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MAULES CREEK COAL MINE **WHC_PLN_MCC_WATER MANAGEMENT PLAN_OVERVIEW**

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1 INTRODUCTION

The Maules Creek Coal Mine (MCCM) is located in the Gunnedah Coal Basin, approximately 18 km north-east of Boggabri in New South Wales (NSW) (Figure 1). The MCCM is currently owned by Maules Creek Coal Pty Limited (MCCPL), a joint venture between Aston Coal 2 Pty Limited (75%) (a wholly owned subsidiary of Whitehaven Coal), ITOCHU Coal Resources Australia Maules Creek (15%) and J-Power (10%).

Project Approval (PA) 10_0138 was granted to Aston Coal 2 Pty Limited by the Planning Assessment Commission of NSW, as delegate of the Minister for Planning and Infrastructure under section 75J of the Environmental Planning and Assessment Act 1979 (EP&A Act) on 23 October 2012. PA 10_0138 allows for the development of a 21 year open cut coal mining operation and associated surface infrastructure, extracting coal at up to 13 Million tonnes per annum of run of mine (ROM) coal.

The MCCM PA 10_0138 has been modified on six occasions briefly described as follows:

- Mod 1: to include the construction of and operation of the high voltage transmission lines and associated switching station in addition to a minor extension of an 11 kilovolt transmission line.
- Mod 2: to include a revised optimised design, alignment and arrangement of an existing approved water pipeline to the Naomi River and the rearrangement of the associated pump installation.
- Mod 3: to revise traffic management conditions and allow for a shuttle bus service to facilitate transportation and construction of local employees to the site.
- Mod 5: to include the continued use of Olivedene Water Supply and associated infrastructure.
- Mod 6: to include the continued use of the existing water supply pipeline and associated infrastructure.
- Mod 7: to amend the final landform design and enable changes to water management infrastructure.
- Mod 8: (pending determination at the time of WMP submission) to include the disposal of end of life mine tyres and operation of mobile crushing units.

1.1 PURPOSE AND SCOPE

This Water Management Plan (WMP) has been developed by Whitehaven Coal to satisfy the requirements of Condition 40, Schedule 3 of PA 10_0138.

This WMP applies to all employees and contractors of Whitehaven Coal that are responsible for the management of water within the project boundary of the MCCM. Water management at MCCM will continue in accordance with this WMP for the remainder of the currently approved mine life until 31 December 2034. As required under Condition 5 schedule 2, MCCM will continue to comply with the WMP (excluding mining operations) beyond the mine life until rehabilitation works have been completed to the satisfaction of both the Secretary and Resources Regulator.

The WMP provides details of the management of surface water and groundwater related impacts associated with the construction and operation of the MCCM. This includes, but not limited to, the management of sediment, the site water balance, water intake in accordance with licences and flooding.

The WMP will be reviewed and revised (to the satisfaction of the Secretary of the Department of Planning, Industry and Environment (DPIE)) in accordance with the requirements of Schedule 5, Condition 5 of PA 10_0138.



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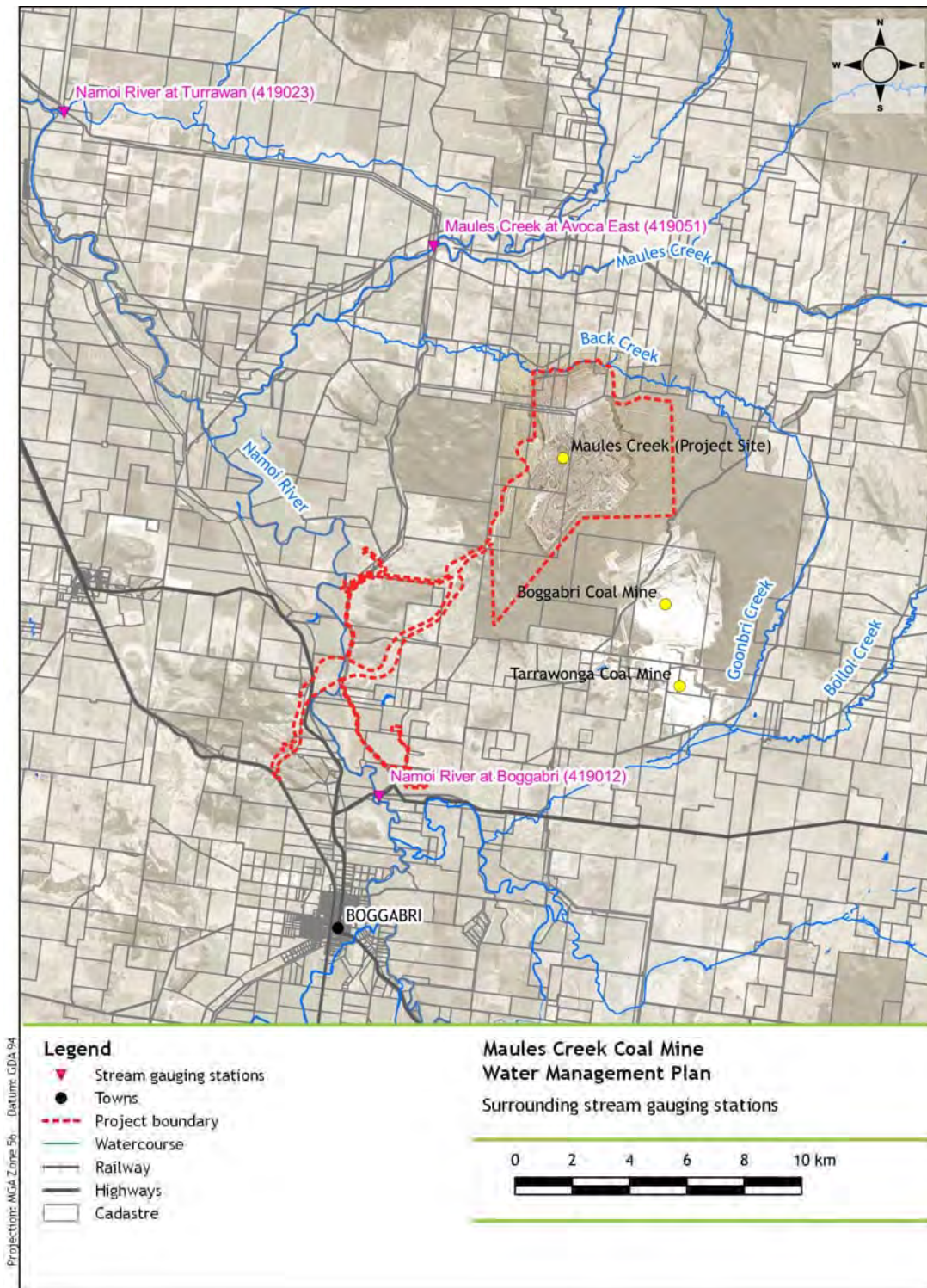


Figure 1 Locality Map

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1.2 PREVIOUS VERSIONS

The WMP was first reviewed and approved in 2013 to satisfy the requirements of PA 10_0138. Since the implementation of the WMP, PA 10_0138 has been modified on five occasions. These modifications however did not require revisions of the WMP. In March 2019 the WMP was revised to incorporate necessary administrative updates.

1.3 CURRENT VERSION

The current version of the WMP has been revised to align with ongoing development of the mine and maintain a high standard of water management protocols, procedures and practice at MCCM.

1.4 STRUCTURE OF THE WATER MANAGEMENT PLAN

The WMP comprises the following documentation in accordance with Condition 40 Schedule 3 of PA 10_0138 (further detailed in Table 1):

- An overarching WMP (this document)
- Site Water Balance (SWB) (Appendix A);
- Surface Water Management Plan (SWMP) (Appendix B);
- Groundwater Management Plan (GWMP) (Appendix C);
- Boggabri-Tarrawonga-Maules Creek Complex (BTM Complex) Water Management Strategy (WMS) (Appendix D).

Table 1
WMP Documentation

Document	Description/Scope
WMP	Describes the statutory obligations to the WMP (section 2) and provides an overview of the MCCM Water Management System (section 3). Section 4 outlines the review and improvement of environmental performance while section 5 describes the management and reporting of incidents, complaints and non-compliances.
Appendix A – Site Water Balance	Details the inputs and outputs of the mine water management system. This includes details of the site water management system and describes storage and use of water to maintain safe and optimal operations in accordance with existing water access licences (WALs), Environmental Protection Licence (EPL) 20221 and Australian New Zealand Guidelines (2018) ANZG.
Appendix B – Surface Water Management Plan	Provides information on baseline surface water data, as well as design objectives, performance criteria, trigger levels and monitoring requirements for surface water management at the mine.
Appendix C – Groundwater Management Plan	Describes the management of groundwater at MCCM. This includes details of the GWMP, predicted impacts and compliance with relevant PA 10_0138 conditions.
Appendix D – BTM Complex Water Management Strategy	Details the relevant water resources, the potential cumulative impacts on resources, and the cumulative water management protocols within the BTM Complex.

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1.5 CONSULTATION

Consultation has taken place with the NSW government in development of the various versions of the WMP, which have been reviewed by DPIE-Water on numerous occasions. Updates to prepare this current version of the WMP have been undertaken in consultation with representatives of the NSW Office of Environmental Heritage (OEH), DoI – Water and North West Local Land Services (NWLLS) (formerly Namoi Catchment Management Authority).

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2 STATUTORY OBLIGATIONS

The statutory obligations of MCCM relating to water management are contained in project-specific approvals, as well as relevant legislation. Project approvals relevant to water management at MCCM include:

- PA 10_0138 (as modified);
- Commonwealth Approval 2010/5566 (as modified);
- relevant licences and permits (including EPL 20221) and mining and coal leases (Mining Lease (ML) 1701, ML 1719, CL 375).

Water management must also comply with general legislative requirements under:

- EP & A Act;
- Protection of the Environment Operations Act 1997 (NSW);
- Water Management Act 2000 (WM Act).

2.1 PROJECT APPROVAL 10_0138

2.1.1 Water Management Plan Requirements

Table 2 describes the requirements under Condition 40, Schedule 3 of PA 10_0138 and indicates where these are addressed within this WMP.

Table 2
Water Management Requirements in PA 10_0138

Schedule 3	
40. The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Secretary. This plan must be prepared in consultation with BCD [now Biodiversity Conservation and Science Directorate within the department], DPIE Water and North West Local Land Services (LLS), by suitably qualified and experienced person/s whose appointment has been approved by the Secretary for approval prior to the commencement of construction. In addition to the standard requirements for management plans (see condition 3 of schedule 5), this plan must include:	
Condition	WMP report section
a. a Site Water Balance...	Appendix A
b. a Surface Water Management Plan...	Appendix B
c. a Groundwater Management Plan...	Appendix C
d. a Leard Forest Mining Precinct Water Management Strategy...	Appendix D

2.1.2 Management Plan (General) Requirements

Condition 3 of Schedule 5 of PA 10_0138 outlines the general management requirements that are relevant to this WMP.

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Table 3
Water Management Requirements in Project Approval 10_0138

MCCM Project Approval 10_0138	Relevant WMP Section
3. The Proponent shall ensure that the management plans required under this consent are prepared in accordance with any relevant guidelines, and include:	
a. detailed baseline data;	Appendix B & C
b. a description of: – the relevant statutory requirements (including any relevant consent, licence or lease conditions); – any relevant limits or performance measures/criteria; – the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;	Section 2 Appendix B & C Appendix B & C
c. a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Section 3 and Appendix A, B & C.
d. a program to monitor and report on the: – impacts and environmental performance of the project; – effectiveness of any management measures (see c above);	Appendix B & C
e. a contingency plan to manage any unpredicted impacts and their consequences;	Appendix B & C
f. a program to investigate and implement ways to improve the environmental performance of the project over time;	Section 4 and Appendix B & C
g. a protocol for managing and reporting any: – incidents; – complaints; – non-compliances with statutory requirements; and – exceedances of the impact assessment criteria and/or performance criteria; and	Section 5
h. a protocol for periodic review of the plan.	Appendix B & C

2.2 EPBC ACT CONTROLLED ACTIONS DECISION

The Commonwealth Approval Environmental Protection and Biodiversity Conservation (EPBC) 2010/5566 for MCCM was granted on 11 February 2013. This has since been varied with latest notice of variation received on 24 March 2021. Conditions 20 to 23 of the Commonwealth Approval relate to water management. However, these conditions have not been varied since the original approval in 2013.

Table 4 details the surface water and groundwater management conditions of EPBC Approval 2010/5566.

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Table 4
Water Management Requirements EPBC Approval

MCCM EPBC 2010/5566	Relevant WMP Section
20. The person taking the action must provide to the Minister for approval, the <i>surface and groundwater management plans</i> as identified in condition 40 of the NSW state government Project Approval dated 23 October 2012 (application number 10_0138). The <i>surface and groundwater management plans</i> must be approved by the Minister prior to commencement of construction.	Appendix B & C
21. The <i>surface and groundwater management plans</i> must be consistent with the National Water Quality Management Strategy .	Appendix B & C
22. The person taking the action must, prior to commencement of construction a description of in collaboration with the proponent to develop and operate the Boggabri Extension (EPBC 2009/5296) and any other approved mines within 20 kilometres (km) of the project area, provide written advice to the Minister demonstrating how the NSW government approved surface water and groundwater management plans (condition 20), addresses the cumulative impact of groundwater drawdown as a result of mining and how this may impact on the consequence health of the remnant native vegetation in the Leard State Forest, the Leard State Forest Conservation Area and surrounding areas. In particular the advice must address the following matters: a. Maximum amount of allowable drawdown in the alluvial aquifer. b. Drawdown in hard rock. c. Trigger levels pertaining to drawdown in the alluvial aquifer when corrective actions will be required to be undertaken. d. Identify the depth of root zone of the native vegetation. e. Monitoring to assess the ongoing quality and quantity of both surface and groundwater to identify impacts on the native vegetation.	Appendix C & D
23. The person taking the action must within 6 months of this approval, or such other timeframe specified by the Minister , provide to the Minister a report on: a. any updated modelling of surface and groundwater impacts that has been undertaken in preparing the <i>surface and groundwater management plans</i>. b. how the <i>surface and groundwater management plans</i> addressed groundwater and surface water impacts on matter of national environmental significance.	Addressed in separate document to SEWPaC (now DAWE)

2.3 LICENCES, PERMITS AND LEASES

Water management at MCCM is conducted in accordance with the following licences and permits as required under the *Water Management Act, 2000*, *NSW Protection of the Environmental Operations Act, 1997*, the *NSW Mining Act*:

- Water Access Licences (WALs).
- EPL 20221.
- ML 1701, ML 1719 and CL 375.
- Mining Operations Plan approved by DP&E – Division of Resources and Geoscience.

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2.3.1 Water Access Licences

Existing MCCM WALs used to account for passive take into the mine workings are detailed in Table 5. Table 5 shows MCCM has sufficient WALs (with carry over) to account for the predicted maximum passive take over the LOM as per the BTM complex Groundwater Model.

Table 5
Maules Creek Current Water Access Licences – Passive take

Water Source	WAL No.	Total Entitlement (units)	Predicted Maximum take and year
Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source	36548	36	144 ML - FY30
	27385	38	
	12613	50	
Upper Namoi Zone 11, Maules Creek Groundwater Source	12479	78	15 ML - FY35
Gunnedah – Oxley Basin MDB Groundwater Source (Gunnedah – Oxley Basin MDB [Other] Management Zone)	29467	306	956 ML - FY24
	36641	800	
	36576	600	

Existing MCCM WALs used to account for licensed extraction from an approved river pump or bore are detailed in Table 6. In addition to these WALs, MCCM has obtained temporary trades (through water allocation assignment trading) to allow for additional Zone 4 and Zone 5 groundwater to be extracted from the Roma, Brighton and Olivedene bores. Temporary trades are common in Zone 4 (78 trades totalling 7,231 units in Financial Year (FY) 2019) and hence offer a reliable market for MCCM to obtain temporary allocation of groundwater to meet any additional demand.

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Table 6
Maules Creek Current Water Access Licences – Extraction

Water Source	WAL No.	Total Entitlement (units)	Extraction location
Lower Namoi Regulator River Water Source (High Security)	13050	3,000	Namoi River - 90WA801901
Maule's Creek Water Source (Maule's Creek Tributaries Management Zone)	41585	30	HWD10 and HWD11
Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source	12722	77	Roma Bore - 90CA807023
	12718	102	Brighton Bore - 90CA807012
Upper Namoi Zone 5, Namoi Valley (Gin's Leap to Narrabri) Groundwater Source	12811	135	Olivedene Bore - 90CA807230
	12791	112	
Upper Namoi Zone 11, Maules Creek Groundwater Source	12480	215	Not in use
	12491	77	
	12473	241	
	12482	77	
	12486	77	
	12489	28	
Maules Creek Unregulated Water Source (Maules And Horsearm Creeks Management Zone)	32474	302	

2.4 OTHER LEGISLATION AND REQUIREMENTS

2.4.1 Water Management (WM) Act 2000

The WM Act 2000 provides for various types of approval for land-based activities that affect the quality and quantity of the State's water resources:

- Water use approval (section 89 of the WM Act) which authorises the use of water at a specific location for a particular use, for up to 10 years.
- Water management work approval (section 90 of the WM Act).
- Controlled activity approval (section 91 of the WM Act) which is a type of controlled activity approval that authorises the holder to conduct activities that affect an aquifer such as approval for activities that intersect groundwater, other than water supply bores and may be issued for up to 10 years.

Water access licences are required to be held under the relevant water sharing plan (WSP) for any water take that occurs as a result of the Project on the various water sources neighbouring the mine.

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The WSPs relevant to the MCCM include:

- Upper and Lower Namoi Regulated River Water Sources WSP (Namoi Regulated WSP);
- Namoi Unregulated and Alluvial Water Sources WSP 2012 (Namoi Unregulated WSP);
- Upper and Lower Namoi Groundwater Sources WSP (Namoi Groundwater WSP); and
- MDB Porous Rock Groundwater Sources WSP (MDB Porous Rock WSP).

2.4.2 Licensing of storages

Water captured by all storages at MCCM will be appropriately licensed under the *WM Act 2000* based on the location and purpose of each storage. Further details of site storages and their licence status is provided in Appendix A (SWB).

2.4.3 Maximum Harvestable Rights Dam Capacity

MCCM's maximum harvestable right dam capacity (MHRDC) has been assessed based on the project lease area.

The MHRDC is calculated by multiplying the project area (3,641 hectares (ha)) by the landholding area multiplier of 0.065 from the Water NSW Maximum Harvestable Right Calculator, giving a total MHRDC of 236.7 ML. The capacity of dams licensed under harvestable rights is provided in Appendix A (SWB).

2.4.4 National Water Quality Management Strategy/ANZG (2018) Guidelines

The National Water Quality Management Strategy is a national approach to protecting the nations water resources by maintaining and improving water quality, while supporting dependent aquatic and terrestrial ecosystems, agricultural and urban communities. In 2018 the Australian & New Zealand (2000) water guidelines were superseded by the ANZG (2018) as an online resource. These guidelines provide a framework for long-term management strategies that protect community values of waterways.

The ANZG (2018) guidelines have been considered, where applicable, in the SWB (Appendix A), Surface Water Management Plan (SWMP) (Appendix B) and Groundwater Management Plan (GWMP) (Appendix C) and BTM Complex WMS (Appendix D).

2.4.5 Aquifer Interference Policy

The *Aquifer Interference Policy* (AIP) clarifies the requirements for obtaining water licenses for aquifer interference activities under NSW water legislation (i.e. *WM Act 2000*). It establishes and objectively defines considerations in assessing and providing advice on whether more than minimal impacts might occur to a key water-dependent asset. The AIP applies throughout the state of NSW and allows for take activities to be accounted for in the state water budget through the appropriate licencing of water taken by aquifer interference activities. The AIP also forms the basis of assessment at various stages of an assessment under the EP&A Act.

The AIP has been considered in the preparation of the SWB (Appendix A), SWMP (Appendix B), GWMP (Appendix C) and BTM Water Management Strategy (Appendix D).

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3 WATER MANAGEMENT OVERVIEW

3.1 SURFACE DRAINAGE NETWORK

MCCM is located within the catchment of Back Creek, a tributary of Maules Creek, which in turn is a tributary of the Namoi River. The mine access road and rail corridor, located to the west of the mine, drain to minor tributaries of the Namoi River. Figure 2 shows site catchment boundaries, water storages and land use across the site for financial year 2021/2022 (FY22).

3.2 WATER MANAGEMENT SYSTEM AND SITE WATER BALANCE OVERVIEW

The water management strategy for the Mine is based on targeted management of water from different sources based on anticipated water quality. Water on the site is categorised as either:

- clean water – water from areas not disturbed by mining;
- mine water – groundwater inflows and surface runoff in mining areas that is likely to come into contact with coal; or
- sediment laden water – runoff from areas disturbed by stripping or placement of overburden material.

Details of site storages for the management clean water, mine water and sediment laden water, as well as a full water balance of the MCCM water management system, are provided in Appendix A. The main storages on the site include:

- Mine Water Dam which is the primary storage for recycled mine water that supplies the major site water demands;
- Raw Water Dam which is a holding dam for clean water imported to the site from external sources; and
- sediment dams which collect runoff from overburden emplacements and recycled to the Mine Water Dam for reuse on the site to reduce external water demands in accordance with DPIE guidelines (DECC, 2008) and the project conditions of consent. In the event the water is not required, MCCM may treat and release to receiving watercourses (in accordance with EPL requirements).

Key water demands include:

- CHPP water usage;
- haul road dust suppression; and
- miscellaneous water usage (i.e. stockpile water usage and vehicle washdown).

The first priority source for meeting minesite demands is the Mine Water Dam which collects water from the following sources:

- Passive groundwater inflows to the open cut mine.
- Runoff captured from the footprint of the mine disturbance area in accordance with appropriate water acquisition rights.
- Fine rejects bleed water captured from the Fines Emplacement Area.

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Where mine water stored on site cannot meet demands, external water is imported from the Namoi River. In the event no water is available in the Namoi River, MCCM will import water from the Olivedene, Roma and Brighton bores. All external water extractions will be undertaken in accordance with the associated approved water supply networks in accordance with water access licences.



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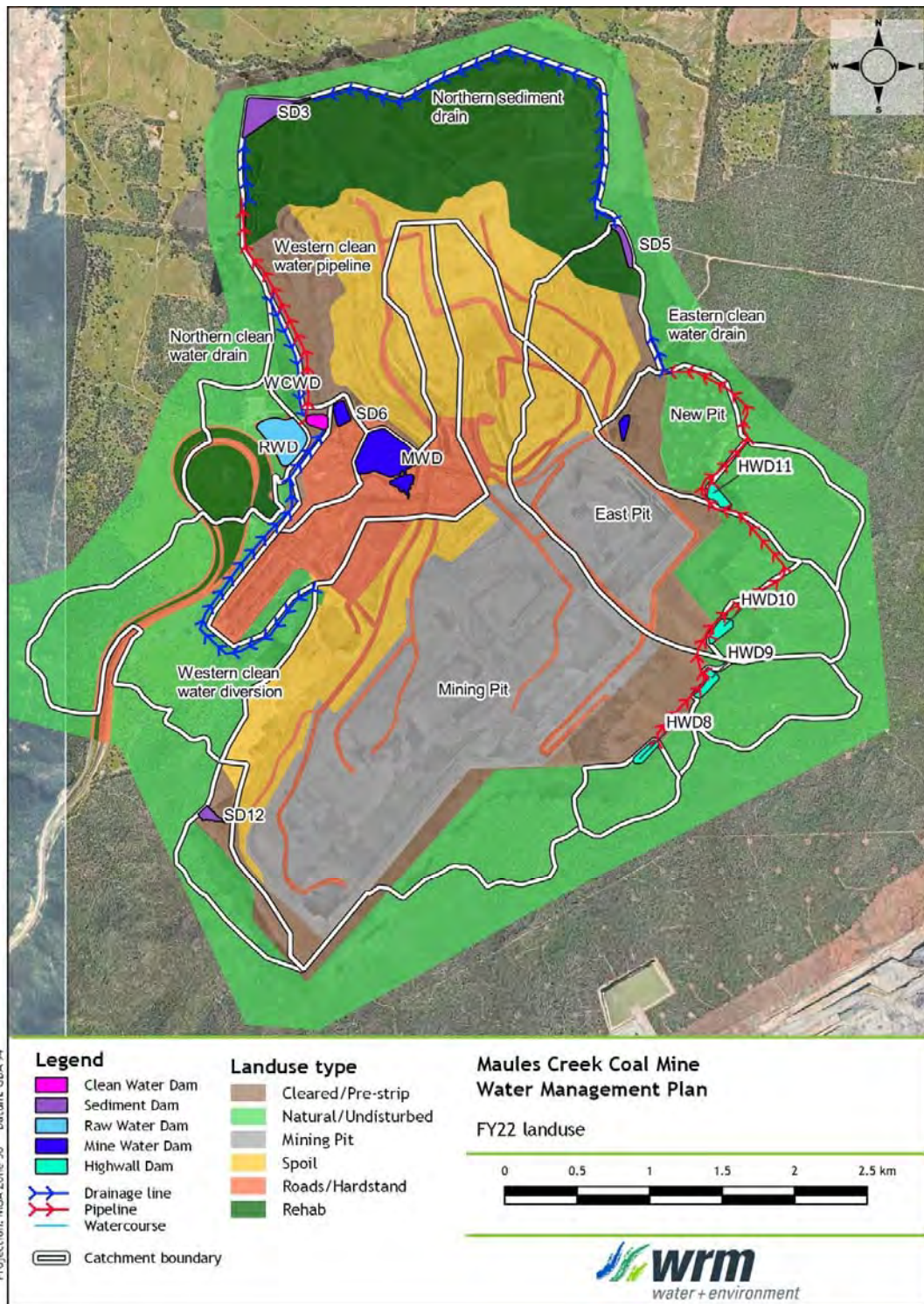


Figure 2 Site catchments, storages and land use – FY22

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3.3 GROUNDWATER

Details of the groundwater system in the vicinity of MCCM are provided in the Groundwater Management Plan (GMP) (Appendix 3).

3.4 BTM COMPLEX OVERVIEW

The BTM Water Management Strategy details the cumulative water management approach taken by the Boggabri, Tarrawonga and Maules Creek mines to monitor and collectively manage the surface water and groundwater impacts of their operations. The Water Management Strategy details the relevant water resources, the potential cumulative impacts on those water resources, and the cumulative water management protocols within the BTM Complex.

A brief overview of the Boggabri Coal Mine (BCM) and Tarrawonga Coal Mine (TCM) is provided below.

3.4.1 Boggabri Coal Mine

BCM is an existing open cut mine that consists of an open cut pit, overburden dump, infrastructure area including coal processing facilities, water management structures, and a rail spur. BCM obtained NSW State Government approval on 18 July 2012, and Commonwealth Government approval on 11 February 2013. These approvals (as modified) allow operations at BCM to extend for a further 21 years at a rate of 8.6 Mtpa of ROM coal. The project approval for BCM provides for operation of existing ancillary equipment; construction and operation of a new coal handling and preparation plant (CHPP); 17 km rail spur line; bridges over the Namoi River and Kamilaroi Highway; a rail load-out facility located at the mine; upgrade of the overburden and coal extraction haulage fleet (with an option for a drag-line); upgrade of electricity transmission lines; and establishment of a water supply borefield and other ancillary infrastructure.

3.4.2 Tarrawonga Coal Mine

TCM is an existing open cut coal mine located immediately south of BCM. TCM initially had approval to extract 2 Mtpa of ROM coal until 2017. TCPL submitted an application in July 2011 under Part 3A of the *Environment Planning and Assessment Act, 1979* (EP&A Act) for an extension of open cut mining operations to 3 Mtpa of ROM coal for a further 17 years. This application was approved by the NSW State Government on 22 January 2013. TCM have modified Project Approval 11_0047 on nine occasions since then, with the most recent being in May 2021. Project Approval 11_0047 allow operations at TCM until 2030 at a rate of 3.5 Mtpa of ROM coal.

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4 REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

4.1 ANNUAL REVIEW

In accordance with Schedule 5, Condition 4 of PA 10_0138, MCCM will submit by the end of March each year (or other such timing as agreed by the Planning Secretary) an Annual Review for the previous calendar year to the Planning Secretary of DPIE, which will fulfil the reporting requirements listed in that condition. The review will include:

- Review of the monitoring results and complaints records of the development over the past year, which includes a comparison of these results against the:
 - relevant statutory requirements, limits or performance measures/criteria;
 - monitoring results of previous years; and
 - relevant predictions in the EIS.
- Validation of the calibration parameters of the water balance model to ensure that the model adequately simulates observed conditions on site;
- Identification of any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- Identification of any trends in the monitoring data over the life of the development;
- Identification of any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and
- Description of measures that will be implemented over the next year to improve the performance of the water management system.

MCCM annual review documentation is publicly available on the MCCM website at <https://whitehavencoal.com.au/our-business/our-assets/maules-creek-mine/> in accordance with Condition 12, Schedule 5 of PA 10_0138.

4.2 REVISION OF WMP

As detailed in Schedule 5, Condition 5 of PA 10_0138, the WMP will be reviewed and revised (to the satisfaction of the Secretary of the DPIE), within three months of the submission of the following documentation:

- Annual Review (Condition 4, Schedule 5);
- Incident Report (Condition 8, Schedule 5);
- Audit (Condition 10, Schedule 5); and
- Any modification to the conditions of the approval PA 10_0138.

As part of the WMP review process, MCCM will provide a report to the Minister (or their delegate) administering the EPBC Act 1999, on any updated water modelling that has been undertaken and how the WMP addresses groundwater and surface water impacts on matters of national environmental significance in accordance with approval EPBC 2010/5566 Condition 23.

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5 REPORTING SYSTEMS

In accordance with Condition 3(g) Schedule 5 of PA 10_0138, MCCM has developed protocols for the management and reporting of any:

- incidents;
- complaints;
- non-compliances with statutory requirements; and
- exceedances of the impact assessment criteria and/or performance criteria.

These protocols are described in the Maules Creek Pollution Incident Response Management Plan.

In accordance with Schedule 5, Condition 8 of PA 10_0138, MCCM shall notify the Planning Secretary and any other relevant agencies of any incident that has caused, or threatens to cause, material harm to the environment at the earliest opportunity, and shall notify of any other incident as soon as practicable.

MCCM will regularly (at least every six months) prepare a summary of monitoring results that are publicly available at the mine site and on the Maules Creek website in accordance with Schedule 5, Condition 9 of PA 10_0138. In addition, a summary of groundwater monitoring results will be included in the Annual Review.

MCCM will report on the operation of the clean water management system quarterly from June 2022, as per the Enforceable Undertaking entered into with NRAR. Documentation will be publicly available on the MCCM website at <https://whitehavencoal.com.au/our-business/our-assets/maules-creek-mine/>

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6 REFERENCES

DECC, 2008 Managing Urban Stormwater, Soils and Construction, Volume 2E
Mines and Quarries, Department of Environment and Climate
Change, June 2008.

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APPENDIX 1 SITE WATER BALANCE

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WHC_PLN_MCC_WATER MANAGEMENT PLAN_APPENDIX A_SITE_WATER_ BALANCE

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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

This document presents the methodology and assumptions used to prepare an estimate of the Malues Creek Coal Mine (MCCM) site water balance for the financial years (FY) from 2021/22 (FY22) to 2023/24 (FY24). The Goldsim software was used to undertake a forecast simulation of the key inflows to and outflows from the site water management system.

Some components of the site water balance will vary substantially from year to year depending upon climatic conditions. The water balance simulation has assessed the performance of the mine water management system under the full range of historical climatic conditions. The presentation of results shows the range of likely values, based on the probability of different climatic conditions.

1.2 STRUCTURE OF THE SURFACE WATER BALANCE

This surface water balance (SWB) forms part of the Water Management Plan (WMP) for MCCM. The MCCM Water Management Plan comprises the following documents:

- An overarching WMP.
- Site Water Balance (this document) (Appendix A).
- Surface Water Management Plan (Appendix B).
- Groundwater Management Plan (Appendix C).
- Boggabri-Tarrawonga-Maules Creek Complex (BTM Complex) Water Management Strategy (Appendix D).

The following sections of the SWB describe:

- Statutory obligations under the project approval (Section 2).
- The site water management system, including adopted measures to minimise clean water use on the site (Section 3).
- The site water demands (Section 4).
- The sources of available water (Section 5).
- Surface water releases from the site water management system (Section 6).
- Climate data used for the surface water balance assessment (Section 7).
- Details of the water balance model and model results (Section 8).
- The process for review and validation of the water balance model (Section 9).
- Reporting procedures (Section 10).
- References (Section 11).

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2 STATUTORY OBLIGATIONS

The Maules Creek Coal Project (PA 10_0138) was approved by the Minister for Planning and Infrastructure under Section 75J of the *Environmental Planning & Assessment Act 1979* (EP & A Act) on 23 October 2012.

Condition 40 (WMP) of Schedule 3 (Environmental Performance Conditions) of the approval requires the proponent to prepare and implement a WMP for the Project which includes a Site Water Balance. The requirements for the site water balance, and where each requirement is addressed in this document, is provided in Table 1.

Table 1 Site Water Balance Requirements from PA 10_0138

Requirement for Site Water Balance	Section of SWB Where Addressed
<i>includes details of:</i>	
<i>– sources and security of water supply, including contingency for future reporting periods;</i>	Section 5
<i>– water use on site;</i>	Section 4
<i>– water management on site;</i>	Section 3
<i>– any off-site water discharges;</i>	Section 6
<i>– reporting procedures, including the preparation of a site water balance for each calendar year;</i>	Section 10
<i>– a program to validate the surface water model, including monitoring discharge volumes from the site and comparison of monitoring results with modelled predictions; and</i>	Section 9
<i>describes the measures that would be implemented to minimise clean water use on site;</i>	Section 3.5

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3 WATER MANAGEMENT SYSTEM

3.1 SURFACE WATER MANAGEMENT OBJECTIVES

The proposed water management strategy for MCCM is based on targeted management of water from different sources based on anticipated water quality. Water on the site is categorised as either:

- clean water – water from areas not disturbed by mining;
- mine water – groundwater inflows and surface runoff in mining areas that is likely to come into contact with coal; or
- sediment laden water – runoff from areas disturbed by stripping or placement of overburden material.

The objectives of the water management system are to ensure:

- clean water runoff from undisturbed catchment areas is diverted away from the mining area, where possible and practical to do so;
- sediment laden runoff from disturbed areas is re-used in the water management system or released into the receiving environment if water quality meets Environmental Protection Licence (EPL) requirements;
- mine water (including water that accumulates within, or drains from, active mining areas, coal reject emplacement areas and Coal Handling and Preparation Plant (CHPP) infrastructure areas) and groundwater collected within open cut pits is contained and reused on-site;
- no discharge of mine water off-site; and
- on-site water demands are satisfied whilst minimising offsite water requirements.

3.2 WATER MANAGEMENT SYSTEM CONFIGURATION

Figure 1 shows a schematic representation of the water circuit for the MCCM water management system. Current and forecast site catchment areas, land use and water management infrastructure for FY22 to FY24 are shown in Figure 2 to Figure 4. Details of storages and their operating rules are provided in Section 3.3.1.

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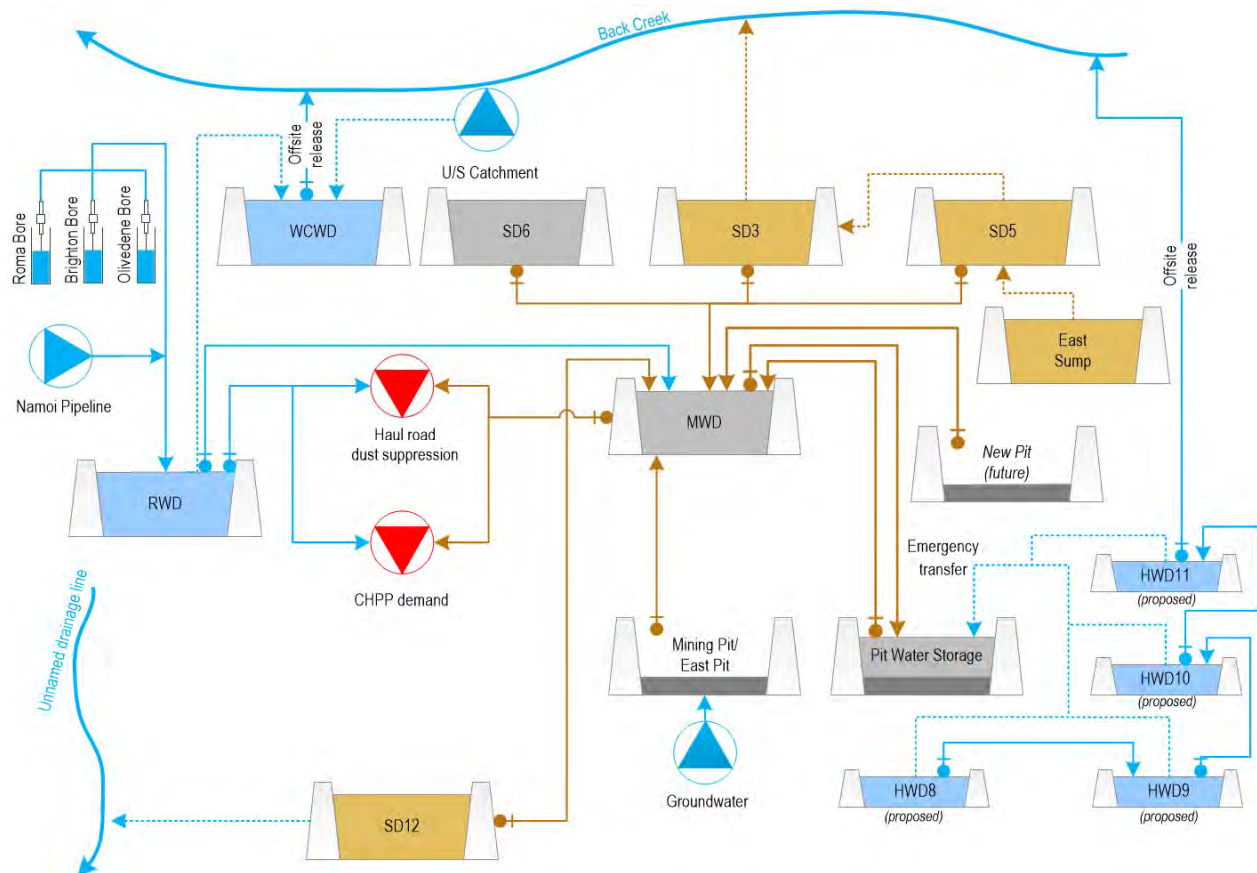


Figure 1 – Schematic of Mine Water Management System

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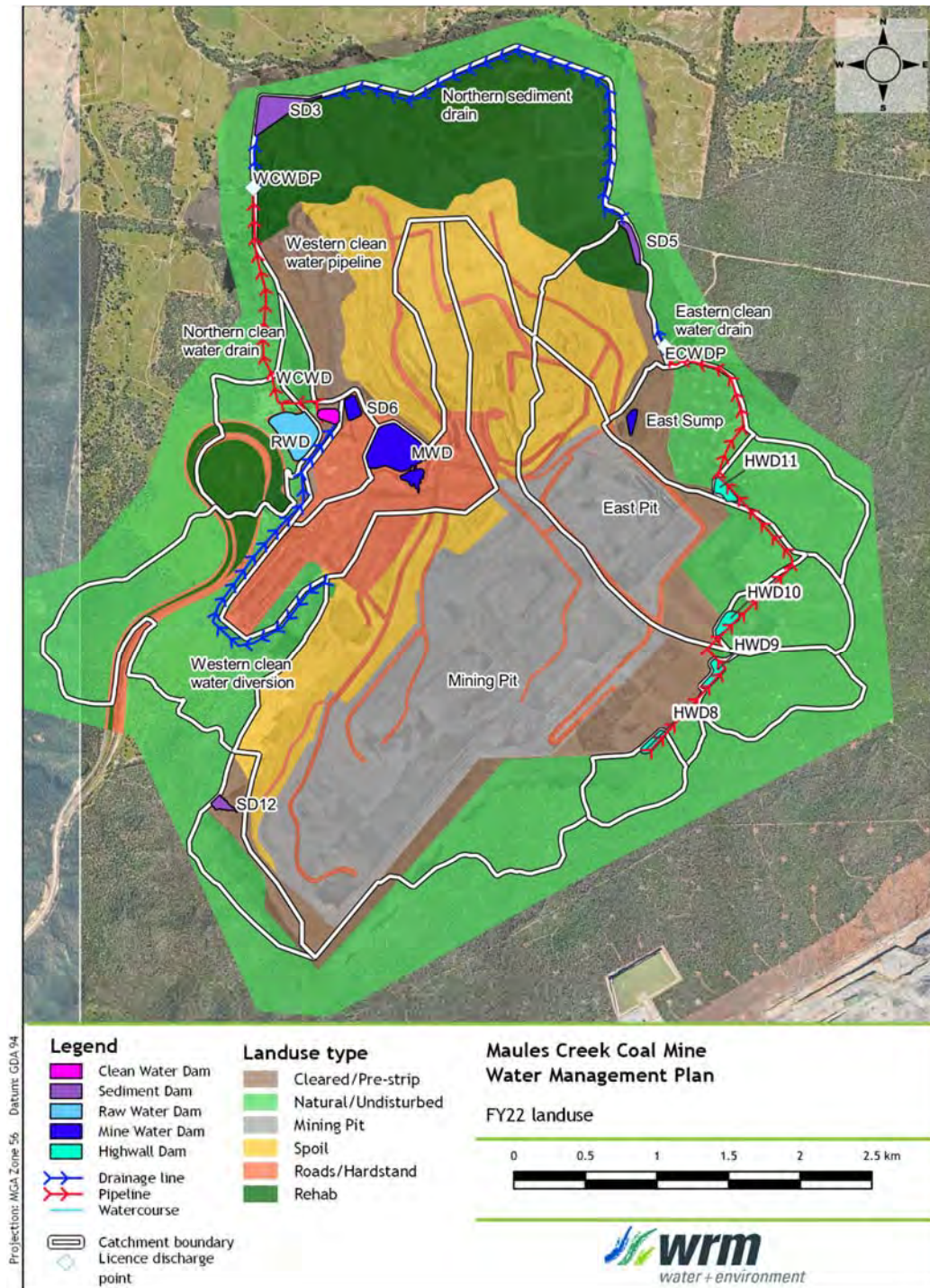


Figure 2 – Site catchments and land use, FY22

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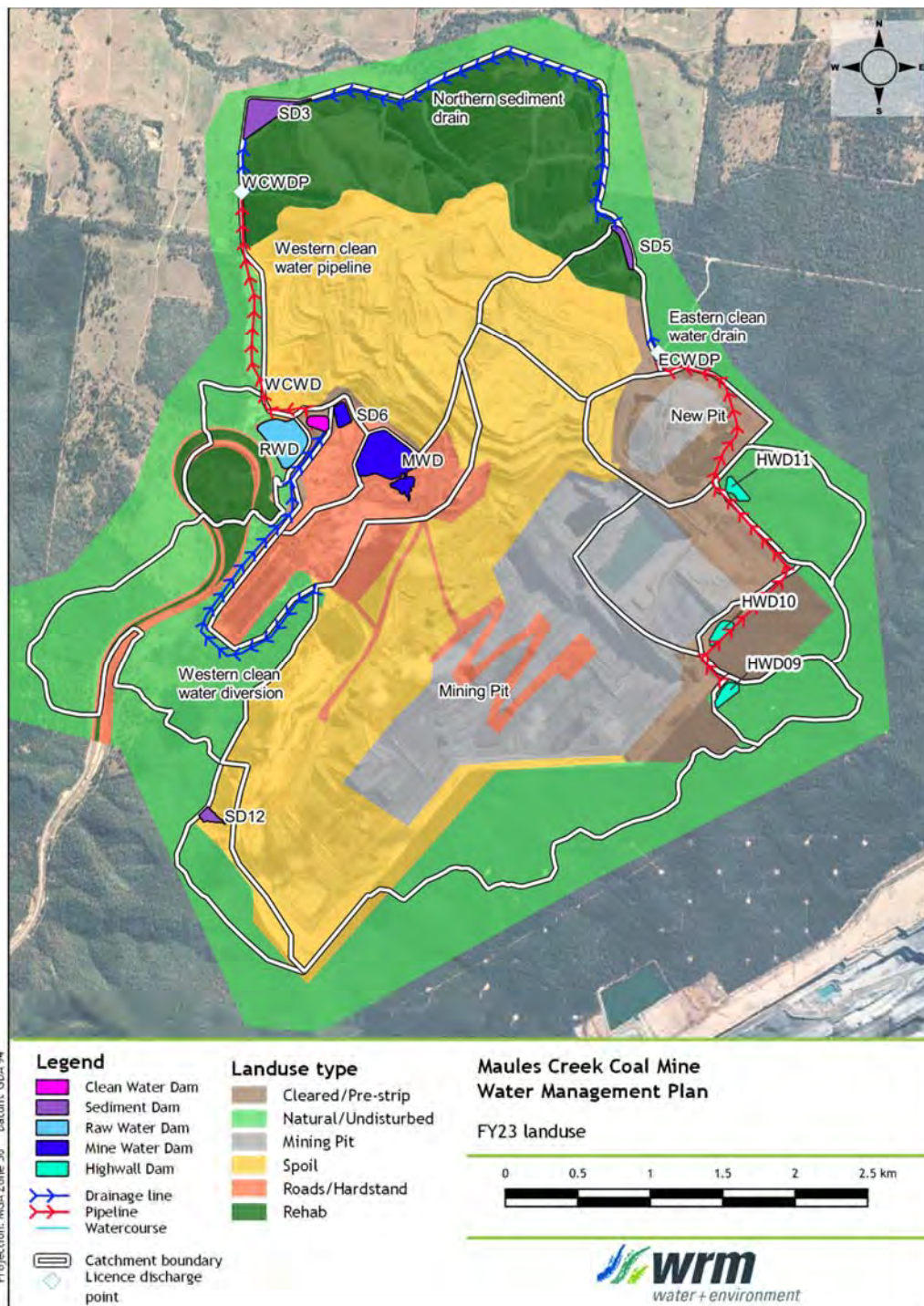


Figure 3 – Site catchments and land use, FY23

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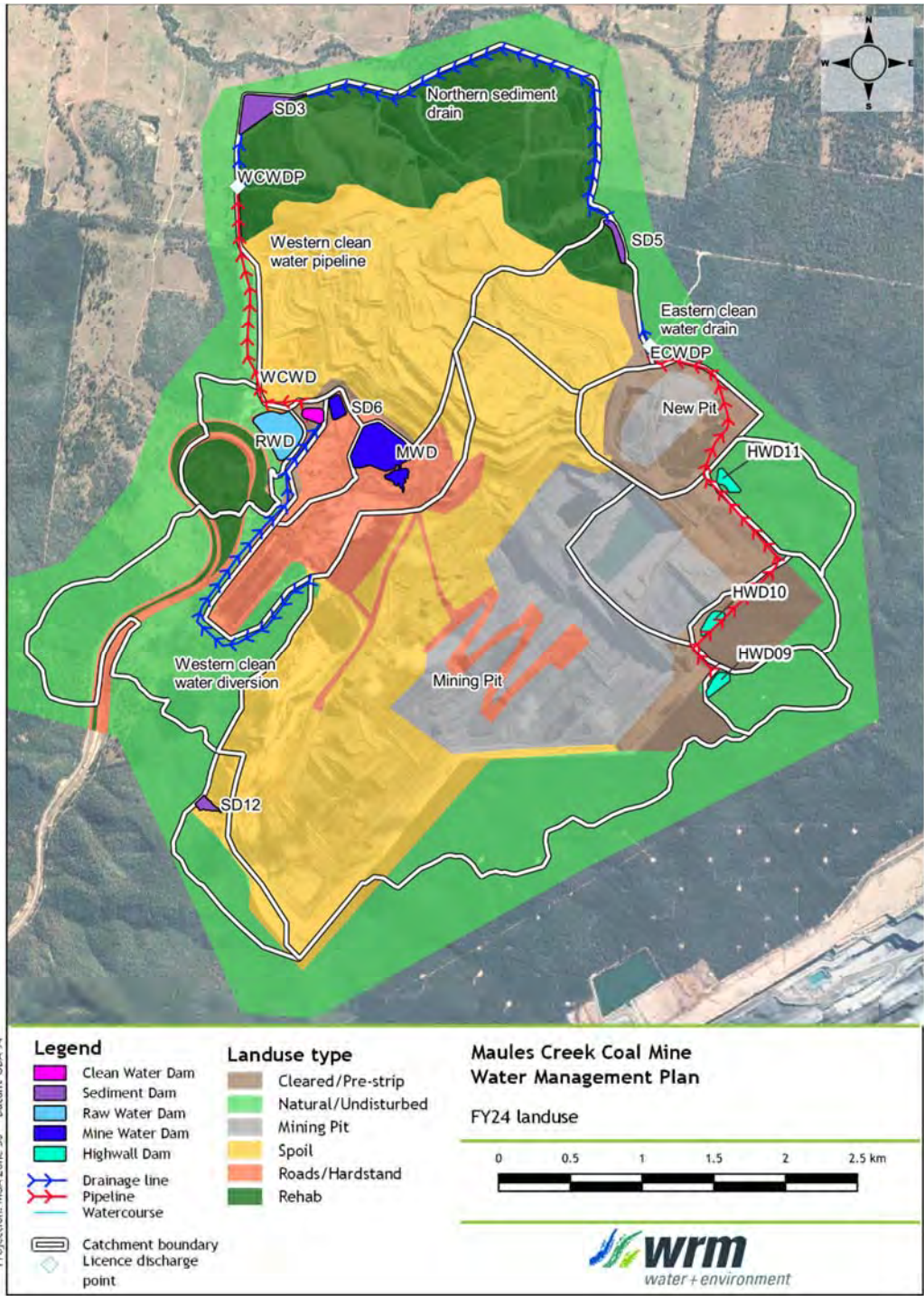


Figure 4 – Site catchments and land use, FY24

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3.3 WATER MANAGEMENT INFRASTRUCTURE

3.3.1 Water Storages

The MCCM site water management system includes storages for management of:

- clean water – Raw Water Dam (RWD), highwall dams and Western Clean Water Diversion Dam (WCWD);
- mine water – Mine Water Dam (MWD), mining pit and Pit Water Storage; and
- sediment laden water – sediment dams (SD).

Details of site storages are shown in Table 2. Adopted storage characteristics for the RWD are shown in Table 3.

The water balance simulation assumed no off-site releases of water from sediment dams. Overflow of sediment dams to the receiving environment can still occur from SD3 and SD12 if rainfall exceeds the design standard, consistent with Condition L2.5 of EPL 20221.

Table 2 MCCM Water Storages

Storage	Minimum Capacity (Megalitres (ML))	Spills To	Comments	Operating rules
MWD ^a	526	Low spot in the landform which cannot drain offsite	Accepts mine water from the pit and CHPP. Captures runoff from the CHPP infrastructure area.	Supplies water management system demands at the highest priority. Transfer to Pit Water Storage when MWD reaches MOV ^c of 340 ML.
Pit Water Storage	1,200 ^e	Mining Pit	Supplementary storage for mine affected water.	Transfers to and from MWD to meet site demands.
RWD	328	Low spot in the landform which cannot drain offsite	Storage dam for Namoi River and bore water supply. Supplementary storage for mine affected water to reduce reliance on external water	Supplies water management system demands at the lowest priority.
Western Clean Water Diversion Dam (WCWD)	15	Low spot in the landform which cannot drain offsite	Captures runoff from the upstream clean water catchment area	Water released off-site to Back Creek.

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Storage	Minimum Capacity (Megalitres (ML))	Spills To	Comments	Operating rules
SD3	169	Off site	Captures runoff from the OEA.	Water released off-site if water quality meets EPL criteria ^d . Otherwise dewatered to MWD.
SD5	18	SD3	Captures runoff from the OEA.	Dewatered to MWD.
SD6	25	Low spot in the landform which cannot drain offsite	Captures runoff from haul road area during operations, and Mine Infrastructure Area (MIA) and CHPP during construction phase.	Dewatered to MWD.
SD12	26	Off site	Captures runoff from the overburden emplacement areas (OEA).	Dewatered to MWD

^a Combined capacity of MWD1 and MWD2

^b MWD and RWD are designed to not spill based on the current water balance modelling, however an emergency spillway is required for dam safety purposes

^c MOV = maximum operating volume

^d Water balance assessment assumed no off-site release

^e MOV displayed, the actual capacity of Pit Water Storage varies as mining progresses

Table 3 RWD Storage Characteristics

RL (mAHD)	Volume (ML)	Area (ha)	Comment
303.0	0	0.1	
304.0	3	1.4	
305.0	31	3.8	
306.0	76	5.5	
306.1	82	5.6	Commence pumping from river
307.0	137	6.4	
308.0	205	7.1	
308.5	243	7.5	Cease pumping from river
309.0	280	7.9	
309.2	296	8.1	
309.6	328	8.3	Spillway level

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3.3.2 Dam Licensing

Water captured by all storages at MCCM will be appropriately licensed under the Water Management Act 2000 (*WM Act 2000*) based on the location and purpose of each storage. The various licence categories for storages are shown in Table 4.

In addition to the categories in Table 4, some dams are categorised as “Diversion Only”. These dams function as part of a clean water diversion system. They are designed to not take water from the environment, but may not meet the definition of a Harvestable Rights dam or Excluded Works. The storage capacity of such dams provides temporary attenuation of inflows to match the capacity of a pumped or gravity diversion system.

Within the Project Boundary, there are numerous minor dams, such as old farm dams and construction-phase sediment basins, that do not form part of the water management system. The locations of all dams within the Project Boundary are shown in **Error! Reference source not found.** Capacities of minor dams have been estimated from surface area and approximate depth.

Details regarding the dams which fall under each of the licence categories is provided in the following sub-sections.

Table 4 – Licence Categories for Site Water Use and Storage

Licence category	Reference	Conditions
Water Access Licence (WAL)	Section 56 <i>WM Act 2000</i>	Approval for water supply works and/or water use from <i>WaterNSW</i>
Harvestable right	Section 53 <i>WM Act 2000</i>	Dam located on a minor stream ¹ . Total of all harvestable rights dams not to exceed 10% of the average regional run-off calculated from landholding area multiplier.
Mixed Rights	New South Wales (NSW) Government Gazette No. 40, Schedule 3, p1630	A dam from which water is taken as a harvestable right, as well as for other water rights. Runoff captured calculated on the average regional run-off calculation assuming 100% capture.
Excluded work	Water Management (General) Regulation 2018 – Schedule 1	Dam for control of erosion, flood detention or capture of drainage consistent with best management practice to prevent the contamination of a water source. Located on a minor stream ¹ .
Exempt	NSW Farm Dams Policy	Pre-1999, less than 7 ML

¹ A minor stream is a first or second order stream

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Clean water compliance

MCCM compliance of clean water take is summarised in Table 5, which shows:

- MCCM has a Harvestable Rights Allowance of 236.7 ML for its project boundary (3,641 ha)
- MCCM has a total Harvestable Rights dam capacity of 16.4 ML (**Error! Reference source not found.**)
- The available Harvestable rights allowance for site is 220.3 ML
- The mixed rights allowance for MCCM is 169.4 ML (220.3 ML divided by 1.3)
- The annual Mixed rights volume captured by MCCM mixed rights dams is 4.6 ML (Table 7)
- There is 166.5 ML of available mixed rights. Water captured by CWDD, HWD8 or HWD9 which is not diverted will be deducted from the available mixed rights and reported on in the Annual Return.

MCCM has contiguous landholdings outside of the project boundary which it can rely on for additional Harvestable Rights allowance if required.

Table 5: MCCM clean water compliance summary

Summary	
Maximum Harvestable Rights Allowance (ML):	236.7
Harvestable Rights Dam Capacity (ML):	16.4
Available Harvestable Rights Allowance (ML):	220.3
Mixed Rights Allowance (ML):	169.4
Mixed Rights Used By Site (ML):	4.6
Available Mixed Rights (ML):	166.5
Additional contiguous land required to comply (ha):	0.0

Excluded Works Exemption

MCCM has 9 excluded works dams and the active mining pit. Dams covered under the excluded works exemption may have clean catchments which are neither possible nor practical to divert in accordance with best management practice.

Harvestable Rights Dams

Harvestable rights dams capture clean water from overland flow and minor streams within the project boundary. MCCM has 14 harvestable rights dams including five farm dams which were built prior to the mine. These farm dams are not used to supply water for the mining operation. Seven of the dams will be decommissioned in 2022/23 to allow the clean catchment to drain to the environment, as per the approved WMP Addendum B. Table 6 shows the harvestable rights dams at MCCM and their storage capacity.

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Table 6: Harvestable Rights Dams

Storage	Dam Capacity (ML)	Comment
Upper Turtle	4.0	Farm Dam/Discharges offsite
Lower Turtle	2.9	Farm Dam/Discharges offsite
MC09	0.5	Decommission in 2022/2023
MC08	0.6	Decommission in 2022/2023
FD01	0.5	Farm Dam/Discharges offsite
FD02	0.4	Farm Dam/Discharges offsite
FD03	0.8	Farm Dam/Discharges offsite
SD10	0.5	Decommission in 2022/2023
MC05	1.1	Decommission in 2022/2023
MC04	0.4	Decommission in 2022/2023
MC02	1.0	Decommission in 2022/2023
MC16	1.4	Discharges to WCWD
SD9	0.2	Decommission in 2022/2023
SD11	2.1	Discharges offsite
TOTAL	16.4	

Mixed Rights dams

Table 7 summarises the mixed rights dam at MCCM, which is RWD2. Mixed rights dams have a component of their catchment which is natural and therefore captures clean water. The annual average runoff captured by RWD2, assuming 100% of runoff is captured, is 4.6 ML compared to the mixed rights allowance of 171.2 ML.

Table 7 Mixed Rights Dams

Dam	Natural Catchment (ha)	Annual runoff (ML)
RWD2	7.02	4.6
Total	7.02	4.6

Clean Water Diversions

Table 8 summarises the clean water diversions at MCCM. Any water captured by these dams that is not diverted will be account for in the following way:

- WCWD, HWD8 and HWD9 will be accounted for against the annual available mixed rights allowance of 166.5 ML and reported in the Annual Return.

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- HWD10 and HWD11 are located on non-minor streams. Water which is not diverted will be accounted for against WAL41585 which has annual allocation of 30 ML (up to 60 ML with carryover).

Table 8 Clean Water Diversions

Dam	Natural Catchment (ha)	Stream type	Water which is not diverted will be accounted for against
WCWD	92.4	Minor	Mixed rights allowance
HWD8	26.8	Minor	Mixed rights allowance
HWD9	48.1	Minor	Mixed rights allowance
HWD10	39.7	Non-Minor	WAL41585 - 30 ML
HWD11	55.0	Non-Minor	WAL41585 - 30 ML
Total	261.9		

HWD = Highwall Dam

Dams on Non-minor Streams

Table 9 summarises the dams on non-minor streams within the MCCM project boundary, the following is of note:

- FD2, FD12 and FD20 are farm dams built prior to the mine and prior to 1999. These dams are less than 7 ML and therefore exempt under the NSW Farm Dam policy. These dams are located outside of the mines project approval boundary, but within the mines ML. MCCM does not extract any water from these dams for the operation.
- SD7 was a farm dam built prior to the mine and prior to 1999. The dam was incorporated in to the mines water management system as part of the construction of the rail corridor, along with the construction of MC10. SD7 and MC10 will be decommissioned in 2022/23 as part of an enforceable undertaking entered into with NRAR and approved in the WMP Addendum B.

Table 9 Dams on Non-minor Streams

Dams	Dam Capacity (ML)	Built prior to 1999	Action
FD2	1.9	Yes	Complies with NSW Farm Dam Policy
FD12	0.44	Yes	Complies with NSW Farm Dam Policy
FD20	1.77	Yes	Complies with NSW Farm Dam Policy
SD7/MC10	18.3	SD7 Yes, MC10 No	Decommission 2022/23

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3.3.3 Drains and Pipelines

The site water management system includes the following key drains and pipelines, as shown in Figure 2 to Figure 4:

- Northern Sediment Drain – drains sediment laden runoff from northern out-of-pit overburden emplacement to SD3.
- Western Clean Water Diversion – collects runoff from undisturbed catchments to the south and west of the coal stockpile area and drains to the Western Clean Water Diversion Dam.
- Eastern Clean Water Pipeline – clean water pipeline that connects the highwall dams and discharges clean water from the dams to Back Creek tributaries east of the mine.
- Western Clean Water Pipeline – discharges from the Western Clean Water Diversion Dam to a tributary of Back Creek west of the mine.
- Northern Clean Water Drain – drains undisturbed catchment runoff to the Western Clean Water Diversion Dam.
- Eastern Clean Water Drain – remnants of the historical highwall diversion drain which is progressively being mined through as the pit advances eastwards.

3.3.4 Clean Water Management System

Details of the clean water management system are provided in Section 4.3 of the Surface Water Management Plan (Appendix B of the WMP).

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Figure 5 – Locations of dams within Project Boundary

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3.4 POTABLE WATER

Potable water is either trucked to site as required or treated to potable standards onsite and stored in water tanks supplying the main office and workshop areas. Potable water is used for drinking and shower purposes within the main office, bathhouse and adjacent workshop areas.

The volumes of potable water used on the site are negligible compared to process water use and hence potable water use is not included in the site water balance.

3.5 MEASURES IMPLEMENTED TO MINIMISE CLEAN WATER USE

Use of clean water on the site is minimised by implementing the following measures:

- Operating the MWD to ensure no spills of mine water to the receiving environment. This ensures maximum recycled water is available on site for reuse.
- Using mine water and sediment laden water to supply site demands as first priority. Water from clean water sources is taken only to supplement any deficit in water availability from the mine water system in compliance with Water Access License conditions or Harvestable Rights.
- Recycle water from the CHPP to re-use in the mine water management system

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4 WATER DEMANDS

4.1 OVERVIEW

The modelled water demands from the mine water management system include:

- coal processing demand from the CHPP;
- dust suppression (dominated by haul road watering); and
- vehicle washdown and stockpile use.

4.2 COAL HANDLING AND PREPARATION PLANT

The adopted forecast annual run-of-mine (ROM) and production tonnages are shown in Table 10.

The recorded CHPP water usage over 2019 was 3,428 ML for an annual ROM tonnage of 8.15 million tonnes. This results in a gross CHPP consumption rate of 420 litres/ROM tonne (L/ROM tonne).

An analysis of site data from the Year 2019 annual review indicates that approximately 70% of the water that is supplied to the CHPP is recycled within the CHPP/belt filter press circuit. Therefore, the estimated net CHPP consumption rate is 127 L/ROM tonne representing approximately 30% of gross CHPP water use.

This estimated net consumption rate has been applied to the forecast ROM tonnages, and the resulting forecast net CHPP water usage is provided in Table 10.

Table 10 Water Management Requirements in Project Approval 10_0138

Year	ROM Tonnage (Mtpa)	Bypass Tonnage (Mtpa)	Feed Tonnage (Mtpa)	Net Usage (ML/yr)
FY22	12.5	1.38	11.13	1,413
FY23	12.6	1.39	11.27	1,431
FY24	12.8	1.42	11.45	1,454

4.3 DUST SUPPRESSION

Haul road dust suppression rates have been estimated using daily rainfall and evaporation data sourced from the SILO database and the predicted haul road length. The haul road length determined from aerial photography is approximately 24 kilometres (km). This is expected to remain the same through to FY24.

The following rules were used to determine the applied dust suppression rate on any given day:

- For a dry day (zero rainfall), the haul road watering rate is equal to the daily evaporation rate.

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- For a rain day when rainfall is less than the daily evaporation rate, the watering rate is reduced and is only required to make up the remaining depth to the daily evaporation rate.
- For a rain day when rainfall exceeds the daily evaporation rate, no haul road watering is required.
- It was assumed that 27.5 metres of the haul road width would be watered twice per day; and
- A seasonal factor was applied to the wet season and dry season daily estimates to account for seasonal variation in the use of dust suppressant emulsions:
 - Wet season (October to March) application factor: 0.85
 - Dry season (April to September) application factor: 1.10

Figure 6 shows the average estimated monthly haul road dust suppression and recorded water cart volumes for 2016 through to 2019 which were drought years, allowing MCCM to plan for the highest rates of dust suppression. This figure shows that the adopted procedure for estimating dust suppression rates provides a reasonable match to the recorded data on a monthly scale. The adopted consumption rates for FY22 to FY24 are summarised in Table 11.

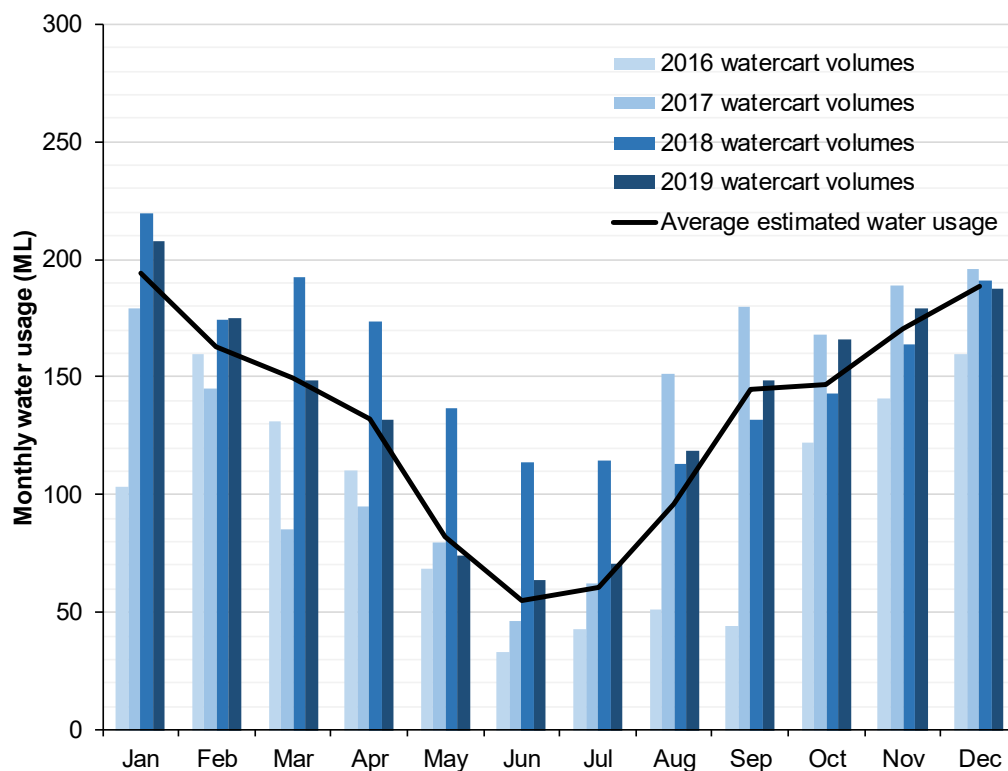


Figure 6 - Comparison of Estimated and Actual Haul Road Dust Suppression Rates

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Operational water use is not heavily dependent on climate. The monthly operation water use was estimated as the average of usage data (MIA supply flowmeter) recorded between 2016 and 2019. The average monthly operational water use is summarised in Table 11.

Table 11 Adopted Monthly Dust Suppression and Operations Usage

Month	Average Haul Road Dust Suppression (ML/month)	Average Operational Use (ML/month)
January	194	6.7
February	163	7.4
March	149	9.7
April	132	11.1
May	82	9.3
June	55	5.2
July	61	4.8
August	96	3.5
September	145	6.0
October	147	7.2
November	171	7.6
December	189	7.4
Annual	1,582	86

4.4 VEHICLE WASHDOWN AND STOCKPILE USE

Consistent with the Year 2020 Annual Review, a vehicle washdown usage of 3 ML/year (8 kilolitres per day (kL/day)) was adopted.

4.5 DEMAND SUMMARY

Table 12 provides a summary of total annual CHPP net demand and other demands for the water balance simulation period (FY22 to FY24). The monthly variation in total demand for FY22 is shown in Figure 7.

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Table 12 Summary of Estimated Annual Water Demands, FY21 – FY24

Year	Net CHPP (ML)	Other (ML)	Total (ML)
FY22	1,413	1,671	3,084
FY23	1,431	1,671	3,102
FY24	1,454	1,671	3,125

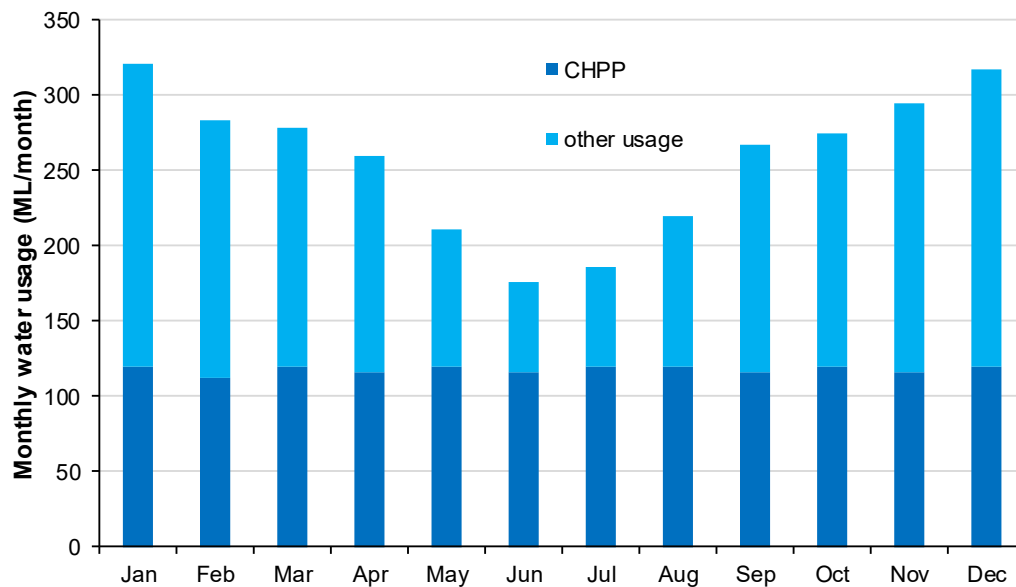


Figure 7 – Forecast Monthly Water Demand, FY21

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5 WATER SOURCES

5.1 GROUNDWATER INFLOWS

The following groundwater inflows to the mining pit were adopted based on groundwater model predictions from the BTM complex groundwater model (AGE, 2021):

- FY22: 1.23 Megalitres per day (ML/d).
- FY23: 1.07 ML/d.
- FY24: 1.43 ML/d.

5.2 CATCHMENT RUNOFF

5.2.1 Rainfall Runoff Model

The Australian Water Balance Model (AWBM) (Boughton, 2004) was used to estimate daily runoff from daily rainfall. The AWBM is a saturated overland flow model which allows for variable source areas of surface runoff.

The AWBM uses a group of connected conceptual storages (three surface water storages and one ground water storage) to represent a catchment. Water in the conceptual storages is replenished by rainfall and is reduced by evapotranspiration. Simulated surface runoff occurs when the storages fill and overflow. Figure 8 shows a conceptual configuration of the AWBM model.

The AWBM model uses daily rainfalls and estimates of catchment evapotranspiration to calculate daily values of runoff using a daily balance of soil moisture. The model has a baseflow component which simulates the recharge and discharge of a shallow subsurface store. Runoff depth calculated by the AWBM model is converted into runoff volume by multiplying by the contributing catchment area. The model parameters define the storage depths, the proportion of the catchment draining to each of the storages, and the rate of flux between them.

Catchment runoff was modelled using the AWBM rainfall-runoff model. Catchments across the site have been characterised into the following land use types:

- Natural (undisturbed catchments, fully rehabilitated spoil and pre-strip areas).
- Compacted (haul roads, pit floor, mine infrastructure).
- Spoil (unrehabilitated overburden emplacement areas).

The adopted rainfall runoff parameters are summarised in Table 13. These parameters have been validated against data from site observations (see Section 9).

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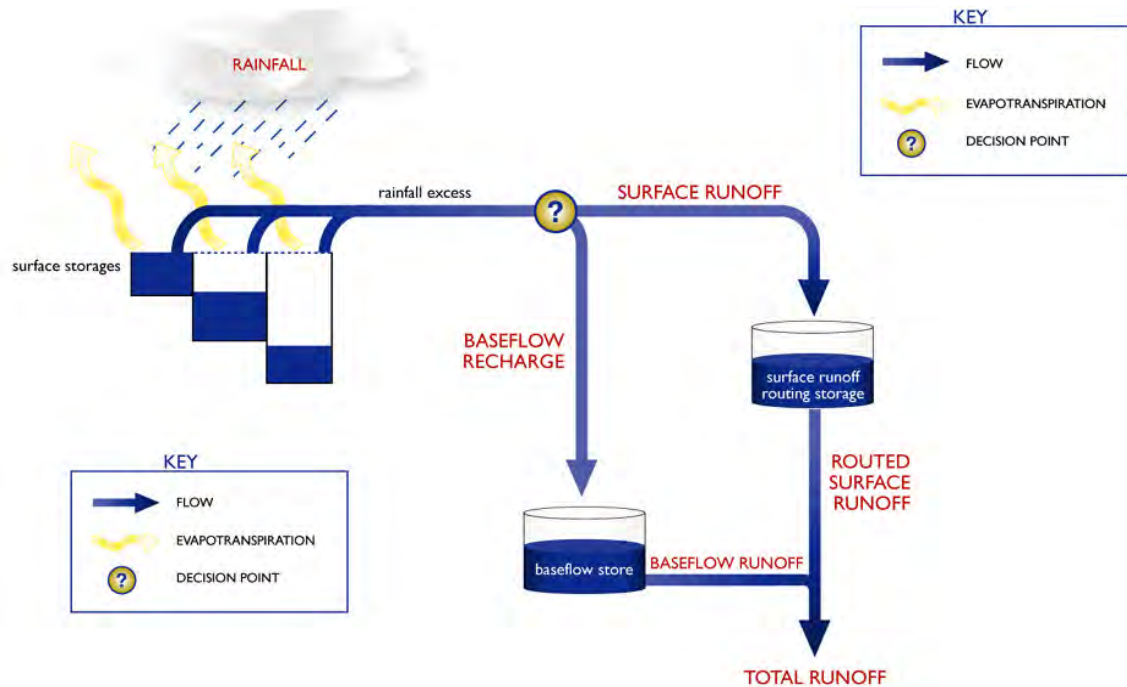


Figure 8 – AWBM Model Configuration

Table 13 Adopted AWBM Parameters for the MCCM Water Balance

Parameter	Natural	Compacted	Spoil
C1 (mm)	9	2	15
C2 (mm)	91	10	50
C3 (mm)	183	30	110
A1	0.134	0.33	0.1
A2	0.433	0.33	0.3
A3	0.433	0.33	0.6
BFI	0	0	0.2
Kbase	0	0	0
Ksurf	0	0	0

mm = millimetres

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5.2.2 Catchment Areas

Figure 2 to Figure 4 show the adopted catchments and land use for FY22 to FY24. Catchment areas for each storage are shown in Table 14.

Table 14 Adopted Catchment Areas

Dam	FY22 Catchment (ha)	FY23 Catchment (ha)	FY24 Catchment (ha)
East Pit	174.4	100.7	100.7
New Pit	^a	79.9	79.9
HWD10	43.9	52.9	52.9
HWD11	57.1	53.9	53.9
HWD8	27.1	^c	^c
HWD9	49.0	36.0	36.0
MWD	132.7	93.9	93.9
Mining Pit	683.5	787.6	787.6
RWD	58.3	56.0	56.0
SD12	43.8	43.8	43.8
SD3	404.4	473.6	473.6
SD5	73.4	85.5	85.5
SD6	24.0	23.9	23.9
WCWD	201.7	191.9	191.9
East Sump	61.6	^b	^b
Total	2,035	2,080	2,080

^a New Pit online by FY23

^b East Sump decommissioned by FY23

^c HWD8 decommissioned by FY23

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5.3 EXTERNAL WATER SUPPLIES

Site water demands can be supplemented by external sources if sufficient water is not available on site to meet demands. External water sources that can supplement site water supply are:

- High security allocation from the Namoi River pipeline.
- Groundwater bores:
 - Olivedene (Zone 5).
 - Brighton (Zone 4).
 - Roma (Zone 4).

Water required from external sources is obtained under Water Access Licences (WALs). Table 15 shows the WALs associated with the Water Supply Works Approval 90WA801901 from which MCCM can draw water. A combined allocation of 4,704 ML is available annually to MCCM under these WALs, which is sufficient to supply the projected raw water demand (assuming each source has water available).

In addition to these WALs, MCCM has obtained temporary trades (through water allocation assignment trading) to allow for additional Zone 4 groundwater to be extracted from the Roma, Brighton and Olivedene bores. Temporary trades are common in Zone 4 (78 trades totalling 7,231 units in FY2019) and hence offer a reliable market for MCCM to obtain temporary allocation of groundwater to meet any additional demand.

To replicate the uncertainty of flows within the Namoi River, it was assumed that water could only be extracted from the Namoi River 4 months per year. This replicated block releases from Lake Keepit which is how the dam is operated in dry periods.

As a water supply contingency measure, water may be obtained from Boggabri Coal Mine (BCM), which has in the past had excess water on site. Approximately 410 ML from BCM was transferred to MCCM in the second half of 2019.

Table 15 MCCM WALs

Site	Water Source	WAL Number	Volume Available (units)
Roma	Upper Namoi Zone 4 Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source	12722	77
Brighton	Upper Namoi Zone 4 Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source	12718	102
Olivedene	Upper Namoi Zone 5 Namoi Valley (Gin's Leap to Narrabri) Groundwater Source	12811	135
Olivedene	Upper Namoi Zone 5 Namoi Valley (Gin's Leap to Narrabri) Groundwater Source	12791	112
Regulated River (High Security)	Lower Namoi Regulated River Water Source	13050	3,000

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External water imports over the simulation period (FY22 to FY24) were modelled based on the rules outlined in Table 16.

Table 16 MCCM Water Importation Rules

Source	Importation Rules	Maximum Daily Rate (ML/d)	Annual extraction limit (ML)
Namoi River pipeline	- Can only be accessed four months of the year (January/February and July/August) to simulate block releases in during droughts - Imported when the inventory of the three major storages (RWD, MWD and Pit Water Storage) falls below 1,000 ML	30	3,000
Roma bore	- Cannot be imported simultaneously with Namoi River water - Imported when the inventory of the three major storages (RWD, MWD and Pit Water Storage) falls below 700 ML	5	1,200
Brighton bore	- Cannot be imported simultaneously with Namoi River water - Imported when the inventory of the three major storages (RWD, MWD and Pit Water Storage) falls below 600 ML	3	204
Olivedene bore	- Cannot be imported simultaneously with Namoi River water - Imported when the inventory of the three major storages (RWD, MWD and Pit Water Storage) falls below 600 ML	1	300
BCM pipeline	<i>Not modelled</i>		

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6 OFF-SITE RELEASES

6.1 MINE WATER

In accordance with mine Project Approvals (Schedule 3 - Condition 38), mine water discharges from site can only occur if:

- The water is equal to or better quality than the receiving environment
- The discharge complies with the discharge limits in Condition L2.5 of EPL 20221

The project is based on a zero-discharge basis for mine water. However, in the event of very wet conditions occurring at the mine, mine water may be treated and discharged if it complies with the EPL.

The Mine Water Dam is not able to spill off lease due to topography and the out of pit emplacement. No uncontrolled discharges of mine water has ever occurred from the mine.

6.2 SEDIMENT LADEN WATER

The water balance assessment assumed no release of water from sediment dams. Overflow of sediment dams to the receiving environment can still occur from SD3 if rainfall exceeds the design standard, in accordance with Condition L2.5 of EPL 20221. In the event of very wet conditions occurring at the mine, dirty water may be treated and discharged in accordance with Condition L2.5 of EPL 20221.

6.3 CLEAN WATER

6.3.1 Highwall Dams

Undisturbed catchment inflows upslope of the Mining Pit highwall are captured by highwall dams HWD8, HWD9, HWD10 and HWD11. The catchment runoff collected by the highwall dams is pumped to Back Creek via LDP45. Further detail of the highwall dam strategy is provided in Section 4.3 of the Surface Water Management Plan (Appendix B of the WMP).

6.3.2 Western Clean Water Diversion Dam

WCWD collects undisturbed runoff via the Western Clean Water Diversion. Clean water collected in WCWD is pumped off-site into a tributary of Back Creek, via the Western Clean Water Pipeline and LDP46 (see Figure 2 to Figure 4), at a maximum rate of 400 Litres per second (L/s). Further detail of the clean water management strategy is provided in Section 4.3 of the Surface Water Management Plan (Appendix B of the WMP).

