WATER MANAGEMENT PLAN

Edition	Rev.	Comments	Author	Authorised By	Date
1	0	Initial Document	SLR	Andrew Behrens	August 2015
	1	Review following consultation	WHC	WHC	September 2015
2	0	Updated Document	SLR	WHC	June 2017
3	0	Updated Document	WRM	WHC	August 2018
	1	Review following NRAR comments	WRM	WHC	July 2019
	2	Review following DPIE comments	WRM	WHC	March 2020
	3	Review following MOD 8 approval	TCM	TCM	September 2020

FOREWORD

In accordance with Schedule 2, Condition 19 of Project Approval PA 11_0047, Tarrawonga Coal Pty Ltd may submit any strategy, plan or program required by the Project Approval on a progressive basis, with the approval of the Director-General. Until they are replaced by an equivalent strategy, plan or program approved under the consent, Tarrawonga Coal Pty Ltd will continue to implement the existing strategies, plans and programs that apply to any development on site in accordance with Schedule 2, Condition 20 of PA 11_0047.

This Water Management Plan will be submitted on a progressive basis.

In accordance with Schedule 2, Condition 39 of PA 11_0047 the Tarrawonga Coal Mine Water Management Plan includes a:

- Site Water Balance;
- Surface Water Management Plan;
- Groundwater Management Plan; and
- Boggabri-Tarrawonga-Maules Creek Complex (BTM Complex) Water Management Strategy.

Whitehaven is in the process of submitting a modification of the Project Approval, which includes an update to the Tarrawonga Mine Operations Plan in 2020. This Water Management Plan will be updated following the completion of these future changes.

TCM have been in consultation with the nearby Boggabri Coal Mine and Maules Creek Project to develop a BTM Complex Water Management Strategy incorporating cumulative water impacts and management, as required under the conditions of PA 11_0047. The Strategy has been provisionally approved by the Department of Planning and Environment with conditions. The current Strategy has been appended to this Plan in Appendix E.

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ACRONYMS USED THROUGHOUT THIS DOCUMENT

AEMR	-	Annual Environmental Management Report
AR	-	Annual Review
AS	-	Australian Standard
CCC	-	Community Consultative Committee
DPIE	-	Department of Planning, Industry and Environment
DRE	-	Division of Resources and Energy
EA	-	Environmental Assessment
EPA	-	Environment Protection Authority
EPL	-	Environment Protection Licence
GSC	-	Gunnedah Shire Council
ML	-	Mining Lease
MOP	-	Mine Operations Plan
Mtpa	-	Million tonnes per annum
NRAR	-	Natural Resources Access Regulator
NSC	-	Narrabri Shire Council
TCM	-	Tarrawonga Coal Mine
TCPL	-	Tarrawonga Coal Pty Ltd
WAL	-	Water Allocation Licence
WMP	-	Water Management Plan

1 INTRODUCTION

1.1 Background

The Tarrawonga Coal Mine (TCM) is located approximately 15 km northeast of Boggabri, 10 km north of the Canyon Coal Mine (formerly Whitehaven, in closure) and south of, and adjacent to, the Boggabri Coal Mine (BCM) (Figure 1). The mine site is contained within Mining Lease (ML) 1579, ML 1693, ML 1685 and ML 1749 as shown in Figure 1. The mine is being developed by Tarrawonga Coal Pty Ltd (TCPL), which is owned by Whitehaven Coal Mining Pty Ltd, and operates under Environment Protection Licence (EPL) 12365 and Project Approval PA 11_0047.

In 2013 TCPL received Project Approval (PA) 11_0047 from the Planning Assessment Commission (as delegate of the Secretary for Planning and Infrastructure) under Part 3A of the *Environmental Planning and Assessment (EP&A) Act* for the Tarrawonga Coal Project which provides for the continuation and extension of the mine. Since 2013, TCPL have made five modifications to PA_110047. Modification 1 was approved by the Minister for Planning, Industry and Environment (DPIE) on 6 November 2014. Modification 2 was approved on 3 November 2016. Modifications 3, 4 and 5 were approved in February, May and August 2017 respectively.

This Water Management Plan (WMP) has been prepared with reference to relevant legislation, approvals and guidelines including the management plan requirements specified in Schedule 3, Condition 39 and Schedule 5, Condition 3 of PA 11_0047. This WMP is consistent with the Tarrawonga Coal Project Environmental Assessment, relating to surface water and groundwater water management and the Mining Operations Plan (MOP).

1.2 Project Description

During the current MOP term, open cut mining will continue eastward within ML 1579, ML 1693, and ML1685 and ML1749. Mine sequencing and overburden emplacement development is shown on Plans 3a to 3f of the current MOP.

The current truck and shovel mining methods will be utilised for pre-stripping and coal recovery. Excavators will be used to load haul trucks to remove overburden and interburden. Coal will also be loaded into haul trucks with excavators. Additionally, a mobile crusher will operate in a gravel stockpiling area where select overburden will be crushed and screened for subsequent dispatch from site.

Operations at TCM over the current MOP period (to November 2020) include:

- continued development of mining operations in the Maules Creek Formation to facilitate a Run of Mine (ROM) coal production rate of up to 3 Mtpa, including open cut extensions:
  - to the east within Mining Lease 1579 and Mining Lease 1693; and
  - to the north within Mining Lease 1685;

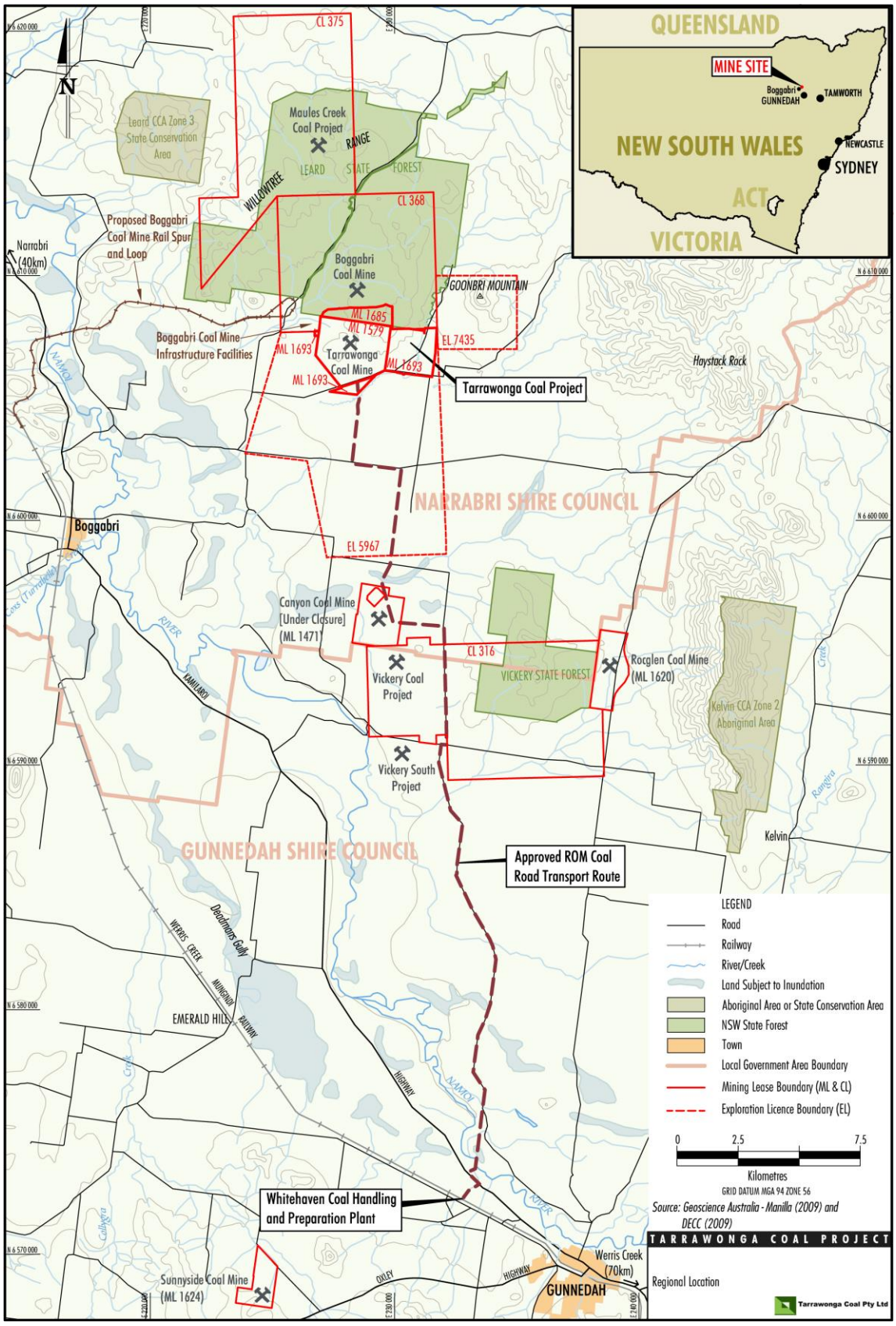

Figure 1 Tarrawonga Coal Mine Location

- ongoing exploration activities;
- continuation of transport of ROM coal via the approved haulage route to the Whitehaven CHPP, or to the Boggabri CHPP via internal haul roads, subject to a suitable commercial agreement between Boggabri and Tarrawonga Mines.
- use of an existing on-site mobile crusher for coal crushing and screening of up to 150,000 tonnes (t) of domestic specification coal per annum for direct collection by customers at the mine site for transport offsite;
- use an existing on-site mobile crusher to produce up to approximately 90,000 m^3 of gravel materials per annum for direct collection by customers at the mine site;
- progressive backfilling of the mine void behind the advancing open cut mining operation with waste rock and reject material from the Gunnedah CHPP;
- continued and expanded placement of waste rock in the Northern Emplacement (including integration with the BCM emplacement) and Southern Emplacement, as mining develops;
- progressive development of new haul roads and internal roads, as mining develops;
- progressive development of sediment basins and storage dams, pumps, pipelines and other water management equipment and structures;
- continued development of soil stockpiles, laydown areas and gravel/borrow areas;
- ongoing monitoring and rehabilitation; and
- other associated minor infrastructure, plant, equipment and activities.

1.3 BTM Complex Water Management Strategy

The BTM Complex Water Management Strategy (WMS) has been developed to manage cumulative impacts from the Boggabri-Tarrawonga-Maules Creek Complex (BTM Complex) on water in the surrounding region. The aim of this strategy is to minimise cumulative impacts on the quality and availability of water resources in the catchment. The extent of the EA boundaries for each of the mines that comprise the BTM Complex are presented in Figure 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 this WMP and all other relevant cumulative impact management documents, all references to the 'Leard Forest Mining Precinct' have been replaced with the term 'BTM Complex'.

Monitoring requirements and impact assessment criteria for the TCM have been developed to be consistent with those developed to achieve the objectives of the BTM Complex WMS (refer to Sections 3 and 5). The current BTM Complex WMS is provided in Appendix E.

1.4 Structure and Purpose of this Document

This WMP describes the measures to be implemented to manage and mitigate the potential impacts of the TCM on water resources.

This Management Plan is structured as follows:

- Section 2 lists the project approvals where each relevant approval condition is addressed in the WMP;
- Section 3 is the surface water management plan;
- Section 4 presents the site water balance;
- Section 5 is the groundwater management plan;
- Section 6 presents the Surface Water and Groundwater Response Plans;
- Section 7 describes the future water management elements of the WMP;
- Section 8 provides details of reporting and review requirements for the WMP; and
- Section 9 lists materials referenced within the WMP.

1.5 Consultation During the Preparation of this Document

In accordance with Schedule 3 Condition 39 of the PA 11_0047, this WMP will be prepared in consultation with the relevant agencies including the NSW Environment Protection Authority (EPA), NSW Department of Industries (DoI Water), Natural Resources Access Regulator (NRAR) and the North West Local Land Services (LLS).

This WMP will be submitted to the Department of Planning, Industry and Environment (DPIE) for approval.

Consultation undertaken as part of Edition 3 of the WMP includes:

- Revision 0 - updated to incorporate comments from the former Department of Planning and Environment (DP&E) and the independent monitor (IM);
- Revision 1 - updated to incorporate comments from NRAR; and
- Revision 2 (this WMP) - updated to incorporate comments and feedback from DPIE and the IM.

The WMP has been provided to the relevant agencies for review following each revision of the document

2 STATUTORY REQUIREMENTS

2.1 Project Approvals

This WMP has been developed to satisfy the requirements of the conditions of the Project Approvals. Table 1 and Table 2 presents the Project Approval conditions relevant to this management plan and the section(s) where these have been addressed in this plan.

The statutory requirements for the Tarrawonga Coal Project relating to water include:

- conditions in schedules 3 and 5 of the PA 11_0047 (Table 1); and
- conditions in the Environment Protection and Biodiversity Conservation (EPBC) 2011/5923 Project Approval relating to sections 130(1) and 133 of the *EPBC Act 1999* (Table 2).

Table 1 Water Related Conditions in Project Approval 11_0047

Condition	Refer to Sections
Schedule 3	
Water Supply 31. The Proponent shall ensure that it has sufficient water for all stages of the project, and if necessary, adjust the scale of mining operations on site to match its available water supply, to the satisfaction of the Secretary.	Section 4
Compensatory Water Supply 32. The Proponent shall provide a compensatory water supply to any owner of privately-owned land whose water supply is adversely and directly impacted (other than a negligible impact) as a result of the project, in consultation with DPI, and to the satisfaction of the Secretary. The compensatory water supply measures must provide an alternative long-term supply of water that is equivalent to the loss attributed to the project. Equivalent water supply should be provided (at least on an interim basis) within 24 hours of the loss being identified. If the Proponent and the landowner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Director- General for resolution. If the Proponent is unable to provide an alternative long-term supply of water, then the Proponent shall provide alternative compensation to the satisfaction of the Secretary.	Section 5.5.2
Surface Water Discharges 33. The Proponent shall ensure that all surface water discharges from the site comply with the discharge limits (both volume and quality) set for the project in any EPL.	Section 4
Goonbri Creek Diversion and Low Permeability Barrier – Performance Objectives 34. The Proponent shall ensure that the project has no greater environmental consequences than predicted in the EA and complies with the performance objectives in Table 12 [of the EA], to the satisfaction of the Secretary.	Not Applicable apart from baseline monitoring (Section 3.5.7). Describes works that are beyond the scope of this WMP. This requirement will be addressed in future revisions of this WMP following approval of the future MOP.
Goonbri Creek Diversion and Flood Bund Concept Design Plan 35. The Proponent shall prepare and implement a Goonbri Creek Diversion and Flood Bund	Not Applicable This WMP has been prepared for the current

Condition	Refer to Sections
Schedule 3	
Concept Design Plan, to the satisfaction of the Secretary. The plan must: a) be prepared in consultation with DPI, OEH and the North West LLS; b) be submitted to the Secretary for approval by December 2016; c) set out the vision statement for the creek diversion; d) assess the surface water and groundwater quality, ecology, hydrological (including flooding) and geomorphic baseline conditions within the creek; e) set out the construction program for the creek diversion and LPB, describing how the work would be staged, and integrated with mining operations; f) describe the revegetation program for the creek diversion and the use of a range of suitable native species; g) establish the water quality, ecology, hydrological (including flooding) and geomorphic performance and completion criteria for the creek diversion and LPB based on the assessment of baseline conditions; and h) be revised in consultation with DPI, OEH and the North West LLS, and resubmitted for approval by the Secretary in response to the findings of the detailed technical design required in condition 36 and the Monitoring and Management Plan in condition 38.	MOP period to Nov 2020 and therefore the Goonbri Creek Diversion and Flood Bund Concept Design Plan has not been included in this WMP. Future revisions of this WMP will be amended to reflect the mine plan as specified in relation to the Goonbri Creek Diversion and Flood Bund Concept Design Plan.
Goonbri Creek Diversion and Low Permeability Barrier – Design and Construction 36. The Proponent shall design the Goonbri Creek diversion and LPB to the satisfaction of DPI and the Secretary. The detailed designs must: a) be designed by a suitably qualified and experienced expert/s; b) be endorsed by DPI and approved by the Secretary prior to the commencement of any works or construction on the Goonbri Creek diversion and LPB; c) be generally in accordance with the conceptual designs in the EA (and depicted in Appendix 6), and applicable Australian Standards (including AS 3798−2007); d) include detailed design, construction and engineering specifications, performance criteria and completion criteria; e) demonstrate that the design would achieve the relevant performance objectives and criteria; and f) demonstrate the LPB design would remain effective over an appropriate lifespan and would withstand mining operations, geological and weather events, decay and corrosive attack – including biological attack.	Not Applicable This WMP has been prepared for the current MOP period to Nov 2020 and therefore the Goonbri Creek Diversion and Flood Bund Concept Design Plan has not been included in this WMP. Future revision of this WMP will be amended to reflect the mine plan as specified in specific relation to the Goonbri Creek Diversion and Flood Bund Concept Design Plan.
37. The Proponent shall: g) construct the Goonbri Creek diversion and LPB prior to undertaking any mining operations within 200 metres of the Goonbri Creek alluvium, and at least 5 years prior to the planned mining in the alluvium; and h) within 2 months of the construction of the Goonbri Creek diversion and LPB, submit an as-executed report to the Secretary and DPI, certified by a practising engineer, confirming that the diversion and barrier have been constructed: • in accordance with the concept design in the EA, applicable Australian Standards (including AS 3798-2007) and the approved design (see condition 36 above); and • in a manner that achieves the performance objectives in Table 18.	Not Applicable This WMP has been prepared for the current MOP period to Nov 2020 and therefore the Goonbri Creek Diversion and Flood Bund Concept Design Plan has not been included in this WMP. Future revision of this WMP will be amended to reflect the mine plan as specified in specific relation to the Goonbri Creek Diversion and Flood Bund Concept Design Plan.
Goonbri Creek Diversion and Low Permeability Barrier – Monitoring and Management Plan 38. The Proponent shall prepare and implement a Goonbri Creek Diversion and Low Permeability Barrier Monitoring and Management Plan to the satisfaction of the DPI and the Secretary. The plan	Not Applicable apart from baseline monitoring (Section 3.5.7)

Condition	Refer to Sections
Schedule 3	
must: a) be prepared by a suitably qualified and experienced expert/s; b) be endorsed by the DPI and approved to the Secretary prior to commencement of any works or construction on the Goonbri Creek diversion and LPB; c) describe the monitoring and maintenance procedures to be implemented and the scheduling of these procedures; d) demonstrate the monitoring system would be capable of timely detection of any failure or deficiency in the LPB and any impacts on Goonbri Creek and its associated alluvium; e) describe the contingency measures that would be implemented in the event of a failure or deficiency in the LPB, or other impact on Goonbri Creek and its associated alluvium; and f) identify the entity that would take responsibility for the future liabilities and costs associated with the long-term monitoring and maintenance of the LPB, flood bund, void and pit lake, and demonstrate that this entity's security and finances would be assured in the long term.	
Water Management Plan 39. The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Secretary. This plan must: a) be prepared in consultation with OEH, DPI and North West LLS, by suitably qualified and experienced person/s whose appointment has been approved by the Secretary, b) be submitted to the Secretary for approval by the end of May 2013; and c) in addition to the standard requirements for management plans (see condition 3 of schedule 5), include a:	This WMP has been prepared based on Regulator's past comments and will be issued to DPIE, DoI Water and North West LLS for review.
(i) Site Water Balance, that includes:details of: ○ sources and security of water supply, including contingency for future reporting periods; ○ incorporating commitments for minimising trucking of off-site water as identified in MOD8; ○ water use and management on site; ○ any off-site water discharges; ○ reporting procedures, including the preparation of a site water balance for each calendar year; • a program to validate the surface water model, including monitoring discharge volumes from the site and comparison of monitoring results with modelled predictions; and describes the measures that would be implemented to minimise clean water use on site;	Section 4
(ii) Surface Water Management Plan, that includes: • detailed baseline data on surface water flows and quality in the water-bodies that could potentially be affected by the project; • detailed baseline data on soils within the irrigation area; • detailed baseline data on hydrology across the downstream drainage system of the Namoi River floodplain from the mine site to the Namoi River, including Barbers Lagoon and The Slush Holes; • a detailed description of the water management system on site, including the: ○ clean water diversion systems; ○ erosion and sediment controls (mine water system); ○ mine water management systems including irrigation areas; ○ discharge limits in accordance with EPL requirements; and ○ water storages; • detailed plans, including design objectives and performance criteria for: ○ design and management of final voids;	Section 3.5, AEMR/AR Section 4.5.5 Section 1.3, 3.5.1 Section 3.2 Section 3.1 Section 3.4 Sections 3.2.6, 4.5.5 Section 3.6 Section 3.2.2 Addressed in future revisions of this WMP

Condition	Refer to Sections
Schedule 3	
	following approval of future MOP.
○ design and management for the emplacement of reject materials, sodic and dispersible soils and acid or sulphate generating materials;	Section 3.2.11
○ the Goonbri Creek diversion and low permeability barrier;	Addressed in future revisions of this WMP following approval of future MOP.
○ reinstatement of drainage lines on the rehabilitated areas of the site; and	Section 3.2.12, 3.5.5
○ control of any potential water pollution from the rehabilitated areas of the site;	Sections 3.2.4, 3.2.12, 3.4
• performance criteria for the following, including trigger levels for investigating any potentially adverse impacts associated with the project:	
○ the water management system;	Section 3.6, 5.5, 6
○ soils within the irrigation area;	Section 4.5.5
○ downstream surface water quality;	Section 3.6.3
○ downstream flooding impacts, including flood impacts due to the flood bunds required for the project; and	Section 3.2.8, 7.3
○ stream and riparian vegetation health, including the Namoi River and its tributaries including Barbers Lagoon and The Slush Holes;	Section 3.5.5, 3.6.3, 6
• a program to monitor and assess:	
○ the effectiveness of the water management system;	Sections 3.5.6, 5.5, 7
○ soils within the irrigation area;	Goonbri Creek diversion and flood bund monitoring are not applicable.
○ the effectiveness of the Goonbri Creek diversion and flood bunds (see conditions 28-31);	This requirement will be addressed in future revisions of this WMP following approval of the future MOP.
○ surface water flows and quality in the watercourses that could be affected by the project; and	
○ downstream flooding impacts;	
• reporting procedures for the results of the monitoring program; and	
• a plan to respond to any exceedances of the performance criteria, and mitigate and/or offset any adverse surface water impacts of the project;	
(iii) Groundwater Management Plan, that includes:	
• 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), that could be affected by the project;	
• detailed plans, including design objectives and performance criteria, for the design and management of:	
○ the proposed final void; and	
○ coal reject and potential acid forming material emplacement;	Sections 5, 3.2.11
• groundwater assessment criteria including trigger levels for investigating any potentially adverse groundwater impacts;	
• a program to monitor and assess:	
○ groundwater inflows to the open cut mining operations;	This requirement will be addressed in future revisions of this WMP following approval of the future MOP.
○ the effectiveness of the LPB;	
○ the seepage/leachate from the LPB, water storages, emplacements and the final void;	
○ interconnectivity between the alluvial and bedrock aquifers;	
○ background changes in groundwater yield/quality against mine-induced changes;	
○ the impacts of the project on:	

Condition	Refer to Sections
Schedule 3	
- regional and local (including alluvial) aquifers; - groundwater supply of potentially affected landowners; - groundwater dependent ecosystems (including potential impacts on stygofauna) and riparian vegetation; • 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 • a plan to respond to any exceedances of the performance criteria; and	 Section 5.4.6 Section 6.5
(iv) Leard Forest Mining Precinct Water Management Strategy, that has been prepared in consultation with other mines within the precinct to: • minimise the cumulative water quality impacts of the mines; • review opportunities for water sharing/water transfers between mines; • co-ordinate water quality monitoring programs as far as practicable; • undertake joint investigations/studies in relation to complaints/exceedances of trigger levels where cumulative impacts are considered likely; and • co-ordinate modelling programs for validation, re-calibration and re-running of the groundwater and surface water models using approved mine operation plans. *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.*	 Section 1.3
Schedule 5	
Management Plan Requirements 3. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include: a) detailed baseline data; b) a description of: • the relevant statutory requirements (including any relevant approval, 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; c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria; d) a program to monitor and report on the: • impacts and environmental performance of the project; • effectiveness of any management measures (see c above); e) a contingency plan to manage any unpredicted impacts and their consequences; f) a program to investigate and implement ways to improve the environmental performance of the project over time; 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 h) a protocol for periodic review of the plan.	 Section 3.5, AEMR/AR Sections 2 Sections 3.6, 5.5 Section 6 Sections 3.2, 3.3, 3.4, 5 Sections 3.5, 5.4, 6, 8 Section 6 Section 6 Section 8.3 Section 6.6 Sections 6.3, 8.3 Sections 6.2 Section 8.1, 8.2

Table 2 Water Related Conditions in the EPBC 2011/5923 Project Approval

Condition	Refer to Sections
Surface and groundwater management plans 15. The person taking the action must provide by the 31 May 2013, to the Secretary for approval, the surface and groundwater management plans as identified in condition 39 of the NSW state government Project Approval dated 22 January 2013 (application number 11_0047).	Not applicable
16. The surface and groundwater management plans must be consistent with the National Water Quality Management Strategy.	Addressed throughout document.
17. The person taking the action must, within six months of this approval, in collaboration with the proponent to develop and operate the Boggabri Extension (EPBC 2009/5256) and the proponent to develop and operate the Maules Creek Mine (EPBC 2010/5566), provide written advice to the Secretary demonstrating how the NSW government approved surface and groundwater management plans, address the cumulative impact of groundwater drawdown as a result of mining and how this may impact on the consequent health of the remnant native vegetation in the Leard State Forest, the Leard State 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.	Sections 5, 5.5
18. The person taking the action must within 6 months of the date of this approval, or such other timeframe specified by the **Secretary**, provide to the **Secretary** a report on: a) any updated modelling of surface and groundwater impacts that has been undertaken in preparing the surface and groundwater management plans b) how the surface and groundwater management plans addressed groundwater and surface water impacts on matters of national environmental significance.	Sections 4, 5.4.6
Goonbri Creek Diversion and Low Permeability Barrier 19. The person taking the action must provide to the **Secretary** for approval, before **commencement of the construction of the permanent Goonbri Creek alignment, permanent flood bund and low permeability barrier**, a Goonbri Creek Diversion and Flood Bund Concept Design Plan. This approved Goonbri Creek Diversion and Flood Bund Concept Design Plan must be implemented.	Not Applicable apart from baseline monitoring (Section 3.5.7) Describes works that are beyond the scope of this WMP. This requirement will be addressed in future revisions of this WMP following approval of the future MOP.
20. The Goonbri Creek Diversion and Flood Bund Concept Design Plan must include: c) an assessment of the surface water and groundwater quality, ecology, hydrological and geomorphic baseline conditions within the creek; d) a description of how restoration of the re-aligned riparian zone will be undertaken to best replicate the habitat of the existing creek, including plant species and fauna habitat features; e) water quality, ecology, hydrological and geomorphic performance and completion criteria for the creek diversion and low permeability barrier based on the assessment of the baseline conditions identified in condition 20 (a); and f) a risk assessment of the environmental consequences of the proposed low permeability barrier and the proposed Goonbri Creek realignment including the potential for impacts on groundwater and surface discharge. The risk assessment	Not Applicable apart from baseline monitoring (Section 3.5.7) Describes works that are beyond the scope of this WMP. This requirement will be addressed in future revisions of this WMP following approval of the future MOP.

Condition	Refer to Sections
must be peer-reviewed. g) details for ongoing monitoring and management of downstream impacts on the adjacent floodplains and Namoi River floodplain.	
21. The person taking the action must ensure that dispersed waters downstream of the Goonbri Creek re-alignment do not adversely affect the downstream environment and avoid any impacts on matters of national environmental significance.	Not Applicable apart from baseline monitoring (Section 3.5.7) Describes works that are beyond the timeframe of this WMP. This requirement will be addressed in future revisions of this WMP following approval of the future MOP.
Leard Forest Mining Precinct Regional Biodiversity Strategy 22. The person taking the action must implement the regional biodiversity strategy as required under condition 41 of the NSW state government project approval dated 22 January 2013 (application number 11_0047). The required seeping report for the development of the strategy must be submitted to the **Secretary** for approval on or before 31 July 2013. The approved strategy must be implemented.	Not applicable
34. If the person taking the action wishes to carry out any activity otherwise than in accordance with the plans, as specified in the conditions, the person taking the action must submit to the department for the Secretary's written approval a revised version of that plan. The varied activity shall not commence until the Secretary has approved the revised plan in writing. The Secretary will not approve a revised plan, unless the revised plan would result in an equivalent or improved environmental outcome. If the Secretary approves the revised plan that plan must be implemented in place of the plan originally approved.	Section 8

2.2 Water Sharing Plans

The TCM is covered by four Water Sharing Plans (WSPs) including the following:

- Namoi Unregulated and Alluvial (commenced 2012);
- Upper Namoi and Lower Namoi Regulated River (replaced 2016);
- NSW Murray-Darling Basin Porous Rock Groundwater (commenced 2012); and
- Upper and Lower Namoi Groundwater (commenced 2006).

The TCM is located within the catchments of Nagero, Bollol and Goonbri creeks. These creeks are located within the Bluevale Water Source, administered under the WSP for the Namoi Unregulated and Alluvial Water Sources. The WSP for the Namoi Unregulated and Alluvial Water Sources includes rules for protecting the environment, water extractions, managing licence holders' water accounts and water trading in the plan area. Nagero, Bollol and Goonbri creeks flow into the Namoi River, which is administered under the WSP for the Upper and Lower Namoi Regulated River (Lower Namoi water source). Licences are required for surface water accessed by the TCM, excluding their 'harvestable right'. Licences are obtained through acquisition from existing licence holders.

The TCM targets coal seams in the Maules Creek Formation within the 'Gunnedah-Oxley Basin – Namoi' Management Zone defined in the WSP for the NSW Murray-Darling Basin Porous Rock Groundwater Sources 2011. The TCM adjoins alluvial sediments that lie

within the Upper Namoi Management Zone 4 (Keepit Dam to Gin's Leap) defined in the WSP for the Upper and Lower Namoi Groundwater Sources 2003, which commenced on 1 November 2006. Figure 2 shows the extent of groundwater WSPs in the vicinity of TCM.

