Coppabella Coal Mine – Environmental Authority Amendment

Groundwater Final Void Assessment Report

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Australia

SLR Project No.: 640.030987.00001-R01-v3.0

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Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
V0.1	23 January 2024	Subhas Nandy	DL	
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V2.1	12 February 2024	Subhas Nandy	Shaun Troon	Shaun Troon
V3.0	13 February 2024	Subhas Nandy	Shaun Troon	Shaun Troon

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 Peabody. Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

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1.0 Introduction

1.1 Approval

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Peabody Energy Australia Pty Ltd (Peabody) to support the preparation of the Coppabella Mine (the 'Project') Environmental Authority Amendment (EA Amendment). Peabody is seeking an amendment to their current EA EPML00579213 to nominate the final void as a non-use management area (NUMA) which includes:

- a change to the final landform and residual void location (**Figure 1-3**). There are currently four pits and these pits are proposed to be merged to form a single pit void; and
- nominate the final void as a non-use management area (NUMA) prior to submission of the PRC plan.

1.2 Existing Operation

The Coppabella Coal Mine (CCM) is located approximately 120 kilometres (km) south-west of Mackay, near the township of Coppabella, within the Isaac Regional Local Government Area, in central Queensland (QLD), Australia. The general location of CCM is shown in **Figure 1-1**.

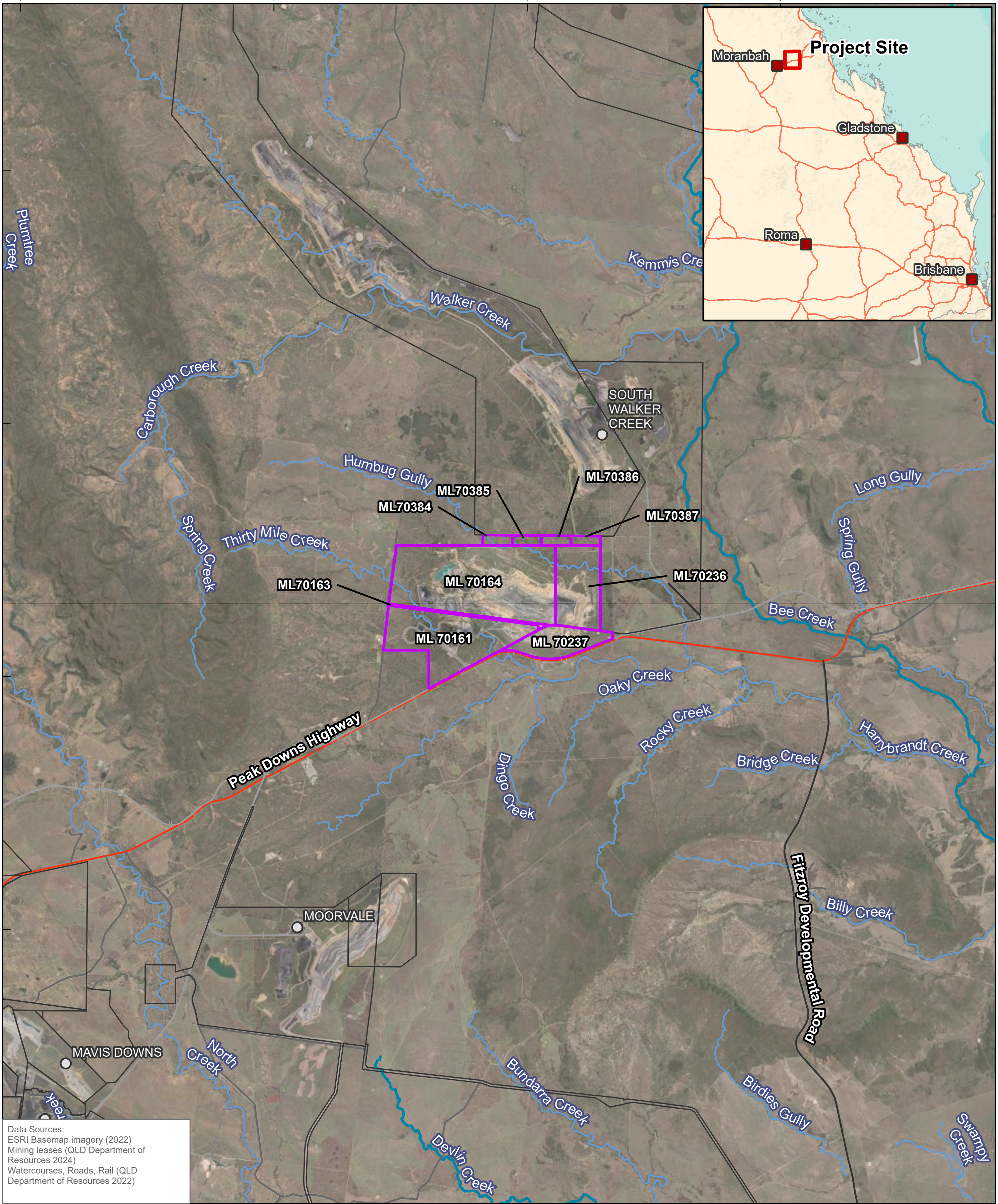
The CCM current operation is authorized under five mining leases (ML70161, ML70163, ML70164, ML70236, ML70237) and one Petroleum Licence (PL1015), under tenure issued by the State Government of Queensland with a total surface area of 3734 ha (**Figure 1-2**).

The CCM is an open cut mining operation which targets the Macarthur Seam of the Rangal Coal Measures and variously its constituent sub-seams including the Phillips and Leichhardt Seams. The open cut operations include:

- Four pits (Creek Pit, Johnson Pit, South Pit and East Pit);
- Seven out of pit spoil dumps;
- Associated mine infrastructure including coal handling and preparation plant (CHPP), Co-Disposal and Reject Co-Disposal area (CDA);
- A raw water dam;
- A raw coal stockpile area; and
- A number of small sediment and surface water containment dams generally located on creeks or gullies.

The general mine layout as well as the existing CCM infrastructure is provided in **Figure 1-2**.

The existing CHPP processes the run of mine (ROM) coal, with process waste disposed on site into the existing tailings and reject co-disposal areas. Product coal is loaded onto the existing CCM train load-out facility and transported to the Dalrymple Bay Coal terminal (DBCT) by coal trains for export overseas.



Data Sources:
ESRI Basemap imagery (2022)
Mining leases (QLD Department of Resources 2024)
Watercourses, Roads, Rail (QLD Department of Resources 2022)

0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:200,000 at A4
Project Number:	640.030987
Date Drawn:	24-Jan-2024
Drawn by:	JH

LEGEND

- Coppabella Mining Lease
- Mining Lease
- Surrounding Mine
- Rail
- Principal Road
- Road
- Minor Road
- Track
- Major Watercourse
- Minor Watercourse

COPPABELLA EA GROUNDWATER ASSESSMENT

LOCALITY PLAN

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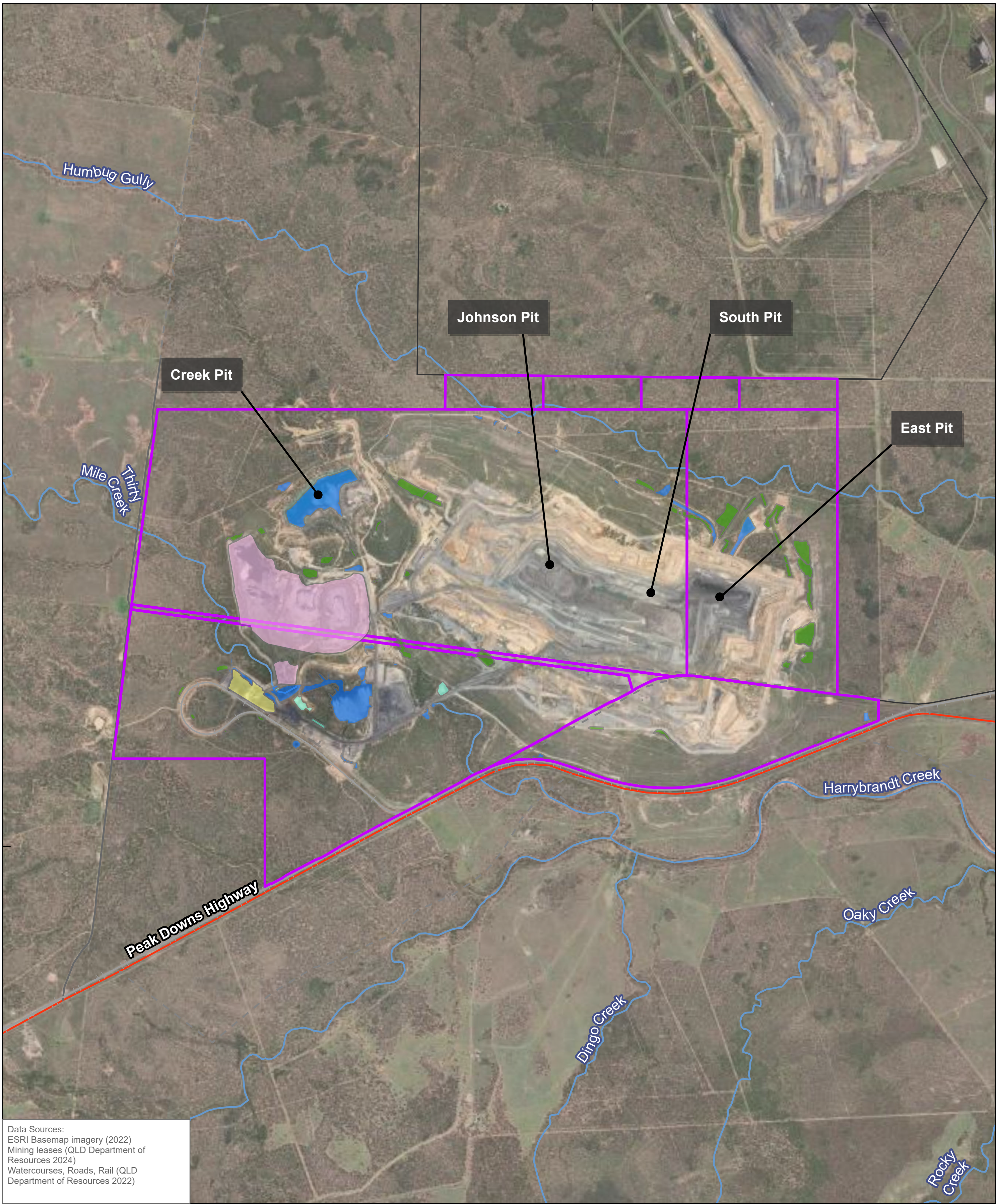
DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE 1-1

Path: H:\Projects-SLR\640-MEL\640-MEL\640.030987.00001 Coppabella EA Groundwater Asse\06 SLR Data\01 CADGIS\GIS\640030987_Coppabella_GW\640030987_Coppabella_GW.aprx\640030987_F1-1_Locality



Data Sources:
ESRI Basemap imagery (2022)
Mining leases (QLD Department of Resources 2024)
Watercourses, Roads, Rail (QLD Department of Resources 2022)

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:60,000 at A4
Project Number:	640.030987
Date Drawn:	09-Feb-2024
Drawn by:	JH

LEGEND

- Co-disposal Area
- Sediment Basin
- Soil Stockpile
- Water Storage
- CHPP
- Coppabella Mining Lease
- Mining Lease
- Rail
- Principal Road
- Road
- Minor Road
- Track
- Major Watercourse
- Minor Watercourse

COPPABELLA EA GROUNDWATER ASSESSMENT

PROJECT LAYOUT

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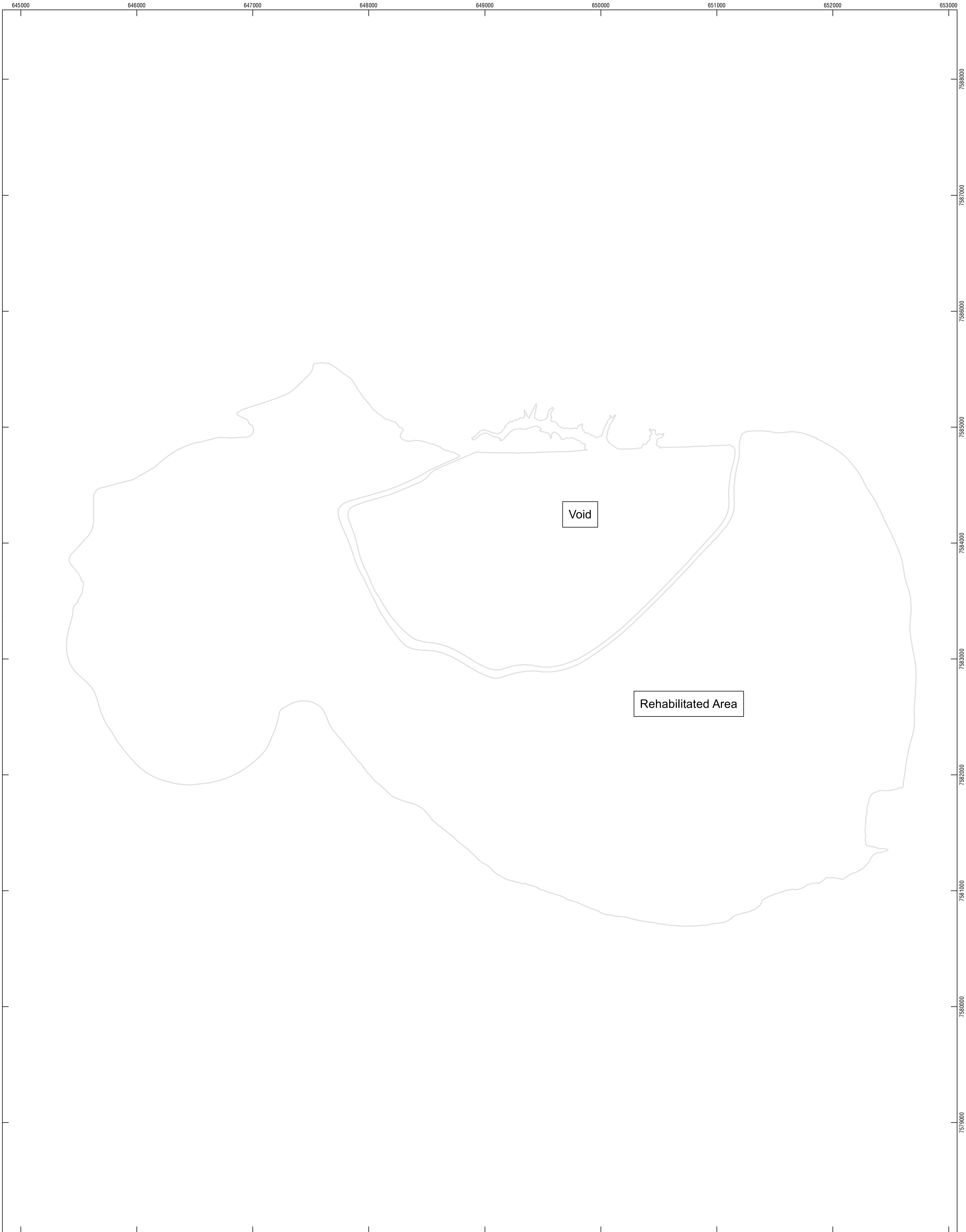
FIGURE 1-2

1.3 The Project

As outlined above, the proposed Project that pertains to this groundwater assessment includes a change to the CCM final landform and residual void location (**Figure 1-3**).

As part of the Project, the final void will be nominated as a non-use management area (NUMA) which will require an amendment to EA EPML00579213.



0 50 100
Meters

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:29,301 at A4
Project Number:	620.30112
Date:	02-Feb-2024
Drawn by:	SS

[redacted]

Legend

Final Landform Outline

Topography (mAHD)

COPPABELLA EA AMENDMENT

Coppabella Void Location

Data Source: DNRME watercourses and ESRI Basemap imagery.
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FIGURE 1-3

C:\Users\Samantha.Sam\OneDrive - SLR Consulting\Documents\Coppabella\640.030987_Void_Location_Figure_1-3.mxd

1.4 Objectives

In support of the EA amendment for the Project, a Groundwater Assessment will need to be carried out. The Groundwater Assessment (this report) comprises two parts:

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

(ii) A quantitative assessment of the potential Project related impacts on that hydrogeological environment.

The scope of work for this Groundwater Assessment was to:

- Review CCM existing groundwater monitoring data and reports (water management plan, groundwater assessment, monitoring reports), including prior studies on the current mine layout, provided by Peabody Energy.
- Review 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, 2019).
- Review relevant CCM site water balance and surface water reports provided by Peabody.
- Review the Project description for the proposed development to confirm the groundwater-specific requirements for the EA amendment.
- Develop an updated conceptual hydrogeological model for CCM including:
  - Definition of hydrostratigraphic units and their hydraulic characteristics (aquifer, aquitard);
  - Definition of aquifer types and their hydraulic properties;
  - Review of the information available to identify the hydraulic characterises of faults;
  - Establishment of the conceptual level groundwater balance including hydrological components of the groundwater systems such as rainfall, groundwater recharge, evaporation/evapotranspiration, loss or gain of groundwater to creeks;
  - Interpolation of groundwater level records for the key groundwater systems where practical and to infer regional and local groundwater flow directions;
  - Identification of potential surface water/groundwater interactions;
  - Development of two schematic 2D hydrogeological cross sections (one north-south and one east-west section) of the aquifer systems to visualise the conceptual understanding developed for the Project site;
  - Identification of relevant environmental values and location of sensitive receptors including GDEs using information provided by Peabody Energy information available from field studies, information available from surrounding projects, and other information retrieved from publicly available data sources.
  - Review of third-party groundwater extraction bores and licenses.
  - Identification of groundwater quality characteristics; and
  - Identification of relevant Water Quality Objectives for groundwater, including indicators and associated trigger values or criteria.
- Estimates groundwater inflow and extent of groundwater level drawdown based on preliminary analytical modelling.

- Identify the hydrogeologic conditions that may influence the design, operation, and/or associated impacts of the proposed development, including but not limited to water quality, structural features, hydraulic gradients, and or inter-aquifer connectivity.
- Assess the impact of the proposed Project on environmental values along with potential management options.

1.5 Information Sources

The main report sources of existing site specific hydrogeologic information utilised in development of this Groundwater Assessment were:

- AGE (2010) Coppabella Underground Project: Groundwater Impact Assessment, prepared for Macarthur Coal Pty Ltd.
- Worley Persons Consulting (2015) Coppabella Area Groundwater Modelling: Groundwater Monitoring Program Design.
- Peabody Energy (2021) Technical Report Summary - Coppabella-Moorvale Joint Venture (CMJV).

The following “other” information sources have been relied upon for the development of this Groundwater Assessment:

- Peabody Energy 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;
  - Geological study reports conducted at 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

Legislative and guidelines relevant to the Project EA amendment as they pertain to groundwater are outlined below.

2.1 Legislation

Relevant State legislation in relation to a coal mining project taking or interfering with groundwater resources in the Project Area are the:

- 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 and Wetland Biodiversity).*

The following sections summarise Queensland groundwater legislation and policy relevant to the Project EA Amendment.

2.1.1 Queensland Water Act 2000

The Water Act, supported by the subordinate Water Regulation 2016, 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 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. 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.

Framework relevant to the Project

The Water Act was amended in 2014 with introduction of the *Water Reform and Other Legislation Amendment Act 2014* (WROLA Act). Changes to this legislation included giving new mines a limited statutory right to take groundwater they intercept through routine mining activities ('associated water'); for example, the groundwater contained within coal seams that is removed with extraction of the coal. The WROLA Act was later amended in 2016 with the introduction of the *Water Legislation Amendment Act 2015* and the *Environmental Protection (Underground Water Management) and Other Legislation Amendment Act 2016* (EPOLA Act), which came into effect on 6th December 2016. The EPOLA Act amends the EP Act and Water Act (Chapter 3), and removes the statutory right to water, requiring applicants to quantify and be licenced for the take of 'associated water'.

Peabody does not hold an Associated Water Licence for Coppabella mine due to the limited groundwater encountered.

Water resources within the Project Area are captured under the Water Plan (Fitzroy Basin) 2011. The plan covers surface water (zone WQ1301) associated with Isaac River, and groundwaters (zone WQ1310 – Fitzroy Basin groundwaters). The Project may interact with groundwater within the Isaac Connors Groundwater Management Area (GMA – Zone 34) of the Fitzroy Basin under the Water Plan (Fitzroy Basin) 2011. This relates to both Groundwater Unit 1 (containing aquifers of the Quaternary alluvium) and Groundwater Unit 2 (sub-artesian aquifers) as shown in **Figure 2-1**. The extent of Groundwater Unit 1 (Isaac Connors Alluvium Groundwater Sub-area) is based on the mapped extent of Quaternary alluvium, which is mapped outside of the Project footprint.

0 20 40 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:1,250,000 at A4
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Drawn by:	JH

LEGEND

- Coppabella Mining Lease
- Isaac Connors Alluvium Groundwater Sub-Area
- Isaac Connors Groundwater Management Area (GMA)
- Major Watercourse

COPPABELLA EA GROUNDWATER ASSESSMENT

ISAAC CONNORS GROUNDWATER MANAGEMENT AREA

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FIGURE 2-1

2.1.2 Queensland Environmental Protection Act 1994

Environmental Authority

Under the EP Act, an environmental assessment is required as part of the application for an Environmental Authority (EA), or the application for an amendment to an existing EA, to undertake an environmentally relevant activity. The process assesses the potential environmental impact of the Project, and how impacts should be avoided, minimised, and managed. The Department of Environment and Science (DES) is responsible for the administration and delivery of applications for an EA, and amendment applications. DES Guideline ESR/2016/3275 *Requirements for site-specific and amendment applications—underground water rights* is directly relevant to the content of this Groundwater Impact Assessment report in relation to the proposed EA amendment application for the Project.

The mine currently operates under EA EPML00579213. The groundwater related conditions are listed in Schedule H5 of the EA and all water related conditions are listed in Schedule G.

Environmental Protection (Water and Wetland Biodiversity) Policy 2019

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

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

Groundwater resources within the vicinity of the Project are scheduled under the EPP Water and Wetland Biodiversity as Isaac Groundwaters of the Isaac River Sub-basin of the Fitzroy Basin Groundwater Zones (WQ1310). The legislated environmental values (EVs) for these groundwaters are:

- Biological integrity of aquatic ecosystems;
- Human use EVs:
  - Suitability of water supply for irrigation;
  - Farm water supply/use;
  - Stock watering;
  - Primary recreation;
  - Drinking water supply;
  - Cultural and spiritual values.

The EPP Water and Wetland Biodiversity also provides limited water quality objectives for underground aquatic ecosystem protection in Fitzroy Basin groundwaters. These WQOs provided in the EPP Water and Wetland Biodiversity are classified by groundwater depth and regional chemistry zone.

2.1.3 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 CCM EA amendment Project. These guidelines are:

- Queensland Department of Environment and Science Guideline - *Requirements for site-specific and amendment applications—underground water rights* - EP Act;
- Queensland Department of Environment and Science Guideline - *Underground water impact reports and final reports* - Water Act; and
- *Australian groundwater modelling guidelines*. Waterlines report. National Water Commission, Canberra, 2012.

A summary of the EP Act guideline requirements and where they have been addressed within this report is provided in **Table 2-1**.

Table 2-1: Requirement for Site Specific and Amendment Applications – Underground Water Rights

	Detail	Section in Report
Part A	A statement that the applicant proposes to exercise underground water rights.	**Section 1.0**
Part B	A description of the area/s in which underground water rights are proposed to be exercised.	**Section 1.0**
Part C	A description of the aquifer/s affected or likely to be affected.	
	• Aquifer type (confined, unconfined, fractured etc.)	**Sections 5.2 and 7.1**
	• Geology/ stratigraphy for each aquifer	**Section 4.0**
	• Depth to and thickness of the aquifers	**Section 4.0**
	• Physical integrity of the aquifer, fluvial processes, and morphology	**Section 5.0**
	• Depth to water level and seasonal changes in levels	**Section 5.0**
	• Hydrogeological cross sections	**Section 7.0**
	• Maps (spatial extent)	**Section 4.0**
Part D	An analysis of the movement of underground water to and from the aquifer.	
	• Inputs (i.e. recharge) and outputs (i.e. baseflow and abstraction);	**Section 5.2**
	• Underground water elevations (i.e. mapped groundwater flow directions);	**Section 5.2**
	• Connectivity between aquifers and hydraulic properties;	**Section 5.2 and 5.3**
	• Preferential flow pathways (i.e. faults);	**Section 5.3.2**
	• Springs.	**Section 5.6.2**

	Detail	Section in Report
Part E	A description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights.	**Section 8.0**
	Predictions should: • Be made for the life of the resource project and for post resource tenure closure; • Be made about the timing, spatial extent, and magnitude of maximum water level declines in affected aquifers; • Be made about the timing and magnitude of groundwater level equilibrium in affected aquifers.	**Section 8.0**
	Produce potentiometric contour maps showing maximum predicted water level decline for each affected aquifer.	**Section 8.0 (discussed)**
	Modelling methodology, including: • Model type (e.g. numerical or analytical); • Modelling platform; • Model inputs; • Model boundary conditions; • Model assumptions and limitations; • Sensitivity analysis and calibration results.	**Section 8.0**
Part F	The predicted quantities of water to be taken or interfered with because of the exercise of underground water rights.	**Section 8.0**
	Details on the methodology used for measuring extraction volumes and developing the extraction schedule.	**Not Applicable**
Part G	Information on predicted impacts to the quality of groundwater that will, or may, happen because of the exercise of underground water rights.	**Sections 6.0 and 9.0**
	Identify the quality of the groundwater prior to the resource activity commencing.	**Section 6.0**
	Explain the variation of chemical concentrations as a result of chemical reactions over the life of the project due to the exercise of underground water rights (i.e. changes in salinity and concentration of dissolved gas).	
	Estimate extent and likelihood of groundwater quality impacts, with justification based on potential sources of contamination.	**Section 9.0**
Part H	Identifying and describing environmental values: • Information on the environmental values that will, or may, be affected by the exercise of underground water rights; • Describe and define environmental value of aquifers, presenting available raw data used. • Document groundwater use, including details on operating bores within the areas predicted to be affected by the exercise of underground water rights.	**Sections 5.5, 6.0.**

	Detail	Section in Report
	Nature and extent of the impacts on the environmental values (risk assessment): • The magnitude, relative size, or actual extent of any impact in relation to the environmental value being affected; • The vulnerability or resilience of the environmental value (severity and duration) Uncertainty of impacts and any assumptions.	**Section 9.0**
	Surface subsidence impacts.	Not applicable
Part I	Information on strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or predicted impacts on the quality of groundwater. Strategies for avoiding, mitigating, and managing the predicted impacts on both environmental values and predicted changes in groundwater quality should include: Objectives which define the outcomes that are intended to be achieved (i.e. avoiding, mitigating, and managing the predicted impacts) and a description of unavoidable impacts to environmental values; Measures (specific methods/procedures/tools) to be implemented to demonstrate how the objectives will be achieved; Indicators relevant to protection of the environmental values (i.e. indicators are the values that are to be measured to gauge whether the objectives are being achieved and are used to are to be used in auditing the performance of measures); A program for monitoring the indicators (see EP Act Guideline for requirements); A reporting program which includes triggers for the review of the strategies, and identifies additional data, assessment, analysis, and reporting requirements.	

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 Dilkera (station 33318), approximately 22 km to the east of the Project. The record is continuous with only minor gaps in the monitoring record; however, this weather station was only in operation from 2012 to 2022. A nearby station at Nebo (station 33054, 28 km north-east of the Project) has a comparatively long record, from 1871 to 2020.

Moranbah Airport (station 34035) is located approximately 42 km south-west of the Project and has been in operation since 2012. This station has a continuous record since opening, with only a few occasional months of missing data. **Table 3-1** provides the details of the nearby operational weather stations.

Table 3-1: Operational BoM Weather Stations near the Project

Name	Site Number	Data Period	Latitude	Longitude	Elevation (mAHD*)	Operational Status	Distance from Project
Nebo	33054	1871-2020	21.69°S	148.69°E	195	Open	28 km north-east
Dilkera	33318	2012-2022	21.81°S	148.69°E	178	Open	22 km east
Moranbah Airport	34035	2012-present	22.06°S	148.08°E	232	Open	42 km south-west
*mAHD = metres Australian Height Datum							

For the purposes of this assessment, SILO Grid point data at latitude: -21.85, longitude: 148.45 (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 such as those discussed above.

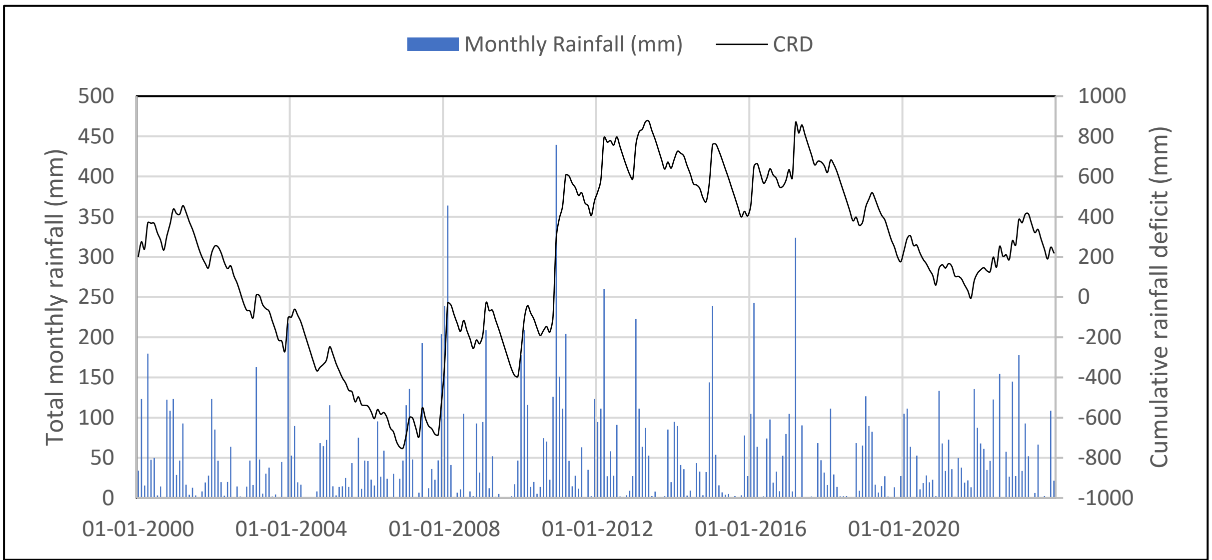
Data spanning January 1970 until June 2023 was used for assessing the long-term trends in the vicinity of the Project. Based on this data, the average annual site rainfall is 612.25 millimetres (mm). The two highest annual rainfalls were recorded for the years 1998 and 2010, with annual rainfalls of 935.9 mm and 1287.9 mm, respectively. The minimum annual rainfall occurred in 1982 with 282.6 mm. Monthly averages for the three nearby BoM stations as well as the SILO grid point are listed in **Table 3-2**.

