Appendix J
Surface Water Impact Assessment

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Boggabri Coal Mine Modification 10

Surface water impact assessment

Prepared for Xenith Consulting Pty Ltd

May 2025

Boggabri Coal Mine Modification 10

Surface water impact assessment

Xenith Consulting Pty Ltd

E230601 RP1

May 2025

Version	Date	Prepared by	Approved by	Comments
V1	25 July 2024	Jason O'Brien Dan Farrow	Sally Callander	First draft
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Executive Summary

ES1 Background

The Boggabri Coal Mine (BCM) is located approximately 15 kilometres (km) north-east of Boggabri in the Gunnedah Basin of New South Wales (NSW). Boggabri Coal Operations Pty Ltd (BCOPL) is seeking approval to modify (MOD 10) the BCM approval (State Significant Development (SSD) approval 09_0182) under Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

MOD 10 to SSD 09_0182 proposes the continuation of mining operations at BCM towards the north-west beyond the approved Mine Disturbance Boundary but entirely within the existing Project Boundary. MOD 10 will facilitate the recovery of an additional 30 million tonne (Mt) of Run of Mine (ROM) coal and extend the life of mining operations by four years until the end of 2040.

There are no proposed changes to the currently approved mining methods, annual ROM coal extraction rate of up to 8.6 million tonnes per annum (Mtpa), the operational workforce, nor the coal seams approved to be mined at BCM. Further to this, MOD 10 does not seek to change the approved operational hours, mining related infrastructure, water management system, coal handling and processing, transport methods and rates and access to the mine site.

ES2 Local watercourses

BCM is located within the catchment of an unnamed ephemeral waterway, locally called Nagero Creek. The Nagero Creek catchment upstream of BCM is contained within the Leard State Forest. The Leard State Forest has been selectively logged in the past but is generally still forested except for BCM, Tarrawonga Coal Mine (TCM), Maules Creek Coal Mine (MCCM), and Leard Forest Road. Most of the catchment downstream of BCM comprises cleared farmland.

Downstream of BCM, Nagero Creek becomes indistinct as it flows across the Namoi River floodplain. These alluvial flats become swampy following rainfall, and natural ponds (such as the 'Slush Holes') and farm dams store water for long periods. There is anecdotal evidence of flood break out flows that connect Nagero Creek to Bollol Creek upstream of the BCM rail spur line and loop. Nagero Creek joins the Namoi River approximately 8 km west of BCM.

The baseline water quality of Nagero Creek is characterised as having neutral to slightly alkaline pH and generally low salinity levels. Background concentrations of turbidity, nitrogen, phosphorus, and several metals are elevated compared to the default water quality objectives (WQO) for the catchment.

The northern portion of the Modification Disturbance Footprint is within the upper headwaters of the Back Creek catchment which currently drains into the approved MCCM mining areas. Back Creek is a tributary of Maules Creek and the Namoi River.

ES3 Water management approach

An existing water management system is in place at BCM and is operated and managed in accordance with BCOPL's current Surface Water Management Plan (SWMP). MOD 10 will extend the end of mine life from 2036 to 2040. It is proposed to continue using the existing water management system as part of MOD 10. Hence, there are no material changes to the approved water management system other than those associated with extending the life of mine (LOM) to 2040.

The existing water management system is described in Chapter 4. Conceptual water management system layouts for several future stages of the mine plan are provided in Chapter 5.

ES4 Surface water related impacts

The impact of MOD 10 on surface water resources was assessed relative to the approved BCM. Incremental impacts to surface water resources relative to the approved BCM include:

- Disturbance of an additional 76 hectares (ha) of the Nagero Creek catchment including the removal of several ephemeral watercourses. The removal of these watercourses will not impact flows downstream of BCM as runoff from the Modification Disturbance Footprint is currently captured as part of the approved mining operations.
- Disturbance and the capture of rainfall from 9 ha of the Back Creek catchment. MOD 10 would impact 0.1% of the Back Creek catchment and therefore is expected to have negligible impact on downstream flows.
- Increased duration of surface water impacts for an additional four years. Impacts during the additional four years are anticipated to be commensurate with impacts associated with the approved BCM.
- Increase to average volume of water that is imported to meet operational water demands. The increase is primarily due to changes in mine progression, particularly the development of haul roads and the corresponding dust suppression needs. Average water imports are still within BCOPL's existing water entitlement limits and will be subject to the same extraction conditions as the approved BCM.

Surface water related impacts associated with MOD 10 are minor in nature and consistent with those of the approved BCM. The existing water management system and SWMP are considered sufficient to manage and monitor any potential changes to surface water resources with the progression of mining.

ES5 Water licensing

Water take requirements associated with the interception of local catchment runoff and the extraction of groundwater to meet operational water demands are established in this Surface Water Impact Assessment (SWIA). A summary of the water licensing requirements, water access licence (WAL) entitlements held by BCOPL that are relevant to this SWIA, and the approach to obtain additional WALs when needed are summarised in Table ES1.

Table ES1 Water licensing summary

Water requirement	Water take mechanism	Water sharing plan	Water source	WALs required	WALs held[6]	Licensing approach[4]
Interception of catchment runoff	Incidental water take	Namoi and Peel Unregulated Rivers Water Sources 2012	Bluevale Water Source	191 ML[5]	93 ML	Temporary trade
External water supply	Namoi River via pump and pipeline	Upper Namoi and Lower Namoi Regulated River Water Sources 2016	Lower and Upper Namoi Regulated River Water Sources	2,040 ML[3]	322 ML[1]	-[2]
	Extracted from borefield via pump and pipeline	Namoi Alluvial Groundwater Sources 2020	Upper Namoi Zone 4, Namoi Valley Groundwater Source		1,028 ML	Temporary trade

Notes: 1. Does not include the 32.1 unit shares of supplementary water that BCOPL hold in these water sources.

2. Additional entitlements required to meet external water supply demands to be preferentially sourced via groundwater.

3. Represents the maximum annual water take based on 130 years of climate data.

4. Licensing approach is in addition to the WALs held by BCOPL.

5. Based on the 80th percentile intercepted runoff volume.

6. WAL volumes assume 100% available water determinations for the relevant water sources.

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1 Introduction

1.1 Background

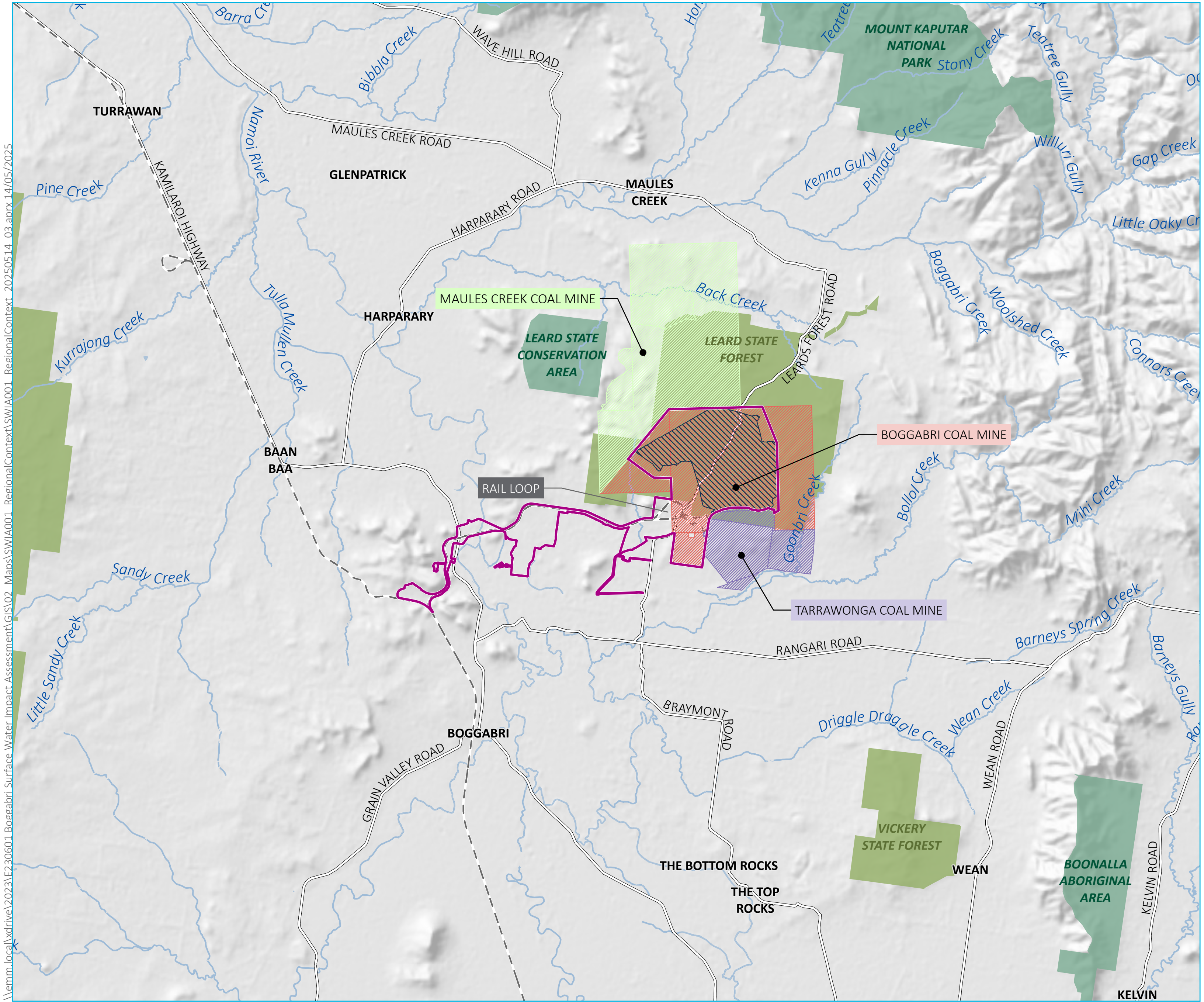
EMM Consulting Pty Ltd (EMM) has been commissioned by Xenith Consulting Pty Ltd (Xenith) (formerly James Bailey & Associates Pty Ltd (JBA)) on behalf of Boggabri Coal Operations Pty Ltd (BCOPL) to undertake a Surface Water Impact Assessment (SWIA) of a proposed modification to operations at the Boggabri Coal Mine (BCM) (MOD 10). The SWIA will be appended to a Modification Report being prepared by Xenith in support of an application to modify the BCM approval (State Significant Development (SSD) approval 09_0182) under Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

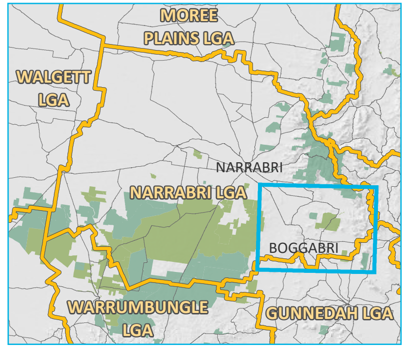
BCM is located approximately 15 kilometres (km) north-east of Boggabri in the Gunnedah Basin of New South Wales (NSW) and is located wholly within the Narrabri Local Government Area (LGA) (refer to Figure 1.1). BCM is part of the Boggabri, Tarrawonga, Maules Creek Coal Mining Complex (BTM Complex) and is immediately adjacent to the Tarrawonga Coal Mine (TCM) to the south and Maules Creek Coal Mine (MCCM) to the north.

MOD 10 to SSD 09_0182 proposes the continuation of mining operations at BCM towards the north-west beyond the approved Mine Disturbance Boundary but entirely within the existing Project Boundary. The Modification Mining Area is illustrated on Figure 1.2. This additional mining proposed by MOD 10 would involve the following:

- Recovery of an additional 30 million tonne (Mt) of Run of Mine (ROM) coal to produce approximately 25 Mt of product.
- Disturbance to an additional 85 hectares (ha) of land.
- Extension to the life of mining operations by four years until the end of 2040.

There are no proposed changes to the currently approved mining methods, annual ROM coal extraction rate of up to 8.6 million tonnes per annum (Mtpa), the operational workforce, nor the coal seams approved to be mined at BCM. Further to this, MOD 10 does not seek to change the approved operational hours, mining related infrastructure, water management system, coal handling and processing, transport methods and rates and access to the mine site.





KEY

- Project boundary
- Approved mine disturbance boundary

Current Mining and exploration title

- Mining/ production lease
- Assessment lease
- Exploration license

Existing environment

- Rail line
- Major road
- Named watercourse
- NPWS reserve
- State forest

INSET KEY

- Major road
- NPWS reserve
- State forest
- Local government area

Source: EMM (2024); ABS (2021); DCSSS (2024); GA (2009)

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Regional locality

Boggabri Coal Operations Pty Ltd
Surface Water Impact Assessment
Figure 1.1

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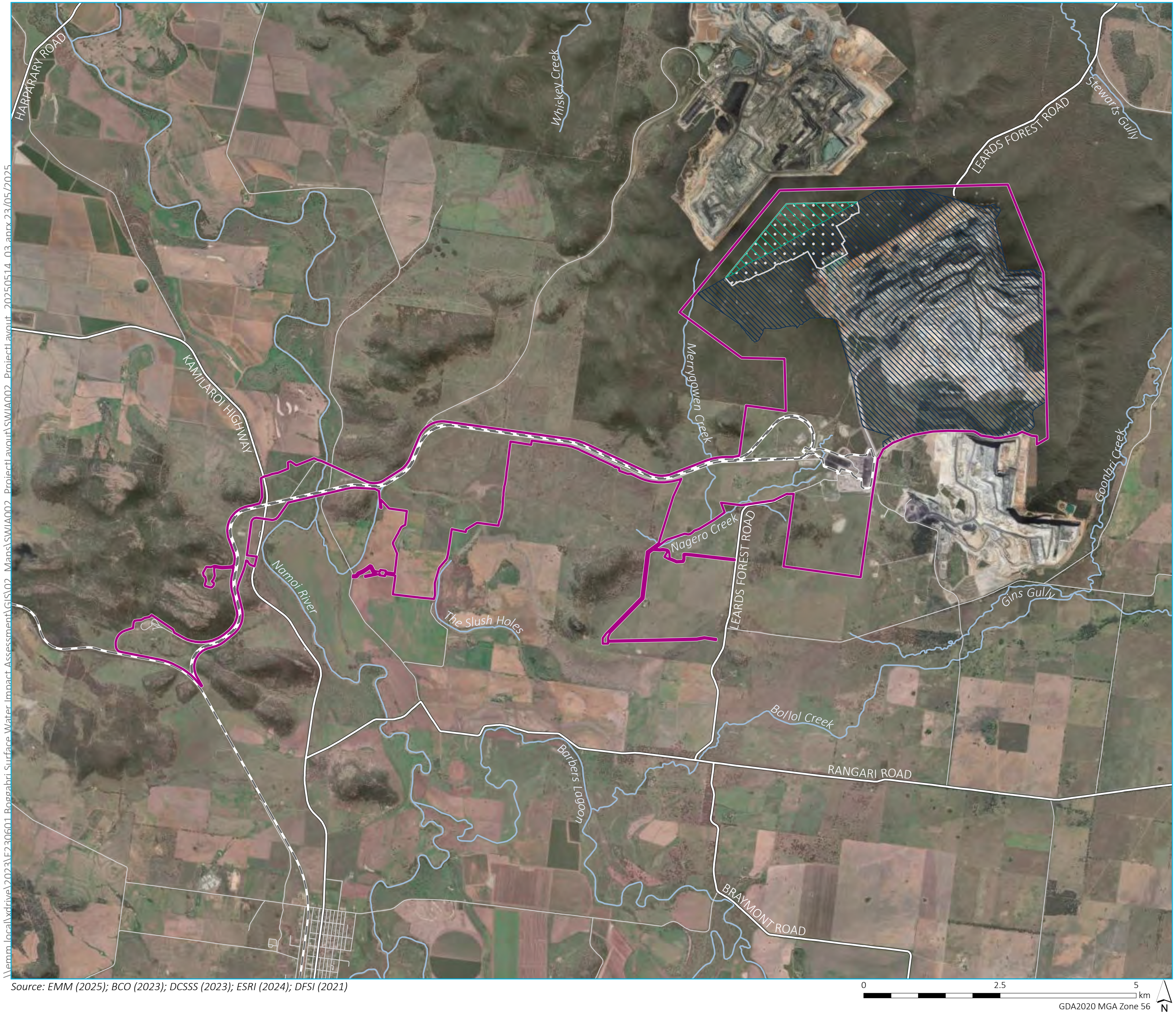

KEY

- Project boundary
- Modification Mining Area
- Modification Disturbance Footprint
- Approved Mine Disturbance Boundary

Existing environment

- Rail line
- Major road
- Minor road
- Named watercourse

Source: EMM (2025); BCO (2023); DCSSS (2023); ESRI (2024); DFSI (2021)

Conceptual Modification Layout

Boggabri Coal Operations Pty Ltd
Surface Water Impact Assessment
Figure 1.2

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1.2 Purpose of this report

This SWIA is an appendix to the Modification Report being prepared by Xenith and should be read in conjunction with it. This SWIA characterises the existing surface water environment, documents the existing and proposed water management system that will be used to avoid and minimise impacts, and assesses residual surface water related impacts resulting from the modification. Residual impacts are assessed relative to the approved BCM as of Modification 8 (MOD 8). A water licensing strategy is also presented to account for any water take that may occur over the life of mine (LOM).

1.3 Report structure

This report is structured as follows:

- Chapter 2 summarises relevant legislation, guidelines, plans and policies considered in this assessment.
- Chapter 3 describes the existing surface water environment.
- Chapter 4 describes the existing water management system at BCM.
- Chapter 5 describes the proposed water management system to be implemented during future mining stages including MOD 10.
- Chapter 6 provides a site water balance for the LOM including MOD 10.
- Chapter 7 assess the impacts of MOD 10 on the surface water environment.
- Chapter 8 addresses water licensing and approval requirements.

2 Assessment framework

2.1 Overview

This section provides a summary of relevant legislation, guidelines, plans and policies that have been considered in this SWIA.

2.2 Relevant legislation

2.2.1 Environmental Planning and Assessment Act 1979

The EP&A Act is the core legislation relating to planning and development activities in NSW and provides the statutory framework under which development proposals are assessed. BCM is classified as SSD under the EP&A Act. Section 4.55(2) of the EP&A Act sets out the assessment and approval framework for project modifications. This SWIA forms part of the Modification Report to support an application under Section 4.55(2) of the EP&A Act for BCM.

2.2.2 Water Management Act 2000

The primary legislation for managing water resources in NSW is the *Water Management Act 2000* (WM Act), which provides for the sustainable and integrated management of the state's water for the benefit of both present and future generations. It sets the framework for providing water for basic landholder rights (domestic and stock, native title and harvestable rights) and for other licensed commercial uses within the context of protection of the state's water sources and their dependent ecosystems and culturally significant sites.

A key component of the WM Act is the separation of water licences from the land which facilitates opportunities for licence holders to trade water, subject to environmental protection considerations. The WM Act outlines the requirements for taking and trading water through water access licences (WALs), water supply work approvals and water use approvals.

Under the WM Act, access to water can only occur under exemption, certain rights, or access licences. Further detail on the legislation and policies relevant to water access, water licensing requirements, and the proposed water licensing and approvals strategy are provided in Chapter 8.

i Water Management (General) Regulation 2018

The NSW *Water Management (General) Regulation 2018* (Water Regulation) is the key regulation made under the WM Act. The regulation specifies important procedural and technical matters related to the administration of the WM Act, including the establishment of WAL categories, approval requirements and exemptions.

ii Water sharing plans

Water sharing plans (WSPs) are statutory documents developed under the WM Act that are designed to establish sustainable use and management of water resources at specific locations and for specific water resource types. WSPs establish the rules for sharing water between the environment and water users, and between competing extractive demands for water. WSPs apply to one or more water sources and establish overall limits to water take, environmental water rules, trading rules and mandatory licence conditions that apply to licence holders within each water source.

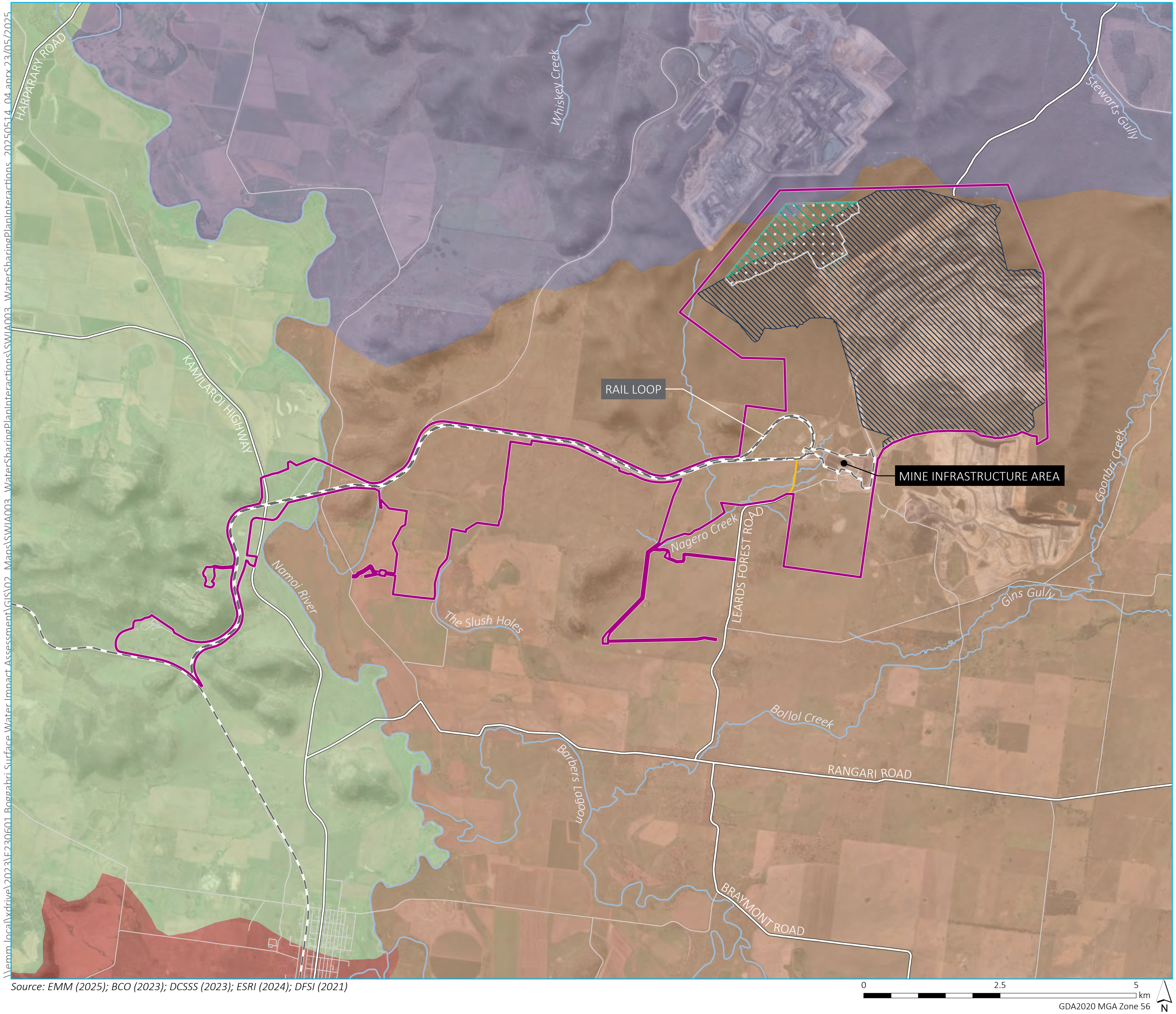
NSW has developed WSPs for all surface water and groundwater sources across the state, including a plan for each river system where major dams have been constructed for the purpose of regulating river flows (regulated rivers), plans that cover one or more water sources where major dams have not been constructed for the purpose of regulating flows (unregulated rivers), and plans for groundwater resources.

a Surface water

Surface water WSPs and water sources relevant to BCM are identified in Table 2.1 and shown in Figure 2.1. Current surface water entitlements held by BCOPL are summarised in Section 8.3.

Table 2.1 WSPs and water sources relevant to BCM

WSP	Water Source	Interaction with BCM operations
Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources 2012	Bluevale Water Source	Location of the physical mining operations. Water management features that intercept runoff may require a licence or allocation from this water source.
	Maules Creek Water Source	The Project Boundary interacts with small areas of the Maules Creek Water Source. No water infrastructure exists or is proposed in this water source.
	Eulah Creek Water Source	The haul road, rail siding and old train loading facilities located to the west of the Namoi River are located in the Eulah Creek Water Source.
Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016	Upper Namoi Regulated River Water Source	Contains the rules relating to water extraction from the Namoi Regulated River from Split Rock Dam water storage to Keepit Dam water storage. A licence from this water source is required if BCOPL were to withdraw water directly from the Upper Namoi River.
	Lower Namoi Regulated River Water Source	Contains the rules relating to water extraction from the Namoi Regulated River from Keepit Dam water storage to the junction of the Namoi River with the Barwon River. Water extracted from the Namoi River in the vicinity of BCM is from this water source and requires a WAL.



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Source: EMM (2025); BCO (2023); DCSSS (2023); ESRI (2024); DFSI (2021)

KEY
- Project boundary
- Haul road
- Modification Mining Area
- Modification Disturbance Footprint
- Approved Mine Disturbance Boundary

Namoi and Peel Unregulated Rivers Water Source
- Bluevale
- Maules Creek
- Eulah Creek
- Coxs Creek

Existing environment
- Rail line
- Major road
- Minor road
- Named watercourse

Surface water sources

Boggabri Coal Operations Pty Ltd
Surface Water Impact Assessment
Figure 2.1

creating opportunities

b Groundwater

Groundwater sources relevant to BCM are managed under the WSP for the Namoi Alluvial Groundwater Sources 2020 and the WSP for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020. Water is sourced from the Upper Namoi Zone 4, Namoi Valley Groundwater Source via the BCM borefield to meet operational water demands (refer to Section 4.6). Further details on groundwater entitlements and licensing requirements are provided in the Groundwater Impact Assessment (AGE 2025).

2.2.3 Protection of the Environment Operations Act 1997

The NSW *Protection of the Environment Operations Act 1997* (POEO Act) provides the statutory framework for managing water pollution in NSW. It is supported by the NSW *Protection of the Environment Operations (General) Regulation 2021* (POEO Regulation), which among other functions prescribes certain matters for the purposes of the definition of water pollution.

The definition of 'water pollution' in the POEO Act sets out the general and specific circumstances that constitute pollution. At its broadest, water pollution means introducing any matter into waters which changes the physical, chemical, or biological condition of the water. It also includes placing any matter where it might fall, descend, be washed, be blown or percolate into any waters.

Under the POEO Act, the NSW Environment Protection Authority (EPA) issues environment protection licences (EPLs) which regulate water pollution for projects and industrial operations. Licence conditions generally relate to pollution prevention and monitoring.

EPL No. 12407 applies to the BCM operations. The current EPL includes 10 surface water related reference points for which specific discharge and monitoring conditions are applied. Licenced discharge points are described in Section 4.8.

2.3 Relevant NSW plans, policies, and guidelines

2.3.1 Guidelines for controlled activities on waterfront land

The WM Act defines waterfront land as the bed of any river, lake or estuary and any land within 40 m of the river banks, lake shore or estuary mean high water mark. Works undertaken on waterfront land generally require a controlled activity approval, unless defined as exempt.

Guidelines for controlled activities have been prepared by NSW Department of Industry (now Department of Climate Change, Energy, the Environment and Water (DCCEEW)). These guidelines provide information on the design and construction of a controlled activity, and other ways to protect waterfront land.

BCM is categorised as SSD in accordance with the provisions of the EP&A Act. A controlled activity approval to undertake work on waterfront land is not required for projects that are defined as SSD. Hence, a controlled activity approval is not required for MOD 10.

2.3.2 NSW Water Quality and River Flow Objectives

The *NSW Water Quality and River Flow Objectives* (DECCW 2006) provides water quality objectives (WQOs) that are consistent with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000) water quality guidelines (refer to Section 2.4.2). The WQOs are "primarily aimed at maintaining and improving water quality, for the purposes of supporting aquatic ecosystems, recreation and where applicable water supply and the production of aquatic foods suitable for consumption and aquaculture activities" (DECCW 2006).

The river flow objectives (RFOs) are the agreed high-level goals for surface water flow management. They identify the key elements of the flow regime that protect river health and water quality for ecosystems and human uses. Where WSPs have been made, RFOs informed the development of these plans but typically more detailed work and understanding of flow management objectives has since been derived to the extent that WSPs effectively supersede the RFOs.

WQOs are provided for catchments throughout NSW. Nagero Creek and other watercourses near BCM are mapped as “uncontrolled streams” (DECCW 2006). The Namoi River is mapped as a “major regulated river”. An assessment against the WQOs has been undertaken as part of this SWIA.

2.3.3 Erosion and sediment control

The following NSW Government guidelines provide guidance on best practice erosion and sediment control methods and are relevant to BCM:

- *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom 2004).
- *Managing Urban Stormwater: Soils and Construction Volume 2E Mines and Quarries* (DECC 2008).

Erosion and sediment control measures are implemented as part of the existing BCM Surface Water Management Plan (SWMP) and Rehabilitation Management Plan (RMP).

2.4 Relevant commonwealth policies and guidelines

2.4.1 National Water Quality Management Strategy

The purpose of the National Water Quality Management Strategy (NWQMS) is to protect the nation’s water resources by maintaining and improving water quality, while supporting dependent aquatic and terrestrial ecosystems, agricultural and urban communities, and industry. Water quality management is based on national guidelines that are implemented at state, regional and local levels.

2.4.2 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) describe water quality objectives for freshwater and marine environments, aquatic ecosystems and primary industries within Australia and New Zealand. The ANZG (2018) guidelines are a revision to the 2000 version of the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* published by the Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

The ANZG (2018) guidelines provide a framework for the development, assessment and implementation of water quality objectives to sustain current, or likely future community values for natural and semi-natural water resources. The ANZG (2018) guidelines include default guideline values (DGVs) that define ranges and maximum values for certain parameters that are suitable for the protection of specific water uses or values.

The DGVs do not make allowance for site-specific factors that may influence water quality. The DGVs may be superseded by site-specific trigger values (SSTVs), should sufficient baseline data (typically greater than 24 months) become available.

