10^{-05}$	$5x10^{-05}$	$5x10^{-05}$	$5x10^{-05}$	$5x10^{-05}$
Cobalt	mg/L	13	0.0005	0.0005	0.0005	0.0016	0.004
Chromium	mg/L	13	0.0005	0.0005	0.0005	0.0005	0.0005
Copper	mg/L	11	0.0005	0.0005	0.0005	0.0005	0.005
Manganese	mg/L	13	0.0005	0.0646	0.216	0.92	1.67
Nickel	mg/L	13	0.0005	0.002	0.004	0.006	0.01
Lead	mg/L	13	0.0005	0.0005	0.0005	0.0008	0.031
Vanadium	mg/L	13	0.0025	0.0025	0.0025	0.0025	0.0025
Zinc	mg/L	11	0.00125	0.00125	0.00125	0.008	0.024
Molybdenum	mg/L	140	0.0005	0.0005	0.001	0.006	0.015
Selenium	mg/L	140	0.005	0.005	0.005	0.005	0.005
Silver	mg/L	131	0.0005	0.0005	0.0005	0.0005	0.006
Uranium	mg/L	13	0.0005	0.0005	0.002	0.0046	0.011

Element	Unit	Number of Observations	Minimum	20th percentile	Median	80th percentile	Maximum
Boron	mg/L	13	0.28	0.328	0.39	0.528	1
Iron	mg/L	140	0.025	0.025	0.06	0.726	3.81
Mercury	mg/L	140	$5x10^{-05}$	$5x10^{-05}$	$5x10^{-05}$	$5x10^{-05}$	0.0001

Appendix C Hydraulic Parameter and Recharge Zone Distribution

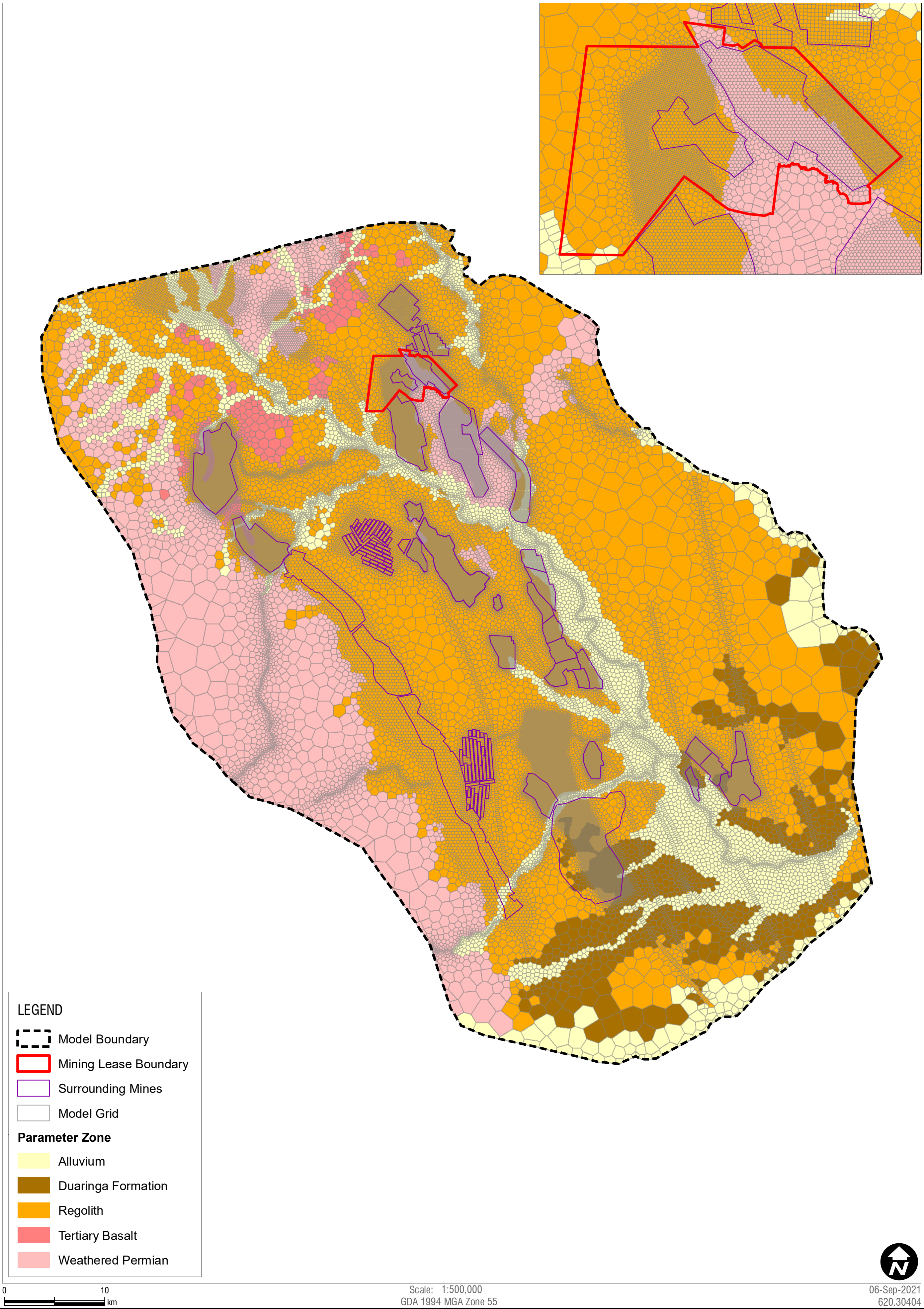
Millennium Mine – Mavis South Extension Project

Supporting documentation to the Environmental Authority (EPML00819213) amendment application Mavis South Underground operations – Groundwater Impact Assessment: State considerations

MetRes Pty Ltd

SLR Project No.: 620.031508.00001

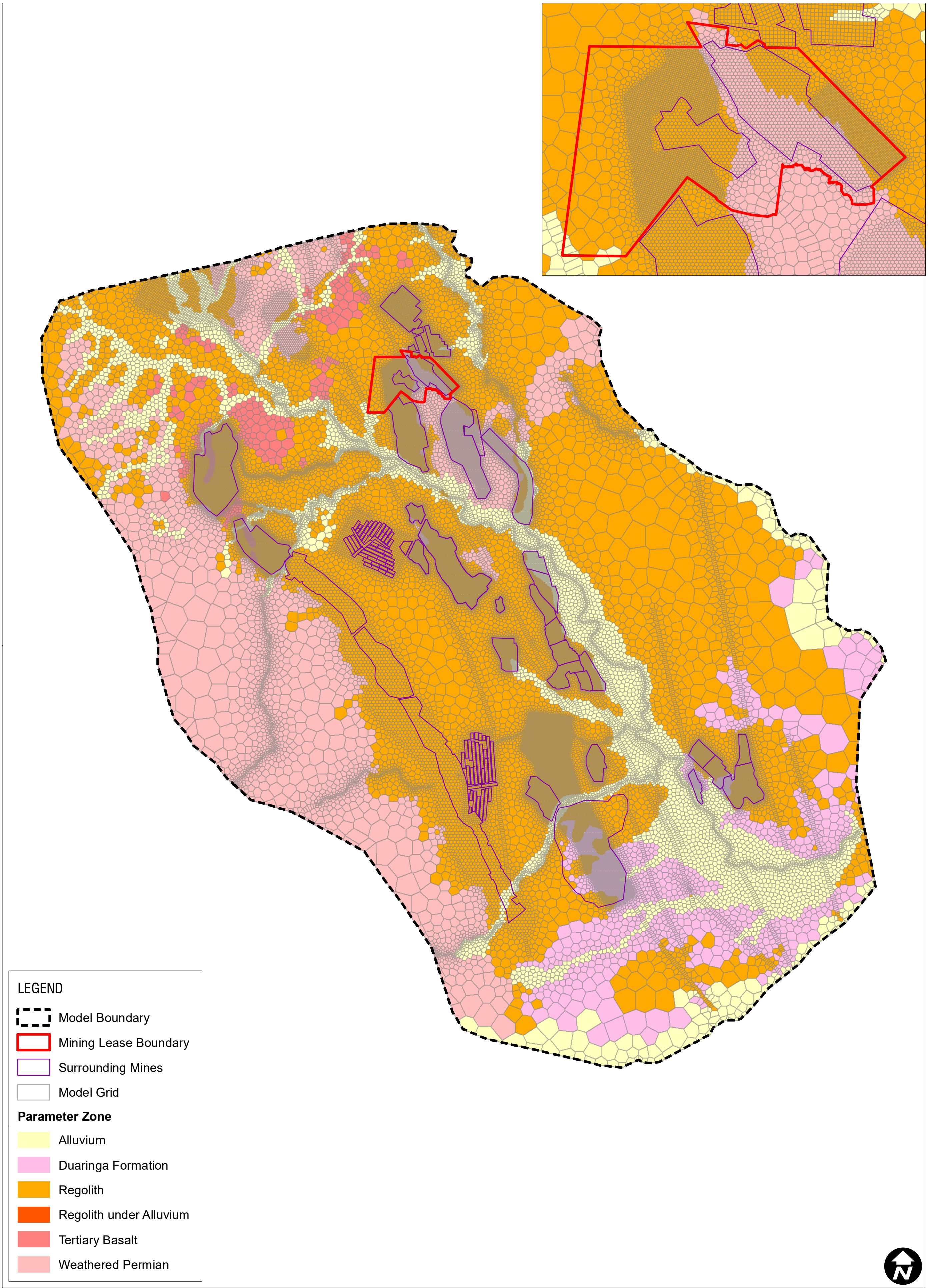
23 November 2023



SLR

Hydraulic Parameter Zone Distribution Layer 1

FIGURE C-1



0 10 km

Scale: 1:500,000
GDA 1994 MGA Zone 55

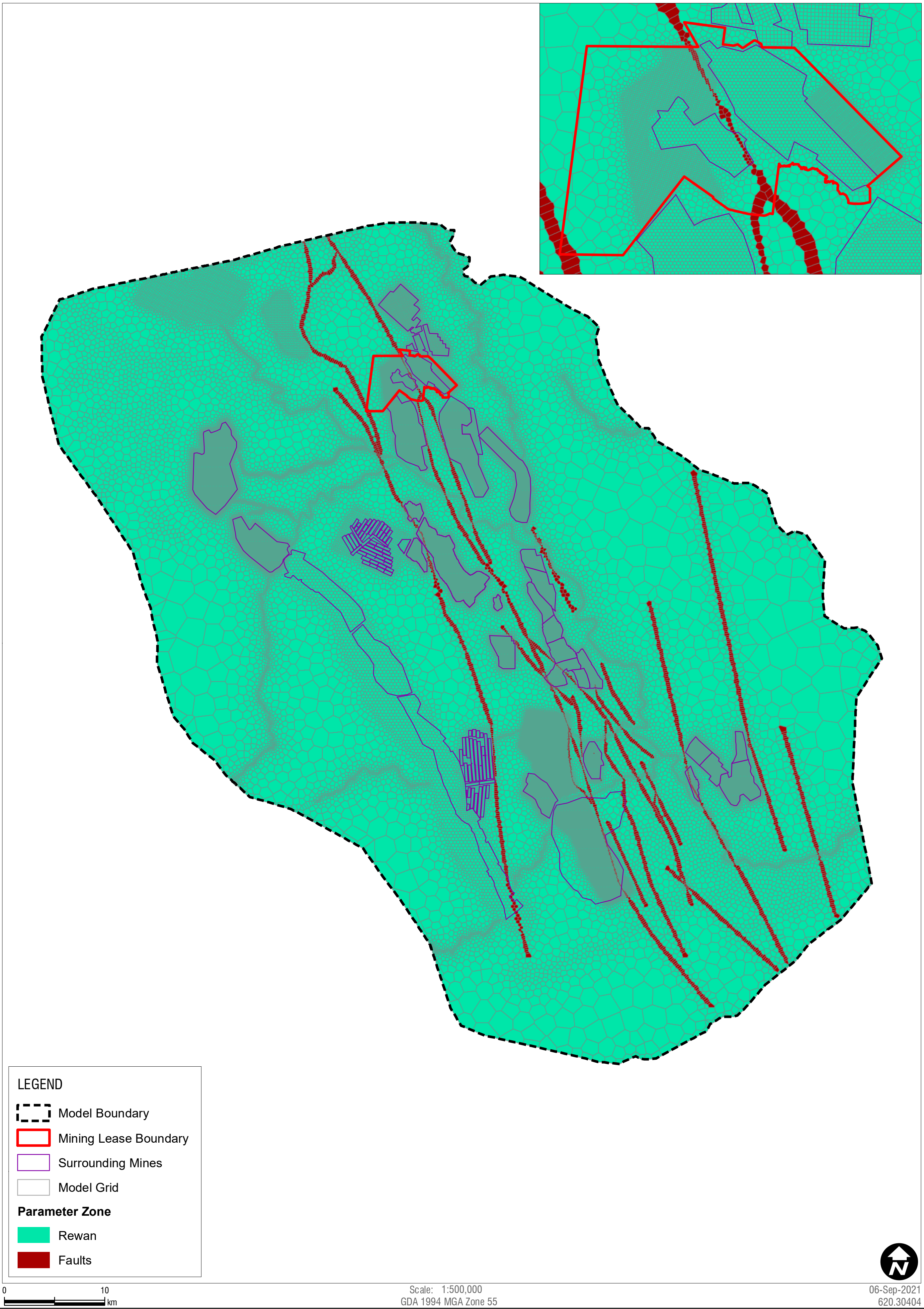
06-Sep-2021
620.30404

H:\Projects-SLR\620-BNE\620-BNE\620.30404.00000 Millennium Mine GW assessment\06 SLR Data\01 CADGIS\GIS\Appendix D\62030464 D-2 Modelled hydraulic conductivity zones.mxd

SLR

Hydraulic Parameter Zone Distribution Layer 2

FIGURE C-2



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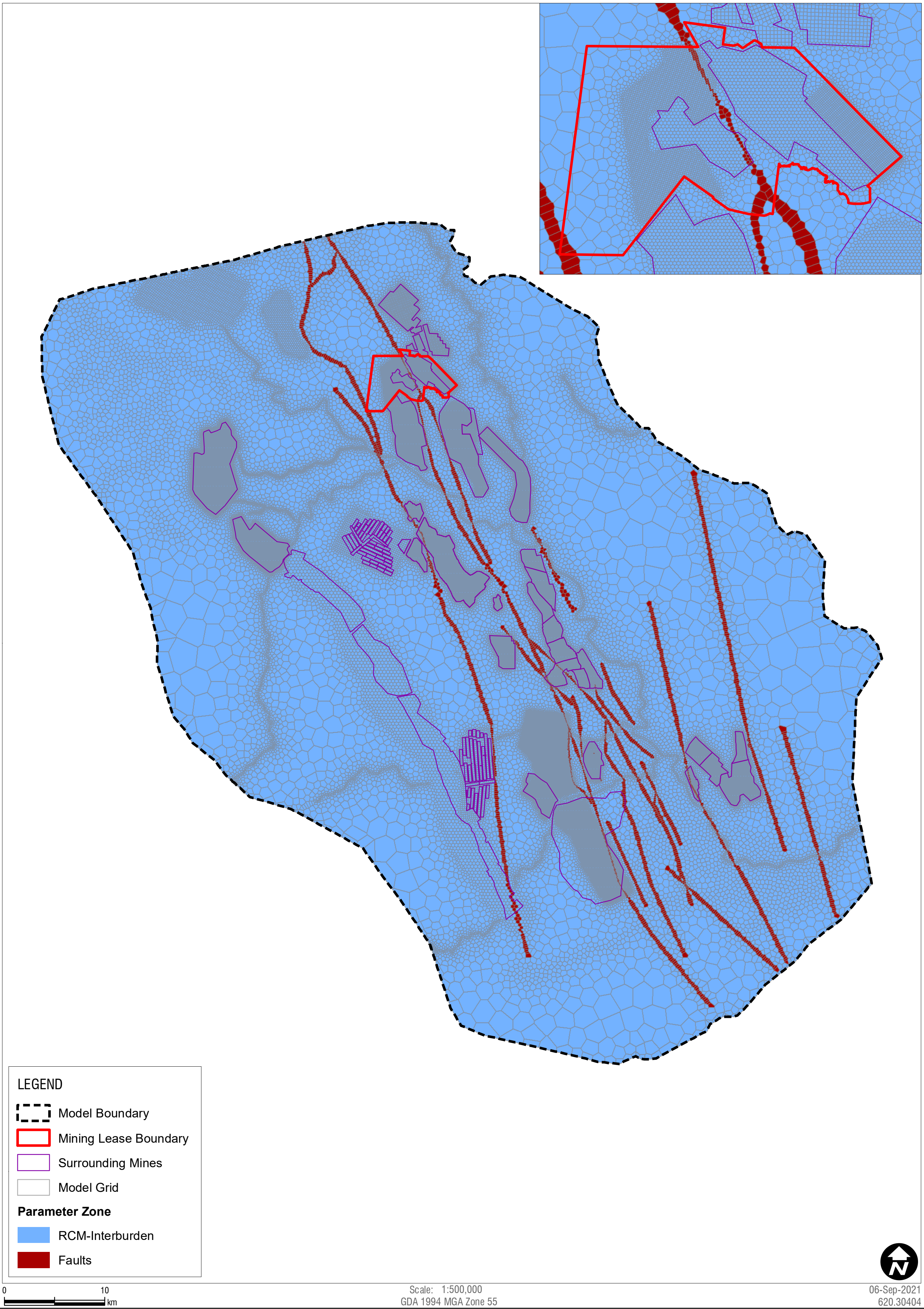
06-Sep-2021
620.30404

SLR

Hydraulic Parameter Zone Distribution Layer 3

FIGURE C-3



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SLR

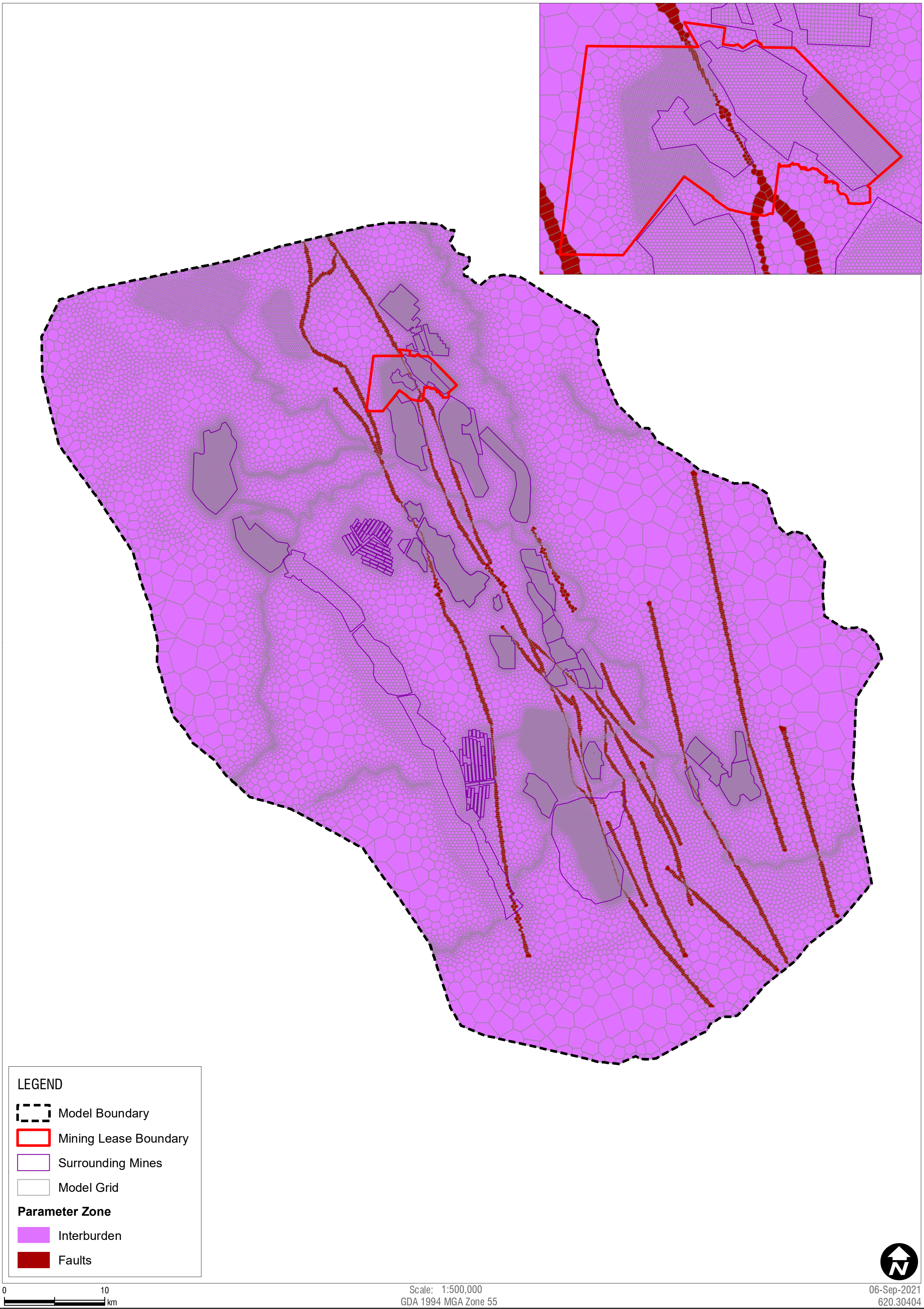
Hydraulic Parameter Zone Distribution Layer 4

FIGURE C-4

SLR

Hydraulic Parameter Zone Distribution Layer 5

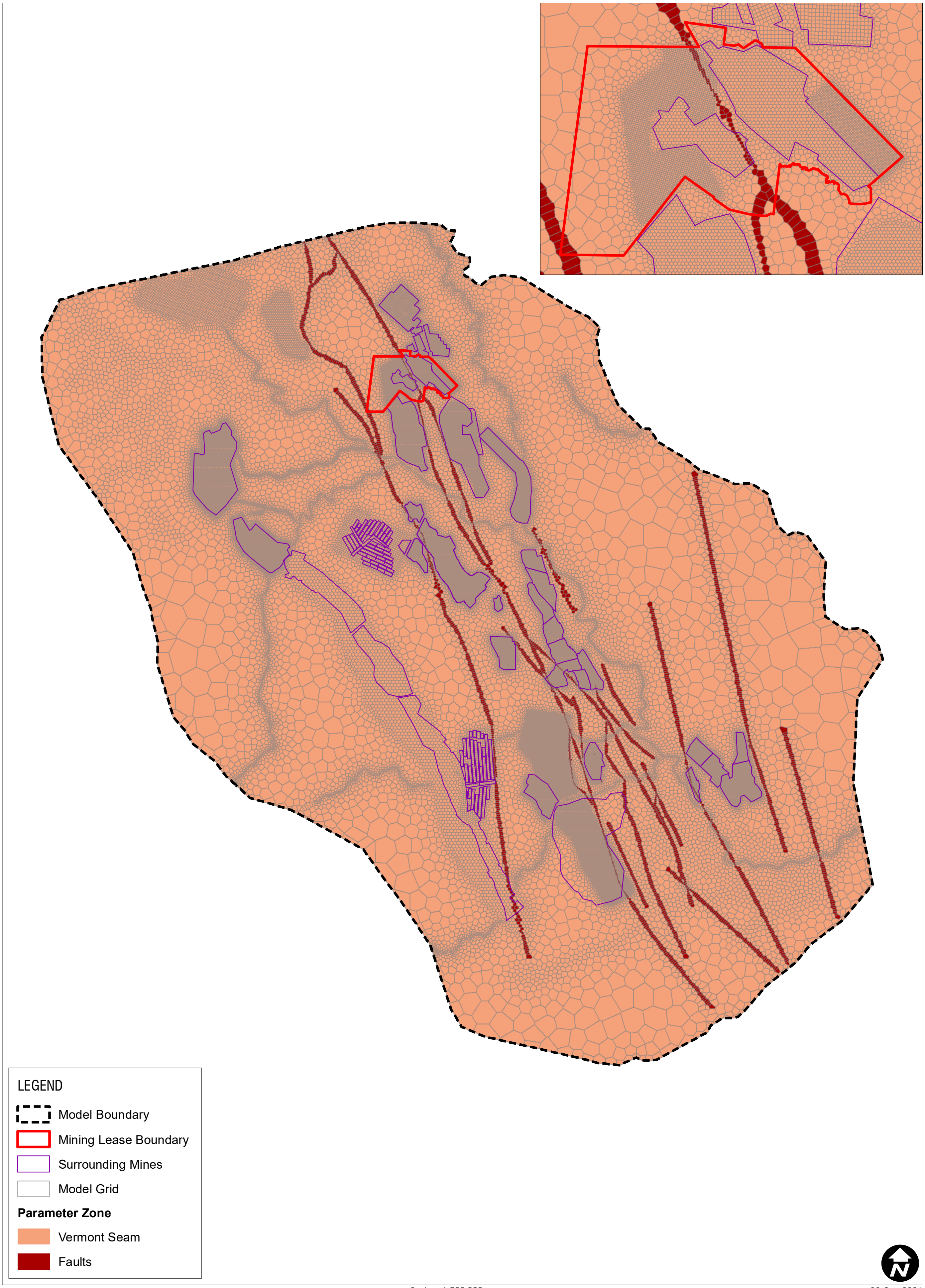
FIGURE C-5



SLR

Hydraulic Parameter Zone Distribution Layer 6

FIGURE C-6



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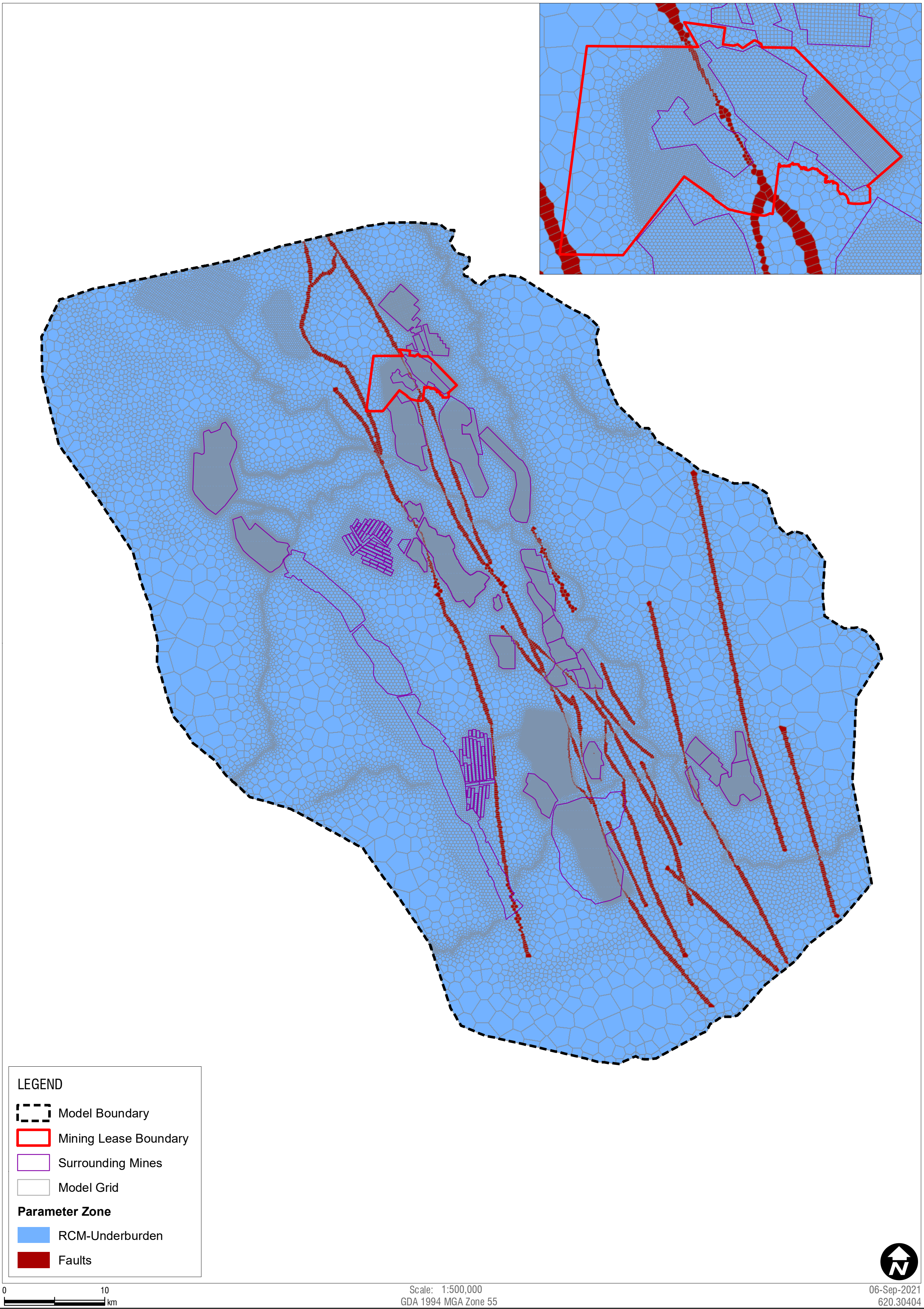
Scale: 1:500,000
GDA 1994 MGA Zone 55

06-Sep-2021
620.30404

SLR

Hydraulic Parameter Zone Distribution Layer 7

FIGURE C-7



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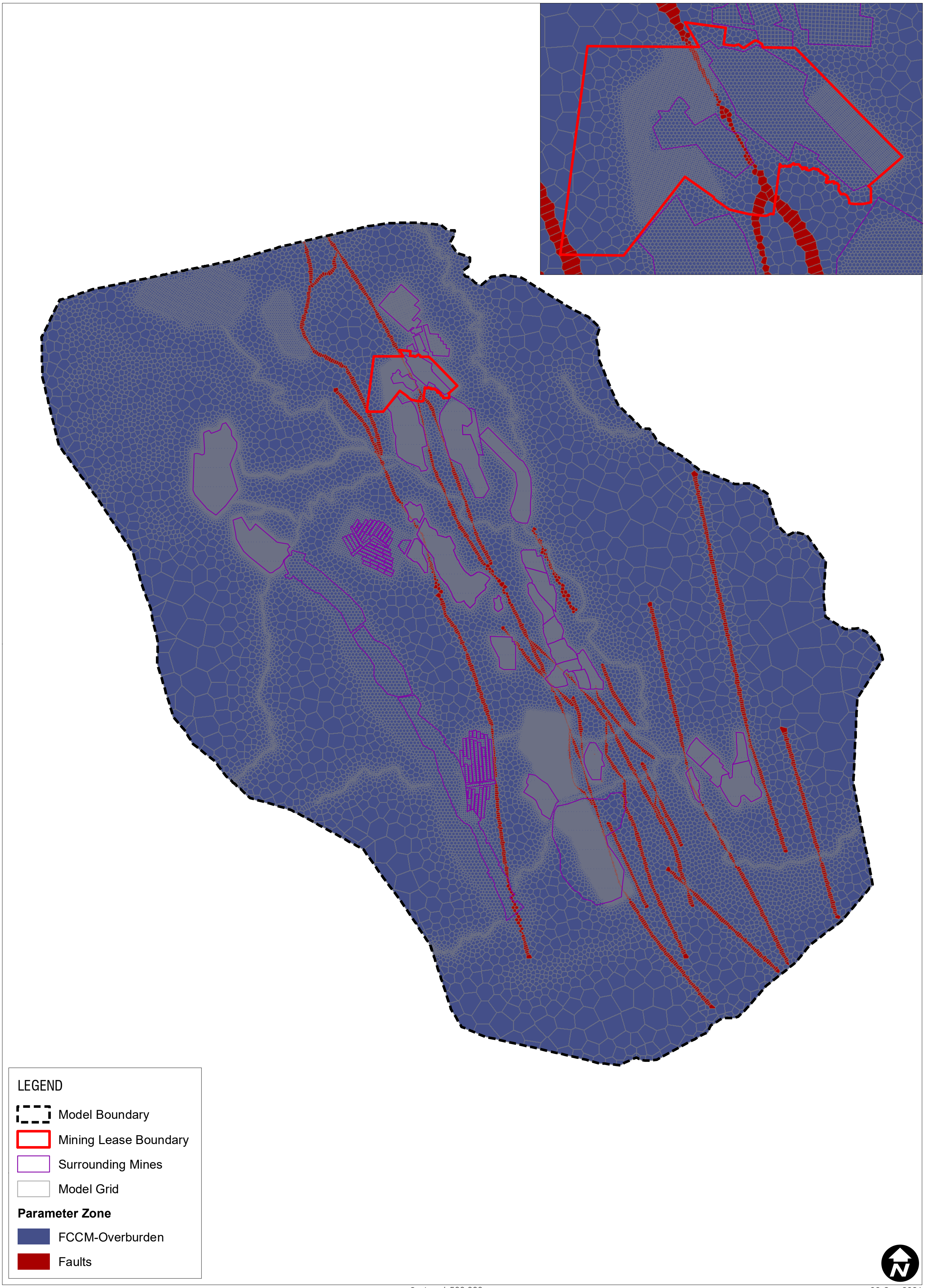
Scale: 1:500,000
GDA 1994 MGA Zone 55

06-Sep-2021
620.30404

SLR

Hydraulic Parameter Zone Distribution Layer 8

FIGURE C-8



0 10 km

Scale: 1:500,000
GDA 1994 MGA Zone 55

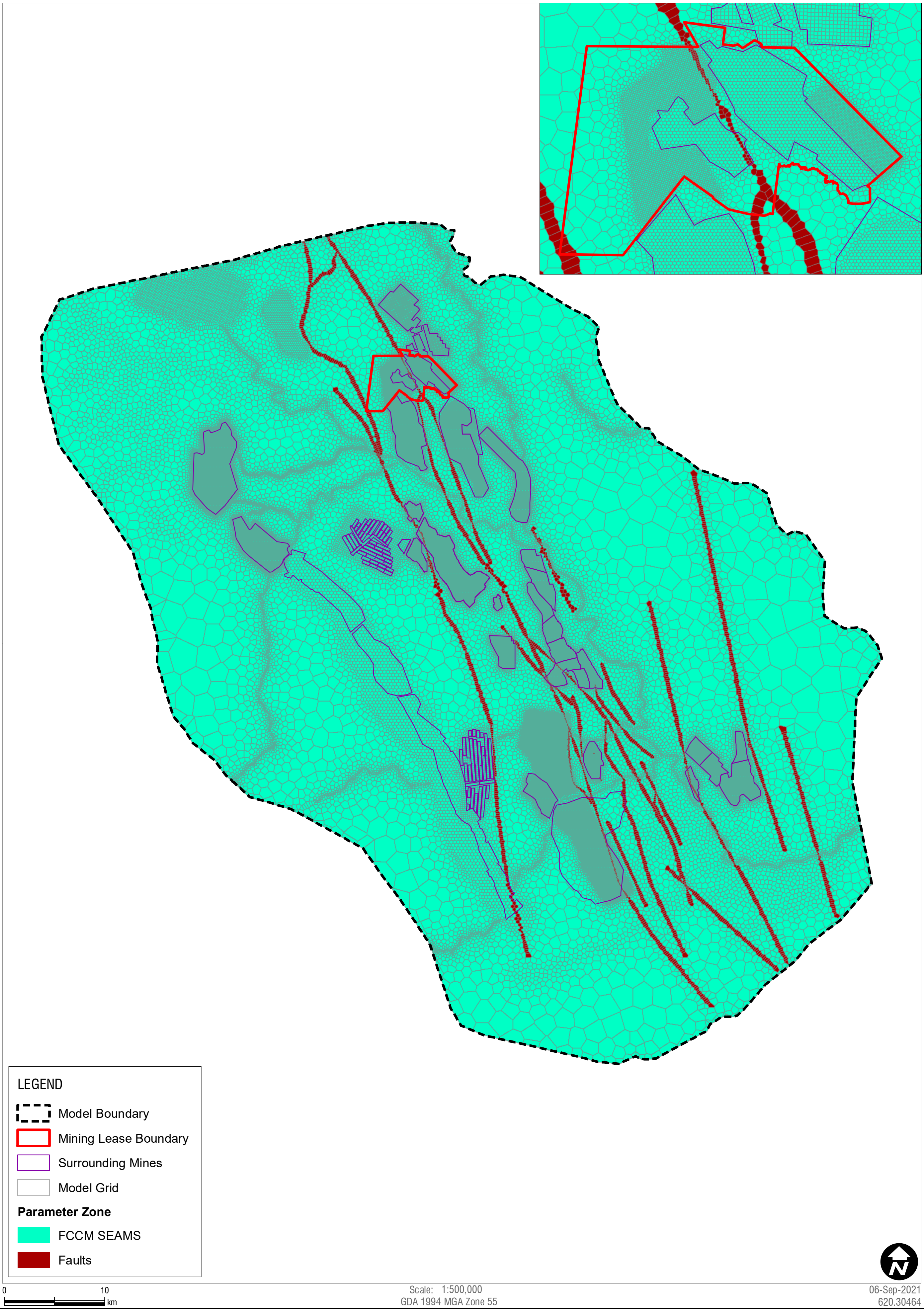
06-Sep-2021
620.30404

H:\Projects-SLR\620-BNE\620-BNE\620.30404.00000 Millennium Mine GW assessment\06 SLR Data\01 CADGIS\GIS\Appendix D\62030404 D-9 Modelled hydraulic conductivity zones.mxd

SLR

Hydraulic Parameter Zone Distribution Layer 9

FIGURE C-9



H:\Projects-SLR\620-BNE\620-BNE\620.30404.00000 Millennium Mine GW assessment\06 SLR Data\01 CADGIS\GIS\Appendix D\62030404 D-10 Modelled hydraulic conductivity zones.mxd

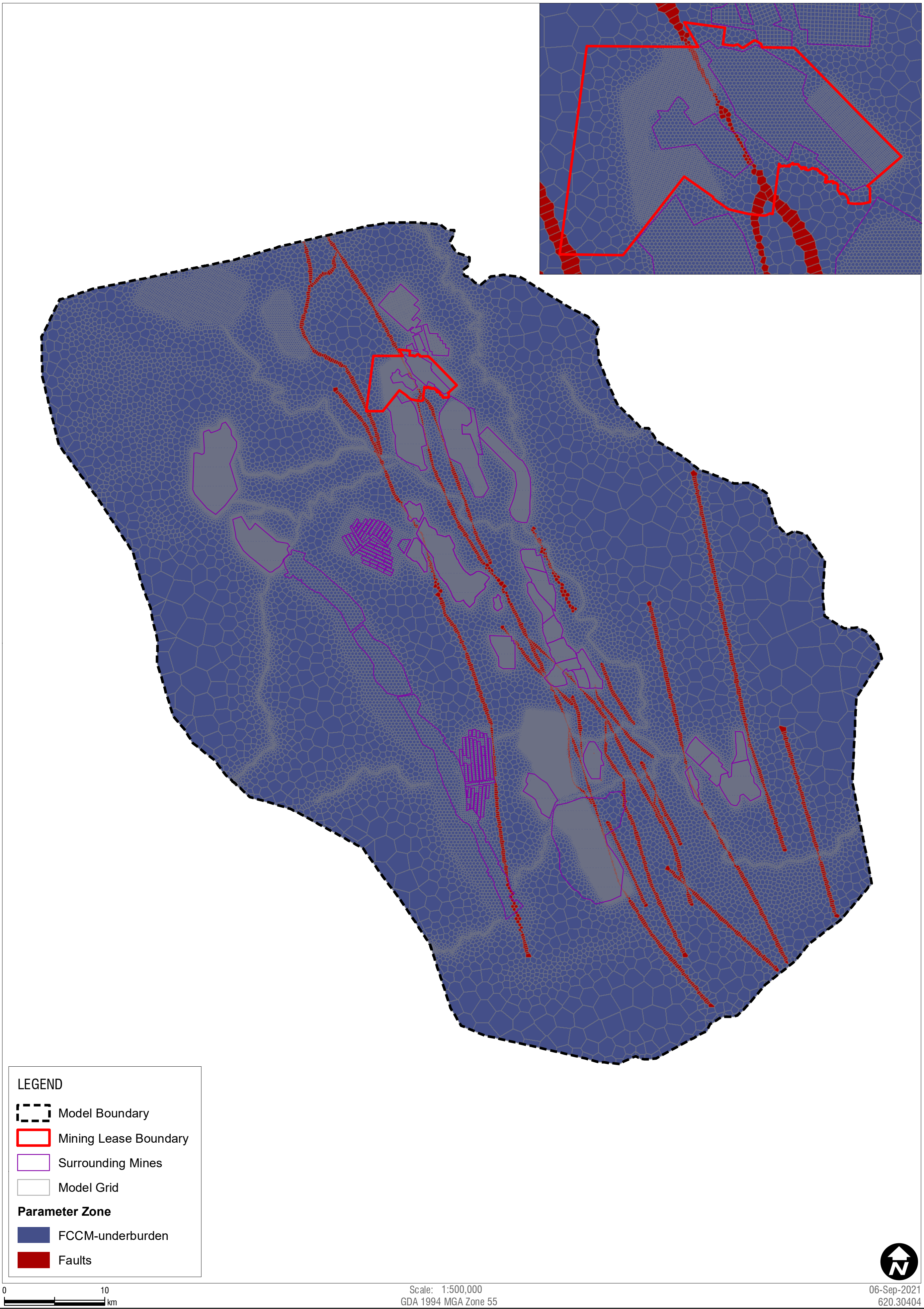
Scale: 1:500,000
GDA 1994 MGA Zone 55

06-Sep-2021
620.30464

SLR

Hydraulic Parameter Zone Distribution Layer 10

FIGURE C-10



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SLR

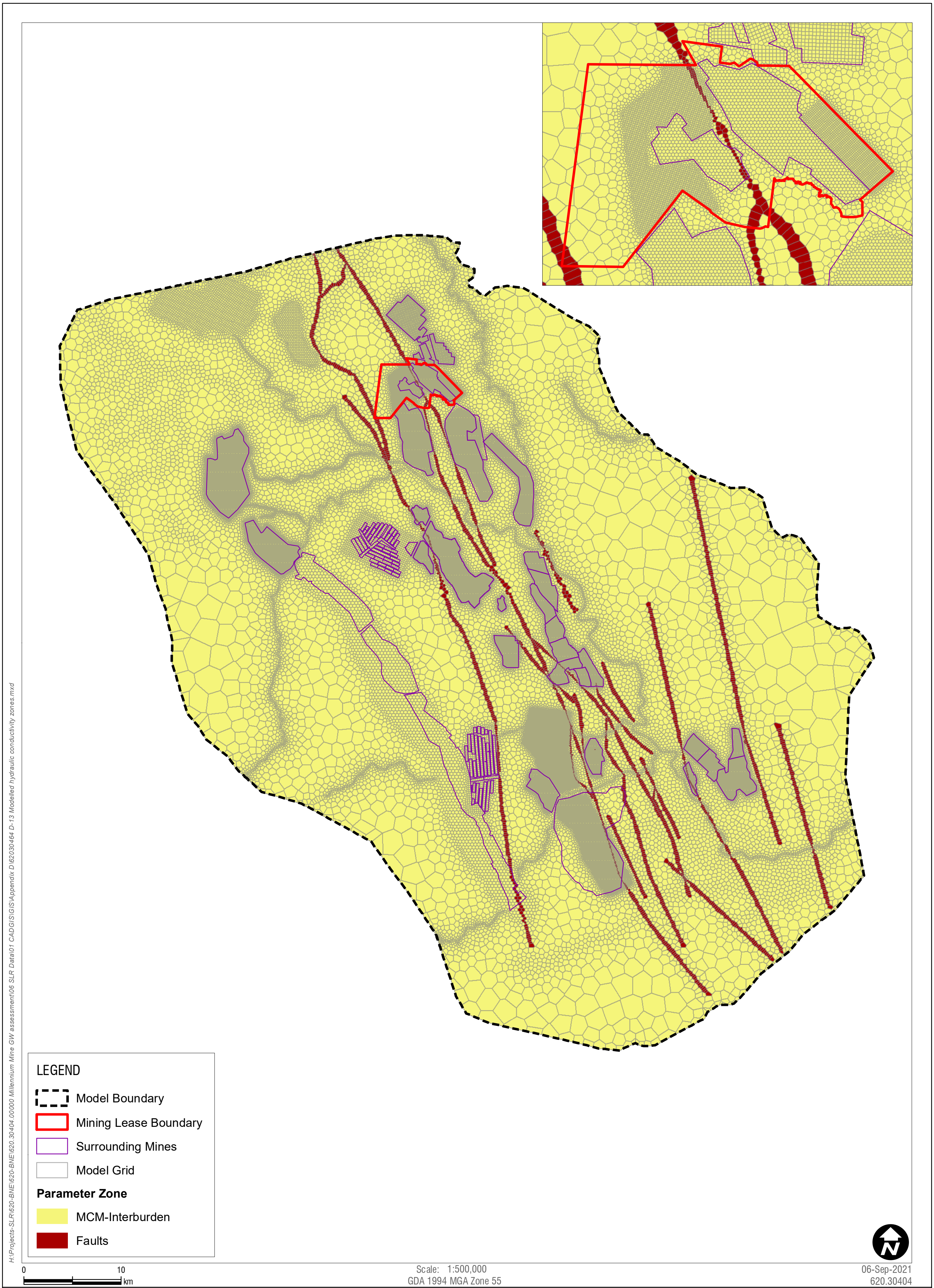
Hydraulic Parameter Zone Distribution Layer 11

FIGURE C-11

SLR

Hydraulic Parameter Zone Distribution Layer 12

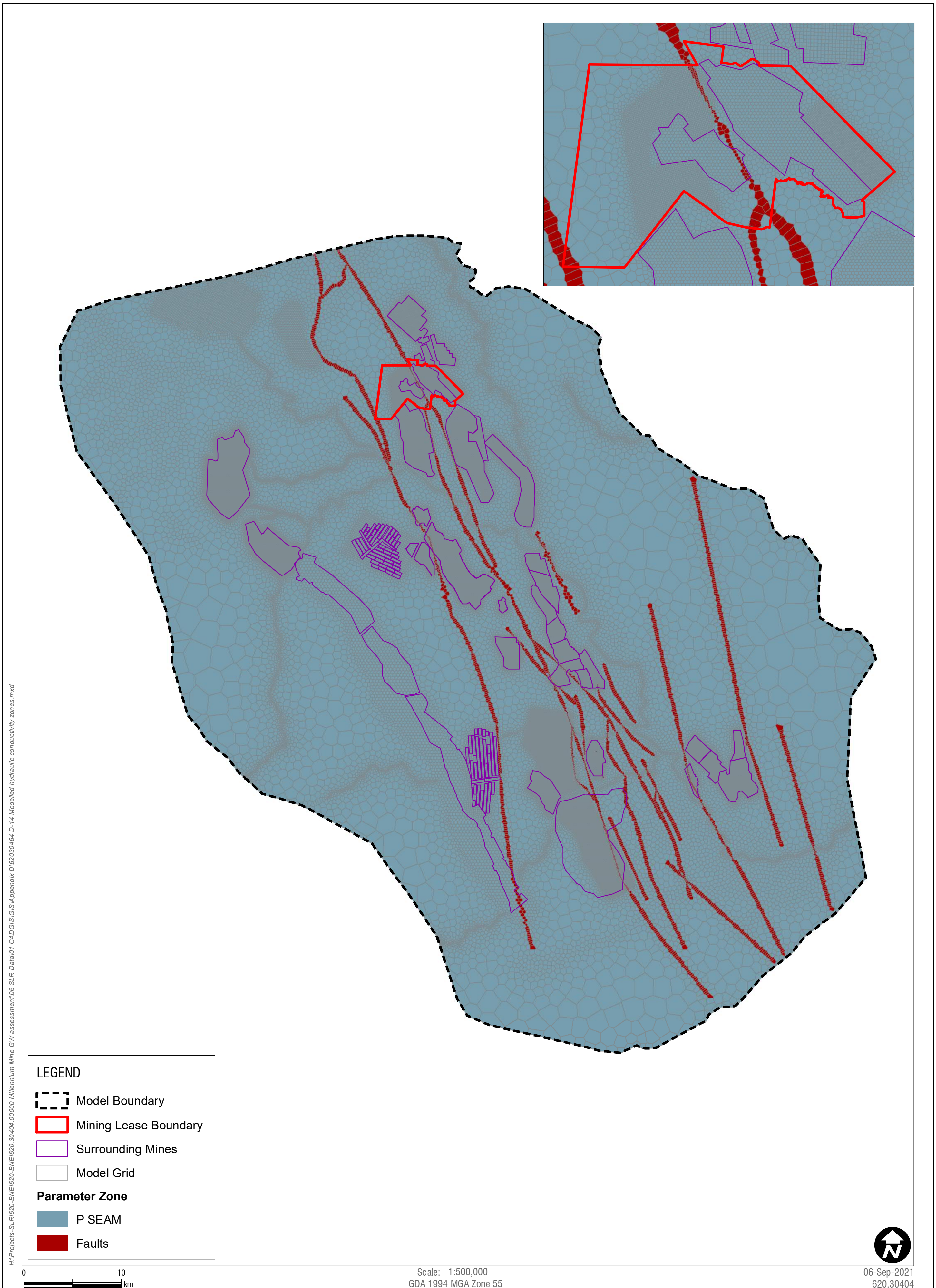
FIGURE C-12



SLR

Hydraulic Parameter Zone Distribution Layer 13

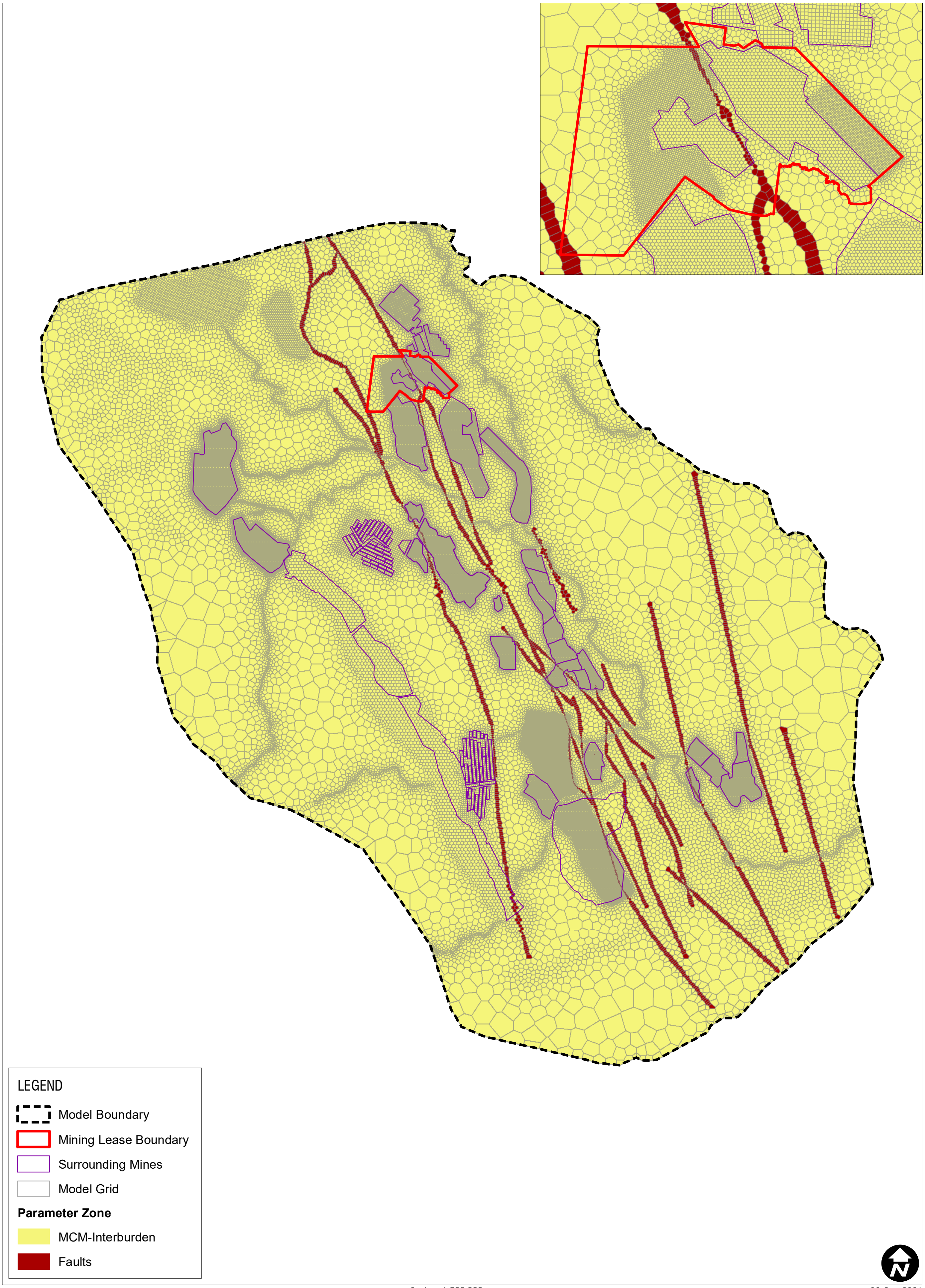
FIGURE C-13



SLR

Hydraulic Parameter Zone Distribution Layer 14

FIGURE C-14



0 10 km

Scale: 1:500,000
GDA 1994 MGA Zone 55

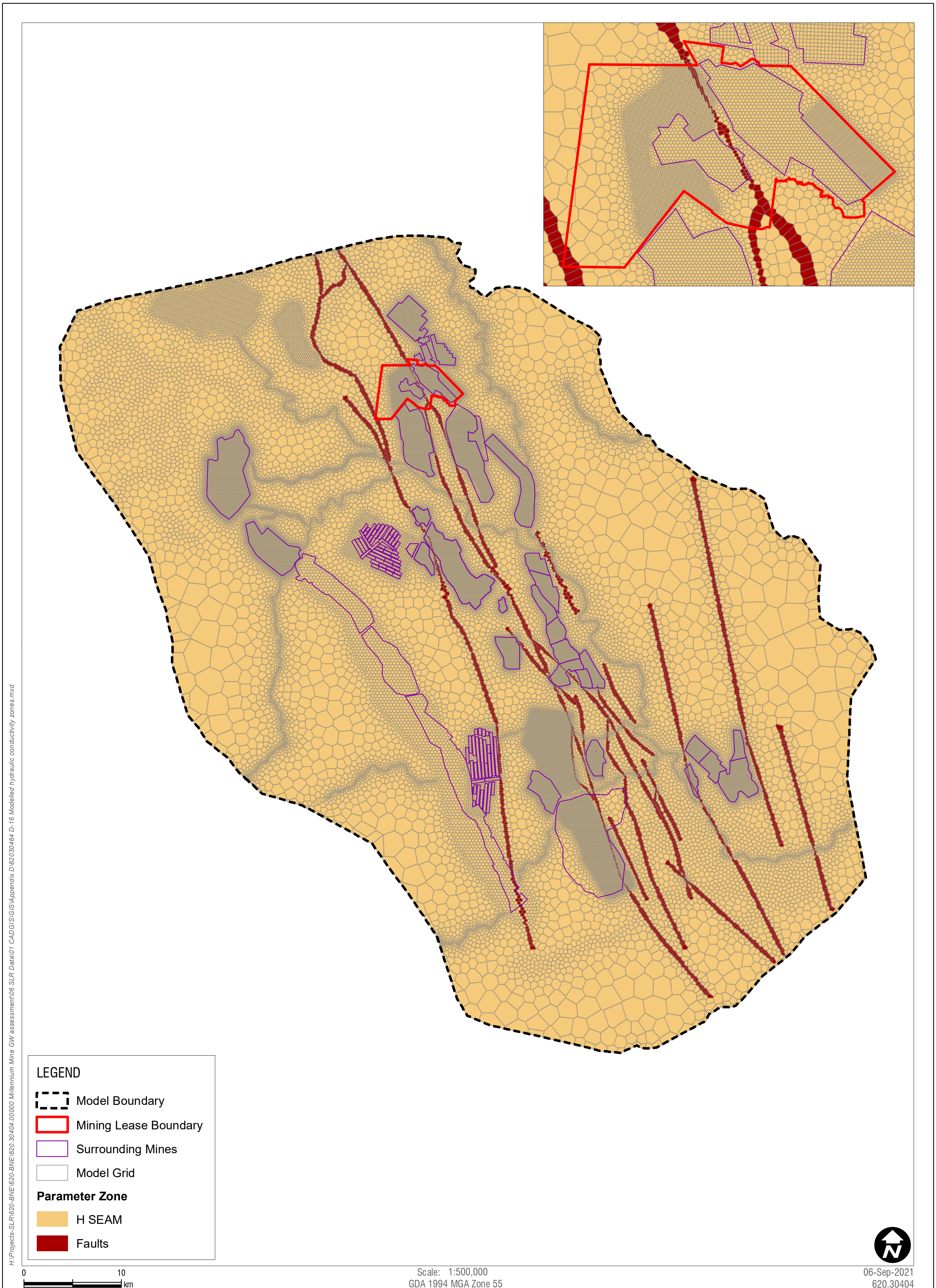
06-Sep-2021
620.30404

H:\Projects-SLR\620-BNE\620-BNE\620.30404.00000 Millennium Mine GW assessment\06 SLR Data\01 CADGIS\GIS\Appendix D\62030464 D-15 Modelled hydraulic conductivity zones.mxd