Table 3-2: 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	38.7	12.2	14.5	22.8	66.3	62.8	562.8
Nebo	141.1	134.9	109.4	45.8	34.5	38.3	27.8	18.3	19.3	30.5	53.1	97.0	747.4
Dilkera	143.5	123.8	93.4	26.8	27.9	24.6	37.1	17.7	21.0	18.9	48.4	67.6	595.9
SILO Data	108.6	98.95	75.1	33.88	33.04	22.29	21.78	20.55	12.89	29.31	63.56	92.3	612.25

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 3-1** shows that, over the past 22 years, above average rainfall has occurred at the beginning of 2008 and in 2011 to 2012. Below average rainfall conditions were observed between 2002 and 2008 as well as between 2017 and 2021. Over the last 2 years, CCM has experienced somewhat higher than average rainfall conditions, as shown by the inclining trend in the CRD.

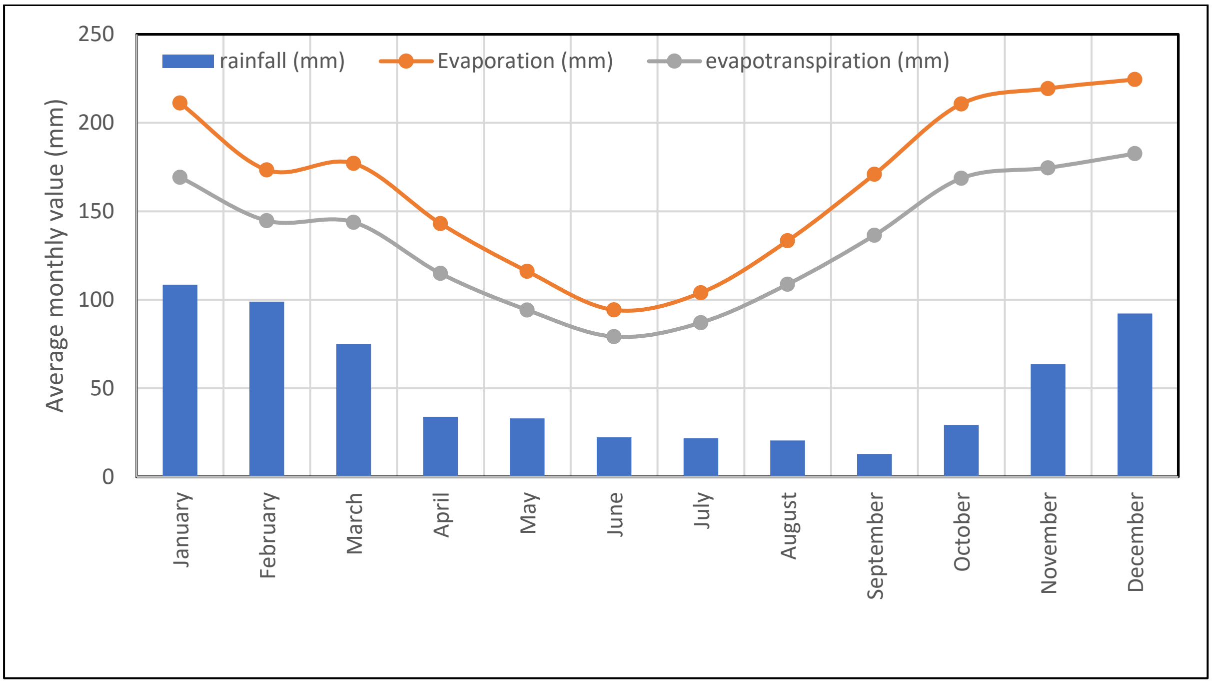
Figure 3-1: Long-term Monthly Rainfall and Cumulative Rainfall Deficit Curve at the Study Area (SILO Grid point -21.85, 148.45).



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 5.2.**

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 (EVT) 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 (EV) is approximately two to three times greater than the average monthly rainfall (**Figure 3-2**). The EVT and EV in the district are about 1,604 mm/year and 1,978 mm/year respectively, according to long-term averages calculated using SILO Grid point data for CCM.

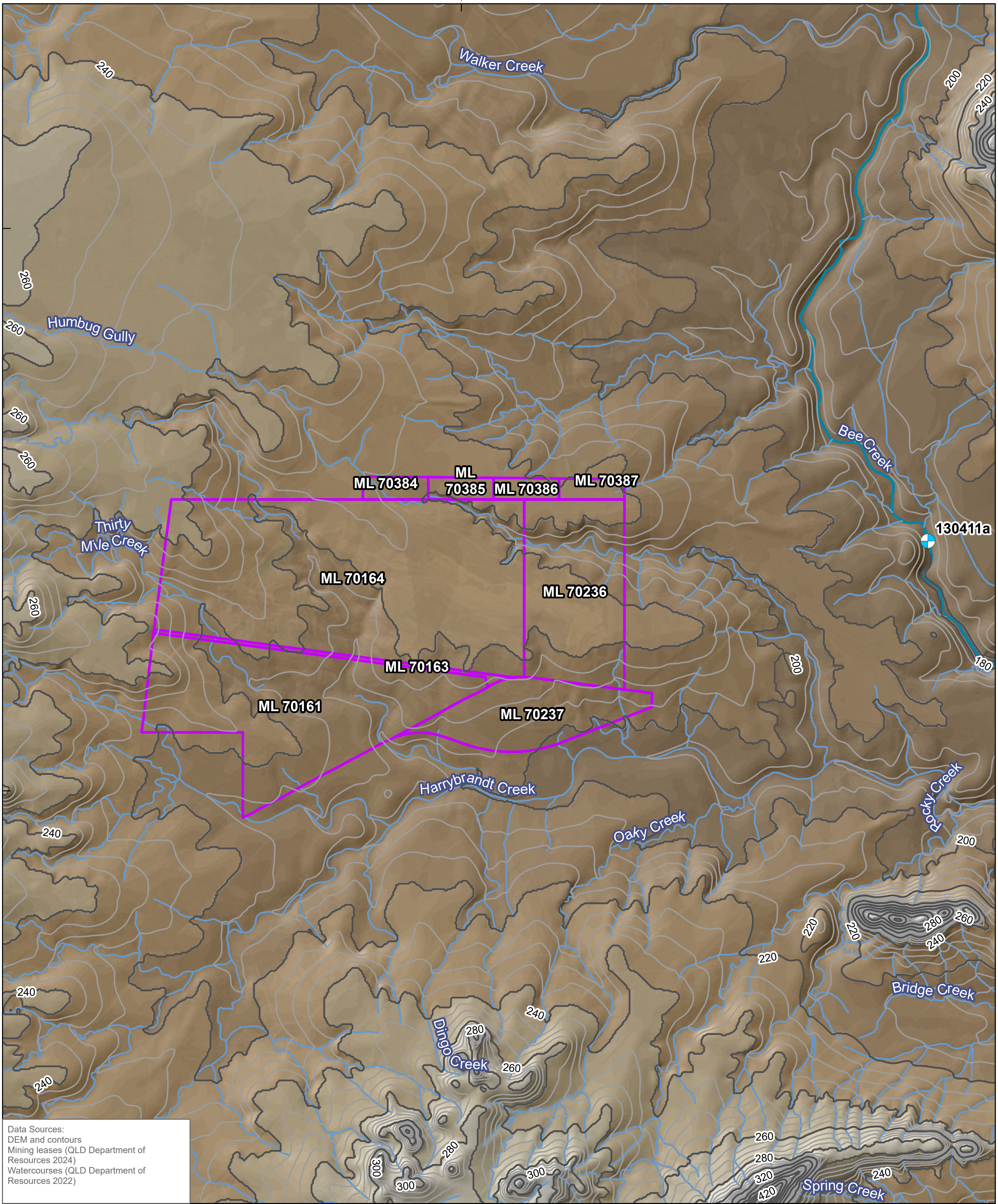
Figure 3-2: Average Monthly Rainfall, Pan Evaporation (EV) and Evapotranspiration (EVT) at SILO Grid Point – 21.85, 148.45



3.2 Topography and Drainage

3.2.1 Topography

The topography of the Study Area is relatively flat with gentle undulation with an overall gradient to the south, towards the Isaac River. Regionally CCM sits with the highest elevations of 280 mAHD and slopping down towards the north and north-east to Humbug Gully (220 mAHD to 210 mAHD), and to the south and southwest towards Thirty Mile Creek and Harrybrandt Creek (200 mAHD) (**Figure 3-3**).



0 1 2 km

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Drawn by:	JH

LEGEND

- Coppabella Mining Lease
- Mining Lease
- Major Watercourse
- Minor Watercourse
- Topographic Contour (5m)
- Topographic Contour (20m)
- Bee Creek Gauging Station

COPPABELLA EA GROUNDWATER ASSESSMENT

TOPOGRAPHY AND DRAINAGE

SLR

FIGURE 3-3

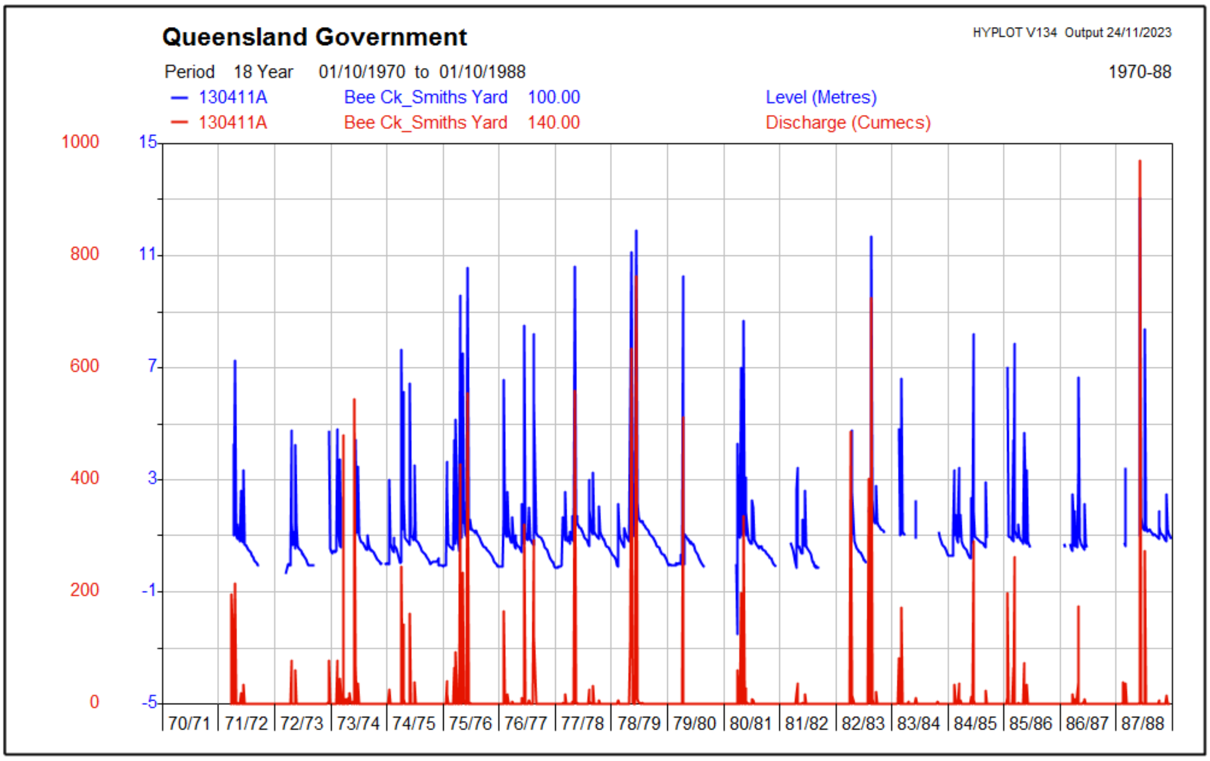
3.2.2 Surface Watercourses

CCM lies within the Connors River central tributaries sub area of the Isaac Connors Rivers Sub-basin of the wider Fitzroy Basin. The Connors River is the main watercourse in the vicinity of CCM, with all drainage lines in the Project vicinity draining toward it. The Connors River flows in a southerly direction, commencing approximately 75 km to the southeast of CCM. The Connors River generally flows west past Mount Bridget, before veering south. The river forms a series of braided channels and continues south, before discharging into the Isaac River at several points north of the Junee National Park, approximately 110 km southwest of CCM.

The CCM site is drained by 30 Mile Creek and Humbug Gully both of which are lower order tributaries of Harrybrandt Creek. Harrybrandt Creek is a tributary of the Connors River, via Bee Creek and Funnel Creek. There are no major natural water bodies located within the proximity of CCM. The hydrology associated with the waterways that traverse the CCM is ephemeral or seasonally variable in nature with flows only for short periods after rainfall, typically in the months of November through May. Historically, little or no flow occurs over long periods, punctuated by floods, typically caused by rain depressions associated with tropical cyclones. Flow parameters vary depending on the rainfall intensity and the condition of the waterway.

A DRDMW gauging station is located along Bee Creek at Smiths Yard (station 130411A) and operated from 1970 to 1988. This station is located approximately 6 km from the CCM and hydrologically slightly upstream. **Figure 3-4** presents stream discharge at the Smiths Yard station from 1970 to June 1988. The nature of the graph confirms ephemeral flows within Bee Creek.

Figure 3-4: Bee Creek (Station 130411A) Stream Flow



Peabody Energy maintain streamflow gauges at four locations in the local catchments of CCM. The gauges are located on both Thirty Mile Creek (gauging started in 2019) and Harrybrandt Creek (gauging started in 2010) at the following key locations (**Figure 3-7**):

- 1.1 km (Harrybrandt Creek) and 0.3 km (Thirty Mile Creek) upstream of CCM; and
- 4.9 km downstream (Harrybrandt Creek) 0.6 km (Thirty Mile Creek of CCM.

Figure 3-5 and **Figure 3-6** indicate both 30 Mile and Harrybrandt Creeks are highly ephemeral streams, with frequent periods of negligible (i.e. less than 0.5 m³/s) or no flows.

Figure 3-5: Recorded water level at Harrybrandt Creek downstream (Peabody Energy, 2023)

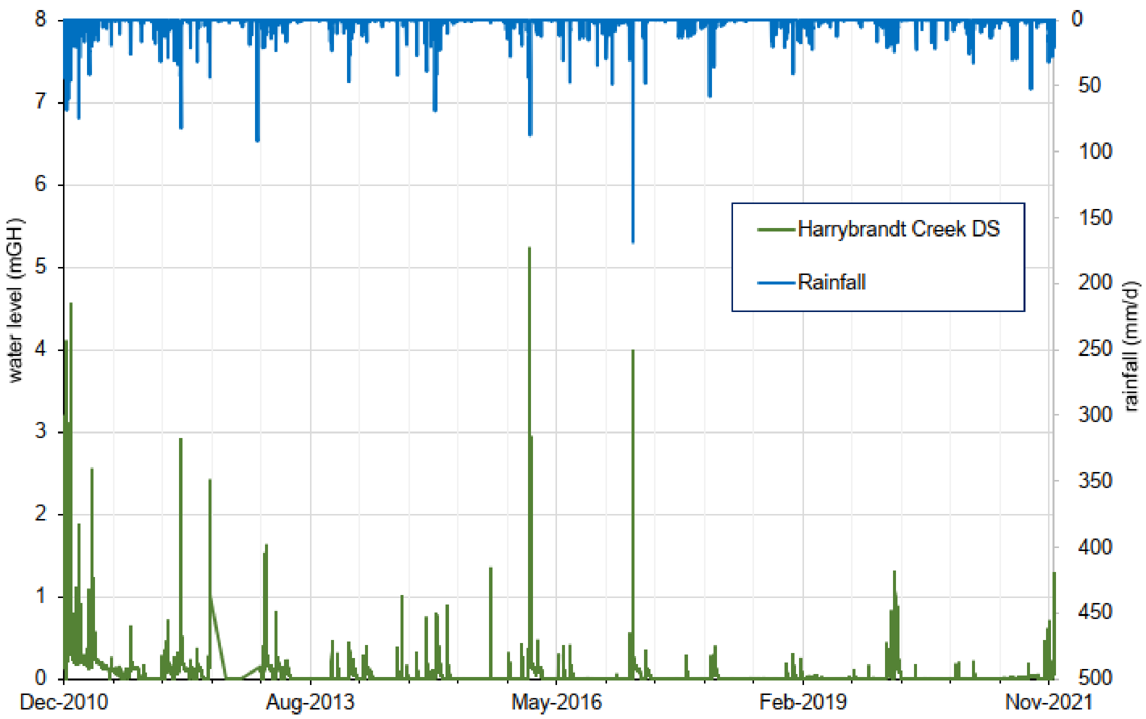


Figure 3-6: Recorded water level at 30 Mile Creek downstream (Peabody Energy, 2023)

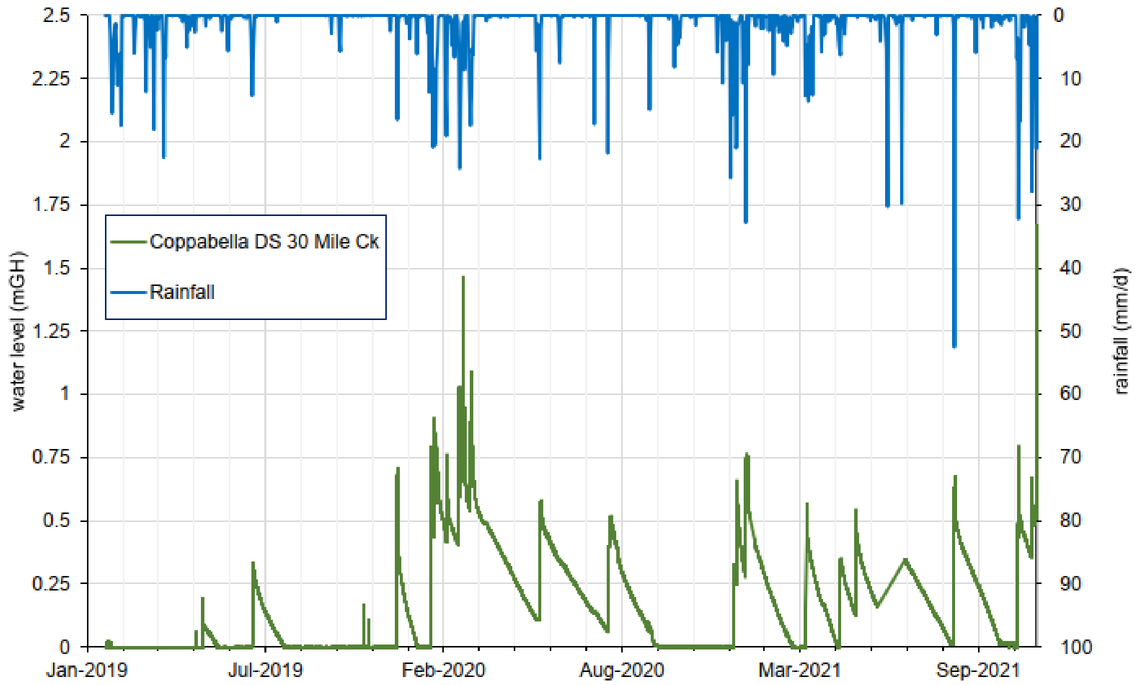
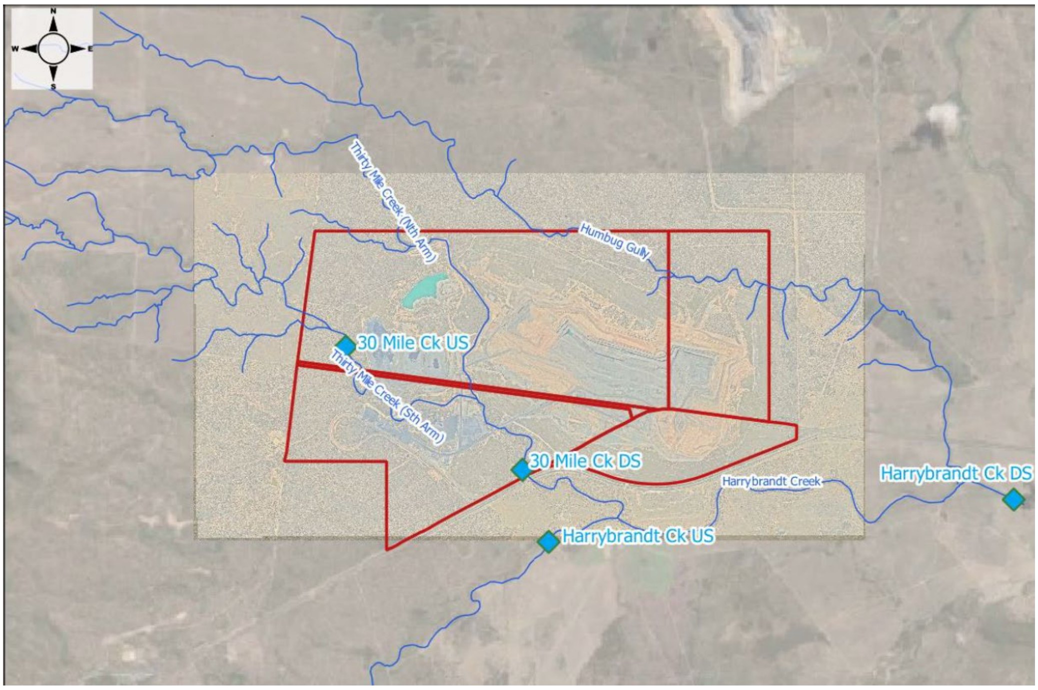


Figure 3-7: Locations of gauging stations (Peabody, 2023)



3.3 Land Use and Mining

CCM operations cover an area of 3,964 hectares (ha). The land outside of mining activities is dominated by cleared native pasture used for grazing, with some proximal areas of land classified under other minimal use. There are no nature conservation areas, including National or State Parks in or nearby CCM. There is no Strategic Cropping Land mapped within CCM.

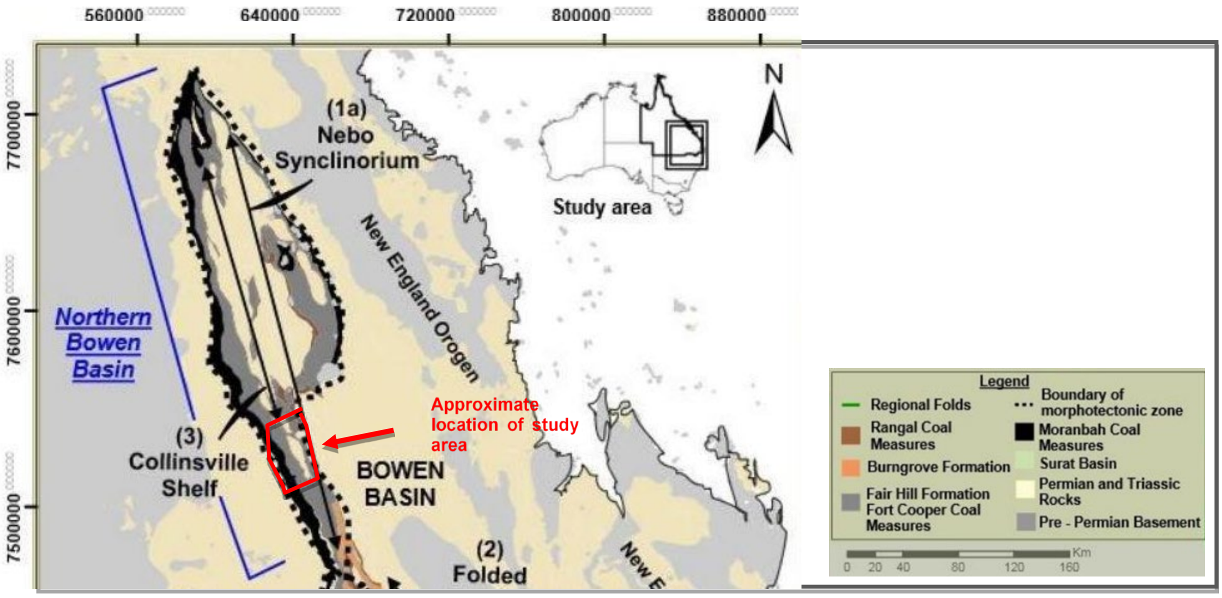
Overall, the two predominant land uses are mining and agriculture (grazing). There are several proposed and active coal mining operations near to CCM. The South Walker Creek (SWC) coal mine is the nearest. There are also proposed wellfields for extraction of coal seam gas (CSG) associated with the Bowen Gas Project, however no CSG gas projects are located within the vicinity of CCM.

4.0 Geology

4.1 Regional Geology

The Coppabella coal deposit is in the central part of the Bowen Basin, a foreland sedimentary basin of approximately 200,000 km^2 (**Figure 4-1**). The Bowen Basin is a north-northwest to south-southeast oriented basin and contains the largest coal reserves in Australia. The southern half of the Bowen Basin is covered by the Surat Basin, and the Galilee Basin exists to the west (Geoscience Australia, 2017).

Figure 4-1: Structural Setting of the Bowen Basin (after Dickins and Malone, 1973)



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 Moranbah Coal Measures, Fort Cooper Coal Measures and Rangal Coal Measures. The Permian strata occur at outcrop on the eastern and western edges of the Basin and are generally unconformably overlain by the Triassic aged terrestrial sedimentary rocks of the Rewan Group.

The Bowen Basin comprises seven morphotectonics zones, including the Tarro Trough, Denison Trough, Springsure Shelf, Collinsville Shelf, Comet Ridge, Nebo Synclinorium, and a Folded Zone (Hutton, 2009). Within the western portion of the Project, the Bowen Basin comprises the Collinsville Shelf which extends west beyond Moranbah and the Study Area boundary, while in the east the Nebo Synclinorium is present, extending close to the township of Nebo, with the eastern margin of the Bowen Basin extending slightly beyond Nebo (within the Study Area). The economic seams of the CCM are contained in the Late Permian Rangal Coal Measures.

The Permian and Triassic units are covered by a thin veneer of unconsolidated to semi-consolidated Cainozoic sediments (Tertiary to Quaternary alluvium and colluvium). The alluvial sediments are localised along rivers and creeks. Volcanic intrusions and extrusions (i.e. basalt) are also present within the region about 16 km northeast of the CCM.

The major lithological units found in the vicinity of CCM are shown in **Table 4-1**.

Table 4-1: General Stratigraphic Sequence

Period	Stratigraphic Unit		Map code	Lithological Description	Thickness (m)*	
					Site (AGE, 2010a, CMJV (2014a)	Wider area (URS 2012)
Quaternary	Alluvium		Qa Qpa	Clay, silt, sand, and gravel; flood-plain alluvium	0.2 to 7	15-35
Quaternary/ Tertiary	Regolith - alluvium, colluvium and other sediments in floodplains, alluvial fans, and high terraces		TQa TU TQf	Locally red-brown mottled, poorly consolidated sand, silt, clay, minor gravel; high-level alluvial deposits (generally related to present stream valleys but commonly dissected)	0.2 to 7	15-30
Tertiary	Suttor Formation		Tu	Quartz sandstone, clayey sandstone, mudstone, and conglomerate; fluvial and lacustrine sediments; minor interbedded basalt.	4-56	0-120
	Duaringa Formation		Tb, Tv	Mudstone, sandstone, conglomerate, siltstone, oil shale, lignite & basalt	0	0-50
Cretaceous	Undifferentiated igneous intrusives		Kgc	Gabbro, dolerite monzogranite	0	Thickness unknown, located12 km southeast of the CCM
Triassic		Moolayember Formation		Micaceous lithic sandstone, micaceous siltstone	0	0-200
	Mimosa Group	Clematis Group	Re	Cross-bedded quartz sandstone, some quartz conglomerate and minor red-brown mudstone.	0	0-300
		Rewan Group	Rr	Lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanilithic pebble conglomerate (at base). Sandstone mudstone & minor	0-650(?)	200-800

Period	Stratigraphic Unit		Map code	Lithological Description	Thickness (m)*	
					Site (AGE, 2010a, CMJV (2014a)	Wider area (URS 2012)
				conglomerate (at base).		
Permian	Blackwater Group	Rangal Coal Measures	Pwj	Calcareous sandstone, calcareous shale, mudstone, and concretionary limestone including the following coal seams: Leichardt. Millennium; and Vermont.	150	25-250
		Fort Cooper Coal Measures	Pwt	Lithic sandstone, conglomerate, mudstone, carbonaceous shale, coal, tuff, tuffaceous (cherty) mudstone.	400(?)	100-600
		Moranbah Coal Measures	Pwb	Labile sandstone, siltstone, mudstone, coal, conglomerate in the east	(?)	100-700
	Back Creek Group		Pb	Quartzose to lithic sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite	(?)	400-1200

4.2 Local Geology

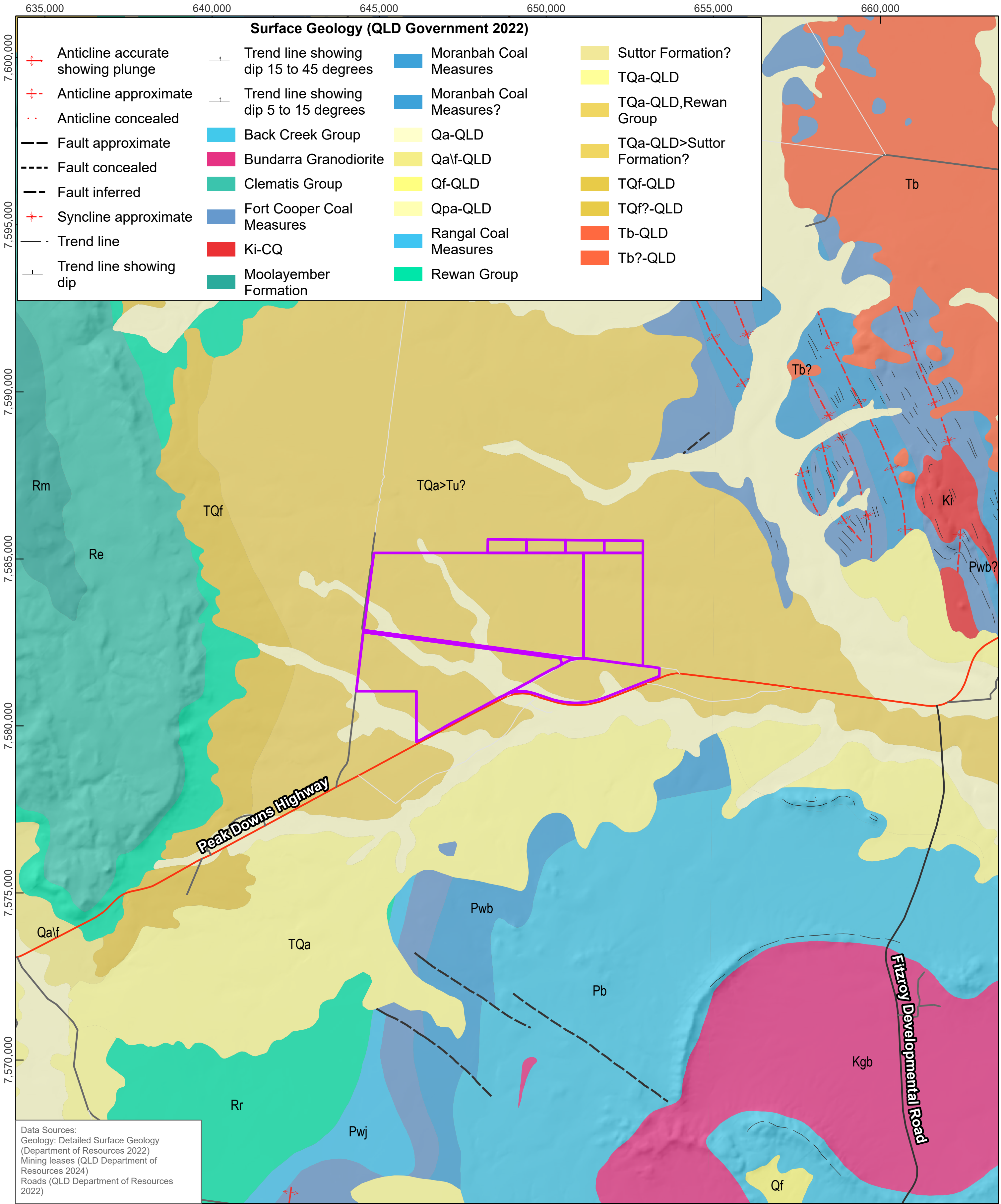
To characterise the stratigraphic units across the site a review of all available site geology and hydrogeology data has been undertaken. The review has included an assessment of existing hydrogeological reports, and modelled floor and roof elevations of identified key stratigraphic units generated from the CCM site geology model.