In accordance with the NWQMS, the ANZG (2018) and (where relevant) ANZECC (2000) guidelines have been applied to establish environmental values and WQOs for watercourses that may be impacted by BCM (refer to Section 3.5.2).

3 Existing environment

3.1 Overview

This section describes the existing surface water environment in proximity to BCM and provides a baseline characterisation of local and regional climate, watercourses, water quality, water use and flooding.

3.2 Climate

3.2.1 Rainfall records

BCOPL maintains a rainfall gauge onsite with data available from 2013 to present. There are also several Bureau of Meteorology (BoM) operated rainfall gauges nearby that provide representative records for BCM. Key information and statistical data for the site gauge and representative BoM gauges are provided in Table 3.1.

Table 3.1 Annual rainfall statistics

Statistic	Units	Boggabri Mayfield (55033)	Boggabri Kanownda (55076)	Boggabri Post Office (55007)	Site gauge
Rainfall record	-	1934–1986	1899–present	1884–present	2013–present
Distance from the site	km	8 km east	12 km north	16 km south-west	0 km
Average rainfall	(mm/year)	597	576	595	606
Lowest rainfall	(mm/year)	308	280	235	211
10th percentile rainfall	(mm/year)	391	369	394	379
Median rainfall	(mm/year)	605	588	591	576
90th percentile rainfall	(mm/year)	772	756	806	926
Highest rainfall	(mm/year)	1,022	886	1,211	1,003

Source: BoM website (climate data online).

The annual rainfall totals shown in Table 3.1 indicate rainfall is relatively consistent across the three BoM gauges and the site gauge. Differences between the lowest and highest annual rainfall totals at each gauge may be attributed to the variability of rainfall distribution across the catchment that may occur in any given year along with differences in the length of record.

Review of the site gauge data over the 2013 to 2023 period indicated annual rainfall totals were similar to those recorded at the Boggabri Post Office and Boggabri (Kanownda) gauges. Hence, regional rainfall data is considered appropriate to represent site conditions in the absence of site-specific data (i.e. prior to the site gauge being commissioned).

Rainfall data from the site gauge is the most representative of the short-term (i.e. the last 10 years) rainfall record at BCM. Rainfall data at the Boggabri Post office gauge is considered the most representative of the long-term rainfall record at the site due to proximity and length of record.

3.2.2 Seasonal trends

Daily rainfall and evaporation data at the Boggabri Post Office gauge were obtained as SILO (Scientific Information for Land Owners) patched point data from the Queensland Climate Change Centre of Excellence. SILO patched point data is based on historical data from the BoM rainfall stations, with missing data 'patched' in by interpolating data from nearby operating stations. SILO data was obtained for Boggabri Post Office gauge from 1889 to 2023.

Monthly rainfall and evaporation statistics for the Boggabri Post Office gauge are shown in Figure 3.1. Median monthly rainfall totals recorded at the site rainfall gauge are also shown for comparative purposes.

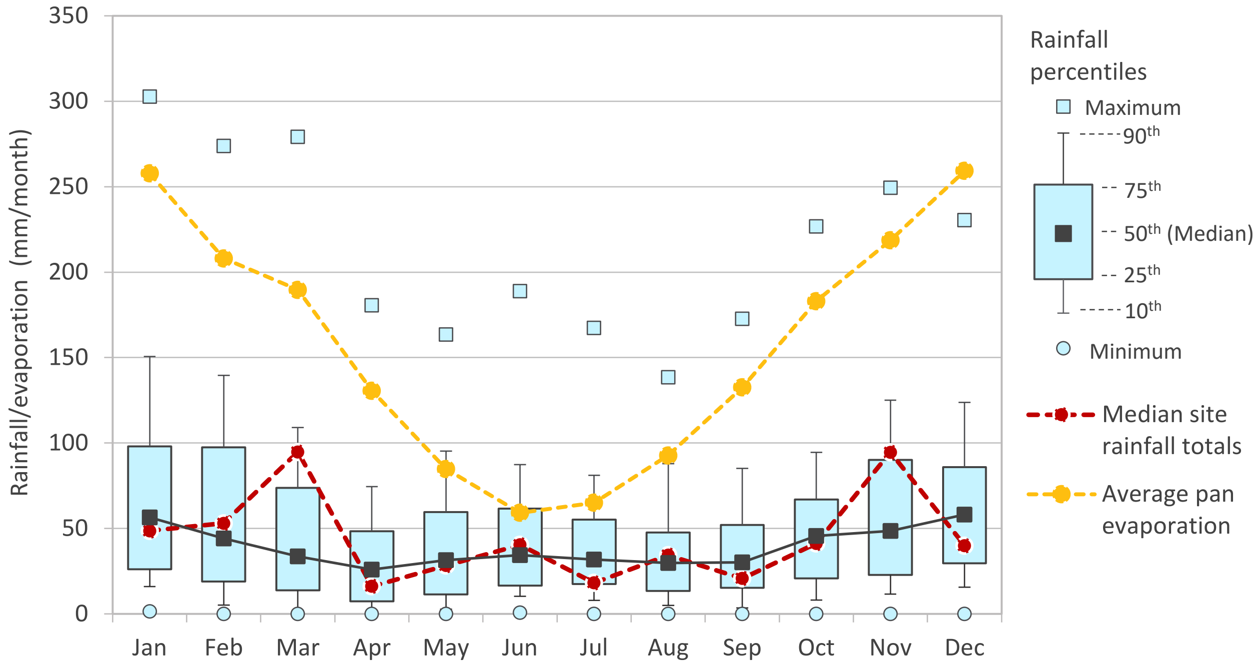


Figure 3.1 Monthly rainfall statistics – Boggabri Post Office (55007)

The rainfall data in Figure 3.1 indicates there is no strong wet and dry season, although more rainfall is generally observed in summer compared to the other seasons. Average monthly evaporation totals are shown to substantially exceed monthly rainfall totals throughout the year.

3.3 Watercourses

BCM is contained within the catchments of Nagero Creek and Bollol Creek. Nagero Creek and Bollol Creek are both small tributaries of the Namoi River, which is part of the Barwon-Darling River system. This section describes the key watercourses relevant to BCM.

3.3.1 Namoi River

The Namoi River is a major regional watercourse with a catchment area of approximately 42,000 km^2. The catchment extends over 350 km in an east-west direction between the Great Dividing Range and the Barwon River. The catchment is bounded by the Nandewar Ranges and Mount Kaputar in the north and the Liverpool and Warrumbungle ranges in the south. The extent of the Namoi River catchment is shown in Figure 3.2.

The Namoi River and several of its main tributaries have their headwater in the Great Dividing Range. Many of the Namoi's tributaries meet the river in the foothills of the ranges including the Peel River, which is a regulated tributary that flows through Tamworth and accounts for 11% of the Namoi River catchment. Other key tributaries include Coxs Creek, Mooki River, Manilla River and Macdonald River, which all join the Namoi River upstream of Boggabri.

Split Rock Dam on the Manilla River and Keepit Dam on the Namoi River are the two main water storages in the Namoi River catchment. These structures provide water to downstream users including town water supply and irrigation. High-yield aquifers exist along the Namoi and Peel rivers and are important water resources for stock and domestic purposes

A rainfall gradient exists across the Namoi River catchment with decreasing rainfall totals observed from east to west. Average annual rainfall totals range from around 1,000 mm/year along the Great Dividing Range in the east to about 480 mm/year in the west.

3.3.2 Nagero Creek

The existing approved Mine Disturbance Boundary and Infrastructure Disturbance Area (associated with the Mine Infrastructure Area (MIA)) are entirely contained within the catchment of an unnamed ephemeral waterway, locally called Nagero Creek. The Nagero Creek catchment is bounded by the Willow Tree Range to the north-east and falls generally to the south-west.

The Nagero Creek catchment upstream of BCM is contained within the Leard State Forest. The forest has been selectively logged in the past but is generally still forested except for BCM, TCM, MCCM, and Leard Forest Road. Most of the catchment downstream of BCM comprises cleared farmland.

Downstream of BCM, Nagero Creek becomes indistinct as it flows across the Namoi River floodplain. These alluvial flats become swampy following rainfall, and natural ponds (such as the 'Slush Holes') and farm dams store water for long periods. There is anecdotal evidence of flood break out flows that connect Nagero Creek to Bollol Creek upstream of the rail spur line and loop leading to BCM.

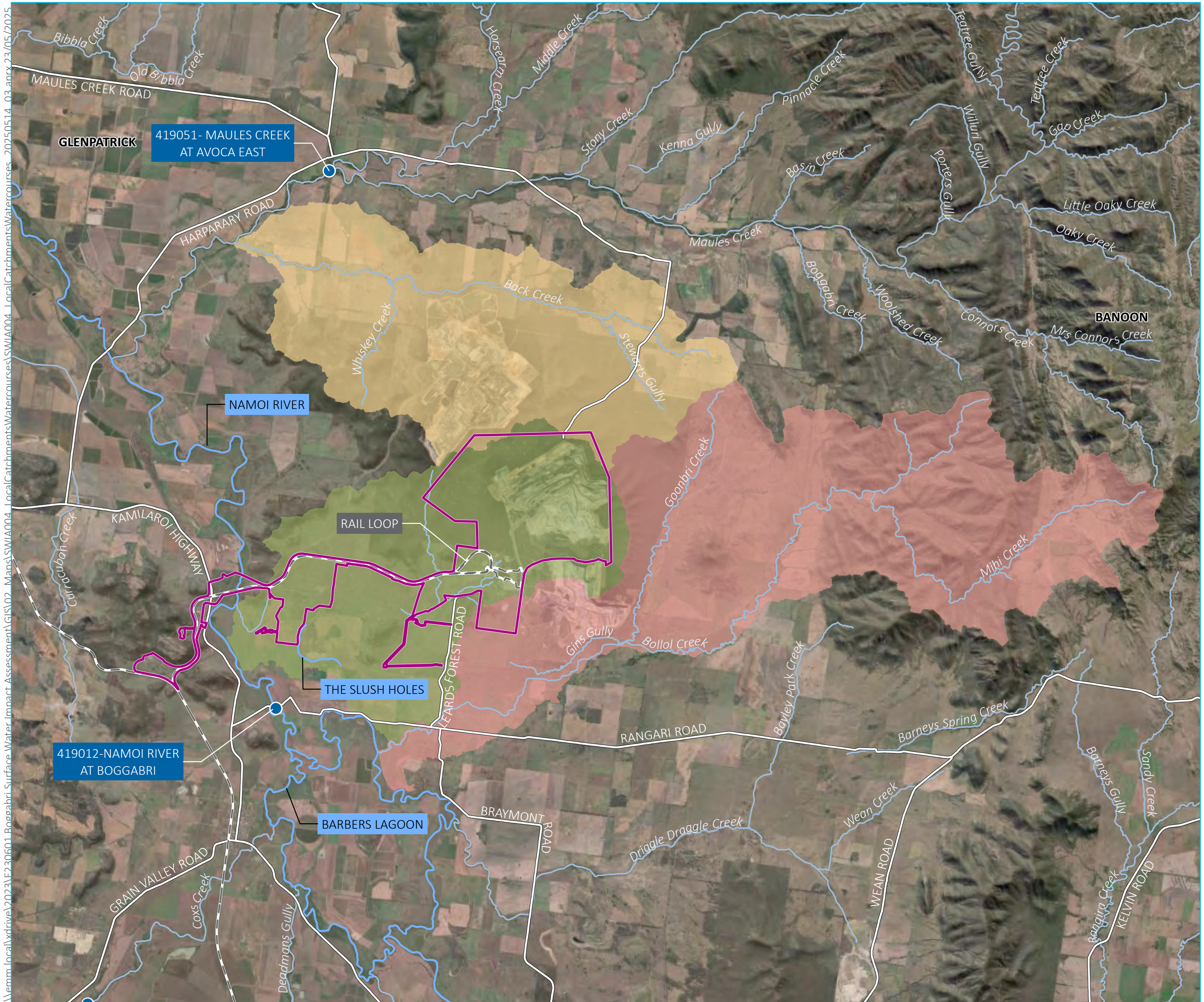
The Nagero Creek catchment is approximately 87 km^2 to the confluence with the Namoi River (about 8 km west of BCM) and accounts for about 0.2% of the total Namoi River catchment area. Nagero Creek and other local watercourses are displayed on Figure 3.2.

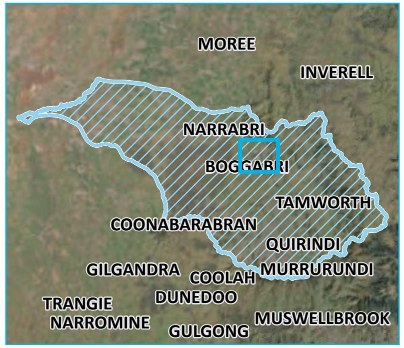
3.3.3 Bollol Creek

The Bollol Creek catchment is to the south of the MIA and approved Mine Disturbance Boundary. Bollol Creek is an ephemeral waterway that flows in a south-west direction past Goonbri Mountain and TCM. The upper catchment consists of forest, while the lower catchment is characterised by a low-lying wide floodplain, which is predominately cleared and used for cropping, grazing and other agricultural purposes.

The Bollol Creek channel is poorly defined across the low-lying floodplain area. Downstream of TCM, flows disperse across the landscape via several pathways associated with shallow, discontinuous swales and divots before eventually reaching Barbers Lagoon to the south and into a series of lagoons to the west known as the Slush Holes (and eventually Nagero Creek), which are relic river channels of the Namoi River. Local anecdotal evidence indicates the bulk of the flow heads southwest to Barbers Lagoon, and ultimately to the Namoi River (Gilbert and Associates 2010).

Bollol Creek has an inferred catchment area of approximately 149 km^2 which accounts for about 0.4% of the total Namoi River catchment area. The Bollol Creek catchment is displayed on Figure 3.2.





Source: EMM (2025); BCO (2023); DCSSS (2023); ESRI (2024); DFSI (2021)

KEY

- Project boundary
- Namoi River catchment (see inset)
- Subject watercourse
- Gauge location

Catchment

- Back Creek catchment
- Bollol Creek catchment
- Nagero Creek catchment

Existing environment

- Rail line
- Major road
- Named watercourse

Local catchments and watercourses

Boggabri Coal Operations Pty Ltd
Surface Water Impact Assessment
Figure 3.2

EMM
creating opportunities

3.3.4 Streamflow regime

Streamflow in proximity to BCM is recorded at several Water NSW operated gauges. Gauge information and streamflow statistics for each of the nearby gauges is presented in Table 3.2. The statistics are presented as annualised totals that have been calculated from available gauge records.

Table 3.2 Streamflow gauges in proximity to BCM

	Namoi at Gunnedah	Namoi at Boggabri	Namoi at Turrawan	Maules Creek at Avoca East
Stream gauge information				
Station number	419001	419012	419023	419051
Record	1968 – present	1955 – present	1995 – present	1975 – present
Record available	99%	100%	100%	100%
Distance from BCM	41 km south	12 km south-east	28 km north-west	15 km north-west
Catchment area	17,100 km^2	22,600 km^2	24,500 km^2	739 km^2
Annual streamflow statistics (GL/year)				
Average	619	768	609	24
Minimum	1	4	2	0
10^{th} percentile	127	164	86	1
25^{th} percentile	227	235	174	3
Median	361	405	313	7
75^{th} percentile	611	940	684	37
90^{th} percentile	1,818	1,971	1,424	50
Maximum	2,866	3,815	3,117	182
General streamflow statistics				
Specific mean discharge[1] (ML/year/km^2)	36	34	25	32
Annual runoff coefficient[2]	4.9%	4.7%	3.4%	4.1%

Notes: 1. Calculated as the average annual streamflow divided by the stream gauge catchment area.
2. Calculated as average annual streamflow divided by the average annual rainfall total for the contributing catchment.

The Namoi River is a highly regulated river system. The specific mean discharge values presented in Table 3.2 indicate the volume of streamflow generated per square kilometre of catchment generally decreases from east to west in line with the rainfall gradient. The presence of large water storages (Split Rock Dam and Keepit Dam) in the upper catchment influence the natural streamflow regime and generally result in lower annual streamflow volumes in wet years (when the storages are being filled) and higher annual streamflow in dry years (when water is released for downstream consumption) compared to the natural regime.

Extraction from the Namoi River is also expected to contribute to decreasing flows moving downstream with approximately 20,000 ML of WALs existing between Gunnedah and Narrabri. The impact of river extraction is more pronounced in drier years when larger volumes of river water are required to meet the demands of irrigators and the mining industry.

The percentage of rainfall that converts to streamflow is shown to range from 3.4% to 4.9%. As with specific mean discharge, anthropogenic effects (storage and extraction) within the catchment are also expected to influence the annual runoff coefficients for the Namoi River gauges.

The contributing catchment to the Maules Creek at Avoca East gauge is the less affected by anthropogenic effects and has an annual runoff coefficient of 4.1%. The Maules Creek catchment is the most comparable to the Nagero Creek and Bollol Creek catchments (which are ungauged). However, it should be noted that Maules Creek generally displays a perennial streamflow regime while both Nagero Creek and Bollol Creek exhibit ephemeral streamflow regimes.

3.4 Existing surface water users

A search of the NSW Water Register (WaterNSW 2023) was completed to establish the distribution and volume of water use within the water sources relevant to BCM. The basic landholder rights and licensed surface water take for the Bluevale Water Source, Lower Namoi Regulated River Water Source, and Upper Namoi Regulated River Water Source are summarised in Table 3.3.

Table 3.3 Available water, basic rights, and licence shares

Water take category	Bluevale Water Source	Lower Namoi Regulated River Water Source	Upper Namoi Regulated River Water Source
Domestic and stock access licences	12 ML/year	1,981 ML/year	90 ML/year
Local water utility access licences	N/A	2,271 ML/year	515 ML/year
Unregulated river access licences	2,972 unit shares	N/A	N/A
Regulated river – general security	N/A	245,350 unit shares	12,072-unit shares
Regulated river – high security	N/A	3,904 unit shares	80-unit shares
Supplementary water	N/A	115,479 unit shares	N/A
Total water access rights	**2,984 entitlement units**	**368,985 entitlement units**	**12,757 entitlement units**

Of the 2,972 ML of unregulated river access licences made available to users of the Bluevale Water Source, approximately 23% (696 ML) and 7% (204 ML) was recorded to have been used in the 2021/2022 and 2022/2023 water years respectively. Zero water use was recorded in the Bluevale Water Source prior to 2021.

The recorded regulated river and supplementary water use within the Lower Namoi Regulated River Water Source ranged from 11% (2018/2019) to 59% (2022/2023) of the total share component since 2018. The volume of water made available in this water source also varied from year to year with the available water determinations (AWDs) ranging from zero in 2018/2019 to more the twice the total share component in 2022/2023. Variations in the AWD have historically only occurred for general security water with high security and supplementary water maintaining an AWD of one.

The recorded regulated river water use within the Upper Namoi Regulated River Water Source varied from 12% (2021/2022) to 48% (2018/2019) of the total share component since 2018. An AWD of half the total share component was issued for general security water during the 2019/2020 water year.

It should be noted the above usage numbers for all water sources are based on recorded values. The reported use is possibly an understatement of actual use for water sources where metering is not mandatory or has not previously been mandatory.

3.5 Surface water quality

3.5.1 Water quality monitoring

Surface water quality monitoring is completed at BCM in accordance with BCOPL's existing SWMP. The water quality results for monitoring location SW2 (EPL point 6), which is upstream of mining operations, are considered representative of the ongoing baseline water quality characteristics of Nagero Creek.

The baseline water quality of Nagero Creek and other surrounding watercourses has also been established in historical assessment documentation associated with BCM, TCM and MCCM. The description of surface water quality provided in this section relies on both recent water quality data obtained in accordance with BCOPL's SWMP and historically reported data.

3.5.2 Water quality objectives

WQOs relevant to BCM are presented in Table 3.4. The WQOs were established using ANZG (2018) default guideline values (DGVs) for slightly to moderately disturbed ecosystems. Where more than one DGV is available for a particular parameter, the most stringent value from all environmental values has been applied as the WQO value in the remainder of this SWIA.

Table 3.4 Water quality objectives – default guideline values

Parameter	Units	Aquatic ecosystem[1]	Livestock water supply	Irrigation water supply
Physico-chemical				
pH	-	**6.5–8.0**	-	6.5–8.5
Dissolved oxygen	%	**90–110**	-	-
Electrical conductivity	µS/cm	**30–350**	3,582[2]	<950[3]
Turbidity	NTU	**25**	-	-
Nutrients				
Ammonia	µg/L	**13**	-	-
Oxidised nitrogen	µg/L	**15**	-	-
Total nitrogen	µg/L	**500**	-	25,000–125,000
Reactive phosphorus	µg/L	**15**	-	-
Total phosphorus	µg/L	**20**	-	800–12,000
Chemical contaminants/toxicants				
Aluminium	µg/L	**55**	5,000	20,000
Arsenic	µg/L	**13**[4]	500	2,000
Cadmium	µg/L	**0.2**	10	50
Chromium	µg/L	**1.0**[5]	1,000	1,000
Copper	µg/L	**1.4**	1,000	5,000
Iron	µg/L	-	-	**10,000**
Lead	µg/L	**3.4**	100	5,000

Parameter	Units	Aquatic ecosystem[1]	Livestock water supply	Irrigation water supply
Manganese	µg/L	**1,900**	-	10,000
Mercury	µg/L	**0.06**	2	2
Nickel	µg/L	**11**	1,000	2,000
Zinc	µg/L	**8**	20,000	5,000
Other chemical contaminants/toxicants	-	As per ANZG (2018)	As per Table 4.3.2 ANZECC (2000)	As per Table 4.2.10 ANZECC (2000)

Notes: 1. Contaminant/toxicant DGVs for slightly to moderately disturbed ecosystems as per ANZG (2018). All other indicators for upland (greater than 150 m AHD) rivers as per DECCW (2006).
2. Derived from a total dissolved solids concentration by using the following equation electrical conductivity x 0.67 = total dissolved solids (ANZEC 2000).
3. For sensitive crops as defined in Table 4.2.4 of ANZECC (2000).
4. As for Arsenic (V).
5. As for Chromium (VI).
Bold denotes adopted WQO.

3.5.3 Local watercourse quality

Water quality data collected as part of the BCM monitoring program was used to characterise local watercourse quality. The water quality data from monitoring location SW2, which is upstream of mining operations, is considered representative of the baseline water quality characteristics of Nagero Creek. Due to the ephemeral nature of Nagero Creek, water quality samples can only be obtained during or shortly after runoff producing rainfall events. Water quality characteristics for SW2 are presented as 20th, 50th and 80th percentile values in Table 3.5. The water quality characteristics are based on samples taken from 2020 to 2022.

Table 3.5 Nagero Creek water quality (SW2)

				Nagero Creek (SW2)		
Parameter	**Units**	**WQO[1]**	**No. samples**	**20th percentile**	**50th percentile**	**80th percentile**
Physico-chemical						
pH	-	6.5–8.0	13	7.4	7.7	8.0
Electrical conductivity	µS/cm	350	13	160	251	**606**
Total suspended solids	mg/L	50	13	5	8	36
Turbidity	NTU	25	13	**132**	**147**	**229**
Nutrients						
Ammonia	µg/L	13	13	BDL	10	**20**
Nitrate (as N)	µg/L	-	13	BDL	10	152
Oxidised nitrogen	µg/L	15	13	BDL	10	**176**
Total nitrogen	µg/L	500	13	**1,140**	**1,500**	**1,720**
Reactive phosphorus	µg/L	15	13	BDL	BDL	BDL
Total phosphorus	µg/L	20	13	**172**	**210**	**270**
Chemical contaminants/toxicants						
Arsenic	µg/L	13	13	1.4	2.0	2.6

Parameter	Units	WQO[1]	No. samples	Nagero Creek (SW2)		
				20th percentile	50th percentile	80th percentile
Cadmium	µg/L	0.2	13	BDL	BDL	0.2
Chromium	µg/L	1.0	13	BDL	**4.0**	**5.3**
Copper	µg/L	1.4	13	**2.4**	**3.0**	**4.5**
Iron	µg/L	10,000	13	347	4,320	6,740
Lead	µg/L	3.4	13	2.4	**4.0**	**5.0**
Manganese	µg/L	1,900	13	-	-	-
Nickel	µg/L	11	13	4.0	9.4	**12.6**
Zinc	µg/L	8	13	**9.6**	**14.0**	**17.6**

Notes: 1. WQO values defined in Table 3.4.

BDL denotes below detection limit.

Bold denotes WQO value exceeded.

The water quality data presented in Table 3.5 indicates Nagero Creek had neutral to slightly alkaline pH and generally low salinity (as measured by electrical conductivity) levels over the monitoring period. Turbidity, total nitrogen, total phosphorus, copper, and zinc concentrations exceeded the WQO values in most samples. Occasional exceedances of the WQO values were observed for several other analytes including ammonia, oxidised nitrogen, chromium, lead, and nickel. The water quality data obtained at SW2 from 2020 to 2022 aligns with historical data from Nagero Creek and other local watercourses in proximity to BCM (Gilbert and Associates 2010, Parsons Brinckerhoff 2010, BCOPL 2017).

3.5.4 Namoi River water quality

The water quality of the Namoi River reflects regional climate, geology, and catchment activities, with a strong correlation to streamflow. High flow events generally lead to increased turbidity, total suspended solids, and nutrients, but lower electrical conductivity. There is a general trend towards increasing concentrations of turbidity, total suspended solids, total nitrogen, and total phosphorus with distance downstream, while pH and electrical conductivity levels remain relatively stable (DPIE 2020).

Water quality monitoring data documented in the *Water quality technical report for the Namoi Surface water resource plan area* (DPIE 2020) was used to characterise the water quality of the Namoi River. Data from the Namoi River at Gunnedah stream gauge location from 2010 to 2015 indicated:

- Electrical conductivity ranged from 230–950 µS/cm with a median value of 480 µS/cm. Electrical conductivity concentrations generally exceeded the WQO value of 350 µS/cm.
- pH ranged from 7.1–9.1 with a median value of 8.0. pH tended to be more alkaline than acidic but was generally within WQO range of 6.5 to 8.0.
- Turbidity ranged from 6.6–990 NTU with a median value of 20 NTU. While occasional spikes in turbidity occurred during high flow events, turbidity concentrations were generally below the WQO value of 25 NTU.
- Total suspended solids ranged from 7–1,300 mg/L with a median value of 26 mg/L.
- Total nitrogen ranged from 200–4,800 µg/L with a median value of 650 µg/L. Total nitrogen concentrations generally exceeded the WQO value of 500 µg/L.

- Total phosphorus ranged from 30–1,200 µg/L with a median value of 80 µg/L. Total phosphorus concentrations generally exceeded the WQO value of 20 µg/L.

When compared to the water quality of Nagero Creek, the Namoi River typically has similar pH, lower turbidity, lower nutrient concentrations, and higher electrical conductivity levels.

3.6 Surface water groundwater connectivity

The smaller watercourses that surround BCM, including Nagero Creek and Bollol Creek, display ephemeral flow regimes as the creek beds are largely above the water table and therefore do not intercept groundwater. These watercourses are conceptualised as 'losing streams' which provide short term recharge to the underlying water table through creek bed seepage following significant or prolonged rainfall events (AGE 2025).

The Namoi River and Maules Creek are observed to receive groundwater inflows at times. Comparison between the Namoi at Boggabri streamflow gauge (419012) and alluvial groundwater levels in nearby bores indicates the Namoi River was primarily a gaining stream from the beginning of records (1975) to 2005 with groundwater levels approximately 1 m above the river water level. Since 2005, periods where the groundwater level is below the river level have increased in frequency, resulting in the Namoi River losing to the groundwater system over these periods. This change in interconnectivity is likely linked to gradual groundwater level declines, which can be observed since the onset of monitoring (AGE 2025).

3.7 Flooding

Several flood studies have been undertaken regionally for the Namoi River, but only a few relate to the stretch of the Namoi River downstream of Boggabri. Key studies undertaken for the Namoi River near BCM include:

- *Continuation of BCM – Namoi River Flood Impact Assessment* (WRM 2009).
- *Tarrawonga Coal Mine Modification – Surface Water Assessment* (Gilbert and Associates 2010).
- *Namoi River flood study for the proposed Maules Creek Mine* (Parsons Brinckerhoff 2011).
- *Drainage Hydrology and Hydraulic Assessment – Common and Boggabri* (Aurecon 2013).

Flooding along the reaches of the Namoi River nearest to BCM is characterised by overbank flows which inundate the extensive floodplain areas on both sides of the channel. During intense and prolonged rainfall events, large areas of the alluvial flats become inundated forming large slow-moving sheets of water which slowly dissipate by evaporation and seepage into the alluvial plains and by slow drainage into the Namoi River via the relic lagoons that are present on the edges of the river.

The largest recorded flood event (maximum daily flow) for the Namoi River at Boggabri and Namoi River at Gunnedah gauges occurred in February 1955. Both gauges have a long period of record. The Namoi River at Turrawan gauge recorded its highest daily flow during another significant flood event in 1976. Other large floods have occurred in January 1971, February 1956 and February 1984 (WRM 2009). The Namoi River flood flows take about two days to travel the 40 km stretch of river from Gunnedah to Boggabri (WRM 2009).

Most infrastructure associated with BCM is located 9 km east of the Namoi River and is elevated above the floodplain and as such is not expected to be impacted by river flooding. The BCM haul road and spur rail line traverse the Namoi River floodplain. Sections of the haul road are inundated during flood events of 20% annual exceedance probability (AEP) magnitude and greater. The rail spur line (including the rail bridge) was designed and constructed to be located above the 1% AEP flood level.

4 Water management system

4.1 Overview

An existing water management system is in place at BCM and is operated and managed in accordance with BCOPL's current SWMP. The existing water management system will form the basis of the mine water management approach over the remaining LOM.

This section describes the water management system and provides information on water management objectives, catchment areas, storages, stormwater drainage, sources of water, and water use. Water quality within the existing water management system is also characterised.