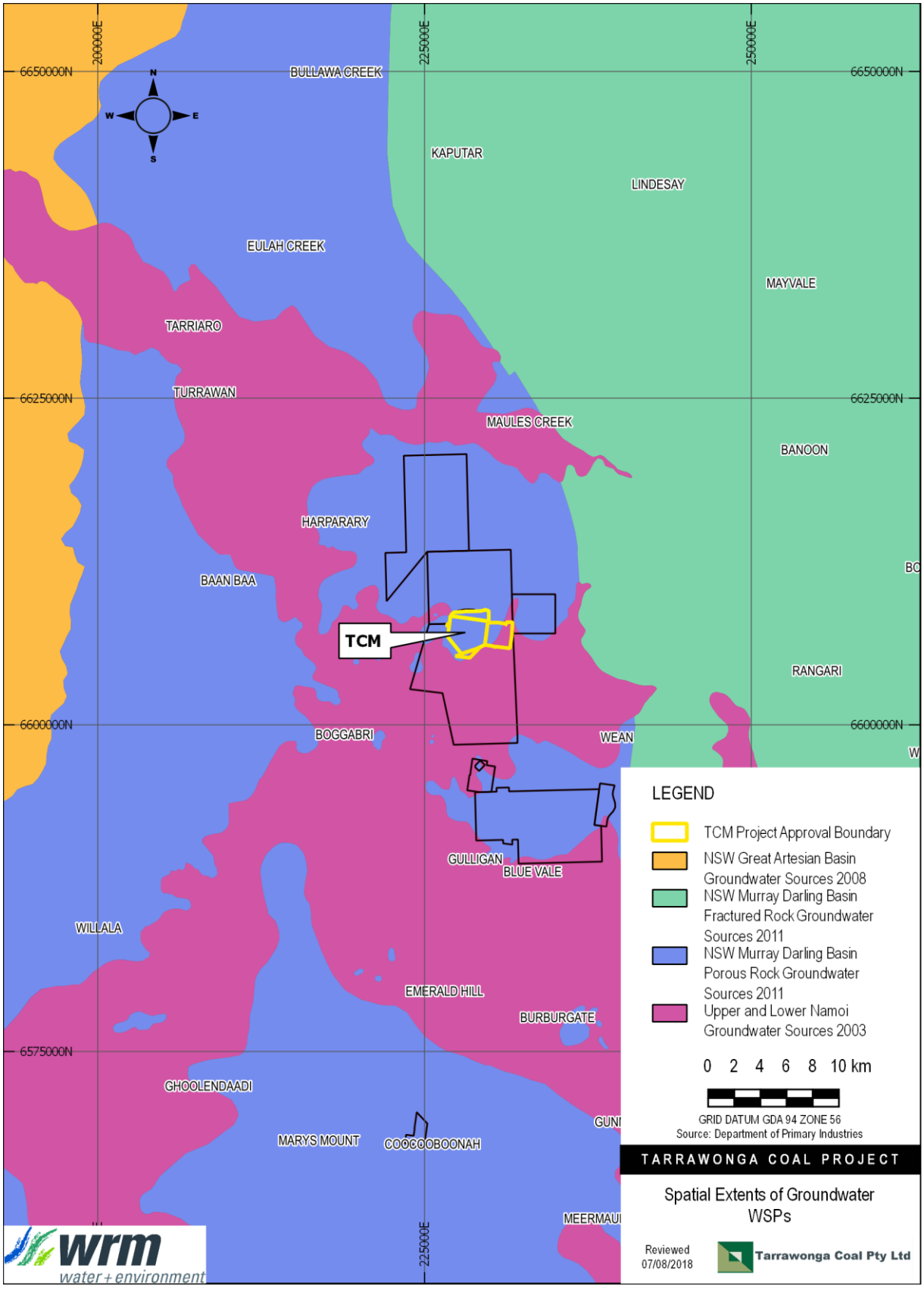

Figure 2 Spatial Extents of Groundwater WSPs

3 SURFACE WATER MANAGEMENT PLAN

3.1 Site Water Management System

Figure 4 shows the general Year 2020 (existing) layout of the TCM water management system. Figure 6 shows the conceptual water circuit schematic of the Year 2020 (existing) operations. The main components of water-related infrastructure include:

- sediment dams to capture sediment in sediment-laden runoff from emplacement areas;
- surface water drains to divert sediment-laden runoff from emplacement areas to sediment dams;
- surface water drains to divert runoff from undisturbed catchments around areas disturbed by mining; and
- a mine water system to store water pumped out of the mine pit area and to collect runoff from coal stockpile areas.

Figure 3 to Figure 5 show the indicative locations of water management infrastructure and mine catchments at TCM for Year 2018 and Year 2020 and Year 2022 (based on current mine planning) respectively.

This Surface Water Management Plan describes the management strategies, management areas, erosion and sediment controls, monitoring program and trigger values for the TCM water management system.

A site water balance was developed for the TCM water management system (refer to Section 4). The site water balance includes water inputs/gains (e.g., rainfall runoff, groundwater inflow, external water, etc.) and water outputs/demands (e.g. evaporation, dust suppression, ROM coal, etc.).

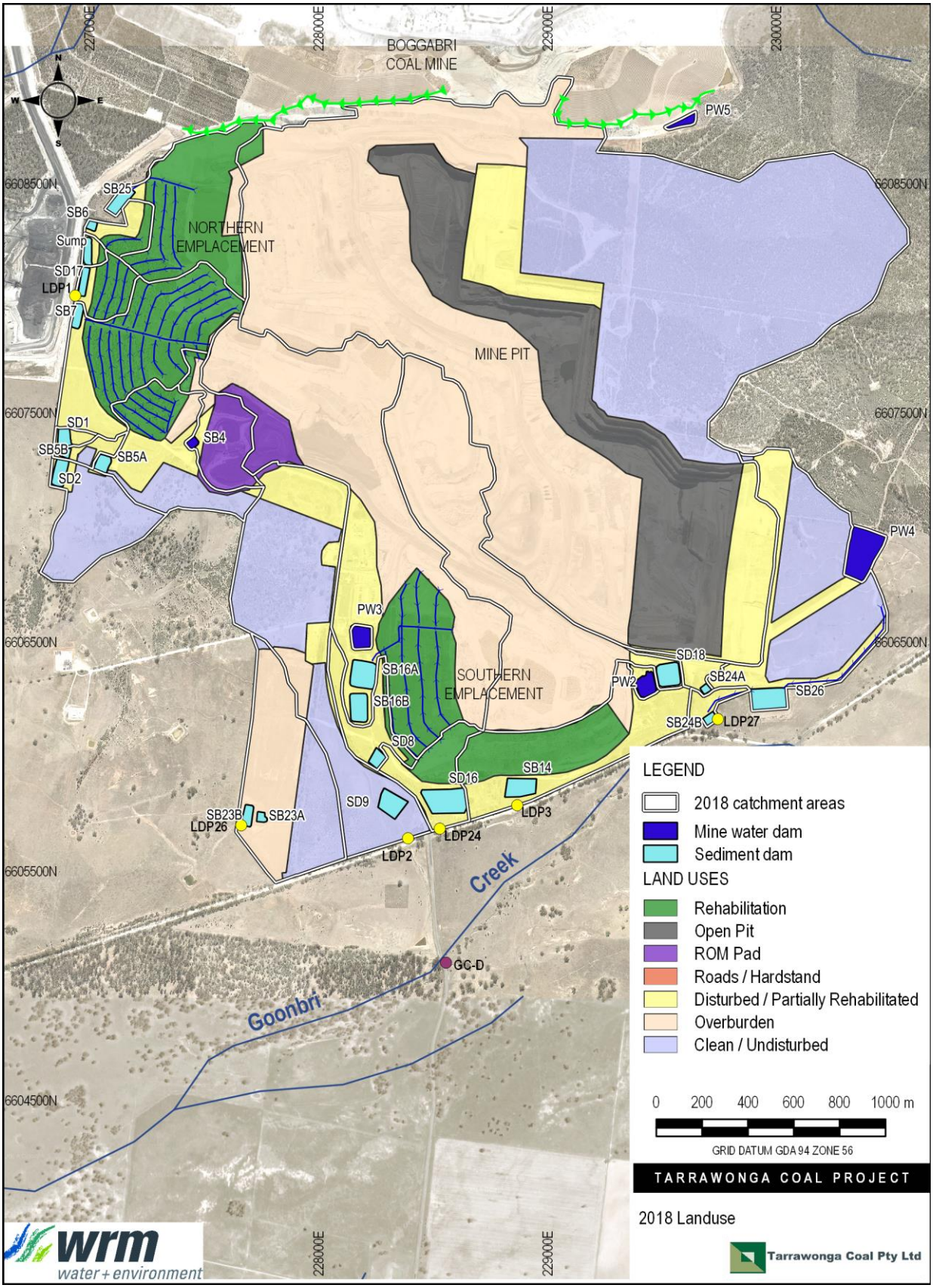

Figure 3 TCM Year 2018 Catchment Plan and Site Layout

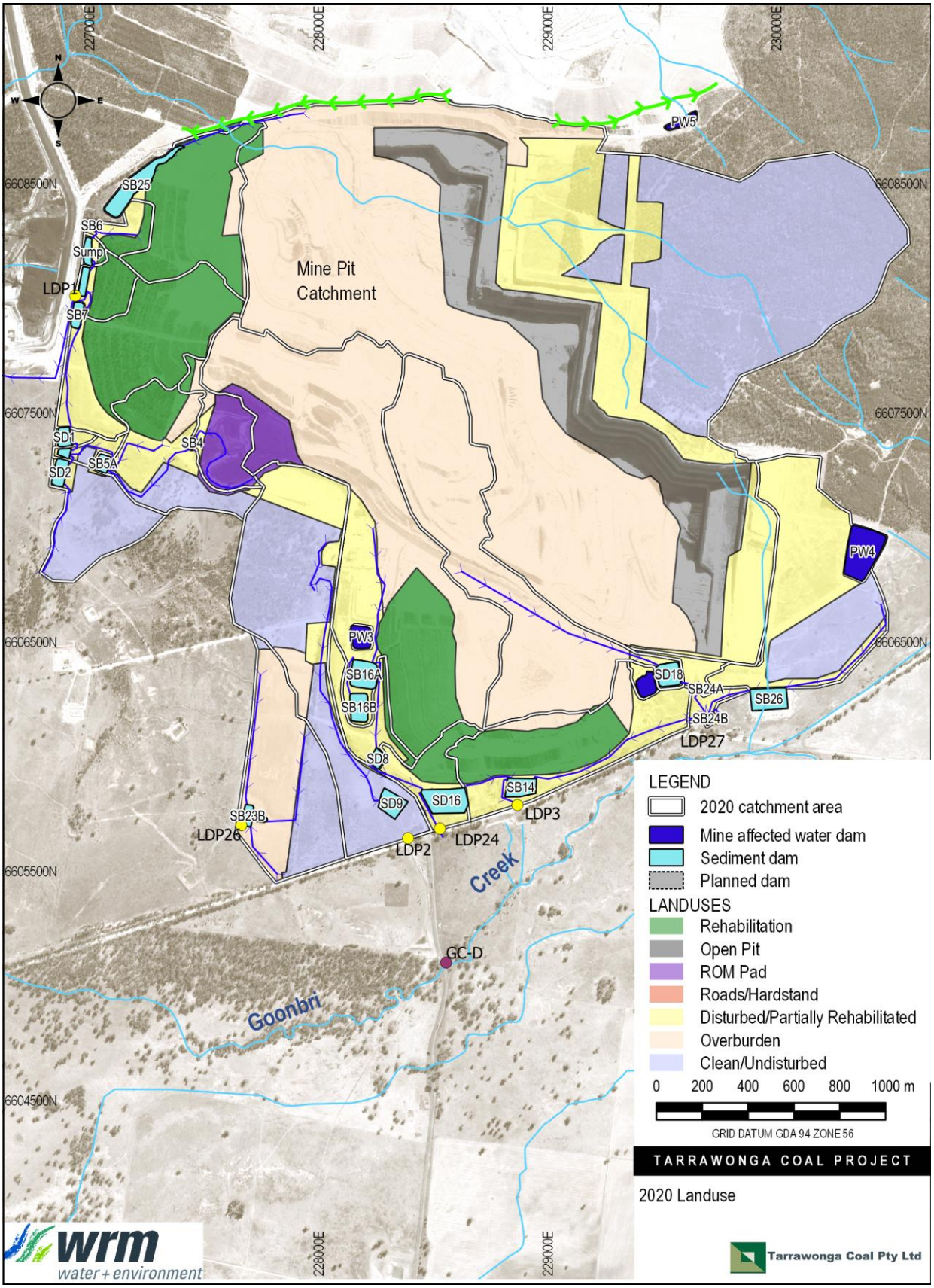

Figure 4 TCM Year 2020 (Existing) Catchment Plan and Site Layout

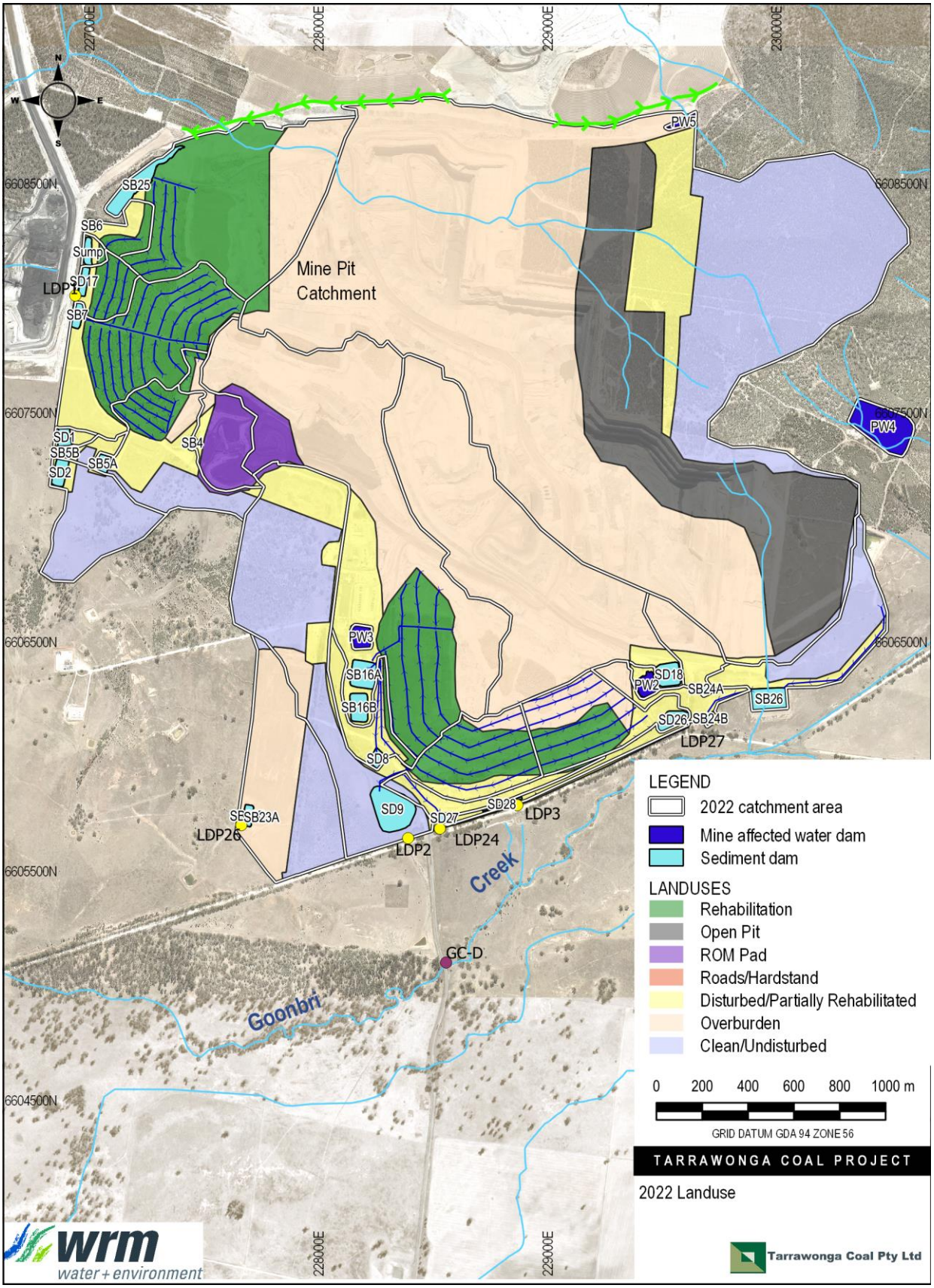

Figure 5 TCM Year 2022 (Forecast) Catchment Plan and Site Layout

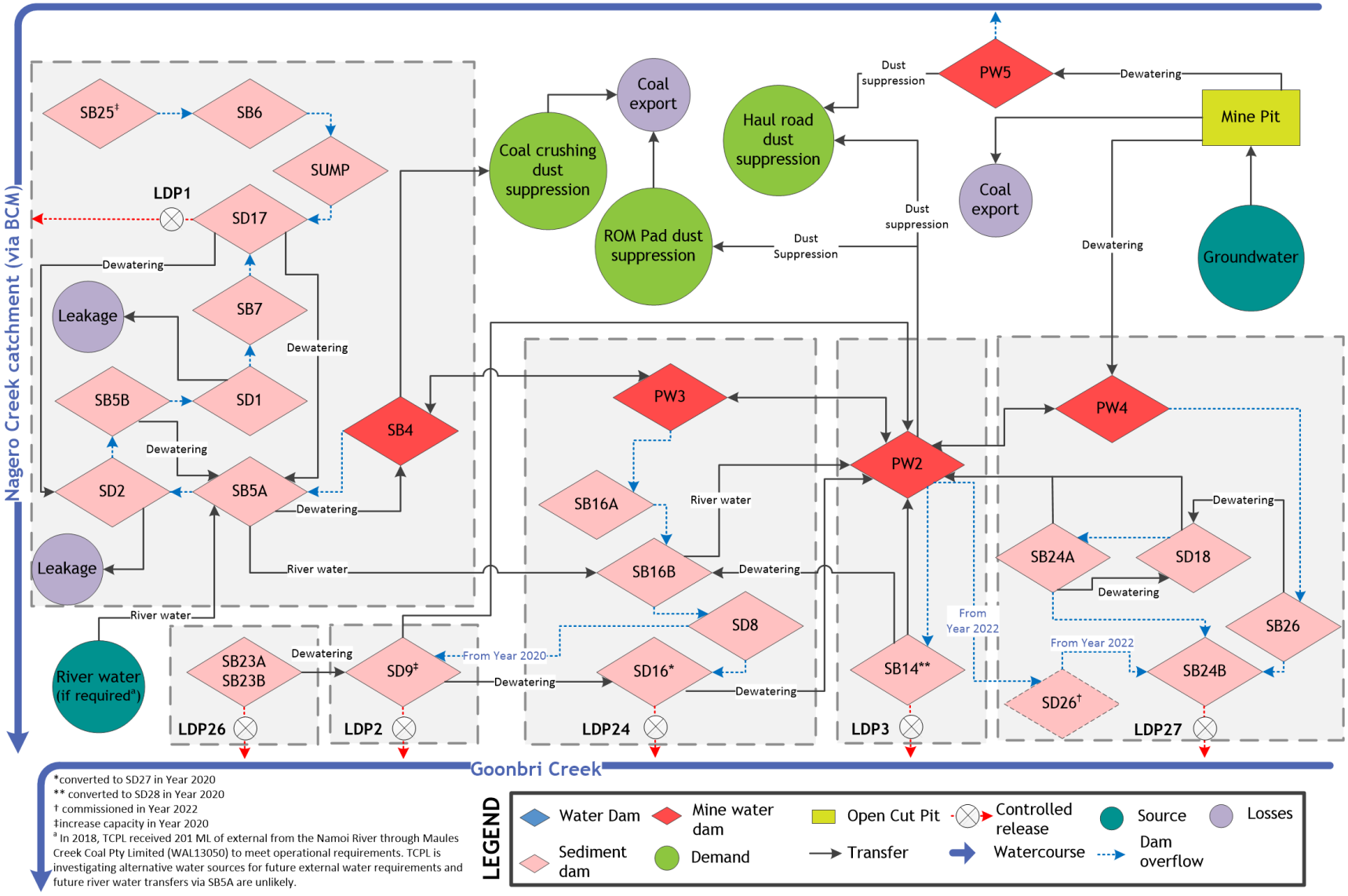

Figure 6 **Year 2020 (Existing) Water Management Schematic**

3.2 Surface Water Management Strategy

3.2.1 General

For the purposes of water management, the water generated at the TCM is divided into four types based on water quality, as detailed below:

- **'Clean'** – surface runoff from the mine site areas where water quality is unaffected by mining operations. Clean water includes runoff from undisturbed areas and any fully rehabilitated areas;
- **'Dirty'** – surface runoff from the mine site areas that are disturbed by mining operations. This runoff may contain silt and sediment, but does not contain contaminated material. However, this runoff must be of sufficient quality prior to discharge into natural water courses, if required;
- **'Contaminated'** – surface water from areas affected by mining operations and potentially containing hydrocarbons. This water requires treatment before it can be released or used on site; and
- **'Mine'** – surface water pumped from the mine pit which potentially contains raised concentrations of total dissolved solids (TDS), and other minerals. This water cannot be released from site.

The TCM surface water management system has been primarily designed in order to:

- manage clean, dirty, contaminated and mine water generated on the mine site to limit their interaction where possible;
- maintain adequate water supply for dust suppression, coal crushing and screening activities on-site;
- capture, store and manage surface water runoff from dirty water catchments and provide controlled release of these waters through Licensed Discharge Points (LDPs) in accordance with EPL conditions; and
- capture and store mine water generated by active mining areas, with no release off-site.

Water management infrastructure at the site comprises of a number of mine water dams to manage mine water and a series of sediment dams and drains used for controlling dirty runoff. Drainage works have been constructed to divert 'clean' water around TCM or away from mine disturbed areas. Figure 4 shows the surface water drainage system for the 2020 TCM site plan.

Water for haul road dust suppression and coal crushing is sourced from mine water storages where possible. Any shortfall is supplemented with dirty water from the sediment dams and then from external water sources as required. During extended wet periods (when dams are at or near capacity) controlled discharge occurs from Licenced Discharge Points (LDPs).

TCM will manage all the water onsite as far as practical. Where possible, excess surface water will be pumped into mine water dams to prevent or minimise the risk of non-compliant off-site discharge from LDPs noting that this may result in excess water stored in mine pits.

TCM is committed to managing on-site water storages in accordance with the surface water management strategy, which as far as practical, limits the risk of non-compliant off-site discharge.

3.2.2 Water Dams

The management of stored water at the TCM includes both dewatering of the dams when they reach a certain capacity and pumping water into the mine water dams from external water sources. 'Trigger' volumes related to the management of water dams at TCM are defined as follows:

- **Operating Volume** is the volume that, when exceeded, triggers the dam to be dewatered (i.e. to another dam at the site). The operating volume determines the "operating water level" based on the specific surveys of the dams.
- **Total Storage Volume** is the overall storage capacity of the dam from the base to the spillway level.
- **Dead Storage Volume** is the volume at which the dam cannot be dewatered with pumps.

Table 3 shows approximate Total Storage Volumes for dams within the site water management system together with their site water management area and destination of spills.

Appendix A shows the current catchment area, operating volume and operating water level for each dam. The operating water level for each dam located at an LDP is surveyed and marked on a gauge board. The operating water level in other storages are marked with a peg within the wall of the dam. A description of each site water management area is provided in Section 3.3.

Table 3 TCM Dam Volumes – Year 2020 (existing) Conditions

Site Water Management Area	Storage	Total Storage Volume (ML)	Spills to
Dirty (Sediment-laden) Dams/Basins			
SD17 (LDP1)	SB25	40.0	SB6
	SB6	1.0	SUMP
	SD17	9.7	BCM via LDP1
	SUMP	3.5	SD17
	SB7	2.7	SD17
	SD1	7.6	SB7
	SD2	29.4	SB5B
	SB5B	3.1	SD1
	SB5A	7.8	SD2
SD9 (LDP2)	SD9	8.8	Goonbri Creek via LDP2
SB14 (LDP3)	SB14	8.6	Goonbri Creek via LDP3
SD16 (LDP24)	SB16A	39.4	SB16B
	SB16B	96.9	SD8
	SD8	3.5	SD16
	SD16	31.6	Goonbri Creek via LDP24
SB23B (LDP26)	SB23A	2.5	SB23B
	SB23B	10.9	Goonbri Creek via LDP26
SB24B (LDP27)	SD18	34.0	SB24A
	SB24A	3.6	SB24B
	SB24B	4.8	Goonbri Creek via LDP27
	SB26	35.5	SB24B
Mine (Pit) Water Dams			
-	Mine Pit	130[a]	-
SB14 (LDP3)	PW2	22.8	SB14
SD16 (LDP24)	PW3	26.5	SB16A
SB24B (LDP27)	PW4	268.5	SB26
n/a	PW5	0.5	-
SD17 (LDP1)	SB4	6.0	SB5A

[a] Reported volume is for the in-pit sump (Lachys). Total Storage Volume of the mine pit is 31 GL

3.2.3 Clean Water

Clean water sources at the mine include:

- incident rainfall and runoff from areas undisturbed by mining and infrastructure;
- licensed groundwater extractions; and
- licenced surface water extractions.

Drains/contour banks are constructed to divert flows around working areas to separate clean water from dirty or contaminated water where possible. Clean water catchments upstream of disturbance areas are directed around these areas and delivered to the natural water courses.

The TCM water management system does not include any operational clean water dams which capture runoff from clean water catchments. Consistent with best practice, the TCM

water management system implements the principle of recycling dirty water and mine water from dirty water and mine water dams to meet operational demands for water. As a result of this, the TCM water management system does not rely upon harvestable rights dams to capture runoff from clean water catchments in accordance with the *Water Management Act 2000* (WM Act).

Given the approved TCM mine plan, it is not feasible or practical to divert all runoff from clean catchments around areas disturbed by mining operations. This is partly because approved mining operations are progressing into clean catchment areas that cannot be gravity drained and because of the interaction between clean and disturbed catchments within the TCM. However, as the TCM water management system continues to evolve, the feasibility of new, appropriate clean water diversions will be considered. Similarly, if necessary, harvestable rights dams may be constructed and used to capture runoff in accordance with TCM's unused harvestable rights entitlement.

3.2.4 Dirty Water

The TCM water management system includes 21 sediment dams which capture and contain dirty water. Consistent with best practice, the purpose of these sediment dams is to prevent dirty water generated at TCM from contaminating downstream watercourses. The dirty water contained within these sediment dams is beneficially reused for operational purposes or released downstream, if of sufficient quality to do so.

The take of dirty water by these sediment dams is exempt from the need for a WAL under the WM Act. The take of this water is exempt due to the combined operation of cl 21(1), cl 12 in Part 1 of Schedule 4, and cl 3 in Schedule 1 of the *Water Management (General) Regulation 2018* (WM Regulation).

This is because each of these sediment dams are located on a "minor stream" and fall within the scope of the "excluded work" in clause 3 in Schedule 1 of the *WM Regulation*, which states:

> *Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority (other than Landcom or the Superannuation Administration or any of their subsidiaries) to prevent the contamination of a water source, that are located on a minor stream.*

As these sediment dams fall within the scope of this "excluded work", these dams also fall within a class of dam which is exempt from the Harvestable Rights Order (HRO, paragraph 3 of Schedule 2). As such, these sediment dams do not capture water in reliance on harvestable rights.

Where it is not feasible to divert runoff from clean catchments, some sediment dams potentially receive some runoff from clean catchments, in addition to dirty water capture. However, the TCM water management system is designed such that this runoff only represents a minor component of the total runoff captured by the TCM water management system.

It is noted that a significant proportion of the clean catchment that generates runoff reporting to TCM's water management system will be mined out as part of approved future mining operations.

The site dirty water system is broadly split into two with the catchment reporting to SD17 (LDP 1) flowing west and the remaining dirty catchments draining to the south to SD9 (LDP 2), SD16 (LDP 24), SB14 (LDP3), SB23B (LDP 26) and SB24B (LDP 27). Certain details of the dirty water management system is provided in Section 3.3 and can be seen in Figure 3. Note that dirty water runoff from a large component of the Northern Emplacement will drain into the mine pits and will be managed as part of the mine water system.

Sediment dams within each of the LDP water management areas are collectively operated to contain runoff from a 5 day 90th percentile rainfall event (38.4mm) in accordance with requirement L2.5 of EPL 12365. Sediment dams are actively managed via water transfer for dust suppression use and controlled release via LDP's to achieve the EPL condition for storage capacity within the sediment dams within 5 days following a rainfall event. All sediment dams at the site are managed in accordance with the Blue Book (Managing Urban Stormwater: Soils and Construction Vol. 1, 4th edition and Vol. 2E Mines and Quarries (Landcom, 2004 and DECC, 2008) – hereafter referred to as the 'Blue Book') as described in Section 3.4.

During large rainfall events, water can exceed the capacity of sediment dams, causing water to spill downstream. In many cases, there is a chain of sediment dams that progressively remove sediment from the water that flows through them. While some sediment dams potentially receive a proportion of runoff from clean catchments, the purpose of these sediment dams is to capture and contain runoff to prevent the contamination of downstream watercourses. It should be noted that six authorised sediment dams are located at the LDPs (SD9, SD16, SD17, SB14, SB23B and SB24B). Water quality in the dams at LDPs (authorised sediment dams) is a significant element in the surface water monitoring program, described in Section 3.5.

All dirty water drainage structures will be designed and constructed in accordance with criteria outlined within the Blue Book.

Due to the nature and scale of the mining operation, not all details required to be contained in an Erosion and Sediment Control Plan (ESCP) under the requirements of the Blue Book can be included on Figure 3. The required details are included on specific ESC Plans developed under the Land Disturbance Protocol.

TCPL are currently working with the NSW EPA to address the key environmental risks from the ROM pad coal contact water (see Section 3.5.8). TCPL has committed to considering and investigating the identified risks and if deemed appropriate explore actions to mitigate these risks in consultation with the EPA. The management of dirty water is further discussed within the site water balance documented in Section 4.

3.2.5 Contaminated Water

The facilities area is the primary area which may produce contaminated water. The specific locations within the facilities area that may produce runoff that contains hydrocarbons includes the:

- workshop; and
- fuel, oil and grease storages.

These areas are managed as follows:

- runoff from these areas drain to an oil/water separator to remove hydrocarbons before draining to SB16A. The oily fraction enters a containment system for pump out and removal from site as necessary; and
- the workshop area has an impermeable surface with bunding that has been designed to direct all flows to the oil/water separator.

3.2.6 Mine Water

The TCM water management system includes 5 mine water dams which capture and contain mine water. Consistent with best practice, the purpose of these mine water dams is to prevent mine water generated at TCM from contaminating downstream watercourses. The mine water pumped into these mine water dams is beneficially reused for operational purposes and is not discharged to downstream watercourses.

The take of mine water by these mine water dams is also exempt from the need for a water access licence under the *WM Act*. The take of this water is exempt due to the combined operation of cl 21(1), cl 12 in Part 1 of Schedule 4, and cl 3 in Schedule 1 of the *WM Regulation*. As such, these dams are exempt under the Harvestable Rights Order and do not capture water in reliance on harvestable rights.

Mine water at TCM contains a mixture of groundwater that seeps into the pit, direct rainfall and runoff from areas immediately surrounding the pits and the ROM Pad. This water is potentially contains elevated TDS concentrations and therefore separated from all other water types. Some mixing of dirty water and mine water is unavoidable due to the topography of the Northern Emplacement. Where this occurs, this water is managed as part of the mine water system.

Mine water runoff is pumped to the mine water dams PW2, PW3, PW4, PW5 and SB4 within the site.

The TCM water management system is designed such that no mine water will be released or discharged from the site. Mine water dams are actively managed via water transfers as well as used for dust suppression activities on haul roads and the ROM pad. A relatively small quantity of water is also used within the crusher. The beneficial reuse of captured mine water for dust suppression purposes minimises TCM's reliance on other sources of water.