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7 CLIMATE DATA

Long term daily rainfall and evaporation data for MCCM was obtained from the SILO database (<https://www.longpaddock.qld.gov.au/silo/>) for the period January 1889 to July 2021 (132 years). Average monthly rainfall and evaporation are shown in Figure 9. Morton's lake evaporation was adopted to represent evaporation for the simulation of the site water balance.

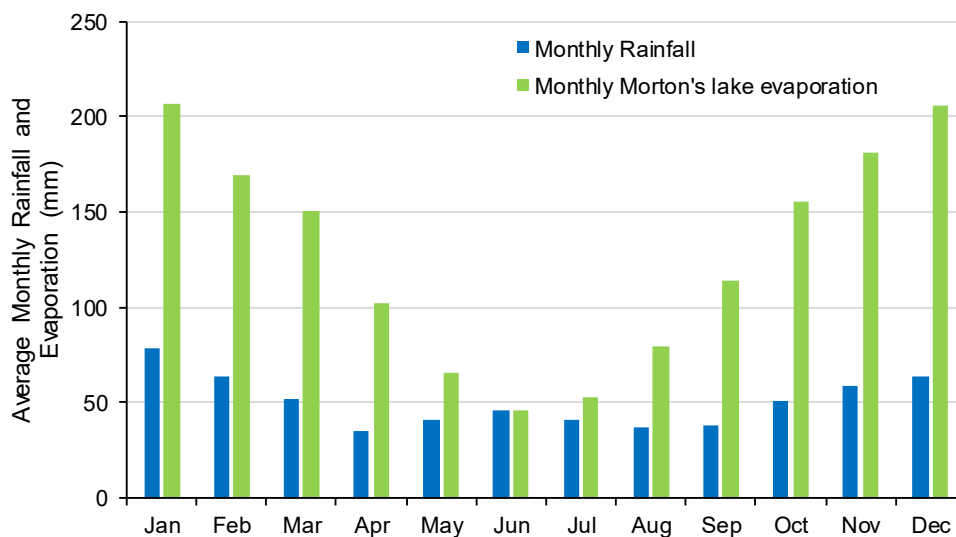


Figure 9 - Average Monthly Rainfall and Evaporation from SILO Database

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8 WATER BALANCE MODEL

8.1 OVERVIEW

The GoldSim water balance model was used to undertake a forecast simulation of the MCCM site water balance under varying climatic conditions over the three-year period FY22 to FY24. The model simulates all major components of the water management system on a daily time step. The simulated inflows and outflows included in the model are provided in Table 17.

Climatic conditions were represented by extracting four-year periods of rainfall from the historical rainfall record which goes back to 1889. Each three-year climate sequence represented by the model is referred to as a “realisation”. The first realisation used recorded rainfall data from 1889 to 1892. The second realisation used data from 1890 to 1893, and so on. The historical rainfall record (1889 to 2021) provides 130 realisations.

Table 17 Simulated Inflows and Outflows to Mine Water Management System

Inflows	Outflows
Direct rainfall on water surface of storages	Evaporation from water surface of storages
Catchment runoff	CHPP demand
Groundwater inflows	Dust suppression demand
Raw water supply	Vehicle wash down
	Offsite spills from storages

The GoldSim model was used to assess the performance of the proposed water management system, including:

- mine water storage inventory;
- raw water requirements from an external source;
- uncontrolled spills from site dams; and
- the overall water balance within the water management system.

Figure 1 shows the conceptualisation of the mine water management system adopted for the water balance model. Note that the coal process water circuit was not explicitly modelled. However, the estimated net water demand from the CHPP was included in the model (refer Table 10).

It is important to note that there is inherent uncertainty with respect to some components of the water balance (e.g. catchment yield/rainfall runoff, mining area groundwater inflows). Best estimates of these

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parameters have been adopted and these estimates will continue to be checked and refined against on-site observations as operations progress.

8.2 FORECAST SIMULATION RESULTS INTERPRETATION

In interpreting the results of a forecast simulation, it should be noted that the results provide a statistical analysis of the water management system's performance over the 3 year forecast period, based on 130 realisations with different climatic sequences.

The model results are presented as a probability of exceedance. For example, the 10th percentile represents 10% probability of exceedance and the 90th percentile results represent 90% probability of exceedance. There is an 80% chance that the result will lie between the 10th and 90th percentile traces.

Whether a percentile trace corresponds to wet or dry conditions depend upon the parameter being considered. For site water storage, where the risk is that available capacity will be exceeded, the lower percentiles correspond to wet conditions. For example, there is only a small chance that the 1 percentile storage volume will be exceeded, which would generally correspond to very wet conditions.

For external site water supply volumes (for example), where the risk is that insufficient water will be available, there is only a small chance that more than the 1 percentile water supply volume would be required. This would generally correspond to very dry climatic conditions.

It is important to note that a percentile trace shows the likelihood of a particular value on each day and does not represent continuous results from a single model realisation. For example, the 50th percentile trace does not represent the model time series for median climatic conditions.

8.2.1 Overall Water Balance

Water balance results from the 130 modelled realisations are presented in Table 18, averaged over each year. The results presented in Table 18 are the average of realisations and will include wet and dry periods distributed throughout the forecast period.

Rainfall yield for each year is affected by the variation in climatic conditions within the adopted climate sequence. It should be recognised that the following components of the water balance are subject to climatic variability:

- Rainfall runoff.
- Evaporation.
- Dust suppression water use.
- Imported water requirement.
- Site releases/spills.

Hence, actual values of these components of the water balance will vary from year to year and may be outside the range of simulated results.

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The results show that, on average:

- The average annual external water demand supplied from external licensed sources ranges between approximately 1,087 ML/year and 1,194 ML/year.
- Evaporation from dam water surfaces ranges between approximately 284 ML/year and 298 ML/year.
- No overflows of mine water occurred in the simulation period.
- Combined runoff and direct rainfall contribute between 2,031 ML/year and 2,121 ML/year.

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Table 18 Annual Water Balance – All Realisations (Averaged)

	Annual Water Balance (ML/period)		
	FY22	FY23	FY24
Water Inputs			
Direct Rainfall + Catchment Runoff	2,121	2,039	2,031
Raw Water (external source)	1,703	1,194	1,110
Groundwater Inflow	448	391	523
Total Inputs	4,272	3,623	3,664
Water Outputs			
Evaporation from Dams and Ponds	298	281	284
Dust Suppression Demand	1,581	1,586	1,589
CHPP Makeup Demand	85	85	86
Construction Water Use	1,401	1,422	1,449
MWD Spills	0	0	0
SD Overflows (off-site)	51	45	46
HWD Off-Site Release	78	64	63
WCWD Off-Site Release	120	112	112
Total Outputs	3,614	3,596	3,629
Change in Stored Volume	658	27	35

8.2.2 Mine Site Storage Inventory

Figure 10 and Figure 11 show the predicted probability of the modelled out-of-pit and in-pit storage volume over the 3 year forecast period. A build-up of water in the active open cut generally occurs when the out of pit storages are too full to accept additional pit water. The primary out-of-pit storages are MWD and Pit Water Storage. MWD is made up of two separate dams and has a full supply capacity of 526 ML. The MOV of the MWD is set at 340 ML to prevent uncontrolled spills. When the stored volume in the MWD is below 340 ML, water can be pumped in from the active pits. If MWD stored capacity exceeds 340 ML, water will need to be managed within the pit. Pit Water Storage has an assumed MOV of 1,200 ML. Therefore, the combined MOV of MWD and Pit Water Storage is 1,540 ML.

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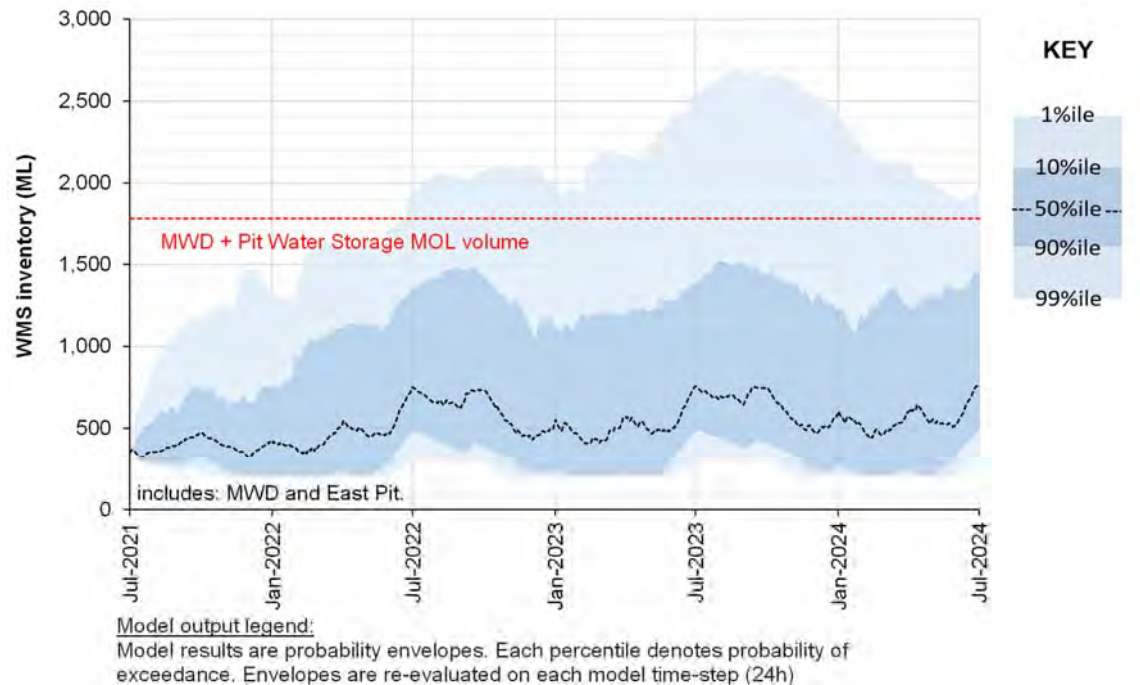


Figure 10 - Forecast MWD and Pit Water Storage Combined Inventory

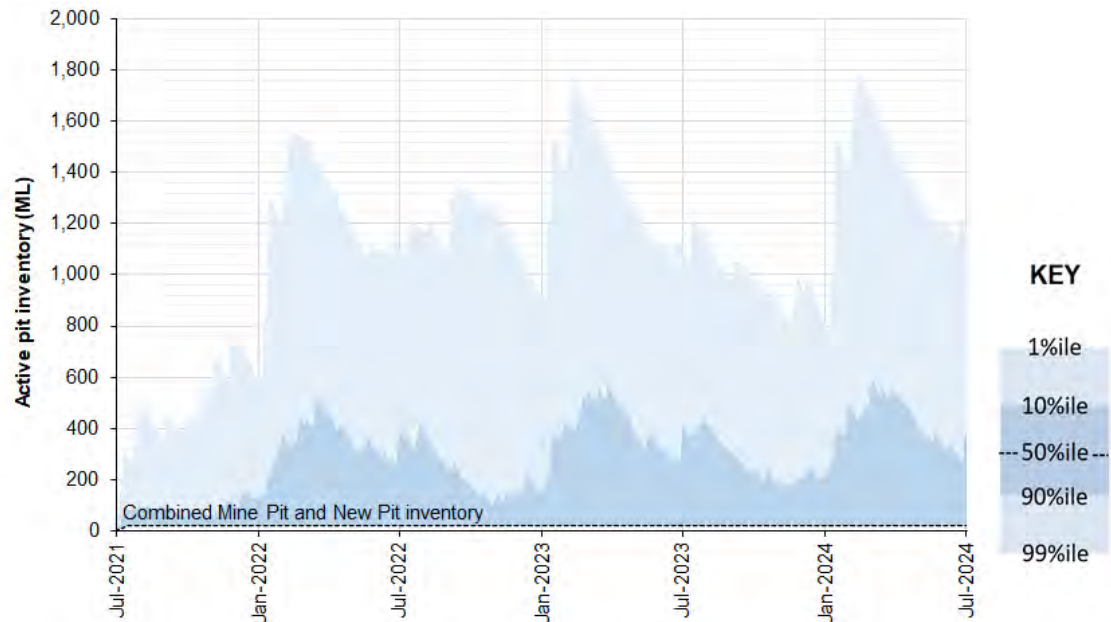


Figure 11 - Forecast In-pit Inventory

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The water balance model results show that:

- The MWD and Pit Water Storage do not empty over the simulation period due to the external water supply.
- The 50th percentile combined MWD and Pit Water Storage volume fluctuates between 300 ML and 800 ML. This suggests that water will be held in pit storage for median conditions, as the MWD MOV will be exceeded.
- There is a 50% chance that there will be no significant accumulated water (i.e. >150 ML) in the pit over the 3 year forecast period.
- There is at least a 10% chance that:
 - MWD and Pit Water Storage will be maintained around the combined MOV over the next 3 years; and
 - the pit water volume will exceed 580 ML over the next 3 years.
- There is a 1% chance that:
 - the combined MWD and Pit Water Storage inventory will exceed 2,700 ML at some point over the next 3 years, however neither of the storages will reach their full supply volume; and
 - the pit water volume will exceed 1,800 ML over the next 3 years.

8.2.3 External Water Requirements

When considering external water requirements, the probabilities have been inverted to indicate the risk of requiring at least the specified volume of water from an external source. Hence, for investigation of external water supply, the 1st percentile represents very dry conditions which provide an indication of the likely upper limit of required water volumes.

When the site mine water supplies are exhausted, site demands (CHPP and dust suppression) draw upon the RWD. Once the MWD drops below a low trigger level, water will be demanded from external sources, as per the rules outlined in Section 5.3. Figure 12 shows the external water requirements from the Namoi River pipeline and the borefields. The following is of note:

- For the Namoi River pipeline source:
 - there is a 90% chance that an annual volume of at least between 200 and 501ML per year of Namoi River water will be required to supply operational demands over the 3 year forecast period;
 - there is a 50% chance that an annual volume of at least between 726 and 954 ML per year of Namoi River water will be required to supply operational demands over the 3 year forecast period; and
 - there is a 10% chance that an annual volume of at least between 1,047 and 1,079 ML per year of Namoi River water will be required to supply operational demands over the 3 year forecast period.
- For the borefield (including the Roma, Brighton and Olivedene bores) source:

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- there is a 90% chance that an annual volume of at least between 0 and 386 ML per year of bore water will be required to supply operational demands over the 3 year forecast period;
- there is a 50% chance that an annual volume of at least between 313 and 789 ML per year of bore water will be required to supply operational demands over the 3 year forecast period; and
- there is a 10% chance that an annual volume of at least between 987 and 1,386 ML per year of bore water will be required to supply operational demands over the 3 year forecast period.
- External water requirements from the Namoi River and from the borefield would not exceed the respective allocations for any of the climatic conditions assessed, therefore complying with license conditions.

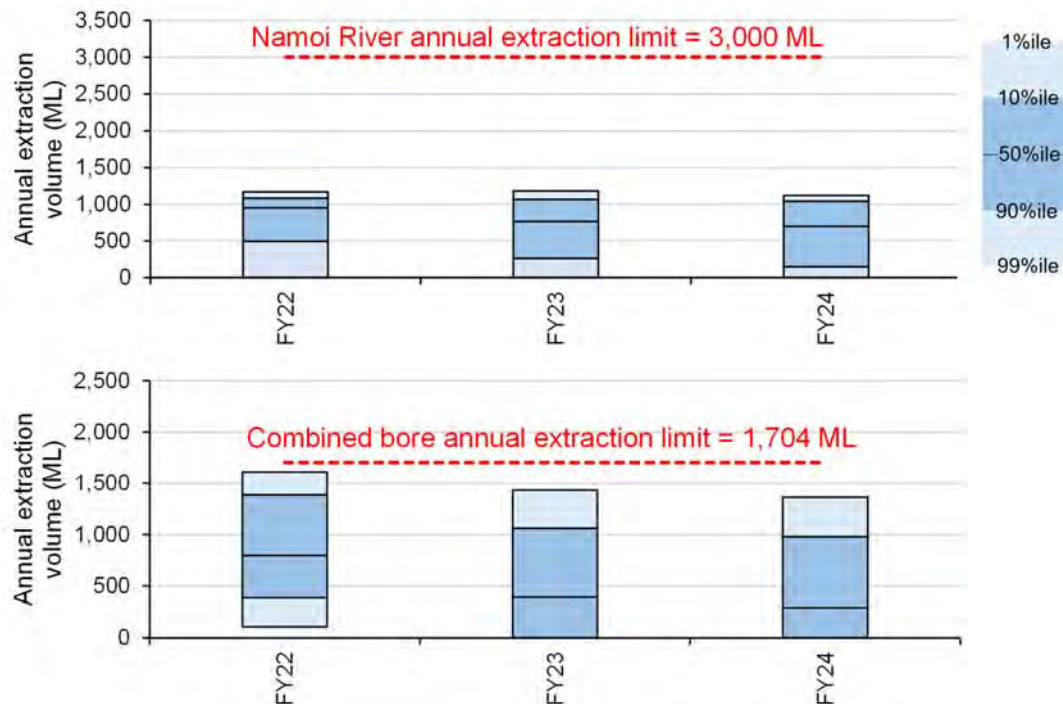


Figure 12 - Forecast Total Annual External Water Supply, Namoi River & Bores

8.2.4 Uncontrolled Spills

Table 19 shows the predicted spills from key site storages over the 3 year forecast period for the median as well as the 90th (dry) and 10th (wet) percentile confidence limits. The results show:

- There are no spills from MWD or RWD under all realisations.
- There is a 50% chance that there would be at least 8 spill days from SD3 over the 3 year period (with an average spill volume of 5 ML per spill event), and 10% chance that there would be at least 33 spill days from SD3 (with an average spill volume of 18 ML per spill event).

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- SD12 would spill for only 8 days during wet (10th percentile) climatic conditions, with an average spill volume of 0.5 ML.

Table 19 Predicted Spills from Key Site Storages Over 3 Year Forecast Simulation

Dam	Probability Percentile	No. of Spill Days	Ave. Spill Volume per spill day (ML)
MWD	10	0	0
	50	0	0
	90	0	0
RWD	10	0	0
	50	0	0
	90	0	0
SD3	10	33	18
	50	6	5
	90	0	0
SD12	10	8	0.5
	50	0	0
	90	0	0

8.2.5 Adaptive Management of Mine Water Balance

The model results presented above represent the application of the adopted mine water management system rules over the mine life, regardless of climatic conditions. In reality, there are numerous options for adaptive management of the mine water management system to accommodate climatic conditions. For example, when excess water is available on site, it may be possible to increase the application of water for dust suppression. These alternative management approaches would be used to reduce the risks to operations associated with climatic variability.

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9 WATER BALANCE MODEL REVIEW AND VALIDATION

The site water balance model has been reviewed and validated on an ongoing basis over the life of the mine to ensure that the model adequately simulates observed conditions on site. The model is reviewed as part of the Annual Review each year.

Figure 13 shows a comparison of simulated and recorded site water inventory for 2018 to 2020 which demonstrates that the model provides a good representation of the site water balance.

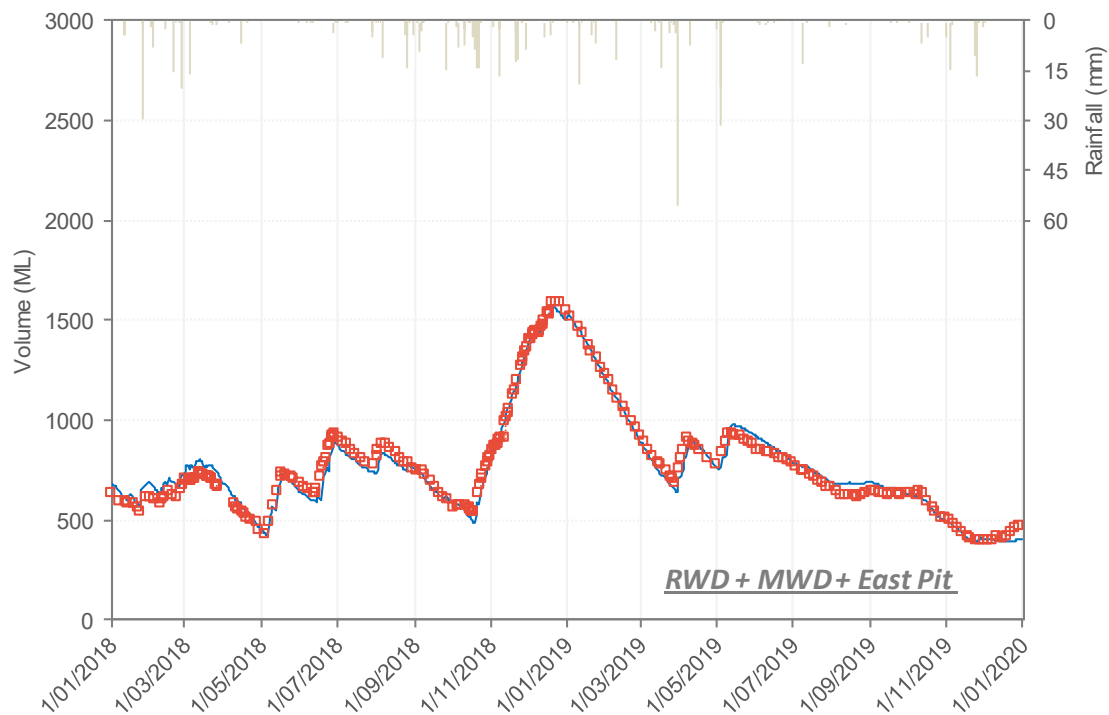


Figure 13 – Water Balance Model Validation for 2019 Comparing Simulated (Blue) and Recorded (Red) Site Water Inventory

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10 REPORTING PROCEDURES

In accordance with Schedule 5, Condition 4 of PA 10_0138, MCCM will submit by the end of March each year (or other such timing as agreed by the Director-General) an Annual Review for the previous calendar year to the Director-General of the Department of Planning, Industry & Environment. The Annual Review will include:

- validation of the calibration parameters of the water balance model to ensure that the model adequately simulates observed conditions on site; and
- a site water balance for each calendar year.

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11 REFERENCES

Boughton, 2004 'The Australian water balance model, Environmental Modelling and Software',
vol. 19, pp. 943-956.

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APPENDIX 2 SURFACE WATER MANAGEMENT PLAN

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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

This document presents the Surface Water Management Plan (SWMP) for MCCM. The SWMP includes baseline surface water data, a description of the surface water management system on the site, design objectives and performance criteria for various aspects of surface water management, and details of the surface water monitoring program.

1.2 STRUCTURE OF THE SURFACE WATER MANAGEMENT PLAN

This SWMP forms part of the Water Management Plan for MCCM. The MCCM Water Management Plan comprises the following documents:

- An overarching Water Management Plan.
- Site Water Balance (Appendix A).
- SWMP (this document) (Appendix B).
- Groundwater Management Plan (Appendix C).
- Boggabri-Tarrawonga-Maules Creek Complex (BTM Complex) Water Management Strategy (WMS) (Appendix D).

The following sections of the SWMP describe:

- Statutory obligations under the project approval (Section 2).
- Baseline surface water data (Section 3).
- The surface water management system on the site (Section 4).
- Surface water impact trigger levels and response plan (Section 5).
- The surface water monitoring programme (Section 6).
- Reporting procedures (Section 7).
- References (Section 8).

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2 STATUTORY OBLIGATIONS

The Maules Creek Coal Project (Project Approval (PA) 10_0138) was approved by the Minister for Planning and Infrastructure under Section 75J of the *Environmental Planning & Assessment Act 1979* (EP & A Act) on 23 October 2012.

Condition 40 (WMP) of Schedule 3 of the Project approval (Environmental Performance Conditions) requires the proponent to prepare and implement a WMP for the Project which includes a SWMP. The requirements for the SWMP, and where each requirement is addressed in this document, are provided in Table 1.

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Table 1 Surface Water Management Plan requirements from Project Approval 10_0138

Requirement for site water balance	Section of SWMP where addressed
Detailed baseline data on surface water flows and quality in the water-bodies that could potentially be affected by the project;	Section 3.2 & 3.3
Detailed baseline data on hydrology across the downstream drainage system of the Namoi River floodplain from the mine site to the Namoi River;	Section 3.2 & 3.3
- A detailed description of the water management system on site, including the: - clean water diversion systems;	Section 4.3 (see also Site Water Balance – Appendix A of WMP)
- erosion and sediment controls (dirty water system);	Section 4.9
- mine water management systems;	Section 4.2 (see also Site Water Balance – Appendix A of WMP)
- discharge limits in accordance with EPL requirements;	Section 5
- water storages;	Section 4.2 (see also Site Water Balance – Appendix A of WMP)
- mine access road and Maules Creek rail spur line.	Section 4.4
- Detailed plans, including design objectives and performance criteria for: - design and management of final voids;	Section 4.7
- design and management for the emplacement of reject materials, sodic and dispersible soils and acid or sulphate generating materials;	Section 4.6
- design and management for construction and operation of the rail spur line and mine access road;	Section 4.4
- reinstatement of drainage lines on the rehabilitated areas of the site; and	Section 4.5
- control of any potential water pollution from the rehabilitated areas of the site.	Section 4.5
- Performance criteria for the following, including trigger levels for investigating any potentially adverse impacts associated with the project: - the water management system;	Section 4.9 & 5
- downstream surface water quality;	Section 4.10
- downstream flooding impacts, including flood impacts due to the construction and operation of the rail spur line and mine access road, and flooding along Back Creek; and	Section 5
- stream and riparian vegetation health, including the Namoi River	Section 3.5 & 6.4
- A program to monitor: - the effectiveness of the water management system; and	Section 6
- surface water flows and quality in the watercourses that could be affected by the project; and	Section 6
- downstream flooding impacts.	Section 6
Reporting procedures for the results of the monitoring program.	Section 7
A plan to respond to any exceedances of the performance criteria, and mitigate and/or offset any adverse surface water impacts of the project.	Section 5

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3 BASELINE DATA

3.1 DRAINAGE NETWORK

MCCM is located within the catchment of Back Creek, a tributary of Maules Creek, which in turn is a tributary of the Namoi River. The mine access road and rail corridor, located to the west of the mine, drain to minor tributaries of the Namoi River. Figure 1 shows the location of the mine and receiving watercourses.

The Namoi River to Boggabri has a catchment area of 22,600 square kilometres (km²). Flow in the river has been regulated by releases from Keepit Dam, located about 56 kilometres (km) west of Tamworth, since the dam's completion in 1960. Keepit Dam has a storage capacity of 425,510 ML.

Maules Creek is ephemeral in the upper catchment. Historical data from the Dam Site gauge (data from 1968 to 1992, catchment area = 171 km²) shows that the creek flows for only about 60% of the time. Further downstream along Maules Creek at the Avoca East gauge (catchment area = 673 km²), the creek flows about 80% of the time. Analysis of recorded streamflow data for the two gauging stations indicates volumetric runoff coefficients (proportion of rainfall that becomes surface runoff) of approximately 5%.

3.2 SITE CATCHMENTS

Figure 2 shows site catchment boundaries, water storages and land use across the site for 2021/22 financial year (FY). Further details of catchment and land use changes due to mine progression over coming years are provided in the Site Water Balance (Appendix A to the WMP).

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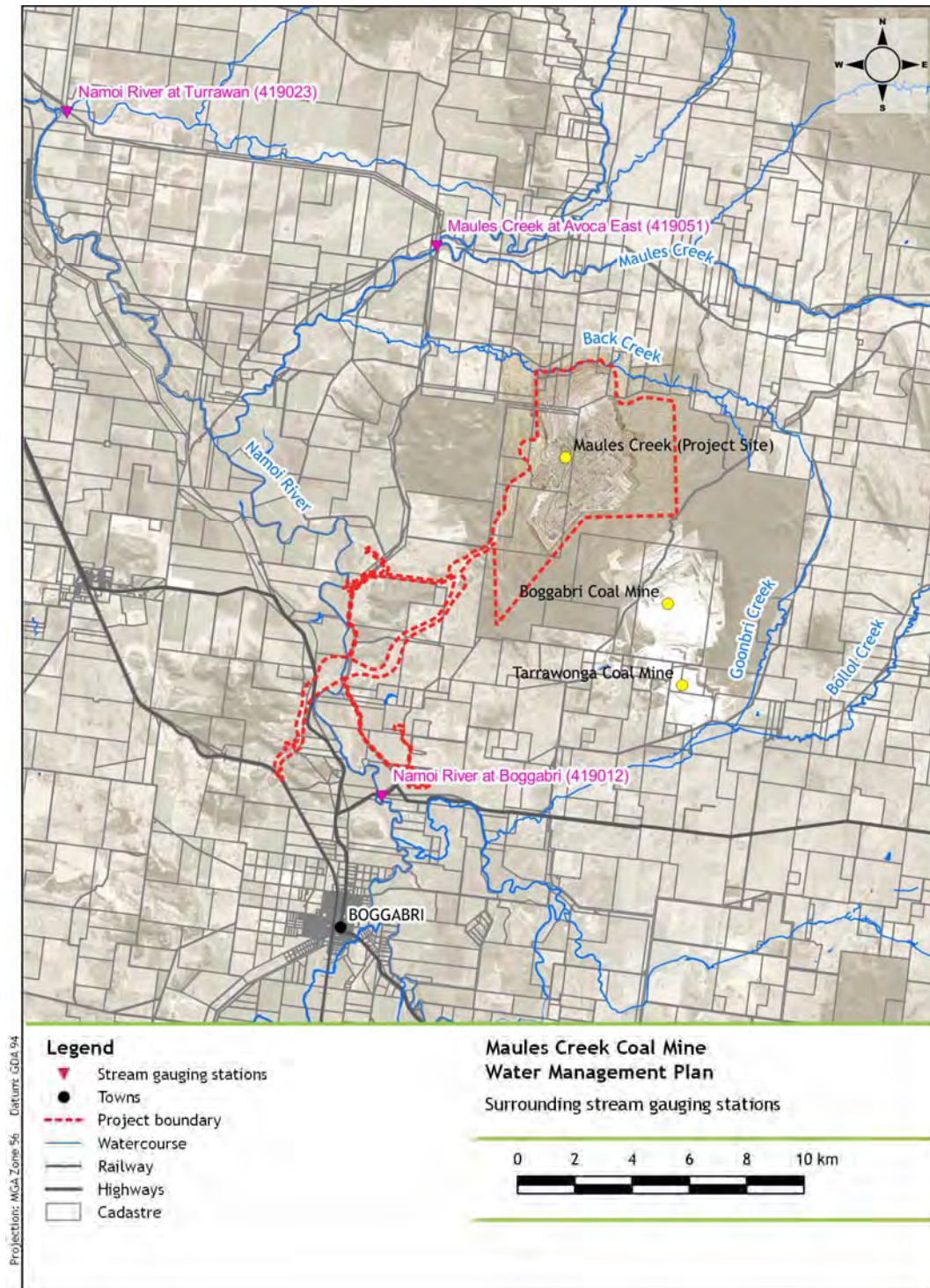
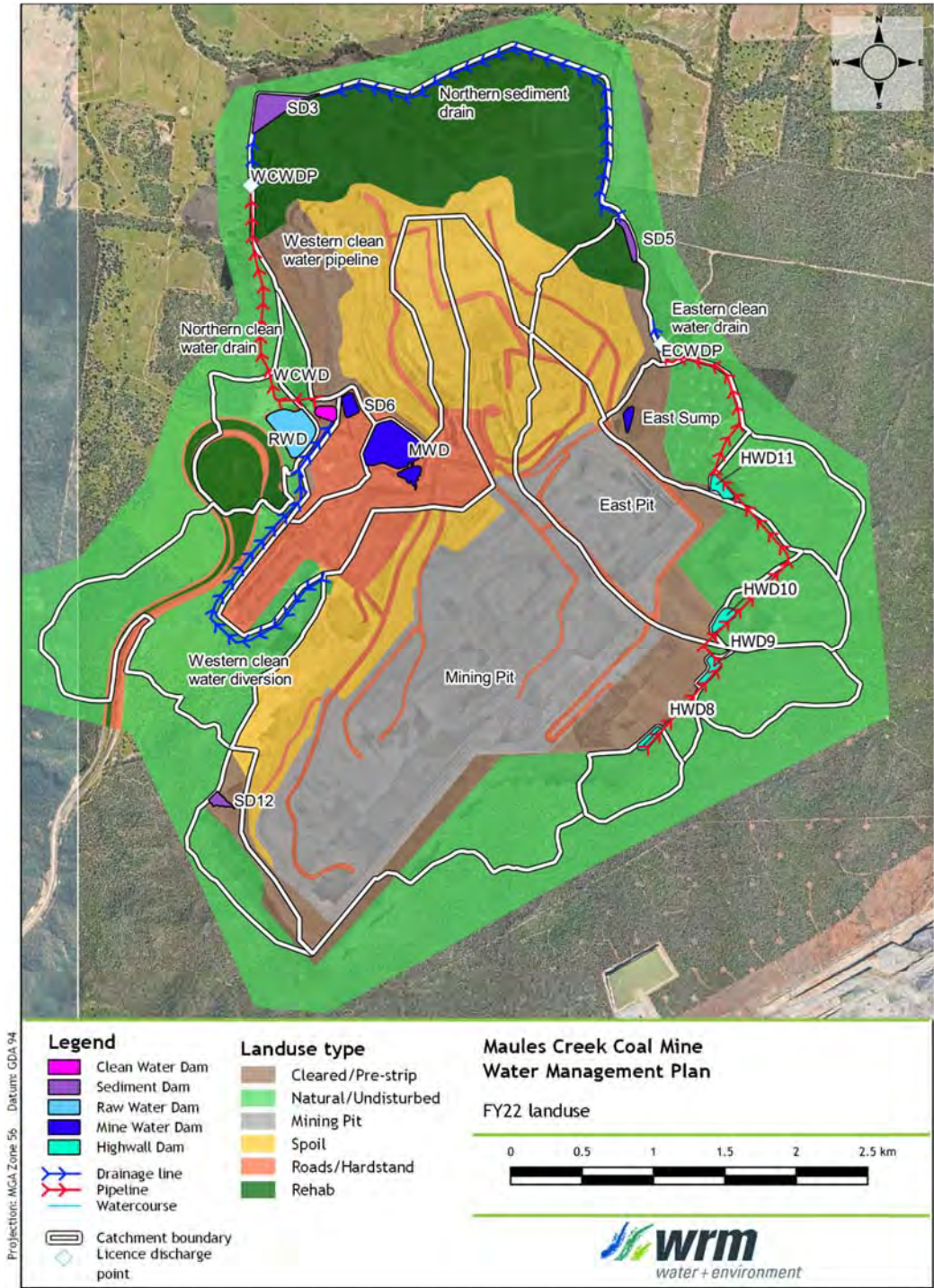


Figure 1 Stream Gauge Locations on Receiving Watercourses

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3.3 STREAMFLOW

Figure 1 shows the locations of streamflow gauges on receiving watercourses. Gauge details are provided in Table 2.

Figure 3 to Figure 8 show a time series of daily flow and ranked daily flow (data taken from <http://www.bom.gov.au/waterdata/>) for the Boggabri and Turrawan gauges in the Namoi River and the Maules Creek gauge at Avoca East.

Table 2 Available streamflow data

Stream	Gauge name	Gauge number	Catchment area (km ²)	Period of record
Namoi River	Boggabri	419012	22,600	1911 -
Namoi River	Turrawan	419023	24,500	1995 -
Maules Creek	Avoca East	419051	673	1972 -

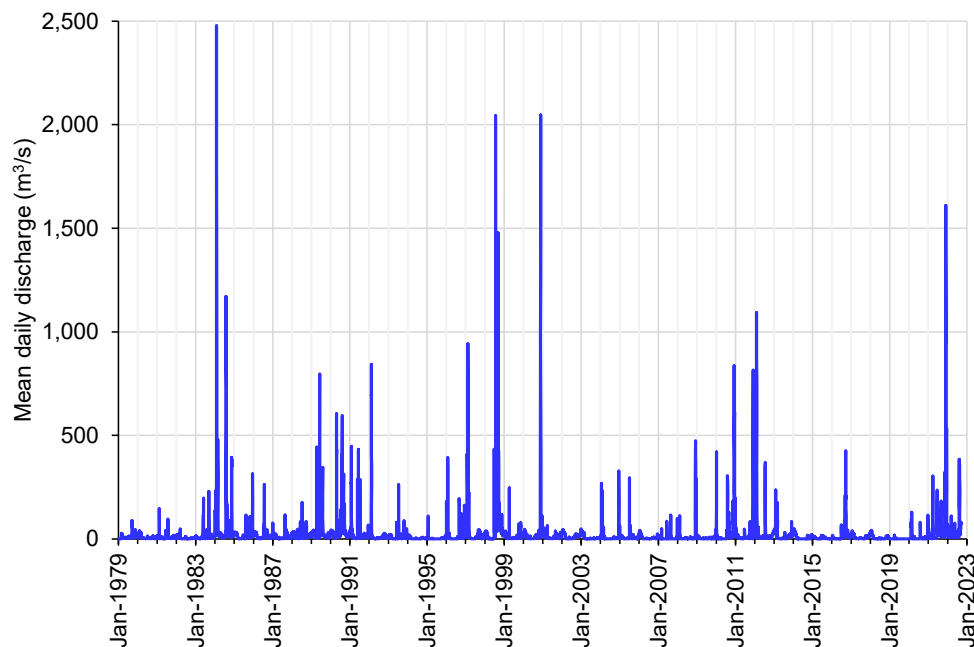


Figure 3 Daily Mean Discharge, Namoi River at Boggabri (Gauge No. 419012)

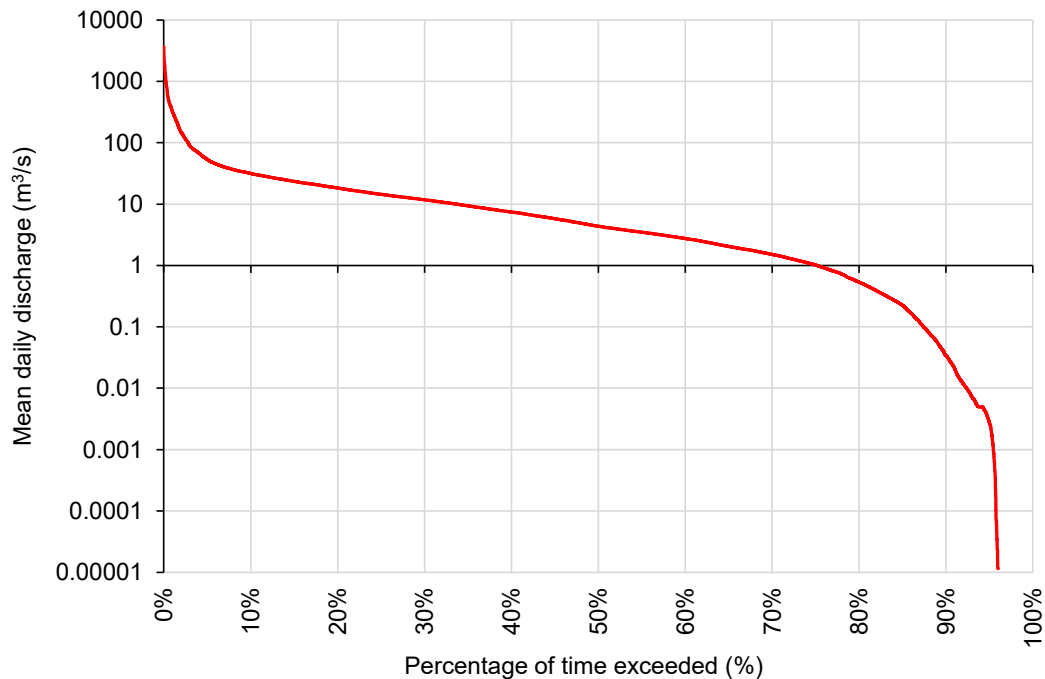


Figure 4 Ranked Flow Plot, Namoi River at Boggabri (Gauge No. 419012)

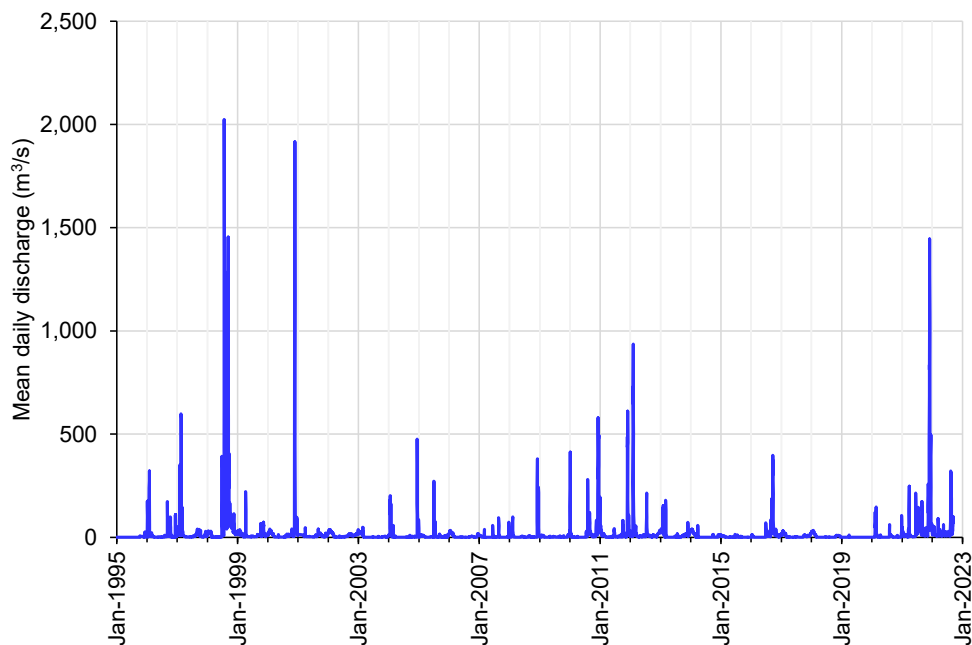


Figure 5 Daily Mean Discharge, Namoi River at Turrawan (Gauge No. 419023)

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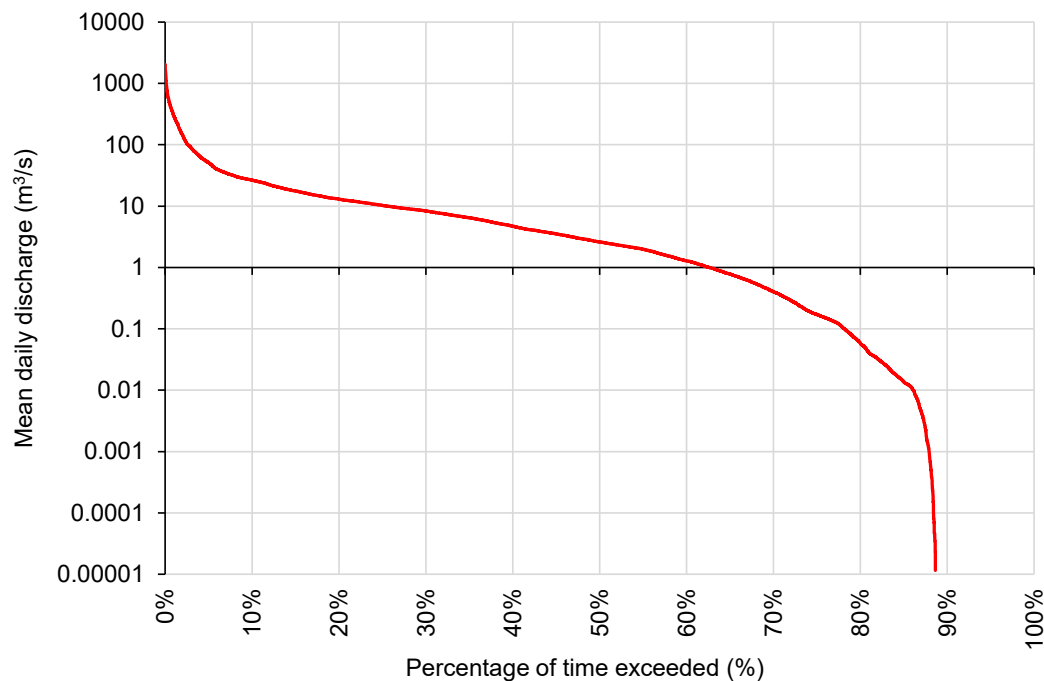


Figure 6 Ranked Flow Plot, Namoi River at Turrawan (Gauge No. 419023)

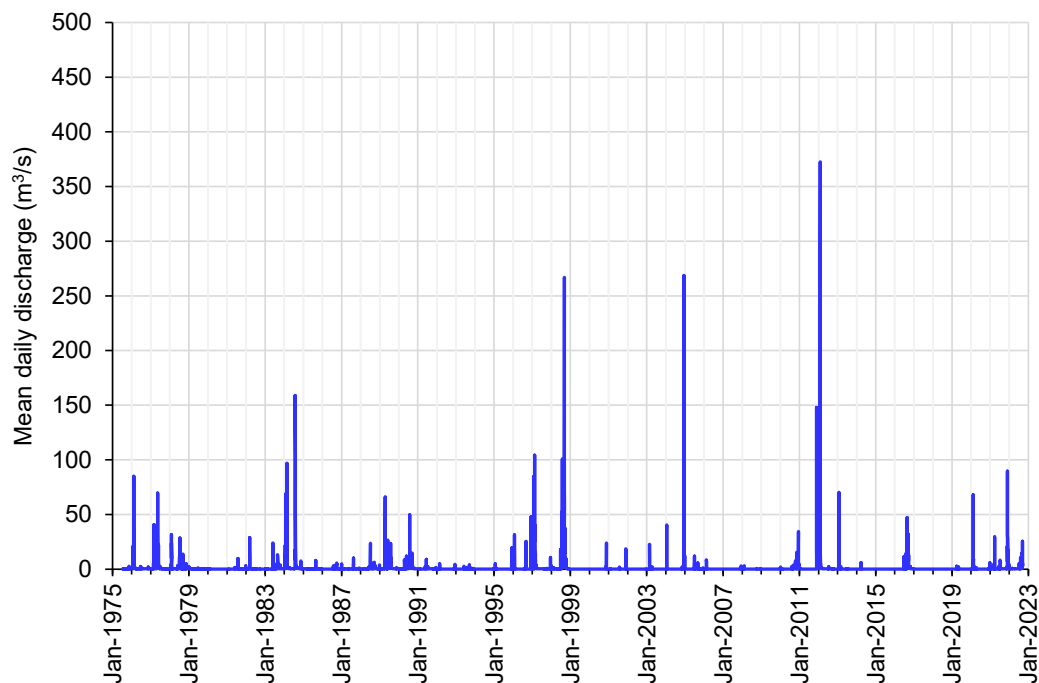


Figure 7 Daily Mean Discharge, Maules Creek at Avoca East (Gauge No. 419051)

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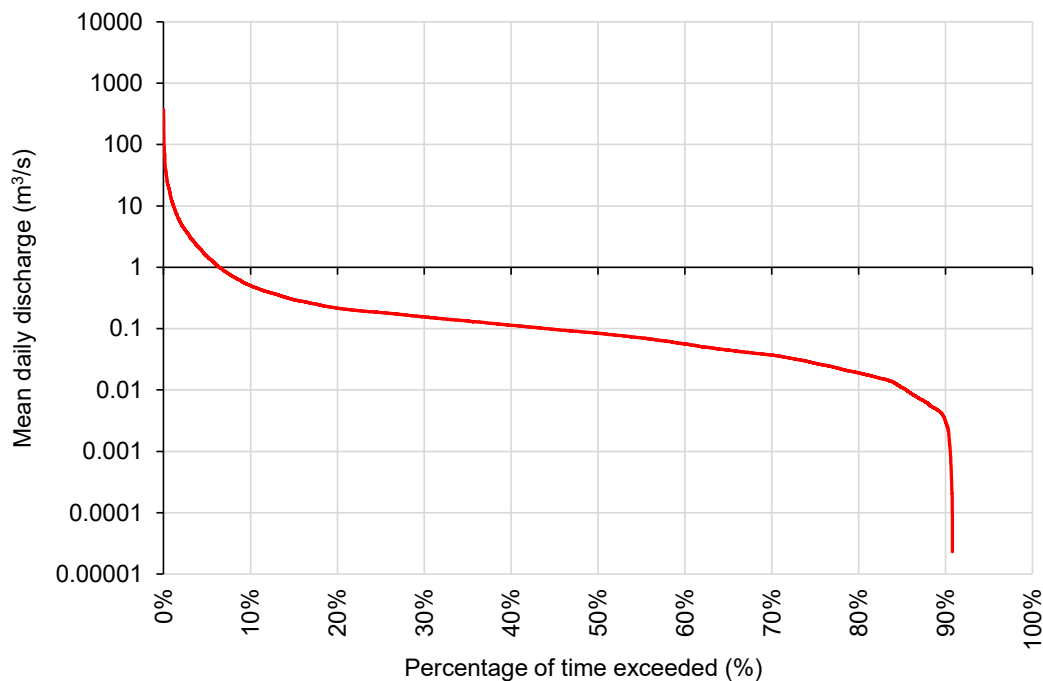


Figure 8 **Ranked Flow Plot, Maules Creek at Avoca East (Gauge No. 419051)**

3.4 SURFACE WATER QUALITY

A summary of the surface water quality sampling results over the last five years for Namoi River, Maules Creek and Back Creek is provided in Table 3 for pH, electrical conductivity (EC), total dissolved solids (TDS) and total suspended solids (TSS). The locations of surface water sampling are shown in Figure 9.

3.4.1 Namoi River

Water quality is sampled at four locations in the Namoi River, identified as SW5, SW6, SW7 and SW8. SW8 is located upstream of the confluence with Maules Creek and therefore is not affected by MCCM releases. Figure 10 shows the pH, EC, TDS and TSS readings respectively for the Namoi River monitoring locations between 2017 and 2021.

pH

pH readings range between 7.85 and 8.50 (20th and 80th percentiles) for SW5, SW6 and SW7 and between 7.99 and 8.44 (20th and 80th percentiles) for SW8. The pH at SW8, which is located upstream of the Maules Creek confluence and hence would not be impacted by releases from the site storages, is similar to values at SW5, SW6 and SW7, located downstream of the Maules Creek confluence. There is no discernible trend in pH at these locations over the last five years.

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EC

EC readings range between 284 and 626 microSiemens per centimetre ($\mu\text{S}/\text{cm}$) (20th and 80th percentiles) for SW5, SW6 and SW7 and between 280 and 554 $\mu\text{S}/\text{cm}$ (20th and 80th percentiles) for SW8. EC at SW5, SW6 and SW7 is typically higher than at SW8. The EC values fluctuate significantly between wet and dry seasons over the last five years.

TDS

TDS readings range between 212 and 381 milligrams per litre (mg/L) (20th and 80th percentile) for SW5, SW6 and SW7 and between 248 and 329 mg/L (20th and 80th percentile) for SW8. The TDS values fluctuate significantly between wet and dry seasons over the last five years.

TSS

TSS readings range between 20 and 104 mg/L (20th and 80th percentile) for SW5, SW6 and SW7 and between 24 and 119 mg/L (20th and 80th percentile) for SW8. The TSS values fluctuate significantly between wet and dry seasons over the last five years.

3.4.2 Maules Creek

Water quality is sampled at two locations in Maules Creek, identified as SW1 and SW2. Figure 11 shows the pH, EC, TDS and TSS readings respectively for Maules Creek monitoring locations between 2017 and 2021.

pH

pH readings range between 7.39 and 7.93 (20th and 80th percentiles) for SW1 and SW2. There is no discernible trend in pH at these locations over the last five years.

EC

EC readings range between 142 and 470 $\mu\text{S}/\text{cm}$ (20th and 80th percentiles) for SW1 and SW2. There is no discernible trend in EC at these locations over the last five years.

TDS

TDS readings range between 202 mg/L and 293 mg/L (20th and 80th percentile) for SW1 and SW2. There is a noticeable upwards trend in TDS over 2018 and 2019, which coincides with the drought conditions during that period. The TDS in 2020 is notably reduced following the February rainfall event.

TSS

TSS readings range between <5 mg/L and 194 mg/L (20th and 80th percentile) for SW1 and SW2. There is a noticeable upwards trend in TSS over 2018 and 2019, which coincides with the drought conditions during that period. The TSS in 2020 is notably reduced following the February rainfall event.

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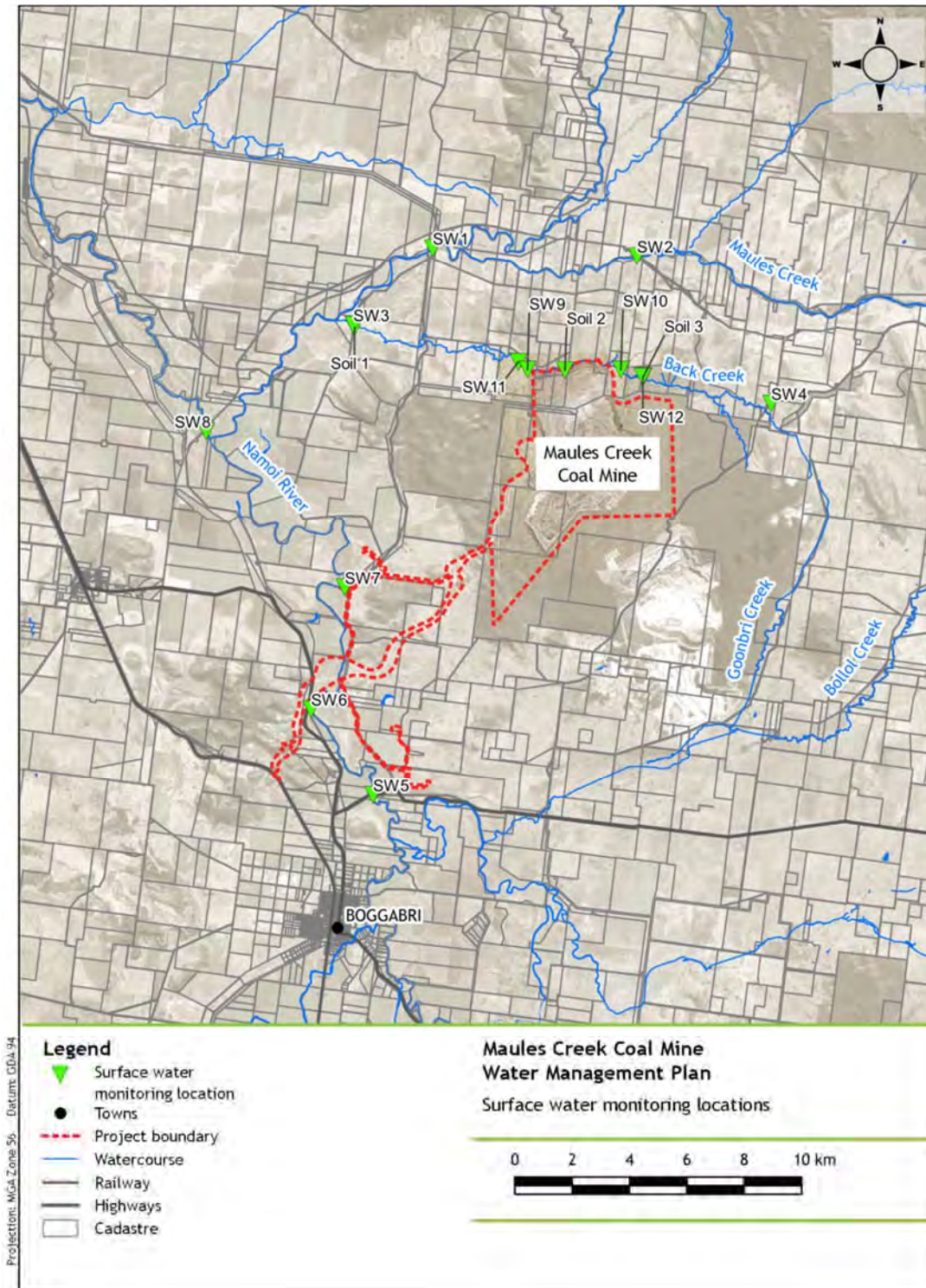


Figure 9 Water Quality Monitoring Locations

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Table 3 Surface Water Quality Data, 2017-2021

Monitoring location	pH				EC (µS/cm)				TDS (mg/L)				TSS (mg/L)			
	No. of samples	20 th %ile	Median	80 th %ile	No. of samples	20 th %ile	Median	80 th %ile	No. of samples	20 th %ile	Median	80 th %ile	No. of samples	20 th %ile	Median	80 th %ile
<u>Namoi River</u>																
SW5	22	7.97	8.17	8.50	22	301	477	597	22	244	281	345	22	27	37	104
SW6	46	7.85	8.23	8.43	47	291	475	626	47	214	309	381	47	20	45	89
SW7	56	8.00	8.26	8.48	57	284	472	573	57	212	282	345	57	25	48	96
SW8	14	7.99	8.14	8.44	14	280	406	554	14	248	263	329	14	24	47	119
<u>Maules Creek</u>																
SW1	54	7.23	7.57	7.88	55	319	364	470	55	202	252	293	55	8	16	42
SW2	5	7.39	7.63	7.93	5	142	372	470	5	241	286	333	5	5	7	194
<u>Back Creek</u>																
SW3	3	N/A	8.10	N/A	2	N/A	197	N/A	2	N/A	334	N/A	2	N/A	198	N/A
SW4	3	7.19	7.69	8.19	5	105	181	271	5	18	210	268	5	N/A	24	N/A
SW9	3	7.60	8.08	8.32	5	50	89	498	5	104	222	453	5	N/A	66	N/A
SW10	1	N/A	8.28	N/A	1	N/A	46	N/A	1	N/A	424	N/A	1	N/A	205	N/A

^a limit of detection

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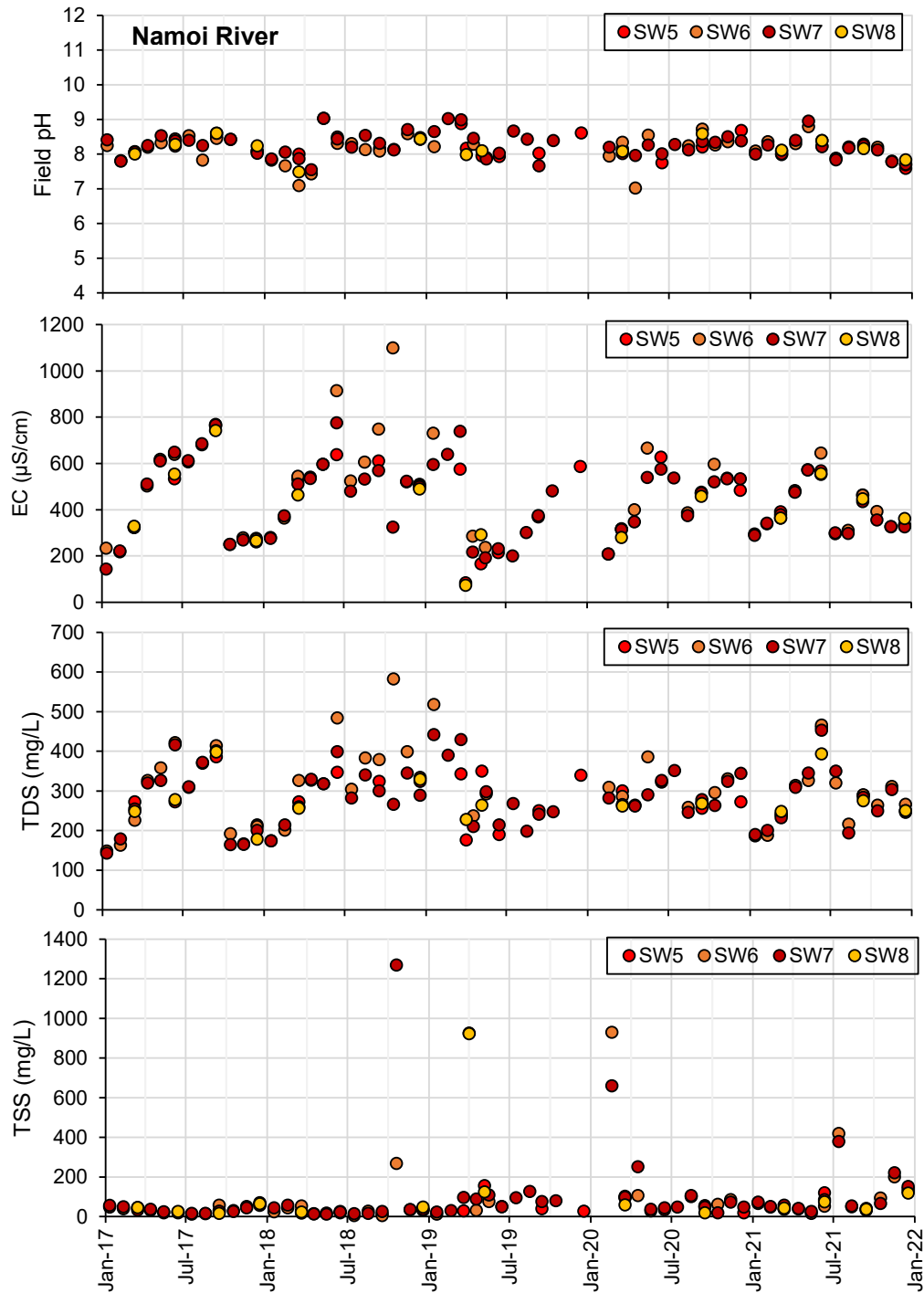


Figure 10 Namoi River Surface Water Quality, 2017 to 2022

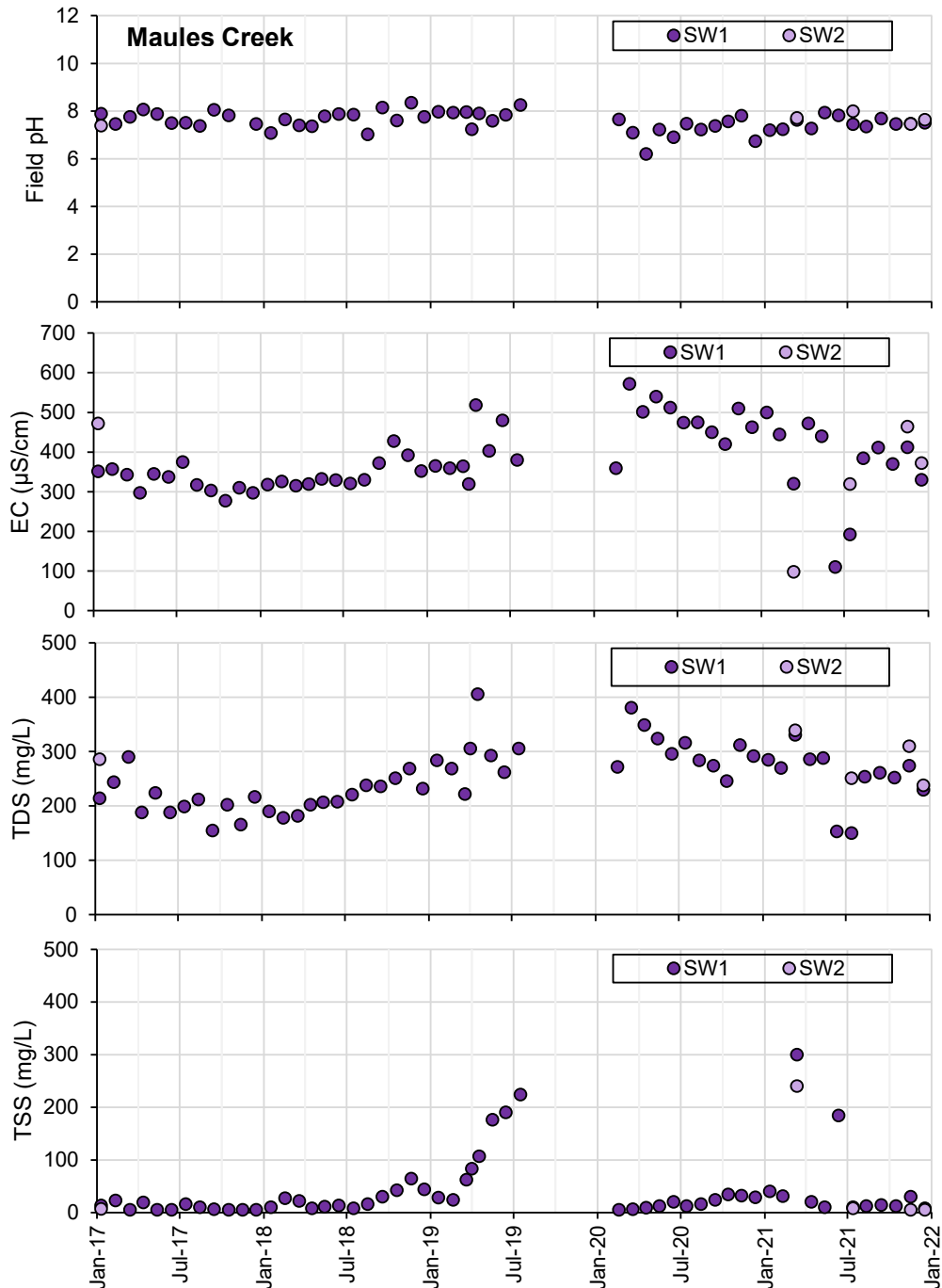


Figure 11 Maules Creek Surface Water Quality, 2017 to 2021

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3.4.3 Back Creek

Water quality is sampled at four locations in Back Creek, identified as SW3, SW4, SW9 and SW10. SW4 and SW10 are located upstream of MCCM operations, and therefore are not affected by MCCM releases. Figure 12 shows the pH, EC, TDS and TSS readings respectively for Back Creek monitoring locations between 2017 and 2021. Two new water quality sampling locations on Back Creek are currently being commissioned (SW11 [downstream] and SW12 [upstream]). No samples for these sites have been taken yet.

pH

pH readings range between 7.69 and 8.28 (50th percentile) for SW3, SW4, SW9 and SW10. There is no discernible trend in pH at these locations over the last five years.

EC

EC readings range between 46 and 197 $\mu\text{S}/\text{cm}$ (50th percentile) for SW3, SW4, SW9 and SW10. There is no discernible trend in EC at these locations over the last five years.

TDS

TDS readings range between 210 and 424 mg/L (50th percentile) for SW3, SW4, SW9 and SW10. There is no discernible trend in TDS at these locations over the last five years.

TSS

TSS readings range between 24 and 205 mg/L (50th percentile) for SW3, SW4, SW9 and SW10. There is no discernible trend in TSS at these locations over the last five years.

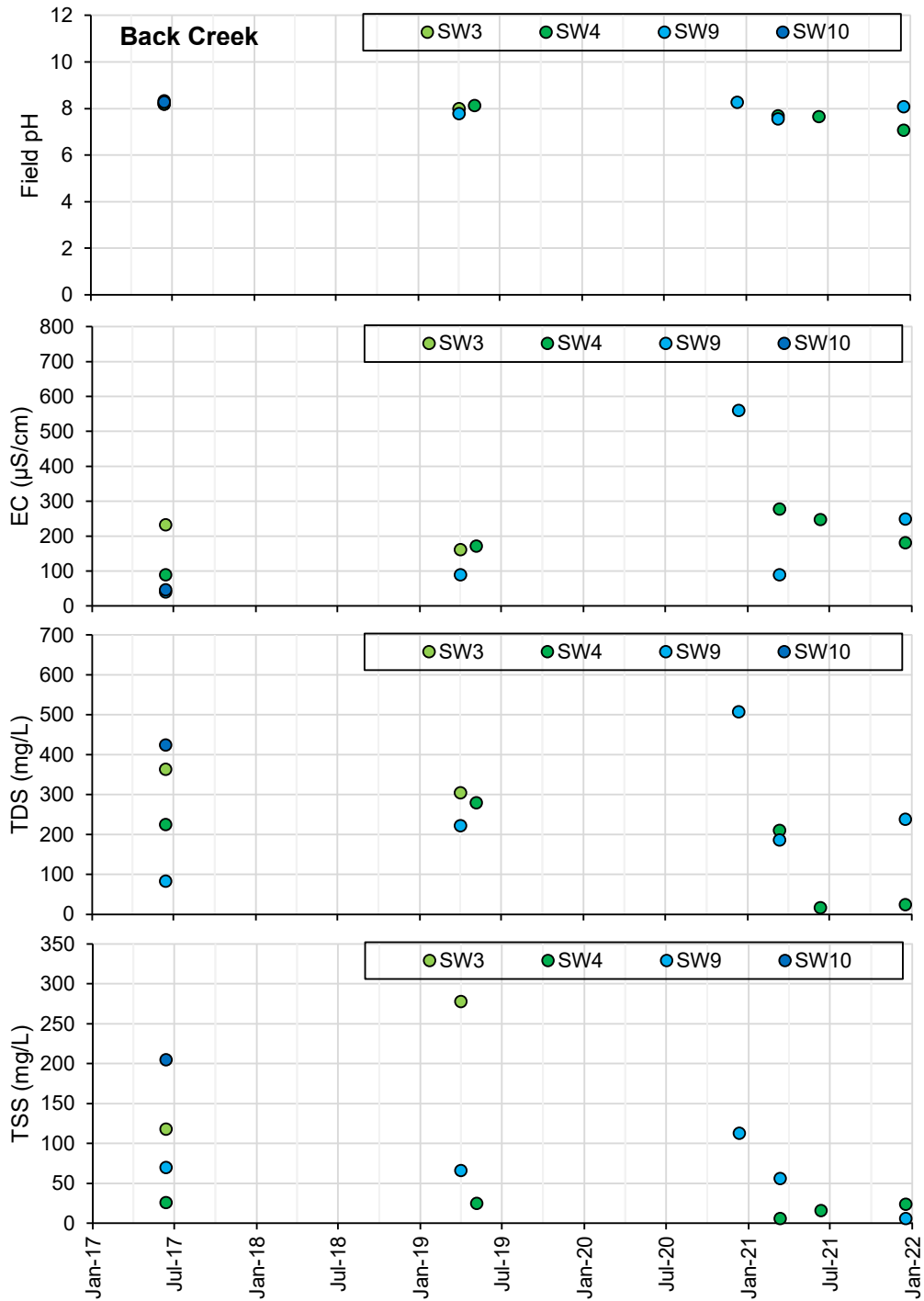


Figure 12 Back Creek surface water quality, 2017 to 2021

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3.5 STREAM HEALTH

Bi-annual stream and riparian vegetation health assessments, including macroinvertebrate monitoring as well as physical and chemical monitoring in accordance with Australian River Assessment System (AusRivAS) guidelines, have been undertaken at nine sites along Back Creek and Maules Creek and two sites along the Namoi River since 2015. The selected survey locations are shown Figure 13.

Monitoring locations BCP1 and BCP 2 are located on Back Creek, upstream of the MCCM. Monitoring locations BCP3, BCP4, BCP5, BCP 6 and BCP 8 are located on Back Creek, downstream of the MCCM. BCP7 and BCP9 are located on Maules Creek, upstream and downstream of the Back Creek confluence, respectively.

From 2022 MCCM will increase the monitoring frequency to biannual (spring and autumn) and locations as shown in Figure 13. The new monitoring sites are as per the recommendations of Peter Hancock (Eco Logical 2021), they include:

- BCUS2 on Back Creek upstream of MCCM.
- MCUS5 and MCUS1 on Maules Creek, upstream of the Back Creek confluence.
- NRDS1 and Henriendi TSR on the Namoi River upstream of the confluence with Maules Creek.

Details of the methodology and results of the annual stream and riparian vegetation health assessments are provided in the annual assessment reports prepared by Eco Logical Australia (2021).

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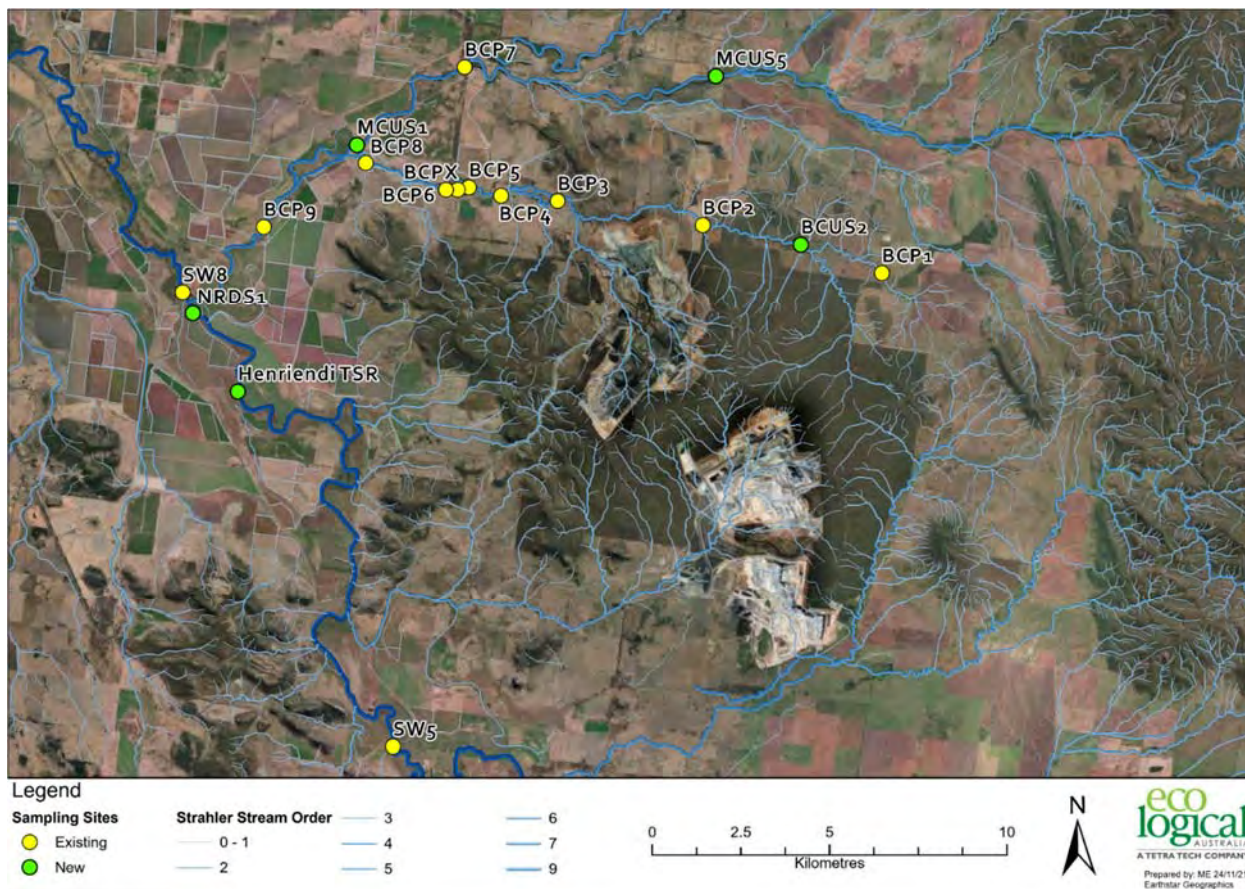


Figure 13 Existing and Proposed New Stream Health Monitoring Locations

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4 SURFACE WATER MANAGEMENT SYSTEM

4.1 SURFACE WATER MANAGEMENT OBJECTIVES

The proposed water management strategy for MCCM is based on targeted management of water from different sources based on anticipated water quality. Water on the site is categorised as either:

- clean water – water from areas not disturbed by mining;
- mine water – groundwater inflows and surface runoff in mining areas that is likely to come into contact with coal; or
- sediment laden water – runoff from areas disturbed by stripping or placement of overburden material.

The objectives of the water management system are to ensure:

- clean water runoff from undisturbed catchment areas is diverted away from the mining area, where possible and practical to do so;
- sediment laden runoff from disturbed areas is re-used in the water management system or released into the receiving environment if water quality meets EPL requirements (treatment may be required);
- mine water (including water that accumulates within, or drains from, active mining areas, coal reject emplacement areas and Coal Handling and Preparation Plant (CHPP) infrastructure areas) and groundwater collected within open cut pits is contained and reused on-site;
- no uncontrolled discharge of mine water off-site; and
- on-site water demands are satisfied whilst minimising external water requirements.

4.2 WATER MANAGEMENT SYSTEM CONFIGURATION AND INFRASTRUCTURE

Details of the site water management system are provided in Section 3 of the Site Water Balance (Appendix A of the WMP). The main components of the system include storages for containment of:

- clean water, such as Highwall Dams (HWD) and the Western Clean Water Diversion Dam (WCWD);
- the Raw Water Dam (RWD) which receives external water from the Namoi River and Bores;
- mine water, such as the Mine Water Dam (MWD) and Pit Water Storage (PWS). The system is managed so that there is no release of mine water from these storages; and
- sediment laden water, such as sediment dams.

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4.3 CLEAN WATER MANAGEMENT SYSTEM

4.3.1 Overview

There are two major clean water management areas within the mine:

- the four HWDs and associated works, located along the highwall on the eastern margin of the mining area.
- the WCWD dam and associated works, located along the western margin of the mining area.

Details of the two clean water management areas are provided in the following sub-sections.

4.3.2 Highwall Dams

The existing clean water management system along the eastern margin of the mining area includes four dams built in early 2022. HWD8, HWD9, HWD10 and HWD11 will intercept clean runoff from the ephemeral drainage lines which drain towards the open cut.

The eastern margin of the open cut is progressing upslope into undulating ridge lines with multiple small catchments. This ridge country prevents the design of a free-draining clean water management system, with elevation changes of +8 metres (m) to +20 m between the proposed highwall dams. For this reason, runoff collected in the highwall dams will be pumped from each dam into a single backbone pipeline, to divert the captured clean water runoff around the eastern side of the active mining area and into a tributary of Back Creek to the north (Figure 14). The water shall be released from the LDP in accordance with the release criteria in the mines EPL.

The highwall dam capacities and pump rates have been designed to achieve a target containment standard of 10% Annual Exceedance Probability (AEP). Design capacities and pump rates are presented in Table 4, as well as indicative operational periods.

Table 4 HWD and Pump Sizing Details

Dam	Catchment Area (ha)	Capacity (ML)	Pump Rate (L/s)	Operational Period
HWD8	27.1	8	15	2022 to 2024
HWD9	49.0	16	30	2022 to 2023
HWD10	47.3	20	30	2022 to 2023
HWD11	57.1	20	40	2022 to 2024

ha = hectares, ML = megalitres, L/s = litres per second

As the open cut progresses towards the east, the highwall dams and the catchments draining to them will be progressively consumed by the open cut. As this occurs, the pump and pipeline arrangements will be augmented to allow runoff from controlled catchments to continue to be diverted around the open cut. When required, the highwall dams will be progressively decommissioned when they are mined through. Replacement highwall dams may be constructed as required, to comply with the WM Act and the project approval.

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Refer to Section 6.5 for details regarding monitoring of the HWDs. Stage storage curves for HWD8, HWD9, HWD10 and HWD 11 are provided in the attached Addendum 1. Clean water that is not diverted by HWD8 and HWD9 shall be accounted for against the sites harvestable rights allowance. Clean water that is not diverted by HWD10 and HWD11 shall be accounted for against WAL 41585, which has an annual allocation of 30 ML.

4.3.3 Western Clean Water Diversion

Due to progressive development of the out-of-pit waste rock emplacement, the existing clean water diversion along the western margin of the MCCM required reconfiguration. Previously, the diversion was a free-draining system which allowed upslope runoff to drain around the mining operations and report to a tributary of Back Creek. Progressive development of the waste rock emplacement resulted in topographical constraints that prevented the free-draining system from functioning.

To allow for ongoing management of the upslope clean water catchment, a clean water diversion dam was constructed in 2021 on the existing western clean water diversion, and a new clean water drain was constructed to collect runoff from the undisturbed catchment in the north-western corner of Coal Lease (CL) 375 and direct it to the new clean water diversion dam (Figure 15).

Runoff collected in the clean water diversion dam is pumped via a pipeline around the toe of the waste rock emplacement to the discharge location on a tributary of Back Creek (Figure 15). The clean water diversion dam capacity and pump rate have been designed to achieve a target containment standard of 10% AEP. The design capacity and pump rate are presented in Table 5. Clean water that is not diverted by this dam shall be accounted for against the sites harvestable rights allowance.

Table 5 Western Clean Water Diversion Dam and Pump Sizing Details

Dam	Catchment Area (ha)	Capacity (ML)	Pump Rate (L/s)	Operational Period
Western Clean Water Dam	200	15	400	2021 to closure

Refer to Section 6.5 for details regarding the monitoring strategy for the WCWD Dam. The stage storage curve for the WCWD Dam is provided in the attached Addendum 1.

