APPENDIX G
Surface water impact assessment

Evolution MINING

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ATC WILLIAMS

REPORT

EMM CONSULTING PTY LIMITED
ABN: 28 141 736 558

COWAL GOLD OPERATIONS OPEN PIT CONTINUATION
Environmental Impact Statement
Surface Water Assessment

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EXECUTIVE SUMMARY

Evolution Mining (Cowal) Pty Limited (Evolution) proposes to extend mining operations at the Cowal Gold Operations through the proposed Open Pit Continuation, herein referred to as the Project. Evolution are seeking approval under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) for the Environmental Impact Statement – a State Significant Development application under Section 4.38 of the EP&A Act.

The main water-related activities associated with the Project would comprise:

- Development of three new satellite open pits (the 'E46', 'GR' and 'E41' pits) to the north and south of the existing E42 open pit, within the current approved mining lease (ML 1535).
- Extending open pit mining operations by approximately 10 years to 2036 and total mine life by approximately 2 years to 2042.
- Expansion of the Integrated Waste Landform (IWL) to accommodate life of mine tailings.
- Extension of the lake protection bund (LPB) system to provide continued separation and mutual protection between Lake Cowal and the mine.
- Upgrades to the existing surface water drainage system, to assist with on-site water management and enhance on-site water conservation.

A number of additional contained water storages (D21, D23, D24 and D25) are proposed for the Project to capture runoff and manage water on site at CGO. Augmentation of on-site water storages would be undertaken within the existing catchment area/disturbance area of each storage. No overflows were predicted in Project water balance model simulations from either of the contained water storages that could overflow to Lake Cowal (D1 and D4) in any of the model simulations.

Water demand associated with the Project is anticipated to be met through the currently approved water supply sources and infrastructure. The maximum water demand to accommodate processing of primary and oxide ore from the underground mine and proposed open cut operations is estimated at 23.9 ML/d in 2040. This compares with an average process plant demand of 22.4 ML/d in 2022 for the current CGO.

The results of Project water balance modelling indicate that there are unlikely to be increased impacts on Lachlan River flows as a result of the Project due to a predicted decrease or only a slight increase in the forecast demand on licensed extraction. The demand from external sources, based on the median rainfall sequence, would average 1,713 ML/year with up to 1,965 ML/year to be sourced from the Lachlan River based on the 90th percentile model results. Based on DPE - Water trading records, there has been adequate allocation assignment water available on the market from this source in previous years to meet this predicted demand requirement even in the event of zero available water determination. It should be noted that CGO will continue to make use of onsite and external low quality water sources to the maximum extent practicable and the Lachlan River is the lowest priority source. The reliance on external borefield sources is forecast to decrease as a result of the Project. The management of supply in a sustainable manner from each external source is implicit within the water balance modelling reported herein and continues to be pertinent. It is recommended that sourcing water from the Bland Creek Paleochannel borefield continue in a similar manner as occurs currently, by alternating between this source and the Lachlan River to manage groundwater levels and provide flexibility with respect to extraction rates and the availability of allocation assignments in the Lachlan River.

Final void water balance model predictions indicate that the E41 and E42 final voids would reach peak equilibrium water levels of more than 70 m below the spill level and 90 m below the spill level respectively (i.e. the final void would be contained). Modelled equilibrium water levels in the E41 final void would be reached after approximately 140 years while the E42 final void equilibrium water level would be reached over a period of approximately 700 years. Groundwater outflow from the final void was not simulated to occur – i.e. the final void would remain a groundwater sink.

Surface water monitoring will continue to be undertaken at specific areas within the Mining Lease and in Lake Cowal (when lake water levels permit). The Project geochemical assessment has concluded that oxide waste rock has a significant risk of being highly saline and/or highly sodic, with attendant implications for water quality and the water quality monitoring program has been reviewed accordingly.

The proposed expanded LPB (separating Lake Cowal from the Project area) comprises two components that form an arc around the expanded Project area, abutting the western lake shoreline. The components consist of an initially constructed Temporary Isolation Bund and ultimately the LPB itself. The Project geochemical assessment has identified potential constituents that could be elevated (relative to background concentrations in Lake Cowal) during LPB construction as a result of contact with or runoff from primary waste rock, which is to be used for expanded LPB construction. In addition, during LPB construction there is the potential for elevated turbidity due to disturbance of lakebed materials. To limit the risk to Lake Cowal water quality, placement of a continuous silt curtain around the outer perimeter of the Temporary Isolation Bund is planned to trap fine sediment and control the migration of suspended material into the lake.

Lake water balance model results indicate that 'wet' expanded LPB construction conditions should prevail (i.e. construction involving placing materials directly into the lake). Therefore, during Temporary Isolation Bund construction, water from Lake Cowal will be captured behind the Temporary Isolation Bund (i.e. on the open pit side). A procedure has been developed to test water quality before and during pumped return of the water captured behind the Temporary Isolation Bund to Lake Cowal. Ongoing testing of Lake Cowal water quality at monitoring locations close to and remote from CGO would provide a means of directly assessing any effects on lake water quality as a result of LPB construction activities and during the return of captured water. The frequency of sampling and testing at lake water quality monitoring sites would be increased during construction. Site specific guideline values may be updated prior to construction of the LPB to include constituents of concern resulting from the recommended further geochemical assessment and to include contemporary data. A Construction Environmental Management Plan would be prepared as part of the detailed design of the expanded LPB, detailing construction activities, testing frequency, environmental management, monitoring and contingencies.

The Project is predicted to have negligible effects on the long term water balance of Lake Cowal and on peak flood levels.

Construction of the expanded Up Catchment Diversion System (UCDS) has the potential to generate elevated sediment during and shortly following construction that could migrate to Lake Cowal. Staged construction of the UCDS would see stilling basins implemented early to act as sediment basins during construction. A soil testwork program would be undertaken as part of detailed design to map and identify the presence of dispersive soils within the proposed footprint of the expanded UCDS and measures to control erosion of and sediment migration from these areas included in the design. A detailed erosion and sediment control plan would be prepared ahead of the construction of the UCDS.

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1 INTRODUCTION

1.1 Background

Evolution Mining (Cowal) Pty Limited (Evolution) is the owner and operator of Cowal Gold Operations (CGO), an existing open pit and underground gold mine approximately 38 kilometres (km) north-east of West Wyalong, in the central west region of New South Wales (NSW).

CGO is located on the traditional lands of the Wiradjuri People and is immediately adjacent to the western foreshore of Lake Cowal, which is an ephemeral waterbody. The existing CGO mine is shown at a regional scale in **MAP 1**.

CGO was first approved in 1999, and open pit mining operations commenced in 2005. Underground mining operations were approved in 2021 and development works to enable underground mining are currently underway.

Evolution is seeking approval for the Project to continue the open pit operations by approximately 10 years to 2036 and extend the total mine life by approximately two years to 2042. This Surface Water Assessment report forms part of an Environmental Impact Statement (EIS) for the Open Pit Continuation Project (the Project). It documents the assessment methods, results and the initiatives built into the Project design to avoid or control surface water impacts, as well as the additional mitigation and management measures proposed to address residual impacts which cannot be avoided.

1.2 Project Overview

The Project will involve further development of the existing E42 open pit and the development of open pit mining in three new and adjacent orebodies, known as 'E46', 'GR' and 'E41'. It is noted that the three new and adjacent orebodies are located within existing mining lease ML 1535. No change to the approved maximum ore processing rate of 9.8 Mt per annum is proposed.

A detailed description of the Project is contained in Chapter 4 of EIS and a conceptual Project layout is shown in **MAP 2**. The Project comprises the following key components:

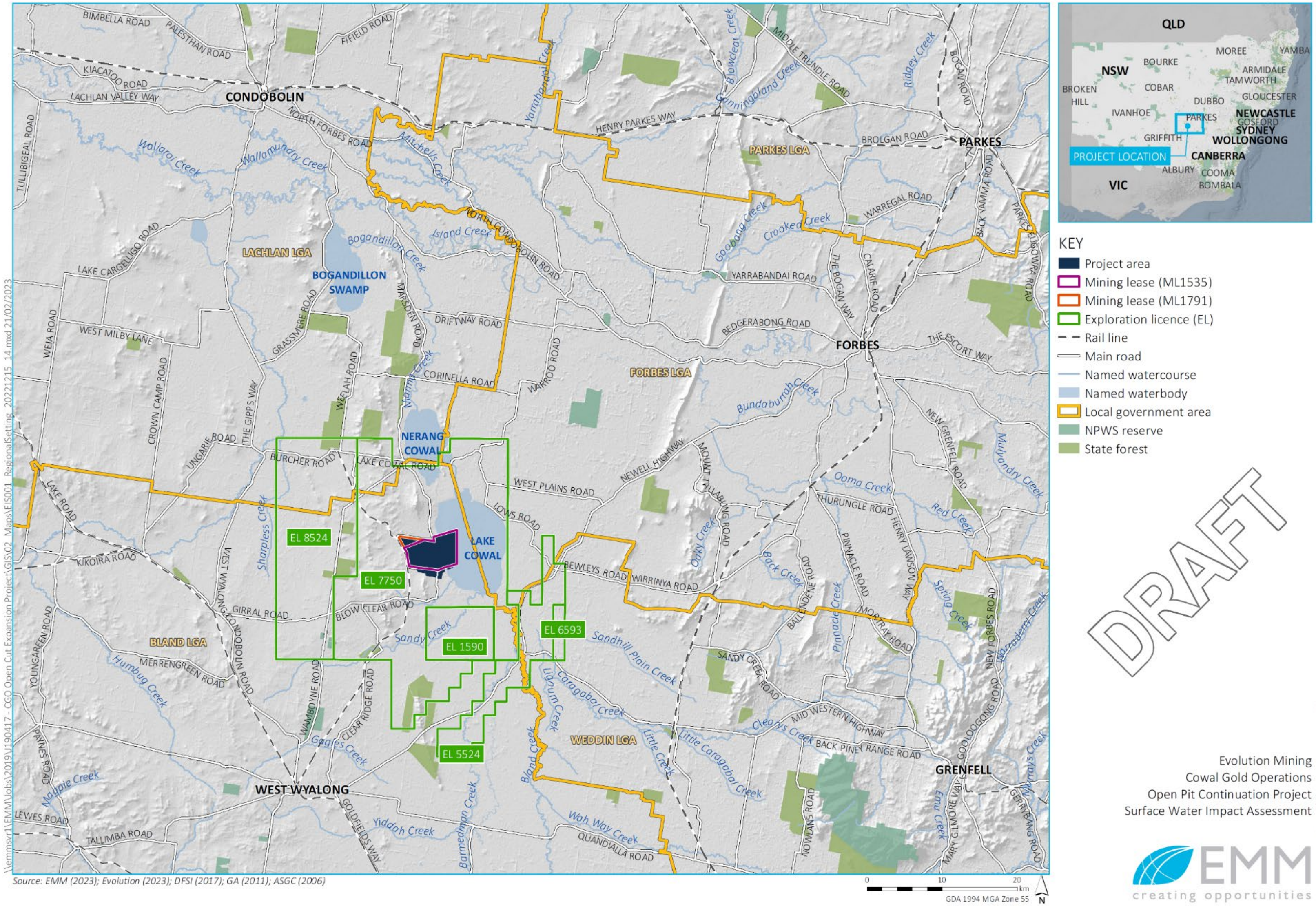
- The continued operation of activities as approved under Development Approval DA14/98 and State Significant Development Approval SSD 10367.
- Development of three new satellite open pits (the 'E46', 'GR' and 'E41' pits) to the north and south of the existing open pit, within the current approved mining lease (ML 1535).
- Extending the existing E42 open pit to the east and south via a 'cutback' (referred to as the Stage I Cutback) within ML 1535.
- Extending open pit mining operations by approximately 10 years to 2036 and total mine life by approximately 2 years to 2042.
- Expansion of the Integrated Waste Landform (IWL) to accommodate life of mine tailings.
- Extension of the lake protection bund (LPB) system to provide continued separation and mutual protection between Lake Cowal and the mine.
- Backfilling of one of the new open satellite pits (E46) with waste rock and establishment of a new waste rock emplacement (WRE) on the backfilled pit to minimise the additional area required for waste rock disposal.
- Expansion of the existing WREs to accommodate additional waste rock.
- Development of additional topsoil and subsoil stockpiles to accommodate materials from pre-stripping the additional disturbance area for reuse during mine rehabilitation.
- Upgrades to existing surface water drainage system, to assist with on-site water management and enhance on-site water conservation.
- Modification of internal site access and haul roads.

- Development of new water storages and relocation of some components of the surface water drainage system.
- Modification and relocation of some existing ancillary mining infrastructure.

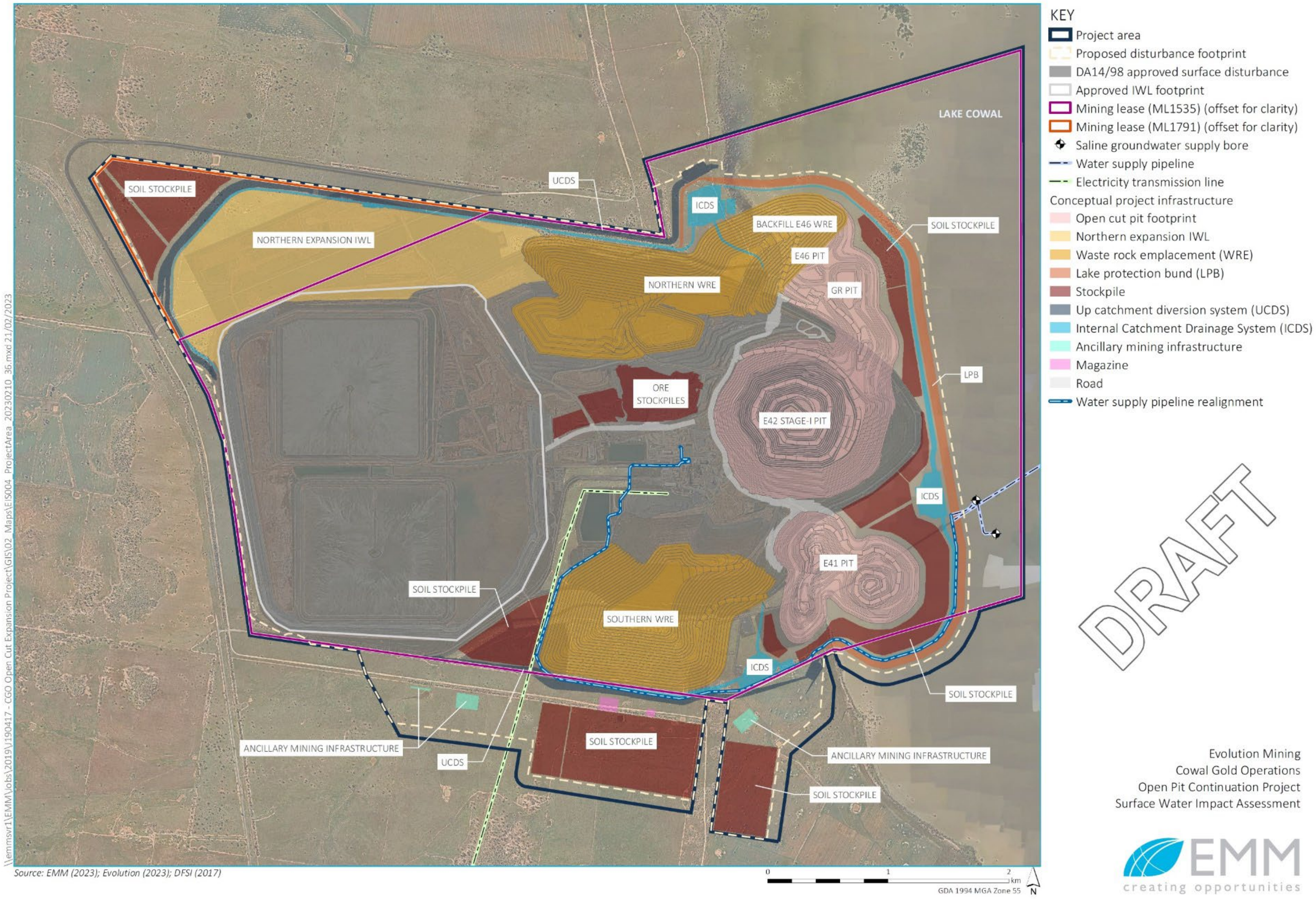
The Project will not change existing maximum ore processing rates or methods, tailings disposal methods, main site access, water supply sources or hours of operation. The Project will also retain the existing open pit mining workforce.

Other than the changes to existing approved activities as set out above, all activities that are currently approved under the existing Ministerial development consents are intended to continue. The existing activities approved under the consents are described in Chapter 3 of the EIS.

MAP 1: REGIONAL SETTING



MAP 2: PROJECT OVERVIEW



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1.3 Assessment requirements

This Surface Water Assessment has been prepared following the appropriate guidelines, policies and industry requirements and following consultation with stakeholders.

The objectives of the NSW *Water Management Act 2000,* which is the principal statute governing management of water resources in NSW, were considered during the assessment. *The Water Management Amendment Act 2014* was passed in 2014 and the provisions commenced on 1 January 2015. The objects of the *Water Management Act 2000* include:

> *…to provide for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations and, in particular:*
>
> (a) *to apply the principles of ecologically sustainable development, and*
>
> (b) *to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality, and*
>
> *(c) to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including:*
>
> *(i) benefits to the environment, and*
>
> *(ii) benefits to urban communities, agriculture, fisheries, industry and recreation, and*
>
> *(iii) benefits to culture and heritage, and*
>
> *(iv) benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water,*
>
> *(d) to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources,*
>
> *(e) to provide for the orderly, efficient and equitable sharing of water from water sources,*
>
> *(f) to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna,*
>
> *(g) to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users,*
>
> *(h) to encourage best practice in the management and use of water.*

The relevant planning instruments, policies, guidelines and plans used as a basis for assessing impacts in this report are listed in **TABLE 1**.

TABLE 1: SUMMARY OF PLANNING INSTRUMENTS, POLICIES, GUIDELINES AND PLANS

1	Water Sharing Plan for the Lachlan Regulated River Water Source 2016	Extraction of water from Lachlan River via the Jemalong Irrigation Channel for use at the CGO has been assessed in accordance with the requirements of the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016*.
2	Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012	Extraction of water from the Western Bland Creek Water Source associated with the CGO has been assessed in accordance with the requirements of the *Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012.*
3	NSW State Rivers and Estuary Policy (NOW)	Potential impacts to Lake Cowal have been assessed with consideration to the NSW State Rivers and Estuary Policy.
4	NSW Government Water Quality and River Flow Objectives (EPA)	The NSW water quality objectives are consistent with the agreed national framework for assessing water quality set out in the Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000a) as listed below.
5	Using the Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000a) and Water Quality Objectives in NSW (DEC, 2006)	The Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000a) has been applied in accordance with this guideline, including consideration of the NSW Government Water Quality and River Flow Objectives (NSW Government, 2022).
6	National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000a)	The surface water quality monitoring results for the existing CGO and surrounding areas have been compared to these guidelines where appropriate.
7	National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ, 2000b)	Surface water quality monitoring would continue to be conducted in accordance with these guidelines.
8	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018)	The ANZG (2018) revision of the Water Quality Guidelines is being progressively updated and is to supersede the ANZECC/ARMCANZ (2000a) Guidelines. The surface water quality monitoring results for the existing CGO and surrounding areas have been compared to these guidelines. Updated default guideline values are yet to be published under the 2018 Guidelines for all constituents and, as such, default values have been adopted from the ANZECC & ARMCANZ (2000a) Guideline as recommended in ANZG (2018) where appropriate.
9	Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC, 2004b)	Surface water quality monitoring would continue to be conducted in accordance with these guidelines.

TABLE 1: SUMMARY OF PLANNING INSTRUMENTS, POLICIES, GUIDELINES AND PLANS (CONTINUED)

10	Managing Urban Stormwater: Soils & Construction (Landcom, 2004) and associated Volume 2E: Mines and Quarries (DECC, 2008)	Existing and planned erosion and sediment controls would be designed in accordance with Landcom (2004) and DECC (2008) to control suspended solids in runoff.
11	Managing Urban Stormwater: Treatment Techniques (EPA, 1997)	Would be considered and applied as relevant to drainage design/management around mine infrastructure area.
12	Managing Urban Stormwater: Source Control (EPA, 1998)	Would be considered and applied as relevant to drainage design/management in mine infrastructure areas.
13	Technical Guidelines: Bunding & Spill Management (now Storing and Handling Liquids: Environmental Protection - Participants Manual [DECC, 2007b]; Environmental Compliance Report: Liquid Chemical Storage, Handling and Spill Management - Part B Review of Best Practice and Regulation [DEC, 2005])	Would be incorporated into standard operating procedures for spill response.
14	NSW Guidelines for Controlled Activities (NOW)	Project assessed as a SSD therefore approvals under Section 89, 90 and 91 of the *Water Management Act 2000* are not required.
15	National Water Quality Management Strategy: Guidelines for Sewerage Systems – Effluent Management (ANZECC/ARMCANZ, 1997)	The existing sewerage systems at CGO (with upgrades as required) would continue to be operated in accordance with the *Environmental Guidelines: Use of Effluent by Irrigation* (DEC, 2004a).
16	National Water Quality Management Strategy: Guidelines for Sewerage Systems – Use of Reclaimed Water (ANZECC/ARMCANZ, 2000c)	The existing sewerage systems at CGO would continue to be operated in accordance with the *Environmental Guidelines: Use of Effluent by Irrigation* (DEC, 2004a) which makes reference to ANZECC/ARMCANZ (2000c).
17	Floodplain Development Manual (NSW Government, 2005)	The potential for the LPB to affect flood levels and/or flood behaviour has been assessed in accordance with the Floodplain Development Manual.
18	Environmental Guidelines: Use of Effluent by Irrigation (DEC, 2004a)	The surface water quality monitoring results from the existing CGO and surrounding areas have been compared to guidelines set in ANZECC/ARMCANZ (2000a) for use of water as irrigation water where relevant.

TABLE 1: SUMMARY OF PLANNING INSTRUMENTS, POLICIES, GUIDELINES AND PLANS (CONTINUED)

19	Guidelines for Practical Consideration of Climate Change (DECC, 2007a)	Considered in the interpretation of post-mine impacts.

ANZECC/ARMCANZ = Australian and New Zealand Environment and Conservation Council/ Agriculture and Resource Management Council of Australia and New Zealand

ANZG = Australian and New Zealand Environment Guidelines

DEC = NSW Department of Environment and Conservation

EPA = NSW Environment Protection Authority

NOW = NSW Office of Water

CRCCH and LWRRDC = Cooperative Research Centre for Catchment Hydrology and Land and Water Resources Research and Development Corporation.

DECC = NSW Department of Environment and Climate Change

DIPNR = NSW Department of Infrastructure, Planning and Natural Resources

The groundwater-related components of the assessment are provided separately in the *Groundwater Impact Assessment* (Appendix H of the EIS). These include a discussion on the *NSW Aquifer Interference Policy 2012* and its implications for the Project.

Under the *Water Management Act 2000*, the *Water Sharing Plan for the Lachlan Regulated River Water Source 2003* commenced on 1 July 2004 and was replaced on 1 July 2016. The *Water Sharing Plan for the Lachlan Regulated River Water Source 2016* covers licensed surface water accessed from the Lachlan River.

Under the *Water Management Act 2000*, the *Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012* commenced on 14 September 2012. The *Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012* applies to all unregulated water sources in the Lachlan catchment which occurs naturally on the surface of the ground, and in rivers, lakes and wetlands.

Within the *Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012,* CGO is located within the Western Bland Creek Water Source, which has a total surface water entitlement of 2,270 megalitres per year (ML/year) divided between 32 surface water licences.

This assessment has been prepared in accordance with requirements set out in the Planning Secretary's Environmental Assessment Requirements (SEARs) for the Project dated 10 June 2022. **TABLE 2** provides a summary of the SEARs (including relevant specific agency advice) related to surface water along with a reference to the relevant section of the report which addresses the requirement.

TABLE 2: SUMMARY OF SEARS AND RELEVANT SECTIONS – SURFACE WATER

Document	Requirements	Report Section
SEARs – General	The Environmental Impact Statement (EIS) meet the minimum form and content requirements as prescribed by Part 8 of the *Environmental Planning and Assessment Regulation 2001*. In particular, the EIS must include but not necessarily be limited to, the following: • An assessment of the likely impacts of the development on the environment, focusing on the specific issues identified below, including:	
	– a description of the existing environment likely to be affected by the development, using sufficient baseline data;	**Section 2.1**
	– an assessment of the likely impacts of all stages of the development, including likely interactions between the development and any other existing, approved or proposed developments in the vicinity including any cumulative impacts, taking into consideration any relevant legislation, environmental planning instruments, guidelines, policies, plans and industry codes of practice;	**Section 8**
	– a description of the measures that would be implemented to avoid, mitigate and/or offset residual impacts of the development, including incident management procedures and the likely effectiveness of these measures, and an assessment of: ■ whether these measures are consistent with industry best practice, and represent the full range of reasonable and feasible mitigation measures that could be implemented; ■ the likely effectiveness of these measures, including performance measures where relevant; and ■ whether contingency plans would be necessary to manage any residual risks; and	**Section 8** and **Section 9**
	– a description of the measures that would be implemented to monitor and report on the environmental performance of the development if it is approved;	**Section 9**
	• a consolidated summary of all the proposed environmental management and monitoring measures.	**Section 9**

TABLE 2: SUMMARY OF SEARS AND RELEVANT SECTIONS – SURFACE WATER (CONTINUED)

Document	Requirements	Report Section
SEARs – Specific Issues (Water)	– description of all works/activities that may intercept, extract, use, divert or receive surface water…;	**Section 4**
	– details of all water take for the life of the development. This is to include water taken directly and indirectly, and the relevant water source where water entitlements are required to account for the water take. If the water is to be taken from an alternative source confirmation should be provided by the supplier that the appropriate volumes can be obtained;	This section, **Section 3.1** and **Section 6.3**
	– details of Water Access Licences (WALs) held to account for any take of water where required, or demonstration that WALs can be obtained prior to take of water occurring. This should include an assessment of the current market depth where water entitlement is required to be purchased;	**Section 3.1**
	– assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure…;	**Section 8** Groundwater Impact Assessment, Appendix H of the EIS
	– assessment of impacts of the development on the lake hydrology, geomorphic stability and water quality, and associated impacts on aquatic ecology of Lake Cowal;	**Section 8** Aquatic Ecology Assessment, Appendix K of the EIS
	– a detailed and consolidated site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply and transfer infrastructure and water storage structures, and measures to minimise water use;	**Section 6.1, Section 6.2**, **Section 6.3** and **Section 6.4**
	– a description of the measures proposed, including monitoring activities and methodologies, to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo;	Water Licensing Strategy, Appendix I of the EIS
	– a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts;	**Section 4.1**, **Section 8** and **Section 9** Groundwater Impact Assessment, Appendix H of the EIS

	– a description of construction erosion and sediment controls, how the impacts of the development on areas of erosion, salinity or acid-sulphate risk or erodible soils types would be managed and any contingency requirements to address residual impacts;	**Section 8.1.2, Section 8.1.3** and **Section 8.1.4**
	– identification and impact assessment of all works located on waterfront land including consideration of the Guidelines for Controlled Activities on Waterfront Land (NRAR 2018);	**Section 8**
	– an assessment of any likely flooding impacts of the development	**Section 6.5.2**

TABLE 2: SUMMARY OF SEARS AND RELEVANT SECTIONS – SURFACE WATER (CONTINUED)

Document	Requirements	Report Section
EPA - Water	Provide details of the project that are essential for predicting and assessing impacts to waters including: a) the quantity and physio-chemical properties of all potential water pollutants and the risks they pose to the environment and human health, including the risks they pose to Water Quality Objectives in the ambient waters (as defined on http://www.environment.nsw.gov.au/ieo/index.htm, using technical criteria derived from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, ANZECC 2000)	**Section 2.3**, **Section 6.5.3**, **Section 8.1.2**, **Section 8.1.3** and **Section 8.2**
	b) the management of discharges with potential for water impacts	**Section 6.5.3**
	c) drainage works and associated infrastructure; land-forming and excavations; working capacity of structures; and water resource requirements of the proposal.	**Section 4**, **Section 3.2** and **Section 4.1.1.1**
	Outline site layout, demonstrating efforts to avoid proximity to water resources (especially for activities with significant potential impacts e.g. effluent ponds) and showing potential areas of modification of contours, drainage etc	**Section 3.1**, **Section 4.1**
	Outline how total water cycle considerations are to be addressed showing total water balances for the development (with the objective of minimising demands and impacts on water resources). Include water requirements (quantity, quality and source(s)) and proposed storm and wastewater disposal, including type, volumes, proposed treatment and management methods and re-use options	**Section 6.1**, **Section 6.2**, **Section 6.3** and **Section 6.4**
	Describe the catchment including proximity of the development to any waterways and provide an assessment of their sensitivity/significance from a public health, ecological and/or economic perspective. The Water Quality and River Flow Objectives on the website: http://www.environment.nsw.gov.au/ieo/index.htm should be used to identify the agreed environmental values and human uses for any affected waterways. This will help with the description of the local and regional area.	**Section 2.1, Section 2.3**
	Describe existing surface and groundwater quality – an assessment needs to be undertaken for any water resource likely to be affected by the proposal and for all conditions (e.g. a wet weather sampling program is needed if runoff events may cause impacts).	**Section 2.3** Groundwater Impact Assessment, Appendix H of the EIS
	Provide site drainage details and surface runoff yield	**Section 3** and **Section 4**
	State the ambient Water Quality and River Flow Objectives for the receiving waters. These refer to the community's agreed environmental values and human uses endorsed by the Government as goals for the ambient waters. These environmental values are published on the website: http://www.environment.nsw.gov.au/ieo/index.htm. The EIS should state the environmental values listed for the catchment and waterway type relevant to your proposal.	**Section 2.3** (River Flow Objectives N/A)

TABLE 2: SUMMARY OF SEARS AND RELEVANT SECTIONS – SURFACE WATER (CONTINUED)

Document	Requirements	Report Section
EPA - Water	State the indicators and associated trigger values or criteria for the identified environmental values. This information should be sourced from the ANZECC 2000 Guidelines for Fresh and Marine Water Quality (http://www.environment.gov.au/water/publications/quality/nwqms-guidelines-4-vol1.html)	**Section 2.3**
	Describe the state of the receiving waters and relate this to the relevant Water Quality and River Flow Objectives (i.e. are Water Quality and River Flow Objectives being achieved?). Proponents are generally only expected to source available data and information. However, proponents of large or high risk developments may be required to collect some ambient water quality / river flow / groundwater data to enable a suitable level of impact assessment. Issues to include in the description of the receiving waters could include: a) lake or estuary flushing characteristics b) specific human uses (e.g. exact location of drinking water offtake) c) sensitive ecosystems or species conservation values d) a description of the condition of the local catchment e.g. erosion levels, soils, vegetation cover, etc e) an outline of baseline groundwater information, including, but not restricted to, depth to watertable, flow direction and gradient, groundwater quality, reliance on groundwater by surrounding users and by the environment f) historic river flow data where available for the catchment.	**Section 2** Groundwater Impact Assessment, Appendix H of the EIS Aquatic Ecology Assessment, Appendix K of the EIS
	No proposal should breach clause 120 of the Protection of the Environment Operations Act 1997 (i.e. pollution of waters is prohibited unless undertaken in accordance with relevant regulations).	**Section 8**
	Identify and estimate the quantity of all pollutants that may be introduced into the water cycle by source and discharge point including residual discharges after mitigation measures are implemented	**Section 6.5.3**
	Include a rationale, along with relevant calculations, supporting the prediction of the discharges	**Section 6.5.3**
	Describe the effects and significance of any pollutant loads on the receiving environment. This should include impacts of residual discharges through modelling, monitoring or both, depending on the scale of the proposal. Determine changes to hydrology (including drainage patterns, surface runoff yield, flow regimes, wetland hydrologic regimes and groundwater).	**Section 6.5.2**, **Section 8** and **Section 9** Aquatic Ecology Assessment, Appendix K of the EIS
	Describe water quality impacts resulting from changes to hydrologic flow regimes (such as nutrient enrichment or turbidity resulting from changes in frequency and magnitude of stream flow).	**Section 6.5.1**
	Identify potential impacts associated with geomorphological activities with potential to increase surface water and sediment runoff or to reduce surface runoff and sediment transport. Also consider possible impacts such as bed lowering, bank lowering, instream siltation, floodplain erosion and floodplain siltation.	**Section 4.1.1.5** **Section 6.5.2** **Section 8**

TABLE 2: SUMMARY OF SEARS AND RELEVANT SECTIONS – SURFACE WATER (CONTINUED)

Document	Requirements	Report Section
EPA - Water	The significance of the impacts listed above should be predicted. When doing this it is important to predict the ambient water quality and river flow outcomes associated with the proposal and to demonstrate whether these are acceptable in terms of achieving protection of the Water Quality and River Flow Objectives. In particular the following questions should be answered: a) will the proposal protect Water Quality and River Flow Objectives where they are currently achieved in the ambient waters; and b) will the proposal contribute towards the achievement of Water Quality and River Flow Objectives over time, where they are not currently achieved in the ambient waters.	**Section 8**
	Where a licensed discharge is proposed, provide the rationale as to why it cannot be avoided through application of a reasonable level of performance, using available technology, management practice and industry guidelines	Section 5.4 of the EIS
	Where a licensed discharge is proposed, provide the rationale as to why it represents the best environmental outcome and what measures can be taken to reduce its environmental impact	Section 5.4 of the EIS, **Section 6.5.3 and Section 8.1.3**
	Reference should be made to Managing Urban Stormwater: Soils and Construction (Landcom, 2004), Guidelines for Fresh and Marine Water Quality (ANZG 2018), Environmental Guidelines: Use of effluent by Irrigation (DEC, 2004a).	**Section 8.1.4**
	Outline stormwater management to control pollutants at the source and contain them within the site. Also describe measures for maintaining and monitoring any stormwater controls.	**Section 4.1**
	Outline erosion and sediment control measures directed at minimising disturbance of land, minimising water flow through the site and filtering, trapping or detaining sediment. Also include measures to maintain and monitor controls as well as rehabilitation strategies	**Section 8.1.3** and **Section 8.1.4**
	Describe waste water treatment measures that are appropriate to the type and volume of waste water and are based on a hierarchy of avoiding generation of waste water; capturing all contaminated water (including stormwater) on the site; reusing/recycling waste water; and treating any unavoidable discharge from the site to meet specified water quality requirements	Section 3.11 of the EIS
	Outline pollution control measures relating to storage of materials, possibility of accidental spills (e.g. preparation of contingency plans), appropriate disposal methods, and generation of leachate	Section 4.2.6 of the CGO Water Management Plan (WMP) (Evolution, 2022a)
	Describe hydrological impact mitigation measures including: a) site selection (avoiding sites prone to flooding and waterlogging, actively eroding or affected by deposition) b) minimising runoff c) minimising reductions or modifications to flow regimes	**Section 4.1.1.4, Section 4.1.1.5** and Section 4.10 of the EIS

TABLE 2: SUMMARY OF SEARS AND RELEVANT SECTIONS – SURFACE WATER (CONTINUED)

Document	Requirements	Report Section
DPE - BCD	6. The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including: a. Flood prone land. b. Flood planning area, the area below the flood planning level. c. Hydraulic categorisation (floodways and flood storage areas). d. Flood hazard.	**Section 6.5.2** **Appendix B**
	7. The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 5% Annual Exceedance Probability (AEP), 1% AEP flood levels and the probable maximum flood, or an equivalent extreme event.	**Section 4.1.1.5**, **Section 6.5.2** and **Appendix B** Note there was only a small modelled impact on flood levels for the 1% AEP hence additional modelling for the 5% AEP was not warranted.
	8. The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios: a. Current flood behaviour for a range of design events as identified in 7 above. This includes the 0.5% and 0.2% AEP year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.	**Section 6.5.2** Note that the 1% AEP and 0.1% AEP were modelled which cover this range of events.
	9. Modelling in the EIS must consider and document: a. Existing council flood studies in the area and examine consistency to the flood behaviour documented in these studies. b. The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood. c. Impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazards and hydraulic categories. d. Relevant provisions of the NSW Floodplain Development Manual 2005.	**Section 6.5.2**

TABLE 2: SUMMARY OF SEARS AND RELEVANT SECTIONS – SURFACE WATER (CONTINUED)

Document	Requirements	Report Section
DPE - BCD	10. The EIS must assess the impacts on the proposed development on flood behaviour, including: a. Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure. b. Consistency with Council Floodplain Risk Management Plans. c. Consistency with any Rural Floodplain Management Plans. d. Compatibility with the flood hazard of the land. e. Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land. f. Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site. g. Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses. h. Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the SES and Council. i. Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the SES and Council. j. Emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the SES.	**Section 4.1.1.5**, **Section 6.5.2** and **Appendix B**
DPE - Water	The identification of an adequate and secure water supply for the life of the project. This includes confirmation that water can be sourced from an appropriately authorised and reliable supply. This is also to include an assessment of the current market depth where water entitlement is required to be purchased.	**Section 6.3.2**
	A detailed and consolidated site water balance.	**Section 6.1**, **Section 6.2**, **Section 6.3** and **Section 6.4**
	Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts.	**Section 8**

		Groundwater Impact Assessment, Appendix H of the EIS
	Proposed surface and groundwater monitoring activities and methodologies.	**Section 9** Groundwater Impact Assessment, Appendix H of the EIS
	Consideration of relevant legislation, policies and guidelines, including the NSW Aquifer Interference Policy (2012), the Guidelines for Controlled Activities on Waterfront Land (2018) and the relevant Water Sharing Plans	This section

1.4 Terminology

A summary of the key terminology used throughout this assessment is provided in below.

1. **Cowal Gold Operations (CGO) –** comprises both the existing open pit mine, underground mine, processing facility, IWL, WRE areas, ore stockpiles and ancillary infrastructure.
2. **The Project area –** outlines the area that is the subject of the development application as shown in Figure 1.2.
3. **Existing and approved disturbance area** – areas that are disturbed and/or approved to be disturbed under the current development consents that apply to CGO.
4. **Additional Disturbance Area** – the areas that will be disturbed by the Project that are outside of the existing and approved disturbance area.
5. **Project disturbance area** – this area is a combination of the additional disturbance area and the existing and approved disturbance area.

1.5 Summary of Relevant Findings of Previous Environmental Approvals Documentation

Cowal Gold Project EIS (North Limited, 1998).

- Surface water on the mine site was to be permanently isolated from Lake Cowal by the Up-Catchment Diversion System (UCDS) and lake isolation system, directing runoff from areas unaffected by mining around the perimeter of the site, and an Internal Catchment Drainage System (ICDS), capturing all site runoff and seepage for re-use in the processing plant. In the longer term, the ICDS would direct site runoff to the final void which would become a permanent sink for groundwater and surface runoff.
- The long term final void water balance was such that the final void was predicted to not spill under any conceivable climate conditions.
- The operational water balance prediction was for a moderately negative site water balance. External water supply would be required from the Bland Creek Paleochannel borefield.
- Mine waste rock material was predicted to have the potential to generate moderately saline seepage, particularly during the active mining phase. During the active mining phase, all runoff and seepage from the WREs would be contained within the ICDS.
- The tailings storages were designed to be able to contain runoff from a 0.1% AEP rainfall event. Any overflow or seepage would be contained within the ICDS, ultimately reporting to the open pit.
- In the longer term, it was predicted there would be little potential for movement of surface water or groundwater from the WREs or of seepage from the tailings storages.
- Use of suitable soils and vegetation in rehabilitation of WREs and the tailings storages was predicted to result in low salt fluxes in surface waters consistent with regional runoff water quality.

Cowal Gold Mine Extension Modification Hydrological Assessment (Gilbert & Associates, 2013) – Modification 11.

- There was no change proposed to the UCDS, directing runoff from areas unaffected by mining around the perimeter of the site, with the ICDS continuing to capture all site runoff and seepage for re-use in the processing plant.
- In order to effectively manage water within the ICDS and maintain water supply, some minor changes were proposed, including some re-direction of internal drainage from constructed mine landforms and construction of an additional raw water storage – D10.
- Augmentation of the external water supply pipeline (across Lake Cowal) was proposed increasing its capacity from 11 ML/day to 14 ML/day. This would also involve construction of another pump station which would be located outside the bounds of the Lake Cowal

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inundation limits and away from drainage paths. Any potential impacts of the pump station construction would be mitigated by appropriate design.

- Water balance modelling indicated that there were no external water supply shortfalls simulated, with the median peak annual water supply requirement from licensed Lachlan River extraction peaking at 2,924 ML. No overflows were predicted in the water balance model from either of the contained water storages (D1 and D4) that could overflow to Lake Cowal.
- Final void water balance modelling indicated that final void equilibrium water levels would be lower than those predicted in North Limited (1998) and would be approximately 80 m below spill level.
- It was concluded that there would be a low risk of more than a negligible hydrological impact on Lake Cowal due to the Modification.

Cowal Gold Operations Mine Life Modification Hydrological Assessment (HEC, 2016) – Modification 13.

- There was no change proposed to the UCDS, directing runoff from areas unaffected by mining around the perimeter of the site, with the ICDS continuing to capture all site runoff and seepage for re-use in the processing plant.
- In order to effectively manage water within the ICDS and maintain water supply, some minor changes were proposed, including some re-direction of internal drainage from constructed mine landforms.
- The two Tailings Storage Facilities (TSFs) were to be progressively raised for the remainder of the mine life, with the area between the two TSFs also used for storage of tailings.
- Two campaigns of oxide ore were to be processed – in 2020 and from 2030 to 2032. Due to the nature of the oxide ore, during these times the demand for process plant makeup water would increase.
- Water balance modelling indicated there were no external water supply shortfalls simulated, with the median peak annual water supply requirement from licensed Lachlan River extraction peaking at 2,853 ML. No overflows were predicted in the water balance model from either of the contained water storages (D1 and D4) that could overflow to Lake Cowal.
- Final void water balance modelling indicated that final void equilibrium water levels would be lower than those predicted in North Limited (1998) and would be more than approximately 80 m below spill level.
- It was concluded that there would be a low risk of more than a negligible hydrological impact on Lake Cowal due to the Modification.

Cowal Gold Operations Processing Rate Modification Hydrological Assessment (HEC, 2018) – Modification 14.

- The ore processing rate was proposed to be increased from 7.5 million tonnes per annum (Mtpa) to up to 9.8 Mtpa through secondary crushing and other upgrades, with concurrent processing of oxide and primary ore.
- Increased annual extraction of water from CGO's external water supply sources and duplication of the existing water supply pipeline across Lake Cowal were proposed to facilitate the increased water demand at the processing plant.
- The two TSFs were to be combined to form one larger TSF which would also accommodate mine waste rock (referred to as the IWL).
- Relocation of water management infrastructure (i.e. UCDS and approved location for contained water storage D10) and other ancillary infrastructure (e.g. internal roads and soil and ore stockpiles) elsewhere within ML 1535 and ML 1791 were proposed.
- Water balance modelling indicated that non-negligible (>20 ML) supply shortfalls were simulated in 13% of the 128 climatic sequences simulated and were predicted to occur either towards the end of the early stage of the IWL (2023 to 2024) or towards the end of the planned predominately oxide ore processing period (2031).

- Based on the modelling results for the median rainfall sequence, the demand from external sources (the eastern saline borefield, the Bland Creek Paleochannel borefield and licensed extraction from Lachlan River water entitlements) averaged 4,247 ML/year, with the median annual water supply requirement from licensed Lachlan River extraction peaking at 2,853 ML.
- No overflows were predicted in the water balance model from either of the contained water storages (D1 and D4) that could overflow to Lake Cowal, contingent upon pumped dewatering of these storages in between rainfall events.
- It was concluded that there would be a low risk of more than a negligible hydrological impact on Lake Cowal due to the Modification.

Cowal Gold Operations Underground Mine Project Hydrological Assessment and Modification 16 (HEC, 2020)

- Proposed development of an underground mine extending beneath and to the north of the existing open pit.
- Proposed development of a tailings paste fill plant, delivery of paste fill via a borehole and backfilling of underground stopes with the paste.
- Increased maximum water demand to accommodate processing of primary and oxide ore from the proposed underground mine and open cut pit operations.
- Based on the modelling results for the median rainfall sequence, the demand from external sources (the eastern saline borefield, the Bland Creek Paleochannel borefield and licensed extraction from Lachlan River water entitlements) averaged 2,744 ML/year, with the median annual water supply requirement from licensed Lachlan River extraction peaking at approximately 2,500 ML. The reductions compared with Modification 14 were predominately due to the reduction in processing rates of oxide ore from the open cut operations.
- No overflows were predicted in the water balance model from either of the contained water storages (D1 and D4) that could overflow to Lake Cowal, contingent upon pumped dewatering of these storages in between rainfall events.
- Final void water balance model predictions indicate that the final void would reach a peak equilibrium water level more than 60 m below the spill level (i.e. the final void would be contained) and that the final void would remain a groundwater sink.
- No impact on inflows to Lake Cowal or the water quality of Lake Cowal were expected to occur because proposed surface changes were to be contained within the current approved disturbance area.

2 HYDROMETEOROLOGICAL SETTING

2.1 Regional Hydrology

CGO is located on the western side of Lake Cowal (refer **MAP 2**) and extends into the natural extent of Lake Cowal. Lake Cowal is an ephemeral, freshwater lake that forms part of the Wilbertroy-Cowal Wetlands which are located on the Jemalong Plain. Lake Cowal is in the lower reaches of the Bland Creek catchment. It also receives periodic inflows from the Lachlan River during periods of high flow[1] when flood waters enter Lake Cowal via two main breakout channels from the north-east. Breakout from the Lachlan River to Lake Cowal occurred in late 2010, in the first half of 2012, in 2016, late 2021 and late 2022 but had not occurred prior to this since 1998. According to site monitoring data, Lake Cowal was relatively dry from July 2018 to August 2020.

Lake Cowal is a large oval shaped lake which, when full, occupies an area of some 105 square kilometres (km^2), holds some 150 gigalitres of water and has a depth of approximately 4 m when full. It overflows to Nerang Cowal, a smaller lake to the north. When flows are sufficient, the lakes ultimately overflow and drain into the Lachlan River via Bogandillon Creek. The Lachlan River is the major regional surface drainage, forming part of the Murray-Darling Basin. Flows in the Lachlan River near Lake Cowal are regulated by releases from Wyangala Dam.

The area surrounding CGO is drained by ephemeral drainage lines which flow to Lake Cowal. Bland Creek and all other tributaries of Lake Cowal are also ephemeral. Bland Creek drains a catchment of approximately 9,390 km^2 which ultimately reports to Lake Cowal at the northern end of the creek (southern end of Lake Cowal). Flow records from a gauging station[2] on Bland Creek indicate that runoff is low, averaging about 5% of rainfall.

2.2 Meteorology

The region experiences a semi-arid climate which is dominated by cool, higher rainfall conditions in winter and hot, relatively dry conditions in summer. **TABLE 3** summarises regional monthly and annual rainfall totals from Bureau of Meteorology (BoM) stations (Wyalong, Ungarie Post Office [PO] and Burcher PO), as well as rainfall recorded at CGO since 2007.

Long term regional rainfall averages[3] 468 millimetres (mm) per annum. Average annual rainfall recorded at CGO from 2007 to July 2022 averaged 456 mm, which compares with an annual average of 466 mm recorded at Wyalong PO and 495 mm at Burcher PO for the same period.

TABLE 4 summarises regional monthly and annual pan evaporation totals from the nearest BoM pan evaporation stations. The nearest BoM pan evaporation station is located at the Condobolin Agricultural Research Station, approximately 65 km north of CGO. Annual pan evaporation averages 1,972 mm at this station.

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1 Inflows from the Lachlan River occur when flows at Jemalong Weir exceed 15,000 to 20,000 ML/day – North Limited (1998).

2 GS 412171 (Bland Creek at Marsden), which operated from 1998 to 2004.

3 From SILO Point Data - https://www.longpaddock.qld.gov.au/silo/point-data/ for location 33° 39'S 147° 24'E. Refer also Section 6.1.2.

TABLE 3: REGIONAL RAINFALL DATA SUMMARY

	Wyalong PO (073054*)		Ungarie PO** (050040*)		Burcher PO (050010*)		CGO	
	Jun-1895 – Dec-2022		Oct-1895 – Jul-2021		Jun-1937 – Dec-2022		Jan-2007 – Jul-2022	
	Mean Total (mm)	Mean No. Raindays	Mean Total (mm)	Mean No. Raindays	Mean Total (mm)	Mean No. Raindays	Mean Total (mm)	Mean No. Raindays
Jan	43.1	4.3	40.6	3.3	45.4	3.8	40.0	7.1
Feb	38.8	3.9	38.0	3.3	42.3	3.5	44.4	6.5
Mar	38.2	4.1	38.5	3.4	42.1	3.6	50.7	7.4
Apr	34.4	4.1	31.9	3.3	34.5	3.6	30.8	5.3
May	39.2	5.8	36.1	4.7	37.5	5.2	30.8	7.4
Jun	43.4	7.7	41.3	5.9	36.9	6.0	41.3	11.9
Jul	42.3	8.5	36.6	6.2	38.9	6.8	33.6	13.5
Aug	39.0	8.0	34.3	6.0	37.9	6.0	23.3	9.3
Sep	36.3	6.4	31.7	4.8	35.4	4.8	29.0	7.0
Oct	45.4	6.1	38.8	4.8	46.1	5.1	31.2	7.9
Nov	38.0	5.0	35.6	3.8	39.4	4.5	47.8	8.2
Dec	44.4	4.8	40.6	3.6	42.1	3.7	51.5	8.2
Annual	483.5	68.7	461.7	53.1	479.4	56.6	455.7	99.6

* BoM Station Number.
** Data contains numerous gaps in recent years and early in the 20th century.
Note: Statistically, the sum of monthly means does not necessarily equal the annual mean.