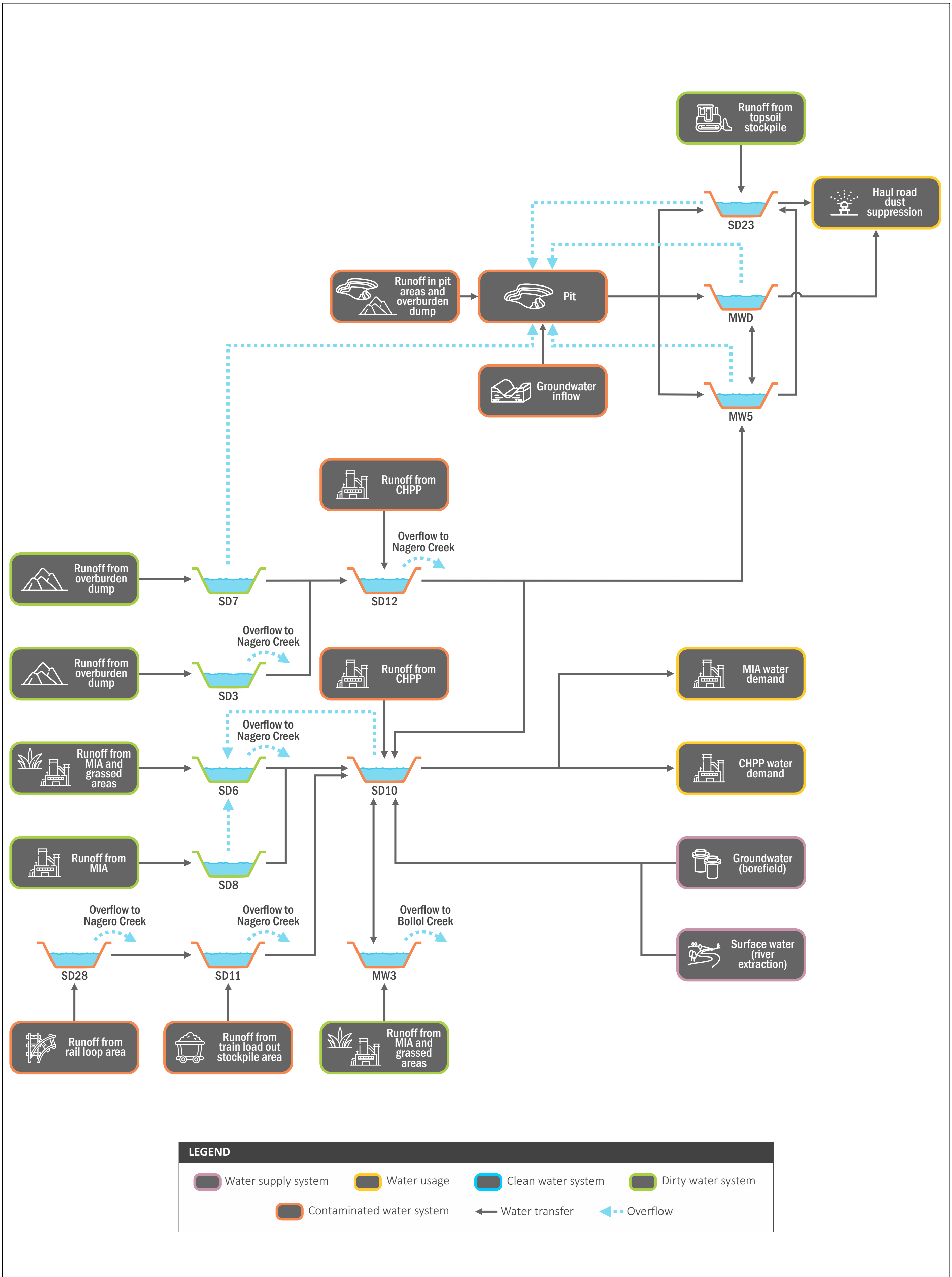
This section should be read in conjunction with Figure 4.1 which diagrammatically describes the water management system.

4.2 Water type classification

The BCM water management system is designed to use and manage water from numerous sources and of varying quality. The terminology used to describe water managed by the mine varies depending on the source, quality, and end use. The water types managed at BCM are defined in Table 4.1.

Table 4.1 Water management terminology

Term	Definition
Clean water	Water that is typically of a higher quality and incudes stormwater runoff from catchments that are not disturbed by mining operations.
Dirty water	Stormwater runoff from catchments disturbed by mining activities such as overburden emplacement areas, rehabilitation areas that are yet to be stabilised, Boggabri Rail Spur Line, haul roads and parts of the MIA. Dirty water may contain elevated concentrations of suspended solids and sediments.
Mine water (or contaminated water)	Includes stormwater runoff generated from coal stockpiles, the coal handling and preparation plant (CHPP), parts of the MIA and the mining void, as well as groundwater inflows to the mining void. Mine water may have elevated concentrations of suspended solids, sediments, ammonia and nitrates.



BCM water management system schematic

Boggabri Coal Operations Pty Ltd

Surface Water Impact Assessment

Figure 4.1

4.3 Water management objectives

BCOPL's overarching water management objective is to minimise the risk of discharging dirty and contaminated water offsite and to maximise the reuse of water onsite. The water management system is designed and operated with consideration of the key objectives described in Table 4.2.

Table 4.2 Water management objectives and approach

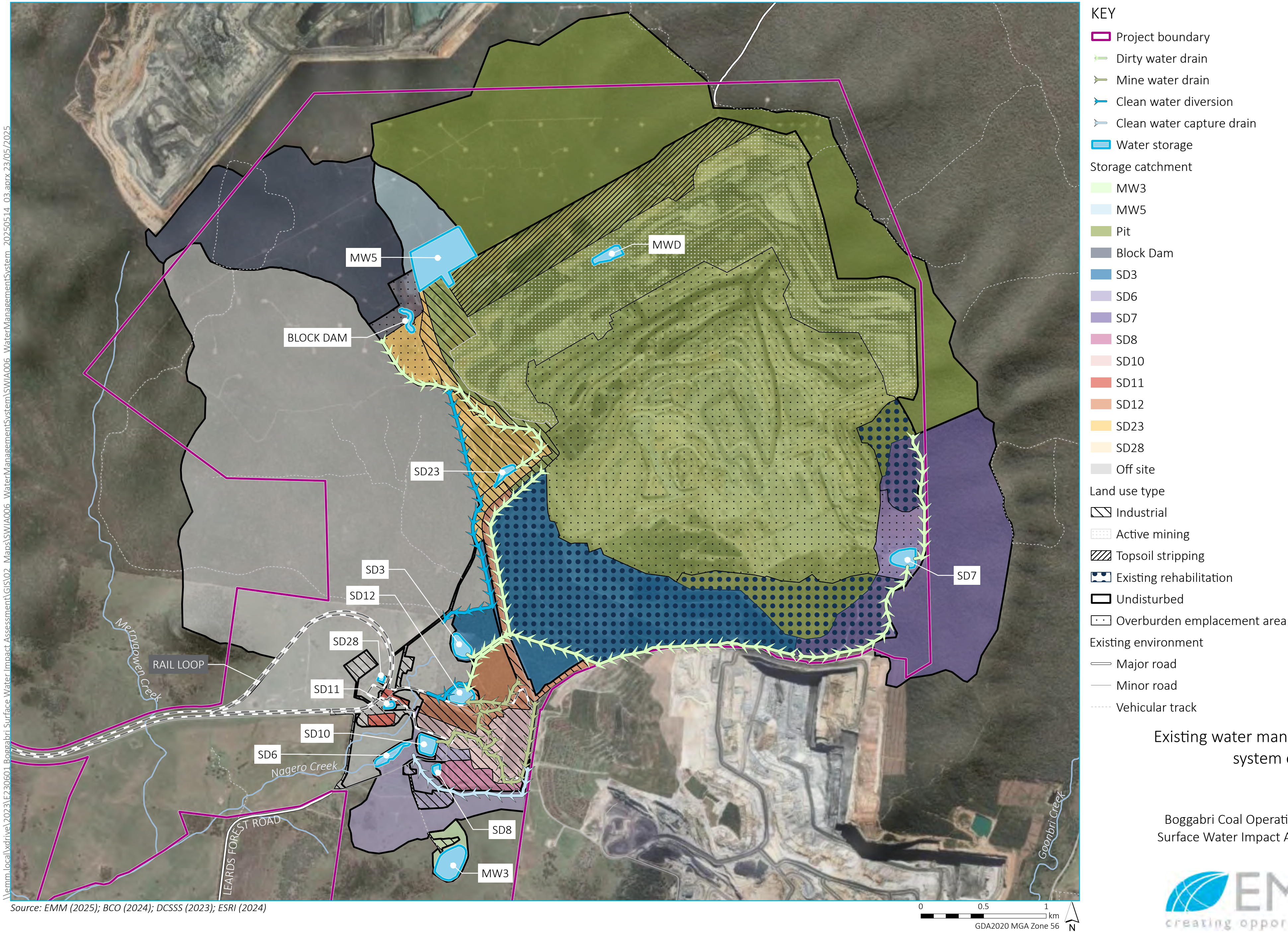
Water management objective	Approach
Where reasonable and feasible, clean water runoff from upstream catchments is diverted around the mine to reduce loading on the water management system.	Clean water runoff from the upstream catchment is diverted away from active mining areas by a series of diversion bunds and drains. Clean water diversions primarily direct runoff away from the CHPP and MIA and the western boundary of the active mining and rehabilitation area. As mining has progressed into the upper Nagero Creek catchment, the implementation of clean water diversions ahead of the active mining area has become impractical due to topographic constraints (steep grades and more pronounced drainage divides). At present, undisturbed catchments upstream of the active mining area drain directly into the mining void and are managed by the water management system.
Provide sufficient onsite storage to minimise the risk of discharging contaminated water.	The BCM water management system has a total storage volume of 3,090 ML and includes an existing 2,200 ML storage (MW5) for the purpose of containing contaminated water onsite. Contaminated water from around the site is dewatered to MW5 to minimise the risk of discharge. Contaminated water can also be stored within the mine void to provide further redundancy in significant rainfall events or extended periods of wet weather.
Provide water quality and quantity controls to treat (via sedimentation) and minimise stormwater discharge offsite.	Sediment dams are in place to capture and treat (via sedimentation) stormwater runoff. Erosion and sediment control measures including sediment dams are generally in accordance with: • *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004) • *Managing Urban Stormwater: Soils and Construction – Volume 2E – mines and quarries* (DECC 2008). Pump systems are in place to dewater sediment dams to minimise stormwater discharges offsite.
Prioritise the use of dirty and contaminated water onsite to reduce demand on external water sources.	Stormwater runoff that is captured in dirty and contaminated water dams is either used directly to supply site water demands or dewatered to mine water dams for storage and later use. Water is imported from external sources once onsite storage volumes are depleted.

4.4 Stormwater management

Stormwater runoff from clean, dirty and mine water catchment areas is managed by the BCM stormwater system. The stormwater management approach and design principles for each water type are described in Table 4.3. An overview of the existing mine water management system is shown in Figure 4.2.

Table 4.3 Existing stormwater management approach

Component	Management approach
Clean water management	The clean water management system consists of a series of diversion bunds and drains that intercept clean runoff from undisturbed catchment areas prior to it entering the active mining area. Clean water that is diverted around the mine is discharged to Nagero Creek. The objective of the clean water management system is to: • minimise the mixing of clean and dirty water runoff • minimise the volume of runoff that requires management within the BCM water management system. In locations where it is not feasible to provide diversion drains due to topographic constraints and advancing topsoil stripping and stockpiling, clean water enters the active mining area and the water management system. At present, undisturbed catchments upstream of the active mining area drain directly into the mining void. The intercepted water is managed within the water management system.
Dirty water management	The dirty water management system consists of a series of dirty water catch drains that intercept sediment-laden runoff from disturbance areas and convey it to sediment dams. The sediment dams provide the primary mechanism for dirty water management and sediment control at BCM. Sediment dams are used to facilitate the settling of suspended solids from intercepted sediment laden runoff and are designed and constructed in accordance with: • *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004) • *Managing Urban Stormwater: Soils and Construction – Volume 2E – mines and quarries* (DECC 2008). Dirty water that is captured in the sediment dams is either harvested by the mine water management system for reuse or discharged to Nagero Creek in accordance with the conditions of EPL 12407. Sediment dams are designed to manage runoff from the 5 day, 90th percentile rainfall event.
Mine water management	The mine water management system aims to capture and contain stormwater runoff from coal contact areas and from groundwater inflows to the active void. The mine water management system is comprised of the following: • Contaminated water dams – capture runoff from the coal stockpile pads in the CHPP. Water stored in contaminated water dams is reused onsite for dust suppression, CHPP process water, or pumped to mine water dams (MWDs) for future reuse. • Mine water dams – are the main long-term water storages for BCM. They receive contaminated water from the sediment dams, contaminated water dams, and active mining areas, as well as imported water from the borefield or Namoi River. MWDs are designed to contain runoff from the 1% AEP, 72 hour storm event.



Source: EMM (2025); BCO (2024); DCSSS (2023); ESRI (2024)

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Existing water management system overview

Boggabri Coal Operations Pty Ltd
Surface Water Impact Assessment
Figure 4.2

4.5 Water management dams

The water management system includes several dams that capture and store stormwater runoff as described in Section 4.4. The existing water management dams are described in Table 4.4 and shown in Figure 4.2.

Table 4.4 BCM water management dams

Dam ID	Description	Type	Storage volume (ML)	Overflows to
MW3	Receives surplus contaminated water from SD10 and runoff from the adjacent grassed area. Effectively operates as an evaporation basin.	Contaminated water dam	153.5	Bollol Creek
MW5	Receives surplus contaminated water from the pit and other active mining areas. MW5 is the primary long-term storage dam at BCM. MW5 will be replaced by MW11 by the end of 2025 (refer to Table 5.1).	Mine water dam	2,200	Pit
MWD	Represents the in-pit mine water dam. The MWD is frequently relocated as mining progresses. The functionality of the dam to transfer water from the pit to MW5 and to provide a dust suppression fill point remain similar over time. The MWD is a turkeys nest dam.	Contaminated water dam	92.8	Pit
Block dam	Receives inflows from the upstream undisturbed catchment area prior to it entering the topsoil stockpile area. The block dam is dewatered to MW5 (or MW11 from the end of 2025).	Transfer dam	17.5	SD23
Pit	Mine void associated with the BCM mining area. The pit is not considered a dam but does receive groundwater inflows and runoff from the active mining area, overburden emplacement areas, and upstream undisturbed catchment. Water that collects in the pit is dewatered to MWD, SD23 or MW5 (MW11 from the end of 2025) for reuse in the water management system.	Mining void	-	-
SD3	Captures dirty water runoff from partially rehabilitated overburden emplacement area and adjacent undisturbed catchment. SD3 is dewatered to SD12 and is a licenced discharge point (EPL 3).	Sediment dam	102.3	Nagero Creek
SD6	Captures dirty water runoff from the MIA and adjacent undisturbed catchment area. Overflows from SD8 and discharges from the TCM water management system drain to SD6. SD6 is dewatered to SD10 and is a licenced discharge point (EPL 1).	Sediment dam	55.9	Nagero Creek
SD7	Captures dirty water runoff from partially rehabilitated overburden emplacement area and adjacent undisturbed catchment. SD7 is dewatered to SD12.	Sediment dam	95.1	Pit
SD8	Captures dirty water runoff from the MIA and is dewatered to SD10.	Sediment dam	13.4	SD6

Dam ID	Description	Type	Storage volume (ML)	Overflows to
SD10	Captures contaminated water runoff from the product coal stockpile and receives pumped inflows from the borefield and Namoi River and several water management dams. SD10 supplies water to the CHPP and MIA and can be dewatered to MW5 (MW11 from the end of 2025) or MW3 during surplus.	Mine water dam	116.4	SD6
SD11	Captures contaminated runoff from the train load out stockpile area and rail loop. SD11 is dewatered to SD10.	Contaminated water dam	16.4	Nagero Creek
SD12	Captures contaminated runoff from the run-of-mine coal stockpile and adjacent undisturbed area and receives pumped transfers from SD3 and SD7. SD12 can be dewatered to MW5 (MW11 from the end of 2025) or SD10.	Contaminated water dam	206.6	Nagero Creek
SD23	Captures dirty water runoff from topsoil stockpile and receives inflow from MW5. SD23 is a dust suppression fill point.	Contaminated water dam	17.0	Pit
SD28	Captures contaminated runoff from the rail loop. SD28 is dewatered to SD11.	Sediment dam	3.5	Nagero Creek

4.6 Water supply

Water is required for several activities onsite including dust suppression, use in the CHPP and as washdown water in the MIA. Water requirements are sourced from water storages and supplemented with imported water in the following priority:

1. Surface water captured onsite in contaminated water, mine water, and sediment dams.
2. Imported groundwater from the Upper Namoi Zone 4 Groundwater Source via the borefield.
3. Imported surface water from the Lower Namoi Regulated River Water Source via the pump station on the Namoi River.

Over the long term, dirty and contaminated water are used for mining activities in preference to import water. However, on occasion imported water may be sourced while stored water is present onsite to meet operational demands. Water demand requirements are established as part of the site water balance in Chapter 6.

4.7 Erosion and sediment control

Erosion and sediment control measures are managed in accordance with BCOPL’s existing SWMP and Rehabilitation Management Plan (RMP) and the following best practice guidelines:

- *Managing Urban Stormwater: Soils and Construction, Volume 1* (Landcom 2004)
- *Managing Urban Stormwater: Soils and Construction, Volume 2E – Mines and quarries* (DECC 2008).

Regular maintenance and inspections are completed to identify additional or changed risk, to instigate improvements and to ensure the continued functionality of the erosion and sediment control measures.

4.8 Licensed discharges

EPL No. 12407 applies to the BCM operations. EPL No 12407 includes 10 surface water related reference points for which specific discharge and monitoring conditions are applied. The EPL points are described in Table 4.5 and shown on Figure 4.3.

Releases to the downstream environment may occur from the three licenced discharge points (EPL points 1, 3 and 4) as uncontrolled overflows (wet weather discharges) or as controlled (via pumping) discharges. Dirty water sediment dams are designed to manage runoff from the 5 day, 90th percentile rainfall event (38.4 mm)[1] and are typically expected to overflow two to four times per year on average (DECC 2008).

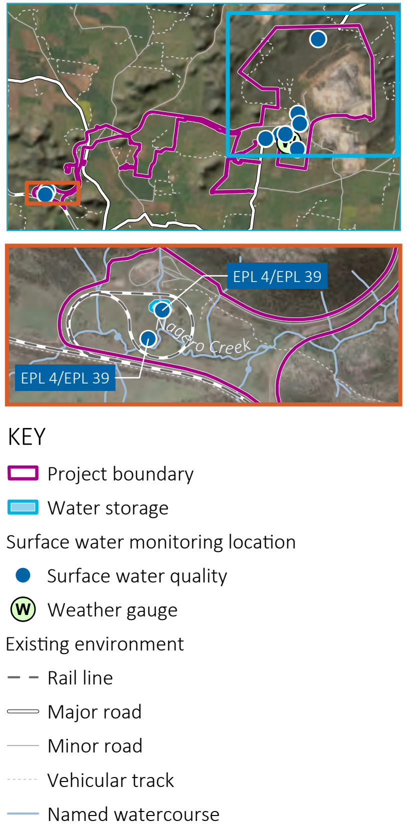
To minimise the risk of contaminated water discharges occurring, EPL No. 12407 also includes a requirement to maintain an air capacity of 1,000 ML within the BCM mine water storages.

Table 4.5 EPL point descriptions and monitoring conditions

EPL ID	Description	Monitoring type	Discharge limits
1	SD6 discharge point	• Discharge water quality monitoring.	• Oil and Grease – 10 mg/L. • pH – 6.5 to 8.5. • Total suspended solids – 50 mg/L[1].
3	SD3 discharge point		
4	SD4 discharge point		
5	Nagero Creek downstream of discharge locations (SW1)	• Surface water quality monitoring.	• Not applicable.
6	Nagero Creek upstream of mining operations (SW2)[2]		
36	Monitoring from within SD6		
38	Monitoring from within SD3		
39	Monitoring from within SD4		
46	Monitoring from within SD12		
47	Monitoring from within MW3		
48	Nagero Creek downstream of mining (SW3)		

Notes: 1. Total suspended solids concentration limits may be exceeded provided that the discharge occurs solely as a result of rainfall that exceeds 38.4 mm over any consecutive 5-day period immediately prior to the discharge occurring and all practical measures have been implemented to dewater all sediment dams within 5 days.
2. The location of SW2 has been progressively moved as mining progresses but has always been maintained upstream of BCM.

[1] 38.4 mm equates to the 5-day 90th percentile rainfall depth for Gunnedah as sourced from Table 6.3a of *Managing Urban Stormwater: Soils and Construction, Volume 1* (Landcom 2004).



Source: EMM (2025); BCO (2023); DCSSS (2023); ESRI (2024)

Surface water and EPL monitoring locations

Boggabri Coal Operations Pty Ltd
Surface Water Impact Assessment
Figure 4.3

EMM creating opportunities

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4.9 Water quality characterisation

Water quality data collected as part of the BCM monitoring program from 2019 to 2025 was used to characterise the water quality of the water management system. Monitoring data was categorised according to whether the sample was collected from downstream of the mine (SW1), sediment dams or contaminated/mine water dams. Water quality characteristics for each category are presented as 20th, 50th and 80th percentile values in Table 4.6. The water management system water quality is compared against the WQOs established in Table 3.4 and Nagero Creek baseline water quality described in Table 3.5. The water quality data presented in Table 4.6 is summarised as follows:

- pH was slightly alkaline at all monitoring locations and was observed to be higher (i.e. more alkaline) in MWDs compared to sediment dams and SW1. The pH of sediment dams and MWDs frequently exceeded the upper limit of the WQO range (6.5–8.0) but was within the EPL limit range (6.5–8.5) for most samples.
- Salinity (as indicated by electrical conductivity) was elevated relative to the WQO value in most sediment dam samples and all MWD samples. Downstream of BCM, salinity levels were fresher and generally below both WQO values and Nagero Creek baseline concentrations.
- Total suspended solids concentrations were generally lower in the sediment dams and MWDs compared to SW1. Total suspended solids concentrations were below the EPL limit (50 mg/L) for most water management system samples.
- Turbidity concentrations exceeded the WQO value in most samples but were generally in line with or below the Nagero Creek baseline concentrations.
- Ammonia and nitrate concentrations were elevated (particularly in samples from the pit floor) in the MWDs and exceeded the WQO values and Nagero Creek baseline concentrations in most samples.
- Total nitrogen concentrations exceeded the WQO value in most sediment dam and SW1 samples but were consistent with background concentrations in Nagero Creek. MWDs exhibited higher total nitrogen concentrations due to the presence of elevated ammonia and nitrate.
- Total phosphorus concentrations exceeded the WQO value in most samples with generally lower concentrations observed in MWDs compared to sediment dams, SW1 and Nagero Creek.
- Metal concentrations in sediment dams and MWDs are generally below the WQO values and background concentrations in Nagero Creek. Chromium, copper, and zinc occasionally exceed the WQO values while less frequent exceedances of cadmium, iron, lead, and nickel were observed.
- Metals concentrations downstream of BCM were consistent with the background concentrations in Nagero Creek. Chromium, copper, and zinc occasionally exceed the WQO values while less frequent exceedances of cadmium, iron, lead, and nickel were observed. Metals concentrations upstream and downstream of BCM were generally higher than what is observed within the water management system.

The overall water quality across BCM is influenced by the source of runoff. Monitoring locations that primarily received inflows from undisturbed catchment areas (SW1 and SW2) exhibited higher metals and phosphorus concentrations than the water management system. Water storages that receive mine water displayed higher pH, electrical conductivity, ammonia, nitrate, and total nitrogen concentrations. Sediment dams exhibited water quality similar to Nagero Creek baseline data but with generally lower metals concentrations and occasionally higher concentrations of salinity and nutrients. The observed discharge water quality from sediment dams (SD3 and SD6) is generally consistent with baseline water quality of Nagero Creek.

Table 4.6 BCM Water management system water quality

					Nagero Creek (SW2)	Downstream[3] (SW1)				Sediment dams (SD3, SD4, SD6, SD7, SD8)				Contaminated/MWDs (Pit floor, MW3, MW5, SD10, SD12, SD23)			
Parameter	Units	DL	WQO[1]	EPL limit[2]	80P	#exceedances/ #samples	20P	50P	80P	#exceedance/ #samples	20P	50P	80P	#exceedances/ #samples	20P	50P	80P
Physico-chemical																	
pH (field)	-	-	6.5–8.0	6.5–8.5	8.0	1/10	7.4	7.5	7.8	29/102	7.6	8.1	8.7	57/126	8.1	8.4	8.7
Electrical conductivity	µS/cm	-	350	-	606	4/10	205	344	444	93/102	402	595	877	126/126	975	1,446	1,869
Oil and grease	mg/L	5	-	10	BDL	0/10	BDL	BDL	BDL	0/23	BDL	BDL	BDL	0/10	BDL	BDL	BDL
Total suspended solids	mg/L	1	-	50	40	6/10	28	82	154	11/43	4	16	83	4/17	5	16	89
Turbidity	NTU	0.1	25	-	229	8/8	110	199	299	44/99	32	78	286	8/124	24	45	119
Nutrients																	
Ammonia as N	µg/L	10	13	-	20	4/8	BDL	15	20	42/61	10	30	70	63/73	20	40	166
Oxidised nitrogen	µg/L	10	15	-	176	4/10	BDL	10	280	49/62	12	55	248	66/73	80	1,870	3,556
Nitrate (as N)	µg/L	10	-	-	152	1/10	BDL	10	270	1/62	10	50	224	25/73	74	1,840	3,474
Total nitrogen	µg/L	10	500	-	1,720	10/10	1,380	1,550	2,880	61/62	520	900	1,480	71/73	900	2,700	4,820
Reactive Phosphorus	µg/L	10	15	-	BDL	6/10	BDL	30	52	21/62	BDL	BDL	48	9/73	BDL	BDL	BDL
Total phosphorus	µg/L	10	20	-	270	10/10	128	235	344	50/62	30	130	300	48/73	20	40	100
Chemical contaminants/toxicants																	
Arsenic	µg/L	1	13	-	2.6	0/10	2.0	2.0	3.0	0/62	1.0	2.0	2.8	0/73	1.0	2.0	3.0
Cadmium	µg/L	0.1	0.2	-	0.2	1/10	BDL	BDL	BDL	4/62	BDL	BDL	BDL	0/73	BDL	BDL	BDL
Chromium (III+VI)	µg/L	1	1.0	-	5.3	7/10	BDL	2.5	6.0	15/62	BDL	BDL	1.9	3/73	BDL	BDL	BDL
Copper	µg/L	1	1.4	-	4.5	10/10	2.0	2.5	5.6	26/62	BDL	1.0	2.6	18/73	BDL	BDL	2.0
Iron	µg/L	50	10,000	-	6,740	1/8	210	1,695	4,050	1/50	BDL	65	1,472	0/63	BDL	BDL	BDL

Parameter	Units	DL	WQO[1]	EPL limit[2]	Nagero Creek (SW2) 80P	Downstream[3] (SW1) #exceedances/ #samples	20P	50P	80P	Sediment dams (SD3, SD4, SD6, SD7, SD8) #exceedance/ #samples	20P	50P	80P	Contaminated/MWDs (Pit floor, MW3, MW5, SD10, SD12, SD23) #exceedances/ #samples	20P	50P	80P
Lead	µg/L	1	3.4	-	**5.0**	4/10	1.0	2.5	**6.0**	10/62	BDL	BDL	2.0	4/73	BDL	BDL	BDL
Manganese	µg/L	1	1,900	-	-	0/1	BDL	BDL	BDL	0/37	BDL	4.0	12.4	0/59	BDL	2.0	13.4
Nickel	µg/L	1	11	-	**12.6**	3/10	3.8	7.5	**12.4**	3/62	1.2	2.0	3.8	10/73	2.0	3.0	7.0
Zinc	µg/L	5	8	-	**17.6**	6/10	BDL	**10.0**	**22.2**	13/62	BDL	BDL	**8.8**	12/73	BDL	BDL	6.6

Notes:
1. WQO values are defined in Table 3.4.
2. EPL limits are defined in Table 4.5 and are only applicable to discharges and are presented for context.
3. Eight out of ten samples were collected during site discharge conditions.
DL denotes detection limit.
BDL denotes below detection limit.
Bold denotes WQO value or EPL limit is exceeded.
Blue denotes the Nagero Creek (SW2) 80th percentile value is exceeded.

5 Proposed water management system

5.1 Overview

MOD 10 will extend the end of mine life from 2036 to 2040. It is proposed to continue using the existing water management system as part of MOD 10. Hence, there are no material changes to the approved water management system other than those associated with extending the LOM to 2040.

This section describes the proposed water management system to be implemented over the remaining LOM including the final landform. It is important to note that the water management system described in this section is conceptual and will require changes as mining progresses.

The proposed water management system was used to inform the site water balance described in Section 6.

5.2 Proposed water management system for future mine stages

The future operational phase of the mine schedule spans a period of 17 years (2024 to end of 2040). Over this time, the mine disturbance area, contributing catchment and land use areas are expected to constantly change as mining progresses. The water management system will be modified as needed to maintain consistency with EPL No 12407, approval conditions, and the objectives described in Section 4.3.

The existing water management system will be largely retained as mining progresses. Most of the future changes will occur within the active mining area to manage water that is generated from previously undisturbed areas and areas that are progressively rehabilitated. New infrastructure will be constructed as required while some elements of the existing system will be decommissioned as they are either mined through or become redundant.

BCOPL provided landform and land use designs for mine schedule years 2025, 2028, 2031, 2034, 2036 and the final landform. The mine schedule years provide a snapshot of the BCM layout at specific points in time to demonstrate how mining is expected to progress. Key changes to the water management system for at each of the snapshot years are described in Table 5.1.