SLR

Hydraulic Parameter Zone Distribution Layer 15

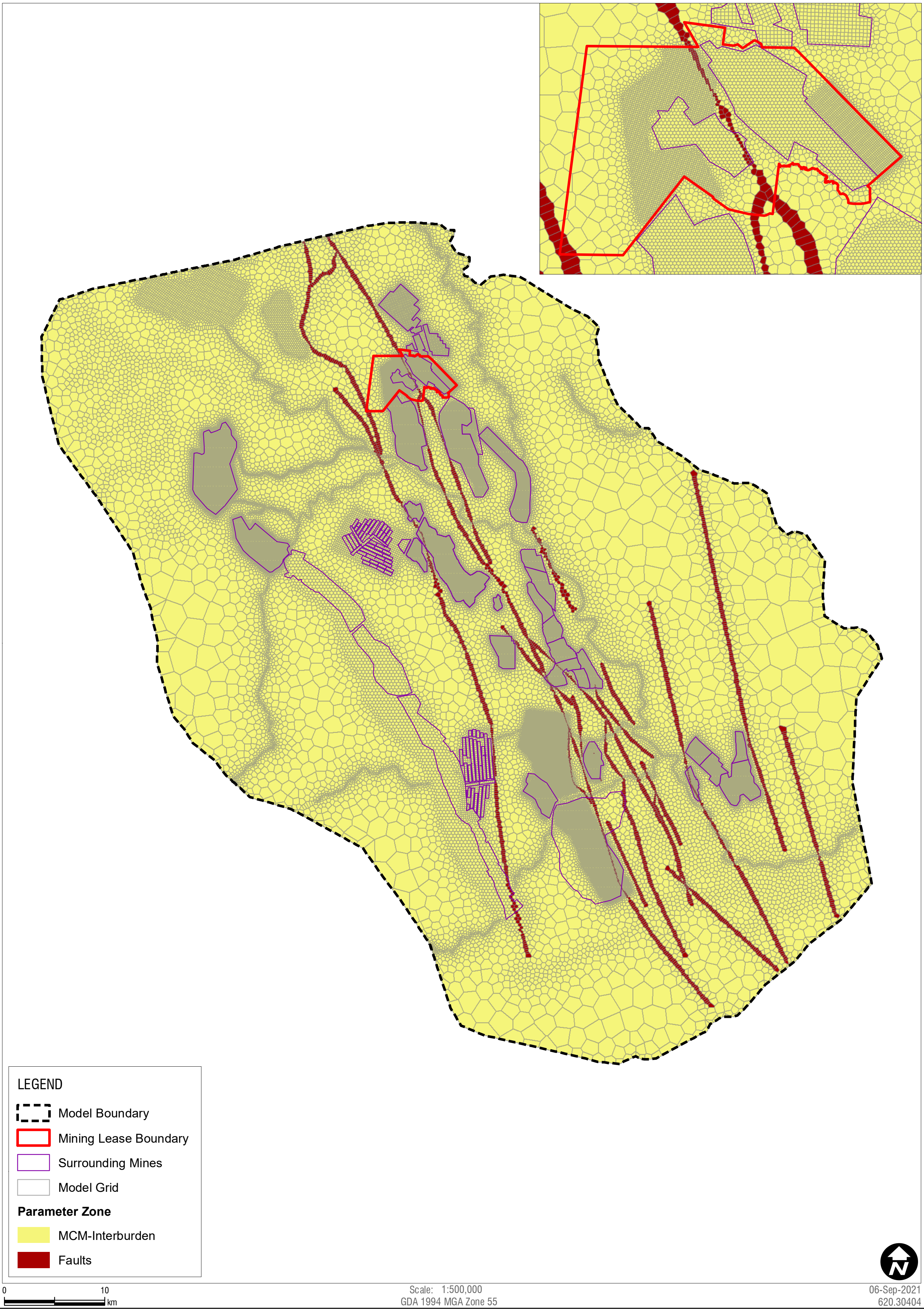
FIGURE C-15



SLR

Hydraulic Parameter Zone Distribution Layer 16

FIGURE C-16



Scale: 1:500,000
GDA 1994 MGA Zone 55

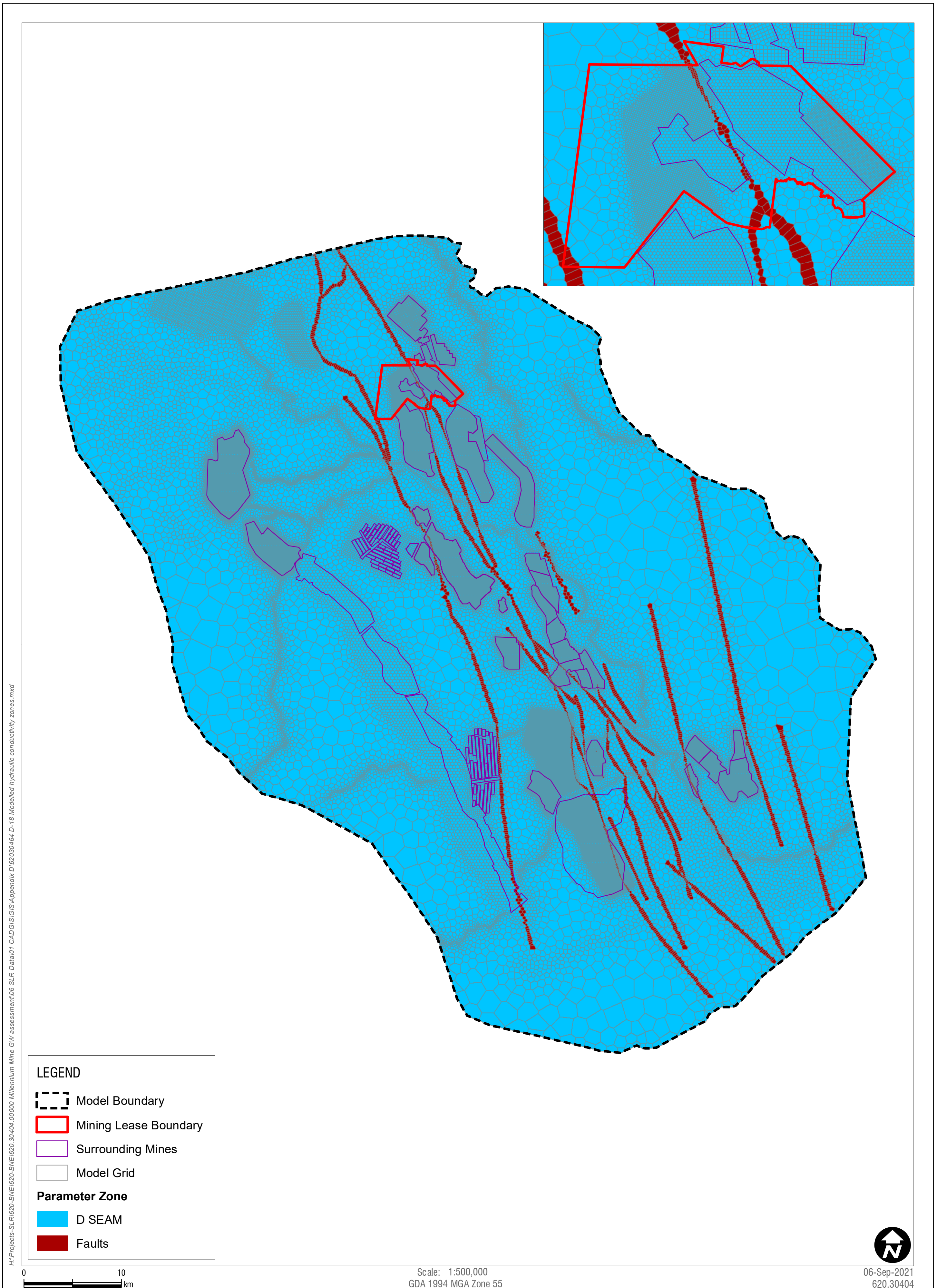
06-Sep-2021
620.30404

H:\Projects-SLR\620-BNE\620-BNE\620.30404.00000 Millennium Mine GW assessment\06 SLR Data\01 CADGIS\GIS\Appendix D\62030464 D-17 Modelled hydraulic conductivity zones.mxd

SLR

Hydraulic Parameter Zone Distribution Layer 17

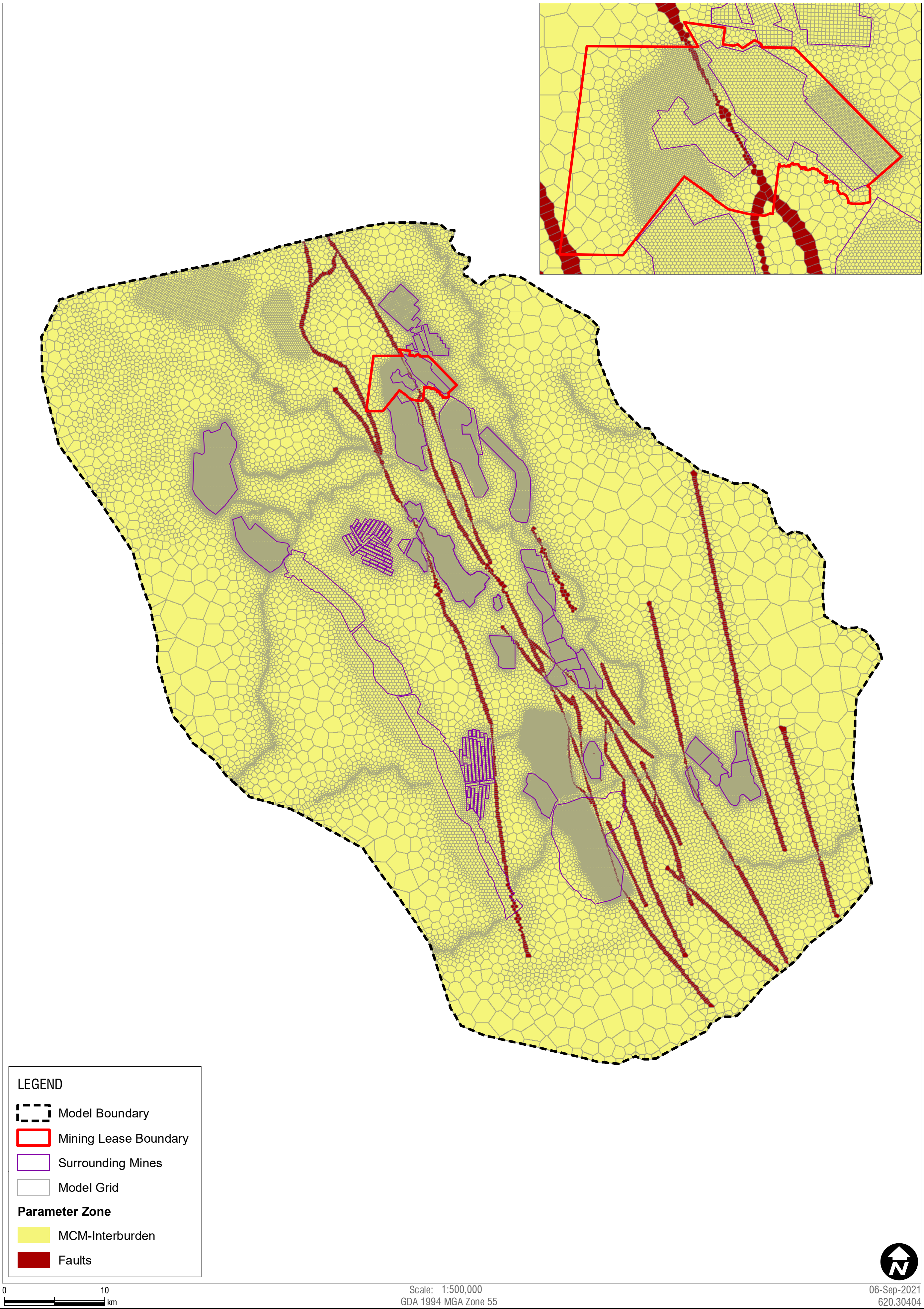
FIGURE C-17



SLR

Hydraulic Parameter Zone Distribution Layer 18

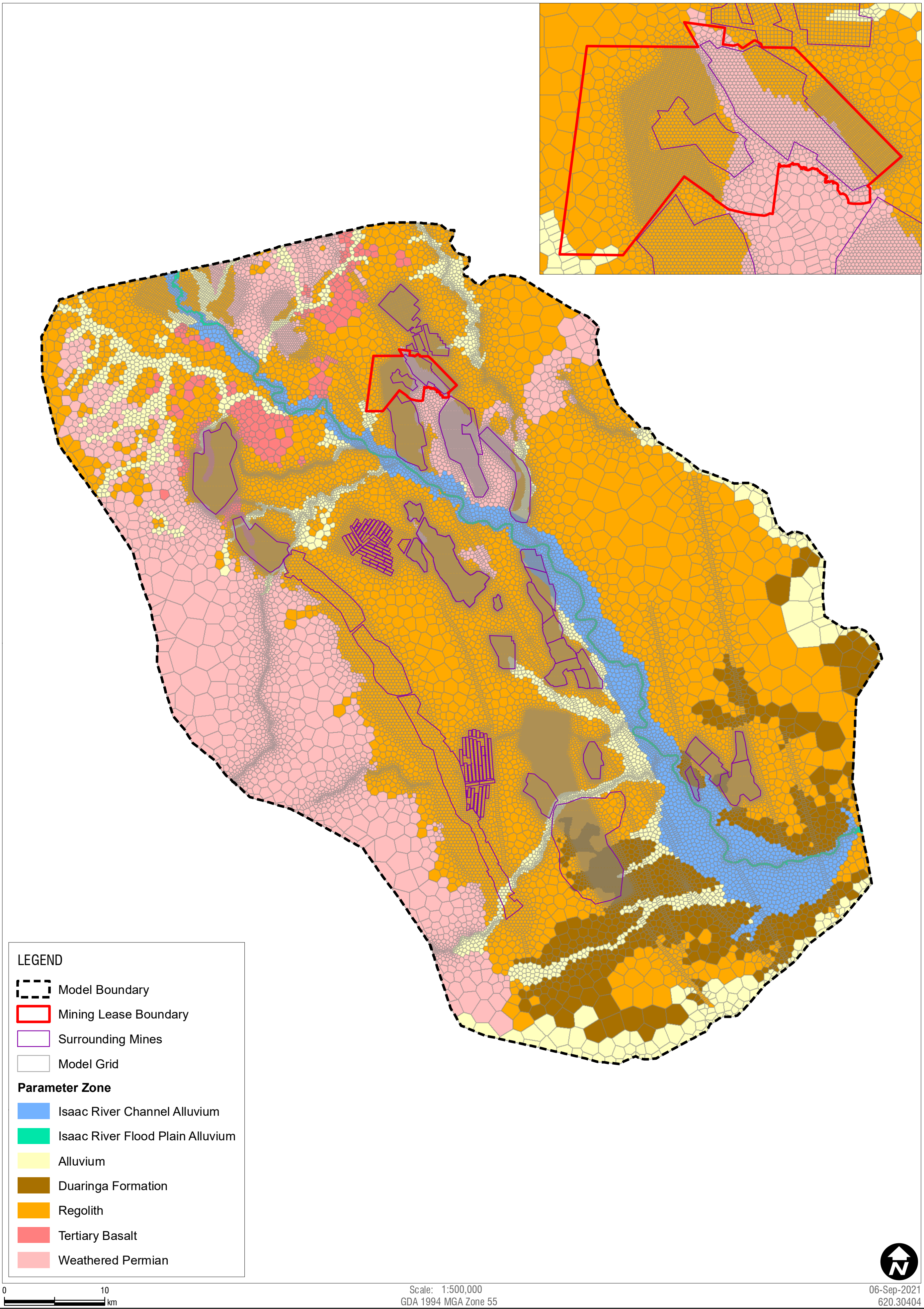
FIGURE C-18



SLR

Hydraulic Parameter Zone Distribution Layer 19

FIGURE C-19



Scale: 1:500,000
GDA 1994 MGA Zone 55

06-Sep-2021
620.30404

H:\Projects-SLR\620-BNE\620-BNE\620.30404.00000 Millennium Mine GW assessment\06 SLR Data\01 CADGIS\GIS\Appendix D\62030464 D-20 Recharge Zone Distribution.mxd

SLR

Recharge Zone Distribution

FIGURE C-20

Appendix D Calibration Bore Hydrographs

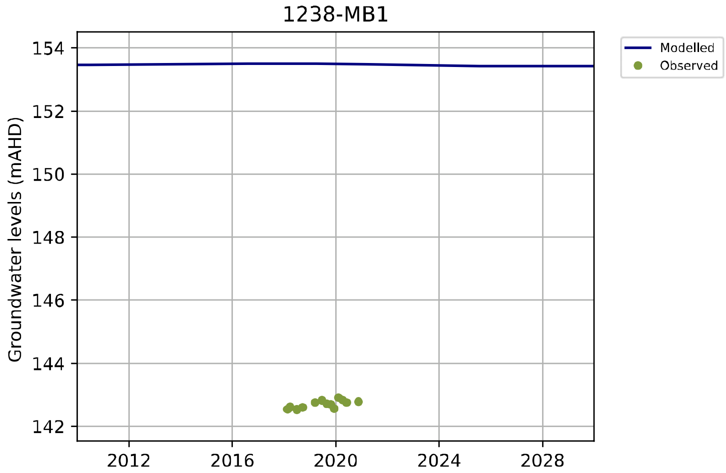
Millennium Mine – Mavis South Extension Project

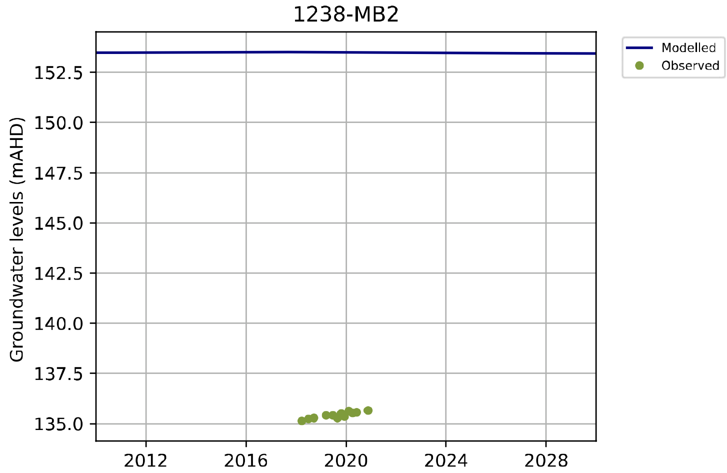
Supporting documentation to the Environmental Authority (EPML00819213) amendment application Mavis South Underground operations – Groundwater Impact Assessment: State considerations

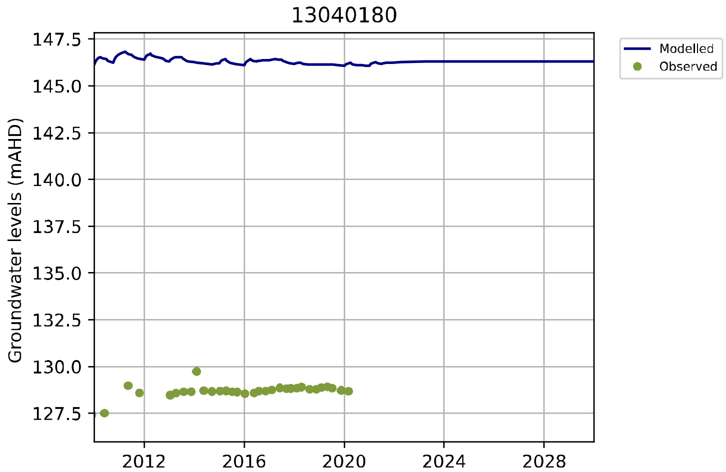
MetRes Pty Ltd

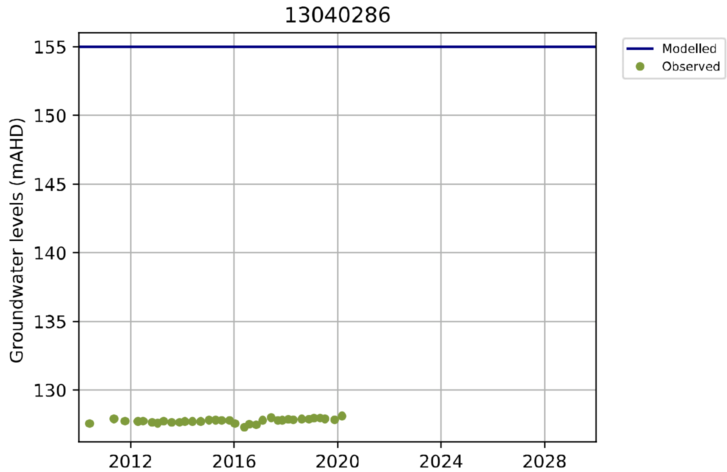
SLR Project No.: 620.031508.00001

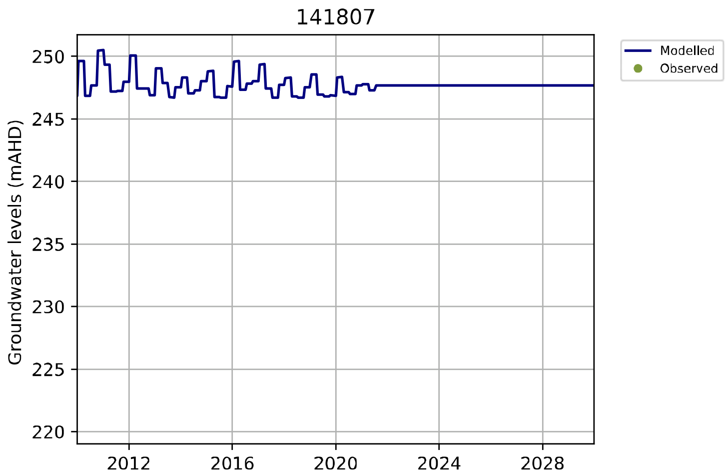
23 November 2023

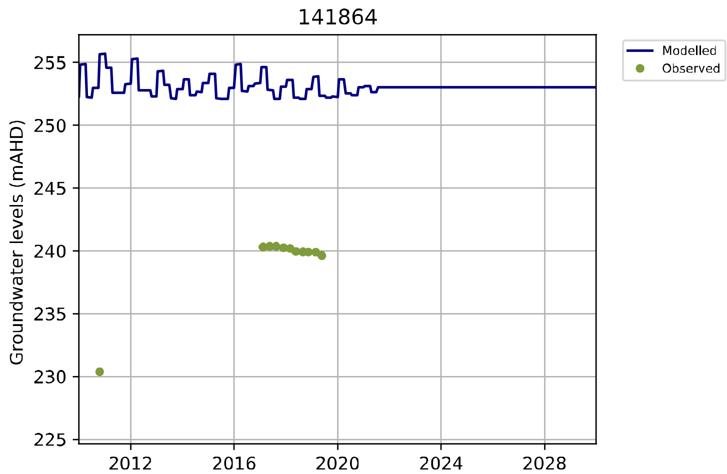

1238-MB1
Groundwater levels (mAHD)
154
152
150
148
146
144
142
2012
2016
2020
2024
2028
Modelled
Observed

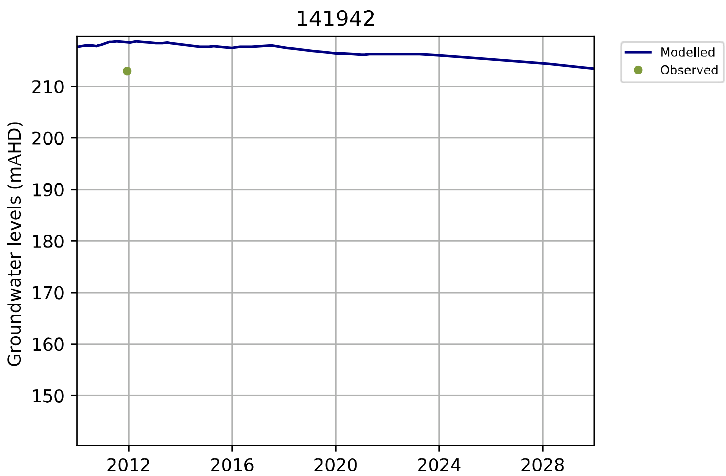

1238-MB2
Groundwater levels (mAHD)
152.5
150.0
147.5
145.0
142.5
140.0
137.5
135.0
2012
2016
2020
2024
2028
Modelled
Observed

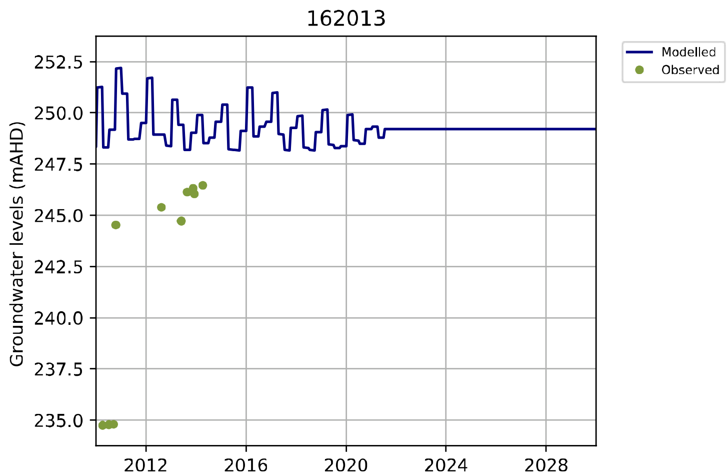

13040180
Groundwater levels (mAHD)
147.5
145.0
142.5
140.0
137.5
135.0
132.5
130.0
127.5
2012
2016
2020
2024
2028
Modelled
Observed

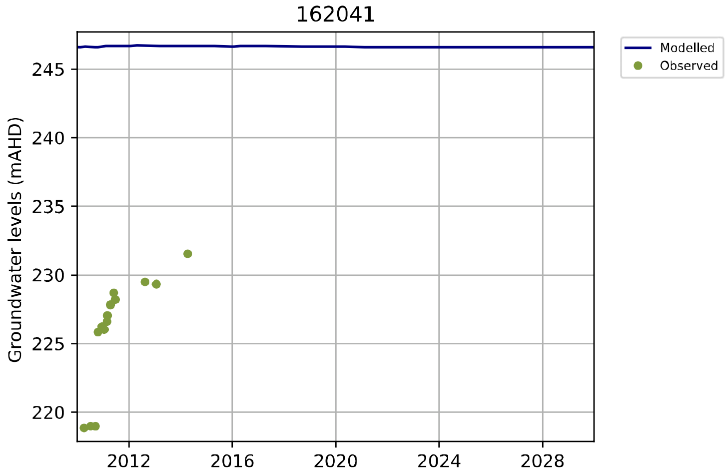

13040286
Groundwater levels (mAHD)
155
150
145
140
135
130
2012
2016
2020
2024
2028
Modelled
Observed

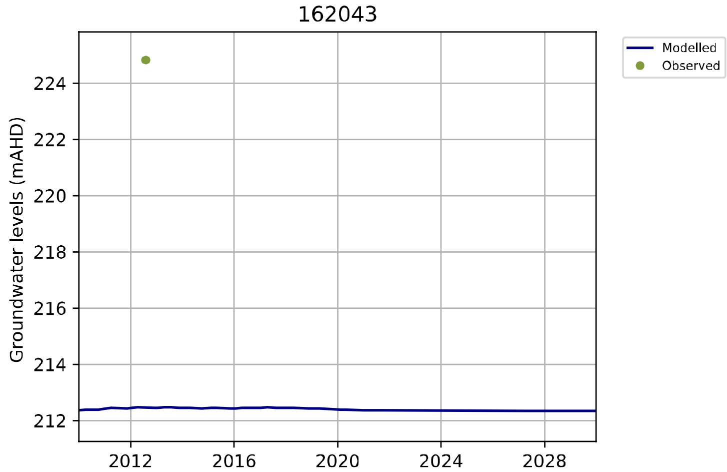

141807
Groundwater levels (mAHD)
250
245
240
235
230
225
220
2012
2016
2020
2024
2028
Modelled
Observed

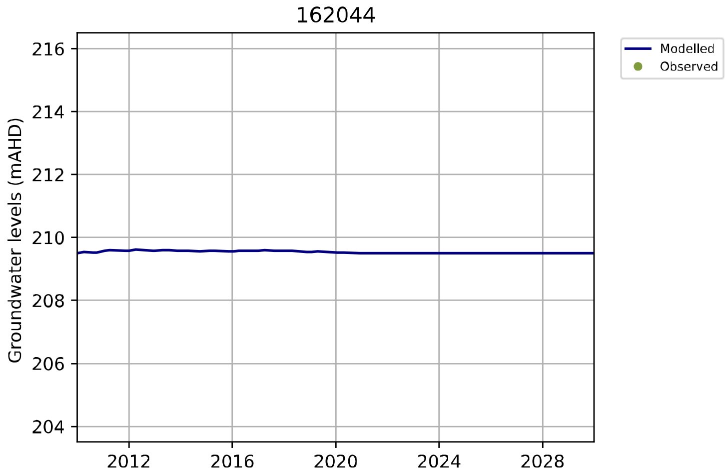

141864
Groundwater levels (mAHD)
255
250
245
240
235
230
225
2012
2016
2020
2024
2028
Modelled
Observed

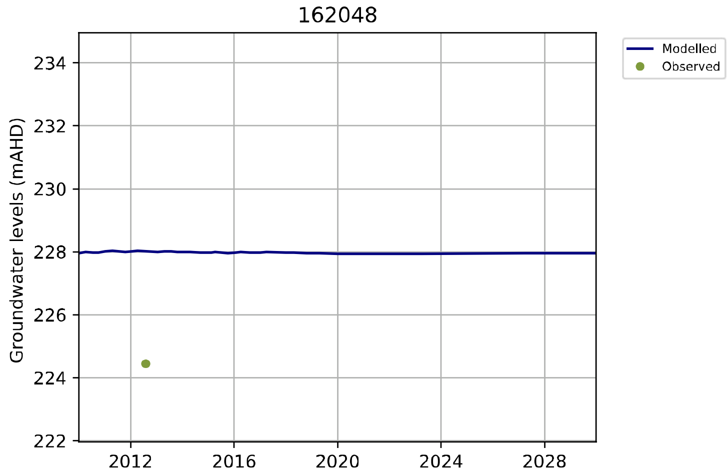

141942
Groundwater levels (mAHD)
210
200
190
180
170
160
150
2012
2016
2020
2024
2028
Modelled
Observed

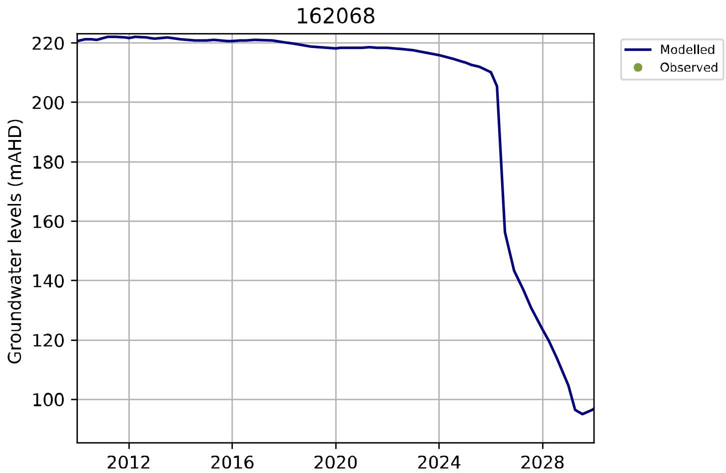

162013
Groundwater levels (mAHD)
252.5
250.0
247.5
245.0
242.5
240.0
237.5
235.0
2012
2016
2020
2024
2028
Modelled
Observed

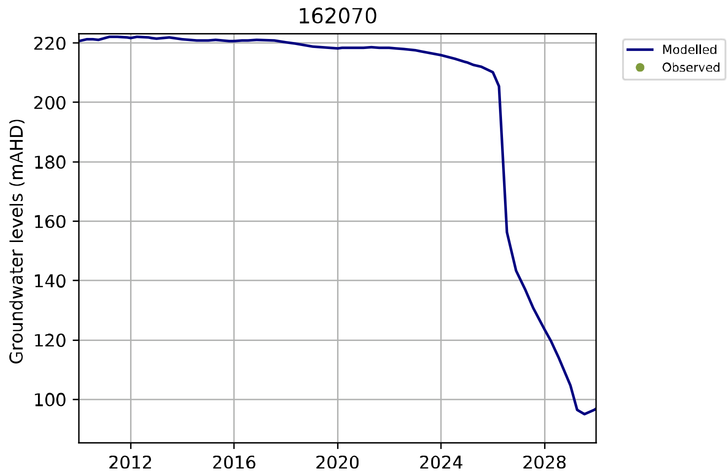

162041
Groundwater levels (mAHD)
245
240
235
230
225
220
2012
2016
2020
2024
2028
Modelled
Observed

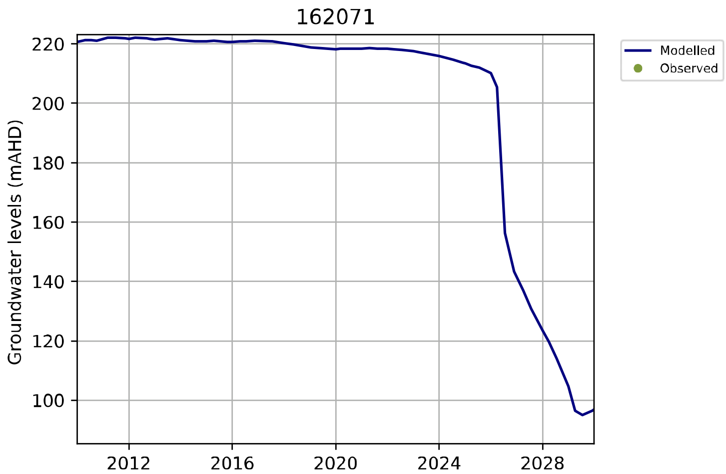

162043
Groundwater levels (mAHD)
224
222
220
218
216
214
212
2012
2016
2020
2024
2028
Modelled
Observed

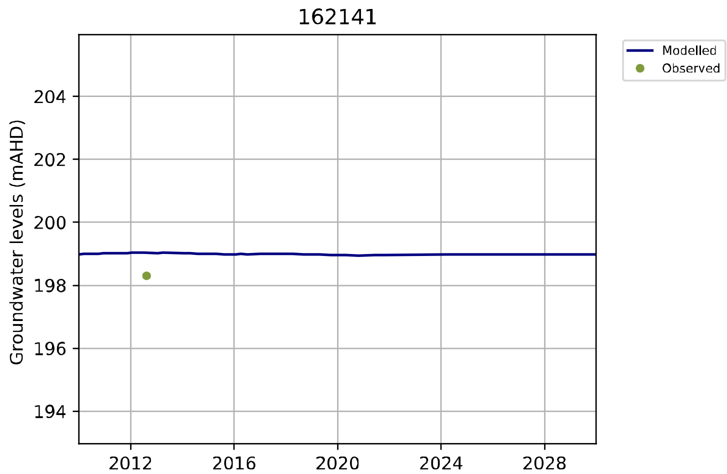

162044
Groundwater levels (mAHD)
216
214
212
210
208
206
204
2012
2016
2020
2024
2028
Modelled
Observed

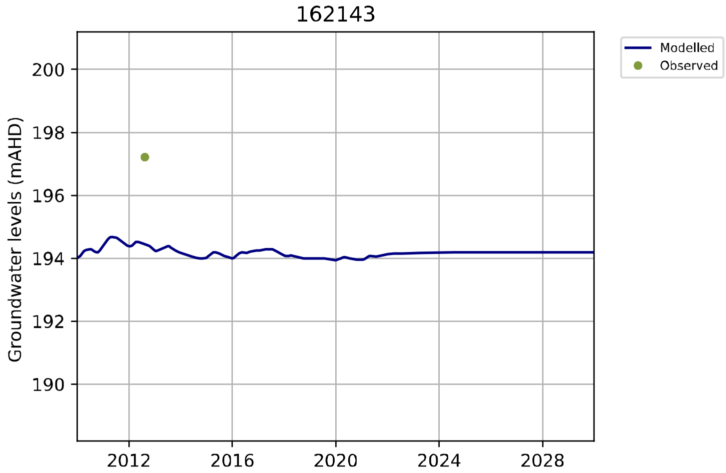

162048
Groundwater levels (mAHD)
234
232
230
228
226
224
222
2012
2016
2020
2024
2028
Modelled
Observed

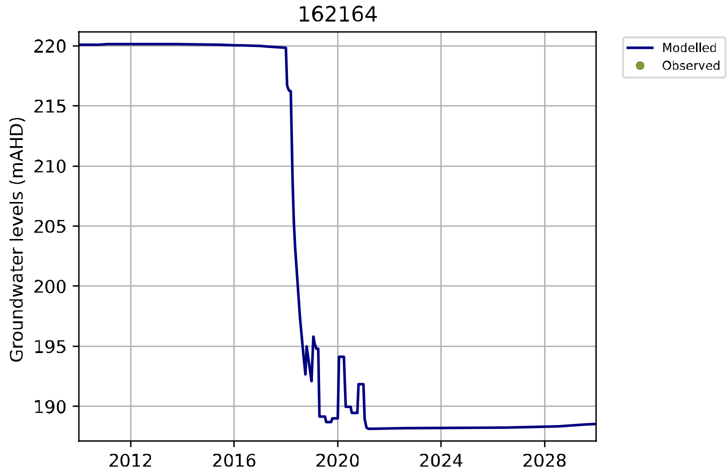

162068
Groundwater levels (mAHD)
220
200
180
160
140
120
100
2012
2016
2020
2024
2028
Modelled
Observed

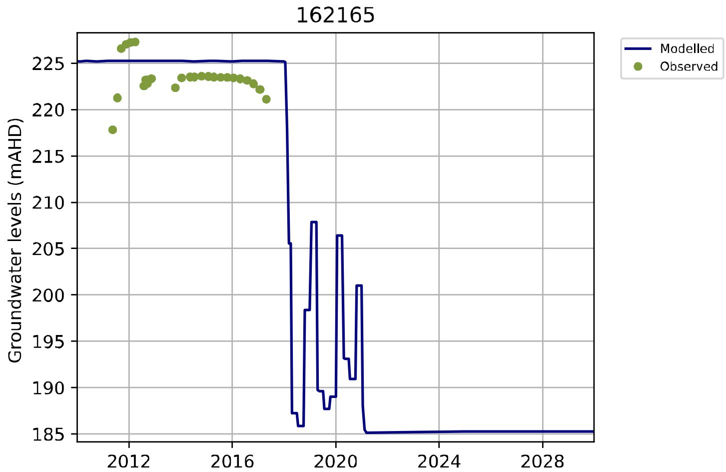

162070
Groundwater levels (mAHD)
220
200
180
160
140
120
100
2012
2016
2020
2024
2028
Modelled
Observed

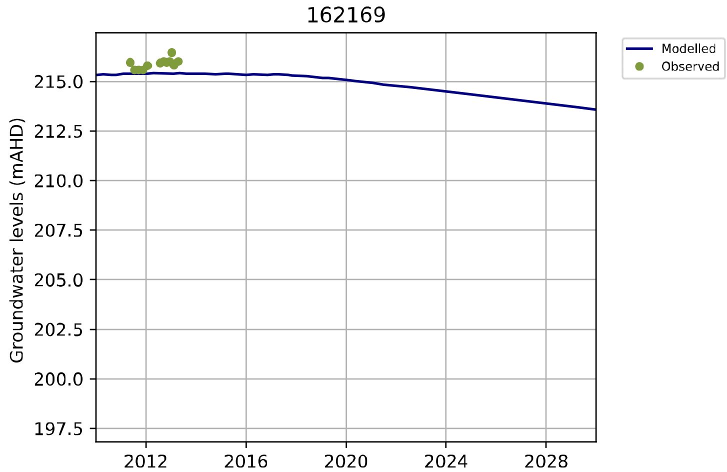

162071
Groundwater levels (mAHD)
220
200
180
160
140
120
100
2012
2016
2020
2024
2028
Modelled
Observed

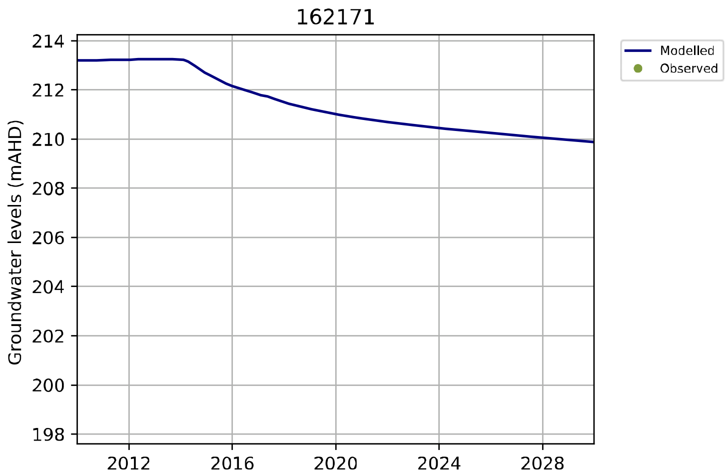

162141
Groundwater levels (mAHD)
204
202
200
198
196
194
2012
2016
2020
2024
2028
Modelled
Observed

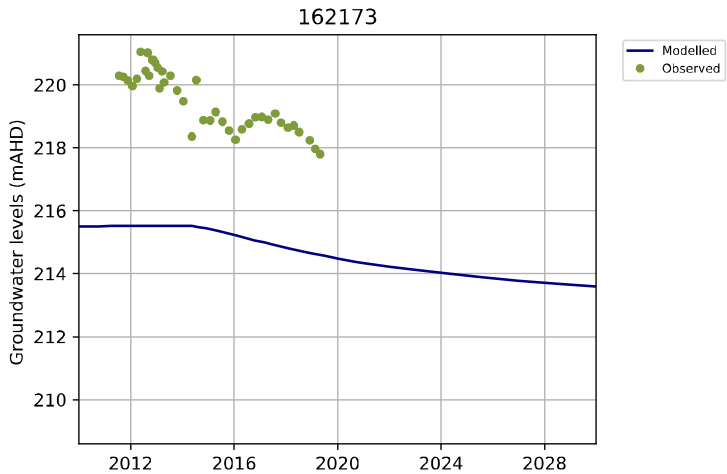

162143
Groundwater levels (mAHD)
Modelled
Observed
190
192
194
196
198
200
2012
2016
2020
2024
2028

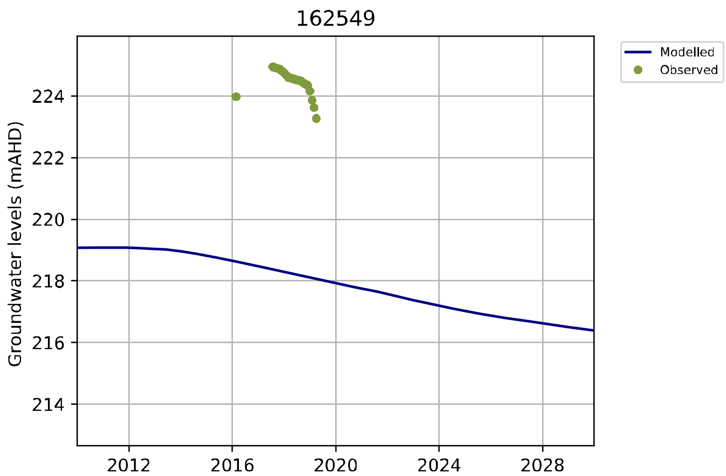

162164
Groundwater levels (mAHD)
Modelled
Observed
190
195
200
205
210
215
220
2012
2016
2020
2024
2028

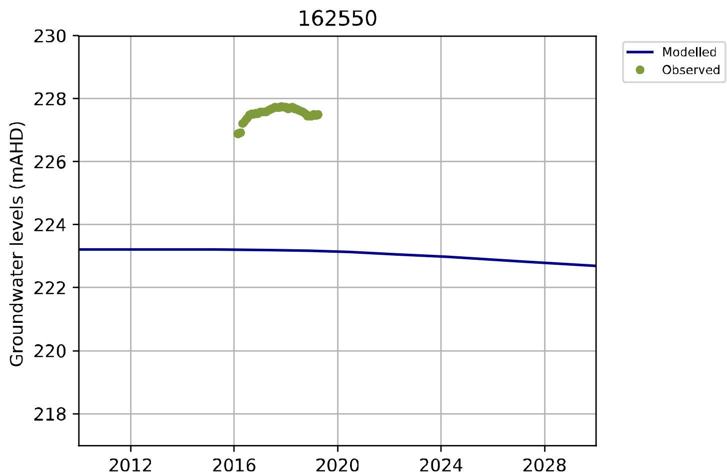

162165
Groundwater levels (mAHD)
Modelled
Observed
185
190
195
200
205
210
215
220
225
2012
2016
2020
2024
2028

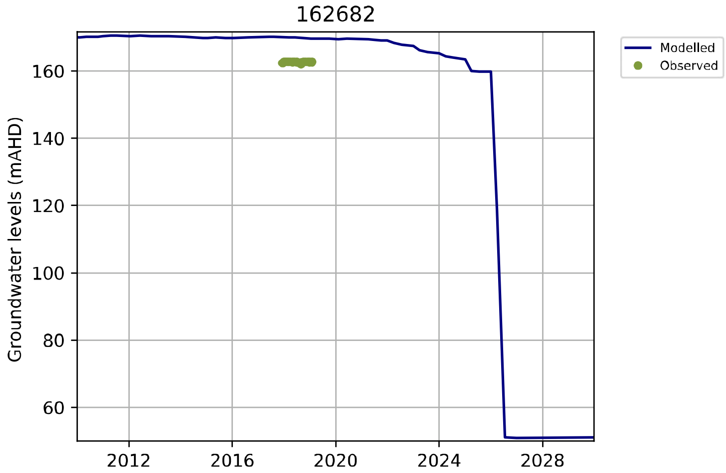

162169
Groundwater levels (mAHD)
Modelled
Observed
197.5
200.0
202.5
205.0
207.5
210.0
212.5
215.0
2012
2016
2020
2024
2028

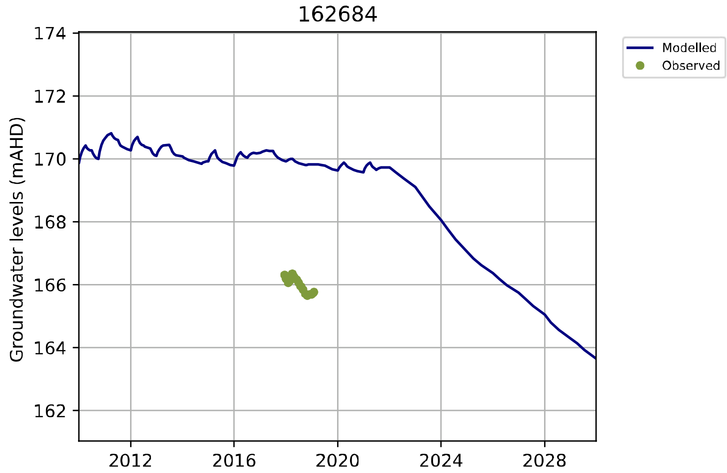

162171
Groundwater levels (mAHD)
Modelled
Observed
198
200
202
204
206
208
210
212
214
2012
2016
2020
2024
2028

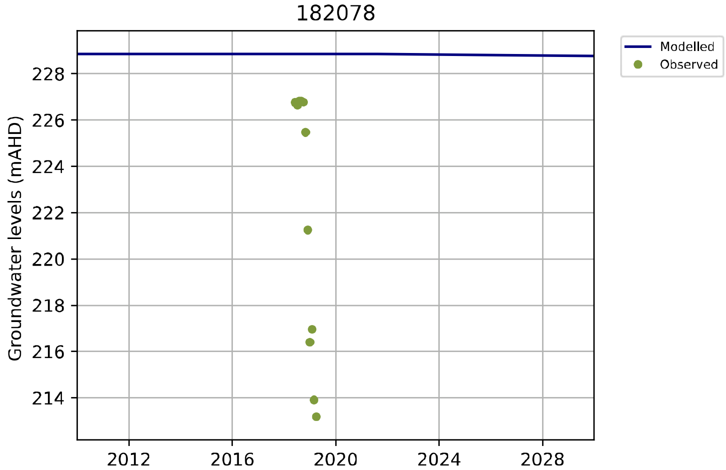

162173
Groundwater levels (mAHD)
Modelled
Observed
210
212
214
216
218
220
2012
2016
2020
2024
2028

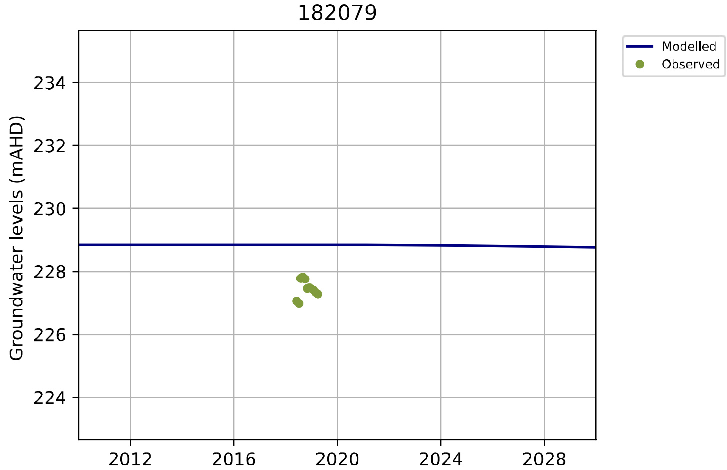

162549
Groundwater levels (mAHD)
Modelled
Observed
214
216
218
220
222
224
2012
2016
2020
2024
2028

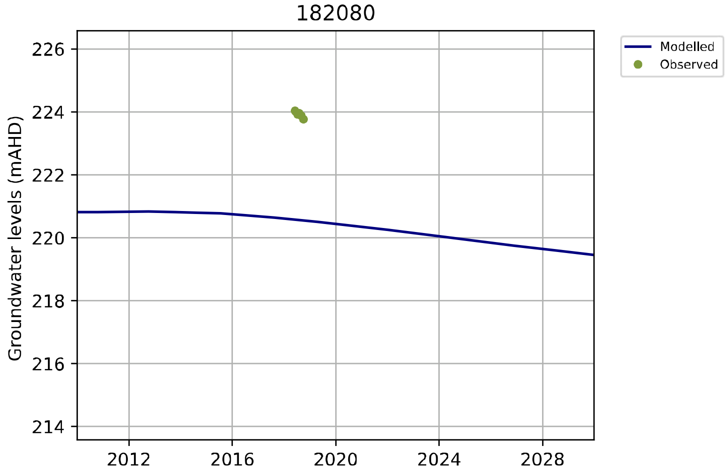

162550
Groundwater levels (mAHD)
Modelled
Observed
218
220
222
224
226
228
230
2012
2016
2020
2024
2028

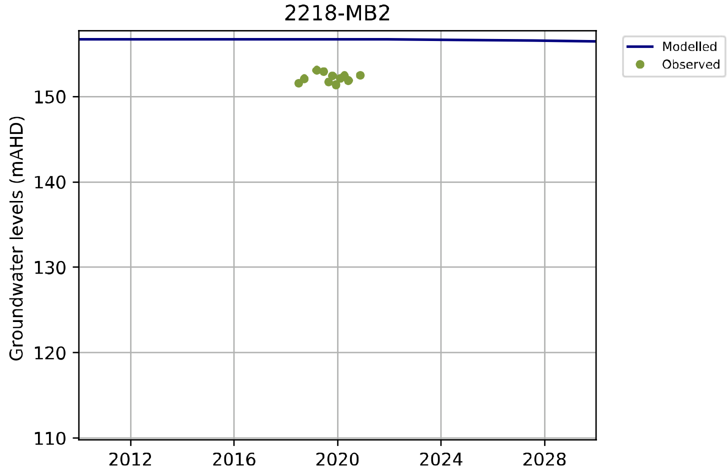

162682
Groundwater levels (mAHD)
160
140
120
100
80
60
2012
2016
2020
2024
2028
Modelled
Observed

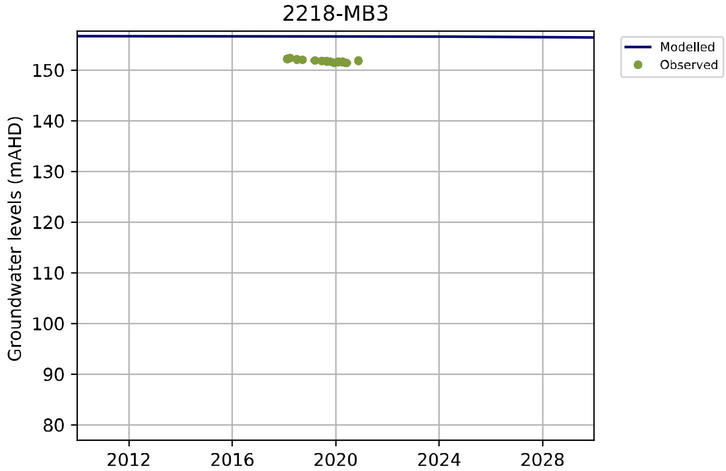

162684
Groundwater levels (mAHD)
174
172
170
168
166
164
162
2012
2016
2020
2024
2028
Modelled
Observed

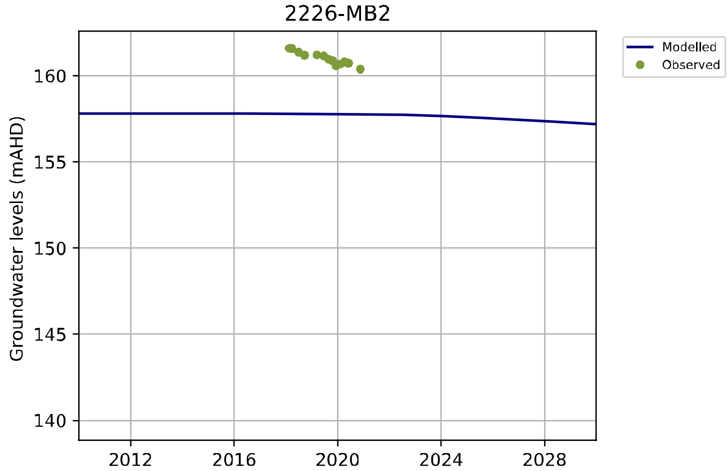

182078
Groundwater levels (mAHD)
228
226
224
222
220
218
216
214
2012
2016
2020
2024
2028
Modelled
Observed

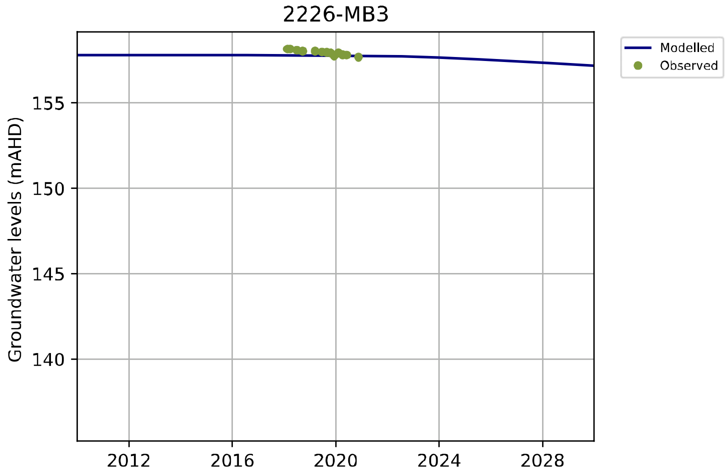

182079
Groundwater levels (mAHD)
234
232
230
228
226
224
2012
2016
2020
2024
2028
Modelled
Observed

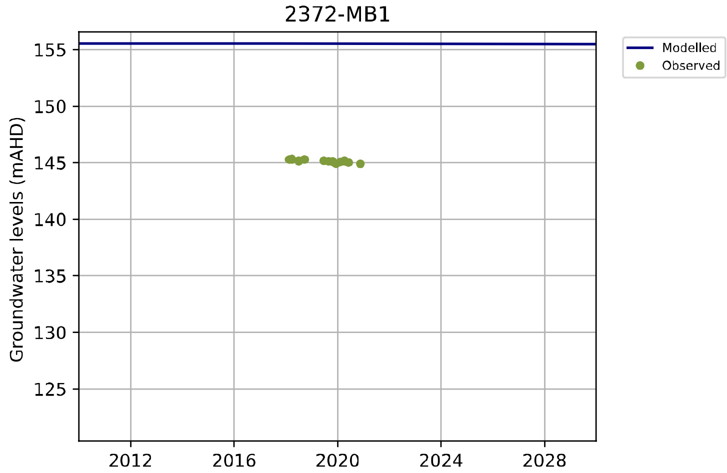

182080
Groundwater levels (mAHD)
226
224
222
220
218
216
214
2012
2016
2020
2024
2028
Modelled
Observed

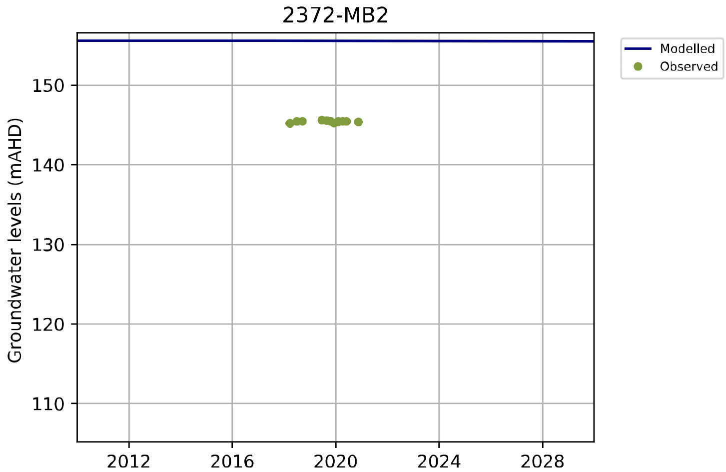

2218-MB2
Groundwater levels (mAHD)
150
140
130
120
110
2012
2016
2020
2024
2028
Modelled
Observed

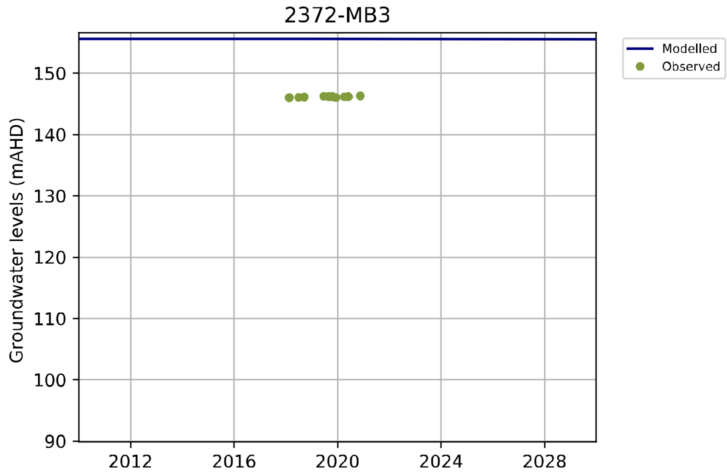

2218-MB3
Groundwater levels (mAHD)
150
140
130
120
110
100
90
80
2012
2016
2020
2024
2028
Modelled
Observed

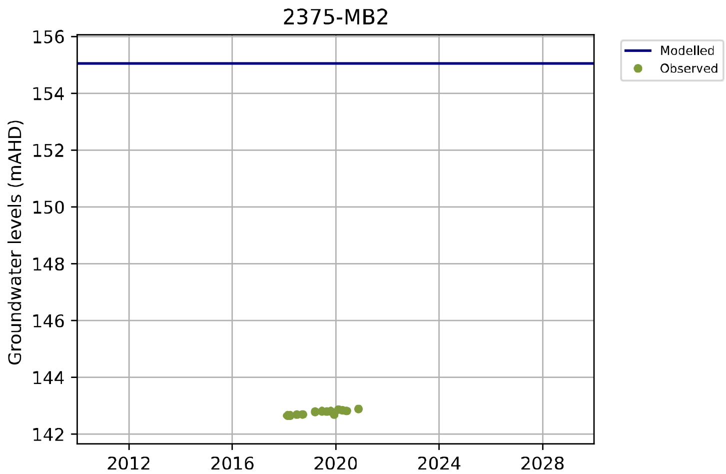

2226-MB2
Groundwater levels (mAHD)
160
155
150
145
140
2012
2016
2020
2024
2028
Modelled
Observed