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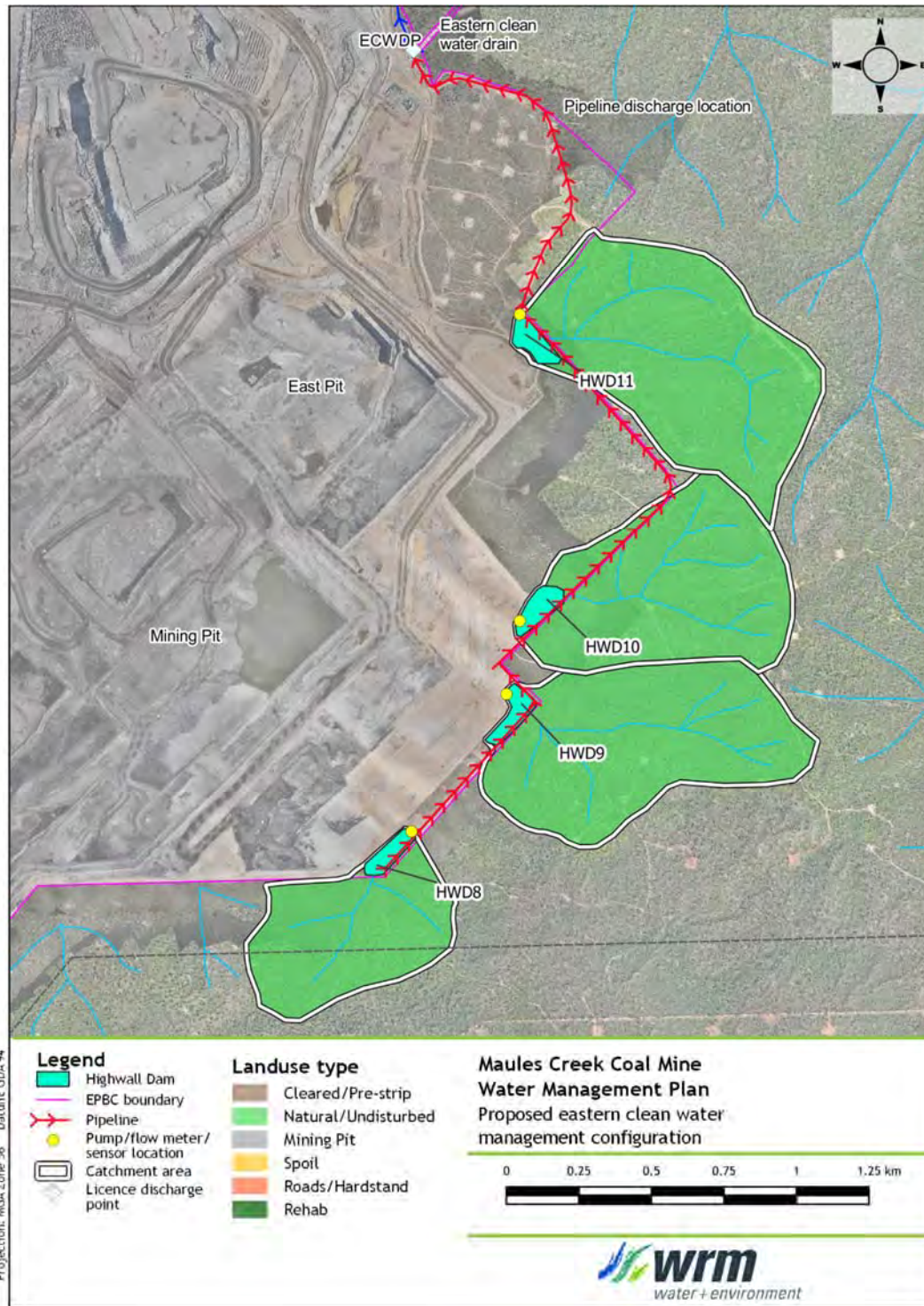


Figure 14 Eastern Clean Water Management Configuration

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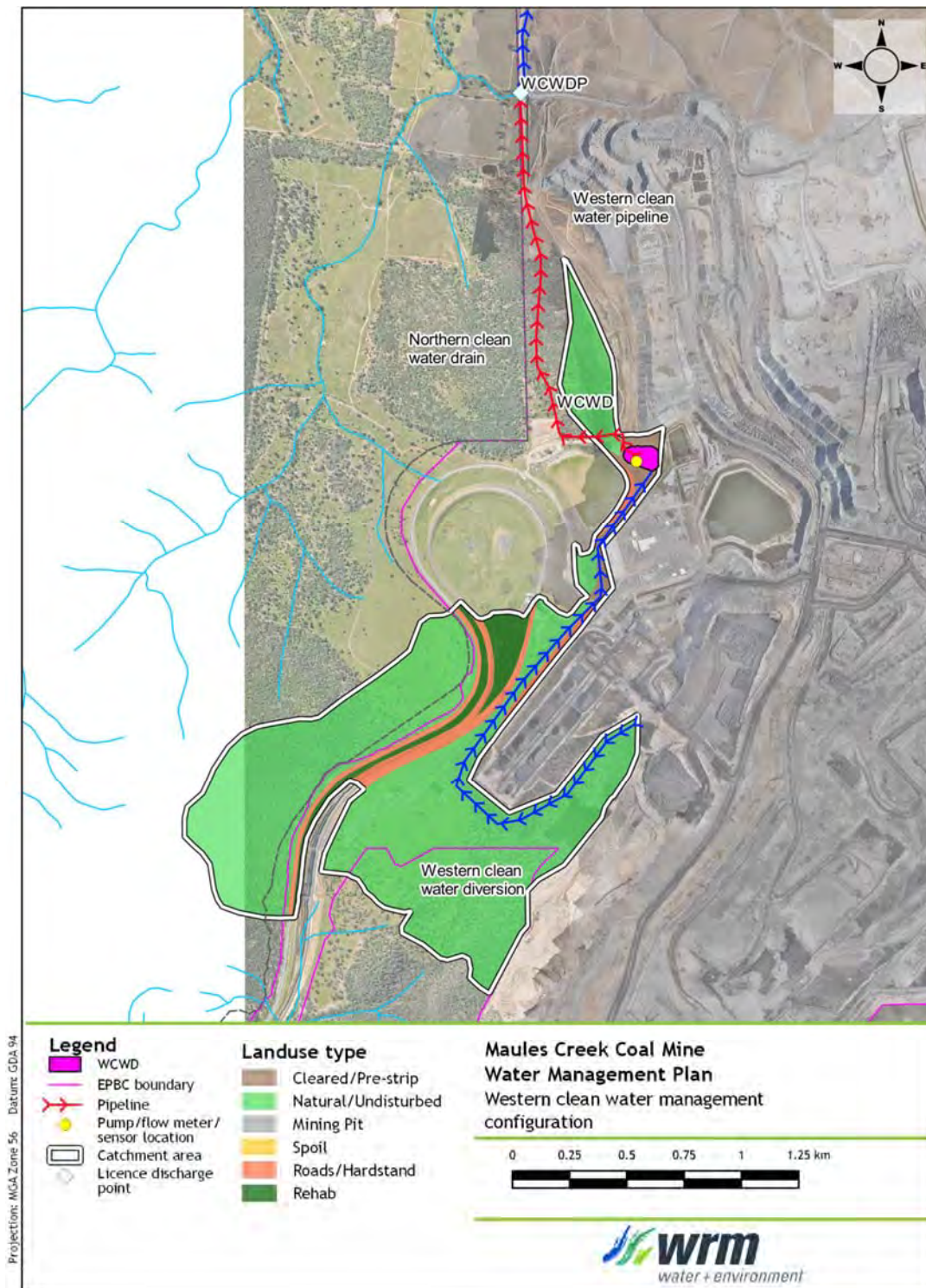


Figure 15 Western Clean Water Management Configuration

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4.4 WATER MANAGEMENT FOR THE RAIL SPUR AND MINE ACCESS ROAD

Water management infrastructure along the mine access road and rail spur line consists of a number of minor sediment dams which were used to manage sediment laden runoff during the construction period. These dams will be decommissioned in 2022/23 as the catchments are now stabilised. These dams will not play an active role in the mine water management system in the future. Addendum B has been submitted which documents the proposed decommissioning works.

4.5 REINSTATEMENT OF DRAINAGE LINES AND WATER POLLUTION CONTROL FOR REHABILITATED AREAS

Details of rehabilitation objectives and techniques are described in the Mine Site Rehabilitation Plan. The key goal of rehabilitation activities is to create landforms that are safe, stable, provide adequate post-mining drainage, and have a shape that is consistent with the types of naturally occurring landform features that occur in the region.

The following drainage design features and techniques may be used to control erosion and provide stable drainage systems for rehabilitated areas:

- Amelioration of dispersive spoil to minimise the risk of rill, gully and tunnel erosion and to allow the infiltration of surface water (reduce the amount and velocity of surface water).
- Contour scarification of compacted surfaces to encourage infiltration and surface roughness.
- Use of cover crops including salt tolerant self-sterile annual grasses (if seasonally and commercially available), native grasses and native legumes to minimise raindrop and sheet erosion of reshaped areas.
- Use of inert rock mulches of appropriate stone sizes and cover where effective and appropriate.
- Vehicle access will be predominantly restricted to designated tracks on mine landforms that have been revegetated to minimise ground disturbance (e.g. erosion and/or compaction).
- Engineered temporary channel banks, slope drains and energy dissipaters in areas where concentrated surface flow may occur to reduce erosion if necessary. However, it should be noted that one of the aims of the landform design process will be to minimise the reliance on structural erosion control measures. Drainage and sediment control structures will be designed in accordance with Table 6.1 of *Managing Urban Stormwater: Soils and Construction Volume 2E – Mines and Quarries* (DECC, 2008). Sediment basins and other water storages will not be located on overburden emplacement areas in order to reduce the potential for tunnel erosion.
- Structural erosion controls may be used on overburden emplacement areas if necessary until vegetation cover is sufficient to provide adequate erosion protection.
- In the larger drainage systems such as clean water drains and modified natural drainage systems, erosion control methods such as cross vanes, rock vanes and J-hook vanes will be used to provide channel bed and bank protection.

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4.6 MANAGEMENT OF POTENTIALLY ACID FORMING MATERIALS

Management of overburden and coal reject materials is described in the MCCM Mining Operations Plan.

Geochemical assessment of site materials indicates that overburden and most potential coal reject materials at MCCM are likely to have negligible (<0.1%) total sulphur content and are therefore classified as Non Acid Forming (NAF). These materials are predicted to generate slightly alkaline and relatively low salinity runoff and seepage following surface exposure, which is evident in water quality data which shows all the dams at the mine are neutral to slightly alkaline. A small proportion of potential coal reject materials are classified as Potentially Acid Forming (PAF) and these materials may generate acidic and more saline runoff and seepage if exposed to oxidising conditions.

Management of overburden and coal reject materials at MCCM includes:

- use of drainage and containment structures;
- pre-stripping topsoil from areas to be mined for use in final rehabilitation activities;
- placement of overburden within the overburden emplacement areas in a manner that limits the risk of surface erosion;
- placement of NAF coal reject materials in the open cut pit and/or co-disposed with overburden;
- burial of PAF coal reject materials from the selected coal seams ensuring at least 15 m final coverage of inert material. Out-of-pit co-disposal of PAF rejects in encapsulation cells may need to be considered until sufficient capacity in the open pit becomes available;
- burial of PAF roof and floor materials from selected coal seams ensuring at least 15m final coverage of inert material; and
- covering carbonaceous waste materials (i.e. not PAF) as soon as practical with at least 5 m of non-carbonaceous NAF overburden material to minimise the length of exposure to oxidising conditions.

4.7 FINAL VOID MANAGEMENT AND DESIGN PARAMETERS

The key objectives to be achieved for the final void (Condition 71 of PA 10_0138) are:

- minimise the size and depth of the final void as far as is reasonable and feasible; and
- minimise the drainage catchment of the final void as far as is reasonable and feasible.

Details of the ultimate final landform (including final void) are presented within the Rehabilitation Management Plan. Further mine planning work will be undertaken as mining operations progress and as part of the work required under the Rehabilitation Management Plan to ensure that the objectives from the PA have been met. This will include the preparation and implementation of a Final Void and Mine Closure Plan (FVMCP). The WMP will be updated to reflect the outcomes of the FVMCP.

4.8 CHEMICAL AND HYDROCARBON STORAGE

All chemical and hydrocarbon storages will be constructed and maintained in accordance with Australian Standard 1940 *The Storage and Handling of Flammable and Combustible Liquids*.

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4.9 EROSION AND SEDIMENT CONTROL

4.9.1 General Principles

Effective erosion and sediment control (ESC) is based on three key activities:

- Erosion control – prevention or minimisation of erosion caused by runoff on disturbed surfaces.
- Drainage control – a secondary erosion control, prevention or minimisation of soil erosion caused by concentrated flows. Appropriate management and separation of different water types through/around the area of concern.
- Sediment control – trapping or retention of sediment generated from either overland flow or concentrated flow.

Best practice sediment control measures cannot, on their own, be relied upon to provide adequate environmental protection without implementing effective erosion and drainage controls. For ESC measures to be effective the following fundamentals are required:

- Integrate ESC measures into the planning phases of mine operations.
- Separate catchments by water types and control water movement through the site.
- Minimise the duration and extent of topsoil and spoil exposure where possible.
- Promptly stabilise disturbed areas where possible (to reduce the duration of disturbance).
- Maximise sediment retention on the site and maximise discharge of water that will achieve water quality compliance conditions.
- Maintain all ESC measures in proper working order at all times.
- Monitor the site and adjust ESC practices to maintain the required performance standard.

Surface runoff water from areas that are disturbed by mining operations (including out-of-pit overburden and haul roads) is considered sediment laden runoff and may contain high sediment loads. Mining and dumping operations will be managed to ensure that runoff from these areas is not significantly affected by coal contact and hence will not contain contaminated material or high salt concentrations.

Activities that have the potential to cause erosion and sediment laden runoff at Maules Creek include:

- vegetation clearing and topsoil stripping;
- stockpiling of topsoil;
- construction of roads and infrastructure;
- construction of overburden emplacement areas;
- re-routing drainage lines via clean water diversions; and
- construction activities as detailed below.

Potential impacts from these activities include:

- increased surface erosion from disturbed and rehabilitated areas through the removal of vegetation and stripping of topsoil;
- increased sediment and pollutant load entering the natural water system; and

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- siltation or erosion of watercourses and water bodies.

The sediment laden runoff produced from these activities must be managed to ensure that downstream water quality is within the adopted water quality compliance criteria. Topsoil stockpiles will be located within the approved Project Disturbance Boundary and will not be located within any drainage line and be developed considering the potential for erosion and sediment issues. Further detail on the management of topsoil stockpiles is provided within the Rehabilitation Management Plan.

Sediment and erosion control measures for the MCCM are designed to ensure effective management of clean surface water and sediment laden runoff from mining and prestrip areas. Sediment mobilisation and erosion will be minimised by:

- installing appropriate erosion and sediment controls prior to disturbance of any land;
- limiting the extent of the disturbance to the practical minimum;
- reducing the flow rate of water across the ground particularly on exposed surfaces and in areas where water concentrates;
- progressively rehabilitating disturbed land and constructing drainage controls to improve stability of rehabilitated land;
- treating rehabilitation areas to promote infiltration;
- protecting natural drainage lines and watercourses by the construction of erosion control devices such as diversion banks, channels and sediment retention dams;
- installing appropriate erosion and sediment controls around all soil stockpiling areas;
- steep gradients will have suitable control measures in place, as required e.g. rock riprap, geotextile fabric; and
- restricting access to rehabilitated areas.

The design of erosion and sediment control measures at MCCM will be based on the principle of ensuring that runoff from disturbed areas is separated from clean area runoff and collected in sediment dams for treatment. Sediment control structures will be designed in accordance with current recommended design standards including:

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

The design of linear construction (including pipelines, roads and rail spur line) will be in accordance with current recommended design standards including:

- *Managing Urban Stormwater, Soils and Construction, Volume 2A Installation of Services;*
- *Volume 2C unsealed roads;* and
- *Volume 2D Main Road Construction.*

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4.9.2 Erosion Control Measures

Erosion control measures will be used to manage dispersive soils and spoils, provide soil surface cover, and to minimise the creation of concentrated surface water flow conditions. Erosion control works will include the measures listed below:

- Amelioration of dispersive spoil to minimise the risk of rill, gully and tunnel erosion and to allow the infiltration of surface water (reduce the amount and velocity of surface water). This will be determined during the soil testing program outlined in the Soil Management Protocol.
- Contour scarification of compacted surfaces to encourage infiltration and surface roughness.
- Use of cover crops including salt tolerant self-sterile annual grasses (if seasonally and commercially available), native grasses and native legumes to minimise raindrop and sheet erosion of reshaped areas.
- Use of inert rock mulches of appropriate stone sizes and cover where effective and appropriate.
- Vehicle access will be predominantly restricted to designated tracks on mine landforms that have been revegetated to minimise ground disturbance (e.g. erosion and/or compaction).
- Engineered temporary channel banks, slope drains and energy dissipaters in areas where concentrated surface flow may occur to reduce erosion if necessary. However, one of the aims of the landform design process will be to minimise the reliance on structural erosion control measures. Drainage and sediment control structures will be designed in accordance with Table 6.1 of *Managing Urban Stormwater: Soils and Construction Volume 2E – Mines and Quarries* (DECC, 2008). Sediment basins and other water storages will not be located on overburden emplacement areas to reduce the potential for tunnel erosion.
- Structural erosion controls may be used on overburden emplacement areas if necessary until vegetation cover is sufficient to provide adequate erosion protection.
- In the larger drainage systems such as clean water drains and modified natural drainage systems, erosion control methods such as cross vanes, rock vanes and J-hook vanes will be used to provide channel bed and bank protection.

4.9.3 Drainage and Sediment Control Measures

Dirty water drains and contour banks will direct runoff from disturbed areas to sediment dams for treatment through sedimentation.

The general arrangement of the proposed drainage and sediment control structures is shown in the staged mine plans (see Section 3 of the Site Water Balance - Appendix A of the WMP). The proposed sediment dams are positioned between the active mining area and Back Creek to capture runoff from the overburden emplacement areas and other disturbed land.

All rehabilitated land where required will be shaped to geofluid design criteria. The geofluid design mimics natural slopes which are drained via rock lined channels into toe drains, which direct water to sediment dams. The water collected in sediment dams is either pumped back into the mine water management system, or discharged offsite (as described below). Water captured in the sediment control system may be released offsite at any time, provided water quality meets EPL conditions and is not required to supply the mine water management system.

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Sediment dam sizes will be based on the following design standards and methodology:

- “Type F” sediment basins consistent with SD 6-4 (page 6-19, Landcom 2004).
- Sediment basin spillway capacity of 50 year average recurrence interval (ARI) peak discharge (to provide a high level of immunity to protect against structural damage).
- Total sediment basin volume = settling zone volume + sediment storage volume. The sediment storage volume is the portion of the basin storage volume that progressively fills with sediment until the basin is de-silted. The settling zone volume is the minimum required free storage capacity that must be restored within 5 days after a runoff event.
- Sediment basin settling zone volume based on 90th percentile (wet conditions) 5-day duration rainfall (38.4 millimetre (mm)) with an adopted volumetric event runoff coefficient for disturbed catchments of 0.5 (note that the percentile referred to in the guidelines is for a 10% chance of exceedance).
- Sediment storage volume = 50% of settling zone volume.

Based on current design guidelines (Landcom 2004, DECC 2008), the sediment dams will be dewatered within 5 days after a runoff event to provide free storage capacity of at least the Settling Zone Volume. Pollutant concentration limits for oil and grease, pH and TSS have been specified in the EPL for discharge from sediment dams. Where pollutant concentrations in sediment dams after a runoff event are less than the limits specified in the EPL, basins may be dewatered to receiving waters. Where a pollutant exceeds the EPL limit, water in basins must be either:

- pumped into the mine water management system;
- pumped to another water storage with available capacity; or
- flocculated to reduce TSS to less than the EPL limit and discharged..

For rainfall events that exceed the design standard (38.4 mm in 5 days), it is possible that the sediment dams may overflow with TSS concentrations that exceed the water quality discharge limits of the EPL. Note however that such overflows are likely to occur during large rainfall events when background suspended solids concentrations in receiving waters are likely to be well above the water quality objective.

4.10 SURFACE WATER DESIGN OBJECTIVES AND PERFORMANCE CRITERIA SUMMARY

Table 6 provides a summary of design objectives and performance criteria for key aspects of surface water management at MCCM, as well as a description of how the various objectives will be achieved. Trigger levels for managing potential adverse surface water impacts are specified in Trigger Action Response Plans (TARPs) in the surface water response plan (see Section 5).

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Table 6 Summary of Surface Water Design Objectives and Performance Criteria

Feature	Design objective	Performance criteria	Achieved by
Mine Water Management System	No uncontrolled discharge of mine water	No uncontrolled discharges at Mine Water Dam spillway Mine Water Dam level maintained below MOV ^a during dry weather	Monitor Mine Water Dam level in accordance with monitoring plan Operate Mine Water Dam in accordance with Mine Water Containment TARP (Table 8)
Downstream Surface Water Quality	No adverse impact on downstream water quality	Receiving water quality below trigger levels	Monitor receiving water quality in accordance with monitoring plan Assess monitoring results and undertake impact assessment in accordance with Receiving Water Quality TARP (Table 9)
Erosion and Sediment Control	Effective control of erosion and sediment runoff in accordance with Landcom (2004) and DECC (2008) guidelines.	Compliance with EPL requirements for discharge from sediment dams	Manage land disturbance in accordance with principles of erosion and sediment control Operate and monitor sediment dams in accordance with Sediment Dams TARP (Table 10)
Stream Health	Maintain or improve stream health along receiving watercourses	No reduction in measures of stream health caused by mining	Comparative assessment of stream health following annual inspection
Flooding	No increase in inundation or erosion due to flooding	No community complaints regarding flooding. No visible change in inundation or erosion during flood events.	Mine infrastructure located outside Back Creek floodplain Undertake inspections and maintenance of mine infrastructure in accordance with Flooding TARP (Table 11)
Clean Water Management	Clean water capture and diversion in compliance with the WM act and project approvals	Clean water dams continually dewatered to receiving watercourse	Operate and maintain clean water management system in accordance with Clean Water Dams TARP (Table 12)

^a MOV = maximum operating volume

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5 SURFACE WATER TRIGGERS AND RESPONSE PLAN

Discharge water quality concentration limits from the site sediment dams are specified for MCCM in EPL 20221 and shown in Table 7. The 100th percentile concentration limits have been adopted as the trigger values for discharge water quality.

Table 7 Sediment dam discharge triggers

Parameter	100 th percentile
Oil and grease (mg/L)	10
pH	6.5-8.5
Total Suspended Solids (mg/L)	50

Trigger levels and contingency actions to respond to key aspects of the water management system performance are provided below for:

- MWD containment (Table 8);
- receiving water quality (Table 9);
- sediment dams (Table 10);
- flooding (Table 11); and
- clean water dams (Table 12).

Table 13 shows surface water quality impact assessment criteria that will be used as trigger values for assessing the surface water impacts from the Project on receiving watercourses. Exceedance of the trigger values will initiate an investigation to assess whether the identified exceedance has potentially been caused by the Project. Where insufficient local reference data is available to determine trigger levels, Australian New Zealand Environment Conservation Council (ANZECC) eco-system trigger values have been adopted. The adopted trigger values will be refined based on ongoing sampling.

Specific release water monitoring requirements for clean water discharges is discussed further in Section 6.5.

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Table 8 TARP - Mine Water Dam Containment

Level	Trigger	Action	Response
Level 1 (Normal)	Mine Water Dam stored volume < 340 ML (MOV)	Continue to monitor levels in accordance with monitoring plan	No response required
Level 2 (Early warning)	Current or forecast heavy rainfall (>25mm in 24 hour period).	- Ensure inter-dam transfer pumping network is operational - Review options for water transfer if required	Post-event review to confirm event was well managed with appropriate resources in place
Level 3A (Exceedance of trigger level)	Mine Water Dam stored volume exceeds 340 ML with inflows still occurring	- Reduce process inflows if practical - Commence transfer from Mine Water Dam to Pit Water Storage to maintain MOV	- Post-event review to confirm suitability of water transfer infrastructure & operational rules - Update operational rules if required - Prepare recommendations and implement modifications or upgrades to water transfer infrastructure
Level 3B (Possible discharge of mine water)	Mine Water Dam stored volume exceeds 473 ML (approximately 90% capacity) with inflows still occurring	- Cease process inflows to storages with highest risk of spill - Maximise pumping capacity for transfer from Mine Water Dam to Pit Water Storage (e.g. relocate mobile pumps)	- Post-event review to confirm suitability of water transfer infrastructure & operational rules - Update operational rules if required - Implement required modifications or upgrades to water transfer infrastructure
Level 4 (Discharge of mine water)	Discharge of mine water from one or more mine water storages	- Complete required actions under Pollution Incident Response Management Plan - Advise DPIE of spill - Collect water quality samples of spills at dam overflow point and upstream and downstream in receiving watercourse - Remediate any environmental harm	- Initiate investigation into reasons for system failure, including assessment of environmental harm - Take actions recommended by investigation to prevent recurrence

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Table 9 TARP – Receiving Water Quality

Level	Trigger	Action	Response
Level 1 (Normal)	All surface water quality samples below trigger levels in Table 13.	No action	Continue to monitor water quality in accordance with monitoring plan
Level 2 (Early warning)	Single value at downstream sampling site exceeds trigger level in Table 13.	- Verify sample analysis to confirm result - Check upstream water quality to assess potential for impact from operations - Advise DPIE of trigger exceedance	- If upstream pollutant concentration is higher or within 5% of downstream value, then no further action required - Otherwise, assess whether operation could potentially have affected water quality and take remedial action, if appropriate
Level 3A (Potential water quality impact – no discharge)	Two or more sequential samples at a downstream sampling site exceed trigger level in Table 13.	- Check upstream water quality to assess potential for impact from operations - Report on likely causes of exceedance and all reasonable and feasible mitigation measures - Advise DPIE of trigger exceedance	- If upstream pollutant concentration is higher or within 5% of downstream values then consider need for review of trigger levels - Implement appropriate mitigation measures after considering all reasonable and feasible options
Level 3B (Potential water quality impact – sediment dam discharge)	Water quality at multiple downstream sampling sites exceeds trigger levels in Table 13. and discharge from site sediment dams has occurred.	- Check upstream water quality to assess potential for impact from operations - Report on likely causes of exceedance and all reasonable and feasible mitigation measures - Advise DPIE of trigger exceedance	- If upstream pollutant concentration is higher or within 5% of downstream values then no further action required - Implement appropriate mitigation measures after considering all reasonable and feasible options
Level 4 (Likely water quality impact –mine water dam discharge).	Single value at downstream sampling site exceeds trigger level in Table 13 and discharge from mine water dam has occurred	- Complete required actions under Pollution Incident Response Management Plan - Check upstream and downstream water qualities to confirm any impact to water quality from operations - Remediate any environmental harm - Advise DPIE of trigger exceedance	- Complete detailed incident review to identify cause of water quality exceedance - Review systems and update procedures as required to prevent recurrence - Implement any other appropriate mitigation measures after considering all reasonable and feasible options

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Table 10 TARP – Sediment Dams

Level	Trigger	Action	Response
Level 1 (Normal)	No site runoff	Continue ongoing inspection and maintenance of sediment dams in accordance with monitoring plan	- No response required - De-silt sediment dam(s) if required
Level 2 (Early warning)	Current or forecast heavy rainfall (>25mm in 24 hour period).	- Ensure transfer pumping network is operational - Undertake inspection to check sediment accumulation	- Post-event review to confirm event was well managed - Check post-event sediment dam levels in sediment dams and de-silt if required
Level 3 (Sediment dam discharge)	Discharge from sediment dam within EPL limits	- Collect sample of sediment dam outflow - Confirm discharge complies with EPL water quality limits	- Post-event review to confirm rainfall exceeded design standard - Review system configuration to ensure operating as designed - Check post-event sediment levels in sediment dams and de-silt if required
Level 4 (Exceedance of water quality target)	Discharge from sediment dam exceeds EPL limits	- Complete required actions under Pollution Incident Response Management Plan - Check if event rainfall exceeds design standard - Notify DPIE if rainfall below design standard - Collect water quality samples of spills at dam overflow point and in receiving watercourse	- Check post-event sediment levels in sediment dams and de-silt if required - Initiate investigation into reasons for system failure, including assessment of environmental harm - Remediate any environmental harm - Take actions recommended by investigation to prevent recurrence

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Table 11 TARP – Downstream Flooding

Level	Trigger	Action	Response
Level 1 (Normal)	No site runoff	Annual (September) inspection of gauge sites on Back Creek and culverts on access road and rail spur	Arrange maintenance if required to ensure culverts are clear of sediment and debris and gauges are functional.
Level 2 (Early warning)	Current or forecast heavy rainfall (>25mm in 24 hour period).	Check gauge recorders on Back Creek are reporting correctly.	Post-event review to confirm gauges functioned correctly.
Level 3 (Flood event)	Namoi River at Boggabri exceeds Bureau of Meteorology Minor Flood level; or Recorded site rainfall of > 50 mm per day; or Recorded flow rate exceeds 5 m³/s in Back Creek	- Undertake site inspection including access road and rail spur to identify any flood damage - Make safe any areas of flood damage or major erosion on the mine site. - Prepare post-flood assessment report including: - details of recorded rainfall; - photographs of identifiable flood marks; and - photographs of identifiable changes in stream condition, such as areas of erosion or deposition.	- Post-event review to confirm gauges functioned correctly. - Review flood event trigger and revise up or down to reflect site experience.
Level 4 (Potential flood impact)	Flood event that causes identifiable damage or community complaint regarding flooding	- Complete actions under Level 3. - Review mining disturbance to assess whether mining operations could have contributed to flooding. - Review rainfall and flow data to assess whether mining activity is likely to have contributed to additional flooding. - Prepare a report documenting the investigation, outcomes and recommendations to prevent recurrence. - Advise complainant of outcome of assessment.	Take actions recommended by investigation to prevent recurrence

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Table 12 TARP – Clean Water Dams

Level	Trigger	Action	Response
Level 1 (Normal)	Clean water dams empty & no site runoff	Continue ongoing inspection and maintenance of clean water dams in accordance with monitoring plan	No response required
Level 2 (Early warning)	Current or forecast heavy rainfall (>25mm in 24 hour period).	- Ensure transfer pumping network is operational - Undertake daily inspection to identify whether runoff inflow has occurred.	Post-event check to confirm no clean water capture
Level 3 (Clean water discharge within water quality target)	Rainfall sufficient to generate runoff inflow to clean water dam resulting in discharge to Back Creek	- Commence clean water pumping as soon as practical - Collect sample of clean water discharge and Back Creek in accordance with clean water monitoring plan - Continue pumping until clean water dams are dewatered	- Post-event check to ensure clean water dams are fully dewatered - Review system configuration to ensure operating as designed - Confirm clean water discharge quality consistent with clean water discharge target - Record the volume of water captured and pumped from the dam - Record the volume of water that spilled from the dam to account against site Harvestable Rights or Water Access License
Level 4 (Clean water discharge exceeding water quality target)	Clean water discharge quality exceeds Back Creek receiving water trigger levels (Table 13) for parameters listed in Table 7: - pH 6.5 to 8.3 - TSS < 80 mg/L - Oil and Grease < 10 mg/L	- Stop pumping clean water dams - If the water quality in Back Creek during the event exceeds the water quality from the clean water discharge, releases can recommence - Treat the dam prior to re-commencing discharge - If the water cannot be treated, pump to the mine water management system	- Inspect the dams to determine potential source of pollutant - Review system configuration to ensure operating as designed - Review receiving water quality to determine any impact between upstream and downstream water quality - Initiate investigation into reasons for exceedance, including assessment of potential environmental harm - Take actions recommended by investigation to prevent recurrence - Record the volume of water pumped to the mine water management system to account against site Harvestable Rights or Water Access License

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Table 13 Receiving Water Quality Trigger Values

Parameter	Unit	ANZG Trigger Value				Recorded Baseline Data (80%ile)			Preliminary Trigger Value			Comment
		Irrigation	Livestock drinking	Eco-system ^d	Recreational	Maules Creek ^g	Back Creek ^h	Namoi River ⁱ	Maules Creek	Back Creek ^k	Namoi River	
pH	pH	-	-	6.5-8.5	5.0-9.0	7.4-8	7.2-8.3	8-8.6	6.5-8.0	6.5-8.3	6.5-8.6	Lower bound based on ANZG guideline for ecosystem protection, upper bound based on baseline data.
EC	µS/cm	1,000 ^a	-	125-2,200	-	432	243	668	430	250	670	Baseline data adopted. Rounded up to nearest ten.
DO (% sat)		-	-	85-110	-	no samples	no samples	no samples	85-110	85-110	85-110	Lack of baseline data, adopted lowest ANZG guideline.
TDS	mg/L	-	2,000 ^a	-	1000	272	267	377	300	300	400	Baseline data adopted. Rounded up to nearest hundred.
Turbidity	NTU	-	-	6-50	6	18	235	66	6-50	6-50	6-50	Lowest ANZG guideline adopted.
TSS	mg/L	-	-		-	25	80	62	30	80	70	Baseline data adopted. Rounded up to nearest ten.
Calcium (Ca)	mg/L	-	1,000	-	-	36	17	43	40	20	50	Baseline data adopted. Rounded up to nearest ten.
Sodium (Na)	mg/L	115 ^c	-	-	300	34	22	53	40	30	60	Baseline data adopted. Rounded up to nearest ten.
Magnesium (Mg)	mg/L	-	2,000 ^b	-	-	14	5	26	20	10	30	Baseline data adopted. Rounded up to nearest ten.
Sulphate (SO ₄)	mg/L	-	1,000	-	400	24	10	49	30	10	50	Baseline data adopted. Rounded up to nearest ten.
Chloride (Cl)	mg/L	175 ^c	-	-	400	37	19	61	40	20	70	Baseline data adopted. Rounded up to nearest ten.
Arsenic (As)	mg/L	0.1 ^f	0.5	0.013 ^{a,e}	0.05	0.001 ^j	0.0046	0.002	0.013	0.013	0.013	Lowest ANZG guideline adopted.
Barium (Ba)	mg/L	-	-	-	1	0.07	0.30	0.06	1	1	1	Lowest ANZG guideline adopted.
Cadmium (Cd)	mg/L	0.01 ^f	0.01	0.0002 ^e	0.005	0.0001 ^j	0.0001 ^j	0.0001 ^j	0.0002	0.0002	0.0002	Lowest ANZG guideline adopted.
Chromium (Cr)	mg/L	0.1 ^f	1	0.001 ^e	0.05	0.001 ^j	0.006	0.002	0.001	0.006	0.002	Baseline data adopted.
Copper (Cu)	mg/L	0.2 ^f	0.4 ^a	0.0014 ^e	1	0.002	0.007	0.005	0.002	0.007	0.005	Baseline data adopted.
Iron (Fe)	mg/L	0.2 ^f	-	-	0.3	0.8	9.9	1.9	0.8	10.0	1.9	Baseline data adopted. Rounded up to nearest tenth.
Lead (Pb)	mg/L	2 ^f	0.1	0.0034 ^e	0.05	0.001 ^j	0.005	0.001 ^j	0.0034	0.0034	0.0034	Lowest ANZG guideline adopted.
Manganese (Mn)	mg/L	0.2	-	1.9 ^e	0.1	0.09	0.5	0.1	0.1	0.1	0.1	Lowest ANZG guideline adopted.
Nickel (Ni)	mg/L	0.2 ^f	1	0.011 ^e	0.1	0.001 ^j	0.01	0.004	0.011	0.011	0.011	Lowest ANZG guideline adopted.
Zinc (Zn)	mg/L	2 ^f	20	0.008 ^e	5	0.018	0.03	0.015	0.02	0.03	0.02	Baseline data adopted. Rounded up to nearest hundreth.
Mercury (Hg)	mg/L	0.002 ^f	0.002	0.0006 ^e	0.001	0.0001 ^j	no samples	0.0001 ^j	0.0006	0.0006	0.0006	Lack of baseline data, adopted lowest ANZG guideline.
Ammonia	mg/L	-	-	0.9	0.1	0.03	0.046	0.03	0.03	0.05	0.03	Baseline data adopted.
Total phosphorus (Total P)	mg/L	0.05 ^f	-	0.025	-	0.18	0.28	0.15	0.2	0.3	0.2	Baseline data adopted. Rounded up to nearest tenth.
Total nitrogen (Total N)	mg/L	5	-	0.35	-	1.16	1.5	0.9	1.2	1.5	1	Baseline data adopted.
Nitrate as N	mg/L	-	400	0.7	10	0.3	0.1	0.2	0.7	0.7	0.7	Lowest ANZG guideline adopted.
Nitrite as N	mg/L	-	30	-	1	0.01	0.01	0.01	1	1	1	Lowest ANZG guideline adopted.

- No trigger value recommended
^a Lowest recommended value
^b Cattle (insufficient information on other livestock)
^c Sensitive crops
^d Upland River (>150 m altitude)
^e 95% of species protected
^f Long term trigger value
^g at SW1 and SW2
^h at SW3, SW4, SW9, SW10 and SW11
ⁱ at SW5, SW6, SW7 and SW8
^j Many samples under detection limit
^k Only 3 samples = lack of baseline data

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6 SURFACE WATER MONITORING PROGRAM

6.1 OVERVIEW

Monitoring of upstream, onsite and downstream water quality and quantity will assist in demonstrating that the site water management system is effective in meeting its objective of no adverse impact on receiving water quality and will allow for early detection of any impacts and appropriate corrective action.

The surface water monitoring program will:

- ensure compliance with the Maules Creek Mine environment protection licences and the BTM Complex WMS;
- provide valuable information on the performance of the water management system and for the validation of the site water balance model; and
- facilitate adaptive management of water resources on the site.

6.2 STANDARDS

Surface water monitoring will be undertaken in accordance with relevant Australian Standards, legislation and NSW Guidelines, including:

- Approved Methods for the Sampling and Analysis of Water pollutants in NSW (DEC, 2004); and
- Australian Standards/New Zealand Standards (AS/NZS) 5667.1:1998 Water Quality – Sampling – Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples.

6.3 MONITORING LOCATIONS, PARAMETERS AND FREQUENCY

A summary of the surface water quality and quantity monitoring program is provided in Table 14. Surface water sampling locations are shown in Figure 9.

Surface water monitoring at SW4, SW5, SW8 and SW9 (which are part of the BTM Complex WMS cumulative monitoring network) will be undertaken in accordance with the BTM Complex WMS. The water quality parameters included in the BTM Complex Monitoring Suite are provided in Table 15.

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Table 14 Surface Water Monitoring Summary

Monitoring location		Parameters	Frequency
On site		Rainfall	Continuous
Maules Creek	SW1, SW2	pH, EC, TSS, TDS, Turbidity	Once during flow events
		Table 15	Monthly if flowing
Namoi River	SW5, SW8	Flow	Continuous
		BTM Complex monitoring suite	Quarterly (+ once during flow events)
	SW6, SW7	pH, EC, TSS, TDS, Turbidity	Monthly
Back Creek	SW4, SW9,	BTM Complex monitoring suite	Quarterly (+ once during flow events)
	SW9, SW10,	Flow	Continuous
	SW11, SW12	Flow Table 15	Continuous Once per discharge event from the clean water dams
	SW3, SW10	Table 15	Once during flow events
Site Clean Water Discharge Points	See Section 6.5		
Mine Water Dam		Table 15	Quarterly
Raw Water Dam & sediment dams		Table 15	Quarterly
Sediment dam overflows		pH, EC, TSS, TDS, Turbidity + Oil & grease	Daily during overflows
In-pit or emplacement seepage flows		Table 15	Quarterly
Emplacement seepage		Table 15	Quarterly
MWD, RWD		Water level	Weekly
HWD and WCWD		Water level, flow rate pH, EC, TSS, TDS, Turbidity + Oil & grease	Continuous Daily during discharge events
Site water use		Water volume pumped from river & bores Make up water delivered to CHPP Water used for dust suppression	Continuous

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Table 15 Receiving Water Quality Parameters to be Sampled

Parameter	Units
pH (field & lab)	-
Turbidity	NTU
EC (field & lab)	µs/cm
Total Dissolved Solids	mg/L
Iron (Fe) - dissolved and absorbed	mg/L
Sulphate as SO ₄ ²⁻ - Turbidimetric	mg/L
Bicarbonate Alkalinity as CaCO ₃	mg/L
Carbonate Alkalinity as CaCO ₃	mg/L
Hydroxide Alkalinity as CaCO ₃	mg/L
Total Alkalinity as CaCO ₃	mg/L
Chloride	mg/L
Calcium	mg/L
Magnesium	mg/L
Sodium	mg/L
Potassium	mg/L
Aluminium	mg/L
Arsenic (filtered)	mg/L
Barium (filtered)	mg/L
Boron (filtered)	mg/L
Bromine (filtered)	mg/L
Cadmium (filtered)	mg/L
Copper (filtered)	mg/L
Iron (filtered)	mg/L
Lead (filtered)	mg/L
Lithium (filtered)	mg/L
Manganese (filtered)	mg/L
Nickel (filtered)	mg/L
Rubidium (filtered)	mg/L
Selenium (filtered)	mg/L
Silver (filtered)	mg/L
Strontium (filtered)	mg/L
Zinc (filtered)	mg/L
Ammonia as N	mg/L
Nitrite as N	mg/L
Nitrate as N	mg/L
Nitrite + Nitrate as N	mg/L
Total Phosphorus as P	mg/L

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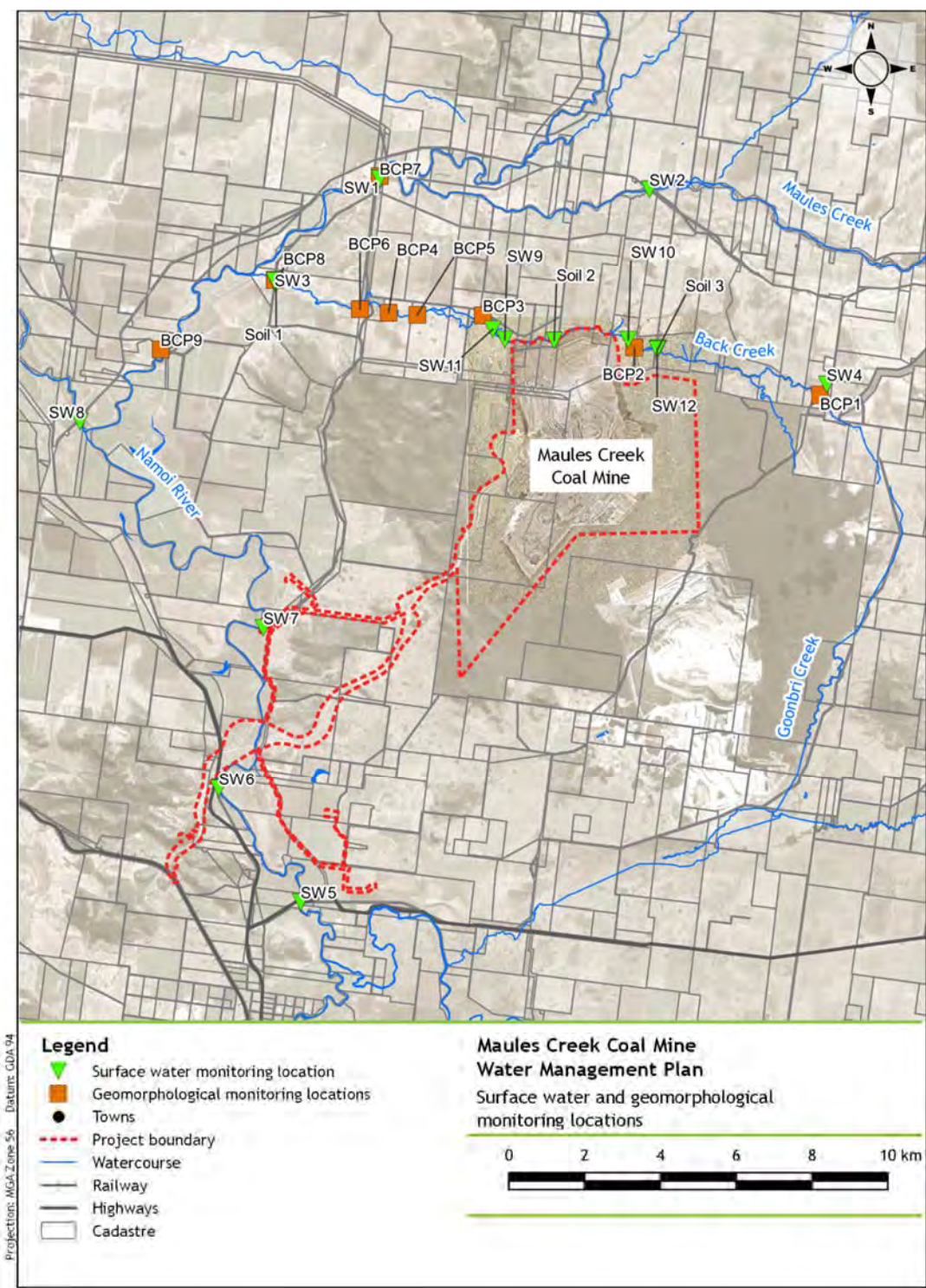


Figure 16 Surface Water Monitoring Locations

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6.4 STREAM HEALTH

Stream and riparian vegetation health will be monitored against the guidelines and standards set out by the Australian River Assessment System: AusRivAS Protocols Development and Testing Report (Final Report) (Water ECOscience Pty Ltd 2002).

The Australian River Assessment System (AusRivAS, Turak et al. 2004) is a nationally standardised approach to biological assessment of stream and riparian environments. It involves a bioassessment using aquatic macroinvertebrates and a complementary physical/chemical assessment to assess the overall ecological health of streams and riparian habitats.

The AusRivAS bioassessment is underpinned by predictive modelling that predicts the aquatic macroinvertebrate fauna assemblage and abundance expected to occur at non-stressed sites. The deviation between the number of taxa expected to occur and the number of taxa that were actually observed (observed:expected ratio, or O/E) is a measure of the ecological health of a stream and riparian environment. The degree to which the number, or type, of taxa collected at a test site deviates from predicted values provides insight on how the water quality or habitat conditions are limiting the biological potential of the site. The O/E ratio ranges from 0 to > 1 and represents a continuum of ecological condition. For ease of interpretation, the continuum can be broken into condition bands that delineate an ecological condition that is impoverished, well below reference, below reference, reference, and richer than reference.

The fundamental assumption behind AusRivAS is that the physical and chemical factors measured at any site are directly related to the number and/or type of macroinvertebrates observed. For this reason, the AusRivAS assessment includes a physical, geomorphological and chemical assessment of the physical condition of the stream environment. Site parameters typically measured include a mixture of the following: geographical position, riparian vegetation, channel morphology, water chemistry, habitat composition, habitat characteristics, organic substratum, inorganic substratum and hydrology (Table 4.11). The AusRivAS physical and chemical assessment uses software that compares site values against predicted values for reference sites. When examined alongside the results of the bioassessment, these results provide an indication of the causes of biological degradation of a stream and riparian environment.

6.4.1 Revised Trigger Action Response Plans (TARPs)

The following triggers for stream and riparian health are included in the 2019 WRP:

- A reduction in O/E scores, such that a site registers in a lower condition band than previously recorded
- Any community complaints relating to adverse impacts on stream and riparian vegetation health
- Visible/observable reduction in stream and riparian vegetation health.

These three triggers are difficult to quantify given the data collected during monitoring (Cumberland Ecology 2015-2020), and they should be replaced with more specific criteria. The O/E scores developed from AUSRIVAS modelling are an unreliable indication of biological condition (Chessman 2021).

The revised triggers for stream health and riparian vegetation are given in Table 16. In applying the triggers, it is important to consider the following when interpreting monitoring results:

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- Natural flow variability of Back Creek and Maules Creek. The indices used as triggers will be affected by the natural wetting and drying regime that occurs in ephemeral creeks, so the interpretation of monitoring results should occur in the context of creek hydrological phase.
- Weather or climatic events that may contribute to apparent declines in ecological function, such as increased turbidity following rainfall events.

Additional surveys and sampling for groundwater dependent vegetation communities, and for stygofauna are planned for spring and summer 2022. Once these have been completed and the extent of these groundwater dependent ecosystems determined, additional TARPS will be determined for these if necessary.

Bi-annual monitoring of sites will yield bi-annual data from which change in stream and riparian vegetation health can be measured over time. The following trigger values have been adopted:

- Univariate analysis of macroinvertebrate indices (EPT, Taxonomic Richness and Signal scores)
- Multivariate analyses of invertebrate communities
- Any community complaints relating to adverse impacts on stream and riparian vegetation health;
- Stream and riparian vegetation health will be assessed by:
 - Normalised Vegetation Index (NDVI); and
 - Assessment of the Melaleuca Bracteata riparian shrubland by site observation of recruitment (saplings <10 cm tall), flowering individuals, signs of stress and signs of scouring around the roots

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Table 16 TARP – Stream Health

Level	Trigger	Action	Response
Level 1 (Normal)	Taxonomic richness, SIGNAL Score, EPT Score, AND invertebrate communities at sites downstream of the mine are all similar to sites upstream of the mine	Continue monitoring in accordance with monitoring plan	No response needed
Level 2 (Early warning)	Some of the above ecological indices are within ranges that are similar to sites upstream of the mine	Review existing water quality (Dissolved Oxygen, Electrical Conductivity, pH, turbidity) and flow data to see if there is a reason for loss of diversity or sensitive taxa. Inspect sediment control devices for proper function, inspect drainage lines for signs of erosion. Repair as needed. Continue monitoring in accordance with plan.	Visual inspection of sediment devices to ensure proper function. Assess follow-up monitoring data for improved condition.
Level 3 (Exceedance of trigger level)	Taxonomic richness, SIGNAL Score, EPT Score, or invertebrate communities at sites downstream of the mine are significantly less than (or outside the range of one standard deviation of) those sites upstream of the mine.	Review water quality data, flow data, and other site-specific information to see if there is a non-mining related explanation for the decline (e.g. drought, seasonal patterns). If not, examine sediment control structures and other infrastructure that may contribute to poorer macroinvertebrate communities.	Visual inspection of sediment devices to ensure proper function. Assess follow-up monitoring data for improved condition.

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Table 17 TARP – Riparian Vegetation

Level	Trigger	Action	Response
Level 1 (Normal)	There is no decline in NDVI for riparian vegetation along Back Creek between survey periods. Diversity in tree and shrub layers, as measured in BAM plots at Back Creek sites, remain consistent through time	Continue monitoring in accordance with monitoring plan Continue monitoring in accordance with monitoring plan	No response needed No response needed
Level 2 (Early warning)	There is a moderate decline in NDVI at some sites along Back Creek, but not all There is a decline in vegetation diversity in shrub and tree layers at some sites along Back Creek.	Compare to field-based assessments such as BAM and RARC and site photos. Review localised groundwater level and water quality data and creek gauging data. Consider supplementary watering of vegetation if necessary. Continue monitoring in accordance with monitoring plan Review groundwater level and water quality data and creek gauging data. Consider supplemental watering if necessary. Continue monitoring in accordance with monitoring plan	Assess follow-up NDVI data for improvement. Review follow-up monitoring data for signs of improvement and increased health in vegetation, including recruitment of shrub and tree species.
Level 3 (Exceedance of trigger level)	There is a severe decline in NDVI at some or all sites along Back Creek There are indications of stress and a lack of recruitment in riparian vegetation communities. Death of several individual trees or shrubs.	Examine BAM data. Review water quality data from groundwater and surface water monitoring programs. Consider supplemental watering. Remediate riparian zone once cause of deaths have been determined and addressed. Review water quality data from groundwater and surface water monitoring programs. Consider supplemental watering. Remediate riparian zone once cause of deaths have been determined and addressed.	Continue monitoring. Follow up assessments on rehabilitation and remediation Continue monitoring. Follow up assessments on rehabilitation and remediation

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6.5 CLEAN WATER DISCHARGE MONITORING

6.5.1 Clean Water Release Infrastructure Details

The release of clean water from the HWDs and the WCWD will be operated in accordance with the released criteria in the EPL, with the aim of maximising the volume of clean water diverted through these diversion systems.

The location of the flow meters, water level sensors and pump for each release location is provided in Table 18, Figure 14 and Figure 15. The flow meters will be located on the pump outlet for each dam to measure flows individually.

Table 18 Clean Water Discharge Flow Meter Water Level Sensor and Pump Locations

Release source	Easting (m) GDA95 Z55	Northing (m) GDA95 Z55
HWD8	226,366	6,613,684
HWD9	226,693	6,614,157
HWD10	226,769	6,614,410
HWD11	226,739	6,615,467
WCWD	224,003	6,615,878

6.5.2 Clean Water Release Monitoring

Clean water discharged from the clean water management systems (HWDs and WCWD) will be monitoring during each release event, as follows:

- At least one sample during the release will be taken from each dam, for the water quality parameters sampled identified in Table 7.
- At least one sample during the release will be taken in Back Creek at locations upstream and downstream of the clean water discharge point, for the water quality parameters sampled identified in Table 14.

Automated samplers will be installed in the new monitoring stations at “SW11” and “SW12” (see Figure 16). The ability to obtain these samples within water quality testing holding times may be subject to access limitations during the event.

Following each event, the discharge and Back Creek receiving water quality results will be assessed against the trigger values identified in Table 7 and Table 13. This may trigger further investigations to assess any potential impacts from the clean water release during the event.

The results of the water quality monitoring data will be reported quarterly on the publicly available MCCM website.

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6.6 STREAMFLOW MONITORING

MCCM currently operate two stream flow gauges in Back Creek, at locations both upstream and downstream of the sediment water and clean water release points (SW9 and SW10 – see Figure 19). An additional two stations are installed at Upstream Flow and Downstream Flow. Refer to Figure 16 for the map showing the locations of the stream flow gauges.

Water level loggers have been installed at each stream gauge location and a rating curve for each site has been derived using the HEC-RAS hydraulic model and surveyed channel cross-sections. The surveyed cross-section locations at SW9 and SW10 are shown in Figure 19. Details of the development of the rating curves are provided in a separate report (WRM 2020).

The rating curves developed for SW9 and SW10 are shown in Figure 17 and Figure 18, respectively. Rating curves will be developed for stations Upstream Flow and Downstream Flow as part of their installation. Annual surveys of the stream bed will be undertaken at each stream gauge and used to review the rating curves and gauge calibration. The survey data will provide a time series of how the stream bed changes over time in response to varying climatic conditions.

Details of the instrumentation and post-processing methodology used to record stream water levels is provided in Addendum 2.

Two new stream flow gauges have been recently installed on Back Creek (SW11 [downstream] and SW12 [upstream]). See Figure 16 for their locations.

They are currently in the process of being commissioned and rated. Once this is complete, this WMP will be updated to include the rating curves and details of the instrumentation.

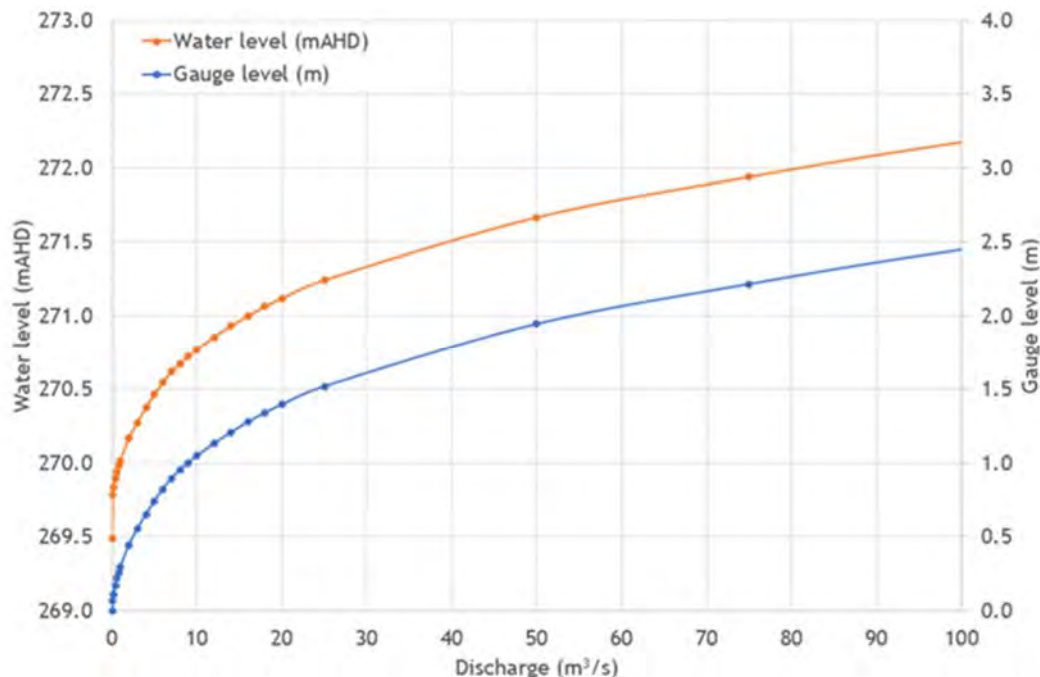


Figure 17 Rating Curve for SW9 Stream Gauge

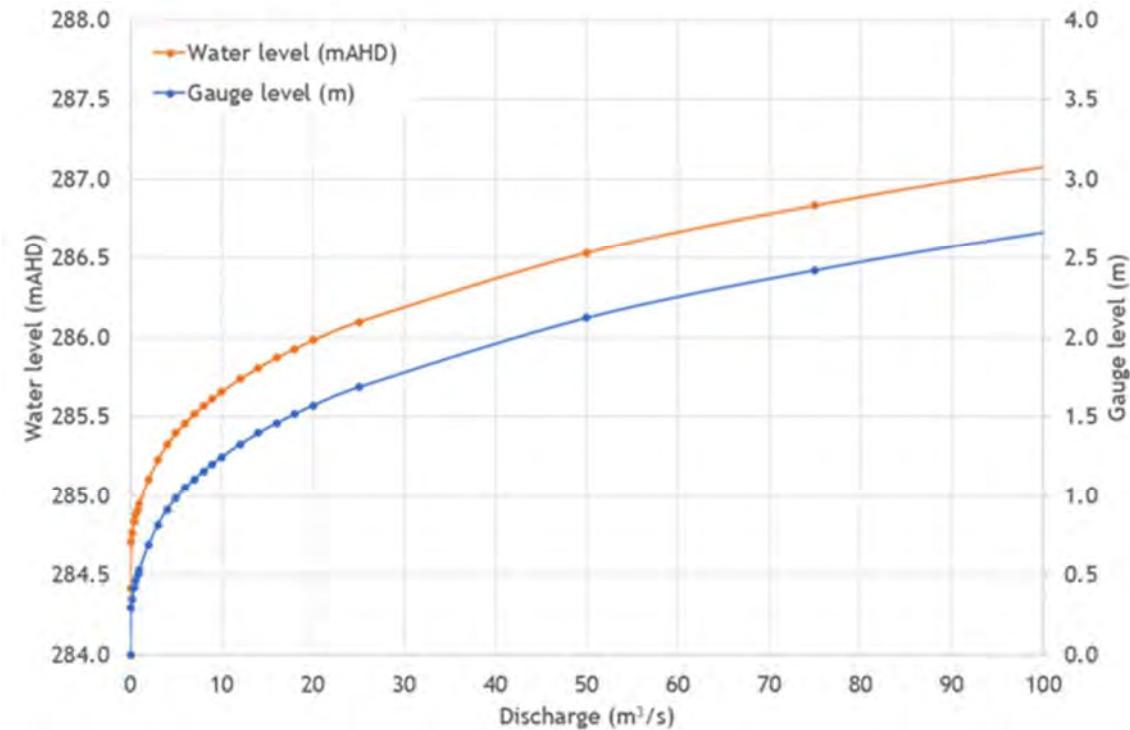


Figure 18
Rating Curve for SW10 Stream Gauge

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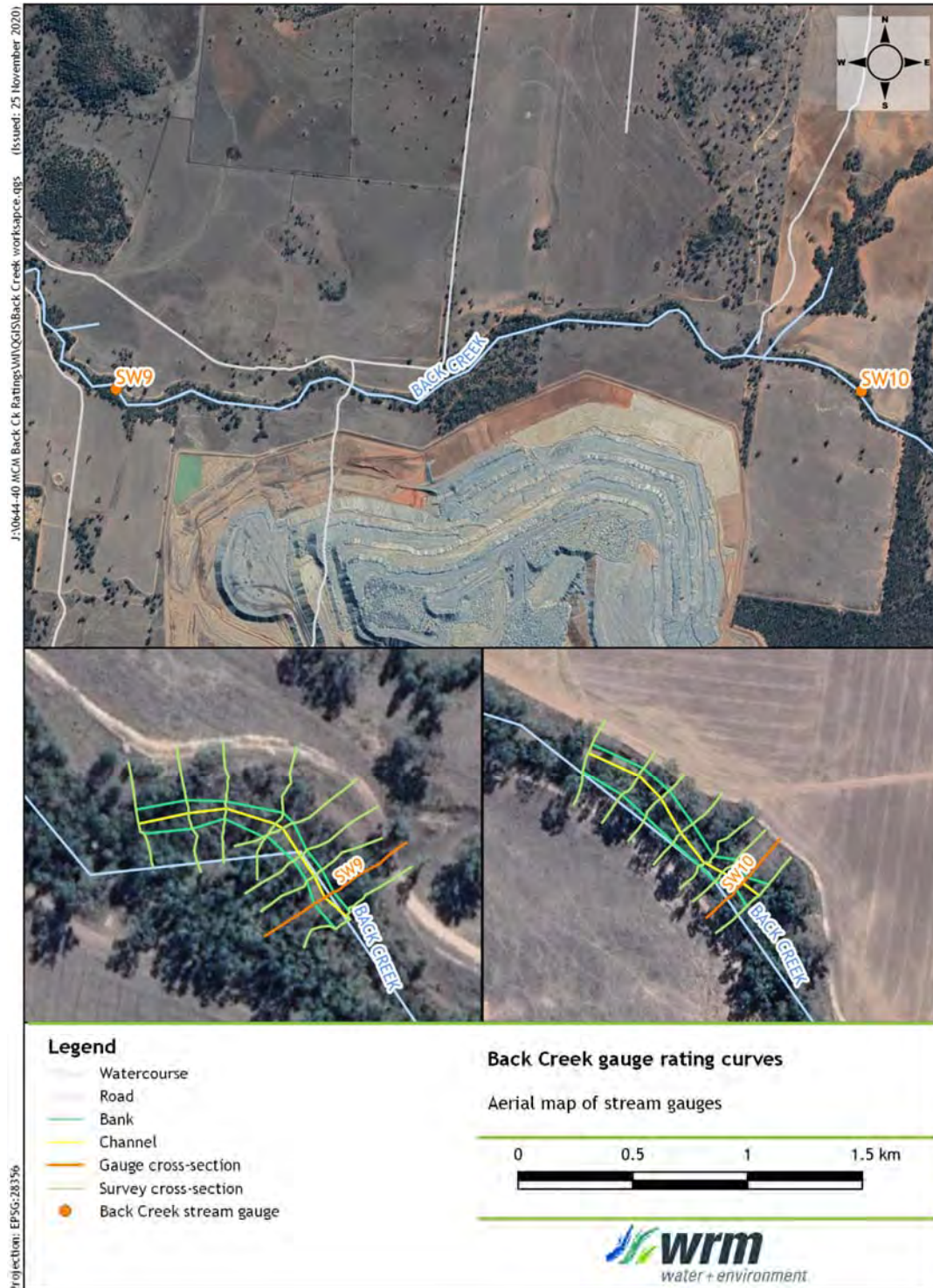


Figure 19 Stream Flow Gauge Locations

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6.7 SHALLOW SOIL AND ROCK MOISTURE CONTENT MONITORING

Multi-level monitoring and reporting of shallow soil and rock moisture content will be undertaken at three locations within the main stream bank of Back Creek. The locations selected allow for monitoring of soil moisture upstream and downstream of the mine. Each location is located within a different geological unit traversed by the creek (sedimentary, volcanic and alluvial). Each location will record daily-average soil moisture at 0.5m, 1.5m, 3m and 6m depths.

The soil moisture records will be reviewed as part of surface water and groundwater model calibration where appropriate.

Table 19 documents the location and equipment type installed at each location. The location of the monitoring locations is shown in Figure 16.

Table 19 Soil Moisture Sensor Details

Site	Location	Sensor	Description
Soil 1	217244.00 m E, 6619868.00 m S	E-State Cellvisor	- Soil moisture sensors @ 0.5, 1.5 m, 3 m, 4.5 m, 6 m depth using Acclima TDR 310H integrated time domain reflectometer sensors - HyQuest TB4 tipping bucket raingauge 0.2mm tip
Soil 2	224583.00 m E, 6618381.00 m S	E-State Cellvisor	- Soil moisture sensors @ 0.5, 1.5 m, 3 m, 4.5 m, 6 m depth using Acclima TDR 310H integrated time domain reflectometer sensors - HyQuest TB4 tipping bucket raingauge 0.2mm tip
Soil 3	227327.00 m E, 6618174.00 m S	E-State Cellvisor	- Soil moisture sensors @ 0.5, 1.5 m, 3 m, 4.5 m, 6 m depth using Acclima TDR 310H integrated time domain reflectometer sensors, - HyQuest TB4 tipping bucket raingauge, 0.2mm tip

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7 REPORTING AND REVIEW

Details of the processes for reporting the results of the monitoring program and review of the WMP are provided in Sections 4 and 5 of the WMP.

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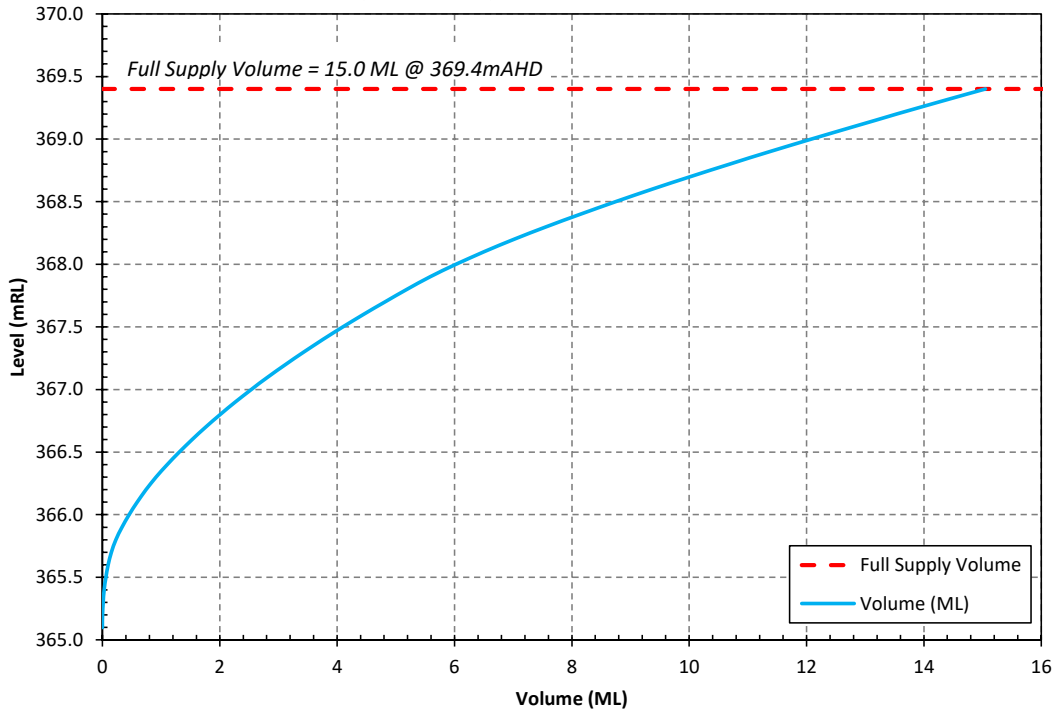
8 REFERENCES

Eco Logical Australia, 2021	Review of Maules Creek Coal Mine Stream Health Monitoring, 30 November 2021.
DECC, 2008	Managing Urban Stormwater, Soils and Construction, Volume 2E Mines and Quarries, Department of Environment and Climate Change, June 2008.
Landcom, 2004	Managing Urban Stormwater, Soils and Construction
Turak, E., Waddell, N., and Johnston, G., 2004	New South Wales (NSW) Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual 2004. Department of Environment and Conservation, Sydney, NSW, Australia.
WRM, 2020	Back Creek Rating Curves – 2020

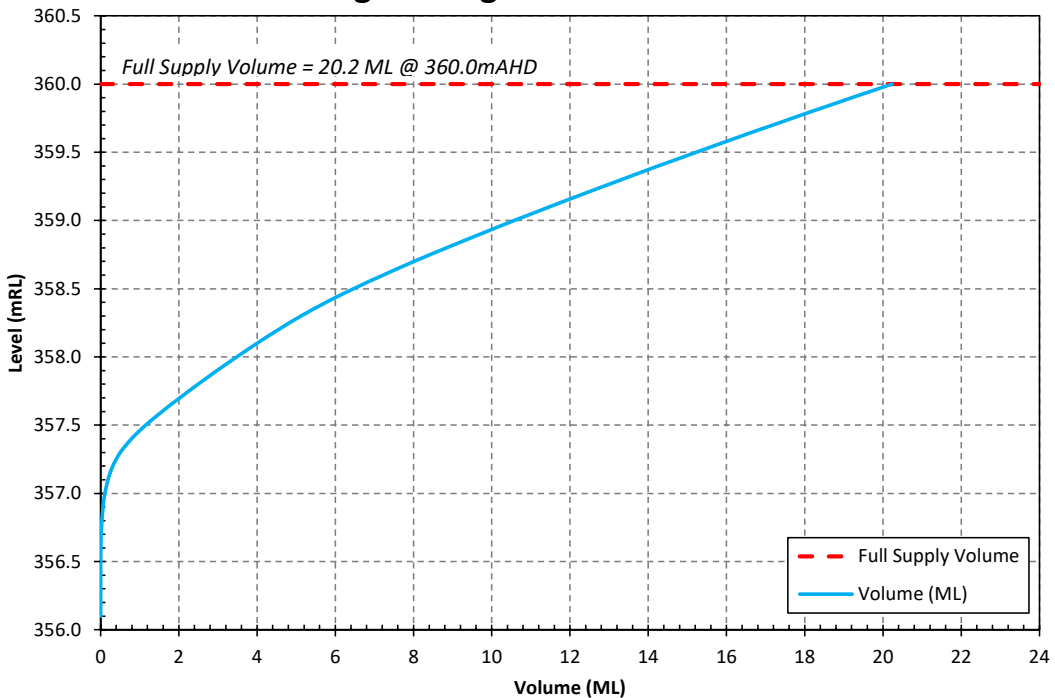
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ADDENDUM 1 – CLEAN WATER DAM STORAGE CURVES

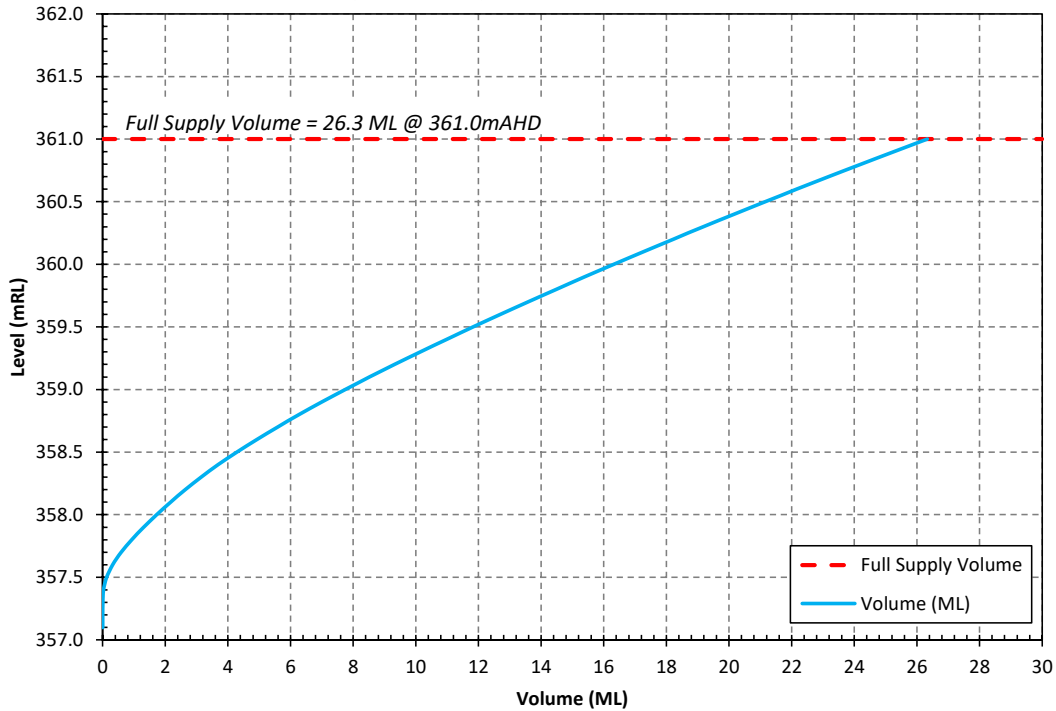
Stage Storage Curve - HWD8



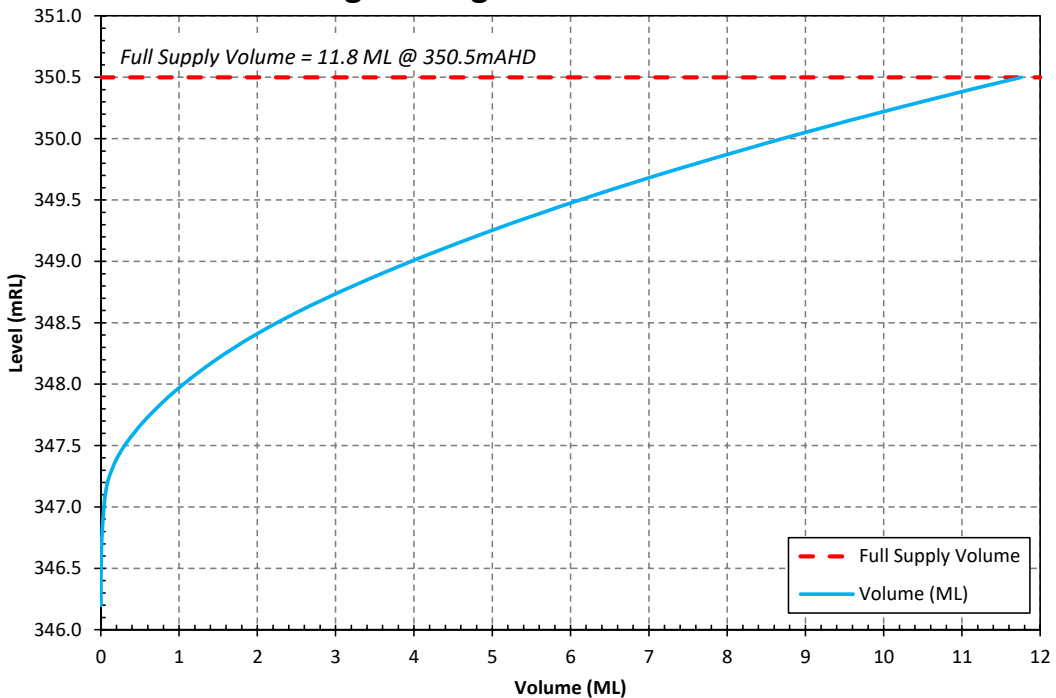
Stage Storage Curve - HWD9



Stage Storage Curve - HWD10



Stage Storage Curve - HWD11



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ADDENDUM 2 – DETAILS OF STREAM WATER LEVEL RECORDING INSTRUMENTATION

Site	Datalogger/telemetry	Principal sensor array
Upstream Flow 226771.00 m E, 6618197.00 m S	Mace Flopro system	- Doppler ultrasonic area velocity sensor with ceramic diaphragm depth sensor - YSI Prosample P automatic water sampler
Downstream Flow 222961.00 m E, 6618674.00 m S	Mace Flopro system	- Doppler ultrasonic area velocity sensor with ceramic diaphragm depth sensor - YSI Prosample P automatic water sampler
MC WS09 MC WS09: 223280.00 m E, 6618403.00 m S	E-State Automation Cellvisor	Solinst Aquavent: atmospheric pressure vented cable, Piezoresistive Silicon with Hastelloy pressure sensor
MC WS10 MC WS10: 226536.00 m E, 6618400.00 m S	E-State Automation Cellvisor	Solinst Aquavent: atmospheric pressure vented cable, Piezoresistive Silicon with Hastelloy pressure Sensor

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APPENDIX 3 GROUNDWATER MANAGEMENT PLAN

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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

This document presents the Groundwater Management Plan (GWMP) for Maules Creek Coal Mine (MCCM), also referred to as the Project. The GWMP outlines the groundwater data collection/analysis methods, performance measures, trigger thresholds and Trigger Action Response Plans (TARPs).

1.2 STRUCTURE OF THE GROUNDWATER MANAGEMENT PLAN

This GWMP forms part of the Water Management Plan (WMP) for MCCM. The MCCM WMP comprises the following documents:

- An overarching WMP;
- Site Water Balance (Appendix A);
- Surface Water Management Plan (Appendix B);
- GWMP (this document) (Appendix C);
- Boggabri-Tarrawonga-Maules Creek Complex (BTM Complex) Water Management Strategy (Appendix D).

The following sections of the GWMP describe:

- Section 2 - Statutory obligations under the project approval;
- Section 3 – Summary of groundwater regime;
- Section 4 – Groundwater monitoring network;
- Section 5 – Data collection methodology;
- Section 6 – Data analysis methods;
- Section 7 – Summary of baseline data;
- Section 8 – TARPs;
- Section 9 – Cumulative impacts and monitoring locations;
- Section 10 – Groundwater model validation;
- Section 11 – Reporting procedures;
- Section 12 – Final void water management; and
- Section 13 – References.

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2 STATUTORY OBLIGATIONS

The Maules Creek Coal Project (Application no. 10_0138) was approved by the Minister for Planning and Infrastructure under Section 75J of the Environmental Planning & Assessment Act 1979 on 23 October 2012.

Condition 40 of Schedule 3 of the approval (Environmental Performance Conditions) requires the Proponent to prepare and implement a WMP for the Project, which includes a GWMP. The requirements for the GWMP, and where each requirement is addressed in this document, are provided in Table 2-1.

Table 2-1 GWMP requirements from Project Approval (PA) 10_0138

Requirement for Groundwater Management Plan	Section of GWMP Where Addressed
Detailed baseline data of groundwater levels, yield and quality in the region, and privately-owned groundwater bores including a detailed survey/schedule of groundwater dependent ecosystems (including stygo-fauna and Melaleuca riparian forest communities), that could be affected by the project;	Section 3, Section 5 and Section 7
The monitoring and testing requirements specified in the Planning Assessment Commission (PAC) recommendations for groundwater management as set out in Appendix 6;	Section 12
Detailed plans, including design objectives and performance criteria, for the design and management of:	
the proposed final void; and	Section 12
coal reject and potential acid forming material emplacement;	Section 12
Groundwater assessment criteria including trigger levels for investigating any potentially adverse groundwater impacts;	Section 8.1, Section 8.2 and Section 8.3
A program to monitor and assess:	
groundwater inflows to the open cut mining operations;	Section 5.4 and Section 6.3
the seepage/leachate from water storages, emplacements, backfilled voids and the final void;	Section 4
interconnectivity between the alluvial and bedrock aquifers;	Section 4
background changes in groundwater yield/quality against mine-induced changes;	Section 4
- the impacts of the project on: - regional and local (including alluvial) aquifers; - groundwater supply of potentially affected landowners; - groundwater dependent ecosystems (including potential impacts on stygofauna and Melaleuca riparian forest communities) and riparian vegetation;	Section 4

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Requirement for Groundwater Management Plan	Section of GWMP Where Addressed
A program to validate the groundwater model for the project, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions; and	Section 10
A plan to respond to any exceedances of the performance criteria.	Section 8.3

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3 SUMMARY OF GROUNDWATER REGIME

3.1 HYDROSTRATIGRAPHIC UNITS

The hydrogeological regime in the MCCM region consists of the following hydrostratigraphic units¹:

- Quaternary alluvium associated with river and creek flood plains that form productive aquifer systems, typically in deeper and coarser grained sediments;
- Weathered bedrock (regolith) that is generally unsaturated in the mining areas, but acts as a temporary water store and pathway during sustained wet periods;
- Permian conglomerate/sandstone/siltstone/shale interburden that act as an aquitard;
- Permian coal seams of the Maules Creek Formation that form a low yielding aquifer; and
- Permian Boggabri Volcanics that typically acts as an aquiclude/aquitard.