TABLE 4: REGIONAL EVAPORATION DATA SUMMARY

	Pan evaporation Condobolin Agricultural Research Station (050052*)	Pan evaporation Condobolin Soil Conservation (050102*)	Pan evaporation Cowra Research Station (063023*)
	1973 – 2022	1971 – 1985	1965 – 2011
	Mean Total (mm)	Mean Total (mm)	Mean Total (mm)
Jan	313.1	235.6	229.4
Feb	248.6	200.6	180.8
Mar	207.7	161.2	148.8
Apr	126.0	102.0	90.0
May	74.4	58.9	49.6
Jun	48.0	36.0	30.0
Jul	49.6	43.4	34.1
Aug	77.5	68.2	49.6
Sep	117.0	96.0	78.0
Oct	182.9	142.6	120.9
Nov	234.0	189.0	162.0
Dec	297.6	235.6	217.0
Annual	1,972	1,571	1,388

* BoM Station Number.
Data obtained from BoM Climate Data Online; http://www.bom.gov.au/climate/data/, accessed on 1 February 2023.
Note: Statistically, the sum of monthly means does not necessarily equal the annual mean.

2.3 Water Quality

2.3.1 Lake Cowal

Baseline water quality reported in the Cowal Gold Project EIS (North Limited,1998) was based on results of an intensive sampling program conducted between 1991 and 1995 and included 34 monitoring locations along four transects across Lake Cowal. This has been supplemented by monitoring campaigns undertaken (when the lake re-filled) from November 2010 through to July 2014, from August 2016 to July 2018 and from December 2021 to February 2022[4]. Sampling of lake inflow from Sandy Creek and Bland Creek was also undertaken from November 2010 through to July 2014 and from August 2016 to January 2017 when sufficient flow permitted. **TABLE 5** summarises the surface water monitoring program for Lake Cowal as detailed in the CGO Water Management Plan (Evolution, 2022a). Monitoring locations are shown in **MAP 3**.

TABLE 5: LAKE COWAL SURFACE WATER MONITORING PROGRAM

CGO Component	Site	Monitoring Frequency	Parameter/Analyte
Lake Cowal Chemical Monitoring	P1, P3, L1, C1	Weekly and following rainfall events of 20 mm or greater in a 24 hour period[5].	Suspended Solids, electrical conductivity (EC), pH.
	Lake Cowal transect sampling sites: • Lachlan Floodway transect – L1, L2, L5, L8, L9, L11 and L13 • Irrigation Channel transect – I1, I3 & I4 • East Shore transect – E1, E3 & E5 • Bland Creek transect – B1, B2, B4 & B6 • CGO transect – P1 to P3 • Control sites transect – C1 to C3	Monthly[6]	EC, pH, turbidity, dissolved oxygen, temperature, lake water level.
		Quarterly[6]	Suspended Solids, alkalinity, cations and anions. Total iron, calcium, magnesium, potassium, sodium, chloride, sulphate, total phosphate, ortho-phosphate, ammonium, nitrogen as nitrate and nitrite. Total and dissolved antimony, arsenic, cadmium, copper, molybdenum, nickel, lead, selenium and zinc.
Lake Cowal Inflow Sites	Lake inflow sites: Lachlan Floodway, Irrigation Channel, Bland Creek and Sandy Creek inflow sites	Monthly[6]	EC, pH, turbidity, dissolved oxygen, temperature.
		Quarterly[6]	Suspended Solids, alkalinity, cations, anions. Total iron, calcium, magnesium, potassium, sodium, chloride, sulphate, total phosphate, ortho-phosphate, ammonium, nitrogen as nitrate and nitrite. Total and dissolved antimony, arsenic, cadmium, copper, molybdenum, nickel, lead, selenium and zinc.

[4] Evolution advises that between 2014 and August 2016 and from July 2018 to November 2021 lake water levels were too low (or the lake dry) for effective sampling to occur.

[5] When lake water is present and the lake water level is at or above 204.5 mRL.

The results of monitoring since 2010 have been summarised in **TABLE 6** and **TABLE 7**. The water quality assessment has been conducted using monitoring data for Lake Cowal recorded over the period November 2010 to February 2022 when the lake levels were sufficient to enable sampling. Results from the assessment period are compared to relevant default guideline values published in ANZECC/ARMCANZ (2000a) and ANZG (2018)[6] and with values obtained from sampling programs conducted during the baseline period prior to commencement of mining operations (1991 to 1995).

Average total nitrogen measured at the lake transect sites was 489 micrograms per litre (µg/L), which was higher than the maximum level recorded during the baseline period (257 µg/L) and the ANZECC/ARMCANZ (2000a) default guideline value for freshwater lakes (350 µg/L). It was, however, lower than the average concentration in lake inflows from Bland Creek and Sandy Creek over the monitoring period (807 µg/L).

Average total phosphorus measured at the lake transect sites was 390 µg/L, which was lower than the baseline data (range 970 to 2,640 µg/L) and lower than the average total phosphorus recorded at the lake inflow sites (Bland Creek and Sandy Creek – 468 µg/L). It was however higher than the ANZECC/ARMCANZ (2000a) default guideline value for freshwater lakes (10 µg/L).

Average pH measured at the lake transect sites was 8.0, which was slightly lower than the average recorded over the baseline period (pH 8.48), but slightly higher than the average recorded at the lake inflow sites (pH 7.5). The range of pH levels recorded at the lake transect sites (pH 5.56 to 11.42)[7] was greater than that recorded at the lake inflow sample locations (pH 5.78 to 9.39) and outside the default guideline value range (pH 6.5 to 8.0) published in ANZECC/ARMCANZ (2000a). The range measured at the lake transect sites during the baseline period was pH 7.72 to 9.8 (which is noted to also be above the upper default guideline value published in ANZECC/ARMCANZ [2000a]).

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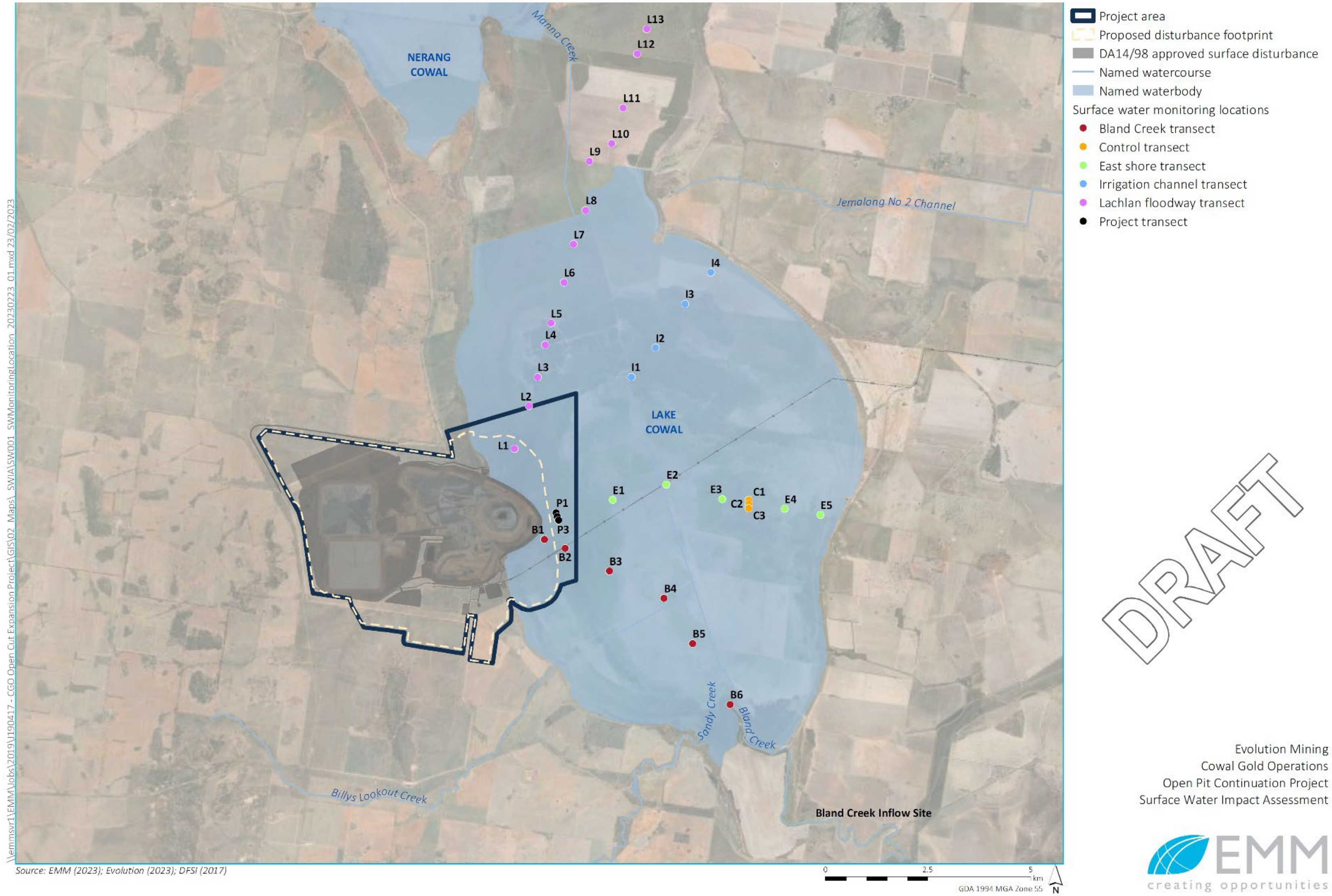
[6] The ANZG (2018) revision of the Water Quality Guidelines is being progressively updated and is to supersede the ANZECC/ARMCANZ (2000a) Guidelines. The surface water quality monitoring results for the existing CGO and surrounding areas have been reviewed against ANZG (2018) where updated default guideline values are available. For constituents in which revised default guideline values are yet to be published under the ANZG (2018), default values have been adopted from the ANZECC & ARMCANZ (2000a) Guideline as recommended in ANZG (2018).

[7] Two field pH values greater than 10 were recorded in late February 2011. Ninety percent of recorded pH values were less than 8.8.

MAP 3: EXISTING SURFACE WATER MONITORING LOCATIONS



Source: EMM (2023); Evolution (2023); DFSI (2017)

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TABLE 6: SUMMARY OF LAKE COWAL WATER QUALITY – GENERIC PARAMETERS

Parameter (Units as stated)	Default Trigger Values[1]		Lake Cowal Baseline Water Quality (1991-1995)	Baseline Data Inflow Sites Only (1991-1992, Dec 93)	Baseline Data Lake Transects (1991-1995)	Lake Cowal Transect Monitoring (Nov 2010 – February 2023)	Lake Cowal Inflow Sites (Nov 2010 – July 2022)
	Protection of Aquatic Ecosystems	Stock Water Protection Low Risk Trigger Value					
Total N (µg/L)	350 µg/L for SE Australia Freshwater Lakes and Reservoirs	No trigger values given	Not available	660 to 2,610 (1,200**)	61 to 257 (136**)	10 to 5,620 (671**)	10 to 2,700 (1,317**)
Total P (µg/L)	10 µg/L for SE Australia Freshwater Lakes and Reservoirs	No trigger values given	Not available	29 to 216 (79**)	970 to 2,640 (1,667**)	10 to 3,950 (386**)	70 to 1,860 (496*)
pH (pH units) - field	6.5 to 8.0 pH for SE Aust. Freshwater Lakes and Reservoirs	No trigger values given	8.27 to 8.67	7.6 to 8.2	7.72 to 9.8 (8.48**)	5.56 to 11.42 (8.01**)	5.78 to 9.39 (7.5**)
EC (measured in field)/TDS	EC 20-30 µS/cm for SE Australia Freshwater Lakes and Reservoirs	TDS triggers 2,500 mg/L dairy cattle, 5,000 mg/L sheep	222 to 1,557 µS/cm	382 to 1,260 µS/cm (726**)	160 to 3,130 µS/cm (881**)	2.09 to 1,801 µS/cm (382**)	34 to 871 µS/cm (218**)
Turbidity (NTU – measured in field)/TSS (mg/L)^	1 to 20 NTU Turbidity Triggers for slightly disturbed ecosystems - lakes	No triggers given	22 to 224 mg/L	0.62 to 234 (70.5**) NTU^ 0.54 to 150 (37.9**) mg/L TSS	7 to 566 (111**) NTU^ 13 to 271 (103.4**) mg/L TSS	7.8 to 2,562 (287**) NTU^ 2 to 1,210 (101**) mg/L TSS	13.4 to 2,819 (356**) NTU^ 4 to 640 (113**) mg/L TSS

mg/L: milligrams per litre; µg/L: micrograms per litre.
EC: electrical conductivity.
TDS: total dissolved solids.
TSS: total suspended solids.
NTU: nephelometric turbidity units.
N: nitrogen.
P: phosphorus.
SE: south-east.
^ Catchments with highly dispersive soils will have high turbidity (ANZECC/ARMCANZ, 2000a).
** Average Value.
[1] Default guideline values were adopted from ANZECC/ARMCANZ (2000a). The NSW Water Quality Objectives do not differ from the ANZECC/ARMCANZ (2000a) Guidelines.
Note: pH, turbidity and EC data were derived from field samples, all other parameters were derived from laboratory analysis.
EC in lakes and reservoirs is generally low but will vary depending on catchment geology (ANZECC/ARMCANZ, 2000a).

TABLE 7: SUMMARY OF LAKE COWAL WATER QUALITY – METALS

Parameter (Units as stated)	Default Trigger Values[1]					Lake Cowal Baseline Water Quality (1991-1995)	Baseline Data Inflow Sites Only (1991-1992, Dec 93)	Baseline Data Lake Transects (1991-1995)	Lake Cowal Transect Monitoring (Nov 2010 - February 2023)	Lake Cowal Inflow Sites (Nov 2010 - July 2022)
	Protection Levels for Aquatic Ecosystems				Stock Water Protection Level					
	99%	95%	90%	80%	Low Risk Trigger Value					
As (Total) (µg/L)	0.8	13	42	140	500	2.6**	<0.1 to 3.5 (1.2**)	<0.5 to 3.98 (2.6**)	1 to 27 (5.4**)	1 to 26 (4.8**)
Cd (Total) (µg/L)	0.06	0.2	0.4	0.8	10	0.055**	<0.05 to 0.5 (0.1**)	<0.05 to 0.5 (0.06**)	0.1 to 1 (0.10**)	0.1 to 0.3 (0.1**)
Cu (Total) (µg/L)	1.0	1.4	1.8	2.5	1,000 µg/L cattle, 400 µg/L sheep	6**	1.6 to 7.5 (3.5**)	2.2 to 15.9 (5.8**)	1 to 32 (7.5**)	2 to 70 (11.2**)
Fe (Total) (µg/L)	No trigger values given				Not sufficiently toxic	-	-	-	50 to 33,600 (9,596**)	900 to 180,000 (18,607**)
Pb (Total) (µg/L)	1	3.4	5.6	9.4	100	2.9**	<0.5 to 7.2 (2.3**)	<0.5 to 6.5 (2.7**)	1 to 15 (4.1**)	1 to 7 (3.4**)
Mn (Total) (µg/L)	1,200	1,900	2,500	3,600	Not sufficiently toxic	-	-	-	55 to 509 (163**)	43 to 509 (212**)
Hg (Total) (µg/L) (inorganic)	0.06	0.6	1.9	5.4	2	>50% of samples less than the Level of Detection Limit (0.1)	<0.1 to 0.4 (0.2**)	<0.1 to 0.4 (0.13**)	All samples less than or equal to the Level of Detection Limit (0.1)	All samples less than or equal to the Level of Detection Limit (0.1)
Zn (Total) (µg/L)	2.4	8	15	31	20,000	12**	<3 to 22 (9.0**)	<3 to 30 (11.7**)	5 to 79 (17.8**)	6 to 234 (32**)
Ni (Total) (µg/L)	8	11	13	17	1,000	-	-	-	2 to 26 (9.7**)	3 to 77 (13**)

As: arsenic. Fe: iron. Hg: mercury. >: greater than.
Cd: cadmium. Pb: lead. Zn: zinc. <: less than.
Cu: copper. Mn: manganese. Ni: nickel. ** Average Value

[1] Default guideline values were adopted from ANZG (2018) and do not differ from ANZECC/ARMCANZ (2000a) for these constituents. The NSW Water Quality Objectives do not differ from the ANZECC/ARMCANZ (2000a) Guidelines.

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Average EC (a measure of salinity) in lake water over the assessment period was 382 microSiemens per centimetre (µS/cm). This is lower than the average EC measured at the lake transect sites during the baseline period (881 µS/cm). The average EC measurements for the lake recorded during the assessment period were slightly higher than the average records for the lake inflow sample locations (218 µS/cm) over the assessment period. Both the average lake inflow and lake transect values recorded during the baseline and assessment periods were well above the ANZECC/ARMCANZ (2000a) default guideline value for slightly disturbed ecosystems of freshwater lakes and reservoirs (20 - 30 µS/cm).

The average turbidity level recorded at lake transect sites during the assessment period was 287 nephelometric turbidity units (NTU), compared to 111 NTU recorded during the baseline period. Average turbidity recorded at lake transects was lower than the average recorded at the lake inflow sample locations (360 NTU) during the assessment period. The levels recorded during the baseline and assessment period were well above the ANZECC/ARMCANZ (2000a) default guideline value for protection of slightly disturbed ecosystems of freshwater lakes and reservoirs (1 to 20 NTU).

Laboratory analysis of lake and inflow water quality samples included analyses for nine metals (arsenic, cadmium, copper, iron, lead, manganese, mercury, nickel and zinc). Mercury concentrations were at or below laboratory detection level at both lake transect and lake inflow sites during the assessment period. Cadmium concentrations were at or below laboratory detection level at lake inflow sites and the majority of samples returned a concentration at or below the laboratory detection level in the lake transect sites with a maximum recorded concentration of 1 µg/L.

Average arsenic, cadmium, nickel and manganese concentrations at the lake transect sites were below the ANZG (2018) default guideline value for protection of slightly to moderately disturbed ecosystems (95% protection level). The average of all detectable metal concentrations, with the exception of arsenic and cadmium, at the lake transect sites were lower than the respective average concentrations measured at the lake inflow sites. The average lake transect site arsenic (5.4 µg/L), cadmium (0.10 µg/L), copper (7.5 µg/L), lead (4.1 µg/L) and zinc (17.8 µg/L) concentrations were greater than the corresponding baseline values. The average lake inflow sites arsenic (4.8 µg/L), copper (11.1 µg/L), lead (10.6 µg/L) and zinc (31 µg/L) were greater than the corresponding baseline values.

In summary, notable results are as follows.

- The range of pH was high relative to ANZECC/ARMCANZ (2000a) default guideline values and baseline ranges, however, as discussed further below has been similarly elevated at sites near and distant to CGO.
- Average total copper, lead and zinc concentrations were high relative to both the ANZG (2018) default guideline values and baseline concentrations however were lower than inflow site concentrations and as discussed further below have been similarly elevated at sites near and distant to CGO.
- Average turbidity was significantly higher than the ANZECC/ARMCANZ (2000a) default guideline value and higher than baseline levels, however as discussed further below turbidity levels have been relatively uniform at sites close to and distant from CGO.
- Total phosphorus concentrations were significantly higher than the ANZECC/ARMCANZ (2000a) default guideline value for freshwater lakes however as discussed further below concentrations have been similar at sites both close to CGO and on the other side of Lake Cowal and lower than inflow site records (it is also noted that the average total phosphorus concentration is much lower than the baseline average).

As surface water runoff within the CGO area is fully contained in the ICDS, there is no obvious causal link between the mining operations and water quality in the lake. Given that groundwater, including any seepage from on-site storages, would flow toward the mine pit (Appendix H of the EIS), the only plausible links between mining activity at CGO and lake water quality would be overflow from dams D1 and/or D4 emplacement when the Lake Temporary Isolation Bund is inundated. Both D1 and D4 storages are fitted with pump back systems and Evolution has advised[8] that they have not overflowed to date. Based on assessment of the monitoring data, there is no evidence that activities at CGO have resulted in changes to water quality in Lake Cowal.

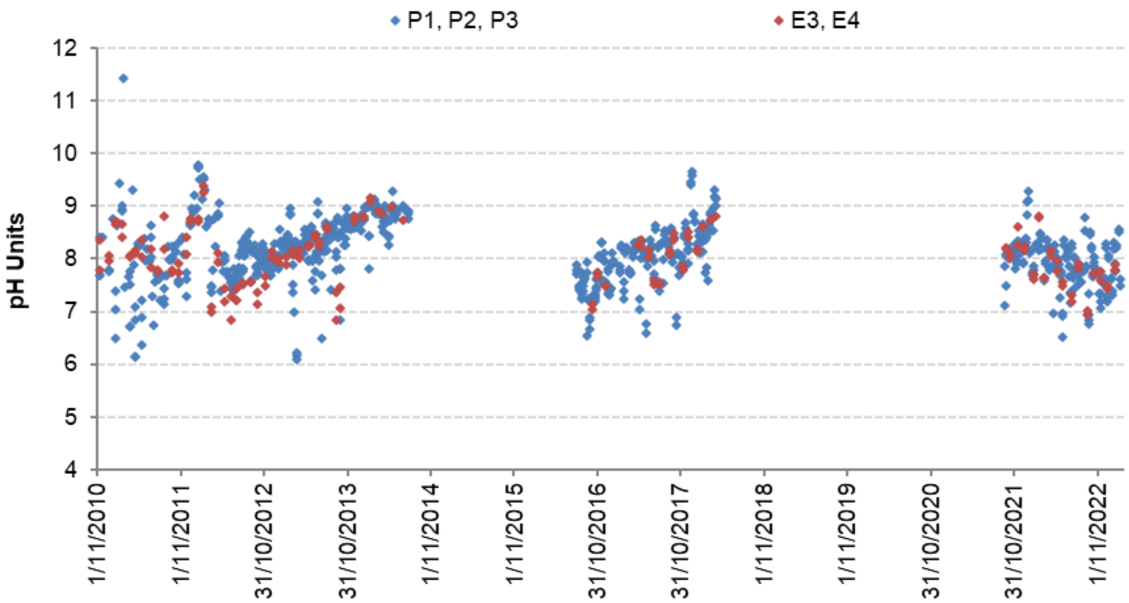
[8] Pers comm., Evolution.

Samples taken at transect sites P1, P2 and P3 are physically close to the Lake Temporary Isolation Bund and therefore more likely to reflect mine-related effects, whilst sites E3 and E4 are on the opposite side of the lake – refer **MAP 3**. A comparison of the monitored results from these sites for pH, copper, lead, zinc, turbidity and total phosphorous is shown in **GRAPH 1** to **GRAPH 7**.

2.3.1.1 Comparison of Monitored pH Across Lake Cowal

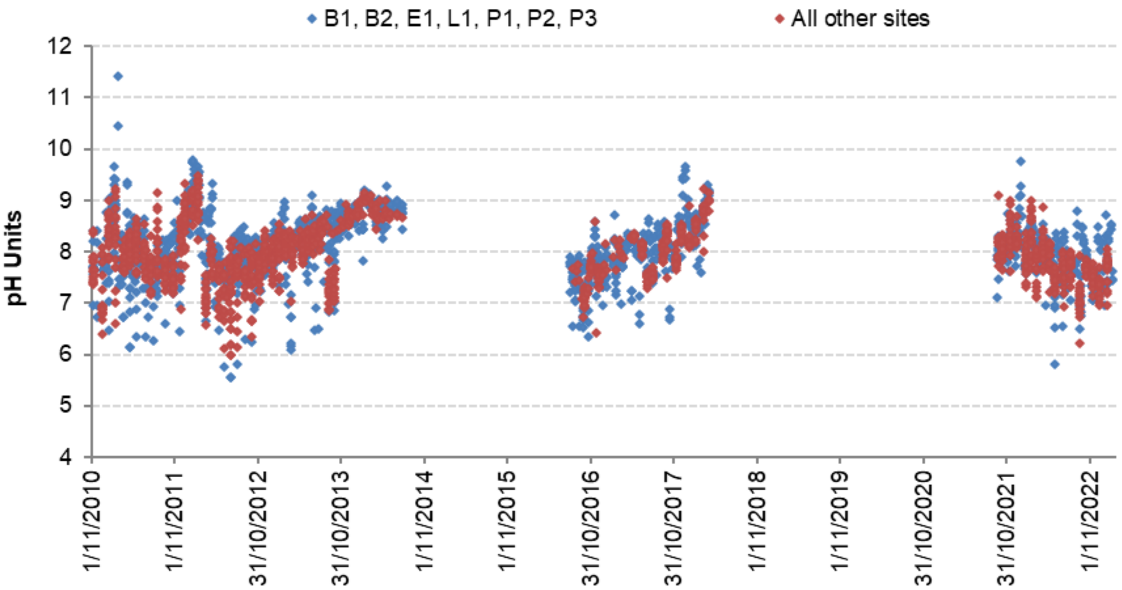
The pH values were relatively elevated at lake sites close to CGO (P1, P2, and P3) in February 2011 compared to sites on the opposite side of the lake (refer **GRAPH 1**). Elevated pH levels were also recorded near CGO in early 2012 although similar levels were also measured on the opposite side of the lake at that time. After the lake refilled in 2016, pH levels have been relatively consistent across the lake except in December 2017 when slightly elevated levels were recorded at lake sites close to CGO (P1, P2 and P3) relative to sites on the opposite side of the lake. Since the lake refilled in late 2021, pH levels have been consistent across the lake in samples collected on similar dates. Three pH values in excess of 9 were recorded at lake sites close to CGO on 28 December 2021 and 3 January 2022, however there were no samples collected from sites on the opposite side of the lake on or near those dates.

GRAPH 1: FIELD MEASUREMENT OF pH AT SELECTED SITES – LAKE COWAL



To further assess whether there was a link between the above noted elevated pH levels and the proximity of the monitoring sites to CGO, a comparison was undertaken of pH levels recorded from 2010 to 2022 at all sites considered to be relatively close to the Lake Temporary Isolation Bund (E1, L1, P1, P2, P3, B1 and B2 – refer **MAP 3**) and all other sites in the lake. As shown in **GRAPH 2**, the pH levels were generally similar at sites close to CGO and at other (more distant) sites for samples collected on similar dates. In February 2011, there was a relatively elevated pH value recorded at site C1 (pH 11.05) which suggests that pH was similarly elevated at sites close to and distant from CGO at this time. On two occasions in December 2017 and once in January 2022, the field pH measurements were slightly elevated at monitoring sites P1 and P3 only, however, the pH measurements did not exceed the maximum pH value (pH 9.8) recorded at lake transect sites during the baseline monitoring period (refer **MAP 3**). The maximum pH recorded at the sites relatively close to the Lake Temporary Isolation Bund on 3 January 2022 was 9.77, with an average value for the three sites monitored on that date of 9.38, which is only slightly higher than the pH recorded at site C1 on the same date of pH 9.11 (site C1 was the only site distant from CGO monitored on this date).

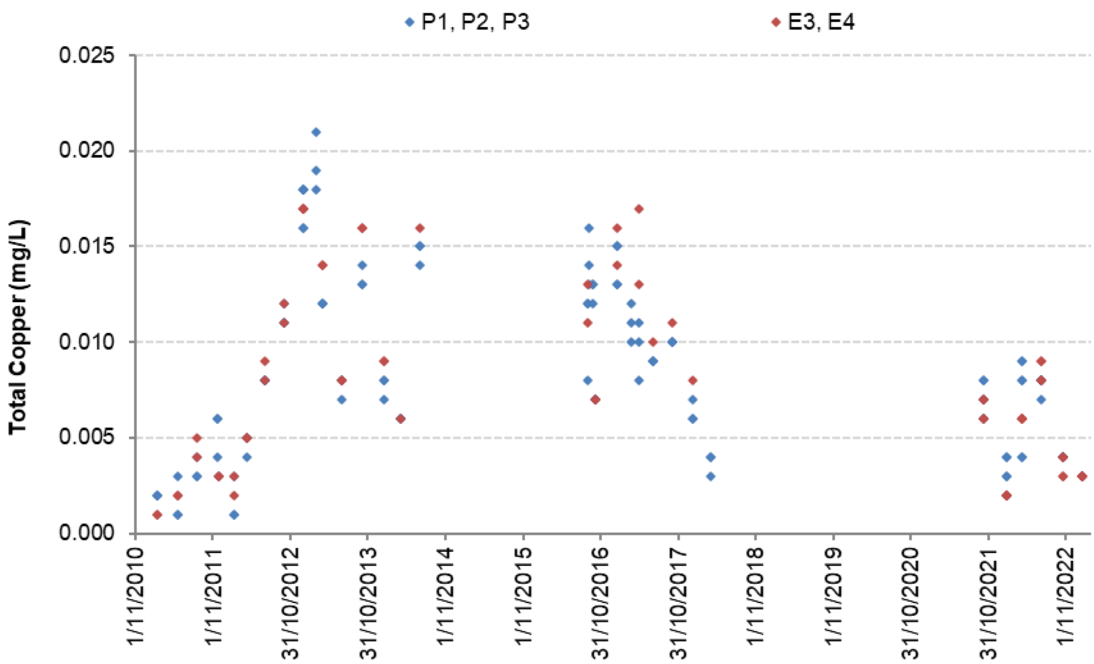
GRAPH 2: FIELD MEASUREMENTS OF pH – LAKE COWAL



2.3.1.2 Comparison of Monitored Copper Concentrations Across Lake Cowal

Monitored copper concentrations at sites close to CGO and sites on the opposite side of the lake are presented in **GRAPH 3**. The monitoring records indicate that copper concentrations have been similar at sites close to CGO and at sites on the opposite side of the lake, with concentrations generally declining between 2012 and early 2023.

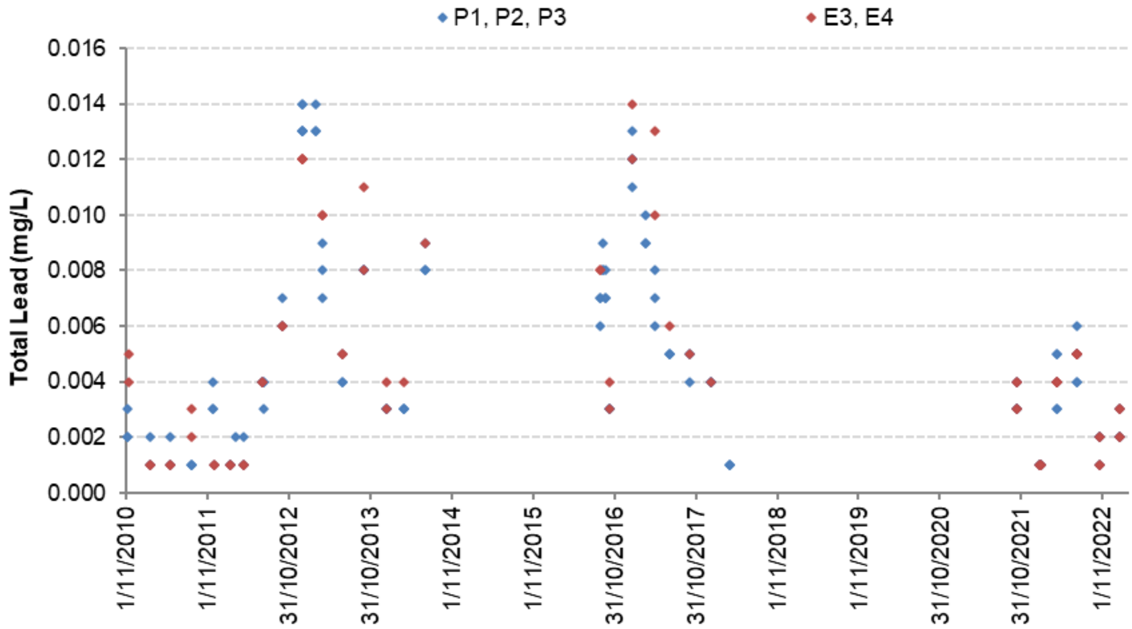
GRAPH 3: RECORDED COPPER CONCENTRATIONS AT SELECTED SITES – LAKE COWAL



2.3.1.3 Comparison of Monitored Lead Concentrations Across Lake Cowal

Monitored lead concentrations at sites close to CGO and sites on the opposite side of the lake are presented in **GRAPH 4**. The monitoring records indicate that lead concentrations have been similar at sites close to CGO and at sites on the opposite side of the lake, with concentrations generally declining between 2017 and early 2023.

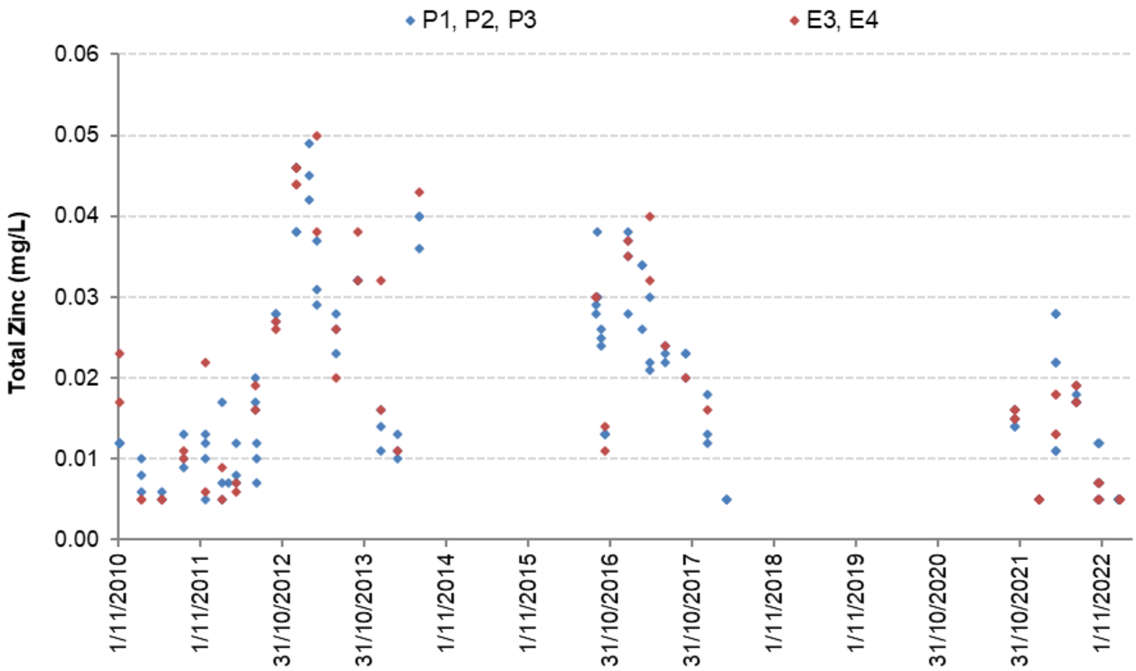
GRAPH 4: RECORDED LEAD CONCENTRATIONS AT SELECTED SITES – LAKE COWAL



2.3.1.4 *Comparison of Monitored Zinc Concentrations Across Lake Cowal*

The monitoring records of zinc concentrations at sites close to CGO and sites on the opposite side of the lake are presented in **GRAPH 5.** The monitoring records indicate that zinc concentrations have also been similar at sites close to CGO and at sites on the opposite side of the lake and have generally declined between 2013 and 2023.

GRAPH 5: RECORDED ZINC CONCENTRATIONS AT SELECTED SITES – LAKE COWAL



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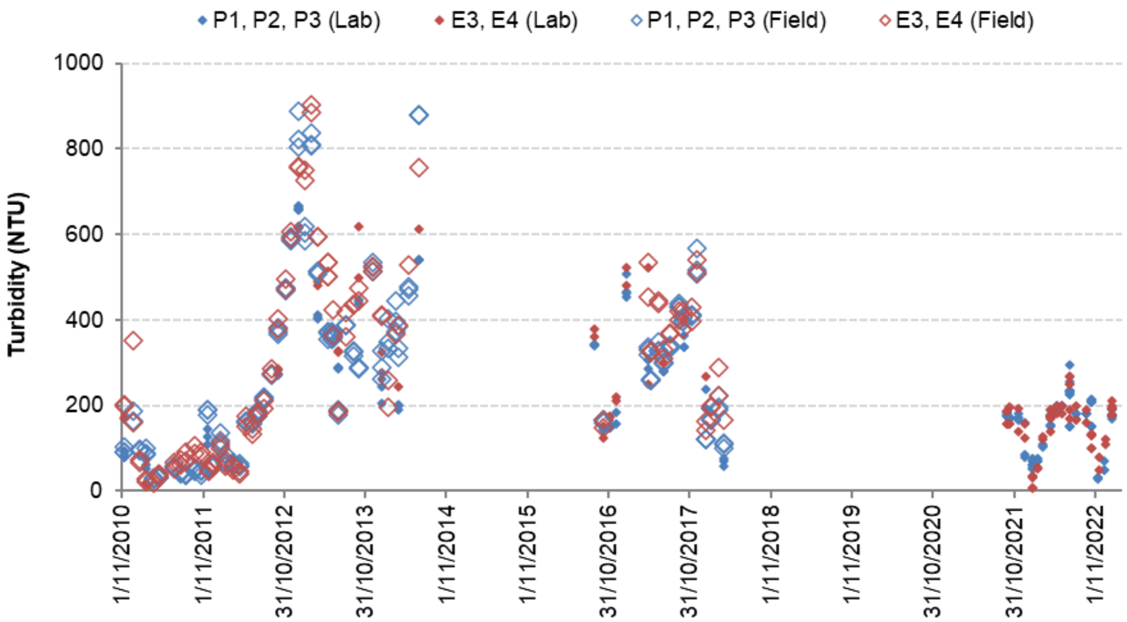
2.3.1.5 Comparison of Monitored Turbidity Across Lake Cowal

The assessment of lake turbidity levels indicates a consistent trend of increasing turbidity from March to December 2012 and May to July 2014 at sites both close to CGO and sites on the other side of the lake – refer **GRAPH 6**. Data from the 2021/22 inflow event indicates much lower turbidity that for previous events, with consistent values at sites both close to CGO and sites on the other side of the lake.

GRAPH 6: RECORDED TURBIDITY CONCENTRATIONS AT SELECTED SITES – LAKE COWAL

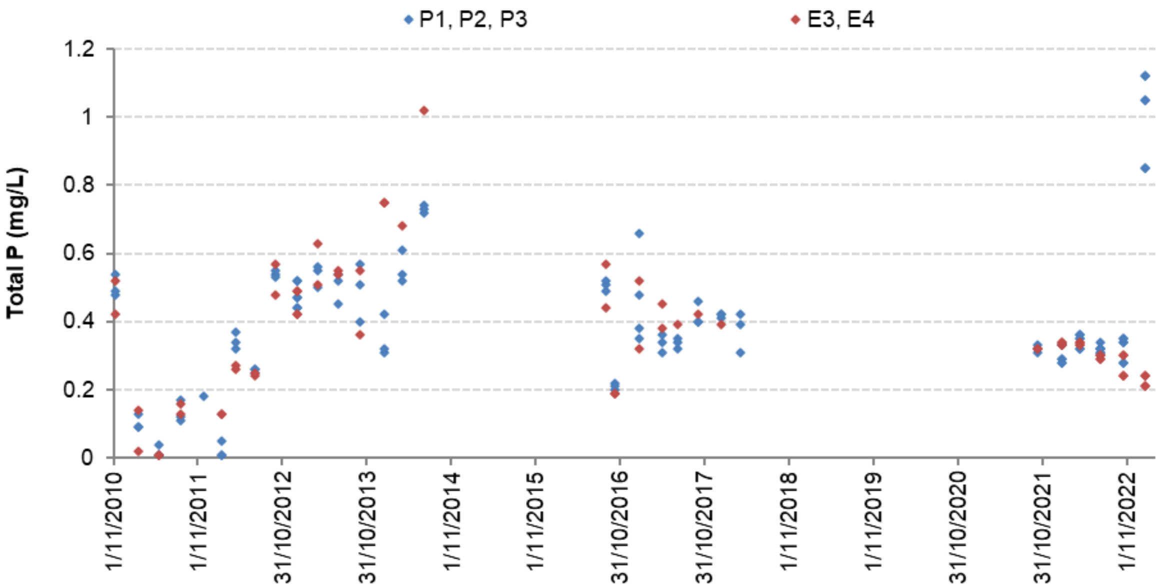


An assessment of the concurrent trends in lake turbidity and lake water level for data from earlier in the period of record indicates periods of increasing turbidity followed by a gradual decline. This has occurred uniformly at sites close to and distant from CGO.

2.3.1.6 Comparison of Monitored Phosphorus Concentrations Across Lake Cowal

Assessment of total phosphorus records indicates that concentrations have been similar at sites both close to CGO and on the other side of the lake apart from one set of elevated readings recorded at sites P1, P2 and P3 in mid-January 2023 (refer **GRAPH 7**).

GRAPH 7: RECORDED TOTAL PHOSPHORUS CONCENTRATIONS AT SELECTED SITES – LAKE COWAL



2.3.2 Other Water Quality Monitoring

As detailed in the CGO Water Management Plan (Evolution, 2022a), surface water monitoring is undertaken at specific locations within mining lease areas including the contained water storages, UCDS, ICDS, open pit and TSFs.

Evolution has provided monitored pH, EC and TSS values in the UCDS from 2007 to January 2023. Recorded pH ranged from 4.78 to 11.16, EC between 25.8 and 19,530 µS/cm and TSS from 4 to 2,140 mg/L.

Evolution has also provided monitored pH, EC and TSS values for site contained water storages and the open pit over a similar period. Ranges of pH in these site storages have been recorded from 4.4 to 10.3, EC between 12 and 142,700 µS/cm and TSS from 1 to 13,700 mg/L. High recorded EC values reflect, at least in part, the use of water supplied from saline groundwater bores and saline groundwater inflow to the open pit.

2.4 Harvestable Right

Landholders in most NSW rural areas are allowed to collect a proportion of the rainfall runoff on their property and store it in one or more dams up to a certain size. This is known as a 'harvestable right'. Maximum harvestable right dam capacity is the total dam capacity allowed under the harvestable right for a given property. It is based on 10% of the average regional rainfall runoff and takes into account local evaporation rates and rainfall periods.

The regulations (made under the *NSW Water Management Amendment Act, 2014*) relating to harvestable right exclude capture of drainage and/or effluent in accordance with best management practice, and dams constructed to control or prevent soil erosion. None of the storages on-site are used to harvest runoff from land and all storages are used to contain contaminated drainage, mine water or effluent in accordance with best management practice or are used to control soil erosion. It is concluded therefore that all CGO storages should be excluded from consideration as a component of the harvestable right calculation. Further information is available in the Water Licensing Strategy (Appendix I of the EIS).

2.5 Groundwater

The groundwater levels and water quality in the region surrounding CGO are described separately in the *Groundwater Impact Assessment* (Appendix H of the EIS).

3 CURRENT CGO WATER MANAGEMENT AND WATER SUPPLY

3.1 Description

CGO currently involves open pit mining and on-site ore processing. On-site ore processing involves crushing and grinding followed by combined flotation and carbon-in-leach circuits. Tailings produced from the processing plant are deposited in the IWL, containing the previously operated two TSFs. Mine waste rock is placed in WREs located to the north, south and east of the open pit (refer **MAP 4**).

The CGO water management strategy for the construction and operational phases of the approved mine development involve the following key principles (North Limited, 1998):

- Minimisation of disturbance areas;
- Containment of potentially contaminated water;
- Recycling of contained water; and
- Progressive stabilisation and revegetation of disturbed areas.

The CGO water management system has been designed such that the approved CGO does not impact on the integrity of Lake Cowal. Mine infrastructure and landforms have been constructed within a contained catchment – the ICDS. The ICDS combines with the UCDS and the lake isolation system to protect Lake Cowal from CGO development activities. The lake isolation system comprises a Temporary Isolation Bund and a permanent isolation bund (i.e. the LPB). The LPB comprises a large engineered embankment that provides a permanent barrier between the lake and the open pit. Runoff from areas upslope of the ICDS (i.e. areas undisturbed by mining) is diverted via the UCDS, around CGO to Lake Cowal. The UCDS comprises a northern and southern limb. The northern UCDS is aligned around the northern perimeter of the IWL and northern WRE. The southern UCDS is aligned around the southern side of the IWL and south of the southern WRE. Both limbs comprise an excavated channel and bund, with flow in the UCDS discharging to stilling basins prior to entering Lake Cowal. When the channel capacity is exceeded, flow floods out over the adjacent countryside, as sheet flow and in adjacent drainage lines, with the bund preventing flow from entering CGO. The UCDS has been designed to accommodate peak flow rates up to the 0.1% AEP.

The main water demand for the approved CGO is for supply to the process plant. Since the commencement of primary ore processing in mid-2007 to November 2022, the CGO processing rate has averaged 7.6 Mtpa and the water demand[9] (total) has averaged 18 ML/day (of which up to approximately 8.8 ML/day on average was supplied by on-site recycling of return water and incident rainfall from the TSF and IWL decant ponds). Since 2019, the average process plant demand has been 22.4 ML/d which is reflective of recent process water demand. Prior to mid-2007, during the initial oxide ore processing phase[10], the ore processing rate averaged 6.4 Mtpa and the water demand (total) averaged 33.7 ML/day. A higher water demand was required for oxide ore due to the finer, clayey nature of the ore.

Other water demands comprise water for construction requirements and haul road dust suppression. Monitoring data (to the end of November 2022) indicates that demand for haul road dust suppression averages 0.62 ML/day, varying through the year from an average of 0.18 ML/day in June to 1.04 ML/day in January.

Water supply for the approved CGO involves re-use of mine process water (tailings water reclaim), capture and re-use of runoff from areas within the ICDS, groundwater inflow to the open pit and groundwater sourced from the saline groundwater supply bores within ML 1535 when Lake Cowal is dry. Other external make-up water supply is provided to the site via the mine borefield pipelines and is drawn from the following sources (in order of priority):

1. Eastern saline borefield.
2. The Bland Creek Paleochannel borefield.
3. Saline groundwater supply borefield located in the south-east of ML 1535.
4. Water extracted from the Lachlan River via the Jemalong Irrigation Channel using regulated flow licences or allocation assignment (temporary transfer) to Evolution on the open market.

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[9] Based on data to end of November 2022 provided by Evolution.

[10] Based on data provided as part of the Modification 11 Surface Water Assessment for period from August 2006 to April 2007 (refer Gilbert & Associates, 2013).

Some water from the external water supply sources is treated by a Reverse Osmosis (RO) plant prior to use in the process plant or to satisfy other operational requirements. Brine from the RO plant is disposed of in the TSFs.

The current CGO water management system components and their linkages (via system transfers) are shown in schematic form in **DIAGRAM 1**.

The external make-up of water supply at CGO is provided to the site via the mine borefield pipeline which draws water from the eastern saline borefield, the Bland Creek Paleochannel borefield and water extracted from the Lachlan River via the Jemalong Irrigation Channel. Water is currently extracted from the Lachlan River using the following regulated river water access licences (WALs):

- WAL42993: 1,400 Unit Shares (General Security)
- WAL40424: 100 Unit Shares (General Security)
- WAL14981: 80 Unit Shares (High Security)
- WAL13749: 0 Unit Shares (High Security)
- WAL13748: 30 Unit Shares (General Security)
- WAL1990: 123 Unit Shares (General Security)

In addition, allocation assignment water is purchased by Evolution on the open market under the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016.* Between approximately 4,000 and 274,000 megalitres (ML) of allocation assignment has been traded annually since records began in the 2004/2005 water year to the 2021/2022 water year[11].

3.2 Contained Water Storages

The ICDS comprises a series of seven internal drainage catchments (each served by a contained water storage for runoff collection) and a water supply storage. Details of the catchment areas and the capacities of the contained water storages are summarised in **TABLE 8**. With the exception of storages D1 and D4, all storages would (in the unlikely event of spill) ultimately overflow to the open pit. Storages D1 and D4 are equipped with pumps which facilitate dewatering of these storages such that they can be emptied in between rainfall events, as required. Runoff from the outer batters of the perimeter WRE ponds against the Temporary Isolation Bund, which has a capacity to store runoff from at least a 1% AEP rainfall event of 48 hours duration. Water that ponds in this area would be pumped to D6 (via D1 or D4) between rainfall events as required.

[11] https://waterregister.waternsw.com.au/ accessed 31 January 2022.

TABLE 8: SUMMARY OF EXISTING/APPROVED CONTAINED WATER STORAGES

Storage	Catchment/Function	Catchment Area (ha)*	Storage Capacity (ML)**
D1	Runoff from northern portion of the northern WRE and the northern and western batters of the IWL.	165	42.3
D2	Runoff/seepage from run-of-mine (ROM) pad, low grade ore stockpile and from the southern portion of the northern WRE area.	256	328
D3	Runoff from perimeter catchment surrounding the open pit and the perimeter WRE areas.	76	14.3
D4	Runoff from the southern perimeter of the southern WRE.	75	62.2
D5A	Process plant area runoff collection.	65	63.6
D6	Process water storage. Main source of process plant make-up.	18	21.7
D8B	Runoff from southern WRE and area between southern TSF and D9.	130	24.0
D9	Process water storage and storage for raw water.	Incident area	688

* Estimated from Jan 2022 site contour plan provided by Evolution
** As advised by Evolution.