4.2.1 Quaternary Alluvial Deposits

The extent of the surficial Quaternary Alluvium across the Study Area is shown in **Figure 4-2** and is associated with the existing and historical watercourses across the region. These complex unconsolidated sediments are extremely heterogeneous, generally comprising channel and floodplain deposits of gravel, sand, silt, and clay. These sediments lie unconformably over the Tertiary and Triassic deposits (where present) in the Study Area. The Quaternary Alluvium generally ranges from 15 m to 35 m in thickness but are up to 50 m thick along the channels of the Connor River (URS 2013).

Local to the site, Quaternary Alluvium is found across the southern boundary of the CCM and is associated with Harrybrandt Creek and Thirty Mile Creek and their tributaries. This unit is described as being up to 7 m thick locally (AGE, 2010a) at the CCM but is of limited extent, due to the general lack of major natural drainage channels across the site.

The alluvial deposits are extensive across the region with greatest concentrations within the Study Area found around the water course of Bee Creek, Cooper Creek, Nebo Creek, Denison Creek, Funnel Creek and Devlin Creek in the east and the upper reaches of the Connor River and associated tributaries in the west and south.



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	640.030987
Date Drawn:	25-Jan-2024
Drawn by:	JH

LEGEND

- Coppabella Mining Lease
- Principal Road
- Road
- Minor Road
- Track

COPPABELLA EA GROUNDWATER ASSESSMENT

SURFACE GEOLOGY

SLR

FIGURE 4-2

Path: H:\Projects-SLR\640-MEL\640-MEL\640.030987.00001 Coppabella EA Groundwater Asse\06 SLR Data\01 CADGIS\GIS\640030987_Coppabella_GW\640030987_Coppabella_GW.aprx\640030987_F4-3_SurfaceGeology

4.2.2 Tertiary Suttor and Duaringa Formations

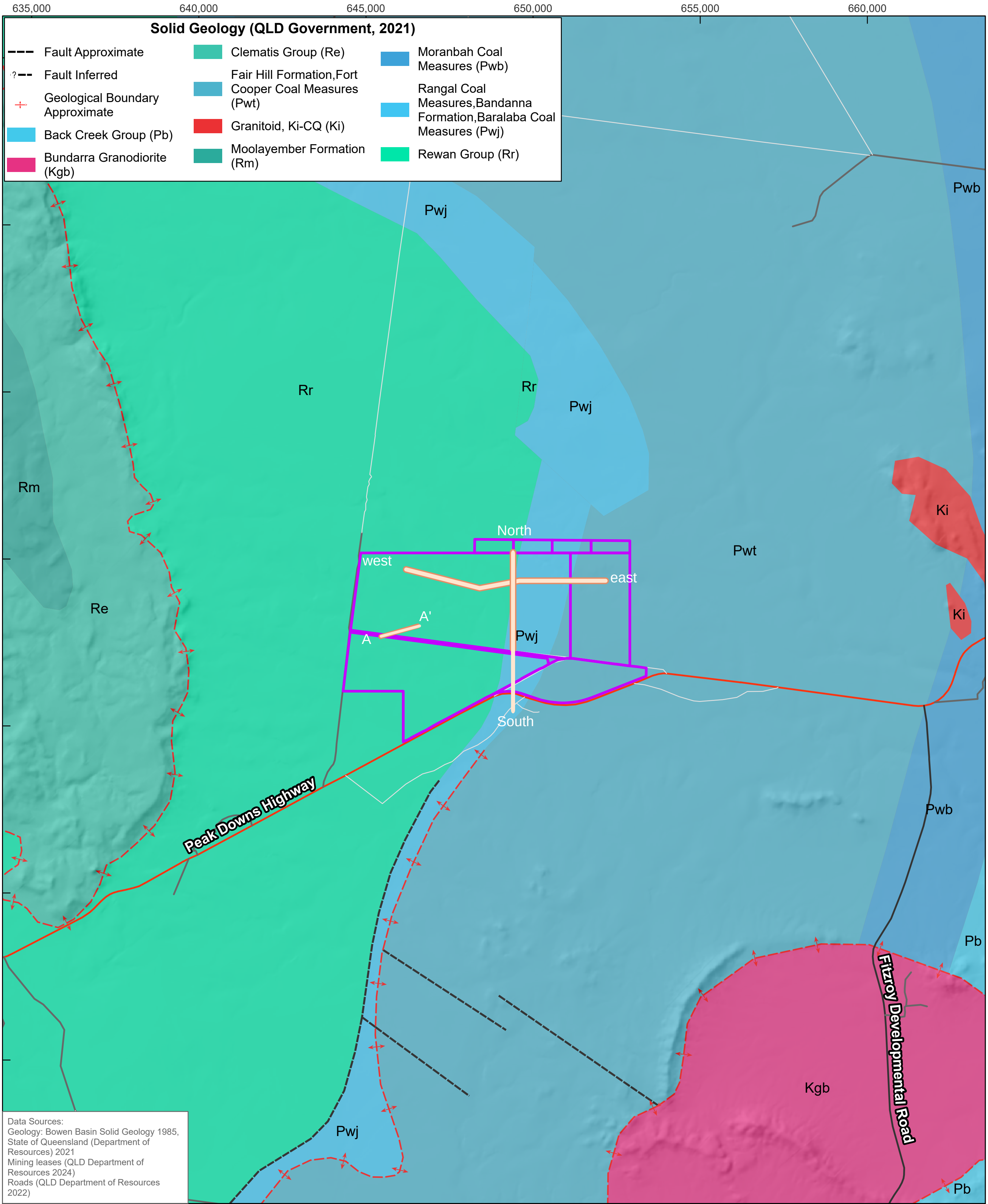
Across the Study Area the undifferentiated Tertiary Sediments and the Suttor Formation are the most dominant Tertiary aged units. The Suttor Formation comprises quartz sandstone, clayey sandstone, mudstone, and conglomerate of fluvial and lacustrine origin along with minor interbedded basalt (Geoscience Australia, 2014). The undifferentiated Tertiary Sediments generally consist of sands, gravels, clays, residual soils, and colluvium. They range up to 120 m thick within the Study Area (proximal to Moranbah) but are generally closer to 15 m thick (WPC, 2015). The Tertiary Sediments extend across the majority of the CCM site **(Figure 4-2)** with a thickness between 4 m and 56 m and an average thickness of 25 m (AGE, 2010a).

The Tertiary Duaringa Formation comprises mudstone, sandstone, conglomerate, siltstone, oil shale, lignite, and basalt (Geoscience Australia, 2014) and is generally restricted to outcrop in the south-east of the Study Area, closer to the Duaringa Basin, which formed as a result of post Bowen Basin faulting (Arrow, 2012). South of the Study Area these sediments can be several hundred meters thick but within the Study Area are generally expected to be less than 60 m thick. Mapping of surface geology (DNRM, 2014; see **Figure 4-2**) within the Study Area suggests that this unit may outcrop some 20 km south-east of the CCM site, beneath the Late Tertiary to Quaternary deposits in the area.

4.2.3 Triassic Rewan Group

The Rewan Group comprises Late Permian to Early Triassic strata with pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerates (at base) (Geoscience Australia, 2014). Where present, the unit conformably overlies the Permian strata in the Study Area and originates from a fluvial-lacustrine depositional environment, being deposited after the peat swamps of the Late Permian had dried out (Cadman et al., 1998). The Rewan Group is extensive over the central and northern parts of the Study Area, outcropping and sub-cropping in a number of areas as part of the folded structures across the region which disrupts the Triassic and Permian strata (see **Figure 4-3**). In the Bowen Basin this unit is up to 800 m thick but within the Study Area it is generally less than 300 m thick (Arrow, 2012).

This unit is mapped across the majority of the CCM site (**Figure 4-3**) but logging has revealed significantly varying thicknesses. Based on stratigraphy presented in (AGE, 2010a) the Rewan Group is less than 100 m thick. This unit is absent in the eastern portion of CCM.



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	640.030987
Date Drawn:	29-Jan-2024
Drawn by:	JH

LEGEND

- Coppabella Mining Lease
- Cross Section Location
- Principal Road
- Road
- Minor Road
- Track

COPPABELLA EA GROUNDWATER ASSESSMENT

SOLID GEOLOGY

SLR

FIGURE 4-3

4.2.4 Permian Coal Measures

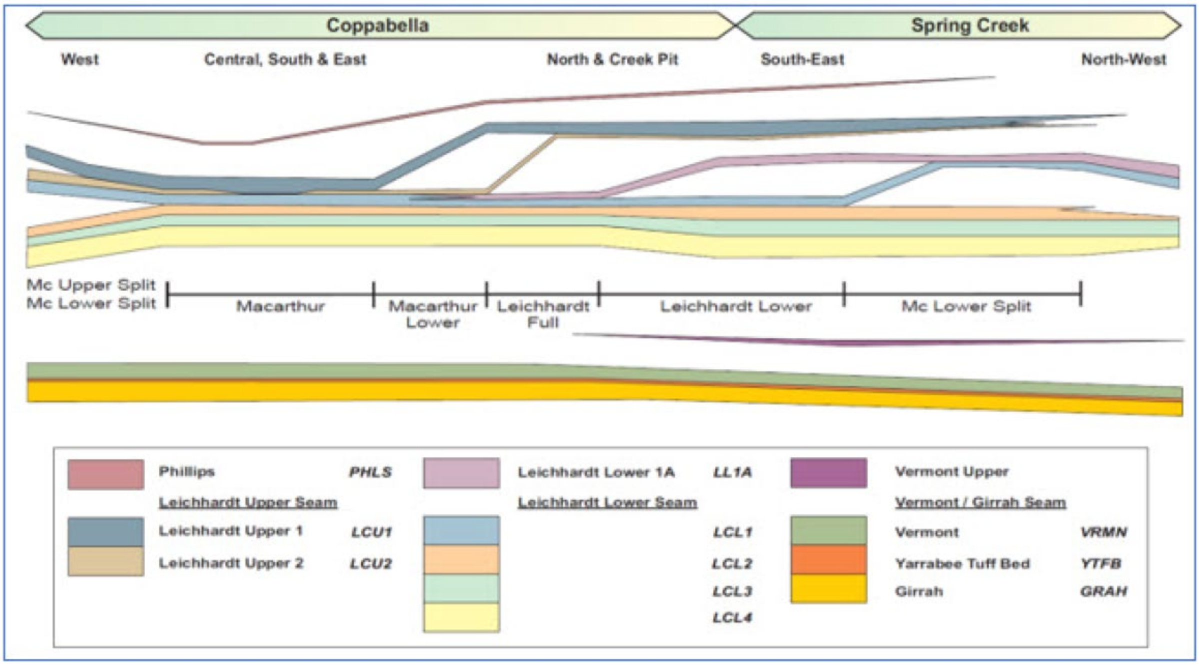
As detailed in T**able 4-1**, the Permian Coal Measures within the regional setting are the Rangal Coal Measures, Fort Cooper Coal Measures, and the Moranbah Coal Measures. The Rangal Coal Measures and Fort Cooper Coal Measures underly CCM and are described further in this section.

4.2.4.1 Rangal Coal Measures

The Rangal Coal Measures are the youngest of the Late Permian Coal Measure formations and contain a number of the economic target seams for coal mining operations within the Study Area. The unit generally comprises calcareous sandstone, calcareous shale, mudstone, coal, and concretionary limestone (Geoscience Australia, 2014). Coal seams within the Rangal Coal Measures include the Phillips, Upper and Lower Leichhardt (coalesced as the Macarthur at the CCM), Vermont Upper and Vermont Lower. This unit conformably overlies the Fort Cooper Coal Measures. The coals seams contain fractured and well-cleated coal seams with overburden and interburden of competent, cross bedded, fine to medium grained sandstone, grey siltstone, carbonaceous shale, and mudstone layers (Arrow, 2012), with localised fracture or fault systems (AGE, 210). The basal marker of the Rangal Coal Measures and its transition from the Fort Cooper Coal Measures is the Yarrabee Tuff, a tuffaceous claystone.

The Rangal Coal Measures which include the economic coal seams mined at CCM are present beneath the site (AGE, 2010). These in turn are underlain by the Fort Cooper Coal Measures which are characterised by the Vermont Seam, Yarrabee Tuff Bed and Girrah Seam, which are understood will not to be intersected by mining. The top of the Fort Cooper Coal Measures is typically around 35m below the Macarthur/Leichhardt Lower Seams mined at this site by open cut mining (**Figure 4-4**). Typically, the Rangal Coal Measures are around 150m thick and consist of lithic sandstone interbedded with siltstone, minor carbonaceous shale, mudstone, and coal.

Figure 4-4: Various coal seam present in the CCM (extracted from Peabody, 2021)



4.2.4.2 Fort Cooper Coal Measures

Within the Study Area, the Fort Copper Coal Measures mainly comprise the Fair Hill Formation, comprising lithic and felspathic labile sandstone, quartzose sublabile sandstone, siltstone, mudstone, calcareous and tuffaceous sandstone, volcanic conglomerate, carbonaceous mudstone, and coal seams (Geoscience Australia, 2014). The Fair Hill Formation is extensive across the Study Area (see **Figure 4-3**) and contains up to seven main coal seams (banded with claystone, mudstone, and siltstone) with interburden consisting mainly of sandstone and mudstone and a total thickness of over 100 m across the Study Area (Arrow, 2012). This unit is present across the CCM site, although the exact extent and thickness is unknown.

4.2.4.3 Moranbah Coal Measures

The Moranbah Coal Measures conformably overlie the Early to Late Permian Back Creek Group and comprise labile sandstone, siltstone, mudstone, coal, and conglomerate (Geoscience Australia, 2014). This unit outcrops to the north, east and west of the CCM site and is regionally extensive underneath the Fort Cooper Coal Measures (Figure 4-3). This unit has a number of coal seam packages which represent target formations for CSG operations in the region ranging from 100 m up to 700 m thick across the region (Arrow, 2012). This unit is present across the CCM site at significant depths, although the exact extent and thickness is unknown.

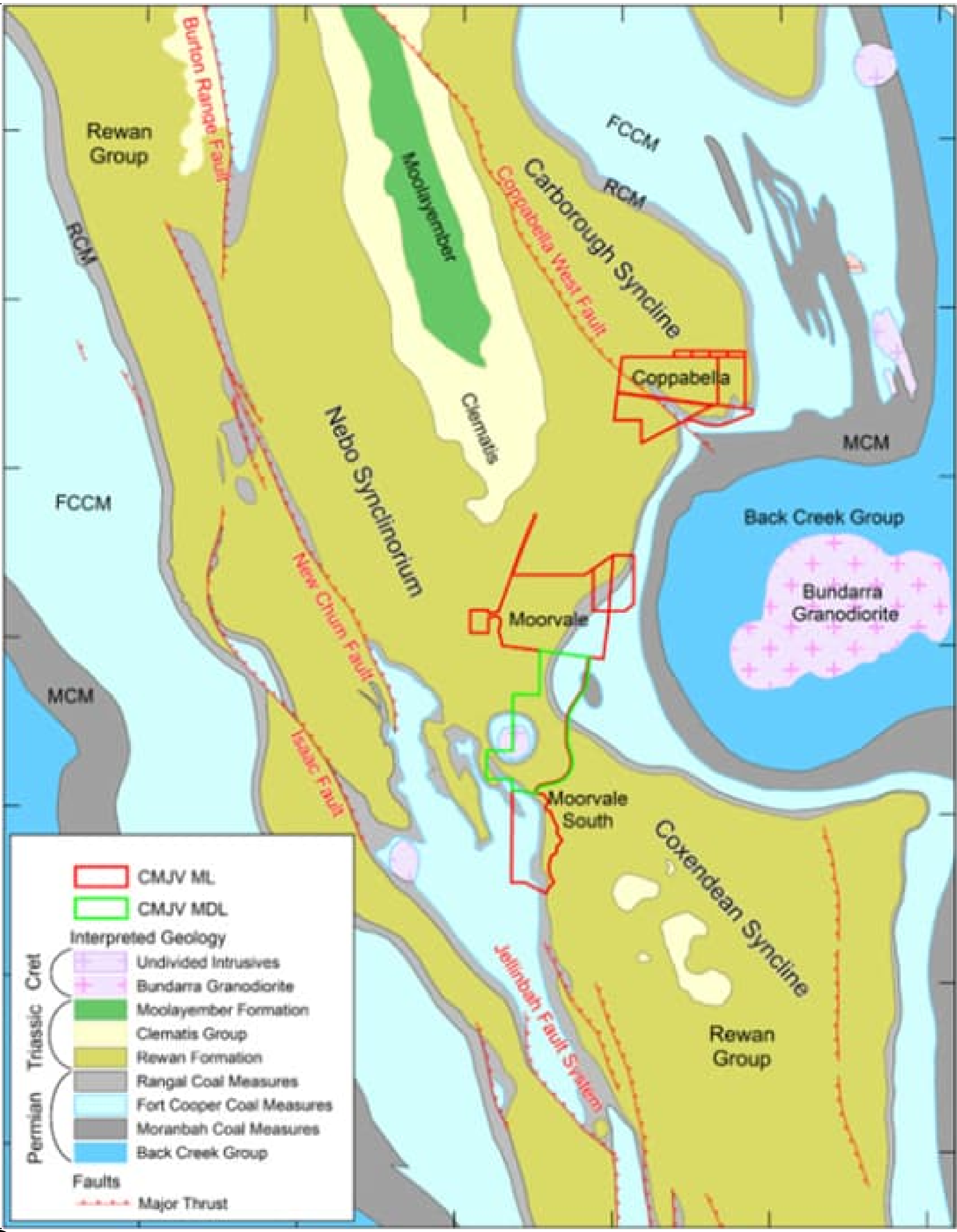
4.2.5 Black Creek Group

The Back Creek Group comprises a number of sub-units including the Exmoor, Blenheim, Gebbie and Tiverton Formations across the Study Area. These units consist of quartzose to sub labile sandstone, carbonaceous and micaceous labile sandstone, siltstone, mudstone, shale, rare limestone, coquinite, and minor conglomerate (Geoscience Australia, 2014). The Back Creek Group underlies the Blackwater Group across the region with extensive sub-crops in the east and along the western margin of the Study Area. The Back Creek Group represents the lowermost unit of those considered in the current site characterisation. This unit is present across the CCM site at significant depths, although the exact extent and thickness is unknown.

4.2.6 Structural Geology

Macarthur Coal (C&M Management) Pty Ltd described the structure of the Coppabella area as being dominated by a broad syncline which closes to the south-east, resulting in a U-shaped zone containing the stratigraphic units that include the mining target coal seams. The syncline axis is orientated north-west in the mine area with Johnson Pit located on its western limb. Structure within the syncline is uniform, with coal seams essentially planar and dipping on average 5° to 6° to the north-east. A series of north-northwest trending faults with an estimated throw of between 10m and 60m offset the subcrop in the north and east. The coal seam subcrop in the Johnson and Creek Pits is terminated in the west and south-west by a north-west trending line of thrust faults with large throws and steep dips and upthrust against Rewan Group sediments (**Figure 4-5**).

Intrusive sills up to 0.5m thick occur throughout the Johnson Pit area, generally either in the upper or lower parts of the coal seams. These intrusions are typically weathered and have decomposed to soft, light grey clays with limited effect on the coal. However, in the East and South Pits, the intrusions are more pervasive resulting in much of the coal seam being cindered. However, their distribution and thickness are highly erratic and variable.



0 5 10 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:300,000 at A4
Project Number:	640.030987
Date Drawn:	29-Jan-2024
Drawn by:	JH

Data Sources:
Information provided by Peabody (2023)

COPPABELLA EA
GROUNDWATER ASSESSMENT

STRUCTURAL FEATURE OF THE CCM
(extracted from Peabody, 2021)

SLR

FIGURE 4-5

Path: H:\Projects-SLR\640-MEL\640-MEL\640.030987.00001 Coppabella EA Groundwater Asse\06 SLR Data\01 CADGIS\GIS\640030987_Coppabella_GW\640030987_Coppabella_GW.aprx\640030987_F4-6_StructuralFeatureCCM

5.0 Hydrogeology

The following section outlines the hydrogeology of the CCM and Study Area sufficient to define the mechanisms that may contribute to potential groundwater impact within the Project Area. There is somewhat limited aquifer testing monitoring data within the Project Area. To offset this, data from adjacent mines and projects, as well as publicly available regional data, has been incorporated in the analysis to complement site data in characterisation of the hydrostratigraphic units.

5.1 Groundwater Monitoring

The groundwater monitoring network at CCM includes three main bore groupings:

- 40 shallow monitoring bores installed in alluvial, spoil, and tailings material around the co-disposal area (CDA) to monitor groundwater levels within the CDA. Some bores were installed in 2005 with more subsequently installed in 2014, 2015, 2019 and 2021. Groundwater quality was monitored (mainly in 2021 and 2022) in 18 bores in the area (**Figure 5-1** and **Table 5-1**).
- 11 monitoring bores were installed in 2009 (**Figure 5-2** and **Table 5-1**) in and around the current CCM, with 7 subsequently mined through. The bores were installed in Tertiary Sediments, Permian interburden and coal seams of the Rangal Coal Measures. Two rounds of groundwater monitoring for limited analytes were undertaken in 2009. Four bores being monitored for groundwater level using data loggers since 2014.
- 11 monitoring bores were installed at the Coppabella North project at the northern side of the Project, targeting Rangal Coal Measures (interburden and coal seams) and Tertiary Sediments (**Figure 5-2** and **Table 5-1**).

Coordinate System: GDA2020 MGA Zone 55
Scale: 1:15,000 at A4
Project Number: 640.030987
Date Drawn: 29-Jan-2024
Drawn by: JH

LEGEND

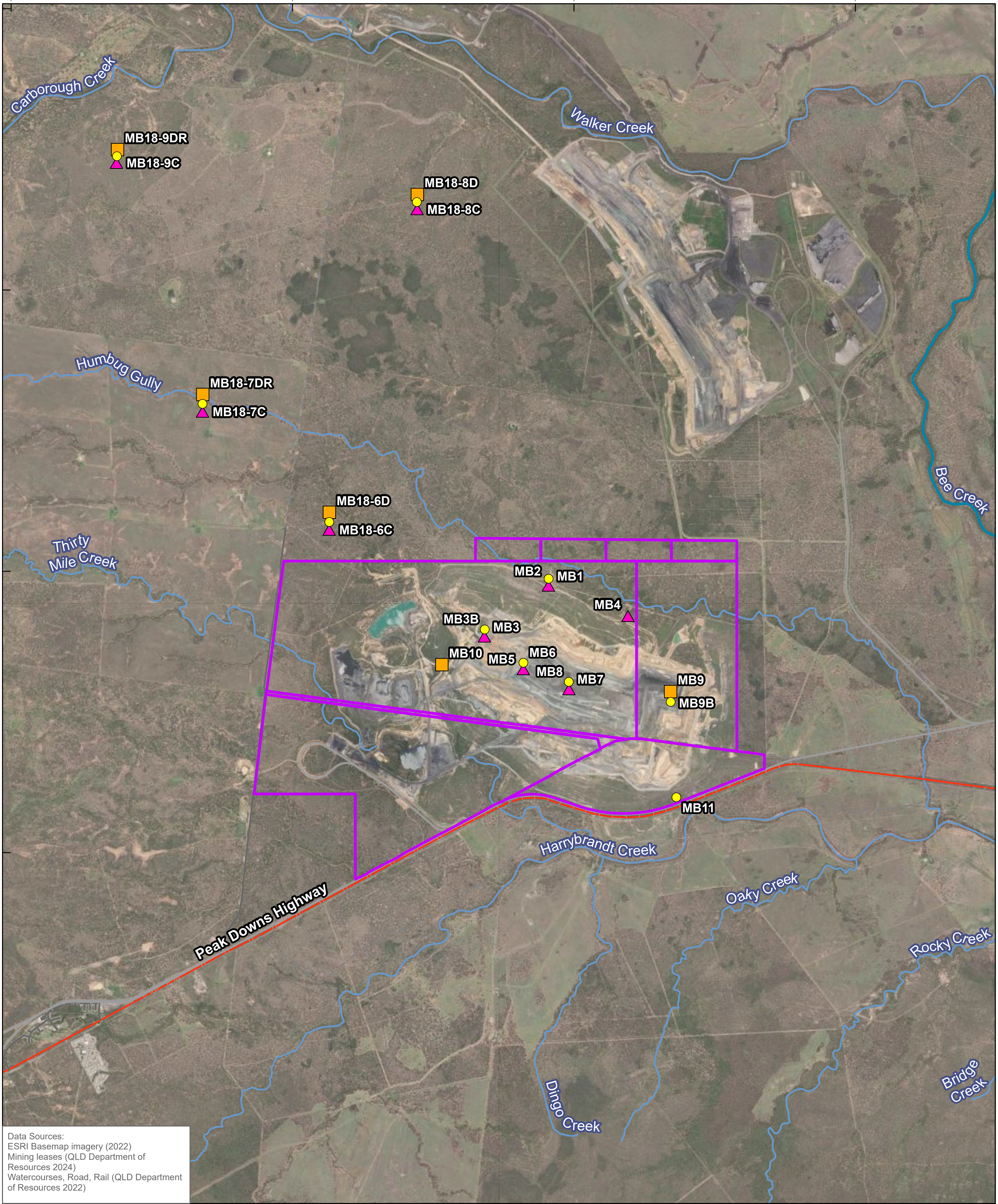
- Co-disposal Area
- Sediment Basin
- Soil Stockpile
- Water Storage
- CHPP
- Johnson Pit
- South Pit and East Pit
- Coppabella Mining Lease
- Rail
- Minor Watercourse
- Groundwater Monitoring Bore

COPPABELLA EA GROUNDWATER ASSESSMENT

MONITORING BORE LOCATIONS CO-DISPOSAL AREA

SLR

FIGURE 5-1



0 1 2 km

Coordinate System: GDA2020 MGA Zone 55

Scale: 1:90,000 at A4

Project Number: 640.030987

Date Drawn: 25-Jan-2024

Drawn by: JH

LEGEND

Coppabella Mining Lease

Rail

Principal Road

Minor Road

Track

Major Watercourse

Minor Watercourse

Grounwater Monitoring Bore - Lithology

Tertiary

Permian Coal Seam

Permian Overburden

COPPABELLA EA GROUNDWATER ASSESSMENT

MONITORING BORE LOCATIONS MINE PIT AND COPPABELLA NORTH AREA

SLR

FIGURE 5-2

Table 5-1 CCM Groundwater Monitoring Network Details

Bore Name	Coordinates (AMG 84, Zone 55)		Top of casing (mAHD)	Ground Surface RL (mAHD)	Depth	Screen top	Screen bottom	Screen Lithology	Location	Comments
	Easting	Northing			mbgl~	mAHD				
P1	646136	7581861	ND	ND	ND	ND	ND	ND	CDA	No logs available; blocked
P2	646753	7582314	252.103	251.315	ND	ND	ND	ND	CDA	No logs available (water level data 2011 to 2023)
P3	647041	7582405	247.73	246.942	ND	ND	ND	ND	CDA	No logs available, no data
P4	647078	7582608	248.549	247.706	ND	ND	ND	ND	CDA	No logs available (water level data 2011 to 2023)
P5/BH09-1	646118	7582674	246.163	245.412	22.4	ND	ND	Spoil & residual clay	CDA	No logs available (water level data 2014 to 2023)
P6/BH09-2	646143	7582752	246.114	245.459	20.8	ND	ND	Coarse unconsolidated material and residual sandy clay	CDA	No logs available (water level data 2014 to 2023)
P7/BH09-3	646109		245.876	245.171	15	ND	ND	Spoil & residual clay	CDA	No logs available (water level data 2014 to 2023)
P8/BH03	646354	7582259	245.92	245.22	24.5	ND	ND	Coarse unconsolidated material and residual sandy clay	CDA	No logs available (water level data 2014 to 2023)
P9/BH02	646084	7582280	245.537	244.861	27.5	ND	ND	Coarse unconsolidated material and residual sandy clay	CDA	No logs available (water level data 2014 to 2023)
P10/BH01	646033	7582532	244.922	244.278	19.3	ND	ND	Fines very soft unconsolidated material	CDA	No logs available (water level data 2014 to 2023)
P11-East	647043	7582910	249.514	248.725		ND	ND		CDA	No logs (water level 2014 to 2023)
P11	646246	7582835	ND	251.223	19	238.487	232.487	Soft then stiff tailings	CDA	Water level 2014 to 2019