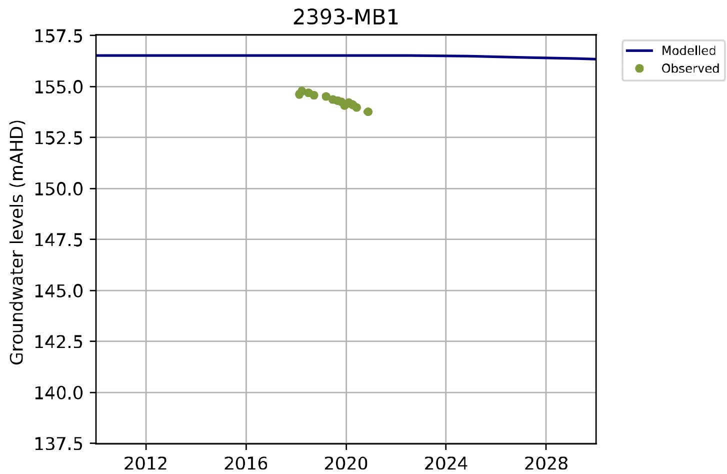

2226-MB3
Groundwater levels (mAHD)
Modelled
Observed

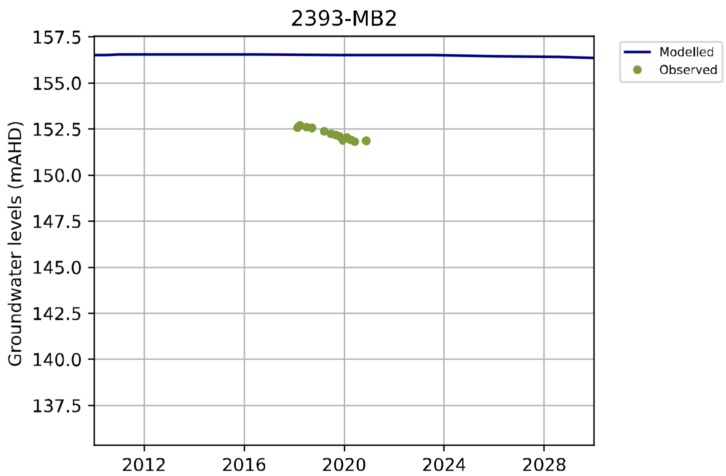

2372-MB1
Groundwater levels (mAHD)
Modelled
Observed

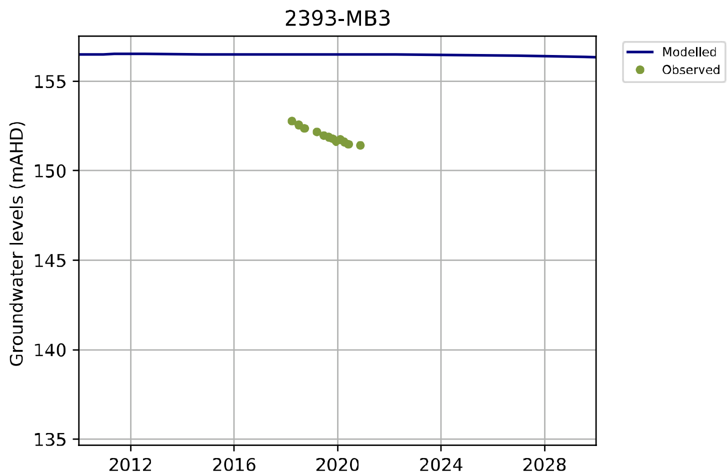

2372-MB2
Groundwater levels (mAHD)
Modelled
Observed

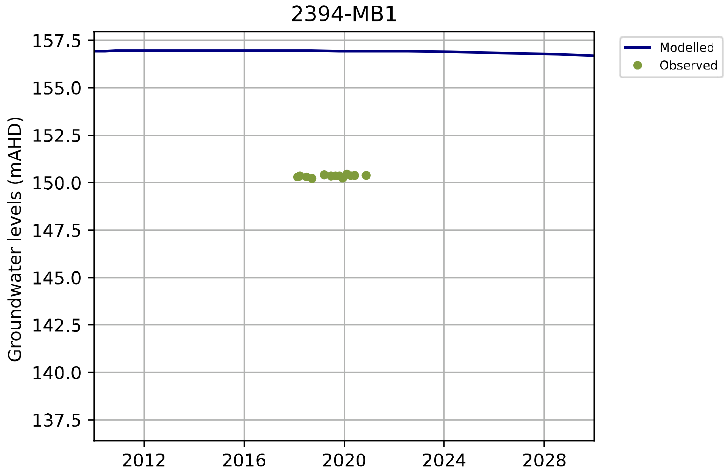

2372-MB3
Groundwater levels (mAHD)
Modelled
Observed

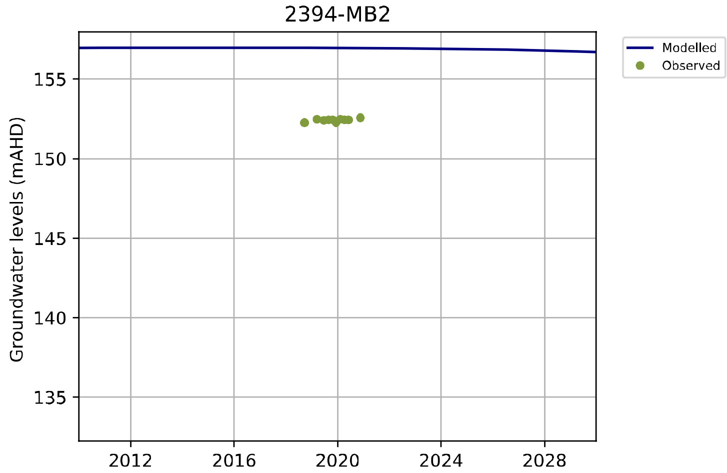

2375-MB2
Groundwater levels (mAHD)
Modelled
Observed

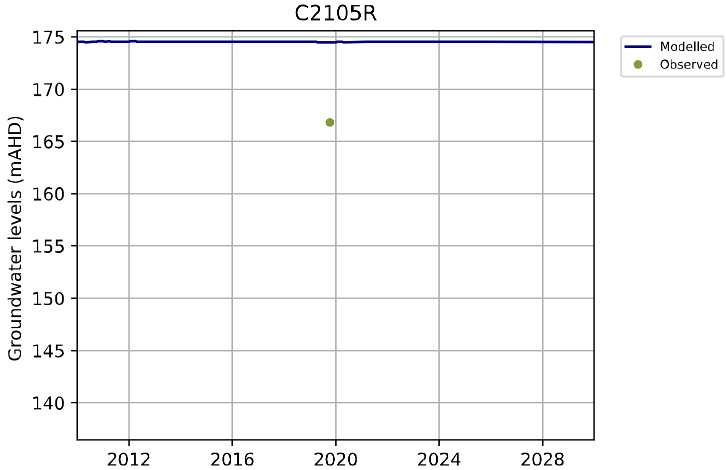

2393-MB1
Groundwater levels (mAHD)
Modelled
Observed

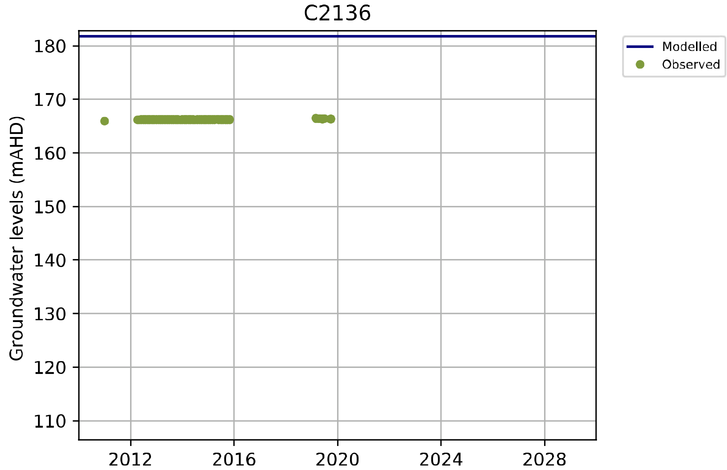

2393-MB2
Groundwater levels (mAHD)
Modelled
Observed

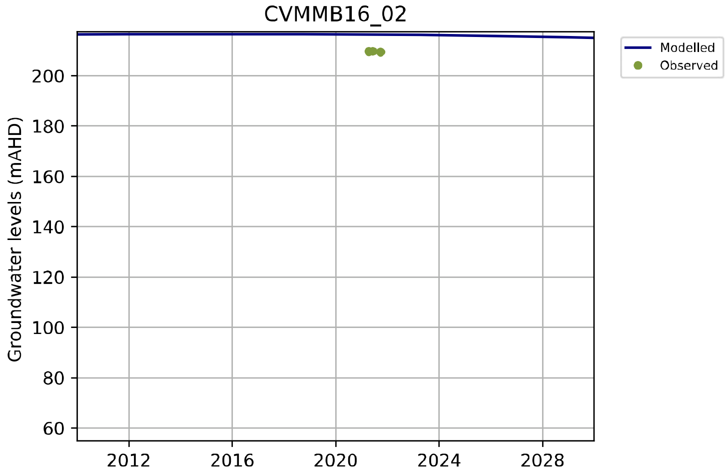

2393-MB3
Groundwater levels (mAHD)
Modelled
Observed

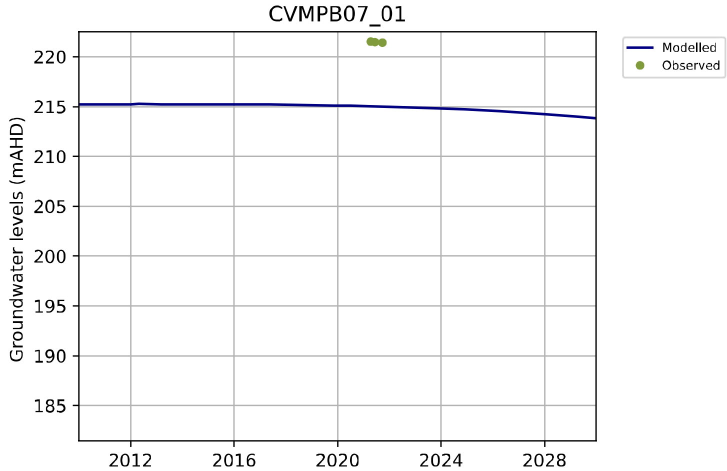

2394-MB1
Groundwater levels (mAHD)
157.5
155.0
152.5
150.0
147.5
145.0
142.5
140.0
137.5
2012
2016
2020
2024
2028
Modelled
Observed

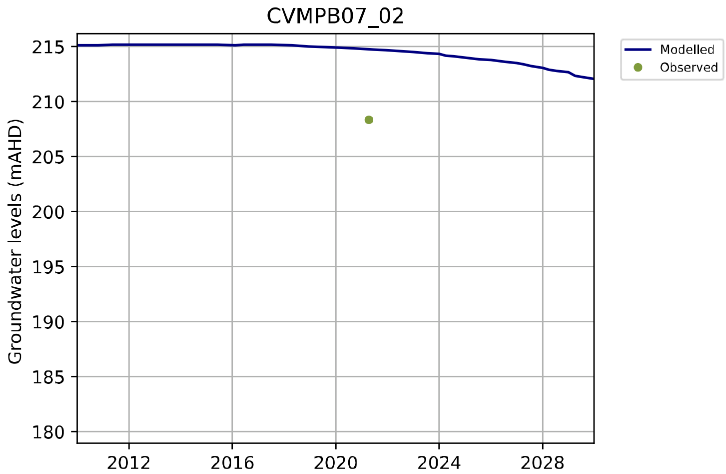

2394-MB2
Groundwater levels (mAHD)
155
150
145
140
135
2012
2016
2020
2024
2028
Modelled
Observed

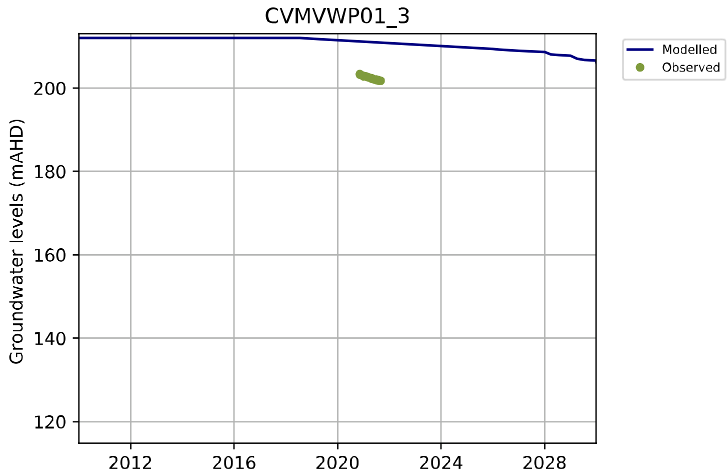

C2105R
Groundwater levels (mAHD)
175
170
165
160
155
150
145
140
2012
2016
2020
2024
2028
Modelled
Observed

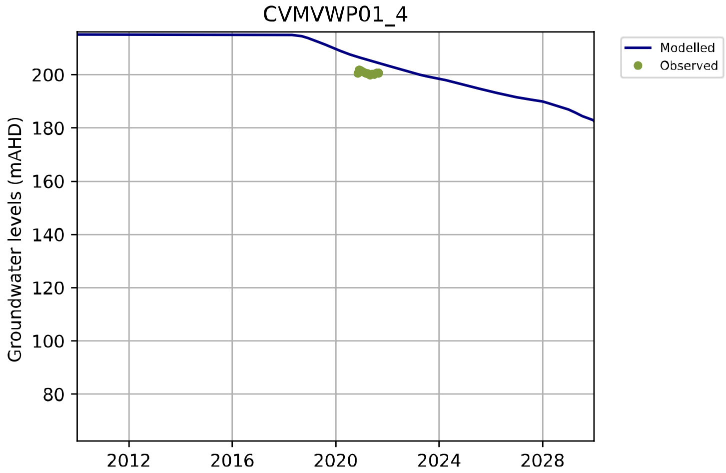

C2136
Groundwater levels (mAHD)
180
170
160
150
140
130
120
110
2012
2016
2020
2024
2028
Modelled
Observed

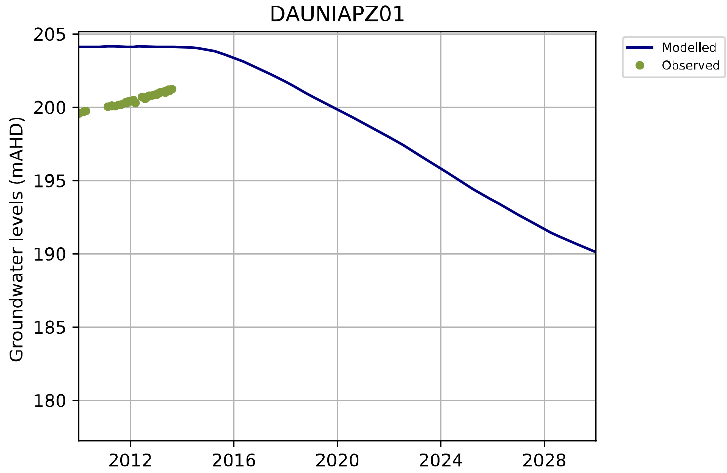

CVMMB16_02
Groundwater levels (mAHD)
200
180
160
140
120
100
80
60
2012
2016
2020
2024
2028
Modelled
Observed

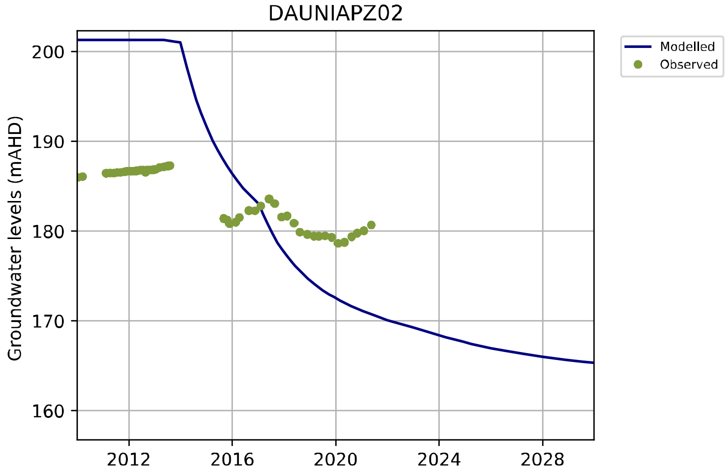

CVMPB07_01
Groundwater levels (mAHD)
220
215
210
205
200
195
190
185
2012
2016
2020
2024
2028
Modelled
Observed

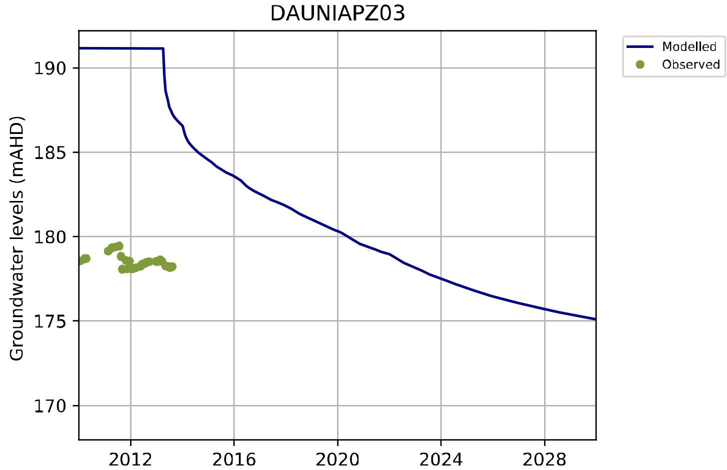

CVMPB07_02
Groundwater levels (mAHD)
215
210
205
200
195
190
185
180
2012
2016
2020
2024
2028
Modelled
Observed

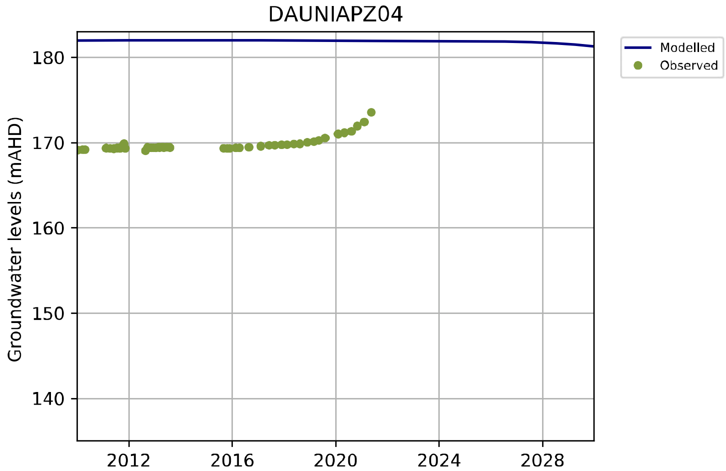

CVMVWP01_3
Groundwater levels (mAHD)
200
180
160
140
120
2012
2016
2020
2024
2028
Modelled
Observed

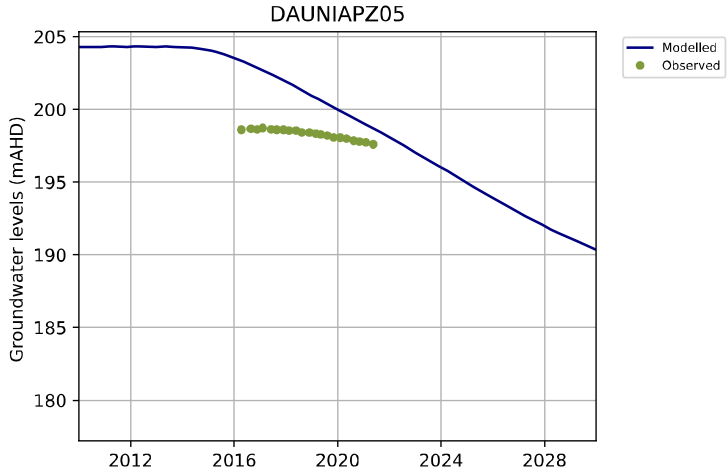

CVMVWP01_4
Groundwater levels (mAHD)
200
180
160
140
120
100
80
2012
2016
2020
2024
2028
Modelled
Observed

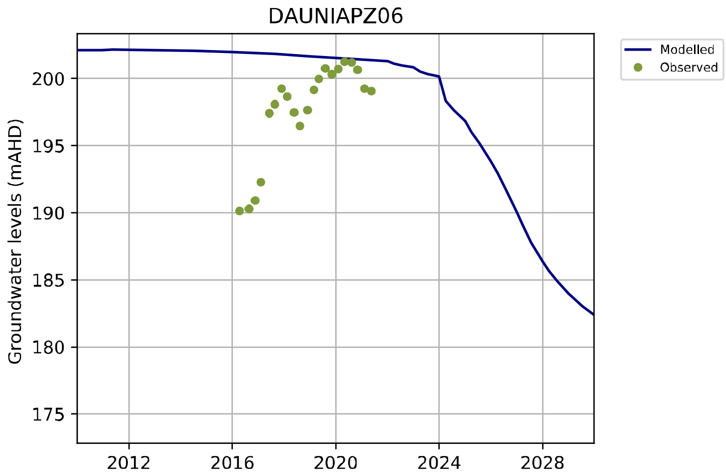

DAUNIAPZ01
Groundwater levels (mAHD)
205
200
195
190
185
180
2012
2016
2020
2024
2028
Modelled
Observed

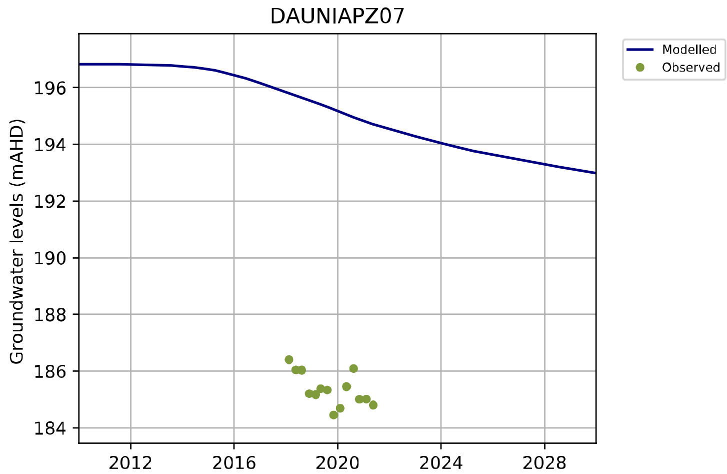

DAUNIAPZ02
Groundwater levels (mAHD)
200
190
180
170
160
2012
2016
2020
2024
2028
Modelled
Observed

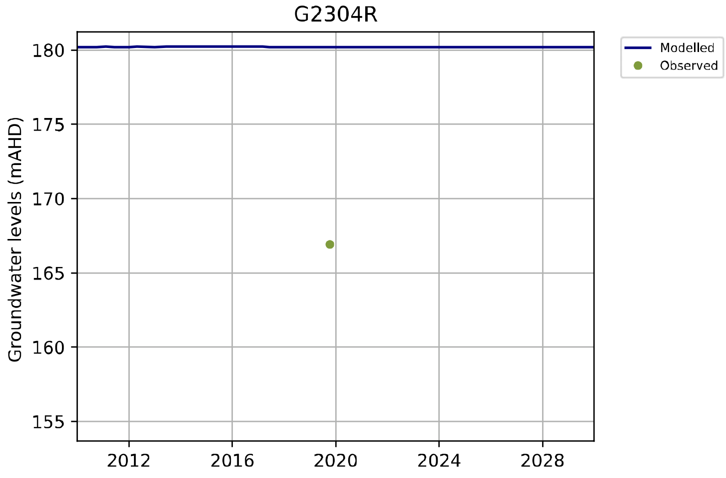

DAUNIAPZ03
Groundwater levels (mAHD)
190
185
180
175
170
2012
2016
2020
2024
2028
Modelled
Observed

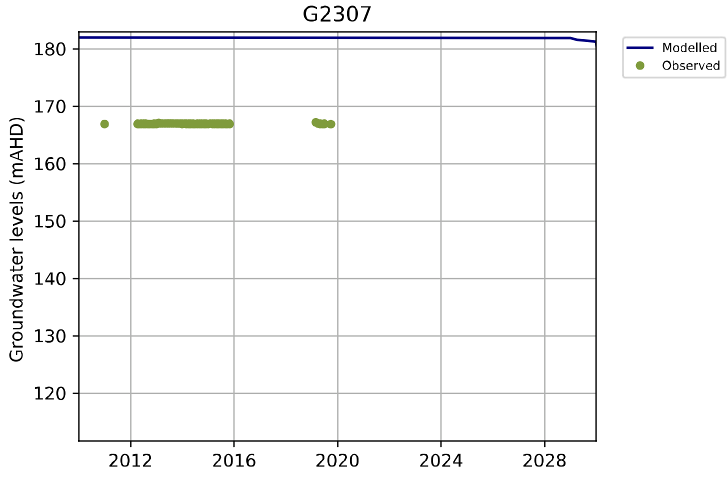

DAUNIAPZ04
Groundwater levels (mAHD)
180
170
160
150
140
2012
2016
2020
2024
2028
Modelled
Observed

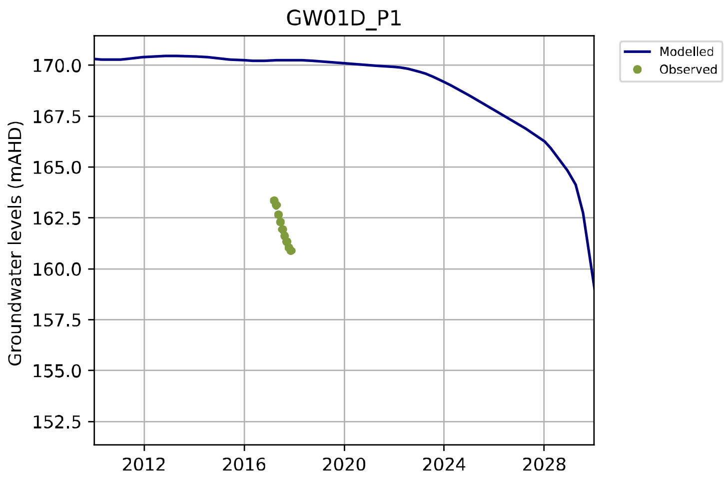

DAUNIAPZ05
Groundwater levels (mAHD)
205
200
195
190
185
180
2012
2016
2020
2024
2028
Modelled
Observed

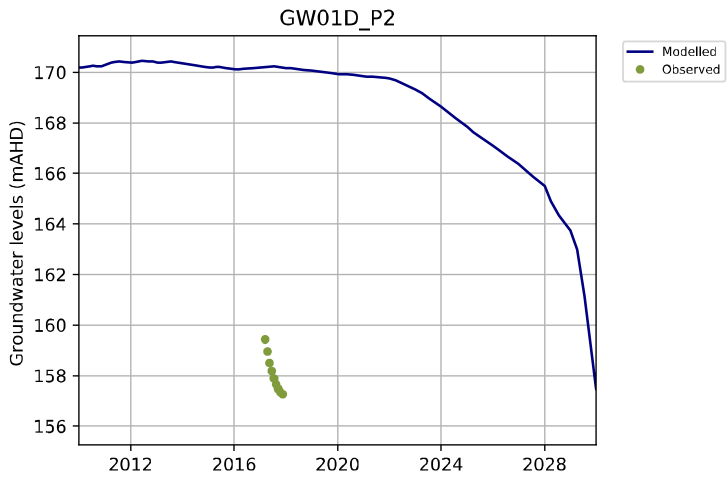

DAUNIAPZ06
Groundwater levels (mAHD)
200
195
190
185
180
175
2012
2016
2020
2024
2028
Modelled
Observed

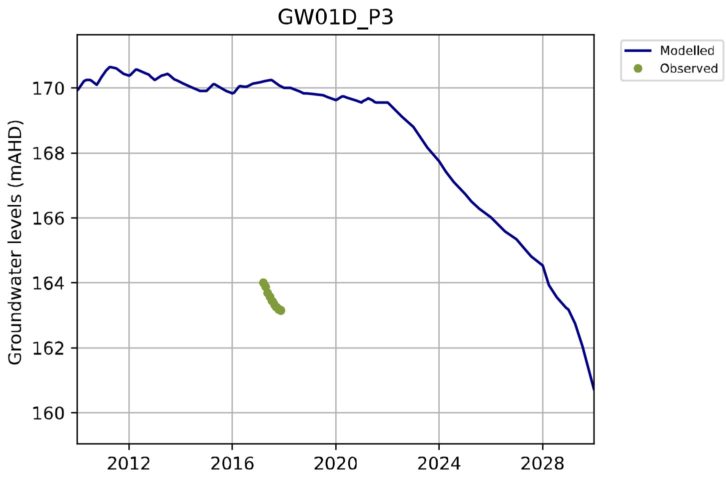

DAUNIAPZ07
Groundwater levels (mAHD)
196
194
192
190
188
186
184
2012
2016
2020
2024
2028
Modelled
Observed

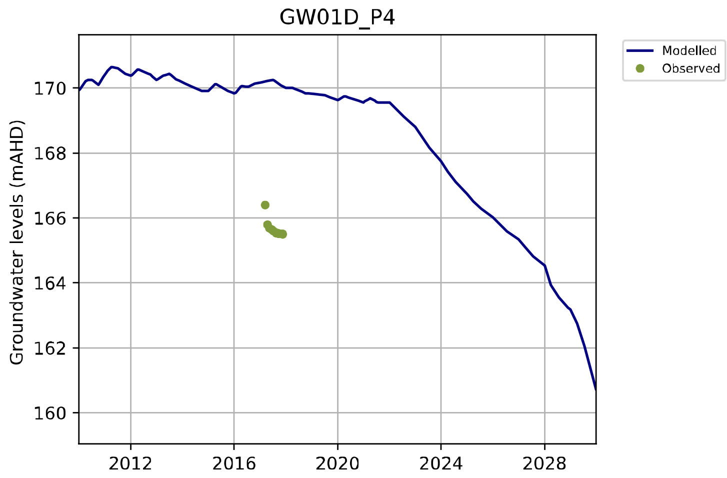

G2304R
Groundwater levels (mAHD)
180
175
170
165
160
155
2012
2016
2020
2024
2028
Modelled
Observed

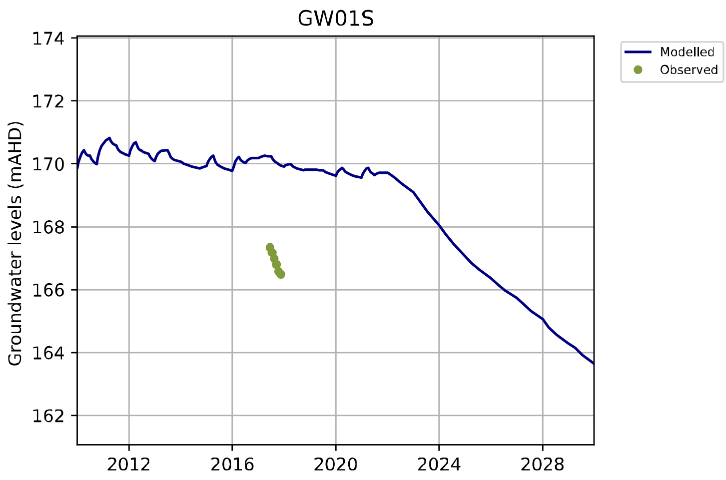

G2307
Groundwater levels (mAHD)
180
170
160
150
140
130
120
2012
2016
2020
2024
2028
Modelled
Observed

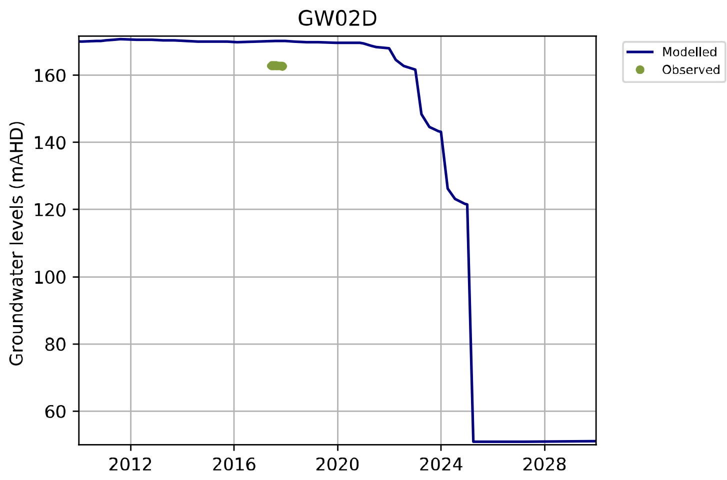

GW01D_P1
Groundwater levels (mAHD)
170.0
167.5
165.0
162.5
160.0
157.5
155.0
152.5
2012
2016
2020
2024
2028
Modelled
Observed

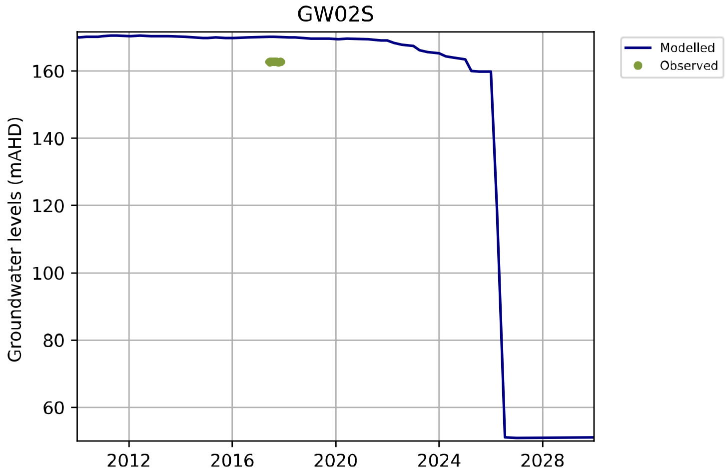

GW01D_P2
Groundwater levels (mAHD)
170
168
166
164
162
160
158
156
2012
2016
2020
2024
2028
Modelled
Observed

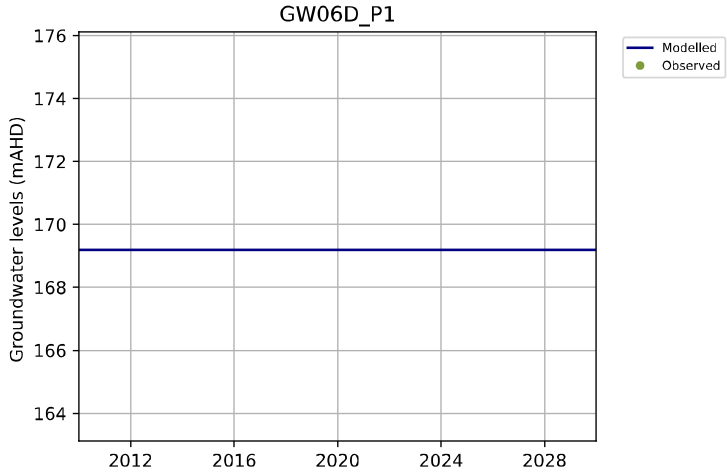

GW01D_P3
Groundwater levels (mAHD)
170
168
166
164
162
160
2012
2016
2020
2024
2028
Modelled
Observed

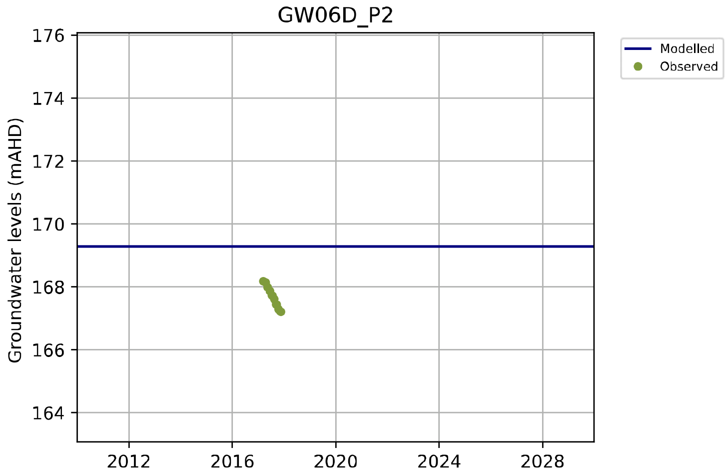

GW01D_P4
Groundwater levels (mAHD)
170
168
166
164
162
160
2012
2016
2020
2024
2028
Modelled
Observed

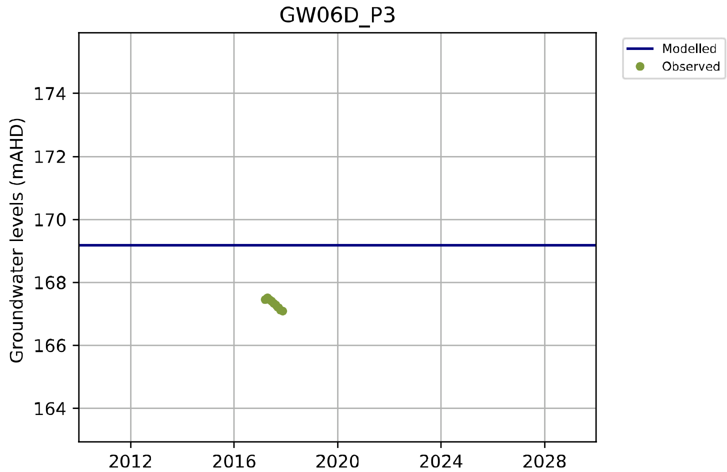

GW01S
Groundwater levels (mAHD)
174
172
170
168
166
164
162
2012
2016
2020
2024
2028
Modelled
Observed

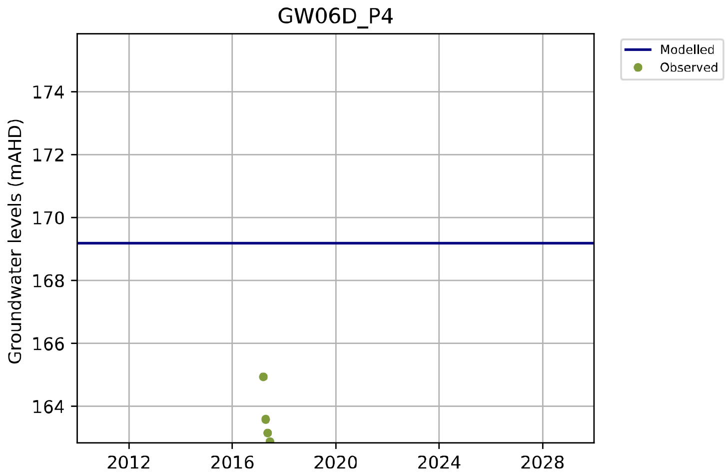

GW02D
Groundwater levels (mAHD)
160
140
120
100
80
60
2012
2016
2020
2024
2028
Modelled
Observed

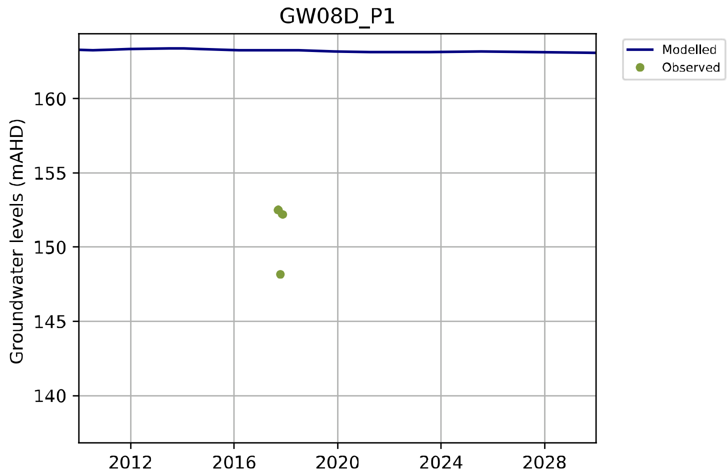

GW02S
Groundwater levels (mAHD)
60
80
100
120
140
160
2012
2016
2020
2024
2028
Modelled
Observed

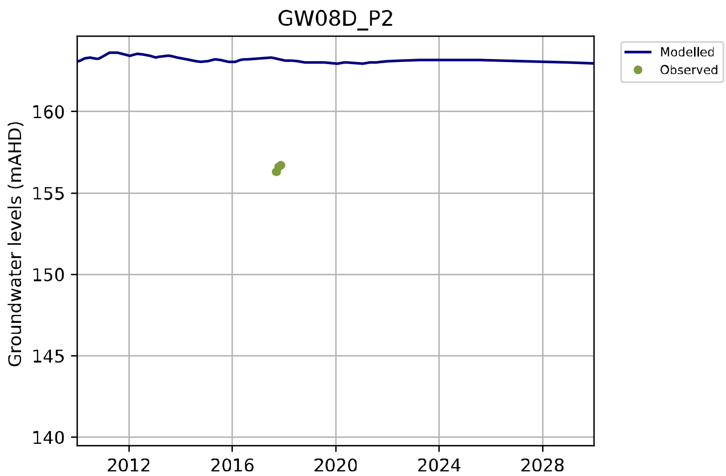

GW06D_P1
Groundwater levels (mAHD)
164
166
168
170
172
174
176
2012
2016
2020
2024
2028
Modelled
Observed

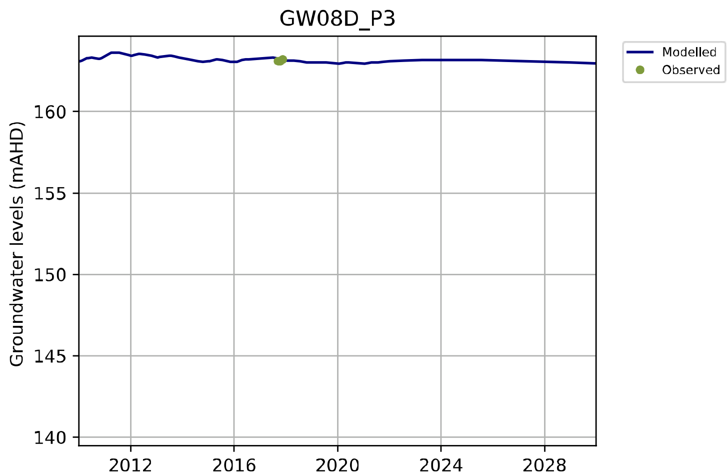

GW06D_P2
Groundwater levels (mAHD)
164
166
168
170
172
174
176
2012
2016
2020
2024
2028
Modelled
Observed

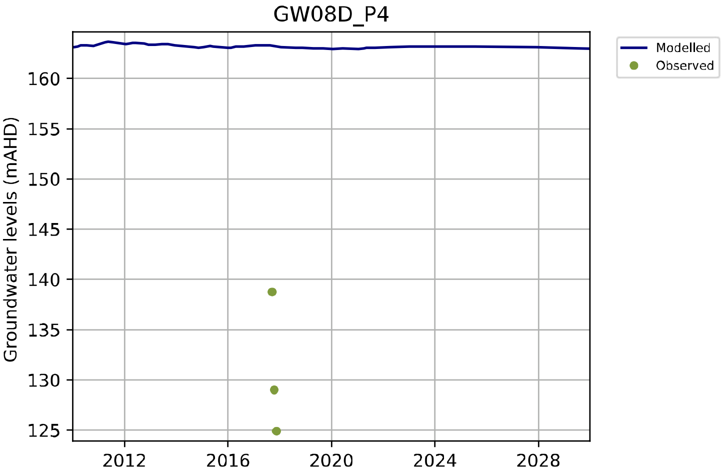

GW06D_P3
Groundwater levels (mAHD)
164
166
168
170
172
174
2012
2016
2020
2024
2028
Modelled
Observed

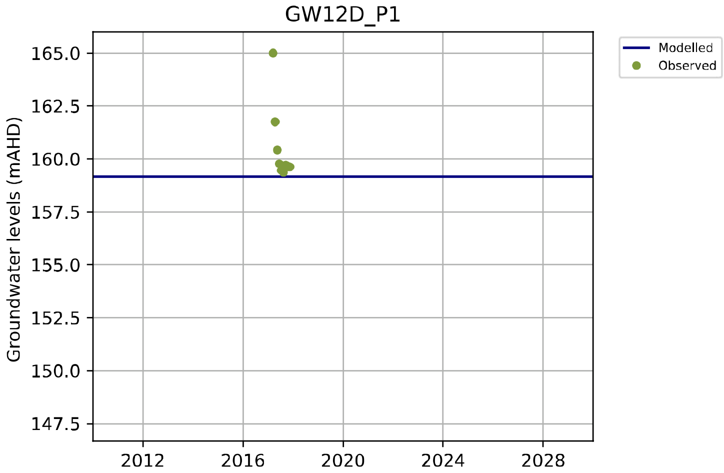

GW06D_P4
Groundwater levels (mAHD)
164
166
168
170
172
174
2012
2016
2020
2024
2028
Modelled
Observed

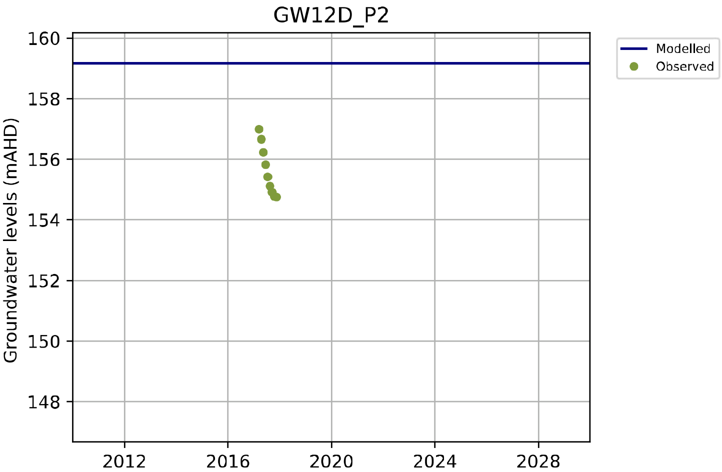

GW08D_P1
Groundwater levels (mAHD)
140
145
150
155
160
2012
2016
2020
2024
2028
Modelled
Observed

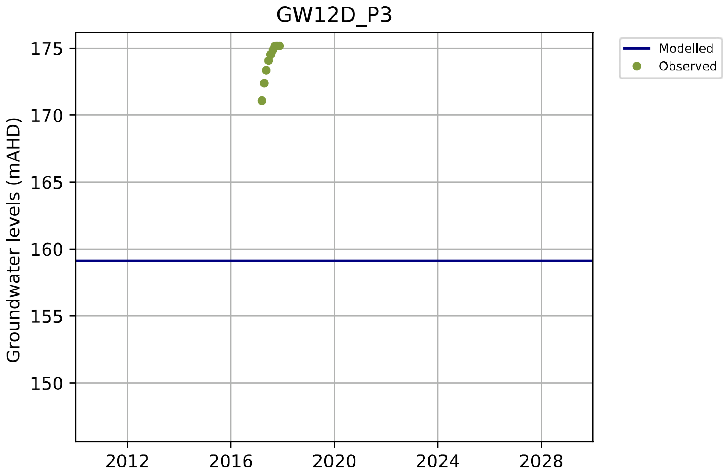

GW08D_P2
Groundwater levels (mAHD)
140
145
150
155
160
2012
2016
2020
2024
2028
Modelled
Observed

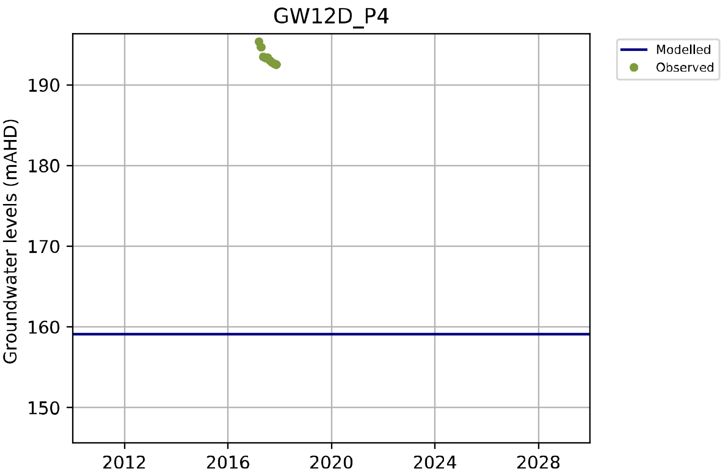

GW08D_P3
Groundwater levels (mAHD)
140
145
150
155
160
2012
2016
2020
2024
2028
Modelled
Observed

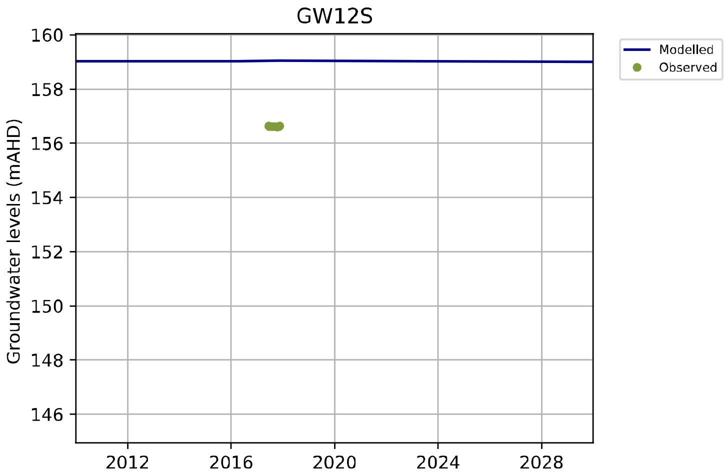

GW08D_P4
Modelled
Observed
Groundwater levels (mAHD)
160
155
150
145
140
135
130
125
2012
2016
2020
2024
2028

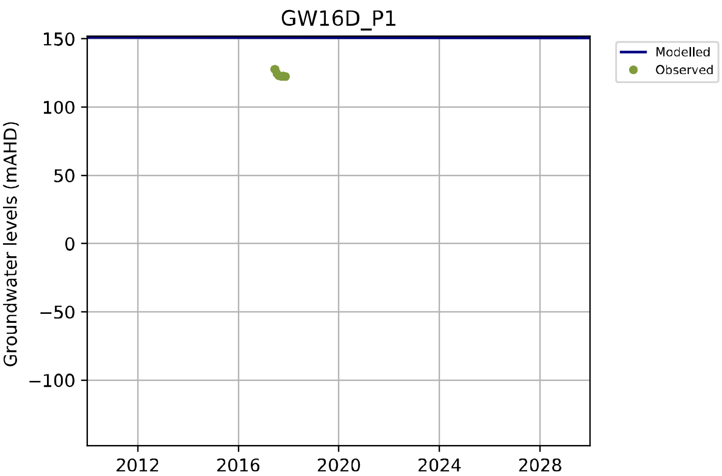

GW12D_P1
Modelled
Observed
Groundwater levels (mAHD)
165.0
162.5
160.0
157.5
155.0
152.5
150.0
147.5
2012
2016
2020
2024
2028

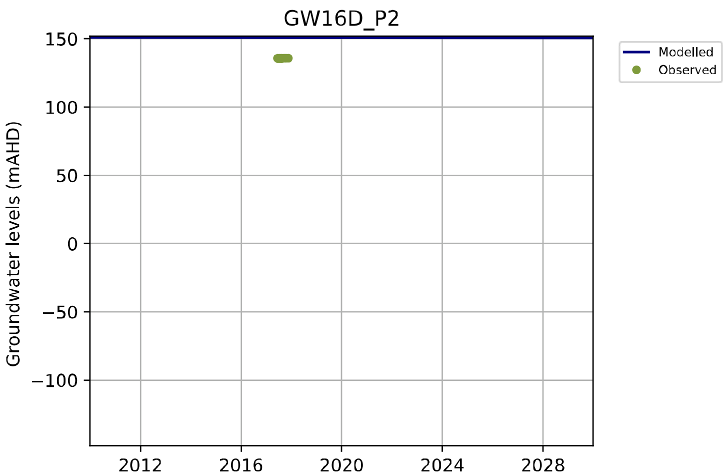

GW12D_P2
Modelled
Observed
Groundwater levels (mAHD)
160
158
156
154
152
150
148
2012
2016
2020
2024
2028

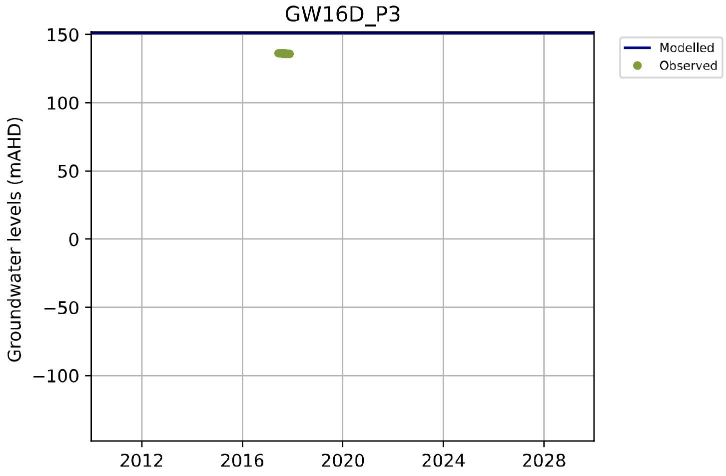

GW12D_P3
Modelled
Observed
Groundwater levels (mAHD)
175
170
165
160
155
150
2012
2016
2020
2024
2028

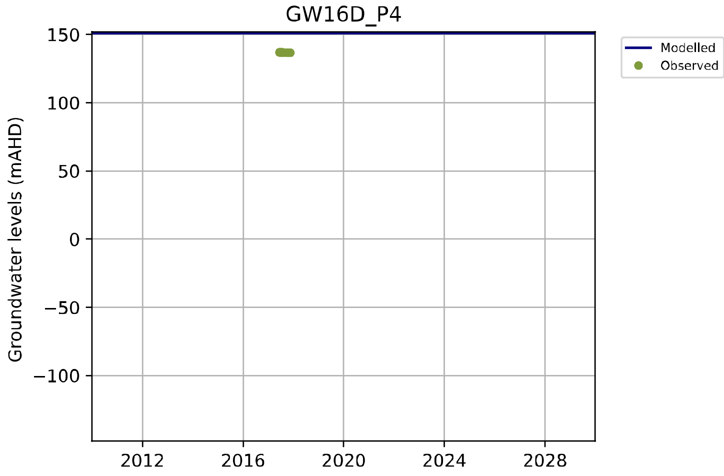

GW12D_P4
Modelled
Observed
Groundwater levels (mAHD)
190
180
170
160
150
2012
2016
2020
2024
2028

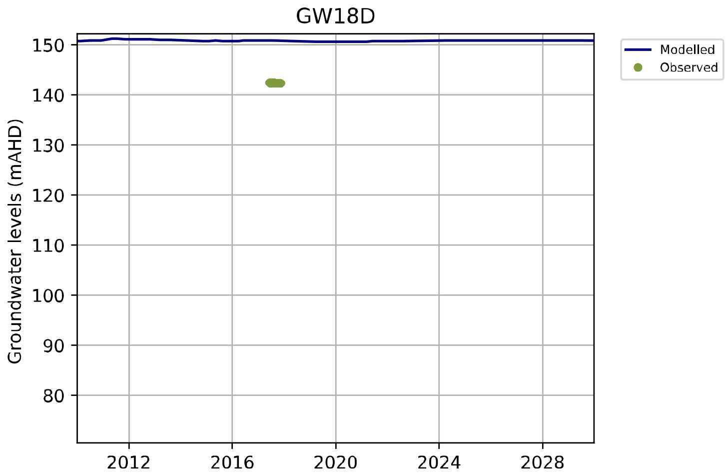

GW12S
Modelled
Observed
Groundwater levels (mAHD)
160
158
156
154
152
150
148
146
2012
2016
2020
2024
2028

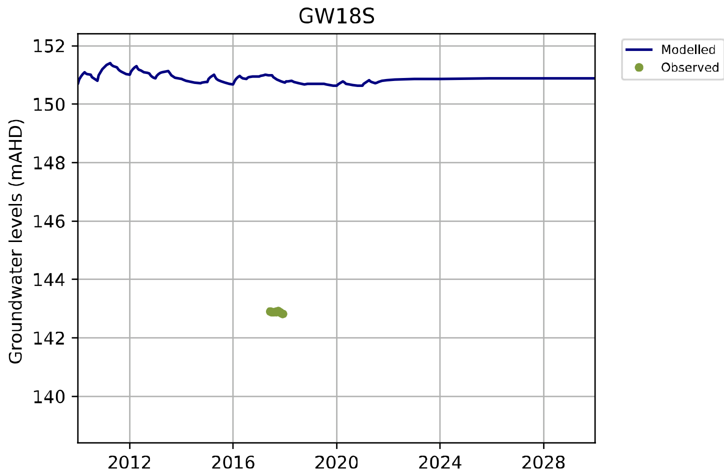

GW16D_P1
Modelled
Observed
Groundwater levels (mAHD)
150
100
50
0
−50
−100
2012
2016
2020
2024
2028

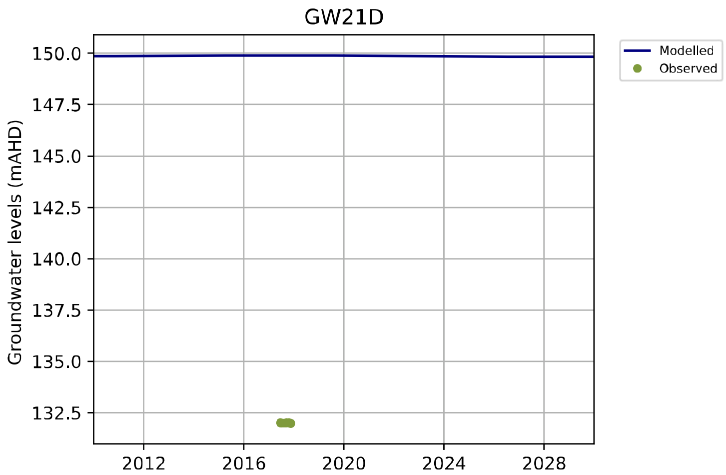

GW16D_P2
Modelled
Observed
Groundwater levels (mAHD)
150
100
50
0
−50
−100
2012
2016
2020
2024
2028