MAP 4: CURRENT (2022) CGO GENERAL ARRANGEMENT

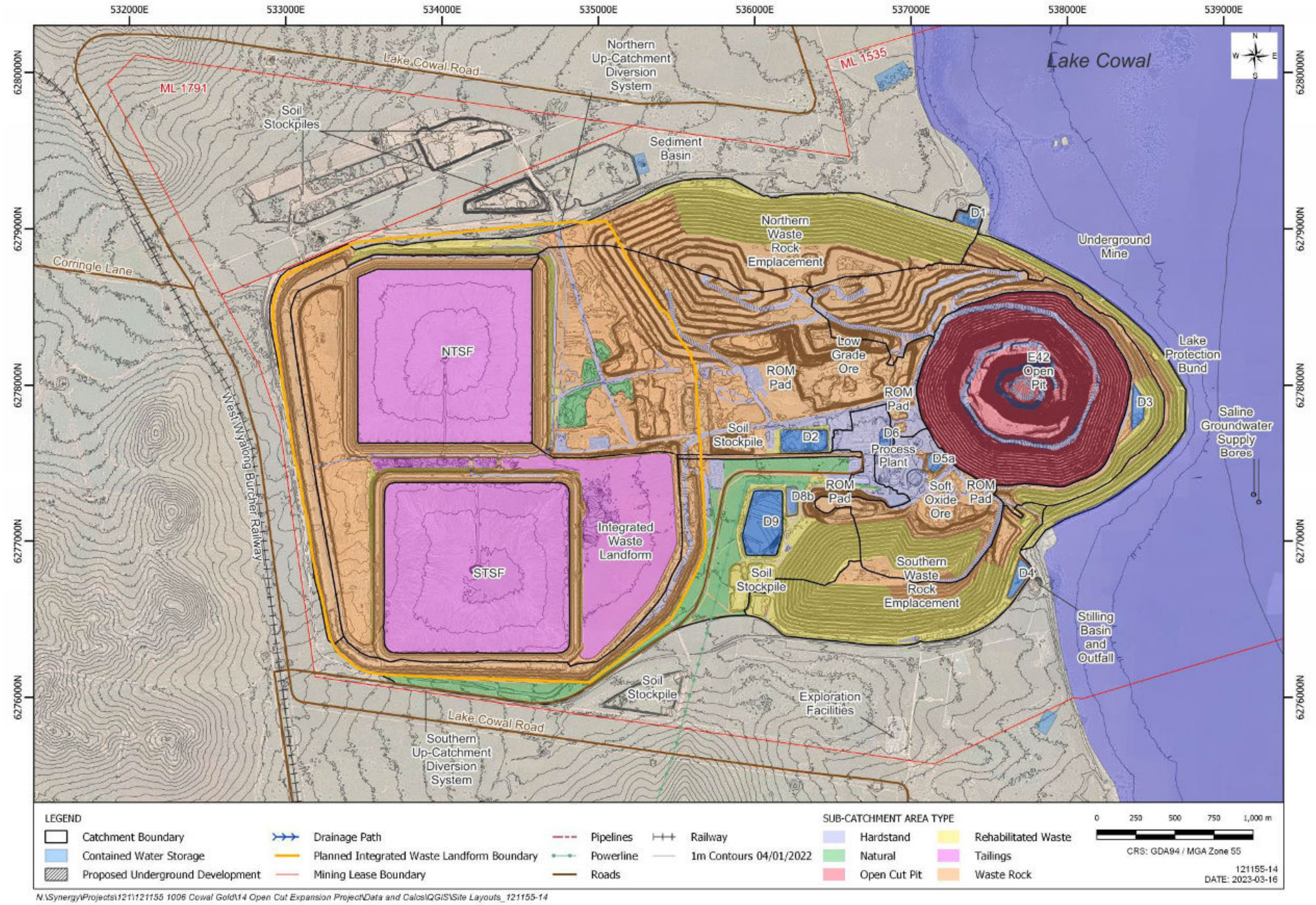

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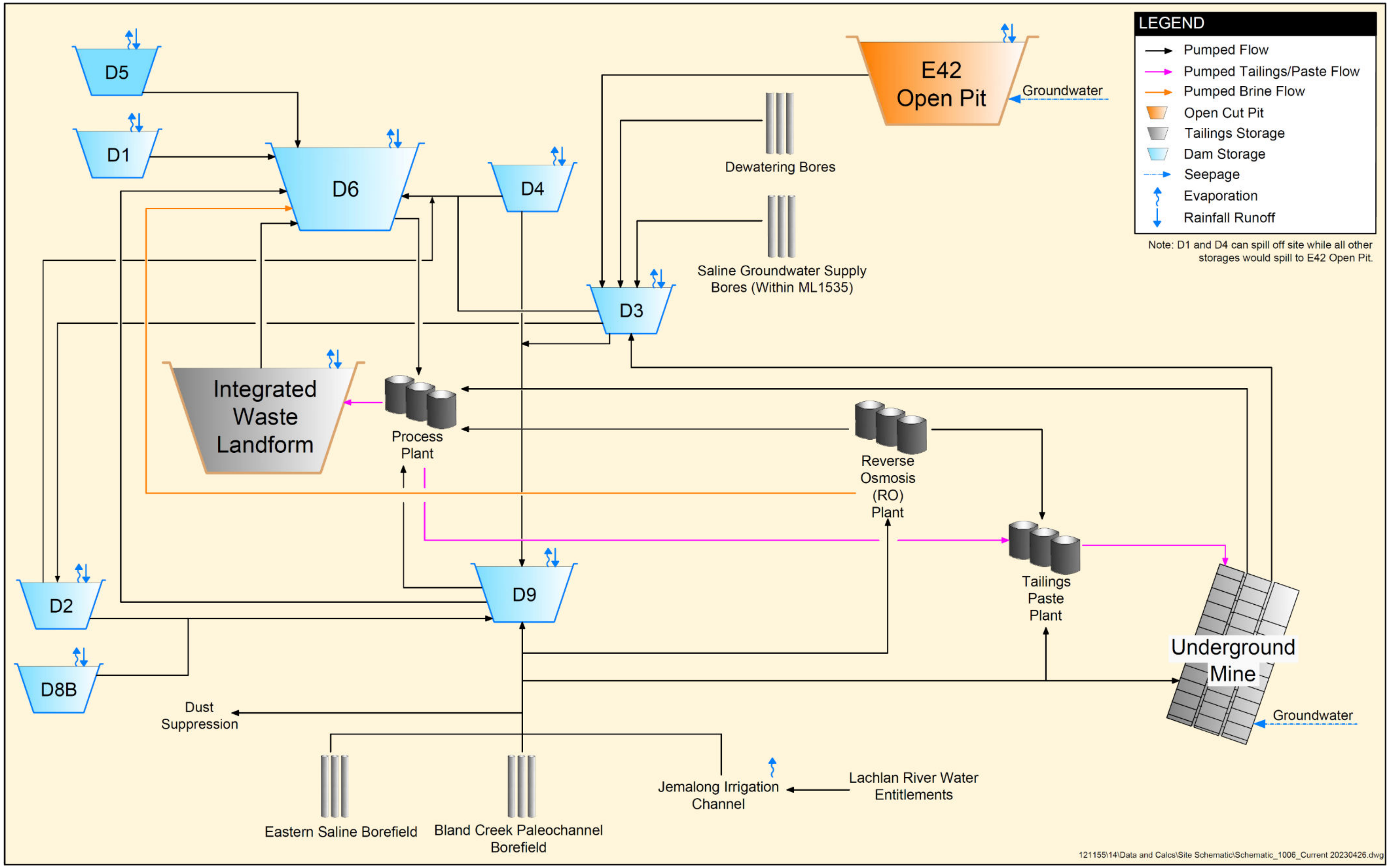
DIAGRAM 1: CURRENT CGO WATER MANAGEMENT SYSTEM SCHEMATIC



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3.3 Open Pit Dewatering

E42 open pit inflows occur via groundwater, incident rainfall and rainfall runoff from areas surrounding the open pit. The catchment area draining to the E42 open pit was estimated to be approximately 136 hectares (ha) in 2022. The E42 open pit would also be the final water containment point in the event of overflow from any of the contained water storages (except D1 and D4 which are emptied by pumping) or in the highly unlikely event of an overflow from the IWL. Inflows to the open pit accumulate in a sump in the pit floor and are pumped to storage D3. As at 27 March 2023, water has temporarily been allowed to accumulate within the E42 open pit, with an estimated 2,110 ML stored.

Groundwater inflow predictions made as part of the Cowal Gold Project EIS (North Limited, 1998) were for quite high groundwater inflow rates. Revised groundwater inflow rates have been undertaken for the Project as reported in the *Groundwater Impact Assessment* (Appendix H of the EIS) – refer **Section 6.1.4**.

3.4 Waste Rock Emplacement Water Management

Mine waste rock from open cut mining operations is placed in three WRE areas: the northern, southern and perimeter WREs (refer **MAP 4**). The northern and southern WREs are integral with the perimeter WRE which is a component of the permanent lake isolation system. The outside faces of the northern and southern WREs form part of the perimeter catchment limits of the approved CGO. The northern WRE is the largest of the emplacement areas.

Runoff from the external face of the northern WRE reports to contained water storage D1 which has been constructed below the external (north-eastern) toe of the northern WRE area and is dewatered by pumping to storage D6.

Runoff from the external face of the southern WRE reports to contained water storage D4 which has been constructed below the external (south-eastern) toe of the southern WRE area and is dewatered by pumping to storage D6.

Runoff from the perimeter WRE area reports to the storage which forms between the toe of the perimeter WRE and the Temporary Isolation Bund. Water that accumulates in this storage is returned to D6 as required.

3.5 Integrated Waste Landform Water Management

The majority of process tailings material is deposited in the IWL which has been formed around the former two TSFs - i.e. northern tailings storage facility (NTSF) and southern tailings storage facility (STSF) (refer **MAP 4**). Tailings are discharged as a slurry from the perimeter of the IWL, with settled tailings forming a sloping surface under sub-aerial conditions. The IWL comprises a confining embankment raised above the surrounding natural surface and, as such, its catchment area comprises only the area inside the confining embankment. The catchment areas of the NSTF and STSF are estimated to be approximately 124 ha and 129 ha respectively[12]. The catchment area of the IWL, excluding the area of the TSFs, is estimated to be approximately[12] 215 ha. It is anticipated that the NTSF and STSF will be covered with tailings in approximately 2029 and 2031 respectively, after which time the IWL will comprise a single large tailings surface area.

The IWL perimeter embankment is progressively raised ahead of the rising tailings surface. In general, tailings are deposited through a 450 mm nominal diameter high density polyethylene (HDPE) pipeline which runs from the process plant to the IWL and along the perimeter embankment. There are spigots (smaller pipe sections) exiting from the deposition pipeline around the circumference of the IWL, which deposit tailings around the internal perimeter of the IWL. Within each spigot is a gate valve which is used to alternate the locations of the deposition, allowing for intermittent drying times of the deposited tailings and for a consistent tailings beach height around the internal perimeter of the IWL.

Rainfall runoff and free water liberated during settling of the tailings (termed 'bleed' water) accumulate in an internal (central) decant pond within the IWL, located between the TSFs. Water which ponds within the former decant ponds (from rainfall) of the two remnant TSFs may be pumped to the IWL

[12] Estimated from January 2022 contour plan provided by Evolution.

decant pond. Temporary water ponds may form against the outer side of the TSF embankments as tailings are deposited from the IWL perimeter – water from these ponds would be pumped to the IWL decant pond. Water from the IWL decant pond is pumped to storage D6 for re-use in the process plant. The IWL has been designed to maintain a minimum freeboard sufficient to store at least the contingency 0.1% AEP rainfall event at all times (Evolution, 2022a).

A portion of the process tailings is used as underground mine paste fill – refer HEC (2020) and **Section 4.1.2**.

3.6 Sewage and Associated Waste Management

A site sewage treatment plant is operational with treated sewage and sullage disposed of (to the West Wyalong Sewage Treatment Plant) to the satisfaction of Bland Shire Council and the EPA in accordance with the requirements of the NSW Department of Health (Evolution, 2022a).

4 FUTURE CGO WATER MANAGEMENT AND WATER SUPPLY

4.1 Water Management

4.1.1 Description of Proposed Project Development

The development of the CGO surface facilities is shown as a post Project construction site layout plan (**MAP 4**) and a series of future conceptual site layout plans (**MAP 5** to **MAP 8**) showing the layout of surface facilities, internal drainage and catchment areas for the Project. The following describes the proposed Project development and surface water features.

4.1.1.1 Staged Development of Project

The Project as at Year 2 (**MAP 5**) would see an extension of the CGO footprint principally to the south-east, north-east and north-west. The LPB system would be reconstructed further out into the Lake Cowal area to provide continued separation and mutual protection between Lake Cowal and the mine. The LPB system (comprising a Temporary Isolation Bund and the LPB itself) would be constructed from benign mine waste rock material and/or borrow areas from within the expanded CGO footprint (refer Section 4.1.1.4). Mining of satellite open pits E46 and E41, located to the north and south of the existing E42 open pit would have commenced, with waste rock material principally placed within extensions of the northern and southern WREs respectively. The UCDS would have been realigned to the north and south of the existing CGO, to encompass:

- an area that would include the future expanded IWL to the north of the existing IWL (termed the "IWL North" herein),
- an expansion of the northern WRE to the north,
- the reconstructed LPB system to the north of open pit E46,
- an expansion of the southern WRE to the south, and
- the reconstructed LPB system to the south of open pit E41.

Further description of the UCDS is provided in Section 4.1.1.5. No further expansion of the UCDS or Project footprint would occur subsequently.

The ICDS would have undergone significant revision with a number of additional contained water storages, modelled as follows:

- D21 (608 ML capacity) located to the north-west of the E46 open pit, capturing runoff from the northern portion of the northern WRE and IWL and the footprint of the IWL North area. D21 would effectively replace the existing D1.
- D23 (455 ML capacity) located between the E42 open pit and the LPB, capturing runoff mainly from the expanded open pit area that is outside the open pits themselves. D23 would effectively replace the existing D3.
- D24 (342 ML capacity) located to the south-west of the E41 open pit, capturing runoff from the southern portion of the southern WRE.
- D25 (15 ML capacity) which would replace and capture runoff from a similar area as the existing D5a.

Remaining contained water storages would continue to function as they do currently. Perimeter drains and bunds would be constructed around the northern and southern boundaries of the expanded CGO footprint to direct site drainage (including drainage from the outer batter of WRE areas) to contained water storages D21 and D24. Ultimately all water will be directed to D23 for return pumping. No contained water storages would be able to spill externally (off site), with all storages contained within the ICDS and spilling ultimately to the E42, E41 and E46 open pits (currently contained water storages D1 and D4 could spill off site if their capacities were exceeded in an extreme rainfall event).

The Project as at Year 5 (**MAP 6**) would see further development of the E42, E46 and E41 open pits, as well as the northern and southern WREs. The outer embankment of the IWL North would be under construction substantially using waste rock material. This would significantly reduce the catchment of contained water storage D21, with a perimeter drain to be located at the toe of the IWL North outer embankment, directing drainage from the outer embankment to contained water storage D21. Tailings within the IWL should cover the NTSF embankment by this stage.

The Project as at Year 7 (**MAP 7**) would see to commencement of mining of the GR open pit, located between the E46 and E42 open pits, with waste rock backfill occurring to the E46 open pit following completion of mining there. The E41 open pit would expand further, consuming the D4 contained water storage., with further expansion of the southern WRE. Tailings within the IWL should cover the STSF embankment by this stage.

The Project as at Year 13 (**MAP 8**) would see the completion of open pit and WRE development. This would include expansion of the GR open pit southwards, with waste rock backfilling of the northern portion. The E41 pit would be further expanded with three separate portions. The IWL North would be receiving tailings following completion of tailings disposal to the main IWL. Significant areas of the southern WRE and the northern portion of the northern WRE would be rehabilitated by this stage, with rehabilitation completed in the remaining Project years.

The Project water management system would be amended to incorporate the additional CGO catchments, open pits and contained water storages. The Project water management system components and their linkages (via system transfers) are shown in schematic form in **DIAGRAM 2**.

4.1.1.2 Waste Rock and Ore Stockpile Runoff

The geochemical assessment for the Project (GEM, 2023) has identified that the Project waste rock (i.e. from the proposed satellite open pits and the expanded E42 open pit) is generally geochemically similar to the waste rock from the current open pit operations (based on previous studies), indicating that the management strategies currently employed for the WREs would not need to be modified to accommodate the additional Project waste rock material. Oxide waste rock has a significant risk of being highly saline and/or highly sodic, potentially adversely affecting revegetation success, runoff quality, sediment dispersion and erosion. Highly saline and/or sodic oxide waste rock should not be used for any site earthworks or construction (GEM, 2023). As is currently undertaken, runoff from WREs (including the batters of the IWL) would continue to be directed to contained water storages.

Stockpiled ROM ore would only be exposed to surface oxidation conditions within the ore stockpiles for short periods, however, it is expected that the low grade ore could be stockpiled and exposed to surface oxidation and leaching processes over long periods which presents a risk to water quality if not appropriately managed (GEM, 2023). Additionally, a small amount of the ROM and low grade ore (particularly from the E41 deposit) may be Potentially Acid Forming (PAF) although development of acidic drainage is not expected to be a concern for the ROM ore stockpiles given the expected short time period of exposure and low quantity of PAF material. However, if the PAF material is exposed on the surface of the stockpiles for an extended period of time, low pH conditions may develop, potentially leading to an increase in salinity, metal solubility and migration into the Project water management system. PAF materials should not be placed within the outer 5 m of stockpile surfaces (GEM, 2023).

Runoff from the ore stockpile areas would continue to be captured and contained within the approved disturbance area. Runoff would be directed to contained water storage D2. In the event that overflow occurs from contained water storage D2, the overflow would migrate to the E42 open pit and would not discharge off site.

MAP 5: CONCEPTUAL SITE LAYOUT AND CATCHMENTS – YEAR 2

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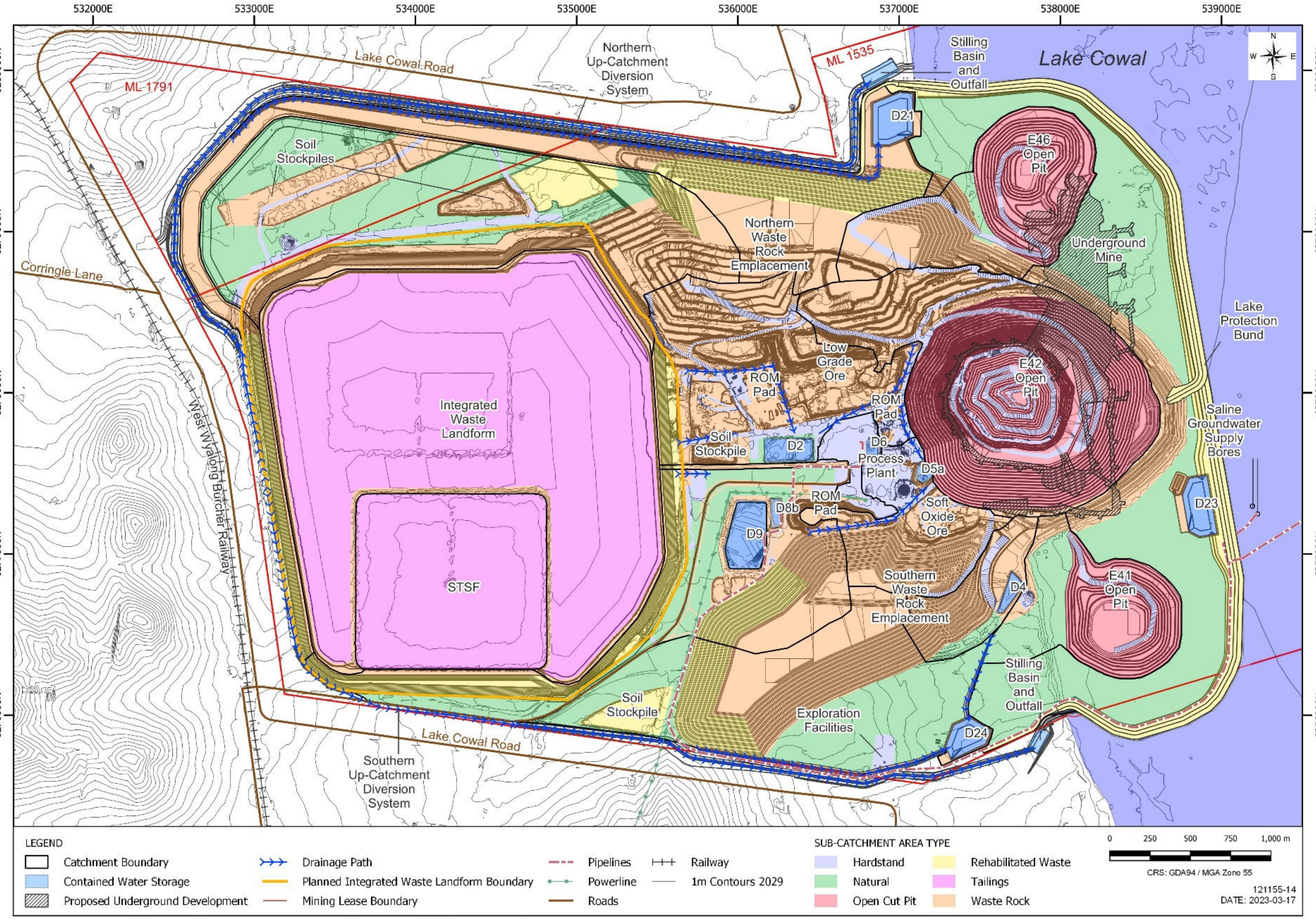
MAP 6: CONCEPTUAL SITE LAYOUT AND CATCHMENTS – YEAR 5



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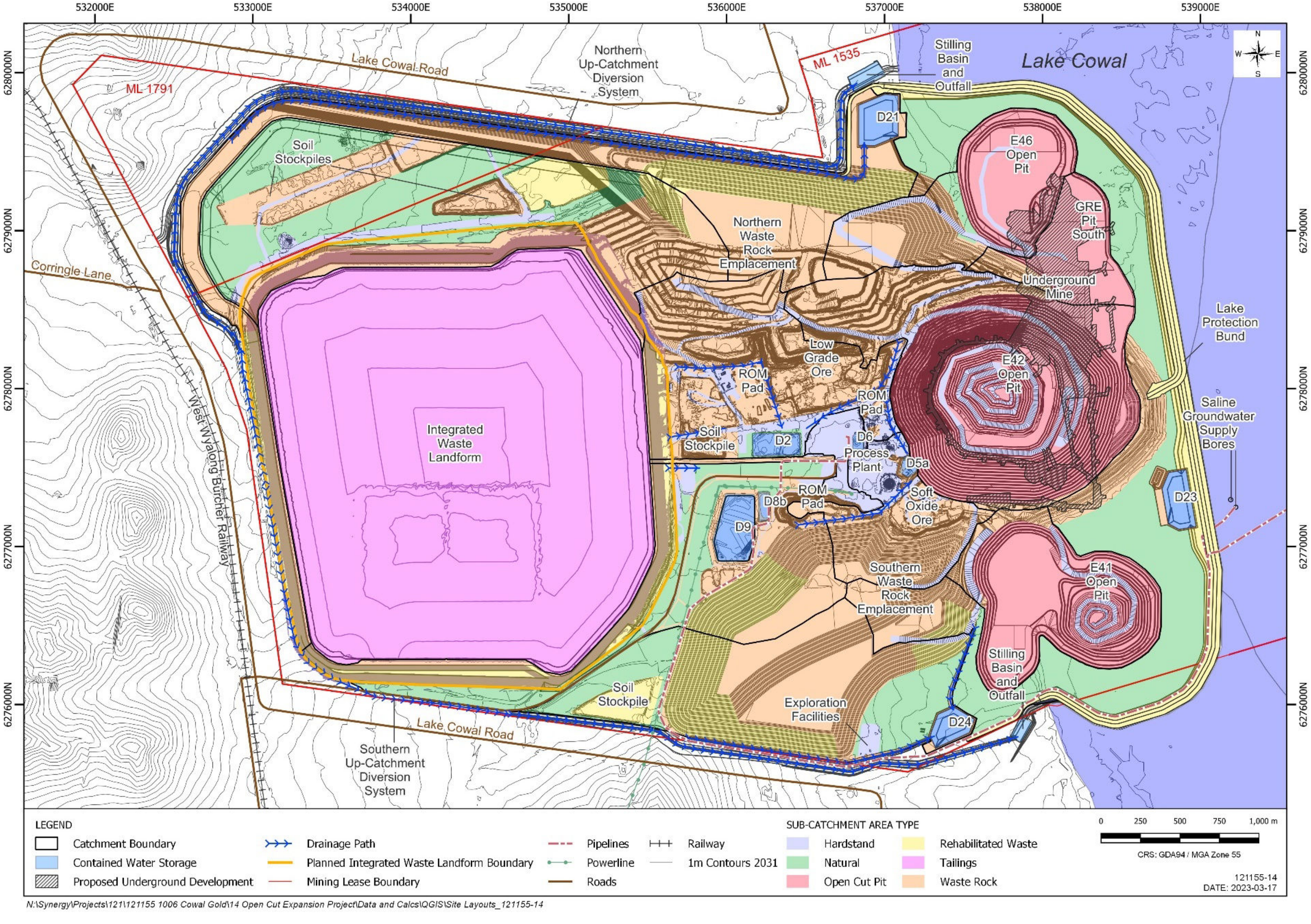
MAP 7: CONCEPTUAL SITE LAYOUT AND CATCHMENTS – YEAR 7



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MAP 8: CONCEPTUAL SITE LAYOUT AND CATCHMENTS – YEAR 13

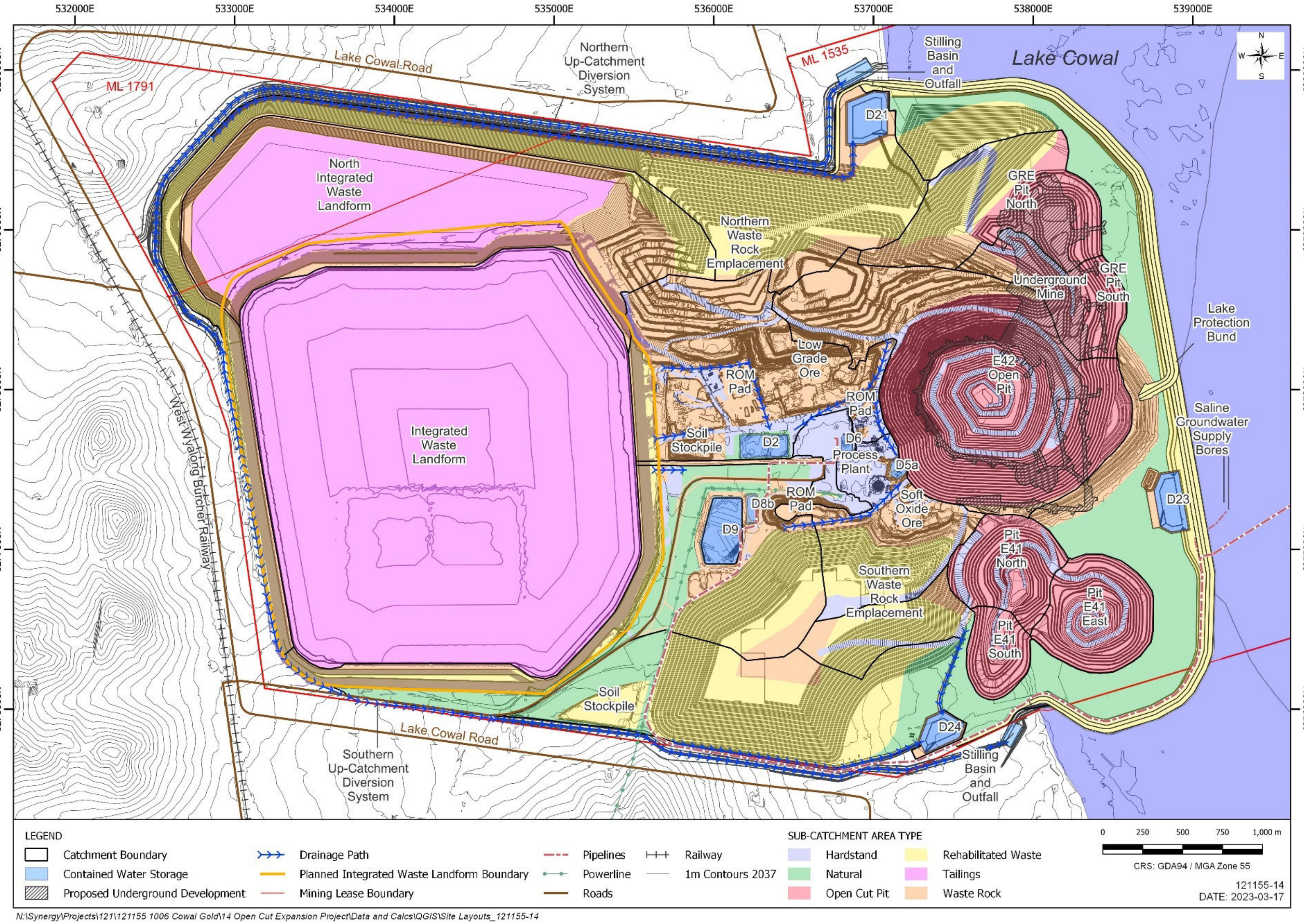

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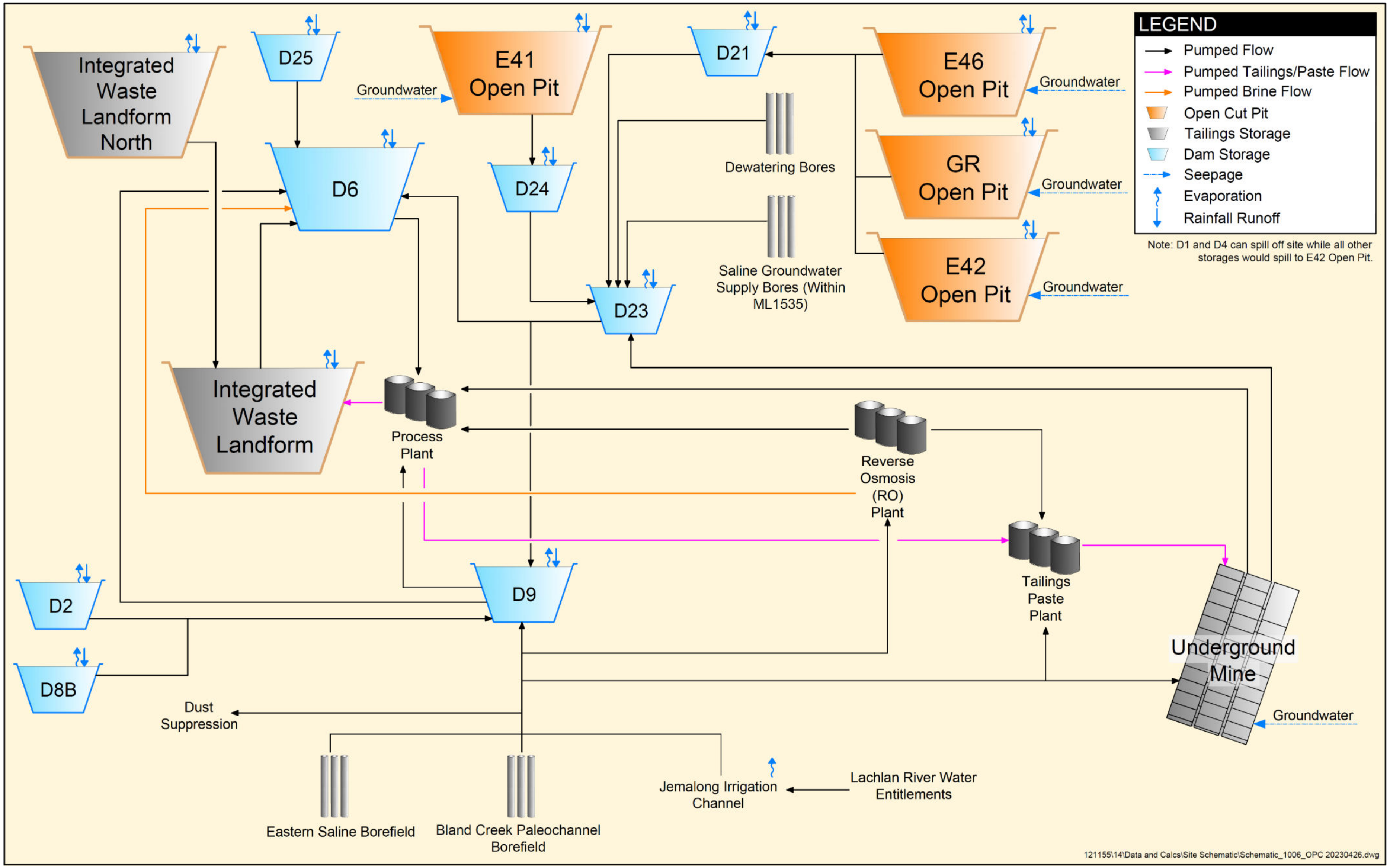
DIAGRAM 2: PROPOSED PROJECT WATER MANAGEMENT SYSTEM SCHEMATIC



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4.1.1.3 Project Tailings Disposal

As outlined in Section 3.5, the IWL is proposed to encompass the existing TSFs and provide adequate tailings storage capacity until approximately Year 9. The IWL North would provide an additional 70 Mt additional tailings storage capacity for the remaining Project life. The IWL embankments would be constructed in stages and integrate with the northern embankment of the existing NTSF and the southern embankment of the existing STSF, while the IWL North embankment would integrate with the existing IWL embankment and the northern embankment of the existing NTSF. A cut-off trench would be constructed beneath the IWL and IWL North embankments along their full perimeter to control seepage. Water for use in embankment construction (for fill conditioning and dust suppression) would be sourced from storage D2 or, if there was insufficient water in D2, from D9.

Full peripheral tailings discharge is planned for the IWL and IWL North in a manner similar to the existing TSFs as described in **Section 3.5**, with tailings discharge cycled around the storage perimeter.

Water management for the existing IWL is described in Section 3.5. Water management for the IWL North would be similar, with a single central decant, comprising a pontoon mounted decant pump located within a circular (in plan) coarse rockfill decant structure. Water would be pumped to the existing IWL and then to contained water storage D6. During the initial operation of the IWL North, temporary pumping may be required from water which accumulates between the edge of the initially forming tailings beach and the central decant; or alternatively trenches or diversion drains may be excavated to facilitate drainage to the central decant prior to the tailings beach establishing from the perimeter embankment to the central decant. AECOM (pers. comm. T. Armstrong, 26 October 2022) have indicated that it is expected there would be a reduction in the rate of recovery of water from settling and consolidation of tailings within the IWL during approximately the first two weeks of the operation of the IWL North. Such a reduction in the reclaim rate has been included in water balance modelling (refer **Section 6.1**).

A portion of the process tailings would continue to be used as underground mine paste fill – refer **Section 4.1.2.**

4.1.1.4 Expanded Lake Protection Bund System

The proposed expanded LPB (separating Lake Cowal from the Project area) comprises two components that form an arc around the expanded Project area, abutting the western lake shoreline. The components consist of an initially constructed Temporary Isolation Bund and ultimately the LPB itself. The concept is similar to the approved lake isolation system but is more extensive and does not involve a perimeter WRE. The existing lake isolation system was constructed without any adverse impacts and has been effective for approximately 19 years which includes periods when the lake level has been elevated.

Construction of the Temporary Isolation Bund and LPB is proposed in two stages (e.g. refer **MAP 5**). An initial northern stage would extend from the Lake Cowal shoreline north of contained water storage D21 to east of the E42 open pit. Thereafter a southern stage would be constructed extending from the southern end of the northern stage to the Lake Cowal shoreline south of the E41 open pit, near contained water storage D24. The proposed construction methodology for both stages is identical.

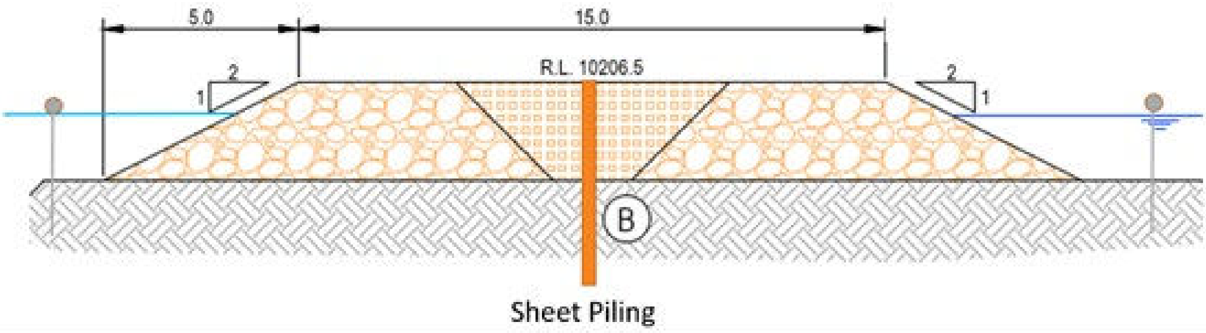
Based on modelling of the water balance of Lake Cowal (refer **Section 6.5.1**), it has been assumed that 'wet' construction of the LPB is likely to be required (i.e. requiring placement of rock fill material directly into Lake Cowal).

The Temporary Isolation Bund would be constructed initially to restrict, to a practical minimum, inflow from the lake to the LPB construction area. The Temporary Isolation Bund would be constructed using inert waste rock material end dumped and pushed from the lake shore to form a bund with a maximum crest level of 206.5 mRL[13] (refer to Appendix A of the EIS), with batter slopes not exceeding 1(vertical [V]): 2(horizontal [H]) (refer to Appendix A of the EIS). Smaller diameter material would be selectively placed within the central portion of the bund and sheet piling used to limit seepage through the bund and foundation. Prior to construction, a continuous silt curtain would be erected around the outer perimeter of the Temporary Isolation Bund, in order to trap fine sediment and control the migration of suspended material into the lake from the Temporary Isolation Bund. Any water captured behind the

[13] mRL = metres Reduced Level. An RL is the vertical distance between a ground level and the adopted level datum, which is usually taken as Australian Height Datum (the official height datum for Australia).

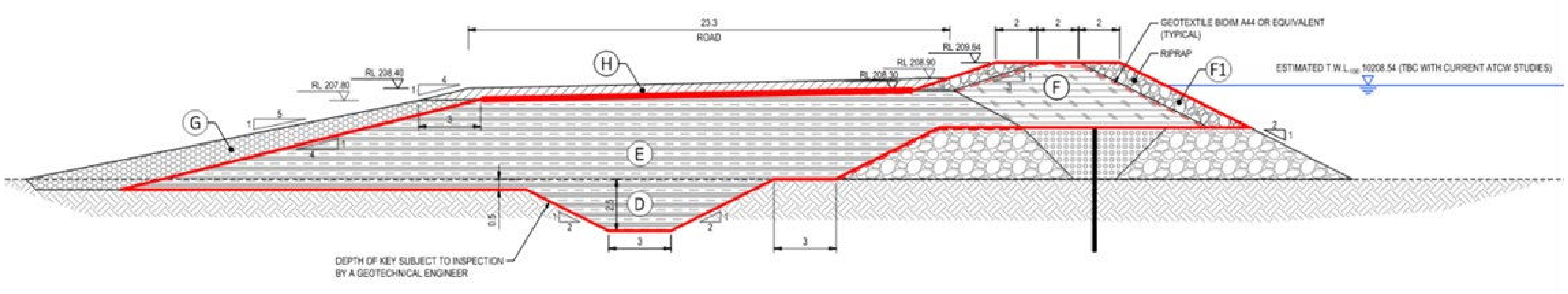
Temporary Isolation Bund (i.e. on the open pit side) would undergo water quality testing, to confirm suitability for release or treatment (if required), prior to pumped release back into Lake Cowal (refer **Section 6.5.3**). A conceptual cross-section of the Temporary Isolation Bund is available in Appendix A of the EIS and is reproduced in **DIAGRAM 3**.

DIAGRAM 3: TEMPORARY ISOLATION BUND CONCEPTUAL CROSS-SECTION



The LPB itself would comprise a low permeability embankment designed to limit, to negligible magnitudes, inflow from the lake to the Project area for the life of the Project and post-closure. The LPB would be constructed to integrate with the Temporary Isolation Bund, with the majority of material placed on the open pit side. The LPB would be constructed to a crest level of 208.9 mRL with protection bunding up to 209.64 mRL as shown in the Lake Cowal LPB Detailed Design drawings (Appendix A of the EIS). The bund will be constructed using a combination of inert waste rock material and/or engineered fill material obtained from borrow areas (including the contained water storages) within the CGO footprint area. The outer (lake side) batters of the LPB would be constructed with batter slopes not exceeding 1V:4H. A conceptual cross-section of the LPB is shown in **DIAGRAM 4**.

DIAGRAM 4: LAKE PROTECTION BUND CONCEPTUAL CROSS-SECTION



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4.1.1.5 Expanded UCDS

The UCDS has been constructed to capture and divert runoff from the catchment areas upslope of CGO and which are unaffected by CGO (refer Section 3.1). The expanded footprint of the CGO associated with the Project would necessitate reconstruction of the UCDS around the expanded footprint. The UCDS would be reconstructed prior to the expansion of the CGO footprint. The overall alignment of the expanded UCDS is indicated in **MAP 5** – once reconstructed, the alignment would not change for the life of the operation.

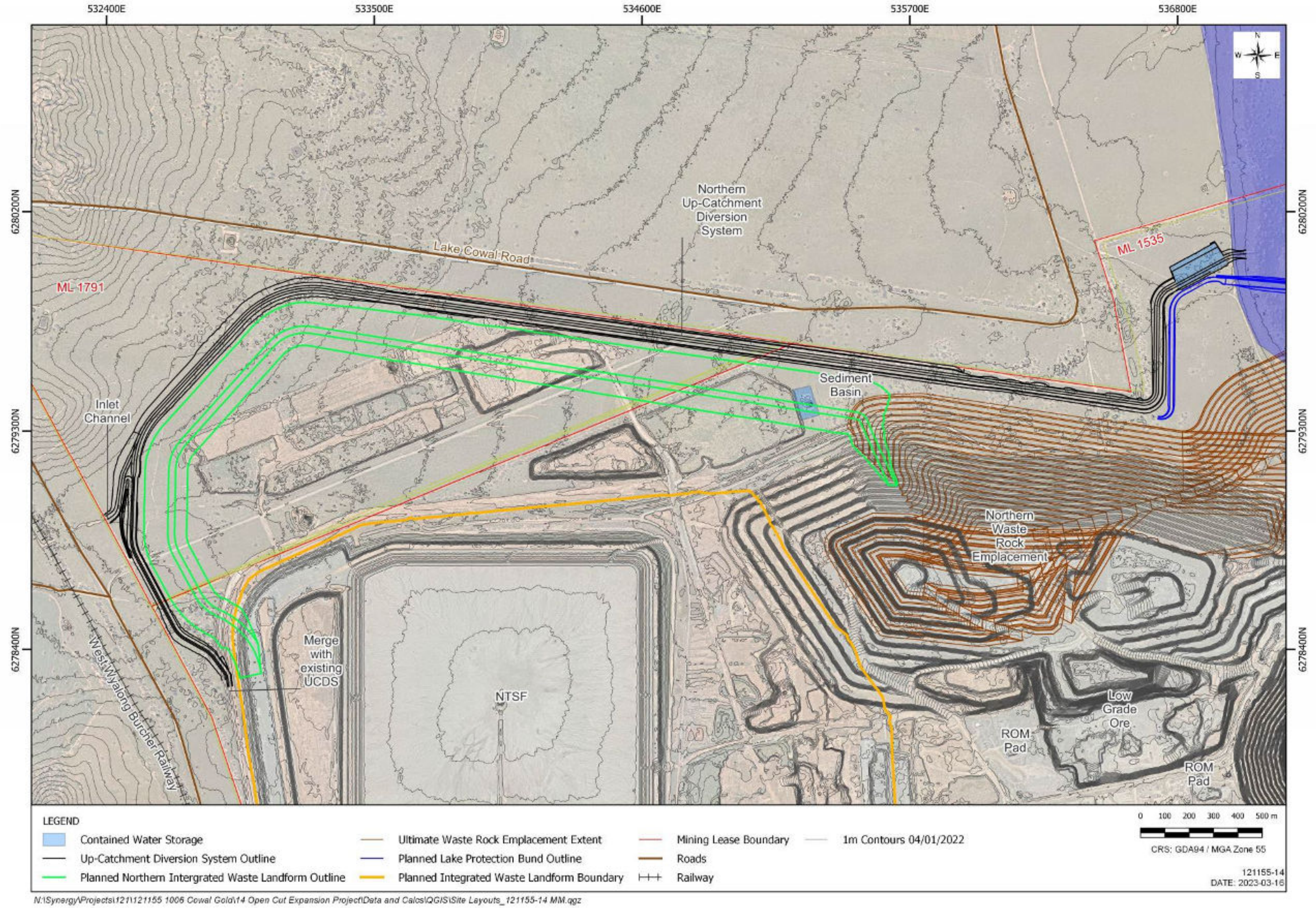
The expanded UCDS has been designed to accommodate peak flow rates up to the 0.1% AEP, with a minimum freeboard of 0.3 m above predicted peak water levels. The plan layout of the northern UCDS is shown in **MAP 9** and the southern UCDS in **MAP 10**. The UCDS channels would be aligned outside the ultimate boundaries of the IWL, IWL North, northern and southern WREs. The cross-sectional profile of the UCDS channels comprise a trapezoidal channel with base width of between 2 m and 20 m, with channel side slopes of 1V:5H. The excavated depths of the channels would vary up to 7 m below the existing surface. As well as earth fill bunds on the CGO side of the UCDS (to prevent flow into CGO), additional bunds on the outside of the UCDS have been incorporated in the design in the upper reaches of both limbs of the UCDS, to prevent flow potentially impacting neighbouring properties not owned by Evolution. Near the downstream end of each limb of the UCDS, these outside bunds are absent, allowing flow to flood out over the adjacent countryside, as sheet flow and in adjacent drainage lines, facilitating a reduction in design flow velocities.

Stilling basins have been designed at the downstream end of each limb of the UCDS. These would be constructed as excavated basins to dissipate the energy of incoming flow (i.e. to reduce the potential for scour and erosion) before allowing quiescent overflow to Lake Cowal from their eastern ends. These stilling basins are proposed as instream features designed to manage scour and erosion potential to mitigate potential impacts, particularly on Lake Cowal. The stilling basins would also temporarily form sediment basins during the construction of the UCDS and during vegetation establishment.

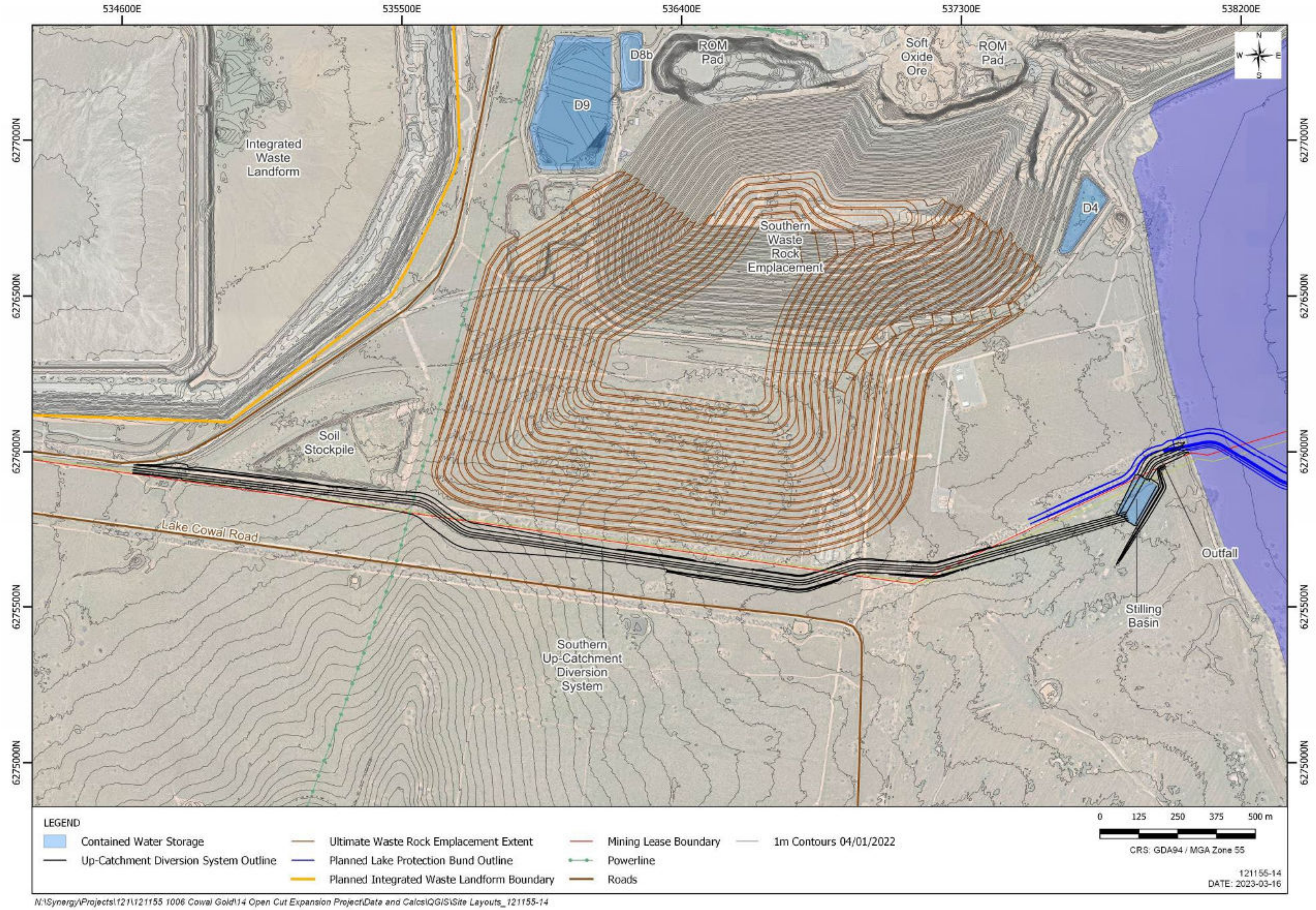
The northern limb of the expanded UCDS would extend significantly further northwards around the IWL North perimeter and would intersect an unnamed drainage line which captures the majority of the catchment to the west of the expanded CGO footprint. An inlet channel and transition into the northern limb of the UCDS has been designed to ensure a smooth transition and mitigate the risk of erosion. Areas such as channel inlets and stilling basin outfalls would include rockfill or other erosion protection, however modelling shows that revegetation would be suitable erosion protection for the majority of the UCDS.