Although using mine water for dust suppression can potentially introduce salts to the dirty water catchments, the quantities of salt are low and therefore not considered to be an issue. Runoff from these areas report to sediment dams where the water quality is tested to ensure any discharges meet EPL conditions.

3.2.7 Surface Water Taken Pursuant to Water Access Licences

As set out above, the water captured and contained by TCM's sediment dams and mine water dams does not need require a water access licence issued under the WM Act. This is because these dams fall within the category of the "excluded work" referred to in cl 3 in Schedule 1 of the *WM Regulation*.

However, as a contingency measure and to be consistent with the principles of the BTM Complex Water Management Strategy, the TCM water management system may import surface water taken pursuant to water access licences where considered necessary to meet operational demands, such as for dust suppression purposes.

In 2018, TCPL received 120 ML of external surface water from Maules Creek Coal Pty Limited (via Boggabri Coal Mine) that was extracted from the Namoi River using WAL13050. This water was used to meet operational requirements including dust suppression and coal crushing.

TCPL is investigating alternative water sources for future external water requirements and hence future river water transfers via SB5A are unlikely. Notwithstanding this, if river water is transferred to SB5A using a WAL in the future, SB5A would be converted to a “Turkeys Nest” raw water dam by diverting runoff inflows from SB4 by installing new drains and diversion bunds that bypass SB5A by directing catchment runoff to SD2.

3.2.8 Flooding

The Namoi River valley has experienced a number of significant floods. The largest confirmed flood occurred in February 1955, with significant floods also being recorded in January 1971, February 1984 and November 2000 (NSW Department of Land and Water Conservation, 2003). The maximum water level reached in the Namoi River at Gunnedah (upstream of the TCM) in the 1955 flood was 264.5 m Australian Height Datum (AHD).

The TCM is predominantly on land with elevations greater than 275 m AHD, and therefore would be above any conceivable flooding of the Namoi River. Low lying areas of the TCM site are potentially affected by flooding from Bollol and Goonbri creeks and will be protected by both temporary and permanent flood bunds in the future (refer to Section 7.3.2).

3.2.9 Potable Water

Potable water at the TCM is sourced from the Gunnedah Shire Council potable water system which is transported to the site via water tankers.

3.2.10 Sewage Treatment and Disposal

Effluent from the sewage and ablutions facilities at the mine are managed through the Council-approved septic system which is serviced by a licenced contractor. Pump outs are undertaken by a licensed waste disposal contractor on an as-needed basis.

3.2.11 Emplacement of Materials

Results of geochemical characterisation testing of mine waste rock and site experience confirm that waste rock drainage is likely to be neutral to slightly alkaline Non-Acid Forming (NAF) material and hence presents a relatively low salinity risk. Waste rock materials are however generally sodic and dispersive and therefore present a risk of accelerated erosion if not adequately managed. The proposed emplacement area design involves the creation and rehabilitation of the final batters on the western side of the Northern Emplacement in the early years of the operations. Rehabilitation on the emplacement areas at the TCM can be seen in Figure 3.

The final design of the top of the emplacement area will involve several sub-catchment areas reporting to drop structures located at batter locations which minimise individual fall heights. This drainage strategy will be implemented progressively as the emplacement area is constructed and progressively rehabilitated. It will be documented in future revisions of this WMP once the future MOP has been approved.

A key requirement for completion of the emplacement area will be to ensure that there are no dispersive or erodible materials left exposed at the surface. This will be achieved by selective placement of waste rock so that all sodic material is either buried at least 1 m beneath non-dispersive waste rock or the exposed sodic material is stabilised by gypsum treatment. Prior to capping of the specific final landform emplacement areas, visual inspections and sampling/soil testing (i.e. dispersion testing, soil testing of the Exchangeable Sodium Percentage (ESP), etc.) will be undertaken to identify all dispersive soils.

The results from the TCP-EA (Appendix N) indicate that if any Potentially acid forming (PAF) materials do occur within the strata they are likely to be located immediately above or below the coal seams. If localised zones of PAF material are identified within the final dump surface they will be either excavated and buried within the dump or covered with 15m of NAF material to reduce the risk of developing low pH conditions or acid rock drainage.

PA11_0047 Modification 2 allows TCM to receive and emplace any type of coal reject material. A risk assessment was undertaken as part of the modification process; this included a reject emplacement methodology, water quality monitoring, geochemical and spontaneous combustion test work, sampling and testing of cover material, and representative source sampling of reject materials. Sampling is further described in Section 3.4 and Section 5 of this WMP and the MOP.

3.2.12 Rehabilitation

Rehabilitation Pollution Control

Rehabilitated areas may still contain elevated suspended sediment for a period of time following seeding. It is expected that the water quality of runoff from portions of the emplacement areas, which have been rehabilitated and where sufficient time has elapsed for vegetation to establish, would reflect runoff water quality from similar un-mined areas. Once water quality test results have shown that runoff from rehabilitated areas is a suitable quality, surface water runoff would be released to the environment.

Prior to the stabilisation of rehabilitated areas, runoff would be actively managed via the Erosion and Sediment Control (ESC) system including sediment dams and water conveyance channels (refer to Section 3.4.2 for design criteria).

Reinstatement of Drainage Lines

The final landform will be designed to generally recreate the natural drainage catchments as closely as possible and would be predominantly free draining, although sediment dams would remain in place until a stable landform is achieved.

The re-establishment of any ephemeral drainage lines would be undertaken in accordance with the Rehabilitation Manual for Australian Streams (LWRRDC and CRCCH), the Draft Guidelines for Designing Stable Drainage Lines on Rehabilitated Mine Sites, formulated by the former NSW Department of Land and Water Conservation (1999), as well as the Guidelines for Controlled Activities – In-Stream Works (DWE, 2008) (DWE guidelines).

Where required, additional stabilisation measures such as contour banks, check dams and rock armouring, designed in accordance with the Blue Book Volume 2E, would be utilised to achieve landform stability.

Keys design elements of drainage line establishment works would include the following:

- implementation of effective temporary erosion controls to provide for the short-term stabilisation of the drainage channel;
- design and construction of drainage channels so that they would be stable for the long-term and would minimise the potential for the migration of any erosion;
- use of natural meanders, where possible, instead of straight lines to reflect natural drainage characteristics; and
- where there are high erosive forces (such as high flow velocity or steep grades) the bed of the drainage channels should be rock lined, where required, and constructed in accordance with the Blue Book.

The key performance criteria used to ensure that the reinstated drainage lines are meeting their design objectives is related to their stability. The reinstated drainage lines should be free of both stream and lateral erosion with progressive improvement of the stream / riparian vegetation health observed over time (during regular monitoring of the drainage lines).

3.2.13 Measures for minimizing requirement for trucking of off-site water:

To minimize requirement for trucking off-site water TCM will:

- apply dust binder products for dust suppression of haul roads and operating areas as required. The usage of binder is optional when water available onsite is above 250ML;
- liaise with the BTM Complex mines (and other Whitehaven Coal mines) and discuss opportunities to share water in accordance with the BTM Water Management strategy when water stored onsite is below 250ML;
- Consider construction of a pipeline to transfer extracted water from the Vickery Coal Mine bore to TCM once Modification of PA11_0047 (MOD7) has been approved by DPIE;

If despite all the above measures water available onsite falls below 100ML, TCM will consider to transfer water extracted from the Vickery Coal Mine (VCM) bore via water haulage trucks that will travel on the approved TCM haulage routes in accordance with Modification of PA11_0047 (MOD8) granted on the 15th of June 2020.

3.3 Site Water Management Areas

3.3.1 General

The existing TCM water management system has seven distinct water management areas including six catchment areas reporting to LDPs and the catchment area reporting to the mine pit. These areas largely follow the topography of the site but also consider the disturbance of the catchments. The catchment areas reporting to each LDP and the mine pit are shown in Figure 3 and listed in Table 4 below.

These catchment areas are made up of different types of land type sub-catchments including disturbed/partially rehabilitated, hardstand, clean, rehabilitation, emplacement area, open pit and coal stockpiles. These water management areas are explained in the following sections. Consideration is also paid to the changing requirements within these areas as the approved works progress.

Table 4 Summary of TCM Catchment Areas

Discharge Location	Land Type	Sub-catchment Area (ha)	Total Catchment Area (ha)
SD17 (LDP1)	Rehabilitation	61.1	121
	Emplacement Area	5.3	
	Hardstand and Water Management Areas	4.1	
	Disturbed/Partially Rehabilitated	21.2	
	ROM Pad and Coal Stockpiles	8.2	
	Clean	21.4	
SD9 (LDP2)	Clean	37.3	52
	Emplacement Area	2.7	
	Disturbed/Partially Rehabilitated	10.9	

	Hardstand and Water Management Areas	1.0	
SB14 (LDP3)	Emplacement Area	2.3	30
	Hardstand and Water Management Areas	1.7	
	Disturbed/Partially Rehabilitated	12.1	
	Rehabilitation	14.1	
SD16 (LDP24)	Rehabilitation	26.1	117
	Emplacement Area	57.8	
	Hardstand and Water Management Areas	5.2	
	Disturbed/Partially Rehabilitated	22.0	
	ROM Pad and Coal Stockpiles	5.5	
SB23B (LDP26)	Emplacement Area	18.9	30
	Hardstand and Water Management Areas	0.5	
	Clean	10.9	
SB24B (LDP27)	Emplacement Area	57.6	108
	Hardstand and Water Management Areas	5.4	
	Disturbed/Partially Rehabilitated	18.3	
	Clean	27.2	
Mine Pit	Clean	142.4	408
	Open Pit	76.6	
	Disturbed/Partially Rehabilitated	32.2	
	Emplacement Area	156.0	
	Rehabilitation	1.0	

3.3.2 SD17 (LDP 1) Water Management Area

The SD17 (LDP 1) water management area currently collects runoff from the partly rehabilitated Northern Emplacement, Northern Extension Emplacement, ROM pad and processing area and is located in the north-west corner of ML 1579 and western portion of ML 1685. Runoff from these areas are collected in nine sediment dams that ultimately report to SD17. A mine water dam (SB4) is also located in the SD17 (LDP 1) water management area to collect runoff from the ROM pad and processing area. LDP 1 is located on the SD17 spillway. Overflows from SD17 spill offsite into the BCM water management system (BCM's sediment dam SD6).

Table 3 and Appendix A shows the current catchment areas, surface areas, operational volumes and storage capacities for the ten dams (SD17, SB5A, SD2, SB5B, SD1, SB7, SUMP, SB6 and SB25) currently located in the SD17 (LDP 1) water management area.

Runoff within the SD17 (LDP 1) water management area is currently managed as follows:

- Runoff from the southern face of the Northern Emplacement and surrounding areas is collected in SB5A. Overflows from SB5A spill into SD2, which in turn spills into SB5B, SD1, SB7 and SD17.
- Runoff from the rehabilitation area on the western face of the Northern Emplacement is collected by contour drains and passed down a drop structure to SB7. Overflows from SB7 spill into SD17.

- Runoff from areas to the north of the Northern Emplacement is collected by a drain that flows in a westerly direction along the mine lease boundary to SB25. Overflows from SB25 spill into SB6, which in turn spill into SUMP and SD17.
- While SD2 receives some runoff from a clean catchment, the purpose of this sediment dam is to capture and contain runoff to prevent the contamination of downstream watercourses. SD2 also receives overflow from SB5A and pumped dirty water transfers. Overflows from SD2 spill to SB5B which in turn spills into SD1, SB7 and SD17.
- Runoff from the southern face of BCM's emplacement area immediately adjoining the TCM MLs is collected in SB25.
- Runoff from the ROM pad is collected in SB4. SB4 is managed in accordance with the Mine Water Storage TARP (Table 30) to minimise the risk of overflows. In this way it is considered separate to the SD17 (LDP 1) water management area and is managed as part of the mine water management system. Overflows from SB4 spill into SB5A.

3.3.3 SB23B (LDP 26) Water Management System

The SB23B (LDP 26) water management area currently collects runoff from partially revegetated soil stockpiles and undisturbed area in ML 1579. Runoff from these areas reports to SB23A and SB23B. LDP 26 is located on the SB23B spillway. Overflows from SB23B flow off site in a westerly direction into an existing farm dam and towards Goobri Creek. Table 3 and Appendix A shows the current catchment areas, surface areas, operational volumes and storage capacities for SB23A and SB23B.

3.3.4 SD9 (LDP 2) Water Management Area

The SD9 (LDP 2) water management area currently collects runoff from a cleared area, partially revegetated soil stock pile area and undisturbed area in ML 1579. Runoff from these areas report to SD9. LDP 2 is located on the SD9 spillway. Overflows from SD9 spill across Goonbri Road into ML 1693 before discharging into Goonbri Creek. Table 3 and Appendix A shows the current catchment area, surface area, operational volume and storage capacity for SD9.

The SD9 (LDP 2) water management area will increase in Year 2020 to include the SD16 (LDP24) water management area due to the expansion of the Southern Emplacement. The SD9 capacity will be increased in Year 2020 to cater for the increase in catchment area. A new drain and road culvert will be constructed to direct overflows from SD8 into SD9.

3.3.5 SD16 (LDP 24) Water Management Area

The SD16 (LDP 24) water management area currently collects runoff from the Southern Emplacement, southern portion of the Northern Emplacement, mine workshops, and site administration offices in ML 1579. Runoff from these areas are collected in four sediment

dams that ultimately report to SD16. Overflows from SD16 spill across Goonbri Road into ML 1693 before discharging into Goonbri Creek. A turkey's nest mine water dam (PW3) is also located in the SD16 (LDP 24) water management area. Table 3 and Appendix A shows the current catchment areas, surface areas, operational volumes and storage capacities for the five dams (PW3, SB16A, SB16B, SD8 and SB16) currently located in the SD16 (LDP 24) water management area.

Runoff within the SD16 (LDP 24) water management area is currently managed as follows:

- Runoff from part of the mine workshop, southeastern face of the Northern Emplacement, part of the ROM Pad and adjacent areas is collected in SB16A. Runoff from part of the mine workshop and facilities area is also collected in SB16B. Overflows from SB16A spill into SB16B, which in turn spills into SD8, and SD16.
- PW3 does not collect runoff from an external catchment and is managed in accordance with the Mine Water Storage TARP (Table 30) to minimise the risk of overflows. In this way it is considered separate to the SD16 (LDP 24) water management area and is managed as part of the mine water management system.

SD16 (LDP 24) water management area will be modified in Year 2020 due to the expansion of the Southern Emplacement and will no longer receive runoff from TCM. SD16 will be decommissioned in Year 2020 due to the expansion of the Southern Emplacement. The majority of runoff from the SD16 (LDP 24) water management area will be diverted to SD9 (LDP 2). A small residual area will be diverted to SB14 (LDP 3). This will require a modification to the MOP and EPL.

3.3.6 SB14 (LDP 3) Water Management Area

The SB14 (LDP 3) water management area currently collects runoff from the Southern Emplacement in ML 1579. Runoff from this area reports to SB14. LDP 3 is located on the SB14 spillway. Overflows from SB14 spill across Goonbri Road into ML 1693 before discharging into Goonbri Creek. Table 3 and Appendix A shows the current catchment areas, surface areas, operational volumes and storage capacities for SB14.

SB14 (LDP 3) water management area will be significantly reduced in area in Year 2020 due to the expansion of the Southern Emplacement. SB14 will be converted to a sump that will be formed behind a new access track due to the expansion of the Southern Emplacement. The new SB14 (SUMP) will be dewatered to PW2. This will require a modification to the MOP and EPL.

3.3.7 SB24B (LDP 27) Water Management Area

The SB24B (LDP 27) water management area currently collects runoff from part of the Southern Emplacement, part of the Northern Emplacement and adjacent areas in ML 1579 and ML 1693. Runoff from these areas are collected in four sediment dams that ultimately

report to SB24B. Overflows from SB24B spill to a Goonbri Road culvert crossing before discharging into Goonbri Creek. Two turkey's nest mine water dams (PW2 and PW4) are also located in the SB24B (LDP 27) water management area.

Table 3 and Appendix A shows the current catchment areas, surface areas, operational volumes and storage capacities for the six dams (PW2, PW4 SD18, SB24A, SB26 and SB24B) currently located in the SB24B (LDP 27) water management area.

Runoff within the SB24B (LDP 27) water management area is currently managed as follows:

- Runoff from part of the Southern Emplacement, part of the Northern Emplacement and adjacent areas is collected in SD18. Overflows from SD18 spill into SB24A, which in turn spills into SB26, and SB24B.
- PW2 and PW4 do not collect runoff from external catchments and are managed in accordance with the Mine Water Storage TARP (Table 30) to minimise the risk of overflows. In this way PW2 and PW4 are considered separate to the SB24B (LDP 27) water management area and are managed as part of the mine water management system.

SB24B (LDP 27) water management area will increase in Year 2020 due to the expansion of the Southern Emplacement. A new dam (known as Eastern Dam) will be constructed to cater for the increase in catchment area. A new road culvert and drain will be constructed to direct overflows from the new eastern dam to SB24B. This will require a modification to the MOP and EPL

3.3.8 Upslope Clean Water Management Area

A significant proportion of the upslope clean management area located to the east of the mine pit highwall will be mined out as part of approved future mining operations: compare Figure 3 against Figure 5.

As approved mining operations progress, the feasibility of new, appropriate clean water diversions in this area will be considered.

3.3.9 Mine Water Management Area

This area consists of the mine pit and areas that drain directly to it as well as the ROM Pad and processing area. No flow leaves the mine pit naturally with pumps moving water to the mine water dams PW2, PW3, PW4, PW5 and SB4. Surface water that enters these areas and is considered mine water. PW2, PW3, PW4 and PW5 do not collect runoff from external catchments. SB4 collects surface runoff from part of the ROM Pad and processing area.

Table 3 and Appendix A shows the current catchment areas, surface areas, operational volumes and storage capacities for the five dams (PW2, PW3, PW4, PW5 and SD4) as well as the mine pit area currently located in the mine water management area.

Mine water dams are managed in accordance with the Mine Water Storage TARP (Table 30) to minimise the risk of overflows to other water management areas.

3.3.10 Future Mining Areas

Future mining areas will progress to the east of the ridge that separates on site flows from those that reach Goonbri Creek. Once the mine has progressed beyond this ridge, clean water catchment areas will naturally drain off site towards Goonbri Creek. The following infrastructure are planned as part of future operations:

- dirty water infrastructure will be constructed to capture water from active waste emplacement areas to prevent uncontrolled discharge; and
- mine water infrastructure will be constructed to manage mine pit water and allow mining access to the coal seam.

Mining in this area is not anticipated to occur within the time frame of the current MOP (to November 2020). Details on future infrastructure including catchment areas, dam sizing and diversion works will be addressed in future updates of this WMP and MOP. Further details on key planned water management infrastructure is provided in Section 7.

3.4 Erosion and Sediment Controls

3.4.1 Monitoring Activities

Erosion or sedimentation may potentially result from any of the following:

- surface runoff from areas disturbed as a result of vegetation or topsoil removal;
- surface runoff from topsoil or subsoil stockpiles prior to establishment of an adequate vegetative cover;
- surface runoff from rehabilitation areas prior to the establishment of a suitable ground cover;
- vehicle and equipment movements;
- construction of water management structures (i.e. dams, diversion drains);
- construction/maintenance of access roads;
- runoff from hardstand areas including roads and the main office area;
- excessive surface water runoff velocity within drainage lines and on disturbed surfaces; and
- surface runoff from ROM and product coal stockpile areas.

3.4.2 On-going Erosion and Sediment Management Practices

The following practices will be implemented to minimise potential for erosion and sedimentation:

- installation of all ESC and water management structures prior to any ground disturbance taking place;
- land disturbance will be minimised by clearing the smallest practical area ahead of disturbance activities;
- where practical, disturbance areas will be shaped so as to provide a free draining surface to direct dirty water runoff into the dirty water management system;
- ESC measures (including sediment dams, conveyance channels, temporary ESC structures, etc.) will be designed and managed (refer to Section 3.4.4) in accordance with the Blue Book. Sediment dams will be specifically sized to contain runoff from a 5 day, 90th percentile rainfall event (38.4mm) in accordance with the requirements documented in EPL 12365. The design criteria for water conveyance channels will be obtained from Table 6.1 of the Blue Book (Vol 2E);
- the erosion and sediment control structures will be inspected periodically or after a rainfall event of >50 mm in a 24-hour period;
- as part of the surface water monitoring program, water flowing from all LDPs will be sampled for suspended sediment;
- if a high risk of site discharge is identified, excess surface water will be pumped into the mine water dams. This would rely on the availability of storage capacity within the mine water dams and all water moved to them would be treated as mine water;
- if discharged water exceeds the LDP TSS limit 50 mg/L then the actions listed in the Surface Water Response Plan documented within Section 6.4 shall be followed;
- all discharge from flumes will flow to sediment basins; and
- if, following heavy rain, significant erosion is identified on the rehabilitated landform, it will be remediated using one or a combination of the following, or similar:
    - filling the erosion channels;
    - cross-ripping (along the contour) to assist infiltration; and/or
    - installation of additional controls, e.g. banks sown with a cover crop; and
- where necessary, temporary ESC measures will be utilised to prevent and/or reduce the potential for adverse erosion developing. Temporary ESC structures

will be constructed and managed in accordance with the principles outlined in the Blue Book.

3.4.3 Site Rehabilitation Management

Active mine processes require ground to be disturbed and re-disturbed on a regular basis. The total area of disturbed ground will be kept to a minimum, as far as practicable, with a programme of rehabilitation. Temporary groundcover is provided for areas where rehabilitation is temporary and final landform is not yet achieved.

Once rehabilitated areas achieve required surface runoff quality specified in the MOP any operational sediment control structures will either be removed or left as passive water storages.

3.4.4 Water Management and ESC Maintenance

Water management and ESC measures are maintained in a functioning condition until areas have been deemed rehabilitated (refer to Section 3.4.3). Where controls are observed not to be functioning correctly, they are reinstated/repaired to the required standard. Where significant erosion occurs on a regular basis, additional controls may be constructed.

Dams

Dams are to be regularly maintained as follows:

- dirty water dams shall be dewatered (Settling Zone) within 5 days of a rainfall event (as per the Blue Book) via:
  - re-use on site for dust suppression/watering vegetation; and/or
  - transferring water to larger storages; and/or
  - controlled discharge off-site if the water quality is sufficient to do so (refer to Section 3.6); and
- de-silting the sediment dams if the sediment has built up to the operating volume (refer to Section 3.2.2 and Appendix A).

Water level signage/gauge boards located within each of the authorised discharge dams (those required to contain runoff from a 5 day, 90th percentile rainfall event (38.4mm) will be used to assist in dam maintenance and operation by clearly displaying the Operating Volume so that it is clear to site personnel when the dams need to be dewatered/desilted.

Conveyance Channels

Conveyance channels will be inspected for signs of erosion along their length and any remedial works undertaken as required. Where significant erosion is observed, additional erosion controls may be constructed e.g. establishment of vegetation cover, use of temporary sediment devices until the vegetation is established, scour protection (rock-armouring or erosion blanket) of the channel surface.

Temporary ESC Structures

Regular visual inspections are made of any temporary erosion and sediment controls such as sediment filter fences, sandbag weirs, etc. to confirm that they are functioning adequately and repaired where required.

Access Roads

The access roads are inspected following large storm events, to determine maintenance requirements. Periodic maintenance will include checking the drainage systems to remove any debris that may block culverts, cross drain outlets and table drains.

3.5 Surface Water Monitoring Plan

3.5.1 General

TCPL has a comprehensive surface water monitoring program in place across the mine site that incorporates:

- the collection of rainfall and meteorological data;
- the collection of water quality data in the onsite dams and surrounding creeks; and
- the collection of water quality and quantity data during any discharge events via any of the LDPs at the TCM.

The objective of the surface water monitoring program is to provide details of the monitoring undertaken on site to monitor the effects of the TCM on existing surface water bodies. The purpose of this monitoring is to assist in detecting if any significant off-site impacts occur as a result of mining and to trigger response plans to adverse impacts.

Note that the following surface water monitoring program has been developed so that it is consistent with the cumulative impact monitoring objectives of the BTM Complex WMS and so that it contributes, where necessary, to the BTM Complex cumulative impact monitoring network.

3.5.2 Monitoring Locations

Figure 7 shows the water quality sampling locations associated with the TCM. The water quality monitoring program has been designed to provide data on the flows leaving site as well as the flows in the receiving creeks.

As mining progresses there may be a need to review the current monitoring network to address potential future impacts to Goonbri Creek. At this time the surface water monitoring program will be updated in consultation with DoI Water and documented within future revisions of this WMP. The system will also be expanded to cover all new water storages that are constructed.

3.5.3 Historical Baseline Water Quality

Baseline data for the TCM including surface water and groundwater quality monitoring, water discharge and level records are reported in the Environmental Assessment, Annual Review and Annual Return. The Environmental Performance at TCM, which is reported in the Annual Review and Annual Return, is compared against historical baseline data and commitments of the Environmental Assessment.

3.5.4 Water Quality Monitoring Schedule

The Water Quality Monitoring Schedule outlined in Table 5 defines the parameters to be sampled and the recommended sampling frequency at each sampling location. The Monitoring Schedule for TCM has been reconciled with the monitoring requirements documented within the BTM Complex WMS. The water quality monitoring program provides for the assessment of background data for flow events in the various creeks as well as regular grab samples from targeted mine water storages on-site. The samples should be collected in a manner consistent with the Approved Method for Sampling and Analysis of Water Pollutants in NSW (OEH, 2004) which includes the following requirements:

- the event-based sampling should enable quantification of any pollutant loads from the mine site and their corresponding impact on the local creek water quality; and
- on-site regular sampling from the water storages allows for any potential problem areas with respect to pollutant generation on-site to be identified in advance ensuring appropriate remedial action can be taken.

Monitoring is conducted in accordance with the relevant Australian Standards.

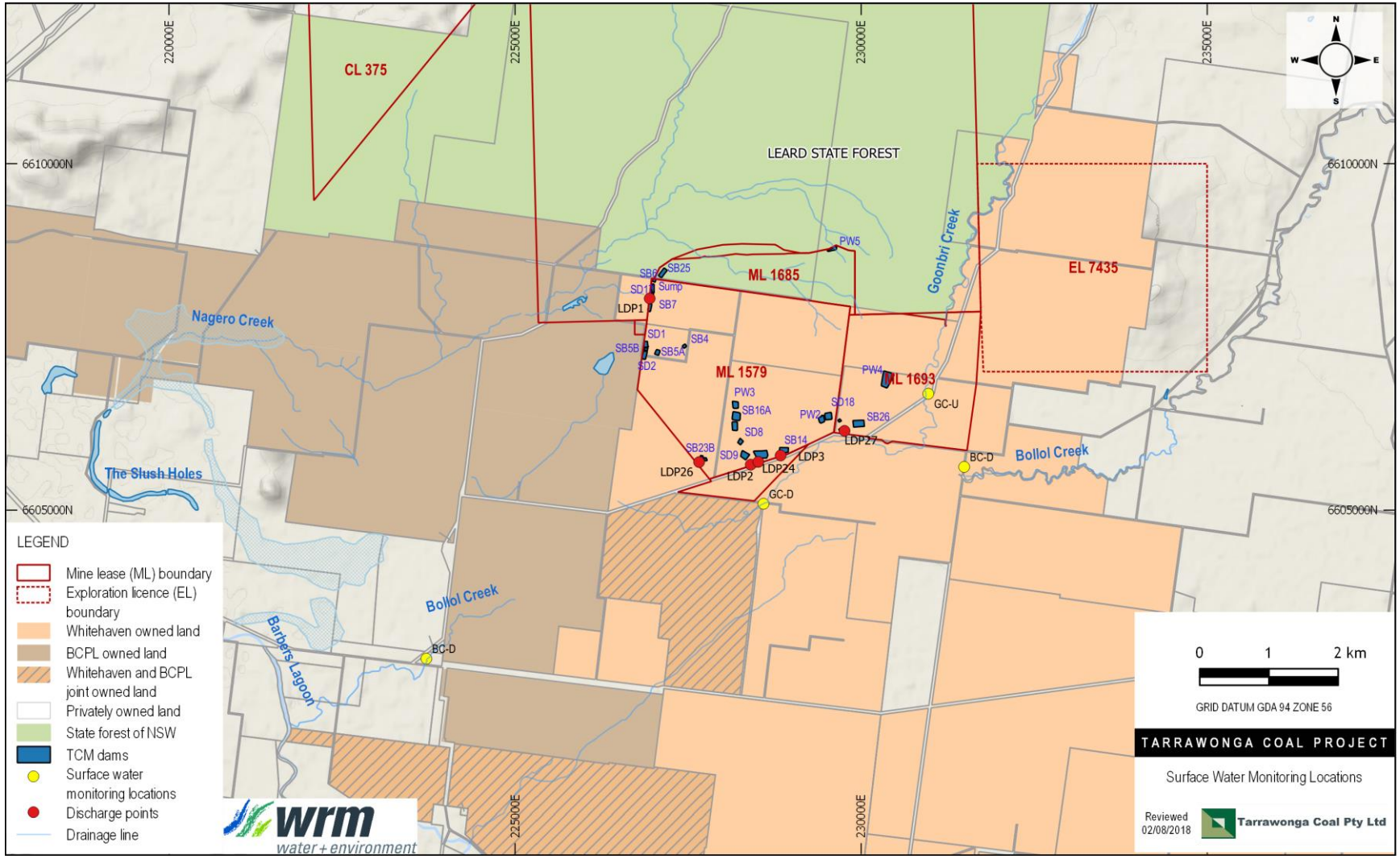

Figure 7 Tarrawonga Coal Mine Surface Water Monitoring Locations

Table 5 TCM Water Quality Monitoring Schedule

Location	Parameters	Frequency
Site (Meteorological Monitoring)	Rainfall Wind speed and direction Temperature (2m & 10m) Relative Humidity Solar Radiation	Rainfall – every hour All others – every 15 minutes
LDP's, mine pit	Water level EC Oil and grease pH TSS Total phosphorous Total Nitrogen Sulphate (SO_4) Total Alkalinity Total Acidity Aluminium Arsenic Cadmium Chromium (Cr VI) Iron Molybdenum Selenium (total) Zinc	Quarterly and following significant rainfall events (water level only) Quarterly (water quality); mine pit, – EC, pH, TSS, Oil and Grease only. As soon as practical following site discharge, but not longer than 12 hours after discharge commences (for LDPs only).
Surrounding Creeks (GC-U, GC-D, BC-U and BC-D)[a]	EC Oil and grease pH TSS Total phosphorous Sulphate (SO4) Total Nitrogen Aluminium Arsenic Cadmium Chromium (Cr VI) Iron Molybdenum Selenium (total) Zinc	Quarterly for GC-U and GC-D but only if the creek is flowing For BC-U and BC-D, as soon as practical following site discharge, but not longer than 12 hours after discharge commences.

[a] NC-U and NC-D on Nagero Creek are monitored by BCM and shared with TCM.

3.5.5 Stream / Riparian Vegetation Health Monitoring

A program to monitor creek line channel stability and health of riparian vegetation within downstream watercourses and reinstated drainage lines will be undertaken throughout the mine life. The monitoring of these conveyance structures and water courses will be undertaken to ensure that their stability is not impacted on by the Project.