Table 5.1 Proposed water management system

Mine plan year[1]	Proposed water management system description	Reference
2025	As mining progresses to the north-west, MW5 will be mined through by the end of 2025 (in accordance with currently approved progression of mining operations). It is intended that MW5 will be replaced by MW11 which will be constructed in vicinity to the existing location of SD23. It is assumed that MW11 will have a similar capacity (2,200 ML) to, and be operated in line with, the existing MW5 dam. SD23 will be decommissioned to facilitate the construction of MW11. Landform changes required for rehabilitation are predicted to increase the catchment area feeding to SD3 from 193 ha to 209 ha. The existing SD3 capacity of 193 ML is sufficient to account for the increase in runoff from the additional catchment area in accordance with the 5 day, 90th percentile rainfall event (38.4 mm) design criteria established in the SWMP. The mine void will continue to collect runoff from the active mining and overburden emplacement areas. Clean water runoff from the upstream catchment area of Nagero Creek will continue to be intercepted by the mine void.	Figure 5.1

Mine plan year[1]	Proposed water management system description	Reference
2028	Mining will progress further to the west through the existing stockpile area and the block dam. The block dam will be decommissioned to enable progression of mining operations. Temporary sediment dams may be established to capture and treat runoff from topsoil stripping activities as mining progresses to the west in accordance with the approved BCM. These dams would be constructed to meet the objectives of the SWMP and would be decommissioned to enable progression of mining operations. A dirty water drain will be established to direct runoff from the new haul road to the west of the active mining area to MW11. Alternatively, the haul road may be graded to drain towards the mining void to prevent discharges occurring to the receiving environment. The established rehabilitation area that drains to SD3 is assumed to be released to the downstream environment, reducing inflows to the water management system and subsequent surface water licensing requirements. The timing of this release will be subject to achieving the BCM rehabilitation objectives for the area, including achieving adequate runoff water quality. The release of the SD3 established rehabilitation area may therefore occur sooner or later than 2028 depending on when the rehabilitation objectives are met. The established rehabilitation areas that drain to SD7 cannot be practically released to the downstream environment due to terrain constraints. Runoff from established rehabilitation areas that collects in SD7 will continue to be managed in accordance with the approved BCM SWMP. The mine void will continue to collect runoff from the active mining and overburden emplacement areas. Clean water runoff from the upstream catchment area of Nagero Creek will continue to be intercepted by the mine void.	Figure 5.2
2031	Mining will have progressed further to the north into the proposed Modification Disturbance Footprint. Temporary rehabilitation areas will be established in the central portion of the Mine Disturbance Area to provide vegetation cover on overburden areas that will eventually be placed in the mine void as part of the final landform. Temporary rehabilitation aims to reduce erosion and sediment mobilisation from these areas as mining progresses. New dirty water dam(s) will be constructed by 2031 to capture dirty water runoff from temporary rehabilitation areas. Consistent with the approved BCM, new dirty water dam SD19 is assumed to be constructed for the purposes of the SWIA and is shown in Figure 5.3. It should be noted the location and capacity of SD19 is indicative only and that BCOPL may construct one or more dirty water dams to achieve a similar purpose and the objectives of the SWMP. The mine void will continue to collect runoff from the active mining and overburden emplacement areas. Clean water runoff from the upstream catchment area of Nagero Creek will continue to be intercepted by the mine void.	Figure 5.3
2034	Mining will have progressed to the far north boundary of the proposed disturbance area and will continue to progress to the west. Temporary sediment dams/drains may be established to capture and treat runoff from topsoil stripping activities as mining progresses to the west in accordance with the approved BCM. These dams/drains would be constructed to meet the objectives of the existing SWMP and would be decommissioned once mining operations are scheduled to progress through these areas. The mine void will continue to collect runoff from the active mining and overburden emplacement areas. Clean water runoff from the upstream catchment area of Nagero Creek will continue to be intercepted by the mine void.	Figure 5.4
2036	Mining will continue to progress to the west. No material changes to the water management system are anticipated compared to the 2034 water management system.	Figure 5.5
Final landform	The final landform will be stable and free draining to the downstream environment except for a final void in the north-west of the Project Boundary. The final void will be partially infilled to a level of 285 m AHD to minimise groundwater inflows and prevent the formation of a permanent pit lake. A clean water diversion bund will be established on the eastern side of the final void to prevent runoff from adjacent areas entering the void. A small residual upstream catchment area to the north will continue to be intercepted by the final void as diversion drains are not considered practical due to terrain constraints.	Figure 5.6

Notes: 1. All staged mine plans are conceptual only and relate to the scheduled status of BCM at the end of the calendar year.

Source: EMM (2025); BCO (2024); DCSSS (2023); ESRI (2024)

KEY
Project boundary
Dirty water drain
Mine water drain
Clean water diversion
Clean water capture drain
Modification Mining Area
Modification Disturbance Footprint
Storage catchment area

Land use type
Stockpile
Active mining
Topsoil stripping
Existing rehabilitation
Proposed rehabilitation
Overburden emplacement area
Water storage

Existing environment
Major road
Minor road
Named watercourse

Conceptual water management system- 2025

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Figure 5.1

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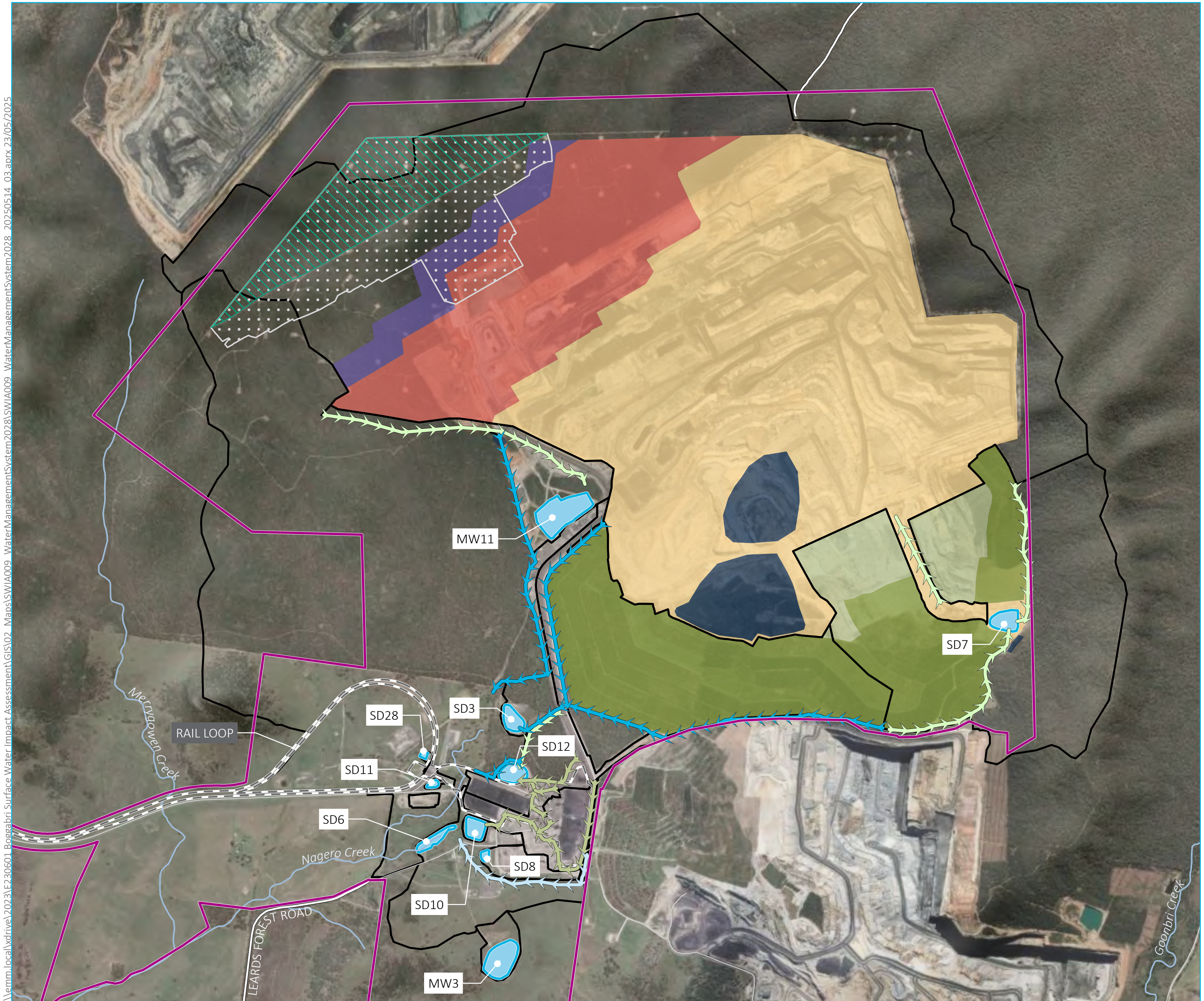

Source: EMM (2025); BCO (2024); DCSSS (2023); ESRI (2024)

KEY
- Project boundary
- Dirty water drain
- Mine water drain
- Clean water diversion
- Clean water capture drain
- Modification Mining Area
- Modification Disturbance Footprint
- Storage catchment area

Land use type
- Stockpile
- Active mining
- Topsoil stripping
- Existing rehabilitation
- Proposed rehabilitation
- Overburden emplacement area
- Water storage

Existing environment
- Major road
- Minor road
- Named watercourse

Conceptual water management system- 2028

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Figure 5.2

EMM creating opportunities

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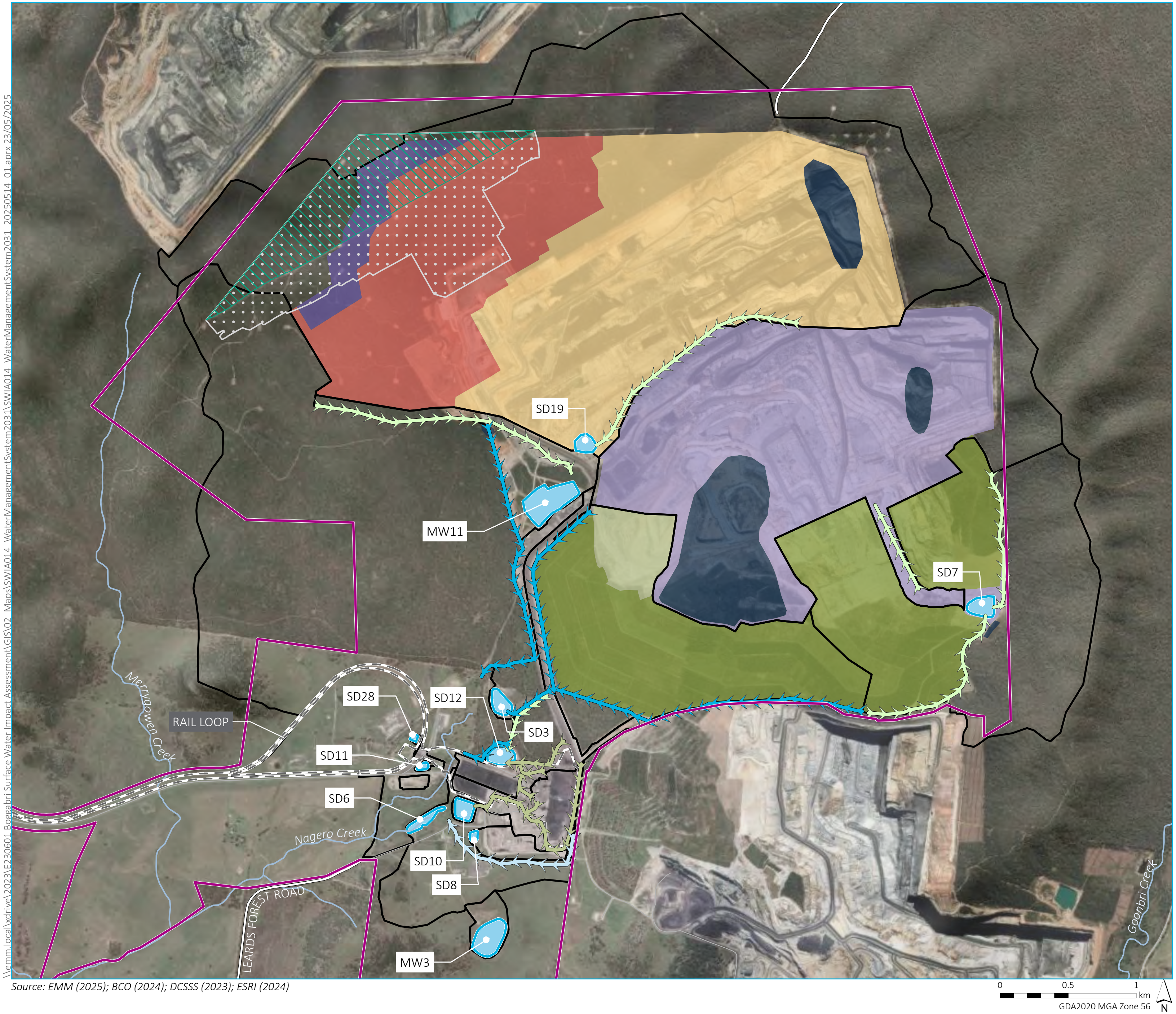

Source: EMM (2025); BCO (2024); DCSSS (2023); ESRI (2024)

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KEY

- Project boundary
- Dirty water drain
- Mine water drain
- Clean water diversion
- Clean water capture drain
- Modification Mining Area
- Modification Disturbance Footprint
- Storage catchment area

Land use type

- Stockpile
- Active mining
- Topsoil stripping
- Existing rehabilitation
- Proposed rehabilitation
- Temporary Rehabilitation
- Overburden emplacement area
- Water storage

Existing environment

- Major road
- Minor road
- Named watercourse

Conceptual water management system- 2031

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Surface Water Impact Assessment
Figure 5.3

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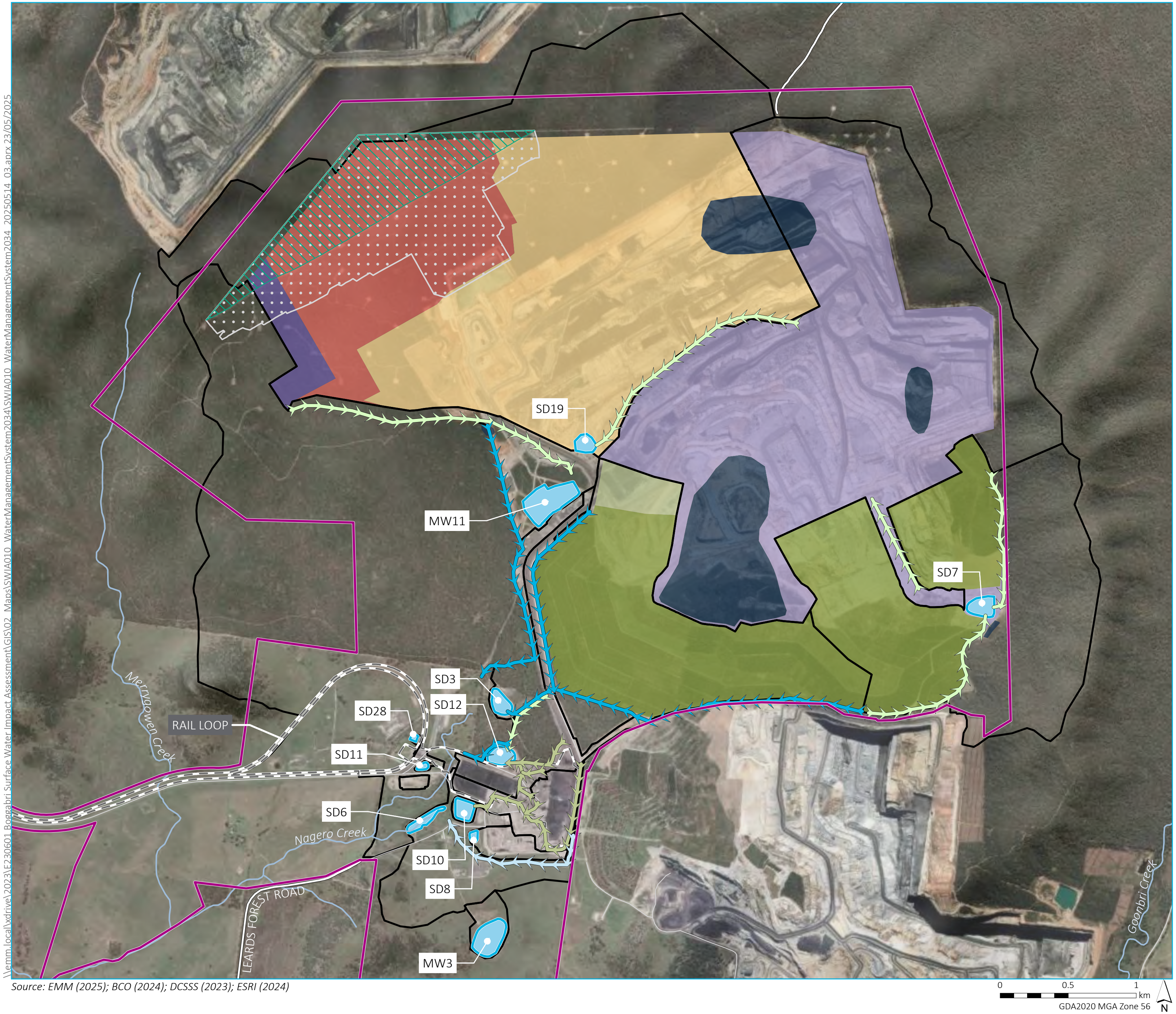

KEY

- Project boundary
- Dirty water drain
- Mine water drain
- Clean water diversion
- Clean water capture drain
- Modification Mining Area
- Modification Disturbance Footprint
- Storage catchment area

Land use type

- Stockpile
- Active mining
- Topsoil stripping
- Existing rehabilitation
- Proposed rehabilitation
- Temporary Rehabilitation
- Overburden emplacement area
- Water storage

Existing environment

- Major road
- Minor road
- Named watercourse

Source: EMM (2025); BCO (2024); DCSSS (2023); ESRI (2024)

Conceptual water management system- 2034

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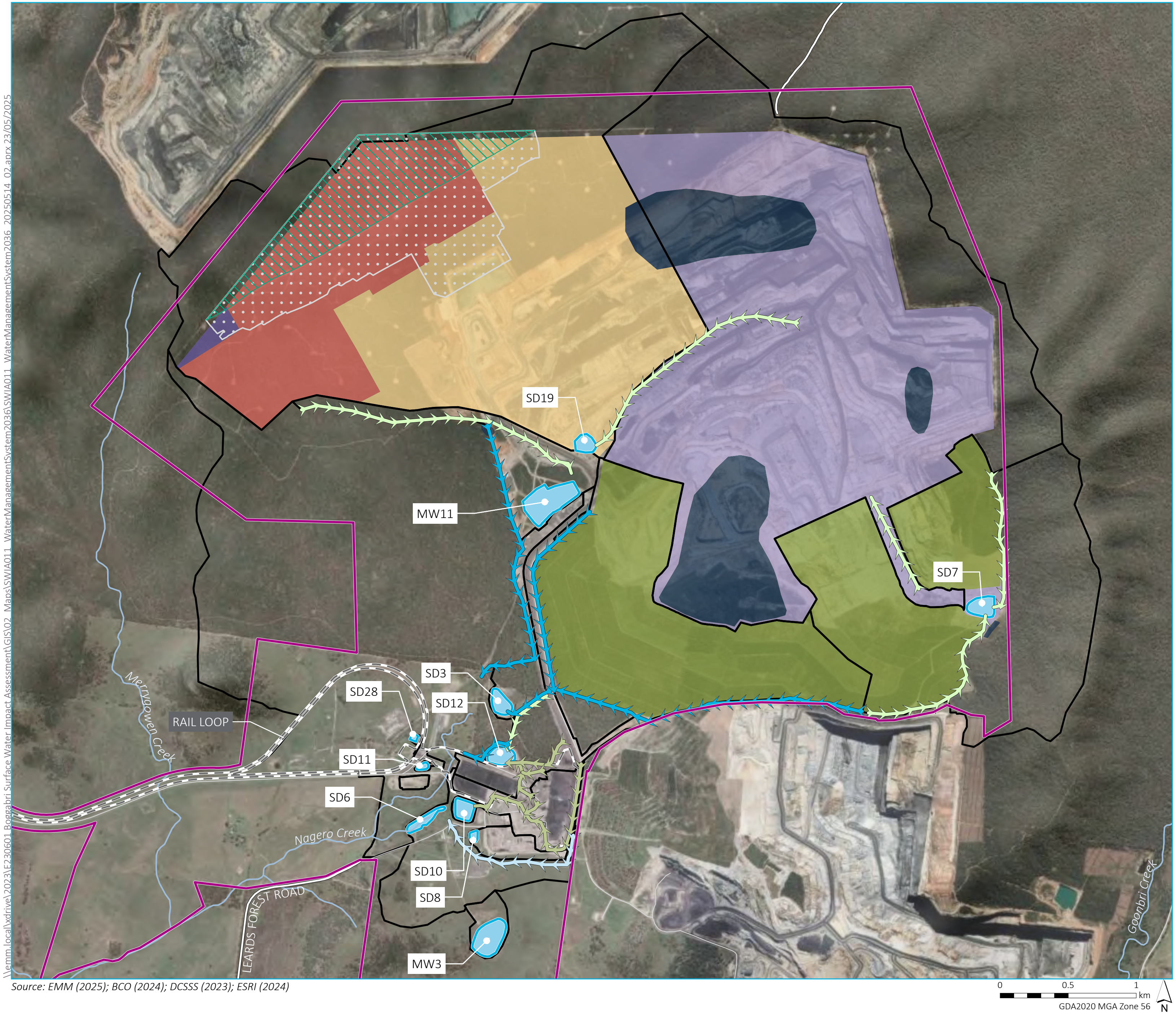
Surface Water Impact Assessment
Figure 5.4



Source: EMM (2025); BCO (2024); DCSSS (2023); ESRI (2024)

KEY

- Project boundary
- Dirty water drain
- Mine water drain
- Clean water diversion
- Clean water capture drain
- Modification Mining Area
- Modification Disturbance Footprint
- Storage catchment area

Land use type

- Stockpile
- Active mining
- Topsoil stripping
- Existing rehabilitation
- Temporary Rehabilitation
- Overburden emplacement area
- Water storage

Existing environment

- Major road
- Minor road
- Named watercourse

Conceptual water management system- 2036

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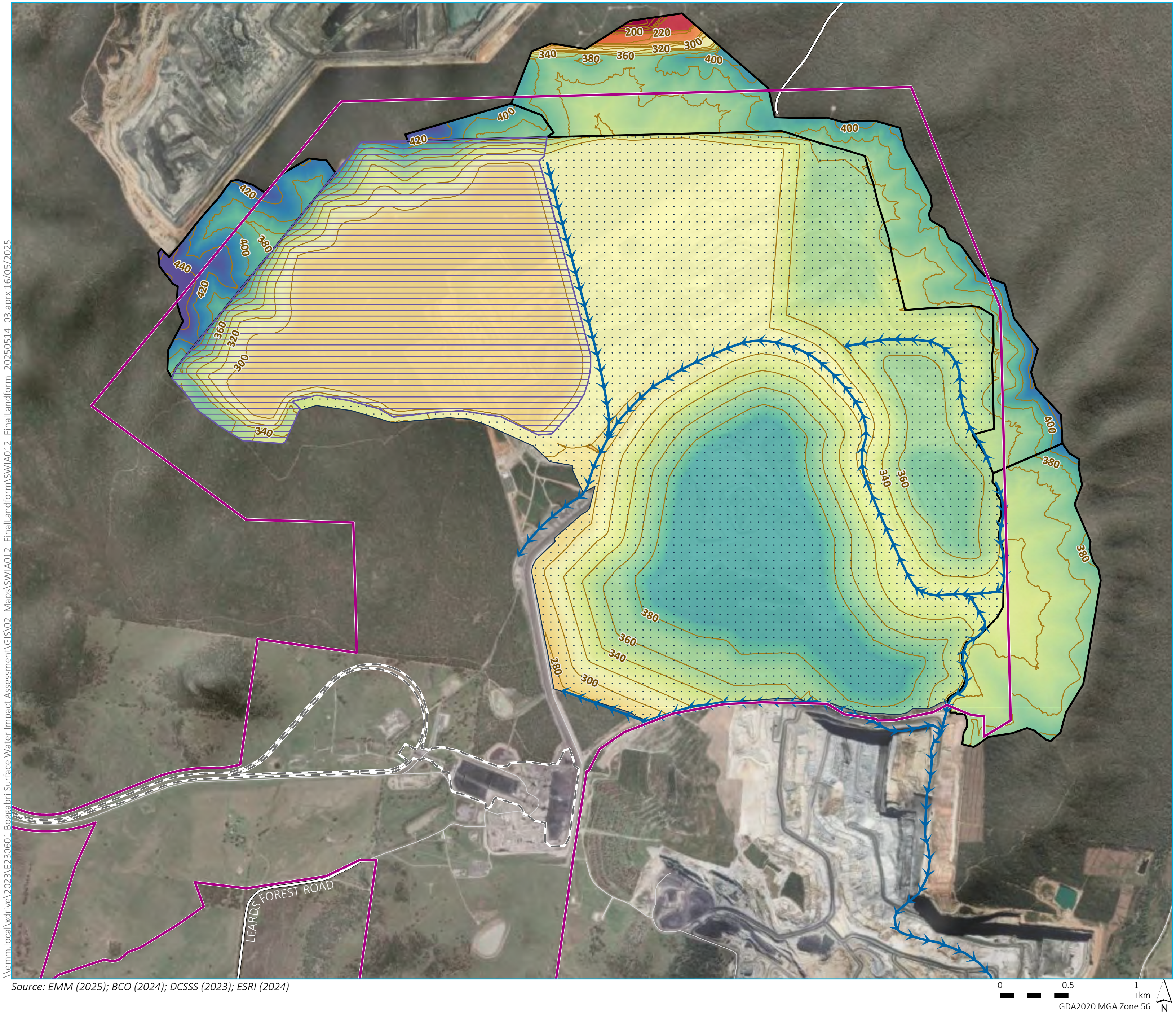
Surface Water Impact Assessment
Figure 5.5



Source: EMM (2025); BCO (2024); DCSSS (2023); ESRI (2024)

KEY

- Project boundary
- Contour
- Drainage

Land use type

- Rehabilitation
- Undisturbed
- Final Void

Final landform (m)

- 465 m
- 54 m

Existing environment

- Major road
- Minor road

Conceptual water management system- final landform

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Surface Water Impact Assessment
Figure 5.6

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6 Site water balance

6.1 Overview

A site water balance model (SWBM) of BCM was developed as part of the *Continuation of Boggabri Coal Mine Project Surface Water Assessment* (WSP 2010). The SWBM was developed using the GoldSim (version 14.0) software package and is reviewed and updated annually. The SWBM has been utilised for the purposes of this assessment.

This section provides a summary of the modelling approach and presents results for the operational and post-closure phases of BCM. The SWBM methodology including key inputs, assumptions, and the calibration/verification process is described further in Appendix A.

6.2 Operational water balance

6.2.1 Modelling approach

A continuous simulation methodology was applied to the SWBM to simulate the response of the water management system under a range of climatic conditions (i.e. rainfall and evaporation). The model was created by representing the water management system as a series of elements, each containing pre-set rules and data, that were linked together to simulate the interaction of these elements. The key water management system components included in the SWBM are show diagrammatically in Figure 4.1.

6.2.2 Model description

The SWBM simulated the volume of water within the water management system based on the following equation:

Change in volume over time = inflows – outflows

Where:

- Modelled inflows consisted of direct rainfall onto the water surface area of each water management dam, catchment runoff, groundwater inflows, and water imported from the borefield and the Namoi River.
- Modelled outflows consisted of evaporation from the water surface area of each water management dam, water use in the CHPP and MIA, water use for dust suppression, and overflows from licenced discharge points.

6.2.3 Probabilistic modelling

To assess the influence of climate variability, the modelling was completed by applying 135 different climate patterns over the simulation timeline. These patterns were based on the historical climate record. The simulation timeline was modelled for 135 ‘realisations’, where each realisation represented a single model run. Each realisation began with a different year of the historical climate record, proceeding consecutively through the historical record (and looped to the start of the record where required). The results from all realisations were used to generate relevant statistical outputs. This method effectively includes all recorded historical climatic events in the water balance model, including high, average, and low rainfall periods.

6.2.4 Snapshot years

The operational phase of the mine schedule include in the SWBM spans a period of 17 years (2024 to end of 2040). During operations, the mine disturbance area, contributing catchment and land use types are expected to constantly change as mining progresses. Rather than incorporating the mine layout for every year of the mine schedule, the mining schedule was simplified in the SWBM by including the details associated with specific years of the mine schedule (referred to as 'snapshot years'). The mine disturbance area, contributing catchment and land use types were linearly interpolated between the snapshot years. This simplification is considered valid as mining would generally progress incrementally rather than stepwise (i.e. large instantaneous changes in the mine layout are not anticipated). The following snapshot years were included in the SWBM: 2024 (existing conditions), 2025, 2028, 2031, 2034, 2036 and 2040 (end of mining).

6.2.5 Rainfall runoff response

Surface runoff from rainfall was estimated using the Australian Water Balance Model (AWBM). The AWBM was developed by Boughton (Boughton 2004) and is widely used across Australia to estimate runoff. The hydrological model calculates runoff and baseflow components from rainfall after allowing for relevant losses and storage. The AWBM was incorporated into the GoldSim SWBM and calibrated/verified using measured water management system data (refer to Appendix A).

6.2.6 Groundwater inflows

The mining void is expected to receive groundwater inflows during operations. Groundwater inflows were estimated using the numerical groundwater model developed for the BTM Complex which was utilised to assess groundwater impacts associated with MOD 10 as documented in *Groundwater Impact Assessment Boggabri Coal Mine Modification 10* (AGE 2025). The BTM Complex groundwater model considers the cumulative impact on groundwater resources resulting from the three adjacent mines and therefore provides the most robust estimate of future groundwater inflows.

The annual groundwater inflow volumes as predicted by AGE (2025) and applied to the SWBM are presented in Figure 6.1. It should be noted the values presented in Figure 6.1 represent the total groundwater inflow volume less evapotranspiration losses that occur at the interface between the mine void and groundwater system. Hence, only groundwater inflows that are available to the water management system were included in the SWBM.

The predicted groundwater inflows associated with MOD 10 are similar to those predicted for MOD 8, with key differences attributed to changes in mine progression. The predicted groundwater inflows for MOD 8 are also provided in Figure 6.1 for context.