Further details of the expanded UCDS including hydrologic and hydraulic modelling are contained in **Appendix A**.

MAP 9: LAYOUT OF EXPANDED UCDS NORTHERN LIMB



MAP 10: LAYOUT OF EXPANDED UCDS SOUTHERN LIMB



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4.1.2 Underground Mine Development

The approved underground mine development would be as described in HEC (2020). Underground mine water would be pumped direct to the process plant or to contained water storage D23.

As part of the proposed underground mine operation, a portion of the process tailings would be thickened to produce a tailings paste. This tailings paste would in turn be used to produce a backfill to support the excavated underground stopes. The paste is proposed to consist of fresh full stream tailings and a cementitious binder (Outotec, 2019). A portion of tailings would feed into a new paste plant feed tank located at the process plant. Following processing, the paste would be reticulated to the stopes via gravity flow. Water supply for the tailings paste plant would be sourced from external supplies (refer **DIAGRAM 2** and **Section 4.2**), however it is anticipated that the majority of this water would be available for recovery and re-use from underground sumps.

4.2 Water Supply

4.2.1 Ore Processing

The main water demand for the Project would continue to be the requirements of the process plant as well as underground mine operation (dust suppression and cooling water requirements), with surface dust suppression (e.g. haul roads), and other potable and non-potable uses forming a smaller portion of the total demand (refer also Section 6.3.1).

Water demand for the process plant is linked to ore processing rates and the type of ore being processed. Annual proposed processing tonnages for each Project year are given in **TABLE 9** and summarised as follows:

- the underground primary ore processing rate would rise to a peak of 2.77 Mtpa in Year 5;
- the open pit primary ore processing rates would decline to 3.91 Mtpa in Year 5 before gradually rising to a peak of 7.40 Mtpa in Year 13;
- oxide ore processing would peak at 2.2 Mtpa by Year 3, remaining at this rate before falling from Year 12;
- a peak combined processing rate of 8.9 Mtpa would be reached in Year 3 and be maintained until Year 16; and
- from Year 12 onwards, processing of underground primary ore would cease.

TABLE 9: PROPOSED PROJECT ORE PROCESSING RATES

Project Year	Oxide Ore (Mt) – Open Cut	Primary Ore (Mt) – Open Cut	Primary Ore (Mt) – Underground Mine	Total (Mt)
1	0.00	5.86	2.06	7.93
2	0.30	5.41	2.40	8.12
3	2.20	4.09	2.61	8.91
4	2.23	4.26	2.44	8.93
5	2.23	3.91	2.77	8.91
6	2.23	4.10	2.58	8.91
7	2.23	4.36	2.32	8.91
8	2.23	4.91	1.79	8.93
9	2.23	5.26	1.42	8.91
10	2.23	6.00	0.68	8.91
11	2.23	6.63	0.05	8.91
12	1.69	7.24	0.00	8.93
13	1.51	7.40	0.00	8.91
14	1.55	7.36	0.00	8.91
15	1.55	7.36	0.00	8.91
16	1.55	7.38	0.00	8.93
17	2.11	6.10	0.00	8.21
18	0.38	0.09	0.00	0.47

Mt = Million tonnes.

Note: There may be discrepancies in totals due to rounding.

The average process plant demand (total) at the above processing rates is estimated at approximately 21.6 ML/day up to the end of Year 17 (when the processing rate decreases significantly), decreasing to 19.6 ML/day between Year 1 and Year 2 when total processing rate decreases (refer also **Section 6.1.7**). The maximum water demand to accommodate processing of ore from the proposed underground mine and open cut operations is estimated at approximately 22.9 ML/day in Year 16.

Water supply would continue to be sourced primarily from on-site sources, with make-up from external water supply sources. The order of priority of water supply sources would be:

1. Reclaim from the IWL decant pond, supplemented by the IWL North decant pond when commissioned.
2. Pumping from the open pit and underground mine sumps.
3. Water from contained water storages (transferred to either storage D6 or D9 as indicated on **DIAGRAM 2**).
4. Groundwater from the eastern saline borefield via the mine borefield pipelines (consistent with existing licensed limits – refer **Section 4.2.3**).
5. Groundwater from the Bland Creek Paleochannel borefield via the mine borefield pipelines (consistent with recommended limits – refer **Section 4.2.4**).
6. Groundwater from the saline groundwater bores located with ML 1535 when lake conditions allow.
7. Water accessed from the Lachlan River via the Jemalong Irrigation Channel using regulated flow licences supplemented by allocation assignment purchased by Evolution on the open market.

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4.2.2 Saline Groundwater Supply Bores

Currently, two saline groundwater supply bores are located within ML 1535 to the south-east of the open pit (refer **MAP 1**). Continued operation of the existing saline groundwater supply bores is proposed for the Project.

Pumping tests (Coffey, 2009) indicate that the groundwater bores could supply up to 1 ML/day of saline water (with an EC of approximately 40,000 µS/cm) for use in the process plant. During periods when Lake Cowal is inundated, the bores would be shut down and capped and, as such, the bores would only operate during low rainfall periods. At various times during the Project, sourcing water from the saline groundwater supply bores would reduce demand on the other external water supply sources.

4.2.3 Eastern Saline Borefield

The eastern saline borefield is located approximately 10 km east of the Lake Cowal eastern shoreline (refer **MAP 1**). Pump tests (Groundwater Consulting Services Pty Ltd, 2010) indicated that the initially installed two bores could supply approximately 1.5 ML/day of saline water (with an EC of approximately 12,000 µS/cm). Two additional bores were commissioned in March 2022. Average extraction since commissioning of the borefield has been approximately[14] 0.44 ML/day. The borefield is currently approved to supply a maximum of 300 ML/year. However, it is understood that licensed allocation can be temporarily transferred from the Bland Creek Paleochannel borefield to boost licensed extraction from the eastern saline borefield to up to 750 ML/year per bore. Evolution hold WAL 36617 from the Lachlan Fold Belt Murray Darling Basin Groundwater Source with a total of 3,623.4 unit shares.

4.2.4 Bland Creek Paleochannel Borefield

Extraction from the Bland Creek Paleochannel borefield would continue for the Project and would continue to be limited by daily and annual licensed volumetric limits, as follows:

- maximum daily rate: 15 ML/day; and
- maximum annual extraction: 3,650 ML.

Extraction would be managed to maintain groundwater levels above established Department of Planning and Environment - Water (DPE - Water) (formerly DI-Water) trigger levels. Modelling results detailed in Coffey (2020b) indicate that a maximum continuous rate of 4 ML/day can be supplied from the Bland Creek Paleochannel borefield while maintaining groundwater levels above the DPE - Water trigger levels. However, it is intended that sourcing water from this borefield would continue in a similar manner as occurs currently, by alternating between this source and the Lachlan River to manage groundwater levels as well as providing flexibility with respect to extraction rates and the availability of allocation assignments in the Lachlan River during "good" rainfall years. Note that Evolution's records indicate an average daily extraction rate from the Bland Creek Paleochannel borefield of 3.7 ML/d from July 2007 to November 2022.

Currently, one of the Bland Creek Paleochannel bores needs to be operated while the eastern saline borefield is operated in order to provide a pressure boost to the eastern saline bore flow and ensure sufficient energy for flow to reach CGO. It is understood that the minimum Bland Creek Paleochannel flow rate is 60 m^3/hour (1.44 ML/day) – from information provided by Evolution. There will be a backflow protection valve installed to remove the potential of saline water backflow into the freshwater pipework as part of the project.

4.2.5 Lachlan River

The proposed external water supply arrangements for the Project involve continued use of water from the Lachlan Regulated River Water Source. CGO High Security (80 unit shares) and General Security (1,653 unit shares) WALs provide an annual allowance (subject to available water determinations [AWDs]) and enable additional annual extraction volumes via water allocation assignments (temporary trade of water). **TABLE 10** lists the annual volume of water extracted from the Lachlan River for use at

[14] Based on data provided by Evolution to end of November 2022.

CGO in comparison with the total volume of water usage from General Security and High Security water allocation assignments for the Lachlan Regulated River Water Source.

TABLE 10: ANNUAL CGO LACHLAN RIVER EXTRACTION AND TOTAL USAGE VOLUMES

Financial Year	Approximate CGO Extracted Volume (ML)	Total Water Usage (ML)†	Percentage of CGO Extraction to Total Water Usage
2007/2008	2,168	14,726	14.7%
2008/2009	1,504	10,172	14.8%
2009/2010	415	2,469	16.8%
2010/2011	0	56,471	0.0%
2011/2012	857	192,428	0.4%
2012/2013	1,488	356,500	0.4%
2013/2014	1,012	212,024	0.5%
2014/2015	2,001	147,697	1.4%
2015/2016	687	168,211	0.4%
2016/2017	0	184,145	0.0%
2017/2018	1,274	117,915	1.1%
2018/2019	2,309	239,175	1.0%
2019/2020	3,771	79,050	4.8%
2020/2021	804	128,536	0.6%
2021/2022	584	142,968	0.4%
2022/2023	0*	27,197‡	0.0%

ML = megalitres

† Source: https://waterregister.waternsw.com.au/

* to 30 Nov 2022.

‡ to 31 Jan 2023

The data presented in **TABLE 10** shows that CGO extracted 584 ML from the Lachlan River in 2021/22, which equated to approximately 0.4% of the total water usage from the Lachlan Regulated River Water Source. The maximum annual CGO Lachlan River water usage as a percentage of CGO total water use occurred in 2009/10 and equated to 16.8%.

Between approximately 4,000 and 274,000 ML of water allocation assignments have been made annually since records began in the 2004/2005 water year to the 2021/2022 water year[15].

TABLE 11 summarises the AWDs made for the Lachlan Regulated River Water Source from August 2015. From 1 July 2011 to 1 July 2015, the General Security AWDs were zero. As of the end of 2022 and following the recent high rainfall period, AWDs for General Security accounts were at 115%, with High Security licences at 100%.

Future water supply requirements for the Project (from external water sources and ultimately licensed extraction from the Lachlan River) have been estimated using a water balance model and reviewed against the historical AWDs made for the Lachlan Regulated River Water Source (refer **Section 6.3**).

[15] https://waterregister.waternsw.com.au/ accessed 31 January 2023.

TABLE 11: LACHLAN REGULATED RIVER WATER SOURCE AVAILABLE WATER DETERMINATIONS

Date	General Security*	High Security
1 Jul 2015	0%	100%
7 Aug 2015	4%	-**
2 Sep 2015	20%	-
2 Oct 2015	25%	-
1 Jul 2016	18%	100%
15 Jul 2016	43%	-
5 Sep 2016	52%	-
10 Apr 2017	57%	-
15 Jun 2017	59%	-
1 Jul 2017	0%	100%
14 Aug 2017	2%	-
1 Jul 2018	0%	100%
1 Jul 2019	0%	87%
1 Jul 2020	0%	70%
10 Aug 2020	-	100%
4 Sep 2020	28%	-
7 Oct 2020	32%	-
9 Nov 2020	38%	-
8 Mar 2021	44%	-
12 Apr 2021	64%	-
10 May 2021	68%	-
10 Jun 2021	70%	-
1 Jul 2021	0%	100%
8 Jul 2021	11%	-
9 Aug 2021	47%	-
8 Sep 2021	48%	-
23 Sep 2021	115%	-
8 Nov 2021	116%	-
18 Jan 2022	119%	-
8 Feb 2022	125%	-
8 Mar 2022	128%	-
22 Mar 2022	121%	-
1 Jul 2022	0%	100%
28 Sep 2022	115%	-

Source: https://waterregister.waternsw.com.au/ &
https://www.industry.nsw.gov.au/water/allocations-availability/allocations/determinations
* Tabulated AWDs accumulate through a given water (financial) year.
** "-" Indicates no change (no AWD made).

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5 POST-CLOSURE WATER MANAGEMENT SYSTEM

Consistent with CGO Development Consent DA 14/98 Condition 2.4(b), rehabilitation of final landforms or disturbed areas would continue to be undertaken progressively for the Project as soon as reasonably practicable following disturbance. Mine closure concepts and management measures are outlined in the Project's *Mine closure and rehabilitation strategy* (Appendix Z of the EIS) and would continue to be developed in accordance with the Rehabilitation Management Plan, the Rehabilitation Management Plan guidelines (NSW Resources Regulator, 2021), the Leading Practice Sustainable Development Program for the Mining Industry – Mine Closure (Department of Industry, Innovation and Science, 2016) and in consultation with the NSW Resources Regulator and other relevant regulatory authorities.

The post-closure water management strategy described in the Cowal Gold Project EIS (North Limited, 1998) included concepts for runoff reduction from WREs and TSFs, and the provision of stable drainage channels to drain site surface water to the final void. These concepts have been retained and further developed in the current CGO Rehabilitation Management Plan (Evolution, 2022b). The Project will retain the general principles outlined in the original EIS (North Limited 1998) however will develop these principles further in line with current leading practice mine closure and rehabilitation practices as described below. A conceptual post-mining general arrangement layout is shown in **MAP 11**.

5.1 Water Management Structures

The permanent (post-closure) water management structures for CGO would comprise:

- UCDS;
- ICDS (including the permanent catchment divide structures); and
- LPB.

Rehabilitation monitoring of the permanent surface water diversion systems would continue to be undertaken post-closure to determine whether the relevant rehabilitation criteria have been met (Evolution, 2022b). Silt fences and flow retention structures would be maintained to reduce the potential for off site migration of sediments until satisfactory surface stability is achieved.

5.2 Waste Rock Emplacements

As part of waste rock emplacement, top surfaces of the WRE will be managed via a series of small shallow basins (depressions), a rehabilitation cover system (including gypsum-treated subsoil and topsoil) that absorbs rainfall and comprises woodland vegetation. The use of depressions is aimed at maximising internal drainage without creating permanent ponding during normal and heavy rainfall events. Containment of runoff on the top of the WREs will also be maximised, via the use of perimeter bunds that have an internal 10(h):1(v) batter grade to ensure any runoff that ponds on surface is well away from the edges of the WRE where it could potentially cause tunnel erosion.

A layer of gypsum and then primary waste rock may be placed over oxide waste rock areas on the top surface to assist with stabilising the sodic and dispersive characteristics of the oxide waste rock. The cover material and thicknesses would be selected to be consistent with the overall objective of reducing runoff from the emplacement surface by encouraging rainfall infiltration and moisture retention in a relatively thick cover layer where it would be available for surface vegetation.

Deep rooting, high transpiration capacity vegetation species would be utilised as cover vegetation to take-up and use the available moisture in the cover layer. The final surface of the WRE areas would be purposely left with a high degree of irregularity to provide surface retention of excess rainfall for longer term infiltration and take-up in the surface cover and plant system.

5.3 Tailings Storages and Integrated Waste Landform

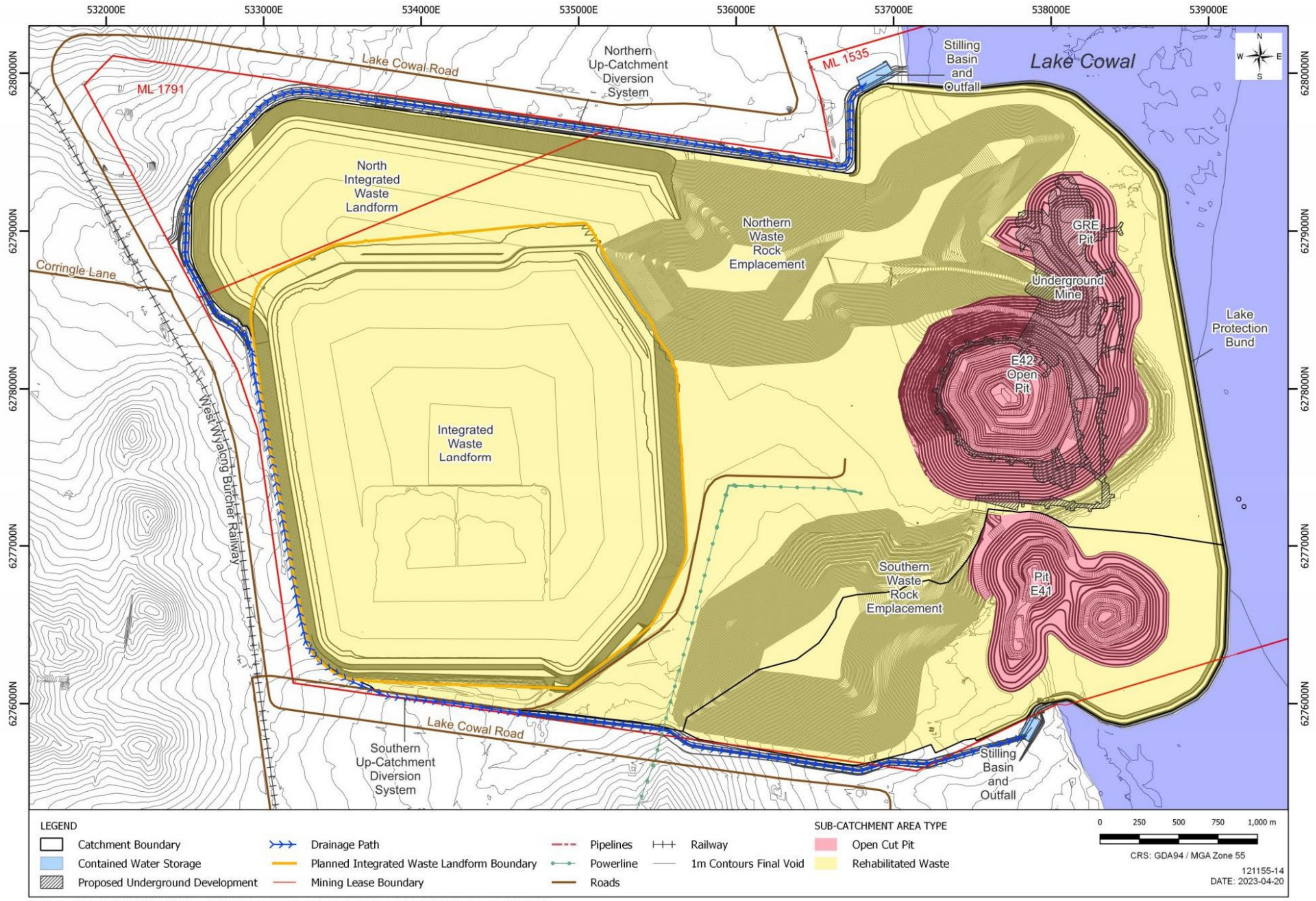
Concepts developed for rehabilitation of the IWL and IWL North comprise a combined landform, with the IWL North forming an abutting landform. External batters and berms of the IWL and IWL North will involve a similar approach as those developed for the outer batters of the WREs. The concepts developed for the top surface (i.e. tailings) include retention of the final inverted cone shape of the final beach surface which would, by virtue of the planned peripheral tailings discharge regime, slope downward from the embankment perimeters toward the central decant areas. The final surface would be covered with a relatively thick layer of low salinity sub-soil and topsoil to support a deep rooting plant cover. A capillary break layer of waste rock between the final tailings surface and the cover has also been identified as a requirement of the surface rehabilitation to prevent salt rise into the overlying soil cover layer. Planned surface irregularities, mounds and swale-like channels are also proposed for transient retention of surface runoff, to enhance moisture retention within the cover system and to provide a formal pathway for any net runoff under extreme conditions to be diverted to the final void.

Evolution is undertaking on-going WRE rehabilitation trials (using a number of different combinations of rock mulch, topsoil and gypsum) as well as rehabilitation trials on the TSFs. Results of these trials would inform the final design of the WRE and IWL rehabilitation. Consistent with the 2018 Independent Monitoring Panel Report recommendations (Bell & Miller, 2018), Evolution would continue to undertake and augment rehabilitation trials with a view to continually refine its approach to achieving large-scale sustainable rehabilitation.

5.4 Final Void

The final open pits, with the exception of the E46 pit (refer **MAP 11**), would be left as voids, while the UCDS and the ICDS would be retained. The E46 pit will be backfilled with the E46 WRE subsequently being established later in the Project life. Surface drainage from the CGO area would be diverted to the final voids via a series of low energy swales. Drainage from areas upslope of the CGO area would flow to Lake Cowal via the UCDS and existing creek lines. The final void water balance for the Project is described in **Section 7**.

MAP 11: CONCEPTUAL GENERAL ARRANGEMENT POST-MINING



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6 ASSESSMENT OF PROJECT OPERATIONAL WATER MANAGEMENT SYSTEM

The structure of this section is as follows:

- A description of the operational system water balance model structure, set-up data and assumptions (Section 6.1).
- An outline of calibration of a component of the water balance model (TSF/IWL) using monitoring data provided by Evolution (Section 6.2)
- Details of water balance model predictions for the remaining mine life (Section 6.3).
- A qualitative assessment of the possible effects of climate change on water balance model results (Section 6.4).
- An assessment of water storage interaction with Lake Cowal (Section 6.5) as a result of the Project.

6.1 Project Water Balance Model Description and Key Data

The ability of the water management system to achieve the objectives of containment of site runoff and security of supply was assessed by simulating the dynamic behaviour of the water balance over the remaining CGO (including the Project) operational life (from 27 March 2023 until 2042) under a range of different climatic conditions that may be encountered. The water balance model structure is generally as per the schematics given in **DIAGRAM 1** and **DIAGRAM 2**. For modelling purposes, the Project is simulated as commencing at the start of 2025, with the commencement of LPB construction.

6.1.1 *General*

The Project will not change the water supply sources or priority system as described in **Section 4.2.1.** The water balance model developed for the Project simulates all the inflows, outflows, transfers and changes in storage of water on-site at each model time step (i.e. 6-hourly basis). The model simulates changes in stored volumes of water in all site storages (contained water storages, TSFs, the IWL, the underground mine and open pits) in response to inflows (rainfall runoff, groundwater inflow, tailings water, groundwater bore extraction and licensed extraction from the Lachlan River) and outflows (evaporation, spill [if any], process plant use and dust suppression use).

For each storage, the model simulates:

Change in Storage = Inflow – Outflow

Where:

Inflow includes rainfall runoff, groundwater inflows to the open pits and underground mine, water liberated from settling tailings ('bleed' water – for the TSFs and IWL) and all pumped inflows from other storages, groundwater bores or the Lachlan River (via the Jemalong irrigation channel).

Outflow includes evaporation, losses from the Jemalong irrigation channel, underground loss (ventilation) and all pumped outflows to other storages or to a water use[16].

Runoff from all mine affected areas (i.e. within the ICDS) is modelled as reporting to one of the contained water storages or the open pits. Pumping rates between model storages were adopted from average transfer rates provided by Evolution and updated information to reflect current pumping rates or planned future rates.

The main water use for the Project, consistent with approved operations is for supply to the Process Plant. A priority system is in use (and was modelled) for supply to contained water storage D6 (the main supply source for the Process Plant). Supply is first drawn from the IWL (return water), the open pits, the underground mine and contained water storages. Final make-up supply is then sourced from the three water supply borefields (refer **Section 4.2.1**). Ultimate make-up supply is then drawn from Lachlan River water entitlements. Lachlan River water is sourced via the Jemalong Irrigation channel – a

[16] The model also provides for and tracks spill if the simulated storage capacity of a water storage is exceeded.

channel loss rate of 1.3 ML/day was adopted based on information provided as part of the Modification 11 Surface Water Assessment (Gilbert & Associates, 2013). This loss rate was applied to water simulated as sourced from the Lachlan River. Evolution have also advised that:

- Lachlan River water is supplied by a third party (Jemalong Irrigation Limited) on a campaign basis; and
- Supply occurs at a rate of 10 to 15 ML/day with a minimum campaign volume of 200 ML.

A rate of 10 ML/day was adopted in the model with a minimum amount pumped in any campaign of 200 ML. Pumped external supply to D9 is requested when the modelled D9 volume drops to below 60% of capacity and ceases when the volume rises above 95.5% of capacity (supply from the Lachlan River continues until the 200 ML volume is reached in a single campaign).

The model was used to assess the future external make-up water supply requirements under the range of model conditions simulated.

Contained water storages D1 and D4 (which capture runoff from WRE areas) are reliant upon pumping to transfer accumulated water to other contained water storages. Pump rates adopted in the model are summarised in **TABLE 12**.

TABLE 12: MODELLED PUMP RATES

From	To	Modelled Pump Rate (L/s)
D1	D6	400*
D2	D9	93
D21	D23	200
D23	D6 and D9	100
D24	D23	41
D3	D6 and D9	50
D4	D6	85
D5/D25	D6	83
D6	Process Plant	At Process Plant demand rate (2nd priority of process supply)
D8b	D9	93
D9	D6	440
D9	Process Plant	At Process Plant demand rate (3rd priority of process supply)
D9	Tailings pump gland water†	27
D9	Construction	At construction demand rate
E41	D24	58
E42	D3/D21	64
E46	D21	58
GR	D21	58
IWL	D6	255
IWL North	IWL	208
Underground	Process Plant	At Process Plant demand rate (1st priority of process supply)

L/s = litres per second

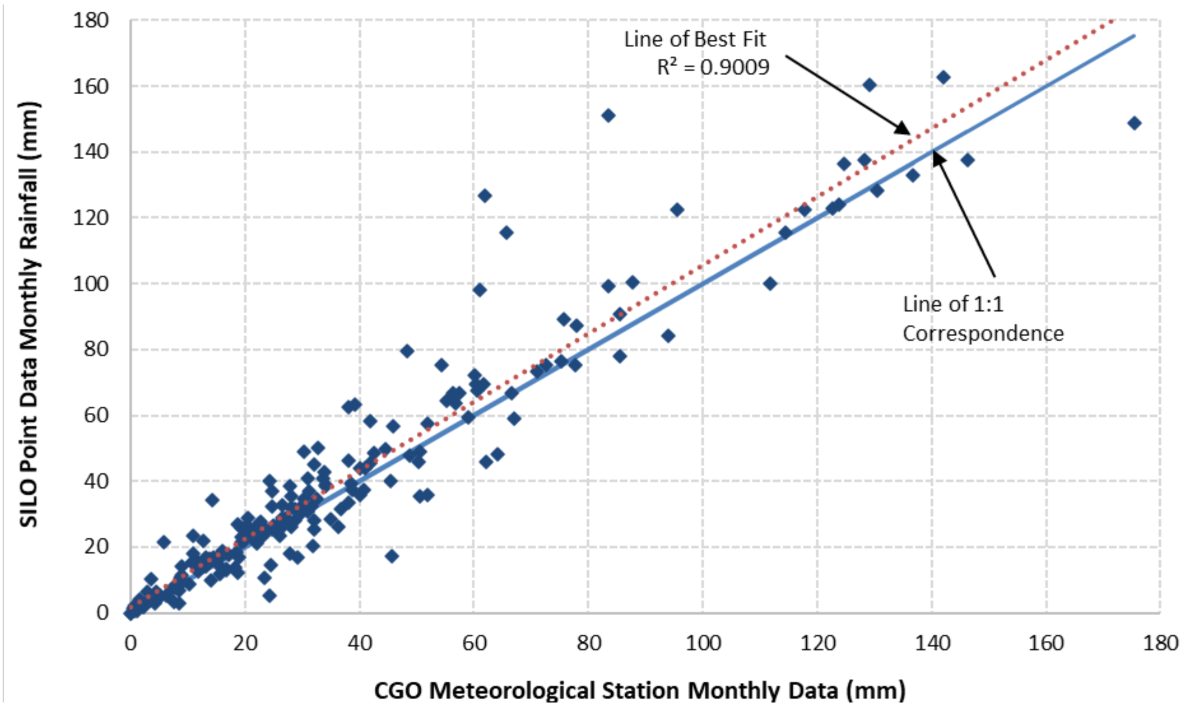
* Existing rate understood to be 200 L/s; modelled rate increased to 400 L/s to control spill risk in pre-Project period.

† Tailings slurry pumps use gland water seals to protect the pump shaft from abrasion. Ultimately the introduced water mixes with tailings slurry and is pumped to the IWL.

6.1.2 Climatic Data

A total of 134 years of daily rainfall and pan evaporation data (from 1889 to 2022) used in the model was sourced from the SILO Point Data[17]. The SILO Point Data was compared with data from the CGO meteorological station (for the period from 2007 to 10 August 2022) and found to be well correlated – refer **GRAPH 8** which shows a plot of monthly rainfall totals from the CGO record versus monthly rainfall totals from SILO Point Data.

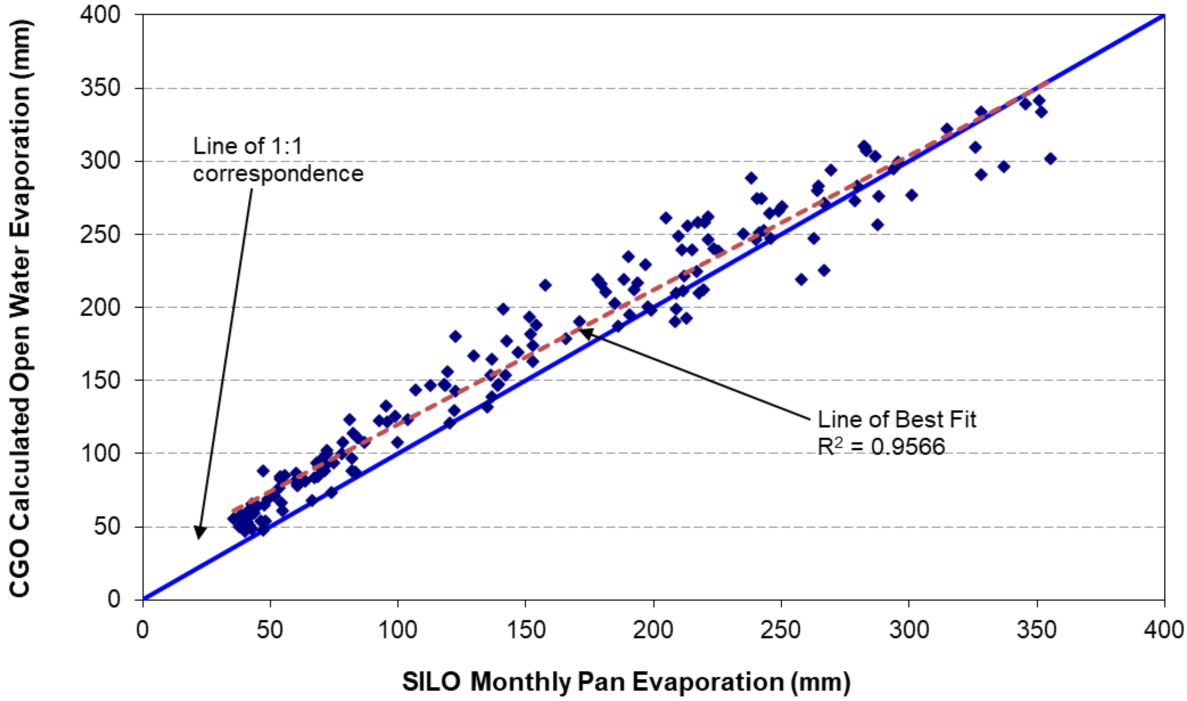
GRAPH 8: MONTHLY RAINFALL COMPARISON – CGO METEOROLOGICAL STATION AND SILO POINT DATA



Open water evaporation for CGO was calculated using the modified Penman equation (Doorenbos and Pruitt, 1977) and daily data obtained from the CGO meteorological station for the period from 2002 to 2020. A plot of monthly evaporation totals calculated for CGO versus monthly pan evaporation totals from SILO Point Data is shown in **GRAPH 9**. This plot again shows the data are well correlated.

[17] The SILO Point Data is a system which provides synthetic data sets for a specified point by interpolation between surrounding point records held by the BoM. Refer https://www.longpaddock.qld.gov.au/silo/point-data/.

GRAPH 9: MONTHLY EVAPORATION COMPARISON – CGO METEOROLOGICAL STATION AND SILO POINT DATA



Note that the inverse slope of the line in **GRAPH 9** gives an estimate of the multiplication factor to adjust SILO Point Data to estimate CGO site open water evaporation. Seasonal factors of 1.13, 1.32, 1.14 and 1.02 (autumn to summer) were derived for use in the model.

Evaporation estimates for open pits were further scaled by 0.7 to simulate the effects of shading and lower wind speed at depth. Evaporation estimates for the IWL decant water pond were also scaled by 0.8 on the basis of calibration (refer **Section 6.2**).

The model was run repeatedly, simulating 134 possible Project “realizations”, each approximately 19¼ years in length (corresponding to the remaining CGO life with the Project). The realizations were formed by moving along the SILO Point Data one year at a time with the first sequence comprising the first 19¼ years in the data, the second realization comprising the 19¼ years starting in year 2, while the third realization commenced in year 3 and so on. The start and end of the SILO Point Data was ‘linked’ so that additional realizations, which included years from both the beginning and end of the historical data, were combined to generate additional realizations. CGO recorded daily rainfall data was used from November 2006[18] to 10 August 2022 instead of the SILO Point Data.

6.1.3 Runoff Simulation

The Australian Water Balance Model (AWBM) (Boughton, 2004) was used to simulate runoff from rainfall on the various catchments and landforms across the CGO area. The AWBM is a nationally-recognised catchment-scale water balance model that estimates streamflow from rainfall and evaporation. Modelling of the following six different sub-catchment types was undertaken:

- natural surface/undisturbed;
- waste rock emplacements;
- rehabilitated areas;
- hardstand (including roads and infrastructure areas);
- open pit; and
- tailings.

[18] Date of commencement of automatic weather station operation, although the first year contained gaps that were infilled with SILO data.

AWBM parameters for undisturbed areas were taken from model calibrations undertaken for a regional stream[19]. The rainfall-runoff model was calibrated as part of the Modification 11 Surface Water Assessment (Gilbert & Associates, 2013), with a review of the tailings sub-catchment AWBM parameters and tailings initial settled density undertaken as a part of this assessment (refer **Section 6.2**). The AWBM parameters used in the model are listed in **TABLE 13**.

TABLE 13: WATER BALANCE MODEL AWBM PARAMETERS

Parameter	Natural Surface	Waste Rock	Rehabilitated Areas	Hardstand	Open Pit	Tailings
C_1 (mm)	10	5	21	2	5	0
C_2 (mm)	101.3	75	56	6	15	30
C_3 (mm)	202.7	-	120	-	-	-
A_1	0.234	0.4	0.13	0.5	0.34	0.07
A_2	0.333	0.6	0.43	0.5	0.66	0.93
A_3	0.433	-	0.44	-	-	-
BFI	0.21	0.4	0.2	0.0	0.1	0.0
K_{base} (day^{-1})	0.806	0.97	0.92	-	0.9	-
K_{surf} (day^{-1})	0.5	0.2	0.2	0.1	0.1	0.2

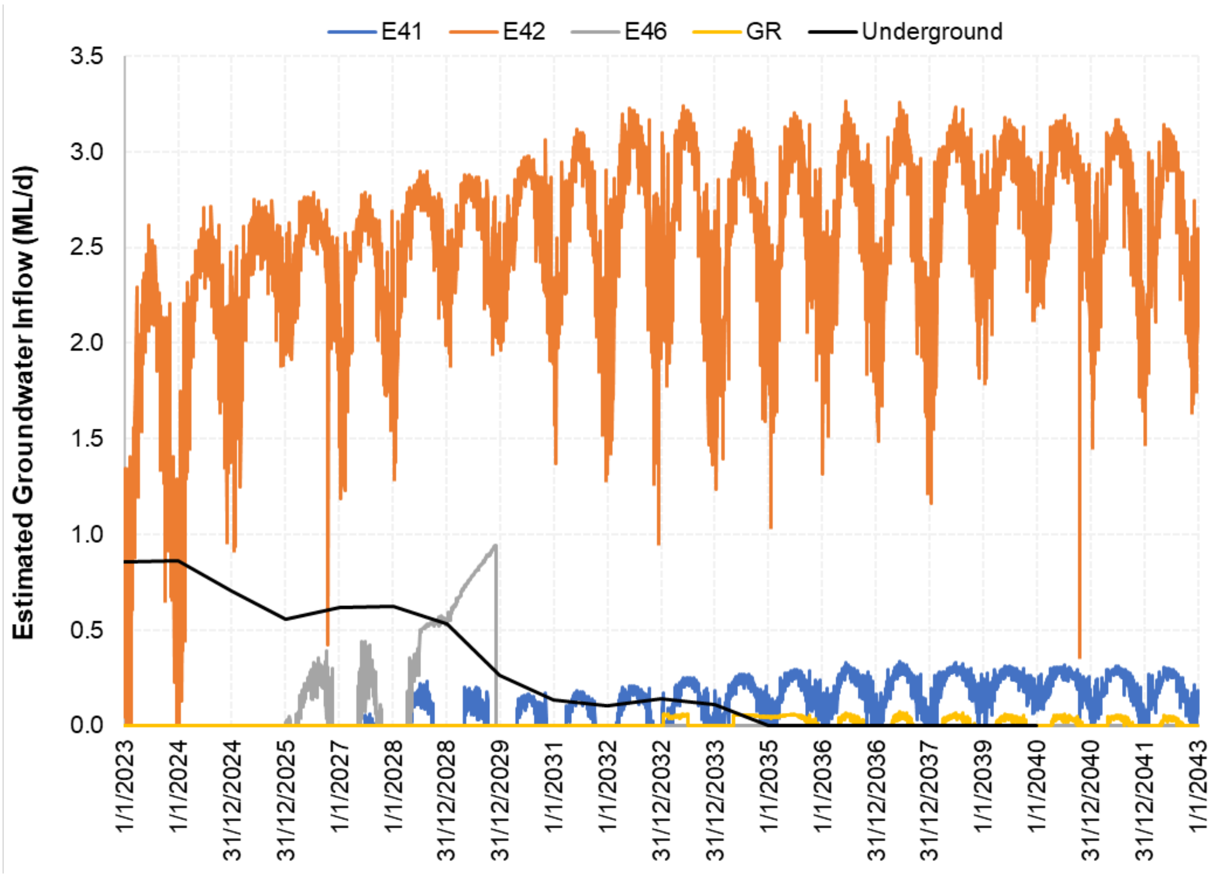
Note: An evapotranspiration factor of 0.85 was used in the model as recommended by Boughton (2006).

6.1.4 Groundwater Inflow

Groundwater inflow to the open pits and underground mine were set to a time-varying rate as predicted by groundwater modelling (Appendix H of the EIS). **GRAPH 10**: summarises the predicted inflow rates for the open pits and underground mine. Note that the open pit groundwater inflows rates have been adjusted by the groundwater consultant for estimated evaporation loss and hence vary daily.

[19]GS410048 - Kyeamba Creek at Ladysmith.

GRAPH 10: PREDICTED MINE GROUNDWATER INFLOW RATES



6.1.5 Borefield Supplies

The maximum pumped rate from the saline groundwater supply bores within ML 1535 was set to 0.7 ML/day (equivalent to 1 ML/day for 5 days/week). These bores are only available as a water source when the water level in Lake Cowal is low enough to allow access. Rather than simulating the water level in Lake Cowal as part of the water balance model, the availability of these bores was approximated by comparing the annual rainfall total for the given model year against long term median annual rainfall – if the annual rainfall in any simulated year was above the long term median, the bores were modelled as being unavailable.

The maximum rate of extraction from the eastern saline borefield was set to a maximum daily rate of 2.4 ML, based on recorded peak flow rates in 2021-2022 (from data provided by Evolution), with a maximum annual total volume of 300 ML (refer **Section 4.2.3**). These bores were modelled as available for the duration of the Project.

The maximum daily rate of extraction from the Bland Creek Paleochannel borefield was set to 10 ML, again based on recorded peak flow rates in 2021-22 (from data provided by Evolution). As described in **Section 4.2.4**, Coffey (2020b) indicate that a maximum continuous rate of 4 ML/day can be supplied from the Bland Creek Paleochannel borefield while maintaining groundwater levels above the DPE - Water trigger levels, which equates to an annual volume of 1,460 ML. This annual limit was used in the model. Note that Evolution's records indicate an average daily extraction rate from the Bland Creek Paleochannel borefield of 3.7 ML/d from July 2007 to November 2022,

Also as described in **Section 4.2.4**, in the model when water from the eastern saline borefield is being sourced, concurrent extraction from the Bland Creek Paleochannel borefield is simulated at a rate of no less than 1.44 ML/day, subject to the above annual volumetric limit.

Supply via the mine borefield pipelines (i.e. Bland Creek Paleochannel borefield, eastern saline borefield and Lachlan River water entitlements) to storage D9 was limited to 22 ML/day maximum rate based on the existing dual pipeline capacity.

6.1.6 CGO Water Demands

The process plant make-up water demand (total) is required to replace water pumped with process tailings to the IWL and to tailings paste backfill. Process plant water demand (total) was based on projected future processing tonnages (refer **TABLE 9**), tailings paste backfill volume and assumed tailings and paste backfill solids content. The total tailings tonnage, tailings paste backfill tonnage and tailings tonnage to the IWL, as provided by Evolution, are shown in **TABLE 14**.

For primary ore (based on the average tailings solids content monitored for the 2 years to the end of June 2022[20]) a solids content of 51.7% applies. The solids content was assumed to apply up to and including 2029 (a period during which oxide ore would only comprise a minor portion of the ore processed). A slightly lower solids content of 51.4% was assumed for oxide ore. It is understood that recent processing has involved the blending of primary and oxide ore and therefore the solids contents derived from recent data are likely reflective of this blend, with this blending planned to continue (refer **TABLE 9**), rather than processing of predominantly oxide ore in any year. The combination of these solids contents and the forecast tailings tonnages in **TABLE 14** give a calculated average future process plant demand of approximately 21.6 ML/day (refer **Section 4.2.1**). An additional 2.3 ML/day of tailings pump gland water was modelled supplied from storage D9, with this water discharging to the IWL/IWL North with process tailings.

As noted in **Section 4.1.2**, a portion of tailings would be processed and used to produce a backfill to support the excavated stopes. The processed tailings for paste backfill is estimated to have a solids content of 72.4%, as advised by Evolution.

A portion of process plant make-up water is required to be of high quality (low salinity water). This water is used in areas such as the semi-autogenous grinding mill and ball mill cooling towers, carbon elution circuit and scientific instrumentation, as well as the tailings paste plant. This water is produced from a reverse osmosis (RO) plant at CGO. The RO plant is normally fed by water from external water supplies only (Bland Creek Paleochannel borefield, eastern saline borefield and Lachlan River water entitlements). RO plant feed is occasionally supplied from storage D9 – as advised by Evolution this occurs when a significant volume of water is stored at CGO – this was simulated to occur when the volume in storage D9 exceeds 95% of capacity and the volume in contained water storage D2 exceeds 90% of its capacity. The modelled RO plant demand was set at 0.29 ML/day as advised by Evolution. Brine from the RO plant is discharged to contained water storage D6, with the rate of brine produced equal to 25% of the feed rate if feed is drawn from storage D9 and 20% otherwise (as advised by Evolution).

Current demand for haul road dust suppression water was set to an average 0.60 ML/day, varying monthly from 0.18 ML/day to 1.04 ML/day, based on monitored data provided by Evolution up to November 2022. Modelled dust suppression demand was set to zero on days with 10 mm of rain or more. Future demands for the Project were increased in proportion to haul road lengths estimated from future stage plans (**MAP 5 to MAP 8**) compared with those estimated from the current (2022) site plan (**MAP 4**).

Water is also required for construction works. A constant demand rate of 0.25 ML/day was set in the model for this purpose (assumed drawn from D9).

Demand for the underground mine would comprise dust suppression and cooling water requirements, estimated at a maximum rate of 2.2 ML/day in Year 1 as advised by Evolution. While the majority of this water would report to the underground sumps and be returned to the surface for re-use, it was assumed that 20% of the water sent underground would be removed as vent loss and increased ore moisture content.

[20]From data provided by Evolution.

TABLE 14: ESTIMATED TAILINGS TONNAGES

Financial Year (FY)*	Total Tailings (Mt)	Tailings to Paste Backfill (Mt)	Tailings to TSFs and IWL (Mt)
2023	8.72	0.11	8.62
2024	8.70	0.43	8.30
2025	7.93	0.80	7.13
2026	8.12	1.03	7.08
2027	8.91	1.06	7.85
2028	8.93	1.06	7.87
2029	8.91	1.01	7.90
2030	8.91	1.06	7.85
2031	8.91	1.04	7.86
2032	8.93	0.90	8.03
2033	8.91	0.62	8.28
2034	8.91	0.69	8.22
2035	8.91	0.48	8.43
2036	8.93	0.02	8.92
2037	8.91	-	8.91
2038	8.91	-	8.91
2039	8.91	-	8.91
2040	8.93	-	8.93
2041	8.21	-	8.21
2042	0.47	-	0.47

* to 30 June of year tabulated
Mt = Million tonnes.
Note: There may be discrepancies in totals due to rounding.

6.1.7 Tailings Water Reclaim

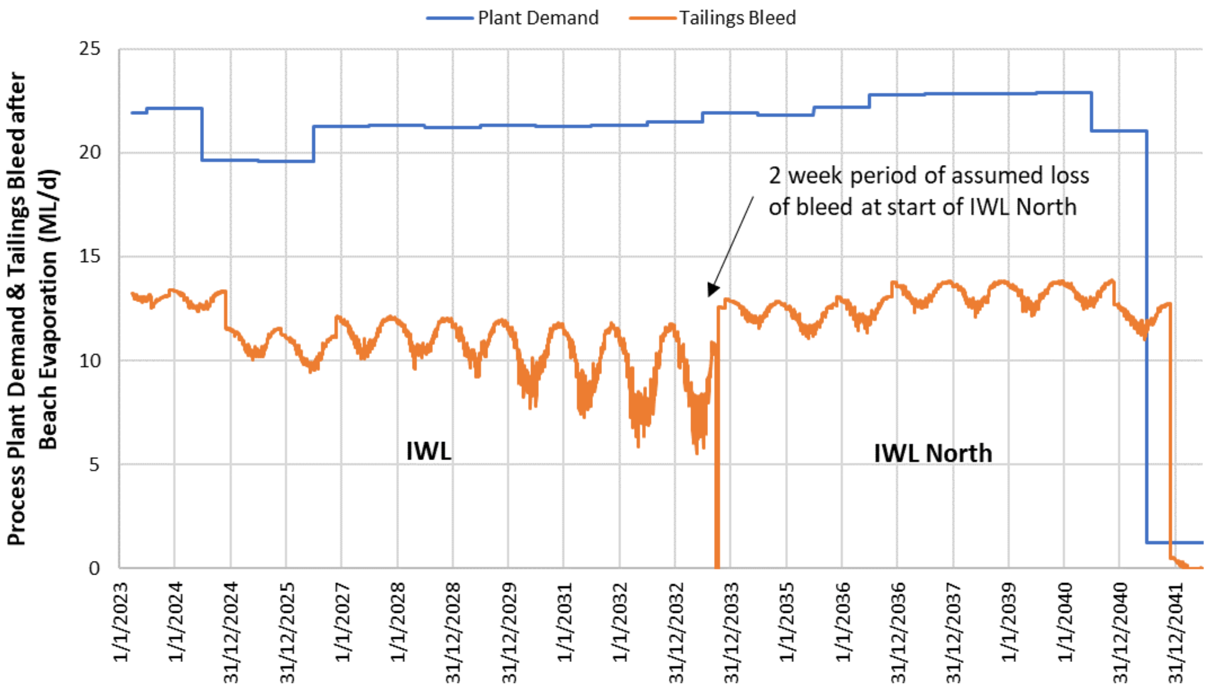
A proportion of water pumped with thickened tailings to the IWL (and previously to the TSFs) reports to the surface of the settling tailings (bleed water). This water, following evaporation from the tailings beach, together with rainfall runoff from the tailings beach, accumulates in the IWL decant pond. The rate of "bleed" is a function of the pumped tailings solids content and the initial settled tailings density. A tailings initial settled density of 1.39 t/m^3 was adopted in the model for simulating the IWL and IWL North water balance on the basis of calibration (refer **Section 6.2**). A 'wet' tailings beach area (area actively receiving tailings) of 10% of the total tailings area at any point in time was adopted for the calculation of evaporation from the tailings beach of the IWL and IWL North.