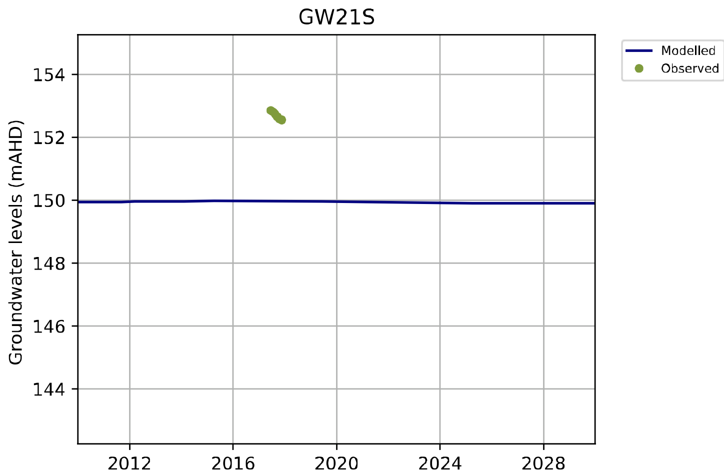

GW16D_P3
Groundwater levels (mAHD)
150
100
50
0
−50
−100
2012
2016
2020
2024
2028
Modelled
Observed

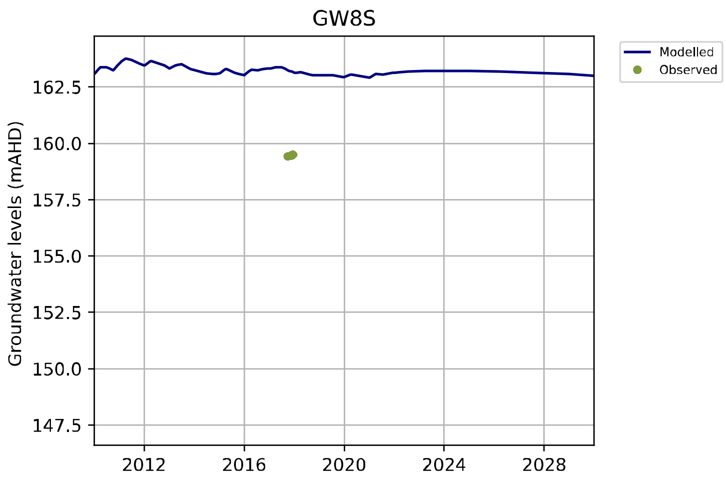

GW16D_P4
Groundwater levels (mAHD)
150
100
50
0
−50
−100
2012
2016
2020
2024
2028
Modelled
Observed

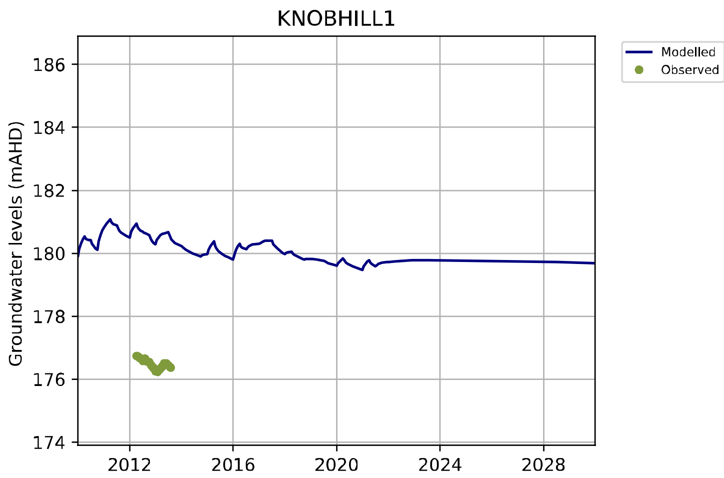

GW18D
Groundwater levels (mAHD)
150
140
130
120
110
100
90
80
2012
2016
2020
2024
2028
Modelled
Observed

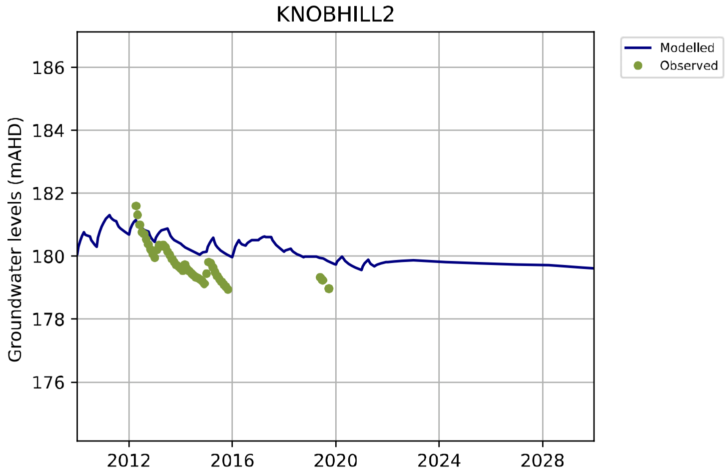

GW18S
Groundwater levels (mAHD)
152
150
148
146
144
142
140
2012
2016
2020
2024
2028
Modelled
Observed

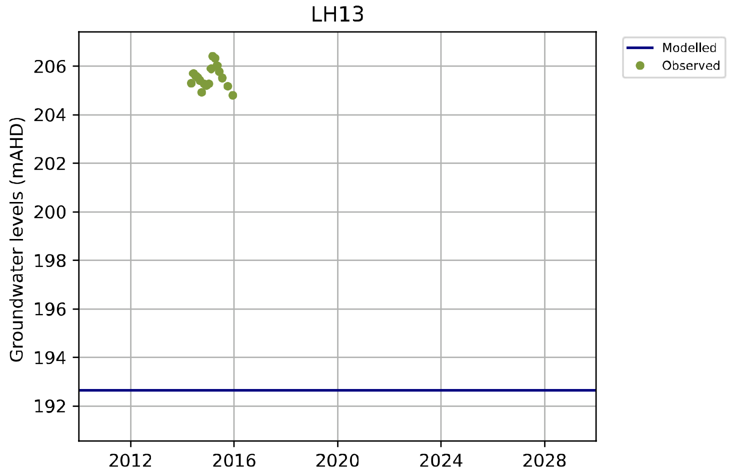

GW21D
Groundwater levels (mAHD)
150.0
147.5
145.0
142.5
140.0
137.5
135.0
132.5
2012
2016
2020
2024
2028
Modelled
Observed

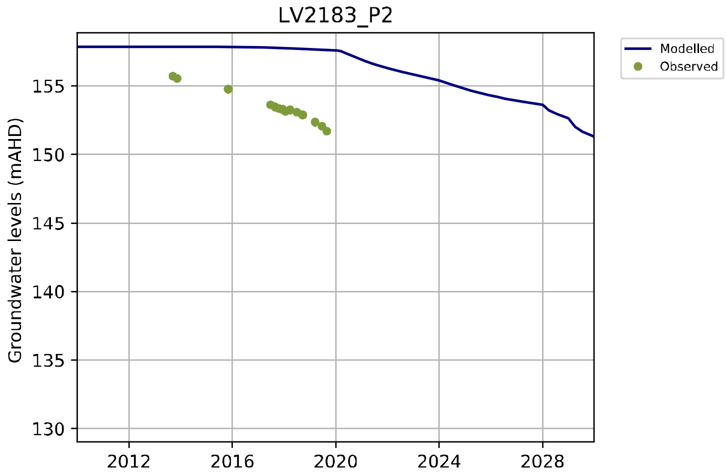

GW21S
Groundwater levels (mAHD)
154
152
150
148
146
144
2012
2016
2020
2024
2028
Modelled
Observed

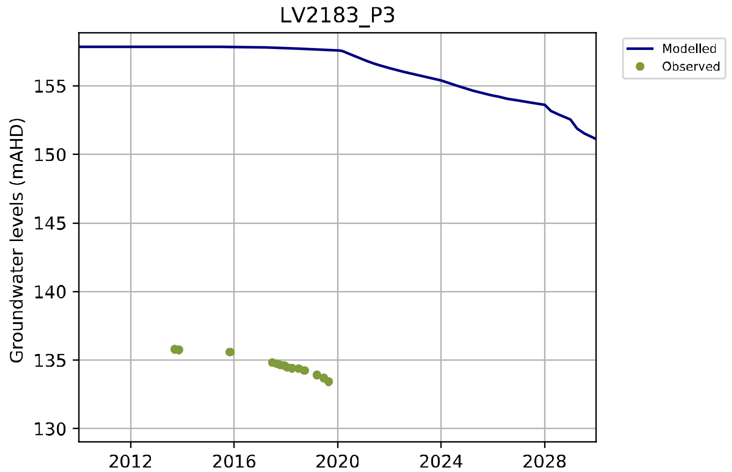

GW8S
Groundwater levels (mAHD)
162.5
160.0
157.5
155.0
152.5
150.0
147.5
2012
2016
2020
2024
2028
Modelled
Observed

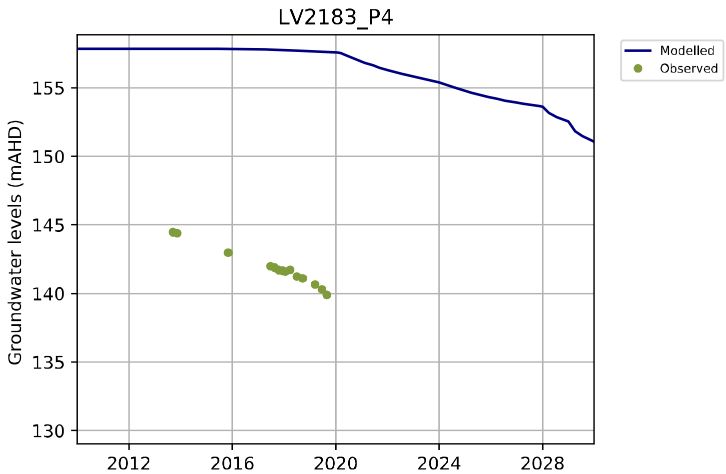

KNOBHILL1
Groundwater levels (mAHD)
186
184
182
180
178
176
174
2012
2016
2020
2024
2028
Modelled
Observed

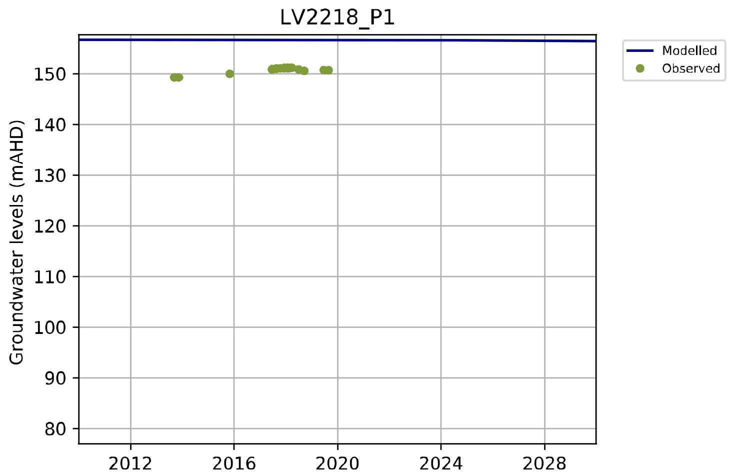

KNOBHILL2
Modelled
Observed
Groundwater levels (mAHD)
186
184
182
180
178
176
2012
2016
2020
2024
2028

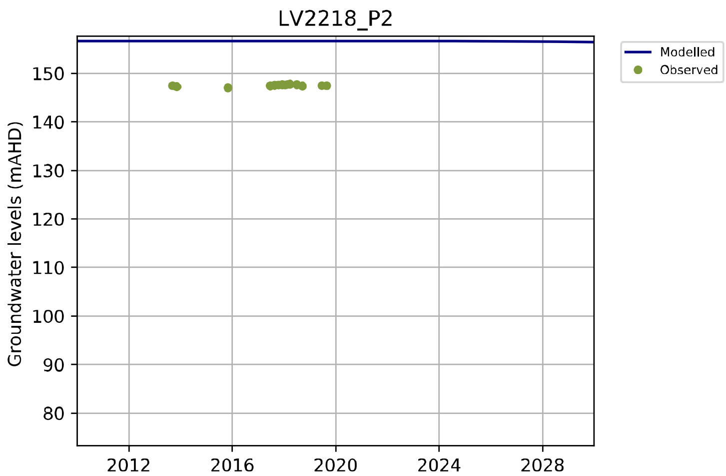

LH13
Modelled
Observed
Groundwater levels (mAHD)
206
204
202
200
198
196
194
192
2012
2016
2020
2024
2028

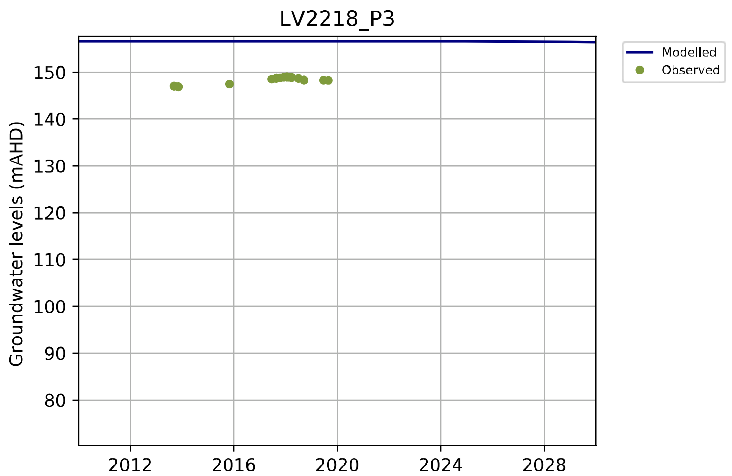

LV2183_P2
Modelled
Observed
Groundwater levels (mAHD)
155
150
145
140
135
130
2012
2016
2020
2024
2028

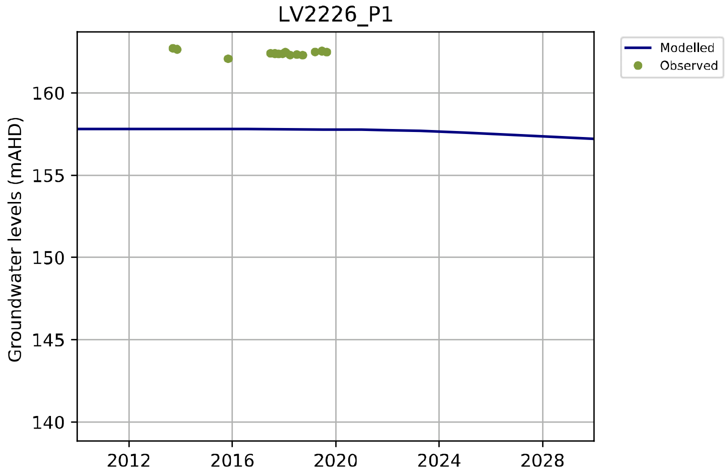

LV2183_P3
Modelled
Observed
Groundwater levels (mAHD)
155
150
145
140
135
130
2012
2016
2020
2024
2028

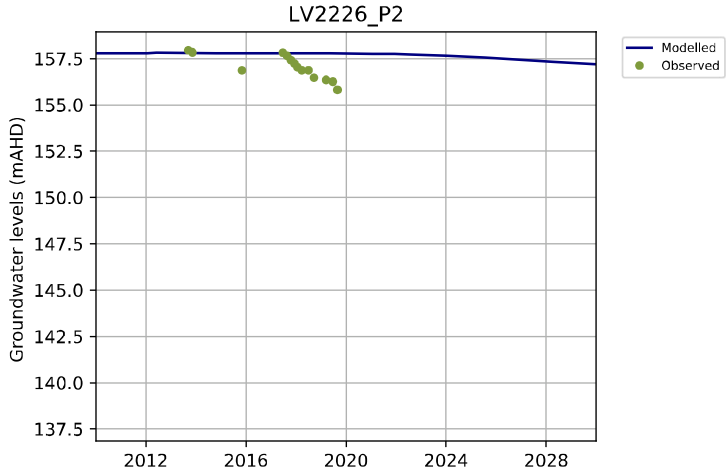

LV2183_P4
Modelled
Observed
Groundwater levels (mAHD)
155
150
145
140
135
130
2012
2016
2020
2024
2028

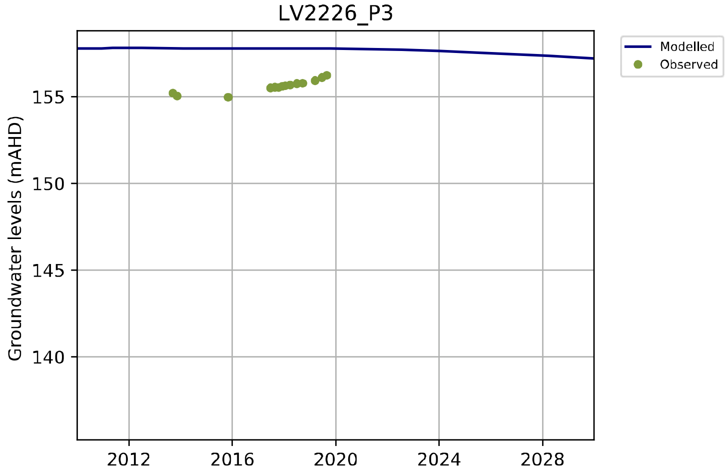

LV2218_P1
Modelled
Observed
Groundwater levels (mAHD)
150
140
130
120
110
100
90
80
2012
2016
2020
2024
2028

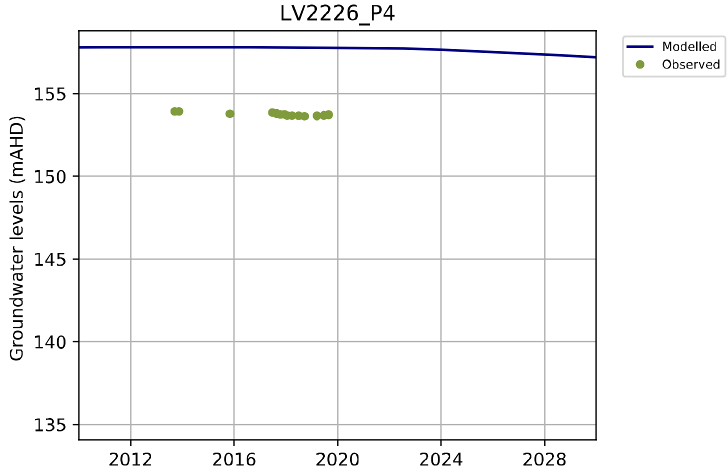

LV2218_P2
Modelled
Observed
Groundwater levels (mAHD)
150
140
130
120
110
100
90
80
2012
2016
2020
2024
2028

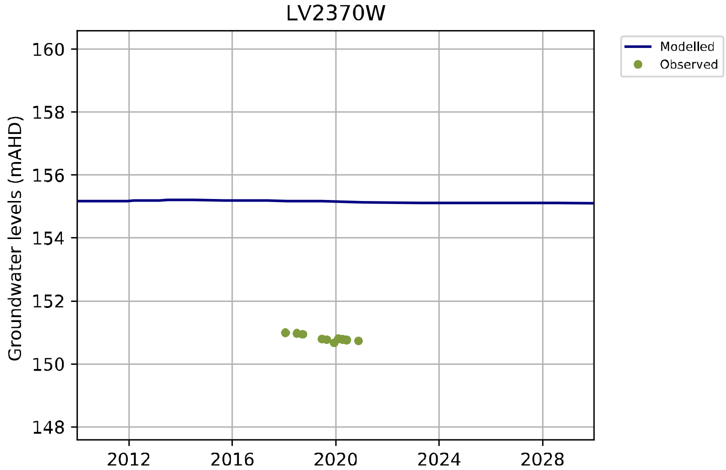

LV2218_P3
Modelled
Observed
Groundwater levels (mAHD)
150
140
130
120
110
100
90
80
2012
2016
2020
2024
2028

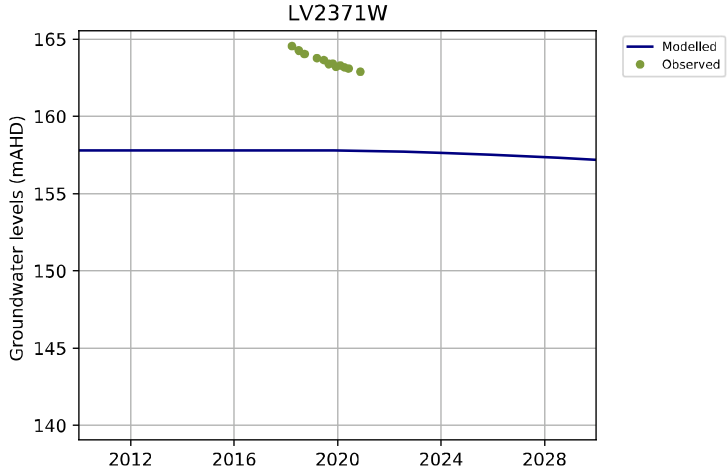

LV2226_P1
Groundwater levels (mAHD)
140
145
150
155
160
2012
2016
2020
2024
2028
Modelled
Observed

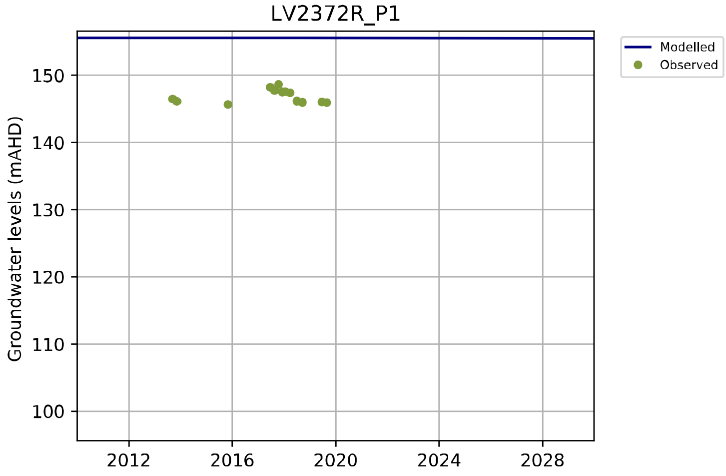

LV2226_P2
Groundwater levels (mAHD)
137.5
140.0
142.5
145.0
147.5
150.0
152.5
155.0
157.5
2012
2016
2020
2024
2028
Modelled
Observed

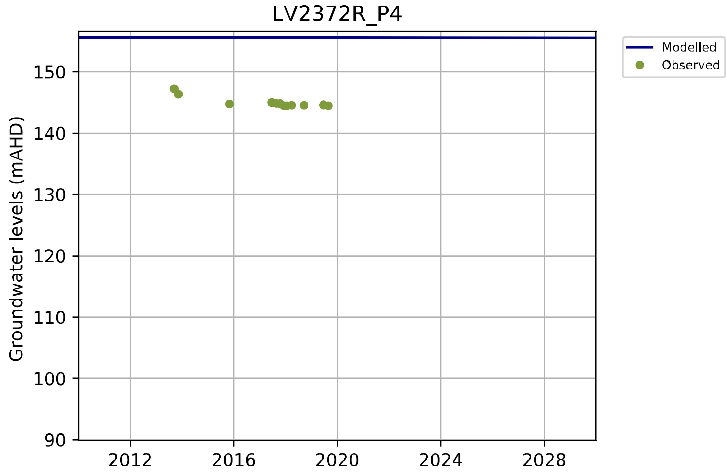

LV2226_P3
Groundwater levels (mAHD)
140
145
150
155
2012
2016
2020
2024
2028
Modelled
Observed

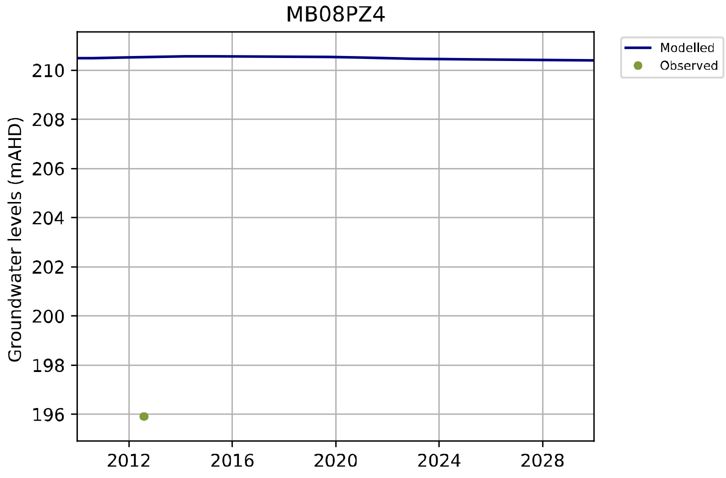

LV2226_P4
Groundwater levels (mAHD)
135
140
145
150
155
2012
2016
2020
2024
2028
Modelled
Observed

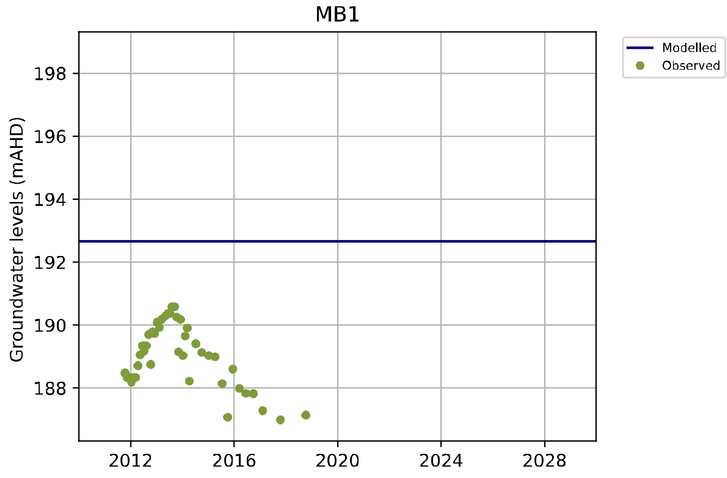

LV2370W
Groundwater levels (mAHD)
148
150
152
154
156
158
160
2012
2016
2020
2024
2028
Modelled
Observed

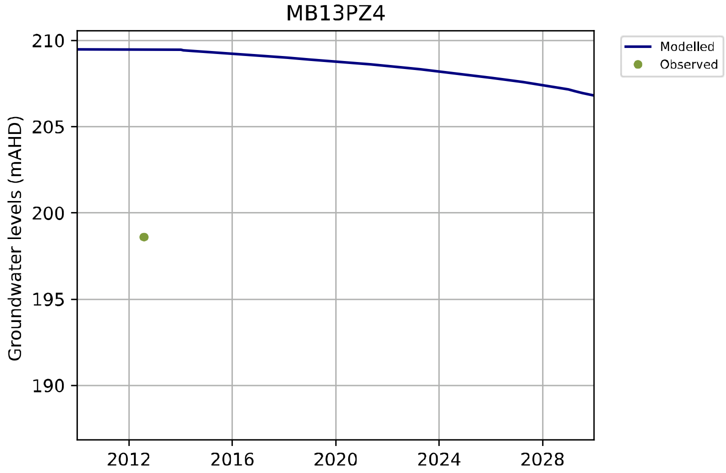

LV2371W
Groundwater levels (mAHD)
140
145
150
155
160
165
2012
2016
2020
2024
2028
Modelled
Observed

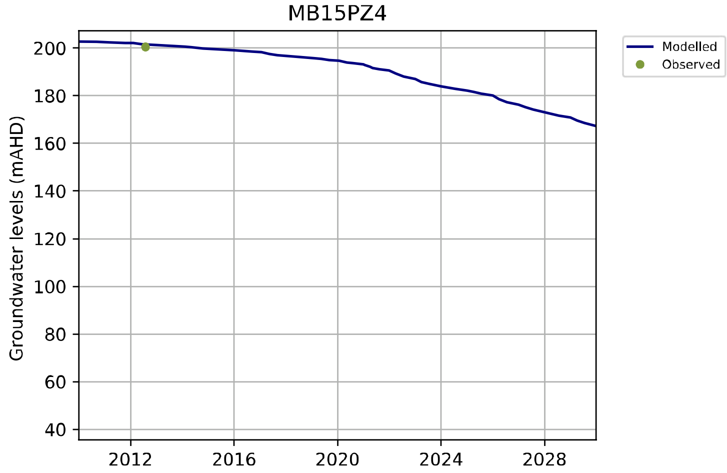

LV2372R_P1
Groundwater levels (mAHD)
100
110
120
130
140
150
2012
2016
2020
2024
2028
Modelled
Observed

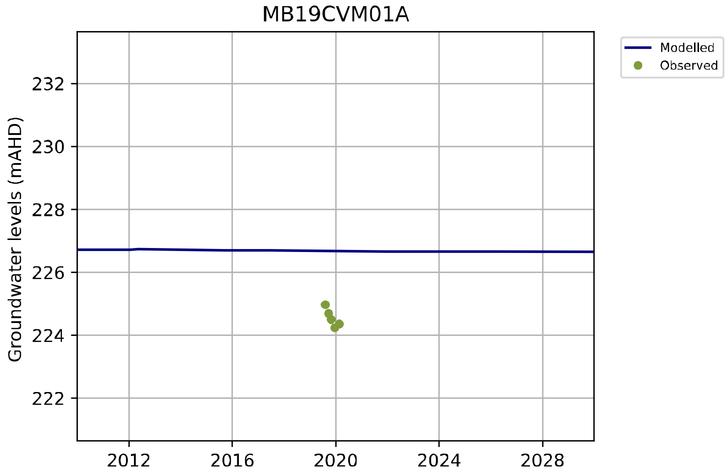

LV2372R_P4
Groundwater levels (mAHD)
90
100
110
120
130
140
150
2012
2016
2020
2024
2028
Modelled
Observed

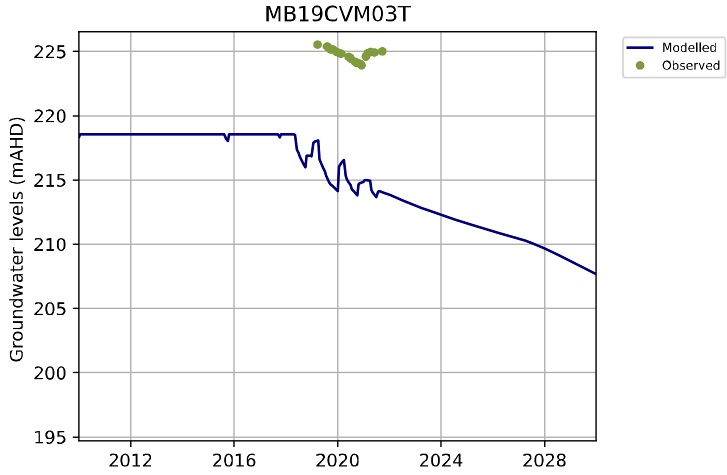

MB08PZ4
Groundwater levels (mAHD)
Modelled
Observed
196 198 200 202 204 206 208 210
2012 2016 2020 2024 2028

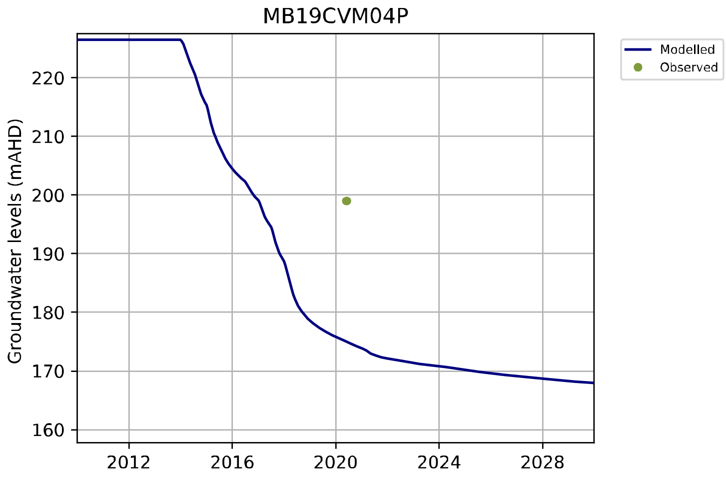

MB1
Groundwater levels (mAHD)
Modelled
Observed
188 190 192 194 196 198
2012 2016 2020 2024 2028

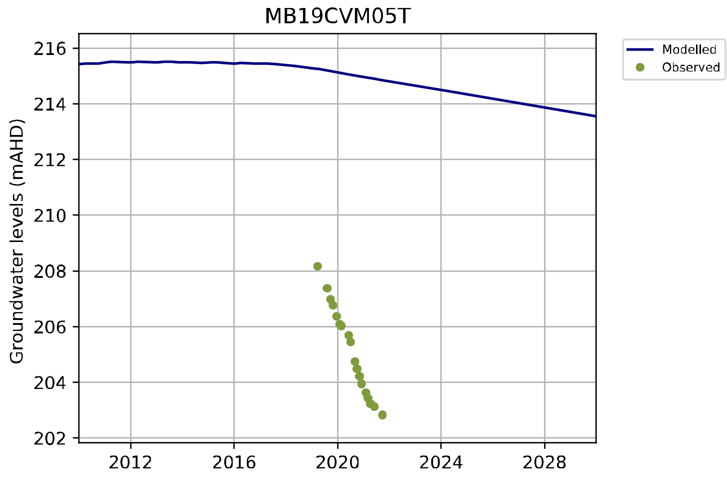

MB13PZ4
Groundwater levels (mAHD)
Modelled
Observed
190 195 200 205 210
2012 2016 2020 2024 2028

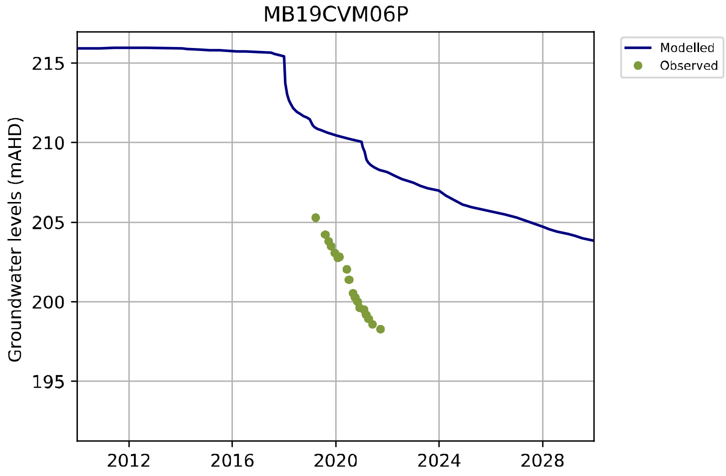

MB15PZ4
Groundwater levels (mAHD)
Modelled
Observed
40 60 80 100 120 140 160 180 200
2012 2016 2020 2024 2028

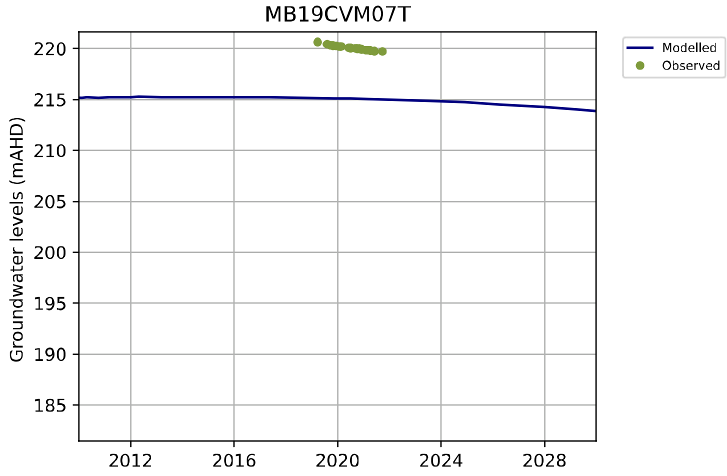

MB19CVM01A
Groundwater levels (mAHD)
Modelled
Observed
222 224 226 228 230 232
2012 2016 2020 2024 2028

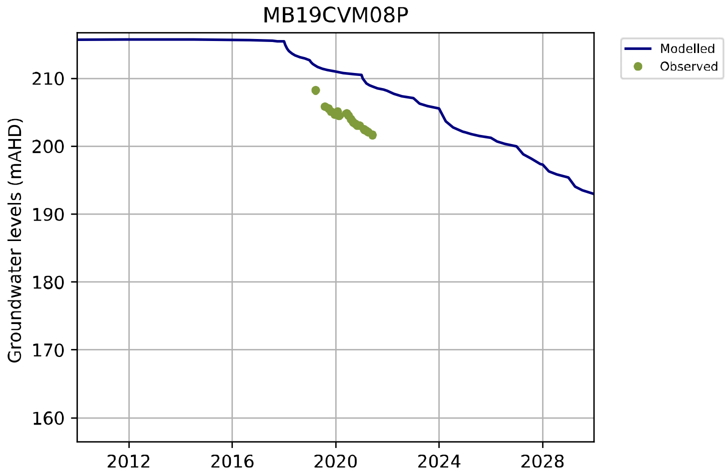

MB19CVM03T
Groundwater levels (mAHD)
Modelled
Observed
195 200 205 210 215 220 225
2012 2016 2020 2024 2028

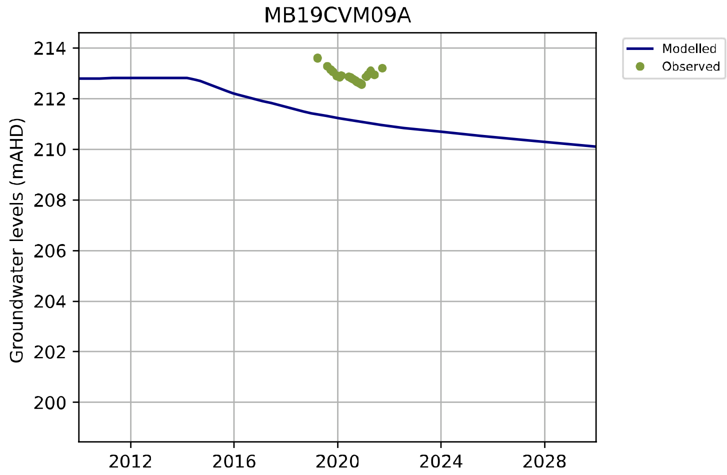

MB19CVM04P
Groundwater levels (mAHD)
Modelled
Observed
160 170 180 190 200 210 220
2012 2016 2020 2024 2028

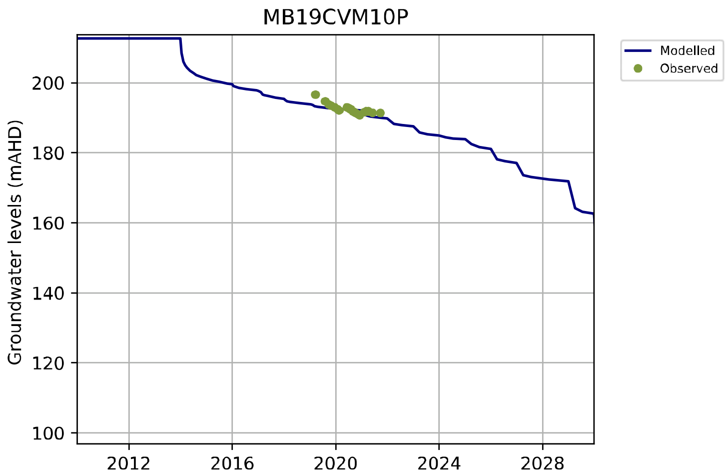

MB19CVM05T
Groundwater levels (mAHD)
Modelled
Observed
202 204 206 208 210 212 214 216
2012 2016 2020 2024 2028

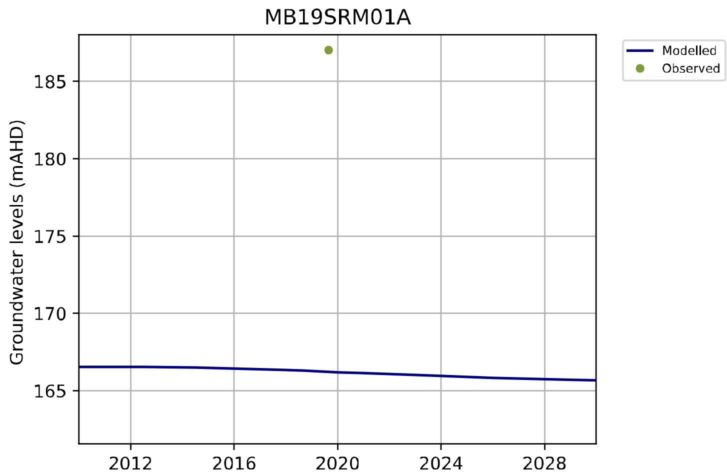

MB19CVM06P
Groundwater levels (mAHD)
215
210
205
200
195
2012
2016
2020
2024
2028
Modelled
Observed

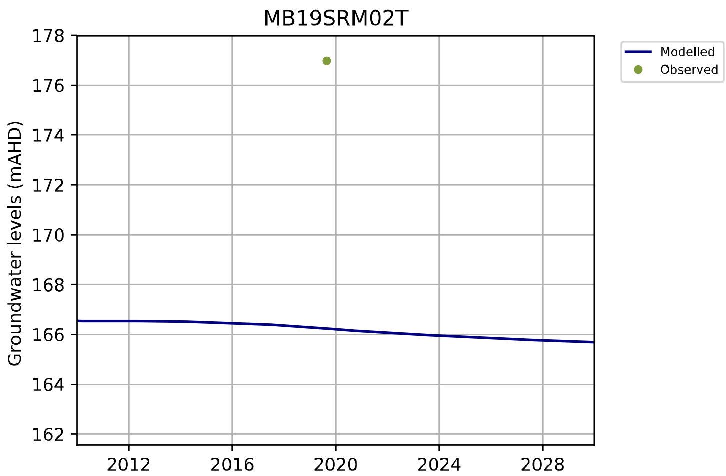

MB19CVM07T
Groundwater levels (mAHD)
220
215
210
205
200
195
190
185
2012
2016
2020
2024
2028
Modelled
Observed

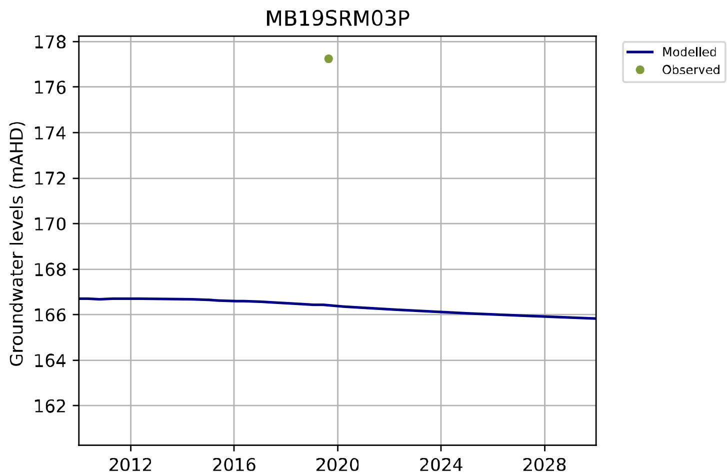

MB19CVM08P
Groundwater levels (mAHD)
210
200
190
180
170
160
2012
2016
2020
2024
2028
Modelled
Observed

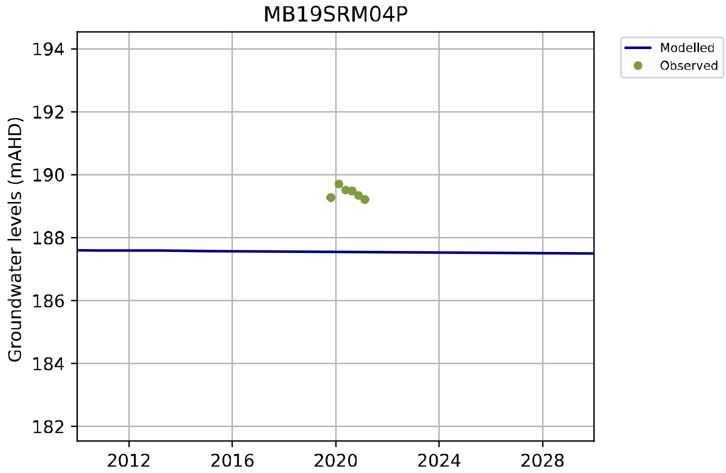

MB19CVM09A
Groundwater levels (mAHD)
214
212
210
208
206
204
202
200
2012
2016
2020
2024
2028
Modelled
Observed

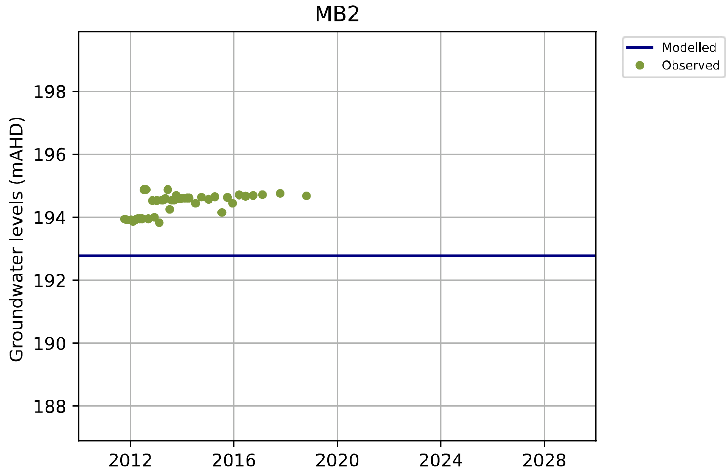

MB19CVM10P
Groundwater levels (mAHD)
200
180
160
140
120
100
2012
2016
2020
2024
2028
Modelled
Observed

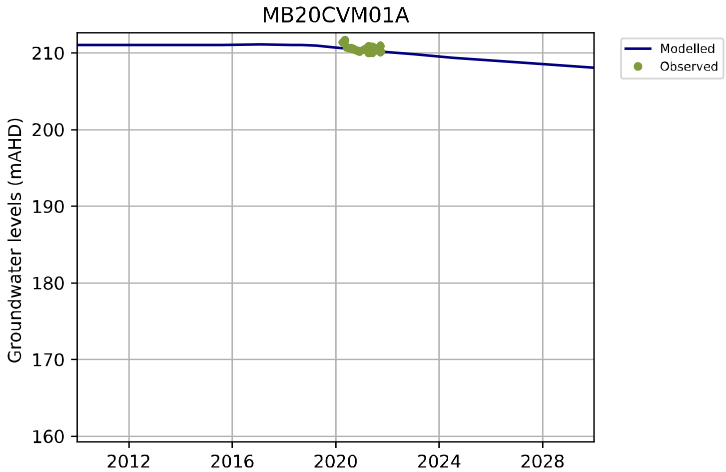

MB19SRM01A
Groundwater levels (mAHD)
185
180
175
170
165
2012
2016
2020
2024
2028
Modelled
Observed

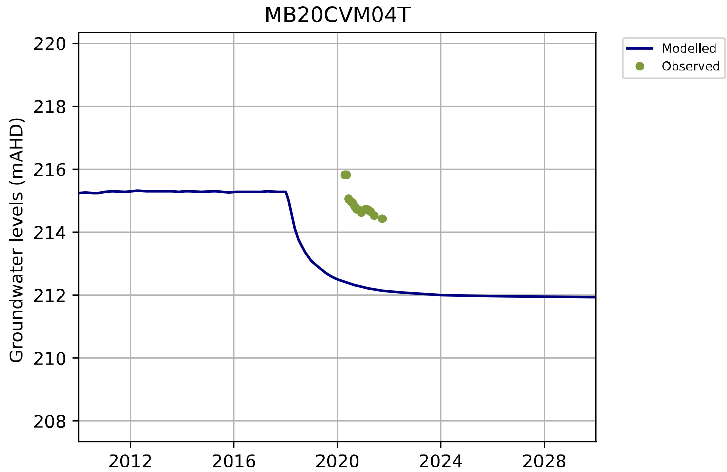

MB19SRM02T
Groundwater levels (mAHD)
178
176
174
172
170
168
166
164
162
2012
2016
2020
2024
2028
Modelled
Observed

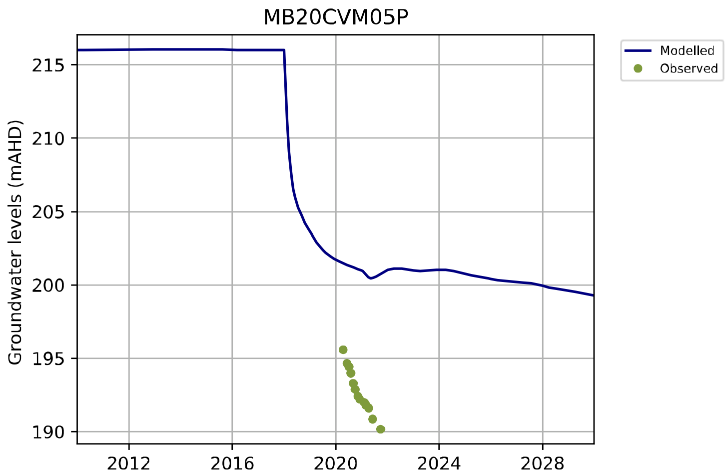

MB19SRM03P
Groundwater levels (mAHD)
178
176
174
172
170
168
166
164
162
2012
2016
2020
2024
2028
Modelled
Observed

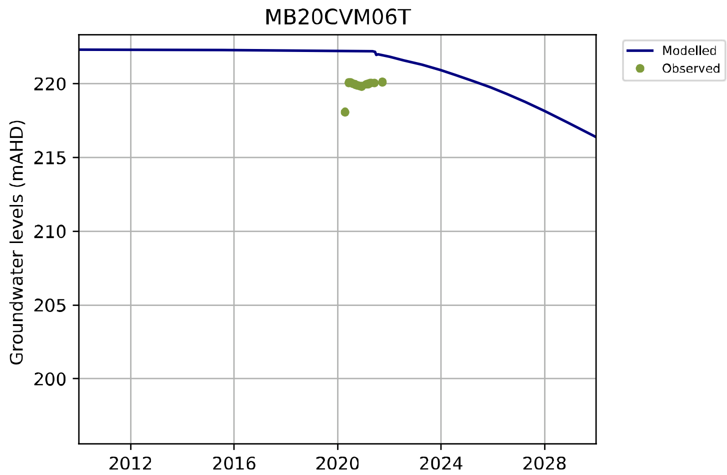

MB19SRM04P
Groundwater levels (mAHD)
194
192
190
188
186
184
182
2012
2016
2020
2024
2028
Modelled
Observed

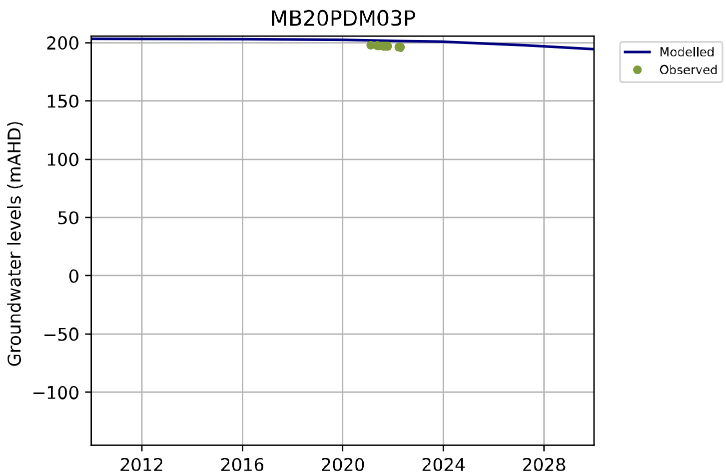

MB2
Groundwater levels (mAHD)
198
196
194
192
190
188
2012
2016
2020
2024
2028
Modelled
Observed

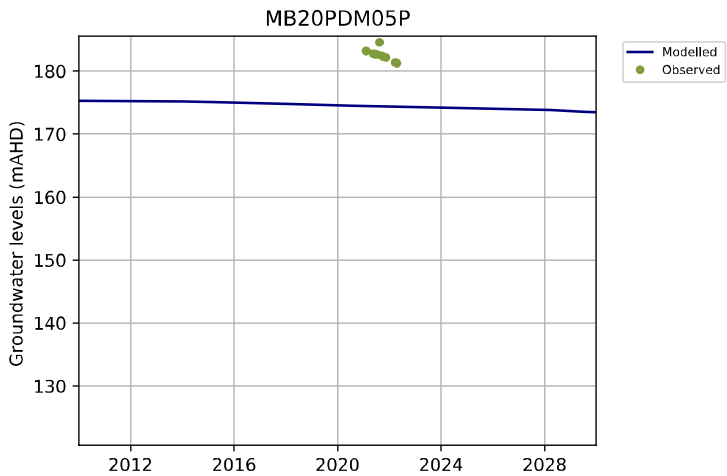

MB20CVM01A
Groundwater levels (mAHD)
210
200
190
180
170
160
2012
2016
2020
2024
2028
Modelled
Observed

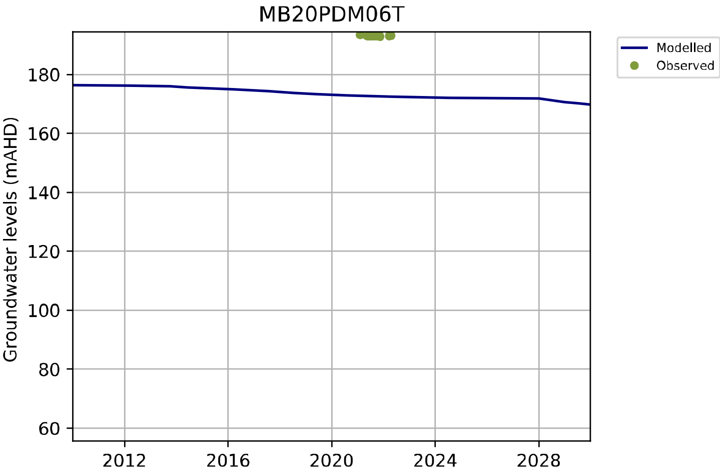

MB20CVM04T
Groundwater levels (mAHD)
220
218
216
214
212
210
208
2012
2016
2020
2024
2028
Modelled
Observed

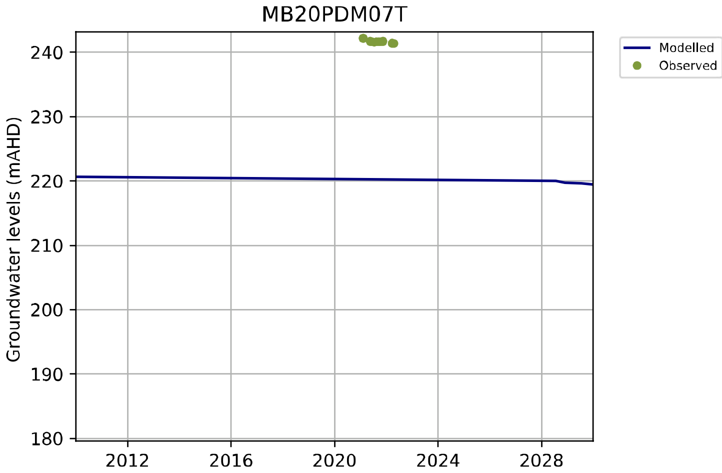

MB20CVM05P
Groundwater levels (mAHD)
215
210
205
200
195
190
2012
2016
2020
2024
2028
Modelled
Observed

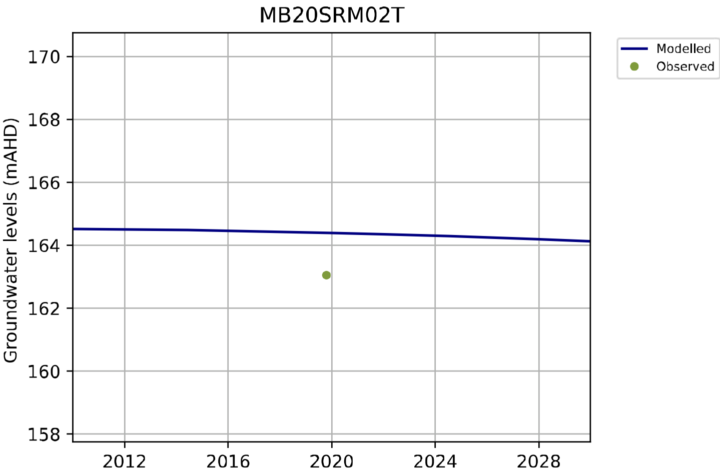

MB20CVM06T
Groundwater levels (mAHD)
220
215
210
205
200
2012
2016
2020
2024
2028
Modelled
Observed

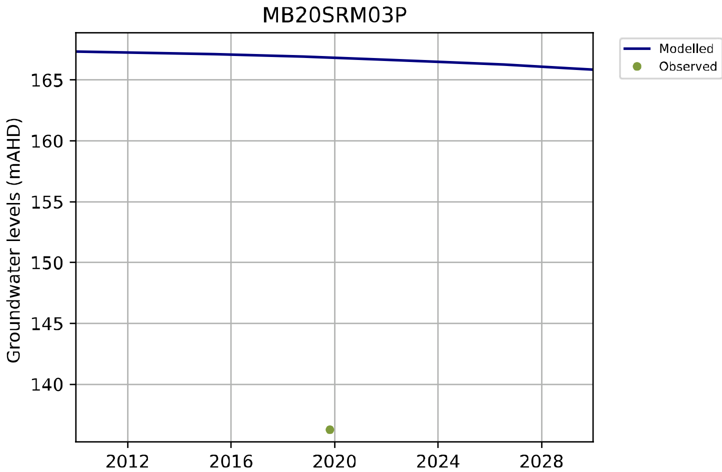

MB20PDM03P
Groundwater levels (mAHD)
200
150
100
50
0
−50
−100
2012
2016
2020
2024
2028
Modelled
Observed

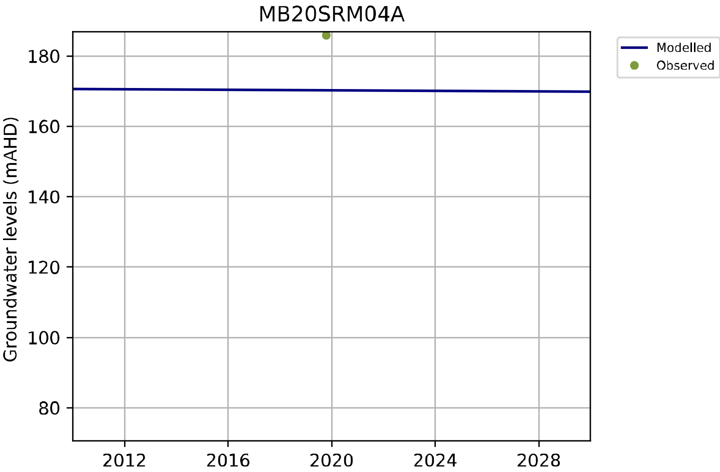

MB20PDM05P
Groundwater levels (mAHD)
180
170
160
150
140
130
2012
2016
2020
2024
2028
Modelled
Observed