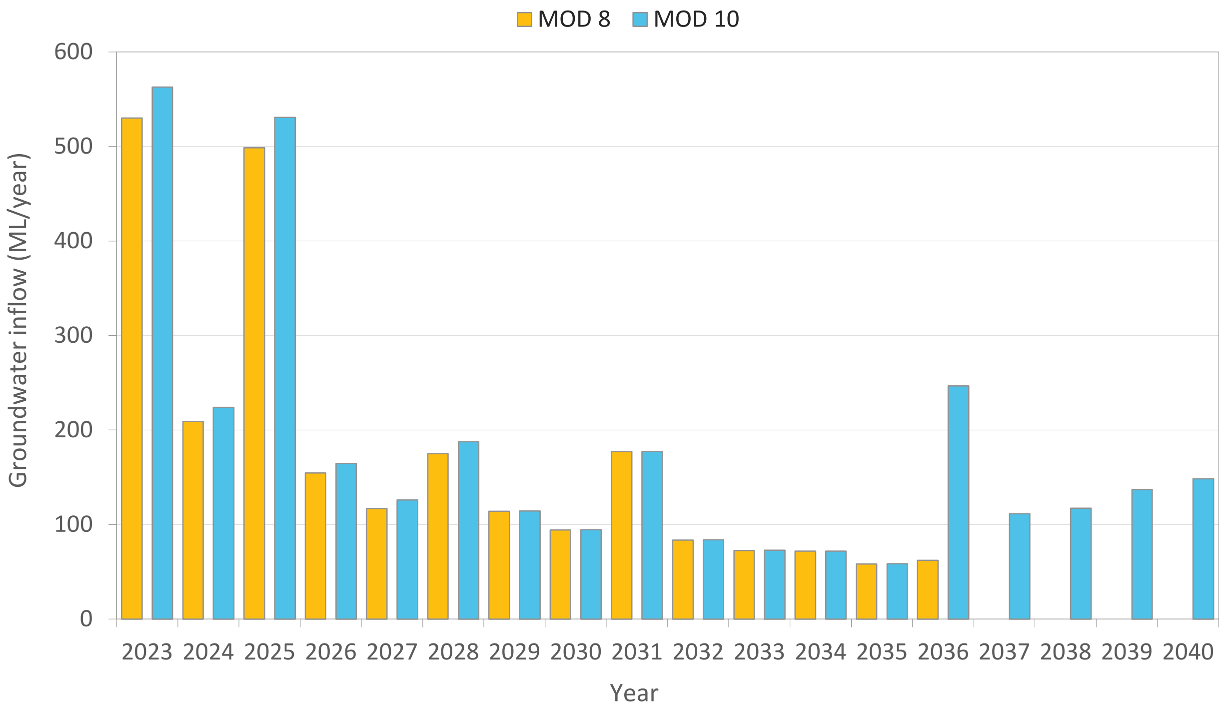


Figure 6.1 Predicted groundwater inflow to the mining void

Source: AGE (2025)

6.2.7 Results

This section presents the water balance results for the operational phase of BCM. A summary of the median annual inflows and outflows for each snapshot year is provided in Table 6.1. Key aspects of the water balance model results are described further in the sections below.

Table 6.1 Summary of median predicted water inputs and outputs

Component	Volume (ML/year)						
	Existing[2]	2025	2028	2031	2034	2036	2040
Inputs (ML)							
Runoff and direct rainfall:							
• Dirty water sediment dams.	87	85	41	165	218	257	318
• Contaminated water dams, MWDs and pit.	722	675	637	592	512	493	473
Groundwater inflows	225	530	188	177	72	247	148
Import from borefield	608	642	1,028	1,028	1,028	670	699
Import from additional sources	0	0	259	138	79	0	0
Total inputs	**1,642**	**1,932**	**2,153**	**2,100**	**1,909**	**1,667**	**1,638**

Component	Volume (ML/year)						
	Existing[2]	2025	2028	2031	2034	2036	2040
Outputs (ML)							
Demands:							
• Dust suppression – haul roads.	1,330	1,544	1,693	1,578	1,429	1,225	1,227
• CHPP/MIA.	311	310	311	310	310	311	310
Evaporation:							
• Dirty water sediment dams.	38	41	39	92	89	90	90
• Contaminated water dams, MWDs and pit.	248	233	202	197	196	199	199
Uncontrolled discharges:							
• Dirty water sediment dams.	0	0	0	0	0	0	0
• Mine water dams and pit.	0	0	0	0	0	0	0
Total outputs	**1,927**	**2,128**	**2,245**	**2,177**	**2,024**	**1,825**	**1,826**
Change in storage[1]	**-291**	**7**	**32**	**48**	**60**	**46**	**8**

Notes: 1. The change in storage represents the median change in storage that is predicted to occur in any given year based on all modelled realisations. It does not represent the difference between median inputs and outputs.

2. Existing conditions relates to the water management system in 2024.

The SWBM results presented in Table 6.1 indicate water imported from the borefield represents between 33% and 54% of total median inflows. Less water is required from the borefield in 2024 (existing conditions) due to the volume of water stored onsite (1,150 ML) at the end of 2023, due to several years of above average rainfall. Rainfall and runoff make up between 32% and 49% of total median inflows while groundwater interception represents between 9% and 27% of total median inflows. Import from additional water sources is predicted to be required under median conditions from mine plan year 2028 to 2034 as a result of peak water demands.

Water used for dust suppression is the largest outflow from the system, representing between 66% and 75% of total median outflows. Peak dust suppression rates occur in 2028 as a result of peak haul road lengths. Dust suppression demands are predicted to decrease as haul road lengths reduce during the later years of mining operations. CHPP and MIA water demand represent approximately 15% of total median outflows while evaporation losses range from 11% to 16% of total median outflows. No offsite discharges from surface water storages are expected under median conditions.

i Water inventory

Forecasted estimates for total site water inventory (including the volume stored in the mine void) are shown in Figure 6.2. The results are presented as the range between the minimum and 5th percentile, 5th percentile and 25th percentile, 25th percentile and median, median and 75th percentile, 75th percentile and 95th percentile, and 95th percentile and maximum values. Percentile values for stored volumes in Figure 6.2 represent the daily results, whereas the values shown in Table 6.1 represent annual results. The current site total storage volume (capacity of all water storages onsite) and the current site storage less EPL airspace requirement of 1,000 ML are also shown for context.

Total site water inventory is shown to remain relatively stable as the mine progresses with the minimum to 75th percentile value range tightly grouped to the median result (shown as the black line). This is expected as the mine is generally in water deficit on an annual basis as rainfall and runoff volumes are typically less than water demands. Hence, the volume of stored water in the system is maintained at a constant (low) level and water is imported from the borefield to meet site water demands. The 75th percentile to maximum result represents the water management system response to significant wet weather periods that could occur in the future (based on historical rainfall events).

The current site total storage volume is shown to have adequate capacity to contain the potential maximum site water inventory under most conditions. However, the results do indicate that water may need to be stored in the mine void for short periods of time under extreme wet conditions as is current practice at BCM. The void associated with the active mining area has a capacity of several thousand megalitres and is more than sufficient to store surplus water during periods of significant wet weather.

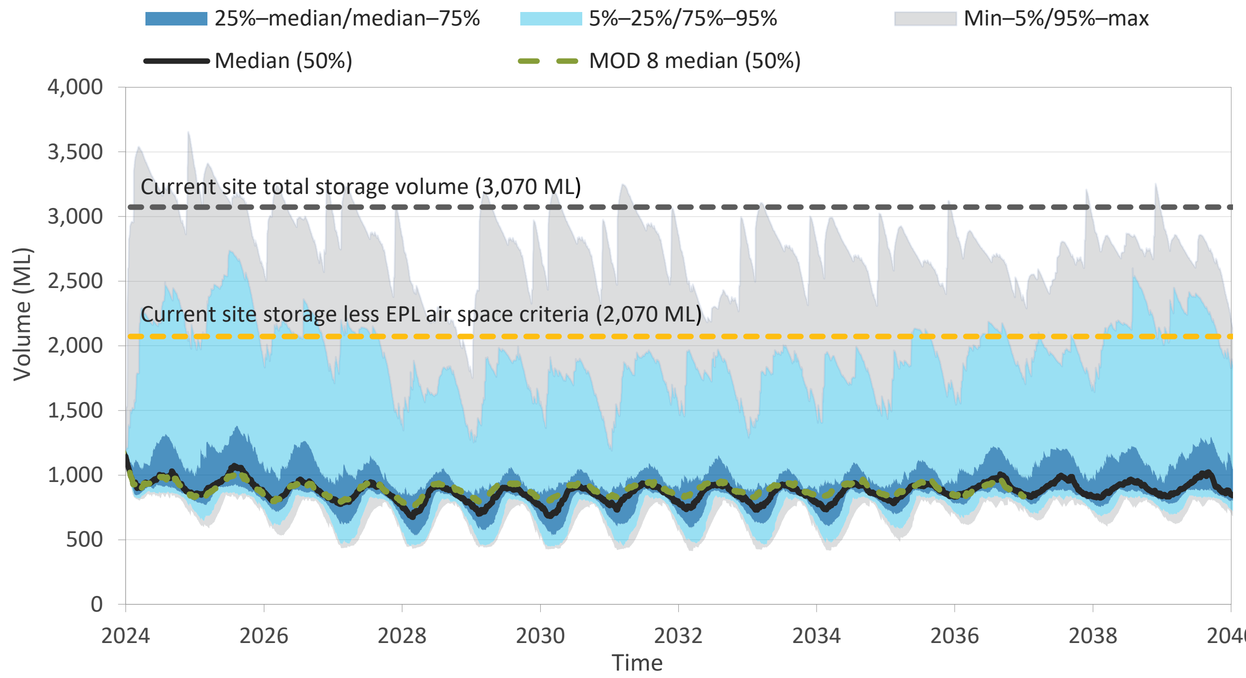


Figure 6.2 Modelled daily timeseries for total site water inventory

ii Interception of undisturbed catchment runoff

Annual runoff from undisturbed catchment area that is predicted to be intercepted over the LOM is shown in Figure 6.3. The predicted volume of intercepted runoff is shown to generally decrease over time as mining progresses to the north and established rehabilitation areas are released downstream, reducing the overall contributing catchment area. It should be noted the volumes shown in Figure 6.3 represent all intercepted runoff from undisturbed catchment areas including runoff that is licensable and runoff that does not require licensing due to exemptions. Licensing requirements for the interception of catchment runoff over the LOM are described in Section 8.4.

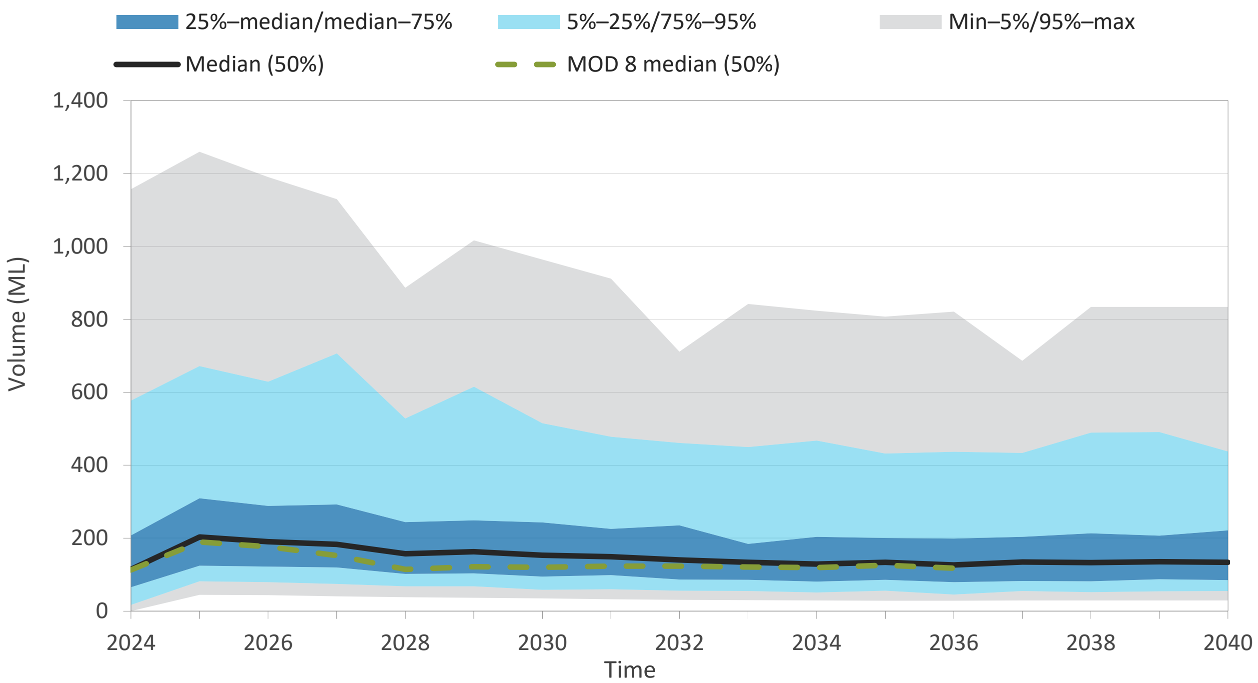


Figure 6.3 Annual runoff volume intercepted from undisturbed catchment

iii External water supply

Annual predicted water imports over the LOM are shown in Figure 6.4. The volume of imported water is compared to BCOPL's existing groundwater entitlements (1,028 unit shares) to extract from the borefield and surface water entitlements (322 unit shares) to extract from the Namoi River. BCOPL preferentially sources import water from groundwater sources and typically utilises account carryover provisions as set out under the rules of the WSP or the temporary trade of entitlement to meet onsite water demands. However, the use of river water is still an option and has therefore been included for consideration in this section.

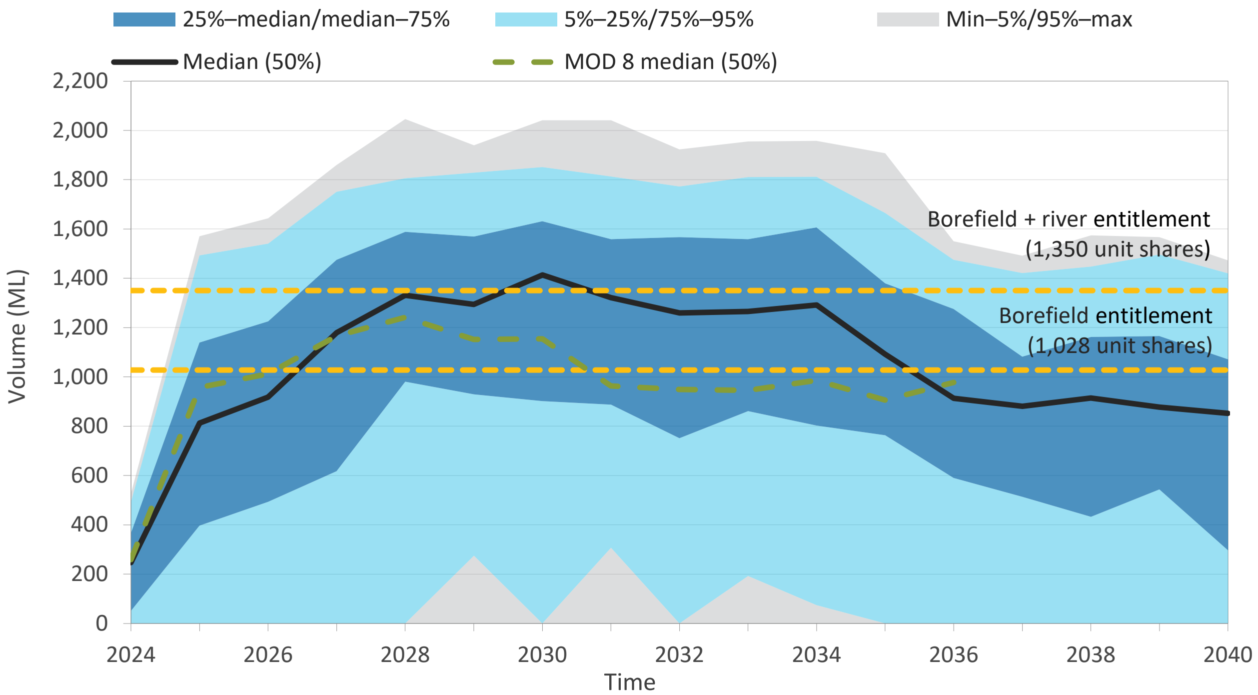


Figure 6.4 Annual water import requirements

Figure 6.4 shows the requirement for imported water is expected to ramp up from 2024 onwards as the existing site water inventory is depleted to meet operational water demands. Imported water is predicted to peak in 2028 due to higher dust suppression requirements associated with peak haul road lengths and decreased runoff potential as larger areas of the existing mine void become rehabilitated. The maximum predicted volume of 2,040 ML/year exceeds BCOPL's existing groundwater and surface water entitlements by 690 ML. The probability of requiring additional water entitlements in excess of BCOPL's existing entitlements ranges from 5–50% per year over the LOM. The licensing approach to obtain additional water entitlements is described in Section 8.5.

The annual median predictions for imported water requirements for MOD 10 are higher than those for MOD 8 between 2028 and 2036. This difference is primarily due to changes in mine progression, particularly the development of haul roads and the corresponding dust suppression needs. For MOD 8, = haul road lengths were expected to peak in the early years of mining (2025), when groundwater inflows (which offset imported water) are predicted to be greater (refer to Figure 6.1). In contrast, the haul road area for MOD 10 are expected reach their maximum extent in 2028 when groundwater inflows are lower. As a result, higher volumes of imported water are projected for MOD 10 during this period to meet dust suppression requirements.

iv System overflows

The modelled overflows from dirty water storages are shown in Figure 6.5. No overflows are predicted under median conditions due to the design capacity of MW5/MW11 providing storage space for dirty water runoff in small to moderate rainfall events.

The occurrence of dirty water discharges generally increases over the LOM as temporary rehabilitation progresses and a larger portion of the disturbance area drains to dirty water dams rather than the mine void. The maximum overflow from dirty water storages of up to 780 ML/year is predicted to occur at the end of the LOM when a substantial portion of the temporary rehabilitation area will drain to sediment dams. The risk of dirty water discharges occurring in any given year is approximately 10% over the LOM.

No overflows from contaminated water dams are predicted for the LOM. Any excess contaminated water will be stored in the pit to prevent overflows.

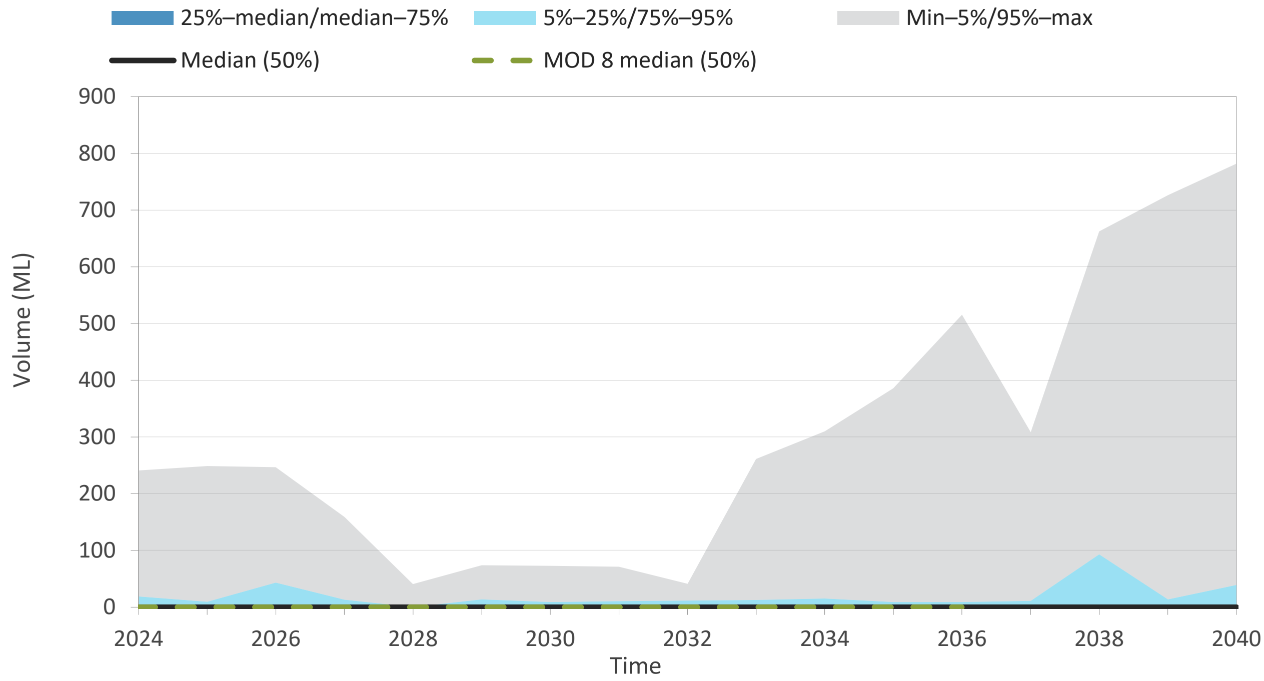


Figure 6.5 Annual overflow volumes from dirty water storages

v Comparison to approved operations water balance

The SWBM was used to compare water balance model results for the approved BCM (MOD 8) against the BCM with the inclusion of MOD 10. The average annual water balance inputs and outputs for MOD 8 and MOD 10 are provided in Table 6.2.

Table 6.2 Average annual water inputs and outputs

Component	Average annual water inputs and outputs over life of mine (ML/year)		
	MOD 8	MOD 10	Difference from MOD 8
Inputs			
Rainfall and runoff	713	750	5%
Groundwater inflows	144	157	9%
Imported from borefield	854	951	11%
Outputs			
Evaporation	280	277	-1%
Water demands	1,638	1,754	7%
Discharges	0	0	-

Table 6.2 shows the water balance inputs and outputs are generally consistent between the MOD 8 and MOD 10 scenarios. A minor increase (7%) in water demands associated with slightly longer haul roads is observed for MOD 10. An 11% increase in imported water is required to meet the additional water demands. The predicted increase in volume imported from the borefield is still within BCOPL's existing groundwater entitlements (1,028 unit-shares) and subject to approved extraction conditions. Hence, the 11% increase in imported water is considered consistent with the approved BCM.

6.3 Final void water balance

The final landform will include a partially infilled final void in the north-west of the Project Boundary. The final void is expected to receive inflows from the adjoining groundwater system, rainfall that occurs directly over the void, and runoff that is intercepted from the upstream catchment that cannot be diverted. These inflows may lead to the accumulation of water in the void. Modelling has been undertaken to assess and confirm the water balance associated with the final void.

6.3.1 Modelling approach

A final void model was developed in GoldSim to determine the long-term water level in the void and to assess potential overflow risks. A continuous simulation methodology was applied to the model to simulate the water level response of the final void under a range of climatic conditions (i.e. rainfall and evaporation).

6.3.2 Model description

The final void model simulated the volume of water within the water management system based on the following equation:

Change in volume over time = inflows – outflows

Where:

- modelled inflows consisted of direct rainfall onto the void and catchment runoff intercepted by the void
- modelled outflows consisted of evaporation from the water surface area of void.

Groundwater inflows and outflows from the final void were excluded from the model on the basis that the long-term groundwater level is predicted to remain at or below the base of the void (AGE 2025) and therefore the potential for water to accumulate within the void will primarily be driven by the difference between rainfall/runoff and evaporation. While infiltration into the underlying overburden that will form the base of the void is expected to occur, zero infiltration losses were applied to the model. This modelling scenario represents a highly conservative scenario where the soil profile is assumed to be fully saturated prior to a rainfall event occurring and hence assumes no infiltration will occur.

6.3.3 Probabilistic modelling

The final landform will be retained in perpetuity and as such will be subject to substantial variation in short and long-term climate. To assess the influence of long-term climate variability, 10,000 years of stochastic climate data was applied to the model. The stochastic data was obtained from DCCEEW's water modelling dataset (DCCEEW 2024) which is comprised of 10,000 year daily data sets of rainfall and potential evapotranspiration generated using observed data combined with Palaeo climate data.

6.3.4 Key assumptions and parameters

Key assumptions and model input parameters applied to the final void model are presented in Table 6.3.

Table 6.3 Final void water balance model assumptions and inputs

Component	Assumption
Climate data	Daily rainfall and evaporation data from DCCEEW's 10,000 year stochastic water modelling dataset was applied to the final void model. Daily rainfall and potential evapotranspiration (FAO56) were obtained for the Boggabri (Milchengowrie) gauge (55034) location and were applied to the model. Data for the Boggabri (Milchengowrie) gauge was selected as it is the closest gauge to BCM with both rainfall and evaporation stochastic climate data available.
Simulation period	The final void model applied a 100 year simulation period following recovery of the regional groundwater level (i.e. once equilibrium is achieved). A 100 year simulation timeframe is considered sufficient to establish whether long-term climate variance could potentially result in the final void overtopping. The final void model was run for 100 realisations so that the entire 10,000 year climate dataset was considered in the modelling.
Void floor level	285 m AHD
Void overflow level	302 m AHD
Void floor area	286 ha
Pit wall area	44 ha

Component	Assumption
Residual catchment area	90 ha
Runoff model	The AWBM developed and calibrated for the SWBM (refer to Section 6.2.5) was used to estimate runoff from the residual catchment area and pit walls. No infiltration losses were applied to direct rainfall onto the void. That is, rainfall was assumed not to infiltrate into the overburden material that will form the base of the void. This assumption represents a highly conservative scenario in which the overburden material is considered fully saturated before any rainfall occurs. In reality, a portion of the rainfall and pooled surface water would infiltrate into the overburden material recharging the groundwater system.
Groundwater inflows	Groundwater modelling indicates the long-term groundwater level in vicinity of the final void will be below the partially infilled final void floor level of 285 m AHD. Hence, no groundwater inflows were applied to the final void model.
Groundwater outflows	No groundwater outflows from the final void were assumed. In reality, as the water level in the void rises, it is anticipated that water would flow into the surrounding groundwater system resulting in lower water levels during and following extended wet periods.

6.3.5 Results

The long-term pit water levels predicted by the final void model are presented in Figure 6.6. The model results indicate the pit is generally expected to remain empty (i.e. a level of 285 m AHD) over the 10,000 year stochastic climate sequence applied to the model. The final void is predicted to experience short periods of ponded water immediately following and shortly after significant rainfall events. This water is rapidly lost to evaporation as expected given historical evaporation rates substantially exceed rainfall in the catchment (refer to Section 3.2.2). The maximum modelled pit water level was 286 m AHD, which is approximately 16 m below the final void overflow level. Consistent with the BCM rehabilitation objectives, the final void is not predicted to permanently retain water (i.e. no pit lake) or reach levels where water would overflow from the void.

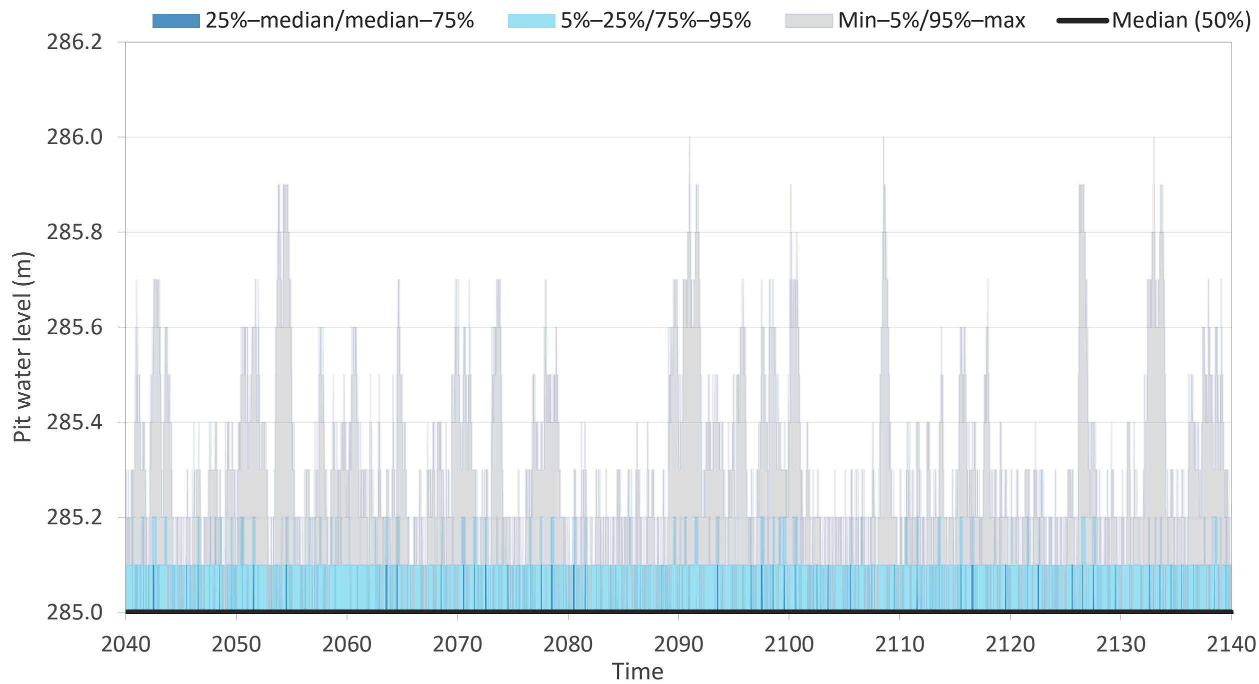


Figure 6.6 Final void long-term water level – base case results

6.3.6 Sensitivity analysis

As the final void is designed to remain in perpetuity, a sensitivity analysis was completed to test how sensitive the maximum predicted pit water level is to key model input parameters (i.e. evaporation) and projected climate change scenarios. The sensitivity scenarios applied to the final void model are described in Table 6.4.

Table 6.4 Final void sensitivity analysis scenarios

Scenario	Description
Input parameters	Evaporation is a key model input that influences losses from water stored in the final void. More water will accumulate for lower evaporation rates while less water will accumulate for higher evaporation rates. To assess the model sensitivity to evaporation, the evaporation rates from the 10,000 year stochastic dataset were adjust ±20% and the model was rerun.
Climate change	Climate change has the potential to impact rainfall and evaporation trends which in turn will influence the volume of water that accumulates in the final void over time. To assess system resilience to climate change, the daily rainfall dataset was adjusted using scaling factors to represent the worst-case plausible future climate scenario with regards to overtopping (i.e. the wettest predicted climate scenario). Evaporation data was not adjusted for this scenario to be conservative as all climate models predicted increases in temperature, and thus, evaporation. The methodology for determining the worst-case climate scenario to be applied to the final void model is described in Appendix B.

The results of the sensitivity analysis are compared to the base case results in Table 6.4. As per the base case scenario, the sensitivity analysis indicated the final void is predicted to remain empty over the long-term. This demonstrates the water level in the pit is insensitive to increased evaporation variability and wetter plausible future climates under typical conditions. Increased maximum water levels were experienced for both sensitivity analysis scenarios compared to the base case with an increase of 0.3 m and 1.0 m observed for the input parameter and climate change scenarios respectively. These increases were associated with extended periods of wet weather and high intensity (and low probability) rainfall events. The results of the sensitivity analysis further support the findings that the final void is consistent with the BCM rehabilitation objectives and is not predicted to permanently retain water or overflow.