3.2 QUATERNARY ALLUVIUM

Quaternary alluvial deposits are associated with floodplains that surround the Permian outcrop, which contains the MCCM footprint. These contains:

- Maules Creek, Middle Creek and Horsearm Creek alluvium to the north;
- Bollol Creek, Driggle Draggie Creek, and Barneys Spring Creek alluvium to the south; and
- Namoi River alluvium to the west.

The alluvial deposits have two stratigraphic units, the basal Gunnedah Formation and the overlying Narrabri Formation. The Narrabri Formation is up to 70 metres (m) thick and is comprised of clayey flood deposits with interbedded sand and gravel, which typically form low to moderate yielding aquifers. The underlying Gunnedah Formation is a productive aquifer used for irrigation, being up to 115 m thick and is dominated by more porous sand and gravel deposits that fill paleo-channels. Finer grained sediments in the Narrabri Formation can act as a concentration and storage zone for salts with water quality varying from fresh to saline. The coarser sediments in the underlying Gunnedah Formation generally contain high quality and low salinity groundwater. A deeply incised paleo-channel, up to 125 m deep which forms a high yielding aquifer is present to the west of the MCCM aligned with the course of the Namoi River. The alluvial material thins in the Maules Creek and Bollol Creek flood plains to the north and south of the MCCM. The alluvial aquifers exhibit variable groundwater yields of between 0.1 litres per second (L/s) and 33 L/s.

¹ A hydrostratigraphic unit is defined as a part of a body of rock that forms a distinct hydrologic unit with respect to the flow of groundwater.

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3.3 PERMIAN BEDROCK

The bedrock underlying the alluvial aquifers outcrops as distinctive, sometimes rugged hills surrounded by the generally flat to gently sloping plains of the Namoi Valley alluvium. The weathered zone is about 25 m in thickness and is sometimes up to 60 m thick within the MCCM where the water table is deeper. The shallow bedrock is generally dry in the elevated areas of the Leard State Forest, however acts as a temporary groundwater store during continued wet periods and provides a pathway for recharge into the underlying fresh rock. The Permian strata can be categorised into the following hydrogeological units:

- hydrogeologically “tight” and hence very low yielding non-coal interburden units that comprise the majority of the Maules Creek Formation strata;
- low to moderately permeable coal seams, which are the prime water bearing strata within the Maules Creek Formation; and
- the underlying Boggabri Volcanics that act as a low permeability basement to the overlying sedimentary units.

The Permian sedimentary deposits are part of the Maules Creek sub-basin that occurs east of the Namoi River and has a regular layered easterly to north-easterly dipping sedimentary sequence which is underlain by the Boggabri Volcanics. The basal Boggabri Volcanics outcrop to the west of the MCCM and the other mines within the BTM complex. The BTM complex is located at the western edge of the Maules Creek sub-basin and therefore coal measures do not occur west of the mining areas where the Boggabri Volcanics bedrock outcrops.

3.4 RECHARGE, DISCHARGE AND RECEPTORS

Recharge to the hydrostratigraphic units occurs through diffuse rainfall recharge, as well as seepage through creek and river beds when flowing. Discharge from the groundwater systems occurs through multiple mechanisms including baseflow to river/creeks (mainly the Namoi River), through water supply bores and via evapotranspiration in areas where shallow water tables promote this process.

Groundwater dependent assets in the area are water supply bores used by surrounding agricultural enterprises and high priority groundwater dependent ecosystems, mainly located in riparian areas along creek lines where the water table is relatively shallow.

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4 GROUNDWATER INFRASTRUCTURE

4.1 EXISTING MONITORING NETWORK

The monitoring infrastructure at MCCM and surrounds include standpipe bores and vibrating wire piezometers (VWP) installed in a series of campaigns since 2010. Monitoring infrastructure for each campaign are numbered with the following prefixes:

- 'MAC' series;
- 'RB' series;
- 'REG' and 'BCM' series; and
- 'GW' bores.

The locations and status of the monitoring network infrastructure are shown in Figure 4-1, with the target geology for each site shown on Figure 4-2. Table 4-1 summarises the details and purpose for each monitoring site in the network.

The 'MAC' series was established around the MCCM footprint in 2010 to gather information on the groundwater regime for the environmental assessment of the mine. This baseline data was used to develop and calibrate a numerical model to predict mining impacts on the groundwater regime. The bores were installed within former exploration holes, with a total of eight groundwater monitoring bores and four VWPs constructed. All of the 'MAC' series monitoring bores and VWPs were damaged or destroyed by the progress of mining, or by protestors, with the exception of standpipe bore MAC1280 which remains active. The MAC1280 monitoring bore is now located immediately to the east of the out of pit waste rock dump.

The 'RB' series of bores was designed to replace the 'MAC' series. The locations of 'RB' and 'REG' bores were discussed with and approved by NSW Office of Water (Tamworth office) prior to installation between October 2013 and February 2014. The 'RB' series comprises three groundwater monitoring bores and five multi-level VWPs. Two of the locations (RB01 and RB02) were constructed in the Maules Creek mining footprint and were removed during mining activities in early 2017.

The 'REG' series comprises twelve regional groundwater monitoring bores and six multi-level VWPs designed to detect cumulative impacts in the alluvial aquifers surrounding the BTM Complex. Of these monitoring locations, BCM1, BCM3 and REG10A were installed along Back Creek to assess the potential for shallow groundwater and the presence of groundwater dependent ecosystems.

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The NSW Department of Planning, Industry and Environment - Water (DPIE Water) maintain a network of monitoring bores within the Namoi alluvium that surrounds MCCM. The purpose of these bores is to monitor groundwater levels and quality within the Narrabri and Gunnedah Formations. These bores all have the prefix 'GW'. A subset of the 'GW' bores have been monitored routinely since the mid-1970s providing a long record of groundwater fluctuations. Some of the bores have electronic water level loggers and are equipped with telemetry with real time datasets available online². 'REG' bores have been strategically located adjacent to selected 'GW' series monitoring bores to create a pair of nested monitoring points that allow the water level trends within the alluvium and underlying bedrock to be recorded and compared, and the potential influence of mining areas assessed.

It should be noted that the 'REG' series monitoring bores were originally intended to form part of the BTM complex regional monitoring network. As these bores were located well beyond the mining areas, the intention was they would allow any cumulative impacts that propagated via the Permian and into the overlying alluvium to be detected and assessed. Since inception MCCM has taken responsibility for monitoring the REG series of bores. While this was not the original intention, for consistency the steps to investigate exceedance events, i.e. the TARPs, have been retained within the MCCM GWMP and are provided in Section 8.3. In the case where exceedances are due to other mines the TARPs provide a process for evaluating cumulative impacts from the BTM complex.

4.2 ADDITIONAL MONITORING NETWORK

To expand the MCCM monitoring network, additional standpipe monitoring bores will be installed at the locations identified in Table 4-1 and Figure 4-2. The bores are planned to be installed by the end of Financial Year (FY) 2022 and will be monitored for groundwater level and quality as indicated in Table 4-1. The purposes of the additional bores are to:

- improve the monitoring network coverage within the alluvial deposit along Maules Creek (REG15 / REG15A and REG16 / REG16A);
- improve the pore pressure monitoring network within the bedrock underlying the Maules Creek alluvium and to allow the interconnectivity between the alluvium and bedrock to be evaluated (REG15 / REG15A and REG16 / REG16A);
- create additional multi-level nested bores by installing bores adjacent to existing sites at different depths (REG4A);
- provide shallow water table monitoring sites adjacent to the out of pit emplacement to measure water quality trends (WRD1 and WRD2);
- determine the presence of water table along Back Creek which will provide input to Groundwater Dependent Ecosystem (GDE) monitoring (BCM04 and BCM05);
- assess groundwater and surface water interactions along Back Creek and Maules Creek (REG15A, REG16A, BCM04, and BCM05); and
- provide water level measurements from open standpipe monitoring bores to verify the pore pressures recorded by selected VWP's (RB05B and REG10B).

² Accessed: <https://realtimedata.waternsw.com.au/>

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4.3 WATER SUPPLY BORES

In 2019 Whitehaven Coal purchased additional groundwater bores and WALs in proximity to mine operations to improve the security of water supply. Under these entitlements and when required, groundwater is extracted via a series of bores from its Roma, Brighton and Olivedene properties. Each extraction bore is equipped with both Whitehaven (WHC) and WaterNSW flowmeters for monitoring purposes.

In addition, routine monitoring of groundwater has been expanded to a series of 14 water supply bores operated by third parties around MCCM since 2014. Of the 14 bores, 11 are located within Whitehaven land and three are located on public land, with land ownership boundaries presented in Figure 4-1 for reference. The purpose of monitoring is to detect changes to groundwater levels and quality at water supply bores in the area. Monitoring activities, such as manual gauging and sample collection, might not be viable when the bore is capped or the pump switched off.

The details of MCCM and third party operated water supply bores are presented in

Table 4-2 and in a map alongside the monitoring network in Figure 4-1.



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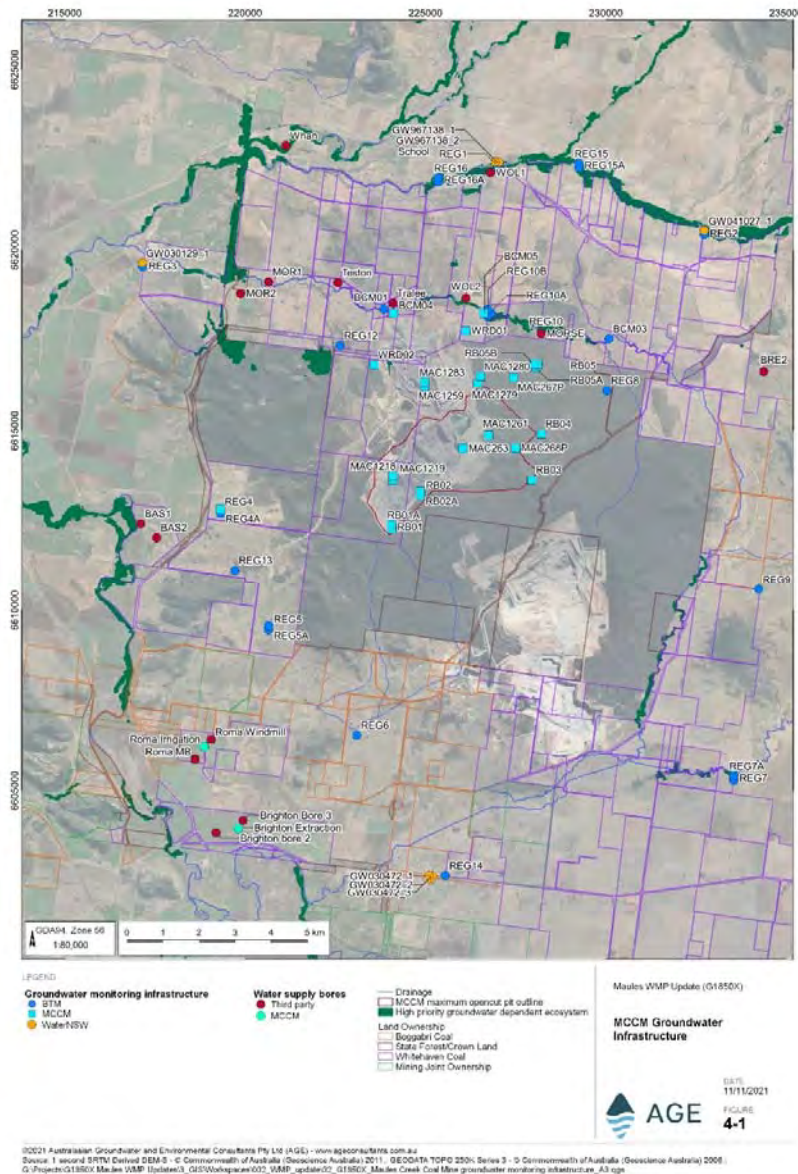


Figure 4-1 MCCM Groundwater Infrastructure



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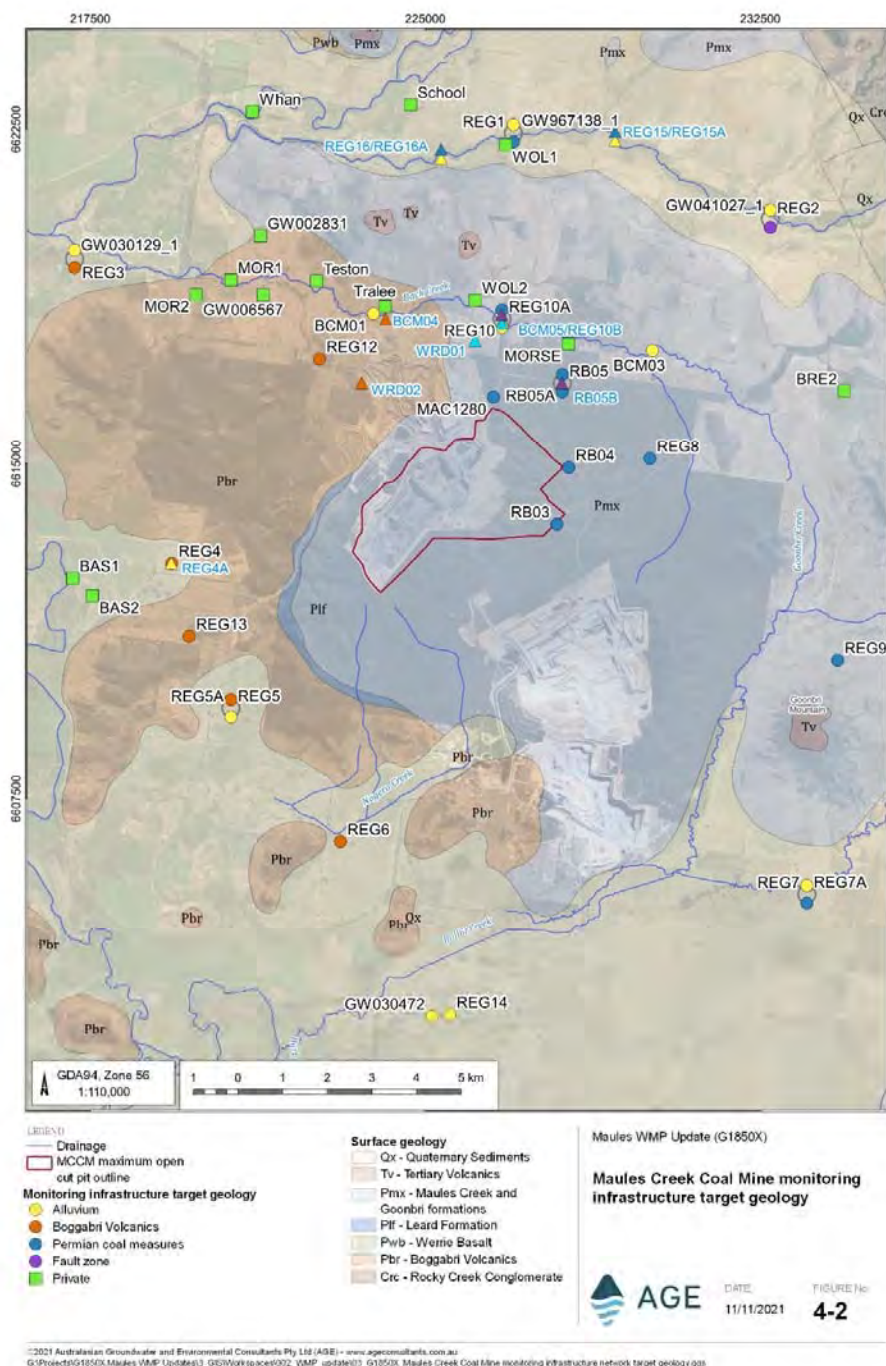


Figure 4-2 MCCM monitoring network target geology

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Table 4-1 Summary of groundwater monitoring network

Bore ID	Managed by ^a	Geology ^b	Status ^c	Type ^d	Easting (m)	Northing (m)	Ground elevation ^e (m AHD)	Depth (m bgl) ^h	Screen or VWP sensor depth (m bgl)	Purpose ^f	Water quality analysis ^g
MAC252	MCCM	Permian	D	SP	266,231	6,614,775	340.6	260	92.5-98.5	6	-
MAC1218	MCCM	Permian	D	SP	224,016	6,613,693	361.4	110	107-110	6	-
MAC1219	MCCM	Permian	D	SP	224,172	6,613,678	370.4	163	107-220	6	-
MAC1259	MCCM	Permian	D	SP	224,959	6,616,286	317	98	94-97	6	-
MAC1261	MCCM	Permian	D	SP	226,750	6,614,872	382.3	180	161-164	6	-
MAC1279	MCCM	Permian	D	SP	226,446	6,616,312	326.9	144	70-73	6	-
MAC1280	MCCM	Permian	A	SP (LL)	226,525	6,616,503	323.5	60	56-59	5, 6, 8, 9	Q
MAC1283	MCCM	Permian	D	SP	224,989	6,616,291	318.2	91	61-64	6	-
MAC263	MCCM	Permian	D	VWP	226,037	6,614,513	348.3	234	105 / 183	6	-
MAC267P	MCCM	Permian	D	VWP	227,440	6,616,472	405.6	299	164 / 257	6	-
MAC268P	MCCM	Permian	D	VWP	227,498	6,614,521	416.8	318	107-220	6	-
BCM01	BTM	Alluvium	A	SP (dry)	223,841	6,618,371	273.4	10	6.75 - 9.75	4	Q
BCM03	BTM	Alluvium	A	SP (dry)	230,085	6,617,546	305	10	6.75 - 9.75	4	Q
RB01A	MCCM	Permian	D	SP	224,058	6,612,341	432.4	205	213.5 - 219.5	2, 5, 6	-
RB01	MCCM	Permian	D	VWP	224,058	6,612,333	433.1	205	97 / 140.5 / 194.5	2, 6	-
RB02A	MCCM	Permian	D	SP	224,853	6,613,266	398.1	270	227 - 233	2, 5, 6	-

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Bore ID	Managed by ^a	Geology ^b	Status ^c	Type ^d	Easting (m)	Northing (m)	Ground elevation ^e (m AHD)	Depth (m bgl) ^h	Screen or VWP sensor depth (m bgl)	Purpose ^f	Water quality analysis ^g
RB02	MCCM	Permian	D	VWP	224,860	6,613,267	381.7	220.5	110 / 162 / 225	2, 6	-
RB03	MCCM	Permian	A	VWP	227,947	6,613,635	407.9	324.4	164 / 242 / 289 / 317	2, 6, 10	-
RB04	MCCM	Permian	A	VWP	228,213	6,614,910	437.5	354	209 / 272.5 / 309 / 339	2, 6, 10	-
RB05A	MCCM	Permian	A	SP (LL)	228,065	6,616,810	328.4	245.3	239 - 245	2, 5, 6, 10	Q
RB05	MCCM	Permian	A	VWP	228,071	6,616,813	328	382	107 / 231 / 280 / 382	2, 6, 10	-
REG1	BTM	Permian	A	VWP	226,946	6,622,396	286.2	255.2	118.7 / 134.5 / 193.5 / 281.5	1, 2, 4, 10	-
GW967138_1	WaterNSW	Alluvium	A	SP	227,001	6,622,422	313.6	82.5	7-Oct	1, 7	Q
GW967138_2	WaterNSW	Alluvium	A	SP	227,001	6,622,422	313.6	82.5	71 - 77	1, 7	Q
REG2	BTM	Permian	A	VWP	232,722	6,620,459	317	255.2	60 / 120 / 200 / 260	1, 2, 4, 10	-
GW041027_1	WaterNSW	Alluvium	A	SP	232,730	6,620,523	318.5	18	8.25 - 14.25	1, 7	Q
REG3	BTM	Volcanics	A	SP (LL)	217,164	6,619,558	241.6	57	50.50 - 56.50	1, 2, 5, 8, 10	-
GW030129_1	WaterNSW	Alluvium	A	SP	217,135	6,619,637	248	24.4	23.2 - 24.4	1, 7	Q
REG4	BTM	Volcanics	A	SP (LL)	219,323	6,612,763	260	72.5	65.5 - 71.5	1, 5, 10	Q
REG5A	BTM	Alluvium	A	SP (dry)	220,646	6,609,514	252	22	18 - 21	1, 2, 5, 10	Q
REG5	BTM	Volcanics	A	SP (LL)	220,649	6,609,521	252.2	78.7	72.2 - 78.2	1, 2, 5, 10	Q

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Bore ID	Managed by ^a	Geology ^b	Status ^c	Type ^d	Easting (m)	Northing (m)	Ground elevation ^e (m AHD)	Depth (m bgl) ^h	Screen or VWP sensor depth (m bgl)	Purpose ^f	Water quality analysis ^g
REG6	BTM	Volcanics	A	SP (LL)	223,100	6,606,534	250.7	96	88.0 - 94.0	1, 5, 10	Q
REG7A	BTM	Alluvium	A	SP (LL)	233,545	6,605,359	291.7	36	24 - 30	1, 2, 4, 5, 10	Q
REG7	BTM	Permian	A	VWP	233,543	6,605,348	291.6	255.2	67.5 / 148.2 / 242.5	1, 2, 4, 10	-
REG8	BTM	Permian	A	VWP	230,030	6,616,113	341.6	TBC	91.5 / 221 / 274	1, 6, 10	-
REG9	BTM	Permian	A	VWP	234,233	6,610,591	346.8	279.2	116.8 / 175.2 / 268	1, 6, 10	-
REG10A	BTM	Alluvium	A	SP (dry)	226,717	6,618,260	287.1	10	6.75 - 9.75	1, 2, 4, 5, 6, 10	Q
REG10	BTM	Permian	A	VWP	226,723	6,618,261	287.1	189.4	55 / 144.2 / 178 / 185.5	1, 2, 4, 6, 10	-
REG12	BTM	Volcanics	A	SP (LL)	222,632	6,617,358	285.6	48.3	38.4 - 44.4	1, 4, 5, 10	Q
REG13	BTM	Volcanics	A	SP (LL)	219,713	6,611,129	277.1	133	128 - 132	1, 5, 10	Q
REG14	BTM	Alluvium	A	SP (LL)	225,547	6,602,649	250.2	102	90 - 96	1, 5, 10	Q
GW030472_1	WaterNSW	Alluvium	A	SP	225,148	6,602,611	248	101.5	23.8 - 25	1, 7	Q
GW030472_2	WaterNSW	Alluvium	A	SP	225,148	6,602,611	248	101.5	57.3 - 59.7	1, 7	Q
GW030472_3	WaterNSW	Alluvium	A	SP	225,148	6,602,611	248	101.5	94.5 - 101.5	1, 7	Q
Roma Windmill	MCCM	Alluvium	A	SP (LL)	219,058	6,606,417	TBC	~12	TBC	3, 5, 7, 10	Q
Roma MB	MCCM	Alluvium	A	SP (LL)	218,612	6,605,871	TBC	89	TBC	3, 5, 7, 10	Q
Brighton Bore ₃	MCCM	Alluvium	A	SP (LL)	219,942	6,604,179	TBC	16.4	12.8 – 15.8	3, 5, 7, 10	Q

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Bore ID	Managed by ^a	Geology ^b	Status ^c	Type ^d	Easting (m)	Northing (m)	Ground elevation ^e (m AHD)	Depth (m bgl) ^h	Screen or VWP sensor depth (m bgl)	Purpose ^f	Water quality analysis ^g
Brighton Bore 2	MCCM	Alluvium	A	SP	219,194	6,603,840	TBC	TBC	TBC	3, 5, 7, 10	Q
RB05B	MCCM	Braymont seam	P	SP (PLL)	228,057	6,616,825	328	110	TBC	2, 5, 8, 10	Q
REG10B	BTM	Braymont seam	P	SP (PLL)	226,719	6,618,263	289.1	55	TBC	2, 5, 8, 10	Q
WRD01	MCCM	Weathered overburden	P	SP (PLL)	226,113	6,617,766	299.5	20	TBC	5, 9, 10	Q
BCM04	MCCM	Volcanics	P	SP (PLL)	224,114	6,618,253	276.6	20	TBC	3, 4, 5, 7, 10, 11	Q
WRD02	MCCM	Volcanics	P	SP (PLL)	223,575	6,616,826	304.5	50	TBC	5, 7, 9, 10	Q
BCM05	MCCM	Alluvium or weathered overburden (first water strike)	P	SP (PLL)	226,705	6,618,254	288.9	20	TBC	3, 4, 5, 7, 10 11	Q
REG15	BTM	Alluvium	P	SP (PLL)	229,249	6,622,349	298.3	<40	TBC	5, 7, 10, 11	Q
REG15A	BTM	Permian coal measures	P	SP (PLL)	229,249	6,622,349	298.3	100	TBC	5, 10	Q
REG16	BTM	Alluvium	P	SP (PLL)	225,355	6,621,947	280.2	<30	TBC	5, 7, 10, 11	Q
REG16A	BTM	Permian coal measures	P	SP (PLL)	225,355	6,621,947	280.2	60	TBC	5, 10	Q
REG4A	MCCM	Alluvium	P	SP (PLL)	219,313	6,612,772	260.2	40	TBC	5, 7, 10	Q

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Table 4-2 Summary of groundwater supply bores

Bore ID	Managed by ^a	Geology ^b	Easting (m)	Northing (m)	Ground elevation ^e (m AHD)	Depth (m bgl) ^h	Screen depth (m bgl)	Water quality analysis ^g
BAS1	Third party on WHC land	TBC	217,107	6,612,427	239*	TBC	TBC	Bi
BAS2	Third party on WHC land	TBC	217,548	6,612,037	238*	TBC	TBC	Bi
BRE2	Third party	Hard rock	234,377	6,616,639	354*	96.3	TBC	Bi
GW006567	Third party on WHC land	TBC	221,374	6,618,792	TBC	59.1	28.7 - 29.3 / 57.9 - 58.5	Bi
MOR1	Third party on WHC land	TBC	220,649	6,619,125	260*	TBC	TBC	Bi
MOR2	Third party on WHC land	TBC	219,871	6,618,803	256*	TBC	TBC	Bi
MORSE	Third party on WHC land	Sandstone	228,203	6,617,691	302*	63.1	TBC	Bi
School	Third party	Gravel	224,673	6,623,048	282*	8.4	TBC	Bi
TESTON	Third party on WHC land	Hard rock	222,568	6,619,102	270*	45.4	TBC	Bi
TRALEE	Third party on WHC land	Basalt	224,102	6,618,538	278*	33.8	TBC	Bi
WHAN	Third party	TBC	221,134	6,622,897	264*	10.0	TBC	Bi
WOL1	Third party on WHC land	TBC	226,799	6,622,149	290*	7.2	TBC	Bi
WOL2	Third party on WHC land	TBC	226,119	6,618,673	285*	TBC	TBC	Bi

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Bore ID	Managed by ^a	Geology ^b	Easting (m)	Northing (m)	Ground elevation ^e (m AHD)	Depth (m bgl) ^h	Screen depth (m bgl)	Water quality analysis ^g
GW002831	Third party on WHC land	TBC	221,313	6,620,116	TBC	TBC	TBC	Bi
Roma Irrigation	MCCM	Alluvium	218,867	6,606,221	TBC	TBC	TBC	Bi
Brighton Extraction	MCCM	Alluvium	219,808	6,603,952	TBC	TBC	TBC	Bi

Notes

Complete records are unavailable for some groundwater bores.

- a. Owner: MCCM = Maules Creek Coal Mine network; BTM = BTM complex network; and WaterNSW = WaterNSW network;
- b. Geology: Permian = Permian coal measures and Volcanics = Boggabri Volcanics;
- c. Status: D = decommissioned, A = active and P = proposed
- d. SP: standpipe; SP (LL): standpipe with existing pressure transducer; and SP (PLL): standpipe with proposed pressure transducer;
- e. Ground elevation: Elevation of water supply bores interpolated from groundwater model digital elevation model. TBC = to be confirmed.
- f. Purpose: Each monitoring site within the network has an identified purpose, or multiple purposes depending on the site location and geological unit it is monitoring. The purposes of the monitoring locations include to:
 1. record regional groundwater levels/pressures and trends;
 2. determine water levels within overlying hydrostratigraphic units and connectivity between units;
 3. detect any significant changes to groundwater levels and quality at water supply works;
 4. detect any significant changes to groundwater levels and quality in vicinity of high-priority groundwater dependent ecosystems;
 5. monitor trends in groundwater quality in main hydrostratigraphic units;
 6. detect localised depressurisation due to mine activities;
 7. monitor groundwater in alluvium;
 8. provide a verification of pressure recorded by VWP sensors grouted into drillholes;
 9. determine changes in groundwater level and quality around the out of pit emplacement;
 10. verify groundwater model predictions; and
 11. assess interaction between groundwater and surface water.
- g. Water quality analysis: Frequency of analysis of Q = quarterly, Bi = biannually.
- h. m bgl - metres below ground level

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5 DATA COLLECTION METHODOLOGY

Groundwater data will be collected through a monitoring program for the life of the mine. Groundwater data collection is undertaken at regular intervals by suitably qualified and experienced personnel. Water level measurements and water sample collection, as well as storage and transportation will be conducted in accordance with the Standard Operating Procedures (SOPs) included in Attachment B. The SOPs are drawn from relevant aspects of the following industry standards:

- The Australian/New Zealand Standard Water quality – Sampling, Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (AS/NZS 5667.1:1998); and
- The Australian/New Zealand Standard Water quality – Sampling, Part 11: Guidance on sampling of groundwaters (AS/NZS 5667.11:1998).

Groundwater data collected from each monitoring round will be collated into a database. The database will include, as a minimum requirement, the following:

- records of manual standing level water measurements and electronic pressure logger or VWP download;
- records of field water quality parameters and sampling methodologies to achieve representative samples;
- records of flow rates of water supply bores equipped with flowmeters;
- tabulated water quality laboratory results and comparison to trigger values;
- a chain of custody supplied to the laboratory of the water samples collected;
- records of original laboratory analysis certificates; and
- records of any issues encountered.

5.1 GROUNDWATER LEVELS

Natural fluctuations in groundwater levels occur in response to a range of stresses. These stresses can range from short term events, such as rainfall recharge events, or long term events, such as multi-year drought. To capture the range of stresses, groundwater levels/pressures will be measured manually and automatically with pressure transducers/loggers, including via VWP.

Standing groundwater levels will be measured in all standpipe bores with a decontaminated electronic water level dipper and recorded to the top of the bore casing. Electronic pressure transducers/loggers have been progressively installed since 2014 and are recording water pressures at daily intervals. To allow for barometric correction of water pressure recorded by the standpipe transducer/logger, a barometric logger will be installed in one of the standpipe bores. Pore water pressures is recorded at boreholes installed with multi-level VWPs. Manual level gauging and pressure logger/VWP sensor downloads will occur as part of each monthly monitoring round. To assess interaction between groundwater and surface water, pressure transducer logging at daily intervals will be undertaken at existing and proposed shallow bores along Back and Maules Creek.

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Registered water supply bores (managed by third parties) identified as being within the simulated zone of depressurisation will be inspected to determine if the bores are still operational and in-use within the 2021/2022 water year. Standing groundwater level measurements will be conducted on a biannual frequency on these water supply bores.

5.2 GROUNDWATER QUALITY

To ensure water samples collected are representative and repeatable for the screened hydrostratigraphic unit, bore purging will be conducted prior to collection of water sample. Field measurement/observations of parameters, including pH, electrical conductivity, temperature, redox potential, colour, odour and sediment load will be recorded. Collected samples will be analysed by a National Association of Testing Authorities (NATA) accredited laboratory for:

- physico-chemical parameters - pH, electrical conductivity and total dissolved solids (TDS);
- major cations - calcium, magnesium, sodium and potassium;
- major anions - chloride and sulfate;
- alkalinity - total, carbonate, bicarbonate and hydroxide;
- nutrients – nitrite, nitrate, ammonia and phosphorous;
- metals (dissolved) - aluminium, arsenic, barium, boron, cadmium, chromium, copper, cobalt, iron, lead, manganese, molybdenum, nickel, selenium, strontium, zinc; and
- ionic checks – total anions, total cations and ionic balance.

Groundwater samples will be collected from the standpipe bores each quarter. The SOP in Attachment B describes the process for collecting groundwater samples.

Samples for water quality analysis are collected from the water supply bores on a biannual basis. The process of collection of groundwater samples from watery supply bores will follow that of monitoring bores.

5.3 GROUNDWATER DEPENDENT ECOSYSTEMS

The Water Sharing Plan (WSP) for the Namoi Alluvial Groundwater Sources 2020 and the WSP for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020 identify the boundaries of high priority groundwater-dependent ecosystems in the MCCM region. The WSPs defines high priority groundwater dependent ecosystems as:

- *any instream ecosystem associated with rivers that have a base flow component to their flow regime;*
- *vegetation that has a high probability of being groundwater-dependent, and is of very high or high ecological value; and*
- *Ramsar wetlands, or wetlands listed in the Directory of Important Wetlands in Australia.*

The location of the high priority groundwater dependent ecosystems identified within the WSP area are shown on Figure 4-1, along with the groundwater monitoring infrastructure. The figure shows that the

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high priority groundwater dependent ecosystems are predominantly located in riparian zones along Maules Creek, Back Creek and the Namoi River. Table 4-1 identifies the purpose of each monitoring bore within the MCCM network and those which will be utilised to assess groundwater level/quality changes in areas where the high priority groundwater dependent ecosystems occur. The historical monitoring of potential impact to GDEs at bores listed in Table 4-1 in the vicinity of potential GDEs shown in Figure 4-1 has indicated no impact to groundwater levels or quality that would trigger further investigation or monitoring for GDEs.

During 2022/2023, MCCM shall engage a suitably qualified and experienced Aquatic and Groundwater Ecologist to conduct additional detailed surveys of Maules Creek and Back Creek to confirm if GDEs (Melaleucia riparian forest communities and stygo-fauna) are present in the areas shown in Figure 4-1. The pre-dawn leaf water potential will be measured at four sites selected along Back Creek to determine if the vegetation is groundwater dependent.

Samples will be collected from 15 selected bores in spring and autumn using a specifically designed net that will be lowered to the bottom and slowly retrieved six times to trap any stygofauna within the bore. The samples will be preserved and analysed under microscope for the presence of stygofauna. Monitoring bore sites situated within the riparian zones along Back Creek, Maules Creek, and the Namoi River around the Maules Creek confluence will be targeted for sample collection.

5.4 GROUNDWATER QUANTITY

The MCCM operates in relatively low permeability geological strata where there is no need for advance depressurisation or dewatering prior to mining for operational and safety reasons. During mining at MCCM, groundwater is allowed to seep into the mining area through the pit walls and floor, with the low permeability of the rock mass meaning the volume of groundwater entering the mining areas is not problematic.

The groundwater seepage rates are commonly difficult to measure as continuous pumping out of the pits is not required. This is because the area of the pit walls and floors is relatively large and promotes evaporation of seepage. Seepage that does flow to the pit floor also commonly becomes bound to material excavated from the pit without needing to be removed via pumping. Any remaining groundwater flows into sumps and is pumped out of mining areas along with any rainfall and runoff that has been collected.

Proponents of aquifer interference activities are required to provide predictions of the volume of water to be taken from a water source as a result of the activity. These predictions need to occur prior to approval and during operations. Water take is categorised based on the manner in which it occurs as follows:

- **Incidental take:** This is water take that is incidental to the mining activity. It includes water that is encountered within and extracted from mine pit workings. Groundwater seepage into the MCCM pits is classified as incidental take.
- **Passive take:** Passive take is water losses from an adjacent groundwater system that occurs indirectly due to an adjacent activity. Passive take is predicted to occur from the Namoi alluvials due to the MCCM activities, even through the alluvial aquifer are not directly intercepted by the mining activity.

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- **Consumptive use:** This category is for water that is pumped from licensed extraction bores and consumed by the mining activity. Water extracted from the Roma, Brighton and Olivedene water supply bores

The estimated volumes of water take from each category need to be measured and reported in an annual review. MCCM must hold a sufficient share component and water allocation to account for the take of water from the relevant water source when the take occurs.

Groundwater in the MCCM region is managed under two Water Sharing Plans, namely the:

- WSP for the Namoi Alluvial Groundwater Sources 2020; and
- WSP for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020.

The WSP for the Namoi Alluvial Groundwater Sources includes all water contained in unconsolidated alluvial sediment aquifers, which are associated with the Namoi River and its tributaries at Maules Creek and Bollol Creek. The Namoi alluvial aquifers are divided into a number of management zones, with Upper Zone 11, Zone 5 and Zone 4 surrounding the MCCM.

Beyond and underlying the alluvial areas, groundwater is managed under the Gunnedah-Oxley Basin sub-division of the WSP for the NSW Murray Darling Basin Porous Rock Groundwater Sources. This plan includes all rocks that are Permian, Triassic, Jurassic, Cretaceous and Tertiary in age, as well as any alluvial sediments within outcropped areas.

Table 5-1 provides a summary of Water Access Licences (WALs) and entitlements held by MCCM to account for water taken during mining, with the methodology used to estimate the water take discussed in Section 6.3.

Table 5-1 Summary of entitlements held by MCCM to account for water take

Water Sharing Plan	WAL Number	Management Zone	Total Entitlement (ML/year)	Purpose
Porous Rock	29467	Gunnedah-Oxley Basin	6	Incidental take
Porous Rock	29588	Gunnedah-Oxley Basin	300	Incidental take
Porous Rock	36641	Gunnedah-Oxley Basin	800	Incidental take
Alluvial	27385	Upper Zone 4	38	Passive take
Alluvial	12613 (in application)	Upper Zone 4	50	Passive take
Alluvial	36548 (in application)	Upper Zone 4	36	Passive take
Alluvial	12811	Upper Zone 5	135	Passive take

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Water Sharing Plan	WAL Number	Management Zone	Total Entitlement (ML/year)	Purpose
Alluvial	12479	Upper Zone 11	78	Passive take
Alluvial	12791	Upper Zone 5	115	Consumptive use - Olivedene
Alluvial	12722	Upper Zone 4	77	Consumptive use - Roma
Alluvial	12718	Upper Zone 4	102	Consumptive use - Brighton

Notes

Total entitlement presented for each WAL captures the volumes for the 2021/2022 water year and is subjected to change from licence acquisition, trading and/or transfers.

6 DATA ANALYSIS METHODS

The methods for analysis of groundwater level, quality and quantity information are described in the sections below.

6.1 GROUNDWATER LEVEL

The methods for analysis of groundwater level data are summarised in a flowchart in Figure 6-1. The flowchart outlines the pre-processing steps, including quality assurance/quality control (QA/QC), that will be undertaken for groundwater level data analysis.

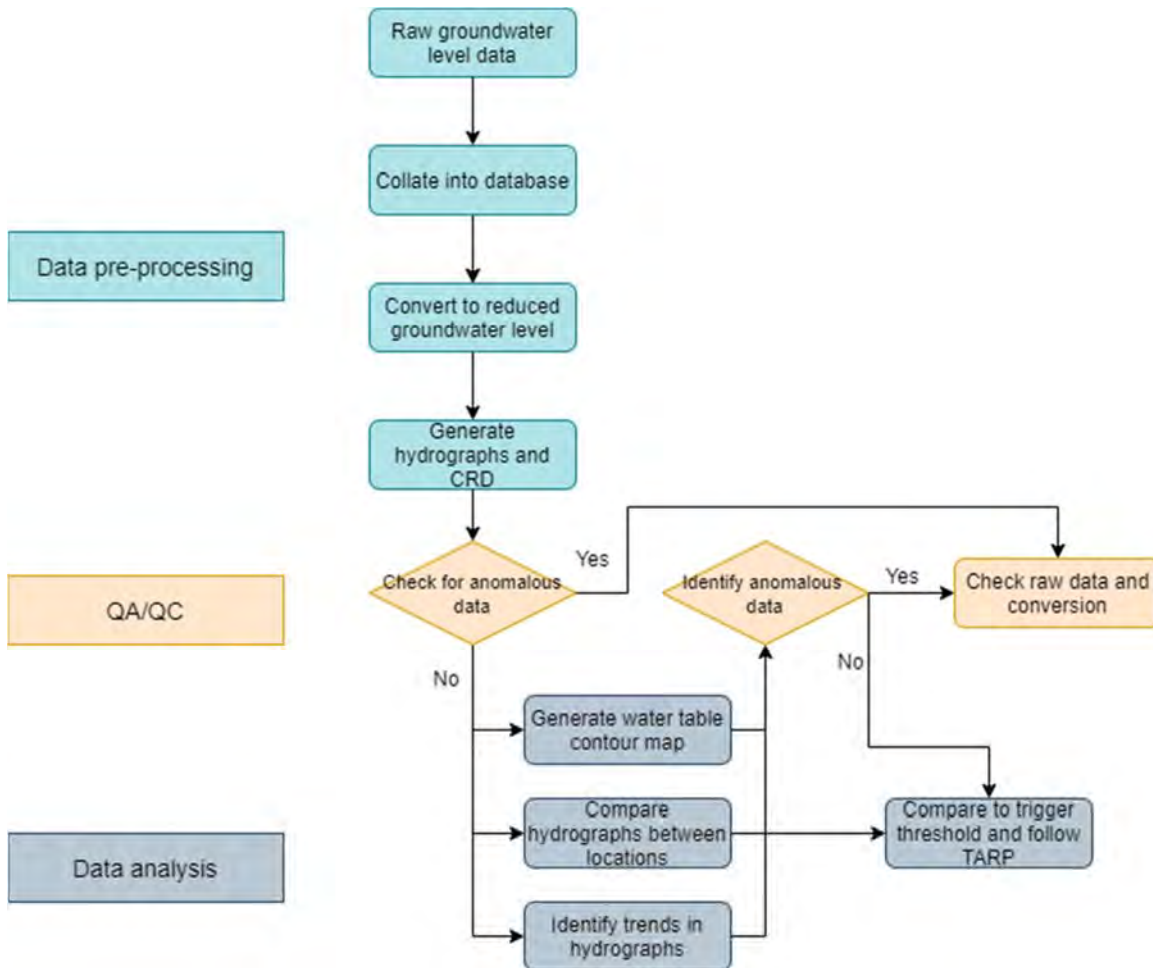


Figure 6-1 Groundwater level data pre-processing and analysis flowchart

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As indicated in the flowchart, manual standing water levels and electronic pressure logger/VWP data will be converted to a reduced water level with respect to Australian height datum (m AHD). Pressure logger data will be adjusted to remove the effects of barometric pressure changes where required.

The reduced water level data will be visualised as time series charts (hydrographs). An example hydrograph is provided in Figure 6-2. Hydrographs will be utilised as a tool to identify occurrence of anomalous data points, which can form part of the QA/QC process. Once anomalous data points are rectified or removed, the hydrographs will be used to understand the behaviour of water in the groundwater regime including:

- recharge/discharge events as indicated by the relationship to the Cumulative Rainfall Departure from mean (CRD);
- the influence of abstraction from irrigation, stock and domestic bores;
- vertical hydraulic gradients at nested locations monitoring water levels in alluvial and Permian strata; and
- any depressurisation effects from MCCM and the BTM complex.

Hydrographs will be compared between monitoring locations to reveal more significant water level changes that could be a result of MCCM activities. Where water level measurements are outside the trigger threshold the TARP process (as outlined in Section 8.3) will be initiated.

Horizontal flow directions within key hydrostratigraphic units with sufficient spatial data will be illustrated by piezometric contour maps. These contour maps will be generated from monitoring data by connecting areas of equal groundwater elevation to create a two-dimensional representation of the piezometric surface. Comparison of contour maps with previous time periods will provide information towards changes in groundwater flow directions over time.

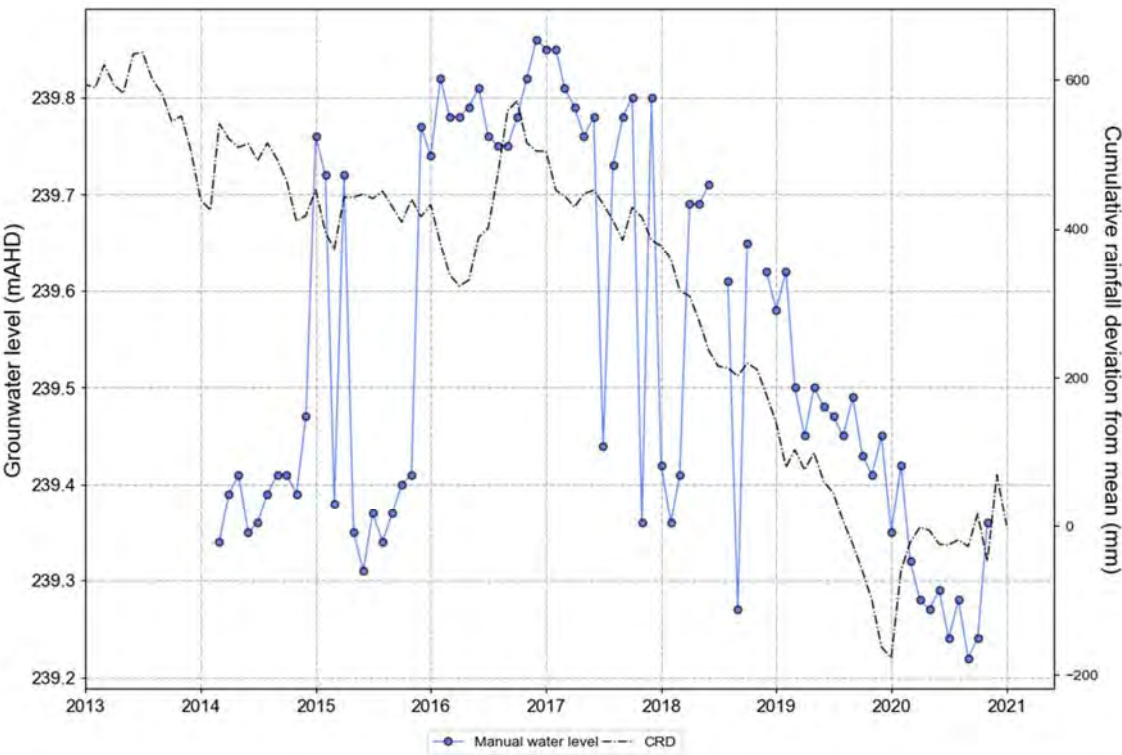


Figure 6-2 Example hydrograph (REG4) for analysis

6.2 GROUNDWATER QUALITY

A total of 29 monitoring bores, 16 water supply bores (14 managed by third parties and two managed by MCCM) will have water samples collected for water quality analysis on a quarterly and biannual basis, respectively. The methodology for analysis of groundwater quality data is summarised in the flowchart in Figure 6-3. Similar to the water level flowchart in Figure 6-1, this flowchart outlines the pre-processing, including QA/QC, as well as the steps that will be undertaken for groundwater quality data analysis.

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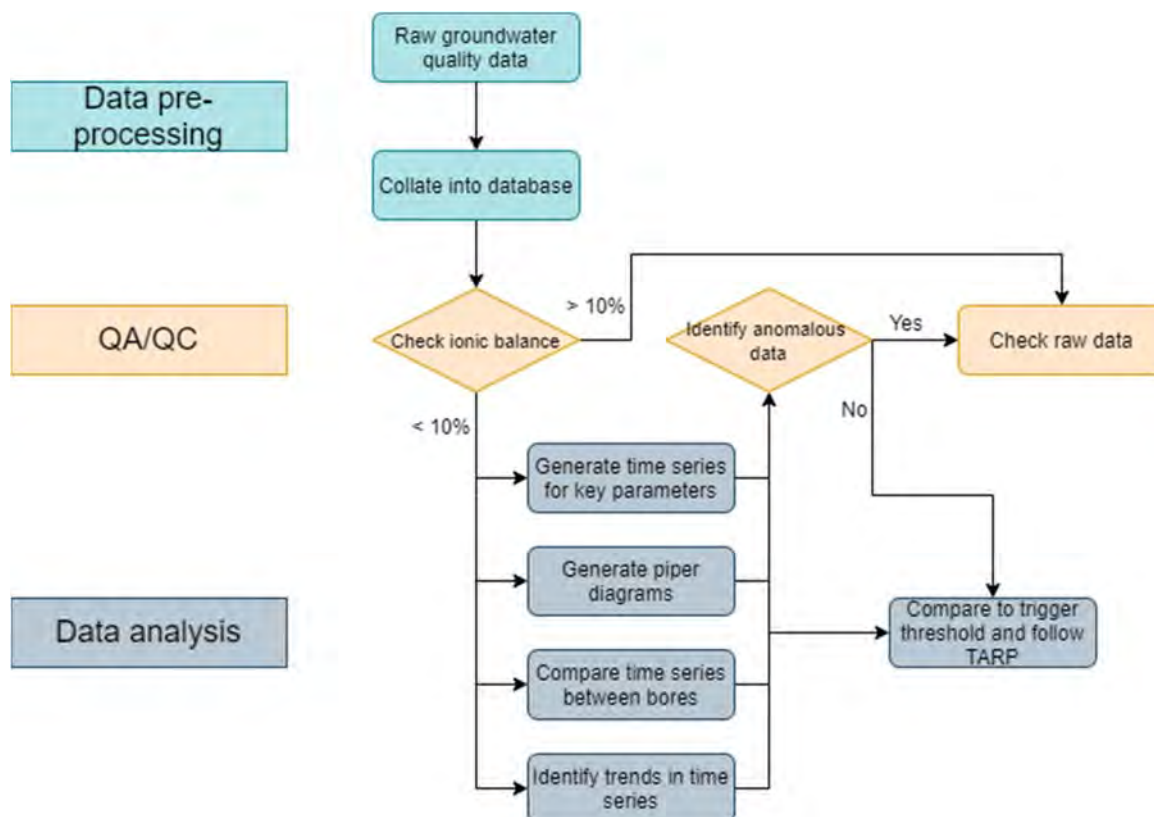


Figure 6-3 Groundwater quality data pre-processing and analysis procedures

Groundwater quality data will be pre-processed for analysis in a similar approach as the method adopted for groundwater levels. Field and laboratory results will be collated and tabulated in a single database that will identify:

- key parameters including pH, TDS and sulfate concentrations that are either greater than the 95th percentile of baseline data or less than the 5th percentile of baseline data;
- ionic balance results which exceed the $\pm 10\%$ margin. (charge of cations should balance that of anions in natural groundwaters); and
- dissolved metal concentrations that exceed ANZECC guidelines for stock and/or irrigation water. Dissolved metals are used for guideline comparison because of their higher bio-availability when compared to total metals.

Groundwater samples with ionic balance beyond the $\pm 10\%$ range will be identified and the cause determined. If necessary, an additional sample will be collected for laboratory analysis within seven days of original sample. Samples that are determined not to be representative will be flagged and removed in subsequent data analysis. Records of sampling method, sample transportation and laboratory consistency of reporting limits are also factors that could influence the occurrence of nonrepresentative values.

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Time series plots will be generated for water quality indicators that have trigger values based on the 5th and 95th percentile of baseline data for pH, TDS and sulfate and compared with short- and long-term water level trends. Figure 6-4 shows an example of the stacked charts that will be generated for each monitoring bore, and the trigger thresholds based on baseline data.

In addition to location specific trigger thresholds for pH, TDS and sulfate, all field and laboratory analytes will be tabulated and compared against ANZECC guideline values for stock and/or irrigation water. Exceedances against the ANZECC stock and/or irrigation guidelines will form water quality trigger thresholds for dissolved metal concentrations as discussed in Section 8.2.3; and will provide information towards existing and evolving conditions of the monitored hydrostratigraphy for other parameters listed in Section 5.2.

Piper diagrams will be generated as a visualisation tool to understand the relative major ion abundance and water chemistry at each monitoring location. Piper diagrams are useful in identifying differing, or mixing, chemistry signatures between hydrostratigraphic units, and how signatures change over with time. An example Piper diagram for water samples collected from third party water supply bores is provided in Figure 6-5.



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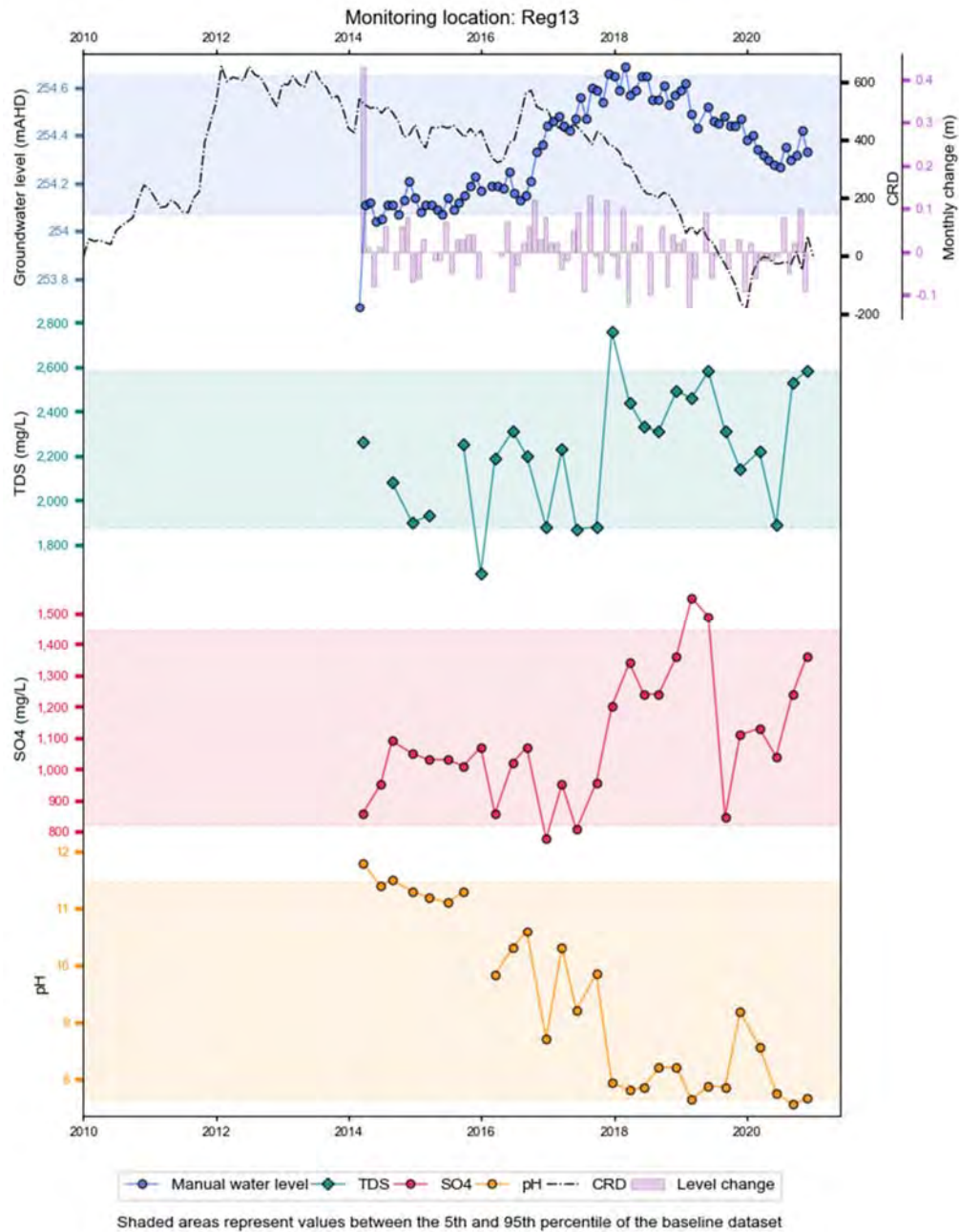


Figure 6-4 Example stacked water quality and water level charts

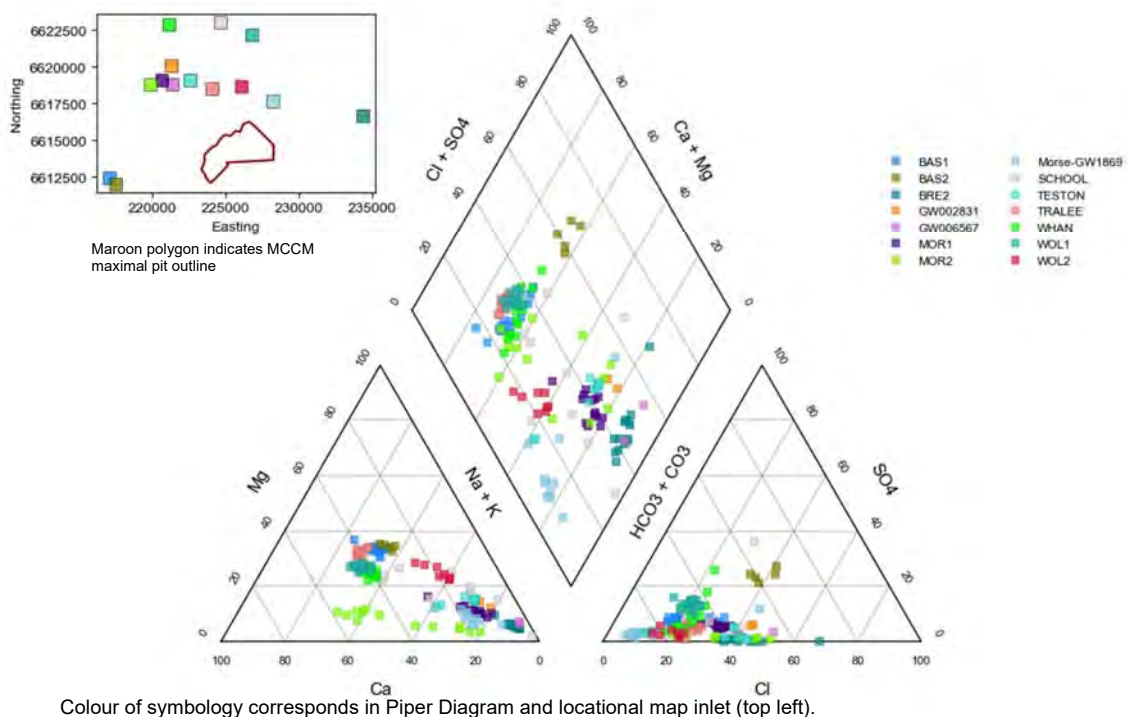


Figure 6-5 Example Piper Diagram for third party water supply bores

6.3 GROUNDWATER DEPENDENT ECOSYSTEMS

The outcomes of 2022/2023 field campaign will be used to identify the occurrence and distribution of stygofauna within the groundwater regime. Groundwater invertebrate (stygofauna) detected will provide an indication of the ecological condition of aquifer ecosystems. Monitoring bores located in areas of high diversity will be selected for use in future monitoring. These bores will be assigned trigger values likely based on water level and electrical conductivity, and will be subject to future stygofauna sampling as part of bi-annual stream health monitoring. TARPS for stygofauna communities and groundwater dependent vegetation will be set during the development of the monitoring program and provided in an updated version of the GWMP.

The location of groundwater dependent vegetation communities will be assessed using the pre-dawn leaf water potential measured at the four selected sites along Back Creek.

Based on the outcome of this survey, MCCM will undertake the following:

- Document the types of GDEs located and the potential for impact from the operation;
- Update mapping in Figure 4-1 to identify where GDEs are present and identify the different GDE communities
- Update the monitoring locations and techniques in Table 4-1 based on the presence of GDEs

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- Develop a TARP for assessing impacts to GDEs at the locations where they have been identified and specific for the type of GDE.

The outcome of this survey work and the updated monitoring program shall be included in future updates of the WMP.

6.4 GROUNDWATER QUANTITY

The volume of incidental groundwater take to the mining areas will be estimated each calendar year using the site water balance model. The site water balance method compares rainfall and runoff inputs to the pits with pumping outputs and storage changes to provide an estimate of pumpable incidental groundwater take from the mining areas. The site water balance model is updated at the end of each calendar year with the results provided in the annual review (refer to separate Site Water Balance Management Plan).

The PA requires “a program to validate the groundwater model for the project, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions”. Every three years the numerical groundwater flow model will be reviewed, validated and if necessary updated. The process will be undertaken with the input of a third party reviewer. The numerical model simulates the subsurface flow of groundwater and provides estimates of incidental water take from the MCCM pits and passive take from the surrounding alluvial aquifers. These water takes will be reviewed as part of the annual review and be used as the basis for determining entitlements required to account for groundwater taken by the mine each calendar year. This will only occur after the model has been approved for use by the DPIE.

Any consumptive water take from the Roma/Brighton water supply bores will be monitored with flowmeters at the bore outlet and reported in the annual review.

The total volume of incidental, passive and consumptive groundwater take will be tabulated each year and compared quantitatively with the licenced entitlements in the annual review.

Different incidental take estimated by the site water balance method and groundwater modelling is not uncommon due to different underlying methodologies and assumptions. Where the water balance model and the numerical model provide differing estimates of groundwater inflow commentary on the potential cause will be provided within the annual review. A conservative approach will be undertaken utilising the highest estimates of groundwater inflow to the mining area to ensure adequate water licenses are held to account for the groundwater intercepted.

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7 SUMMARY OF BASELINE DATA

MCCM have been collecting groundwater data through the existing and progressively expanding monitoring infrastructure since October 2010. The results of the monitoring have been provided each year in annual reviews. Groundwater levels have fluctuated over this period due to a range of factors including climatic conditions (i.e., drought), agricultural extraction and local mine dewatering of open pits.

Figure 7-1 provides a graphical summary of the quarterly groundwater level changes compared with quarterly rainfall and the CRD. Each row of squares in Figure 7-1 represents one monitoring location. The bottom chart in Figure 7-1 displays quarterly rainfall and CRD. By comparing the bottom chart with the upper chart, the influence of climate on the entire groundwater system can be observed. Events such as the declining groundwater levels experienced during the 2017 to 2019 drought, and the subsequent recovery in the volcanics and alluvium in early 2020 are evident. Less pronounced recoveries in groundwater levels are observed closer to the mining operations in the Permian coal measures due to the influence of mining induced depressurisation on the strata, as predicted by groundwater modelling.

In general, depressurisation due to mining has been limited to the vicinity of MCCM within the Permian coal measures. Monitoring locations targeting these units near the open pits have recorded declines in groundwater levels once mining has progressed into the geological layer which is being monitored. Monitoring locations designed to target the alluvium (to the north and south) and Bogabri Volcanics (to the west and south-west) have not recorded changes in groundwater levels and quality that can be attributed to the dewatering of MCCM pits. The changes in groundwater levels recorded at the more distant monitoring locations are characteristic of climate factors, such as the multi-year drought between 2017 and 2019, and to a certain extent agricultural abstraction in the alluvial systems.

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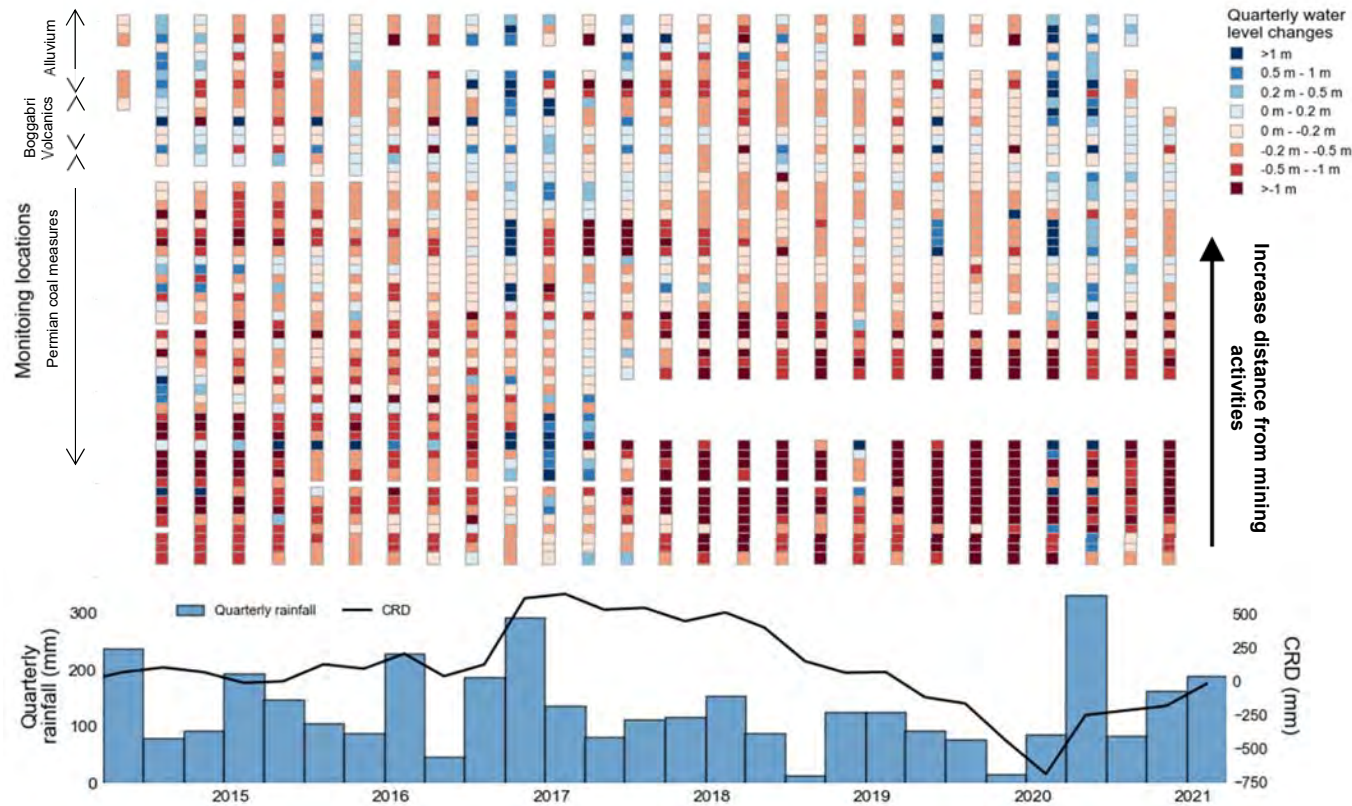


Figure 7-1 Summary of quarterly groundwater level changes at each location over time

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The relationship between groundwater levels, physio-chemical parameters (pH and TDS) and sulfate concentrations at each location are further illustrated graphically in timeseries charts within Attachment C. Stable trends for groundwater quality parameters, including physio-chemical parameters, major ions and metal concentrations are generally recorded at monitored standpipe bores. Exceptions to this include:

- a number of monitoring bores that have yielded highly alkaline samples due to cement grout use during installation of the bore (MAC1280, REG4, REG13); and
- slow rises in salinity as measured by TDS (REG12, RB05A) and sulfate (REG5).

Attachment E includes a summary of water quality datasets.

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8 TRIGGER ACTION RESPONSE PLANS

8.1 PERFORMANCE MEASURES

Schedule 3 Condition 40(c) of the PA 10_0138 stipulates that the groundwater monitoring program must establish performance measures to evaluate potential changes to existing groundwater sources. Mining activities that intercept the water table or interfere with groundwater systems are considered aquifer interference activities under the New South Wales Aquifer Interference Policy (AIP). The minimal impact considerations described in the AIP have been adopted as the groundwater performance measures for the MCCM. The minimal impact considerations in the AIP are dictated by the productivity (highly or less productive) and nature of the groundwater source (alluvial or porous/fractured rock).

The Quaternary alluvial system, which is classified as a highly productive groundwater source, has some differences in performance measures compared with the Permian bedrock units of the Gunnedah Oxley Basin, which are classified as a less productive porous rock system. The performance measure will vary for each type of monitored receptor, which includes water supply works, monitoring bores in close vicinity to high-priority groundwater dependent ecosystems and regional monitoring bores. The boundaries of high-priority groundwater dependent ecosystems are defined by the WSP for the Namoi Alluvial Groundwater Sources and WSP for the NSW Murray Darling Basin Porous Rock Groundwater.

The performance measures of each monitored groundwater system with respect to groundwater receptors and the applicable monitoring locations are presented in Table 8-1 and graphically on a map in Figure 8-1.

While monitoring locations REG12 and REG10 are located in close proximity to high-priority groundwater dependent ecosystems, the bore screen targets the deep Permian bedrock groundwater system, which is unlikely to support groundwater dependent ecosystems. No performance measures are applied to these bores.

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Table 8-1 Groundwater performance measures

Potential mining issue or impact	Receptor	Water source type	Applicable to	Performance measures
Water level changes due to water take, drawdown and aquifer interconnectivity	Water supply bores	• Highly productive alluvial • Less productive porous rock	BRE2, MORSE, WOL1, WOL2, Tralee, Teston, MOR1, MOR2, Whan, BAS1, BAS2, School, GW006567, GW002831, Brighton Extraction and Roma Irrigation	No more than 2 m drawdown attributable to mining activities
	Standpipe monitoring bore within 40 m of high priority groundwater dependent system	• Highly productive alluvial • Less productive porous rock	BCM01, BCM03, BCM05, REG7A, REG10A, GW967138_1, GW967138_2 and GW041027_1	Not more than 10% cumulative variation in water table 40m from GDEs attributable to mining
	Regional standpipe monitoring bore	• Highly productive alluvial	REG3, REG5A, REG7A, REG14, GW967138_1, GW967138_2, GW041027_1, GW030472_1, GW030472_2, GW030472_3 GW030129_1, Roma Windmill, Roma MB and Brighton Bore 3	Cumulative pressure head decline of not more than 40% of pressure head above base of water source
Water quality changes due to mining activities, final void and	Water supply bore	• Highly productive alluvial • Less productive porous rock	BRE2, MORSE, WOL1, WOL2, Tralee, Teston, MOR1, MOR2, Whan, BAS1, BAS2, School, GW006567, GW002831, Brighton Extraction and Roma Irrigation	No change in existing beneficial use category due to mining

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Potential mining issue or impact	Receptor	Water source type	Applicable to	Performance measures
emplacement waters	Standpipe monitoring bore within 40 m of high priority groundwater dependent system	- Highly productive alluvial (semi-confined) - Less productive porous rock	BCM01, BCM03, BCM05, REG7A, REG10A, GW967138_1, GW967138_2, GW041027_1	No change in existing beneficial use category due to mining
	Regional standpipe monitoring bore	- Highly productive alluvial - Less productive porous rock	REG3, REG5A, REG7A, REG14, GW967138_1, GW967138_2, GW041027_1, GW030472_1, GW030472_2, GW030472_3, GW030129_1, Roma Windmill, Roma MB and Brighton Bore 3	No change in existing beneficial use category due to mining

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8.2 TRIGGERS AND CONTROL CHARTS

Control charting is a graphical and statistical tool to track changes in recorded data over time. The inclusion of appropriate thresholds on control charts is used to inform trigger management actions. Control charts and threshold triggers developed for the monitoring network are shown on the charts included in Attachment C and Attachment D.

8.2.1 Standpipe Groundwater Levels

Groundwater data, including levels and quality, have been analysed with methods described in Section 6 to determine the baseline period for each monitoring standpipe location. The baseline dataset is used to calculate the 5th and 95th percentile of measured groundwater levels as outlined in Section 6.1 for each monitoring standpipe location which is set as the trigger threshold on the control charts. Groundwater levels are expected to exceed the 5th/95th percentile threshold on ten percent of measurements given future fluctuations are representative of baseline conditions.

Water levels in the majority of monitoring locations not affected by BTM complex mining are categorised to reflect baseline conditions up to 2020. Interim trigger thresholds have been calculated for locations do not have sufficient data (less than eight measurements) assuming the existing data is reflective of baseline conditions. The interim trigger thresholds will be updated once sufficient data is acquired for these locations. The water level trigger thresholds for each monitoring location are summarised in Table 8-2.

Table 8-2 Water level trigger thresholds for monitoring bores and water supply bores

Monitoring location	Measurement unit	Baseline period	Rationale behind baseline period selection ^	Trigger threshold calculated from baseline data	
				5%	95%
BAS1	Metres below reference point	Start – 2020	2, 5	8.9 *	9.3 *
BAS2		Start – 2020	5, 6	7.5 *	11 *
BRE2		Start – 2020	1, 2, 3	17.9	19
GW002831		NA	5, 6	TBC	TBC
GW006567		Start – 2020	5, 6	18.3 *	18.6 *
MOR1		Start – 2020	1, 2	12.1	13.4
MOR2		Start – 2020	1, 2, 3	13.1	13.3
Morse-GW1869		Start – 2020	1, 2, 3	21.6	21.9
SCHOOL		NA	2, 5	TBC	TBC
TESTON		Start – 2020	1, 2	19.7	20.0
TRALEE		Start – 2020	1, 2	19.7	20.3
WHAN		Start – 2020	1, 2, 3	3.5	5.6
WOL1		Start – 2020	1, 2, 3	3.1	6.4
WOL2		Start - 2018	2	9.9	12.0
Roma Windmill #		Start – 2020	1, 3	11.1 *	12.4 *
Roma MB #		Start – 2020	1, 3	12.1 *	13.0 *

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Monitoring location	Measurement unit	Baseline period	Rationale behind baseline period selection ^	Trigger threshold calculated from baseline data	
				5%	95%
Brighton Bore 3 #		Start – 2020	1, 3	10.9 *	11.1 *
Brighton Bore 2		TBC	TBC	TBC	TBC
MAC1280	Metres Australia Height Datum	Start – 2020	1, 2	263.4	273.7
RB05a		Start – 2017	1, 2	269.4	272.5
REG12		Start – 2020	1, 3	259.6	259.9
REG13		Start – 2020	1, 3	254.1	254.7
REG14		Start – 2020	1, 3, 4	228.2	230.6
REG3		Start – 2020	1, 2, 3, 4	225.3	228.9
REG4		Start – 2020	1, 2, 3	239.3	239.8
REG5		Start – 2020	1, 3	234.1	234.6
REG6		Start – 2020	1, 2, 3, 4	227.8	230.5
REG7a		Start – 2020	1, 2, 3	282.5	285.5
GW967138_1		Start – 2020	1, 3	279.9	284.4
GW967138_2		Start – 2020	1, 3	278.1	281.4
GW041027_1		Start – 2020	1, 3	306.9	314.4
GW030129_1		Start – 2020	1, 3, 4	239.2	241.6
GW030472_1		Start – 2020	1, 3, 4	229.0	229.4
GW030472_2		Start – 2020	1, 3, 4	230.2	232.4
GW030472_3		Start – 2020	1, 3, 4	230.3	232.1
REG2_VW1 #		Start – 2020	7	307.8	313.2
REG7_VW1 #		Start – 2020	3, 7	295.1	296.5

Notes

* = Interim water level triggers as less than eight data points or two years of baseline monitoring; TBC = less than two years of monitoring; # = VWP sensors only included where no impact was predicted by numerical modelling; and Start = beginning of monitoring;

^ = Classification of rationale behind baseline period selection for each standpipe monitoring location and includes:

1. stable trends exhibited in groundwater levels;
2. stable trends exhibited in majority of groundwater quality parameters;
3. groundwater level fluctuations reflective of climate influences;
4. groundwater level fluctuations reflective of agricultural abstractions;
5. insufficient groundwater level data to represent features of hydrostratigraphy;
6. insufficient groundwater quality data to represent features of hydrostratigraphy; and
7. no predicted impacts from numerical modelling.

8.2.2 VWP Groundwater Levels

The majority of VWPs are designed to detect local depressurisation under the influence of mine dewatering. It is expected and predicted by numerical modelling the pore pressures will decline at these locations that are around the mine pit. A two-tier approach based on numerical modelling results has been adopted to develop triggers for the VWP sensors next to the mining area, which is a different

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approach compared to computing percentile thresholds from the baseline dataset. The first tier is the model predicted maximum drawdown, with the second tier being the lowest predicted groundwater elevation. Both tiers must be exceeded to be to an exceedance event.

Sensor REG2_VW1 and REG7_VW1 are not predicted to exhibit impacts to groundwater levels from mining activities. Triggers for these sensors are computed from percentile thresholds and presented in Table 8-2. The two-tier trigger threshold that applies for the rest of the VWP sensors are summarised in Table 8-3. Hydrographs showing the two tiers are included in Attachment C.

Table 8-3 Water level trigger thresholds for VWP monitoring locations

VWP sensor	Tier 1 threshold	Tier 2 threshold
RB03_VW1	231.2	242.2
RB03_VW2	168.8	169.5
RB03_VW3	125.9	129.7
RB03_VW4	142.2	142.4
RB04_VW1	280.7	244.5
RB04_VW2	127.6	173.3
RB04_VW3	140.4	141.2
RB04_VW4	135.7	138.7
RB05_VW1	256.8	262.5
RB05_VW2	209.9	211.3
RB05_VW3	188.0	190.8
RB05_VW4	195.8	216.6
REG1_VW1	260.6	259.4
REG1_VW2	259.5	258.3
REG1_VW3	255.9	258.2
REG1_VW4	244.8	258.4
REG2_VW1	310.1	295.1
REG2_VW2	No predicted impact – triggers based on 5 th /95 th threshold	
REG2_VW3	301.4	272.4
REG2_VW4	262.6	235.9
REG7_VW1	No predicted impact – triggers based on 5 th /95 th threshold	
REG7_VW2	249.6	228.8
REG7_VW3	242.3	224.9
REG8_VW1	270.0	260.4
REG8_VW2	163.9	186.0
REG8_VW3	183.5	177.9
REG9_VW1	308.0	278.2
REG9_VW2	252.3	205.5
REG9_VW3	239.8	204.0

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VWP sensor	Tier 1 threshold	Tier 2 threshold
REG10_VW1	269.4	276.1
REG10_VW2	226.2	230.7
REG10_VW3	225.8	226.7
REG10_VW4	223.2	226.6

8.2.3 Groundwater Quality

As discussed in Section 8.2.1, groundwater level and quality data, including the wide range of parameters, have been analysed to identify location-specific baseline conditions/period by the methods described in Section 6.2. Review of the baseline data have identified representative parameters to adopt for groundwater quality thresholds. 5th and 95th percentile triggers for pH, TDS and sulfate concentrations have been calculated and are presented on the control charts included in Attachment C. The trigger thresholds for each monitoring site and water quality indicator are summarised in Table 8-4.

Table 8-4 Water quality trigger thresholds

Monitoring location	Trigger threshold calculated from baseline data					
	TDS (mg/L)		pH		SO4 (mg/L)	
	5%	95%	5%	95%	5%	95%
BAS1	259	391	6.9	7.6	10	29
BAS2 *	527	789	7.0	7.6	101	168
BRE2	1,314	2,976	7.8	8.3	1	18
GW002831 *	727	826	7.6	7.9	38	42
GW006567 *	1,065	1,155	8.4	8.5	37	38
MOR1	766	999	7.6	8.1	33	48
MOR2	47	134	7.3	8.0	1	1
Morse-GW1869	496	787	7.2	7.8	7	47
SCHOOL	19	313	6.6	7.7	2	21
TESTON	790	1,412	7.3	8.0	10	61
TRALEE	716	788	7.1	7.8	17	42
WHAN	193	318	7.1	7.7	7	49
WOL1	265	347	7.2	7.9	30	39
WOL2	284	404	8.0	8.3	5	15
MAC1280	1,440	2,460	11.5	12.6	1	36
RB05a	825	1,095	7.4	8.0	50	117
Reg12	1,085	1,431	7.5	8.4	44	71
Reg13	1,873	2,580	7.7	11.5	821	1445
Reg14	451	712	7.6	8.5	29	80
Reg3	598	791	7.9	8.5	74	107
Reg4	411	762	8.3	11.7	9	29

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Monitoring location	Trigger threshold calculated from baseline data					
	TDS (mg/L)		pH		SO4 (mg/L)	
	5%	95%	5%	95%	5%	95%
Reg5	943	1,221	7.4	8.3	103	295
Reg6	955	1,415	7.8	10.5	109	180
Reg7a	380	548	7.2	8.0	25	60
GW967138_1	TBC	TBC	TBC	TBC	TBC	TBC
GW967138_2	TBC	TBC	TBC	TBC	TBC	TBC
GW041027_1	TBC	TBC	TBC	TBC	TBC	TBC
GW030129_1	TBC	TBC	TBC	TBC	TBC	TBC
GW030472_1	TBC	TBC	TBC	TBC	TBC	TBC
GW030472_2	TBC	TBC	TBC	TBC	TBC	TBC
GW030472_3	TBC	TBC	TBC	TBC	TBC	TBC
Roma Windmill	TBC	TBC	TBC	TBC	TBC	TBC
Roma MB	TBC	TBC	TBC	TBC	TBC	TBC
Brighton Bore 3	TBC	TBC	TBC	TBC	TBC	TBC
Brighton Bore 2	TBC	TBC	TBC	TBC	TBC	TBC

Notes

* = Interim water level triggers as insufficient data has been recorded; and TBC = to be confirmed.

The control charting method has not been adopted for metal concentrations as these are typically less variable. Dissolved metal concentrations will be compared to the most appropriate ANZECC guidelines depending on the environmental value of the monitored hydrostratigraphy, which generally draws water for stock, domestic and irrigation purposes.

8.2.4 Groundwater Quantity

The total volume of incidental, passive and consumptive groundwater take will be tabulated each year and reported in the annual review. The next three years will also be reported and compared to WALs held by MCCM to demonstrate there is sufficient water held to account for water taken incidentally, passively and consumptively. Should the estimated annual groundwater take be greater than the water access licenses held by MCCM then additional units will be acquired or transferred on the water market.