Monitoring of the drainage lines is to include:

- a channel stability assessment encompassing:

- documenting general observations of water quantity and quality;
- documenting locations and dimensions of significant erosive or depositional features so that any subsequent changes can be evaluated quantitatively;
- establishing multiple photographic points at representative locations, so that photos can be taken over multiple inspections in a repeatable manner; and
- written descriptions of the stream at each of the photographic points, focussing on evidence of erosion and exposed soils;

- an AUSRIVAS assessment encompassing:
- habitat assessments;
- water quality monitoring; and
- aquatic flora and fauna surveys.

Results of successive monitoring data will be reviewed and compared to previous rounds of baseline monitoring to assess whether there is any degradation of the riparian vegetation or stream channel. Where degradation or adverse erosion is occurring, additional investigations will be undertaken to assess whether the impacts may be associated with the operation of the TCM and ameliorative actions undertaken if association is identified and as required.

3.5.6 Monitoring and Assessment of Existing Water Management System

Ongoing regular monitoring of the existing water management system is undertaken to ensure that the system is working effectively to meet the TCM water management objectives. This monitoring includes the following:

- visual inspections of water management structures (i.e. dams; conveyance structures and ESC measures) annually and after significant rainfall (>50 mm in a 24-hour period);
- review of the water quality monitoring program in Section 3.5.4 as required;
- review of the number of site discharges as part of the Annual Review; and
- assessment of past water takes under the existing groundwater licenses as part of the Annual Review.

Where issues are identified they will be investigated and rectified in accordance with the Surface Water and Groundwater Response Plan detailed in Section 6.

3.5.7 Monitoring, Surveys and Assessments for Future Goonbri Creek Re-Alignment

The TCM Life of Mine Plan is currently being updated and will no longer require the Goonbri Creek Re-alignment. Notwithstanding this, the Goonbri Creek Re-Alignment is included in the current PA11_0047 and has therefore been considered until the PA11_0047 and MOP

is updated to reflect this change. The monitoring requirements that would be undertaken if the future Goonbri Creek Re-alignment went ahead is discussed below.

Monitoring, survey and assessments of the existing creek will be undertaken by TCPL on a bi-annual basis to ensure that appropriate baseline characterisation of the creek can be established to inform future design work. The baseline monitoring, survey and assessments relating to the Goonbri Creek Re-alignment as recommended in Section 6.5 of the Surface Water Assessment (SWA) contained within Appendix B of the TCP-EA are:

1. Detailed cross sectional and longitudinal survey should be conducted along Goonbri Creek from upstream of the realignment section to the existing TCM to Gunnedah haul road crossing. This should be supplemented with a Lidar survey to define the existing floodplain areas associated with Goonbri Creek and the Bollol Creek confluence and downstream to Barbers Lagoon and the Slush Holes.
2. A numerical hydraulic model should be developed to simulate the existing hydraulic characteristics of Goonbri Creek along the surveyed route and down to the Bollol Creek confluence. The hydraulic characteristics of the area from the Bollol Creek confluence downstream to Barbers Lagoon and the Slush Holes should also be modelled using a 2-dimensional model. This modelling would utilize the topographical survey data generated by the survey recommended in 1 above and the observations captured by the flow and water level monitoring recommended in 3 below.
3. Results of modelling should be used to provide more concise baseline characterisation of the existing geomorphologic and hydraulic characteristics of Goonbri and lower Bollol Creeks as a basis for final design of the permanent Goonbri Creek alignment.
4. Condition surveys of Goonbri Creek should be undertaken periodically during/following a range of climatic conditions (i.e. following prolonged dry periods and significant flood events) to document creek condition for a range of baseline/pre-mine conditions of the watercourse.
5. Flow monitoring on Goonbri Creek should be established upstream and downstream of the proposed re-alignment (Figure 38 from the SWA provides some recommended locations) to: (a) support the development of catchment models during the detailed design phase to confirm or adjust the design flows in this report; and (b) assist in management and performance evaluation monitoring during and post construction. Water level monitoring to determine the distribution of flows in the lower reaches of Bollol Creek and the alluvial flats should also be conducted to support detailed hydraulic modelling (Figure 38 from the SWA provides some recommended locations). Verification of the monitoring locations recommended within the SWA will be undertaken by TCPL.
6. The hydraulic model(s) developed in 2 above should be re-calibrated against water level monitoring data on Goonbri Creek (collected after completion of the initial modelling) and used to test and refine the design of the permanent Goonbri Creek alignment to meet its design objectives and criteria.

7. Control or reference sites and reaches for a channel stability monitoring program should be identified and baseline topographical and geomorphic condition surveys conducted. Bollol Creek and Goonbri Creek upstream of the permanent alignment should be used to locate suitable (representative) reference reaches. The reaches should have similar characteristics to Goonbri Creek over the section being realigned and/or similar to the reach types envisaged in the permanent Goonbri Creek alignment design. Historical changes in these reaches should be assessed using historical data including aerial photography. Condition surveys should also be conducted following significant flow events to assess background responses to flow events.

The SWA also makes a number of additional recommendations (points 8-14) regarding works associated with the Goonbri Creek Re-Alignment. These recommendations are not required immediately and will therefore be included in future revisions of the WMP following approval of the future MOP.

3.5.8 Coal Contact Water Study

The proposed plan for the coal contact surface water quality assessment has been provided to the EPA and Whitehaven Coal await feedback.

3.6 Surface Water Impact Assessment Criteria and Trigger Values

Surface water trigger value criteria have been adopted for:

- surface water quality discharged from the TCM;
- surface water quantity discharged from the TCM; and
- surface water quality downstream of the TCM.

3.6.1 Water Quality Discharged from TCM

Impact assessment criterion for surface water is only relevant to water actually discharged from the TCM. Surface water quality limits from EPL 12365 are shown in Table 6.

Table 6 Surface Water Quality Discharge Limits

Pollutant	Units of Measure	100 percentile concentration limit
Oil and Grease	mg/L	10
pH	pH	6.5-8.5
Total Suspended Solids (TSS)	mg/L	50

3.6.2 Water Quantity Discharged from TCM

To ensure consistency and achieve the surface water quantity objectives outlined in the BTM Complex WMS, the following triggers have been adopted for TCM:

- complaints regarding impacts on stock and domestic local surface water catchments; and

- complaints regarding perceived unacceptable flooding of downstream properties in local catchments.

Exceedance of the trigger values will initiate activation of the Response Plan as outlined in Section 6.

3.6.3 Water Quality Downstream of TCM

Proposed trigger levels for surface water quality downstream of TCM are based on the ANZECC (2000) guidelines and available monitoring data for the TCM. This section sets a broad range of trigger levels for all ephemeral creeks in the area based on ANZECC default values and from the broader precinct monitoring data that is available.

Table 7 shows a preliminary assessment of trigger values that will be used for assessing the surface water impacts from the TCM. These trigger values are consistent with those developed for achieving cumulative impact management objectives in the BTM Complex WMS. The adopted trigger values will be refined using locally derived values where appropriate based on sampling that has been undertaken in accordance with the monitoring programme documented within this WMP.

Exceedance of the trigger values at downstream sites with less than trigger values at upstream sites, will initiate activation of the Response Plan as outlined in Section 6.

Table 7 TCM Ambient Surface Water Quality Trigger Levels

Parameter	ANZECC[a,b]	Historical upstream[c]	Trigger
Total Phosphorus (µg/L)	20	110-360	110-360
Total Nitrogen (µg/L)	250	500-3000	500-3000
EC (µS/cm)	30-350	33-275	30-350
pH	6.6-8.0	5.9-7.8	5.9-8.0
Total suspended solids (mg/L)	NA	32-220[d]	32-220
Aluminium (µg/L)	150	2160	2160
Arsenic (µg/L)	360	NA	360
Cadmium (µg/L)	0.8	NA	0.8
Chromium (Cr VI) (µg/L)	40	NA	40
Iron (µg/L)	NA	1680	1680
Molybdenum (µg/L)	NA	NA	NA
Selenium (total) (µg/L)	34	<10	<10
Sulphate (µg/L)	NA	NA	NA
Zinc (µg/L)	31	NA	31

[a] Most sensitive EV is aquatic ecosystems.
[b] Trigger values for freshwater at a level of 80% of protection of species.
[c] Based on the envelope of BTM Complex available ambient monitoring data.
[d] TSS range does not include data from TCM available ambient monitoring data (1983/84), as it is significantly higher than levels recorded by BCM in 2008/09 and are at present considered to be outliers. Concentration levels to be reviewed once further ambient monitoring data becomes available.

4 SITE WATER BALANCE

4.1 Overview

A detailed site water balance assessment over the full project life was undertaken as part of the surface water impact assessment (RS, 2012). The initial water balance assessment used the Goldsim software to simulate and assess the performance of the site water management system under varying climatic sequences, catchment conditions and operational stages. The model simulated the operations of all major components of the water management system on a daily time step.

A revised water balance model has been developed using the OPSIM software to predict the likely performance of the site water management system. The site water management system has been assessed using the water balance model for the next 3 years of operations, consistent with the current MOP (Year 2018 to Year 2020) as well as an additional 2 years based on the Year 2022 mine plan. The OPSIM water balance model has been developed to simulate the behaviour of the site water management infrastructure and has been validated by comparison to recorded site data during the Year 2017 operations. The simulated inflows and outflows included in the OPSIM model are given in Table 8.

Table 8 Simulated Inflows and Outflows to Water Management System

Inflows	Outflows
Direct rainfall on water surface of storages	Evaporation from water surface of storages
Catchment runoff	Dust suppression demand
Groundwater inflows	ROM coal crusher demand
External water supply	Coal moisture export loss
	Seepage from storages
	Controlled releases from storages
	Offsite spills from storages

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

- mine storage inventory;
- water requirements from external sources;
- uncontrolled spills from the mine water and dirty water storages; and
- the overall water balance within the water management system.

Details of the water management system infrastructure and configuration are provided in Section 3.3. Details of the model configuration, modelling methodology and data inputs are provided in the water balance report (WRM, 2018).

Figure 6 shows the conceptualisation of the mine water management system adopted for the water balance model.

4.2 Water Balance Objectives

The principal objectives of the site water balance are associated with water security and the acceptable discharge of water offsite, where required. The specific objectives of the site water balance include the following:

- no water is required to be sourced from external sources during a median rainfall year;
- all mine water is to be contained on-site as much as practicable; and
- the number of offsite discharges occurring during an average rainfall year should be no greater than what is predicted for dams designed in accordance with the Blue Book.

4.3 Model Representation, Accuracy and Assumptions

Investigation outcomes are dependent on the accuracy of input assumptions. There is inherent uncertainty with respect to some key site characteristics (e.g. catchment yield/rainfall runoff, mining area groundwater inflows). These assumptions will be checked and refined against on-site observations as data becomes available.

The TCM water model for the forecast period (Year 2018 to Year 2022) was modelled in OPSIM as shown in the water schematic diagram presented in Figure 6. The following assumptions/simplifications were incorporated in the model:

- the model was run on a daily time step based on 130 years of Patch Point rainfall and Data Drill evaporation data for the BoM's Boggabri Post Office station (55007) obtained from the SILO service;
- modelled operating rules were based on advice from TCPL. In reality, external influences may result in changes to the operating rules;
- all water storages were modelled individually in the forecast (Year 2018 to Year 2022) assessment;
- runoff from catchments was represented by the Australian Water Balance Model (AWBM) methodology, as described in Section 4.4.2;
- potable water and wastewater was not included in the site water balance;
- it was assumed that 10% of sediment dam capacity and 5% of mine water dam capacity is "dead storage" and or filled with sediment and therefore not available; and
- the Total Storage Volume, initial water volumes, operating volumes and surface areas of the TCM dams were based on information provided by TCPL.

4.4 Water Sources (Inputs)

4.4.1 Rainfall

Three BoM meteorological stations with long-term (greater than 100 years) daily rainfall records are located within the vicinity of TCM including:

- Boggabri Post office (station number 55007), which is located approximately 13.2 km to the southwest of TCM;
- Boggabri (Retreat) (station number 55044), which is located approximately 13.5 km to the southeast of TCM; and
- Turrawan (Wallah) (station number 55058)), which is located approximately 29.5 km to the northwest of TCM.

Table 9 shows the average monthly rainfall statistics at the above stations.

Table 9 Summary of Average Regional Monthly and Annual Rainfall and Rain Days

Month	Boggabri Post Office (55007) 1884 - 2018		Boggabri (Retreat) (55044) 1889-2018		Turrawan (Wallah) (55058) 1910-2015	
	Rainfall (mm)	Rain days	Rainfall (mm)	Rain days	Rainfall (mm)	Rain days
January	71.5	5.5	72.0	5.2	81.4	5.5
February	63.1	4.8	61.2	4.6	60.7	4.4
March	45.3	4.1	42.6	3.8	45.3	3.7
April	33.3	3.5	34.8	3.1	33.6	2.9
May	41.3	4.2	38.0	3.7	40.6	3.5
June	43.8	5.3	44.1	4.8	42.2	4.5
July	41.0	5.3	42.1	4.9	40.1	4.5
August	38.1	4.9	37.2	4.4	36.2	4.2
September	37.7	4.6	40.0	4.5	36.7	3.8
October	50.7	5.4	50.0	5.1	50.5	4.7
November	59.7	5.5	59.1	5.4	60.7	5.2
December	63.1	5.7	61.2	5.2	62.5	5.3
Annual	**588.6**	**58.7**	**582.4**	**54.6**	**590.6**	**52.2**

It can be seen from Table 9 that the average annual rainfall from the three nearby stations are similar with the annual rainfall ranging from 582.4 to 590.6 mm/year. Rainfall data from the Boggabri Post Office station was adopted for the site water balance assessment due to its proximity to the TCM as well as length and completeness of the data.

Three years (1935, 2011 and 1984) were chosen to represent the 10th (dry year), 50th (median year) and 90th percentiles (wet year) respectively. These values are summarised in Table 10.

Table 10 Comparison of Total Annual Precipitation

Representative annual rainfall	Statistical Percentile Precipitation (mm)	Actual Precipitation (mm)	Difference (mm)
Dry Year (10th percentile, 1935)	393.8	394.3	-0.5
Median Year (50th percentile, 2011)	584.7	584.7	0.0
Wet Year (90th percentile, 1984)	795.8	798.6	2.8

It can be seen from Table 10 that the differences between the statistical and actual precipitation for the selected dry, median and wet years are minimal (less than 0.5%) and as such these years are considered to be appropriate for use within the OPSIM model.

In addition to the dry, median and wet rainfall years, the model was run for 126 climatic realisations developed using the 130 years of rainfall and evaporation data over the 5-year forecast period (Year 2018 to Year 2022) to assess the potential medium-term performance in the water management system.

4.4.2 Water Generated from Runoff

The Australian Water Balance Model (AWBM) (Boughton, 2004) was used to simulate runoff from rainfall on the various catchments and landforms across TCM. The AWBM is a nationally-recognised catchment water balance model that can relate runoff to rainfall with daily data, and calculates losses from rainfall for flood hydrograph modelling. Modelling of the following six different TCM sub-catchment types was undertaken (as shown in Figure 3):

- natural surface/undisturbed;
- active waste rock emplacements;
- partially rehabilitated areas;
- rehabilitated areas;
- hardstand; and
- open pit.

AWBM runoff parameters were determined from a review of literature based guideline values and validation of the water balance model to recorded water data from Year 2017 (see Section 4.7). The parameters used are shown in Table 11 below.

Table 11 Water Balance AWBM Parameters

Parameter	Natural (Undisturbed)	Active	Partially Rehabilitated	Rehabilitated	Hardstand	Open Pit
C1 (mm)	13	7	10	13	2	2
C2 (mm)	127	70	65	85	0	20
C3 (mm)	255	0	65	85	0	0
A1	0.13	0.3	0.15	0.13	1	0.1
A2	0.43	0.7	0.60	0.43	0	0.9
A3	0.44	0	0.25	0.44	0	0
BFI	0.23	0.8	0.1	0.1	0.0	0.1
Kbase	0.98	0.98	0.95	0.95	0.96	0.9
Ksurf	0.5	0.5	0.2	0.2	0.1	0.2

4.4.3 Groundwater Inflow

Table 12 shows the predicted annual groundwater inflow rate to the mine pit modelled by Heritage Computing (2012). The predicted annual groundwater inflow rate ranges from 168 ML/yr (0.46 ML/d) to 252 ML/yr (0.69 ML/d) between Year 2018 and Year 2022.

Table 12 Predicted groundwater inflows into the mine pit

Project year	Annual Pit inflow (ML/yr)	Daily Pit inflow (ML/day)
2018	183	0.50
2019	168	0.46
2020	220	0.60
2021	252	0.69
2022	252	0.69

4.4.4 Water Obtained from External Sources

TCM has a licence to access 300 ML of groundwater over the course of any given year should it be required for operational use on-site, which comprises the two groundwater extraction licenses detailed in Table 22. Sourcing external water is only required if on-site mine water and dirty water sources are depleted. It has been assumed within the OPSIM model that external water is transferred to the TCM water management system at a rate of 5 ML/d. In 2018, TCPL also obtained 120 ML of external surface water from the Namoi River (WAL 13050 owned by Maules Creek Coal Pty Limited) to meet operational water requirements.

4.5 Water Losses and Usage (Outputs)

4.5.1 Evaporation

Evaporation records are available from the Keepit Dam (station number 55276) and Gunnedah Resource Centre (station number 55024) meteorological stations, which have recorded average annual evaporation of approximately 1,825 mm and 1,853 mm, respectively. The average monthly pan evaporation rates from these meteorological stations can be seen in Table 13 below.

Table 13 Summary of Average Regional Class 'A' Pan Evaporation (mm)

Month	Keepit Dam (55276) 1972-2006	Gunnedah Resource Centre (55024) 1971 - 2010	SILO Data Drill data for Boggabri Post Office 1889 – 2018
January	255.7	248.4	264.3
February	204.5	202.1	213.2
March	182.1	196.4	201.2
April	124.1	138.2	138.3
May	80.6	90.4	87.9
June	56.1	61.7	61.5
July	63.9	64.8	66.6
August	89.2	91.8	93.9
September	129.3	127.4	132.2
October	172.7	174.9	184.5
November	207.7	206.1	223.4
December	259.4	250.5	265.1
Annual	**1825.3**	**1852.7**	**1932.1**

For the purpose of the water balance, SILO Patch Point daily evaporation data for Boggabri Post Office was used. The SILO Patch Point average annual pan evaporation is approximately 1,935 mm, which is similar to the Keepit Dam and Gunnedah Resource Centre averages (see Table 13).

Figure 8 shows the variation of mean monthly pan evaporation, Moreton's Lake evaporation and evapotranspiration (actual and wet) at the Boggabri Post Office using SILO Data Drill data. Annual average pan evaporation rates are approximately 3.3 times the average annual rainfall. The evaporation rate is high throughout the year, with highest evaporation rates occurring in the months between October and March. Morton's Lake evaporation has been used to estimate evaporation loss from storages, which is on average 82% of pan evaporation in the vicinity of the project.

Soil moisture evapotranspiration losses in the AWBM model was estimated using Morton's Wet evapotranspiration, which is on average 96% of Morton's Lake evaporation in the vicinity of the project.

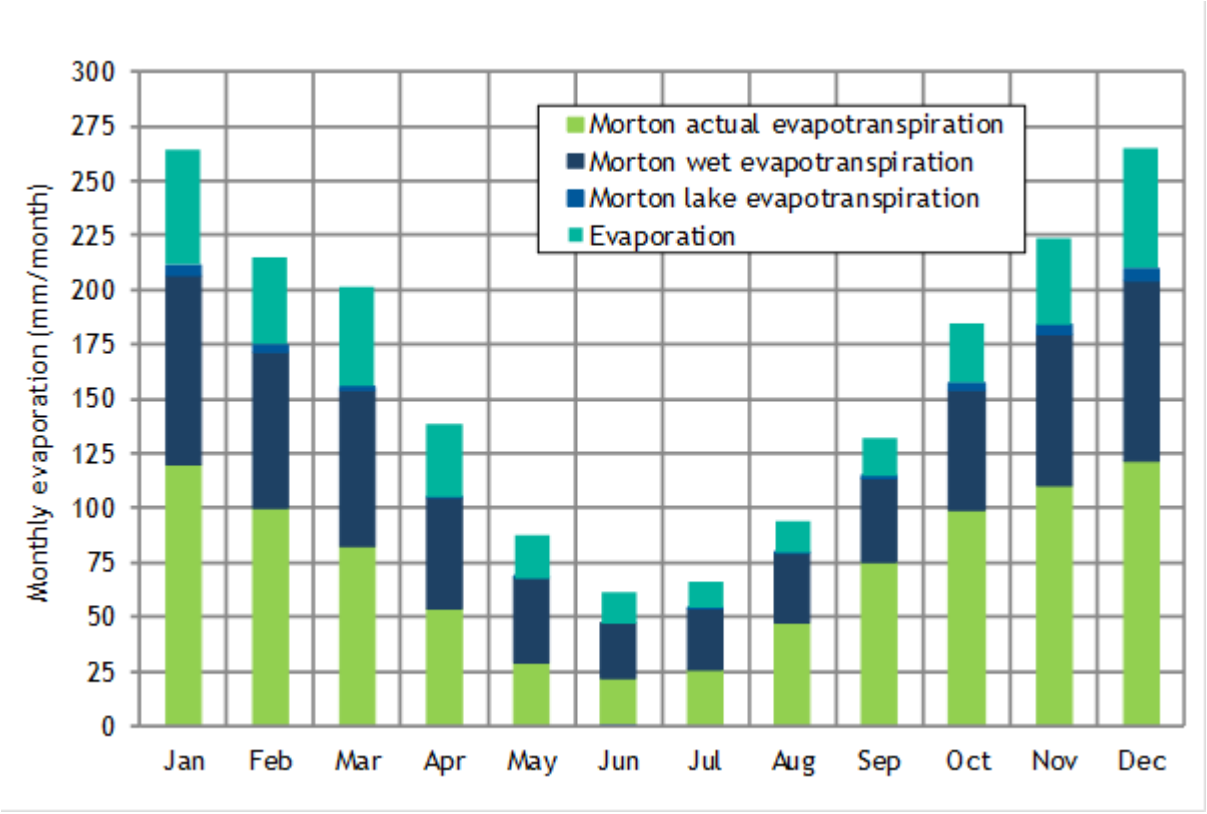

Figure 8 **Mean monthly evaporation and evapotranspiration at Boggabri Post Office based on 130 years of SILO Data Drill evaporation data**

4.5.2 Leakage from SD1 and SD2

Anecdotal evidence suggests that leakage occurs from SD1 and SD2. Based on discussions with TCPL personnel SD1 and SD2 was assumed to lose a combined 0.1 ML/day and modelled accordingly within OPSIM.

4.5.3 Loss of Water Through Coal Export

The final coal product can absorb water from a number of sources, such as; the pit floor, dust suppression of stockpiles and through the ROM handling process. The typical moisture content of ROM coal from TCM for processing is around 7%. For the purpose of the water balance it is assumed that 5% is lost from the pit floor sources (e.g., groundwater) and 2% is entrained from water used at the ROM Pad (through dust suppression and coal crushing processes).

This equates to a loss of water from TCM of up to 0.575 ML/d (or 210.0 ML/year) based on the maximum coal production rate of 3 Mtpa (in accordance with the PA 11_0047 MOD 1).

4.5.4 Operational Water Demands

Dust Suppression

The majority of water use on site would be for dust suppression activities undertaken along haul roads and on the ROM Pad. Water cart volumes recorded in Year 2017 was 656 ML. This volume includes both haul road and ROM Pad dust suppression. Water for dust suppression is directly sourced from the PW2 and PW5 storages.

Haul road dust suppression rates for Year 2018 onwards were estimated using daily rainfall and evaporation data for the Boggabri Post Office from the SILO service and the haul road length. The haul road length for 2018 was measured from the provided aerial photographs and is approximately 16.2 km. This is expected to remain the same through to Year 2022.

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

- for a dry day (zero rainfall), the haul road watering rate is equal to the daily evaporation rate;
- 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; and
- it was assumed that 27.5 metres of the haul road width would be watered.

Figure 9 shows the monthly percentage of haul road dust suppression in comparison to recorded water cart volumes for 2015, 2016 and 2017. This figure shows that the average estimated rate is a good approximation of the recorded date on a monthly scale. The average monthly usage rates for Year 2017 (measured) and predicted rates for Year 2018 to Year 2022 are summarised in Table 14.

In 2018, TCM started using a commercial binder to reduce the haul road dust suppression requirements. The supplier of the binder (Dust-A-Side Australia Pty Ltd) has advised that the use of the binder could reduce haul road dust suppression requirements by up to 50%. This reduction is not reflected in Table 14.

Table 14 Estimated haul road dust suppression usage

Haul road length (km)	Haul road dust suppression water usage (ML)	
Month	**Year 2017 (measured)**	**Year 2018 onwards (calculated average)**
January	73	91
February	93	76
March	50	69
April	42	47
May	40	30
June	23	20
July	32	23
August	50	35
September	66	50
October	59	68
November	60	79
December	70	89
Annual	**656**	**677**

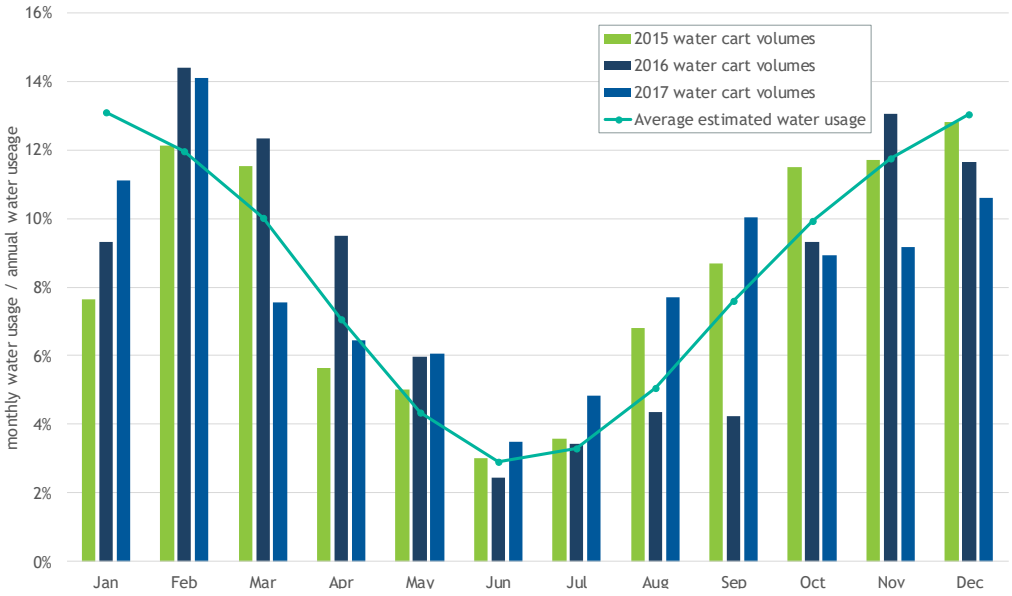

Figure 9 Comparison of estimated and actual monthly haul road dust suppression rates

Coal Crushing Demand

A crusher is used to pre-process ROM coal at TCM prior to its transport to Whitehaven's CHPP near Gunnedah. The crusher uses a relatively small quantity of water which it sources from the water management system. A significantly larger volume of water is required to be sprayed onto the ROM Pad to suppress dust from this area.

The coal crusher demand modelled in OPSIM was 35 ML/year. SB4 supplies water to the coal crusher. If water is low in SB4, water is sourced from SB5A further to the west. Water for these uses is then sourced from the mine water dams.

4.5.5 Irrigation to Support Vegetation Establishment on Partially Rehabilitated Area

Appendix B of the TCP-EA refers to irrigation to support vegetation establishment on partially rehabilitated areas. However, water is rarely used for irrigation and there is no intention to undertake any large scale (area and or duration) irrigation unless there is such an excess of water that irrigation was required to avoid uncontrolled discharges. As such, no allowance for irrigation has been made within this site water balance investigation. If any long term irrigation is planned to be undertaken then consideration would be given to undertaking soil testing to confirm that it is suitable to accept the irrigated water. Additionally, in accordance with Project Approval (PA 11_0047), if any long term irrigation is planned then a program to monitor and assess the soils within the irrigation area would be developed in consultation with the Regulator, as would performance criteria and trigger values.

4.5.6 Site Discharges and Controlled Releases via Licensed Discharge Points

A number of existing LDPs have been included in the water balance model. These LDPs are associated with the following storages (refer to Figure 6); SD17 (LDP 1), SD9 (LDP 2), SB14 (LDP 3), SD16 (LDP 24), SB23B (LDP26) and SB24B (LDP27). It is TCPL's intention to maintain water within the LDP water storages by dewatering, where required, to other dams onsite with adequate storage capacity to minimise the risk of off-site discharge (refer to Figure 6 for the locations where dams are typically dewatered to). Controlled releases offsite from the authorised sediment dams occur when the dam volume (and the volume within the other dams that it gets dewatered to) exceeds the operating volume.

Any controlled release of water offsite would need to be of a suitable quality and be undertaken with all the necessary monitoring. When the sediment dam associated with a LDP exceeds the Total Storage Volume, water discharges (overflows) offsite.

4.6 Water Management System Operating Rules

In order to minimise the amount of external water required and to reduce the risk of off-site discharge TCPL proactively manages the water within the various water storages at the TCM. TCPL will ensure that during situations where an offsite overflow from the mine water system is possible, all water that is required to be transferred to the mine water system shall be pumped to the PW4. It is acknowledged that this has the potential to cause flooding and operational issues within the pit however this is considered to be preferential to mine water discharging offsite.

The management of stored water at the TCM includes both dewatering of the dams when they reach the Operating Volume and pumping water into the mine water dams from external water sources when the water level in all of the dams drops below the Dead Storage Volume level. Further definitions of the dam related terminology are provided in Section 3.2.2.

4.7 Model Calibration and Verification

4.7.1 Overview

The WB model was run from 1 January 2017 to 31 March 2018 using the recorded rainfalls and dust suppression rates provided my TCM personnel. The WB model was validated by comparing the Year 2017 model outputs to recorded data. The validation was undertaken to refine parameters (e.g. AWBM parameters and pumped transfer rules) and improve the confidence of the model predictions for Year 2018 onwards. The validation data used in this assessment is as follows:

- metered mine pit dewatering rates. According to the mine pit dewatering data, a total of 313 ML was pumped out from 3 January to 3 November;
- site inventory water volumes (see Table 15) were based on the following:
  - volumes reported in the previous TCM WMP for 1 January 2017;
  - water levels recorded by TCM personnel on 14 September 2017;
  - aerial photographs and site LiDAR for 1 March 2017 and 1 March 2018; and
  - volumes provided by TCM personnel for 1 July 2018;
- external water requirements. Based on advice from TCM personnel, no external water was required between 1 January 2017 and 31 March 2018;
- spills from sediment dams. Based on advice from TCM personnel, there were no sediment dam spills between 1 January 2017 and 31 March 2018; and
- controlled release volumes. Based on advice from TCM personnel, there were no controlled releases between 1 January 2017 and 31 March 2018.