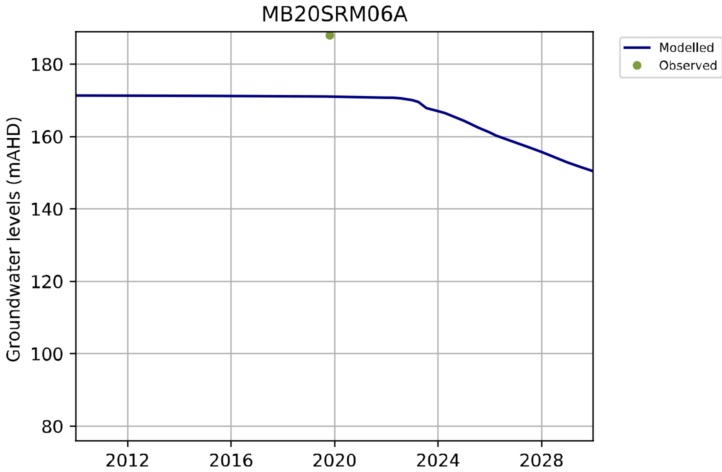

MB20PDM06T
Groundwater levels (mAHD)
60
80
100
120
140
160
180
2012
2016
2020
2024
2028
Modelled
Observed

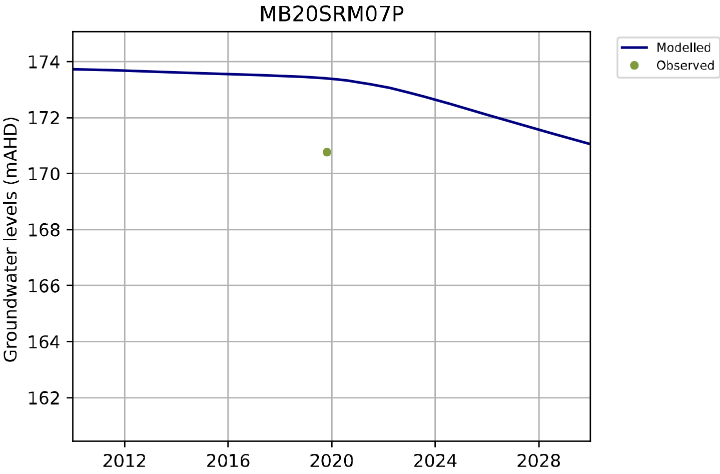

MB20PDM07T
Groundwater levels (mAHD)
180
190
200
210
220
230
240
2012
2016
2020
2024
2028
Modelled
Observed

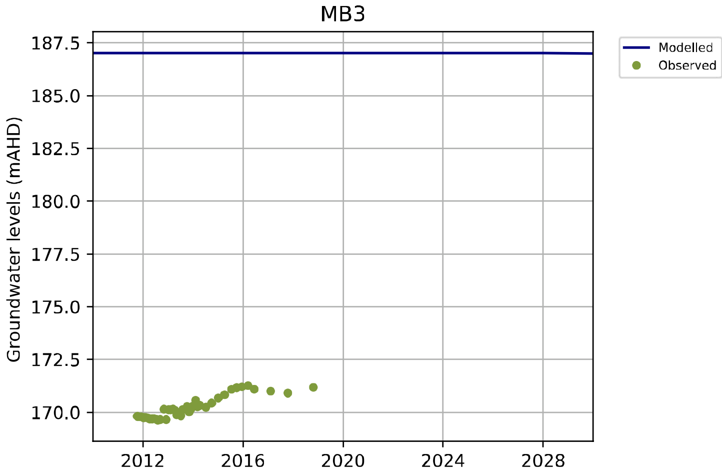

MB20SRM02T
Groundwater levels (mAHD)
158
160
162
164
166
168
170
2012
2016
2020
2024
2028
Modelled
Observed

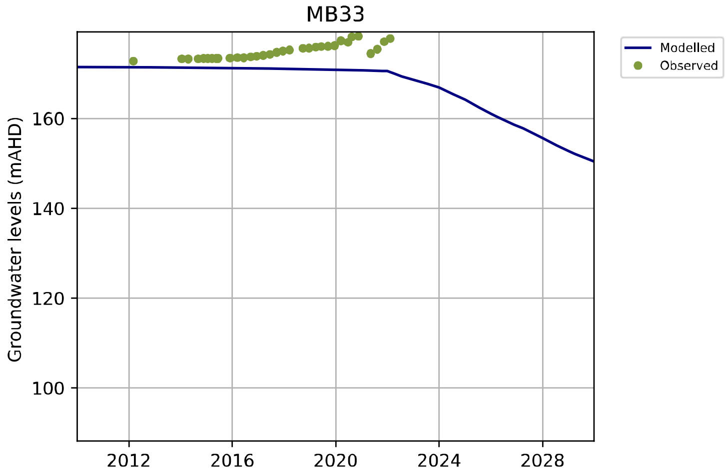

MB20SRM03P
Groundwater levels (mAHD)
140
145
150
155
160
165
2012
2016
2020
2024
2028
Modelled
Observed

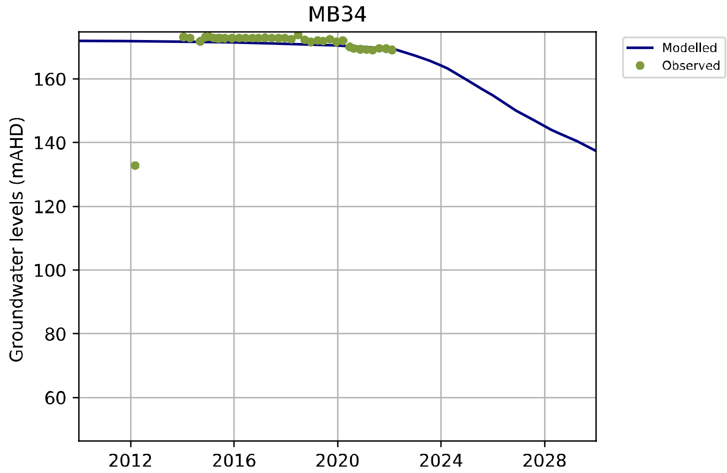

MB20SRM04A
Groundwater levels (mAHD)
80
100
120
140
160
180
2012
2016
2020
2024
2028
Modelled
Observed

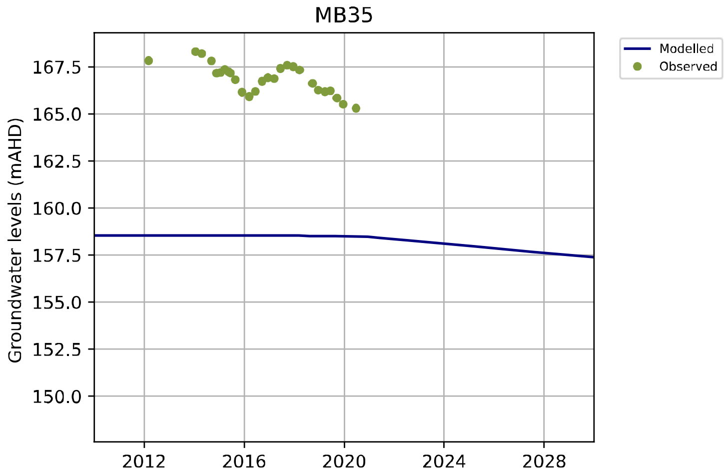

MB20SRM06A
Groundwater levels (mAHD)
80
100
120
140
160
180
2012
2016
2020
2024
2028
Modelled
Observed

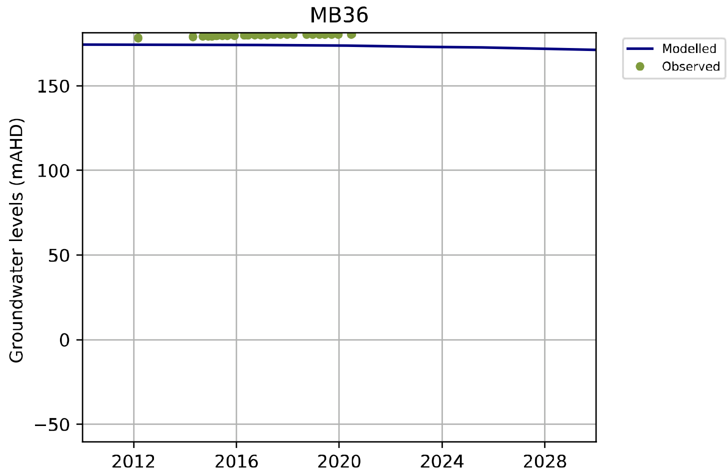

MB20SRM07P
Groundwater levels (mAHD)
162
164
166
168
170
172
174
2012
2016
2020
2024
2028
Modelled
Observed

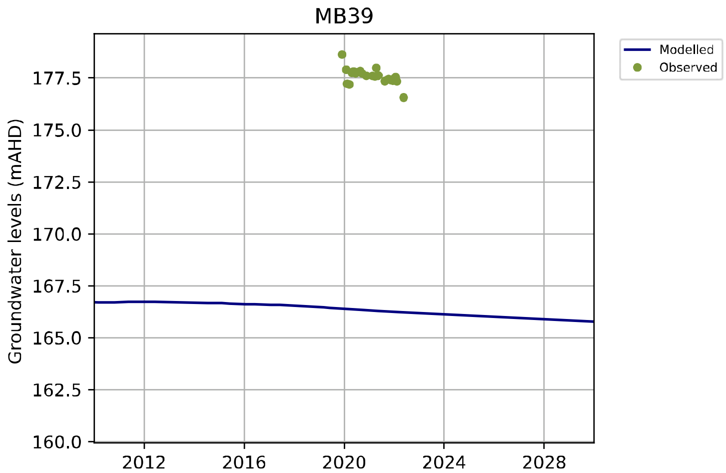

MB3
Groundwater levels (mAHD)
170.0
172.5
175.0
177.5
180.0
182.5
185.0
187.5
2012
2016
2020
2024
2028
Modelled
Observed

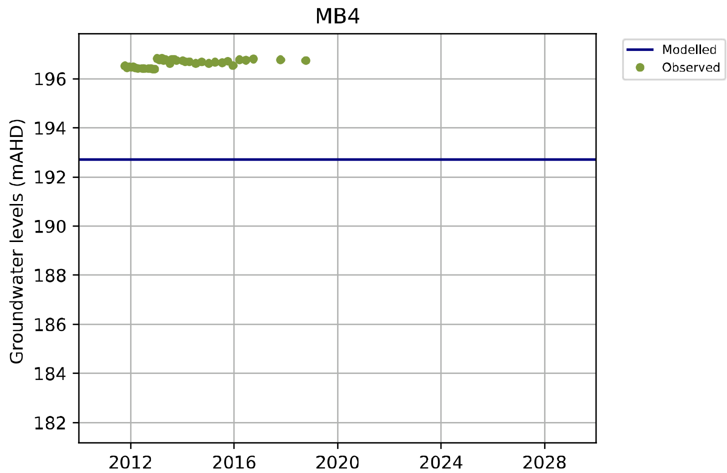

MB33
Groundwater levels (mAHD)
160
140
120
100
2012
2016
2020
2024
2028
Modelled
Observed

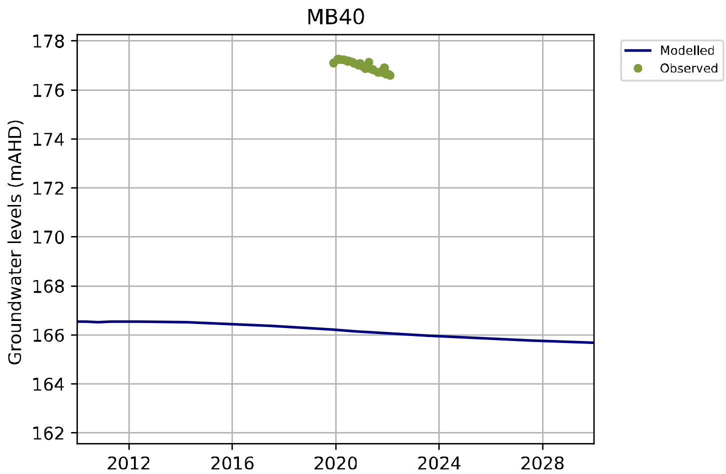

MB34
Groundwater levels (mAHD)
160
140
120
100
80
60
2012
2016
2020
2024
2028
Modelled
Observed

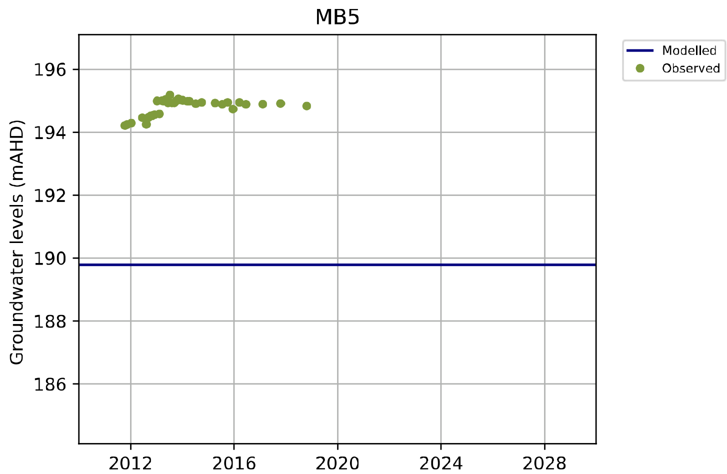

MB35
Groundwater levels (mAHD)
167.5
165.0
162.5
160.0
157.5
155.0
152.5
150.0
2012
2016
2020
2024
2028
Modelled
Observed

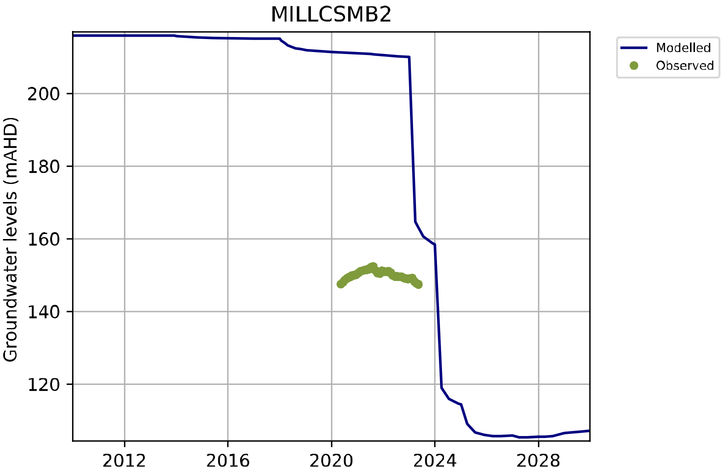

MB36
Groundwater levels (mAHD)
150
100
50
0
−50
2012
2016
2020
2024
2028
Modelled
Observed

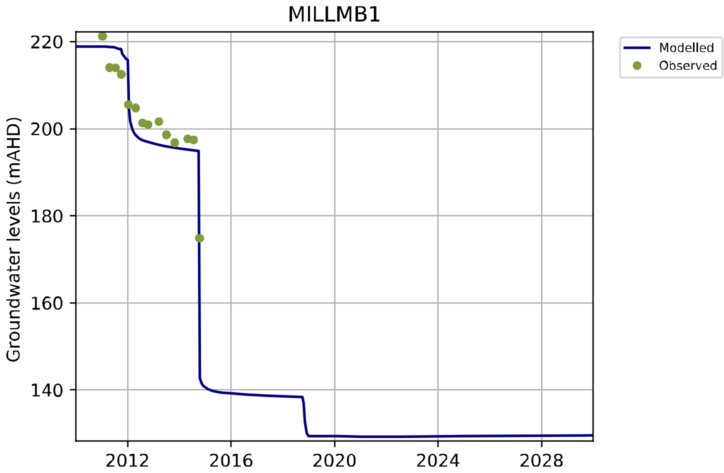

MB39
Groundwater levels (mAHD)
177.5
175.0
172.5
170.0
167.5
165.0
162.5
160.0
2012
2016
2020
2024
2028
Modelled
Observed

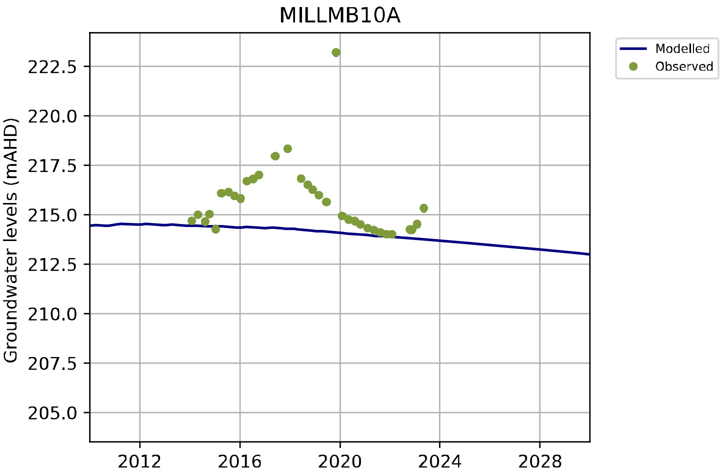

MB4
Groundwater levels (mAHD)
196
194
192
190
188
186
184
182
2012
2016
2020
2024
2028
Modelled
Observed

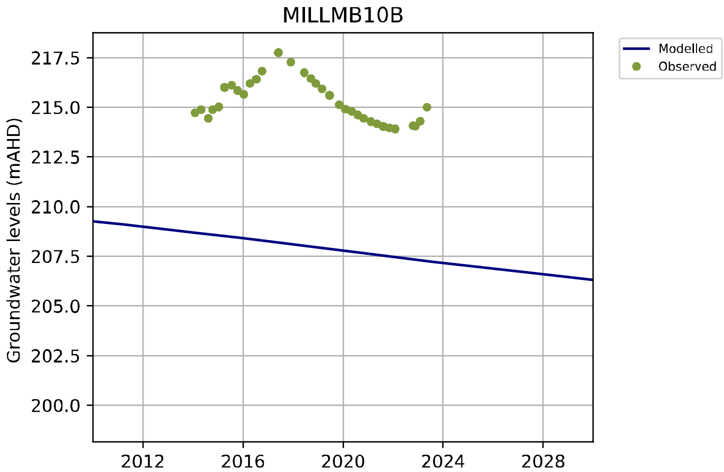

MB40
Groundwater levels (mAHD)
178
176
174
172
170
168
166
164
162
2012
2016
2020
2024
2028
Modelled
Observed

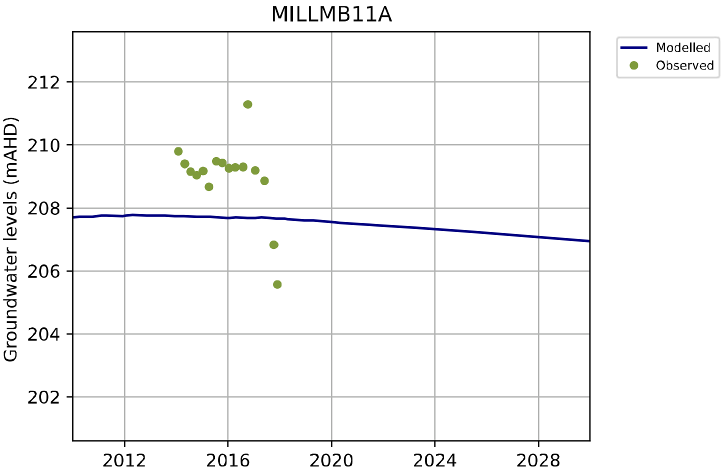

MB5
Groundwater levels (mAHD)
196
194
192
190
188
186
2012
2016
2020
2024
2028
Modelled
Observed

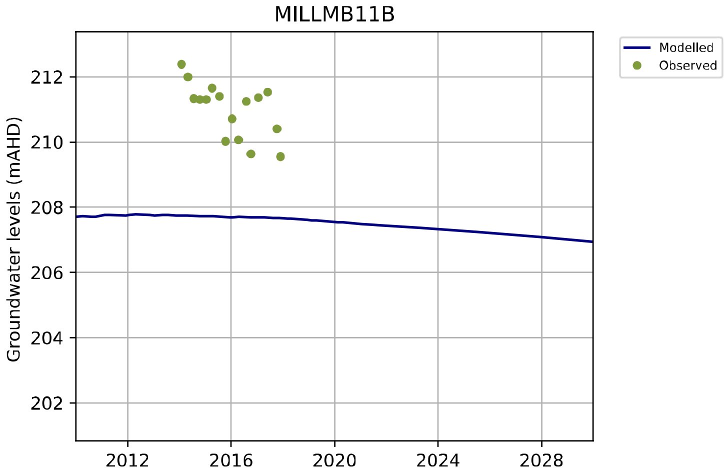

MILLCSMB2
Groundwater levels (mAHD)
200
180
160
140
120
2012
2016
2020
2024
2028
Modelled
Observed

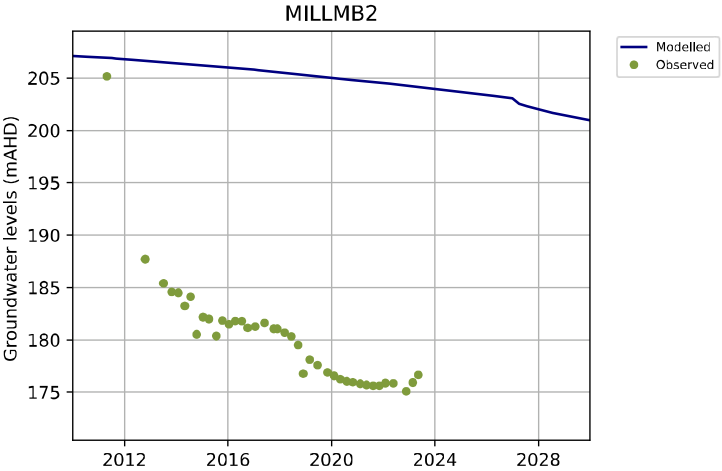

MILLMB1
Groundwater levels (mAHD)
220
200
180
160
140
2012
2016
2020
2024
2028
Modelled
Observed

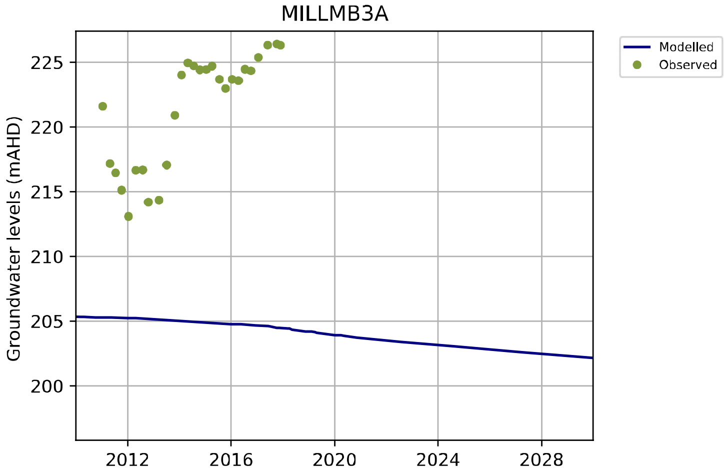

MILLMB10A
Groundwater levels (mAHD)
222.5
220.0
217.5
215.0
212.5
210.0
207.5
205.0
2012
2016
2020
2024
2028
Modelled
Observed

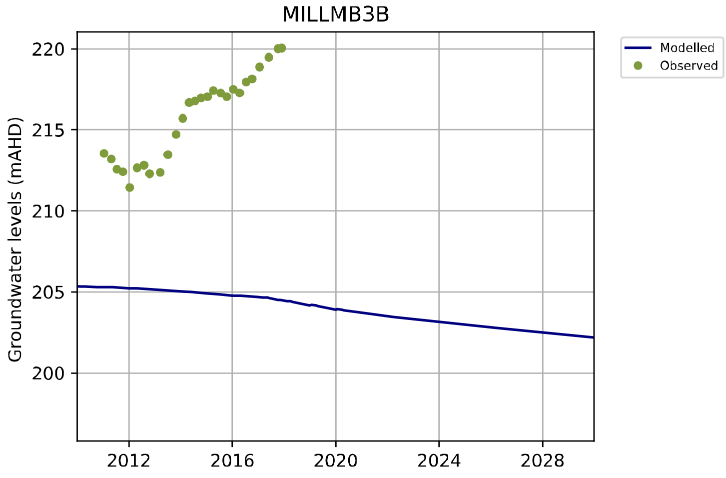

MILLMB10B
Groundwater levels (mAHD)
217.5
215.0
212.5
210.0
207.5
205.0
202.5
200.0
2012
2016
2020
2024
2028
Modelled
Observed

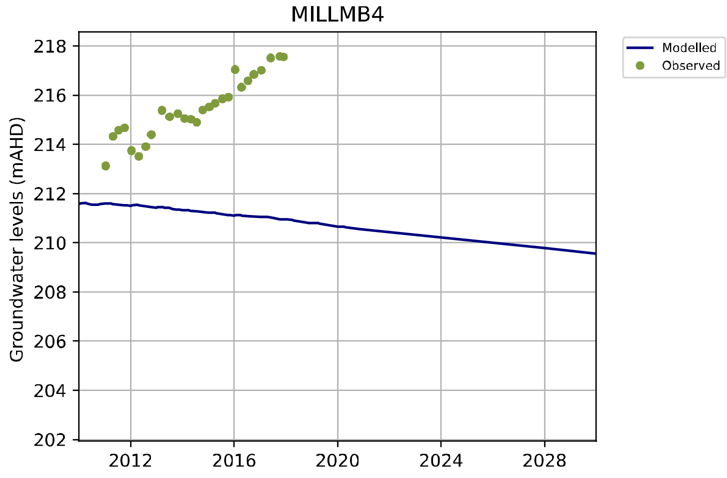

MILLMB11A
Groundwater levels (mAHD)
212
210
208
206
204
202
2012
2016
2020
2024
2028
Modelled
Observed

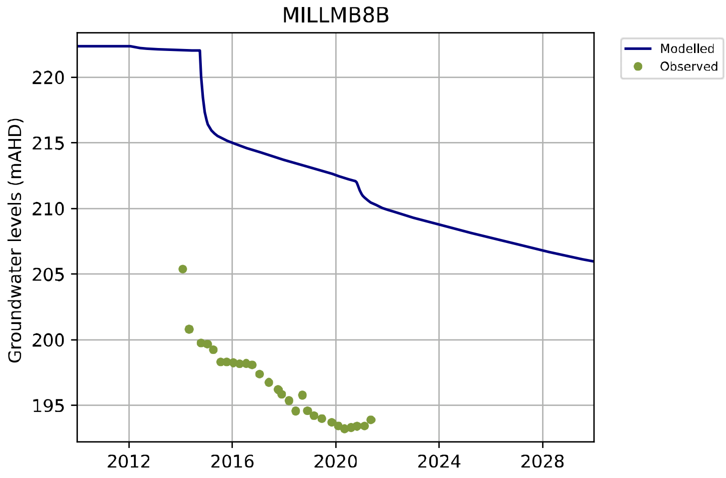

MILLMB11B
Groundwater levels (mAHD)
212
210
208
206
204
202
2012
2016
2020
2024
2028
Modelled
Observed

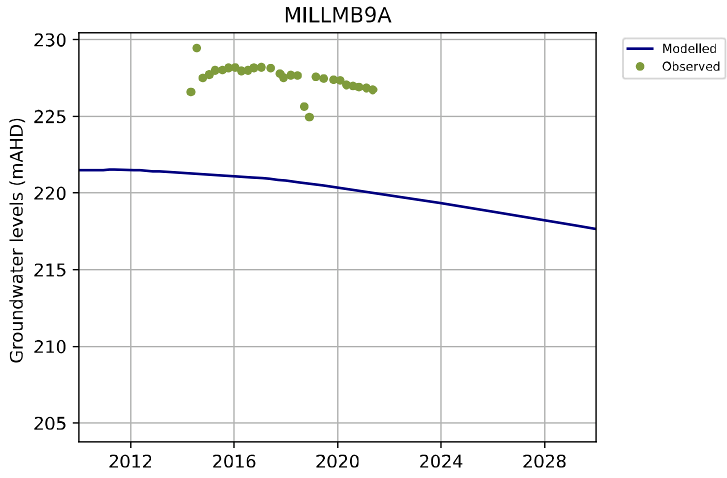

MILLMB2
Groundwater levels (mAHD)
205
200
195
190
185
180
175
2012
2016
2020
2024
2028
Modelled
Observed

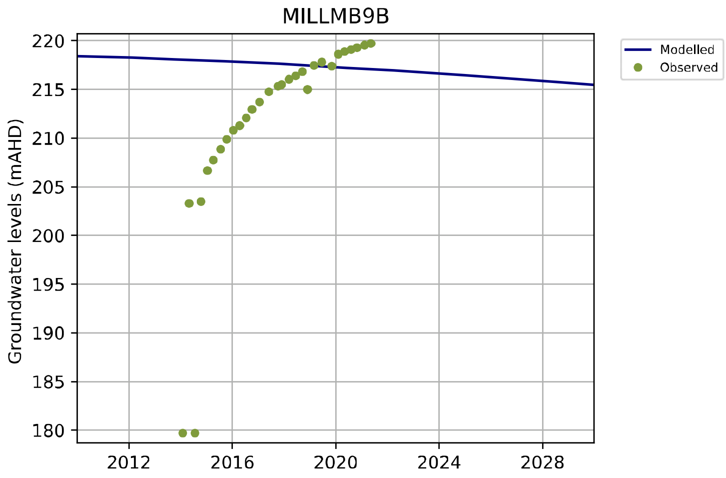

MILLMB3A
Groundwater levels (mAHD)
225
220
215
210
205
200
2012
2016
2020
2024
2028
Modelled
Observed

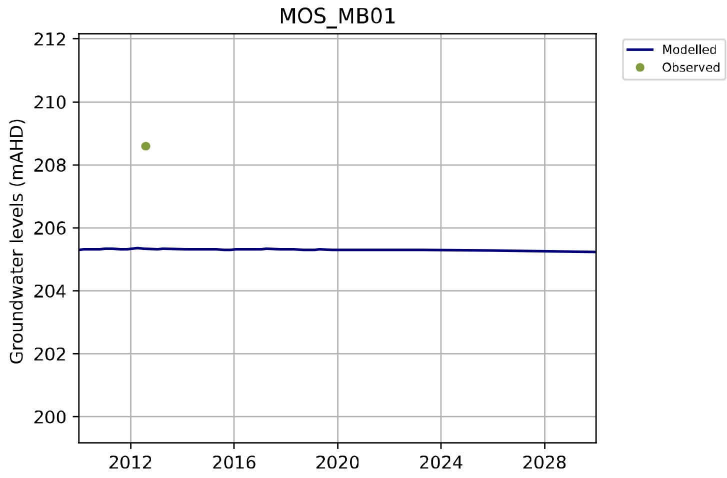

MILLMB3B
Groundwater levels (mAHD)
Modelled
Observed

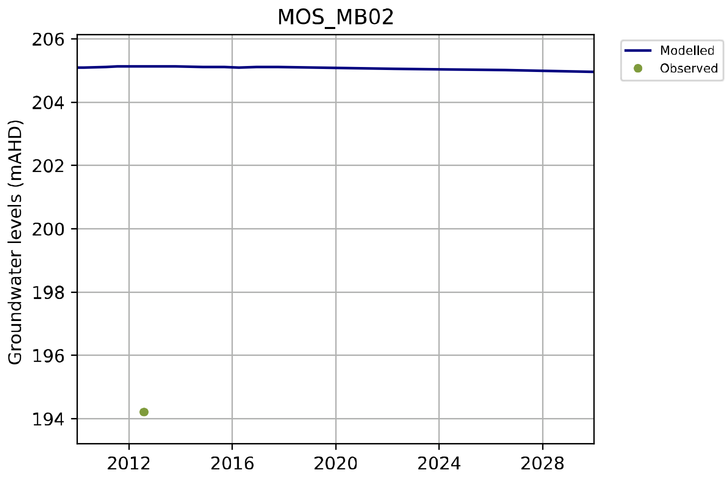

MILLMB4
Groundwater levels (mAHD)
Modelled
Observed

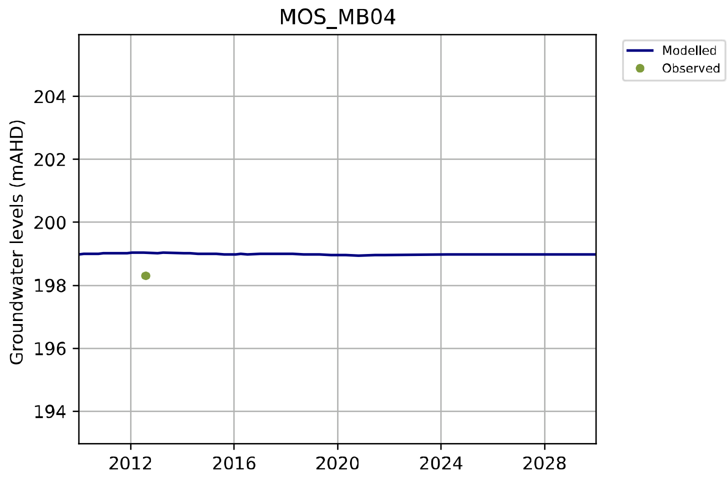

MILLMB8B
Groundwater levels (mAHD)
Modelled
Observed

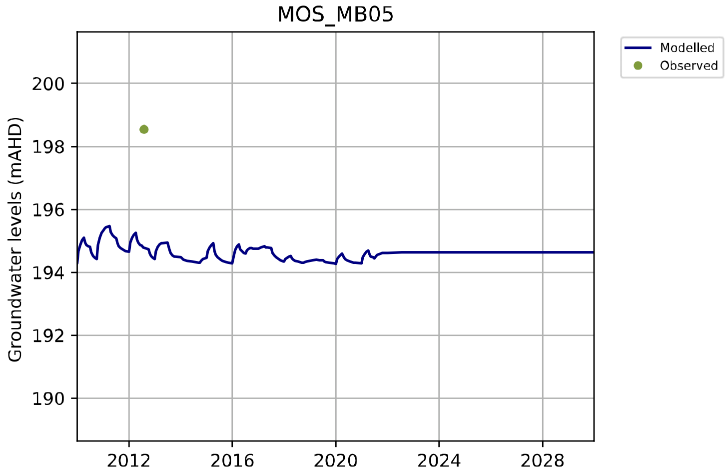

MILLMB9A
Groundwater levels (mAHD)
Modelled
Observed

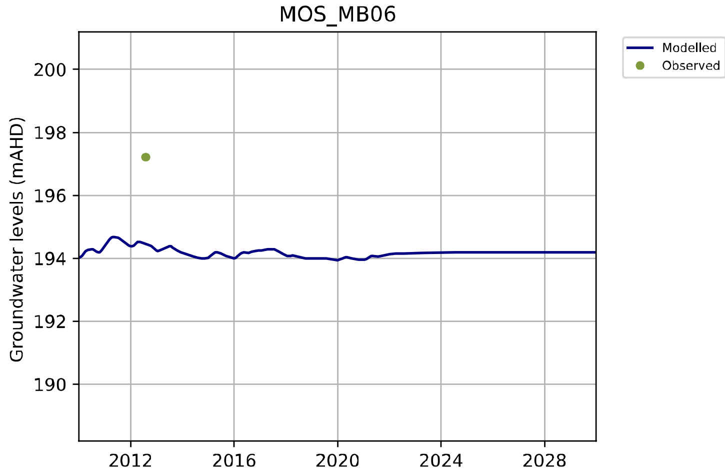

MILLMB9B
Groundwater levels (mAHD)
Modelled
Observed

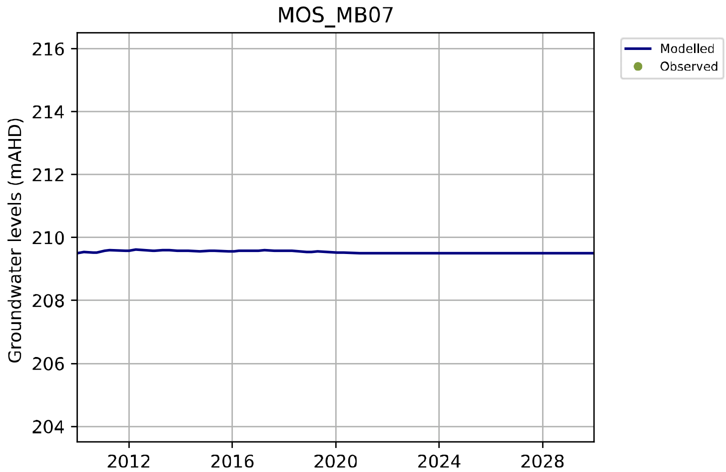

MOS_MB01
Groundwater levels (mAHD)
Modelled
Observed

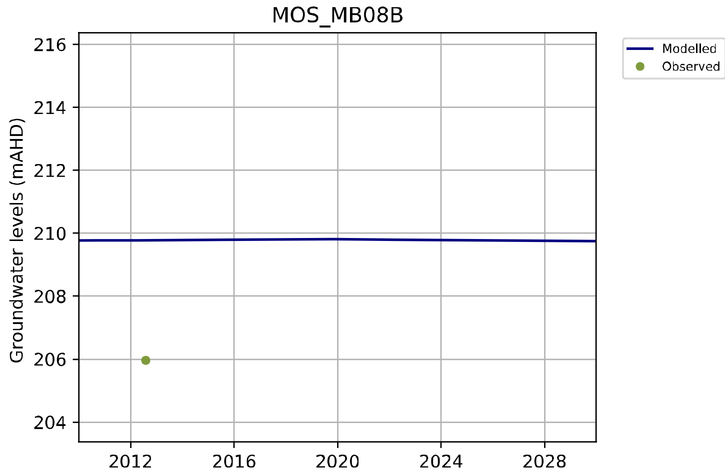

MOS_MB02
Groundwater levels (mAHD)
Modelled
Observed

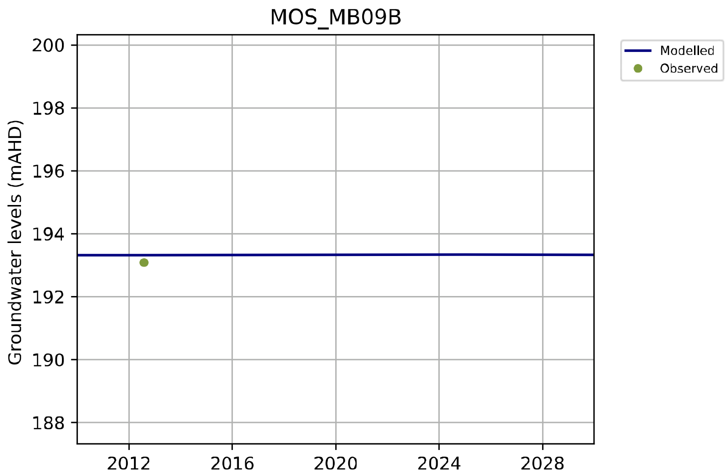

MOS_MB04
Groundwater levels (mAHD)
Modelled
Observed

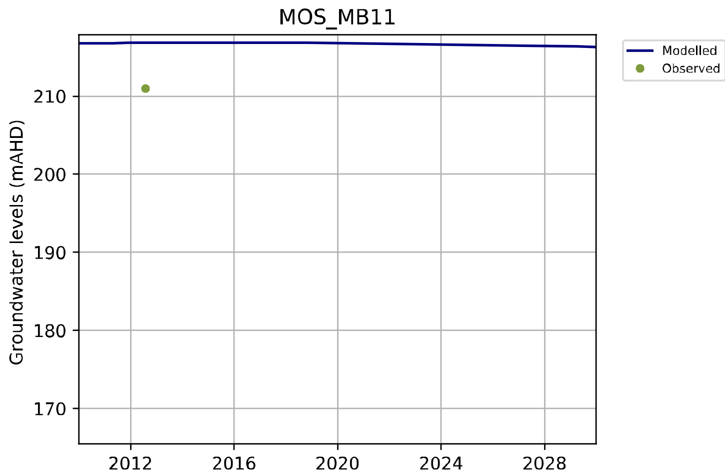

MOS_MB05
Groundwater levels (mAHD)
190
192
194
196
198
200
2012
2016
2020
2024
2028
Modelled
Observed

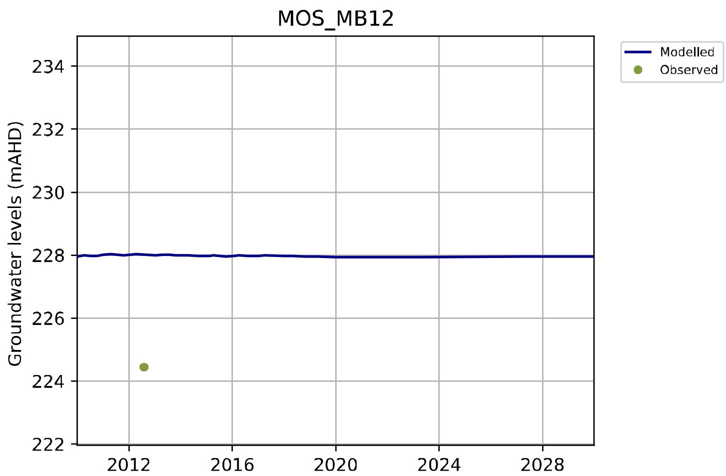

MOS_MB06
Groundwater levels (mAHD)
190
192
194
196
198
200
2012
2016
2020
2024
2028
Modelled
Observed

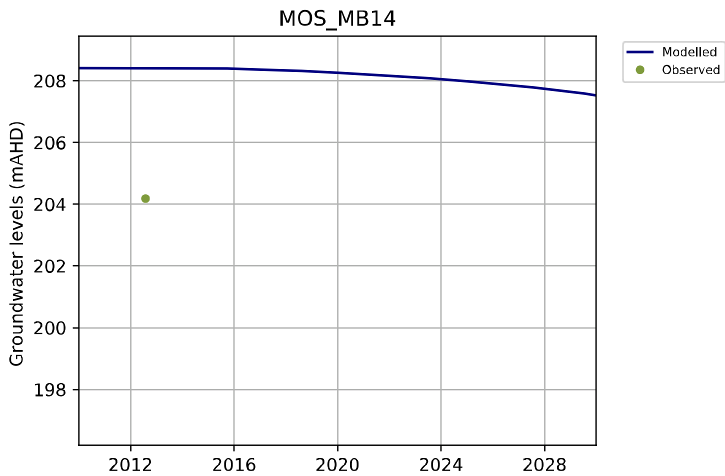

MOS_MB07
Groundwater levels (mAHD)
204
206
208
210
212
214
216
2012
2016
2020
2024
2028
Modelled
Observed

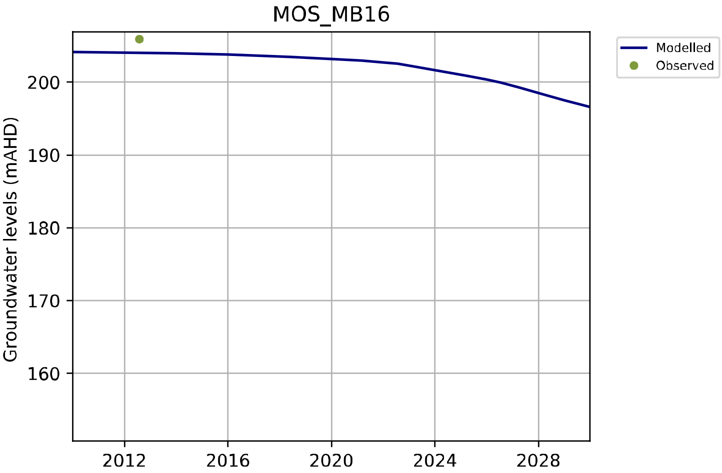

MOS_MB08B
Groundwater levels (mAHD)
204
206
208
210
212
214
216
2012
2016
2020
2024
2028
Modelled
Observed

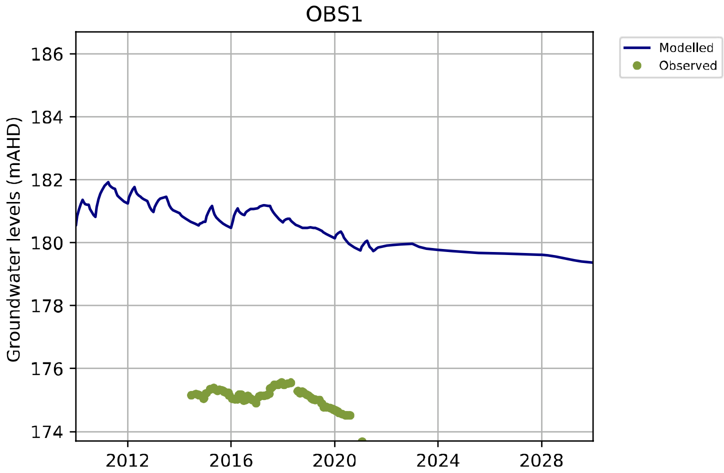

MOS_MB09B
Groundwater levels (mAHD)
188
190
192
194
196
198
200
2012
2016
2020
2024
2028
Modelled
Observed

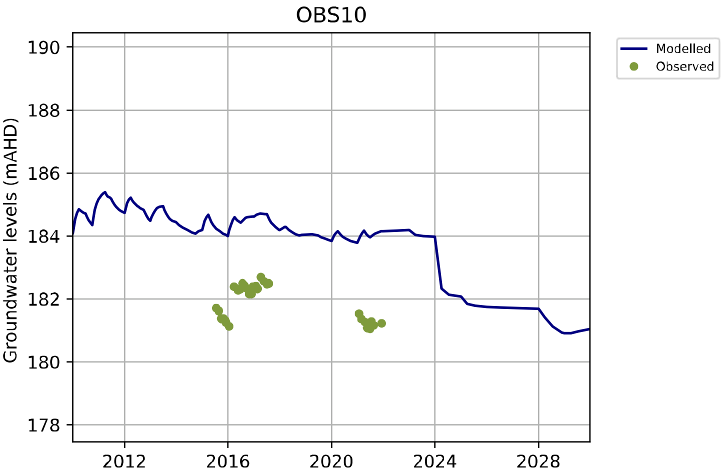

MOS_MB11
Groundwater levels (mAHD)
170
180
190
200
210
2012
2016
2020
2024
2028
Modelled
Observed

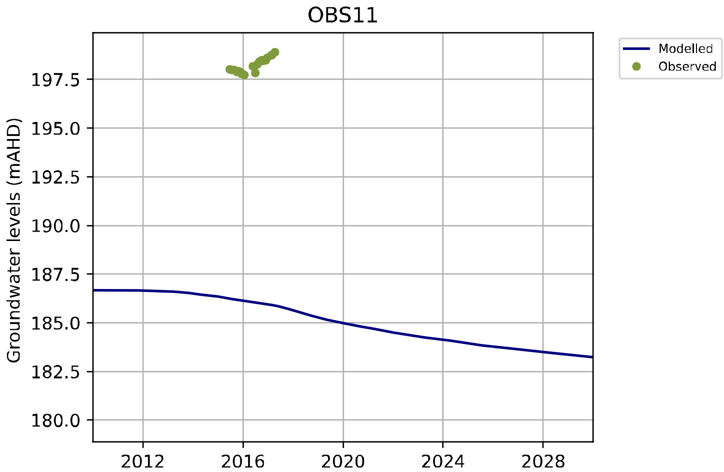

MOS_MB12
Groundwater levels (mAHD)
222
224
226
228
230
232
234
2012
2016
2020
2024
2028
Modelled
Observed

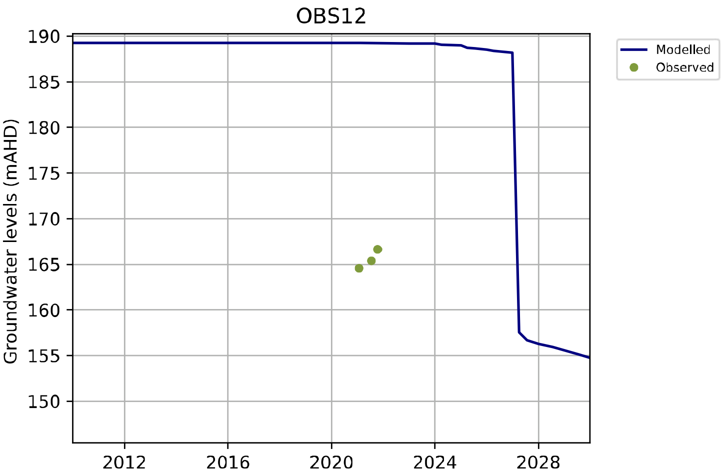

MOS_MB14
Groundwater levels (mAHD)
198
200
202
204
206
208
2012
2016
2020
2024
2028
Modelled
Observed

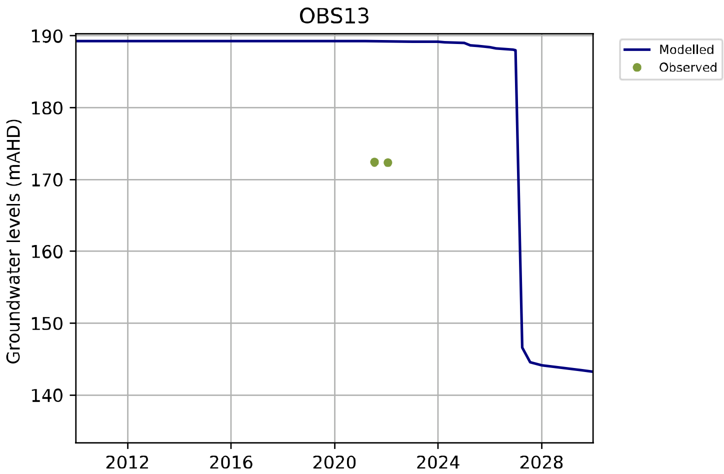

MOS_MB16
Groundwater levels (mAHD)
200
190
180
170
160
2012
2016
2020
2024
2028
Modelled
Observed

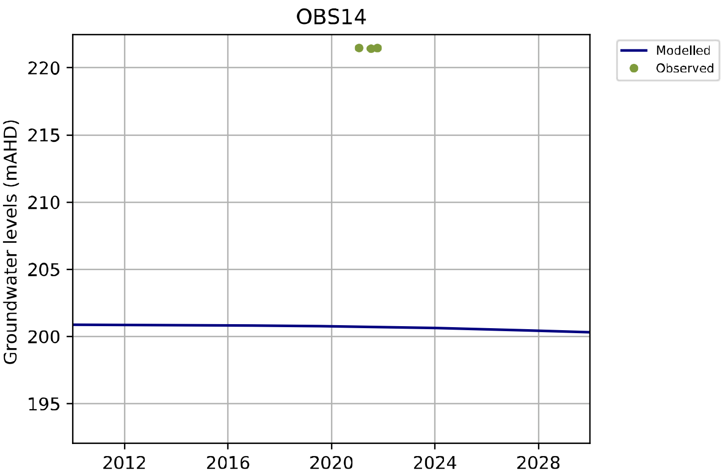

OBS1
Groundwater levels (mAHD)
186
184
182
180
178
176
174
2012
2016
2020
2024
2028
Modelled
Observed

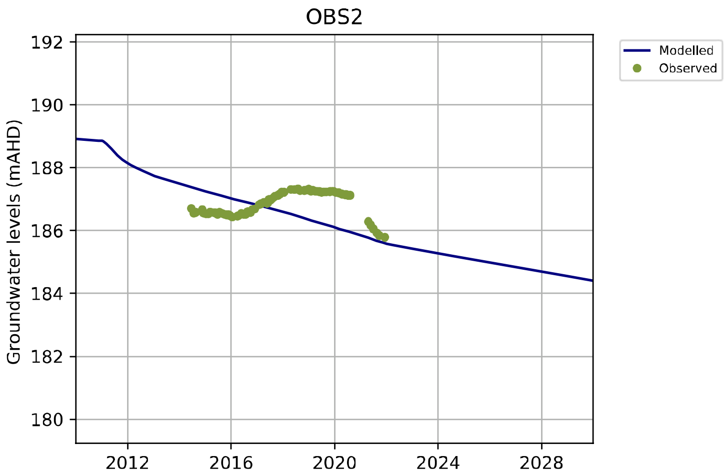

OBS10
Groundwater levels (mAHD)
190
188
186
184
182
180
178
2012
2016
2020
2024
2028
Modelled
Observed

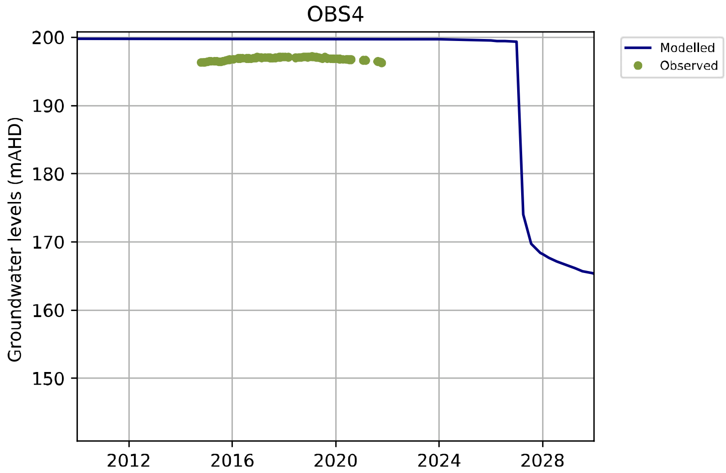

OBS11
Groundwater levels (mAHD)
197.5
195.0
192.5
190.0
187.5
185.0
182.5
180.0
2012
2016
2020
2024
2028
Modelled
Observed

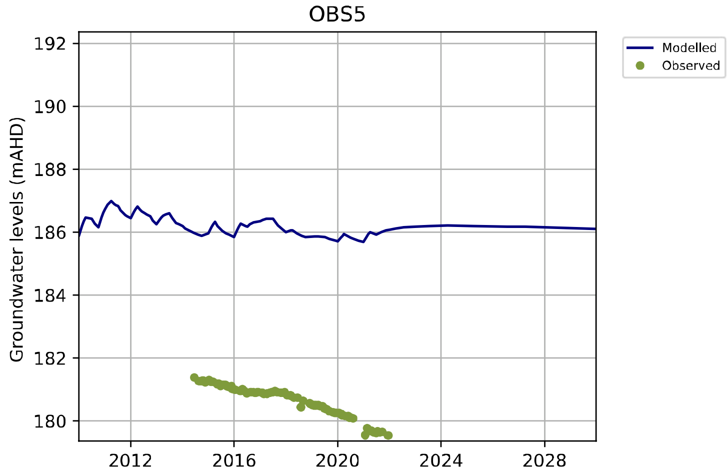

OBS12
Groundwater levels (mAHD)
190
185
180
175
170
165
160
155
150
2012
2016
2020
2024
2028
Modelled
Observed

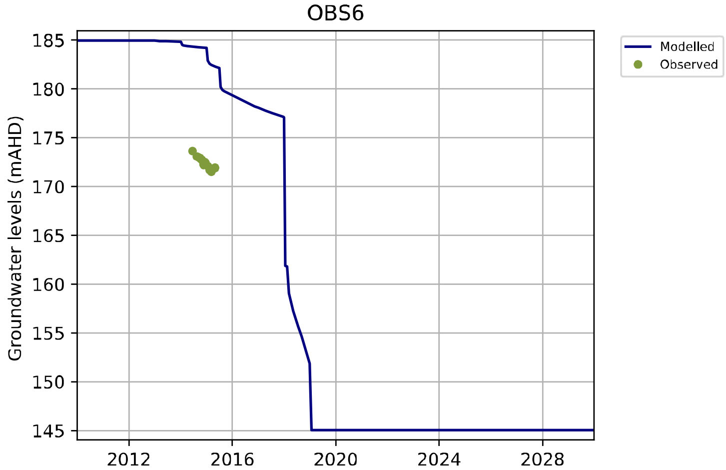

OBS13
Groundwater levels (mAHD)
190
180
170
160
150
140
2012
2016
2020
2024
2028
Modelled
Observed

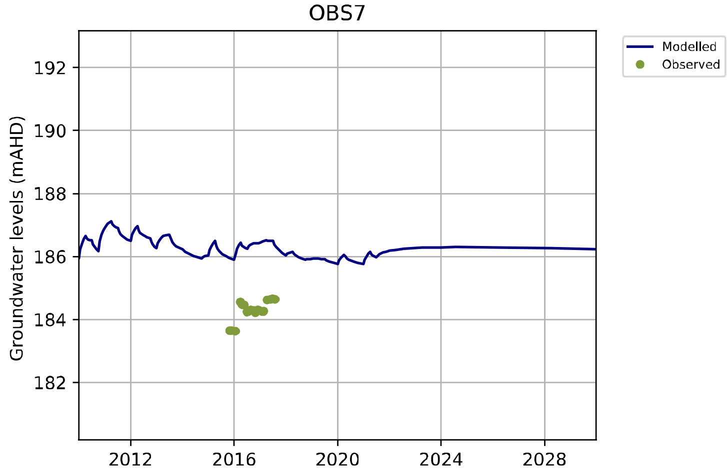

OBS14
Groundwater levels (mAHD)
220
215
210
205
200
195
2012
2016
2020
2024
2028
Modelled
Observed

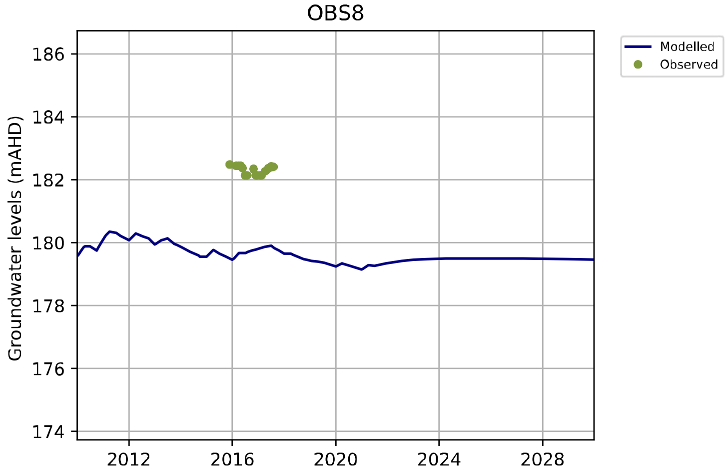

OBS2
Groundwater levels (mAHD)
192
190
188
186
184
182
180
2012
2016
2020
2024
2028
Modelled
Observed

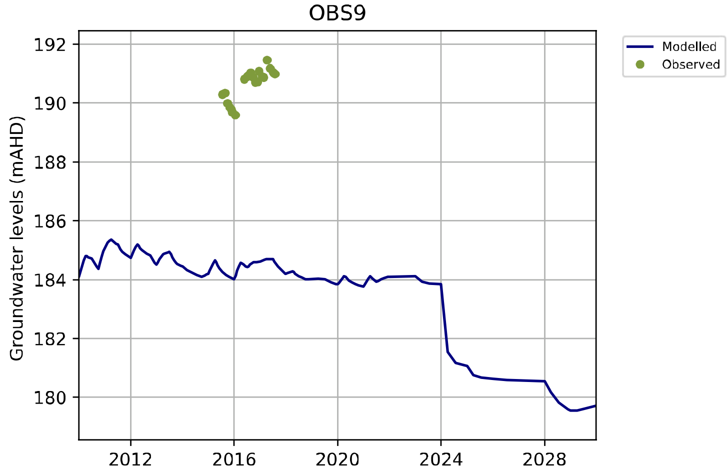

OBS4
Groundwater levels (mAHD)
200
190
180
170
160
150
2012
2016
2020
2024
2028
Modelled
Observed