Table 6.5 Final void model sensitivity analysis results

Sensitivity analysis	Long-term water level (m AHD)	Maximum water level (m AHD)	Increase in maximum from base case (m)	Minimum freeboard (m)
Input parameters	285 (empty)	286.3	0.3	15.7
Climate change	285 (empty)	287.0	1.0	15

7 Surface water impacts

7.1 Overview

This section describes impacts to the surface water environment due to MOD 10. Impacts are assessed relative to the approved BCM (MOD 8). Mitigation measures and residual impacts are described.

7.2 Direct impacts to watercourses

MOD 10 will mine through the upper reaches of several ephemeral watercourses in the upper Back Creek and Nagero Creek catchments. The Back Creek catchment immediately downstream of the BCM is impacted by approved operations at MCCM. The upper headwaters of Nagero Creek currently drain into the approved operations at the BCM.

The impacted watercourse reaches collectively drain an area of approximately 85 ha, which represents the entire additional disturbance area that will be impacted by MOD 10. The impacted watercourses are shown in Figure 7.1.

7.3 Surface water quantity

7.3.1 Streamflow regimes

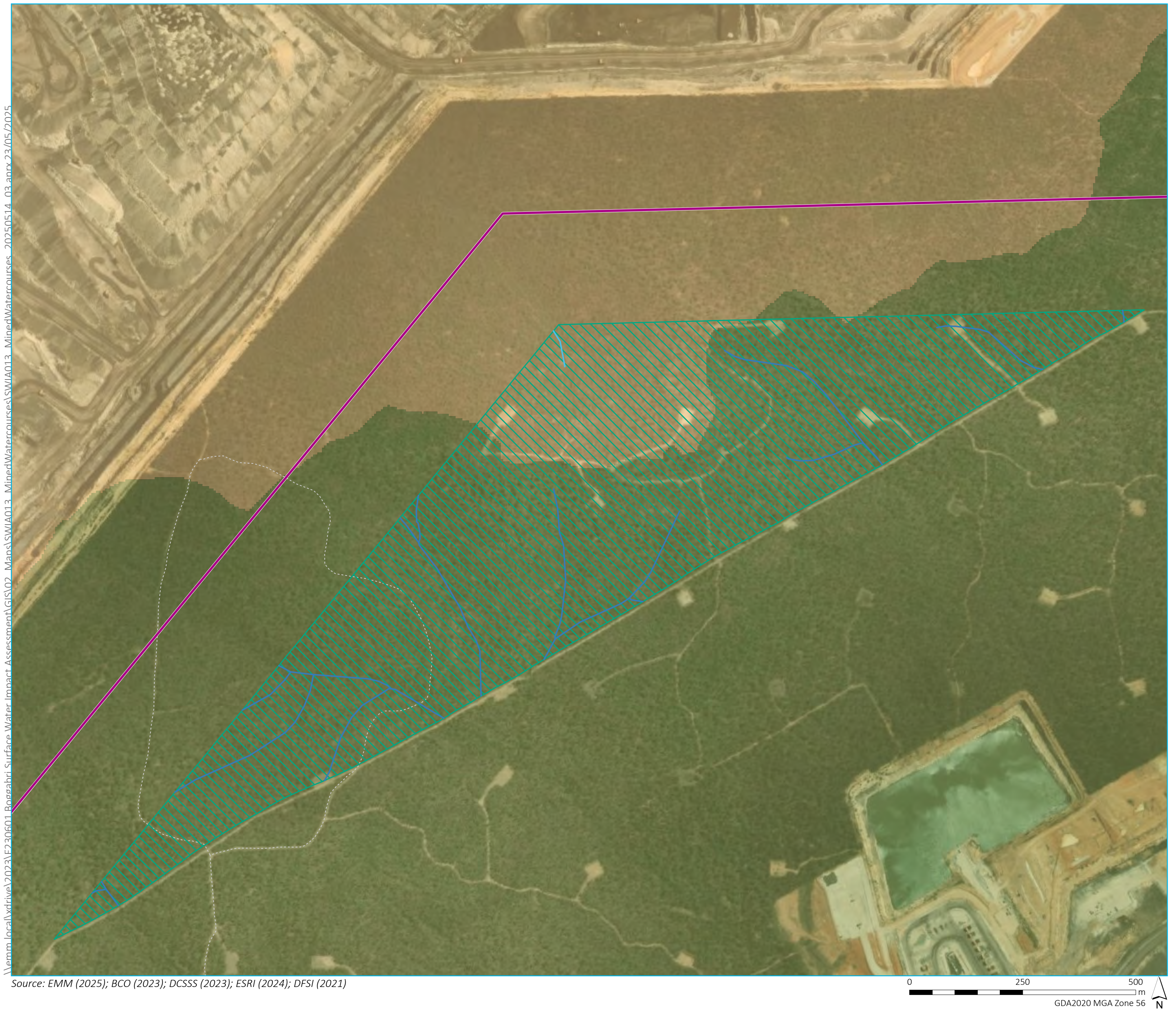
MOD 10 has the potential to impact the streamflow regime of local watercourses compared to the approved BCM by increasing intercepted catchment areas, extending the duration of disturbance, and altering the frequency and volume of water management system discharges.

i Increased intercepted catchment

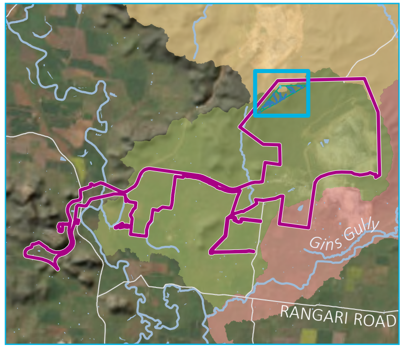
MOD 10 will disturb an additional 76 ha of the upper headwaters of the Nagero Creek catchment which represents approximately 1% of the total Nagero Creek catchment area. Runoff from the portion of the Nagero Creek catchment impacted by MOD 10 is intercepted by existing mining operations or is planned to be intercepted as mining progresses to the north-west as part of the approved BCM. Hence, no additional impacts to the streamflow regime of Nagero Creek are expected due to an increase in disturbance area associated with MOD 10.

The northern portion of MOD 10 will disturb 9 ha of the upper headwaters of the Back Creek catchment which currently drains into the approved MCCM mining areas. Back Creek has a catchment area of 97 km^2 and is a tributary of Maules Creek and the Namoi River. MOD 10 will reduce the Back Creek catchment by approximately 0.1% compared to the approved BCM. Due to the relatively small area impacted, the reduction in catchment area is expected to have negligible impact on the streamflow regime of Back Creek.

The final landform is generally consistent with the approved BCM, albeit the additional 85 ha of area. Hence, no material impacts to catchment areas or downstream flow regimes are expected as a result of MOD 10.



Source: EMM (2025); BCO (2023); DCSSS (2023); ESRI (2024); DFSI (2021)



KEY

- Project approval area
- Mined through stream
  - Back Creek
  - Nagero Creek
- Modification Disturbance Footprint
- Catchment
  - Back Creek catchment
  - Bollol Creek catchment
  - Nagero Creek catchment
- Existing environment
  - Major road
  - Named watercourse
  - Waterbody

Watercourse reaches mined through due to MOD 10

Boggabri Coal Operations Pty Ltd
Surface Water Impact Assessment
Figure 7.1

EMM
creating opportunities

ii Increased life of mine

MOD 10 will extend the LOM and therefore result in the interception of rainfall and runoff, and groundwater inflows, for an additional four years. MOD 10 does not include significant changes to the design criteria of the approved existing water management system, and these inputs have been considered in the site water balance modelling.

The water management system will continue to capture and manage rainfall runoff and groundwater inflows from the mine disturbance area in line with the approved BCM and the descriptions provided in Chapter 4 and Chapter 5. The reduction in runoff will be consistent with the impacts associated with the approved BCM, and therefore the potential for changes to downstream flow regimes and users are comparable to approved impacts, albeit extended by four years.

The Groundwater Impact Assessment (AGE 2025) indicates that negligible impacts are anticipated to surrounding watercourses as a result of additional groundwater interception and therefore the potential for impacts to flow regimes are consistent with approved operations.

MOD 10 will not substantially reduce the catchment area to Nagero Creek, Bollol Creek and the Namoi River compared to the approved BCM and hence will not materially change the approved impacts.

iii Discharges from the water management system

The existing water management system is operated to prevent offsite discharges from mine and contaminated water dams. No offsite discharges from mine and contaminated water dams are predicted for the LOM (refer to Section 6.2.7).

No overflows from dirty water storages are predicted under median conditions (refer to Table 6.1). Discharges from dirty water storages are predicted to occur during periods of significant rainfall (refer to Figure 6.5). The frequency and volume of discharges predicted for MOD 10 is comparable with the approved BCM as of MOD 8 (refer to Table 6.2).

Discharges will continue to be managed under the existing SWMP and in accordance with the conditions of EPL No. 12407 for the additional four-years of mining operations. Impacts to downstream watercourses and users due to the extended period of disturbance are considered minor and manageable with the existing and proposed management measures in place.

7.3.2 Water use and availability

The current site storage volume is shown to have adequate capacity to contain the potential maximum site water inventory under most conditions (refer to Section 6.2.7), with water stored in the mine void on occasion for short periods following significant rainfall or extended wet periods when mining is likely not feasible. MOD 10 does not include significant changes to the design criteria of the approved existing water management system.

The existing mine water demands will be extended by four years. Water balance modelling indicates that the current WALs remain sufficient to supply BCM under median conditions, with the periodic purchase of additional water to continue as per current practice onsite (refer to Section 8.5).

The potential for changes to downstream water users is limited to the additional four-year disturbance period. The potential impacts are considered minor compared to the approved BCM.

7.4 Surface water quality

The water quality data presented in Section 4.9 identifies that overall water quality across BCM is influenced by the source of water or contributing catchment. Sediment dams generally exhibit water quality similar to Nagero Creek baseline data but with generally lower metals concentrations and higher concentrations of salinity and nutrients. Residual water quality impacts associated with dirty water overflows from sediment dams are considered to be comparable to approved BCM impacts, albeit extended for four years.

Water quality impacts to downstream watercourses and users due to the extended period of disturbance associated with MOD 10 are considered minor and manageable with the existing and proposed management measures in place.

7.5 Flooding and watercourse stability

MOD 10 does not propose changes to existing infrastructure located in or near the Namoi River floodplain or significant changes to the water management system. Dirty water discharges will continue to be managed under the existing SWMP for the additional four-year disturbance period. MOD 10 does not include changes to the downstream surface flow and flooding regimes, except due to extending mining. The potential for changes to downstream flooding regimes and watercourse stability are considered negligible, and consistent with approved BCM impacts.

7.6 Cumulative impact assessment

MOD 10 is anticipated to result in changes to cumulative impacts associated with the BTM Complex:

- MOD 10 will disturb an additional 76 ha of the upper headwaters of the Nagero Creek catchment, representing about 1% of the total catchment area, noting that runoff from this area is already intercepted by the approved BCM. MOD 10 represents a 1% increase to the maximum cumulative BTM Complex disturbance area in the Nagero Creek catchment of 2,717 ha[2].
- MOD 10 will reduce the Back Creek catchment area by approximately 9 ha (0.1%), noting that runoff from this area is already intercepted by MCCM water management system, and is unlikely to materially change streamflow in Back Creek. MOD 10 represents a 1% increase to the maximum cumulative BTM Complex disturbance area in the Back Creek catchment of 1,599 ha[3].
- MOD 10 will result in continued water demand, groundwater interception and reduced runoff to Nagero Creek, Bollol Creek and the Namoi River for an additional four years to 2040, which is broadly consistent across the BTM Complex (MCCM is currently approved to operate until 2034 and TCM until 2035).
- Incremental water quality impacts from the extended disturbance period are considered minor and consistent with approved BCM impacts. The conceptual final landform objectives remain unchanged, including the BTM Complex cumulative landform objectives. No changes in flood risk impacts are anticipated, maintaining a low risk for the LOM, and no change in cumulative flood risk.

[2] Estimated based on this assessment and data provided in *Tarrawonga Coal Mine Life of Mine Modification Surface Water Assessment and Site Water Balance* (HEC 2019).

[3] Estimated based on this assessment and data provided in *Maules Creek Coal Project Environmental Assessment* (Hansen Bailey 2011).

7.7 Mitigation measures and residual impacts

Mitigation measures and residual impacts associated with the BCM (including MOD 10) are summarised in Table 7.1. The following is described for each potential surface water related impact:

- impact pathway and potential risk/effect
- existing and proposed mitigation controls and actions
- residual impacts.

Table 7.1 Mitigation measures and residual impacts

Impact	Impact pathway	Potential risk/effect	Mitigation actions/controls (existing and proposed)	Residual impact compared to MOD 8
Direct impacts to watercourses.	Increased mine disturbance area.	Mining activities associated with the BCM will unavoidably remove several ephemeral watercourses reaches in the upper headwaters of Nagero Creek and Back Creek.	No mitigation actions or controls proposed.	**Minor** – while some sections of watercourse will be mined through as a result of MOD 10, the total length of watercourse removed is relatively minor compared to the disturbance resulting from the broader BTM Complex.
Surface water quantity.	Increased mine disturbance area.	Reduced runoff to receiving watercourses due to the capture of rainfall and runoff within the BCM disturbance area.	Runoff from increased mine disturbance area within the Nagero Creek catchment is currently captured and managed by the water management system as part of the approved BCM. The BCM will result in the capture of rainfall from 9 ha (0.1%) of the Back Creek catchment. This water will be managed by the BCM water management system.	**Negligible** – no additional surface water runoff will be captured from the Nagero Creek catchment compared to the approved BCM. The reduction to the Back Creek catchment is negligible and unlikely to result in any material changes to streamflow in Back Creek.
	Increased life of mine.	Reduced runoff to receiving watercourses due to the capture of rainfall and runoff within the water management system for an additional four years.	The water management system will continue to capture and manage rainfall and runoff from the mine disturbance area in line with the approved BCM and the descriptions provided in Chapter 4 and Chapter 5.	**Minor** – MOD 10 will result in reduced runoff to receiving watercourses for an additional four years. The reduction in runoff is consistent with the impacts associated with the approved BCM.
	Discharge from dirty water dams.	Altered flow regime in receiving watercourses due to changes in the volume of controlled or uncontrolled releases.	No change to the licensed discharge criteria for the sediment dams under EPL No. 12407 is proposed as part of MOD 10.	**Negligible** – discharges from dirty water dams are predicted to be similar to those which have been previously assessed and approved for the BCM.
	Discharge from mine and contaminated water dams.	Altered flow regime in receiving watercourses due to changes in the volume of uncontrolled releases.	The existing water management system is operated to prevent offsite discharges from mine and contaminated water dams.	**None** – water balance model results indicate no offsite discharges from mine and contaminated water dams are predicted for the LOM.

Impact	Impact pathway	Potential risk/effect	Mitigation actions/controls (existing and proposed)	Residual impact compared to MOD 8
	Groundwater interception.	Altered flow regime in receiving watercourses due to changes to the indirect effects of groundwater drawdown.	BCM will continue to be managed in accordance with the existing groundwater management plan (GWMP) which provides a framework to assess, manage, and mitigate impacts resulting from groundwater interception/drawdown.	**None** – groundwater interception is not anticipated to impact the flow regime of local watercourses or the Namoi River.
	Water extraction (via pump).	Reduced streamflow and water availability in the Namoi River due to changes in the volume of water that requires extraction to meet BCM water demands.	Obtained water will be acquired under a WAL and in accordance with BCMs existing SWMP and GWMP.	**Negligible** – extraction rates are predicted to be similar to the approved BCM.
	Final landform design.	Reduced runoff to receiving watercourses due to the capture of rainfall and runoff within the final landform void.	Revised conceptual final landform to align with rehabilitation objectives outlined in the rehabilitation management plan (RMP) and final void and mine closure plan that will evolve over the LOM.	**Negligible** – the reduction in runoff due to the final void will be consistent with the impacts associated with the approved BCM.
Surface water quality.	Increased mine disturbance area.	Increased loads of suspended sediment, nutrients, and metals in runoff generated from the MOD 10 disturbance area.	Surface water is managed in accordance with BCM's existing SWMP. The SWMP will be updated to include MOD 10 following approval of MOD 10.	**Negligible** – impacts to downstream watercourse values due to the increase in mine disturbance area are comparable to approved BCM and manageable with the existing management measures in place.
	Increased life of mine.	Reduced water quality in receiving watercourses due to changes in the volume and quality of controlled or uncontrolled releases.	Continued low risk of impacts due to infrequent (10% probability of occurring in a given year) dirty water overflows predicted for the additional LOM.	**Minor** – impacts to downstream watercourse values due to the increased LOM are comparable to approved BCM and manageable with the existing management measures in place.
	Discharge from dirty water dams.	Reduced water quality in receiving watercourses due to changes in the volume and quality of controlled or uncontrolled releases.	No change to the discharge criteria for the three sediment dams within the EPL No. 12407 is proposed as part of MOD 10.	**Negligible** – discharges expected to have similar water quality to existing operations. Hence, impacts to downstream watercourse are negligible compared to the approved BCM.
	Discharge from mine and contaminated water dams.	Reduced water quality in receiving watercourses due to changes in the volume and quality of uncontrolled releases.	The existing water management system is operated to prevent offsite discharges from mine and contaminated water dams.	**None** – water balance model results indicate no offsite discharges from mine and contaminated water dams are predicted for the LOM.

Impact	Impact pathway	Potential risk/effect	Mitigation actions/controls (existing and proposed)	Residual impact compared to MOD 8
	Final landform design.	Reduced water quality in receiving watercourses due to changes in the volume and quality of discharges from final void.	The final void has been designed to reduce the risk of overflow events occurring.	**None** – model results indicate the final void will not overflow which is consistent with the approved BCM.
Flooding.	Discharge from mine water management system.	Increased flood flows in receiving watercourses due to changes in the volume of uncontrolled releases.	No significant changes proposed as part of MOD 10 that would alter the existing flood risk.	**None** – risk of changes to downstream flooding regimes is consistent with the approved BCM.
Watercourse stability.	Discharge from mine water management system.	Increased scour potential or sediment loads in receiving watercourses due to changes in the volume of uncontrolled releases.	Dirty water discharges to be managed in accordance with the existing SWMP.	**Negligible** – impacts to downstream watercourse stability considered to be negligible given discharge frequency and volume are predicted to be similar to the approved BCM.
Cumulative impacts.	All of the above.	Cumulative effects of prolonged mining activities on the surface water environment.	All of the above.	**Minor** – incremental impacts to watercourses and catchment areas will not result in substantial changes to those which have been previously assessed and approved within BTM Complex. Residual impacts are considered minor and manageable with the existing management measures in place.

7.8 Comparison to previous approvals

A qualitative assessment of surface water related impacts associated with MOD 8 (granted 22 January 2024), MOD 9 (granted 2 March 2023), and MOD 10 (current modification) in the context of the current approved BCM (i.e. up to and including Modification 7 (MOD 7)) is provided in Table 7.2. The comparison is intended to establish the incremental changes to surface water related impacts that have occurred since approval of MOD 7.

Table 7.2 Comparison of the approved operations (as approved up to MOD 7), MOD 8, MOD 9 and MOD 10

Surface water related aspect	MOD 7 approved BCM (approved 2019)	MOD 9 compared to MOD 7	MOD 8 compared to MOD 7	MOD 10 compared to MOD 8	Cumulative MOD 8, 9 and MOD 10 (compared to MOD 7)
Direct impacts to watercourses.	• The approved disturbance area of 2,047 ha represents around 24% of the total Nagero Creek catchment area (8,700 ha). • No direct impacts to Back Creek.	• No change.	• No change.	• Additional 85 ha of disturbance. • MOD 10 will result in the capture of rainfall from 9 ha (0.1%) of the Back Creek catchment.	• Total disturbance area of 2,132 ha represents 25% of the total Nagero Creek catchment, which is less than 1% increase on MOD 7. • MOD 10 will result in the capture of rainfall from 9 ha (0.1%) of the Back Creek catchment.
Streamflow impacts.	• Runoff from the mining area is captured and managed by the water management system. • Runoff from the Nagero Creek catchment upstream of the active mining area is captured and discharged downstream. • Surface water will be managed in accordance with the WMP and SWMP until the end of mine life in 2033. • Sediment dams are designed to manage runoff from the 5 day, 90^{th} percentile rainfall event (38.4 mm).	• No change.	• Three year mine life extension to 2036. • Runoff from upstream of active mining shown to drain freely to the pit. • Reduced discharge from dirty water storages based on the assumption that runoff from rehabilitated areas is released to the downstream environment.	• Four year mine life extension to 2040. • Similar discharge from dirty water storages compared to MOD 8.	• Minor increase in the volume of runoff from the Nagero Creek catchment that is captured and managed in the water management system. • No material changes to discharges from dirty water storages. • Prolonged period of disturbance and capture of runoff to end of 2040.
Water demand.	• Intercepted runoff and dirty and contaminated water are captured and reused onsite. • Imported water (when needed) will be sourced from the BCM borefield or the Namoi River using BCOPL's water access licences.	• Marginal increase in water demand for dust suppression at the mobile crushing facility.	• Marginal increase in water demand for dust suppression.	• Increase in water demand for dust suppression.	• Increases in water demand, largely associated with dust suppression. • The existing mine water demands will be extended by seven years.

Surface water related aspect	MOD 7 approved BCM (approved 2019)	MOD 9 compared to MOD 7	MOD 8 compared to MOD 7	MOD 10 compared to MOD 8	Cumulative MOD 8, 9 and MOD 10 (compared to MOD 7)
Surface water quality.	• No predicted contaminated discharges from MWDs during LOM. • No discharges from dirty water dams predicted under median conditions. Low risk of impacts due to dirty water overflows predicted to occur two to four times per year on average.	• No change.	• Changes to dirty water discharge frequency and volume not expected to materially impact water quality risks over LOM.	• Dirty water discharges are comparable to MOD 8.	• No material changes to water quality risks over the LOM.
Final void (drainage and pit lake).	• Rehabilitation objective to establish a free draining final landform. • Minimise size and depth of final pit void and retain no surface water (i.e. no pit lake). • Integrate mine planning including drainage with adjoining mines.	• No change.	• Minor changes to final landform design but generally consistent with MOD 7.	• Minor changes to final landform design but generally consistent with MOD 8.	• The final landform is generally consistent with the approved BCM. Hence, no material impacts anticipated.

8 Water licensing and approvals

8.1 Overview

This section describes the surface water licensing requirements for BCM including water take mechanisms, the volume of entitlement required, licensing options and strategy, and the proposed regulatory pathway to obtain the required entitlements if sufficient licences are not already held by BCOPL.

Groundwater licences are required to extract water from the borefield to supply operational water demands and are also discussed in this section. Further details on the licensing requirements for other groundwater take mechanisms (i.e. groundwater interception) are provided in the Groundwater Impact Assessment (AGE 2025).

8.2 Water regulatory and policy context

The WM Act provides for water sharing between different water users, including environmental, basic landholder rights and licence holders. Under the WM Act, the pathways to 'take' surface water (and groundwater) at BCM include:

- basic landholder rights (including harvestable rights dam for storages on minor watercourses)
- under an exemption under the WM Act (including the take of water from minor streams to prevent contamination of a water source)
- obtaining appropriate WALs.

The 'take' of surface water at BCM occurs via the interception of rainfall/runoff as a result of mining activities and via the extraction of water from the Namoi River by pump and pipeline.

8.3 Existing water access licenses

Existing surface water related WALs held by BCOPL are identified in Table 8.1. BCOPL also hold 1,028 unit shares in the Upper Namoi Zone 4, Namoi Valley Groundwater Source which is used to extract water from the BCM borefield to meet water demands. Details of the groundwater licences held by BCOPL are provided in the Groundwater Impact Assessment (AGE 2025).

Table 8.1 Summary of existing licences held by BCM

Licence number	WSP	Water Source	Category	Entitlement (ML)	Nominated works
44134	Namoi and Peel Unregulated Rivers Water Sources 2012	Bluevale Water Source	Unregulated River	93	90MW833094
37067	Upper Namoi and Lower Namoi Regulated River Water Sources 2016	Upper Namoi Regulated River Water Source	Regulated River (General Security)	128	-[1]
2571		Lower Namoi Regulated River Water Source		51	90CA801763
2595				143	90CA801819
2596			Supplementary Water	26.5	90CA801819
2572				5.6	90CA801763

Notes: 1. WAL 37067 primarily used for downstream temporary trade purposes.

8.4 Water licence requirements

8.4.1 Operations

i Interception of local catchment runoff

Water take during operations will occur due to the interception of local catchment runoff by the mine void and other active mining areas not covered by a water take and use exemption.

The portion of MOD 10 within the Maules Creek Water Source (i.e. Back Creek catchment) will only receive rainfall that occurs directly within the pit and will not receive runoff from the surrounding catchment. Rainfall that occurs directly within the pit is considered exempt from licensing requirements.

Mining operations currently, and will continue to, intercept local catchment runoff from the Bluevale Water Source. The interception of local catchment runoff from the Bluevale Water Source, which is not under basic landholder rights or exempt, is subject to licensing requirements.

The SWBM was used to calculate licensing requirements associated with the interception of local catchment runoff from the Bluevale Water Source. Licensable runoff volumes for dry (20^{th} percentile), typical (50^{th} percentile), and wet (80^{th} percentile) rainfall conditions are presented in Table 8.2.

Table 8.2 Licensable local catchment runoff – Bluevale Water Source

Snapshot year		Licensable volume (ML/year)		
	Licensable catchment area (ha)	20^{th} percentile	50^{th} percentile	80^{th} percentile
2024	633	94	159	284
2025	603	89	151	270
2028	353	52	88	158
2031	306	45	77	137
2034	270	40	68	121
2036	270	40	68	121
2040	270	40	68	121

The licensable catchment area in Table 8.2 is shown to decrease over time as mining progresses further north-west reducing the overall catchment from which clean runoff is intercepted by the mine and established rehabilitation areas are progressively released to the downstream environment. The licensable water take is shown to vary from 40 ML/year for dry conditions to 284 ML/year for wet conditions.

The SWBM estimates 284 ML of entitlement is generally sufficient to meet BCOPL's licensing requirements over the LOM. It should be noted that no specific policy exists for calculating licensing requirements that include the interception of local catchment runoff. Licensing the 80^{th} percentile value is considered a reasonable approach given the expected variation in annual runoff volumes and the annual carry over rules defined in the WSP for the Namoi and Peel Unregulated Rivers Water Sources 2012.

BCOPL currently hold 93 ML of entitlement in the Bluevale Water Source which is predicted to be sufficient to cover licensing requirements during drier years. The licensing approach to obtain additional water entitlements for years where water take exceeds BCOPL's existing 93 ML entitlement is described in Section 8.5.1.

ii External water supply

Water is required for several activities onsite including dust suppression, use in the CHPP and as washdown water in the MIA. The water balance model was used to calculate the volume of water that would need to be imported from external sources to meet operational water demands over the mine life.

The water balance model predicts up to 2,040 ML/year of external water supply will be required over the remaining LOM. External water supply will be sourced as:

- Groundwater take – from the Upper Namoi Zone 4, Namoi Valley Groundwater Source in accordance with the WSP for the Namoi Alluvial Groundwater Sources 2020.
- Surface water take – from the Lower Namoi Regulated River Water Source in accordance with the WSP for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016.

External water supply will be preferentially sourced from the Namoi Valley Groundwater Source via the BCM borefield. BCOPL's combined surface water and groundwater WAL entitlements that could be used to meet the external water supply demand are approximately 1,350 ML/year. The licensing approach to obtain additional water entitlements for years where water take exceeds BCOPL's entitlement is described in Section 8.5.2.

8.4.2 Closure

The final landform will contain a partially infilled open pit void in the north-west portion of the Project Boundary. The base of the final void was designed to be filled with overburden to a level above the water table and is therefore not expected to receive persistent groundwater inflows post closure. The final void will receive inflows from:

- rainfall that occurs directly over the void surface
- runoff from residual catchment areas upstream of the void where diversion drains are impractical (due to terrain constraints).

The final void will be passively managed with inflows (rainfall and runoff) and outflows (evaporation and infiltration) occurring naturally with no proposed pumped extraction or reuse. EMM's understanding is that no WAL is required for direct rainfall accumulation within the footprint of voids and dams. There are some precedents that are drawn on:

- WALs are not currently required for accumulation of rain that falls directly on active mine pits or quarries.
- WALs are not required for direct rainfall onto turkey's nest dams (with no catchment). Note that these can be extremely large and are pervasive in north-western and western NSW.

A residual catchment area of 90 ha will drain to final void (refer to Figure 5.6). Licensing of this volume is not proposed as the final void will be passively managed so that any intercepted water will either infiltrate or evaporate. The physical take (via pump or some other means) of water from the final void is not proposed.

8.5 Licensing approach

This section provides an overview of the overall BCM water licensing strategy to demonstrate sufficient water entitlements are currently held or can be obtained for all water take mechanisms.

8.5.1 Interception of local catchment runoff

Water take associated with the interception of local catchment runoff from the Bluevale Water Source is uncontrolled and weather dependent. Hence, the volume of surface water take that occurs from year to year will vary, with lower water take volumes occurring in dry years and higher water take volumes occurring in wet years. The local catchment area that is intercepted and requires licensing by BCM will also reduce over time as mining progresses to the north and west. To account for this variation and to ensure BCOPL hold sufficient WALs to cover any water take, water take from the Bluevale Water Source is accounted for using recorded site data and the SWBM.

The water accounting methodology is completed in accordance with the Enforceable Undertaking (EU 230608) issued by NRAR on 8 June 2023. Water accounting is undertaken on a quarterly basis whereby the SWBM is used to determine the volume of water take that occurred during the previous quarter (using measured site data) and predict (using short term climate forecasts) the volume of water take expected to occur in the following quarter. BCOPL purchase (via temporary trade) additional water entitlements to cover any measured or predicted water take in excess of BCOPL's existing WALs.