During the initial phase of tailings discharge to the IWL North, there is likely to be a period of water loss as the floor of the storage saturates and a tailings beach forms. This was modelled as a 2 week period on the basis of advice from tailings specialists[21]. During this period, all bleed water was modelled as lost.

Modelled rates of process plant demand and typical tailings bleed (for one modelled realization) are shown in **GRAPH 11**.

[21] T. Armstrong, AECOM, pers. comm., 26 October 2022.

GRAPH 11: PROCESS PLANT DEMAND AND TYPICAL TAILINGS BLEED



6.2 Water Balance Model Calibration

As discussed in **Sections 6.1.6** and **6.1.7**, the main water demand for the Project is for supply to the process plant. As indicated in **GRAPH 11**, a significant portion of plant demand is recycled from tailings reclaim via bleed water. Therefore, the prediction of tailings bleed is key to calculating process plant makeup demand.

The TSF water balance was calibrated as part of the Modification 11 Surface Water Assessment (Gilbert & Associates, 2013), using monitored site data from 2007 to 2010. With an additional 12 years' of data available, the calibration of this component of the water balance (now including the IWL) has been revised and updated as part of this Surface Water Assessment.

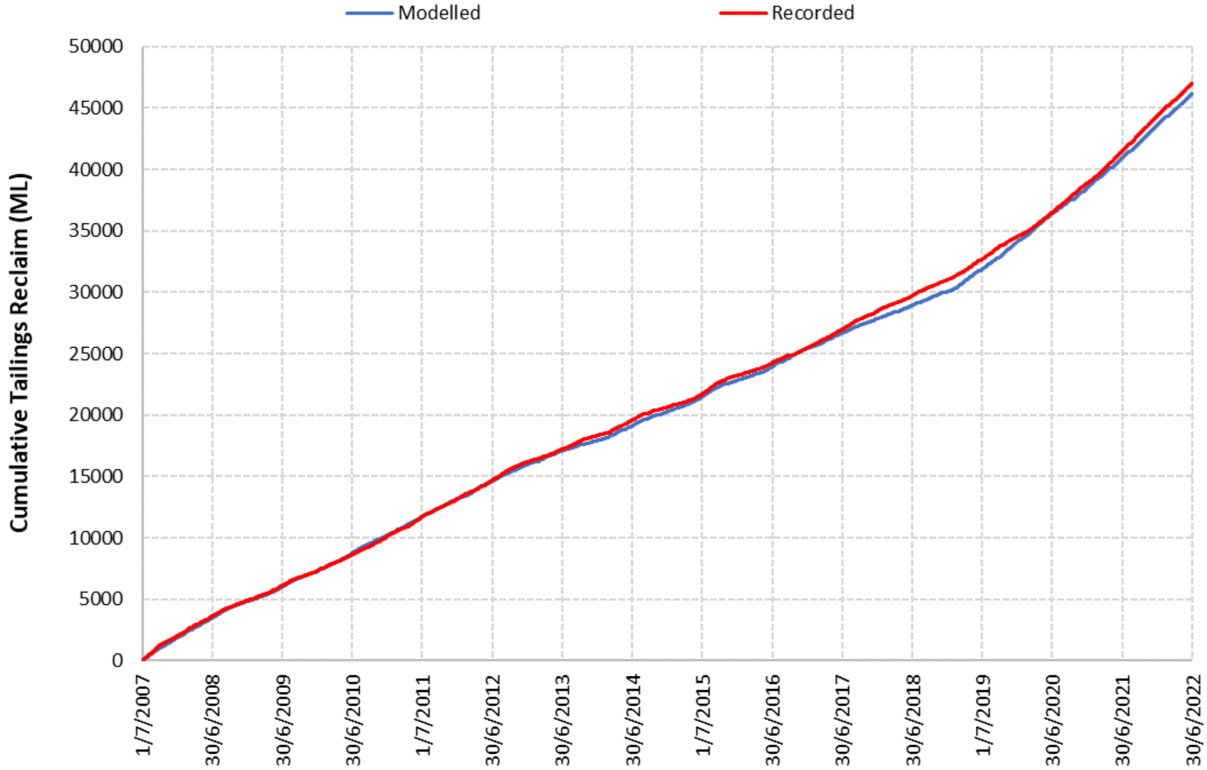
Evolution provided the following data for use in model calibration:

1. Daily tonnes of ore processed.
2. Daily solids content of tailings.
3. Daily volume of reclaim from the two TSFs and the IWL.
4. Tailings beach surface contours for the TSFs (for the STSF in 2007 and for both TSFs at 7 points in time from 2010 to 2022) and the IWL (in 2021 and 2022).
5. Daily site rainfall data.
6. Daily weather station data which was used to calculate daily evaporation rate.

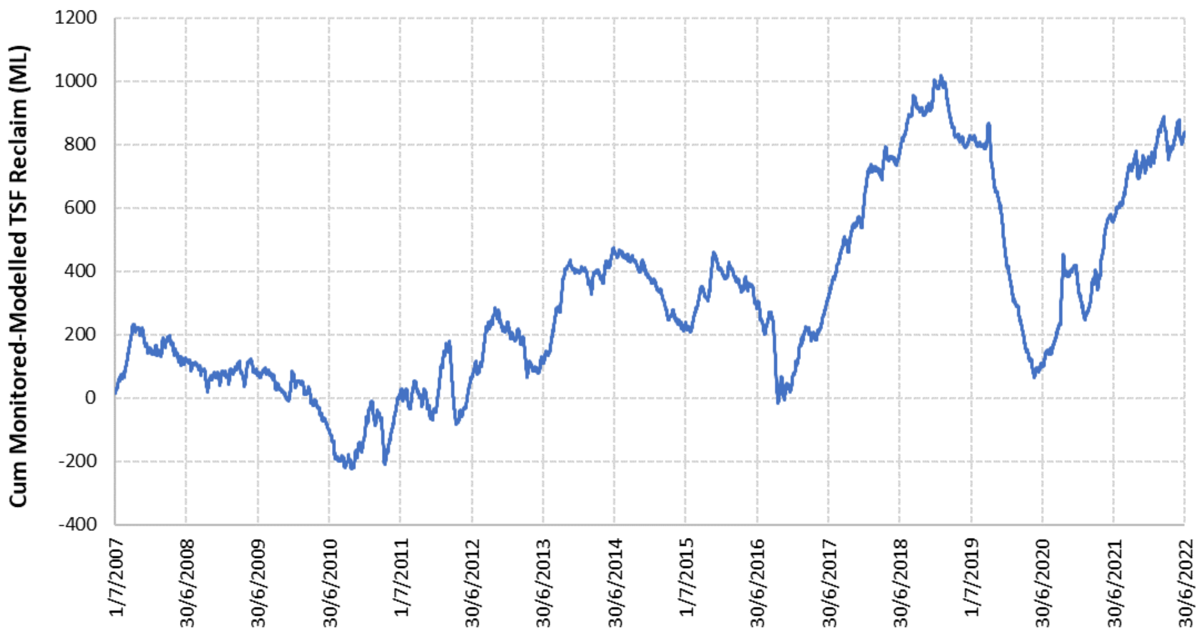
The data spanned the period from mid 2007 to mid 2022.

Items 1, 2, 4, 5 and 6 above were used as input to the model and the model was used to simulate the period of available data and output volumes of reclaim from the TSFs and IWL. The cumulative volume modelled was compared against the cumulative volume from item 3 above. Adjustments to model parameters were made to improve the match between modelled and recorded cumulative volumes of reclaim. The resulting plot of cumulative tailings reclaim volume is shown in **GRAPH 12**, while **GRAPH** 13 shows a graph of the difference between the two cumulative plots.

GRAPH 12: WATER BALANCE MODEL CALIBRATION – TSF/IWL CUMULATIVE RECLAIM



GRAPH 13: WATER BALANCE MODEL CALIBRATION – MONITORED TO MODELLED TSF/IWL RECLAIM DIFFERENCE



The data plotted in **GRAPH 12** shows an excellent match between modelled and monitored cumulative volumes, with a coefficient of determination (R^2) on daily cumulative flow of 0.9997. The data plotted in **GRAPH 13** indicates an average difference between monitored and modelled cumulative reclaim of approximately 300 ML, up to a maximum of approximately 1,000 ML over a 15 year period.

Rainfall runoff (AWBM) parameters for the tailings surface and tailings initial settled densities were adjusted as a result of model calibration. The following lists the resulting calibrated values:

- AWBM C_2 surface store capacity: 30 mm.

- An initial settled of 1.24 t/m^3 up to mid December 2010 (period of mainly oxide ore processing), followed by 1.39 t/m^3 thereafter.
- Decant pond evaporation estimates scaled by 0.8 (refer **Section 6.1.2**).

6.3 Simulated Future Performance of Water Management System

The water balance model was used to simulate the likely performance of the Project water management system over the simulated 134 climatic realizations. The model was run commencing on 27 March 2023 with storage volumes and mine conditions as they were at that date (based on data supplied by Evolution). The simulation was run until 30 June 2042 with model key data as described or given in **Section 6.1**. The model simulates no limit on extraction from Lachlan River entitlements. If borefield supplies are inadequate to meet the demands for water importation to CGO, water is sourced from the Lachlan River and is limited only by the capacity of the borefield pipelines (i.e. 22 ML/day).

Model results are presented in the sub-sections below. Note that the model results incorporate the period of time between the modelled start date (27 March 2023) and the Project start date in order to link to existing initial conditions.

6.3.1 Overall Water Balance

The forecast water balance is summarised in **TABLE 15** which gives forecast average system inflows and outflows for those model realizations which equate to the 10th percentile (low rainfall), median and 90th percentile (high rainfall) average annual rainfall for the Project life, simulated to extend from the start of 2025 to 30 June 2042. Note that 18 years is a significant period of time and that this period would contain periods of high and low rainfall for all modelled realizations.

TABLE 15: WATER BALANCE MODEL RESULTS - AVERAGED OVER PROJECT LIFE

	10th percentile Rainfall Realization (Low)	Median Rainfall Realization	90th percentile Rainfall Realization (High)
Average Rainfall (mm/year)	426.8	459.9	500.4
Inflows (ML/year)			
Catchment Runoff	2,105	2,553	3.018
Tailings Bleed	4,460	4,460	4,460
Open Pit and Underground Mine Groundwater	1,066	1,066	1,066
Saline Groundwater Supply Bores (within ML 1535)	6.9	4.7	1.8
Bland Creek Paleochannel Bores	870	782	627
Eastern Saline Bores	298	299	300
Lachlan River Licensed Extraction*	760	632	362
Total Inflow	**9,566**	**9,795**	**9,833**
Outflows (ML/year)			
Evaporation	1,644	1,731	1,758
Haul Road Dust Suppression	279	278	276
Construction Water	91	91	91
Process Plant Supply	7,475	7,475	7,475
Overflow	0	0	0
Underground Mine Vent Loss	74	74	74
Total Outflow	**9,564**	**9,649**	**9,674**

ML/year = megalitres per year mm/year = millimetres per year

* Modelled volume of water actually reaching CGO – excludes irrigation channel losses (refer **Section 6.1.1**).

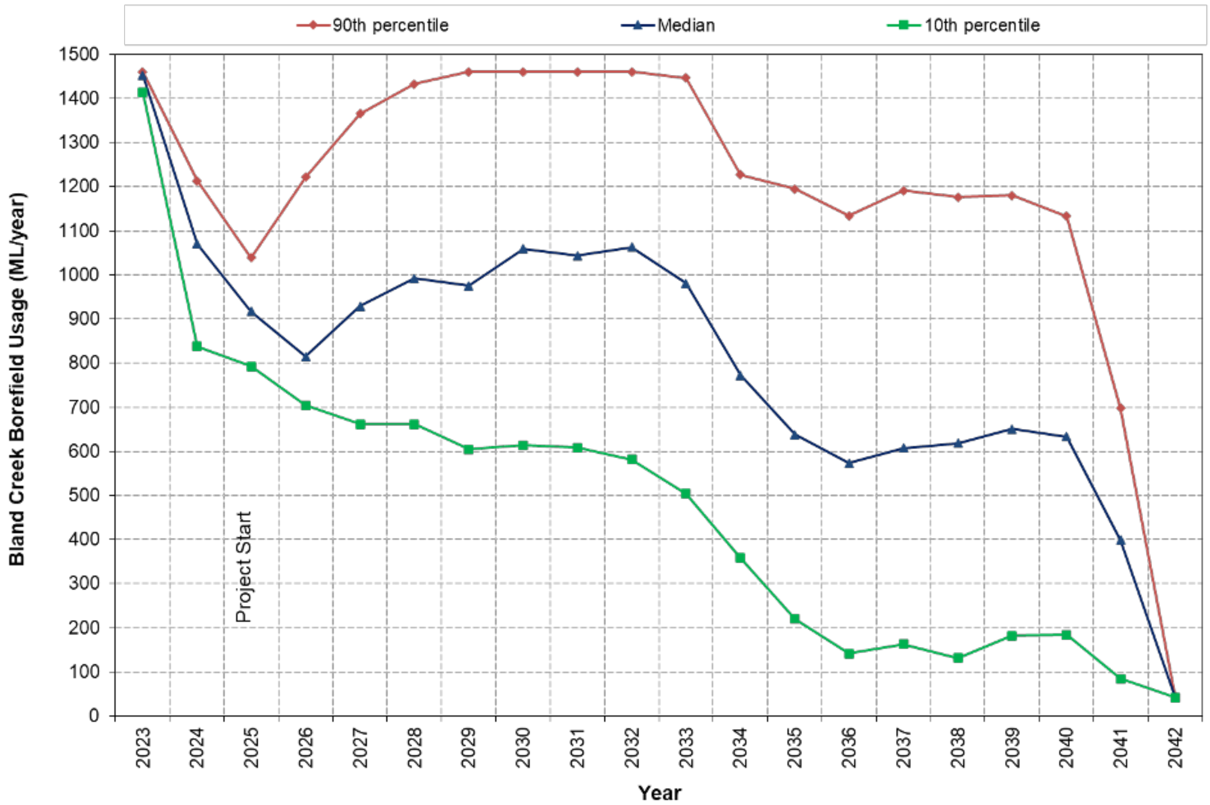
The results summarised in **TABLE 15** show that, for the median rainfall realization, the predicted total inflows average 9,795 ML/year while total outflows average 9,649 ML/year. Model results indicate that an average of 782 ML/year would be required to be sourced from the Bland Creek Paleochannel bores based on the median rainfall sequence - equivalent to 2.1 ML/day. Model results indicate an average 760 ML/year requirement from Lachlan River licensed extraction for the 10th percentile (low) rainfall realization. The average Lachlan River licensed extraction rates tabulated above represent a decrease or a slight increase compared with the values forecast in the Underground Mine Project Surface Water Assessment (HEC, 2020): the average annual rate for the median rainfall realization has decreased from, 686 ML/year to 632 ML/year, the value for the 10th percentile rainfall realization has slightly increased from 754 to 760 ML/year, while the value for the 90th percentile rainfall realization has decreased significantly from 676 ML/year to 362 ML/year. The average extraction rate from the Bland Creek Paleochannel and eastern saline bores is predicted to decrease compared with values given in HEC (2020): the average annual rate of extraction for the eastern saline bores for the median rainfall realization has decreased from 430 ML/year to 299 ML/year, while the average annual extraction from the Bland Creek Paleochannel bores has decreased from 1,628 ML/year to 782 ML/year.

6.3.2 CGO Annual External Water Demand

The total demand from external sources (the eastern saline borefield, the Bland Creek Paleochannel borefield and licensed extraction from Lachlan River water entitlements) in **TABLE 15** for the median rainfall realization averages 1,713 ML/year. This compares with 2,592 ML/year predicted as part of the Underground Mine Project Surface Water Assessment (HEC, 2020), indicating that reliance on external sources is likely to decrease as a result of the Project. This is related to an increase in simulated tailings bleed (based on calibration of that component of the model – refer **Section 6.2**), the increase in the catchment area of the CGO and the number and depth of open pits planned as part of the Project (refer **Section 4.1.1.1**).

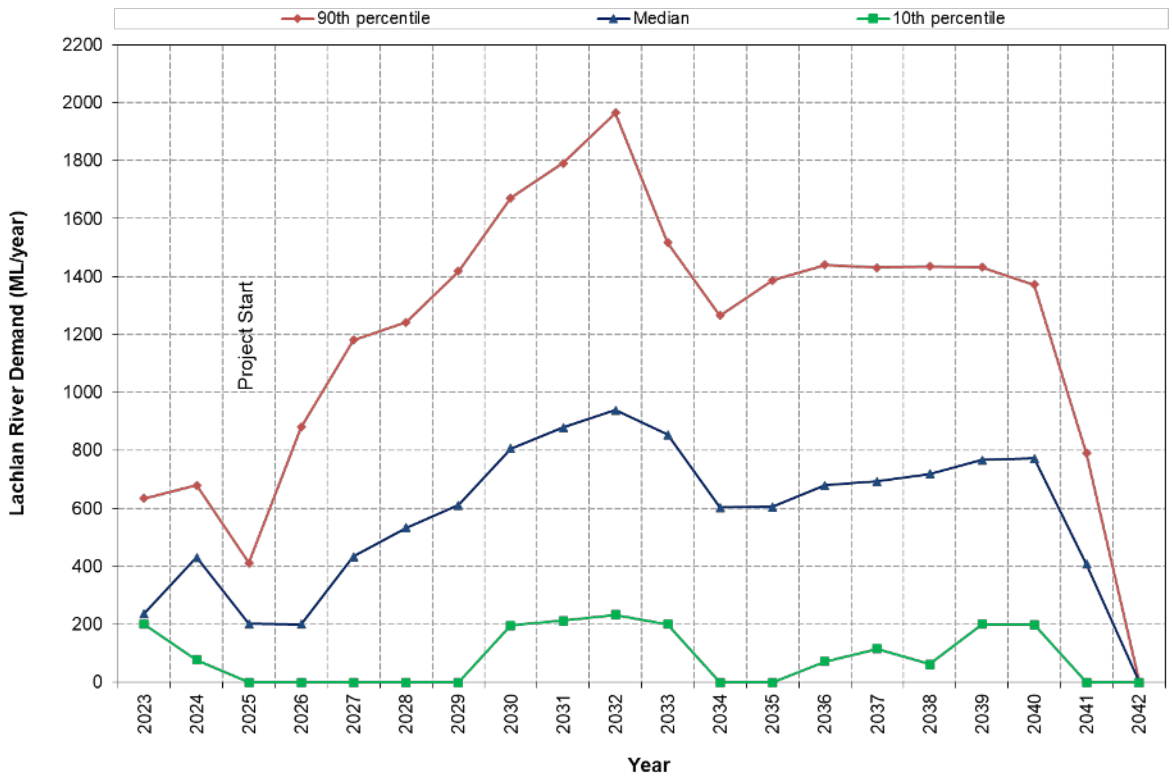
The annual distribution of forecast water demands from the Bland Creek Paleochannel borefield and Lachlan River Licensed Extraction are shown in **GRAPH 14** and **GRAPH 15** as probability plots over the forecast period – i.e. the 10th, 90th and median forecast annual volumes compiled from all 134 realizations. The 90th percentile results for each forecast year are only exceeded in 10% of 134 modelled realizations, while the 10th percentile volumes are exceeded in 90% of modelled realizations. There is a predicted 80% chance that the forecast volumes will fall between the 10th and 90th percentile results in each year. It is important to note that none of these plots represents a single climatic realization (unlike the results presented in **Section 6.3.1**) – these probability plots are compiled from all 134 realizations - e.g. the median results do not represent the results for the median climatic conditions. These percentile plots indicate ranges within which the predicted annual volumes could vary, within these risk or confidence limits/levels. The forecast supply from the eastern saline borefield is approximately 300 ML/year for all complete years modelled, for the 10th, 90th and median statistical results.

GRAPH 14: PREDICTED ANNUAL BLAND CREEK PALEOCHANNEL BOREFIELD USAGE



The results in **GRAPH 14** indicate the median annual demand from the Bland Creek Paleochannel borefield is predicted to be approximately 800 to 1,100 ML/year until 2033 before declining with the commissioning of the IWL North, which is likely associated with an increased CGO total tailings area (the tailings sub-catchment has a relatively high modelled runoff rate) and a higher forecast bleed rate (after evaporation) from the IWL North (refer **GRAPH 11**). A reduction in forecast production and demand from 2041 (refer **GRAPH 11**) results in a reduction in demand towards the end of the forecast period.

GRAPH 15: PREDICTED DEMAND FOR ANNUAL LACHLAN RIVER LICENSED EXTRACTION



The results in **GRAPH 15** indicate the median annual demand from the Lachlan River is forecast to increase up until 2032. Thereafter the demand follows a similar pattern to the Bland Creek Paleochannel borefield.

The maximum predicted annual demand from the Lachlan River is approximately 1,965 ML based on the 90th percentile model results. Based on DPE - Water trading records (refer **Section 4.2.5**), there has been adequate allocation assignment water available on the market from this source in previous years to meet this predicted demand requirement even in the event of zero AWD.

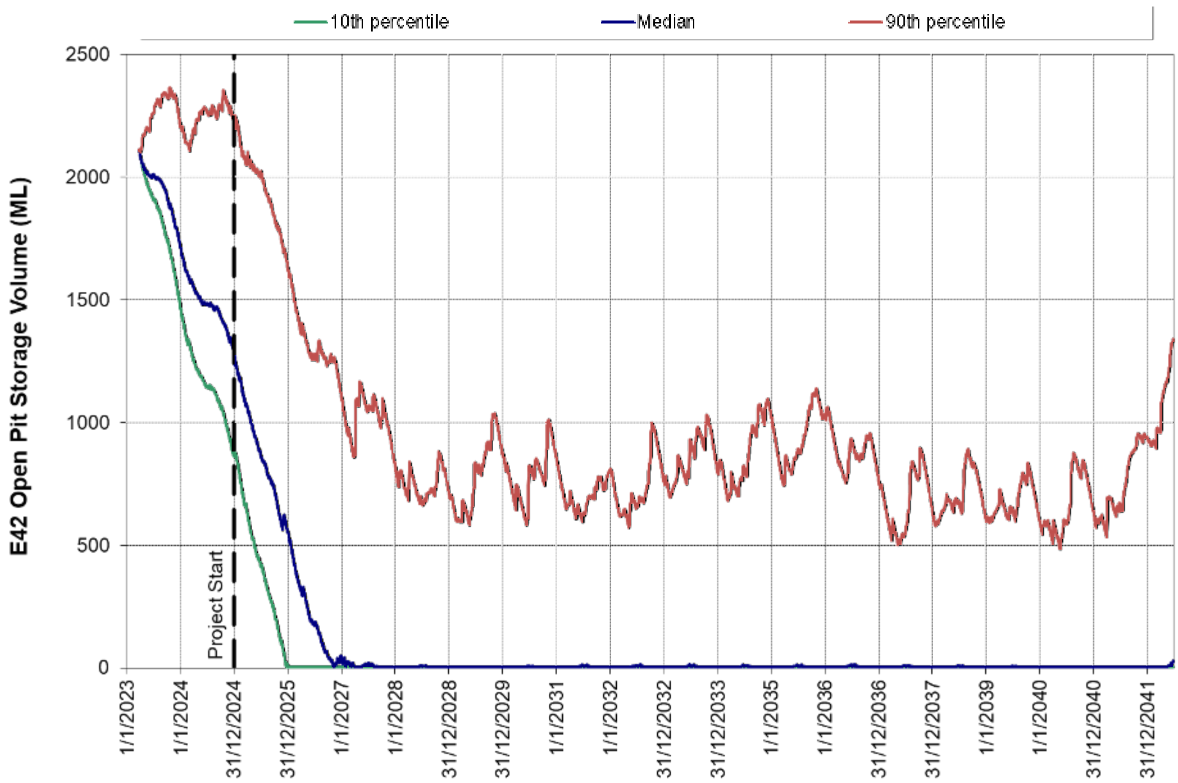
6.3.3 Supply Shortfall

No supply shortfalls were predicted for any of the 134 water balance model simulations, subject to the supply demand being available from the borefields and the Lachlan River.

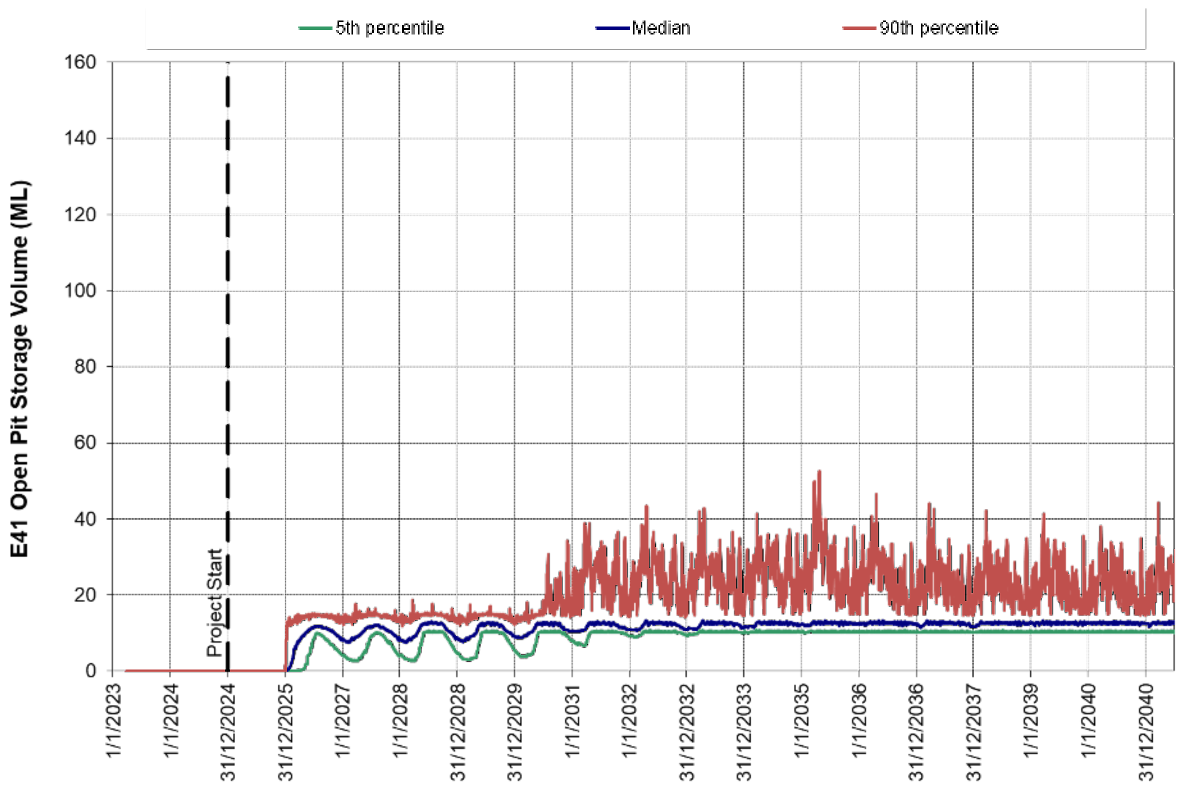
6.3.4 Open Pit Water Volumes

Forecast stored water volumes in open pits E42, E41, E46 and GR are shown as probability plots compiled from all 134 modelled realizations in **GRAPH 16** to **GRAPH 19**. It is again important to note that none of these plots represents a single climatic realization as these probability plots are calculated from all 134 realizations - e.g. the median results do not represent the results for the median climatic conditions.

GRAPH 16: PREDICTED E42 OPEN PIT WATER VOLUME

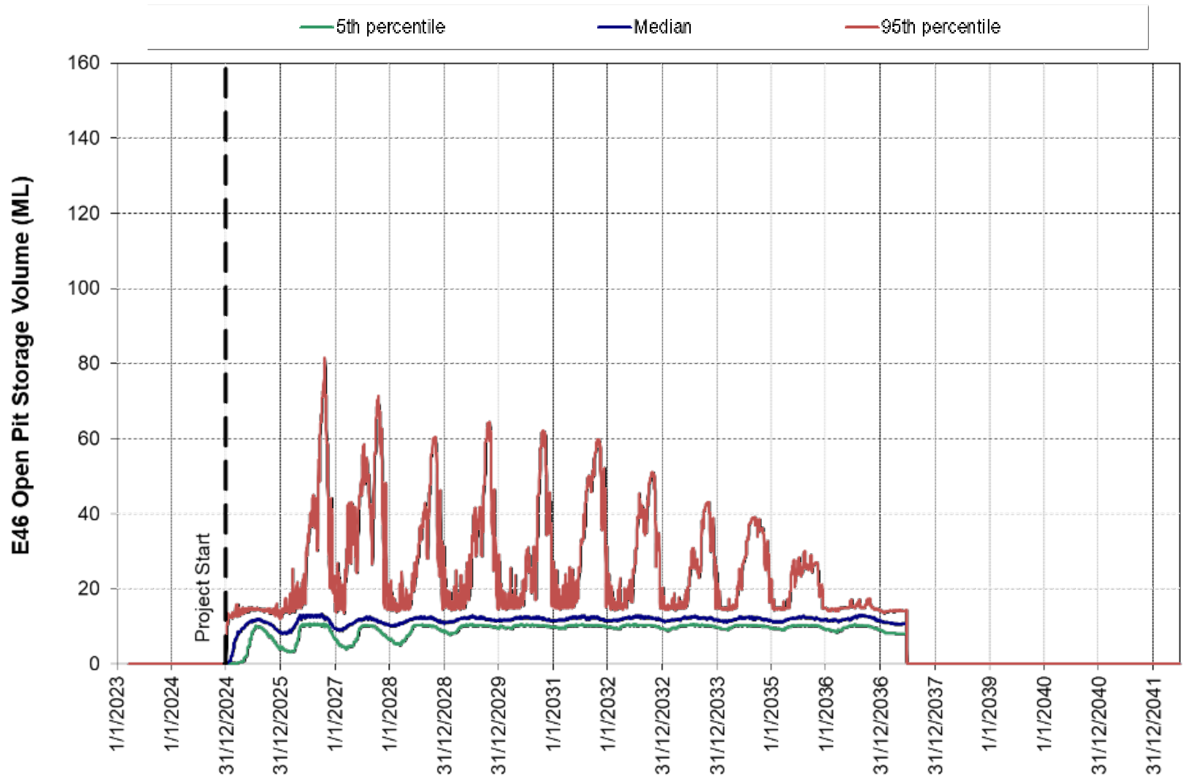


GRAPH 17: PREDICTED E41 OPEN PIT WATER VOLUME

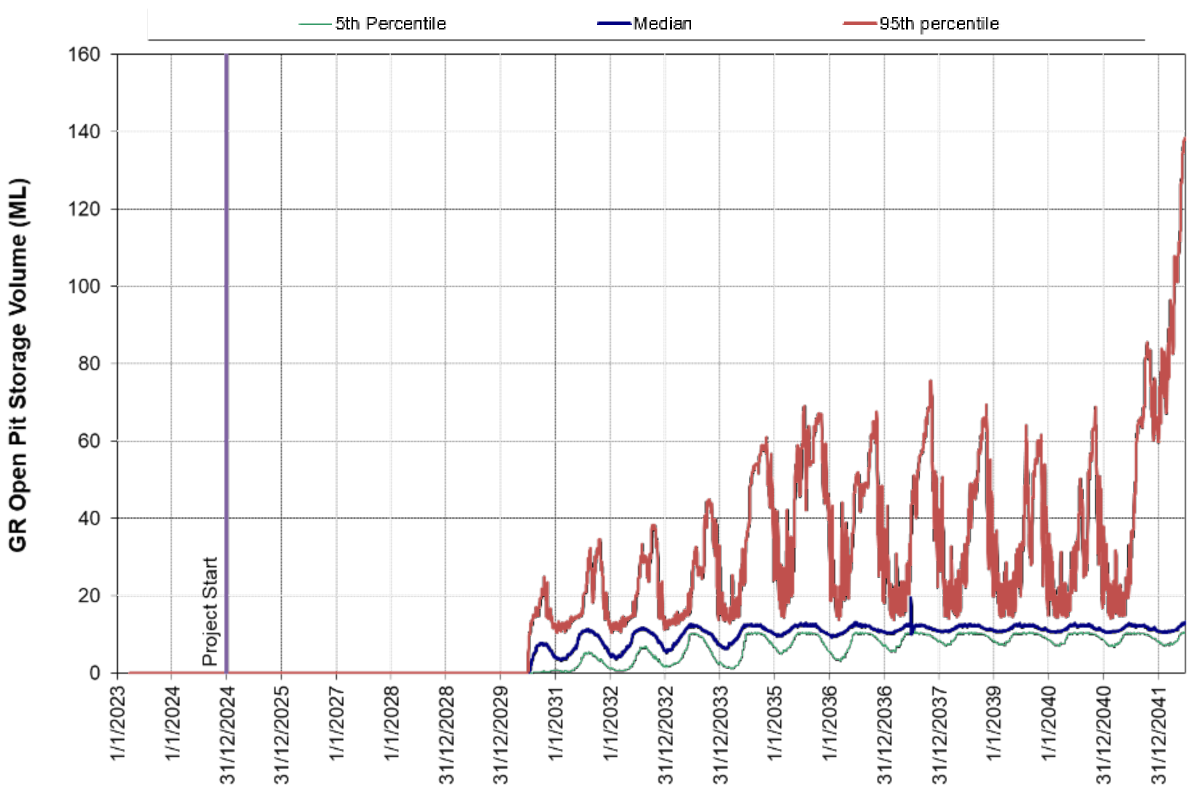


TAILINGS.WATER.WASTE.

GRAPH 18: PREDICTED E46 OPEN PIT WATER VOLUME



GRAPH 19: PREDICTED GR OPEN PIT WATER VOLUME



The existing E42 open pit contains approximately 2,100 ML (as at March 2023 – the start of the simulation period). Pit dewatering should see the E42 stored water volume decrease, however, given its significant catchment area and several contained water storages simulated as spilling to this open pit (refer **DIAGRAM 2**), there is a risk (illustrated by the 90th percentile plot in **GRAPH 16**) that the E42 open pit may experience an increase in water volume at times during and following higher rainfall.

Model results indicate that water volumes in open pits E41, E46 and GR are forecast to be much lower than E42 as these open pits do not receive overflow from the contained water storages (all overflows from contained water storages are simulated to report to E42). Any increase in water volume in these open pits is likely to be relatively small and short term.

6.3.5 Forecast Spills from Contained Water Storages

Contained water storages D1 and D4 currently could spill off site. Their catchments and pumping systems are managed to control catchment inflow and dewater the storages in between rainfall events. Upon expansion of the LPB, D1 and D4 would be contained within CGO (refer **MAP 5**) (i.e. by the end of Year 2 of the Project) and would no longer be able to spill off site, eventually being consumed by expanded WREs.

No off site spill is predicted from contained water storages D1 and D4 prior to containment by the expanded LPB in any of the modelled realizations. This result is contingent on an increase in the D1 pumping rate from 200 L/s to 400 L/s (refer **TABLE 12)**.

Spills could occur from other existing or planned contained water storages, however these would be contained within the ICDS, ultimately reporting to the E42 open pit.

6.4 Climate Change Effects and Water Balance Implications

Recent (post 1950) changes to temperature are evident in many parts of the world including Australia. The Intergovernmental Panel on Climate Change (IPCC) has, in its most recent (sixth) assessment (2021), concluded that:

> *It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred.*

Predicting future climate using global climate models (GCMs) is now undertaken by a large number of research organizations around the world. In Australia much of this effort has been conducted and co-ordinated by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). CSIRO and BoM have published a comprehensive assessment of future climate change effects on Australia and future projections (CSIRO and BoM, 2015a). This is based on an understanding of the climate system, historical trends and model simulations of climate response to future global scenarios. Simulations have been drawn from an archive of more than 40 GCMs developed by groups around the world. Modelling has been undertaken for four Representative Concentration Pathways (RCPs), which represent different future scenarios of greenhouse gas and aerosol emission changes and land-use change.

Predictions of future climate from these various models and RCPs have been used to formulate probability distributions for a range of climate variables including temperature, mean and extreme rainfall and potential evapotranspiration. Predictions are made relative to the IPCC reference period 1986 to 2005 for up to 14 future time periods between 2025 and 2090. Predictions for 2025 are relatively insensitive to future emission scenarios because they largely reflect greenhouse gases that have already been emitted. Longer term predictions become increasingly more sensitive to future emission scenarios.

Assessments of likely future concurrent rainfall and evapotranspiration changes have been undertaken using the online Climate Futures Tool (CSIRO and BoM, 2015b). Projected changes from all available climate models are classified into broad categories of future change defined by these two variables, which are the most relevant available parameters affecting rainfall runoff. The Climate Futures Tool excludes GCMs which were not found to perform satisfactorily over the Australian region. The assessments assumed a conservatively high emissions scenario – RCP 8.5 (representing a future with little curbing of emissions, with a carbon dioxide level continuing to rapidly rise to the end of the century).

An assessment was performed for 2040 (i.e. close to the planned end of Project life) for the Central Slopes region of the continent which showed the mean annual change from the reference period to be -2.8% change (i.e. a reduction) in rainfall and 4.6% change (i.e. an increase) in evapotranspiration.

These effects are likely to, in the longer term, lead to small reductions in rainfall runoff in the Project area. However, the implications of climate change predictions on water management are unlikely to be significant over the Project because they are small compared to the natural climatic variability.

6.5 Interaction with Lake Cowal

The proposed surface changes associated with the Project expand on the current approved disturbance area, with the expansion of the LPB and UCDS (refer **Section 4.1.1.4** and **4.1.1.5**). This would have the following direct effects on Lake Cowal:

- A small reduction in the catchment area reporting to Lake Cowal and hence a potential effect on the long term lake water balance.
- A small reduction in the lake storage capacity and hence a potential effect on lake peak flood levels.

In addition, Lake Cowal water levels are currently elevated and there is a significant possibility that the construction of the expanded LPB would involve 'wet' construction of the lake isolation bund (refer **Section 6.5.1.3**, with water captured behind the Temporary Isolation Bund (i.e. on the open pit side) requiring management.

The above issues have been addressed in the following sub-sections.

6.5.1 Lake Water Balance Modelling

The current catchment of the ICDS is estimated at approximately 14.0 km^2 and is estimated to increase to approximately 22.7 km^2 by Year 2 of the Project. This compares with the estimated approximate 9,760 km^2 pre-CGO catchment area of Lake Cowal. Therefore, the existing area intercepted by the ICDS equates to approximately 0.14% of the Lake Cowal catchment, while, with the Project, this is estimated to increase to 0.23% - an increase of approximately 0.09%. The expanded LPB is expected to decrease the lake surface area (at its spill level to Nerang Cowal) by approximately 1.7% and its capacity by approximately 1.9%.

In order to assess the impact of the Project on the lake water balance, a water balance model of Lake Cowal was developed, with and without the Project.

6.5.1.1 Model Set-Up and Key Data

The structure of the lake water balance model was similar to that of the Project water management system, with the model simulating, on a daily time step, change in volumetric storage equal to inflows minus outflows. Inflows comprise catchment rainfall runoff, direct rainfall on the lake water surface and flood inflows from the Lachlan River, while outflows comprise evaporation and spills to Nerang Cowal and the downstream Lachlan River.

Daily climate data used in the model comprised a total of 133 years of daily rainfall and pan evaporation data (from 1889 to 2021) sourced from the SILO Point Data for a location near the catchment centroid of Bland Creek (the main tributary of Lake Cowal). The data was used to forecast a period of 133 years from the start of the Project using the historical climate data.

The AWBM (Boughton, 2004) was used to simulate runoff from rainfall for the Lake Cowal catchment. Lake catchment AWBM parameters were initially taken from calibrated parameters for the region and then adjusted as part of model calibration (refer **Section 6.5.1.2**). Rainfall on the water surface of the lake was added directly to the water balance with no catchment losses.

The lake level-volume-area relationship (used to calculate water area and level from modelled volumes) was calculated from bathymetric survey of the lake stitched together with aerial site survey information provided by Evolution. This survey file was supplemented with publicly available data of the surrounding region. A relationship between lake water level and downstream spill flow rate was estimated from the results of lake flood modelling (refer **Section 6.5.2)**).

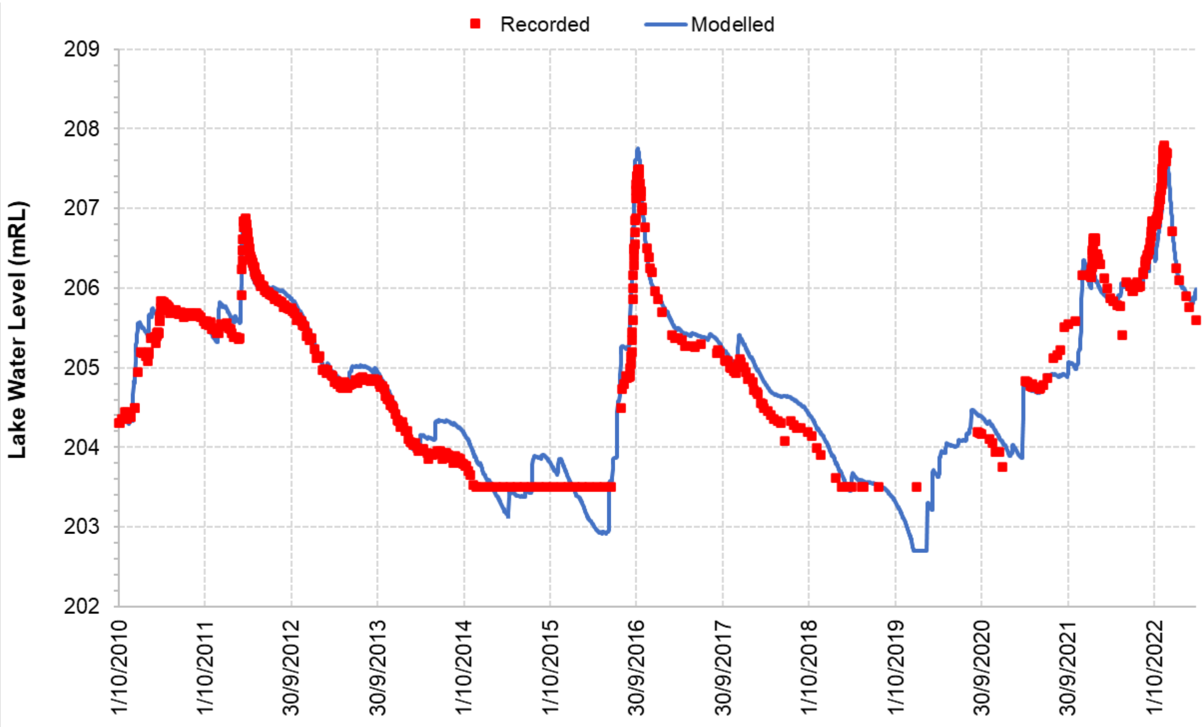
Lake evaporation was estimated based on daily modelled lake water area and SILO Point Data pan evaporation data (factored to convert pan evaporation to estimates of open water evaporation) – refer **Section 6.1.2**.

A significant component of lake inflows occur from Lachlan River 'breakout' flows – i.e. overflows from the river that occur at locations near Jemalong Weir during river high flow events. Historical daily flows in the Lachlan River at Jemalong Weir were obtained from river gauging station data[22] and were supplemented with the results of river system modelling provided by DPE[23] using the calibrated system hydrologic model of the Lachlan River. These flows were used to estimate breakout flows to Lake Cowal/Nerang Cowal, with breakout flows subject to flow routing (developed as part of model calibration).

6.5.1.2 Model Calibration

Recorded Lake Cowal water level data was supplied by Evolution for the period from October 2010 to June 2022. Modelling was undertaken to simulate the water balance using historical climate data (sourced from SILO Point Data) for this period. Model parameters (including AWBM parameters and breakout flow routing parameters) were adjusted in order to improve the match between recorded and modelled water levels. A plot of recorded and modelled water levels is given in **GRAPH 20**.

GRAPH 20: LAKE WATER BALANCE MODEL CALIBRATION



The modelled water levels in **GRAPH 20** replicate recorded levels very well. Note that lake levels below 203.5 mRL were not able to be recorded, with data records defaulting to that level when actual levels were lower. The coefficient of determination (R^2) on recorded to modelled flows, disregarding the low lake level data, is 0.95.

6.5.1.3 Model Forecast

Lake water levels were forecast using the calibrated lake water balance model using the 134 year daily SILO Point Data (from 1889 to March 2023), together with Lachlan River 'breakout' flows as described in **Section 6.5.1.1**). The forecast commenced with a lake water level at 205.6 mRL as recorded on 27 March 2023 (from data provided by Evolution). Simulations were undertaken using the existing lake catchment area and the reduced catchment area, surface area and capacity of the lake with the Project. Modelled water levels are shown in **GRAPH 21**.

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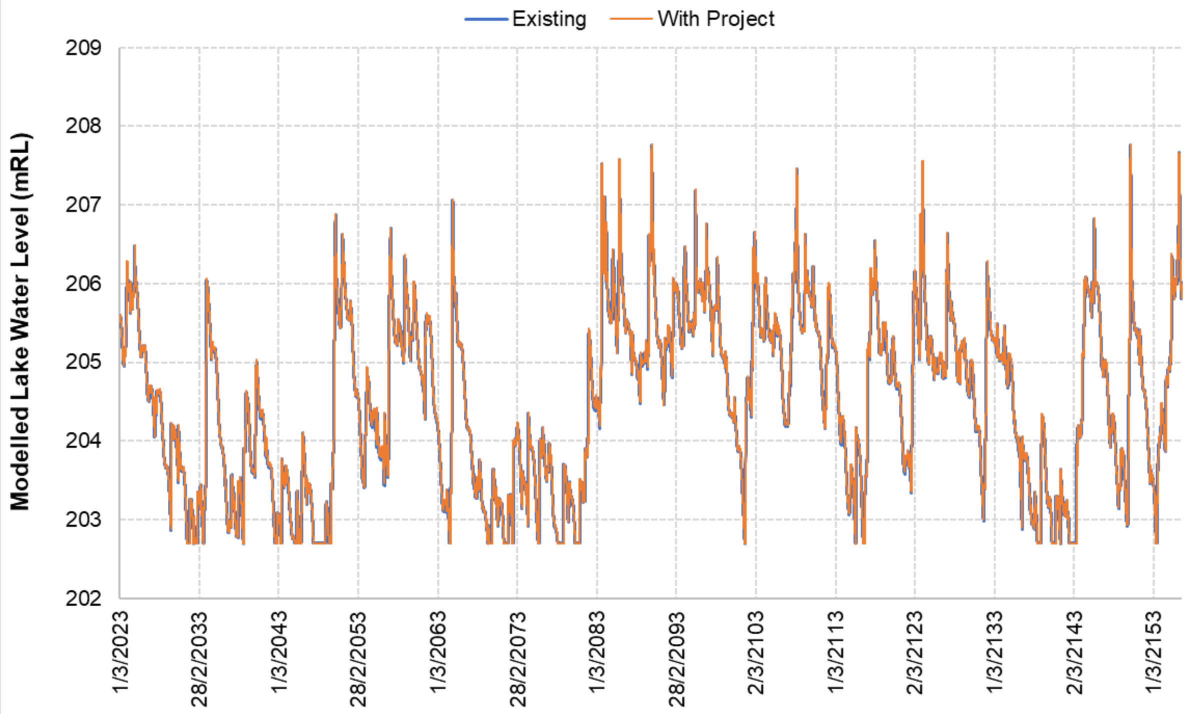
[22]Daily streamflow data record for GS412036 Lachlan River at Jemalong commencing August 1948 – downloaded from https://realtimedata.waternsw.com.au/ 30 March 2023.
[23] Data provided via email from K. Berry, Senior Modeller, Water Modelling Unit DPE, 9 May 2022.

GRAPH 21: MODELLED LONG TERM LAKE COWAL WATER LEVELS



The two sets of water levels plotted in **GRAPH 21** are very similar. The lowest lake water levels (during periods of low rainfall) are predicted to reduce somewhat as a result of the Project due to the reduced catchment area (noting that at these low water levels, the surface area of the lake would be unaffected by the expanded LPB and hence evaporation would be unaffected). The average increase in water levels over the simulation period is approximately 9 mm, while the average increase during times of high lake water levels (when lake levels are above 206 mRL) is less than 3 mm.

The modelled 134 year water balance components are summarised in **TABLE 15**.

TABLE 16: SUMMARY MODELLED LAKE WATER BALANCE

	Existing	With Project
Inflows (GL)		
Catchment Runoff	14,168	14,156
Direct Rainfall	6,555	6,462
Lachlan River Inflows	10,409	10,409
Outflows (GL)		
Spill	15,152	15,281
Evaporation	16,399	16,168

Note: GL = gigalitres or thousands of ML.

The modelled 134 year reduction in lake runoff plus direct rainfall as a result of the Project is predicted to amount to approximately 0.5% of existing runoff plus direct rainfall. Spill from the lake is predicted to increase by approximately 0.9% compared with existing modelled spill volumes.

The above predicted changes to the water balance of Lake Cowal as a result of the Project are considered to be negligible.

Lake water balance model results were also used to assess the length of time for the Lake Cowal level to fall from approximately 206 mRL (water level as at late 2022) to 204 mRL, a level which could allow expanded LPB construction to occur in substantially 'dry' conditions (i.e. without placing materials directly into the lake). The range varied from approximately 2.3 years to 17 years with a median of 3.9 years. On this basis and given proposed Project timing, it is likely that 'wet' LPB construction conditions should prevail.