Table 15 TCM dam inventory for the Year 2017 (validation) period

Dam Name	Stored Volume (ML)				
	1 Jan 2017	1 Mar 2017	14 Sep 2017	1 Mar 2018	1 Jul 2018
PW2	22	7	20	7	20
SD16	13	0	2	2	0
PW3	14	10	19	12	25
SB16A	16	28	36	22	36
SB16B	42	27	36	9	84
SB25	2	2	2	2	0
MWD/PW4	73	120	74	20	25
Pit	175	30	29	30	100
Total	**375**	**224**	**218**	**104**	**290**

4.7.2 Results

The water balance model was calibrated by adjusting the AWBM parameters for the active land use. The adopted AWBM parameters are shown in Table 11. A comparison of the modelled and recorded pit dewatering volumes and site water inventory is shown in Table 16 and Figure 10, respectively. In both cases, the modelled data appears to satisfactorily fit the recorded data.

A water balance for the mine pit was undertaken estimate the groundwater inflow rates for comparison with groundwater model predictions. Figure 11 presents the mine pit water balance between 1 January 2017 and 3 November 2017 (306 days) based on:

- measured water volume dewatered from the mine pit recorded in the "surface water pumping" log book by TCM personnel;
- measured water levels in the mine pit;
- coal export losses based on an in-situ coal moisture content of 5 w/w%; and
- estimated evaporation and catchment runoff by the OPSIM model.

The estimated total groundwater inflow to the mine pit for the period assessed was approximately 144 ML (on average, 0.47 ML/d) using the water balance method. This is good agreement with the groundwater model predicted inflow rate of 153 ML (on average, 0.50 ML/d). The groundwater model predicted inflow rate was adopted given the minor differences between the groundwater inflow calculated using the water balance method.

The model results for the Year 2017 validation run suggested that no external water was required between 1 March 2017 and 1 March 2018, which is consistent with the Annual Review. The model results also showed that no controlled releases or spills occurred from TCM LDPs for the validation period, which is also consistent with the Annual Review.

The adopted parameters were considered suitable for this assessment.

Table 16 Recorded and modelled mine pit dewatering volumes in Year 2017

Dewatering period	Recorded volume (ML)	Modelled volume (ML)
3/1/2017 - 11/3/2017	162	158
12/3/2017 - 23/6/2017	35	40
24/6/2017 - 3/11/2017	116	116
Total	**313**	**314**

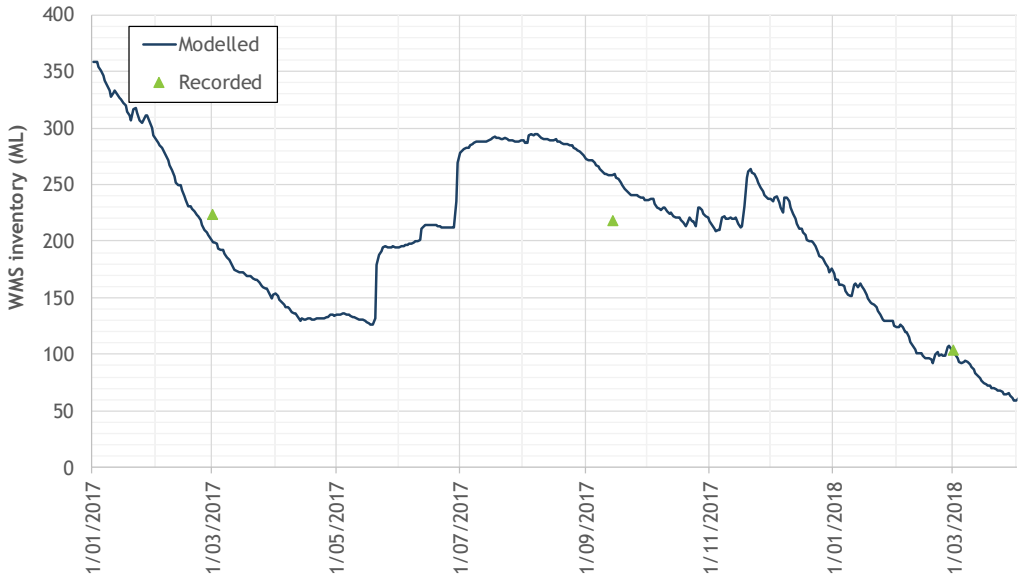

Figure 10 Validation of the TCM total site water inventory – January 2017 to March 2018

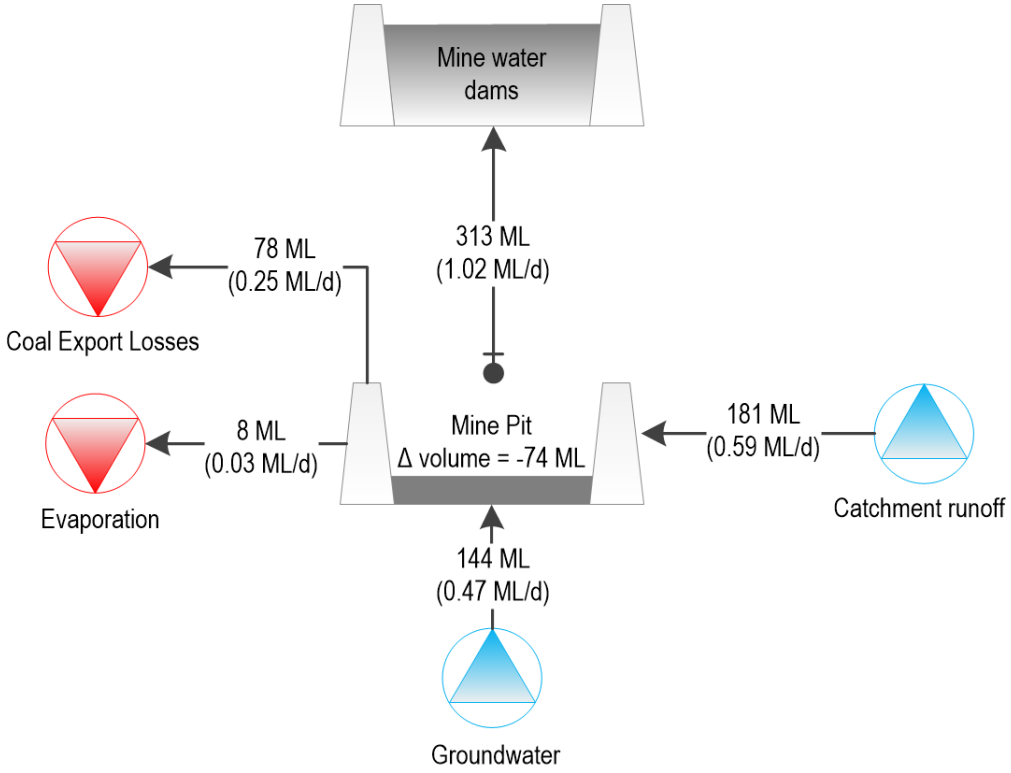

Figure 11 Mine pit water balance schematic – 1 January 2017 to 3 November 2017 (306 days)

4.8 Modelled Water Management System Performance

4.8.1 General

The simulated performance of the water management system has been assessed against its design objectives (as listed in Section 4.2). The water volumes that need to be managed by the system will vary widely because of the large range of different weather conditions experienced at the TCM. The aspects of the system which would enable it to operate effectively during drought are different to those that would accompany prolonged wet periods. The system will also need to manage short term as well as long term climatic patterns and trends. The ability of the system to meet its design objectives under a range of climatic conditions has been assessed by simulating the system over the next 5 years for 126 simulations using 130 years of rainfall data.

For the purpose of the water balance assessment, the base case assumed that a commercial dust suppressant binder was not used as there is currently no site data to determine the potential reduction in dust suppression use. This provides a conservatively high estimate of external water requirements. A sensitivity assessment was undertaken to confirm the report potential benefits of a commercial dust suppressant binder. Sensitivity analyses were also undertaken for other key modelling assumptions including runoff quality and runoff quantity.

4.8.2 Interpretation of model results

In interpreting the results of the water balance assessment, it should be noted that the results provide a statistical analysis of the water management system's performance over 5 years, based on 126 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 depends upon the parameter being considered. For site water storage, where the risk is that available storage 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 correspond to very wet climatic conditions. For off-site 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 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.

4.8.3 Overall TCM Water Balance Results

Table 17 shows a summary of the Year 2019 site water balance results for a dry (90% confidence trace), median (50% confidence trace), wet (10% confidence trace) and average rainfall year. The following is of note for the Year 2019 site water balance:

- For a characteristic dry year, the total site will experience a deficit. Conversely, for a characteristic wet year, the total site inventory will experience a surplus. For average and median year, the site inventory will remain relatively neutral.
- The majority of the mine water stored on site will be used on site for operational water uses such as haul road dust suppression and coal crushing or exported off site bound to coal trucked to the Whitehaven CHPP.
- External water is not required to make-up haul road dust suppression demands for the median year assessed. Notwithstanding this, external sources were required for approximately 70% of realisations assessed. Table 17 indicates that for a dry rainfall year there is potential for the TCM's water deficit to exceed the water available within the existing groundwater licenses of 300 ML.
- Sediment dam controlled (pumped) releases are predicted to occur in most years. The predicted annual controlled release volumes range from 6 ML for a dry year to 89 ML for a wet year, with an average volume of 70 ML.

Table 17 Summary of Water Balance Results – Year 2019

Description	Dry Year 1935 (ML/year)	Median Year 2011 (ML/year)	Wet Year 1984* (ML/year)	Average of 126 simulations (ML/year)
Water Source (Inputs)				
Total runoff	334	818	1,250	812
Groundwater inflow	168	168	168	168
Total Input	**502**	**986**	**1418**	**980**
Water Losses and Usage (Outputs)				
Evaporation (from water storage)	129	148	189	150
Moisture loss in coal	106	106	106	106
Crusher	34	30	35	34
Haul road & and ROM pad dust suppression	706	635	625	675
Leakage from SD1 & SD2	2	8	21	10
Total Output	**977**	**928**	**977**	**975**
Water Surplus/Deficit				
Total Input minus Total Output	**-476**	**58**	**442**	**5**
External water required	296	0	0	183
Off Site Release and Discharge				
Controlled release	6	61	89	70
Offsite overflow (wet weather discharge)	0	0	1	5
Total Offsite Release and Discharge	**6**	**63**	**89**	**75**

* 1984 was a leap year (with 366 days)

4.8.4 Risk of off-site overflows (spills)

The frequency of off-site uncontrolled overflows in Year 2019 (wet weather discharges) is shown in Table 18. This table shows that the sediment dam spills are not predicted to occur from all LDPs except for SD17 (LDP1) and SB24B (LDP27), which are predicted to occur during rainfall years that are wetter than the 20th percentile climatic conditions. Spills from SD17 (LDP1) and SB24B (LDP27) are predicted to occur less than 2 times per year on average, which is less than the Blue Book expectations of 2 – 4 times per year for a sediment dam sized based on a 5 day, 90th percentile rainfall event.

Mine water dams do not spill for any of the 126 modelled realisations, which was one of the objectives of the water balance. The majority of the mine water inventory will be utilised for haul road dust suppression.

Table 18 Risk and Number of Dam System Offsite Spills

Dam System	Annual chance of spill	Dry Year 1935 (No. of overflows)	Median Year 2011 (No. of overflows)	Wet Year 1984 (No. of overflows)	Average of 126 simulations
SD17 (LDP1)	15%	0	0	0	0.21
SD9 (LDP2)	<1%	0	0	0	0
SB14 (LDP3)	<1%	0	0	0	0
SD 16 (LDP24)	<1%	0	0	0	0
SB23B (LDP26)	<1%	0	0	0	0
SB24B (LDP27)	10%	0	0	1	0.17
Mine Water Dams	<1%	0	0	0	0

4.8.5 Water Storage Behaviour

Figures B1 to B6 in Appendix B shows the dirty water inventories, Total Storage Volume and Operational Volumes for each LDP catchment. Figures B7 and B8 in Appendix B shows the mine water dam inventories and mine pit water inventories respectively. These figures show the range in storage volumes within the dirty water and mine water systems between Year 2018 and Year 2022 based on 126 climate simulations.

The following is of note regarding site storage behaviour between Year 2018 and Year 2022:

- The mine water dam water inventories are maintained at or below the Full Storage Volume for all climatic conditions assessed (see Figure B7).
- The mine pit would begin to accumulate water for a wet (10^{th} confidence trace) rainfall year and wetter. There is a 10% and 1% exceedance probability that the mine pit inventory will exceed 600 ML and 1,500 ML respectively by the beginning of January 2023 (see Figure B8). Under all other climate conditions considered, stored inventories are less than 130 ML (the capacity of the current in-pit storage).
- The dirty water dam water inventories within all LDPs are generally maintained at or below the combined operating level for all climatic conditions assessed with the exception of the LDP1 system and the LDP27 system (see Figures B1 to B6).

The risk of spills from LDPs is discussed further in Section 4.8.4.

4.8.6 Mine Pit Inundation Risk

Figure 12 shows the predicted annual maximum stored water inventories in the mine pit for median (50% confidence trace), wet (10% confidence trace), very wet (5% confidence trace) and extreme wet (1% confidence trace) climate conditions. Figure 13 shows the number of days per year that more than 130 ML would be stored in the mine pit. This represents the capacity of the in-pit storage (Lachy's). Table 19 summarises the annual maximum stored volume in the mine pit and the number of days per year that more than

130 ML would be stored in the mine pit for the median (50% confidence trace), wet (10% confidence trace) and extreme wet (1% confidence trace) climate conditions.

The results assume that the mine pit will be used to store excess mine water that cannot be used for operational water demands. If adequate storage capacity is not made available to dewater the mine pit, excess water would have to be held in an inactive part of the mine pit until spare out of pit storage becomes available. If water has to be held in the mine pit for prolonged periods of time, this may cause interruptions to coal production.

Table 19 Predicted Annual Maximum Stored Water Volume in the Mine Pit and number of days the Mine Pit stores more than 130 ML

Year	50% confidence trace		10% confidence trace		1% confidence trace	
	Volume (ML)	No. of days	Volume (ML)	No. of days	Volume (ML)	No. of days
2018 [a]	100	0	111	0	358	155
2019	53	0	378	307	931	361
2020	66	0	638	352	1,405	366
2021	81	0	822	365	1,570	365
2022	106	0	896	365	1,673	365

[a] 6-month period from July 2018 to December 2018

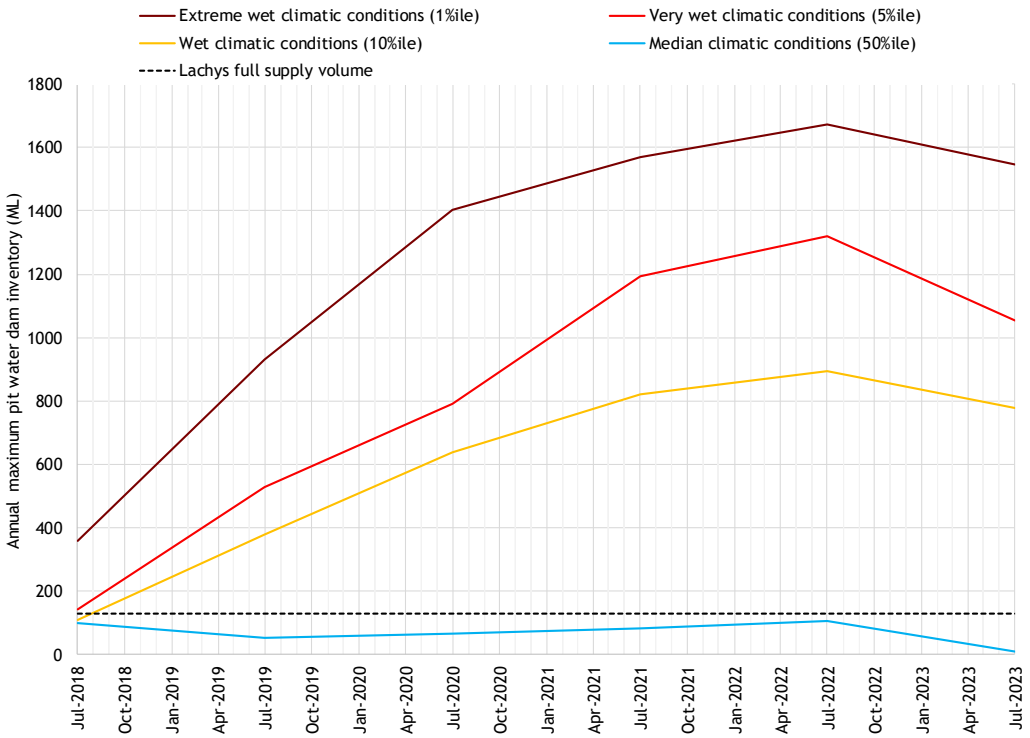

Figure 12 Predicted Annual Maximum Stored Water Volume in the Mine Pit

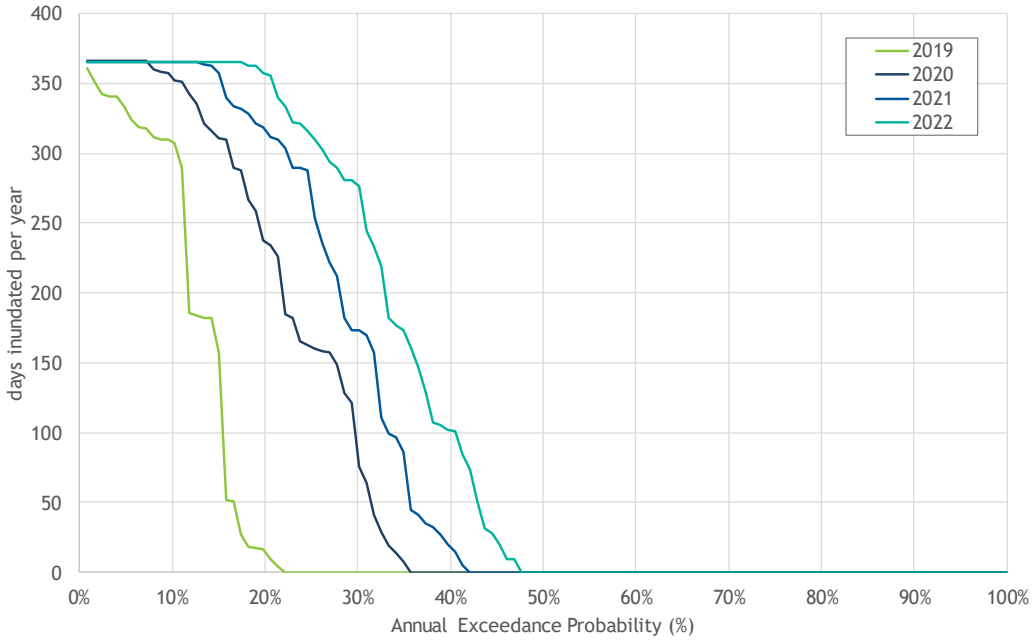

Figure 13 Predicted annual number of days the Mine Pit stores more than 130 ML

4.8.7 External water requirements

Figure 14 shows the predicted annual volume (in ML) of external water supply required to meet on-site water demands between 2019 and 2022 with and without the use of dust suppressant binders. Table 20 summarises the predicted external water requirements between 2018 and 2022. For conditions where dust suppressant binders are not applied, the following is of note with respect to the model results:

- the predicted total external water supply requirement ranges between 0 ML to 700 ML during the next 4.5 years of operations;
- there is a 50% probability that less than 170 ML of external water will be required in 2019 and less than 100 ML will be required in 2020. There is 50% chance that no external water will be required in 2021 or 2022;
- there is a 90% probability that less than 440 ML of external water will be required in 2019 and 2020, and less than 370 ML will be required in 2021 and 2022; and
- there is a 99% probability that less than 690 ML of external water will be required each year during the 4-year period.

Dust suppressant binders are available to reduce haul road dust suppression demand and thereby reduce road water requirements by 50%. The following is of note for the scenario where dust suppressant binders are implemented (see Figure 14 and Table 20):

- for 2019 and 2020, dust suppressant binders would reduce external water requirements by up to 450 ML in the driest 50% of climatic conditions; and

- for 2021 and 2022, dust suppressant binders will be required in the driest 30% of climatic conditions with the existing groundwater licence.

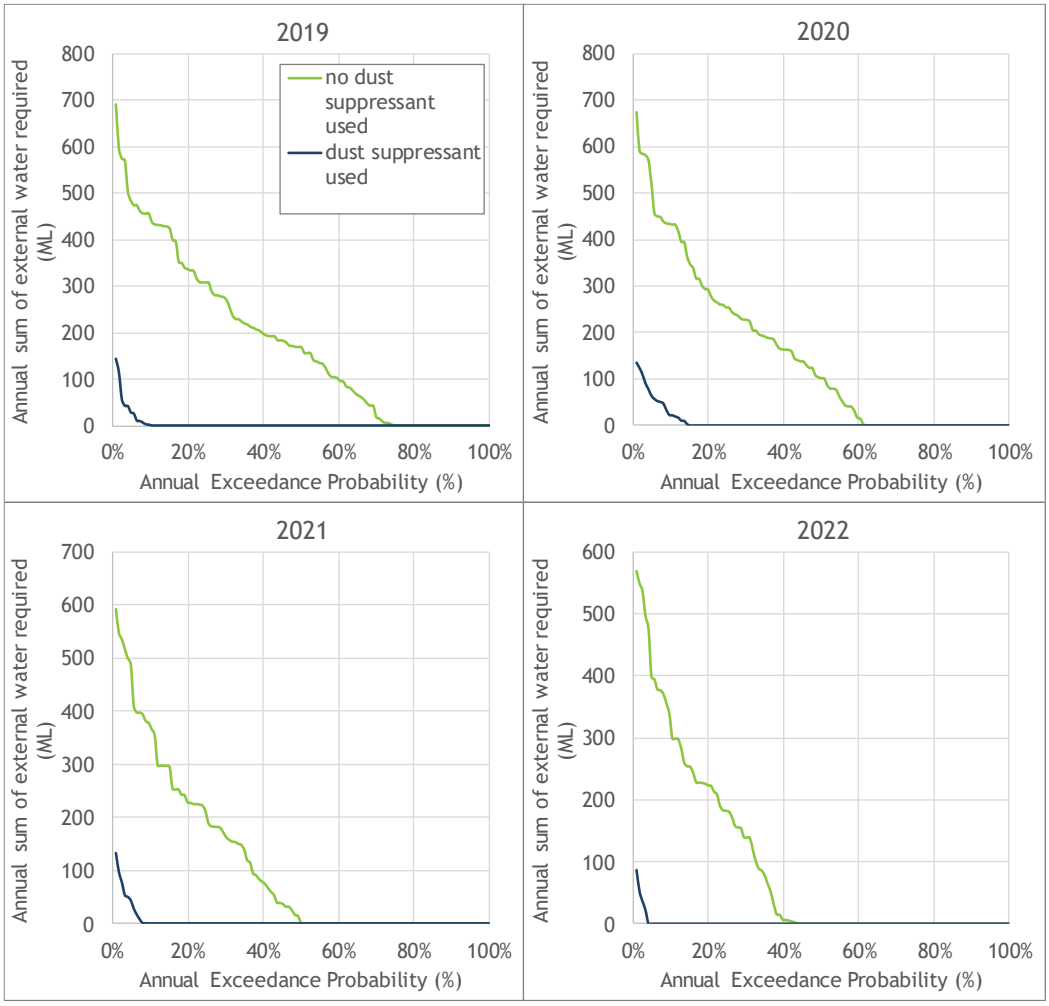

Figure 14 Predicted annual external water requirements -Year 2019 to Year 2022

Table 20 Predicted Annual External Water Requirements – Year 2018 to Year 2022

Year	90% confidence trace		50% confidence trace		10% confidence trace		1% confidence trace	
	Without binder	With binder	Without binder	With binder	Without binder	With binder	Without binder	With binder
2018 [a]	0	0	0	0	89	0	110	0
2019	0	0	168	0	438	0	690	145
2020	0	0	101	0	431	22	672	135
2021	0	0	2	0	367	0	593	132
2022	0	0	0	0	298	0	568	88

[a] 6-month period from July 2018 to December 2018

4.9 Sensitivity Analysis

A number of sensitivity analyses were undertaken to assess the potential impact of variations in key parameters to the performance of the water management system. The sensitivity scenarios that were assessed are as follows:

- Scenario 1: Decrease in haul road dust suppression by 50% to account for the implementation of dust suppressant binders;
- Scenario 2: Including SD18 in the mine water dam system due to deteriorating runoff water quality; and
- Scenario 3: Changing runoff quantity by adjusting AWBM soil capacity by ±20%.

Full results of the sensitivity analyses are presented in the water balance report (WRM, 2018). The following is of note regarding the three scenarios assessed:

- Scenario 1: reducing the haul road dust suppression demand will significantly decrease the volume of external water required. External water will only be required for the driest 15% of climatic sequences. The assessment against the existing groundwater licence allocation is given in Section 4.8.7. Further, the maximum annual volume required will be approximately 150 ML. The use of a dust suppressant will, however, significantly increase the pit inundation risk. For the wettest 1% of climatic conditions the total pit inventory will be increased by up to 800 ML, relative the base case.
- Scenario 2: including SD18 into the mine water system will increase the pit inundation risk. For the wettest 1% of climatic conditions the total pit inventory will be increased by up to 400 ML, relative the base case. However, the number of days that the pit is inundated will not be significantly affected.
- Scenario 3: altering the soil moisture capacity will significantly impact the pit inundation risk. Increased soil capacity will reduce the pit total pit inventory whereas decreased soil capacity will increase the total pit inventory.

4.10 Water Balance Review/Verification

The site water balance (including reporting procedures) will be reviewed annually and as part of the review process of this document. It should also be reviewed if changes to the mine layout occur or if the water management systems operating rules/procedures change in the future.

The water balance model is considered to be a good broad scale model which can be improved as assumptions are clarified and operational rules / procedures are refined or altered. Monitored dam water levels and offsite discharges will continue to be compared to the results of future updates of the OPSIM model to validate the data/assumptions used within the model.

Following the approval of future MOPs, the OPSIM model will be updated to include all future activities within the WMP period including the activities planned under the Project

Approval (PA 11_0047). This will enable an ongoing programme to be developed to validate the OPSIM data/assumptions as the mine progresses.

Table 21 shows TCM's actions that have been undertaken, as well as planned actions to improve on future water balance assessments. The TCM WMS is constantly adapting to reflect mining progression and changing conditions. TCM's planned improvements will evolve alongside the WMS, facilitating an adaptive management approach in accordance with Schedule 5 Condition 2 of PA 11_0047.

Table 21 Proposed TCM Water Balance Improvements

Planned improvement	Actions undertaken to date	Future planned actions
Detailed recording of pumped transfer volumes from the pit and dams. The installation of water flowmeters on pipelines could be undertaken to further improve this accuracy.	• One flowmeter has been installed at the mine pit sump.	• Develop and implement a flow monitoring system. • Investigate opportunities for installation of flowmeters or similar. • Assess preferred location to install a second flow meter.
Detailed recording of operational water use is collected (e.g. crusher, dust suppression, etc.).	• Dust suppression volume is estimated from water cart usage. • Two flowmeters have been purchased.	• Develop and implement a flow monitoring system • Investigate opportunities for installation of flowmeters or similar. • Assess suitable pipeline to install flowmeter (e.g. SB4 to ROM and crusher dust suppression).
Accurate and up-to-date details on the dam operating volumes and the trigger volumes.	• The Water Management Plan was updated in Q3 2018, as per Schedule 5, Condition 5 of the Project Approval (PA11_0047)	• Refine operational levels and volumes based on future MOPs and water balances.
Accurate estimation of dam leakage rates.	• No actions undertaken yet.	• Investigate and develop a program to monitor potential leakage from dams. • investigate most suitable frequency to monitor water levels and flow.
Monitoring of the ROM coal moisture content and loss of water through coal export.	• A sampling program has been developed.	• build a database for ROM coal moisture sampling data. • Refine and optimise the ROM coal moisture monitoring program.
Monitoring TCM sediment dams water levels.	• Gauge boards were installed at the spillway of the licenced discharge dams. These gauge boards have been used in the operation and management of water level in these dams. • The water balance model	• Develop a sediment dam monitoring program to monitor water levels and volumes. • Assess suitable water level monitoring technology for use onsite.

	calibration and update is undertaken on (at least) an annual basis.	

5 GROUNDWATER MANAGEMENT PLAN

5.1 Groundwater Systems

The TCM EA identified two groundwater systems in the vicinity of the mine, namely:

- Porous Rock groundwater system – including the coal measures of the Maules Creek Formation; and
- Alluvial groundwater system – associated with the low-lying floodplains of the Upper Namoi.

The coal resource and existing mining operations are located within the Maules Creek sub-basin of the Early Permian Bellata Group, which is within the porous rock (i.e. sedimentary rock) groundwater systems of the Gunnedah Basin, and lies within the boundary defined in the WSP for the Porous Rock Groundwater Source. The coal resource is wholly located within the Gunnedah-Oxley Basin – Namoi Management Zone.

The mine site is bordered by alluvial sediments which are associated with the Bollol Creek, Goonbri Creek and Nagero Creek surface drainages. These sediments are part of the Upper Namoi Alluvium and their groundwater's lie within the Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source, also known as the Upper Namoi Zone 4 water source. The mine extension will encroach into these alluvial sediments, thus monitoring and management of the alluvial groundwater system, as well as appropriate licences, will be required.

5.2 Groundwater Dependent Ecosystems

The locations of Groundwater Dependent Ecosystems (GDEs) are detailed in Appendix F of the TCP–EA and are shown in Appendix C. High priority GDEs are only listed in the Murray-Darling Basin Porous Rock WSP, at a distance of approximately 90 km to the south of the TCM. GDEs closest to the TCM occur approximately 30 km west of the site in the NSW Gunnedah-Oxley Basin groundwater source, comprising springs on Sandy Creek near Bulga Hill.

Additional GDEs, not listed as high priority in the WSPs, are noted in the BoM GDE Atlas for riparian ecosystems and terrestrial ecosystems. The nearest are along Goonbri Creek, classified as high potential for groundwater interaction.

It should be noted that much of the neighbouring Leard State Forest has a low potential for groundwater interaction. This is because the groundwater table is relatively deep (up to 100 m) which is well below the remanent vegetation root zone.

5.3 Groundwater Licences

The Water Sharing Plan for the NSW Murray-Darling Basin Porous Rock Groundwater Sources commenced in January 2012. TCM currently holds 300 ML of volumetric licence

allocation in the Gunnedah - Oxley Basin MDB Groundwater Source. The allocation was approved under licences WAL29548 (50 ML) and WAL31084 (250ML).

The existing operations at the TCM are located outside of the Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source defined by the Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources. Licences under the *WM Act* are required to be held by TCM if mining has a far-field effect of drawing down more water from the alluvium to the underlying strata than would occur naturally. TCM currently holds WAL36548 (36 ML) in the Upper Namoi Groundwater Source (Zone 4).

These groundwater licences currently allow TCM to extract up to a total of 336 ML per year from groundwater sources. Table 22 is showing a summary of the licence numbers and water sources.