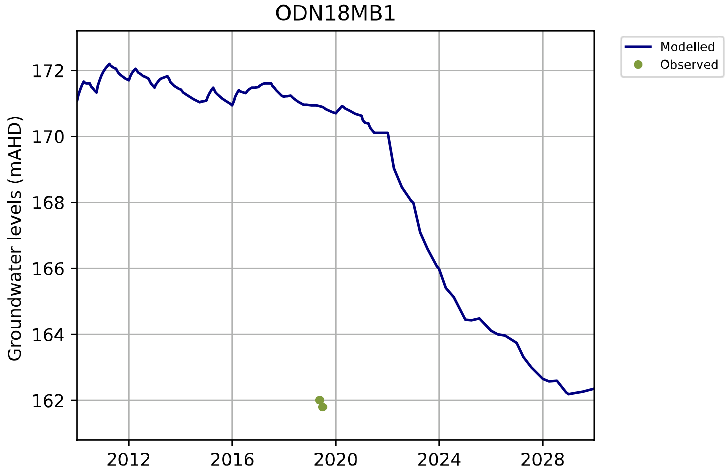

OBS5
Groundwater levels (mAHD)
192
190
188
186
184
182
180
2012
2016
2020
2024
2028
Modelled
Observed

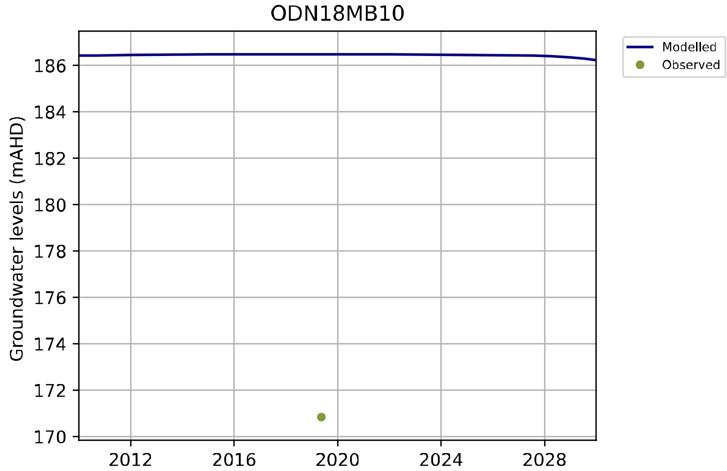

OBS6
Groundwater levels (mAHD)
185
180
175
170
165
160
155
150
145
2012
2016
2020
2024
2028
Modelled
Observed

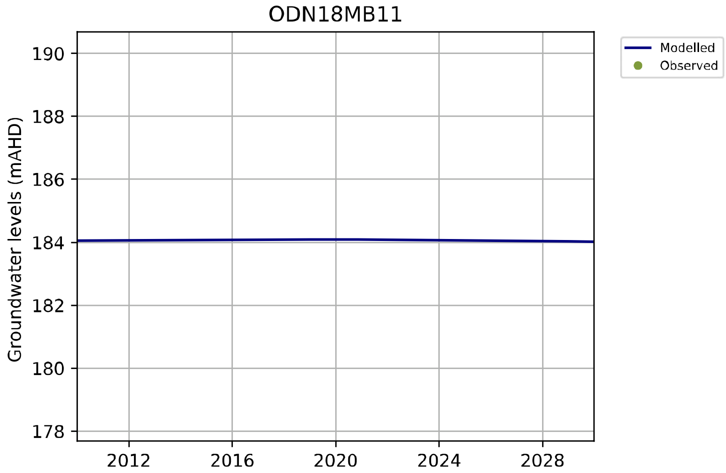

OBS7
Groundwater levels (mAHD)
192
190
188
186
184
182
2012
2016
2020
2024
2028
Modelled
Observed

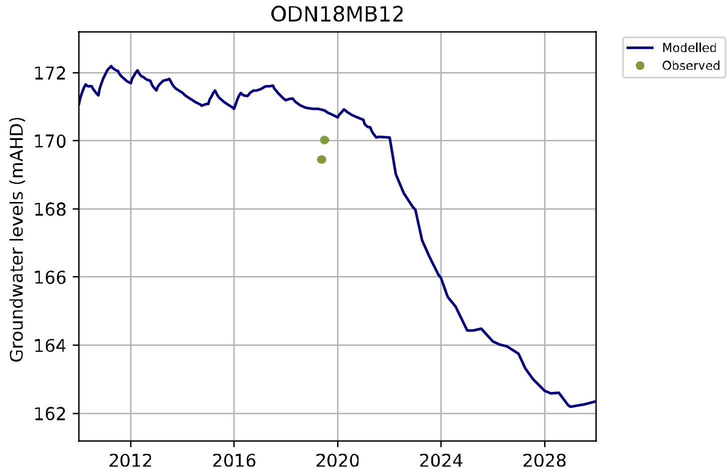

OBS8
Groundwater levels (mAHD)
186
184
182
180
178
176
174
2012
2016
2020
2024
2028
Modelled
Observed

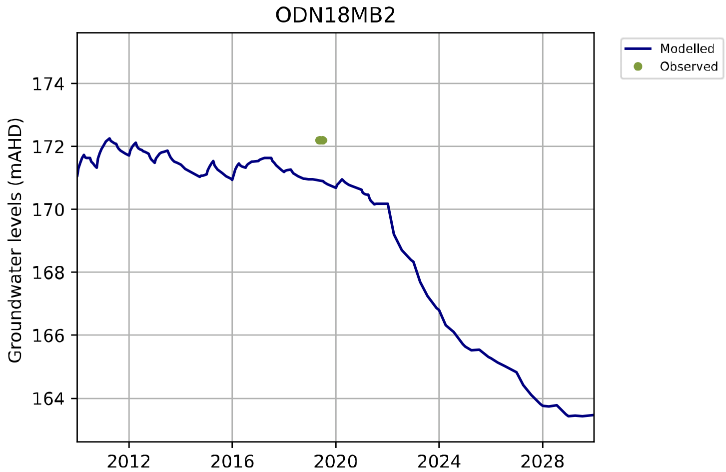

OBS9
Groundwater levels (mAHD)
192
190
188
186
184
182
180
2012
2016
2020
2024
2028
Modelled
Observed

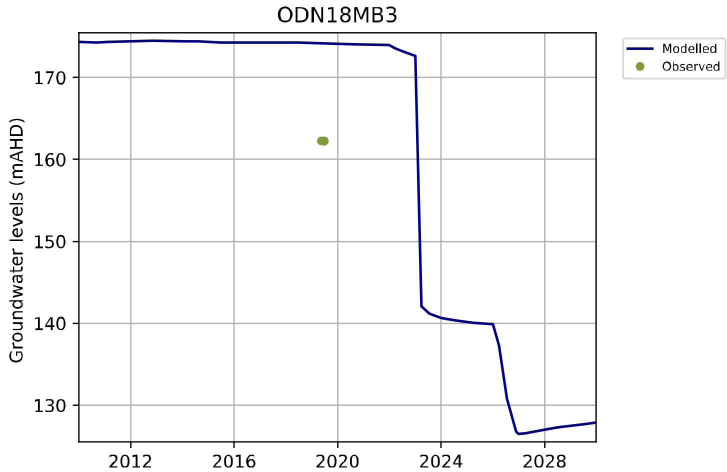

ODN18MB1
Groundwater levels (mAHD)
172
170
168
166
164
162
2012
2016
2020
2024
2028
Modelled
Observed

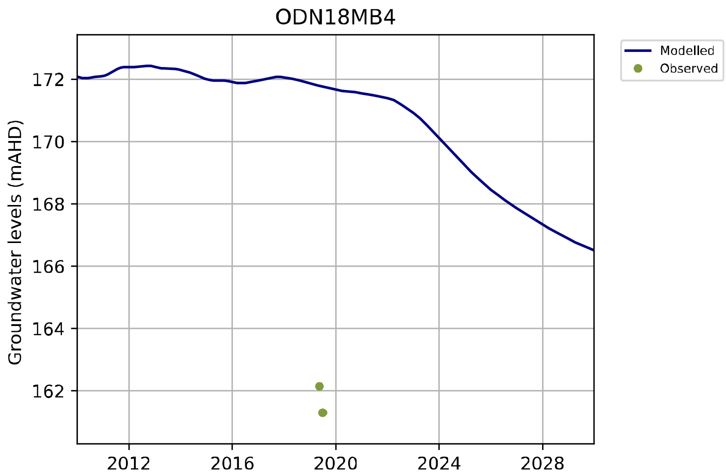

ODN18MB10
Groundwater levels (mAHD)
186
184
182
180
178
176
174
172
170
2012
2016
2020
2024
2028
Modelled
Observed

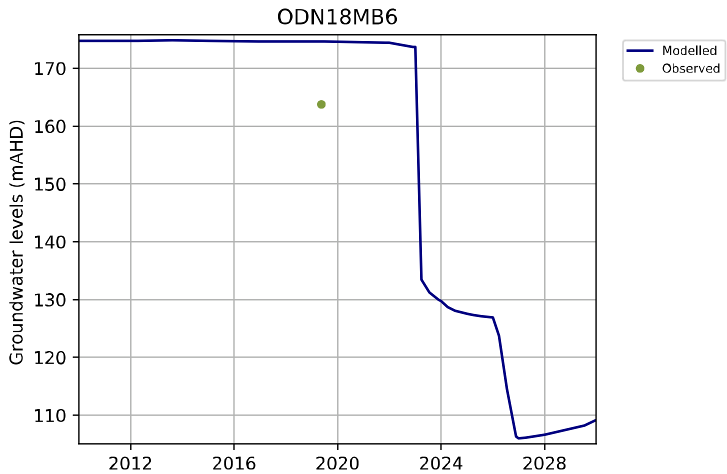

ODN18MB11
Groundwater levels (mAHD)
190
188
186
184
182
180
178
2012
2016
2020
2024
2028
Modelled
Observed

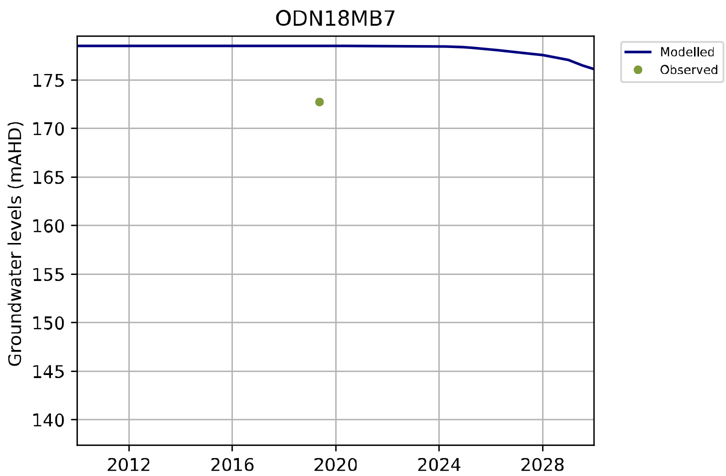

ODN18MB12
Groundwater levels (mAHD)
172
170
168
166
164
162
2012
2016
2020
2024
2028
Modelled
Observed

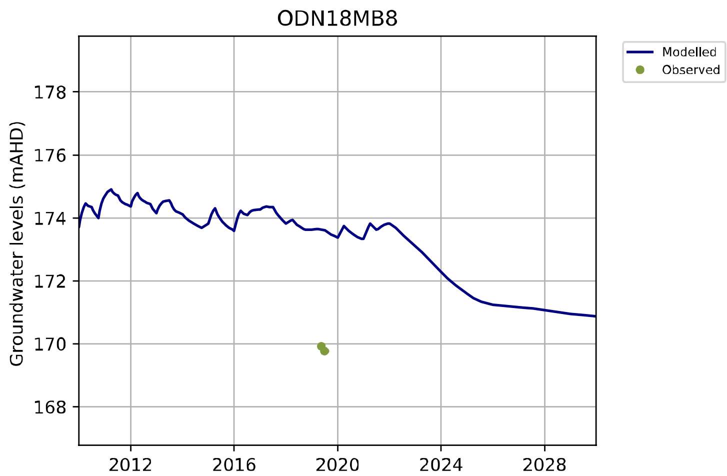

ODN18MB2
Groundwater levels (mAHD)
174
172
170
168
166
164
2012
2016
2020
2024
2028
Modelled
Observed

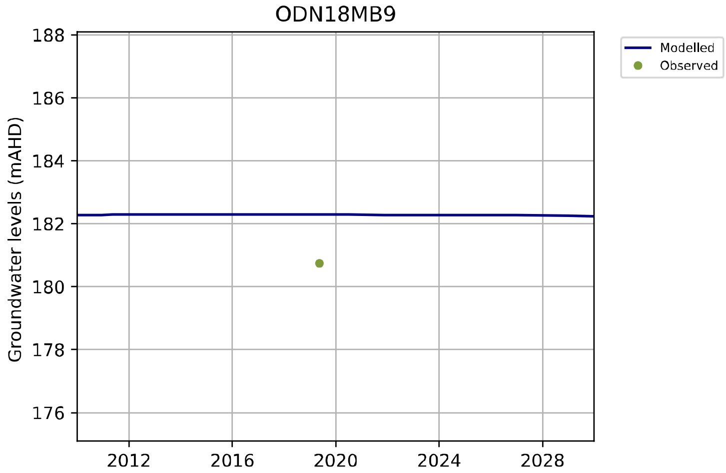

ODN18MB3
Groundwater levels (mAHD)
170
160
150
140
130
2012
2016
2020
2024
2028
Modelled
Observed

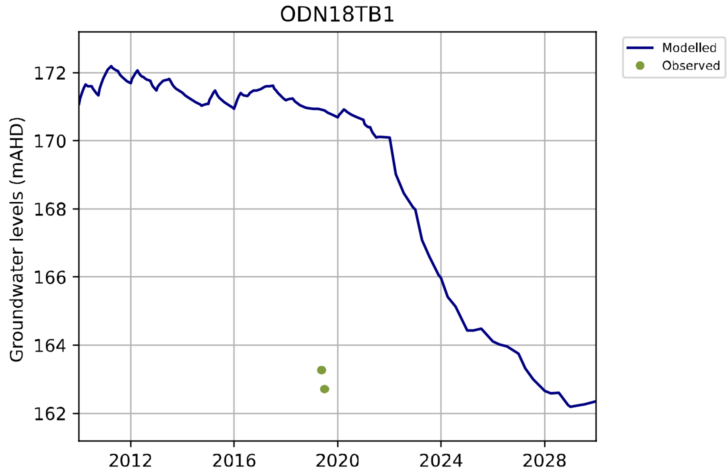

ODN18MB4
Groundwater levels (mAHD)
172
170
168
166
164
162
2012
2016
2020
2024
2028
Modelled
Observed

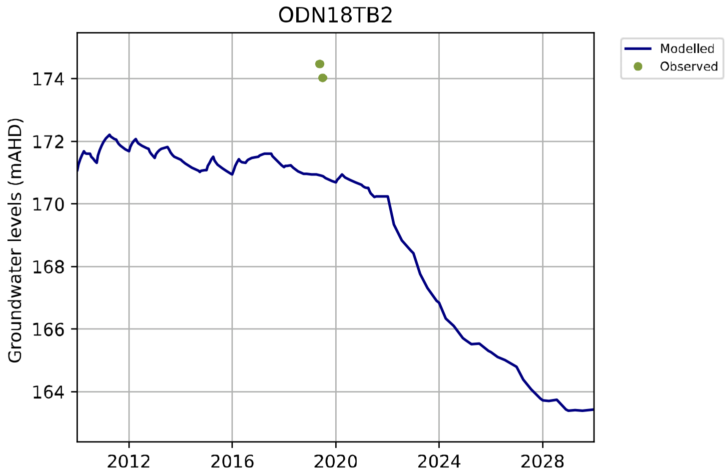

ODN18MB6
Groundwater levels (mAHD)
170
160
150
140
130
120
110
2012
2016
2020
2024
2028
Modelled
Observed

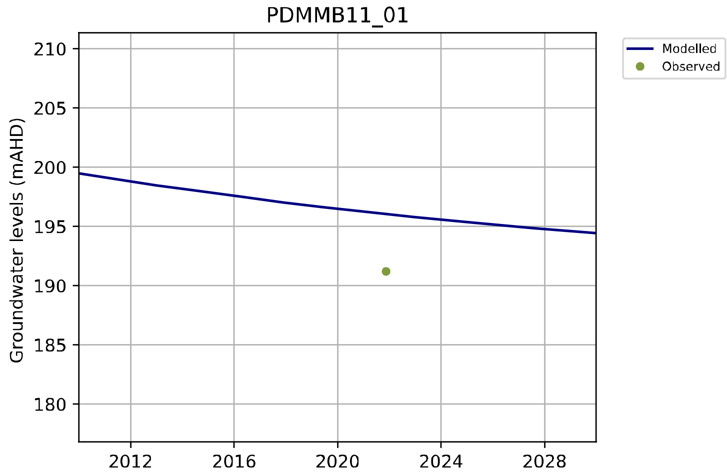

ODN18MB7
Groundwater levels (mAHD)
175
170
165
160
155
150
145
140
2012
2016
2020
2024
2028
Modelled
Observed

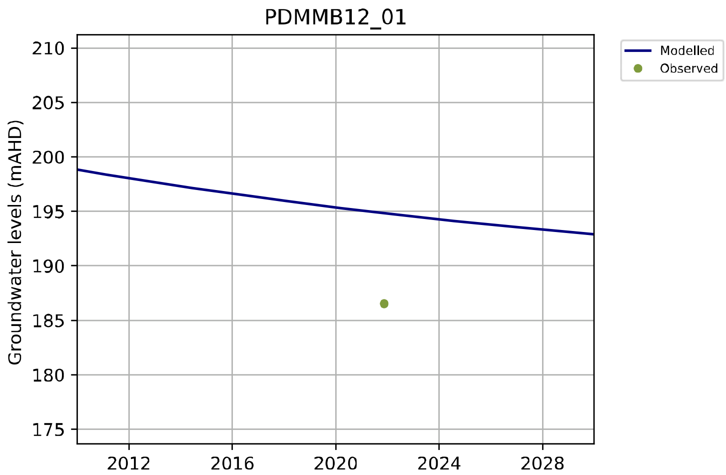

ODN18MB8
Groundwater levels (mAHD)
178
176
174
172
170
168
2012
2016
2020
2024
2028
Modelled
Observed

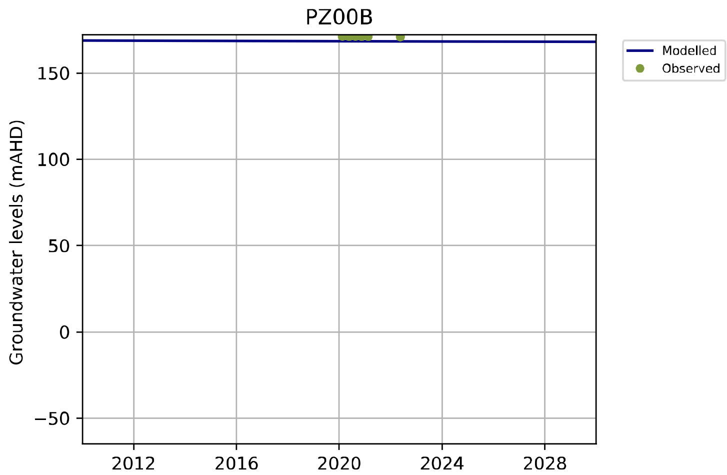

ODN18MB9
Groundwater levels (mAHD)
188
186
184
182
180
178
176
2012
2016
2020
2024
2028
Modelled
Observed

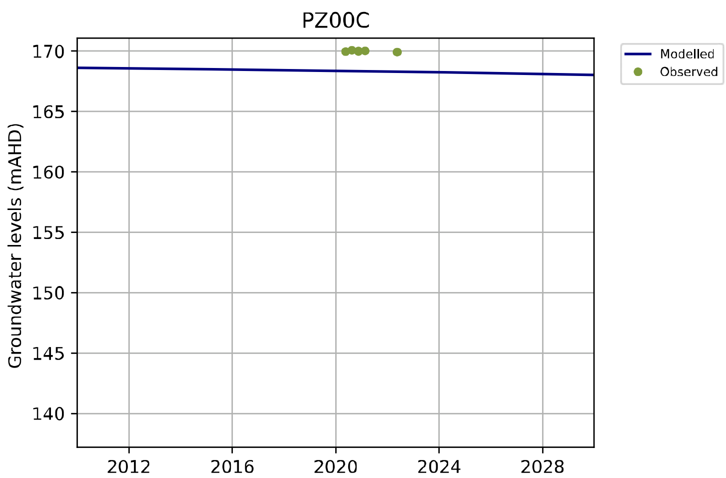

ODN18TB1
Groundwater levels (mAHD)
172
170
168
166
164
162
2012
2016
2020
2024
2028
Modelled
Observed

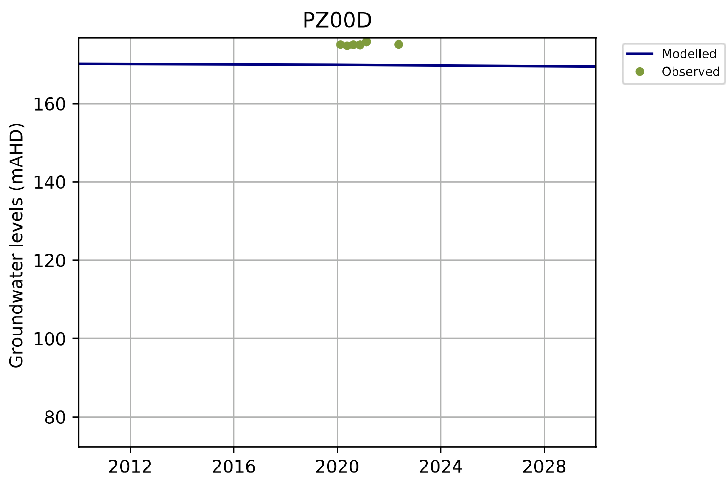

ODN18TB2
Groundwater levels (mAHD)
174
172
170
168
166
164
2012
2016
2020
2024
2028
Modelled
Observed

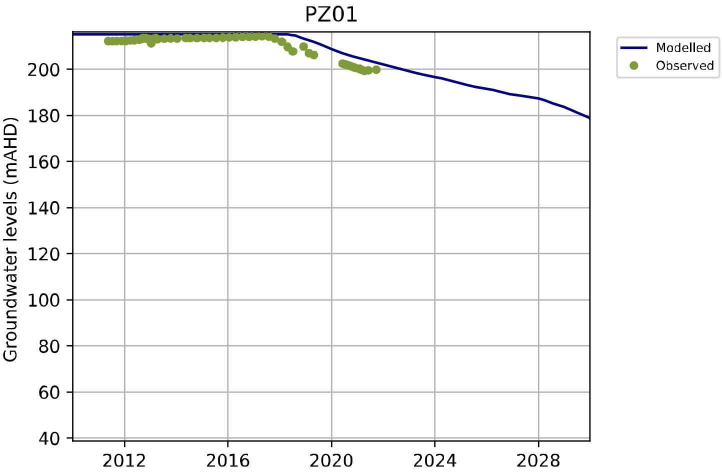

PDMMB11_01
Groundwater levels (mAHD)
210
205
200
195
190
185
180
2012
2016
2020
2024
2028
Modelled
Observed

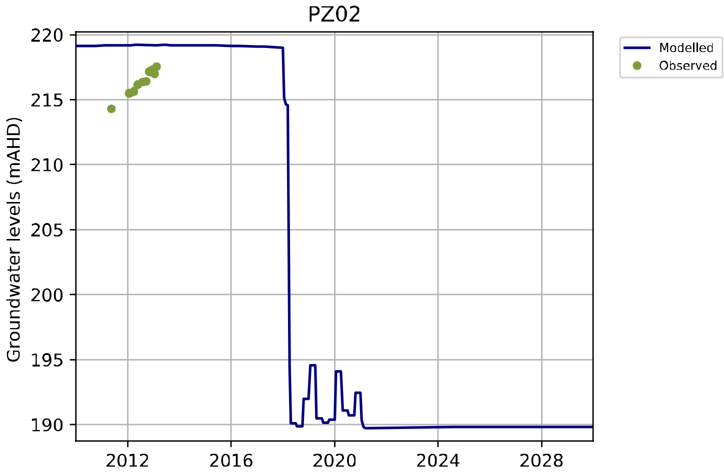

PDMMB12_01
Groundwater levels (mAHD)
210
205
200
195
190
185
180
175
2012
2016
2020
2024
2028
Modelled
Observed

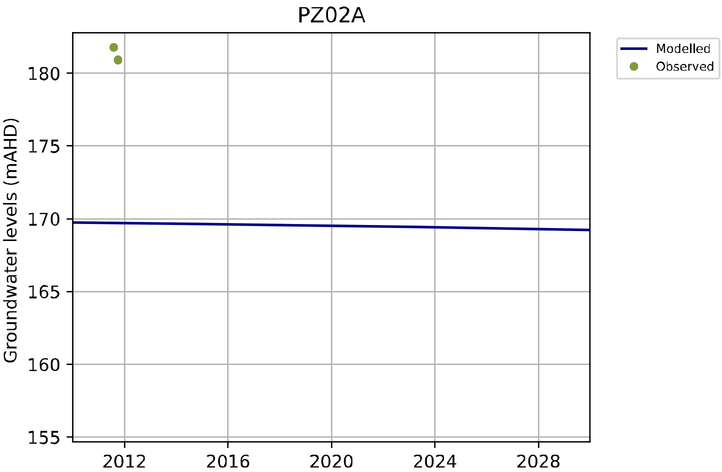

PZ00B
Groundwater levels (mAHD)
150
100
50
0
−50
2012
2016
2020
2024
2028
Modelled
Observed

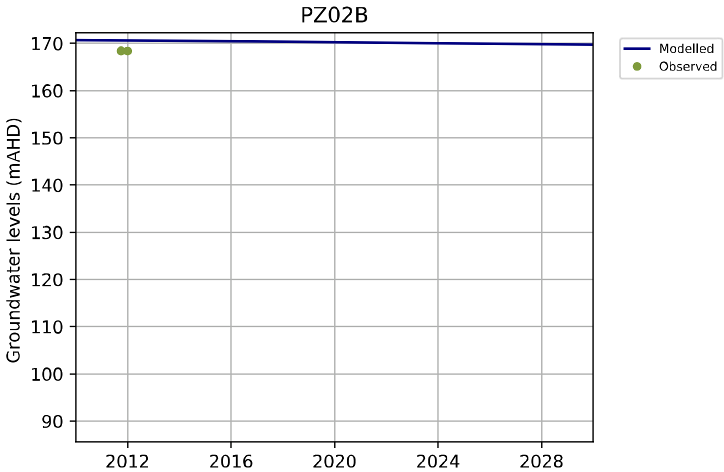

PZ00C
Groundwater levels (mAHD)
170
165
160
155
150
145
140
2012
2016
2020
2024
2028
Modelled
Observed

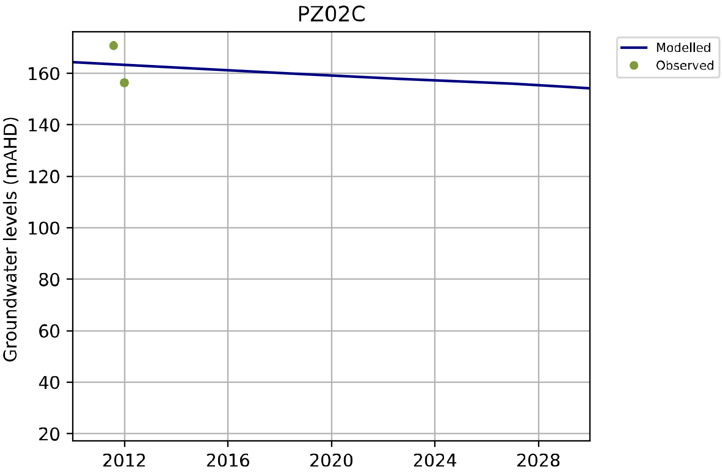

PZ00D
Groundwater levels (mAHD)
160
140
120
100
80
2012
2016
2020
2024
2028
Modelled
Observed

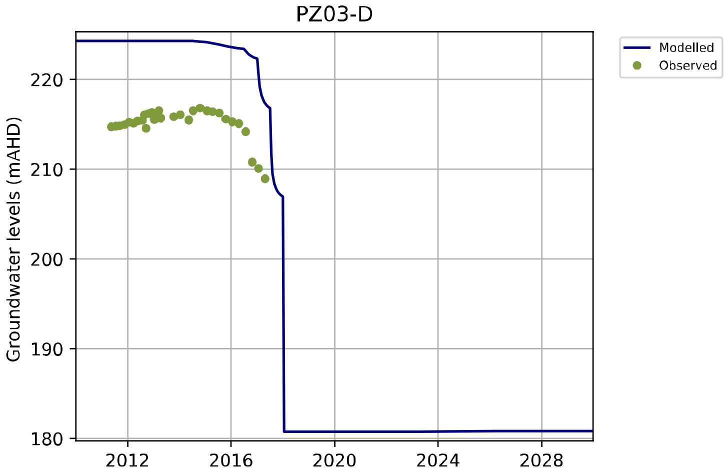

PZ01
Groundwater levels (mAHD)
Modelled
Observed
2012
2016
2020
2024
2028

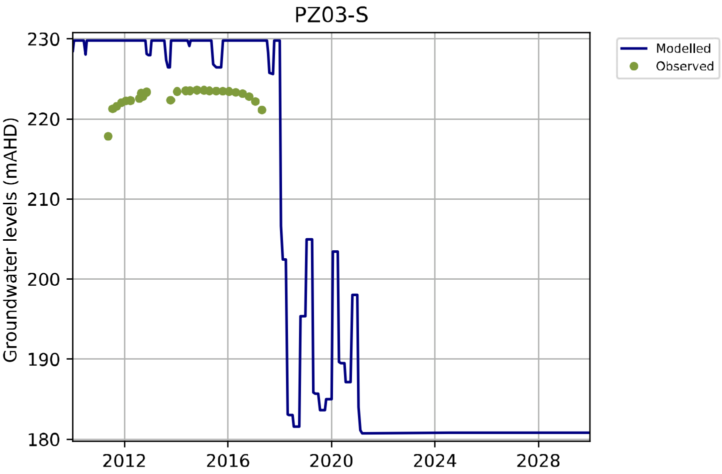

PZ02
Groundwater levels (mAHD)
Modelled
Observed
2012
2016
2020
2024
2028

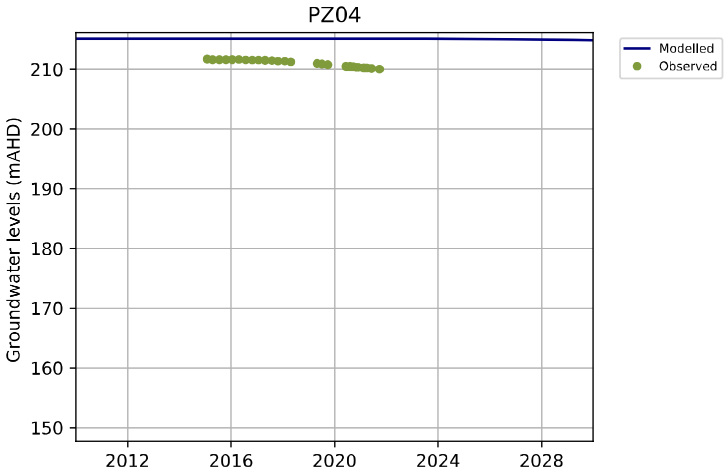

PZ02A
Groundwater levels (mAHD)
Modelled
Observed
2012
2016
2020
2024
2028

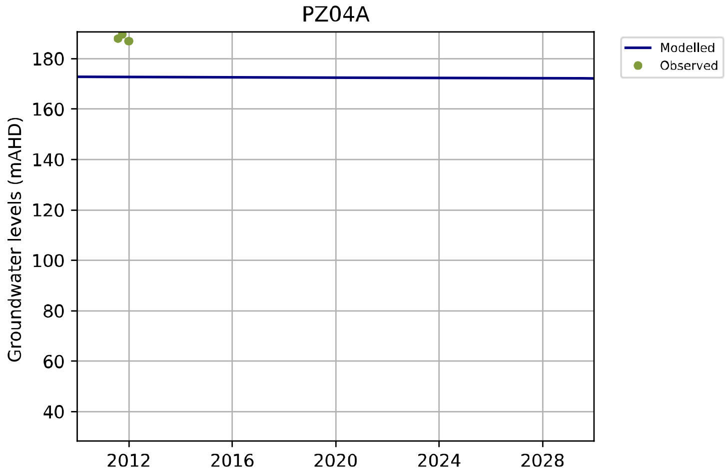

PZ02B
Groundwater levels (mAHD)
Modelled
Observed
2012
2016
2020
2024
2028

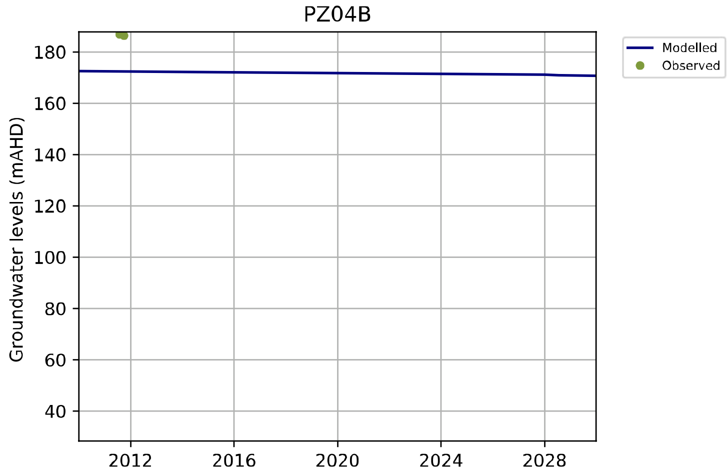

PZ02C
Groundwater levels (mAHD)
Modelled
Observed
2012
2016
2020
2024
2028

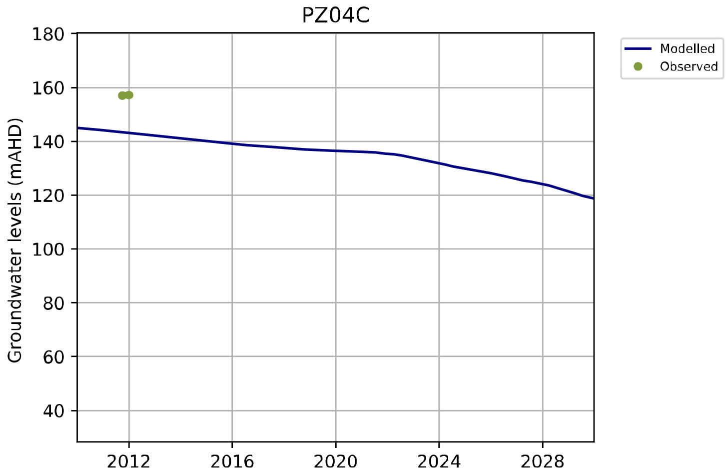

PZ03-D
Groundwater levels (mAHD)
Modelled
Observed
2012
2016
2020
2024
2028

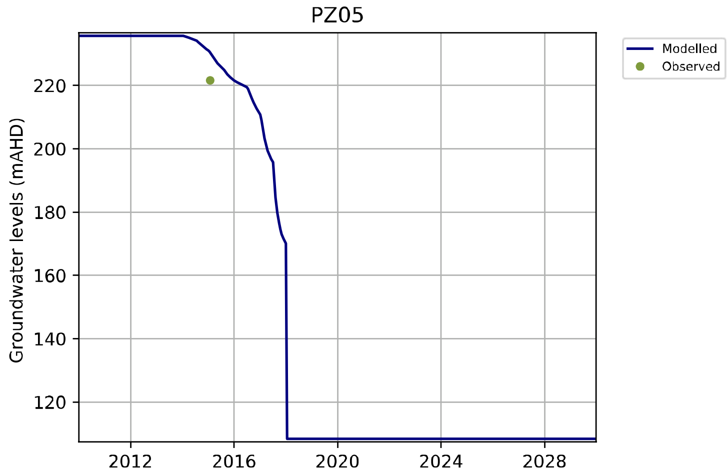

PZ03-S
Groundwater levels (mAHD)
Modelled
Observed
2012
2016
2020
2024
2028

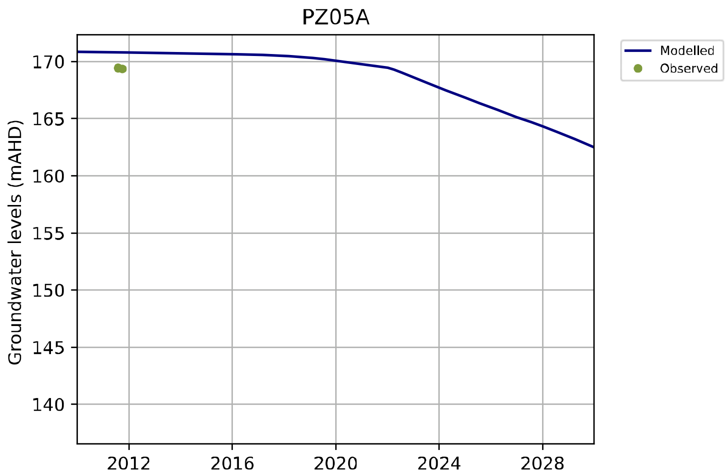

PZ04
Groundwater levels (mAHD)
Modelled
Observed
2012
2016
2020
2024
2028

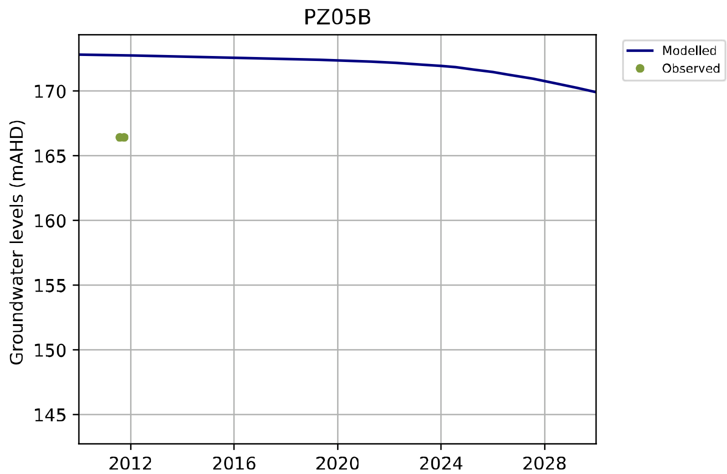

PZ04A
Groundwater levels (mAHD)
40
60
80
100
120
140
160
180
2012
2016
2020
2024
2028
Modelled
Observed

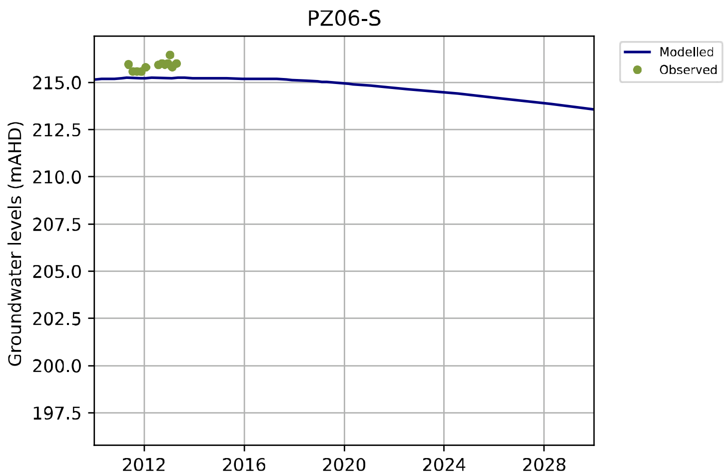

PZ04B
Groundwater levels (mAHD)
40
60
80
100
120
140
160
180
2012
2016
2020
2024
2028
Modelled
Observed

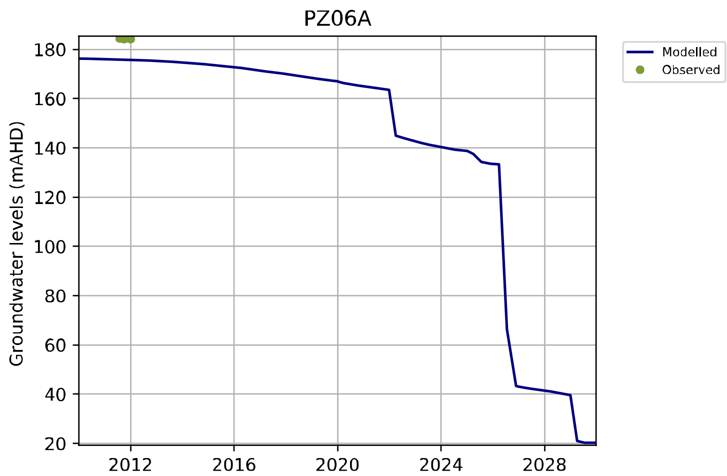

PZ04C
Groundwater levels (mAHD)
40
60
80
100
120
140
160
180
2012
2016
2020
2024
2028
Modelled
Observed

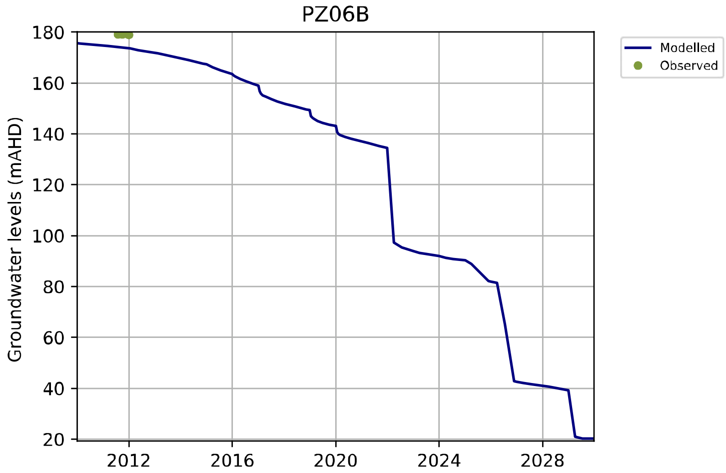

PZ05
Groundwater levels (mAHD)
120
140
160
180
200
220
2012
2016
2020
2024
2028
Modelled
Observed

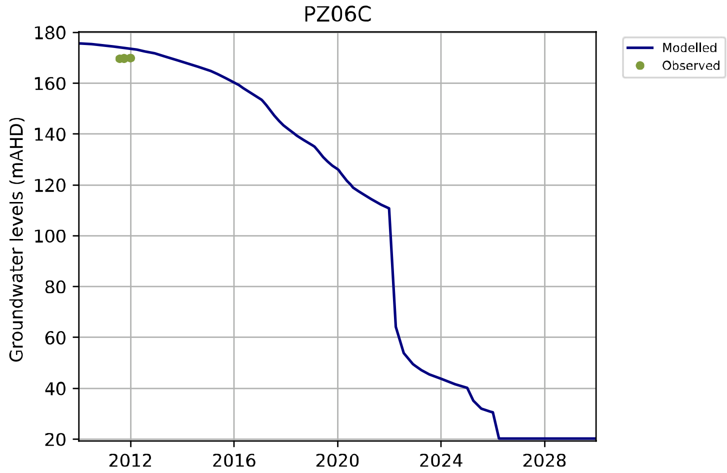

PZ05A
Groundwater levels (mAHD)
140
145
150
155
160
165
170
2012
2016
2020
2024
2028
Modelled
Observed

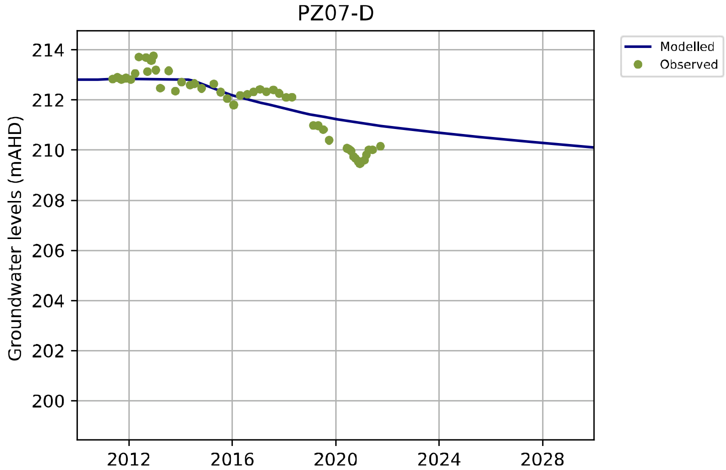

PZ05B
Groundwater levels (mAHD)
145
150
155
160
165
170
2012
2016
2020
2024
2028
Modelled
Observed

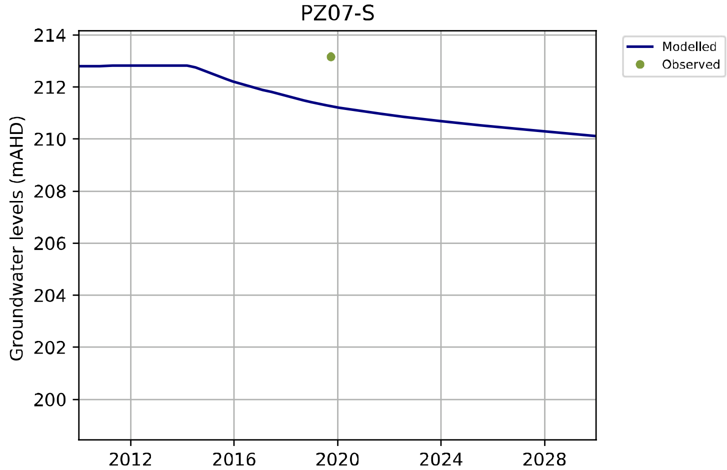

PZ06-S
Groundwater levels (mAHD)
197.5
200.0
202.5
205.0
207.5
210.0
212.5
215.0
2012
2016
2020
2024
2028
Modelled
Observed

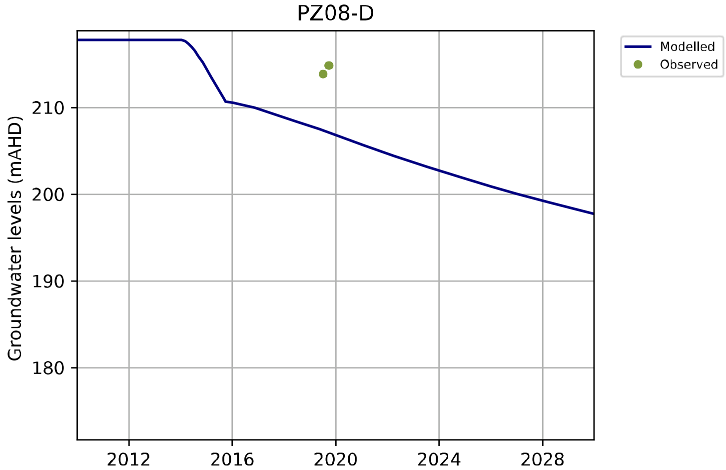

PZ06A
Groundwater levels (mAHD)
20
40
60
80
100
120
140
160
180
2012
2016
2020
2024
2028
Modelled
Observed

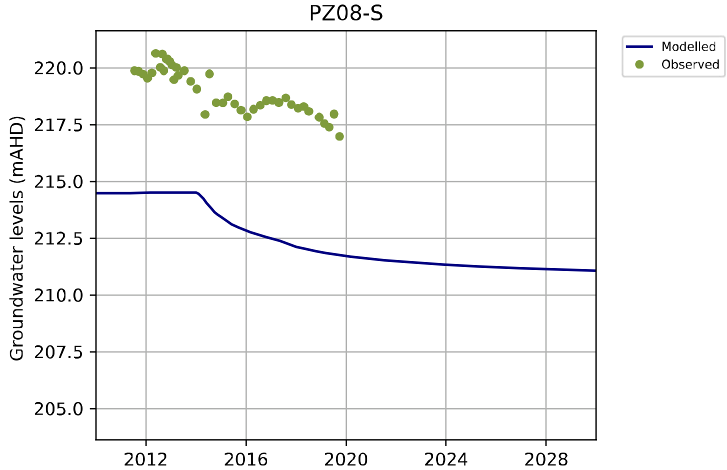

PZ06B
Groundwater levels (mAHD)
180
160
140
120
100
80
60
40
20
2012
2016
2020
2024
2028
Modelled
Observed

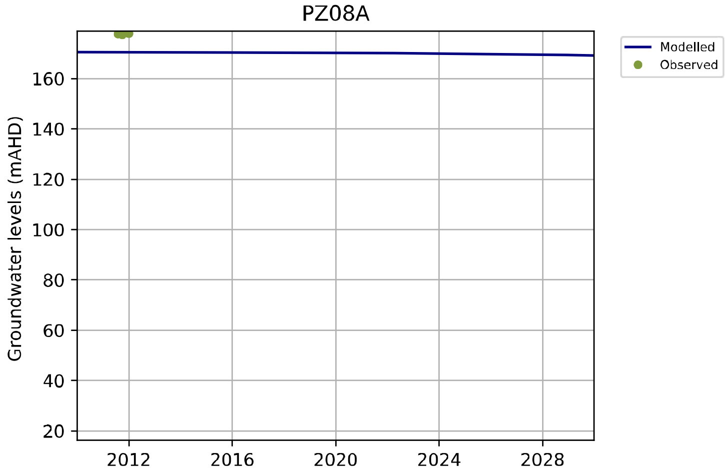

PZ06C
Groundwater levels (mAHD)
180
160
140
120
100
80
60
40
20
2012
2016
2020
2024
2028
Modelled
Observed

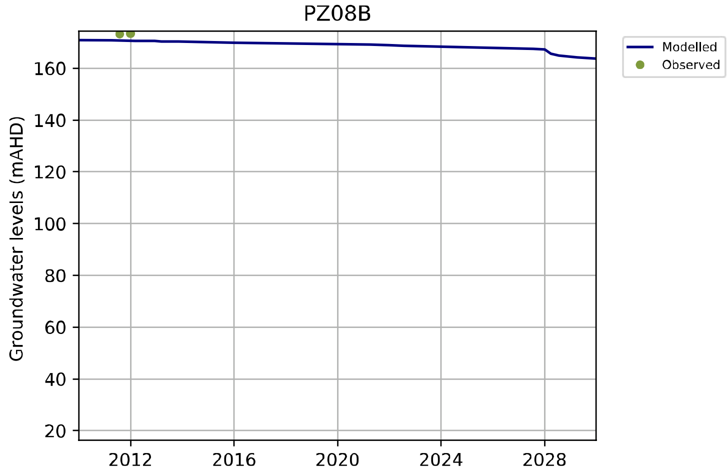

PZ07-D
Groundwater levels (mAHD)
214
212
210
208
206
204
202
200
2012
2016
2020
2024
2028
Modelled
Observed

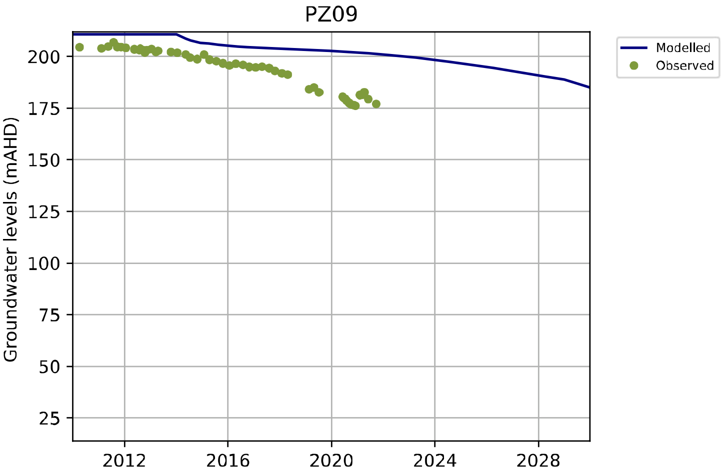

PZ07-S
Groundwater levels (mAHD)
214
212
210
208
206
204
202
200
2012
2016
2020
2024
2028
Modelled
Observed

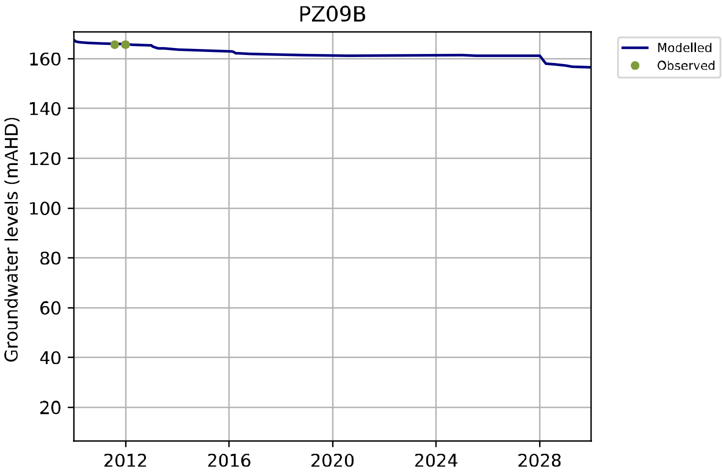

PZ08-D
Groundwater levels (mAHD)
210
200
190
180
2012
2016
2020
2024
2028
Modelled
Observed

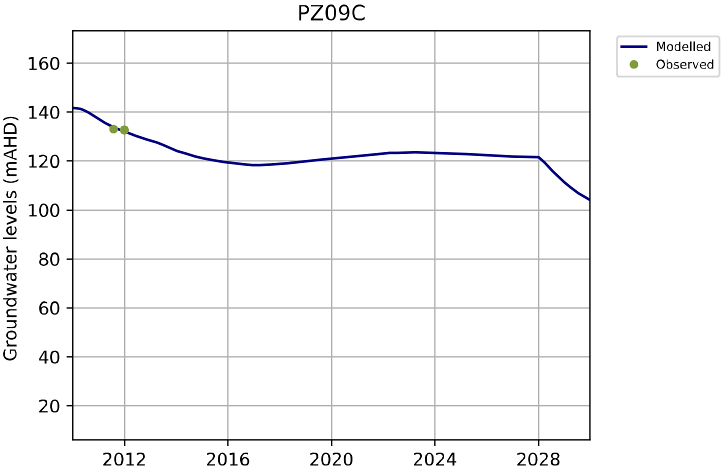

PZ08-S
Groundwater levels (mAHD)
220.0
217.5
215.0
212.5
210.0
207.5
205.0
2012
2016
2020
2024
2028
Modelled
Observed

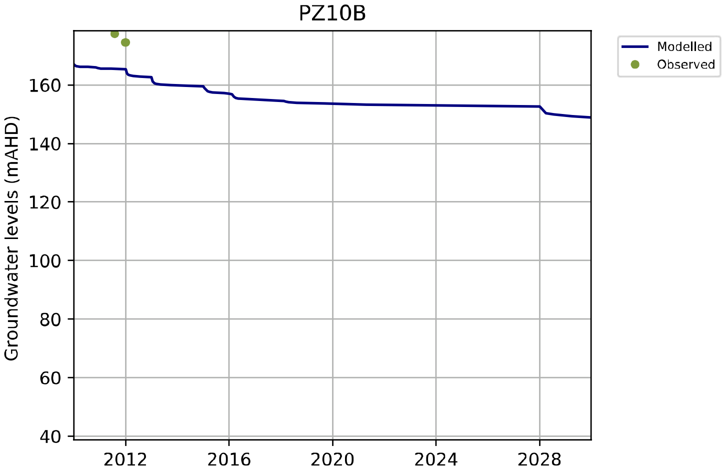

PZ08A
Groundwater levels (mAHD)
160
140
120
100
80
60
40
20
2012
2016
2020
2024
2028
Modelled
Observed

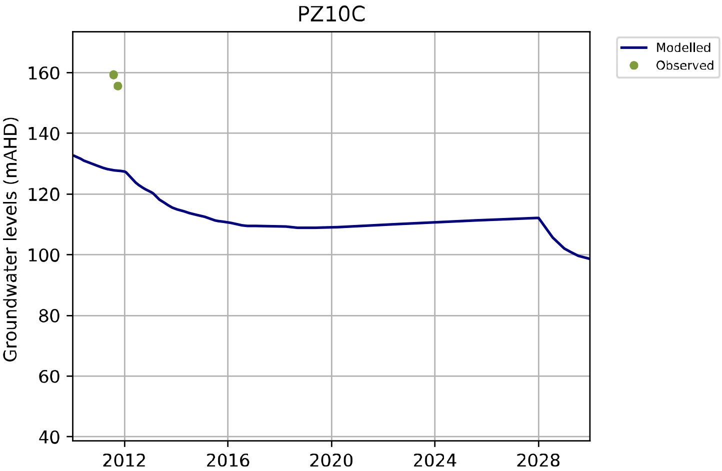

PZ08B
Groundwater levels (mAHD)
160
140
120
100
80
60
40
20
2012
2016
2020
2024
2028
Modelled
Observed

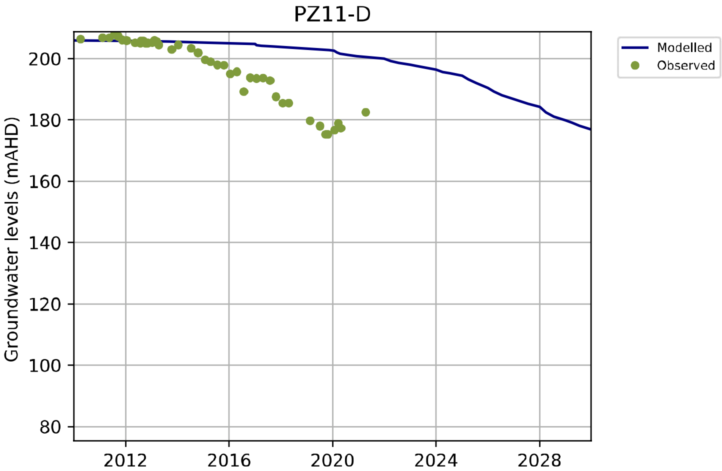

PZ09
Groundwater levels (mAHD)
200
175
150
125
100
75
50
25
2012
2016
2020
2024
2028
Modelled
Observed