The Bluevale Water Source has a total of 2,972 unit-shares of unregulated river access licences (refer to Section 3.4). BCOPL would need to obtain an additional 191 unit-shares to achieve the predicted 284 ML/year licensable water take from the Bluevale Water Source during wet conditions (refer to Table 8.2). BCOPL has historically been successful in temporary trading water entitlements to account for water take associated with the interception of local catchment runoff.

In contrast to the typical trading market where water is sought during dry conditions when demand is high, BCOPL require additional entitlements during wet conditions when there is unlikely to be a large demand for water across the water sources. It is therefore anticipated that sufficient water would be available in the market for trade when required.

8.5.2 External water supply

BCOPL preferentially source external water supply from the BCM borefield in preference to pumping from the Namoi River. Water take from the Lower Namoi Regulated River Water Source and Upper Namoi Zone 4, Namoi Valley Groundwater Source is controlled and accounted for via pump metering. BCOPL monitor pump volumes to ensure extraction volumes do not exceed their WAL entitlements for these water sources.

Water requirements in excess of BCOPL's WAL entitlements have historically been met via account carry over rules that are applicable to groundwater sources within the WSP for the Namoi Alluvial Groundwater Sources 2020 or via temporary trade within the Upper Namoi Zone 4, Namoi Valley Groundwater Source.

The Upper Namoi Zone 4, Namoi Valley Groundwater Source has a total of 21,000 unit-shares of aquifer access licences and an active trading market. BCOPL has historically been successful in temporary trading water entitlements to meet operational water demands during drier periods including during the 2018 to 2019 drought.

The significant number of entitlements available and active water market provides confidence that BCOPL will be able to continue using temporary trade as a viable option to secure any additional water entitlements that may be needed during drier periods.

8.6 Licensing summary

Water licensing requirements, WAL entitlements held by BCOPL that are relevant to this SWIA, and the approach to obtain additional WALs when needed are summarised in Table 8.3.

Table 8.3 Water licensing requirements summary

Water requirement	Water take mechanism	Water sharing plan	Water source	WALs required	WALs held[6]	Licensing approach[4]
Interception of catchment runoff	Incidental water take	Namoi and Peel Unregulated Rivers Water Sources 2012	Bluevale Water Source	191 ML[5]	93 ML	Temporary trade
External water supply	Namoi River via pump and pipeline	Upper Namoi and Lower Namoi Regulated River Water Sources 2016	Lower and Upper Namoi Regulated River Water Sources	2,040 ML[3]	322 ML[1]	-[2]
	Extracted from borefield via pump and pipeline	Namoi Alluvial Groundwater Sources 2020	Upper Namoi Zone 4, Namoi Valley Groundwater Source		1,028 ML	Temporary trade

Notes:

1. Does not include the 32.1 unit shares of supplementary water that BCOPL hold in these water sources.
2. Additional entitlements required to meet external water supply demands to be preferentially sourced via groundwater.
3. Represents the maximum annual water take based on 130 years of climate data.
4. Licensing approach is in addition to the WALs held by BCOPL.
5. Based on the 80th percentile intercepted runoff volume.
6. WAL volumes assume 100% available water determinations for the relevant water sources.

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Abbreviations

Abbreviation	Meaning
AEP	Annual exceedance probability
ANZECC	*Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000; ANZG 2018)
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AWBM	Australian Water Balance Model
AWDs	Available water determinations
BCM	Boggabri Coal Mine
BCOPL	Boggabri Coal Operations Pty Limited
BoM	Bureau of Meteorology
BTM Complex (BTM)	Boggabri, Tarrawonga, Maules Creek Coal Mining Complex
CHPP	Coal handling and preparation plant
DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
DGVs	Default guideline values
EMM	EMM Consulting Pty Ltd
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	Environment Protection Authority
EPL	Environment protection licence
GWMP	Groundwater Management Plan
ha	Hectares
JBA	James Bailey & Associates Pty Ltd
km^2	Square kilometres
LGA	Local Government Area
LOM	Life of mine
m	Metre
m AHD	Level in metres Australian Height Datum
MCCM	Maules Creek Coal Mine
mg/L	Milligrams per litre
MIA	Mine infrastructure area
ML/year	Megalitre per year

Abbreviation	Meaning
mm	Millimetre
MOD	Modification
Mtpa	Million tonnes per annum
MWD	Mine water dam
NRAR	Natural Resources Access Regulator
NSW	New South Wales
NTU	Nephelometric Turbidity Unit
NWQMS	National Water Quality Management Strategy
POEO Act	NSW *Protection of the Environment Operations Act 1997*
RFOs	River flow objectives
RMP	Rehabilitation Management Plan
ROM	Run of Mine
SILO	Scientific Information for Land Owners
SSD	State Significant Development
SWBM	Site water balance model
SWIA	Surface Water Impact Assessment
SWMP	Surface Water Management Plan
TCM	Tarrawonga Coal Mine
TSS	Total suspended solids
WALs	Water access licences
Water Regulation	NSW *Water Management (General) Regulation 2018*
Water sharing plans	WSPs
WM Act	NSW *Water Management Act 2000*
WQOs	Water quality objectives
µg/L	Micrograms per litre
µS/cm	Microsiemens per centimetre

Appendix A

Water balance method statement

EMM
creating opportunities

A.1 Overview

A site water balance model (SWBM) of the Boggabri Coal Mine (BCM) was developed in GoldSim version 14.0 (GoldSim Technology Group 2021). The water balance methodology and assumptions were sourced from the BCM Water Management Plan (WMP), available spatial data, advice from BCOPL and site observations.

A.2 Modelling approach

A.2.1 GoldSim model

The SWBM applies a continuous simulation methodology that simulates the response of the water management system under a range of climatic conditions (i.e. rainfall and evaporation). The SWBM has been created by representing each process of the water management system with pre-determined responses that reflect how the proposed water management system will operate.

Rainfall, evaporation, and groundwater inflows to the mining area are the key environmental variables applied to the model. The response of the system to these variables is evaluated by investigating specific outputs across the system over the simulation timeframe.

A.2.2 Simulation period

The SWBM was developed to simulate the following periods:

- Historical water management system performance (back to approximately 2019) for calibration and verification purposes.
- Current (existing) and future operational phases of the mine including MOD 10 which represents a 17 year period from 2024 to the end of 2040.

The SWBM includes 135 years of historical rainfall and evaporation data allowing the life-of-mine to be simulated using a range of climate conditions.

A.2.3 Snapshot years

The future operational phase of the mine schedule spans a period of 16 years (2024 to 2040). Over this time, the mine disturbance area, contributing catchment and land use areas are expected to constantly change as mining progresses. Rather than incorporating the mine layout for every year of the mine schedule in the SWBM, the mine progression was simplified by including the details associated with specific years of the mine schedule ('snapshot years'). The mine disturbance, contributing catchment and land use areas were linearly interpolated between the snapshot years.

The following snapshot years were included in the SWBM: 2024 (existing conditions), 2025, 2028, 2031, 2034, 2036 and 2040.

A.2.4 Time step

Water is pumped across the BCM water management system based on pre-determined rules and pump rates (refer to Appendix A.3.5). Daily pump rates for some transfers, such as those between MW5 and SD23 may exceed the actual volume of water that requires pumping in each day (to meet demands) resulting in more water being transferred than what would occur under actual operations.

A sub-daily timestep was required to allow less than the maximum daily pump rate to be transferred per day. The SWBM applies a 6-hour timestep to adequately simulate the ability to operate pumps at sub-daily intervals.

A.3 Model assumptions

A.3.1 Climate

i Rainfall

Daily rainfall data at the Boggabri Post Office gauge was obtained as SILO (Scientific Information for Land Owners) patched point data from the Queensland Climate Change Centre of Excellence. SILO patched point data is based on historical data from the BoM rainfall stations, with missing data 'patched' in by interpolating data from nearby operating stations. SILO data was obtained for Boggabri Post Office gauge from January 1889 to December 2023. The SILO patched point daily rainfall data was applied to the model.

Daily rainfall was applied to calculate direct rainfall onto the simulated water surface of each modelled storage whereby the volume of direct rainfall was calculated as the product of the simulated rainfall depth and the water surface area of the storage, calculated from surveyed stage-storage-area relationships.

Daily rainfall was also applied to the rainfall runoff model described in Appendix A.3.2 to estimate runoff from the water management system contributing catchment.

Data from the site rainfall gauge was used for calibration and validation purposes.

ii Evaporation

Daily evaporation rates at the Boggabri Post Office gauge were obtained as SILO patched point data from January 1889 to December 2023. Evaporation data was sourced as Morton's potential evapotranspiration and Morton's shallow lake evaporation. Evaporation data was applied to the SWBM as follows:

- Morton's potential evapotranspiration – applied to the rainfall runoff model (refer to Section A.3.2) and to calculate dust suppression demand (refer to Section A.3.7).
- Morton's shallow lake evaporation – applied to calculate evaporation from pond water surface areas.

A.3.2 Runoff model

i Australian Water Balance Model (AWBM)

Surface runoff was estimated using the Australian Water Balance Model (AWBM). The AWBM was developed by Boughton (2004) and is widely used across Australia to estimate streamflow and runoff. The hydrological model calculates runoff and baseflow from rainfall after allowing for relevant losses and storage.

The AWBM is a 'bucket model'. It describes catchment runoff processes using the concept of surface stores (buckets), which trap rainfall and must fill before runoff can occur. Spatial variability is incorporated by using three stores, each with a different capacity (C1, C2 and C3) and partial areas (A1, A2 and A3, where A1+A2+A3=1). Hence, parts of the catchment generate runoff after only a small depth of rain has fallen, while other parts of the catchment only generate runoff after significant ponds have formed and overflowed.

Since the AWBM is a continuous simulation model, antecedent moisture conditions within the catchment are tracked over time within the stores such that catchment wetness from preceding rainfall affects runoff generated by subsequent rainfall. For example, the first day of rain after a dry summer will generate a lower percentage of runoff than subsequent days of rainfall.

A schematic of how the AWBM represents rainfall runoff is shown in Figure A.1. The AWBM and parameter values applied to each land use type are discussed further in Appendix A.3.2ii.

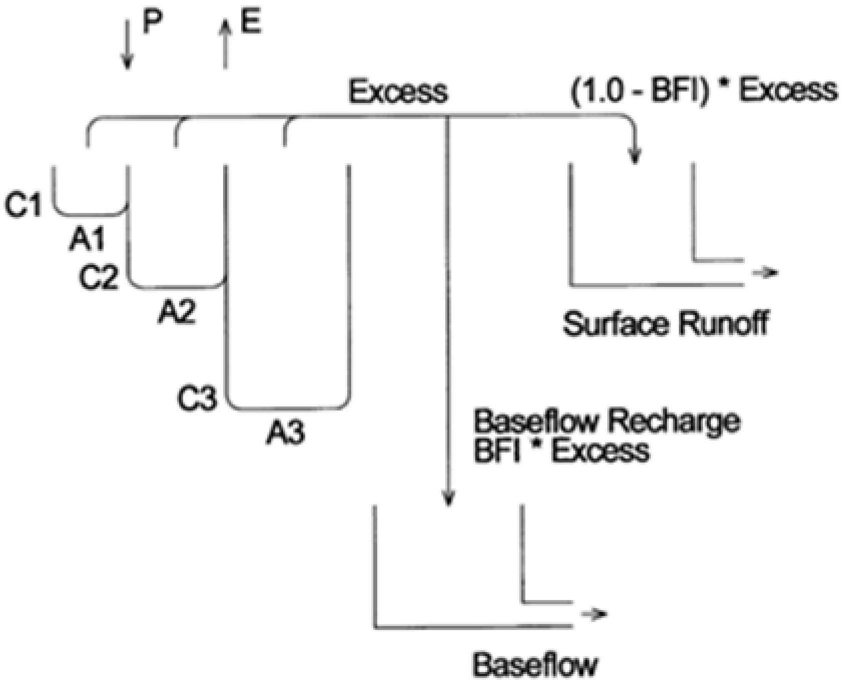


Figure A.1 Schematic of the AWBM rainfall runoff representation (Boughton 2004)

ii AWBM parameters

The AWBM is defined by nine parameters: three soil storage capacities, three partial areas, and three recession parameters. The AWBM parameters were selected to reflect the different hydrological responses of the various land use categories across BCM. The land use categories considered were undisturbed, rehabilitated spoil, industrial (hardstand and infrastructure areas), mining void (pit), active spoil and pre-strip.

AWBM parameters were calibrated using measured site data (storage volumes) and regional streamflow gauge data. The calibration and verification process is described in Appendix A.4 while the resulting AWBM parameters applied to the SWBM are presented in Table A.1.

Table A.1 Adopted AWBM parameter values

Land use	Recession parameters			Partial areas			Soil storage capacities		
	BFI	K_{base}	K_{surf}	A1	A2	A3	C1	C2	C3
Industrial	0	0	0	0.134	0.433	0.433	10	35	85
Mining area	0	0	0	0.2	0.2	0.6	15	50	150
Pre-Strip	0.2	0.98	0	0.134	0.433	0.433	15	60	150
Rehabilitation	0.6	0.99	0	0.2	0.2	0.6	20	120	200
Spoil	0.9	0.99	0	0.2	0.2	0.6	20	130	220
Undisturbed	0.05	0.98	0	0.134	0.433	0.433	13	120	200

A.3.3 Catchments

The contributing catchment area to each water management dam at several stages in the LOM are provided in Table A.2. The contributing catchment area and land use to each water management dam are shown spatially in Section 4 and 5 of the SWIA. The contributing catchment area to each storage was linearly interpolated between the snapshot years for the purposes of the SWBM.

Table A.2 Catchment areas over life of mine

Catchment	Catchment area (ha)					
	Existing	2025	2028	2034	2036	2040
Existing						
MW3	10.7	10.7	10.7	10.7	10.7	10.7
MW5	40	-	-	-	-	-
MWD	1.7	1.7	1.7	1.7	1.7	1.7
Block dam	167	164	-	-	-	-
Pit	1,406	1,384	1,521	1,019	869	757
SD3	188	202	2	2	2	2
SD6	64	64	64	64	64	64
SD7	208	264	347	347	347	347
SD8	10.9	10.9	10.9	10.9	10.9	10.9
SD10	32	32	32	32	32	32
SD11	3.9	3.9	3.9	3.9	3.9	3.9
SD12	46	50	49	49	49	49
SD23	61	-	-	-	-	-
SD28	0.6	0.6	0.6	0.6	0.6	0.6
Proposed				-	-	-
SD19	-	-	-	479	633	809
MW11	-	53	55	57	58	58
Total	**2,239**	**2,241**	**2,097**	**2,075**	**2,081**	**2,145**

A.3.4 Water storages

All water management dams included in the SWBM, and their key operating volumes, are summarised in Table A.3. BCOPL maintain an in-pit mine water dam (MWD) during operations. The in-pit MWD is typically relocated and renamed frequently as the mine progresses. However, the functionality of the storage to transfer water from the pit to MW5/MW11 and to provide a dust suppression fill point for the pit area remain similar over time.

Table A.3 Water storage assumptions

Storage	Type	Dead storage (ML)	LOV (ML)	HOV (ML)	Capacity (ML)	Overflows to
Existing storages						
MW3	Contaminated water dam	1.0	5.0	131.0	153.5	Bollol Creek
MW5	Mine water dam	1.0	600	1,961	2,200	Pit
MWD	Contaminated water dam	1.0	1.0	33.8	92.8	Pit
Block dam	Transfer dam	1.0	1.0	-	17.5	SD23
Pit	Mining void	1.0	25.0	200.0	-	-
SD3	Sediment dam	16.7	33.3	34.3	102.3	Nagero Creek
SD6	Sediment dam	8.7	17.4	18.4	55.9	Nagero Creek
SD7	Sediment dam	11.7	23.3	24.3	95.1	Pit
SD8	Sediment dam	1.6	3.3	4.3	13.4	SD6
SD10	Mine water dam	9.7	19.4	61.7	116.4	SD6
SD11	Contaminated water dam	1.4	2.7	3.7	16.4	Nagero Creek
SD12	Contaminated water dam	17.2	34.4	35.4	206.6	Nagero Creek
SD23	Contaminated water dam	1.6	3.2	4.2	17.0	Pit
SD28	Sediment dam	1.0	0.6	1.6	3.5	Nagero Creek
Proposed storages						
SD19	Sediment dam	1.0	40	41	251[1]	SD3
MW11	Mine water dam	1.0	600	2,000	2,200	Pit

Notes: 1. Based on storage volume required for 2034 and 2036 mine layouts.

A.3.5 Operating rules and transfers

The operating rules applied to pump transfers in the SWBM model are summarised in Table A.4. The pumps were modelled to switch on when the on trigger occurred and the specific conditions were true. The pump remained on until the off trigger occurred, or the conditions became false. The pump triggers and conditions are generally based on the low operating volume (LOV) and high operating volume (HOV) for each storage as defined in Table A.3. The following overarching operating rules were also applied to the SWBM:

- Water was not pumped from dirty water storages for reuse when the volume stored in the pit exceeded the HOV. This rule is intended to allow dirty water discharges to occur (subject to meeting EPL conditions) rather than risking overflows from contaminated storages as a result of harvesting excess dirty water.
- Water was pumped from contaminated storages (via SD10) to MW3 when the stored volume in MW5/MW11 exceeded the HOV. MW3 is no longer used in the day-to-day operation of the water management system and is instead used as an evaporation basin to increase water losses during wet periods.
- Water was pumped from contaminated storages to the pit to avoid overflows in wet periods. This operating rule only occurs as a last resort once the stored volume in MW3 and MW5/MW11 exceeded their respective HOV.

Table A.4 Pump operating rules

Pump from	Pump to	Pump rate (ML/day)	On trigger	Off trigger	Conditions
Existing					
Pit	MW8	5.0 (10.0 if pit volume exceeds 200 ML)	Pit > LOV	Pit < LOV	MW8 < HOV
Pit	MW5	5.0 (10.0 if pit volume exceeds 200 ML)	Pit > LOV	Pit < LOV	MW5 < HOV
Pit	SD23	5.0 (10.0 if pit volume exceeds 200 ML)	Pit > LOV	Pit < LOV	SD23 < HOV
MW3	SD10	3.5	MW3 > HOV	MW3 < LOV	SD10 < HOV
MW5	MWD	5.0	MW5 > dead storage volume	MW5 < dead storage volume	MWD< HOV
MW5	SD23	5.0	MW5 > dead storage volume	MW5 < dead storage volume	SD23 < HOV
MW5	SD10	5.0	MW5 > dead storage volume	MW5 < dead storage volume	SD10 < HOV
SD3	SD12	5.0	SD3 > HOV	SD3 < LOV	SD12 < HOV Pit < HOV
SD6	SD10	2.0	SD6 > HOV	SD6 < LOV	SD10 < HOV Pit < HOV
SD7	SD12	10.0	SD7 > HOV	SD7 < LOV	SD12 < HOV
SD8	SD10	1.9	SD8 > HOV	SD8 < LOV	SD10 < HOV
SD10	MW5	10.0	SD10 > HOV	SD10 < HOV	MW5 < HOV
SD10	MW3	10.0	SD10 > HOV	SD10 < HOV	MW3 < HOV MW5 > HOV
SD10	Pit	10.0	SD10 > HOV MW3 > HOV MW5 > HOV	SD10 < HOV MW3 < HOV MW5 < HOV	-
SD11	SD10	2.0	SD11 > HOV	SD11 < LOV	SD10 < HOV
SD12	MW5	20.0	SD12 > HOV	SD12 < LOV	MW5 < HOV
SD23	MW5	3.0	SD23 > HOV	SD23 < HOV	MW5 < HOV
Proposed					
Pit	MW11	5.0 (10.0 if pit volume exceeds 200 ML)	Pit > LOV	Pit < LOV	MW11 < HOV
MW11	MWD	5.0	MW11 > dead storage volume	MW11 < dead storage volume	MWD < HOV
MW11	SD10	5.0	MW11 > dead storage volume	MW11 < dead storage volume	SD10 < HOV
SD10	MW11	10.0	SD10 > HOV	SD10 < HOV	MW11 < HOV
SD12	MW11	20.0	SD12 > HOV	SD12 < LOV	MW11 < HOV

Pump from	Pump to	Pump rate (ML/day)	On trigger	Off trigger	Conditions
SD19	MW11	3.0	SD23 > HOV	SD23 < HOV	MW11 < HOV

A.3.6 Water sources

i Rainfall and runoff

Surface water runoff that drains into the water management dams is stored for use onsite. The volume of inflows to each storage is calculated as the sum of direct rainfall onto the storage water surface and the runoff generated from the contributing catchment.

The volume of direct rainfall is calculated as the product of the rainfall depth and the storage water surface area. Each storage includes a stage storage relationship whereby the assumed exposed surface area of stored water varies with the volume of water stored each day.

The volume of catchment runoff is calculated as the product of catchment area (refer to Table A.2) and the runoff depth calculated for each land use type by the AWBM described in Appendix A.3.2.

ii Groundwater inflows to the mining void

Groundwater inflows were estimated using the numerical groundwater model developed for the Boggabri, Tarrawonga, Maules Creek Complex (BTM Complex) as documented in *Groundwater Impact Assessment Boggabri Coal Mine Modification 10* (AGE 2025). The BTM Complex groundwater model considers the cumulative impact on groundwater resources resulting from the three adjacent mines and therefore provides the most robust estimate of future groundwater inflows.

The predicted annual groundwater inflow volumes for the BCM were applied to the water balance model and are shown in Figure A.2.

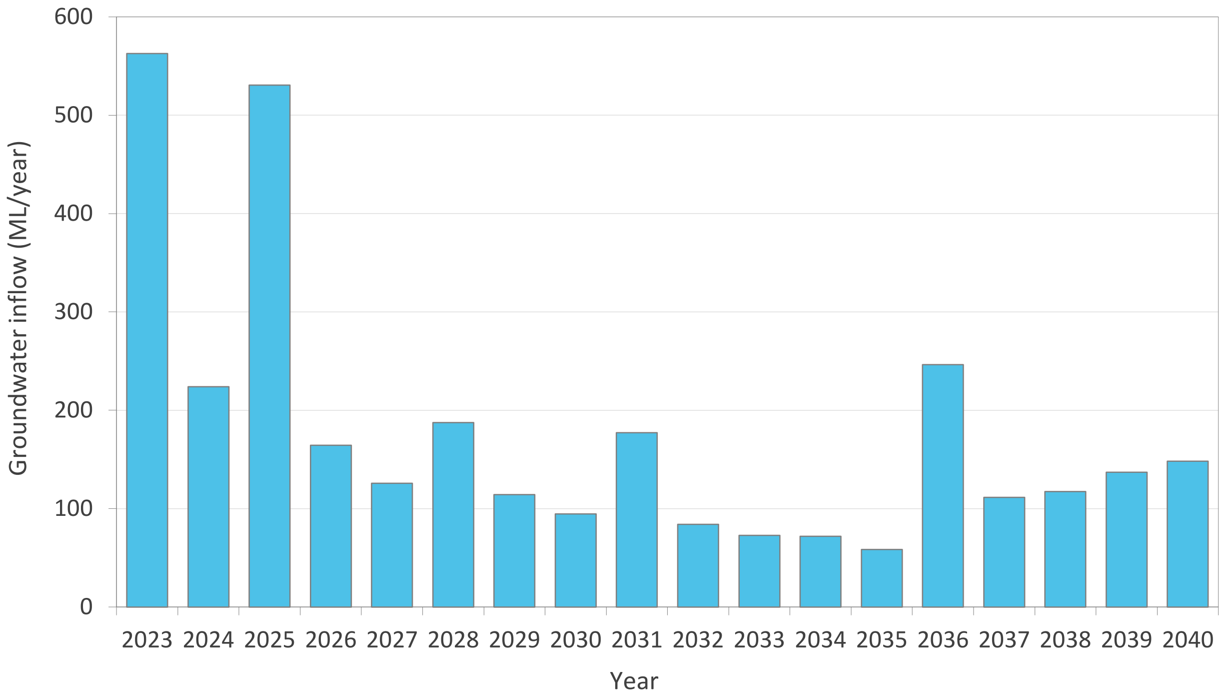


Figure A.2 Predicted groundwater inflow to the mining void

Figure A.2 shows groundwater inflow to the mining void is predicted to peak in 2028. Groundwater inflows are predicted to gradually decline over the LOM so that inflows are generally less than 200 ML/year from 2026 onwards. Groundwater that is collected in the mine void is pumped to the water storages in accordance with the pump operational rules described in Appendix A.3.5.

iii Imported water

External water supply can be sourced from the BCM borefield or the Namoi River via pump and pipeline. Water imports are triggered in the model when the volume of water stored in MW5/MW11 recedes below the LOV of 600 ML. Water imports enter the water management system via SD10 prior to being pumped to the coal handling and preparation plant (CHPP) and mine infrastructure area (MIA) to meet water demands or MW5/MW11 to meet dust suppression demands via the fill points in SD23 and MWD. Water imports are assumed to occur at a rate of 5.6 ML/day (consistent with site practices) when required.

Due to the unreliable nature of the Namoi River water source, the option to extract water from the river is currently switched off in the SWBM. Hence all water is sourced from the borefield under exiting groundwater entitlements held by BCOPL or via additional groundwater entitlements that can be traded to make up system shortfalls.

Allowing MW5/MW11 to drawdown to the LOV before importing water is intended to maximise the reuse of dirty and contaminated water stored onsite before sourcing water from external sources.

A.3.7 Water demands

i Dust Suppression

Water is required for dust suppression on haul roads and other disturbed areas. Dust suppression for the CHPP coal stockpiles, coal crushing areas, and coal loading areas and MIA are accounted for in the CHPP an MIA demands (refer to Appendix A.3.7ii).

Modelled dust suppression demand is calculated as a factor of haul road surface area multiplied by the daily evaporation rate less rainfall so that no dust suppression occurs on days where the rainfall rate exceeds the evaporation rate. An effective width of 50 m was assumed for all haul roads as calibrated in previous versions of the SWBM. The haul road lengths applied to the model are based on the mine layout for the snap-shot years. Haul road lengths were interpolated linearly between the snap-shot years. The haul road lengths applied to the SWBM are shown in Figure A.3.

Water used for dust suppression is preferentially sourced from recycled contaminated water from various storages depending on the mine progression. Currently, there are fill points at the MWD and SD23. There is also a fill point located at SD7 which is not currently being utilised.

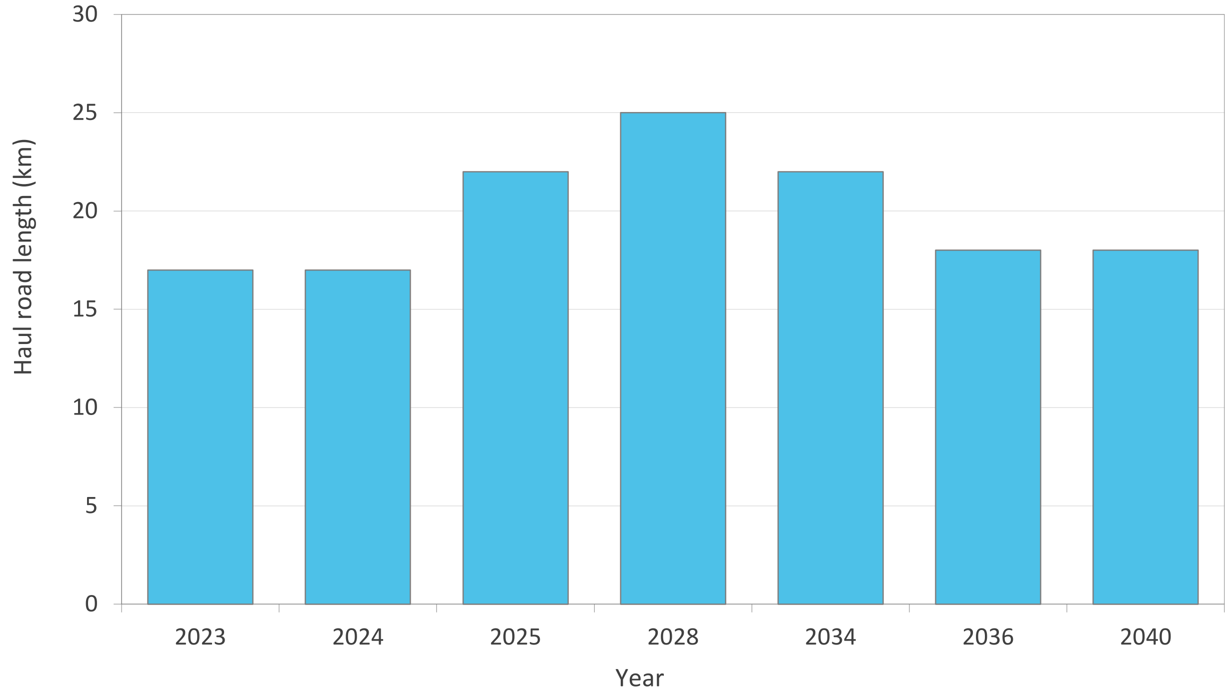


Figure A.3 Haul road lengths applied to the SWBM

ii CHPP and MIA Water Demand

The CHPP requires water for coal washing, dust suppression, and as fire suppression. Water is required for vehicle washdown in the MIA. Washdown water is recycled, however, water is required to make-up evaporative losses. Make-up water for the CHPP and MIA is currently sourced from SD6 and SD10 via a filtration system.

Potable water is used in the administration building and amenities during operations. Potable water is currently sourced from groundwater entitlements (WAL 29473) assigned to the Lovton Bore. Wastewater from the administration building and amenities are treated in an onsite treatment plant. Potable water demand and wastewater generated by the onsite treatment plant were not considered in the SWBM analysis due to the relatively minor volumes involved.

A combined CHPP and MIA water demand of 0.85 ML/day was applied the water balance model based on recent historical recorded values which are shown in Figure A.4. The demand is simulated in the model as a constant flow rate that is extracted from SD10. The assumption of a constant flow rate is appropriate for the purpose of the SWBM as actual day to day variations in operations will be attenuated by the water storage onsite.