Whitehaven entities hold WALs 12651 and 12653 in the Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Water Source under the Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2019 associated with the existing Vickery Coal Mine groundwater bore (90CA807002). As a contingency measure, groundwater extracted via the existing Vickery Coal Mine groundwater bore will be accounted for under WALs held or obtained under the Water Management Act (including WALs 12651 and 12653). As such, the take of groundwater via the existing Vickery Coal Mine groundwater bore will be regulated under the Water Management Act and Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2019.

Groundwater monitoring boreholes owned by Whitehaven are also licensed under the existing Bore Licences (e.g. 90BL253276, 90BL253278, 90BL253841, 90BL253279, 90BL253280, 90BL254255, 90BL254254, 90BL254253, 90BL254220, 90BL102564, 90WA809087, 90BL116929, 90BL255930), which set out conditions of use for the monitoring bores. These monitoring bore licences are purely held by Whitehaven and not third parties.

Heritage Computing (2011) determined, through groundwater modelling, that the licensing requirement for the Gunnedah - Oxley Basin MDB Groundwater Source would be a maximum of 252 ML/a in years 1 to 11 of the mine (to the end of 2023) if the TCM were acting alone, without the cumulative effect of the Boggabri Mine. Recent re-modelling conducted by Heritage Computing suggests a reduction of about 4 percent in the maximum take, so that the estimated licensable take is now 242 ML/a. If the effect of the Boggabri Mine is considered, the take by the TCM would be about 190 ML/a maximum from the porous rock water source. The licensable take (242 ML/a) is equivalent to 76 percent of porous rock licences held by TCM.

From year 12 (2024) onwards, pit inflow would be contributed from alluvium as well as porous rock and waste rock. The maximum predicted take from the alluvial water source was determined by Heritage Computing (2011) to be about 198 ML/a.

The BTM Complex groundwater model is currently being updated in 2019 to confirm the TCM future predicted take from alluvial water sources. TCM's current volumetric licence

allocation for alluvial water sources will be reviewed after the groundwater model has been updated to determine the appropriateness of current WALs held by TCM.

Table 22 Groundwater Licences

WAL No	Water Sharing Plan	Water Source	Work approval	Amount (ML)
WAL29548	NSW Murray Darling Basin Porous Rock Groundwater Sources	Gunnedah - Oxley Basin MDB Groundwater Source	90WA822536	50
WAL31084*	NSW Murray Darling Basin Porous Rock Groundwater Sources	Gunnedah - Oxley Basin MDB Groundwater Source	90WA827848	250
WAL36548	Upper and Lower Namoi Groundwater Sources	Upper Namoi Zone 4 Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source	90CA807018	36
			Total	**336 ML**

*Licence for the removal of ground water from open excavations such as the mine pit (refer Section 3.2.6)

5.4 Groundwater Monitoring Program

5.4.1 General

TCPL has a groundwater monitoring program in place that incorporates the collection of water quality and water level data from monitoring bores. The bores are a combination of standpipes and vibrating wire piezometers (VWPs). Occasional water level readings are taken in some private production bores and wells not specifically designed for monitoring.

The TCM network is supported by a number of neighbouring monitoring networks (Heritage Computing, 2012):

- DoI Water network;
- Maules Creek Coal Project network;
- Boggabri Coal Mine network; and
- Gins Leap Gap research network.

A groundwater assessment was carried out as part of the TCP-EA and this included the construction of a groundwater model (Heritage Computing, 2011). The model investigated the effects of the mine operations both in isolation and in combination with surrounding mines. These results are referenced throughout this section.

5.4.2 Monitoring Objectives

The objectives of groundwater level monitoring are:

- to provide baseline pre-mining groundwater levels in space and time, recognising that measurements of pressure variations with depth are necessarily limited by the expense of surface-to-seam holes;

- to quantify natural time variations in groundwater levels;
- to record mining-induced changes in groundwater levels in space and time;
- to provide a foundation for characterisation of aquifer and aquitard properties by numerical model calibration;
- to facilitate groundwater model evolution through verification of simulated heads against those measured;
- to reveal mining-induced changes in groundwater flow directions and hydraulic gradients;
- to provide evidence for the degree of stream-aquifer interaction, especially losses of stream water, and whether the losses are permanent or temporary;
- to allow assessment of impacts on potential groundwater dependent ecosystems (GDEs) i.e. Bracteates Honeymyrtle low riparian forest (refer Appendix F of the TCP–EA), and stygo-fauna;
- to allow assessment of yield/drawdown impacts on other groundwater users; and
- to monitor post-mining rates of groundwater pressure recovery.

The objectives of groundwater quality monitoring are:

- to provide baseline pre-mining groundwater quality data in space and time, for a range of informative and diagnostic indicator species;
- to quantify natural changes in water quality in time and space;
- to record mining-induced changes in groundwater quality in space and time;
- to facilitate confirmation or revision of the conceptual model for chemical evolution and groundwater flow directions;
- to assess whether any changes in water quality with time occur during and after mining, and whether such changes are likely to have a material effect on beneficial uses;
- to establish whether enhanced rainfall recharge through backfill provides a freshening effect on groundwater, or instead mobilises latent chemicals;
- in the case of a water-filled final void, to assess the risk of migration of saline void waters during the post-mining recovery phase whenever such waters are not contained as a groundwater sink; and
- to assess whether acid rock drainage has occurred.

5.4.3 Monitoring Locations

The monitoring network consists of 8 standpipe piezometers, 8 additional locations for groundwater level monitoring, and a total of 12 VWPs installed in locations TA-60C (4) and TA-65C (8) (Figure 15).

The network monitors water level and water quality across the site and is targeted equally between the alluvial aquifer that interacts with the Namoi River, and the rocks hosting the coal seams. The locations of these monitoring bores (past and present) are shown in Figure 7 and a description of the monitoring program is given in Table 23. The additional monitoring, carried out for the investigation into the mine extension, will be formally incorporated into the site monitoring network as the mining operation progresses.

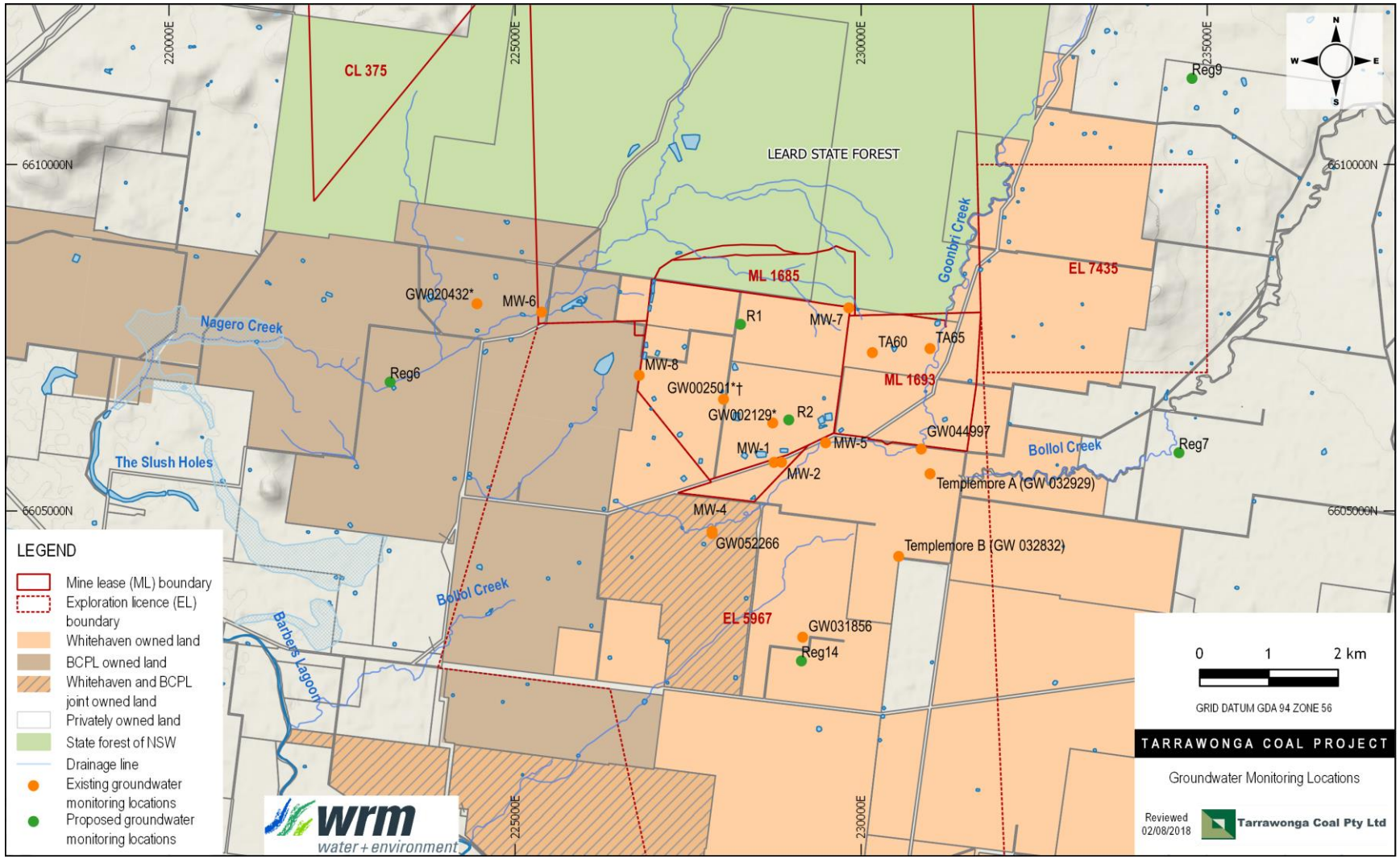

Figure 15 Tarrawonga Coal Mine Groundwater Monitoring Locations

The primary installed monitoring bores are:

- MW-1: located in the Permian coal measures (interburden) on the "Thuin" property;
- MW-2: located in the alluvial aquifer on the "Thuin" property;
- MW-4: located in the alluvial aquifer on the "Tarrawonga" property;
- MW-5: located in the surface water drainage line to the southwest of the mine. This location would also serve as an indicator to impacts on the alluvial aquifer servicing the "Bollol Creek Station" groundwater system;
- MW-6: located in the alluvial aquifer of Nagero Creek;
- MW-7: located in the Permian sediment up hydraulic gradient of the mine area; and
- MW-8: located on the western side of the mining lease and is the most recent monitoring point.

In addition to the above piezometers, TCM also has monitored groundwater levels within eight bores, three of which are now decommissioned:

- GW044997 – located in the alluvial aquifer on the "Templemore" property;
- Templemore A - located in the alluvial aquifer on the "Templemore" property;
- Templemore B - located in the alluvial aquifer on the "Templemore" property;
- GW031856 – located in the alluvial aquifer on the "Ambardo" property;
- GW052266 – located in the alluvial aquifer on the "Tarrawonga" property (data available for 2009);
- GW002501 – located within the mine site (data available from 2006 to 2008) but removed by the advancing open cut;
- GW002129 – located within the mine site (data available from 2006 to 2009) but removed by the advancing open cut;
- GW020432 – located in the volcanics groundwater system on the "Merriown" property (now decommissioned; measurements from 2006 to 2008).

The existing TCM network of piezometers will be augmented, particularly prior to and during Years 12 to 17 of the extension and remain in place for at least two years post-mining (i.e. aligned with the anticipated open cut intersection with the alluvial groundwater system inside the low permeability barrier). This network of piezometers would be installed for the purposes of monitoring:

- the construction of the low permeability barrier (to quantify and validate the predicted short-term/localised dewatering impacts);
- groundwater levels and water quality in the alluvial groundwater system on the inside of the low permeability barrier as mining advances (to validate the predicted mine inflow and dewatering rates);

- groundwater pressures in the porous rock groundwater system/coal measures (to validate the predicted depressurisation effects at depth); and
- groundwater levels and water quality in the alluvial groundwater system on the outside of the low permeability barrier as mining advances (to validate the predicted negligible impacts).

If physically feasible, additional piezometers would be installed in mine waste rock behind the advancing open cut to provide information on recharge rates and mine waste rock permeability and to validate groundwater modelling assumptions and predictions with respect to the emplacements. The proposed TCM monitoring bores R1 and R2 which will be located in the spoil dumps (as shown in Figure 15) are anticipated to be installed in 2019.

Details of any additional future monitoring bores will be included in future revisions of this WMP.

5.4.4 Baseline Data

Baseline data for the TCM including surface water and groundwater quality monitoring, water discharge and level records are reported in the Environmental Assessment, Annual Review and Annual Return. The Environmental Performance at TCM, which is reported in the Annual Review and Annual Return, is compared against historical baseline data and commitments of the Environmental Assessment.

Appendix F of the TCP–EA assessed the potential for groundwater dependent vegetation to occur near the Project area noting a single community (Bracteates Honeymyrtle low riparian forest) as being potentially groundwater dependent.

5.4.5 Groundwater Monitoring Schedule

The Groundwater Monitoring Schedule outlined in Table 23 defines the parameters to be sampled for in the TCM groundwater monitoring network and the recommended sampling frequency at each sampling location. Continuous water level measurements are obtained at two standpipes and at two VWP sites. At other standpipes, water levels are measured quarterly at the same time as field measurements of pH, EC and water temperature. At six-monthly intervals, samples are collected from each standpipe for laboratory analysis of 16 metals and 9 anions, as well as laboratory measurement of pH, EC, TDS, ammonia, nitrite and nitrate.

The proposed future local groundwater monitoring programme is summarised in Table 24. The groundwater monitoring programme would augment the existing TCM groundwater monitoring programme and utilise the results of neighbouring mine groundwater monitoring programmes (i.e. Boggabri Coal Mine and Maules Creek Coal Project), refer Table 25.

The groundwater monitoring programme would monitor groundwater conditions for changes as a result of mining and should include consideration of aquifer definition and interactions, strata hydraulic properties, expected drawdown extent and groundwater quality.

Table 23 Groundwater Monitoring Network

Site	Registered Bore No.	Licence Number	Property	Location		Parameter & Frequency			Screen/ sensor depth (mbgl)	Status
				Easting MGA-56	Northing MGA-56	Standing Water Level	EC, pH, Temp	Na, Ca, K, Mg, Fe, Mn, Al, As, Cl, SO_4, HCO_3, NO_3 and NO_2, TRH		
MW-1	GW967848	90BL253276	"Thuin"	228743	6605702	Continuous	Quarterly	Six monthly	52-56	Active monitoring bore
MW-2	GW967849	90BL253278	"Thuin"	228851	6605704	Continuous	Quarterly	Six monthly	4-7	Active monitoring bore
MW-4	GW967850	90BL253279	"Tarrawonga"	227848	6604708	Quarterly	Quarterly	Six monthly	17-20	Active monitoring bore
MW-5	GW967851	90BL253280	"Templemore"	229488	6605985	Quarterly	Quarterly	Six monthly	5.3-8.3	Active monitoring bore
MW-6^	GW967881	90BL254255	"Merriown"	225385	6607871	Quarterly	Quarterly	Six monthly	29-32	Active monitoring bore
MW-7	GW967883	90BL254254	"Mine Site"	229823	6607932	Quarterly	Quarterly until Sep.2012	Six Monthly until Sep.2012	102-105	Active monitoring bore
MW-8	GW976882	90BL254253	"Mine Site"	226795	6606958	Quarterly	Until Jul.2007	Until Jul.2007	23-26	Active monitoring bore
GW002501*†	GW002501		"Mine Site"	228013	6606613	Until Oct 2008	Until Oct.2008	Until Oct.2008	-	Decommissioned monitoring bore
GW002129*	GW002129	90BL254220	"Mine Site"	228724	6606271	Until Jan.2009	Until Apr.2008	Until Apr.2008	-	Decommissioned monitoring bore
GW044997	GW044997	90BL102564	"Templemore"	230870	6605895	Quarterly	Until Nov.2012	Until Sep.2012	-	Stock & domestic
GW031856	GW031856	90WA809087	"Ambardo"	229157	6603179	Quarterly	Quarterly	Six monthly	-	Stock & domestic
GW052266	GW052266	90BL116929	"Tarrawonga"	227848	6604674	Quarterly	Quarterly	Six monthly	-	Stock & domestic
GW020432*	GW020432		"Merriown"	224451	6607991	Until Oct.2008	Until Jan.2007	Until Jan.2007	-	Decommissioned monitoring bore
Templemore A†			"Templemore"	230997	6605537	Quarterly	Quarterly	Six monthly	-	Stock & domestic
Templemore B†			"Templemore"	230544	6604345	Quarterly	Quarterly	Six monthly	-	Stock & domestic
TA60*	90BL255930		"Mine Site"	230164	6607286	Continuous	-	-	69, 89, 109, 118	Decommissioned monitoring bore
TA65	90BL255930		"Mine Site"	230997	6607344	Continuous	-	-	30, 35, 47, 56, 97, 110, 136, 153	Active VWPs

* Bore no longer used. Monitoring undertaken until bore was removed by the advancing mine pit
† May not have been licensed. Stock/domestic bore from previous landowners on land acquired by Tarrawonga
TRH- Total Recoverable Hydrocarbons
^ Bore was damaged in early 2019

Table 24 Proposed Local Groundwater Monitoring Programme

Parameter	Location	Timing
Piezometers (Groundwater Levels – m AHD)	• Existing monitoring network (TCM and surrounding mines/projects).	• Quarterly - mine life.
	• Additional Alluvial groundwater system monitoring network (pit side and flood plain side of low permeability barrier).	• Years 10-17 and at least 2 years post-mining.
	• Additional Porous Rock groundwater system monitoring bores (flood plain side of low permeability barrier).	• Years 10-17 and at least 2 years post-mining.
	• Additional bore installations in the waste emplacement (if feasible) behind the advancing open cut.	• Progressive over the mine life.
Groundwater Quality Metals: • Al, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Mn, Hg, Ni, Se, V, Zn Cations: • Ca, Mg, Na, K. Anions: Cl, SO4, OH, CO3, HCO3 Nutrients: • NH3, NO2, NO3 Total Recoverable Hydrocarbons (TRH): • C6-C10 Fraction, C6-C10 Fraction Minus BTEX, >C10-C16 Fraction, >C10-C16 Fraction minus Naphthalene, >C16-C34Fraction, >c34-40 Fraction, >c10-C40 Fraction, Sum of BTEX, Total Xylenes, Naphthalene Other: • pH, EC, TDS.	• At piezometers above. • TRH only at MW1	• Quarterly for field pH and EC; six-monthly for laboratory analysis of full suite. • Six monthly for TRH
Mine Water Balance	• Measurement of volumes extracted from the open cut/sump to MWDs, pumped water, coal moisture, etc.	• Mine life.

Table 25 Regional Groundwater Monitoring Programme near the TCM

Bore	Easting (MGA 56)	Northing (MGA 56)	Piezometers	Reason
Reg6	223,196	6,606,862	Standpipes in alluvium and underburden (2)	Within predicted 1m water table drawdown zone in Nagero Creek alluvium. Adjacent old DoI Water bore GW036010.
Reg7a	234,594	6,605,841	Standpipes in alluvium and underburden (2)	On edge of predicted 1m water table drawdown in Bollol Creek alluvium. Adjacent bore BCS6.
Reg9	234,782	6,611,244	VWP interburden and coal seams (8)	In moderate drawdown zone to north-east of Tarrawonga mine and east of Boggabri mine. In Maules Creek Formation.
Reg14	229,139	6,602,836	VWP interburden and coal seams (8)	In Bollol Creek alluvium well outside any predicted drawdown. Adjacent bore GW031856 in Tarrawonga network.

The results of the groundwater monitoring programme would be compared with modelling predictions. If significant departures occur from predictions, the model would be re-calibrated at the next scheduled three-yearly update.

5.4.6 Evaluation of the Groundwater Model

The evaluation of model performance is tied to trigger exceedance protocols in Section 6.5.An independent review of the model and its performance should be conducted in accordance with PA 11_0047 Schedule 3 Condition 38(a)(iii), which 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."*

Other circumstances which may trigger further development or refinement of the groundwater model include:

- a significant change to the mine plan;
- acquisition of new hydrogeological information, such as groundwater levels and aquifer properties (i.e. hydraulic conductivity) which are significantly different from calibrated values used in the model; and
- groundwater drawdown and inflows which significantly exceed model predictions for that stage of mining.

The TCM groundwater model chronology includes:

- Developed for the Environmental Assessment in 2011 using MODFLOW-SURFACT software.
- Model performance assessed in 2015 and updated for actual mining sequence.
- Conversion to MODFLOW-USG in 2019. Currently undergoing re-calibration

5.5 Groundwater Trigger Values

Groundwater trigger value criteria have been adopted for:

- groundwater quality;
- impacts on existing licensed users;
- mine inflow rate; and
- mine pit water quality.

Specific triggers related to groundwater levels are addressed at Section 6.5.

5.5.1 Groundwater Quality Criteria

The EC levels within sampled water indicate that most groundwater's are at the limit of potable use but are suitable for livestock, irrigation and other general uses.

The groundwater quality objectives of the BTM Complex Water Management Strategy are:

- to maintain the most sensitive identified beneficial use of all groundwater systems potentially affected by the BTM Complex operations, consistent with the NSW State Groundwater Quality Protection Policy, and the Aquifer Interference Policy; and
- within this, to maintain the annual average EC values within the historical 95th percentile.

According to the Upper and Lower Namoi Groundwater Sources WSP, the beneficial uses of the alluvial groundwater sources surrounding the Complex are "raw water for drinking", and "agricultural use". No beneficial uses are specified for the porous rock aquifers in the Murray Darling Basin Porous Rock (Gunnedah-Oxley Basin) WSP. Given the typically high salinity of the water, the beneficial use is likely to be 'stock watering'.

A performance indicator is developed in Section 6.5 for annual average EC values of groundwater samples.

In addition, compliance of other water quality parameters would be checked against National Environment Protection Council (NEPC) agricultural and livestock guidelines as shown in Table 26.

Table 26 Groundwater Quality Criteria

Analyte	Agricultural Irrigation (mg/L)	Livestock (mg/L)
Aluminium	5	5
Arsenic (total)	0.1	0.5
Boron	0.5	5
Cadmium	0.01	0.01
Chromium (total)	1.0	-
Chromium (VI)	0.1	1.0
Cobalt	0.05	1
Copper	0.2	0.5
Iron	0.2	-
Manganese	2.0	-
Mercury (total)	0.002	0.002
Nickel	0.02	1.0
Selenium	0.02	0.02
Zinc	2.0	20.0
Calcium	-	1000
Nitrate	-	400
Nitrite	-	30
Sulphate	-	1000
TDS (salinity)	600 (conversion from EC)	2400

- No published values
Source: Modified after NEPC (1999)

5.5.2 Impacts on Licensed Users

The groundwater modelling carried out for the TCP-EA indicates that the drawdown effects on groundwater users in the vicinity of the mine are not likely to be significant (that is, less than 1 m) and would not materially affect the existing or potential future beneficial use of groundwater. One bore located in the Leard State Forest (GW967859) that draws water from the shallow porous rock source is predicted to experience approximately 8m of drawdown as a result of the TCM and approximately 20m from all surrounding mines. The Boggabri Coal Mine groundwater network already includes a monitoring bore (IBC2139) adjacent to this location.

Two nearby privately owned bores on the Coomalgah property are predicted to have a maximum drawdown of about 1 m. Bore Reg7a has been sited on the Coomalgah property to monitor any approaching drawdown. If the water supply of any owner of privately-owned land is adversely and directly impacted (other than a negligible impact) as a result of the TCM then TCPL will provide a compensatory water supply to the land owner in consultation with DoI Water, and to the satisfaction of the Secretary in accordance with Schedule 3 Condition 32 of the Project Approval.

At other sites where minimal impact is expected, baseline levels were established during the TCP-EA investigations. Measured hydrographs for each bore are presented in Appendix AB of Heritage Computing (2011).

The maximum drawdown expected at each non-mine monitoring or production bore is presented in Appendix AD of Heritage Computing (2011).

With respect to the Aquifer Interference Policy and impacts to licensed users; the minimal impact considerations of 2 m maximum drawdown at third-party production bores or wells are outlined below.

The TCM-EA (Appendix A, Figure A-44) notes that the predicted 2 m drawdown extent, due to the TCM alone, for the alluvium/regolith water table is expected to extend about 4 km to the north and east, about 2.5 km to the west, with no extension to the south (due to truncation of target coal seams by faulting). Of 121 registered bores within 5 km of the TCM, 67 are on land owned by Whitehaven or BCPL. There are no private bores within the 2 m drawdown zone of influence drawing water from alluvium. One bore in the Leard State Forest (GW967859) that would draw water from porous rock is expected to have a maximum drawdown of about 8 m due to the TCM alone and about 20 m cumulative impact from all three mines. If this bore is in use, a make-good arrangement is warranted.

5.5.3 Mine Pit Inflow Rates

TCM's experience on site since commencing operations in 2006 has found low to very low groundwater inflows. Volumes of water collected via in-pit sumps from May 2006 to April 2012 have ranged from 0.03 to 0.15 ML/day averaged over each year, gradually increasing with time (Heritage Computing, 2012). The volumes are estimates based on pumping hours and average pumping rates. It is difficult to ascertain the contribution of groundwater inflows to these volumes, as the rates are affected by rainfall, runoff, evaporation, possible water transfers, possible Mine Water Dam leakages, and pump mobility and variability.

The numerical model built for the TCP-EA determined the potential time-varying inflow rates from the porous rock and alluvial groundwater systems into the open cut pit. The model predicted that the total inflows would vary between approximately 0.4 and 1.1 ML/day over the life of the mine with an average of about 0.7 ML/day.

The predicted annual groundwater volumes required to be licensed over the life of the mine and post-mining are summarised in Table 27. These values are conservative in the sense of assuming no diminution of inflows due to the cumulative effects of the neighbouring mines.

For the Gunnedah - Oxley Basin MDB Groundwater Source, recent re-modelling conducted by Heritage Computing suggests a reduction of about 4 percent in the maximum take in Years 1 to 11, so that the estimated licensable take is now 242 ML/annum. (If the effect of the Boggabri Mine is considered, the take by the TCM would be about 190 ML/annum maximum from the porous rock water source.) The licensable take (242 ML/annum) is equivalent to 76 percent of porous rock licences held by TCM.

From Year 12 (2024) onwards, pit inflow would be contributed from alluvium as well as porous rock and waste rock. The maximum predicted take from the alluvial water source was determined by Heritage Computing to be about 198 ML/a. The BTM Complex groundwater model is currently being updated in 2019 to confirm the TCM future predicted take from alluvial water sources. TCM's current volumetric licence allocation for alluvial water sources will be reviewed after the groundwater model has been updated to determine the appropriateness of current WALs held by TCM.

The BTM Complex Water Management Strategy recommends that a trigger be established for groundwater take in excess of approved/licensed extraction as described in Table 34.

Table 27 Estimated Groundwater Licensing Requirements

Water Sharing Plan	Management Zone/ Groundwater Source	Predicted Average Annual Inflow Volumes Requiring Licensing (ML/annum)			
		Years 1 to 11	Year 12	Years 13 to 17	Post Mining
Porous Rock Groundwater Water Sharing Plan	Gunnedah-Oxley Basin – Namoi	209 (Average) 252 (Maximum)	209	209 (Average)	167 (Maximum)
Upper and Lower Namoi Groundwater Sources	Upper Namoi Zone 4 – Namoi Valley (Keepit Dam to Gin's Leap)	Negligible	198	142 (Average) 169 (Maximum)	Negligible

5.5.4 Mine Pit Water Quality

Groundwater quality within the site is highly variable, with measured EC ranging from 440 µS/cm to about 7,500 µS/cm in alluvium and from 530 µS/cm to about 2,800 µS/cm in coal. In general, the median values are about 1,000 µS/cm in coal, about 2,000 µS/cm in alluvium and volcanics and about 2,500 µS/cm in coal measures interburden (Heritage Computing, 2011). The inflow quality will be determined by coal and interburden salinities initially, with contributions from alluvial waters from Year 12 (2024).

The salinity and chemistry of mine inflow has an effect on site water management and water treatment, but does not raise any impacts of environmental concern. Accordingly, measurements of groundwater quality in bores and surface water quality in streams are more appropriate. Notwithstanding this, TCM will to continue monitoring surface water quality in the mine pit, and in particular pH, to monitor the potential for acid rock drainage related impacts.

6 SURFACE WATER AND GROUNDWATER RESPONSE PLAN

6.1 General

The Surface Water and Groundwater Response plan includes a protocol for managing and reporting any:

- incidents;
- complaints;
- non-compliances with statutory requirements;
- exceedances of the impact assessment criteria and or performance criteria; and
- a protocol for periodic review of the plan.

This surface water and groundwater response plan uses an adaptive management approach to limit the risk of a mine-related exceedance occurring/recurring in accordance with Schedule 5 Condition 2 of PA 11_0047.

6.2 Exceedance Response Protocol

Where an exceedance of the trigger values documented in Section 3.6 and Section 5.5 is identified, TCPL will follow the procedure listed in Table 28. This procedure will also apply in the event of an exceedance of allocated water volumes under the site's Water Access Licences for groundwater sources (listed in Table 22) or the measurement of a substantial change in groundwater quality more than the trigger levels defined within this WMP.

Table 28 Exceedance Response Protocol

Stage	Procedure
1	Record the timing, location, environmental conditions and any contributing factors to the exceedance.
2	Assess the monitoring results for any anomalies or causes.
3	Inspect sampling point and areas upstream to ascertain cause of exceedance.
4	Repeat sampling if required to confirm results exceed trigger level.
5	Review operational practices in accordance with the Unforeseen Impacts Protocol in Table 29 to determine if any current operational practice contributed to the exceedance.
6	If safe then cease any controlled discharges which may be causing the non-compliance and/or contain contaminated water, where possible, to prevent environmental harm.
7	Remediate any environmental harm, where possible, and use an external contractor if required.
8	If mine related then inform relevant agencies and community (if required) in accordance with Section 8.3 of this WMP and Schedule 5 Condition 8 of PA 11_0047.
9	Seek external support/ advice if required.
10	Provide a response to relevant agencies according to Schedule 5 Condition 8 of PA 11_0047.
11	Implement ameliorative measures on site in consultation with relevant agencies to minimise the potential for future exceedance.
12	Assess the performance of implemented measures against the respective trigger values given in Section 3.6 and Section 5.5

6.3 Unforeseen Impacts Protocol

The procedure outlined in Table 29 will be followed in the event that any unforeseen surface water or groundwater impacts (exceedances) occur. The procedure will be in general accordance with the Exceedance Response Protocol in Section 6.2.

Table 29 Unforeseen Impact Protocol Procedure

Stage	Procedure
1	Review the unforeseen impact, including consideration of: • Any relevant monitoring data; and • Current mine activities and land management practices in the relevant catchment.
2	Commission an investigation into the unforeseen impact by an appropriate specialist selected in consultation with appropriate regulatory authorities.
3	Develop appropriate ameliorative measures based on the results of the above investigations, in consultation with the relevant authorities.
4	Implement additional monitoring where relevant to measure the effectiveness of the ameliorative measures.

6.4 Surface Water Response Plan

Trigger action response plans (TARPs) to limit the risk of, and respond to, exceedances of surface water triggers is provided below for:

- mine water storage (Table 30);
- sediment dams (Table 31) and
- downstream water quality (Table 32)

Response plans for other surface water related events are provided in Table 33.