The flow and volume recorded on the flowmeters of each extraction bore will be reported in the Annual Review.

8.2.5 Groundwater Dependent Ecosystems

The outcome of the GDE survey work, updated monitoring program and TARPs shall be included in future updates of the WMP.

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8.2.6 Summary of Triggers

The control chart triggers for groundwater levels, quality and water take are summarised in Table 8-5.

Table 8-5 Control chart triggers for groundwater levels, quality and pit inflows

Component	Applicable to	Control chart triggers
Groundwater level	All standpipe monitoring bores	5% / 95% of baseline data
	All VWP's	Two tier approach
	All monitored water supply bores	5% / 95% of baseline data
Groundwater quality (pH, TDS and SO ₄)	All Standpipe monitoring bores	5% / 95% of baseline data
	All monitored water supply bores	5% / 95% of baseline data
Groundwater quality (metals)	All standpipe monitoring bores	Three exceedances of appropriate ANZECC guidelines based on beneficial use
	All monitored water supply bores	Three exceedances of appropriate ANZECC guidelines based on beneficial use
Water take	Incidental, passive and consumptive groundwater take	> 100 % of Water Access Licences units for each applicable water source affected by MCCM

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8.3 TRIGGER ACTION RESPONSE PLAN

The performance measures and control thresholds described in the previous two sections form the basis of a trigger action response plan (TARP) that outlines actions and responses in the event trigger thresholds are exceeded. The exceedance of a trigger threshold on their own occurrence does not indicate when and what mitigation, management or ceasing work may be an appropriate response. The re-confirmed exceedances will prompt an investigation, carried by suitably qualified personnel, to determine the reasons for triggers, which could include but not be limited to climatic conditions, agriculture abstraction and mining activities. In the case exceedances are attributed to mining activities, the changes in groundwater conditions, such as a decrease in water level or increase in salinity, will be compared to performance measures (discussed in Section 8.1) to evaluate the significance of any impacts manifested on the groundwater systems. The procedures to be undertaken in the event of a trigger event is graphically summarised Figure 8-2.

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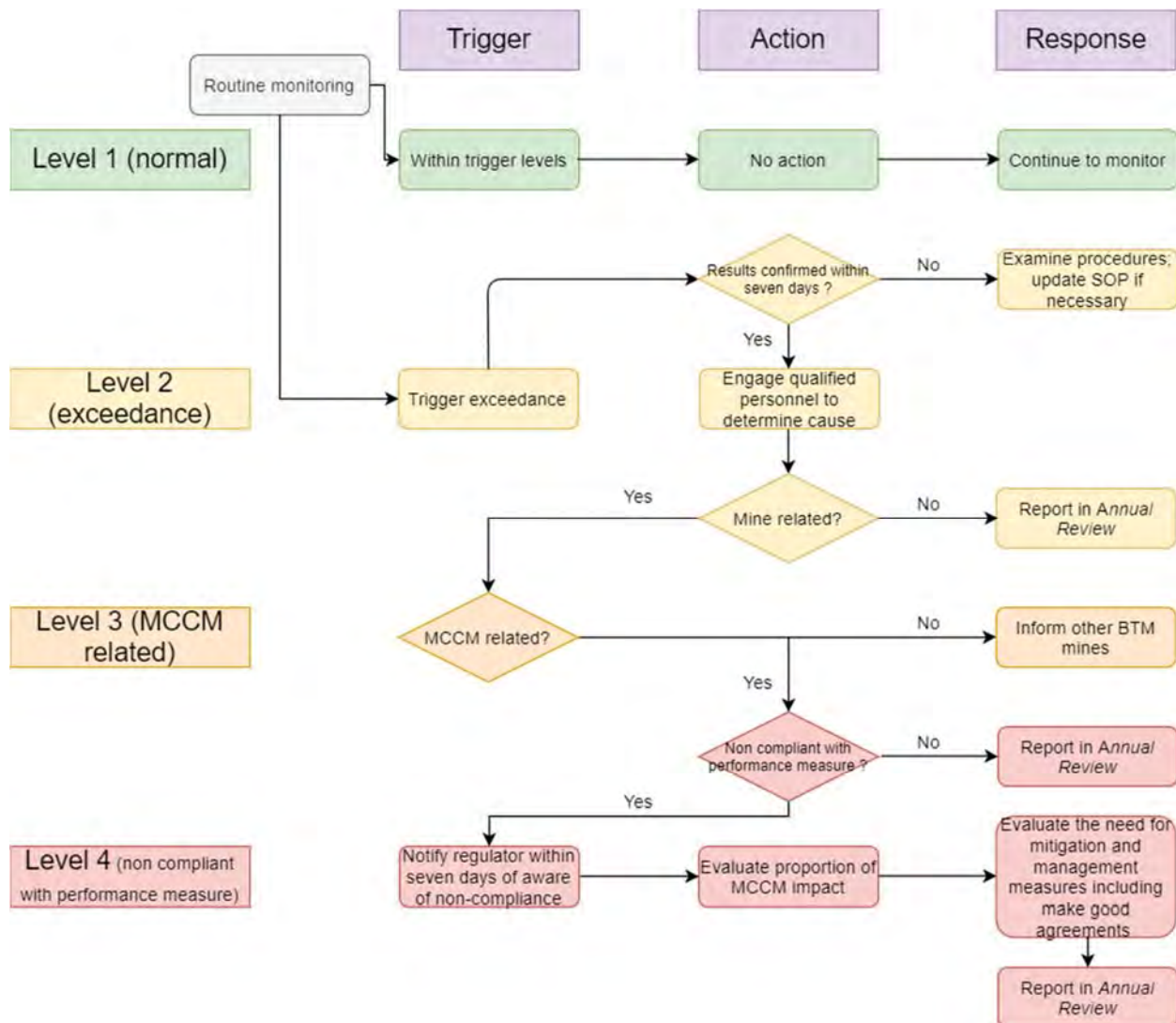


Figure 8-2 Flowchart and decision tree of procedures to be undertaken for trigger events

The results of the trigger investigations will be reported in each annual review. Each year if it is clear the baseline dataset is changing in response to factors not related to mining such as climate or agriculture then the trigger thresholds will be recalculated, and the control thresholds adjusted to improve the baseline statistics. When this occurs the GWMP will be updated.

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9 CUMULATIVE IMPACTS AND MONITORING LOCATIONS

The close proximity of the BTM mining operations will result in a cumulative impact whereby the zones of depressurisation produced by each operation overlap and become more extensive in the overlapping areas. As per the recommendations of the Groundwater Impact Assessment presented in the Maules Creek Coal Project Environmental Impact Statement (Hansen Bailey 2011), MCCM established a regional monitoring network (the REG series of bores) in 2013 specifically designed to monitor and manage cumulative groundwater impacts resulting from mining activities. This series of bores is currently monitored and with exceedances investigated by MCCM.

Should the resultant investigation, as outlined by the TARP in Section 8.3, conclude the exceedance is attributed to mining within other BTM mines and resulted in performance measures not being met then the BTM Water Management Strategy will be used to determine how the complex implements management and mitigation measures.

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10 GROUNDWATER MODEL VALIDATION

The validity of the groundwater model predictions will be reviewed every three years against water level data and estimates of water take to determine if the model is providing useful predictions. If the numerical model predictions do not compare well with the observations over the previous three year period, then the numerical model will be updated and if necessary recalibrated. Predictions of water level changes and water take will be undertaken using the updated model. The uncertainty in predictions will also be assessed.

Where changes to the nature of the predicted impacts is identified through the modelling then the suitability of the monitoring network and water supply bore monitoring will be reviewed to determine if changes are warranted.

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11 REPORTING

11.1 ANNUAL REVIEW

The results of groundwater monitoring data will be compiled in the Annual Review. The results of any trigger exceedance investigations will also be summarised in the Annual Review.

11.2 MODEL VALIDATION

The validation of the groundwater model will be reported every three years commencing August 2024.

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12 FINAL VOID

12.1 PAC REQUIREMENTS

During the review of the Maules Creek Coal Project by the PAC, it was suggested that there may be potential adverse impacts to the quality of groundwater resources post mining, should rejects and Potentially Acid Forming (PAF) materials not be managed appropriately.

As per Schedule 6 of PA 10_0138, the expert advisor to the PAC recommended gathering further hydro-geochemical information at MCCM, including:

- The proposed 17 additional monitoring bores be equipped with water level or pore pressure monitoring transducers installed at vertical separations such that the future impacts of strata depressurisation can be adequately measured and mapped;
- Core tests to be completed to assess the distribution and variability of hydraulic conductivities of (unfractured) interburden at sufficient number of bore locations to quantify porous groundwater flow and storage contributions associated with interburden;
- XRD-XRF analyses to be undertaken on core samples obtained at a sufficient number of bore locations to establish mineralogy of interburden likely to be exposed to pit resaturation;
- Hydro chemical modelling to be undertaken in order to determine the long term void water quality. This study should include batch reaction (full saturation) trials on waste interburden (spoils) to confirm hydro chemical modelling outcomes.

These requirements of collecting additional information have now been completed and is described in reports prepared by RGS (2019, 2020) and AGE (2017).

12.2 FINAL VOID MINE CLOSURE PLAN

A draft final void mine closure plan (FVMCP) was prepared in 2020 by MCCM. It was recommended the final version of the FVMCP that is due in 2026 include:

- using the updated BTM complex groundwater flow model to simulate water level recovery in the final void and provide estimates of groundwater inflow for the water balance model;
- collecting spoil samples from site and conducting laboratory testing to determine permeability and porosity (at emplaced pressure) for use in updated groundwater modelling;
- conducting additional column testing to resolve inherent uncertainties including:
 - replacing deionised water with groundwater collected from bores or in-pit at the MCCM;
 - replacing crushed core with actual spoil material collected from the MCCM emplacements;
 - using peristaltic pumps to pump groundwater through columns to represent gradual movement of groundwaters;
- continuing to investigate the timeframe for the first flush of salts using continued column testing and hydrochemical modelling; and

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- extending the period of hydrochemical modelling to estimate the period for which the void waters will have a beneficial use, as for example stock water.

This will be further considered prior to commencement of the Final FVMCP.

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13 REFERENCES

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Hansen Bailey (2011), Maules Creek Coal Project Environmental Impact Statement.

New South Wales Government (2020), “*Water Sharing Plan for the Namoi Alluvial Groundwater Sources Order 2020*”, Website accessed at: <https://legislation.nsw.gov.au/view/html/inforce/current/sl-2020-0346>

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RGS (2019). *Final Void Hydrogeochemical Assessment – Maules Creek Coal Mine*. Report No. 2018041, dated 06/09/2019

RGS (2020). *Characterisation of Mining Waste Materials – Maules Creek Coal Mine*. Report No. 2017003, dated 12/10/2020

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14 ATTACHMENT A – BOREHOLE CONSTRUCTION LOGS

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15 ATTACHMENT B – STANDARD OPERATING PROCEDURES

Standard Operating Procedure on Field Documentation, Groundwater Level Gauging, Groundwater Sampling and Appropriate Storage and Handling Practices

1) Purpose

These procedures describe the approach to be taken for the collection, storage/handling and documentation of representative groundwater samples.

2) Scope

These procedures apply to groundwater monitoring and sampling activities for Maules Creek Coal Mine. Where there is substantial variation from these procedures, a note must be made in the job briefing sheets or field notes describing the procedure that is to be used.

3) Procedures

3.1) Field equipment

All necessary equipment to conduct the groundwater sampling should be checked prior arriving on site. Field equipment required to conduct the perform the groundwater sampling include:

- Water level dipper;
- Tape measure;
- GPS unit;
- Tablet, Laptop or similar for pressure logger data download;
- Water quality meter with sensor probes for pH, electrical conductivity, temperature and redox potential, and appropriate calibration solutions;
- Appropriate personal protective equipment including long sleeve shirt and long pants, hard hat or broad brimmed hat, sun screen, gloves, protective eyewear and protective footwear;
- Water quality sample bottles;
- Filters and syringes;
- Nitrile gloves;
- Freshwater for rinsing;
- 12 fridge or cooler box and ice;
- Bailer or submersible pump; and
- Decontamination liquid to rinse reusable equipment.

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3.1) Field notes

Written or digital records must be maintained for groundwater monitoring and sampling activities. These records must cover field observations and give an account of daily works and events. Paper based records must be protected from the elements and all entries made in indelible ink. Field data recorded digitally in the field using a tablet, laptop or similar device must be backed up to a secondary storage device on a regular basis (e.g. daily).

Field observations collected shall include the following:

- Weather conditions;
- GPS coordinates and elevation of bore if survey has not been completed yet;
- Health and safety issues on site;
- Description of the conditions of the monitoring bore;
- Total depth of bore (where possible);
- Results of any field testing;
- Calibration results of water quality meter;
- Details of samples collected including time and date, sample, identification number and bore location, procedures used in sample collection, and instrument readings;
- Descriptions of visual and olfactory characteristics during each measurement including details such as elapsed time, volume purged, colour, turbidity, odour, sheen etc. when performing a well purge; and
- Photographs of the monitoring location visited.

Supporting information such as safety plans, site plans, and a copy of this standard operating procedures must be accessible to the field sampler when conducting monitoring and sampling.

3.2) General sampling procedures:

1. Record the condition, coordinates and elevation.
2. Record depth to standing groundwater level in the bore with a water level meter. Depth measurements should be referenced to an established datum or measuring point (e.g., top of bore casing).
3. Retrieve pressure logger (if present) within bore. Download data from pressure logger with correct cables and software with laptop.
4. Record the top of bore casing from ground level.
5. Decontaminate all reusable sampling equipment (i.e., pumps and cables) prior to use at each location.
6. Ensure that the water quality meter has been calibrated within the last 24 hours.
7. Compute water volume in the bore with standing water level, bore depth and bore diameter.

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8. Lower the decontaminated pump or bailer into the bore. Ensure discharge outlet is placed at distances from bore when utilising a pump setup. Safe manual handling practices must be followed when lifting / carrying sampling equipment. Note any trip hazards prior to proceeding. If required; seek assisting when lifting heavy equipment and the position the field vehicle to minimise carry distance.
9. During purging, field water quality parameters such as pH, electrical conductivity, redox potential, temperature and sediment load should be recorded at regular intervals. Once sediment load is minimal, three bore volumes have been removed and field parameters are stable (within 10%, within 0.2°C for temperature), a groundwater sample can be collected.
10. Low yielding wells that do not yield three bore volumes in one visit should be purged dry and left to recover. Following recovery of groundwater levels, sampling can proceed as the recovered standing water should be representative of inflows from the screened hydrostratigraphic unit.
11. Scan the sample bottles with digital application provided by testing laboratory on tablet or mobile phone. If digital application is not available from testing laboratory, label sample bottles using a Xylene free permanent marker with details including bore name, sample round number, sampler name, date and time.
12. Record any other specific bottle filling instructions on the sample bottles before filling them. Note which samples need to be field filtered and/or contain preservatives such as acids.
13. Conduct filling of sample bottle with nitrile gloves.
14. For samples requiring field filtration, rinse and fill a new container with the water from the bore. Fill the syringe with water from the bore, attach the filter to the end of the syringe. Sit the filter over the sample bottle and push the water through from the syringe. Continue to do this until the sample bottle is full before screwing the cap on tightly.
15. Preserve samples in cooler boxes/eskies provided by testing laboratory that are chilled at or around 4°C. The cooler boxes will be sealed, clearly labelled with the name and address of the testing laboratory.
16. Ensure preservation of samples in cooler boxes do not exceed the recommended sample holding times. The holding times will vary according to the NATA-certified method being used by the laboratory and should be clarified with the nominated laboratory.
17. Include chain of custody (COC) form detailing each sample sent to the laboratory. A COC form must be completed while in the field. When groundwater samples are relinquished, ensure that the receiving party have signed the form indicating the time and date. A copy of the signed form must be retained and filed as a record of samples sent and analyses requested. Where electronic COCs are used, all digital records and emails must be filed appropriately.

Care must be given to avoid loss or decay of sample labels during storage and handling. The sample label must be written on the cap of the sample bottle if the decay of sample label is unavoidable. The sample will then be sealed and recorded in a chain-of-custody form from the laboratory nominated for the analysis.

3.3) Pressure logger/VWP download procedures:

1. Connect to pressure logger/VWP sensor with appropriate cable.
2. Download data once connection is secured.
3. Check the recording interval times for synchrony for all pressure loggers/barometric loggers/VWP sensors.
4. Record the battery storage and memory of pressure logger/VWP sensors.

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**Standard Operating Procedure on
Quality Assurance Sampling**

1) Purpose

The purpose of this procedure is to describe the approach to be taken for the collection of quality assurance samples during groundwater sampling.

2) Scope

This procedure applies when groundwater samples are collected.

3) Procedures

For the collection of the required field quality control (QC) samples refer to *SOP on Field Documentation, Groundwater Level Gauging, Groundwater Sampling and Appropriate Storage and Handling Practices*.

3.1) Quality assurance sampling

3.1.1) Field blind duplicates (Intra-laboratory duplicates)

Field blind duplicates are duplicate samples that are sent as independent samples to the same laboratory for analysis to assess the repeatability of the analytical results and the variation in analyte concentration between samples collected from the same sampling point. Field blind duplicates must be collected typically at a frequency of 1 in 20 samples (i.e., 5%).

Field blind duplicates must be taken simultaneously when the original sample is taken. Both the duplicate sample and the sample should be agitated as little as possible, preferably direct from the discharge line. The duplicates should be labelled without any indication of its original sampling point and sent for analysis as usual.

3.1.2) Field split duplicates (Inter-laboratory duplicates)

Field splits are duplicate samples that are sent to different laboratories for analysis to assess the analytical proficiency of the laboratories. Field split duplicates must be collected at a frequency of 1 in 20 samples (i.e. 5%). The combined blind and split frequency should be at least 10% of the total sample number. Field split duplicates are collected using the same procedures as for field blind duplicates.

3.1.3) Field blanks

Field blanks monitor possible contamination that may be accidentally introduced when actually collecting the sample in the field. A sample container must be filled with deionised water in the field, sealed, labelled and sent for analysis as usual.

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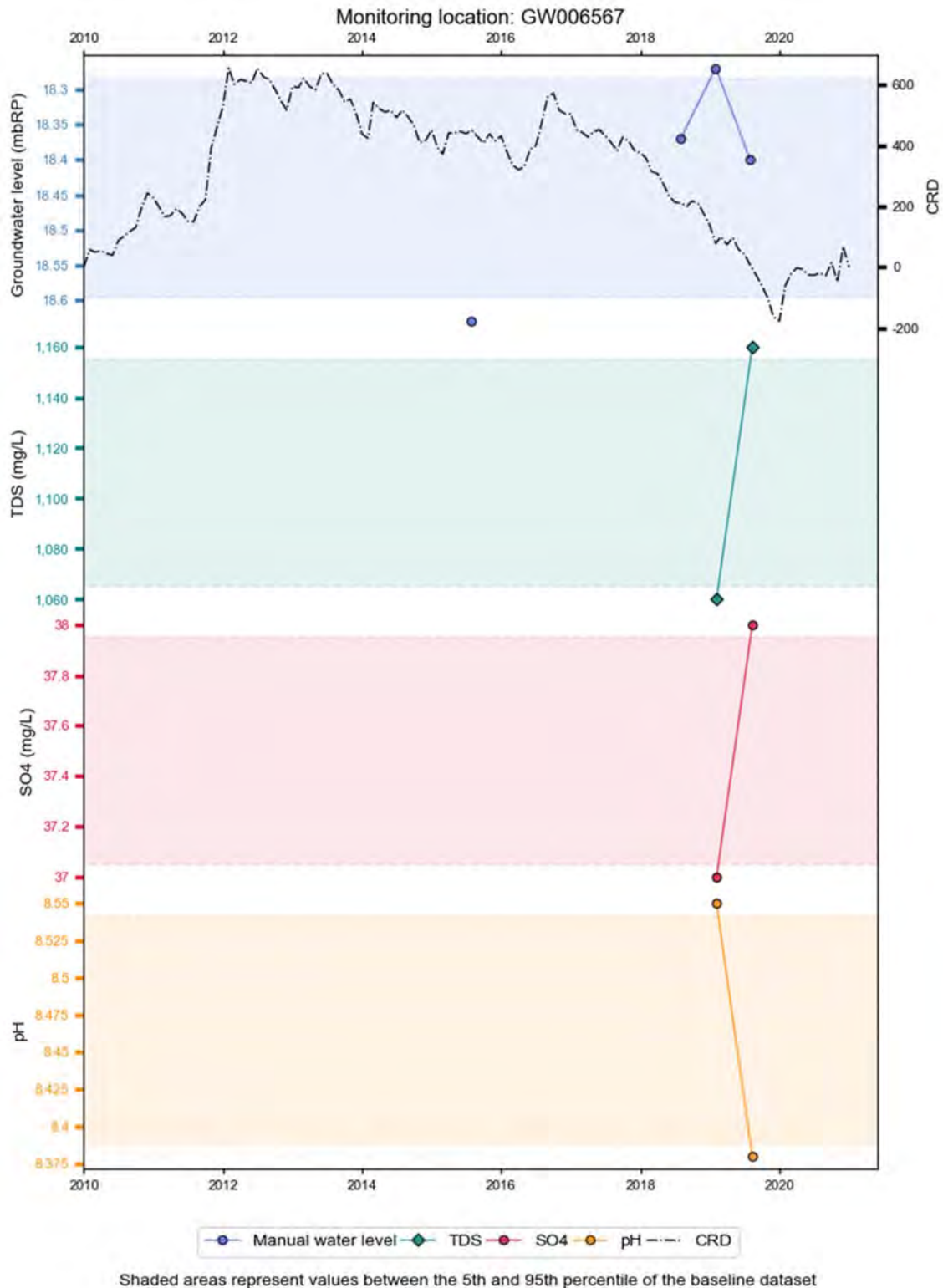
16 ATTACHMENT C – SUMMARY OF WATER LEVEL AND WATER QUALITY TIME SERIES DATA



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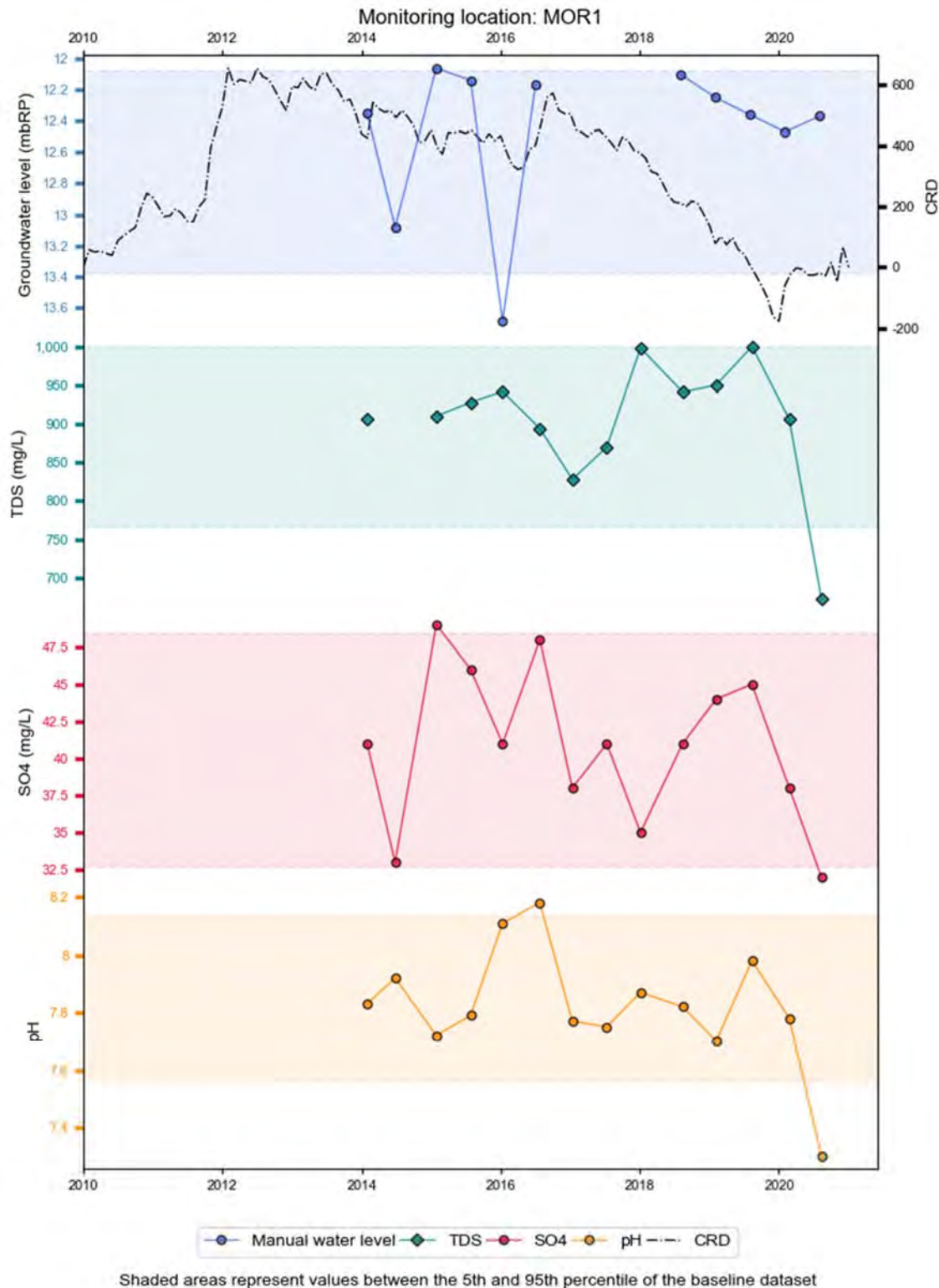




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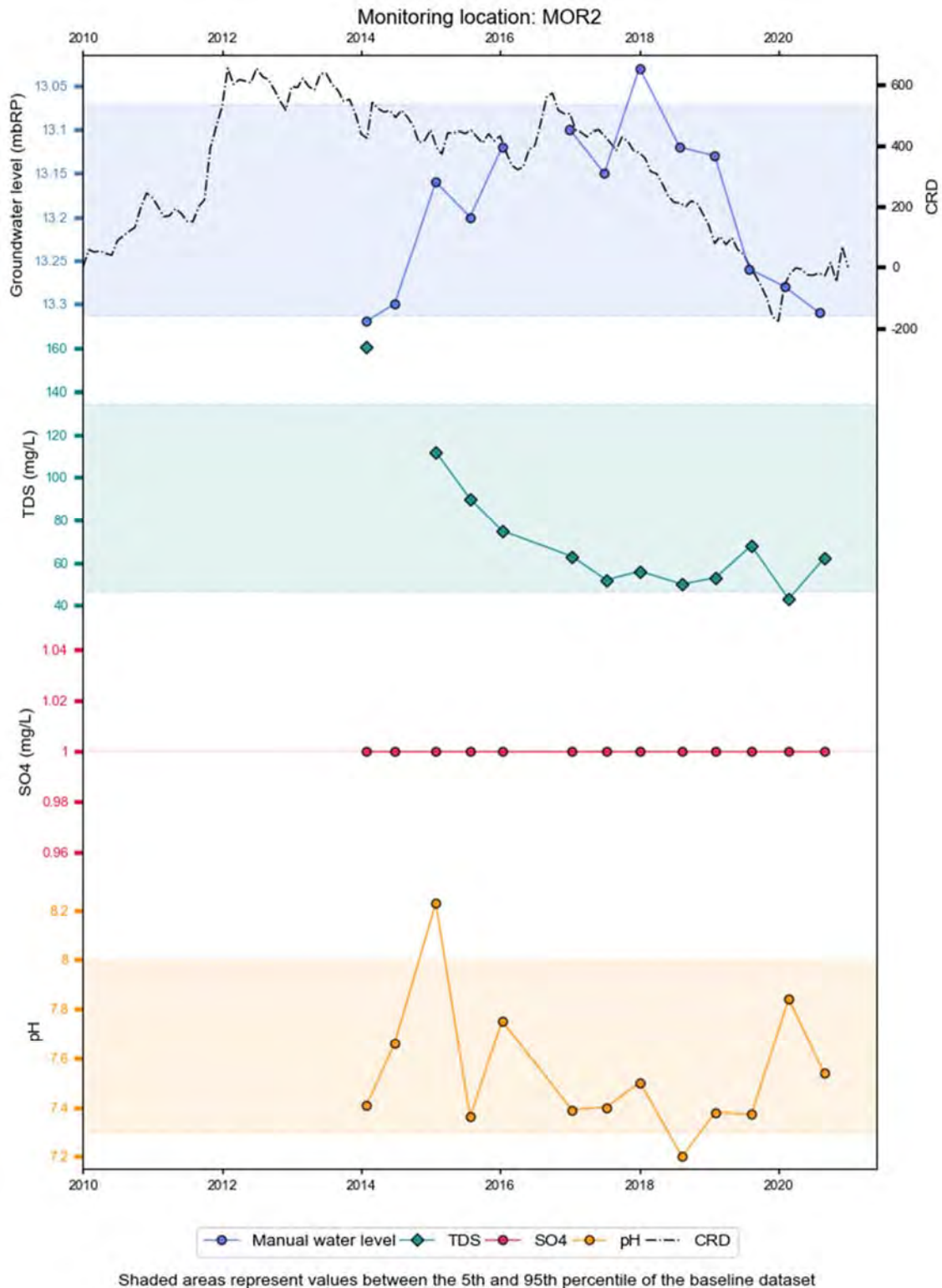




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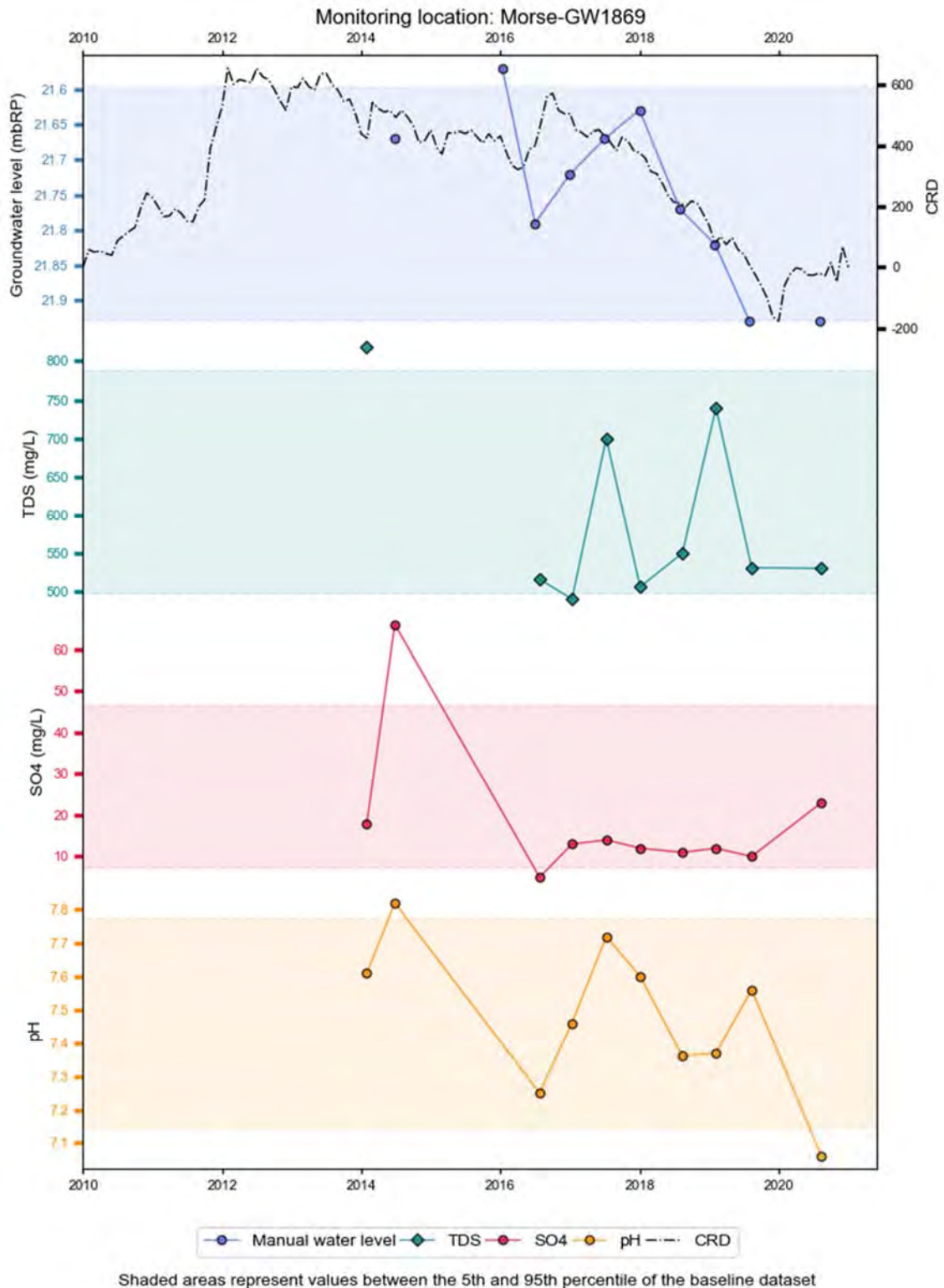




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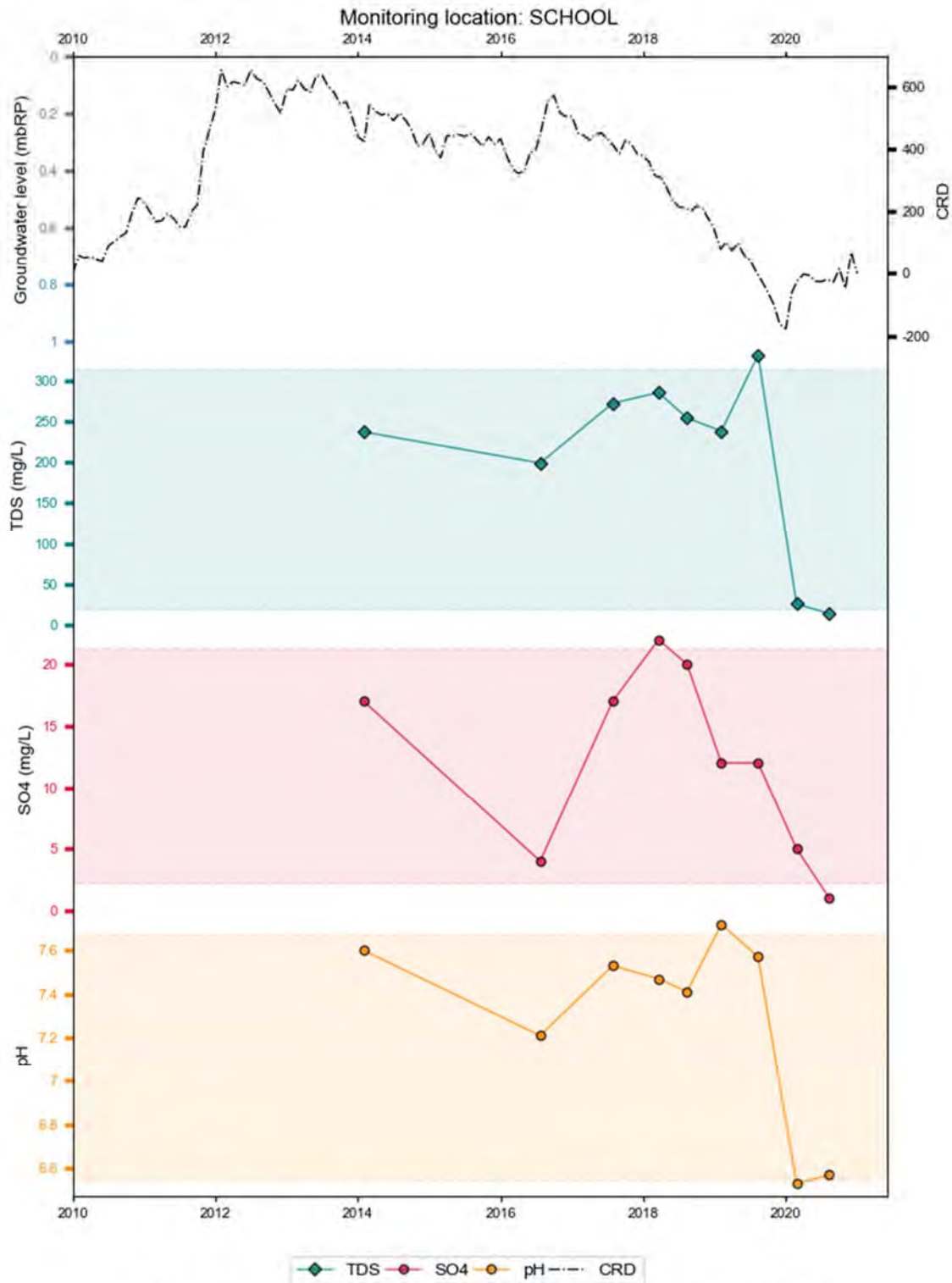




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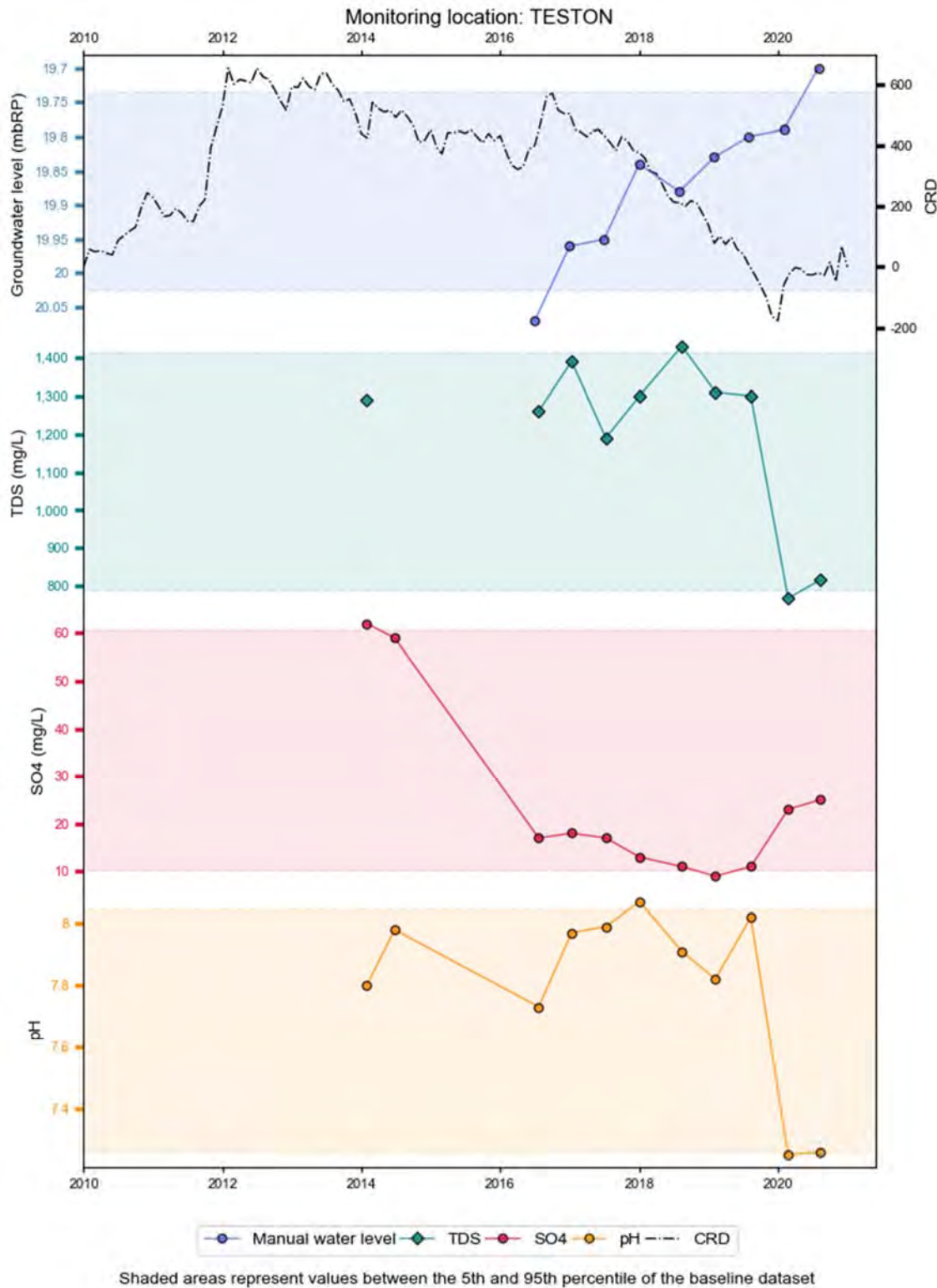
Shaded areas represent values between the 5th and 95th percentile of the baseline dataset



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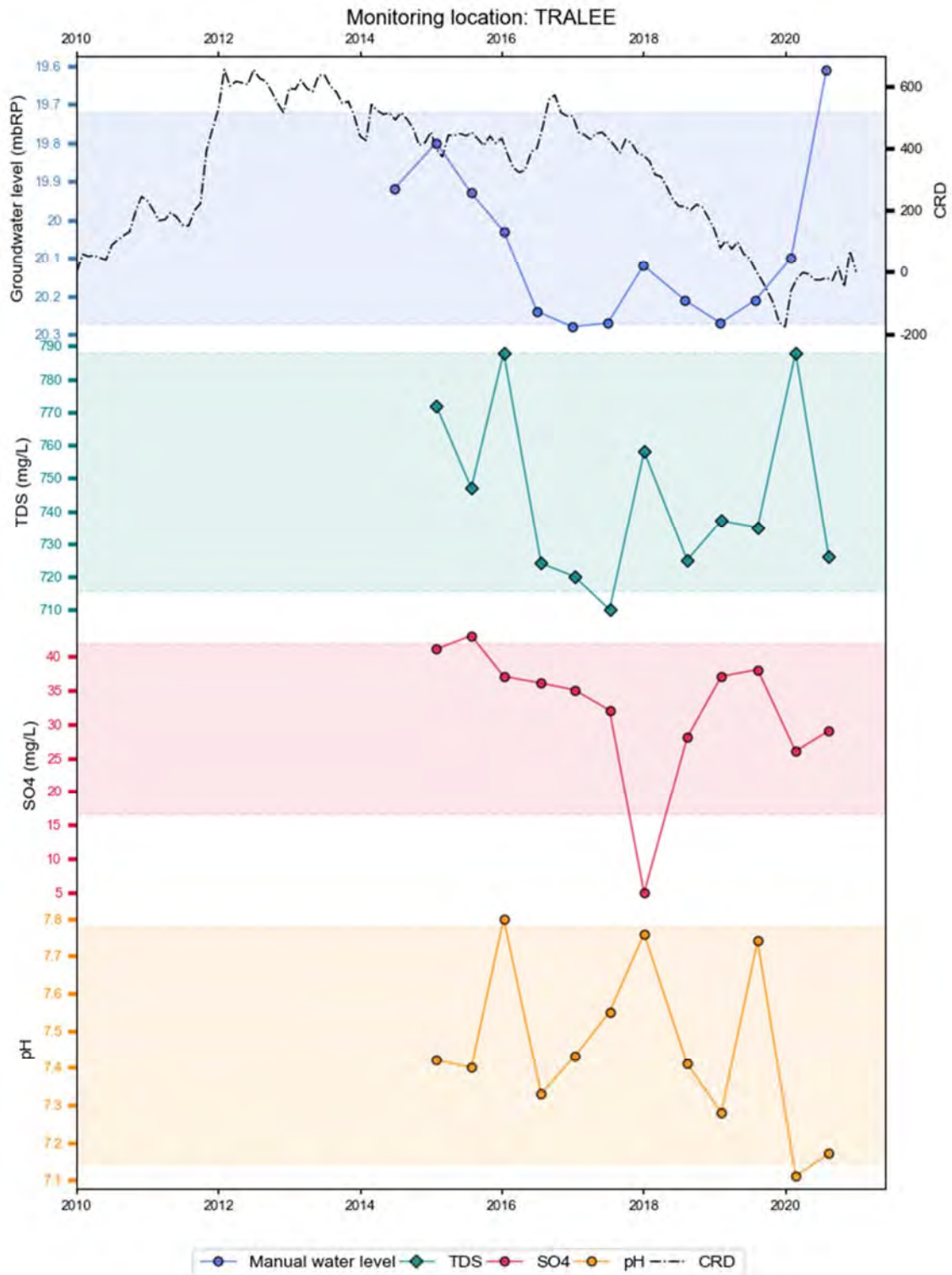




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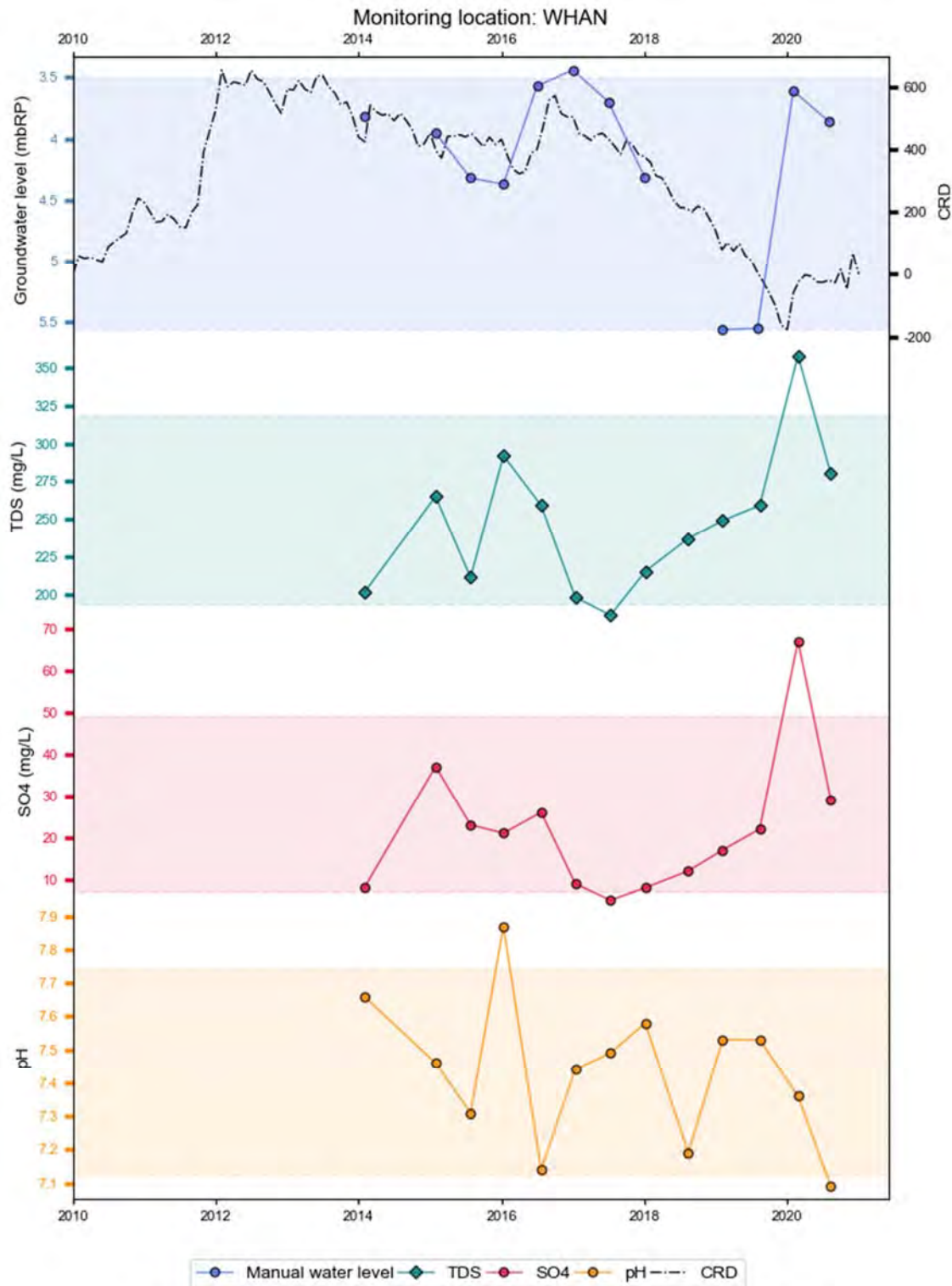
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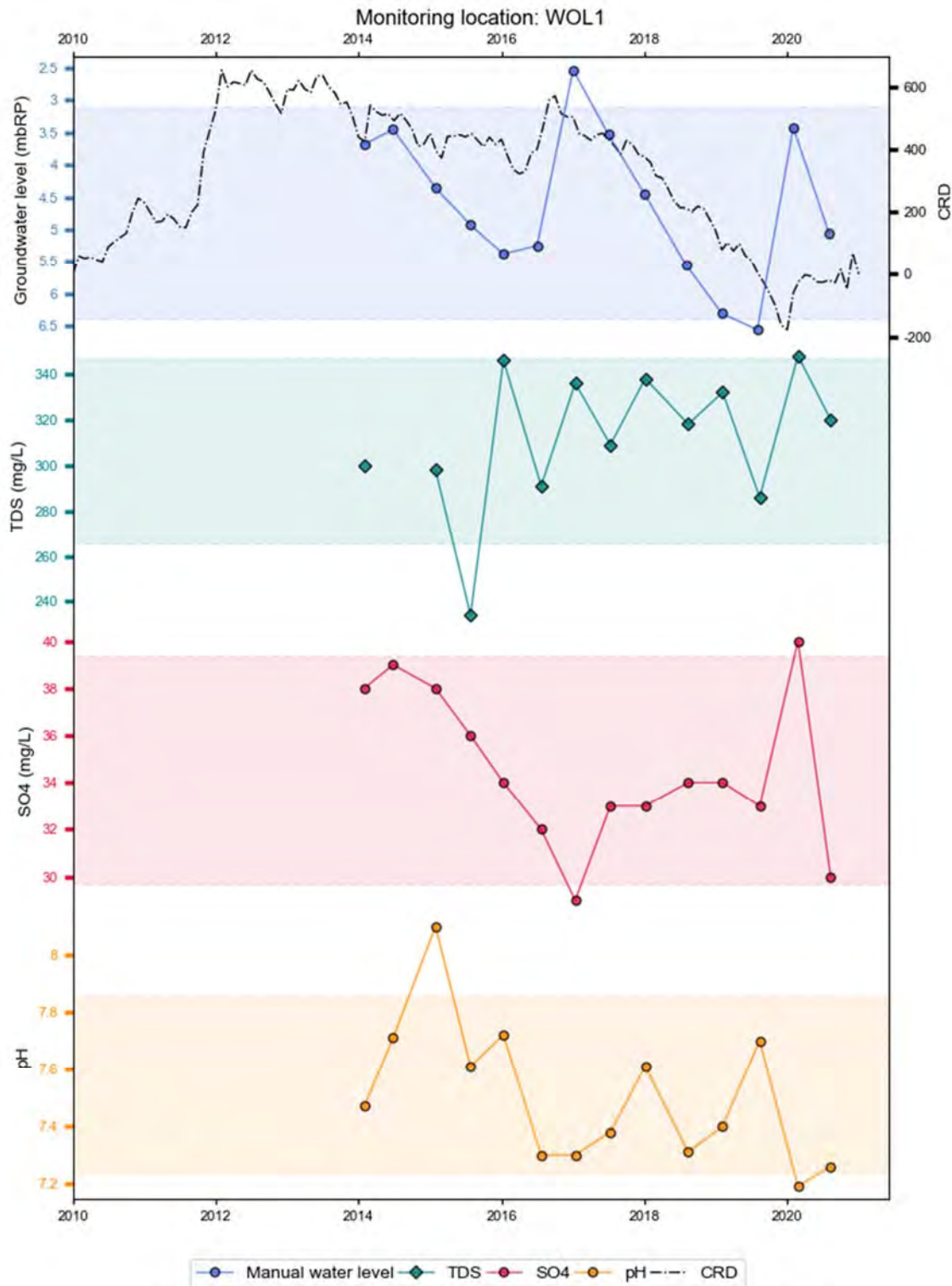
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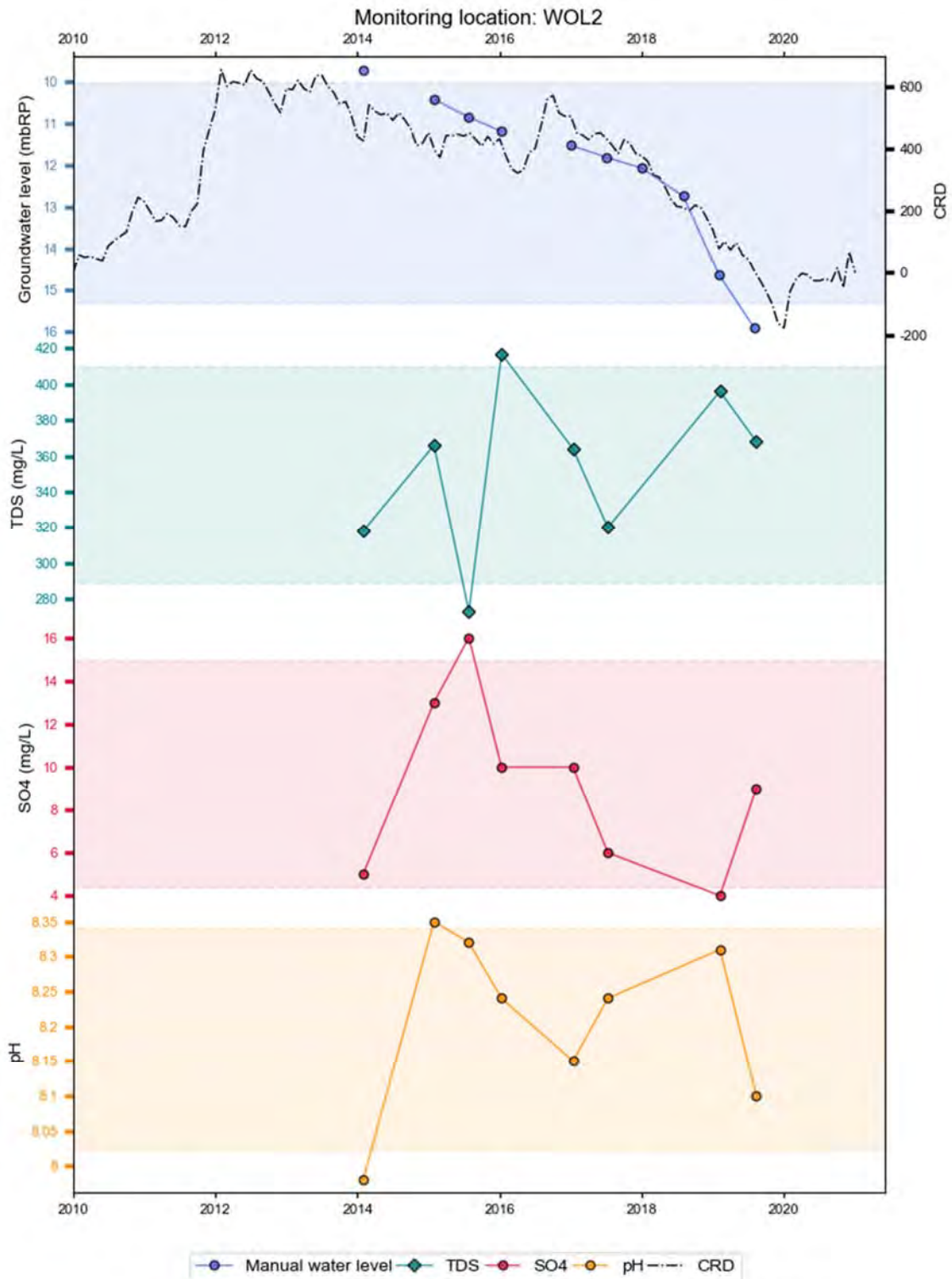
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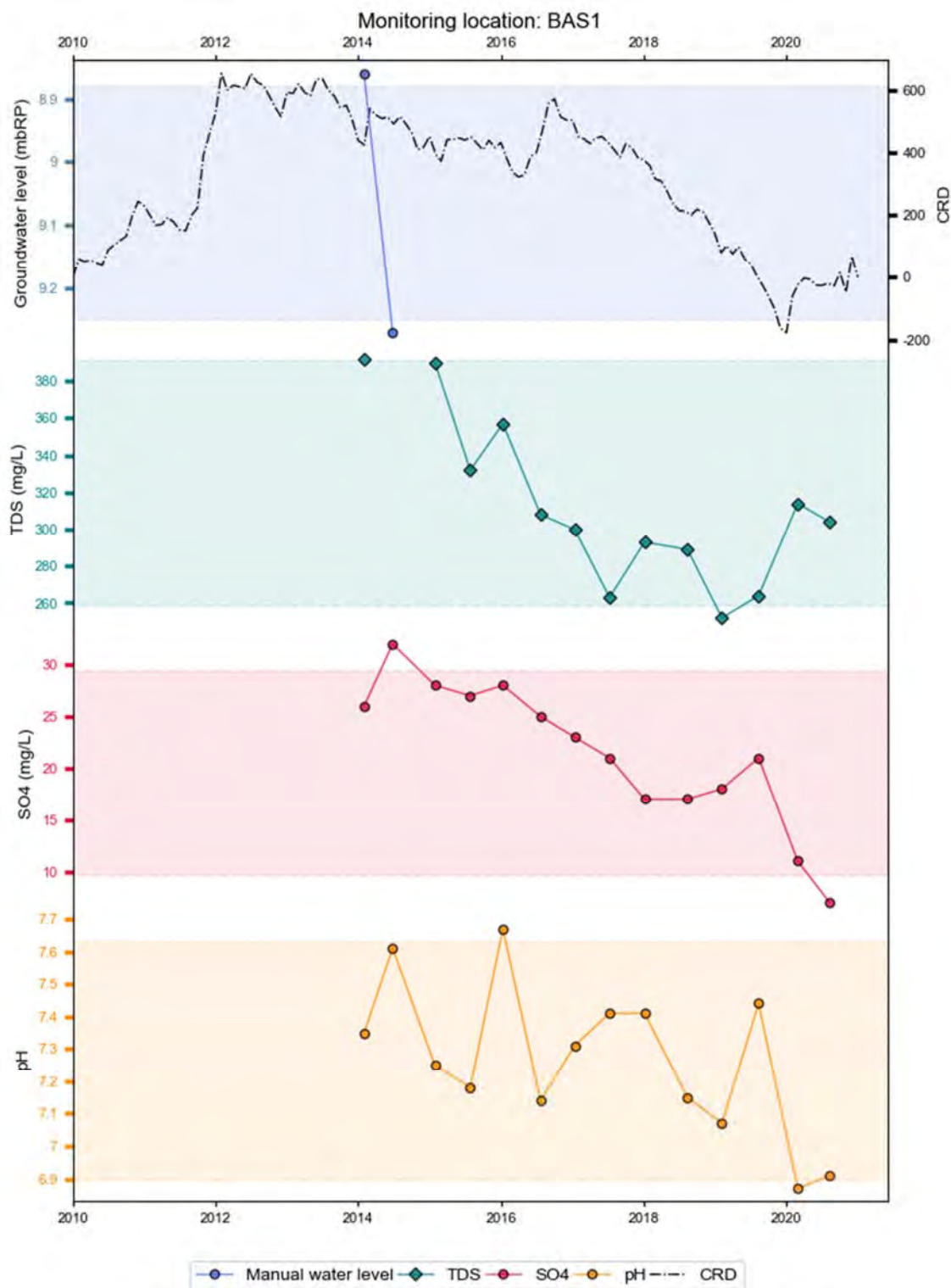
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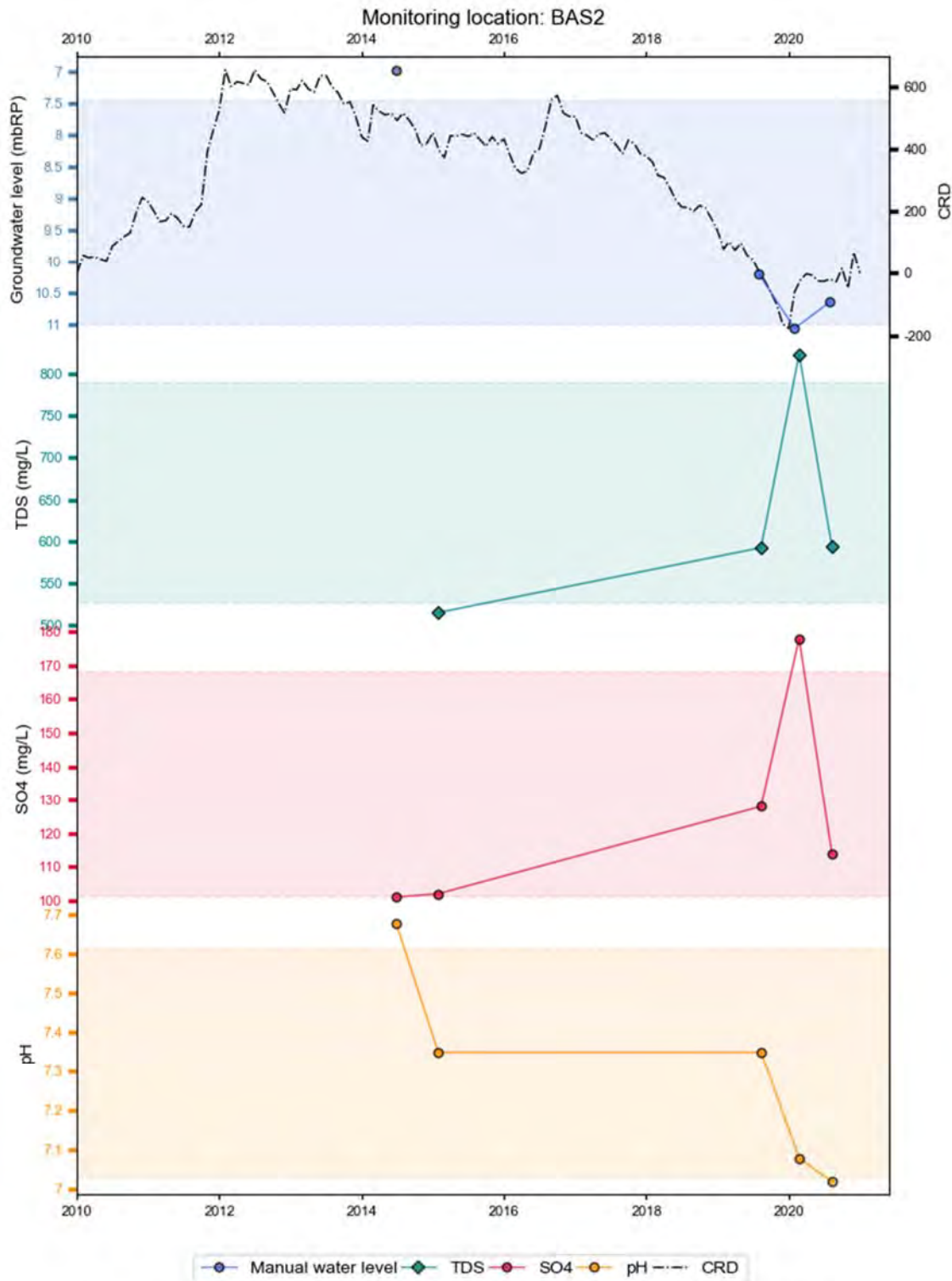
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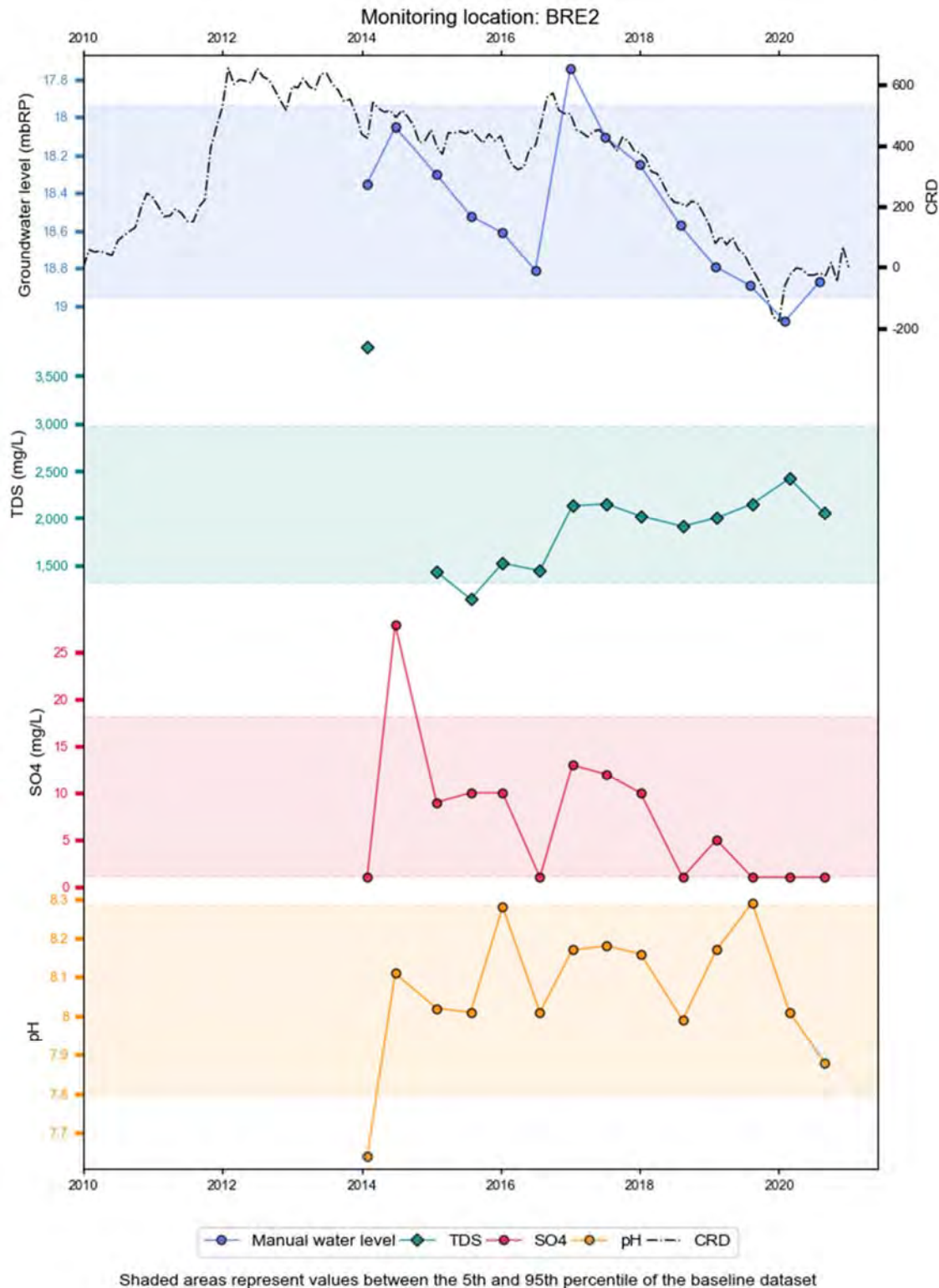




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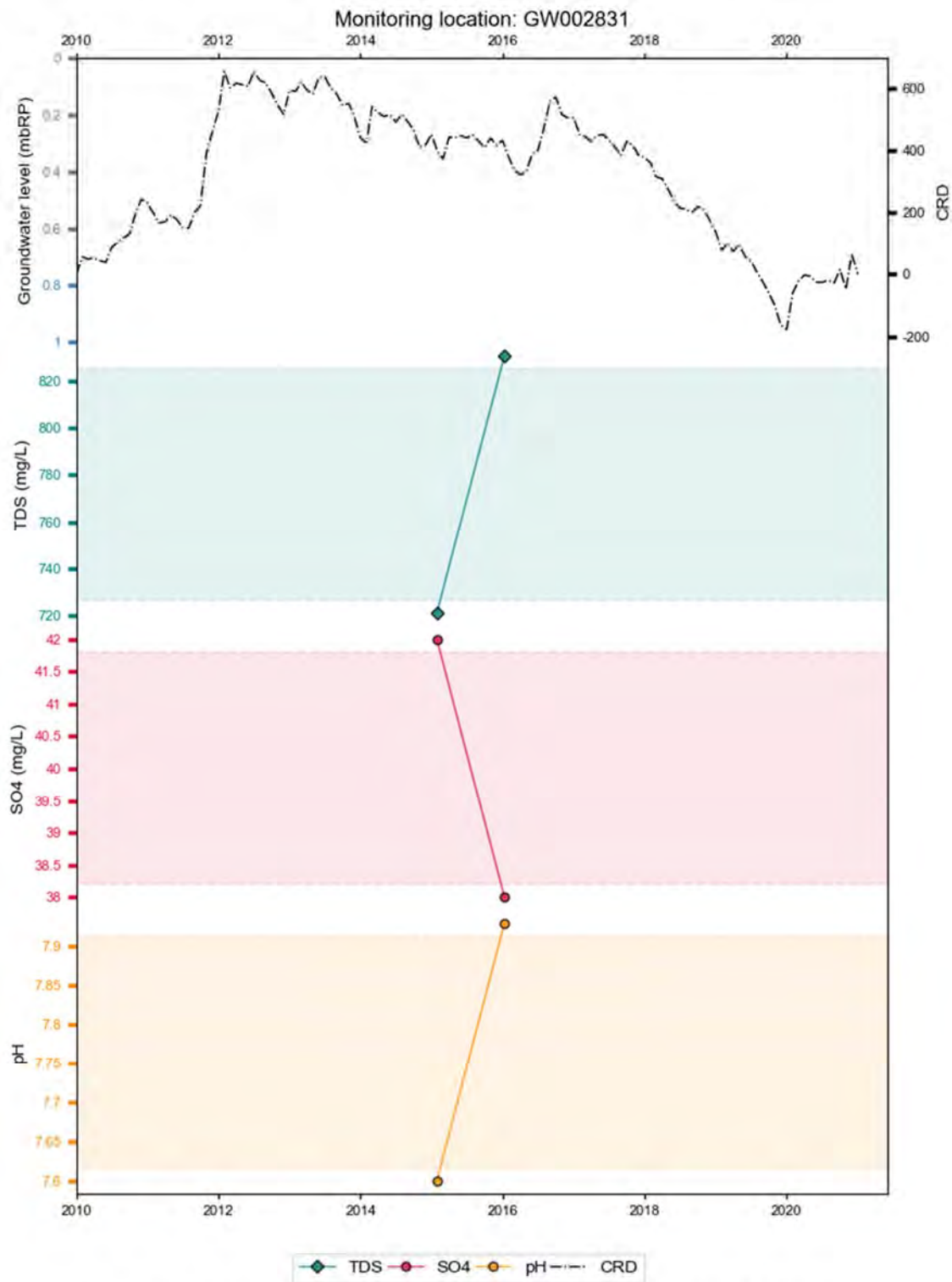




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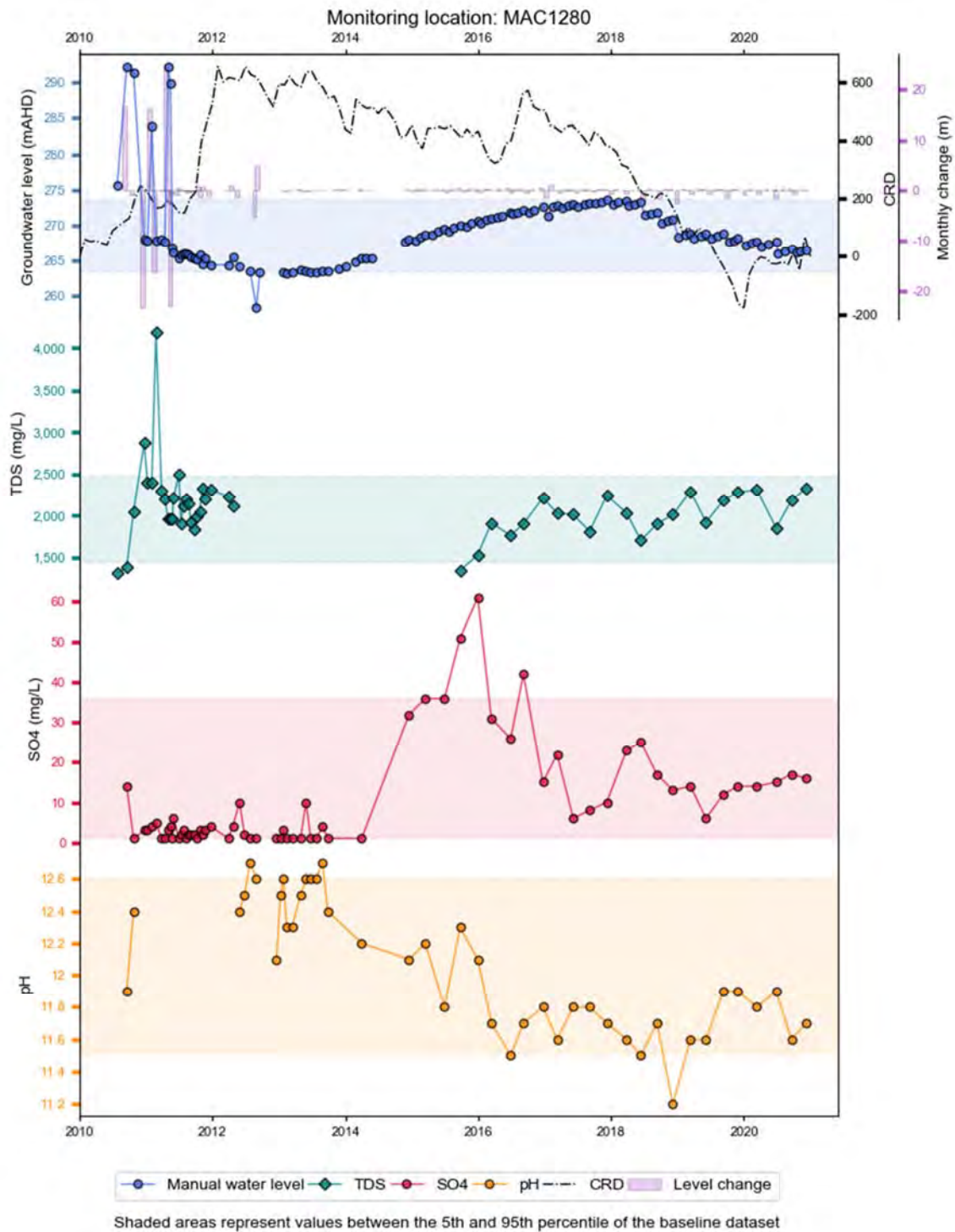
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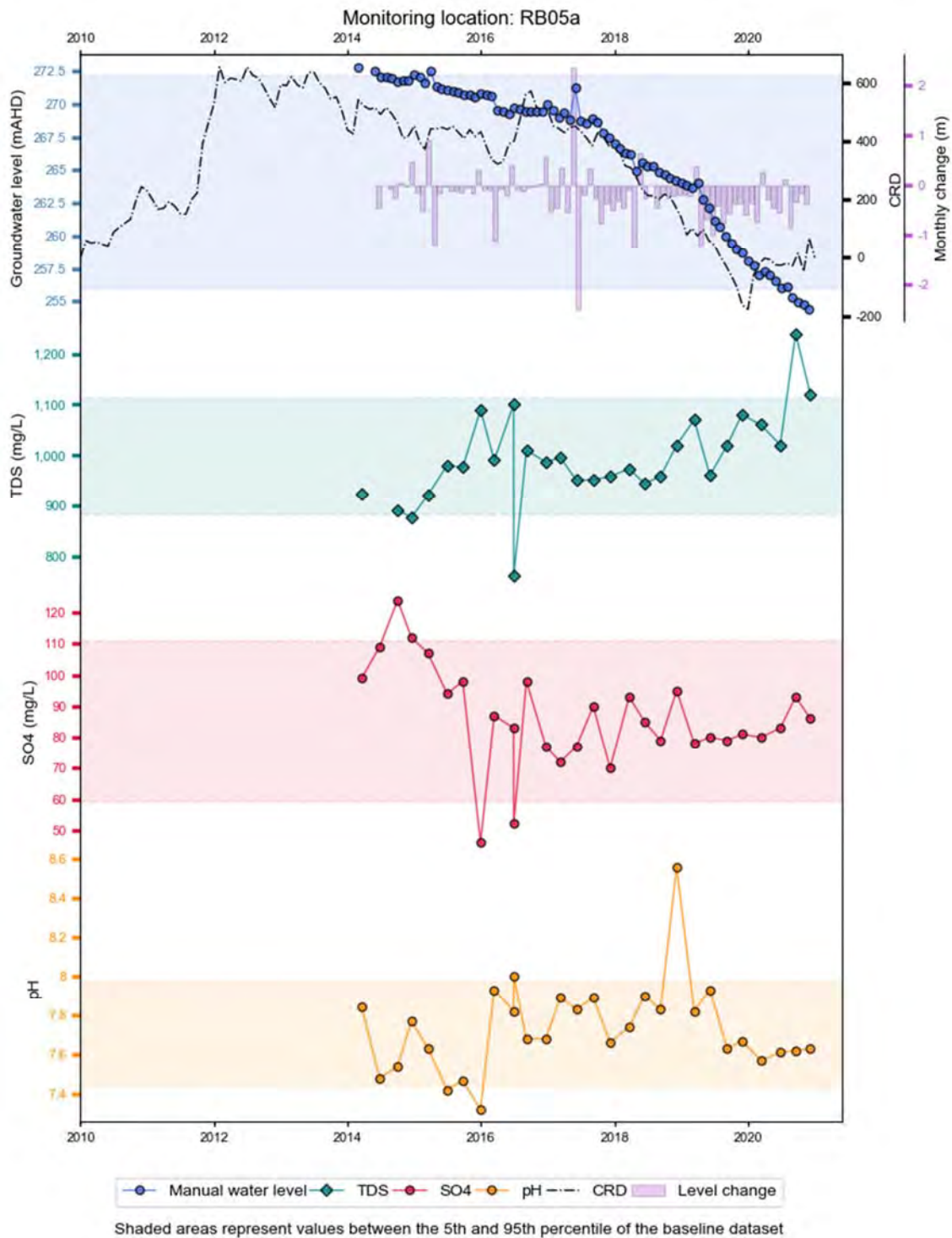




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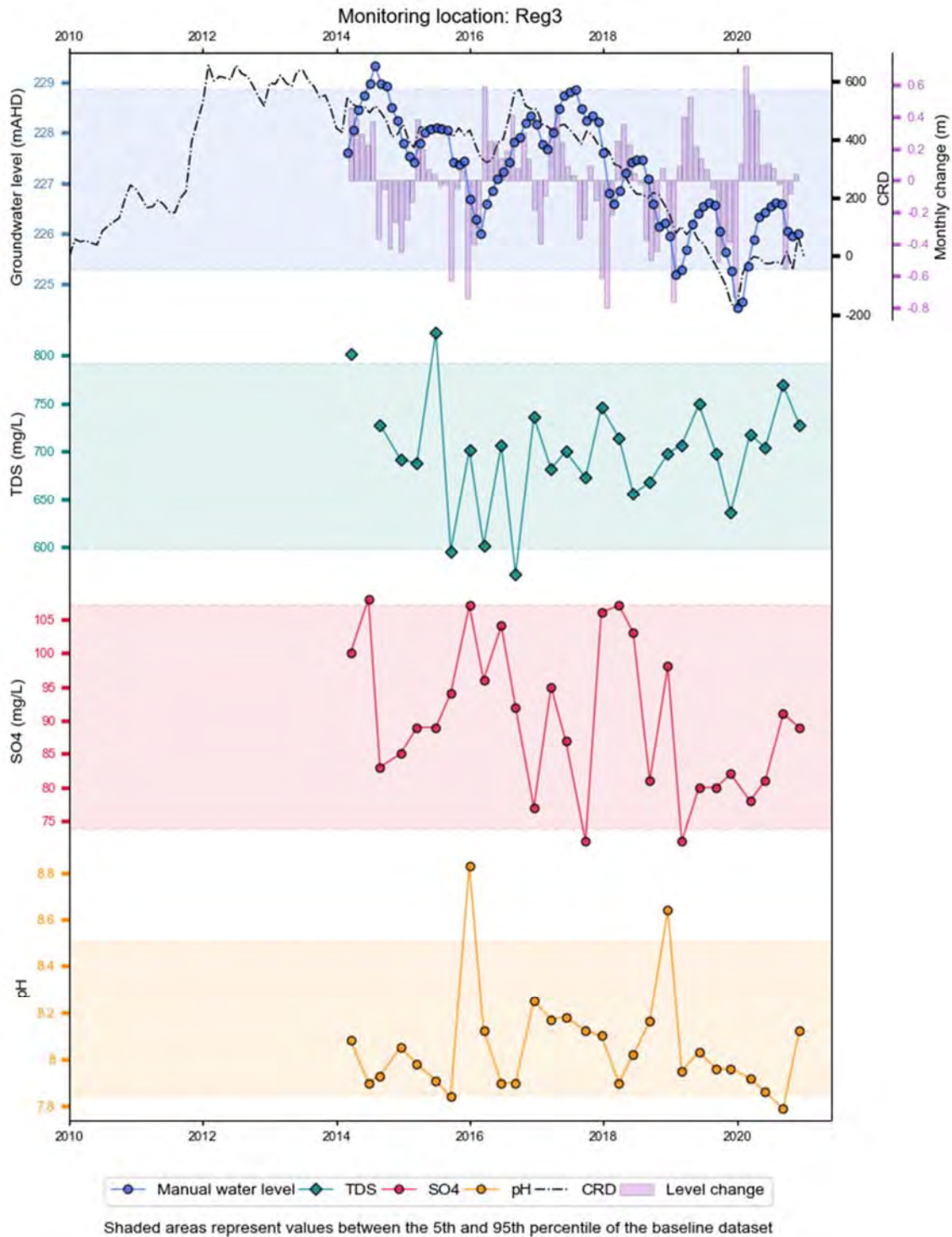