Bore Name	Coordinates (AMG 84, Zone 55)		Top of casing (mAHD)	Ground Surface RL (mAHD)	Depth	Screen top	Screen bottom	Screen Lithology	Location	Comments
	Easting	Northing			mbgl~	mAHD				
P12	646267	7582895		251.386	18	240.128	234.128	soft tailings	CDA	Water level 2014 to 2023
P13	646300	7582975		251.092	18	239.197	233.197	soft tailings	CDA	Water level 2014 to 2023
P14	646845	7582323	249.796	249.145	30	228.145	219.145	spoil	CDA	Water level 2017-2023
P15	646846	7582244	238.235	237.308	19.5	224.808	217.808	spoil	CDA	Water level 2017-2021
P16	647067	7582496	247.564	246.994	31	222.494	215.994	spoil	CDA	Water level 2017-2023
P21	645685	7582459	219.509	219.376	5.5	218.376	213.876	Clayey sand	CDA	Water level 2015
P21B	645686	7582455	219.525	ND	10	211.025	209.525	sand	CDA	Water level 2021-2023 Water Quality 2021-2022
P21C	645683	7582464	219.693	ND	15	206.193	204.693	clay	CDA	Water level 2021-2023 Water Quality 2021-2022
P22	645675	7582586	221.379	220.764	5.5	219.764	215.264	Sandy clay	CDA	Water level 2015-2023 Water Quality 2021
P22B	645680	7582589	221.594	220.987	10.5	212.987	210.987	Shale/Clay	CDA	Water level 2021-2023 Water Quality 2021-2022
P22C	645681	7582586	221.513	220.928	14.5	208.928	206.928	Shale/Clay	CDA	Water level 2021-2023 Water Quality 2021-2022
P23	645628	7582876	227.625	226.919	5.5	225.919	221.419	Sandy clay	CDA	Water level 2015-2023 Water Quality 2021-2022
P23B	645630	7582880	227.59	226.699	10.5	218.699	216.699	Shale/Clay	CDA	Water level 2020-2023 Water Quality 2021-2022
P23C	645629	7582868	227.447	226.58	14.5	214.58	212.58	Shale/Clay	CDA	Water level 2020-2023 Water Quality 2021-2022
P24	645569	7583258	234.073	233.408	5.5	232.408	227.908	Clayey sand, clay	CDA	Water level 2015 Water Quality 2021-2022

Bore Name	Coordinates (AMG 84, Zone 55)		Top of casing (mAHD)	Ground Surface RL (mAHD)	Depth	Screen top	Screen bottom	Screen Lithology	Location	Comments
	Easting	Northing			mbgl~	mAHD				
P24C	645566	7583253	234.738	ND	15	222.738	219.738	sand	CDA	Water level 2021-2023 Water Quality 2021-2022
P25	645821	7582477	231.99	231.38	13.3	221.63	218.63	Waste/spoil	CDA	Water level 2019-2023 Water Quality 2021-2022
P26	645655	7583135	241.77	240.93	13.3	231.18	228.18	Waste/spoil	CDA	Water level 2019-2023 Water Quality 2021-2022
P27	645829	7582500	240.25	239.54	23				CDA	Water level 2019-2023 Water Quality 2021-2022
P28A	645597	7583059	230.982	ND	5	227.482	225.982	sand	CDA	Water level 2021-2023 Water Quality 2021-2022
P28B	645596	7583066	231.047	ND	10	222.547	221.047	sand	CDA	Water level 2021-2023 Water Quality 2021-2022
P28C	645594	7583074	231.169	ND	15	217.669	216.169	clay	CDA	Water level 2021-2023 Water Quality 2021-2022
P29A	645464	7582775	219.098	ND	5	215.598	214.098	clayey sand	CDA	No data
P29B	645465	7582777	219.001	ND	10	210.501	209.001	claystone	CDA	No data
P30A	646153	7583252	258.125	ND	24	240.125	234.125	spoil	CDA	No data
P30B	646147	7583253	258.054	ND	54.82	209.234	203.234	spoil & clay	CDA	Water level 2021-2023 Water Quality 2021-2022
P31	646580	7582976	255.655	ND	21	240.655	234.655	spoil	CDA	Water level 2021-2023 Water Quality 2021-2022
P32	646995	7583025	239.902	ND	10.6	232.302	229.302	spoil	CDA	Water level 2021 Water Quality 2021

Bore Name	Coordinates (AMG 84, Zone 55)		Top of casing (mAHD)	Ground Surface RL (mAHD)	Depth	Screen top	Screen bottom	Screen Lithology	Location	Comments
	Easting	Northing			mbgl~	mAHD				
MB1**	649433	7584688	ND	228.42	104	136.42	124.42	Permian Overburden	Around the open cut mine	Installed in 2009, water level monitored since 2014 using data logger, water quality for two rounds in 2009. Average groundwater level 180.17 mAHD in 2009.
MB2**	649437	7584688	ND	228.5	48	191.9	184.7	Tertiary	Around the open cut mine	Installed in 2009. Average groundwater level 190.2 mAHD in 2009.
MB3**	648301	7583783	ND	225.25	119	123.25	106.25	Permian Overburden	Around the open cut mine	Installed in 2009, water quality for two rounds in 2009 and subsequently been destroyed during mining Average groundwater level 177.45 mAHD in 2009.
MB3B**	648302	7583786	ND	225.33	21	214.33	204.33	Tertiary	Around the open cut mine	Installed in 2009, water quality for two rounds in 2009 and subsequently been destroyed during mining. Dry in 2009.
MB4**	650847	7584038	ND	220.09	112	117.09	108.09	Permian Overburden	Around the open cut mine	Installed in 2009, water level monitored since 2014 using data logger, water quality for two rounds in 2009. Average groundwater level 183.1 mAHD in 2009.
MB5**	648986	7583194	ND	225.32	76	158.32	149.32	Permian Overburden	Around the open cut mine	Installed in 2009, water quality for two rounds in 2009 and subsequently been destroyed during mining. Average groundwater level 177.92 mAHD in 2009.
MB6**	648989	7583194	ND	225.25	43	188.25	182.25	Tertiary	Around the open cut mine	Installed in 2009, water quality for two rounds in 2009 and subsequently been destroyed during mining. Average groundwater level 185.96 mAHD in 2009.

Bore Name	Coordinates (AMG 84, Zone 55)		Top of casing (mAHD)	Ground Surface RL (mAHD)	Depth	Screen top	Screen bottom	Screen Lithology	Location	Comments
	Easting	Northing			mbgl~	mAHD				
MB7**	649798	7582858	ND	229.61	101	143.61	128.61	Permian Overburden	Around the open cut mine	Installed in 2009, water quality for two rounds in 2009 and subsequently been destroyed during mining Average groundwater level 175.16 mAHD in 2009.
MB8**	649795	7582855	ND	229.66	39	196.66	190.66	Tertiary	Around the open cut mine	Installed in 2009, water quality for two rounds in 2009 and subsequently been destroyed during mining (dry in 2009).
MB9**	651604	7582566	ND	224.69	118	113.69	107.69	Coal Seam	Around the open cut mine	Installed in 2009, water quality for two rounds in 2009 and subsequently been destroyed during mining. Average groundwater level 160.75 mAHD in 2009.
MB9B**	651606	7582565	ND	224.72	27	203.72	197.72	Tertiary	Around the open cut mine	Installed in 2009, water quality for two rounds in 2009 and subsequently been destroyed during mining. Dry in 2009.
MB10**	647540	7583160	ND	220.19	89	137.19	131.19	Coal Seam	Around the open cut mine	Installed in 2009, water level monitored since 2014 using data logger, water quality for two rounds in 2009. Average groundwater level 173.2 mAHD in 2009.
MB11**	662981	7553121	ND	199.4	26	179.4	173.4	Alluvial/Tertiary	Around the open cut mine	Installed in 2009, subsequently been destroyed during mining. Average groundwater level from dry 181.75 mAHD in 2009.
MB18-6B***	645652	7585875	237.11	236.326	36	204.326	201.326	Tertiary	Coppabella North	Installed in 2019, (dry).
MB18-6C***	645640	7585871	237.182	236.437	107	132.437	129.437	Permian Overburden	Coppabella North	Installed in 2019, water quality for two rounds in 2019, water quality and level data including logger in 2019. Average

Bore Name	Coordinates (AMG 84, Zone 55)		Top of casing (mAHD)	Ground Surface RL (mAHD)	Depth	Screen top	Screen bottom	Screen Lithology	Location	Comments
	Easting	Northing			mbgl~	mAHD				
										groundwater level 140.1 mAHD in 2019.
MB18-6D***	645644	7585892	236.603	236.087	184	77.087	71.087	Permian Coal	Coppabella North	Installed in 2019, water quality for two rounds in 2019, water quality and level data including logger in 2019. Average groundwater level 199.89 mAHD in 2019.
MB18-7B***	643400	7587975	251.991	251.073	45	212.073	206.073	Tertiary	Coppabella North	Installed in 2019, water quality for two rounds in 2019, water level data including logger in 2019. Average groundwater level 221.207 mAHD in 2019.
MB18-7C***	643397	7587962	252.268	251.324	190	69.324	63.324	Permian Overburden	Coppabella North	Installed in 2019, water quality for two rounds in 2019, water level data including logger in 2019. Average groundwater level 157.6 mAHD in 2019.
MB18-7DR***	643391	7587979	252.149	251.153	236.66	29.153	23.153	Permian Coal	Coppabella North	Installed in 2019, water quality for two rounds in 2019, water level data including logger in 2019. Average groundwater level 217.55 mAHD in 2019.
MB18-8B***	647208	7591562	230.83	230.062	30	206.062	200.062	Tertiary	Coppabella North	Installed in 2019, water quality for two rounds in 2019, water level data including logger in 2019. Average groundwater level 203.66mAHD in 2019.
MB18-8C***	647225	7591551	231.621	230.733	171	66.733	60.733	Permian Overburden	Coppabella North	Installed in 2019, water quality for two rounds in 2019, water level data including logger in 2019. Average groundwater level 79.88 mAHD in 2019.

Bore Name	Coordinates (AMG 84, Zone 55)		Top of casing (mAHD)	Ground Surface RL (mAHD)	Depth	Screen top	Screen bottom	Screen Lithology	Location	Comments
	Easting	Northing			mbgl~	mAHD				
MB18-8D***	647217	7591544	231.474	230.699	201	46.699	40.699	Permian Coal	Coppabella North	Installed in 2019, water quality for two rounds in 2019, water level data including logger in 2019. Average groundwater level 199.55 mAHD in 2019.
MB18-9B***	641879	7592377	248.524	247.808	21	232.808	226.808	Tertiary	Coppabella North	Installed in 2019, dry.
MB18-9C***	641876	7592362	249.252	248.227	204	56.227	50.227	Permian Overburden	Coppabella North	Installed in 2019, water quality for two rounds in 2019, water level data including logger in 2019. Average groundwater level 220.18 mAHD in 2019.
MB18-9DR***	641890	7592366	249.122	248.135	248	13.135	8.135	Permian Coal	Coppabella North	Installed in 2019, water level data including logger in 2019. Average groundwater level 219.75 mAHD in 2019.
~ metres below ground level; *SWL=Standing water level; #Rangal Coal Measures; + Fort Cooper Coal Measures; ^ Not Available; **Projection AGD 66; ***projection MGA 94; CDA = Co-disposal area; ND = No data										

5.2 Groundwater Distribution, Flow, Recharge and Discharge

5.2.1 Cainozoic Sediments

5.2.1.1 Groundwater Distribution and Flow

At CCM, the unconsolidated alluvial sediments associated with Thirty Mile Creek and Harrybrandt Creek, other Cainozoic sediments (e.g. Tertiary sediments), and weathered regolith, generally function as one interconnected hydrogeologic unit, though with significant heterogeneity given the lithological and stratigraphic distinctions within. The aquifer is mainly unconfined to semi-confined in nature.

As shown in **Table 5-1** above, groundwater monitoring of the shallow unconsolidated Cainozoic alluvial sediments at CCM is limited to the CDA and adjacent Thirty Mile Creek (**Figure 1**-2). Coarse rejects and tailings from the CHPP are selectively placed within the approved CDA. The shallow bores were installed within the shallow alluvial, spoil/tailings material (**Table 5-1**) and mainly located at the perimeter of the CDA area and some are located within CDA and CDA1 (**Figure 5-1** shows the locations and **Table 5-1** provides the screen lithology of all the bores).

Figure 5-3 presents hydrographs of the bores installed within spoil/tailings material and mostly located inside CDA boundary. As these bores are installed in spoil/tailings area, the water level response is related to the CDA operation (deposition of tailings material in the area with time and water level in the tailing storage facility) and therefore considered separate from this review process.

Figure 5-3: Hydrographs for bores installed inside the CDA (within spoil/tailing materials)

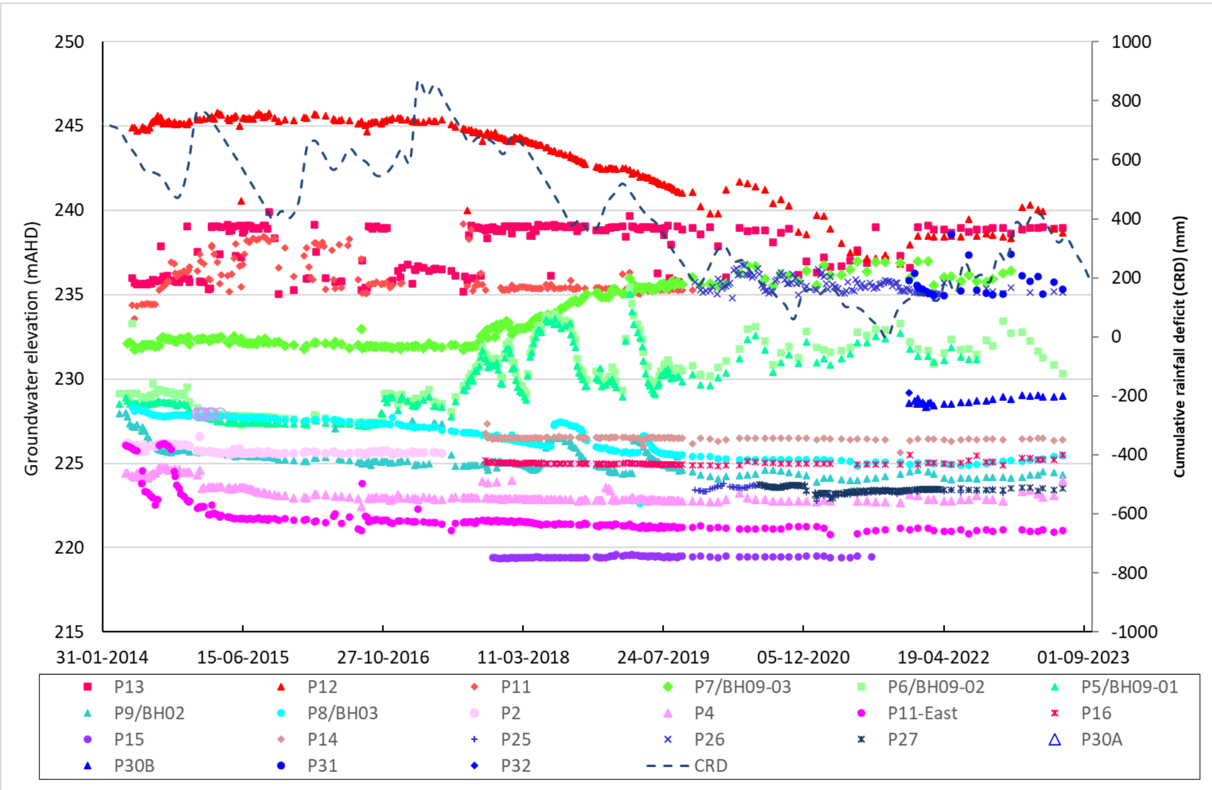


Figure 5-4: Hydrographs for monitoring bores installed at the western boundary (alluvial material)

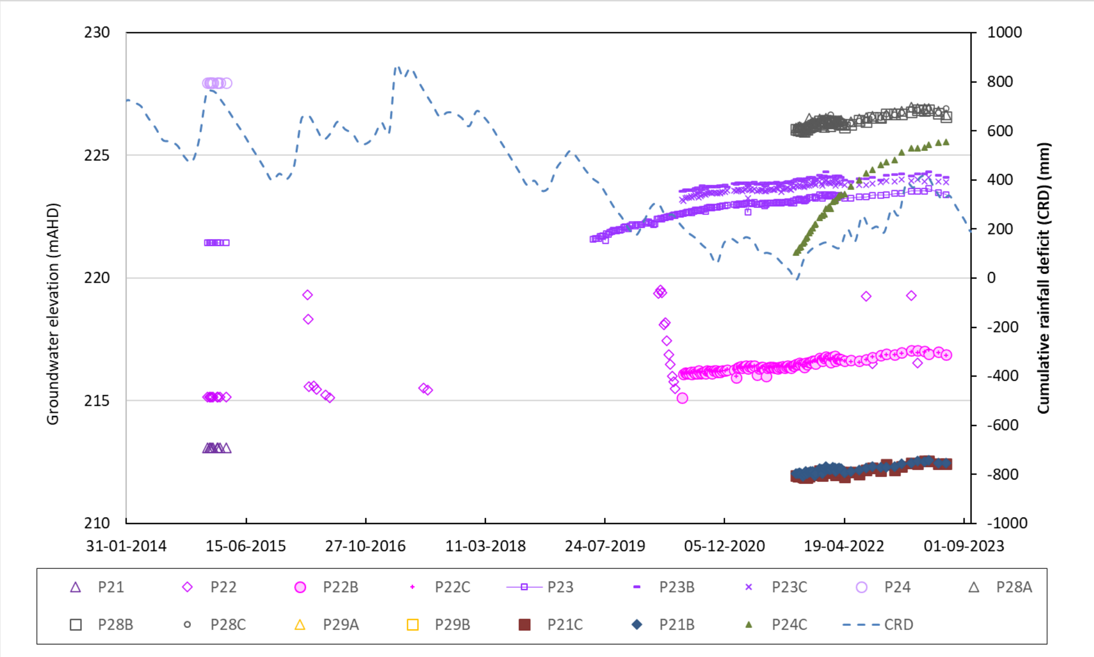
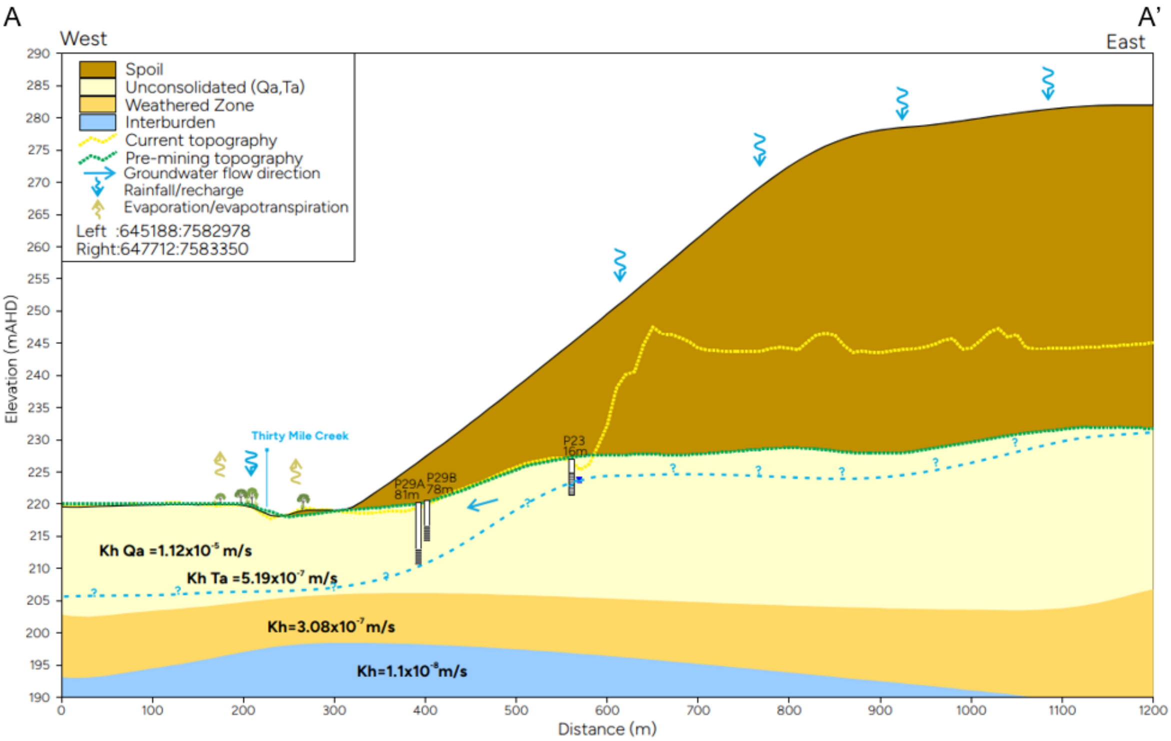


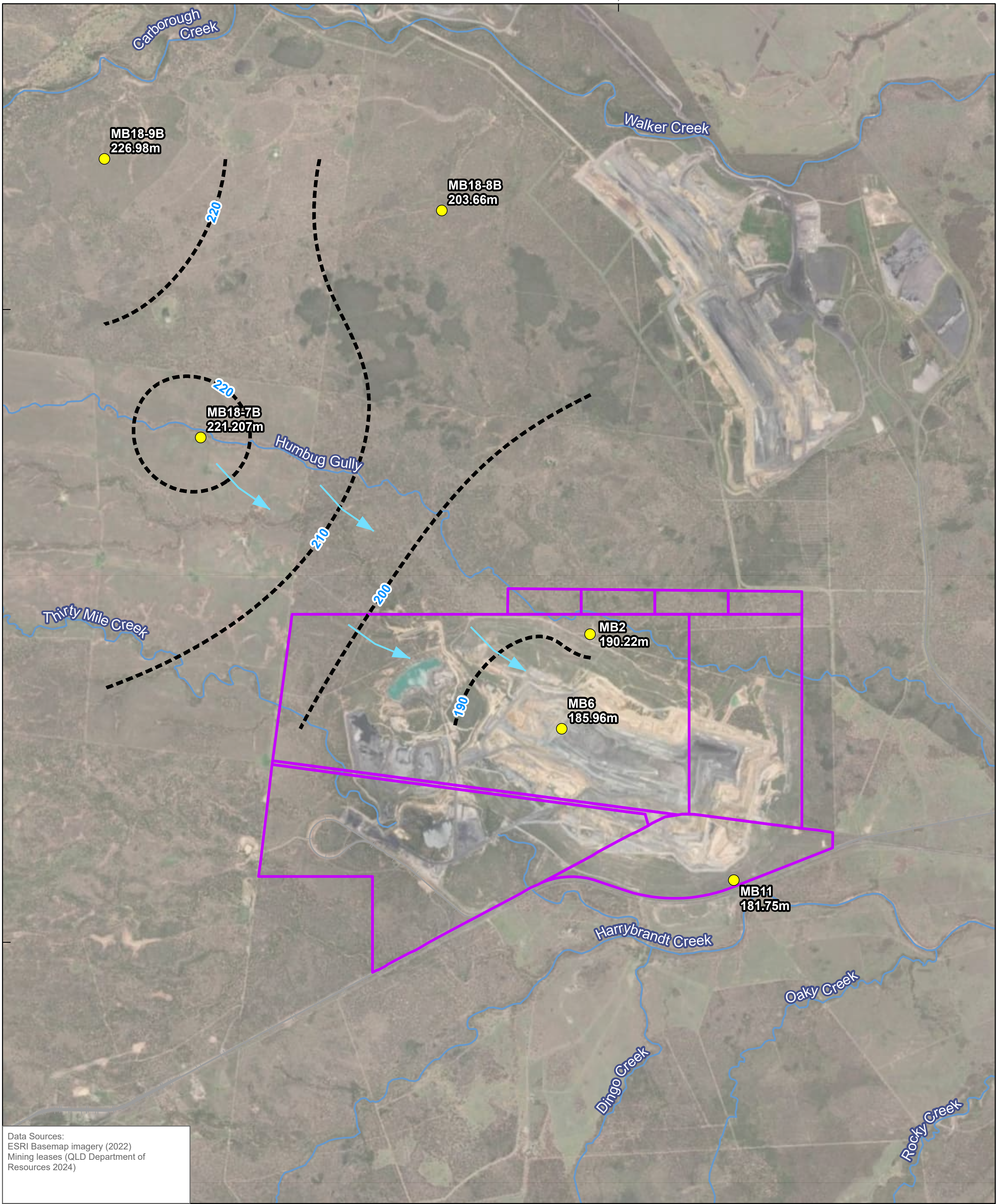
Figure 5-4 represents the hydrographs for the bores installed within the natural material (alluvial soil) at the western boundary of the CDA area. The hydrographs showed a rising trend in all bores with an obvious trend observed in P24C. P29 and P29A remained dry during monitoring. To understand the groundwater flow behaviour from the CDA towards the Thirty Mile Creek, a conceptual hydrogeological cross section is presented in **Figure 5-5**. The bores installed within natural alluvial material are selected to understand groundwater surface water interaction in this area. The location of this cross section is shown in **Figure 4-3**. The cross section shows the groundwater level profile across the western boundary of the CDA and Thirty Mile Creek. As presented in **Figure 5-5**, the groundwater level close to the creek at P29A and P29B is at a depth of at least 10 m below ground level (P29A and P29B remained dry since monitoring began in 2021). This confirms that the Thirty Mile Creek is a losing stream.

Figure 5-5: Conceptual model at CDA Area



Six monitoring bores (MB2, MB3B, MB6, MB8, MB9B and MB11) were installed within the Tertiary sediments around the mine pit in 2009 (**Figure 5-2** and **Table 5-1**). Three bores (MB3B, MB8 and MB9B) remained dry following installation. Other than MB2, all bores were subsequently mined through. Groundwater levels within this area were restricted to the year 2009 and remained within the range 181mAHD to 190 mAHD (**Table 5-1**). The average groundwater levels for these bores are presented in **Table 5-1**. MB2 commenced monitoring in 2014. A stable to slightly rising groundwater level trend (**Figure 5-7**) is noted up to 2019 where the groundwater level stabilises, showing limited drawdown and therefore limited impact due to mining (as this bore is located about 450m away from the current edge of the pit). Four additional bores (MB18-6B, MB18-7B, MB18-8B, MB18-9B) were installed within Tertiary sediments in 2019 at the northern portion of the open pit (**Figure 5-2** and **Table 5-1**) (WorleyParsons Consulting, 2019). Groundwater levels in these bores were only monitored in 2019. The average groundwater levels for these bores are presented in **Table 5-1**.

A groundwater potentiometric surface map for the Tertiary sediment aquifer is presented in **Figure 5-6** which indicates aquifer flow in a southeasterly direction.



Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	640.030987
Date Drawn:	29-Jan-2024
Drawn by:	JH

LEGEND

- Coppabella Mining Lease
- Rail
- Minor Watercourse
- Groundwater Elevation Contour (mAHD)
- Groundwater Bore

COPPABELLA EA GROUNDWATER ASSESSMENT

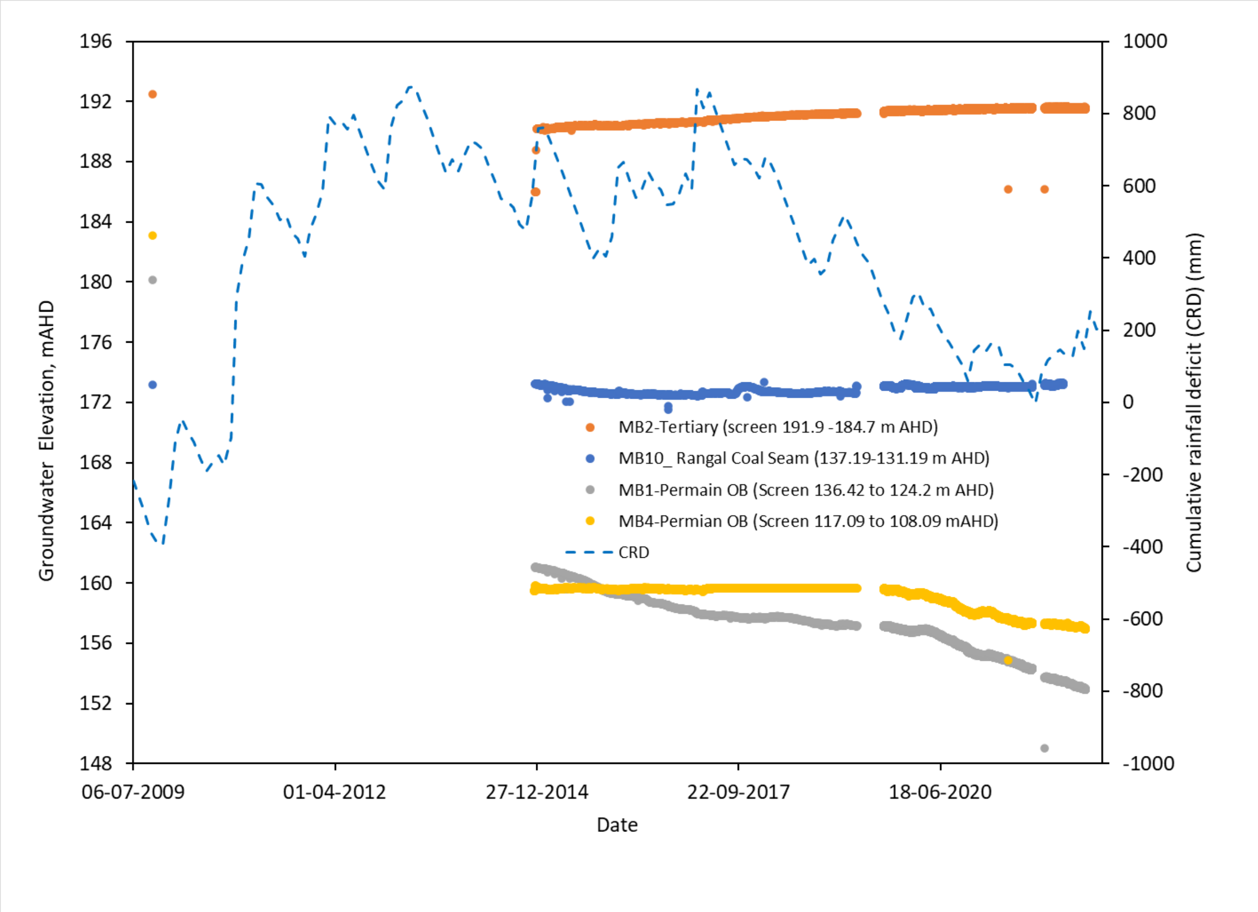
POTENTIOMETRIC SURFACE AND GROUNDWATER FLOW DIRECTION - TERTIARY AQUIFER

SLR

FIGURE 5-6

Path: H:\Projects-SLR\640-MEL\640-MEL\640.030987.00001 Coppabella EA Groundwater Asse\06 SLR Data\01 CADGIS\GIS\640030987_Coppabella_GW\640030987_Coppabella_GW.aprx\640030987_F5-10_GWContours_Tertiary

Figure 5-7: Hydrographs for monitoring bores installed within Tertiary and Permian aquifers



5.2.1.2 Recharge and Discharge

The recharge to the alluvium is considered to be mostly from stream flow or flooding (losing streams), with direct infiltration of rainfall also occurring where there are no substantial clay barriers in the shallow subsurface.

Groundwater within the alluvium is discharged as evapotranspiration from riparian vegetation growing along the creek bed of Thirty Mile Creek, Harrybrandt Creek, Humbug Gully, as well as potential short term baseflow contributions after significant rainfall and flood events which result in saturation of the alluvium. Geological logs in the Study Area indicate the alluvium is underlain by low hydraulic conductivity stratigraphy (i.e. claystone, siltstone and sandstone), which restricts the rate of downward leakage to underlying formations.

Non-alluvial regolith material comprises weathered low hydraulic conductivity strata (i.e. clay and claystone), which restricts rainfall recharge. Groundwater discharge occurs primarily via evapotranspiration, with some short term baseflow to streams from the regolith following wet climatic conditions. Vertical seepage through the regolith is limited by the low hydraulic conductivity units it is derived from.