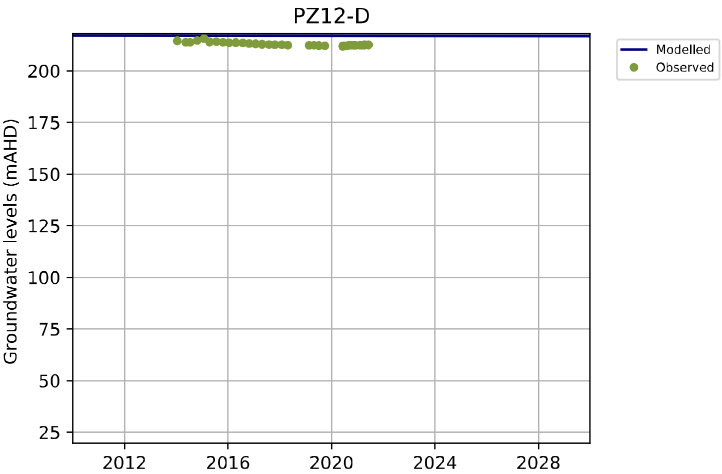

PZ09B
Groundwater levels (mAHD)
160
140
120
100
80
60
40
20
2012
2016
2020
2024
2028
Modelled
Observed

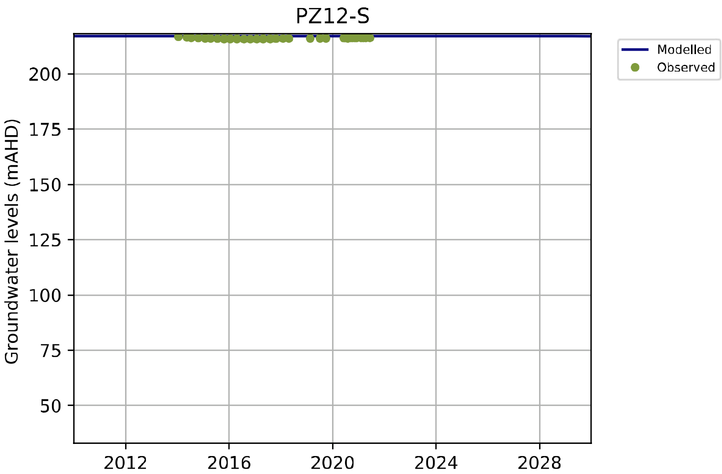

PZ09C
Groundwater levels (mAHD)
160
140
120
100
80
60
40
20
2012
2016
2020
2024
2028
Modelled
Observed

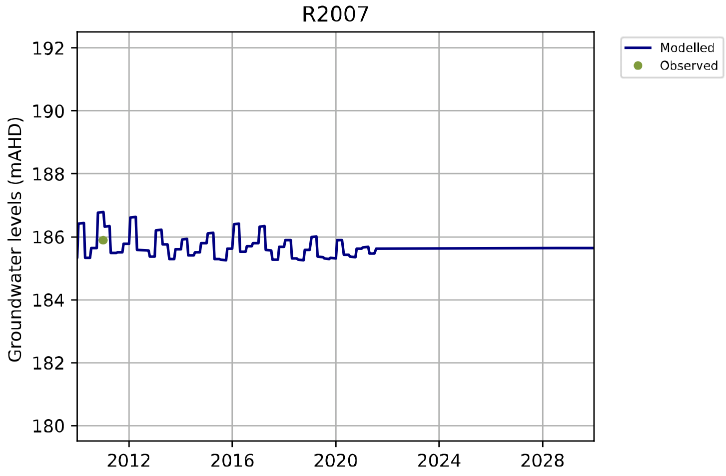

PZ10B
Groundwater levels (mAHD)
160
140
120
100
80
60
40
2012
2016
2020
2024
2028
Modelled
Observed

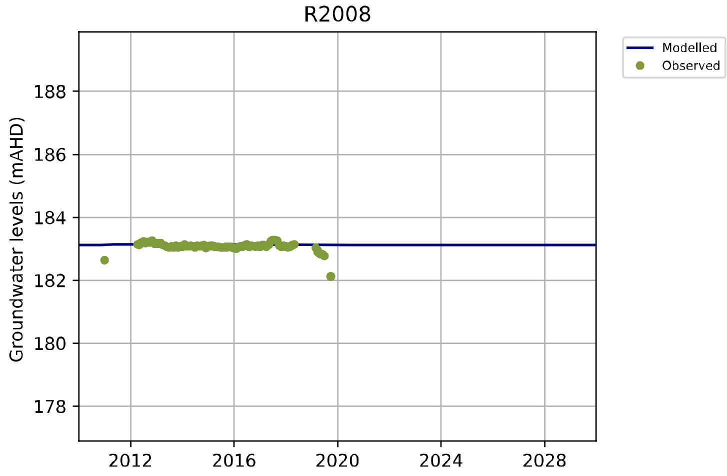

PZ10C
Groundwater levels (mAHD)
160
140
120
100
80
60
40
2012
2016
2020
2024
2028
Modelled
Observed

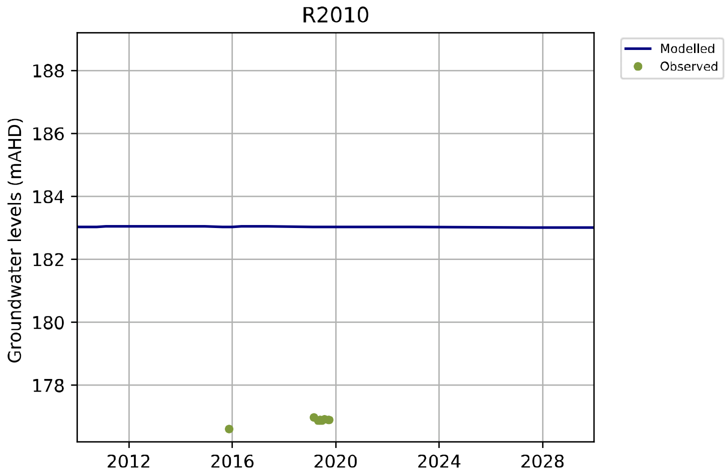

PZ11-D
Groundwater levels (mAHD)
200
180
160
140
120
100
80
2012
2016
2020
2024
2028
Modelled
Observed

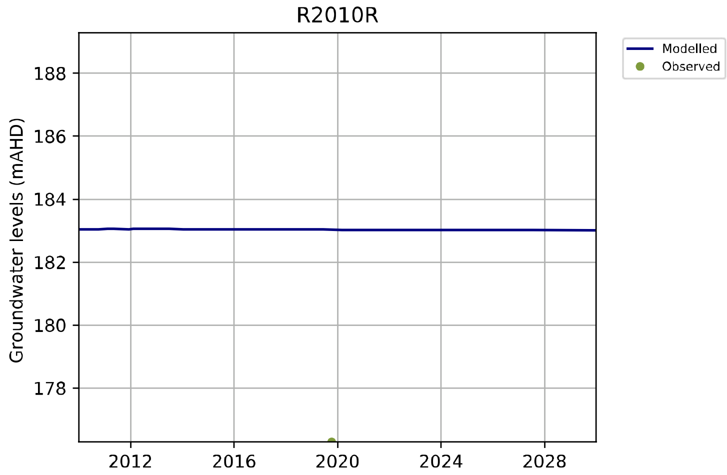

PZ12-D
Groundwater levels (mAHD)
200
175
150
125
100
75
50
25
2012
2016
2020
2024
2028
Modelled
Observed

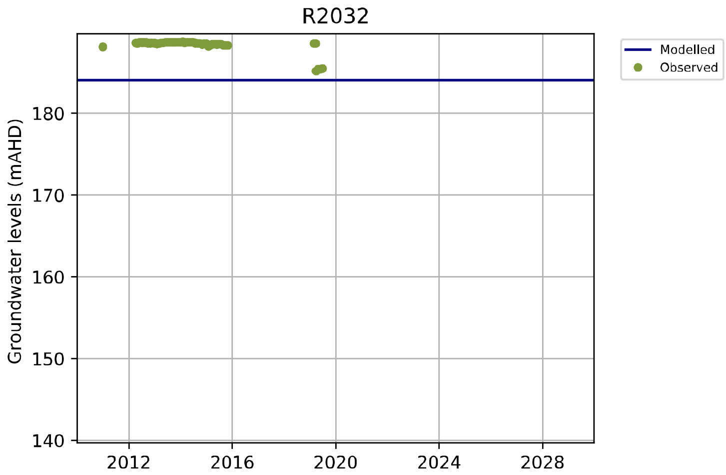

PZ12-S
Groundwater levels (mAHD)
200
175
150
125
100
75
50
2012
2016
2020
2024
2028
Modelled
Observed

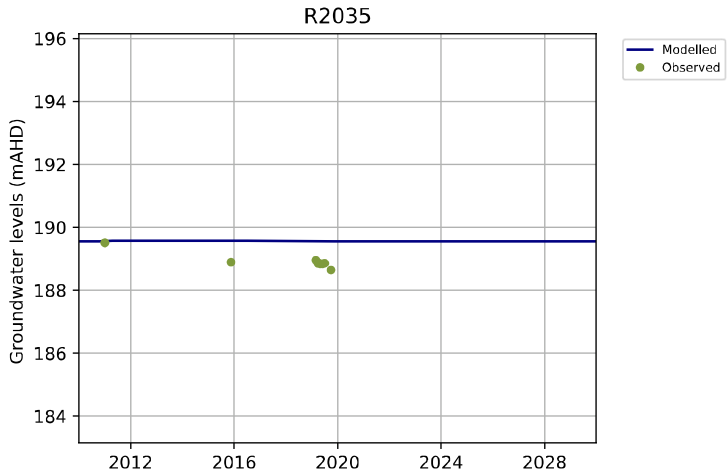

R2007
Groundwater levels (mAHD)
192
190
188
186
184
182
180
2012
2016
2020
2024
2028
Modelled
Observed

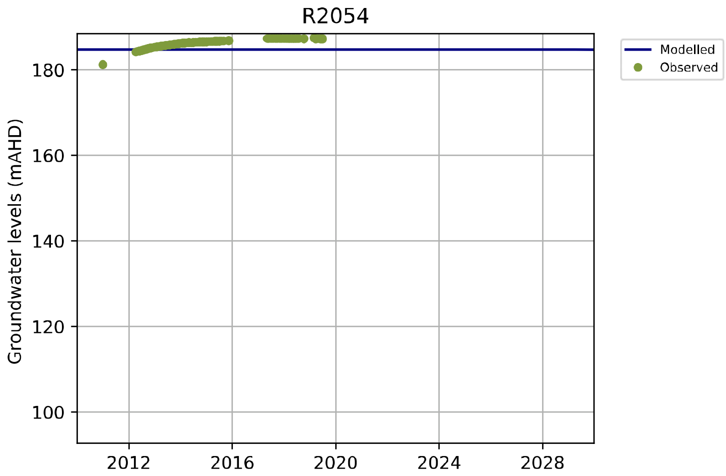

R2008
Groundwater levels (mAHD)
188
186
184
182
180
178
2012
2016
2020
2024
2028
Modelled
Observed

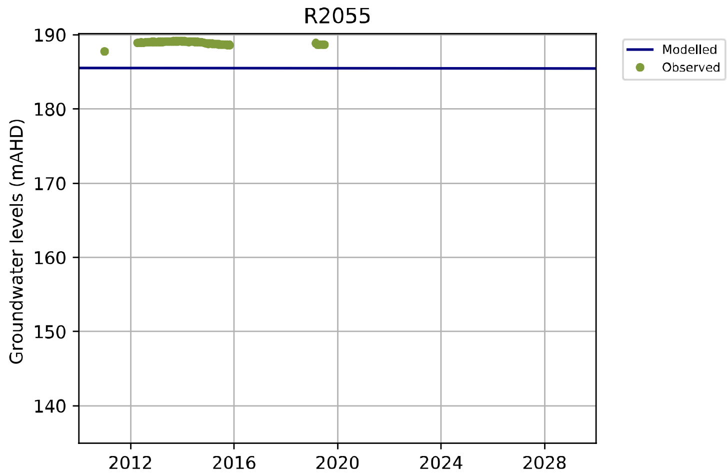

R2010
Groundwater levels (mAHD)
188
186
184
182
180
178
2012
2016
2020
2024
2028
Modelled
Observed

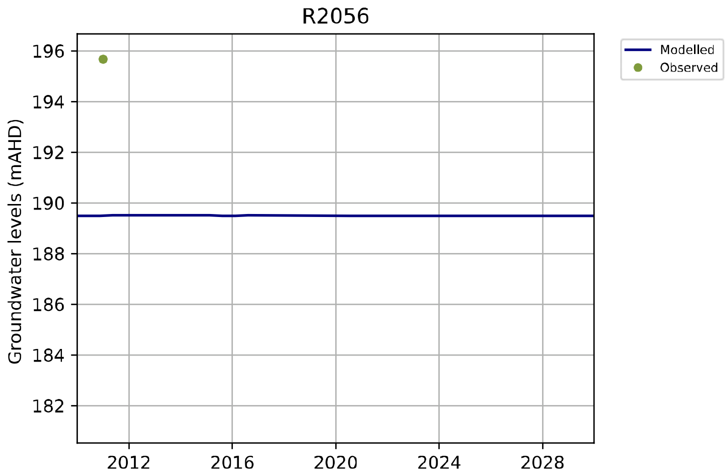

R2010R
Groundwater levels (mAHD)
188
186
184
182
180
178
2012
2016
2020
2024
2028
Modelled
Observed

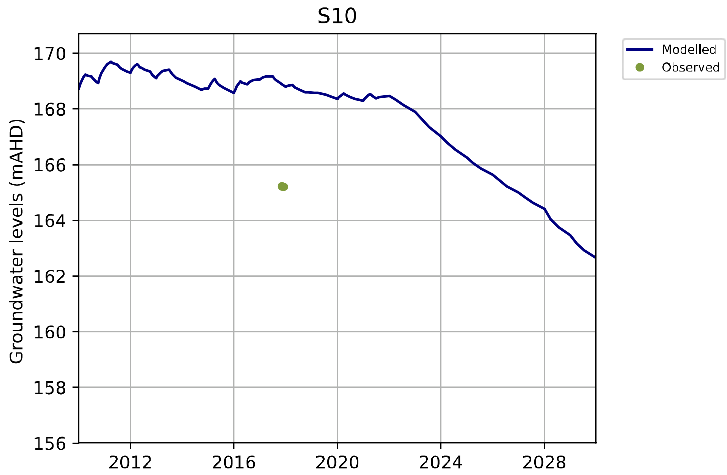

R2032
Groundwater levels (mAHD)
180
170
160
150
140
2012
2016
2020
2024
2028
Modelled
Observed

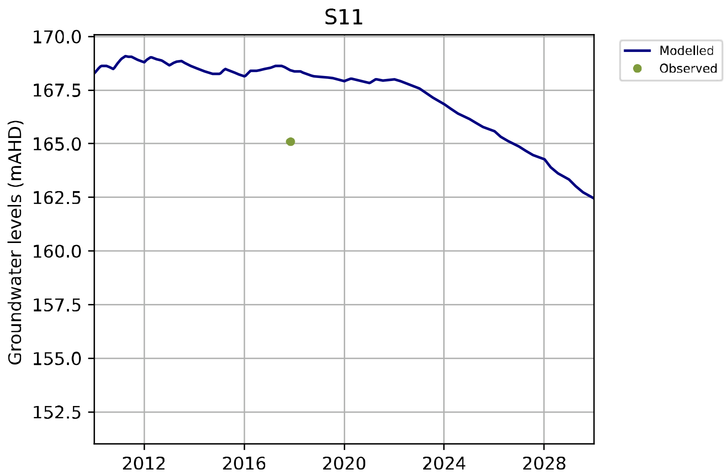

R2035
Groundwater levels (mAHD)
196
194
192
190
188
186
184
2012
2016
2020
2024
2028
Modelled
Observed

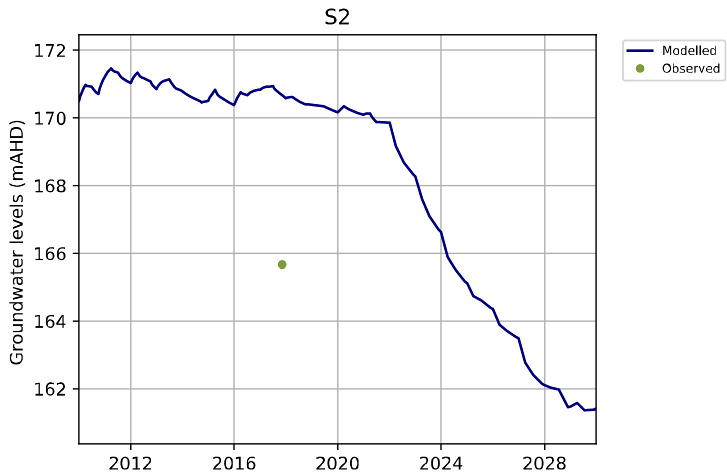

R2054
Groundwater levels (mAHD)
180
160
140
120
100
2012
2016
2020
2024
2028
Modelled
Observed

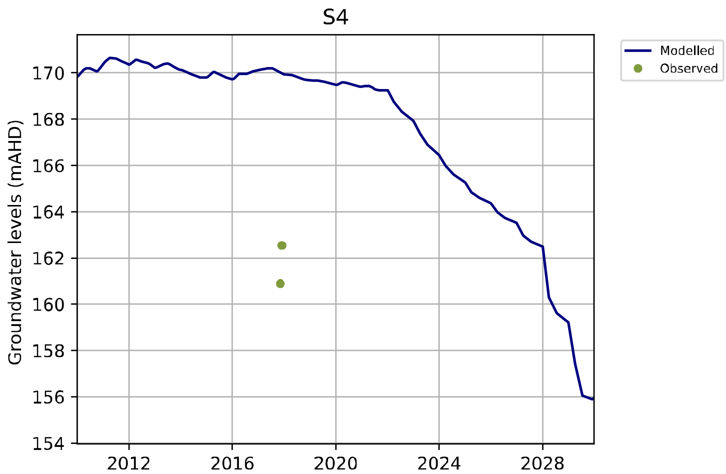

R2055
Groundwater levels (mAHD)
190
180
170
160
150
140
2012
2016
2020
2024
2028
Modelled
Observed

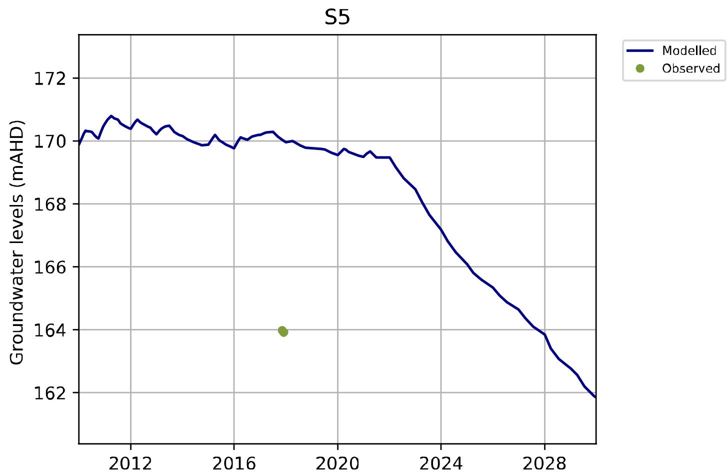

R2056
Groundwater levels (mAHD)
196
194
192
190
188
186
184
182
2012
2016
2020
2024
2028
Modelled
Observed

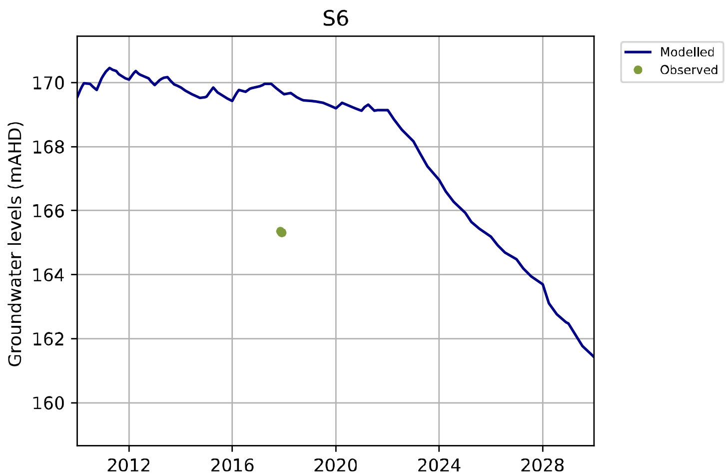

S10
Groundwater levels (mAHD)
170
168
166
164
162
160
158
156
2012
2016
2020
2024
2028
Modelled
Observed

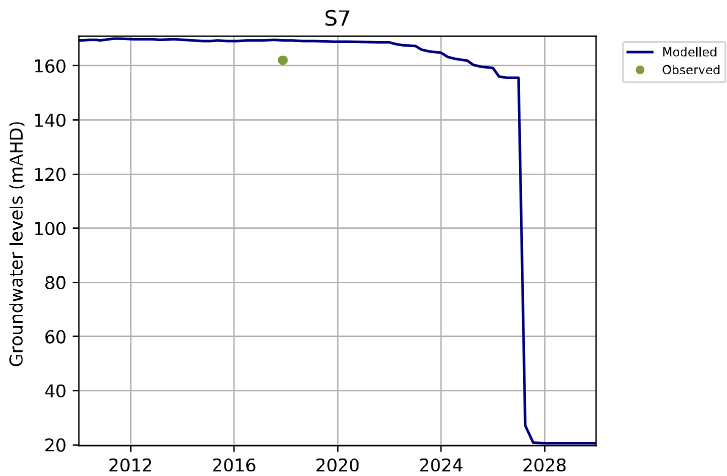

S11
Groundwater levels (mAHD)
170.0
167.5
165.0
162.5
160.0
157.5
155.0
152.5
2012
2016
2020
2024
2028
Modelled
Observed

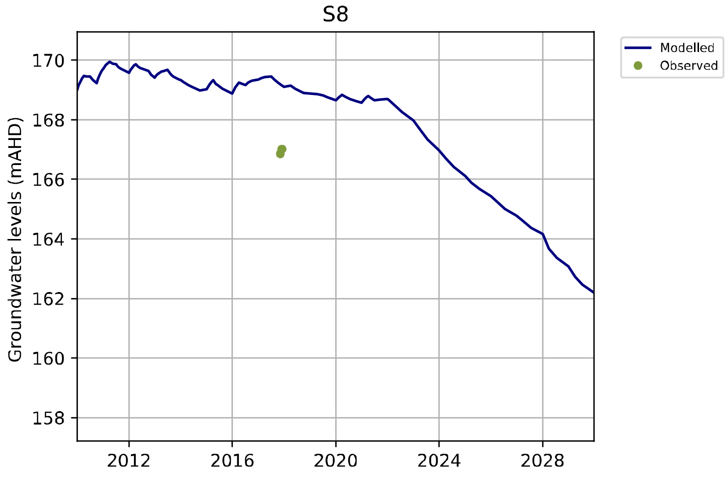

S2
Groundwater levels (mAHD)
172
170
168
166
164
162
2012
2016
2020
2024
2028
Modelled
Observed

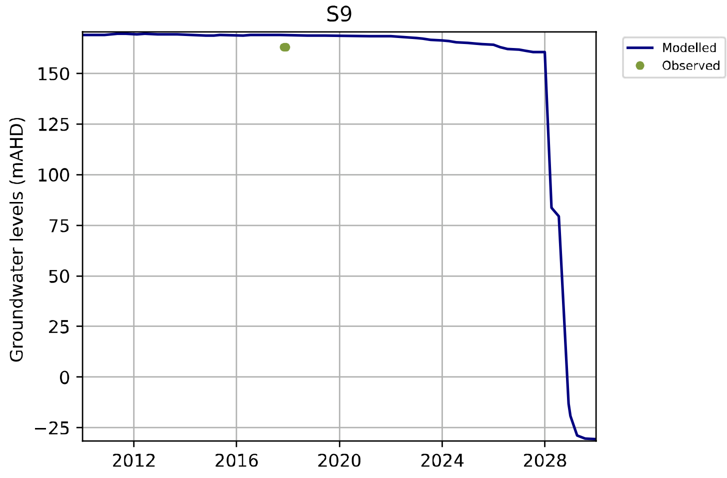

S4
Groundwater levels (mAHD)
170
168
166
164
162
160
158
156
154
2012
2016
2020
2024
2028
Modelled
Observed


S5
Groundwater levels (mAHD)
172
170
168
166
164
162
2012
2016
2020
2024
2028
Modelled
Observed

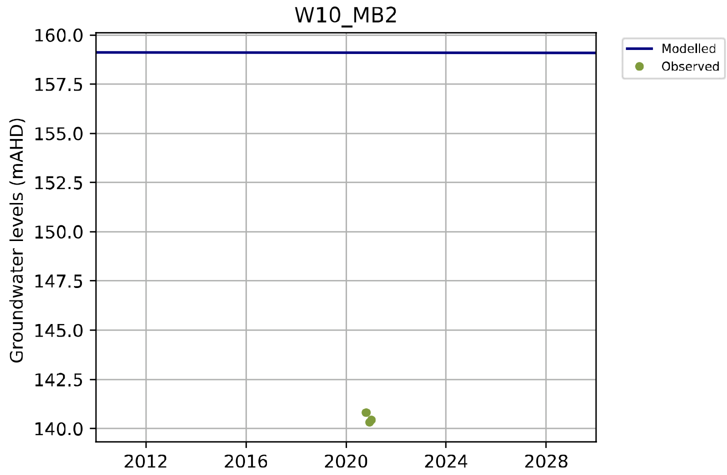

S6
Groundwater levels (mAHD)
170
168
166
164
162
160
2012
2016
2020
2024
2028
Modelled
Observed

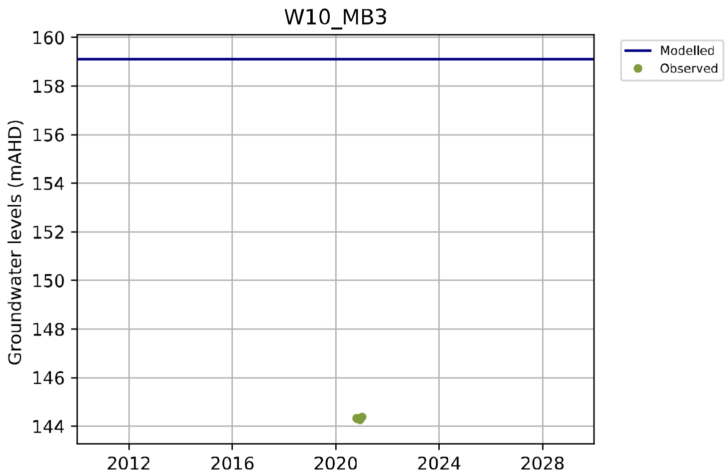

S7
Groundwater levels (mAHD)
160
140
120
100
80
60
40
20
2012
2016
2020
2024
2028
Modelled
Observed

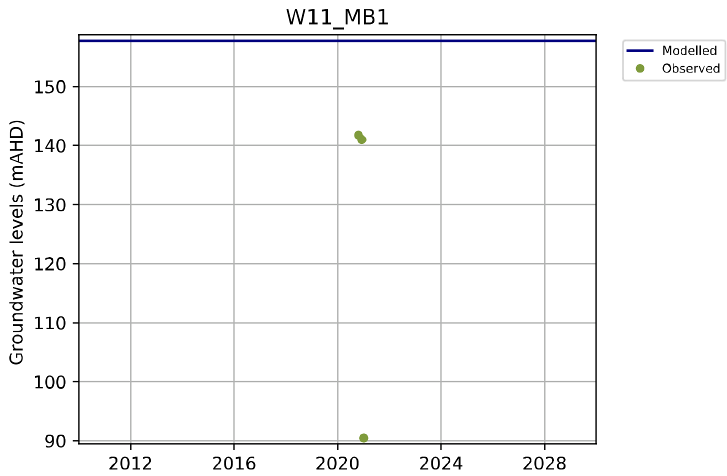

S8
Groundwater levels (mAHD)
170
168
166
164
162
160
158
2012
2016
2020
2024
2028
Modelled
Observed

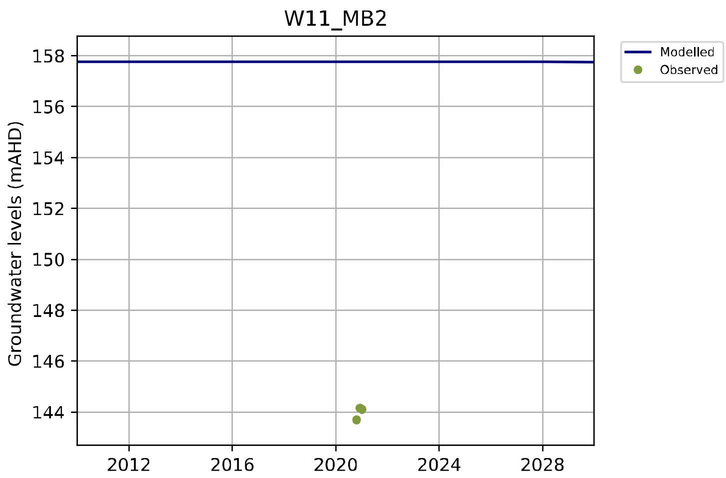

S9
Groundwater levels (mAHD)
150
125
100
75
50
25
0
−25
2012
2016
2020
2024
2028
Modelled
Observed

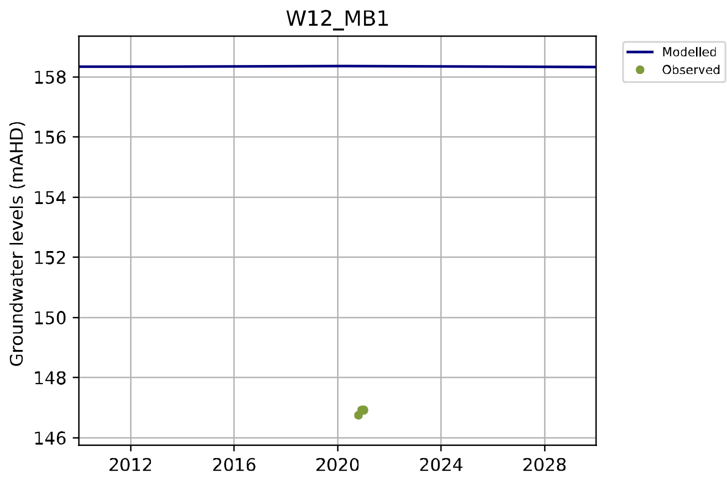

W10_MB1
Groundwater levels (mAHD)
160
158
156
154
152
150
148
146
2012
2016
2020
2024
2028
Modelled
Observed

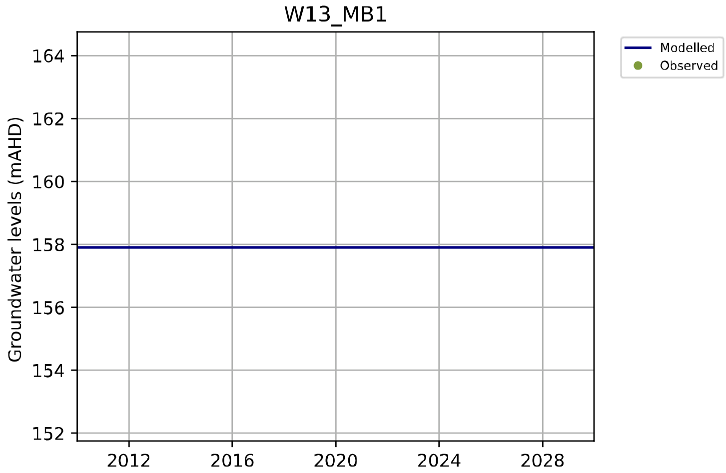

W10_MB2
Groundwater levels (mAHD)
160.0
157.5
155.0
152.5
150.0
147.5
145.0
142.5
140.0
2012
2016
2020
2024
2028
Modelled
Observed

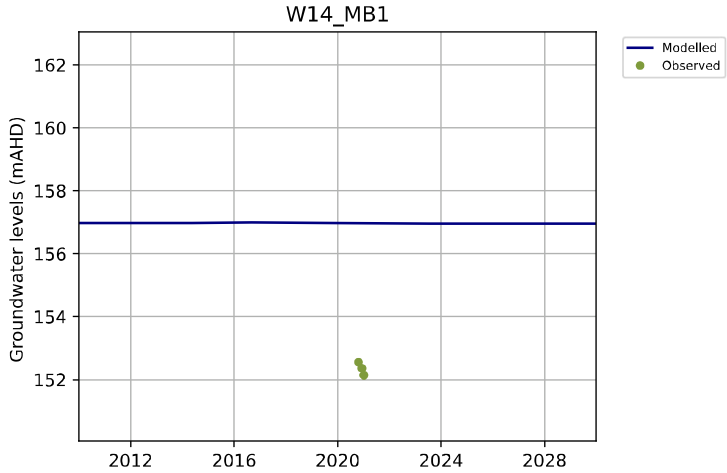

W10_MB3
Groundwater levels (mAHD)
160
158
156
154
152
150
148
146
144
2012
2016
2020
2024
2028
Modelled
Observed

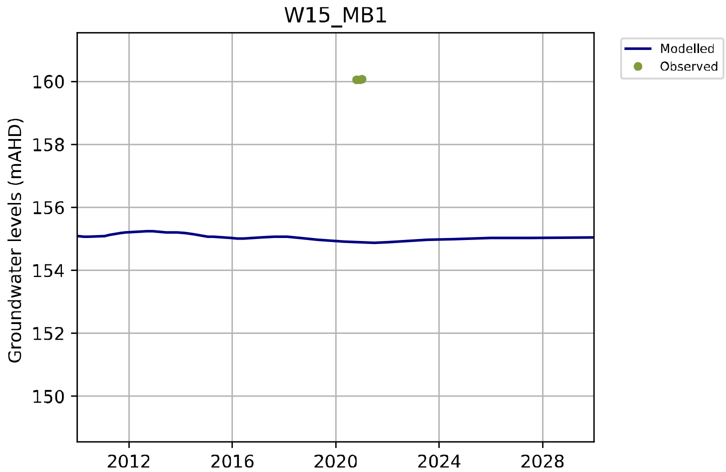

W11_MB1
Groundwater levels (mAHD)
150
140
130
120
110
100
90
2012
2016
2020
2024
2028
Modelled
Observed

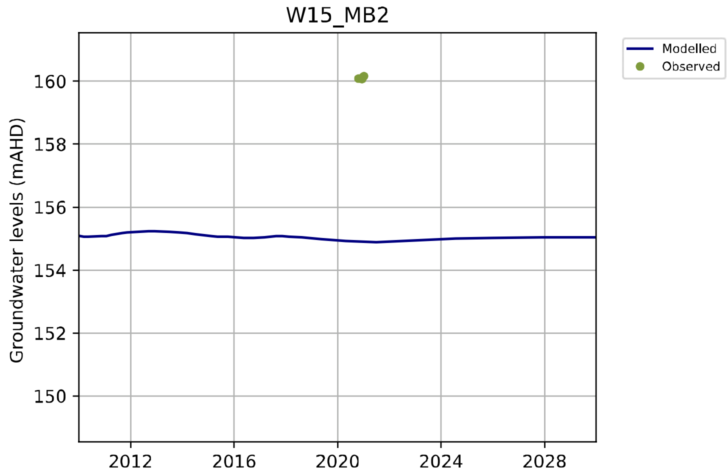

W11_MB2
Groundwater levels (mAHD)
158
156
154
152
150
148
146
144
2012
2016
2020
2024
2028
Modelled
Observed

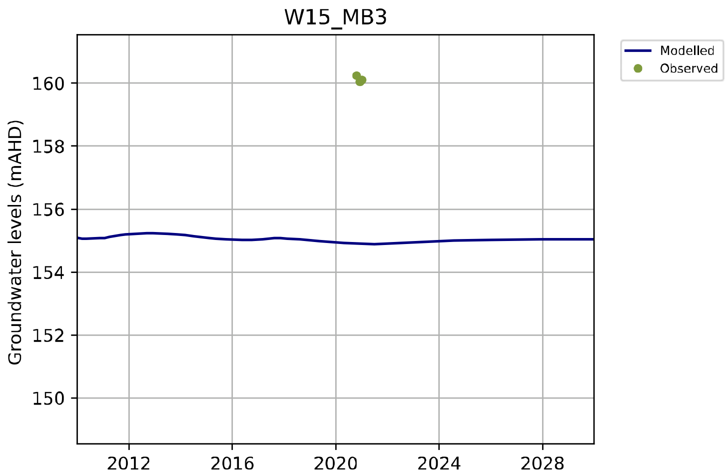

W12_MB1
Groundwater levels (mAHD)
158
156
154
152
150
148
146
2012
2016
2020
2024
2028
Modelled
Observed

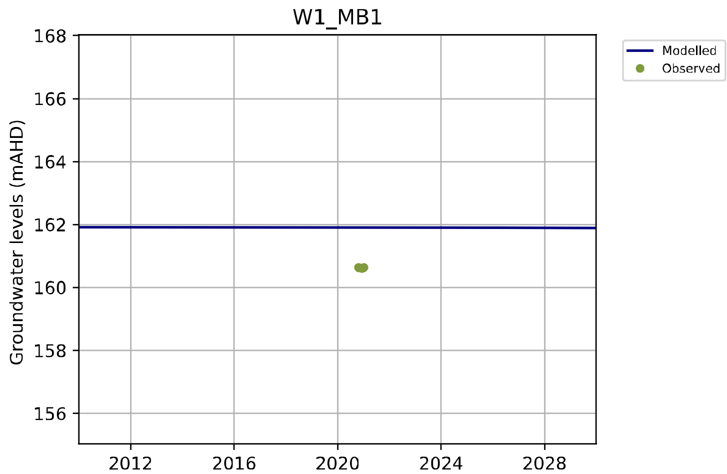

W13_MB1
Groundwater levels (mAHD)
164
162
160
158
156
154
152
2012
2016
2020
2024
2028
Modelled
Observed

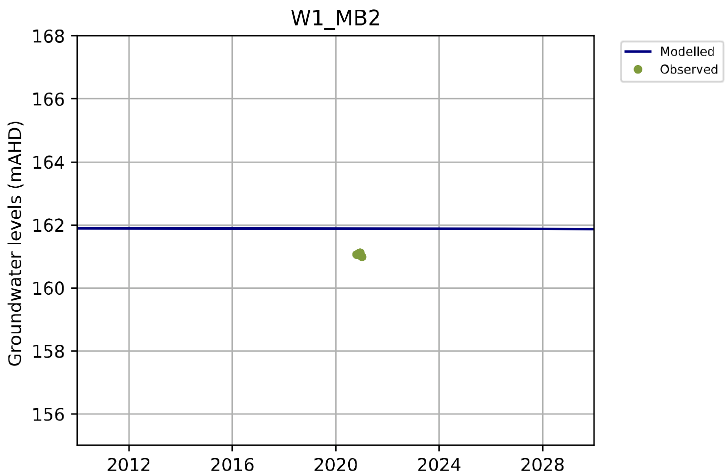

W14_MB1
Groundwater levels (mAHD)
162
160
158
156
154
152
2012
2016
2020
2024
2028
Modelled
Observed

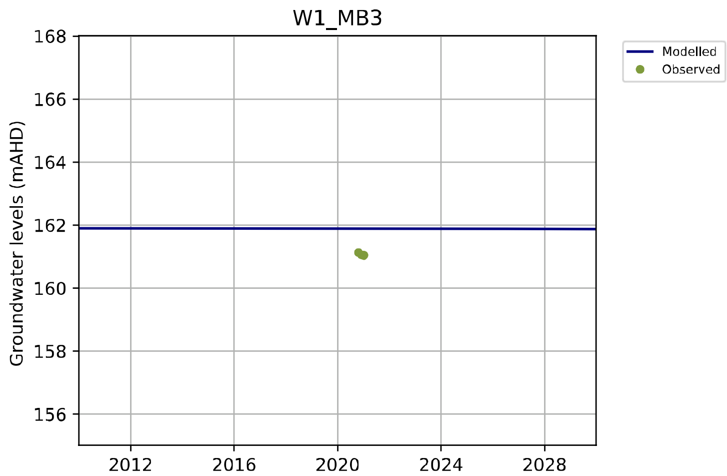

W15_MB1
Groundwater levels (mAHD)
160
158
156
154
152
150
2012
2016
2020
2024
2028
Modelled
Observed

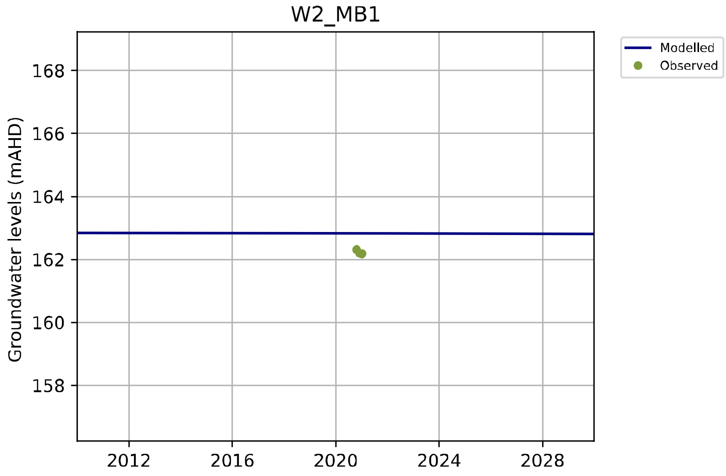

W15_MB2
Groundwater levels (mAHD)
160
158
156
154
152
150
2012
2016
2020
2024
2028
Modelled
Observed

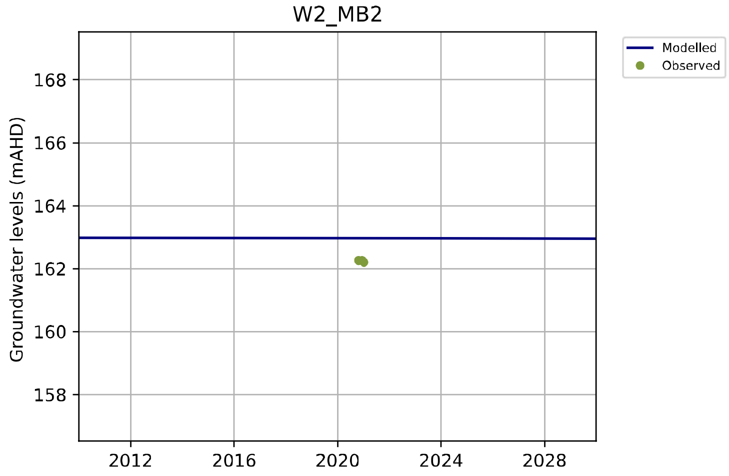

W15_MB3
Groundwater levels (mAHD)
160
158
156
154
152
150
2012
2016
2020
2024
2028
Modelled
Observed

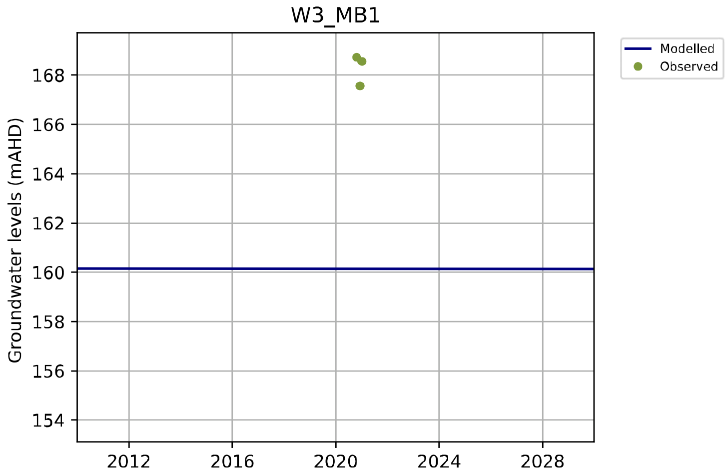

W1_MB1
Groundwater levels (mAHD)
168
166
164
162
160
158
156
2012
2016
2020
2024
2028
Modelled
Observed

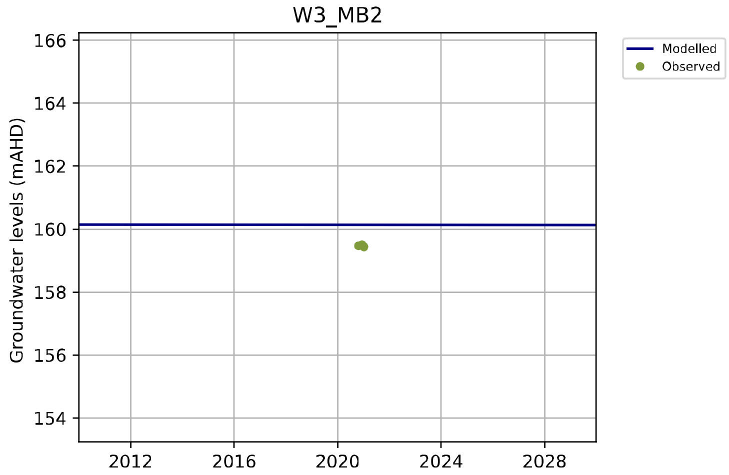

W1_MB2
Groundwater levels (mAHD)
168
166
164
162
160
158
156
2012
2016
2020
2024
2028
Modelled
Observed

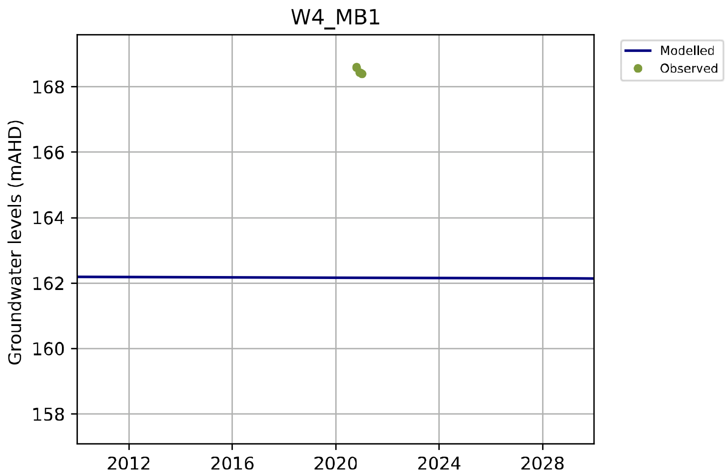

W1_MB3
Groundwater levels (mAHD)
168
166
164
162
160
158
156
2012
2016
2020
2024
2028
Modelled
Observed

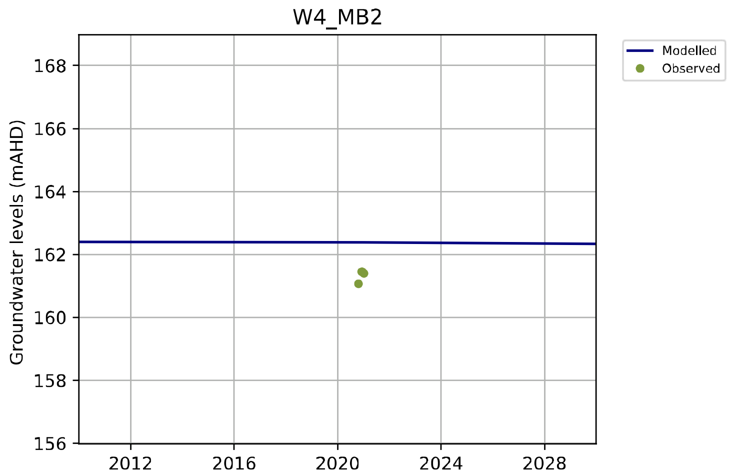

W2_MB1
Groundwater levels (mAHD)
Modelled
Observed
158 160 162 164 166 168
2012 2016 2020 2024 2028

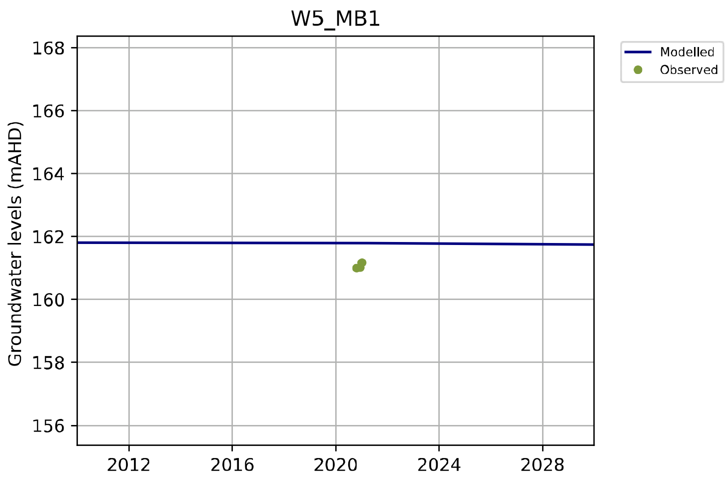

W2_MB2
Groundwater levels (mAHD)
Modelled
Observed
158 160 162 164 166 168
2012 2016 2020 2024 2028

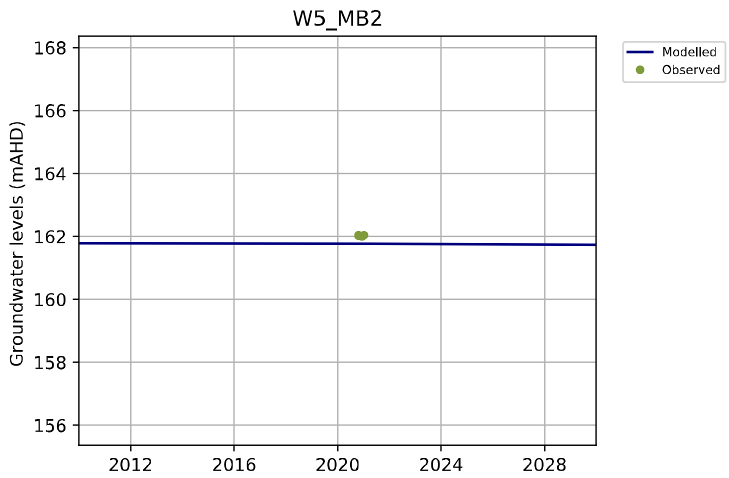

W3_MB1
Groundwater levels (mAHD)
Modelled
Observed
154 156 158 160 162 164 166 168
2012 2016 2020 2024 2028

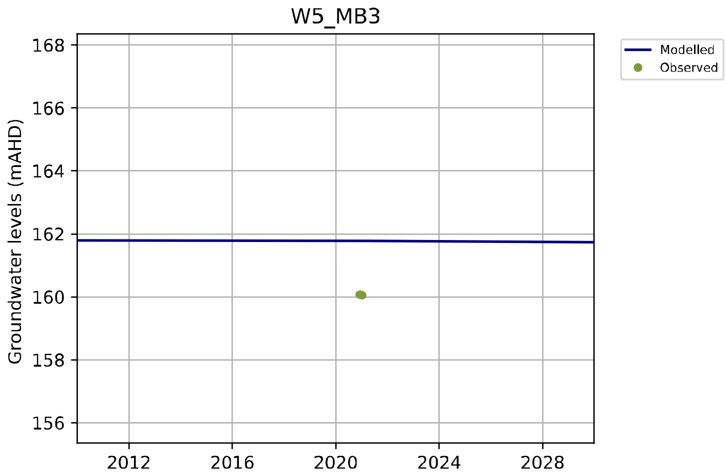

W3_MB2
Groundwater levels (mAHD)
Modelled
Observed
154 156 158 160 162 164 166
2012 2016 2020 2024 2028

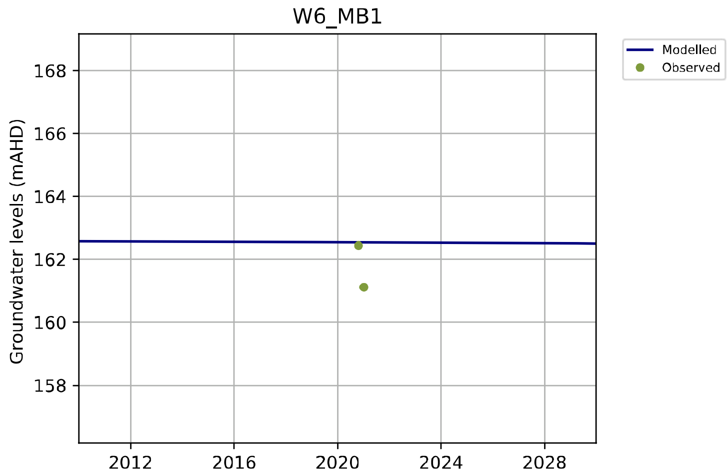

W4_MB1
Groundwater levels (mAHD)
Modelled
Observed
158 160 162 164 166 168
2012 2016 2020 2024 2028

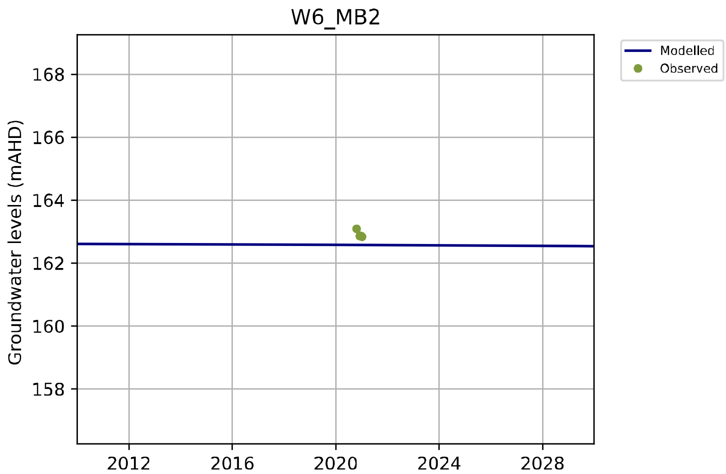

W4_MB2
Groundwater levels (mAHD)
Modelled
Observed
156 158 160 162 164 166 168
2012 2016 2020 2024 2028

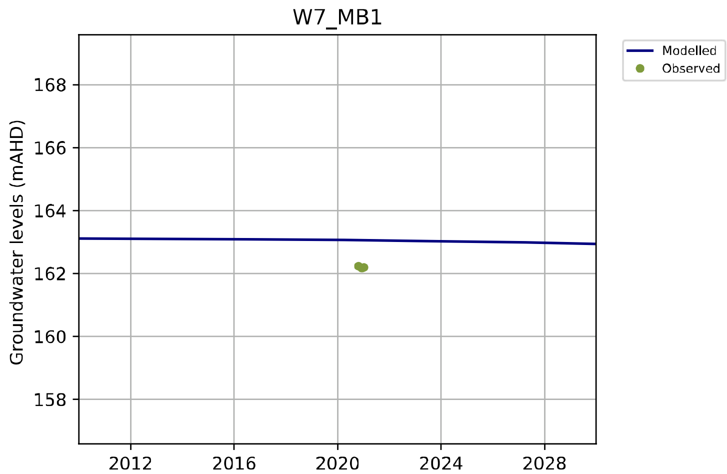

W5_MB1
Groundwater levels (mAHD)
Modelled
Observed
156 158 160 162 164 166 168
2012 2016 2020 2024 2028

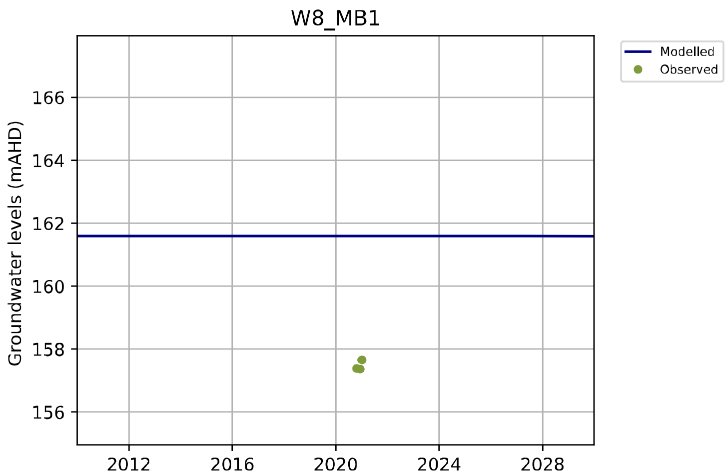

W5_MB2
Groundwater levels (mAHD)
Modelled
Observed
156 158 160 162 164 166 168
2012 2016 2020 2024 2028

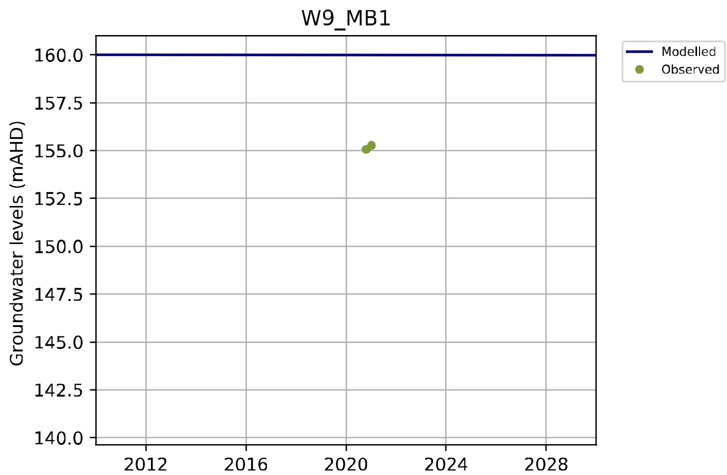

W5_MB3
Groundwater levels (mAHD)
Modelled
Observed
168
166
164
162
160
158
156
2012
2016
2020
2024
2028

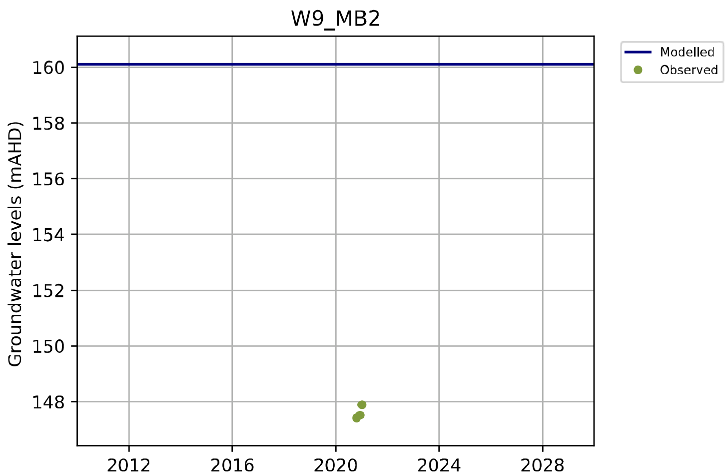

W6_MB1
Groundwater levels (mAHD)
Modelled
Observed
168
166
164
162
160
158
2012
2016
2020
2024
2028