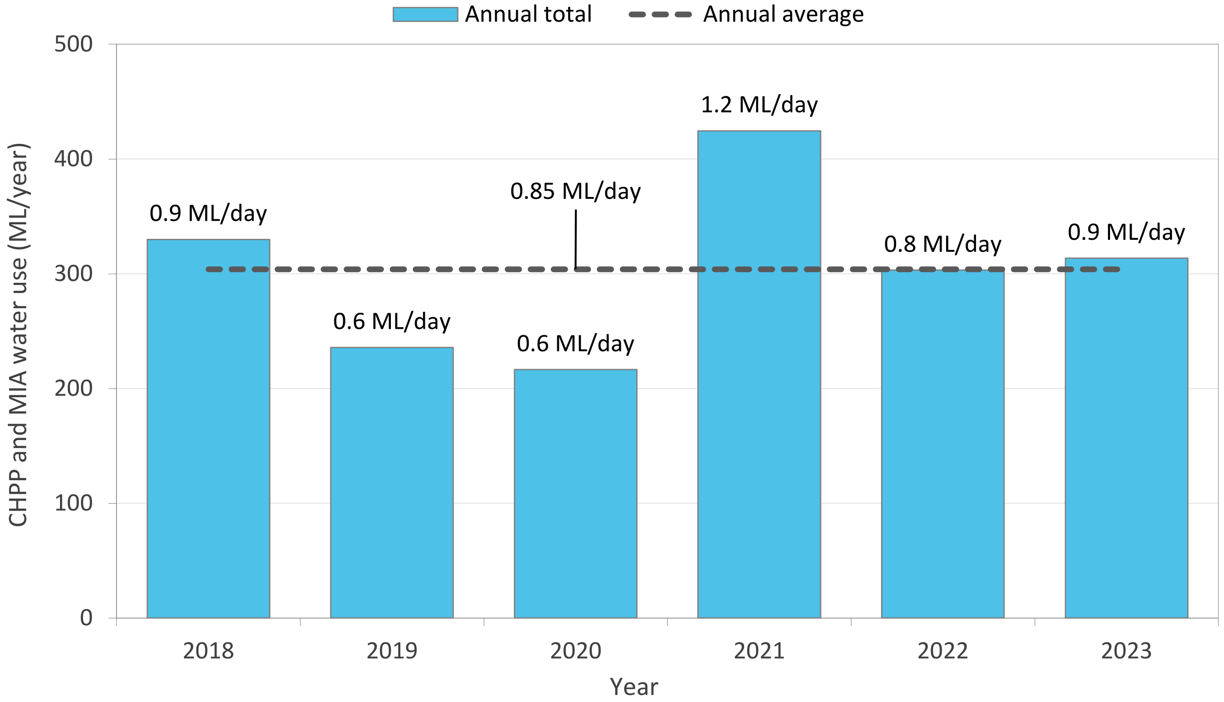


Figure A.4 Recorded CHPP and MIA water use

A.3.8 Seepage

Typically, losses associated with seepage from water storages are minor compared to evaporation and pumped outflows. Hence, seepage losses are assumed to be negligible for modelling purposes and are therefore set to zero in the SWBM model.

A.4 Model calibration and verification

Model calibration and verification provides confidence the SWBM predictions are adequately representing water management system processes. This section describes the SWBM calibration and verification process and results.

A.4.1 Data and assumptions

BCOPL monitor and record rainfall data, water management dam storage levels (from which storage volumes can be calculated), water use, and flow meter data at various locations across BCM. BCOPL provided observed site data for several water management storages and flow meter locations over the 2019 to 2023 period.

Calibration and verification of the SWBM was completed by comparing observed site data with simulated results from the SWBM using the water management system assumptions described in Appendix A.3. The observed data used in the calibration and verification process are described in Table A.5.

Table A.5 Calibration and verification data

Model aspect	Available data
Rainfall	• Observed daily rainfall at the site weather gauge from 1 July 2019 to 31 December 2023.
Evaporation	• Daily evaporation and evapotranspiration totals obtained as patched point data from SILO at the Boggabri Post Office gauge (55007).
Storage volumes	• MW5 storage volume from 1 July 2019 to 31 December 2023. • SD10 storage volume from 1 July 2019 to 31 December 2023. • Total site storage volume from 1 July 2019 to 31 December 2023.
Water use data	• Recorded dust suppression use from 1 July 2019 to 31 December 2023. • Recorded water use in the CHPP and MIA from 1 July 2019 to 31 December 2023. • Recorded borefield extraction volumes for the 2020, 2021, 2022 and 2023 water years.

A.4.2 Rainfall and runoff

Rainfall and runoff are used to estimate the volume of water that contributes to each of the water management storages over the simulation timeframe. Rainfall that occurs onto the surface of a storage directly contributes to the stored volume. The volume of runoff generated following rainfall varies according to the land use of the contributing catchment.

The rainfall runoff response from the various land use types across BCM were represented by the AWBM as described in Appendix A.3.2. As most of the storages across BCM receive runoff from more than one land use type, it is difficult to extract the individual runoff response attributed to a specific land use from the broader catchment area. Calibration was therefore completed for the total observed storage volume to capture all land uses and catchment areas contributing runoff to the BCM water management system.

The AWBM parameters were selected to reflect the different hydrological responses (i.e. low, moderate, and high runoff potential) expected for each land use type included in the SWBM. Whereby land use types with high runoff potential would result in a larger annual runoff coefficient (as predicted by the SWBM) compared to land use types with low runoff potential. The assumed hydrologic response of each land use type is described in Table A.6.

The AWBM parameters were adjusted until the assumed hydrologic response assumptions were met and a reasonable match was observed between the observed and modelled total site storage volume. The resulting AWBM parameters that were subsequently applied to the SWBM are provided in Table A.1.

Table A.6 Hydrological response of modelled land use types

Catchment land use	Assumed hydrologic response	Justification	Annual volumetric runoff coefficient
Industrial	High runoff potential	Includes compacted surfaces such as access roads and hardstand areas. Some localised ponding is expected to occur within industrial land use areas.	0.13
Mining area	Moderate runoff potential	Includes compacted surfaces and exposed rock. Considerable local depressions and areas of ponding are present which can hold up water in the landscape rather than allowing it to drain to the water management system.	0.08
Pre-strip	Moderate runoff potential	Soil infiltration capacity expected to be similar to the undisturbed land use type except where compaction has occurred. Lower rainfall losses are expected due to vegetation removal.	0.07

Catchment land use	Assumed hydrologic response	Justification	Annual volumetric runoff coefficient
Rehabilitation	Low runoff potential	Similar properties to the undisturbed landscape are expected once landform and vegetation communities are established.	0.05
Spoil	Low runoff potential	Active spoil areas are assumed to have significant water holding capacity within the rock and soil matrix.	0.05
Undisturbed	Low runoff potential	Hydrologic response based on observed runoff coefficient at local and regional streamflow gauges (refer to Section 3.3.4 of the SWIA).	0.05

A.4.3 Water inventory

BCOPL routinely records storage levels in accordance with the monitoring program described in the existing Surface Water Management Plan (SWMP). Recorded storage levels were used to verify the SWBM is adequately replicating the storage volumes for the total site, MW5, and SD10. These storages were selected for verification as they represent key aspects of the water management system.

i Total site storage

The observed and modelled total site stored volume from 1 July 2019 to 31 December 2023 are compared in Figure A.5.

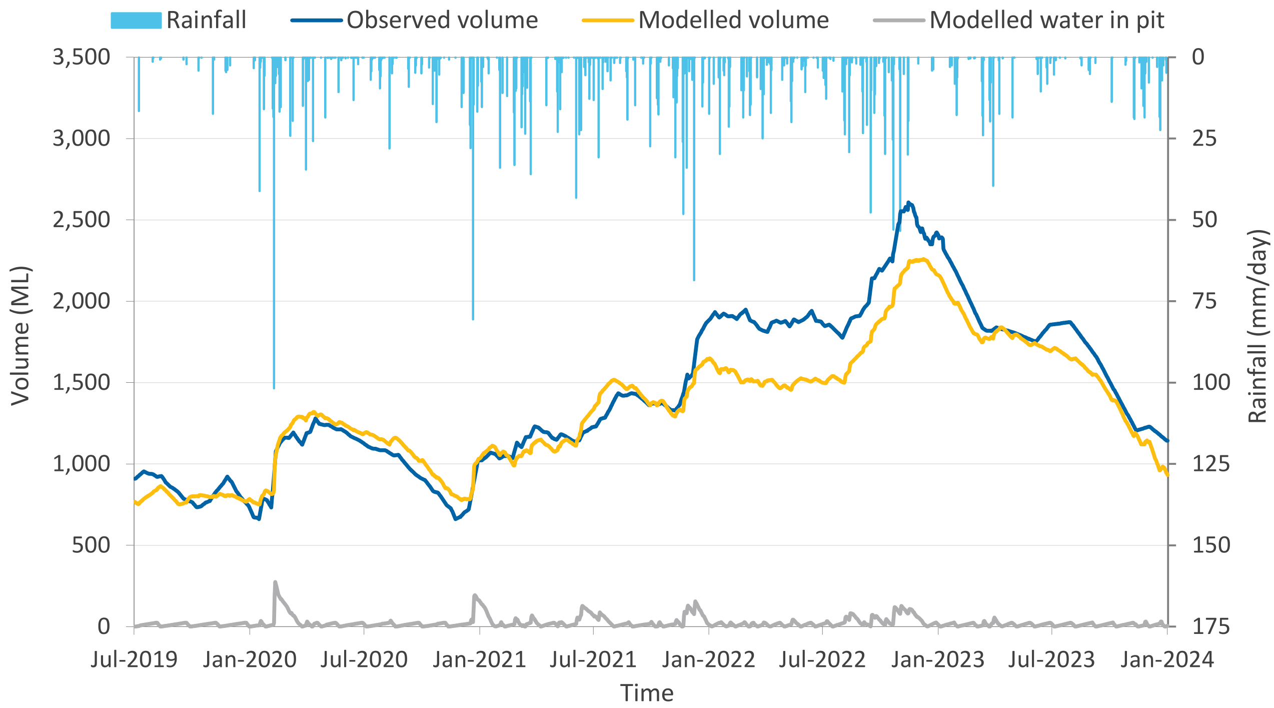


Figure A.5 Observed vs modelled total site storage volume

Figure A.5 shows the modelled storage volume (yellow line) provides a good representation of the observed storage volume (blue line) with similar responses to rainfall occurring for both results. The modelled and observed storage volume are a good match from January 2020 to November 2021. The modelled results show a subdued response to the wet weather period in November and December 2021. After which, the modelled results are shown to follow a similar rise and fall in response to rainfall and storage outflows to the end of 2023. The total storage volume from January 2022 to December 2023 is generally lower than the observed storage volume due to the underestimation of the 2021 rainfall event.

Overall, the model shows an acceptable fit for total inventory, with the modelled rate of drawdown after rainfall events correlating well with the observed data. Except for the November and December 2021 rainfall event, the magnitude of inflows from rainfall events is also captured by the AWBM runoff model.

ii MW5 storage

The observed and modelled storage volume in MW5 from 1 July 2019 to 31 December 2023 are compared in Figure A.6.

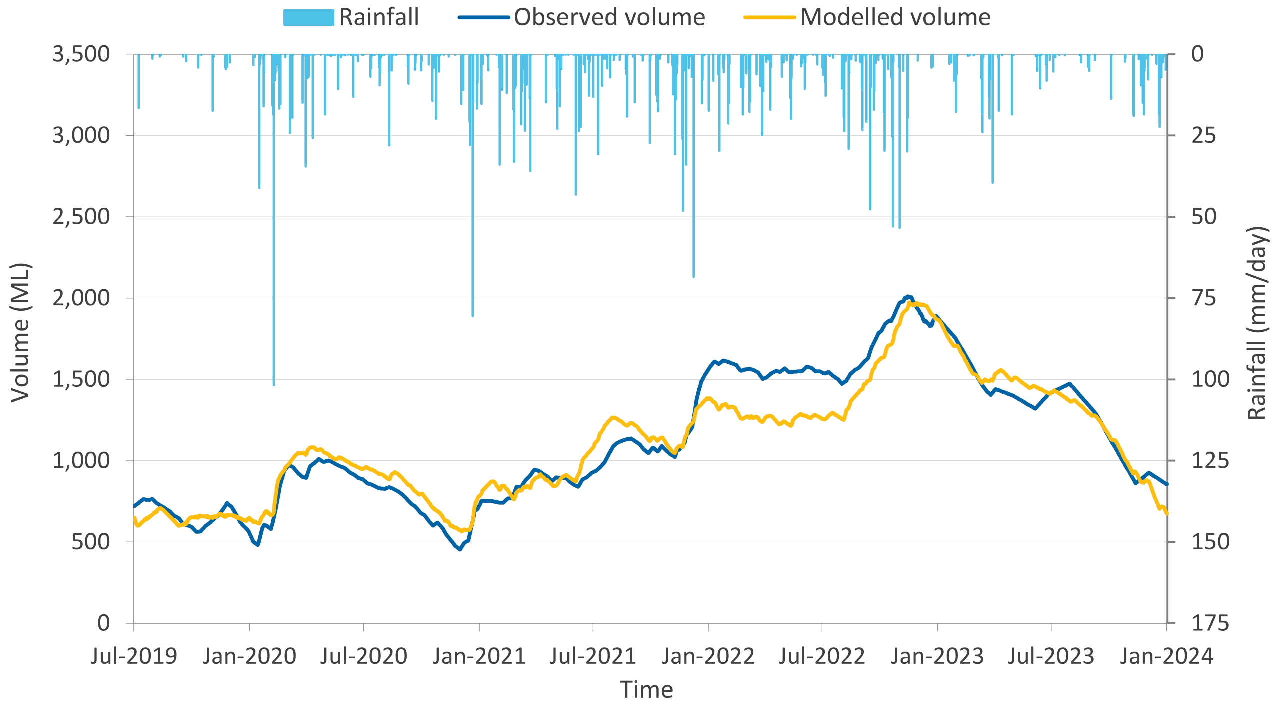


Figure A.6 Observed vs modelled MW5 storage volume

Figure A.6 shows the modelled storage volume in MW5 is a good match to the observed storage volume with similar responses to rainfall occurring for both results. The modelled volume is underestimated following the November and December 2021 rainfall event as per the total site stored water. The modelled MW5 volume matches the observed peak that occurred During the November 2022 rainfall event as the pumping and transfer rules described in Appendix A.3.5 preferentially send water to MW5 from the rest of the water management system whenever an excess is observed up until MW5 reaches its HOV.

iii SD10 storage

The observed and modelled storage volume in SD10 from 1 July 2019 to 31 December 2023 are compared in Figure A.7.

SD10 operates as a transfer point for water to and from MW5 as well as supplying water to the CHPP and MIA. Modelled storage volumes are elevated compared to observed values prior to January 2023. The modelled storage volumes are similar to observed values from January 2023 onwards. Modelled storage volumes are shown to follow a relatively stable trend as per the observed values. This is expected as SD10 has a relatively small contributing catchment area and is therefore strongly influenced by pumped transfers to and from other elements of the water management system. The modelled operating logic is considered to be capturing the operation of SD10 adequately.

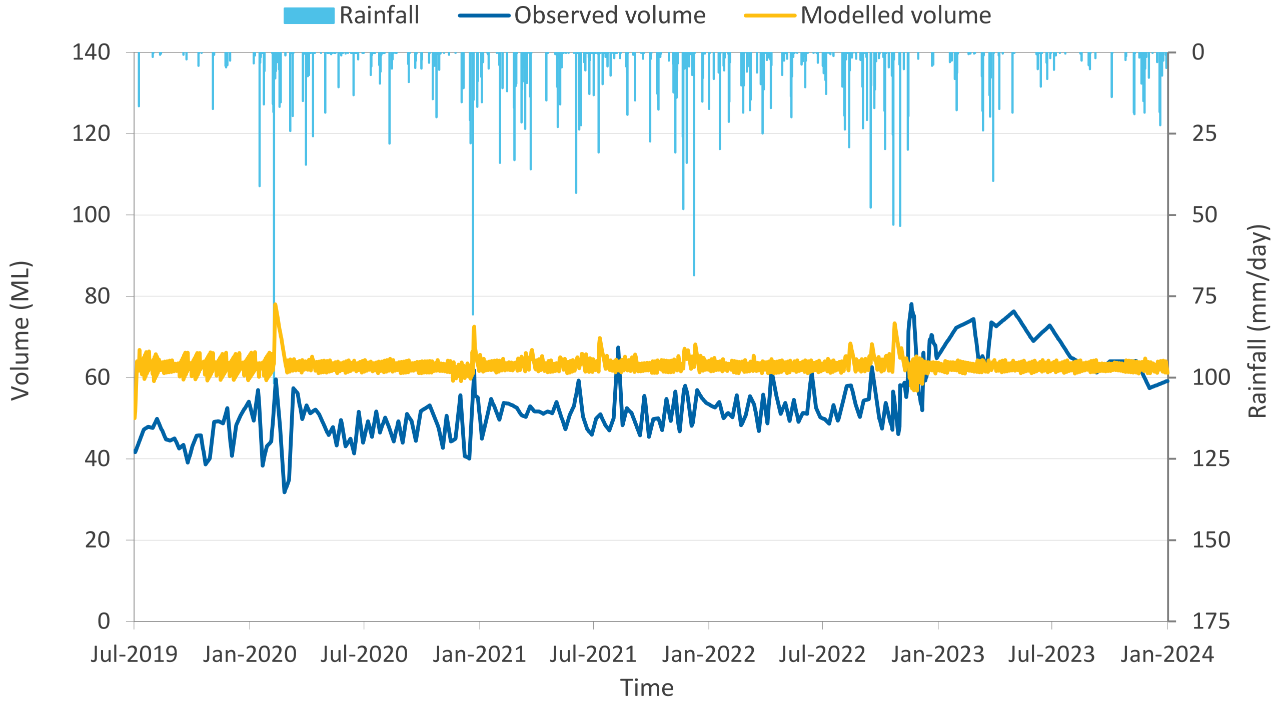


Figure A.7 Observed vs modelled SD10 storage volume

iv Summary

Modelled storage volumes generally match observed storage volumes with the key trends in rainfall and runoff adequately represented. Typically, modelled results differ from observed results due to the model operating rules described in Appendix A.3.5. In reality, water may be preferentially held in one storage or another on a case-by-case basis which is difficult to replicate in a model based on rules and assumptions.

A.4.4 External water import

Consistent with the BCM water source prioritisation strategy, the SWBM preferentially sources import water from groundwater sources as water from the Namoi River is often unreliable during dry periods. As a result, modelled water import has been classified as either groundwater import or additional import, where the additional import is assumed to be sourced from the purchase of additional temporary groundwater entitlements (but other options such as river water may be explored). Modelled water imports are compared to observed water imports on a water year (July to June) basis in Figure A.8.

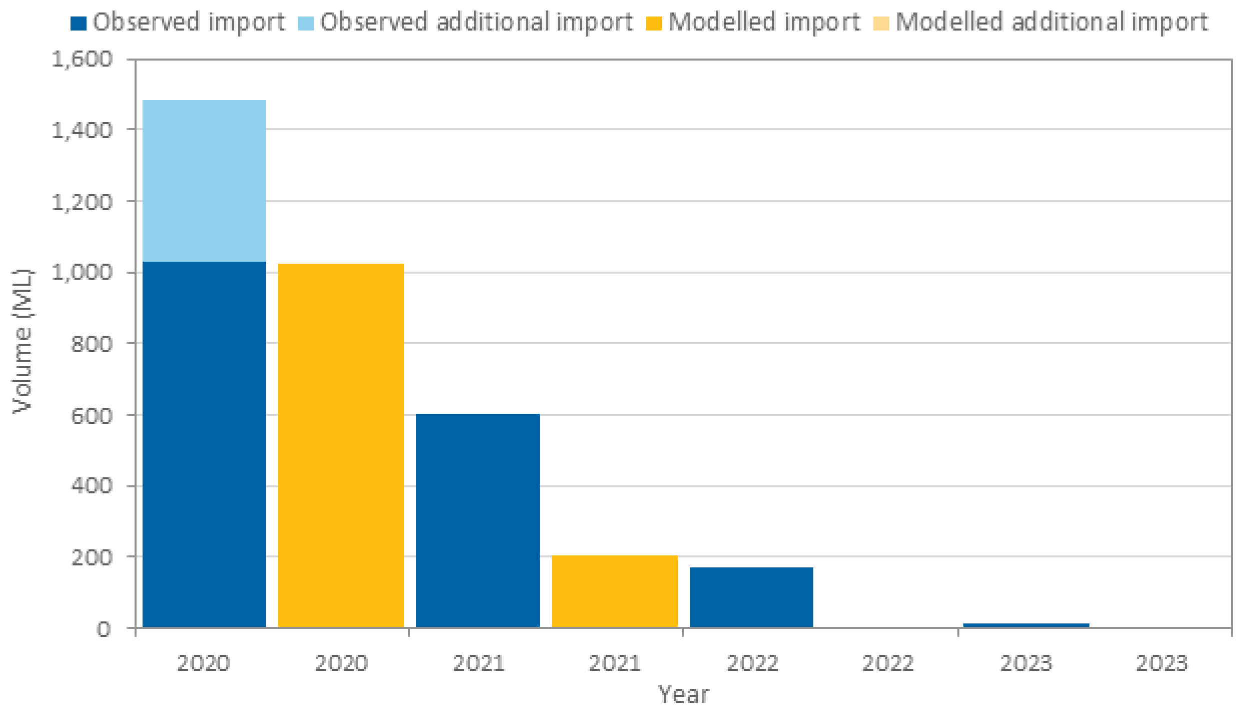


Figure A.8 Observed vs modelled water import: water year (July to June)

The SWBM is shown to generally underestimate the volume of water imported from the borefield or additional sources. The underestimation of imported water from 2020 to 2022 is primarily associated with the updated SWBM logic which preferentially sources CHPP and MIA water demand (several hundred megalitres a year) from SD10 via a filtration system (implemented in the 2022 calendar year) rather than directly from the borefield.

Due to the substantial volume of water stored onsite (refer to Figure A.5) through 2022 and 2023, only 13.6 ML was imported from the borefield during the 2022/2023 water year. The SWBM predicted zero water imports during 2022 and 2023 which is consistent with the observed values. The performance of the SWBM in simulating water imports will continue to be verified over a range of climatic conditions as part of the annual water balance review

A.4.5 Dust suppression water use

Monthly and annual modelled dust suppression use is compared to observed values in Figure A.9. Modelled dust suppression use generally shows a good match to observed values. Annual modelled dust suppression values range from 18% higher than observed values in 2020 to 6% less than observed values in 2023. Monthly modelled dust suppression is shown to follow similar trends to observed values (i.e. higher in summer and lower in winter).

Total haul road area and the applied evaporation rate both have a degree of uncertainty around them when estimating dust suppression, as such the small variance from observed usage is acceptable for the SWBM. The methodology for modelling dust suppressions is outlined in Appendix A.3.7.

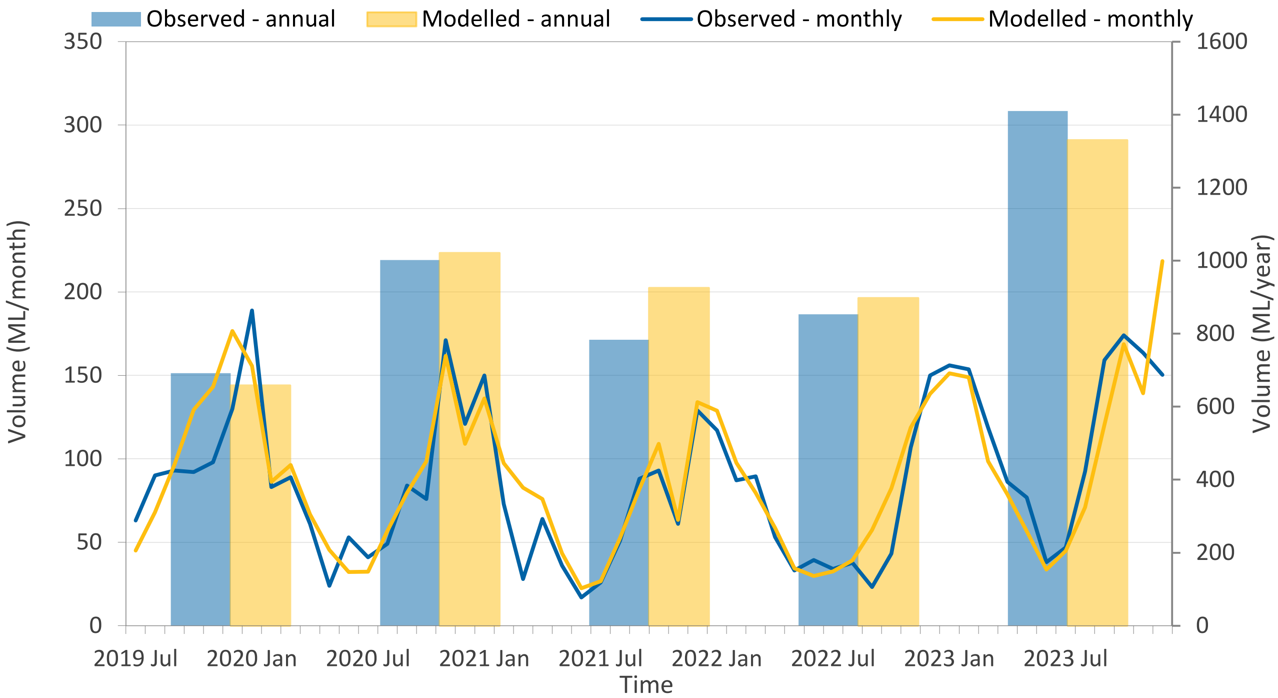


Figure A.9 Observed vs modelled dust suppression

A.4.6 Verification outcome

The performance of the SWBM against total and key storage volumes, water import, and dust suppression was found to provide a suitable estimation of observed values. As a result, the SWBM is considered adequate and suitable to forecast conditions for the LOM.

A.5 Results

Water balance model results are presented in Section 6.2.7 of the SWIA.

Appendix B

Final void climate change analysis

EMM
creating opportunities

B.1 Background

As outlined in Section 6.3.3, the final void model uses a 10,000 year stochastic daily rainfall and evaporation dataset to enable a robust understanding of the influence of climate variability on the BCM final void. However, this does not account for the influence of climate change which will affect the baseline from which climate variability occurs. To assess system resilience to climate change, the daily rainfall dataset was perturbed using scaling factors to represent the worst-case plausible future climate scenario with regards to overtopping (i.e. the wettest predicted climate scenario). This appendix describes the available climate change data and the scenario adopted for the final void modelling.

B.2 Available data

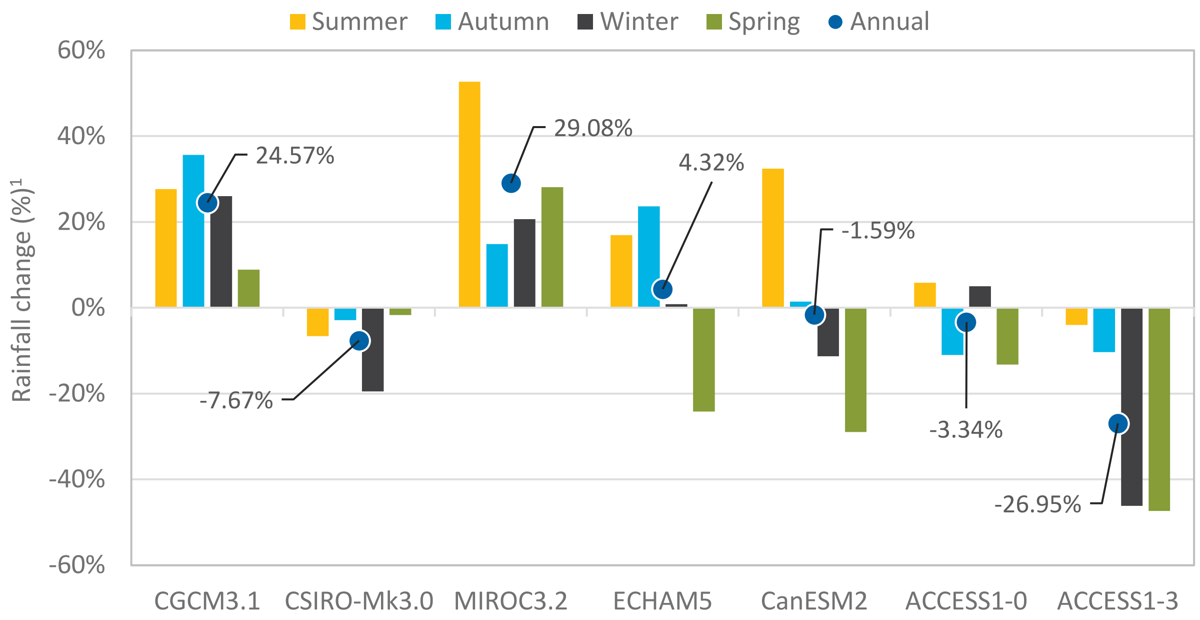
Global Climate Models (GCMs) are used to predict climate change, however, they are unable to provide detailed descriptions of future climatic conditions at a regional scale. At national and state levels, government agencies are responsible for determining and providing guidance on data use for climate change assessments in Australia, including which GCMs are suitable for different locations, and methods for downscaling global data for regional use. Advice is provided by:

- CSIRO and Bureau of Meteorology, via the Climate Change in Australia website.
- The NSW government, via the AdaptNSW website (and related portals and reports).

The NSW and Australian Regional Climate Modelling (NARCliM) project is a collaboration led by the NSW Government with the ACT and South Australian governments and input from the University of New South Wales's Climate Change Research Centre. It was established to produce regional climate projections and data for studies into the impacts of climate change in south-east Australia. To date, there have been two NARCliM releases with suites of regional climate projections, and a third is expected in 2024 but not available at the time of modelling. The climate models in each NARCliM release were considered for perturbing the 10,000-year daily rainfall dataset to account for potential climate change influences.

B.3 Climate model selection

A key focus of the final void modelling is to demonstrate the long-term water level in the void and to assess the risk of overtopping. The wettest future climate scenario from the NARCliM climate projections is anticipated to result in the worst-case (i.e. highest water levels) outcomes for the final void model. Figure B.1 shows the change in seasonal and annual rainfall compared for each of the NARCliM climate projections for BCM. CGCM3.1 and MIROC3.2 provide the wettest scenarios, with MIROC3.2 being slightly wetter (29% annual increase) overall due to a higher increase in summer rainfall. Monthly scaling factors associated with the MIROC3.2 climate projection were applied to the 10,000 year stochastic rainfall dataset to create the climate perturbed dataset for the sensitivity analysis.



1. Compared with the 1990-2009 average based on NARCLiM climate change modelling (NSW Government 2023)

Figure B.1 Comparison of annual rainfall change across NARCliM climate projections

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