5.2.2 Permian Coal Measures

5.2.2.1 Groundwater Distribution and Flow

Groundwater within the Permian Coal Measures is confined and sub-artesian. CCM monitoring bores intersecting the Permian Coal Measures are shown in **Figure 5-2** and details of installation provided in **Table 5-1**.

The following bores were installed within the Permian coal seams (Rangal Coal Measure at various depth):

- MB9 was installed in 2009 but was destroyed during mining activity and no data are available (AGE, 2010).
- MB10 was installed in 2009 and has been monitored since late 2014 to date (see **Figure 5-7**). Groundwater levels in this bore have been fairly stable since monitoring started.
- MB18-6D, MB18-7D, MB18-8D and MB18-9D were installed in 2019 (Advisian, 2019) at the northern portion but away from the open cut mine (**Figure 5-2**). The average groundwater levels for these bores in 2019 are presented in **Table 5-1** but no long-term groundwater level data for these bores are available.

A potentiometric surface for the Rangal Coal Measures (coal seam) at CCM was developed using the limited available groundwater level data (2009 data at MB9, recent data at MB10, and 2019 data at MB18-6D, MB18-7D, MB18-8D and MB18-9D) which is presented in **Figure 5-8**.

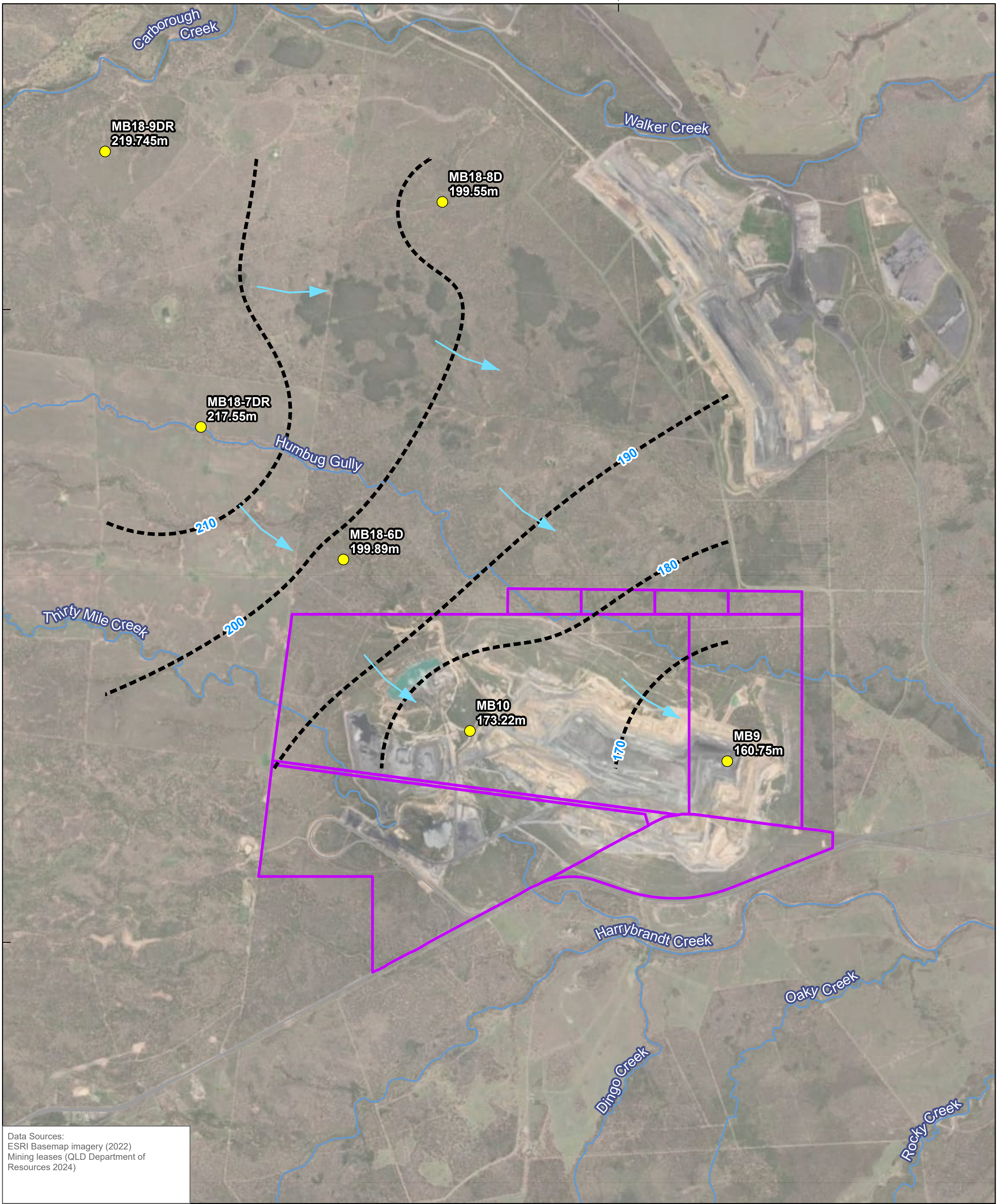
Groundwater in the Rangal Coal Measures (coal seams) flows in a southeasterly direction with local modification in the vicinity of the active CCM. Local groundwater flow is therefore towards the active mine pits, whilst regional flow remains towards the southeast.

The following bores were installed within Permian overburden and interburden (within Rangal Coal Measure).

- MB1 and MB3, MB4, MB5 and MB7 were installed in 2009. MB3 and MB5 were destroyed during mining activity and no data are available after 2009 (AGE, 2010). Groundwater levels in MB1 and MB4 have been monitored since 2014 to date and hydrographs for these bores are presented in **Figure 5-7**. The hydrographs showed a decreasing trend in groundwater levels and are about 27 m lower than the levels initially recorded in 2009 (**Table 5-1** and **Figure 5-7**). The decreasing water level in these bores is due to CCM approved mining activity.
- MB18-6C, MB18-7C, MB18-8C and MB18-9C were installed in the Permian overburden and interburden in 2019 (Advisian, 2019) within the northern portion of the open cut mine (**Figure 5-2**). Groundwater levels for these bores are not available beyond 2019. The average groundwater level for these bores is presented in **Table 5-1** however no long-term groundwater level data was referenced.

A potentiometric surface for the Permian overburden and interburden bedrock aquifer (Rangal Coal Measure) at CCM was developed using available groundwater level data (2009 data at MB3 and MB7, recent data at MB1 and MB4, and 2019 data at MB18-6C, MB18-7C, MB18-8C and MB18-9C) which is presented in **Figure 5-9**.

Groundwater in the Permian overburden and interburden general flows to the south-east with local modification in the vicinity of the active CCM. A localised low groundwater elevation is noted in MB18-8C. It is unknown if this low groundwater elevation in the overburden bedrock aquifer is due to impact from the adjacent South Walker Mine or it is just an anomalous groundwater level. Local groundwater flow is therefore towards the active mine pits, whilst regional flow remains towards the southeast.



Data Sources:
ESRI Basemap imagery (2022)
Mining leases (QLD Department of Resources 2024)

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	640.030987
Date Drawn:	29-Jan-2024
Drawn by:	JH

LEGEND

- Coppabella Mining Lease
- Rail
- Minor Watercourse
- Groundwater Elevation Contour (mAHD)
- Groundwater Bore

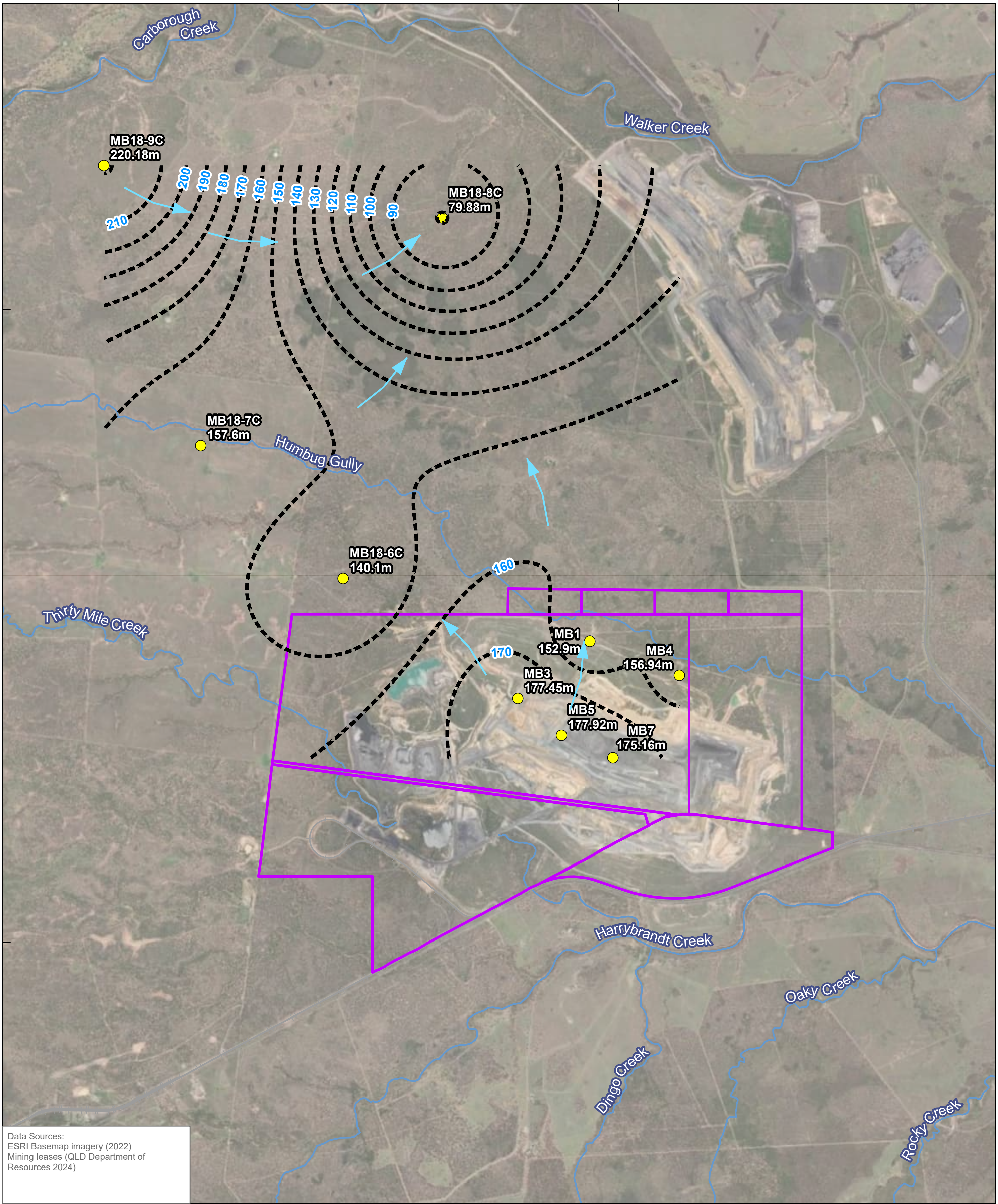
COPPABELLA EA GROUNDWATER ASSESSMENT

POTENTIOMETRIC SURFACE AND GROUNDWATER FLOW DIRECTION - PERMIAN COAL AQUIFER

SLR

FIGURE 5-8

Path: H:\Projects-SLR\640-MEL\640-MEL\640.030987.00001 Coppabella EA Groundwater Asse\06 SLR Data\01 CADGIS\GIS\640030987_Coppabella_GW\640030987_Coppabella_GW.aprx\640030987_F5-13_GWContours_PermianCoal



Data Sources:
ESRI Basemap imagery (2022)
Mining leases (QLD Department of Resources 2024)

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
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LEGEND

- Coppabella Mining Lease
- Rail
- Minor Watercourse
- Groundwater Bore
- Groundwater Elevation Contour (mAHD)

COPPABELLA EA GROUNDWATER ASSESSMENT

POTENTIOMETRIC SURFACE AND GROUNDWATER FLOW DIRECTION - PERMIAN OVERBURDEN AQUIFER

SLR

FIGURE 5-9

Path: H:\Projects-SLR\640-MEL\640-MEL\640.030987.00001 Coppabella EA Groundwater Asse\06 SLR Data\01 CADGIS\GIS\640030987_Coppabella_GW\640030987_Coppabella_GW.aprx\640030987_F5-14_GWContours_PermianOverburden

5.2.2.2 Recharge and Discharge

Recharge to the Permian Coal Measures occurs where the unit subcrops. Coal measures and interburden are generally of low hydraulic conductivity with the coal seams being the most permeable horizons along which groundwater can flow more readily. Groundwater discharge from the coal measures in the vicinity of CCM occurs via evaporation from pit faces within mining operations.

Pre-mining Groundwater Level in Permian Coal Measures

AGE (2010) considered a pre-mining groundwater level of 180 mAHD in the Permian aquifers which is average to the groundwater level data in Permian Coal Measures presented in **Section 5.2.2**. Hatch (2016) also considered pre-mining groundwater level as 180 mAHD within their water balance model assessment.

5.3 Hydraulic Properties

5.3.1 Aquifer Hydraulic Parameter Ranges

AGE (2010) and Blomfield (2021) undertook slug tests at CCM to determine the hydraulic conductivity of various hydrostratigraphic units (**Table 5-2**). The hydraulic conductivity data indicates:

- The Permian overburden has a much higher hydraulic conductivity than typical literature values.
- Coal seam hydraulic conductivities were found to have much lower than literature values.
- No data is available for weathered bedrock material as well as Triassic Rewan Formation.
- Quaternary alluvial and Tertiary sediments are similar to literature values.

AGE (2010) conducted groundwater modelling to assess the impact on groundwater for an underground extension of the project and modelled parameters are presented in **Table 5-2**.

Table 5-2: Site hydraulic testing results and model parameters

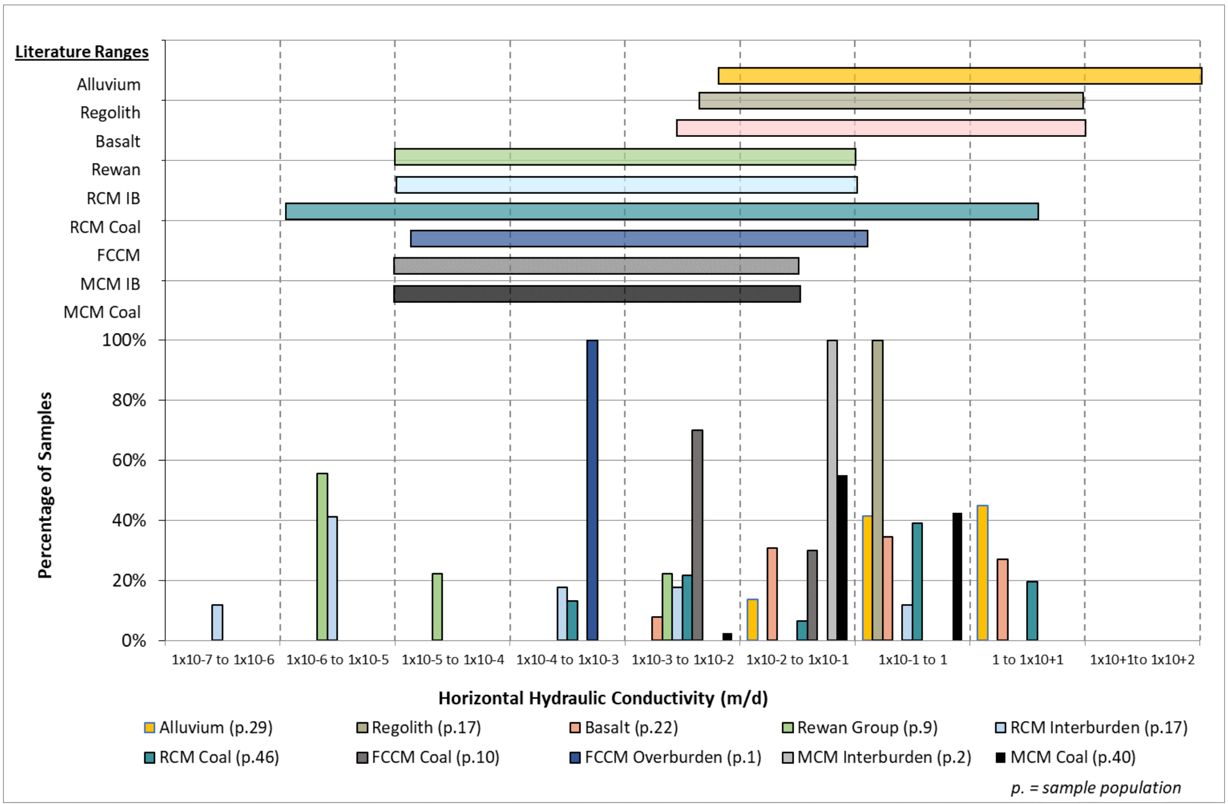
Hydrostratigraphic units	Hydraulic conductivity (Slug Test) (m/s) AGE,2010 Blomfield Environmental Pty Ltd (2021)	Hydraulic conductivity (m/day) Geometric Mean	Horizontal Hydraulic conductivity (m/day) (modelled value, AGE 2010)	Vertical Hydraulic conductivity (m/day) (modelled value, AGE 2010)	Specific Yield (modelled value, AGE 2010)	Specific Storage (per m) (modelled value, AGE 2010)
Quaternary/residual soil units	P22B – 2.66 x 10^{-5} P22C – 1.63 x 10^{-5} P22C – 1.56 x 10^{-5} P22C – 3.68 x 10^{-6} P23B – 1.88 x 10^{-5} P23B – 2.07 x 10^{-5}	1.1664	0.968	0.968	0.2	1 x 10^{-5}

Hydrostratigraphic units	Hydraulic conductivity (Slug Test) (m/s) AGE,2010 Blomfield Environmental Pty Ltd (2021)	Hydraulic conductivity (m/day) Geometric Mean	Horizontal Hydraulic conductivity (m/day) (modelled value, AGE 2010)	Vertical Hydraulic conductivity (m/day) (modelled value, AGE 2010)	Specific Yield (modelled value, AGE 2010)	Specific Storage (per m) (modelled value, AGE 2010)
	P23C – 1.03×10^{-5} P23C – 2.1×10^{-5} P23C – 6.88×10^{-6}					
Tertiary Sediments	MB2 – 1.4×10^{-6} MB6 – 3.75×10^{-7} MB11 – 1.65×10^{-6}	0.082	0.045	0.0045	0.2	1×10^{-5}
Weathered bedrock	NA		2.66×10^{-2}	$7.71e^{-3}$	0.01	$1. \times 10^{-3}$
Triassic (Rewan Formation)	NA		1.45×10^{-3}	1.6×10^{-5}	0.01	6.12×10^{-4}
Permian Overburden (Rangal Coal Measure)	MB1 – 3.22×10^{-6} MB3 – 2.05×10^{-6} MB4 – 3.10×10^{-8} MB5 – 1.82×10^{-5}	0.11	9.6×10^{-4}	9.6×10^{-5}	0.01	3.13×10^{-4}
Target Coal Seam (Rangal Coal Measure)	MB9 – 3.71×10^{-8} MB10 – 3.14×10^{-8}	2.94×10^{-3}	5.8×10^{-2}	8.64×10^{-3}	0.01	3.77×10^{-4}
Permian Overburden underneath coal seam	NA	NA	2.27×10^{-5}	2.27×10^{-6}	0.01	2×10^{-5}

A large volume of aquifer hydraulic testing information is also available from adjacent and nearby mines for the same hydrogeologic units that are found at the CCM. Given the similar geology, these data are considered representative of the hydraulic properties of the units at CCM.

A histogram of the spread of horizontal hydraulic conductivity from the field testing at the adjacent and nearby Daunia Mine, Winchester South Project, Olive Downs Project and Moorvale South Project, is presented in **Figure 5-10** (SLR,2023). The results are compared to the range of documented values for the various units in literature. The comparison shows that the field results for alluvium, regolith, Rangal Coal Measures and Fort Cooper Coal Measures within the Study Area and immediate surrounds fall within the range of field data collected through other studies across the Bowen Basin. It is also noted that the results of the site-specific testing documented in **Table 5-2** above generally fall within the range of regional and literature values for each hydrostratigraphic units, indicating the site-specific dataset aligns with the regional dataset.

Figure 5-10: Horizontal hydraulic Conductivity Ranges from Tests in the Vicinity of CCM



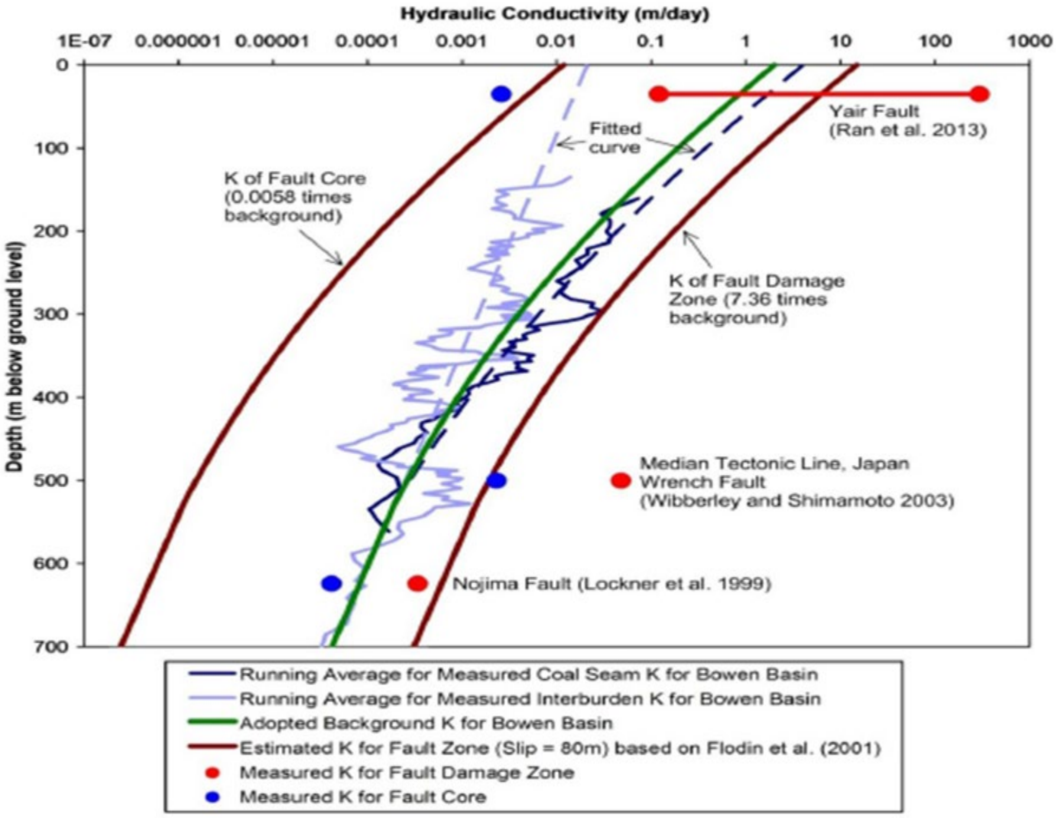
5.3.2 Faulting

There are several faults trending northwest-southeast within the Permian strata across CCM and the surrounding area.

As identified by Jourde *et al*. (2002), faulting can result in higher permeabilities within strata parallel with the fault plane, and lower permeabilities within strata perpendicular to the fault plane. However, this can also be dependent on whether faults are currently active (Paul *et al.*, 2009). Faulting has been inactive within the Bowen Basin for over 140 million years (Clark *et al.*, 2011), indicating that the fault zones are less likely to act as conduits to flow; this is due to filling of the fault fractures over time through hydrothermal alteration and mineralisation (Uysal *et al.*, 2000). Drill core logs from within the broader Study Area show that where fractures and faults have been geologically logged, many fractures are “healed” with calcite and siderite (SLR, 2021b). This indicates that although the system contains a fracture network, many of the existing fractures are cemented, which reduces the effective permeability of the fracture when compared to any open fracture network.

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 5-11**), 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 than the regional host rock, and the damage zone approximately an order of magnitude higher.

Figure 5-11: Faulting Conceptual Model Developed by Coffey (2014)



Downhole hydraulic testing was conducted in the Permian Coal Measures for the Winchester South Project located southwest of CCM. Fault zones were confirmed to be intersected at these drillholes due to the presence of fracturing, calcite infills, and slickensides in core obtained from the drillholes, all of which are considered an indicative marker of faulting. Testing results showed relatively low hydraulic conductivity values ranging from 6.93×10^{-5} to 2.07×10^{-3} m/day, and in line with those presented in **Figure 5-11**. These properties indicate that the faulting zones intercepted and tested are 'healed' and not pathways for preferential groundwater flow.

Laboratory geotechnical analysis of core samples of interburden immediately above and below coal seams proximal to a fault zone has previously been undertaken in support of groundwater assessments in the Study Area (e.g., SLR, 2020). The samples recorded vertical hydraulic conductivity (Kv) of 50% to 160% of horizontal hydraulic conductivity (Kh); i.e., although some samples show a typical Kv of somewhat less than Kh, some samples also suggest greater Kv than Kh which may be indicative of preferential vertical flow pathways associated with faulting. However, it was also noted that these areas of increased Kv are limited vertically, with samples collected from the same drillhole at horizons further above and below the fault zone (interburden and Rewan Group) returning a lower Kv of between 11% and 76% of Kh.

The impact of faults on groundwater flow within the Study Area was also assessed as part of the Bowen Gas Project (Arrow Energy, 2012). 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 bores 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 horizontal 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.

5.4 Baseline Groundwater Quality

Groundwater quality sampling at CCM has been conducted in the following locations:

- around the open pit in 2009
- around the CDA in 2021-2022
- in the northern part of the open pit in 2019.

This section presents the chemical characteristics of groundwater within the various geological units across CCM and the wider Study Area. Comparison with scheduled Environmental Values and Water Quality Objectives is provided in **Section 6.0**. Summary statistics are provided in **Appendix A**.

5.4.1 Water Type

The proportions of the major anions and cations were used to characterise the hydrochemical facies of groundwaters at CCM. The anion-cation balance from the CCM monitoring bores is shown on the Piper and Durov diagram in **Figure 5-12** and **Figure 5-13** respectively.

Figure 5-12: Piper Plot for CCM Groundwater Monitoring Bores

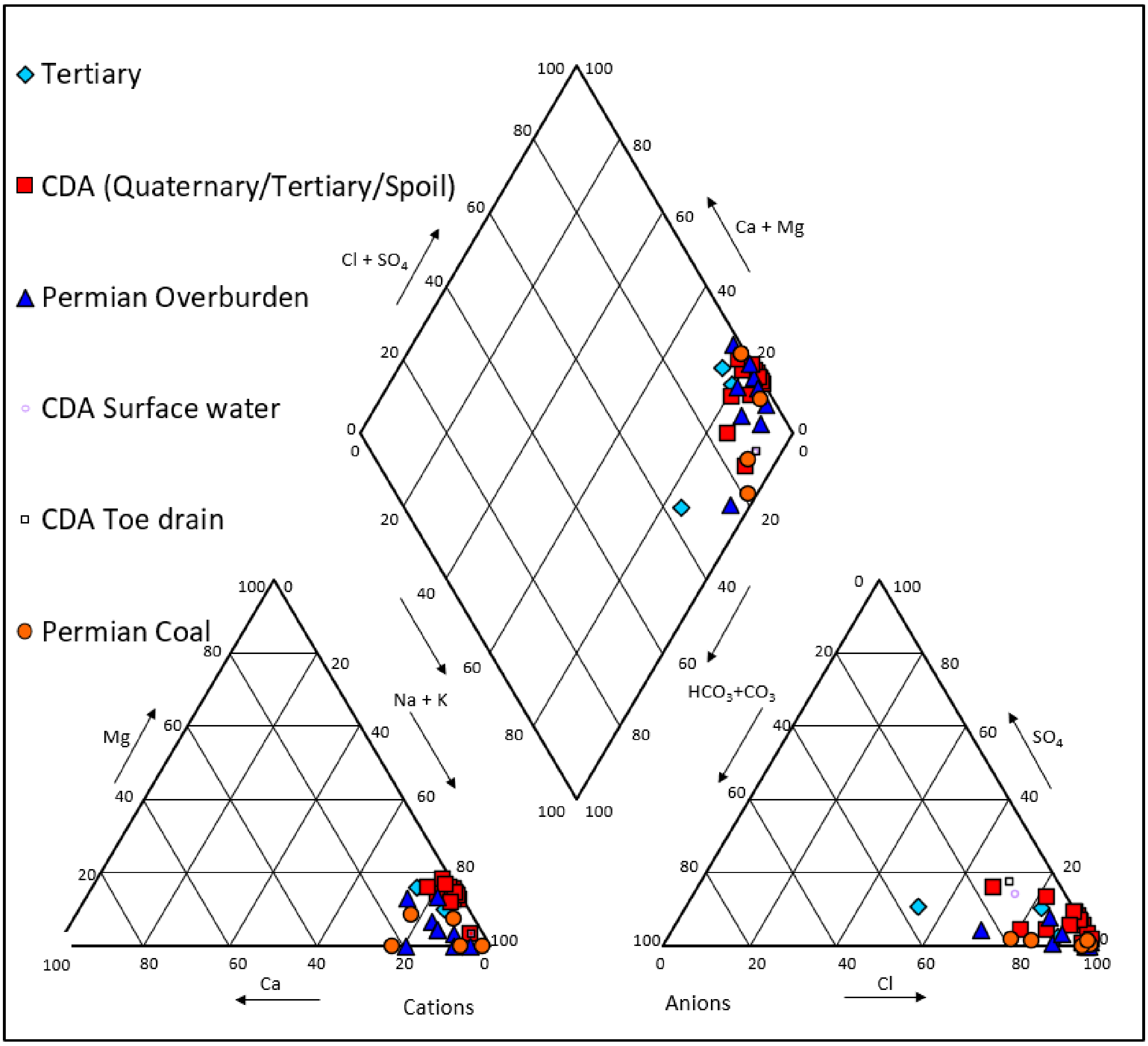
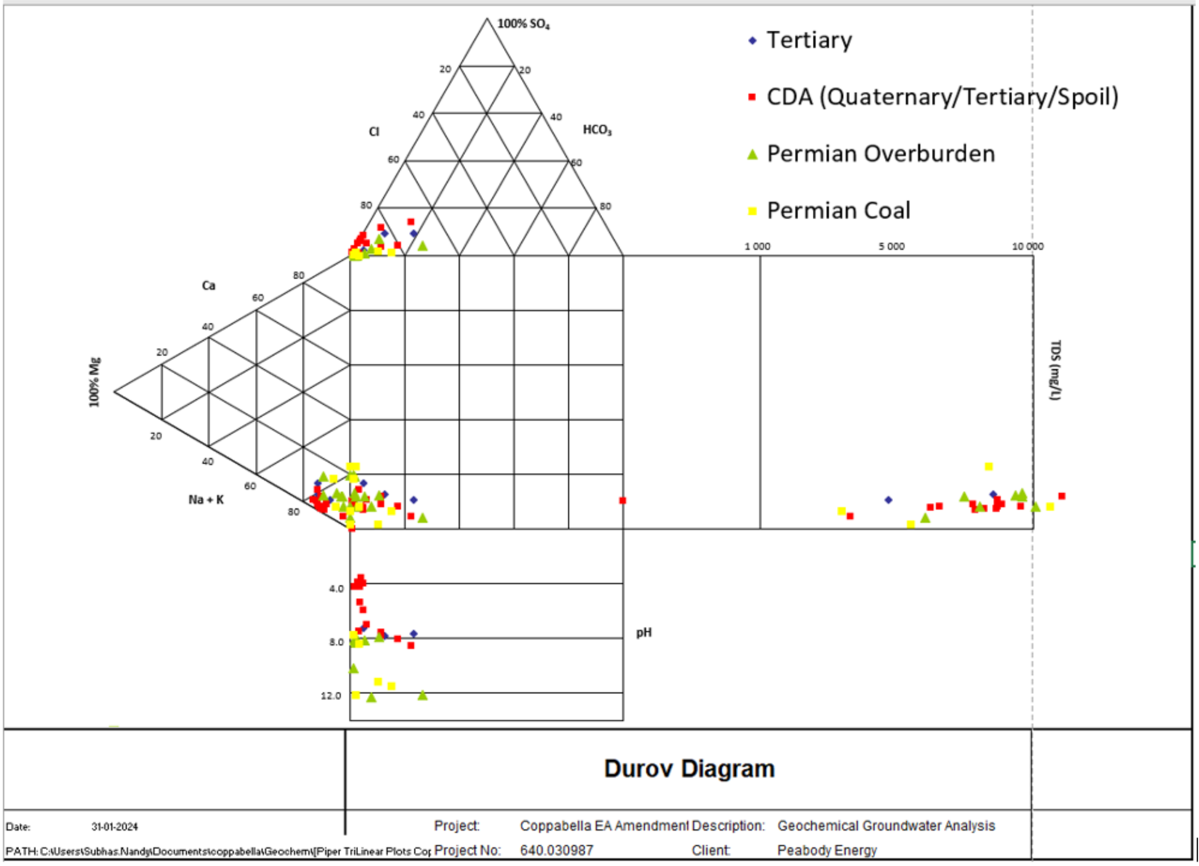


Figure 5-13: Durov Plot for CCM Monitoring Bores



The results for both Permian and Cainozoic sediments/regolith show that the dominant groundwater type across CCM is Sodium (Na) – Chloride (Cl) type.