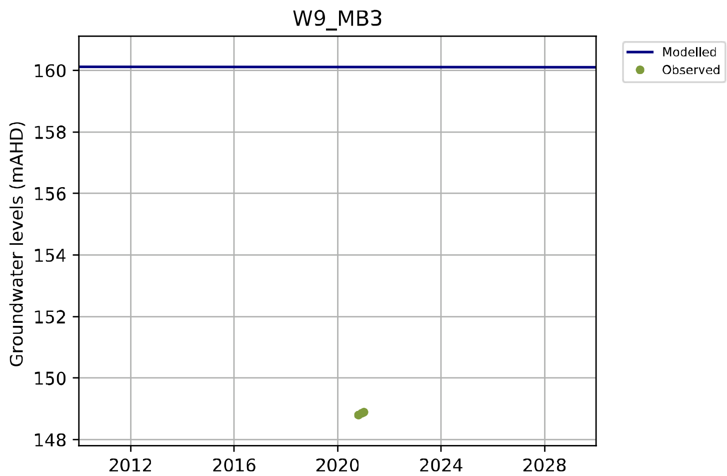

W6_MB2
Groundwater levels (mAHD)
Modelled
Observed
168
166
164
162
160
158
2012
2016
2020
2024
2028

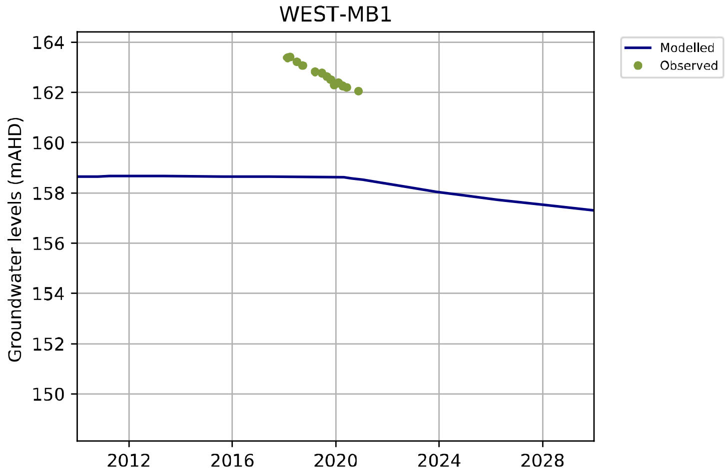

W7_MB1
Groundwater levels (mAHD)
Modelled
Observed
168
166
164
162
160
158
2012
2016
2020
2024
2028

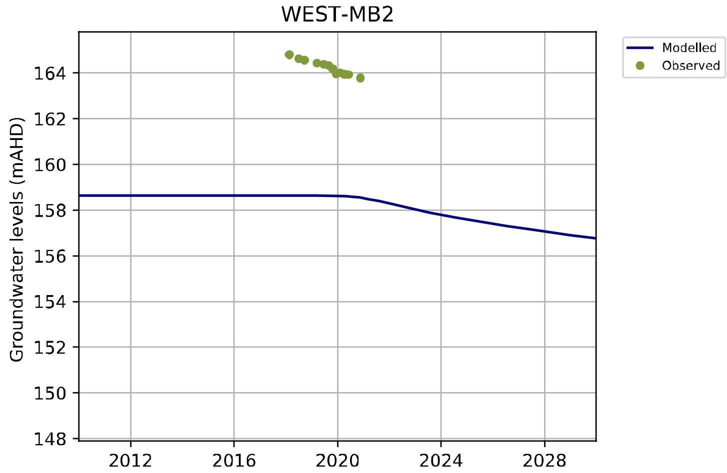

W8_MB1
Groundwater levels (mAHD)
Modelled
Observed
166
164
162
160
158
156
2012
2016
2020
2024
2028

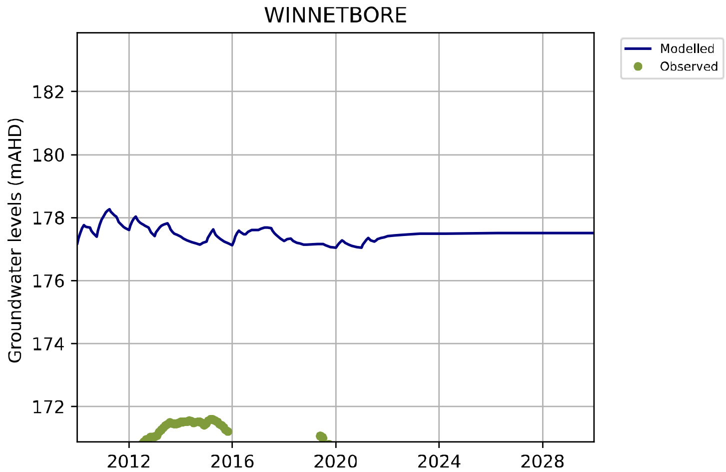

W9_MB1
Groundwater levels (mAHD)
Modelled
Observed
160.0
157.5
155.0
152.5
150.0
147.5
145.0
142.5
140.0
2012
2016
2020
2024
2028


W9_MB2
Groundwater levels (mAHD)
Modelled
Observed
160
158
156
154
152
150
148
2012
2016
2020
2024
2028


W9_MB3
Groundwater levels (mAHD)
Modelled
Observed
160
158
156
154
152
150
148
2012
2016
2020
2024
2028


WEST-MB1
Groundwater levels (mAHD)
164
162
160
158
156
154
152
150
2012
2016
2020
2024
2028
Modelled
Observed


WEST-MB2
Groundwater levels (mAHD)
164
162
160
158
156
154
152
150
148
2012
2016
2020
2024
2028
Modelled
Observed


WINNETBORE
Groundwater levels (mAHD)
182
180
178
176
174
172
2012
2016
2020
2024
2028
Modelled
Observed

Appendix E Model Calibration Results

Millennium Mine – Mavis South Extension Project

Supporting documentation to the Environmental Authority (EPML00819213) amendment application Mavis South Underground operations – Groundwater Impact Assessment: State considerations

MetRes Pty Ltd

SLR Project No.: 620.031508.00001

23 November 2023

ID	Easting	Northing	Layer	Average Residual	Min	Max
8	623737.3946	7552148.347	1	7.31	7.31	7.31
11	627188.9648	7546901.094	2	5.31	5.31	5.31
13	627188.9648	7546901.094	2	5.87	5.87	5.87
14	628766.4004	7546683.404	2	4.72	4.72	4.72
15	629073.6875	7546802	2	4.67	4.67	4.67
16	628769.4753	7544267.781	12	-0.41	-0.41	-0.41
7978	629578.1859	7556425.764	5	-0.40	-0.40	-0.40
7979	629689.1277	7559293.602	7	-4.54	-4.54	-4.54
7987	629690.2795	7559289.351	4	-4.43	-4.43	-4.43
7998	629571.2201	7556435.627	7	-0.50	-0.50	-0.50
37861	649155.3164	7504816.23	10	-27.42	-27.42	-27.42
38418	607248.0576	7539434.469	1	-37.83	-37.83	-37.83
43305	647097.5625	7516801.5	8	-23.73	-23.73	-23.73
43639	639103.25	7511121.5	14	28.75	28.75	28.75
44053	660370.3031	7501067.9	1	-21.56	-21.56	-21.56
44161	647450.2013	7540376.666	1	-1.10	-1.10	-1.10
44164	648115.0807	7540940.855	2	-3.65	-3.65	-3.65
44625	650582.0457	7509559.103	9	-30.94	-30.94	-30.94
67216	655336.9323	7526242.081	1	7.08	7.08	7.08
67217	656736.8125	7522643	1	1.32	1.32	1.32
67218	658580.3747	7521572.38	1	2.95	2.95	2.95
88525	671435.3921	7522100.821	2	-21.67	-21.67	-21.67
88526	671807.7678	7519924.798	2	-22.11	-22.11	-22.11
88527	665129.4118	7516176.231	1	-17.70	-17.70	-17.70
88528	664218.7603	7516696.885	9	-23.70	-23.70	-23.70
89454	653309.6733	7513657.399	9	-35.17	-35.17	-35.17
89469	648143.5054	7505736.868	12	-21.25	-21.25	-21.25
89470	647789.4059	7504136.418	1	11.81	11.81	11.81
90015	643819.3394	7503120.189	1	11.88	11.88	11.88
90074	671475.9644	7510752.076	12	-17.82	-17.82	-17.82
90076	672081.6655	7515564.249	15	-16.62	-16.62	-16.62
90480	652491.6784	7519640.534	8	-32.82	-32.82	-32.82
97180	654592.2966	7527231.739	1	-4.23	-4.23	-4.23
97181	656501.8342	7524052.534	1	-3.02	-3.02	-3.02
97182	657134.9241	7522439.104	1	-10.59	-10.59	-10.59
97183	657523.3135	7522193.752	1	-10.47	-10.47	-10.47
97184	659035.3125	7519506	1	-15.94	-15.94	-15.94
97185	659228.6875	7519277	1	-15.54	-15.54	-15.54

ID	Easting	Northing	Layer	Average Residual	Min	Max
105427	630273.9718	7570188.632	1	5.98	5.98	5.98
105435	616941.1565	7570650.87	1	0.35	0.35	0.35
105677	621765.412	7573512.506	1	-7.37	-7.37	-7.37
122458	644901.7914	7526815.746	8	-13.43	-13.43	-13.43
132627	649608.875	7525155.5	2	-11.07	-11.07	-11.07
136090	647462.1372	7540131.55	2	-2.05	-2.05	-2.05
136689	635788.3375	7528197	2	-7.81	-7.81	-7.81
141382	628829.6013	7542612.196	12	-4.79	-4.79	-4.79
141383	627386.2025	7549825.073	1	-16.41	-27.09	-15.62
141457	621765.412	7573512.506	1	-7.37	-7.37	-7.37
141458	622449.6604	7572911.906	1	-22.52	-22.52	-22.52
141655	659199.7364	7554627.402	7	-48.04	-48.04	-48.04
141656	659199.7364	7554627.402	2	15.63	15.63	15.63
141661	661844.8962	7553229.513	2	-4.95	-4.95	-4.95
141662	663205.3651	7552752.841	2	-4.64	-4.64	-4.64
141685	631576.4932	7557584.035	1	-5.29	-8.09	-3.25
141807	621765.412	7573512.506	1	-28.22	-30.23	-26.97
141808	621108.3143	7572355.691	1	11.35	11.35	11.35
141864	622449.6604	7572911.906	1	-25.38	-32.98	-18.26
141865	622449.6604	7572911.906	1	-17.28	-17.28	-17.28
141942	607522.8344	7569986.876	1	-7.23	-7.23	-7.23
141943	606971.75	7570095.5	1	-5.86	-5.86	-5.86
141944	611267.6915	7567392.013	1	-9.91	-9.91	-9.91
141945	604893.1279	7569821.132	1	-2.76	-2.76	-2.76
141950	608867.9663	7570898.385	1	-4.16	-4.16	-4.16
141975	632803.125	7558463.5	2	6.64	6.64	6.64
141976	632803.125	7558463.5	2	-4.47	-4.47	-4.47
141978	632403.125	7558463.5	2	-4.86	-4.86	-4.86
141981	621765.412	7573512.506	1	-4.67	-4.67	-4.67
158010	642563.4484	7519965.658	9	3.52	3.52	3.52
158011	639767.081	7514036.276	12	8.91	8.91	8.91
158484	648132.9602	7524037.518	2	-4.71	-4.71	-4.71
158485	643191	7521957	9	1.68	1.68	1.68
161572	671961.6658	7538284.655	2	-14.91	-14.91	-14.91
161573	671961.6658	7538284.655	2	-14.14	-14.14	-14.14
161578	672603.2647	7534937.262	2	-11.17	-11.17	-11.17
162011	622449.6604	7572911.906	1	-6.87	-6.87	-6.87
162012	622449.6604	7572911.906	1	-9.11	-9.11	-9.11
162013	621853.6688	7572146.281	4	-9.43	-18.29	-6.56

ID	Easting	Northing	Layer	Average Residual	Min	Max
162014	622449.6604	7572911.906	1	-9.82	-9.82	-9.82
162016	621108.3143	7572355.691	2	8.77	8.77	8.77
162017	621108.3143	7572355.691	2	8.58	8.58	8.58
162020	621765.412	7573512.506	2	-8.00	-8.00	-8.00
162041	621765.412	7573512.506	1	-24.87	-31.39	-18.70
162043	613172.8348	7559686.886	2	7.63	7.63	7.63
162044	615450.6678	7560778.892	2	-4.07	-4.07	-4.07
162046	618525.3948	7557341.384	10	-0.98	-0.98	-0.98
162068	605991.6563	7571115.375	1	-11.49	-11.49	-11.49
162070	605991.6563	7571115.375	1	-12.09	-12.09	-12.09
162071	605868.5234	7570957.781	1	-11.78	-11.78	-11.78
162138	620332.0364	7547431.576	12	-4.88	-4.88	-4.88
162141	613758.4101	7562281.922	1	-0.36	-0.36	-0.36
162145	614924.0725	7551010.377	10	-2.91	-2.91	-2.91
162163	609756.5059	7560097.391	18	-6.57	-9.62	9.14
162164	608381.8125	7558287.5	1	-1.37	-5.93	12.21
162165	608881.8125	7556728.5	2	-1.85	-7.24	2.28
162166	608881.8125	7556728.5	18	-8.40	-10.15	-2.64
162167	610681.8125	7555343	13	-5.40	-6.11	-4.83
162168	608881.8125	7554130.5	2	-11.86	-12.43	-11.47
162169	611151.985	7551712.071	2	1.36	1.07	1.95
162170	611151.985	7551712.071	13	-2.43	-2.46	-2.42
162171	612399.1753	7550558.933	1	-0.92	-0.98	-0.81
162172	612399.1753	7550558.933	13	-0.49	-1.78	1.51
162173	611258.8125	7549492.5	2	6.61	1.00	12.64
162174	611258.8125	7549492.5	17	-10.62	-12.03	-9.59
162175	614308.8125	7548886.5	13	-6.27	-12.52	-2.09
162177	616874.75	7547722	14	-5.39	-13.54	-1.38
162234	629629.1875	7559274.5	5	-0.89	-0.89	-0.89
162235	629629.1875	7559274.5	5	-4.55	-4.55	-4.55
162236	629629.1875	7556503.5	5	-0.40	-0.40	-0.40
162472	635703.125	7554999.5	10	-11.12	-11.49	-10.31
162504	610681.8125	7557248	1	-0.12	-0.49	0.89
162505	610731.8125	7557161.5	1	-1.78	-2.97	0.29
162547	618541.5	7570555.268	3	-9.64	-9.73	-9.37
162548	619108.5376	7568572.905	3	1.17	0.86	1.55
162549	619280.5625	7567287	1	8.57	7.41	9.02
162550	620153.8772	7567512.354	2	6.86	6.22	7.08
162551	619117.8354	7572855.171	3	-4.94	-5.35	-4.18

ID	Easting	Northing	Layer	Average Residual	Min	Max
162552	618859.0049	7571994.664	3	-6.32	-6.88	-5.73
162565	617422.5316	7568836.283	10	0.55	-13.95	8.95
162682	641132.5	7546549.5	1	-7.33	-7.87	-7.16
162684	642541.9375	7547447.5	1	-3.84	-4.18	-3.46
162806	611083.8193	7562798.135	1	7.75	7.75	7.75
162810	620182.3004	7573345.369	1	-9.42	-10.20	-8.77
162811	621902.4566	7569056.383	1	5.82	4.77	6.87
162812	621902.4566	7569056.383	1	7.24	6.29	7.46
162839	631207.9375	7564740	1	-10.71	-10.71	-10.71
162841	639747.1875	7558334.5	1	-13.10	-17.49	-8.71
165325	640162.4162	7515909.058	12	7.00	7.00	7.00
182077	618952.1713	7571336.241	3	-8.47	-8.74	-8.18
182078	619779.3501	7568171.601	2	-2.21	-10.95	2.71
182079	619779.3501	7568171.601	2	3.33	2.88	3.72
182080	619675.345	7567400.161	2	6.13	5.99	6.25
182390	616511.75	7571966.5	1	-21.12	-21.77	-20.22
182391	616511.75	7571966.5	1	-45.36	-49.15	-35.09
182392	616511.75	7571966.5	1	-20.22	-21.08	-19.44
13040180	667717.0043	7516307.632	1	-17.95	-20.18	-16.53
13040181	667921.1897	7515910.951	1	-16.69	-16.69	-16.69
13040183	668841.3851	7514638.248	1	-18.50	-18.50	-18.50
13040184	669753.8703	7514366.093	1	-19.13	-19.13	-19.13
13040282	604808.0163	7545951.137	1	-2.44	-2.82	-2.08
13040283	628126.072	7527314.101	1	-19.88	-22.36	-17.09
13040284	620410.653	7566201.768	1	11.95	10.33	12.70
13040286	660288.7563	7536948.699	2	-27.57	-28.19	-27.13
1235C-VWP1	650028	7522291.5	4	-18.12	-19.12	-10.73
1235C-VWP2	650028	7522291.5	5	-20.46	-24.08	-19.66
1235C-VWP3	650028	7522291.5	6	-22.04	-23.69	-20.82
1235C-VWP4	650028	7522291.5	7	-36.00	-39.69	-21.56
1238-MB1	651060.4905	7523437.585	2	-11.03	-11.20	-10.80
1238-MB2	651060.4905	7523437.585	7	-18.35	-18.63	-18.08
2183-VWP1	644147.5625	7520525.5	4	-14.95	-15.18	-14.80
2183-VWP2	644147.5625	7520525.5	5	-6.59	-8.21	-4.44
2183-VWP3	644147.5625	7520525.5	6	-25.43	-26.47	-24.36
2183-VWP4	644147.5625	7520525.5	7	-18.00	-20.01	-14.95
2218-MB2	645658.9181	7522957.668	3	-5.79	-6.62	-4.94
2218-MB3	645658.9181	7522957.668	5	-6.13	-6.53	-5.65
2218-VWP1	645658.9181	7522957.668	5	-7.40	-8.73	-6.86

ID	Easting	Northing	Layer	Average Residual	Min	Max
2218-VWP2	645658.9181	7522957.668	6	-10.47	-10.93	-10.21
2218-VWP3	645658.9181	7522957.668	7	-9.62	-11.07	-8.96
2218-VWP4	645658.9181	7522957.668	7	-5.46	-6.46	-4.45
2226-MB2	643155.5	7522152	3	1.06	0.43	1.60
2226-MB3	643155.5	7522152	5	-2.20	-2.46	-2.02
2226-VWP1	643155.5	7522152	4	2.25	1.91	2.53
2226-VWP2	643155.5	7522152	5	-3.14	-4.34	-2.24
2226-VWP3	643155.5	7522152	6	-4.57	-5.19	-3.93
2226-VWP4	643155.5	7522152	7	-6.42	-6.53	-6.26
2372-MB1	647627.6875	7526233	2	-11.25	-11.47	-11.08
2372-MB2	647627.6875	7526233	2	-11.49	-16.80	-10.79
2372-MB3	647627.6875	7526233	7	-10.46	-12.03	-10.12
2372-VWP1	647627.6875	7526233	6	-9.52	-10.75	-7.76
2372-VWP2	647627.6875	7526233	7	-10.68	-11.92	-9.65
2372-VWP3	647627.6875	7526233	8	-12.73	-14.12	-9.74
2372-VWP4	647627.6875	7526233	8	-11.49	-12.02	-9.28
2375-MB2	648277.6735	7524041.774	7	-12.89	-13.01	-12.75
2375-VWP1	648132.9602	7524037.518	6	-13.21	-13.68	-11.22
2375-VWP2	648132.9602	7524037.518	7	-14.87	-16.07	-14.44
2375-VWP3	648132.9602	7524037.518	8	-16.09	-16.51	-15.90
2393-MB1	645912.7621	7523272.005	2	-3.40	-3.98	-3.00
2393-MB2	645912.7621	7523272.005	5	-5.51	-5.89	-5.08
2393-MB3	645912.7621	7523272.005	7	-5.83	-6.36	-5.04
2394-MB1	645129.0591	7523210.212	1	-8.09	-8.21	-7.96
2394-MB2	645129.0591	7523210.212	3	-5.87	-7.21	-3.33
BMB	639477	7560278	7	-18.54	-32.33	-7.23
BORE2	634831.6865	7550006.294	1	-6.10	-6.10	-6.10
BORE3	634831.6865	7550006.294	10	-6.15	-6.15	-6.15
BORE5	631340.9327	7560011.498	9	-23.13	-24.24	-21.74
BORE7	637929.8975	7552627.657	9	-6.82	-6.82	-6.82
BULLOCK_P	635987.4167	7528216.167	10	0.57	0.57	0.57
C2105	634696.75	7541900.5	5	-7.10	-8.57	-6.90
C2105R	634646.75	7541814	5	-7.54	-7.54	-7.54
C2136	631696.75	7547270	5	-14.44	-14.72	-14.21
CATTLE_CG	670695.3607	7537205.711	17	4.33	4.33	4.33
DAUNIAPZ01	632533.9997	7561905	8	-3.12	-4.36	-2.17
DAUNIAPZ02	635299.9995	7560237	5	-14.51	-18.15	-11.24
DAUNIAPZ03	632331.9998	7558326	8	-9.69	-11.38	-0.01
DAUNIAPZ04	635531.0001	7554554	4	-11.33	-20.63	-7.28

ID	Easting	Northing	Layer	Average Residual	Min	Max
DAUNIAPZ05	632575.9997	7561914	8	-5.33	-5.89	-4.98
DAUNIAPZ06	631776.0004	7561217	7	1.01	-6.60	4.65
DAUNIAPZ07	631627.0001	7559539	9	-5.73	-6.62	-4.84
G2304	633246.75	7543199.5	7	-13.99	-13.99	-13.99
G2304R	633246.75	7543199.5	7	-13.83	-13.83	-13.83
G2307	630846.75	7547876	7	-13.32	-13.41	-13.09
GW01D_P1	642541.9375	7547447.5	7	-8.34	-9.48	-7.02
GW01D_P2	642541.9375	7547447.5	5	-12.09	-12.91	-10.73
GW01D_P3	642541.9375	7547447.5	3	-6.61	-6.89	-6.12
GW01D_P4	642541.9375	7547447.5	3	-4.43	-4.58	-3.72
GW01S	642541.9375	7547447.5	1	-3.01	-3.29	-2.82
GW02D	641132.5	7546549.5	7	-7.43	-7.54	-7.39
GW02S	641132.5	7546549.5	1	-7.44	-7.50	-7.36
GW06D_P1	639142.2963	7542125.12	11	9.32	9.00	9.71
GW06D_P2	639142.2963	7542125.12	10	0.38	-0.13	0.84
GW06D_P3	639142.2963	7542125.12	10	-0.02	-0.25	0.17
GW06D_P4	639142.2963	7542125.12	9	-4.42	-5.19	-2.29
GW08D_P1	645167.2285	7539812.215	5	-12.18	-14.97	-10.63
GW08D_P2	645167.2285	7539812.215	4	-6.58	-6.81	-6.41
GW08D_P3	645167.2285	7539812.215	3	0.03	-0.02	0.12
GW08D_P4	645167.2285	7539812.215	3	-32.20	-38.16	-24.35
GW12D_P1	641632.5903	7532921.709	5	-0.28	-1.44	4.20
GW12D_P2	641632.5903	7532921.709	5	-5.17	-6.05	-3.81
GW12D_P3	641632.5903	7532921.709	4	13.18	10.29	14.38
GW12D_P4	641632.5903	7532921.709	3	32.65	31.71	34.53
GW12S	641632.5903	7532921.709	2	-4.22	-4.24	-4.21
GW16D_P1	660840.125	7525340.5	7	-27.32	-28.71	-23.43
GW16D_P2	660840.125	7525340.5	5	-15.34	-15.41	-15.25
GW16D_P3	660840.125	7525340.5	3	-15.00	-15.21	-14.77
GW16D_P4	660840.125	7525340.5	3	-14.31	-14.47	-14.13
GW18D	656879.3891	7522786.573	7	-8.35	-8.37	-8.33
GW18S	656879.3891	7522786.573	1	-7.78	-7.93	-7.66
GW21D	661701.8437	7521537.173	9	-17.94	-17.96	-17.93
GW21S	661701.8437	7521537.173	2	2.64	2.50	2.80
GW8S	645167.2285	7539812.215	1	-3.62	-3.70	-3.55
KNOBHILL1	631021	7553963	1	-3.38	-3.68	-3.18
KNOBHILL2	630446.375	7554123.5	1	-0.25	-0.86	0.99
LAKEV3	648132.9602	7524037.518	2	3.54	3.54	3.54
LH13	627188.9648	7546901.094	2	7.61	3.65	8.72

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LV2370W	648277.6735	7524041.774	2	-3.20	-5.10	12.53
LV2371W	643155.5	7522152	2	3.45	2.74	4.37
MB08PZ1	615840.5003	7559226.227	14	-14.82	-14.82	-14.82
MB08PZ2	615840.5003	7559226.227	14	-14.96	-14.96	-14.96
MB08PZ3	615840.5003	7559226.227	14	-16.30	-16.30	-16.30
MB08PZ4	615840.5003	7559226.227	14	-16.85	-16.85	-16.85
MB1	623212.5	7551624.5	9	-4.31	-6.34	-1.89
MB13PZ1	615148.1894	7551249.067	14	-11.18	-11.18	-11.18
MB13PZ2	615148.1894	7551249.067	14	-10.44	-10.44	-10.44
MB13PZ3	615148.1894	7551249.067	14	-10.45	-10.45	-10.45
MB13PZ4	615148.1894	7551249.067	14	-12.81	-12.81	-12.81
MB15PZ1	620332.0364	7547431.576	14	-11.04	-11.04	-11.04
MB15PZ2	620332.0364	7547431.576	14	-13.09	-13.09	-13.09
MB15PZ3	620332.0364	7547431.576	14	-13.73	-13.73	-13.73
MB15PZ4	620332.0364	7547431.576	14	-10.86	-10.86	-10.86
MB19CVM01A	610440.4249	7548333.987	1	-2.55	-2.86	-2.14
MB19CVM03T	610285.2581	7551342.539	2	7.06	6.21	7.95
MB19CVM04P	610285.2581	7551342.539	17	-14.66	-14.66	-14.66
MB19CVM05T	610980.4335	7551514.562	2	-8.43	-10.22	-6.22
MB19CVM06P	610980.4335	7551514.562	13	-12.07	-14.53	-9.09
MB19CVM07T	611530.2908	7552530.443	2	6.02	5.80	6.42
MB19CVM08P	611530.2908	7552530.443	16	15.65	14.71	16.62
MB19CVM09A	612459.7197	7550870.058	1	0.87	0.62	1.45
MB19CVM10P	613308.8125	7549925.5	12	-7.67	-8.83	-5.00
MB19SRM01A	640035.7517	7515604.909	1	19.22	19.22	19.22
MB19SRM02T	639891.1875	7515766	2	9.31	9.31	9.31
MB19SRM03P	639891.1875	7515766	18	18.06	18.06	18.06
MB19SRM04P	637119.1756	7511242.516	2	-9.39	-9.39	-9.39
MB2	623720.5938	7549401.25	9	2.54	1.10	3.02
MB20CVM01A	610048.378	7560517.679	1	-3.17	-3.64	-2.26
MB20CVM04T	608273.677	7559760.029	2	-0.92	-1.26	-0.22
MB20CVM05P	608273.677	7559760.029	17	-16.78	-18.06	-15.09
MB20CVM06T	610981.8182	7549030.86	2	-2.25	-3.88	-1.88
MB20PDM03P	621256.1875	7547902.5	2	-16.89	-16.89	-16.89
MB20PDM05P	630106.8938	7532701.502	11	-92.70	-92.70	-92.70
MB20PDM06T	628778.25	7532642	2	64.22	64.22	64.22
MB20SRM02T	635826.7022	7527798.941	2	-0.78	-0.78	-0.78
MB20SRM03P	635826.7022	7527798.941	18	-5.56	-5.56	-5.56
MB20SRM06A	636596.3701	7520021.894	2	23.73	23.73	23.73

ID	Easting	Northing	Layer	Average Residual	Min	Max
MB20SRM07P	641487.187	7508028.519	18	-1.50	-1.50	-1.50
MB3	627386.2025	7549825.073	3	-16.03	-17.56	-14.95
MB33	636813.1974	7520485.002	17	16.55	16.55	16.55
MB34	638209.2331	7518174.368	17	-31.93	-31.93	-31.93
MB35	642713.0703	7520289.187	17	3.22	3.22	3.22
MB36	639942.4096	7514408.391	17	9.43	9.43	9.43
MB37	632153.26	7515424.641	19	1.72	1.72	1.72
MB4	626512.8704	7543916.2	9	5.01	4.39	5.71
MB5	628829.6013	7542612.196	9	5.14	-7.86	5.92
MILLMB1	627785.4697	7565127.544	4	-4.11	-11.77	1.17
MILLMB10A	630746.4529	7563771.552	9	-0.44	-2.24	6.74
MILLMB10B	630750.454	7563770.553	10	-0.98	-2.43	1.17
MILLMB11A	631899.4464	7562907.557	2	2.36	-0.95	4.70
MILLMB11B	631899.4464	7562907.557	2	4.36	3.03	5.66
MILLMB2	627804.4695	7563280.555	6	-1.51	-4.34	9.85
MILLMB3A	630061.4568	7562379.56	2	18.83	10.02	24.42
MILLMB3B	630056.4568	7562369.56	2	13.21	8.38	18.02
MILLMB4	630430.4547	7563386.554	2	0.47	-2.25	2.76
MILLMB7	628862.4636	7566512.536	2	-23.26	-23.43	-23.09
MILLMB8B	627186.4731	7566002.539	4	-23.85	-25.31	-19.80
MILLMB9A	628397.4663	7565526.542	9	15.39	13.16	16.46
MILLMB9B	628407.4662	7565534.542	10	-0.34	-33.22	8.60
MOS_MB01	610623.6922	7562640.877	2	3.20	3.20	3.20
MOS_MB02	612080.4755	7562288.35	12	-20.27	-20.27	-20.27
MOS_MB04	614204.5002	7562414.079	2	0.42	0.42	0.42
MOS_MB05	615192.8125	7563121.5	2	4.26	4.26	4.26
MOS_MB06	616149.9589	7561341.239	2	3.10	3.10	3.10
MOS_MB07	615450.6678	7560778.892	2	-4.07	-4.07	-4.07
MOS_MB08B	615840.5003	7559226.227	10	-6.84	-6.84	-6.84
MOS_MB09B	618385.0785	7558103.376	10	-0.45	-0.45	-0.45
MOS_MB11	611574.251	7558431.569	12	-5.58	-5.58	-5.58
MOS_MB12	613595.2659	7557331.595	2	-3.45	-3.45	-3.45
MOS_MB14	615148.1894	7551249.067	10	-2.42	-2.42	-2.42
MOS_MB16	620332.0364	7547431.576	12	-5.38	-5.38	-5.38
MP01D	630685.3125	7524218	1	5.95	5.95	5.95
MP02D	630685.3125	7524218	1	5.75	5.75	5.75
MP03D	630685.3125	7524218	1	5.45	5.45	5.45
MP04D	630685.3125	7524218	1	5.35	5.35	5.35
MP05D	630589.5625	7524245	1	5.55	5.55	5.55

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MP06	630703.25	7524458	1	8.29	8.29	8.29
MP07	630647.8413	7524052.256	1	5.37	5.37	5.37
MP07D	630462.3902	7524472.354	1	5.81	5.81	5.81
MP08	630481.871	7524099.034	1	2.47	2.47	2.47
MP09	630395.875	7524227	1	3.52	3.52	3.52
MP10	630462.3902	7524472.354	1	5.11	5.11	5.11
MPGW11	631114.4509	7565460.542	3	4.30	4.30	4.30
MPGW12	631494.4487	7565140.544	3	-13.55	-13.55	-13.55
MPGW13	631874.4466	7564820.546	3	-12.87	-12.87	-12.87
MPGW14	632259.4444	7564495.548	3	-17.02	-17.02	-17.02
MPGW2	629434.4604	7566550.536	3	-17.13	-17.13	-17.13
MPGW3	629849.458	7566275.538	3	-14.53	-14.53	-14.53
MPGW4	630264.4557	7566000.539	3	-9.01	-9.01	-9.01
MPGW5	630684.4533	7565720.541	3	-4.90	-4.90	-4.90
ODN18MB1	640309.75	7547851	5	-9.06	-9.16	-8.96
ODN18MB10	639463.5	7554574	9	-17.92	-17.92	-17.92
ODN18MB11	638639.8834	7553471.89	9	-12.94	-12.94	-12.94
ODN18MB12	640214.9375	7547881	7	-1.27	-1.56	-0.98
ODN18MB2	640214.9375	7547881	1	1.17	1.16	1.17
ODN18MB3	639763.5	7551456	5	-12.79	-12.79	-12.79
ODN18MB4	640489.6165	7549964.092	1	-10.76	-11.18	-10.34
ODN18MB6	639963.5	7551802.5	5	-11.76	-11.76	-11.76
ODN18MB7	640263.5	7554747	1	-7.63	-7.63	-7.63
ODN18MB8	638943.7866	7550215.225	1	-4.24	-4.31	-4.17
ODN18MB9	640091.5625	7557377	5	-5.52	-5.52	-5.52
ODN18TB1	640310.1002	7548016.93	5	-8.03	-8.30	-7.75
ODN18TB2	640309.75	7547851	1	3.28	3.06	3.49
ODN18VWP1	640310.1002	7548016.93	7	-10.25	-10.25	-10.25
ODN18VWP2	640310.1002	7548016.93	5	-11.66	-11.66	-11.66
ODN18VWP3	640310.1002	7548016.93	4	-10.51	-10.51	-10.51
PTMOBS1	630111	7554627	5	-5.69	-16.54	-3.44
PTMOBS10	627784	7556229	2	-1.82	-2.62	-1.31
PTMOBS11	630313.01	7556960	2	13.35	12.84	14.16
PTMOBS2	631340.9474	7557632.866	6	-3.76	-7.91	3.48
PTMOBS4	626685.4177	7562094.061	4	-3.55	-15.92	-0.70
PTMOBS5	625955.2119	7557272.88	2	-5.12	-14.54	-2.82
PTMOBS6	628874.8094	7556593.447	5	-5.58	-27.11	-0.97
PTMOBS7	625570	7556820	2	-1.51	-2.02	-1.07
PTMOBS8	631867	7553655	1	2.81	2.59	3.20

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PTMOBS9	627800	7556217	5	6.15	5.24	6.65
PZ01	609990.1615	7560324.422	18	-3.42	-7.27	6.31
PZ03-D	608981.8125	7556902	18	-7.91	-9.89	-4.38
PZ03-S	608981.8125	7556902	2	-7.18	-12.19	-2.35
PZ04	610881.8125	7555516	13	-5.48	-6.25	-4.92
PZ05	608981.8125	7554303.5	18	-12.22	-15.91	-1.32
PZ06-S	611394.9703	7551817.025	1	1.66	0.97	4.99
PZ07-D	612459.7197	7550870.058	12	-0.59	-2.08	0.36
PZ07-S	612459.7197	7550870.058	1	-0.09	-0.53	1.07
PZ08-D	611508.8125	7549925.5	2	-5.38	-11.23	2.30
PZ08-S	611508.8125	7549925.5	1	4.82	1.35	5.91
PZ09	614458.8125	7548973	13	-7.11	-16.16	-1.79
PZ11-D	616933.125	7547803.5	14	-6.06	-13.63	-1.71
PZ12-D	610831.8125	7557335	13	-4.13	-5.24	-1.60
PZ12-S	610781.8125	7557421.5	1	-1.25	-1.58	-0.58
R2008	631256.1355	7542649.535	7	-1.49	-2.42	-1.28
R2009	631256.1355	7542649.535	6	2.40	2.08	2.77
R2010	631540.6635	7543092.546	7	-7.75	-9.23	-7.42
R2010R	631540.6635	7543092.546	5	-8.10	-8.10	-8.10
R2032	630494.4947	7545824.069	5	3.92	0.79	4.35
R2034	629477.4267	7545172.354	2	-4.67	-5.71	-3.66
R2035	629142.8881	7545205.573	2	-5.90	-6.12	-5.69
R2054	629223.6875	7548101.5	6	2.47	-2.62	3.61
R2055	628773.6875	7547841.5	7	4.20	3.05	4.46
RIVER_BORE	654039.375	7526997	3	-12.37	-12.37	-12.37
S10	642549.4473	7546071.1	1	-3.74	-3.79	-3.71
S11	642453.6092	7545291.206	1	-3.38	-3.38	-3.38
S2	641329.2072	7547660.055	1	-4.80	-4.80	-4.80
S4	641582.5	7546809	1	-7.54	-9.14	-7.44
S5	642084.0596	7547162.411	1	-6.04	-6.09	-6.00
S6	642120.567	7546562.784	1	-4.27	-4.30	-4.24
S7	641432.5	7545856.5	1	-7.45	-7.48	-7.43
S8	642158.6468	7546262.21	1	-2.33	-2.52	-2.27
S9	641782.5	7545423.5	1	-6.17	-6.19	-6.15
SWAMP_BORE	645624.8816	7528603.577	9	-9.32	-9.32	-9.32
UNKNOWN1	670566.0369	7516590.296	1	-11.21	-11.21	-11.21
UNKNOWN1_6	650392.9128	7522800.567	6	-15.40	-15.40	-15.40
UNKNOWN1_9	656743.3074	7515809.305	9	-10.84	-10.84	-10.84
UNKNOWN2	656743.3074	7515809.305	2	-18.02	-18.02	-18.02

ID	Easting	Northing	Layer	Average Residual	Min	Max
W1_MB1	637932.6126	7531436.914	2	-1.44	-1.75	-1.13
W1_MB2	637932.6126	7531436.914	5	-0.67	-0.70	-0.64
W1_MB3	637932.6126	7531436.914	7	-0.66	-0.70	-0.62
W10_MB2	641974.4479	7524443.702	3	-19.54	-19.78	-19.29
W10_MB3	641974.4479	7524443.702	8	-15.95	-15.98	-15.93
W11_MB1	644071.6973	7525050.214	3	-17.58	-17.94	-17.21
W11_MB2	644071.6973	7525050.214	5	-15.04	-15.27	-14.81
W12_MB1	643364.6597	7530326.167	2	-12.83	-12.92	-12.74
W13_MB1	645471.9375	7531129	9	-9.57	-9.63	-9.51
W13_MB2	645471.9375	7531129	9	-10.02	-10.04	-10.00
W14_MB1	645525.9375	7528779.5	2	-5.79	-5.89	-5.69
W14_MB2	645525.9375	7528779.5	9	-8.60	-8.62	-8.58
W15_MB1	648878.328	7527871.5	2	4.31	4.31	4.31
W15_MB2	648878.328	7527871.5	7	4.58	4.58	4.59
W15_MB3	648878.328	7527871.5	8	4.51	4.41	4.61
W2_MB1	637687.5801	7530751.356	2	0.43	0.37	0.50
W2_MB2	637687.5801	7530751.356	9	0.40	0.40	0.40
W3_MB1	640587.5865	7529633.154	1	7.42	6.84	8.00
W3_MB2	640587.5865	7529633.154	2	-1.23	-1.25	-1.22
W4_MB1	638182.5047	7528964.388	1	7.04	6.96	7.12
W4_MB2	638182.5047	7528964.388	2	-0.21	-0.40	-0.02
W5_MB1	638581.1773	7527784.808	3	-0.30	-0.30	-0.29
W5_MB2	638581.1773	7527784.808	5	0.72	0.70	0.73
W5_MB3	638581.1773	7527784.808	7	-1.23	-1.23	-1.23
W6_MB1	637890.158	7527828.68	9	-1.90	-4.73	0.93
W6_MB2	637890.158	7527828.68	9	0.75	0.75	0.75
W7_MB1	637550.8979	7526276.279	9	0.49	0.46	0.52
W8_MB1	639342.8566	7523772.028	9	-4.39	-4.40	-4.38
W9_MB2	641060.4375	7524350.5	7	-13.10	-13.15	-13.05
W9_MB3	641060.4375	7524350.5	8	-11.75	-11.78	-11.72
WEST-MB1	643101.6263	7520093.904	2	1.43	0.81	2.06
WEST-MB2	643101.6263	7520093.904	9	2.98	1.53	4.09
WHITETANK	629744.9258	7542783.362	9	4.03	4.03	4.03
WINNETBORE	634831.6865	7550006.294	1	-5.76	-6.96	-5.29
YARDBORE1	642610.6375	7519359.017	11	-0.03	-0.03	-0.03

Appendix F Bore Logs for Groundwater Monitoring Bores

Millennium Mine – Mavis South Extension Project

Supporting documentation to the Environmental Authority (EPML00819213) amendment application Mavis South Underground operations – Groundwater Impact Assessment: State considerations

MetRes Pty Ltd

SLR Project No.: 620.031508.00001

23 November 2023

Bore Report

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
162245	Sub-Artesian Facility	Existing	09/12/2013	Mackay	3980 - ISAAC REGIONAL

Details

Description			
Parish	4308 - STALBRIDGE		
Original Name	MB 8A		
Driller Name	BAKER, STEVEN JOHN		
Drill Company	HODGE DRILLING		
Const Method	ROTARY AIR		
Bore Line			
D/O File No	LON/515/000 (1733)	**Polygon**	
R/O File No		**Equipment**	
H/O File No		**RN of Bore Replaced**	
Log Received Date	06/01/2014	**Data Owner**	DNR
Roles	Mine Monitoring		

Location

Latitude	22-00-34	**Basin**	1304
Longitude	148-13-59	**Sub-area**	
GIS Latitude	-22.00952409	**Lot**	2
GIS Longitude	148.2330537	**Plan**	GV165
Easting	627275		
Northing	7565606	**Map Scale**	
Zone	55	**Map Series**	
Accuracy		**Map No**	
GPS Accuracy		**Map Name**	
Checked	Yes	**Prog Section**	

Casing

7 *records for RN* 162245

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	09/12/2013	1	0.00	22.00	Polyvinyl Chloride			115
A	09/12/2013	2	22.00	30.00	Screen			115
A	09/12/2013	3	20.00	30.00	Gravel Pack	3.000	GR - Gravel Size	150
X	09/12/2013	4	17.00	20.00	Bentonite Seal			150

Bore Report

From Year:

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
X	09/12/2013	5	6.00	17.00	Cuttings or other fill between casing and hole wall			150
X	09/12/2013	6	5.00	6.00	Grout			150
X	09/12/2013	7	0.00	5.00	Grout			157

Strata Logs

8 *records for RN* 162245

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	1.00	SOIL
2	1.00	3.00	CLAY, RED
3	3.00	5.00	CLAY
4	5.00	6.00	CLAY, SANDY
5	6.00	12.00	CLAY
6	12.00	13.00	CLAY, HARD
7	13.00	15.00	CLAY
8	15.00	30.00	SANDSTONE

Stratigraphies

0 *records for RN* 162245

Aquifers

0 *records for RN* 162245

Pump Tests Part 1

0 *records for RN* 162245

Pump Tests Part 2

0 *records for RN* 162245

Bore Conditions

0 *records for RN* 162245

Elevations

0 *records for RN* 162245

Water Analysis Part 1

0 *records for RN* 162245

From Year:

Water Analysis Part 2
0 *records for RN* 162245

Water Levels
0 *records for RN* 162245

Wire Line Logs
0 *records for RN* 162245

Field Measurements
0 *records for RN* 162245

Special Water Analysis
0 *records for RN* 162245

From Year:

Bore Report

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
162244	Sub-Artesian Facility	Existing	09/12/2013	Mackay	3980 - ISAAC REGIONAL

Details

Description			
Parish	4308 - STALBRIDGE		
Original Name	MB 8B		
Driller Name	BAKER, STEVEN JOHN		
Drill Company	HODGE DRILLING		
Const Method	ROTARY AIR		
Bore Line			
D/O File No	LON/515/000 (1733)	Polygon	
R/O File No		Equipment	
H/O File No		RN of Bore Replaced	
Log Received Date		Data Owner	DNR
Roles	Mine Monitoring		

Location

Latitude	22-00-34	Basin	1304
Longitude	148-13-59	Sub-area	
GIS Latitude	-22.00952846	Lot	2
GIS Longitude	148.2329962	Plan	GV165
Easting	627270		
Northing	7565605	Map Scale	
Zone	55	Map Series	
Accuracy		Map No	
GPS Accuracy		Map Name	
Checked	Yes	Prog Section	

Casing

8 *records for RN* 162244

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	09/12/2013	1	0.00	62.00	Polyvinyl Chloride			115
A	09/12/2013	2	62.00	80.00	Screen			
A	09/12/2013	3	60.00	80.00	Gravel Pack	3.000	GR - Gravel Size	150
X	09/12/2013	4	57.00	60.00	Bentonite Seal			150

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
X	09/12/2013	5	6.00	57.00	Cuttings or other fill between casing and hole wall			150
X	09/12/2013	6	5.00	6.00	Grout			150
X	09/12/2013	7	0.50	5.00	Grout			150
X	09/12/2013	8	0.00	0.50	Grout			200

Strata Logs

8 *records for RN* 162244

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	1.00	SOIL
2	1.00	3.00	CLAY, RED
3	3.00	5.00	CLAY
4	5.00	6.00	CLAY, SANDY
5	6.00	12.00	CLAY
6	12.00	13.00	CLAY, VERY HARD
7	13.00	15.00	CLAY
8	15.00	80.00	SANDSTONE

Stratigraphies

0 *records for RN* 162244

Aquifers

0 *records for RN* 162244

Pump Tests Part 1

0 *records for RN* 162244

Pump Tests Part 2

0 *records for RN* 162244

Bore Conditions

0 *records for RN* 162244

Elevations

0 *records for RN* 162244

From Year:

Water Analysis Part 1
0 *records for RN* 162244

Water Analysis Part 2
0 *records for RN* 162244

Water Levels
0 *records for RN* 162244

Wire Line Logs
0 *records for RN* 162244

Field Measurements
0 *records for RN* 162244

Special Water Analysis
0 *records for RN* 162244

From Year:

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
162246	Sub-Artesian Facility	Existing	09/12/2013	Mackay	3980 - ISAAC REGIONAL

Details

Description			
Parish	4308 - STALBRIDGE		
Original Name	MB 9A		
Driller Name	BAKER, STEVEN JOHN		
Drill Company	HODGE DRILLING		
Const Method	ROTARY AIR		
Bore Line			
D/O File No	LON/515/000 (1733)	**Polygon**	
R/O File No		**Equipment**	
H/O File No		**RN of Bore Replaced**	
Log Received Date	06/01/2014	**Data Owner**	DNR
Roles	Mine Monitoring		

Location

Latitude	22-00-40	**Basin**	1304
Longitude	148-14-39	**Sub-area**	
GIS Latitude	-22.01112592	**Lot**	2
GIS Longitude	148.2442927	**Plan**	GV165
Easting	628434		
Northing	7565419	**Map Scale**	
Zone	55	**Map Series**	
Accuracy		**Map No**	
GPS Accuracy		**Map Name**	
Checked	Yes	**Prog Section**	

Casing

6 *records for RN* 162246

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	09/12/2013	1	0.00	22.00	Polyvinyl Chloride			115
A	09/12/2013	2	22.00	30.00	Screen			115
A	09/12/2013	3	20.00	30.00	Gravel Pack	3.000	GR - Gravel Size	150
X	09/12/2013	4	17.00	20.00	Bentonite Seal			150

From Year:

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
X	09/12/2013	5	6.00	17.00	Cuttings or other fill between casing and hole wall			150
X	09/12/2013	6	0.00	6.00	Grout			165

Strata Logs

7 *records for RN* 162246

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	1.00	SOIL
2	1.00	3.00	CLAY
3	3.00	4.00	CLAY, SANDY
4	4.00	5.00	ROCK
5	5.00	8.00	CLAY, SANDY
6	8.00	12.00	CLAY
7	12.00	30.00	COAL SEAM

Stratigraphies

0 *records for RN* 162246

Aquifers

1 *records for RN* 162246

Rec	Top (m)	Bottom (m)	Lithology	Date	SWL (m)	Flow	Quality	Yield (L/s)	Contr	Cond	Formation Name
1	12.00	30.00	COAL - Coal						N	PS	MORANBAH COAL MEASURES

Pump Tests Part 1

0 *records for RN* 162246

Pump Tests Part 2

0 *records for RN* 162246

Bore Conditions

0 *records for RN* 162246

Elevations

0 *records for RN* 162246

From Year:

Water Analysis Part 1	**0** *records for RN* 162246
Water Analysis Part 2	**0** *records for RN* 162246
Water Levels	**0** *records for RN* 162246
Wire Line Logs	**0** *records for RN* 162246
Field Measurements	**0** *records for RN* 162246
Special Water Analysis	**0** *records for RN* 162246

From Year:

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
162247	Sub-Artesian Facility	Existing	09/12/2013	Mackay	3980 - ISAAC REGIONAL

Details

Description			
Parish	4308 - STALBRIDGE		
Original Name	MB 9B		
Driller Name	BAKER, STEVEN JOHN		
Drill Company	HODGE DRILLING		
Const Method	ROTARY AIR		
Bore Line			
D/O File No	LON/515/000 (1733)	**Polygon**	
R/O File No		**Equipment**	
H/O File No		**RN of Bore Replaced**	
Log Received Date	06/01/2014	**Data Owner**	DNR
Roles	Mine Monitoring		

Location

Latitude	22-00-40	**Basin**	1304
Longitude	148-14-39	**Sub-area**	
GIS Latitude	-22.01108319	**Lot**	2
GIS Longitude	148.2442497	**Plan**	GV165
Easting	628430		
Northing	7565424	**Map Scale**	
Zone	55	**Map Series**	
Accuracy		**Map No**	
GPS Accuracy		**Map Name**	
Checked	Yes	**Prog Section**	

Casing

6 *records for RN* 162247

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	09/12/2013	1	0.00	80.00	Polyvinyl Chloride	8.000	WT - Wall Thickness	115
A	09/12/2013	2	60.00	74.00	Screen	0.800	AP - Aperture Size	115
A	09/12/2013	3	58.00	80.00	Gravel Pack	0.300	GR - Gravel Size	
X	09/12/2013	4	55.00	58.00	Bentonite Seal			150

From Year:

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
X	09/12/2013	5	6.00	55.00	Cuttings or other fill between casing and hole wall			150
X	09/12/2013	6	0.00	6.00	Grout			165

Strata Logs

11 *records for RN* 162247

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	1.00	SOIL
2	1.00	3.00	CLAY
3	3.00	4.00	CLAY, SANDY
4	4.00	5.00	ROCK
5	5.00	8.00	CLAY, SANDY
6	8.00	12.00	CLAY
7	12.00	32.00	COAL SEAM, MORANBAH
8	32.00	36.50	MUDSTONE
9	36.50	54.00	COAL SEAM, MORANBAH
10	54.00	72.00	SANDSTONE
11	72.00	80.00	MUDSTONE

Stratigraphies

0 *records for RN* 162247

Aquifers

0 *records for RN* 162247

Pump Tests Part 1

0 *records for RN* 162247

Pump Tests Part 2

0 *records for RN* 162247

Bore Conditions

0 *records for RN* 162247

Bore Report

From Year:

Elevations	**0** *records for RN* 162247
Water Analysis Part 1	**0** *records for RN* 162247
Water Analysis Part 2	**0** *records for RN* 162247
Water Levels	**0** *records for RN* 162247
Wire Line Logs	**0** *records for RN* 162247
Field Measurements	**0** *records for RN* 162247
Special Water Analysis	**0** *records for RN* 162247

Bore Report

From Year:

Bore Report

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
162249	Sub-Artesian Facility	Existing	10/12/2013	Mackay	3980 - ISAAC REGIONAL

Details

Description			
Parish	2420 - ILSINGTON		
Original Name	MB 10A		
Driller Name	BAKER, STEVEN JOHN		
Drill Company	HODGE DRILLING		
Const Method	ROTARY AIR		
Bore Line			
D/O File No	LON/515/000 (1733)	Polygon	
R/O File No		Equipment	
H/O File No		RN of Bore Replaced	
Log Received Date	06/01/2014	Data Owner	DNR
Roles	Mine Monitoring		

Location

Latitude	22-01-39	Basin	1304
Longitude	148-15-57	Sub-area	
GIS Latitude	-22.0274232	Lot	4
GIS Longitude	148.2657576	Plan	SP190266
Easting	630635		
Northing	7563596	Map Scale	
Zone	55	Map Series	
Accuracy		Map No	
GPS Accuracy		Map Name	
Checked	Yes	Prog Section	

Casing

6 *records for RN* 162249

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	10/12/2013	2	27.00	35.00	Perforated or Slotted Casing			
A	10/12/2013	3	25.50	35.00	Gravel Pack	0.300	GR - Gravel Size	150
X	10/12/2013	1	0.00	35.00	Polyvinyl Chloride	0.800	WT - Wall Thickness	115
X	10/12/2013	4	23.00	25.50	Bentonite Seal			150
X	10/12/2013	5	6.00	23.00	Cuttings or other fill between casing and hole wall			150
X	10/12/2013	6	0.00	6.00	Grout			165

Bore Report

From Year:

Strata Logs

12 *records for RN* 162249

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	0.50	SOIL
2	0.50	3.00	CLAY
3	3.00	8.00	CLAY, SANDY
4	8.00	8.50	CLAY, DRY
5	8.50	9.00	COAL, WEATHERED
6	9.00	14.00	CLAY
7	14.00	17.00	MUDSTONE
8	17.00	20.00	SANDSTONE
9	20.00	20.20	COAL
10	20.20	21.00	MUDSTONE
11	21.00	26.00	SANDSTONE
12	26.00	35.00	SANDSTONE, COARSE

Stratigraphies

0 *records for RN* 162249

Aquifers

1 *records for RN* 162249

Rec	Top (m)	Bottom (m)	Lithology	Date	SWL (m)	Flow	Quality	Yield (L/s)	Contr	Cond	Formation Name
1	20.00		COAL - Coal SDST - Sandstone	10/12/2013	-19.80	N	"BRACKISH"	14.00	Y	PS	

Pump Tests Part 1

1 *records for RN* 162249

From Year:

Pipe	Date	Rec	RN of Pumped Bore	Top (m)	Bottom (m)	Dist (m)	Meth	Test Types	Pump Type	Suction Set (m)	Q Prior to Test (l/s)	Dur of Q PR (mins)	Pres on Arriv (m)	Q on Arriv (l/s/)
A	10/12/2013	1	162249	20.00			PUM		AIR	26.00				

Pump Tests Part 2

1 *records for RN* 162249

Pipe	Date	Rec	Test Dur (mins)	SWL(m)	Recov Time (mins)	Resid DD (m)	Max DD or P RED (m)	Q at Max DD (l/s)	Time to Max DD (mins)	Max Q (l/s)	Calc Stat HD (m)	Design Yield (l/s)	Design BP (m)	Suct. Set (m)	Tmsy (m2/Day)	Stor
A	10/12/2013	1	60	-19.80				14.00						26.00		

Bore Conditions

0 *records for RN* 162249

Elevations

0 *records for RN* 162249

Water Analysis Part 1

0 *records for RN* 162249

Water Analysis Part 2

0 *records for RN* 162249

Water Levels

0 *records for RN* 162249

Wire Line Logs

0 *records for RN* 162249

Field Measurements

0 *records for RN* 162249

Special Water Analysis

0 *records for RN* 162249

From Year:

Bore Report

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
162248	Sub-Artesian Facility	Existing	10/12/2013	Mackay	3980 - ISAAC REGIONAL

Details

Description			
Parish	2420 - ILSINGTON		
Original Name	MB10B		
Driller Name	BAKER, STEVEN JOHN		
Drill Company	HODGE DRILLING		
Const Method	ROTARY AIR		
Bore Line			
D/O File No	LON/515/000 (1733)	Polygon	
R/O File No		Equipment	
H/O File No		RN of Bore Replaced	
Log Received Date	06/01/2014	Data Owner	DNR
Roles	Mine Monitoring		

Location

Latitude	22-01-39	Basin	1304
Longitude	148-15-57	Sub-area	
GIS Latitude	-22.02746627	Lot	4
GIS Longitude	148.2657368	Plan	SP190266
Easting	630633		
Northing	7563592	Map Scale	
Zone	55	Map Series	
Accuracy		Map No	
GPS Accuracy		Map Name	
Checked	Yes	Prog Section	

Casing

6 *records for RN* 162248

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	10/12/2013	1	0.00	80.00	Polyvinyl Chloride	0.800	WT - Wall Thickness	115
A	10/12/2013	2	64.00	76.00	Perforated or Slotted Casing	0.800	AP - Aperture Size	
A	10/12/2013	3	62.00	80.00	Gravel Pack	0.300	GR - Gravel Size	150
X	10/12/2013	4	59.00	62.00	Bentonite Seal			150

Bore Report

From Year:

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
X	10/12/2013	5	6.00	59.00	Cuttings or other fill between casing and hole wall			150
X	10/12/2013	6	0.00	6.00	Grout			165

Strata Logs

13 *records for RN* 162248

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	0.50	SOIL
2	0.50	3.00	CLAY
3	3.00	8.00	CLAY, SANDY
4	8.00	8.50	CLAY, DRY
5	8.50	9.00	COAL, WEATHERED
6	9.00	14.00	CLAY
7	14.00	17.00	MUDSTONE
8	17.00	20.00	SANDSTONE
9	20.00	20.20	COAL
10	20.20	21.00	MUDSTONE
11	21.00	26.00	SANDSTONE
12	26.00	78.00	SANDSTONE, COARSE
13	78.00	80.00	MUDSTONE

Stratigraphies

0 *records for RN* 162248

Aquifers

2 *records for RN* 162248

Rec	Top (m)	Bottom (m)	Lithology	Date	SWL (m)	Flow	Quality	Yield (L/s)	Contr	Cond	Formation Name
1	20.00	20.20	COAL - Coal	10/12/2013	-18.50	N	"BRACKISH"	12.00	N	PS	

From Year:

Rec	Top (m)	Bottom (m)	Lithology	Date	SWL (m)	Flow	Quality	Yield (L/s)	Contr	Cond	Formation Name
2	66.00	78.00	SDST - Sandstone			N	"BRACKISH"	0.10	N	PS	

Pump Tests Part 1

1 *records for RN* 162248

Pipe	Date	Rec	RN of Pumped Bore	Top (m)	Bottom (m)	Dist (m)	Meth	Test Types	Pump Type	Suction Set (m)	Q Prior to Test (l/s)	Dur of Q PR (mins)	Pres on Arriv (m)	Q on Arriv (l/s/)
A	10/12/2013	1	162248	26.00	78.00		PUM		AIR	65.00				

Pump Tests Part 2

1 *records for RN* 162248

Pipe	Date	Rec	Test Dur (mins)	SWL(m)	Recov Time (mins)	Resid DD (m)	Max DD or P RED (m)	Q at Max DD (l/s)	Time to Max DD (mins)	Max Q (l/s)	Calc Stat HD (m)	Design Yield (l/s)	Design BP (m)	Suct. Set (m)	Tmsy (m2/Day)	Stor
A	10/12/2013	1	60					0.10						65.00		

Bore Conditions

0 *records for RN* 162248

Elevations

0 *records for RN* 162248

Water Analysis Part 1

0 *records for RN* 162248

Water Analysis Part 2

0 *records for RN* 162248

Water Levels

0 *records for RN* 162248

Wire Line Logs

0 *records for RN* 162248

Field Measurements

0 *records for RN* 162248

Special Water Analysis

0 *records for RN* 162248

From Year:

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