Table 30 Mine Water Storage TARP

Level	Trigger	Action	Response
Level 1 (Normal)	Mine water dam water level below 80% operating water level in Table A2 [a]	• Continue to monitor levels in accordance with monitoring plan	• No response required
Level 2 (Early warning)	Current or forecast rainfall greater than 25 mm/d	• 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 if required
Level 3A (Possible exceedance of operational level)	Mine water dam water level exceeds 80% operating water level in Table A2 (80% capacity) with inflows still occurring [a]	• Reduce process inflows if practical • Commence transfer from storages with highest risk of spill if possible	• Post-event review to confirm suitability of water transfer infrastructure & operational rules if required • Update operational rules if required • Prepare recommendations for modifications or upgrades to water transfer infrastructure if necessary
Level 3B (Possible discharge of mine water)	Mine water dam water level exceeds 95% operating water level in Table A2 (95% capacity) with inflows still occurring [a]	• Cease process inflows to storages with highest risk of spill • Maximise pumping capacity for dewatering of storages with highest risk of spill (e.g. relocate mobile pumps) where practical	• 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 if necessary
Level 4 (Discharge of mine water)	Discharge of mine water from one or more mine water storages	• Activate Exceedance Response Protocol actions in Section 6.2 • Collect water quality samples of spills at dam overflow point and in receiving watercourse in accordance with Section 3.5.4	• Activate Unforeseen Impacts Protocol in Section 6.3

[a] The SB4 operating water level is 20% of the Full Storage Capacity as it receives catchment inflows from the ROM Pad.

Table 31 Sediment Dam TARP

Level	Trigger	Action	Response
Level 1 (Normal)	Sediment dam water level below operational level in Table A1	• Continue ongoing inspection and maintenance of sediment dams in accordance with Section 3.5	• No response required • Check sediment levels in sediment dams and de-silt if required
Level 2A (Early warning)	Current or forecast rainfall greater than 25 mm/d	• Ensure transfer pumping network is operational • Review options for water transfer if required • Undertake inspection to check sediment accumulation if required	• Post-event review to confirm event was well managed if required • Check post-event sediment levels in sediment dams as required
Level 2B (Exceedance of operational level)	Sediment dam water level exceeds operating water level in Table A1 with inflows still occurring	• Dewater storages with highest risk of off-site discharge where possible • Take water quality sample and compare against triggers level in Table 6 if required • Consider options for controlled releases (e.g., pumping requirements, treatment)	• Review system configuration to ensure operating as designed if required • Check post-event sediment levels in sediment dams as required
Level 3B (Sediment dam discharge)	Off-site Discharge (e.g., controlled release, spills) from authorised sediment dams with TSS, pH or Oil and grease less than trigger level in Table 6	• Collect sample of LDP outflow in accordance with Section 3.5.4 • Confirm water quality in dam outflow less than trigger levels in Table 6	• 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
Level 4 (Exceedance of water quality target)	Discharge from sediment dam with TSS, pH or Oil and grease greater than trigger level in Table 6	• Activate Exceedance Response Protocol actions in Section 6.2 • Check if event rainfall exceeds design standard • Notify relevant agencies and community 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 • Activate Unforeseen Impacts Protocol in Section 6.3

Table 32 Downstream Water Quality TARP

Level	Trigger	Action	Response
Level 1 (Normal)	All surface water quality samples below trigger levels in Table 7	• No action	• Continue to monitor water quality in accordance with monitoring plans
Level 2 (Early warning)	Single value at downstream sampling site exceeds trigger level in Table 7	• Check upstream water quality to assess potential for impact from operations in accordance with Section 3.5 • Activate Exceedance Response Protocol actions in Section 6.2	• 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 7	• Check upstream water quality to assess potential for impact from operations in accordance with Section 3.5 • Activate Exceedance Response Protocol actions in Section 6.2	• If upstream pollutant concentration is higher or within 5% of downstream values then consider need for review of trigger levels • Implement appropriate mitigation measures, if required
Level 3B (Potential water quality impact – sediment dam discharge)	Water quality at multiple downstream sampling sites exceeds trigger levels in Table 7 and discharge from site sediment dams has occurred	• Check upstream water quality to assess potential for impact from operations in accordance with Section 3.5 • Activate Exceedance Response Protocol actions in Section 6.2	• If upstream pollutant concentration is higher or within 5% of downstream values then no further action required • Implement appropriate mitigation measures, if required
Level 4 (Likely water quality impact – mine water dam discharge).	Single value at downstream sampling site exceeds trigger level in Table 7 and discharge from mine water dam has occurred	• Activate Exceedance Response Protocol in Section 6.2	• Activate Unforeseen Impacts Protocol in Section 6.3

Table 33 Surface Water Network and Infrastructure Contingency Actions

Trigger	Action/Response
Mechanical failure of pumping equipment prevents scheduled transfers	• Ensure adequate spares are available. Source temporary equipment if possible.
Damage to water storage infrastructure	• Regular visual inspection of infrastructure, especially following significant rainfall.
Failure of water storage structure	• Notify relevant agencies and/or communities in accordance with Section 8.3 of this WMP. • Investigate the downstream impacts of the failure and complete a detailed report on the impacts of the failure, including an assessment of likely water volume and quality, and required remedial actions. • Investigate the reason for failure of the structure and ensure the stability of other water storages at risk. • Assess the effects of the failure on the water management system and implement mitigation measures.
Water demands or catchment yield depart from assumed values used in modelling	• Investigate reasons. • Revisit site water balance modelling if required.
Short-term water demand forecast may approach the entitlement under high security water licences	• Further improvements in water use efficiency. • Investigate procurement of additional water licences. • Extraction of groundwater from existing or new bores (within licence conditions). • Increased retention of site runoff without discharge.
Stream and riparian vegetation health monitoring indicates measurable declining vegetation health.	• Undertake an investigation in accordance with the Unforeseen Impacts Protocol (Section 6.3).
Site inspections indicate unexpected erosion or sedimentation downstream of the mine.	• Undertake an investigation in accordance with the Unforeseen Impacts Protocol (Section 6.3).
Oil/chemical spill event	• Stop all work in the area where the spill occurred. • Deploy spill response kits if applicable and contain the spill if safe to do so. • Notify the Environmental Officer or representative and consult safety data sheet, if relevant. • Mitigate spill. • Notify potentially affected persons (where necessary). • Report incident internally. • Notify and report to the incident to the relevant agencies, if required. Refer to Section 8.3 for incident reporting requirements. • Complete Exceedance Response Protocol actions in Section 6.2, if required. • Undertake an investigation in accordance with the Unforeseen Impacts Protocol (Section 6.3).

6.5 Groundwater Response Plan

Specific trigger levels have been designed to alert TCM to observed parameter responses which are outside of normal variation and predicted responses, or where observed parameter values do not follow anticipated trends.

The triggers for instigation of response actions would occur when observed changes to monitored parameters exceed specified levels. Such changes in observed parameters or conditions include:

- sudden inrush of groundwater into the mine pit in exceedance of predicted inflows;
- significant change in observed water quality or groundwater levels between sampling rounds;
- changes in trends over an extended period for groundwater levels and quality; and
- a significant increase or variation from model predictions

The BTM Complex Water Management Strategy supports the performance indicators proposed by Heritage Computing (2012) for detection of far-field and mid-field regional groundwater impacts. An additional performance indicator has been developed for near-field effects. The four performance indicators and response actions are defined in Table 34.

Note that the use of a 5th percentile rule for far-field effects means that groundwater elevations can be expected to be below this threshold for 5 percent of measurements, if future climatic conditions match what has occurred during the baseline monitoring period. To counteract spurious measurements, which could occur for example during maintenance of a sensor or downloading or water sampling, a 7-day average is proposed to cover such events. In addition, to ensure any exceedance of a trigger is sustained and is therefore significant, a 1-month exceedance duration is proposed to allow water levels to stabilise. This would "trigger" an investigation in the first instance, not an immediately reportable incident.

A specific groundwater Trigger Action Response Plan (TARP) is provided in Table 34.

Specific monitoring and assessment of impacts to GDE's are detailed in the TCM's Biodiversity Management Plan.

Table 34 Groundwater Performance Indicators and Response Actions

Effects	Performance Measure	Performance Indicator	Assessment	Monitoring Sites (in proximity to TCM)	Control Sites (in proximity to TCM)	Action
Far-field	Tolerable reduction in water table level in alluvium fringing the BTM complex	Groundwater level hydrographic response based on 7-day moving average data compared with rainfall and the historical 5th percentile water levels established for the preceding 24 months of data.	The performance indicator is exceeded if groundwater levels are lower than the 5th percentile for more than one month, or more than 1.5 m below the minimum recorded historical level[1].	Reg6, Reg7a	Reg14	If the performance indicator is exceeded, comparison will be made with the control site(s) very far from mining to establish whether the exceedance is due to natural seasonal variations. If the cause cannot be ascribed clearly to climate, a groundwater specialist will be engaged to determine the reason for the exceedance.
Mid-Field	Expected reduction in deep groundwater pressures within the Maules Creek Formation coal measures.	Vertical hydraulic head profiles and time-varying reductions in groundwater head.	The performance indicator is exceeded if the measured groundwater heads and vertical head differences depart substantially from model predictions, or if the uppermost sensor has a head more than 1.5 m below the minimum recorded historical level[1].	Reg9	NA	If the performance indicator is exceeded, a groundwater modelling specialist will be engaged to determine the reason for the exceedance. A check would first be made for alignment of actual mine progression with that assumed for model predictions. A decision would be made as to whether model re-calibration is warranted.

[1] This will provide advance warning of a groundwater level approaching the 2m impact threshold of the Aquifer Interference Policy.

Effects	Performance Measure	Performance Indicator	Assessment	Monitoring Sites (in proximity to TCM)	Control Sites (in proximity to TCM)	Action
Chemical	Tolerable increase in shallow groundwater electrical conductivity (EC) in alluvium fringing the BTM complex	Groundwater EC average data compared with the historical 95th percentile EC established for the full length of record (greater than 24 months).	The performance indicator is exceeded if the annual average EC value at the time of the annual review is higher than the historical 95th percentile.	Reg6, Reg7a	NA	If the performance indicator is exceeded, comparison will be made between sites to establish whether the exceedance is due to natural seasonal variations. If the cause cannot be ascribed clearly to climate, a groundwater specialist will be engaged to determine the reason for the exceedance.
Near-Field	Expected reduction in deep groundwater pressures within the Maules Creek Formation coal measures between the mine and Goonbri Creek.	Vertical hydraulic head profiles and time-varying reductions in groundwater head.	The performance indicator is exceeded if the measured vertical head differences and rate of decline of groundwater heads depart substantially from model predictions.	TA60C, TA65C	NA	If the performance indicator is exceeded, TCM will seek external advice and a groundwater modelling specialist may be engaged to determine the reason for the exceedance. A check would first be made for alignment of actual mine progression with that assumed for model predictions. A decision would be made as to whether model re-calibration is warranted.

Table 35 Groundwater Monitoring Network

System / measure	Monitoring		Response		
	Methodology	Purpose	Trigger	Action	Responsibility
Groundwater Levels – Namoi River alluvial aquifer	• Sites: • Local groundwater bores in alluvium: MW2, MW4, MW5, MW6, GW031856, GW044997, GW052266 • Regional groundwater bores in alluvium: Reg6, Reg7a, Reg14. • Parameters: • Water level. • Analysis: • Comparison to predicted drawdown taking into account natural variations observed in background reference sites.	• To provide baseline water level data and to identify water level impacts. • To verify that drawdown impacts on specified Namoi River Alluvium bores are consistent with model predictions and compliant with the AIP impact threshold. • To re-calibrate and validate model with additional data.	• Performance Measure: Tolerable reduction in water table level in alluvium fringing the BTM complex. • Performance Indicator: Groundwater level hydrographic response based on 7-day moving average data compared with rainfall and the historical 5th percentile water levels established for the preceding 24 months of data. • Assessment: The performance indicator is exceeded if groundwater levels are lower than the 5th percentile for more than one month, or more than 1.5 m below the minimum recorded historical level.	• Engage a suitable specialist to undertake an investigation within 30 days on any identified changes or likely causes for the event, including recommendations in accordance with Section 6.5. • Notify agencies of the results of the investigation within 40 days of the engagement of the specialist, at conclusion of assessment. • Implement contingency responses as agreed with government agencies and in accordance with specialist's recommendations.	Environmental Officer or representative.
Groundwater Levels – Coal Measures and Boggabri volcanics	• Sites: • Local groundwater bores: MW1, MW7, MW8. • Mine site vibrating wire piezometers: TA60C, TA65C. • Regional groundwater bores: Reg9 • Parameters: • Water level • Analysis: • Comparison to predicted drawdown taking into account natural variations.	• To provide baseline water level data and to identify water level impacts. • To verify that impacts at specified monitoring bores are consistent with model predictions. • To re-calibrate and validate model with additional data.	• Performance Measure: Expected reduction in deep groundwater pressures within the Maules Creek Formation coal measures. • Performance Indicator: Vertical hydraulic head profiles and time-varying reductions in groundwater head. • Assessment: The performance indicator is exceeded if the measured groundwater heads and vertical head differences depart substantially from model predictions. • At TA60C and TA65C, the performance indicator is exceeded if the measured vertical head differences and rate of decline of groundwater heads depart substantially from model predictions.	• Engage a suitable specialist to undertake an investigation within 30 days on any identified changes or likely causes for the event, including recommendations in accordance with Section 6.5. • Notify agencies of the results of the investigation within 40 days of the engagement of the specialist, at conclusion of assessment. • Implement contingency responses as agreed with government agencies and in accordance with specialist's recommendations.	Environmental Officer or representative.

System / measure	Monitoring		Response		
	Methodology	Purpose	Trigger	Action	Responsibility
Mine water inflows – volume/rate	• Sites: • Water pumped out of the pit. Includes rainfall that collects in the pit. • Parameters: • Volume. • Analysis: • Comparison to predicted volumes in mine water management and groundwater models. Estimated by back-calculating groundwater inflow annually from full water balance taking into account rainfall, runoff, transfers, dam leakage, moisture and evaporation. •	• To verify that groundwater inflows are consistent with model predictions. • To provide inflow data that can be used to re-calibrate and validate the groundwater model.	• Groundwater take in excess of approved/licensed extraction, assessed annually	• TCPL to back-calculate groundwater inflow from water balance annually for Annual Review reporting. • Engage a suitable specialist to undertake investigation and report on any identified changes /likely causes and recommendations in accordance with Section 6.5. • Notify agencies when exceedance becomes known, and provide updates throughout investigation above, and at conclusion of assessment. • Implement contingency responses as agreed with government agencies and in accordance with specialist's recommendations.	Environmental Officer or representative.
Groundwater Quality	• Sites: • Local groundwater bores in alluvium: MW2, MW4, MW5, MW6, GW031856, GW044997, GW052266 • Regional groundwater bores in alluvium: Reg6, Reg7a. • Parameters: • Water quality – laboratory analysis suite. • Analysis: • Comparison to NEPM and baseline water quality.	• To provide baseline water quality data and to identify water quality impacts or changes in beneficial use of groundwater in alluvium.	• Performance Measure: Tolerable increase in shallow groundwater electrical conductivity (EC) in alluvium fringing the BTM complex. • Performance Indicator: Groundwater EC average data compared with the historical 95th percentile EC established for the full length of record (greater than 24 months). • Assessment: The performance indicator is exceeded if the annual average EC value at the time of the annual review is higher than the historical 95th percentile.	• Engage a suitable specialist to undertake investigation and report on any identified changes /likely causes and recommendations in accordance with Section 6.5. • Notify agencies when exceedance becomes known, and provide updates throughout investigation above, and at conclusion of assessment. • Implement contingency responses as agreed with government agencies and in accordance with specialist's recommendations.	Environmental Officer or representative.

6.6 Complaints

Whilst all endeavours will be made by TCPL to avoid adverse water impacts on local landowners / residents, it is acknowledged that from time to time such impacts may occur. In order to ensure an appropriate and consistent level of reporting, response and follow-up to any complaints is adopted by TCPL, the following complaints management protocol will be followed:

- A publicly advertised telephone complaints line will be in place to receive complaints during operating hours and record complaints at other times.
- Each complaint received will be recorded on a Complaints Register, which will include the following details:
  - The date and time of complaint.
  - Any personal details the complainant wishes to provide or if no such details are provided a note to that effect.
  - The nature of the incident that led to the complaint.
  - The action taken by TCPL in relation to the complaint, including any follow-up contact with the complainant.
  - If no action was taken by TCPL, the reason why no action was taken.
- The Environmental Officer or representative will be responsible for ensuring that an initial response is provided within 24 hours of receipt of a complaint (except in the event of complaints recorded when the mine is not operational).
- Data from the site weather station will be obtained for the time applicable to the complaint for use in determination of cause and identification of future remedial actions.
- Additional measures will be undertaken as required to address the complaint. This may include visiting the complainant, or inviting the complainant to the mine site.
- Once the identified measures are undertaken, the Environmental Officer or representative will sign off on the relevant complaint within the Complaints Register.
- If necessary, follow-up monitoring will take place to confirm the source of the complaint is adequately mitigated.
- A copy of the Complaints Register will be kept by TCPL and made available to the CCC and the complainant (on request). A summary of complaints received every 12 months will be included in the Annual Review.

Based on the nature of individual complaints, specific contingency measures may be implemented to the (reasonable) satisfaction of the complainant. The Environment Officer or representative retains responsibility to ensure that complaints received are properly recorded and addressed appropriately.

7 FUTURE WATER MANAGEMENT ELEMENTS

7.1 General

There are a number of aspects of the approved future works that have the potential to affect water quality leaving the site, or watercourse stability around the site. These factors are briefly discussed in the following sections however they will be covered in more detail in future revisions of this WMP and MOP, once more detailed work has been carried out on these specific future water management elements.

7.2 Final Void

The plan for mine closure includes leaving a final void that would achieve a water level close to pre-mine water levels in the coal measures. The final void design would ensure that water does not spill from the void, affecting the downstream watercourses. A previous water balance model of the final void, developed for the TCP-EA, was used to show that an equilibrium state would be reached. It was found that by partially backfilling the void, the water level could be controlled and raised to the desired, pre-mining level. This was one of several options that could be used in the design of the final structure; however this would be further developed during the detailed planning of mine closure as would considerations regarding how the hydrostatic pressure will be reduced in the alluvium immediately adjacent to the void.

7.3 Goonbri Creek Diversion, Low Permeability Barrier and Permanent Flood Bund

The TCM Life of Mine Plan is currently being updated and will no longer require the Goonbri Creek Re-alignment. Notwithstanding this, the Goonbri Creek Re-Alignment is included in the current PA11_0047 and has therefore been considered until the PA11_0047 and MOP is updated to reflect this change. The proposed works that would be undertaken if the future Goonbri Creek Re-alignment went ahead is discussed below.

The Goonbri Creek diversion is proposed in the current MOP for the full mining plan to be achieved. To prevent interaction between the creek and the final mine void a barrier to ground and flood flows is required. The following sections describe the three elements in their order of construction if the Goobri Creek diversion were to occur.

7.3.1 Low Permeability Barrier

A low permeability barrier would be constructed in the alluvium, approximately 50-100 m to the east and south-east of the final open cut extent. Construction of the low permeability barrier would be completed before 2024, which is when the open cut intersects the alluvium that feeds Goonbri Creek.

The depth of the alluvium adjacent to the open cut extent has been determined with reference to local borehole logs and a transient electromagnetic (TEM) geophysical investigation conducted in the area (described in the TCP-EA). Further geotechnical

evaluation of the required excavation depths to the basement rock on the final barrier alignment would be undertaken as part of its detailed engineering design.

The low permeability barrier would be constructed using a soil-bentonite mixture to meet the following design objectives:

- Minimise the potential for local drainage of alluvial groundwater into the open cut during operations and post-mining;
- Minimise the potential for future instability of the open cut batters formed in the alluvium (achieved by reducing the groundwater hydrostatic head in the alluvium immediately adjacent to the open cut/final void);
- Maintain the hydraulic character of Goonbri Creek by minimising the potential loss of baseflow; and
- Maintain the value of alluvial groundwater, by minimising potential interactions with the mine final void, post-mining.

It is expected that the low permeability barrier would reduce groundwater seepage from the alluvium to the open cut from approximately 3.3 ML/day to 0.1 ML/day (across a length of some 2 km).

Construction of the section of the low permeability barrier that crosses the existing alignment of Goonbri Creek would be timed to avoid periods when surface water flow in the creek is occurring. A temporary means of channelling flows around the in-creek construction activities (e.g. cutting and/or dam and pumping system) would be installed as a contingency measure if a rainfall event was to occur.

Until such time that the permanent flood bund is completed and the permanent Goonbri Creek alignment is commissioned, this portion of the low permeability barrier would be protected from erosion scouring at the surface by rock armouring or equivalent.

The final design of the low permeability barrier would also consider the potential impacts of blasting on the consolidation of the soil-bentonite mixture and the subsequent differential settlement to the adjacent geological sequences/interfaces and keying-in of the cut-off barrier.

Further details regarding the design considerations, construction methodology and predicted performance of the low permeability barrier are provided in Appendix R and Section 4.4 of the TCP-EA.

7.3.2 Permanent Flood Bund

A permanent flood bund would be constructed to prevent inundation of the open cut during operations and post-mining. The permanent flood bund would generally coincide with the alignment of the low permeability barrier.

The permanent flood bund would be designed to a height that would provide protection against the peak flood height associated with a Probable Maximum Precipitation rainfall event. The width and geometry of the permanent flood bund would be such that it is stable under these extreme flow conditions.

The permanent flood bund would consist of an engineered clay fill core, which would be sub-excavated into the natural surface. Rock fill armouring would be placed on the eastern side of the clay fill core. The bund would then be topsoiled for revegetation.

For sections of the permanent flood bund running parallel to internal haul roads, the height of the bund would be increased to 6m as a noise mitigation measure.

Further details regarding the design, function and construction of the permanent flood bund are provided in Appendixes B and R of the TCP-EA.

7.3.3 Goonbri Creek Diversion

In the later stages of open cut mining at the TCM the pit would progress through a 3 km section of Goonbri Creek. The permanent Goonbri Creek alignment would be established by 2024 to the east of the open cut, prior to the open cut advancing into this section of the creek.

The permanent Goonbri Creek alignment would be constructed to meet the following design objectives:

- Construct a low flow channel that approximates the existing section of Goonbri Creek upstream of TCM in terms of stream geometry, hydrology and geomorphology;
- Mimic the meandering path of the existing alignment of Goonbri Creek, such that the length of the permanent Goonbri Creek alignment is approximately the same length as the section of Goonbri Creek being removed;
- Minimise the disturbance to the reaches of Goonbri Creek upstream of the permanent Goonbri Creek alignment; and
- Provide a stable transition back to the existing Goonbri Creek alignment which results in no detectable change to the hydraulic conditions in the reaches of Goonbri Creek or the Bollol Creek floodplain area downstream.

It is anticipated that the typical stages of construction may include:

- Excavation to form the low flow channel in the upper (i.e. northern) portion of the permanent Goonbri Creek alignment;
- Use of spoil from this excavation to form swales in the lower portion of the permanent Goonbri Creek alignment;
- Placement of rock fill armouring and topsoil on the eastern embankment of the permanent flood bund;
- Rock fill and woody debris placement to create a pool-riffle system within the low flow channel alignment;
- Revegetation of the low flow channel and its banks; and
- Revegetation of the surface of the permanent flood bund.

Once construction of the permanent Goonbri Creek alignment is completed and the revegetation has had time to become established, the northern end of the permanent flood bund would be constructed across the existing Goonbri Creek alignment. This would direct upstream surface water flows into the constructed low flow channel, thereby commissioning the permanent Goonbri Creek alignment. A small section of the existing Goonbri Creek alignment upstream of the permanent flood bund would also be backfilled.

7.4 Rejects Disposal Area

Reject material from the Whitehaven CHPP will be returned via truck to TCM for disposal. All reject material will be co-disposed within the footprint of the void with waste rock material. Reject material will be “mixed” with the waste overburden and interburden. This will primarily be achieved through the loading of the reject material over the dump face and the alternating of reject and mine waste dumping at the reject disposal areas. Generally, this material will be layered within the overburden material evenly to minimise any stability impacts.

An assessment of a concept cover system that would be required for the rejects disposal area(s) at TCM is given in the MOP. A refined design will be presented in future MOPs that includes the final rehabilitation of the rejects disposal area(s). The following reject emplacement methodology will be employed to limit sulphide oxidation and acid generation and/or the migration of any acid or sulphate species that may be generated from migrating beyond the pit shell:

- The acid forming potential of reject will be minimised through the dilution effect of co-disposal with overburden (including ongoing cover of overburden as part of the operational overburden emplacement process).
- Reject will be placed at least 30m inside the pit shell footprint.
- A setback angle of 30° will be utilised for ‘supercharged’ co-disposed rejects and overburden material (i.e. for areas where the backfill is higher than the original topography).
- The final cover of 5m of NAF material will be emplaced within a targeted maximum of 1 month from the time of co-disposal in the final lift of the waste emplacement that contains co-disposed reject (i.e. 5m below final landform). The 5m cover will sufficiently reduce oxygen diffusion and/or water infiltration and provides sufficient thickness for a base for the growth medium, which will overlie the cover.
- In line with MOP commitments, growth medium will be provided above the cover for rehabilitation to support successful long-term revegetation.

The risk of spontaneous combustion at TCM will be managed according to Section 3.2.5 of the MOP. The risk of a spontaneous combustion event at Tarrawonga is considered to be low. Testing was conducted on each coal seam to be exposed by mining at Tarrawonga, with 0.44% sulphur content being the highest recorded value (Velyama Seam). The low percentage of inorganic sulphur is indicative of a low potential for exothermic oxidation

reactions. TCM conducts Annual sampling and analysis of representative source reject material from the CHPP to assess for spontaneous combustion potential, as per Section 3.2.5 of the MOP.

Operational checks and controls to be implemented to ensure compliance with this methodology would include:

- water quality monitoring;
- survey controls (to identify where reject material has to be placed and to confirm appropriate placement of rejects material);
- annual geochemical and spontaneous combustion test work; and
- sampling and testing of cover material.

8 REPORTING AND REVIEW

8.1 Regular Reporting

TCPL will provide regular reporting on the environmental performance of the mine, CCC reports and Annual Reviews on Whitehaven's website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of PA 11_0047.

8.2 Audit and Management Plan Review

In accordance with the requirements of Schedule 5 Condition 5 of PA 11_0047, this document will be reviewed within three months of the submission of an:

- Annual Review;
- Incident Report (see Section 8.3);
- Independent Environmental Audit under Schedule 5 Condition 10 of PA 11_0047;
- any modification to the MOP; or
- any modification to PA 11_0047.

TCPL will investigate and implement ways to improve the environmental performance of the project over time. This will be achieved by keeping abreast of best practice in the industry for water management and monitoring options and reporting on the performance of the TCM water management system in the Annual Review.

8.3 Incident Reporting

In accordance with the requirements of Schedule 5 Condition 8 of PA 11_0047, TCPL will notify, at the earliest opportunity, the Secretary and any other relevant agencies of any incident that has caused, or threatens to cause, material harm to the environment.

For any other incident associated with the project, TCPL shall notify the Secretary and any other relevant agencies as soon as practicable after TCPL becomes aware of the incident.

Within 7 days of the date of the incident, TCPL shall provide the Secretary and any relevant agencies with a detailed report on the incident, and such further reports as may be requested.

Where any exceedance of a trigger value in Section 3.6 or Section 5.5 occurs, TCPL will also submit a report to DPIE in accordance with the requirements of Schedule 5 Condition 2 of PA 11_0047.

The outcomes of any Unforeseen Impacts Protocol (Section 6.3) will be reported in the Annual Review. The implementation of any mitigation measures will be undertaken in consultation with relevant agencies and will be reported in the Annual Review.

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APPENDIX A –DAM TRIGGER VOLUMES, SURFACE AREAS AND LEVELS

Table A1 Current (Year 2020) TCM Sediment Dam Trigger Volumes, Surface Areas and Levels

Dam System	Dam Name	Total Storage Trigger			Operating Trigger	
		Volume (ML)	Level (spillway) (mAHD)	Surface Area (m^2)	Volume (ML)	Water Level (mAHD)
Sediment dams						
SD17 (LDP1)	SB25*	40.0	TBA	22,480	35.3	TBA
	SB6*	1.0	281.0	1,222	1.0	280.9
	SD17	9.7	273.9	4,239	0.6	272.1
	Sump*	3.5	279.0	4,326	1.4	278.0
	SB7*	2.7	280.7	6,138	1.3	280.1
	SD1*	7.6	282.6	3,198	1.0	279.6
	SD2	29.4	282.6	4,650	10	280.5
	SB5B	3.1	281.5	2,184	0.6	279.8
	SB5A	7.8	288	3,504	1.6	286.0
SD9 (LDP2)	SD9	8.8	274.2	3,235	1.5	271.5
SB14 (LDP3)	SB14	8.6	272	4,253	4.0	270.7
SD16 (LDP24)	SB16A*	36.4	283.4	6,641	34.5	283.2
	SB16B	96.9	283.6	11,020	92.1	283.3
	SD8*	3.5	276.5	2,200	1.0	274.7
	SD16	31.6	273.1	10,700	8.7	270.5
SB23B (LDP26)	SB23A*	2.5	270.3	1,200	1.0	269.0
	SB23B	10.9	269.3	3,514	3.0	266.9
SB24B (LDP27)	SD18	34.0	285	10,500	21.0	283.7
	SB24A	3.6	278.8	1,968	1.0	276.8
	SB24B*	4.8	275.3	1,937	1.0	263.0
	SB26	35.5	276.4	14,669	16.0	274.1

* Does not receive or supply pumped inflows in the OPSIM model

Table A2 Current (Year 2020) TCM Mine Water Dam Trigger Volumes, Surface Areas and Levels

Dam Name	Total Storage Trigger			95% Operating Trigger*		80% Operating Trigger	
	Volume (ML)	Level (spillway) (mAHD)	Surface Area (m^2)	Volume (ML)	Water Level (mAHD)	Volume (ML)	Water Level (mAHD)
PW2	22.8	284.2	5,894	21.4	284.0	18.2	283.5
PW3	26.5	287.7	7,430	25.2	287.5	21.2	286.8
PW4	268.5	288.0	28,799	255	287.5	214.8	285.7
PW5	0.5	337.7	5,080	0.4	336.8	0.4	336.2
SB4	6.0	301.5	2,658	1.2	300.7	-	-

* Operational triggers are 95% of the total storage triggers except for SB4. SB4 operational triggers are 20% of the total storage triggers as it receives catchment runoff from the ROM Pad.

APPENDIX B – INDIVIDUAL DAM SYSTEM WATER BALANCE RESULTS

The modelled LDP and mine water storage volumes over the 5-year forecast period (Year 2018 to Year 2022) are provided below in Figures B1 to B8. These figures also show the Total Storage Volume and Operational Volume for each LDP and mine water system.