5.4.2 Salinity

Salinity is a key constraint to water management and groundwater use and can be described by Total Dissolved Solids (TDS) concentrations, or by Electrical Conductivity (EC) as a surrogate for TDS. EC statistical data for CCM bores is shown in **Appendix A** (**Tables A2 to A3**)

The average salinity results for shallow Alluvium/Tertiary aquifer and Permian (coal seam and overburden) aquifer are presented in **Table 5-3**. The average salinity of both these aquifers are high and not suitable even for stock water except for a short period of time.

Table 5-3: Average salinity value

Name of the Formation	Average salinity (µs/cm)	ANZG (2023) salinity guideline value for beef cattle (µs/cm)		
		No adverse effects expected	Livestock should adapt without loss of production	Livestock may tolerate for short periods if introduced gradually
Permian aquifer (Coal seam and overburden)	13,494	0-5,970	5,970-7,462	7,462-14,925

Name of the Formation	Average salinity (µs/cm)	ANZG (2023) salinity guideline value for beef cattle (µs/cm)		
		No adverse effects expected	Livestock should adapt without loss of production	Livestock may tolerate for short periods if introduced gradually
Shallow Cainozoic aquifer (Alluvium and Tertiary aquifer)	12,710			

5.4.3 pH

pH statistics for CCM groundwater is presented in **Appendix A (Tables A2 and A3)** for bores screened in the Cainozoic sediments/regolith and in the Permian. The results for both Permian and Cainozoic sediments/regolith bores across CCM show that pH generally ranges from neutral to alkaline in Permian bores and very acidic to almost neutral in shallow alluvial bores installed around the CDA.

The average pH results for shallow Alluvium/Tertiary aquifer and Permian (coal seam and overburden) aquifer are presented in **Table 5-4**. The average pH in shallow Cainozoic aquifer indicates acidic groundwater and Permian aquifer is alkaline. The pH values are outside default guideline values to limit corrosion and fouling of pumping, irrigation, and stock watering system.

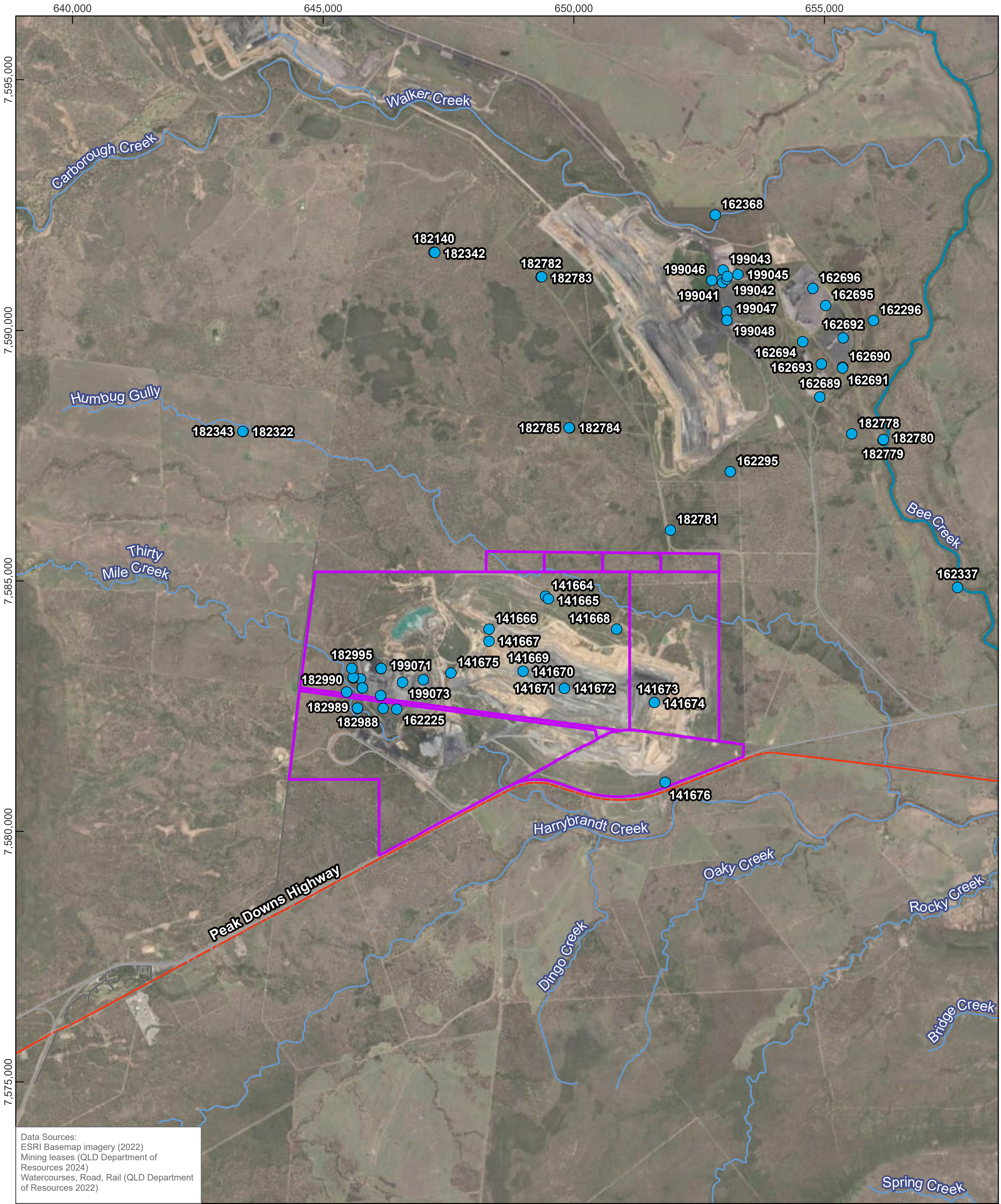
Table 5-4: Average pH value

Name of the Formation	Average pH	ANZG (2023) pH guideline value to limit corrosion and fouling of pumping, irrigation, and stock watering systems			
		LSGV	LDGV	DGV	SGV
Permian aquifer (Coal seam and overburden)	9.5	5	6	8.5	9
Shallow Cainozoic (Alluvium and Tertiary aquifer)	5.6				
L = Lower; SGV = short term guideline value; DGV = default guideline value					

5.5 Groundwater Usage – Anthropogenic

5.5.1 Queensland Registered Bore Database

The Queensland registered groundwater bore database (GWDB) records 73 registered bores within 10 km of the CCM Project (**Figure 5-14**). The details contained within the GWDB indicate that all 73 of these bores are mine monitoring bores. Therefore, there are no private bores identified in the GWDB within 10 km of the CCM Project.



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	640.030987
Date Drawn:	25-Jan-2024
Drawn by:	JH

LEGEND

- Coppabella Mining Lease
- Rail
- Principal Road
- Minor Road
- Track
- Major Watercourse
- Minor Watercourse
- Registered Bore

COPPABELLA EA GROUNDWATER ASSESSMENT

REGISTERED MONITORING BORES SURROUNDING COPPABELLA MINE

SLR

FIGURE 5-14

5.5.2 Mining

CCM has been in operation since 1998 and mining has progressed in a general east to west direction with successive strips mined towards the North-Northeast. Conservatively estimated water takes in 2023 has averaged 53 ML/year (ATC William, 2023). Passive groundwater inflow to pits is the only groundwater take at CCM. There is no active dewatering to facilitate mining or groundwater extraction for water supply at CCM.

Groundwater inflow to the CCM pit generally manifests as seeps on the pit walls. Most of the groundwater inflow evaporates directly from the mining face and any remaining groundwater pools at the base of pits. This water is then left to evaporate, or is pumped out of the pit, along with any captured surface water runoff. At CCM this is observed to be in very small volumes. Any groundwater pumped from the pits is transferred into three on-site water storages and incorporated into the mine water management system.

5.6 Groundwater Usage – Environmental

5.6.1 Groundwater Dependent Ecosystems

A Groundwater Dependent Ecosystem (GDE) is an ecological feature in which the plant and/or animal community is dependent in some way on the availability of groundwater to maintain its structure and function. GDEs are typically classified as either:

- aquatic GDEs (i.e. ecosystems dependent on the surface-expression of groundwater.
- terrestrial GDEs (i.e. ecosystems dependent on the sub-surface presence of groundwater, including some riparian vegetation communities); and
- subterranean GDEs (aquifer and cave ecosystems, e.g. stygofauna).

GDEs can require access to groundwater on a permanent (obligate) or intermittent (facultative) basis to meet all or some of their water requirements to maintain their communities of plants and animals, ecological processes, and ecosystem services (Doody *et al.*, 2019).

5.6.1.1 National Atlas of Groundwater Dependent Ecosystems

National scale desktop mapping of potential GDEs is available in the Bureau of Meteorology (BoM) National Atlas of GDEs (GDE Atlas). This mapping is based largely on national datasets which may indicate potential groundwater dependence. The GDE Atlas provides three classifications of land areas that have the potential to contain GDEs based on the desktop assessment used to compile the GDE Atlas:

- High potential for groundwater interaction (indicating a strong possibility the ecosystem is interacting with groundwater);
- Moderate potential for groundwater interaction; or
- Low potential for groundwater interaction (indicating it is relatively unlikely, but still possible, the ecosystem will be interacting with groundwater and will include ecosystems that are not interacting with groundwater).

It should be noted that the GDE Atlas mapping does not generally indicate the presence of actual GDEs (unless specifically indicated in the Atlas), but rather, provides high level guidance with three levels of confidence on the potential for GDEs to occur and therefore where further investigation is required to determine whether GDEs are present.

The GDE Atlas designates areas of high, moderate and low potential for GDE's to be present within and near the CCM, specifically associated with the Thirty Mile Creek, Harrybrandt Creek and Bee Creek (**Figure 5-15**).

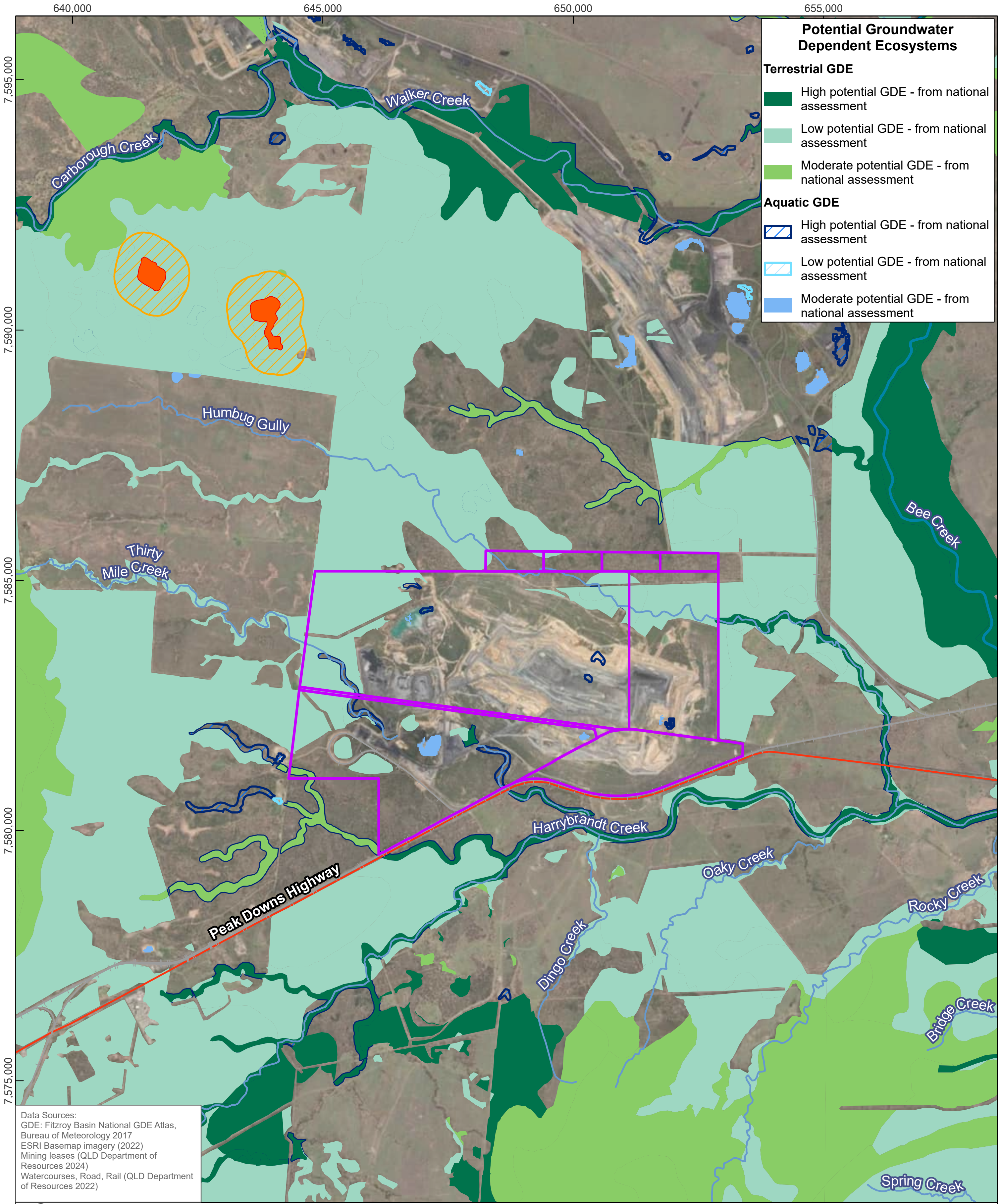
The GDE Atlas identifies the potential for aquatic GDEs in the vicinity of the CCM Project, including:

- Within CCM project footprints, isolated wetlands on the Thirty Miles Creek and its tributaries. Several CCM water management features are also designated as having high to low potential for groundwater interaction – these are active mine water management features and not regarded as GDEs.
- In the vicinity of CCM, Harrybrandt Creek and its tributaries are mapped as having high potential for groundwater interaction; and
- In the vicinity of CCM, isolated wetlands on the Harrybrandt Creek and its tributaries, Thirty Mile Creek and Bee Creek floodplain are mapped as having high to low potential for groundwater interaction. It should be noted that some of these areas are already disturbed as part of existing approved operations at CCM and adjacent South Walker Creek mine.

The GDE Atlas also identifies the potential for terrestrial GDEs in the vicinity of the CCM Project, including:

- Within the project footprint of CCM mainly low potential terrestrial GDEs were identified with the exception of a small area within Thirty Mile Creek
- Near CCM, low to high potential GDEs were identified within the Harrybrandt Creek and its tributaries, Thirty Mile Creek, and Bee Creek.

Shallow groundwater exists close to Thirty Mile Creek. Groundwater levels at less than 5 mbgl were recorded in (P22B, P22C, P23B, P23C, P28A, P28B and P28C). Shallow groundwater in this area may potentially support terrestrial vegetation.



0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	640.030987
Date Drawn:	29-Jan-2024
Drawn by:	JH

LEGEND

- Coppabella Mining Lease
- Rail
- Principal Road
- Major Watercourse
- Minor Watercourse
- Wetland of High Ecological Significance
- Wetland Trigger Area

COPPABELLA EA GROUNDWATER ASSESSMENT

POTENTIAL GROUNDWATER DEPENDENT ECOSYSTEMS

SLR

FIGURE 5-15

Path: H:\Projects-SLR\640-MEL\640-MEL\640.030987.00001 Coppabella EA Groundwater Asse\06 SLR Data\01 CADGIS\GIS\640030987_Coppabella_GW\640030987_Coppabella_GW.aprx\640030987_F5-20_GDEs

5.6.1.2 Local GDE Studies

No site specific local GDE studies are available. AGE (2010) concluded that no GDEs were identified or were known to exist within the CCM area. On the basis that the groundwater table in the Tertiary aquifers was in excess of 18m below ground level and even deeper for the Permian and Coal Seam aquifers, and the water quality within these deeper aquifers was saline, AGE (2010) concluded that mining within the CCM area will not intersect or impact on groundwater associated with a GDE. However, subsequent investigation identified presence of shallow groundwater in alluvium in the CDA western boundary close to the Thirty Mile Creek (**Figure 5-5**) but the Creek remains a losing stream.

A recent GDE study was completed for the nearby South Walker Creek Mine (SWC) (BHP, 2019). This study is particularly relevant to the CCM since the study focussed on the potential GDEs mapped in the vicinity of the Bee Creek (i.e., the Bee Creek and associated floodplain environment that is also present close to CCM). The results of the study indicated:

- There is no evidence for the presence of Type 2 GDEs (dependent on the surface expression of groundwater), and therefore is extremely unlikely in the study area.
- The SWC Mine may potentially support Type 3 GDEs (represent vegetation that depends on groundwater below the surface) in areas where shallow groundwater is present.
- No site-specific stygofauna study was undertaken, but it is unlikely that any stygofauna, if present in the alluvial aquifer, are endemic to 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 Study Area.

5.6.3 Wetland Protection Areas

The Map of Queensland wetland environmental values are a statewide statutory map under the EPP (Water and Wetland Biodiversity). It identifies wetlands of high ecological significance (HES) and general ecological significance (GES) across the state. Wetland protection areas (WPA) are policy trigger buffer areas that protect HES wetlands in the Great Barrier Reef catchments. The aim of the WPA buffer is to limit development within proximity of the HES wetland to provide for continual ecological protection.

An HES wetland is identified approximately 5.4 km northwest of the northwestern extent of the CCM (refer **Figure 5-15**). The WPA area associated with the HES wetland remains outside of the CCM footprint. The HES wetland corresponds with palustrine wetlands mapped as moderate potential terrestrial GDE in the GDE Atlas. As previously discussed, the clay-rich substrates of these wetlands are likely to hold surface water run-off for extended periods creating the above ground conditions for the wetland ecosystem.

6.0 Environmental Values

6.1 Scheduled EVs

Groundwater resources within the vicinity of the CCM Project are scheduled under the EPP Water and Wetland Biodiversity as Isaac Groundwaters of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1310). The legislated EVs for these groundwaters (**Table 6-1**) are:

- Biological integrity of aquatic ecosystems – these occur where groundwater baseflow supports streams and water holes to some extent (e.g., seasonally, or permanently).
- Human use EVs:
    - Suitability of water supply for irrigation – where groundwater is used to grow crops and pastures for commercial purposes.
    - Farm water supply/use – where groundwater is used to provide domestic supply and support growing of domestic produce.
    - Stock watering – where groundwater is used to provide stock water supplies.
    - Drinking water supply – where groundwater is used for potable water supply.
    - Primary recreation – where groundwater supports recreational use that involves direct contact ad a high probability of being swallowed, e.g., diving, swimming, water skiing.
    - Cultural and spiritual values – where groundwater supports both indigenous and non-indigenous values, e.g., recreational fishing, heritage, ecology.

Table 6-1: Environmental Values of Isaac Groundwaters of the Isaac River Sub-basin of the Fitzroy Basin

Environmental Values (DEHP, 2011)											
Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human Consumption	Primary Recreation	Secondary Recreation	Visual Recreation	Drinking water	Industrial use	Cultural, spiritual, and ceremonial
✓	✓	✓	✓			✓			✓		✓

6.2 Water Quality Objectives

6.2.1 Isaac River Sub-basin Environmental Values

Water Quality Objectives (WQOs) are long-term goals for water quality management (DEHP, 2011) and relate specifically to the different EVs. The purpose of defining WQOs is to support and protect EVs. They are numerical concentration levels or narrative statements of indicators established for receiving waters to support and protect the designated EVs for those waters. They are based on scientific criteria or water quality guidelines but may be modified by other inputs (e.g., social, cultural, economic).

Where groundwater quality analysis results exceed a particular WQO for a particular EV, it is considered indicative that the groundwater may be unsuitable for supporting that particular EV.

DEHP (2011) provides Water Quality Objectives for the EVs described in **Section 6.1**, as summarised in **Table 6-2**.

Table 6-2: Water Quality Objectives for Isaac River Sub-basin Environmental Values

Water Quality Indicator	Unit	ADWG Guidelines[1]		Isaac River Sub-basin EVs[2]		
		Health	Aesthetic	Irrigation	Stock	Aquatic 95% spp[3]
pH	-		6.5 to 8.5			6.5 to 8.5
Aluminium	mg/L		0.2		5	0.055
Calcium	mg/L				1000	
Chloride	mg/L		250			
Magnesium	mg/L				2000	
Manganese	mg/L	0.5	0.1	10		1.9
Sodium	mg/L		180			
Sulfate	mg/L				1000	
Zinc	mg/L		3			0.008
Arsenic	mg/L	0.01		2	0.5	0.024
Cadmium	mg/L	0.002			0.01	0.0002
Chromium	mg/L	0.05			1	0.001
Cobalt	mg/L			0.1	1	
Copper	mg/L	2	1		1	0.0014
Lead	mg/L	0.01			0.1	0.0034
Mercury	mg/L	0.001			0.002	0.0006
Nickel	mg/L	0.02			1	0.011
Selenium	mg/L	0.01			0.02	0.005
Silver	mg/L	0.1				0.05

1. Table 4 of Isaac River Sub-basin Environmental Values and Water Quality Objectives: Drinking water EV.
2. Table 2, Table 9, Table 10 and Table 11 of Isaac River Sub-basin Environmental Values and Water Quality Objectives: Aquatic ecosystem – moderately disturbed.
3. Table 3.4.1 of Australian and New Zealand Guidelines for Fresh and Marine Water Quality: trigger values for slightly-moderately disturbed systems (95% level of protection).

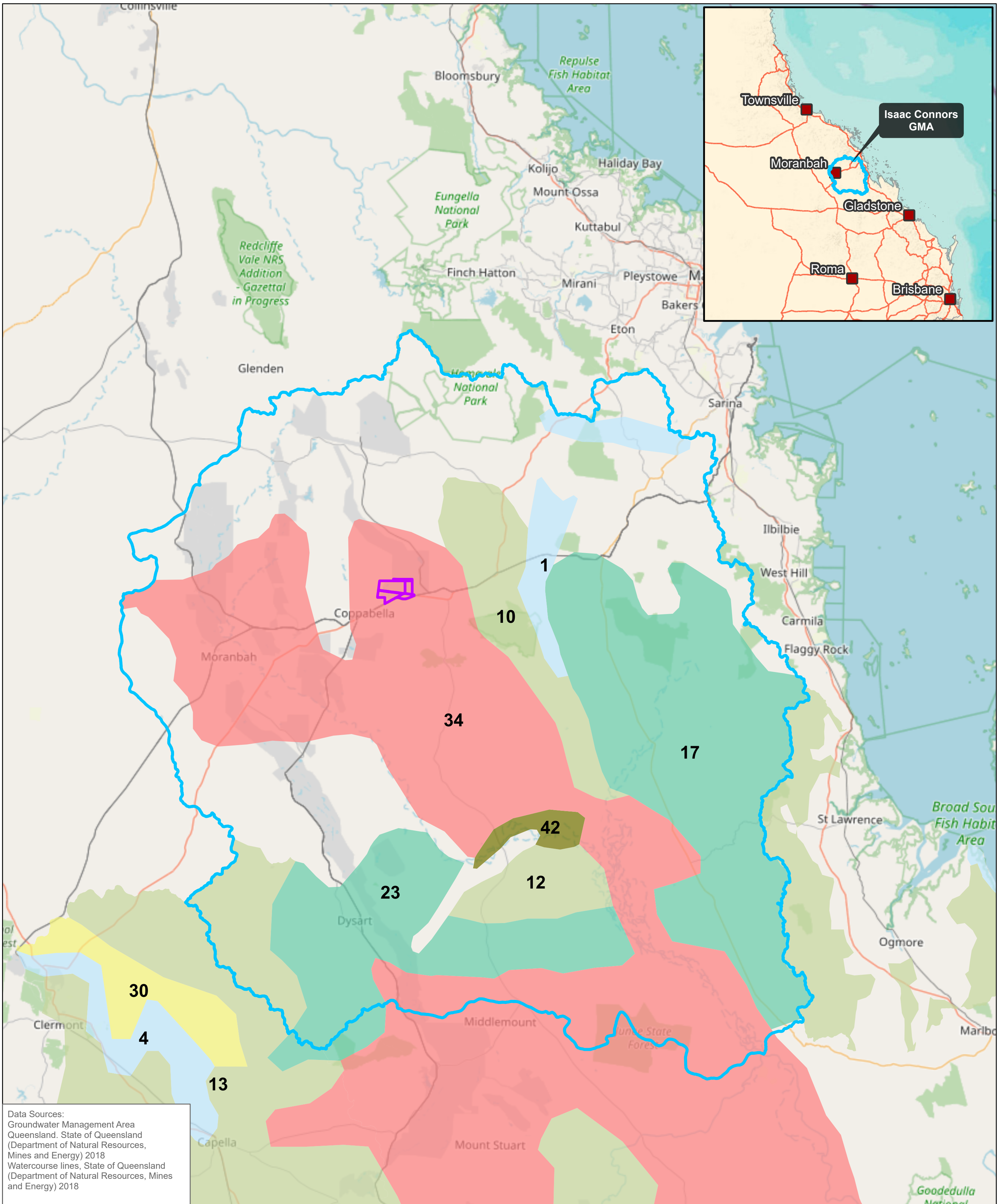
6.2.2 Fitzroy Basin Groundwaters

The EPP Water and Wetland Biodiversity also provides limited WQOs specifically for underground aquatic ecosystem protection in Fitzroy Basin groundwaters.

WQOs vary across the Fitzroy Basin and are defined on the basis of groundwater Chemistry Zones (**Figure 6-1**). The applicable Chemistry Zone for the CCM Project is Isaac Groundwater (Zone 34; Sodic Sequence - Saline: Na, Cl). These WQOs are classified by groundwater depth ('shallow' being <30 m depth, and 'deep' being >30 m depth) and are summarised in **Table 6-3**. The management intent of Zone 34 WQOs is to maintain each of 20th, 50th and 80th percentile values.

Table 6-3: Isaac River Sub-basin Zone 34 WQOs for groundwater resources (aquatic ecosystem protection) (DEHP, 2011)

Water Quality Indicator	Unit	Shallow Groundwater (<30m)			Deep Groundwater (>30m)		
		20th Percentile	50th Percentile	80th Percentile	20th Percentile	50th Percentile	80th Percentile
EC	uS/cm	498	2150	8910	3419	6100	16000
Hardness	mg/L as $CaCO_3$	163	674	2228	359	919	3208
pH	-	7.1	7.75	8.1	7.4	7.8	8.03
Alkalinity	mg/L	154	435	752	156	275	536
Ca	mg/L	18	84	215	46	145	442
Mg	mg/L	27	108	389	35	115	491
Na	mg/L	135	747	1500	480	1100	2565
Cl	mg/L	171	1309	3185	753	1900	5905
SO_4	mg/L	12	140	318	25	138	398
HCO_3	mg/L	187	536	878	188	330	650
NO_3	mg/L	0	0.95	5.3	0.01	2.15	14.92
SiO_2	mg/L	21	36	52	16	25	36
F	mg/L	0.1	0.28	0.5	0.02	0.155	0.4
Fe	mg/L	0	0.03	0.14	0	0.05	0.246
Mn	mg/L	0	0.01	0.16	0	0.05	0.291
Zn	mg/L	0	0.015	0.06	0.01	0.025	0.317
Cu	mg/L	0	0.01	0.03	0.017	0.03	0.03
SAR	-	4.37	10.85	18.21	10.5	15.6	24.65
RAH	meq/L	0	0	2.3	0	0.24	6.25



Data Sources:
Groundwater Management Area Queensland. State of Queensland (Department of Natural Resources, Mines and Energy) 2018
Watercourse lines, State of Queensland (Department of Natural Resources, Mines and Energy) 2018

0 20 40 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:1,250,000 at A4
Project Number:	640.030987
Date Drawn:	24-Jan-2024
Drawn by:	JH

LEGEND

- Coppabella Mining Lease
- Isaac Connors Groundwater Management Area (GMA)

Groundwater Chemistry Zones

Alluvial Sequence

- Low-moderate salinity: balanced cations, HCO3, Cl;
- Moderate salinity: Na > Mg > Ca, Cl (SO4 above average)
- Low salinity: balanced cations, HCO3
- Saline: Na, Cl

Sodic Sequence

- Saline: Na, Cl
- Low-moderate salinity; Na, HCO3 > Cl

COPPABELLA EA GROUNDWATER ASSESSMENT

WQ1310 - FITZROY BASIN GROUNDWATER ZONES

SLR

FIGURE 6-1

Path: H:\Projects-SLR\640-MEL\640-MEL\640.030987.00001 Coppabella EA Groundwater Asse\06 SLR Data\01 CADGIS\GIS\640030987_Coppabella_GW\640030987_Coppabella_GW.aprx\640030987_F6-1_GWZone

6.3 Comparison of CCM Groundwater Quality Data with Scheduled EVs and WQOs

6.3.1 Water Quality Objectives for Isaac River Sub-basin Environmental Values

A comparison of CCM monitoring bore data with the WQOs for the scheduled EVs in the Isaac River Sub-basin is presented as **Table 6-3** and full summary statistics are provided as **Appendix A (Table A1)**. The locations of the monitoring bores are presented in **Figure 5-1**and **Figure 5-2**.