6.5.2 Lake Cowal Flood Modelling

Modelling was undertaken in two parts: hydrologic modelling of the Lake Cowal catchment to assess lake inflow rates, followed by hydraulic modelling using the modelled flow rates to calculate peak flood levels.

6.5.2.1 Hydrologic Modelling

To inform hydraulic modelling, hydrologic modelling of the lake catchment was undertaken. A total catchment of approximately 10,293 km^2 reports to Lake Cowal with Bland Creek being the primary reporting watercourse. Other tributaries report via a series of irrigation channels and local creeks mainly east of Lake Cowal. The extent of the catchment modelled is shown in Map 1 in Appendix B.

Hydrologic modelling was undertaken using the RORB model (Laurenson et al, 2010). RORB is a widely accepted rainfall runoff routing model for simulating flood hydrographs (flow rate versus time) generated from rainfall events falling on the modelled catchment. RORB model rainfall losses and routing parameters were derived using guidelines provided for ungauged[24] catchments in the Australian Rainfall and Runoff flood estimation guidelines – ARR 2019 (Ball, et al, 2019). ARR 2019 guideline initial loss values are typically high because these are based on recorded events – most of which have a higher AEP (i.e. are more common) than the design events modelled. A conservative approach was taken to the selection of design rainfall losses, to reflect ARR 2019 recommendations – i.e. the adoption of relatively low values for modelled rainfall events with a low AEP (rare or extreme events).

Modelling was undertaken for three events – 1% (1:100) AEP, 0.1% (1:1,000) AEP and the Probable Maximum Flood (PMF). Rainfall temporal patterns and areal reduction factors were also obtained from ARR 2019. Rainfall for Probable Maximum Precipitation (PMP) was calculated using methods described in BoM (2005) and BoM (2006). In line with the ARR 2019 guidelines, there are 10 'ensemble' temporal patterns applicable to each rainfall event, each with different durations. Different temporal patterns were applied for three events modelled. For each rainfall event, the RORB model was run using the ten temporal patterns[25] for the range of applicable event durations. For each duration, the modelled hydrograph which produced the closest peak flow to the median peak flow (of ten) at the Bland Creek inlet to Lake Cowal was selected as the representative hydrograph for that duration. For each of the three rainfall events, the rainfall duration which gave the highest peak flow rate (i.e. the 'critical duration') was selected for use in subsequent hydraulic modelling. Model predicted peak flow rates at the Bland Creek inlet to Lake Cowal for the three modelled rainfall events are summarised in **TABLE 17**.

TABLE 17: SUMMARY OF MODELLED PEAK FLOW RATES

	1:100 AEP	1:1,000 AEP	PMF
Rainfall depth (mm)	166	235	330
Peak flow rate (m^3/s)	6,910	11,247	32,140
Critical Duration (hours)	48	48	24

Forecast flow hydrographs produced by RORB were used as inputs to the hydraulic model.

6.5.2.2 Hydraulic Modelling

Flood (hydraulic) modelling of Lake Cowal has been undertaken to simulate peak lake flood levels for a range of rare and extreme flood events, likely to be in excess of events experienced in recorded history and simulated by lake water balance modelling (refer **Section 6.5.1**). Modelling has been undertaken for existing conditions (with the existing LPB) and with the Project (with the expanded LPB) to assess changes which may occur as a result of the Project. Simulation of peak flood levels extended over an area from the southern end of Lake Cowal through to the outflow point north of Nerang Cowal to Bogandillon Creek. The model extent for the hydraulic modelling is shown in Map 2 of Appendix B.

[24] No suitable streamflow and concurrent rainfall records with recording frequency of less than one day were able to be located for the modelled catchment of Lake Cowal.

[25] Sourced from the ARR Data Hub: http://data.arr-software.org/

The aim of the flood modelling was to:

- characterise the existing flood regime and flood levels;
- assess the likely impact to flood levels as a result of the Project and consequent impacts to properties around the lake; and
- inform elevations for key Project infrastructure including the LPB, UCDS and stilling basins.

Hydraulic modelling was conducted using the two-dimensional numerical hydraulic model TUFLOW (BMT, 2018). TUFLOW is a commonly used flood modelling software system which produces predictions of flood levels, flow velocities and other hydraulic parameters in two-dimensional space using finite difference simulation methods.

TUFLOW input information includes the following:

- A digital elevation model (DEM) of the ground surface in the modelled area. A DEM of the existing topography was obtained by combining DEM data derived from Leica-Geosystems Airborne Digital Sensor (Geoscience Australia, 2021), site survey and bathymetric survey of Lake Cowal. An 80 m square TUFLOW finite difference mesh was set up using this data with a 10m sub-grid covering areas of interest, covering the full modelled area (refer Map 2 in Appendix B).
- Estimates of modelled area roughness/friction factors. The estimates for this study were obtained from interpretation of aerial and terrestrial photographs and literature guidelines.
- Flow hydrographs for the modelled events as generated from the hydrological modelling – refer Section 6.5.2.1.
- Downstream (northern) model boundary – set as a constant slope boundary at the outlet from Nerang Cowal, at the intersection between Manna Creek and Bogandillon Creek (refer Map 2 in Appendix B).
- Initial water levels within the lake were set to a level of 206.3 mRL at the commencement of the modelling period. These levels were adopted from interpretation of the DEM surface at the outflow and interpretation of historical lake water levels to simulate the lake at full capacity with overflow to Bogandillon Creek, shown in Graph 20.

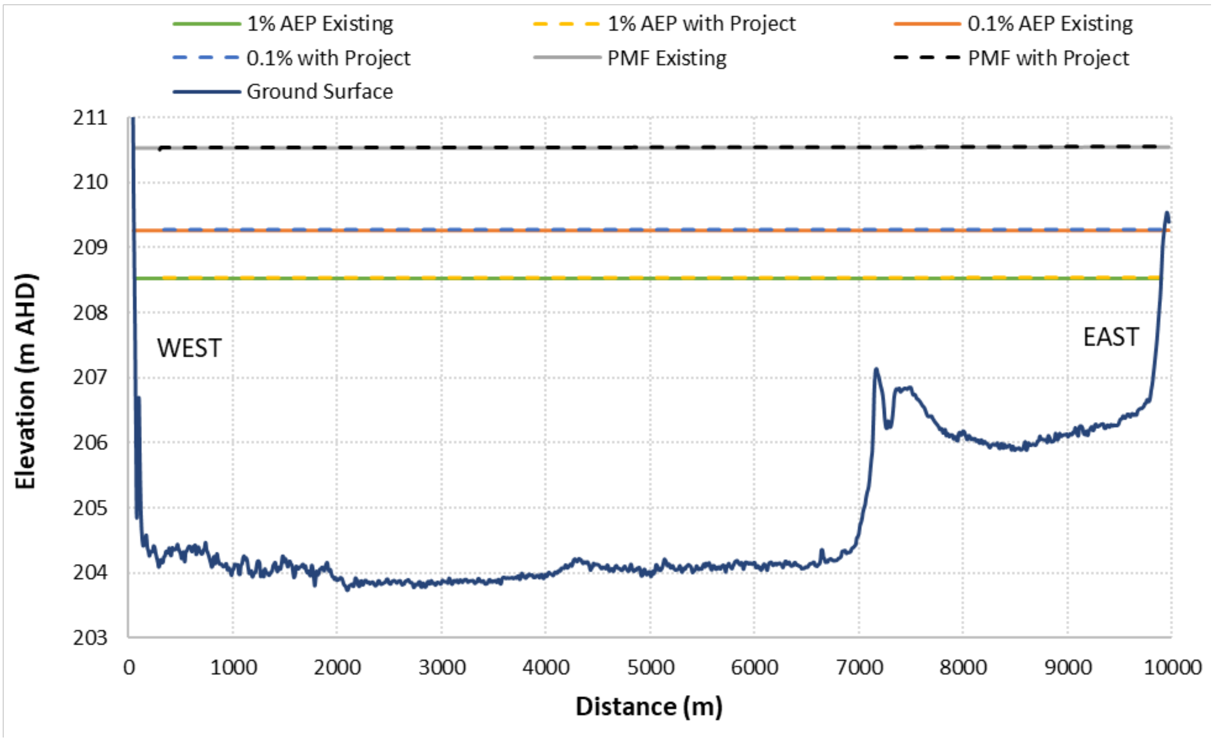
Geometric data pertaining to flow structures such as culverts, bridges and roads were not included in the hydraulic model. Due to the relatively long durations of the critical rainfall events (refer **TABLE 17**), it is expected that these structures would have a relatively low impact on the attenuation within the modelled area.

The hydraulic model uses sophisticated numerical processes to simulate routing of flows through the DEM and this is more accurate and robust than the flow routing performed by the hydrological model. The hydrologic model was however used to provide inflow hydrographs for a series of 'inflow' points at the upstream boundary of the hydraulic model (Bland Creek and surrounding minor tributaries). Flood levels predicted by TUFLOW varied with time as the simulated hydrograph passed through the modelled area – the modelled maximum flood levels for each modelled event were recorded and were used to generate predicted peak flood levels and extents presented herein.

6.5.2.3 Predicted Peak Flood Levels

Predicted peak flood levels and flow velocities for the existing conditions within Lake Cowal and with the Project (expanded LPB) are shown as a series of maps in Appendix B, for the three flood events modelled. The modelled changes in peak flood levels and velocities as a result of the Project compared with predicted flood levels for existing conditions are also given as maps in Appendix B. Predicted peak flood levels are shown in **GRAPH 22** which depicts an approximately west to east cross-section across Lake Cowal at the CGO, located as shown in Map 2 of Appendix B.

GRAPH 22: MODELLED LAKE COWAL PEAK FLOOD LEVELS



The increase in predicted peak flood level was small with an average change of 0.013 m for the cross-section for the 1% AEP, 0.014 m for the 0.1% AEP and 0.010 m for the PMF.

6.5.2.4 Floodplain Mapping

The following features have been mapped in general accordance with the NSW Floodplain Development Manual (NSW Government, 2005):

- Flood prone land;
- Floodways;
- Flood planning area.

Flood prone land is defined as land susceptible to flooding during up to a PMF event (NSW Government, 2005). PMF flood level and extent maps are included in the modelled flood mapping in Appendix B.

Floodway areas are defined as areas where significant discharge occurs during floods and are often aligned with naturally defined channels (NSW Government, 2005). This reference also outlines that the 1% AEP event is generally applicable for defining the flood limit on residential developments, encompassing majority of the landowners in the vicinity of Lake Cowal. The PMF provides the upper limit for the expected flooding and is used for emergency response planning.

Flood hazard, as defined in NSW Floodplain Development Manual, is calculated through the product of the flow depth and velocity. Interpretation of the flood modelling results, comparing the existing flood scenario with the Project flood scenario, shows a small increase in flood depth and depth-velocity product. This correlates to a small increase in the spatial distribution of flood hazard classification however this equates to a negligible change in the magnitude of the flood hazard classifications and hydraulic categories in the region defined by the modelling domain.

For the purposes of this study and in the context of Lake Cowal, in the vicinity of the Project area and local landowners, the 1% AEP flood level has been adopted for the flood planning area. Flood planning areas are shown in Map 21 in Appendix B as modelled levels for the 1% AEP flood for the existing and proposed LPB configurations. Adopting a 0.5 m increase on the 1% AEP flood levels would be recommended for the flood planning levels to account for appropriate freeboard.

6.5.2.5 *Regional Flood Management Plan*

Lake Cowal is positioned between four local government areas, however studies that have been completed do not detail flood management for Lake Cowal specifically. A previous flood assessment of Lake Cowal was undertaken by the NSW Government and is summarised in the Floodplain Management Plan - Lachlan River (Jemalong Gap to Condobolin) (NSW Department of Primary Industries Office of Water, 2012b). This assessment addressed previous concerns regarding the potential for levees to restrict the floodplain capacity and increase the flows into the lake. Assessment for both smaller and larger floods found little impact on lake flood levels.

The published Council Floodplain Risk Management Plans and Rural Floodplain Management Plans in the area do not include specific details on Lake Cowal itself hence were not considered.

6.5.3 Management of Water Captured by Expanded LPB Construction

6.5.3.1 *Overview*

As described in **Section 4.1.1.4**, the expanded LPB comprises two components, an initially constructed Temporary Isolation Bund and the LPB itself. The Temporary Isolation Bund would be constructed in two stages, to restrict, to a practical minimum, inflow from Lake Cowal to the LPB construction area and provide an opportunity for the lake level to recede ahead of LPB construction. The Temporary Isolation Bund would be constructed using primary waste rock material that would be end dumped and pushed from the lake shore to form a bund. Within the bund, smaller diameter material would be selectively placed, with sheet piling used to limit seepage through the bund and foundation (refer **DIAGRAM 3** for conceptual cross-section). In addition and prior to any Temporary Isolation Bund construction activity, a continuous silt curtain would be erected around the outer perimeter of the Temporary Isolation Bund to trap fine sediment and control the migration of suspended material into the lake from the Temporary Isolation Bund (refer **Section 8.1.3**).

During a wet construction scenario of the expanded Temporary Isolation Bund, water from Lake Cowal will be captured behind the Temporary Isolation Bund (i.e. on the open pit side). This water will require management and return to Lake Cowal. The *Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012* precludes the take of water from Lake Cowal, accordingly an application for a special purpose access licence (SPAL) under the *Water Management Act (2000)* will be made to allow this water to be taken and subsequently returned to Lake Cowal as discussed further in the Water Licensing Strategy (refer to Appendix I of the EIS).

Geo-Environmental Management (GEM, 2023) has undertaken geochemical characterisation of the CGO primary waste rock material (intended to be used in the construction of the expanded Temporary Isolation Bund and LPB itself). Water extracts from semi-crushed waste rock material were analysed for a range of environmentally significant parameters. GEM (2023) identified molybdenum and selenium as constituents that could be elevated as a result of contact with or runoff from waste rock material used in the construction of the expanded Temporary Isolation Bund. Further review of the primary waste rock water extract analytical results found that pH and EC values were elevated compared to background concentrations in Lake Cowal (refer **Section 2.3.1**).

The following potential impacts to Lake Cowal water quality associated with the construction of the expanded Temporary Isolation Bund and LPB have been identified:

- <u>During expanded Temporary Isolation Bund construction</u>: Generation of fine sediment and migration of suspended material as waste rock is pushed from the lake shore to form the bund, which could increase turbidity levels in the lake. The silt curtain erected around the perimeter of the Temporary Isolation Bund would mitigate suspended material from entering Lake Cowal, however, the water trapped on the inside of the bund may be affected. This potential risk, if unmitigated, is considered high given that:
  - disturbance of the lakebed material would result in a high mobilisation potential for fine sediments during construction; and
  - Lake Cowal comprises fresh water (refer **Section 2.3.1**), where sedimentation processes are slower than that of more saline water.
- <u>During expanded LPB construction</u>: Given the proposed construction of the Temporary Isolation Bund and LPB using primary waste rock, lake water and runoff from rainfall will have

contact with the construction material. Mobilisation of some constituents may occur as a result, potentially resulting in some elevated concentrations of environmentally significant constituents relative to background concentrations in Lake Cowal. This potential risk is considered low, given that:

- the waste rock has been characterised as inert (GEM, 2023); and
- volumes of runoff that are in contact with the waste rock are expected to be low compared to total catchment runoff reporting to Lake Cowal.

Based on the above potential water quality risks and results given in GEM (2023), the assumed constituents of concern (COC) are as follows:

- Physico-chemical parameters; pH, EC and turbidity.
- Dissolved metals; molybdenum and selenium.

The risk to Lake Cowal water quality will be mitigated by stockpiling the waste rock material to be used within the CGO existing disturbance area and undertaking a geochemical testing program to confirm that the material is inert (i.e. non-acid forming, not sodic/dispersive or saline and contains relatively low soluble environmentally significant constituents). Note that the COC should be updated prior to and during expanded LPB construction based on further geochemical assessment as well as analysis of the water captured behind the Temporary Isolation Bund during construction prior to return of this water to Lake Cowal.

The methodology for management of the lake water captured behind the expanded Temporary Isolation Bund has been developed as follows:

- Review Lake Cowal water quality against relevant guidelines.
- Establish Site Specific Guideline Values (SSGVs) for Lake Cowal to be used as follows:
  - release or target criteria for water captured behind the Temporary Isolation Bund; and,
  - for assessment of ongoing lake water quality monitoring.
- Develop a procedure for on-site management, transfer and treatment (if required) of the water captured behind the Temporary Isolation Bund.

These are described in the remainder of this **Section 6.5.3** below.

6.5.3.2 Surface Water Quality

To provide an indication of representative water quality conditions within Lake Cowal, recorded water quality data has been compared to the ANZECC/ARMCANZ (2000a) and ANZG (2018)[26] default guideline values for:

- Physical and chemical stressors in south-east Australia freshwater lakes and reservoirs;
- Protection of aquatic ecosystems for toxicants in slightly-moderately disturbed systems; and
- Livestock drinking water.

The resulting default guideline values are summarised in **TABLE 18**.

[26] The ANZG (2018) revision of the Water Quality Guidelines is being progressively updated and is to supersede the ANZECC/ARMCANZ (2000) Guidelines. The surface water quality monitoring results for the existing CGO and surrounding areas have been reviewed against ANZG (2018) where updated default guideline values are available. For constituents for which revised default guideline values are yet to be published under the ANZG (2018), default values have been adopted from the ANZECC & ARMCANZ (2000) Guideline as recommended in ANZG (2018).

TABLE 18: DEFAULT GUIDELINE VALUES

Parameter	ANZECC & ARMCANZ (2000) and ANZG (2018) Default Guideline Values (µg/L unless otherwise stated)		
	Aquatic Ecosystems (95% level of species protection)	Freshwater Lakes and Reservoirs - South-East Australia	Livestock Drinking Water (Low Risk Trigger Value)
pH	-	6.5 – 8 pH units	-
EC (field)	-	20 -30 µS/cm	-
Turbidity (field)	-	1 – 20 NTU	-
Molybdenum	-	-	150
Selenium	11	-	-

TABLE 19 presents a summary of the water quality monitoring data recorded in Lake Cowal at all transect sites (refer **Section 2.3.1**) over the period from 2010 to 2023. The monitoring results were compared with the default guideline values and the percentage of exceedances tabulated.

TABLE 19: LAKE COWAL WATER QUALITY SUMMARY

Parameter		DGV*	Minimum	Median	Maximum	No. of Samples	Exceedances**
		(µg/L unless otherwise stated)					
pH		6.5 – 8 pH units	5.56 pH units	8.02 pH units	11.42 pH units	3,783	51.5%
EC (field)		30 µS/cm	2.09 µS/cm	324.5 µS/cm	1,801 µS/cm	3,734	99.9%
Turbidity (field)		1 – 20 NTU	7.80 NTU	215.8 NTU	2,562 NTU	1,585	97.8%
Dissolved	Molybdenum	150	<1	1	4	1,362	NIL
	Selenium	11	<10	10	10	1,320	NIL

* Default guideline values as per **TABLE 18**.

** The exceedance percentages reported indicate the percent of Lake Cowal water quality results that are outside the default guideline value range rather than indicating any specific impact is occurring.

The water quality summary presented in **TABLE 19** shows that default guideline values are, at times, naturally exceeded in the Lake Cowal transects, most notably pH, EC and turbidity. Accordingly, SSGVs have been derived for Lake Cowal as detailed in **Section 6.5.3.3.**

6.5.3.3 Site Specific Guideline Values

To reflect local conditions, ANZG (2018) recommend that SSGVs should be derived for physical and chemical constituents monitored in surface water systems. ANZG (2018) recommend that the 80th percentile value of water quality monitoring data recorded over a minimum period of 2 years should be adopted as the SSGV. The 20th percentile value of pH monitored over a minimum period of 2 years is recommended to be adopted for the lower pH SSGV.

As constituent values may at times naturally exceed the 80th percentile value of the baseline water quality data, an exceedance of an SSGV is not considered as immediate evidence of an impact, rather an indication of potential changes in water quality characteristics which may result in impacts to aquatic ecosystems or other beneficial uses.

Where a baseline constituent value does not exceed the default guideline value, the default guideline value has been adopted as the SSGV. As such, the SSGVs have been derived by adopting the default guideline value or the 80th percentile (20th percentile for pH lower bound) of the water quality data obtained for Lake Cowal transects for the period of record. **TABLE 20** presents the SSGVs and the derivation method for each COC for Lake Cowal.

TABLE 20: SITE SPECIFIC GUIDELINE VALUES – LAKE WATER QUALITY

Parameter	Derivation Method	Site Specific Guideline Value (µg/L unless otherwise stated)
pH	DGV* as per **TABLE 19** for lower limit and the 80th percentile for upper limit	6.5 - 8.5 pH units
EC (field)	80th percentile	499 µS/cm
Turbidity (field)	80th percentile	460 NTU
Dissolved Molybdenum	DGV* adopted as per **TABLE** 19	150
Dissolved Selenium		11

* Default guideline value

6.5.3.4 Review of Potential Quality of Water Captured during Expanded LPB Construction Relative to Lake Cowal

To assess the upper bound water quality for the COC relative to concentrations in Lake Cowal, the following data was reviewed:

- Analytical results of water extracts from primary waste rock samples from GEM (2023). These results provide an indication of the potential metals concentrations that may exist in runoff from the expanded Temporary Isolation Bund and LPB during and shortly after construction. A summary of the data and the percentage of exceedances of the SSGVs are given in TABLE 21.
- Contained water storages D1 and D4 water quality results from December 2004 to January 2023 (where available). As described, in Section 3.2, these storages capture runoff predominantly from WRE areas and give an indication of the potential runoff water quality from waste rock. A summary of data and the percentage of exceedances of the SSGVs are given in TABLE 22.

TABLE 21: PRIMARY WASTE ROCK WATER EXTRACTS ANALYTICAL RESULTS COMPARISON TO SSGVS

Parameter		SSGV	Minimum	Median	Maximum	No. of Samples	Exceedances*
		(µg/L unless otherwise stated)					
pH		6.5 – 8.5 pH units	8.2	8.5	8.9	11	58.8%
EC		500 µS/cm	298	488	679	11	45.5%
Dissolved	Molybdenum	150	3.5	10.9	53.8	11	NIL
	Selenium	11	0.5	1.1	31.4	11	9.1%

* The exceedance percentages reported indicate the percent of waste rock water extracts analytical results that are outside the SSGV range rather than indicating any specific impact is occurring.

TABLE 22: CONTAINED WATER STORAGES D1 AND D4 WATER QUALITY COMPARISON TO SSGVS

Parameter		SSGV	Minimum	Median	Maximum	No. of Samples	Exceedances
		(µg/L unless otherwise stated)					
D1							
pH (field)		6.5 – 8.5 pH units	4.36	8.4	11.14	619	47.2%
EC* (field)		499 µS/cm	8	4,810	18,969	468	98.9%
Turbidity (field)		460 NTU	1.8	8.3	49.5	33	NIL
Dissolved	Molybdenum	150	<1	2	11	51	NIL
Dissolved	Selenium	11	<10	10	100	50	6.0%
D4							
pH (field)		6.5 – 8.5 pH units	5.91	8.1	9.63	33	39.4%
EC (field)		499 µS/cm	409	8,476	12,432	33	97.0%
Turbidity (field)		460 NTU	621	2,274	3,263	16	100%
Dissolved	Molybdenum	150	<1	3	5	45	NIL
Dissolved	Selenium	11	<10	10	30	44	2.3%

*EC values included in this assessment include only those where water storages were not at low levels, as evapo-concentration effects would result in unrepresentative EC results for runoff.

A summary of the comparison of primary waste rock water extracts analytical results against the SSGVs as presented in **TABLE 21** shows that:

- Generally, pH and EC values are elevated compared to SSGVs.
- The concentration of molybdenum does not exceed the Lake Cowal SSGV.
- The concentration of selenium exceeded the SSGV for less than 10% of the samples.

A summary of the contained water storages (D1 and D4) water quality against the SSGVs as presented in **TABLE** 22 shows that:

- pH and EC values are elevated compared to SSGVs.
- The concentration of molybdenum does not exceed the Lake Cowal SSGVs in all storages for the period of record.
- The concentration of selenium exceeded the SSGV at times, however, exceedances were infrequent.

Generally, the comparison of COC metals concentration in primary waste rock water extracts analytical results and contained water storages D1 and D4 against the Lake Cowal SSGV suggests that the potential for elevated concentrations in runoff from the expanded Temporary Isolation Bund and LPB relative to Lake Cowal is likely to be low. This is evidenced by the limited exceedances observed against the SSGVs. As noted in **Section 6.5.3.1**, the volumes of runoff from the expanded Temporary Isolation Bund and LPB are expected to be low compared to total catchment runoff reporting to Lake Cowal mitigating the potential for increased concentration of these metals in Lake Cowal. Nevertheless, the concentrations of the above metals would be monitored in the water captured behind the Temporary

Isolation Bund prior to and during release as described in **Section 9.1**. The pH and EC in primary waste rock water extracts analytical results and pH, EC and turbidity in contained water storages D1 and D4 compared with Lake Cowal SSGVs suggests that there could be significant potential for elevated EC, pH and turbidity values outside the $80^{th}/20^{th}$ percentile of Lake Cowal values. Salinity, pH and turbidity may therefore require treatment in water captured behind the Temporary Isolation Bund and LPB prior to return of this water to Lake Cowal. It is also recommended that EC, pH and turbidity be monitored in the water captured behind the Temporary Isolation Bund prior to and during release as described in **Section 9.1**.

It should be noted that water captured behind the Temporary Isolation Bund and LPB would predominantly comprise water from Lake Cowal. The above analytical results represent a conservative estimate of the COC metals concentrations, turbidity, EC and pH that *could* occur if significant runoff/seepage from waste rock material to the captured water occurred.

6.5.3.5 Management of Water Captured during Expanded LPB Construction

It is recommended that water captured behind the Temporary Isolation Bund conceptually be managed as follows:

1. Prior to pumping of water back to Lake Cowal, field and laboratory testing should be undertaken for a wide range of water quality parameters (refer **Section 9.1**) including the COC.
2. Comparison of the test results to the SSGVs (as described in **Section 6.5.3.3**) should be undertaken to assess whether treatment of the captured water is required and to identity constituents requiring treatment.
3. A series of appropriately designed water treatment units should be installed along the Temporary Isolation Bund (refer **DIAGRAM 3**) and used to treat water prior to return to Lake Cowal.
4. Sampling and testing of lake water at transect sites should be undertaken at an increased frequency (refer **Section 9.1**) to assess whether lake water quality exceeds the SSGVs which, if exceeded may trigger a cessation of discharge and an investigation of the cause of the exceedance. Further details would be included in the Construction Environmental Management Plan (CEMP) which would include the LPB and address both a wet and dry construction.

Water quality sampling and testing should continue during and following the period of pumping of water back to Lake Cowal, as described **Section 9.1**.

7 FINAL VOID WATER BALANCE MODELLING

7.1 Model Description

As described in **Section 5.4**, three of the proposed open pits are to remain as final voids, namely E41, E42 and GR pits, with E46 being backfilled with waste. The E42 and GR voids join to become one void and are herein referred to as E42 final void. A daily timestep, final void water balance model has been set-up using the GoldSim® simulation package. The model simulates the volume stored in the two final void water bodies by simulating the inflows, outflows and resultant volume of water:

Change in Storage = Inflow – Outflow

Where:

Inflow includes direct rainfall, runoff, inflow from spill from adjacent voids (E41 and GR voids) if any and groundwater inflow.

Outflow includes evaporation and spill to adjacent voids (E41 and GR voids) if any.

7.2 Key Data and Assumptions

The model simulates inflow from remnant final void catchment rainfall runoff (including direct rainfall), groundwater inflow from bedrock as well as outflow due to evaporation on a daily basis. Key model input data include the following:

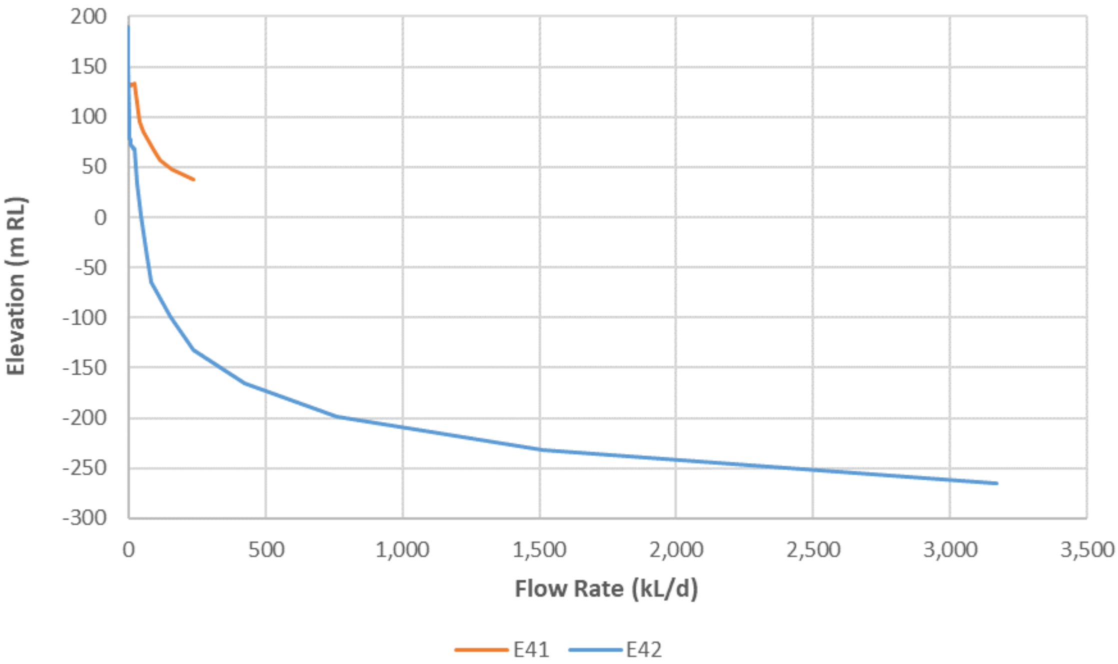
- A 134-year rainfall and evaporation data set (1889 to 2022 inclusive) for the CGO mine (SILO Point Data, refer Section 2.2). The data set was repeated several times over to generate an extended period of data for final void simulation – to ensure equilibrium water levels were reached during the simulation period.
- A constant pan factor of 0.7 was assumed for calculation of evaporation from the final void until the water level reached 10 m below the E41 final void spill level (if this occurs) and 20 m below the E42 final void spill level at which point the monthly pan factors listed in Section 6.1.2 were used. The lower pan factor used for lower final void levels reflects lower evaporation likely at depth as a result of shading and wind speed reduction effects.
- Rainfall runoff was estimated using the AWBM applied to the final void sub-catchments, in a manner similar to the operational water balance model (refer Section 6.1.3). Direct rainfall was simulated on the contained water surface.
- No interstitial storage within the backfilled E46 void has been accounted for within the final void modelling. It is assumed that all runoff from the E46 catchment reports to the E42 final void.
- It is assumed that post-mining, the connectivity with the underground mine access tunnel voids and the stopes would be hydraulically sealed. It is assumed that the groundwater flux adopted accounts for interaction between the underground mining and the final voids. Predicted rates of groundwater flux versus water level in the open pits were provided by the groundwater specialists (Appendix H of the EIS), as shown in GRAPH 23. For elevations below the supplied data, a constant groundwater inflow rate was adopted equal to the rate at the lowest elevation as advised by the groundwater consultant.

The total catchment area reporting to the two final voids is shown in **MAP 11**, with the sub-catchment distribution presented in **TABLE 23**.

TABLE 23: FINAL VOID CATCHMENT SUMMARY

	Catchment Area (ha)		
Sub-catchment type	**E41 Final Void**	**E42 Final Void**	**Total**
Open Pit	94.7	219.1	313.8
Rehabilitated Waste	231.6	1,725.2	1,956.8
Total	**326.3**	**1,944.3**	**2,270.6**

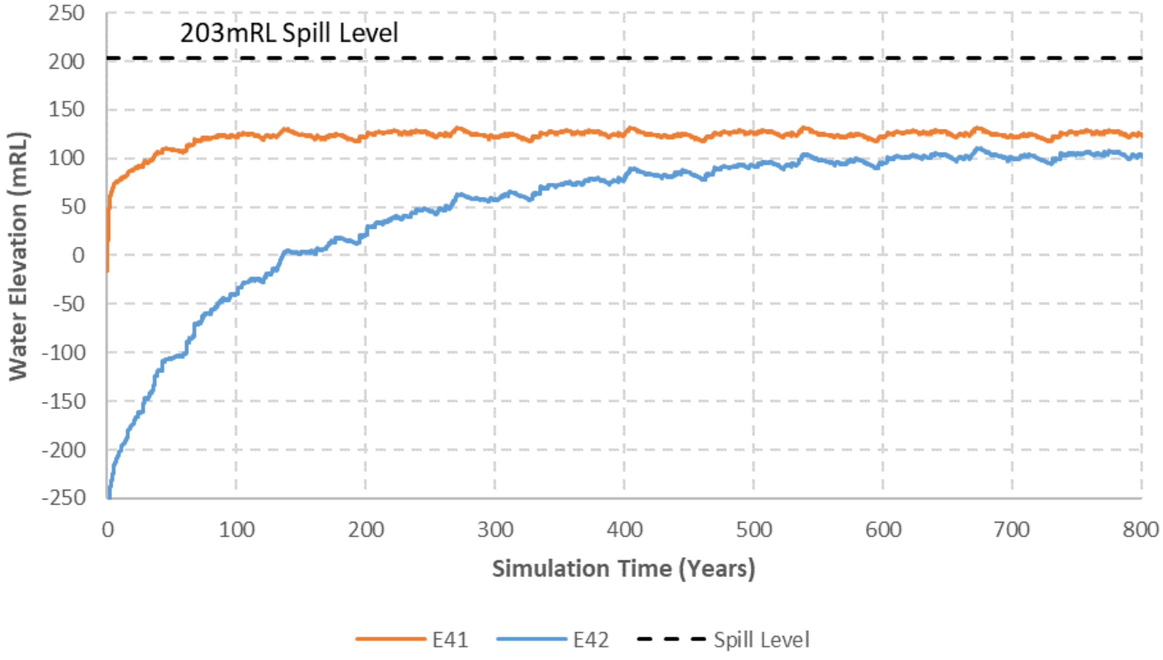
GRAPH 23: ADOPTED FINAL VOID GROUNDWATER INFLOW RATES



7.3 Simulated Future Water Levels

The model-predicted final void water levels are shown in **GRAPH 24** in comparison with the final void spill level of 203 mRL.

GRAPH 24: SIMULATED FINAL VOID WATER LEVEL



The model predictions indicate that the E41 final void would reach an equilibrium level of approximately 130 mRL which is more than 70 m below the spill level (i.e. the final void would be contained) after approximately 140 years. A long term equilibrium level of approximately 110 mRL within the E42 void (i.e. more than 90 m below the spill level) would be reached slowly over a period of approximately 700 years. Given the water level and groundwater flux relationship provided, groundwater outflow was not simulated to occur – i.e. the final void would remain a groundwater sink.

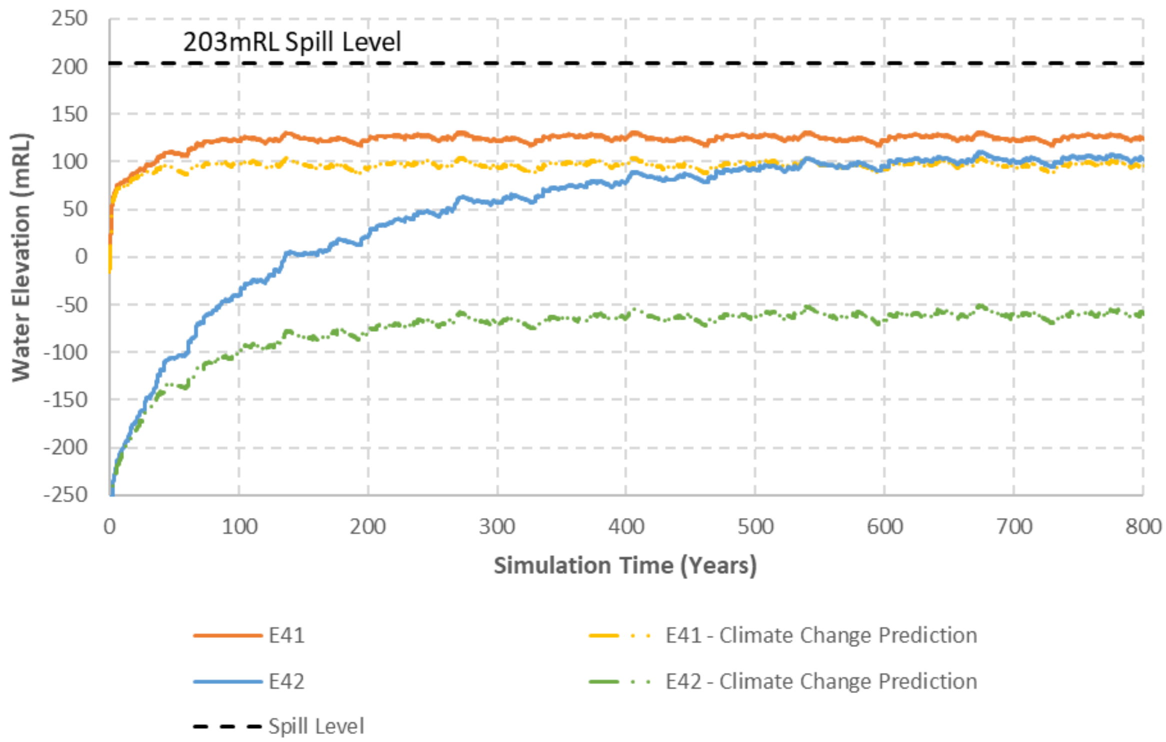
The void water quality would reflect the influence of the high salinity in the groundwater (refer **Section 2.3.2**). Given that the only outflow from the final void would be evaporation, salinity is predicted to increase trending to hyper-salinity in the very long term. Water quality in the final void at any given point in time would vary with depth as a result of mixing and stratification processes that would occur as a result of temperature and salinity differentials.

7.4 Implications of Climate Change on Final Void Water Balance

As described in **Section 6.4**, climate change predictions have been derived for the CGO region using the Climate Futures Tool (CSIRO and BoM, 2015b). An assessment was performed for 2090 (i.e. approximately 50 years post the end of the proposed Project life)[27] for the Murray Basin region of the continent which showed the mean annual change from the reference period to be -8.6% (i.e. a reduction) in rainfall and 19.4% (i.e. an increase) in evapotranspiration. No estimates are available for evaporation.

The final void water balances were simulated with the predictions of monthly mean change in the percentage of rainfall and evapotranspiration, as derived from the Climate Futures Tool as at 2090, applied to the rainfall and evapotranspiration rates adopted in the final void water balance model (evaporation rates were assumed to reduce in line with evapotranspiration estimates). The predicted final void water levels considering potential climate change impacts are shown in **GRAPH 25**.

GRAPH 25: PREDICTED FINAL VOID WATER LEVEL FOR 2090 CLIMATE CHANGE FACTORS



The model predictions indicate that the E42 final void would reach a predicted equilibrium level of - 50 mRL, more than 250 m below the spill level (i.e. the final void would be contained). Equilibrium levels would be reached by approximately 400 years, compared to the predicted 700 years for the base

[27] No predictions are available beyond 2090 using the Climate Futures Tool.

case model. Equilibrium levels within the E41 final void would still be reached in approximately 140 years, at a predicted level of 102 mRL.

Considering the increase in evapotranspiration rates predicted from the Climate Futures Tool predictions, the rate of progression to hyper-saline concentrations in the final voids would likely occur more rapidly than under natural conditions.

8 POTENTIAL SURFACE WATER IMPACTS AND MITIGATION MEASURES

The following recommendations are made in consideration of the surface water management issues assessed for the Project:

- The changes to water management outlined in this report be implemented in accordance with accepted and leading practice management.
- The monitoring program and associated annual water management system performance reviews continue to be undertaken over the remaining CGO and Project life.

8.1 Construction and Operational Phase

8.1.1 External Water Supply Sources

The results of Project water balance modelling (refer **Section 6.3.1**) indicate that there are unlikely to be increased impacts on Lachlan River flows as a result of the Project due to a predicted decrease or only a slight increase in the forecast demand on licensed extraction. It should be noted that CGO will continue to make use of onsite and external low quality water sources to the maximum extent practicable and the Lachlan River is the lowest priority source (refer **Section 3.1**). Any water sourced from the Lachlan River would be obtained via licensed extraction (including existing WALs and allocation assignment purchased on the open market). The forecast Lachlan River extraction demand would continue to be very small relative to historical total extraction from the river (refer **Section 4.2.5**).

The reliance on external borefield sources is forecast to decrease as a result of the Project (refer **Section 6.3.2**). Nevertheless, the management of supply in a sustainable manner from each external source is implicit within the water balance modelling reported herein and continues to be pertinent. It is recommended that sourcing water from the Bland Creek Paleochannel borefield continue in a similar manner as occurs currently, by alternating between this source and the Lachlan River to manage groundwater levels and provide flexibility with respect to extraction rates and the availability of allocation assignments in the Lachlan River.

8.1.2 Runoff from Mine Landforms

The CGO WREs and the IWL are to be enlarged for the Project. These areas, together with the open pits, will comprise the majority of the expanded CGO surface area. The Project geochemical assessment (GEM, 2023) has undertaken an assessment of samples of waste rock and ore likely to be generated by the Project. The assessment has concluded that oxide waste rock has a significant risk of being highly saline and/or highly sodic, with attendant implications for water quality. This material should be identified as part of operational waste rock characterisation and its use in the expanded LPB construction avoided. Although GEM (2023) predicted only a small proportion of PAF waste rock, ongoing operational waste rock characterisation should identify any such material and avoid its placement near the final outer surfaces of the WRE to avoid potential PAF runoff from rehabilitated WREs. PAF waste rock should also not be used for expanded LPB construction. The GEM (2023) assessment identified a similar risk for low grade and ore stockpiles and such materials should be identified and their long term stockpiling near outer (exposed) surfaces avoided to reduce the potential for increased salinity and metal solubility, potentially affecting runoff quality. GEM (2023) also identified a small proportion of PAF material within the E41 deposit ore. Further sampling and characterisation of ore should be undertaken to ensure that processing of such materials can be scheduled so that the process tailings do not remain near the surface of the final tailings deposited within the IWL and IWL North, in order to avoid a risk of long term degraded runoff water quality from these areas once rehabilitated.

The water quality monitoring program has been reviewed with respect to the potential for enrichment of specific metals in the waste rock, ROM ore and low grade ore, as described in **Section 9.1**.

8.1.3 Expanded Lake Protection Bund

Lake water captured behind the expanded LPB during construction of the Temporary Isolation Bund (refer **Section 4.1.1.4**) is planned to be returned to Lake Cowal by pumping (refer **Section 6.5.3**). This water has the potential to be affected by contact with and runoff from materials used in the construction of the Temporary Isolation Bund. Geochemical characterisation undertaken by GEM (2023) has identified potential constituents that could be elevated (relative to background concentrations in Lake Cowal) as a result of contact with or runoff from primary waste rock (refer **Section 6.5.3**). In addition, there is the potential for elevated turbidity due to disturbance of lakebed materials. In order to limit the risk to Lake Cowal water quality from the return of water captured behind the expanded LPB, a procedure will be developed in consultation with the EPA, to test water quality before and during pumped return of the captured water to Lake Cowal (refer **Section 6.5.3.5**) and to manage water return accordingly.

Placement of inert waste rock directly into Lake Cowal during construction of the Temporary Isolation Bund also has the potential to affect the water quality on the lake side of the LPB. The risk to Lake Cowal water quality will be mitigated by stockpiling the waste rock material to be used within the CGO existing disturbance area and undertaking a geochemical testing program to confirm that the material is inert (i.e. non acid forming, not sodic/dispersive or saline and contains relatively low soluble environmentally significant constituents). Placement of inert waste rock onto the floor of the lake is likely to generate locally increased turbidity and suspended material. Placement of a continuous silt curtain around the perimeter of the Temporary Isolation Bund is planned to trap fine sediment and control the migration of suspended material into the lake. Appropriately designed and installed silt curtains[28] have found widespread use in recent years, including in freshwater lakes and impoundments, and have been effective in controlling turbidity.

Ongoing testing of Lake Cowal water quality at monitoring locations close to and remote from CGO would provide a means of directly assessing any effects on water quality as a result of LPB construction activities and during the return of captured water. The frequency of sampling and testing at lake water quality sites would be increased during construction (refer **Section 9.1**). SSGVs (refer **Section 6.5.3.3**) would be updated prior to construction of the LPB to include COC resulting from the recommended further geochemical assessment (refer **Section 6.5.3.1**) and to include contemporary data.

A CEMP would be prepared as part of the detailed design of the expanded LPB, detailing construction activities, testing frequency, environmental management, monitoring and contingencies. The CEMP would include a trigger action response plan for assessing water quality, including contingency measures, such as changes to water treatment. The CEMP would be submitted to DPE for review and comment prior to commencement of construction.

The expanded LPB is predicted to have negligible effects on the long term water balance of Lake Cowal and on peak flood levels (refer **Sections 6.5.1**and **6.5.2**).

8.1.4 Expanded Up-Catchment Diversion System

Construction of the expanded UCDS has the potential to generate elevated sediment during and shortly following construction that could migrate to Lake Cowal. A detailed erosion and sediment control plan would be prepared ahead of the construction of the UCDS and submitted to DPE for review and comment. This plan would be prepared in accordance with the principles described in Landcom (2004) and DECC (2008) guidelines, including:

- limiting surface disturbance and restricting access to undisturbed areas;
- progressive rehabilitation/stabilisation of disturbance areas;
- separation of runoff from disturbed and undisturbed areas, where practicable;
- construction of surface drains to control and manage surface runoff; and
- construction of sediment dams/basins to contain runoff up to a specified design criterion.

Construction would be staged so that the proposed UCDS stilling basins (refer **Section 4.1.1.5**) were constructed (excavated) ahead of upslope reaches of the UCDS so that the basins could act as sediment basins. A soil testwork program would be undertaken as part of detailed design to map and identify the presence of dispersive soils within the proposed footprint of the expanded UCDS and measures to control erosion of and sediment migration from these areas included in the design. Such measures may involve treatment of exposed surfaces or stockpiled fill materials with gypsum.

[28] E.g. https://chatoyer.com.au/silt-sediment-control/silt-curtain/

8.2 Post-Closure

Post-closure surface water impacts would include possible risks of structural instability of final mine landforms affecting Lake Cowal water quality (dispersivity, salinity and turbidity/sedimentation) - landforms such as the LPB and UCDS. Erosion modelling using the SIBERIA software has been carried out (refer Appendix Z of the EIS) to identify any locations within the final landform that may require modification or additional erosion treatment to achieve tolerable erosion targets. Final void modelling (refer **Section 7.3**) suggests the risk of discharge from the final void water bodies to Lake Cowal is low. There is potential for reduced inflow to Lake Cowal as a result of the increased catchment area of the final voids.

Evolution is undertaking batter rehabilitation trials (using a number of different combinations of rock mulch, soil and vegetation). Results of these trials will inform the final design of the WRE rehabilitation and will also allow prediction of sediment generation rates likely to be generated from the final landform to the Lake. The *Mine closure and rehabilitation strategy* (Appendix Z of the EIS) predicted final landform sediment generation rates that were of the same magnitude as (albeit somewhat greater than) those predicted from the site under pre-mine conditions. However, given the direction of most of the site runoff to the final void, the area reporting to Lake Cowal would be reduced and therefore so would the net sediment yield to Lake Cowal. Likewise, the majority of salt generated from the final landform would be directed to the final void which is predicted to trend towards hyper-saline conditions in the long term (regardless of salt influx).

The Project geochemistry assessment (GEM, 2023) found that the proposed Project waste rock is geochemically similar to the waste rock from the current open pit operations, indicating that the management strategies currently employed for the WREs would not need to be modified to accommodate the Project waste rock. The salt concentration in runoff from the rehabilitated outer WRE to Lake Cowal would be expected to reduce with time as salts present in the near surface layers were removed by natural leaching. Identification and selective placement of potentially saline or sodic oxide waste rock away from the outer near surface WRE areas should control the potential for this material to lead to elevated final landform runoff salinity which reports off site. In the longer term the predicted steady state TDS concentration in runoff from the WREs which reports off site is not likely to exceed 100 mg/L (North Limited, 1998) or an EC of approximately 150 µS/cm. This is less than the minimum value in the baseline data for Lake Cowal of 222 µS/cm (refer **TABLE 5**). Salt fluxes from WREs were predicted to be extremely small compared with inflows to the lake from Bland Creek and the Lachlan River.

The final void water balance modelling (**Section 7**) has indicated that the final void water levels should stabilise well below spill levels and below the local water table level under both natural conditions and with consideration to potential climate change effects. The majority of the CGO site post-closure would continue to drain to the final void and would therefore have no impact on the water quality of Lake Cowal. The final profiles of the WREs, IWL, IWL North and the LPB have or would be designed to effectively preclude instability which could cause impact on the Lake (*Mine closure and rehabilitation strategy*, Appendix Z of the EIS). Stabilisation of the outer batters of the expanded mine WREs (using rock mulch and vegetation) would be undertaken well ahead of mine closure, allowing time for "proving" the stability of these batters. Similarly, the expanded UCDS would be designed and profiled such that peak flow velocities and bed shear stresses generated during the design event would not result in significant[29] erosion or geomorphic instability (refer to Appendix A). The expanded UCDS would have been in operation for approximately 18 years at the end of the Project life. This again allows time for "proving" the stability of the UCDS. Any unforeseen instability would lead to remedial works which would result in an improvement in the durability of the UCDS.