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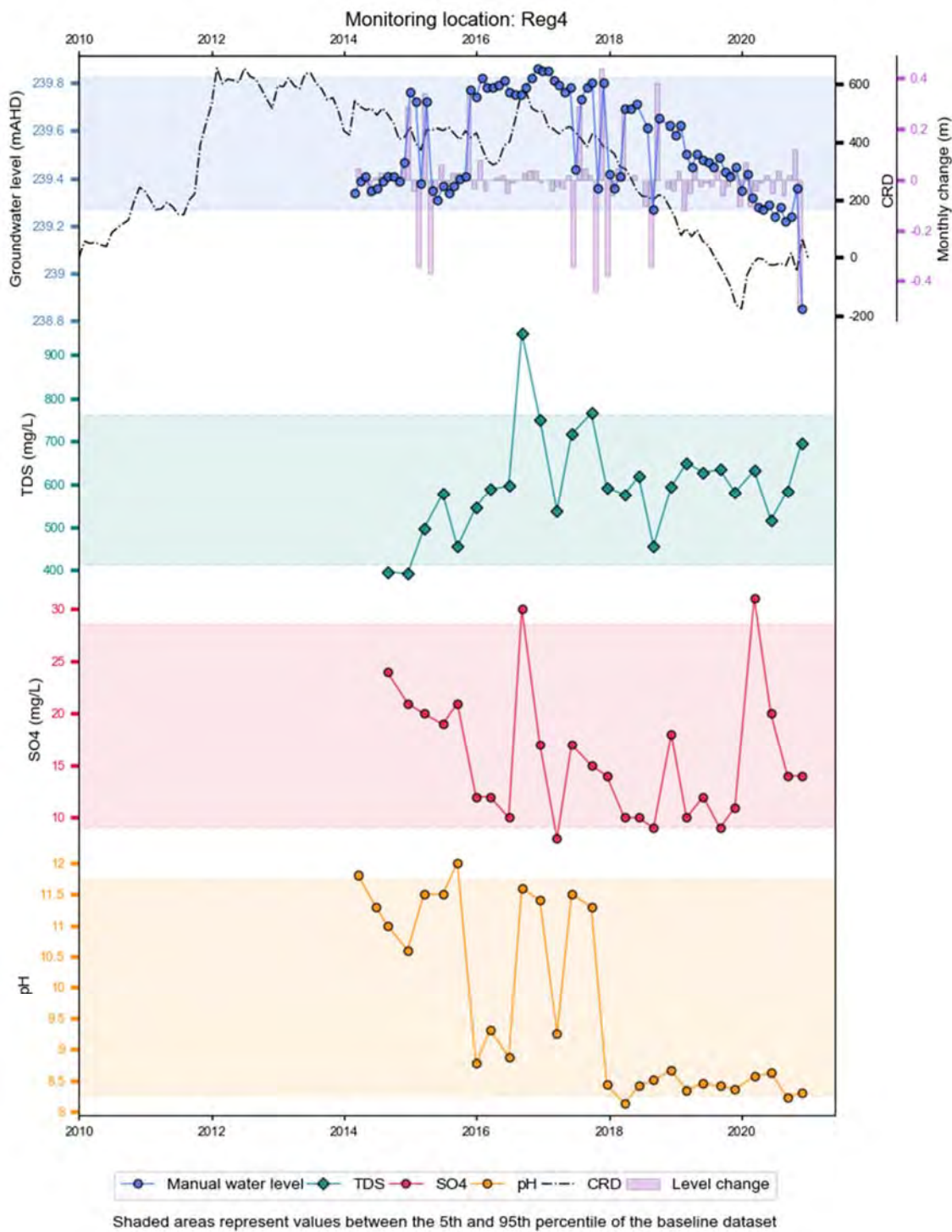




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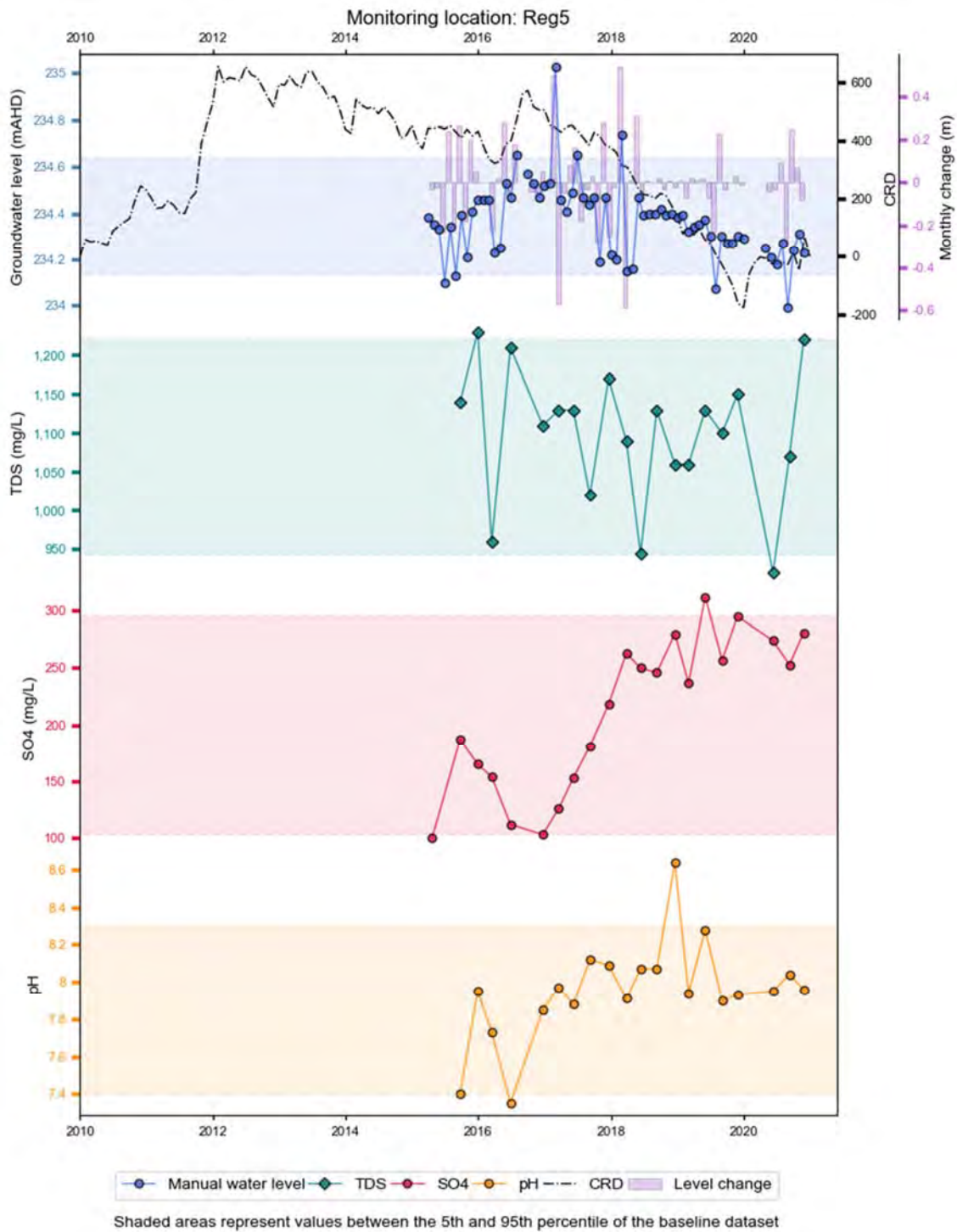




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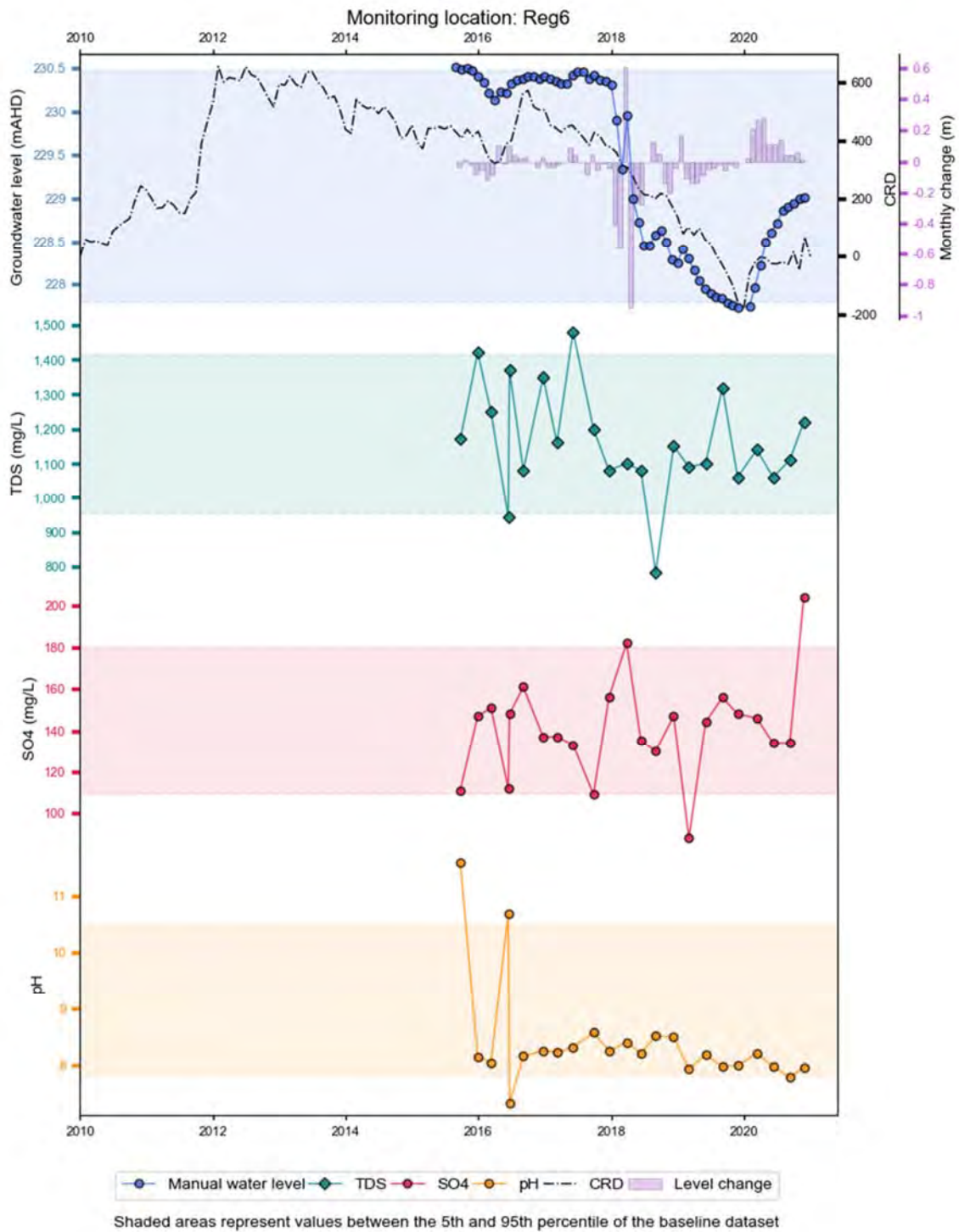




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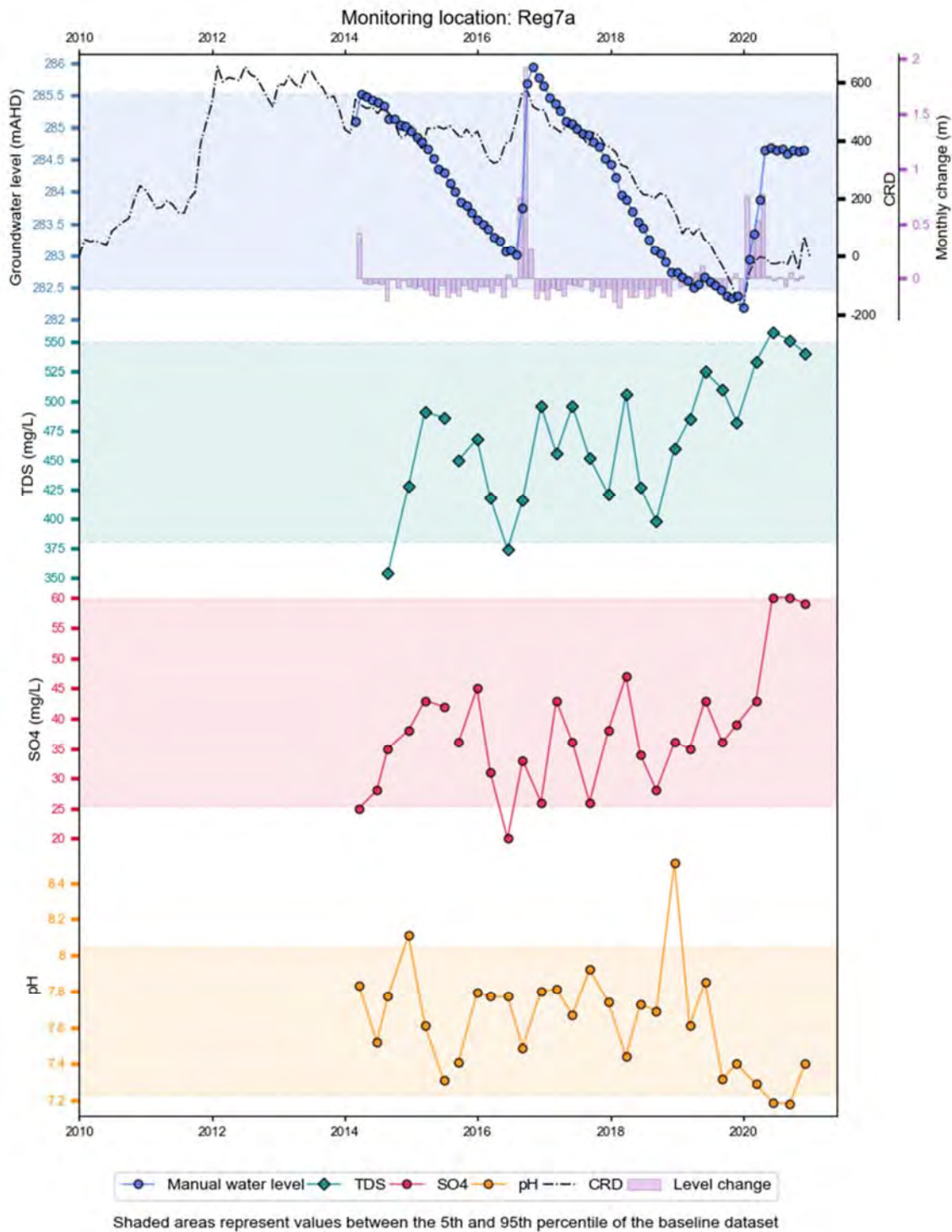




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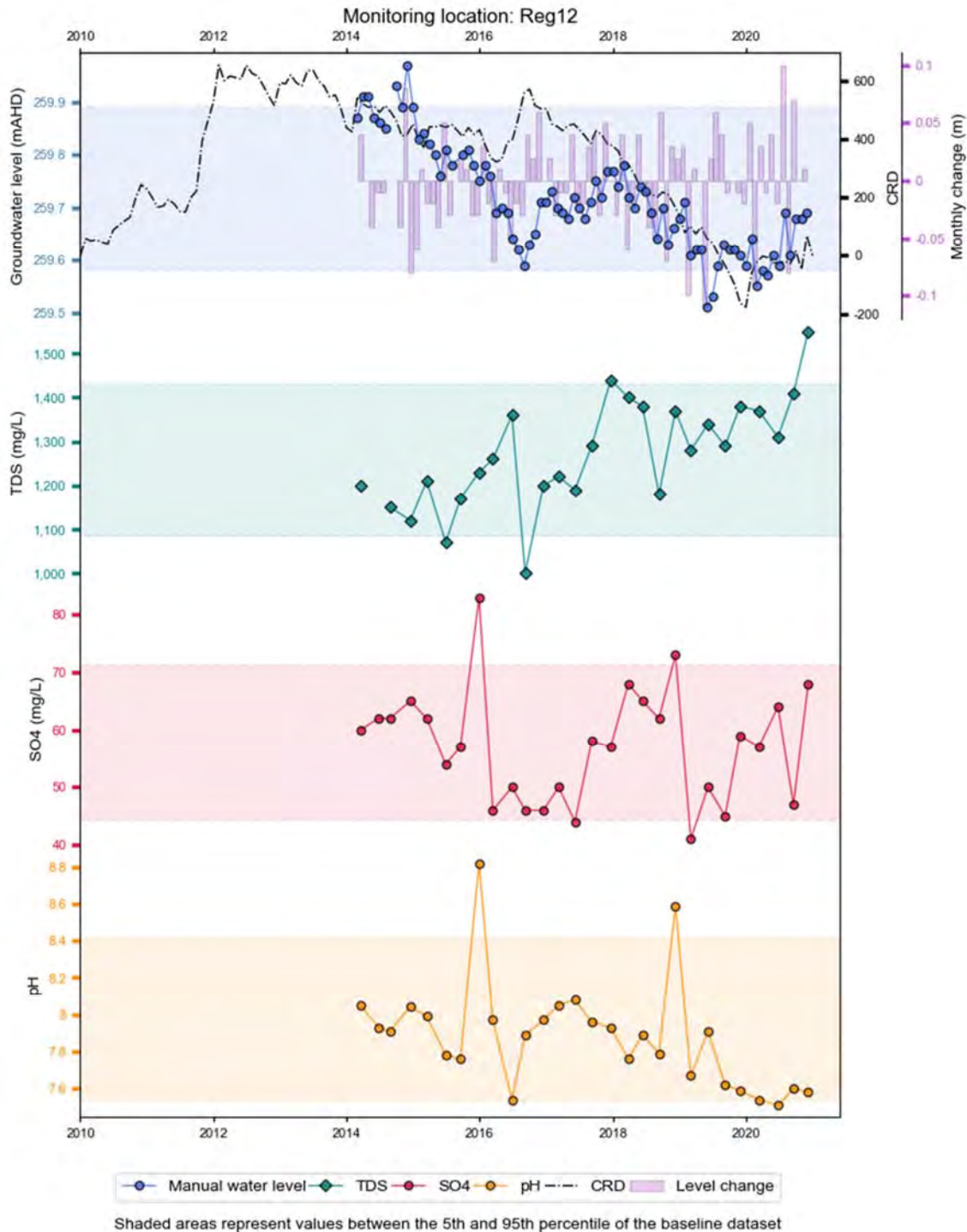




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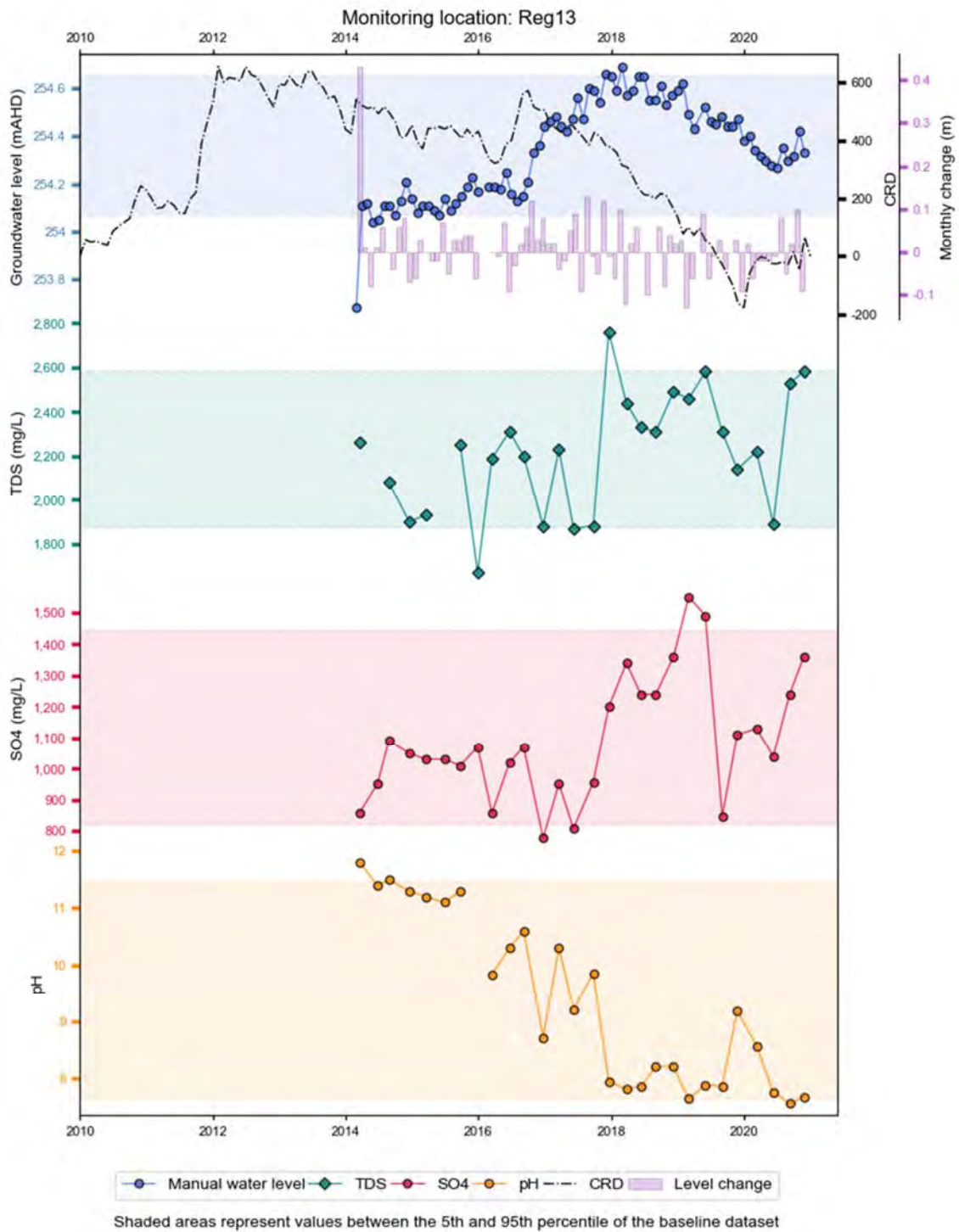




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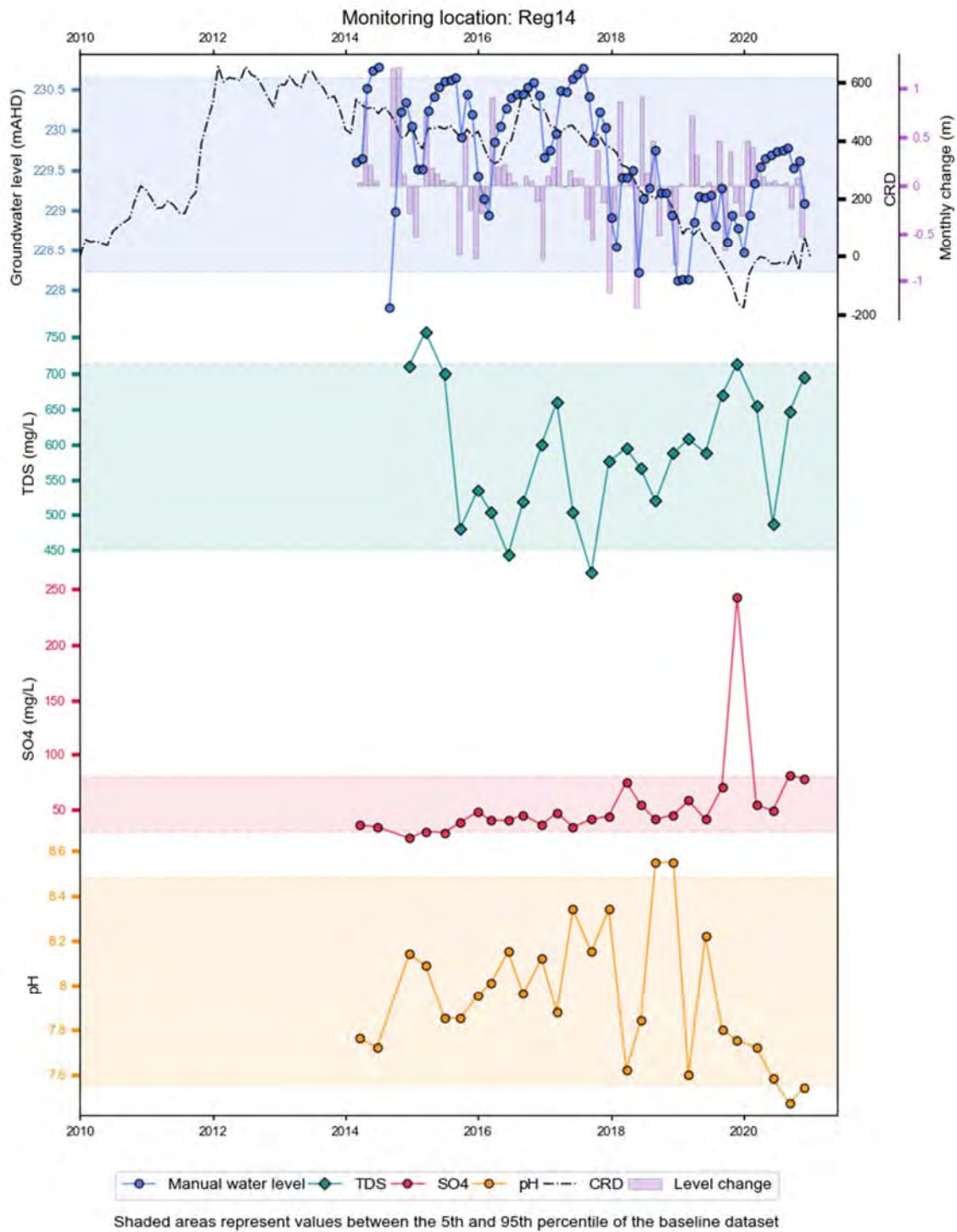




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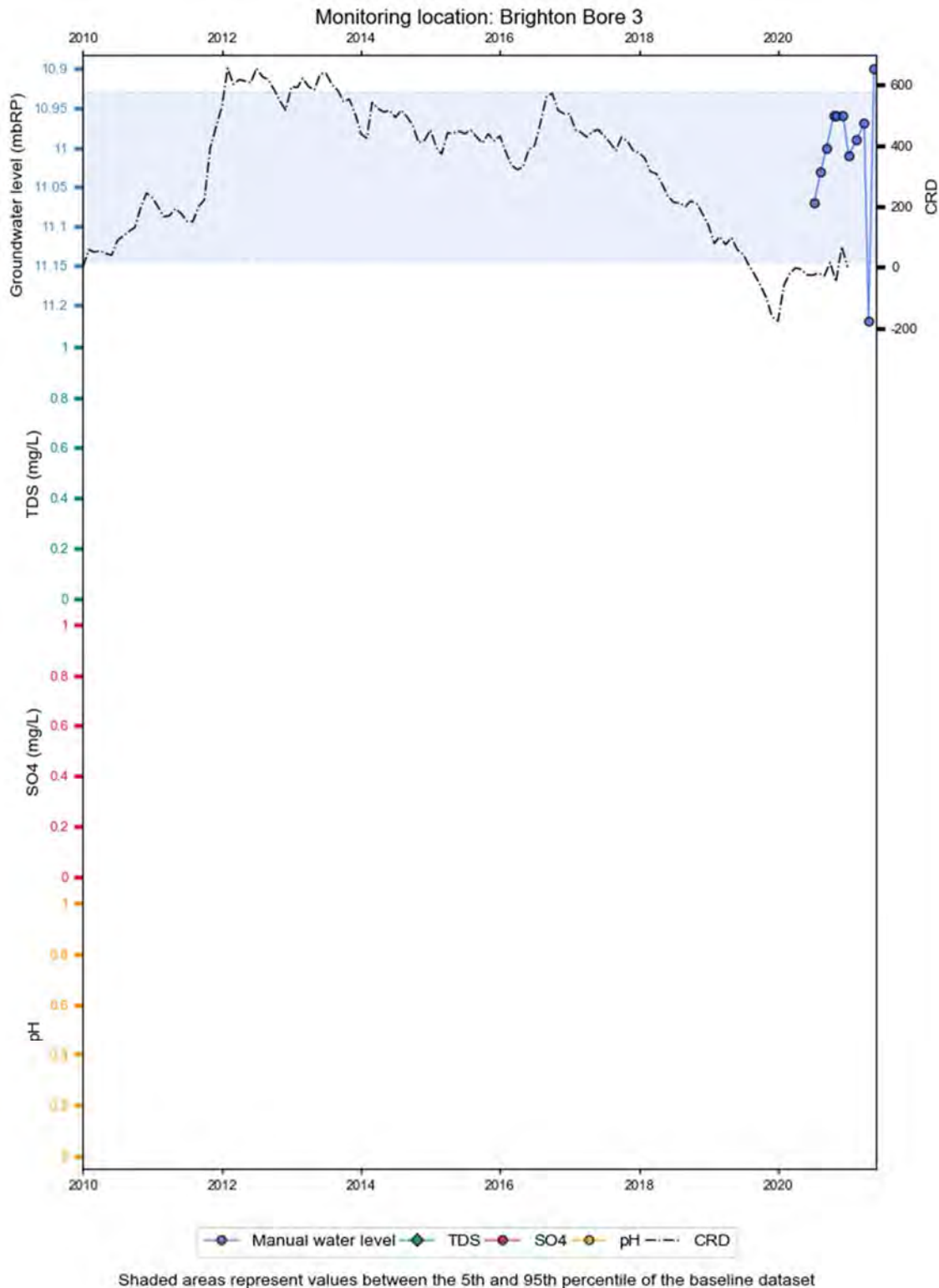




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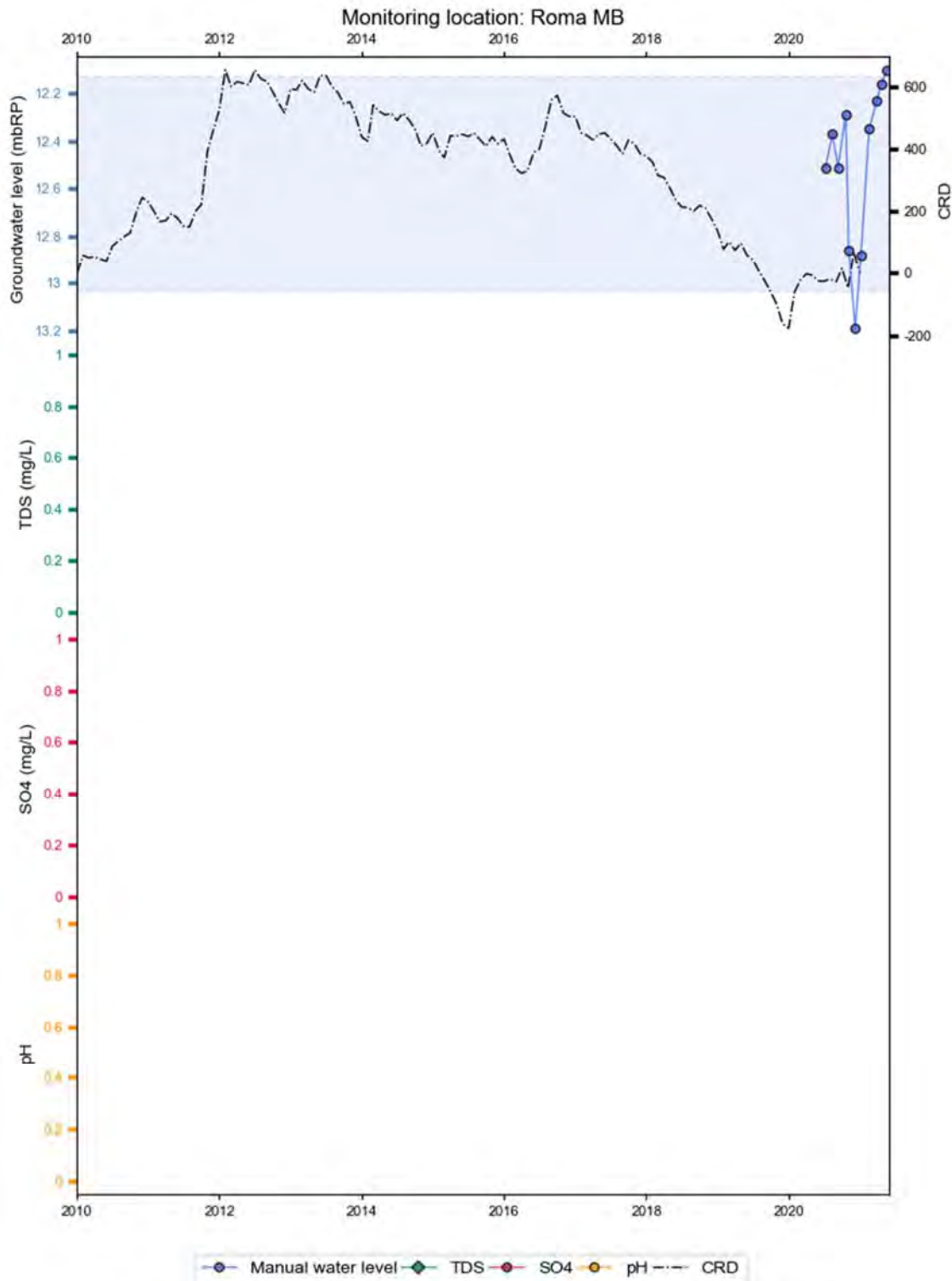




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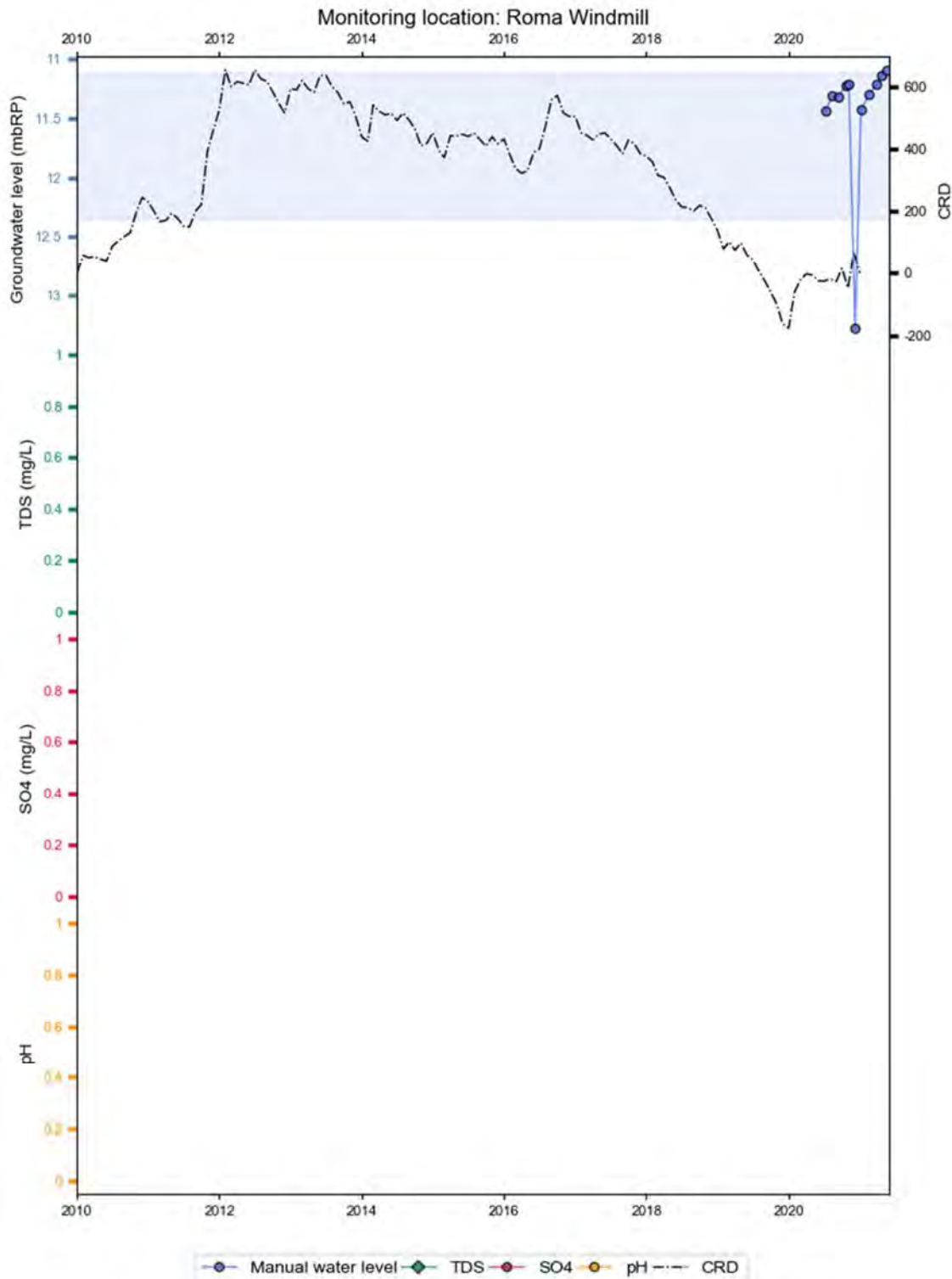




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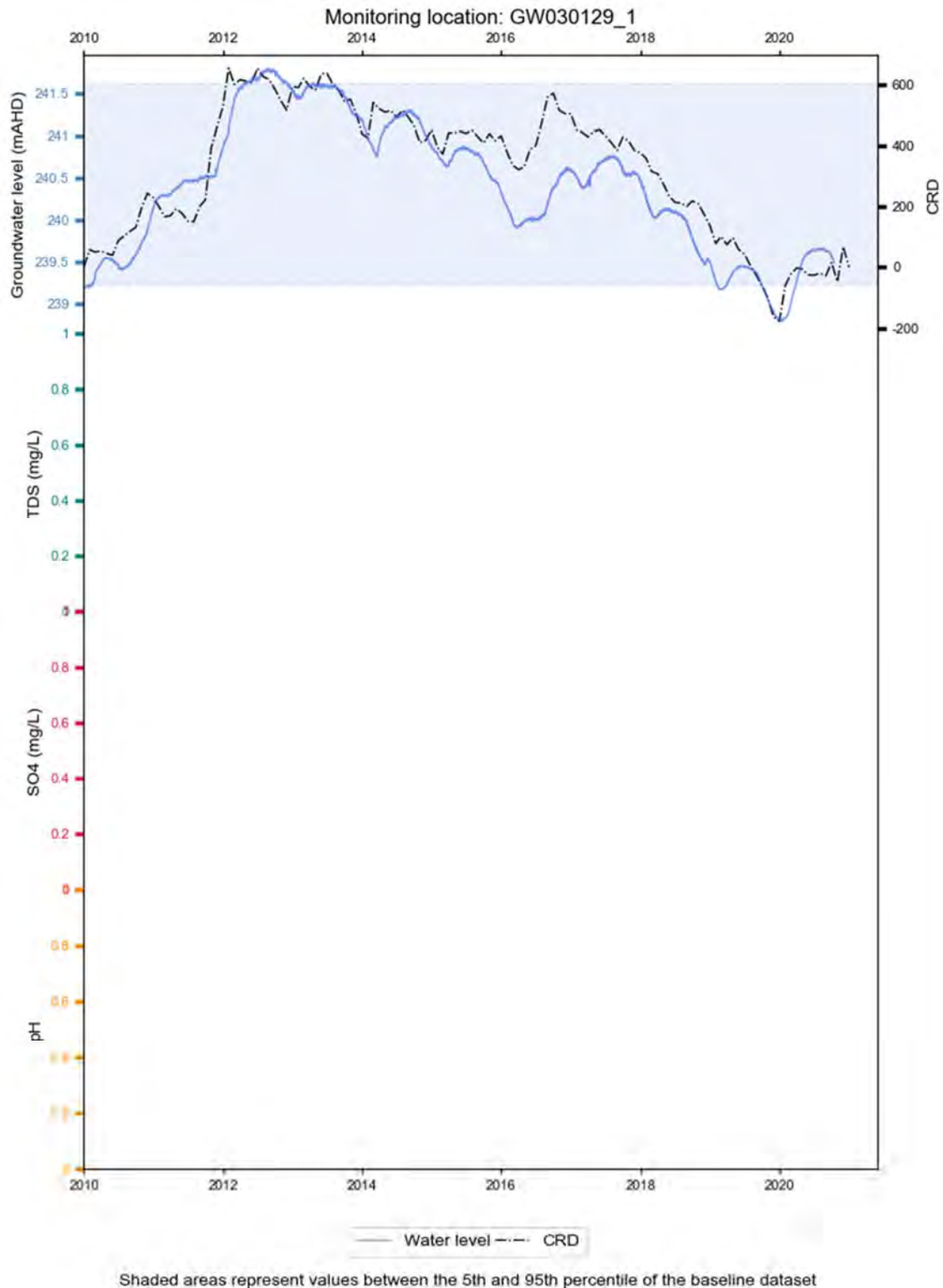
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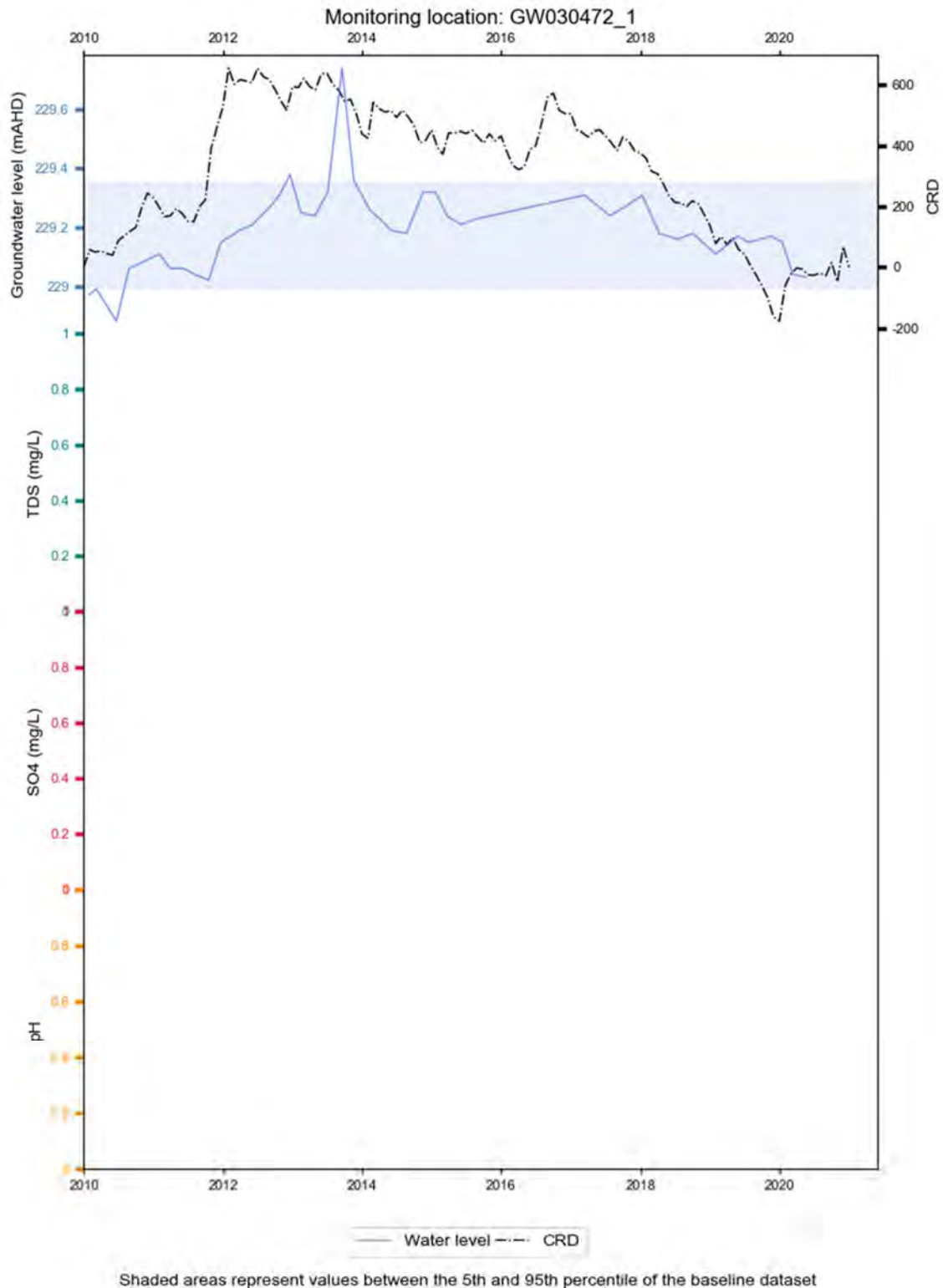




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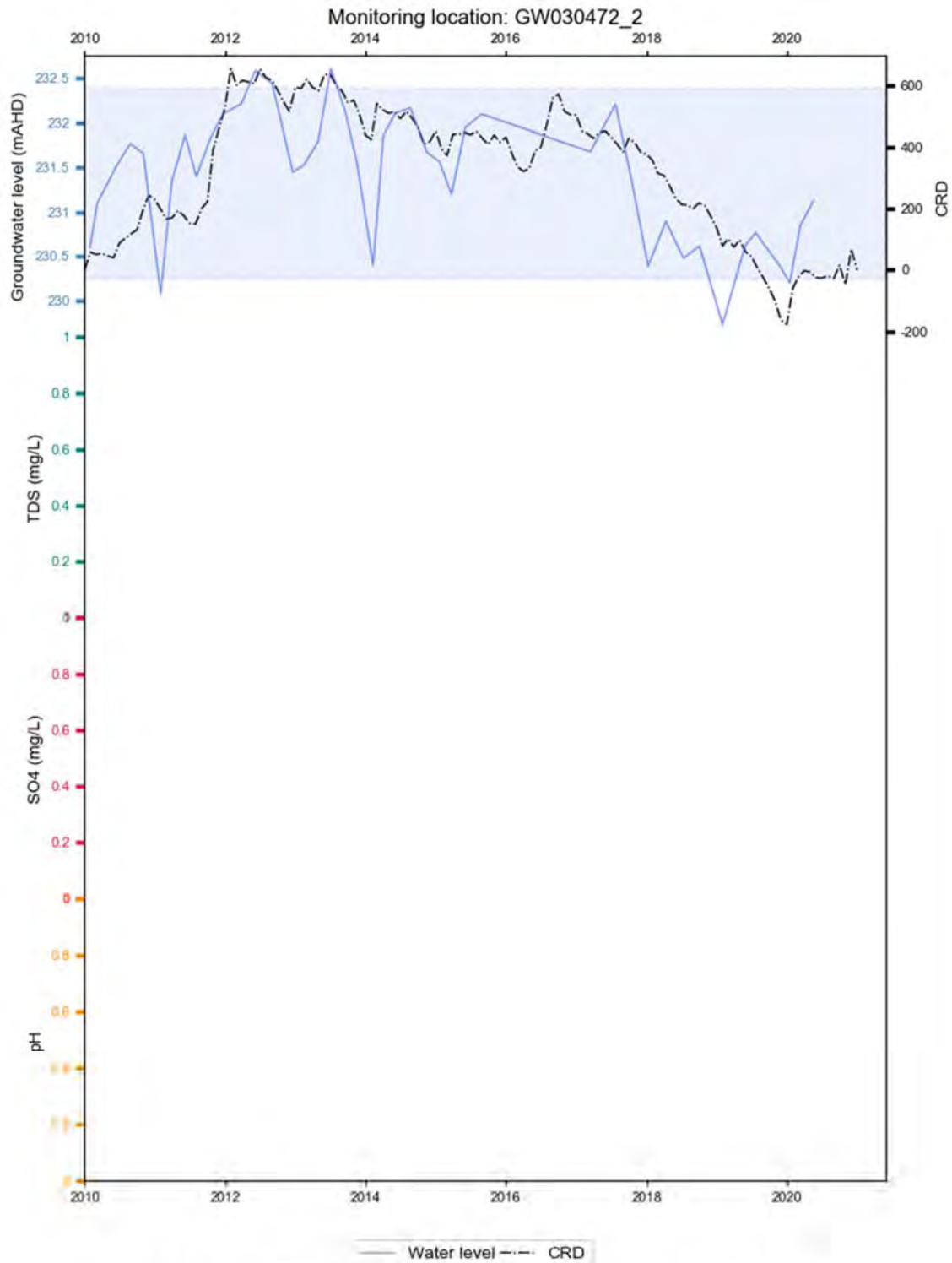




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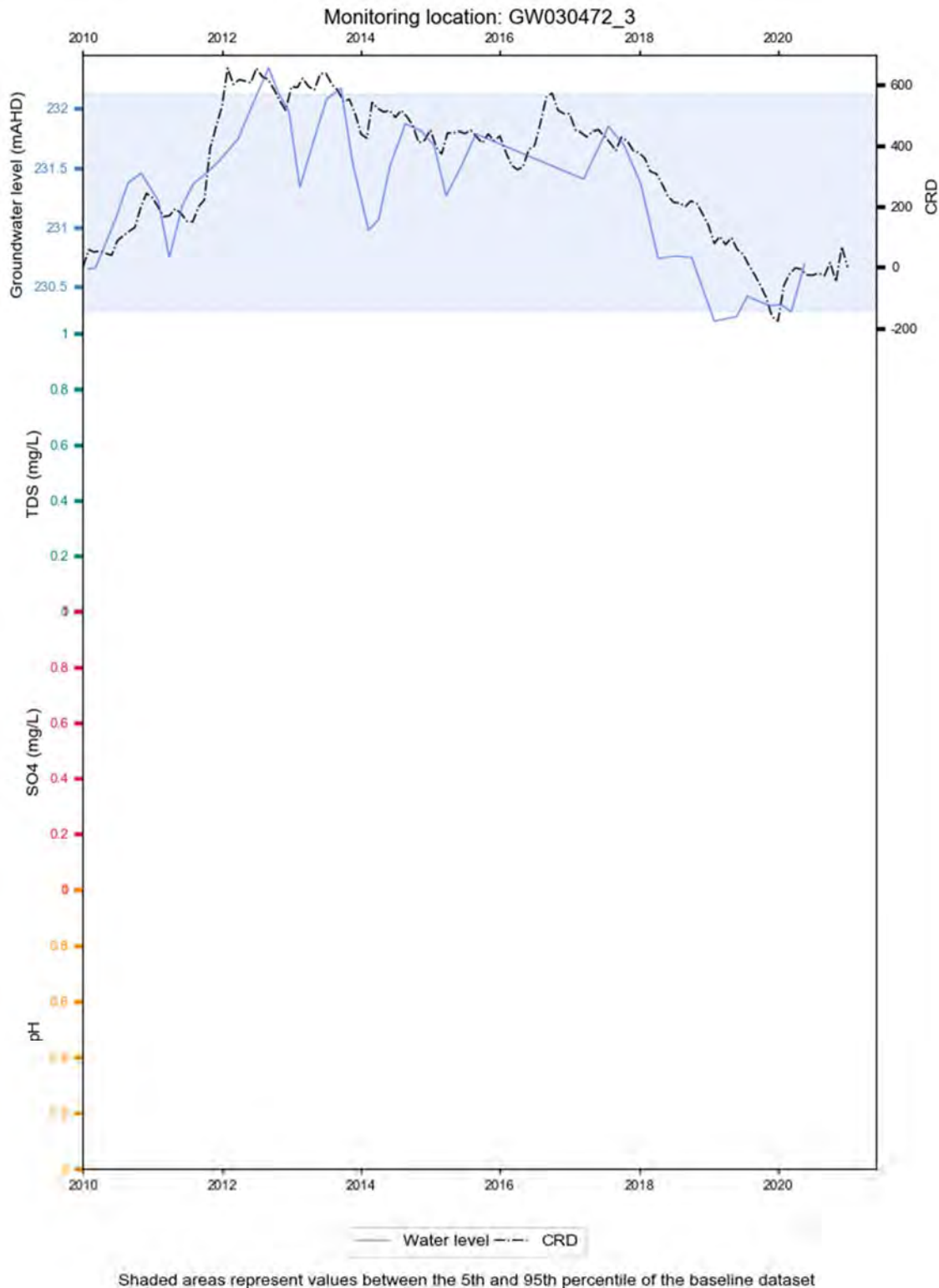
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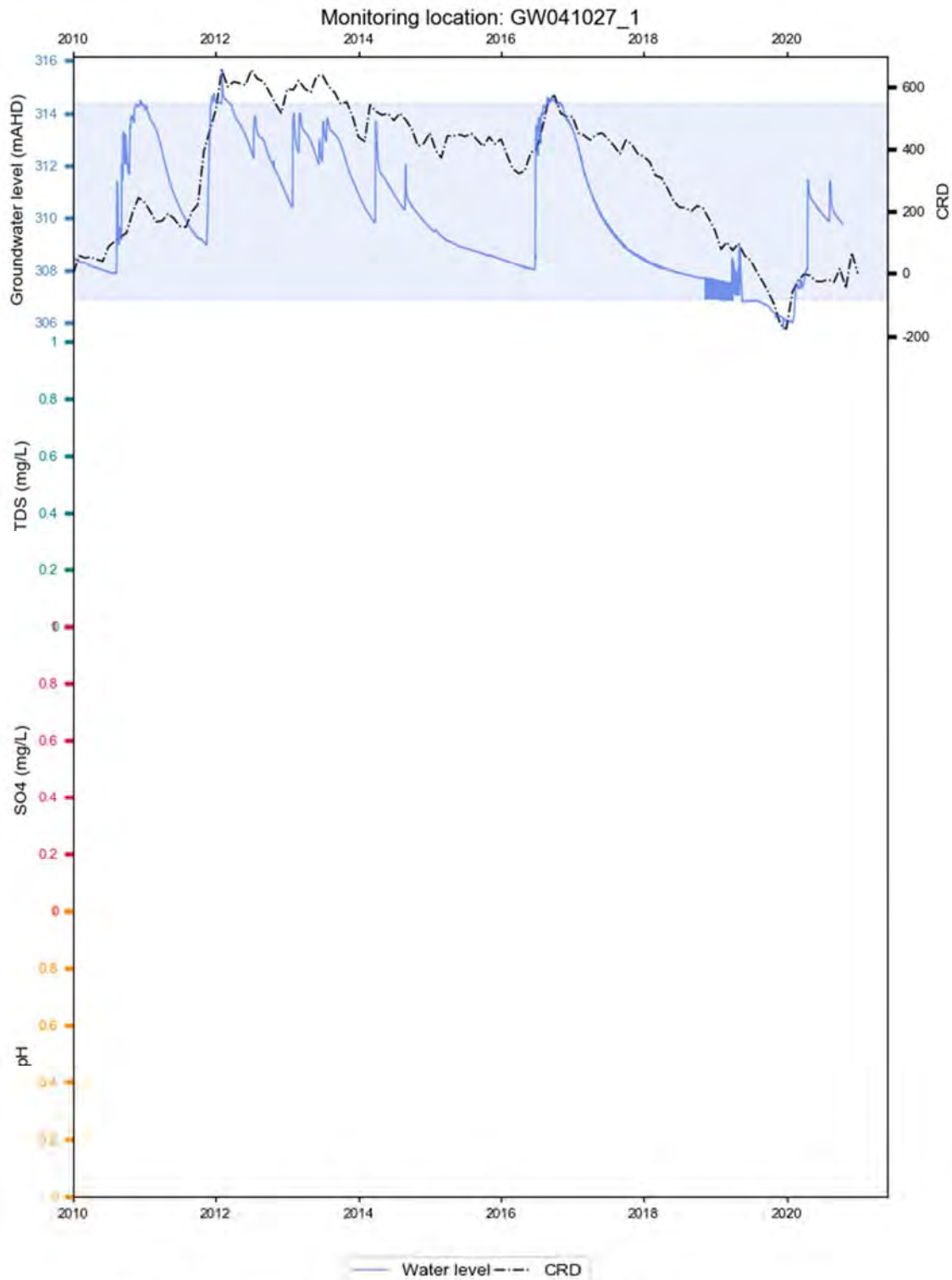




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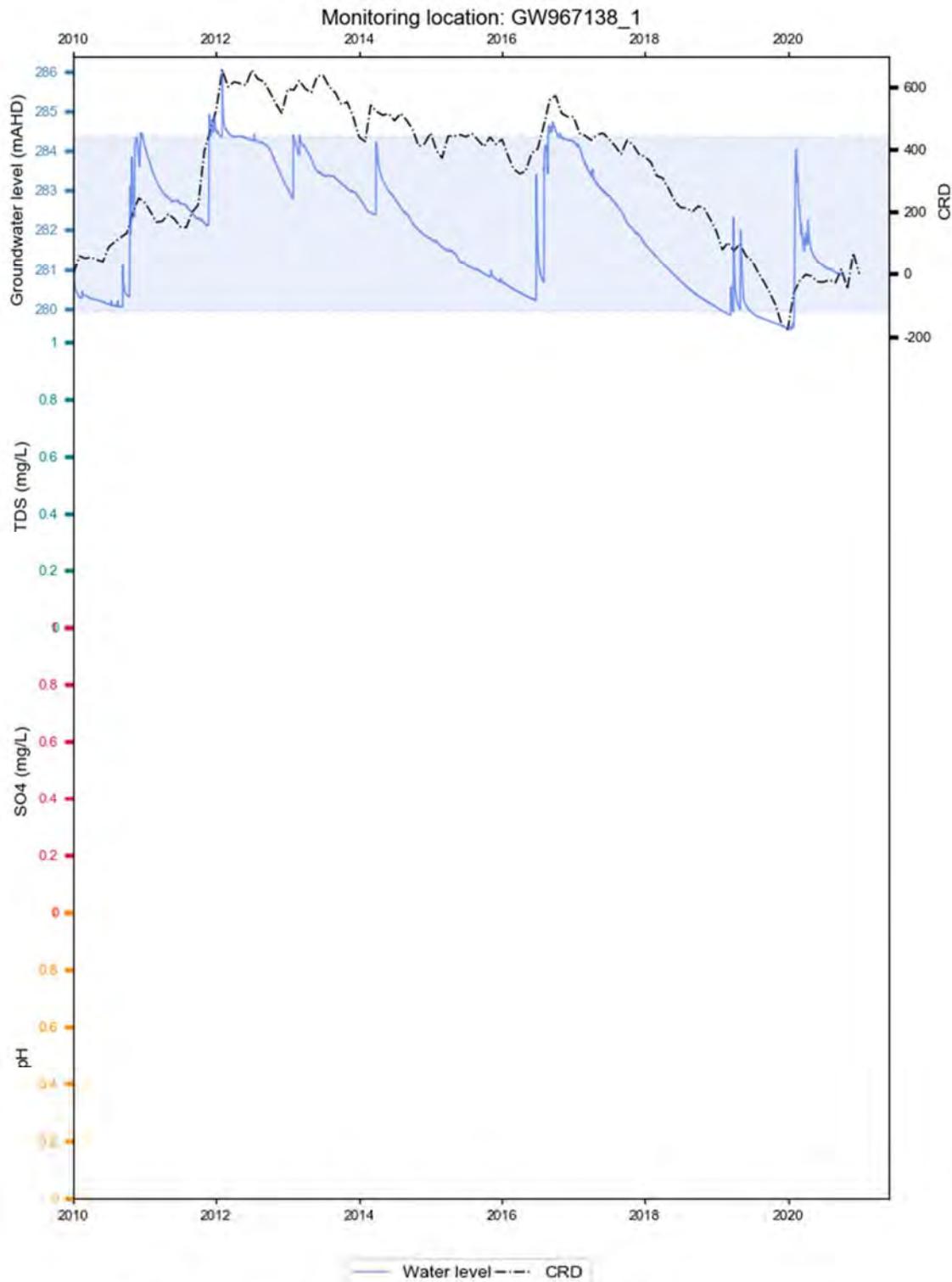
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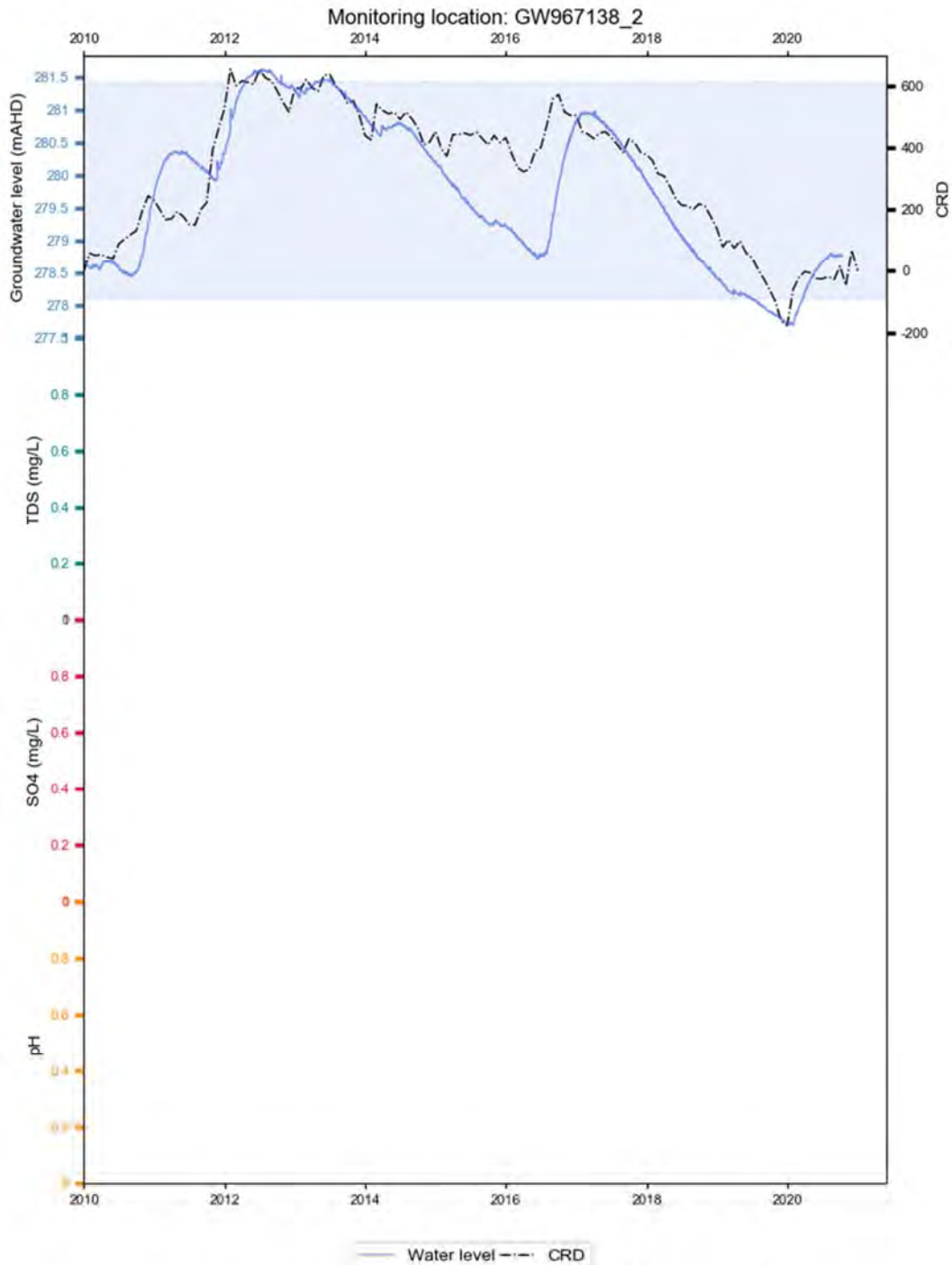
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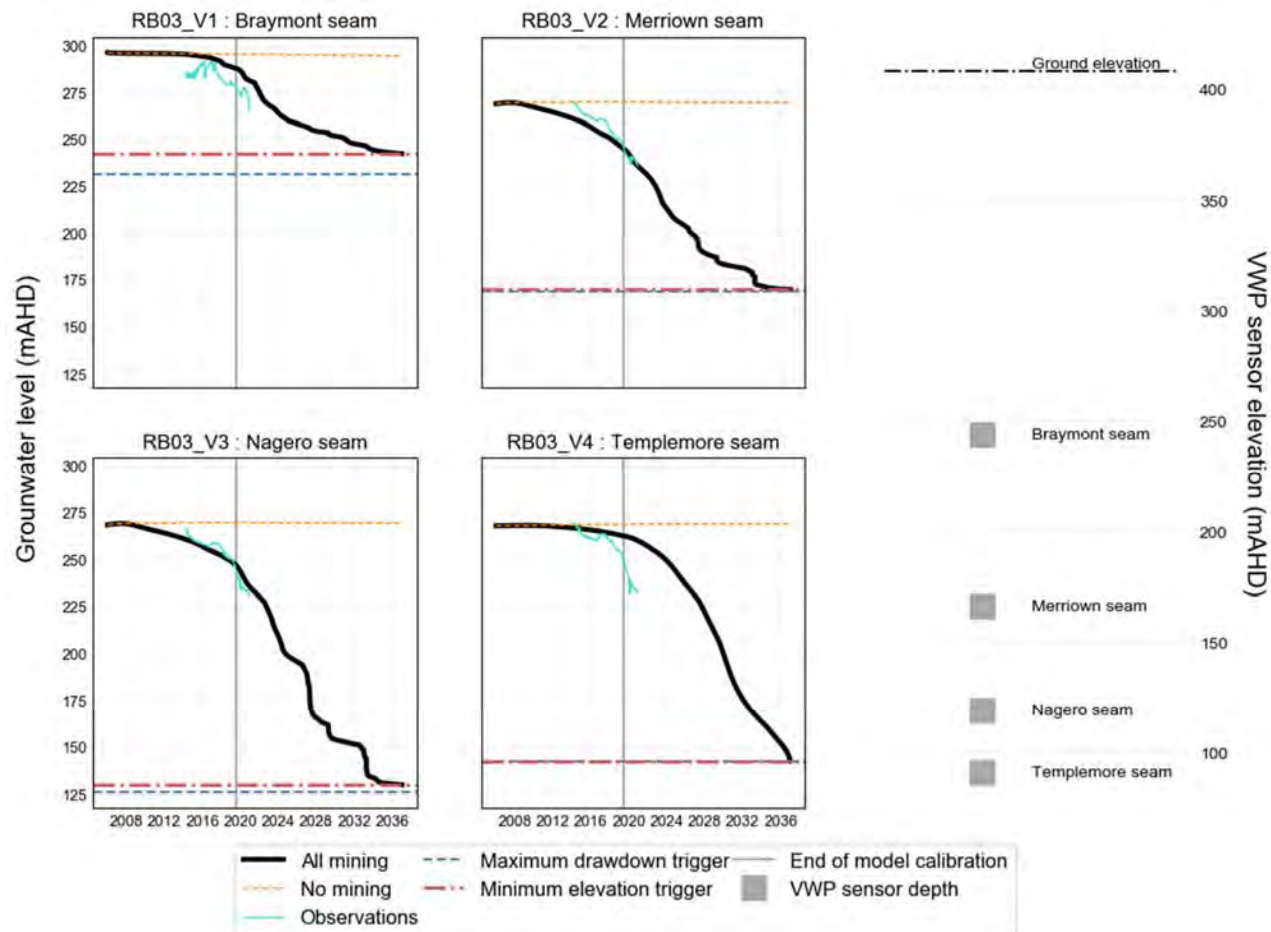
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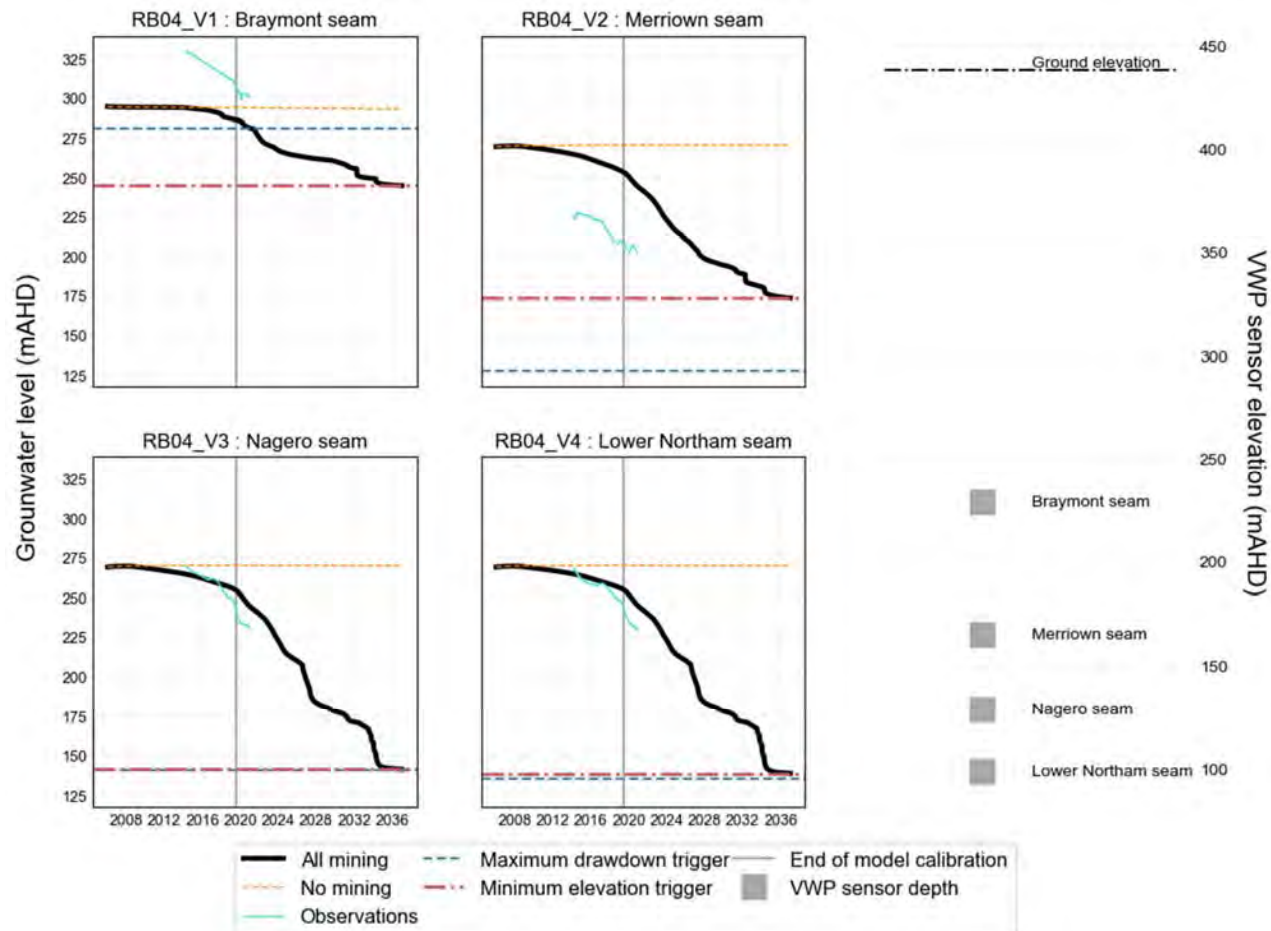


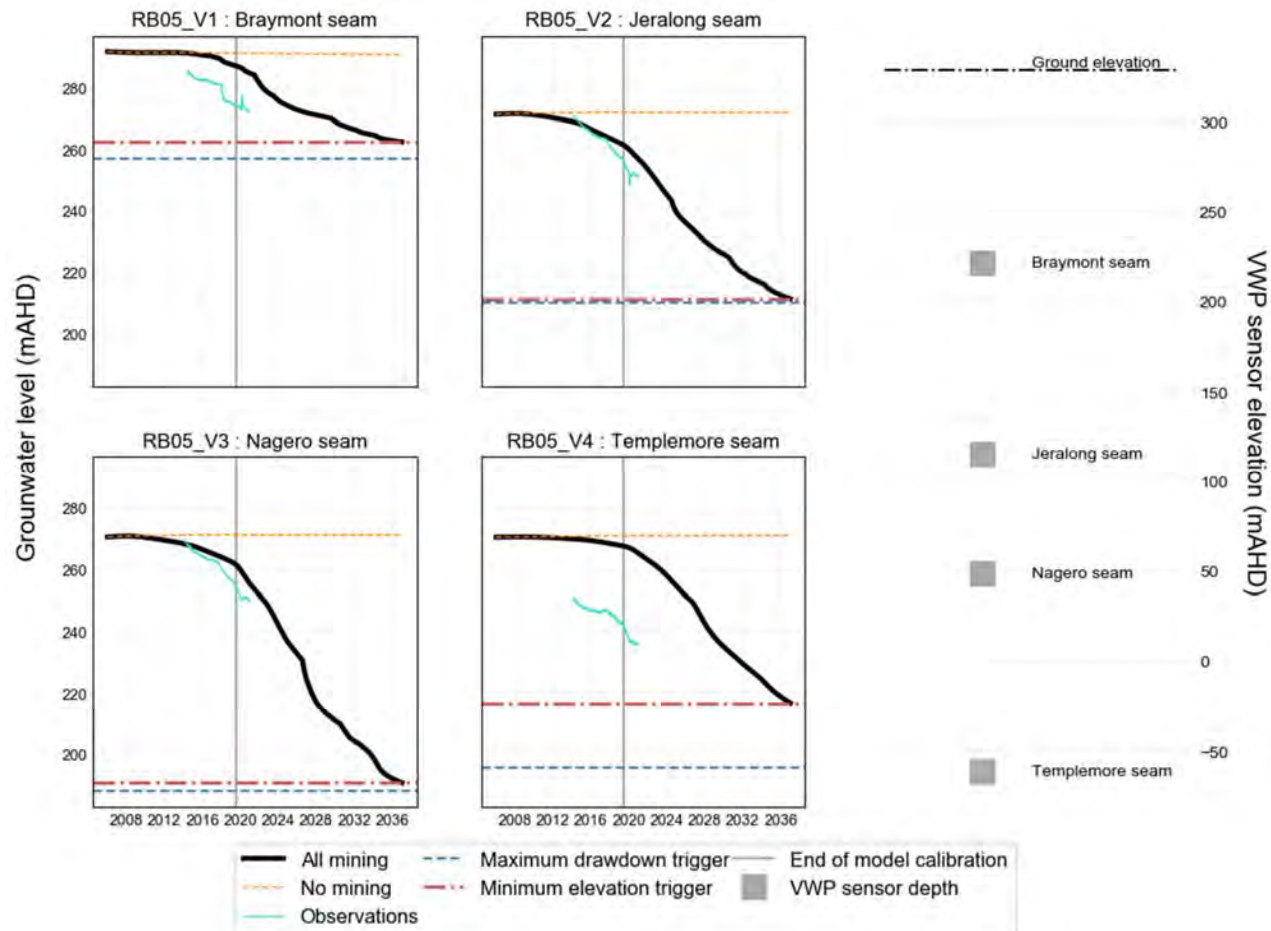
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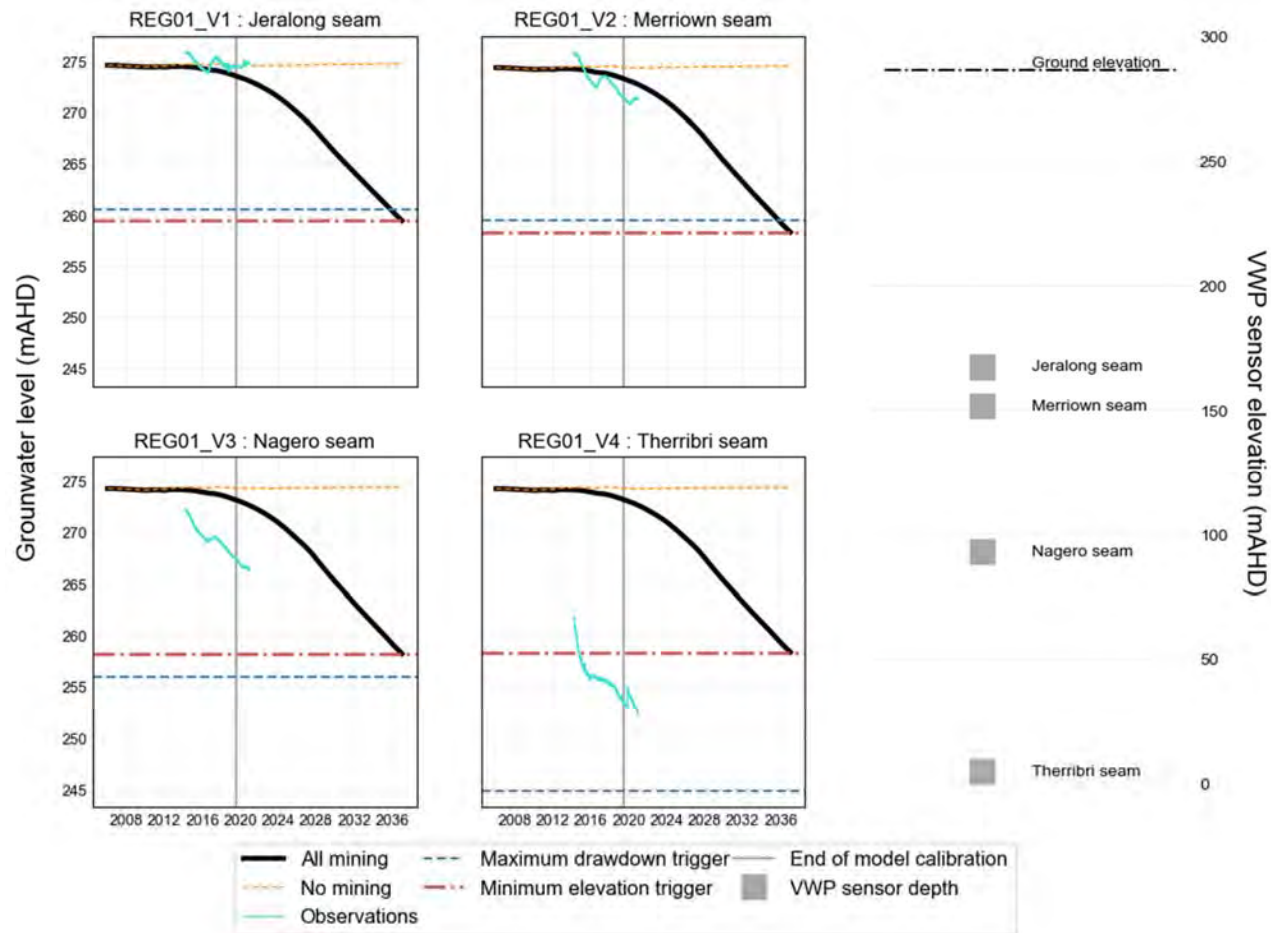
17 ATTACHMENT D – SUMMARY OF VWP MONITORING DATA AND TRIGGERS