Alluvium monitoring bore data (**Appendix A, Table A1**) generally suggest that alluvial groundwater at CCM is unsuitable for the Drinking Water EV with respect to sodium, chloride, and a number of metals (arsenic, lead mercury lead and selenium) concentrations. Alluvium groundwater data also generally indicate it is not suitable for supporting the Aquatic Ecosystems EV with respect to aluminium, pH, arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, and selenium concentrations. Other than sulfate and cobalt in singular bores, arsenic, and selenium concentration in three bores the data suggests that alluvium groundwater is suitable for supporting the Stock watering and Irrigation EVs.

Permian monitoring bore data suggests that Permian groundwater at CCM is also generally unsuitable for the Drinking Water EV with respect to sodium, manganese, and chloride concentrations. Permian groundwater quality also generally indicates it is not suitable for supporting the Aquatic Ecosystems EV with respect to pH, aluminium zinc concentrations, and arsenic, chromium, copper, and selenium concentrations at some bores. The data suggests that Permian groundwater is not suitable for supporting the Stock watering (except short period due to higher salinity) and Irrigation EVs (as the pH values are outside the default value to limit corrosion and fouling of pumping, irrigation, and stock watering systems).

6.3.2 Water Quality Objectives for Fitzroy Basin Groundwaters

A comparison of CCM monitoring bore data with the WQOs for the Fitzroy Basin Isaac River Sub-basin Zone 34 WQOs for groundwater resources (aquatic ecosystem protection) is presented in **Table A2 Appendix A** (< 30m depth) and **Table A3, Appendix A** (>30m depth). The 80th percentile of the CCM data per bore (refer **Appendix A**) has been chosen for the comparison consistent with DES (2021). The data for the deeper bores are limited to two rounds of sampling, and the higher value has been considered for comparison.

The data suggests that shallow groundwater at CCM (i.e., bore depth <30m) is generally unsuitable for Aquatic Ecosystems with much of the 80th percentile parameter concentrations exceeding the relevant WQOs.

The data show that for deeper groundwater at CCM (i.e., bore depth >30m) most parameters exceed one or more of the WQOs except for nitrate, copper, and silica. The data suggests that the deeper groundwater at CCM, similar to shallow groundwater, is generally unsuitable for Aquatic Ecosystems.

7.0 Conceptual Hydrogeological Model

A conceptual model of the groundwater regime has been developed based on the review of the available hydrogeological data for CCM and surrounds. It is important to note that the conceptual hydrogeological model presented here represents an evolution of the hydrogeological understanding at CCM with the conceptual model having first been developed by AGE (2010). The CCM groundwater regime has also been enhanced by incorporating the relevant elements of conceptualisation from other nearby projects that occur in the same hydrogeologic environment (e.g., South Walker Creek and Moorvale).

7.1 Hydrogeological Setting

The CCM Project is located within the northern part of the Bowen Basin. The geology of the Project Area comprises the stratified sequences of the Permian aged Rangal Coal Measures that occur at subcrop, and underlie Regolith comprised of weathered Permian rock and unconsolidated to semi-consolidated Tertiary-aged sediment. Overlying the Regolith in proximity to the Thirty Miles Creek, Harrybrandt Creek and Bee Creek and their tributaries is Quaternary alluvium deposited by the Creeks. The Triassic Rewan Group strata that unconformably overlie the coal measures to the west. The main hydrogeological features at the CCM Project include:

- Cainozoic unconsolidated sediments:
  - Quaternary alluvium – unconfined aquifer where sparsely saturated (water-bearing strata of permeable rock, sand, or gravel) associated with Thirty Mile Creek and Harrybrandt Creek.
  - Quaternary to Tertiary alluvium, colluvium and weathered units (collectively termed regolith) – unconfined and largely unsaturated unit bordering alluvium.
- Permian Coal Measures (confined and sub-artesian) with:
  - An upper weathered horizon;
  - Hydrogeologically ‘tight’ interburden units with aquitard properties; and
  - Coal seams that exhibit water bearing properties associated with secondary porosity through cracks and fissures.

7.2 Unconsolidated Sediments

Along the Thirty Mile Creek, Harrybrandt Creek, Bee Creek and their tributaries, the alluvium comprises a highly heterogeneous distribution of silts to sands interspersed with lenses of clays and gravels. The hydraulic properties of the alluvium vary due to the variable lithologic composition.

Where present (especially in the CDA area close to the Thirty Mile Creek), groundwater occurs within the alluvium at depths of around 3.5 mbgl to > 10 mbgl, typically disconnected from the riverbed elevation of Thirty Mile Creek (**Figure 5-5**). Similarly, the groundwater level in MB2 is much lower than the creek bed elevation of Humbug Gully (**Figure 7-2**) indicating a losing stream. Recharge to the unconsolidated sediments is primarily from stream flow losses or flooding (losing streams), with direct infiltration of rainfall also occurring rapidly where there are no substantial clay barriers in the shallow sub-surface. Discharge is via evapotranspiration from vegetation growing along creek beds and possibly minor short duration baseflow events after significant rainfall/flooding which results in saturation of the alluvium.

Groundwater modelling undertaken by AGE indicated that the shallow Quaternary and Tertiary aquifer is already dewatered under the current excavation/pit footprint.

Hydraulic connection between the Cainozoic unconsolidated sediments and the underlying formations is limited to areas where relatively high hydraulic conductivity units (e.g., coal seams) subcrop beneath the unconsolidated sediments, although the weathering horizon at the interface of the Permian and overlying Cainozoic units may reduce this connectivity. General downward recharge to deeper units is limited by the low hydraulic conductivity (confining) coal measure interburden sequences.

7.3 Permian Coal Measures

In the Permian strata, groundwater movement is preferentially along the coal seams which generally have higher permeability than the interburden which comprises thick sequences of interbedded lower permeability sandstone/siltstone/claystone generally confining the individual coal 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 subcrop where the overlying strata allows. Regionally, groundwater within the Permian Coal Measures flows in a south-easterly direction with local flow towards the active mining areas.

The Permian Coal Measures at site have undergone extensive deformation, including folding and faulting. Faults are common, with major northwest-southeast trending faults (i.e., Coppabella West Fault), and minor southwest-northeast trending faults. These faults significantly compartmentalise the Permian groundwater system. Review of regional fault behaviour within the wider Study Area and from external studies 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 are limited to small vertical horizons (<20 m) and is variable between faults dependent on localised hydrothermal activity and mineralisation in-filling pore spaces. No hydraulic testing of faults at CCM are available however data from the wider Study Area, it indicates that faulting zones tested are not pathways for preferential flow but rather act as hydraulic barriers.

7.4 Environmental Values

The scheduled Environmental Values (EVs) of water in the CCM region (Isaac River Sub-basin) are Drinking Water (human consumption), Stock watering, Irrigation, and Aquatic Ecosystem protection. Groundwater quality data has been compared to the Water Quality Objectives for these EVs. The alluvium within the Study Area is fresh to saline with a high degree of spatially and temporal variability. The salinity of alluvial groundwater in the CCM is brackish to saline. Based on chemistry, most of the water in this aquifer suitable for stock water supply and irrigation but is not suitable for drinking water or protective of aquatic ecosystems.

Review of the Queensland GWDB data indicates no groundwater users within 10 km radius of CCM. Based on the shallow groundwater identified close to the Thirty Mile Creek and previous ecological studies at adjacent South Walker Creek Mine, it is possible that the shallow groundwater where present in close vicinity to creeks and tributaries may support terrestrial GDEs.

Review of water quality data indicates water within the Permian Coal Measures is generally brackish to saline and is only considered suitable for some stock watering (beef cattle or sheep). Based on chemistry, most of the water in the Permian aquifer is suitable for stock watering and irrigation but is not suitable for drinking water or protective of aquatic ecosystems. No Stock water supply bores in the Permian aquifer are identified within 10 km of the CCM Project.

7.5 Conceptual Model and Key Considerations for the Project

A graphical representation of the conceptual hydrogeological model is presented in **Figure 7-1** and **Figure 7-2**.

Figure 7-1: CCM Conceptual Hydrogeological Model (West-East Section)

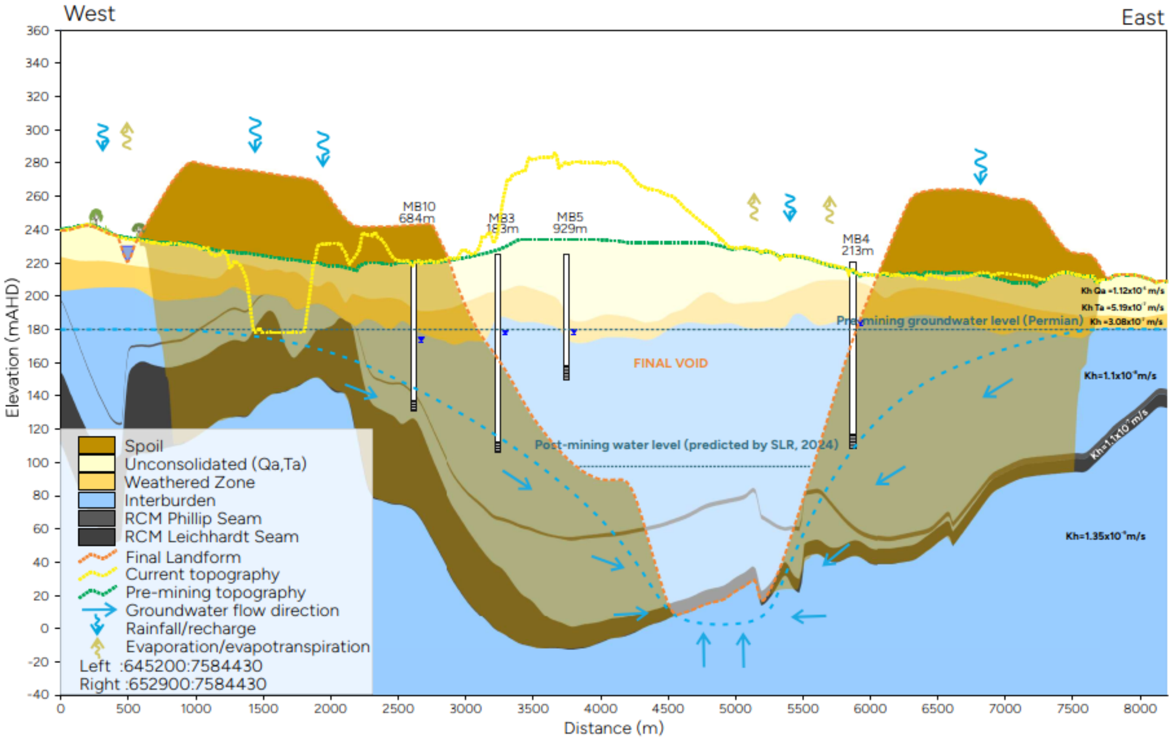
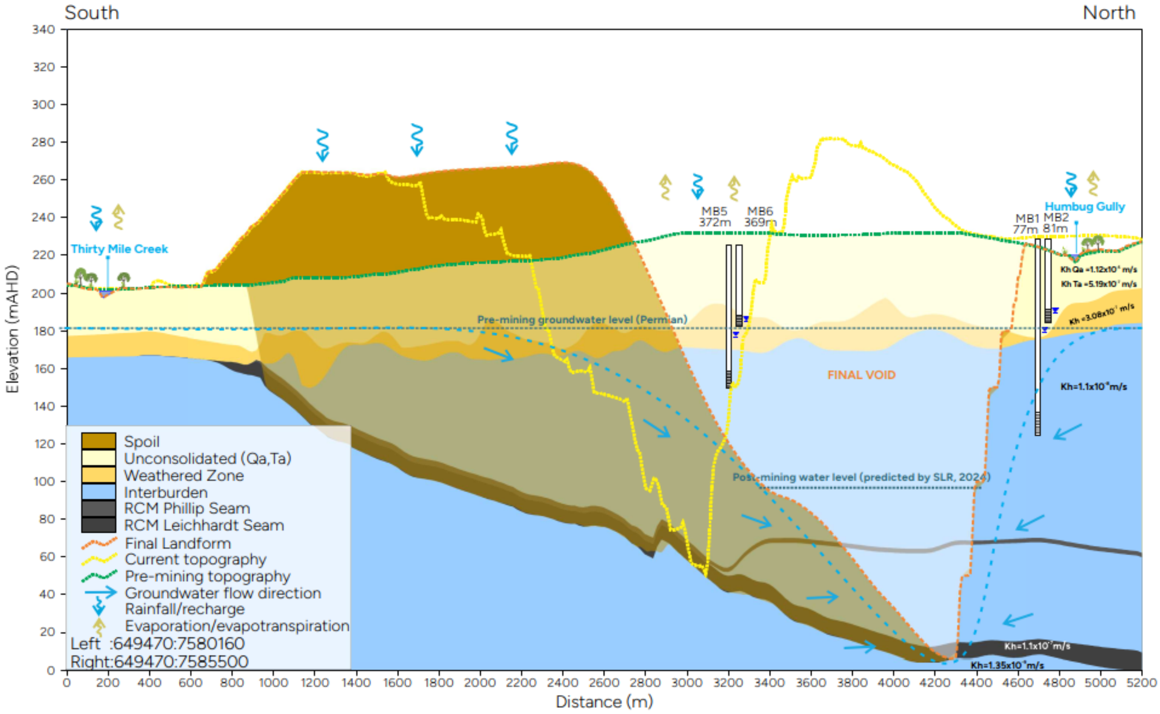


Figure 7-2: CCM Conceptual Hydrogeological Model (South - North Section)



The key considerations that have been identified in relation to the Project's groundwater impact assessment are:

- There is significant local influence of existing approved mining operations on the Permian Coal Measures groundwater system in terms of existing groundwater drawdown. Given the scale of the Project in comparison to existing operations, the potential for significant additional impacts to the Permian Coal Measures arising from the Project is limited.
- The Environmental Values of groundwater in the vicinity of the Project are likely limited to stock watering where salinity is tolerable for short period, mainly in the alluvial aquifer, and deep-rooted terrestrial vegetation along the riparian corridors. There is no evidence of other environmental use of groundwater, and the available water quality data shows parameter concentrations above relevant criteria for most natural environmental uses.

8.0 Groundwater Analytical Model

8.1 Model Details

This section provides a summary of the design and development of the analytical groundwater model used to support this Groundwater Impact Assessment.

8.1.1 Model Objectives

Analytical modelling was undertaken in support of the Groundwater Impact Assessment for the CCM Project (final void) to evaluate the potential impacts of the Project void on the local groundwater regime. The objectives of the predictive (preliminary) modelling were to predict:

- maximum groundwater inflow to the final mine void as a function of mine position;
- the extent of drawdown (radius of influence);
- groundwater inflow rate to the final void (post-mining) for various pit lake level, which will be used in the surface water modelling to determine pit lake water level within the final void
- determine the residual drawdown (following recovery); and
- Identify areas of potential risk, where groundwater impact mitigation/control measures may be necessary.

8.1.2 Model Design

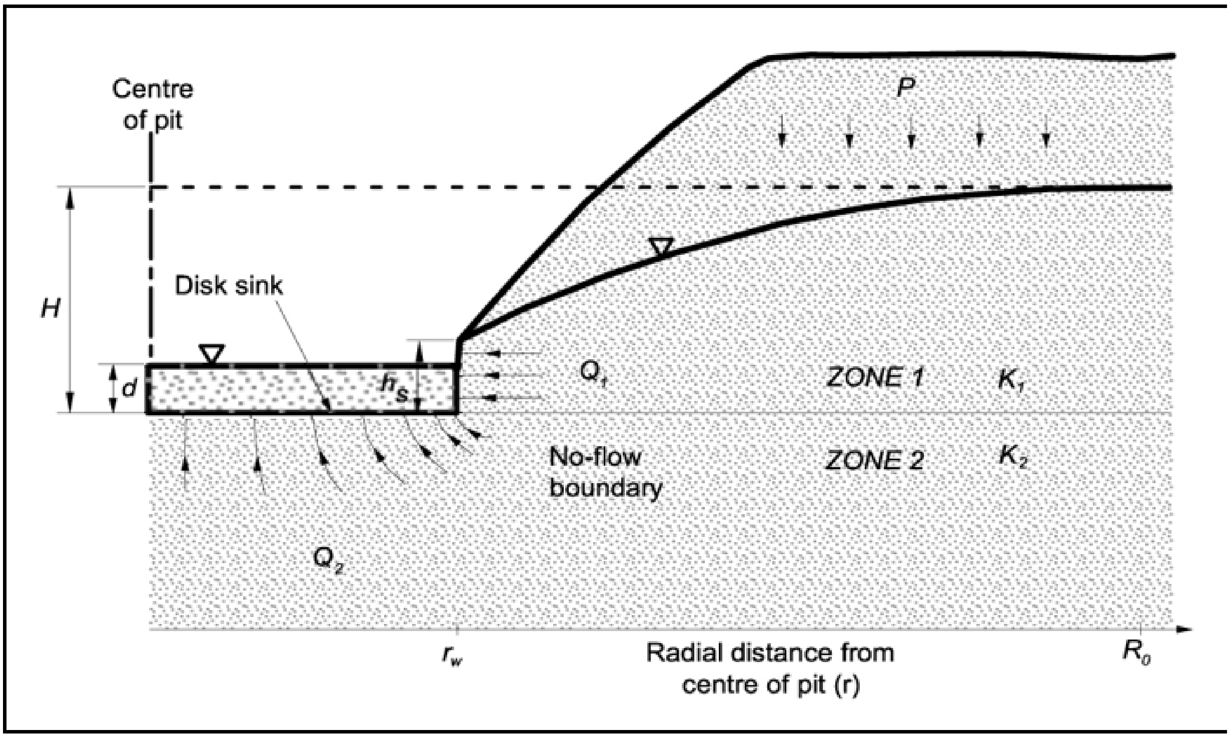
The analytical groundwater model was developed based on the conceptual groundwater model, presented within **Section 7.0**. Conceptualisation of the groundwater regime are key to achieving a reliable groundwater model. Conceptualisation is a simplified overview of the groundwater regime (i.e. the distribution and flow of groundwater) based on available data and experience.

- Following points are considered for groundwater inflow calculation for the EA amendment:
    - The four existing pits at CCM site will be merged or rehabilitated into single final pit void of about 460 ha for the EA amendment (**Figure 1-3**). The elevation of the bottom of the final pit void varies from 6 mAHD at a small corner to 20 mAHD at a major part of the pit floor and thus mining will extend to average 20mAHD (average bottommost pit floor elevation of final void). All the impact assessments are based on the final pit void geometry.
    - The storage height relationship of final void for the surface water assessment (SLR, 2024) is considered to calculate the effective pit radius.
    - Pre-mining groundwater levels in the Permian Coal Measures is approximately 180 mAHD **(Section 5.2.2.3**).
    - It is considered that the Tertiary aquifer has been dewatered during current mining activity. The groundwater model developed by AGE (2010) confirmed this showing groundwater levels as depressurised. The inflow component from the Tertiary aquifer is minimal and ignored.
    - A consolidated average 10 m thick saturated Permian coal seam and 150 m thick saturated Permian overburden defined the aquifers utilised within the model.

8.1.3 Groundwater Model

The steady-state analytical solution of Marinelli and Niccoli (2000) (**Figure 8-1**) **.** is adopted to fulfil the objectives of the analytical modelling approach. As this is a steady state model it, is considered to be conservative for estimating the extent of drawdown (radius of influence), post recovery inflow to determine the pit lake level and extent of post mining residual drawdown.

Figure 8-1: Conceptual diagram of the Marinelli and Niccoli analytical solution (modified from Marinelli and Niccoli, 2000)



The analytical solution to calculate radius of influence is provided below:

$$H = \sqrt{h_s^{\,2} + \frac{P}{K_{h1}}\left[R_0^{\,2} \ln\left(\frac{R_0}{r_w}\right) - \frac{R_0^{\,2} - r_w^{\,2}}{2} \right]}$$

Where,

H = Height of water table at radius of influence

h_s = Saturated thickness to seepage face

Drawdown (s) = (H-hs)

d = depth of ponded water

K_{h1} = Layer 1 horizontal hydraulic conductivity

K_{v2} = Layer 2 vertical hydraulic conductivity

K_{h2} = Layer 2 horizontal hydraulic conductivity

P= recharge

R_0 = radius of influence from centre of the pit

r_w = radius of the pit

Q1 = flow through layer 1 and

Q2 = flow through layer 2

The groundwater inflow is calculated using two zones as presented in **Figure 8-1**.

$$\boxed{Q_1 = P\pi\left(R_0{}^2 - r_w{}^2\right)}$$

and

$$Q_2 = 4r_w\left(\frac{K_{h2}}{m_2}\right)(H - d)$$

Where,

$$\boxed{m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}}$$

The following assumptions have been applied:

- steady-state, unconfined, horizontal radial flow;
- uniformly distributed recharge at the water table;
- the static water table is horizontal;
- groundwater flow is horizontal;
- groundwater flow to the pit is axially symmetric.
- the aquifer is homogeneous, isotropic and of uniform thickness in each zone.

8.1.4 Input Parameters

The input parameters are presented in **Table 8-1** .

Table 8-1: Input parameters to estimate groundwater inflow from the Permian Coal Seam and Overburden aquifers.

Parameter	Permian Coal Seam aquifer	Permian Overburden aquifer	Comment
H	160 (m)	150 (m)	Based on the pre-mining water level (180 mAHD) and final void bottom most pit floor (coal seam at 20 mAHD and Permian overburden as 30 mAHD).
k_{h1}	0.0095 m/day	0.00095 m/day	These values are considered appropriate based on the literature value and depth of these units (**Section 5.3.1**).
K_{v2}	0.0000095 m/day		These values are considered appropriate based on the literature value (**Section 5.3.1**).
K_{h2}	0.0000216 m/day		These values are considered appropriate based on the literature value (Section 5.3.1).
r_w	295 (m)	384(m)	Based on the storage height relationship of the final void at the base of coal seam and overburden (SLR, 2024) (See **Table 8-2**). A conical cylinder is considered.
	705 (m)	705 (m)	Based on the storage height relationship of the final void (SLR, 2024). Total void volume of 181,500 ML at a height of 180 mAHD is used. A right circular cylinder is considered. This is considered very conservative.
d	0.1 (m)	0.1 (m)	The final void reaches full excavation depth , 20 mAHD for coal seam and 30 mAHD for overburden.
h_s	0.1 (m)	0.1 (m)	The final void reaches full excavation depth, 20 mAHD for coal seam and 30 mAHD for overburden.

Table 8-2: Effective pit radius and pit floor level of the final void

Pit Floor Level	Area (m^2)	Radius (m)
20 mAHD (Permian Coal seam 10 m thick)	272,700	294.6
30 mAHD (base of overburden)	452,300	383.6

8.1.4.1 Groundwater Inflow Estimation

The maximum groundwater inflow is estimated when the final void reaches to 20 mAHD and presented in **Figure 8-2** and **Figure 8-3** . While considering a conical cylinder, the total groundwater inflow value is estimated as 431 m^3/day out of which 365 m^3/day is contributed by the Permian coal seam aquifer and 66 m^3/day is contributed by the Permian overburden aquifer. While considering a right circular cylinder (conservative scenario), the total groundwater inflow value is estimated as 753 m^3/day out of which 632 m^3/day is contributed by the Permian coal seam aquifer and 121 m^3/day is contributed by the Permian overburden aquifer.

8.1.4.2 Maximum Extent of Drawdown

The maximum extent of drawdown (radius of influence) is estimated at the end of mining (completely dewatered final void to 20 mAHD). As this model is a steady state model, the maximum extent of drawdown is considered conservative. The maximum extent of drawdown at Permian coal seam is estimated as 3534 m (right circular cylinder) and 2829 m (conical cylinder) from the centre of the pit. The maximum drawdown estimated from the Permian overburden is 1664 m (right circular cylinder) 1284 m (conical cylinder). Extent of this drawdown is considered conservative as the model represents a steady state condition.

8.1.4.3 Groundwater Recovery

The post mining groundwater inflow to the pit is required for the estimation of post mining void lake water level recovery. Marinelli and Nicolli (2000) steady state equation is considered appropriate to estimate groundwater inflow to the pit for incrementally increasing pit lake levels after the cessation of mining up to the time that an equilibrium lake level is achieved. This quasi-steady state situation can be modelled in Marinelli and Niccoli (2000) solution by ponding depth (d) value and saturated thickness of seepage face(hs) value.

The groundwater inflow is calculated at various pit lake water levels by changing d and h_s values from bottom of the pit to pre-mining groundwater conditions. The inflow volumes are high (430 m^3/day and 753 m^3/day considering void geometry as conical cylinder and right circular cylinder respectively) at the beginning of the recovery as the gradient remains high. However, as the pit lake level recovers, the groundwater inflow volume is also reduced (**Figure 8-2** and **Figure 8-3**) due to the change in hydraulic gradient.

These inflow values were used to determine the pit lake recovery levels as part of the surface water assessment of this CCM EA amendment (SLR, 2024).

Figure 8-2: Groundwater inflow to the final void at various pit lake levels (considering a conical cylinder of void geometry)

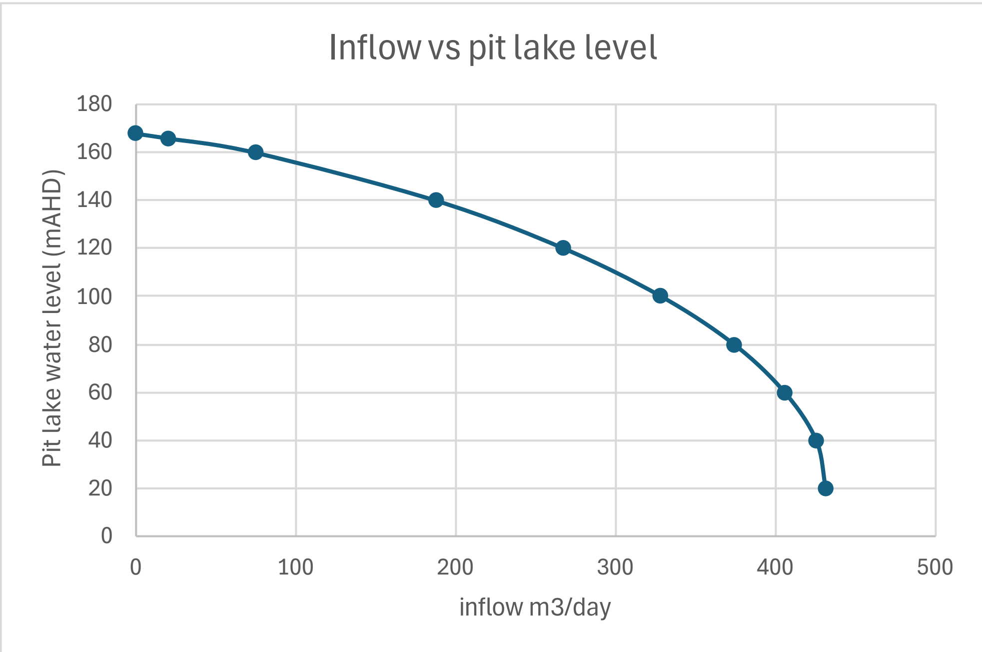
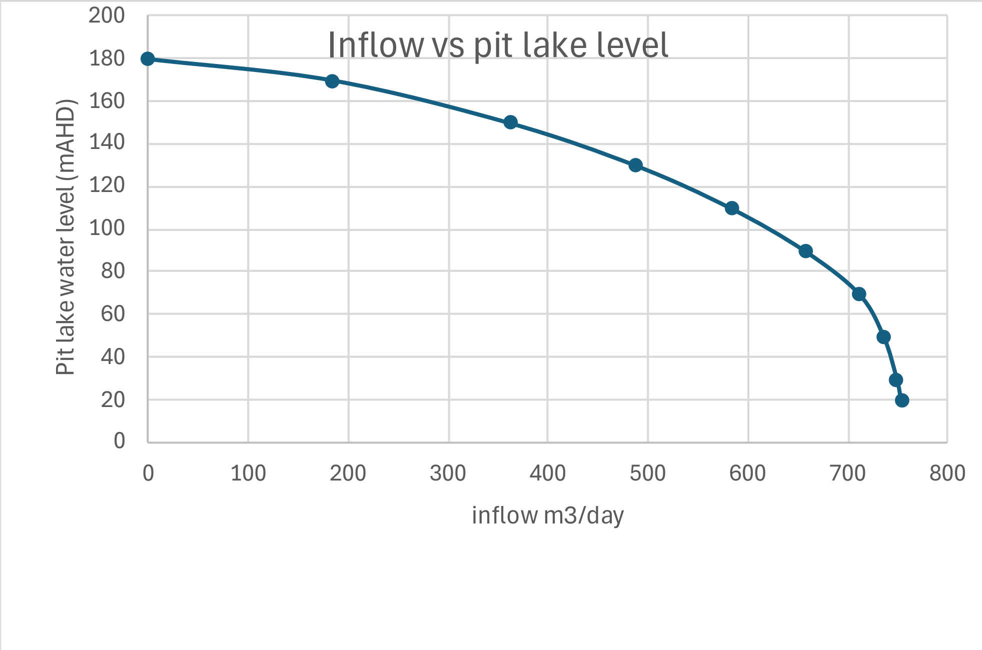


Figure 8-3: Groundwater inflow to the final void at various pit lake levels (considering a right circular cylinder of the void geometry).



8.1.4.4 Residual Postmining Drawdown Extent

Using the above groundwater inflow data (**Figure 8-2**), the final void pit lake level is predicted to be at 81 mAHD and 48.7 mAHD for two scenarios (considering two catchment areas) (SLR, 2024). The final void pit lake level is much lower than the pre-mining groundwater level at Permian overburden and coal seam aquifers (180 mAHD). The final void will therefore act as a sink.

The extent of residual drawdown is estimated by changing saturated thickness to seepage face (hs) to match 81 mAHD and 48.7 m AHD (final void pit lake level). The residual extent of drawdown is estimated as 3072 m and 2967 m for final void pit lake level of 48.7 m AHD and 81 m AHD respectively in Permian coal seam aquifer. The residual extent of drawdown is estimated as 1385 m and 1349 m for final void pit lake level of 48.7m and 81 m respectively in the Permian overburden aquifer.

As the final pit void remains as a sink, it will limit off site migration of groundwater where the quality has been affected by mining. The CCM EA Amendment to final void is therefore, not expected to have any significant impact on groundwater quality. The water quality (salinity) of the final pit lake is discussed in surface water assessment report (SLR, 2024). These findings will further support the final void to be considered as a NUMA from a groundwater impact perspective.