The proposed surface changes associated with the Project are largely to be contained within the catchment area of the final voids. The potential effects of total surface flow to Lake Cowal can be assessed on the basis of reduction in catchment area. The area and percentage of pre-CGO Lake Cowal catchment area (i.e. 9,760 km^2) captured by the final voids are shown in **Error! Reference source not found.** for both approved operations and the Project.

[29]The design intent in regard to erosion and geomorphic instability is that the scale and magnitude of erosion and/or geomorphic instability within the constructed expanded UCDS would be consistent with expected erosion and geomorphic instability likely to occur in the drainage features as they existed in the CGO area prior to all mine related disturbance.

TABLE 24: LAKE COWAL CATCHMENT AREA COMPARED TO FINAL VOID

	Final Void Catchment Area (ha)	Percentage of pre-CGO Lake Cowal Catchment
Approved (HEC, 2020)	1,133	0.12%
Project	2,271	0.23%

TABLE 24 shows that the percentage change in lake catchment area a result of the Project is negligible and results in negligible change to lake inflows (refer **Section 6.5.1**).

9 MONITORING, MITIGATION AND MANAGEMENT

9.1 Operational Surface Water Monitoring and Management

Surface water monitoring is currently undertaken at CGO in accordance with Development Consent Condition SSD 10367 B9 (d) (ii) and DA14/98 Condition 4.5(b) and will continue for the Project. All surface water monitoring would be undertaken in accordance with the *Approved Methods for the Sampling and Analysis of Water Pollutants* in NSW (DEC, 2004b). Surface water monitoring will continue to be undertaken at specific areas within the Mining Lease area including the contained water storages (existing and proposed), UCDS, ICDS, open pit(s) and TSFs/IWL (Evolution, 2022a). Surface water monitoring will continue to be undertaken in Lake Cowal (when lake water levels permit) at monitoring sites along the six transects used during the baseline monitoring program (refer **TABLE 5**) to enable evaluation of water quality data against records of baseline monitoring, in accordance with Development Consent Condition SSD 10367 B9 (d) (ii) and DA14/98 Condition 4.4(a)(ii). During the construction of the expanded LPB, the following changes are recommended to the program for Lake Cowal chemical monitoring given in Evolution (2022a):

- Monthly monitoring would be increased to weekly;
- Quarterly monitoring would be increased to monthly; and
- Analysis of total and dissolved chromium is added to the suite of metals analyses (identified as a constituent of concern by GEM [2023]).

The changed monitoring regime would continue for the period of Temporary Isolation Bund and LPB construction and for a period post construction until it can be established that the COC at sites close to CGO do not exceed the concurrent concentrations at sites on the opposite side of the lake for three consecutive months. Details would be included in the CEMP.

A discharge monitoring program will be developed in consultation with the EPA. This monitoring program will be implemented before and during discharge of lake water captured behind the expanded LPB and will include a trigger action response plan and contingency measures such as changes to water treatment.

The potential enrichment of silver and mercury in waste rock, ROM ore and/or low grade ore has been identified by GEM (2023). Therefore, it is proposed that the analysis of these metals is added to the site water quality monitoring program for contained water storages. The current site water quality monitoring program includes monitoring of arsenic, antimony, cadmium, copper, molybdenum, nickel, lead, selenium and zinc for contained water storages as defined in the CGO Water Management Plan (Evolution, 2022a). It is proposed that the monitoring program is revised to also include monitoring of total and dissolved chromium. It is also proposed that monitoring of metals be expanded to include contained water storages D1 and D4.

The results from the monitoring programs will continue to be maintained in a database for review and assessment and used to assist in the management of the quality and quantity of surface and groundwater within and around CGO. The monitoring report results and any specialist interpretations of trends observed in the monitoring data will be reported as part of the annual review process.

It is recommended that the site water balance model is updated and verified on a regular basis to maintain the model as a reliable tool for assessing the effectiveness of the site water management system. At a minimum this should occur every three years in accordance with Development Consent condition B9 (d) (iv). Annual forecast water balance modelling will inform near term water supply reliability for the Project as it progresses.

9.2 Post-Mining Surface Water Monitoring and Management

Water quality monitoring should continue for a minimum of two years following cessation of mining and processing operations with monitoring data reviewed at annual intervals (as part of the annual review process) over this period. Reviews should involve assessment against long term performance objectives that are derived from baseline conditions or a justifiable departure from these, with due allowance for climatic variations. If objectives are not substantially met within the two-year period, management measures should be revised and the monitoring period extended.

The surface water quality monitoring program during and following mine closure (including monitoring of water quality in the final voids) would be developed in consultation with relevant Government agencies (Evolution, 2022a). The geotechnical stability of the final voids would be reviewed by an appropriately qualified and experienced person and the stability of the final voids would continue to be surveyed from the cessation of mining until lease relinquishment (i.e. until the final void walls can be demonstrated to be geotechnically stable and present an acceptably low risk of environmental harm). Survey assessments would be undertaken annually to determine and quantify any movement of the LPB until permanent stability is demonstrated (Evolution, 2022a).

9.3 Potential Contingency Measures

Potential contingency measures in the event of unforeseen impacts or impacts in excess of those predicted would include:

- cessation of activities that have led to the impacts;
- conducting additional monitoring (e.g. increase in monitoring frequency or additional sampling locations) to confirm impacts and inform the proposed contingency measures; and
- refinements to the water management system design such as additional water treatment, modification of construction activities, additional containment dams, increases to storage or pumping capacity, installation of new structures as required to address the identified issue.

10 SUMMARY AND CONCLUSIONS

Evolution proposes to extend mining operations at CGO through the Project by extending open pit mining operations by approximately 10 years to 2036 and total mine life by approximately 2 years to 2042. This will include the development of three new and adjacent orebodies and expansion of the area of CGO.

The following summarises the key outcomes of the surface water assessment for the Project:

- A number of additional contained water storages (D21, D23, D24 and D25) are proposed for the Project to capture runoff and manage water on site at CGO. Augmentation of on-site water storages would be undertaken within the existing catchment area/disturbance area of each storage. No overflows were predicted in Project water balance model simulations from either of the contained water storages that could overflow to Lake Cowal (D1 and D4) in any of the model simulations.
- The maximum water demand to accommodate processing of primary and oxide ore from the underground mine and proposed open cut operations is estimated at 23.9 ML/d in 2040. This compares with an average process plant demand of 22.4 ML/d in 2022 for the current CGO.
- Site water balance model results indicate that the demand from external sources, based on the median rainfall sequence, would average 1,713 ML/year with up to 1,965 ML/year to be sourced from the Lachlan River based on the 90th percentile model results.
- Based on DPE - Water trading records, there has been adequate allocation assignment water available on the market from this source in previous years to meet this predicted demand requirement even in the event of zero available water determination.
- The management of supply in a sustainable manner from each external source is implicit within the water balance modelling reported herein and continues to be pertinent. It is recommended that sourcing water from the Bland Creek Paleochannel borefield continue in a similar manner as occurs currently, by alternating between this source and the Lachlan River to manage groundwater levels and provide flexibility with respect to extraction rates and the availability of allocation assignments in the Lachlan River.
- Final void water balance model predictions indicate that the E41 and E42 final voids would reach peak equilibrium water levels of more than 70 m below the spill level and 90 m below the spill level respectively (i.e. the final void would be contained). Modelled equilibrium water levels in the E41 final void would be reached after approximately 140 years while the E42 final void equilibrium water level would be reached over a period of approximately 700 years. Groundwater outflow from the final void was not simulated to occur – i.e. the final void would remain a groundwater sink
- The Project geochemical assessment has concluded that oxide waste rock has a significant risk of being highly saline and/or highly sodic, with attendant implications for water quality and the water quality monitoring program has been reviewed accordingly.
- The Project geochemical assessment has identified potential constituents that could be elevated (relative to background concentrations in Lake Cowal) during LPB construction as a result of contact with or runoff from primary waste rock, which is to be used for expanded LPB construction. In addition, during LPB construction there is the potential for elevated turbidity due to disturbance of lakebed materials. To limit the risk to Lake Cowal water quality, placement of a continuous silt curtain around the outer perimeter of the Temporary Isolation Bund is planned to trap fine sediment and control the migration of suspended material into the lake. Furthermore, a procedure has been developed to test water quality before and during pumped return of the water captured behind the Temporary Isolation Bund to Lake Cowal. Ongoing testing of Lake Cowal water quality at monitoring locations close to and remote from CGO would provide a means of directly assessing any effects on lake water quality as a result of LPB construction activities and during the return of captured water. The frequency of sampling and testing at lake water quality monitoring sites would be increased during construction. Site specific guideline values would be updated prior to construction of the LPB to include COC resulting from the recommended further geochemical assessment and to include contemporary data. A CEMP would be prepared

as part of the detailed design of the expanded LPB, detailing construction activities, testing frequency, environmental management, monitoring and contingencies.

- The Project is predicted to have negligible effects on the long term water balance of Lake Cowal and on peak flood levels.
- Construction of the expanded UCDS has the potential to generate elevated sediment during and shortly following construction that could migrate to Lake Cowal. Staged construction of the UCDS would see stilling basins implemented early to act as sediment basins during construction. A detailed erosion and sediment control plan would be prepared ahead of the construction of the UCDS.

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CONDITIONS OF REPORT

1. This report must be read in its entirety.
2. This report has been prepared by ATCW for the purposes stated herein and ATCW's experience, having regard to assumptions that can reasonably be expected to make in accordance with sound professional principles. ATCW does not accept responsibility for the consequences of extrapolation, extension or transference of the findings and recommendations of this report to different sites, cases, or conditions.
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APPENDICES

APPENDIX A – UP-CATCHMENT DIVERSION SYSTEM MODELLING

A1 Existing Layout

The existing Up-Catchment Diversion System (UCDS) comprises a northern and southern limb. The northern UCDS is aligned around the northern perimeter of the Integrated Waste Landform (IWL) and northern waste rock emplacement (WRE). The southern UCDS is aligned around the southern side of the IWL and south of the southern WRE. The primary inflows to both the northern and southern UCDS is situated upstream of the IWL to the west of the mining lease. Both drains comprise an excavated low flow channel and bund, discharging to stilling basins prior to release to Lake Cowal. When the low flow channel capacity is exceeded, overbank flow extends onto the adjacent land surface, as sheet flow and in adjacent drainage lines.

A2 Basis of Design

The spatial boundary for the revised UCDS is containment between the current mining lease, mine-owned land tenure and both existing and proposed infrastructure such as the IWL and WRE.

The hydrological risk criteria under the current mine approval and as advised by Evolution was adopted as 0.1% Annual Exceedance Probability (AEP) for the long term/permanent UCDS (northern and southern limbs).

To meet these criteria, the UCDS works have been:

1. sized to safely convey the design peak flow event without overflowing to the mine operational area or onto adjacent tenure boundaries (including Lot 36/37), and

The design intent in regard to erosion and geomorphic instability is that the scale and magnitude of erosion and/or geomorphic instability within the constructed expanded UCDS would be consistent with expected erosion and geomorphic instability likely to occur in the drainage features as they existed in the CGO area prior to all mine related disturbance.

The hydrological analysis of the UCDS catchments was undertaken in accordance with recommended procedures outlined in Australian Rainfall and Runoff (ARR2016). Design hydrographs for the peak flow event were simulated using rainfall routing modelling software (RORB).

A two-dimensional hydraulic modelling software package (TUFLOW) was used to simulate the hydraulic performance of the UCDS. The UCDS was separated into two separate hydraulic models for the northern and southern reaches, extending from the historic railway culverts, located to the west of the mining lease, eastwards to the western edge of Lake Cowal.

A3 Design Features

The UCDS has been designed to contain the flow within the profile until it reaches a point downstream where it does not impact neighbouring land tenure boundaries. The overbank flow is designed to reduce flow velocity prior to entering the stilling basins, situated at the downstream extent of the channels.

Additional bunds have been incorporated in the design to prevent water from impacting neighbouring tenure boundaries and from entering the mine operational area for the 0.1% AEP design event. A minimum freeboard allowance of 300 mm above the simulated peak water levels has been incorporated into the design bund crest levels.

The cross-sectional profile of the UCDS channel comprises a trapezoidal channel with base width of between 2 and 20 m. The channel banks have a design batter slope of 1 vertical unit to 5 horizontal units. The channel is aligned along the boundary of the proposed IWL and WRE footprints. The design excavation depth of the channel varies up to a maximum of 7 m and it is assumed that construction will involve excavation of predominantly alluvial and colluvial sediments. The design longitudinal gradients of the UCDS channel vary from 0.2% to 0.5%.

APPENDIX B – LAKE COWAL FLOOD MODELLING

Map 001: Hydrological Modelling RORB Catchment Delineation

Map 002: Hydraulic Modelling Model Extent

Map 003: 1% AEP Existing Flood Scenario Modelled Flood Depth

Map 004: 1% AEP Existing Flood Scenario Modelled Flood Velocity

Map 005: 0.1% AEP Existing Flood Scenario Modelled Flood Depth

Map 006: 0.1% AEP Existing Flood Scenario Modelled Flood Velocity

Map 007: PMF Existing Flood Scenario Modelled Flood Depth

Map 008: PMF Existing Flood Scenario Modelled Flood Velocity

Map 009: 1% AEP With Project Flood Scenario Modelled Flood Depth

Map 010: 1% AEP With Project Flood Scenario Modelled Flood Velocity

Map 011: 1% AEP Flood Scenario Existing Versus With Project Depth Change

Map 012: 1% AEP Flood Scenario Existing Versus With Project Velocity Change

Map 013: 0.1% AEP With Project Flood Scenario Modelled Flood Depth

Map 014: 0.1% AEP With Project Flood Scenario Modelled Flood Velocity

Map 015: 0.1% AEP Flood Scenario Existing Versus With Project Depth Change

Map 016: 0.1% AEP Flood Scenario Existing Versus With Project Velocity Change

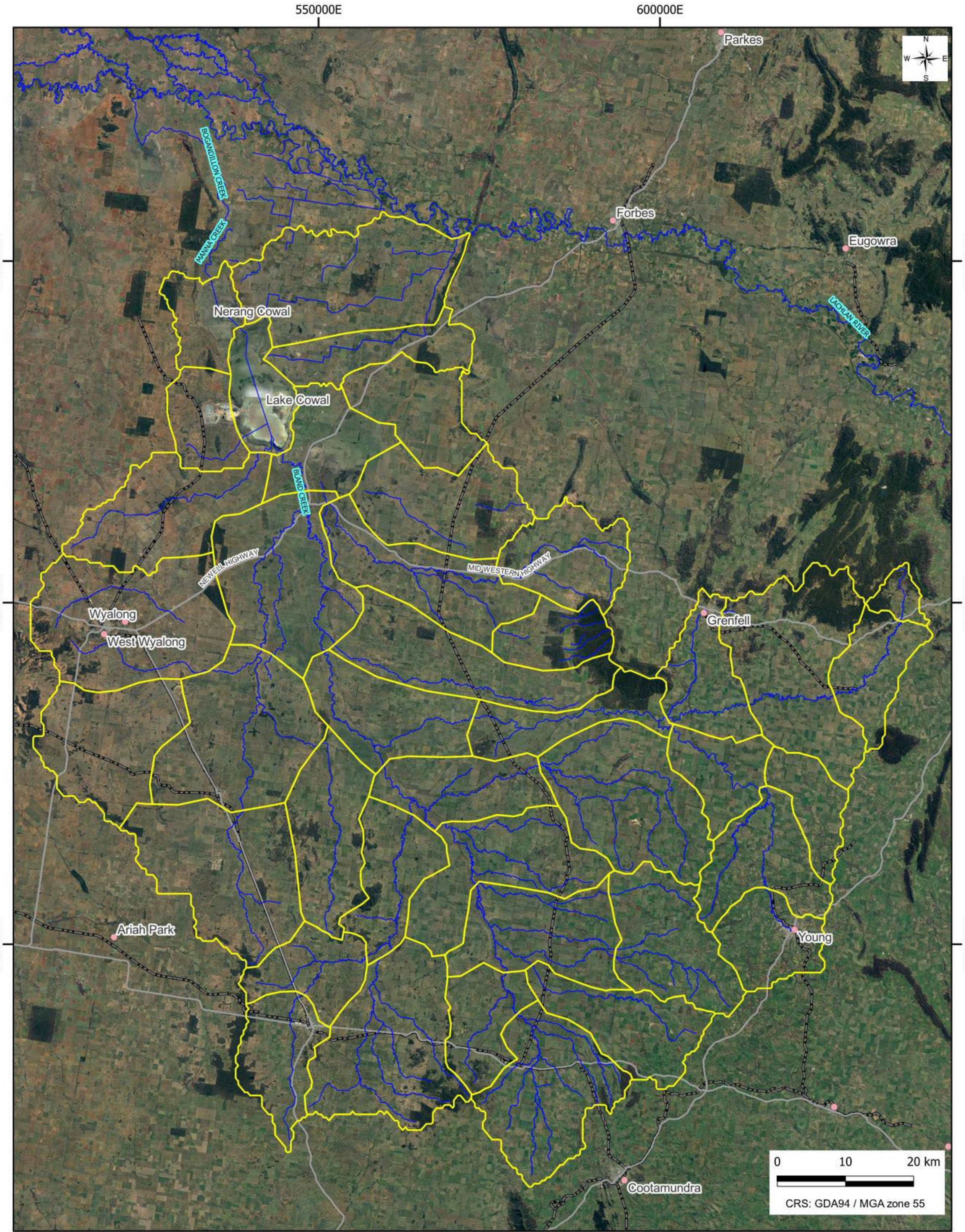
Map 017: PMF With Project Flood Scenario Modelled Flood Depth

Map 018: PMF With Project Flood Scenario Modelled Flood Velocity

Map 019: PMF Flood Scenario Existing Versus With Project Depth Change

Map 020: PMF Flood Scenario Existing Versus With Project Velocity Change

Map 021: Hydraulic Assessment Flood Planning Area



LEGEND

- RORB Catchment Delineation
- Watercourse
- Roads
- Railway

LAKE COWAL FLOOD ASSESSMENT
HYDROLOGICAL MODELLING
RORB CATCHMENT DELINEATION

MAP 001

121155-14-R001

DATE: 2023-03-23

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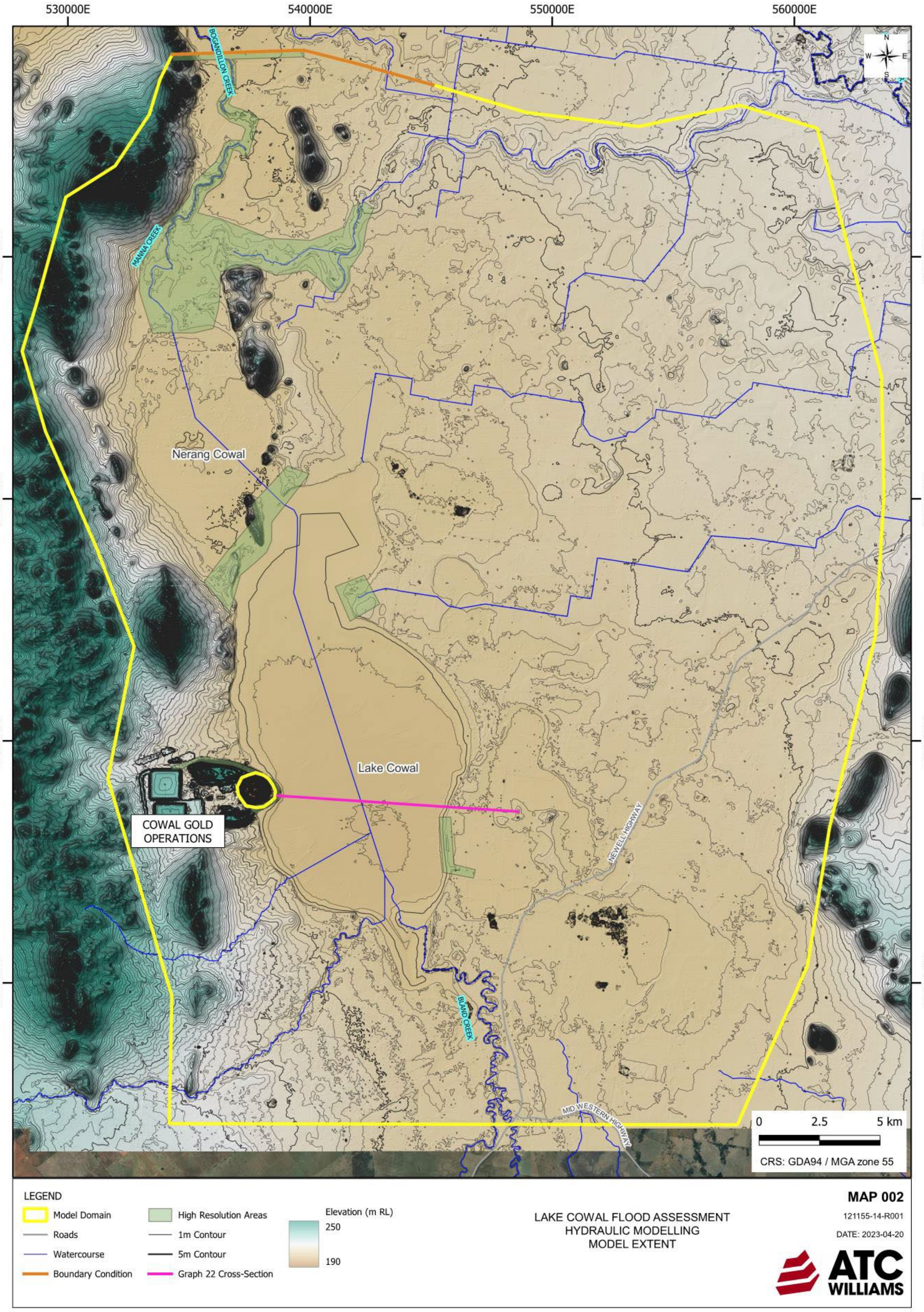

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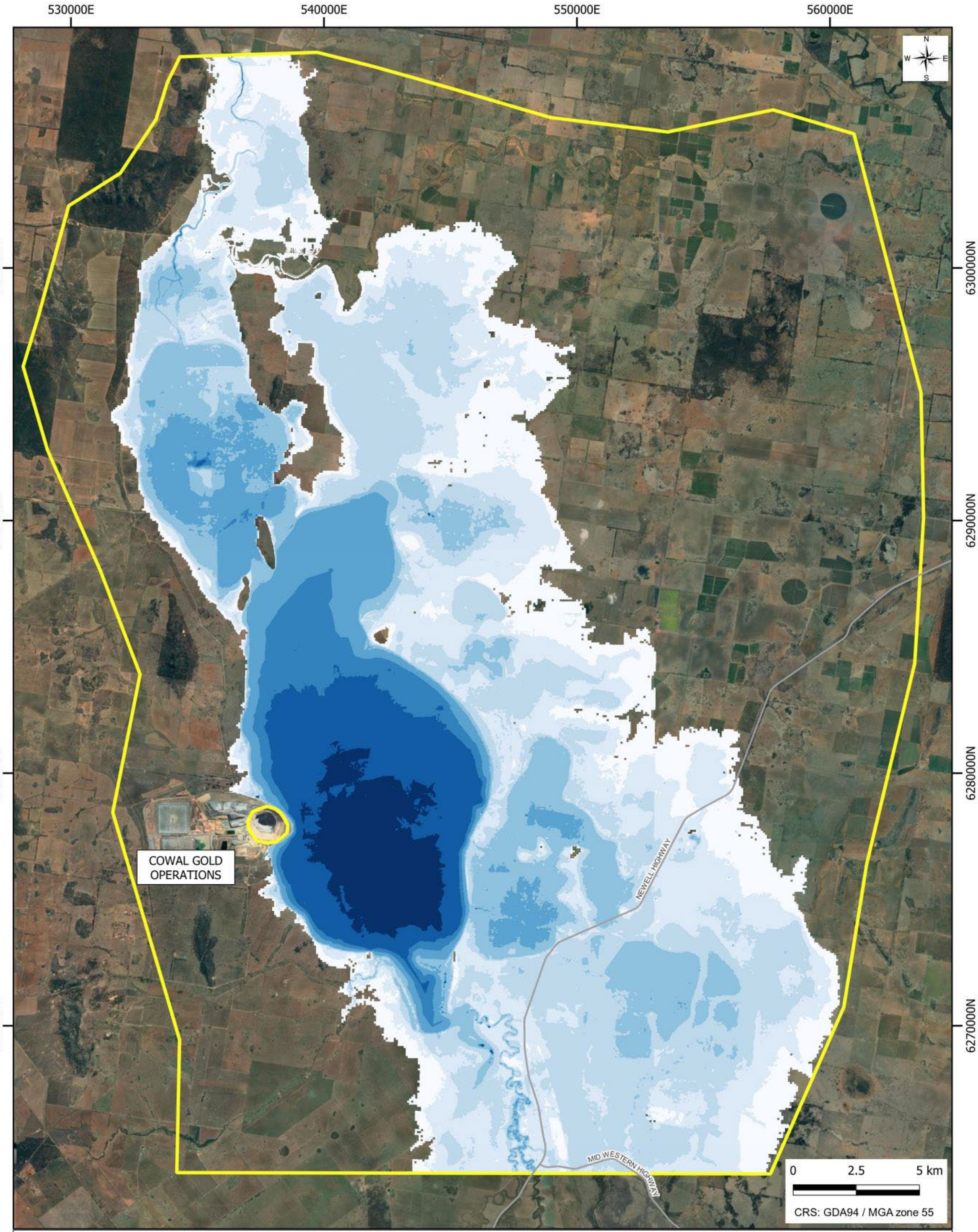

LEGEND

- Model Domain
- Roads

Modelled Flood Depth

- <= 0.75 m
- 0.75 - 1.50 m
- 1.50 - 2.25 m
- 2.25 - 3.00 m
- 3.00 - 3.75 m
- 3.75 - 4.50 m
- 4.50 - 5.25 m
- > 5.25 m

LAKE COWAL FLOOD ASSESSMENT
1% AEP EXISTING FLOOD SCENARIO
MODELLED FLOOD DEPTH

MAP 003

121155-14-R001

DATE: 2023-04-20

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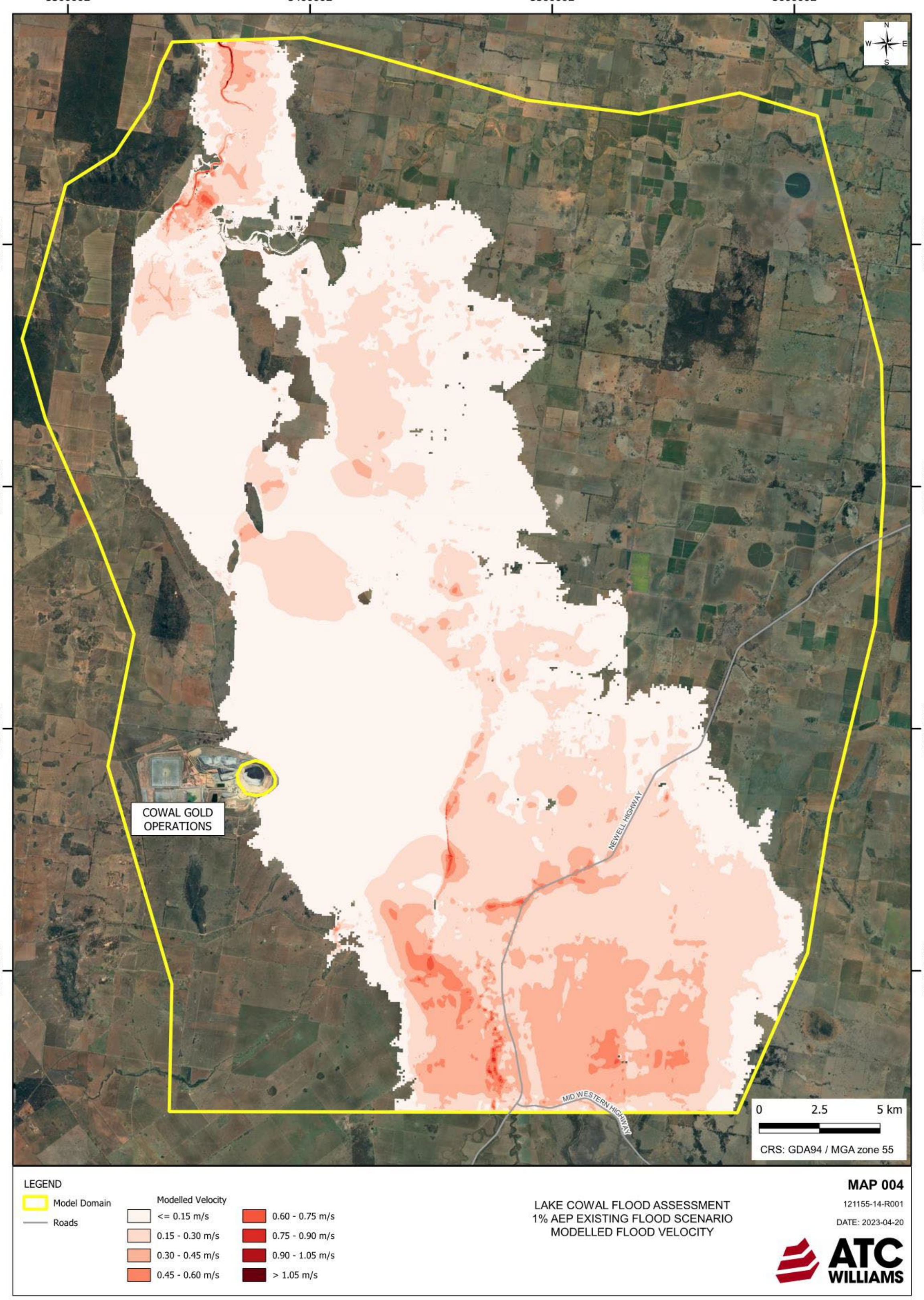

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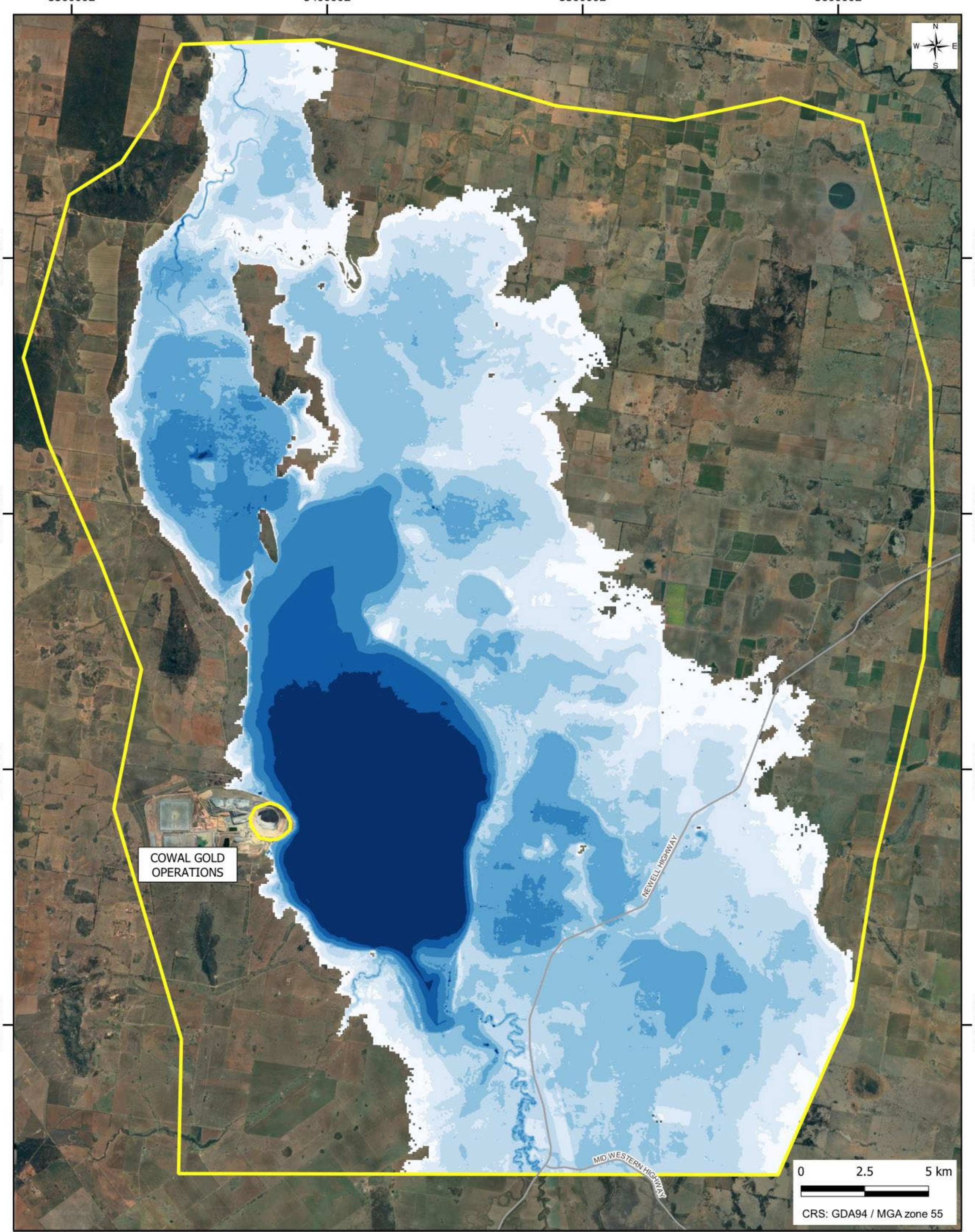

LEGEND

Model Domain

Roads

Modelled Flood Depth

<= 0.75 m	3.00 - 3.75 m
0.75 - 1.50 m	3.75 - 4.50 m
1.50 - 2.25 m	4.50 - 5.25 m
2.25 - 3.00 m	> 5.25 m

LAKE COWAL FLOOD ASSESSMENT
0.1% AEP EXISTING FLOOD SCENARIO
MODELLED FLOOD DEPTH

MAP 005

121155-14-R001

DATE: 2023-04-20

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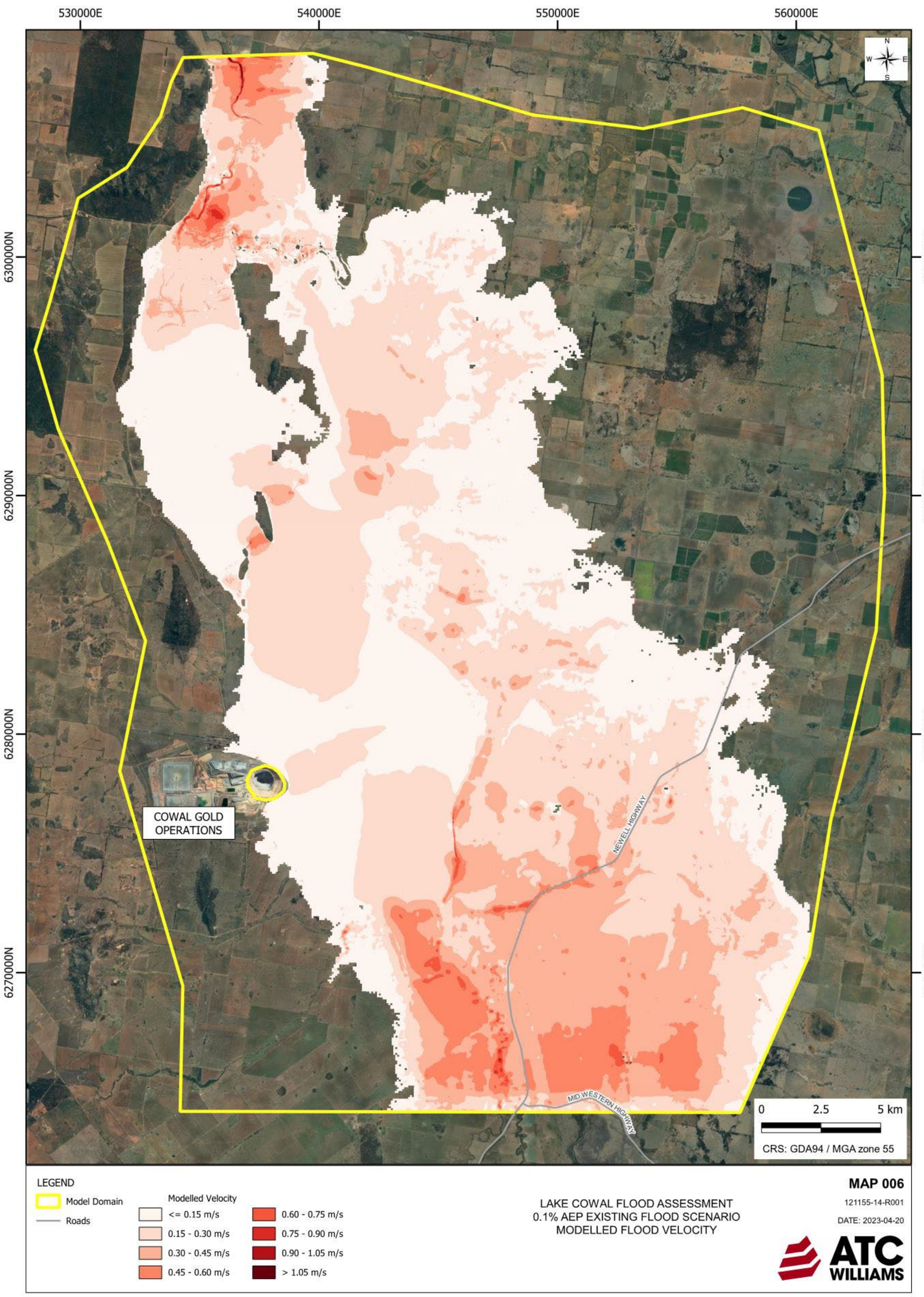

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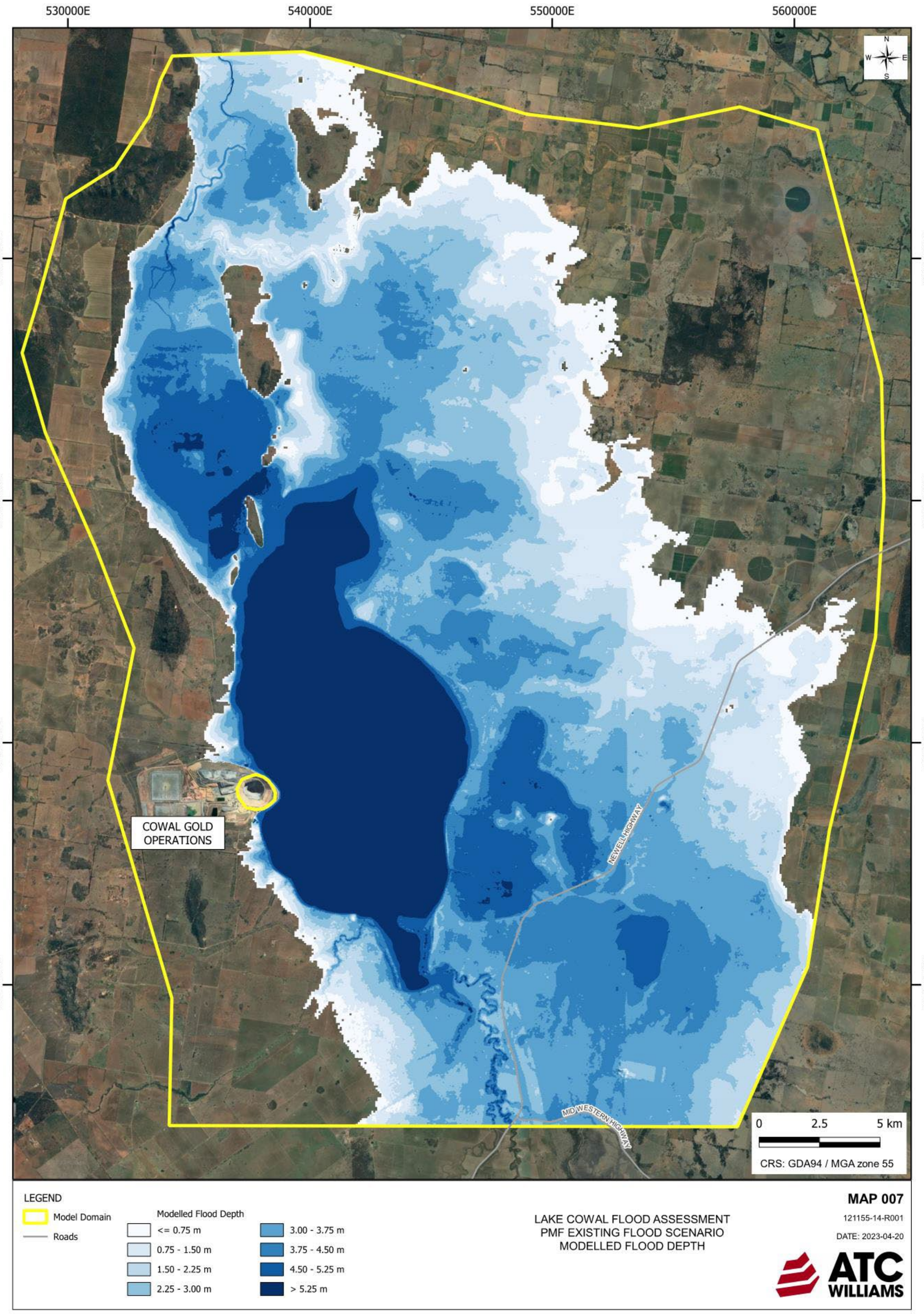

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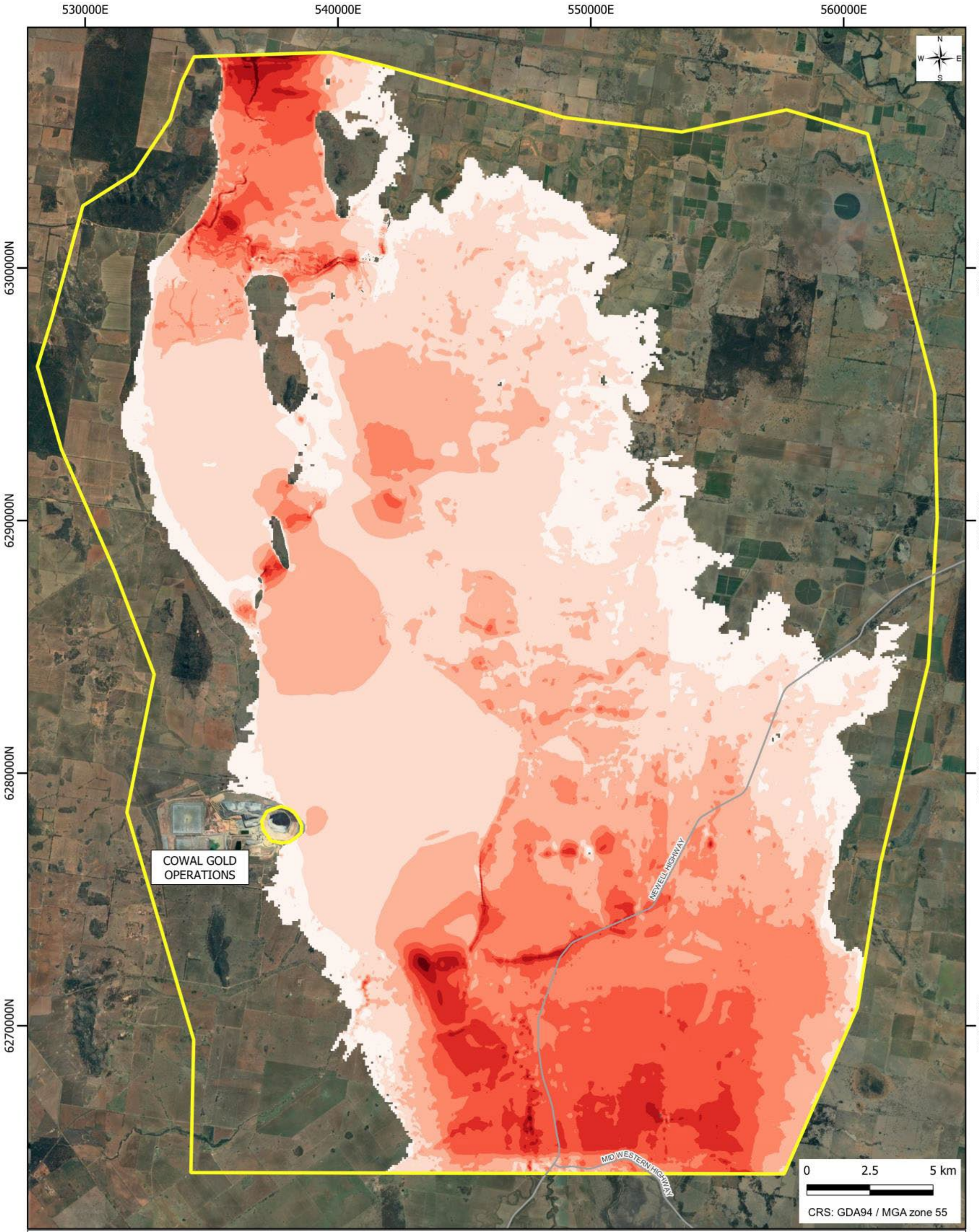

LEGEND

Model Domain

Roads

Modelled Velocity

- <= 0.15 m/s
- 0.15 - 0.30 m/s
- 0.30 - 0.45 m/s
- 0.45 - 0.60 m/s
- 0.60 - 0.75 m/s
- 0.75 - 0.90 m/s
- 0.90 - 1.05 m/s
- > 1.05 m/s

LAKE COWAL FLOOD ASSESSMENT
PMF EXISTING FLOOD SCENARIO
MODELLED FLOOD VELOCITY

MAP 008

121155-14-R001

DATE: 2023-04-20

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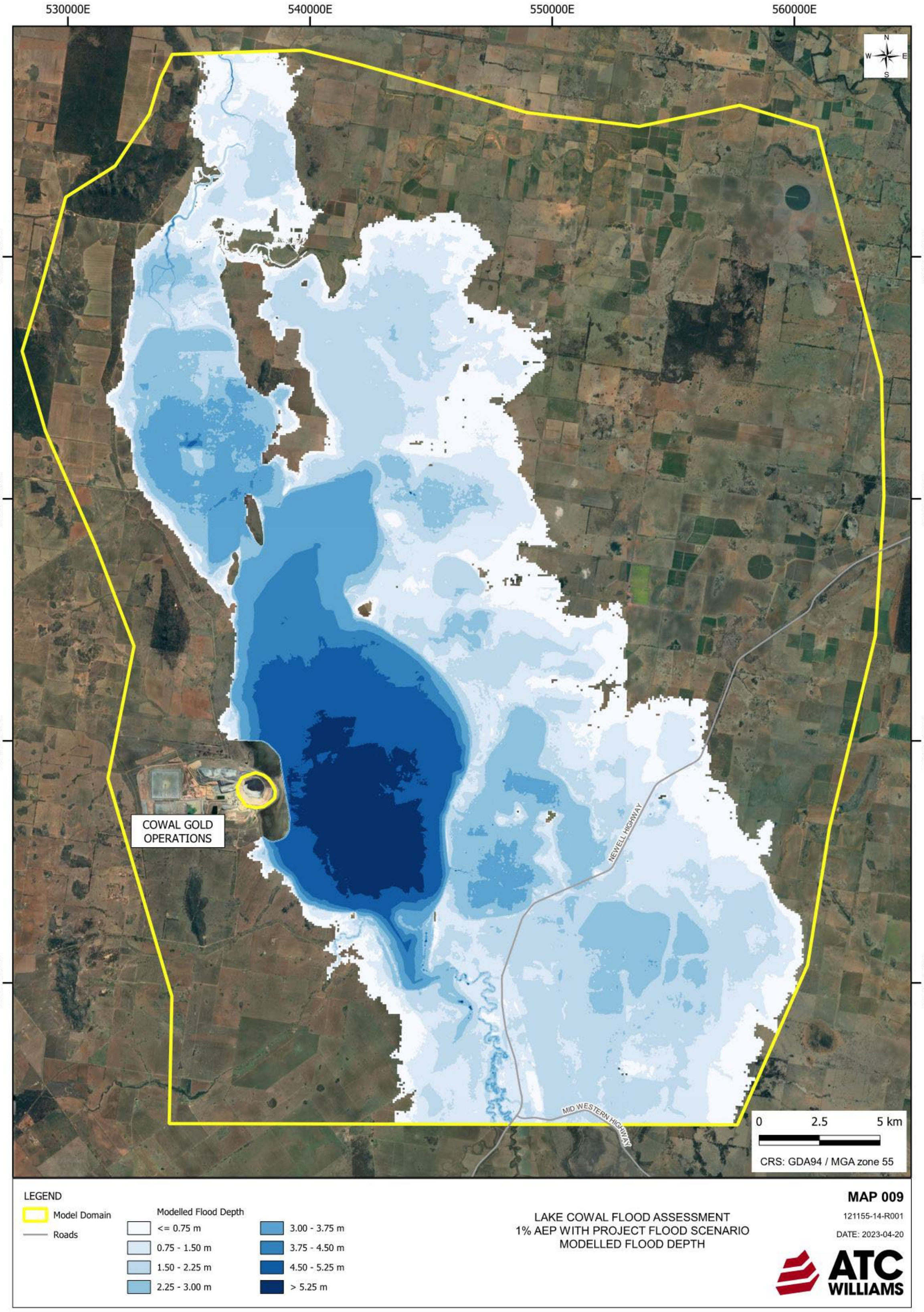
TAILINGS.WATER.WASTE.