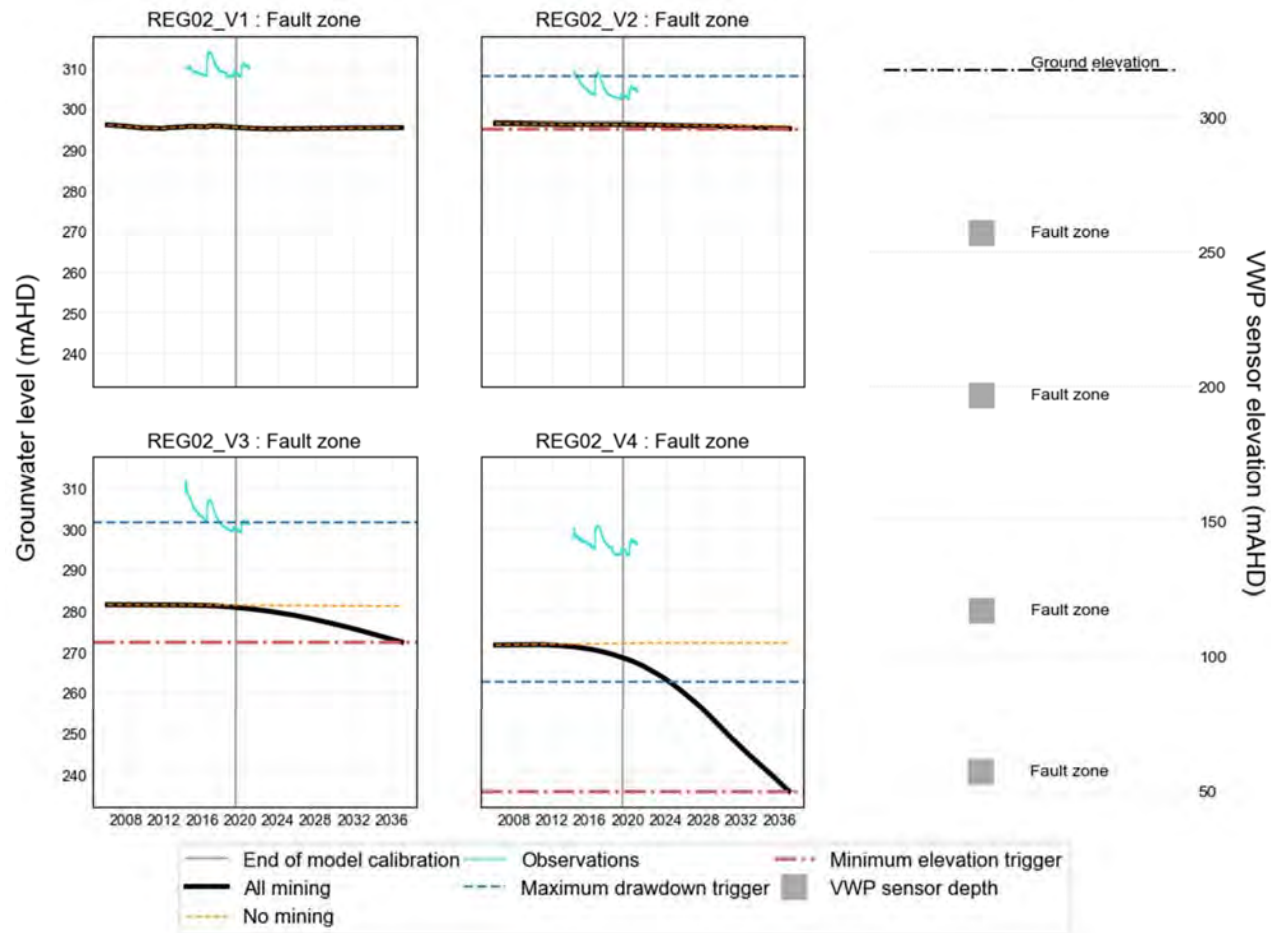






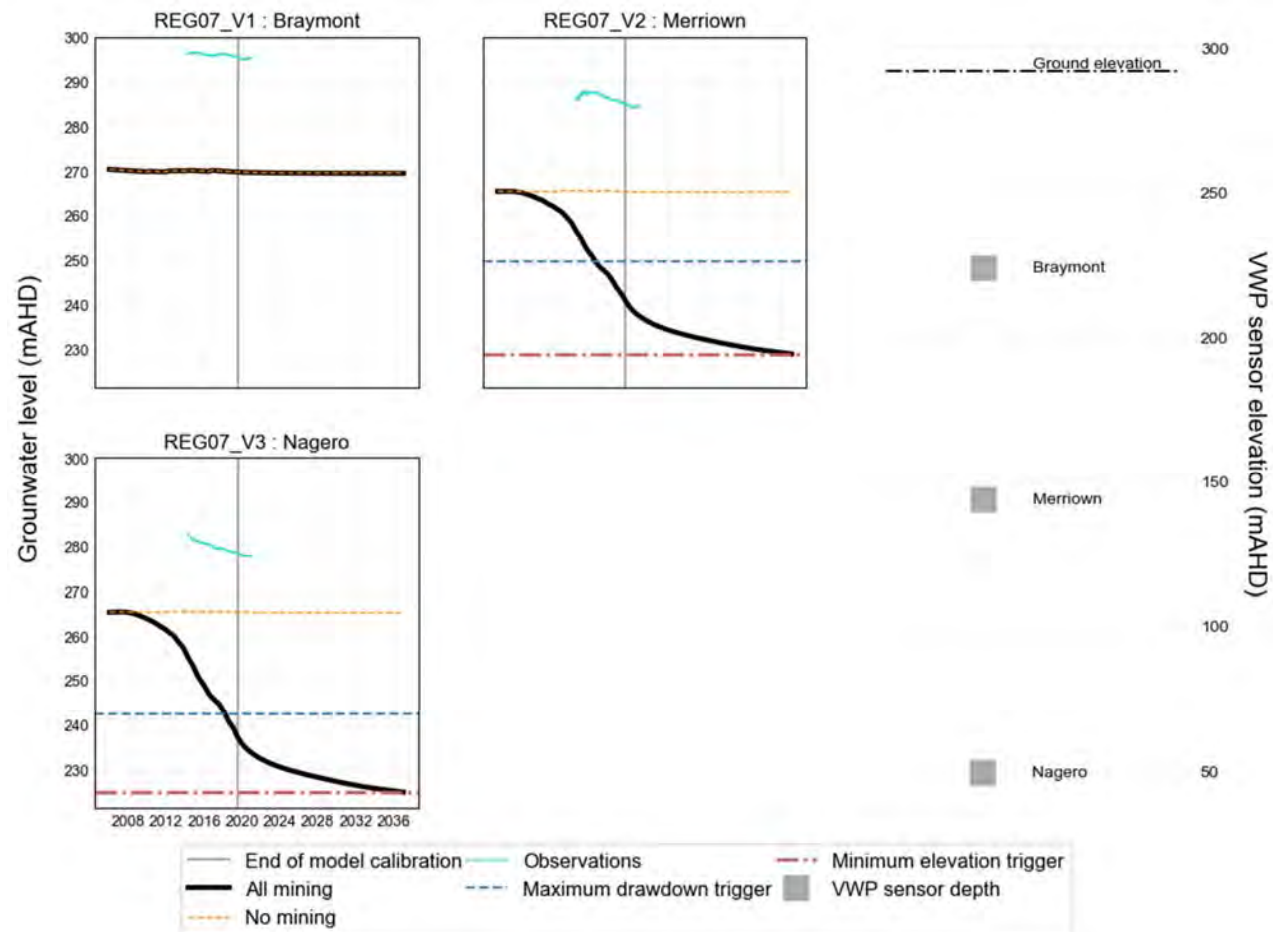
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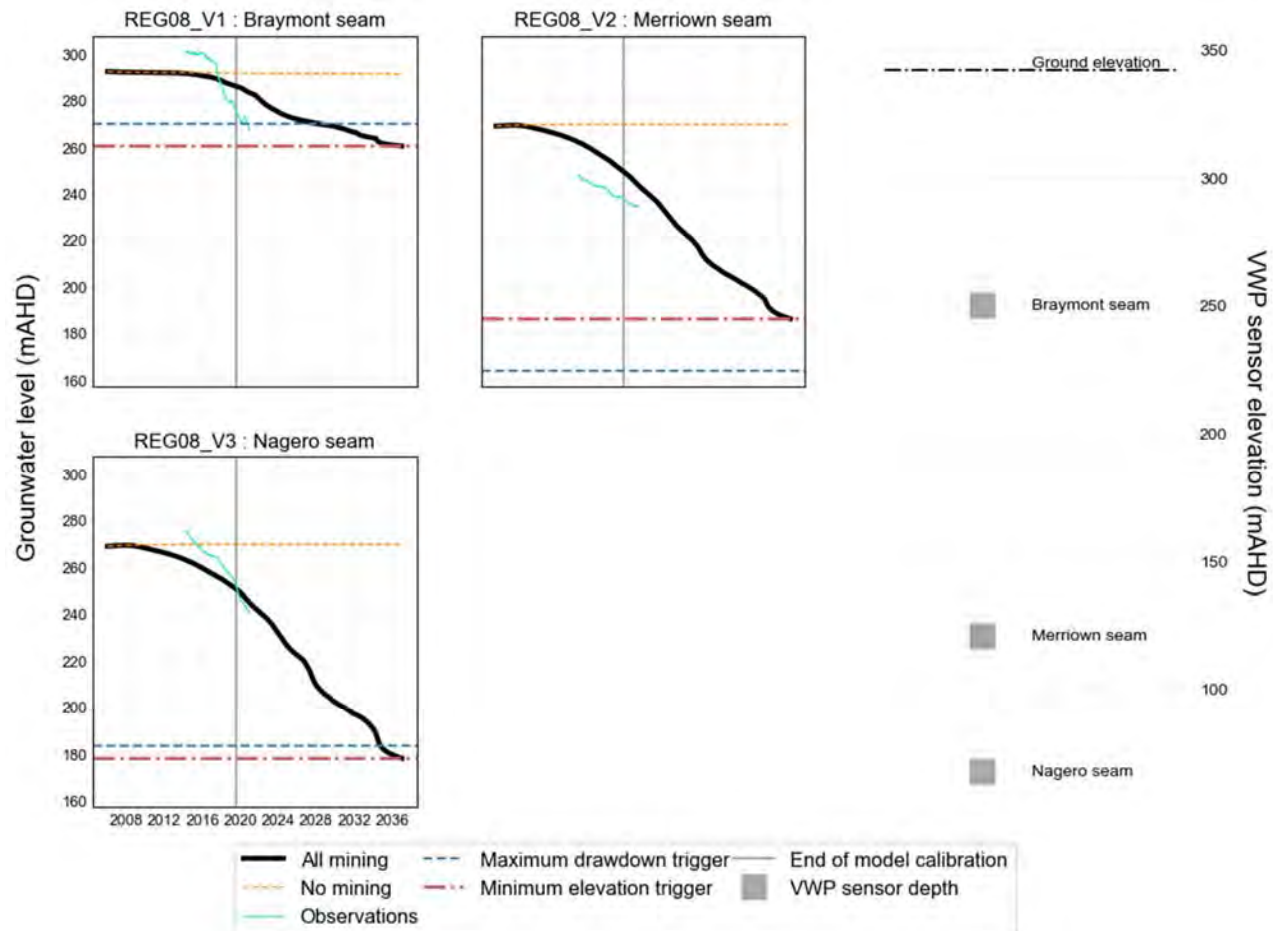


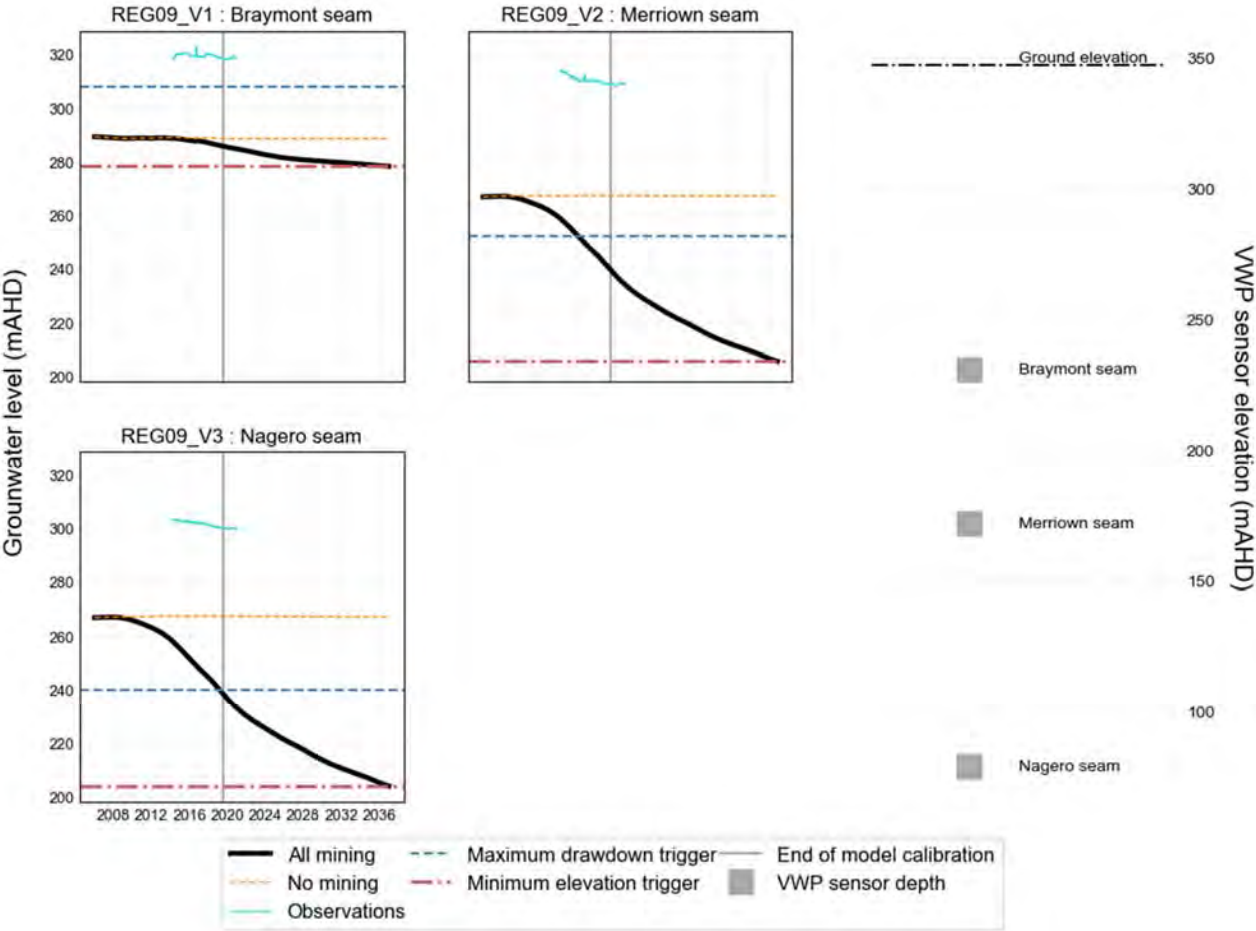


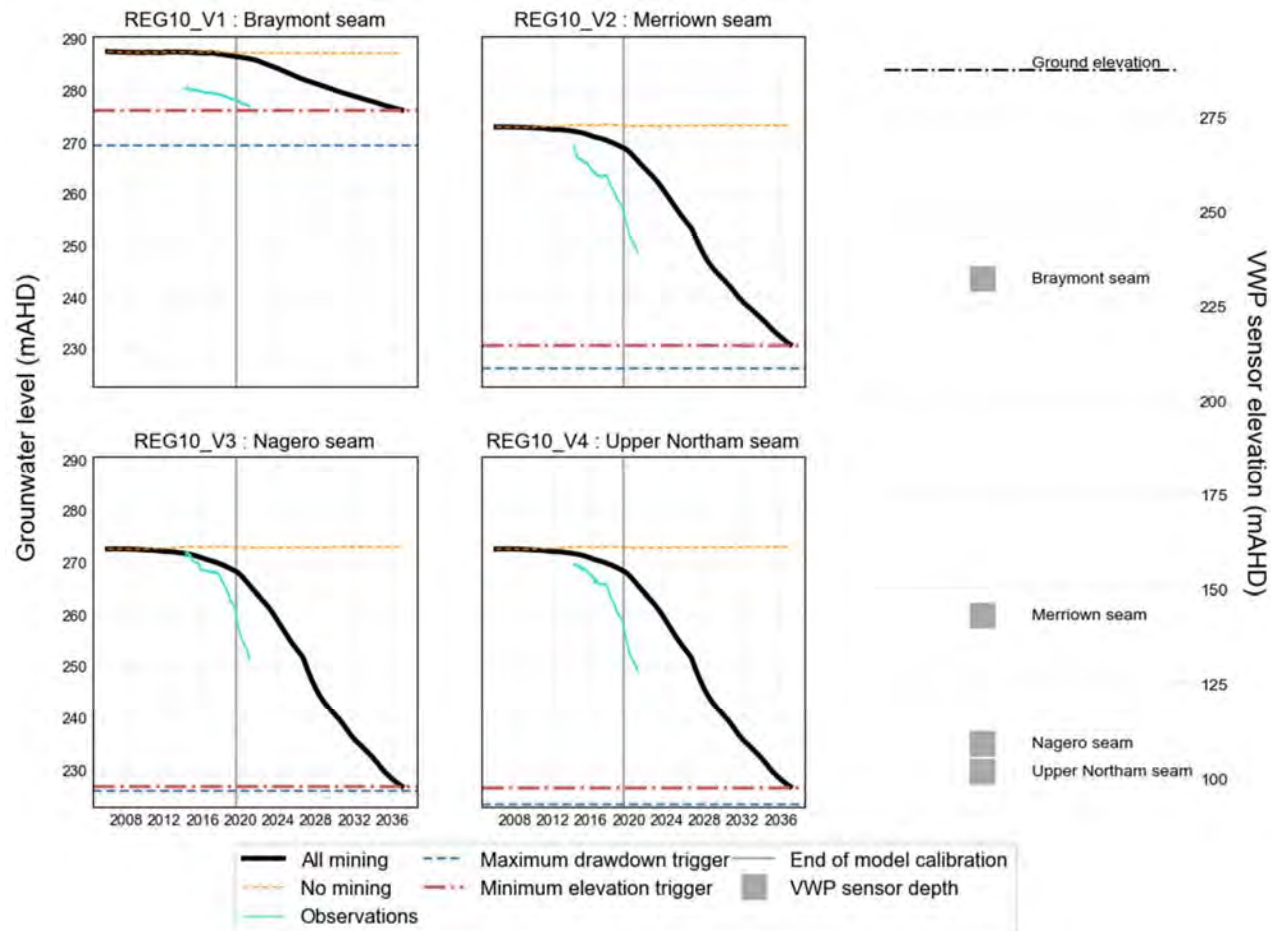
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18 ATTACHMENT E – SUMMARY OF WATER QUALITY DATASETS

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APPENDIX 4 BTM COMPLEX WATER MANAGEMENT STRATEGY

BOGGABRI - TARRAWONGA - MAULES CREEK COMPLEX

WATER MANAGEMENT STRATEGY



MAY 2019

Project No. WHC-13-15

Document No. 00972624-004

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A	29 September 2012	C. Callipari & V. O'Keefe	L. Doeleman	J. Green
B	6 March 2013	R. Rollins & N. Harcombe	S. Trott, B. Bird	J. Green, D. Martin, D. Young
C	10 December 2014	N. Harcombe, R. Rollins & V. O'Keefe	S. Crick	
D	9 August 2017	A. Blakeney & J. McDonough	D. Martin & H. Russell	P. Forbes, L. Johnson, S. Mitchell
E	20 June 2018	BTM	BTM	BTM
F	9 May 2019	Resource Strategies	BTM	BTM

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Whitehaven Coal (Tarrawonga)	Environmental Superintendent
Whitehaven Coal (Maules Creek)	Environmental Superintendent
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Contractors	Project Manager

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1. INTRODUCTION

1.1 BACKGROUND AND PURPOSE

The purpose of the cumulative Boggabri-Tarrawonga-Maules Creek Complex (BTM Complex)¹ Water Management Strategy is to document the approach that will be taken by mines within the BTM Complex to monitor and collectively manage the cumulative surface water and groundwater impacts of their operations. The Water Management Strategy details the relevant water resources, the potential cumulative impacts on those water resources, and the cumulative water management protocols within the BTM Complex.

The BTM Complex is an existing mining precinct located within and around the Leard State Forest, approximately 15 kilometres (km) north-east of Boggabri in the Narrabri Local Government Area (LGA) (Figure 1.1). The BTM Complex includes the Tarrawonga Coal Mine (TCM) in the south, the Boggabri Coal Mine (BCM) to the north and the Maules Creek Coal Mine (MCCM) to the north-west. The extent of the relevant tenements for each of the mines that comprise the BTM Complex are presented in Figure 1.1.

BCM is managed by Boggabri Coal Operations Pty Limited (BCOPL), a wholly owned subsidiary of Idemitsu Australia Resources Pty Limited (IAR).

MCCM is managed by Maules Creek Coal Pty Ltd, a wholly owned subsidiary of Whitehaven Coal Mining Limited (Whitehaven).

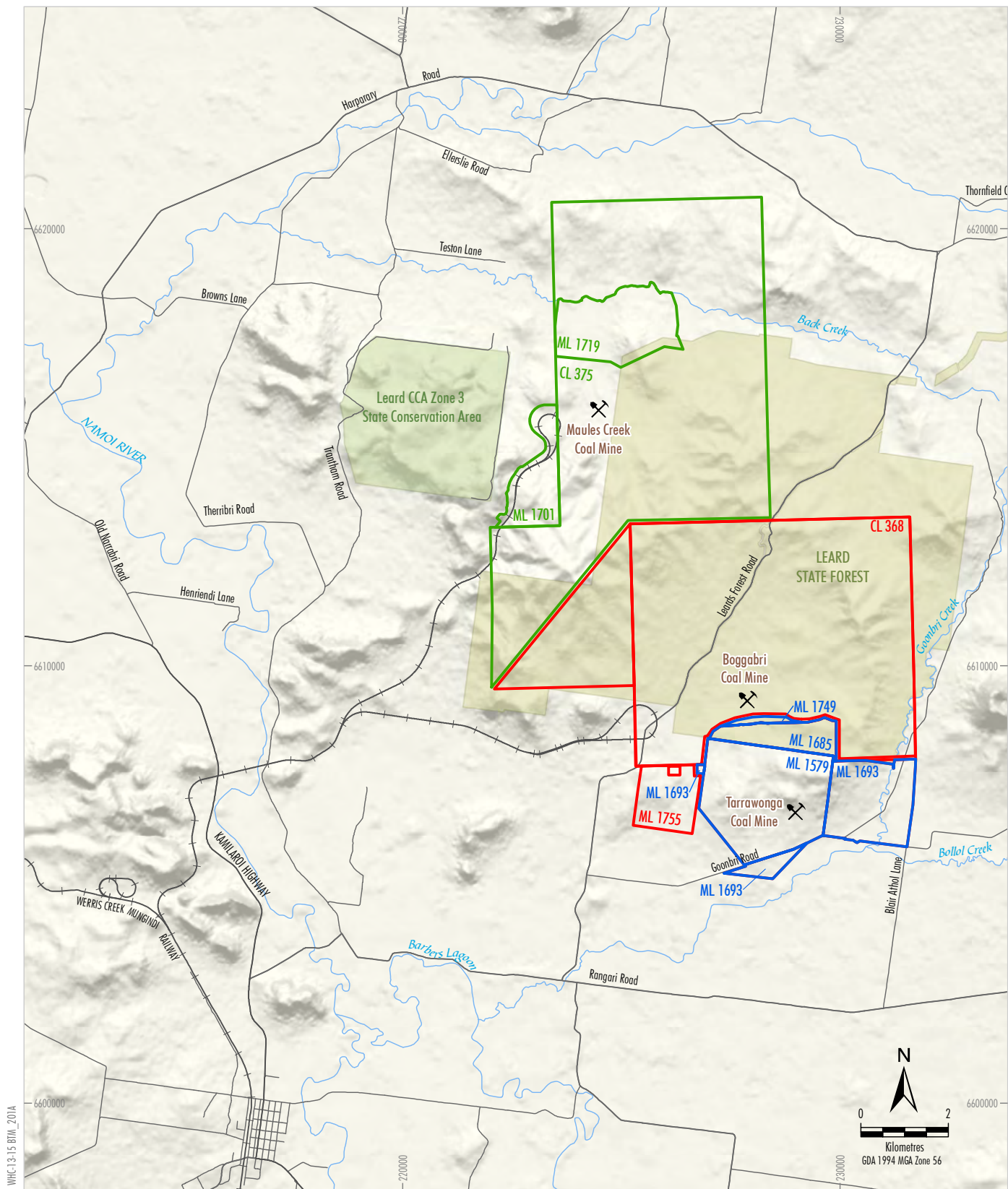
TCM is managed by Tarrawonga Coal Pty Ltd, a wholly owned subsidiary of Whitehaven.

A summary of the ownership details for each mine within the BTM Complex is provided below in Table 1.1.

Table 1.1
Management and ownership of BTM Complex Mines

Mine	Management	Ownership	Share
Boggabri Coal Mine	Boggabri Coal Operations Pty Limited	Idemitsu Australia Resources Pty Ltd	80%
		Chugoku Electric Power Australia Resources Pty Ltd	10%
		NS Boggabri Pty Ltd	10%
Maules Creek Coal Mine	Maules Creek Coal Pty Ltd	Aston Coal 2 Pty Limited (owned 100% by Whitehaven Coal Limited)	75%
		Itochu Coal Resources Australia Maules Creek Pty Ltd (ICRA MC)	15%
		J-Power Australia (J-Power) Pty Ltd	10%
Tarrawonga Coal Mine	Tarrawonga Coal Pty Ltd	Whitehaven Coal Mining Limited	100%

¹ In previous environmental assessments and approval documents this group of mines has been referred to as the Leard Forest Mining Precinct. For the purposes of the Water Management Strategy and all other relevant cumulative impact management documents, all references to the 'Leard Forest Mining Precinct' have been replaced with the term 'BTM Complex'.



LEGEND

- Mining Tenement Boundary - Boggabri Coal Mine
- Mining Tenement Boundary - Tarrawonga Coal Mine
- Mining Tenement Boundary - Maules Creek Coal Mine
- NSW National Parks and Wildlife Services (NPWS) Estate
- State Forest
- +— Railway

Source: Whitehaven Coal Limited (2016); NSW Department of Land and Property Information (2016); NSW Department of Industry (2016); Office of Environment and Heritage NSW (2016)



BTM WATER MANAGEMENT STRATEGY Regional Location

Figure 1.1

Development applications for the continued operation of the BCM (Project Approval 09_0182) and the development of the MCCM (Project Approval 10_0138) were determined by the NSW Planning Assessment Commission (PAC) in July and October 2012 respectively, under delegation by the NSW Minister for Planning and Infrastructure. Subsequent to this, the Department of the Environment and Energy (DoEE) (formerly the Commonwealth Department of Environment [DoE]), granted conditional approval for both the BCM (EPBC 2009/5256) and the MCCM (EPBC 2010/5566) on 11 February 2013. These projects were granted approval subject to stringent conditions related to the management of cumulative impacts.

The TCM application for continuation of mining was approved on 22 January 2013, with similar cumulative impact management conditions to those detailed in the BCM and MCCM approvals.

Approval conditions require the preparation of a suite of environmental strategies developed in partnership by all three mines of the BTM Complex. This Water Management Strategy has been developed to satisfy each mine's project approval conditions. Approval conditions relevant to the management of cumulative water impacts within the BTM Complex are detailed in Table 1.2.

Table 1.2
Approval requirements for a Water Management Strategy

BCM PA 09_0182	MCCM PA 10_0138	TCM PA 11_0047	Details	Section
Sch. 3 Cond. 38 (d)	Sch. 3 Cond. 40 (d)	Sch. 3 Cond. 39 (c)(iv)	<i>The Proponent shall prepare and implement a Water Management Plan for the project... this plan must include: "... a <u>Leard Forest Mining Precinct Water Management Strategy</u> that has been prepared in consultation with other mines within the Precinct to:</i>	
			▪ <i>minimise the cumulative water quality impacts of the mines;</i>	Section 1.1
			▪ <i>review opportunities for water sharing/water transfers between mines;</i>	Sections 1.1, 3 and 4.3
			▪ <i>co-ordinate water quality monitoring programs as far as practicable;</i>	Sections 1.1 and 6.2
			▪ <i>undertake joint investigations/studies in relation to complaints/exceedances of trigger levels where cumulative impacts are considered likely; and</i>	Sections 1.1 and 8
			▪ <i>co-ordinate modelling programs for validation, re-calibration and re-running of the groundwater and surface water models using approved mine operation plans.</i> <i>Note: The Leard Forest Mining Precinct Water Management Strategy can be developed in stages and will need to be subject to ongoing review dependent upon the determination of and commencement of other mining projects in the area."</i>	Section 4

1.2 SCOPE

This document is the overarching strategy for cumulative surface water and groundwater management at the BTM Complex.

Individual mines manage their ongoing operations and associated surface water and groundwater management in accordance with their site-specific Water Management Plans (WMPs). Statutory requirements relating to water quality are considered in each site-specific WMP. Table 1.3 outlines the status of the site-specific WMPs for the BTM Complex at the time of writing this document.

Table 1.3
Status of Site-Specific Water Management Plans

Mine	Site-specific WMP Status
BCM	Last published May 2017. Available on the Idemitsu website (https://www.idemitsu.com.au/mining/operations/boggabri-coal/approvals-plans-reports/)
MCCM	Last published March 2019. Available on the Whitehaven website (http://www.whitehavencoal.com.au/sustainability/environmental-management/maules-creek-mine/)
TCM	No approved WMP. A draft WMP was submitted to DoI -Water (then DPI – Water) in August 2018 for review and TCPL is currently addressing comments from DoI – Water at the time of writing this document.

DoI - Water – NSW Department of Industry – Water.

DPI - Water – NSW Department of Primary Industries – Water.

1.3 SUMMARY OF PREVIOUS STUDIES

Previous environmental studies carried out for individual BTM Complex projects have been used in preparation of this document. A summary of these studies is presented in Table 1.4. These studies are publically available on the respective company websites and on the Major Projects database.

Given the location of the BTM Complex within the Namoi Catchment, reference is also made to findings of the Namoi Catchment Water Study (Schlumberger, 2012), commissioned by the NSW Government in August 2010. The study involved a strategic assessment of the likelihood of potential impacts from coal and gas development in the Namoi Catchment on the quantity and quality of surface and groundwater resources.

Table 1.4
Summary of Previous Water Impact Assessment Studies

Surface Water	Groundwater
Boggabri Coal Mine	
Parsons Brinckerhoff, <i>Continuation of Boggabri Coal Mine Project – Surface Water Assessment</i> , prepared for Hansen Bailey as part of the Environmental Assessment, October 2010*	Australasian Groundwater & Environmental Consultants Pty Ltd (AGE), <i>Continuation of Boggabri Coal Mine Groundwater Assessment</i> , prepared for Boggabri Coal Pty Ltd, October 2010
WRM, <i>Continuation of Boggabri Coal Mine- Namoi River Flood Impact Assessment</i> , prepared for Hansen Bailey, December 2009	Parsons Brinckerhoff, <i>Boggabri Coal Mine - Project Approval Modification Environmental Assessment (MOD 5)</i> , November 2015
Tarrawonga Coal Mine	
Gilbert and Associates Pty Ltd, <i>Tarrawonga Coal Project-Surface Water Assessment</i> , prepared for Whitehaven Coal Pty Ltd, March 2010	Heritage Computing Pty Ltd, <i>A Hydrogeological Assessment in Support of the Tarrawonga Coal Project Environmental Assessment</i> , prepared for Tarrawonga Coal Pty Ltd, January 2012*
Gilbert and Associates Pty Ltd, <i>Tarrawonga Coal Project-Surface Water Assessment</i> , prepared for Whitehaven Coal Pty Ltd, November 2011	GeoTerra Pty Ltd, <i>Surface Water and Groundwater 2006/2009 Monitoring Tri-annual Review</i> , prepared for Tarrawonga Coal Pty Ltd, November 2009
GeoTerra Pty Ltd, <i>Surface Water and Groundwater 2006/2009 Monitoring Tri-annual Review</i> , prepared for Tarrawonga Coal Pty Ltd, November 2009	
Maules Creek Coal Mine	
WRM, <i>Surface Water Impact Assessment for Maules Creek Coal Project</i> , prepared for Aston Resources, 9 February 2011	Australasian Groundwater & Environmental Consultants Pty Ltd (AGE), <i>Maules Creek Coal Project Groundwater Impact Assessment</i> , prepared for Aston Resources Ltd, June 2011*

Table 1.4 (Continued)
Summary of Previous Water Impact Assessment Studies

Surface Water	Groundwater
NSW Planning Assessment Commission, <i>Review Report- Maules Creek Coal Project</i> , March 2012	Heritage Computing Pty Ltd, <i>Peer Review of the Maules Creek Coal Project Groundwater Impact Assessment</i> , prepared for Aston Resources Ltd, February 2011
NSW Planning and Environment, <i>Director General's Environmental Assessment Report- Major Project Assessment Maules Creek Coal Project</i> , August 2012	NSW Planning Assessment Commission, <i>Review Report- Maules Creek Coal Project</i> , March 2012
	NSW Planning and Environment, <i>Director General's Environmental Assessment Report- Major Project Assessment Maules Creek Coal Project</i> , August 2012
	AGE Pty Ltd, <i>Installation of Monitoring Bore Network & Updating Groundwater Model</i> , 2014
BTM Complex	
	AGE, <i>Boggabri; Tarrawonga Maules Creek Complex Numerical Model Update</i> , August 2018*

* Study details the potentially cumulative impacts of the BTM Complex.

1.4 AGENCY CONSULTATION

The Water Management Strategy draws upon the site-specific WMPs and site water balance reports for the three mines. These documents have undergone extensive review by DP&E on numerous occasions and subsequent approval.

The site-specific mine WMPs which form the basis of the Water Management Strategy have been prepared in consultation with representatives from the NSW Office of Environment and Heritage (OEH), DoI – Water and North West Local Land Services (NWLLS) (formerly Namoi Catchment Management Authority).

The draft version of the Water Management Strategy has been reviewed by DP&E and comments have been addressed. A draft version of this BTM Complex Water Management Strategy has also been provided to DoI – Water, and a final draft version will also be provided to DoI – Water.

1.5 DOCUMENT STRUCTURE

The structure of this report is as follows:

- Section 1** Provides an introduction to the Water Management Strategy, including the background and scope of the Water Management Strategy. A list of previous studies is also included.
- Section 2** Provides an overview of the BTM Complex mines (BCM, TCM, MCCM).
- Section 3** Briefly outlines the existing surface water and groundwater resources of the area and the administrative context of their management.
- Section 4** Summarises the existing site-specific surface water and groundwater models for each mine, and cumulative modelling for the BTM Complex.
- Section 5** Describes potential cumulative impacts and issues associated with the BTM Complex.
- Section 6** Describes surface water and groundwater monitoring networks relevant to the BTM Complex.

- Section 7** Describes surface water and groundwater impact mitigation and response to triggers.
- Section 8** Describes how the Water Management Strategy will be implemented and the complaint management strategy.
- Section 9** Outlines the requirements for reviewing and revising the Water Management Strategy.
- Section 10** Lists the references used in this document.

2. THE BTM COMPLEX

The BTM Complex is located in the Narrabri LGA in the Northwest Slopes and Plains of New South Wales. The BTM Complex is located within and adjoining the Leard State Forest, north-east of Boggabri and south of Maules Creek. The major regional centres of Narrabri and Gunnedah are located approximately 50 km north-west and 40 km south-east of the BTM Complex, respectively.

2.1 BOGGABRI COAL MINE

BCM is an existing open cut mine that consists of an open cut pit, overburden dump, infrastructure area including coal processing facilities, water management structures, and a rail spur.

BCM obtained NSW State Government approval on the 18 July 2012, and Commonwealth Government approval on 11 February 2013. These approvals (as modified) allow operations at BCM to extend for a further 21 years at a rate of 8.6 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. The project approval for BCM provides for operation of existing ancillary equipment; construction and operation of a new coal handling and preparation plant (CHPP); 17 km rail spur line; bridges over the Namoi River and Kamilaroi Highway; a rail load-out facility located at the mine; upgrade of the overburden and coal extraction haulage fleet (with an option for a drag-line); upgrade of electricity transmission lines; and establishment of a water supply borefield and other ancillary infrastructure.

2.2 TARRAWONGA COAL MINE

TCM is an existing open cut coal mine located immediately south of BCM. TCM initially had approval to extract 2 Mtpa of ROM coal until 2017. TCPL submitted an application in July 2011 under Part 3A of the Environment Planning and Assessment Act 1979 (EP&A Act) for an extension of open cut mining operations to 3 Mtpa of ROM coal for a further 17 years. This application was approved by the NSW State Government on 22 January 2013.

TCM have modified Project Approval 11_0047 on a number of occasions since then, with the most recent being in November 2018. Project Approval 11_0047 allow operations at TCM until 2030 at a rate of 3 Mtpa of ROM coal.

2.3 MAULES CREEK COAL MINE

A Project Application for the MCCM was submitted to the NSW Department of Planning (now Department of Planning and Environment) in August 2010 under Part 3A of the EP&A Act. Project approval was granted by the Planning Assessment Commission under delegation of the Minister for Planning and Infrastructure on 23 October 2012. The project approval allows for the construction and operation of an open cut coal mine, with the recovery of up to 13 million tonnes per annum (Mtpa) of ROM coal for a period of 21 years. Key features of the project include transportation of coal by rail to Newcastle, and development of site infrastructure including a CHPP and associated facilities, a train loading facility and rail spur and loop, a mine access road, communications and power reticulation, explosives storage, and a water pipeline from the Namoi River.

Construction of the MCCM commenced in December 2013. Extraction of first coal commenced in the fourth quarter of 2014.

3. WATER RESOURCES AND ADMINISTRATIVE CONTEXT

3.1 SURFACE WATER

3.1.1 Catchments and streams

The slopes and upland areas of the BTM Complex are drained by a series of ephemeral streams rising in the Willowtree Range. The local drainage catchments associated with the area are, from the north, Maules Creek, Back Creek, 'Nagero Creek', Goonbri Creek and Bollol Creek, as shown in Figure 3.1.

BCM is contained within the catchment of an unnamed ephemeral waterway, locally known as 'Nagero Creek'. Nagero Creek drains west towards the Namoi River.

MCCM is largely within the Back Creek catchment with small tributaries flowing north into Back Creek which itself then flows west to meet Maules Creek before flowing into the Namoi River.

TCM is within the catchments of Nagero, Goonbri and Bollol Creeks. These creeks and their unnamed tributaries drain in a westerly and south-westerly direction towards the Namoi River.

Further detail regarding each site-specific mine's surface water systems is provided in the BCM, MCCM and TCM surface water assessments (available on each respective company website).

3.1.2 Relevant surface water sharing plans

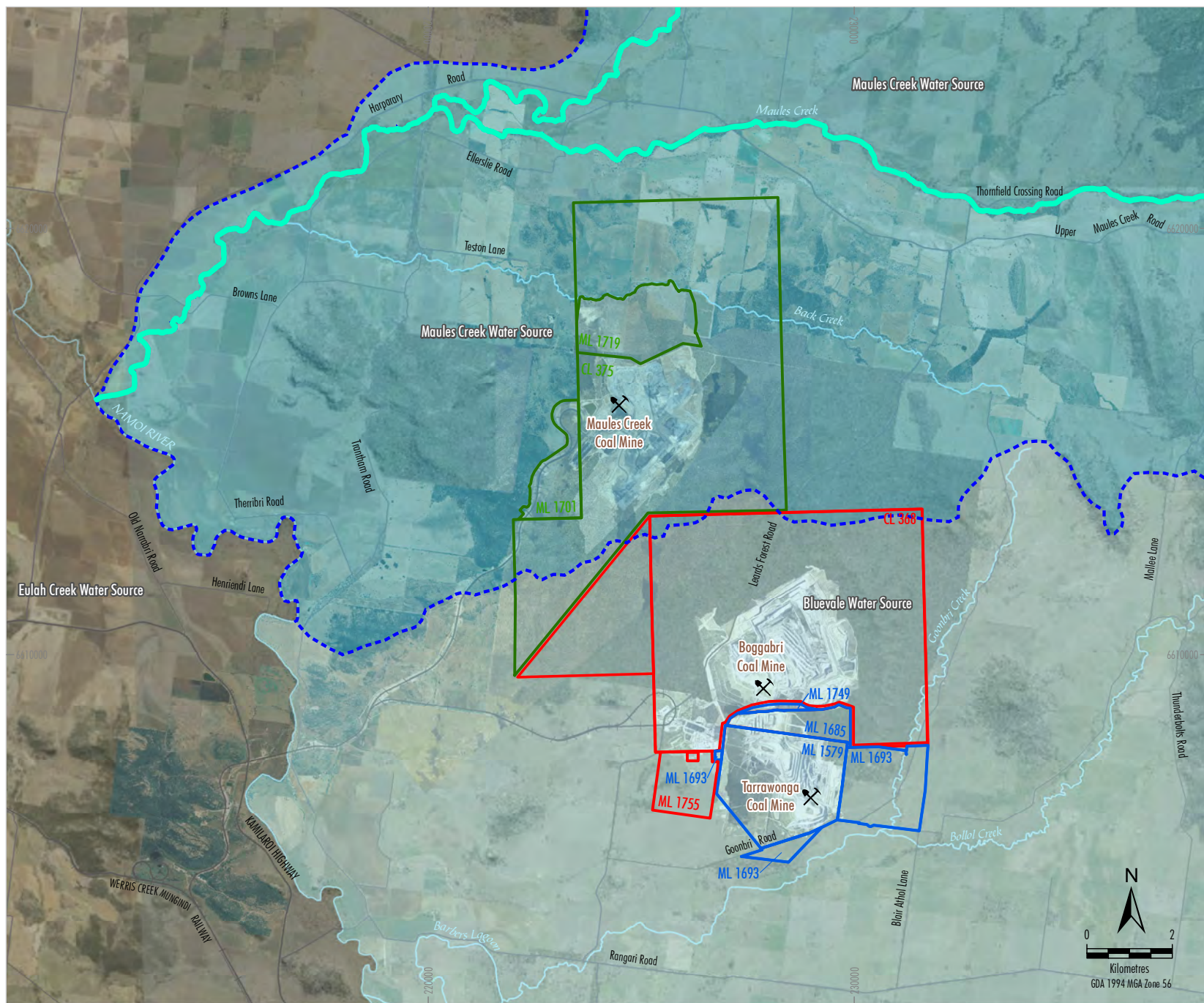
The BTM Complex lies within the Maules Creek Water Source, administered under the Water Sharing Plan (WSP) for the Namoi Unregulated and Alluvial Water Sources. The Maules Creek Water Source is divided into two management zones, the Maules and Horsearm Creeks Management Zone, and the Maules Creek Tributaries Management Zone (Figure 3.1). These local unregulated creeks flow into the Namoi River, which is administered under the WSP for the Upper and Lower Namoi Regulated River Water Sources. Water access licences (WALs) for both these water sources are fully allocated. Each mine site is responsible for holding or obtaining sufficient WALs prior to accessing surface water. WALs currently held by each mine site are listed in Section 3.3.

3.2 GROUNDWATER

3.2.1 Regional geology and hydrogeology

The BTM Complex is located in an area geologically characterised by the Permian Maules Creek Formation, with minor Quaternary alluvium to the south-east and Permian Boggabri Volcanics to the south-west (DMR, 1998). Minor alluvium is also associated with local creeks. Beyond the mining leases, extensive Quaternary alluvium deposits overlie the Boggabri Volcanic deposits to the west and south-west, and the Maules Creek Formation to the south. Coal is extracted from the seams of the Maules Creek Formation. Further south the alluvium directly overlies the Boggabri Volcanics (Figure 3.2).

The thickness of the highly productive Quaternary alluvial deposits along the Namoi River ranges from approximately 30 m to 120 m, decreasing from the thicker palaeochannel in the south-west to a thin cover in the east. The regional groundwater flow direction within this alluvium is generally to the north-northwest. Groundwater in the alluvium associated with Bollol Creek flows south-west towards the Namoi River.



- LEGEND**
- Mining Tenement Boundary - Boggabri Coal Mine
 - Mining Tenement Boundary - Tarrowonga Coal Mine
 - Mining Tenement Boundary - Maules Creek Coal Mine
 - Maules Creek Tributaries Management Zone
 - Maules and Horsearm Creeks Management Zone
 - Bluevale Water Source
 - Maules Creek Water Source
 - Eulah Creek Water Source

Source: Department of Industry (2019); DPI - Gunnedah Coalfield South (2013)



Figure 3.1

The Maules Creek alluvial aquifers are located north of BTM and are divided into two distinct zones by a constriction in the flood plain created by the outcropping Permian basement. Upstream of the constriction the Maules Creek alluvium is some 90 square kilometres (km²) in area and drained by three ephemeral creeks; Horesarm Creek, Middle Creek and Maules Creek (i.e. Upper Namoi Zone 11, Maules Creek Groundwater Source). Downstream of the constriction area, Horsearm Creek and Middle Creek discharge into Maules Creek and a zone of permanent water holes known as Elfin Crossing are present. The Maules Creek alluvial plain widens significantly in this area and Maules Creek eventually discharges into the Namoi River about 11 km west of the MCCM mining lease (AGE, 2011).

Bore yields in the alluvial aquifers are highly variable and dependent on the nature and thickness of the sediment intersected when drilling. The bores in the alluvial aquifers show a very wide range in yields, from less than 1 L/s up to a maximum of 175 L/s (AGE, 2018).

The major groundwater aquifers within the Maules Creek Formation are the coal seams, in particular the Merriown Seam. The Maules Creek Formation aquifers are 'confined' to 'semi-confined', bounded below by fresh volcanic bedrock and above by low permeability sandstones and conglomerates. Leakage from the Permian strata is restricted, both between coal seam layers and from the overlying and underlying sandstone, shale, conglomerate and siltstone. Groundwater flow direction in the Maules Creek Formation is to the south-west (Parsons Brinckerhoff, 2012a), consistent with the topographic gradient. The groundwater flow within the coal seams of the Maules Creek Formation is controlled primarily by lateral flow within the seams.

Residual volcanic soils associated with the Boggabri Volcanics (weathered profile) to the south-west of the mine lease areas are generally thick enough to retain groundwater volumes of consequence, however their permeability is low. The weathered rock aquifer is generally 40 m to 50 m thick and provides a hydraulic connection between the coal seam aquifers and the alluvium associated with ephemeral creeks ('Nagero Creek' and Bollol Creek) and the Namoi River.

Further details regarding the hydrogeology of the BTM Complex area are provided in the site-specific groundwater assessments and in the *Boggabri, Tarrawonga, Maules Creek Complex Numerical Model Update* (AGE, 2018).

3.2.2 Relevant groundwater sharing plans

The three BTM Complex mines target coal seams in the Maules Creek Formation within the Gunnedah-Oxley Basin MDB Groundwater Source defined in the WSP for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011. The surrounding alluvial sediments lie within the following groundwater sources, defined in the WSP for the Upper and Lower Namoi Groundwater Sources 2003 (Figure 3.3):

- Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source.
- Upper Namoi Zone 5, Namoi Valley (Gin's Leap to Narrabri) Groundwater Source.
- Upper Namoi Zone 11, Maules Creek Groundwater Source.

The BTM Complex mines are required to obtain access licences for any volumetric groundwater impacts on these water sources. These may be direct impacts such as drainage of the alluvial or porous rock groundwater sources via bores and/or pumps from mine workings, or indirect impacts resulting from drainage, or reduction in inflows to the alluvial groundwater sources. The Upper and Lower Namoi alluvial groundwater sources are fully allocated. As such, licences to account for volumetric impacts would need to be obtained from existing holders. Water entitlements currently held across the BTM Complex are detailed in each mine's respective surface water and groundwater management plans and are provided in Section 3.3.

3.3 WATER ACCESS LICENCES

Table 3.1 summarises the surface water and groundwater WALs currently held (at the time of writing) by each mine site. Mine-specific WMPs contain the predicted annual take per mine.

Table 3.1
Water Access Licences for the BTM Complex

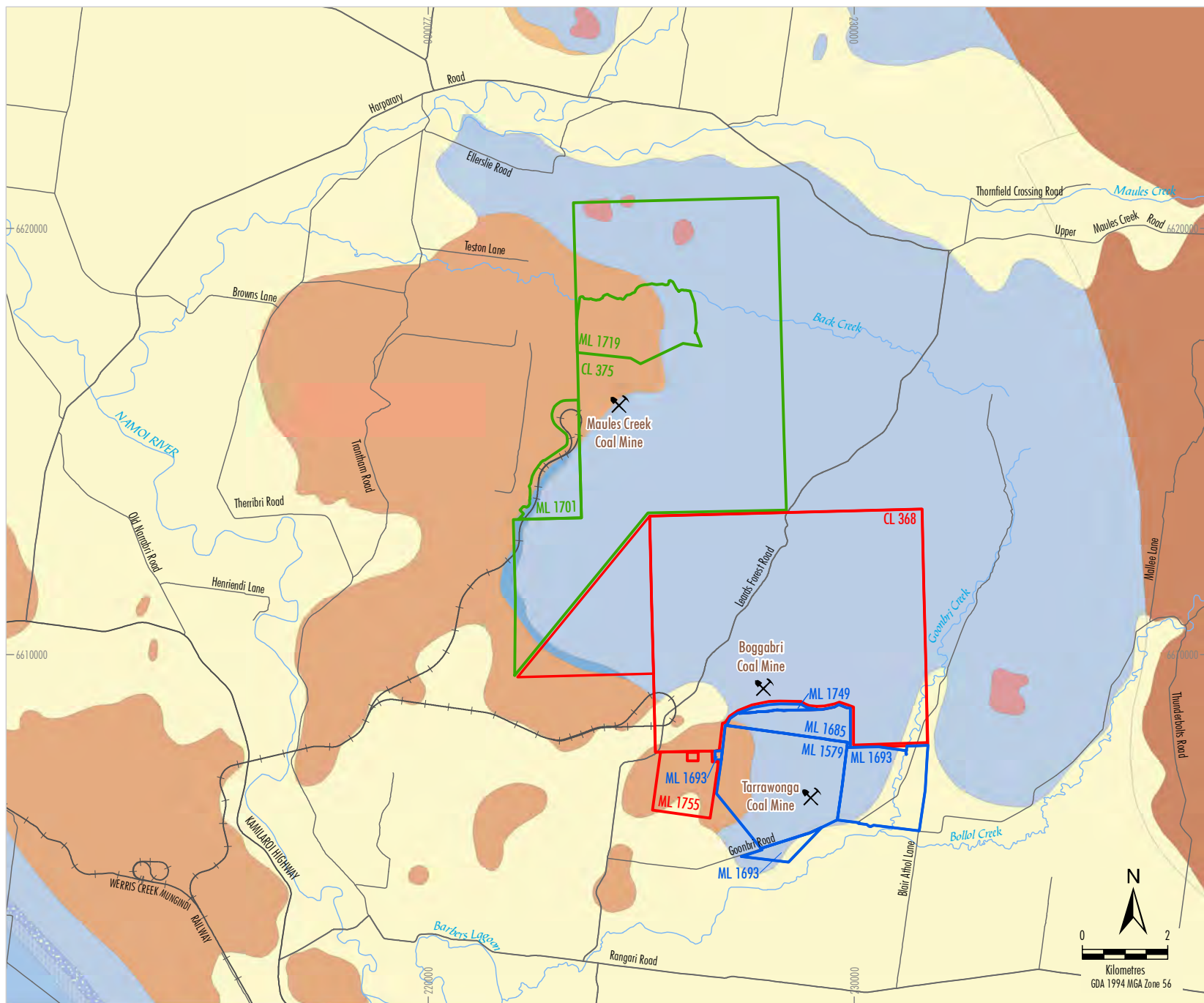
Water Source	Predicted Water Take*#	Licence No.	Total Entitlement (units) ^	Type
Maules Creek Coal Mine				
Lower Namoi Regulated River Water Source	As required	WAL13050	3,000.00	Surface water extraction
Maules Creek Water Source (Maules Creek Tributaries Management Zone)	N/A	WAL41585	30.00	Surface water extraction
Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source	60	WAL27385	38.00	Indirect Aquifer Interception
		WAL12645	35.00	Indirect Aquifer Interception
Upper Namoi Zone 5, Namoi Valley (Gin's Leap to Narrabri) Groundwater Source	0	WAL12811	135.00	Indirect Aquifer Interception
Upper Namoi Zone 11, Maules Creek Groundwater Source	4	WAL12479	78.00	Indirect Aquifer Interception
	-	WAL27383	0.00	Indirect Aquifer Interception
	-	WAL12491	77.00	Indirect Aquifer Interception
	-	WAL12480	215.00	Indirect Aquifer Interception
Gunnedah - Oxley Basin MDB Groundwater Source (Gunnedah - Oxley Basin MDB [Other] Management Zone)	108	WAL36641	800.00	Aquifer interception
Gunnedah - Oxley Basin MDB Groundwater Source (Gunnedah - Oxley Basin MDB [Other] Management Zone)	-	WAL29588	0.00 (subject to conditions)	N/A
Gunnedah - Oxley Basin MDB Groundwater Source (Gunnedah - Oxley Basin MDB [Other] Management Zone)	306	WAL29467	306.00	Aquifer interception
Boggabri Coal Mine				
Lower Namoi Regulated River Water Source	As required	WAL2571	51.00	Surface water extraction
	As required	WAL2572	5.60	Surface water extraction
	As required	WAL2595	243.00	Surface water extraction
	As required	WAL2596	26.50	Surface water extraction
Upper Namoi Regulated River Water Source	-	WAL37067	128.00	Surface water extraction
Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source	-	WAL12691	457.00	Aquifer Extraction
	-	WAL12767	3.00	Aquifer Extraction
	-	WAL15037	172.00	Aquifer Extraction
	-	WAL24103	275.00	Aquifer Extraction
	-	WAL36547	37.00	Aquifer Extraction
	66	WAL37519	84.00	Aquifer Extraction
Upper Namoi Zone 11, Maules Creek Groundwater Source	4	WAL42234	20.00	Indirect Aquifer Interception
Gunnedah - Oxley Basin MDB Groundwater Source (Gunnedah - Oxley Basin MDB [Other] Management Zone)	-	WAL29473	142.00	Aquifer Extraction
	459	WAL29562	700.00	Aquifer Interception
Tarrawonga Coal Mine				
	145	WAL31084	250.00	Aquifer Interception

Gunnedah - Oxley Basin MDB Groundwater Source (Gunnedah - Oxley Basin MDB [Other] Management Zone)	-	WAL29548	50.00	Aquifer Interception
Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source	21	WAL36548	36.00	Indirect Aquifer Interception
Upper Namoi Zone 11, Maules Creek Groundwater Source	1	WAL12480	215.00	Indirect Aquifer Interception

* Value provided via predictive water modelling of the BTM Groundwater Model to be revised periodically. Please refer to section 5.2.

Predicted modelled water take maximum value to 2020 as per Table 8.10 of BTM Complex Numerical Model Update until a future model review identifies revised predicted values.

^ Licenced entitlement does not include accounting for any licenced carryover permitted under applicable Water Sharing Plan conditions.



LEGEND

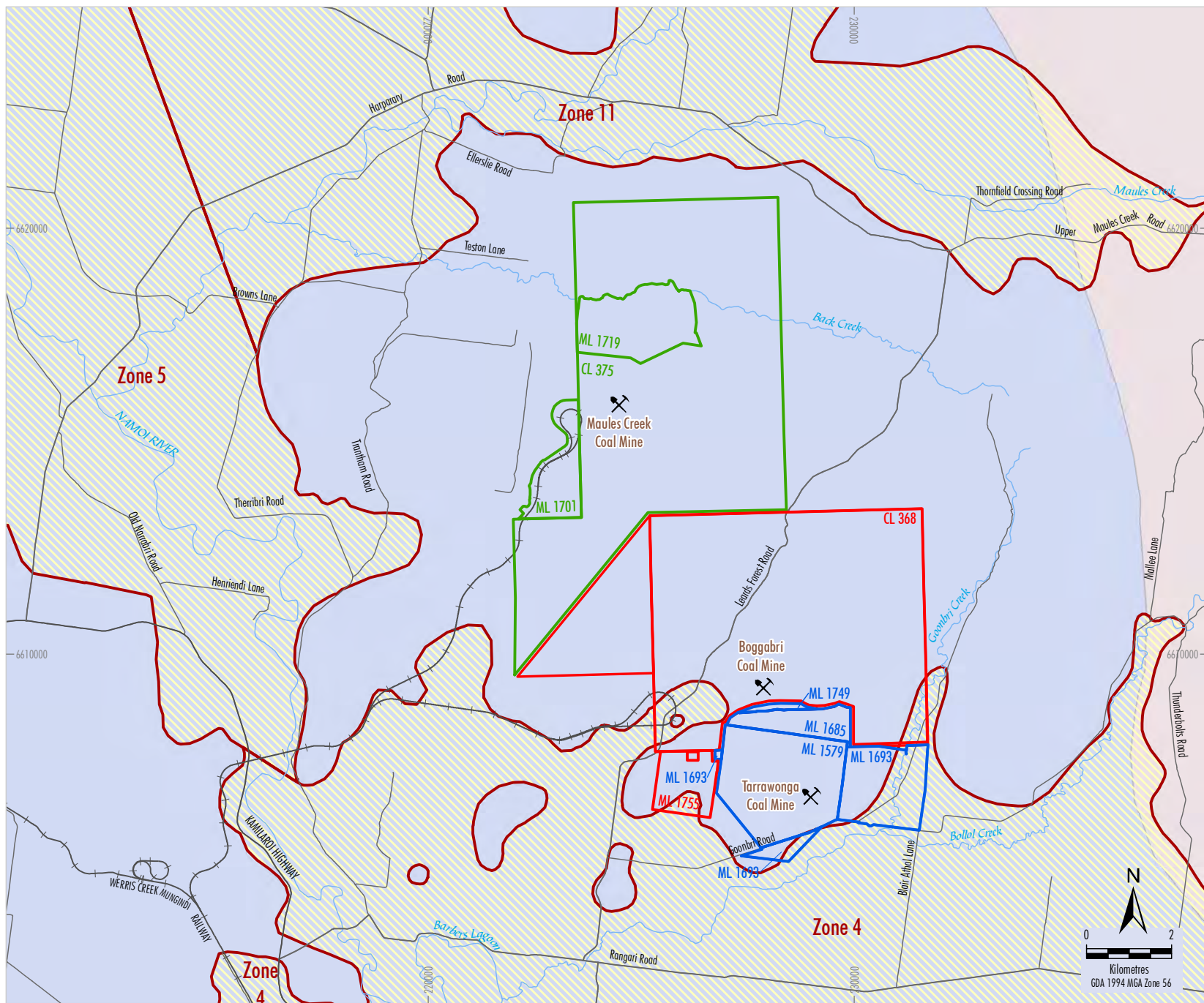
- Mining Tenement Boundary - Boggabri Coal Mine
- Mining Tenement Boundary - Tarrawonga Coal Mine
- Mining Tenement Boundary - Maules Creek Coal Mine

Regional Geology Legend (relevant formations)

- Undifferentiated Alluvial Deposits
- Maules Creek Formation
- Ph
- Pbr

Source: Department of Industry (2019); DPI - Gunnedah Coalfield South (2013)

Figure 3.2



LEGEND

- Mining Tenement Boundary - Boggabri Coal Mine
- Mining Tenement Boundary - Tarrawonga Coal Mine
- Mining Tenement Boundary - Maules Creek Coal Mine

Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003

- Alluvial Groundwater Source

Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011

- Gunndah-Oxley Basin MDB Groundwater Source

Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011

- New England Fold Belt MDB Groundwater Source

Source: Department of Industry (2019); DPI - Gunndah Coalfield South (2013)

WHITEHAVEN COAL **IBG**

BTM WATER MANAGEMENT STRATEGY

Relevant Groundwater Sources

Figure 3.3

4. MODELLING

Site-specific surface water and groundwater assessments have previously been prepared for Environmental Assessments and Environmental Impact Statements for the MCCM, TCM and BCM (Table 1.3). The surface water and groundwater models developed to support these assessments are described in Sections 4.1.1 and 4.2.1.

In addition to site-specific assessment, cumulative consideration and modelling of surface water and groundwater has been conducted for the BTM Complex in support of this WMS, which is described in Sections 4.1.2 and 4.2.2.

The overall goal of cumulative consideration/modelling is to demonstrate the conceptual understanding of the cumulative behaviour of surface and groundwater resources in the BTM Complex area, and as such:

1. to estimate quantitatively the cumulative impacts from the BTM Complex on groundwater and surface water resources to inform appropriate management responses (e.g. licence acquisition, compensatory measures for affected landholders, structural measures, additional monitoring, etc.);
2. to estimate the contribution to impacts by individual mines in order to determine appropriate responsibilities for management responses; and
3. to verify the predicted impacts over the course of mining operations through evaluation of design hydraulic behaviour, mine inflows and groundwater drawdown magnitude/extent, with this information feeding back into the above management responses.

4.1 SURFACE WATER

4.1.1 Site-Specific Modelling

Hydrologic and hydraulic models have been developed for BCM (Parsons Brinckerhoff, 2010). The purpose of the modelling was to assess the potential impact of BCM on peak flows in the 'Nagero Creek' catchment, and for the preliminary sizing of diversion drains. The hydrologic and 1D hydraulic models were developed using XPSWMM (version 10.6) software. These models do not include hydraulic structures (such as culverts), but do include sediment basins from the northern spoil dump at the existing TCM.

The Boggabri XPSWMM model provided results for the 5, 20 and 100 year Average Recurrence Interval (ARI) design storm events, for Years 1, 5, 10 and 21 of BCM. The modelling suggests that peak flow rates at the catchment outlet (where 'Nagero Creek' meets the Namoi River floodplain, approximately 1 km downstream of BCM) will reduce over the life of the mine, as a result of water being captured and reused on site (Parsons Brinckerhoff, 2010).

Additionally, a flood study was prepared by WRM (2011) for BCM, using TUFLOW software. The intent of the model was to assess the impact of the proposed rail bridge, haul road upgrade and Therribri Road overpass on the Namoi River floodplain. The model boundary was restricted to the infrastructure area of the Namoi River, and predicted a negligible to minor impact to flood levels, extent and velocities.

Hydrologic and hydraulic modelling has also been carried out for the TCM by Gilbert & Associates (2011). The purpose of the modelling was to design the realignment of Goonbri Creek around the eastern edge of the proposed extended open cut pit. Hydrological modelling was carried out using RORB software, to predict peak design flows for the 2, 20 and 100 ARIs and the Probable Maximum Flood (PMF). 1D hydraulic modelling was carried out using HEC-RAS software to assess the viability of the channel design.

Gilbert & Associates (2011) recommend further hydraulic modelling be carried out using additional survey data, to model the hydraulic characteristics of Goonbri Creek down to Bollol Creek, and downstream to Barbers Lagoon and the Slush Holes. The results of the recommended additional modelling could then be used to provide a more accurate baseline characterisation of existing conditions in Goonbri Creek and Bollol Creek in the final design of the realigned section of Goonbri Creek. Recommendations of the report (among others) include the placement of flow gauging stations on Goonbri Creek to verify and calibrate the completed models, and to assist in performance evaluation during and post construction.

The results of the hydraulic modelling indicate that peak flow velocities in the channel and overbank areas are indicators of stability in the Goonbri Creek realignment.

Hydrological analysis for MCCM was carried out using the Rational Method (WRM, 2011). The method was used to estimate the 100 year ARI design flood discharges in Back Creek along the reach adjacent to the proposed northern overburden area. The estimated flows were then input into a HEC-RAS model to determine the extent of flooding along Back Creek and to quantify potential impacts of TCM on flood levels and behaviour. The results of the modelling indicate that the proposed limit of disturbance is outside of the 100 year ARI flood extent, and therefore no adverse impact to flood levels or behaviour from TCM is expected for flood events up to the 100 year ARI.

4.1.2 Cumulative Considerations

To achieve the cumulative objectives, it is proposed that a detailed review of site-specific surface water models be undertaken to determine if and how cumulative flow behaviour has been incorporated, in terms of flow distribution, timing, depth and velocities throughout the BTM Complex area and downstream. The models should be assessed for their capabilities and limitations with respect to prediction of cumulative surface water impacts as a result of the BTM Complex.

4.2 GROUNDWATER

4.2.1 Site-Specific Modelling

The three existing regional groundwater models are already standardised on common software, namely MODFLOW-SURFACT Version 4 that is distributed commercially by HydroGeoLogic, Inc. (Virginia, USA). This software is able to simulate variably saturated flow and can handle desaturation and re-saturation of multiple aquifers without the “dry cell” problems of Standard-MODFLOW. This is pertinent to the dewatering of water-bearing formations adjacent to open cut mines and to reliable prediction of water level recovery post-mining.

However, there are differences in the user interfaces to each model. The TCM model (Heritage Computing, 2012b) uses the Groundwater Vistas Version 6 graphic user interface (GUI), while the BCM and MCCM models (AGE, 2010 and 2011) rely on proprietary FORTRAN code with some assistance from the PMW in GUI.

More fundamentally, the models differ in the number of model layers and in the way in which target coal seams have been aggregated, reflecting different mining objectives and variable seam geometry for each site.

Each of the BCM, TCM and MCCM models undergo regular maintenance and recalibration as additional data on groundwater responses to progressive mining improves the understanding of the groundwater systems.

4.2.2 Cumulative Modelling

Heritage Computing (2012)

Groundwater modelling of cumulative groundwater impacts was undertaken by Heritage Computing (2012a) as part of the development of the Water Management Strategy. This is in addition to two regional models developed incrementally by AGE for BCM and MCCM, and a separate regional model for TCM developed by Heritage Computing.

The Heritage Computing (2012) groundwater model utilised the geological layers developed during the data sharing process established between the BCM, TCM and MCCM.

The potential cumulative surface water and groundwater impacts and issues are discussed in Section 5.1.

Australasian Groundwater and Environmental Consultants (2018)

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) prepared the report *Boggabri, Tarrawonga, Maules Creek Complex Numerical Model Update* (AGE, 2018) to satisfy the approval conditions for the verification of predicted groundwater impacts against observed datasets every three years. Each of the BTM Complex mines are required to prepare a “*Groundwater Management Plan, which includes... a program to validate the groundwater model for the project, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions*”.

As part of the report, the numerical model for the BTM complex was reviewed and verified against monitoring data collected since 2013. Prior to further calibration the model was imported into MODFLOW USG to allow the geological units to be more accurately represented. Further calibration of the model aimed at reproducing the water level trends observed within the BTM complex monitoring bore network. The calibration resulted in increasing the coal seam hydraulic conductivity (AGE, 2018).

The modelling results and outcomes are described in Sections 5.2 and 5.3.

5. POTENTIAL CUMULATIVE IMPACTS AND ISSUES

Regional numerical modelling conducted as part of the Namoi Catchment Water Study (Schlumberger, 2012) concluded that the area encompassing the BTM Complex (defined as Upper Namoi Zone 4, Namoi Valley [Keepit Dram to Gin's Leap] Groundwater Source) is considered to be at moderate risk from coal and gas developments. In addition, Upper Namoi Zone 5 Namoi Valley (Gin's Leap to Narrabri) Groundwater Source and Upper Namoi Zone 11, Maules Creek Groundwater Source have been located in the vicinity of the BTM Complex and are considered to be at moderate and high risk from mining and coal seam gas developments, respectively. Schlumberger (2012) indicated potential impacts within the Namoi Catchment would likely occur as follows:

- Interception of rainfall and run-off; There is a greater potential for open-cut mines to intercept rainfall and run-off. Where possible operators tend to divert existing surface water drainage around the perimeter of the site to minimise drainage into the open cut. Water intercepted is removed from the surface/groundwater systems and stored on-site for use in operations or treated and discharged.
- Lowering of groundwater levels; Mining below the water table can have an impact on groundwater resources. Dewatering of pits can potentially induce local changes in groundwater gradients and flow directions.
- Pit runoff water and pumped groundwater can be contaminated with suspended solids and/or dissolved minerals and metals, and would need to be treated before discharge into the local drainage system.

Sections 5.1 and 5.2 provide an overview of the detailed assessments of the potential surface water and groundwater impacts associated with BTM Complex operations undertaken as part of the Environmental Assessments (EAs) and technical reports prepared in support of development applications for each project. A summary of previous surface water and groundwater studies is provided in Table 1.4.

5.1 SURFACE WATER

5.1.1 Contaminant export

Mine water, containing suspended solids and soluble salts, will be generated from coal stockpiles and the mining void, as well as groundwater inflows to the mining void. In addition, dirty water containing suspended solids will be generated from runoff from disturbed areas within the mine sites, including from infrastructure areas, unshaped spoil dumps and haul roads. For all mines, mine water will be retained onsite for use (if required), and dirty water will report to settlement ponds for on-site use, or be shared with other mines within the BTM Complex, subject to water sharing agreements being reached on terms acceptable to the mines acting reasonably, or discharged from site in line with approval conditions and licences for each of the mines.

The management of dirty water and mine water at each of the mines is detailed in each site-specific WMP. It will remain the responsibility of each mine to implement the mitigation measures detailed in their WMP's to reduce any cumulative impacts on the surrounding environment during operations and post-mining until relinquishment of the relevant leases.

5.1.2 Catchment areas and flows to local creeks and Namoi River

Mining operations will result in modifications to local surface water catchments. The area of undisturbed (or rehabilitated) catchment draining to the local creeks will reduce over the life of each mine, as the area draining to dirty and mine water management systems increases. Areas draining to local catchments will subsequently increase as rehabilitation is established and runoff is of suitable quality.

Peak flow rates at the catchment outlets are likely to reduce over the life of the mines. This reduction may be attributed to dirty water runoff being captured in sediment dams, thus attenuating peak flow rates. An overall reduction in catchment outflow may also be associated with mine water runoff being stored on-site for reuse, rather than being discharged to the creeks.

Surface water will also, where possible, be diverted around disturbed and mining areas and directed into catchment outlets.

Given the very small contribution of these creeks to the Namoi River catchment, the impacts on the Namoi River flows downstream and the Namoi River water users are likely to be minimal. However, local creek environmental flows may be affected.

The extent to which impacts on streamflows persist beyond the life of BTM Complex will depend on the final landform for each mine (i.e. changes in runoff direction due to the final landforms and permanent catchment excision due to final voids). It will remain the responsibility of each mine to ensure rehabilitation and landform design (including final void catchment areas) is undertaken in accordance with the relevant site-specific approvals.

In locations where the landforms interface, consultation will be conducted between the relevant BTM Complex mines to achieve beneficial cumulative landform objectives (e.g. to minimise long term water impacts).

5.1.3 Flooding

Investigations undertaken as part of the EAs for each mine found that peak flow rates at catchment outlets in the BTM Complex area are likely to reduce as mine areas increase, as described in the section above.

Changes to landforms and hydrology from BTM Complex mining and overburden emplacement have the potential to change flood characteristics for flood prone areas.

For BCM, analysis undertaken by WRM Water and Environment Pty Ltd, and summarised in the EA (WRM, 2009) indicated that mine infrastructure would cause no riverbank erosion upstream or downstream of the project, and predicted a minor impact on flood levels, extent and velocities.

Gilbert & Associates (2011) undertook initial hydrologic and hydraulic modelling for the TCM. The assessment identified the TCM to be predominantly on land with an elevation greater than 275 m AHD, which is above any conceivable flood impact. It determined that the proposed flood bund and embankments of the Goonbri Road realignment would have minimal impact on the Goonbri/Bollol Creek floodplain south of Dripping Rock Road. As part of the proposed Goonbri Creek realignment, further hydraulic modelling will be carried out using additional survey data, to model the hydraulic characteristics of Goonbri Creek down to Bollol Creek, and downstream to Barbers Lagoon and the 'Slush Holes'. The results of this additional modelling can then be used to provide a more accurate baseline characterisation of existing conditions in Goonbri Creek and Bollol Creek in the final design of the realigned section of Goonbri Creek.

Hydrologic and hydraulic analysis for MCCM was carried out by WRM (2011) to determine the extent of flooding along Back Creek and to quantify potential impacts of the MCCM on flood levels and behaviour. Results indicated that the proposed limit of disturbance is outside of the 100 year ARI flood extent, and therefore no adverse impact to flood levels or behaviour from the project is expected for flood events up to the 100 year ARI.

5.2 GROUNDWATER

5.2.1 Groundwater flow

Changes to groundwater flows in areas surrounding each mine are anticipated. Schlumberger (2012) highlighted potential for below water table mining in either open-cut or underground mines to have an impact on quantity and quality of groundwater resources. Dewatering of pits and mines can potentially induce local changes in groundwater gradients and flow directions.

Worst case cumulative groundwater impact assessment undertaken by AGE (2010) determined that cumulative groundwater depressurisation impacts could be expected from the TCM, BCM and MCCM projects. The modelling indicated that depressurisation would reduce the net volume of groundwater flowing from the Permian bedrock into the overlying alluvial aquifers by approximately 30%.

5.2.2 Alluvial aquifer impacts

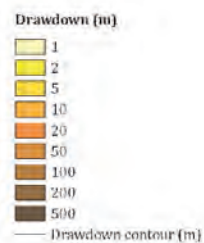
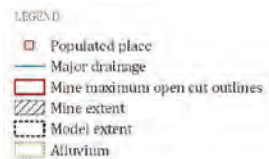
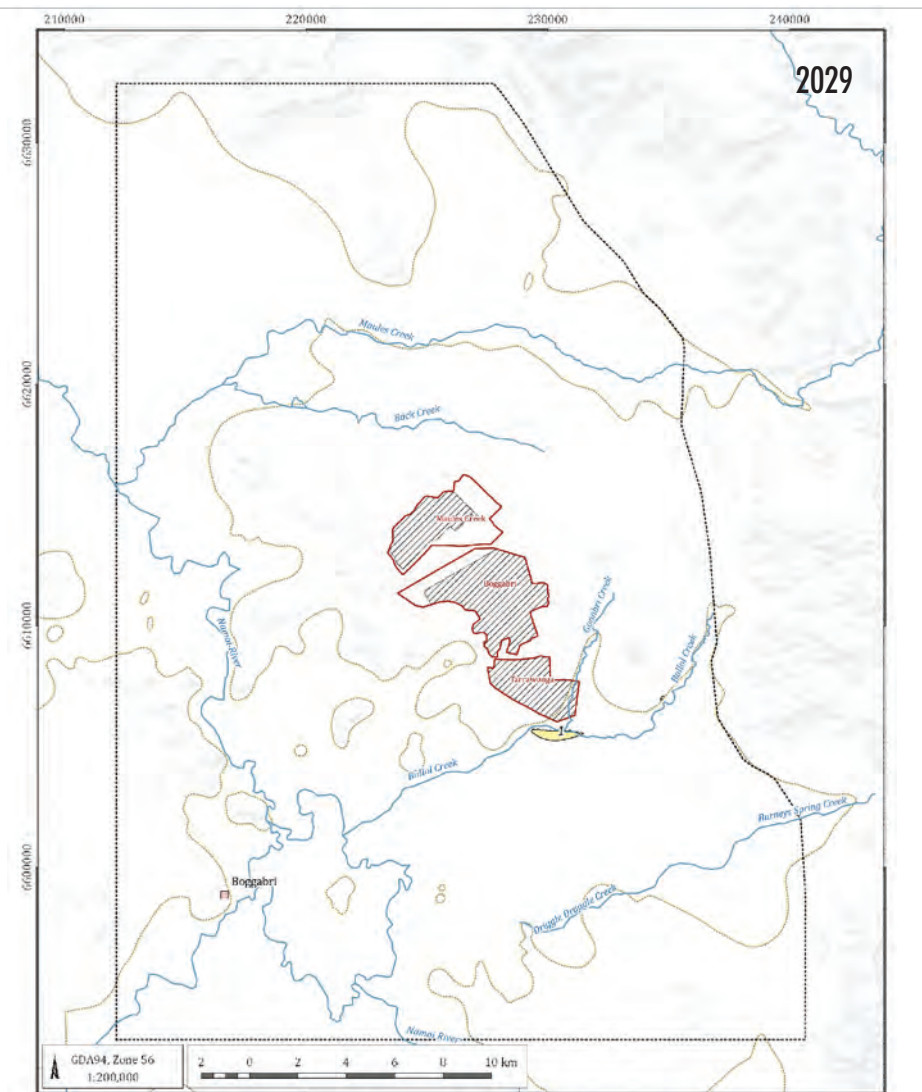
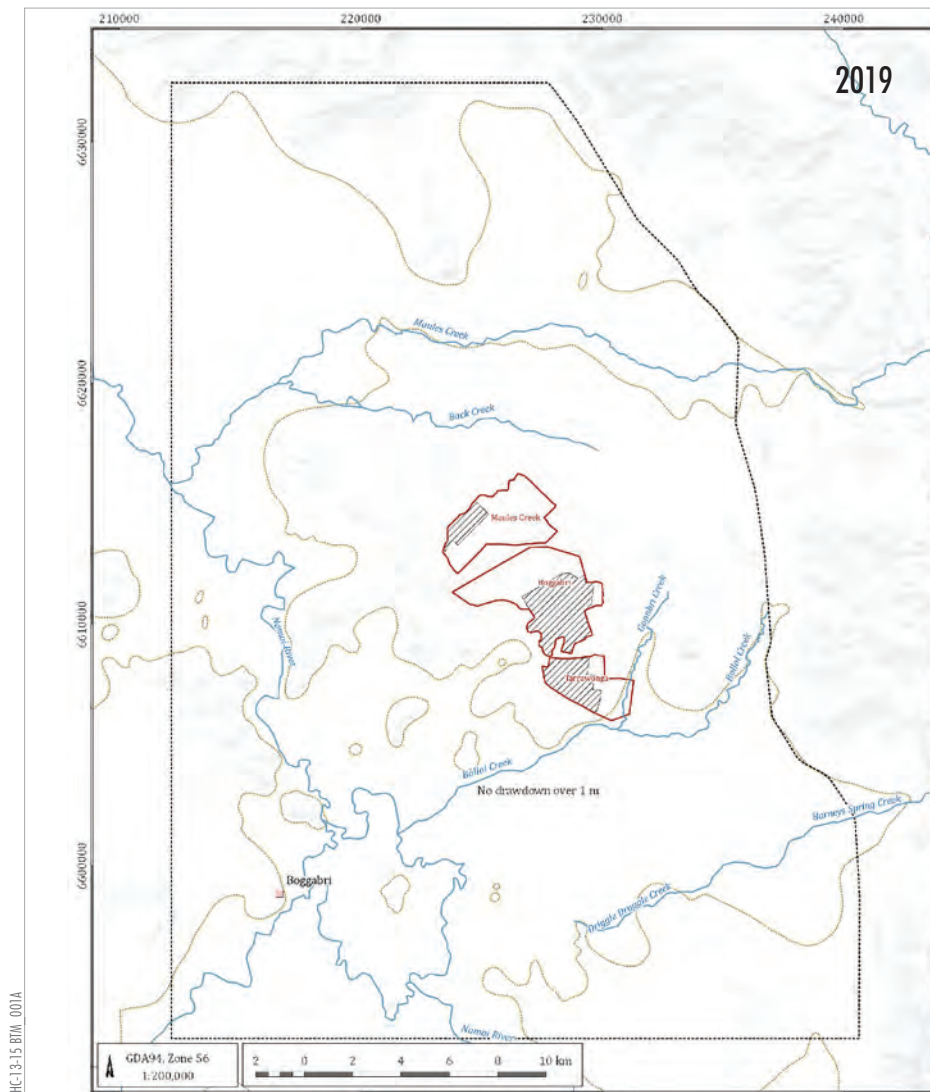
Changes in alluvial groundwater volumes and levels have the potential to occur as a result of mining within the BTM Complex.