8.2 Model Predictive Uncertainty/Limitation

The analytical modelling techniques are limited in their application to simplified flow situations as they do not take into account any of the following limiting factors:

- a sloping aquifer and water table;
- complex boundary conditions such as geometrical shape, and geological features such as faults and dykes;

- multiple aquifer layers often found within the Coal Measures;
- variation of the storage coefficient with time;
- compression of the aquifer due to spatial variation of permeability with destressing and depth;
- inclined coal deposits; and
- variable boundary conditions of overlying bodies of water such as river, creeks, dams including variations in their water depth.

These uncertainties cannot be quantified using analytical approaches.

9.0 Potential Impacts on Groundwater Resources

9.1 Isaac Connors Groundwater Management Area

The CCM EA Amendment Project does not directly intercept groundwater from Isaac Connors Groundwater Unit 1 (Quaternary alluvium) under the Water Plan (Fitzroy Basin) 2011, meaning, all direct groundwater take by the CCM Project is from Isaac Connors Groundwater Unit 2 (sub-artesian aquifers). The maximum predicted direct take is presented in **Section 8.1.4.1** which indicates the CCM Project groundwater take would be 275 ML/year from Groundwater Unit 2.

9.2 Potential Impacts on Groundwater Users

9.2.1 Privately-Owned Supply Bores

Chapter 3 of the *Water Act 2000* provides bore drawdown threshold triggers of 2 m for unconsolidated aquifers (i.e., alluvium and regolith at CCM), and 5 m for consolidated aquifers (i.e., Permian Coal Measures at CCM). The maximum extent of drawdown in the Permian Coal Measures at CCM is about 3534 m from the centre of the pit at steady state condition (**Section 8.1.4.2**). There are no known privately-owned bores within the unconsolidated (Alluvium and Regolith) or consolidated (Permian Coal Measures) aquifers within 10 km radius of CCM. Therefore, no privately owned groundwater supply bores will be impacted by the CCM EA amendment as the predicted extent of drawdown is 3534 m from the centre of the final void.

9.2.2 Ecological Sites

The aquatic in-stream ecosystems associated with the Thirty Mile Creek, Harrybrandt Creek, Bee Creek and its tributaries are largely not dependent on the surface expression of groundwater but are instead maintained by surface water flows. Additionally, the riparian wetlands are not likely to be fed by groundwater and therefore not to be considered aquatic GDEs.

Any dependency on groundwater for terrestrial riparian vegetation along the creek beds and surrounding ephemeral wetlands is likely to be highly facultative, with only the deeper-rooted terrestrial vegetation immediately adjacent the creek channel likely to have any groundwater dependency.

The ephemeral wetlands are also not likely to be aquatic GDEs as these wetlands do not receive groundwater discharge, rather, the clay-rich substrates of these wetlands are likely to hold surface water run-off for extended periods. There would be negligible drawdown in the shallow aquifers (alluvium and regolith) along the thirty Miles Creek, Harrybrandt Creek and their tributaries as a result of the CCM EA amendment Project. Therefore, there would be no adverse impacts to terrestrial riparian vegetation associated as a result of the CCM Project.

In summary, the CCM EA amendment Project is not predicted to have any material impacts on potential or actual GDEs due to changes in groundwater quality or resources.

9.3 Potential Impacts on Creek Flows

The Creeks in CCM are highly ephemeral in nature, flowing only following rainfall events that are sufficient to generate significant surface runoff. As outlined within the conceptual model (Section 7.0 and Section 5.2.1) Thirty Mile Creek is a losing stream. Similarly, the Humbug Gully and Harrybrandt Creek are ephemeral losing creeks, with seepage of surface water into the underlying alluvium during discrete flow events. It is therefore predicted that there will be no impact on ephemeral creek flows from the CCM.

9.4 Potential Impacts on Groundwater Quality

Groundwater quality is generally considered to be poor for usability as discussed in **Sections 5.4** and **6.0.** This section describes the potential sources and pathways of groundwater contamination associated with the CCM.

Groundwater quality impacts can be caused by two principal means:

- direct release of ‘contaminants’ to groundwater,
- induced movement of different quality groundwater as a result of groundwater level changes.

Activities occurring in the CCM that have the potential for direct groundwater quality impacts through contaminant release (e.g., fuel spills) would be minor, localised, and subject to standard onsite remediation and management. Therefore, any significant groundwater quality impacts would only result from groundwater level impacts that affect groundwater movement. The extent and magnitude of predicted groundwater level drawdown resulting from the CCM is relatively small (the radius of influence of drawdown is 3534 m from the centre of the final void), meaning there is little potential for induced movement of different quality groundwater distal to the groundwater affected by the CCM. Furthermore, the maximum final void pit lake recovery level is predicted to be at 81 mAHD or 48.7 m AHD (SLR, 2024), which are lower than the pre-mining groundwater level at Permian overburden and coal seam aquifers (180 mAHD). The final void will therefore act as a sink and limit off site migration of groundwater where the quality has been affected by mining. It is, therefore expected that the CCM will have minimal impact on groundwater quality.

10.0 Limitations of the Assessment

The accuracy of the assessment is reliant on the accuracy of the utilised data, as detailed in Section 2. SLR has assumed all source data to be fit for purpose and sufficiently accurate for the purpose of this assessment. Except where noted, no verification of accuracy of the information has been carried out. In the event that some of the information which was relied upon for this assessment is found to be inaccurate, then some or all of the findings may change.

Several assumptions have been made to inform the development of the conceptual and analytical models. The modelling and sensitivity assessment provides guidance regarding the likely importance of these assumptions and parameters on the model results. However, the passage of time and additional further studies may refine these assumptions leading to improvements in model accuracy, and changes to the conclusions drawn in this report.

Although the analyses undertaken, as detailed in this report, were done so with the appropriate care and professionalism, this report shall only be used for the purposes intended. The analyses detailed in this report were undertaken solely for the purpose of addressing the requirements for the final void groundwater assessment for Coppabella Mine in accordance with the relevant documentation.

This report should be read in full, and no excerpts are to be taken as representative of the findings. This report has been prepared on behalf of Peabody and SLR accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

11.0 Reference

Advisian (2019) Groundwater borehole monitoring program report, (May 2019) Prepared for Peabody Australia

AGE, 2010. Coppabella Underground Project, Groundwater Impact assessment (Project No. G1474)

ANZG, 2023. Water Quality for Irrigation and General Water Uses: Guidelines. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand governments and Australian state and territory governments, Canberra

Arrow Energy, 2012. Chapter 14: Groundwater, Arrow Bowen Gas Project – Environmental Impact Statement

ATC William 2023. Peabody Qld Mines – 2023 Associated Water Take Report (Report ref. 122111.03, R01, REV 0)

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 Series No. 82, June 2012.

BHP, 2019. South Walker Creek Mulgrave Resource Access: Stage 2C (MRA2C) EPBC 2017-7957

Blomfield Environment Pty Ltd., 2021. Peabody Coppabella Bore Hydraulic Conductivity Testing

Bureau of Meteorology (BoM) Climate Data Online. Available at: http://www.bom.gov.au/climate/data/index.shtml

Bureau of Meteorology (BoM), 2017. Groundwater Dependent Ecosystems Atlas. Available at: http://www.bom.gov.au/water/groundwater/gde/map.shtml

Bureau of Meteorology (BoM), 2019. National Groundwater Information System. Available at: http://www.bom.gov.au/water/groundwater/ngis/

Cadman, S.J., Pain, L., & Vuckovic, V., 1998. Bowen and Surat Basins, Clarence-Moreton Basin, Sydney Basin, Gunnedah Basin and other minor onshore basins, Qld, NSW and NT. Canberra, Bureau of Resource Sciences, Australian Petroleum Accumulations Report 11

CMJV 2014. Peabody Energy Exploration Spring Creek Resources September 2014; Document Number: PE-CIP-STD-CI01 Version: 2

Clark, D., McPherson, A. and Collins, C., 2011. Australia's seismogenic neotectonic record. Geoscience Australia record 2011/11

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

Department of Environment and Heritage Protection (EHP), 2011. Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No.130 (part waters of the Isaac River Sub-basin (including Connors River). September 2011. Queensland Government Department of Environment and Heritage Protection. https://environment.des.qld.gov.au/__data/assets/pdf_file/0032/88817/fitzroy_isaac_river_wqo_290911.pdf

Department of Environment and Science (DES), 2021. Using monitoring data to assess groundwater quality and potential environmental impacts. Version 1. Queensland Government, Brisbane.

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

Dickins, J. M., & Malone, E. J., 1973. Geology of the Bowen Basin, Queensland. Bureau of Mineral Resources. Geology and Geophysics, Bulletin, 130

Doody TM., Hancock PJ., Pritchard JL., 2018. 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

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

Hatch, 2016. Hydrology and Aquatic Ecology Assessment, prepared for Peabody Energy Australia, Report ref. H351065-00000-228-230-0001

Hutton, A. C., 2009.Geological Setting of Australasian Coal Deposits. In R. Kininmonth & E. Baafi (Eds.), Australasian Coal Mining Practice (pp. 40-84). 15-31 Pelham Street, Carlton Victoria 3053: The Australasian Institute of Mining and Metallurgy

IESC, 2018. Uncertainty analysis – Guidance for groundwater modelling within a risk management framework. Information Guidelines Explanatory Note. Independent Expert Scientific Committee. Commonwealth of Australia 2018.

Jourde H, Flodin E.A., Aydin A., Durlofsky L.J., and Wen X.H., 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. Master of Philosophy thesis, University of Queensland

Marinelli F and Niccolli W.L., 2000. Simple analytical equation for estimating ground water inflow to a mine pit. Ground Water, Vol. 38., No. 2, P 311-314.

Middlemis, H., Merrick, N., and Ross, J., 2001. Murray-Darling Basin Commission – Groundwater Flow Modelling Guideline. Report for MDBC. January 2001.

Paul P.K, Zoback M.D, and Hennings P.H. 2009. Fluid Flow in a Fractured Reservoir Using a Geomechanically Constrained Fault-Zone-Damage Model for Reservoir Simulation. SPE Reservoir Evaluation & Engineering, Volume 12, Number 4, p. 562-575

Peabody Energy Corporation,2021. Technical Report Summary - Coppabella-Moorvale Joint Venture (CMJV), S-K1300

Peabody Energy Australia Pty Ltd 2023, Coppabella Coal Mine Water Management Plan (CB-ENV-WATERMGTPLN, version 6)

QLD Government SILO, 2022. Australian climate data from 1889 to yesterday. Available at: https://www.longpaddock.qld.gov.au/silo/

SLR, 2020. Winchester South Project Groundwater Impact Assessment. Report prepared for Whitehaven Coal Ltd, November 2020.

SLR, 2021a. Millennium Mine Supporting documentation to the Environmental Authority (EPML00819213) amendment application Mavis Underground operations - Groundwater Impact Assessment. Report prepared for MetRes Pty Ltd, October 2021.

SLR, 2021b. Caval Ridge Mine Horse Pit Extension Project Groundwater Assessment. Report prepared for BM Alliance Coal Operations Pty Ltd, December 2021.

SLR, 2023. Poitrel Mine Highwall Mining Project -Groundwater Impact Assessment. Report prepared for Stanmore Resources Limited (Report reference 620.30245-R03)

SLR, 2024. Coppabella Coal Mine – Environmental Authority Amendment Surface Water Assessment and Final Void Assessment Report (Report reference 640.030987.00001)

URS, 2012. Groundwater Impact Assessment, Bowen Gas Project. Prepared for Arrow Energy Pty Ltd., November 2012

WorleyParsons Consulting (2015) Coppabella area Groundwater Modelling – Stage 1 data collection and review, Report reference 201001-00508 – 00-EN-REP-00001

12.0 Feedback

At SLR, we are committed to delivering professional quality service to our clients. We are constantly looking for ways to improve the quality of our deliverables and our service to our clients. Client feedback is a valuable tool in helping us prioritise services and resources according to our client needs.

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Appendix A Groundwater Chemistry Statistics

Coppabella Coal Mine – Environmental Authority Amendment

Groundwater Final Void Assessment Report

SLR Project No.: 640.030987.0001-R01-v3.0

13 February 2024

Table A1: Groundwater Chemistry Statistics compared with EV criteria

		Alluvium																	
		P21B	P21C	P22	P22B	P22C	P23	P23A	P23B	P23C	P24C	P28A	P28B	P28C	Drinking - Health	Drinking - Aesthetic	Irrigation	Stock	Aquatic 95^{th} %
Analytes	Unit	80th percentile	80th percentile	Single value	80th percentile	80th percentile	80th percentile	Single value	80th percentile	80th percentile	80th percentile	80th percentile	80th percentile	80th percentile					
pH Value	pH Unit	6.66	6.85		5.04	6.23	4.79	4.54	4.96	4.13	3.95	7.25	3.99	4.87		6.5 to 8.5			6.5 to 8.5
Aluminium	mg/L	7030.00	4464.00	0.01	0.05	4520.00	1.04	0.89	1.12	0.89	5.14	2384.00	4.29	1.69		0.20		5.00	0.06
Calcium	mg/L	263	176	ND	9	44	33	ND	21	7	14	42	10	12				1000	
Chloride	mg/L	7500	5870	ND	3260	4720	5070	ND	4850	4820	5180	3040	4530	4170		250			
Magnesium	mg/L	413	320	ND	168	305	260	ND	237	224	286	160	214	187				2000	
Manganese	mg/L	1.520	0.202	0.001	0.146	0.418	0.284	0.212	0.116	0.229	0.235	0.333	0.116	0.988	0.5	0.1	10		1.9
Sodium	mg/L	3720	3380	ND	1830	2500	2550	ND	2620	2610	2860	2040	2420	2390		180			
Sulfate as SO4 - Turbidimetric	mg/L	186.6	418.2	37	506.8	393.6	236.4	204	480.8	486.4	612.2	235.4	365.2	581.2				1000	
Zinc	mg/L	0.029	0.0176	0.044	0.022	0.095	0.0116	<0.005	0.008	0.0086	0.0962	0.007	0.0358	0.0642		3			0.008
Arsenic	mg/L	0.003	0.001	<0.001	0.04	<0.001	0.7	<0.001	0.51	0.001	0.003	0.001	0.001	0.002	0.01		2	0.5	0.024
Cadmium	mg/L	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	0.002	0.0001	0.00064	0.002			0.01	0.0002
Chromium	mg/L	0.001	<0.001	<0.001	0.004	0.003	0.042	0.016	0.036	0.025	0.745	0.001	0.015	0.066	0.05			1	0.001
Cobalt	mg/L	0.032	0.013	0.001	0.059	0.021	0.010	0.009	0.006	0.018	0.110	0.001	0.042	0.122			0.1	1	
Copper	mg/L	0.020	0.001	<0.001	0.002	0.018	0.006	0.003	0.002	0.003	0.030	0.002	0.014	0.009	2	1		1	0.0014
Lead	mg/L	<0.001	<0.001	<0.001	0.002	<0.001	0.019	0.014	0.011	0.018	0.043	0.002	0.024	0.020	0.01			0.1	0.0034
Mercury	mg/L	15.300	0.180	<0.0001	0.200	0.310	1.100	<0.0001	0.090	0.180	<0.0001	3.120	0.710	0.320	0.001			0.002	0.0006
Nickel	mg/L	0.007	0.023	0.025	0.071	0.042	0.106	0.137	0.041	0.067	0.868	0.005	0.070	0.118	0.02			1	0.011
Selenium	mg/L	0.007	0.006	<0.01	0.131	0.008	0.054	<0.01	0.069	0.215	<0.01	0.020	0.059	0.068	0.01			0.02	0.005
Silver	mg/L	0.003	0.007	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.020	<0.001	<0.001	0.1				0.05

* Two rounds of data (highest value taken); ND = No data; Highlighted values exceeds WQO parameters

Table A1: Groundwater Chemistry Statistics compared with EV criteria

	Deep bores (in Tertiary and Permean (coal and interburden) bedrock)																					
	MB18-6C*	MB18-6D*	MB18-7B*	MB18-7C*	MB18-7DR2	MB18-8B*	MB18-8C*	MB18-8D*	MB18-9C*	MB09*	MB10*	MB1*	MB3*	MB4*	MB5*	MB7*	MB6*	Drinking - Health	Drinking - Aesthetic	Irrigation	Stock	Aquatic 95th %
Analytes																						
pH Value	8.62	11.97	6.87	12.40	11.52	6.44	11.64	12.26	12.42	7.71	8.37	8.06	8.03	8.27	7.93	8.12	7.83		**6.5 to 8.5**			**6.5 to 8.5**
Aluminium	0.03	3.38	0.01	15.00	0.02	<0.01	<0.01	0.57	1.17	0.01	0.01	<0.01	<0.01	0.01	0.02	<0.01	0.10		**0.20**		**5.00**	**0.06**
Calcium	234	57	87	60	27	498	804	476	191	580	150	270	165	266	165	524	148				**1000**	
Chloride	3850	1010	1670	1100	2410	9040	7000	2790	1990	7650	5610	4960	4360	4760	4660	6970	4590		**250**			
Magnesium	64	<1	92	<1	<1	542	<1	<1	<1	214	150	113	49	70	248	331	310				**2000**	
Manganese	0.170	<0.001	0.150	<0.001	<0.001	0.950	<0.001	<0.001	<0.001	ND	ND	ND	ND	ND	ND	ND	ND	0.5	**0.1**	**10**		**1.9**
Sodium	2350	887	1480	1490	1780	4810	3740	1840	2160	3690	3330	2620	2580	2640	2790	3520	2870		**180**			
Sulfate as SO4 - Turbidimetric	44	23	452	95	74	338	93	49	96	49	2	2	2	2	583	4	793				**1000**	
Zinc	0.01	0.01	0.04	0.01	<0.005	0.19	<0.005	<0.005	0.01	ND	ND	ND	ND	ND	ND	ND	ND		**3**			**0.008**
Arsenic	0.01	0.01	<0.001	0.028	0	<0.001	ND	<0.001	0.01	0.003	0.008	0.005	0.003	0.001	0.014	0.001	0.002	0.01		**2**	**0.5**	**0.024**
Cadmium	ND	ND	ND	0.0002	<0.0002	0.0001	ND	<0.0002	0.0002	ND	ND	ND	ND	ND	ND	ND	ND	0.002			**0.01**	**0.0002**
Chromium	<0.001	<0.001	ND	0.010	0.010	<0.001	0.020	ND	0.070	ND	ND	ND	ND	ND	ND	ND	ND	0.05			**1**	**0.001**
Cobalt	ND	<0.001	<0.001	ND	<0.001	ND	ND	<0.001	<0.001	ND	ND	ND	ND	ND	ND	ND	ND			**0.1**	**1**	
Copper	<0.001	<0.001	ND	0.010	ND	0.090	<0.001	0.010	0.000	ND	ND	ND	ND	ND	ND	ND	ND	2	**1**		**1**	**0.0014**
Lead	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.000	0.000	ND	ND	ND	ND	ND	ND	ND	ND	0.01			**0.1**	**0.0034**
Mercury	ND	ND	ND	ND	<0.0002	ND	ND	<0.0002	<0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.001			**0.002**	**0.0006**
Nickel	0.005	0.003	0.008	ND	<0.001	0.002	0.005	0.010	0.003	ND	ND	ND	ND	ND	ND	ND	ND	0.02			**1**	**0.011**
Selenium	<0.01	<0.01	<0.01	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.01			**0.02**	**0.005**
Silver	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.001	0.004	0.002	0.002	0.002	0.002	0.001	0.1				**0.05**

* Two rounds of data (highest value taken
data; Highlighted values exceeds WQO p

Table A2: Groundwater chemistry statistics compared with WQOs zone 34 shallow

		P21B	P21B	P21B	P21C	P21C	P21C	P22B	P22B	P22B	P22C	P22C	P22C	P23	P23	P23	P23B	P23B	P23B	P23C	P23C	P23C	P24C	WQOs (aquatic ecosystems)Fitzroy Groundwater Zone 34 (shallow <30m)		
Analytes	**Unit**	20th percentile	50th percentile	80th percentile	20th percentile	50th percentile	80th percentile	20th percentile	50th percentile	80th percentile	20th percentile	50th percentile	80th percentile	20th percentile	50th percentile	80th percentile	20th percentile	50th percentile	80th percentile	20th percentile	50th percentile	80th percentile	20th percentile	**20th percentile**	**50th percentile**	**80th percentile**
Electrical Conductivity @ 25°C	µS/cm	19140	20500	20740	16840	17600	17960	9552	9720	10200	12980	13500	13820	13120	13800	14100	13280	13600	13800	13180	13550	13920	13920	**498**	**2150**	**8910**
Hardness		2378	2378	2378	1773	1773	1773	723	723	723	1381	1381	1381	1166	1166	1166	1040	1040	1040	951	951	951	1227	**163**	**674**	**2228**
pH Value	pH Unit	6.514	6.56	6.656	6.686	6.75	6.846	4.746	4.93	5.044	5.92	6.09	6.226	4.128	4.175	4.786	4.778	4.86	4.964	4.04	4.08	4.134	3.582	**7.1**	**7.75**	**8.1**
Total Alkalinity as CaCO3	mg/L	345	345	345	1070	1070	1070	11	11	11	271	271	271	<1	<1	<1	3	3	3	<1	<1	<1	<1	**154**	**435**	**752**
Calcium	mg/L	263	263	263	176	176	176	9	9	9	44	44	44	33	33	33	21	21	21	7	7	7	14	**18**	**84**	**215**
Magnesium	mg/L	413	413	413	320	320	320	168	168	168	305	305	305	260	260	260	237	237	237	224	224	224	286	**27**	**108**	**389**
Sodium	mg/L	3720	3720	3720	3380	3380	3380	1830	1830	1830	2500	2500	2500	2550	2550	2550	2620	2620	2620	2610	2610	2610	2860	**135**	**747**	**1500**
Chloride	mg/L	7500	7500	7500	5870	5870	5870	3260	3260	3260	4720	4720	4720	5070	5070	5070	4850	4850	4850	4820	4820	4820	5180	**171**	**1309**	**3185**
Sulfate as SO4 - Turbidimetric	mg/L	74.2	94	186.6	346	386	418.2	454.2	488	506.8	373.8	385.5	393.6	178.4	203	236.4	469.6	473	480.8	463	474.5	486.4	591	**12**	**140**	**318**
Bicarbonate Alkalinity as CaCO3	mg/L	345	345	345	1070	1070	1070	11	11	11	271	271	271	<1	<1	<1	3	3	3	<1	<1	<1	<1	**187**	**536**	**878**
Nitrate as N	mg/L	0.02	0.02	0.02	0.024	0.03	0.036	0.056	0.06	0.08	0.01	0.055	0.11	0.122	0.195	0.316	0.05	0.06	0.068	0.08	0.08	0.09	0.932	**0**	**0.95**	**5.3**
Silica		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**21**	**36**	**52**
Fluoride	mg/L	0.3	0.3	0.3	0.6	0.6	0.6	0.2	0.2	0.2	0.2	0.2	0.2	0.14	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.24	0.4	**0.1**	**0.28**	**0.5**
Iron	mg/L	0.696	0.795	0.894	1.440	1.440	1.440	0.460	0.460	0.460	0.690	0.690	0.690	0.138	0.220	0.300	0.194	0.395	0.596	0.196	0.355	0.514	0.162	**0**	**0.03**	**0.14**
Manganese	mg/L	0.708	1.095	1.520	0.027	0.150	0.202	0.128	0.134	0.146	0.208	0.366	0.418	0.208	0.229	0.284	0.082	0.110	0.116	0.195	0.209	0.229	0.161	**0**	**0.01**	**0.16**
Zinc	mg/L	0.009	0.020	0.029	0.008	0.011	0.018	0.017	0.021	0.022	0.015	0.019	0.095	0.008	0.010	0.012	0.005	0.005	0.008	0.006	0.008	0.009	0.082	**0**	**0.015**	**0.06**
Copper	mg/L	0.0014	0.002	0.020	0.001	0.001	0.001	0.002	0.002	0.002	0.006	0.012	0.018	0.004	0.004	0.006	0.002	0.002	0.002	0.003	0.003	0.003	0.013	**0**	**0.01**	**0.03**
SAR	meq/L	33	33	33	35	35	35	30	30	30	29	29	29	33	33	33	36	36	36	37	37	37	36	**4**	**11**	**18**
RAH		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0**	**0**	**2.3**

ND = No data;Highlighted values exceeds WQO

Table A2: Groundwater chemistry statistics compared with WQOs zone 34 shallow

		P24C	P24C	P28A	P28A	P28A	P28B	P28B	P28B	P28C	P28C	P28C	WQOs (aquatic ecosystems)Fitzroy Groundwater Zone 34 (shallow <30m)		
Analytes	**Unit**	50th percentile	80th percentile	20th percentile	50th percentile	80th percentile	20th percentile	50th percentile	80th percentile	20th percentile	50th percentile	80th percentile	**20th percentile**	**50th percentile**	**80th percentile**
Electrical Conductivity @ 25°C	µS/cm	14600	14980	9850	10150	10440	12280	12800	12920	11760	12000	12240	**498**	**2150**	**8910**
Hardness		1227	1227	772	772	772	917	917	917	809	809	809	**163**	**674**	**2228**
pH Value	pH Unit	3.91	3.946	6	7.13	7.246	3.38	3.62	3.99	4.046	4.28	4.87	**7.1**	**7.75**	**8.1**
Total Alkalinity as CaCO3	mg/L	<1	<1	979	979	979	<1	<1	<1	<1	<1	<1	**154**	**435**	**752**
Calcium	mg/L	14	14	42	42	42	10	10	10	12	12	12	**18**	**84**	**215**
Magnesium	mg/L	286	286	160	160	160	214	214	214	187	187	187	**27**	**108**	**389**
Sodium	mg/L	2860	2860	2040	2040	2040	2420	2420	2420	2390	2390	2390	**135**	**747**	**1500**
Chloride	mg/L	5180	5180	3040	3040	3040	4530	4530	4530	4170	4170	4170	**171**	**1309**	**3185**
Sulfate as SO4 - Turbidimetric	mg/L	603.5	612.2	218	227.5	235.4	349.6	362.5	365.2	563.2	568	581.2	**12**	**140**	**318**
Bicarbonate Alkalinity as CaCO3	mg/L	<1	<1	979	979	979	<1	<1	<1	<1	<1	<1	**187**	**536**	**878**
Nitrate as N	mg/L	0.985	1.12	15.32	24.05	40.18	0.01	0.01	0.026	0.382	0.55	0.73	**0**	**0.95**	**5.3**
Silica		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**21**	**36**	**52**
Fluoride	mg/L	0.4	0.46	1.02	1.2	1.2	0.3	0.3	0.4	0.24	0.3	0.3	**0.1**	**0.28**	**0.5**
Iron	mg/L	0.340	0.404	1.510	1.510	1.510	0.630	0.685	0.786	0.454	0.550	0.818	**0**	**0.03**	**0.14**
Manganese	mg/L	0.215	0.235	0.036	0.288	0.333	0.102	0.108	0.116	0.919	0.958	0.988	**0**	**0.01**	**0.16**
Zinc	mg/L	0.091	0.096	0.005	0.006	0.007	0.029	0.035	0.036	0.052	0.059	0.064	**0**	**0.015**	**0.06**
Copper	mg/L	0.023	0.030	0.001	0.001	0.002	0.002	0.002	0.014	0.006	0.006	0.009	**0**	**0.01**	**0.03**
SAR	meq/L	36	36	32	32	32	35	35	35	37	37	37	**4**	**11**	**18**
RAH		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0**	**0**	**2.3**

ND = No data;Highlighted values exceeds WQO

Table A3: Groundwater chemistry statistics compared with WQOs zone 34 deep

		MB09*	MB10*	MB1*	MB3*	MB4*	MB5*	MB7*	MB6*	MB18-6C*	MB18-6D*	MB18-7B*	MB18-7C*	MB18-7DR2*	MB18-8B*	MB18-8C*	MB18-8D*	MB18-9C*	WQOs (aquatic ecosystems)Fitzroy Groundwater Zone 34 (deep >30m)		
Analytes	**Unit**																		20th %ile	50th %ile	80th %ile
Electrical Conductivity @ 25°C	µS/cm	16400	13800	13600	12600	13300	13700	16000	12400	11303	5717	6245	10605	8695	26901	21987	14043	16275	3419	6100	16000
Hardness		2342	1000	1146	617	957	1446	2689	1662	852	147	601	154	72	3503	2014	1194	482	359	919	3208
pH Value	pH Unit	7.71	8.37	8.06	8.03	8.27	7.93	8.12	7.83	8.16	11.97	6.87	12.4	11.52	6.44	11.64	12.26	12.42	7.4	7.8	8.03
Total Alkalinity as CaCO3	mg/L	133	302	135	179	163	608	175	694	348	541	944	1750	646	618	62	1220	2330	156	275	536
Calcium	mg/L	580	150	270	165	266	165	524	148	234	57	87	60	27	498	804	476	191	46	145	442
Magnesium	mg/L	214	150	113	49	70	248	331	310	64	1	92	1	1	542	1	1	1	35	115	491
Sodium	mg/L	3690	3330	2620	2580	2640	2790	3520	2870	2350	887	1480	1490	1780	4810	3740	1840	2160	480	1100	2565
Chloride	mg/L	7650	5610	4960	4360	4760	4660	6970	4590	3850	1010	1670	1100	2410	9040	7000	2790	1990	753	1900	5905
Sulfate as SO4 - Turbidimetric	mg/L	49	2	2	2	2	583	4	793	44	23	452	95	74	338	93	49	96	25	138	398
Bicarbonate Alkalinity as CaCO3	mg/L	133	302	135	179	163	608	175	694	348	<1	944	<1	<1	618	<1	<1	<1	188	330	650
Nitrate as N	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	0.05	<0.01	<0.01	0.05	<0.01	0.04	<0.01	0.01	<0.01	0.01	2.15	14.92
Silica		ND	ND	ND	ND	ND	ND	ND	ND	17.6	48.2	15.6	38.6	5	12.8	4.6	1	8	16	25	36
Fluoride	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	0.4	0.8	0.3	1.8	0.8	0.2	0.5	1.1	1.2	0.02	0.155	0.4
Iron	mg/L	1.05	0.27	0.57	0.27	0.43	0.4	0.8	0.4	1.12	<0.05	<0.05	0.12	<0.05	0.21	<0.05	<0.05	<0.05	0	0.05	0.246
Manganese	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	0.144	0.008	0.164	0.028	0.111	0.932	0.181	0.011	0.042	0	0.05	0.291
Zinc	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	0.01	0.008	0.044	0.018	0.052	0.21	0.045	0.007	0.018	0.01	0.025	0.317
Copper	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	0.003	0.004	0.003	0.017	0.036	0.111	0.004	0.008	0.009	0.017	0.03	0.03
SAR	meq/L	33.3	46.0	33.8	45.3	37.2	32.1	29.6	30.8	35.1	31.9	26.4	52.3	91.6	35.5	36.3	23.2	42.9	10.5	15.6	24.7
RAH		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0	0.2	6.3

* Only 2 sets of data are present, not enough for statistical analysis, highest value taken; ND = No data;Highlighted values exceeds WQO parameters

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