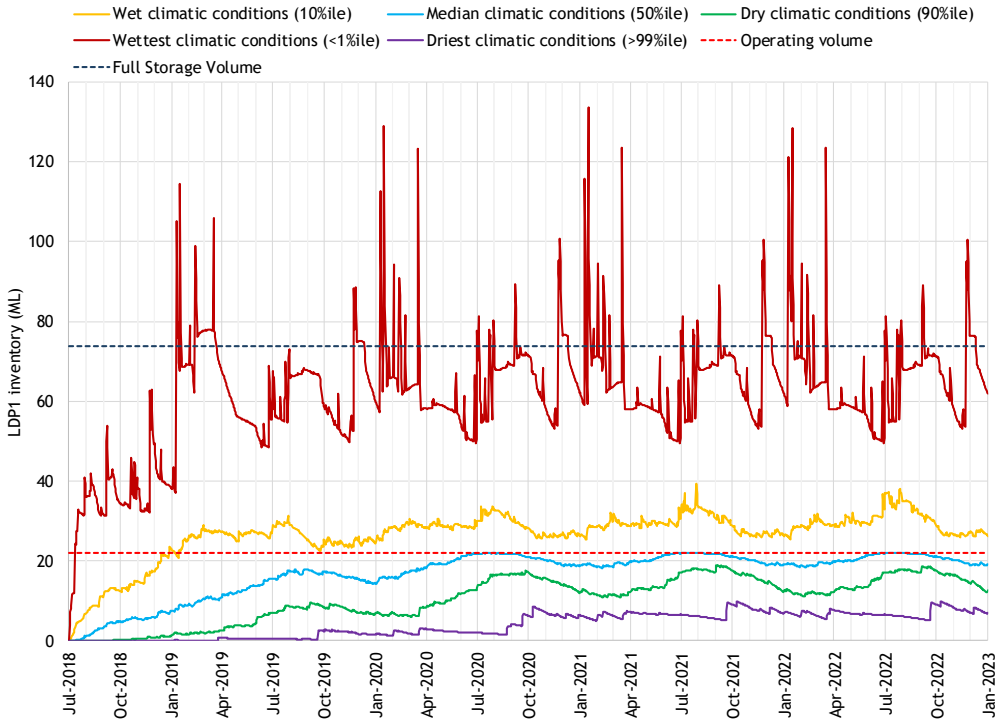


Figure B1 Forecast LDP1 Catchment Stored Inventory Results

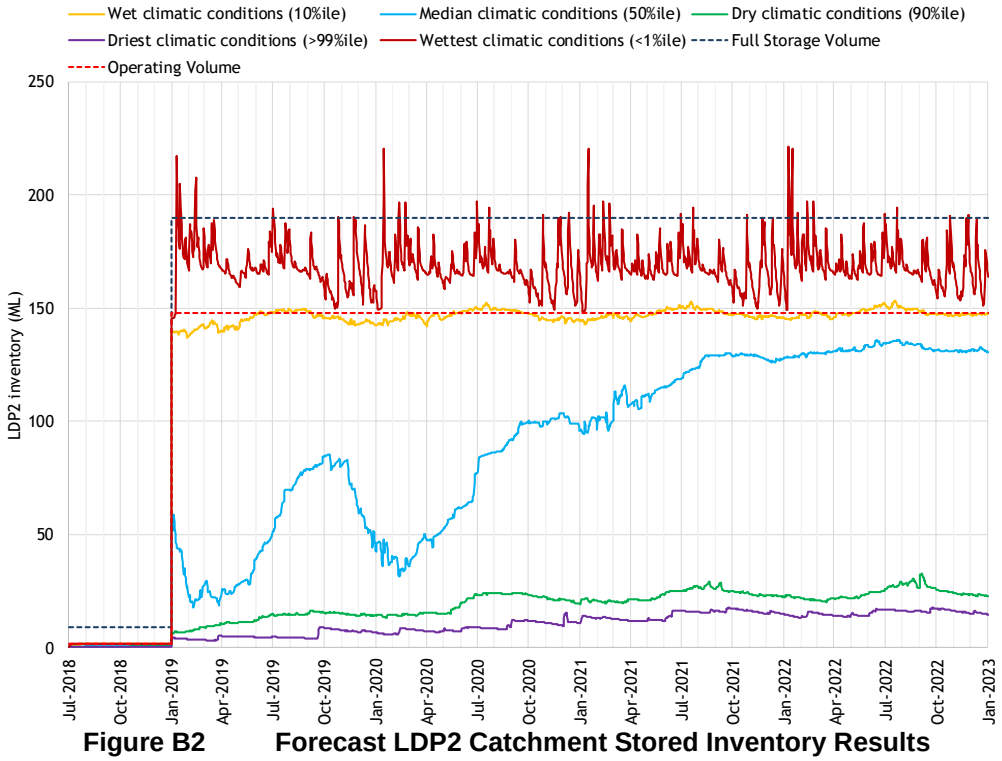


Figure B2 Forecast LDP2 Catchment Stored Inventory Results

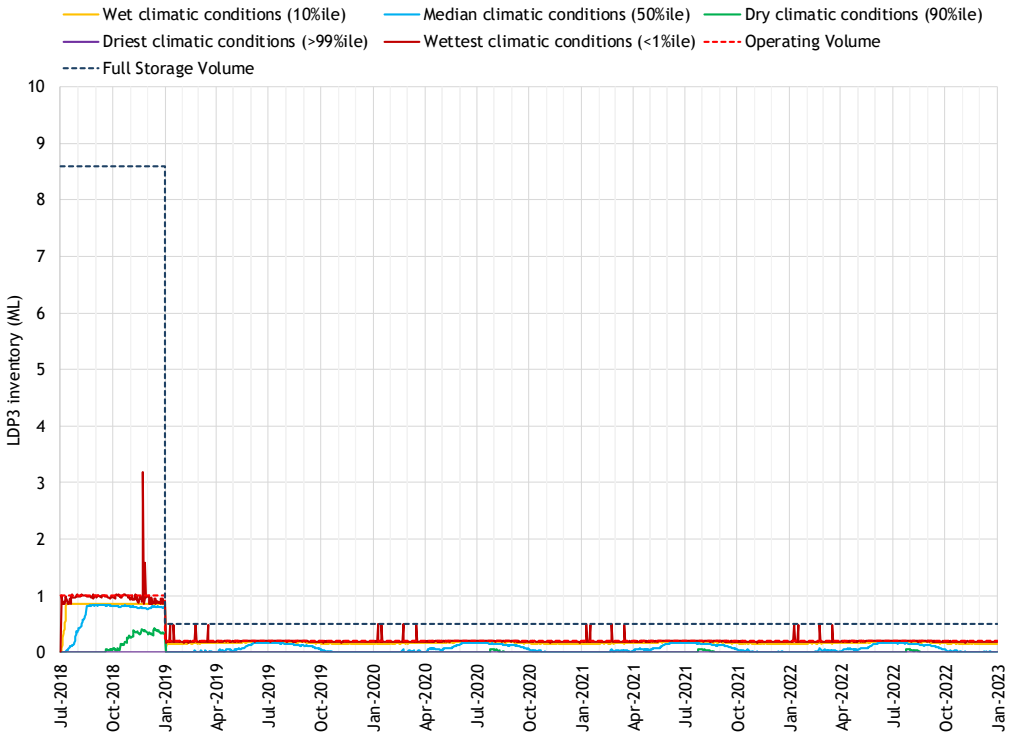


Figure B3 Forecast LDP3 Catchment Stored Inventory Results

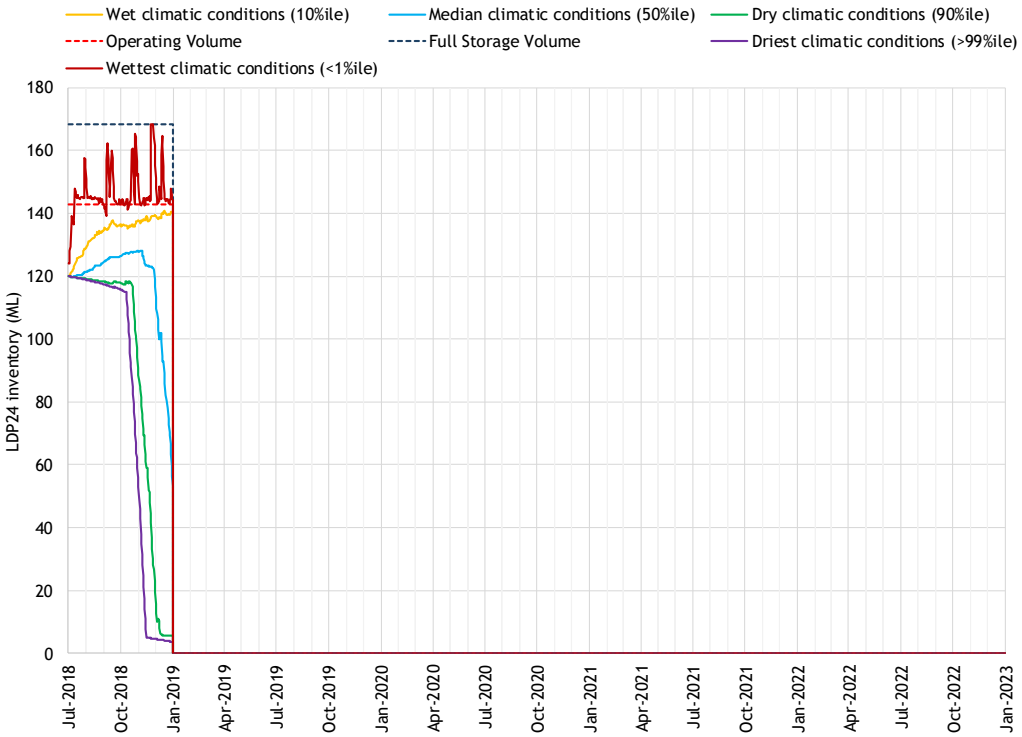


Figure B4 Forecast LDP24 Catchment Stored Inventory Results

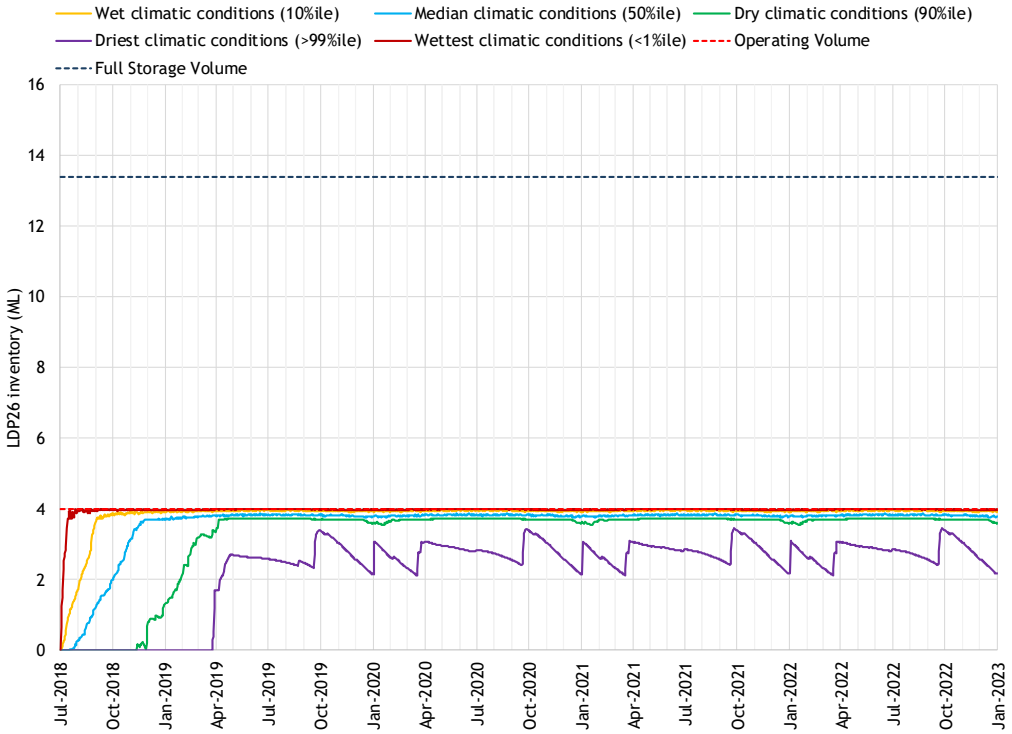


Figure B5 Forecast LDP26 Catchment Stored Inventory Results

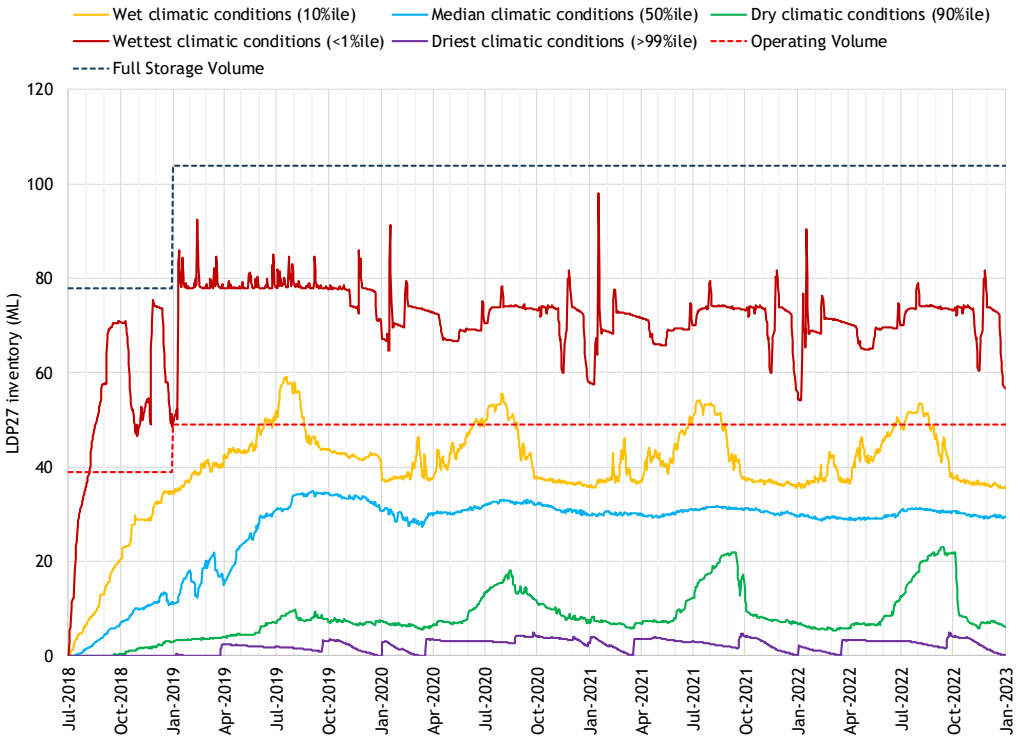


Figure B6 Forecast LDP27 Catchment Stored Inventory Results

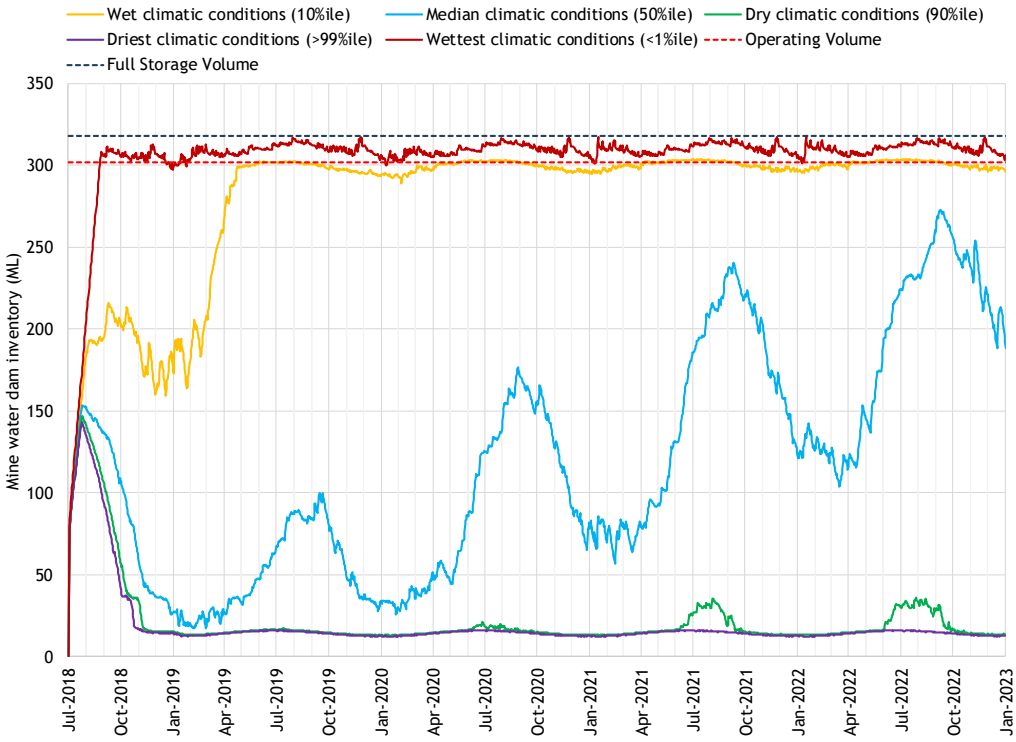


Figure B7 Forecast Mine Water Inventory Results (Excluding the Mine Pit)

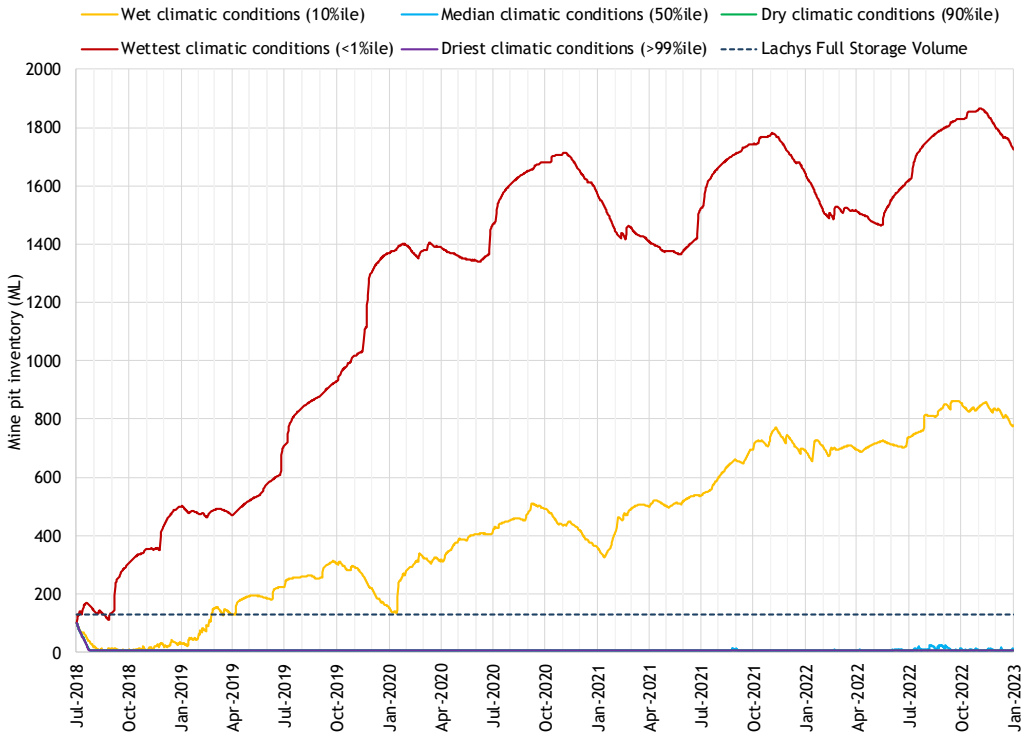
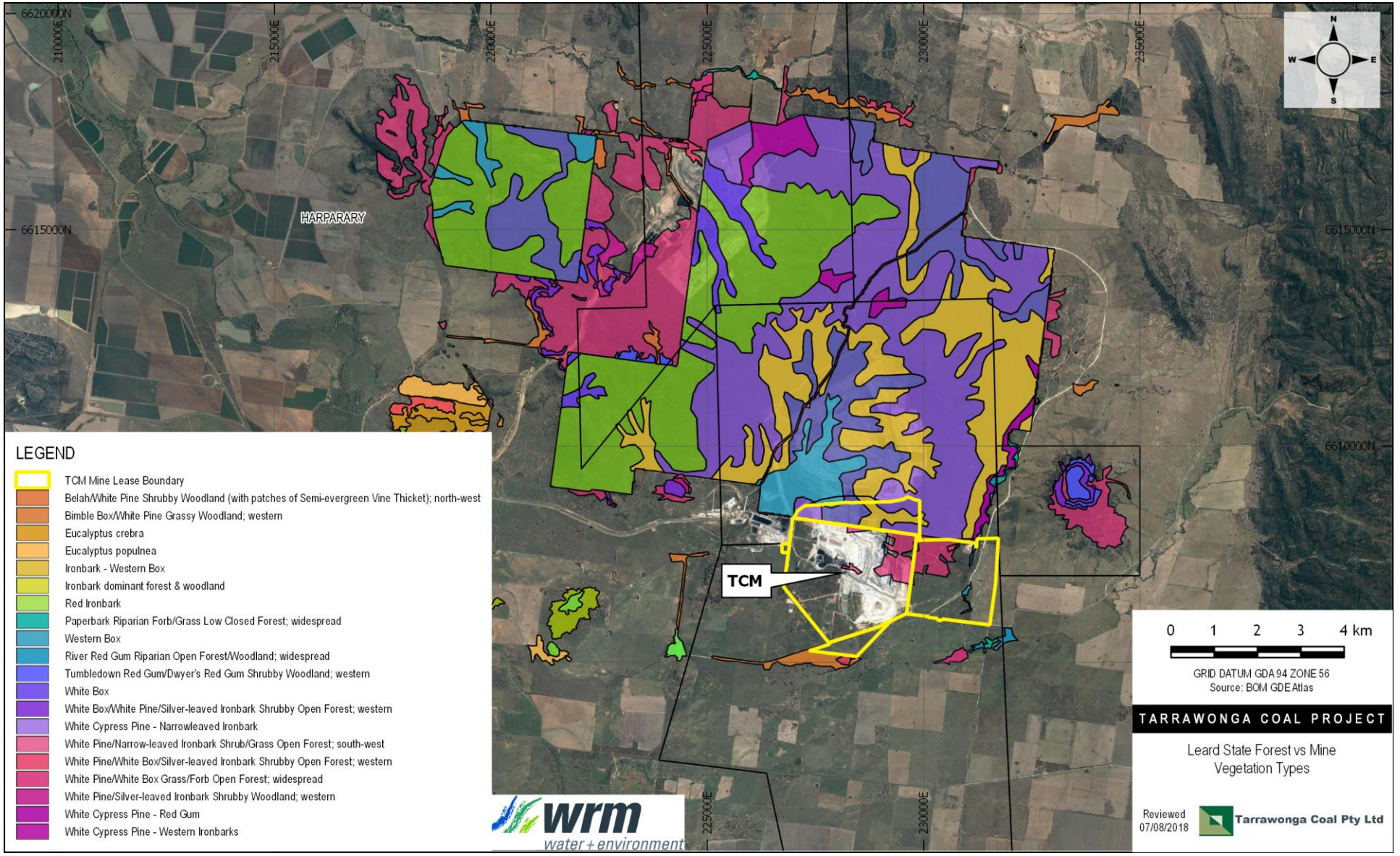
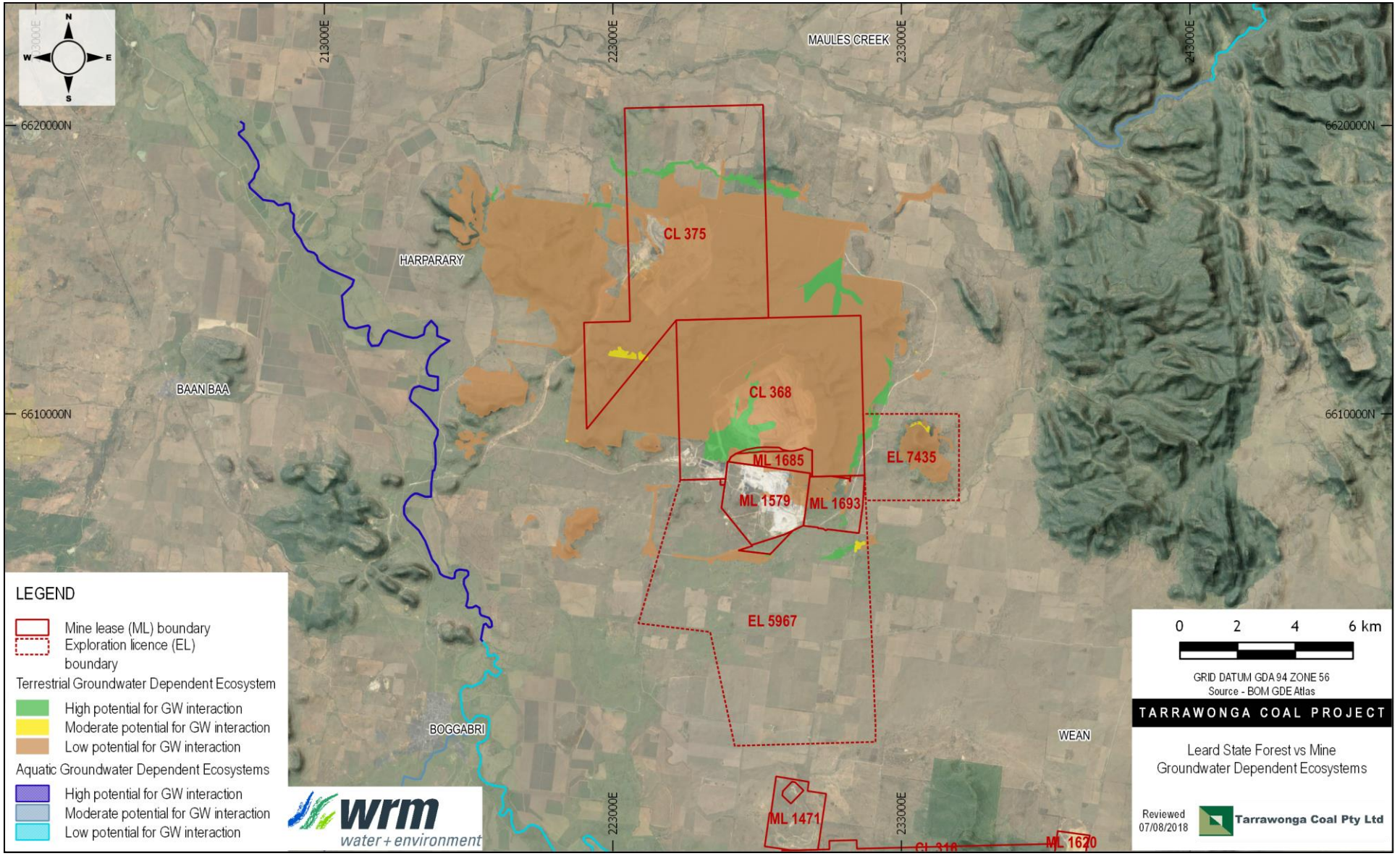


Figure B8 Forecast Mine Pit Water Inventory Results

APPENDIX C – GROUNDWATER DEPENDANT ECOSYSTEM DETAILS


6620000N
6615000N
6610000N
210000E
215000E
220000E
225000E
230000E
235000E
HARPARARY
TCM
N
W
E
S
LEGEND
TCM Mine Lease Boundary
Belah/White Pine Shrubby Woodland (with patches of Semi-evergreen Vine Thicket); north-west
Bimble Box/White Pine Grassy Woodland; western
Eucalyptus crebra
Eucalyptus populnea
Ironbark - Western Box
Ironbark dominant forest & woodland
Red Ironbark
Paperbark Riparian Forb/Grass Low Closed Forest; widespread
Western Box
River Red Gum Riparian Open Forest/Woodland; widespread
Tumbledown Red Gum/Dwyer's Red Gum Shrubby Woodland; western
White Box
White Box/White Pine/Silver-leaved Ironbark Shrubby Open Forest; western
White Cypress Pine - Narrowleaved Ironbark
White Pine/Narrow-leaved Ironbark Shrub/Grass Open Forest; south-west
White Pine/White Box/Silver-leaved Ironbark Shrubby Open Forest; western
White Pine/White Box Grass/Forb Open Forest; widespread
White Pine/Silver-leaved Ironbark Shrubby Woodland; western
White Cypress Pine - Red Gum
White Cypress Pine - Western Ironbarks
wrm
water + environment
0 1 2 3 4 km
GRID DATUM GDA 94 ZONE 56
Source: BOM GDE Atlas
TARRAWONGA COAL PROJECT
Leard State Forest vs Mine Vegetation Types
Reviewed 07/08/2018
Tarrawonga Coal Pty Ltd


213000E
223000E
233000E
243000E
6620000N
6610000N
MAULES CREEK
HARPARARY
BAAN BAA
BOGGABRI
WEAN
CL 375
CL 368
ML 1685
ML 1579
ML 1693
EL 7435
EL 5967
ML 1471
ML 1620
LEGEND
Mine lease (ML) boundary
Exploration licence (EL) boundary
Terrestrial Groundwater Dependent Ecosystem
High potential for GW interaction
Moderate potential for GW interaction
Low potential for GW interaction
Aquatic Groundwater Dependent Ecosystems
High potential for GW interaction
Moderate potential for GW interaction
Low potential for GW interaction
wrm water + environment
0 2 4 6 km
GRID DATUM GDA 94 ZONE 56
Source - BOM GDE Atlas
TARRAWONGA COAL PROJECT
Leard State Forest vs Mine Groundwater Dependent Ecosystems
Reviewed 07/08/2018
Tarrawonga Coal Pty Ltd

APPENDIX D – LETTER OF ENDORSEMENT

NSW GOVERNMENT Planning & Environment

Planning Services
Resource Assessments
Contact: Stephen Shoesmith
Phone: 9274 6164
Email: Stephen.shoesmith@planning.nsw.gov.au

Mr Sebastien Moreno
Environmental Superintendent
Whitehaven Coal Ltd
PO Box 600
GUNNEDAH NSW 2380

Dear Mr Moreno

Tarrawonga Coal Mine (MP 11_0047)
Appointment of Water Experts

I refer to your letter dated 4 June 2018 seeking the Secretary's approval for WRM Water & Environment (WRM) to review and revise the Water Management Plan for the Tarrawonga Coal Mine.

The Department has reviewed the curricula vitae of Mr Julian Orth and Mr Greg Roads of WRM and considers that they are suitably qualified and experienced to undertake the work.

Accordingly, the Secretary approves the appointment Mr Orth and Mr Roads of WRM to update the Water Management Plan.

Should you have any enquiries in relation to the above, please contact Stephen Shoesmith on 9274 6164.

Yours sincerely

Mike Young 5/6/18.
Director
Resource and Energy Assessments
as nominee of the Secretary

Department of Planning and Environment
320 Pitt Street Sydney 2000 | GPO Box 39 Sydney 2001 | planning.nsw.gov.au

APPENDIX E – CURRENT BOGGABRI-TARRAWONGA-MAULES CREEK COMPLEX (BTM COMPLEX) WATER MANAGEMENT STRATEGY