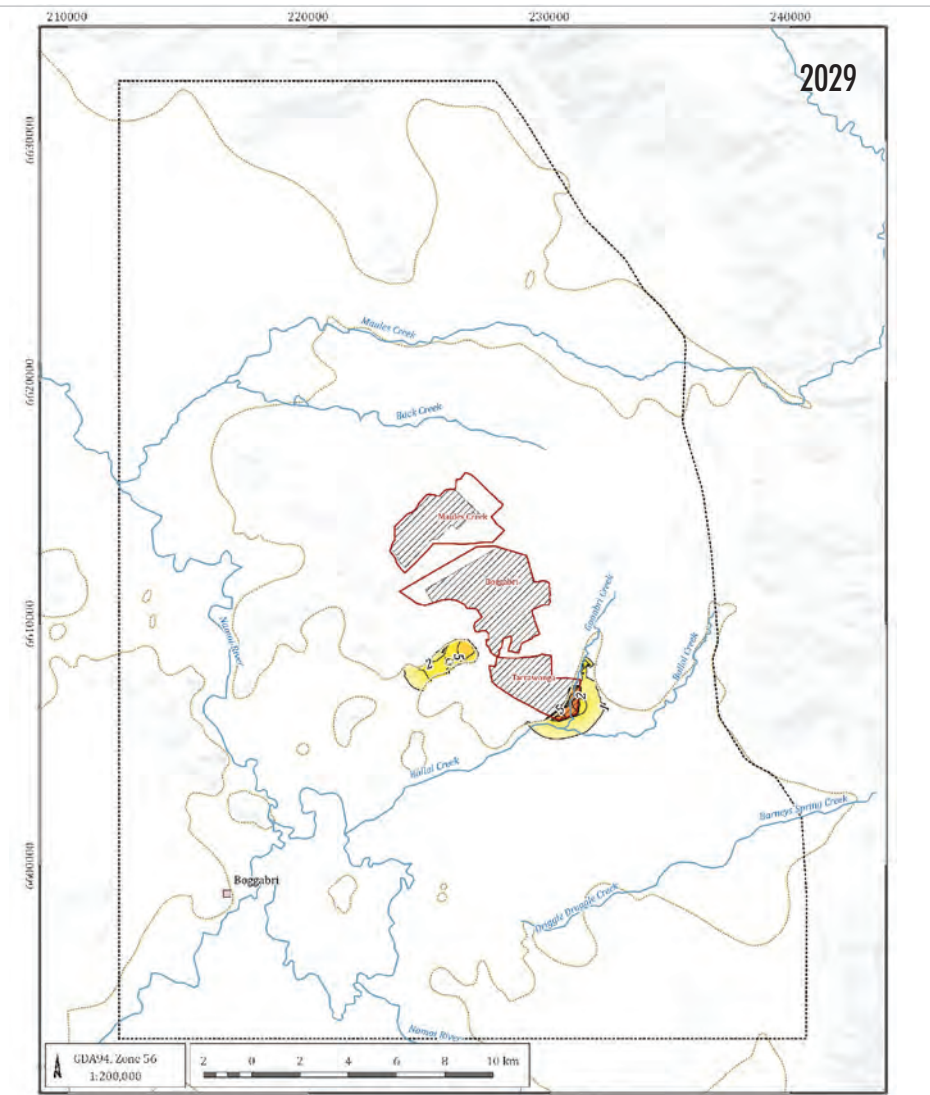
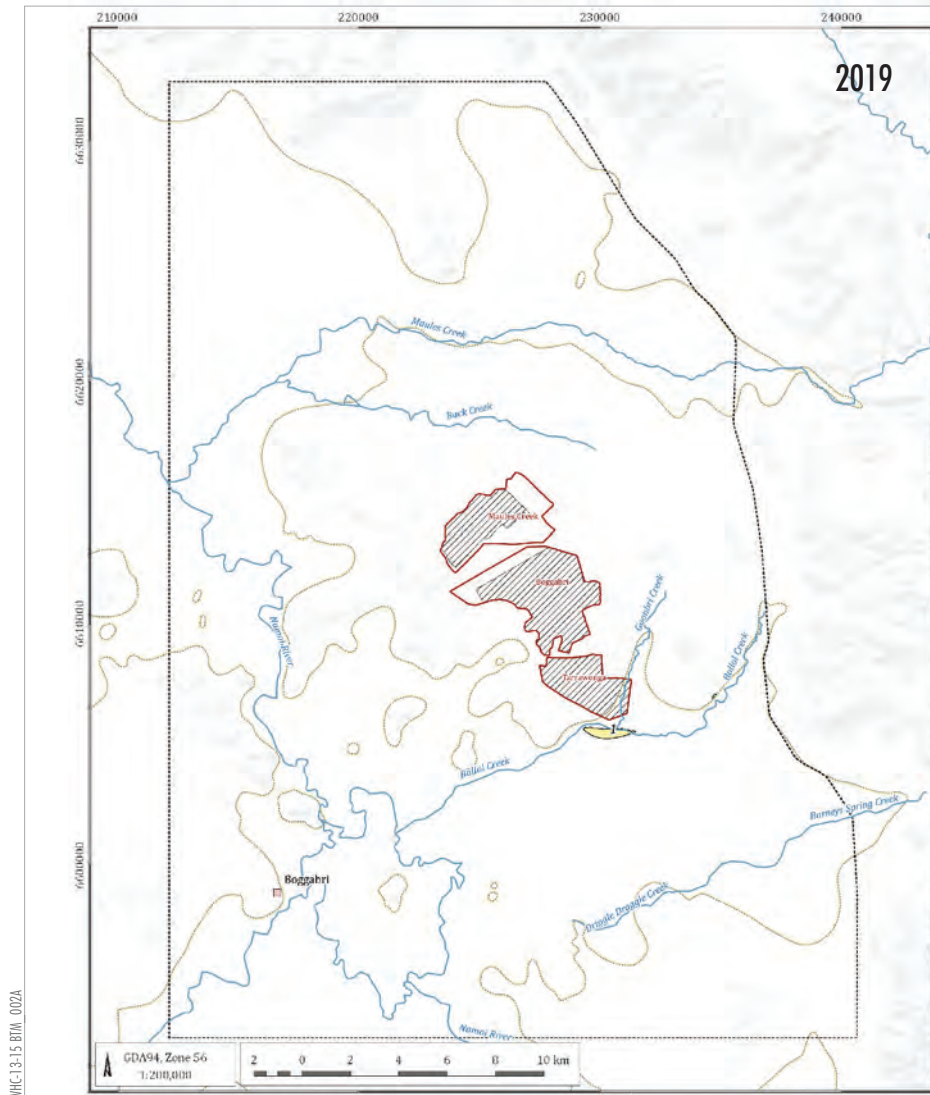
The recalibrated model prepared by AGE (2018) predicted limited and localised drawdown within the Narrabri and Gunnedah alluvium, consistent with previous versions of the model. As shown on Figures 5.1 and 5.2, the drawdown is confined to the zones of alluvium that have infilled valleys immediately adjacent to the active mining areas at Boggabri and Tarrawonga Mine (AGE, 2018).

The drawdown shown in Figures 5.1 and 5.2 represent the cumulative impact on the groundwater regime generated by all three mines operating together. Appendix A contains a series of figures that show how each mine contributes proportionally to the total drawdown and cumulative impact (taken from Appendix D of AGE [2018]). The figures show the proportion of each mine to the cumulative impact is most significant within the active mining area and reduces with distance from the mine. The figures also show that the proportion for each mine changes with time, as mining depth and location progresses.

Modification 5 of the Boggabri Coal Mine involved establishment and operation of a borefield which included two production bores and four contingency production bores. The borefield will contribute to regional cumulative groundwater drawdown associated with the adjacent mining operations. This is estimated to be an additional groundwater drawdown of 1 to 3 m in the alluvium to the east and north-east of the borefield where mine cumulative drawdown is experienced (Parsons Brinckerhoff, 2015).

Insert Figure 5.1





LEGEND

- Populated place
- Major drainage
- Mine maximum open cut outlines
- Mine extent
- Model extent
- Alluvium

Drawdown (m)

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

Drawdown contour (m)



BTM WATER MANAGEMENT STRATEGY

Cumulative Groundwater
Drawdown Extent -
Gunnedah Alluvium

Figure 5.2

5.2.3 Hard rock aquifer impacts

Impacts to hard rock aquifers are considered to be a potential cumulative issue for the BTM Complex.

Figure 5.3 shows the predicted drawdown extent within the Merriown Seam (refer to AGE [2018] for further details regarding model layers). Compared to previous modelling, the drawdown predicted by the updated model is less extensive to the west and does not extend into the Boggabri Volcanics, but is more extensive towards the east reaching the model boundary. These differences are expected to be a result of:

- changing from MODFLOW SUFACT to MODFLOW USG that allowed pinching out of the coal seams towards the west where they do not exist;
- a simplified approach to representing rainfall recharge (use of the pseudo soil option); and
- the more permeable hydraulic conductivity values determined from the calibration process.

The drawdown shown in Figure 5.3 represents the cumulative impact on the groundwater regime generated by all three mines operating concurrently. Appendix A contains a series of figures that show how each mine contributes proportionally to the total drawdown and cumulative impact.

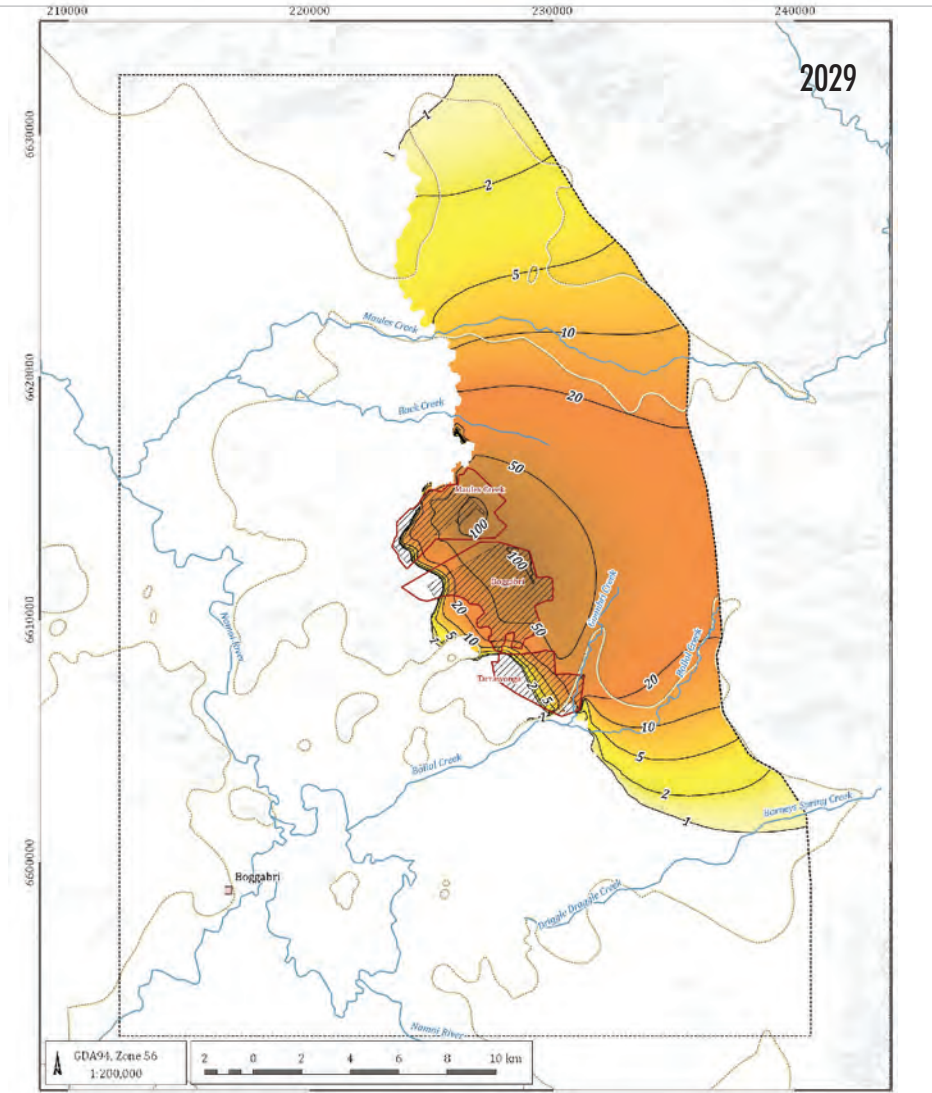
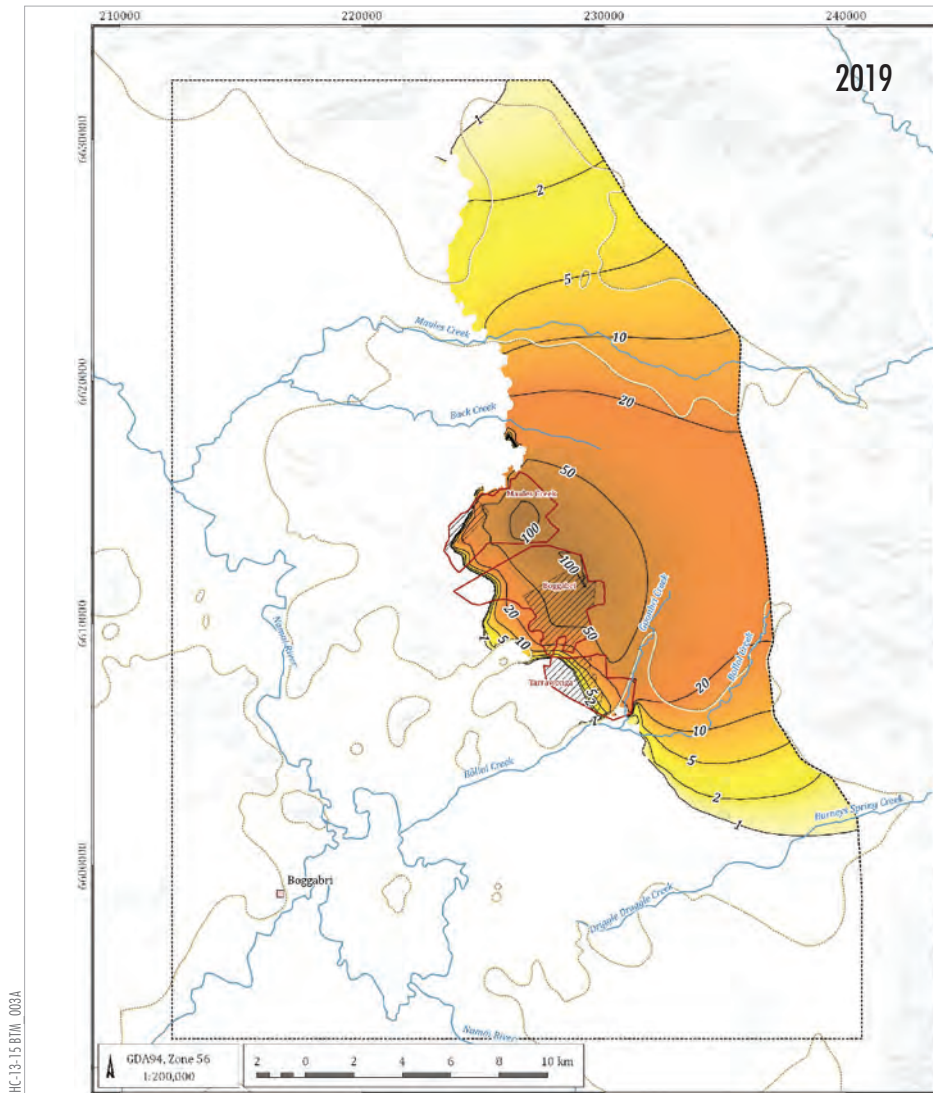
5.2.4 Water quality impacts

The open cuts for each mine in BTM Complex are considered groundwater sinks during operations and post-mining (i.e. final landform) (AGE, 2010; AGE, 2011; Heritage Computing 2012b). The open cuts will draw in groundwater from surrounding aquifers, preventing the release of potentially brackish to saline water back into the surrounding aquifers.

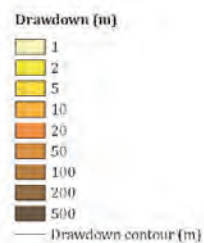
5.3 WATER SUPPLY AND DEMAND

All site WMPs for the BTM Complex mines aim to:

- divert clean water runoff where possible from undisturbed catchment areas around the mine workings into local creeks ('Nagero Creek' for BCM, 'Nagero', Bollol and Goonbri Creeks for TCM, and Back Creek for MCCM);
- capture dirty water from disturbed areas in sedimentation dams. If the water quality meets licence requirements, and the water is not required for use on-site, it may be discharged into the local catchments or alternatively, if required, shared with other mines within the BTM Complex, subject to water sharing arrangements being agreed between the mines on terms acceptable to the mines acting reasonably;
- use dirty water wherever possible for coal processing and dust suppression;
- use imported water as follows:
 - for BCM, to supplement water from on-site surface water storages and its Zone 4 borefield to meet dust suppression and coal processing demands and as potable water for use in vehicle wash down and construction activities;
 - for TCM, use imported raw water for potable water as well as for other site water deficits and use groundwater from a licensed production bore with an annual entitlement of 50 ML during protracted dry periods; and
 - for MCCM, use imported raw water from an existing high security licence for 3000 ML/yr from the Namoi River for mining operations.



- LEGEND
- Populated place
 - Major drainage
 - Mine maximum open cut outlines
 - Mine extent
 - Model extent
 - Alluvium



Source: AGC, (2018)

Each mine may experience shortfalls during prolonged dry periods. Further details are contained within each mine's respective site water balances.

It is proposed that the mines explore opportunities for water sharing and water transfers between mines within the BTM Complex. This may include sharing excess mine water stored on-site as well as purchasing and/or trading of any excess surface water or groundwater (either allocated or produced) between the mines. The infrastructure to be utilised to share the water between the mines will depend on the terms of the agreement reached between the mines (acting reasonably) as to the volume of water to be transferred and the location of the water source and ultimate destination. The water sharing may involve the use of both permanent and temporary water management infrastructure. Water management plans will be updated where required to reflect any new water sharing arrangements and infrastructure.

Where it is not practicable or feasible to share water, additional water may be purchased on the open market, either temporarily or permanently, by the relevant mine to make up any shortfalls. Furthermore, groundwater may also be traded on a temporary or permanent basis within the greater Gunnedah-Oxley Basin Groundwater Source.

AGE (2018) concluded that the three mines cumulatively have sufficient water licenses to account for groundwater intercepted by mining in the areas managed under the Water Sharing Plan for the NSW Murray-Darling Basin Porous Rock Groundwater Sources, and sufficient water licenses to account for water indirectly removed from Zone 4 and 11 of the alluvial aquifers managed under the Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources.

6. MONITORING

6.1 EXISTING MONITORING NETWORK

6.1.1 Surface water

Surface water monitoring in the BTM Complex area is carried out by BCM, TCM and MCCM in line with their respective WMPs.

Refer to the approved WMP for each mine's existing surface water monitoring program, including locations, frequency and parameters. The approved site-specific WMPs developed and managed in accordance with the relevant site-specific approvals and licences.

Reporting of surface water monitoring can be found in site-specific Annual Reviews.

6.1.2 Groundwater

Groundwater levels and quality

The current groundwater monitoring network within the BTM Complex comprises a combination of monitoring bores and vibrating wire piezometers (VWPs). Monitoring has been carried out for BCM since mid-2006, TCM since June 2006 and MCCM since June 2010 (AGE, 2018). Installation of the groundwater monitoring network is described in more detail in AGE (2018).

Refer to the approved WMPs for each mine's existing groundwater monitoring locations, frequencies and parameters.

Groundwater seepage

Monitoring of groundwater pit seepage is currently carried out for all mines within the BTM Complex.

The seepage monitoring programs for each of the sites is detailed in their approved site WMPs and includes tracking water pumped from the pit, and calculations of groundwater seepage via water balance calculations.

6.2 BTM COMPLEX CUMULATIVE IMPACT MONITORING NETWORK

6.2.1 Surface water

This section details the cumulative surface water monitoring program to be implemented across the BTM Complex. The program focuses on ambient monitoring in order to identify and manage cumulative impacts on surface water quality, flows and third parties. Monitoring locations have been strategically selected to enable the distribution of surface water quality and quantity impacts from each mine to be understood and appropriately managed.

The cumulative surface water monitoring program does not supersede site WMPs currently in place. Rather the program has been developed to work in parallel. The monitoring locations selected for the cumulative monitoring network are part of the existing networks of each mine (Table 6.1 below). The management of data and reporting for the cumulative network is discussed in Section 8. Table 6.1 sets out the surface water quality and flow monitoring locations, parameters, sampling frequencies and reasoning, with locations shown on Figure 6.1.

Table 6.1
Cumulative Surface Water Monitoring Program

Location	Frequency ^e	Parameters	Rationale
Boggabri Coal Mine			
SW2	Event based ^d	Field parameters - EC & pH, TSS, oil and grease, nutrients ^b , metals ^c	Monitors ambient conditions on 'Nagero Creek' upstream of BCM
SW1	Event based	Field parameters - EC & pH, TSS, oil and grease, nutrients ^b , metals ^c	Monitors conditions on 'Nagero Creek' downstream of BCM, and downstream of TCM (TCM discharges to 'Nagero Creek' and Goonbri Creek)
Tarrawonga Coal Mine			
GC-U	Event based when the creek is flowing and until a baseline is established, then quarterly + event based only when the creek is flowing.	Field parameters ^a , TSS, oil and grease, nutrients ^b , metals ^c	Monitors ambient conditions on Goonbri Creek upstream of TCM and proposed Goonbri Creek realignment
BC-U	Event based when the creek is flowing and until a baseline is established, then quarterly + event based only when the creek is flowing.	Field parameters ^a , TSS, oil and grease, nutrients ^b , metals ^c	Monitors conditions of Bollol Creek just upstream of the confluence of Goonbri and Bollol Creeks, upstream of TCM and proposed Goonbri Creek realignment
BC-D	Quarterly + event based only when the creek is flowing.	Field parameters ^a , TSS, oil and grease, nutrients ^b , metals ^c	Monitors conditions just downstream of the confluence of Goonbri and Bollol Creeks, downstream of TCM and proposed Goonbri Creek realignment
Maules Creek Coal Mine			
SW4	Monthly + event based until a baseline is established, then quarterly (March, June, September, December) + event based	Field parameters ^a , TSS, oil and grease, nutrients ^b , metals ^c	Monitors ambient conditions on Back Creek upstream of MCCM
SW9	Quarterly (March, June, September, December) + event based	Flow measurement + field parameters ^a , TSS, oil and grease, nutrients ^b , metals ^c	Monitors conditions on Back Creek downstream of MCCM
SW5	Monthly + event based until a baseline is established, then quarterly (March, June, September, December) + event based	Flow measurement + field parameters ^a , TSS, oil and grease, nutrients ^b , metals ^c	On the Namoi River, upstream of the BTM Complex
SW8	Monthly + event based until a baseline is established, then quarterly (March, June, September, December) + event based	Flow measurement + field parameters ^a , TSS, oil and grease, nutrients ^b , metals ^c	On the Namoi River, downstream of confluence with Maules Creek and downstream of the BTM Complex

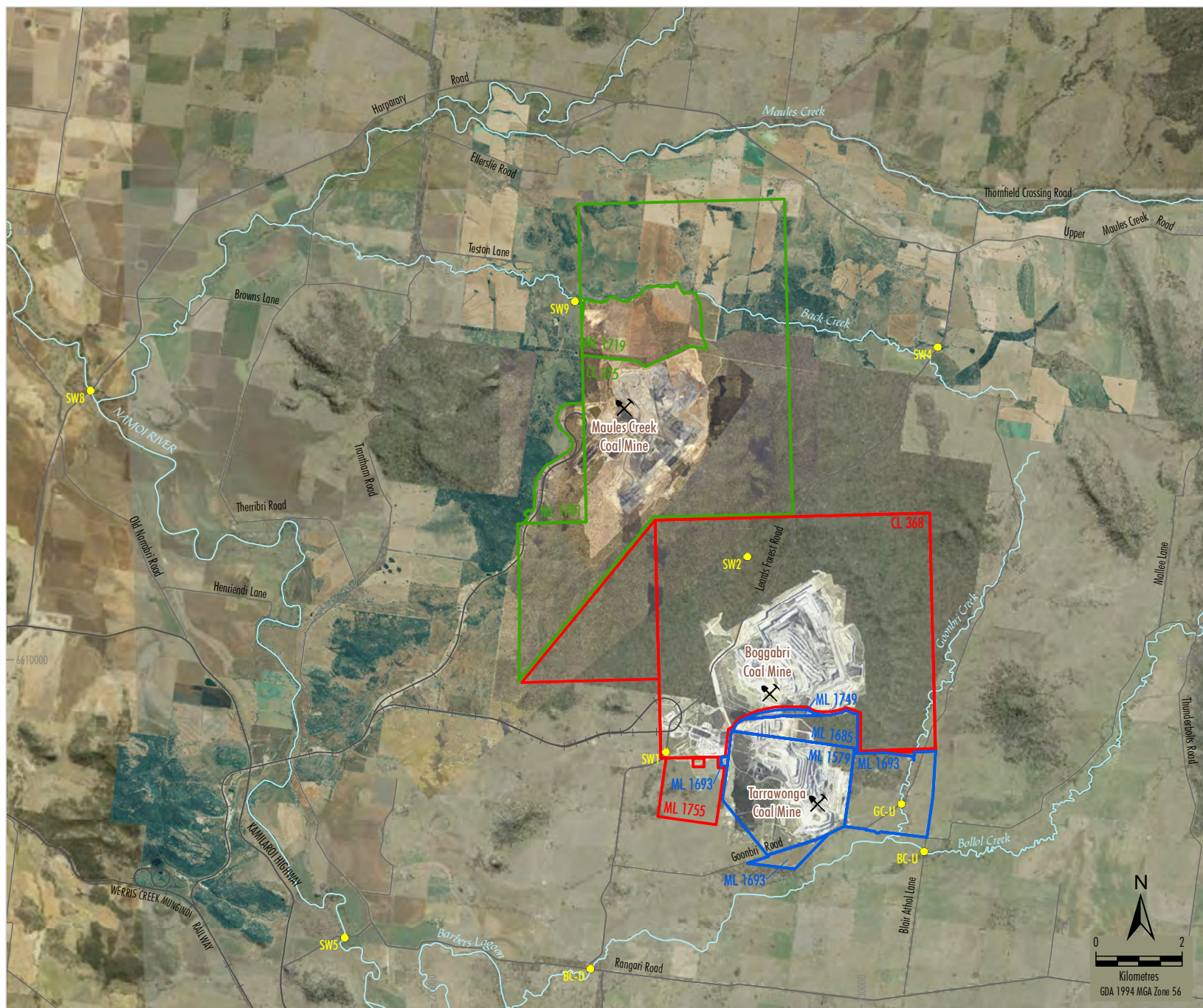
a: pH, EC, temperature, dissolved oxygen, turbidity, ORP

b: Nutrients: phosphorus (total), phosphorus (reactive), nitrogen (total)

c: Aluminium, arsenic, cadmium, chromium, copper, iron, manganese, nickel and zinc.

d: 'Event based' refers to as soon as practicable after a discharge from authorised discharge point has occurred. Please refer to mine specific WMPs for more detailed descriptions of events including post-event monitoring frequency.

e: Quarterly and monthly monitoring within ephemeral creeks (i.e. Nagero Creek, Bollol Creek and Goonbri Creek) will only be undertaken if the creeks are flowing at the time of the scheduled monitoring.



LEGEND

- ▭ Mining Tenement Boundary - Boggabri Coal Mine
- ▭ Mining Tenement Boundary - Tarrawonga Coal Mine
- ▭ Mining Tenement Boundary - Maules Creek Coal Mine
- BTM Cumulative Surface Water Network

Source: Department of Industry (2019); DPI - Gunnedah Coalfield South (2013)



Figure 6.1

Water quality parameters listed in Table 6.1 have been specified based on a combination of existing Environment Protection Licences (EPL) (12407 for the BCM, 20221 for the MCCM and 12365 for the TCM), Namoi catchment uncontrolled streams Water Quality Objectives (WQOs) (DoI – Water, 2006), monitoring carried out for existing surface water operational plans and recommendations made in previous studies (Parsons Brinckerhoff, 2010; Gilbert & Associates, 2011; WRM, 2011).

Flow monitoring involving the installation of water level logger or similar within the main channel of the creeks has been recommended where feasible at the locations listed in Table 6.1 and are considered to be more appropriate than permanent flow gauging stations for the following reasons:

- flow in each creek is ephemeral;
- SW2 will eventually be rendered obsolete due to the progression of mining; and
- water level recording equipment is easier to deploy, does not require extensive calibration and is easier to maintain than flow gauging station equipment.

6.2.2 Groundwater

Groundwater levels and quality

Recommendations were made by Heritage Computing (2012a) to monitor and manage the cumulative impacts on groundwater conditions as a result of mining within the BTM Complex. Those recommendations have been used to guide the development of the BTM Complex groundwater monitoring program.

The program is based on a network of monitoring bores and VWP's to monitor regional groundwater conditions, in addition to existing monitoring bore networks (Section 6.1.2). During October 2013 to January 2014, the proposed bores were constructed. Some sites selected for groundwater quality monitoring have been aligned with existing bores that monitor alluvial aquifers, with the new bores placed to monitor underlying aquifers at the same location. Some sites were selected for water level monitoring only. A number of bores have automatic dataloggers installed to collect continuous water level data, which can be downloaded during sampling rounds.

Some monitoring bores were combined or substituted for those previously recommended in individual mine EAs, provided the targeted lithology and construction was consistent with the rationale defined by Heritage Computing (2012a). Possible rationalisations are included in Table 6.2.

Table 6.2 sets out the cumulative groundwater monitoring network, along with sampling frequencies, parameters and rationale. MCCM installed all individual bores that make up the cumulative groundwater monitoring network. A consultant engaged by MCCM sample these bores for cumulative data for the BTM Complex. Figure 6.2 shows the cumulative groundwater monitoring network for the BTM Complex. Monitoring locations for the cumulative groundwater monitoring network were selected as per recommendations from Heritage Computing (2012a) and in consultation with regulatory agencies.

Groundwater seepage and use

The current groundwater seepage monitoring program being implemented for each mine (Section 6.1.2) will be used to provide a dataset for periodic water balance modelling across the BTM Complex.

Table 6.2
Cumulative Groundwater Monitoring Locations

Location	Installation type (no. piezometers)	Bore Depth (m)	Screen/Sensor Depth (mgb)	Sampled lithology	Frequency	Parameters	Rationale
Reg1	VWP in interburden and coal seams (4)	N/A	118.7	Alluvium (existing bore GW967138/2), interburden and coal seams	Continuous water level measurement (datalogger).	Water level	Just outside predicted 1 m water table drawdown (Heritage Computing, 2012a). To assess potential impact on middle reaches of Maules Creek. Adjacent DoI – Water bore GW967138/1/2.
			134.5				
			193.5				
			281.5				
Reg2	VWP in interburden and coal seams (4)	N/A	60	Alluvium (existing bore GW041027) and underburden	Continuous water level measurement (datalogger).	Water level	Just outside predicted 1 m water table drawdown (Heritage Computing, 2012a). To assess potential impact on upper reaches of Maules Creek. Adjacent DoI – Water bore GW041027.
			120				
			200				
			260				
Reg3	Bore (1)	57	50.50 – 56.50	Boggabri Volcanics	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters ^a + major ions + metals ^b + nutrients ^c	Just outside predicted 1 m water table drawdown (Heritage Computing, 2012a). To assess potential impact on lower reaches of Maules Creek. Adjacent DoI – Water bore GW030130.
Reg4	Bore (1)	72.5	65.5 – 71.5	Boggabri Volcanics	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters ^a + major ions + metals ^b + nutrients ^c	Outside predicted drawdown impact zones (Heritage Computing, 2012a). 2 km east of Namoi River.

Table 6.2 (Continued)
Cumulative Groundwater Monitoring Locations

Location	Installation type (no. piezometers)	Bore Depth (m)	Screen/Sensor Depth (mgb)	Sampled lithology	Frequency	Parameters	Rationale
Reg5	Bore (1)	78.7	72.2 – 78.2	Boggabri Volcanics	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters ^a + major ions + metals ^b + nutrients ^c	Within predicted 1 m water table drawdown zone in alluvium (Heritage Computing, 2012a).
Reg5a	Bore (1)	22	18 – 21	Alluvium	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters ^a + major ions + metals ^b + nutrients ^c	Within predicted 1 m water table drawdown zone in alluvium (Heritage Computing, 2012a).
Reg6	Bore (1)	96	88.0 – 94.0	Boggabri Volcanics	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters ^a + major ions + metals ^b + nutrients ^c	Within predicted 1 m water table drawdown zone in 'Nagero Creek' alluvium (Heritage Computing, 2012a). To assess potential impact on 'Nagero Creek'.
Reg7	VMP in interburden and coal seams (3)	N/A	67.5	Maules Creek Formation interburden and coal seams	Continuous water level measurement (datalogger).	Water level	On edge of predicted 1 m water table drawdown in Bollol Creek alluvium (Heritage Computing, 2012a). To assess potential impact on Bollol Creek. Adjacent bore BCS6.
			148.2				
			242.5				
Reg7a	Bore (1)	36	24 – 30	Bollol Creek Alluvium	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters ^a + major ions + metals ^b + nutrients ^c	On edge of predicted 1 m water table drawdown in Bollol Creek alluvium (Heritage Computing, 2012a). To assess potential impact on Bollol Creek. Adjacent bore BCS6.

Table 6.2 (Continued)
Cumulative Groundwater Monitoring Locations

Location	Installation type (no. piezometers)	Bore Depth (m)	Screen/Sensor Depth (mgl)	Sampled lithology	Frequency	Parameters	Rationale
Reg8	VWP in interburden and coal seams (3)	N/A	91.5	Maules Creek Formation interburden and coal seams	Continuous water level measurement (datalogger).	Water level	In high drawdown zone east of MCCM and north-east of BCM (Heritage Computing, 2012a). In Maules Creek Formation.
			221				
			274				
Reg9	VWP in interburden and coal seams (3)	N/A	115.8	Maules Creek Formation interburden and coal seams	Continuous water level measurement (datalogger).	Water level	In moderate drawdown zone to north- east of TCM and east of BCM (Heritage Computing, 2012a). In Maules Creek Formation.
			175.2				
			268				
Reg10	VWP in interburden and coal seams (4)	N/A	55	Shallow Maules Creek Formation (and Back Creek water)	Continuous water level measurement (datalogger).	Water level	In moderate drawdown zone on Back Creek north of MCCM (Heritage Computing, 2012a). To assess potential impact on Back Creek. In Maules Creek Formation.
			144.2				
			178				
			185.5				
Reg10a	Bore (1)	10	6.75 – 9.75	Alluvium	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters ^a + major ions + metals ^b + nutrients ^c	In moderate drawdown zone on Back Creek north of MCCM (Heritage Computing, 2012a). In Maules Creek Formation.

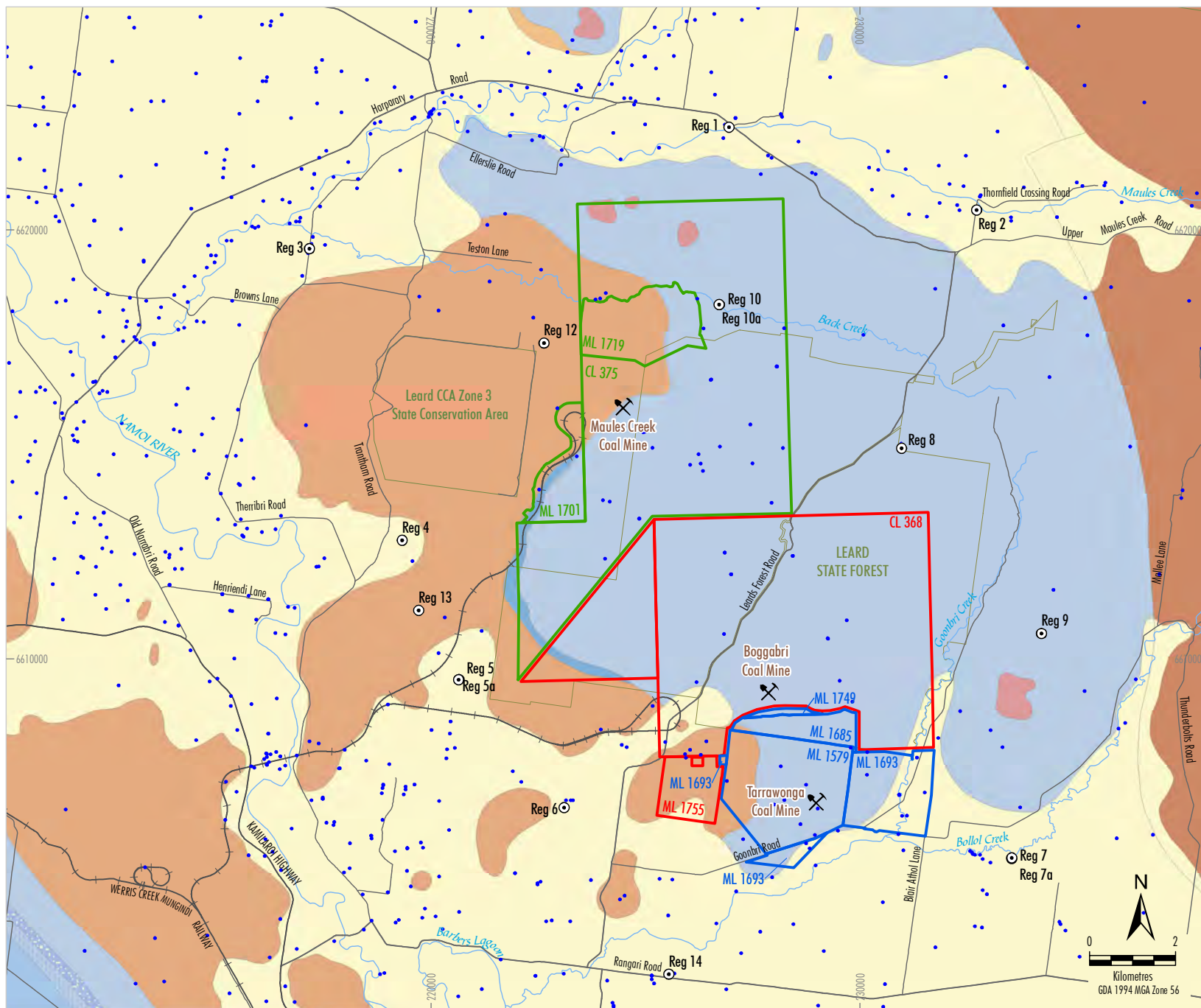
Table 6.2 (Continued)
Cumulative Groundwater Monitoring Locations

Location	Installation type (no. piezometers)	Bore Depth (m)	Screen/Sensor Depth (mgb)	Sampled lithology	Frequency	Parameters	Rationale
Reg12	Bore (1)	48.3	38.4 – 44.4	Boggabri Volcanics	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters ^a + major ions + metals ^b + nutrients ^c	Within 1 m regolith drawdown zone north- west of MCCM (Heritage Computing, 2012a). In Boggabri Volcanics.
Reg13	Bore (1)	133	128 – 132	Boggabri Volcanics	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters ^a + major ions + metals ^b + nutrients ^c	On edge of 1 m regolith drawdown zone west of BCM (Heritage Computing, 2012a). In Boggabri Volcanics.
Reg14	Bore (1)	102	90 - 96	Alluvium	Quarterly (March, June, September, December) until baseline established, then half yearly.	Water level + field parameters ^a + major ions + metals ^b + nutrients ^c	In Bollol Creek alluvium well outside any predicted drawdown. Adjacent bore DoI – Water GW030472.

a: pH, EC, temperature, dissolved oxygen, turbidity, ORP.

b: Aluminium, arsenic, cadmium, chromium, copper, iron, manganese, nickel and zinc.

c: Nutrients: phosphorus (total), phosphorus (reactive), nitrogen (total).



- LEGEND**
- Mining Tenement Boundary - Boggabri Coal Mine
 - Mining Tenement Boundary - Tarrawonga Coal Mine
 - Mining Tenement Boundary - Maules Creek Coal Mine
 - NSW National Parks and Wildlife Services (NPWS) Estate
 - State Forest
 - Railway
 - BTM Cumulative Groundwater Network
 - Water NSW Registered Bore
- Regional Geology Legend (relevant formations)**
- Undifferentiated Alluvial Deposits
 - Maules Creek Formation
 - Pfl Leard Formation
 - Pbr Boggabri Volcanics

Source: Department of Industry (2019); DPI - Gunnedah Coalfield South (2013)

WHITEHAVEN COAL

BTM WATER MANAGEMENT STRATEGY

Cumulative Groundwater Monitoring Locations for the BTM Complex

Figure 6.2

7. IMPACT MITIGATION

The site-specific WMPs for each of the mines within the BTM Complex contain the following:

- water management and mitigations measures;
- water quality and quantity triggers; and
- event definitions.

Where the monitoring program identifies water quality results above a set trigger level then:

- Each mine in the BTM Complex will be notified as soon as practicable of the monitoring result.
- Monitoring results will be reviewed against previous results to identify a trend or other anomaly.
- An investigation of the potential cause of the impact will be undertaken as well as deliberation between BCM, TCM and MCCM to identify the mine/mines potentially causing the exceedance. The investigator will consider and document:
 - the extent of potential water issue;
 - the receiving environment of the potential water issue; and
 - the timeframe of the potential water issue.
- The mine/mines identified in the previous step as causing the exceedance rectify the issue where possible.
- Report to external agencies will be undertaken, as required by each mine's Project Approval conditions.

8. MANAGEMENT AND IMPLEMENTATION

Each site will maintain the responsibility to comply with the management and monitoring requirements contained in their site management plans, approvals and licences specific to their operation to minimise their impact on water quality and subsequently on the cumulative water quality with the BTM Complex.

The sites will work collectively to coordinate the modelling programs where required.

The Water Management Strategy is one of a number of cumulative environmental management strategies developed in response to mine development approval conditions. As such, the mines will work collectively to:

- Convene BTM Complex meetings quarterly to discuss cumulative monitoring results.
- Communicate changes to any site-specific monitoring locations.
- Provide access to monitoring locations.
- Share data relating to the cumulative monitoring network.
- Respond in a timely manner to requests to enable the Water Management Strategy to be implemented.

Table 8.1 articulates the roles and responsibilities for identifying and managing cumulative impacts where joint mitigation is required.

Table 8.1
Roles and Responsibilities for the BTM Complex

Role	Responsibility	Timing
Roles within the BTM Complex Sites Site General Manager or Mine Manager/HSE Manager*	• Each site to comply with the management and monitoring requirements contained in their respective site management plans.	Ongoing
	• Each site to complete surface water and groundwater monitoring required under the BTM Water Strategy.	As required
	• Each mine to maintain responsibility for site-specific licencing requirements.	Ongoing
	• Provide the relevant resources to enable implementation of the BTM Water Management Strategy.	As required
	• BTM Complex sites will ensure the relevant operational personnel are aware of this document.	As required
Site Environmental Representatives (Environmental Superintendent or Environmental Officer*)	• Represent respective operations at regular BTM Complex meetings regarding water management.	As required
	• Regularly convene meetings to discuss cumulative monitoring results.	Quarterly
	• Coordinate updates collectively to the Water Management Strategy.	As required
	• Liaise across BTM sites to address trigger events and review mitigation options.	As required
	• Investigate cumulative complaints with other BTM site representatives.	As required
	• Provide access to monitoring locations.	As required
	• Assist in data and information provision as required by the Water Management Strategy.	Ongoing
	• Share data relating to the BTM Complex cumulative monitoring network.	Ongoing
	• Apply and implement the required monitoring and/or modelling methodologies.	Ongoing and as required
	• Notify sites within the BTM Complex of the monitoring result where the monitoring program identifies water quality results exceed trigger level listed in individual WMPs and identify the mine/mines causing the exceedance.	As required

	Undertake joint mitigation if required as per any relevant agreed terms.	As required
	Implement and coordinate reviews of the Water Management Strategy.	Refer to Section 9
	Implement the site-specific mitigation measures and controls within the applicable site WMP.	Ongoing
Strategy groundwater & surface water monitoring contractors & modelling consultants	Review and if necessary, update any BTM Complex surface water and groundwater models on an agreed periodic basis.	Refer to Section 9
	Advise the relevant site of any in-field monitoring related incidents that may have cumulative relevance to the BTM sites.	As required

*or delegate

8.1 COMPLAINT MANAGEMENT

It is recognised that each mine within the BTM Complex has their own complaint handling and incident management protocols, including hotlines, and that these will continue to operate independently. The Water Management Strategy supports the use of the existing mechanisms, with individual mining operations investigating complaints that are raised with them. If the investigating mine considers the complaint to be potentially related to a cumulative impact, it will:

- Advise the other mines of the complaint and potential for cumulative impact as soon as practicable.
- Seek comments from other mines on the complaint/issue.
- Investigate the complaint jointly to determine if the impact was cumulative.
- Develop a response jointly to the complaint.
- Log the complaint on their complaints register where found to be cumulative impact.

9. REVIEW AND REVISION

The BTM Complex WMS has been developed with the input of representatives of BCM, TCM, and MCCM. It is proposed to review, and update if required, the WMS every three years. The review and update of the WMS will be undertaken by BTM, TCM and MCCM collectively. The review would include consideration of new or different monitoring technologies that could be incorporated into the cumulative monitoring program.

Each of the BTM Complex mines are required to prepare a *“Groundwater Management Plan, which includes... a program to validate the groundwater model for the project, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions”*. Accordingly, the cumulative groundwater model would be reviewed every three years. Any substantial and relevant changes to the model resulting from the review would be considered in the context of the WMS, and the WMS would be updated to reflect the changes if required. It is noted that this version of the WMS includes consideration of the report *Boggabri, Tarrawonga, Maules Creek Complex Numerical Model Update* prepared by AGE (2018).

The supporting site-specific WMPs and monitoring plans will be reviewed, and if necessary revised in accordance with Schedule 5, Condition 5 of each site-specific Project Approval:

Within 3 months of the submission of an:

- (a) annual review under condition 4 above;*
- (b) incident report under condition 8 below;*
- (c) audit under condition 10 below; or*
- (d) any modification to the conditions of this approval,*

the Proponent shall review, and if necessary, revise, the strategies, plans, and programs required under this approval to the satisfaction of the Secretary.

The site-specific BCM, TCM and MCCM models undergo regular maintenance and recalibration as additional data on groundwater responses to progressive mining improves the understanding of the groundwater systems.

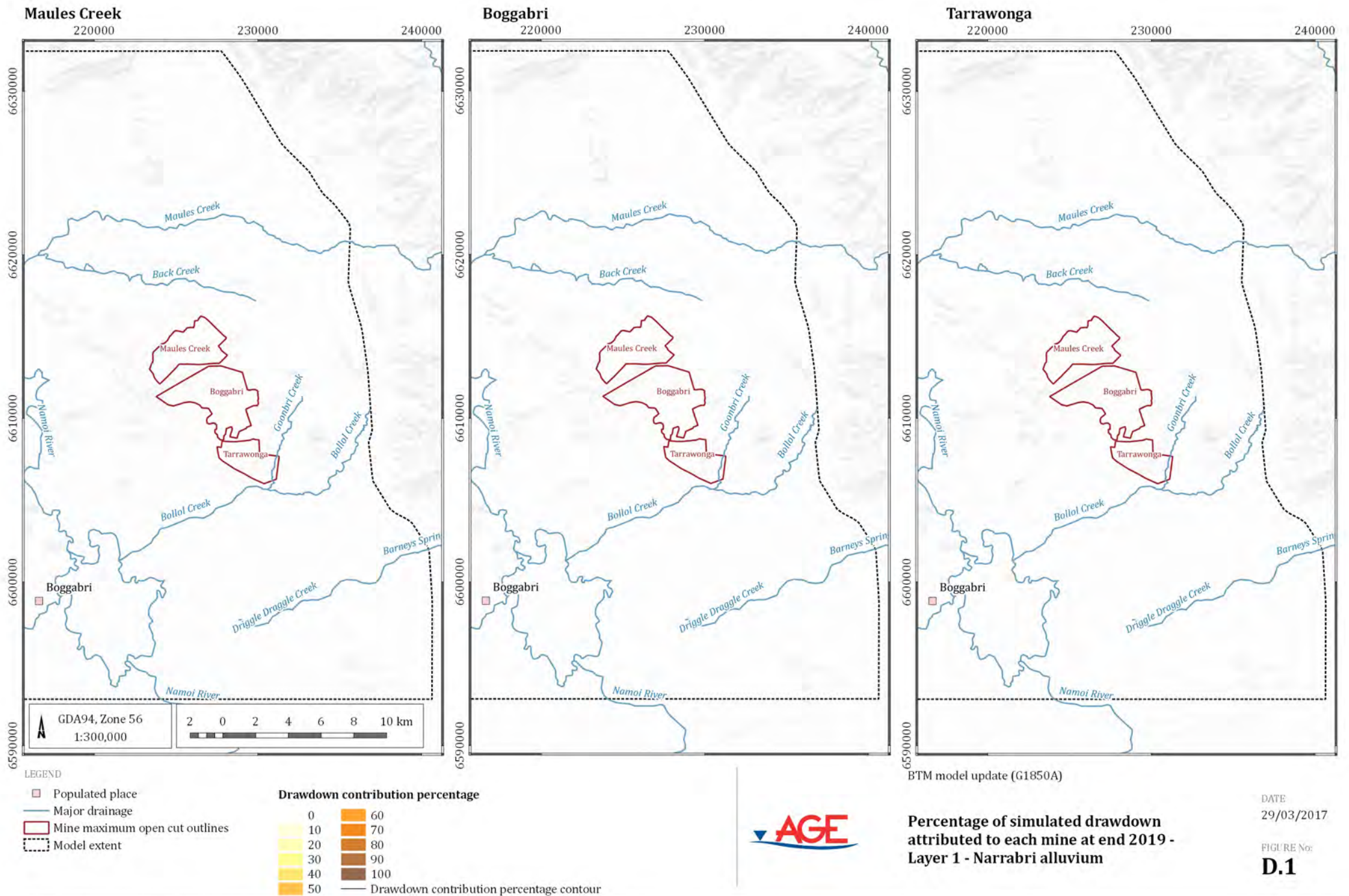
10. REFERENCES

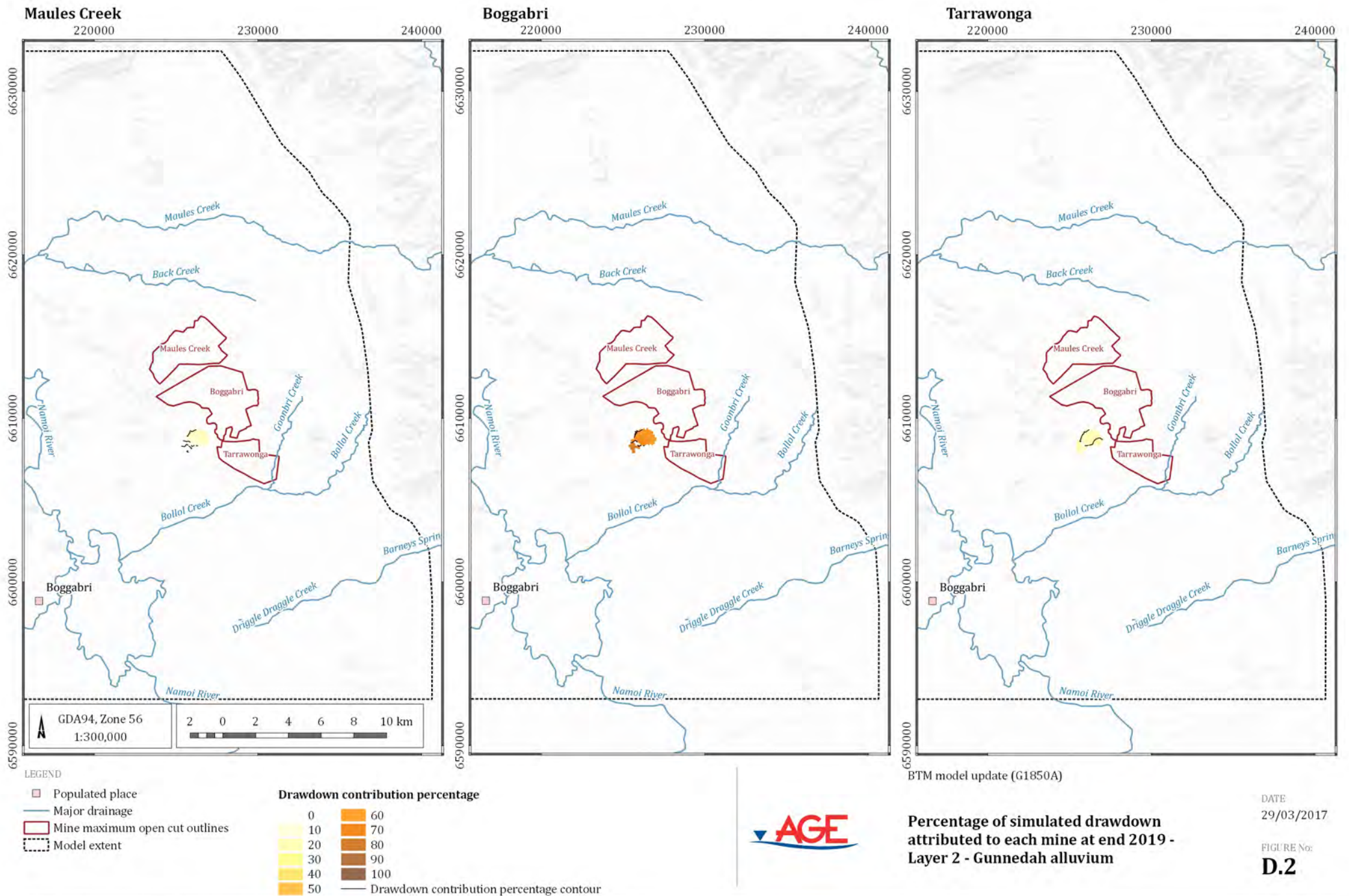
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APPENDIX A

**SITE-SPECIFIC CONTRIBUTION TO CUMULATIVE GROUNDWATER DRAWDOWN
(FROM AGE [2018])**

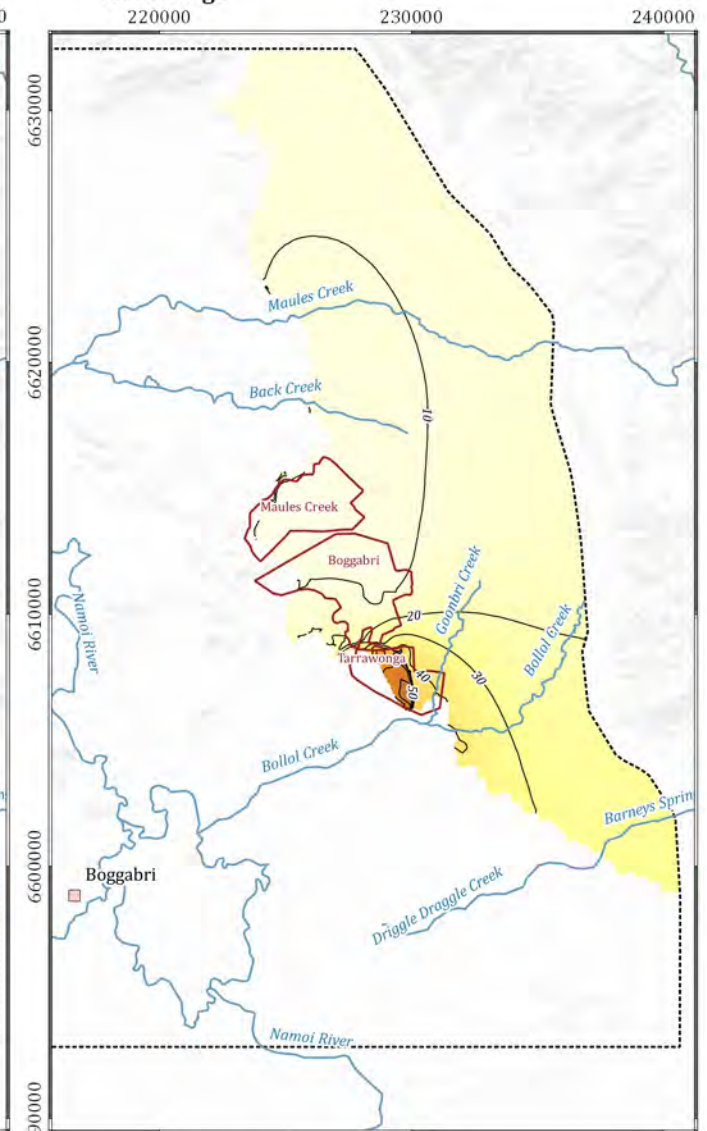
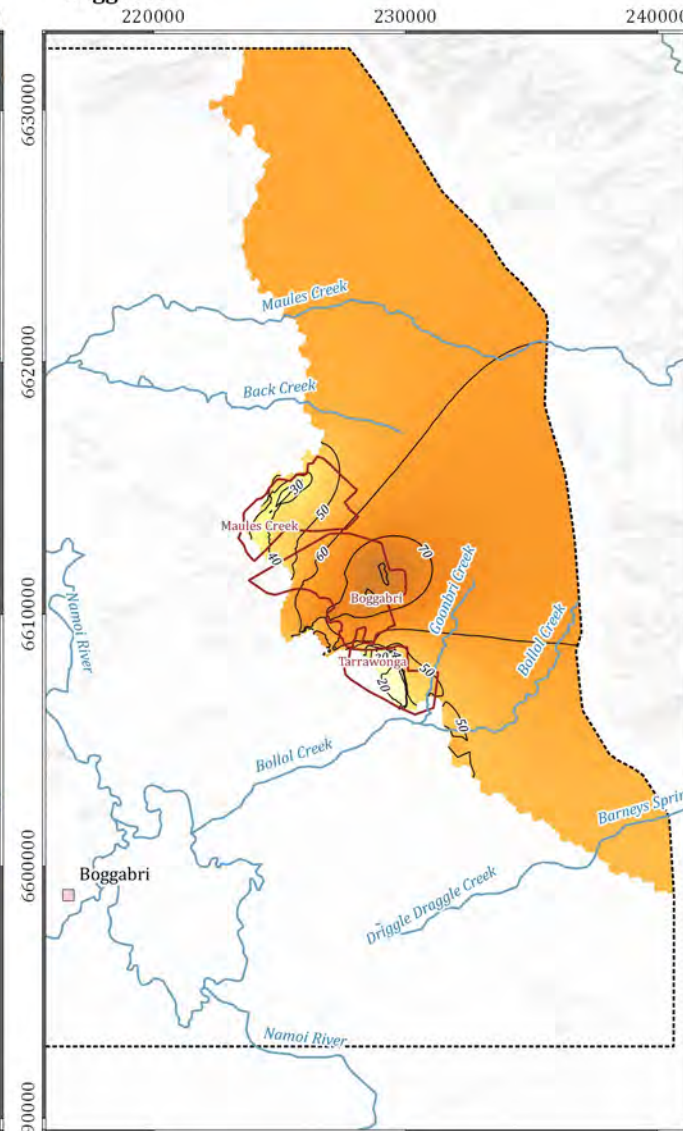
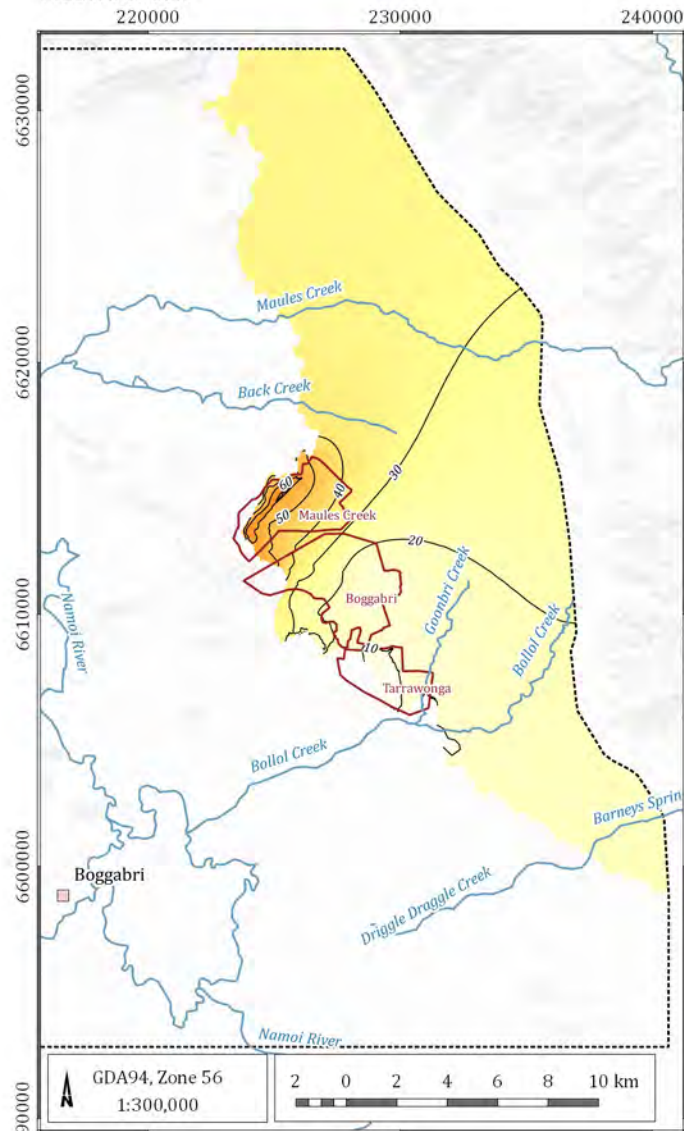




Maules Creek

Boggabri

Tarrawonga



LEGEND

- Populated place
- Major drainage
- Mine maximum open cut outlines
- Model extent

Drawdown contribution percentage

- 0
- 10
- 20
- 30
- 40
- 50
- 60
- 70
- 80
- 90
- 100

Drawdown contribution percentage contour



BTM model update (G1850A)

Percentage of simulated drawdown attributed to each mine at end 2019 - Layer 8 - Merriown seam

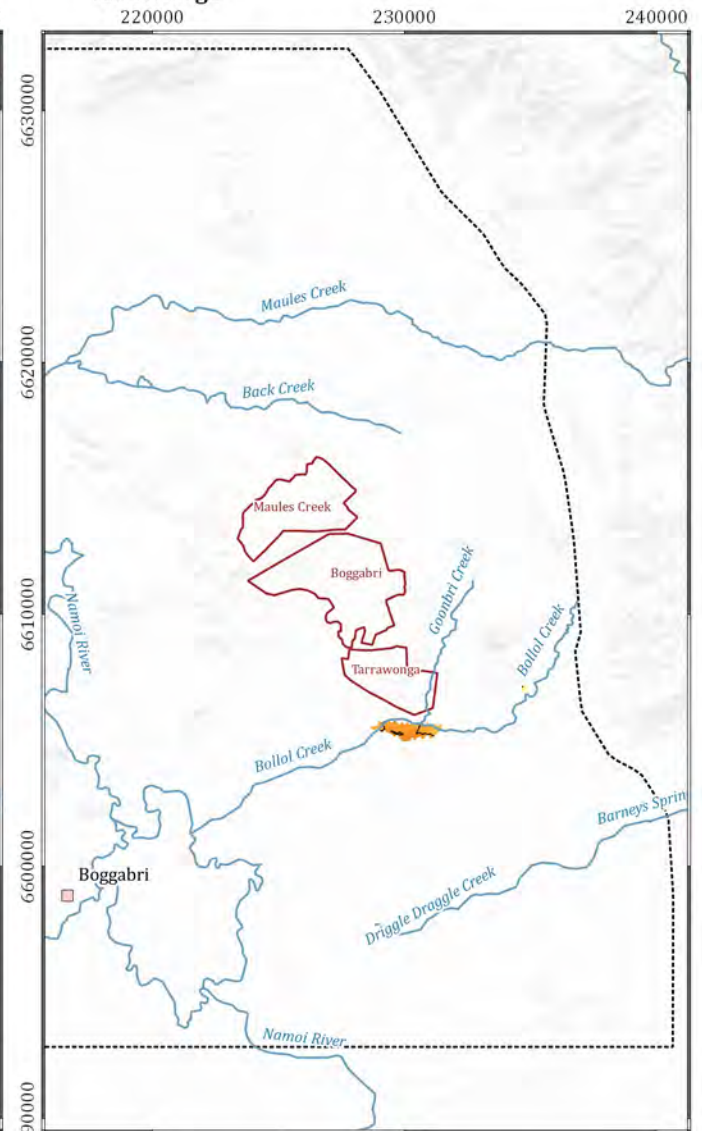
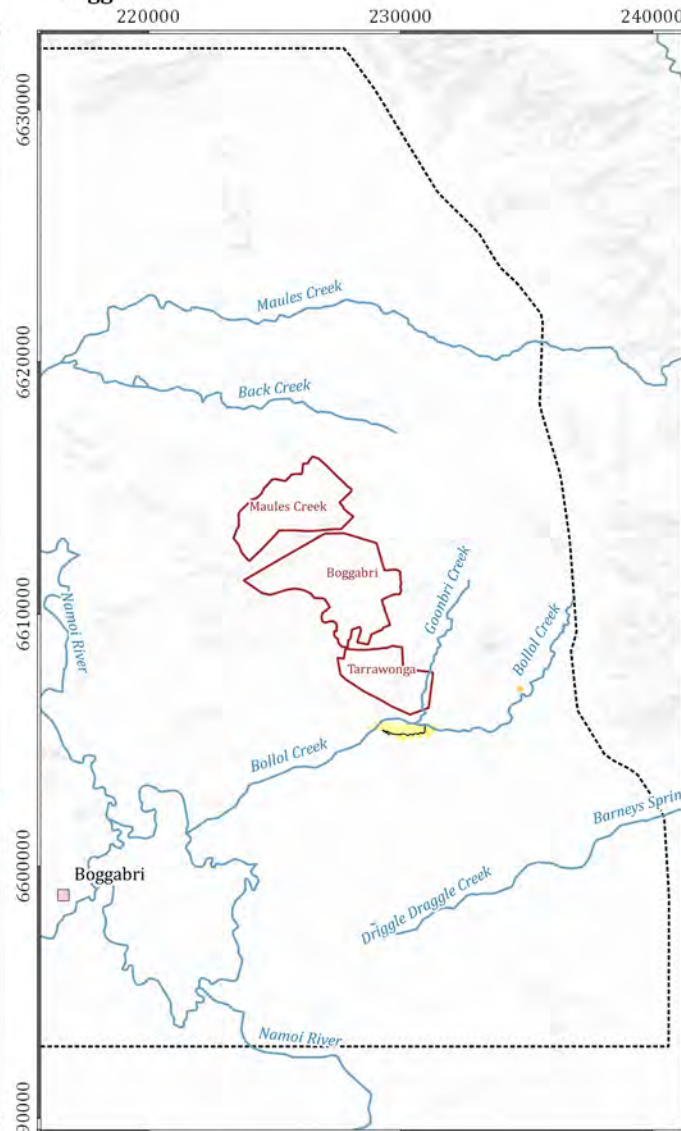
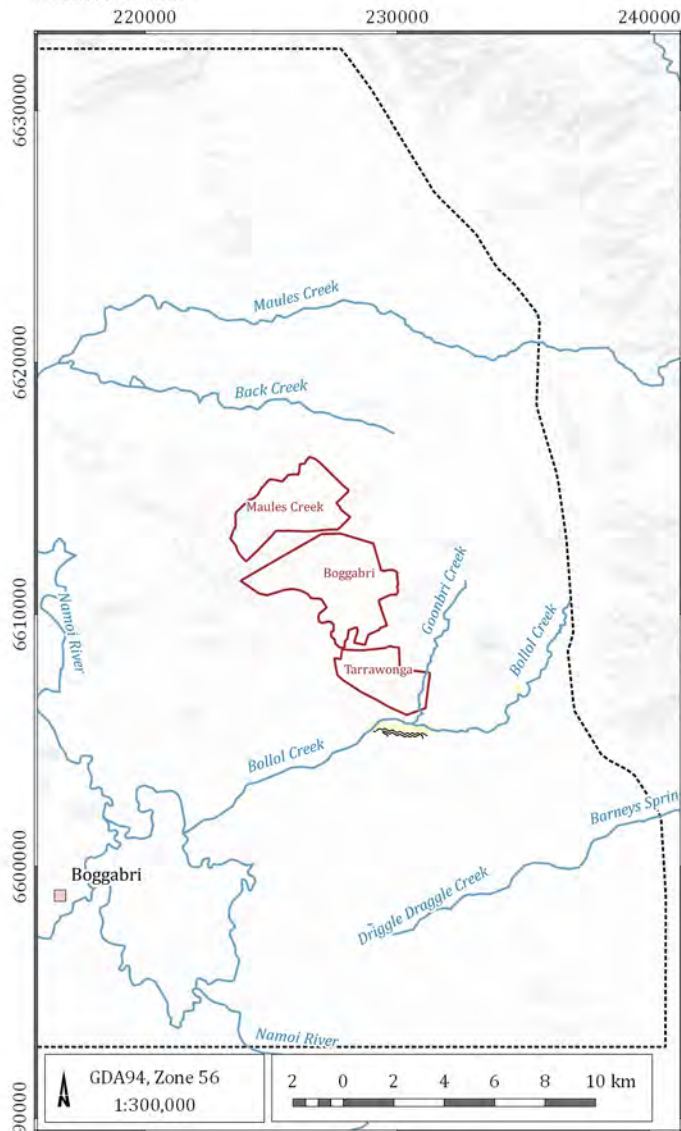
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FIGURE No:
D.3

Maules Creek

Boggabri

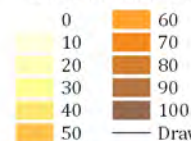
Tarrawonga



LEGEND

- Populated place
- Major drainage
- Mine maximum open cut outlines
- Model extent

Drawdown contribution percentage



Drawdown contribution percentage contour

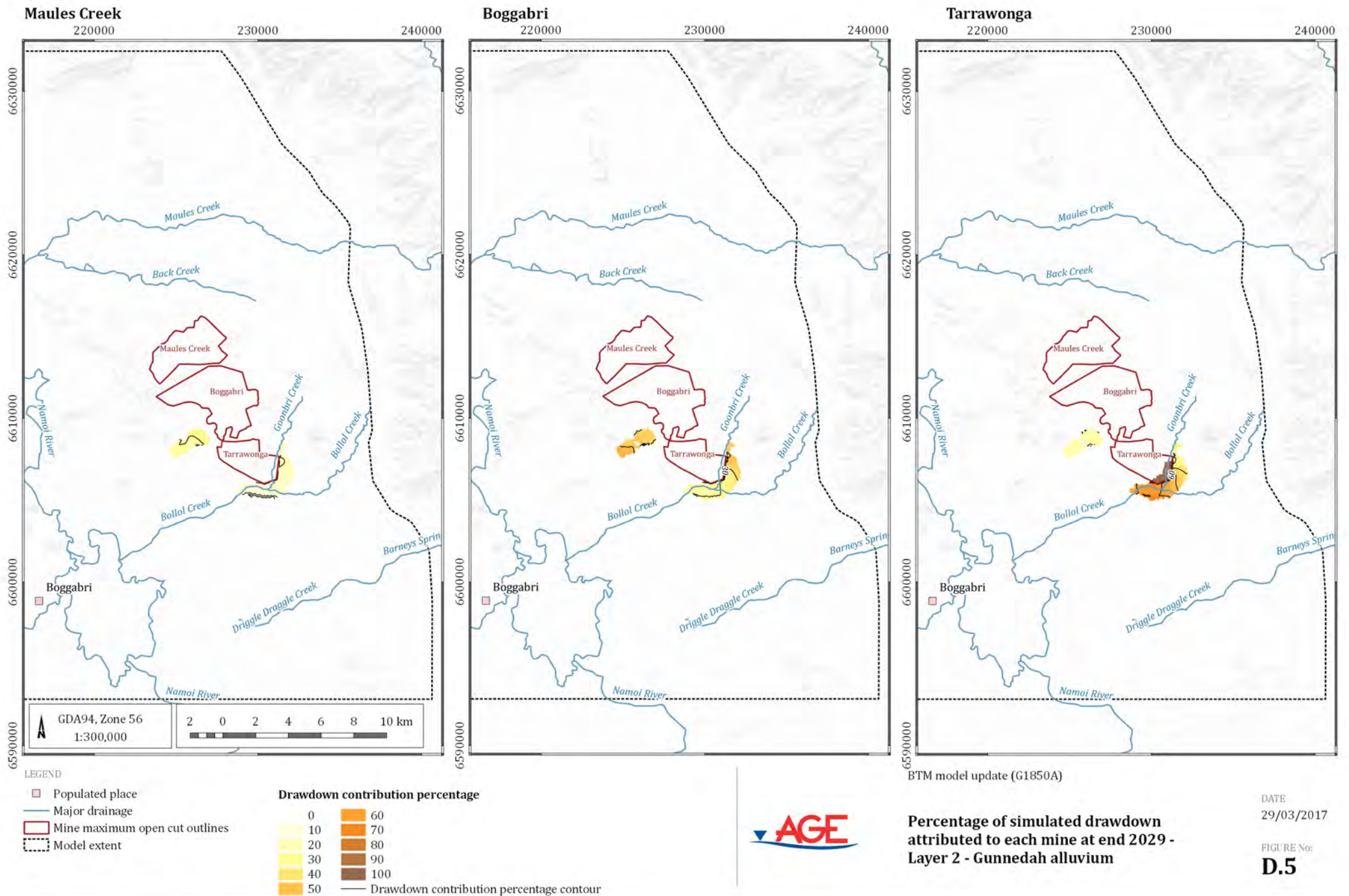


BTM model update (G1850A)

Percentage of simulated drawdown
attributed to each mine at end 2029 -
Layer 1 - Narrabri alluvium

DATE
29/03/2017

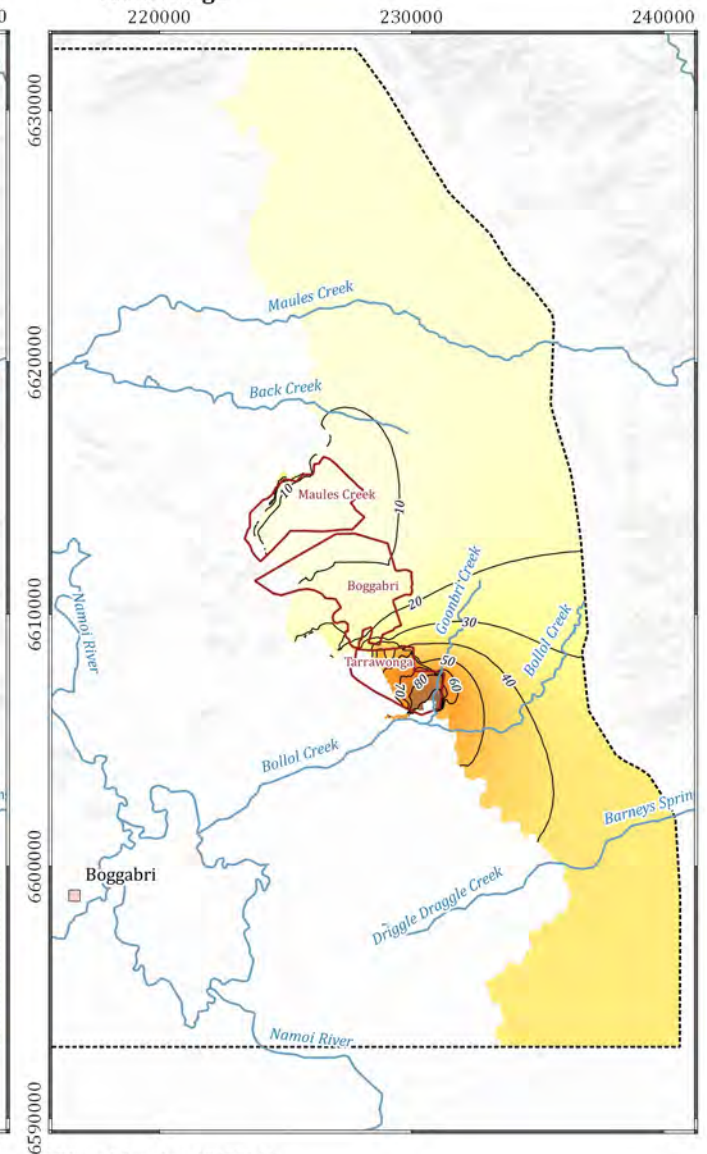
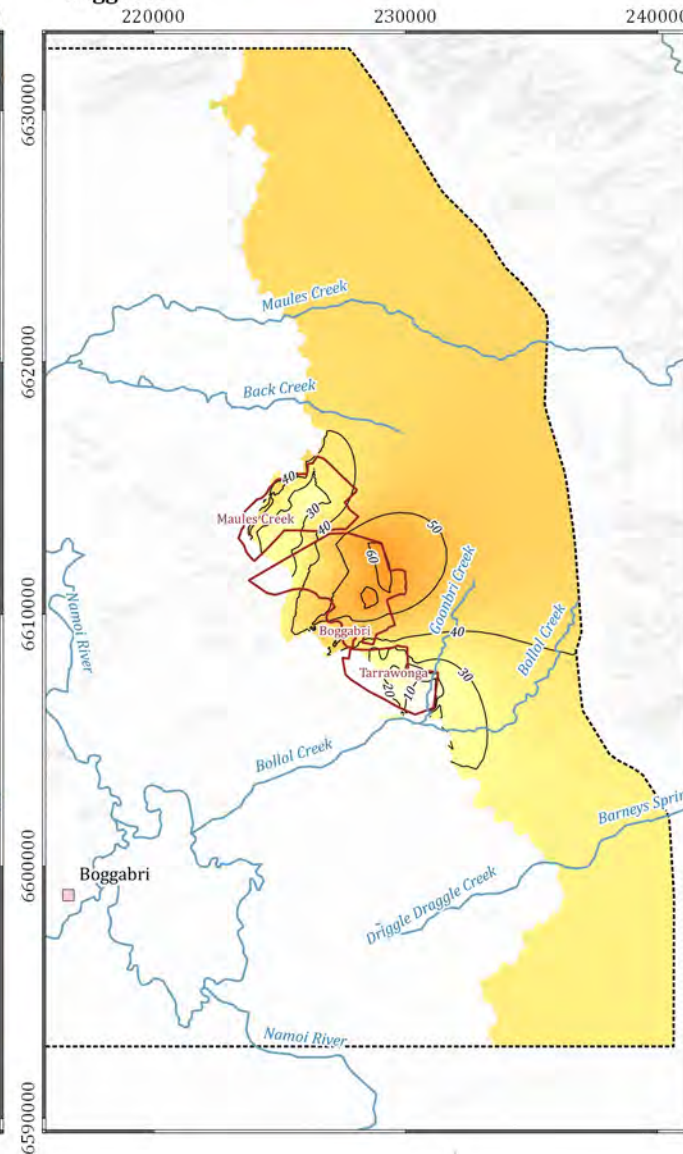
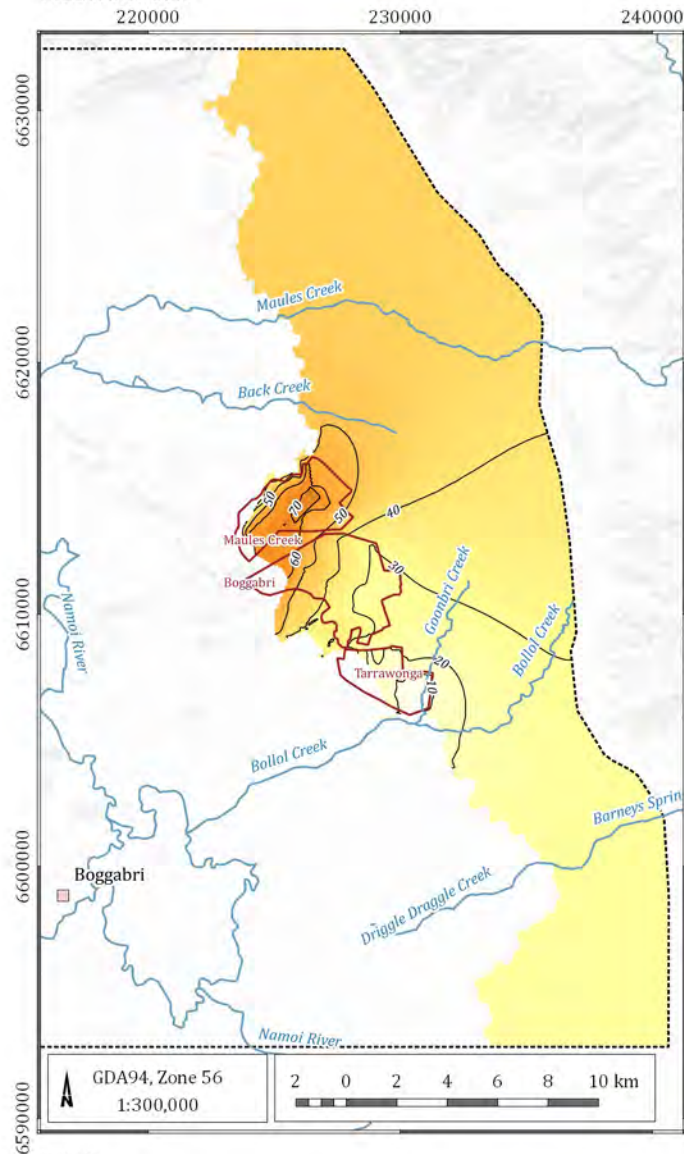
FIGURE No:
D.4



Maules Creek

Boggabri

Tarrawonga



LEGEND

- Populated place
- Major drainage
- Mine maximum open cut outlines
- Model extent

Drawdown contribution percentage

- 0
- 10
- 20
- 30
- 40
- 50
- 60
- 70
- 80
- 90
- 100

Drawdown contribution percentage contour



BTM model update (G1850A)

Percentage of simulated drawdown attributed to each mine at end 2029 - Layer 8 - Merriown seam

DATE
29/03/2017

FIGURE No:
D.6