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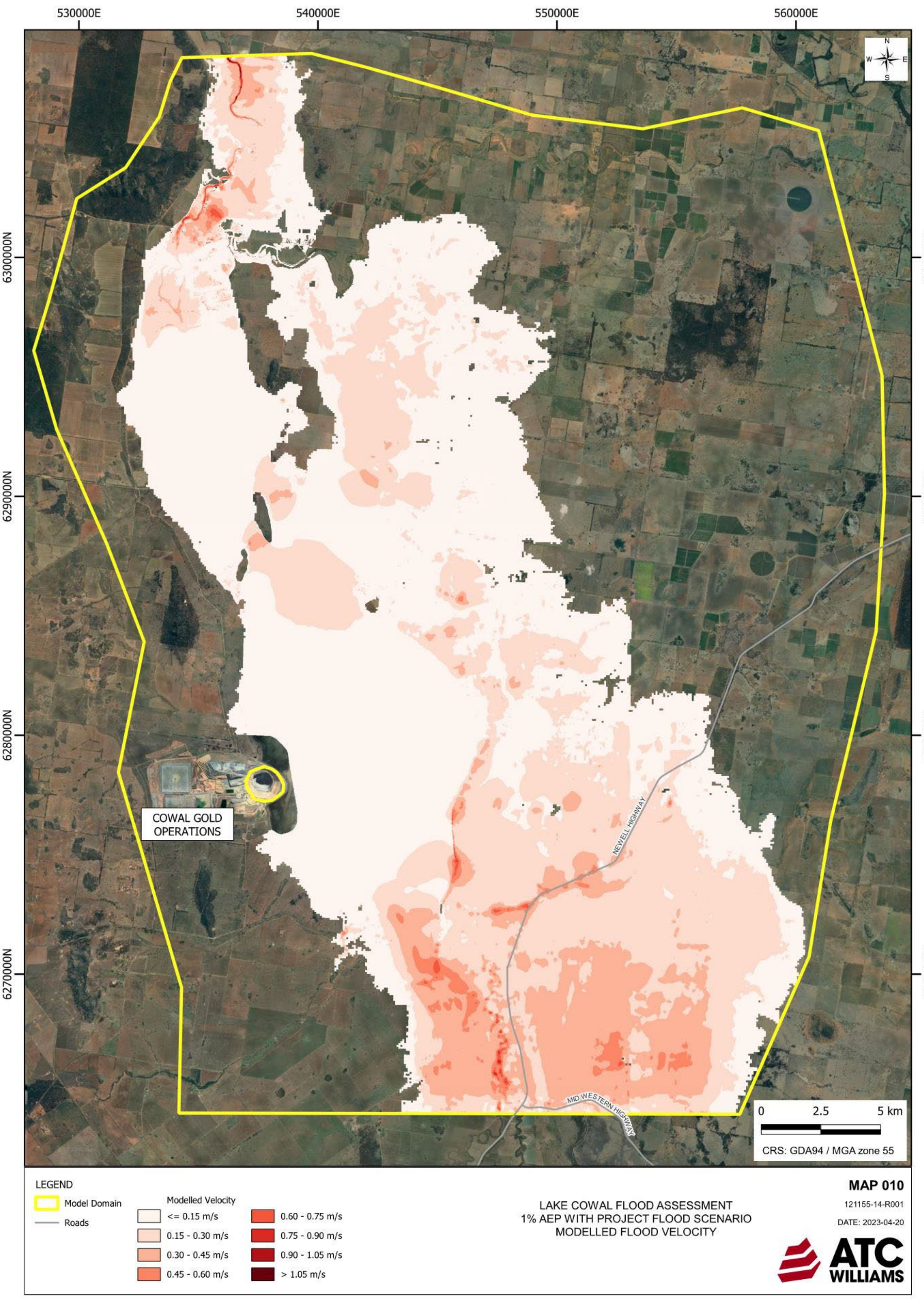

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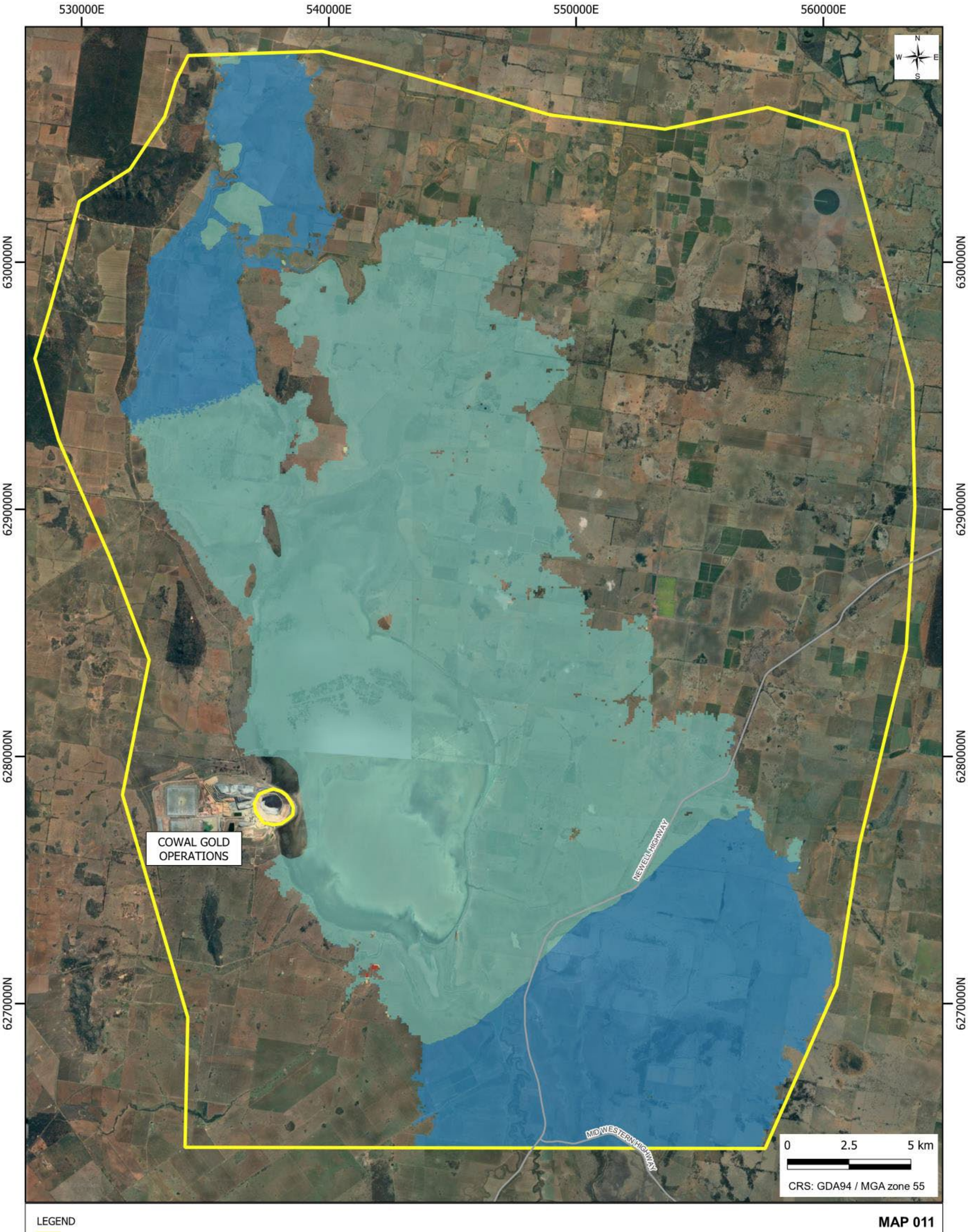

LEGEND

Model Domain

Roads

Predicted Flood Depth Change

<= 1.25 cm

1.25 - 2.5 cm

2.5 - 3.75 cm

3.75 - 5.0 cm

5.0 - 6.25 cm

6.25 - 7.5 cm

7.5 - 8.75 cm

> 8.75 cm

LAKE COWAL FLOOD ASSESSMENT
1% AEP WITH PROJECT FLOOD SCENARIO
EXISTING VS WITH PROJECT DEPTH CHANGE

MAP 011

121155-14-R001

DATE: 2023-04-20

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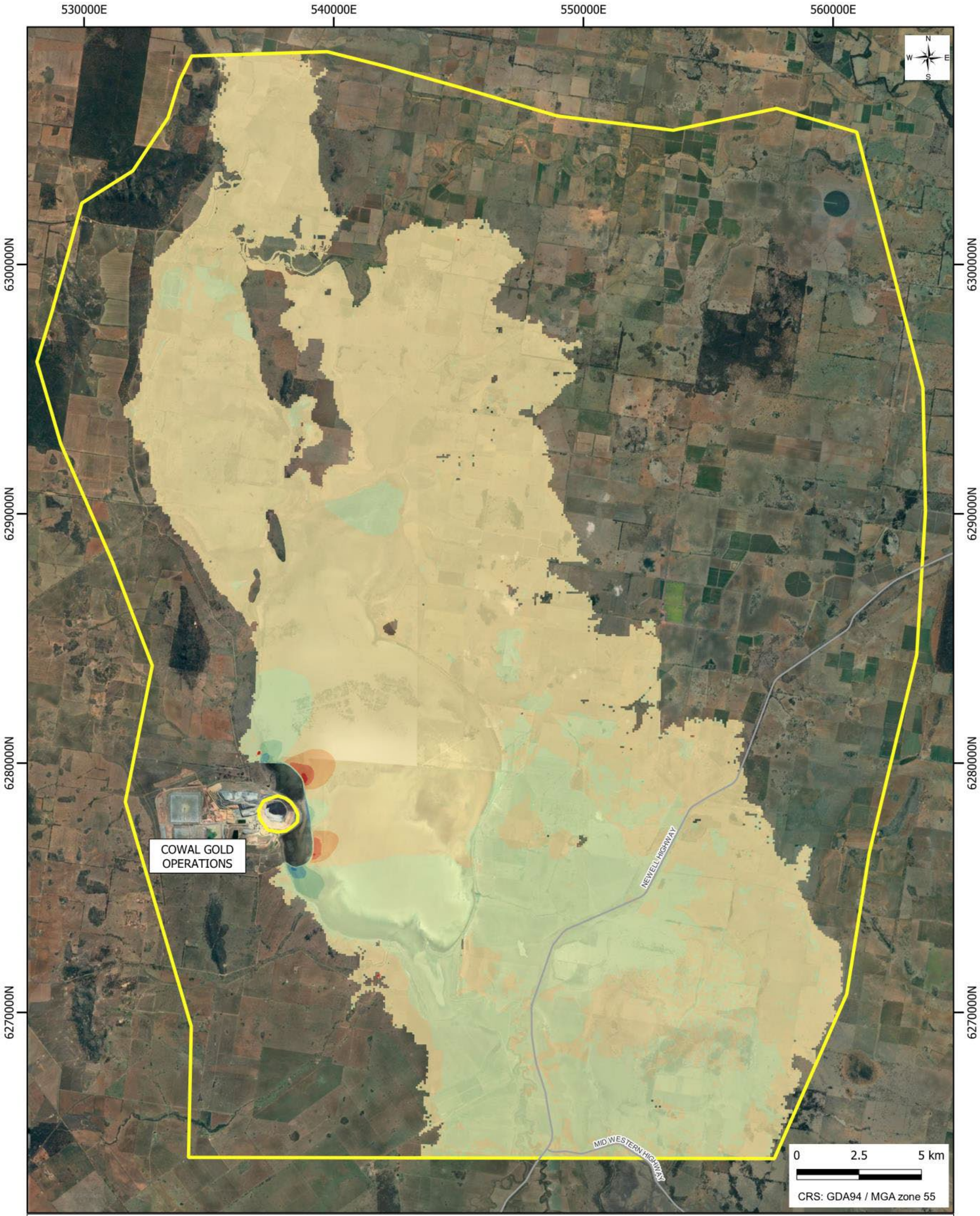

LEGEND

- Model Domain
- Roads

Predicted Velocity Change

- <= -0.04 m/s
- -0.04 - -0.03 m/s
- -0.03 - -0.01 m/s
- -0.01 - 0.00 m/s
- 0.00 - 0.01 m/s
- 0.01 - 0.03 m/s
- 0.03 - 0.04 m/s
- > 0.04 m/s

LAKE COWAL FLOOD ASSESSMENT
1% AEP WITH PROJECT FLOOD SCENARIO
EXISTING VS WITH PROJECT VELOCITY CHANGE

MAP 012

121155-14-R001

DATE: 2023-04-20

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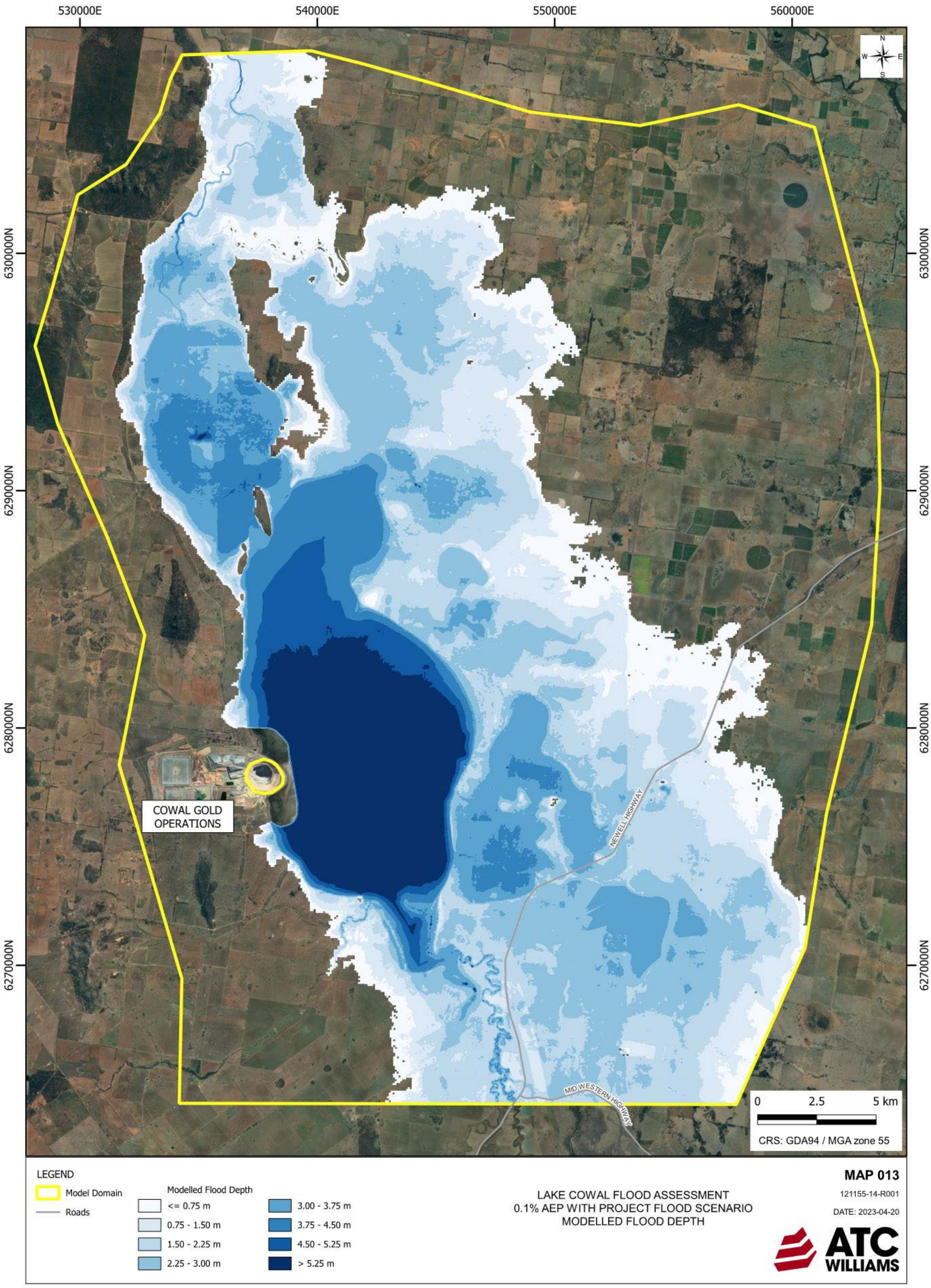

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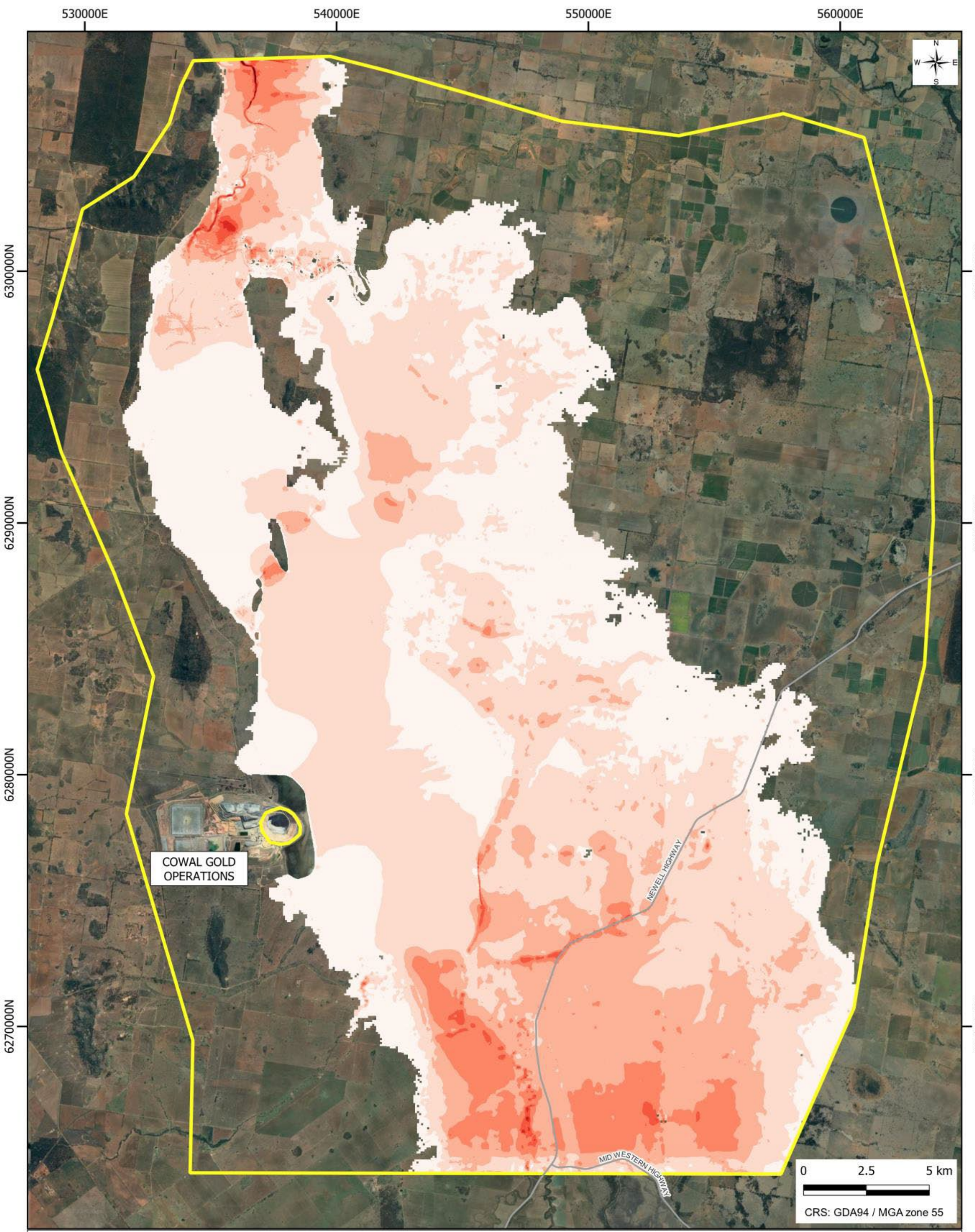

LEGEND

Model Domain

Roads

Modelled Velocity

<= 0.15 m/s	0.60 - 0.75 m/s
0.15 - 0.30 m/s	0.75 - 0.90 m/s
0.30 - 0.45 m/s	0.90 - 1.05 m/s
0.45 - 0.60 m/s	> 1.05 m/s

LAKE COWAL FLOOD ASSESSMENT
0.1% AEP WITH PROJECT FLOOD SCENARIO
MODELLED FLOOD VELOCITY

MAP 014

121155-14-R001

DATE: 2023-04-20

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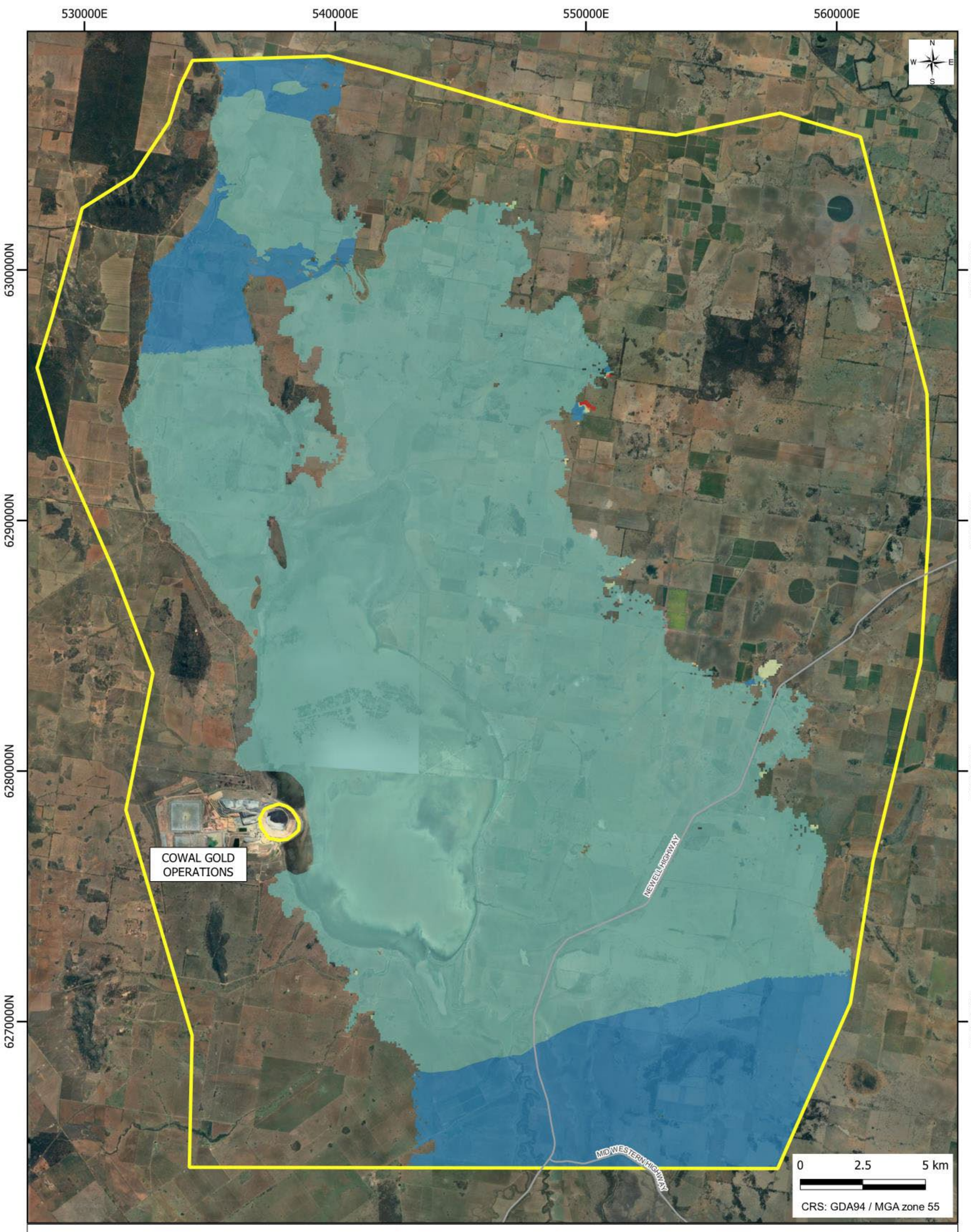

LEGEND

- Model Domain
- Roads

Predicted Flood Depth Change

- <= 1.25 cm
- 1.25 - 2.5 cm
- 2.5 - 3.75 cm
- 3.75 - 5.0 cm
- 5.0 - 6.25 cm
- 6.25 - 7.5 cm
- 7.5 - 8.75 cm
- > 8.75 cm

LAKE COWAL FLOOD ASSESSMENT
0.1% AEP WITH PROJECT FLOOD SCENARIO
EXISTING VS WITH PROJECT DEPTH CHANGE

MAP 015

121155-14-R001

DATE: 2023-04-20

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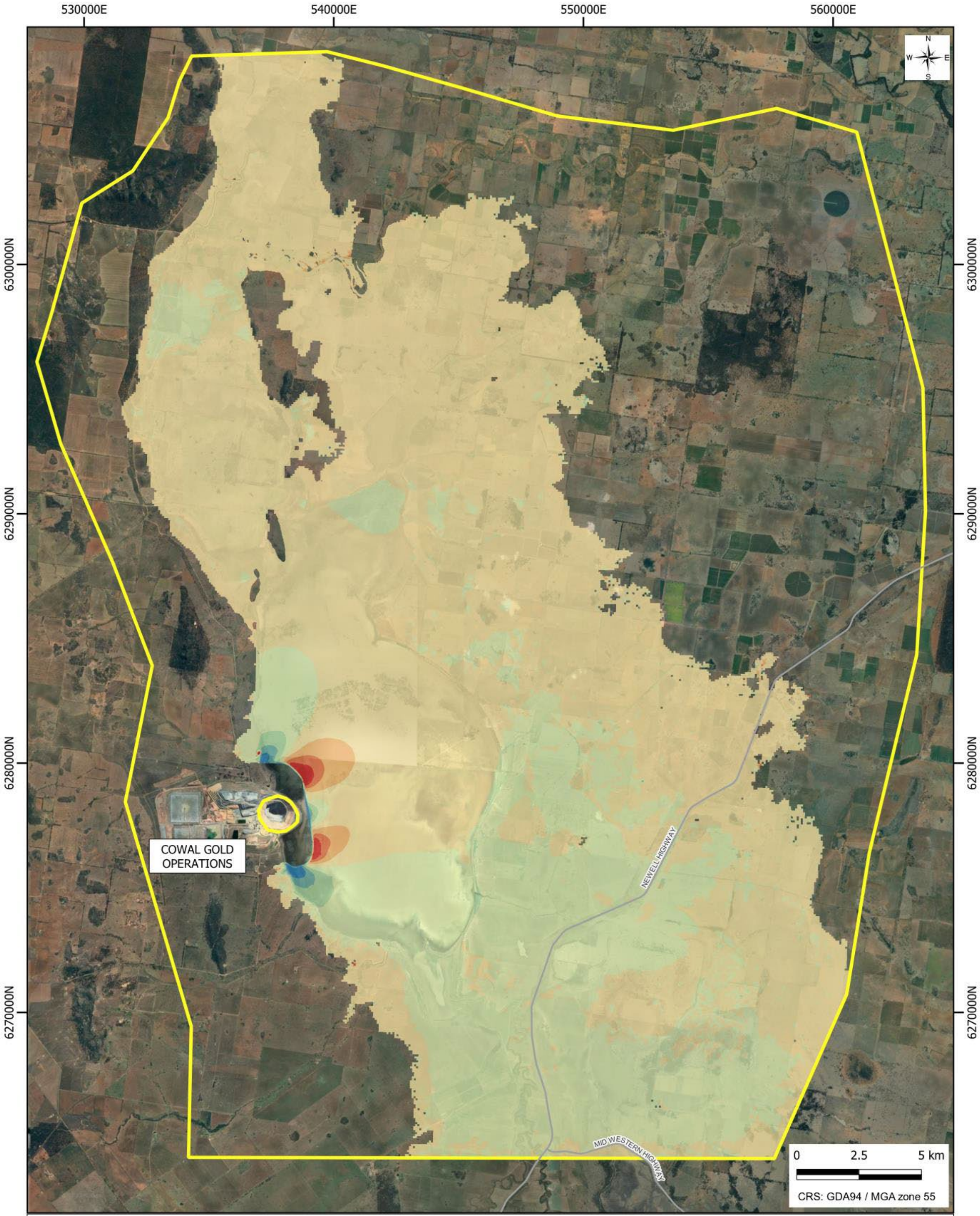

LEGEND

Model Domain

Roads

Predicted Velocity Change

- <= -0.04 m/s
- -0.04 - -0.03 m/s
- -0.03 - -0.01 m/s
- -0.01 - 0.00 m/s
- 0.00 - 0.01 m/s
- 0.01 - 0.03 m/s
- 0.03 - 0.04 m/s
- > 0.04 m/s

LAKE COWAL FLOOD ASSESSMENT
0.1% AEP WITH PROJECT FLOOD SCENARIO
EXISTING VS WITH PROJECT VELOCITY CHANGE

MAP 016

121155-14-R001

DATE: 2023-04-20

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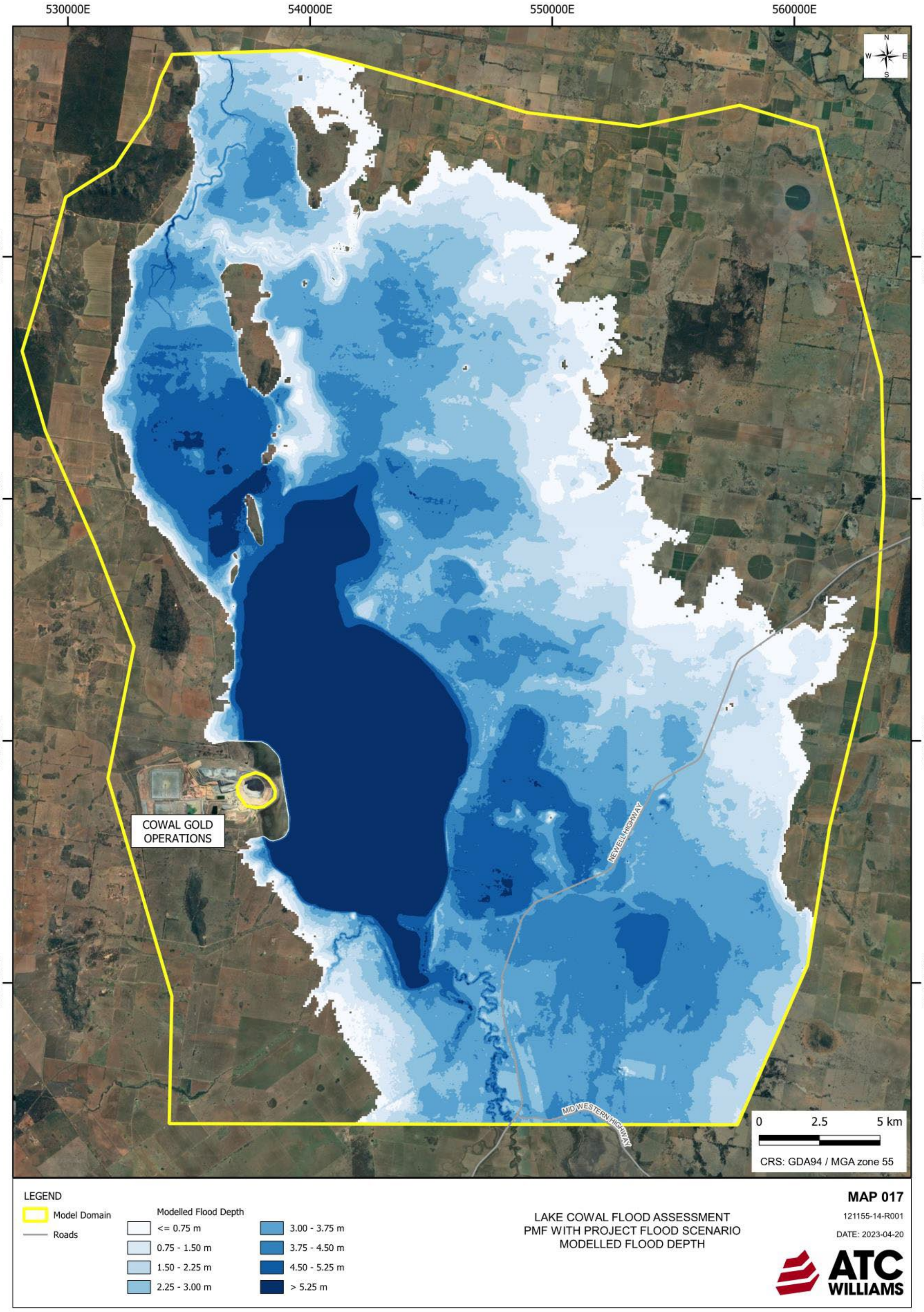

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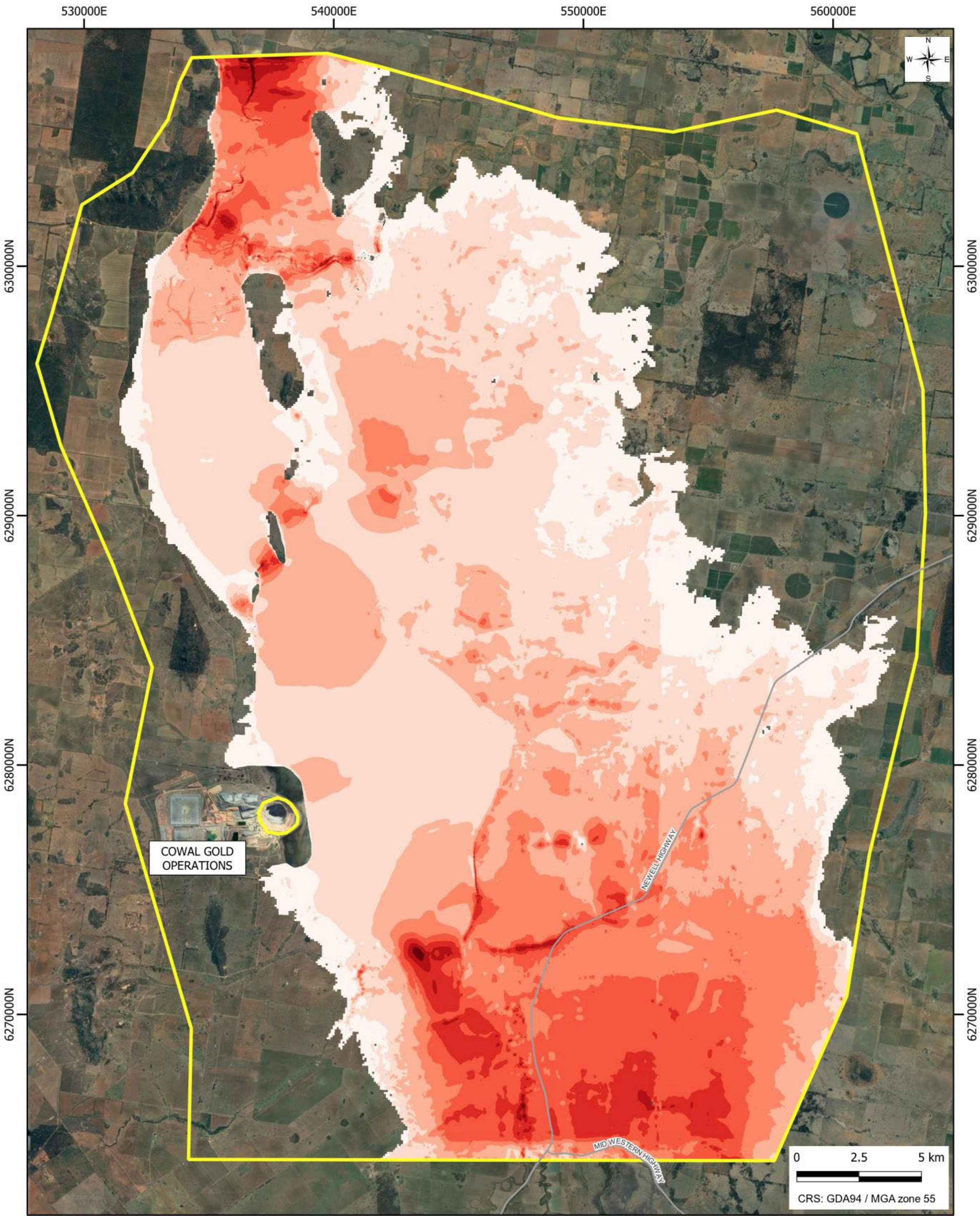

LEGEND

Model Domain

Roads

Modelled Velocity

<= 0.15 m/s	0.60 - 0.75 m/s
0.15 - 0.30 m/s	0.75 - 0.90 m/s
0.30 - 0.45 m/s	0.90 - 1.05 m/s
0.45 - 0.60 m/s	> 1.05 m/s

LAKE COWAL FLOOD ASSESSMENT
PMF WITH PROJECT FLOOD SCENARIO
MODELLED FLOOD VELOCITY

MAP 018

121155-14-R001

DATE: 2023-04-20

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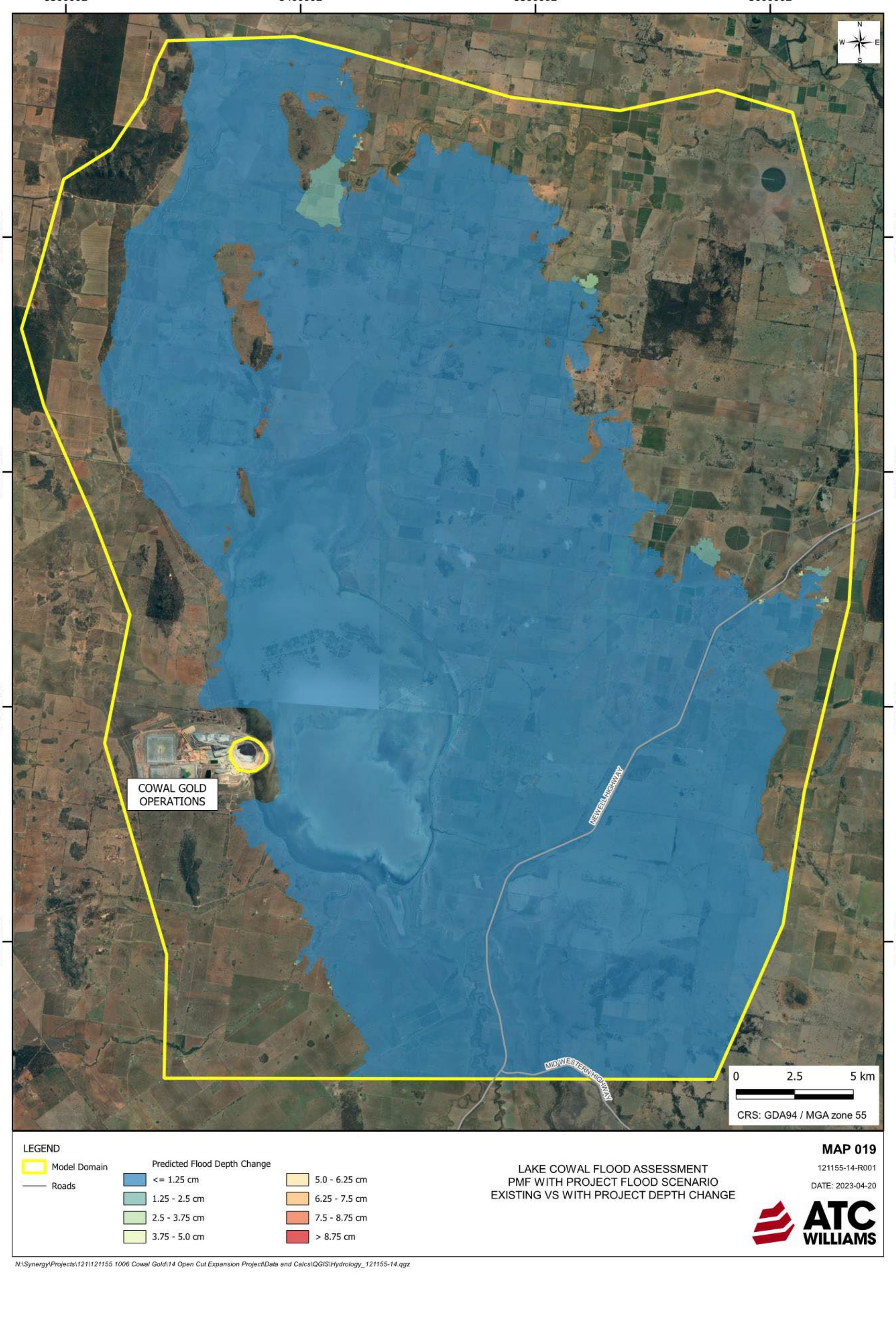

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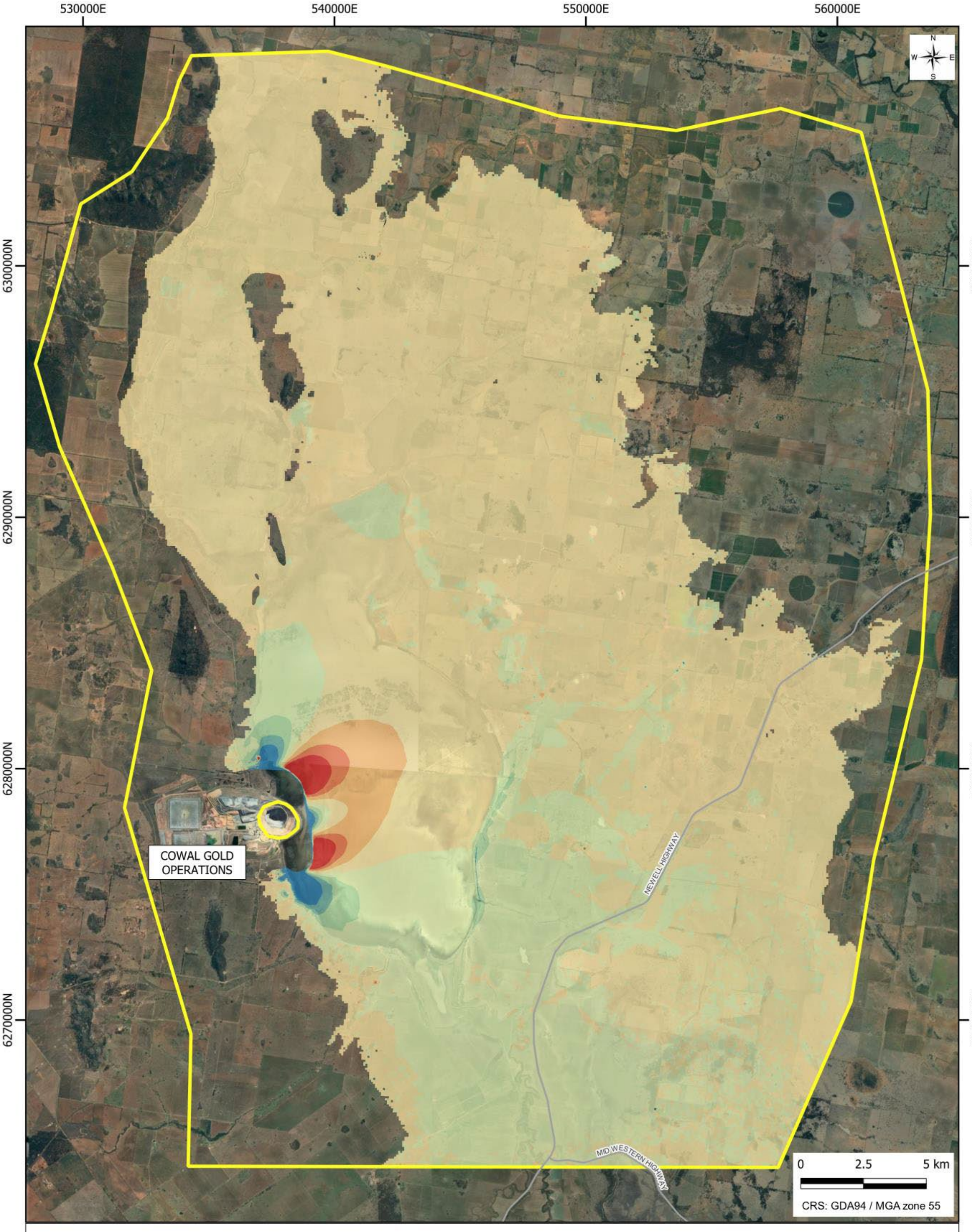

LEGEND

Model Domain

Roads

Predicted Velocity Change

<= -0.04 m/s
-0.04 - -0.03 m/s
-0.03 - -0.01 m/s
-0.01 - 0.00 m/s
0.00 - 0.01 m/s
0.01 - 0.03 m/s
0.03 - 0.04 m/s
> 0.04 m/s

LAKE COWAL FLOOD ASSESSMENT
PMF WITH PROJECT FLOOD SCENARIO
EXISTING VS WITH PROJECT VELOCITY CHANGE

MAP 020

121155-14-R001

DATE: 2023-04-20

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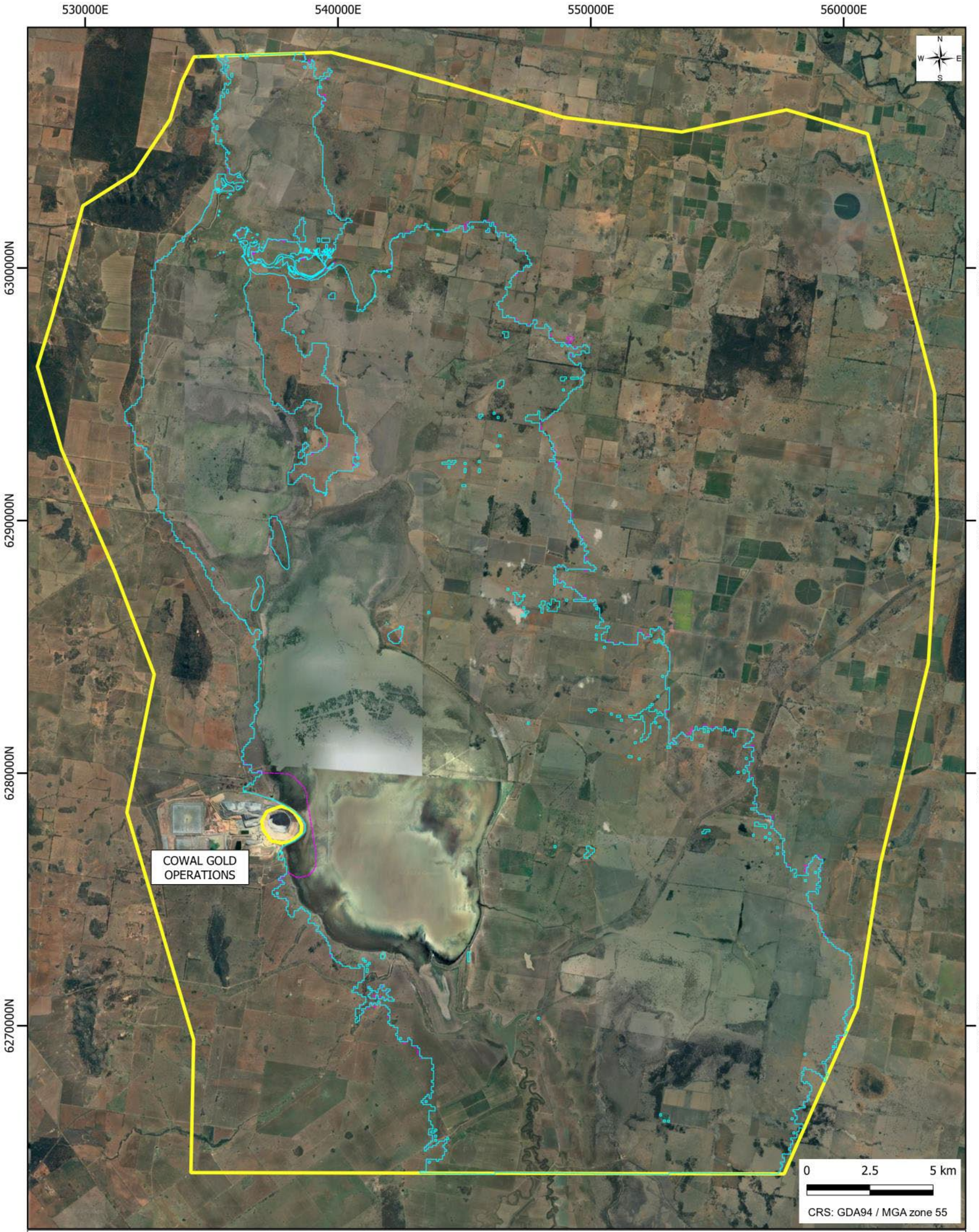

LEGEND

- Modelled Existing Flood Extents 1% AEP
- Modelled with Project Flood Extents 1% AEP
- Model Domain
- Roads

LAKE COWAL FLOOD ASSESSMENT
HYDRAULIC ASSESSMENT
FLOOD PLANNING AREA

MAP 021

121155-14-R001

DATE: 2023-04-20

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